5-2015

GIS AND DATABASE MANAGEMENT: SUMMER 2014 INTERNSHIP WITH THE TOWN OF ANDOVER, MASSACHUSETTS

Heather Marie Cormier
Clark University

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HEATHER M. CORMIER

MAY 2015

A MASTER'S PROJECT

Submitted to the faculty of Clark University, Worcester, Massachusetts,

in partial fulfillment of the requirements for the degree of

Master of Science in Geographic Information Sciences for Development and Environment

in the Department of International Development, Community, and Environment

And accepted on the recommendation of

Yelena Ogneva-Himmelberger, Chief Instructor

ABSTRACT

GIS AND DATABASE MANAGEMENT:

SUMMER 2014 INTERNSHIP WITH THE

TOWN OF ANDOVER,

MASSACHUSETTS

HEATHER M. CORMIER

My internship with the Town of Andover, Massachusetts took place during May, June, and July 2014. I worked directly with one supervisor, Laura DeGroot, for all projects, which included editing GIS administrative layers (e.g. boundaries, roads, zoning and school districts, etc.), creating new maps for recycling routes and septic systems within the town, analysis of census data, GPS data collection, and template design for online hiking trail maps. This report also details the mission of the town and how my internship played a role in achieving many of the overarching goals for data availability and communication, along with a reflection of the internship experience and examples of my products. I would recommend this internship to anyone aiming to work in local government, as I gained both technical and professional experience throughout the summer and a network of useful contacts.

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Yelena Ogneva-Himmelberger, Ph.D.

Chief Instructor

ACADEMIC HISTORY

Name:	Date:
Heather Marie Cormier	May 2015

Baccalaureate Degree:

B.S. Economics-Finance

Source:	Date:
Bentley University	May 2010

Occupation and Academic Connection since date of baccalaureate degree:

Teaching Assistant – Advanced Raster GIS, Clark University, Worcester, MA (2015)

GISDE Lab Manager, Clark University, Worcester, MA (2014)

Conservation Volunteer, American Conservation Experience, Catalina Island, CA (2014)

Contract Development & Assessment Analyst, Sunovion Pharmaceuticals, Inc., Marlborough, MA (2012–2013)

Contract Operations Specialist, Sunovion Pharmaceuticals, Inc., Marlborough, MA (2010–2012)

DEDICATION

This final paper is dedicated to my family and friends who have supported me throughout my academic pursuits, especially these past two years, as well as my brilliant fellow GISDE classmates. Without their encouragement and confidence in my success, I would not be where I am today.

ACKNOWLEDGEMENTS

First, I would like to thank my exceptionally caring and motivating professors whom I had the privilege of learning from and working with during my time at Clark, especially Dr. John Rogan, Dr. Yelena Ogneva-Himmelberger, Dr. Alex Gardner, Dr. Florencia Sangermano, and Dr. Jie Tian. I would also like to thank the Town of Andover and my incredible internship supervisor, role model, and friend Laura DeGroot, who was so passionate about helping me to gain GIS experience and to have invaluable professional and field opportunities as an intern. Finally, I would like to express my sincere gratitude to the communities of Clark University, the IDCE department, and the Graduate School of Geography, which were all unwavering in support and inspiration.

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CHAPTER 1: INTRODUCTION

Throughout my undergraduate studies at Bentley University, I was interested in the coupling of analytical subjects and creative outlets. I graduated with a Bachelor of Science degree in Economics-Finance, along with a second Liberal Studies Major in Quantitative Perspectives, and a minor in Information Design and Corporate Communication. I took many mathematical-based courses, as well as web design and effective speaking so that I could learn not only to apply a quantitative perspective to my field, but also to be able to connect with others of diverse backgrounds. I completed numerous business-related internships throughout those four years and subsequently worked for a pharmaceutical company in various accounting, finance, and contracting roles, but always desired to gain more education, especially in an even greater technical capacity.

After gaining valuable experience in the private sector, I decided to pursue the Geographic Information Science for Development and Environment (GISDE) Master program at Clark University to learn geospatial skills and how to conduct scientific research. This program is also closely linked to three other programs with focuses on community and international development, as well as environmental science and policy, which have become strong interests and passions of mine over the past few years.

As part of the requirements for the GISDE program, I chose to pursue an internship to gain imperative experience applying GIS skills to real-world situations. My internship took place during the months of May, June, and July 2014 with the Town of Andover, Massachusetts, within its GIS Department. While there, I was able to focus on core GIS skills I had learned in the classroom, such as manipulating geospatial data and tables, conducting analysis, and creating maps, as well as to improve my developing skills in cartography and map design. I also gained

new knowledge under the supervision of the GIS coordinator in the areas of mobile device applications and data formats for bridging different software. In addition to gaining tangible abilities, this internship also gave me the opportunity to learn about the operation of a small town government and to gain experience working remotely with GIS consultants.

This internship paper is organized into multiple chapters regarding the organization, projects, and assessment of my experience at the Town of Andover. Chapter 2 will focus on the background and mission of the organization, as well as the main areas of work and structure of the GIS department. Chapter 3 will focus on my responsibilities throughout different projects and how these related to the mission of the organization. Chapter 4 will focus on my observations of required and attained skills, as well as how this internship related to my academic and career goals. Finally, there is a conclusion, figures, and references at the end of the report to support the previous chapters.

CHAPTER 2: DESCRIPTION OF THE ORGANIZATION

2.1 Background

The Town of Andover, Massachusetts, often referred to as the "Home of America", is located in northeastern Massachusetts in Essex County, about ten miles from the state of New Hampshire. It is bordered by the cities of Lawrence and Methuen and the towns of North Andover, North Reading, Wilmington, Tewksbury, and Dracut. Originally settled by Native Americans in 1636 under the name Cochichawicke, it was later incorporated in 1646 as the Town of Andover, named for the hometown of many of its English settlers. The town is home to participants of the Revolutionary and Civil Wars, the oldest public school system in the United States, numerous historic mills and farms, and many more recent housing and industrial developments. This historical and cultural diversity is respected and cherished by residents. The Town of Andover regularly holds Open Town Meetings in which any registered voter may come and participate, speak, and vote on articles. In their vision and desires for Andover's future, citizens clearly intend to continue promoting many ideal characteristics, such as, among others, offering quality education, protecting open space and recreation, maintaining small-town character and historical heritage, and respecting cultural diversity.

2.2 Mission and Main Areas of Work

The mission of the Town of Andover, Massachusetts' Geographic Information System (GIS) program is "to provide town-wide spatial information for mapping and analyzing data about our community" (Geographic Information Systems 2012). The department was started in 1998, originally using aerial photography and GPS field collection points to derive planimetric data layers and to map water, sewer, and drainage networks. Digitized maps created from engineering surveys, such as parcels and wetlands, have also been incorporated into the GIS database. The

database managed by the GIS department has grown to now include topography, zoning, districting, routes, recreation, conservation, and historic preservation sites, to name a few. In addition, although it is an independent municipal department, the Town of Andover and nearly sixty other towns in Massachusetts formed the Massachusetts Orthoimagery Consortium (MassOrtho) to coordinate an airplane flyover in the spring of 2014 in order to acquire detailed orthoimagery of these communities at a reduced cost to all involved, which will help with updating obsolete planimetrics (e.g. roads, building footprints, and water bodies) within the town.

Since residents are highly involved in town management and decision making, the GIS department maintains a map library on its website, where the public may freely download maps in PDF format, as well as select GIS data layers. It also provides links to resources, such as MassGIS, the 2010 Federal Census Maps, FEMA Flood Maps, and historic USGS quadrangle maps of New England and New York. Many of these sites have interactive maps and access to other state and regional data at no cost. Hard copy plotted maps, such as digital orthophoto, planimetric, and assessor's maps are also available for purchase from the town.

2.3 Organizational Structure

The Town of Andover's GIS department is located within the Town Offices building at 36 Bartlet Street in Andover, Massachusetts. The GIS department resides within the Information Technologies (IT) department, which allows for more administrative privileges and directly budgeted resources. Solely operated by the GIS coordinator, Laura DeGroot, it is currently a department of one, although Laura has managed a few interns over her tenure. Her GIS skills are impressive and self-taught, as she has learned on the job from conferences and workshops, online tutorials, consultants, and municipal peers. Laura often works as a liaison between multiple

departments, working in close coordination with the Engineering and Planning divisions. These departments share a plotter for printing large maps (e.g. 36” x 36”), and also have access to the online interactive mapping system MIMAP, which allows editing and printing of GIS layers and maps across departments. Maps are often produced for specific public works projects or to be used as visual aids at planning board meetings.

