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GLS 470: Field Camp

June 3, 2017

Salem Harbor Dredging Survey

Figure 1. Locus map of New England. The red dot labeled Salem represents where Salem is in respect to the rest of New England.

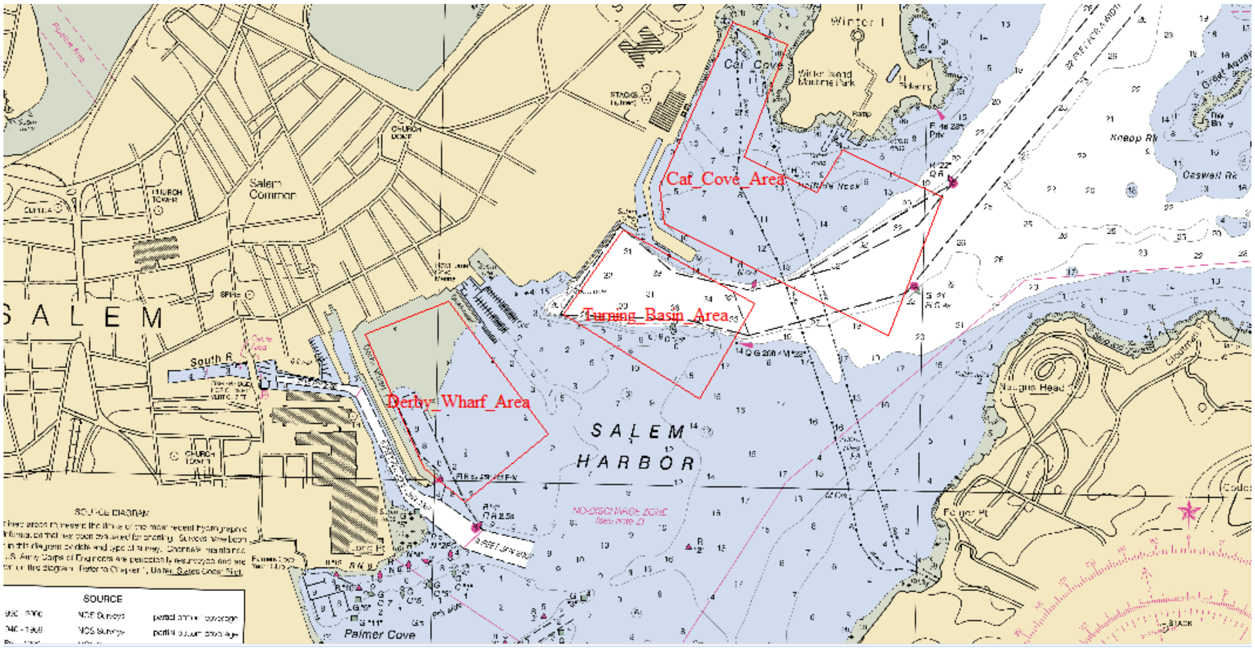


Figure 2. Locus map displaying the three target sites for a potential CAD cell in Salem Harbor labeled and outlined in red.

Abstract

The city of Salem wants to dredge South River in Salem Harbor in hopes to make the harbor more accessible to tourists and put the soiled sediment into a CAD (Confined Aqueous Disposal) cell either in Derby Wharf, Turning Basin, or Cat Cove. A CAD cell is a hole in clean sediment where you are going to put the contaminated sediment to confine the contaminants, so they do not spread. Multiple surveys were conducted including bathymetric surveys, sub-bottom sonar surveys, and a hazard survey. We used Surfer8 and SonarWiz5 to interpret our data we recorded on the boat. We used contaminant data to recreate a contaminant graph relating sample concentrations with standard ERL and ERM values. I have three great cross sections from each target area, Derby Wharf, Cat Cove, Turning Basin, all displaying a clear sediment-water interface, disconformity, and acoustic basement. We studied core samples as well that correlate with the geophysical data we were doing with the sub-bottom Sonar. Even though putting a CAD cell in Turning Basin could cause transportation and boat mooring issues, I still believe that Turning Basin would be the best place for a CAD cell due to the excess of Pleistocene glaciomarine sediment.

Introduction and Background

The city of Salem has hired Viking Consulting LLC to examine and assess the sediments in the South River of Salem Harbor (*fig 1)*. The main question to be answered is, are the sediments contaminated and how contaminated are they? Contamination is the concentration of a certain substance. If that concentration value causes harm to the environment or any form of life, it is considered contaminated. ERL (effects range low) and ERM (effects range median) are numerical standards that determine how harmful a certain concentration of a substance can be. "The numerical guidelines should be used as informal screening tools in environmental assessment. The guidelines should be accompanied by the information on the incidence of effects"(Long).

Salem would like to dredge South River in hopes to extend the shorelines and make the channel more accessible to the tourism industry with more docks, deeper channels, and a larger shoreline. If these sediments in this area of the harbor are contaminated with legacy metals due to the tanning industry waste of Peabody, MA; the soiled sediments must be disposed of properly in a CAD cell. A CAD cell, or Confined Aqueous Disposal Cell, is used to dispose of these contaminated sediments in a manner that will prevent further contamination. The goal is to dredge the South

River and remove the contaminated Holocene estuarine sediments and place them in a CAD cell in one of the target areas; Cat Cove, Turning Basin, or Derby Wharf (*fig. 2)*. The CAD cell will confine and bury the contaminated Holocene sediments in clean Pleistocene sediments. “We have developed methods to make dredging projects result in positive gains for the environment through the isolation of contamination and the restoration and creation of habitats” (Fredette & French).

Methods

A fathometer on a small boat was used to get current depths of the South River. Surfer8 was then used to produce a digital bathymetric map of the waterway. Once the bathymetric survey in Surfer was completed, basic math was used to calculate the volume of soiled sediment to be dredged out of this area.

