LEBANON PEDESTRIAN & BICYCLIST ADVISORY COMMITTEE
NOVEMBER 7, 2024 - 4:00 PM
MEETING ROOM 1, CITY HALL OR REMOTE VIA VIRTUAL PLATFORM
LEBANONNH.GOV/LIVE

1. **Call to Order**

   A. To participate in this meeting, please join live via Microsoft Teams or call 929-229-5356 (access code: 646 577 623#). If you have trouble accessing this meeting, please email catheryn.hembree@lebanonnh.gov.

2. **Approval of Minutes**

   A. September 3, 2024

3. **Open to the Public**

4. **Study Items**

   A. Presentation: Dartmouth College - Engineering Project: E-Bike Charging Stations

   B. Sachem - DHMC Connector

   C. **Brickyard One Nominee Trust, 174 Hanover Street Ext (Tax Map 48, Lot 4), 0 Hanover Street Ext (Tax Map 48, Lot 2), 0 Hanover Street Ext (Tax Map 48, Lot 1), and 238 Hanover Street (Tax Map 63, Lot 1), zoned R-1, R-O-1 & R-3:** Review and comment on updated Site Plan for Planning Board application, PB2024-22-SPR.

   D. Complete Streets Policy

5. **Other Business**

   A. Updates from Other Boards

      - Planning and Development
      - Planning Board
      - City Council
      - Police Reports
      - Mascoma River Greenway Coalition
      - Class VI Roads
      - Communications Plan

6. **Future Agenda Items**

7. **Adjournment**

The order of agenda items is subject to change.

Meetings are open for in-person and remote attendance. Members of the public that wish to attend remotely may do so by going to LebanonNH.gov/Live where you will find instructions on how to enter the meeting. Members of the public will be able to participate and ask questions through the City's virtual platform or by phone. Please note: Should technical difficulties occur during the meeting that disrupts virtual or phone connection(s), the meeting will continue without remote access capabilities.

DRAFT

PEDESTRIAN & BICYCLIST ADVISORY COMMITTEE
REGULAR MEETING MINUTES
COUNCIL CHAMBERS– CITY HALL &
REMOTE VIA VIRTUAL PLATFORM LebanonNH.gov/LIVE
7:00 PM, SEPTEMBER 3, 2024

MEMBERS PRESENT: **Colin Smith (Chair); Erling Heistad (City Council); Haynes Bunn; Ben Swanson (Alt); Sean Dittrich; Jared Toon (Alt); Tim Gilbert; Marie McCormick [7:15pm]**

MEMBERS ABSENT: **George Sykes (City Council, Alt); Clifton Below (Alt)**

STAFF PRESENT: **Catheryn Hembree (Associate Planner)**

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1) CALL TO ORDER:

Chair Smith called the meeting to order at 7:00 PM.

2) APPROVAL OF MINUTES

A. August 6, 2024

A MOTION was made by Mr. Heistad to approve the meeting minutes of August 6, 2024, as presented. Seconded by Ms. Bunn.
****The vote on the MOTION was approved (3-0-2).***

3) OPEN TO THE PUBLIC:

Brandon Hill, Oak Ridge neighborhood, stated that a couple of months ago a capital investment projects presentation before the Planning Board mentioned that one of the proposed projects was a connector road between Sachem Village and DHMC. It was noted that the connector road had the support of this Committee, and he would like to know if this was an accurate representation. He noted that the proposed route has a 10% grade. This does not seem bike/ped friendly. The connector road is proposed to be 22' wide with an additional 10' dedicated to bike/ped users. This would require approximately 1.6 hectares of land.

Chair Smith stated that in terms of the Bike Ped Plan, the idea of connecting Sachem Village and DHMC utilizing a path is important. The Committee has not reviewed a detailed alignment or layout for this route though. Mr. Dittrich stated that he believes this was described as some paving along the preexisting powerline segment. Ms. Hembree noted that the design plans have never been shown to this Committee.

Mr. Hill noted that he believes this plan will be presented at the City Council meeting on the 18th. Chair Smith stated that the Committee has only discussed a trail in this area, so complete Committee support for anything else may not be entirely correct.

Marie McCormack entered the meeting at 7:15pm.

The Committee agreed to address this further at its next meeting.

5) OTHER BUSINESS – *The Committee addressed this agenda item at this time.*

A. Review and Comment on Planning Board Application: Brickyard One Nominee Trust, 174 Hanover Street (Tax Map 48, Lot 4), 0 Hanover Street (Tax Map 48, Lot 2), 0 Hanover Street (Tax Map 48, Lot 1), and 238 Hanover Street (Tax Map 63, Lot 1), zoned R-1, R-O-1, R-3 & RL-3: Request for Site Plan Review and a Conditional Use Permit pursuant to Sections 308.2, 310.2, 311A.2, and 501.2 of the Zoning Ordinance for a proposed 474-unit multi-family Planned Unit Residential Development (PURD) totaling +/- 731,600 sq. ft. in size, consisting of 11 buildings together with parking, utilities, landscaping, access, and other related site improvements. Applicant also requests a Conditional Use Permit pursuant to Section 308.4 of the Zoning Ordinance to allow an increase in the maximum permitted building height from 45 ft. to 55 ft. **PB2024-22-CUPSPR**

Ms. Hembree stated that the Planning Board is still in negotiations on this project. The applicant has submitted a new traffic study, but it did not change much from the original. It was noted that the sight lines at Old Etna Road will be difficult, and this should be teed up as much as possible. This could also be considered for an all-way stop. There was also concern expressed regarding the Evans Drive and Hanover Street intersection. There should be flashing beacons or a pedestrian controlled light at this intersection.

Ms. Bunn asked about the time period for the pedestrian counts that were taken. Ms. Hembree agreed and stated that she asked for the counts to be completed at a more appropriate time.

The Committee discussed recommendation items to send along including extending the sidewalk along the north side of the property, teeing up the Etna Road intersection and making it an all-way stop, including pedestrian controls at the Evans Drive/Hanover Street intersection, and allowing for updated pedestrian counts.

Mr. Dittrich stated that he believes it will be important to have traffic stop at the Evans Street intersection. A multiuse path along one quiet section of Hanover Street could be utilized before the school property starts. The transition into the existing network may be more dangerous, if pushed away from where it is now.

B. Review and Comment on Planning Board Application: The Muse Lebanon, LLC (applicant), City of Lebanon (property owner), 20 Spencer Street (Tax Map 92, Lot 31), zoned LD: Request for Site Plan Review for a proposed +/-76,064 sq. ft. multi-family building with 80 affordable housing units, together with parking, utilities, landscaping, access, and other related site improvements. Applicant also requests a Conditional Use Permit pursuant to Article III, Section 307.6.B.2 of the Zoning Ordinance to waive the requirement to reserve space within the street level story of the building for non-residential uses. **PB2024-36-SPR**

The Committee discussed that this plan shows indoor bike storage on the ground floor. The plan also shows a playground to be built near the rail trail. Ms. McCormack expressed concern regarding the intersection at Spencer Street where there used to be a stop sign and is no longer.

The Committee discussed recommendation items such as flashing beacon at the crosswalk, three way stop at Campbell/Spencer/Parkhurst streets, bring back the stop sign at Spencer, considerations at the rail trail such as speed tables, blinking lights, or raised crossings, and a landscape plan for the development.

C. Middle School Traffic Flow Discussion

Ms. McCormick explained that there has been an ongoing safety issue along Route 4 during drop off and pick up times for the Middle School. The idea to change the movement of cars on the Middle School site seems too complex at this time, so the proposal is to reroute the cars to surrounding streets. School started last Thursday, and it is unclear how this change is working. There is a proposal to make a paved shoulder along Prospect Street. There was a question raised as to why there isn't a sidewalk along Prospect Street

Ext. Concern was expressed regarding the sight distance along Laplante Road. Mr. Heistad suggested a staggered school start in order to spread out the traffic issues.

There was discussion that the short area of paved shoulder may not make the route safe for middle schoolers to travel, depending on the time of day. This could be a good location for an actual sidewalk.

The Committee discussed recommendation items such as a traffic study to determine solutions for the onsite queuing, additional sidewalks, and additional signage indicating pedestrian usage.

4) STUDY ITEMS

A. Review Complete Streets Policy
   i. Street type definitions
   ii. Characteristics needed to be a complete street

The Committee agreed to address this topic at a future meeting.

B. Updates from Other Boards
- Planning & Development
- Planning Board
- City Council
- Police Reports
- Mascoma River Greenway Coalition
- Class VI Roads
- Communications Plan

This item was not addressed at this time.

6) FUTURE AGENDA ITEMS

None at this time.

7) ADJOURMENT:

A MOTION was made by Mr. Heistad to adjourn the meeting. Seconded by Mr. Dittrich.
****The vote on the MOTION was approved (6-0).***

The meeting was adjourned at 8:53 PM.

Respectfully submitted,
Kristan Patenaude, Recording Secretary

Cook Engineering Design Center at Dartmouth

Pre-Proposal

Submitted in partial fulfillment of the requirements for

Engineering Design Methodology and Project Initiation

Electric Bicycle Charging Infrastructure in Lebanon, NH

October 25, 2024

Sponsored by

The City of Lebanon

Project Team #20

Grace Connolly, Gannon Forsberg, Nathan McAllister, Avery Moorhead

Faculty Adviser

Professor Vicki May

DARTMOUTH ENGINEERING

Table of Contents

Problem Statement and Significance

The City of Lebanon, NH hopes to build [three to five] electric bike charging stations in high-use areas to both meet the needs of current e-bike users and encourage residents to buy e-bikes to lower their carbon footprints. The City hopes to use the Kilton Library, two potential locations on the city mall, and the city green [Colburn Park]. There is currently uncertainty about several aspects of this project, most significantly whether to use renewable energy to power the charging stations and whether e-bike owners should bring their own chargers. In addition funding must be found to construct the charging stations. However, there is precedent for solving these problems. Major cities such as New York and Boston have announced plans to build e-bike charging and renting stations, building on their existing bases of widely used bicycle rental systems (CitiBike and Blue Bikes, respectively). With respect to small cities on the scale of Lebanon, a pilot study conducted by NREL found e-bikes were the preferred method of transportation for distances of one to four miles. More than half of all daily car trips in the United States were under three miles, meaning that electric bikes would serve well as a substitute for these daily trips. Additionally, the city of Burlington, VT has installed three e-bike public e-bike chargers in their downtown, showing that plans very similar to those of Lebanon, NH have already been implemented.

Objectives, Milestones and Deliverables

Objectives

The broad objective of our project is to advise the City of Lebanon on the design and installation of an accessible and safe e-bike charger. We will provide the City with a design that both promotes electric bike usage among Lebanon residents and serves the needs of current e-bike users. We plan to work with the City to create a plan that will optimize the needs of different residents, while minimizing the cost to the City.

There are three main objectives for this project: to survey residents, design an e-bike charging station, and identify sources of funding. All three of these components support one another. For example, through administering a survey, valuable insight will be gained on public opinion that will inform our design choices, and finding funding for the project will ultimately enable project execution (at some point in the future). For more detailed information on each of these three objectives (and progress made for each), see the Design Process section.

In addition to the questions we plan to address through our survey, we also have research questions focused on the technical feasibility of the project and the potential for securing funding.

Specifically, these are:

1. What should our group's final deliverable be? For example, should we design a charger ourselves, or should we purchase one off the shelf?
2. If we design a charger should the charger simply include an outlet and a place for users to lock their bikes? Or should it include different connectors for users' bikes.
3. What is the feasibility of TIF funding or lobbying the IRA? Are either of these options feasible within the scope of our project?

4. How can we use similar projects in other cities as a model for this project, and to what extent will they be useful?
5. Is solar power well suited for this project? If so, would battery storage or connection to the grid be a better option?
6. How can we ensure electrical components are adequately sheltered from the weather?

We will work to address all of these questions by conducting comprehensive technical research, reaching out to our sponsor and other stakeholders, such as the Lebanon Energy Advisory Committee (LEAC), and potentially speaking with policymakers.

Specifications

Regardless of the exact scope of our project, there are a number of specifications and requirements that must be met by our charger design. These specifically include the capacity and versatility of the charger, safety, cost effectiveness and security. In terms of capacity, the City of Lebanon would like each charging station to have four chargers, to allow for multiple bikes to charge while still being space-efficient. The chargers also must be compatible with at least 90% of electric bike models, in order to be able to properly serve the community. In addition, the charger needs to automatically shut off after six hours to mitigate the potential for fire. We also need to produce a cost-effective plan or identify funding sources, as the source of funding is uncertain. We also need to design a bike charger that would include a negligible chance of theft. See Appendix 4 for more information on our specifications.

