Long-Term Management Strategies for the Maintenance of Private Roads on Nantucket

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An Interactive Qualifying Project
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the
degree of Bachelor of Science

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17 December 2015

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Abstract

Of the 270 miles of roads on Nantucket, approximately 174 miles (or 64%) of them are privately owned. These privately owned roads are often poorly maintained due to a lack of effective long-term maintenance strategies, resulting in increased risk to public safety. The goal of this project was to evaluate long-term management strategies for the maintenance of private roads and to make recommendations for improvement appropriate for Nantucket. The team interviewed a number of Nantucket officials and homeowners, as well as several officials from other towns in Massachusetts. With the knowledge gained from these interviews, the team created a list of criteria which Nantucket officials can use to prioritize future road takings and suggested long-term management strategies.

Acknowledgments

We would like to extend thanks to the many people who lent their time and expertise to our project. Our sponsor, Kara Buzanoski, was extremely helpful over the duration of this project, providing insight into town practices and helping us reach out to other town officials. She not only took time each week to meet with us to ensure the project was on track, but she also provided tours of DPW facilities and some problem roads on the island.

Dominic Golding and Reinhold Ludwig, our project advisors, were also immensely helpful. They not only spent countless hours suggesting revisions to our report, but they also asked questions which broadened our view on the issues with private roads on Nantucket.

We would like to thank all of the people who set aside time for us to interview them, be it in person, over the phone, or through email. This project would not have been possible without the collective expertise of these individuals.

Finally, we would like to thank the Maria Mitchell Association for providing housing and Young's Bicycle Shop for providing bicycles for the duration of our stay on the island.

Executive Summary

Sixty-four percent of Nantucket's roads are privately owned and thus the abutters are responsible for maintenance. Frequently, these roads are in poor condition for many reasons including an unwillingness to pay for maintenance and a lack of proper knowledge of performing road maintenance. The deplorable condition of many of these roads causes slower response times by emergency personnel. In 2012, another Worcester Polytechnic Institute project team (Cocks, Corrigan, and LaRue, 2012) conducted research that resulted in a method for assessing road conditions to prioritize a list of thirty-eight private roads on the island. They did not, however, create a comprehensive list of quantitative criteria that the town could adopt when considering if a road should be taken and made public. Prior to our project, the Town of Nantucket did not have a method for managing the maintenance of private roads on the island or a quantitative method for prioritizing roads for taking.

The goal of our project was to evaluate long-term management strategies for the maintenance of private roads and to make recommendations appropriate for Nantucket's Department of Public Works (DPW). In order to reach our goal, we:

- Determined best practices in managing the maintenance of private roads in other comparable towns in Massachusetts;
- Evaluated current maintenance practices of private roads, with and without homeowners associations, on Nantucket;
- Evaluated the town's current plans for private road maintenance in order to suggest future strategies and priorities;
- Created a checklist of criteria which the town can use to identify whether a road should be taken or not; and
- Applied the checklist of criteria to select roads to demonstrate their use.

Prior to arriving on island we learned that the County of Nantucket had recently taken Boulevarde, which is used as a cut through from Surfside to the airport and thus is heavily used by the public. This taking was the first taking of many that the DPW plans to conduct in the next ten years in an effort to alleviate traffic in the downtown area. During our project, we interviewed twenty-three people, including local officials, homeowners, and other town DPW

directors about the maintenance of private roads and the reasons for taking private roads. Building on these ideas, we modified and expanded upon the criteria developed by the Nantucket Roads and Right of Way Committee in order to develop a quantitative list of criteria that we subsequently applied to three different private roads: Millbrook Road, Warrens Landing Road, and Somerset Road from Friendship Lane to Vesper Lane. These roads have either been the center of discussion among homeowners and the town, or are included in the DPW Capital Plan. Our broad categories for these criteria are:

- Importance to the traffic network,
- Public Safety,
- Homeowners Associations,
- Abutters, and
- Cost to the town.

Each of these categories we developed includes a set of sub-criteria that can be assessed quantitatively. Through field work including traffic counts, road condition evaluations, and evaluations using ArcGIS, we 'scored' each sample road against the criteria and created a protocol that Nantucket's DPW can use to prioritize takings. We recommend that the DPW apply our criteria and protocols to assess other roads considered for taking in the future.

Through our discussions with different stakeholders we also discovered other practices that Nantucket's DPW may be able to apply to increase maintenance efforts among abutters or homeowners associations. From our interviews of other seasonal town DPW directors we learned that they incentivize abutter maintenance, but on an entirely voluntary basis, with a snow plowing policy that states the town will only plow a private road that meets the standards set by the policy. Many Nantucket stakeholders whom we interviewed had mixed opinions about such a policy. Most of the town officials indicated that it would be a good idea to have a similar policy, but that it would be difficult to incentivize people to participate, especially on older roads that are not up to standard. Despite these concerns, we recommend that the Town of Nantucket draft and implement a snow plowing policy with standards that are adapted specifically for Nantucket. Since it is a voluntary program, it will not solve the maintenance issue. However, it may encourage some abutters to either strive to reach the required standards if their roads are not compliant, or to continue to maintain their roads if they are.

Lastly, we observed that not all abutters are aware of their responsibilities regarding private road maintenance. This is evident in the differing foci of the twenty-two homeowners associations on the island. Only half of the homeowners associations allocate a portion of their collected dues to road maintenance; the other half focuses on unrelated issues, and thus leaves their roads unmaintained. In addition to this, some homeowners have expressed concerns regarding a lack of knowledge on how to maintain their roads. This lack of knowledge causes abutters to ignore the worsening condition of their roads until they become completely impassable. If the town, either through a forum, brochure, or section on its website, were to inform the residents of their maintenance responsibilities and the different techniques used, more private roads on the island would be maintained by the abutters.

If Nantucket can prioritize private roads for taking, incentivize abutters to maintain their roads to a well-publicized standard, and educate abutters on how to reach that standard, then the conditions and safety of the private roads on the island may significantly improve. However, if the town continues to expect poorly informed and unmotivated homeowners to appropriately maintain their roads without any incentives or guidance, the situation will likely worsen, creating an increased threat to the safety of its residents. By adopting our recommendations, the Town of Nantucket would have a long-term management strategy for the maintenance of private roads that will improve their long-term condition.

Authorship

The team edited all sections of the document collaboratively. Overall, Allison Paquin was the primary writer, however the tables below define both the primary and secondary authors for each individual section. Andrew Mahn worked primarily with ArcGIS and produced all pictures and figures (unless otherwise cited). Kevin Ouellette led interviews and analyzed all traffic count and road evaluation data.

Authorship of the Main Report

Section	Primary Author	Secondary Author
1.0 Introduction	AP	-
2.0 Background	AP	-
2.1 Road Classification ...	AP	-
2.2 Managing and Maintaining ...	AP	KO
2.3 Nantucket's Management ...	AP	AM, KO
2.4 Summary	AM	-
3.0 Methods	AM	-
3.1 Objective 1	KO	AP
3.2 Objective 2	AP	-
3.3 Objective 3	AP	-
3.4 Objective 4	AP	-
3.5 Objective 5	AP	-
4.0 Findings	AP	-
4.1 Best Practices ...	AP	KO
4.2 Current Maintenance...	AP	-
4.3 Nantucket's Current Plan ...	AM	-
4.4 Taking Criteria	KO	AP
4.5 Criteria Application	KO	AM
4.6 Other Issues of Concern	AP	AM
5.0 Conclusions ...	-	-
Conclusion 1	KO	-
Recommendation 1	KO	-
Conclusion 2	AP	-
Recommendation 2	AP	-
Conclusion 3	AM	-
Recommendation 3	AM	-
Future Work	AP	KO

Authorship of Appendices

Section	Primary Author	Secondary Author
Appendix A	AP	-
Appendix B	KO	-
Appendix C	KO	-
Appendix D	KO	-
Appendix E	AM	KO
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Appendix G	AM	-
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1.0 Introduction

Massachusetts has over 36,000 miles of road. Approximately 82% of these roads are maintained by cities and towns. Due to the harsh New England weather, the lack of funding, and the complex hierarchy of jurisdiction, it is a challenge to keep roads well maintained. Eighty-eight percent of all Massachusetts' public roads are in fair or worse condition. Approximately 10% of Massachusetts roads are privately owned, although the percentage among towns varies substantially. Surprisingly, the total mileage of private roads is unknown because the state does not systematically collect these data. Many private roads in the state are in worse condition than the publicly-owned roads, in large part due to the fact that the costs of and responsibility for maintenance typically falls to the abutters along the roads.

Nantucket faces a larger problem than most other Massachusetts towns because of the mileage of private roads on the island. Of the 270.9 miles of road on the island, 173.5 miles (64%) are privately owned and maintained. Seasonal communities on Cape Cod have similar percentages of private roads. However, non-seasonal communities have significantly fewer. Many private roads in Nantucket do not meet generally accepted standards. Emergency vehicles often have difficulty traveling on these roads and emergency services worry that some properties may not even be accessible in the event of an emergency. These private roads are typically maintained by abutters, sometimes through one of the 22 homeowners associations on island. However, many abutters are unwilling to pay for maintenance necessary to keep the roads in a satisfactory condition.

Many towns in Massachusetts, including Nantucket, have bylaws which allow the town to repair private roads. Often this is done at the request of the abutters through a petition. However, each town requires a certain percentage of abutters to sign the petition. Nantucket, for example, requires 50%. Due to differing opinions on road maintenance and funding, the approval of the necessary percentage of abutters often cannot be reached.

Similarly, many towns in Massachusetts have bylaws allowing the town to take private roads, and Nantucket is no different. While taking roads gives these towns the most control over the maintenance of a road, it is an expensive option because many private roads have to be substantially improved to bring them up to town code. Furthermore, taking roads means the town has to pay for maintenance indefinitely, which can require raising property taxes.

The goal of this project was to evaluate long-term management strategies for the maintenance of private roads and to make recommendations appropriate for Nantucket. We interviewed representatives from other towns to determine the best practices for private road management from similar towns. Additionally, we assessed current practices and opinions in Nantucket by conducting interviews with town officials, homeowners, and other stakeholders. This information allowed the team to identify which practices were best suited for Nantucket. We used this information to create a checklist of criteria which the town can use to determine whether or not a private road should be taken. Finally, the team identified a select number of private roads on the island to use as examples of how to apply the criteria in the future.

2.0 Background

In this background, the team first gives an overview of roads in Massachusetts, including descriptions of the different types of roads. The team then briefly describes the legal liability faced by the owners of a road before segueing into a discussion about three different approaches towns take to maintain private roads and recoup the cost of repairs. The three approaches are: 1) abutters individually or collectively repairing and maintaining the private roads; 2) the town repairing the roads and recouping the cost in various ways; or 3) the town taking the road and accepting responsibility for its repair and maintenance. The team discusses the bylaws, policies, and procedures developed by comparable towns to implement these approaches before concluding with an examination of the current practices and controversies on Nantucket.

2.1 Road Classification and Management Responsibilities in Massachusetts

The state of Massachusetts has 36,384.24 miles of road which are divided into a complex hierarchy that determines which political jurisdiction, if any, is responsible for maintenance and repair (Massachusetts Department of Transportation and Office of Transportation Planning, 2015). Massachusetts' roads fall into four different functional classes and nine different jurisdictions (see Table 2.1). The Massachusetts Department of Transportation Highway Division (MassDOT) produces an end of year report, the *Massachusetts Road Inventory Year End Report*, which provides the mileage of roads by jurisdiction and functional class. Table 2.1 reports the total miles of road for each jurisdiction and functional class for the state of Massachusetts (Massachusetts Department of Transportation and Office of Transportation Planning, 2015).

Table 2.1: Massachusetts road mileage by jurisdiction and functional class

Jurisdiction	Functional Classes				
	Interstate	Arterial	Collector	Local	Total
MassDOT	574.53	2,192.37	190.12	56.88	**3,013.90**
City/Town Accepted	0.00	4,439.77	4,330.93	20,688.71	**29,459.40**
DCR	0.00	117.89	4.23	135.35	**257.46**
Massport	0.17	6.12	0.00	1.98	**8.27**
State Park	0.00	1.74	7.40	268.44	**277.58**
State Institutional	0.00	3.46	1.57	78.24	**8.27**
County Institutional	0.00	0.00	0.01	3.60	**3.61**
Combined Federal	0.00	3.36	6.85	97.17	**107.38**
Unaccepted	0.00	6.73	14.02	3,152.63	**3,173.3**
Total	**574.69**	**6,771.44**	**4,555.12**	**24,482.99**	**36,384.24**

(Massachusetts Department of Transportation and Office of Transportation Planning, 2015).

The roads described above are of three main types: public ways, statutory private ways, and private ways. Different entities are responsible for the maintenance of each of these road types.

Public ways are roads that were created for the benefit of the public. All of the roads mentioned in Table 2.1, except for unaccepted roads, fall into this category. Their maintenance is the responsibility of the public, whether it is the country, state, county, city, or town. The three main types of public roads are state highways, county ways, and town ways. The state, or more specifically, MassDOT, is responsible for the maintenance of the state highways. The towns are responsible for the portion of the county ways that pass through their town. Towns and cities are also responsible for the maintenance of town ways (Smithers, 2011). Public ways compose over

90.2% or 32,850.02 miles of the 36,384.24 miles of roads in Massachusetts. Towns and cities are the predominant jurisdictions with 29,459.40 miles (82%) of the 36,384.24 miles of roads within the state.

Statutory private ways are created for the benefit of an individual or group of individuals with the knowledge and approval of the public. These are roads listed as unaccepted in Table 2.1. A statutory private way is open to public use, but is the responsibility of the abutters to maintain the road (Smithers, 2011). Based on the *Massachusetts Road Inventory Year End Report* (2014), there is an average of nine miles of statutory private roads per town. In total, this category makes up 8.7%, or 3,173.3 miles of the 36,384.24 miles of roads.

Private ways are roads that were created by an individual or group of individuals without the approval of the town. As such, there is often limited data on these roads. Table 2.1, for example, does not have data on private ways. A private way is the responsibility of its abutters to maintain and repair, and cannot be used by the public without the consent of the homeowners (Smithers, 2011). The mileage of private ways in Massachusetts is not known precisely by MassDOT because state laws and regulations do not require that the creation and maintenance of these roads be reported to the state (Massachusetts Department of Transportation and Office of Transportation Planning, 2015). Sometimes, however, these data are available at the town level. During our assessment of other towns, we collected information about the proportion of the private roads. Based on the towns we sampled, seasonal communities have a higher percentage of private roads than year-round communities. Specific values are included in Table 2.2, along with some other information about the different towns.

Table 2.2: Summary of Compared Towns

Town	Annual Population	Seasonal Population	Square Mileage (land)	Annual Population Density (people/sq. mi.)	Seasonal Population Density (people/sq.mi.)	Mileage of Roads	Mileage of Private Roads	Percentage of Private Roads	Residential Tax Rates (Per $1000)
Barnstable	44,529	120,000	59.81	744.51	2006.35	461.24	190.05	41.20	$9.30
Dedham	24,716	-	10.60	2331.70	-	107.26	18.40	17.15	$15.87
Eastham	5,445	30,000	13.96	390.04	2149.00	104.02	62.00	59.60	$7.10
Franklin	32,836	-	26.63	1233.05	-	170.63	27.00	15.82	$14.84
Nantucket	10,856	50,000	44.97	241.41	1111.85	270.90	173.50	64.05	$3.61
North Attleborough	26,997	-	19.10	1413.46	-	132.02	4.74	3.59	$13.14
Wellfleet	3,500	17,000	20.47	170.98	830.48	206.29	110.83	53.73	$6.78

(Douglas, 2015), (Nantucket County, Massachusetts, 2015), (D. Santos, personal communication, November 19, 2015), (M. Hollowell, personal communication, December 3, 2015), (R. Cantoreggi, personal communication, December 10, 2015), (N. Andres, personal communication, November 30, 2015), (Nantucket Planning and Economic Development Commission, 2015), (Town of Wellfleet, n.d.), (Private ways: Road acceptance policy and procedures FAQ's, 2015).

Within the broad category of private ways there are subcategories. One of the main subcategories is paper roads. Paper roads are roads that exist in a deed or plan, but have not been created yet. The deed or plan determines who has the right to create, improve, and maintain the road. The rights are typically given to the individuals who require the road for access to their property (Atherton et al., 2009). A second subcategory is proprietors' ways. Proprietors are organizations or individuals that own land within the town. Proprietors' ways were created by proprietors to access common land. Historically, a proprietors' way was owned and maintained by the proprietors along the road. In most cases, the proprietors' entity split up into private ownership (Atherton et al., 2009). However, in Nantucket, the proprietor entity remained (Karttunen, 2008). This will be discussed further in section 2.3.

This project focuses on management of the maintenance of private roads which includes both statutory private ways and private ways. The maintenance of private roads is typically overlooked because of the complex hierarchy of road jurisdiction and the lack of funding at the local level. As explained in more detail below, many private roads are meant to be maintained individually and/or collectively by the owners of properties that abut the road, but it is common for abutters to be unaware of this responsibility or unwilling to act. With 3,173.3 miles of statutory private ways and an unknown mileage of private ways, there are many miles of road that are poorly maintained (Massachusetts Infrastructure Investment Coalition, 2006). This lack of maintenance is not only a safety hazard, but also a legal liability.

A road, whether it is public or private, must be maintained by its respective owner. If damage is caused by neglected maintenance, the owner is responsible. This is stated by Chapter 84 Section 15 of the Massachusetts General Laws:

> If a person sustains bodily injury or damage in his property by reason of a defect or a want of repair ..., and such injury or damage might have been prevented, or such defect or want of repair ... might have been remedied by reasonable care and diligence on the part of the county, city, town or person by law obliged to repair the same, he may, if such county, city, town or person had or, by the exercise of proper care and diligence, might have had reasonable notice of the defect or want of repair ..., recover damages therefor from such county,

city, town or person (Personal injuries or property damage from defective ways, 1693 & Supp. 1992).

In other words, road maintenance is required and the person or organization obliged to maintain the road is liable for injury or damage that is caused by any negligence. In this project, we focus on the obligations of homeowners and homeowner associations because they are primarily responsible for the maintenance of private roads.

2.2 Managing and Maintaining Private Ways

Road maintenance is a major issue because of the expanse of the road network and the complicated nature of the multiple jurisdictions. Excluding local roads, most roads in Massachusetts are in a fair condition or worse (see Appendix A for a classification of condition), as shown in Table 2.3 (Massachusetts Infrastructure Investment Coalition, 2006). The condition of local roads, defined as "minor roadways in neighborhoods used primarily for short trips," (Massachusetts Infrastructure Investment Coalition, 2006) are not rated in this table as the state is not required to collect this information.

Table 2.3: Road condition in Massachusetts based on functional class

Classification	Very Good	Good	Fair	Mediocre	Poor
Interstate	66.5%	5.1%	24.1%	4.0%	0.2%
Arterials	0.8%	5.0%	50.4%	33.5%	10.3%
Collector Roads	3.2%	10.4%	53.3%	24.4%	8.7%
Local Roads	N/A	N/A	N/A	N/A	N/A
Total	5.2%	7.3%	50.3%	28.1%	9.1%

(Massachusetts Infrastructure Investment Coalition, 2006).

Road maintenance is very important to the way of life in an area. According to the Massachusetts Infrastructure Investment Coalition (2006), "The quality of our roads has a tremendous impact on the economy and the quality of life in Massachusetts." When roads are

not maintained effectively and efficiently, the annual cost of travel increases. It is estimated that the cost to maintain a car driven on unmaintained roads is about $400 more per year than it is to drive a car on maintained roads. Unmaintained roads cause more tire wear, vehicle damage from hitting potholes, and lower fuel efficiency. This $400 annual increase per driver equates to roughly $1.2 billion per year that drivers in Massachusetts have to pay (Massachusetts Infrastructure Investment Coalition, 2006). This, however, is not the only issue. Poorly maintained roads may also fall into such disrepair that bodily harm can be caused by driving down them. In some cases, the level of disrepair impedes the travel of emergency vehicles, creating a major safety hazard for residents.

Preventive maintenance is the preferred approach because "studies have shown that a program of consistent preventive maintenance can reduce the life-cycle costs of a pavement surface by about one-third" (Massachusetts Infrastructure Investment Coalition, 2006). Unfortunately, a lack of funds forces most towns to focus on reactive rather than preventive maintenance (Massachusetts Infrastructure Investment Coalition, 2006). Typically, a town in Massachusetts receives most of its funding for road maintenance from the state through the Chapter 90 Program[1], but these funds may be used only for the maintenance, repair, and improvement of public ways and not private roads.

Due to the absence of state funding for private road maintenance, towns in Massachusetts use three different maintenance methods:

- Maintenance by abutters either individually or collectively;
- Maintenance by town with betterments assessed on abutters; and,
- Town taking, by which the town becomes the sole owner of the road and thus is responsible for maintenance.

2.2.1 Abutter Maintenance

A private road is generally the legal responsibility of its abutters since they are liable for any damage caused by neglected maintenance. Thus, one approach to managing private roads is

[1] Chapter 90 was enacted on March 23, 1973. It was created to fund Capital Improvement Projects through Transportation Bond Issues. There are specific guidelines for what the funds can be used for that include any maintenance on roadways, bike paths, and roadsides on public ways. This maintenance can include, but is not limited to, resurfacing, general repairs, work on drainage, sidewalks, curbs, and guardrails, roadside landscaping, and bike path construction or repair (Massachusetts Department of Transportation Highway Department, 2015).

for the town to leave all maintenance responsibility to the abutters. In some case, homeowners associations may take responsibility for the maintenance of private roads owned by its members. There are about 300,000 homeowners associations in the United States, which means about 53% of homeowners belong to a homeowners association (HOA-USA, 2015). The general role of a homeowners association is to create a sense of community for the neighborhood and also maintain all shared elements of the neighborhood. The extent of the required maintenance depends on the homeowners association. Some associations only have to worry about minor maintenance concerns whereas others have to maintain all aspects of their neighborhood, which would include the roads within their boundaries (HindmanSanchez, 2015). Whether there is a homeowners association or just abutters working together, a private contractor is generally needed to repair the road as necessary following the techniques and methods summarized in Appendix A (Town of Nantucket: Recently Asked Questions (RAQs), n.d.). With this management approach, the town would take on a passive role where at most it would encourage abutters to make repairs.

