Stakeholder Design Considerations for Geothermal Networks in Framingham, MA

This report describes the stakeholder considerations that should be taken into account in the planning, design and deployment of geothermal networks. This report was developed for the Flagg Loop in Framingham, MA and is a product of the Budget Period 1 (BP1) "Planning and Design" of the Community Geothermal Heating and Cooling (CGHC) grant awarded by the Department of Energy (DOE) to HEET. The partner organizations of this project are: Eversource Energy- the Deployment Partner; the City of Framingham - the Municipal Partner, Salas O'Brien - the Design Partner, and HEET, the main recipient. HEET is a non-profit with a mission to drive systems change through an ethical and efficient thermal energy transition

This report summarizes key learnings from the operational Concord Loop that is operational and adjacent to the Flagg Loop. The stakeholders consulted include the deployment team, the participating utility for the Concord Loop, the design partner, the City, the LeGUp research team and other community partners. The stakeholder recommendations described in the next section can form the basis for best practices on how to design, build and deploy geothermal networks and are applicable to any other geothermal network from the pre-feasibility to the construction stage.

Stakeholder Engagement

Stakeholder engagement has been a key aspect in the community acceptance of the first Framingham loop. The first loop has had a very positive response throughout the community. Residents from homes blocks away and even other towns have contacted Eversource to ask if they can be added to the loop. Members of the community portray pride in their community's innovation and "first installation" status. Residents from nearby towns have voiced interest in having the technology in their neighborhood. It is strongly recommended that a multifaceted stakeholder and community engagement approach be implemented in the second project, similar to the successful effort in the Framingham first loop. This approach included the following outreach initiatives:

- **Regular weekly tabling:** Eversource has been available on a weekly basis to provide information about the status of the construction and geothermal networks. They regularly set up informational tables along the established Framingham loop. Through this type of community engagement, Eversource has been able to address emerging questions from the local residents.
- **Office hours:** Regular office hours have been held by Eversource to answer questions not only from community members directly involved with the 1st loop but also from communities external to the 1st loop that are interested in geothermal networks.

- **Monthly construction updates:** Eversource provides monthly construction updates that are shared publicly on their website.
- **Contacts:** There is a dedicated email address on the website for inquiries related to the geothermal pilot project.
- **Community specific outreach such as the 'Girls in Science' day:** Identifying opportunities to engage and educate, such as the wonderful science day for 8th grade girls at a local middle school that is physically on the loop location. This included Portuguese translation to address community needs and had state leaders attend as well.

Design Considerations

- **Size of main pipe:** The diameter of the main pipe is often a cost consideration, however the costs of using a pipe with a larger diameter should be balanced with the potential gains. Having a pipe with a larger diameter enables the addition of future thermal loads to the loop and provides more thermal inertia, making the system more resilient to spikes in thermal demand.
- **Boreholes on the right of way**: Salas O'Brien has experience in the design of projects with boreholes in the street, one of which has been in operation for two years. At their Berczy Glen project, which was a new construction, the geothermal pipe was installed 9 feet deep in the right-of-way as the lowest pipe of all the services. All utility piping was installed at the same time in the street. The project by National Grid in Lowell intends to test this concept in a retrofit scenario.
- **Heat exchanger at the entrance of every building:** Heat exchangers may not be needed outside every building. The type of building and other risk considerations determine whether a heat exchanger is needed. For single family homes, a heat exchanger may not be needed, as it would increase costs and decrease the efficiency of the system. Additionally, the amount of piping that goes in single family buildings is minimal, so the risk of having problems with piping is greatly reduced. In the new construction projects that Salas O'Brien has been involved with energy transfer stations were not installed in the single-family homes. For big buildings such as the Farley building, it is recommended that a heat exchanger be placed outside the building to ensure that, if something happens to the piping inside the building, the issue does not affect the rest of the system.
- **Piping and equipment inside buildings**: The project has surfaced the following best practices to be applied when feasible: 1) keep all geothermal piping inside buildings to minimize heat loss and costs, and 2) keep any related pumps inside buildings to avoid the cost of building a pump house and to bypass the confined space required when using vaults.
- **Inclusion of glycol in the system:** There are case studies in northern climates such as Canada where systems do not use glycol (antifreeze), however this can limit a system's capacity. Given that the working fluid from the 1st loop will be mixed with that of the 2nd loop in two locations along Rose Kennedy Ln it is reasonable to have the same