Milestones

We will use the following milestones to ensure that our project is on pace to successfully finish by the end of winter term:

Fall, Weeks 5-6: The main objectives of these weeks are data collection. Specifically, we will meet with and reach out to stakeholders such as LEAC and the Upper Valley Lake Sunapee Regional Planning Commission (UVLSRPC). We also plan to reach out to and meet with company stakeholders such as Omer & Bob's and e-bike charging companies to learn more about the e-bike charging landscape. We also plan to draft and edit our survey; we will ask the stakeholders we speak with for feedback on the survey. Lastly, we will begin to conduct more technical research regarding the feasibility of designing an e-bike charger ourselves.

Evidence of Success: Scheduled meetings with LEAC, UVLSRPC, and company stakeholders. A draft of the survey and a draft of comprehensive technical research will be completed.

Fall, Weeks 7-8: During these weeks we will send our survey to the City of Lebanon for approval. Additionally, we will continue to conduct robust technical research. We will draft a recommendation of what we believe the best design option will be (see Design Considerations).

Evidence of Success: Drafted survey sent to the City. Technical research report completed.

Fall, Weeks 9-10: We will finalize a project scope recommendation to the City of Lebanon. We will continue to meet with stakeholders for feedback.

Evidence of Success: Project scope recommendation finalized and sent to the City.

Winter, Weeks 1-3: We will begin preliminary technical design work on the e-bike charger.

Evidence of Success: Preliminary technical design shared with our advisor (Vicki May)

Winter, Weeks 4-6: We will finish a draft of our technical design. We will continue to meet with stakeholders for feedback.

Evidence of Success: Preliminary technical design research shared with stakeholders such as the City and LEAC.

Winter, Weeks 7-9: We will reach out to the City and other stakeholders for formalized feedback about our technical proposal. We will improve our design with this feedback. Lastly, we will send a final version to the City.

Evidence of Success: Final report sent to the City.

By the end of this term, we plan to have data from surveys released to city of Lebanon residents about the need for e-bike charging stations to guide and support our designs. We additionally plan to further analyze literature and data available about other installations of electric bike charging infrastructure in other locations to inform our final project.

Deliverables

To summarize, our deliverables by the end of ENGS 89 are to complete and distribute a survey that is used to inform our project scope. Additionally, we will complete a preliminary technical design of the charger. This will include a draft electrical schematic as well as a mechanical mockup. Lastly, we will continue to conduct preliminary research surrounding funding options.

By the end of ENGS 90, we will have completed the technical design of the e-bike charger for the City's use. Additionally, we will provide a recommendation on the funding sources we suggest the City pursue. As a secondary deliverable (if time and resources permit) we will also author a whitepaper to inform future e-bike infrastructure projects nationally and internationally.

Design Process

Within the overall design process, we are breaking down the project into three individual phases: first, the design and administration of a public survey to inform project goals; second, the hardware development (mechanical and electrical) of a bike charging station; and third, the strategic search for funding to enable project execution in the future. Each of these subcategories is outlined in more detail below.

Survey

First diving into the survey administration component, we are in the process of drafting questions such that survey respondents are providing data that goes directly towards informing project goals. This means working backwards and asking "what information do we hope to glean from this survey" in order to shape the questions around the desired outcomes. In beginning the design of the survey, we have identified some key information we are looking for:

How many people use e-bikes within the City?
Do riders usually carry their chargers in Lebanon?
What models of e-bikes are most dominant in and around Lebanon?
Would community members pay a small fee (similar to Park Mobile) to charge in a public space?
How much would residents be willing to pay for public charging?
What additional amenities would add value for all residents to the project?

We plan to take this draft to Tad Montgomery and expect to go through multiple iterations with feedback from Tad as the City weighs in with their goals for this survey. Once both we and the City are sufficiently pleased with the design of the survey and confident in its outcomes, we will begin administering it in Lebanon. Time is of the essence; if this process takes too long, we will be surveying community members during the cold months of winter and may receive different data based on the lack of e-bike use during the winter months. Tad and Shaun Mulholland (Lebanon City Manager) suggested administering the survey along the Greenway that starts in Lebanon and runs towards Lake Mascoma in order to solicit responses from the electric bike-riding community members. We are also interested in collecting data from bike shops to gauge local market conditions. All of these factors are being considered in the design of a survey.

Technical Design

An understanding of current technologies is an important starting point as we consider how to approach our hardware design. Public electric bike charging stations have been designed for various use-cases, including for rental bike fleets and for e-bike owners.When thinking about charging infrastructure, rental fleets have the distinct advantage of design continuity: standardized bike models mean that chargers can be specifically designed for the type of e-bike. In considering designing infrastructure for use by e-bike owners, more complexity is introduced due to the variety of charging specifications that exist. E-bikes generally have batteries with sizes between 360Wh to 1 KWh ("Electric Bike Batteries Explained"). These batteries take on average 4-6 hours to charge; the average cost of charging is 11.25 cents per charge (see appendix 6) ("How do I charge"). Most e-bikes use batteries that are either 36V or 48V but some lower and higher options exist ("E-Bike Batteries"). Additionally, e-bike batteries use a variety of connectors to charge; there is not one standardized connector.

Working with Feldberg librarian Jentry Campbell, we were able to identify previous surveys and studies on electric bike charging infrastructure. Most literature puts electric bikes in the category of "micromobility vehicles" along with electric scooters, to separate them from larger electric vehicles such as cars. In advance of our proposal, we will thoroughly examine these sources to see how this prior research can inform our own designs for this project. The City of Lebanon has indicated that they would appreciate our using these sources as a blueprint for our designs. In addition, we are planning to look at infrastructure built in similar-sized New England cities such as Burlington, VT and Northampton, MA to serve as a basis for our project design.

Figure 1: ***Left:*** *preliminary mockup of a possible design, with 5 grommets for different styles of cables to be routed through.* ***Middle:*** *standardized CitiBike fleet charging station.* ***Right:*** *self-service charging rack with just an outlet, user brings charger*

Current solutions to the self-service charging station include: first, bike racks with outlets mounted on the exterior surface, and second, bike racks with a locker into which a removed battery can be placed. Both of these options are purchasable online, and could be an easy, off-the-shelf solution for the City. However, these options require users to carry their bike-specific chargers (which tend to be quite bulky) with them in order to use them. Multi-connector wall chargers do exist (we have ordered one for investigative purposes), but have not been widely integrated into public infrastructure. Taking this shortcoming into account, the lack of universal chargers is a key area of innovation that we have identified. Given the current market, we synthesized a solution space that can be referenced to in Appendix 1, which includes descriptions, pros and cons, and preliminary spec comparisons, but we also explore these options in a written format in the following paragraphs.

There are a number of different technical project options that our team could pursue. The first decision that we must make is which type of charger we design. There are three potential options. First, we could purchase an off the shelf e-bike charger with outlets. The charger would have a bike rack and an outlet for users to plug in their charger. Second, we could design a charger that has a bike rack and an outlet. This design would be similar to the off the shelf options but would be more optimized to the City's needs and potentially cheaper. Third, we could design an e-bike charger with different connectors so that users do not have to bring their own chargers. This option would be the most convenient for users but would be more technically challenging to implement and likely more expensive. See Appendix 1 for a more detailed description of the advantages and drawbacks of each option.

Our next consideration is how the e-bike charger is powered. Again, there are three options we could pursue. First would be a charger powered by a solar panel and a battery. The battery would power the charger when the sun is not shining. This option would be the most expensive of all options but the charger would be completely self sufficient and run completely on renewable energy. The second option would be to connect the charger to both a solar panel and the electrical grid. This option would be less expensive than including a battery but the charger would not be completely powered on renewable energy. For the third option, the charger would be connected to the electrical grid and solar would not be included. See Appendix 2 for more information.

Our last consideration is the addition of a payment system. There are four options. The first option is a coin or card operated payment system. This option is the best way to collect payment as the charger would not work without payment, but it would be the most technically difficult to create and likely the most expensive option. The second option would be a parking meter style payment system where the meter goes green when the user pays and red if payment has not been received. This option is likely cheaper and easier to implement compared to the first option, but users may not pay if there is not sufficient enforcement of the chargers. The third option is an honor system where users are encouraged to pay each time they use the charger. This solution would be much easier and cheaper to implement but it is possible that users take advantage of it and do not pay. Finally, the town could provide the electricity for free. It is likely cheaper to provide the electricity for free than to set up a payment system to collect payment. However, it could be seen as unfair for the City to provide electricity for a charger that only some residents would use. See Appendix 3 for more information.

While we still need to meet with the City to finalize our project scope, our current recommendation is to design a charger powered by solar energy and a battery. The product will include different connectors into which users can plug their e-bike battery. The charger with different connector cords is the best option because users do not have to bring their chargers, which makes the product more convenient for users compared to the current state of the art. We also recommend the addition of a solar panel and a battery solution. While there is an additional cost of installing the battery and solar panel (~$1400) we believe that this cost will be nearly offset by the cost of not having to pay for electricity (Tad predicted an electricity cost will be approximately $1,300 over the first three years). There is also the added benefit of the project using 100% renewable energy, and it will hopefully encourage Lebanon residents to adopt green technologies. Lastly, we do not recommend a payment system at this time due to added installation costs, potential maintenance, and barriers to usage.

Financing

Finally, we are considering how best to engage with the economic side of this project. The City of Lebanon has not secured funding for the construction of the e-bike chargers, and thus is still looking for the financial capital required to bring it to fruition. The engineering work we are providing in consultation to the City is a small financial burden in itself, since we are asking for a slice of Tad's time that could be used on other (potentially more lucrative) projects. However, we bring unpaid labor as well as a small budget from Dartmouth for development-related expenses. To build the chargers in Lebanon, three potential avenues were identified in conversation with Tad and Shaun:

1. *Tax Increment Financing (TIF)* would increase local taxes over time, using the additional dollars for infrastructure projects such as this one. This is likely the most straightforward path

toward funding, but comes at the expense of local residents who may not own e-bikes or benefit from the existence of charging stations.

2. *Lobbying the provision of the Inflation Reduction Act* which provides 30-50% federal subsidies for electric vehicle charging infrastructure. E-bikes are *not* considered EVs under federal law; rather, they are classified as Low-Speed Electric Bicycles, and thus public e-bike chargers are not eligible for federal subsidies. Tad has mentioned that he has started the conversation with relevant parties to see what can be done about expanding the IRA provision to include e-bike charging infrastructure.

3. *Applying for private funding*, like a grant from a local company (i.e Hypertherm or Solaflect) or the Jack and Dorothy Byrne Foundation. This path could be especially effective, but may raise concerns about optics from the City Council according to Tad and Shaun. Regardless of the path we choose, there will be some overhead on our end to consider the economic burden of this project and pitch its value to the relevant stakeholders.

Broader Context

This project has salient environmental, economic and safety considerations that our team must consider. First, it is important to consider that the City of Lebanon is interested in the project because they want to promote sustainability and environmentally friendly transportation. The project is not simply to make it easier for e-bike users to charge their bikes; it is also to promote sustainability and decarbonization. As a result, we hope to prioritize the visibility of the charger in Lebanon. If the charger is in a highly visible location then more people will see it and potentially buy e-bikes or at least consider more environmentally friendly modes of transportation.

It is also important to consider the economics of this project. At the moment, the City of Lebanon has no funding available to build or design this project. Additionally, the City would like to charge users each time they use a charger. This is despite the fact that it will cost more to install a payment system than it will be to give the electricity to users for free. Council members have stated that this is because it is unfair to give a service for free, that only some residents can benefit from. Therefore, it is extremely important that we make design as inexpensive as possible. We hope to research potential funding opportunities as a part of our project, but this is a secondary objective. We plan to use our survey (see Appendix 5) to determine whether there is sufficient demand to build a charging station if there is a payment associated with its use.

There is also a safety risk associated with the project ("E-Bike and E-Scooter Safety"). Specifically, we must plan for if an e-bike battery is set on fire as we cannot control how the public takes care of their batteries. To mitigate this risk, we envision that our design will automatically stop charging after [6 hours]. Additionally, it is imperative that the batteries are easily accessible to the Fire Department so that they can douse them with water if the need arises.

There are a number of secondary and tertiary stakeholders who could be impacted by this project. First, Lebanon residents with e-bikes are likely to benefit from this project, as they will have access to public chargers. Other potential users of the project are e-bike users traveling through the City and potential Lebanon residents; there are a number of proposed housing developments in the City and future residents may benefit from the chargers. Bike stores in the area, such as Omer & Bob's are likely to benefit from the project as the demand for e-bikes may increase.

Some stakeholders may experience harm from this project. For example, if the City chooses to use TIF funding (see Financing), City residents may see an increase in their tax bill. The chargers could also have unforeseen expenses or maintenance costs which could put a strain on the City budget and resources. Lastly, some of the potential sites of the project are located in areas where it is currently not permitted for residents to bike. The installation of the chargers could encourage illegal biking in these pedestrian areas, and as a result, could make the area more unsafe for pedestrians.