The department effectively accomplishes its mission, as there is a large amount of spatial information about the community available across the organization and to the public through online resources. It is actively managed and updated on a reasonable basis. The department is also well-funded in comparison to many GIS departments in nearby towns. However, Laura is a part-time employee, and the town could benefit from additional staffing. She regularly attends interdepartmental meetings to assess the needs for additional visual data and analysis and is also approached directly on an ad hoc basis when needs arise. As a summer intern, I was privileged to witness both sides, attending a few meetings with other working groups, as well as working on specific and time-sensitive requests. Although projects could certainly be completed in a more timely manner if the department had more dedicated resources, the culture of the department was quite relaxed and supportive. I was allowed and encouraged to take initiative, and other departments were receptive to new ideas, creativity, and collaboration.

CHAPTER 3: INTERNSHIP RESPONSIBILITIES

As the GIS Intern reporting to the sole GIS Coordinator, I had diverse responsibilities throughout my time with the Town of Andover, including updating internal town databases, creating maps for initiatives within the town offices, conducting analyses for other departments, and collecting field data. In addition to direct responsibilities, my supervisor was concerned with my personal career development and encouraged me to attend the Spring Northeast Arc Users Group (NEARC) Conference at the University of Massachusetts in Amherst, MA during the first week of my internship, as well as a few interdepartmental meetings throughout the summer to meet and network with our internal stakeholders using our products. I was exposed to a great deal of data and learned about the workings and timelines of a town department while being given flexibility to be creative and opportunities to lead the design of projects.

3.1 Organization's Mission

In 2012, the Town of Andover published a new master plan with a vision and main goals for seven elements of the plan, including land use and zoning; housing; economic development; open space and recreation; natural, historic, and cultural resources; transportation and circulation; and municipal facilities and town services:

1. Land use and zoning must create a balance of residential, commercial and industrial development, a mix which is vital to a community's continued quality of life and long term sustainability;
2. Preserve sustainable expansion of the housing stock to provide economic benefits such as jobs and services generated by construction and the spending power brought by new residents;

3. Focus on increasing market productivity and job opportunities, as well as providing the opportunity for the creation or importation of new companies;
4. Conserve natural and working lands that play an essential role in the economic, environmental and social well-being of communities;
5. Protect the natural resources in Andover because they are vulnerable to human impact and preservation is essential for maintaining community sustainability;
6. Monitor existing transportation conditions and identify current and projected future transportation problems and needs, while estimating the environmental and financial impacts;
7. Maintain public facilities (including educational and cultural), parks, grounds, and trees; maintain and continue to improve the function of the water treatment plant; and provide the highest-level of public safety to Andover's citizens and business community

   (Town of Andover, Massachusetts 2012 Master Plan: A Framework for Decision Making).

The GIS department plays a role in maintaining data on and providing analysis for each of these elements, and therefore I was acquainted with most of these goals during my internship.

3.2 Interdepartmental Coordination

The Town of Andover already recognizes a need for a GIS department as a separate department within the organization. In other small towns, mapping and analysis tasks are sometimes included within the IT or planning departments, or are outsourced to a consulting firm. Although the GIS Coordinator, Laura DeGroot, does work occasionally with outside ESRI and other consultants, she produces much of the final mapping products and analysis largely on her own. Therefore, there were many projects she had been meaning to complete but did not have enough

time or resources, so she worked with the Town Manager to hire a summer intern. I helped conduct research, updated and created new templates for maps, and downloaded census data to be used in a housing analysis.

The GIS department maintains large datasets that change depending on new regulations and development within the town, so sometimes it is necessary to update maps frequently. Within the last year, MassGIS has initiated the Digital Parcel Standard, Level 3 project to update parcel data provided by municipalities in an effort to have consistent data design across all towns for accurate data sharing. As of the summer of 2014, MassGIS declared that the boundary between the towns of Andover and Lawrence is a "known outstanding boundary discrepancy" (MassGIS). Since a portion of the town boundary needed to be redrawn, road, zoning, and district maps needed to be updated, as well. For example, the Department of Transportation needed updated snow plow maps in order to identify where to send trucks during a storm. The Andover public school system needs accurate district maps in order to determine which students are considered town residents and which should be attending other towns' public schools. Recycling customers also changed, as did the weekly scheduling of pickups, so town employees needed to understand their new routes.

In addition to being quietly instrumental to the smooth functioning of town public works, Laura was very interested in demonstrating the value of GIS to other staff and possibly growing the department if the need existed. Many other departments throughout the organization rely on spatial information but may not have the skillset to create visualizations to be used for analysis, community engagement, and decision making.

3.3 Projects

As previously stated, I worked on a variety of projects during my internship in Andover this past summer. Many involved updating existing feature classes and geodatabases. I began with some simple editing of the town boundary to update road layers (see Figure 1); paving, snow plowing, and sanding routes; as well as zoning, school, precinct, congressional, state representation, watershed, senior residential, and groundwater protection overlay districts (see Figure 2). I would then update any necessary road lengths and parcel shape areas in the appropriate attribute tables and export as new shapefiles to be updated in the data files.

Recycling routes also needed to be edited to the new town boundary and updated according to a revised biweekly schedule by road. The map in Figure 3 was printed at a size of 36”x36” using a plotter in order to be able to read the schedule and all road names within the town. Figure 4 shows a smaller (11”x 17”) black and white version to be printed for recycle crew members.

Figure 5 shows a map I created of the existing septic systems located within the Haggetts Pond Watershed. Various colored parcels represent when the septic systems were installed, so that town officials could determine which were the oldest and most likely to need replacement because of new regulations. The inset depicts where Haggetts Pond is located in relation to the rest of the town’s sewer pipelines. This map was also printed at a size of 36”x36” using a plotter in order to be able to read and present at meetings.

In an example of interdepartmental coordination, the planning division and zoning board were interested to see the distribution of median incomes and elderly populations (see Figures 6-8) across the town and requested an analysis from the GIS department. Although still in the early stages of concept and design, this type of analysis could be used to identify where might be the best location to construct a new multifamily housing development. I spent some time

downloading current census and American Community Survey data from the United States Census Bureau's website in order to join census tracts and block groups to age and income data being examined. I produced maps showing the distributions of elderly populations, median age, and median household income across the town and provided these to the planning division to use in a larger analysis.

Laura was mindful of my interest in environmental GIS, so she coordinated some smaller projects working on updating conservation easements and restrictions within the town, which required some georeferencing of engineering survey maps and tracing parcel outlines.

The largest project I was involved in was mapping walking trails within public parks and grounds in the town as part of an initiative to bring more awareness and access to recreational opportunities for local residents. I was provided with paper maps of marked trails, and I used a combination of two Android phone applications, Collector (Figure 9) and MyTracks, to obtain GPS locations and track my paths. I then downloaded the .gpx files from cloud storage and imported them into ArcMap as point data, which I converted to lines. I would take pictures (Figure 10) with my phone at significant landmarks, which were later geotagged in ArcMap from their respective latitude/longitude coordinates and automatically placed on the map precisely where the pictures had been taken. I created the eight maps in Figures 11 -14, as well as the basemap template and a set of standardized symbols in Figure 15 to be used for future maps included in Andover's ParkFinder application.

Finally, after the completion of each project, the GIS Coordinator requested that I create a ReadMe file of work instructions and screenshots detailing my steps so that they might be replicated or updated by herself or a future intern. An excerpt can be seen in Figure 16.

CHAPTER 4: INTERNSHIP ASSESSMENT

This GIS summer internship with the Town of Andover gave me an introduction to working in a local government setting and how GIS is used to maintain the smooth operation of various departments and the coordination of officials' and citizens' goals. I witnessed many instances of careful planning and interdepartmental teamwork. Although I felt well prepared from my experiences at Clark University, I realized there was a breadth of new knowledge to gain from a public sector point of view and attempted to engage in new and diverse projects as much as possible.

4.1 Clark Skillset

Through GIS and remote sensing coursework, I am proficient with ArcGIS and IDRISI software and am well versed in vector and raster analysis. These came in handy quite a bit, since although my supervisor was experienced with ArcMap and planimetrics, she was fairly unfamiliar with remote sensing technologies and downloading data from outside sources. I was able to incorporate some new census and American Community Survey data to investigate the town's demographic breakdown, which would be used in analyzing a proposed multifamily housing development. Prior editing and georeferencing skills were useful when updating different community layers and translating PDF survey drawings to our database. Finally, I believe that the GISDE program instills in its students a sense of pride in regards to cartography. I used IDRISI to create additional layers (e.g. hillshades) and combined these with vector layers in ArcMap for the trail maps to appear more realistic and visually appealing. I also appreciated having this background to help update old maps and create new ones that could be easily understood by stakeholders and the public.

