

A Site and Stormwater Management Plan for a Boy Scout Council Service Center in Worcester, MA

*A Major Qualifying Project Submitted to the
Faculty of Worcester Polytechnic Institute in
Partial Fulfillment of the Requirements
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Abstract

This project aims to produce a site and stormwater management plan for the development of a Council Service Center on a parcel in Worcester, Massachusetts for the Mohegan Council of the Boy Scouts of America. The team utilized GIS to identify environmental and legal constraints. Next, the team produced alternative site layouts on AutoCAD with Best Management Practices following the Massachusetts Stormwater Handbook. The team recommended a site layout with a building envelope, parking, viable access and stormwater management techniques.

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Colin Novick, Executive Director, The Greater Worcester Land Trust

Tom Chamberland, Vice President- Membership, Mohegan Council of the Boy Scouts of America

Capstone Design Statement

To meet the capstone requirement of this project, a site plan and stormwater management plan was designed for a new Service Council Center on the Coal Mine Brook parcel, which is owned by the Mohegan Council of the Boy Scouts of America. The development of this plan consisted of many steps outlined by the team including a site assessment, identification of buildable land area, design of site layouts and production of a Best Management Practice (BMP) stormwater management plan through investigation of the site's hydrology.

The team analyzed the existing condition of the Coal Mine Brook parcel using GIS and field observation to identify constraints within the site. These constraints were considered when the team developed alternative layouts of the building, parking areas, and points of access. In addition, the hydrology of the site was evaluated for the pre-development conditions and multiple post-development conditions based on the alternate layout options. The stormwater BMPs were selected and sized to best mitigate the increase of stormwater runoff from the new development. The final layouts of the building, parking, access road and stormwater BMPs were drafted as site plans through AutoCAD. Lastly, the team evaluated each of the options to ultimately recommend a layout to the Mohegan Council for their new Service Council Center.

The Accreditation Board for Engineering and Technology (ABET) defines student learning outcomes as the following: "an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability." The team also met ABET definitions by "communicating effectively" and "using the techniques, skills, and modern engineering tools necessary for engineering practice". This project considered the following realistic constraints throughout the process: economic, environmental, sustainability, ethical, health & safety, and social & political issues.

Economic: Site plans and stormwater management plans need to be economically feasible. The costs of the different layout options such as the BMPs and different parking lot materials were calculated to aid in developing the final recommendation. The benefits of the options were also taken into account to determine the most cost-efficient option.

Environmental: Matching the pre-development and post-development stormwater runoff values was a main concern for this project. Stormwater can become contaminated through vehicle discharge or winter salting and needs to be treated before it can enter any other body of water. In addition, constraints including utilities (water, sewer, electricity), terrain and slopes, erodible soil, conservation of the brook, legal restrictions (Worcester's local zoning codes, ordinances and deed restrictions), excess noise, and any more encountered were analyzed to ensure that the new development would not be detrimental to the environment.

Sustainability: The Mohegan Council has a firm desire to use sustainable practices in their land use applications, so sustainability was considered throughout the site layout process. The stormwater management plan was designed to mitigate short and long-term storms with maintenance feasible for the council. In addition, the team produced sustainable recommendations for the construction and operation of the council service building through

conversations with the Greater Worcester Land Trust, a non-profit organization purposed to preserve and conserve Worcester's open space.

Ethical: The project team carried out research, report writing, field visits and all design aspects of the project in a morally acceptable manner and with a firm priority on ethical behavior per the America Society of Civil Engineers code of ethics. The team avoided any improper interferences with any of the stakeholders on the site.

Health & Safety: Public health and safety is a strong concern as the Coal Mine Brook is part of the Blackstone River Watershed and is protected by the Greater Worcester Land Trust. The team's design reduces runoff and associated contamination in order to prevent harm to any humans and organisms affected by the local watershed.

Social & Political: The project team acknowledged the importance of politics and regulations associated with land development. Legal restrictions were evaluated and followed through the process of site design. The options were presented in accordance to researched restrictions on the site, and necessary steps to meet the associated requirements were identified.

Professional Licensure Statement

Professional licensure is a certification obtained by engineers that indicates competency and acceptance of the technical and the ethical obligations of the engineering profession. The title of Professional Engineer (PE) is the highest standard for engineers, representing achievement and assurance of quality.

To become professionally licensed, individuals must graduate from a four-year accredited engineering program, pass the Fundamentals of Engineering (FE) examination, and then work under a PE for four years before completing the last step of certification, passing the Practices of Engineering (PE) exam. The engineer must receive the PE in the state(s) that they work in and must renew it by the guidelines of each state-issued license. Licensed engineers can prepare, sign, seal and submit engineering plans and designs to public and private clients.

Professional licensures protect the health, safety, and welfare of the public by ensuring that each engineer is qualified to perform engineering design. This licensure protects the quality of design, review, and supervision of projects by maintaining a standard for the individuals that perform these tasks. To the engineers that receive the title of a Professional Engineer, it is a critical step in career advancement and recognition for their skills, knowledge, and experience.

Executive Summary

Site development is a process that requires a significant amount of research, design, and community and stakeholder involvement. There are many constraints and environmental concerns that can impact the development of a site such as zoning setbacks, parking requirements, and stream buffers. An exceedingly important environmental concern is stormwater runoff, which can pollute watersheds if not properly treated. Because of this, the Massachusetts Stormwater Handbook specifies Total Suspended Solids (TSS) requirements and Best Management Practice (BMP) design specifications to ensure that runoff from development does not harshly affect the surrounding environment.

This project was intended to aid the Mohegan Council in producing a site and stormwater management plan for the development of a new Council Service Center. The Mohegan Council of the Boy Scouts of America is headquartered in Worcester, Massachusetts. They possess the opportunity to develop a seven-acre parcel of land, the Coal Mine Brook parcel. This land is located in Worcester at the intersection of Plantation Street and the Interstate 290 Eastbound off-ramp. The Mohegan Council's goal to develop a sustainable Council Service Center that engages the local community can be met by utilizing the existing resources on the site to reduce the impacts of the proposed development. The objectives of this project were:

Objective 1 - Collaborate with Stakeholders: The MQP team collaborated with the Mohegan Council and the Greater Worcester Land Trust (GWLT) to incorporate their knowledge and feedback throughout the course of the project.

Objective 2 - Analyze Existing Conditions: The team analyzed the existing conditions within the site using Geographical Information Systems (GIS) and site visits to identify and synthesize design constraints.

Objective 3 - Identify and Evaluate Layout Options to Make Recommendations: Three alternate layouts with different access points were identified; BMPs were researched and designed for each option. These site layouts were updated with feedback from advisors, the Mohegan Council, and the GWLT to produce a final recommendation.

In the initial phases of this project, a site constraints analysis was performed through site visits and use of GIS databases. The team looked at data from MassGIS, and walked the site to determine the layout, location, and potential access points as well as potential buildable land. It was determined that the three acres on the northern side of the property of land are buildable. This part of the parcel is completely north of Coal Mine Brook and has 3-8% slopes, which are acceptable for development. Environmental constraints were also analyzed including flood zones, habitats, soils and slopes, legal restrictions, water resources, and noise pollution. This parcel was not in a flood zone and did not have endangered habitats, though there is a trout population in the Coal Mine Brook. The soil was determined to be sandy loam and the slopes were outlined in the GIS map the team created. The team learned that the property to the south of the Coal Mine Brook is protected by the Greater Worcester Land Trust, which indicates certain restrictions to development. Water resources were analyzed and found to include: the Coal Mine Brook, minimal wetlands along the edge of the brook, and proximity to Lake Quinsigamond.

Finally, it was determined that there is noise pollution on the property from I-290 East and Plantation Street traffic.

The team found three potential means of accessing this part of the parcel: First, through an existing curb cut off of Plantation Street that is an appropriate sight-distance away from the I-290 Eastbound off-ramp. Secondly, new access from the Notre Dame Health Care Facility to the west of the property through a proposed road extension. Lastly, the team considered a through road with both of these access points. The access options all had different road lengths, which therefore impacted the stormwater management calculations and informed best management practices.

To evaluate both the existing and post-development hydrology, the NRCS (Natural Resources Conservation Service)/ SCS (Soil Conservation Service) method was utilized through HydroCAD. This process quantified the runoff volume for different design storms through calculations involving the time of concentration, hydrologic condition, hydraulic condition, and the land use. Per Worcester's regulations, stormwater runoff values were calculated for 1-year, 2-year, 10-year, 25-year, and 100-year design storms. The pre-developed site does not produce much stormwater due to being composed entirely of sandy loam soil, which has a high infiltration rate. After initial site layouts were decided upon, the post-development hydrology was evaluated separately for each new surface: the building, the parking lot, and the access road. These post-development volumes calculated through HydroCAD were used to select and size the best stormwater BMPs to reduce the post-development runoff volumes to or below the pre-development volumes.

Stormwater BMPs were researched utilizing the Massachusetts Stormwater Handbook and the Massachusetts Watershed Coalition BMP Cost Catalog to determine which BMPs were feasible for the site. A ranking analysis was utilized to determine the best BMP to mitigate the runoff from each particular surface. Criteria considered for this analysis was applicability, cost per acre impervious area, groundwater recharge, TSS removal, pollutant removal, TSS maintenance, and aesthetics. These criteria were weighted based on importance to the site to determine the best mitigation strategy.

The team's final recommendation was access from Plantation Street, with stormwater BMPs for each of the impervious surfaces that would be introduced by the development of a Council Service Center. The BMP chosen to treat the roof runoff was a bioretention area to be located between the building and the parking lot for landscaping. Porous pavement was chosen to treat runoff from the parking lot, with a bioretention area in the middle of the lot for overflow runoff. The BMP chosen for the access road was a grassed channel, with a vegetated filter strip and a sediment forebay as pretreatment. This stormwater management plan provided the necessary TSS removal on a site-wide basis and followed specifications set forth in the Massachusetts Stormwater Handbook.

The team believes that the implementation of these recommendations would allow for a feasible and sustainable Council Service Center to meet the vision of the Mohegan Council. This project puts the Mohegan Council one step closer to developing on the Coal Mine Brook parcel.

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Authorship Page

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1.0 Introduction

An important goal in site design is reducing the effects of land use on the environment. Sustainable development practices aim to address this goal and meet the needs of future generations by considering environmental, social, and economic aspects in the design and building process (The World Bank Group, 2017). Vital steps in sustainable site development that prevent or reduce impact on the environment include performing site analyses and implementing Best Management Practices for stormwater, an increasing issue in site development (Marsh, 2010). Sustainable site design practices have been gaining attention in recent years, through research and information availability as well as in federal and local government policies.



Figure 1: Map of Coal Mine Brook Parcel (City of Worcester GIS database)

Worcester, Massachusetts is the second largest city in New England but has plentiful neighborhood centers and green spaces that must be protected (Worcester Culture Coalition, 2017). The Mohegan Council of the Boy Scouts of America (BSA), headquartered in Worcester, is an organization that is dedicated to fostering life skills and community involvement (Boy Scouts of America, 2017). The Vice President of this council, Tom Chamberland, expresses the importance of green infrastructure and the reduction of environmental footprints in their development projects. Their camp, Treasure Valley Scout Reservation, is an example of this effort, utilizing composting latrines and solar LED lights sourced through their 6MW and 2.5MW solar farms (T. Chamberland, 2017).

The Mohegan Council possesses the opportunity to continue their sustainable practices further by developing a seven-acre parcel of land in Worcester for a new Council Service Center. This land is located at the intersection of Plantation Street and the Interstate 290 Eastbound off-ramp as seen in Figure 1 outlined in red, a location with heavy through traffic. This new space is envisioned to be used as a marketing resource, retail space, and meeting space. The Mohegan Council would like to foster community involvement by sharing this space with local organizations and utilizing the outdoor recreation opportunities.

The council faces several design constraints for this new development. There is limited buildable land due to the Coal Mine Brook, which divides the property, and steep slopes surrounding the brook, which complicates development. There are also limited options for road access to the buildable area of the parcel due to the proximity of the Interstate 290 off-ramp. The brook and its quality are protected and monitored by the Greater Worcester Land Trust (GWLT). Any new development would alter the current hydrology of the site and potentially increase stormwater runoff.

The goal of this project is to design a site layout and a stormwater management plan for the Coal Mine Brook parcel to aid the Mohegan Council in developing a new Council Service Center. The objectives of this project are as follows:

- Objective 1: Collaborate with Stakeholders
- Objective 2: Analyze Existing Conditions
- Objective 3: Identify and Evaluate Layout Options to Make Recommendations

Collaboration with stakeholders including the Mohegan Council and the GWLT will provide the team with general insight and design considerations to incorporate into the site plan. Analysis of the existing conditions of the site will provide the team with constraints that can be organized and prioritized. The buildable land will be made evident through this evaluation and next step will be the design of alternative site layouts including stormwater management options for the parcel. Finally, recommendations will be made based on analysis of these options. This project will provide the Mohegan Council with a site plan and a coordinating stormwater management plan. Ultimately, it will provide an opportunity to be one step closer in the process of developing a new Council Service Center.

2.0 Background

This chapter outlines the information about the Coal Mine Brook parcel, design considerations for the development of the property, and an overview of general site development and stormwater management information and practices.

2.1 Coal Mine Brook Parcel Information

2.1.1 Location and Geography

The parcel is located in northeast Worcester, Massachusetts at the intersection of Plantation Street and the Interstate 290 Eastbound off-ramp as seen in Figure 2. The buildable land is bordered by Plantation Street to the East, a sewer line easement to the north, Notre Dame Health Care Center to the west, and Coal Mine Brook to the south. The parcel and its surroundings can be seen in Figure 2.



Figure 2: Coal Mine Brook Parcel and Surroundings (Mass Online GIS)

2.1.2 Greater Worcester Land Trust

The Greater Worcester Land Trust is a small non-profit organization that works to preserve Worcester County's open space (The Greater Worcester Land Trust, 2014). A Conservation Restriction was put in place by the GWLT along and surrounding the brook to assure the parcel would be retained in predominantly its natural, scenic and open condition and to help preserve the Coal Mine Brook's water quality, habitat and scenic appeal. The Worcester East-West hiking trail, a 14-mile city hiking trail, runs through the middle of the parcel within the conserved area.

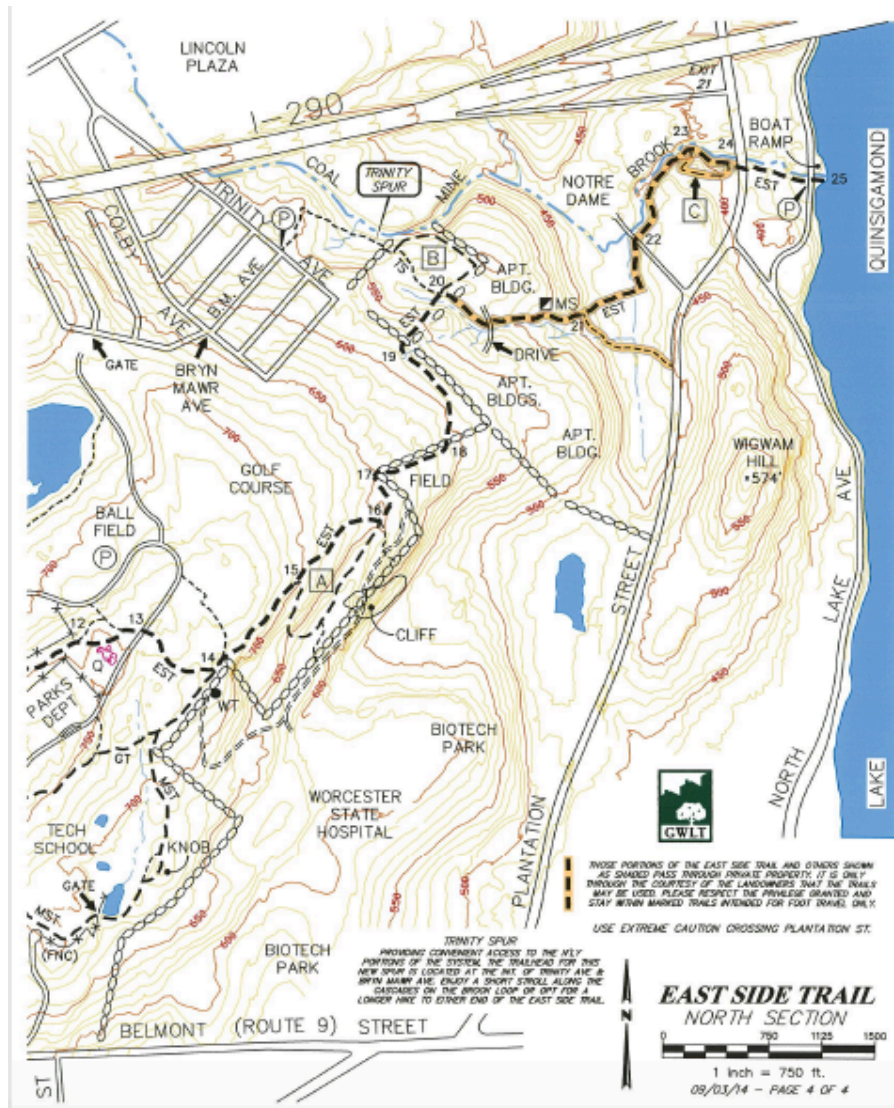


Figure 3: North Section of the Worcester East-West Trail (The Greater Worcester Land Trust, 2014)

This trail ensures the existence of a wildlife connector and establishes an extensive contiguous greenway of conservation land from Green Hill Park, the trail's eastern link to the premises (Park Spirit, 2016). The north section of this trail is shown in Figure 3, which contains the Coal Mine Brook parcel in the northeast corner of the map.

2.1.3 Mohegan Council

The Mohegan Council of the Boy Scouts of America (BSA) plans to utilize this site for both Boy Scout and public community usage. Specifically, in regards to the Boy Scout operation, the Council desires to develop a Council Service Center complete with a supportive retail scout shop, an open meeting space, offices, and a parking area. In addition, due to the parcel's proximity to I-290, the council intends to use this site as a marketing opportunity for passing traffic to demonstrate the activity of the Mohegan Council (T. Chamberland, 2017).

2.2 Boy Scout Land Use

Boy Scouts utilize land and buildings for many different purposes. These include office spaces for administrative use, outdoor recreational spaces or camps, indoor recreational centers, and educational areas.

The Mohegan Council Boy Scouts currently maintain the Treasure Valley Scout Reservation (TVSR) in Rutland, Massachusetts, which hosts a variety of events. Residential camp, adventure camp, skills training, and year-round Boy Scout training are some of the functions held at TVSR by the council. Overall the purpose of facilities such as TVSR is to serve the Boy Scout program in "inspiring the leaders of tomorrow", while upholding standards for environmental protection and working to reduce their carbon footprint (Mohegan Council, 2017).

Table 1 provides general BSA Council Service Center design considerations from the 1998 Draft of Program of Requirements sent to the Mohegan Council.

Table 1: Council Service Center Requirements (BSA, 1998)

| Criteria | Requirement |
|-------------------------------------|--|
| Aesthetic | The Service Center must embody efficiency and environmental sensitivity. |
| Maintenance | The Service Center must be designed with greatest possible durability, lowest possible maintenance, and must provide for future expansion. |
| Zones/ Access Requirements | The facility should be divided into three zones, the Scout Shop, the Meeting Room(s), and Offices, which all must be securable without restricting access to the other zones with access to restrooms and kitchen/break room(s). |
| General Components | The Service Center Site Plans include street access, parking, loading, waste removal, surface water run-off, landscaping, paving, lighting, signage, and a flag plaza/sculpture site. |
| General Spatial Requirements | Ancillary areas must include an entry lobby, a media resource room for storage and display of checkout items, a trading post and trading post stock room, a kitchen/break room, a main conference room, an administrative conference room, a program room, men's and women's bathrooms, a janitorial room, a central computer and switching room, a shipping/receiving room, a storage room for records, programs, office supplies, field service and conference room furniture and equipment. |

2.3 Site Development

2.3.1 Importance of Stakeholder Involvement

Site development is a complex process that involves stakeholders, the existing land, and designing with respect to the surrounding community, local and state regulations. The purpose of

site planning is to synthesize client goals and aspects of civil engineering, architecture, landscape architecture, and environmental planning. It is the process of creatively and efficiently drafting different purposes for sections of land for private or public clients (Rubenstein, 3). Stakeholders consistently inform the decision-making process during the process of land development.

2.3.2 Site Analysis

Site analysis is a process to determine the limiting constraints to then identify the opportunities available for land development (LaGro, 2013). A site analysis aims to investigate the makeup and operation of a proposed use program on a site. This is typically performed after the land use has been proposed but the layout and appropriate design need to be developed. Site analysis involves evaluating the proposed environment for features or situations that would either facilitate or threaten the desired land use in order to recommend the most appropriate layout (Marsh, 2010).

a. Constraints

A synthesis of client needs, planner needs, and community needs is necessary to understand the scope of a project in terms of constraints. (Marsh, 2010). The needs of the Mohegan Council and the requirements of the Greater Worcester Land trust will be considered in the site analysis process. Typical constraints identified through site analysis are identified in Table 2.

Table 2: Potential Constraints for Site Development

| Potential Constraints | Examples |
|---------------------------|--|
| Ecological Infrastructure | Aquifer recharge areas, wetlands, surface water, critical wildlife habitat |
| Health or Safety Hazards | Floodplains, earthquake fault zones |
| Physiographic Barriers | Steep slopes, highly erodible soils, shallow bedrock |
| Natural Resources | Prime farmland, sand and gravel deposits, specimen trees, scenic views |
| Historic Resources | Historic buildings, archeological sites |
| Legal Restrictions | Zoning codes, subdivision ordinances, easements, deed restrictions |
| Nuisances | Noises, odors, unsightly views |

Environmental Data

There are multiple sources of environmental data for analysis and planning, including firsthand field observation, aerial photos and satellite imagery. Another strong source of information can come from topographic contour maps published by the U.S. Geological Survey. Soil maps from the U.S. National Resources Conservation Service give the classification and description of soils to a depth of 4 or 5 feet as well as a representative slope. The U.S. Geological Survey also includes data and reports for earthquake hazards, stream discharge records, groundwater surveys, geological formations and water resources (Marsh, 2010).

Wetlands

Wetlands serve the purpose of "flood conveyance, barriers to erosion by waves, flood storage, sediment control, pollution control, sources of nutrients for animals, habitats, aquifer recharge, recreation, open space, and aesthetic values" (Rubenstein, 28). There are virtual maps and wetland data files available that show where on or around site wetlands may exist.

It is imperative to check with state and local laws and ordinances regarding wetlands before designing to build. In many cases, permitting is required. The Massachusetts Wetlands Protection Act (General Laws Chapter 131, P40, and the Act) seeks to protect wetlands as well as waterfronts and other water affected land (Worcester Conservation Commission, 2015). There are restrictions on development within specified buffer zones. The Massachusetts River Protection Act specifies a 200-ft buffer from the center of the water resource (wetland). However, as Worcester is an urban setting, the Massachusetts Wetland Protection Act allows the 100-ft buffer change, defined in the Department of Environmental Protection document: 310 CMR 10.02(1)(a).

Habitats

Unique habitats are plant or animal habitats that are particularly vulnerable to development (National Geographic). For this reason, it is important to research the site for any of these habitats and develop around them so that they are not disturbed or destroyed.

Physical Barriers to Development

Physical barriers include steep slopes and soils. When developing a site, it is critical to have an understanding of the slopes and any existing or opportunities for erosion on the property. There are limits to where construction and/or development can occur on a site based on slope percentages and soil maps, which are outlined by states and counties. Soil maps are created from field testing and surveying. Worcester, for example, has surveys and general soil maps available online or by request from the City of Worcester.

Transportation

Another area of important research is transportation in, out, and around a site that is being developed. There are both logistical and safety considerations when it comes to traffic flow in and out of a parcel. For safety purposes the type of roads near a site must be considered. Road types may include highways, main roads, local roads, bike paths, and access roads. Depending on the type of road and the anticipated use, there are dimensions and turning radii associated to maintain traffic flows and safety.

Design standards can be researched state by state. Other details such as sight-distance calculations, speed zones, and parking information can be found on counties' zoning maps or Department of Transportation's websites. Furthermore, road and parking lot designs are important for the site planner to consider, especially in regards to their impact on, stormwater management.

b. Geographical Information Systems (GIS)

Geographical Information Systems (GIS) is a commonly used program with spatial and geographical databases and map layers. Research conducted during site analysis comes from any existing previous documentation of the site, site visits and observations, and GIS data. This resource is often used as a preliminary data source for learning about landscapes and environmental services in any area. It allows the user to visualize different aspects of data and categorize it to recognize trends throughout maps and informational charts (ESRI, 2018).

The GIS database provides various relevant data layers including aerial photographs, terrain, impervious surfaces, demographic information, conservation areas, infrastructure, physical land resources, and regulatory areas. GIS data along with the collection of other comprehensive research provides a suitable platform for the continuation of a site-planning project.

2.4 Stormwater Management

2.4.1 Importance of Stormwater Management

The change in the volume, rate and quality runoff reaching streams and rivers is one of the most serious problems associated with land development. It increases property damage from flooding and erosion, reduces water quality and degrades habitats (Marsh, 2010). Thus, stormwater has been an increasingly substantial consideration for site planning. A plan for the rerouting of stormwater flow in a development plan is necessary in most site design applications.

2.4.2 Runoff Movement

Stormwater is either intercepted by vegetation, absorbed directly into the soil, or it runs off the surface of land into streams, rivers and low spots within a region's topography. Stormwater volumes generally increase with slope and ground coverage by impervious surfaces such as concrete and asphalt. Similarly, these volumes decrease as soil organic content and vegetative cover increase (Marsh, 2010). Hence, the development of land strongly affects the increase in stormwater and its associated pollutants within a watershed.

2.4.3 Stormwater Control

In order to develop practices to manage stormwater runoff when developing a piece of land, the existing land must first be analyzed. Then, practices may be implemented to best use the natural landscape to mitigate runoff.

a. Evaluating Hydrology: Pre and Post Development

Evaluating the preexisting hydrology is important in stormwater planning and is typically done when analyzing a site for constraints, as stormwater management is an important part of site development.

After initial layouts of the site were developed then the post-development hydrology was evaluated based on the new site for comparison against the pre-development runoff values.

Both the pre- and post-development hydrology can be analyzed with HydroCAD, a stormwater modeling computer software. Site specific data and design storm rainfall values can be input to

this software for the calculation of runoff flow and volume values and the development of hydrographs, which are graphical representations of flow rate over time. This software also allows for the specification of the preferred stormwater calculation method.

The National Resources Conservation Service (NRCS) published a Technical Release (TR-55) as a simplified method to calculate peak runoff volume, rate of discharge, hydrographs and storage volumes. This method is most applicable to small urbanized watersheds to help estimate design parameters for stormwater control and is one of the approaches available for use through HydroCAD.

b. Developing Mitigation

Best Management Practices

Best Management Practices (BMPs) are measures taken to prevent or reduce impacts of land use development and practices on the environment, specifically associated with runoff systems. These are usually proactive measures as part of land use planning and design (Marsh, 2010). When proposing a plan to conservation commissions, developers investigate possible practices to be used to manage the stormwater in accordance to the state or local stormwater management standards (Massachusetts Department of Environmental Protection, 2012, Vol 2 Ch. 1). BMPs can be planning techniques or structural applications, both of which mitigate the impacts of runoff.

The goal of most stormwater management strategies in site planning is to plan for the development to result in little or no increase in discharge, whether by returning the excess stormwater to the ground or storing the excess water close by to release it over time. To design a site-scale BMP plan, a spreadsheet approach to stormwater accounting may be used, which involves calculating the volume of the stormwater produced from each surface within the site before and after development. Calculating volume is based on the site's coverage, coefficient of runoff and storm size. The post-development volume should be brought as close to the predevelopment value as possible (Marsh 2010). This practice is necessary in community and site-specific planning, being most applicable after the hydrology of a parcel is assessed to ensure that significant alterations are not made to the runoff volume. Some common BMPs include:

- **Leaching Catch Basins:** Leaching catch basins consist of a pre-cast concrete barrel and riser that have an open bottom. They allow runoff to infiltrate into the ground when combined with deep sump catch basins for pretreatment, shown in Figure 4. This BMP requires maintenance annually or as needed, involving inspection and removal of debris.



Figure 4: Leaching Catch Basin (Commonwealth of Massachusetts, 2018)

- **Bioretention Areas:** Bioretention treats stormwater prior to infiltration using soils, plants, and microbes. Runoff is directed via piped or sheet flow, filtering through the soil media, and then exfiltrating and providing groundwater recharge or being intercepted by an underdrain for conveyance, shown in Figure 5. This BMP requires inspection, trash removal and mowing monthly or as needed. Mulching, fertilizing, pruning, and removing dead vegetation is required annually.



Figure 5: Bioretention Area/ Rain Garden (Commonwealth of Massachusetts, 2018)

- **Stormwater Wetlands:** Stormwater wetlands treat runoff through vegetation uptake, retention and settling in shallow pools that support wetland plants in order to maximize pollutant removal, shown in Figure 6. This BMP requires wetland inspection twice a year for the first three years of construction, forebay cleaning annually and sediment removal from the wetland system once every 10 years.



Figure 6: Stormwater Wetlands (Commonwealth of Massachusetts, 2018)

- **Dry Detention Basins:** Dry detention basins hold runoff, allowing solids to settle and reducing flooding, shown in Figure 7. This BMP requires inspection twice a year and after major storms, examination for clogging or outflow, mowing, trash and debris removal twice a year, and sediment removal from the basin once every 5 years.



Figure 7: Extended Dry Detention Basin (Commonwealth of Massachusetts, 2018)

- **Sand & Organic Filters:** Sand & organic filters utilize self-contained beds of sand or peat and perforated underdrains or cells to filter runoff, shown in Figure 8. This BMP requires filter inspection and debris removal after every major storm for the first few months and every 6 months thereafter.



Figure 8: Sand & Organic Filter (Commonwealth of Massachusetts, 2018)

- **Treebox Filters:** Treebox filters use an open bottom concrete barrel filled with permeable soil media, an underdrain and a tree to filter runoff, shown in Figure 9. This BMP requires inspection annually, raking of media surface twice a year and media replacement when the tree is replaced.



Figure 9: Treebox Filter (Commonwealth of Massachusetts, 2018)

- **Wet Basins:** Wet basins treat runoff using a permanent pool of water that allows sediments to settle and removes soluble pollutants, shown in Figure 10. This BMP requires inspection, mowing, and sediment forebay checking at least twice a year. Sediment removal is required as necessary or once every 10 years.



Figure 10: Wet Basin (Commonwealth of Massachusetts, 2018)

- **Grassed Channels:** Grassed channels accept sheet or piped flow, utilizing sedimentation and gravity to treat runoff while conveyed through a vegetated drainage system, shown in Figure 11. This BMP requires sediment removal from the forebay and grassed channel annually and mowing once a month. Repairs to the vegetation due to erosion are required as needed or once a year.



Figure 11: Grassed Channel (Commonwealth of Massachusetts, 2018)

- **Water Quality Swales:** Water quality swales treat and convey runoff with vegetated open channels, shown in Figure 12. This BMP requires swale inspection and repairs monthly after construction and twice a year thereafter. Sediment and debris removal is required annually while mowing and re-seeding is only required as needed.

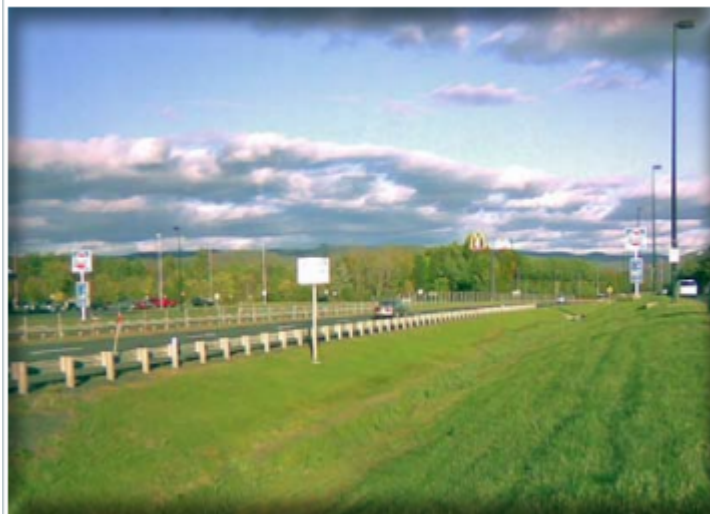


Figure 12: Water Quality Swale (Commonwealth of Massachusetts, 2018)

- **Dry Wells:** Dry wells infiltrate runoff into small-excavated pits that are backfilled with aggregate, treating uncontaminated roof runoff, shown in Figure 13. This BMP requires inspection after every major storm for the first few months after construction and then annually. The water depth also needs to be observed at 24- and 48-hour intervals after a storm.



Figure 13: Dry Well (Commonwealth of Massachusetts, 2018)

- **Porous Pavement:** Porous pavement uses air voids to allow water to pass through paved surfaces and infiltrate into the subsoil, shown in Figure 14 (Commonwealth of Massachusetts, 2018). This BMP requires inspection and assessment of exfiltration capacity annually. Monitoring drainage is required after storms and power washing and vacuum sweeping is required as needed.



Figure 14: Porous Pavement (Commonwealth of Massachusetts, 2018)

Massachusetts Stormwater Standards

The Massachusetts Stormwater Handbook specifies standards regarding stormwater discharge to wetlands, peak discharge rates, groundwater recharge, Total Suspended Solids (TSS) removal and other stormwater management strategy requirements. These standards protect the surrounding environment when developing a site. Volume 1 of the Massachusetts Stormwater Handbook outlines these standards and the legal and regulatory framework of the handbook. Volume 2 discusses the elements of stormwater management, focusing on BMPs. The third volume describes the preparation of a Stormwater Report, which is required when submitting a Wetlands Notice of Intent for a project. This report must accompany a permit and be prepared under the direction of a Registered Professional Engineer (RPE) licensed in Massachusetts (Commonwealth of Massachusetts, 2018).

Water Quality Standards

The Massachusetts Stormwater Handbook was utilized to identify the stormwater management standards required for this project. Total Suspended Solids removal of 80% is required, which can be met with the treatment and pretreatment devices selected for the project. There are also water quality requirements for the standards, as "the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This standard is met when the stormwater management system is designed to infiltrate the required recharge volume" (Overview of Massachusetts Stormwater Standards, 2017). Thus, the required recharge volume can be determined using equations from the Massachusetts Stormwater Handbook Volume 3: Documenting Compliance.

Time of Drawdown

Time of drawdown is the time it takes for a BMP to infiltrate runoff for a specific storm event. The Massachusetts Stormwater handbook requires that a BMP infiltrate within 72 hours. The time of drawdown can also be determined using equations from the Massachusetts's Hydrology Handbook for Conservation Commissioners.

3.0 Objective 1: Collaborate with Stakeholders

The team's project was an iterative design process with the sponsor, the Mohegan Council of the Boy Scouts, and the Greater Worcester Land Trust. This chapter identifies information about the parcel received from the Mohegan Council as well as design feedback.

The team communicated with Tom Chamberland of the Mohegan Council to ensure he was aware of site visits, thoughts, and concerns that the team needed feedback on throughout the project. The team was also in communication with Colin Novick of the Greater Worcester Land Trust throughout the design process.

3.1 Documents Received

A site visit with advisors, Suzanne LePage, Paul Mathisen, and Mr. Chamberland took place on September 14, 2017. The team discussed project goals, Mr. Chamberland's vision of the Service Council Center building, and potential development constraints. Mr. Chamberland also gave the team documents with information on the Greater Worcester Land Trust and deed information. Additional documents received by Mr. Chamberland on November 11, 2017 were updated survey and contour information, the location of utility lines, and preliminary building drawings. These documents can be found in Appendix B.

3.1.1 Land Trust and Deed

The documents received from Mr. Chamberland further revealed that an Easement Agreement was granted by The Fallon Clinic Incorporation (now Reliant Medical Group) to Notre Dame Health Care Center Incorporation. Reliant Medical Group is a healthcare facility located across Plantation Street from the Coal Mine Brook parcel. The Notre Dame Health Care Center is a senior care center abutting the northwest side of the property. On December 1, 1991, The Fallon Clinic granted this Easement Agreement to Notre Dame Health Care Center as a General Utilities Easement Area. This easement serves the purpose of laying out, constructing and maintaining communication, gas, water, telephone and existing sewer cables, lines, wires and pipes. An amendment to this agreement on July 10, 1992 allowed the grantor, Fallon Clinic, to connect certain utilities within the easement property to service their main property, if necessary.

Following this Easement, the parcel was granted to the Greater Worcester Land Trust. On December 9, 1998, the trustees of Lakeside Liquidating Trust, Kenneth H. Kronlund, Jr., Thomas F. Mullins III, and Stephen M. Pezzella granted the Greater Worcester Land Trust a Conservation Restriction and public trail easement of approximately 7.3 acres, which was conveyed to them in the Worcester Registry of Deeds in Book 19485, Page 317. Within the parcel, forty percent of the land encompasses two building envelopes, one on the north side and one on the south side. The north side of the property is for building a headquarters for the Mohegan Council of the BSA and the south side is for hiking and camping purposes by the Boy Scouts. The Conservation Restriction was put in place to assure the premises would be retained in predominantly its natural, scenic, and open condition and to help preserve the Coal Mine Brook's water quality, habitat, and scenic appeal. The restricted area also provides for a continuation of the trail links for Worcester's East-West Trail, to help ensure the existence of a

wildlife connector and help establish an extensive contiguous greenway of conservation land from Green Hill Park, the trails eastern link to the premises.

3.1.2 Environmental Assessment

A Preliminary Phase I Environmental Assessment was prepared for Lakeside Realty Company, the grantors of the Conservation Restriction and Public Trail Easement to the Greater Worcester Land Trust in January 1998. Cullinan Engineering Company determined there was no evidence of a release or threat of release of oil or hazardous materials on the site (Cullinan Engineering, 1998). There are no other available environmental studies or assessments on the site.

3.1.3 Survey Information

The survey given to the team by the Mohegan Council was originally a PDF, then traced on to AutoCAD to identify the parcel's contours and other features. This presented a scaling challenge, which was resolved after the team met with Mr. Novick. He notified the team of Worcester's 2-foot contour tax parcel maps located under the City of Worcester Tax maps website. From this same page, information about the parcel value and size was found. The city assessed the land at a value of \$2,639,700 and a total parcel area of 317,552 square feet (City of Worcester, 2018). This map aided to the resolution of the scaling issues, making for accurate measurements of the building envelope, parking lot, and BMPs designed by the team.

3.2 Input Incorporation

The team met with members of the Mohegan Council multiple times throughout the project process to present on the status of the project, design considerations, and stormwater management techniques. The team also met with Mr. Novick on December 13, 2017 to discuss the student project and concerns about development on the site. The full reports of these meetings can be found in Appendix C.

The team presented their final designs and recommendations to members of the Mohegan Council on February 21, 2018.

3.2.1 Design Requirements

a. Square Footage of Building

From the Council Service Center Program of Requirements document given to the team by Mr. Chamberland, it was determined that the required square footage necessary to satisfy the Mohegan Council's service center design requirements was a building with a total floor area of at least 4,800 square feet as seen in Table 3. This was rounded up to 6,000 total square feet because Mr. Chamberland expressed designing for maximum retail and meeting space. In addition, the team incorporated this extra space to provide for community involvement and the possible merging of the Mohegan Council with another local council. Thus, 3,000 square feet was determined as the impervious area to be introduced by the footprint of a two-story building.

Table 3: Area Requirements for the Council Service Center

| Space | Size (sq-ft) |
|-------------------------|--------------|
| Entrance Area | 270 |
| Scout Shop Area | 1500 |
| Bathrooms | 320 |
| Conference Rooms | 936 |
| Office Management Areas | 560 |
| Storage | 624 |
| Offices | 614 |
| Total Area | 4824 |

b. Square Footage of Parking

The square footage of the parking lot was based on the Mohegan Council's needs and the zoning requirements of the parcel. The parcel's office and retail land use application required 1 parking spot for every 300 square feet of floor area, resulting in a minimum requirement of 20 parking spaces. The Mohegan Council desired 50-60 spaces to provide for their larger meetings, increasing the area yielding the 11,300 square foot total. The team decided to include 50 parking spots in the design and to leave extra space between the parking lot and the eastern edge of the property should the Council desire to increase the parking lot area.

c. Access Options

Mr. Chamberland and other members on the Mohegan Council were interested in various access options. The council and team decided upon three options: access from Plantation Street, access from the neighboring Notre Dame Healthcare facility, and an access road running all the way through the property. Thus, three possible conceptual layouts were developed and assessed by the team.

4.0 Objective 2: Analyze Existing Conditions

This chapter evaluates the existing conditions of the Coal Mine Brook parcel and the potential challenges these conditions pose to development within the parcel. The aspects that were evaluated are as follows: elevations and contours, roads, utilities, legal restrictions, water resources, and personal observations through site visits.

4.1 Site Analysis

The Coal Mine Brook parcel in Worcester, MA offers 7.3 acres of space, a scenic hiking trail, and the potential to be the new office and retail space for the Mohegan Council of the BSA. The team used GIS both online through Oliver and within the WPI database to choose data layers and information to analyze this parcel.

Layers used in the GIS analysis include MassDEP wetlands, City of Worcester Tax Parcel 2-foot contours, MassDOT major roads, Worcester assessors level 3 tax parcels, priority and estimated habitats, NRCS SSURGO certified soils, and MassDEP hydrography. These layers are depicted in Figure 15 and the blue outline is the Coal Mine Brook parcel. The existing hydrology and DEP wetlands layers were useful in determining the locations of the water resources and stream buffer zones. Contours and soils by slope were relevant to building envelope and parking lot placement. Designing these on flat land reduces the amount of cut and fill that needs to be done during construction. Finally, other layers such as roads, parcels, and protected lands aided the outline of the parcel and its location within the community. NHESP Priority Habitats of Rare Species and NHESP Estimated Habitats of Rare Wildlife were layers that were investigated for this parcel but did not encompass the parcel.

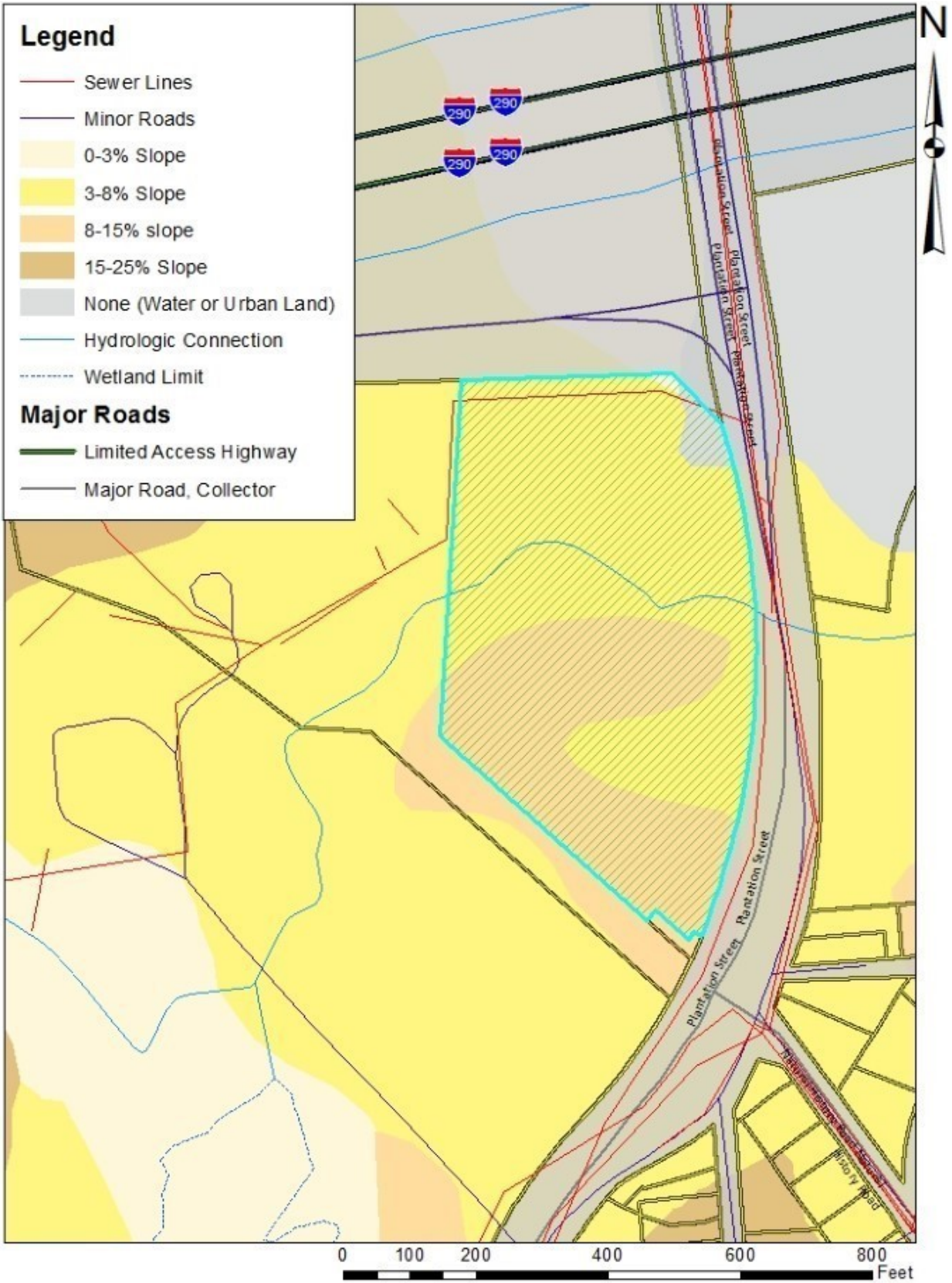


Figure 15: GIS Site Analysis Data

4.1.1 Elevations and Soils

Elevation contours dictate where water on a site will flow into adjacent sub basins. Contour lines are used to determine the high and low points on and around a parcel, which helps delineate water flow and indicate hills and slopes. The team used the Massachusetts government website to download MassGIS data for Elevation Contours (1:5,000).

Soil data was gathered from the Natural Resources Conservation Service SSURGO certified soil layer in WPI's G-drive library, which stores WPI's GIS database. These files in WPI's database store data primarily obtained from Massachusetts GIS. These files classify the soil types by area and the slope grade of each area. The slopes are measured by percent slope, starting at 0%, indicating flat land. The three sections of soils by slope data relevant to this parcel and the surrounding area include 0-3%, 3-8%, and 8-15%. The higher percentage the slope is, the steeper the land is and the more difficult it is to develop or build upon.

The north side of the property has mostly 3-8% slope, which is satisfactory for the development of a building and parking lot. The south side of the property consists of steeper slopes, which would require more gradation of the land and higher development costs.

From GIS, it was determined that the soil type north of the brook is entirely sandy loam. This informed hydrology calculations.

4.1.2 Roads

Roads were evaluated for access purposes using the MassDOT major roads GIS layer. Major roads near the Coal Mine Brook parcel include the Interstate-290 off-ramp to the north and Plantation Street to the east. This information indicated that there would be high traffic volumes along the north and east sides of the property, making it an ideal location for marketing opportunities, as noted in meetings with Mr. Chamberland. Although, the high traffic volumes will also cause other effects for the parcel like increased noise.

4.1.3 Utilities

Utility information was collected on GIS for sewer lines from the MWRA Water/Sewer Services layer. There is a water main along the west side of the property and a sewer easement to the north. The easement information was gathered from a survey document the team received from Mr. Chamberland on November 7, 2017. It is shown oriented north in Figure 16.