Sub-bottom Sonar was used to study Derby Wharf, Turning Basin, and Cat Cove. “Previous geophysical work in Salem Sound suggests the stratigraphy contains a bedrock basement unit draped by a glaciomarine unit disconformably overlain by an estuarine unit”(Annadale). Sub-bottom Sonar was performed to get a detailed cross-section of the sediment-water interface, acoustic basement, and disconformity between the Holocene estuarine sediments and the Pleistocene glaciomarine sediments using p-waves. P-waves are shot downward from a transducer underwater at 1500m/s at either 10kHz, or 3.5kHz. The waves will bounce off the layers and come back to the hydrophone, which then will then display a black and white digital cross-section of that line recorded. SonarWiz5 was used for recording the sub-bottom data on the boat, and processing and editing the lines in the office. Surfer8 was again used to make isopach maps of glaciomarine sediment thicknesses and estuarine sediment thicknesses, and then used to calculate the total sediment volumes in each of the target areas.

A visual site assessment was recorded on foot around the South River to determine if there were any hazards that could be a potential danger to a dredging project. Gaia GPS was used to record the coordinates of these hazards on a digital map, while also taking notes. Google Maps was then used to create a detailed map of the South River with the hazards clearly labeled and outlined.

Contaminant data from South River sediments was used to create a table in Excel. NOAA’s sediment quality guidelines document, and the article by Long allowed us to compare the sediment contaminant data to the ERL (effects range low) and ERM (effects range median) for trace metals and PCBs to determine if the sediment is contaminated and how contaminated they really are.

Results

The first question being asked is, is the sediment in South River contaminated and if so, how contaminated is it? I used NOAA and Long’s articles to compare the ERL and ERM values with contaminant data of sediments to reconstruct a table in Excel.

	1	**2**	**3**	**4**	**SC-A/B**	**SC-C/D/E**	**SC-F**	**SC-G/I**	**SC-H**
Arsenic	<9.8	10	7	9.4	8.7	11.3	8.8	4.9	1.1
Cadmium	3	3.1	1.3	2.9	1.1	2.6	1.4	0.081	0.072
Chromium	550	420	330	540	358	419	357	36.3	16.4
Copper					36	110	72.3	13.2	5
Lead	190	530	120	490	93.9	337	185	10	4.8
Mercury	0.72	1.4	0.37	0.72	0.52	1.4	0.61	0.028	0.017
Nickel					21	28.4	18.5	27.1	10
Zinc					98.7	253	171	41.9	17.8
Phenanthrene	2100	4200	<600	3900					
Benz(a)anthracene	2100	2800	<600	3200					
Benzo(a)pyrene	2200	2600	<600	3700					

Chrysene	2000	2500	<600	<1000					
Fluoranthene	4200	5800	640	7900					
Pyrene	4100	5900	650	7400					

Figure 3. Contaminant data from South River sediments are being compared to NOAA and Long's ERL and ERM values. The red boxes are showing a ppm (parts per million) concentration value greater than the ERM, the yellow boxes are showing a ppm value higher than the ERL but lower than the ERM, and the un-highlighted boxes display a concentration value lower than the ERL.

In the first table I recreated in Excel based on Long's ERL and ERM (*fig. 3)*, you can see that most of the boxes are highlighted either red or yellow, showing contamination of trace metals and PCBs. Nine samples were taken from South River for examination, and although a few samples show little-to-no contamination, most sediment samples are clearly contaminated with multiple metals and/or PCBs.

	VC2009-101	VC2009-102	VC2009-103	VC2009-104	VC2009-105	VC2009-106(1.5-3.7)	VC2009-106(1.5-3.7)	VC2009-107	VC2009-106(3.9-7.4)
(PPM)									
Arsenic				22.9	17.2	6.25		15.4	7.28
Cadmium				3.18	2.58	0.52		1.29	0.649
Chromium				333	720	29.9		576	38.1
Copper				191	145	10.3		102	13.3
Lead				944	560	6.43		512	8.32
Mercury				1.66	3	0.0188		2.8	0.0226
Nickel				36.8	31.4	18.1		23.6	23.2
Silver									
Zinc				368	344	48.3		250	58.3
(PPB)									
Acenaphthene				996	830	11.6		174	13.7
Acenaphthylene				948	762	11.6		357	13.7
Anthracene				1550	1100	11.6		616	13.7
Fluorene				1120	830	11.6		320	13.7
Naphthalene				1550	1210	11.6		607	13.7
Phenanthrene				6230	4420	11.6		1620	13.7
Benz(a)anthracene				3760	2920	11.6		1810	13.7
Benzo(a)pyrene				3180	2520	11.6		1940	13.7
Chrysene				3660	3120	11.6		1630	13.7
Dibenzo (a,h) anthracene				744	599	11.6		472	13.7
Fluoranthene				9040	7990	11.6		3060	13.7
Pyrene				7190	5670	11.6		2900	13.7

Figure 4. Contaminant data from South River Vibracore samples are being compared to NOAA and Long's ERL and ERM values. The red boxes are showing a contamination concentration greater than the ERM, the yellow boxes are showing a value higher than the ERL but lower than the ERM, and the un-highlighted boxes display a concentration value lower than the ERL. In this plot, the PCBs are in ppb units (parts per billion) and the metals are in ppm units (parts per million).

In the second table I recreated in Excel (*fig. 4)*, three of the nine cores have high contamination values of metals and PCBs, while the other six seem to be uncontaminated. Most of these values in red are much higher than the ERL and ERM value guidelines which could potentially be a threat to the environment and/or population.

	VC2009-104	VC2009-105	VC2009-106(1.5-3.7)	VC2009-106(3.7-7.4)	VC2009-107
Total PCBs	576.1	730.8			48.4

Figure 5. Contaminant data from South River sediments are being compared to NOAA and Long's ERL and ERM values. The red boxes are showing a contamination concentration greater than the ERM and the yellow boxes are showing a value higher than the ERL but lower than the ERM. The PCBs are listed in ppb units (parts per billion).

In the third table I recreated in Excel (*fig. 5)*, two cores are displaying high total PCB contamination while the other core is displaying median PCB contamination. Regardless of the amount of contamination, all of these sediment samples are contaminated with PCBs.

After determining if the sediment in South River is contaminated, the next step is to figure out how much sediment is contaminated and needs to be dredged out. We do this by using a fathometer on a small dinghy, collecting data and making a bathymetric isopach map on Surfer8.