2.2.2 Town Maintenance

The second option is for towns to repair the roads themselves and try to either recoup the costs from the abutters or just cover the costs out of town funds. Massachusetts General Laws Chapter 40, Section 6N permits towns to assist in making temporary repairs to a private road. Section 6N reads as follows:

> Cities and towns may by ordinance or by-law provide for making temporary repairs on private ways. Such ordinance or by-law shall determine (*a*) the type and extent of repairs; (*b*) if drainage shall be included; (*c*) if the repairs are required by public necessity; (*d*) the number of percentage of abutters who must petition for such repairs; (*e*) if betterment charges shall be assessed; (*f*) the liability limit of the city or town on account of damages caused by such repairs; (*g*) if the ways shall have been opened to public use for a term of years; and (*h*) if a cash deposit shall be required for said repairs (Private ways; temporary repairs, ordinances or by-laws, 1975 & Supp. 1977).

This law provides a framework for towns from which to build their own bylaws for managing the maintenance of private roads, however, each individual town must determine the specifics of the resulting law. We identified four towns which have by-laws pertaining to the repair of private roads that align with Section 6N (Barnstable, Eastham, North Attleborough, and Wellfleet), and have interviewed representatives from two of those towns (North Attleborough, Eastham). There are two key areas in which the laws from each town differ: the percent of abutters who must petition the town to request repairs, and the assessment of betterments.

The number of abutters required for a petition is significant because the higher the necessary percentage of abutters, the more difficult it is to collect the necessary signatures. In Eastham, the petition must be signed by 100% of the abutters on the section of road to be repaired. Wellfleet, however, requires only 50% of abutters, while Barnstable and North Attleborough require a majority, or 51%. This being said, Wellfleet is not reliant on a petition from the abutters. This will be explained further later in this section.

When work is done to improve the condition of a private road, the value of the properties along the road may increase, which is called a betterment. Assessing betterments is when a town, in order to pay for the cost of repairs, charges the owner for the increase in property value caused by the repaired road. Eastham and Barnstable both assess betterments to offset the cost of repairing private roads. Wellfleet and North Attleborough, however, do not. North Attleborough, in particular, pays for repairs through the Town Highway Department Budget. While Wellfleet does not assess betterments for repairs, they do require the road to be available for public use indefinitely. In addition, signs must be posted that read “Private Road Public May Use at Own Risk.” (Terkanian, 2015).

A major limitation of the laws based on Section 6N like those described above is that the town cannot easily act until it is petitioned by the abutters. To address this limitation, Wellfleet wrote into its law that the Highway Surveyor may take an active role and approach the abutters to ask for permission to repair the road. If 50% of abutters agree, then the road can be repaired.

In 2014, the Massachusetts Senate passed an act specifically for Barnstable, described in Massachusetts General Laws Acts 2014, Chapter 339, which allows Barnstable to take an active role in private road management as well. This law appears to permit Barnstable to repair a private road without the consent of the abutters, but it does not allow for the assessment of betterments to recoup costs. Rather it is assumed the town will bear the cost, stating that “the

investment of public funds in the private way shall be obtained by grant or other acquisition by the town on behalf of the public" (An act relative to private road maintenance, 2014). Verification of this interpretation and examples of this and other laws are described in the findings section.

2.2.3 Taking of Private Ways

A third option towns use to manage the maintenance of private roads is taking them. When a town takes a road it accepts full responsibility for upgrading the road to current standards and for maintenance at the town's expense. This can be a very expensive option for the town, but sometimes it is necessary to guarantee the road will be properly maintained. Since this option is so expensive, it is not a decision that is taken lightly. In general, a private road built to code is more likely to be taken because the repairs required to meet town standards would cost less than they would for a road not built to code which may require major re-engineering and reconstruction.

In 1951, Massachusetts enacted the Subdivision Control Law, Chapter 41 Sections 81K through 81GG inclusively. One of the main reasons for the passage of this law was to allow for adequate vehicular traffic to reach new lots. If the access road to a new subdivision "does not have a sufficient width, suitable grades and adequate construction to provide for the needs of vehicular traffic in relation to the proposed use of the land" then the town Planning Board does not need to approve an Approval Not Required (ANR) Application (Department of Housing and Community Development, 2009). An ANR allows a subdivision to be built without being considered a subdivision, which means the town agrees that the plan meets standards and has acceptable access without any additional work to the access roads. If the ANR application is not approved, then the plan is treated as a subdivision and needs to go through further approval steps and the roads need to be brought up to standard to allow for adequate vehicular passage. The Planning Board in some towns discusses the situation with the fire department to determine if the road meets these standards, since these decisions are based mostly on opinion (Gloucester Planning Board, 2008). Roads that are not wide enough for emergencies vehicles can become impassable especially when another vehicle is on the road, leaving the homeowners further down the road stranded in the case of an emergency. A fire truck is typically ten feet wide and a ladder truck generally needs sixteen feet of vertical clearance. Because of this, the American Planning

Association, Massachusetts Chapter and the Home Builders Association of Massachusetts (2011) recommend that roads should be at least sixteen to twenty feet wide. These requirements are for creating new subdivisions, but they can also be applied when determining whether or not a road should be taken.

Many roads built before 1951, when the Subdivision Control Law was enacted, however, do not meet these standards (Perry, n.d.). A road built before this law was enacted is considered an 'ancient way' and all of these roads are determined to be statutory private roads unless the abutters can prove that it belongs within a different classification (Dawson, 2005). By giving the road this classification it allows the public to continue using the road, but assigns all maintenance and upgrade responsibilities to the abutters (Dawson, 2005). Since the abutters are in charge of upgrades, the road is typically not repaired to meet current roadway standards. If they fail to meet these standards then the Planning Board may choose not to designate the road 'public' (Dawson, 2005). These requirements force most roads that were created before 1951 to remain private and thus the abutters remain responsible for their maintenance and upgrades.

Given these difficulties, not all town officials and DPW directors believe that they have an obligation to take private roads, but many towns within Massachusetts do have laws in place that allow them to take a private road, making it public. In our initial sample of towns, we found three (Dedham, Franklin, and North Attleborough) that have bylaws regarding the taking of private roads.

The towns in Massachusetts that we have researched that have a clear method for taking private roads require abutters and affected individuals to sign a petition requesting that their road be considered for taking. Once these petitions are submitted, a selection committee will decide whether the road should be taken or not. Many of the towns that we researched do not have clear criteria to determine if a road should or should not be taken. As a result, the process varies year to year and town to town. In an effort to standardize this process, the Town of Dedham created a new method for taking private roads that was approved at town meeting in March of 2015. The "Road acceptance policy and procedures" (2015) article lists seven criteria that are used to prioritize which roads will be taken (Table 2.4).

Table 2.4: Criteria used to determine of a private road will be taken

Criteria Number	Criteria
1	Leads to a public facility
2	Intersects with 2 public ways or contains private way segment within a public way
3	Dead end road that intersects a Public Way with a length greater than or equal to 200 feet with a minimum of 5 residences with access to Private Way
4	Dead end road that intersects a public way with a length less than 200 feet and/or less than 5 residences with access to Private Way
5	Intersects with 2 Private Ways, Intersects with a public way and a private way, or dead end which intersects with a private way
6	Private Ways constructed pursuant to Planning Board approval under the Subdivision Control Law where the Planning Board waived or relaxed standards for roadway construction upon request of the applicant. Such private ways shall be classified in Group 6 notwithstanding how they might otherwise be classified as set forth above.
7	Private Drives

(Road Acceptance Policy and Procedures, 2015).

According to this newly accepted policy, any roads that are in groups one, two, and three are more likely to be taken than four, five, and six. This was determined based on their benefit to the general public rather than just the people living on them. Any roads that are in group seven are not considered for taking because they only benefit a single household. Dedham places all roads built before the 1951 Subdivision Control Law in group six because they would cost the town significantly more to take than a road that meets these standards and only requires basic road maintenance.

The next concern with many programs considering road taking is who will pay for the necessary repairs. Some towns require the abutters to pay for the repairs needed to bring a road up to standard before the road can be taken. Other towns pay for the repairs once the road is taken. In most situations, Dedham would pay for one hundred percent of the necessary repairs if the road were to be taken (Private ways: Road acceptance policy and procedures FAQ's, 2015). In contrast, North Attleborough requires that the abutters repair the road so that it meets specifications before it can be considered for taking (M. Hollowell, personal communication, September 21, 2015).

Some town officials believe they are obligated to take private roads. In the *MetroWest Daily News*, Riley (2013) wrote an article discussing the issues that surround private roads. He said the Town of Franklin has an especially good method for taking these private roads because Brutus Cantoreggi, a previous DPW Director, strongly believed that private ways were built with the knowledge that they would eventually be public ways so the town had an obligation to take these roads (Riley, 2013).

Taking roads as a part of a town's road maintenance plans may be pursued, but is often the most expensive option. In addition to obtaining any necessary easements, the town also takes on responsibility for all long-term maintenance costs incurred, including both regular maintenance and seasonal maintenance, such as snow plowing. A limited budget may force towns to act based on immediate need, rather than preventative maintenance; this limitation may mean that towns simply cannot afford to take many private roads. For this reason, the necessity to prioritize road takings is justified, and is why certain private roads may not be considered for taking.

Towns in Massachusetts generally rely on abutters to maintain private roads, though this is often not as reliable as is necessary for the safety of those using the road. We identified three management approaches which can be used to improve the maintenance of private roads, however we need to know whether Nantucket has already tried any of these techniques. Thus, in the next section, we identify Nantucket's current management practices and the controversies the island faces.

2.3 Nantucket's Management Techniques

2.3.1 Nantucket's Private Roads

Nantucket is a small island 30 miles off the coast of Massachusetts. Contained within its 44.97 square miles of land (Nantucket County, Massachusetts, 2015) are 97.4 miles of public road and 173.5 miles of private roads (Nantucket Planning and Economic Development Commission, 2015) which includes 2.25 miles of proprietors' ways (N. Porter, personal communication, November 2, 2015). This means that private roads, many of which are either sand or dirt, make up 64% of the island's total road mileage (Nantucket Planning and Economic Development Commission, 2015). Putting this into perspective is difficult because it is hard to collect reliable data on private roads from other towns in Massachusetts. However, by contacting

DPW directors from each of the towns we researched, we collected accurate private road mileage (Table 2.2). Based on our six sample towns, year-round towns have fewer private roads than seasonal towns on Cape Cod. However, all of the towns we have researched have a smaller percentage of private roads than Nantucket. Figure 2.1 shows a map of the different types of roads on Nantucket.

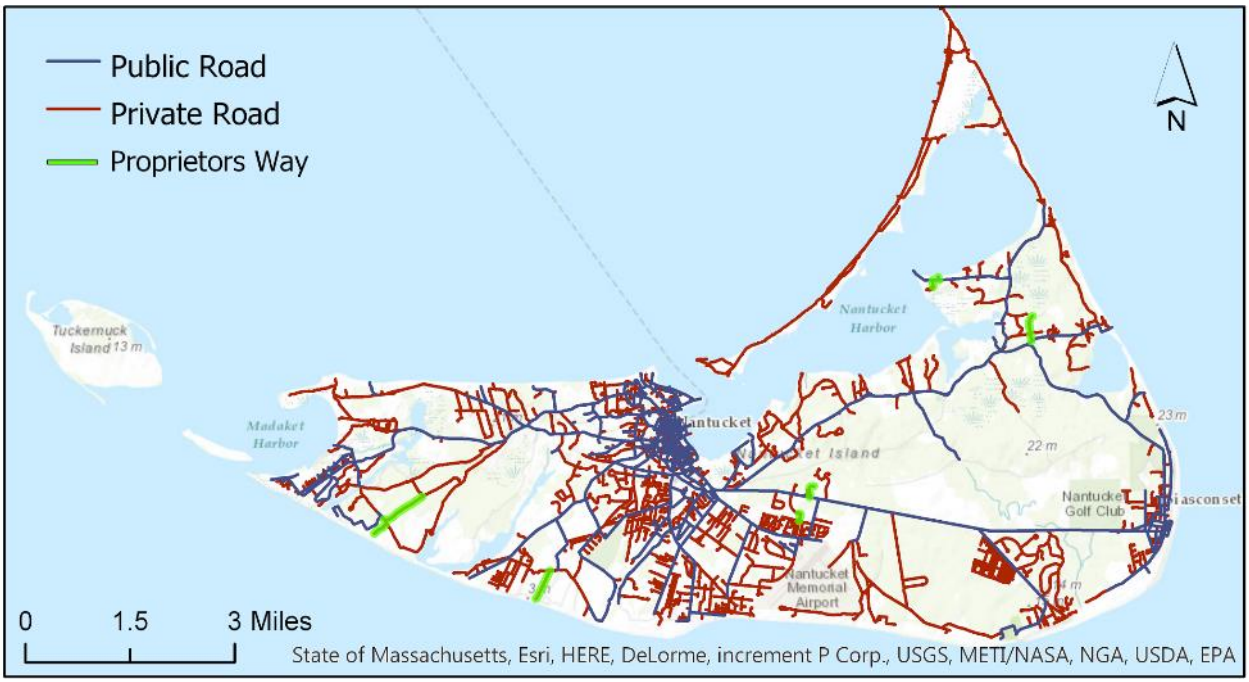

Figure 2.1: Road ownership on Nantucket

Private roads in Nantucket are handled differently than private roads in the rest of Massachusetts. For example, the proprietor entity owning proprietors' ways still exists. The town is now the majority stakeholder and, because of this, the general public has the right to use these ways. However, Massachusetts General Laws Chapter 82 releases the town from the responsibility of maintaining these roads (Atherton et al. , 2009), meaning maintenance responsibilities of proprietors' ways are often undetermined.

Another difference in Nantucket is that many of the roads created before 1951 have not been taken by the town. This means these roads now have statutory private way status, allowing the public to use the road, but requiring abutters to maintain them. According to Woodward (1990), there are also three factors that give the public the right to use a private road, so most private roads, whether statutory or not, are required to allow public access. These factors are:

> If the town owns a lot on a private road, they say, it may veto any closing that limits access to the land. If the public has been allowed to freely use the road for 20 years or more, they have a claim to perpetual rights to pass and repass over the road. If the Planning Board has approved a subdivision and required certain access points, the town may prohibit the closing of these defined entrance roads.

This has given rise to abutters voicing concerns regarding the usage of their roads by the public. One such concern is that there may be legal barriers to enforcing laws on private roads. A speeding ticket, or even driving under the influence whilst on a private road, may not be easily enforced (Woodward, 1990). Other concerns include increased traffic in the area, and increased wear on the road.

Another issue with private roads on Nantucket is that many of the private roads were built before the town had restrictions on road design, and as such they were generally created with a single car in mind, resulting in extremely narrow roads with sharp turns. This is an issue for emergency equipment, as portions of the roads can be impassable, creating a major risk to the safety of residents further down the road. This issue is compounded by poor maintenance, resulting in encroaching vegetation, potholes, and other defects. For example, in 2003 there was a pothole on Monohansett Road, a road near the airport, which was large enough to be described as a gully. Suzanne Parks was quoted saying “The other day I went out, and saw an SUV come through it fast...it’s a wonder he didn’t flip over...A couple of cars were afraid to go through it. I saw them stop and then turn around and go back.” (Kinsella, 2003). Figure 2.2 shows two examples of similar potholes: one on Somerset Road and the other on Rugged Road.

a) b)

Figure 2.2: a) A pothole on Somerset Road and b) a large depression on Rugged Road

In addition to this, there are many logistical issues with the private roads on the island, including a lack of signs and the existence of several paper roads. These issues are important because even if a road is passable, emergency personnel might have trouble finding a house on a poorly marked road. Additionally, they might get stuck because a road that exists on a map either does not actually exist or ends before it does on the map.

2.3.2 Nantucket's Current Regulations

Abutters' Maintenance

Nantucket has very few laws concerning the maintenance of private roads on the island. Like many towns in Massachusetts, the abutters are responsible for maintaining their road. In some situations, a homeowners association organizes maintenance of the roads within their area. The Nantucket Subdivision Rules and Regulations govern the construction of new roads and the creation of a homeowners association if the roads will remain private after construction is complete. The following discussion includes details about the specific requirements for new subdivisions on Nantucket.

Private roads and ways on the island are partially covered by Massachusetts General Law Chapter 41 § 81, also known as the Subdivision Control Law. Its purpose, generally speaking, is to ensure the safety of a town or city's inhabitants by regulating the construction of private ways as they apply to subdivisions. (Purpose of law, 1953 & Supp. 1985) These subdivision control

measures can be used by planning boards in order to ensure that subdivisions are appropriately accessible by public ways.

The Nantucket Subdivision Rules and Regulations sets a guideline for all new subdivisions on Nantucket based on the Massachusetts Subdivision Control Laws. When a new subdivision is proposed the first thing the Planning Board requires is that the existing ways the subdivision will use as access meet the standards set for any new roads that will be added. There are different standards for the different functional classes of roads that can be created. The functional classes include minor subdivision streets and secondary subdivision streets. A minor subdivision street is for the use of the abutters and is not meant for through traffic. A secondary subdivision connects minor streets to major streets and other community facilities. Table 2.5 shows the different classifications of roads and the standards laid out for each.

Table 2.5: Minimum standards for the types of streets in Nantucket

Type of Street	Width of Layout	Width of Roadway	Minimum Centerline Radius	Maximum Centerline Radius	Minimum Centerline Grade	Minimum Curb Radius at Street Intersection
Secondary	40’	22’	300’	6%	0.5%	25’
Minor	40’	20’	200’	10%	0.5%	15’

(Nantucket Planning Board, 1999).

There are also rules for dead end streets that specify that the maximum length cannot exceed one thousand feet and that there must be an exterior radius at the end, of at least sixty feet that vehicles can use to turn around. Within a rural location the standards may be modified to maintain the character of the land. The board uses the following criteria to determine if the road requirements should be waived:

- zoning and density of land use;
- number of lots and probable traffic volume in the proposed subdivision;
- applicable covenants restricting future density increase (e.g., one dwelling per lot);
- projected future development likely to use road;

- other public uses of the road (e.g., beach access);
- road length; and,
- design of the road and of the development with respect to preservation of open space, scenic amenity, and other conservation measures (Nantucket Planning Board, 1999).

The final major requirements for roads in a new subdivision pertain to public access of the area. The access roads are required to have "sufficient width, suitable grades and adequate construction to provide for vehicular traffic and to ensure direct ingress and a rapid response time for emergency vehicles" (Nantucket Planning Board, 1999) Also the public needs to have legal right to access these ways.

The 1991 revision to the Nantucket Subdivision Rules and Regulations added that if the roads within a new subdivision will remain private or if there is common land within the subdivision, the Planning Board requires that a homeowners association is formed and that a fund is set up to provide financial support necessary for road maintenance in the future (A. Vorce, personal communication, December 10, 2015). The only requirement for this fund is that the initial funds cannot be used until 25 years after completion of the project and it can only be used for the maintenance of a road within the boundaries of the homeowners association. Before those 25 years, the homeowners association is required to assess dues and fund road maintenance (Nantucket Planning Board, 1999).

Roads that are within new subdivisions are required to be maintained by the homeowners association created during the construction of the subdivision. Private roads that were constructed before the 1991 revision of the Subdivision Rules and Regulations were put in place do not typically have a homeowners association that is required to do maintenance (A. Vorce, personal communication, December 10, 2015). In these situations, the abutters are required to maintain the road themselves.

Town Maintenance

A chapter on Streets and Sidewalks is written into Nantucket's Town Code, and makes provisions for private roads and ways on the island. Chapter 127, Article VIII, titled "Private Road Betterments" was adopted on April 13, 1998 and approved later that year on July 31, 1998.

The article's intention is to create a system where requests may be made to have the city perform repairs on privately-owned roads. Article VIII specifically authorizes Nantucket's Board of Selectmen to arrange the repair of private roads within the town. Specifically, performing "grading, drainage, paving, resurfacing and curbing" work on private roads are all explicitly covered under §127.

While Nantucket's Town Code's "Private Road Betterments" act creates a partial framework for the town's maintenance of private roads, the article was not designed to address the majority of private roads in need of repair or maintenance. While the article's overall intent is to provide a means for private road owners to obtain needed repairs, the article itself makes the process to do so cumbersome for private road abutters (Town of Nantucket, MA, 1998). Since the manpower and financial resources of the Department of Public Works is finite, the act is better viewed as a last resort for those owning property on private roads.

When the abutters of a private road choose to utilize the "Private Road Betterments" act, there are barriers that must be overcome for the town to consider making repairs. The Board of Selectmen are given the exclusive right in part B to determine whether or not repairs may be undertaken for the factors of "public convenience and necessity." Arguably, many of the private roads in need of repair are *necessary* to repair due to impeded access by emergency vehicles. However, the decision by the Board of Selectmen is only one requirement to fund the repair of a private way. In addition, at least 50% of abutters must agree that repairs are necessary; such abutters must also prove through documentation that they represent 50% or greater ownership of the road (Town of Nantucket, MA, 1998).

The Office of the Town Manager for Nantucket discusses the use of the Private Roads Betterment law on their website. Quoting Articles III and VIII of the Town Code, they remind residents that the town is generally not responsible for non-public ways. Furthermore, the town states that "rarely does the required percentage of abutters agree to the assessment." (Town of Nantucket: Recently Asked Questions, n.d.) While the town suggests that abutters collaborate to hire a contractor to perform repairs instead of the Department of Public Works, not all residents may agree to share the cost of repairs when they believe the road is the town's responsibility. The town has also stated on its Recently Asked Questions page that even if the road is frequently used by the public for travel, they are not responsible for the conditions of the road "...without the required abutter approvals for the betterment assessment" (Woodward, 1990).

Town Taking

There are a few areas on the island that seem to be a continuous problem for the public. The recurring roads mentioned in the *Inquirer* year after year are Boulevarde, Monohansett Road, Okorwaw Avenue, and Lovers Lane. These roads are commonly used by the public to get to the municipal airport from the Surfside area. These roads are shown in Figure 2.3.