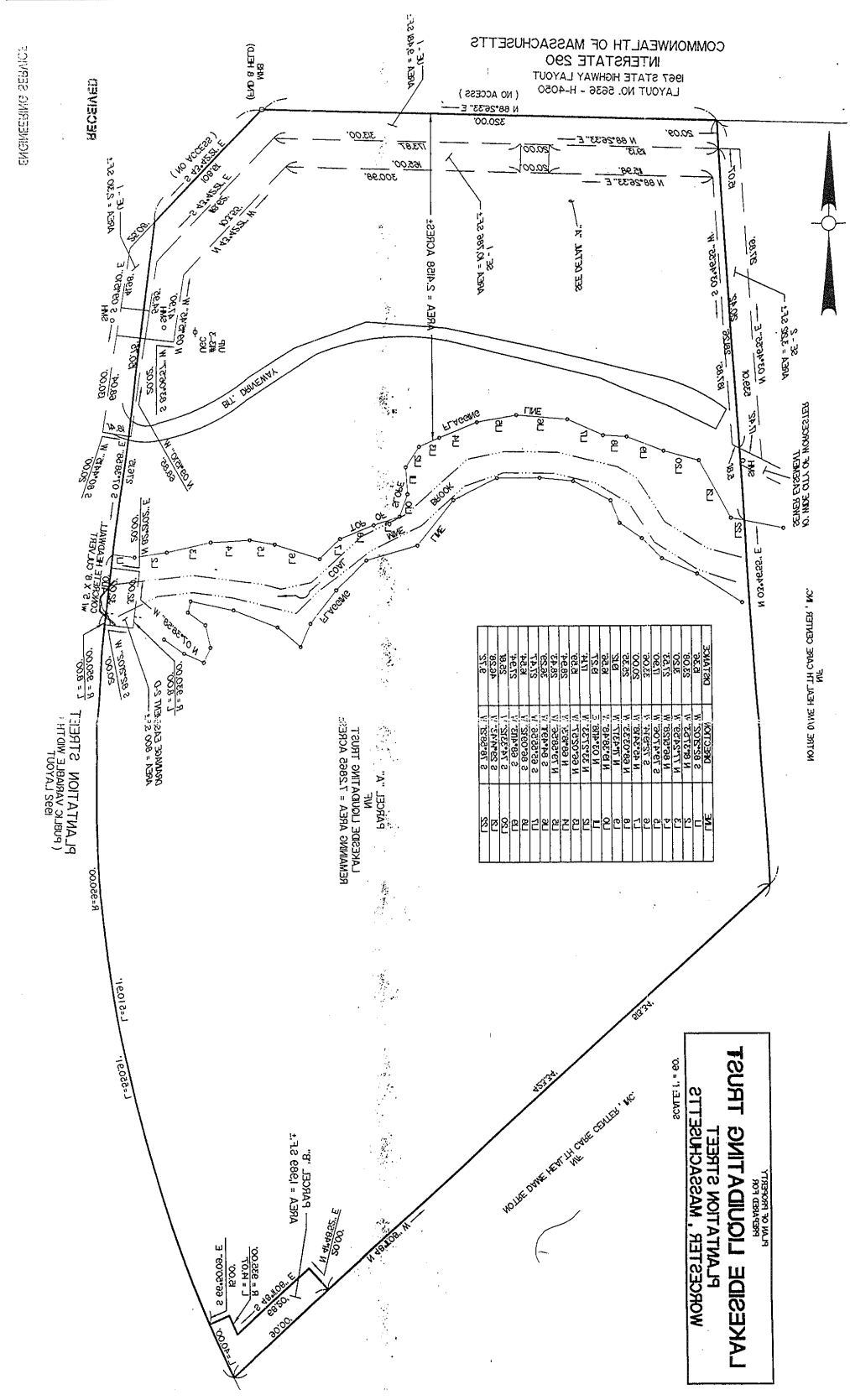


Figure 16: Coal Mine Brook Parcel Survey

4.1.4 Legal Restrictions

Through research and conversations with Mr. Chamberland the team discovered that the Coal Mine Brook is protected by the Greater Worcester Land Trust.

The team met with Mr. Novick on December 13, 2017 to ensure that the team's project was informed and up to date with restrictions due to the Greater Worcester Land Trust. During this meeting, the team and Mr. Novick also discussed the addition of a campsite. He instructed on where the campsites could be located south of the brook. Sustainable development options and the importance of the water quality of the Coal Mine Brook and wildlife safety was also discussed, as there are protected trout in the brook.

4.1.5 Water Resources

a. Existing Hydrology

Within the property runs the Coal Mine Brook from the west to the east. This brook flows to Lake Quinsigamond, which is a part of the Blackstone River Watershed.

There are no wetlands shown on or in the immediate area of the Coal Mine Brook parcel. The Massachusetts River Protection Act indicates that a 100-foot buffer on either side of this body of water must be recognized (Mass.gov, 2017). Typically, according to the Act, a 200-foot buffer would be necessary along year-round flowing streams and rivers. In Worcester, certain urban areas are allowed the 100-ft buffer change, which are defined in the Department of Environmental Protection document: 310 CMR 10.02(1)(a). The Coal Mine Brook parcel falls into this 100-foot buffer requirement. Development within this zone will require a Notice of Intent for approval from Worcester's Conservation Commission.

The team used the MassDEP Hydrography layer in WPI's GIS database to determine exactly what water resources are on or near the property. These could include but are not limited to: streams, rivers, oceans, marshes, ponds, and lakes.

The flow of runoff was determined qualitatively by reviewing the elevation contours of the site. Figure 17 depicts assumed flows of water, drawn in purple perpendicular to the contours. The red shows the general majority of the flow. The most water flows primarily to the Coal Mine Brook from most of the area north of the brook, with some of the flow in the northeast of the property flowing directly to Plantation Street.



Figure 17: Runoff Delineation (Created on Paint)

b. Runoff Peak Flows and Volumes

To evaluate both the existing and post-development hydrology, the NRCS (Natural Resources Conservation Service)/ SCS (Soil Conservation Service) method was utilized as outlined by United States Department of Agriculture’s Urban Hydrology for Small Watersheds Technical Release 55 (TR-55) document. This process quantified the runoff volume for different design storms by investigation of the time of concentration, hydrologic condition, hydraulic condition, and the land use. This method is most applicable to the Coal Mine Brook Parcel because it is a small urban area.

The data collection and calculation results from the SCS Method were then applied in the HydroCAD software. The team entered the surface areas and conditions, runoff flow length, slope, and the rainfall volumes from the Massachusetts Hydrology Handbook for Conservation Commissioners into the software to plot the hydrographs. Per Worcester's regulations, stormwater runoff values were calculated for 1-year, 2-year, 10-year, 25-year, and 100-year design storms. These rainfall values are determined from weather history and type III hyetographs, which represent rainfall amounts over time. The rainfall amounts for the design storms are as follows: 2.5 inches for 1-year, 3.1 inches for 2-year, 4.6 inches for 10-year, 5.4 inches for 25-year, and 6.5 inches for 100-year.

The hydrology was evaluated for the area north of the brook, which equates to three acres. The pre-developed site is entirely composed of one surface area type - sandy loam soil. This soil has a high infiltration rate for water and a low runoff curve number of 30. The curve number represents a surface's ability to infiltrate water; the lower the number, the higher infiltration ability. The sheet flow length for the predevelopment condition was 300 feet with a slope of 9.3% taken along the longest runoff route originating in the Northeast corner of the site. The remainder of the flow was a shallow concentrated flow through the brook, which has a shallower slope of 1%. From these values, HydroCAD was used to plot hydrographs that can be found in Appendix D. An example of a hydrograph is in Figure 18.

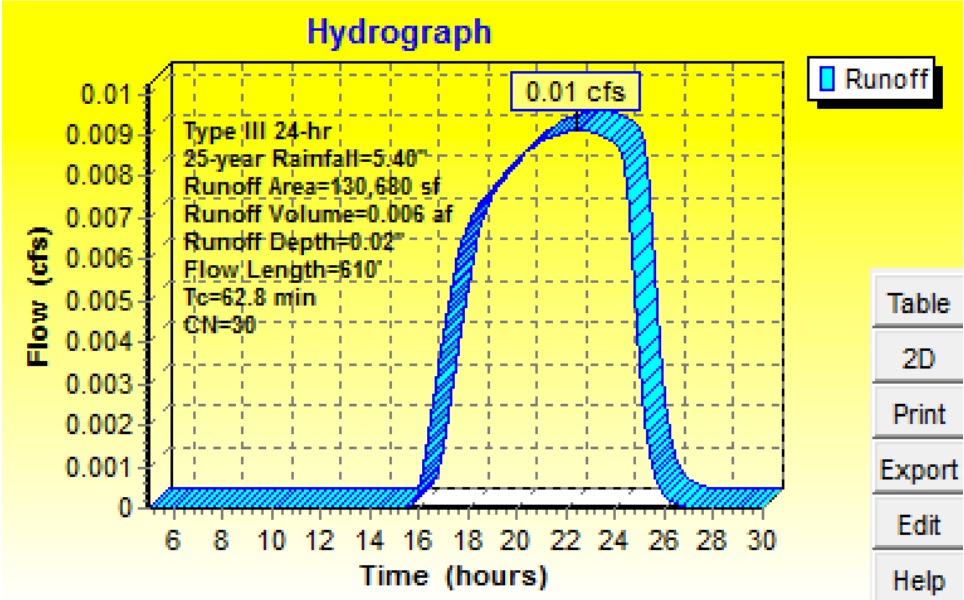


Figure 18: Pre-Development Hydrograph for Worcester's 25-year Design Storm

Hydrographs show the runoff flow over time. They also present other information such as the amount of rainfall, time of concentration, peak flow and total runoff volume. The volume is determined by calculating the area under the curve. The HydroCAD hydrographs created for the pre-development conditions provided the pre-development runoff values displayed in the Table 4.

Table 4: Pre-Development Runoff Values for Worcester Design Storms

| Pre-Development | 1-year | 2-year | 10-year | 25-year | 100-year |
|----------------------------|--------|--------|---------|---------|----------|
| Peak Flow (cfs) | 0 | 0 | 0 | 0.01 | 0.05 |
| Runoff Volume (acre-feet) | 0 | 0 | 0 | 0.006 | 0.033 |
| Runoff Volume (cubic feet) | 0 | 0 | 0 | 261 | 1437 |

The pre-developed site does not produce much stormwater runoff due to the natural conditions of the site. The site is composed entirely of sandy loam soil, providing an excellent hydrologic condition and a high infiltration rate. For the less intense, more frequent storms, all of the rainfall

is absorbed into the soil. The 25-year and 100-year do produce some runoff which runs either to the brook or over to Plantation Street as specified in most recent figure 5.

4.1.6 Site Visit Observations

The team visited the site multiple times to analyze constraints personally. Reports and photos for these site visits can be found in Appendix E.

a. Distance Measurements

Distance and road data were collected from the site on December 6, 2017 using a measuring wheel. This data was collected to determine the safety of an access point and to improve AutoCAD scaling before the team received a more accurate map to utilize in the software.

b. Excess noise

Another constraint analyzed during the team's site visits was excess noise, which could potentially affect employees' hearing and health over time, making it important to note and measure. From a site visit on October 19, 2017 at 11:00am, the team took a video with sound at the center of the north side of the property and determined that there is consistent traffic noise.

The maintenance or addition of shrubbery and trees between the development and the road will potentially mitigate noise pollution. The noise and city sounds are not completely negative, as there is a small section of the parcel in the Southwest corner that is protected by the GWLT and reserved for campsites. Having 2-4 tent platforms and a pedestal grill in this area would allow kids from the city to experience and learn about camping while still being surrounded by familiar sights, sounds, and smells. It is a potential educational device for the Boy Scouts.

Based on the team's constraints analysis and site visits, the next step was to determine the optimal building envelope locations and parking lot locations. From there, options for the building and parking combination were identified and analyzed further.

5.0 Objective 3: Identify and Evaluate Layout Options

This chapter identifies and compares the different alternatives for development. Different options were explored for BMP types, driveway access points, and parking lot materials. The post-development hydrology for these varying possibilities was evaluated in order to both size BMPs and compare the runoff values for each option.

5.1 Post-Development Hydrology

The post-development hydrology calculations were performed the same way as the pre-existing hydrology using the NRCS/ SCS method and HydroCAD. The peak flows and runoff volumes were calculated for the building, the parking lot, and the access road separately for each design storm. The post-development hydrology was compared with the pre-development conditions, which were presented in Section 4.1.4.

5.1.1 Building Roof Runoff

Hydrographs were plotted through HydroCAD by inputting values for the time of concentration, area, and the rainfall design storm data used with the predevelopment condition. The time of concentration for the building was 0.1 minutes, calculated through inputting the following values for a sheet flow: a smooth surface type, a Manning's number of 0.011, a flow length of 15.5 feet, and a slope of 4/12 (a common roof slope). For the area, the building footprint was previously calculated to be 3,000 square feet as a two-floor building. This was input into the system with a curve number of 98 for the impervious roof.

The peak runoff flow and the runoff volume from the hydrographs are presented in Table 5.

Table 5: Building Roof Runoff Values for Worcester Design Storms

| Roof Runoff | 1-year | 2-year | 10-year | 25-year | 100-year |
|----------------------------|--------|--------|---------|---------|----------|
| Peak Flow (cfs) | 0.19 | 0.24 | 0.35 | 0.42 | 0.5 |
| Runoff Volume (acre-feet) | 0.013 | 0.016 | 0.024 | 0.029 | 0.035 |
| Runoff Volume (cubic-feet) | 566 | 697 | 1045 | 1263 | 1525 |

The runoff amounts are small for the less intense, more frequent storms and increase for the more intense, less frequent storms. The resulting values will be mitigated through BMPs and were used to determine the necessary sizes of the possible BMPs.

5.1.2 Parking Lot Runoff

The hydrology for the parking lot was evaluated for three different conditions: an entirely asphalt paved lot, an entirely porous pavement lot, and a partly paved lot with gravel overflow parking. For each option the total area of the parking lot was 11,300 square feet. The time of concentration for the paved calculations remained the same at 1.2 minutes, calculated by inputting the following values for a sheet flow: a smooth surface type, a Manning's number of 0.011, a flow length of 65 feet, and a slope of 1%. The time of concentration for the gravel overflow option was 1.9 calculated with all of the same values as the other two options except a gravel surface type with a Manning's number of 0.020. The curve numbers were 55 for porous

pavement, 98 for asphalt pavement, and 76 for gravel. In the third option with gravel overflow parking lot, the paved area was 3,767 square feet while the gravel area was 7,533 square feet.

The peak runoff flows and the runoff volumes from the hydrographs are presented in Table 6.

Table 6: Parking Lot Runoff Values for Worcester Design Storms

| Parking Lot Runoff | | 1-year | 2-year | 10-year | 25-year | 100-year |
|---------------------------|----------------------------|--------|--------|---------|---------|----------|
| Peak Flow (cfs) | Entirely Porous Pavement | 0.003 | 0.02 | 0.2 | 0.34 | 0.56 |
| | Entirely Asphalt Pavement | 0.69 | 0.86 | 1.29 | 1.52 | 1.83 |
| | Asphalt/Gravel Combination | 0.35 | 0.51 | 0.93 | 1.17 | 1.49 |
| Runoff Volume (acre-feet) | Entirely Porous Pavement | 0.002 | 0.005 | 0.017 | 0.026 | 0.039 |
| | Entirely Asphalt Pavement | 0.048 | 0.061 | 0.092 | 0.108 | 0.131 |
| | Asphalt/Gravel Combination | 0.023 | 0.033 | 0.061 | 0.076 | 0.099 |

The porous pavement option results in the least amount of runoff by a significant difference from the asphalt pavement and asphalt pavement/gravel options. The porous pavement runoff volumes were similar to those of the building and could be managed through BMPs. These values were used to determine the necessary sizes of the possible BMPs to mitigate this excess runoff.

5.1.3 Access Road Runoff

Through analysis of the site, three different points were identified for the access roads. These three access road options were designed using asphalt pavement but each possibility yields a different runoff volume due to different road lengths. All of the access roads have a curve number of 98 for asphalt pavement, a smooth surface type with a Manning's number of 0.011, and a road width of 18 feet.

The Plantation Street access option has a road length of 170 feet, area of 3,060 square feet, and a time of concentration of 1.3 minutes. The Notre Dame access option has a length of 100 feet, area of 1,800 square feet, and a time of concentration of 0.9 minutes. The through access option has a length of 450 feet, area of 8,100 square feet, and a time of concentration of 2.1 minutes. The runoff peak flows and volumes for each option are presented in Table 7.

Table 7: Access Road Runoff Values for Worcester Design Storms

| Access Road Runoff | | 1-year | 2-year | 10-year | 25-year | 100-year |
|---------------------------|--------------------------|--------|--------|---------|---------|----------|
| Peak Flow (cfs) | Plantation Street Access | 0.19 | 0.23 | 0.35 | 0.41 | 0.49 |
| | Notre Dame Access | 0.11 | 0.14 | 0.21 | 0.24 | 0.29 |
| | Through Access | 0.49 | 0.61 | 0.91 | 1.07 | 1.29 |
| Runoff Volume (acre-feet) | Plantation Street Access | 0.013 | 0.016 | 0.025 | 0.029 | 0.035 |
| | Notre Dame Access | 0.008 | 0.01 | 0.015 | 0.017 | 0.021 |
| | Through Access | 0.035 | 0.044 | 0.066 | 0.078 | 0.094 |

An important point of information for the Notre Dame access option is that the runoff for the access road was only calculated for the length of the road on the Coal Mine Brook parcel property. The table values show it as the option producing the least amount of runoff. However, the actual values would be greater due to the segment of road necessary to connect the existing road to Notre Dame Health Care's driveway.

5.2 Stormwater BMP Research

Stormwater BMPs were researched to determine the most appropriate management of the runoff created by the impervious surfaces being introduced by development of the parcel. Tables were developed based on information in the Massachusetts Stormwater Handbook Volume 2 Chapter 2 to compare the benefits of each treatment and pretreatment BMP in the handbook. Costs were determined from the Massachusetts Watershed Coalition's BMPs Cost Catalog, as cost comparison is also an important factor in selecting green infrastructure. These full tables may be found in Appendix F.

5.2.1 Evaluation of Alternatives

The information collected from the Massachusetts Stormwater Handbook Volume 2 Chapter 2 and the Massachusetts Watershed Coalition BMPs Cost Catalog was utilized to perform an analysis to determine the most ideal treatment BMPs for the site. The criteria of each treatment BMP were weighted based on this information to inform the selection process.

Each criterion was ranked on a scale of 1 to 5, 5 being the most ideal to the site. A multiplication factor of 1 to 3 was then applied to each score for each criterion with 3 being the most important and 1 being the least important. Applicability, total suspended solids removal, and aesthetics were weighted the highest (3), as they were considered the most important factors for the site. Cost, pollutant removal, and maintenance were weighed as the second most important factors in BMP selection (2), with groundwater recharge deemed the least important (1). This ranking system was created with insight from other similar Major Qualifying Projects from Worcester Polytechnic Institute. This ranking system was utilized to determine the best BMPs for the three impervious areas being introduced, the roof, the parking lot, and the access road.

a. Building Roof Runoff

For the runoff from the roof, the BMPs considered were leaching catch basins, bioretention, stormwater wetlands, dry detention basins, sand & organic filters, treebox filters, wet basins, and finally dry wells, added after a recommendation by Mr. Chamberland during the meeting on January 23, 2018. Based on this scoring system, bioretention was determined to be the best treatment BMP to manage stormwater runoff from the roof of the Council Service Center. Bioretention was the highest ranked BMP with a ranking of 76 out of a possible 80, followed by the dry well which scored 62 points. This can be seen in Table 8. The next highest ranked BMP was stormwater wetlands and wet basins, which were eight points below the bioretention score, indicating that bioretention is the best mitigation option for the intended use of the land.

Table 8: Building Roof BMP Ranking

| Roof Runoff | Multiplication Factor | Leaching Catch Basin | Bioretention | Stormwater Wetlands | Dry Detention Basin | Sand & Organic Filters | Treebox Filters | Wet Basins | Dry Wells |
|-------------------------------|-----------------------|----------------------|--------------|---------------------|---------------------|------------------------|-----------------|------------|-----------|
| Applicability | 3 | 3 | 5 | 3 | 2 | 2 | 4 | 2 | 5 |
| Cost Per Acre Impervious Area | 2 | 3 | 4 | 4 | 3 | 2 | 1 | 5 | 3 |
| Groundwater Recharge | 1 | 1 | 5 | 1 | 1 | 1 | 1 | 1 | 5 |
| TSS Removal | 3 | 4 | 5 | 4 | 3 | 4 | 4 | 4 | 4 |
| Pollutant Removal | 2 | 4 | 5 | 5 | 4 | 4 | 3 | 5 | 3 |
| TSS Maintenance | 2 | 2 | 4 | 3 | 2 | 2 | 1 | 5 | 3 |
| Aesthetics | 3 | 4 | 5 | 4 | 1 | 1 | 5 | 3 | 4 |
| Total | - | 52 | 76 | 58 | 37 | 38 | 50 | 58 | 62 |

Bioretention will result in adequate total suspended solids removal, can be implemented without too much difficulty on the site, will require average maintenance, and will be an aesthetically pleasing mitigation device. This BMP is most suitable in small urban areas and with well-drained soils, requiring 5-7% of the area that drains to them. Bioretention receives 90% TSS removal with adequate pretreatment and has a total nitrogen removal efficiency of 30-50%, total phosphorous removal of 30-90%, and total metal removal of 40-90%. Due to the vegetation, bioretention can help provide shade and habitat, absorb noise from Plantation Street and the I-290 Eastbound off-ramp, provide windbreaks, and enhance landscaping aesthetics on the Coal Mine Brook parcel (Commonwealth of Massachusetts, 2018). Bioretention areas require careful landscaping and maintenance, which costs around \$250 per year. The installation cost is \$4,775 for a 0.25-acre impervious drainage area, with a design and permitting cost of \$1,000. The treatment cost per pound TSS per year is \$0.74 per pound (Massachusetts Watershed Coalition, 2018). Additionally, bioretention can be implemented as part of the landscaping between the building and the parking lot and can also serve as an educational device about stormwater management for the Boy Scouts.

b. Parking Lot Runoff

For the parking area, porous pavement, grassed channels, and water quality swales were also considered. Dry wells were not considered, as they are better suited for less polluted applications. From the analysis in Table 9, a bioretention area and porous pavement were determined to be the best treatment BMPs to manage stormwater runoff from the parking lot of the Council Service Center. Bioretention ranked 76 followed by the porous pavement which scored 65 points. The next highest ranked BMP was a water quality swale, which scored six points lower than the porous pavement.

Table 9: Parking Lot BMP Ranking

| Parking Lot Runoff | Multiplication Factor | Leaching Catch Basin | Bioretention | Stormwater Wetlands | Dry Detention Basin | Sand & Organic Filters | Treebox Filters | Wet Basins | Grassed Channel (Biofilter Swale) | Water Quality Swale (Dry) | Permeable Pavement |
|-------------------------------|-----------------------|----------------------|--------------|---------------------|---------------------|------------------------|-----------------|------------|-----------------------------------|---------------------------|--------------------|
| Applicability | 3 | 4 | 5 | 2 | 2 | 2 | 5 | 2 | 4 | 3 | 5 |
| Cost Per Acre Impervious Area | 2 | 3 | 4 | 4 | 3 | 2 | 1 | 5 | 5 | 5 | 4 |
| Groundwater Recharge | 1 | 1 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 |
| TSS Removal | 3 | 4 | 5 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 |
| Pollutant Removal | 2 | 4 | 5 | 5 | 4 | 4 | 3 | 5 | 3 | 4 | 3 |
| TSS Maintenance | 2 | 2 | 4 | 3 | 2 | 2 | 1 | 5 | 4 | 5 | 2 |
| Aesthetics | 3 | 4 | 5 | 4 | 1 | 1 | 5 | 3 | 4 | 3 | 5 |
| Total | - | 55 | 76 | 53 | 37 | 38 | 53 | 58 | 58 | 59 | 65 |

Porous pavement is applicable for paved surfaces with gentle slopes and is suitable for soils with a permeability of at least 0.17 inches per hour. As the Coal Mine Brook parcel has sandy loam

soil with an infiltration rate of 0.8 inches per hour, it is a great fit to manage runoff from the parking lot. It provides peak flow attenuation for small storms and is useful in cold climates if properly maintained, an important aspect for the Worcester area's cold winters. However, winter deicing techniques such as salting on this BMP will reduce efficiency by clogging pores, and over-aggressive plowing with steel blades can damage porous pavement. Snow can be managed in winter months on porous pavement by saving money on de-icing methods and using rubber plow blades instead, which is an investment of around \$500 (Hanley Wood Media, 2014). Porous pavement receives 80% TSS removal when the storage bed holds 1/2 inch or 1-inch water quality volume and drains within 72 hours (Commonwealth of Massachusetts, 2018). Porous asphalt costs range from \$3-5 per square foot, with aggressive maintenance required using jet washing or vacuum street sweepers, costing \$500-1,000 per year (Massachusetts Watershed Coalition, 2018).

The differing options for parking lot material were examined through a cost analysis and discussions with Mr. Chamberland. The cost/runoff ratio is the lowest for an entirely porous pavement lot, making it the most cost-effective option, shown in Table 10. This furthers the team's recommendation to implement porous pavement to mitigate parking lot runoff on the Coal Mine Brook parcel.

Table 10: Cost Analysis for Parking Lot Options

| | Area (sq-ft) | Material | Unit Cost of Material (per sq-ft) | Total Cost | Runoff Volume for 25-year (cf) | Ratio of Cost to Runoff Volume |
|-----------------------------------|--------------|-----------------|-----------------------------------|-------------|--------------------------------|--------------------------------|
| Asphalt Pavement | 11,300 | Asphalt | \$1.88 | \$21,244.00 | 4704 | 0.22 |
| Porous Pavement | 11,300 | Porous Pavement | \$4 | \$45,200.00 | 1133 | 0.03 |
| Asphalt/Gravel Combination | 3,767 | Asphalt | \$1.88 | \$8,739.22 | 3311 | 0.38 |
| | 7,533 | Gravel | \$0.22 | | | |

In total, it was determined using zoning codes and the Mohegan Council's recommendation that the parking area would be 11,300 square feet. In addition, the parking lot is to be graded 1% towards the center to direct water flow to a bioretention area, to be introduced in the center of the parking lot. 1% is suitable for a parking lot and parking space slope per the Code of Massachusetts Regulations Parking and Passenger Loading Zones. Since the flow length of the runoff through the parking lot is short, there is a low time of concentration. A higher slope would decrease this time of concentration even further, which is unnecessary. However, the lot still requires a slope to direct the stormwater.

c. Access Road Runoff

For the access road, the same BMPs were considered as in the parking lot BMP analysis. The analysis in Table 11 shows that a grassed channel (biofilter swale) was determined to be the best treatment BMP to manage stormwater runoff from the driveway to the Council Service Center. The grassed channel earned 64 points, followed by the leaching catch basin, which scored 61 points. The grassed channel was chosen over the leaching catch basin, as the channel will utilize the well-drained soils, and requires shallower excavation during construction. Porous pavement and a dry water quality swale were also heavily considered, but these mitigation techniques are

not applicable with steep slopes, and the access road to the service center will have a slope of about 8-12%.

Table 11: Access Road BMP Ranking

| Access Road Runoff | Multiplication Factor | Leaching Catch Basin | Bioretention | Stormwater Wetlands | Dry Detention Basin | Sand & Organic Filters | Treebox Filters | Wet Basins | Grassed Channel (Biofilter Swale) | Water Quality Swale (Dry) | Permeable Pavement |
|-------------------------------|-----------------------|----------------------|--------------|---------------------|---------------------|------------------------|-----------------|------------|-----------------------------------|---------------------------|--------------------|
| Applicability | 3 | 5 | 1 | 1 | 1 | 3 | 5 | 1 | 5 | 3 | 1 |
| Cost Per Acre Impervious Area | 2 | 3 | 4 | 4 | 3 | 2 | 1 | 5 | 5 | 5 | 4 |
| Groundwater Recharge | 1 | 1 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 |
| TSS Removal | 3 | 4 | 5 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 |
| Pollutant Removal | 2 | 4 | 5 | 5 | 4 | 4 | 3 | 5 | 3 | 4 | 3 |
| TSS Maintenance | 2 | 2 | 4 | 3 | 2 | 2 | 1 | 5 | 4 | 5 | 2 |
| Aesthetics | 3 | 5 | 3 | 4 | 1 | 1 | 5 | 3 | 5 | 3 | 3 |
| Total | - | 61 | 58 | 52 | 34 | 41 | 53 | 55 | 64 | 59 | 47 |

Grassed channels accept sheet or piped flow and are ideal when adjacent to roadways and parking lots. This BMP yields 50% TSS removal with a sediment forebay as pretreatment (Commonwealth of Massachusetts, 2018). Maintenance for grassed channels is minimal, involving mowing as needed, yearly inspection, trash and debris removal, and yearly sediment removal, all of which costs \$500 per year. The installation cost for a one-acre impervious drainage area is \$11,292, with a design and permitting cost of \$1,500. The treatment cost per pound TSS per year is \$0.71 per pound (Massachusetts Watershed Coalition, 2018). Although the chosen BMP will result in less than 80% total suspended solids removal, it is the best option to treat the limited amount of water that will run off of the access road, and it will require limited altering to the existing vegetation.

The grassed channel will be aesthetically pleasing, as it will essentially mimic the pre-existing hydrology with the channel leading to the Coal Mine Brook. This BMP will require a Notice of Intent to be filed for Worcester's Conservation Commission because it is within the 100-foot stream buffer. However, it will result in minimal impact to the buffer zone, will require more shallow excavation than more structural BMPs, and will have erosion control with rip rap before the Coal Mine Brook.

d. BMP Layout

The bioretention area chosen to treat the runoff from the roof was placed between the building and the parking lot to add landscaping value. This is shown in Figure 19. The parking lot is to be made of porous pavement, with a bioretention area in the middle to accept overflow from the porous parking lot.

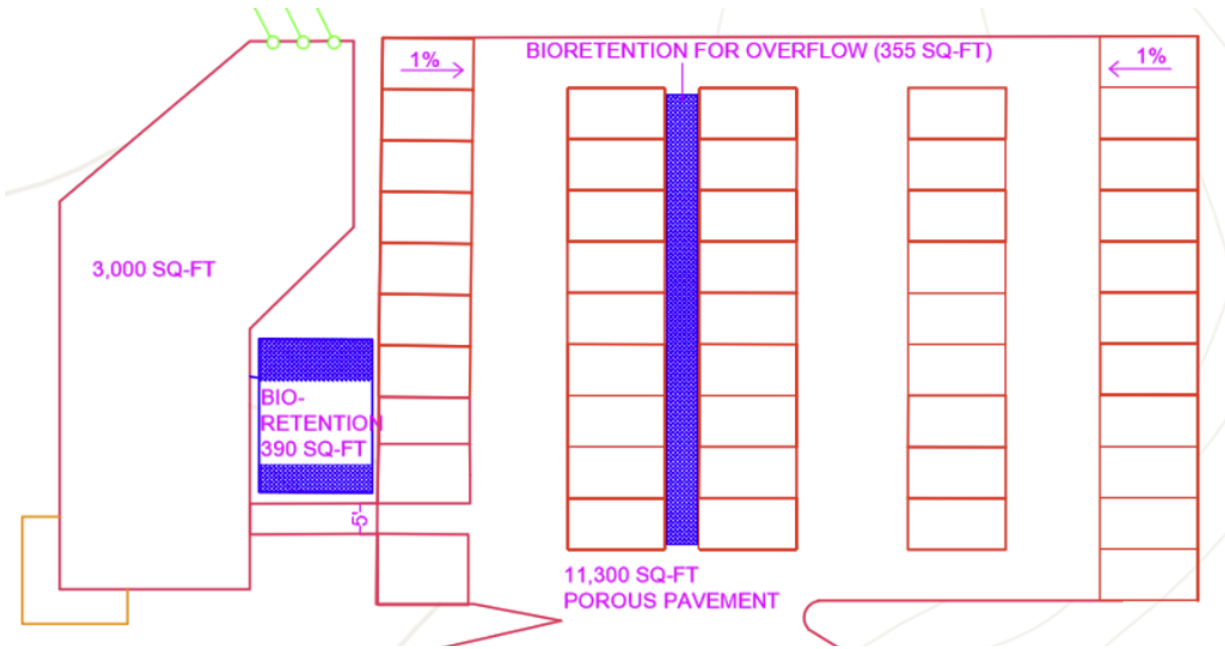


Figure 19: Building and Parking Lot BMP Layout

The grassed channel chosen to treat the runoff from the access road was placed towards the bottom of the road near the curb cut and the setback of the property. Pretreatment for the grassed channel includes a vegetated filter strip and a sediment forebay. This BMP combination leads to the Coal Mine Brook, shown in Figure 20.

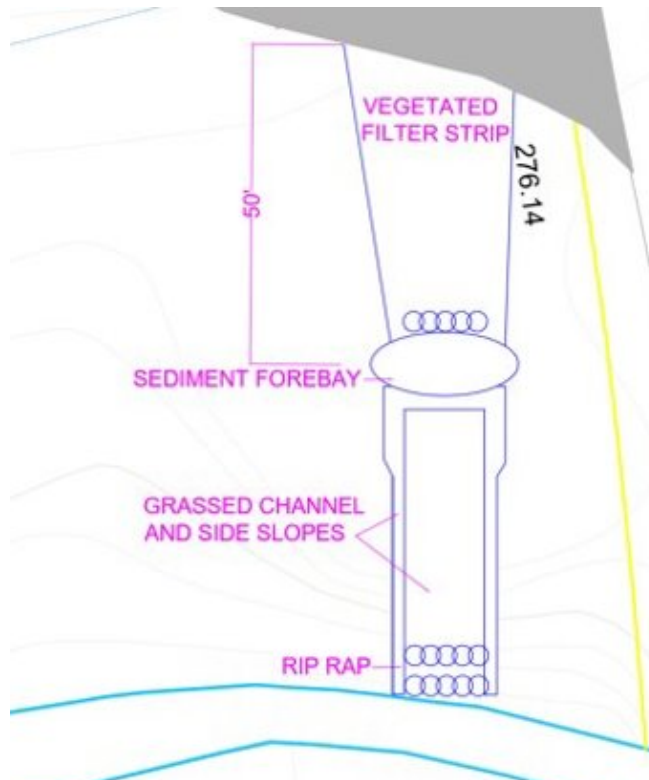


Figure 20: Access Road BMP Layout

5.2.2 BMP Sizing

Based on the runoff values from HydroCAD for a 25-year storm, the necessary BMP storage sizes were calculated to accommodate the associated runoff volumes from the total of impervious surfaces being introduced to the site. Table 12 shows the preliminary calculations done to determine the sizes of the bioretention areas for both the building and parking lot. These proposed sizes do account for infiltration of the stormwater over the course of the storm. The storage size for the grassed channel was not included because it is a conveyance BMP that does not store runoff. These initial proposed sizes do not account for infiltration of the stormwater over the course of the storm and were further evaluated through HydroCAD.

Table 12: Initial BMP Sizing Calculations

| | 25-year runoff volume (cf) | Conservative Volume (cf) | Bioretention Depth (ft) | Surface Area (sq-ft) |
|--------------------------------------|----------------------------|--------------------------|-------------------------|----------------------|
| Building Bioretention Area | 1133 | 1140 | 2 | 570 |
| Parking Lot Bioretention Area | 1263 | 1270 | 2 | 635 |

To avoid oversizing these bioretention areas, HydroCAD was utilized with the same initial sub-catchment areas to calculate the post-development runoff. Ponds were added into the HydroCAD files to represent the bioretention areas. To account for the outflow of stormwater from the bioretention areas, these ponds were equipped with two outlets in HydroCAD: infiltration for the water entering into the soil and a broad-crested rectangular weir at the top elevation for overflow. For both ponds, the soil is sandy loam providing an infiltration rate of 0.80 inch per hour. Table 13 shows the tested surface areas and volumes used in HydroCAD to ultimately determine the proper bioretention sizes.

Table 13: HydroCAD BMP Sizing Calculations

| Parking Lot Bioretention Pond | | | Building Bioretention Pond | | |
|-------------------------------|---------------------------|-----------------------|----------------------------|---------------------------|-----------------------|
| Surface Area (square feet) | Input Storage Volume (cf) | Storage Required (cf) | Surface Area (square feet) | Input Storage Volume (cf) | Storage Required (cf) |
| 570 | 1140 | 621 | 635 | 1270 | 662 |
| 400 | 800 | 682 | 500 | 1000 | 714 |
| 380 | 760 | 690 | 450 | 900 | 736 |
| 360 | 720 | 698 | 405 | 810 | 757 |
| 355 | 710 | 700 | 390 | 780 | 764 |
| 350 | 700 | Overflow | 385 | 770 | 767 |
| | | | 380 | 760 | Overflow |

The tests started at the initial surface area and volumes. Once these values were entered into HydroCAD, the required storage could be determined by analyzing the hydrographs for the pond. The difference between the input (stormwater runoff volume) and the output (infiltration volume) represents the required storage volume. Since the team's initial calculations were overdesigning, the numbers were decreased slightly for each test until the input storage and the storage required were close. The highlighted rows in Table 13 represent the volumes that will provide the necessary storage as well as extra area to ensure that the bioretention areas will be

suitable for a 25-year storm. The parking lot bioretention pond will have a surface area of 355 square feet and a volume of 710 cubic feet. The building bioretention pond will have a surface area of 390 square feet and a volume of 780 cubic feet.

5.2.3 Stormwater Standards

a. Recharge Volume

Recharge volume is one of the standards specified in the Massachusetts Stormwater Handbook. The required recharge volume can be determined using the following equation from the Massachusetts’s Stormwater Handbook Volume 3: Documenting Compliance:

*Required Recharge Volume Equation: $Rv = F * (1 \text{ ft} / 12 \text{ in}) * \text{Impervious Area}$*

$Rv = \text{Required Recharge Volume (feet}^3\text{)}$

$F = \text{Target Depth Factor associated with each Hydrologic Soil Group (inch)}$

$\text{Impervious Area} = \text{pavement and/ or rooftop area on site (feet}^2\text{)}$

The required recharge volume for the runoff of each area was calculated using the total impervious area of the roof and the target depth factor of 0.6 inch for the Hydrologic Group A soil on the property, which is sandy loam. The Coal Mine Brook Parcel is not in a critical area such as flood zones and wellhead protection areas that would require an increased depth for recharge. These calculations were based on the static method, assuming no exfiltration until complete recharge. The required recharge volume for the roof runoff was 150 cubic feet, 565 cubic feet for the parking lot runoff, and 153 cubic feet for the access road runoff. Each of these requirements is met by the chosen BMP sizes. Table 14 shows these values.

Table 14: Required Water Quality Volumes

| Water Quality Volume | | | |
|----------------------|---------------------------------------|--|----------------------------------|
| Runoff Surface | Impervious Surface Area (square feet) | Recharge Volume Requirement (cubic feet) | Bioretention Volume (cubic feet) |
| Roof | 3,000 | 150 | 710 |
| Parking Lot | 11,300 | 565 | 780 |
| Access Road | 3,060 | 153 | n/a |

b. TSS Removal

Every BMP chosen for the site besides the grassed channel meets the 80% TSS removal requirement specified in the Massachusetts Stormwater Handbook. The only exception for less than 80% TSS removal being achieved at each outlet discharging to a wetland is when the discharge is considered *de minimis*. This condition is specified in the third volume of the Massachusetts Stormwater Handbook as well. Due to the steep conditions and minimal space between the brook and the access road, the stormwater discharge from the access road may be considered *de minimis*, in which an 80% TSS removal rate is achieved on a site-wide basis for

design purposes, with the discharge meeting certain conditions specified in the handbook. The 80% overall weighted average from the site was calculated using the equation in the Documenting Compliance chapter as follows:

$$\text{Weighted Average \%} = \frac{(\text{Area 1}) (\text{TSS\% 1}) + (\text{Area 2}) (\text{TSS\% 2}) + (\text{Area 3}) (\text{TSS\% 3})}{(\text{Area 1} + \text{Area 2} + \text{Area 3})}$$

Area = size, in acres or square feet

TSS% = Assigned TSS removal rate expressed as %

The removal efficiencies for the chosen BMPs were taken from the TSS Table in Volume 1 of the Massachusetts Stormwater Handbook, shown in Table 15.

Table 15: TSS Table (Commonwealth of Massachusetts, 2018)

| TSS Table | |
|--------------------------------|--|
| Best Management Practice (BMP) | TSS Removal Efficiency |
| Vegetated Filter Strips | 10% if at least 25 feet wide, 45% if at least 50 feet wide |
| Bioretention Areas | 90% with adequate pretreatment |
| Grassed Channels | 50% if combined with forebay or other pretreatment |
| Porous Pavement | 80% if designed with adequate storage capacity |

The weighted average was calculated for the total impervious area and the associated BMP TSS removal rates as they are, with the 3,000 square foot roof with a bioretention area yielding 90% TSS removal, and an 11,300 square foot parking lot with porous pavement yielding 80% TSS removal. The grassed channel and sediment forebay combination without additional pretreatment was first examined for the 3,060 square foot access road, yielding 50% TSS removal. The result was as follows, a weighted average of 74.65%. This is less than the 80% requirement, so additional pretreatment for the grassed channel was investigated.

$$\text{Weighted Average \%} = \frac{(3,000 \text{ sq. Ft.}) (90\%) + (11,300 \text{ sq. Ft.}) (80\%) + (3,060 \text{ sq. Ft.}) (50\%)}{(3,000 + 11,300 + 3,060 \text{ sq. Ft.})} = 76.44\%$$

The Massachusetts Stormwater Handbook Documenting Compliance Volume specifies that TSS removal rates cannot be directly added. Instead, additional BMPs remove only the percentage of TSS that is routed to them after an initial amount of TSS is removed by the preceding BMP. Therefore, the addition of 25-foot-wide vegetated filter strips as pretreatment to the grassed channel and sediment forebay provided an additional 10% TSS removal, yielding a 55% total TSS removal. The weighted average for the site with the addition of 25-foot-wide vegetated filter strips was 77.32%, still below the required 80%. However, with 50-foot-wide vegetated filter strips as additional pretreatment to the grassed channel and sediment forebay, an additional 45% TSS removal is provided yielding a total of 72.50% removal for this BMP combination. This results in an 80.41% weighted average for the site, satisfying the 80% requirement, shown in the calculation below.

$$\text{Weighted Average \%} = [(3,000 \text{ sq. Ft.}) (90\%) + (11,300 \text{ sq. Ft.}) (80\%) + (3,060 \text{ sq. Ft.}) (72.50\%)] / (3000 + 11,300 + 3,060 \text{ sq. Ft.}) = 80.41\%$$

The peak flow rate for the 2-year-24-hour storm is 0.23 cfs, which is below the 1 cfs requirement for the *de minimis* condition. The bioretention area for the roof as well as the porous pavement and bioretention area within the parking lot provide also recharge to the Coal Mine Brook. To further satisfy this condition, controls must be placed to prevent erosion to the stream, for which rip rap was placed into the design at the bottom of the grassed channel before the Coal Mine Brook. Another requirement of this condition is the identification of source control and pollution prevention measures in a Pollution Prevention Plan to be provided by a Registered Professional Engineer. Mitigating the drainage area contributing to the untreated outlet will also be reduced to the maximum extent possible if there is only access from Plantation Street.

c. Time of Drawdown

The time of runoff drawdown by which the BMPs will recharge was calculated for the bioretention areas based on the sizes of each. The equation for time of drawdown was utilized from the Hydrology Handbook for Conservation Commissioners.

$$\text{Time of Drawdown Equation: } Td = Rv / (K / 12 * Ar)$$

$$Td = \text{Time of drawdown (hours)}$$

$$Rv = \text{Storage volume (ft}^3\text{)}$$

$$K = \text{Saturated Hydraulic Conductivity (Rawl's Rate) (inches/hour)}$$

$$Ar = \text{Bottom Area (ft}^2\text{)}$$

The K value used in this equation was 1.02 inches per hour, the rate at which sandy loam infiltrates runoff, from the Rawl's Rate table in Volume 3 of the Massachusetts Stormwater Handbook. The time of drawdown for the bioretention area in the parking lot was 24 hours, which is less than 72 hours and therefore satisfactory for design purposes according to the

Massachusetts Stormwater Handbook. The time of drawdown for the bioretention area treating the roof runoff was also 24 hours because they have the same depth, which is also satisfactory. These values are shown in Table 16.

Table 16: Time of Drawdown Calculations

| BMP | BMP Volume (cubic feet) | BMP Depth (feet) | BMP Area (square feet) | Time of Drawdown (hours) |
|-------------------------------|-------------------------|------------------|------------------------|--------------------------|
| Parking Lot Bioretention Pond | 710 | 2 | 355 | 24 |
| Building Bioretention Pond | 780 | 2 | 390 | 24 |

5.2.4 Design

This section includes design specifications gathered from Volume 2 Chapter 2 of the Massachusetts Stormwater Handbook, with recommendations on layering and material use for each of the selected BMPs.

a. Bioretention

The layers that make up bioretention areas must be designed with attention to layering and materials to provide necessary infiltration. The depth of soil media for bioretention areas is designed to be between 2 and 4 feet for both bioretention areas used in the design for the Coal Mine Brook parcel. The bottom of the excavation for a bioretention area should consist of course gravel, over pea gravel, over sand, topped with a soil mix that is uniform, free of stones, consisting of 40% sand, 20-30% topsoil, and 30-40% compost, with no more than 5% clay. The topsoil component can be sandy loam, for which excavated soil from the site may be used. On top of the planting soil should be 2-3 inches of mulch, graded to allow 6-8 inches of ponding, shown in Figure 21. The plants included in a bioretention area should include a mix of at least three different native herbaceous perennials and three native shrubs. A stone or pea gravel diaphragm prior to bioretention aids in accepting sheet flow and removing sediments (Commonwealth of Massachusetts, 2018).

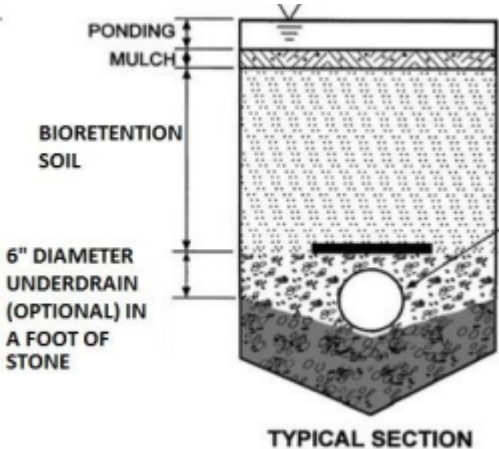


Figure 21: Bioretention Area Section View (Commonwealth of Massachusetts, 2018)

b. Porous Pavement

It is imperative to porous pavement design to comprise the layers with specific materials. Porous asphalt is mixed with a low content of fine sand, having 10-25% void space. The storage beds should be constructed with 4 inches of uniformly graded crushed stone, a filter course of poorly graded sand or backrun gravel at least 12 inches thick, a filter blanket of pea stone gravel at least 3 inches thick, and a reservoir course of uniformly graded crushed stone with a high void content, and a flat bottom draining to native soils, depicted in Figure 22 (Commonwealth of Massachusetts, 2018).

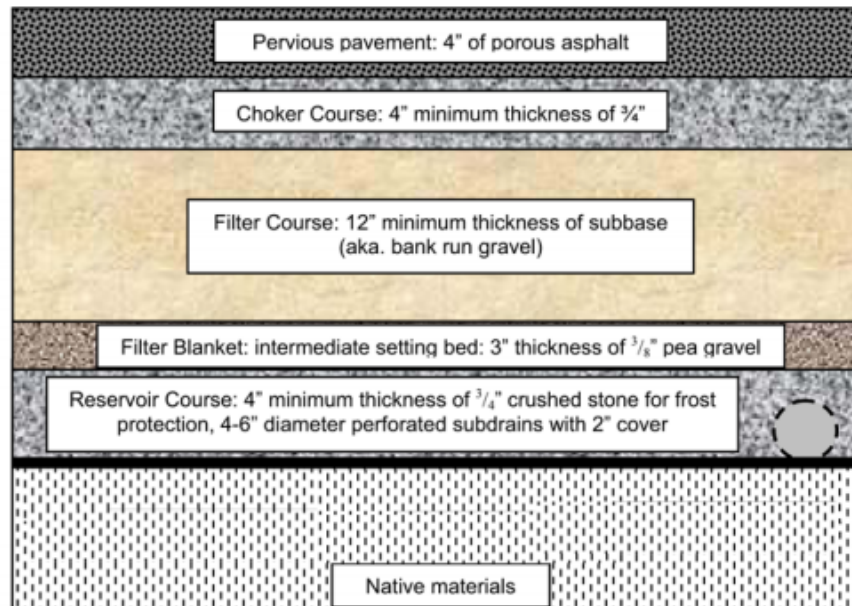


Figure 22: Porous Pavement Section View (Commonwealth of Massachusetts, 2018)

c. Grassed Channel

A sediment forebay is necessary to accept flow with a check dam separating the forebay from the grassed channel. Rip rap prior to the sediment forebay and at the end of the grassed channel will aid with erosion control for runoff prior to entering the grassed channel and before entering Coal Mine Brook. The channel should be designed so that the runoff depth does not exceed 4 inches, and the velocity does not exceed 1 foot per second during a 24-hour storm. The channel length should be designed to achieve the 9-minute minimum hydraulic residence time associated with the selected design storm. Most permeable soils that can support dense grass growth are suitable for use in a grassed channel. Clays and gravelly and course soils do not support dense grass growth. Sandy loams with an organic content of 10 to 20% with no more than 20% clay are recommended by MassDEP. Grasses planted in a grassed channel should have a height of 6 inches or less are recommended to promote sedimentation and resistance to flow. (Commonwealth of Massachusetts, 2018).

5.3 Access

Property access is an important piece of the project's development. In section 3.2, Input Incorporation, there were three conceptual layouts determined from three different potential access points. These are: access from Plantation Street via an existing curb cut, access from NDHC facility with a proposed new driveway, and through-access utilizing both of these concepts.

The team researched Mass DOT rules for curb cuts and stopping sight distances in order to determine if the existing curb cut on Plantation Street is at a safe distance from the yield sign off the I-290 exit ramp at the Northeast corner of the parcel. Research from the Massachusetts Department of Transportation (DOT) Basic Design Controls Chapter 3 and a phone conversation with Tonya Johnson and Chris Chambers of the District 3 Highway Division aided the team. The Design Controls document is a design guide put forward by the Massachusetts DOT.