4.2 On the Job Skillset

While working at the town offices, I had the opportunity to network with colleagues from the IT, Planning, Recreation, and Public Works departments, as well as to meet some key town officials, such as the Town Manager, Reginald "Buzz" Stapczynski. I learned how to effectively communicate with coworkers who are inexperienced with GIS and technical terminology, as well as to prioritize, multitask, and manage my own deadlines. Since I often worked directly with only one individual, I relied heavily on educating myself through trial and error, research, and reading blog posts from other Arc users. Laura had documented quite a bit of her knowledge into ReadMe files that I would consult and then update or create new ones, based on what I had discovered or learned from other departments.

Beyond the professional development skills I learned on the job, I also gained further technical experience. Laura made sure to acquaint me with some new platforms for conducting GIS work, such as ArcGIS Online and Android phone GPS applications like Collector and MyTracks. Due to the combination of multiple software programs, I frequently needed to learn how to convert between data formats. I really valued having this exposure, as I was able to see how organizations that might not be able to afford the latest private software are still able to manage and accomplish significant achievements.

4.3 Relation to Academic and Career Goals

Overall, this internship related well to my course studies thus far because it incorporated what I already knew so that I could then build upon this base and apply it to a new field, while still gaining new knowledge. I learned some very practical uses for GIS and map-making that are not always the focus of a graduate program setting (e.g. editing and labeling tools) and was also

presented with some conservation and environmental applications of GIS I have not yet studied, especially in terms of policy making.

The internship gave me some exposure to the role of town politics and budgeting of funds. I witnessed resource and scheduling challenges firsthand that I will likely encounter again in my career, so this was valuable to observe how my supervisor dealt with these issues. I was able to work with a consultant who specializes in GIS and gain his outside perspective of identifying a client's needs and finding creative solutions. I am sure this will be vital in the future whether I consult or simply need to communicate ideas and needs from one department of an organization to another. I would not hesitate to recommend this internship to future GISDE students because of the variety of project topics and guidance and encouragement from my direct supervisor. I was pleased to learn that Andover still intends to partake in the MassOrtho flyover in 2015, so future interns may have expanded opportunities to work with this dataset and to present findings to the Board of Trustees, which would be invaluable for a career in local government or community development. Although I anticipated more experience with planimetrics, I was satisfied with the autonomy I was granted in regards to the trail project and enjoyed the combination of independent data collection and periodic feedback from involved parties. I came to realize over the summer that I desire an environmentally-focused career that will include remote sensing analysis and greater interaction within and across teams.

CHAPTER 5: CONCLUSION

After working in various private sector settings, I was pleased to gain experience in the public sector with this internship. I appreciate the opportunity to add to my technical skillset, prepare for a professional career in the GIS field, and to acquire an inside look at the functioning of a small town government. Throughout the summer, I learned to effectively communicate visual knowledge to those who are not formally trained in GIS and to manage diverse small and large projects from beginning to end. I worked alongside a remarkable supervisor and generous coworkers from other departments, who I remain in contact with. I am honored to be held in high regard amongst them and to be continued to be considered for future employment. Overall, I was satisfied with the internship and feel this experience and the network of contacts I gained will be invaluable to my future goals.

FIGURES

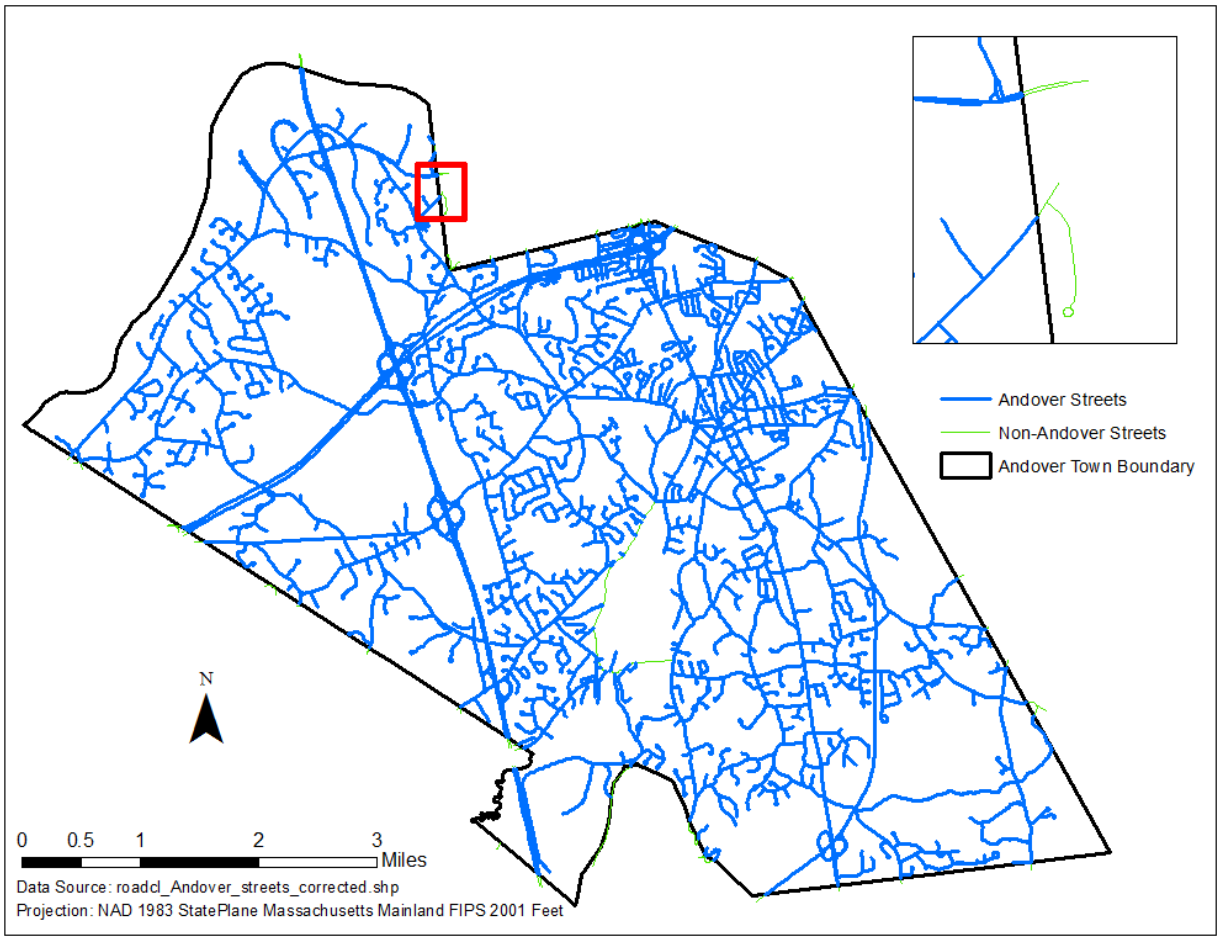


Figure 1 Map of street network within the Town of Andover, Massachusetts. Blue streets within the town boundary are accurate, while the green streets outside the boundary have been updated to reflect the appropriate town they now belong to.

