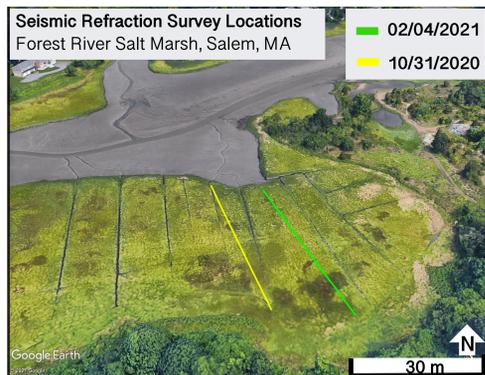


## INTRODUCTION

- The bedrock at the Forest River salt marsh is Salem Gabbro Diorite (Goldsmith et al., 1988). A core taken there indicates a layer of blue-gray clay on top of the bedrock, overlain by 3.2 m of organic-rich peat (Incatasciato et al., 2015).
- If a seismic refraction survey is completed, one can see changes in stratigraphy due to differences in material properties. It quantifies the change of p-wave velocity by recording the distance and time traveled by the p-wave.
- The velocity of a p-wave propagating through a material varies based on density, and elasticity of the medium. With increasing density, the seismic velocity of a material will decrease. The elastic properties that affect p-wave velocity are Young's Modulus, Poisson's ratio, Bulk modulus and shear modulus.



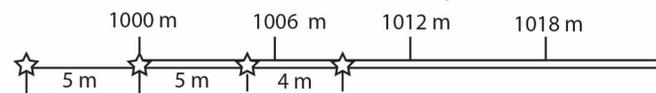
**Figure 1:** A map of the Forest River salt marsh in Salem, MA showing the two survey line locations on 10/31/2020 (yellow) and 02/04/2021 (green).

## METHODS

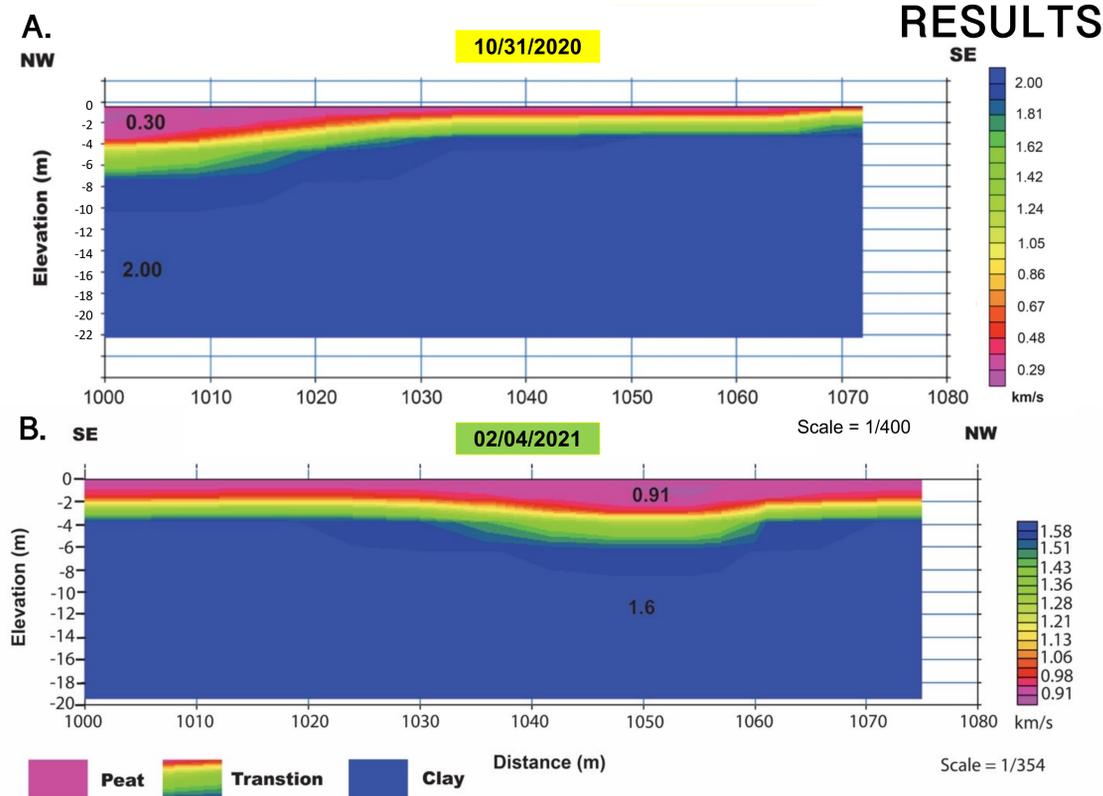
- Two seismic refraction surveys were completed, one on 10/31/2020 and another on 02/04/2021.
- P-wave arrivals were identified in the software Pickwin
- Pickwin then created a time v. distance plot using the p-wave arrivals and geophone geometry (Fig. 2).