From the Massachusetts DOT, the team found that according to Table 17, at 30 mph on a 3% downgrade, the appropriate stopping sight distance would be 205 feet.

Table 17: MassDOT Stopping Sight Distances

Exhibit 3-8

Motor Vehicle Stopping Sight Distances

| Design Speed | Stopping Sight Distance (ft) by Percent Grade (%) | | | | | | |
|--------------|---|-----------|-----|------|---------|-----|-----|
| | 0 | Downgrade | | | Upgrade | | |
| | | 3 | 6 | 9 | 3 | 6 | 9 |
| 20 | 115 | 116 | 120 | 126 | 109 | 107 | 104 |
| 25 | 155 | 158 | 165 | 173 | 147 | 143 | 140 |
| 30 | 200 | 205 | 215 | 227 | 200 | 184 | 179 |
| 35 | 250 | 257 | 271 | 287 | 237 | 229 | 222 |
| 40 | 305 | 315 | 333 | 354 | 289 | 278 | 269 |
| 45 | 360 | 378 | 400 | 427 | 344 | 331 | 320 |
| 50 | 425 | 446 | 474 | 507 | 405 | 388 | 375 |
| 55 | 495 | 520 | 553 | 593 | 469 | 450 | 433 |
| 60 | 570 | 598 | 638 | 686 | 538 | 515 | 495 |
| 65 | 645 | 682 | 728 | 785 | 612 | 584 | 561 |
| 70 | 730 | 771 | 825 | 891 | 690 | 658 | 631 |
| 75 | 820 | 866 | 927 | 1003 | 772 | 736 | 704 |

Source: A Policy on Geometric Design of Streets and Highways, AASHTO, Washington DC, 2004. Chapter 3 Elements of Design

The actual distance calculated with a measuring wheel on December 6, 2017 from the yield sign on the off-ramp to the middle of the curb cut was approximately 322 feet. Therefore, the existing curb cut is within the stopping sight distance regulations.

Minimum Required distance = 205 feet

Actual distance = 322 feet

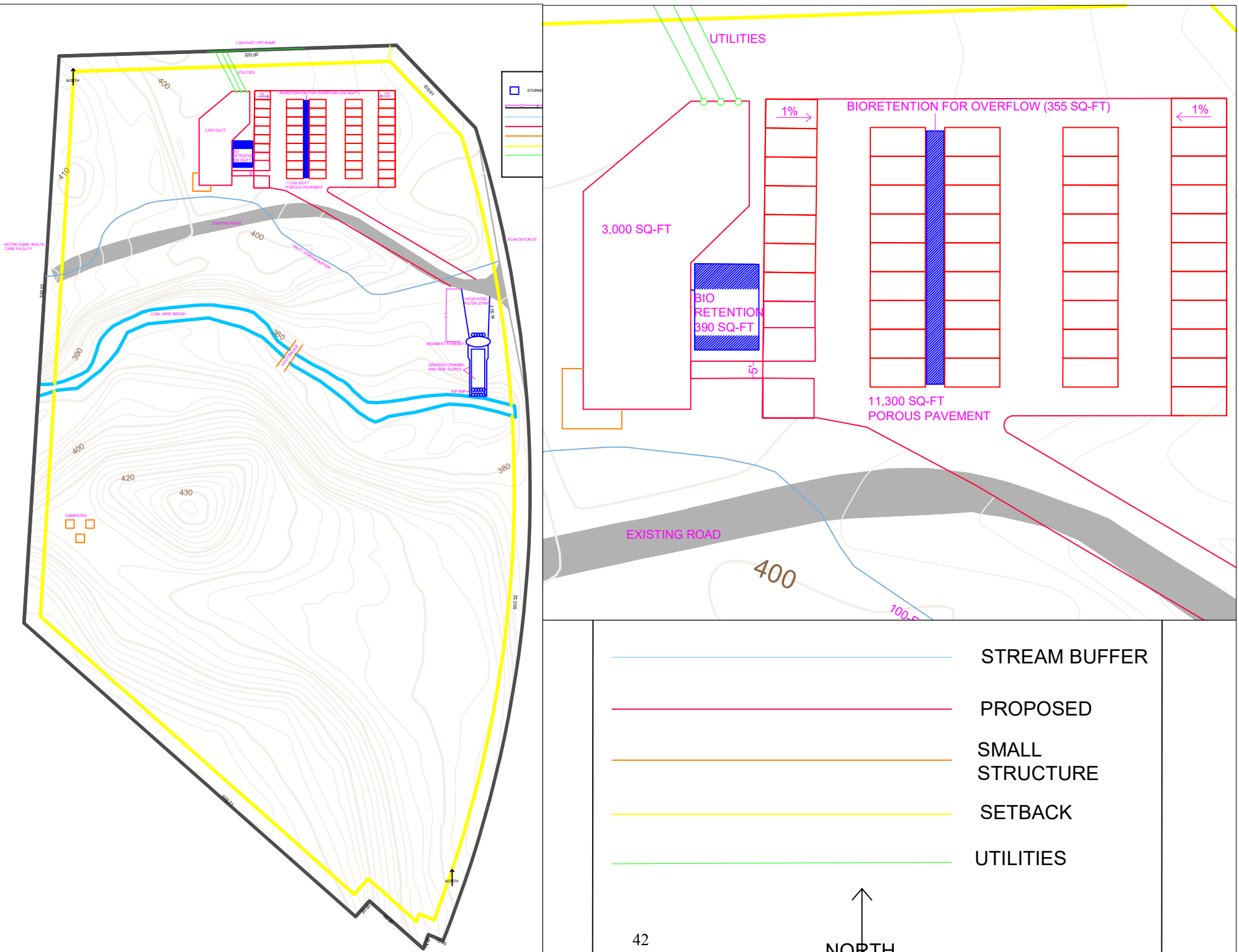
205 feet < 322 feet

Thus, accessing the site from Plantation Street is a safe and viable option.

5.4 Site Layout Options

The team drafted preliminary layouts on AutoCAD for the following three layouts: access from Plantation Street, access from a proposed driveway on the Notre Dame Health Care facility, and access completely through the site, utilizing both of these options. The following site layouts, figure 23, 24, and 25, include the Council Service Center building, a parking lot, an access road, and the BMPs that will mitigate the introduction of impervious surfaces for each.

Figure 23: Plantation Street Access Layout



- STREAM BUFFER
- PROPOSED
- SMALL STRUCTURE
- SETBACK
- UTILITIES

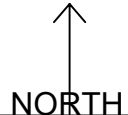


Figure 24: Notre Dame Access Layout

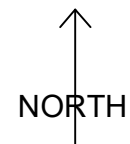
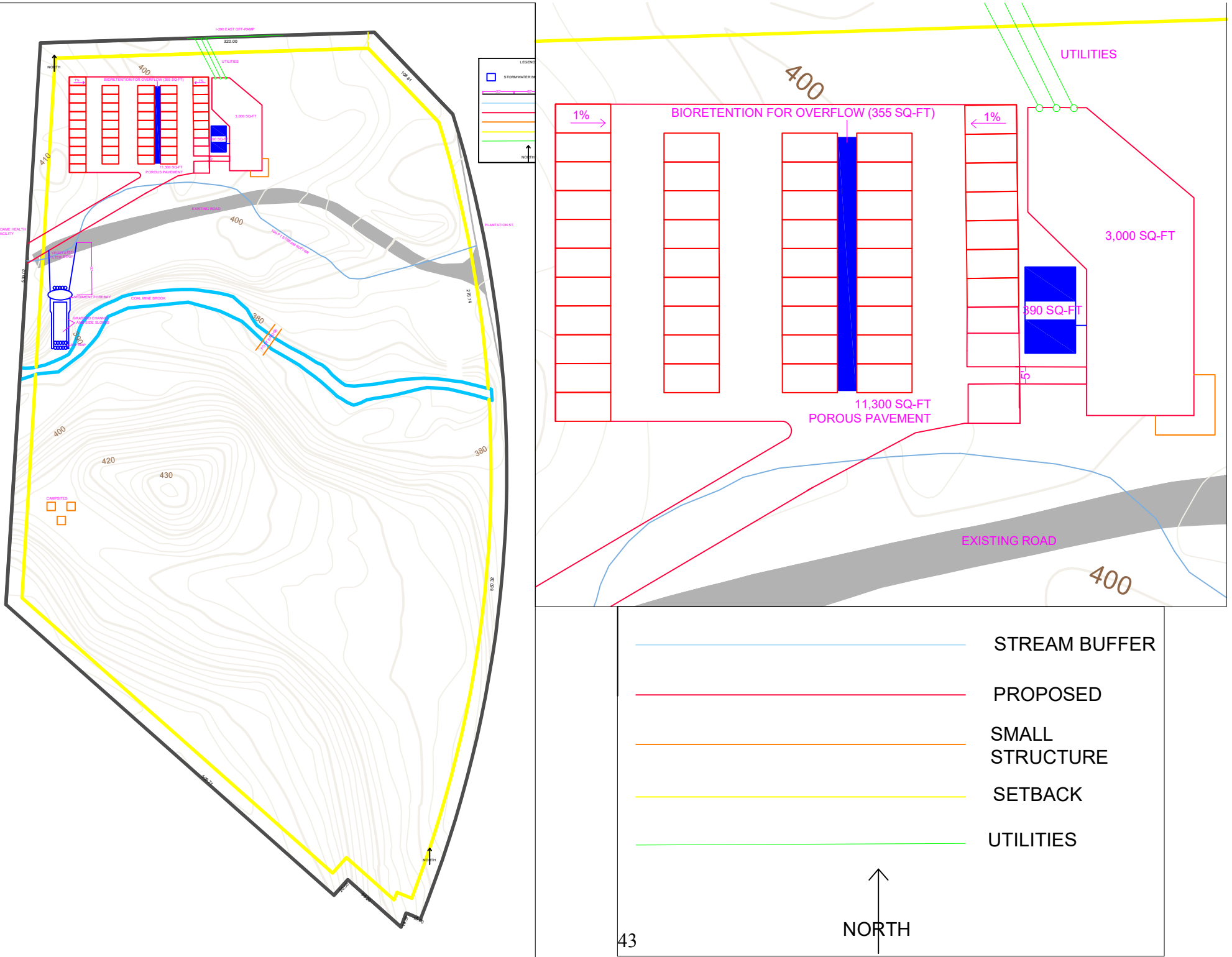
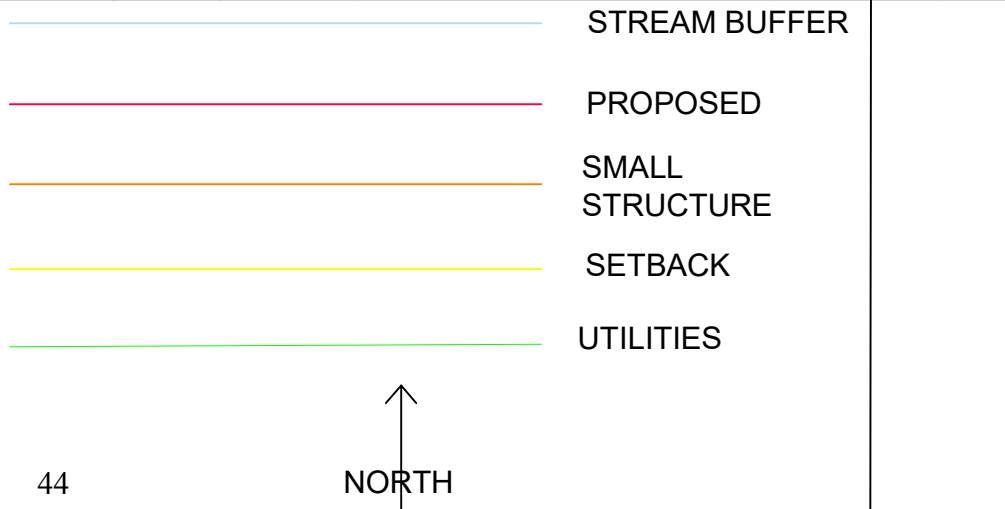
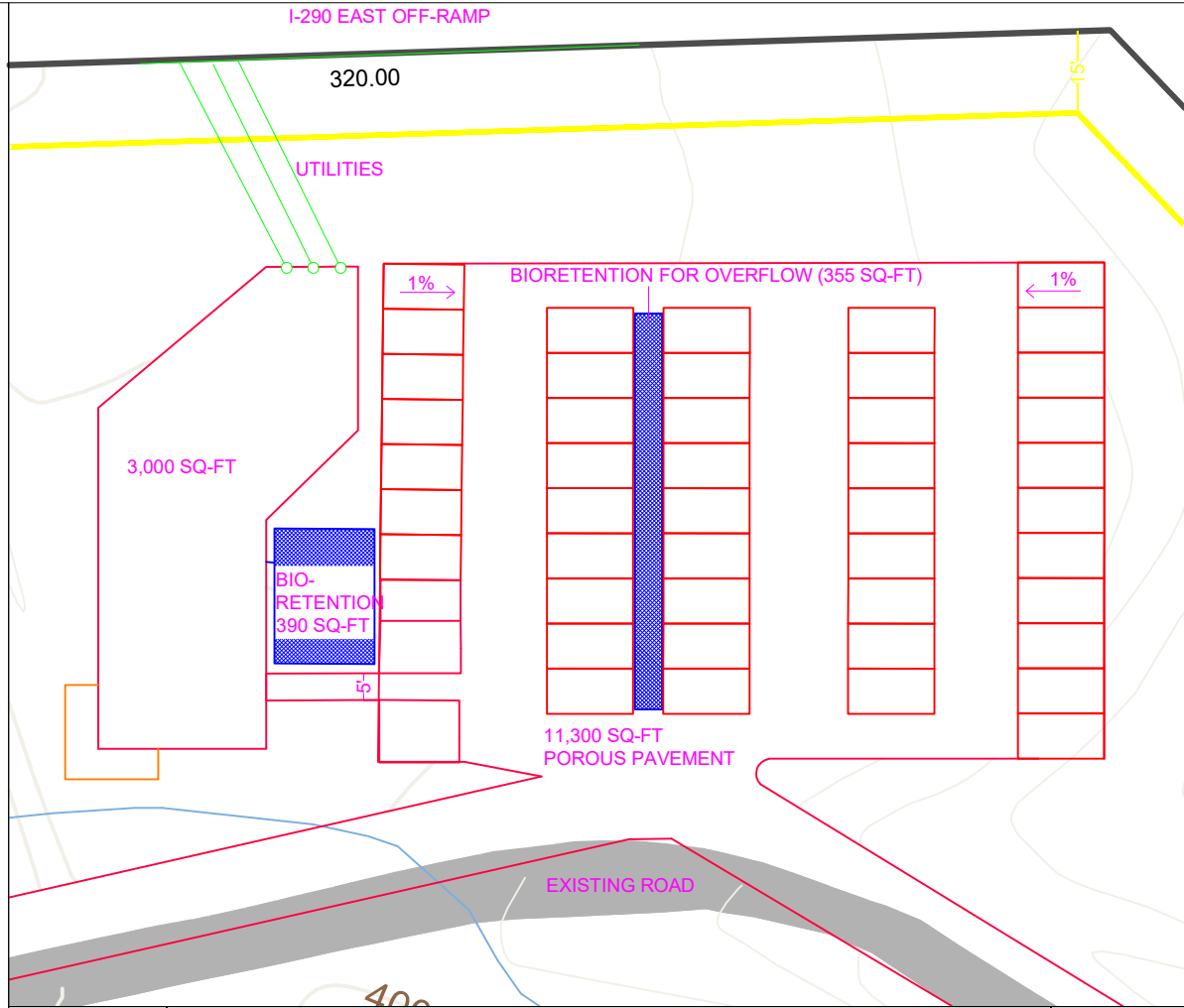
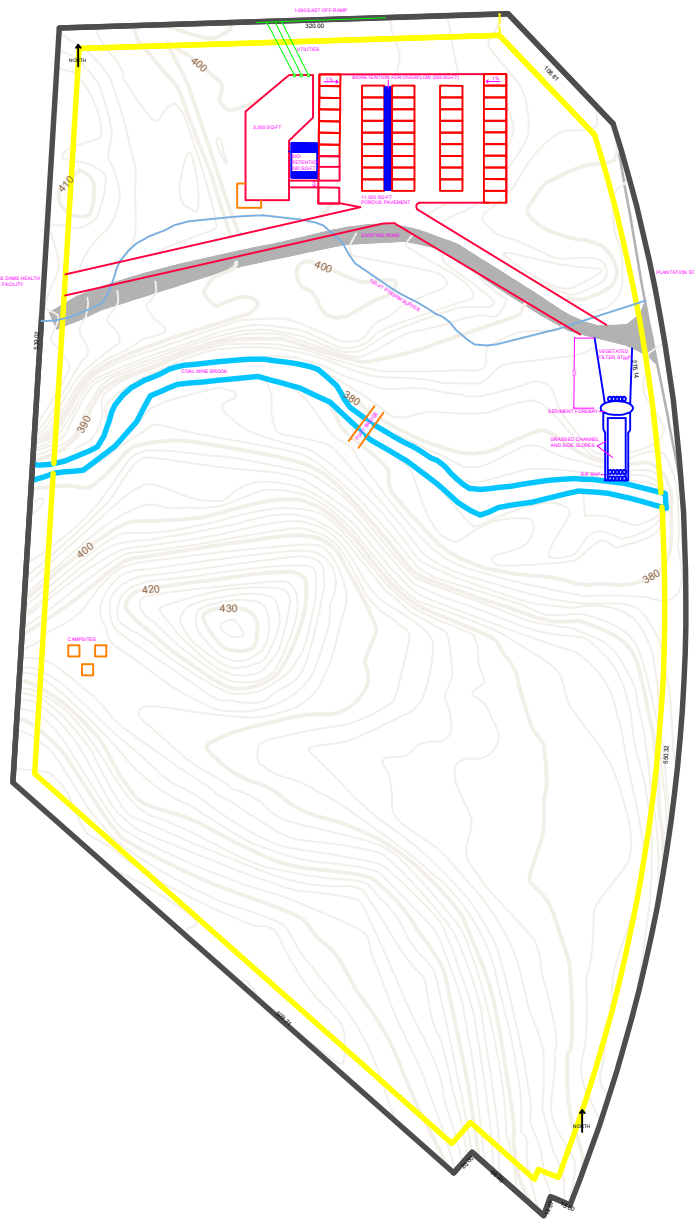


Figure 25:



5.5 Future Steps for the Coal Mine Brook Parcel

The Mohegan Council's focus on education and sustainability for the development of their properties includes more than attention to environmental constraints and stormwater management techniques. This section comprises general recommendations for the council for the development of the Coal Mine Brook parcel with regards to camping, solar energy, and LEED building design.

Campsite

When the team met with Mr. Novick of the Greater Worcester Land Trust on December 13, 2017, he stressed the importance of Boy Scout involvement on the site and using the brook as an education and camping tool for generations to come. He suggested that the team include platforms in the design for camping, and a small pedestrian bridge which is allowed as part of the land trust, depicted in orange in Figure 26.



Figure 26: Proposed Campsite Platforms

Sustainability

Sustainability is a main priority for the Mohegan Council, as they work to reduce the environmental footprint on the property they own, promoting solar energy and environmental education.

When the team met with Mr. Novick, he expressed the importance of utilizing existing impervious areas to capture solar energy, rather than clearing additional vegetation. As this site develops, solar energy may be of interest to the Mohegan Council. The team recommends that the development of solar farms in structures on top of the building or above the parking area to generate energy for the new Mohegan Council Service Center. Solar parking canopies are a great option for utilizing existing space and are used throughout New England, with the largest solar parking canopy at Bristol Community College in Fall River, Massachusetts, shown in Figure 27.

However, both solar parking canopies and solar structures on the building will affect the BMPs that were recommended and will require additional stormwater mitigation studies.



Figure 27: New England's Largest Solar Parking Canopy (SI Staff, 2015)

Building Design

LEED (Leadership in Energy and Environmental Design) is a globally recognized building design rating system. The LEED framework is applicable to individual buildings, communities and home projects to ensure sustainable design, construction, operation and maintenance of buildings. LEED Certification is separated into four levels based on the amount of points a development earns through different categories – certified at 40-49 points, silver at 50-59 points, gold at 60-79 points, and platinum at 80+ points. The possible points come from the following categories: location & transportation, sustainable sites, water efficiency, energy & atmosphere, material & resources, indoor environmental quality, innovation, regional priority. Buildings that become LEED certified buildings ultimately cost less to operate, require fewer resources to build and operate, and are better for occupants and the environment than conventional buildings.

6.0 Conclusion and Recommendations

This project aids the Mohegan Council in being one step closer to the development of a new Council Center on the Coal Mine Brook parcel. The knowledge of the environmental and legal constraints on the parcel coupled with access options and stormwater mitigation recommendations provides the Council with a deeper understanding of the site and how the property may be best developed. This chapter discusses a brief overview of the project and recommendations for the Mohegan Council.

The team generated three alternate layouts each with differing access points; one from Plantation Street, one from the neighboring Notre Dame Health Care facility, and one through the site connecting these points. The surface areas of the building and parking lot are the same for all of the layouts. Ultimately, the team recommends that the first layout option, accessing the parcel from the Plantation Street side, is the best choice for this project. There is sufficient sight distance to provide safe to access the property from this point. There is an existing curb cut, which significantly lowers the cost of the project because creating a new curb cut will not be necessary as part of the engineering design and construction. However, the existing curb cut will need improvement during the eventual construction stage.

The layout option with access from Plantation Street also allows for siting of the building and parking lot to be completely out of the 100-foot stream buffer from the Coal Mine Brook. In addition, it is more convenient to access the site from Plantation Street for a visitor because accessing from the Notre Dame side of the property involves multiple extra turns and small, curved roads into the private Notre Dame facility, which will be more time consuming and possibly confusing. This layout is overall the most cost-effective and convenient. Figure 23 depicts the recommended site and stormwater management plan.

The MQP team worked to produce a stormwater management scheme that produced no more runoff than what already exists on the Coal Mine Brook Parcel, utilizing the well-drained soils and the contours on the site as factors in BMP selection. The runoff from the roof, the parking lot and the access road were separated to determine the runoff using HydroCAD, which informed the BMP sizing process. All of the BMPs, except the grassed channel that treats the runoff from the access road, are also outside of the 100-foot stream buffer. The grassed channel will require a Notice of Intent to Worcester's Conservation Commission. However, it will only slightly alter the existing hydrology and will prevent runoff from the access road from flowing onto Plantation Street or from flowing directly to the stream without treatment.

The recommended BMPs will successfully mitigate the impacts of runoff that the development of a Council Service Center will create on the site. Bioretention ponds, porous pavement and the grassed channel will be aesthetically pleasing, require an average amount of maintenance and can serve as educational devices for the Boy Scouts of Worcester and the community. In addition, bioretention will supply habitat, shade, and landscaping to the parking lot and in front of the Council Service Center.

The development of this site will provide crucial meeting, marketing and retail opportunities for the Mohegan Council and their affiliates. It may also engage the surrounding community through

recreational outdoor space. Additional actions that may be implemented include building design and studies on construction costs. Any changes in the footprint of the building, parking lot and access road will require studies to analyze the differences in stormwater runoff, as it is heavily impacted by these designs. A sustainable Council Service Center that supports the needs of the Mohegan Council and fosters engagement with the community of Worcester is in sight with these recommendations and further measures to reduce impacts of development.

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Appendices

Appendix A: Project Proposal

A Site Plan with Stormwater Management Considerations for the Mohegan Council

A Major Qualifying Project Proposal by
Sydney Brooks, Abigail King, Thea Reymann
Advised by Suzanne LePage and Paul Mathisen



WPI

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Capstone Design Statement

This project satisfies the requirements for a major capstone design project, as specified by the Worcester Polytechnic Institute (WPI) Department of Civil and Environmental Engineering. This states how a WPI Major Qualifying Project meets design requirements. This civil and environmental engineering design project includes the design of a site plan and stormwater management plan for the Plantation Street Parcel owned by the Mohegan Council of the Boy Scouts of America. The development of this plan will consist of many steps outlined by the team including a site assessment, identification of buildable land area, design of a site layout and production of a best management practice (BMP) stormwater plan through investigation of the site's hydrology. The American Society of Civil Engineers' (ASCE) code of ethics upholds the importance of safety, service, truth, faithfulness, merit, professionalism and fairness in all civil engineering applications.

The team will analyze the Plantation Street Parcel using GIS and field observation in order to identify constraints within the site and determine the buildable land area. The site's constraints will then be considered in the development of alternative layouts for the new Service Council Center building, parking areas, and points of access to be presented to the Mohegan Council of Boy Scouts for feedback and selection. The final layout will be completely drafted as a site plan through AutoCAD. In addition, the team will concurrently produce a stormwater management plan by investigating the hydrology of the predeveloped site and designing BMPs to minimize the effect of the new development on stormwater run-off.

This project will consider realistic constraints through addressing the economic, environmental, sustainability, ethical, health and safety, social and political issues in the following manner:

Economic: A site layout and BMP design will need to be economically feasible. Some large scale BMPs may not be feasible for this project and cost-benefit relationships will need to be analyzed in the selection of BMPs.

Environmental: Keeping the parcel with equal predevelopment and post development volumes for stormwater is a main focus in this project. Constraints including utilities (water, sewer, electricity), terrain and slopes, erodible soil, conservation of the brook, legal restrictions (Worcester's local zoning codes, ordinances and deed restrictions), excess noise, community impact on the environment and any other encountered will be analyzed.

Sustainability: The Mohegan Council has a firm desire to use sustainable technologies in their land use applications, so sustainability will be a main concentration throughout the site layout process. The stormwater management plan in particular will be designed to intercept both short and long-term storms.

Ethical: The project team will carry out research, report writing, field visits and all design aspects of the project in a morally acceptable manner with a firm priority of ethical behavior per ASCE code of ethics.

Health and Safety: Public health and safety is a strong concern as the Coal Mine Brook is part of the local watershed and is protected by the Worcester Land Trust. The design will strive to reduce runoff and associated contamination in order to reduce harm to humans and organisms potentially affected by the local watershed.

Social and Political: The project team acknowledges the importance of politics and regulations associated with land development and formulated objectives to address these regulations in the design process.

1. Introduction

An important goal in site design is reducing the effects of land use on the environment. Sustainable development practices aim to address this goal and meet the needs of future generations by considering environmental, social, and economic aspects in the design and building process (The World Bank Group, 2017). Vital steps in sustainable site development that prevent or reduce impacts of land use development on the environment include performing site analyses and implementing Best Management Practices for stormwater, an increasingly large problem in site development (Marsh, 2010). This concept has been gaining attention in recent years, through practices and information availability as well as in federal and local government policies, all of which form a basis for sustainable site design.



Figure 1: Map of Plantation Street Parcel outlined in red (City of Worcester GIS Database)

Worcester, Massachusetts is the second largest city in New England but has plentiful neighborhood centers and green spaces that must be protected (Worcester Culture Coalition, 2017). The Mohegan Council of the Boy Scouts of America (BSA), headquartered in Worcester, is an organization that is dedicated to fostering life skills and community involvement (Boy Scouts of America, 2017). The Vice President of this council, Tom Chamberland, expresses the importance of green infrastructure and the reduction of environmental footprints in their development projects. Their camp area, Treasure Valley Scout Reservation, is an example of this effort utilizing composting latrines and solar LED lights sourced through their 6MW and 2.5MW solar farms (T. Chamberland, 2017). The Mohegan Council possesses the opportunity to continue their sustainable practices further by developing a seven-acre parcel of land in Worcester for a new Council Service Center. This piece of land is located at the intersection of Plantation Street and the Interstate 290 Eastbound off-ramp as seen in Figure 1 outlined in red, a location with heavy through traffic. This new space is envisioned to be used as a marketing resource, retail and meeting space and to foster community involvement by sharing this space with local organizations.

The council faces several design constraints for this new development. There is limited buildable space for the Council Service Center due to Coal Mine Brook which divides the property and the steep slopes within the buildable area. There are also limited options for road access to the center. The brook and its water quality are also protected and monitored by the Greater Worcester Land Trust. Any new development would alter the current hydrology of the site and potentially increase stormwater runoff.

The goal of this project is to design a site layout and a stormwater management plan for the Plantation Street Parcel to aid the Mohegan Council in developing a new Council Service Center. The objectives of this project are as follows:

- Objective 1: Perform a Site Analysis on Plantation Street Parcel
- Objective 2: Identify Buildable Land
- Objective 3: Design a Site Layout
- Objective 4: Produce a Stormwater Management Plan

A site analysis will provide the team with constraints that can be organized and prioritized. The evaluation of these constraints will make clear the buildable land available. This step will lead to the design of alternative site layouts including a stormwater management plan for the parcel. Through these steps our project will provide the Mohegan Council with a site plan and a coordinating BMP stormwater management plan, and an opportunity to be one step closer in the process of developing a new Council Service Center.

2. Background

This chapter outlines the information about the Plantation Street Parcel, design considerations for the development of the property, and an overview of site planning and stormwater management.

2.1 Information on the Plantation Street Parcel

The parcel is located at the intersection of Plantation Street and the Interstate 290 Eastbound off-ramp as seen in Figure 1. The buildable land is bordered by Plantation Street to the East, a sewer line easement to the North, Notre Dame Health Care Center to the West, and Coal Mine Brook to the South. The parcel and surroundings can be seen in Figure 2 below.



Figure 2: Google Imagery- Plantation Street Parcel: The parcel is outlined in red. The blue line indicates Coal Mine Brook and the grey line indicates the abandoned access road. (Massachusetts GIS)

Forty percent of the land encompasses two buildable areas, one of which is on the north side of the property for building a headquarters for the Mohegan Council and the other for hiking and camping purposes by the Boy Scouts on the south end of the property.

A conservation restriction was put in place along and surrounding the brook to assure the parcel would be retained in predominantly its natural, scenic and open condition and to help preserve the Coal Mine Brook's water quality, habitat and scenic appeal. This restricted area also provides for a continuation of the trail links for Worcester's East Side Trail (of the Worcester East-West Trail), to help ensure the existence of a wildlife connector and to establish an extensive contiguous greenway of conservation land from Green Hill Park, the trails eastern link to the premises.

The Mohegan Council of the Boy Scouts of America plans to utilize this site for both Boy Scout and public community usage. Specifically, in regards to the Boy Scout operation, they want to develop a Council Service Center complete with a supportive retail scout shop, an open meeting space, offices and a parking area. In addition, due to the parcel's proximity to I-290, the council intends to use this site as a marketing opportunity for passing traffic to demonstrate the activity of the Mohegan Council.

2.2 Boy Scout Land Use

Boy Scouts utilize land and buildings for many different purposes. These include office spaces for administrative use, outdoor recreational spaces or camps, indoor recreational centers, and educational areas. The Mohegan Council Boy Scouts currently maintain the Treasure Valley Scout Reservation (TVSR) which hosts a variety of events. Residential camp, adventure camp, skills training, and year-round Boy Scout training are some of the functions held by the council. Overall the purpose of facilities such as TVSR is to serve the Boy Scout program in "inspiring the leaders of tomorrow" (Mohegan Council, 2017) while upholding standards for environmental protection and working to reduce their carbon footprint.

General BSA Council Service Center design considerations from the 1998 Draft of Program of Requirements sent to the Mohegan Council are included in the following table.

Table 1. Council Service Center Requirements (BSA, 1998)

| | |
|------------------------------|--|
| Aesthetic | The Service Center must embody efficiency and environmental sensitivity. |
| Security | The facility must be secure with 24-hour surveillance. |
| Maintenance | The Service Center must be designed with greatest possible durability, lowest possible maintenance, and must provide for future expansion. |
| Zones/ Access Requirements | The facility should be divided into three zones, the Scout Shop, the Meeting Room(s), and Offices, which all must be securable without restricting access to the other zones with access to restrooms and kitchen/break room(s). |
| General Components | The Service Center Site Plans include street access, parking, loading, waste removal, surface water run-off, landscaping, paving, lighting, signage, and a flag plaza/sculpture site. |
| General Spatial Requirements | Ancillary areas must include an entry lobby, a media resource room for storage and display of checkout items, a trading post and trading post stock room, a kitchen/break room, a main conference room, an administrative conference room, a program room, men's and women's bathrooms, a janitorial room, a central computer and switching room, a shipping/receiving room, a storage room for records, programs, office supplies, field service and conference room furniture and equipment. |

2.3 Site Planning and Stormwater Management

The purpose of site planning is to synthesize client goals and aspects of civil engineering, architecture, landscape architecture, and environmental planning. It is the process of creatively and efficiently drafting

different purposes for sections of land for private or public clients (Rubenstein, 3). General steps involved in site planning are provided in the following diagram, figure 3.

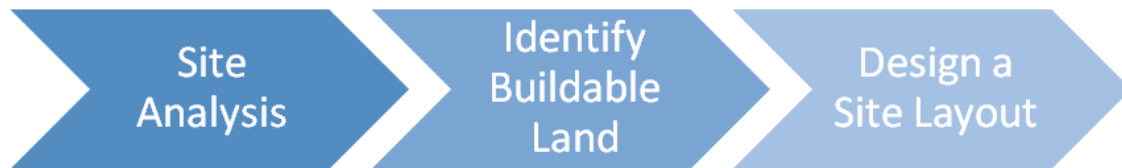


Figure 3: Site Planning Flowchart

The city of Worcester's Developer's Guide provides useful information on city processes for the review and approval of proposed projects and associated permits. The performance standards by which a project is reviewed include:

1. "Traffic and pedestrian circulation;
2. Parking and loading;
3. Location, size and design of buildings, signs and lighting;
4. Adequacy of storm water, drainage, water supply and disposal facilities;
5. Conformance with landscaping design standards and adequate open space;
6. Protection of neighboring properties against noise, glare and unsightliness;
7. Adequacy of fire protection, and susceptibility to flooding, erosion or sedimentation;
8. Conformance with the site plan design with historic resources; and
9. Adequacy of land impact on the regional transportation system" (City of Worcester, 2009).

These standards are a useful model by which projects can be planned. The compilation of access, stormwater, landscaping, and conformance with regulations will be discussed further in the following sections as a site layout must incorporate all of these.

2.3.1 Objective One: Site Analysis

Site analysis is a process to determine the limiting constraints to then identify the opportunities available for land development (LaGro, 2013). A site analysis aims to investigate the makeup and operation of a proposed use program on a site. This is typically performed after the land use has been proposed but the layout and appropriate design need to be developed. Site analysis involves evaluating the proposed environment for features or situations that would either facilitate or threaten the desired land use in order to recommend the most appropriate layout (Marsh, 2010). Typical constraints identified through site analysis that are applicable to site planning are identified in Table 2. A synthesis of client needs, planner needs, and community needs is necessary to understand the scope of the project in terms of constraints. Client needs are often outlined to a planner or contractor through meetings, presentations, company documents, or interviews. Planners have schedules, budgets, and designs that are contingent on aforementioned constraints and client needs. Finally, the community in which a site is located should be evaluated to make sure the site continues to fit with the community's plans and ideals after development.

Table 2: Potential Constraints (LaGro, 2013)

| Potential Constraints | Examples |
|----------------------------------|--|
| Ecological Infrastructure | Aquifer recharge areas, wetlands, surface water, critical wildlife habitat |
| Health or Safety Hazards | Floodplains, earthquake fault zones |
| Physiographic Barriers | Steep slopes, highly erodible soils, shallow bedrock |
| Natural Resources | Prime farmland, sand and gravel deposits, specimen trees, scenic views |
| Historic Resources | Historic buildings, archaeological sites |
| Legal Restrictions | Zoning codes, subdivision ordinances, easements, deed restrictions |
| Nuisances | Noises, odors, unsightly views |

Environmental considerations are one of the largest areas of research for site analysis. There are multiple sources of environmental data for analysis and planning, including firsthand field observation, aerial photos and satellite imagery. Another strong source of information can come from topographic contour maps published by the U.S. Geological Survey. Soil maps from the U.S. National Resources Conservation Service give the classification and description of soils to a depth of 4 or 5 feet as well as a representative slope. The U.S. Geological Survey also includes data and reports for earthquake hazards, stream discharge records, groundwater surveys, geological formations and water resources (Marsh, 2010).

Geographical Information Systems, or GIS, is a commonly used program with spatial and geographical databases and map layers. Research conducted during site analysis comes from previous documentation of the site (if it exists), site visits and observations, and GIS data. This resource is often used as a preliminary data source for learning about landscapes and environmental services in any area. It allows the user to visualize different aspects of data and categorize it to recognize trends throughout maps and informational charts. The GIS database provides various relevant data layers including aerial photographs, terrain, impervious surfaces, demographic information, conservation areas, infrastructure, physical land resources, and regulatory areas. GIS data along with the collection of other comprehensive research provides a suitable platform for the continuation of a site-planning project.

2.3.2 Objective Two: Identifying Buildable Land

In the previous section, potential constraints were outlined. A subsequent step is evaluating this data to aid in identifying the buildable area. The most important factors in identifying a buildable area include:

- Ecological infrastructure
- Physical barriers
- Transportation
- Accessibility

Ecological infrastructure includes perhaps the most important constraints to acknowledge. Two valuable aspects of the ecological infrastructure that are considered when identifying a building location include

wetlands and unique habitats. Wetlands serve the purpose of "flood conveyance, barriers to erosion by waves, flood storage, sediment control, pollution control, sources of nutrients for animals, habitats, aquifer recharge, recreation, open space, and aesthetic values" (Rubenstein, 28). GIS wetland data files show where on or around a site the wetlands exist.

It is important to check with state and local laws and ordinances regarding wetlands before building or designing to build on a property. In many cases, permitting is required. For example, there is a Massachusetts Wetlands Protection Act (General Laws Chapter 131, P40, the Act) that seeks to protect wetlands as well as waterfronts and other water affected land (Worcester Conservation Commission, 2015). These distinct ecosystems must be protected.

Unique habitats are plant or animal habitats that are particularly vulnerable to development (National Geographic). For this reason, it is important to research the site for any of these habitats and develop around them so that they are not disturbed, ruined, or destroyed.

Physical barriers include steep slopes and degrading soils. When potentially developing a site, it is critical to have an understanding of the slopes and any erosion on the property. There are limits to where construction and/or development can occur on a site based on slope percentages and soil maps which are outlined by states and counties. General soil maps and detailed soil maps are created from field testing and surveying. Worcester, for example, has surveys and general soil maps available online or by request of the city of Worcester.

Another area of important research is transportation in, out, and around a site that is being developed. There are both logistical and safety considerations when it comes to traffic flow in and out of a parcel. For safety purposes the type of roads near a site must be considered. Road types may include highways, main roads, local roads, bike paths, and access roads. Depending on the type of road and the anticipated use, there are dimensions and turning radii associated to maintain safety and be reasonable for traffic flows.

Design standards can be researched state by state. Below is an example of roadway types from the Massachusetts Department of Transportation (Mass DOT) Basic Design Controls document (Mass DOT, 2006). Other details such as sight-distance calculations, speed zones, and parking information can be found at MassDOT as well. Furthermore, road and parking lot designs are important for the site planner to consider for stormwater management.

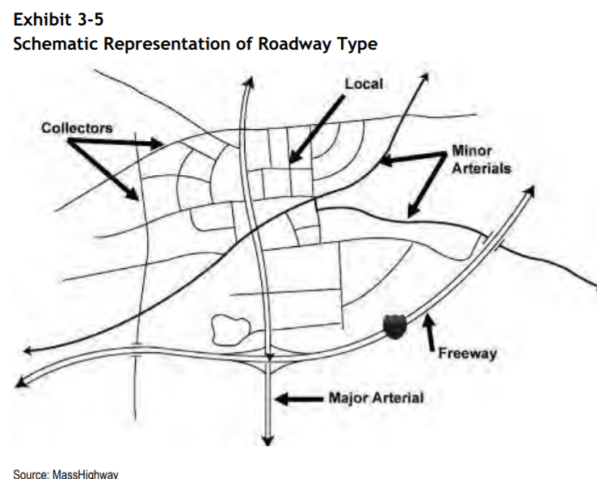


Figure 4. Massachusetts Road Types (Massachusetts Department of Transportation, 2006)

A key to environmentally friendly design is having green space and good walkability because it reduces the number of cars on the property. Walkways, benches, bike paths, and pathways are all ways to make a site more pedestrian friendly. Accessibility is another critical research factor for roads and parking lots in particular. The 2010 Americans with Disabilities Act (ADA) Standards for Accessible Design requires that businesses provide accessible parking spaces (Department of Justice, 2010). The process of identifying the buildable area of a site includes these transportation and other parking related constraints, which are all vital factors in development.

2.3.3 Objective Three: Designing a Site Layout

After collecting and organizing the site data and determining the buildable land available, a planner can design a layout for the site to plot the building location as well as site access, parking, utilities, stormwater management practices, landscaping, and more. Site layouts are planned while considering the physical site restrictions and the requirements of the client. Many planners begin by creating one or multiple conceptual designs of the site before they progress to creating more detailed plans. This allows them to incorporate feedback from the client as they design. The initial conceptual plans may begin as hand drawn sketches before being integrated with a computer software, such as AutoCAD (LaGro, 2013).

A next step for a conceptual design is to draft and visualize exactly what it is going to look like. AutoCAD is a commercial computer-aided design and drafting software useful in civil engineering applications including land survey data plotting, hydrology, transportation and architecture (SDC Publications, 2017). It allows for creating illustrative site plans and inputting aerial imagery, photography and hand drawn sketches as the base layers for proposed development.

2.3.4 Objective Four: Stormwater Management

The change in the volume, rate and quality runoff reaching streams and rivers is one of the most serious problems associated with land development. It increases property damage from flooding and erosion, reduces water quality and degrades habitats (Marsh, 2010). Thus, stormwater has been an increasingly substantial consideration for site planning. A plan for the rerouting of stormwater flow in a development plan is necessary in most site design applications.

Stormwater is either intercepted by vegetation, absorbed directly into the soil, or it runs off the surface of land into streams, rivers and low spots within a region's topography. Stormwater volumes generally increase with slope and ground coverage by hard surfaces such as concrete and asphalt. Similarly, these volumes decrease as soil organic content and vegetative cover increase (Marsh, 2010). Hence, the development of land strongly affects the increase in stormwater within a watershed and pollutants within it.

A particular development has its own stormwater system that consists of precipitation, stormwater delivery and discharge. The on-site runoff and its contaminants usually consists of land clearing resulting in soil compaction, construction of impervious cover, lawn fertilization and garbage burning. Removal of runoff on sites involves gutters, downspouts, yard drains and field tiles. Finally, the delivery of stormwater to a receiving water body can involve curbs, gutters, ditches and storm sewers. Various combinations of these levels of control may be selected for different settings and problems (Marsh, 2010). This site stormwater system is represented in figure 5.

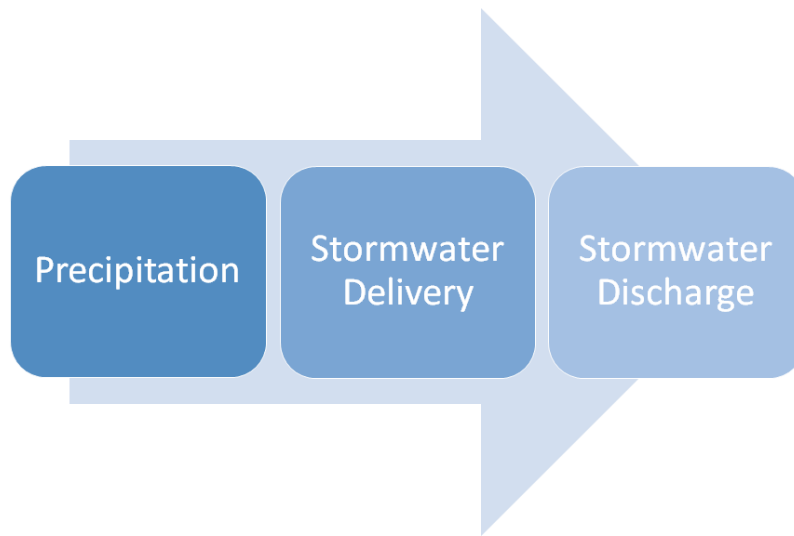


Figure 5: Stormwater System Schematic

2.3.4.1 Stormwater Planning

As planning for the mitigation of stormwater depends heavily on the project itself, various steps must be taken to ensure that the best practice is applied to successfully manage surface runoff and associated pollutants. First, the existing hydrology of a site must be evaluated to accurately understand the current hydrologic conditions and future conditions that would exist with development. Next, a plan should be developed based upon Best Management Practices to best match the conditions of the site before development. The following stormwater planning steps are most successful if carried out concurrently with the site planning process.

2.3.4.2 Step 1: Evaluate Existing Hydrology

The first step of stormwater management usually occurs when beginning the initial stages of land use planning. Minimizing the environmental impact of stormwater and pollutants is especially important when in proximity of water bodies, streams and wetlands. Typical low impact development techniques include preserving existing vegetation, minimizing impervious surface areas, and reducing runoff flow from the site (Massachusetts Department of Environmental Protection, 2012). Each of these techniques helps reduce environmental footprint in land development. Before beginning the planning, it is imperative to model the pre- and post-developed hydrologic performance of a site to define the watershed and identify water features and slopes. This information, available from surveying and topography maps, GIS data, and various other city sources, helps make the development of a stormwater management plan concise and accurate. This step is most useful if done concurrently with site analysis in the development of a site plan.

2.3.4.3 Step 2: Develop Stormwater Management Plan Based on Best Management Practices

BMPs (Best Management Practices) are measures taken to prevent or reduce impacts of land use development and practices on the environment, specifically associated with runoff systems. These are usually proactive measures as part of land use planning and design (Marsh, 2010). When proposing a plan to conservation commissions, developers investigate possible practices to be used to manage the stormwater in accordance to the state or local stormwater management standards (Massachusetts

Department of Environmental Protection, 2012, Vol 2 Ch 1). BMPs can be planning techniques or structural applications, both of which mitigate the impacts of runoff.

The goal of most stormwater management strategies in site planning is to plan for the development to result in little or no increase in discharge, whether by returning the excess stormwater to the ground or storing the excess water close by to release it over time. To design a site-scale BMP plan, a spreadsheet approach to stormwater accounting may be used, which involves calculating the volume of the stormwater produced from each surface within the site before and after development. Calculating volume is based on the site's coverage, coefficient of runoff and storm size. The post-development volume should be brought as close to the predevelopment value as possible (Marsh 2010). This practice is necessary in community and site-specific planning, being most applicable after the hydrology of a parcel is assessed to ensure that significant alterations are not made to the runoff volume.

The strategy to be used in a particular project depends on a variety of factors including construction cost, local topographic and soil conditions, the design of the program and local policy (Marsh, 2010). Commonly used strategies are included in the following table.

Table 4: Stormwater Management Strategies

| Strategy | Method |
|-------------------------------|--|
| Site-Adaptive Planning | Begins with defining sites in the local watershed with good hydrologic performance (good capacity of holding and absorbing stormwater), and classifying these parcels as preferred sites. The next step is to reduce the introduction of impervious surfaces (to reduce the absorption of stormwater) whenever possible. |
| Source Control | Involves disposing of stormwater at or very close to its point of origin. Usually accomplished onsite, involving some kind of soil infiltration by directing stormwater into vegetated areas, shallow depressions, troughs, or pits, where it then infiltrates into the ground. This method is most effective for small, low-intensity or long-duration storms. |
| Basin Storage | Involves directing stormwater to a holding basin and then releasing slowly over an extended period of time to reduce the rate of delivery of stormwater from developed land into streams. Involves the construction of storage facilities such as detention basins (ponds sized to store the design storm) to catch runoff delivered by a network of storm drains. |

BMP practices can be grouped into strategies involving the aforementioned stormwater system, which includes precipitation, release and delivery. BMPs are generally implemented at the planning policy level through community planning, zoning ordinances and bylaws, development permits and the building permit process (Marsh, 2010). Site Removal (Release) BMPs are formulated to disconnect the site as a source of stormwater from the watershed's drainage system (Source Control). These methods are generally well suited to manage low to moderate magnitude runoff events.

Delivery BMPs are the most widely used application of stormwater management. These engineering measures are designed to efficiently remove stormwater from developed areas to streams, lakes, harbors and constructed ponds. These are generally used to reduce the risk of flooding and property damage from large, infrequent storm events. This need can be reduced or eliminated with source controls and site-based BMPs.

The most ideal application of stormwater management is a nonstructural approach involving source control and pollution prevention. In the municipal sense, source control planning involves different ways to control the stormwater quality such as implementing regional regulations, managing the materials, fertilizers, and pesticides at regional and industrial sites, limiting winter road salting, and controlling the erosion and sediment (Massachusetts Department of Environmental Protection, 2012, Vol 2 Ch 1). This process is seen in city development processes and regulations. It is of utmost importance to allocate necessary space for the BMP practice when designing a site layout, as the space required can vary and further alter the hydrology of the site.

3. Methodology

This chapter outlines the project goal, objectives, deliverables expected from the project, a project schedule and detailed steps involving the production of the outlined deliverables.