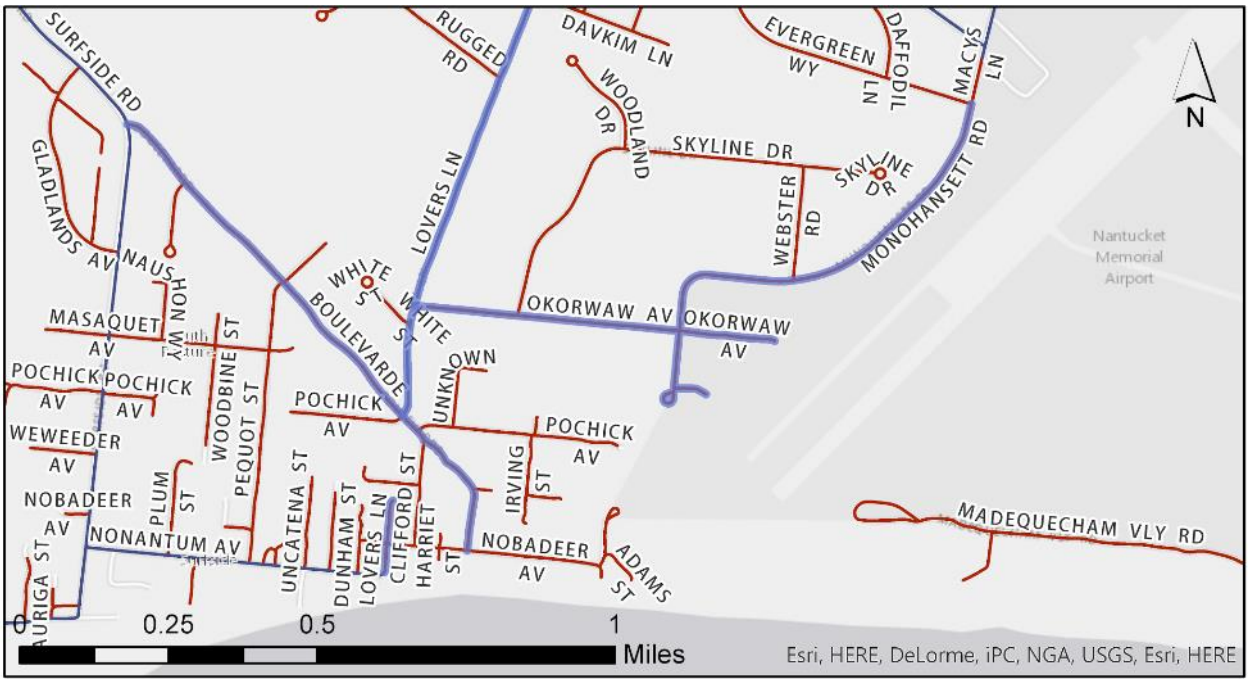

Figure 2.3: A map showing Boulevarde, Okorwaw Avenue, Lovers Lane, and Monohansett Road

The roads were first mentioned in the 1994 article, “DPW targets 8 private roads for $185,000 in repairs” because the town planned to repair them to improve school bus travel routes. Akasie (1994) quoted Commissioner Tim Soverino saying, “‘I know there’s going to be criticism, but we have to start somewhere. If we don’t, we’ll still be talking about this four years down the line.’” Many criticized the idea of spending town money on private roads. The next reference the *Inquirer* makes to these roads was in 2003, not four years as Soverino predicted, but nine years later. The roads were still in the same deplorable condition as in 1994. According to Kinsella (2003) one of the main reasons these roads are not maintained is because “no private association exists with the responsibility to keep up the condition of the roads in question.” The town decided that these roads should be taken, but they needed approval of the abutters beforehand (Kinsella, 2003). The last time these roads were mentioned in the *Inquirer* was 2009. The

conditions of the roads had apparently deteriorated even further. Jeff Willet, the former DPW director, "…indicated the roads will not be plowed next winter due to their current condition, and school buses no longer travel down any of them" (Graziadei, 2009). The condition of these particular roads continued to be a concern in 2013. The Nantucket Memorial Airport Master Plan of 2013 recommended that the town take these private roads in order to address the problem (Jacobs Engineering, 2013). The homeowners are unable to keep up with the necessary maintenance especially because there is only a residents association in the area, which is not required to perform road maintenance like a homeowners association. These issues made it a necessity for the town to take the roads. During the April 2015 town meeting Boulevarde was taken and there is a plan to take Monohansett Road, Okorwaw Avenue, and a section of Lovers Lane to complete the cut through between Surfside and the airport.

Based on how long it took the town to address the issue with these roads, taking has not been a first step for road maintenance on Nantucket. However, with the increase in traffic each year, the town is discussing methods to alleviate traffic in some of the worst areas. After the successful taking of Boulevarde, the town is starting to consider takings as an option for private road maintenance. This will be discussed further in Findings, section 4.3.

2.4 Summary

On Nantucket there are a significant number of private roads. It is the responsibility of the abutters to maintain them; however, these duties are often neglected. Despite the town having a law allowing it to repair private roads in need, the conditions required are rarely met. This results in dangerous driving conditions, potentially preventing emergency personnel from reaching a home in need. The town's current technique for managing the maintenance of private roads is not working, and so the team identified three approaches used by other Massachusetts towns. We identified additional details of the approaches taken by other towns in the management of the maintenance of private roads, and will then develop a method to identify which approaches might be appropriate for particular roads or road segments on Nantucket. We have also created a list of criteria which the town should use when considering taking a road. Our method for developing and implementing these are discussed in the Methods chapter.

3.0 Methods

The overall goal of this project was to evaluate long-term management strategies for the maintenance of private roads and to make recommendations appropriate for Nantucket's Department of Public Works based on this evaluation. To accomplish this goal, we:

- Determined best practices in managing the maintenance of private roads in other comparable towns in Massachusetts;
- Evaluated current maintenance practices of private roads, with and without homeowners associations, on Nantucket;
- Evaluated the town's current plans for private road maintenance in order to suggest future strategies and priorities;
- Created a checklist of criteria which the town can use to identify whether a road should be taken or not; and
- Applied the checklist of criteria to select roads to demonstrate its use.

These objectives are summarized in Figure 3.1.

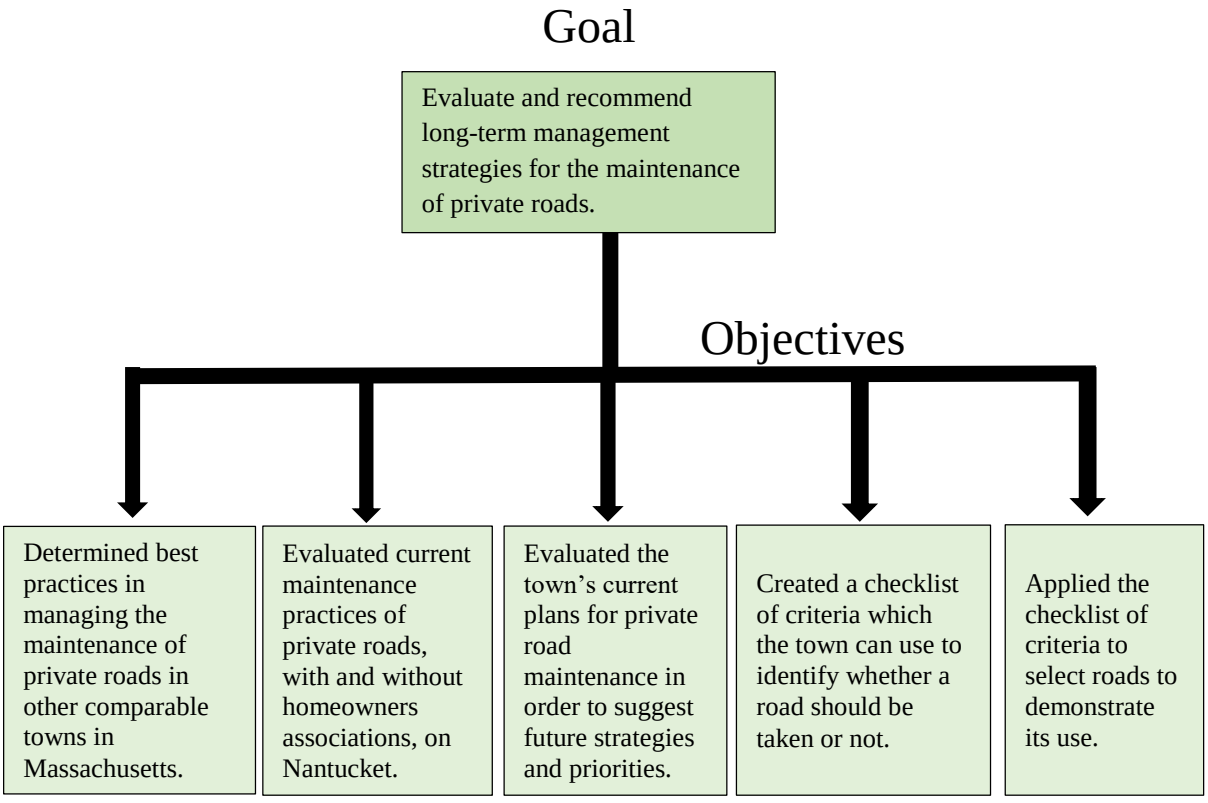

Figure 3.1: Objectives overview

We conducted in-depth qualitative interviews with a variety of experts and stakeholders on the island. These interviews followed the generic protocols described below:

- **Sourcing Interviewees:** Through background research we developed a list of potential interviewees. We expanded this set of interviewees through communication with our sponsor, Kara Buzanoski, the director of the Nantucket Department of Public Works (DPW), and recommendations from other interviewees; we thus developed a larger sample using the snowball effect. This method relied on the idea that the interviewee who is knowledgeable in the subject area would know of other potential contacts who could provide valuable insights for the team.
- **Initial Contact:** The team contacted potential interviewees by either email or phone to determine whether they were willing to be interviewed. If they were willing, a date, time, and location were set for the interview. Face to face interviews were preferred, but when this was not possible we arranged a phone or email interview.
- **Ethical Considerations:** Every interview conducted by the team began with a member reading the formal preamble, shown in Appendix B, Section 1, to the interviewee. This preamble explained the purpose and goals of the project, and the interviewee's right to skip a question or stop the interview entirely for any reason. The team then discussed what level of confidentiality the interviewee desired, and whether the team could use direct quotes from the interview. The team also explained that if a quote was used, a copy of the section from the final report containing the quote would be sent to the interviewee so that he/she could review and confirm that the use of the quote aligned with what the interviewee intended.
- **Preparations:** The team conducted background research on the individual in order to compose a set of questions that were specific to the interviewee and their department or association from which to build the interview script. A standard script is shown in Appendix C Section 1 and department specific questions are in Appendix C Section 2.
- **Conducting the Interview:** Each interview lasted 30 minutes to an hour. One member of the team led the discussion while the other two recorded detailed notes of the conversation.

- **Analysis:** After all the related interviews were conducted, the common topics, areas of concern, and other relevant information was collected and summarized to help the team understand the overall viewpoints of the stakeholders.

3.1 Objective 1: Determined Best Practices in Managing the Maintenance of Private Roads in Other Comparable Towns in Massachusetts.

The team began preliminary fact-finding interviews with representatives from certain towns in Massachusetts in order to understand how these towns compare to Nantucket. Barnstable, Eastham, and Wellfleet were chosen because, like Nantucket, they are largely seasonal communities and had documentation relating to private road maintenance on their town websites. Dedham and Franklin were chosen because they have well defined approaches to road takings. North Attleborough was chosen because it is the hometown of a member of the team and has policies for the maintenance and taking of private roads. In every case, the team contacted the DPW director of the respective town by email.

The team's first email to the interviewee included the informal preamble shown in Appendix B, Section 2 a brief explanation of our reason for contacting the interviewee specifically, a few questions for the interviewee, and a closing statement which included how the interviewee could contact us. Our goal with these interviews was to clarify and expand upon information the team found online about the town's practices. Examples of some of the topics discussed were:

- The number of private roads in town;
- Clarification of specific points in the town's bylaw;
- Examples of maintenance or taking practices in action; and the
- Funding methods used to offset taking or maintenance costs.

We received responses from Mark Hollowell, DPW Director for North Attleborough, Neil Andres, DPW Superintendent for Eastham, and Robert Cantoreggi, DPW Director for Franklin.

Midway through our time on Nantucket, we followed up with the representatives of these towns (except for North Attleborough) through phone interviews using the interview protocol described above and a script similar to the general script in Appendix D. The purpose of these interviews was to further clarify certain practices in these other towns, building on the background research of Nantucket's current operations. Another reason for these interviews was

to verify the information we found during our background research. North Attleborough was excluded because we had only one further question for the DPW director which was answered in an email.

The team also interviewed Nantucket's Fire Chief Paul Rhude because of his previous experience working in Barnstable. The information he provided was used to supplement the information given by DPW Director Santos.

3.2 Objective 2: Evaluated Current Maintenance Practices of Private Roads, With and Without Homeowners Associations, on Nantucket.

We conducted extensive background research on Nantucket's current private road management practices online prior to our arrival on the island. Once on island, we extended our background research using sources suggested by interviewees. Examples of these documents include the Traffic Rules and Regulations and the Subdivision Rules and Regulations, which were mentioned during our interview with Mike Burns and are located on the Nantucket Planning and Land Use Services (PLUS) page on the town website.

This background research was supplemented by a number of interviews. A complete list of the interviewees is shown in Appendix E. The team interviewed representatives from the Department of Public Works, the Nantucket police and fire departments, the Board of Selectmen, and the Assistant Town Manager in order to understand current road maintenance practices within Nantucket. We also discussed practices used in other towns in order to determine whether these practices had been considered in the past, or if they could be considered for the future. For each interview we asked specific questions based on each person's position within the town. These questions are outlined in Appendix C, Section 2. Appendix E shows the topics we discussed with each department and association that we interviewed. Kara Buzanoski was our project sponsor, and participated in weekly meetings with our team. Deputy Fire Chief Ed Maxwell was interviewed because of his knowledge of the roads on Nantucket, and Police Chief William Pittman was interviewed for a similar reason. Assistant Town Manager Gregg Tivnan was interviewed based on his knowledge of town practices.

We also interviewed a variety of stakeholders, including a real estate agent, and Nantucket's property tax assessor. The goal of these interviews was to determine how living on a private road affects property values and property taxes.

We also interviewed representatives from the Wannacomet Water Company and the electric company. Each of the above groups use many of the roads on the island as they provide utilities and services to island residents. Through these interviews we learned how easements on private roads have been handled historically, how they are handled now, and the issues caused by poor maintenance.

The team next focused on homeowners associations as they are the organizing element for the homeowners in the area. We interviewed members of the Civic League, the entity which represents all of the homeowners associations on the island, in order to understand current road management practices, common issues with private roads, the level of involvement in maintaining roads, and the opinions on the different management strategies the town could implement within the homeowners associations in general. We contacted presidents of specific associations for the following reasons: the Madaket Resident and Siasconset Association were recommended because of their involvement in town government, the Cisco Civic Association was recommended because of the effectiveness of their road maintenance practices, and the Surfside Association was recommended because of their recent involvement in the taking of Boulevarde and the eventual takings of Lovers Lane, Okorwaw Avenue, and Monohansett Road.

Through these interviews we gained a general understanding of the strengths and weaknesses of the current practices on Nantucket, and whether stakeholders on the island support or reject some of the proposed strategies. Appendix E shows the topics discussed with the team's interviewees. Once we collected the information we were able to define different management strategies that were ideal for different situations present among private roads on the island.

After interviewing the five homeowners associations we had a better understanding of the crucial information needed from each association. Knowing this, we contacted the presidents of the remaining seventeen homeowners associations (a complete list of homeowners associations and their presidents is included in Appendix F) using our typical email communication method and asked the following questions:

- What percentage of the homes in your association's area are dues-paying members?
- What are your association's annual dues?
- What percentage or amount of these dues goes towards road maintenance?

We also asked these questions during our interviews, so we collected this information from every association that responded. This allowed us to make a table comparing all the homeowners associations depicting how much they spend on road maintenance each year (Appendix G). We then went to a number of the association's roads and took pictures to visually represent how well maintained the roads in each association were and how this compared to their dues.

3.3 Objective 3: Evaluated the Town's Current Plans for Private Road Maintenance in Order to Suggest Future Strategies and Priorities.

Shortly before arriving on island we discovered that Boulevarde was taken during the April town meeting and that the Nantucket Department of Public Works had a ten year capital plan outlining the taking of other roads and bringing them up to town standard. We attended a Capital Program Committee meeting, at which Kara Buzanoski presented the fiscal year 2017 plan, in order to observe what support or opposition the plan received from the committee, if any, and to see how the different organizations worked together. We interviewed Lee Saperstein and Allen Reinhard, members of the Roads and Right of Way Committee to learn more about why the specific roads outlined in the plan were being taken ahead of other roads. We also discussed with them the concerns of the public with these takings and the conversation that surrounded the takings.

The team also interviewed Transportation Planner Mike Burns in order to further understand the town's current and future plans. He pointed the team to the 2016 Nantucket Regional Transportation Plan.

To get more information about the public opinion of the potential takings and other town plans, we included these as discussion topics in the homeowners association interviews described in section 3.2.

3.4 Objective 4: Created a Checklist of Criteria Which the Town can use to Identify Whether a Road Should be Taken or Not.

Our main deliverable for the project was a list of quantifiable criteria which the town can apply to a private road in order to determine whether it should be taken. In order to create these criteria, the team examined the roads which had recently been taken by the town or were under

consideration for taking in order to determine some of the important aspects that the town used to justify the takings of those roads. From this, the team was able to develop criteria that aligned with what the town considered important during the Boulevarde taking. We further expanded our criteria based on what interviewees believed to be important. This information was determined during the same interviews described previously. Within each interview we asked what the main issues on a private road were and what criteria they would consider when deciding how to prioritize the taking of these roads.

Early in this process we learned that the Roads and Right of Way Committee already had a list for potential takings with a basic prioritization and certain criteria they considered for each road. We worked to combine this set of criteria with what we had determined was important previously. Our main goal was to determine how to quantify the criteria we defined. Many of the criteria we quantified with solid numbers were determined through observation or examination of the road. When this was not possible we developed a scientific way to quantify each category to reduce the subjectivity as much as possible. The criteria list we created went through many iterations throughout the course of the project based on feedback from our sponsor and advisors, as well as added information we received from our interviews.

3.5 Objective 5: Applied the Checklist of Criteria to Select Roads to Demonstrate its Use

Through discussion with Kara Buzanoski and based on information we collected during the various interviews, we determined three private roads which we used as examples of how the criteria were assessed and applied. These roads were Warrens Landing Road, Millbrook Road, and Somerset Road (map included in Figure 4.9). On each of these roads we performed traffic counts and analyzed road condition. The team performed a turning movement count at two locations on Millbrook and three locations on both Warrens Landing Road and Somerset Road. A turning movement count is conducted on the road in question where it connects to another major road and is performed during morning and evening rush hour between the hours of 7 to 9 A.M. and 4 to 6 P.M. on a typical weekday. The list below describes the data collected during the traffic count:

1. The number of cars that drove by the road in question, taking note of their directions of travel

2. The number of cars that turned onto the road in question and from what directions they came from
3. The number of cars that turned off the road in question and what directions they went

Examples of the tables we used for a three-way intersection or a four-way intersection are included in Appendix H. These counts were used to determine the use of the roads.

On each of these roads we also determined the road condition. We first used ArcGIS to determine the average width of the road and the overall length of the road. We then took note of the surface type of the road. We next used the evaluation method detailed in the 2012 "Evaluating Private Roads on Nantucket" IQP (Cocks, Corrigan, LaRue, 2012). This included evaluating the severity of potholes, corrugation, rutting, and loose aggregate. When in the field we measured one hundred foot segments with a one hundred foot tape measure and then determined the square footage of any corrugation, loose aggregate, or rutting that was present within the segment. We then counted the number of potholes present and determine which category of each defect was present. The different categories and the prioritization system we used aligned with the evaluation worksheet created during The Evaluation of Private Roads IQP (Cocks, Corrigan, LaRue, 2012). A copy of the evaluation worksheet is in Appendix I. Instead of using printed copies of the form, we recreated the form on KoboToolbox, a web-based surveying tool which allowed us to use a cell phone to record the data while in the field and then export it to an Excel document afterwards. The evaluation form we used can be found in Appendix G. The result of this evaluation is a numerical priority value for each of the roads, allowing for an easy comparison between them.

Finally, we assessed other aspects of each road including the number of properties along the road, the focus of the area's homeowners association if one's present, whether the abutters of the road have requested adoption or not, and the cost to repair the road. We assessed number of properties along the road using ArcGIS by counting the number of main structures on each property along the road. When determining the focus of the homeowners association, we first determined if a homeowners association was present in the area using the ArcGIS homeowners' association layer. If there was one present we determined if they focused on road maintenance through either an interview or an email including the three questions listed in section 3.2. We determined if the abutters have requested their road be taken through conversations with the

homeowners association's president. We also spoke to town officials such as the Roads and Right of Way Committee because they discuss road maintenance with abutters frequently. Finally, we determined the cost to repair the road by calculating both the cost to construct and the cost to grind and regrade. Already paved portions of the road need to be ground and regraded before reconstruction. First the square footage of the paved portion of the road was calculated and then the total grinding cost is calculated using the first equation in Table 3.1. This equation assumes grinding and regrading costs five dollars per square foot of pavement. We calculated the road construction cost using the second equation in Table 3.1. This equation first calculates the area to be paved in square yards, then converts this to the tons of material necessary for a one inch pavement depth. It then assumes a three inch depth is needed, and so multiplies the number of tons needed by three. Lastly, this equation calculates the cost to reconstruct the road by assuming the construction costs $220 per ton of material (K. Buzanoski, personal communication, December 8, 2015).

Table 3.1: Equations for calculating repair cost

	Equations
Grinding and Regrading	Total Grinding Cost = (length x width) x $5
Reconstruction	Total Cost = ((((length x width)/9) x 0.056) x 3) x $220

(K, Buzanoski, personal communication, December 8, 2015).

A discussion of how the criteria were developed and a description of each are presented in the Findings chapter.