We plan to investigate all of these factors further by continuing to speak to our sponsor Tad, City Council members, Lebanon Pedestrian Bicycle Advisory members, Lebanon Energy Advisory Committee members, Omer & Bob's, and potentially the fire department. By speaking with these stakeholders we will be better able to understand the context surrounding our project and also hopefully learn about additional unintended harms that we have not yet considered. We also plan to create a survey which will help us learn more about community members' concerns surrounding the project (see Appendix 5).

Approach and Methodology

Ultimately, our plans may vary depending on input from the City of Lebanon. While many aspects of the project are still undecided, such as where the chargers will be sited, whether our team will be designing entirely new chargers or using off the shelf chargers, and where funding will come from for the project, we plan to move forward by providing recommendations. We will apply engineering science in this project through our design of the charging stations. Even if we choose an off the shelf charger and do not have to incorporate additional components such as a payment system, we will have to analyze the components of charging stations on the market to ascertain which will best meet the needs of the City of Lebanon. In addition, we will have to determine whether the necessary electrical infrastructure is in place at the location of each charging station, and make sure that all electrical components are safe and compatible with one another.

The largest technical risk of the project is the risk of fire inherent in handling and charging lithium-ion batteries. There is no standardization among electric bike chargers and batteries, and some e-bikes may carry batteries that are not up to safety standards and prevent real fire risks, as indicated by the 130 fires started by e-bikes just in New York City in 2022. Given that in 2019 there were only 13 battery fires, this dramatic increase has been attributed to poor charging practices (charging beyond full battery and continued use of damaged batteries), and purchase of off-brand models that have not been properly tested. We plan to lower this risk by shutting off charging after a set amount of time, having a sensor to detect fires, and making it so that e-bikes and their batteries can be easily removed by firefighters. In addition, we will want to consider whether to restrict charging to recognized brands, and how such an action could be carried out. It is also worth noting that these fires occurred among the 237,500 electric bikes in New York City in 2022, resulting in an estimated one fire per 1,826 e-bikes, meaning the risk is relatively small given that the maximum charging capacity for all racks in Lebanon will be 20 e-bikes.

For this project, any experiments we conduct will be related to prototyping of the charging station. Designing a prototype of a charging station would involve creating electrical schematics and mechanical mock-ups before moving into construction of a prototype. We would want to ensure that, due to the variations in voltage draws of e-bike batteries, that charging stations could be safely used for charging by the vast majority of e-bike users in Lebanon, and that features such as fire detection, payment collection, locking mechanisms, and charging shutoff are functional.We would also want to test the safety and functionality of these charging stations in the types of inclement weather conditions (hot sun, rain, snow, salt, high winds) that are very common in New Hampshire. Once we have determined whether we will design our own charger or not, we will move forward with a more detailed planning process for both prototyping and experimentation.

For this project, our primary source for statistical analysis would be the survey we plan to distribute to city residents to inform our decisions around the charger. We plan to use the methods we are currently learning in Engs 93, which three of us are taking this term. We may also perform optimization analysis to determine the best chargers to suit our needs for this project.

While we have conducted preliminary research on similar projects in other locations, we will conduct in-depth analyses on these projects and their success (or lack thereof). In addition, we will have had far more communication with the City of Lebanon, which will enable us to have a narrower scope for this project, which will in turn make a feasibility study far more accurate. In addition, we plan to have a clearer understanding of how the e-bike charging stations will be funded, which will likewise give us a better picture of the feasibility of this project. Determining feasibility will include factoring in all of these variables, as well as looking back on the progress we have made this term.

Project Management

Each team member brings unique experience and expertise to this project, and together we have the tools necessary to be successful. In terms of safety training, three team members have taken Digital Electronics (Engs 31) and all team members have taken Introduction to Engineering (Engs 21), which required electrical safety training and machine shop safety training, respectively. These together should constitute the safety training required for this project. The one team member who had not taken the electrical safety training previously completed it this term. More information by individual is outlined in the following paragraphs.

Avery is an electrical engineering major who is specializing in power electronics. She has internship experience in the aerospace industry where she worked on the wiring of planes. In addition, she has energy system modeling research experience. Lastly, she also worked on a theoretical solar siting project with Grace. Avery is the electrical lead for the project.

Grace is concentrating in Energy Engineering, although she has taken significant electrical engineering coursework such as Digital Electronics, Linear Circuits, and Power Electronics. She and Avery have previously worked on a theoretical solar siting project, which involved learning a great deal about energy systems in this region of New Hampshire. This exercise taught them about the research necessary for any siting project and how to adapt research on general practices to specific locations. Grace will be able to assist Avery with the work related to electronics, as well as work on ensuring compatibility between the various electrical components of the project. As is the case for everyone working on the project, she will also work on outreach and communication with the City of Lebanon and other interested parties. Grace is the team treasurer and has extensive experience with Purchase Cards.

Nathan is the resident Mechanical Engineering major, with multiple years in industry settings designing mechanisms in Solidworks, fabricating custom components, and even doing some MIG and TIG welding. He has also taken reading courses in Electrical Engineering and did an power electronics internship with a lighting controls company. Finally, he is engaging with public policy through a Rockefeller Center fellowship this year, and developing know-how in the case that the team and sponsors want to approach what could be a difficult lobbying process to expand the EV charging infrastructure provision of the IRA.

Gannon is an electrical engineering major who is interested in energy and sustainability. He has taken classes in signal processing, power electronics, energy systems and economics. He will be able to assist with economic analysis of the design and will handle electrical design along with Avery and Grace. Gannon is also managing the survey administration to determine e-bike usage in the Upper Valley region.

Given our collective experiences, one gap of knowledge stands out above the rest: we lack exposure to any civil engineering. This would include expertise on issues such as safety, zoning and construction. Fortunately, we have resources in the City of Lebanon, such as the City electrician. At a group meeting with relevant City officials, we were informed that such experts will be responsible for most safety, zoning, and compatibility with infrastructure issues, as any public project must meet a high standard. We also have civil engineering resources at Dartmouth, as our faculty advisor, Vicki May, is a civil engineer, and Dave McDevitt at Thayer is a licensed electrician. In addition, we need to fill in gaps in our knowledge on Lebanon specifically, as the City has specific policies to which we must adhere. We plan to do so by collaborating closely with the City and being proactive about updating them with any concerns or changes to our plans.

Appendix

Appendix 1: Primary Project Deliverable Options

Primary Design Options	**Buy an outlet charger**	**Design an outlet charger**	**Design a charger with different connectors**
Description	An off the shelf charger could be purchased that the City of Lebanon could install. The charger would have a place to lock the bike and an outlet for the user's charger.	We could design a charger that would give users a place to lock their bike and an outlet.	A charger could be created that has different connectors, so a user can plug their battery into the connector that fits their battery.
Benefits	This option would be the most technically simple option and it is likely to be very reliable.	We could optimize the charger to the City's needs.	This option would be the most useful to e-bike users as they would not have to bring their charger with them
Drawbacks	Users would still have to bring their charger with them, which is inconvenient. The off the shelf solutions may not be optimized for the City (e.g. may not be weatherproof)	It will be more technically difficult to design a charger rather than purchasing one.	Potentially more technically difficult to design a charger with different connectors compared to an outlet charger.. The provided connectors may not work for every e-bike.
Additional Information			
Installation Cost ($)	$11,000[1]	<$8,000	<$10,000
Monthly Cost/upkeep ($)	Unknown	Unknown	Unknown
Safety (1-3)[2]	3	3	2
Charging Versatility (1-3)[3]	3	3	2
Ease of use (1-3)	1	1	3
Technical Feasibility (1-3)	3	2	2

[1] Calculated based on cost of four $1,500 chargers plus construction costs
[2] 1 is the worst, 3 is the best
[3] Charging versatility is the proportion of e-bikes that can be charged using the product

Appendix 2: Secondary Project Deliverable Options: Solar

Solar Options	**Solar Included**		**Solar not included**
Project Options	Solar with battery storage (not connected to the grid).	Solar connected to the grid.	Project is only connected to the electrical grid.
Description	A solar panel and battery would be connected to the charger. The charger would not be reliant on the grid.	A solar panel would be connected to the charger. The charger would also be connected to the grid, for when the sun is not shining.	The charger would be connected to the electrical grid.
Benefits	The charger would be self-sufficient and would supply its own electricity needs. The charger would use 100% renewable energy and could encourage residents to use renewable energy.	The charger would produce some of its electricity using solar power. The charger could encourage residents to use renewable energy.	Connecting the charger to the grid would be the cheapest option and likely the easiest to implement technically.
Drawbacks	Adding solar and battery storage would be the most expensive option. The solar panel will produce more electricity than needed.	Would be a more expensive option than just connecting the charger to the grid. Would still be reliant on the grid.	The charger would not run on majority renewable energy. The charger would not encourage residents to use renewable energy.
Additional Information			
Added Installation Cost ($800)	$1360	$800	$0
Added Monthly Cost/upkeep	None[1]	None	None
Environmental impact (1-3)	3	2	1
Community impact (1-3)	3	3	1

Appendix 3: Secondary Project Deliverable Options: Payment Systems

Payment Options	**Payment System included**			**Payment system not included**
Subcategories	**Coin or card operated metering system**	**Parking meter style payment system**	**Honor system payment style**	**The electricity for the charger would be provided for free to the user.**

Description	A coin or card operated metering system would be installed. Users would use coins to pay for a certain amount of charging time, and when payment is not received the charger will not work. Plugzio is a current market option that the City could buy.	A parking meter-style payment system would be included. Users pay for a set amount of time to charge and the meter will be green. When there is no payment the meter will be red.	Payment is on the honor systems. Users are asked to pay a fee with a card or coins everytime they use the charger. One option is to use a Square QR code which is free to the City. (There's a 3%+30 cent cost to the user) ("QR Code Payments and Ordering")	Users could charge their bike without paying a fee.
Benefits	This option would collect payment for the City which could cover both electricity and maintenance costs. This option is the best way to ensure that payment is collected for each use [4]	This option would collect payment for the City which could cover both electricity and maintenance costs. This option will be technically easier than installing a card or coin operated metering system.	This option would collect payment for the City which could cover both electricity and maintenance costs. This option is likely the easiest and cheapest way to implement a payment system.	It will be cheaper to provide the electricity for free than to install a payment system to recoup the electricity costs. It will be easier to design and install the charger. There will be fewer maintenance needs as there is one fewer technical component of the project.
Drawbacks	This option will be one of the most expensive options. This option is also likely to have more maintenance/reliability issues compared to other options as there are additional technical components.	There is an added cost to installing this charger which will be more expensive than providing the electricity for free. Unless there is police enforcement of the charger, users could take advantage of the charger and use it without paying.	There is an added cost to installing this charger which will be more expensive than providing the electricity for free. Users may take advantage of the honor system and not pay.	If the project is tax-payer funded, residents of Lebanon will pay for something they may not use.
Additional Information				
Added Installation Cost	$400[5]	$400	$0	$0
Added Monthly Cost/upkeep	$16	Unknown	$0	$0
Added Cost to User	$2	$2	$2.5	$0

[4] Solar panels and batteries routinely come with extended warranties (~25 years)
[5] Value calculated by Tad Montgomery

Appendix 4: Specifications Table

Requirement	**Specification**	**Justification**
Number of charging slots	We must build a charging station that meets the demand for charging in Lebanon, NH [4 slots] informed by survey data	If a charger is built that doesn't have enough charging slots, not enough users will be able to use it. If it is too big then it will not be cost effective
Charging Versatility	The product must be able to charge a variety of different e-bike batteries that use different voltages and connectors. Specifically, the charger should work for [>90%] of e-bike models.	If the charger is not versatile only a limited number of e-bike users will be able to charge their bikes.
Safety	Charger will automatically shut off after [6 hours] in order to mitigate potential fire risks	We want to make sure the risk of injury and death are negligible. Additionally, we will put sufficient space between the chargers so the Fire Department can easily put out a possible fire
Cost Effectiveness	We must build a cost-effective charger as we will have to rely on grant or TIF funding: [<$10,000] total installation cost	Unless the charger we design than current market options the city will not be able to afford to install it
Security	We will include a way for users to securely lock their bikes [negligible chance of theft]	E-bikes could be stolen from the chargers if they are not locked
Environmental Impact	Our design will have [minimal or positive] impact on the surrounding environment, and derive [>50%] of its electricity from renewable sources	The purpose of this project is to promote and encourage electric bike usage as an alternative to cars, and should in practice support the goal of lowering negative human impact on the environment.
Community Impact	Our design will have [minimal or positive] impact on the surrounding community	This project aims to promote usage of electric bikes, which has the potential to result in the positive human impact seen in non-car reliant societies. We hope to foster this potential for connection in our project design.

