

Looking at LiDAR to Map Stone Walls

At first, a bare earth LiDAR image may appear to represent some strange and exotic landscape. It appears that way because before this technology was developed, it was not possible to map the land surface in such detail without actually surveying it on foot. This is especially true in a state like New Hampshire where more than 80% of that surface is covered by trees. The ability of the LiDAR sensor to “see” beneath the trees is what makes the view so novel and strangely unfamiliar.

The LiDAR image reveals surface features in amazing detail. With a trained eye you can begin to see different landforms, both large and small, some so subtle that you would not be likely to see them even if you were actually standing there. Details in a LiDAR hillshade image come into focus once you recognize that differences in elevations of the surface appear as contrasting shades of light to dark. A virtual sun casts virtual shadows in this image. Higher elevations appear brighter. Change the simulated direction and angle of illumination and the view changes to highlight some features and subdue others. At least two different hillshade images, with directions of illumination perpendicular to one another, are needed to reveal most of the detail. Additional hillshades may be helpful in some situations. Different landforms and features, whether natural or man-made, have distinctive shapes, patterns, and textures that become easier to recognize once you have become acquainted with their “LiDAR look” or topographic signature.

Seeing Stone Walls, Imagining the Past

In this particular application, we are interested in accurately identifying and mapping stone walls. You will need to develop confidence and a mental search image that will help you to distinguish a stone wall from something else that may have a similar appearance in the LiDAR landscape. Fortunately, very few features in nature form straight lines, limiting the potential for confusion and misinterpretation. As for confounding manmade features, possibilities are basically limited to roads and driveways or drainage ditches. The most challenging situation for correct identification occurs where a stone wall runs parallel with a road, especially if there is a roadside ditch or the road is flanked by an embankment where it has been cut into a hillslope. A stone wall appears as a relatively bright line toward the “sun” paired with a darker shadow line. This pattern is reversed for a ditch or a roadcut, but these differences may be difficult to see in practice, even by switching to a different hillshade direction. The best option in this case is to view the scene using aerial photography to hopefully clarify the actual situation on the ground. With luck, there will be other visible clues as to the presence or absence of a stone wall.

Stone walls do not usually occur as a single line segment in isolation but form part of an interconnected network of lines that come together at roughly right angles. These outline a cluster of rectangular areas that were formerly agricultural fields or pastures (and perhaps still are today, although the treeline may have encroached upon them somewhat). Because stone walls often coincide with property boundaries, looking at a tax map with parcel boundaries may help to confirm the presence of a wall that you have tentatively identified from its LiDAR signature alone. The “texture” of the land surface between

suspected walls can offer some clues. Fields that were picked clean of rocks and plowed (or were not all that rocky to begin with) exhibit a relatively smooth-looking surface in the LiDAR hillshade. The bounding walls tend to stand out from their surroundings. Pasturelands were generally much rougher and rockier and the stone walls more difficult to distinguish. The likelihood of finding stone walls in the steepest, roughest and most broken terrain is comparatively small, primarily because walls were least likely to have ever been built where the soil was too thin for even meager patches of grass to grow. Nonetheless, stone walls can even be found in some unlikely places where a farmer was determined to make every acre count.

A stone wall signature does not always appear as a continuous line, but may consist of a series of shorter segments that the eye is able to connect across the gaps. Swiping between northwest-to-southeast and northeast-to-southwest hillshades may help to reveal the “hidden” segments. However, it is entirely possible that gaps actually exist where the wall has been physically removed or has completely fallen down.

Once you are confident in having identified a stone wall, the next step is to “map” it using the basic tools provided by the NH Stone Wall Mapper. The instructions that follow are intended to help you get started by focusing on a limited number of steps. The appropriate section of the document “Getting Started with the NH Stone Wall Mapper” is referenced in each step. You can read through the entire section to learn more about the full range of options available and develop a “work flow” that best suits your preferences. The objective here, however, is to provide the basics that will enable you to map the first of what we hope will be many stone walls and be fascinated by the LiDAR landscape in the process.