4.0 Findings

The following chapter presents the team's findings from their work while on Nantucket. First, we clarify and expand upon the best practices of the other towns we have researched and include the opinions of Nantucket stakeholders. Then we elaborate on the current maintenance practices on Nantucket's private roads. Third, we discuss Nantucket's current plan for the taking of private roads. Then we explain the development of the list of criteria the town should consider when taking a road. The team describes the application of these criteria on four roads on the island in order to demonstrate how to evaluate each criterion. Finally, we discuss the other concerns about private roads.

4.1 Best Practices in Compared Towns

Through interviews and communication with DPW directors in other towns we learned what current practices for private road maintenance are used. A key practice that Eastham, Wellfleet, and Barnstable are starting to implement is a snow plowing policy that incentivizes abutter maintenance. Each of the six towns also has at least one law that allows them to conduct maintenance on private roads, which are introduced in the background and elaborated in Table 4.1. Finally, we discuss and elaborate upon the takings discussion started in the Background chapter.

Table 4.1: Summary of Compared Best Practices

Town	Law on Private Road Maintenance?	Number of Abutters who must Approve Repair (%)	Who Pays for Maintenance?	Are Betterments Assessed?	Process for Taking a Road?	Petition Required for Taking?	Who Pays for Improvements for Taking?
Barnstable	Yes 2 Laws	Law A: 51% Law B: 0%	Law A: Abutters Law B: Town	Law A: Yes Law B: No	No	N/A	N/A
Dedham	-	-	-	-	Yes	-	Town
Eastham	Yes	100%	Abutters	Yes	Yes	Yes	Town
Franklin	-	-	-	-	Yes	-	-
Nantucket	Yes	50%	Abutters	Yes	-	Yes	-
North Attleborough	Yes	51%	Town	No	Yes	Yes	Abutters
Wellfleet	Yes	50%	-	No	-	No	-

Law A: An act relative to private road maintenance;

Law B: Temporary repair on private ways

(D. Santos, personal communication, November 19, 2015), (Road acceptance policies and procedures, 2015), (N. Andres, personal communication, November 30, 2015), (M. Hollowell, personal communication, December 3, 2015), (K. Buzanoski, personal communication, November 17, 2015), (R. Cantoreggi, personal communication, December 10, 2015), (Repair of private roads, 2014), (Temporary repairs on private ways, 2014), (Temporary repairs on private ways, n.d.), (Streets and ways, 2015).

4.1.1 Snow Plowing as a Maintenance Incentive

Wellfleet and Eastham have policies about snow plowing private roads. They use the policies to incentivize abutters to maintain their roads to a specific standard. Currently Barnstable is considering a similar policy. In 2012, the Wellfleet board of selectmen voted in new standards for private roads. It was decided that a road meeting these standards would continue being plowed by the town, while non-compliant roads would not. The standards for Wellfleet are summarized in Table 4.2.

Table 4.2: Private road standards for snow removal

Town	Eastham	Wellfleet
Surface Type	Paved	Paved
Surface Width	20 ft	10 ft
Vertical Clearance	14 ft	14 ft
Roadside Clearance	2 ft	3 ft
Street Sign Required?	Yes	Yes

(Bragg, 2015), (Town of Eastham Private Roads Snow Removal Policy, 2015).

This plan only affects the 124 paved private roads. The 150 to 200 private dirt roads within Wellfleet are not currently plowed by the town, and as a result this plan does not affect them (Bragg, 2015). Currently only 38% of the paved private roads in Wellfleet are compliant. However, implementation of this plan has been delayed to the winter of 2016-2017, providing more time for roads to be brought up to standards. Ideally, this strategy provides the town with a low cost way to keep many of the private roads in the area maintained.

Eastham has a nearly identical plan, providing snow plowing services for roads which meet the standards shown in Table 4.2. Currently only 16% of the private roads in Eastham comply with these standards (N. Andres, personal communication, November 30, 2015). Barnstable provides snow plowing services as well. However, Barnstable does not have restrictions as to what defines a plowable road. Barnstable instead plows all private roads, including unpaved roads, unless the road is on the “Do Not Plow” list. According to DPW

Director Dan Santos, this list is currently out of date. Recently, a policy similar to those in Wellfleet and Eastham was drafted. This law would allow Barnstable to require certain standards before plowing the road. The main concern, however, is their ability to assess compliance with the standards due to the size of the town (D. Santos, personal communication, November 19, 2015).

Overall, we received very mixed responses from the stakeholders we interviewed regarding the implementation of similar policies in Nantucket. Some stakeholders were very supportive of an approach similar to Wellfleet's, while others voiced concerns regarding implementation and level of participation. The Nantucket Department of Public Works (DPW) Director, Kara Buzanoski, the Emergency Management Coordinator, Dave Fronzuto, the Assistant Town Manager, Gregg Tivnan, the Planning Director, Andrew Vorce, and the General Manager of the Wannacomet Water Company, Bob Gardner, all shared the opinion that setting a basic standard that all private roads have to meet in order for the town to plow their road is a great incentive for homeowners to maintain their roads. They also agreed that incentivizing a standard would increase overall public safety because it would help make the roads more accessible to both utility crews and emergency personnel. Andrew Vorce suggested that the policy be adapted so that it applies to compacted gravel roads along with paved roads in order to increase participation (A. Vorce, personal communication, December 10, 2015). Claire Graves, the President of the Fisher's Landing Association, also supported implementing a plowing program. She believed that the roads maintained by the Fisher's Landing Association already meet the standards described in Wellfleet's plan, and so her area would easily comply with such a plan (C. Graves, personal communication, November 30, 2015).

The Chairman of the Roads and Right of Way Committee, Allen Reinhard, the President of the Cisco Civic Association, Carol Langer, and the President of the Siasconset Association, Mark Donato, think using snow removal as an incentive for road maintenance is a great idea in principal, but believe it would be hard to implement and then continue to enforce. National Grid's Vice President of Operations for the New England South Division, Dave Fredericks and Deputy Fire Chief, Ed Maxwell both believe having minimum standards would help the town, but both also expressed concerns about implementation and level of participation in such a program (D. Fredericks, personal communication, November 10, 2015) (E. Maxwell, personal communication, November 2, 2015). When asked about a snow removal plan, Carol Langer said, "In a perfect world, that sounds wonderful. We are a long way from that" (C. Langer, Personal Communication,

November 13, 2015). She was most concerned with the three feet of brush clearance, noting that people on Nantucket often like their privacy. Tom Quigley, the President of the Surfside Association, supported these concerns, stating that these standards would never be accepted in the Surfside Association and would face heavy resistance in the rest of Nantucket since widening and improving roads changes the characteristics of the area (T. Quigley, personal communication, November 19, 2015). Chief of Police, William Pittman and Mark Donato mirrored Tom Quigley's concern that there would be major resistance. "I'm sure there would be pushback. I see pushback when people try to trim bushes alongside the road" (W. Pittman, personal communication, November 3, 2015). Lee Saperstein, Secretary of the Roads and Right of Way Committee and a member of the Nantucket Civic League, voiced the concern that people are not receptive of changes to their road (L. Saperstein, personal communication, November 2, 2015).

Acceptance of a snow removal plan was not the only issue brought forth, however. Reinhard believed it would be difficult to implement the requirements on existing roads (A. Reinhard, personal communication, November 4, 2015). Charles Stott, the President of the Madaket Residents Association, supported this, claiming that bringing roads up to the standards defined in Wellfleet would be too expensive. He also noted that this would aid only a small portion of Nantucket's residents as many residents are seasonal (C. Stott, personal communication, November 10, 2015). Ed Maxwell was unsure how such a plan would be implemented (E. Maxwell, personal communication, November 2, 2015), while Dave Fredericks' main concern was the town's ability to monitor the compliance of the standards for an extended period of time (D. Fredericks, personal communication, November 10, 2015).

4.1.2 Town Maintenance Practices

During our interview with DPW Director Dan Santos, we learned that Barnstable has 190 miles of private road, which is 41% of the roads in Barnstable. As discussed in the background, Barnstable has a policy that allows the abutters to petition the town for maintenance of their private road. Dan Santos confirmed this policy is still in effect and elaborated by saying that the maintenance cost can be paid upfront or over a twenty-year period. He also noted, however, that the program is not as robust as it could be because it is hard to get 51% of the abutters to sign the petition (D. Santos, public communication, November 19, 2015). Dan Santos also confirmed that the Massachusetts Senate did pass the Massachusetts General Laws Acts 2014, Chapter 339 solely

for Barnstable and that our interpretation of the law was correct in that the town does not need to get consent from the abutters, but they also cannot charge the abutters for the maintenance. To be eligible for maintenance, a private road must connect two town roads and have been heavily used by the public for at least twenty years. The Barnstable DPW has done maintenance under this law on four different roads over the last year costing the town a total of $750,000 (D. Santos, personal communication, November 19, 2015).

4.1.3 Town Taking Practices

As we discussed in the background, different towns have different criteria they consider when deciding whether or not they should take a road. North Attleborough requires that the road be brought up to town standard and then the taking must be requested at town meeting and approved by the majority of representatives (M. Hollowell, personal communication, December 3, 2015). Roads are typically not brought up to town standards by the abutters, so they are not taken, but the process is in place. Barnstable does not have a process for taking roads and does not plan to take any roads in the near future because they conduct all the necessary maintenance on private roads without actually taking the road because of the Massachusetts General Law described in the previous section (D. Santos, personal communication, November 19, 2015). Lastly, Eastham takes at least one private road a year, thus reducing the number of private roads.

Each one of these towns has a different method for managing the maintenance of private roads. Some work better than others, but no one has found a perfect strategy. Because of this, many of the policies that are in place elsewhere receive a lot of mixed opinions about its functionality in Nantucket. A number of Nantucket's stakeholders seem to be in support of a snow removal incentive plan for maintenance, while others either express doubts or outright reject such a plan. Despite these doubts, a snow removal program would likely help Nantucket significantly. Owners of newly built roads would have incentive to keep their roads well maintained in order to receive continued plowing, and owners of existing roads may work to raise the condition of their roads to the levels necessary to have their roads plowed. Plus, anybody who did not want to alter the condition of their road would not be required to, which would ideally reduce the resistance a snow removal program faced.

Maintaining roads in a similar way to Barnstable and North Attleborough, which is typically at the town's expense, would likely not work well as a long-term maintenance strategy

for Nantucket. Attempting to pass an act similar to the one passed for Barnstable would likely face a large amount of resistance as abutters would fear the town's ability to pave a road without abutter consent.

Lastly, focusing on taking roads is likely a good approach for Nantucket to take when improving existing roads. Such a strategy, while costly, would allow the town to have complete control of the road's maintenance.

4.2 Current Maintenance Practices on Nantucket

4.2.1 Homeowners Associations

We have interviewed 23 people (Appendix E) who have a stake in private road maintenance. We asked each interviewee what they believe the role of a homeowners association (HOA) is, and received different answers in every instance. One item that people did agree upon was that the association should focus on the concerns and needs of its members. Kara Buzanoski believes that the homeowners associations should focus on the betterments and the maintenance of the shared land within the association (K. Buzanoski, personal communication, November 3, 2015), which agrees with Lee Saperstein's definition of the role of the HOA (L. Saperstein, personal communication, November 2, 2015).

When talking to Andrew Vorce we learned that homeowners associations were required for any new subdivisions constructed after 1991. These associations are required to collect dues and maintain their roads. Subdivisions created before this were not required to have homeowners associations, but many have residents associations (A. Vorce, personal communication, December 10, 2015). The difference between a residents association and a homeowners association is that a residents association is not required by deed, so participation is voluntary and they cannot charge dues for betterments including road maintenance (T. Quigley, personal communication, November 19, 2015). This distinction means that homeowners associations and residents associations have different abilities, which cause their difference in focus. Even though homeowners associations are required to collect dues and maintain their roads, they do not all do this to the same level. The level of maintenance within an association is dependent on the homeowners' motivation to maintain.

To learn what level of road maintenance each homeowners association performed, we interviewed five of the twenty two association presidents and contacted the other seventeen

through email; a listing of each association and its respective president is included in Appendix F. During these interviews, we discovered that each association has a different focus. The five associations represented in our interviews were the Cisco Civic Association, the Surfside Association, the Fisher's Landing Association, the Madaket Residents Association, and the Siasconset Association. Through talking to these associations we learned that the number of active members and the amount of dues that went towards road maintenance correlated with the road condition.

Some of the associations were very focused on road maintenance, while others did little to no maintenance. Appendix J includes a table that compares the percentage of members that pay dues, the annual dues, and the percentage of annual dues that fund road maintenance. Dues vary from $15 per year for the Tom Nevers Civic Association to $4,000 per year for the Brant Point Association. Approximately 60%, or of eleven of the eighteen, homeowners associations we received a response from had annual dues of $100 or less. The associations with the highest dues tended to have a high percentage of active members and spend a large portion on road maintenance.

We interviewed Carol Langer from the Cisco Civic Association and Claire Graves from the Fisher's Landing Association because they charge relatively high dues, $200 and $850 respectively, and focus on road maintenance. They both understand the homeowners' obligation to maintain roads, so a large portion of their annual dues goes toward road maintenance. The Cisco Civic Association is also focused on improving public safety, so they work to improve accessibility of emergency vehicles. In the past they have purchased no parking signs and speed bumps. They also maintain the road and cut back brush, but they do have to limit how often they grade the road and how far they cut back the vegetation because people enjoy their privacy. In addition, roads that are not as well maintained are seen by some as speed deterrents (C. Langer, personal communication, November 13, 2015). The Fisher's Landing Association's roads are all paved, so they do not need to maintain them to the extent that a dirt or gravel road needs to be maintained, but some maintenance is still required (see Figure 4.1). They have resealed and patched cracks and potholes in the past, but they focus solely on their neighborhood roads. They consider the access road, Warrens Landing Road, a public thoroughfare that the public uses more than the members of their association (C. Graves, personal communication, November 30, 2015).

Figure 4.1: Fisher's Landing

We interviewed the Cisco Civic Association and Fisher's Landing Association because we were told that they charged the highest dues, but when we contacted other associations through email we discovered that the two associations with the highest dues were Brant Point Association and Naushop. They respectively charge $3000-$4000 and $1900 per year per household. The Brant Point Association has a single shell road that they use their funds to maintain, but Naushop has a neighborhood of paved roads that they maintain (Figure 4.2). Naushop has $3,000 set aside for biannual crack filling, $15,000 for operating maintenance and cleaning, and $877,000 for future pavement replacement (K. Gentner, personal communication, December 2, 2015). The main thing that these four associations have in common is the high percentage of members (greater than 90%) that pay dues.

Figure 4.2: Goldfinch Drive

The other three association presidents we interviewed included Charles Stott of the Madaket Resident Association, Tom Quigley of the Surfside Association, and Mark Donato of the Siasconset Association. Within these associations, no money was raised for road maintenance through the association's dues. The Madaket Resident Association is spread across the entire Madaket area and thus there are not any private roads that all members of the association use, so they do not know where to start if they do road maintenance. The association is made up of both paved and unpaved roads that are used as alternate routes to avoid traffic on Madaket. An example of one of the paved roads is Long Pond Drive, which they added a speed bump to in order to slow vehicles using it to avoid traffic on Madaket (Figure 4.3). The one thing they have done in the past to facilitate road maintenance in their area was to provide a grant for homeowners collecting money for maintenance (C. Stott, personal communication, November 10, 2015).

a) b)

Figure 4.3: a) Long Pond Drive and b) a traffic calming device

The Siasconset Association is a rare association on the island. It has very few private roads for the homeowners to maintain and the private roads they do have are less than one hundred feet long (M. Donato, personal communication, November 17, 2015). Finally, the Surfside Association is a residents association not an HOA, so they cannot charge dues for maintenance. They do have a voluntary fund that they use for basic maintenance, but their roads have become public thoroughfares, so they cannot keep up with the necessary maintenance using only the voluntary funds (T. Quigley, personal communication, November 19, 2015). Boulevarde is one of the roads

in their area that has become a public thoroughfare and thus they have not been able to keep up with the necessary maintenance as you can see in Figure 4.4.

Figure 4.4: Unpaved portion of Boulevarde

Overall, these three associations have much lower dues than the ones that focus mainly on road maintenance and they have specific reasons why they do not focus on road maintenance.

Of the remaining fifteen associations most have annual dues of less than $100 and very few put any money towards road maintenance. Within this group there are other resident associations like the Surfside Association, so they cannot spend dues on maintenance. These associations include the Polpis Association and the Nantucket Town Association. Since not all the homeowners associations keep up with the maintenance of roads, some homeowners have started to take responsibility for road maintenance on the road that they abut.

In conclusion, the different HOAs on the island are all very different and have varying foci. They are all concerned about private roads in their area to some extent, but the amount that they maintain them varies based on the cohesion and dues of the association.

4.2.2 Homeowners Initiated Maintenance

In areas where homeowners associations do not maintain private roads, some homeowners take it upon themselves to pay for maintenance or collect funds from neighbors to defray the costs. Private road maintenance has been an issue for years, so there are many examples of homeowners initiating maintenance. The following section gives four examples of homeowners initiating maintenance.

This first example shows that private roads are not just a current issue and that homeowners have been raising money for maintenance for years. Lili Baker was mentioned in a 2003 article in the *Inquirer* titled "Town will use public money to repair worst private roads", which was about the roads that connect the airport to Surfside, including Boulevarde, Okorwaw Avenue, Lovers Lane, and Monohansett Road. Lili Baker lives on Webster Street, which connects to Monohansett Road. She "... solicit[ed] money from neighbors to pay for more repairs, not to mention spending $2,500 out of her own pocket in the cause" (Kinsella, 2003). She also commented that she was tired of paying for repairs with her own money and that she was going to start letting someone else fight the battle because the roads are no longer residential roads.

Another more recent example of a homeowner taking responsibility for the maintenance of the private road occurs currently on Eat Fire Springs Road (Figure 4.5). Rain slowly causes giant gullies to form on the road making the road only passable by a single car. Once the road reaches this state, which occurs every two to three years, Peter Morrison, the co-president of the Nantucket Civic League, contacts the other homeowners on the road asking for $200 from each so that he can hire a contractor to repair the road. He typically gets about an 80% response rate and is therefore able to afford to pay a contractor to perform the necessary maintenance (P. Morrison, personal communication, November 2, 2015).

Figure 4.5: Eat Fire springs Road

In the Tom Nevers Area, one of the local fire fighters is currently raising money to perform maintenance on Exeter Street. He is trying to collect $8,000 total to hard pack the road, but he is

receiving resistance from his neighbors because they do not want to pay for a portion of the road that they do not have to use. Neighbors have argued that they only use the first fifty feet of the road, so they should not have to pay for the maintenance of the entire length. Even with the resistance and complaints he was able to raise the necessary funds to maintain the road (F. Hanlon, personal communication, November 12, 2015).

Our last example took places a few years ago in the Madaket Residents Association area. According to Charles Stott, the abutters on Arkansas Avenue (Figure 4.6) got together and collected money to repair their road. A few neighbors did not contribute and then complained that the work was not done well after it was completed. Even with the few neighbors that did not contribute they were able to collect enough money with help from a grant from the HOA to hire a contractor to repair the road (C. Stott, personal communication, November 10, 2015).

Figure 4.6: Arkansas Avenue road condition

Based on these examples it is clear that not all homeowners are willing to support maintenance of the road they live on, but enough are willing to that the homeowners initiating the maintenance are still able to collect enough funds. One of the main concerns homeowners have when performing maintenance on their own is a lack of knowledge about how to properly maintain it and the total cost, especially when the roads are heavily used by the public. Many let the road become almost impassable before considering maintenance. Once the road reaches this point they need to hire a contractor to complete the maintenance for them. There are few road contractors on the island, so they all tend to hire the same main contractor. They typically allow the contractor to determine what needs to be done to the road because homeowners do not

understand proper maintenance techniques. Once the project is complete the homeowners typically question if they were charged a fair price and if the maintenance was performed correctly. This lack of knowledge for proper maintenance techniques prevents many homeowners from taking the initiative to do maintenance themselves. The homeowners that have performed maintenance have done so because of need, but it is not done often or in a preventive manner.

4.2.3 Town Maintenance

The town also performs some maintenance on private roads. Typically this maintenance is in the form of plowing during a major storm. According to Dave Fronzuto, Emergency Management Coordinator, the town plows roads during a winter storm when public safety is a concern. Since these roads are typically poorly maintained they cannot just send a plow driver who does not know the area. They also have to send a police officer and typically a truck to deliver fuel to isolated homeowners. The three drivers share their knowledge of the roads to minimize damage to the equipment. The goal of the emergency management team is to allow people to safely stay in their homes. They only bring people to the shelter if absolutely necessary and then will do anything within their power to get them back home safely as soon as possible (D. Fronzuto, personal communication, November 18, 2015).

The water company also does significant amounts of maintenance on private roads, but it is not normally by choice. When we interviewed Bob Gardner, we learned that they face a lot of issues with water mains on private roads. The main issue is when the homeowners grade the roads it can expose the top of the water main. This exposure causes the water main to break and the water company has to repair the damage. Once they fix the water main they are expected to leave the road in a condition that is better than it was ever in. Since the water company spends a lot of money trying to repair roads after they have to perform maintenance on one of their mains they have gone to the extreme of paving a private road when they put a main in an attempt to avoid the issue. Some examples of this were Bayberry Lane and Ticcoma Way, where the water company paved the roads because they were in such disrepair that they knew they would lose cover on the water main creating major problems later that would cost them more in the long run. In the case of Bayberry, they charged the homeowners for the road to be paved, but two abutters never paid. For Ticcoma Way, they paved the road at no cost to the homeowners (B. Gardner, personal communication, November 16, 2015). The poor management of the private roads on the island

causes problems for all the different departments that provide services to the homes on private ways.

4.3 Nantucket's Current Plan for Road Taking

The Department of Public Works has a ten-year capital project plan, summarized in Table 4.3, to fund the takings of private roads; Figure 4.7 depicts a map highlighting the affected roads. Planned expenditures include the taking and design phases, and in some cases, construction costs. For example, the taking of Boulevarde and related roads such as Okorwaw Avenue and Monohansett Road will cost the town $3,000,000, of which $1,000,000 covers the taking (i.e., purchase of easements) and design phase, with the remainder for construction costs. The relatively high costs involved in this road taking can be justified by the road's frequent use as a cut through by the public to the airport.