Appendix 5: Draft E-Bike Usage Survey

General Information

What city are you from?

Do you own a bike or e-bike?

How long do you spend commuting/in transit each day?

What modes of transportation do you use?

For bike owners:

Bike Usage

How often do you use your e-bike?
How often do you use your e-bike compared to a self-powered bike?
What do you use your e-bike for?
What seasons and weather conditions do you feel comfortable using your bike in?
How would you describe e-bike usage in Lebanon and the UV? Do you know others who use e-bikes?

Charger Usage

Do you bring your e-bike charger with you?
How and when do you charge your e-bike?
How long does it take to charge your bike?
What model of e-bike do you use?
Would you use an e-bike charging station to recharge your bike in downtown Lebanon?
What scenarios would you use this charging station in? (e.g., while at work)
Where in the City would a charger like this be most useful?

Safety Considerations

Have you ever had problems with battery and electrical issues?
Have you ever had problems with bike vandalism and theft in Lebanon?
How do you store your bike? Would you be interested in public, secured bike storage in a location near the Lebanon mall?

For non-bike owners:

Do you see yourself purchasing and using a bike or e-bike in the near future?
What would need to change for you to purchase an e-bike?

Payment System

Would you pay for usage of a public e-bike charging station in downtown Lebanon?
What would be your suggested price for a full battery recharge?
What would be the most convenient way to pay for this service?
Would you support funding this charging station with a marginal tax increase to residents in the immediate area?

Principles

- None/few of these questions should have open-ended answers. We want quantitative data.
- We need to think about where and how to administer this survey to ensure it is representative of the general population. We have reached out to three community governance groups for advice on this.
- We need to determine how to extrapolate data about e-bike usage from our responses. Reach out to companies (e.g. Omer and Bob's, e-bike manufacturers) about demand growth to help

Appendix 6: Electricity Cost Calculations

(From Tad's E-Bike Charging Station Memo to the City of Lebanon)

Cost of Charging: E-Bike batteries range in capacity from 200 Wh to 1 kWh, and the average battery is about 600 Wh. Assuming the average rider using a City EBCS charge port needs a charge in order to complete a trip 2 , that would mean the battery is fairly empty, say at 20% charge. This implies that 480 Wh is needed to fill an average battery backup. At 22.5 cents per kWh, this is 11.25 cents of electricity. Two charges per day per EBCS is a conservative estimate for the first year after these EBCS are installed. <u>This implies 120 charges per month x $0.1125 would be $13.50 per month for electricity.</u>

Installing a system to charge a fee for e-bike charging might be $400-600 per EBCS and also have a monthly interconnection fee if the system is on a network (see Plugzio below). Other options for getting City electricity costs for this program reimbursed are accepting donations with an easy way for users to make small donations close to the EBCS, and/or offering EBCS sponsorships to local businesses as advertising. Below is a conservative estimate of the annual electricity cost to the City of operating these EBCS based on the assumptions in bullets:

- 4 charges per day for all three EBCS in Year 1
- Battery size ranges from 0.2 kWh to 1.0 kWh, with an average charge of 0.6 kW
- Usage doubles in year 2, triples in year 3
- Electricity current cost of $0.225/kWh (CPCNH's Clean 100) with annual inflation rate of 5%
    - Year 1 cost: 365 x 4 x 0.6 x $0.225 = $197.00
    - Year 2 cost: 365 x 8 x 0.6 x $0.225 x 1.05: = $413.00
    - Year 3 cost: 365 x 12 x 0.6 x $0.225 x 1.05 x 1.05 = $652.00

These are conservative estimates. The usage and cost could be much less than this at the start but grow higher over time.

Appendix 7: Preliminary Solar Panel Sizing Calculation

Assuming an average charge of .6 kW and all four chargers being used at once.
0.6kW *4 = 2400 Watts Solar
2400/5 hours per charge = 480W

As solar panels are often not efficient on cloudy days I am assuming that the panel must be significantly bigger **= 750 W**
Estimated cost of a 750 W solar panel = $800 ("750W Solar Panel Kit.")
Estimated cost of battery storage:
$400/kWh to $750/kWh. 750*0.75 =$562.5 (Bennett)

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2025-2030 Capital Improvement Program

PROJECT REQUEST FORM #1

1. **DEPARTMENT:** Public Works

2. **PROJECT TITLE & NUMBER:** Sachem Village to DHMC Connector Road and Multi-Use Path

3. **PURPOSE OF PROJECT REQUEST FORM:** New Project

4. **DEPARTMENT PRIORITY:** Improve Efficiency for Emergency Vehicles and Buses and ped/bike connection

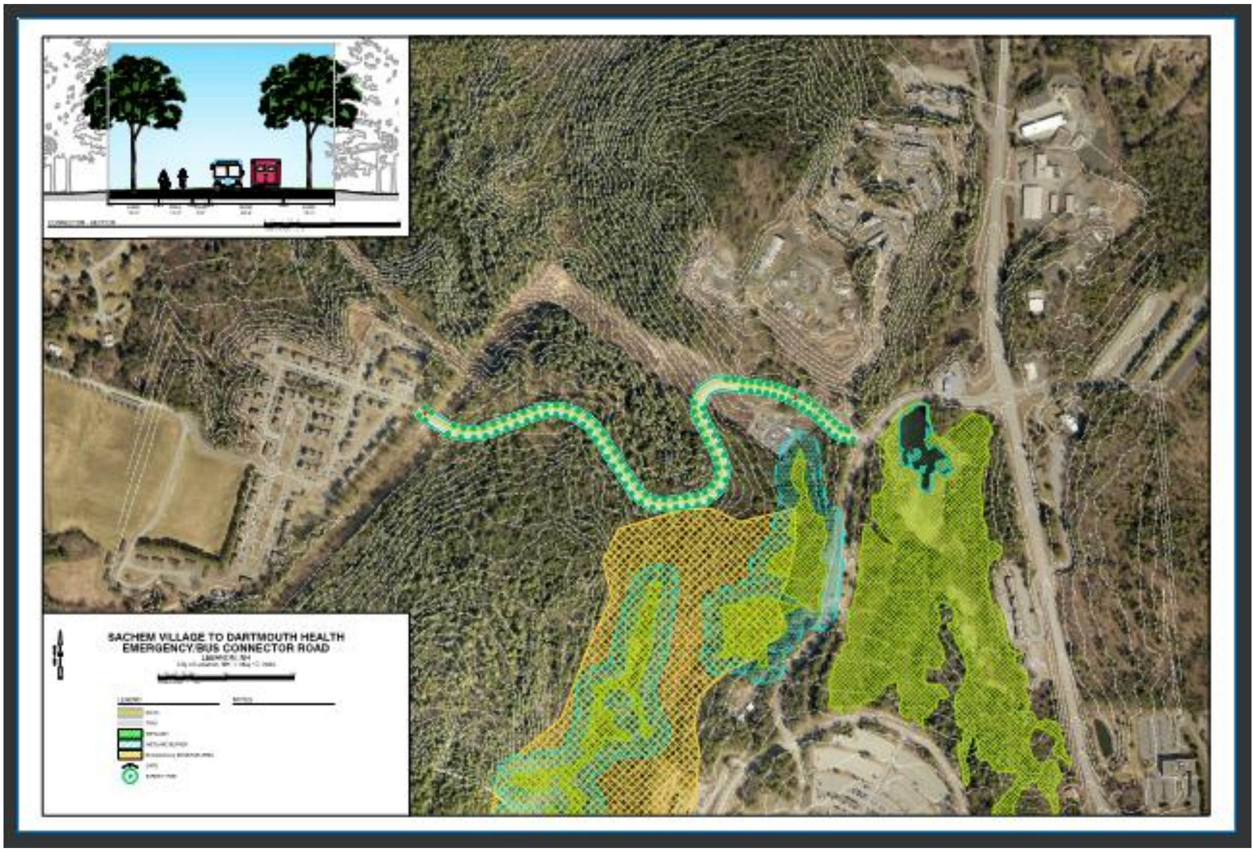
5. **LOCATION:** Ralston Lane to Gile Drive

6. PROJECT DESCRIPTION/JUSTIFICATION: The Sachem Village to Dartmouth Hitchcock Medical Center (DHMC) Emergency/Bus Connector Road and Multi-use Path project will consist of a 22' wide roadway for community buses and emergency vehicles and a 10' wide multi-use path for pedestrians and bicycles. The project will provide an important connection from northern West Lebanon and Hanover (Route 10) to Medical Center Drive (Route 120). The connection will improve efficiency and travel times for buses, fire trucks, ambulances, and other emergency vehicles. The multi-use path will allow pedestrians to walk or bike from the Route 10 side of town to the Route 120 employment center area. The multi-use path will intersect with multiple trails traversing Indian Ridge and the Boston Lot Conservation Area.

The main challenges are related to the environment and land use. The roadway will cross over Dartmouth College and DHMC property, an active transmission line corridor, and a conservation easement. The roadway alignment necessitates a stream crossing which will require an open bottom span structure. The roadway is proposed to cross steep slopes, approaching the maximum allowable roadway grade, and will require significant stormwater management efforts. The roadway layout will avoid impacts to high value wetlands and ecologically sensitive areas (shown cross-hatched in the graphic below).

The City is pursuing funding from the Congestion Mitigation and Air Quality (CMAQ) Improvement Program administered through the Federal Highway Administration. The CMAQ program would pay for 80% of the project cost and the City would be responsible for the remaining 20%. The City will be establishing a Special Assessment District to account for the remaining 20%. The project is programmed for construction in 2031.

2025-2030 Capital Improvement Program



City of Lebanon, New Hampshire
APPLICATION FOR CONDITIONAL USE PERMIT
SUPPORT STATEMENT

Office Use Only	Date Received: ____________	Application No.: ____________

I. APPLICATION CHECKLIST

- *Application form*
- *Public Hearing Notification List*
- *Filing fee*
- *This form, including written responses to the Section 302.4.D requirements, outlined below*
- *A site plan*
- *Optional: photos and any other materials in support of your application*

II. PROJECT DESCRIPTION

I (we) hereby request a Conditional Use Permit as provided for in Article(s) III, Section(s) 308.4, of the Lebanon Zoning Ordinance.

Please describe your proposed project with as much detail as possible. You can respond in the space provided below or on a separate sheet of paper.

The Project proposes the construction of a 474-unit multi-family development totaling approximately 440,054 SF, with 14 total buildings. Parking, landscaping, access, utilities, and other site improvements are proposed as part of the Project. This CUP is requested only for the buildings in the R-1 zone, as buildings within R-0-1 will be 45' maximum in compliance with that zone.

III. CONDITIONAL USE PERMIT CRITERIA

In order to obtain a Conditional Use Permit, you must demonstrate to the Planning Board that the proposal satisfies the applicable criteria set forth in Sections A and B below. You must address each criteria in the space provided or on a separate sheet of paper.

A. Specific Criteria

The Conditional Use Permit is authorized by Article V, Section 501.1.B of the Zoning Ordinance which requires the applicant to demonstrate that (*please address any criteria set forth in the Zoning Ordinance that specifically apply to your proposed use or project)*:

The Project is submitting a site plan application for the development as a Planned Unit Residential Development (PURD). To minimize paved area on-site and provide covered parking for residents, the proposed apartment building designs include parking below the buildings. Pursuant to Zoning Ordinance Article III, Section 308.4, a CUP is required in support of building heights up to 55' with parking below in the R-1 zone.

B. General Criteria per Section 302.4.D

A conditional use permit shall be granted only if the Planning Board determines that the proposal conforms to all of the following standards:

1. The site is suitable for the proposal. This includes:

   a. Adequate vehicular and pedestrian access for the intended use.

The Project proposes two driveway and sidewalk connections to Hanover St. providing full circulation through the development. Additional sidewalks and walking paths are also proposed as resident amenities.

   b. The availability of adequate public services to serve the intended use including emergency services, pedestrian facilities, safe access, and other municipal services.

Emergency vehicle access and separated sidewalks are proposed through the Site with two connections to Hanover St. Fire hydrants are proposed along the main vehicular route through the site. A fiscal impact analysis discussing municipal service and school system impacts is included with the application package.

   c. The absence of environmental constraints (floodplain, steep slope, etc.) proposed to be impacted by the intended use.

Proposed site work minimizes wetland impacts to the maximum extent practicable and is not expected to impact floodplain. The Project has been designed to work with the natural topography to minimize ground disturbance, and to utilize natural features, such as Densmore Pond, as a resident amenity, providing a walking path overlooking the pond along its length.

   d. The availability of appropriate utilities to serve the intended use including water, sewage disposal, stormwater treatment, electricity, and similar utilities.

