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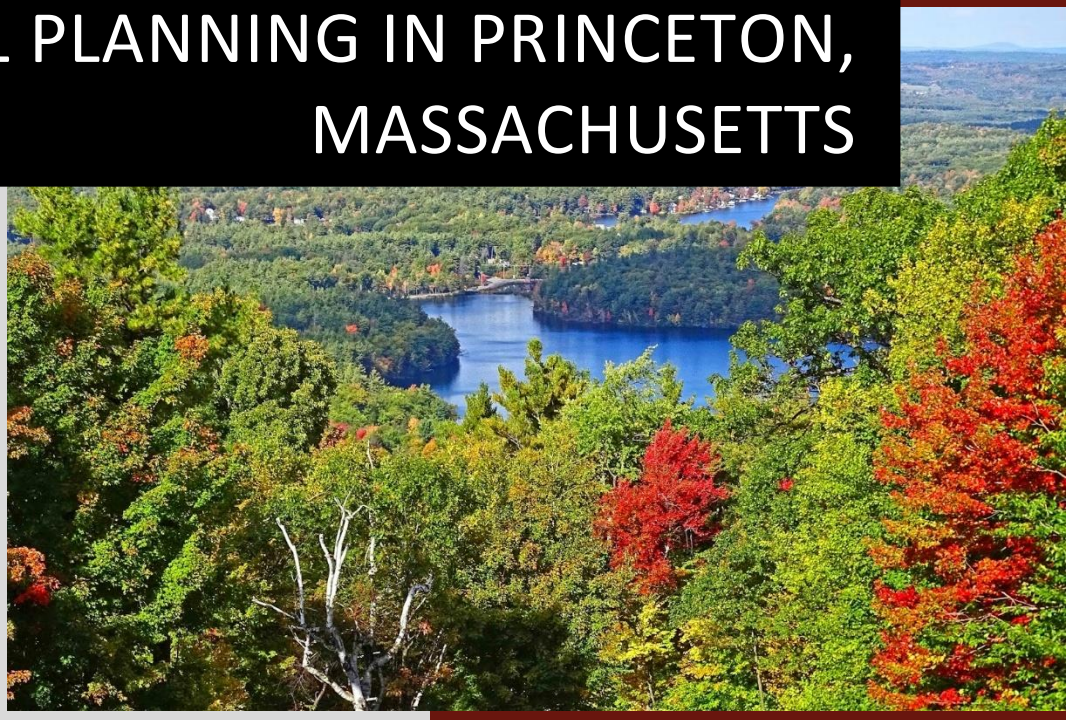
DEVELOPING A STRATEGY GUIDE FOR TRAIL PLANNING IN PRINCETON, MASSACHUSETTS



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Developing a Strategy Guide for Trail Planning in Princeton, Massachusetts

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ABSTRACT

Princeton, Massachusetts, has faced challenges negotiating with private and government entities to develop a town-wide connected recreational trail system. This project provides a detailed strategy guide for the Princeton Open Space Committee to overcome these challenges and develop future trails in Princeton. To achieve this, we conducted a GIS analysis of existing trails, consulted with key stakeholders to determine trail building regulations, and interviewed 11 local trail planning groups to determine best practices for trail standards and maintenance plans. Based on our findings, we provided a comprehensive trail map and recommendations to advance future trail projects.

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AUTHORSHIP

MATTHEW KARNS contributed to the writing of the Executive Summary, Multipurpose Trails, Environmental Impacts, Land Use, and both Analyzing Existing Trail Network sections, as well as the editing of each section of the report. He also completed the ArcGIS maps for the project and participated in and analyzed all of the interviews.

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EXECUTIVE SUMMARY

Within the 36 square miles of Princeton, Massachusetts, there are nearly 100 miles of trails. Many of these trails are located in underdeveloped land open for public use, also called "open space land". A study of Princeton residents, conducted by the Princeton Open Space Committee (OSC), found that nearly 80% of respondents hike or walk along roads in a year, with about 50% doing so frequently (Princeton OSC, 2020). This same group has also expressed concerns about walking along roads, with cars speeding by. In order to encourage more people to walk around town, as well as ensure safety, the Princeton OSC has the goal of creating a network of multipurpose trails that connects the 100 miles of disconnected trails, called the Trails Around Princeton (TAP). However, the Princeton OSC has faced resistance to the project. Trails that would comprise the TAP cross over land owned by various stakeholders, whom each have reservations.

The purpose of this study is to create a strategy guide, which includes recommendations for the Princeton OSC to use when developing the TAP project and any future trail projects. This guide considers the TAP's overall goals of connecting areas of the town together while also connecting to neighboring towns' trail systems. In addition, our research highlights successful ways to work with private landowners, government organizations, and sportsman clubs to gain permission for trail creation on their land. Lastly, we reviewed best practices for maintenance and trail standards to provide implementation strategies for the TAP project. This was completed by evaluating land ownership maps, reviewing other towns' successes, and researching potential hindrances, which will create a framework to help build trail connections in the future.

MAPPING TRAILS

To gain an understanding of the current state of recreational trails in Princeton, we inventoried and mapped the existing trails on QGIS using GPX files provided by the Princeton OSC and using Open Street Maps. This enabled us to analyze trails that run on private or restricted property. We also evaluated tax maps to identify land ownership in Princeton, which revealed the stakeholders that the Princeton OSC would need to communicate with for trail creation. This method produced 128 trails in Princeton, totaling 97.38 miles. While collecting information on

these trails, we learned of 35 trails that have a restriction, including an inability to map the trails publicly. In total, 43.2% of the trail mileage in Princeton has a limitation. Furthermore, of the trails without restrictions 70% are on three geographically close conservation areas. Without the ability to map and advertise the trails, the Princeton OSC will struggle to optimize the use of the TAP, putting the goals of the project in jeopardy. Another limitation with the Princeton trail network is that only 24 of the 92 unrestricted trails, just 15.62 miles, are multipurpose. In order to improve the current network of trails, it was essential to understand the restrictions and reservations of significant stakeholders in town.

STAKEHOLDERS

Through policy research and interviews, we discovered challenges with the Massachusetts Division of Fisheries and Wildlife (MassWildlife) and the Department of Conservation and Recreation Division of Water Supply Protection (DWSP). The Walking Trails Policy (Division of Fisheries and Wildlife, 2016) and 313 CMR: DIVISION OF WATER SUPPLY PROTECTION (Trial Court Law Libraries, 2018) detail guidelines which groups like the Princeton OSC can follow when planning a trail on government-owned land. Through our interviews *(see Appendix A)*, we were informed that trail creation is currently not permitted on land owned by the DWSP due to their primary goal of watershed protection. Most proposals to build a trail on their land will not be approved, but proposed trails that cross land regulated by the Watershed Protection Act (WsPA) and are not owned by DWSP, may be considered. Additionally, maintenance of the trail falls on the organization responsible for building.

We also communicated with both sportsman clubs in Princeton, the president of the Nimrod League of Holden and the vice president from the Norco Sportsman club, who shared their concerns for a trail on their land. In general, both clubs expressed concerns over the safety of hikers, due to their active shooting ranges and hunting seasons. They were also worried about the negative impacts that a multipurpose trail could have on their lands. However, Nimrod was willing to work with the Princeton OSC in the design of a trail on their land while Norco was opposed to the idea.

BEST PRACTICES

Similarly, we conducted interviews with 11 different groups throughout Massachusetts who had experience in trail planning. From these interviews *(see Appendix B),* we learned of different trail maintenance strategies and ways to work with the DWSP, MassWildlife, and private landowners. All groups had avoided working with MassWildlife due to their difficult policies. Most groups have struggled with DWSP negotiations, but we found that some groups were able to place trails on their land. They have had to present a detailed proposal that lays out the trail and limits environmental impacts. Concerning private landowners, many interviewees suggested building a relationship with the landowner to negotiate with them. The goal of these negotiations should be to get an easement for the specified land. We also found that many of these towns have implemented unique maintenance strategies that utilize mailing lists volunteers. This aids with plans such as the "adopt-a-trail" program used by the Appalachian Mountain Club and Leominster, which involves volunteers maintaining small sections of the trail network.

Finally, we researched the standards put in place by different organizations. The two national classification systems and trail standards we researched are from the United States Forest Service (USFS) and the National Park Service (NPS). The USFS trail class matrix *(see Appendix C) is* one of the most universally referenced trail classification systems within the United States (United States Forest Service, 2008). The trail building and design standards that we found from the NPS *(see Appendix D)* laid out basic trail design measurements and information on how to build a trail up to their standards (NPS, 1998).

RECOMMENDATIONS

After carefully reviewing the above findings, we established a series of recommendations that best fit the Princeton OSC's goals for trail planning and building. In regard to trail building standards, we recommend that the Princeton OSC design and build trails to at least Trail Class 3 according to the United States Forest Service's trail class matrix. We also recommend that Princeton mirror the maintenance strategy of Leominster, including an "adopt-a-trail" program, which has also been used by the Appalachian Mountain Club and the Midstate Trail.

Concerning private landowner permissions, we recommend the Princeton OSC acquire at least a written easement for the land, which would provide security for the trail. While higher levels of land acquisition would be preferred, they can often be difficult to attain. For the Nimrod League of Holden, we recommend working with the club to propose a hiking-only trail plan that avoids their shooting ranges. If these conditions are satisfied, the Nimrod League of Holden might be more open to permit a public trail. On the contrary, we recommend not building trails through Norco Sportsman Club lands and find a way around them whenever possible. For government organizations, we recommend creating a detailed trail plan that follows standards outlined by the DWSP and MassWildlife. We also recommend gathering public support and consistently lobbying state representatives and DWSP officials to help approve trails on these lands.

We further recommend expanding the existing trail system to connect to trails within and around Princeton, which can be accomplished with Leominster, as the Leominster Trail Stewards (LTS) is the most organized and prepared to improve connections with Princeton. For intra-town connections, we recommend that the Princeton OSC focuses on trails connecting Leominster State Forest with the Thomas Prince School and Wachusett Meadow with Boylston Park. One topic of research that should be considered for trail creation in Princeton is the possibility of including sidewalks or curbside walkways. These could create safe routes to other trails and maintain the connectivity of Princeton's trail system. By utilizing roads, the committee will also be able to save time and money while still connecting areas of town.

By following our strategy guide, the Princeton OSC will have a guideline on how to proceed with trail creation and accomplish their goals of interconnecting town recreational resources and connecting to neighboring towns. While there may be pitfalls ahead for the committee and we recognize that these ideas may take years to come to fruition, these recommendations should allow for a long-lasting and impactful trail network in the town of Princeton.

INTRODUCTION

Over 200,000 miles of trails stretch across the United States of America. These pathways act as connections between communities and nature, creating experiences that benefit societal health and local economies. However, despite this expansive network of trails, many trails and recreational spaces are not connected, creating difficulties for users to access all parts of a town's trail system. Better access to these trails would increase the opportunity to experience these positive benefits. Princeton, Massachusetts, is an example of a town that would benefit from a connected recreational trail system.

There are nearly 100 miles of trails within the town of Princeton, mostly located in underdeveloped land open for public use, also called "open space land". The Princeton Open Space Committee (OSC) is a government organization tasked with the conservation and preservation of this public land, as well as maintaining natural recreation spaces, and developing and promoting trails in town. In a survey conducted by the Princeton OSC, 75% of the population of Princeton chooses to walk or hike on these trails (Princeton OSC, 2020). Similarly, nearly 80% of respondents hike or walk along roads in a given year, and some have expressed concerns about the cars speeding close by (Princeton OSC, 2020). To encourage more people to walk around town, as well as ensure safety, the Princeton OSC has the goal of creating a network of multipurpose trails, called the Trails Around Princeton (TAP), that connects different areas of town. This system would allow more opportunities for residents to travel around the town without the use of a car. However, the Princeton OSC has faced some resistance to the project as the trails that would comprise the TAP cross over land owned by various stakeholders, whom each have reservations. Government conservation organizations such as the Department of Conservation and Recreation Division of Water Supply Protection (DWSP) and the Massachusetts Division of Fisheries and Wildlife (MassWildlife), express concerns about the environmental impact the trails could have. Sportsman clubs with large tracts of land are concerned over hikers' safety, while private landowners have state privacy as their main concern. Princeton has been generally unsuccessful in negotiating with private and government entities. It does not currently have a strategy to successfully navigate obstacles detrimental to the development of a connected trail system.

The purpose of this study is to create a strategy guide, which includes recommendations for the Princeton OSC to use when developing the TAP project and any future trail projects. This guide considers the TAP's overall goals of connecting areas of the town together while also connecting to neighboring towns' trail systems. In addition, our research highlights successful ways to work with private landowners, government organizations, and sportsman clubs to gain permission for trail creation on their land. Lastly, we reviewed best practices for maintenance and trail standards to provide implementation strategies for the TAP project. This review was completed by evaluating land ownership maps, reviewing other towns' successes, and researching potential hindrances. Synthesizing the information from these methods aided in creating a framework to help build trail connections in the future.

In what follows, we provide background on multipurpose trails, information on the town of Princeton, and roadblocks past trail creation efforts have encountered. We then detail the methodology of our research: mapping existing trails in Princeton, discovering government and sportsman club policies, researching common implementation strategies, and interviewing government organizations, sportsman clubs, and other nearby trail planning groups. These results include information on the status of trails in Princeton, best practices from other trail planning groups, and guidelines on how to work with government organizations. From this research, we came up with recommendations for the Princeton OSC to observe when developing future projects.

BACKGROUND

Due to the continuous shift towards an urban lifestyle, more than 50% of the world's population now lives in urban areas, and that number is steadily increasing. A study found that urbanization is related to increased levels of mental illness, in part, due to increased levels of acute social stress (Bratman et al., 2015; Lederbogen et al., 2011). On the contrary, it has been shown through many studies that exposure to natural areas has a positive impact on mental health, mainly in mitigating illnesses, such as depression, and reducing stress (Brown et al., 2013; Hartig et al., 2014; White et al., 2013). A simple way that people can access natural areas to improve their mental health is hiking trails. On a short-term basis, being in nature can improve mood and sensory perception (NPS, n.d.). Similarly, hiking benefits physical health as it can help build

stronger muscles and bones while improving balance (NPS, n.d.). Furthermore, if done enough, hiking can reduce blood pressure, reducing the risk of cardiovascular disease and diabetes (Thomsen et al., 2018).

With the numerous positive benefits, trail systems are experiencing a boost in usage, which has a direct correlation to local economic boosts. In the United States, outdoor recreation creates over six million jobs and generates 88 billion dollars in tax revenue, which is, in part, because approximately 84 million people a year use the national trails (Thomsen et al., 2018; U.S. Department of Agriculture, 2017). Thus, the proper use and management of natural resources and recreational areas can benefit a region not only economically but also by improving the health of individuals.

In this section, we provide an overview of multipurpose trails and some of the environmental impacts that occur as a direct correlation. We discuss the town of Princeton, its environment, and the division of open space land between different organizations. We also discuss trails located in Princeton, the prior work on the TAP project, and some previously encountered roadblocks.

MULTIPURPOSE TRAILS

Recreational trails have a deep-rooted history in the United States. Prior to the late 18th century, America was a rural society with people living and working on their farms. The most convenient form of travel was along footpaths through the undeveloped countryside. For most people, walking through nature was a daily occupational necessity (Forest History Society, n.d.). However, the onset of urbanization and industrialization in the 19th century altered American life and culture drastically. An increasing number of people began living and working in urban areas, as opposed to the rural countryside (FHS, n.d.). The commute to work changed from a walk amidst nature to a walk down crowded and gloomy city streets. Even rural workers spent less time walking through the countryside as trains and steamboats replaced walks to the city or market (Chamberlain, 2016). By 1920, half of the U.S. population lived in cities, and the advent of streetcars and automobiles further reduced the need for walking. These factors eliminated long walks from daily life, and people surrounded by a network of roads and buildings yearned for long walks in the wilderness. Hikes and adventures allowed Americans to escape their urban environment and grueling work schedules, giving them more opportunities to enjoy nature and

relax. Many gained an appreciation for the natural world as urbanization and aggressive lumber tactics started to cut away at America's miles of wilderness (FHS, n.d.). Trails and hiking grew in popularity, and by 1955 over one million people utilized the National Forests trail system, with many others hiking in local conservation areas (United States Department of Agriculture Forest Service, 1956). Many trails that were once used for transportation now served as a recreational resource.

Trails' popularity has further increased due to the multitude of uses that they can have. Along with hiking, some areas allow mountain biking and horseback riding. Mountain biking began to popularize during the 1970s as people began modifying old street bikes and taking them down mountain paths (Marin Museum of Bicycling, n.d.). In 2018, over 8.5 million Americans mountain biked in some capacity with another 39 million biking on paved surfaces (Outdoor Foundation, 2020). Of these cyclists, only about 8% classify themselves as very comfortable cyclists, with 60% stating they are interested in cycling but have some concerns, generally over safety or ability (Dill & McNeil, 2013). To encourage cyclers to bike more often, towns need to have a safe and accessible way for bikers to travel around the town. Trails are an ideal way to do this, as they can provide scenic rides away from the danger of biking along a road. Similarly, horseback riders can utilize trail systems to get around, ensuring both the rider and the horse stay safe. These activities highlight how trails can provide opportunities for people to explore nature, unwind, and exercise in a myriad of ways. In the modern era, where many people work inside, people search for ways to connect with and appreciate nature through trails. Once used as the main method of transportation, trails have taken on a recreational role in society that provides numerous opportunities for exercise and relaxation.

Despite the changing role of trails over time, they still serve their original purpose: to connect nature and people. By having many trails in a town, people can use non-motorized transportation to travel from one part of town to another. Furthermore, users are safer as they can avoid roads and the threat of cars in favor of using the trail system. Additionally, a walk on forest trails can be more serene than walking along a road, making for a more enjoyable experience. However, without proper management, trails can be harmful to the surrounding environments.

ENVIRONMENTAL IMPACTS

Trails that experience significant use have the potential to damage the local environment severely. Without proper management, trail users can trample vegetation, alter ground conditions, and introduce foreign weeds (Turton, 2005). Trampling is one of the most significant concerns with trails because of the domino effect that can occur. Repeatedly stepping on vegetation can cause it to die out quickly, leaving the trail's topsoil exposed. This exposure creates an opportunity for invasive plant species to move into the area and negatively impact the balanced ecosystem (Turton, 2005). These invasive plants not only affect the composition of plants in the area but also affect the wildlife that depends on said plant life. High volume trails further impact wildlife because the continuous stream of people can interrupt animals' regular habits and routines. This interruption leads to fragmentation of the ecosystem, where human-made trails divide previously connected and continuous natural areas (Santarém et al., 2015). However, by implementing proper design and management techniques, the negative impact of trails can be minimized.

Turton (2005) and Marion & Wimpey (2017) suggest using raised boardwalks to limit the effects of trampling. Raised boardwalks would protect the soil and vegetation, as well as prevent trampling, which would preserve the natural ecosystem. This would allow for large numbers of hikers to use the trails without having a significant impact on the environment. However, Santarém and Santos (2015) argue that boardwalks are not a proper solution to this problem for several reasons. Their primary argument is that boardwalks would still disrupt wild animals in the area. Furthermore, they argue that shadow cast by the boardwalk is likely to affect nearby plants, causing ecological changes regardless. Lastly, they point out the costs associated with maintaining the boardwalk. Instead, they propose regulating the number of people that can use the trails over a certain length of time, such as a season. By limiting the number of hikers on the trail, the disruption to the environment is limited. To aid in this while still providing ample recreation opportunities, they encourage the use of other trails to distribute the flow of hikers evenly.

A significant outcome of trampling is soil erosion, which needs to be considered when both planning and implementing recreational trails. The detrimental effects of soil erosion are so severe that some refer to it as the most significant factor regarding the long-term sustainability of a trail (Marion et al., 2016). As vegetation along the trail dies out, their roots decompose, loosening the soil and making the trail susceptible to erosion if it is not designed and maintained correctly (Marion & Wimpey, 2017). The most visible effect of erosion is rutting, which removes soil from the trail surface, exposing roots and rocks along the trail. Rutting increases the risk of injury and hiking difficulty, as the trail is no longer smooth and flat. To avoid the hassle of walking on the rough terrain, hikers often go around the original rutted trail, widening it and causing even more ecological harm (Marion & Wimpey, 2017). The soil run-off from rutting and erosion can enter nearby waterways, potentially decreasing water quality and leading to abnormal bacteria growth, which can have a significant negative impact on the environment (Marion et al., 2016).

Furthermore, maintenance is more difficult on rutted trails as transporting supplies becomes more strenuous. The amount of fill needed to repair the trail can be significant, leading to expensive maintenance costs (Marion et al. 2016). Because of how challenging soil erosion is to fix, and the severity of the potential problems, it is vital that soil erosion is taken into serious consideration when designing a trail.

Marion & Wimpey (2017) have explored how to mitigate problems associated with trail erosion. While they mention that using an alternate path material, such as gravel, is an option, they believe the best way to mitigate erosion is by evaluating the trail with a combination of methods. The key methods they suggest are the trail grade and trail slope alignment angle. The trail grade is measured by calculating the change in height over the change in distance. This method, on its own, is useful for the classification of trail difficulty and steepness. However, it is not sufficient by itself to determine a trail's resistance to erosion. The trail slope alignment (TSA) angle measures the angle between the fall line of the hill and the direction of the trail, with 0° being parallel. The closer the angle is to 90°, the better, as water is more likely to flow off the side of the trail rather than down it *(see Figure 1)*. Marion & Wimpey (2017) determined that these methods alone were insufficient to combat the problem of erosion, so they proposed a system combining them. From this, they developed a guideline to help reduce erosion by ranking a trail

segment from good to very poor, outlined in *Table 1*. By designing a trail that remains in the "Good" or "Neutral" range, the trail will limit erosion, be more sustainable, and require less maintenance.

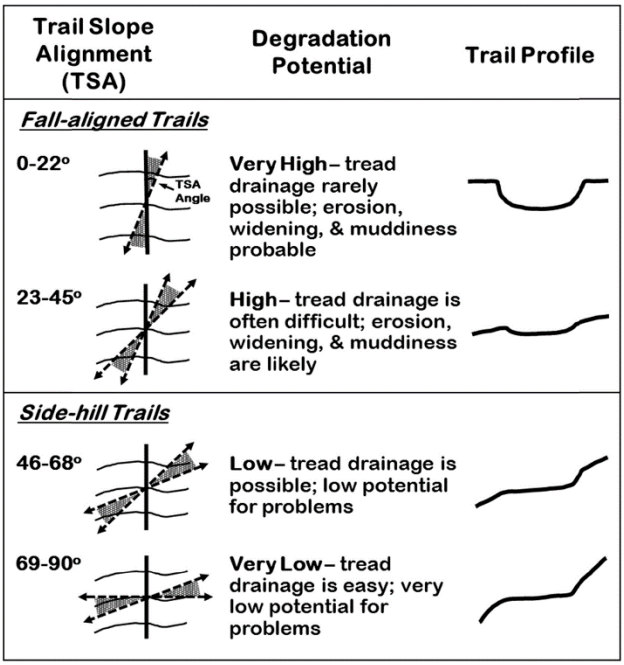


FIGURE 1: A DEPICTION OF THE TRAIL SLOPE ANGLE (MARION & WIMPEY, 2017)

Trail Sustainability Rating	Trail grade and trail slope alignment criteria
Good:	Trail grade of 3-10% and TSA > 30°
Neutral:	Trail grade of 0-2%
Poor:	Trail grade of 3-10% and TSA of 0-30°, or trail grade of 11-20% and TSA > 30°
Very Poor:	Trail grade of 11-20% and TSA of 0-30°, or trail grade of >20%

TABLE 1: A PROPOSED TRAIL SUSTAINABILITY RATING SYSTEM (MARION & WIMPEY, 2017)

Due to the potential impact that recreational trails can have on the environment, government organizations have placed heavy restrictions on trail development in Princeton to achieve their organization's goals of maintaining water quality or preserving wildlife. However, when properly designed, trails can be constructed on these lands in a manner that aligns with these organization's goals. Trails can limit environmental impacts by concentrating traffic onto pathways with a sustainably designed hardened tread (Marion & Wimpey, 2017). The trails in these government areas would promote recreation and connections while also preserving the goals of the land.

PRINCETON

The town of Princeton was established in 1759, with a population of fewer than 285 people (Beaman, 1970). As of 2019, Princeton consists of 35.8 square miles, with a population of 3,531 (Town of Princeton Massachusetts, n.d.). Princeton has an abundance of recreational sites, interesting topography, and a diverse environment that offers a glimpse at the land's history and provides a fantastic location for hiking. Most of the hiking trails used in Princeton today can be traced back to footpaths used in the 17th century, long before Princeton was founded. Both Native Americans and settlers utilized these footpaths (Walker, n.d.). Many of these trails lead through recreational sites such as Leominster State Forest, a popular hiking, biking and rock-climbing location, and Wachusett Mountain *(shown in Figure 2)*, a popular skiing and snowboarding destination.

Princeton's environment varies in landscape and topography, making it suitable for hiking and biking trails. The three prominent peaks in Princeton include Wachusett Mountain, Little Wachusett Mountain, and Pine Hill, which create an attractive environment for multipurpose trails. According to Princeton's OSC, the town is "characterized by rolling hills, rocky slopes, and numerous small valleys, with babbling brooks and quiet ponds" (Princeton OSC, 2020). These varying landscapes create a diverse environment that is invaluable to the Princeton recreational experience.

FIGURE 2: A PICTURE OF THE NORTH LOOKOUT ON WACHUSETT MOUNTAIN (PRINCETON OSC, 2020)

Secondary growth and old-growth forests are also prominent aspects of Princeton's landscape. Secondary growth forests are forests that have regrown in previously cleared areas. These forests have reclaimed much of Princeton's land, as over 70% of the land was previously cleared for farmland. In contrast, old-growth forests have been around for at least 120 years without disruption. The Old Growth Forest, one of the largest old-growth forests east of the Connecticut River, is located on the slope of Wachusett Mountain and has been there for over 350 years (Princeton OSC, 2020).

LAND USE

Due to its sloping terrain and many wetlands, Princeton is limited in how it can utilize its land. This limitation is furthered by the town's low population density, which, when compared to neighboring towns, is roughly half of Rutland's, the next smallest town. This low population density and the steep slopes of the area lead to only 34% of Princeton's land being used for residential purposes while 4% is commercial and 2% is agricultural. This composition leaves a substantial amount of land totaling 12,830 acres or about 56%, for open space purposes in

Princeton (Princeton OSC, 2020). This is shown in *Figure 3*, which displays the land ownership for Princeton.

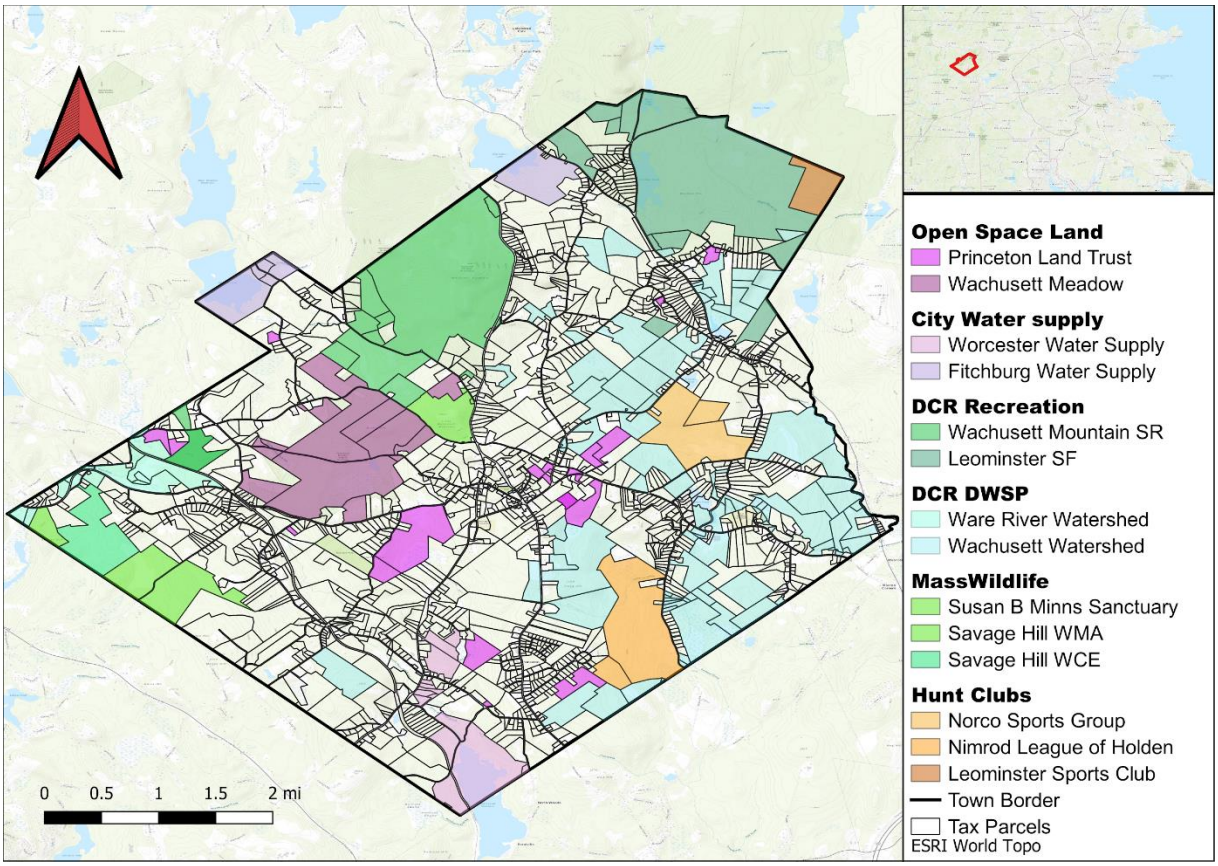


FIGURE 3: A PROPERTY MAP OF PRINCETON WITH OPEN SPACE LAND HIGHLIGHTED

The open space land in Princeton is categorized based on ownership and access. The first category is land owned by the town of Princeton, which includes local parks and schools. Seven different properties around the town fall into this category, including Boylston Park and the Four Corners Conservation Area. Similarly, the state of Massachusetts owns large swaths of land for recreation, including Leominster State Forest, which features 1,380 acres of land in the Northern part of Princeton. The other state-owned property in Princeton is Mount Wachusett State Reservation, with 1,350 acres of land inside Princeton's western border. Wachusett Mountain is the northern part of a continuous, uninterrupted stretch of conserved and protected land, with the other two pieces being Minns Wildlife Sanctuary and the Wachusett Meadow Wildlife

Sanctuary. These two areas combine to make up another 1,148 acres of protected land, featuring numerous hiking trails. In total, these three conservation areas comprise about 2,500 acres of open space land in western Princeton (Princeton OSC, 2020).