Mapping What You See

The first step is to decide where in New Hampshire you want to map and then zoom to that location by (1) using the scroll wheel on the mouse or (2) left-clicking and dragging to create a rectangle that surrounds your area of interest or (3) clicking the “+” or “-” buttons in the upper left corner of the map [see “Navigating in the Main Map”]. Locations where some stone walls have already been mapped are shown in pink against the green, mostly forested background of the aerial image of the state. Left click and drag to explore the neighborhood. Town boundaries appear in blue as you zoom in.

Click on the second icon from the left (Layers List - looks like a stack of books) under the header “NH Stone Wall Mapper – Public” to expose a dropdown list of data layers that are available for you to view. Notice the two LiDAR hillshade layers with different directions (NW and NE) of virtual illumination listed. Click to check the box next to one of these (you may experience a short delay while the screen refreshes to reveal the LiDAR landscape). Take some time to pan around and zoom in and out to get a feeling for the lay of the land as it appears in the LiDAR hillshade.

Often, it can be helpful to view both hillshade directions before deciding what features to map. Click on the Layers List icon again, uncheck the hillshade direction you previously selected and check the other one. You may find that what you thought were gaps in your wall actually contain remnants of a wall or that other segments of wall are revealed where you did not see them before. The NH Stone Wall Mapper provides a handy tool to more easily switch between both hillshades by peeling away one to see

the other. To activate this “Swipe” tool, first check off both hillshades in the Layers List, then click on the icon on the far right under the header “NH Stone Wall Mapper – Public” (three horizontal bars with an arrow head in the lower right). Hover on the “Swipe” icon that appears and click on the right-facing arrow head to open a “Select the layer(s) ...” box with a dropdown list expanded by the downward-facing arrow head. Select “LiDAR Hillshade (NE).” Click on the vertical divider (a horizontal double-headed arrow will appear) and drag it back and forth to compare both hillshades at any specific location, NW hillshade on the left and NE hillshade on the right. Notice the often dramatic differences in shadowing and contrast between the two images.

Once you have identified some likely stone walls in an area where you would like to start mapping, click on the third icon from the left (looks like a light bulb and pen) under the header “NH Stone Wall Mapper – Public.” This is the “Smart Editor” tool, which enables you to trace the stone walls that you identify and add them to the Wall-to-Wall database [see “Working in the Smart Editor Tab: Mapping a Wall”]. Choose one of the stone walls to map and zoom in or out so that both of the ends or corners of the wall are visible at the same time. Zoom in enough to enlarge the hillshade signature as much as possible before it begins to appear blurry and grainy.

You are now ready to trace the wall one mouse click at a time, starting at one end with a click and clicking along the way each time there is a change in direction. Try to follow the line where the bright side meets the dark side in the LiDAR signature, which should be closest to the actual middle of the wall. Double click when you get to the end of the wall or corner to stop recording. If there appears to be a major gap in the line of the wall, stop tracing when you reach the gap, and start tracing a new wall on the other side. You can use the “Edit Geometry” button to adjust the alignment by hovering over any vertex and moving it. Once you are satisfied with your tracing, click “Save” to preserve your wall, but please be aware that you cannot make any changes after saving. **Congratulations! You have just contributed your first stone wall to the NH Wall-to-Wall database.**

If you want to be recognized by your fellow stone wall enthusiasts (and posterity) as the wall mapper, enter your chosen user name and an email in the boxes provided. This will allow the “Wall-to-Wall” community to acknowledge your contribution and keep you in the running to rise in the ranks from a “One-hander” to a “Stone Boat Captain” based on how many miles of stone wall you map. With your permission, these “milestones” will be shared with the NH Stone Wall Mapping Facebook group.

Any two layers in the Layers List can be swiped, so that you can visualize aerial photographs or parcel boundaries along with the hillshades. The key to using this tool correctly is to remember that whatever layer you select in the “Swipe” pop-up box must be farther down the Layer List than the other layer that you selected.

We hope that you enjoy your experience with the NH Stone Wall Mapper and welcome any suggestions on how we might make it easier and more fun to use. Please feel free to share your comments via email at geology@des.nh.gov or by joining the NH Stone Wall Mapping Facebook group. We are always interested in learning new tricks and tips that make stone wall identification more accurate and efficient.