Table 4.3: Department of Public Works condensed ten-year capital plan

Request	Ch. 90 TIP Construction	FY 2016 through FY 2020	FY 2021 through FY 2025	Ten-Year Total (Not Incl. Ch. 90 or TIP)
Road takings: Amelia/PB initiative		$100,000		$100,000
Road takings: Friendship/Somerset		$250,000		$250,000
Road takings: Winn Street		$250,000		$250,000
Road taking: Ticcoma to Lovers' Lane		$250,000		$250,000
Road construction: Fairgrounds to Monomoy Rd 700'		$350,000		$350,000
Road construction: Amelia Dr to Polpis Rd 1300'		$550,000		$550,000
Boulevarde area reconstruction		$3,000,000		$3,000,000
Road Maintenance (Chapter 90)	$637,307	$4,300,000	$4,500,000	$8,800,000
First Way road construction		$750,000		$750,000

(K. Buzanoski, personal communication, October 27, 2015).

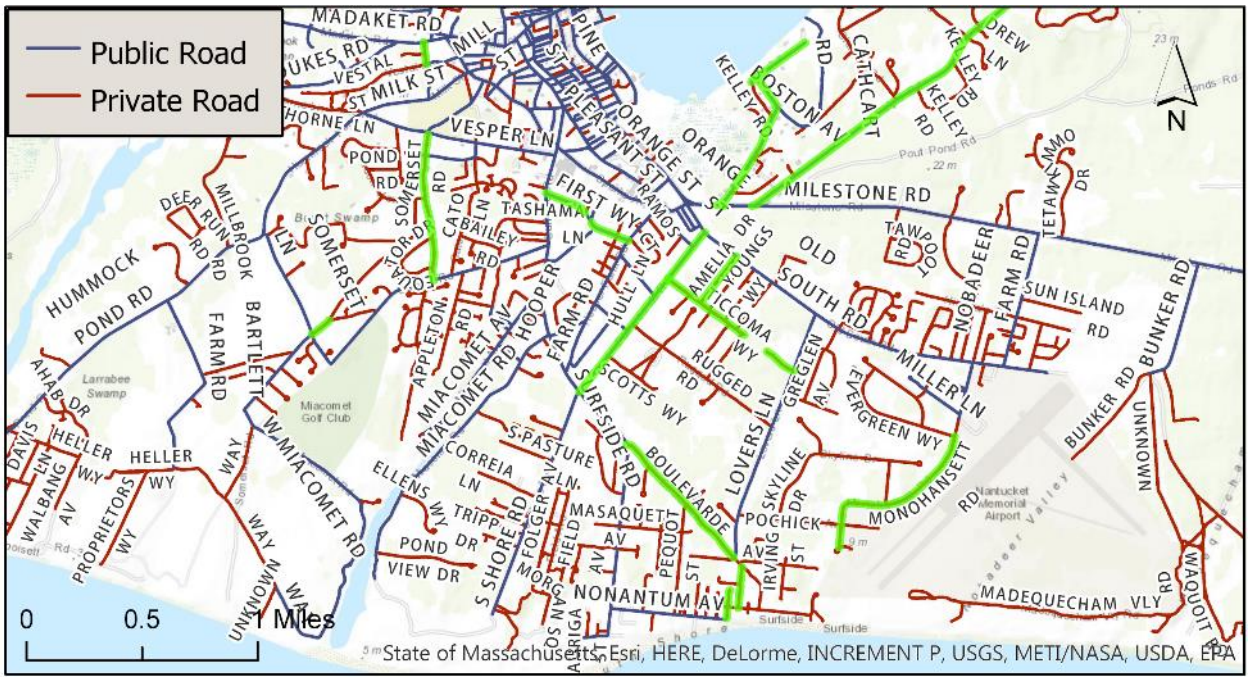

Figure 4.7: Map depicting roads covered under the DPW's ten-year plan

Other road takings include Amelia Drive and Ticcoma Way, both of which are being taken to relieve traffic on Old South Road. There are concerns with Amelia Drive because it currently allows on street parking because of the presence of businesses along it. It is not currently wide enough to allow two-way traffic and parking, but if they do not allow the parking it is extremely straight, so people are concerned about speeding. Also they would face a lot of resistance because the business would have nowhere for their employees or customers to park. Friendship Lane and Somerset Road are being taken to reduce traffic on both Quaker Street and Prospect Street; drainage installation and maintenance will also occur as a result of this taking due to the large drainage issues seen in Figure 4.8.

Figure 4.8: Drainage issues on Friendship Lane

Winn Street, presently designated a two-way street is also being taken, and will also reduce traffic on Quaker Street and Prospect Street. However, additional considerations will need to be made for Winn Street, as it is very narrow, as shown in Figure 4.9. As such, sight lines would need to be addressed or the street would need to be designated a one-way street to meet town standards.

Figure 4.9: Portion of Winn Street showing sight lines and road condition

4.4 Taking Criteria

We discussed the Roads and Right of Way Committee's Potential Road Takings List with Allen Reinhard. This list is sorted based on criteria to consider when taking. The full takings list is in Appendix K, but the criteria from the table are as follows:

- Public use of this Road,
- Road links Two Public Roads,
- Public Safety Concerns,
- Traversable by Emergency Vehicles,
- Abutters' Request,
- Access to Public Property Including Beaches, and
- Traffic Circulation Patterns.

When we went through each criterion with Allen Reinhard, we learned that many are anecdotal and difficult to assign a value to. In addition to this, some are very closely related. For example, the committee determined public use of the road by talking to abutters to see the kind of use the road experiences. Typically, however, the public use of a road is high if it links two public roads or leads to a public property (including beaches). Public safety concerns and traversability by emergency vehicles are very similar and include the overall condition of the road and the average age of the residents. Traffic circulation patterns are also related to public use of the road, but can be viewed as finding alternate routes to address circulation problems (A. Reinhard, personal communication, November 4, 2015).

One of the objectives of our project was to create a more rigorous set of criteria which could be objectively applied to identify priorities for road takings. To create our criteria, we used a combination of the Roads and Right of Way Committee criteria and criteria suggested by other interviewees. Most of the interviewees suggested criteria similar to the Roads and Right of Way Committee criteria, although they placed greater emphasis on particular items and some interviewees suggested additional criteria. Ed Maxwell was not only concerned with road condition, but also the overgrowth of the vegetation and the population density on the road (E. Maxwell, personal communication, November 2, 2015). Dave Fredericks suggested that we should also consider the abutters reason for request and the political issues surrounding the road (D. Fredericks, personal communication, November 10, 2015). Mike Burns, the Transportation Planner, said a potential criterion is if the road already meets town standards (M. Burns, personal

communication, November 3, 2015). The firefighters agreed that one of our criteria should be the size and/or the lack of house numbers. Finally, Tom Quigley and Claire Graves agreed that if a road had become a public thoroughfare then it should be taken by the town (T. Quigley, personal communication, November 19, 2015) (C. Graves, personal communication, November 30, 2015).

From all of these suggestions, the Roads and Right of Way Committee's criteria list, and feedback from both our sponsor and advisors we created a list of criteria that can be applied to any road the town is considering taking. This list includes the broad categories of the importance to the traffic network, public safety, homeowners and residents associations, abutters, and cost to town. Within each of the broad topics we have sub-criteria that can be easily determined allowing the priority of the road to be determined. The complete table of these criteria is located in Appendix L. Each broad category will be explained along with its subcategories below.

4.4.1 Importance to the Traffic Network

Certain roads are more important to the traffic network for a variety of reasons, and so the team created four sub-criteria in order to account for a number of these reasons. These criteria are:

- Level of use (cars/hr),
- Road category,
- Number of sole access roads, and
- Leads to or contains a public facility.

The level of use is the number of cars which utilize the road in question. These criteria were based on the traffic counts described in Methods. This is important because the more used a road is, the more important it is to the traffic network. Road category indicates the main reason the town would want the road. The two categories the team has used are connector, which is a road that connects two public facilities, and access, which is a road which accesses a public facility. This is not meant to be an exclusive list, and therefore should be expanded as new road categories are needed. Public facilities are defined by the team as any location accessed by the public. This definition includes public buildings, land, roads, and beaches. This means the fourth criterion, leads to or contains a public facility, indicates that there is one of the before mentioned facilities on or accessed by the road. The team includes a brief note describing what the facility is in each case. The number of sole access roads is simply the number of roads which can only be accessed

by using the road in question. The more roads there are in this category, the more important the road is to the traffic network.

4.4.2 Public Safety

Public safety has been a crucial topic for many stakeholders including the fire department and emergency management personnel. As such, the three sub-criteria below have been created in order to capture the risk to public safety presented by the road. They are as follows:

- Bike route / bike route connector,
- Road condition value (per 100 foot road segment), and
- Structures per mile.

Bike traffic is key on Nantucket, and as such so is bike safety. Taking a road and paving it potentially entices increased bike traffic on the road, and so considerations for this must be made. Therefore, the team created the bike route / bike route connector criterion, which indicates whether taking the road would connect two bike routes. Vehicular traffic safety is also a concern, as poorly maintained roads may cause damage. In addition to this, emergency vehicle access is crucial, and is greatly inhibited by poorly maintained roads. Therefore, the team created the criterion Road condition value (per 100 foot section). This value resulted from the road evaluation conducted by the team. Calculation of this value is described in section 4.5, however it is based on the extent and severity of ruts, corrugations, loose aggregate, and potholes on the road. The number of structures is a public safety concern because increased structure density results in a greater probability of emergency personnel being needed somewhere on the road.

4.4.3 Homeowners and Residents Associations

As discussed in section 4.2.1, many homeowners and residents associations work to keep their roads maintained. However, not all of them do, and of those that do there are different levels of funding for projects. As such, the team created the following sub-criteria:

- Presence of an HOA
- Amount per member put towards maintenance

Without an HOA or residents association, repairs to roads are conducted sporadically. As such, the presence of an HOA or residents association is a necessary criterion. However, it is also

necessary to know how much money per member is put towards maintenance, and the value varies greatly between the different associations.

4.4.4 Abutters

Resistance from abutters can delay the taking of a road for years, as it did with Boulevarde. Therefore, knowing whether the abutters have requested their road be taken or not can give insight into how difficult the process will be. Seeing this, the team created the following sub-criteria:

- Abutter Request, and
- Reason for request

Knowing the reason for the request is the second sub-criterion, as it may give insight into the issues with the road.

4.4.5 Cost to Town

Cost is a crucial aspect to any project, and having cost estimates is therefore key to making informed decisions. The following sub-criteria summarize the major costs based on the length, width, and surface type of the road.

- Road Length (feet)
- Average width (feet)
- Surface type
- Cost to grind & regrade
- Cost to reconstruct

The two major costs are the cost to grind and regrade the paved portions of the road, and the cost to reconstruct the road. Both costs are based on the length and average width of the road, and so they have been added as sub-criteria for reference.

4.5 Criteria Application

Once we finalized the criteria, we applied them in the field to three different roads to test their ‘real-world’ application. These roads included Millbrook Road, Warrens Landing Road, and Somerset Road from Friendship Lane to Vesper Lane (Figure 4.10). The table containing the assessed criteria is located in Appendix O. Somerset Road is in the DPW’s ten-year capital plan. The DPW plans to take it and repair it, so we wanted to apply our criteria to reinforce this

decision. Both Millbrook Road and Warrens Landing Road have been in many current discussions of private roads. They also appear on the Roads and Right of Way Committee's Potential Road Takings List, so we wanted to see how these roads compared to the roads that had already been taken or were prioritized for taking already. By applying these criteria we also provide the DPW with examples of how the criteria should be correctly applied to a private road.

Figure 4.10: Warrens Landing Road, Millbrook Road, and Somerset Road

For each of the roads we performed traffic counts and evaluated road condition (Raw data included in Appendix M and Appendix N, respectively) as described in the methods chapter while in the field. For each traffic count, the number of cars which utilized the road in question were summed (this includes cars turning off of the road, turning onto the road, or passing by on the road). This was done for each intersection along the road at which the team conducted a traffic count. These totals were then averaged to get the average number of cars which used the road in question. Then, in order to compare the roads to each other, the average number of cars per hour using the road was calculated. This value was the value used in the criteria table.

For road evaluations, a road condition value per 100 foot section of road was calculated for use in the criteria table. This value was calculated based on the extent and severity of potholes, corrugation, aggregate, and rutting on the road. On each road segment, a value of zero to nine was assigned for each category of defect following the process laid out in the prior private road IQP (Cocks, Corrigan, LaRue, 2012). This means each 100 foot section of road had four condition values ranging from zero to nine. The values were summed, and all sums from each section were

added together to get the total condition value for the road. This was then divided by the number of sections to get the average condition value per 100 foot section of road. This value was then used for the table as it was easy to compare these values between roads as they are not dependent on the total length of the road.

4.5.1 Millbrook Road

- **Level of Use**

Of the three roads evaluated by the team, Millbrook Road had the lowest average usage per hour at 28.6 cars per hour. As shown in Figures 4.11 and 4.12, there was a distinct difference between the level of usage of Millbrook's Road southern entrance at Hummock Pond Road and its northern entrance at Madaket Road.

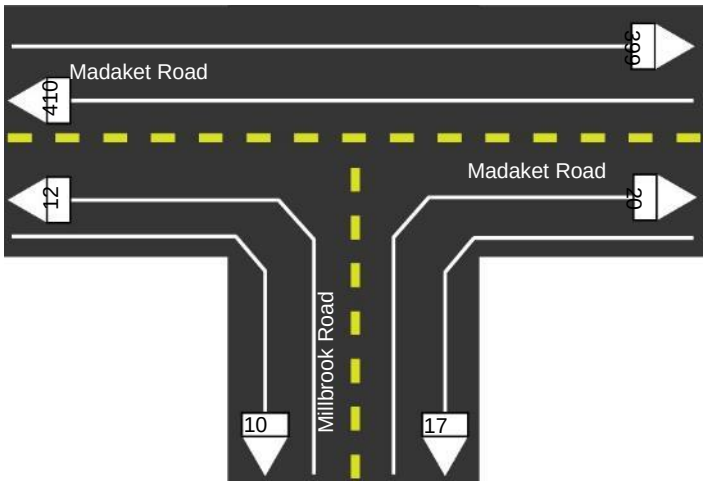

Figure 4.11: Turning movement count where Millbrook Road meets Madaket Road

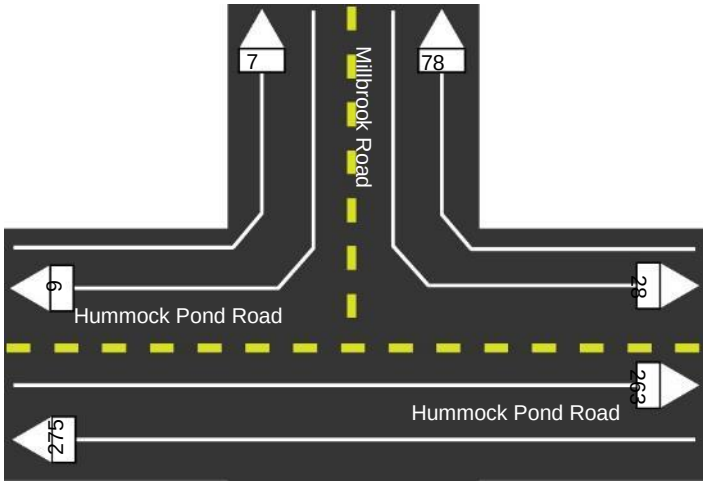

Figure 4.12: Turning movement count where Millbrook Road meets Hummock Pond Road

At the Hummock Pond intersection 42.5 cars used Millbrook per hour, while at the Madaket Road intersection, 14.8 cars used Millbrook Road per hour. This difference can likely be explained by the business located on Millbrook Road. This difference indicates that Millbrook Road's primary use is not currently as a cut through.

- **Road Category**

The team labeled Millbrook Road as a connector because it connects Hummock Pond Road and Madaket Road which are two major public roads.

- **Number of Sole Access Roads**

There are two roads which can only be accessed by Millbrook Road: Deer Run Road and Paradise Drive. Both of these roads have a number of residences, adding to the level of traffic on Millbrook.

- **Leads to or Contains a Public Facility**

As previously mentioned, Millbrook Road connects Madaket Road to Hummock Pond Road. Therefore, by the team's definition, Millbrook Road leads to a public facility.

- **Bike Route / Bike Route Connector**

Millbrook Road currently links two major bike paths: the Madaket path and the Cisco path. If Millbrook Road were to be taken and repaired, there would likely be increased bike traffic on the road. Therefore, considerations should be made to keep bike traffic safe.

- **Road Condition Value**

Millbrook Road's average condition value per 100 foot segment was 5.56. This was the highest condition value of the roads evaluated by the team, indicating the highest extent and severity of defects. The majority of the defects on Millbrook Road were potholes, which contributed to 62% of the total condition value.

- **Number of Structures**

There are 68 structures along Millbrook Road. This includes structures on Deer Run Road and Paradise Drive.

- **Presence of an HOA**

There is no homeowners or residents association in the area of Millbrook Road.

- **Abutter Request?**

Abutters have not requested Millbrook Road be taken by the town. Many have mentioned that they do not want Millbrook Road to be paved. This indicates attempts to take Millbrook Road may receive resistance from abutters.

- **Cost to Grind and Regrade**

The paved portion of Millbrook Road, totaling 1,834 feet of road and average of 15.5 feet wide, would cost approximately $142,000 to grind and regrade.

- **Cost to Reconstruct**

Millbrook Road, totaling 6,325 feet long and an average of 15.5 feet wide, would cost approximately $403,000 to reconstruct once the paved portion of the road has been ground and graded.

4.5.2 Warrens Landing Road

- **Level of Use**

Warrens Landing Road had a similar level of use to Millbrook Road at 22.3 vehicles per hour. However, unlike Millbrook Road, Warrens Landing Road's intersections had less variability between their levels of use as seen in Figures 4.13, 4.14, and 4.15.

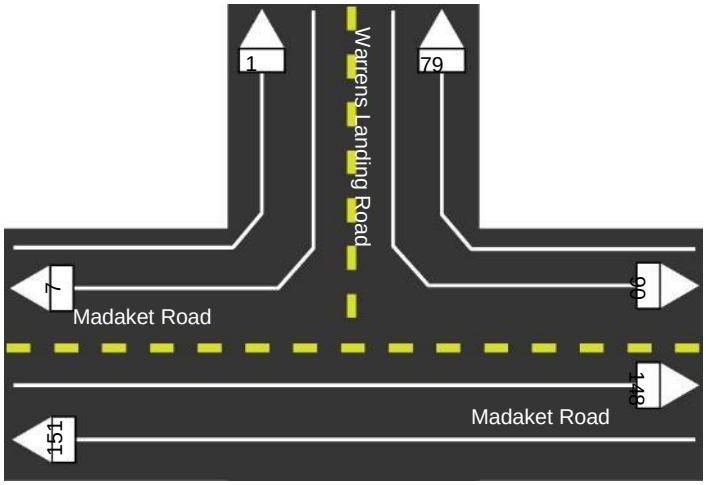

Figure 4.13: Turning movement count where Warrens Landing Road meets Madaket Road

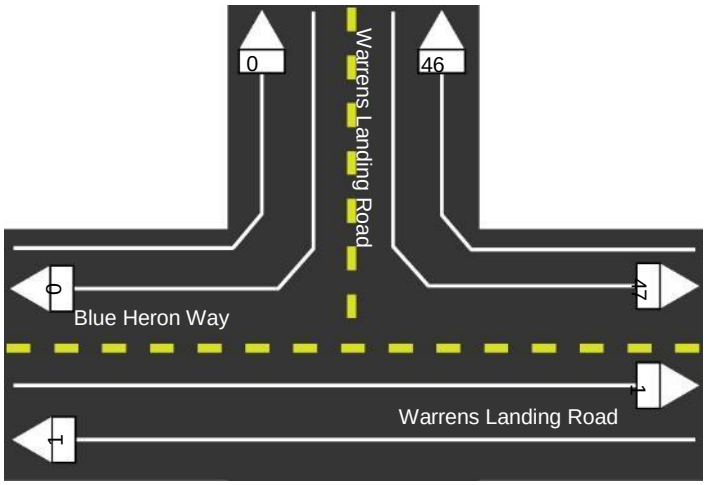

Figure 4.14: Turning movement count where Warrens Landing Road meets Blue Heron Way

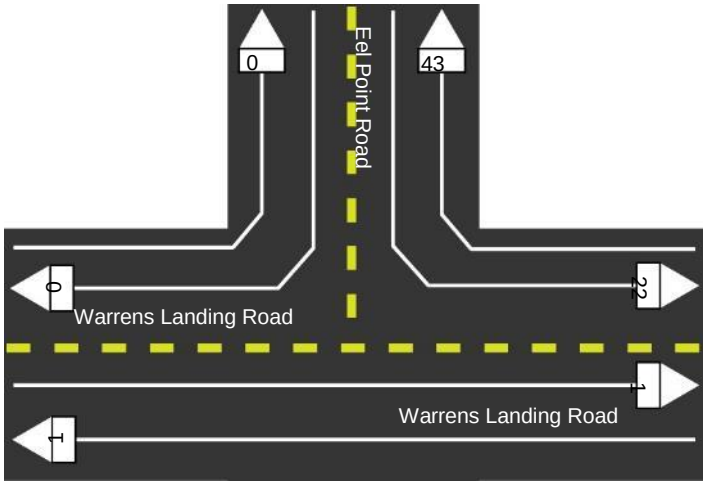

Figure 4.15: Turning movement count where Warrens Landing Road meets Eel Pont Road

The Madaket Road intersection had 44.3 cars per hour, the Blue Heron Way intersection had 24.3 cars per hour, and the Eel Point Road intersection had 20.0 cars per hour. One thing that is important to note is that 80 cars entered Warrens Landing Road from Madaket Road in total, and 45 cars left Warrens Landing Road heading onto Eel Point Road. This indicates that approximately 56% of the cars turning onto Warrens Landing Road were using it to get to Eel Point Road, meaning usage is split evenly between public and private traffic.