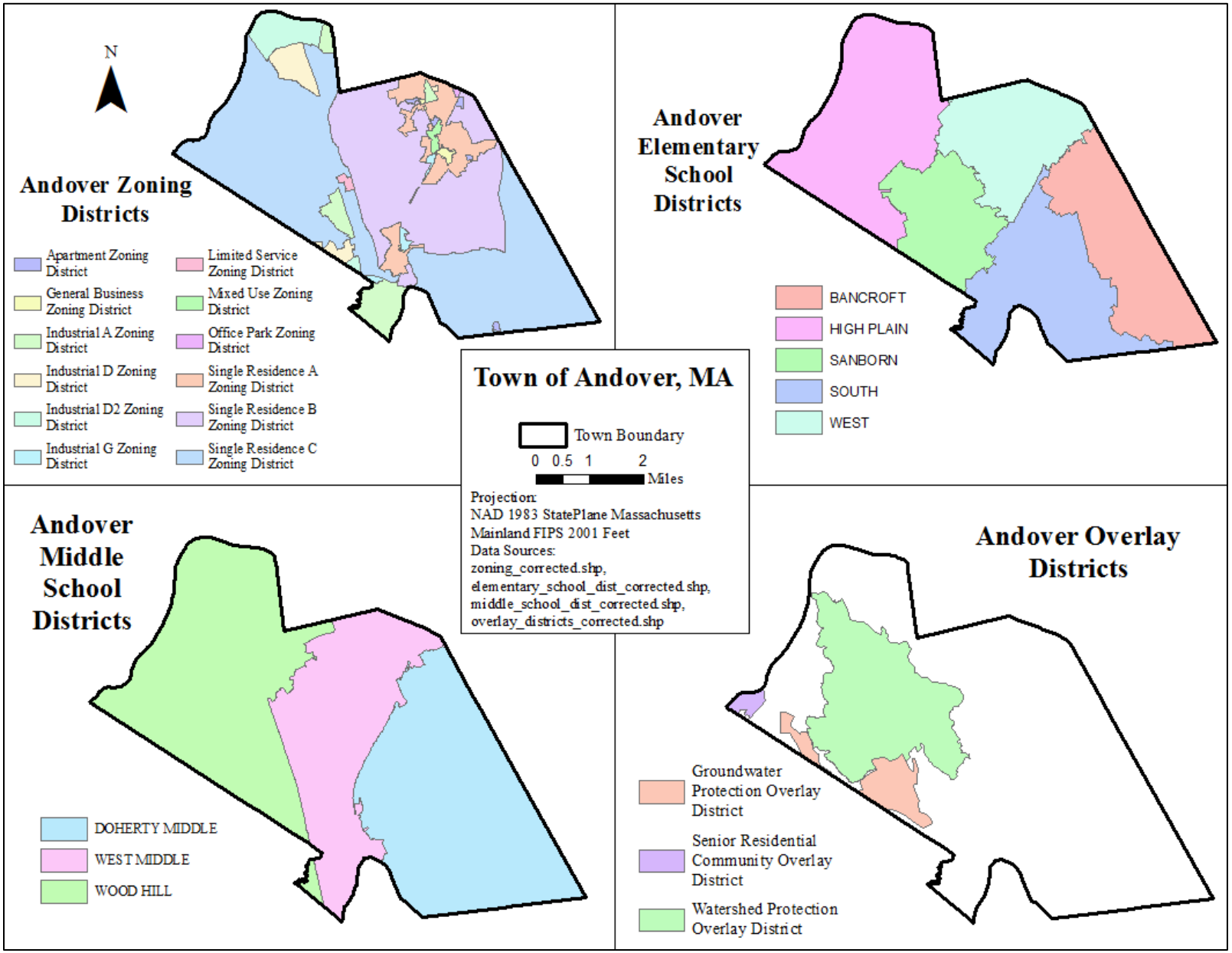


Figure 2 Maps of updated zoning and districting within the Town of Andover, Massachusetts, according to the new town boundary of 2014.

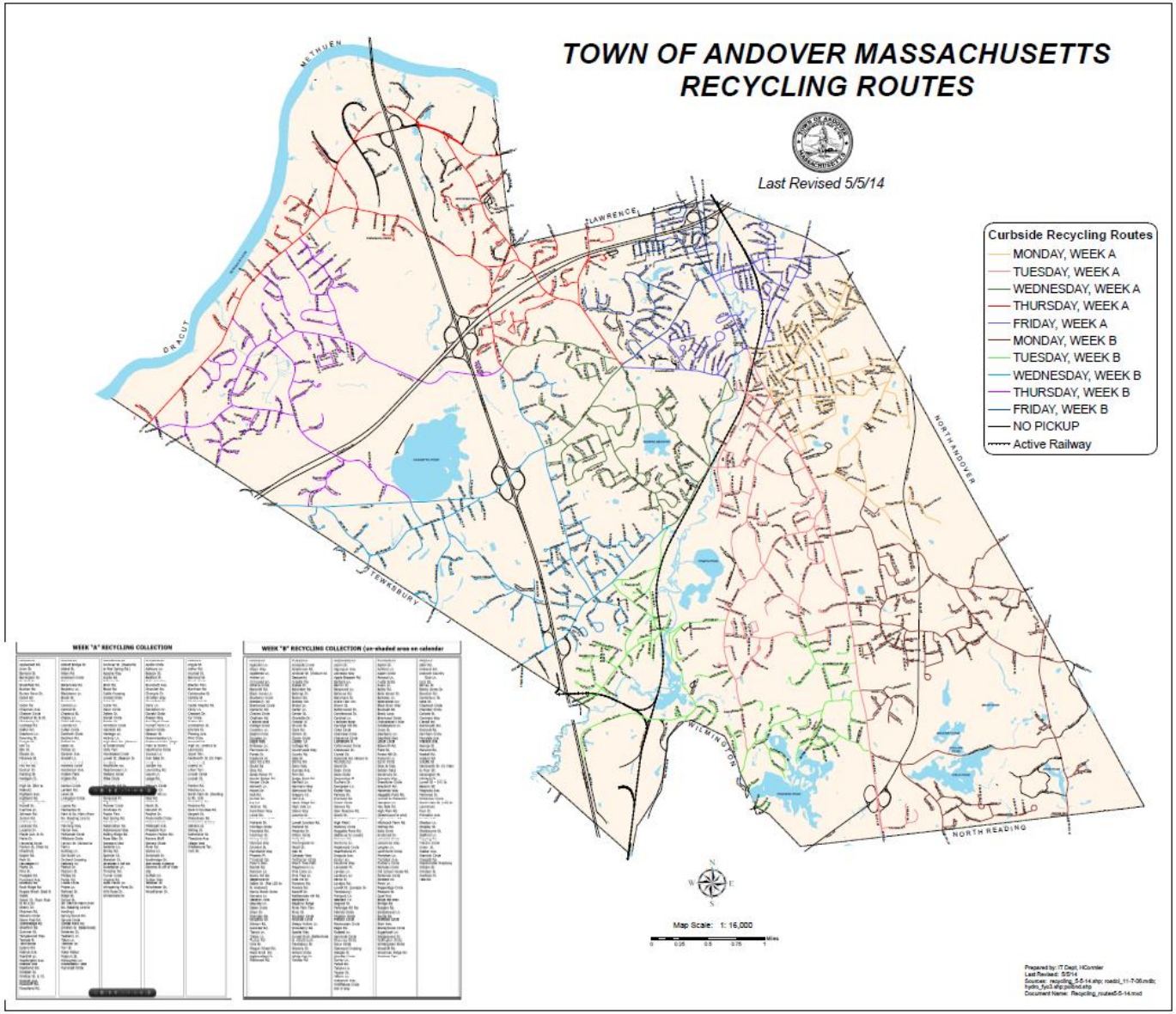


Figure 3 Color 36" x 36" map of recycling routes within the Town of Andover, Massachusetts, along with schedule of pickup by week and day per street.