Municipal sewer and water are available in Hanover Street, and stormwater treatment is being provided via infiltration and detention systems in various areas across the Site. Electric and other telecommunication services are available in Hanover Street. Capacities of each utility will be confirmed through the design phase of the Project.

2. External impacts: The external impacts of the proposed use on abutting properties and the neighborhood shall be commensurate with the impacts of adjacent existing uses or other uses permitted in the zoning district. This shall include, but not be limited to, water runoff, drainage, traffic, noise, odors, vibrations, dust, fumes, hours of operation, and exterior lighting and glare. In addition, the location, nature, design, and height of the structure and its appurtenances, its scale with reference to its surroundings, and the nature and intensity of the use, shall not have an adverse effect on the surrounding environment nor discourage the appropriate and orderly development and use of land and buildings in the neighborhood. The proportion of the site proposed to be occupied by impervious surfaces shall be minimized to the extent necessary to preclude unreasonable risk of runoff, erosion, sedimentation, and other potentially adverse on-site or off-site effects.

The Project has taken measures to minimize impacts to abutting properties and the predominately residential neighborhood. PURDs are an allowed use in each zoning district the Site lies within, and multifamily developments are an allowed use in the districts where the apartment buildings are proposed. Stormwater runoff quality and quantity shall be maintained or improved. The redevelopment of the Site will be an improvement over the existing vacant, deteriorating remnants of the Densmore Brickyard that presents a public safety hazard and visually detracts from the area. Landscaping and architectural design will result in a pleasing and complimentary aesthetic across the currently derelict parcel. Mainly tucked away from the public road, the buildings' scale will be less noticeable and is also consistent with similar developments along the nearby Route 120 corridor. Construction impacts (dust, fumes, traffic) will be limited to the max. extent practicable and subject to US EPA sedimentation/dust control requirements.

3. <u>Character of the site development</u>: The proposed layout and design of the site shall not be incompatible with the established character of the neighborhood and shall mitigate any external impacts on abutters, the neighborhood, and nearby public ways and infrastructure. This shall include, but not be limited to, the relationship of the building(s) to the street, the amount, location, and screening of off-street parking, the treatment of yards and setbacks, the buffering of adjacent properties, and provisions for vehicular and pedestrian access to and within the site.

The largest proposed structures are located well beyond the required building setbacks, and landscape screening is proposed to address undesirable views. The vast majority of parking will not be visible to abutters, due to distance, vegetative screening, and positioning below the podium construction buildings in additionally screened parking areas. Vehicle and pedestrian access to/from the site will be provided at two driveway connections at Hanover Street that provide continual access across the Site.

4. <u>Character of the buildings and structures</u>: The design of any new buildings or structures and the modification of existing buildings or structures on the site shall not be incompatible with the established character of the neighborhood. This shall include, but not be limited to, the scale, height, and massing of the building or structure, the roof line, locations of access, and visual compatibility with the area.

The design of the new buildings is intended to be similar to other multi-family developments that have been recently built along the Mt. Support Road corridor. The Site also intends to utilize the existing features like Densmore Pond and the existing brick kilns to enhance the site. The heights of the buildings are a maximum of 45' and 55' above grade, as permitted by zoning district in the Zoning Ordinance.

5. <u>Preservation of natural, cultural, historic, and scenic resources</u>: The proposed use and layout of the site, including all related development activities, shall to the greatest extent practicable preserve identified natural, cultural, historic, and scenic resources on the site and shall not degrade such identified resources on abutting properties. This shall include, but not be limited to, identified wetlands, floodplains, significant wildlife habitat and documented wildlife corridors, stonewalls, mature tree lines, identified historic buildings or sites, scenic views, and viewsheds.

The Project has minimized wetland impacts by crossing at the narrowest locations practicable, and aims to maintain and utilize existing elements on-site to enhance the resident's experience. Some of the existing brick kilns will be maintained and multiple patios with overlooks of Densmore Pond are proposed. The elevation of the development provides desirable view corridors from the overlooks into the valley to the east. Cultural and historic resource assessment will be performed prior to ground disturbing activity on-site.

October 25, 2024

Ref: 52933.00

Tim Corwin
Deputy Planning and Development Director
City of Lebanon
51 North Park Street
Lebanon, NH 03766

Re: Trip-Generation Letter
Lebanon Brickyard Residential Development
Hanover Street, Lebanon, New Hampshire

Dear Tim:

VHB prepared and submitted an August 2024 Traffic Impact Study for the proposed Lebanon Brickyard residential development to be located along the west side of Hanover Street in Lebanon, New Hampshire. At that time, the development program consisted of constructing 474 apartment units in 10 four-story buildings. During the local permitting process, the development program has changed to consist of 474 multifamily units to include 422 apartment units, 51 townhouse units, and 1 residential unit for the property caretaker within the maintenance building. VHB has prepared this letter to summarize the trip-generation estimates for the revised build program and provide a comparison to the site trips estimated within the Traffic Impact Study. In summary, the additional trips to be generated by the current development would generally result in the same intersection operational results as those documented within the August 2024 Traffic Impact Study.

Trip Generation Methodology

To estimate the volume of traffic to be generated by the proposed project, trip rates that are published in the Institute of Transportation Engineers (ITE) Trip Generation Manual[1] were reviewed. The site trips were estimated using ITE Land Use Code 221: Multifamily Housing (Mid-Rise) for 301 apartment units (4-10 residential floors), ITE Land Use Code 220: Multifamily Housing (Low-Rise) for 121 apartment units (2-3 residential floors), and ITE Land Use Code 220: Multifamily Housing (Low-Rise) for 51 townhouse units (2-3 residential floors). The property caretaker is not anticipated to generate vehicle trips to and from the site during the peak time periods (i.e., these trips would occur off-peak). Table 1 summarizes the peak hour trip-generation estimates of the proposed development. In addition, Table 1 includes a trip comparison to those estimates evaluated within the August 2024 Traffic Impact Study. The trip-generation calculations are attached to this letter. These site trips may be higher than anticipated as residents may use the other modes of available transportation rather than personal vehicles (e.g., Advance Transit, Upper Valley Loop Trail, and pedestrian bridge over I-89).

1 Institute of Transportation Engineers. Trip Generation Manual, 11th ed. Washington, DC, Sept. 2021.

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Table 1 Trip-Generation Summary

Peak Hour/Direction	Mid-Rise Multifamily Trips [a]	Low-Rise Multifamily Trips [b]	Total Proposed Trips [c]	Traffic Study Trips [d]	Additional Trips [e]
Weekday AM					
Enter	28	18	46	45	1
Exit	93	58	151	152	(1)
Total	121	76	197	197	0
Weekday PM					
Enter	72	60	132	113	19
Exit	46	35	81	72	9
Total	118	95	213	185	28
Saturday Midday					
Enter	62	36	98	97	1
Exit	59	35	94	93	1
Total	121	71	192	190	2

a ITE Land Use Code 221: Multifamily Housing (Mid-Rise) for 301 units.
b ITE Land Use Code 220: Multifamily Housing (Low-Rise) for 172 units (121 apartment units and 51 townhouse units).
c Mid-Rise Multifamily Trips plus Low-Rise Multifamily Trips.
d ITE Land Use Code 221: Multifamily Housing (Mid-Rise) for 474 units.
e Traffic Study Trips minus Total Proposed Trips.

In comparison to the project evaluated within the Traffic Impact Study, the proposed development program is estimated to result in the same total trips during the weekday AM peak hour, 28 additional vehicle trips (19 entering and 9 exiting) during the weekday PM peak hour, and 2 additional vehicle trips (1 entering and 1 exiting) during the Saturday midday peak hour. Based on ITE methodologies[2] and New Hampshire Department of Transportation (NHDOT) guidance,[3] a development may result in a change in vehicular operations (i.e., noticeably drop level of service or increase volume-to-capacity ratios) if the addition of site trips would increase peak hour traffic volumes at an intersection by 100 vehicles or more. In general, traffic increases less than this threshold could be attributed to the fluctuation of vehicles due to driver patterns that occur during the day, on different days of the week, or different months of the year. As shown in Table 1, the additional trips to be generated by the proposed build program would generally result in the same intersection operational results documented within the August 2024 Traffic Impact Study.

Sincerely,

VHB

Jason R. Plourde

Jason R. Plourde, PE, PTP
Transportation Systems Team Leader

Attachments

2 ITE Recommended Practice: Multimodal Transportation Impact Analysis for Site Development. Washington, DC: Institute of Transportation Engineers. 2023.

3 Bollinger, Robert E. Inter-Department Communication. New Hampshire Department of Transportation, Bureau of Traffic. 17 Feb. 2010.

Attachments

Trip-Generation Calculations

ITE TRIP GENERATION WORKSHEET
(11th Edition, Updated 2021)

LANDUSE: Multifamily Housing (Mid-Rise) - Not Close to Rail Transit: *4-10 stories*
LANDUSE CODE: 221 Independent Variable --- Number of Dwelling Units
SETTING/LOCATION: General Urban/Suburban
JOB NAME: 301 dwelling units
JOB NUMBER:

WEEKDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Total Trip Ends Low	Total Trip Ends High	Independent Variable Range Average	Independent Variable Range Low	Independent Variable Range High	Directional Distribution Enter	Directional Distribution Exit
DAILY	11	0.93	4.54	3.76	5.40	201	60	330	50%	50%
AM PEAK OF GENERATOR	23	0.89	0.35	0.13	0.53	226	21	1,168	26%	74%
PM PEAK OF GENERATOR	22	0.93	0.39	0.19	0.60	221	21	1,168	60%	40%
AM PEAK (ADJACENT ST)	30	0.91	0.37	0.15	0.53	173	26	490	23%	77%
PM PEAK (ADJACENT ST)	31	0.91	0.39	0.19	0.57	169	26	490	61%	39%

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	1,368	684	684	1,390	695	695
AM PEAK OF GENERATOR	105	27	78	102	27	76
PM PEAK OF GENERATOR	117	70	47	112	67	45
AM PEAK (ADJACENT ST)	111	26	86	121	28	93
PM PEAK (ADJACENT ST)	117	72	46	118	72	46

SATURDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Total Trip Ends Low	Total Trip Ends High	Independent Variable Range Average	Independent Variable Range Low	Independent Variable Range High	Directional Distribution Enter	Directional Distribution Exit
DAILY	5	0.91	4.57	4.03	5.31	250	140	330	50%	50%
PEAK OF GENERATOR	5	0.92	0.39	0.34	0.43	250	140	330	51%	49%

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	1,376	688	688	1,346	673	673
PEAK OF GENERATOR	117	60	58	121	62	59

SUNDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Total Trip Ends Low	Total Trip Ends High	Independent Variable Range Average	Independent Variable Range Low	Independent Variable Range High	Directional Distribution Enter	Directional Distribution Exit
DAILY	5	0.85	3.77	3.06	4.24	250	140	330	50%	50%
PEAK OF GENERATOR	5	0.79	0.32	0.26	0.42	250	140	330	55%	45%

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	1,136	568	568	1,092	546	546
PEAK OF GENERATOR	96	53	43	94	52	42

ITE TRIP GENERATION WORKSHEET

(11th Edition, Updated 2021)

LANDUSE: Multifamily Housing (Low-Rise): *2-3 Story* - Not Close to Rail Transit
LANDUSE CODE: 220 Independent Variable --- Number of Dwelling Units
SETTING/LOCATION: General Urban/Suburban
JOB NAME: 172 dwelling units
JOB NUMBER:

WEEKDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Total Trip Ends Low	Total Trip Ends High	Independent Variable Range Average	Independent Variable Range Low	Independent Variable Range High	Directional Distribution Enter	Directional Distribution Exit
DAILY	22	0.86	6.74	2.46	12.50	229	33	494	50%	50%
AM PEAK OF GENERATOR	40	0.76	0.47	0.25	0.98	234	12	1,103	24%	76%
PM PEAK OF GENERATOR	38	0.80	0.57	0.25	1.26	231	12	1,103	62%	38%
AM PEAK (ADJACENT ST)	49	0.79	0.40	0.13	0.73	249	12	1,103	24%	76%
PM PEAK (ADJACENT ST)	59	0.84	0.51	0.08	1.04	241	12	1,103	63%	37%

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	1,160	580	580	1,178	589	589
AM PEAK OF GENERATOR	81	19	61	88	21	67
PM PEAK OF GENERATOR	98	61	37	107	66	41
AM PEAK (ADJACENT ST)	69	17	52	76	18	58
PM PEAK (ADJACENT ST)	88	55	32	95	60	35

SATURDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Total Trip Ends Low	Total Trip Ends High	Independent Variable Range Average	Independent Variable Range Low	Independent Variable Range High	Directional Distribution Enter	Directional Distribution Exit
DAILY	1	--	4.55	4.55	4.55	282	282	282	50%	50%
PEAK OF GENERATOR	1	--	0.41	0.41	0.41	282	282	282	51%	49%