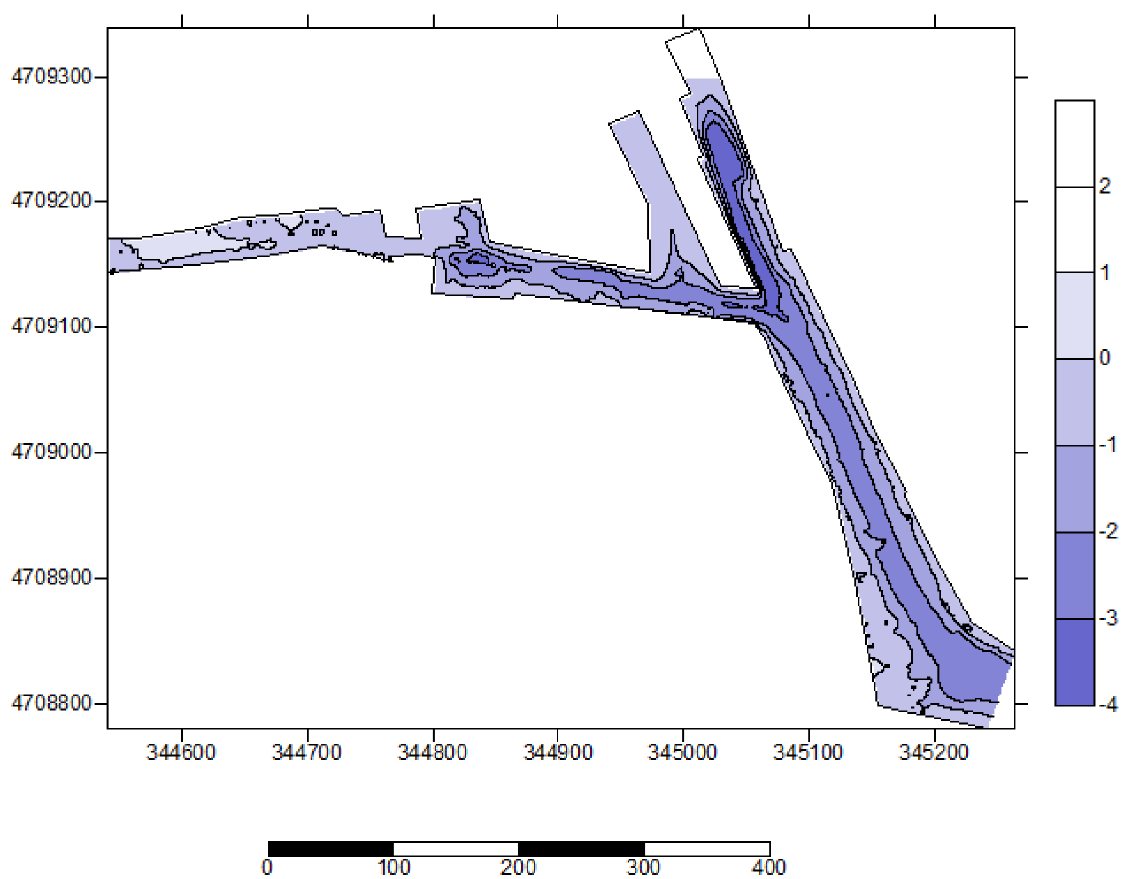


Figure 6. Bathymetric isopach map created in Surfer8 displaying the depths of the sediment in South River. The dark purple displays areas deeper than the lighter areas.

After creating the bathymetric isopach map (*fig. 6)*, we could then calculate the total volume of contaminated Holocene estuarine sediment in Surfer8 that needs to be dredged out of the river, which came to approximately 76153.345854218 cubic meters.

Figure 7. Google Earth map displaying all the potential hazard sites of the South River such as; a granite sea wall surrounding the perimeters, wooden support, wooden boundary wall, metal drain, ladder, and cable crossing.

After making the bathymetric map, we walked around the perimeter of the potential dredging area and created a hazard map highlighting and labeling all the features of the South River that could act as a hazard to a dredge project (*fig. 7)*. The old granite sea wall surrounding the perimeters of the river seemed to be falling apart and could possibly collapse if we were to dredge the channel. A few smaller hazards were observed in the basin such as a cable crossing and a wooden stick.

To continue our survey, we needed to figure out what target area would be a good CAD cell location, and why it would be a good fit by performing sub-bottom sonar surveys. The first area we went to was Derby Wharf, followed by Cat Cove, and Turning Basin (*fig. 8*).