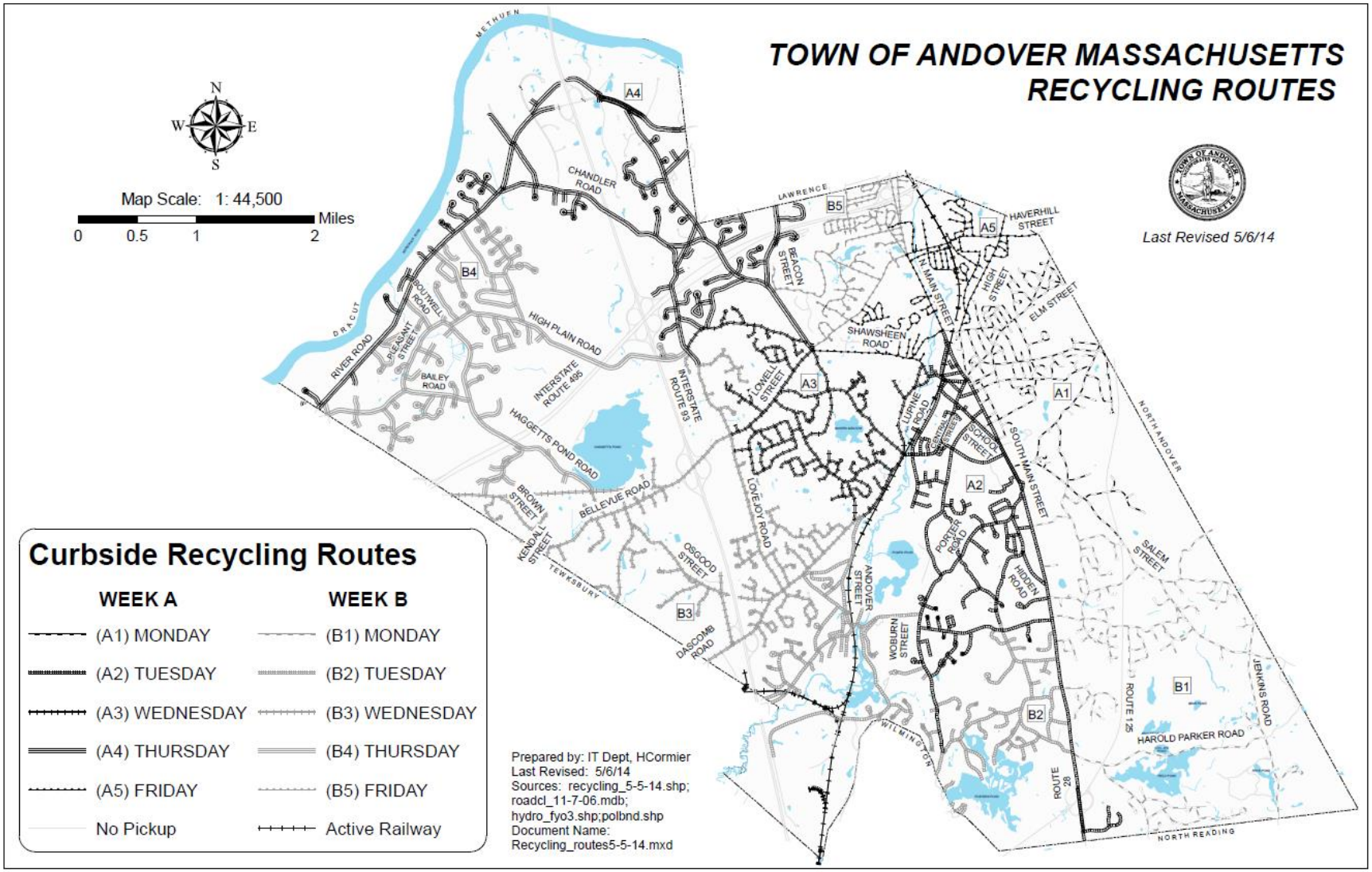


Figure 4 Black and white 11" x 17" map of recycling routes within the Town of Andover, Massachusetts, coded according to schedule of pickup by week and day per street.

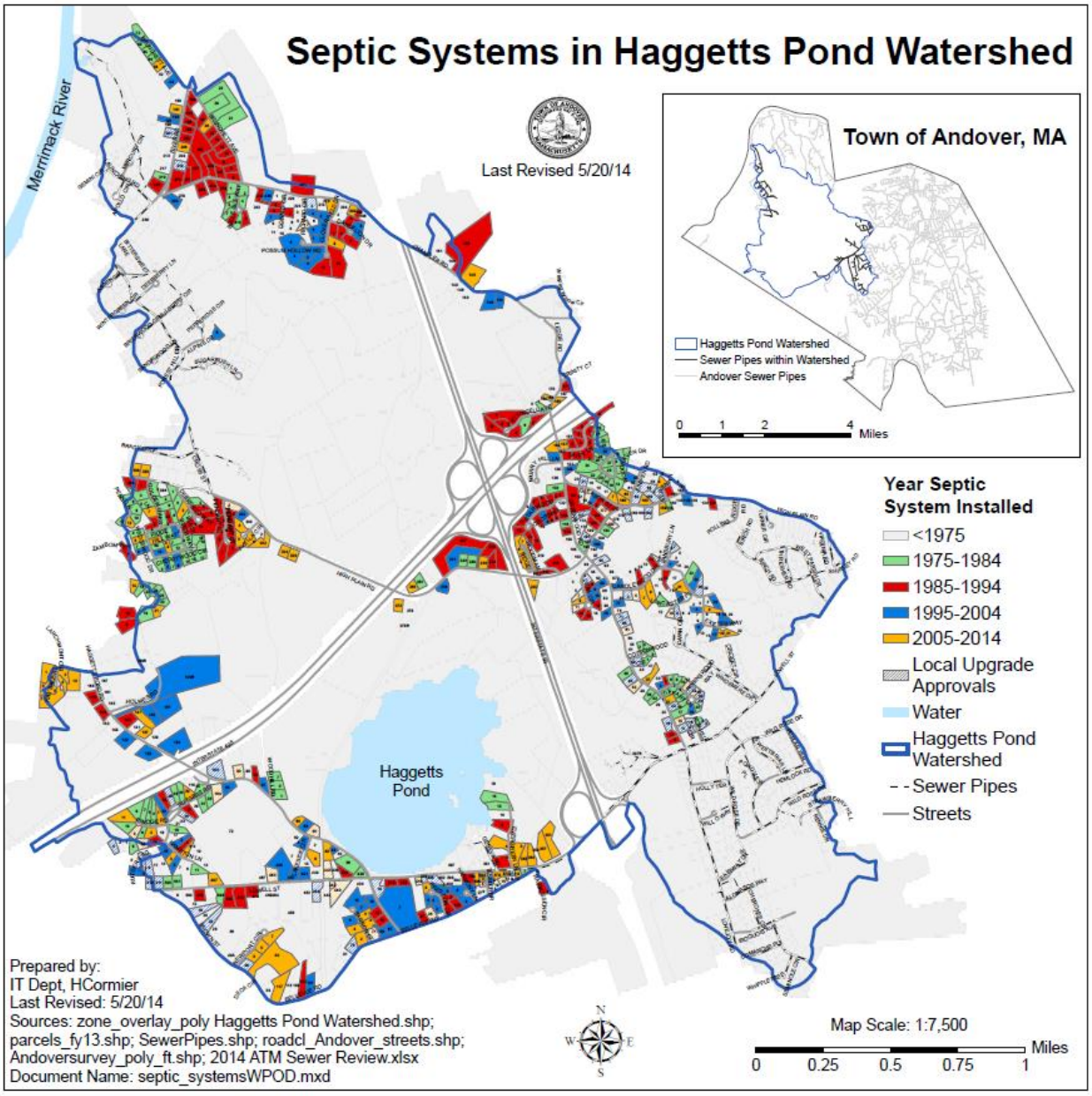


Figure 5 Map of septic systems within the Haggetts Pond Watershed in the Town of Andover, Massachusetts. Parcels are colored according to year of install. Inset shows current sewer pipe network in town.

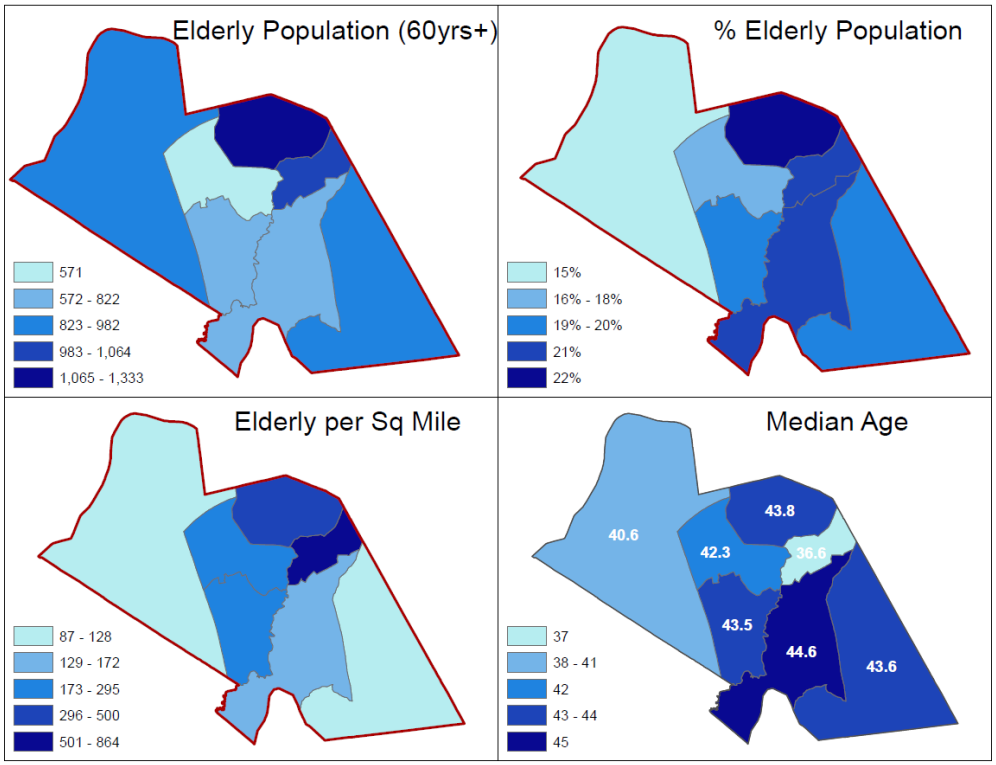


Figure 6 Maps of elderly populations within the Town of Andover, Massachusetts to be used in the multifamily housing development analysis.