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	784	392	392	--	--	--
PEAK OF GENERATOR	71	36	35	--	--	--

SUNDAY

RATES:

	# Studies	R^2	Total Trip Ends Average	Total Trip Ends Low	Total Trip Ends High	Independent Variable Range Average	Independent Variable Range Low	Independent Variable Range High	Directional Distribution Enter	Directional Distribution Exit
DAILY	1	--	3.86	3.86	3.86	282	282	282	50%	50%
PEAK OF GENERATOR	1	--	0.36	0.36	0.36	282	282	282	55%	45%

TRIPS:

	BY AVERAGE Total	BY AVERAGE Enter	BY AVERAGE Exit	BY REGRESSION Total	BY REGRESSION Enter	BY REGRESSION Exit
DAILY	664	332	332	--	--	--
PEAK OF GENERATOR	62	34	28	--	--	--

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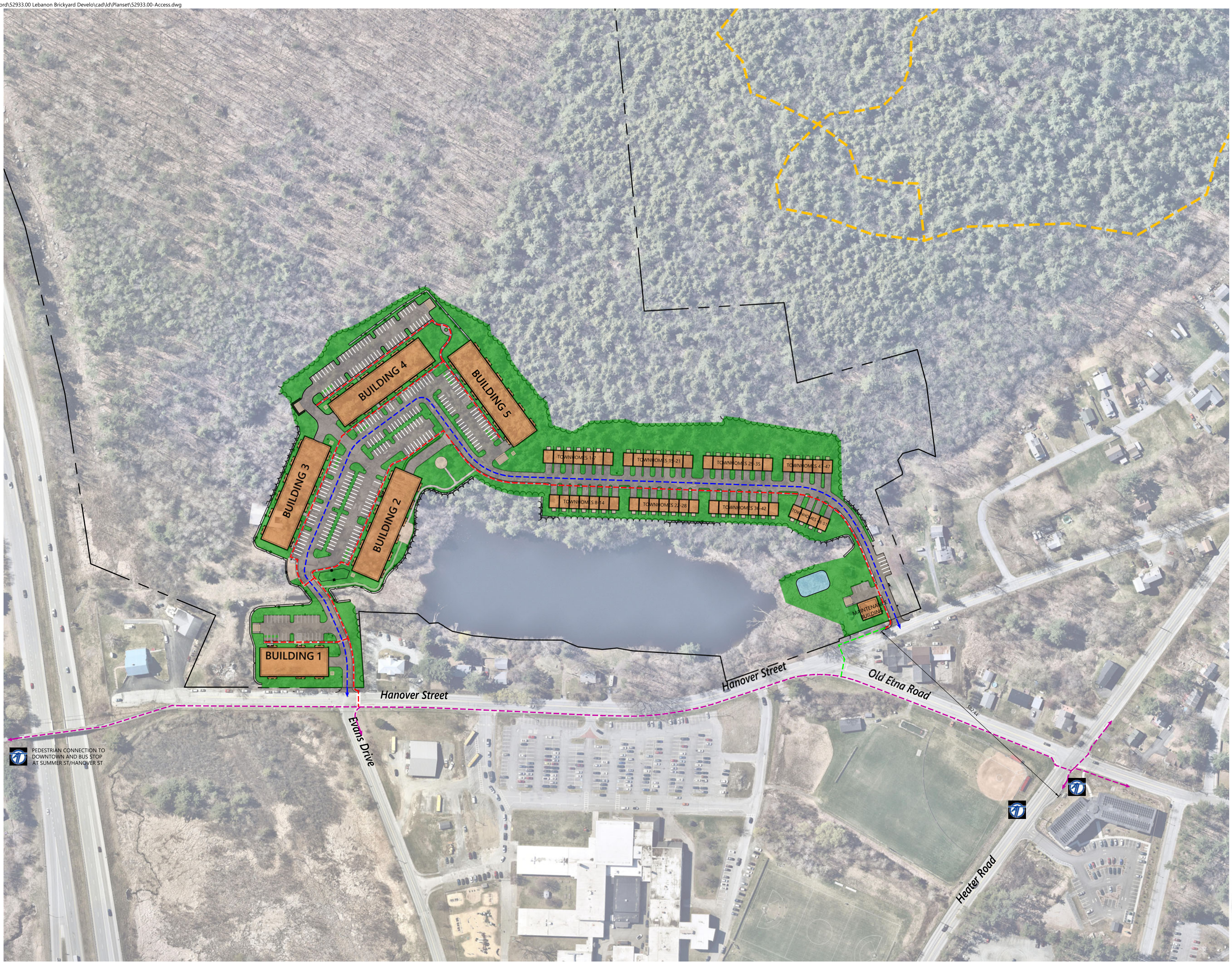

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Legend

- PEDESTRIAN PATH TO PUBLIC R.O.W.
- VEHICLE PATH TO PUBLIC R.O.W.
- EXISTING PEDESTRIAN PATHS
- UPPER VALLEY MOUNTAIN BIKE ASSOCIATION TRAILS
- POTENTIAL FUTURE PEDESTRIAN PATH

0 50 100 200Feet

The Brickyard Residential Development

174 Hanover Street Extension
Lebanon, New Hampshire 03766

No.	Revision	Date	Appvd.
1	Completeness Review Comments	07/02/24	DF
2	Response to Comments Update	08/06/24	DF
3	Revised Layout Resubmission	10/24/24	DF

Designed by TMD | Checked by MJV

Issued for: **Permitting** | Date: **May 10, 2024**

Not Approved for Construction

Drawing Title
Access and Circulation Plan

Drawing Number
C1.3

STATE OF NEW HAMPSHIRE
DAVID H. FENSTERMACHER
No. 13382
LICENSED
PROFESSIONAL ENGINEER

Sheet 4 of 50

Project Number
52933.00

Saved Friday, October 25, 2024 3:33:12 PM TDAGUIAR Plotted Friday, October 25, 2024 5:09:29 PM Derek Bosworth

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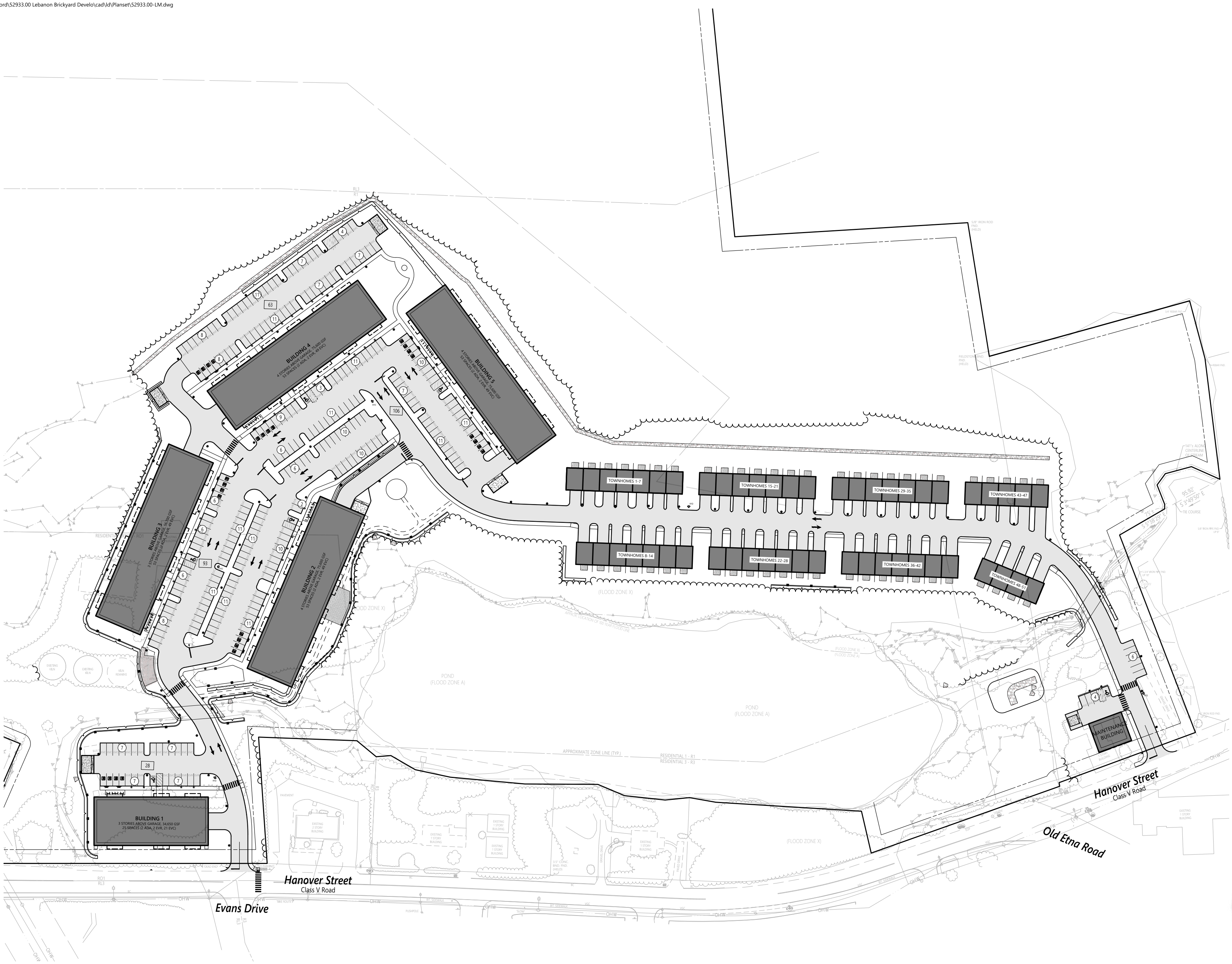

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Notes

EVC ELECTRIC VEHICLE CAPABLE PARKING SPACE

EVR ELECTRIC VEHICLE READY PARKING SPACE

0 30 60 120Feet

The Brickyard Residential Development

174 Hanover Street Extension
Lebanon, New Hampshire 03766

No.	Revision	Date	Appvd.
1	Response to Comments Update	08/06/24	DF
2	Revised Layout	10/09/2024	DF
3	Revised Layout Resubmission	10/24/24	DF

Designed by TMD — Checked by MJV

Issued for: **Permitting** — Date: May 10, 2024

Not Approved for Construction

Drawing Title
Overall Site Plan

Drawing Number
C1.4

STATE OF NEW HAMPSHIRE – DAVID H. FENSTERMACHER No. 13382 LICENSED – PROFESSIONAL ENGINEER

Sheet 5 of 50

Project Number
52933.00

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603.391.3900

Sign Summary

M.U.T.C.D. Number	Specification Width	Specification Height	Desc.
R1–1	30"	30"	STOP
R7–1	12"	18"	NO PARKING ANY TIME
R7–8	12"	18"	RESERVED PARKING
R7–8P	12"	6"	VAN
D9–11B	12"	18"	
D9–11BP	12"	12"	ELECTRIC VEHICLE CHARGING

SNOW STORAGE AREA

0 15 30 60 Feet

The Brickyard Residential Development

174 Hanover Street Extension
Lebanon, New Hampshire 03766

No.	Revision	Date	Appvd.
1	Completeness Review Comments	07/02/24	DF
2	Response to Comments Update	08/06/24	DF
3	Revised Layout Resubmission	10/24/24	DF