- **Road Category**

  The team labeled Warrens Landing Road as an access road because it accesses Madaket Harbor, Eel Point, and 40th Pole Beach.

- **Number of Sole Access Roads**

  There are seven roads which can only be accessed by Warrens Landing Road, resulting in a large amount of additional traffic.

- **Leads to or Contains a Public Facility**

  Warrens Landing Road leads to Madaket Harbor, Eel Point, and provides an alternate route to 40th Pole Beach. Therefore, Warrens Landing Road leads to a public facility.

- **Bike Route / Bike Route Connector**

  Warrens Landing Road does not connect a bike route.

- **Road Condition Value**

Warrens Landing Road's average condition value per 100 foot segment was 5.36. This was only slightly less than Millbrook Road's condition value. The majority of the defects on Warrens Landing Road prior to its intersection with Eel Point Road were potholes, contributing to 55% of the total condition value. However, after the intersection with Eel Point Road, rutting became the major issue, contributing to 53% of the total condition value for those segments. An important note is that if the town only took Warrens Landing Road up to the intersection with Eel Point Road, the average condition value per segment would drop to 3.97.

- **Number of Structures**

There are 119 structures accessed by Warrens Landing Road. The majority of these are on sole access roads.

- **Presence of an HOA**

The Fisher's Landing Association is in the area of Warrens Landing Road; however, they do not currently maintain it for the reason described below in 'Reason for the Request?'

- **Amount of Dues per Member put Towards Maintenance**

Of the $850 charged per member annually, between $425 and $595 goes to road maintenance. However, as previously mentioned, none of this is currently used for repairs on Warrens Landing Road.

- **Abutter Request?**

The Fisher's Landing Association has requested that Warrens Landing Road be taken, meaning the taking would likely face little resistance from abutters.

- **Reason for the Request?**

The Fisher's Landing Association wants Warrens Landing Road to be taken because they claim it is used more by the public than the abutters, or it has become a public thoroughfare. This is supported by the traffic count data collected by the team and described previously.

- **Cost to Grind and Regrade**

The paved portion of Warrens Landing Road, totaling 2,921 feet of road and average of 15.4 feet wide, would cost approximately $226,000 to grind and regrade.

- **Cost to Reconstruct**

Warrens Landing Road, totaling 4,950 feet long and an average of 15.4 feet wide, would cost approximately $315,000 to reconstruct once the paved portion of the road has been ground and graded.

4.5.3 Somerset Road

- **Level of Use**

Of the three roads evaluated by the team, Somerset Road had the highest average usage per hour at 63.7 cars per hour. As shown in Figures 4.16, 4.17 and 4.18, there was only a minimal difference between the levels of usage of Somerset Road at each intersection examined.

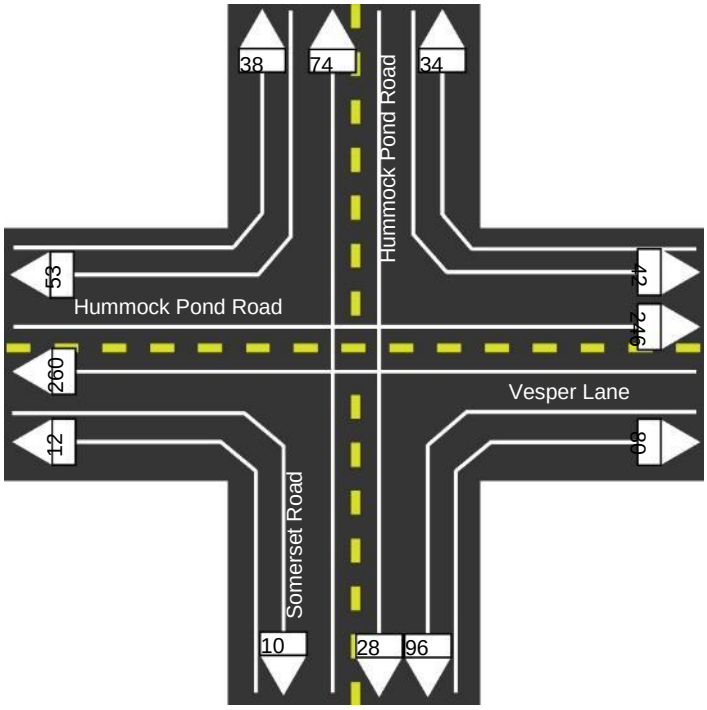

Figure 4.16: Turning movement count where Somerset road meets Vesper Lane

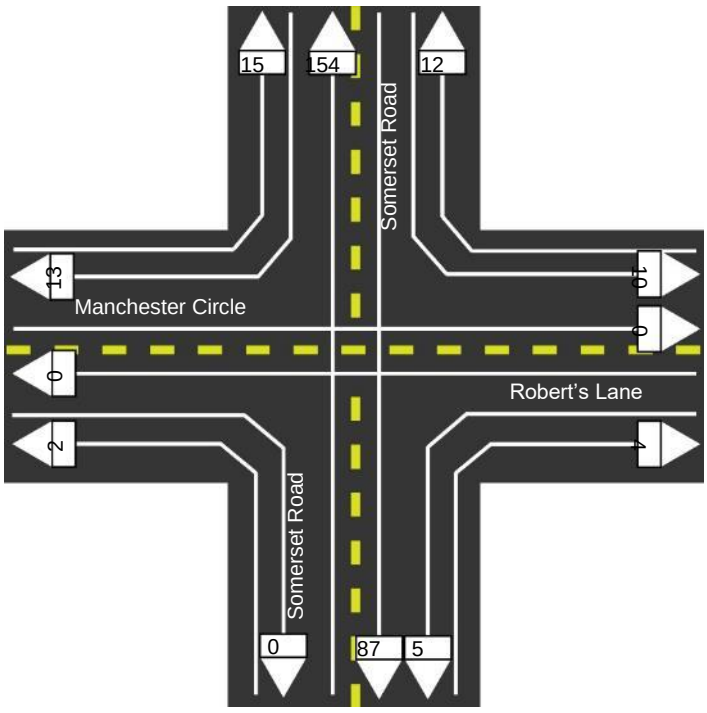

Figure 4.17: Turning movement count where Somerset Road meets Roberts Lane

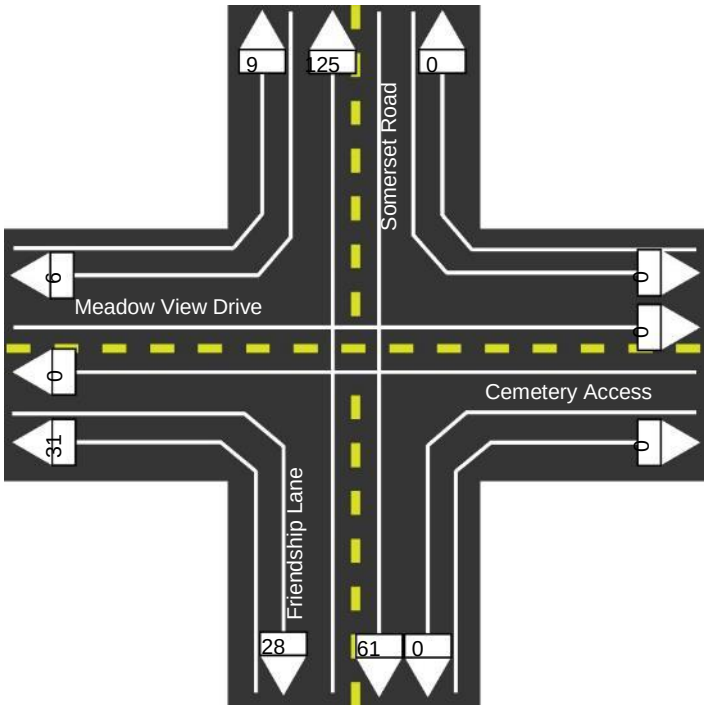

Figure 4.18: Turning movement count where Somerset Road meets Friendship Lane

The intersection with Vesper Lane totaled 71.3 cars per hour, the intersection with Roberts Lane totaled 75.5 cars per hour, and the intersection with Friendship Lane totaled 50.3 cars per hour. Most importantly, 125 cars entered the south end of Somerset Road from Friendship Lane, and 166 cars left the north end of Somerset Road. This strongly suggests that this portion of road is used primarily by the public as approximately 75% of the cars leaving the north end of Somerset Road came from Friendship Lane.

- **Road Category**

  The team categorized Somerset Road as a connector because it connects Bartlett Road (through Friendship Lane) to Vesper Lane and Hummock Pond Road.

- **Number of Sole Access Roads**

  There are no roads solely accessible by Somerset Road.

- **Leads to or Contains a Public Facility**

  Somerset Road does lead to public facilities, these being Hummock Pond Road, Vesper Lane, and Bartlett Road (through Friendship Lane).

- **Bike Route / Bike Route Connector**

  Somerset Road would not connect any current bike routes.

- **Road Condition Value**

  Somerset Road's average condition value is the lowest of the three roads evaluated by the team at 2.25. However, this value was almost exclusively resulting from the unpaved portion of Somerset Road as the paved portion had a condition value of 0.11. The majority of the issues on Somerset Road were corrugations, which contributed to 64% of the total condition value.

- **Number of Structures**

  Somerset Road had the fewest number of structures at only 16, mainly due to the lack of sole access roads.

- **Presence of and HOA**

  There is no HOA present in the area of Somerset Road.

- **Abutter Request?**

  Abutters have not requested that Somerset Road be taken.

- **Cost to Grind and Regrade**

  The paved portion of Somerset Road, totaling 895 feet long and an average of 16.9 feet wide, would cost $76,000 to grind and grade.

- **Cost to Reconstruct**

Somerset Road, totaling 1,517 feet long and 16.9 feet wide, would cost $105,000 to reconstruct once the paved sections have been ground and graded.

4.6 Other Issues of Concern

Through discussion with stakeholders we discovered a few very interesting issues that private roads face along with the issues that have already been discussed. These issues include easements for utilities, street signs, house numbers, and addresses, paper roads, road ownership, and discontinuous roads, and tax values, property values, and insurance rates. Each of these can be an issue for the homeowners themselves, but more frequently they are an issue for the emergency personnel and utility workers.

4.6.1 Easements

Through discussion with utility workers we learned that a utility cannot be put on a private road unless an easement is agreed upon. An easement is land that the homeowners allow the utility workers to use for their equipment, whether it be a water main or electrical wires. One of the main issues with easements on private roads is that the road does not tend to stay in one place. The lane of travel of a private road often changes because of a pothole or large puddle on the existing road. As people drive around to avoid damage to their vehicles they change the lane of travel.

Over time the movement of the road surface and the maintenance of the road can damage or dislocate the equipment of the utility workers. After storms, Dave Fredericks has additional crew members come over from the mainland to help repair damage. They have had problems locating transformers because porches have been built over them or brush has grown in. These problems are typically indicative of a road moving over time or an easement being setup in the center of property instead of along the road because private roads are typically not laid out where they were planned to be on maps. The electric company also has issues with exposed wires on the ground (Figure 4.19). It has buried wires under the road surface and over time they have become exposed because of maintenance done on the road or road surface being lost during a storm (D. Fredericks, personal communication, November 10, 2015). The inability to quickly access transformers and exposed wires on the ground can impact the electric company's ability to fix issues quickly; it can also be a potential public safety concern.

Figure 4.19: Electrical cable traversing an easement on Skyline Drive

The water company typically asks for a twenty-foot easement, but because of the narrowness of the roads and the proximity of the houses to the road they typically only get ten feet with a five-foot temporary construction easement on either side. Just like for the electric company road maintenance and grading of the road cause problems for their water mains because they become exposed and get broken. Unlike the electric company they have standards for what can be placed within an easement because they agree to pay for all damages on an easement that occur during maintenance. These standards prevent the building of structures and what landscaping can be done so that they are not paying too much in damage costs (B. Gardner, personal communication, November 16, 2015).

Utility companies are often concerned about getting easements, like the one seen in Figure 4.20, approved especially on a proprietors' way where a single abutter can stop the entire process. They are also concerned about damage costs they will accrue because of the poor maintenance or over grading of a road. Lastly, they are concerned with the movement of their easement as the road shifts, so access to their equipment on the road may be impeded.

Figure 4.20: Filled easement trench on Skyline Drive

4.6.2 Street Signs, House Numbers, and Addresses

The fire department has experienced a lot of problems with missing street signs and missing or illegible house numbers. Nantucket has a standard street sign for public roads, which is represented in Figure 4.21 by the lower left image of the Massachusetts Avenue street sign. The town is required to put a standard double-sided street sign on private roads where they intersect public roads (K. Buzanoski, personal communication, November 17, 2015). Homeowners on private roads that do not intersect public roads need to install their own street sign, but these typically are not the standard town signs. The other three pictures in Figure 4.21 depict street signs at the intersection of two private roads. These non-standard signs are difficult to read especially from a fire truck at night or in inclement weather.

Visible house numbers are required by law and there is a $50 fine for any house that does not comply. The main issue with this law is that it is not enforced by any town entity (D. Dilworth, personal communication, November 13, 2015). Thus there are many houses that lack visible house numbers making it difficult for the fire department to locate homes during an emergency.

Figure 4.21: Equator Drive, Long Pond Drive, Massachusetts Avenue, and Washington Avenue signage

4.6.3 Paper Roads, Road Ownership, and Discontinuous Roads

Paper roads, or roads that seemingly exist on deeds, maps, or other documents but do not exist physically are an issue common in Nantucket. Paper roads are often an issue of public safety because house addresses do not always match the road that the house can be accessed from. This issue occurs because the road the house was supposed to be built on according to the original plans and maps was never completed. The fire department attempts to mitigate this concern by planning their routes to a scene prior to departing. Another issue prompted by paper roads are roads that are not continuous. Washington Avenue should extend from G Street to North Cambridge Street. While the avenue starts and ends at those locations, there are large gaps in between that were never built, making the "road" unable to be traversed by a vehicle, emergency or otherwise (Figure 4.22).

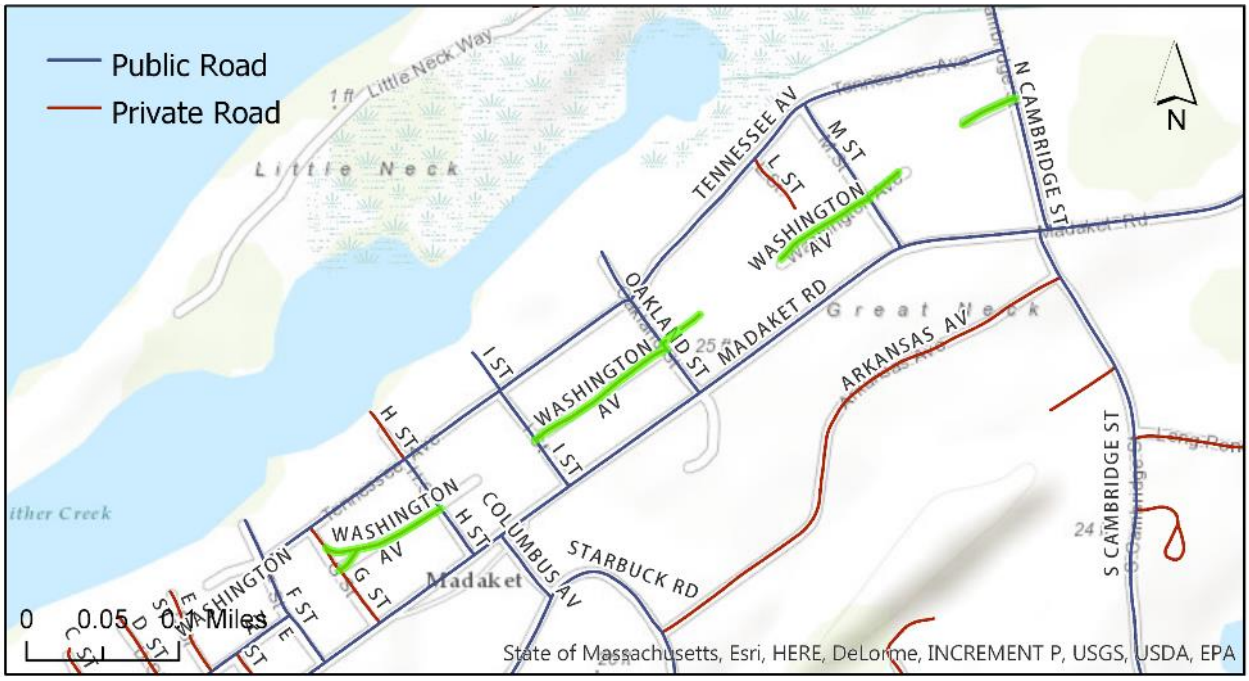

Figure 4.22: Privately-owned section of Washington Avenue

Aside from paper roads, access on private roads may be impeded by locked fences, gates, or chains. While such blockades are not technically allowed on a road, public or private, there are areas known to the fire department in which they exist. One such road that contains a blockade is Capaum Road; three abutters to the road collectively installed a locked gate, with the location of the key unknown to the fire department. When the fire department responds to this area, they must plan a route that avoids this road, potentially increasing their response time (R. Bates, personal communication, November, 12, 2015).

4.6.4 Tax Rates, Property Values, and Insurance Rates

Many of the stakeholders on the island including Kara Buzanoski and Gregg Tivnan believe that both property values and tax rates are affected by living on a private road and the maintenance of the road. Gregg Tivnan mentioned a change in tax role when we were discussing the cost of taking a private road (G. Tivnan, personal communication, November 6, 2015). To learn more about the effect living on a private road has on tax rates and property values we talked to Debbie Dilworth, the town's assessor. During our discussion with her we discovered some surprising information. According to Debbie Dilworth, both tax rates and property values do

not change depending on if your road is private or not. When we asked if the condition of the road affected property value she responded, “You’d think that, but some of my highest values are on the most deplorable roads” (D. Dilworth, personal communication, November 13, 2015). Rather than being affected by road condition property value is typically based on location and the property itself. Tax rates are not affected by private roads because roads are not taxed in Massachusetts, thus there is no change in tax role when a road is taken (D. Dilworth, personal communication, November 13, 2015).

The same town officials also believed that insurance rates were assessed based on road condition. After communication with an insurance representative through our advisor, we learned that insurance rates used to be affected by the surface type, paved or unpaved, of the road, but they no longer are. Thus insurance rates are not affected by whether or not a road is public or not (D. Golding, personal communication, December 8, 2015).

We interviewed a real estate agent, Jennifer Shalley, to learn how property values are affected by private versus public roads in the real estate market. She confirmed that property value is not generally affected by whether the road is private or public. However, it is affected by the condition of the road and the presence of utilities. A road being unpaved limits the number of clients willing to look at it, thus lowering the demand. Other people want to live on an unpaved road because of the character. When discussing the topic of knowledge of responsibility with other stakeholders, we found that many lacked knowledge of their responsibility. However, according to Jennifer Shalley, they inform all clients of the ownership of the road, who is responsible for maintenance, and if a homeowners association is present in the area. This being said, she welcomed the idea of having a uniform way to distribute this information. In summary, property values, from a real estate agent’s perspective, are affected by road condition, and the presence of utilities rather than the road’s ownership (J. Shalley, personal communication, December 11, 2015).

5.0 Conclusions and Recommendations

Conclusion 1: Criteria to Prioritize Roads

Nantucket, just like many other towns in Massachusetts, faces a significant problem with respect to the management of private road maintenance. The maintenance and repair of private roads is the responsibility of the abutters and the homeowners associations in the area. Due to a lack of knowledge of proper maintenance techniques and responsibility, or a strong desire for privacy, many of the roads are in a state of disrepair. Sixty-four percent of roads on Nantucket are private and their construction predates the establishment of design requirements such as minimum width standards. Due to the lack of design requirements, many of the roads are extremely narrow and do not meet current town standards. The condition of the private roads causes a public safety concern because it affects emergency vehicle access by completely inhibiting it or by increasing response times. Over the years there have been cases of fire department vehicles being damaged or getting stuck on the way to an emergency. In order to prevent these problems from occurring there needs to be a method for managing the maintenance of these private roads.

Due to the extent of the problem it is not expected that the town can take on the maintenance of all the roads at once, so there needs to be a priority system that allows the DPW to determine what roads need to be taken by the town and which ones will remain private. The roads taken by the town may then be brought up to standard and maintained by the DPW. Thus we created a list of measurable criteria which the town can apply to roads it is considering for taking, and applied these criteria to three roads to represent examples of their use.

Recommendation 1: We recommend that the DPW and the town utilize this list of criteria when determining whether or not to take a road. These criteria should be applied to the roads currently on the Potential Road Takings List to verify the current rankings of each road. In addition, the criteria should be applied to roads added to the list of potential takings in the future. We recommend conducting more extensive traffic counts as part of the process to determine road takings, ideally including multiple days from multiple different times in the year. This would provide a more accurate representation of the level of use on each road considered. Once the priorities have been adjusted, it is recommended that the town continue working with the DPW to adopt the highest priority roads.

Conclusion 2: Snow Removal Policy

Other seasonal towns, with a high percentage of private roads, incentivize abutter maintenance with a snow removal policy. They guarantee that a private road that meets the specific requirements described in the policy will be plowed. Eastham has stricter requirements than Wellfleet, but based on conversations with various stakeholders on island even Wellfleet's standards would receive significant resistance from residents on private roads. Typically, residents enjoy their privacy and would like to maintain the country landscape, even if it affects their safety and the safety of the people around them.

Recommendation 2: We recommend that the Town of Nantucket draft an adapted snow removal policy that is appropriate for Nantucket. Since the policy is voluntary, only abutters who want their roads to comply with the requirements should participate. If a policy is created, it would most likely apply to newer private roads that were built to the subdivision rules and regulations because they will already meet most of the standards the town sets. For them, the plan would incentivize continued maintenance in order for the town to continue to plow their roads. For older private roads that were not built to a standard, the plan may not be enough of an incentive for many homeowners to participate. However, the policy has the potential to incentivize some homeowners living on existing roads to better maintain their roads. Compared to alternative options the town could use to maintain roads, this plan is a cheaper solution because they have to pay for plowing, but not for the maintenance of the road.

