Rail Station Feasibility Study And Proposal

Senior Project

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# Contents

List of Figures ................................................................. 3  
List of Tables ................................................................. 4  
Executive Summary .......................................................... 5  
Introduction ........................................................................... 6  
Phase I: Initial Site Selection ................................................. 9  
Phase II: Merrimack Site Feasibility Study ............................... 11  
  a) Proximity to Manchester Airport Access Road ..................... 11  
  b) Access Requirements .................................................... 14  
  c) Parking Space Constraints .............................................. 15  
  d) Wetland Impacts .......................................................... 15  
  e) Bald Eagles ................................................................. 16  
  f) Hazardous Waste ........................................................ 17  
  g) Traffic Impacts ............................................................ 17  
  h) Economic Impacts ....................................................... 17  
Comparison with Other Sites ............................................... 19  
Phase III: Site Design Proposal ............................................. 20  
  a) Site preparation .......................................................... 20  
  b) Pavement ................................................................. 21  
  c) Parking ................................................................. 24  
  d) Platform Design ........................................................ 25  
Design Recommendation .................................................. 29  
Bibliography ........................................................................ 30
Acknowledgements ....................................................................................................................... 31
Appendix A: Cost Estimation ........................................................................................................ A1
Appendix B: Platform Design ....................................................................................................... A2
Appendix C: Pavement Design .................................................................................................... A3
List of Figures

Figure 1: Proposed route for the NH Capitol Corridor ................................................................. 8

Figure 2: Map and aerial photo of Manchester site ................................................................. 9

Figure 3: Map and aerial photo of Bedford site ....................................................................... 10

Figure 4: Map and aerial photo of Merrimack site ................................................................ 10

Figure 5: Manchester-Boston Regional Airport in relation to surrounding highway system..... 11

Figure 6: Manchester Airport Access Road, connecting the F.E. Everett Turnpike to the airport. 1

Figure 7: Conceptual NH DOT plans for MAAR (NHDOT) .................................................... 13

Figure 8: Space under the MAAR for a road. Looking North ................................................ 14

Figure 9: The primary site of interest is labeled as "NHDOT." The indicated abutting property
will have to be acquired or used by agreement to meet access and space requirements............. 1

Figure 10: Wetlands are marked in shades of green. The orange boxes indicate the Merrimack
site (NHDOT). ............................................................................................................................ 16

Figure 11: Property acquired for bald eagle protection. The arrow indicates the Merrimack Site
(NHDOT)........................................................................................................................................ 1

Figure 12: Property Value ......................................................................................................... 18

Figure 13: Permeable Pavement ................................................................................................. 23

Figure 14: Design of subbase soil and gravel layers ................................................................. 24

Figure 15: The site with and without a parking garage. Note that with a parking garage there is
room for a light commercial building ....................................................................................... 25
List of Tables

Table 1: Design matrix: final site selection (SNHPC). The lower score is better. .......................... 1

Table 2: Land Clearing Costs ........................................................................................................ 21
Executive Summary

The purpose of this study is to provide a student contribution to the overall effort of the NH Capitol Corridor rail project (introduced below). It is the intention of the research team, which consists of civil engineering students at UNH, to gain a better understanding of the complex relationships between state and local government and private parties. The scope of the project spans from economic planning and information gathering to site analysis and comparison with proposals for site development including some design aspects. With that said, this project meets the multidisciplinary requirements for a UNH Senior Project while also providing an opportunity to put into practice the skills and principles which the group members have learned during the course of their studies.

The study was completed in three phases. In phase 1 three sites were selected based on internet available GIS data. Three criteria were used to select these three sites: access to existing tracks and the Manchester-Boston Regional Airport (MBRA); space available at the site for parking; and obvious prohibitive site specific environmental issues. A site in Merrimack was selected as being the most likely site for a rail station.

In phase 2 a full feasibility study was completed for the Merrimack site. This study examined the three primary criteria in more depth in addition to several other issues including traffic and economic impacts. The Merrimack site was also compared to the other two sites using criteria from the Southern New Hampshire Planning Commission (SNHPC).

