# Visualizing Groundwater Vulnerability | Tufts University, Massachusetts

## INTRODUCTION

Tufts University is located on the border of Medford and Somerville, right outside of Boston, Massachusetts. Resting on a drumlin, the geology is unique and complicated with evidence of a historic strandline, glacially deposited till, as well as a network of underground aquifers. Centrally located in an area that has substantial snow and ice throughout the winter, salting roads and walkways is extremely common. This study seeks to study and identify places most at risk for groundwater contamination caused by this road salt.

Groundwater, or the water that moves slowly through small permeable cracks (aquifers) below Earth's surface, is one of earth's most valuable resources. Constituting 90% of total supply, groundwater represents earth's largest store of unfrozen freshwater. More than 40% of global irrigation and about 44% of the U.S. population's drinking supply depends on groundwater. Our dependence on groundwater makes the study and protection of this unique resource of utmost importance.

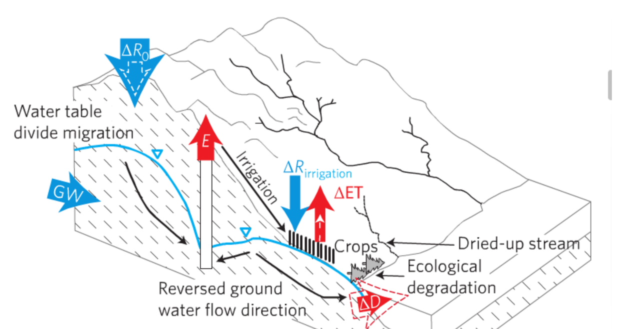



Figure 1: Diagram of groundwater flow. Red arrows represent outflow, blue arrows inflow.

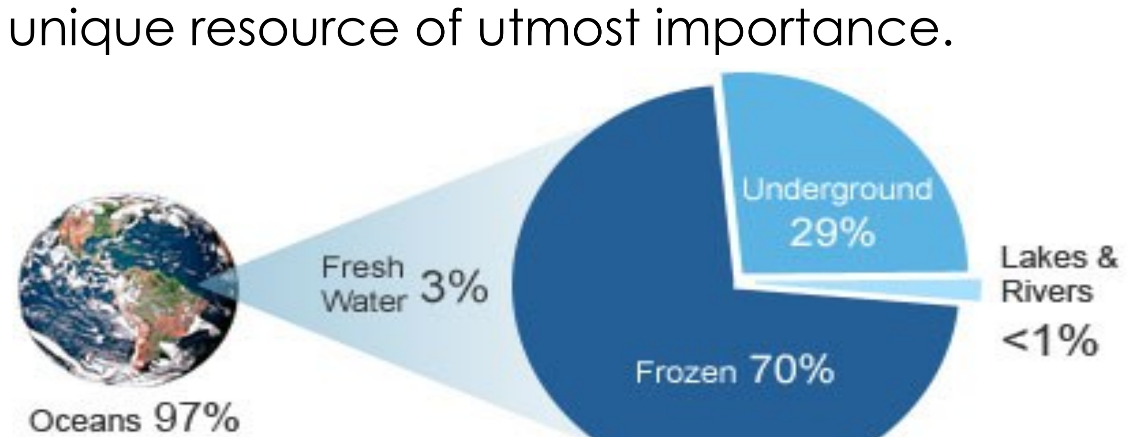



Figure 2: Global water supply. Note the small amount of available freshwater and and of that, the importance of groundwater.

As an educational institution, several survey wells are installed across Tufts' campus, making it an excellent location for study. On November 14, 2013 all wells were surveyed using a SOLINST Inc. TCS device to measure distance to water, temperature and specific conductance (later converted to total dissolved solids, TDS). A GPS unit acquired latitude and longitude data for each site. This data provided the necessary information to assess the threat posed by road salt pollution on Tufts Campus.