3.1 Project Goal, Objectives and Deliverables

The goal of this project is to produce a site layout and a stormwater management plan for the Plantation Street Parcel to aid the Mohegan Council in developing a new Council Service Center. Several steps are required to develop these deliverables. The objectives are as follows:



Figure 6: Plantation St. MQP Site Plan Flowchart

3.2 Project Schedule

This Gantt chart provides the weekly schedule for the completion of project objectives. The light color shaded cells represent task accomplished for the production of this proposal. The darker colored cells correlate with the project objectives: red is objective 1, green is objective 2, orange is object 3 and blue is objective 4. The yellow cells indicate the meeting times with our sponsor.

| Plantation Street MQP Project Schedule | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|-------|--------|--------|--------|-------|-----------------------------|--------|--------|--------|--------------------------------------|--------|---|---------------------|-------|--|--------|--------|--------|-------|--------|--------|--------|-------|--------|--------|--------|------------------------------|--|--|--|--|--|--|--|--|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | | | | | | | | | |
| 28-Aug | 4-Sep | 11-Sep | 18-Sep | 25-Sep | 2-Oct | 9-Oct | 16-Oct | 23-Oct | 30-Oct | 6-Nov | 13-Nov | 20-Nov | 27-Nov | 4-Dec | 11-Dec | 18-Dec | 25-Dec | 1/1/18 | 8-Jan | 15-Jan | 22-Jan | 29-Jan | 5-Feb | 12-Feb | 19-Feb | 26-Feb | | | | | | | | | |
| Background Research | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Methods Research | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Project Proposal and Edits | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | Finalize Project Proposal | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | Conduct Site Analysis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | Identify Buildable Area | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | Design Site Layouts | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | Select a Site | | | | | | | | | | | | | | | | | | | | |
| | | | | | | Evaluate Existing Hydrology | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | Develop Stormwater Management Plan Based on Best Management Practices | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | *Meeting to Determine Building Usage | | | | | *Meeting/ Presentation of Alternate Site Layouts | | | | | | | | | | | | *Meeting/ Final Presentation | | | | | | | | |
| MQP Report | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

3.3 Perform Site Analysis on Plantation Street Parcel

The first project objective is to evaluate the Plantation Street Parcel to gather information about the possible constraints to consider for the following objective. An initial site walkthrough provides basic observable constraints of the site. Our team will utilize GIS data to further investigate the geographical aspects within our parcel. Our team will:

1. Take photographs and field notes at a site visit
2. Create GIS maps including hydrography, geography, streets, soils and slopes
3. Analyze previous geological survey and Phase 1 Environmental Analysis

An access investigation will be conducted in order to propose the most ideal driveway location for the proposed building. Our team will:

1. Research the Massachusetts DOT curb cut and access management regulations
2. Explore possible points of access, including options that require sharing a driveway with the neighboring parcel

The constraints we will consider include utilities (water, sewer, electricity), terrain and slopes, erodible soil, conservation of the brook, legal restrictions (Worcester's local zoning codes, ordinances and deed restrictions), excess noise, community impact on the environment and any more we encounter through our investigations.

3.4 Identify Buildable Land

Once the specific constraints of our site are identified and evaluated, the next step is to organize and prioritize the constraints in order to identify buildable areas suitable for the Council Service Center. Some of the restrictions of concern for our site will be wetland regulations, traffic access, physical barriers, and accessibility. Considerations of these aspects for our site will reveal the space suitable for development of the Council Service Center.

3.5 Design a Site Layout

Once the buildable area is determined, our team will create alternate preliminary designs for the building space proposed. We will utilize AutoCAD to develop alternative layouts that are conducive to the needs of the council. Guidelines outlined in the 1998 Draft of Program of Requirements for a Council Service Center and feedback from the Mohegan Council on the applicability of this document will be heavily incorporated into the site layout design process. The alternate site layouts will include the building, access to and parking areas for the site, and chosen stormwater management practices. These layouts will be produced through an iterative process with the Mohegan Council through investigating their vision for the site layout and merging it with the desired guidelines from the Draft of Program of Requirements for a Council Service Center. We will ultimately select the final site layout from feedback after presenting the designed alternatives to the council. We will also continuously incorporate any feedback that is provided on the layout(s) to produce the best plan in line with their expectations.

3.6 Produce a Stormwater Management Plan

Based on Marsh's model (2010), our team has formulated the following steps in figure 7 for the stormwater management plan to be included in the site layout.

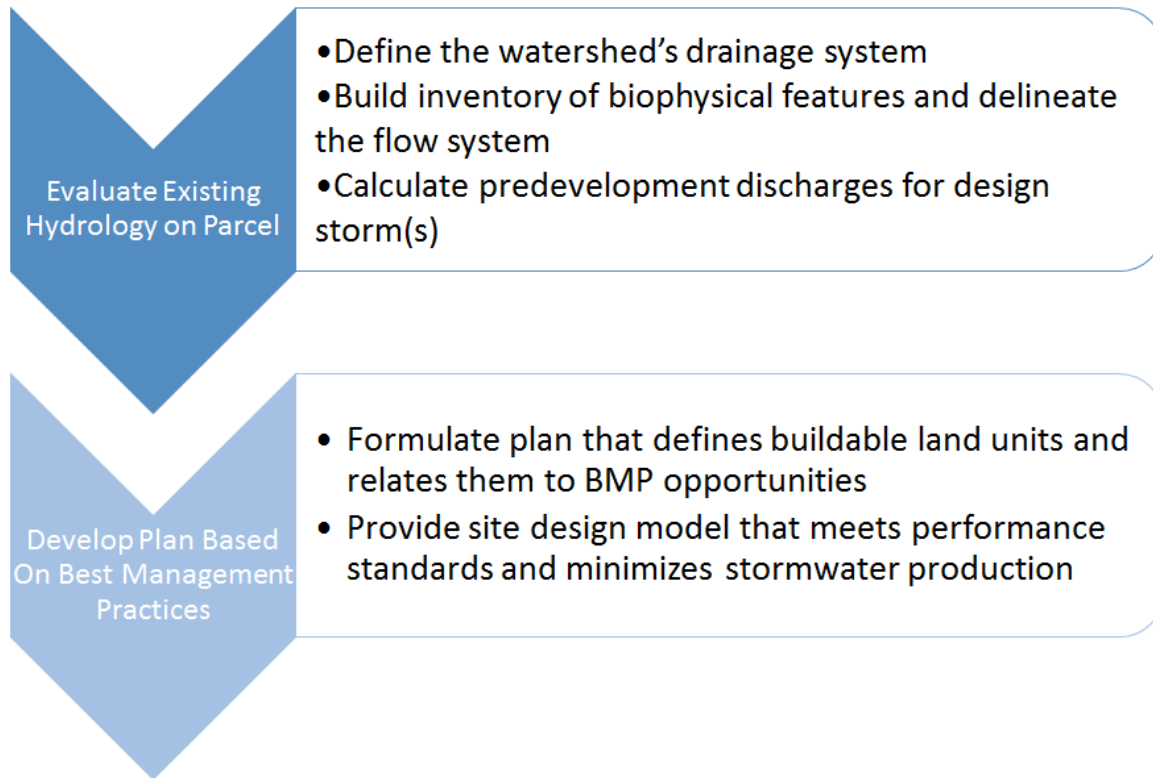


Figure 7: Plantation St. MQP Stormwater Management Flowchart

Step 1: Evaluate Existing Hydrology on Parcel

For undeveloped lands, the first step in the BMP process is to define the site's location in the drainage system within the local watershed, what runoff processes are operating there, and what conditions are associated with the location. It is helpful to model the predeveloped hydrologic performance within the area to estimate how much stormwater is generated, and the patterns and processes by which this runoff moves over the area downslope. Finding areas that do or do not contribute stormwater begins with the mapping of slopes, soils, vegetation, water features and land uses. Areas that include permeable soils, substantial vegetation, or are wetlands are ideal noncontributing areas. Field examinations can verify the absence or paucity of surface runoff. In this process, small channel features such as swales, gullies and rills can confirm or deny stormwater data (Marsh, 2010). In this way, field visits will be necessary to confirm or deny stormwater runoff areas identified from modeling.

As the existing hydrology must be evaluated in order to plan a mitigation effort, our team will first look at all the legal and physical restrictions on the parcel, creating a map that visualizes any deeded land, restricted building zones, wetlands, and other areas that cannot be developed.

After determining where development cannot occur and including water feature information on a map of the parcel, we will use GIS data to define the watershed of the parcel. The same program will be used to define slopes on the parcel while hydrologic mapping will provide a visual example of the flow delineation.

Step 2: Develop Plan Based on Best Management Practices

During the site layout process, our team will develop a BMP based stormwater management plan. Our team will research the BMPs and implement best practices in the site layout that meet performance standards and model this new hydrology within and around the site.

The team will calculate predevelopment and post development discharges for design storms indicated by the City of Worcester for the proposed stormwater management plan.

The city of Worcester, Massachusetts Wetlands Protection Ordinance and Wetlands Protection Regulations indicate that projects requiring hydraulic/hydrologic calculations need to provide plans showing labeled subcatchment areas, cover, soil types, drainage paths and design points. Analysis of the 1 (or 2), 10, 25, and 100-year frequency storms for predevelopment and post development conditions must also be provided along with a concise summary of peak flow rates and flood elevations and duration at design points (City of Worcester Office of Planning and Community Development, 2016). This model will be used in the team's site stormwater application to simulate a consultant level stormwater management final design.

3.7 Expected Results and Deliverables

There are deliverables and goals associated with the four main objectives of this project.

Firstly, the site analysis will include information from previous documents about the parcel. The products from this analysis will be data sheets and reports.

The team expects the second objective of identifying buildable land to be a shorter aspect of the project and be largely based on results and outcomes of the site analysis.

A stormwater management plan based on Best Management Practices will provide the design and spatial location of appropriate landscaping and infrastructure within the site layouts.

Thirdly, the team will design alternate site layouts in AutoCAD and print them on 11x18 paper to present to the Mohegan Council. The final layout will be identified after edits are made from feedback from the council.

4. References

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5. Appendices

Appendix A: Site Visits

Plantation Street Site Visit

Date: September 1st, 2017 @ 10:00

Weather: 64°F, Sunny

Attendees: Sydney Brooks, Abigail King, Thea Reyman

Initial walk-through of the site: The team observed important aspects of the site such as the overgrown paved path (Figure 1), the steep slopes and erosion around the brook (Figures 2 and 3) and the East-West Worcester hiking trail (Figure 4).



Figure 1: Abandoned Access Road through Parcel



Figure 2: Steep Slopes along Coal Mine Brook



Figure 3: Erosion along Coal Mine Brook



Figure 4: Marking for East-West Worcester Hiking Trail

Plantation Street Site Visit

Date: September 14th, 2017 @ 14:00

Weather: 76°F, Sunny

Attendees: Sydney Brooks, Tom Chamberland, Abigail King, Suzanne LePage, Paul Mathisen, Thea Reyman

Meeting with sponsor, Tom Chamberland

- The team discussed Tom’s vision for a building space: a marketing resource, a retail space, and a meeting space and to foster community involvement by sharing this space with local organizations. He also expressed the importance of sustainably developing the site to align with the Council's goal of reducing their environmental footprint
- The team received archival documents from the Mohegan Council pertaining to the parcel's historical ownership, use and development. Below is a list of all the documents received:
 - AOL Site Discussion Email Chain
 - Boy Scouts of America Project Schedule Email Chain
 - Boy Scouts of America Field Service Request Email Chain
 - Deeds and Easements

- Environmental Site Analysis
- Katahdin Area Boy Scout Council Service Center Advertisement
- Plan of Property
- Program of Requirements for the Council Service Center
- Salisbury Mills Service Center Plans
- Worcester Coal Mine News Article
- The team will continuously check in with Tom Chamberland and the Mohegan Council stakeholders via email.

Appendix B: Documents Received

The following documents are included in this appendix:

- Deeds and Easements
- Environmental Site Analysis
- Plan of Property
- 254 Mohegan Council - Site Development Plan
- Service Center Program of Requirements General 2009
- Plantation Site May 16 AutoCAD drafts
- Topography Maps May 16

Worcester District Registry of Deeds - 20/20 Perfect Vision i2 Document Detail Report

Current datetime: 3/22/2012 7:26:40 AM

| Doc# | Document Type | Town | Book/Page | File Date | Consideration |
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| Property-Street Address and/or Description | | | | | |
| PLANTATION ST WORCESTER | | | | | |
| Grantors | | | | | |
| LAKESIDE LIQUIDATING TRUST | | | | | |
| Grantees | | | | | |
| References-Book/Pg Description Recorded Year | | | | | |
| Registered Land Certificate(s)-Cert# Book/Pg | | | | | |

EXHIBIT A

PLAN OF PROPERTY
PREPARED FOR
LAKESIDE LIQUIDATING TRUST
PLANTATION STREET
WORCESTER, MASSACHUSETTS
SCALE: 1" = 60'

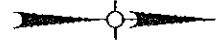
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|------|-------------|----------|
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| L2 | N 87°52' W | 21.06 |
| L3 | N 77°24' SE | 8.02 |
| L4 | N 62°32' W | 27.23 |
| L5 | S 79°47' SE | 17.80 |
| L6 | S 72°34' W | 33.06 |
| L7 | N 43°14' W | 20.00 |
| L8 | N 88°03' W | 25.30 |
| L9 | N 77°07' W | 20.00 |
| L10 | S 83°44' W | 8.56 |
| L11 | S 01°49' E | 8.97 |
| L12 | N 33°23' E | 19.71 |
| L13 | N 08°52' E | 6.00 |
| L14 | N 08°52' E | 26.91 |
| L15 | N 78°34' W | 28.43 |
| L16 | S 84°04' W | 27.27 |
| L17 | S 82°52' W | 27.27 |
| L18 | S 86°00' W | 6.24 |
| L19 | S 84°45' W | 27.84 |
| L20 | S 71°11' W | 18.6 |
| L21 | S 70°11' W | 42.88 |
| L22 | S 78°58' W | 5.72 |

PARCEL "A"
NF
LAKESIDE LIQUIDATING TRUST
REMAINING AREA = 72665 ACRES:

NOTRE DAME HEALTH CARE CENTER, INC.

NOTRE DAME HEALTH CARE CENTER, INC.

CITY OF WORCESTER
SEWER EASEMENT

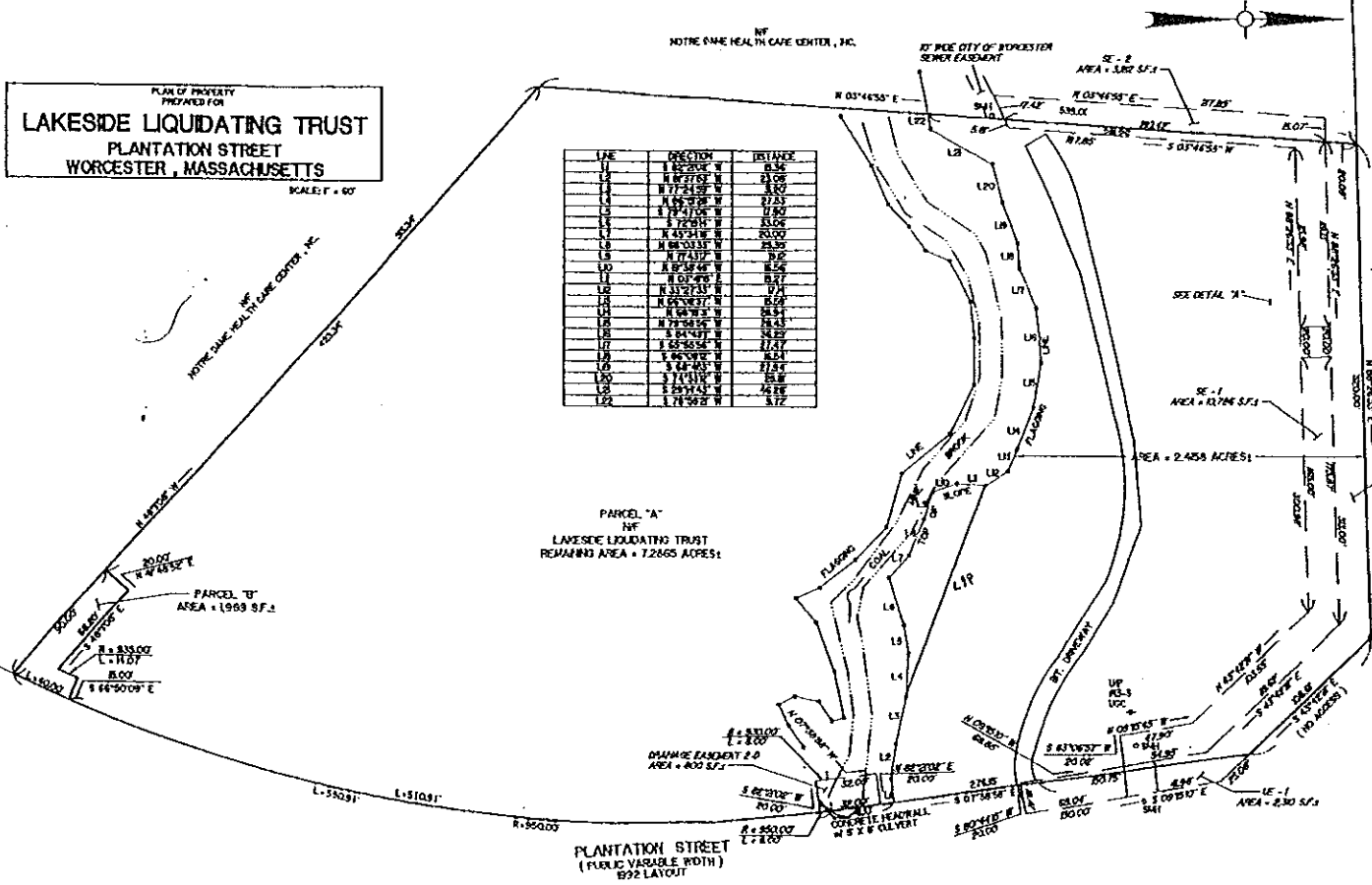


ATTEST: WORC. Anthony J. Vigiotti, Register

COMMONWEALTH OF MASSACHUSETTS
REG. STATE HIGHWAY LAYOUT
LAYOUT NO. 5035 - 1-4-59

BOOK 20872 PAGE 49

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Worcester District Registry of Deeds - 20/20 Perfect Vision i2 Document Detail Report

Current datetime: 3/22/2012 7:13:05 AM

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| Property-Street Address and/or Description | | | | | |
| PLANTATION ST LT B PL BK 736-57 | | | | | |
| Grantors | | | | | |
| PEZZELLA STEPHEN M, MULLINS THOMAS F III, KRONLUND KENNETH H JR, LAKESIDE LIQUIDATING TRUST | | | | | |
| Grantees | | | | | |
| FALLON FOUNDATION | | | | | |
| References-Book/Pg Description -Recorded Year | | | | | |
| Registered Land Certificate(s)-Cert# Book/Pg | | | | | |

198061

WE, STEPHEN M. PEZZELLA, KENNETH H. KRONLUND, JR. and THOMAS F. MULLINS III as Trustees of Lakeside Liquidating Trust, a Massachusetts nominee Trust u/d/t dated December 22, 1997 and recorded in the Worcester District Registry of Deeds in Book 19485, Page 304 (hereinafter "Lakeside" or "Grantor")

for consideration paid, and, in full consideration of less than One Hundred Dollars (\$100.00)

grant to THE FALLON FOUNDATION, a Massachusetts charitable corporation with a business address of 100 Central Street, Worcester, Worcester County, Massachusetts (hereinafter "Fallon Foundation" or "Grantee")

with quitclaim covenants

a parcel of land located on the west side of Plantation Street in Worcester shown as Parcel B on a plan by Cullinan Engineering Co., Inc. titled "Plan of Property Worcester, MA dated November 9, 1998 and recorded in Plan Book 136 as Plan 57 with the Worcester District Registry of Deeds and bounded and described as follows:

Beginning at a point on the westerly sideline of Plantation Street at the most southeasterly corner of the parcel to be described; said point also being the most northeasterly corner of land now or formerly of Notre Dame Health Care Center, Inc.;

THENCE N 48° 11' 08" W, along land now or formerly of Notre Dame Health Care Center, Inc. a distance of 90.00 feet to a point;

THENCE along other land now or formerly of Lakeside Liquidating Trust the following four (4) courses;

N 41° 48' 52" E, a distance of 20.00 feet to a point;

S 48° 11' 08" E, a distance of 68.20 feet to a point;

In a northerly direction by a curve to the left having a radius of 935.00 feet, an arc distance of 14.07 feet to a point;

AND S 66° 50' 09" E, a distance of 15.00 feet to a point on the westerly sideline of Plantation Street;

THENCE in a southerly direction along the westerly sideline of Plantation Street by a curve to the right having a radius of 950.00 feet, an arc distance of 40.00 feet to the Point of Beginning.

The above described parcel contains 1,989 square feet, more or less.

Being a portion of the premises conveyed to the Grantor by deed of Lakeside Realty Company dated December 29, 1997 and recorded in the Worcester District Registry of Deeds in Book 19485, Page 317.

This parcel is conveyed together with the benefit of certain restrictions recited in a deed from Grantor to Mohegan Council, Inc., Boy Scouts of America for adjacent property dated December 18, 1998 and recorded as Instrument Number 198060 on December 31, 1998 with the Worcester District Registry of Deeds.

Subject to the declaration and imposition of the following restrictions on the property:

A. RESTRICTION ON OTHER USES

The premises shall not be used by any health care provider competing with the Fallon Clinic, Inc. or any successor or assign of the Fallon Clinic, Inc..

B. CONSERVATION RESTRICTION AND PUBLIC TRAIL EASEMENT

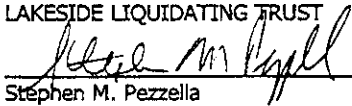


The premises are conveyed subject to the Conservation Restriction and Public Trail Easement granted to The Greater Worcester Land Trust, Inc. by Lakeside and recorded at the Worcester District Registry of Deeds on December 31, 1998 as Instrument Number 198060.

PLANTATION STREET, WORCESTER, MA.

98 DEC 31 AM 11:00

This sale does not constitute a sale or transfer of all the assets of Grantor located in Massachusetts.


IN WITNESS WHEREOF, the said Stephen M. Pezzella, Kenneth H. Kronlund, Jr. and Thomas F. Mullins, III as Trustees of Lakeside Liquidating Trust have caused this instrument to be signed, acknowledged and delivered for the Trust and on its behalf this 18th day of December, 1998.

LAKESIDE LIQUIDATING TRUST

 Stephen M. Pezzella
 Trustee

 Kenneth H. Kronlund, Jr.
 Trustee

 Thomas F. Mullins III
 Trustee

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss. December 18, 1998

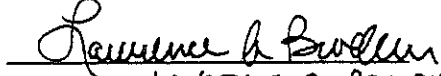
Then personally appeared the above-named Stephen M. Pezzella, Trustee of Lakeside Liquidating Trust and acknowledged the foregoing instrument to be his free act and deed as Trustee, before me


 LAWRENCE A. BRODEUR
 Notary Public
 My Commission Expires: 12-25-03

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss. December 18, 1998

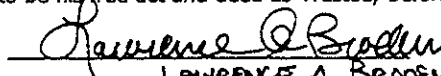
Then personally appeared the above-named Kenneth H. Kronlund, Jr., Trustee of Lakeside Liquidating Trust and acknowledged the foregoing instrument to be his free act and deed as Trustee, before me


 LAWRENCE A. BRODEUR
 Notary Public
 My Commission Expires: 12-25-03

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss. December 18, 1998

Then personally appeared the above-named Thomas F. Mullins, III, Trustee of Lakeside Liquidating Trust and acknowledged the foregoing instrument to be his free act and deed as Trustee, before me


 LAWRENCE A. BRODEUR
 Notary Public
 My Commission Expires: 12-25-03

ATTEST: WORC. Anthony J. Vigliotti, Register

Worcester District Registry of Deeds - 20/20 Perfect Vision i2 Document Detail Report

Current datetime: 3/22/2012 7:12:59 AM

| Doc# | Document Type | Town | Book/Page | File Date | Consideration |
|---|---------------|------|-----------|------------|---------------|
| 198058 | CERTIFICATE | | 20872/28 | 12/31/1998 | |
| Property-Street Address and/or Description | | | | | |
| SEE 19485-304 | | | | | |
| Grantors | | | | | |
| PEZZELLA STEPHEN M, MULLINS THOMAS F III, KRONLUND KENNETH H JR, LAKESIDE LIQUIDATING TRUST | | | | | |
| Grantees | | | | | |
| | | | | | |
| References-Book/Pg Description Recorded Year | | | | | |
| 19485/304 DEC 1997 | | | | | |
| Registered Land Certificate(s)-Cert# Book/Pg | | | | | |
| | | | | | |

TRUSTEES CERTIFICATE
LAKESIDE LIQUIDATING TRUST

We, Stephen M. Pezzella, Kenneth H. Kronlund, Jr. and Thomas F. Mullins III, being all the present Trustees of Lakeside Liquidating Trust w/d/t dated December 22, 1997 and recorded on December 31, 1997 in the Worcester District Registry of Deeds in Book 19485, Page 304 hereby certify as follows:

1. That we have been authorized by the beneficiaries of said Trust to transfer to The Fallon Foundation as a charitable donation (or for consideration of less than One Hundred Dollars (\$100.00)) a parcel of land located on the westerly sideline of Plantation Street shown as Parcel B on a plan by Cullinan Engineering Co., Inc. titled "Plan of Property-Worcester, MA" dated November 9, 1998 and recorded in Plan Book 736 as Plan 57 in the Worcester District Registry of Deeds. Said parcel contains 1989 square feet.

Said conveyance to be subject a Restriction on Use by Competitors of the Fallon Clinic, Inc. and subject to a Conservation Restriction and Public Trail Easement to the Greater Worcester Land Trust, Inc.

- 2. Lakeside Liquidating Trust is as of this date presently in existence.
- 3. There are no unrecorded amendments to this Trust.
- 4. The beneficiaries of the Trust are not corporations.

WITNESS our hands and seals this 18th day of December 1998.

 Stephen M. Pezzella
 Trustee as aforesaid

 Thomas F. Mullins, III
 Trustee as aforesaid

 Kenneth H. Kronlund, Jr.
 Trustee as aforesaid

98 DEC 31 AM 11:00

WOR. COUNTY ABST. CO.
ORDER NO P3869

MAN 120: JOHN M. COLLINS
47 MEMORIAL DRIVE
SARASOTA FL 34237

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss

December 18, 1998

Then personally appeared the above-named Stephen M. Pezzella and acknowledged the foregoing instrument to be his free act and deed, before me.

Lawrence A. Brodeur
Notary Public LAWRENCE A. BRODEUR
My Commission Expires: 12-25-2003

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss

December 18, 1998

Then personally appeared the above-named Thomas F. Mullins, III and acknowledged the foregoing instrument to be his free act and deed, before me.

Lawrence A. Brodeur
Notary Public LAWRENCE A. BRODEUR
My Commission Expires: 12-25-2003

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss

December 18, 1998

Then personally appeared the above-named Kenneth H. Kronlund, Jr. and acknowledged the foregoing instrument to be his free act and deed, before me.

Lawrence A. Brodeur
Notary Public LAWRENCE A. BRODEUR
My Commission Expires: 12-25-2003

ATTEST: WORC. Anthony J. Vigliotti, Register

Worcester District Registry of Deeds - 20/20 Perfect Vision i2 Document Detail Report

Current datetime: 3/22/2012 7:12:58 AM

| Doc# | Document Type | Town | Book/Page | File Date | Consideration |
|---|---------------|------|-----------|------------|---------------|
| 198057 | CERTIFICATE | | 20872/26 | 12/31/1998 | |
| Property-Street Address and/or Description | | | | | |
| SEE 19485-304 | | | | | |
| Grantors | | | | | |
| PEZZELLA STEPHEN M, MULLINS THOMAS F III, KRONLUND KENNETH H JR, LAKESIDE LIQUIDATING TRUST | | | | | |
| Grantees | | | | | |
| | | | | | |
| References-Book/Pg Description Recorded Year | | | | | |
| 19485/304 DEC 1997 | | | | | |
| Registered Land Certificate(s)-Cert# Book/Pg | | | | | |
| | | | | | |

198057

TRUSTEES CERTIFICATE
LAKESIDE LIQUIDATING TRUST

We, Stephen M. Pezzella, Kenneth H. Kronlund, Jr. and Thomas F. Mullins III, being all the present Trustees of Lakeside Liquidating Trust u/d/t dated December 22, 1997 and recorded on December 31, 1997 in the Worcester District Registry of Deeds in Book 19485, Page 304 hereby certify as follows:

1. That we have been authorized by the beneficiaries of said Trust to grant to the Greater Worcester Land Trust, Inc. a Conservation Restriction and Public Trail Easement on property containing approximately 7.3 acres, located on the west side of Plantation Street south of the Interstate 290 sideline in Worcester, Massachusetts and shown as Parcels A & B on a plan by Cullinan Engineering Co., Inc. titled "Plan of Property - Worcester, MA" dated November 9, 1998 and recorded with the Worcester District Registry of Deeds in Plan Book 736 as Plan 57.

2. Lakeside Liquidating Trust is as of this date presently in existence.

3. There are no unrecorded amendments to this Trust.

4. The beneficiaries of the Trust are not corporations.

WITNESS our hands and seals this 18TH day of December 1998.

Stephen M. Pezzella
Trustee as aforesaid

Thomas F. Mullins, III
Trustee as aforesaid

Kenneth H. Kronlund, Jr.
Trustee as aforesaid

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss

December 18, 1998

Then personally appeared the above-named Stephen M. Pezzella and acknowledged the foregoing instrument to be his free act and deed, before me.

Notary Public LAWRENCE A. BRODEUR
My Commission Expires: 12-25-03

WOR. COUNTY ABS. CO.
ORDER NO. P3869

MAIL TO: JOHN M. COLLINS
40 MEMORIAL DRIVE
ANDOVERSBURY, MA 0145

98 DEC 31 AM 11:00

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss

December 18, 1998

Then personally appeared the above-named Thomas F. Mullins, III and acknowledged the foregoing instrument to be his free act and deed, before me.

Lawrence A. Brodeur
Notary Public LAWRENCE A. BRODEUR
My Commission Expires: 12-25-03

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss

December 18, 1998

Then personally appeared the above-named Kenneth H. Kronlund, Jr. and acknowledged the foregoing instrument to be his free act and deed, before me.

Lawrence A. Brodeur
Notary Public LAWRENCE A. BRODEUR
My Commission Expires: 12-25-03

ATTEST: WORC. Anthony J. Vigliotti, Register

Worcester District Registry of Deeds - 20/20 Perfect Vision i2 Document Detail Report

Current datetime: 3/22/2012 7:13:00 AM

| Doc# | Document Type | Town | Book/Page | File Date | Consideration |
|---|---------------|------|-----------|------------|---------------|
| 198059 | CERTIFICATE | | 20872/30 | 12/31/1998 | |
| Property-Street Address and/or Description | | | | | |
| SEE 19485-304 | | | | | |
| Grantors | | | | | |
| PEZZELLA STEPHEN M, MULLINS THOMAS F III, KRONLUND KENNETH H JR, LAKESIDE LIQUIDATING TRUST | | | | | |
| Grantees | | | | | |
| | | | | | |
| References-Book/Pg Description Recorded Year | | | | | |
| 19485/304 DEC 1997 | | | | | |
| Registered Land Certificate(s)-Cert# Book/Pg | | | | | |
| | | | | | |

198059

TRUSTEES CERTIFICATE
LAKESIDE LIQUIDATING TRUST

JKP

We, Stephen M. Pezzella, Kenneth H. Kronlund, Jr. and Thomas F. Mullins III, being all the present Trustees of Lakeside Liquidating Trust w/d/t dated December 22, 1997 and recorded on December 31, 1997 in the Worcester District Registry of Deeds in Book 19485, Page 304 hereby certify as follows:

1. That we have been authorized by the beneficiaries of said Trust to transfer as a charitable donation (or for consideration of less than One Hundred Dollars (\$100.00)) a parcel of land located on the westerly sideline of Plantation Street along the southerly sideline of Interstate 290 containing 7.2865 acres to the Boy Scouts of America Mohegan Council.

This conveyance is to be for the purpose of providing the Mohegan Council, Inc., Boy Scouts of America with a site for a new headquarters building. The conveyance will be subject to a Conservation Restriction and Public Trail Easement to the Greater Worcester Land Trust, Inc., a Restriction on Use of Green Space, a Restriction on Use by Competitors of the Fallon Clinic, Inc. and a reversionary interest in Lakeside should the Mohegan Council fail to construct its' headquarters building on the parcel to be conveyed within fifteen (15) years of the date of conveyance.

- 2. Lakeside Liquidating Trust is as of this date presently in existence.
- 3. There are no unrecorded amendments to this Trust.
- 4. The beneficiaries of the Trust are not corporations.

WITNESS our hands and seals this 18th day of December 1998.

Stephen M. Pezzella

Stephen M. Pezzella
Trustee as aforesaid

Thomas F. Mullins III

Thomas F. Mullins, III
Trustee as aforesaid

Kenneth H. Kronlund, Jr.

Kenneth H. Kronlund, Jr.
Trustee as aforesaid

98 DEC 31 AM 11:00

WOR. COUNTY ABST. CO.
ORDER NO *p 3869*

MAIL TO: JOHN M. CULIAS
417 MEMORIAL BRIDGE
WINDSOR MA 01845

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss

December 18, 1998

Then personally appeared the above-named Stephen M. Pezzella and acknowledged the foregoing instrument to be his free act and deed, before me.

Lawrence A. Brodeur
Notary Public LAWRENCE A. BRODEUR
My Commission Expires: 12-25-03

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss

December 18, 1998

Then personally appeared the above-named Thomas F. Mullins, III and acknowledged the foregoing instrument to be his free act and deed, before me.

Lawrence A. Brodeur
Notary Public LAWRENCE A. BRODEUR
My Commission Expires: 12-25-03

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss

December 18, 1998

Then personally appeared the above-named Kenneth H. Kronlund, Jr. and acknowledged the foregoing instrument to be his free act and deed, before me.

Lawrence A. Brodeur
Notary Public LAWRENCE A. BRODEUR
My Commission Expires: 12-25-03

ATTEST: WORC. Anthony J. Vigliotti, Register

O'HARA - BUTHRAY ASSOCIATES, INC.

Real Estate Appraisal Services

11 Harvard Street
Worcester, MA 01609

Tel: (508) 757-9381
Fax: (508) 752-1544

Michael J. O'Hara, MAI, MRA
Joel Buthray, MAI

December 14, 1998

Mr. Kenneth Kronlund, Trustee
Lakeside Liquidating Trust
425 North Lake Avenue
Worcester, MA 01605

Dear Mr. Kronlund:

An appraisal of the land owned by Kenneth Kronlund, Thomas Mullins and Stephen Pezzella, as Trustees of Lakeside Liquidating Trust at Plantation Street, Worcester, Massachusetts has been completed at your request. The subject is comprised of a 7.2865± acre (AC) tract zoned Business, Office (BO-2.0). The property is also within a Water Resources Protection Overlay District (GP-2 and GP-3) zone.

As the subject is unencumbered by a lease, the property rights appraised are the fee simple estate.

As you stated, the site is to be sold to the Boy Scouts of America, Inc., with the stipulation that they may only develop 40% of the site (2.9±AC). An easement will be granted in perpetuity to the Greater Worcester Land Trust, Inc. for the remaining 60% of the land (4.4±AC) for trail and conservation use, which is effectively the same as gifting them this land fee simple.

At your request, the property has been valued under two premises.

Premise One is the market value of the property in its entirety.

Under Premise Two, the market value has been broken out into two components: the market value of the land to be developed by the Boy Scouts of America; and the market value of the land to be essentially gifted to the Greater Worcester Land Trust, Inc.

The estimates of value and final conclusions are subject to the assumptions and limiting conditions (Pages 6-7), and to the special limiting conditions (Page 9). They are contingent on the subject conforming to all federal, state, and municipal regulations.

The miscellaneous items in the Addendum are included to facilitate identification of the property and to support or clarify information presented in this 50 page report.

Lakeside Liquidating Trust
December 14, 1998

The document which follows is a complete appraisal as defined by the Uniform Standards of Professional Practice (USPAP) presented in a self-contained report. The appraisal is based on inspection on December 3, 1998, and on pertinent facts about the subject as of this date, and on the compilation and analysis of market data.

The estimated market values of the fee estate of the subject property as of December 3, 1998 are:

PREMISE ONE
EIGHT HUNDRED THOUSAND DOLLARS
\$800,000

PREMISE TWO
LAND TO BE DEVELOPED BY BOY SCOUTS OF AMERICA
FOUR HUNDRED FIVE THOUSAND DOLLARS
\$405,000

LAND TO BE GIFTED TO GREATER WORCESTER LAND TRUST, INC.
THREE HUNDRED NINETY-FIVE THOUSAND DOLLARS
\$395,000

This firm disclaims the validity of appraisal reports which lack original signatures on the letter of transmittal, on the Certification, and after the reconciliation of value estimates.

Respectfully submitted,



Joel A. Buthray, MAI
Certified General
Real Estate Appraiser
Commonwealth of MA #929

EXECUTIVE SUMMARY

| | |
|-----------------------------------|--|
| Report prepared for | Lakeside Liquidating Trust |
| Property owner | Kenneth Kronlund, Thomas Mullins and Stephen Pezzella, as Trustees of Lakeside Liquidating Trust |
| Property classification | Commercial land |
| Property location | Plantation Street Worcester, Massachusetts |
| Purpose of the report | Estimate market values |
| Use of the report | Client's use |
| Property rights appraised | Fee simple estate |
| Date of inspection | December 3, 1998 |
| Date of valuation | December 3, 1998 |
| Date of report | December 14, 1998 |
| Zone classification | Business, Office (BO-2.0). The property is also within a Water Resources Protection Overlay District (GP-2 and GP-3) zone. |
| Assessment data | Assessed as part of a larger parcel |
| Size of parcel | 7.2865±AC with 810.96± feet of frontage (FF) on Plantation Street |
| Property improvements | None |
| Highest and best use If vacant | Build to suit or owner occupied building allowed by zoning |
| Marketing period | 1 year |
| Valuation analysis | |
| Site value | |
| Premise One | \$800,000 |
| Premise Two | |
| Boy Scouts Of America | \$405,000 |
| Greater Worcester Land Trust | \$395,000 |
| Cost approach | Not applicable |
| Sales comparison approach | See site value |
| Income capitalization approach | Not developed |

FIRST AMENDMENT TO EASEMENT AGREEMENT

FIRST AMENDMENT TO EASEMENT AGREEMENT, dated as of ~~May~~^{July 10}, 1992 (this "Amendment"), and effective upon recording with the Worcester District Registry of Deeds (the "Registry"), between THE FALLON CLINIC, INC. (the "Grantor"), having its principal place of business at 630 Plantation Street, Worcester, Massachusetts, NOTRE DAME HEALTH CARE CENTER, INC. (the "Grantee"), having its principal place of business at 555 Plantation Street, Worcester, Massachusetts, and NOTRE DAME ~~NORMAL INSTITUTE~~^{LONG-TERM CARE CENTER} (the "Institute"; the Grantor, the Grantee and the Institute are collectively called the "Parties").

WHEREAS, the Parties have entered into that certain Easement Agreement, dated as of December 1, 1991 (the "Easement Agreement"), and recorded with the Registry at Book 13830, Page 003; and

WHEREAS, the Parties desire to amend certain provisions of the Easement Agreement; and

WHEREAS, the Parties desire to substitute for Exhibit A to the Easement Agreement the revised plan attached hereto as Exhibit A;

NOW THEREFORE, in consideration of the foregoing and other good and valuable mutual consideration, the receipt and sufficiency of which are hereby acknowledged, the Parties hereby agree as follows:

1. Exhibit A to the Easement Agreement is hereby deleted and Exhibit A attached hereto is substituted therefor.
2. Section 1 of the Easement Agreement is hereby deleted in its entirety and the following is substituted therefor:

"Grant of Easement; Purpose of Easement: The Grantor hereby grants to the Grantee and the Notre Dame Normal Institute (the "Institute"), and each of their respective successors and assigns, an easement (the "Easement") to use the portion of the Easement Area as is on the Grantor's Premises, as such terms are hereinafter defined, in common with others entitled thereto for the purposes set forth herein. The Easement may be used by the Grantee for the purpose of providing utility services sufficient to serve a 123-bed nursing home to be developed and operated on the Grantee's Premises, as such term is hereinafter defined, and to serve any other future use of such premises of substantially equivalent intensity. The

JUL 23 9 39 AM '92

Easement may also be used by the Institute for the purpose of providing underground telephone service sufficient to serve the current use of the Remaining Property, as such term is hereinafter defined, and to serve any other future use of such premises of substantially equivalent intensity."

3. The first sentence of Section 3 of the Easement Agreement is hereby deleted in its entirety and the following is substituted therefor:

"The easement area (the "Easement Area") shall be a strip of land approximately forty (40) feet wide partially on the property belonging to the Grantor on Plantation Street in Worcester, Massachusetts (the "Grantor's Premises"), shown as "Fallon's Premises" on the plan recorded in the Registry at Plan Book 654, Plan 89 (the "Easement Plan"), running from Plantation Street to the westerly boundary of the Grantor's Premises, and partially on the Grantee's Premises (as hereinafter defined) as shown on the Easement Plan."

4. The third sentence of Section 3 of the Easement Agreement is hereby deleted in its entirety and the following is substituted therefor:

"The dominant estate shall be that certain parcel of land owned by the Grantee having an area of approximately 7.16 acres abutting the westerly and southerly boundaries of the Grantor's Premises, shown as "Notre Dame Normal Institute to be Deeded to Notre Dame Health Care Center, Inc." on the Easement Plan (the "Grantee's Premises") and that certain parcel of land owned by the Notre Dame Normal Institute (the "Institute") having an area of approximately 44.5 acres abutting the westerly and southerly boundaries of the Grantee's Premises, and more particularly described in the plan of land recorded in the Registry at Plan Book 336, Plan 64 (the "Remaining Land")."

5. The first and second paragraphs of Section 4 of the Easement Agreement are hereby deleted in their entirety and the following substituted therefor:

"Description of Easement: The Easement shall consist only of (i) the exclusive easement for the benefit of the Grantee's Premises, the Grantor's Premises and the Remaining Land (a) with respect to the Grantee's Premises and the Grantor's Premises, to use and enter upon the General Utilities Easement Area for the purpose of laying out, constructing, installing, using, repairing, maintaining and replacing television

or other information communication, electrical, gas, water, and telephone cables, lines, wires, pipes, conduits and appurtenances, together with the right of access to and egress from the Easement Area for such purposes and (b) with respect to the Remaining Property, to use and enter upon the General Utilities Easement Area for the purpose of laying out, constructing, installing, using, repairing, maintaining and replacing telephone cables, lines, wires, pipes, conduits and appurtenances, together with the right of access to and egress from the Easement Area for such purposes (the "General Utilities Easement"); and (ii) the nonexclusive easement for the benefit of the Grantee's Premises to use and enter upon the Sewer Easement Area for the purpose of laying out, constructing, installing, using, repairing, maintaining and replacing sewer pipes, conduits and appurtenances, together with the right of access to and egress from the Easement Area for the foregoing purposes (the "Sewer Easement").

The Easement shall run with the land and shall bind and inure to the benefit of the Grantor, the Grantee and the Institute, respectively, and their respective successors in title to the Grantor's Premises, the Grantee's Premises and the Remaining Property, respectively. The Grantee or the Institute shall be responsible for maintaining and repairing any and all wires, cables, pipes, conduits and other equipment and appurtenances installed by it in the Easement Area. The Grantor shall cooperate with the Grantee and the Institute in such maintenance and repair. The Grantee or the Institute, respectively, shall be responsible for restoring the surface of the Easement Area to substantially the same condition as it was prior to the commencement of any work therein by or for the Grantee or the Institute, respectively, upon completion of any such work.

6. Section 5 of the Easement Agreement is hereby deleted in its entirety and the following is substituted therefor:

"5. Fallon's Right to Connect Utilities: The Grantor and its successors in title to the Grantor's Premises shall have the right to connect utilities serving the Grantor's Premises to any water supply and to any sewer line installed in the Easement Area to serve the Grantee's Premises, subject to (i) reasonable agreement by the Grantee as to location and manner of making the connection and the capacity of the existing water and sewer lines to serve the proposed connection; and (ii) approval by any governmental authority having

jurisdiction over any such connection. The Grantor shall bear the cost of obtaining any such required approval and making any such connection. The Grantee shall install, at its own expense, sewer and water connection stubs in the approximate location shown on Exhibit A attached hereto. The cost of any change in the location or dimension of such connection point for the benefit of the Grantor shall be borne entirely by the Grantor.

In addition, only if, as and when the Grantee installs underground telephone service in the Easement Area, the Grantee shall also provide, in the same trench in the Easement Area, an additional conduit for future telephone service to the Grantor's Premises as shown on the Exhibit A (but shall not be obligated to provide the telephone cable or any appurtenant equipment). The installation of such telephone conduit by the Grantee shall be subject to the approval of the telephone utility company providing the service and of any governmental authority having jurisdiction. The Grantor shall pay the cost of installing any telephone cable in such conduit and of any appurtenant equipment, and shall thereafter bear the cost of maintaining, repairing and replacing the telephone conduit, cable and appurtenant equipment serving the Grantor's Premises.

No provision contained in this Agreement shall in any way affect the Grantee's or the Institute's right to use and to continue to use the existing overhead telephone line which spans the Grantor's Premises and currently provides telephone service to the Grantee's Premises and the Remaining Property (the "Overhead Line"). If both the Grantee and the Institute install underground telephone service in the Easement Area the Grantor may, only if, as and when such installation is completed by both the Grantee and the Institute and telephone service to both the Grantee's Premises and the Remaining Property has commenced through the underground telephone service in the Easement Area, remove the Overhead Line at its sole expense, subject to approval by the telephone utility company and any governmental authority having jurisdiction."

7. Except as amended by this Amendment, all the terms and provisions contained in the Easement Agreement remain unchanged and are in full force and effect.

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed and delivered as a sealed instrument by their respective duly authorized representatives, as of the date first set forth above.

FALLON CLINIC, INC.

By: Robert E. Madigan
ROBERT E. MADIGAN, JR.
Title: Human Factor

NOTRE DAME HEALTH CARE CENTER, INC.

By: Catherine Quinlan
Title: President

Long Term Care Center
NOTRE DAME ~~NORMAL INSTITUTE~~

By: Catherine Quinlan
Title: President

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss.

June 26, 1992

Then personally appeared the above-named Robert E. Maher Jr., the Administrator of Fallon Clinic, Inc., and acknowledged the foregoing instrument to be his/her free act and deed before me

Susan M. Naraghi
Notary Public
My commission expires: March 11, 1994
SUSAN M. NARAGHI
NOTARY PUBLIC
My Commission Expires March 11, 1994

COMMONWEALTH OF MASSACHUSETTS

Essex, ss.

July 10, 1992

Then personally appeared the above-named CATHERINE OWENS, the PRESIDENT of Notre Dame Health Care Center, Inc., and acknowledged the foregoing instrument to be his/her free act and deed before me

Judith E. Feldman
Notary Public
My commission expires: 3/13/98

COMMONWEALTH OF MASSACHUSETTS

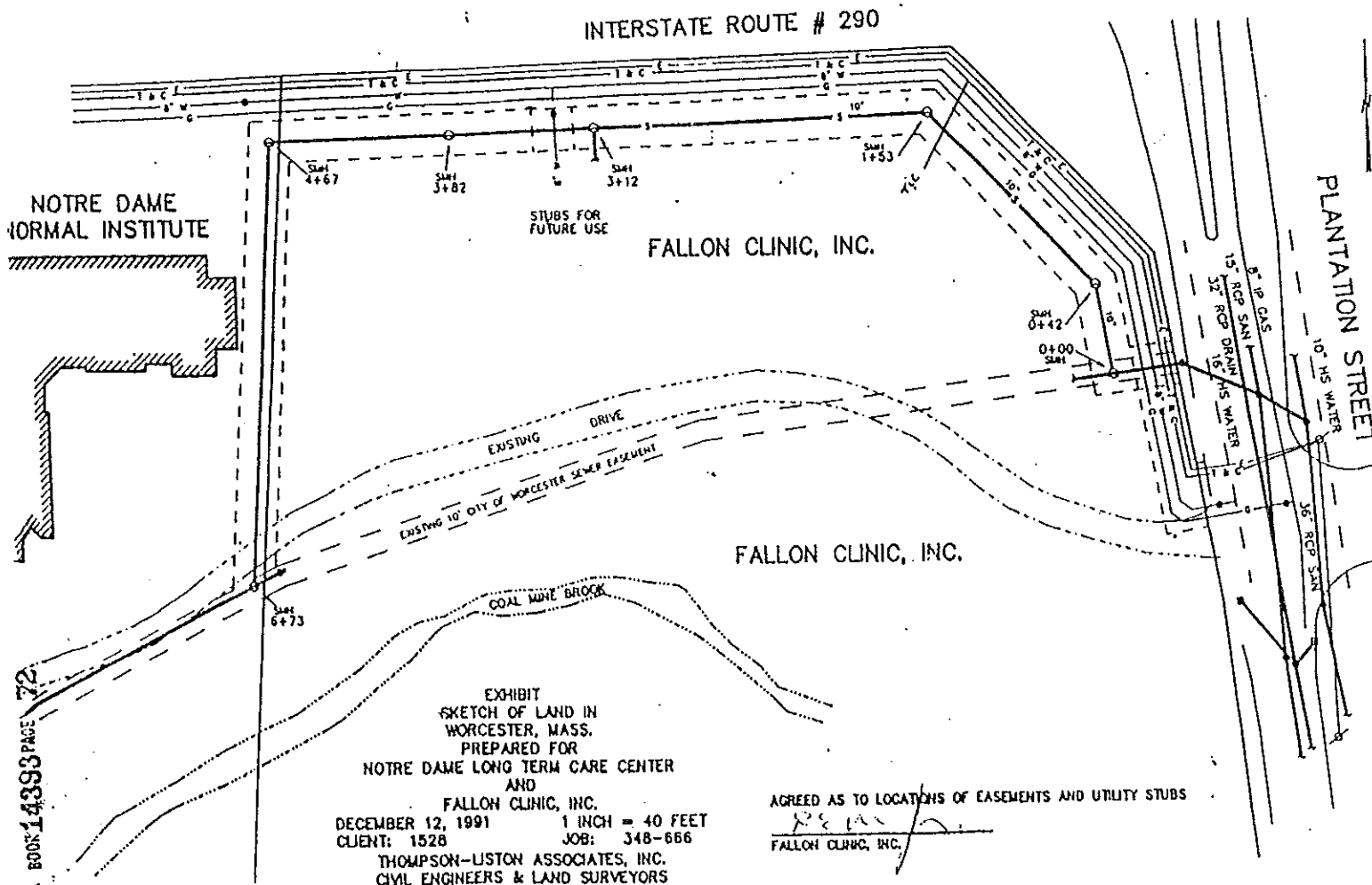
Essex, ss.