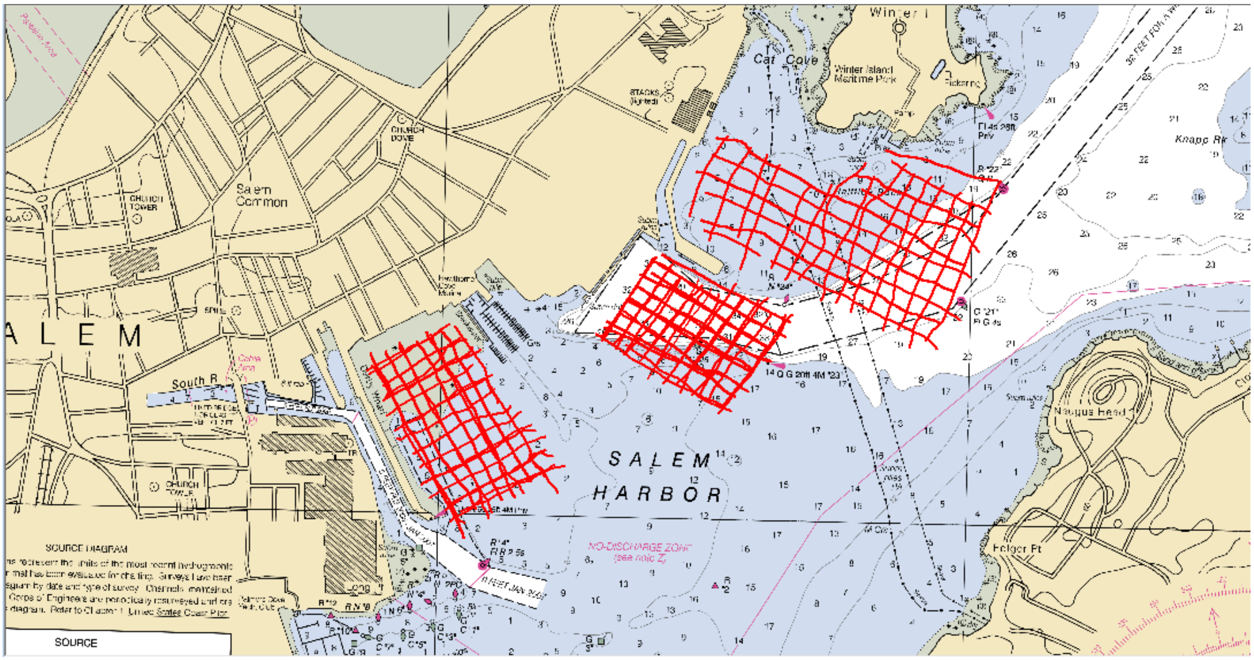


Figure 8. Locus map of Salem Harbor from SonarWiz5 displaying all the sediment-water interfaces of the lines we recorded while at each site. From left to right; Derby Wharf, Turning Basin, Cat Cove.

The first area my group surveyed using sub-bottom Sonar was Derby Wharf. When we went to Derby Wharf, we used the 10kHz frequency and 20-25dB gain settings to see a clear sediment-water interface and disconformity in deeper water. We also used the 3.5kHz frequency at 600 watts and 55-65dB gain settings to get a clearer picture on the acoustic basements to ensure maximum data coverage. My best line at Derby Wharf was my line 20 (*fig. 9)*, recorded at 10kHz and 35dB. After all the lines were processed, we used Surfer 8 to create isopach maps for the Holocene sediment layer (*fig. 10)*, Pleistocene sediment layer (*fig. 11)* and to calculate the volume of each. There was also a sediment core studied at this location, placed on line 15a (*fig. 12,* to prove the geophysical data correlates with the lithologic data.

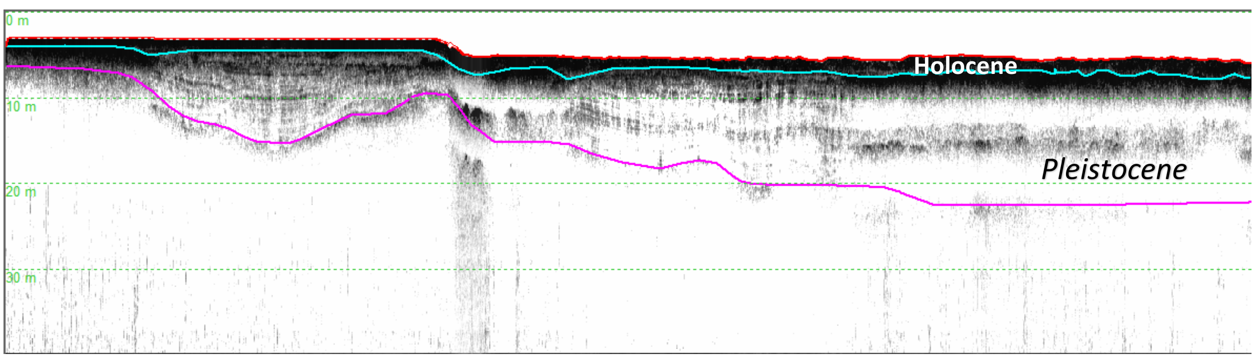


Figure 9. This is my money shot line from Derby Wharf recorded at 10kHz and 35dB. The starting longitude/latitude for this line is $42° \; 31.22276'N/070° \; 53.13356'W$ and the ending longitude/latitude is $42° \; 30.96656'N/070° \; 52.95002'W$. The pink line displays the acoustic basement, the blue line is representing the disconformity between the Holocene estuarine sediments and the Pleistocene glaciomarine sediments, and the red line at the top is showing the sediment-water interface. VE=3.3x