In phase 3 a site layout was proposed with two options for parking including one with a parking garage and one with a surface parking lot.
Introduction

The New Hampshire Rail Transit Authority (NHRTA), working with the City of Manchester, Southern New Hampshire Planning Commission (SNHPC), City of Nashua, Nashua Regional Planning Commission and the Manchester Boston Regional Airport (MBRA), is proposing to reinstate passenger rail service on the existing rail corridor between Boston, MA (North Station) and Manchester, NH, with future service to Concord, NH.

This existing rail corridor has been identified as the New Hampshire Capital Corridor, though it is being proposed that the Massachusetts Bay Transportation Authority (MBTA) operate the service to Manchester. The project is in the phase in which feasibility studies are being completed on potential sites for railway stations along the proposed route.

The vast majority of the railways in New Hampshire are freight railways. Currently they are owned and operated by Pan Am Railways. In 1983 Pan Am Railways bought out the Boston and Maine Railroad which had been in existence since 1836. In 1886 the Boston and Maine railroad acquired the Worcester, Nashua, and Rochester Railroad and in 1887 it acquired the Boston and Lowell Railroad. With these two acquisitions, the Boston and Maine Railroad owned rails from Boston, MA north to Concord, NH. Pan Am Railways now owns these same tracks but are currently using them for freight transport only (Passenger Rail Task Force, 2007).

Commuter rail transport ended on the lines in 1967 due to ridership and funding issues. In the early 1980’s, a pilot program for commuter rail was started. The experiment was successful and it seemed that commuter rail would return to Southern New Hampshire. However, federal legislation cut the funding for the program and eventually the schedule was reduced to one train per day causing interest in the railroad to die out. Since then, several attempts have been made to revitalize the railroad but each is met with a host of issues such as service schedules, station locations, operation of the railroad, and funding (Passenger Rail Task Force, 2007).

In 2006, Gov. John Lynch brought together a host of stakeholders such as Pan Am Railways, the cities of Manchester and Nashua, the Nashua Regional Planning Commission, the Southern New Hampshire Planning Commission, among others to create a proposal to bring commuter rail back
into New Hampshire. The proposal was accepted and studies to estimate the cost of such a project and to address the other issues stated above have been ongoing since then. Also, the NH Rail Transit Authority and NH DOT have taken over the majority of the planning and design for the project in association with the New Hampshire Railroad Revitalization Association.

Preliminary plans call for commuter rail service to be reinstated from Manchester to Lowell, from whence passengers can continue on to Boston. There will be four round trips per day in each direction with three of them occurring during the commuting hours. There will be three or four stations built along the route: one in Nashua, one in downtown Manchester, one next to Manchester Boston Regional Airport and possibly one in Merrimack. Site feasibility studies for Manchester, Nashua and Manchester Boston Regional Airport are being conducted. In September 2008 a ridership estimate was completed. Preliminary studies show that most of the rail that is now used for freight transport will be structurally sound to support the commuter trains, however, some additional structures, such as bridges, will have to be built in addition to the three stations.
Figure 1: Proposed route for the NH Capitol Corridor
Phase I: Initial Site Selection

After reviewing local GIS data, three sites were selected to undergo further study. The initial site selection was based on three major criteria: size, accessibility, and environmental factors. The site had to be big enough to accommodate a minimum twelve-hundred-space parking lot. In terms of access, the potential sites need to have easy access to the airport, public roads, and the railroad. The final criterion was to make sure construction of the station would not be impeded by environmental concerns, mainly wetlands. Flexibility was used in applying the criteria to allow for design adaptations which could make a site work within limiting constraints.

The first site selected is located in Manchester on the eastern bank of the Merrimack River, off of Winston Street and Brown Ave, as seen in Figure 2 below. Pros of this first site are the lack of wetlands and the fact that parking would be located on an existing vacant lot. This means that the site would be more or less pavement ready. The cons of this site is that the primary parking area is not located directly next to the tracks as shown in Figure 2, and there is not enough room behind the existing building next to the tracks to fit in a full length platform.