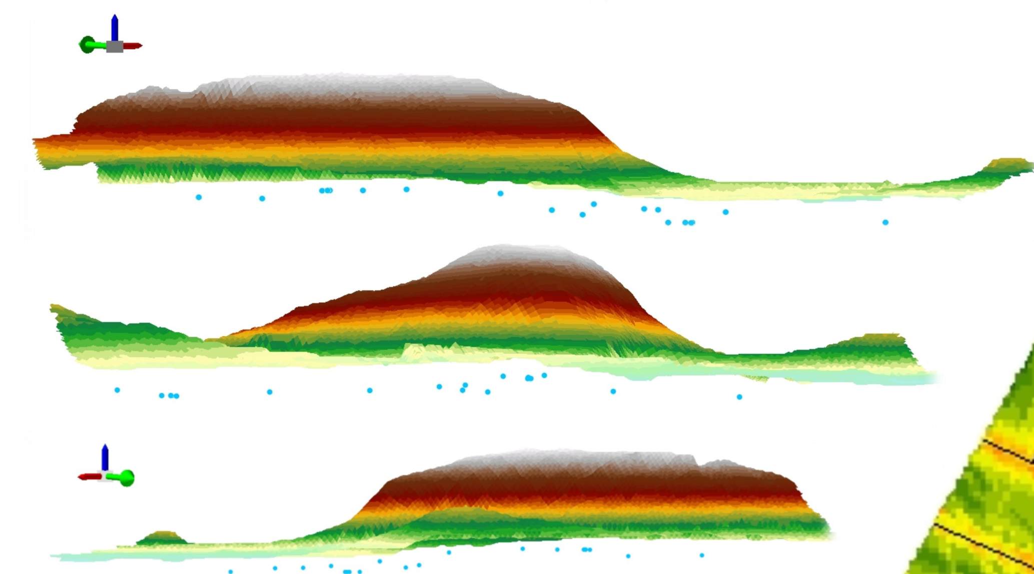
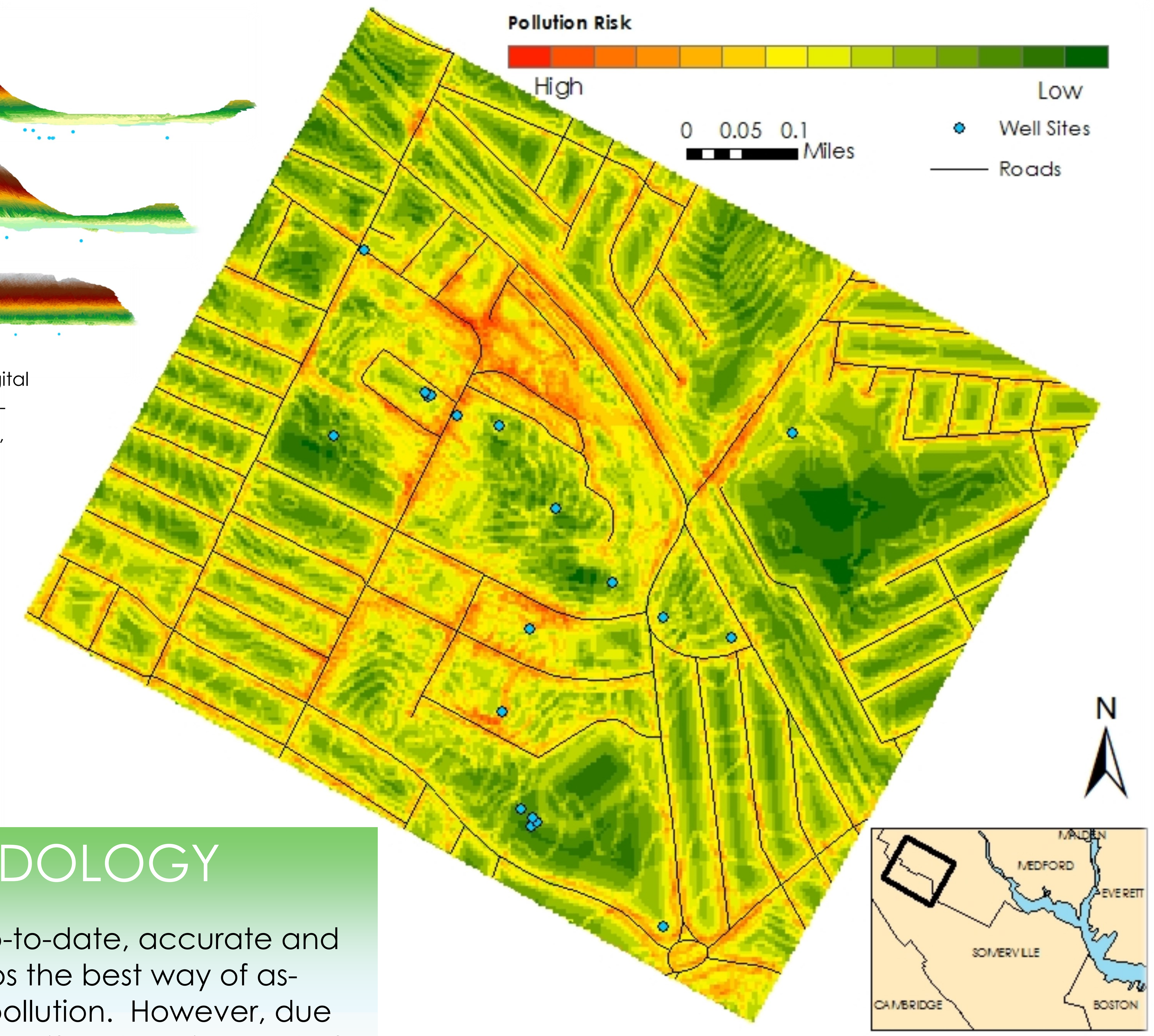