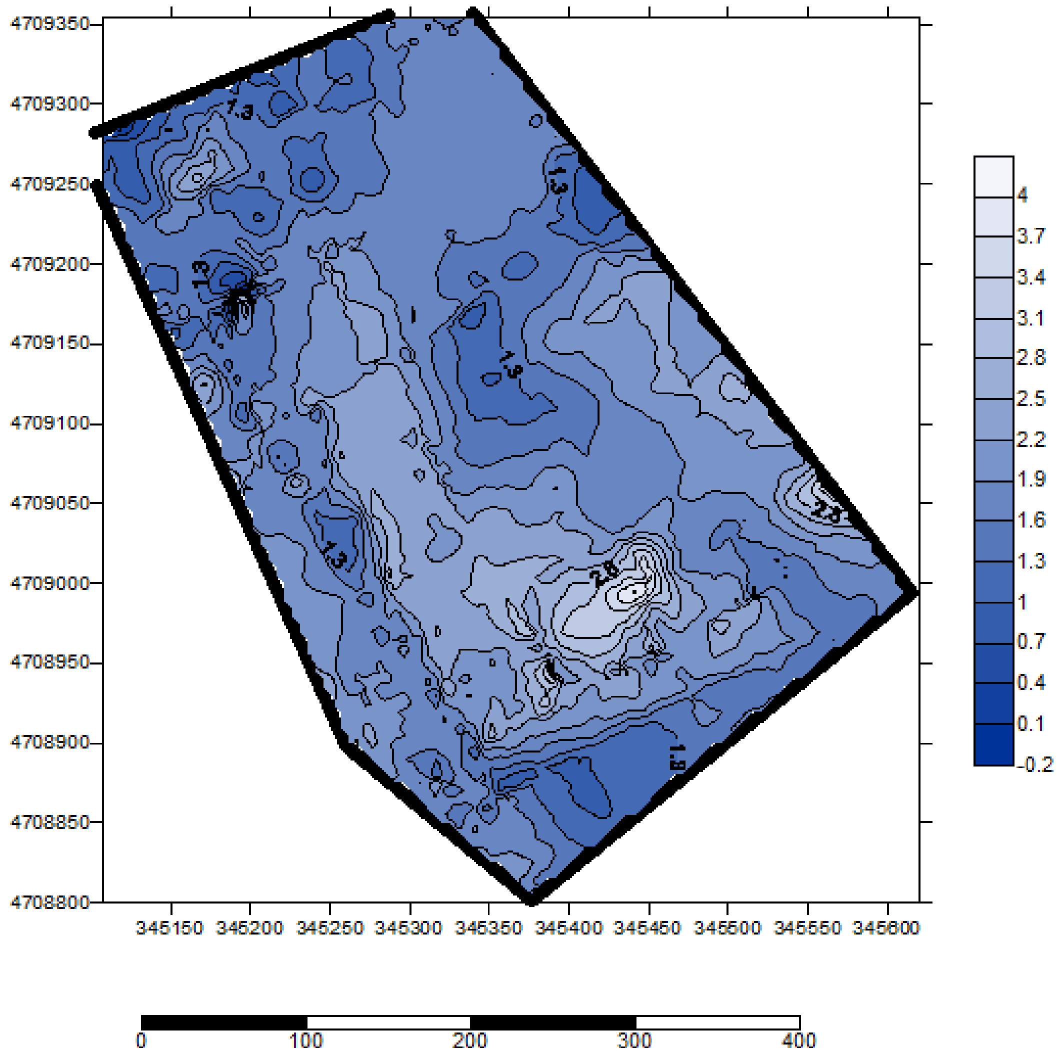


Figure 10. Isopach map made in Surfer8 of the Derby Wharf Holocene estuarine sediment layer. Darker blue colors represent a thinner surface than the lighter blues. The total Holocene volume at this area was approximately 277346.34425294 cubic meters.

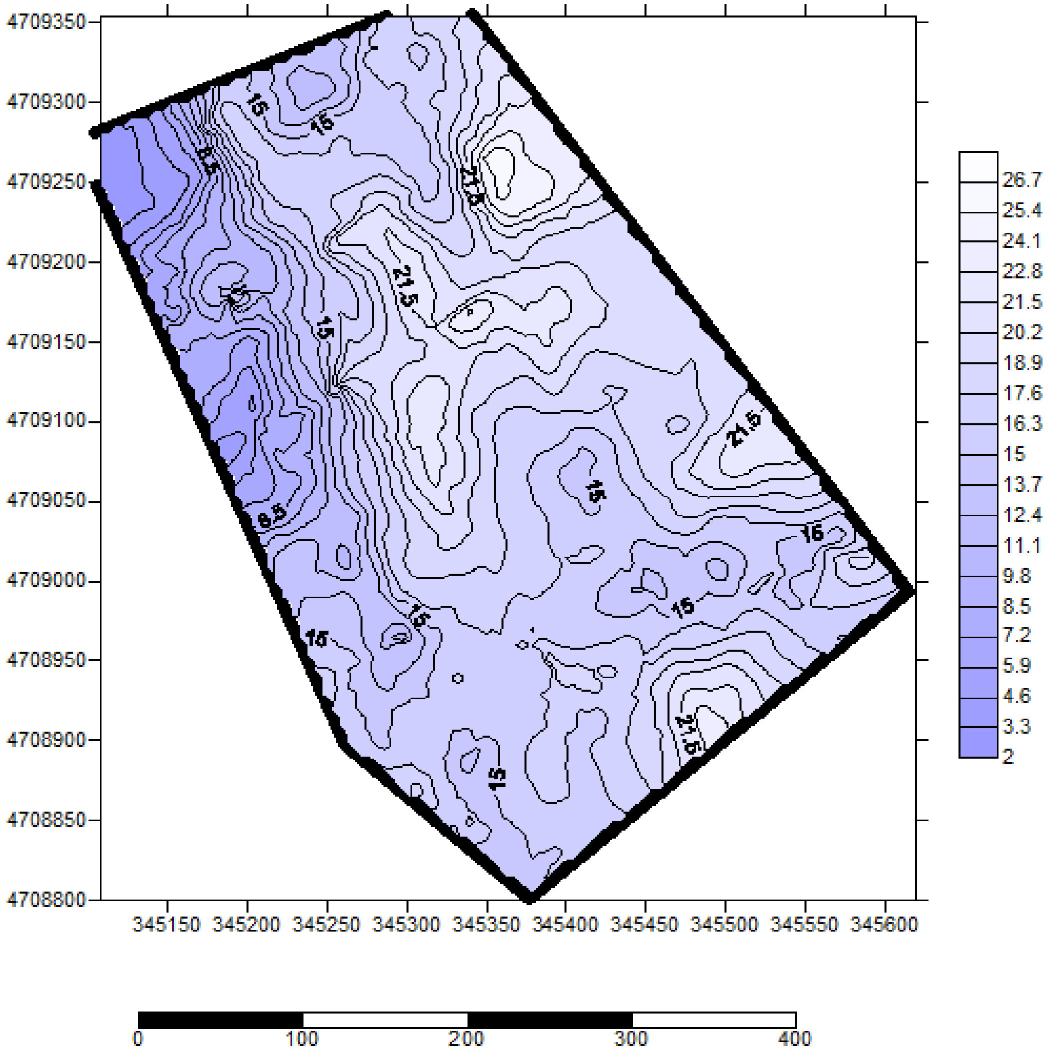


Figure 11. Isopach map made in Surfer8 of the Derby Wharf Pleistocene glaciomarine sediment layer. Darker purple colors represent a thinner surface than the pale purples. The total Pleistocene volume at this area was approximately 2479894.7514047 cubic meters.