![Figure 2: Map and aerial photo of Manchester site](image)

The second site selected is located in Bedford, just north of the MAAR as shown in Figure 3 below. The main advantage of this site is that it would be easy to link into the MAAR so traffic coming to and from the airport will be able to access the station easily. The main disadvantages of this site is the presence of a stream right through the center of the site as seen below and space
requirements; the site would only be big enough to fit approximately 450 parking spaces due to the presence of a wetland diving the site in two.

Figure 3: Map and aerial photo of Bedford site

The third site selected is located in Merrimack adjacent to the Merrimack/Bedford town line just south of the MAAR as seen in Figure 4 below. The advantages of this site are the lack of any obvious wetlands and access to the MAAR would be easy to achieve. The disadvantages of this site are one, the narrow dimensions; the site is only 200’ to 300’ wide. Also, there is a 25’ elevation change on site that would need to be leveled with if a parking lot or structure were built.

Figure 4: Map and aerial photo of Merrimack site

Based on the above preliminary investigations, the Merrimack site was chosen as being the most likely to succeed. It was later discovered that the SNHPC had identified the same three sites as potential candidates but had only done feasibility studies on the first two.
Phase II: Merrimack Site Feasibility Study

a) Proximity to Manchester Airport Access Road

The Manchester-Boston Regional Airport has seen a sharp increase in recent years, pushing the need for better access to the airport. The airport is located just two miles from Interstate 293 in Manchester, but is only accessible by Brown Avenue in Manchester, a relatively small street plagued by traffic and congestion. The airport is less than one mile from the Everett Turnpike, but the Merrimack River and Route 3 stand between the airport and direct highway access, as seen in Figure 5.

Figure 5: Manchester-Boston Regional Airport in relation to surrounding highway system

As part of a plan to bolster access to the airport and to fuel the economy of the relatively undeveloped region south of Manchester, a new access road is being built called the Manchester Airport Access Road (Young). With the addition of the new access road and ramps, one thousand acres of land for industry has been opened up for development—The largest in New Hampshire (Samuel). Route 3, which runs parallel to the Everett Turnpike, will see a great increase in traffic with the completion of the MAAR. From Route 3 (River Road), there will be both on and off ramps to both The Everett Turnpike and the newly finished MAAR, as seen in Figure 6. With new direct access to the turnpike, local planning commissions are relying on this
area to become the ‘economic engine’ of the region, becoming a vital part of Bedford, Merrimack, Londerry and Manchester’s development.

The MAAR will provide even more convenient access to the already popular Manchester-Boston Regional Airport, giving it even more of an advantage as the airport continues to thrive in the region. With plans for passenger numbers to double from roughly four million up to eight million passengers per year, the airport is eager for the possible passenger rail service that could return the region in the next few years. Fortunately, the existing tracks pass right underneath the new MAAR on the West bank of the Merrimack River, and near the ramps that will connect the Turnpike, Route 3, and the MAAR. This creates an ideal location for a possible commuter station and eventual transportation center.

The Merrimack site location is ideally positioned to interface with and would add value to the area affected by the MAAR. The ramps exiting the Everett Turnpike will provide immediate access to the Merrimack site. This will allow people traveling to or from the Manchester-Boston Regional Airport a chance to take advantage of the train. The airport has expressed interest in this opportunity, and would provide dedicated, direct service from the airport to the commuter station just across the river, via the access road.
The proposed rail station would be located in close proximity to the bridge that will span the Merrimack River, meaning the ramp access to and from the airport will be very convenient. The overall driving time between the airport and the station would be less than 10 minutes (B&I Transportation Consulting, LLC).

The MAAR will tie the region together, connecting southern New Hampshire, Boston, the expanding airport, and the future economic hub of the greater Manchester area. Once the new access road is complete in 2010, southern Manchester, NH and the surrounding communities will be more connected and the Merrimack site would be located at the center of the expected economic activity.

Figure 7: Conceptual NH DOT plans for MAAR (NHDOT)
b) Access Requirements

There are several requirements for access to the site. First it must have access to both the airport and the tracks. Since the site is parallel to the tracks this is not a problem. Also, the site was selected in a large part because of its proximity to the new MAAR which was discussed previously. Additionally, the site must of two points of entrance and egress for emergency vehicles. The first point of access point can be provided by a road running under the North side of the MAAR as seen in Figure 8.