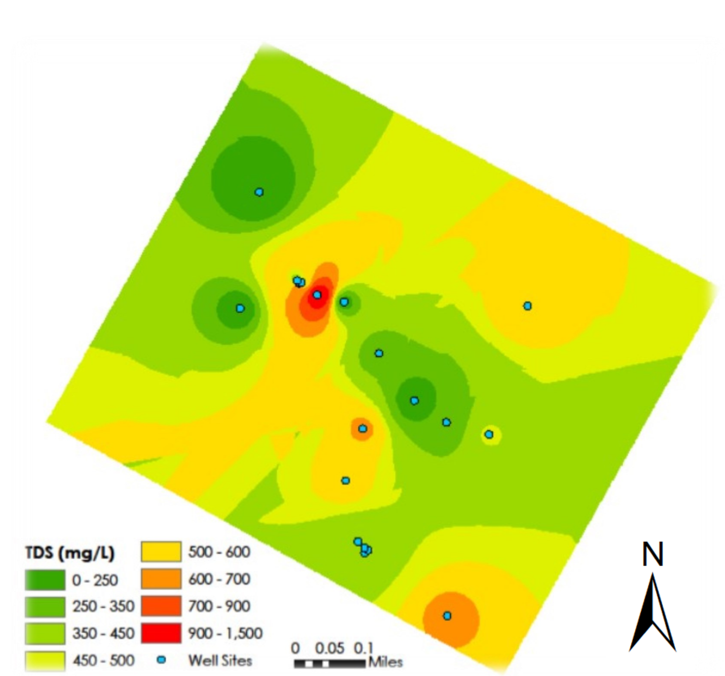
Figure 3: A 3D representation of a digital elevation model of Tufts Campus shown from 3 angles (the south, the east, and the north, respectively). Hydraulic head below is represented by the light blue dots.