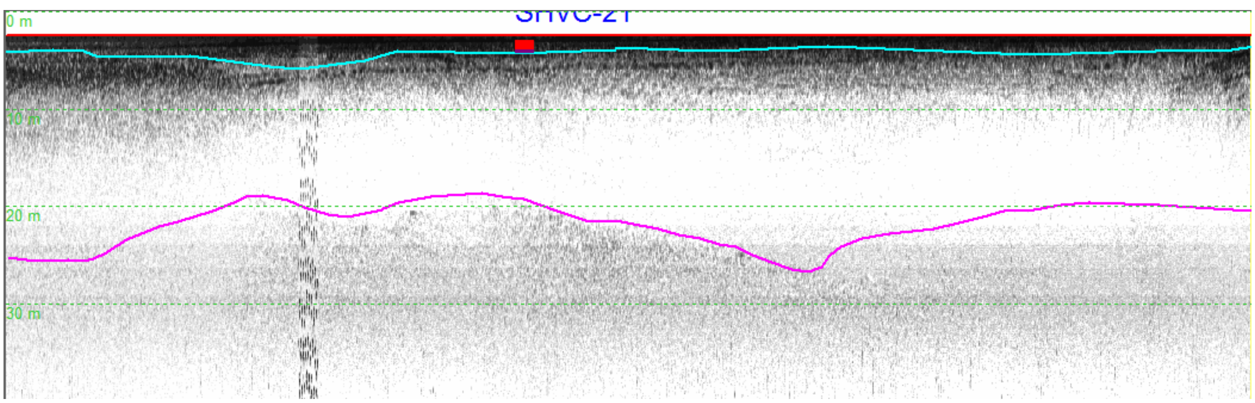


Figure 12. The sediment core labeled SHVC-21 was taken from Derby Wharf at the UTM coordinates $42° 31.1157'N/70° 52.9452156\ 'W$ (description in appendix B). VE= 3.5x

The second area my group surveyed using sub-bottom Sonar was Cat Cove. We used a frequency of 10kHz and a gain of 35-40 for all our lines in Cat Cove. We were able to get nice features using just one frequency. My best line at Cat Cove was line 12 (*fig. 13)*, recorded at 10kHz and 40dB. After all the lines were processed and interpreted, we used Surfer 8 to create isopach maps for the Holocene sediment layer (*fig. 14)*, Pleistocene sediment layer (*fig. 15)* and to calculate the volume of each.

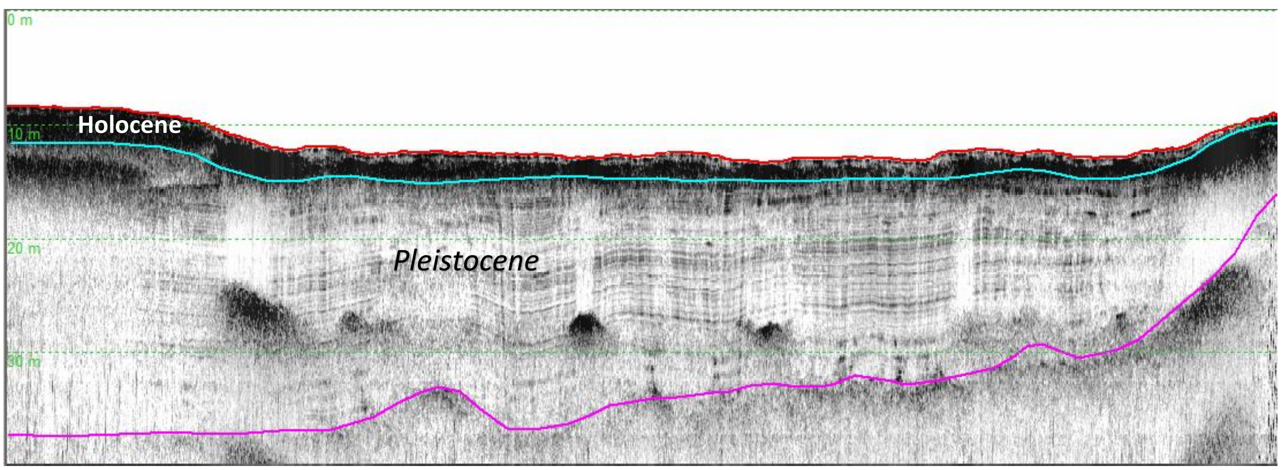


Figure 13. This is my money shot line from Cat Cove recorded at 10kHz and 40dB. The starting longitude/latitude for this line is $42° 31.24713'N/070° 52.11421'W$ and the ending longitude/latitude is $42° 31.45438'N/070° 52.0071'W$. The pink line displays the acoustic basement, the blue line is representing the disconformity between the Holocene estuarine sediments and the Pleistocene glaciomarine sediments, and the red line at the top is showing the sediment-water interface. VE=4.5x