Designed by TMD Checked by MJV

Issued for Permitting Date May 10, 2024

Not Approved for Construction

Drawing Title
Layout and Materials Plan 1

Drawing Number
C2.1

STATE OF NEW HAMPSHIRE DAVID H. FENSTERMACHER No. 13332 LICENSED PROFESSIONAL ENGINEER

Sheet 7 of 50

Project Number 52933.00

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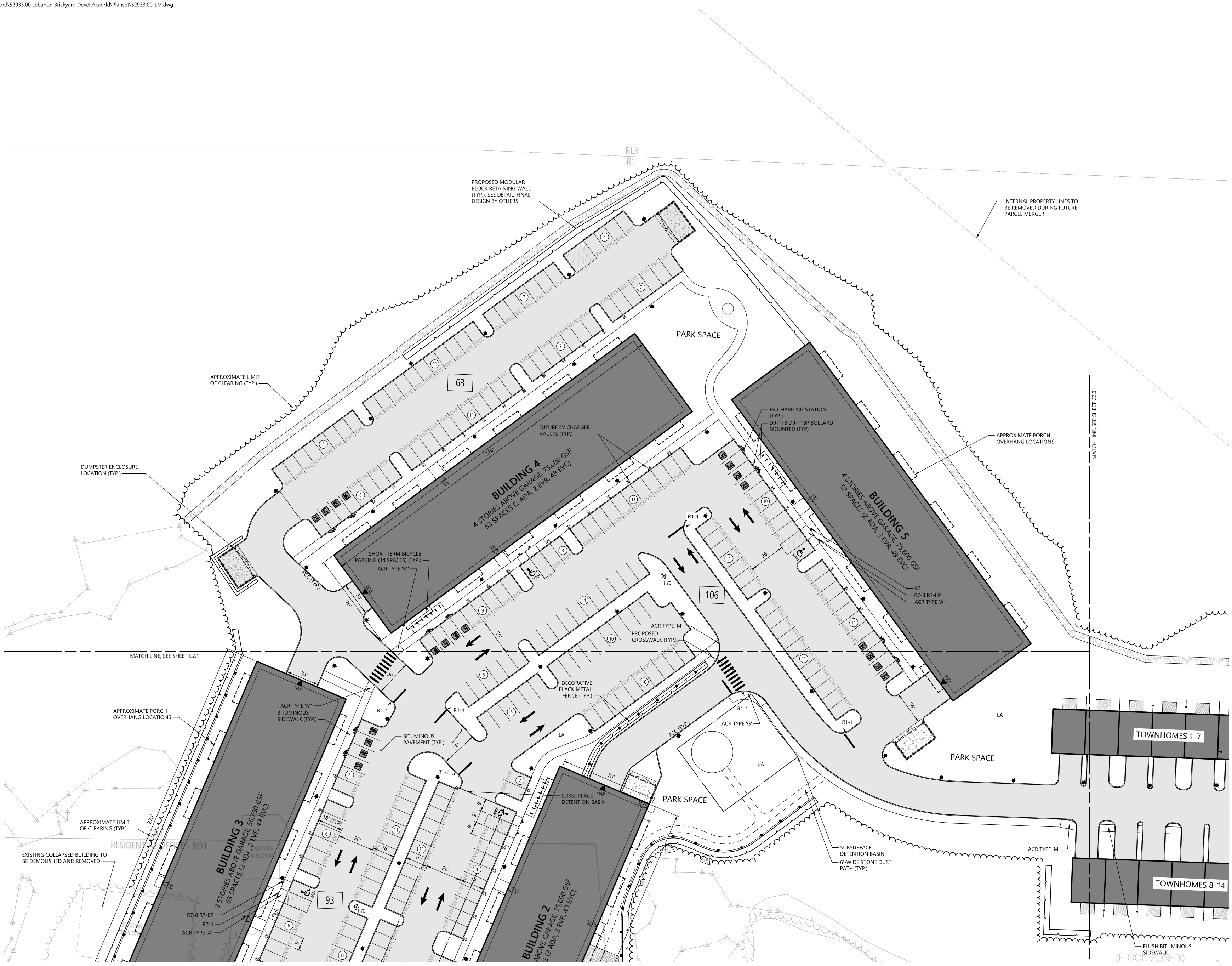

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The Brickyard Residential Development

174 Hanover Street Extension
Lebanon, New Hampshire 03766

No.	Revision	Date	Appvd.
1	Completeness Review Comments	07/02/24	DF
2	Response to Comments Update	08/06/24	DF
3	Revised Layout Resubmission	10/24/24	DF

Designed by: TMD
Checked by: MJV
Issued for: Permitting
Date: May 10, 2024

Not Approved for Construction

Drawing Title
Layout and Materials Plan 2

Drawing Number
C2.2

STATE OF NEW HAMPSHIRE
DAVID H. FENSTERMACHER
No. 13332
LICENSED
PROFESSIONAL ENGINEER

Sheet 8 of 50

Project Number
52933.00

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603.391.3900

SNOW STORAGE AREA

0 15 30 60 Feet

The Brickyard Residential Development

174 Hanover Street Extension
Lebanon, New Hampshire 03766

No.	Revision	Date	Appvd.
1	Completeness Review Comments	07/02/24	DF
2	Response to Comments Update	08/06/24	DF
3	Revised Layout Resubmission	10/24/24	DF

Designed by TMD
Checked by MJV

Issued for: Permitting
Date: May 10, 2024

Not Approved for Construction

Drawing Title
Layout and Materials Plan 3

Drawing Number
C2.3

STATE OF NEW HAMPSHIRE DAVID H. FENSTERMACHER No. 13332 LICENSED PROFESSIONAL ENGINEER

Sheet 9 of 50

Project Number
52933.00

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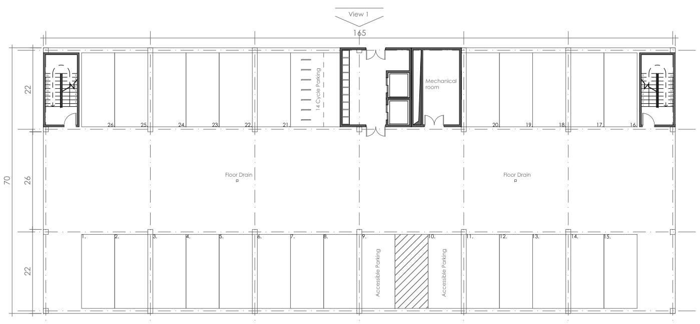
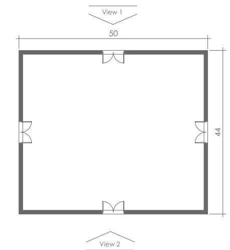
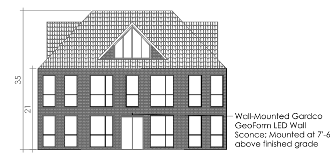


BUILDING 1 | Parking Level Plan



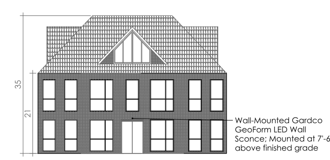
MAINTENANCE BUILDING | GROUND FLOOR PLAN

BUILDING 1 | View 1 Elevation
FACING HANOVER STREET



MAINTENANCE BUILDING | View 1 Elevation

BUILDING 1 | View 2 Elevation
SURFACE PARKING AREA



MAINTENANCE BUILDING | View 2 Elevation

NOTES

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0 12 24 36 ft
1/16" = 1'0" at original paper size

Sheet 47 of 50

REV	DESCRIPTION	DRN	DATE
P3	Submission	VT	24/08/02
P2	Submission	SS	24/08/02
P1	Submission	SS	24/05/07

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CLIENT

PROJECT
Lebanon NH

DRAWING STATUS
PLANNING

DRAWING NAME
BUILDING 1 & MAINTENANCE BUILDING
PROPOSED PLAN & ELEVATIONS

DRAWING NO. 0089-1201-P3
REV P3

DATE 24/08/02
DRAWN SS
SCALE 1/16" = 1'0" @A1
CHECKED VT

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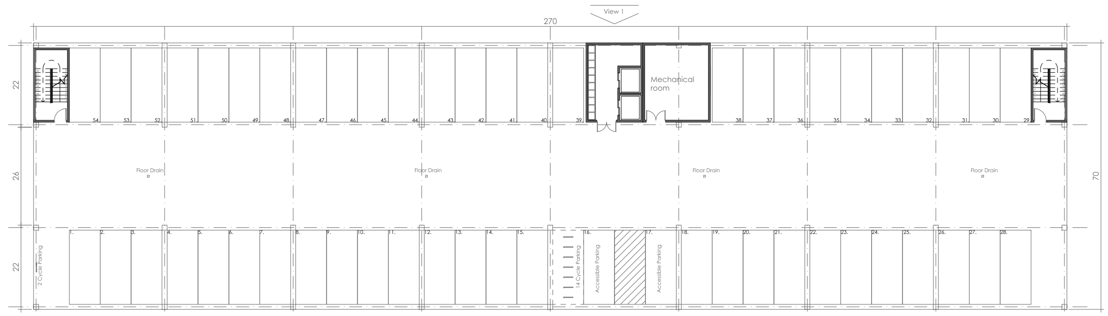
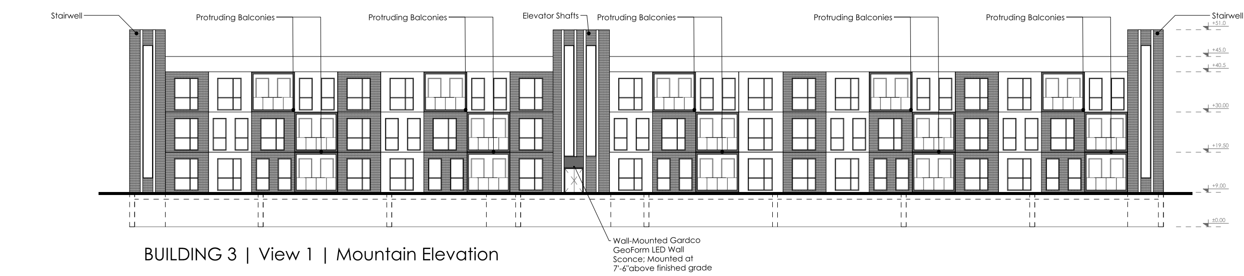


BUILDING 3 | Parking Level Plan



BUILDING 3 | View 1 | Mountain Elevation

BUILDING 3| View 2 | Lake Elevation

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0 12 24 36 ft
1/16" = 1'0" at original paper size

Sheet 48 of 50

REV	DESCRIPTION	DRN	DATE
P3	Submission	VT	24/08/02
P2	Submission	SS	24/08/02
P1	Submission	SS	24/05/07

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PROJECT
Lebanon NH

DRAWING STATUS
PLANNING

DRAWING NAME
BUILDING 2 | PROPOSED PLAN & ELEVATIONS

DRAWING NO. 0089-1202-P3
REV P3

DATE 24/08/02
DRAWN SS

SCALE 1/16" = 1'0" @A1
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N
W E
S

DRAFT

LebGIS

Data Sources:
Roads/Streets - LebGIS
Hydrology - USGS
Municipal Boundary - Granit

Map Printed: 8/12/2013

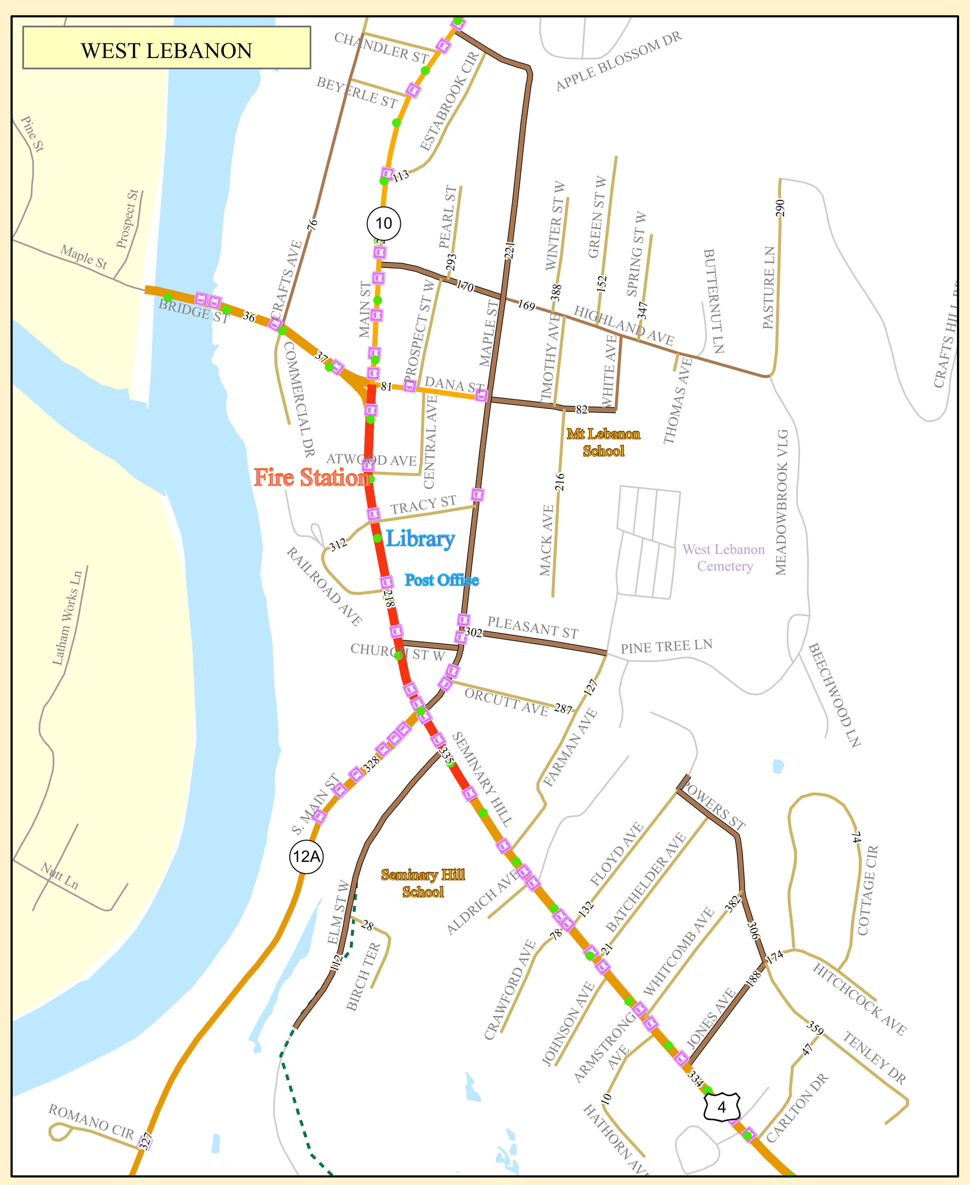
Long Range Multimodal Transportation Plan