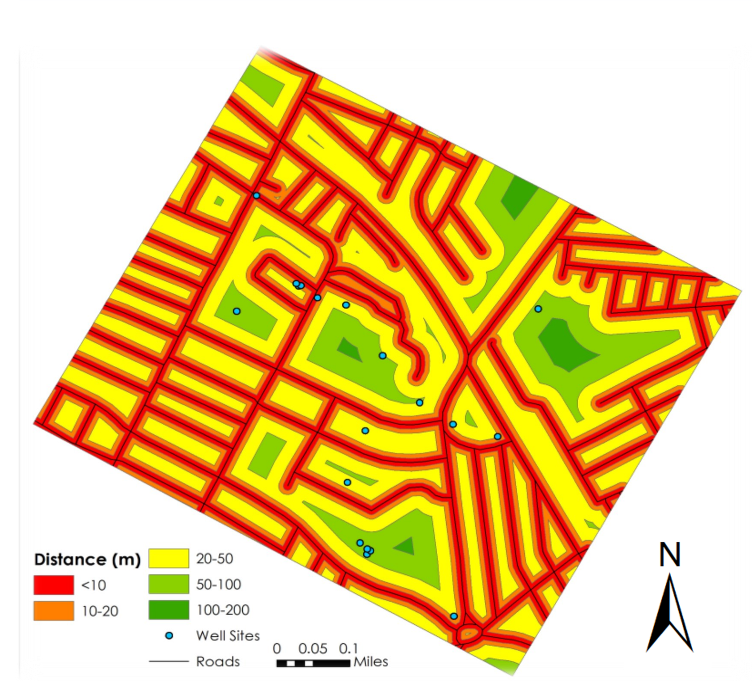

## METHODOLOGY

The collection of up-to-date, accurate and reliable data is perhaps the best way of assessing groundwater pollution. However, due to the wide extent of aquifers, the high cost of installing wells, and the time needed to survey, it is not reasonable to have real-time total dissolved solids (TDS) data everywhere. Instead, this study sought to combine real-time data with road salt pollution risk factors. By considering both collected data and outside risk factors, some of the uncertainty associated with limited collection facilities could be mitigated. For this study, 2 different high salt surface types were considered: roads and walkways. Correlation between proximity to high salt surface types and a high TDS value was determined using several buffers of varying size (see small maps below) and a spatial join. In addition, areas of high slope were determined using a digital elevation model. Finally, measured TDS values were interpolated to create a map of estimated TDS throughout campus. All variables were factored in to the overall risk assessment to create a final map that shows areas of highest concern for road salt pollution of groundwater.