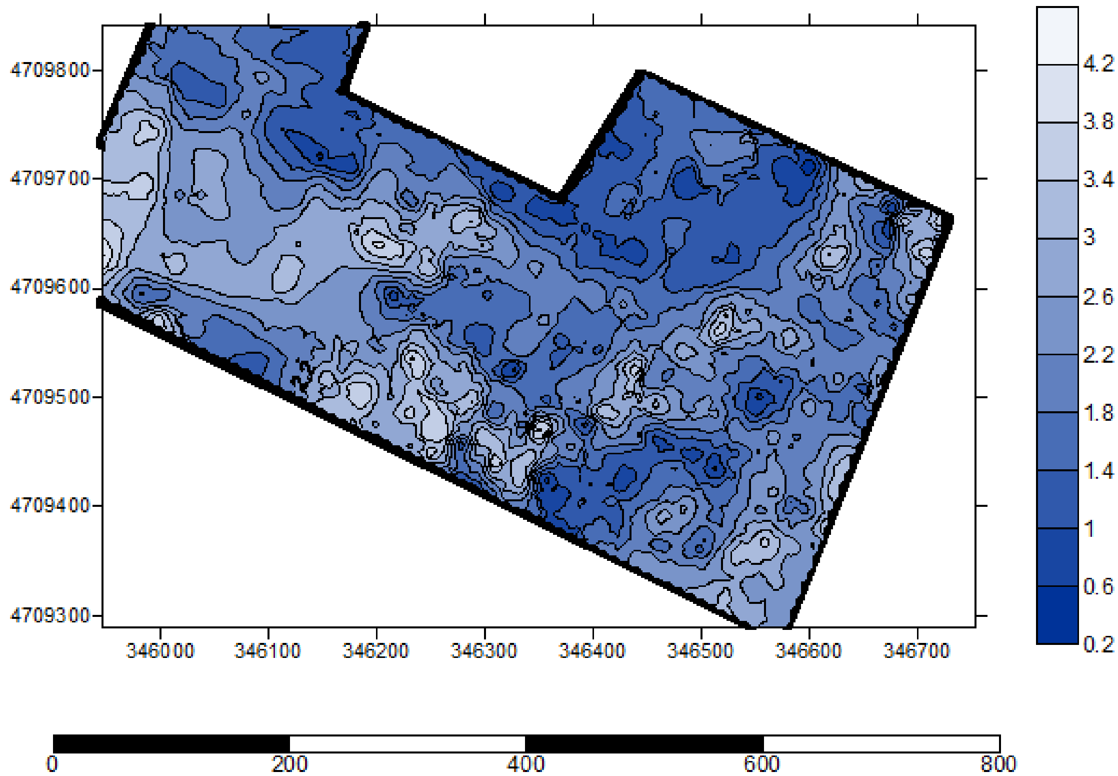


Figure 14. Isopach map made in Surfer8 of the Cat Cove Holocene estuarine sediment layer. Darker blue colors represent a thinner surface than the lighter blues. The total Holocene volume at this area was approximately 510213.10912582 cubic meters.

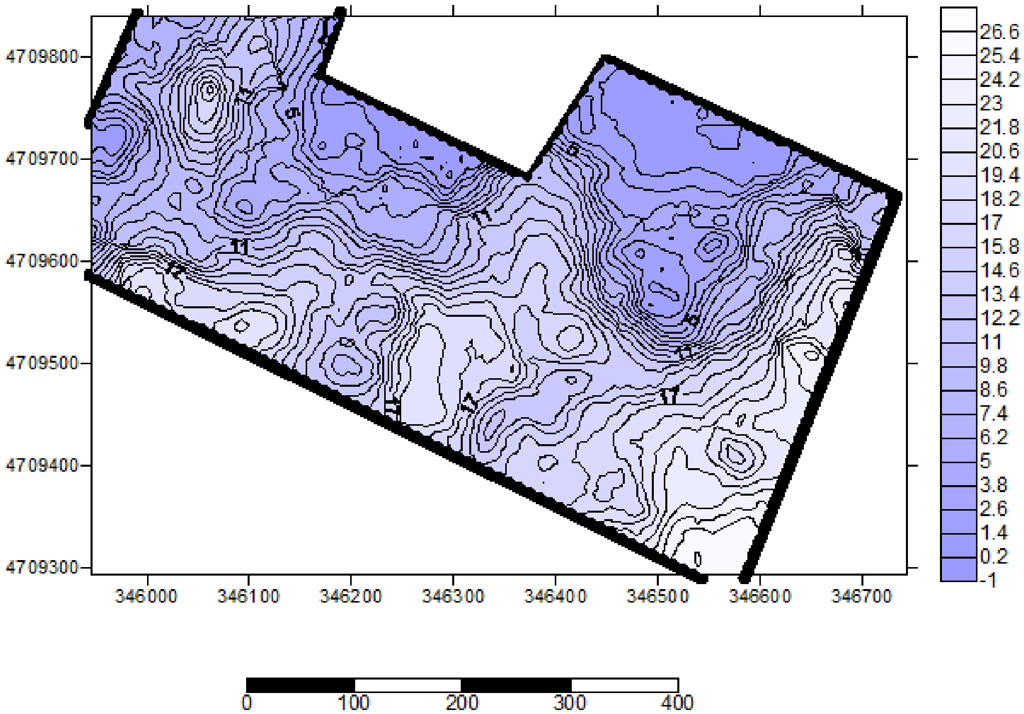


Figure 15. Isopach map made in Surfer8 of the Cat Cove Pleistocene glaciomarine sediment layer. Darker purple colors represent a thinner surface than the lighter purples. The total Pleistocene volume at this area was approximately 2900871.7808725 cubic meters.

The last area my group surveyed using sub-bottom Sonar was Turning Basin. When we went to Turning Basin, we used the 10kHz frequency and 35-38dB gain settings to see a clearer sediment-water interface and disconformity than the 3.5kHz. We used the 3.5kHz frequency at 600 watts and 65-68dB gain settings to get a clearer picture on the acoustic basements to ensure maximum data coverage. My best line at Turning Basin was my line 34 (*fig. 16)*, recorded at 10kHz and 35dB. After all the lines for this area were processed, we used Surfer8 to create isopach maps for the Holocene sediment layer (*fig. 17)*, Pleistocene sediment layer (*fig. 18)* and to calculate the volume of each. There was a sediment core studied at this location, placed on line 27 (*fig. 19)* to prove the geophysical data correlates with and lithologic data.