July 10, 1992

Then personally appeared the above-named CATHERINE OWENS, the PRESIDENT of Notre Dame Normal Institute, and acknowledged the foregoing instrument to be his/her free act and deed before me

Judith E. Feldman
Notary Public
My commission expires: 3/15/98

EXHIBIT "A"



ATTEST: WORC., Anthony J. Vigliotti, Register

BOOK 14393 PAGE 72

EXHIBIT
SKETCH OF LAND IN
WORCESTER, MASS.
PREPARED FOR
NOTRE DAME LONG TERM CARE CENTER
AND
FALLON CLINIC, INC.
DECEMBER 12, 1991 1 INCH = 40 FEET
CLIENT: 1528 JOB: 348-666
THOMPSON-LISTON ASSOCIATES, INC.
CIVIL ENGINEERS & LAND SURVEYORS

AGREED AS TO LOCATIONS OF EASEMENTS AND UTILITY STUBS
REIN
FALLON CLINIC, INC.

Green
1/4/91

EASEMENT AGREEMENT

EASEMENT AGREEMENT, dated as of December 1, 1991 (this "Agreement") and effective upon recording with the Worcester District Registry of Deeds (the "Registry"), between the Fallon Clinic, Inc. (the "Grantor"), having its principal place of business at 630 Plantation Street, Worcester, Massachusetts, and Notre Dame Health Care Center, Inc. (the "Grantee"; the Grantor and the Grantee are collectively called the "Parties"), having its principal place of business at 555 Plantation Street, Worcester, Massachusetts.

Confirmed
B14455
P 136

Property: 555 Plantation Street Worcester ma

1. Grant of Easement; Purpose of Easement: The Grantor hereby grants to the Grantee, its successors and assigns, an easement (the "Easement") to use the portion of the Easement Area as is on the Grantor's Premises, as such terms are hereinafter defined, in common with others entitled thereto for the purposes set forth herein. The Easement may be used by the Grantee for the purpose of providing utility services sufficient to serve a 123-bed nursing home to be developed and operated on the Grantee's Premises, as such term is hereinafter defined, and to serve any other future use of such premises of substantially equivalent intensity.

2. Consideration: The consideration for the Easement shall be a total of One Dollar (\$1) paid to the Grantor by the Grantee, the receipt and sufficiency of which are hereby acknowledged by the Grantor by its signature hereon.

3. Easement Area and Dominant and Servient Estates: The easement area (the "Easement Area") shall be a strip of land approximately forty (40) feet wide partially on the property belonging to the Grantor on Plantation Street in Worcester, Massachusetts (the "Grantor's Premises"), shown as "Fallon's Premises" on the plan attached hereto as Exhibit A (the "Easement Plan") and recorded herewith, running from Plantation Street to the westerly boundary of the Grantor's Premises, and partially on the Grantee's Premises as shown on the Easement Plan. The servient estate shall be the Grantor's Premises. The dominant estate shall be that certain parcel of land owned by the Grantee having an area of approximately 7.16 acres abutting the westerly and southerly boundaries of the Grantor's Premises, shown as "Notre Dame Normal Institute to be Deeded to Notre Dame Health Care Center, Inc." on the Easement Plan (the "Grantee's Premises"). The Easement Area, as further shown on the Easement Plan, comprises two areas: (i) a strip of land of approximately twenty (20) feet wide (the "Sewer Easement Area"); and (ii) the portion of the Easement Area not included in the Sewer Easement Area (the "General Utilities Easement Area").

Dec 16 3 42 PM '91

4. Description of Easement: The Easement shall consist only of (i) the exclusive easement for the benefit of the Grantee's or the Grantor's respective Premises to use and enter upon the General Utilities Easement Area for the purpose of laying out, constructing, installing, using, repairing, maintaining and replacing television or other information communication, electrical, gas, water, and telephone cables, lines, wires, pipes, conduits and appurtenances, together with the right of access to and egress from the Easement Area for the foregoing purposes (the "General Utilities Easement"); and (ii) the nonexclusive easement for the benefit of the Grantee's Premises to use and enter upon the Sewer Easement Area for the purpose of laying out, constructing, installing, using, repairing, maintaining and replacing sewer pipes, conduits and appurtenances, together with the right of access to and egress from the Easement Area for the foregoing purposes (the "Sewer Easement").

The Easement shall run with the land and shall bind and inure to the benefit of the Grantor and the Grantee, respectively, and their respective successors in title to the Grantor's Premises and the Grantee's Premises, respectively. The Grantee shall be responsible for maintaining and repairing any and all wires, cables, pipes, conduits and other equipment and appurtenances installed by it in the Easement Area. The Grantor shall cooperate with the Grantee in such maintenance and repair. The Grantee shall be responsible for restoring the surface of the Easement Area to substantially the same condition as it was prior to the commencement of any work therein by or for the Grantee, upon completion of any such work.

Nothing in this Agreement shall modify, amend, alter or affect in any way any person's right to utilize the existing municipal sewer line located on Grantor's and Grantee's Premises nor, upon completion of any sewer line installed in the Easement Area and acceptance of such new sewer line and associated easement by the City of Worcester, as contemplated hereby, shall anything in this Agreement limit the right of any person to use such new sewer line in any manner permitted by the City of Worcester and any other governmental agency having jurisdiction.

5. Fallon's Right to Connect Utilities: The Grantor and its successors in title to the Grantor's Premises shall have the right to connect utilities serving the Grantor's Premises to any water supply and to any sewer line installed in the Easement Area to serve the Grantee's Premises, subject to reasonable agreement by the Grantee as to the location and manner of making the connection and the capacity of the existing utility lines to serve the proposed connection, and subject to approval by any governmental authority having jurisdiction over any such connection. The Grantor shall bear the cost of making any such connection. The Grantee shall install at its own expense,

however, sewer and water connection stubs in the number and approximate location shown on the Plan entitled "Site Plan", dated August 5, 1991 and revised on or about December 9, 1991 prepared by Thompson-Liston Associates, copies of which have been initialed by the Grantor and the Grantee and delivered to one another on or about the date hereof. The cost of any change in the number, location or dimension of such connection points for the benefit of the Grantor shall be borne entirely by the Grantor.

In addition, if the Grantee installs underground telephone service in the Easement Area, it shall also provide, in the same trench in the Easement Area, an additional conduit for future telephone service to the Grantor's Premises (but shall not be obligated to provide the telephone cable or any appurtenant equipment). The installation of such telephone conduit by the Grantee shall be subject to the approval of the telephone utility company providing the service and of any governmental authority having jurisdiction. The Grantor shall pay the cost of installing any telephone cable in such conduit and of any appurtenant equipment, and shall thereafter bear the cost of maintaining, repairing and replacing the telephone conduit, cable and appurtenant equipment serving Fallon's Premises.

6. Compliance with Law and City of Worcester Requirements: Each party agrees that it shall exercise its rights under this Agreement only in compliance with and subject to applicable federal, state or local laws, statutes, ordinances, codes, rules and regulations, and only with any required approval or consent of utility companies, service providers or governmental agencies having jurisdiction over or rights in the Easement Area. In addition, each Party agrees to grant an easement within the Easement Area to any utility company and/or to the City of Worcester or any other governmental authority requiring such an easement for the purposes set forth in Paragraphs 3 and 4 hereof, in form and substance satisfactory to such utility company or governmental agency or authority. Finally, the Parties agree that the Sewer Easement shall be abandoned by the Grantee at such time as the Grantor grants and the City of Worcester accepts an easement in the Sewer Easement Area for the benefit of the City of Worcester to operate and maintain as a municipal sewer the sewer trunk line to be installed by the Grantee in the Sewer Easement Area. The Grantor will cooperate with the Grantee in obtaining such acceptance by the City of Worcester, and will grant any easement in the Sewer Easement Area, and execute and deliver such other documents and instruments, as the City of Worcester may require in connection with such acceptance.

8. Insurance and Indemnification: Each Party shall obtain and maintain liability and other insurance covering the Easement Area in such commercially reasonable amounts and coverages as shall be mutually agreed upon. In addition, each Party shall

indemnify and hold harmless the other party from and against any and all loss, cost, damage and expense arising from the exercise by the indemnifying party of its rights in the Easement Area.

IN WITNESS WHEREOF, the parties have caused this Agreement to be executed and delivered as a sealed instrument by their respective duly authorized representatives, as of the date first set forth above.

FALLON CLINIC, INC.

By: RE Maher

Title: Administrator

NOTRE DAME HEALTH CARE CENTER, INC.

By: Ellen Reynolds, SNO

Title: Treasurer

COMMONWEALTH OF MASSACHUSETTS

Suffolk ss.

December 13, 1991

Then personally appeared before me the above named Ellen Reynolds, SNO, the Treasurer of NOTRE DAME HEALTH CARE CENTER, INC. and acknowledged the foregoing instrument to be his/her free act and deed.

(seal)

Michael S. Saul
Notary Public

My commission expires 1/2/93

COMMONWEALTH OF MASSACHUSETTS

Worcester ss.

December 12, 1991

Then personally appeared before me the above named Robert E. Maher, Jr., the Administrator of FALLON CLINIC, INC. and acknowledged the foregoing instrument to be his/her free act and deed.

(seal)

Lawrence A. Burdick
Notary Public

My commission expires 1-24-97
42866.6

INTERSTATE ROUTE # 290

NOTRE DAME
NORMAL INSTITUTE

FALLON CLINIC, INC.

PLANTATION STREET

ATTEST: WORC., Anthony J. Vigilanti, Register

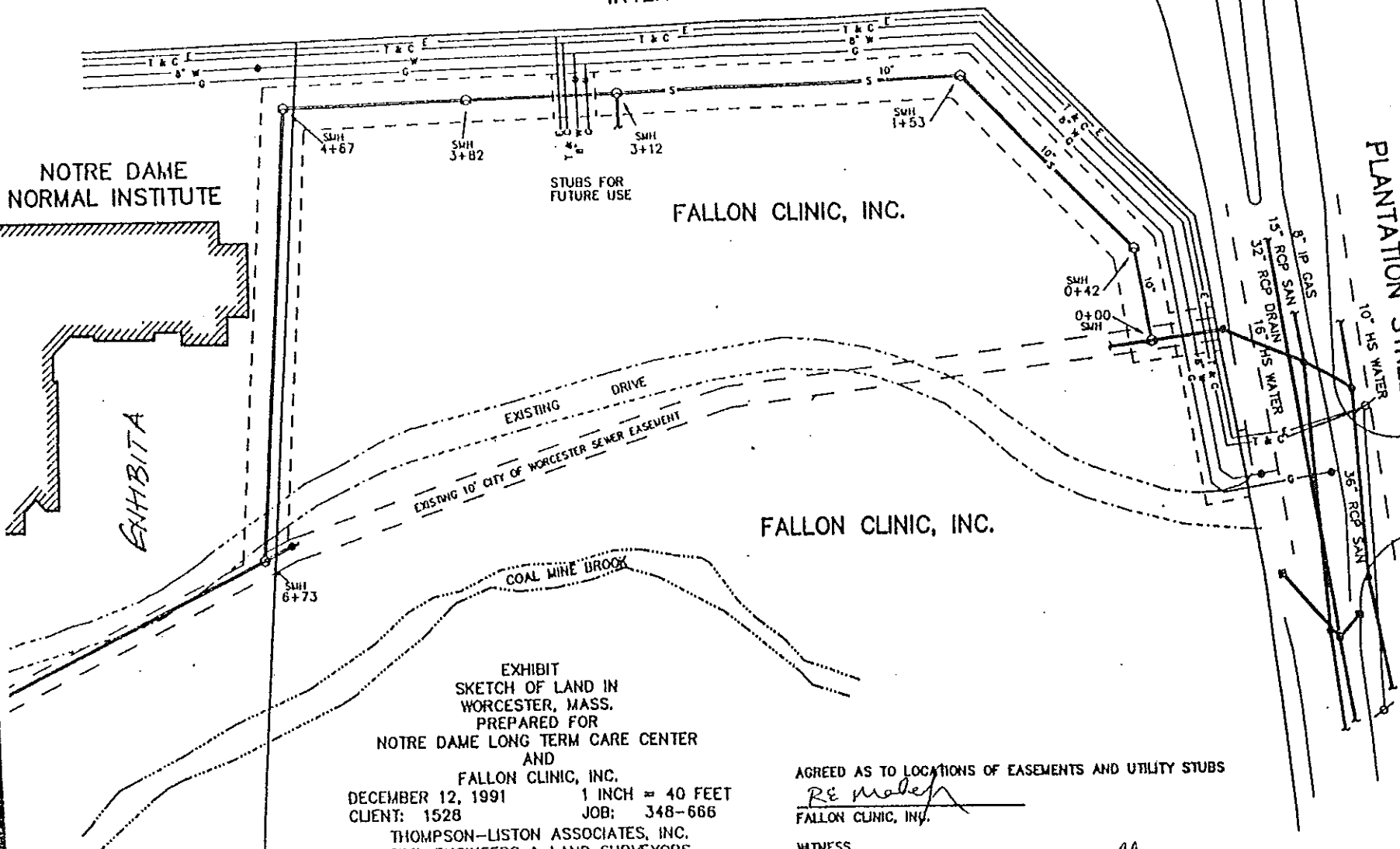


EXHIBIT
 SKETCH OF LAND IN
 WORCESTER, MASS.
 PREPARED FOR
 NOTRE DAME LONG TERM CARE CENTER
 AND
 FALLON CLINIC, INC.

DECEMBER 12, 1991 1 INCH = 40 FEET
 CLIENT: 1528 JOB: 348-666

THOMPSON-LISTON ASSOCIATES, INC.
 CIVIL ENGINEERS & LAND SURVEYORS
 51 MAIN STREET, PO BOX 470
 BOYLSTON, MASS. 01505-0470

AGREED AS TO LOCATIONS OF EASEMENTS AND UTILITY STUBS

Re Maher
 FALLON CLINIC, INC.

WITNESS
Andrew B. Liston
 ANDREW B. LISTON

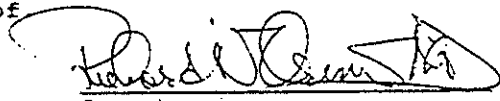
EL

FALLON CLINIC, INC.

By Action by Consent of the Directors of Fallon Clinic, Inc. (the "Corporation") as of December 1, 1991, the following vote was adopted and remains in full force as of the date hereof:

Voted: That the Administrator of the Corporation, Robert E. Maher, Jr., be and hereby is authorized and directed, and in consideration of One Dollar (\$1), to execute and deliver for recording an Easement Agreement with Notre Dame Health Care Center, Inc., providing for an easement for utilities over the property of the Corporation on Plantation Street in Worcester, Massachusetts, for the benefit of Notre Dame Health Care Center, Inc., its successors and assigns, such Easement Agreement to be in form and substance as such Administrator shall approve, such approval to be conclusively evidenced by the execution and delivery thereof

DATED: December 16, 1991



Secretary
Richard M. Orino, M.D.

Dec 16 3 42 PM '91

ATTEST: WORC., Anthony J. Vigliotti, Register

Worcester District Registry of Deeds - 20/20 Perfect Vision i2 Document Detail Report

Current datetime: 3/22/2012 7:13:00 AM

| Doc# | Document Type | Town | Book/Page | File Date | Consideration |
|---|-----------------------------|------|-----------|------------|---------------|
| 198060 | CONSERVATION RESTRICTION | | 20872/32 | 12/31/1998 | |
| Property-Street Address and/or Description | | | | | |
| RESTRICTS, APPROVAL & ACCEPT PLANTATION STPL BK 736-57 SEE R | | | | | |
| Grantors | | | | | |
| PEZZELLA STEPHEN M, MULLINS THOMAS F III, KRONLUND KENNETH H JR, LAKESIDE LIQUIDATING TRUST, GREATER WORCESTER LAND TRUST INC, WORCESTER CITY OF, UNITED STATES OF AMERICA SEC OF ENVIR AFFAIRS | | | | | |
| Grantees | | | | | |
| GREATER WORCESTER LAND TRUST INC | | | | | |
| References-Book/Pg Description Recorded Year | | | | | |
| Registered Land Certificate(s)-Cert# Book/Pg | | | | | |

198060

CONSERVATION RESTRICTION
and
PUBLIC TRAIL EASEMENT
to

THE GREATER WORCESTER LAND TRUST, INC.

Kenneth H. Kronlund, Jr., Thomas F. Mullins III, and Stephen M. Pezzella, as Trustees of Lakeside Liquidating Trust, a Massachusetts trust w/d/t dated December 22, 1997, and recorded in the Worcester District Registry of Deeds in Book 19485, Page 304, hereby grant, as a charitable gift, with quitclaim covenants, to The Greater Worcester Land Trust, Inc. ("Grantee") in perpetuity and exclusively for conservation purposes, a Conservation Restriction and public trail easement having the terms and conditions hereinafter set forth (the "Conservation Restriction") on certain parcels of land located in the City of Worcester, Worcester County, Massachusetts, containing approximately 7.3 acres, more or less, said parcels being more particularly described in Exhibit A attached hereto (the "Premises"), being the same premises conveyed to them by deed recorded in the Worcester District Registry of Deeds in Book 19485, Page 317. Forty percent of the area within the Premises comprises two "Building Envelopes, one for purposes of building of a Headquarters by and for the Mohegan Council of the Boy Scouts of America ("Boy Scouts") and the other for purposes of hiking and camping by the Boy Scouts. The Building Envelopes are more particularly described in Exhibit B and Exhibit C attached hereto. Hereinafter the term "Grantor" shall mean the said Trustees of the Lakeside Liquidating Trust and their successors and assigns.

PLANTATION STREET, WORCESTER, MA.

98 DEC 31 AM 11:00

* OF 172 SHREWSBURY ST.
WORCESTER, MA.

Purpose

This Conservation Restriction is defined in and authorized by Sections 31-33 of Chapter 184 of the General Laws and otherwise by law. Its purpose is to assure that the Premises will be retained in perpetuity predominantly in its natural, scenic and open condition, and to prevent any use of the Premises that will significantly impair or interfere with the conservation values thereof. The conservation and permanent protection of the Premises will yield a significant public benefit for the following reasons:

1. In close proximity to the premises is Green Hill Park, a City of Worcester park of approximately 482 acres of which 242 acres remain in their natural wooded state. The park contains numerous walking trails and other avenues for active and passive recreation as well as a municipal golf course. The two parcels of land between the park and the Premises are also significantly wooded areas. While some development is anticipated on these parcels, it is expected to be limited in nature and prospects for Conservation Restrictions on critical portions of each parcel are high.

2. The Premises are primarily wooded in nature with a wooded knoll providing a scenic vista into the cliffed area of the Premises traversed by Coal Mine Brook, a rare City of Worcester waterway in that it remains in significantly a natural state for much of its course. The brook is quite scenic and is a habitat for brook trout. The Conservation Restriction will help preserve the brook's water quality, habitat, and natural scenic beauty.

WOR. COUNTY ABST. CO.
ORDER NO. P3869

MAILED ? JONAS M. COLLINS
47 MEMORIAL BLVD
SHREWSBURY, MA 01545

3. The City of Worcester's East Side Trail traverses Green Hill Park and is designed to traverse the properties along a greenway between the park and the Premises and continue through the Premises along Coal Mine Brook. The trail is designed to continue across Plantation Street along the course of Coal Mine Brook to the mouth of the brook into Lake Quinsigamond, through undeveloped land owned by the City of Worcester. The Restricted Area thus provides for a continuation of the trail links for the East Side Trail;

4. Pursuant to this Conservation Restriction, the general public will have the right to use a specified trail through the Premises which connects with existing trails on the lands mentioned in the preceding paragraph. The Boy Scouts will be encouraged to use the East Side Trail as well. This Conservation Restriction will therefore establish a connection between two otherwise separate sections of trail. Furthermore, the conservation and permanent protection of the Premises will ensure that the land remains suitable and attractive for such a trail;

5. The Premises provide a relatively natural area offering a diversity of habitat for plants and animals, including forests, a pleasant wooded knoll, wetlands and open fields. As mentioned above, the Premises also help to link together a greenway for the City of Worcester's East Side Trail. Protection of the Premises will therefore provide a buffer area and help to protect the integrity of these greenway parcels, help ensure the existence of a wildlife connector through them and help establish an extensive contiguous greenway of conservation land of about 218 acres which, simply by virtue of its size, is significant as wildlife habitat, especially in an urbanized city; and

6. The Premises provide scenic views enjoyed by members of the general public traveling along Plantation Road and State Highway Route 290. The permanent protection of the Premises from development, except within the Building Envelope, will preserve these views.

Terms

The terms of this Conservation Restriction are as follows:

A. Prohibited Uses. Except as to reserved rights set forth in paragraph B below, the following acts and uses are expressly prohibited on the Premises:

1. Constructing, placing any building, tennis court, landing strip, mobile home, swimming pool, asphalt or concrete pavement, sign, billboard or other advertising display, antenna, utility pole, tower, conduit, line or other temporary or permanent structure or facility on, above or under the Premises;

2. Mining, excavating, dredging or removing from the Premises of soil, loam, peat, gravel, sand, rock or other mineral resource or natural deposit;

3. Placing, filling, storing or dumping on the Premises of soil, refuse, trash, vehicle bodies or parts, rubbish, debris, junk, waste or other substance or material whatsoever or the installation of underground storage tanks, except that soil and other materials may be placed and stored on the Premises for use in connection with activities permitted under paragraph B;

4. Cutting, removing or otherwise destroying trees, grasses or other vegetation except as permitted under paragraph B or as reasonably necessary in connection with activities permitted under paragraph B;

5. Activities detrimental to drainage, flood control, wildlife habitat, water conservation, water quality, erosion control, soil conservation or scenic views;

6. The use of motorcycles, motorized trail bikes, snowmobiles and all other motor vehicles, except in connection with forestry uses permitted under paragraph B or as reasonably necessary in exercising any of the other rights reserved in paragraph B, or as required in emergencies or by police, firefighters or other governmental agents in carrying out their lawful duties; and

7. Any other use of the Premises or activity thereon which is inconsistent with the purposes of this Conservation Restriction or which would materially impair significant conservation interests unless necessary for the protection of the conservation interests that are the subject of this Restriction.

B. Reserved Rights. All acts and uses not prohibited in paragraph A are permissible. Notwithstanding the provisions of paragraph A, the following acts and uses are also permitted:

1. In accordance with generally accepted forest management practices,
 - a. selective pruning and cutting to prevent, control or remove hazards, disease, insect damage or fire, or to preserve the present condition of the Premises, including vistas, woods roads, and trails;
 - b. harvesting trees to provide firewood or construction materials for use on the Premises; and
 - c. the cutting of trees for any purpose, including without limitation commercial timber production, in accordance with a plan, prepared by a professional forester and approved by the Grantee, that is designed to protect the conservation values of the Premises, including without limitation, scenic and wildlife habitat values.
2. The construction, maintenance, repair and replacement of:
 - a. trails and roads for pedestrian or non-motorized bicycle use (including trail markers and a reasonable number of directional and informational signs no larger than two square feet) or as reasonably necessary for the uses herein permitted;
 - b. fencing, gates and stone walls; and
 - c. a pedestrian bridge across Coal Mine Brook, with the prior written approval of the Grantee. Such approval will be granted only after the Grantee is satisfied that the

design and placement of the bridge complies with the purposes of the Conservation Restriction, and that it will not physically interfere with public access to and enjoyment of the East Side Trail. With these considerations in mind, approval by the Grantee shall not be unreasonably withheld or delayed.

3. The Building Envelope described in Exhibit B, attached hereto, is being created for the express purpose of providing an appropriate location for a new headquarters building for the Mohegan Council of the Boy Scouts of America. It is provided, however, that no disturbance for landscaping, building or construction purposes will occur within ten (10) feet of the southerly boundary of the building envelope; nor will any building be erected closer than twenty-five (25) feet from said southerly boundary. The use of the Building Envelope is limited to construction, installation, replacement, addition, maintenance, and repair, of the headquarters building together with: access; parking; utilities (including without limitation septic or other sewage disposal system, well or other water supply, telephone, radio, television or other antennae, electricity and gas); appropriate appurtenant structures and uses such as garage, fencing, gardening and landscaping appropriate to such uses; and any other facilities generally associated (at the time such facility is used or to be used) with a Boy Scout Headquarters on properties similar to the Premises. This provision will expire in 15 years insofar as it limits the building to a Boy Scout Headquarters; thereafter, this Conservation Restriction does not limit the usage of the building constructed within this building envelope.

4. The Building Envelope described in Exhibit C, attached hereto, is being created for the express purpose of providing a low-impact camping area for the Boy Scouts only, and not subsequent successors. To this end, the following are permitted: tents, picnic tables, fire places and such structures, buildings, or pavement as directly relate to low-impact camping or hiking and as are required in following governmental and/or National Boy Scout Rules and Regulations for such purposes. In any event, the area covered by any structure, building or pavement within this Building Envelope, will not exceed 26,000 square feet. This provision is effective only for so long as the Boy Scouts own the Premises.

5. With the prior written approval of the Grantee, the installation, maintenance, repair and replacement of utility lines, water lines, wells and septic systems and similar services outside the Building Envelope described in Exhibit B, or partially outside such Building Envelope, for use in connection with structures located or to be located within such Building Envelope. Said approval shall be granted if and only if it is shown that no practical alternative site exists within such Building Envelope and that the proposed location for such septic system will not impair the purposes of this Conservation Restriction significantly more than other practical locations.

C. Notice and Approval. Whenever notice to or approval by Grantee is required hereunder, Grantor shall notify Grantee in writing not less than sixty (60) days prior to the date Grantor intends to undertake the activity in question. The notice shall describe the nature, scope, design, location, timetable and any other material aspect of the proposed activity in sufficient detail to permit Grantee to make an informed judgment as to its consistency with the purposes of this Conservation Restriction. Where Grantee's approval is required, Grantee shall grant or withhold its approval in writing within sixty (60) days of receipt of Grantor's written request therefor. Failure of Grantee to respond in writing within such 60 days shall be deemed to constitute approval

by Grantee of the request as submitted. Grantee's approval shall not be unreasonably withheld, and may only be withheld upon a showing that the proposed activity will materially impair the purposes of this Conservation Restriction.

Any written notice required or permitted hereunder shall be deemed delivered if sent by certified mail, return receipt requested, postage prepaid, to the Grantee c/o George Dresser, Esq., at 4 Dix St., Worcester, MA 01609, to the Boy Scouts at the Mohegan Council Boy Scouts of America, 19 Harvard St., Worcester, MA, 01609, or, with respect to assignees, to the address set forth in a recorded instrument transferring title to the Premises or rights hereunder, or to such other addresses as the parties may designate in writing from time to time.

D. Extinguishment. If circumstances arise in the future such as render the purpose of this Conservation Restriction impossible to accomplish, this Conservation Restriction can only be terminated or extinguished, whether in whole or in part, by judicial proceedings in a court of competent jurisdiction. If any change in conditions ever gives rise to extinguishment or other release of the Conservation Restriction under applicable law, then Grantee, on a subsequent sale, exchange or involuntary conversion of the Premises, shall be entitled to a portion of the proceeds in accordance with paragraph D.1 below, subject, however, to any applicable law which expressly provides for a different disposition of proceeds. Grantee shall use its share of the proceeds in a manner consistent with the conservation purpose set forth herein.

1. Proceeds. Grantor and Grantee agree that the donation of this Conservation Restriction gives rise for purposes of this paragraph to a property right, immediately vested in Grantee, with a fair market value determined by multiplying the then-current fair market value of the Premises unencumbered by this Conservation Restriction (minus any increase in value after the date of this grant attributable to improvements) by the ratio of the value of this Conservation Restriction at the time of this grant to the value of the Premises, without deduction for the value of this Conservation Restriction, at the time of this grant. The values at the time of this grant shall be determined using the methods used to calculate the deduction for federal income tax purposes allowable by reason of this grant, pursuant to Section 170(h) of the Internal Revenue Code of 1986, as amended. For the purposes of this paragraph, the ratio of the value of this Conservation Restriction to the value of the Premises unencumbered by this Conservation Restriction shall remain constant.

2. Condemnation. Whenever all or any part of the Premises or any interest therein is taken by public authority under power of eminent domain or other act of public authority, then Grantor and Grantee shall cooperate in recovering the full value of all direct and consequential damages resulting from such action. All related expenses incurred by Grantor and Grantee shall first be paid out of any recovered proceeds, and the remaining proceeds shall be distributed between Grantor and Grantee in shares equal in proportion to the aforementioned ratio (though if a less-than-fee interest is so taken, the proceeds shall be equitably allocated according to the nature of the interest taken). Grantee shall use its share of the proceeds in a manner consistent with the conservation purpose set forth herein.

E. Access. The Conservation Restriction hereby conveyed does not grant to Grantee, to the public generally, or to any other person any right to enter upon the Premises except that

1. there is hereby granted to Grantee and its representatives the right to enter the Premises

a. at reasonable times, with reasonable notice and in a reasonable manner (i.e. seven days advance notice in general) for the purpose of inspecting the Premises to determine compliance herewith;

b. at reasonable times, with reasonable written notice and in a reasonable manner (i.e. seven days advance notice in general) for the purpose of maintaining the trail described in Exhibit D attached, including the installation and maintenance of trail markers and a reasonable number of directional and informational signs no larger than two square feet, and for purposes of stream maintenance and stewardship with regard to Coal Mine Brook; and

2. there is hereby granted to the general public the right to pass and repass on foot or on non-motorized bicycles during daylight hours for purposes of passive recreation over the trail described in Exhibit D attached, provided that

a. the Grantor's liability for such use is limited as set forth in Massachusetts General Laws Chapter 21, Section 17C, the Recreational Use Statute;

b. the Grantee shall regulate such public use so as to protect and promote the conservation and aesthetic values of the Premises and the privacy and property rights of the Grantor, either by informal monitoring of such use, or, if reasonably requested by the Grantor because informal monitoring is not working, by enforcement of written rules which shall at a minimum prohibit littering, fires (including smoking), alcoholic beverages, motor vehicles of all kinds, firearms, loud noises, and destruction or defacement of growing plants or other property, and shall in other respects be as reasonably determined by the Grantee, in consultation with the Grantor;

c. for safety reasons or if enforcement of such rules becomes impossible, or if the Grantee regularly neglects to enforce such rules, or if violation of such rules for any reason becomes prevalent, then the Grantee may close the trails to public use for such period of time as it may determine necessary, or the Grantor, including the Boy Scouts, if they become its successor, but not subsequent successors, may close the trail for no more than 7 days if it determines necessary for safety reasons (provided that the neither may permanently close the trails to public use), and either the Grantor or the Grantee may enforce such closure against members of the public; and

d. if there is a disagreement between the Grantor and Grantee over whether one of them has improperly closed the trails to the public or has refused to close the trails to the public, then the disagreement shall be submitted to binding arbitration pursuant to the rules of the American Arbitration Association, and the arbitrator shall determine whether the

trails should be closed to the public, and if so, for how long (provided that the arbitrator may not permanently close the trails to public use).

F. Legal Remedies of Grantee. The rights hereby granted shall include the right to enforce this Conservation Restriction by appropriate legal proceedings and to obtain injunctive and other equitable relief against any violations, including without limitation relief requiring restoration of the Premises to its condition prior to such violation (it being agreed that Grantee will have no adequate remedy at law), and shall be in addition to, and not in limitation of, any other rights and remedies available to Grantee. Grantor covenants and agrees to reimburse Grantee all reasonable costs and expenses (including without limitation reasonable counsel fees) incurred in enforcing this Conservation Restriction or in taking reasonable measures to remedy or abate any violation thereof, provided that an intentional (which adjective will only apply if and when and so long as the Boy Scouts succeed to the Grantor) violation of this Conservation Restriction is acknowledged by Grantor or determined by a court of competent jurisdiction to have occurred. By its acceptance, Grantee does not undertake any liability or obligation relating to the condition of the Premises, including with respect to compliance with hazardous materials or other environmental laws and regulations. Enforcement of the terms of this Conservation Restriction shall be at the discretion of Grantee, and any forbearance by Grantee to exercise its rights under this Conservation Restriction shall not be deemed or construed to be a waiver.

G. Acts Beyond Grantor's Control. Nothing contained in this Conservation Restriction shall be construed to entitle Grantee to bring any action against Grantor for any injury to or change in the Premises resulting from causes beyond the Grantor's control, including, but not limited to, fire, flood, storm and earth movement, actions by third parties, or from any action taken in good faith by Grantor under what it believes are emergency conditions to prevent, abate, or mitigate significant injury to the Premises resulting from such causes.

H. Duration and Assignability. The burdens of this Conservation Restriction shall run with the Premises and shall be enforceable against Grantor in perpetuity. Grantee is authorized to record or file any notices or instruments appropriate to assuring the perpetual enforceability of this Conservation Restriction, and Grantor agrees to execute, acknowledge and deliver any such instruments upon request. The benefits of this Conservation Restriction shall be in gross and shall not be assignable by Grantee, except in the following instances from time to time to a responsible entity similar in structure and purpose, and with a similar geographic focus (Worcester-based if feasible) as the original Grantee: (i) as a condition of any assignment, Grantee requires that the purpose of this Conservation Restriction continue to be carried out, and (ii) the assignee, at the time of assignment, qualifies under Section 170(h) of the Internal Revenue Code of 1986, as amended, and applicable regulations thereunder, and under Section 32 of Chapter 184 of the General Laws as an eligible donee to receive this Conservation Restriction directly. Notwithstanding the foregoing, if the Grantor objects to the assignee, the matter may be submitted to arbitration as set forth in paragraph 2.C, unless otherwise ordered by a court.

I. Subsequent Transfers. Grantor agrees to incorporate by reference the terms of this Conservation Restriction in any deed or other legal instrument by which Grantor conveys any interest in all or a portion of the Premises, including, without limitation, a leasehold interest. Unless the transfer is to the Mohegan Council, Boy Scouts of America (or its affiliated nominee),

Grantor further agrees to give written notice to Grantee of the transfer of any interest at least thirty (30) days prior to the date of such transfer. Failure of Grantor to do so shall not impair the validity of such transfer or of this Conservation Restriction, and shall not limit the enforceability of this Conservation Restriction in any way.

J. Termination of Rights and Obligations. Notwithstanding anything to the contrary contained herein, the rights and obligations under this Conservation Restriction of any party holding any interest in the Premises shall terminate upon transfer of that party's interest, except that liability for acts or omissions occurring prior to transfer, and liability for the transfer itself if the transfer is in violation of this Conservation Restriction, shall survive the transfer.

K. Estoppel Certificates. Upon request by Grantor, Grantee shall within forty-five (45) days execute and deliver to Grantor any document, including an estoppel certificate, which certifies Grantor's compliance with any obligation of Grantor contained in this Conservation Restriction, and which otherwise evidences the status of this Conservation Restriction as may be requested by Grantor.

L. Representations of the Grantee. The Grantee represents that it is a private, charitable, non profit conservation land trust, that it is a qualified organization as that term is defined in Section 170(h)(3) of the Internal Revenue Code of 1986, that it is organized and operated for the purpose of preserving and conserving natural resources, natural habitats and environmentally sensitive areas and for other charitable, scientific and educational purposes, and that it has both the necessary funds and the commitment to hold this Conservation Restriction exclusively for conservation purposes in perpetuity and to enforce its terms.

M. Construction.

1. Controlling Law. The interpretation and performance of this Conservation Restriction shall be governed by the laws of the Commonwealth of Massachusetts.

2. Liberal Construction. Any general rule of construction to the contrary notwithstanding, this Conservation Restriction shall be liberally construed in favor of the grant to effect the purposes of this Conservation Restriction and the policy and purpose of General Laws Chapter 184, Sections 31-33. If any provision in this instrument is found to be ambiguous, an interpretation consistent with the purposes of this Conservation Restriction that would render the provision valid shall be favored over any interpretation that would render it invalid.

3. Severability. If any provision of this Conservation Restriction shall to any extent be held invalid, the remainder shall not be affected.

4. Entire Agreement. This instrument sets forth the entire agreement of the parties with respect to the Conservation Restriction and supersedes all prior discussions, negotiations, understandings, or agreements relating to the Conservation Restriction, all of which are merged herein.

5. Captions. The captions in this instrument have been inserted solely for

convenience of reference and are not a part of this instrument and shall have no effect upon construction or interpretation.

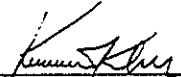
6. Effective Date. Grantor and Grantee intend that the Conservation Restrictions arising hereunder shall take effect when all requisite signatures pursuant to M.G.L. Chapter 184, Section 32, have been obtained and this document has been recorded in the Worcester District Registry of Deeds.

7. Miscellaneous. Approval of this Conservation Restriction pursuant to M.G.L. Chapter 184, Section 32, by any municipal officials and by the Secretary of Environmental Affairs is not to be construed as representing the existence or non-existence of any pre-existing rights of the public, if any, in and to the Premises, and any such pre-existing rights of the public, if any, are not affected by the granting of this Conservation Restriction.

No documentary stamps are required as this Conservation Restriction and Public Trail Easement is a gift.

Executed under seal this 9TH day of DECEMBER, 1998.

Lakeside Liquidating Trust
By:


Kenneth H. Kronlund, Jr., Trustee


Thomas F. Mullins III, Trustee


Stephen M. Pezzella, Trustee

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss.

DECEMBER 9, 1998

Then personally appeared the above-named Kenneth H. Kronlund, Jr., Thomas F. Mullins III and Stephen M. Pezzella, Trustees, Lakeside Liquidating Trust, and acknowledged the foregoing instrument to be their free act and deed, before me.

Lawrence A. Brodeur

Notary Public LAWRENCE A. BRODEUR

My commission expires: 12-25-03

ACCEPTANCE OF GRANT

The above Conservation Restriction is accepted this 10th day of December, 1998.

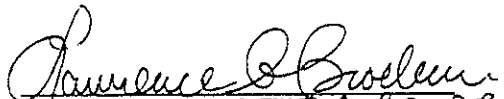
Greater Worcester Land Trust, Inc.

By: 
Allen W. Fletcher, President

COMMONWEALTH OF MASSACHUSETTS

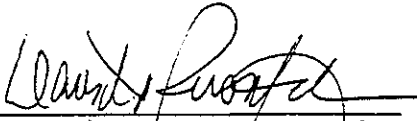
Worcester, ss. December 10, 1998

Then personally appeared the above-named Allen W. Fletcher and acknowledged the foregoing instrument to be the free act and deed of The Greater Worcester Land Trust, Inc., before me

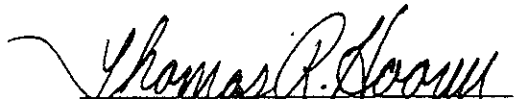

Notary Public LAWRENCE A. BRODER
My commission expires: 12-25-03

APPROVAL BY CITY COUNCIL AND CITY MANAGER

The undersigned, City Clerk of the City of Worcester, Massachusetts, hereby certify that at a meeting duly held on December 15, 1998, the City Council voted to approve the foregoing Conservation Restriction to the Greater Worcester Land Trust, Inc. pursuant to M.G.L. Chapter 184 Section 32.


City Clerk DAVID J. CUSHICK

The undersigned, City Manager of the City of Worcester, Massachusetts, pursuant to a vote of the City Council taken at a meeting duly held on December 15, 1998, do hereby approve the foregoing Conservation Restriction to the Greater Worcester Land Trust, Inc. pursuant to M.G.L. Chapter 184 Section 32.

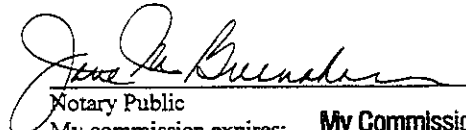

City Manager THOMAS R. HOOVER

COMMONWEALTH OF MASSACHUSETTS

Worcester, ss.

December 23, 1998

Then personally appeared the above named Thomas R. Hoover and acknowledged the foregoing instrument to be his free act and deed, before me.


Notary Public
My commission expires: My Commission Expires
July 30, 2004



APPROVAL BY SECRETARY OF ENVIRONMENTAL AFFAIRS
COMMONWEALTH OF MASSACHUSETTS

The undersigned, Secretary of the Executive Office of Environmental Affairs of the Commonwealth of Massachusetts, hereby certifies that the foregoing Conservation Restriction and Public Trail Easement to Greater Worcester Land Trust, Inc. has been approved in the public interest pursuant to M.G.L. Chapter 184, Section 32.

Date: January 29, 1998

[Signature]
Secretary of Environmental Affairs
Jan REITSMAN

COMMONWEALTH OF MASSACHUSETTS

Suffolk, ss. Dec. 29, 1998

Then personally appeared the above-named Jan Reitsman
and acknowledged the foregoing instrument to be his or her free act and deed,
before me.

[Signature]
Notary Public
My commission expires: Dec. 31, 2004

[Signature]

EXHIBIT A

The Premises subject to this Conservation Restriction consist of Parcels A and B as shown on a Plan of Property Prepared for Lakeside Liquidating Trust, Plantation Street, Worcester, Massachusetts, by Cullinan Engineering, dated November 9, 1998, and recorded at the Worcester District Registry of Deeds, Plan Book 736, Plan 57, being the same premises conveyed to the Lakeside Liquidating Trust by deed recorded in the Worcester District Registry of Deeds in Book 19485, Page 317:

EXHIBIT B

The Building Envelope for the headquarters building referred to in Section 3 of Paragraph B is described as follows:

Its boundaries on its northerly, easterly and westerly sides are the boundaries of the Premises described in Exhibit A, and its boundary on its southerly side is the "Flagging Line" as shown on the sketch attached as Exhibit E; provided that, for this purpose, the segments L4, L5, L6, L7, L8, L9, L10, and L11, are replaced by the single segment L99, all as shown on said sketch.

EXHIBIT C

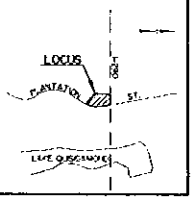
The Building Envelope for low impact camping, referred to in Paragraph B.4 is described as follows:

Its boundary on its northerly side is a line parallel to and one hundred feet southerly of the southerly edge of Coal Mine Brook, and its boundaries on its southerly, easterly and westerly sides are the boundaries of the Premises described in Exhibit A; provided, however, that all areas above four hundred twenty (420) feet in elevation are excluded from the Building Envelope.

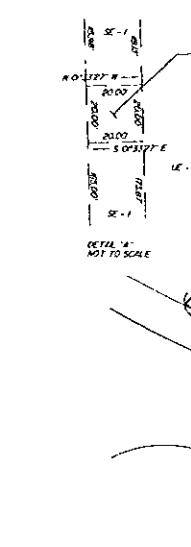
EXHIBIT D

The area subject to the public trail easement is the area between Coal Mine Brook and a line parallel to and one hundred feet southerly of the southerly edge of Coal Mine Brook. The Grantee may locate the trail within this easement area at its discretion, and may relocate it from time to time within such area.

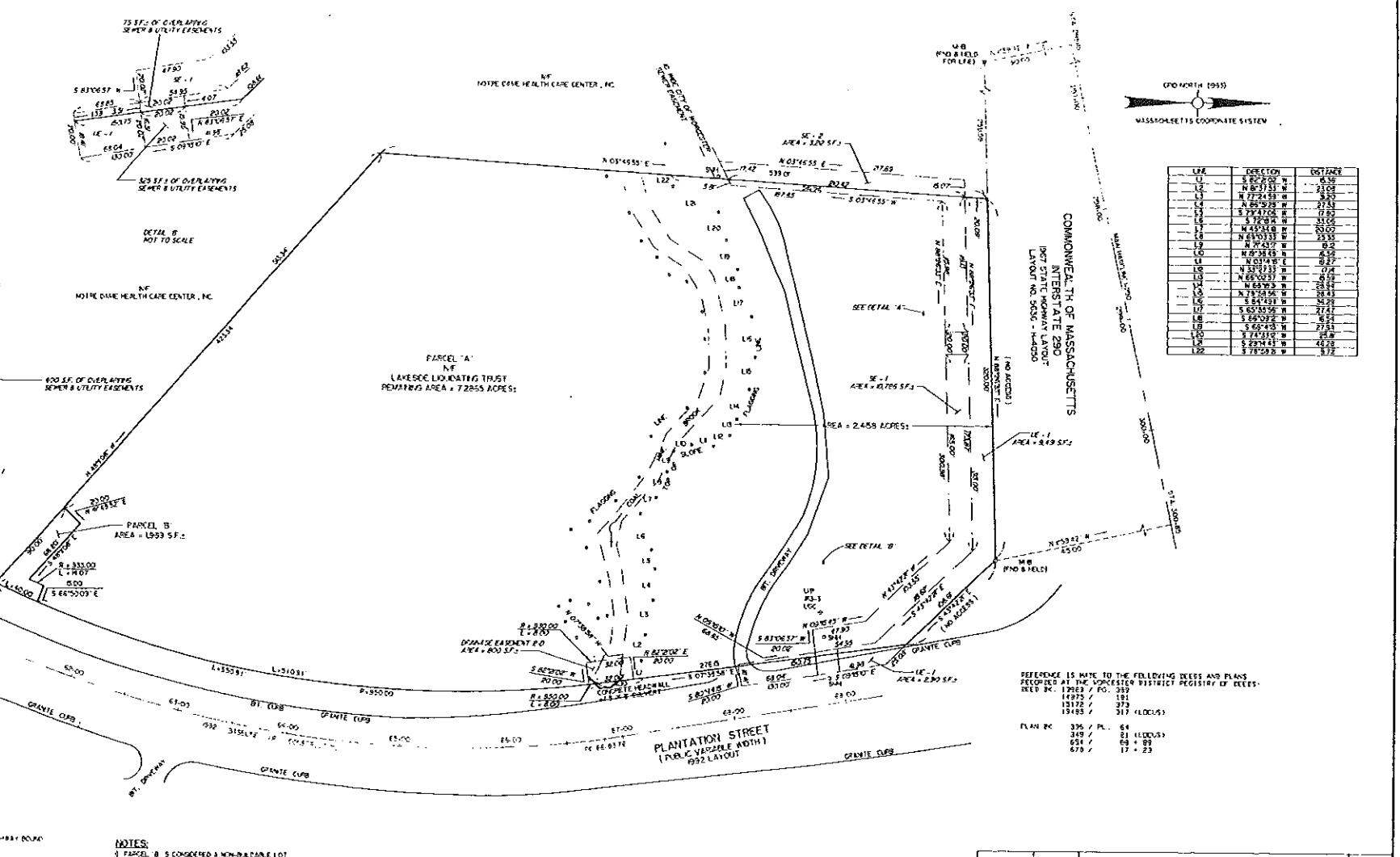
WORCESTER DISTRICT REGISTER
OF DEEDS - WORCESTER, MA
DEED BOOK - 136, PAGE 57
RECORDING - 12-21-93
10.00 AC. P. 1
STATE
PLAN NO. 336 / PL. 64
IN BOOK
FILE NO.
DATE
ADDRESS
Cullinan Engineering
Registered



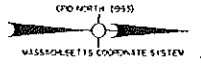
LOCUS
NOT TO SCALE



LOCATION MAP
NOT TO SCALE



| LINE | DIRECTION | DISTANCE |
|------|-----------------|----------|
| L1 | S 82° 20' 00" W | 6.58 |
| L2 | N 8° 31' 31" W | 23.08 |
| L3 | N 77° 24' 51" W | 8.85 |
| L4 | N 88° 29' 28" W | 27.13 |
| L5 | S 77° 47' 00" W | 27.00 |
| L6 | S 72° 58' 11" W | 23.00 |
| L7 | N 45° 31' 18" W | 23.00 |
| L8 | N 45° 31' 18" W | 23.00 |
| L9 | N 45° 31' 18" W | 23.00 |
| L10 | N 45° 31' 18" W | 23.00 |
| L11 | N 45° 31' 18" W | 23.00 |
| L12 | N 45° 31' 18" W | 23.00 |
| L13 | N 45° 31' 18" W | 23.00 |
| L14 | N 45° 31' 18" W | 23.00 |
| L15 | N 45° 31' 18" W | 23.00 |
| L16 | N 45° 31' 18" W | 23.00 |
| L17 | N 45° 31' 18" W | 23.00 |
| L18 | N 45° 31' 18" W | 23.00 |
| L19 | N 45° 31' 18" W | 23.00 |
| L20 | N 45° 31' 18" W | 23.00 |
| L21 | N 45° 31' 18" W | 23.00 |
| L22 | N 45° 31' 18" W | 23.00 |



REFERENCE IS MADE TO THE FOLLOWING DEEDS AND PLANS
RECORDED AT THE WORCESTER DISTRICT REGISTER OF DEEDS:
DEED BK: 1262 / PG. 289
10172 / 183
13172 / 273
13183 / 313 (LOCUS)
PLAN BK: 336 / PL. 64
349 / 81 (LOCUS)
654 / 68 + 89
679 / 17 + 23

- LEGEND:**
- BT. BOUNDARY
 - E. EAST
 - FWD. FOUND
 - L. LENGTH OF ARC
 - M.B. MASSACHUSETTS HIGHWAY BOUND
 - N. NORTH
 - N.F. NORTH BY FORMERLY
 - R. RADIUS OF ARC
 - S. SOUTH
 - S.F. SQUARE FEET
 - SE-E. SEWER EASEMENT # NUMBER
 - SH. SHED
 - STA. STATION (BANKED)
 - UE-E. UTILITY EASEMENT # NUMBER
 - LOC. UNDERGROUND CABLE
 - UP. UTILITY POLE
 - A. REST
 - RT. RIGHT

NOTES:

- PARCEL B IS CONSIDERED A NON-INDIVIDUAL LOT AND IS TO REMAIN THE OWNERSHIP OF THE FOUNDATION.
- PLACED LOCATION OF EXISTING TOP OF SLOPE.
- AREA OF PROPERTY SHARING BETWEEN THE WORTHLEY TRUST AND THE WORTHLEY PROPERTY LINE, 2.584 ACRES.