Conclusion 3: Homeowner Education on Private Road Maintenance

A lack of knowledge regarding road maintenance is often expressed as a concern; addressing this issue is important in order to get abutters of private roads to perform needed maintenance. Some homeowners may not realize that they even live on a private road, and those that do may not be aware of what the distinction means in terms of their rights and responsibilities. For those abutters, a technique is needed to convey what their responsibilities are, and why they are important to follow through with. In addition, it is necessary to inform abutters of private roads what proper maintenance techniques are; part of this process should include familiarizing abutters with the various types of maintenance techniques, such as paving and grading. Once abutters understand what maintenance types may be appropriate for their roads, it is possible to direct them to appropriate contractors who can assist with their project. Jennifer Shalley, a real estate agent on

Nantucket, said that her clients are already informed about some of this information when buying a property on a private road. However, she said having a uniform way to distribute such information would be very helpful and she welcomed the idea of a brochure or website providing this information. (J. Shalley, personal communication, December 11, 2015).

Recommendation 3: We recommend that the town compile and distribute private road maintenance information, as described above, through one or more media. Potential media include, but are not limited to, a brochure (such as the one presented in Evaluating Private Roads on Nantucket (2012)), an informational page on the town's website, and periodic information sessions with homeowners and homeowner association members (potentially organized by the Civic League).

Future Work

If we were to continue this project, we would first complete our analysis of Somerset Road, Warrens Landing Road, and Millbrook Road by conducting more extensive traffic counts. The traffic counts conducted by the team only lasted four hours on a single day. Therefore, these may not represent an accurate reflection of the road's usages. To obtain a more accurate count of the average usage of the road, it is recommended that traffic counts be carried out over extended periods of time and at different points during the year. This would provide a better representation of the level of use of the road. We would then continue to apply the criteria in our report to other roads on the DPW's current potential takings list. Once complete, these roads should be prioritized in order to streamline future takings.

Another area in which we could continue our research would be to further assess homeowners' opinions on a variety of topics. Currently, the team only discussed the issues in the report with homeowners associations presidents. Given more time, we could survey a larger number of homeowners in an effort to collect:

- Current levels of knowledge on road maintenance,
- Opinions on standards for a snow removal policy, and
- Opinions on the best medium for educating homeowners on road maintenance.

This survey could then be acted upon to draft a snow removal policy and to create an educational program about road maintenance.

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Appendix A: Cost Effective Unpaved Road Maintenance

The first step in maintaining an unpaved road is determining the condition of the road. The Ministerio de Obras Públicas (MOP) developed a method called the Modelos de Deterioro de Caminos No Pavimentados (Chamorro, de Solminihac, Salgado, & Barrera, 2009). They created an equation which calculated the unpaved condition index (UPCI) by objectively measuring eight different defect types. These defect types can be found in the Table A.1 with a description of how to measure them. This table was recreated from the original document.

Table A.1: Road defects considered in survey guidelines

Defect Type	Measuring Method and Units
Corrugations	Mean depth in centimeters of three measures of the vertical deformation observed in a section
Erosion	Mean depth and width in centimeters of critical erosions observed between or within sample sections
Potholes	Mean diameter (d), typical depth (D) and number (n) of potholes recorded per section; units are square centimeters obtained from the product d*D*n
Rutting and loose aggregate	Mean depth in centimeters of three measures of the vertical deformation observed in a section
Oversized aggregates	Maximum diameter in centimeters of exposed oversized aggregate representative of a section
Roughness (IRI)	International roughness index measured with response type device in m/km
Transverse profile	Qualitative measure of the transverse fall of the section. Rated as 0 if good, 0.5 if fair, and 1 if poor
Drainage condition	Drainage problems, especially evidenced in the presence of moisture. Rated as 0 if good, 0.5 if fair, and 1 if poor.

(Chamorro et al., 2009).

There were two similar equations used; one includes roughness and the other does not. During their research, the MOP found that corrugation and potholes produced a similar result as

roughness, so if roughness could be measured then the corrugation and number of potholes on the road did not need to be measured. The equations are written as follows:

Does not include roughness: UPCI=10-1.16CR-2.25PT-1.47ER-0.33RT-1.560OA-1.58CW
Includes Roughness: UPCI=11.64-0.41IRI-1.60ER-0.40RT-1.79OA-1.57CW (Chamorro et al., 2009)

A table (Table A.2) was created based on a bulleted list of each abbreviation included in the original text.

Table A.2: Abbreviations used in road condition equations

Abbreviation	Description	Unit
CR	corrugation	cm
PT	potholes	m^2
ER	erosion	1 unless measured as greater than 5 cm then road is automatically considered very poor
RT	rutting/transverse deformation	cm
OA	oversized aggregate	1 if aggregate of 10cm+ is common
CW	crown condition	0=good, 0.5=fair, 1=poor
IRI	International roughness index	m/km

(Chamorro et al., 2009).

One of the MOP's goals for this project was to create a versatile system for determining the condition of unpaved roads. Using the equations above and the measurement techniques described in Table A.1, the conditions of unbound gravel, stabilized gravel, and earth can be determined. They also determined the different UPCI condition limits for three different climates related to the three different road types. The three climates they focused on were dry, Mediterranean, and humid. They also looked at humid and icy climates, such as the typical New England climate, but they determined that road condition values were the same for humid climates as it was for humid

and icy so they were included as one. Focusing on the humid climate, Table A.3 was created from the original three tables included in the text that depicts the UPCI condition limit values for a humid climate (Chamorro et al., 2009).

Table A.3: Overall condition rating based on the calculation

Condition	Unbound Gravel	Stabilized Gravel	Earth
Very good	10 to 8.0	10 to 8.5	10 to 8.0
Good	7.9 to 7.0	8.4 to 7.5	7.9 to 6.5
Fair	6.9 to 5.0	7.4 to 5.5	6.4 to 4.5
Poor	4.9 to 3.5	5.4 to 4.0	4.4 to 3.0
Very Poor	3.4 to 1.0	3.9 to 1.0	2.9 to 1.0

(Chamorro et al., 2009).

Using the calculated values from the equations and Table A.3, the condition of the road can be determined and then an appropriate maintenance method can be applied.

There are many different methods of maintenance that can be performed on an unpaved road. The maintenance strategy used depends on the condition of the road. One form of maintenance that should be conducted on unpaved roads that have a fair or lower rating is blading. Blading drags the road, flattening high spots and filling low spots. This should not be done when the road is wet, but when it is supposed to rain. Do not perform blading on a road that is in adequate condition because it can cause quicker degradation of roads. If the roads condition cannot be repaired with the blading, grading is the next option. Grading digs into the surface of the road and redistributes the material to recreate a good road condition. Sometimes more material has to be added to create the proper crown on the road to promote proper drainage (Choctawhatchee, Pea and Yellow Rivers Watershed Management Authority, 2000). The correct maintenance method for the road condition needs to be chosen so that money is not spent on an unnecessary method of repair.

Appendix B: Preambles

Section 1: Formal Preamble for Face-to-Face and Phone Interviews

We are a group of students from Worcester Polytechnic Institute working in collaboration with the Nantucket Department of Public Works to evaluate long-term management strategies for the maintenance of private roads on the island. We would like to ask you a few questions on current policies and practices regarding private roads. Please know that you may skip any question you are not comfortable answering, and may also stop the interview for any reason. Since your views are important, we would like to quote you in our final report but we will give you the right to review any quotations we use prior to publication. If you prefer we can anonymize your contributions. May we proceed?

Section 2: Informal Preamble for Town Officials and other Stakeholders Contacted through Email

We are a group of students from Worcester Polytechnic Institute working in collaboration with the Nantucket Department of Public Works. We are currently working to develop long-term management strategies for the maintenance of private roads on the island.

Appendix C: Potential Interview Questions

Section 1: Standard Interview Script

General Script

What private roads seem to be the biggest problem?

- What should be done to fix these roads?
- Are there roads which were initially okay but are now a problem?
- Why are they becoming a problem?
- Where are there complains about public use of private roads?

We have heard that emergency vehicles periodically get stuck on private roads. What are the major causes of this?

- Which roads cause the most trouble?
- How frequently do these issues occur?

What was some of the discussion around the taking of Boulevarde?

Should the town consider maintaining private roads without taking them?

- Why/why not?

Would the snow removal program created in Wellfleet work in Nantucket?

What is the role of a homeowners association?

- Do Homeowners Associations, in general, keep us with the maintenance of their roads?
- Do you have concerns regarding their ability or desire to maintain their roads?
- Are there concerns among homeowners about a lack of knowledge on how to properly maintain a road?

Who else should we talk to?

Section 2: Department Specific Questions

Department Specific:

- Assessor
    - Does the ownership of a road affect property value or taxes?
    - Does the condition of a road affect property value or taxes?
- Civic League
    - Is there a way to determine an HOA's cohesiveness and focus through numbers?
- Electric Company
    - How are easements on private roads handled?

Fire Department

- Are there issues with a lack of access to water for fighting fires on private roads?

- Homeowners Associations
    - What is the focus of your association?
    - How do you maintain the roads in your area?
    - What percentage of potential members within the area are active?
    - What do you charge for dues?
    - What portion of these dues go towards road maintenance?
    - Has your association ever approached the town asking for help with maintenance of for public acceptance of one of your roads?
- Planning Board
    - How should we conduct traffic counts?
- Police Department
    - How is traffic violation enforcement different on private roads?
- Wannacomet Water Company
        - Are there any water lines along private roads?
        - Are specialized vehicles needed for work on skinny or unpaved roads?

Appendix D: General Script for Town Interviews

General road numbers

- Number of total roads - mileage preferred
- Number of private roads - mileage if possible

Issues with private roads

- Are there any issues with private roads in _____?
- Public safety / Emergency personnel
- Road condition / width / height / encroachment

Current management practices for the maintenance of private roads

- How does ___ currently handle private roads?
- Are there any town programs or initiatives focused on either maintaining or adopting private roads?
- Wellfleet's board of selectmen developed a standard for private roads, including the following requirements: visible street sign / 14 ft of clearance above road surface / 10 feet of width / place for town vehicles to turn around
- Does ____ have any standards such as this for private roads?

Town maintenance

- Does the town maintain any private roads?
- How is this maintenance funded? By the abutters? By the town?

Criteria for adoption

- How does ____ go about adopting private roads?
- Do you have a set of criteria which determines whether a road should be adopted?
- How do you assess this criteria?

Homeowners associations

- Are there a lot of homeowners associations in ____?
- Are they generally seasonal?
- How many are mostly focused on private ways?
- Do these associations generally keep up with the maintenance of their roads?
- Do you have any concern about either their ability or their willingness to keep up with maintenance?

Who else should we talk to?

Appendix E: Interviewee Table

Interviewee	Organization	Position	Road Condition	Maintenance Funding	Public Safety Concerns	Taking	Town Maintenance	Abutter Maintenance	Other
Kara Buzanoski	DPW	Director	X	X	X	X	X	X	
Ed Maxwell	Fire Department	Deputy Chief	X		X	X	X	X	
Paul Rhude	Fire Department	Chief	X		X	X	X	X	
Peter Morrison	Nantucket Civic League	Co-President	X	X	X	X	X	X	
Dave Fredericks	National Grid of S. New England	VP of Operations	X		X	X	X	X	
William Pittman	Police Department	Chief	X		X	X	X	X	
Allen Reinhard	R&ROW / Civic League	Chairman / President	X			X	X	X	
Lee Saperstein	R&ROW / Civic League	Member / Member	X			X	X	X	
Gregg Tivnan	Town Manager's Office	Assistant Town Manager	X			X	X	X	
Mike Burns	Town of Nantucket	Transportation Planner	X				X	X	
Bob Gardner	Wannacomet Water Company	General Manager	X	X		X		X	
Dave Fronzuto	Emergency Management	Coordinator	X		X		X	X	
Debbie Dilworth	Town of Nantucket	Assessor				X			Tax and property assessments
Andrew Vorce	Town of Nantucket	Planning Director	X		X	X		X	Subdivision Rules and Regulations
Carol Langer	Cisco Civic Association	President	X	X		X	X	X	
Charles Stott	Madaket Resident Association	President	X	X		X	X	X	
Mark Donato	Siasconset Civic Association	President	X	X		X	X	X	
Tom Quigley	Surfside Association	President	X	X		X	X	X	
Claire Graves	Fisher's Landing Association	President	X	X		X	X	X	
Jennifer Shalley	Windwalker Real Estate	Director of Research & Broker Associate							Property values

Appendix F: List of Homeowners Associations

Representative	Association Name	Email of Representative
Mason Heydt	Brant Point Association	heydtfive@gmail.com
Carol Langer	Cisco Civic Association	carollanger@comcast.net
Laura O' Donnell	Fisher's Landing Assn	lrodonell@partners.org
Sarah Oktay	Harbor South Association	sarah.oktay@umb.edu
Marcia Butman	Hinckley Lane Association	mbutman@gmail.com
Robert Williams	Hummock Pond Association	robertw188@gmail.com
Neil Graner	Hummock Pond of Nantucket HOA	bill.grieder@gmail.com
Georgia Snell	Hussey Farm Association	snellhotel@gmail.com
Bill Grieder	Madaket Conservation Association	bill.grieder@gmail.com
Charles Stott	Madaket Residents Association	stott.charles9@gmail.com
Peter Campanella	Monomy	campanellapf@aol.com
Charles Walters	Nantucket Town Association	carulus38@hotmail.com
Ken Gentner	Naushop	kgentner@optonline.net
Patty Roggeveen	Pine Valley Association	pattyroggeveen@gmail.com
Bob Shapiro	Pocomo Association	rsslks@pobox.com
Mary Wawro	Polpis Association	marycarita@me.com
Richard Peterson	Quidnet-Squam Association	petersor@att.net
Mark Donato	Siasconset Association	m.donato@comcast.net
Thomas Quigley	Surfside Association	tquigley2@aol.com
Dual Macintyre	Tom Nevers Civic Association	dualmacintyre@comcast.net
Tony Cahill	Wauwinet Landowners Association	tcahilljr1@aol.com
John Johnson	West Miacomet Homeowners Association	ljljatthebeach@aol.com

(Nantucket Civic League, 2015).

Appendix G: HOA Information Table

Association	President	Percentage of active members out of possible members	Dues Charged	Percentage of Dues Spent on Maintenance	Notes
Brant Point Association	Mason Heydt	100%	$3000-$4000	17%-25%	Dues and percent spent on maintenance are dependent on the year
Cisco Civic Association	Carol Langer	92%	$200	87.50%	-
Fisher's Landing Association	Claire Graves	100%	$850	50 - 70%	-
Harbor South Association	Sarah Oktay	-	-	-	-
Hinckley Lane Association	Marcia Butman	95%	$50	Majority	$5 per person goes to Civic League
Hummock Pond Association	Robert Williams	99%	$25	$14	$14 sounds like a separate fee on top of dues
Hummock Pond of Nantucket HOA	Neil Graner	82%	$250	0%	Work done as required. Improvement of $5 million done in 2013
Hussey Farm Association	Georgia Snell	50%	$250	Majority	Some goes toward snow plowing and brush cutting
Madaket Conservation Association	Bill Grieder	-	$30	0%	-
Madaket Residents	Charles Stott	65% - 75%	$50	0%	-
Monomy	Peter Campanella	73%	$50	0%	-
Nantucket Town Association	Charles Walters	10%	$20-$125	0%	Residents Association
Naushop	Ken Gentner	99%	$1,900	Majority	Bi-annual crack filling: $3,000 Operating Maintenance/Cleaning: $15,000 Future pavement replacement fund: $877,000
Pine Valley Association	Patty Roggeveen	-	-	-	-
Pocomo Association	Bob Shapiro	90%	$100	0%	-
Polpis Association	Mary Wawro	about 75%	$50	0%	Residents association, abutters do maintenance
Quidnet-Squam Association	Richard Peterson	85% - 95%	$150 per home	$6000-$12000 avg. 70% ($9000)	-
Siasconset Association	Mark Donato	50%	$45	0%	-
Surfside Association	Tom Quigley	37.50%	$25	0%	Residents Association, separate voluntary fund for road maintenance
Tom Nevers Civic Association	Randy Ringer	25% - 49%	$15	0%	Residents association
Property Owners of Tom Nevers East	Burt Johnson	100%	$300	majority	-
Wauwinet Landowners Association	Tony Cahill	75%	$70-$140	$1500-$3000	Two different dues depending on if you live south or north of the inn
West Miacomet Home Owners Association	John Johnson	-	-	-	-

Appendix H: Online Worksheet used for Road Evaluation

Road Name: _____

Section Information:

Section #: _____
Section Start: _____
Section End: _____

Aggregate:

Extent 1: _____
Extent 2: _____
Extent 3: _____

Potholes:

Depth: _____
Extent: _____

Corrugations:

Extent 1: _____
Extent 2: _____
Extent 3: _____

Ruts:

Extent 1: _____
Extent 2: _____
Extent 3: _____

Road Width:

Start of Segment: _____
End of Segment: _____

Road Height:

Start of Segment: _____
Middle of Segment: _____
End of Segment: _____

Notes:

_____

_____

_____

Appendix I: Traffic Count Tables used During Counting

Traffic Count Location: _____ **AM / PM** **Date:** _____

TIME	CARS PASSING HEADING TOWARDS TOWN	CARS PASSING HEADING AWAY FROM TOWN	CARS TURNED ON COMING FROM TOWN	CARS TURNED ON COMING FROM _____	CARS TURNED OFF HEADING TOWARDS TOWN	CARS TURNED OFF HEADING AWAY FROM TOWN	TRAILERS 	OTHER *
TO								
TO								
TO								
TO								

Traffic Count Location: _____ AM / PM Date: _____

TIME	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	TO	TRAILERS	OTHER
TO														
TO														
TO														
TO														

Appendix J: Evaluation Worksheet

Unpaved Road Condition Survey.

Road Name: _____

Section #: _____

Section Start Location: _____

Section End Location: _____

Loose Aggregate

Severity	Extent <10%	Extent 10-30%	Extent >30%
<1"	1	2	3
1-3"	4	5	6
>3"	7	8	9

Potholes

Severity	Extent (#/100 ft) <5	Extent (#/100 ft) 5-10	Extent (#/100 ft) >10
<1"	1	2	3
1-3"	4	5	6
>3"	7	8	9

Corrugations

Severity	Extent <10%	Extent 10-30%	Extent >30%
<1"	1	2	3
1-3"	4	5	6
>3"	7	8	9

Ruts

Severity	Extent <10%	Extent 10-30%	Extent >30%
<1"	1	2	3
1-2"	4	5	6
>2"	7	8	9

Width
Straight 16' (y / n)
Actual: _____
Corners 20' (y / n)
Actual: _____
Cause: (Surface Width, Banks, Overgrowth)
Notes:

Height
Minimum: 14' (y / n)
Actual:_____

Notes:

(Cocks, Corrigan, LaRue, 2012).

Appendix K: Roads and Right of Way Committee Potential Takings List

POTENTIAL ROAD TAKINGS LIST, November 2015 w/ K. Buzanoski Recommendations									
Order	**Road**	**Public Use of this Road**	**Road links Two Public Roads**	**Public Safety Concerns**	**Traversable by Emergency Vehicles**	**Abutters' Requests**	**Access to Public Property Including Beaches**	**Traffic Circulation Patterns**	**Other Benefits to the General Public; Comments**
1	Boulevarde	Yes	Yes	Moderate	Difficult	Yes, %age	Yes	Heavy	Route to Surfside Beaches; Surfside to Airport; Taking Underway
2	Airport Roads: Boulevarde, Clifford Street, Lovers Lane, Okorwaw, Monohansett	Yes	Yes	Moderate	Difficult	Yes, %age	Yes	Heavy	Taking Underway
3	Friendship Lane, from Bartlett Road to Joy Street	Yes	Yes	Moderate	Difficult	Yes, %age	No	Light	Drainage and maintenance problems
4	First Way	Yes	Yes	Substantial	Moderate	Yes	Yes	Heavy	This way is due to be re-built to provide safe access to the public schools campus
5	Winn Street	Yes	Yes	Moderate	Difficult	Yes	No	Moderate	Taking and rebuilding will provide public access around Quaker Burial Ground to beach bike paths.
6	Amelia Drive and Ticcoma Way	Yes	Yes	Moderate	Moderate	Yes	No	Heavy	Expanding commercial developments; narrow roadway limits two-way traffic
7	Backus Way	Yes	Yes	Substantial	Difficult	No	Yes	Heavy	Backus Way is a private road but is part of the road and pedestrian links to the public schools campus.
8	Millbrook Road	Yes	Yes	Slight	Moderate		Yes	Moderate	
9	Smooth Hummocks Way	Yes	Yes	Slight	Moderate		Connection	Light	Alternate access to Bartlett Farm and beaches
10	Cato Lane; if connected	Yes	Yes	Moderate	Easy	No	Connection	Heavy	Alternate access to Mid-Island if connected
11	Eel Point Road from No. ? To Warrens Landing Road	Yes	Yes	Slight	Difficult		Yes	Light	Eel Point and Warrens Landing
12	Warrens Landing Road	Yes	Yes	Slight	Moderate	Yes, FLA	Yes	Light to moderate	Access to Warrens Landing and Eel Point; Fisher's Landing Assn Letter
No Rec	Hooper Farm Road	Yes	Yes	Slight	Moderate	No	No	Light	Abutters do not wish taking
No Rec	Eel Point Road, from end of public road to Number ?	Yes	Yes	Moderate	Difficult		Yes	Light	40th Pole and Eel Point
No Rec	Red Barn Road	Yes	Yes	Slight	Difficult	No	Yes	Light	West Moors, Head of Plains, FAA Property
No Rec	Somerset Road, from Raceway Drive to Friendship Lane	Yes	Yes	Slight	Difficult	Yes, %age	Yes	Light	

Appendix L: Our Criteria List

Road Name			
Level of use (cars/hr)			
Road category			
Road notes			
Number of sole access roads			
Leads to or contains a public facility? †			
Bike route / bike route connector			
Road condition value (per 100 ft road segment)			
Number of Structures			
Presence of an HOA			
Amount per member put towards maintenance			
Abutter request?			
Reason for request			
Length (feet)			
Average width (feet)			
Surface type			
Cost to grind & regrade ($)			
Cost to reconstruct ($)			

Terminology Notes:

† A **public facility** is defined as any location accessed by the public.