While these properties are open to the public, there are some parcels of land in Princeton that are privately owned and used for recreation. Sportsman clubs, like the Nimrod League of Holden and Norco Sportsman Club, own some of these lands and provide recreational use for members yet limit public access to their lands. In total, these organizations own 739 acres of forest and waterways on the east side of town. At these clubs, members can fish, hike, and hunt on the land while the public only has access during special events. In contrast, the Princeton Land Trust (PLT) is a private organization that provides the general public access to their numerous conservation areas. In total, they own 24 properties that total 379 acres of land, but they also have conservation restrictions on another 298 acres of land spread out around town. These lands allow the public to hunt and hike, similar to the lands owned by the town or the state (Princeton OSC, 2020).

The last category of land ownership is land owned by government organizations for conservation purposes. These include the 259 acres reserved by the Massachusetts Division of Fish and Wildlife (MassWildlife) for hunting, hiking, and nature observation as well as 3,434 acres of land owned by the DWSP for watershed protection. The DWSP controls this land because Princeton is about 10% open water or wetlands. These wetlands flow into four public reservoir supplies: Wachusett, Quabbin, Fitchburg, and Quinapoxet. Princeton's wetlands provide about 30% of the water to the Wachusett Reservoir, which, along with the Quabbin Reservoir, supplies water to nearly 2.5 million people in the Boston area (Princeton OSC, 2020). To maintain water quality, the DWSP has imposed strict restrictions and regulations for what is allowed on their property (Princeton OSC, 2020). In addition, the DWSP has designated some of their lands as priority habitats for rare species. Similarly, other organizations, such as sportsman clubs and MassWildlife, may have restrictions for their properties, causing potential issues for trail planning.

HISTORY OF THE TAP PROJECT

A survey conducted for the 2020 Princeton Open Space and Recreation Plan found that there is a large community of hikers that live in the town of Princeton. To improve the town's system of hiking trails, the Princeton OSC wants to connect different parts of town using multipurpose trails. Initially, this was attempted with a loop trail that connected seven critical areas of the town. However, this plan was unrealistic as uncooperative landowners owned most of the land targeted for trail creation. Furthermore, it was realized that there was a need to connect more than just these seven areas. Instead, to simplify the project and expand the number of connections beyond one loop, the Princeton OSC shifted focus to a network of trails, which was named the TAP. However, they have encountered several roadblocks while planning this system.

One such obstacle is the restrictions that have been imposed by local government organizations. For example, the DWSP has many limitations when developing or operating near watersheds, which are areas of land that collect surface and groundwater. They follow and enforce the Watershed Protection Act (WsPA), which "regulates land use and activities to protect the drinking water supply" (Department of Conservation and Recreation, n.d.). This act establishes two different protection zones - primary and secondary - with different regulations depending on the proximity to water features. These restrictions have limited the creation of trails in any DWSP watershed area. The Princeton OSC would like to work with the DWSP as the proposed TAP aims to create trails that would need DWSP permission.

The two private sportsman clubs, Norco Sportsman Club and the Nimrod League of Holden, have expressed concern over trail creation on their lands with the primary concern being user safety. They are also concerned the trail may be damaged by mountain bikes and other non-motorized vehicles, and the presence of vehicles and animals may scare away wildlife in the area. Because of this, there are currently no public trails through these properties. These restrictions, along with those posed by the DWSP, have hindered the progress of the TAP.

Neighboring towns have navigated some of these roadblocks, but Princeton has yet to overcome these obstacles. The Princeton OSC must cooperate with the regulations of government organizations and private sportsman clubs to achieve their goal of creating new trails throughout

the town. The purpose of our project is to find these regulations and restrictions, as well as find out how nearby towns have navigated these restrictions to create trails. With this information, we were able to make recommendations to the Princeton OSC in the form of a trail strategy guide. For this strategy guide to be effective, the creation of a comprehensive map of the current trails and potential connections to other towns was necessary. The data we collected, using methods outlined in the following section helped to formulate a plan for current and future trail creation in Princeton.

METHODOLOGY

The Princeton trail system is a valuable recreational resource for locals, and a trail strategy guide would support the creation of future trails, including the TAP Project. Our research project shows where future trails could connect to existing trails within and around Princeton. The strategy guide that we created includes blueprints for dealing with challenges that may arise in the planning or building process. These challenges include roadblocks created by government organizations and local sportsman clubs, as well as the maintenance and construction of a sustainable trail. In this section, we explain our methods for evaluating the status of existing recreational trails and spaces, relevant government policies and sportsman club policies, and how other towns have navigated these policies.

ANALYZING EXISTING TRAIL NETWORK

To establish a strategic plan for the TAP project, we began by taking stock of the current status of trails in Princeton, which involved locating and taking inventory of the existing trails. We would have used physical observation and GPS recording to accomplish this but could not because of the COVID-19 social distancing policies.[1] Instead, we had to rely on existing maps

[1] Starting in mid-March of 2020, a strain of CoronaVirus caused a global pandemic. As a result, governments issued stay at home orders unless absolutely necessary. This included the shutdown of colleges and high schools. WPI closed its doors shortly after and we were told to complete our IQP from home. Due to federal, state, and university regulations, we were unable to travel to our project site to study the area.

and residents of the town to provide us with knowledge of the town's trails. We then had to map the trails onto one centralized map to analyze the status of trails in the town.

The first step to taking inventory of the existing trails was conducting a review of trail maps from the state, town, and private organizations. To accurately record this data, we created a spreadsheet that organized the trail information, including the location of the trailhead and length of the trail. The first set of maps we reviewed were state-owned recreation lands, such as Wachusett Mountain State Reservation and Leominster State Forest. These recreation areas have miles of mapped public trails, making them an ideal group to start the collection. We then studied maps from lands owned by private conservation organizations, like Massachusetts Audubon's Wachusett Meadow and Princeton Land Trust's many properties. While these maps covered many of the public open space lands in the town, we also wanted to map trails that may not be in these open spaces. To do this, we utilized the Princeton OSC website, which had a list of "Princeton Hikes!" that the Princeton OSC organized around the town. These hikes had recorded many of the trails in Princeton, several of which were not on open space land. Our final step asked a member of the Princeton OSC for their compiled list of trails. This list was in the form of a spreadsheet and contained information about landowners, user groups that are allowed, and how public the trail is. This spreadsheet provided us more detailed information about the public trails and information about trails that are not publicly available on maps. Combining the information from these resources allowed us to create a comprehensive list of trails in the area.

To visualize and analyze this trail information, we mapped the town's trails onto a single GIS map. We chose to create a GIS map because it would allow us to analyze the trails and land ownership. This includes being able to overlay ownership maps and open space maps, displaying select trails based on certain characteristics, and changing symbology. These options allowed us to analyze the status of trails in town better, as well as create different maps to highlight our points. To accomplish this, we initially used ArcGIS to start mapping the trails. However, the Princeton OSC did not have access to ArcGIS, so we transitioned to QGIS, a free, open-source software that they could use. Since we were unable to travel to Princeton to map the trails ourselves, we had to rely on alternate sources for the trail information. The two sources that we utilized were ".gpx" files provided to us by the Princeton OSC and trail maps from Open Street Maps. To process the ".gpx" files and have them appear as trails in QGIS, we selected the

desired file and then chose the desired import format. These formats varied between "track" and "route", depending on the specifics of the ".gpx" file. We repeated this process for all of the files that we were given. The other format of trail data we used was through Open Street Maps, a worldwide collaborative effort to create a free editable map. To make use of the information on this map, we imported the Open Street Maps basemap, which outlined the remaining trails. From there, we traced the trails highlighted in the base map into their unique features on the map. This process allowed us to manipulate and analyze the trails, which we would not have been able to do from the basemap. By combining these two sources, we created a GIS map of the trails in Princeton that we could use for analysis and recommendations.

STAKEHOLDER POLICIES

By conducting online research and interviews with government organizations, private sportsman clubs, and individuals from 11 conservation and recreation groups in Massachusetts, we were able to understand the policies that present challenges to the TAP project. The entities with these policies include the DWSP, the Norco Sportsman Club, the Nimrod League of Holden, and MassWildlife. By learning about their regulations, we were able to determine potential pitfalls that could hinder the progress of the trail. We also interviewed individuals from other trail planning groups to determine the best ways to cooperate with the DWSP. By aggregating and analyzing these policies and best practices, we were able to provide suggestions to the Princeton OSC on how they could navigate the regulations in place. These tasks were accomplished through online research and conducting interviews with individuals from the DWSP, the two sportsman clubs, and other trail planning groups.

We focused our research on the government organizations as the private sportsman clubs do not have a published set of rules for non-members on their land. By searching the website of the Commonwealth of Massachusetts, we were able to find organizations' policies regarding the land they owned. The keywords used to find DWSP policies were "watershed" and "regulations." For MassWildlife, the words used were "trails" and "policy." When reviewing these documents, we noted any details that pertained to the project. This research allowed us to gain a general understanding of the written regulations, the means of enforcement, and the reasons for these regulations to be in place.

To further investigate regulations from the DWSP, we held a semi-structured interview with an individual from the organization. Our questions *(see Appendix A)* focused on the set of regulations that are in place for the Wachusett Reservoir watershed. We also asked for examples of ways that trails have been placed successfully on their land, and ways the Princeton OSC could do the same. We also contacted the private sportsman clubs to set up an interview similar to the one held with the DWSP. The questions in these interviews *(see Appendix A)* focused on their concerns with trail creation on their land, ways to alleviate those concerns, and what they would like to see from a trail to benefit their members. These interviews were held via Zoom, lasted approximately 45 to 60 minutes, and recorded, with their permission, so that we could refer to them as we generated our results.

We also held 11 additional interviews with members from a variety of different trail planning groups, such as local town OSCs, conservation committees, and land trusts. These groups included the neighboring towns of Sterling, Holden, Westminster, Leominster, Rutland, and Hubbardston. We also interviewed one member from each of the Groton, Sturbridge, and Westborough OSCs, as well as a lead maintainer for the Midstate trail through central Massachusetts, and a member of the New England Mountain Bike Association. We chose to interview, via Zoom or conference call, these individuals, due to their experience working with trails in their respective areas. All of these interviews were semi-structured and ranged from 30 to 60 minutes in length. Our questions *(see Appendix B)* focused on the level of success that these towns had when cooperating with any of the governmental organizations or sportsman clubs.

TRAIL IMPLEMENTATION STRATEGIES

To learn about the trail planning process, common trail standards, and maintenance practices, we interviewed experienced trail planning groups and researched best practices. Understanding the standards other towns have implemented and their results provided guidance on how to best design and build trails based on their experiences. Furthermore, we gathered information on how these towns maintained their system of trails. We also researched the impacts that multipurpose trails can have on the community and the environment as well as ways to mitigate these impacts. By interpreting this data, we were able to make suggestions to the Princeton OSC on standards they should have for their trails, helping them provide a pleasant user experience while also protecting the environment.

During our interviews with other trail planning groups, as described in the previous section, we asked about their methods for designing and maintaining their trails *(see Appendix B).* These experienced trail planners are local to the area and have insight into the environment of the town of Princeton, as well as experience mitigating environmental damage from the trail. Their experience has allowed them to refine their methods and strategies for trail creation. Because these trail planners have varying backgrounds, they have varied perspectives and approaches to trail planning. By interviewing as many planners as we could, we were able to learn different systems for trail building and designing. These interviews helped us gain information about trail standards for specific areas of land and understand what best practices for building a safe and sustainable trail. Through these interviews, we also sought information about how these trail groups maintain their system of trails. This process involved questioning how they acquired the person-power to complete their maintenance projects as well as the regularity of scheduled maintenance projects. We accumulated information on multiple strategies that groups have implemented to keep trails in prime condition. We also spoke with the trail planning interviewees about best practices for approaching private landowners with a trail proposal that crosses their land. Negotiating with private landowners is another important step in the process, albeit difficult. There are many more private landowners than there are public or open space landowners, and they all have varying views about trails on their properties, which makes it impractical to speak with all of them.

Moreover, we conducted a review of different trail plans to provide information on how other towns have created and maintained their trail systems. We reviewed six trail plans from across the country provided by the Princeton OSC and one provided by the Groton trail committee for their town. These towns included Groton MA, Westborough MA, Sturbridge MA, Frisco CO, Sandy Springs GA, and Farmers Branch TX. A review of these documents allowed us to garner information on how to form our strategy guide and recommend the most feasible strategies for Princeton.

To become familiar with national trail standards so we could recommend them to the Princeton OSC, we reviewed official documents covering trail design and management standards. This review focused on information from organizations such as the United States Forest Service (USFS) and the National Park Service (NPS) and included their trail standards and classification systems. This provided information on national standards for trails and examples to bring to our interviews with the Princeton OSC.

Utilizing the above methods enabled us to create a comprehensive trail strategy guide for the town. The collection of data from the Princeton OSC helped us understand what trails exist, previous work that they attempted for this project, and what problems they have encountered along the way. They provided us guidance on how to approach private sportsman clubs and government organizations based on their past struggles with these groups. We also researched and interviewed organizations about their policies and standards to see what issues Princeton may encounter as they implement the TAP project. Finally, we interviewed other town trail creation representatives about how they created their town's project plans as well as best practices for implementation. All of these methods helped us create and recommend a plan for future trail creation in Princeton.

RESULTS

In this section, we discuss the findings that our methods uncovered, which helped us create a strategy guide that includes recommendations for the Princeton OSC to use when developing the TAP project and any future projects. This guide provides them with a pathway to move forward on the TAP project. Our results evaluate the current status of trails in the town, government policies that impact trails on their land, and practices for designing, implementing, and maintaining trails.

ANALYZING EXISTING TRAIL NETWORK

A list of hiking trails in Princeton was compiled through a review of public maps and information provided by Princeton OSC members. This list contained information about the trail's name, location in town, allowed usage, and information on where to find trail maps. As we accumulated our list of trails, we were informed by the Princeton OSC of trails that cannot be mapped publicly because of landowner restrictions. For this reason, we omitted trails that have this distinction from the maps included in this paper. However, we still mapped and analyzed these trails, to provide accurate data, and to fully evaluate the trails in town. In total, we accumulated information on 128 trails and recreational roads in Princeton. Recreational roads provide car access to conservation lands but are also commonly used for recreational uses. For example, the State Administration Road provides access to the Wachusett Mountain State Reservation, which provides access for state vehicles. The road is not driven on frequently, so it is used by many for recreational purposes. There are 18 such roads in Princeton which help expand the network of recreational travel in town.

In total, there are 97.38 miles of trails in the town of Princeton. We learned of 35 trails that cannot be mapped publicly. These trails total over 40 miles in length, equaling roughly 42% of the total trail mileage in town. We further found, from our review of trails, that 17 of the trails in Princeton run on private land that does not have "no trespassing" signs posted. In Massachusetts a person walking on private property must be made aware that they are not allowed on the property in order to be trespassing (Mass. Gen. Laws ch.266, §120, n.d.). This means that property without a "no trespassing" sign can be walked on without breaking the law. In total, 43.2% of the trail mileage in Princeton has at least one limitation on it. Of the unrestricted, or

public, trails in town, close to 70% of the mileage is on three geographically close conservation areas. This disparity can be seen in *Figure 4*, as most of the public trails are clustered in the northwest portion of town. In total, there are only 17.39 miles of unrestricted trails outside of these properties, most of which are on Princeton Land Trust lands scattered around the town.

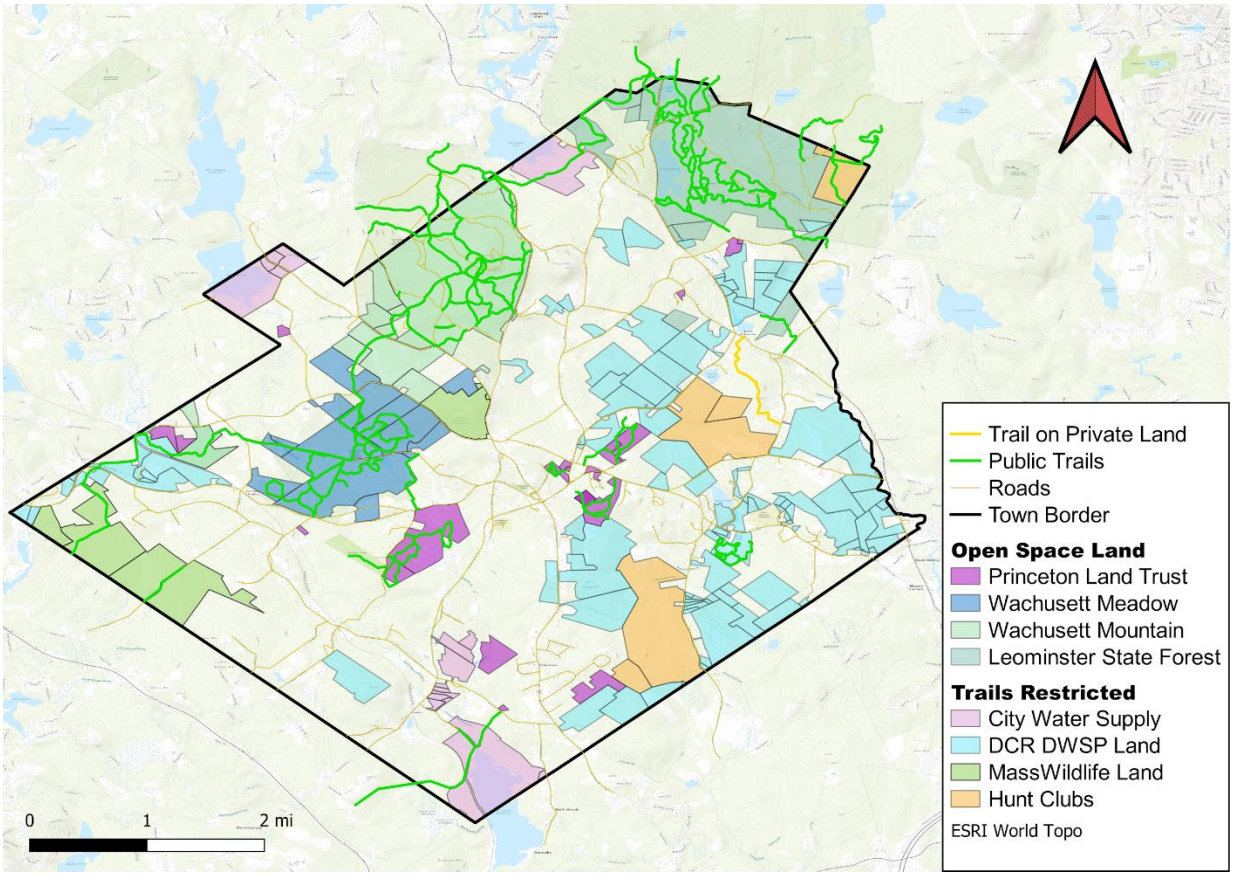


FIGURE 4: A MAP OF THE PUBLIC TRAILS, ROADS AND OPEN SPACE LAND PARCELS IN PRINCETON, MA

The number of trails in Princeton provides an excellent opportunity for a large scale interconnected hiking network. However, much work is needed to develop the existing network into a widely used, comprehensive trail system. Primarily, the inability to map a large portion of the trails in town poses significant problems for a feasible trail system. Without the ability to map and advertise the trails, the Princeton OSC will struggle to optimize the use of the TAP, putting the goals of the project in jeopardy. Furthermore, the ambiguity this creates could force people to go to more crowded trails, causing overuse and having negative impacts on the

environment in those areas. Moreover, critical sections of trails on unmarked private property could be shut down by the landowner posting "no trespassing" signs. This closure is likely if the landowner discovers the trail independently or by seeing hikers using it. Therefore, a written agreement with the landowner is required to ensure the longevity and security of the trail.

While the large concentrations of public trails in Princeton offer substantial recreational opportunities, they do not foster connections to different parts of town. There needs to be a serious effort put into the development of trails outside Wachusett Meadow, Wachusett Mountain, and Leominster State Forest to accomplish the goal of a comprehensive and interconnected trail system. Getting written approval to map the trails publicly would allow over 39 miles of trails in Princeton to become public. Furthermore, it would ensure that landowners approve of the trails and won't shut them down.

Another limitation with the current unrestricted trails in Princeton is that only 24 of them, totaling just 15.62 miles, are multipurpose, which is less than 20% of the trails in town. In comparison, a dedicated mountain biker would be able to cover 20 miles in as little as 3 hours. This data stresses the significant lack of opportunities for mountain bikers and horseback riders, who can traverse all the trails in Princeton in an afternoon. While there are opportunities for these activities on roadways, it is significantly riskier and less enjoyable. Though recreational roads provide a decent opportunity as well, they are also limited in distance and number. The multipurpose trails face a similar problem to all the other recreational trails as they are located primarily in the northern part of the town, which *Figure 5* shows. Without the creation of connected, multipurpose trails throughout the town, these user groups cannot make use and benefit from the trail network.

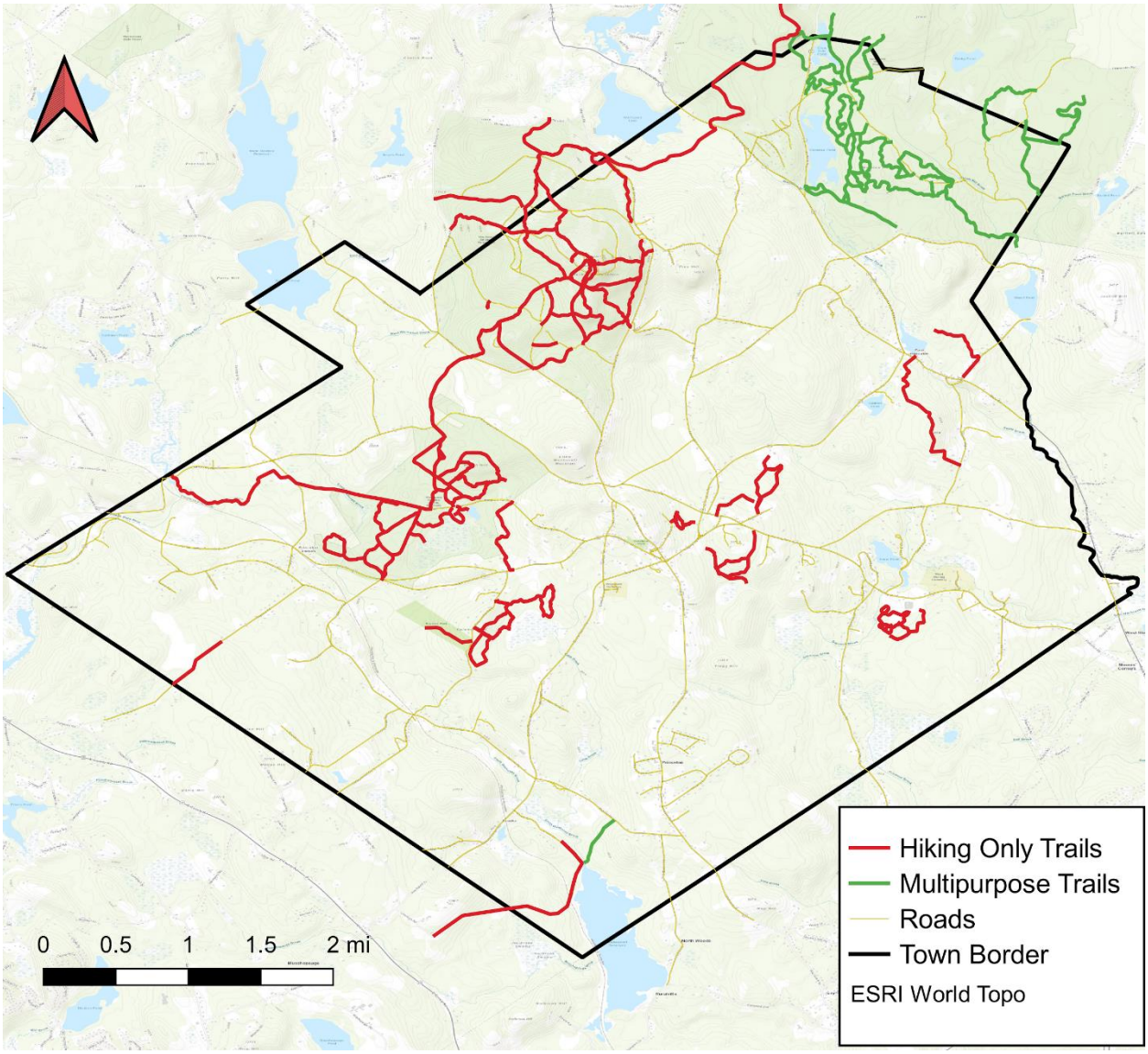


FIGURE 5: A MAP OF THE USES OF TRAILS IN PRINCETON, MA.

STAKEHOLDER POLICIES

We gathered information on policies and regulations for trail use through online research and interviews with government organizations, private sportsman clubs, and individuals from 11 conservation and recreation groups in Massachusetts. We found that the government organizations, DWSP and MassWildlife, are generally opposed to trail building in favor of upholding their organizational mission. Norco Sportsman Club is not interested in trail planning, while the Nimrod League of Holden is willing to support trails on their land. *Figure 6* summarizes these results. These findings informed our recommendations to the Princeton OSC on how to navigate strict regulations to find success for their future trail systems.