percentage of glycol in both. Reconsidering the cost and benefits of the percentage may be an optimization lever.

- **Resiliency:** Resiliency is a key factor in the design of the entire system. There are redundant pumps planned for the boreholes and the main loop to ensure the system is always operational. Additionally, for a large system, it is recommended to have a standby pump to ensure that an unworking pump can be replaced within 24 hours. Including sensors in different parts of the loop will help identify issues in need of repair, and pipes should be clearly labeled or stenciled with 'geothermal.'

Construction considerations

- **Space needed for drilling**: Although drillers specify defined space required for their work, accounting for buffer and planning for additional space is recommended. The directional drilling used at the Farley building allowed for a smaller surface area footprint, enabling partial usage of the parking lot even during operations.
- **Noise reduction:** Residents can be particularly sensitive to noise. Limiting construction to normal office working hours can help mitigate discomfort. Communicating when periods of more noise will happen can help gain community acceptance.
- **Subcontractors:** Minimizing the number of subcontractors involved in construction would help reduce miscommunication among the different organizations.
- **Parking**: It has been important for the community to vet impacts or disruption to parking during the construction. Parking is important to discuss with the community before construction, including plans for temporary solutions. Lack of access to parking in one location caused staff to work remotely. It was also a challenge to have the start of operations coincide with the time that schools started. A parking success was a lot where parking was restricted but still available during drilling in the lot that used deviated or inclined drilling, which has a smaller surface footprint compared to vertical boreholes.
- **Unexpected findings during drilling**: When something unexpected was found in the subsurface during drilling, boreholes were moved, and the finding was recorded. For example, at one site, drillers found an unmarked electrical conduit. They left it untouched and marked it on the plans.
- **Shifting timelines**: Future project teams will want to communicate from the beginning that construction timelines may vary. Shifting timelines at one borehole field location delayed construction and access to parking, affecting the tenants.

Expansion considerations

- **Connections between adjacent loops**: Various design parameters should be considered when planning future expansion of geothermal loops. The design team proposed that the most cost-effective way to interconnect two loops was by joining them using two sections of 20 ft length pipes, each along the common main pipe in Rose Kennedy Ln. This type of interconnection allowed for thermal transfer while also minimizing cost of the interconnection.

- **Sizing of the system,** which includes the number of boreholes and the size of the main pipe, should be done considering the maximum number and thermal load of buildings that could join the system. Additionally, it should take into account the expansion of the loop with future adjacent loops.
- **Direction of flow in the loop:** As the first loop gets planned, the direction of the flow should be considered, taking into account the location and flow of a potential second or third loop. It may be the case that the combined system flows more efficiently in one direction.

Weatherization

- **Weatherization** of the buildings needs to be completed to assure that energy efficiency is maximized, reducing the size of the overall system. Weatherization includes improving building envelopes, closing air drafts, and performing a blower door test, amongst other preventative activities. The combined effect of weatherizing all connected buildings can affect the size of the geothermal network needed and thus the cost of infrastructure.

Other thermal sources

- Using other thermal sources and sinks where available, such as ponds or lakes, can be more cost-effective than using boreholes if the body of water is located in the immediate vicinity of the loop. Framingham's 2nd loop is next to Gleason Pond on Pridiville Ave. The design team investigated using the pond as a thermal source and sink, and found its thermal use was not optimal due to the relatively shallow depth of the pond.