Figure 8: Space under the MAAR for a road. Looking North.
The second access point would have to be provided by an adjacent vacant through either acquisition or use by agreement with the owner. The lot is shown in Figure 9.

**c) Parking Space Constraints**

The commuter station site requires space for 1200 parking spaces on opening day. This is to account for the estimated 1000 initial daily riders with an additional 20% capacity for future increases. It was determined that the primary Merrimack site would only have space for 800 parking spaces. This would however be increased to over 1200 spaces with the use of the abutting property. It is recommended that the land owner be approached in regards to this property.

Another possibility for parking is to build a parking garage. A parking garage would fit entirely on the NHDOT owned property and also provide vertical expansion opportunities to meet future parking demand. At the same time this would free up the Abutting property for commercial use to take advantage of the new rail station.

**d) Wetland Impacts**

No wetlands were found on either of the two properties being considered. The Merrimack GIS maps were consulted in addition to wetland maps which were prepared for the MAAR environmental report (see Figure 10).
Additionally, a site walk was conducted during which no obvious signs of wetlands were found. Even though the maps show no wetlands directly on the properties, there are wetlands on abutting properties which may impact the proposed site due to setback requirements.

**e) Bald Eagles**

Another environmental consideration for the Merrimack site was the bald eagles. The Merrimack site was initially acquired by the state as part of a program to protect the bald eagles which are known to occasionally nest in the area. Despite this, the bald eagle issue does not seem important for this site because previous to being acquired it was mostly cleared of trees and also bald eagles have not been seen in the area for a few years (Normandeau Associates, Inc., 2008) (B&I Transportation Consulting, LLC).
f) **Hazardous Waste**

There are mounds of unidentified fill which pose a potential source of hazardous waste on the privately owned property being considered for this site. The source of this fill should be identified in further study.


g) **Traffic Impacts**

Traffic impacts were investigated but with the MAAR bringing a large amount of new traffic to the area it would be unlikely that the Merrimack site would make much of a noticeable impact. A more extensive traffic study was done on the neighboring Bedford site and it came to a similar conclusion (PB Americas, Inc., 2008).


h) **Economic Impacts**

Rail stations are a major mode of transportation and can become a central hub for a metropolitan area. The Manchester-Boston Airport area has been growing at an increasing rate over the last several years and currently has limited accessibility. As accessibility to an area becomes easier or more direct there is a tendency for economic activity in the region to increase. In order for a region to develop it must expand and network with other major metropolitan districts (Debrezion, Pels, & Rietveld, 2004). As mentioned previously the Merrimack site is located within a region which is becoming more connected. The Manchester-Boston Regional Airport is already functioning as an economic driver for this area and businesses, real estate values, and commuters could all additionally benefit from a multi-modal train station being constructed in the Manchester Airport region. A train station will not only add economic value to the area but will also provide a more convenient form of transportation to and from Boston.

When putting a rail service in place there are different options for the type of service the rail can offer: light rail transit, heavy rail transit, commuter transit, or the equivalent of a rail station with rapid bus transit. Commuter rail stations have the greatest impact on property values when compared to the other rail options. Commuter rail stations also have a higher effect on the value of commercial properties when compared to the impact of residential properties. On average commercial properties will increase 19.1 percent with the addition of a commuter rail station. While residential properties still increase in value it is only at an average of 4.6 percent. Single
family homes will see the greatest increase in value at 4.8 percent, and then condominiums at 4.3 percent and last multifamily homes on average will increase 4.0 percent (Debrezion, Pels, & Rietveld, 2004). The increase in both residential and commercial property values will help the surrounding area develop and grow into a major business district. The sites are located within a quarter mile of numerous commercial and residential areas. There should also be enough space in the surrounding area to encourage future development and growth.