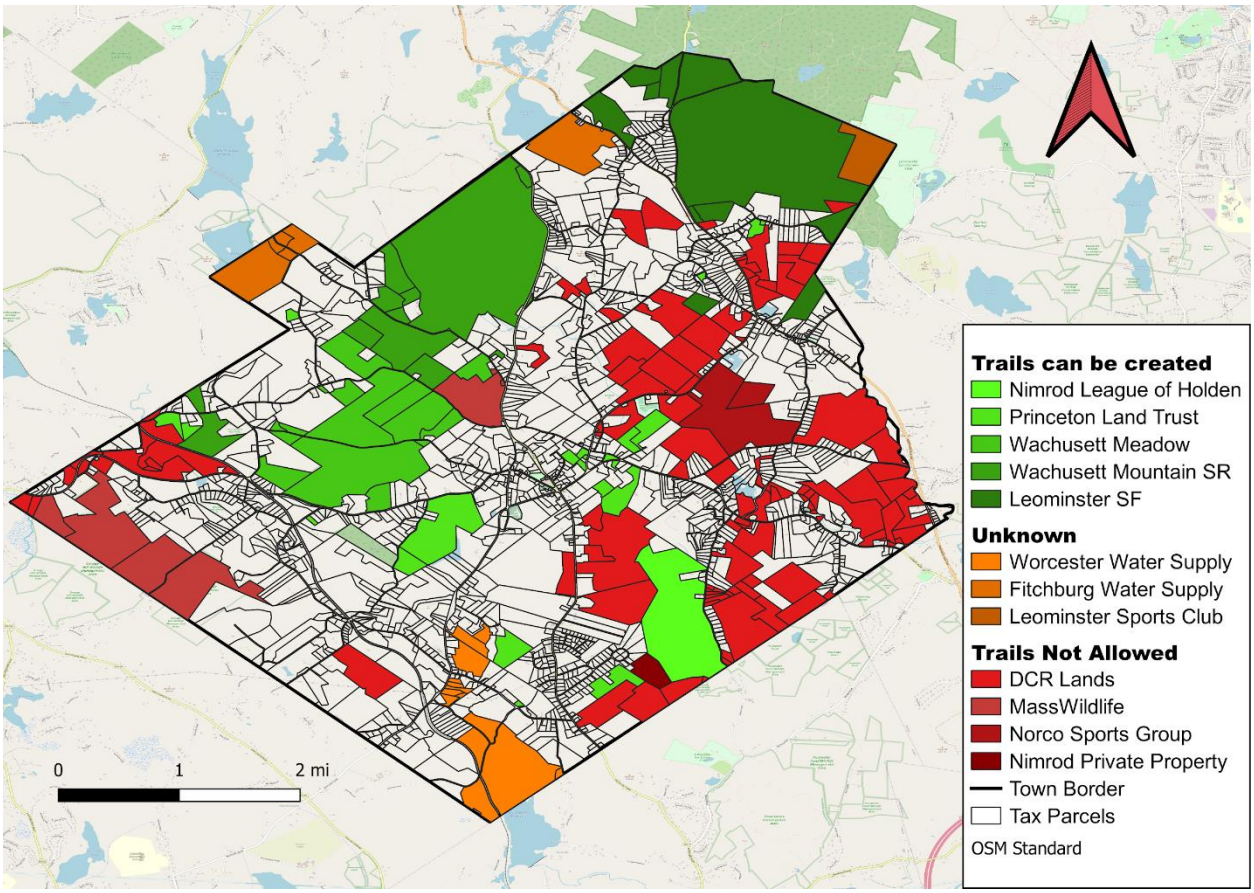


FIGURE 6: A MAP DISPLAYING THE ABILITY TO CREATE TRAILS FOR OPEN SPACE LAND IN PRINCETON

According to the official website for the Commonwealth of Massachusetts, the policies that the DWSP and MassWildlife possess regulate most types of activity on their protected land. The DWSP does not allow alteration of land within 400 feet of a reservoir or 200 feet of a tributary. All pollutants or litter are prohibited, and groups larger than 25 people are not permitted onto watershed land to make a distinction between parks and conservation land. This policy also limits organized recreational activities. And, access to their land must be through a gate and available for hiking only. The Commissioner holds power to open designated areas of land to more than just hiking, meaning access for dogs and horses, as well as mountain bikes, skis, or some other means of non-motorized transport. The above regulations, and others, were found in DCR 313 CMR: DIVISION OF WATER SUPPLY PROTECTION (Trial Court Law Libraries, 2018), an official document by the DWSP. Our search for MassWildlife policies produced similar results in the form of their Walking Trails Policy (Division of Fisheries and Wildlife, 2016). MassWildlife has a set of guidelines that groups like the Princeton OSC can follow when planning a trail. Due to this, creating a trail on MassWildlife land would require an extensive proposal that covers all aspects of the build process.

Additional information regarding trails on DWSP land was gathered by interviewing the Regional Director for the Wachusett watershed. This individual informed us that trail creation is currently not permitted on land owned by the DWSP. Most proposals to build a trail on their land will not be approved, and they will only consider the proposal if it contains detailed plans to limit environmental impacts that could be caused by a trail there. However, proposed trails that cross land regulated by the WsPA, but are not owned by DWSP, may be considered. *Figure 7* displays the land protected by this law. In one example from 2019, Princeton proposed a trail on town-owned land within a buffer zone, an area of natural protection at the edge of open water. The WsPA prohibited this trail, but the applicant applied for a variance, which is an exemption to certain building regulations in a protected area. This variance required Princeton to demonstrate that there would be a limited impact on water quality and to create as much wetland as they were disturbing. It was approved, and the trail has since gone into development. Additionally, maintenance of the trail falls on the organization responsible for building. This individual highlighted the importance of the existing laws, as the primary goal of the DWSP is for watershed protection.

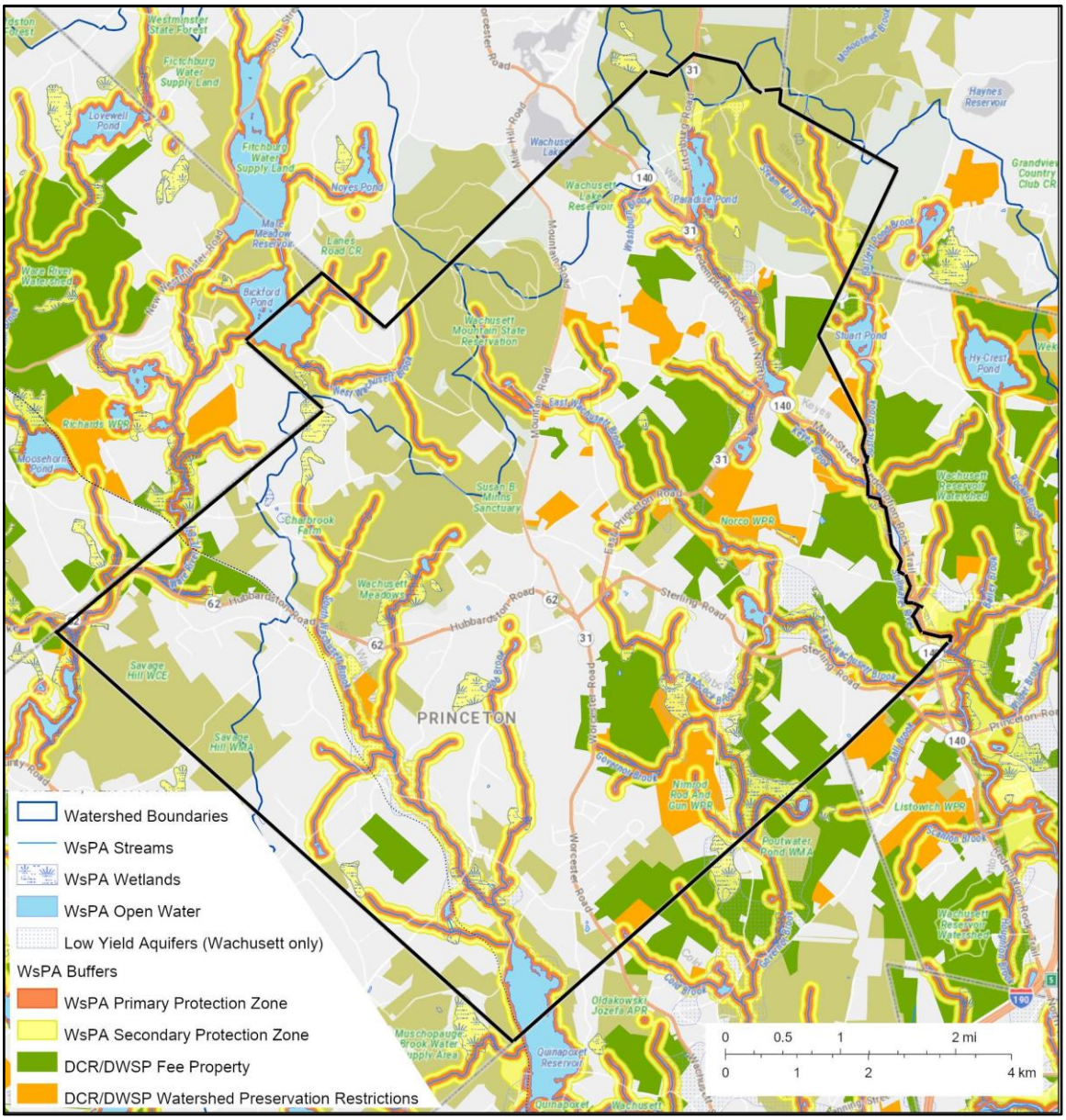


FIGURE 7: A MAP OF THE RESTRICTED AREAS DUE TO THE WATERSHED PROTECTION ACT (WSPA)

Furthermore, we contacted the leadership within the sportsman clubs, those being the Norco Sportsman Club and the Nimrod League of Holden. The leader in the Norco Sportsman Club expressed several concerns that were representative of most of the club. In a brief response to a few of our questions regarding concerns and ways to alleviate those concerns, the representative stated that safety is a number one priority as there would most likely be hunters on the property.

The easiest way to avoid the injury of a hiker would be to avoid having trails into Norco's land. The club is also worried about being held liable for any injuries. They also stated how members already had access to existing trails on the property, so the addition of new trails would not add any benefit for the members.

Conversely, the Nimrod League of Holden has shown interest in working with Princeton to build a trail on their land. A leader of the organization expressed that the majority of their land, totaling approximately 500 acres, is open to the public. However, 400 of the acres on the northern edge of the property have a conservation restriction in place by the DWSP, meaning their approval is needed to place trails on the Nimrod club's land. This land is also significantly safer than the southwest sections of the property that are unrestricted by the DWSP. This section is the location of the club's shooting ranges and is generally off-limits to the public. The individual we spoke to would like the trail to avoid that section of the property, as the risk of harm increases with proximity to the ranges, and liability for hiker safety would fall on the club. This is different from the DWSP restricted land, where liability is covered by the state of Massachusetts. One major concern that arose was the level of traffic that the trail could endure if made public and accessible by mountain bikers and other forms of non-motorized usage. The Nimrod club is worried that an increase in usage could cause unwanted damage to the land. This could be alleviated by restricting access to hikers only, as well as potentially keeping the trail unpublicized. For the specifics of the trail, the Nimrod club is willing to support construction and continue maintenance for the trail's lifespan. They would follow the Princeton OSC's expected trail standards, as well as best practices for water crossings. The Nimrod League of Holden, in comparison to Norco, is more willing to cooperate with the Princeton OSC.

Moreover, interviews with individuals from 11 conservation and recreation groups throughout Massachusetts explored feasible ways to work with the DWSP, MassWildlife, and private sportsman clubs. While no individual we spoke to had experience working with private sportsman clubs, most recommended avoiding their land for safety purposes. We learned that most trail planning groups avoid working with MassWildlife entirely, as they've recently shifted their policies on trails and do not allow new ones on their property. They've also begun to shut down unofficial trails on their land. More interviewees, however, have interacted with the DWSP and provided their approaches to create trails on DWSP land.

In Westborough, MA, negotiations with the DWSP for the Wachusett watershed have been occurring for the past ten years. Westborough initiated contact with the DWSP property manager for the region and presented trails that existed before DWSP was aware. The town requested authorization to finish this trail. In response, the DWSP said they would look the other way. Afterward, DWSP denied Westborough's proposal to create a new trail on DWSP land outside of a critical water protection zone. However, Westborough already possessed rights to build a trail near a water treatment plant, so they found it hypocritical that the DWSP would pick and choose which trails to permit. To push this issue, Westborough involved state representatives in supporting their trail plans and pressuring the DWSP. Since the DWSP is generally unwilling to argue with representatives, the town has had more success.

Similarly, the New England Mountain Bike Association (NEMBA) has worked with DWSP in the Ware River watershed. They've found success by having widespread public support, starting petitions and newsletters, maintaining organization credibility, presenting scientific reports that review trails built on watershed land, and conducting field visits with the DWSP to locations of interest. The DWSP has had further hesitations with NEMBA because the DWSP feels that bikes are more harmful to the environment than hiking. In response, NEMBA has cited studies that dispel this notion. From the above findings, we've determined that the DWSP is a difficult organization to work with, but they are willing to cooperate with groups that have well thought out plans.

TRAIL IMPLEMENTATION STRATEGIES

The interviews we conducted with local trail conservation and recreation groups also focused on standards, maintenance, and landowner permissions. Information gathered through online research supported these findings. In addition, we reviewed project plans given to us by the Princeton OSC and the town of Groton, which provided a clear outline for our strategy guide and any future project plans in Princeton. Furthermore, these findings informed our recommendations to the Princeton OSC on how to build and maintain a sustainable trail network.

STANDARDS

When building trails, there are unique standards and best practices put in place by different organizations, such as the United States Forest Service and the NPS, each with their own priorities and regulations to follow. These standards, though not mandatory for Princeton to follow, help organizations keep their recreational trails clean and in working order for those who use them. The two national trail standards and classification systems we researched were examples taken from the two organizations mentioned above. Both organizations had similar systems, which made it easy to compare them with the practices used by different towns. The USFS trail class matrix *(see Appendix C)* is one of the most universally referenced trail classification or trail class systems within the United States (United States Forest Service, 2008). A trail class matrix is a ranking system that organizes trails into five classes of development based on physical attributes of the trail, such as tread, signage, and accessibility. Most of the towns that we interviewed did not use a trail classification system, though the one that does, Leominster, uses the same system as the USFS. The trail building and design standards that we found from the NPS *(see Appendix D)* laid out necessary trail design measurements and information on how to build a trail up to their standards (NPS, 1998).

We also found, through interviews with Princeton's six neighboring towns, that they have similar trail guidelines in place. These are general guidelines rather than standards because they are less detailed and are not mandatory. For example, the NPS trail standards document lays out specific measurements for each part of a trail, while individual town standards do not have as much specificity. Each town has its way of creating and implementing these guidelines, but they are most often created by the town's OSC or trail committee. These towns are usually not as strict about following them because no one is holding them accountable.

MAINTENANCE

There are a variety of trail maintenance plans in the six neighboring towns surrounding Princeton. For example, Leominster uses an "adopt-a-trail" approach to maintenance, where an organization or individual can volunteer to maintain a trail once a month, or as needed. This idea stemmed from the Appalachian Mountain Club's (AMC) original "adopt-a-trail" maintenance

plan. According to the member that we interviewed from the Leominster Trail Stewards (LTS), this plan proved to be successful in garnering trail maintenance volunteers, which is why Leominster has decided to adapt it for their town. Leominster also utilizes the help of local businesses during the United Way Day of Caring, where companies pay employees for a day to volunteer for local community service projects. The United Way Day of Caring can gather anywhere from 50 to 70 volunteers for trail maintenance alone. Some local boy scout troops occasionally donate their time to cleaning the trails as well.

Other towns, such as Groton, Sturbridge, and Westminster, have created a mailing list or Facebook group for people who are willing to volunteer to maintain trails local to them. When maintenance is needed, or regularly, they send notifications to volunteers and assign each of them a trail or section of trail to maintain. In Westborough, when heavy equipment is needed, such as chainsaws, local land trusts can hire people or ask assistance from qualified volunteers. The Midstate trail has a more structured maintenance program where they go through a training course and orientation with interested volunteers to get them comfortable and certified with the necessary equipment. Because the Midstate trail runs through many towns, they assign volunteers to specific sections based on their location, to not inconvenience anyone. Though each town has its unique system for trail maintenance, they all understand through experience that it is best to have maintainers that are willing to help and want to be there; otherwise, nothing will get accomplished.

TRAIL PLANS

Based on our review of the six trail plans supplied to us by the Princeton OSC and the Groton Trail Committee, a professionally written trail plan varies in length depending on the intention and detail of the document. Within these documents, there is information on why the town wants to build trails, where they want to build them, and what types of trails they are interested in building. These documents all seemed to have a similar format and flow, beginning with an executive summary for the document, followed by an introduction before moving into a clear and detailed vision plan. By the end, they would list recommendations, which often included maps of the area with potential new trails or trail connections, as well as a prioritized list of

projects to complete first and how to complete these projects. When created and used properly, a trail plan can help towns gain approval for their projects and boost public support.

LANDOWNER PERMISSIONS

When interviewing Princeton's neighboring towns about their experience working with private landowners, we discovered that it was a difficult process for many. This was due to the inconsistencies associated with dealing with a variety of people. Every town we spoke to suggested having someone familiar with the landowner begin negotiations about putting a trail through their property. Once negotiations have begun, the towns try to gain landowner approval for the trail; *Table 2* lays out the methods for doing so.

Method	Definition
1. Land Donation -	Ownership of the land is given to the OSC
2. Land Acquisition -	The OSC purchases the land the trail is on
3. Easements -	A legal document where a private landowner agrees to allow a public trail on their land for a specified or indefinite amount of time.
4. Trail Licenses -	Similar to an easement but the landowner has the right to revoke the agreement at any time
5. Handshake Agreements -	A verbal agreement between the landowner and the OSC allowing a trail through their property

TABLE 2: A PRIORITY LIST OF WAYS TO OBTAIN LAND FROM LANDOWNERS FOR TRAIL CONSTRUCTION

For gaining access to private land, a land donation or acquisition would be preferred as it provides security for the trail as the trail group owns the land. However, easements are the most common way that trail groups gain access to land. This is because they provide security for the trail but the landowner maintains possession of the land. A similar process for gaining private landowner approval is by getting a trail license. Trail groups use this form of approval infrequently because a trail license, though similar to an easement, can be revoked by the landowner at any time, making it unreliable. Yet, some towns have had to settle for handshake agreements depending on the particular landowner. In addition, if there is a change in ownership

and the trail is under a handshake agreement or trail license, then the trail needs to be renegotiated to gain the permission of the new landowner.

From these findings, we were able to make determinations on the solutions and approaches we felt best suited the goals of the Princeton OSC and the TAP project. This includes information on potential connections to neighboring towns and how to proceed with the project inside Princeton. These methods, and how to deal with specific issues that may arise, were included in the strategy guide we are providing to the Princeton OSC. All of this data helped us create recommendations that Princeton can use to expand its current system of trails without hindrances.

CONCLUSIONS AND RECOMMENDATIONS

The town of Princeton does not have a plan for the creation of trails or a set process for gaining permission from landowners for trail building. Based on our findings from research on trail standards and policies, interviews with key stakeholders, and trail committee members outside of Princeton, we created a strategy guide for the Princeton OSC *(see Appendix E)*. This guide should aid in the creation of future trails within their town and includes recommendations on essential aspects of trail creation, such as trail planning standards and receiving landowner permissions. In addition, we included a map of all of the trails within Princeton to inform its OSC on the current state of trails and potential connections that can be made. This information can be used by the Princeton OSC to create a project plan for the TAP and other projects the Princeton OSC may undertake. In this section, we elaborate on the recommendations in the strategy guide.

Our first recommendation is the implementation of appropriate trail building standards, which should follow the United States Forest Service's trail class matrix *(see Appendix C)*. We suggest that most trails should be in Trail Class 3, or "Developed," so that the path is apparent, clear, and more handicap-accessible than the lower level trails. Moreover, the class three trails require less maintenance than the higher level trails. Because the Princeton OSC wants a system of continuous and defined trails, Trail Class 3 should be the minimum requirement for the network. However, trails developed on DWSP land should be in Trail Class 5, or "Fully Developed," to fulfill DWSP accessibility and maintenance requirements. While higher classification levels may

require more resources, they provide more accessibility and, in some cases, are mandated by landowners. We also recommend adhering to the trail sustainability rating table displayed in *Figure 2*, to limit maintenance and environmental impacts. By following these standards, a status quo is maintained in all trails within Princeton.

It is necessary to perform consistent trail maintenance to keep a trail up to original standards. We recommend that Princeton mirror the maintenance strategy of the Appalachian Mountain Club, which includes an "adopt-a-trail" program. Leominster is currently adapting this program, and we recommend Princeton work with the LTS to implement this strategy. This program divides the maintenance of different trail sections to groups of volunteers who are willing to donate their time. This system is useful for organizations that manage large trail networks since the maintenance work is distributed to the volunteers. Another common practice among trail groups that can benefit this program is the accumulation of a substantial list of contacts who may be willing to volunteer. The Princeton OSC currently has a small list of names for this reason. The growth of this list would allow Princeton to contact a large number of people who may be willing to adopt sections of trails as well as aid in organizing large scale service days.

Our next set of recommendations focuses on navigating private land permissions and government policies. Our recommendation to the Princeton OSC concerning the private landowner permissions is to find someone who knows the landowner well enough to begin negotiations. From there, the Princeton OSC should aim to acquire at least a written easement for that land. During this negotiation, it is also helpful to consider landowner opinions for the trail. For example, a landowner may not want a trail to run through a large portion of their land or to cross a certain point on their property. Ensuring the trail plan meets their concerns increases the likelihood that they will agree to the creation of the trail. In addition, this allows the landowner to be more comfortable with the proposed trail, as they have had a say in the planning process. We recommend involving local hiking groups as they can help tremendously in this process since they often know more residents and may be willing to talk with landowners about building trails on their property.

In addition to landowners, we have specific recommendations for working with sportsman clubs within Princeton. Sportsman clubs have year-round shooting ranges and seasonal hunting on their land. If there is a public trail running through this area, a hiker could accidentally be injured while using the trail. Therefore, there needs to be careful planning with club input, to ensure that the trails are in a safe location, and users are aware of risks and how to mitigate them. For the Nimrod League of Holden, we recommend proposing a trail plan that avoids their shooting ranges, which are in a 100 acre area in the southwest portion of the property. DWSP approval would be needed for a trail on the remaining 400 acres, as there is a conservation restriction on the land. This trail should also be restricted to hiking only, as there is a concern for overuse by mountain bikes and other non-motorized vehicles, and should also follow best practices for water crossings. If these conditions are satisfied, then the Nimrod League of Holden might be more open to having a public trail on their property. However, for the Norco Sportsman club, we recommend not building trails through their lands and finding a way around them wherever possible. According to them, by avoiding the hunt club land, hikers would be significantly safer and could hike without concern about being shot.

On the contrary, for government-owned land, we recommend the Princeton OSC avoid proposing trails that cross DWSP or MassWildlife land. Currently, the DWSP does not allow new trails on their land. While other towns have had some successes in creating trails, there are usually extenuating circumstances that created the opportunities for these trails. Even if approaching the DWSP with a thorough plan, they are likely to reject the idea. Avoiding their land can significantly reduce the amount of time spent negotiating with the DWSP. Additionally, Princeton land ownership maps show potential alternate routes that avoid DWSP owned land.

If their land is unavoidable, then we recommend that Princeton build most of the TAP and then ask for DWSP approval with a thorough but flexible trail plan. The network should first have support from the community to increase the likelihood of getting approval. Next, the proposal should consider and plan for the possible environmental impacts to that area and include detailed plans for any possible water crossings. We also recommend lobbying state representatives, as they can influence the DWSP into allowing trail development on protected land. MassWildlife currently does not allow trail creation on their land, so we recommend avoiding their properties.

With the number of existing trails in Princeton, there are a plethora of opportunities for connections in Princeton and its neighboring towns. We recommend communicating with Leominster first because it appears that the LTS is the most organized and willing to improve connections with Princeton. To create trails with Leominster, they urged that the Princeton OSC, the LTS, the DWSP, Wachusett chapter of the New England Mountain Biking Association, and the Water Department plan potential trail connections. All of these groups have trail expectations, standards, and regulations that need to be considered before trail creation.

For internal connections, we recommend that the Princeton OSC focuses on trails between Leominster State Forest and the Thomas Prince School. Connecting these areas would join significant parts of the town together through areas that currently lack public trails. Furthermore, the implementation of this trail can act as a model for the system and dealing with private landowners. Unfortunately, this connection would be 5.32 miles long, needing to navigate around DWSP land and private properties, making it a time-consuming process. However, the center section of this trail is not on DCR land and only needs landowner permission to make it a public trail. Another option the Princeton OSC should consider is connecting Wachusett Meadow to Boylston Park, as seen in *Figure 8*. This connection would only require the permission of, at most, three private landowners. It would also unite the trail systems in Wachusett meadow to a more central part of town, creating even more possibilities for internal trail connections.

One area for potential future research is the possibility of including sidewalks or curbside walkways for trail creation in Princeton. While organizations like the DWSP and Norco Sportsman Club prohibit the construction of trails on their land, utilizing roads would create a detour around their properties. Sidewalks or curbside pathways could create safe routes to other trails and maintain the connectivity of Princeton's trail system. In addition, sidewalks could also serve the focal purpose of stream crossings using an existing road bridge or crossing. By utilizing roadways, the committee should be able to save time and money while still connecting areas of town. While the construction of the sidewalks may be expensive and require approval, proper implementation would ensure a safe, connected network. This potential offers the opportunity for further research to understand these possibilities better.

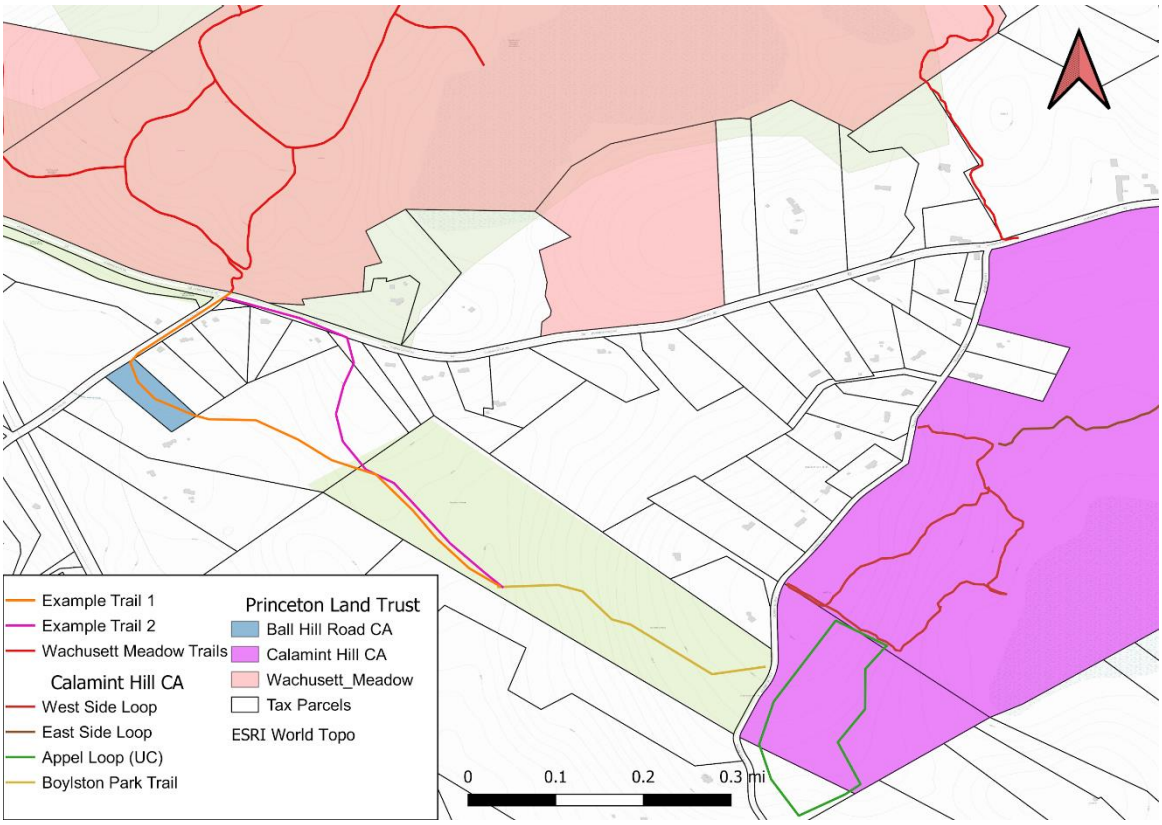


FIGURE 8: A MAP OF POTENTIAL ROUTE TO CONNECT WACHUSETT MEADOW TO BOYLSTON PARK.

Our strategy guide provides the Princeton OSC with a guideline on how to proceed with trail creation and accomplish their goals of interconnecting town recreational resources and connecting to neighboring towns. While there may be pitfalls ahead and some ideas may take years to come to fruition, the recommendations provided allow for a long-lasting and impactful trail network in the town of Princeton.