60-20 ZONE

APPROVAL UNDER THE SUBDIVISION CONTROL LAW NOT REQUIRED
PLANNING BOARD OF WORCESTER DATE: 11-11-93

I HEREBY CERTIFY TO THE BEST OF MY PROFESSIONAL JUDGEMENT,
INFORMATION AND BELIEF THAT THIS PLAN IS BASED ON FIELD SURVEYS,
DEEDS AND PLANS OF RECORD AND CONFORMS TO THE RULES AND
REGULATIONS OF THE REGISTER OF DEEDS

Neil J. Cullinan 11-11-93



| DATE | ISSUE | REVISION | DESCRIPTION | APP. |
|------|-------|----------|-------------------------------|------|
| | | | PLAN OF PROPERTY PREPARED FOR | |
| | | | LAKESIDE LIQUIDATING TRUST | |
| | | | PLANTATION STREET | |
| | | | WORCESTER, MASSACHUSETTS | |
| 0 | 1 | 2 | 3 | 4 |
| 0 | 20 | 60 | 20 | FEET |
| 0 | 1 | 2 | 3 | 4 |
| 0 | 5 | 6 | CENTIMETERS | |

SCALE: 1"=40 FEET

DATE: NOVEMBER 9, 1993

RES. DEF. FLD. JGG. CAP. MTL.
P.L.C. FHS. DAY. FIG. CHK. WTL.

PLAN NUMBER: 020115-0 / P33 (33)
SHEET: 1 OF 1

THE ABOVE ENFORCEMENT IS NOT A DETERMINATION OF CONFORMANCE WITH ZONING REGULATIONS.

ELEC FILE # 000312.02V0

**PRELIMINARY PHASE I 21E
ENVIRONMENTAL SITE ASSESSMENT**

LAKESIDE REALTY COMPANY
UNDEVELOPED PARCEL OF LAND (BOOK 46, SHEET 45, PARCEL B)
PLANTATION STREET AT I-290
WORCESTER, MA 01605

Prepared for:

LAKESIDE REALTY COMPANY
C/O WILLIAM R. PICARD
54 WESLEYAN STREET
SHREWSBURY, MA 01545

January, 1998

Prepared by:

CULLINAN ENGINEERING CO., INC.
200 AUBURN STREET
AUBURN, MASSACHUSETTS 01501





January 23, 1998

CEC No. 970361

Lakeside Realty Company
C/O William R. Picard
54 Wesleyan Street
Shrewsbury, MA 01545

**Subject: Preliminary Phase I 21E Environmental
Site Assessment
Undeveloped Parcel of land (Book 46, Sheet 45, Parcel B)
Plantation Street at I-290
Worcester, MA 01605**

Dear Mr. Picard:

Pursuant to our agreement, Cullinan Engineering Co., Inc. (Cullinan) has conducted the Preliminary Phase I Environmental Site Assessment of the undeveloped parcel of land located at the corner of Plantation Street and I-290, Worcester, Massachusetts (the "subject Site") (see Figures 1 and 2) for Lakeside Realty Company (Client).

The purpose of this Assessment was to evaluate data obtained through performance of our Scope of Work to assess the likelihood as to whether a release or threat of release of hazardous materials or oil, as defined in Massachusetts General Laws, Chapter 21E (M.G.L. C. 21E) and the Massachusetts Contingency Plan (310 CMR 40) (M.C.P.) has taken place on the subject Site. This assessment was prepared using the ASTM Standards on Environmental Site Assessments for Commercial Real Estate as a guide. The following Scope of Services was performed:

An associate of Lakeside Realty Company was interviewed in order to inquire about possible environmental concerns, known releases and past use(s) of the site.

Research of local, state and federal files was conducted in order to inquire about possible environmental concerns or known releases at the site.

Certain public officials were contacted in order to inquire about possible environmental concerns or known releases at the Site.

A site reconnaissance was conducted to observe possible evidence of a release or threat of release of oil or hazardous materials.

AUBURN • BOSTON

ENGINEERS • ENVIRONMENTAL CONSULTANTS • LAND SURVEYORS

200 AUBURN STREET, AUBURN, MA 01501 508/832-5811 FAX- 508/832-5799

Preparation of this report containing observations, conclusions, and recommendations relating to the apparent environmental conditions at the Site. This report includes an opinion by Cullinan as to whether or not there has been a release of hazardous materials or oil at the site and will define the limitations regarding this opinion. The report and opinion is based solely upon the services described herein and is not based upon scientific tests or procedures beyond the scope of described services or the time and budgetary constraints imposed by the Client.

Background

The 8.281 acre parcel is shown as Parcel B in Book No. 46, Sheet No. 45 of the Worcester Assessing Department Maps (see Figures 1 and 2). UTM Zone 19 coordinates for the subject Site are $46^{\circ}85^{\prime}54.0^{\prime\prime}$ N and $2^{\circ}72^{\prime}36.0^{\prime\prime}$ E. Latitude and longitude for the subject Site are $42^{\circ} 17' 30''$ N and $71^{\circ} 45' 40''$ W respectively.

The subject Site appears to be within a Zone II interim well head protection area (IWPA) according to the Department of Environmental Protection (DEP) Bureau of Waste Site Cleanup (BWSC) Priority Resource Map No. 80, dated October 7, 1997.

The subject Site does not lie within the Special Flood Area (100 year flood) as shown on the Federal Emergency Management Agency Flood Insurance Rate Map, Community Panel Number 250349 0015 A, dated August 15, 1980.

The subject Site is currently undeveloped (see Figure 2). Coal Mine Brook flows in an easterly direction through the middle of the property. Vegetated wetlands exists along the northerly and southerly shores of the brook. A portion of the northerly area is vegetated with grass and the remainder of the property is predominantly wooded. Inferred site hydrogeology involves groundwater and surface runoff flowing in an east-northeasterly direction.

Site History

The subject Site is currently undeveloped, as previously reported. The current or former property owners are as follows:

| | |
|---|--------------------|
| Fallon Clinic, Inc. | 5/22/78 - Present |
| Herbert M. Dean & John A. Duggan | 9/23/75 - 5/22/78 |
| Geo. N. Hayeck & Ernest S. Hayeck (Trustees of Wigwam Hill Assoc.) | 10/27/71 - 9/23/75 |
| Notre Dame Normal Institute | Prior to 10/27/71 |



The subject Site Parcel was created and derived from a 127± acre parcel of the Notre Dame Normal Institute. It has been reported that the Site has never been previously developed and remains undeveloped.

Abutting Properties

The abutting properties include a residential dwelling to the south on property of the Notre Dame Normal Institute. The abutting property to the west is utilized as the Notre Dame Health Care, Inc. Facility. An Interstate I-290 off-ramp abuts the site to the north and the Fallon Clinic Inc. Facility is located east of the site on the east side of Plantation Street.

Record Research

Environmental Data Resources, Inc. conducted an environmental record search of the Site under subcontract to Cullinan. Complete research results are attached in Appendix C.

The United States Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) List, dated August 1, 1997, was consulted. No listings were detected within a one-half (1/2) mile radius of the Site.

The Federal Resource Conservation and Recovery Act (RCRA) List of Hazardous Waste Handlers, dated July 1, 1997 was consulted. No listings were reported within a one-half (1/2) mile radius of the Site.

The corrective action report (CORRACTS) List which identifies hazardous waste handlers with RCRA correction activity, dated December 1, 1996 was consulted. No listings were reported within a one (1) mile radius of the Site.

The National Priority List (NPL) of sites, dated September 25, 1997, did not indicate any such sites within a one (1) mile radius of the Site.

The Commonwealth of Massachusetts, Department of Environmental Protection (DEP State Hazardous Waste Sites (SHWS) lists including the Transition List of Confirmed Disposal Sites and Locations to be Identified (LTBI's) dated August 1993, April 1994 and April 1995 and the List of Confirmed Disposal Sites and Locations to be Investigated dated July 24, 1997 were consulted.

Six (6) sites are identified on the List of Confirmed Disposal Sites and Locations To Be Investigated within a one (1) mile radius of the Site. None of the six (6) locations are adjacent to the Site. The possibility of these locations having any affect on the Site cannot be determined with certainty without additional investigation beyond the scope of services established for this site assessment.

The Commonwealth of Massachusetts, MA Spills List, which includes sudden releases reported to DEP from the mid 1980's through September 30, 1993, was consulted. There were no listings for the subject Site.



The Massachusetts Leaking Underground Storage Tank (LUST) database dated July 24, 1997 was consulted. There were no listings within a one-half (1/2) mile radius of the Site.

The DEP Solid Waste Facility Database/Transfer Stations (SWF/LF) List which contains an inventory of solid waste disposal facilities or landfills dated August 1, 1997 was consulted. There were no listings reported within a one-half (1/2) mile radius of the Site.

The City of Worcester Office of Health and Code Enforcement was contacted regarding incidents involving the release or threat of release of hazardous materials or oil on the Site. No such incidents were revealed.

The DEP file review did not reveal any further information regarding the release or threat of release of hazardous materials or oil within a one-half (1/2) mile radius of the Site.

Site Visit

A site visit was conducted on January 12, 1998, by a representative of Cullinan. During the Site visit, visual observations were made to observe possible evidence of a release or threat of release of oil or hazardous materials (see Figures 2 and 3). These observations and disclosures were the basis for the description of the subject Site contained in the background portion of this report. Additional visual observations not included in the background portion of this report are as follows:

There was no visual evidence of any previous development on the Site except for a paved access drive that runs in an east west direction on the property north of Coal Mine Brook. It appears that this drive is no longer utilized since a landscaped area has been constructed along the westerly property line. A gate exists across the driveway along the easterly property line to prevent access.

There was visual evidence that the area just west of the easterly property line may have been used as a construction staging area and storage area for construction materials (i.e. pipe, curbing) during the reconstruction of Plantation Street. Some excavation has occurred along the easterly property line during the reconstruction of Plantation Street. The location of the property line could not be determined at the time of the site visit.

There was visual evidence of many abandoned 1 gallon and 5 gallon rusted cans, small containers and debris in a depressed area approximately 330 feet south of Coal Mine Brook adjacent to the easterly property line (See Figure 3, 5 of 5). The previous contents of the cans and containers is unknown. A visual inspection of the areas where the cans and containers were located did not reveal any evidence of a release at this time.

There was no other visual evidence of any release or threat of release of hazardous materials or oil on the Site.



Summary and Conclusions

This Preliminary Site Assessment Report for the referenced Site, has been prepared in a manner consistent with guidelines for a "Preliminary Assessment" as presented in the "Massachusetts Contingency Plan" (310 CMR 40.541) and with Standard Practices for an Environmental Site Assessment as presented in the ASTM Standards E1427-94. This investigation included a site reconnaissance, review of site history, contact with certain public officials and record research.

The review of the federal, state and local agencies did not reveal any direct evidence of a release or threat of release of hazardous materials or oil at the subject Site, as defined in M.G.L. C. 21E and the M.C.P.

Based upon the results of the services performed, it is Cullinan's opinion that no evidence exists that would indicate a release of hazardous materials or oil has occurred at the subject Site, other than the possibility of a release in the area of the abandoned cans and containers. The status and condition of the subsurface soil conditions in the area of the abandoned cans and containers cannot be concluded with certainty without conducting a subsurface investigation, including laboratory analysis of groundwater and/or soil samples. The possibility of a release of hazardous materials or oil to the soil cannot be concluded with certainty. Further investigation of subsurface conditions is warranted.

The results of the history review, Site reconnaissance visit, and inquiry at the DEP, EPA, and the Worcester Office of Health and Code Enforcement are thought to be indicative of the subject Site, however, the possibility of encountering differing conditions below the surface of the subject Site may possibly exist. The opinions expressed by Cullinan are subject to the General Conditions of the executed contract and the limitations contained in Appendix A of this report.

If you have any questions concerning this information, please do not hesitate to contact one of the undersigned.

Sincerely,



William J. Richard
Project Engineer



Kenneth W. Hodgson, Jr., PE
Vice President
Chief Engineer

WJR:KWH:dlp



FIGURE 1
(LOCUS PLAN)



CLIENT / PROJECT LAKESIDE REALTY COMPANY

DATE JANUARY 14, 1998 JOB NO. 920361

SUBJECT: 8.281 AC ± PARCEL, PLANTATION ST. @

BY WJR CHKD. BY KWH SHEET 1 OF 1

I-290, WORCESTER, MA - ZIE ENVIRONMENTAL SITE ASSESSMENT



LOCUS PLAN

SCALE: 1" = 2083' ±
BASE MAP USGS QUAD SHEET
MARLBOROUGH, MA

FIGURE 1

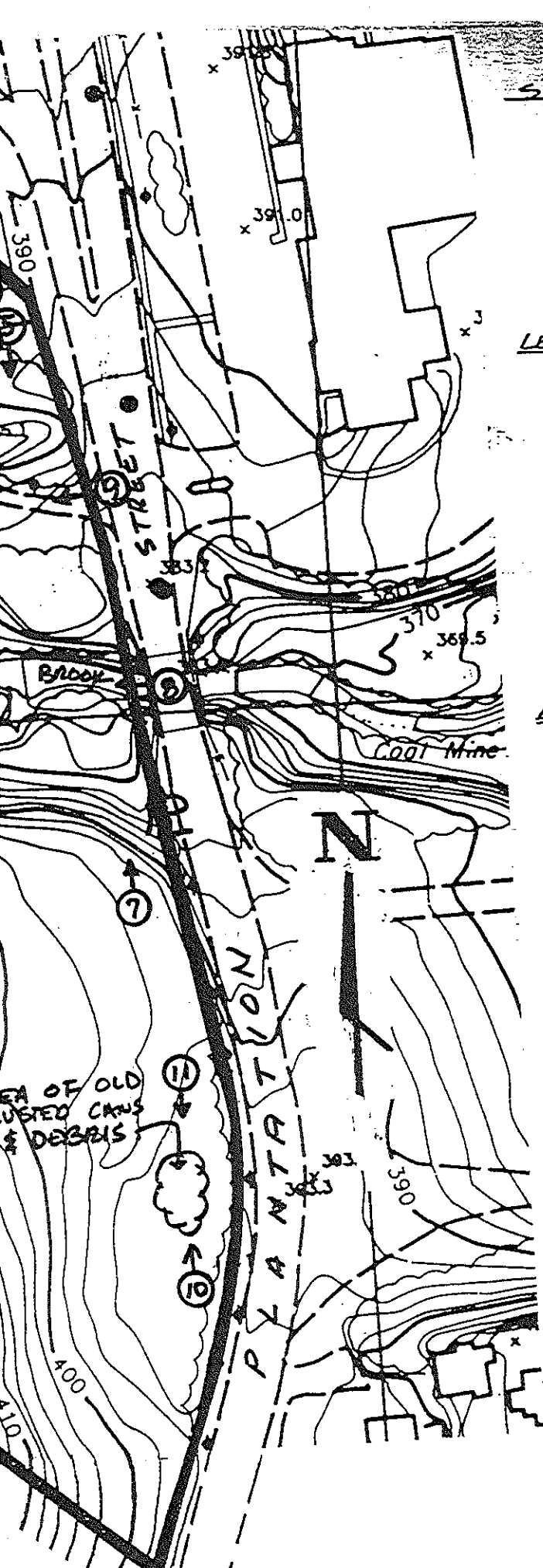
FIGURE 2

(SITE PLAN)



FIGURE 3
(PHOTOS)





SOURCE: -ASSESSING DEPT. BK.46 SH.45
CITY OF WORCESTER

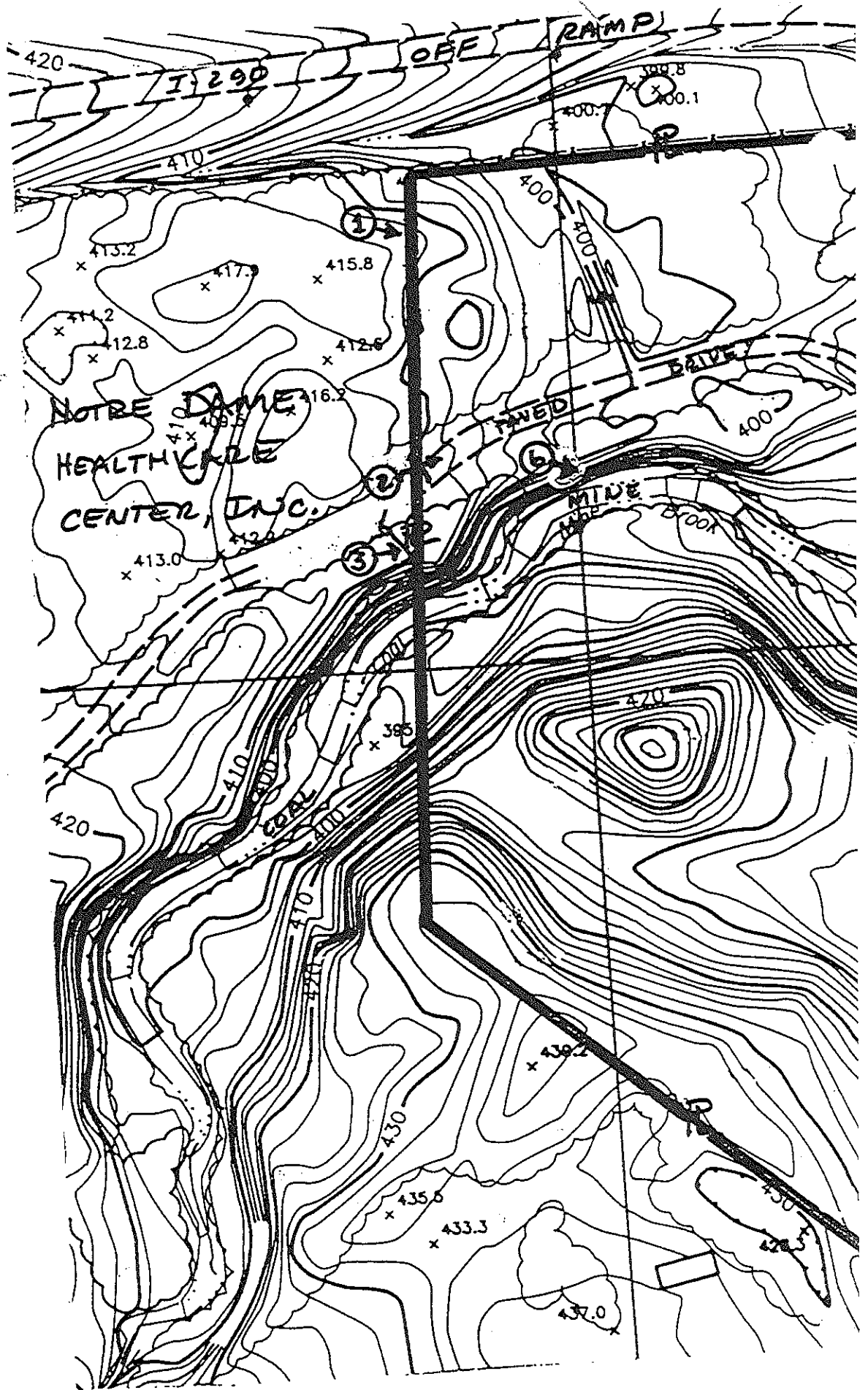
-TOPOGRAPHIC MAP SH.063
CITY OF WORCESTER, DPW
MARCH, 1988 BY QUINN ASSOCIATES

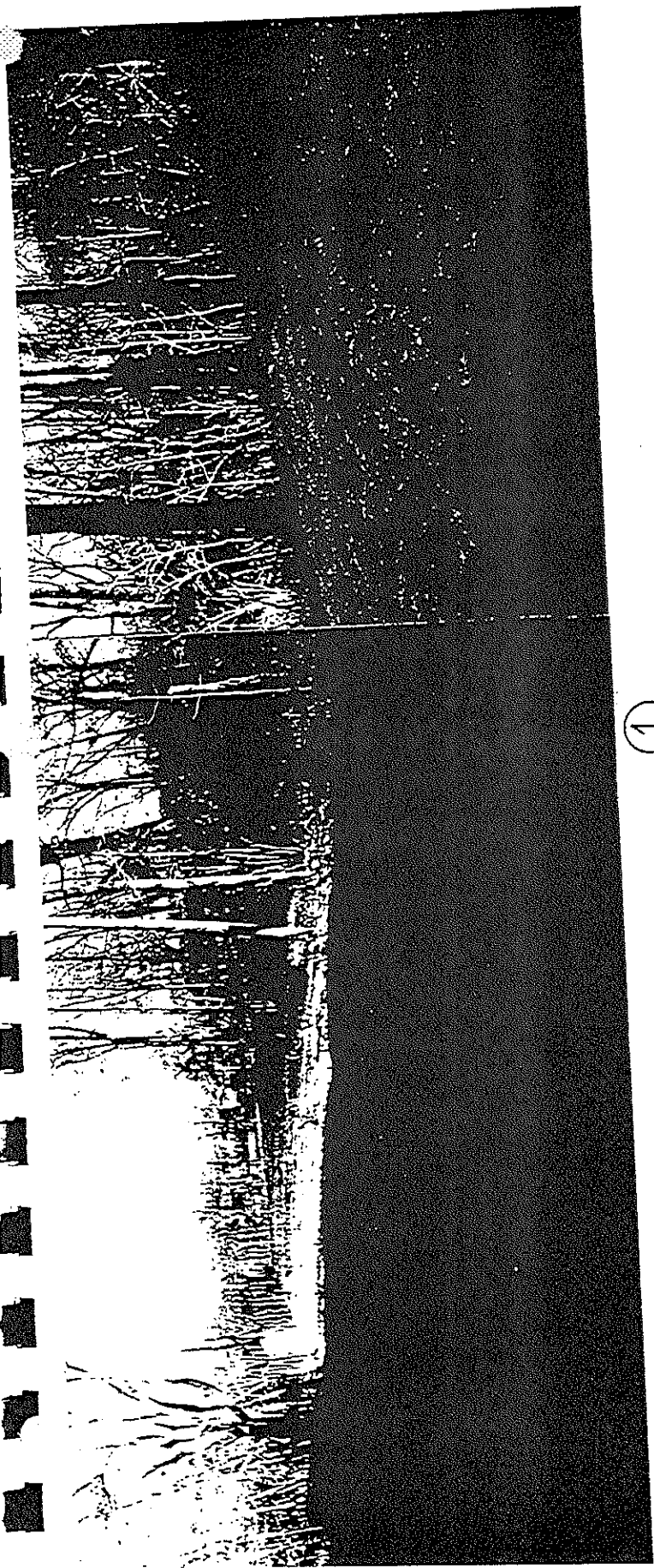
LEGEND:

- LOCATIONS APPROXIMATE ONLY
- ① → PHOTO LOCATION AND DIRECTION
- P— PROPERTY LINE
- ~ ~ ~ TREE LINE
- · · · - EDGE OF BROOK
- ~ ~ ~ CONTOUR LINES
- x - FENCE LINE
- - - EDGE OF PAVEMENT

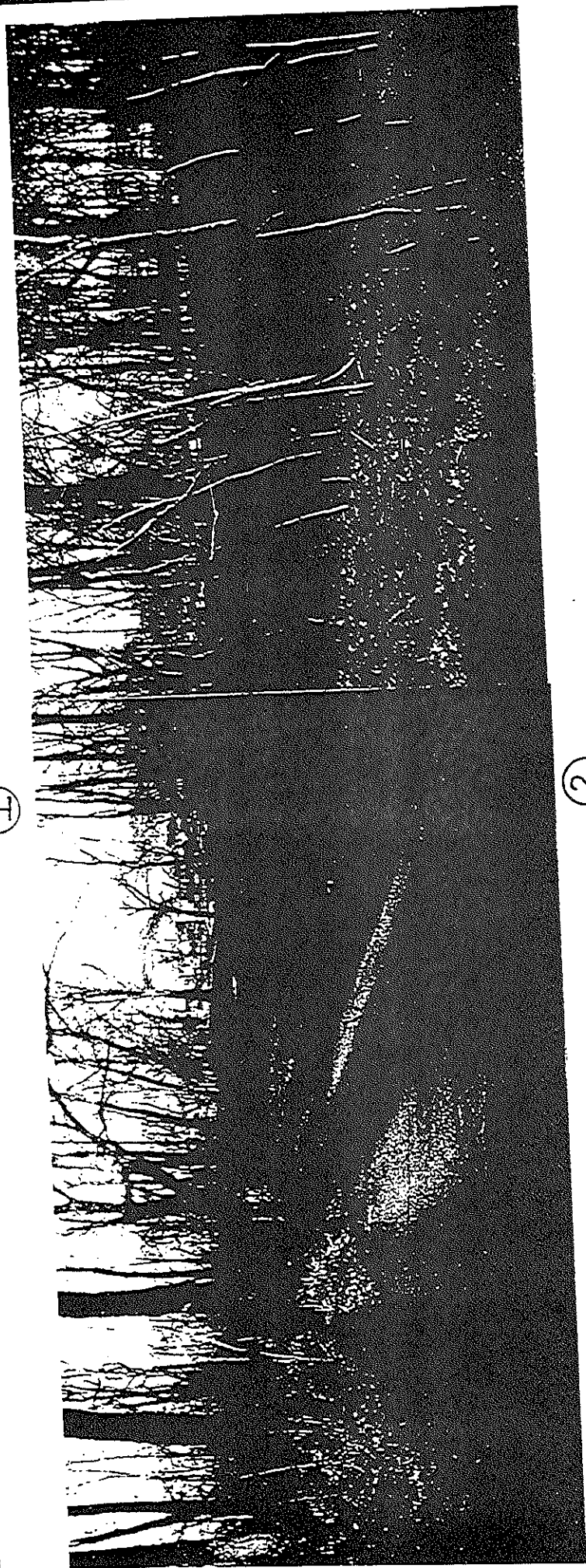
NOT TO SCALE:

FIGURE 2



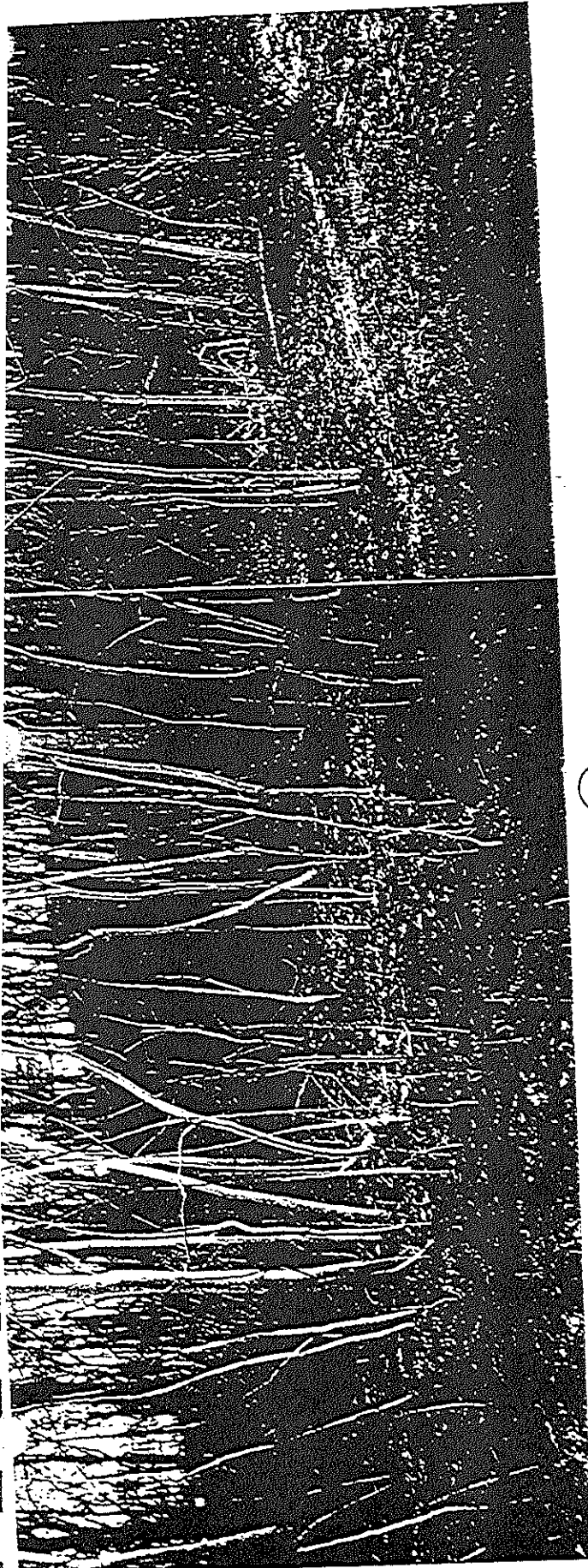


(1)

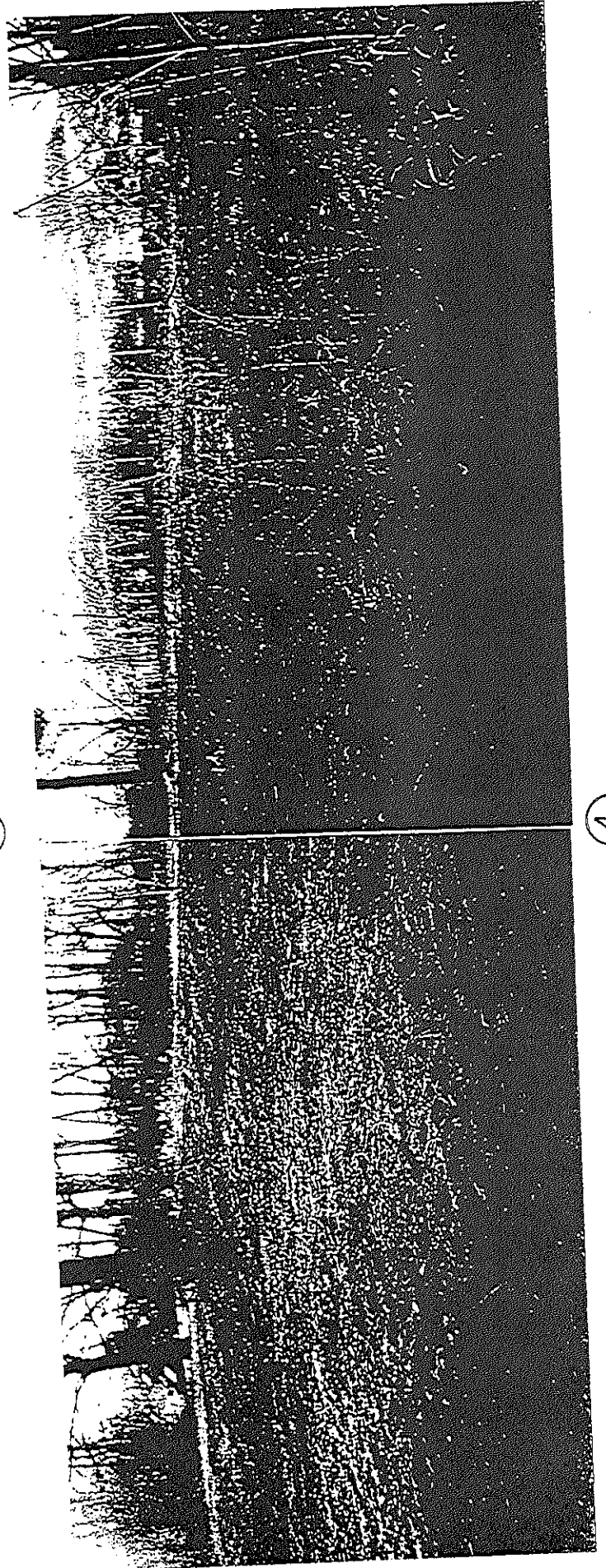


(2)

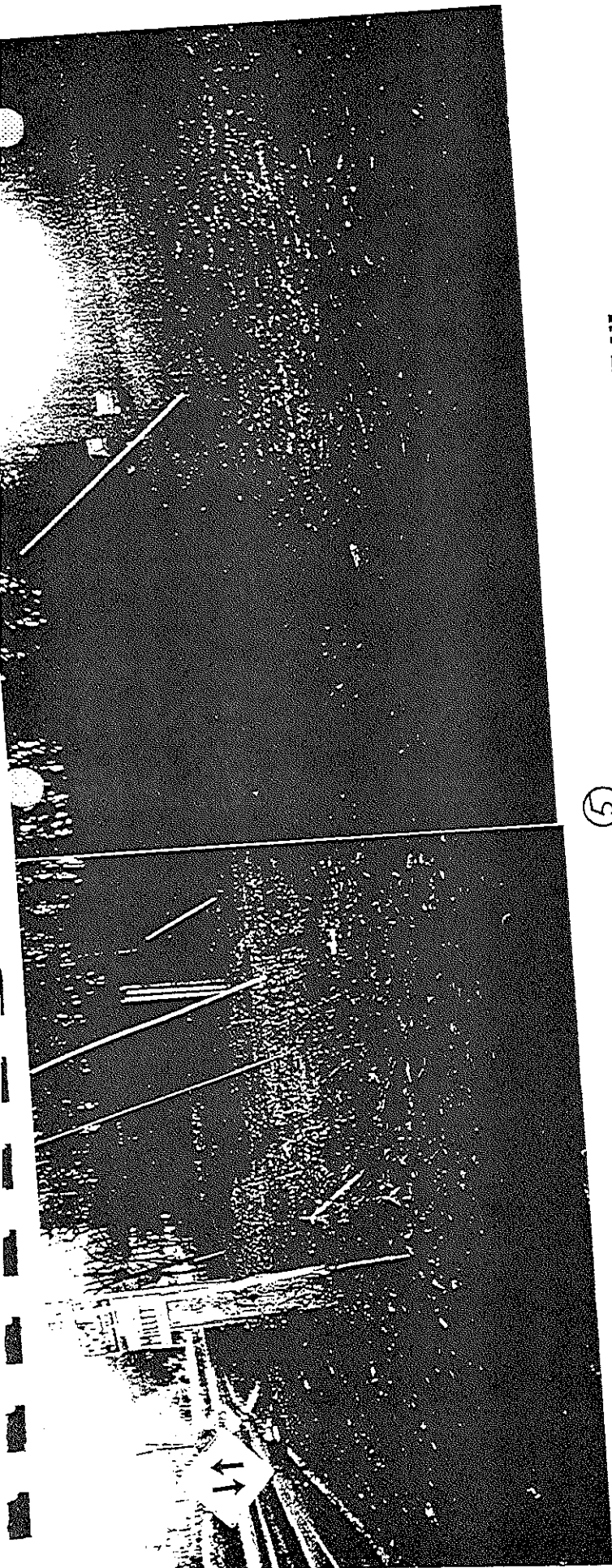
FIGURE 3



3



4



5



6

FIGURE 3



7



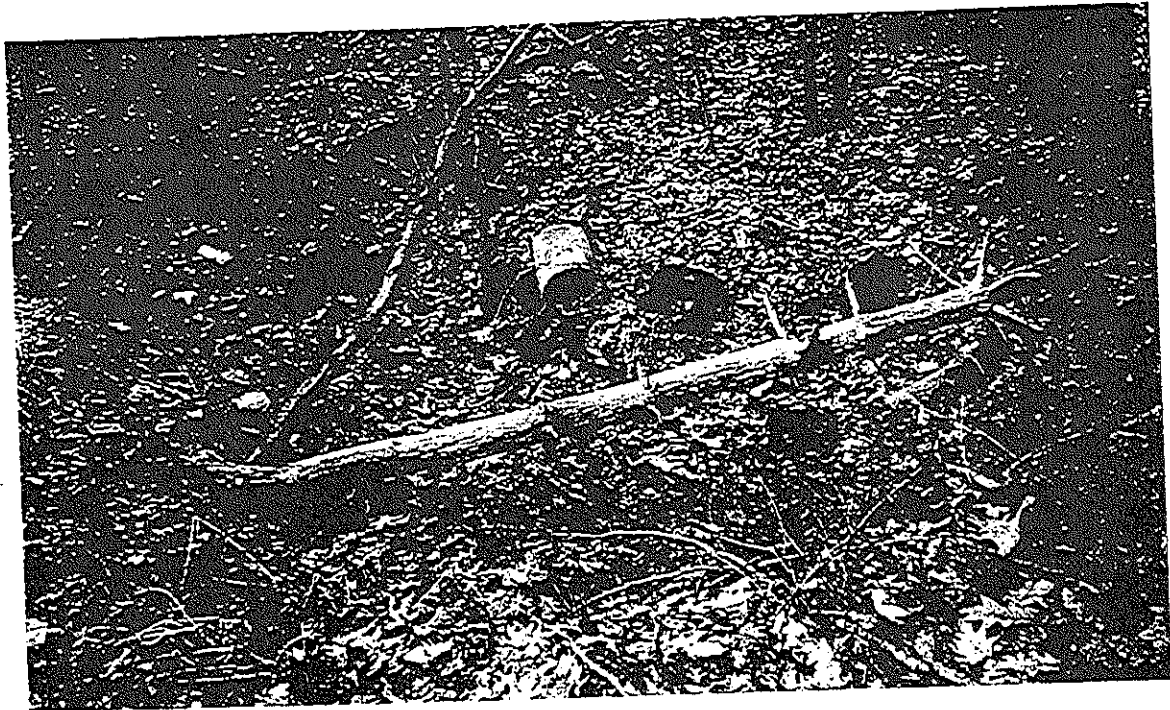
8



9



10



11

FIGURE 2

May 6, 1998



Lakeside Realty Company
C/O Mr. William R. Picard, AICP
54 Wesleyan Street
Shrewsbury, MA 01545

Subject: Addendum to Preliminary Phase 1 21E Environmental Site Assessment
Dated January 23, 1998
Undeveloped Parcel of land (Book 46, Sheet 45, Parcel B)
Plantation Street at I-290
Worcester, MA

Dear Mr. Picard,

This letter serves to provide further information regarding the above referenced property, specifically addressing the area noted in the Preliminary Site Assessment prepared by Cullinan Engineering Co., Inc., dated Jan. 23, 1997, where an area of discarded 1 gallon and 5 gallon rusted cans, containers and debris were found approximately 330 feet south of Coal Mine Brook and adjacent to Plantation Street on the easterly property line. The cans appeared to be of the type that would have been typical of those used to contain oil before the use of plastic containers became common.

In order to determine if oil had been released in the area, the rusted cans and debris were removed from the area using a backhoe. The debris was approximately 2 feet in depth. Upon removal of the debris, a composite soil sample was taken at the bottom of the debris pile. The sample was evaluated for olfactory evidence of impact and analyzed in the field using a Photoionization Detector calibrated to a benzene standard. No volatile organic compounds (VOC's) were detected in the field.


The soil sample was then submitted for laboratory analysis of Extractable Petroleum Hydrocarbons (EPH) via Mass DEP modified EPA Methods 8100 and 8270. The results of this analysis showed that no extractable petroleum hydrocarbons were detectable above the applicable method detection limits for each EPH parameter. The results of this lab analysis and a letter from our subconsultant, Corporate Environmental Advisor (CEA) is attached.

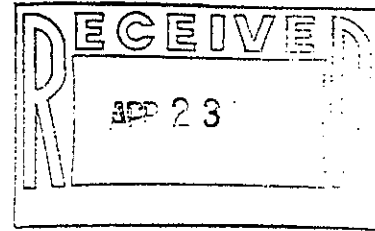
Based upon these findings, it does not appear that there has been a release of oil in this location.

If you have any questions concerning this information, please do not hesitate to contact one of the undersigned.

Sincerely,


David R. Morrow
V.P. / Project Engineer


Kenneth W. Hodgson, Jr., PE
V.P. / Chief Engineer



April 22, 1998

Mr. David R. Morrow
Vice President
Cullinan Engineering
200 Auburn Street
Auburn, MA 01501

**RE: Summary Letter
Vacant Fallon Clinic Land
Plantation Street
Worcester, MA
CEA Ref. # 3615-98-1**

Dear Mr. Morrow:

Pursuant to your request, Corporate Environmental Advisors, Inc. (CEA) respectfully submits the following summary letter pertaining to soil sampling performed at the above referenced property.

During an inspection of the above referenced property by Cullinan Engineering personnel numerous empty containers and other waste materials were discovered at the top of the embankment directly abutting Plantation Street. CEA was subsequently contacted and asked to evaluate any environmental concerns associated with the discovery of the material. Upon further inspection of the area, CEA determined that the materials, which consisted of old oil containers, glass and other metal containers, were empty and could be disposed of as standard solid waste.

CEA recommended that upon removal of the material, a confirmatory composite soil sample should be collected from the base of the pile and submitted for laboratory analysis for Extractable Petroleum Hydrocarbons (EPH) via Massachusetts Department of Environmental Protection (MA DEP) modified EPA Methods 8100 and 8270. This analysis is recommended by the MA DEP to evaluate sites where releases of oils such as motor or fuel oil may have occurred.

On April 8, 1998, upon removal of the material, CEA collected a composite soil sample at the location of the former solid waste pile. Prior to submittal for laboratory analysis, the sample was evaluated for olfactory evidence of impact and analyzed in the field utilizing a Photoionization Detector (PID) calibrated to a benzene standard. A PID is a useful instrument for the analysis of volatile organic compounds (VOCs) some of which may not be picked up during the EPH analysis. The sample did not exhibit any olfactory or PID evidence of contamination.

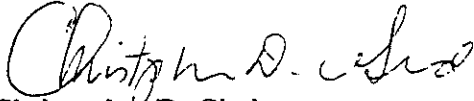
Based upon the results of the laboratory analysis, a copy of which is enclosed with this letter, no extractable petroleum hydrocarbons were detected above the applicable method limits of detection for each EPH parameter.

As such, there is no evidence to suggest that a release to the environment has occurred as a result of the dumping of the material discussed herein. Since the results of the analysis does not reveal any evidence of petroleum impact, no notification to the MA DEP is required.

If you have any questions regarding this or any other matter, please do not hesitate to contact the undersigned at (508) 835-8822.

Sincerely,

CEA, Inc.



Christopher D. Glod
Project Manager

CDG:cdg

pc: Steven M. Migridichian, PG, LSP
CEA, Inc.



SPECTRUM ANALYTICAL, INC.

Massachusetts Certification M-MA 138
Connecticut Approval # PH 0777
Rhode Island # 98 & Maine # n/a
New Hampshire ID # 2538
New York ID #11393
Florida HRS87448

April 13, 1998

CEA, Inc.
127 Hartwell Street
West Boylston, MA 01583

Attn: Chris Glod

Client Project No.: 3615-981

Location: Cullinan - Worcester, MA

Lab ID No.

Client ID

Analysis Requested

AB02042

S-2

Extractable Oil Hydrocarbons

Authorized by

Hanibal Fayeh
President/Laboratory Director

ENVIRONMENTAL ANALYSES

TEL: 413-789-0018 - FAX 413-789-4076

SPECTRUM ANALYTICAL, INC.
Laboratory Report

Client ID: S-1
Lab ID No.: AB02042

Location: Cullinan - Worcester, MA
Client Job No.: 3615-981

Matrix: Soil
Collected: 04/08/98 by CEA
Received on 04/09/98 by DDR
QC and Data Review by

Preservative: Refrigeration
Container: 1 Glass Soil Jar
Condition of Sample as Received: Satisfactory
Delivered by: Courier

Extractable Petroleum Hydrocarbons
MA DEP Modified EPA 8270/8100

| Parameter for AB02042 | Results | MDL | Extracted | Analyzed | Analyst |
|---------------------------------|--------------|-------|-----------|----------|---------|
| Aliphatics/Aromatics(mg/Kg) | | | | | |
| C9 - C18 Aliphatics | Not detected | 66 | 04/11/98 | 04/12/98 | MB |
| C19- C36 Aliphatics | Not detected | 66 | 04/11/98 | 04/12/98 | MB |
| C11- C22 Aromatics | Not detected | 66 | 04/11/98 | 04/12/98 | MB |
| Targeted PAH's Analytes (ug/Kg) | | | | | |
| Acenaphthene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Acenaphthylene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Anthracene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Benzo (a) anthracene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Benzo (b) fluoranthene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Benzo (k) fluoranthene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Benzo (a) pyrene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Benzo (g,h,i) perylene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Chrysene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Dibenz (a,h) anthracene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Fluoranthene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Fluorene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Indeno (1,2,3-cd) pyrene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| 2-Methylnaphthalene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Naphthalene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Phenanthrene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Pyrene | Not detected | 168.0 | 04/11/98 | 04/12/98 | MB |
| Surrogate Recovery(%) | | | | | |
| 1-Chloro-octadecane(%SR) | 88 | | 04/11/98 | 04/12/98 | MB |
| Ortho-Terphenyl(%SR) | 76 | | 04/11/98 | 04/12/98 | MB |
| % Solids | 80.7 | 0.1 | 04/11/98 | 04/13/98 | KS |

Spectrum Analytical, Inc.
Laboratory Report Supplement

References

- Methods for the Determination of Organic Compounds in Drinking Water. EPA-600/4-88/039. EMSL 1988.
- Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79-020. EMSL 1983.
- Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater. EPA 600/4-82-057. EMSL 1982.
- Test Methods for Evaluating Solid Waste. Physical/Chemical Methods. EPA SW-846. 1986.
- Standard Methods for the Examination of Water and Wastes. APHA-AWWA-WPCF. 16th Edition. 1985.
- Standard Methods for Comparison of Waterborne Petroleum Oils by Gas Chromatography. ASTM D 3328. 1982.
- Oil Spill Identification System. U.S. Coast Guard CG-D-52-77. 1977.
- Handbook for Analytical Quality Control in Water and Wastewater Laboratories. EPA 600/4-79-019. EMSL 1979.
- Choosing Cost-Effective QA/QC (Quality Assurance/Quality Control) Programs for Chemical Analyses. EPA 600/4-85/056. EMSL 1985.

Report Notations

- Not Detected, = The compound was not detected at a concentration
Not Det. ND or nd equal to or above the established method detection
limit.
- NC = Not Calculated
- MCL = EPA Maximum Contamination Level
- VOA = Volatile Organic Analysis
- BFB = 4-Bromofluorobenzene (an EPA 624 Surrogate)
- p-DFB = 1,4-Difluorobenzene (an EPA 624 Surrogate)
- CLB-d5 = Chlorobenzene-d5 (an EPA 624 Surrogate)
- BCP = 2-Bromo-1-chloropropane (an EPA 601 Surrogate)
- TFT = *o, o, o*-Trifluorotoluene (an EPA 602 Surrogate)
- Decachlorobiphenyl = (an EPA 608/8080 Surrogate)

Definitions

Surrogate Recovery = The recovery (expressed as a percent) of a non method analyte (see surrogates listed above) added to the sample for the purpose of monitoring system performance

Matrix Spike Recovery = The recovery (expressed as a percent) of method analytes added to the sample for the purpose of determining any effect of sample composition on analyte recovery.

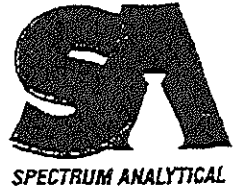
Laboratory Replicate = Two sample aliquots taken in the analytical laboratory and analyzed separately with identical procedures. Analyses of laboratory duplicates give a measure of the precision associated with laboratory procedures, but not with sample collection, preservation, or storage procedures.