These increases in values can be expected for an area within a quarter mile of the rail station. There are numerous businesses within our selected site including companies such as Coke, UPS, as well as several smaller warehouses and businesses. Beyond this distance property values will still increase but at a decreasing rate as the distance increases (Debrezion, Pels, & Rietveld, 2004). As the rail service grows and more people take advantage of the easy transportation the effects on property values will only increase and effect additional properties at greater distances from the station. Networking with surrounding areas is crucial to the development of an area and the addition of a rail station is a major from of networking. Manchester lies between the major cities of Concord N.H. and Boston M.A. and setting up connections between these cities will fuel the economic development of the area.
Comparison with Other Sites

With the feasibility study complete, the Merrimack site was plugged into the same Matrix that was used by the SNHPC to compare the other two potential sites. It was found that the Merrimack site scored better than either the Bedford or Brown Ave. sites.

### Station Site Comparison Matrix

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Existing Highway Infrastructure Impacts (capacity &amp; accessibility)</td>
<td>None</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>None</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>2 Impacts on Proposed Ridership</td>
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<td>None</td>
<td>Yes</td>
<td>None</td>
<td>None</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3 Wetlands Impacts</td>
<td>No Impacts</td>
<td>Yes</td>
<td>None</td>
<td>Yes</td>
<td>Some</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4 Convenience</td>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5 Initial Site Development Costs</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>6 Platform Requirements</td>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7 Future Expansion Capabilities</td>
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<td>Yes</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8 Pedestrian Station Access</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>9 Zoning Issues</td>
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<td>None</td>
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<tr>
<td>10 ADA Costs</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>11 Adequate Surface Parking for Opening Day</td>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>1</td>
<td>0</td>
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<td>12 Development/Redevelopment Potential</td>
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<td>Yes</td>
<td>Yes</td>
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<td>13 Close Proximity to Airport</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>0</td>
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<tr>
<td>14 Site Access Costs</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>15 Access to Utilities (Water, Sewer, Gas, etc.)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>16 Any Restrictive Property Easements</td>
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<td>Yes</td>
<td>None</td>
<td>Yes</td>
<td>Yes</td>
<td>1</td>
<td>0</td>
<td>1</td>
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</table>

**Total Weighted Score (Low Score Required)**

<table>
<thead>
<tr>
<th>Bedford</th>
<th>Brown Ave.</th>
<th>Merrimack</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 1: Design matrix: final site selection (SNHPC). The lower score is better.
Phase III: Site Design Proposal

The four aspects of the station that played a part in the design of the proposed station are explained in detail below.

a) Site preparation

Once a site has been selected, the first step toward the completion of this rail station will be to prepare the site for construction. Costs for clearing the land, leveling and grading the site, as well as compaction were figured using RS Means. After walking the site and getting some rough dimensions using a to-scale map, it was decided that the site could feasibly be leveled off using the soil that is currently there. Soil from areas of higher elevation would be cut and moved to areas where the elevation is lower, bringing the level of the entire area to an elevation of approximately 140ft. It was decided that this method would be viable because, after doing some research, the soil properties for the area were not found. It is still unclear, even after talking to authorities from the town of Merrimack, whether or not boreholes have ever been drilled in this area to determine the soil properties. Clearing trees and brush was figured at $4.25/acre for an estimated final cost of $27,000. Bulldozing the site to level it in a cut-and-fill fashion (as described above) was calculated for a 200 horsepower bulldozer on an open site with a 50ft haul. This cost was provided at $1.15 per cubic yard for an estimated cost of $48,000. Bringing the site to the desired grade for construction of the proposed amenities was figured at a price of $0.80 per cubic yard for a total estimated cost of $30,000. Finally, compaction was then calculated using a riding, vibrating roller with six inch lifts for three passes at a cost of $0.42 per cubic yard. This totaled $18,000, bringing the total cost for site preparation to approximately $128,000. (Means, R.S., 2005).
Table 2: Land Clearing Costs

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Clearing</td>
<td>$4.25/acre</td>
<td>$27,000</td>
</tr>
<tr>
<td>Leveling</td>
<td>$1.15/yard$^3</td>
<td>$48,000</td>
</tr>
<tr>
<td>Site Grade</td>
<td>$.80/yard$^3</td>
<td>$30,000</td>
</tr>
<tr>
<td>Compaction</td>
<td>$.42/yard$^3</td>
<td>$18,000</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td><strong>128,000</strong></td>
</tr>
</tbody>
</table>

**b) Pavement**

When designing a parking lot there are a few options on how to prepare the surface. One could decide to use an asphalt surface, a concrete surface, or a permeable pavement system. Asphalt and concrete have similar pros and cons, while permeable pavement has many unique advantages. Asphalt and permeable pavement were the two options that were considered for the Merrimack site.