BIBLIOGRAPHY

Beaman, G. H. (1970). *A brief history of Princeton*. Town of Princeton, Massachusetts. www.town.princeton.ma.us/

Bratman, G. N., Hamilton, J. P., Hahn, K. S., Daily, G. C., & Gross, J. J. (2015). Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proceedings of the National Academy of Sciences*, *112*(28), 8567–8572. https://doi.org/10.1073/pnas.1510459112

Brown, D. K., Barton, J. L., & Gladwell, V. F. (2013). Viewing nature scenes positively affects recovery of autonomic function following acute-mental stress. *Environmental Science & Technology*, *47*(11), 5562–5569. https://doi.org/10.1021/es305019p

Department of Conservation and Recreation. (n.d.). *Watershed Protection Act.* Mass.gov. https://www.mass.gov/watershed-protection-act

Dill, J., & McNeil, N. (2013). Four Types of Cyclists?: Examination of typology for better understanding of bicycling behavior and potential. *Transportation Research Record*, 2387(1), 129–138. https://doi.org/10.3141/2387-15

Division of Fisheries and Wildlife. (2016). *MassWildlife's trail policy.* Mass.gov. https://www.mass.gov/service-details/masswildlifes-trails-policy

Forest History Service. (n.d.). *Hiking in America*. https://foresthistory.org/research-explore/us-forest-service-history/policy-and-law/recreation-u-s-forest-service/hiking-in-america/

Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and health. *Annual review of public health*, *35*, 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443

Lederbogen, F., Kirsch, P., Haddad, L., Streit, F., Tost, H., Schuch, P., Wüst, S., Rietschel, M., Deuschle, M., Meyer-Lindenberg, A., & Pruessner, J. (2011). City living and urban upbringing affect neural social stress processing in humans. Nature, 474(7352), 498–501. https://doi.org/10.1038/nature10190

Marin Museum of Bicycling. (n.d.). *Mountain biking history*. https://mmbhof.org/mtn-bike-hall-of-fame/history/

Marion, J. L., Leung, Y.-F., Eagleston, H., & Burroughs, K. (2016). A review and synthesis of recreation ecology research findings on visitor impacts to wilderness and protected natural areas. *Journal of Forestry*, *114*(3), 352–362. https://doi.org/10.5849/jof.15-498

Marion, J. L., & Wimpey, J. L. (2017). Assessing the influence of sustainable trail design and maintenance on soil loss. *Journal of Environmental Management*, *189*, 46–57. https://doi.org/10.1016/j.jenvman.2016.11.074

Mass. Gen. Laws Chapter 266, § 120 (n.d.). https://malegislature.gov/laws/generallaws/partiv/titlei/chapter266/section120

National Park Service. (n.d.). *Benefits of hiking*. https://www.nps.gov/subjects/trails/benefits-of-hiking.htm

National Park Service. (1998). *North Country trail handbook for trail design, maintenance and construction. Chapter 4 standards for trail construction.* https://www.nps.gov/noco/learn/management/upload/NCT_CH4.pdf

Outdoor Foundation. (2020). 2019 Outdoor Participation Report. https://outdoorindustry.org/wp-content/uploads/2015/03/19_OIA_008_Participation_Report_final_2.pdf

Princeton Open Space Committee. (n.d.). *Princeton hikes! Trail documentation.* Town of Princeton, Massachusetts. https://www.town.princeton.ma.us/open-space-committee/pages/princeton-hikes-trail-documentation

Princeton Open Space Committee. (2020). *Open space recreation plan sections 2-5.* Internal document provided to the Princeton IQP Group

Santarém, F., Silva, R., & Santos, P. (2015). Assessing ecotourism potential of hiking trails: A framework to incorporate ecological and cultural features and seasonality. *Tourism Management Perspectives*, *16*, 190–206. https://doi.org/10.1016/j.tmp.2015.07.019

Thomsen, J. M., Powell, R. B., & Monz, C. (2018). A systematic review of the physical and mental health benefits of wildland recreation. *Journal of Park and Recreation Administration*, *36*(1), 123–148. https://doi.org/10.18666/jpra-2018-v36-i1-8095

Town of Princeton, Massachusetts. (n.d.). *Town data.* Town of Princeton, Massachusetts. https://www.town.princeton.ma.us/about-princeton/pages/town-data

Trial Court Law Libraries. (2018). *313 CMR.*, https://www.mass.gov/law-library/313-cmr

Turton, S. M. (2005). Managing environmental impacts of recreation and tourism in rainforests of the wet tropics of Queensland World Heritage Area. *Geographical Research*, *43*(2), 140–151. https://doi.org/10.1111/j.1745-5871.2005.00309.x

United States Department of Agriculture Forest Service. (1956). *Report of the chief of the Forest Service, 1955.* Washington, DC: U.S. Department of Agriculture. https://hdl.handle.net/2027/umn.31951d00709905n

United States Forest Service. (2008). *National trail class matrix.* https://www.fs.fed.us/recreation/programs/trail-management/documents/trailfundamentals/National_Trail_Class_Matrix_10_16_2008.pdf

Walker. (n.d.). “Massachusetts State Parks.” *Leominster State Forest, a Massachusetts state forest located near Clinton, Fitchburg and Gardner*, www.stateparks.com/leominster_state_forest_in_massachusetts.html.

White, M. P., Alcock, I., Wheeler, B. W., & Depledge, M. H. (2013). Would you be happier living in a greener urban area? A fixed-effects analysis of panel data. *Psychological Science*, *24*(6), 920–928. https://doi.org/10.1177/0956797612464659

APPENDICES

APPENDIX A: STAKEHOLDER INTERVIEW QUESTIONS

This appendix outlines the questions that we asked the private sportsman clubs and government organizations in the interviews that were conducted.

We are a group of students from Worcester Polytechnic Institute working in collaboration with the Princeton Open Space Committee. We will be working to create a trail strategy plan for future trails in Princeton, Massachusetts. This interview will ask about trail regulations your group has in place and any experience you have had working with different trail committees. Participation in the research is voluntary and you are not required to answer any questions.

DWSP Questions

1. What regulations are there that would hinder trail construction on your land, specifically in Wachusett Reservoir watershed land?
2. What can be done in order to build trails on DWSP land while cooperating with regulations?
3. Have there been any towns in Worcester County that have created trails on DCR watershed protected land? Do you know how they were able to do so?
4. What regulations are present in surface water protection areas? What are these restrictions?
5. What can be done in order to build trails in surface water protection areas while cooperating with regulations?

Sportsman Club Questions

1. What are your concerns with a trail being placed on your land?
    a. Do you have any ideas on how to alleviate these concerns?
2. What would be the ideal structure for liability on trails on your land?
3. What would you like to see from a possible trail for your members to get the most benefit?
    a. Would maintenance of the trail/area by the OSC be a good incentive?
4. Could these trails be multipurpose trails where pets, equestrians, and bikers are allowed?
5. What areas of your land are completely off-limits?
    a. Due to shooting ranges, common hunting areas, etc.?
6. Would you be willing to work with the OSC in the future in planning a trail through your land?

APPENDIX B: CONSERVATION AND RECREATION GROUP QUESTIONS

This appendix outlines the questions that we asked the different conservation and recreation groups in the interviews that were conducted.

We are a group of students from Worcester Polytechnic Institute working in collaboration with the Princeton Open Space Committee. We will be working to create a trail strategy plan for future trails in Princeton, Massachusetts. This interview will ask about you and your group's experience in trail planning and development within your town, as well as your work with other public or private landowners. Participation in the research is voluntary and you are not required to answer any questions.

1. Can you give us some background on yourself?
2. Does your town have a system of trails that connects different parts of town?
    a. For example, a loop around the town?
3. How do you go about maintaining your system of trails? Is it mostly volunteer work?
4. What are some issues you encountered when building a trail? How did you solve these problems?
    a. Examples: Dealing with private landowners, dealing with organizational restrictions, etc.
5. Do you have any experience with the Department of Conservation and Recreation or the Division of Fisheries and Wildlife?
6. Does your town have any sportsman clubs? If so, have you been able to build any trails on their land?
7. Does your town have a trail strategy plan that you would be willing to share with us?
8. Do you have any advice for the creation of a trail strategy plan?
9. What is your process for planning and creating a trail?
10. Does your town have any possible trail connections with Princeton?
11. Do you have any other contacts that could be of use for us?

APPENDIX C: UNITED STATES FOREST SERVICE TRAIL CLASS MATRIX

This appendix lays out the United States Forest Service's trail classification system.

ROS: Recreation Opportunity Spectrum - Allows accurate stratification and definition for classes of outdoor recreation environments. This system divides recreation settings into six broad categories: urban, rural, roaded natural, semi-primitive motorized, semi-primitive non-motorized, and primitive.
WROS: Wilderness Recreation Opportunity Spectrum - Wilderness is a special, legally designated category that can cross classes.

Trail Attributes	Trail Class 1 Minimally Developed	Trail Class 2 Moderately Developed	Trail Class 3 Developed	Trail Class 4 Highly Developed	Trail Class 5 Fully Developed
Tread & Traffic Flow	• Tread intermittent and often indistinct • May require route finding • Single lane with no allowances constructed for passing • Predominantl y native materials	• Tread continuous and discernible, but narrow and rough • Single lane with minor allowances constructed for passing • Typically native materials	• Tread continuous and obvious • Single lane, with allowances constructed for passing where required by traffic volumes in areas with no reasonable passing opportunities available • Native or imported materials	• Tread wide and relatively smooth with few irregularities • Single lane, with allowances constructed for passing where required by traffic volumes in areas with no reasonable passing opportunities available • Double lane where traffic volumes are high and passing is frequent • Native or imported materials • May be hardened	• Tread wide, firm, stable, and generally uniform • Single lane, with frequent turnouts where traffic volumes are low to moderate • Double lane where traffic volumes are moderate to high • Commonl y hardened with asphalt or other imported material
Obstacles	• O bstacles common, naturally ocurring, often substantial and intended to provide increased challenge • Narrow passages; brush, steep grades, rocks and logs present	• Obstacles may be common, substantial, and intended to provide increased challenge • Blockages cleared to define route and protect resources • Vegetation may encroach into trailway	• Obstacles may be common, but not substantial or intended to provide challenge • Vegetation cleared outside of trailway	• Obstacles infrequent and insubstantial • Vegetation cleared outside of trailway	• Obstacles not present • Grades typically < 8%

Trail Attributes	Trail Class 1 Minimally Developed	Trail Class 2 Moderately Developed	Trail Class 3 Developed	Trail Class 4 Highly Developed	Trail Class 5 Fully Developed
Constructed Features & Trail Elements	• Structures minimal to non-existent • Drainage typically accomplished without structures • Natural fords • Typically no bridges	• Structures of limited size, scale, and quantity; typically constructed of native materials • Structures adequate to protect trail infrastructure and resources • Natural fords • Bridges as needed for resource protection and appropriate access	• Structures may be common and substantial; constructed of imported or native materials • Natural or constructed fords • Bridges as needed for resource protection and appropriate access	• Structures frequent and substantial; typically constructed of imported materials • Contructed or natural fords • Bridges as needed for resource protection and user convenience • Trailside amenities may be present	• Structures frequent or continuous; typically constructed of imported materials • May include bridges, boardwalks, curbs, handrails, trailside amenities, and similar features
Signs[2]	• Route identification signing limited to junctions • Route markers present when trail location is not evident • Regulator y and resource protection signing infrequent • Desination signing, unless required, generally not present • Information and interpretive signing generally not present	• Route identification signing limited to junctions • Route markers present when trail location is not evident • Regulator y and resource protection signing infrequent • Destination signing typically infrequent outside of wilderness; generally not present in wilderness • Information and interpretive signing not common	• Route identification signing at junctions and as needed for user reassurance • Route markers as needed for user reassurance • Regulator y and resource protection signing may be common • Destination signing likely outside of wilderness; generally not present in wilderness • Information and interpretive signs may be present outside of wilderness	• Route identification signing at junctions and as needed for user reassurance • Route markers as needed for user reassurance • Regulator y and resource protection signing common • Destination signing common outside of wilderness; generally not present in wilderness • Information and interpretive signs may be common outside of wilderness • Accessibility information likely displayed at trailhead	• Route identification signing at junctions and for user reassurance • Route markers as needed for user reassurance • Regulator y and resource protection signing common • Destination signing common • Information and interpretive signs common • Access ibility information likely displayed at trailhead
Typical Recreation Environs & Experience[3]	• Natural, unmodified • ROS: Typically Primitive to Roaded Natural • WROS: Typically Primitive to Semi-Primitive	• Natur al, essentially unmodified • ROS: Typically Primitive to Roaded Natural Typically • WROS: Typically Primitive to Semi-Primitive	• Natur al, primarily unmodified • ROS: Typically Primitive to Roaded Natural • WROS: Typically Semi-Primitive to Transition	• May be modified • ROS: Typically Semi-Primitive to Rural Roaded Natural to Rural setting • WROS: Typically Portal or Transition	• May be highly modified • Commonly associated with visitor centers or high-use recreation sites • ROS: Typically Roaded Natural to Urban • Generally not present in Wilderness

[1] For National Quality Standards for Trails, Potential Appropriateness of Trail Classes for Managed Uses, Design Parameters, and other related guidance, refer to FSM 2353, FSH 2309.18, and other applicable agency references.

[2] For standards and guidelines for the use of signs and posters along trails, refer to the Sign and Poster Guidelines for the Forest Service (EM-7100-15).

[3] The Trail Class Matrix shows the combinations of Trail Class and Recreation Opportunity Spectrum (ROS) or Wilderness Recreation Opportunity Spectrum (WROS) settings that commonly occur, although trails in all Trail Classes may and do occur in all settings. For guidance on the application of the ROS and WROS, refer to FSM 2310 and 2353 and FSH 2309.18.

United States Forest Service. (2008). *National Trail Class Matrix.* https://www.fs.fed.us/recreation/programs/trail-management/documents/trailfundamentals/National_Trail_Class_Matrix_10_16_2008.pdf

APPENDIX D: NATIONAL PARK SERVICE TRAIL CONSTRUCTION DESIGN STANDARDS

This appendix lays out the National Park Service's specific standards.

ROS: Recreation Opportunity Spectrum - Allows accurate stratification and definition for classes of outdoor recreation environments. This system divides recreation settings into six broad categories which, at times, overlap: urban, rural, roaded natural, semi-primitive motorized, semi-primitive non-motorized, and primitive.
WIDNR: Wisconsin Department of Natural Resources. This section in the appendix is specific for the state of Wisconsin and can, therefore, be ignored for the purposes of this study.

Standards (desired)	**ROS Class**			
	Urban	**Rural and Roaded Natural**	**Semiprimitive**	**Primitive**
Tread Width Hiking Segments Accessible Segments	 48" 60"	 24" 36"	 18" 28"	 *
Clearing Width (each side of tread))	24"	12" (WIDNR-24")	12"	*
Clearing Height (min.)	10'	8' (WIDNR-10')	8'	*
Slope(max.sustained) Hiking Segments Accessible Segments	 10% 5%	 10% 8%	 15% 12%	 *
Slope (max.) Hiking Segments Accessible Segments	 15% for 100' 8% for 30'	 20% for 100' 10% for 50'	 30% for 100' 10% for 50'	 *
Cross Slope (max)	3%	5%	8%	*
Other Accessible Segment Standards Passing Spot Int.-max Rest Area Interval-max	 N/A 1200'	 600' 1200'	 1200' 1/2 mile	 N/A N/A
Surfaces	Asphalt. Concrete. Stabilized-aggregate. Screening(1). Wood Chip. Sod.	Native. Wood Chip(2). Stabilized-aggregate. Screening(1).	Native	Native
Accessible Surfaces	Asphalt. Concrete. Stabilized-aggregate.	Asphalt. Stabilized-aggregate.	Native. Stabilized-aggregate.	Native

*In Primitive ROS (wilderness), human impacts and changes to the scenery are meant to be less obtrusive—when entering a wilderness area, one accepts greater personal risk. Trails in primitive areas lay "light-on-the-land." Because of this, no hard standards have been established. Generally, the tread is more faint, the grade varies depending on the terrain, etc. However, it is still important to consider trail design standards which protect the environment. Because trails in wilderness areas may receive less frequent maintenance, designing a trail that requires little maintenance is of utmost importance.

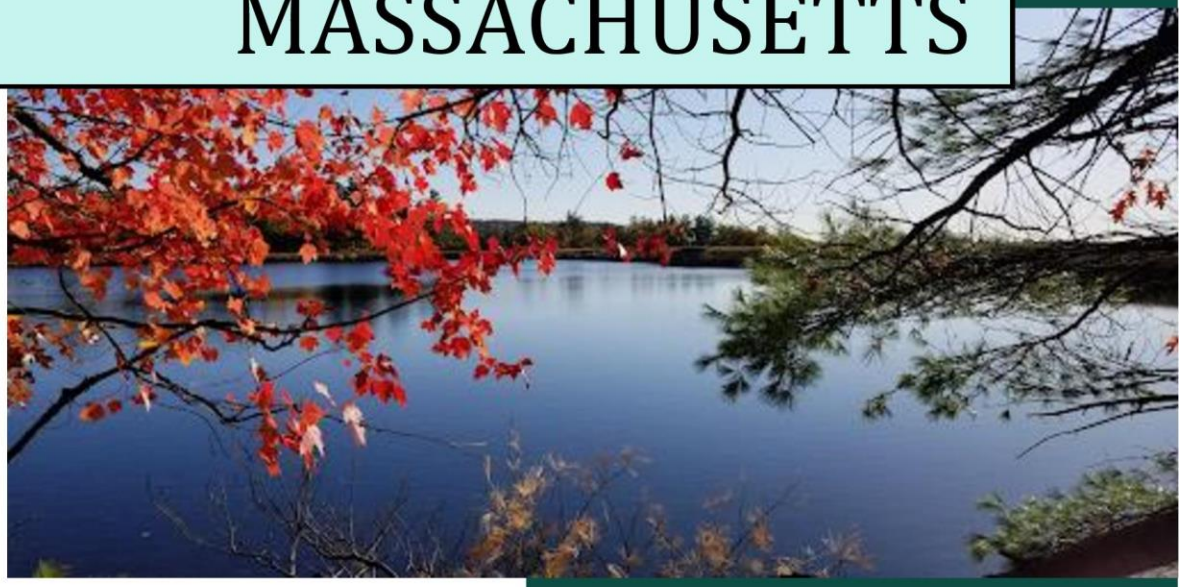
National Park Service. (1998). North Country Trail Handbook for Trail Design, Maintenance and Construction. Chapter 4 Standards for Trail Construction. https://www.nps.gov/noco/learn/management/upload/NCT_CH4.pdf

APPENDIX E: A STRATEGY GUIDE FOR TRAIL PLANNING IN PRINCETON, MASSACHUSETTS

This appendix is the strategy guide created for the Princeton OSC.

2020

A STRATEGY GUIDE FOR TRAIL PLANNING IN PRINCETON, MASSACHUSETTS



(Princeton OSC, 2020)

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ABSTRACT

This document provides the Princeton Open Space Committee with a set of recommendations for trail planning formulated by extensive research and analysis of land use policies, standards, and trail plans. Included are recommendations for standards, maintenance, processes for acquiring landowner permission, and potential connections within and outside of Princeton. We also include a list of implementation strategies to aid the TAP project going forward and a map containing all the current trails within Princeton.

ACKNOWLEDGEMENTS

Our group would like to thank the following people and organizations for supporting this project:

- The Princeton Open Space Committee, for an opportunity to complete this project.
- Rick Gardner, for providing vital information to aid in the completion of this project.
- Professors John-Michael Davis and Hektor Kashuri, for their guidance through every stage of this project.
- All the trail committee members, private organizations, and government associates that we interviewed for your information and guidance for trail creation.

AUTHORSHIP

This guide was prepared by Matthew Karns, Mason Ocasio, Steven Pardo, and Mackenzie Warren, students at Worcester Polytechnic Institute.

DEFINITION OF TERMS

The term “project plan” refers to a plan developed for a town’s trail network. This is most often used with respect to the Trails Around Princeton project plan. It is also referred to as a trail vision guide by some.

The term “trail plan” refers to the design and planning of an individual trail.

The term “trail standards” refers to the design and building specifications of trails.

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1.0 INTRODUCTION

There are nearly 100 miles of trails within the town of Princeton, many of which reside on open space land. In a survey conducted by the Princeton Open Space Committee (OSC), 75% of the population of Princeton chooses to walk or hike on these trails (Princeton OSC, 2020). The study also found that nearly 80% of respondents hike or walk along roads in a year, with roughly 50% doing so frequently (Princeton OSC, 2020). This same group of people has also expressed concerns about walking along roads, with cars speeding close by. To encourage more people to walk around town, as well as to ensure safety, the Princeton OSC has the goal of creating a network of multipurpose trails, called the Trails Around Princeton (TAP), that connects different areas of town. This system would allow more opportunities for residents to travel around the town without the use of a car.

However, the trails that would comprise the TAP cross land owned by various stakeholders, whom each have reservations about trail construction. Government conservation organizations such as the Department of Conservation and Recreation Division of Watershed Protection (DWSP) and the Massachusetts Division of Fisheries and Wildlife (MassWildlife), have expressed concerns about the environmental impact trails could have. The DWSP, in particular, has many limitations when developing or operating near watersheds. They enforce the Watershed Protection Act, which "regulates the land use and activities to protect the drinking water supply" (Department of Conservation and Recreation, n.d.). This act establishes two different protection zones - primary and secondary - with different regulations depending on the proximity watershed tributaries. The two sportsman clubs, Norco Sportsman Club and the Nimrod League of Holden, have expressed concerns over building public trails on their land, with the primary concern being safety for the users. They are also concerned that the trail may be damaged by overuse from mountain bikes and other non-motorized vehicles, and that the presence of vehicles and other animals may scare away wildlife in the area. Because of this, there are currently no public trails through these properties, even though they would be convenient paths for the TAP. This strategy guide provides recommendations on how to work with these landowners and alleviate their concerns .

1.1 LAND USE

Due to its sloping terrain and large quantity of wetlands, Princeton is limited in how it can utilize its land. These limitations are furthered by the town's low population density, which, when compared to neighboring towns, is roughly half that of Rutland, the next smallest town. This low population density and the steep slopes and ledges of the area lead to only 34% of Princeton's land being used for residential purposes while 4% is commercial, and 2% is agricultural. This composition leaves a substantial amount of open space land totaling 12,830 acres or about 56% of the land in Princeton (Princeton OSC, 2020). A map showing land ownership can be seen in Figure 1, highlighting the vast amount of open space land.

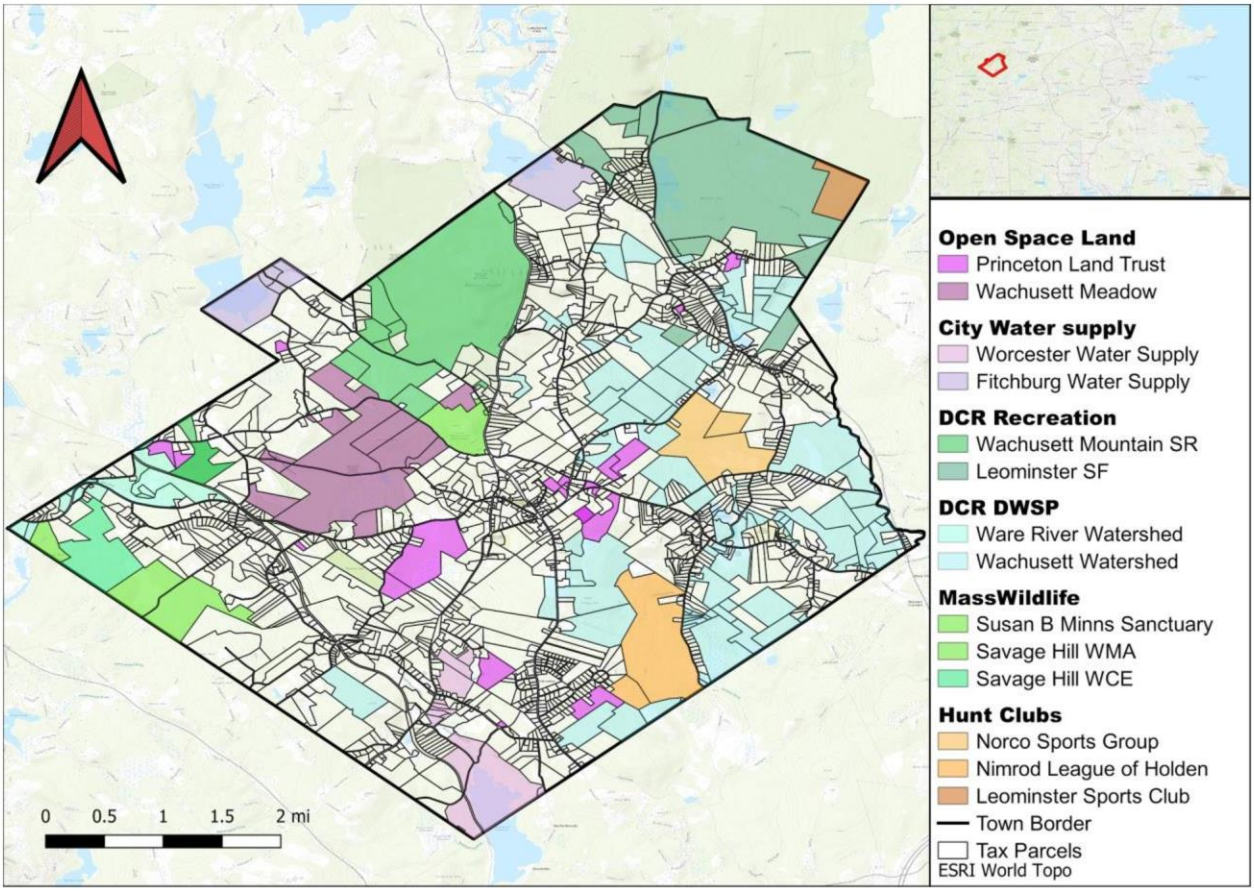


FIGURE 1: A PROPERTY MAP OF PRINCETON WITH OPEN SPACE LAND HIGHLIGHTED

The open space land in Princeton is divided into different categories based on ownership and access. The first category is land owned by the town of Princeton and managed by the Parks and Recreation Department, which mainly includes local parks and schools. Seven different properties around the town fall into this category, including Boylston Park and the Four Corners Conservation Area. Similarly, the state of Massachusetts owns large swaths of land, mainly for recreation, including Leominster State Forest, which features 1,380 acres of land in the Northern part of Princeton. The forest features many multi-purpose trails, both inside Princeton and in the neighboring town of Leominster. The other piece of state-owned land in Princeton is Mount Wachusett State Reservation, with 1,350 acres of land inside Princeton's western border. Mount Wachusett is known for its winter ski area, but it also features miles of trails up to the summit and around the mountain. These trails are not just limited to hiking, as some provide access for biking or horseback riding. Wachusett Mountain is the northern part of a continuous, uninterrupted stretch of conserved and protected land, with the other two pieces being Minns Wildlife Sanctuary and the Wachusett Meadow Wildlife Sanctuary. These two areas combine to make up another 1,148 acres of protected land, featuring numerous hiking trails. In total, these three conservation areas comprise about 2,500 acres of open space land in western Princeton (Princeton OSC, 2020).

While these properties are open to the public, there are some parcels of land in Princeton that are privately owned and used for recreation. Some of these lands are owned by sportsman clubs, like the Nimrod League of Holden and Norco Sportsman Club, who provide recreational use for their members. In total, these organizations own 739 acres of forest and waterways on the east side of town. Furthermore, the Princeton Land Trust (PLT) is a private organization that provides the general public access to their numerous conservation areas. In total, they own 24 properties that total 379 acres of land, but they also have conservation restrictions on another 298 acres of land around town. These lands allow the public to hunt, hike, and observe nature similar to the lands owned by the town or the state (Princeton OSC, 2020).

The last category of land ownership is land owned by public and non-profit organizations. These include the 259 acres reserved by MassWildlife for hunting, hiking, and nature observation as well as 3,434 acres of land owned by the DWSP for watershed protection. Princeton is about 10% open water or wetlands, which flow into four public reservoir supplies: Wachusett, Quabbin, Fitchburg, and Quinapoxet. Princeton's wetlands provide about 30% of the water to the Wachusett Reservoir, which, along with the Quabbin Reservoir, supplies water to nearly 2.5 million people in the Boston area (Princeton OSC, 2020). To maintain water quality, the DWSP has imposed strict restrictions and regulations for what is allowed on their property (Princeton OSC, 2020). In addition, some of the areas protected by the DWSP are designated as priority habitats for rare species.

1.2 EXISTING PRINCETON TRAILS

We accumulated information on 128 trails and recreational roads in Princeton, with the trails totaling 97.38 miles. We learned of 35 trails that cannot be mapped publicly. These trails total over 40 miles in length, equaling roughly 42% of the total trail mileage in town. We further found, from our review of trails, that 17 of the trails in Princeton run on private land that does not have “no trespassing” signs posted. In Massachusetts, a person walking on private property must be made aware that they are not allowed on the property to be trespassing. This rule means that property without a “no trespassing” sign can be walked on without breaking the law. In total, 43.2% of the trail mileage in Princeton has at least one limitation on it. Of the unrestricted, or public, trails in town, close to 70% of the mileage is on three geographically close conservation areas. This disparity can be seen in Figure 2, as most of the public trails are clustered in the northwest portion of town. In total, there are only 17.39 miles of unrestricted trails outside of these properties, most of which are on Princeton Land Trust lands scattered around the town.