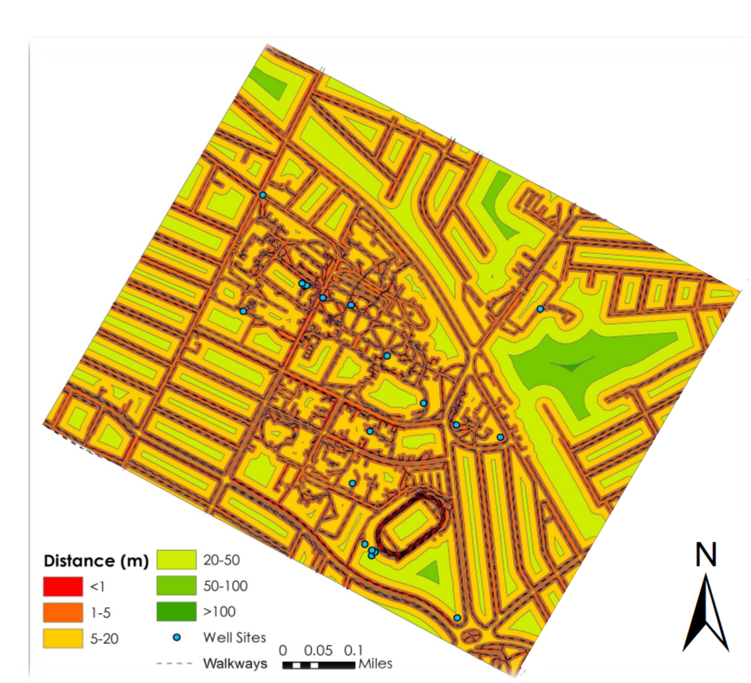
### Total Dissolved Solids



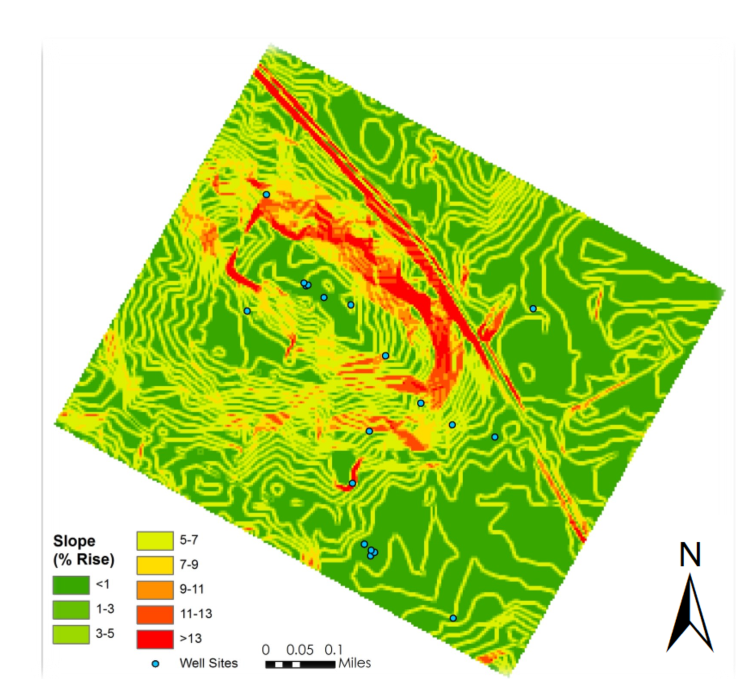

### Proximity to Roads




### Proximity to Walkways




### Areas of High Slope




## RESULTS/CONCLUSIONS

This study yielded multifaceted results. The buffer analysis demonstrated that areas closer to both roads and walkways show a higher TDS, meaning there is more salt contamination. As you get further and further away (from 10m-50m for roads and 1m-10m for walkways), average TDS goes down. This indicates that there is some correlation between proximity to high salt surfaces and water pollution, giving credence to the next part of the results.

| Distance (m) | Well Count | Average TDS (mg/L) |
|---|---|---|
| 10 | 2 | 700.975 |
| 20 | 6 | 586.205 |
| 50 | 13 | 496.277 |

Table 1: Road Buffer Analysis

| Distance (m) | Well Count | Average TDS (mg/L) |
|---|---|---|
| 1 | 5 | 441.391 |
| 5 | 11 | 398.28 |
| 10 | 16 | 354.19 |

Table 2: Walkways Buffer Analysis

The final map shows the areas most at risk for groundwater contamination via road salt. They appear concentrated in the north central part of campus, fortunately in an area with limited wells. These areas should be watched with scrutiny and installation of drinking wells limited.

There is still substantial room for expansion of analysis. First, the area considered in this study is relatively small. Because groundwater flows across vast areas, pollution must be considered dynamically and without spatial constraints. Furthermore, road salt is not the only type of groundwater pollution: many other factors could be considered including fertilizer, construction byproducts, oil, and other chemical contaminants. Future research could build off this analysis by taking a wider scope and considering more varied pollutants.


Madeleine Ball


GIS 101 | December 13, 2013

Data Sources: MassGIS, Tufts M Drive, Derived

Projection: NAD State Plane Massachusetts Mainland FIPS 2001 Feet

Scale: 1: 8,985

Tufts UNIVERSITY