Asphalt is by far the most widely used method due to its low cost and its relative ease to maintain. Asphalt has been used worldwide for decades and its proven track record makes it a good choice for most situations. There are also more contractors who can install an asphalt parking lot as opposed to a concrete or permeable parking lot. If done right, all the maintenance required is filling in cracks and potholes on a regular basis. If the subbase is strong enough, even potholes and cracks will not develop for a long period of time.

Without knowing the soil types at the site and where the ground water level is, it was difficult to properly design a subbase. Because there are no boring logs available, it was assumed that the soil conditions on the site were average and that the ground water level was well below a critical level. After the assumptions were made, a total depth of the surface and subbase was determined to be 2 feet and 7.5 inches. It will incorporate a surface course of 1.5 inches, a binder course of 3
inches, a base course of 9 inches, a subbase of 12 inches, and a compact subgrade of 6 inches (Huang, 2003).

One drawback of using asphalt, or concrete, is that it disrupts the immediate area’s hydrology. Storm water is rain water that has collected on the ground. Most of this water later evaporates, some turns into runoff, and the rest absorbs into the ground. A parking lot multiplies the effects of storm water. Parking lots increase the amount of runoff and decrease the amount of shallow and deep ground penetration. The water also collects car debris, including metals and oil, and carries them through the watershed if nothing is done. A detention pond is a common way to contain the storm water until the debris has been removed, and then water can be released in a controlled manner. For the Merrimack site, a detention pond was designed to hold a 50 year storm event, with a factor of safety of 3.11. The pond will have 2:1 slopes, a depth of 20 feet, and a volume of 498000 cubic feet. The detention pond was only sized for costing purposes and was rejected in favor of the permeable pavement system.

With more people today attempting to take better care of the environment, new innovations are commonly being put into practice. Permeable pavement is one innovation that has the potential to revolutionize urban areas. Currently, storm water is collected in detention ponds or in sewers. The sewers take the water away to treatment plants and the local ground water supply has a harder time getting replenished. Permeable pavement takes that storm water and allows it to flow right back into the ground, much more like nature intended. There are significant sublayers of gravel and sand that remove the car debris; which are more effective than a detention pond. Figure 13: Permeable Pavement, illustrates how permeable pavement reduces storm water. There are also special liners that can be added if extra care of the ground water has to be taken.
The procedure for designing a subbase for permeable pavement was different than the procedure for regular asphalt. The difference between the two stems from the subbase being required to hold a 25 year storm event. This was calculated by assuming a void space in the gravel layers and then dividing the inches of rainfall by the void space. The calculated subbase has to be at least 17 inches, not including the surface layer. For this particular site, however, it was the frost depth that controlled the depth. The frost depth required the subbase to be 26 inches. This total depth of 27 inches is greater than the 26 inch minimum depth required due to the frost line. As shown in Figure 14: Design of subbase soil and gravel layers below, the first layer will be 4 inches, the choker course will be 4 inches, the filter course will be 12 inches, the filter blanket has to be 3 inches, and the reservoir course has to be 4 inches for the Merrimack site (Stormwater Center, 2007).
The drawback to this new technology is that it is so new. Not many contractors are familiar with it, and not many engineers know how to maintain it. In fact, some cases have been reported where the permeable top has actually been sealed due to a lack of understanding. It also requires vacuuming every few years which can be expensive and difficult (Stormwater Center, 2007).