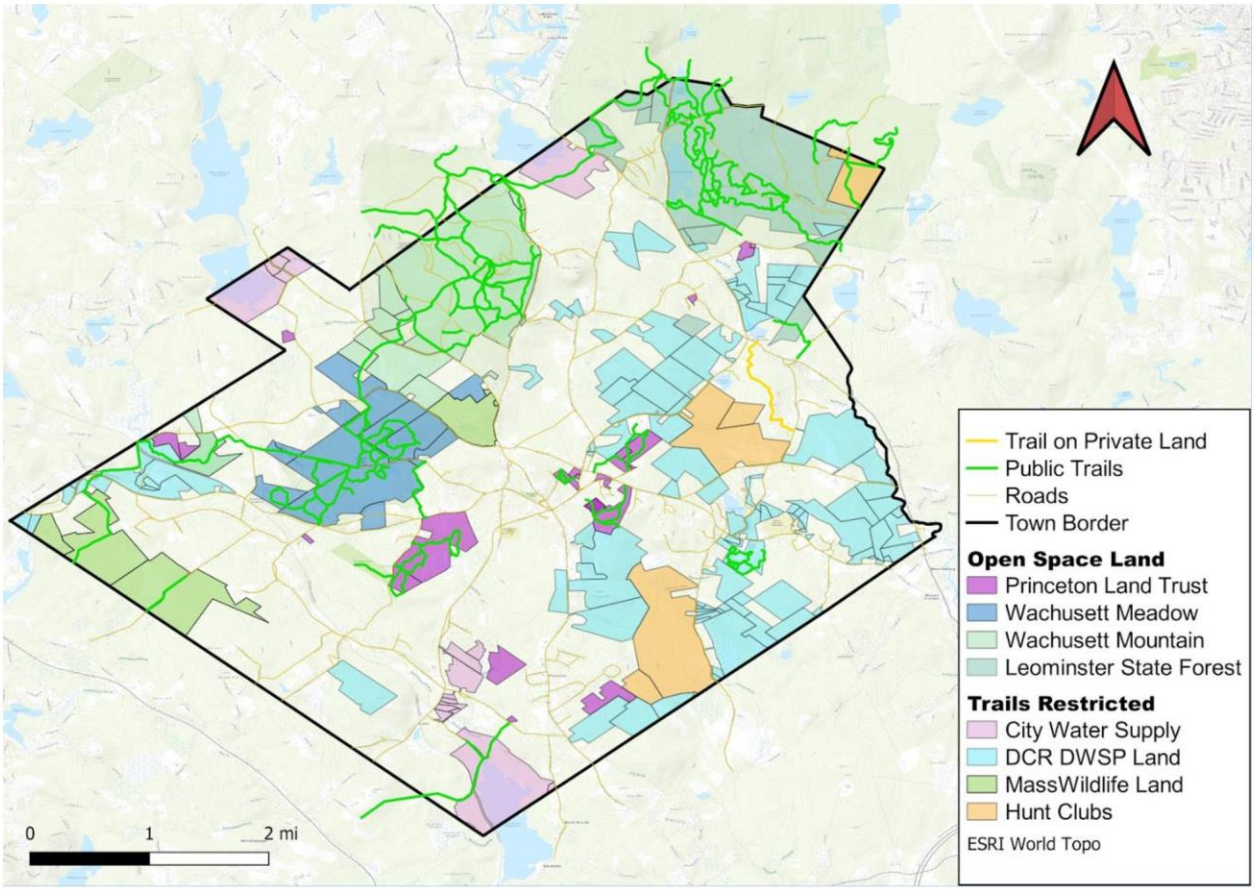


FIGURE 2: A MAP OF THE TRAILS, ROADS AND OPEN SPACE LAND PARCELS IN PRINCETON, MA

The large quantity of trails in Princeton provides an excellent opportunity for a large-scale interconnected hiking network. However, extensive work needs to be done to develop the existing network into a widely used, expansive trail system. Primarily, the inability to map a large portion of the trails in town poses significant problems for a feasible trail system. Without the ability to map and advertise the trails, the Princeton OSC will struggle to optimize the use of the TAP, putting the goals of the project in jeopardy. Furthermore, the ambiguity that this creates could force people to go to more crowded trails, which would cause overuse and negatively impact the environment in those areas. It is vital to receive landowner approval for the trails on their land to be publicized, which is the case for any trail but is especially pertinent to the ones running on unmarked private property. In those cases, critical sections of the trail could be shut down by the landowner posting "no trespassing" signs. This is likely to happen if the landowner discovers the trail independently or by seeing hikers using it. Therefore, a written agreement with the landowner is required to ensure the longevity and security of the trail. This includes getting written approval to publicly map the trails, which would allow over 39 miles of trails to become public.

Another limitation with the current unrestricted trails in Princeton is that only 24 of them, totaling just 15.62 miles, are multipurpose. In comparison, a mountain biker would be able to cover 20 miles in as little as 3 hours. This data stresses the significant lack of opportunities for mountain

bikers and horseback riders in the town, as all the trails in the town can be traversed in an afternoon. While there are opportunities for these activities to be done on roadways, it is significantly riskier. Though recreational roads provide a decent opportunity as well, they are limited in distance and number. The multipurpose trails face a similar problem to all the other recreational trails as they are located primarily in the northern parts of the town, which Figure 3 displays. Without the creation of connected, multipurpose trails throughout the town, these user groups will not be able to make use of the trail network and receive the benefits.

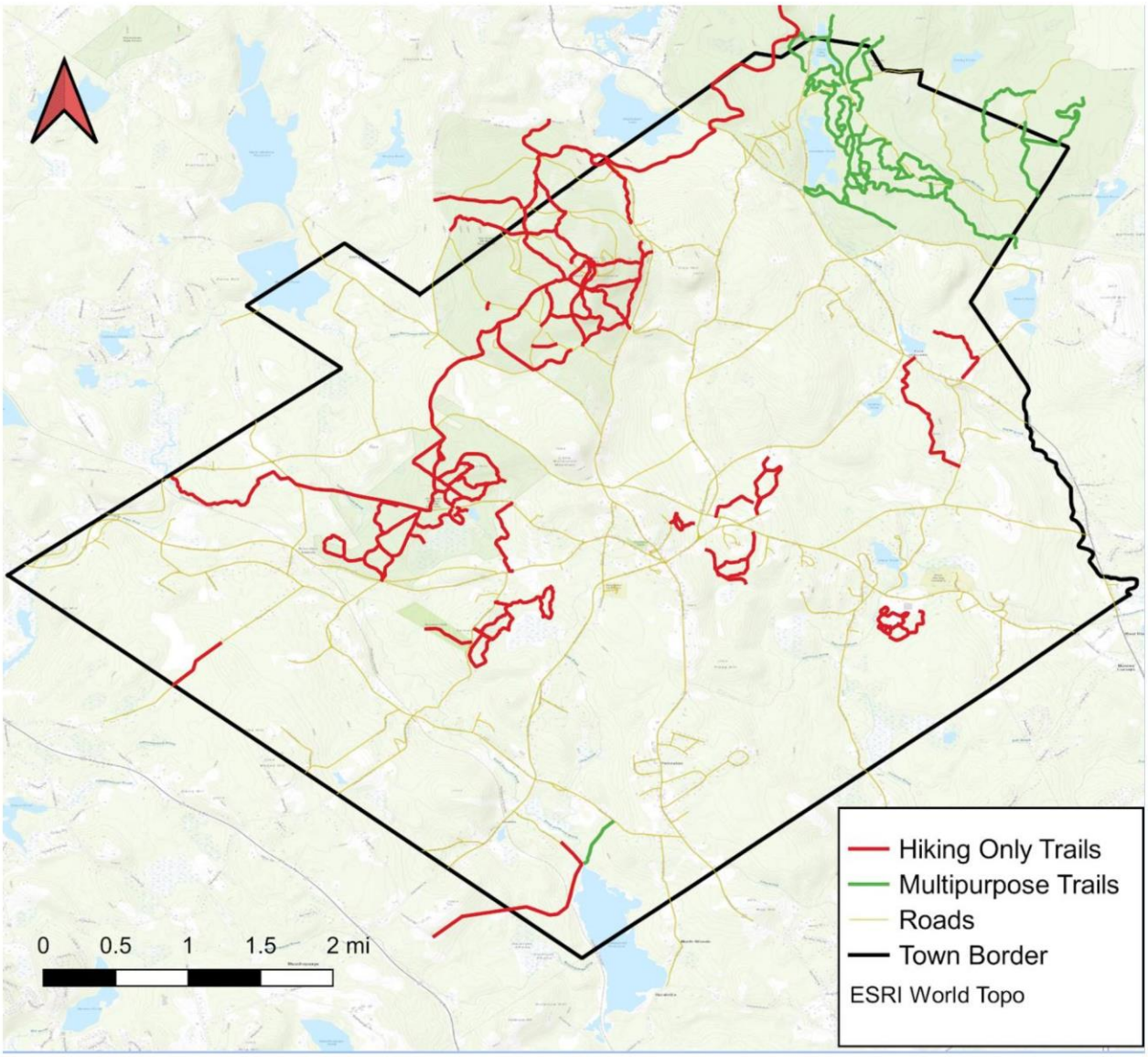


FIGURE 3: A MAP OF THE USES OF TRAILS IN PRINCETON, MA

1.3 TRAIL IMPACTS

A trail that experiences significant usage has the potential to cause severe damage to the local environment. Without proper management, trail users can trample vegetation, alter ground conditions, and introduce foreign weeds (Turton, 2005). Trampling is one of the most significant concerns with hiking trails because of the domino effect that can occur. Repeatedly stepping on vegetation can cause it to die out quickly, leaving the trail's topsoil exposed. Furthermore, as the ground is stepped on repeatedly, its natural conditions are altered, generally becoming more compact. These two factors can allow an invasive species of plants or weeds to move into the area, negatively impacting the balanced ecosystem (Turton, 2005). These invasive plants not only affect the composition of vegetation in the area, but also affect the wildlife that depends on said vegetation. High volume trails further impact wildlife because of the continuous stream of people using them, interrupting the wildlife's regular habits and routines. This interruption quickly leads to fragmentation of the ecosystem, the division of formerly connected areas due to the presence of human-made trails (Santarém et al., 2015). However, implementation of proper design and management techniques can minimize the negative impacts of trails.

The most significant byproduct of trampling is soil erosion, which needs to be considered when planning and implementing recreational trails. The detrimental effects of soil erosion are so severe that it is referred to by some as the most significant factor regarding the long-term sustainability of a trail if it is not designed and maintained properly (Marion et al., 2016). The most visible effect of erosion is rutting, which exposes roots and rocks along the trail. Rutting increases the risk of injury and hiking difficulty, as the trail is no longer smooth and flat. Often, to avoid the hassle of walking on the rough terrain, it is common for hikers to go around the original rutted trail, widening it and causing even more ecological harm (Marion & Wimpey, 2017). The soil run-off from rutting and erosion can enter nearby waterways, potentially contaminating the water. These particulates and potential contaminants decrease water quality and lead to abnormal bacteria growth, which can have a significant negative impact on the environment (Marion et al., 2016). Furthermore, maintenance is more difficult on rutted trails as transporting supplies becomes more strenuous. Similarly, the amount of fill needed to repair the trail can be significant, leading to expensive maintenance costs (Marion et al. 2016). Because of how challenging soil erosion is to fix, and the severity of the potential problems, it is vital that soil erosion is taken into serious consideration when designing a trail.

To limit environmental impacts, Turton (2005) and Marion & Wimpey (2017) suggest using raised boardwalks to limit the effects of trampling. By using raised boardwalks can protect the soil and vegetation from trampling, preserving the natural ecosystem. Boardwalks would also allow for large numbers of hikers to use the trails without having a significant adverse impact on the environment. However, boardwalks are costly to install and maintain, and can still fragment the ecosystem. Another option to limit trail erosion is the use of an alternate path material, such as gravel. A downside to this method is that the trail can have a less natural feel, but this can be mitigated by mixing the gravel with topsoil.

However, Marion and Wimpey (2017) believe the best way to mitigate erosion is by evaluating the trail on a combination of methods. The two key methods they suggest are the trail grade and trail slope alignment angle. The trail grade, or slope, is measured by calculating the change in height over the change in distance and is reported as percentage. The trail slope alignment angle measures the angle between the slope of the hill and the direction of the trail. The closer the angle is to 90°, the flatter the trail is, as it goes along the hill rather than straight up. This system is depicted in Figure 4. Marion & Wimpey (2017) determined that these methods alone were not sufficient to combat the problem of erosion, so they proposed a system that combines the two methods that would best prevent erosion. From this, they developed a guideline to help reduce erosion by ranking a trail segment from good to very poor based upon these factors, outlined in Figure 5. By designing a trail that remains in the "Good" or "Neutral" range, erosion and maintenance can be limited.

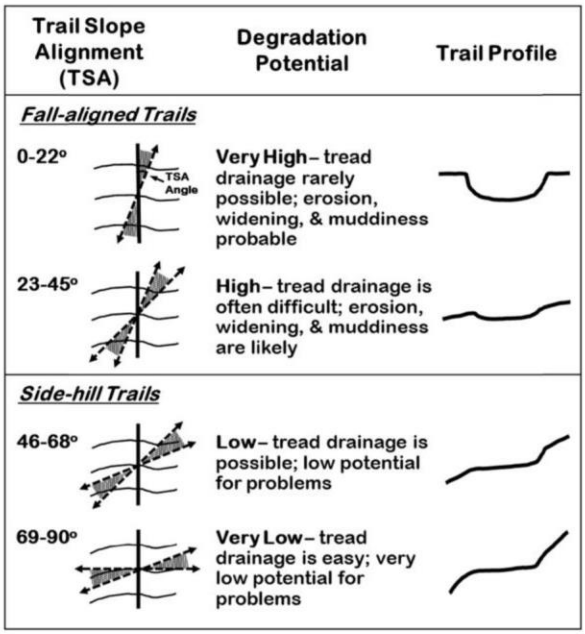


FIGURE 4: A DEPICTION OF THE TRAIL SLOPE ANGLE (MARION & WIMPEY, 2017)

Trail Sustainability Rating	Trail grade and trail slope alignment criteria
Good:	Trail grade of 3-10% and TSA > 30°
Neutral:	Trail grade of 0-2%
Poor:	Trail grade of 3-10% and TSA of 0-30°, or trail grade of 11-20% and TSA > 30°
Very Poor:	Trail grade of 11-20% and TSA of 0-30°, or trail grade of >20%

FIGURE 5: A PROPOSED TRAIL SUSTAINABILITY RATING SYSTEM (MARION & WIMPEY, 2017)

Due to the potential impact that recreational trails can have on the environment, government organizations have placed heavy restrictions on trail development. These regulations are put in place to achieve their organizations' goals of maintaining water quality or preserving wildlife. However, with proper design considerations, trails can be constructed on protected lands in a sustainable manner that aligns with the goals of these groups. Trails, when constructed properly, can limit environmental impacts by concentrating traffic onto set pathways with hardened tread that are designed to limit their negative impact. (Marion & Wimpey, 2017) Trails created in these areas would promote recreation and connections while also preserving the goals of the land.

2.0 INFORMATION COLLECTION

Our group used three different methods to collect the data analyzed within this guide. First, we mapped all of the current and proposed trails within Princeton using a GIS mapping software to inventory and analyze the existing trails. To aid in this process, Rick Gardner provided us with many GPX files of trails he had hiked all around Princeton, and we used Open Street Maps to record the remaining trails onto our GIS map. Mapping trails in Princeton gave us insight into the private organizations, landowners, and government organizations that would major be stakeholders for the TAP. Furthermore, this map of trails gave us potential locations for internal connections within Princeton, as well as external connections with surrounding towns.

To gather information about trail creation processes and experience with government roadblocks, we interviewed members from different trail committees and organizations within Massachusetts. The six conservation and recreation groups within Princeton's neighboring towns that we spoke with were the Leominster Trail Stewards, the Sterling OSC, the Westminster OSC, the White Oak Land Trust, the North County Land Trust, and the Rutland Conservation Commission. We asked if any of these towns had ideas about creating trail connections with Princeton. We also spoke with representatives from other conservation and recreation groups in Massachusetts, including the Groton Trails Committee, the Sturbridge Trails Committee, the town of Westborough, the Wachusett Chapter of NEMBA, and the Midstate Trail. In these interviews, we focused on topics such as trail creation, trail maintenance, and landowner permissions. These questions were asked

to the six neighboring towns as well. We also interviewed a representative from the Nimrod League of Holden to understand the club's concerns with trail creation on their land, ways to alleviate those concerns, and what they'd like to see from a trail to benefit their members. A representative from the Norco Sportsman Club that we spoke with was unwilling to participate in an interview but responded with brief answers to our questions. Lastly, we spoke to a representative from the DWSP. This interview focused on the set of regulations that are in place for the Wachusett Reservoir watershed, ways that trails have been successfully created on their other properties, and ways the Princeton OSC could do the same.

We researched trail standards, environmental impacts of trails and how to mitigate them, and local government policies regarding recreational trails. Our focus was on the main stakeholders in Princeton that would impact trail building: the Department of Conservation and Recreation, the Division of Water Supply Protection, and the Massachusetts Division of Fisheries and Wildlife. We searched for information that would hinder or limit trail creation on lands owned by these entities. In addition to these policies, we looked into different trail standards that can be implemented. These standards can be found on both the United States Forest Service (USFS) and the National Parks Service websites. The USFS provided a classification table that contains trail information for different types of trails. The National Parks Service had measurements for national trail standards such as width, slope, and type of surface.

3.0 RECOMMENDATIONS

The following series of recommendations were formulated from the information gathered, as mentioned above.

3.1 PROJECT PLAN

WE RECOMMEND THE CREATION OF A PROJECT PLAN BE BUILT OFF OF THE CONTENTS OF THIS DOCUMENT.

In our interviews with Massachusetts town conservation and recreation groups, it became clear that there are not many towns in the area that have a formal project plan for their trails. The development of one would allow Princeton to become a leader among these towns on top of organizing the future of trails in Princeton.

A vital benefit of a formal project plan is that it allows the goals of the project to be easily communicated to others. With a clear, well-written plan, a person will be able to understand almost everything about the project, without needing a meeting or verbal explanation. Furthermore, the plan can be the first step to convincing groups to approve the project or provide assistance as it will lay out the needs for a trail system and the benefits that the system can bring. This plan can be a crucial first step in getting approval for the trail moving forward as it should clearly state your intentions and possibly ease concerns. The plan can also help ensure that progress is made on the project, as the group will remain focused and on track for development. Furthermore, it will keep

the committee organized so that all members can know how much progress the committee has made, and how much more remains.

WE RECOMMEND THE PROJECT PLAN LAY OUT, IN DETAIL, THE PLAN FOR THE TAP PROJECT.

A well-written project plan should be around 75 pages, though that varies depending on the intention and detail of the document. However, if the intended goal of the document is gather support for the project, the documentation should be under a hundred pages. A project plan should answer the questions:

1. Why do we want to build trails?
2. Where do we want to build them?
3. What types of trails do we want to build?

The contents of the project plans that we reviewed were relatively consistent. In the beginning, there was an executive summary for the document, highlighting the key aspects of the documents focusing on why the project is necessary. From there, there is an introduction which has a wide range of information. Often this includes:

- A brief history of the town with a focus on transportation and recreation
- Existing conditions of recreational trails in town
- Limitations of the current network of trails
- Benefits a system of non-motorized pathways could bring to Princeton
- A definition of the project including the purpose, vision, and values of the planning process

After the introduction, the project plan should begin to identify potential trails to realize the goals and vision of the system. These trail plans should be detailed, outlining what areas of town are going to be connected, the benefits provided by the trail, potential limitations or roadblocks, and a map of the proposed trail. The more detail provided for the proposed trail, the easier it will be to get approval and buy-in for the project. Once identified, potential new trails should be categorized based upon the purpose of the trail (ex. Connecting two trails). Once categorized, trail plans should be ranked based upon priority, which should keep the open space committee focused on one trail at a time. When created and used correctly, the project plan can be a valuable tool for the Princeton Open Space Committee. Groton's trail plan, which we used as an example, can be found in Appendix A.

3.2 PRIVATE LANDOWNER PERMISSIONS

WE RECOMMEND ACQUIRING AT LEAST AN EASEMENT FROM LANDOWNERS FOR ALL TRAILS.

Working with private landowners and trying to build recreational trails on their property can be a difficult process. Once a landowner has agreed to a public trail on their property, the next step would be to acquire a form of approval for the trail. The different forms of landowner approval are:

1. Land Donation -	Ownership of the land is given to the OSC
2. Land Acquisition -	The OSC purchases the land the trail is on
3. Easements -	A legal document where a private landowner agrees to allow a public trail on their land for a specified or indefinite amount of time.
4. Trail Licenses -	Similar to an easement but the landowner has the right to revoke the agreement at any time
5. Handshake Agreements -	A verbal agreement between the landowner and the OSC allowing a trail through their property

We recommend an easement because it is easier to acquire than a land donation or acquisition, though it still provides security for the trail. It is often necessary to keep track of when the land is changing owners and continue working with the new landowner to maintain easements, trail licenses, and handshake agreements.

WE RECOMMEND UTILIZING FRIENDS OF LANDOWNERS TO BEGIN NEGOTIATIONS FOR TRAIL CREATION.

It is easier to negotiate with private landowners when there is a personal connection between the landowner and the negotiator. This familiarity makes for a more relaxed conversation where they can express their concerns and ideas. Some towns have found that involving local hiking groups can help tremendously in this process, as they often know more locals and may even be willing to talk with landowners they know about building trails on their property.

WE RECOMMEND BEING FLEXIBLE AND COMPROMISING WITH LANDOWNERS DURING NEGOTIATIONS.

Taking the landowners' concerns into consideration may be the difference between them agreeing or disagreeing with the proposed trail idea. Understanding what they care about on their land and how they feel about a possible trail is crucial to the success of the negotiation. Working with these

landowners and brainstorming solutions to their concerns can ease worries that they may have. A prime example of this would be a landowner that doesn't want bikes or horses on their property. By agreeing to this stipulation, the trail could be built. Once the landowner becomes comfortable with the trail on their land, the subject of mountain biking can be broached again.

3.3 NORCO SPORTSMAN CLUB

WE RECOMMEND NOT BUILDING TRAILS THROUGH NORCO LANDS FOR SAFETY CONCERNS, AND INSTEAD FINDING A WAY AROUND THEM.

The Norco Sportsman Club specifically told us that they are not interested in building trails on their lands. There are land restrictions in place for the public's safety as they have shooting ranges on their land, and hunting is also allowed. This endangers hikers or anyone else who wishes to use a trail through their land. Furthermore, the club is concerned about liability as they do not want to be held liable for a potential accident.

WE RECOMMEND CREATING A DETAILED TRAIL PLAN BEFORE SPEAKING WITH THE NORCO SPORTSMAN CLUB, IF A TRAIL ON THEIR LAND IS DEEMED NECESSARY.

If the Norco Sportsman Club is willing to work with the OSC, then a detailed but flexible trail plan will benefit negotiations with them. However, the first meeting should consist of getting information about their planning process and understanding what they would be willing to allow. If the Princeton OSC is going to work with them, we recommend getting in contact with their President, as different members have varying perspectives on the TAP project.

3.4 NIMROD LEAGUE OF HOLDEN

WE RECOMMEND WORKING WITH THE NIMROD LEAGUE OF HOLDEN TO CREATE TRAILS ON THEIR LAND.

The Nimrod club has shown interest in working with the Princeton OSC to develop trails on the Nimrod club's land and is willing to appoint a team that would oversee this project on their end. The next steps in this process would be to provide the Nimrod club with information regarding the TAP project and the progress that has been made over the last five years. A proposed trail plan should be shared with the club's members to foster additional support for the project.

WE RECOMMEND PROPOSING A TRAIL PLAN THAT AVOIDS THE NIMROD CLUB'S SHOOTING RANGES.

The shooting ranges are located in a 100 acre area in the southwest portion of the Nimrod club's property, which should be avoided for safety purposes. The other 400 acres are currently open to the public and are therefore available for trail building. DWSP approval is required as there is a conservation restriction on this land.

WE RECOMMEND PROPOSING A HIKING ONLY TRAIL AND SPEAKING WITH THE NIMROD CLUB FURTHER ABOUT THE POSSIBILITY OF PUBLICIZING IT.

The Nimrod club expressed concern for overuse by mountain bikes and other forms of non-motorized usage if the trail was to be public and multipurpose. To create a public trail, we recommend the trail be restricted to hiking only, as this would alleviate the concerns about overuse. If the trail were multipurpose, the club would want the trail to be unpublished to limit usage.

WE RECOMMEND PROVIDING THE NIMROD CLUB WITH BEST PRACTICES FOR TRAIL MAINTENANCE AND WATER CROSSINGS.

The Nimrod club is willing to maintain all trails on their land, so the Princeton OSC should provide standards that the club could follow. Another request from the club is that the Princeton OSC provides the best possible water crossing designs to satisfy the DWSP.

3.5 MASSWILDLIFE

WE RECOMMEND NOT BUILDING TRAILS ON MASSWILDLIFE LAND AS THEY HAVE THE MOST STRICT REGULATIONS.

MassWildlife has recently changed its stance on trails and has shut down any unofficial trails on their lands. They also prevent the creation of new trails for conservation purposes. All of the other trail planning committees that we spoke with also avoid MassWildlife land because of how strict the policies are. For more information regarding their specific policies, see MassWildlife's trail policy.

3.6 DCR DWSP

WE RECOMMEND AVOIDING INTERACTION WITH DWSP OWNED LAND.

The DWSP serves an essential purpose as it preserves water quality in the state of Massachusetts. Recently leadership has changed hands, and the organization has become more strict. Currently, the DWSP does not allow new trails on their land. This belief has been continually maintained and enforced on all of their properties, but especially Wachusett Reservoir land. While some other towns have had some successes in creating trails, there are usually extenuating circumstances that have caused the opportunities for these trails. Even if the OSC approaches the DWSP with a thorough plan, they are likely to reject the idea. Avoiding their land will reduce the amount of time spent negotiating with the DWSP, as in some cases, negotiations have lasted over a decade. Additionally, Princeton land ownership maps show potential alternate routes that avoid all major land parcels owned by the DWSP. However, these routes would still pass through land regulated by the Watershed Protection Act. The DWSP has mentioned that this land is easier to negotiate for, as the most significant regulation is that all alteration of land must be at least 200 feet from a tributary. When asked if the DWSP would consider allowing formal trails to limit the damage of

illegal trails, they cited the Central Massachusetts Rail Trail, which is currently serving that purpose.

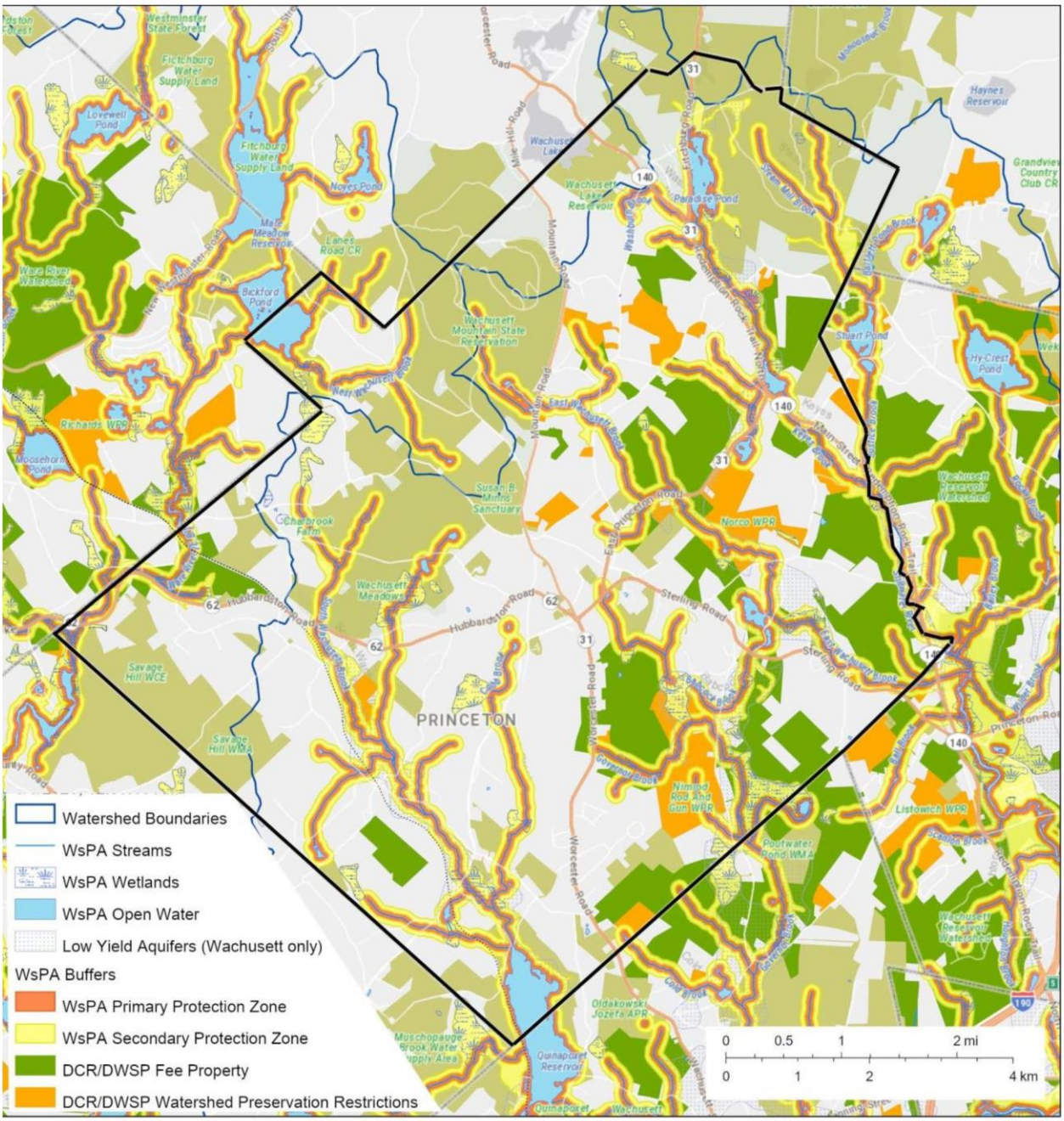


FIGURE 6: A MAP OF THE RESTRICTED AREAS DUE TO THE WATERSHED PROTECTION ACT (WSPA)

IF GOING THROUGH DWSP LAND IS NECESSARY, WE RECOMMEND BUILDING MOST OF THE TAP AND THEN ASKING WITH A THOROUGH BUT FLEXIBLE TRAIL PLAN.