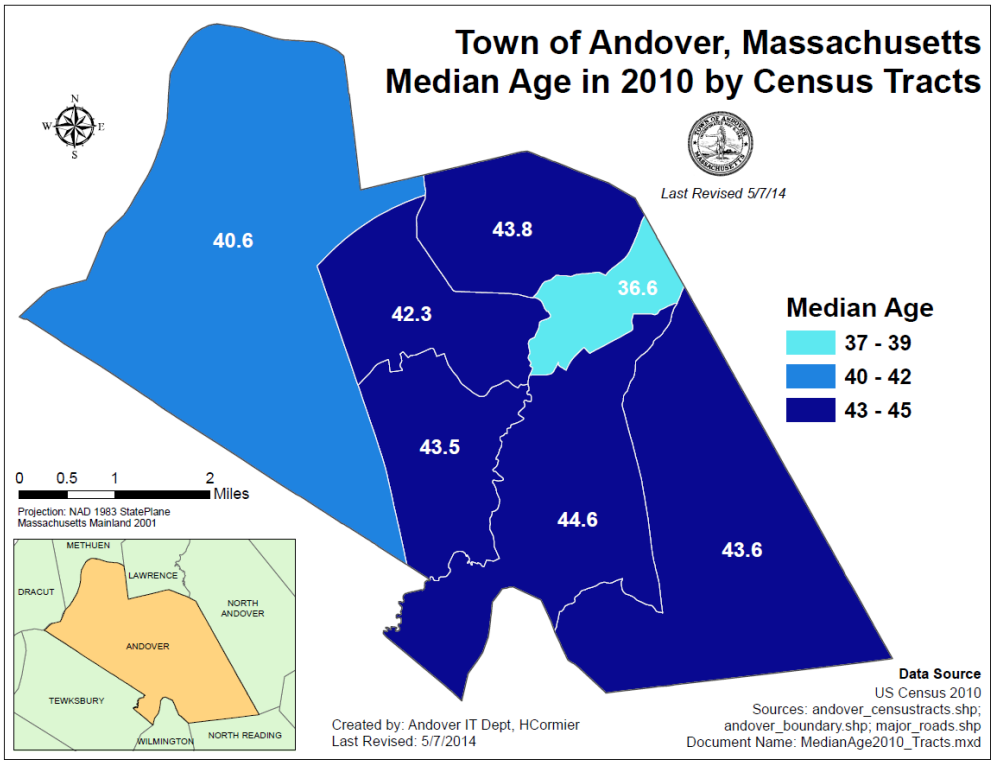


Figure 7 Map of median age by census tract in 2010 in the Town of Andover, Massachusetts.

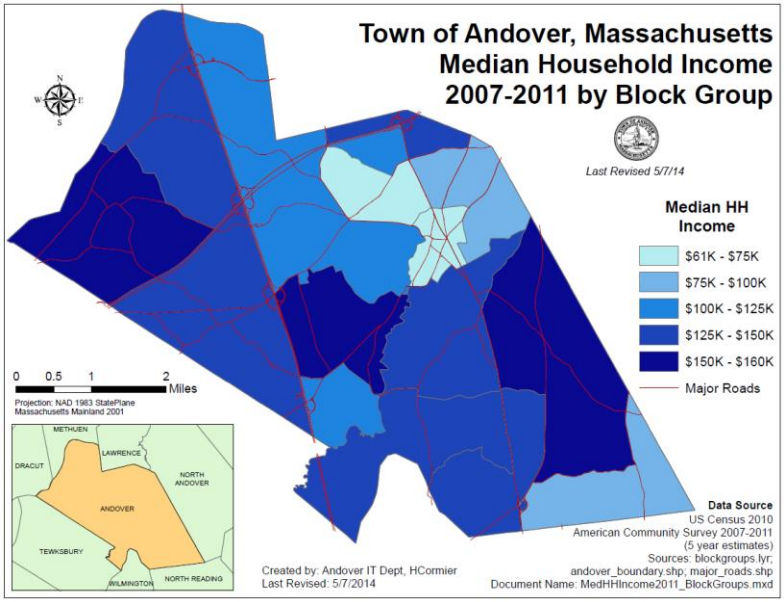


Figure 8 Map of median household income by block group for the years 2007-2011 in the Town of Andover, Massachusetts.

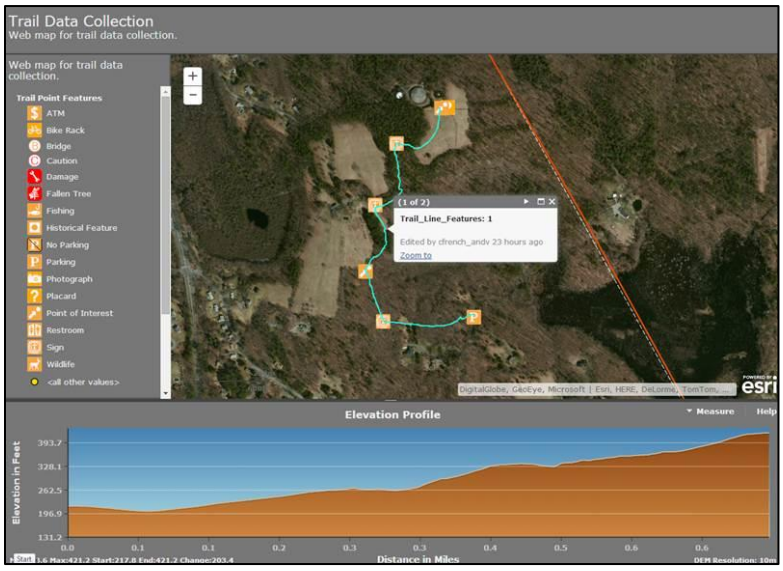


Figure 9 Screenshot of ArcGIS Collector application to collect GPS data points by phone in the field.

Figure 10 Photograph of picnic area captured by Android phone then geotagged as a data point in hiking trail maps.