The cost of both the asphalt and the permeable pavement are actually very similar. The detention pond excavation and the amount of cement treated sand and gravel drove up the cost for the asphalt method. The large amount of crushed gravel and sand drove up the cost for the permeable pavement. Depending on the soil conditions, parts of the native soil could be used to save money. Because the cost of the traditional asphalt pavement was $2.59 million and the cost of the permeable pavement was $2.72 million, the obvious choice was to go with the more modern, more environmentally friendly, permeable pavement.

c) Parking

The design of the parking lot for the commuter station servicing the Manchester-Boston Regional Airport needed to incorporate several things. The parking lot capacity of 1200 spaces was the most important factor when considering the design. The space restrictions were equally as important, with the railroad tracks to the east, and a more elevated property to the West. The neighboring property’s elevation restricted the expansion of the parking lot to the West, resulting in the proposed retaining wall to maximize the usable space in the proposed lot. A driveway to the north of the lot will provide one entrance from Route 3, while the second entrance will be to the south, where the west end of the property to be acquired meets Route 3.

The platform was the next controlling factor. Once a platform width of fifteen feet was suggested, the parking lanes were developed. A minimum distance of 24 feet is required for travel lanes within a parking lot. The parking lanes are designed in an East to West direction, meaning the lanes between all parked cars will be oriented East to West, while the direction of all parked vehicles will be North-South. This seemed like the most efficient way to support the 1200-space requirement. This distance was used to space the ends of the parking lanes from the platform, along with the lanes between the rows of parked vehicles.
As for the parking spaces, 9’ by 18’ is the required space dimensions by the town of Merrimack, NH. Over twenty sections of end-to-end parking spaces is suggested, with each section contains about 50 spaces, depending on the exact location within the lot. The sections become smaller the farther south within the site, being restricted by the dimensions of the parcel and railroad tracks.

With these standard parking spaces, and the appropriate amount of handicapped accessible spaces, the parking lot design will fully support the needs of the commuter station at the Merrimack, NH site.

A parking garage was also considered. It was sized for three story 2000 parking space garage with the capability to add floors if further capacity was needed. It was estimated that the site would cost $40,000,000 with a parking garage and $6,000,000 with only a surface parking lot. Figure 15 shows the site with and without a parking garage with the estimated costs for each.

![Figure 15: The site with and without a parking garage. Note that with a parking garage there is room for a light commercial building.](image)

d) Platform Design

One of the design elements of the project included designing the station platform to be located at the site. At this time it is not known what train carrier will be providing service along the proposed route, however since Amtrak already has trains running through New Hampshire and into Massachusetts it was assumed that they would be a possible carrier on the route. Therefore the platform and waiting areas were designed to Amtrak standards found in the *Amtrak Station Program and Planning – Standards and Guidelines Version 2.2*. The platform was also designed to meet the Americans with Disabilities Act (ADA) requirements. Preliminary sizing of the
platform as a whole was done using *Appendix C – Waiting Capacity* of the Amtrak standard. This section ensures that the platform waiting area is big enough to support the expected number of passengers waiting for a train at any given time. The calculations are based on the number of peak hour trains, the number of daily riders on those trains, and the area taken up by waiting passengers. An area of 20SF per passenger was utilized for standing passengers to allow for comfortable moving area for other passengers and their baggage. An additional 10SF per passenger was used to accommodate seated waiting passengers. Based on the peak hour ridership it was determined that the platform was required to have a surface waiting area of 1380SF with approximately 50 seats for passengers to sit on while waiting (Calculations may be found in the Platform Design appendix).

Once the required waiting area was determined it was compared to the recommended waiting area. The Amtrak Standard states that the preferred length of platforms is 700 feet and the preferred width is 12 feet. This gives a total surface waiting area of 8400SF which is well above the required minimum.

With the overall size of the platform known, design of the structural elements was started. The platform was designed as a set of 12’ x 15’ slabs (for a total of 47 slabs), supported by two 700’ beams which would be supported on a total of 94 columns. All structural elements were designed to be built of reinforced concrete with a compressive strength of 5000 psi and were designed according to the guidelines set forth by the *American Concrete Institute (ACI) 318-08 Standard*. All steel is to be Grade 60 reinforcing bars.