Before approaching the DWSP for trail creation, the TAP project should be well established, which includes having a widespread network of existing trails that spans the town. Only then will the DWSP entertain a thorough trail proposal, though the response will still most likely be no. Furthermore, the network should have support from the community to increase the likelihood of getting approval. This public support, as well as active maintenance, will act as proof of a successful trail system, which will strengthen the proposal to the DWSP. The proposal should then only focus on one trail connection at a time. This proposal should consider and plan for the possible environmental impacts to that area and include plans for any possible water crossings. This proposal should also provide a formal maintenance plan. See DCR 313 CMR: DIVISION OF WATER SUPPLY PROTECTION for regulations and exemptions.

WE RECOMMEND LOBBYING TO STATE REPRESENTATIVES TO AID IN NEGOTIATIONS WITH THE DWSP.

State representatives can provide needed support for a trail proposal, specifically for negotiations with the DWSP. Representative Kim Ferguson, Senator Anne Gobi, and Matt Beaton, Secretary of Environmental Affairs, are all individuals who have supported trail building for other planning groups. See Appendix D for additional information on how groups have interacted with the DWSP.

3.7 TRAIL BUILDING STANDARDS

WE RECOMMEND DESIGNING CLASS THREE TRAILS FOR ACCESSIBILITY PURPOSES, AS OUTLINED IN THE UNITED STATES FOREST SERVICE'S TRAIL CLASS MATRIX IN APPENDIX B.

These classes are a loose guideline as to how trails should be developed, depending on the land and resources. We have also laid out the standards that should be followed when working with outside organizations.

- Signage
    - Must be provided by or approved by the landowner (DCR, hunt club, etc.)
    - Non-multi use trails should be labeled as such
        - Gates should be placed to deter motorized vehicles if necessary
    - "Keep dogs on leash" signs should be located at trail heads
    - "Horses stay to the side" signs at appropriate trail heads
- Horseback Riding
    - Prohibit on handicap accessible trails
    - Keep off to the side if possible (wider trails, signage)
    - Prohibit motorized vehicles on these trails

WE RECOMMEND ADHERING TO THE TRAIL SUSTAINABILITY RATING BELOW.

The ideal way to limit the erosion and muddiness of a trail surface is to ensure that rainwater stays off the trail. There have been many suggested ways to accomplish this, including the commonly used half rule. However, researchers Marion and Wimpey (2017) studied erosion on trails across the United States and found that the best method to limit erosion was to combine the trail grade and trail slope alignment methods (TSA). This combination of methods informed their trail sustainability rating system, which is outlined below in Figure 7.

Trail Sustainability Rating	**Trail grade and trail slope alignment criteria**
Good:	Trail grade of 3-10% and TSA > 30°
Neutral:	Trail grade of 0-2%
Poor:	Trail grade of 3-10% and TSA of 0-30°, or trail grade of 11-20% and TSA > 30°
Very Poor:	Trail grade of 11-20% and TSA of 0-30°, or trail grade of >20%

FIGURE 7: A PROPOSED TRAIL SUSTAINABILITY RATING SYSTEM (MARION & WIMPEY, 2017)

To limit erosion, designing, and building trails in the "Good" or "Neutral" category is crucial. This should be the best way to ensure that the trails are consistently in a good state while limiting the amount of maintenance required. If current trials in town are prone to erosion, rerouting them using this system will be helpful. While no system is perfect at mitigating erosion, this method would be the best to keep maintenance work and costs low, while also helping the environment.

WE RECOMMEND UTILIZING DIFFERENT TREAD MATERIALS TO LIMIT EFFECTS OF EROSION.

While the system outlined above should be used for all trails and should be the go-to method for limiting erosion, there are some ways to reduce the risk of erosion further. A way to supplement this method would be to modify the soil texture of the trail. This is commonly done with the use of gravel, which is both less susceptible to soil erosion and more able to sustain heavy traffic. A study conducted by Kochenderfer & Helvey (1987) found that gravel roads lose 88% fewer substrates than non-gravel roads, either from erosion or displacement. While a complete gravel path may be inappropriate in some places, mixing gravel with the native soil should provide some of the benefits of a gravel path, while maintaining the natural feel of the property. Combining this strategy, with the trail sustainability rating above, may help ensure the trails are sustainable and long-lasting.

For areas in which the grade of the trail can't be kept to a minimum, different types of stonework can limit the effects of erosion. Using rock steps or stone pitching, laying rocks in the trail to protect the native soil, is the best way to achieve this.

WE RECOMMEND DESIGNING TRAILS ON DWSP LAND THAT FOLLOW THE STANDARDS OUTLINED IN THE DCR TRAILS GUIDELINES AND BEST PRACTICES MANUAL.[1]

This manual outlines all of the DCR's restrictions and regulations when it comes to trail building. If trails are to be built on DCR land in the future, all trail plans should follow their standards, providing the best chance the trails will be approved.

3.8 MAINTENANCE

WE RECOMMEND USING AN "ADOPT-A-TRAIL" PROGRAM FOR THE MAINTENANCE OF THE TAP.

The towns surrounding Princeton have different strategies for maintenance that are tailored to their town specifically. Princeton's trail maintenance strategy can mimic another town's strategy, or it can use a combination of different strategies. However, the "adopt-a-trail" program that is being adapted by the Leominster Trail Stewards (LTS) is a viable option for Princeton. This same program has been very successful for both the Appalachian Mountain Club and the Midstate Trail, which is why LTS is adopting it. This program splits the trail into sections for groups of volunteers to maintain. This delegation makes the program particularly useful for groups that have large numbers of trails, as the Princeton OSC hopes to. A thorough application and education process helps ensure that the adopter is well qualified and dedicated to the project.

See appendix C for additional information regarding this program and other maintenance strategies utilized by towns near Princeton.

[1] https://www.mass.gov/files/documents/2016/08/tf/dcr-guidelines.pdf

3.9 INTRA-TOWN CONNECTIONS

WE RECOMMEND CONNECTING WACHUSETT MEADOW TO BOYLSTON PARK AND THE CALAMINT HILL CONSERVATION AREA.

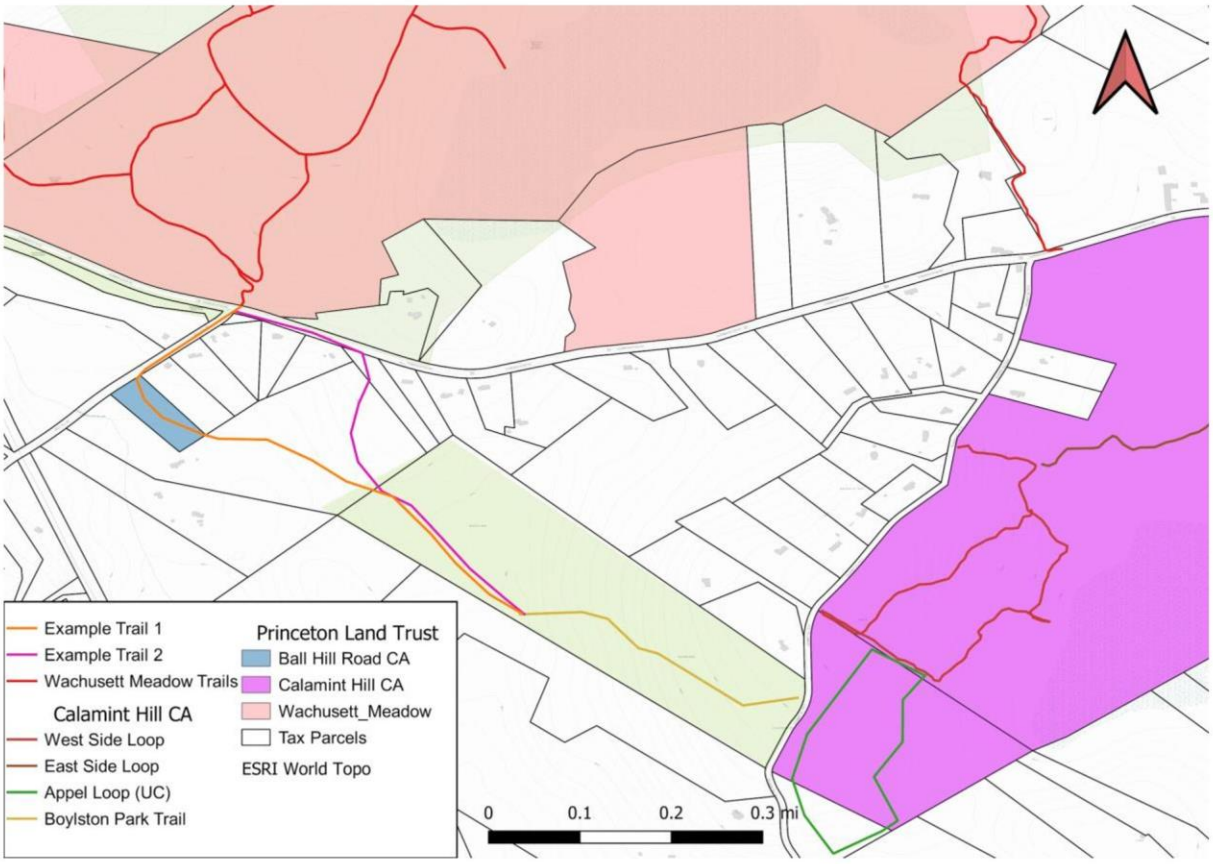


FIGURE 8: MAP OF POTENTIAL ROUTE TO CONNECT WACHUSETT MEADOW TO BOYLSTON PARK

This connection can be completed by implementing a trail along Ball Hill Road, through PLT land, one sizable private property, and into Boylston park. Some maps indicate this route crosses over a stream, so a bridge would be needed. There is an alternative route that would not require a bridge but would require more approvals from private landowners. This route travels along route 62, then through two private properties, and into Boylston Park. A good thing about this potential connection is that there are a myriad of ways these properties can be connected. Meaning if one private landowner says no, there are still options for completing the trail and linking these areas.

The benefits of this trail would be quite large for the Trails Around Princeton Project as this link would connect the trail systems of Wachusett Meadow, Wachusett Mountain, and Leominster State Forest, with the more centralized Calamint Hill Conservation Area. From the Calamint Hill area, there are many options for potential connections, including trails near the center of town.

WE RECOMMEND GETTING WRITTEN EASEMENTS AND FORMALIZATION OF THE MOSHER TRAIL

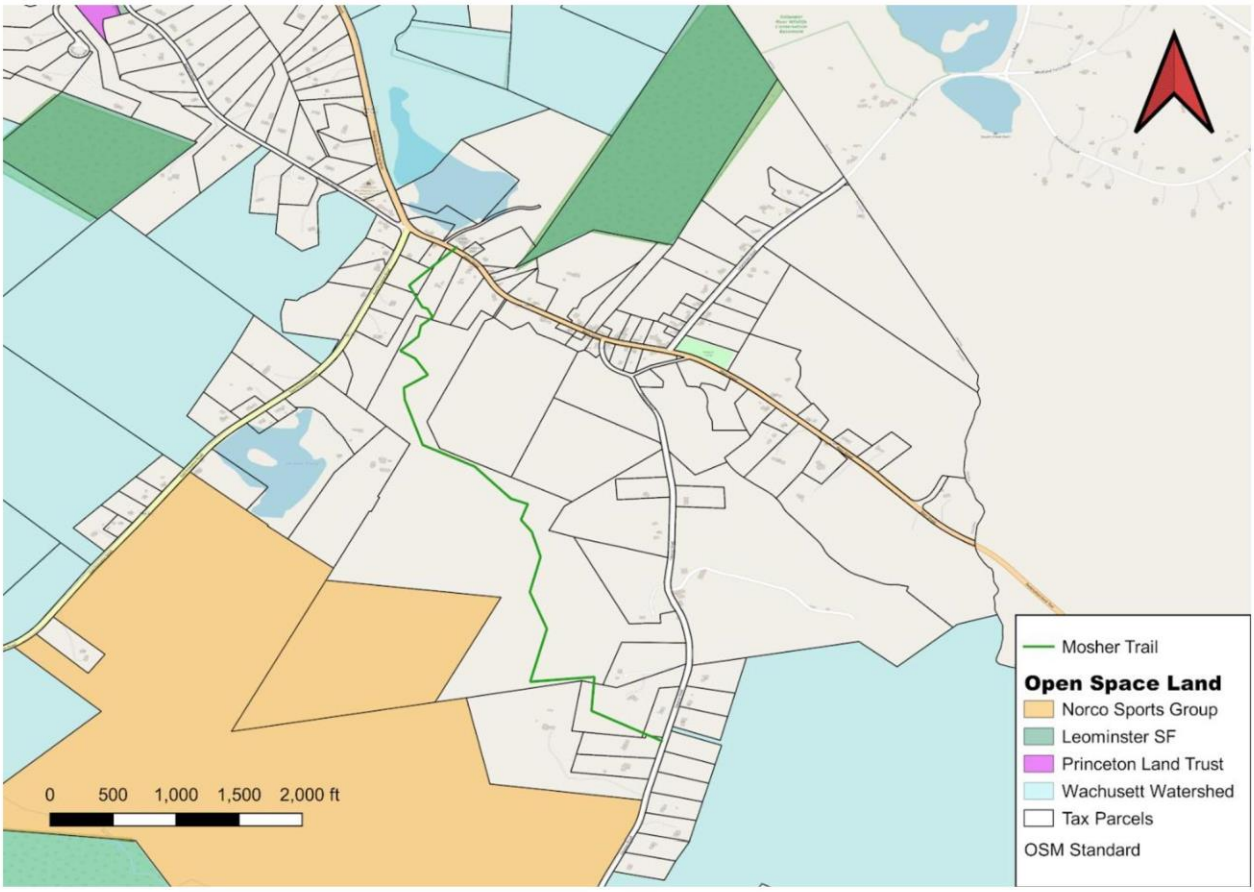


FIGURE 9: A ZOOMED IN MAP OF MOSHER TRAIL AND POTENTIAL CONNECTING TRAILS

From the information that we have gathered, Mosher trail can be publicized but has not yet received an easement or written approval from the landowner. This status is unique and offers excellent potential for the completion of the trail. Furthermore, the position and length of the trail would make it an excellent model for the project, one that can be shown off to members of the town to gather support for the system. Lastly, when formalized, this trail would be the first public trail in the area.

This trail, in theory, also presents many opportunities for the TAP project as it is in a prime location near Leominster State Forest, and connects two roads. Furthermore, it also provides the option of connecting with trails near Stuart Pond in Sterling. However, the problem with this trail is that it is sandwiched between two DCR DWSP properties. However, if this trail exists, then it may be easier to convince the DCR to allow the extension of the network into their land, as there is already an existing trail. If this is the case, then this trail would be the middle link in connecting LSF to the Thomas Prince School Trails, as seen in Figure 10, below.

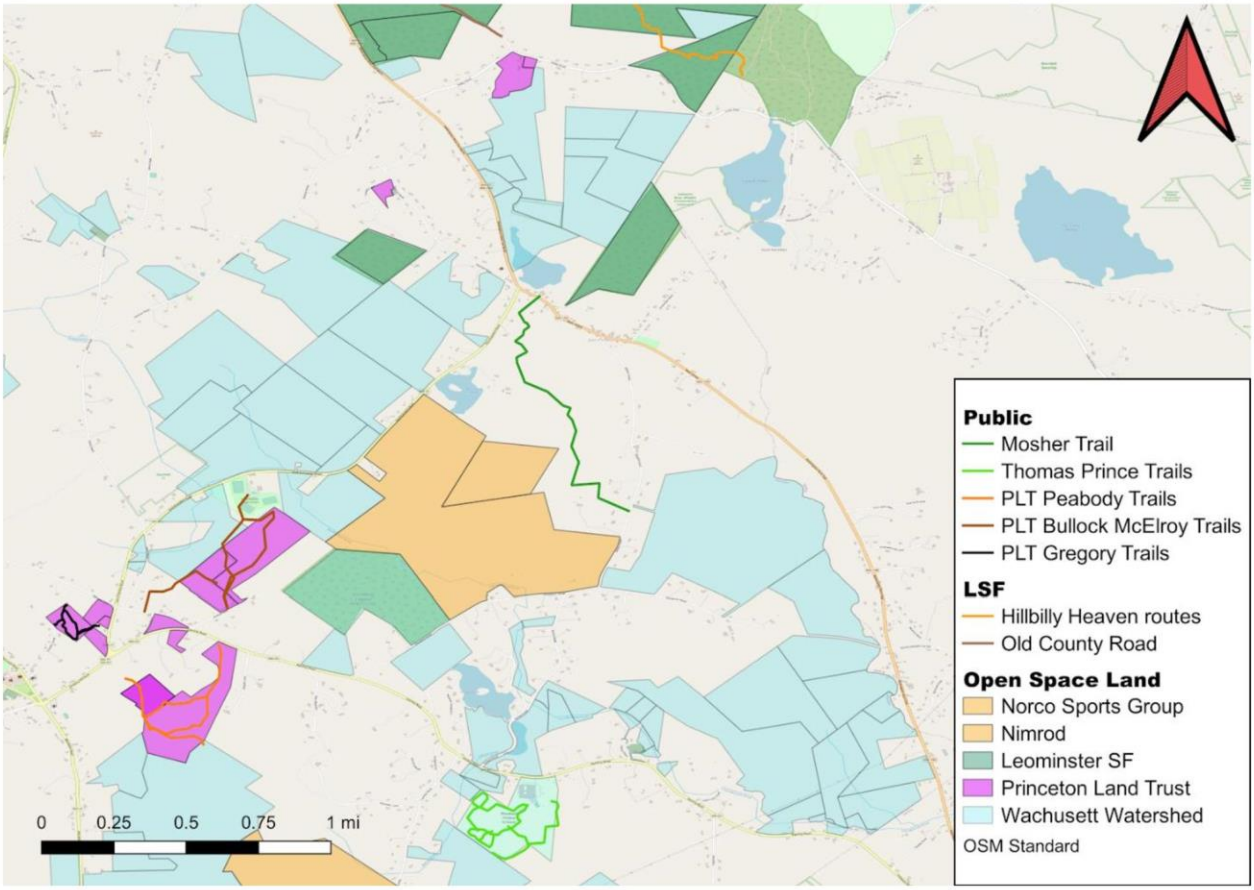


FIGURE 10: A ZOOMED-OUT MAP OF MOSHER TRAIL AND OTHER TRAILS IN THE AREA

In general, there is a substantial promise for trails in Princeton. However, the network needs to be made as public as possible. There are many current trails in the town that would prove to be great connections, yet struggle to serve this purpose due to their restrictions. If even half of these trails could have their restrictions lifted, the promise for the TAP project would be enhanced significantly. This formalization process may be arduous and frustrating, but it can pay off significantly in the end. This is why we recommend a focus on a model trail, and on easier to complete trails at the beginning. As these trails are finished and opened to the public, the residents of the town will begin to support the project, providing more momentum and sway with larger organizations. Furthermore, the focus on the easier trails will allow the Princeton OSC to begin the process of lobbying to and working with the DCR on the other trails in the system.

WE RECOMMEND THE REVIEW OF THE FEASIBILITY OF SIDEWALKS AS AN INSTRUMENTAL PART OF THE TAP.

During this project, our group was unable to review the possibilities of limited sidewalks or roadside walkways. However, we feel that in some areas of town, they may be useful to implement.

While the construction of the sidewalks may be expensive and require their approval, in some instances, they may be able to save money while ensuring a safe, connected network.

There are several reasons for this recommendation. Primarily, because the DCR and Norco Sportsman Club are unwilling to have trails on their land, the best way to traverse in the northeastern part of town may be using a mixture of sidewalks and hiking paths. This can be seen in Figure 11, below, which displays the open space parcels on how willing they are to allow trails. The sidewalks would allow for safe non-motorized travel along roadways to create trails and connections around properties that do not want the TAP. While it would not be a recreational hiking trail, it could be a vital way to connect parts of town. We also recommend further research into sidewalks, as they could be crucial in crossing the numerous rivers and wetlands that are in the town. There is little point in building a new bridge or crossing when a road already accomplishes the same task. By utilizing this road crossing, the committee can save time and money, while accomplishing the same task.

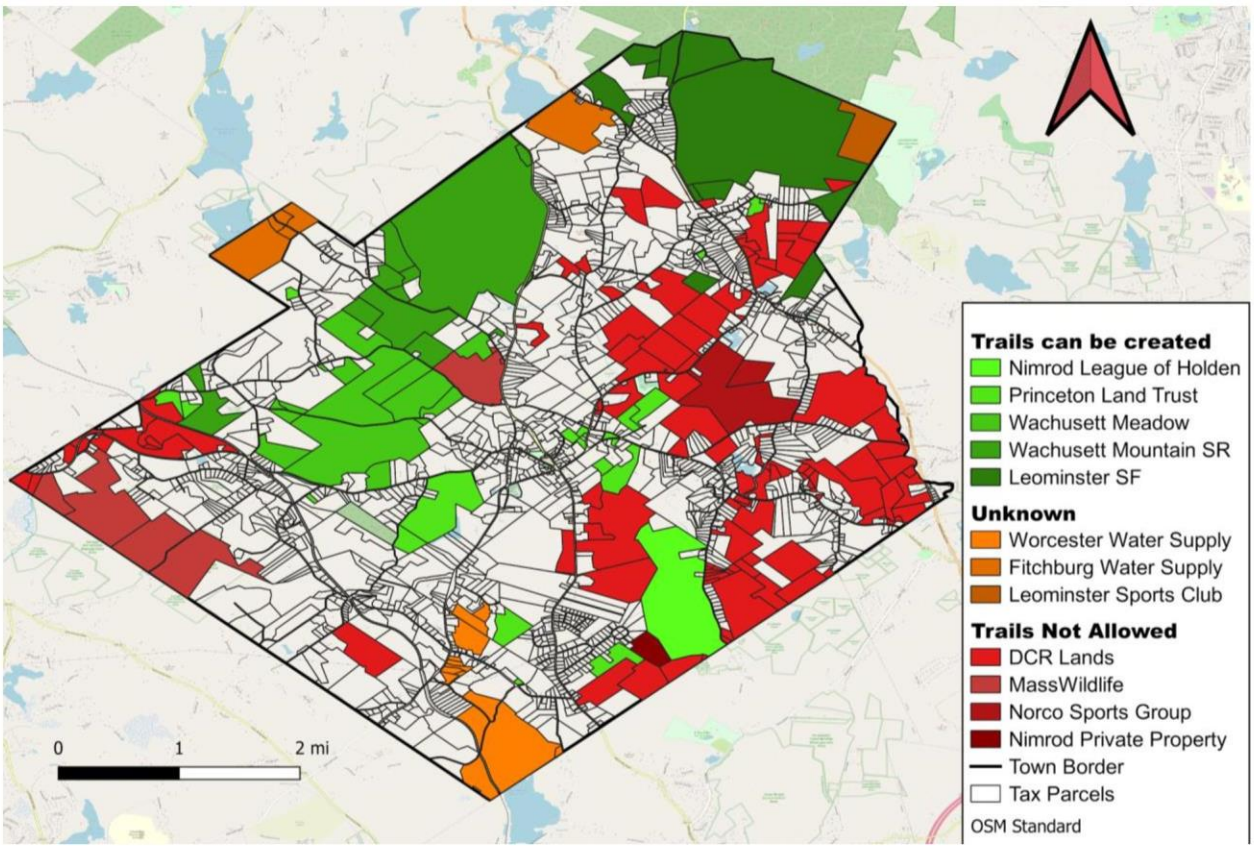


FIGURE 11: A MAP OF OPEN SPACE PROPERTIES WILLINGNESS TO ALLOW TRAILS

3.10 INTERTOWN CONNECTIONS

WE RECOMMEND FOSTERING TRAIL CONNECTIONS WITH LEOMINSTER FIRST.

Leominster recommended that the Princeton Open Space Committee, the Leominster Trail Stewards, the DCR, Wachusett NEMBA, and the Water Department have a meeting to complete the potential trail connections. Communication between all of these groups is needed to complete the connections. They seemed willing to plan this meeting to further the process of trail creation.

See Appendix E for specific information gathered from the towns neighboring Princeton.

WE RECOMMEND SHARING MAP DATA WITH CMRPC AND MRPC.

To learn about trail data from neighboring towns, we recommend reaching out to the Central Massachusetts Regional Planning Commission (CMRPC) and Montachusett Regional Planning Commission (MRPC) to see if they have comprehensive and available trail maps of the neighboring towns. We also recommend sharing the map of public trails in Princeton with these groups so they can begin working with Princeton on trail network planning.

4.0 IMPLEMENTATION STRATEGY

This section outlines the next steps that the Princeton OSC should take.

1. Begin work on a long term, detailed project plan for the TAP.
    - 1.1. Reach out to Leominster to begin planning potential trails
    - 1.2. Evaluate the feasibility of sidewalks
    - 1.3. Evaluate the feasibility of the Adopt-a-Trail program for the TAP
        - 1.3.1. Select alternative maintenance plan, if necessary
    - 1.4. Evaluate potential funding sources
    - 1.5. Evaluate desired style of water crossing
2. Negotiate and attain written agreements for Mosher Trail
    - 2.1. Modify trail to incorporate suggested standards
3. Connect Boylston Park to Wachusett Meadow
    - 3.1. Survey the area and determine ideal route for the trail
    - 3.2. Begin conversation with landowners to determine if route is achievable
    - 3.3. Design and build trail to suggested standards
4. Begin implementation of maintenance strategy
    - 4.1. Expand mailing list of volunteers for maintenance
5. Create and publicize a map of all trails around town
6. Determine best routes to connect Calamint Hill Area to the Center of town.
7. Evaluate the northeast section of town and determine the ideal route to connect LSF to Mosher Trail to Thomas Prince School.
    - 7.1. Explore option of the trail passing through and connecting to Sterling
    - 7.2. Explore possibility of using roads or sidewalks, due to the heavily restricted nature of the area
    - 7.3. If deemed necessary, begin communication with DWSP for trail development
8. Evaluate potential to connect Thomas Prince School to the center of town
9. Explore possibility of creating a trail through Nimrod land, to connect Thomas Prince school to the southeastern portion of town

BIBLIOGRAPHY

Department of Conservation and Recreation. (n.d.). *Watershed Protection Act.*, https://www.mass.gov/watershed-protection-act

Kochenderfer, J. N., & Helvey, J. D. (1987). Using Gravel to Reduce Soil Losses from Minimum-Standard Forest Roads. *Soil and Water Conservation, 42,* 46-50

Marion, J. L., Leung, Y.-F., Eagleston, H., & Burroughs, K. (2016). A review and synthesis of recreation ecology research findings on visitor impacts to wilderness and protected natural areas. *Journal of Forestry*, *114*(3), 352–362. https://doi.org/10.5849/jof.15-498

Marion, J. L., & Wimpey, J. L. (2017). Assessing the influence of sustainable trail design and maintenance on soil loss. *Journal of Environmental Management*, *189*, 46–57. https://doi.org/10.1016/j.jenvman.2016.11.074

Princeton Open Space Committee. (2020). *Open Space Recreation Plan Sections 2-5.* Internal document provided to the Princeton IQP Group

Santarém, F., Silva, R., & Santos, P. (2015). Assessing ecotourism potential of hiking trails: A framework to incorporate ecological and cultural features and seasonality. *Tourism Management Perspectives*, *16*, 190–206. https://doi.org/10.1016/j.tmp.2015.07.019

Turton, S. M. (2005). Managing environmental impacts of recreation and tourism in rainforests of the Wet Tropics of Queensland World Heritage Area. *Geographical Research, 43*(2), 140–151. https://doi.org/10.1111/j.1745-5871.2005.00309.x

APPENDIX A: GROTON MASSACHUSETTS STRATEGY GUIDE OUTLINE

This appendix is a process for the creation of a project plan, created by Paul Funch from Groton.

A Process for Developing a Trails Vision

Paul Funch
Groton Trails Committee, Chair
Montachusett Regional Trails Coalition, Member

Presentation to Fitchburg Greenway Committee

21 April 2016

What is a Trails Vision?

- A trails planning document developed by a committee
- A summary of what trails infrastructure currently exists and a vision of how it could be improved to benefit the community's residents
- A summary of municipal regulations and community priorities that promote or impede improvements to the trails infrastructure
- A compilation and rank ordering of potential trail improvements (new trails, enhancements to existing trails, new connections to/from existing trails) based on agreed-upon criteria
- A high-level implementation plan

What Are the Goals of a Trails Vision?

- They need to be uniquely identified for each town/city
- An opportunity to take into account:
  - The current state of the town's/city's trails
  - Residents' attitudes towards trails, recreation, business development, education, and tourism
  - The financial resources required
  - The potential benefits and challenges
- An opportunity to develop a consensus on the relative priorities of all proposed trail projects
- An opportunity to develop an implementation plan for moving forward

My Goals Today

- To describe the 9-step process Groton used in developing its Trails Vision
- To highlight what I believe are the KEY steps or sub-steps, regardless of how you might tailor the overall process for your community
- To describe the benefits I believe you can realize by going through this process

#1: Charter a Vision Committee

- Formally charter an ad hoc or standing committee to raise awareness and to establish schedule expectations
- KEY: Seek broad representation on committee to strengthen the consensus recommendations. Seek members who have deep knowledge of the municipality's processes that will need to be used in implementing the vision, such as members of the following boards, commissions, committees, etc.:
  - Trails Committee
  - Planning Board
  - Conservation Commission
  - Council on Aging
  - Commission on Accessibility
  - Parks Commission
  - Sustainability Commission
  - Economic Development Committee
  - Historical Commission
  - Greenways Committee
- Six to nine ACTIVE members are recommended in order to balance diversity with good group dynamics

#2: Define What Is Meant by "Trails"

Trails considered in Groton's report:
- Woods Trail
- Path
- Pathway
- Sidewalk
- Dirt Road
- Rail Trail
- "Blue" (River) Trail

Uses not considered in Groton's report:
- Snowmobiles
- Other Motorized Vehicles (motorbikes, ATVs, etc.)