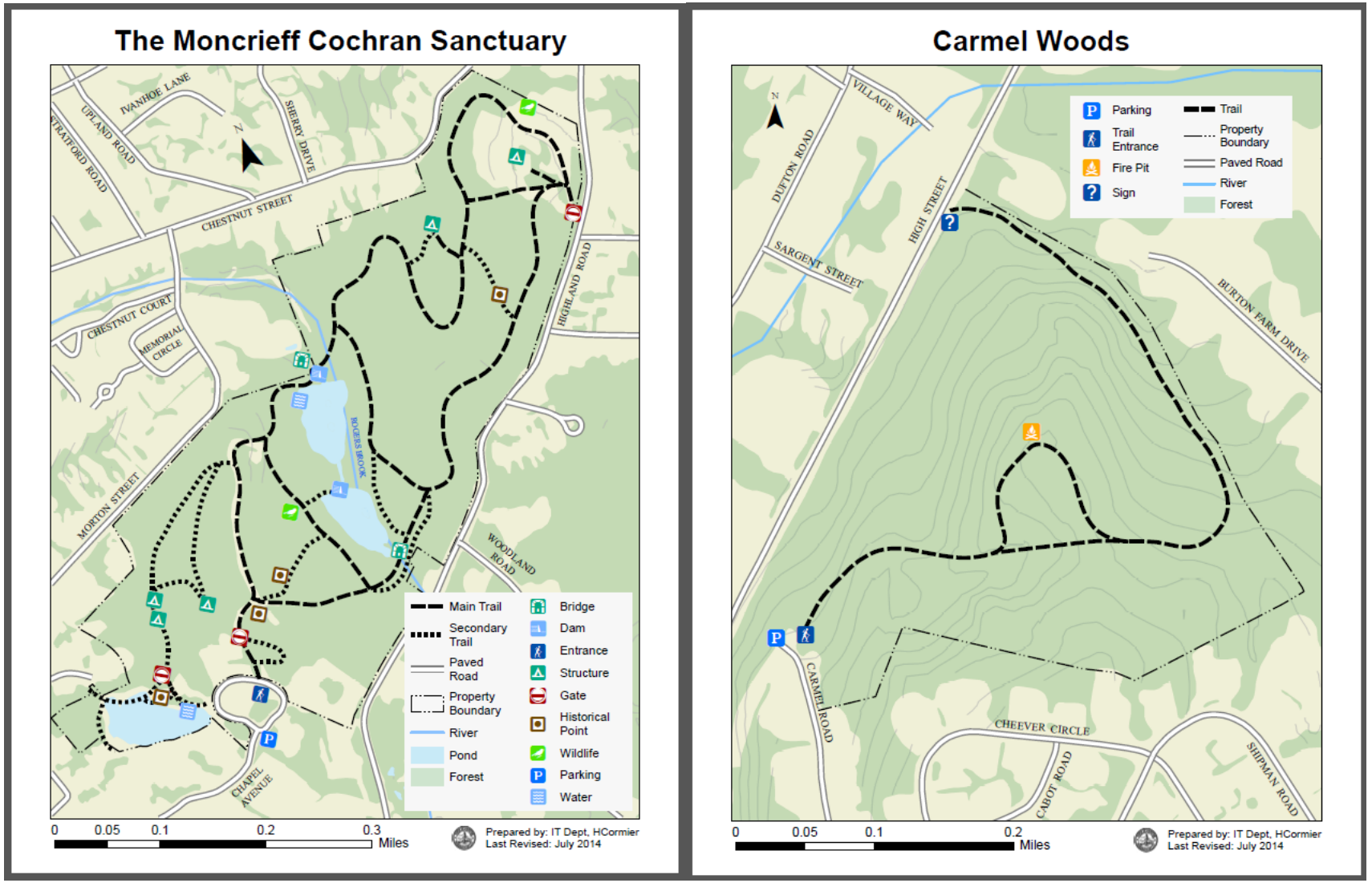


Figure 11 Original maps created from collected GPS points along The Moncrieff Cochran Sanctuary (left) and Carmel Woods (right) hiking trails in Andover, Massachusetts.

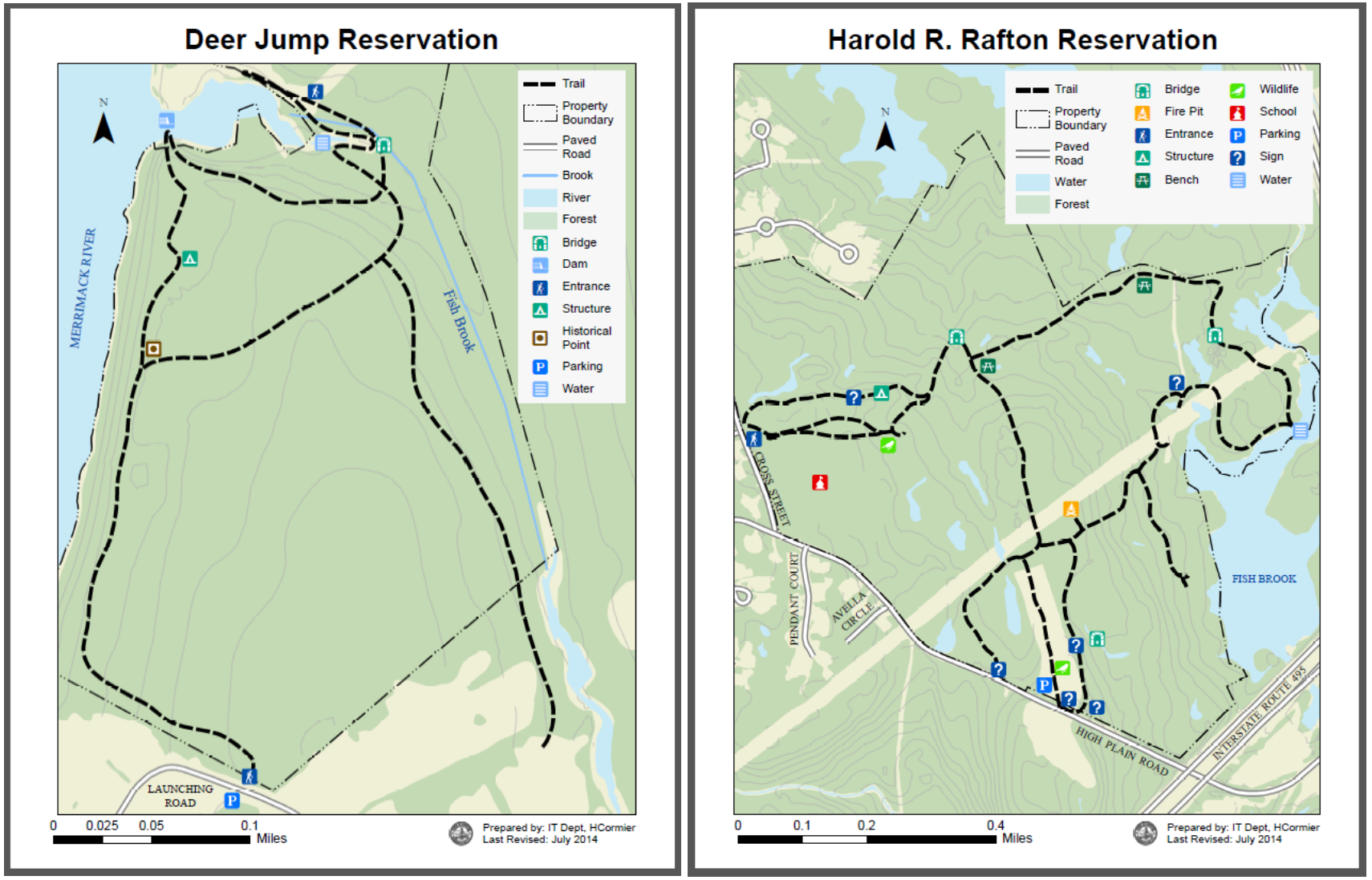


Figure 12 Original maps created from collected GPS points along Deer Jump Reservation (left) and Harold R. Rafton Reservation (right) hiking trails in Andover, Massachusetts.