The first members designed were the slabs since the only remaining dimension to be determined was the slab thickness. According to ACI 318-08 Table 9.5a the minimum depth for a one way simply supported slab is the span length divided by 20. This gave a minimum slab depth of 7.2 inches. For constructability purposes a depth of 7.5 inches was used. Next, the amount of reinforcing steel required was determined. This was done by determining the amount of flexural moment that the slab would be subject to based on a live loading of 150psf (used by Amtrak) and the dead load of the slab itself. Once the applied flexural moment was determined it was compared to the amount of flexural moment that the slab could support and the minimum amount of steel required was calculated. This was then checked against the maximum amount of steel that could be provided and it was determined that for every 15’ slab section, 10 #5
reinforcing bars spaced every 18 inches was required (Calculations as well as a cross section may be found in the Appendix).

The next members to be designed were the beams. Preliminary dimensions were found by ACI 318-08 standards stating that the height required is the span divided 18.5; equaling 12.97 inches. From here, ACI standards stated to pick a preliminary width of 2/3 the height; equaling 8.65 inches. For ease of construction a preliminary beam size of 10” x 14” was selected. Next, the amount of steel required for reinforcement was determined in the same manner as that for the slabs and it was determined that 3 #9 bars would be needed (Calculations and cross section found in Appendix).

The final members to be designed were the columns. These were designed using an Excel spreadsheet developed for both homework and a design project in CiE 774 - Reinforced Concrete. As seen in the sample output in the Appendix, the spreadsheet has input fields for the size of the column, the axial load on the column, type and number of reinforcing bars, and the flexural moment to be applied to the column. Axial loads were determined by LRFD load cases taking into account the live load of 150 psf, dead load from the slab and beams. As a conservative estimate, the flexural moment was taken as 1/10 of the moment in the beams. Next different size columns with different sizes of reinforcing bars were plugged into the spreadsheet to determine what would be appropriate. The spreadsheet creates an “Interaction Curve” for the column based on the axial loads and moments and as long as the applied loads and moment fall within the maximum limits calculated the column is deemed “safe.” This trial an error process was done until a working column design was reached (Excel output sheets can be found in the appendix).

As stated above, the platform was also designed to meet ADA standards. For this platform, the major considerations that were taken into account were the platform height, access to the platform, and warning strips. According to the ADA, vertical differences between a platform surface and a vehicle at rest at the platform are limited to 5/8” and the horizontal spacing between the two is limited to 3”. The ADA does recognize that under most circumstances these requirements are not able to be met. Therefore, it requires that all vehicles provide bridges for crossing horizontal gaps and ramps for vertical access. Since all Amtrak trains contain ramps and or bridges this requirement was not specifically designed for. Access to the platform will be
provided by stairs positioned along the length of the platform and by wheelchair ramps located at each end of the platform. The slope of these ramps is limited to and will be 1:20 meaning that for every 20’ of ramp length it will rise 1’. Another safety consideration that was taken into account was warning strips that are required at the edge of the platform. They will be 2’ wide, per Amtrak standards, and be painted yellow.

The total cost for the platform was calculated to be $349,000. This includes concrete and steel for the slabs, beams, and columns. The in place cost of each element was taken as five times the cost of the material alone, a conservative estimate used in other classes. Material costs were taken from recent issues of Engineering News Record. Additional breakdown of the costs can be found in the Appendix.
Design Recommendation

The surface parking lot with permeable pavement was determined to be the most cost effective solution. However, if the capital funds are available a parking garage would provide for greater flexibility in design while also providing for future expansion should the station’s use increase as expected. It is also recommended that additional abutting land owners are approached about further increasing the land area being developed in relation to the commuter station. If more land were available, it would allow for an opportunity to coordinate a commercial center in conjunction with the commuter station.
Bibliography

B&I Transportation Consulting, LLC. *Statewide Planning and Research Grant Preliminary Commuter Rail Station Site Evaluation Report for Manchester Boston Regional Airport*. Southern New Hampshire Planning Commission.


Acknowledgements

The group would like to sincerely thank David Preece and Michael Izbiki from the SNHPC for their help and advice for this project. Without them it would not have been possible.
# Appendix A: Cost Estimation

Table 3: Adapted from SNPC

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Appendix B: Platform Design
Appendix C: Pavement Design