### Legend

- Geophone
- Shot Point

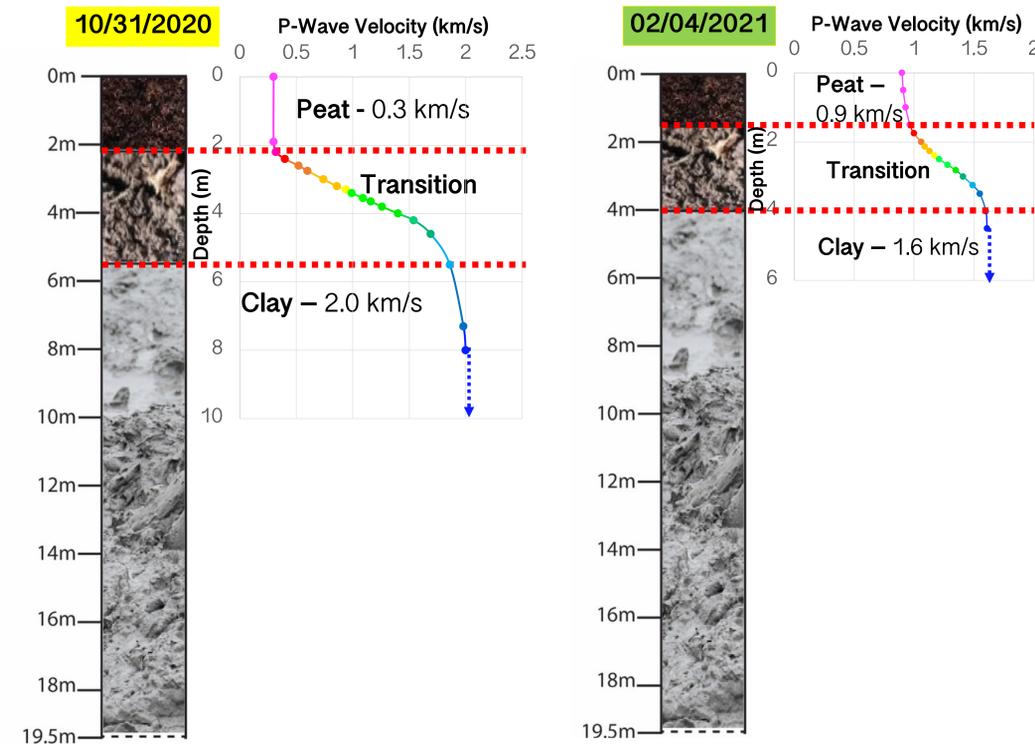


**Figure 2:** A visual representation of the shot point and geophone geometry on one side of the survey line. The full length of the line was 1072 m, the geophone were placed every 6 m, and the shot point locations were mirrored on the opposite side.



**Figure 3:** Stratigraphic cross sections developed from the seismic refraction surveys completed on 10/31/2020 (A) and 02/04/2021 (B).

## RESULTS



**Figure 4:** Stratigraphic columns developed by graphing the change in p-wave velocity with increasing depth.

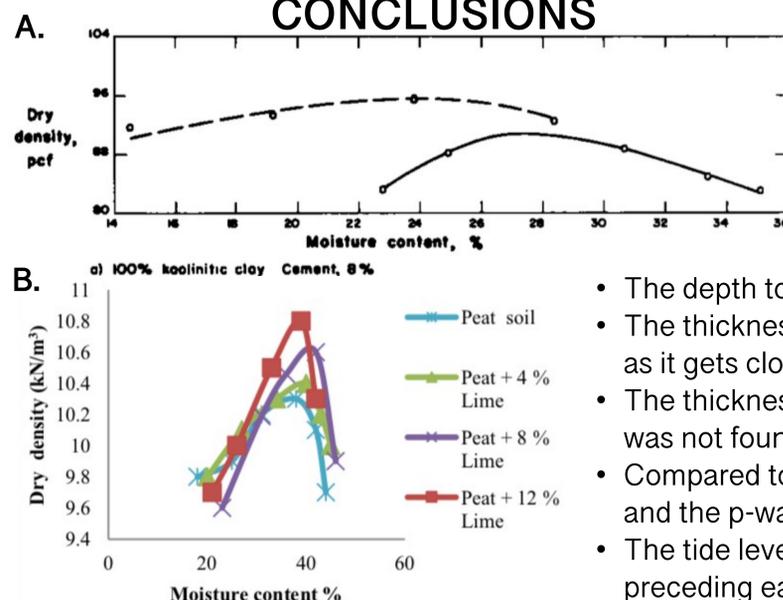
Survey Date	Peat	Clay
10/31/2020	0.31 km/s	2.0 km/s
02/04/2021	0.90 km/s	1.6 km/s

**Table 1:** The p-wave velocities for peat and clay on each survey date.

Survey Conditions	Time Since Last Rain Event	Tide Level	Relative Soil Moisture
10/31/2020	2 days (1 in)	2.75 ft	Wetter
02/04/2021	3 days (0.9 in)	1.75 ft	Drier

**Table 2:** The relative moisture conditions for both survey dates based on rain and tide levels.

## CONCLUSIONS



**Figure 5:** Graphs showing how the densities of clay (A) (Davidson, 1962) and peat (B) (Karthigeyan, 2019), change with increasing moisture content %.

- The depth to bedrock was constrained to deeper than 19.5 m.
- The thickness of the peat is in the range of 1.6-2.2 m and gets thicker as it gets closer to the Forest River.
- The thickness of the clay is greater than 17.3 m but because bedrock was not found it's actual thickness is unknown.
- Compared to the 10/31 survey, the p-wave velocity of peat increased and the p-wave velocity of clay decreased (Table 1).
- The tide levels during each survey and the precipitation events preceding each survey were used to determine the relative soil moisture conditions (Table 2).
- The change in density caused by the increase in moisture from 10/31 to 02/04 likely caused the changes in p-wave velocity.

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Davidson, Donald T, et al. "Moisture-Density, Moisture-Strength and Compaction Characteristics of Cement-Treated Soil Mixtures." 1962, pp. 42-63., <http://onlinepubs.trb.org/Onlinepubs/hrbulletin/353/353-003.pdf>.

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Data from Table 2 obtained from [tidesandcurrents.noaa.gov](https://tidesandcurrents.noaa.gov) and [wunderground.com](https://wunderground.com).