Field Duplicate = Two separate samples collected at the same time and place under identical circumstances and treated exactly the same throughout field and laboratory procedures. Analysis of Field duplicates give a measure of the precision associated with sample collection, preservation and storage, as well as with laboratory procedures.

Relative Percent Difference (%RPD) = The precision measurement obtained on duplicate/replicate analyses.
%RPD is calculated as:

$$\%RPD = \frac{(\text{value1} - \text{value2})}{\text{ave. value}} \times 100\%$$

CHAIN OF CUSTODY RECORD



Page of

| | | | | | | | | | | | | | | | | | | | | | | |
|---|-------------|------|----------|--------|---------------------------------|-------------------------|-----------|---------------------|----------------------|-----------------------|------------------|------------------|-------------------|--------------------|--------------------------|-------------------------|-------------------|--------------------------|------|-------|--------------------|----------------------|
| PROJECT NO.: 3615-98-1 | | | | | REPORT TO: CEA, Inc. | | | | | | | | | | | | | | | | | |
| SITE NAME: Cullinan | | | | | | | | | | | | | | | | | | | | | | |
| LOCATION: Worcester | | | STATE MA | | ADDRESS: | | | | | | | | | | | | | | | | | |
| REFERENCE QUOTE NUMBER (RON): | | | | | CITY | | STATE | | ZIP | | | | | | | | | | | | | |
| PURCHASE ORDER NO.: | | | | | INVOICE TO: CEA, Inc. | | | | | | | | | | | | | | | | | |
| PROJECT Mgr: COG | | | | | | | | | | | | | | | | | | | | | | |
| SAMPLER(s): MEB | | | | | CITY | | STATE | | ZIP | | | | | | | | | | | | | |
| SAMPLE TYPE & MATRIX CODES: | | | | | CONTAINERS | VOC's | | SVOC's | TPH | METALS | OTHER | | | | | | | | | | | |
| 1 = 4°C 2 = HCl 3 = H ₂ SO ₄ 4 = HNO ₃ 5 = OTHER | | | | | / 40 ml VOA VIALS | / OF AMBER GLASS LITERS | | / OF PLASTIC LITERS | / OF GLASS SOIL JARS | 1-60178010 2-60278020 | 1-50278021 2-524 | 1-6248240 2-8260 | 1-NITBE 2-KETONES | 1-8270 2-BN 3-PAHS | 1-PCBS 2-PEST (608/8080) | 1-GC(8100M) 2-GC(8015M) | 1-YPH (CEPD) 3-ID | 1-IR(418.1) 2-OIL/GREASE | PP13 | RCRAB | As, Cu, Cr, Hg, Pb | 1-PH 2-FLASH 3-REACT |
| C = COMPOSITE G = GRAB | | | | | 1 = AQUEOUS | 3 = SLUDGE | 5 = OTHER | 2 = SOIL | 4 = SEDIMENT | MATRIX | SAMPLE TYPE | PRESERVATIVE | | | | | | | | | | |
| LAB USE ONLY | SAMPLE I.D. | DATE | TIME | MATRIX | SAMPLE TYPE | PRESERVATIVE | | | | | | | | | | | | | | | | |
| AA 02047 | S-1 | 4/8 | PM | 2 | C | 1 | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| AA | | | | | | | | | | | | | | | | | | | | | | |
| RELINQUISHED BY: <i>[Signature]</i> | | | | | RECEIVED BY: <i>[Signature]</i> | | | | | DATE | | TIME | | | | | | | | | | |
| | | | | | | | | | | 4/9/98 | | 1750 | | | | | | | | | | |
| | | | | | | | | | | 4-9 | | 1705 | | | | | | | | | | |

SPECIAL INSTRUCTIONS: 1 soil sample for EPH

SPECIAL HANDLING: Please check

- Return Sample after Analysis
- Dispose of Sample after 60 days
- Standard TAT - 7 to 10 Business days
- Special TAT - ~~48~~ - 48 hr - 72 hr - 5 b. days
- TAT begins when sample is received at test facility.
- TAT for samples rec'd after 3 pm will begin on the next business day.
- All TAT's are subject to laboratory approval and customer consent.

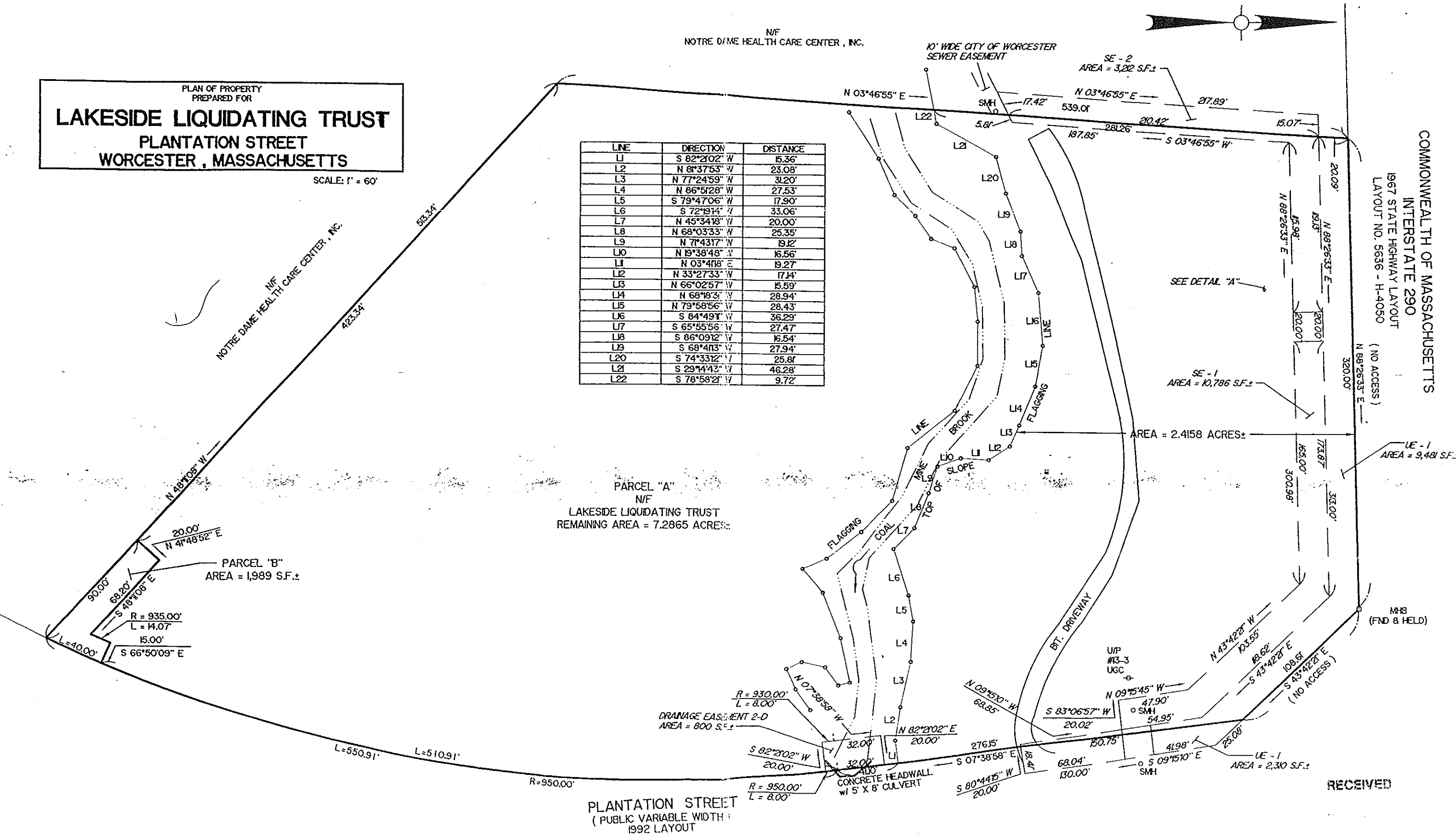
DATE RESULTS NEEDED: 4/10/98

PLAN OF PROPERTY
PREPARED FOR
LAKESIDE LIQUIDATING TRUST
PLANTATION STREET
WORCESTER, MASSACHUSETTS

SCALE: 1" = 60'

| LINE | DIRECTION | DISTANCE |
|------|---------------|----------|
| L1 | S 82°21'02" W | 15.36' |
| L2 | N 8°37'53" W | 23.08' |
| L3 | N 77°24'59" W | 31.20' |
| L4 | N 86°51'28" W | 27.53' |
| L5 | S 79°47'06" W | 17.90' |
| L6 | S 72°19'14" W | 33.06' |
| L7 | N 45°34'18" W | 20.00' |
| L8 | N 68°03'33" W | 25.35' |
| L9 | N 7°43'17" W | 19.12' |
| L10 | N 19°38'48" W | 16.56' |
| L11 | N 03°41'18" E | 19.27' |
| L12 | N 33°27'33" W | 17.14' |
| L13 | N 66°02'57" W | 15.59' |
| L14 | N 68°18'3" W | 28.94' |
| L15 | N 79°58'56" W | 28.43' |
| L16 | S 84°49'1" W | 36.29' |
| L17 | S 65°55'56" W | 27.47' |
| L18 | S 86°09'12" W | 16.54' |
| L19 | S 68°41'3" W | 27.94' |
| L20 | S 74°33'12" W | 25.81' |
| L21 | S 29°14'43" W | 46.28' |
| L22 | S 78°58'21" W | 9.72' |

PARCEL "A"
N/F
LAKESIDE LIQUIDATING TRUST
REMAINING AREA = 7.2865 ACRES±



COMMONWEALTH OF MASSACHUSETTS
INTERSTATE 290
1967 STATE HIGHWAY LAYOUT
LAYOUT NO. 5636 - H-4050
(NO ACCESS)

UE - 1
AREA = 9,481 S.F.±

SE - 1
AREA = 10,786 S.F.±

AREA = 2.4158 ACRES±

SE - 2
AREA = 3,202 S.F.±

UE - 1
AREA = 2,310 S.F.±

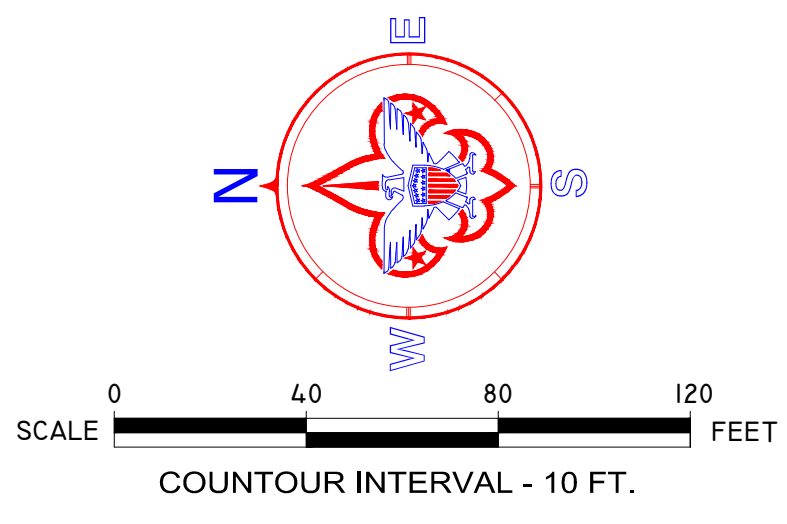
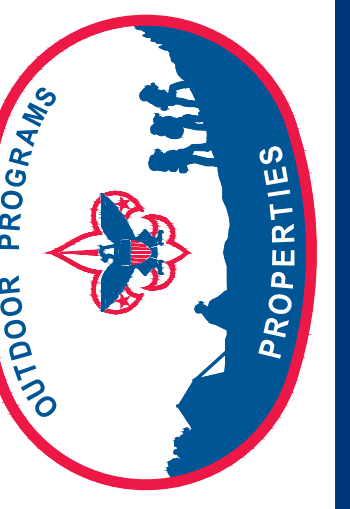
DRAINAGE EASEMENT 2-D
AREA = 800 S.F.±

PARCEL "B"
AREA = 1,989 S.F.±

PLANTATION STREET
(PUBLIC VARIABLE WIDTH)
1992 LAYOUT

RECEIVED

ENGINEERING SERVICE



LEGEND

| | | | |
|---------------------------------|---------------------|-----------------|--|
| PROPERTY BOUNDARIES | --- --- --- --- | CAMPFIRE CIRCLE | |
| CAMPSITE BOUNDARIES | --- --- --- --- | CHAPEL | |
| ROAD - PRIMARY | ==== ==== ==== ==== | SOCCER | |
| ROAD - SECONDARY | --- --- --- --- | SOFTBALL | |
| FOOTPATH | --- --- --- --- | RIFLE RANGE | |
| CONTOUR - MAIN | --- --- --- --- | ARCHERY | |
| CONTOUR - SECONDARY | --- --- --- --- | ARCHERY - CUB | |
| FENCE | --- --- --- --- | SHOTGUN | |
| WOODED AREA | | POOL / SHOWER | |
| PROPOSED VEGETATION / SCREENING | | | |
| WETLANDS | | | |
| SWAMP / MARSH | | | |
| CREEK | | | |
| INTERMEDIATE STREAM | | | |
| BRIDGE | | | |
| GATE | | | |
| STRUCTURES: EXISTING | | | |
| PROPOSED | | | |
| DEMOLITION | | | |

REVISIONS:

MOHEGAN COUNCIL

19 HAVARD STREET
WORCESTER, MA 01609
PHONE: 508-752-3768
FAX:

BOY SCOUTS OF AMERICA
PROPERTIES DEPARTMENT

1325 W. WALNUT HILL LANE
IRVING, TEXAS 75038
PHONE: 972-580-7826
FAX: 972-580-2563

SITE DEVELOPMENT PLAN
SERVICE CENTER
MOHEGAN COUNCIL
WORCESTER, MASSACHUSETTS

DESIGNED: DC
DRAWN BY: HR
CHECKED: DC
ISSUED DATE: JULY 28, 2016

I. GENERAL

This program of requirements is intended as a planning guide. Where specific numbers are shown, they are to be used as working estimates of what is required. They are an indication of an approximate size in square foot area, and variation is expected as specific requirements become better defined.

Design Considerations

1. The Council Service Center is the headquarters office of a non-profit, volunteer supported and directed organization, which serves youth. The facility itself primarily serves adult volunteers rather than youth.
2. The Service Center must convey a positive image to those who see it. It must be an embodiment of good stewardship and fiduciary responsibility for a non-profit organization. It should also demonstrate functional efficiency and environmental sensitivity.
3. The building and site must be designed for the greatest practical durability and lowest practical maintenance. Components should be selected for advantageous life cycle cost.
4. This facility must be designed to incorporate the letter and spirit of accessibility guidelines of the Americans With Disabilities Act. Where local requirements are the lesser, the ADA guidelines are to prevail.
5. The design of the site and building must allow for possible future expansion beyond what is presently foreseen.
6. In general, the visual elements of the design should express function. It is the specific intent of the Council to avoid trendy styles likely to become dated.
7. Security is an important concern. The design of the site and building must promote 24-hour security of persons and property. Special emphasis is directed to this issue related to volunteer meetings at night, off-hour arrival or departure of staff, and unattended parking.

For the purpose of access control, the facility is divided into three zones. Each zone has independent access and security requirements:

1. Scout Shop - A retail operation which must be accessible when the office and/or meeting facilities are closed and secured. Access to restrooms and vending area is required.
2. Meeting Room(s) - Must be accessible when the office and/or Scout Shop facilities are closed and secured. Access to restrooms, kitchen/break room and vending area is required.
3. Offices - Must be securable without restricting access to Scout Shop or Meeting Room(s).

II. SITE REQUIREMENTS

The following is a list of requirements that are the "components" of on-site development. These components will predominantly be shown on a Site Plan, which is a drawing that will graphically depict on-site vehicular circulation, parking areas, pedestrian walkways, landscape areas, and the building footprint.

1. Access
 - a. Street - Direct ingress/egress – for both directions of traffic. If a corner site is contemplated, this applies to both streets.
2. Parking
 - a. On-site - Number of spaces per code, with 30 space minimum.
 - b. Accessible Parking, as required by local code
 - c. Overflow - n/a.
3. Loading

UPS-type service with no impedance of ingress, egress or parking.
4. Waste Removal

Make convenient work area and Scout Shop. Meet local requirements for screening.
5. Snow & Surface Water Run-off

Provide location for storage of snow removed from parking area. Provide positive flow for surface water and melting snow away from building and pedestrian traffic, without "ponding."
6. Landscaping

Design in context with the surrounding area, utilizing hardy native plants with the lowest possible maintenance requirements. Utilize low water usage plants.
7. Paving
 - a. Parking - Provide for lowest long-term cost.
 - b. Walks - to conform with ADA and local requirements.
8. Lighting
 - a. Parking - General illumination is required for safety and security.
 - b. Walks - Provide illumination where required for safety.
 - c. Building - No requirement to illuminate building exterior generally.
 - d. Security - Provide illumination at all entries, exterior doors, and other as appropriate.
 - e. Provide light shields and other such fixtures to prevent light pollution and trespass.
9. Signage
 - a. Deliveries - Directional signs as required.
 - b. Main identification - Distinctive, low, monument (possibly illuminated).

III. SPATIAL REQUIREMENTS

Entry Vestibule

70 SF
(10 x 7)

| | |
|---------------------|---|
| <u>Function</u> | Serve as an "weatherlock" |
| <u>Requirements</u> | Strong communication of Scouting in action via photos, graphics, etc. Display of memorabilia, trophies, BSA logo, etc. Weatherlock vestibule at entry. Video display. |
| <u>Systems</u> | Electrical: One Duplex 110V outlets, for cleaning Telephone/Data: NSR Lighting: General HVAC: No requirements |
| <u>Finishes</u> | Wall: Decorative, higher quality, easy maintenance. Ceiling: NSR. Floor: Durable, low maintenance, high traffic impact. Provide walk-off mat flush with floor, ADA compliant |
| <u>FF&E</u> | No special requirements |

Lobby
192 SF
(12 x 16)

| | |
|---------------------|---|
| <u>Function</u> | Main public access to facility for meetings, Scout Shop, customer service, toilets. |
| <u>Requirements</u> | Strong communication of Scouting in action via photos, graphics, etc. Display of memorabilia, trophies, BSA logo, etc. |
| <u>Systems</u> | Electrical: Duplex 110V outlets, each wall. Floor outlets (flush) at intervals for displays (verify location). Telephone/Data: Jack for phone at visitor table. Lighting: General and special for displays, etc. (track?) HVAC: No special requirements, unless lobby is sized for meeting overflow. |
| <u>Finishes</u> | Wall: Decorative, higher quality, easy maintenance. Ceiling: No special requirements Floor: Durable, low maintenance, high traffic impact. |
| <u>FF&E</u> | Visitor table (to complete paperwork) with chairs; area rug(s) if non-carpet flooring is used. |

Media Resources
8 SF
(2 x 4)

| | |
|---------------------|--|
| <u>Function</u> | Alcove display for distributed materials. |
| <u>Requirements</u> | locate adjacent to lobby |
| <u>Systems</u> | refer to Lobby notes |
| <u>Finishes</u> | Wall: Decorative, higher quality, easy maintenance. Ceiling: No special requirements Floor: Durable, low maintenance, high traffic impact. |
| <u>FF&E</u> | Shelves and racks for materials |

Scout Shop

800 SF
(20 x 40)

| | |
|---------------------|---|
| <u>Function</u> | Retail sales/display |
| <u>Requirements</u> | Sales area should have "store front display" to street. Sales counter/enclosure, 8' x 10'. Off-hour accessibility. High visibility. |
| <u>Systems</u> | Electrical: TBD. Telephone/Data: Dual voice/data jack at counter. Lighting: General, plus TBD specialty. HVAC: Zoned, with in-room thermostatic control. |
| <u>Finishes</u> | Wall: TBD. Ceiling: NSR. Floor: High traffic impact carpet. |
| <u>FF&E</u> | TBD. |

Scout Shop Dressing Room

25 SF
(5 x 5)

| | |
|---------------------|--|
| <u>Function</u> | Retail sales/display |
| <u>Requirements</u> | Louvered door, bench, mirror and coat hooks, compliant with ADA |
| <u>Systems</u> | Electrical: TBD Telephone/Data: NSR Lighting: General HVAC: NSR |
| <u>Finishes</u> | Wall: TBD. Ceiling: NSR. Floor: High traffic impact carpet. |
| <u>FF&E</u> | NSR |

Scout Shop Stock Room

160 SF
(10 x 16)

| | |
|---------------------|--|
| <u>Function</u> | Temporary storage of goods received at the Scout Office |
| <u>Requirements</u> | Should have double doors to outside, shelves of storage and access Scout Shop |
| <u>Systems</u> | Electrical: Duplex 110V wall outlet at entry. Telephone/Data: NSR Lighting: General HVAC: Zoned with Scout Shop. Mechanical: NSR |
| <u>Finishes</u> | Wall: NSR Ceiling: NSR Floor: Concrete, stained or sealed. |
| <u>FF&E</u> | Shelving |

Main Conference Room

936 SF
(26 x 36)

| | |
|---------------------|---|
| <u>Function</u> | Meeting space for 35 people, seated at tables (seminar style). |
| <u>Requirements</u> | Acoustic privacy, with visual privacy and black-out capability. Combination presentation board. Minimal exterior windows. |
| <u>Systems</u> | <p>Electrical: Minimum one duplex 110V per 12 linear feet outlet on each wall. PC power outlet. Multiple duplex 110V floor outlets (verify locations). Power supply above ceiling for projection screen.</p> <p>Telephone/Data: Wall phone, floor jack (verify location). Dual voice and data jack at PC location.</p> <p>Lighting: General fluorescent, with within-room switch. Recessed incandescent down lights on rheostat for note-taking.</p> <p>HVAC: Silent, in-room thermostatic control.</p> |
| <u>Finishes</u> | <p>Wall: Special finish.</p> <p>Ceiling: Decorative.</p> <p>Floor: Carpet.</p> |
| <u>FF&E</u> | Fifteen (16) 2'x6' seminar tables, with thirty-six (36) stackable chairs. Four (2) presentation boards. One (1) overhead projection screen. |

Break Room

140 SF
(10 x 14)

| | |
|---------------------|---|
| <u>Function</u> | Break room with limited food preparation for conference room |
| <u>Requirements</u> | Kitchen sink, disposal, goose neck faucet microwave, refrigerator. Garbage receptacle. Instant Hot Water tap. Minimum 8' long base and overhead kitchen cabinets. Two vending machines. Secure storage for vending and paper items. Seating for 3 for daily lunch/break. Off-hour accessibility. |
| <u>Systems</u> | Electrical: Provision for appliances, disposal, and vending machine. Duplex 110V outlets at back-splash, 36" O.C. Convenience wall outlets. Telephone/Data: Jack for wall phone at entry. Lighting: NSR HVAC: NSR Plumbing: CW line to refrigerator for ice machine CW line for coffee maker |
| <u>Finishes</u> | Wall: Decorative Ceiling: NSR Floor: Durable, low maintenance |
| <u>Adjacencies</u> | Immediate: NSR; convenient to conference room and entry/lobby. |
| <u>FF&E</u> | Table and three chairs. Two vending machines. One each: refrigerator, microwave, ice machine. |

TOILETS

414 SF

(23 x 18)

| | | |
|---------------------|---|--|
| <u>Function</u> | Toilet facility for general office and public access. Supports conference room and Scout Shop. Assume two lavatories and three fixtures each for men and women. | |
| <u>Requirements</u> | Emphasis on durable, low maintenance fixtures and finishes. Noise containment of speech and fixture operation. Graffiti resistant. Accessible from lobby, meeting and Scout Shop areas while office space is secured (off-hours). Lounge, per local code. | |
| <u>Systems</u> | Electrical: | One duplex 110V wall outlet near entry. One duplex 110V outlet on a side wall above counter top. |
| | Telephone/Data: | None. |
| | Lighting: | General, plus supplemental vanity lighting. |
| | HVAC: | Augmented exhaust. |
| <u>Finishes</u> | Wall: | Durable, washable per local codes. |
| | Ceiling: | NSR. |
| | Floor: | Durable, hard, sanitary. |
| <u>Adjacencies</u> | Immediate: | NSR; convenient to lobby, Main Conference Room and Scout Shop. |

JANITORIAL
 48 SF
 (6 x 8)

| <u>Function</u> | <u>Requirements</u> | <u>Systems</u> | <u>Finishes</u> | <u>FF&E</u> | |
|---|---------------------------|---|---|--|-----------------|
| Storage of janitorial equipment and supplies. | Mop sink, supply storage. | Electrical: Duplex 110V outlet. Telephone/Data: N/A. | Lighting: Impact resistant, surface-mounted. HVAC: Vent in door. Plumbing: HW and CW, with "demand" water heater. | Wall: Durable, washable. Ceiling: Utilitarian. Floor: Durable, washable. | Steel shelving. |

STORAGE, OFFICE SUPPLY

96 SF
(12 x 8)

| | |
|---------------------|---|
| <u>Function</u> | Central storage for office supply materials, administrative copy center, coffee bar, etc. |
| <u>Requirements</u> | Open access to copy machine, secured off-hours. Some secure storage (closets or lockable cabinets). |
| <u>Systems</u> | Electrical: One duplex 110V wall outlet each for backsplash and entry; duplex 110V wall outlet (dedicated circuit) for copier. Telephone/Data: None. Lighting: NSR. HVAC: NSR. |
| <u>Finishes</u> | Wall: NSR. Ceiling: NSR. Floor: Carpet. |
| <u>Adjacencies</u> | Immediate: S.E. Secretary. |
| <u>FF&E</u> | Shelving or cabinets for supplies. |

Work/ Mail Room

392 SF

(14 x 28)

Function Long work area with fax, copies and printers along one wall, counters on the other and tables in the center for assembling packages of printed information and preparation of material to be mailed out.

Requirements Computer workstation, printing equipment, processing equipment, mail processing: incoming/outgoing, acoustic containment, wide aisle clearance for equipment and bulk material, manager workstation

Systems

| | |
|-----------------|---|
| Electrical: | Verify |
| Telephone/Data: | Verify |
| Lighting: | General: 70fc minimum Special: verify need for task lighting |
| HVAC: | NSR |
| Mechanical: | NSR |

Finishes

| | |
|----------|------------------------------------|
| Wall: | Durable, washable |
| Ceiling: | Acoustic |
| Floor: | Extremely durable, low maintenance |

FF&E Verify

SCOUT EXECUTIVE

216 SF
(12 x 18)

| | |
|---------------------|--|
| <u>Function</u> | CEO office. Executive office with visitor seating in front of desk, Round 36" conference table, four chairs. |
| <u>Requirements</u> | Acoustical privacy, with visual privacy capability. Small closet. Built-in bookcase with cabinet-type doors. Maximum exterior window exposure, "controlled" view. Second access to corridor (may be via small conference room). |
| <u>Systems</u> | Electrical: Minimum two duplex 110V outlets each wall. Floor outlet (flush) under desk. PC power near data jack. Telephone/Data: Dual voice and data wall jack at credenza; floor jack (flush) under desk and coffee table. Lighting: Low level general illumination. Recessed incandescent wall washers on one wall with rheostat. HVAC: "Silent." |
| <u>Finishes</u> | Wall: Special color/finish on all walls. Ceiling: Decorative, very high STC, NRC, SPA. Floor: Carpet. |
| <u>FF&E</u> | Executive desk, chair, credenza. Round 36" conference table, three visitor chairs. |

Small Conference Room

144 SF
(12 x 12)

| | |
|---------------------|--|
| <u>Function</u> | Office with visitor seating in front of desk, Round 36" conference table, four chairs. |
| <u>Requirements</u> | Acoustical privacy, with visual privacy capability. |
| <u>Systems</u> | Electrical: Minimum two duplex 110V outlets each wall. Outlet flush under desk. PC power near data jack. Telephone/Data: Dual voice and data wall jack at credenza; floor jack (flush) under desk and coffee table. Lighting: General, parabolic lenses HVAC: "Silent." |
| <u>Finishes</u> | Wall: Durable, washable Ceiling: Acoustic Floor: Carpet |
| <u>FF&E</u> | Table and 6 chairs |

DISTRICT EXECUTIVE

144 SF
(12 x 12)

| | |
|---------------------|--|
| <u>Function</u> | Office with visitor seating in front of desk |
| <u>Requirements</u> | Acoustical privacy, with visual privacy capability. |
| <u>Systems</u> | Electrical: Minimum two duplex 110V outlets each wall. Outlet flush under desk. PC power near data jack. Telephone/Data: Dual voice and data wall jack at credenza; floor jack (flush) under desk and coffee table. Lighting: General, parabolic lenses HVAC: "Silent." |
| <u>Finishes</u> | Wall: Durable, washable Ceiling: Acoustic Floor: Carpet |
| <u>FF&E</u> | Desk, chair, credenza. |

PROGRAM / FINANCE DIRECTOR

144 SF
(12 x 12)

| | |
|---------------------|--|
| <u>Function</u> | Office with visitor seating in front of desk |
| <u>Requirements</u> | Acoustical privacy, with visual privacy capability. |
| <u>Systems</u> | Electrical: Minimum two duplex 110V outlets each wall. Outlet flush under desk. PC power near data jack. Telephone/Data: Dual voice and data wall jack at credenza; floor jack (flush) under desk and coffee table. Lighting: General, parabolic lenses HVAC: "Silent." |
| <u>Finishes</u> | Wall: Durable, washable Ceiling: Acoustic Floor: Carpet |
| <u>FF&E</u> | Desk, chair, credenza |

OFFICE MANAGER / BOOKKEEPER

120 SF
(10 x 12)

| | |
|---------------------|--|
| <u>Function</u> | Office with visitor seating in front of desk |
| <u>Requirements</u> | Acoustical privacy, with visual privacy capability. |
| <u>Systems</u> | Electrical: Minimum two duplex 110V outlets each wall. Outlet flush under desk. PC power near data jack. Telephone/Data: Dual voice and data wall jack at credenza; floor jack (flush) under desk and coffee table. Lighting: General, parabolic lenses HVAC: "Silent." |
| <u>Finishes</u> | Wall: Durable, washable Ceiling: Acoustic Floor: Carpet |
| <u>FF&E</u> | Desk, chair, credenza, locking file cabinets |

REGISTAR

120 SF
(10 x 12)

| | |
|---------------------|--|
| <u>Function</u> | Office with visitor seating in front of desk |
| <u>Requirements</u> | Acoustical privacy, with visual privacy capability. |
| <u>Systems</u> | Electrical: Minimum two duplex 110V outlets each wall. Outlet flush under desk. PC power near data jack. Telephone/Data: Dual voice and data wall jack at credenza; floor jack (flush) under desk and coffee table. Lighting: General, parabolic lenses HVAC: "Silent." |
| <u>Finishes</u> | Wall: Durable, washable Ceiling: Acoustic Floor: Carpet |
| <u>FF&E</u> | Desk, chair, credenza, locking file cabinets |

STORAGE, RECORDS

220 SF

(10 x 22)

| | |
|---------------------|---|
| <u>Function</u> | Secure storage for council records. This space may be included in a detached building, convenient to staff entrance, shipping/receiving |
| <u>Requirements</u> | Provided secure door to outside and to program storage space. |
| <u>Systems</u> | Electrical: N/A. Telephone/Data: N/A. Lighting: NSR HVAC: none |
| <u>Finishes</u> | Wall: Utilitarian Ceiling: NSR Floor: Sealed concrete |
| <u>FF&E</u> | Optional shelving |

STORAGE, PROGRAM

308 SF
(14 x 22)

| | |
|---------------------|---|
| <u>Function</u> | Secure storage for field staff. This space may be included in a detached building, convenient to staff entrance, shipping/receiving |
| <u>Requirements</u> | Individual closet-size spaces, lockable (6 @ 3' x 4' required) Provide a garage door for access and paved drive to door. |
| <u>Systems</u> | Electrical: N/A. Telephone/Data: N/A. Lighting: NSR HVAC: none |
| <u>Finishes</u> | Wall: Utilitarian Ceiling: NSR Floor: Sealed concrete |
| <u>FF&E</u> | Optional shelving |

IV. BUILDING SYSTEMS

ELECTRICAL

- Power circuits for the Central Processing Unit (CPU) and personal computers (PC): Ground to earth, color code all receptacles, maintain circuit integrity.
- All floor outlets are to be flush with floor surface (verify for code compliance).
- Service to building is to be underground, via conduit.
- Distribution to site fixtures and exterior signage is to be via underground conduit. Accurate as-built drawing is required.

TELEPHONE/DATA

- Service to building is to be underground, via conduit.
- All distribution is to be via conduit (coded for line identification) to wall or floor jacks. Specify conductor or fish wire in each.

LIGHTING

- Select fixtures by analytical comparison of long-term cost.
- Security lighting for site and building exterior is to be timer-controlled and photoelectric-enabled.
- For incandescent fixtures, if applicable, specify long-life bulbs.
- Verify for applicability of motion detection activation.
- Provide fixtures that limit or prevent light trespass and light pollution.

HVAC (Heating, Ventilation, and Air Conditioning)

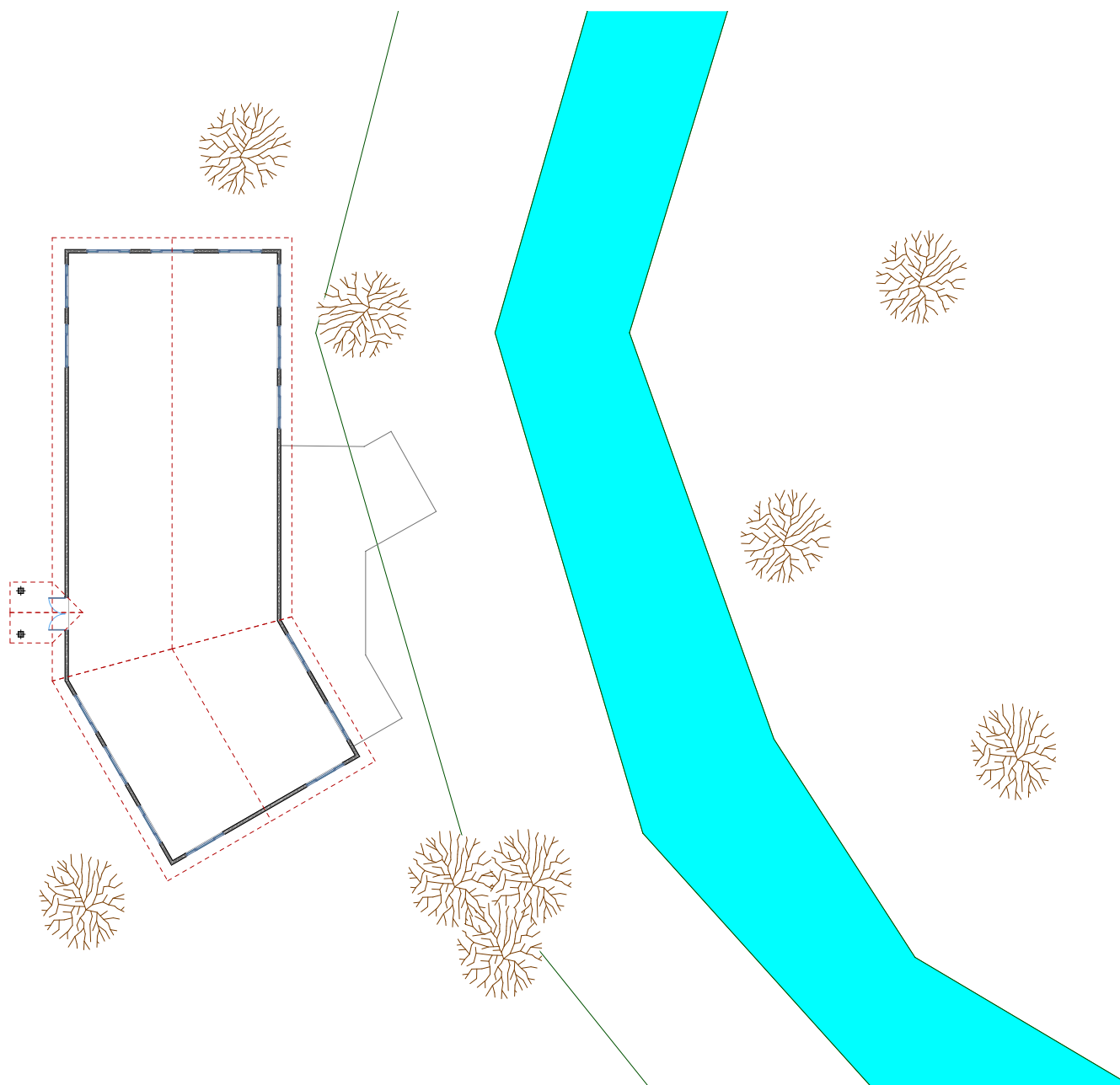
- Select system by analytical comparison of long-term cost.
- Provide "smart" controls with authorized-only access.
- Locate all equipment requiring routine maintenance (filters, etc.) in easily accessible places.
- Design zoned system which allows setbacks and versatility for "off-hours" operations.

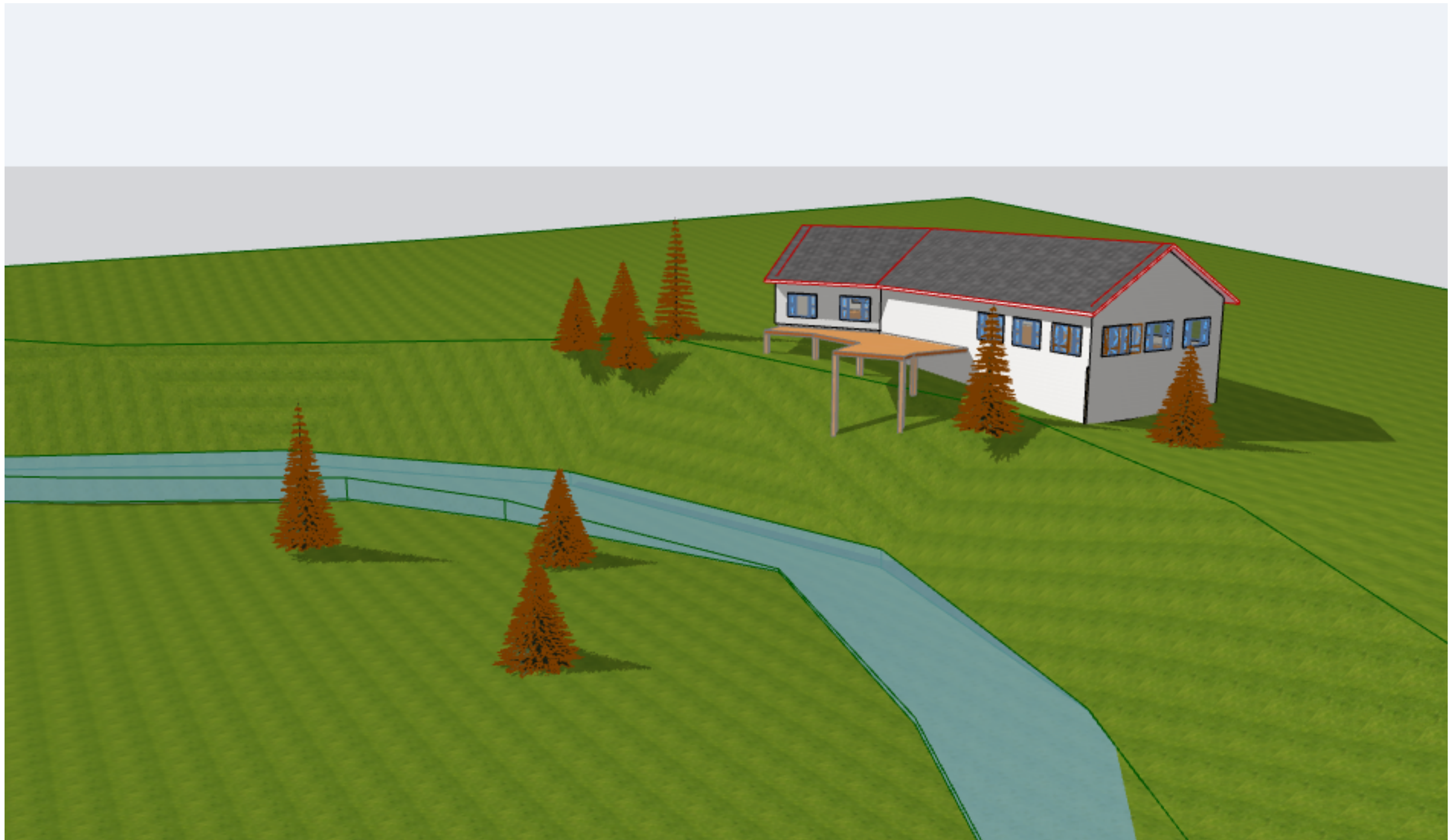
FIRE SUPPRESSION

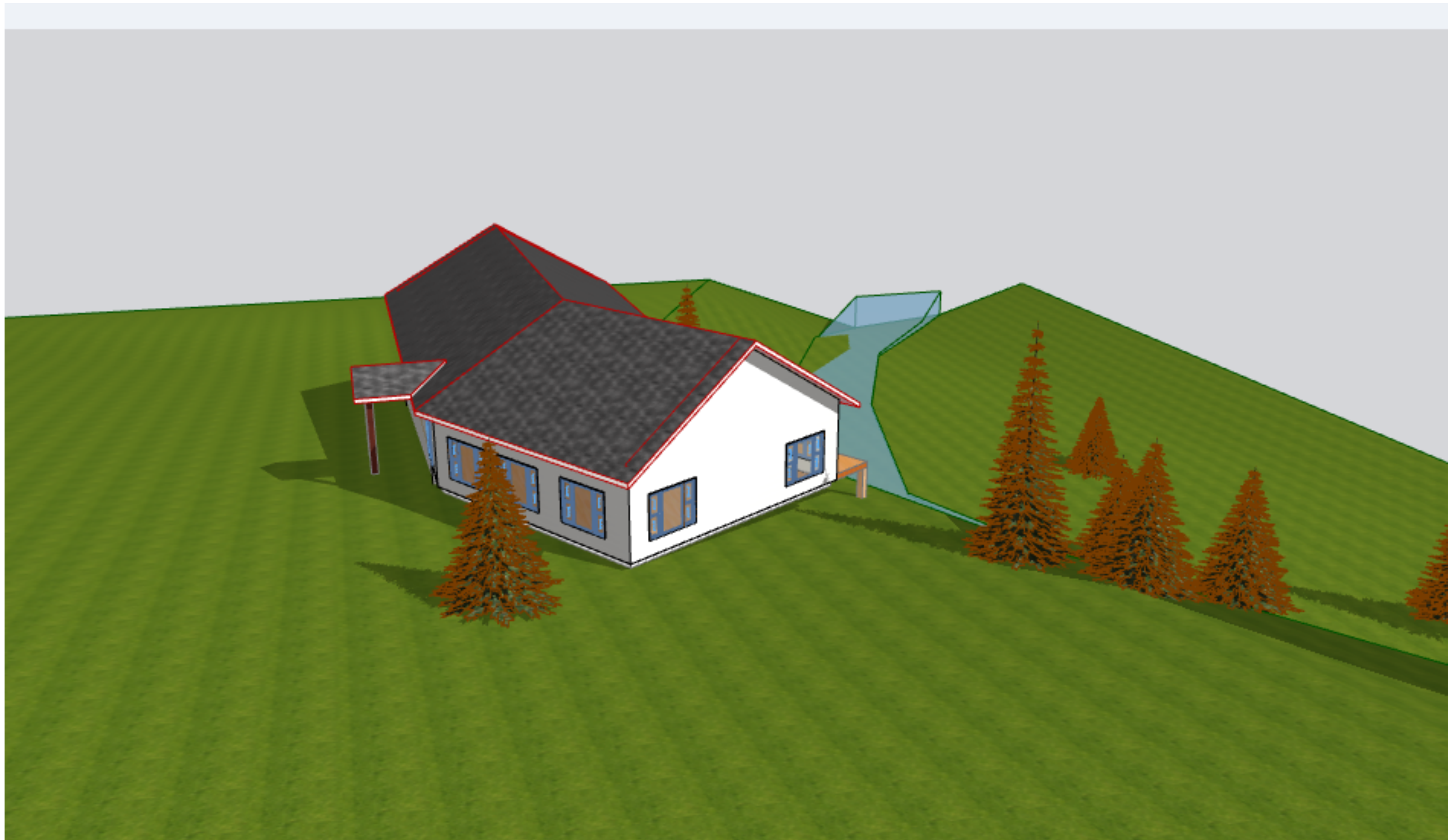
- Provide fire suppression throughout, with non-destructive system in designated spaces. Conduct cost/risk analysis.
- Smoke/ fire detection and monitoring system per local requirements.
- Alarm system per local requirements, with an audible alarm as a minimum.

PLUMBING

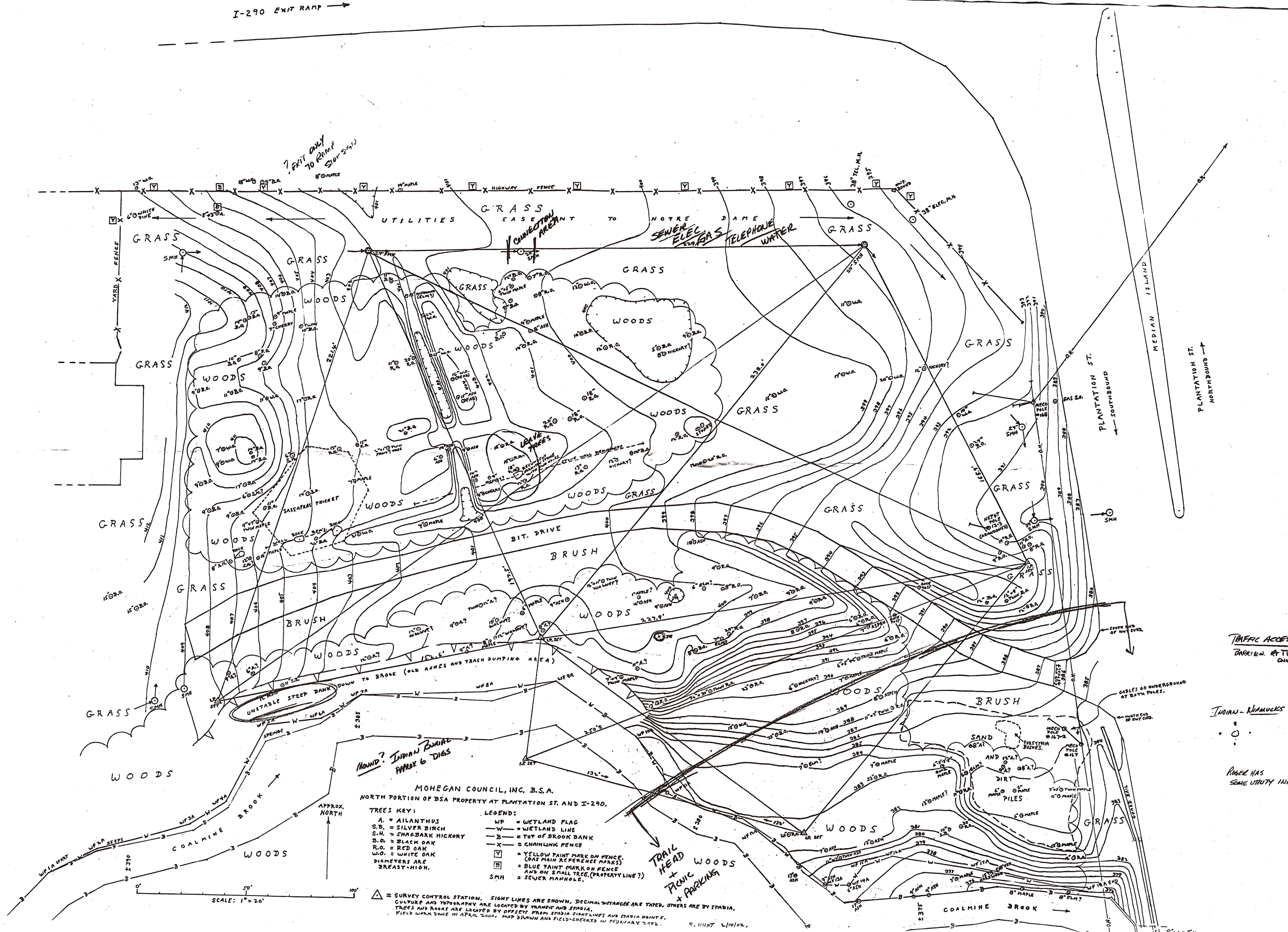
- All operable fixtures to have "accessible" controls.
- All fixtures to have individual water supply cut-off valves (as applicable).
- Select water heating system by analytical comparison of long-term costs. Consider demand water heaters.
- Seat height of toilet fixtures in all "accessible" compartments is to be 17" (minimum allowable for ADA).







I-290 EXIT RAMP →



MOHEGAN COUNCIL, INC. B.S.A.
 NORTH PORTION OF BSA PROPERTY AT PLANTATION ST. AND I-290.