Groton's Trails Vision, 2014-2019

Report can be downloaded at http://www.townofgroton.org/Town/BoardsCommittees/TrailsVisionCommittee.aspx

#3: Document Purposes, Vision, and Values

- Purposes
  - At a high level, what is wanted and why?
  - Who benefits and in what ways?
  - To create a plan for moving forward after the document is finished
- Vision
  - What would the town/city be like if all the projects identified in the vision were realized?
- Values
  - Where is the committee coming from? What do they believe in?
- KEY: Discussions of these items, or similar ones, will help the committee identify areas of agreement and disagreement at a high level of abstraction and will help to identify paths to consensus on specific projects

#4: Take Stock of What Exists

- Describe/understand/document existing practices of boards and committees that foster the goals of the Trails Vision Committee
- Describe/understand/document the existing infrastructure that will be expanded and/or enhanced by the projects identified in the vision document
- Providing everyone on the Trails Vision Committee with a solid understanding of the current conditions will help in "racking and stacking" the projects that the committee identifies

#5: Identify All Potential Projects

- KEY: Assemble a good number of potential projects from all sources
  - From current "Open Space and Recreation Plan," if one exists
  - From the current "Master Plan"
  - Projects that have been "talked about" by residents, volunteers, et al.
  - Any additional projects offered by members of the Trails Vision Committee
- KEY: The Vision Committee should discuss each project enough so that everyone understands
  - Scope and rationale for project
  - High-level design of project
  - Challenges to implementation of project

#6: Organize Projects Into Groups

- Each trails vision committee should develop its own way of organizing the recommended projects
- In Groton's Trails Vision, we grouped 23 projects into three categories:
  1. Those that connect existing pathways with new desirable destinations
  2. Those that enhance accessibility and/or recreational and/or educational opportunities
  3. Those that involve the development of new local and inter-town/city pathways

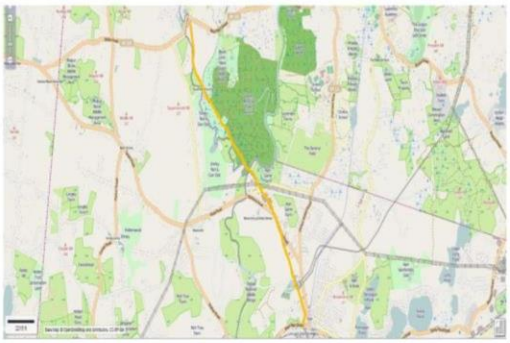
Example 1: Extend Sidewalk to Senior Center

- Sidewalk on a busy road from W. Groton Center currently ends 0.25 miles from Senior Center driveway
- Old road right-of-way can provide scenic path through the woods and past a pond
- Benches can be added for rest and nature viewing
- W. Groton senior citizens could safely get additional exercise and have a pleasant woods experience on their way to the Senior Center

Example 2: Nashua Riverwalk

- Fully-accessible trail along the Nashua River, 1.2 miles long
- Ample parking at both ends, but in need of upgrading for handicap access
- Benches can be added for rest and nature viewing
- Adjacent to Groton's largest subdivision, to an equestrian center (old fairgrounds), to a canoe/kayak rental business, and to conserved land & trails both to the north and south
- Could become centerpiece of Groton's Trails Network

Example 3: Rail Trail From W. Groton to Ayer



- Convert railroad right-of-way into 2.1 mile Rail Trail
- Will provide multiple access points to Groton's Town Forest
- Will connect conservation parcels on east and west banks of the Nashua River
- Will provide a safe and healthy alternative for commuter access to/from Ayer Commuter Rail Station
- Requires transfer of ownership of right-of-way

#7: Prioritize Projects

- KEY: Discussing how best to prioritize projects is another important way to develop consensus on the committee
- There is no best way; find what works for your community and your committee
- We used 3 dimensions and had 3 relative ratings in each dimension:
  1. Benefit (small number of users, a medium number of users, a large number of users)
  2. Time Period (1-2 years, 3-4 years, 5 or more years)
  3. Cost (<$25K, $25K-$250K, >$250K)
- Projects within a group (see Step #6) were prioritized first by Time Period, then by Benefit, and then by Cost, since the Committee wanted to emphasize the "low hanging fruit" and "biggest bang for the buck" projects within each type
- The committee felt that the community would support more of the projects if they saw several examples of what could be done within the first 5 years

#8: KEY: Develop Implementation Plan

- While communities (like all of us!) are often aware of many projects that are desired, it is enormously helpful to have both a vision and a rational plan for accomplishing the projects that collectively achieve the vision
- The implementation plan that is developed should represent a broad consensus opinion on the merits and challenges of the projects identified; as such, it can help to focus attention on how best to implement a project rather than defending whether it should be implemented or not
- An implementation plan can provide transparency and predictability to the municipality's budget process, which may improve the likelihood that the individual trails projects will be supported by the Town/City Manager/Selectmen/Finance Committee, et al.

#9: KEY: Sustain the Vision

- Continuously seek advocates who will lead the highest priority projects to completion; without such people, progress will stop
- The implementation plan, and some of the projects themselves, will undoubtedly change over time due to development, storm damage, property transfers, etc., so plan for an update every 5-10 years
- Celebrate the projects that are completed; this will inform the citizens of the progress being made and will likely increase their demand for completing additional projects

Final Thoughts

- A long-term trails vision for a community is likely to get lost if it is not documented
- A documented trails vision is less likely to be ignored by a municipality if it represents the views of many people, each with different perspectives
- People are more likely to support a trail implementation plan that considers many alternatives and prioritizes the most promising ones based on reasonable selection criteria
- "Success breeds success." A track record of implementing successful trail projects that provide clear benefits is likely to garner continuing public support for an overarching trails vision

APPENDIX B: UNITED STATES FOREST SERVICE TRAIL CLASS MATRIX

This appendix lays out the United States Forest Service's trail classification system.

ROS: Recreation Opportunity Spectrum - Allows accurate stratification and definition for classes of outdoor recreation environments. This system divides recreation settings into six broad categories: urban, rural, roaded natural, semi-primitive motorized, semi-primitive non-motorized, and primitive.
WROS: Wilderness Recreation Opportunity Spectrum - Wilderness is a special, legally designated category that can cross classes.

Trail Attributes	Trail Class 1 Minimally Developed	Trail Class 2 Moderately Developed	Trail Class 3 Developed	Trail Class 4 Highly Developed	Trail Class 5 Fully Developed
Tread & Traffic Flow	• Tread intermittent and often indistinct • May require route finding • Single lane with no allowances constructed for passing • Predominantl y native materials	• Tread continuous and discernible, but narrow and rough • Single lane with minor allowances constructed for passing • Typically native materials	• Tread continuous and obvious • Single lane, with allowances constructed for passing where required by traffic volumes in areas with no reasonable passing opportunities available • Native or imported materials	• Tread wide and relatively smooth with few irregularities • Single lane, with allowances constructed for passing where required by traffic volumes in areas with no reasonable passing opportunities available • Double lane where traffic volumes are high and passing is frequent • Native or imported materials • May be hardened	• Tread wide, firm, stable, and generally uniform • Single lane, with frequent turnouts where traffic volumes are low to moderate • Double lane where traffic volumes are moderate to high • Commonl y hardened with asphalt or other imported material
Obstacles	• O bstacles common, naturally ocurring, often substantial and intended to provide increased challenge • Narrow passages; brush, steep grades, rocks and logs present	• Obstacles may be common, substantial, and intended to provide increased challenge • Blockages cleared to define route and protect resources • Vegetation may encroach into trailway	• Obstacles may be common, but not substantial or intended to provide challenge • Vegetation cleared outside of trailway	• Obstacles infrequent and insubstantial • Vegetation cleared outside of trailway	• Obstacles not present • Grades typically < 8%

Trail Attributes	Trail Class 1 Minimally Developed	Trail Class 2 Moderately Developed	Trail Class 3 Developed	Trail Class 4 Highly Developed	Trail Class 5 Fully Developed
Constructed Features & Trail Elements	• Structures minimal to non-existent • Drainage typically accomplished without structures • Natural fords • Typically no bridges	• Structures of limited size, scale, and quantity; typically constructed of native materials • Structures adequate to protect trail infrastructure and resources • Natural fords • Bridges as needed for resource protection and appropriate access	• Structures may be common and substantial; constructed of imported or native materials • Natural or constructed fords • Bridges as needed for resource protection and appropriate access	• Structures frequent and substantial; typically constructed of imported materials • Contructed or natural fords • Bridges as needed for resource protection and user convenience • Trailside amenities may be present	• Structures frequent or continuous; typically constructed of imported materials • May include bridges, boardwalks, curbs, handrails, trailside amenities, and similar features
Signs[2]	• Route identification signing limited to junctions • Route markers present when trail location is not evident • Regulator y and resource protection signing infrequent • Desination signing, unless required, generally not present • Information and interpretive signing generally not present	• Route identification signing limited to junctions • Route markers present when trail location is not evident • Regulator y and resource protection signing infrequent • Destination signing typically infrequent outside of wilderness; generally not present in wilderness • Information and interpretive signing not common	• Route identification signing at junctions and as needed for user reassurance • Route markers as needed for user reassurance • Regulator y and resource protection signing may be common • Destination signing likely outside of wilderness; generally not present in wilderness • Information and interpretive signs may be present outside of wilderness	• Route identification signing at junctions and as needed for user reassurance • Route markers as needed for user reassurance • Regulator y and resource protection signing common • Destination signing common outside of wilderness; generally not present in wilderness • Information and interpretive signs may be common outside of wilderness • Accessibility information likely displayed at trailhead	• Route identification signing at junctions and for user reassurance • Route markers as needed for user reassurance • Regulator y and resource protection signing common • Destination signing common • Information and interpretive signs common • Access ibility information likely displayed at trailhead
Typical Recreation Environs & Experience[3]	• Natural, unmodified • ROS: Typically Primitive to Roaded Natural • WROS: Typically Primitive to Semi-Primitive	• Natur al, essentially unmodified • ROS: Typically Primitive to Roaded Natural Typically • WROS: Typically Primitive to Semi-Primitive	• Natur al, primarily unmodified • ROS: Typically Primitive to Roaded Natural • WROS: Typically Semi-Primitive to Transition	• May be modified • ROS: Typically Semi-Primitive to Rural Roaded Natural to Rural setting • WROS: Typically Portal or Transition	• May be highly modified • Commonly associated with visitor centers or high-use recreation sites • ROS: Typically Roaded Natural to Urban • Generally not present in Wilderness

[1] For National Quality Standards for Trails, Potential Appropriateness of Trail Classes for Managed Uses, Design Parameters, and other related guidance, refer to FSM 2353, FSH 2309.18, and other applicable agency references.

[2] For standards and guidelines for the use of signs and posters along trails, refer to the Sign and Poster Guidelines for the Forest Service (EM-7100-15).

[3] The Trail Class Matrix shows the combinations of Trail Class and Recreation Opportunity Spectrum (ROS) or Wilderness Recreation Opportunity Spectrum (WROS) settings that commonly occur, although trails in all Trail Classes may and do occur in all settings. For guidance on the application of the ROS and WROS, refer to FSM 2310 and 2353 and FSH 2309.18.

United States Forest Service. (2008). *National Trail Class Matrix.* https://www.fs.fed.us/recreation/programs/trail-management/documents/trailfundamentals/National_Trail_Class_Matrix_10_16_2008.pdf

APPENDIX C: MAINTENANCE STRATEGIES

Below are different strategies for maintenance from towns within close proximity to Princeton:

Groton has a different maintenance plan. When a new trail is created, some people will do a "rough clean" in order to start the trail in the best aesthetic condition. In addition, their trail committee compiled a list of 340 people that are interested in cleaning trails. This list is not restricted to Groton residents only. From our research, we found that most towns have an email/ contact list for people willing to help with volunteer projects.

The town of **Sturbridge** has a very simple plan for maintenance. They plan a monthly cleaning day where 10 to 15 volunteers will clean all the trails. In addition, a few retired residents work nights and do a lighter clean like cleaning signs and picking up feces. This plan doesn't require too many volunteers, but Sturbridge doesn't have many trails so their plan fits.

The **Westborough** trail maintenance plan is a little different. They recruit volunteers to check the trails every couple of weeks, similar to towns already mentioned. However, Westborough has teamed up with a local land trust in order to have the opportunity to request larger equipment if needed. In addition, most of the lighter amounts of work are dealt to boy scouts, which provides more volunteer work.

The **North County Land Trust** has conservation area monitors, one monitor for each of the seven areas. These monitors will go out monthly, collect data about what trails need maintenance, and report back so that volunteer groups can be formed. These volunteers can be trail users or students from nearby schools. These groups will clean all trails that need maintenance on one large trail maintenance day.

Westminster primarily uses the internet to gather trail maintenance volunteers, whether it's through their town's website, Facebook, or any other form of social media. Also, the White Oak Land Trust collects volunteers for maintenance and may have meetings to assign work as well. The Wachusett chapter of the NEMBA has created a "friend group" to help clean trails. Sterling follows the Wachusett Greenway Model where there is a list of volunteers that maintain trails on their own terms, usually two people per trail. These groups all believe that anyone in the area who wants to clean trails can happily do so.

APPENDIX D: NOTES FROM INTERVIEWS

Below we answer questions provided by the Princeton OSC. Additional information gathered for the specific towns is also included.

General Questions:

1. Do they have a good map of formal and informal trails/connections?
2. Working with DCR and hunt clubs?
3. Mountain biking connection ideas?

Rutland:

1. The Rutland trail map was taken from the CMRPC website (see Appendix E). The Rutland Conservation Commission has no significant information on trails in their town.
2. The Commission has a close working relationship with DCR, but not in regard to trails.
3. The Commission does not work in trail planning, so they have no information about mountain biking or any trail connections.

Other Questions

- Are they involved with Overlook Farm trails?
    - Overlook Farm is owned by Heifer International, but the property has seen no activity in several years.

Sterling:

1. Sterling is interested in creating trails connecting with Princeton. These trails could connect with the area near and west of Stuart Pond, and may have to go through Leominster State Forest to avoid DCR-protected land. Sterling does have a map of their trails (see Appendix F) but they do not have a long-term strategy developed to further their trail system.
2. Sterling has already committed against building trails on DCR-protected land after speaking with them.
3. They do not have any ideas or plans for mountain biking connections.

Other Questions:

- Do you have any plans for formal or informal trails connecting from the Poutwater Pond area?
    - They do not have any current plans.
- Have you considered inter-town connections to tie their many trail systems together?
    - They do not currently have any plans for inter-town connections, though they would be interested.
- How has Sterling been able to publish their trails/What did they learn from meeting with the DCR?
    - The published trails were allowed by previous DCR leadership. Current leadership met to discuss this, and because they previously existed, the trails and their maps were allowed to stay.

Westminster:

1. The Westminster trail map was taken from the MRPC website, though it is dated 2010 (see Appendix G). It seems that most of the land in the town is privately owned and would require extensive permissions to add new trails.
2. They do not have much experience working with DCR or hunt clubs as the OSC is not very active and has no plans for new trails.
3. They do not have any ideas or plans for mountain biking connections.

Other Questions:

- Are there any plans to connect other parts of town with Princeton? Maybe around mare Meadow Reservoir?
    - Mare Meadow Reservoir is owned by Fitchburg. There is no trespassing on the property. If permissions were granted then a trail there is feasible, but the owners seem like they don't want to do the work involved.
- Are there any plans for Hagar Park?
    - Any plans to make connections through Hager Park would have to be communicated with the Hager Park Commissioners, a separate entity that controls and maintains the trails through the park.
    - Any other trails would have to go through Bolton Road, which is private and would also require permission.

Hubbardston:

1. The Hubbardston trail map was taken from the MRPC website (see Appendix H). We spoke with the previous chair for the Hubbardston OSC who currently works with the North County Land Trust, but would recommend the Princeton OSC speak with the current chair.
2. DCR DWSP often has conservation restrictions on their land. They said these restrictions are put in place to prohibit anything DCR thought could have negative impacts in the future. There was a conservation restriction on North County Land Trust property that was put in place by the DCR, but they were allowed to make new trails that were already included in their stewardship plan when these restrictions were written.
3. They do not have any ideas or plans for mountain biking connections.

Other Questions:

- Any plans for connections to Princeton? How about the Quabbin to Wachusett Trail idea?
    - The North County Land Trust seemed to only be interested in the Zins conservation area for means of connection with Princeton. There aren't many ways to connect in this area and they all require permission from the landowners. Some landowners have hung up "no trespassing" signs on their land. However, if permission is granted, then the connection would work nicely. The trail cannot go around this land, but it could be restricted in order to please the landowner.
- Trail connections west of Bickford Pond?
    - A new landowner has put up "no trespassing" signs.
    - They suggested negotiating with the landowner and possibly hanging up "no ATV" or other signs.

Holden:

1. The Holden trail map was taken from the CMRPC website (see Appendix I). According to the White Oak Conservation Society, there is no official trail planning committee in Holden, so there are most likely no maps of the town's trails. We recommend speaking with the Holden Recreation Department.

Other Questions:

- Are there any trails east of Route 31 that might connect with Princeton?
    - There are trails that could connect, though no progress has been made

Leominster:

1. Leominster does have a map of trails in Leominster, though it was created through GIS (see Appendix J). The Leominster MRPC trail map is also included, and was taken from the MRPC website.
2. Recommends not working with hunt clubs. DCR DWSP is sensitive to how much recreation happens on their land. If they exceed limitations, a 1-1.5 billion dollar filtration project could be required.

Other Questions:

- Princeton's border with Leominster is entirely within LSF, which already provides great connections to Monoosnoc and areas to the East. Is there any interest in more connections to Princeton?
    - Possibly, but there should be a general planning session with folks from DCR, Wachusett NEMBA, Leominster LTS and the Water Dept. before any concrete plans are made to expand. All three groups have limited staff and volunteer resources and want to make sure that the maintenance of new trails is possible before creating new obligations.

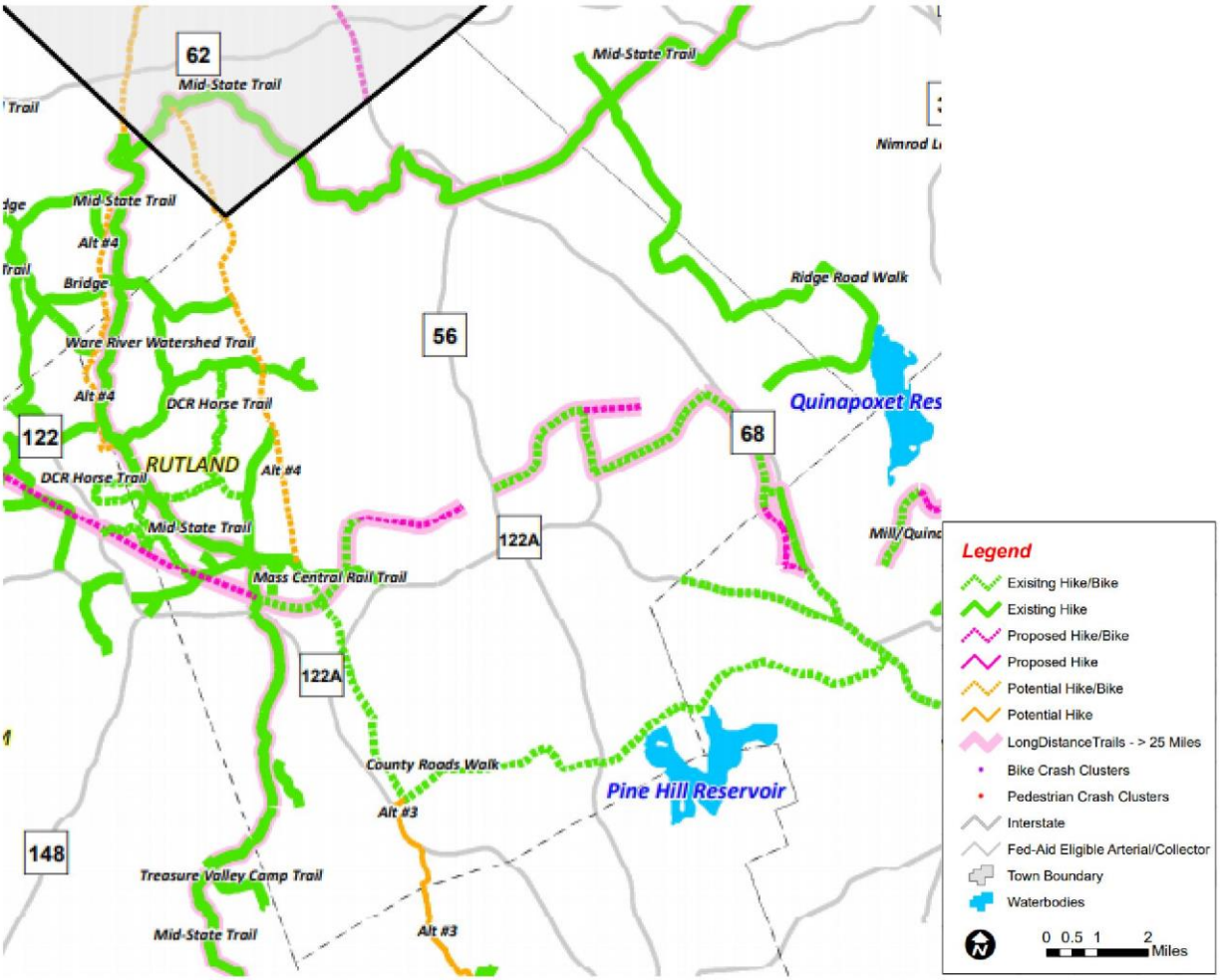
Westborough:

Negotiations with the DWSP for the Wachusett watershed have been occurring for the past ten years. First, Westborough initiated contact with the DWSP property manager for the region and presented trails that existed prior to DWSP awareness. To finish this trail, the town requested authorization from the DWSP which, in response, said they would look the other way. Next, when Westborough aimed to create a new trail on DWSP land that was set at a distance from a nearby waterway, they were denied access. However, Westborough already possessed rights to build a trail near a water treatment plant, so they found it hypocritical that the DWSP would pick and choose which trails to permit. To push this issue, Westborough involved state representatives to get support for their trail plans, and since the DWSP is generally unwilling to argue with them, the town has had more success.

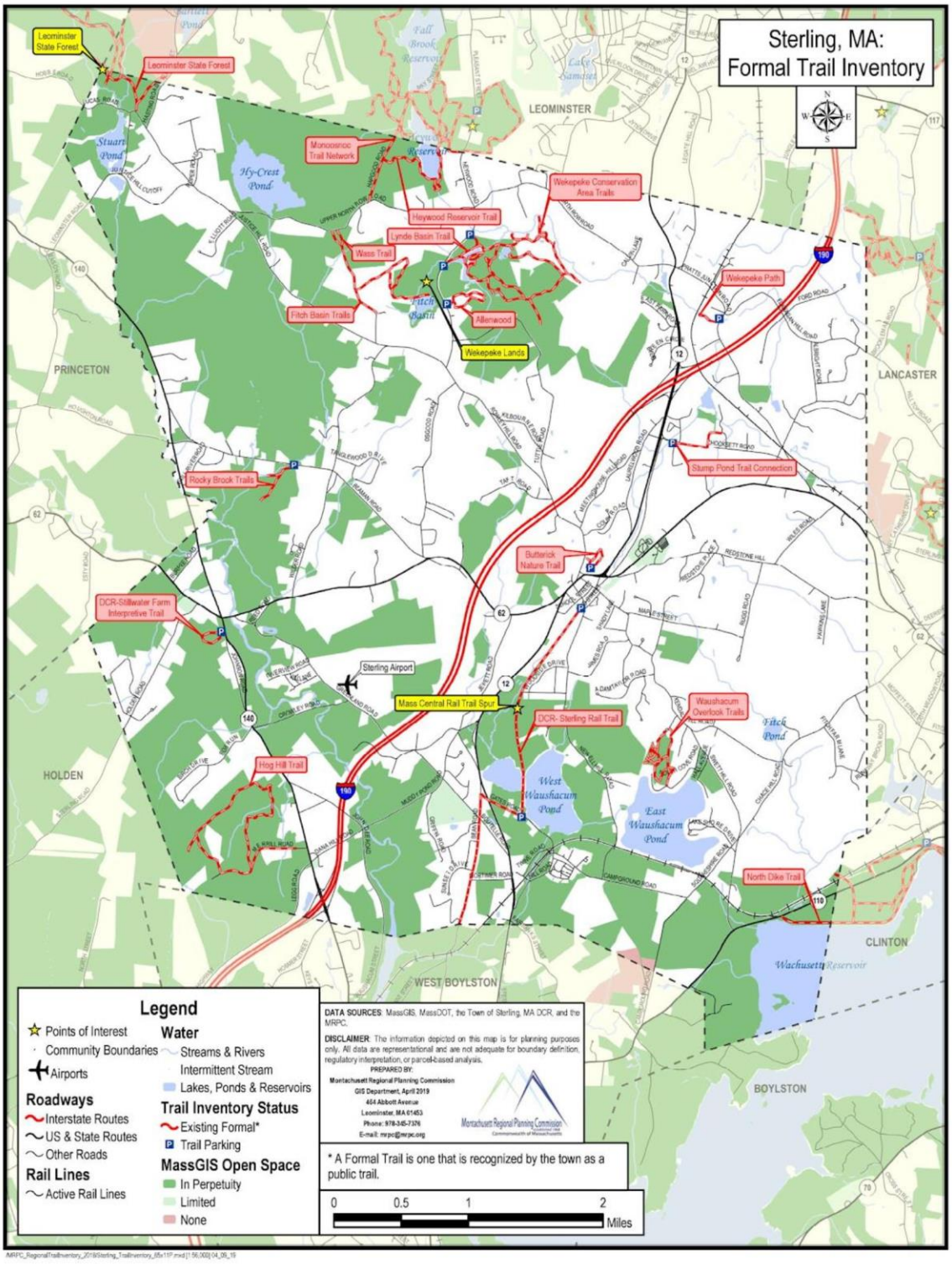
NEMBA:

The New England Mountain Bike Association (NEMBA) has worked with DWSP in the Ware River watershed. They've had some progress, which was the result of having widespread public support, starting petitions and newsletters, maintaining organization credibility, presenting scientific reports reviewing trails that have been built on watershed land, and conducting field visits with the DWSP to locations of interest. The DWSP has had additional hesitations with NEMBA because the DWSP feels that bikes are more harmful to the environment than hiking. In response, NEMBA has cited studies that dispel this notion. See Appendix K for the official Ware River Trail Proposal.