Appendix M: Traffic Counts Raw Data

Section 1: Millbrook Road

Millbrook Road - Madaket Rd Intersection (11/18/2015)

		Madaket Road From West						Madaket Road From East						Millbrook Road From South						
		Right		Thru		Bikes	Peds	Thru		Left		Bikes	Peds	Right		Left		Bikes	Peds	Interval Total
Vehicle Type		P	C	P	C	-	-	P	C	P	C	-	-	P	C	P	C	-	-	-
Start Time	7:00 AM	1	0	29	1	0	0	46	1	0	0	0	0	2	0	2	0	0	0	82
	7:30 AM	1	0	43	2	0	1	75	10	4	0	0	0	3	0	1	0	0	0	140
	8:00 AM	1	0	47	12	0	0	63	14	4	0	1	0	2	0	2	0	0	0	146
	8:30 AM	1	0	43	6	0	1	62	6	4	0	0	0	0	1	2	0	0	0	126
Total		4	0	162	21	0	2	246	31	12	0	1	0	7	1	7	0	0	0	494
Start Time	4:00 PM	5	0	64	14	0	0	34	2	2	0	0	0	4	0	2	0	0	0	127
	4:30 PM	0	0	54	4	0	0	34	3	1	0	0	0	3	1	0	0	0	0	100
	5:00 PM	1	0	44	7	0	0	36	0	2	0	0	0	4	0	2	0	0	0	96
	5:30 PM	0	0	27	2	0	0	24	0	0	0	0	0	0	0	1	0	0	0	54
Total		6	0	189	27	0	0	128	5	5	0	0	0	11	1	5	0	0	0	377
Grand Total		10	0	351	48	0	2	374	36	17	0	1	0	18	2	12	0	0	0	871
Approach %		2.4	0.0	85.4	11.7	0.0	0.5	87.4	8.4	4.0	0.0	0.2	0.0	56.3	6.3	37.5	0.0	0.0	0.0	
Total %		1.1	0.0	40.3	5.5	0.0	0.2	42.9	4.1	2.0	0.0	0.1	0.0	2.1	0.2	1.4	0.0	0.0	0.0	

Vehicles using Millbrook	59		Vehicles using Millbrook per hour	29.5

Millbrook Road - Hummock Pond Rd Intersection (11/18/2015)

		Hummock Pond Road From West						Hummock Pond Road From East						Millbrook Road From North						
		Thru		Left		Bikes	Peds	Right		Thru		Bikes	Peds	Right		Left		Bikes	Peds	Interval Total
Vehicle Type		P	C	P	C	-	-	P	C	P	C	-	-	P	C	P	C	-	-	-
Start Time	7:00 AM	18	2	1	0	0	0	6	0	21	3	1	1	0	0	12	0	0	1	66
	7:30 AM	24	0	0	0	0	0	14	1	34	1	0	0	1	0	7	0	0	0	82
	8:00 AM	31	3	0	0	0	0	11	1	41	3	1	1	1	0	13	0	0	0	106
	8:30 AM	24	1	1	0	0	0	7	1	29	1	0	0	2	0	15	1	0	0	82
Total		97	6	2	0	0	0	38	3	125	8	2	2	4	0	47	1	0	1	336
Start Time	4:00 PM	50	2	1	0	0	0	9	0	36	5	0	1	0	0	10	2	1	0	117
	4:30 PM	48	1	1	0	0	1	14	0	41	2	1	1	0	0	8	0	0	0	118
	5:00 PM	41	0	3	0	0	2	9	0	36	0	0	2	4	0	3	0	0	0	100
	5:30 PM	15	3	0	0	0	0	5	0	22	0	1	0	1	0	5	0	0	0	52
Total		154	6	5	0	0	3	37	0	135	7	2	4	5	0	26	2	1	0	387
Grand Total		251	12	7	0	0	3	75	3	260	15	4	6	9	0	73	3	1	1	723
Approach %		91.9	4.4	2.6	0.0	0.0	1.1	20.7	0.8	71.6	4.1	1.1	1.7	10.3	0.0	83.9	3.4	1.1	1.1	
Total %		34.7	1.7	1.0	0.0	0.0	0.4	10.4	0.4	36.0	2.1	0.6	0.8	1.2	0.0	10.1	0.4	0.1	0.1	

Vehicles using Millbrook	170	Vehicles using Millbrook per hour	85

Section 2: Somerset Road

Somerset Road - Meadow View/Friendship/Cemetery Intersection (12/1/2015)

		Somerset Road From North								Friendship Road From South								Meadow View Drive From West								Cemetery Access Road From East								
		Right		Thru		Left		Bikes	Peds	Right		Thru		Left		Bikes	Peds	Right		Thru		Left		Bikes	Peds	Right		Thru		Left		Bikes	Peds	Interval Total
Vehicle Type		P	C	P	C	P	C	-	-	P	C	P	C	P	C	-	-	P	C	P	C	P	C	-	-	P	C	P	C	P	C	-	-	-
Start Time	7:00 AM	0	0	3	0	0	0	1	0	0	0	20	0	0	1	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	29
	7:30 AM	1	0	7	0	0	0	0	0	0	0	53	0	8	0	1	0	5	0	0	0	3	0	2	0	0	0	0	0	0	0	1	0	81
	8:00 AM	1	0	6	0	0	0	0	0	0	0	17	0	3	0	1	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35
	8:30 AM	0	0	7	0	0	0	0	0	0	0	11	0	3	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	23
	Total	2	0	23	0	0	0	1	0	0	0	101	0	14	1	2	0	15	0	0	0	6	0	2	0	0	0	0	0	0	0	1	0	168
Start Time	4:00 PM	3	0	11	0	0	0	0	0	0	0	7	0	7	0	0	0	5	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	36
	4:30 PM	0	0	11	0	0	0	0	0	0	0	7	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23
	5:00 PM	1	0	10	0	0	0	0	0	0	0	10	0	5	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	30
	5:30 PM	0	0	6	0	0	0	0	0	0	0	0	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
	Total	4	0	38	0	0	0	0	0	0	0	24	0	16	0	1	0	13	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	100
	Grand Total	6	0	61	0	0	0	1	0	0	0	125	0	30	1	3	0	28	0	0	0	9	0	3	0	0	0	0	0	0	0	1	0	268
	Approach %	8.8	0.0	89.7	0.0	0.0	0.0	1.5	0.0	0.0	0.0	78.6	0.0	18.9	0.6	1.9	0.0	70.0	0.0	0.0	0.0	22.5	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	
	Total %	2.2	0.0	22.8	0.0	0.0	0.0	0.4	0.0	0.0	0.0	46.6	0.0	11.2	0.4	1.1	0.0	10.4	0.0	0.0	0.0	3.4	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	

Vehicles using Somerset	201	Vehicles using Somerset per hour	100.5

Somerset Road - Manchester/Roberts Intersection (12/1/2015)

		Somerset Road From North								Somerset Road From South								Manchester Circle From West								Roberts Lane From East								
		Right		Thru		Left		Bikes	Peds	Right		Thru		Left		Bikes	Peds	Right		Thru		Left		Bikes	Peds	Right		Thru		Left		Bikes	Peds	Interval Total
Vehicle Type		P	C	P	C	P	C	-	-	P	C	P	C	P	C	-	-	P	C	P	C	P	C	-	-	P	C	P	C	P	C	-	-	-
Start Time	7:00 AM	1	0	3	0	0	0	1	0	0	0	21	0	1	0	0	1	0	0	0	0	5	1	0	0	1	0	0	0	1	0	0	0	36
	7:30 AM	0	0	11	0	0	0	0	0	3	0	60	1	0	0	3	0	0	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0	84
	8:00 AM	0	0	7	1	1	0	0	0	0	0	16	1	1	0	1	1	0	0	0	0	1	0	0	1	7	0	0	0	1	0	0	0	39
	8:30 AM	0	0	10	0	2	0	0	0	0	0	15	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	29
	Total	1	0	31	1	3	0	1	0	3	0	112	3	2	0	4	2	0	0	0	0	8	1	0	1	10	0	0	0	4	1	0	0	188
Start Time	4:00 PM	2	1	17	0	4	1	0	0	1	0	9	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	39
	4:30 PM	1	1	13	0	1	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	25
	5:00 PM	5	0	14	2	1	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	44
	5:30 PM	2	0	8	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	16
	Total	10	2	52	3	6	1	0	0	1	0	38	1	0	0	1	0	0	0	0	0	5	1	0	1	2	0	0	0	0	0	0	0	124
	Grand Total	11	2	83	4	9	1	1	0	4	0	150	4	2	0	5	2	0	0	0	0	13	2	0	2	12	0	0	0	4	1	0	0	312
	Approach %	9.9	1.8	74.8	3.6	8.1	0.9	0.9	0.0	2.4	0.0	89.8	2.4	1.2	0.0	3.0	1.2	0.0	0.0	0.0	0.0	76.5	11.8	0.0	11.8	70.6	0.0	0.0	0.0	23.5	5.9	0.0	0.0	
	Total %	3.5	0.6	26.6	1.3	2.9	0.3	0.3	0.0	1.3	0.0	48.1	1.3	0.6	0.0	1.6	0.6	0.0	0.0	0.0	0.0	4.2	0.6	0.0	0.6	3.8	0.0	0.0	0.0	1.3	0.3	0.0	0.0	

Vehicles using Somerset	302	Vehicles using Somerset per hour	151

Somerset Road - Hummock Pond/Vesper Intersection (12/1/2015)

		Hummock Pond Road From North								Somerset Road From South								Hummock Pond Road From West								Vesper Lane From East								
		Right		Thru		Left		Bikes	Peds	Right		Thru		Left		Bikes	Peds	Right		Thru		Left		Bikes	Peds	Right		Thru		Left		Bikes	Peds	Interval Total
Vehicle Type		P	C	P	C	P	C	-	-	P	C	P	C	P	C	-	-	P	C	P	C	P	C	-	-	P	C	P	C	P	C	-	-	-
Start Time	7:00 AM	2	0	1	0	1	0	0	0	19	0	8	0	1	0	0	0	0	0	39	0	12	0	0	0	3	0	17	0	5	2	0	0	110
	7:30 AM	4	0	1	0	5	0	0	0	24	1	26	0	3	0	0	0	1	0	50	0	17	2	0	0	13	0	31	0	9	2	0	0	189
	8:00 AM	5	0	3	0	5	0	0	0	8	0	12	0	3	0	0	0	2	0	29	0	10	0	0	0	6	0	23	0	5	2	0	0	113
	8:30 AM	2	1	4	0	7	0	0	0	3	0	11	0	3	0	0	0	3	0	35	0	8	0	0	0	2	0	24	0	5	2	0	0	110
	Total	13	1	9	0	18	0	0	0	54	1	57	0	10	0	0	0	6	0	153	0	47	2	0	0	24	0	95	0	24	8	0	0	522
Start Time	4:00 PM	8	0	10	0	6	0	0	0	9	0	5	0	1	0	0	0	1	0	37	0	9	0	0	0	7	0	35	0	14	0	0	0	142
	4:30 PM	12	0	4	0	9	0	0	0	7	0	3	0	0	0	0	0	1	0	34	0	2	0	0	0	5	0	27	0	10	0	0	0	114
	5:00 PM	14	0	4	0	4	0	0	0	4	0	7	0	0	0	0	0	1	0	31	0	4	0	0	0	3	0	38	0	15	0	0	0	125
	5:30 PM	5	0	1	0	5	0	0	0	5	0	2	0	1	0	0	0	2	0	21	0	4	0	0	0	2	0	30	0	9	0	0	0	87
	Total	39	0	19	0	24	0	0	0	25	0	17	0	2	0	0	0	5	0	123	0	19	0	0	0	17	0	130	0	48	0	0	0	468
	Grand Total	52	1	28	0	42	0	0	0	79	1	74	0	12	0	0	0	11	0	276	0	66	2	0	0	41	0	225	0	72	8	0	0	990
	Approach %	42.3	0.8	22.8	0.0	34.1	0.0	0.0	0.0	47.6	0.6	44.6	0.0	7.2	0.0	0.0	0.0	3.1	0.0	77.7	0.0	18.6	0.6	0.0	0.0	11.8	0.0	65.0	0.0	20.8	2.3	0.0	0.0	
	Total %	5.3	0.1	2.8	0.0	4.2	0.0	0.0	0.0	8.0	0.1	7.5	0.0	1.2	0.0	0.0	0.0	1.1	0.0	27.9	0.0	6.7	0.2	0.0	0.0	4.1	0.0	22.7	0.0	7.3	0.8	0.0	0.0	

Vehicles using Somerset	285	Vehicles using Somerset per hour	142.5

Section 3: Warrens Landing Road

Warrens Landing Road - Madaket Road Intersection (11/19/2015)

		Madaket Road From West						Madaket Road From East						Warrens Landing Road From North						
		Thru		Left		Bikes	Peds	Right		Thru		Bikes	Peds	Right		Left		Bikes	Peds	Interval Total
Vehicle Type		P	C	P	C	-	-	P	C	P	C	-	-	P	C	P	C	-	-	-
Start Time	7:00 AM	19	0	0	0	0	0	9	3	4	0	0	0	1	0	10	0	0	0	46
	7:30 AM	17	1	0	0	0	0	11	2	22	3	0	0	2	0	16	1	0	0	75
	8:00 AM	26	0	0	0	0	0	9	3	15	4	1	0	1	0	6	1	0	0	66
	8:30 AM	18	4	0	0	0	0	8	2	21	2	0	0	1	1	11	1	0	0	69
Total		80	5	0	0	0	0	37	10	62	9	1	0	5	1	43	3	0	0	256
Start Time	4:00 PM	20	1	0	0	0	0	11	0	27	0	0	0	0	0	7	1	0	0	67
	4:30 PM	25	1	1	0	0	0	10	0	18	1	0	0	0	0	14	3	0	0	73
	5:00 PM	10	0	0	0	0	0	4	0	19	0	0	0	0	0	8	0	0	0	41
	5:30 PM	6	0	0	0	0	0	7	0	15	0	0	0	0	1	11	0	0	0	40
Total		61	2	1	0	0	0	32	0	79	1	0	0	0	1	40	4	0	0	221
Grand Total		141	7	1	0	0	0	69	10	141	10	1	0	5	2	83	7	0	0	477
Approach %		94.6	4.7	0.7	0.0	0.0	0.0	29.9	4.3	61.0	4.3	0.4	0.0	5.2	2.1	85.6	7.2	0.0	0.0	
Total %		29.6	1.5	0.2	0.0	0.0	0.0	14.5	2.1	29.6	2.1	0.2	0.0	1.0	0.4	17.4	1.5	0.0	0.0	

Vehicles using Warrens Landing	177	Vehicles using Warrens Landing per hour	88.5

Warrens Landing Road - Blue Heron Way Intersection (11/19/2015)

		Warrens Landing Road From East						Warrens Landing Road From North						Blue Heron Way From West						
		Right		Thru		Bikes	Peds	Right		Left		Bikes	Peds	Thru		Left		Bikes	Peds	Interval Total
Vehicle Type		P	C	P	C	-	-	P	C	P	C	-	-	P	C	P	C	-	-	-
Start Time	7:00 AM	2	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	12
	7:30 AM	8	0	1	0	0	0	0	0	10	1	0	0	0	0	0	0	0	0	20
	8:00 AM	2	1	0	0	0	0	0	0	6	2	1	0	1	0	0	0	0	0	13
	8:30 AM	4	0	0	0	0	0	0	0	8	0	0	0	1	0	0	0	0	0	13
Total		16	1	1	0	0	0	0	0	34	3	1	0	2	0	0	0	0	0	58
Start Time	4:00 PM	10	1	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	15
	4:30 PM	10	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	15
	5:00 PM	5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	7
	5:30 PM	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Total		28	1	0	0	0	0	0	0	10	0	0	0	1	0	0	0	0	0	40
Grand Total		44	2	1	0	0	0	0	0	44	3	1	0	3	0	0	0	0	0	98
Approach %		93.6	4.3	2.1	0.0	0.0	0.0	0.0	0.0	91.7	6.3	2.1	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
Total %		44.9	2.0	1.0	0.0	0.0	0.0	0.0	0.0	44.9	3.1	1.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	

Vehicles using Warrens Landing	97	Vehicles using Warrens Landing per hour	48.5

Warrens Landing Road - Eel Point Road Intersection (11/19/2015)

		Warrens Landing Road From East						Warrens Landing Road From West						Eel Point Road From North						
		Right		Thru		Bikes	Peds	Thru		Left		Bikes	Peds	Right		Left		Bikes	Peds	Interval Total
Vehicle Type		P	C	P	C	-	-	P	C	P	C	-	-	P	C	P	C	-	-	-
Start Time	7:00 AM	6	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	9
	7:30 AM	10	2	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	0	19
	8:00 AM	6	3	0	0	0	0	0	0	0	0	1	0	0	0	1	2	0	0	13
	8:30 AM	6	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	9
Total		28	8	0	0	0	0	0	0	0	0	1	0	0	0	10	3	0	0	50
Start Time	4:00 PM	2	1	0	0	0	0	0	0	0	0	0	0	0	0	9	1	0	0	13
	4:30 PM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	7	3	0	0	11
	5:00 PM	3	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5
	5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
Total		6	1	1	0	0	0	1	0	0	0	0	0	0	0	18	4	0	0	31
Grand Total		34	9	1	0	0	0	1	0	0	0	1	0	0	0	28	7	0	0	81
Approach %		77.3	20.5	2.3	0.0	0.0	0.0	50.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	80.0	20.0	0.0	0.0	
Total %		42.0	11.1	1.2	0.0	0.0	0.0	1.2	0.0	0.0	0.0	1.2	0.0	0.0	0.0	34.6	8.6	0.0	0.0	

Vehicles using Warrens Landing	80	Vehicles using Warrens Landing per hour	40

Appendix N: Road Evaluation Raw Data

Section 1: Somerset Road Evaluation

Grand Total Condition Value	36		Paved Condition Value:	1		Unpaved Condition Value:	29		Transition Condition Value:	6
Number of Segments	16		Number of Segments	9		Number of Segments	6		Number of Segments	1
Condition Value per Segment	2.25		Paved Value per Segment	0.11		Unpaved Value per Segment	4.83		Transition Value per Segment:	6.00

Average Width	16.9		Average Paved Width	18.3		Average Unpaved Width	14.9		Average Transition Width	14.5
Average Height Issue	12.5		Average Height Issue (Paved Sections)	14		Average Height Issue (Unpaved Sections)	12.2		Average Height Issue (Transition Sections)	0
Number of Height Issues	6		Number of Height Issues (Paved Sections)	1		Number of Height Issues (Unpaved Sections)	5		Number of Height Issues (Transition Sections)	0

Section 2: Millbrook Evaluation

Grand Total Condition Value	350		Paved Condition Value:	37		Unpaved Condition Value:	296		Transition Condition Value:	17
Number of Segments	63		Number of Segments	17		Number of Segments	44		Number of Segments	2
Condition Value per Segment	5.56		Paved Value per Segment	2.18		Unpaved Value per Segment	6.73		Transition Value per Segment:	8.50

Average Width	15.5		Average Paved Width	19.1		Average Unpaved Width	14.8		Average Transition Width	18
Average Height Issue	11.5		Average Height Issue (Paved Sections)	0		Average Height Issue (Unpaved Sections)	11.5		Average Height Issue (Transition Sections)	0
Number of Height Issues	15		Number of Height Issues (Paved Sections)	0		Number of Height Issues (Unpaved Sections)	15		Number of Height Issues (Transition Sections)	0

Section 3: Warrens Landing

Grand Total Condition Value	268		Paved Condition Value:	62		Unpaved Condition Value:	194		Transition Condition Value:	12
Number of Segments	50		Number of Segments	29		Number of Segments	20		Number of Segments	1
Condition Value per Segment	5.36		Paved Value per Segment	2.14		Unpaved Value per Segment	9.70		Transition Value per Segment:	12.00

Average Width	15.4		Average Paved Width	17.9		Average Unpaved Width	11.7		Average Transition Width	15
Average Height Issue	12.5		Average Height Issue (Paved Sections)	0		Average Height Issue (Unpaved Sections)	12.5		Average Height Issue (Transition Sections)	0
Number of Height Issues	1		Number of Height Issues (Paved Sections)	0		Number of Height Issues (Unpaved Sections)	1		Number of Height Issues (Transition Sections)	0

Appendix O: Criteria Filled In

Road Taking Criteria

		Somerset Rd *(Friendship Lane to Vesper Lane)*	Millbrook Rd	Warrens Landing Rd
Importance to Traffic Network	Level of use (cars/hr)	63.7	28.6	22.3
	Road category	Connector	Connector	Access
	Road notes	- Connects Friendship to Vesper	- Alleviates traffic on Quaker - Provides quicker route between Madaket and Cisco	- Accesses Madaket Harbor, eel Point, and 40th Pole
	Number of sole access roads	0	2	7
	Leads to or contains a public facility? †	Yes - Vesper Lane and Hummock Pond Road	Yes - Madaket Road and Hummock Pond Road	Yes - 40th Pole Beach and Eel Point
Public Safety	Bike route / bike route connector	No	Yes (Madaket Path to Cisco Path)	No
	Road condition value (per 100 ft road segment)	Total - 2.25 Paved - 0.11 Unpaved - 4.83	Total - 5.56 Paved - 2.18 Unpaved - 6.73	Total - 5.36 Paved - 2.14 Unpaved - 9.70
	Number of Structures	16	68	119
HOA	Presence of an HOA	None	None	Fisher's Landing Association
	Amount per member put towards maintenance	N/A	N/A	$425 - $595
Abutters	Abutter request?	No	No	Yes
	Reason for request	N/A	N/A	Public use is greater than private use
Cost to Town	Length (feet)	1517	6325	4950
	Average width (feet)	16.9	15.5	15.4
	Surface type	Paved - 895 ft Unpaved - 622 ft	Paved - 1834 ft Unpaved - 4491 ft	Paved - 2921 ft Unpaved - 2029 ft
	Cost to grind & regrade ($)	76,000	142,000	226,000
	Cost to reconstruct ($)	105,000	403,000	315,000

Terminology Notes:

† A **public facility** is defined as any location accessed by the public.