- TREES KEY:**
- A. = ALANTHUS
 - S.B. = SILVER BIRCH
 - S.H. = SHARBARCK HICKORY
 - B.O. = BLACK OAK
 - R.O. = RED OAK
 - W.O. = WHITE OAK
 - DIAMETERS ARE BREAST-HIGH.
- LEGEND:**
- WF = WETLAND FLAG
 - WL = WETLAND LINE
 - B = TOP OF BROOK BANK
 - X = CHAINLINK FENCE
 - = YELLOW PAINT MARK ON FENCE (GAS MAIN REFERENCE MARKS)
 - = BLUE PAINT MARK ON FENCE AND ON SMALL TREE (PROPERTY LINE?)
 - SMH = SEWER MANHOLE.

△ = SURVEY CONTROL STATION. SIGHT LINES ARE SHOWN, DECIMAL DISTANCES ARE TYPED, OTHERS ARE BY STADIA.
 CULTURE AND TOPOGRAPHY ARE LOCATED BY TRAMMEL AND STADIA.
 TREES AND ROCKS ARE LOCATED BY OFFSET FROM STADIA SIGHTLINES AND STADIA POINTS.
 FIELD WORK DONE IN APRIL 2000, MAP DRAWN AND FIELD-CHECKED IN FEBRUARY 2002.
 R. HUNT 2/14/02.

TRAFFIC ACCESS:
 BARRIER AT TURN ONLY

INDIAN - NOMUCKS

ROGER HAS SOME UTILITY INFO

Appendix C: Meeting Reports

Meeting with Colin Novick

Greater Worcester Land Trust Office

December 13, 2017 10:00am

Attendees: Colin Novick, Sydney Brooks, Abby King, Thea Reymann

Meeting Minutes:

Working with NDHC

- Sisters of NDHC are interesting to work with. They don't directly manage their own property and hire a property manager. GWLT bought land from them and took about 10 years.
- The property manager of the property must be identified to communicate about access to the property from the northwest side of the parcel.
- If we get a name from the sisters of who their property manager is, we can let Colin know and he will let us know whether it's the same as the man he worked with.

Access

- In terms of access, it's great that we already have a curb cut.
- It is a quick and easy way come off of Plantation Street. It could take a while and a lot of extra time to access it from the NDHC side. The team informed Colin that Tom Chamberland wants to investigate two access points and a road with both options. Colin suggested possibility of two access points on Plantation Street with one further up, closer to the ramp. This could be a problem with sight distance unless the off-ramp is changed into a stop sign from a yield sign.

Parcel, GWLT Involvement

- Under the City of Worcester Tax maps – Property details and 2 ft contours of the parcel are available in the S16 parcel document. Colin sent it to us.
- From the GIS Worcester Parcel, the city is accessing the land at \$2,639,700. The parcel is 317,552 square feet.
- The camping area on site could be a transition for urban kids to camping because it's next to the high way with some noise and lights. Part C from the easement specifies the camping area needs to be under elevation of 420 feet, this is a small portion of the land south of the brook.
- Raised platforms for the camping area (essentially decks) to prevent the ground from being beat up would be common for a boy scout camping area. A fire ring is not allowed because it's a danger to air quality but a pedestal grill is okay as an "enclosed cooking fire" because it's different than a bonfire.

- Adding two or three 8x8ft or 10x10ft squares to specify the camping area to aid the Mohegan Council in thinking about utilizing this land would be great.
- Colin wants to engage the site because a lot of focus is put on the building and parking areas.

Conservation Restriction

- Conservation restriction- The GWLT checks up annually to make sure nothing is violating it (buildings, dumping, etc.)
- Colin would like for fence to be gone although it was necessary because there was dumping going on.
- The conservation restriction allows for a footbridge over the brook to aid in encouraging the scouts to go outside.
- GWLT controls the East-West trail and ensures that it's clear of debris.
- Coal mine brook has trout in it and it is a cold-water fishery. A high temperature hitting the brook could kill off this species, making stormwater management essential.

Design

- Thru: Building the lot in the buffer zone would be trickier instead than only having the access road in the buffer. 100ft would involve filing a Notice of Intent. The lot could be moved upwards so it's only the road on it to make this simpler.
- Notre Dame: Not a short drive in, Colin agrees it's an inconvenient way in to the site.
- Land clearing is necessary for development of BMPs outside of the parking area. Tree box filters could be used in and around parking because it's already cleared as opposed to next to the access road. It would be easy to put rain gardens in the parking lot area as an island. This would also make the parking lot cooler. Keeping the trees around the parking lot will also aid in keeping the parking lot cool. This would make sure that the water is not going to be too hot when it runs off.
- Recommendation: solar panels above parking lot or on top of the building. So that no extra area needs to be cleared solely for solar energy. Putting the panels on top of the parking lot would also aid in shading the parking lot.
- By including recommendations such as camping area, footbridge over brook, interpretive informational trail markers, solar panels above parking lot/on building, this would plant seeds in the Council's head for design options involving the boy scouts and fostering involvement with the land.

Sponsor Meeting

Kaven Conference Room

January 23, 2018 3:00pm

Attendees: Tom Chamberland, Paul Mathisen, Suzanne LePage, Sydney Brooks, Abby King, Thea Reymann

Meeting Minutes:

- Pre-Development Hydrology
- Building Envelope
- Parking Lot and Overflow Parking
 - If the parking lot was expanded from gravel to being fully paved, what would the increase in the BMP sizing be? We should look into comparing the BMP sizes for the entirely paved and partly gravel lots based on the hydroCAD numbers.
 - Having central BMPs in the parking lot can allow for some landscaping too.
 - Look into new requirements. Does Worcester require parking lot landscaping (Ex. Some places require for there to be a planting island after 10 spaces or so)
- 3 Layout Concepts
 - Layout 1: Plantation Street Access
 - Layout 2: Notre Dame Access
 - Layout 3: Through Access
 - Ladies of Notre Dame have a right of way with the access road. This haven't been confirmed or denied. Do not necessarily have to build a road all the way through but cannot block the route with new development.
- Post Development Hydrology
 - Plantation Street Access Layout Design
 - 25 and 100 Year Design Storms
- Stormwater Mitigation Design
 - Best Management Practices (BMP) Selection
 - Placing trees in a box is potentially problematic for their growth. Tom recommended looking into structural soil, it has more open pores and allows trees to grow better. Look into structural soils as an alternative to the tree box filter.
 - Disturbing to natural area to put the treebox filters in doesn't seem to make the most sense logically. They may be better suited to fit in a parking lot. Determine possibility of a more natural alternative to put on the side of the road to treat that road runoff.
 - The roof runoff could be treated differently than the parking lot runoff. Two systems could be created and the one treating the roof runoff does not require as high a level of treatment. Professor LePage suggested the possibility of collecting the roof runoff water and using it to water the landscaping.
 - BMP Sizing
 - Water Quality
- BMP Conceptual Layout
 - If the culverts could be made without any manholes it could be cheaper. A sump could also contribute to the pretreatment.
 - Moving the bioretention pond south east could account for more of the road runoff. Also, an option is to move it to the right of the parking lot and route the water that way since the parking lot is already graded.

- Design Files
 - Layout 1: Plantation Street Access
 - Layout 2: Notre Dame Access
 - Layout 3: Through Access
- Recommendations
 - Discussed Mass Highway opinions with the existing curb cut. Decided the team must clearly explain that point with the sight distance calculations within our report.
- Questions and Comments
 - There is currently water flowing out onto Plantation Street from the current access road. Through a phone call with Mass Highway, the team may be able to figure out if we need to capture all of the water from the new driveway or if some of it can be grandfathered into the existing water flow out onto Plantation Street. We should figure out by how much our design is reducing the water that is flowing off of the driveway currently.
 - Scheduled a meeting on February 7th at 10am to meet with Tom and the National BSA Engineer. The place is TBD.
 - Tom mentioned meeting again at the end of February to present our final project to him and other members of the Mohegan council. We should contact him to schedule this.

Meeting with Dave Cornell (BSA Project Architect)

Kaven Conference Room

February 7, 2018

Attendees: Dave Cornell, Sydney Brooks, Abby King, Thea Reymann

Meeting Minutes

Building

- Program of requirements will evolve. Building sizes may become bigger. We're designing for 6000 sq. ft. We may provide just a little exploration into what will happen if it goes bigger.
 - Ex. if we go to 10,000 square feet how will that impact the design and the parking required
- Next year, a new project team may look into the building more in depth.

Parking Lot

- We have 1 handicap spot. We could increase the number of spots but it doesn't seem like we'd need to. There are 20 handicap spots at the national boy scout office and many of them sit empty.
- We don't realistically have enough room for 60 spots from our design it seems. We need to either increase or show the spaces on our layout design file.

- If there needs to be more parking (more than 60), where would that overflow parking be? Since the driveway is narrowed, there's no room to park on the side.
 - Could we increase the driveway width slightly, just to allow for more overflow parking? Perhaps we could make it just 18' across instead.
 - Also, how would the spots be marked? On the pavement or permeable pavement, they would be marked with stripes. There wouldn't be stripes on any gravel.

Stormwater BMPs

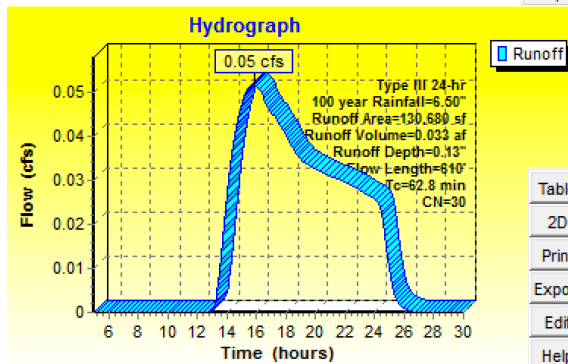
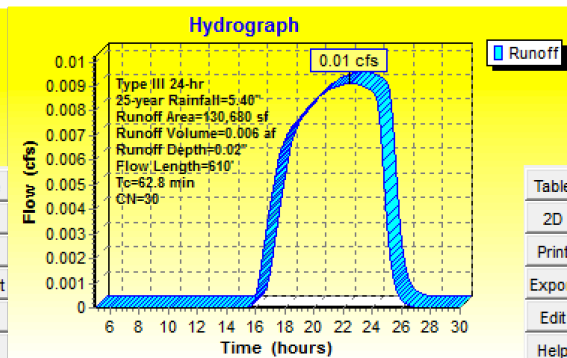
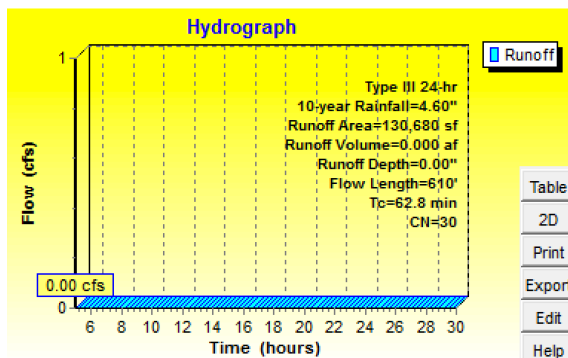
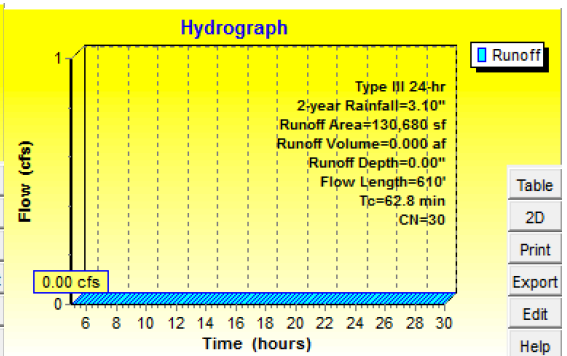
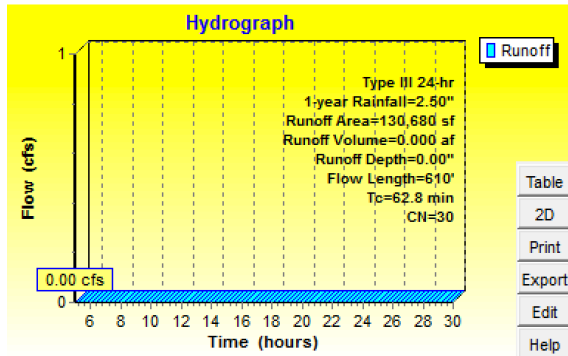
- Touch upon the maintenance of our recommended BMPs in our report definitely to further explain them.
- Did we consider incorporating a water feature of sorts? A brook, pond, etc. ?
- Access Road
 - Grass channels are prone to erosion especially during the heavier rain storms. How will we prevent this?
 - Possibly tier it so that it slows down the velocity and perhaps prevent erosion
 - In Switzerland, Mr. Cornell has seen them put metal panel troughs in roadways that drain sideways to the other side of the road to a separate BMP. We could look into this more to direct the water.
- Parking Lot
 - The thickness of permeable pavement would certainly be an impact to disrupt there. 3-4 feet deep over the entire space of the parking lot would be a lot of soil that would be cut. Where would this go? Could it be filled somewhere else on the site?
 - Mr. Cornell thinks the best option would be for nothing to leave the site. Try to match the soil cut and fill as much as possible. It's expensive and unsustainable to cut a lot of dirt and move it somewhere else.
 - Since it is sandy loam, it does not provide much structural capacity.

Pedestrian Bridge and Campsites

- How would people reach the pedestrian bridge? It wouldn't necessarily require stairs but some sort of footpath or possibly rocks

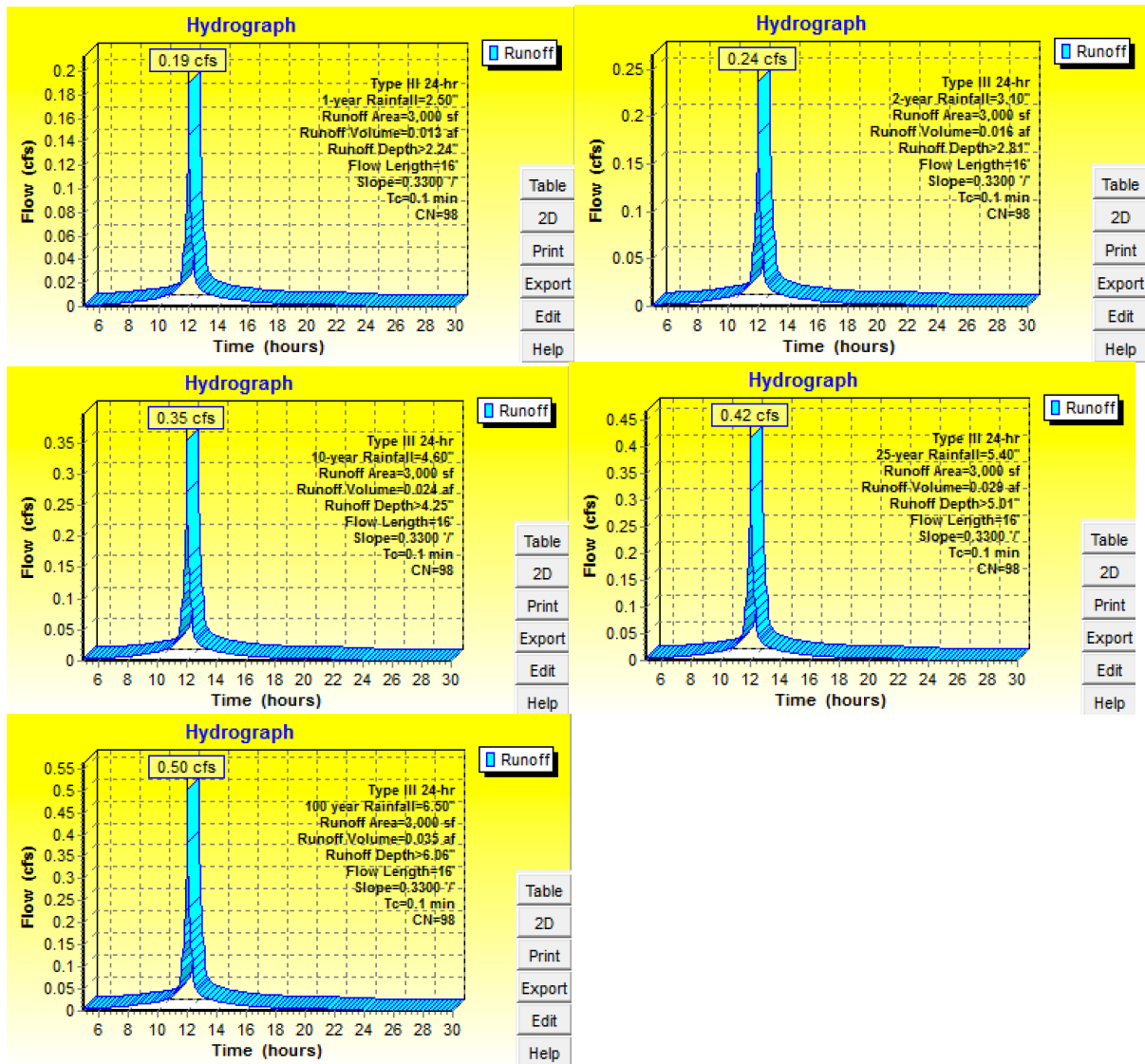
Appendix D: Hydrographs

Pre-Development



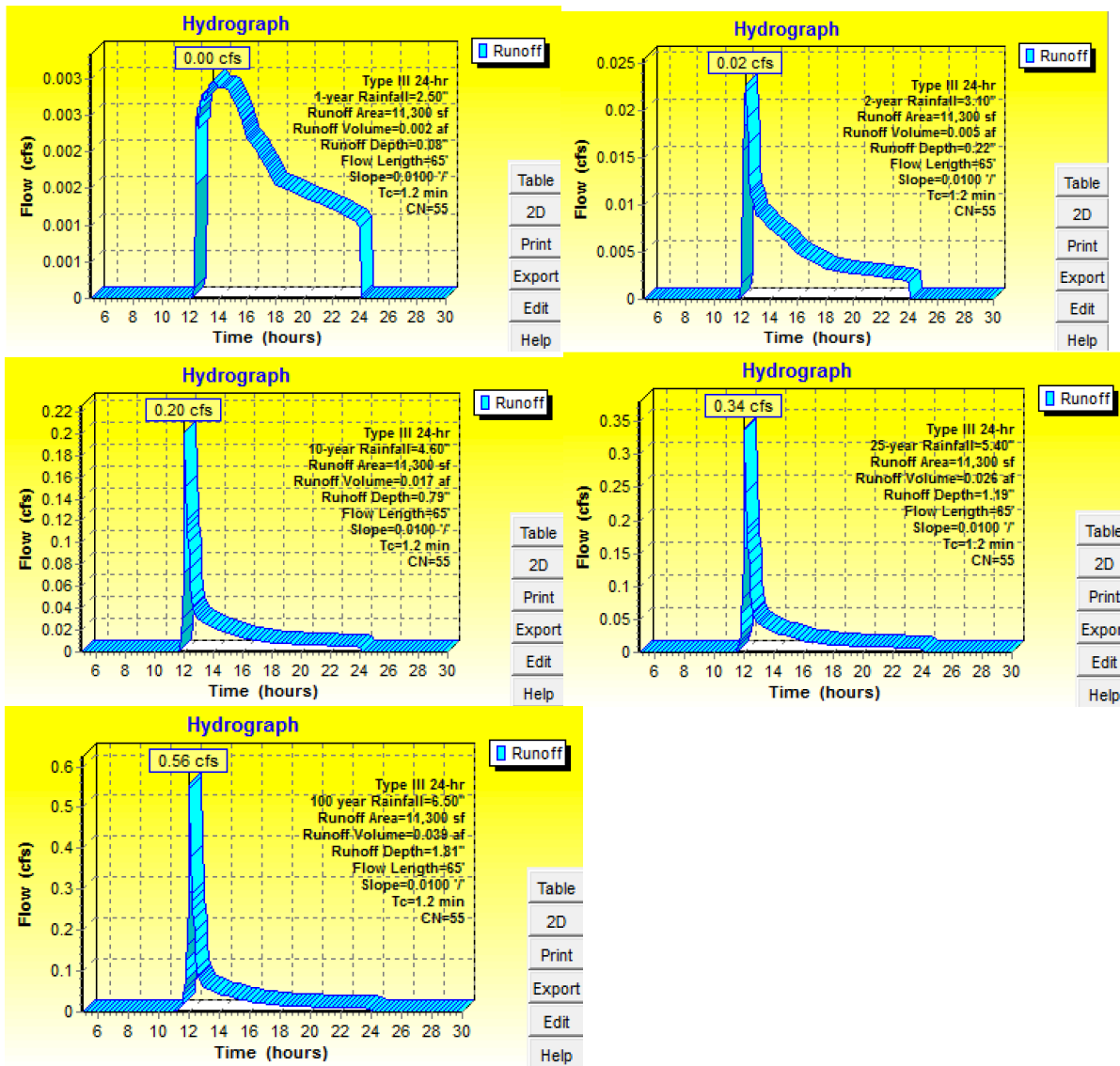
Post-Development

- Building Roof Runoff

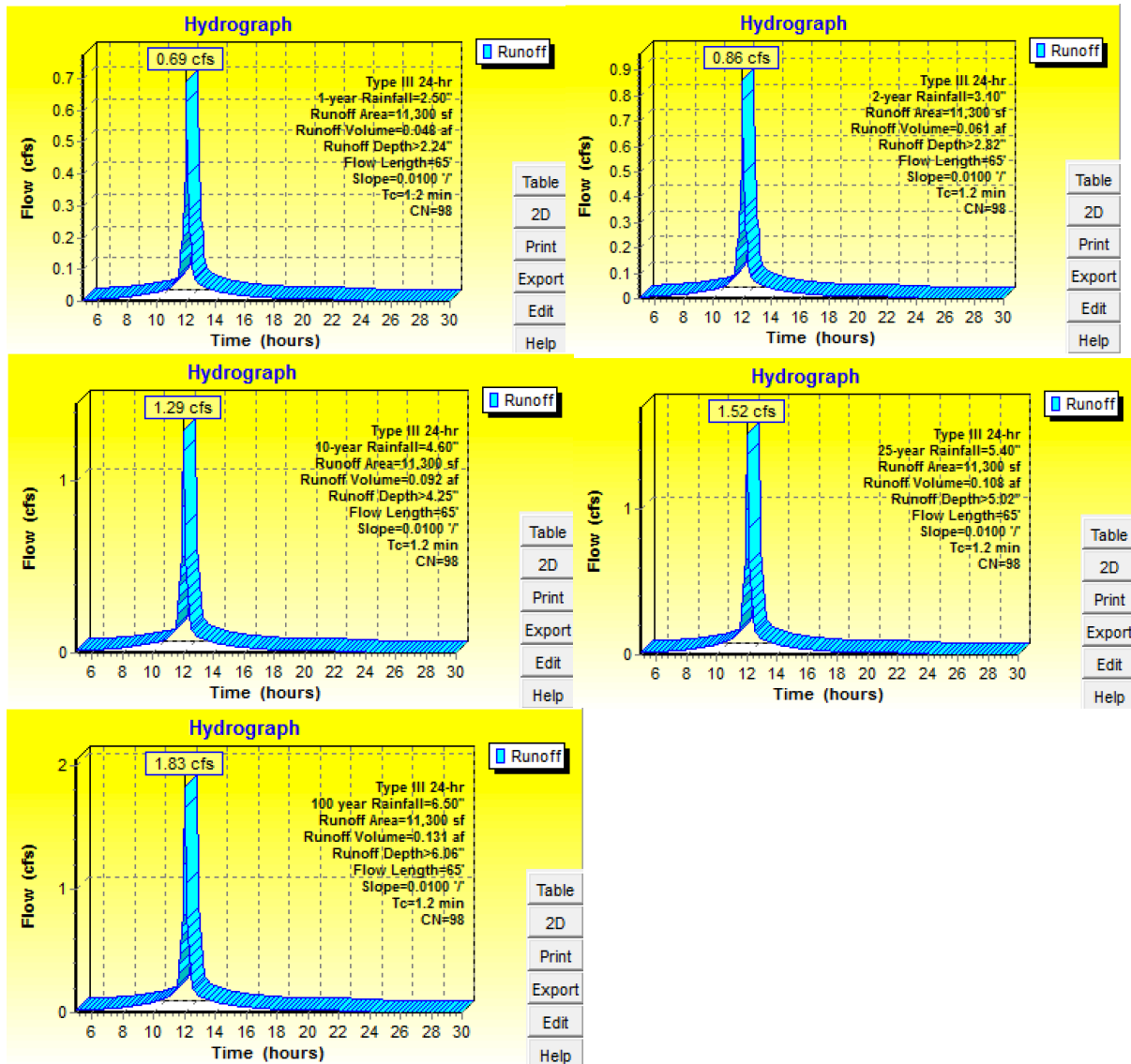


- **Parking Lot Runoff**

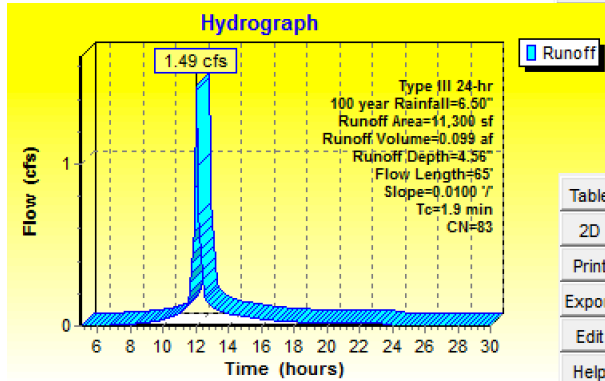
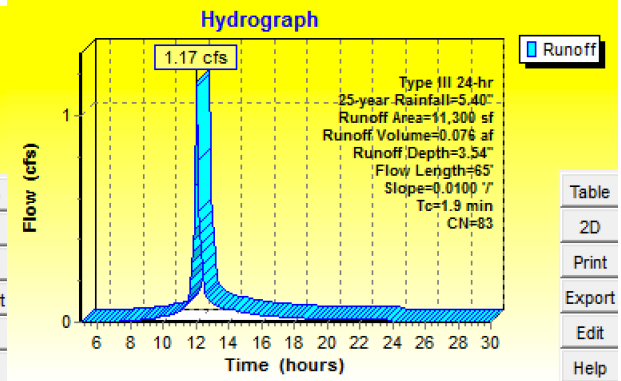
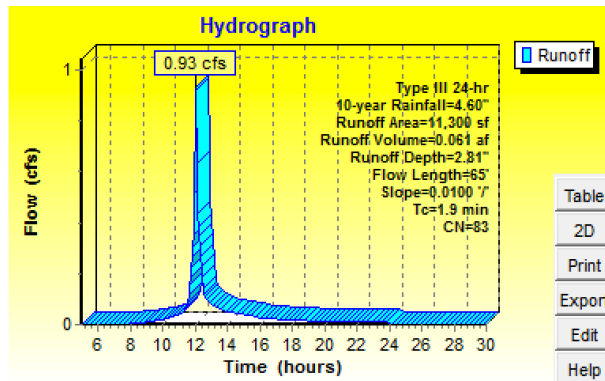
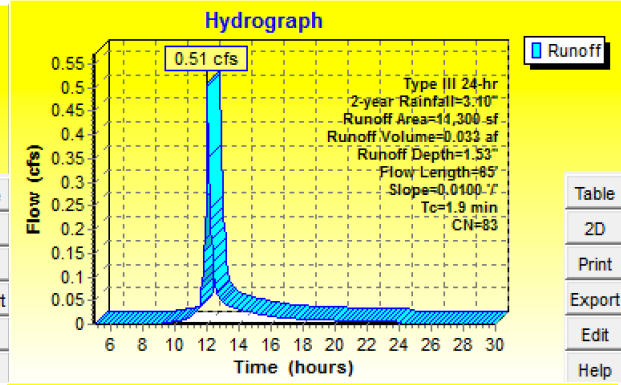
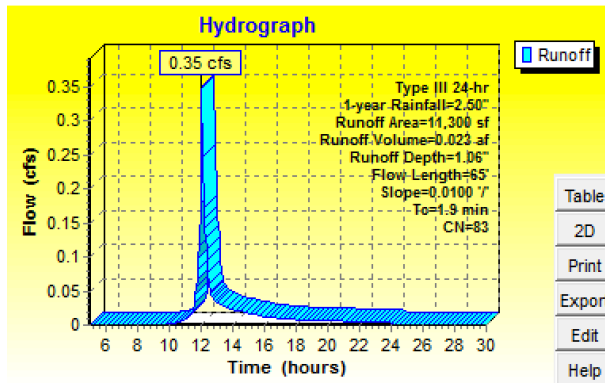
Porous Pavement



Asphalt Pavement

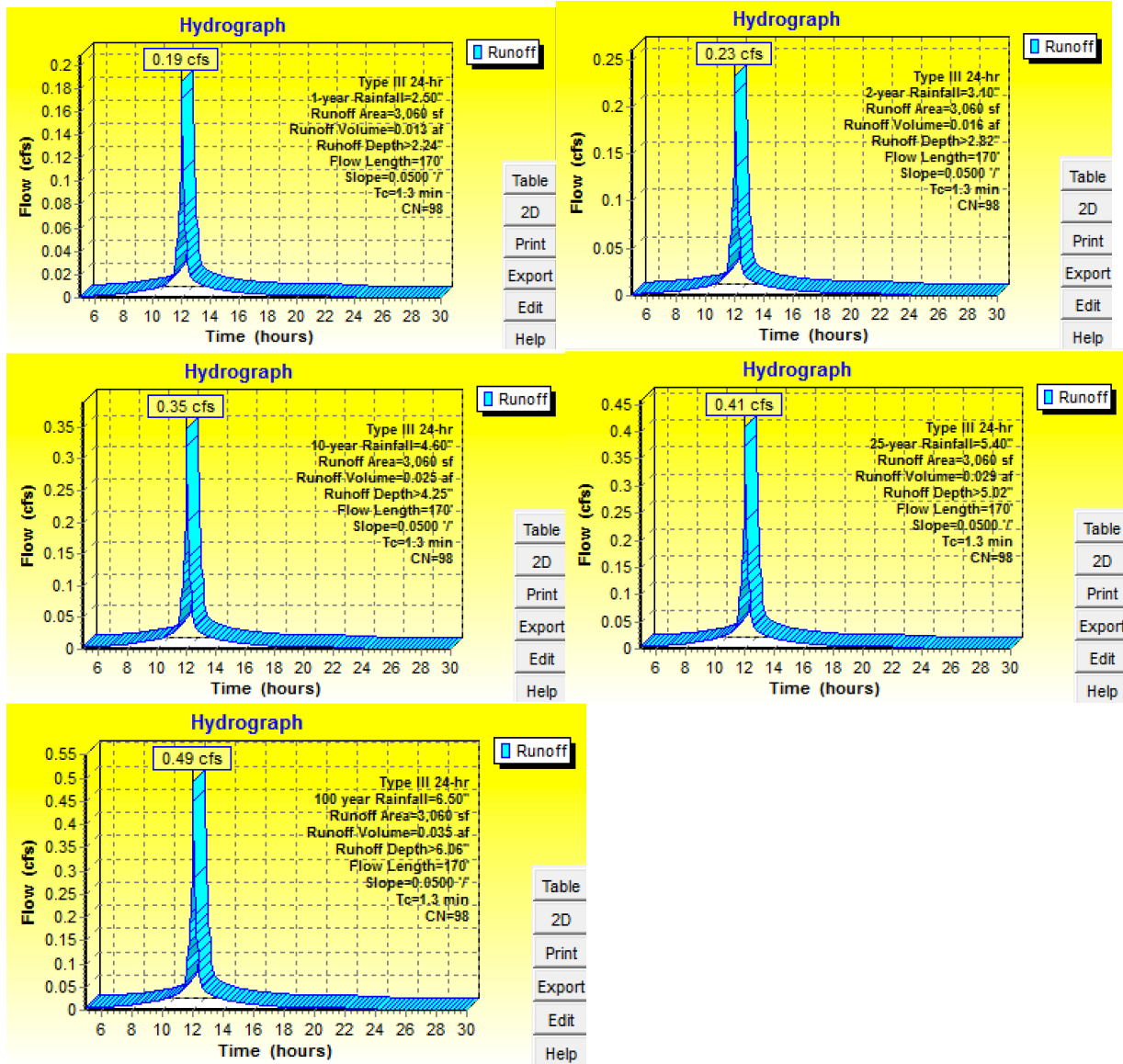


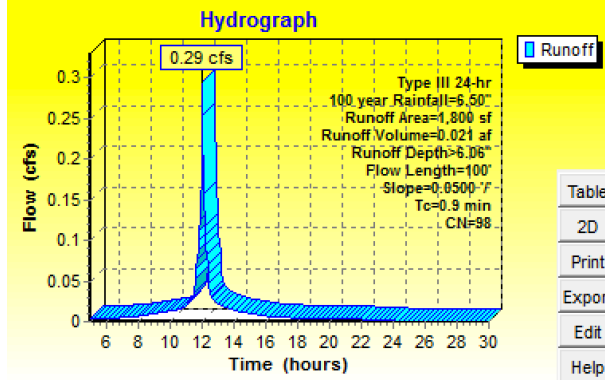
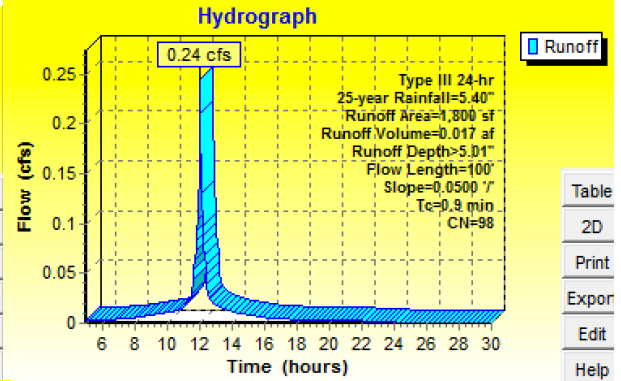
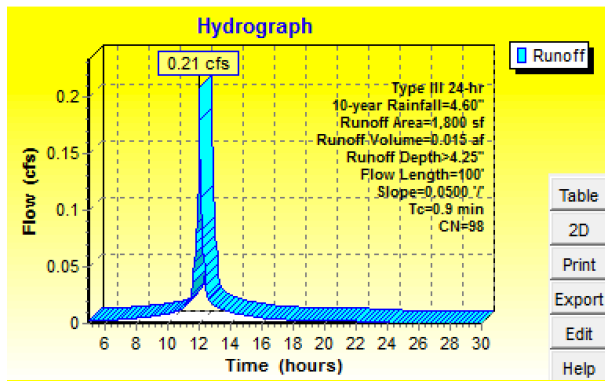
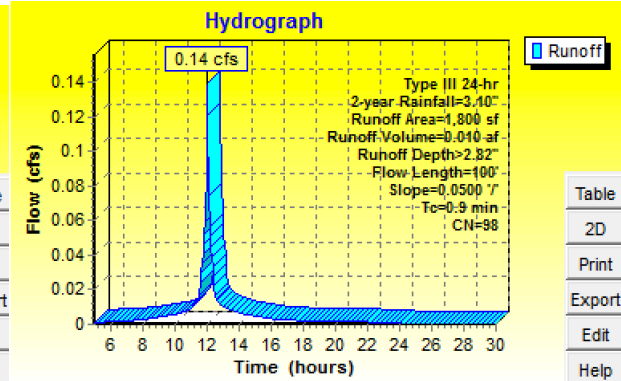
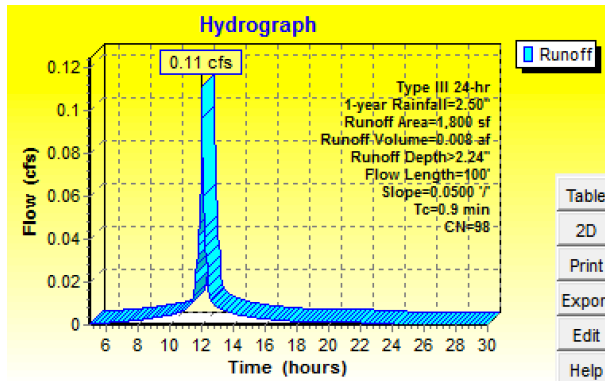
Asphalt/Gravel Combination



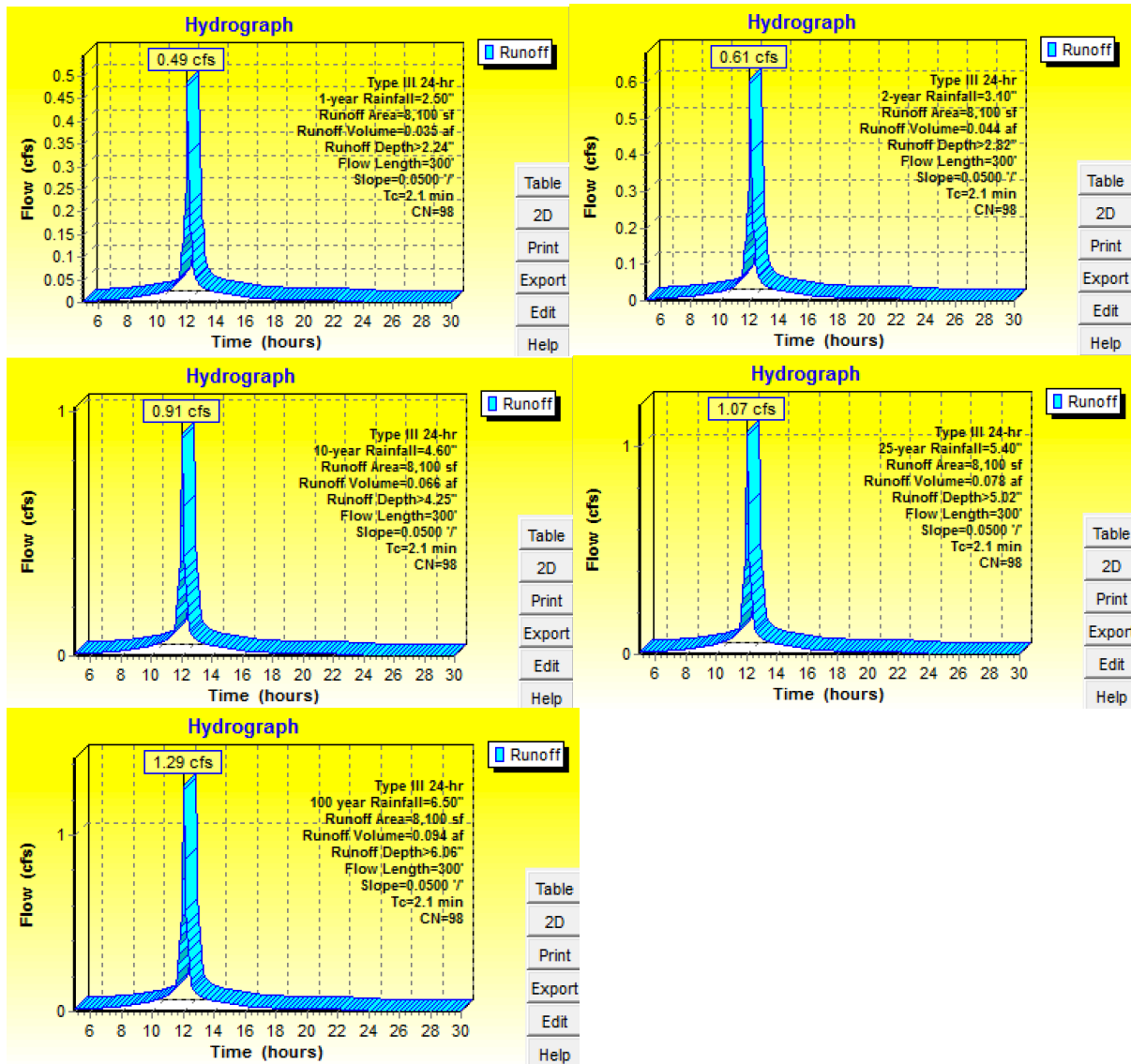
- Access Road Runoff

Plantation Street Access





Through Access



Appendix E: Site Visit Reports

- **September 1, 2017**

Weather: Sunny, 64°F

Attendees: Sydney Brooks, Abigail King, Thea Reymann

Initial walk-through of the site: The team observed important aspects of the site such as the overgrown paved path (Figure 1), the steep slopes and erosion around the brook (Figures 2 and 3) and the East-West Worcester hiking trail (Figure 4).



Figure 1: Abandoned Access road through Parcel



Figure 2: Steep Slopes along Coal Mine Brook



Figure 3: Erosion along Coal Mine Brook



Figure 4: Marking for East-West Worcester Hiking Trail

- **September 14, 2017**

Weather: Sunny, 76°F

Attendees: Sydney Brooks, Tom Chamberland, Abigail King, Suzanne LePage, Paul Mathisen, Thea Reyman

Meeting with sponsor, Tom Chamberland

The team discussed Tom's vision for a building space: a marketing resource, a retail space, and a meeting space and to foster community involvement by sharing this space with local organizations. He also expressed the importance of sustainably developing the site to align with the Council's goal of reducing their environmental footprint

The team received archival documents from the Mohegan Council pertaining to the parcel's historical ownership, use and development. The documents received from this site visit and more are in Appendix C.

- **October 19, 2017**

Weather: Sunny, 65°F

Attendees: Abby King

Site Analysis

From the site visit we identified points of access. The off ramp from 290 ends within a 25-foot buffer zone around the Coal Mine Brook, therefore access would not be permitted along that side. At the end of a current asphalt pathway within the parcel, abutting the Notre Dame health care property, there is a road in site that gives NDHC (Notre Dame Health Care) access. The only possible access point to our parcel would be a continuation of this road to the existing asphalt road on the parcel. Other options, such as access roads that would cross the brook, are not possible because of the steep slopes (8-15% according to GIS) that are on either side of the brook. It is also important to note that access on this side of the property will not require intensive research on the Massachusetts DOT curb cut and access management regulations

We did not look at existing hydrology as it is outlined on the GIS mapping. There is one brook that goes through the property called Coal Mine Brook.

Utilities

It is clear by the presence of fire hydrants that there is a main across the street from the property near the Reliant Healthcare facility (outlined on Google Map photo in this week's folder). Sewer easement information can be found in the Plan of Property document in this week's folder as well. Other utility jurisdiction information can be found in the research document.

- **December 6, 2017**

Weather: Cloudy, 41°F

Attendees: Sydney Brooks, Abby King, Thea Reymann

Data Collected: Sight Distance and Access Road figures

Sight Distance Data

| Sight Distance Figures | Distance (meters) | Distance (feet) |
|--|--------------------------|------------------------|
| Middle of Plantation St. Curb cut to yield sign on I-290 E off ramp | 82 | 269.03 |
| End of Plantation St. Curb cut to curve on I-290 E off ramp | 102 | 334.65 |
| End of Plantation St. Curb cut to yield sign on I-290 E off ramp | 76 | 249.34 |
| Curve of I-290 E off ramp to yield sign | 26 | 85.3 |

Access Road Data

| Access Road Figures | Distance (meters) | Distance (feet) |
|---|--------------------------|------------------------|
| Curb cut Width | 12, 13 | 39.37, 42.65 |
| Road Width at Plantation St. end | 4.5 | 14.76 |
| Road Width at Notre Dame end | 5 | 16.40 |
| Access Road Length | 131 | 429.79 |
| End of Access Curb cut to Creek Grate on Plantation St. | 27 | 88.58 |
| Middle of Access Curb cut to Creek Grate on Plantation St. | 35 | 114.83 |

Appendix F: Stormwater BMP Research Tables

| |
|---|
| 3 |
| 4 |
| 5 |

| | | | | | | | | | | |
|-----------------------|---|--|---|---|---|------------------------------------|--|---|---|--|
| TSS Removal (3) | 80% with deep sump catch basin pretreatment | 90% with pretreatment | 80% with sediment forebay | 50% with sediment forebay | 80% with pretreatment | 80% assumed | 80% with sediment forebay | 50% with pretreatment | 70% with sediment forebay or other practice | 80% if storage bed holds half-inch rain and infiltrates < 72 hrs |
| Pollutant Removal (2) | Removes oil and grease. No data. | 30-40% Nitrogen, 30-90% Phosphorous, 40-90% Metals | 20-55% Nitrogen, 40-60% Phosphorous, 20-85% Metals, Up to 75% Pathogens | 15-50% Nitrogen, 10-30% Phosphorous, 30-50% Metals, Less than 10% Pathogens | 20-40% Nitrogen, 10-50% Phosphorous, 50-90% Metals | No data. | 10-50% Nitrogen, 30-70% Phosphorous, 30-75% Metals, 40-90% Pathogens | -121% Phosphorous | 10-90% Nitrogen, 20-90% Phosphorous | No data. |
| TSS Maintenance (2) | \$ 1.51/lb./yr. | \$ 0.74/lb./yr. | \$ 0.96/lb./yr. | \$ 1.77/lb./yr. | \$ 1.95/lb./yr. | \$ 2.45/lb./yr. | \$ 0.47/lb./yr. | \$ 0.71/lb./yr. | \$ 0.67/lb./yr. | Varies. Aggressive maintenance required. |
| Aesthetics (3) | Underground. | Visually appealing. Can provide shade. | Visually appealing. Mosquito breeding. | Can be unattractive. | Can be unattractive. Underground. Possible odor problems. | Visually appealing. Provides shade | Visually appealing. Mosquito breeding. Invasive Species. | Visually appealing. Mosquito control necessary. | Visually appealing. Mosquito breeding. Subject to damage and erosion. | Visually appealing. |
| Total | 55 | 76 | 53 | 37 | 38 | 53 | 58 | 58 | 59 | 65 |

| |
|--------------------|
| Access Rd. Runoff: |
| Scoring: |
| 1 |
| 2 |
| 3 |
| 4 |
| 5 |

| BMP/ Criteria | Leaching Catch Basin | Bioretention | Stormwater Wetlands | Dry Detention Basin | Sand & Organic Filters | Treebox Filters | Wet Basins | Grassed Channel (Biofilter Swale) | Water Quality Swale (Dry) | Permeable Pavement |
|-----------------------------------|--|---|---|---|---|---|--|---|--|---|
| Applicability (3) | Requires limited space. Entrapment hazard for small animals. | Requires moderate space. Educational opportunity. Improves landscaping. Wind/noise pollution reduction. | Requires significant space. Educational opportunity. | Requires Significant space. | Requires limited space. May be ineffective in winter. | Requires limited space. Improves landscaping. Wind/sound pollution reduction. | Requires significant space. | Requires limited space. Accepts sheet or pipe flow. | Requires limited space. Impractical with steep slopes. | Paved surfaces with well-drained soils. Improves landscaping. Applicable in cold climates. Clogging potential. Slopes less than 5%. |
| Cost Per Acre Impervious Area (2) | \$ 60,400/ac. | \$ 33,100/ac. | \$ 38,554/ac. | \$ 44,157/ac. | \$ 78,072/ac. | \$ 97,062/ac. | \$ 18,782/ac. | \$ 17,792/ac. | \$ 23,537/ac. | Asphalt: \$3-5 per square foot Concrete: \$5-10 |
| Groundwater Recharge (1) | No | Yes | No | No | No | No | No | No | No | Yes |
| TSS Removal (3) | 80% with deep sump catch basin pretreatment | 90% with pretreatment | 80% with sediment forebay | 50% with sediment forebay | 80% with pretreatment | 80% assumed | 80% with sediment forebay | 50% with pretreatment | 70% with sediment forebay or other practice | 80% if storage bed holds half-inch rain and infiltrates < 72 hrs |
| Pollutant Removal (2) | Removes oil and grease. No data. | 30-40% Nitrogen, 30-90% Phosphorous, 40-90% Metals | 20-55% Nitrogen, 40-60% Phosphorous, 20-85% Metals, Up to 75% Pathogens | 15-50% Nitrogen, 10-30% Phosphorous, 30-50% Metals, Less than 10% Pathogens | 20-40% Nitrogen, 10-50% Phosphorous, 50-90% Metals | No data. | 10-50% Nitrogen, 30-70% Phosphorous, 30-75% Metals, 40-90% Pathogens | -121% Phosphorous | 10-90% Nitrogen, 20-90% Phosphorous | No data. |
| TSS Maintenance (2) | \$ 1.51/lb./yr. | \$ 0.74/lb./yr. | \$ 0.96/lb./yr. | \$ 1.77/lb./yr. | \$ 1.95/lb./yr. | \$ 2.45/lb./yr. | \$ 0.47/lb./yr. | \$ 0.71/lb./yr. | \$ 0.67/lb./yr. | Varies. Aggressive maintenance required. |

| | | | | | | | | | | |
|----------------|--------------|---|---|----------------------|---|---------------------------------------|---|--|---|---------------------|
| Aesthetics (3) | Underground. | Visually appealing. Can provide shade. | Visually appealing. Mosquito breeding. | Can be unattractive. | Can be unattractive. Underground. Possible odor problems. | Visually appealing. Provides shade | Visually appealing. Mosquito breeding. Invasive Species. | Visually appealing. Mosquito control necessary. | Visually appealing. Mosquito breeding. Subject to damage and erosion. | Visually appealing. |
| Total | 61 | 58 | 52 | 34 | 41 | 53 | 55 | 64 | 59 | 47 |