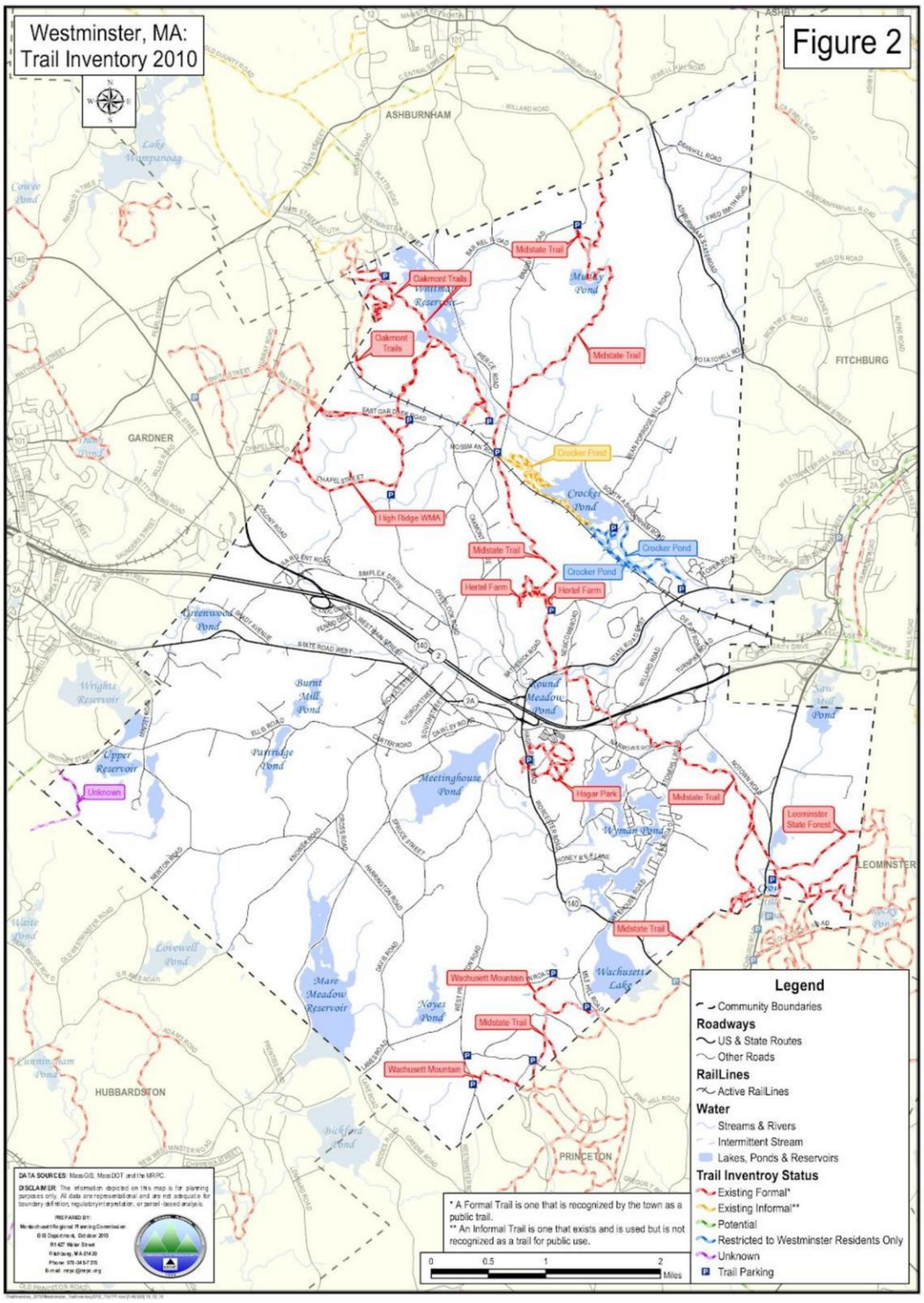
APPENDIX E: RUTLAND CMRPC TRAIL MAP



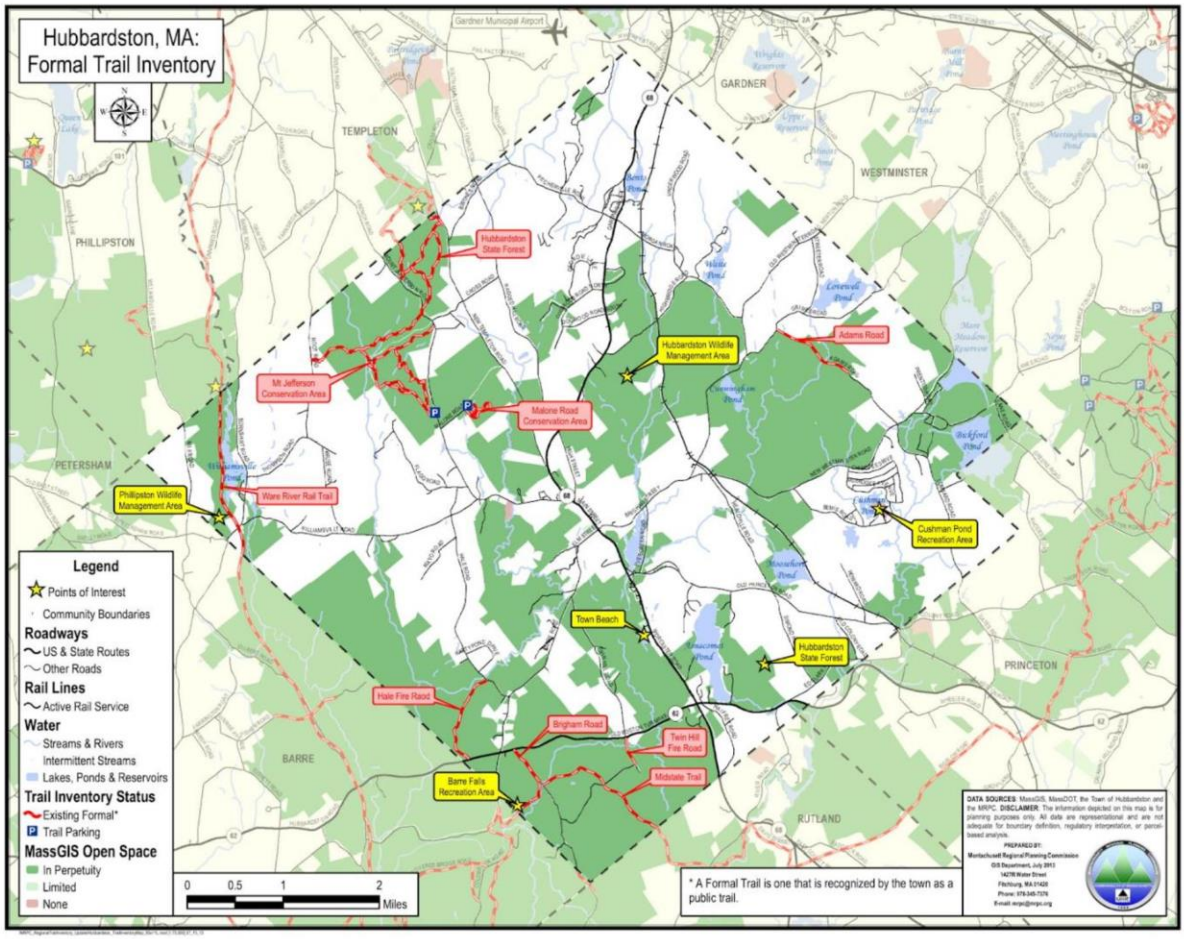
APPENDIX F: STERLING MRPC TRAIL MAP



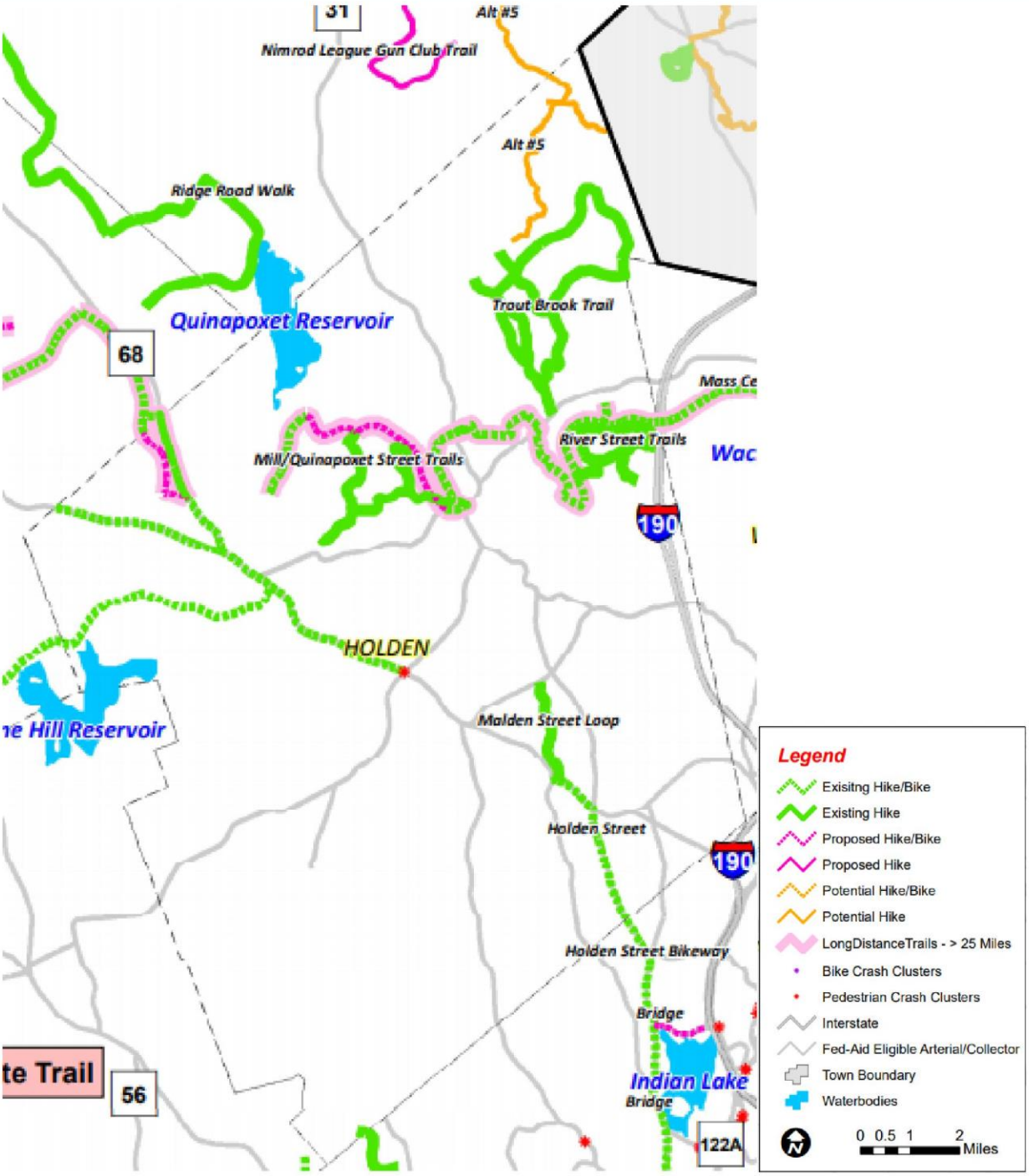
APPENDIX G: WESTMINSTER MRPC TRAIL MAP



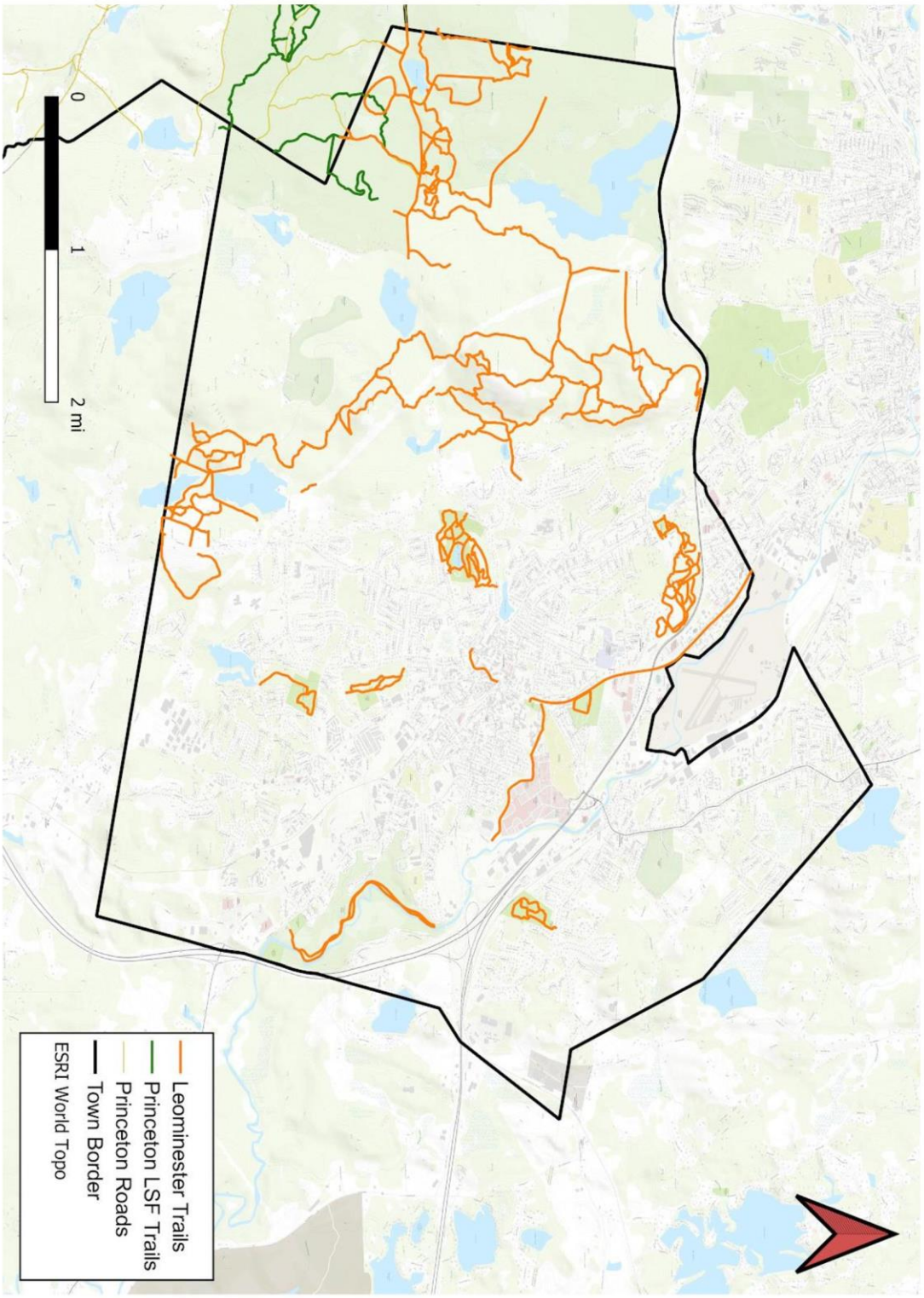
APPENDIX H: HUBBARDSTON MRPC TRAIL MAP

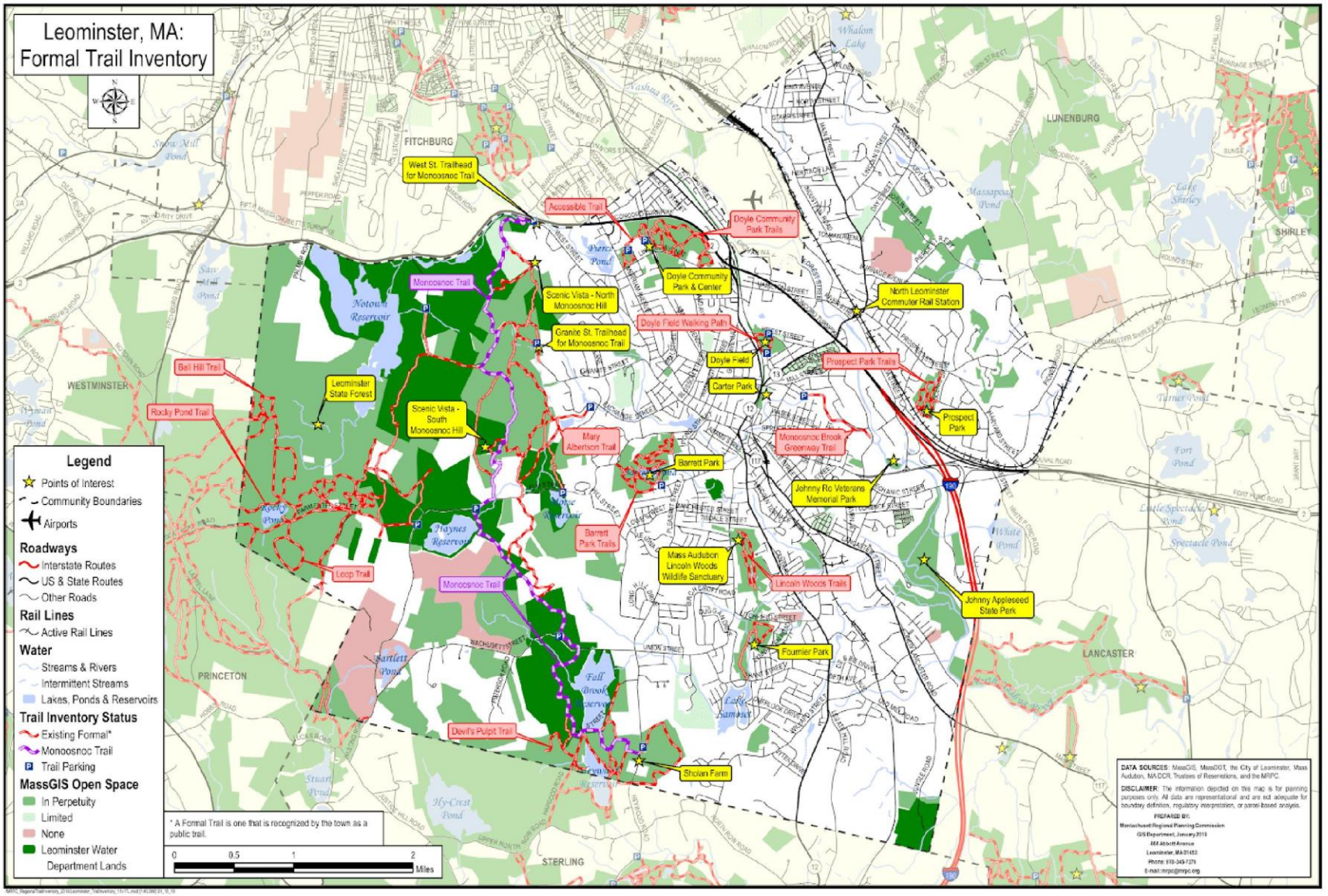


APPENDIX I: HOLDEN CMRPC TRAIL MAP



APPENDIX J: LEOMINSTER TRAIL MAPS




Leominster, MA:
Formal Trail Inventory
West St. Trailhead for Monoosnoc Trail
Accessible Trail
Doyle Community Park Trails
Doyle Community Park & Center
Monoosnoc Trail
Scenic Vista - North Monoosnoc Hill
Granite St. Trailhead for Monoosnoc Trail
Doyle Field Walking Path
Doyle Field
Carter Park
North Leominster Commuter Rail Station
Prospect Park Trails
Prospect Park
Ball Hill Trail
Leominster State Forest
Rocky Pond Trail
Scenic Vista - South Monoosnoc Hill
Mary Albertson Trail
Barrett Park
Monoosnoc Brook Greenway Trail
Johnny Ro Veterans Memorial Park
Barrett Park Trails
Mass Audubon Lincoln Woods Wildlife Sanctuary
Lincoln Woods Trails
Johnny Appleseed State Park
Loop Trail
Monoosnoc Trail
Fournier Park
Devil's Pulpit Trail
Sholan Farm
FITCHBURG
LUNENBURG
SHIRLEY
WESTMINSTER
PRINCETON
LANCASTER
STERLING
Legend
Points of Interest
Community Boundaries
Airports
Roadways
Interstate Routes
US & State Routes
Other Roads
Rail Lines
Active Rail Lines
Water
Streams & Rivers
Intermittent Streams
Lakes, Ponds & Reservoirs
Trail Inventory Status
Existing Formal*
Monoosnoc Trail
Trail Parking
MassGIS Open Space
In Perpetuity
Limited
None
Leominster Water Department Lands
* A Formal Trail is one that is recognized by the town as a public trail.
0 0.5 1 2 Miles
DATA SOURCES: MassGIS, MassDOT, the City of Leominster, Mass Audubon, MA DCR, Trustees of Reservations, and the MRPC.
DISCLAIMER: The information depicted on this map is for planning purposes only. All data are representational and are not adequate for boundary definition, regulatory interpretation, or parcel-based analysis.
PREPARED BY:
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GIS Department, January 2015
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E-mail: mrpc@mrpc.org

Proposal for Ware River Watershed Public Access for Mountain Biking

February 2019

Introduction

This proposal hopes to address the following:

- Legitimizing the activity of trail-based mountain biking in the WRW.
- Auditing existing WRW trails and potential trail corridors for sustainability, perceived value, and compatibility with management objectives.
- Discussing potential management problems and proposals on how to address them.

In writing this proposal, we recognize the primary purpose of all DWSP-managed lands is water supply protection. We commend the DWSP and all stakeholders for their diligent efforts supporting this complex mission. However, we also must recognize that allowing balanced, reasonable public access to these same lands is not only critical for the citizens in the WRW area, it is also a stated goal of the DWSP. Our proposal legitimizes a benign, passive, recreational activity that has been happening in the WRW for decades with no impact to water quality.

Further, there exists a widespread, 35+ mile trail network within the WRW that we would like to assist in evaluating for sustainability and potential for authorization on a case-by-case basis. We recognize the WRW land holdings are an important large and growing open space component in our region whose preservation is appreciated by many citizens that live here for exactly this reason. However, we also recognize that there are countless studies showing separately that not only do people need a connection with nature and physical activity for their health and mental wellbeing, but they also need these outdoor resources close to their homes to reduce the "friction" of engaging in physical activity. We believe the WRW trail network can enable essential connections between other trails and networks in and around the DWSP-managed WRW parcels.

Finally, while *any* form of human access anywhere in the WRW carries risk, we feel strongly that if concerned citizens and DCR/DWSP staff and others partner together we can address any potential or actual problems that result and with a minimum of additional staff time or budgetary investment by the DWSP or other agencies. Along these lines, approximately 170 citizens from various user groups have together formed a group known as the Friends of the Ware River Watershed in an effort to unite for purposes of watershed stewardship volunteerism in partnership with our government. By punishing offenders, and not user groups as a whole, we can eliminate nefarious activities while enabling healthful pursuits in the WRW.

Permissibility of Mountain Biking

We are requesting that the DWSP recognize mountain biking as a low-impact, legitimate, form of passive recreation on trails within the WRW. Specifically we would ask that DWSP align its regulations with those of its parent agency DCR which by default allows bicycling alongside hiking and other non-motorized uses on most other DCR-managed public lands as follows:

> CMR 302 12.12: Rules of Conduct on DCR Properties – Non-motorized Vehicles; Trails
> (1) All non-motorized trail uses shall be permitted on any forest trail, forest way, trail or rail trail unless posted closed with appropriate signage, or prohibited by regulation or law.

Additionally, when DCR evaluated mountain biking in recent Resource Management Plans for compatibility with those properties, it wrote statements such as these from the Harold Parker State Forest RMP:

> "Mountain biking, as with all recreational trail uses, can cause trampling, soil compaction, erosion and sedimentation. The degree of impact is similar to that of hikers (Cessford, 2002)."
>
> "Due to its low impact nature, mountain biking can be accommodated in most areas of the forests without significantly impacting natural resources. It is a quiet activity that in most cases has minimal impact on breeding animals. However, it should be directed away from more sensitive habitats like vernal pools."

And this from the Middlesex Fells RMP:

> "This RMP concludes that, with respect to environmental impacts, [hiking and mountain biking] have similar impacts and should be evaluated similarly."

We know conclusions of all RMPs are specific to the property being evaluated and the amount of use predicted for it. That said, both locations above but especially the Fells are near significant populations and would see far higher use than the rural and remote WRW, yet the conclusions were still positive for mountain biking.

Additionally and importantly, we don't feel there is any existing, fact-based evidence to suggest that mountain biking has a meaningfully higher impact than hiking and certainly less impact than equestrian use, both of which are currently supported on trails within the WRW. We wish for this existing non-motorized shared-use to be allowed to continue, with the addition of mountain biking, on trails deemed authorized.

Finally, we do not feel that existing scientific studies comparing passive recreational impacts are invalid when considering such use on lands designated for water supply protection. If, for example, hiking is deemed low-impact in state forests, it doesn't become higher impact if this foot traffic is instead on watershed lands. Likewise, any conclusions that mountain biking has similar impacts as hiking apply equally on watershed lands. We feel that the WRW's hydrologic distance from the primary water supply sources of the Quabbin and Wachusett Reservoirs already allows more permissive public access policy and the change we propose would be an adjustment of policy less consequential than other policy changes or approved activities before it. Further, history has shown that decades of past mountain biking activity in the WRW, despite being disallowed, has had no discernible effect on water quality.

Trail Assessment

We would like to sit with DWSP and DCR staff to look at the current inventory of trails and areas that could support trails and try to meet the following objectives from the trail user perspective:

1. Evaluate all known existing trails for three criteria:
    a. Sustainability. A trail that is unsustainable or cannot be made so with a reasonable effort should be closed. Such trails either require excessive maintenance or have a negative effect on their environment or both.
    b. Compatibility with DWSP management objectives published earlier.
    c. Value to the trail system. Trails that provide critical connections and/or offer other desirable traits (great scenery, for example) have higher value than others.
2. Look to enable several long-distance, primarily single-track, shared-use connection corridors:
    a. Two north-south corridors, one on the western half and one on the eastern half of the WRW
    b. Two east-west corridors, one on the northern half and one on the southern half of the WRW
3. Recognize that all trail users we've spoken to about the WRW prefer trails over roads as a means of travel. Trails are a much more naturally immersive experience both in their scenery and challenge and also offer desired isolation from vehicular traffic. Further, we hear from women especially that they feel much safer on trails as plenty of interesting characters have been seen on the WRW roads.

The WRW is the largest, and thus most essential, part of the open space inventory in Central Mass. Not only does it offer vast potential for low-impact recreational use within the boundaries of DWSP-management, but it also

affords excellent opportunities for connecting neighboring shared-use trail networks together. We have the opportunity to consider connections from these and other properties and trail networks through the WRW:

- Hubbardston State Forest
- Mt Jefferson Conservation Area (Hubbardston)
- Oakham State Forest
- Templeton State Forest
- Treasure Valley Scout Reservation
- Camp Marshall 4H (Spencer)
- Spencer State Forest
- Felton Field (Barre)
- Otter River State Forest
- Lake Dennison Recreation Area

Our proposal includes several maps we have prepared that show many of the trails that exist today, especially in the southern portion of the WRW. We are aware that the map is not a conclusive representation of all existing trails but we have made an effort to show all of the trails that were in active use as of 2014, the most recent height of WRW trail activity. While DWSP has performed some level of trail inventory in the past, we are asking for a fresh start whereby we review things together, relying not only on maps but also on field visits to confirm our understandings. Each trail shown in our map is classified by us as one of:

- likely sustainable as-is
- potentially sustainable following review and remediation
- unsustainable with recommendation to close

Beyond our map, however, there are plenty of other trails and roads that exist on the ground and could meet earlier objectives. Additionally, there are some forest tracts where we know of no existing trails that would offer great potential for trail connections. If we could look at maps together around a table, and then confirm our findings with some field visits, we think we would be well-positioned to solve the recreational needs of our community.

Problems and Solutions

If there is one word that land managers fear when allowing multiple uses of land, it's conflict. Conflict might be between trail users or it could also be between uses and management goals. As we know, it's impossible to please everybody, but having been a regular WRW visitor for nearly 20 years and having spoken to many other such regulars, it has become apparent that conflicts between recreational users in the WRW are extremely rare. There simply were never that many people accessing the vast WRW at any given time and place to present conflict.

That said, there are often anecdotes from a vocal minority about violations or annoyances observed, such as an unleashed dog, pet waste left behind, an unconscientious trail user, and so on. How we approach each other's use on shared public lands typically determines how well we get along. To this end our organization has recently partnered with others across multiple user groups in the area to prepare a "Tips for Trails" pamphlet which we intend to post and/or distribute on social media and at trailheads where permitted to help us understand and improve each other's recreational use and etiquette. We are including a copy of this pamphlet here for your consideration.

Beyond conflict, we know there are other concerns about legitimization of mountain biking. One we hear often is the risk that new unauthorized trails will be created. This behaviour is certainly not unique to mountain biking, but land managers are not wrong to consider it. This is an interesting perspective since users create such trails to satisfy an unmet recreational need, yet the concern is often raised during discussions about expanding trail access to meet such need. This presents an ironic catch-22 whereby authorized trails that users want/need are held up over concerns that users will construct unauthorized trails. What we've observed is that working with recreationists to hear and attempt to meet their needs goes a long way towards building mutual respect for each other's challenges and leads to better adherence to land manager regulations. However, at the end of the day, we must rely on the the vast majority of rule-abiding users to report problematic behavior such as unauthorized trail building when discovered. In turn, the land managers (DWSP and supporting entities) need to punish offenders

once discovered. A zero-tolerance policy combined with outreach, partnership, and enforcement has a high likelihood of success.

Similar approaches are also effective against conflicts due to speed, specifically differences in speed of travel between user groups. We address this in the "Tips for Trails" pamphlet as well. It's important to note that these sorts of conflicts are often rooted in trail design, specifically the lack of sufficient sight lines to see other trail users as they approach each other or the lack of challenges to slow travel down, in conjunction with unconscientious user behavior. Here again, the few should not ruin it for the many; education is essential to correcting user behavior.

Finally, it's also worth mentioning solitude as a trait some recreationists seek outdoors. This is a purely subjective desire that becomes difficult to achieve on public lands close to population centers, but that does not accurately describe the WRW. The fact is that trails, by design, focus use on an approved corridor through the forest. As such, users are concentrated on these ways and encounters, however unlikely, are possible. The presence of any other person, whatever their mode of travel, will disrupt perceptions of solitude. To wish the trail to yourself is an unfair perspective given that these lands are shared by all of us. The essence of shared-use involves users sharing a limited resource, in this case a trail network, and accepting compromise in exchange for access.

Conclusion

Together we have come a long way on the WRW issue and we commend the DWSP for this very open and fair public access plan revision process. We strongly believe that recreational trail solutions are available that would require a minimum investment due to the combined energies of the many passionate citizens who love the WRW and wish to assist in stewardship of it. We think there is ample evidence, both in controlled studies and in observations of success stories across the country, that a collaborative shared-use model between the various passive recreation user groups and the land managers (DWSP) can lead to a solution that benefits all parties and results in a cleaner and more controlled watershed than would be possible otherwise.