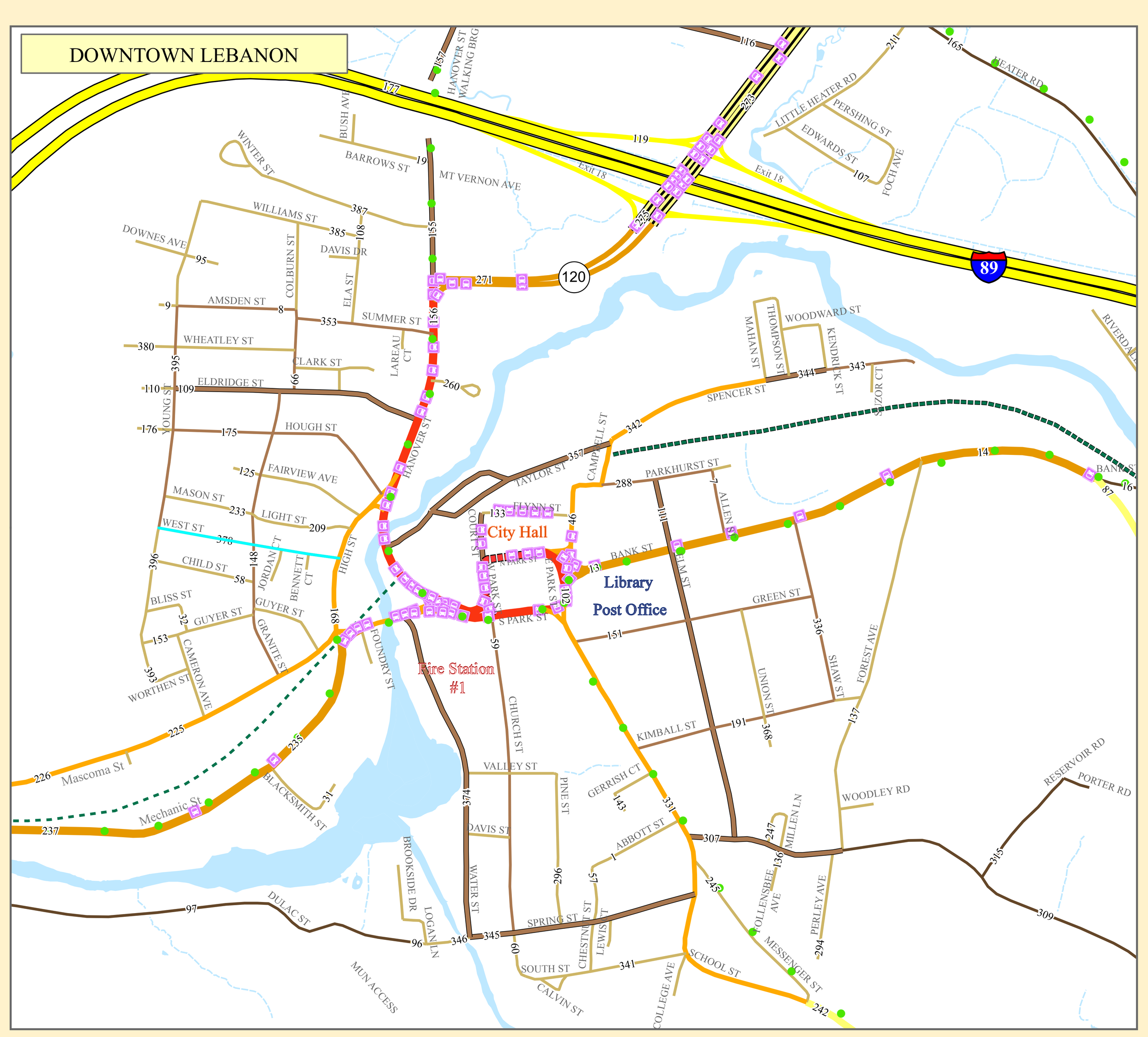
CITY OF LEBANON N.H.
INCORPORATED JULY 4 1761
ESTABLISHED 1958

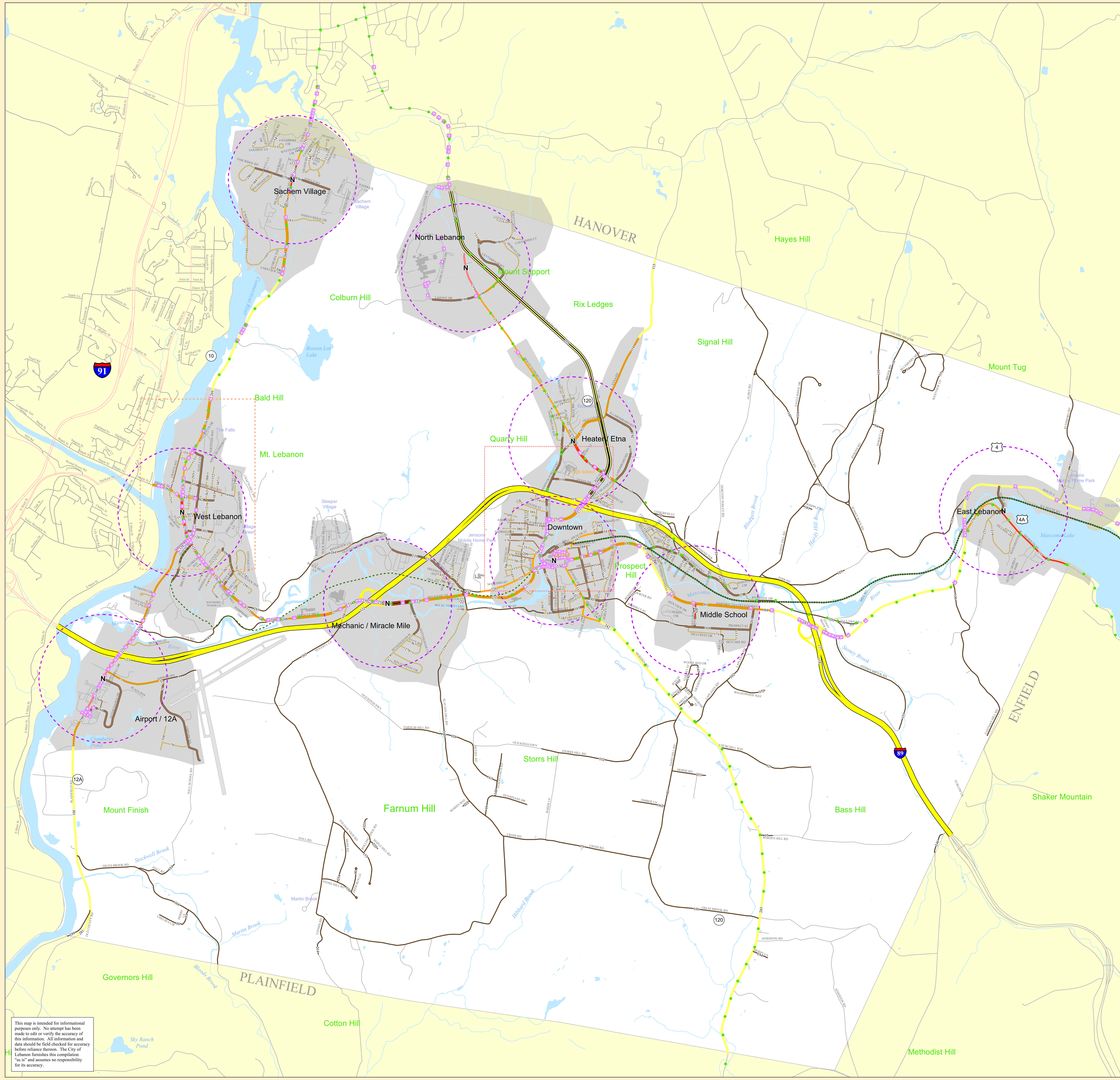
- Statewide Bike Route
- Transit Network
- Off Street Corridor

Street Classification

- Thru Corridor
- Placemaking Corridor
- Connector Corridor
- Local Corridor
- Other
- 1/2 Mi Walkable Radius







This map is intended for informational purposes only. No attempt has been made to edit or verify the accuracy of this information. All information and data should be field checked for accuracy before reliance thereon. The City of Lebanon furnishes this compilation "as is" and assumes no responsibility for its accuracy.

CITY OF LEBANON POLICY STATEMENT ON DESIGN AND CONSTRUCTION STANDARDS FOR STREETSCAPES

Effective Date: June 27, 2012

Authorized By:

Greg Lewis, City Manager

Approved by City Council: June 27, 2012

POLICY STATEMENT: Streets must be designed and constructed in a manner that protects the financial interest of the community, and that preserves the character and ecology of existing neighborhoods. They must withstand long-term use by a diverse population, allowing safe travel by motorists, bicyclists, and pedestrians, and be planned with future development patterns in mind.

PURPOSE: To provide safe, cost-cautious, well-planned travel-ways that serve the best interests of the Lebanon Community now and for the foreseeable future.

1. FUNCTIONAL CLASSES OF STREETS

PLACEMAKING – Lower-speed streets with ample sidewalks and facilities for all travel modes (bikes, transit, cars, pedestrians) designed to accommodate the highest volume of traffic for the space allocated. Main Street, West Lebanon and Hanover Street, Lebanon are examples of the Placemaking class.

THRU - Higher-speed thoroughfares, often with many travel lanes and very large rights-of-way. Interstate 89 and Route 120 (North to Hanover) are examples of the Thru class.

CONNECTOR – A street that transitions travelers from a higher-speed Thru street to a lower-speed Placemaking street. Seminary Hill, West Lebanon and Bank Street, Lebanon are examples of the Connector class.

LOCAL – Smaller low-speed, low-volume residential and rural streets that can safely accommodate bicycles and pedestrians. The majority of streets in the City are considered to be in the Local class.

2. LOCAL STREET TYPOLOGIES

<u>LOCAL LINK</u> – Often accommodates bicycle and pedestrian traffic with sidewalks, and possible bike lanes. Street is used as a connection to higher volume streets and specific destinations.

<u>LOCAL COLLECTOR</u> – Creates a merger of local streets, but does not conduct significant through-traffic. Street is usually served with one sidewalk.

<u>QUIET STREET</u> – Locally utilized with very little through traffic. Travel way is shared by all users and street does not contain sidewalks.

3. DESIGN STANDARDS FOR STREET CLASSES AND TYPOLOGIES

A. PLACEMAKING, THRU, & CONNECTOR STREETS

The functional classes of these streets often dictate that they serve as "gateways" (in one form or another) and should therefore be designed in a manner that is inviting, highly usable, and aesthetically welcoming for residents and visitors. Construction should include concrete sidewalks, granite curbing, sufficient facilities for all forms of travel, and street trees wherever possible.

B. LOCAL (TO INCLUDE LOCAL LINK, LOCAL CONNECTOR, AND QUIET STREETS)

The functional class and typology of these streets allow for greater flexibility in design and construction. Reconstructed streetscapes should be planned to facilitate existing conditions (i.e. replacement of existing sidewalks and/or curbing) unless neighborhood input dictates change.

1. Streets deemed to be "quiet" streets shall not contain sidewalks unless neighborhood input requires reconsideration. Curbing and/or a drainage swale shall be utilized to separate private property from the street line, and to control the movement/disbursement of water.

2. Curbing materials (whether or not there is a sidewalk) shall be determined at the time of final design and should be based on the character and ecological conditions of the existing neighborhood.

3. Separated bicycle lanes should be considered on streets deemed to be "local link," and in some cases, "local collector."

4. PROTECTION OF EXISTING TREES

Street trees enhance the quality of life in the City, and serve an important function in traffic calming and encouraging pedestrian travel. To the greatest extent possible, existing trees shall be protected and maintained during street projects. An expert on urban tree maintenance and preservation shall be consulted during the design phase to assess all potentially affected trees, and a report shall be provided outlining options to mitigate any impact. Property owners and/or residents of the street shall be informed of the report's findings before the final street design is completed.

In the event a tree must be removed, all attempts will be made to replace the tree in the same general vicinity where the tree existed.