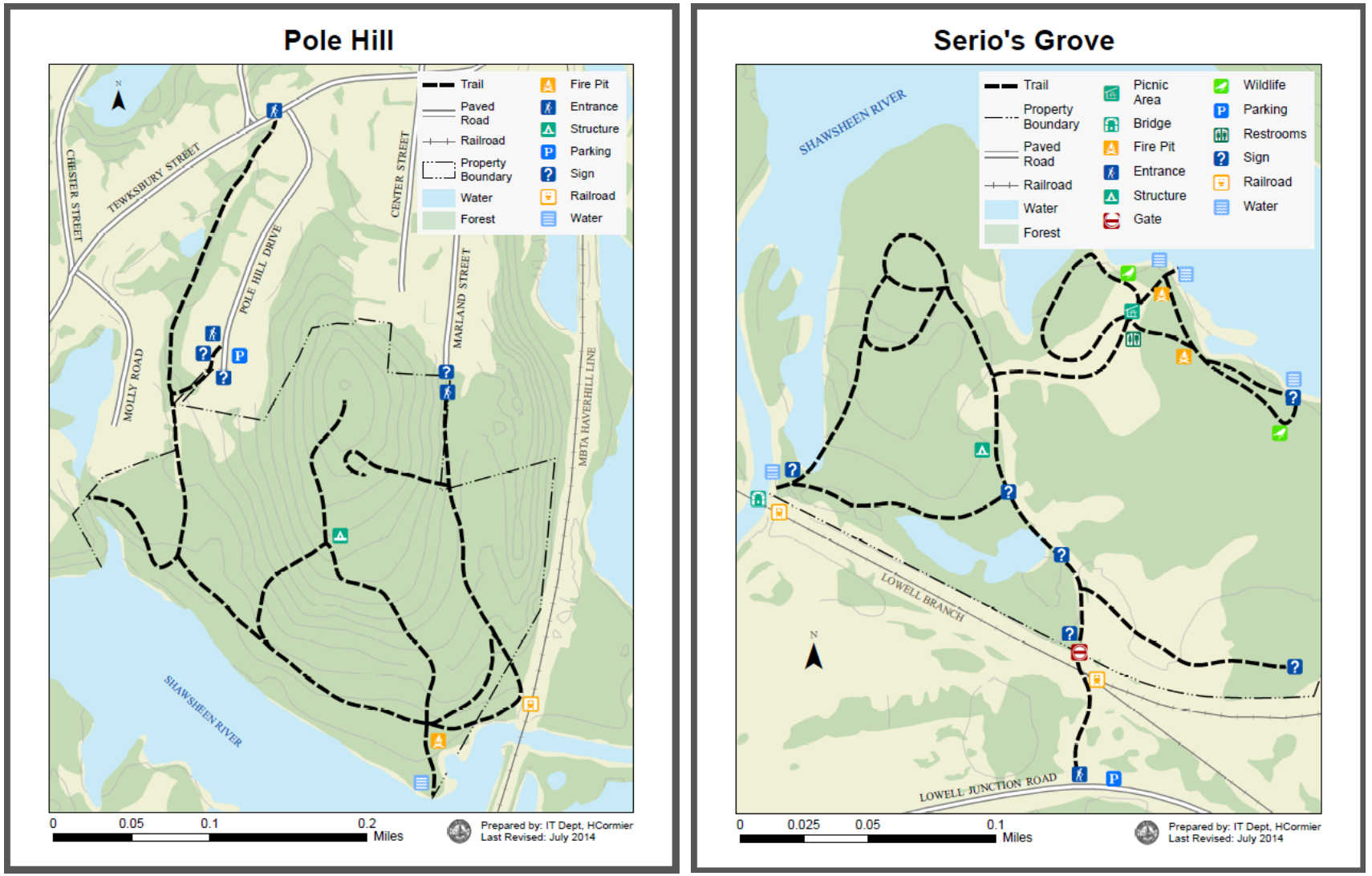


Figure 13 Original maps created from collected GPS points along Pole Hill (left) and Serio's Grove (right) hiking trails in Andover, Massachusetts.

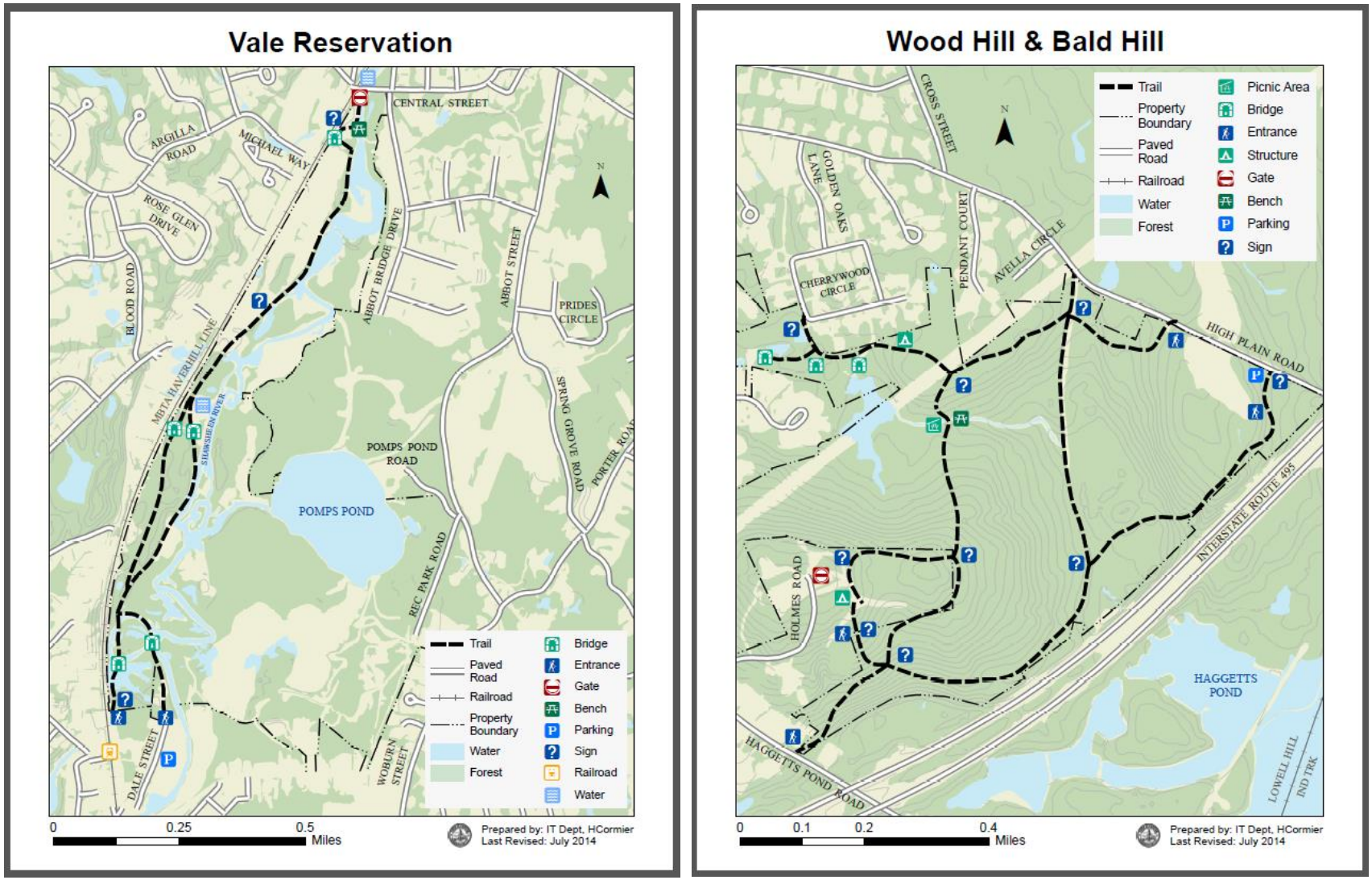


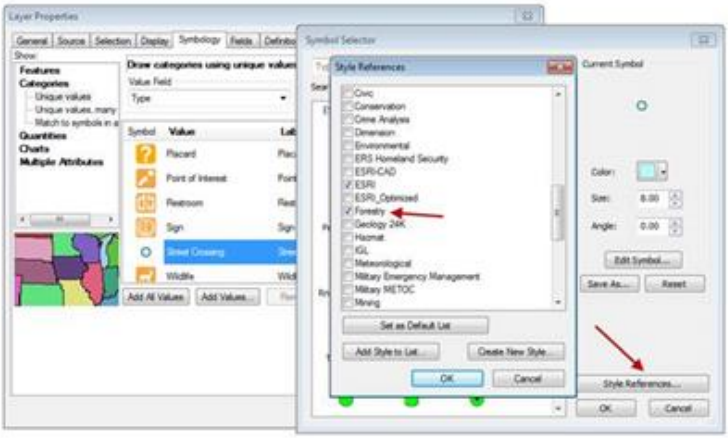
Figure 14 Original maps created from collected GPS points along Vale Reservation (left) and Wood Hill & Bald Hill (right) hiking trails in Andover, Massachusetts.

Figure 15 Original basemap template created for hiking trail maps in Andover, Massachusetts.

README FILE FOR TRAIL COLLECTION

ArcGIS Online

1. Under the Trail features layer properties in ArcMap > symbology tab, add the new values by type > right-click properties for selected symbols > with style references, using Forestry checked on.



2. Scroll down to pick a symbol that seems to fit the theme, and change color (e.g. electron gold).

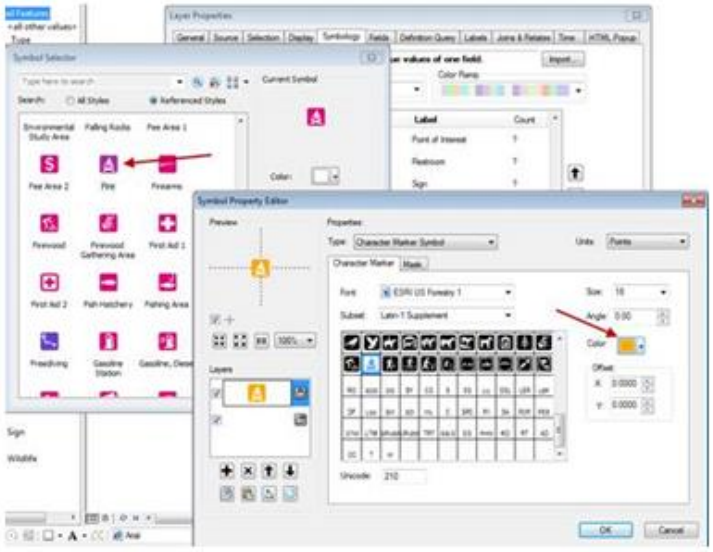


Figure 16 Excerpt from a ReadMe file of work instructions and screenshots detailing steps to be replicated in future work.

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