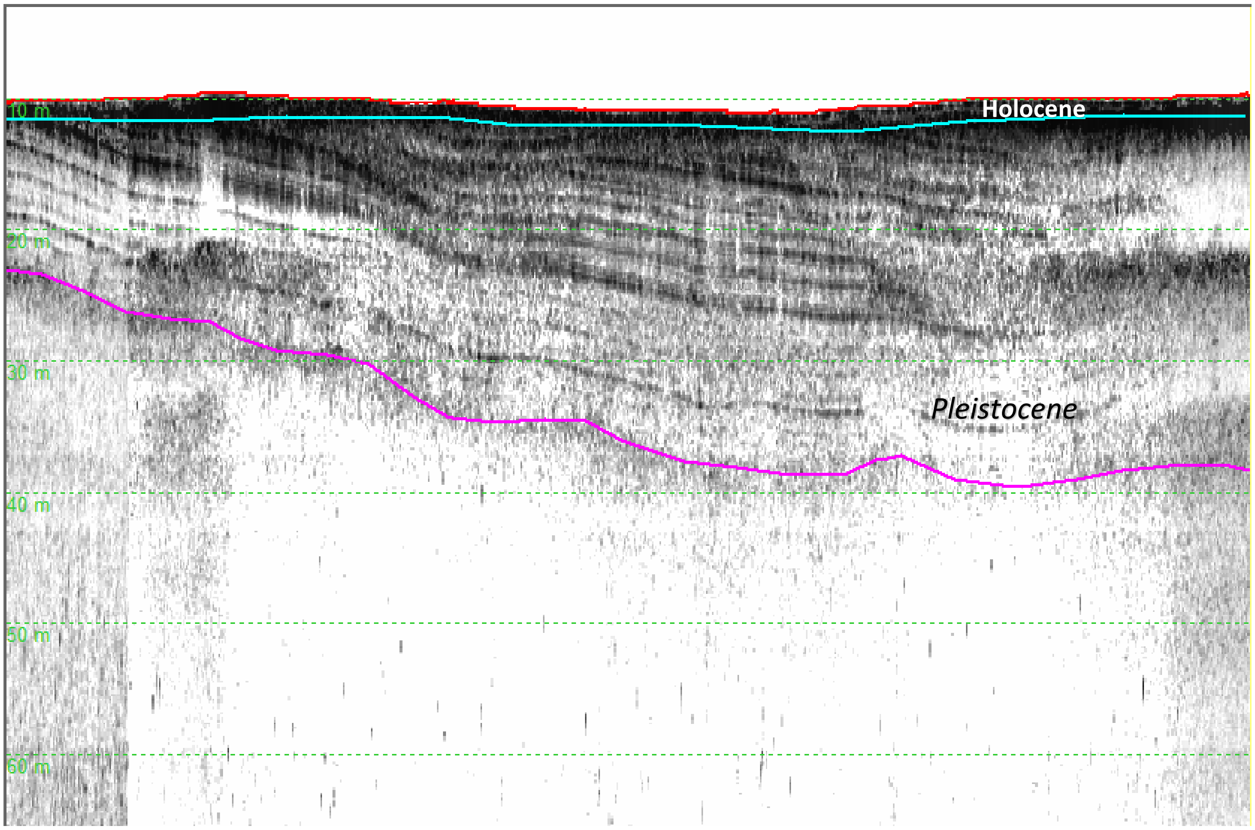


Figure 16. This is my money shot line from Turning Basin recorded at 10kHz and 35dB. The starting longitude/latitude for this line is $42° \ 31.34122'N/070° \ 52.62632'W$ and the ending longitude/latitude is $42° \ 31.24420'N/070° \ 52.38598'W$. The pink line displays the acoustic basement, the blue line is representing the disconformity between the Holocene estuarine sediments and the Pleistocene glaciomarine sediments, and the red line at the top is showing the sediment-water interface. VE=4.5x

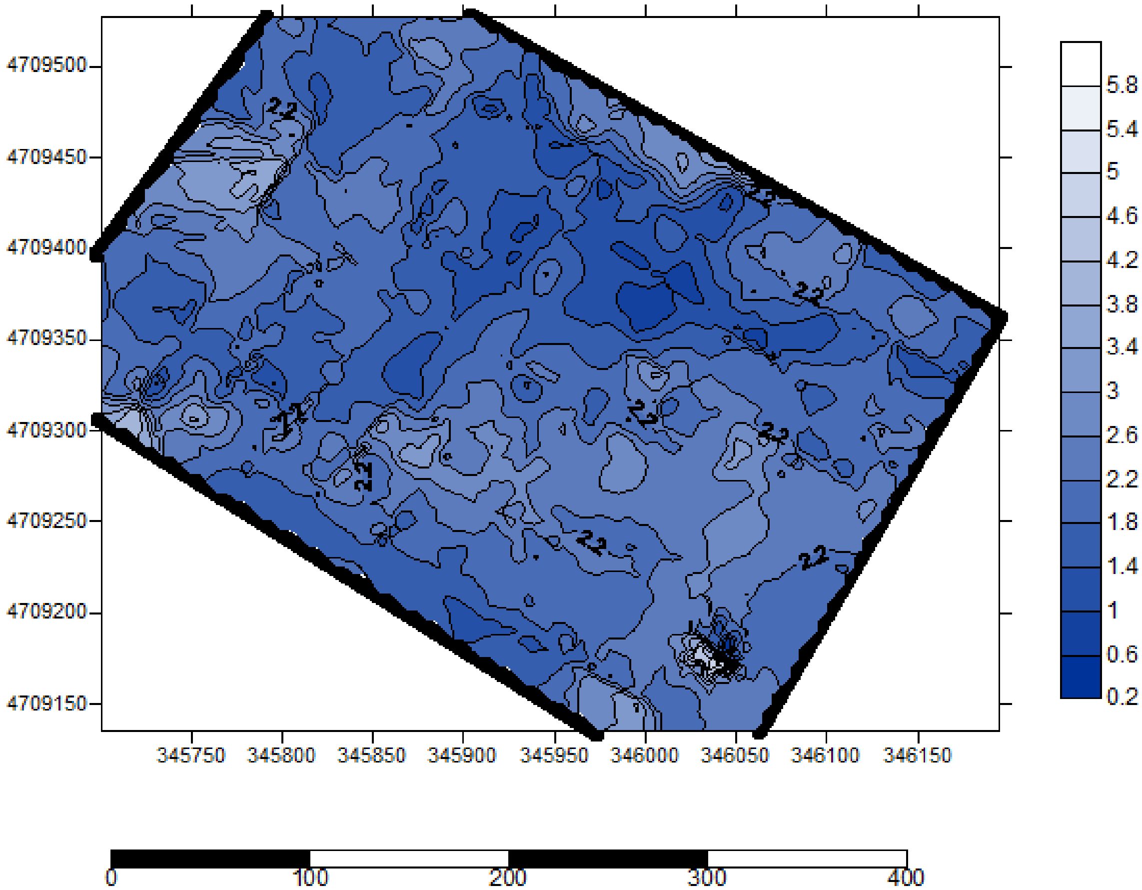


Figure 17. Isopach map made in Surfer8 of the Turning Basin Holocene estuarine sediment layer. Darker blue colors represent a thinner surface than the lighter blues. The total Holocene volume at this area was approximately 252390.12500765 cubic meters.

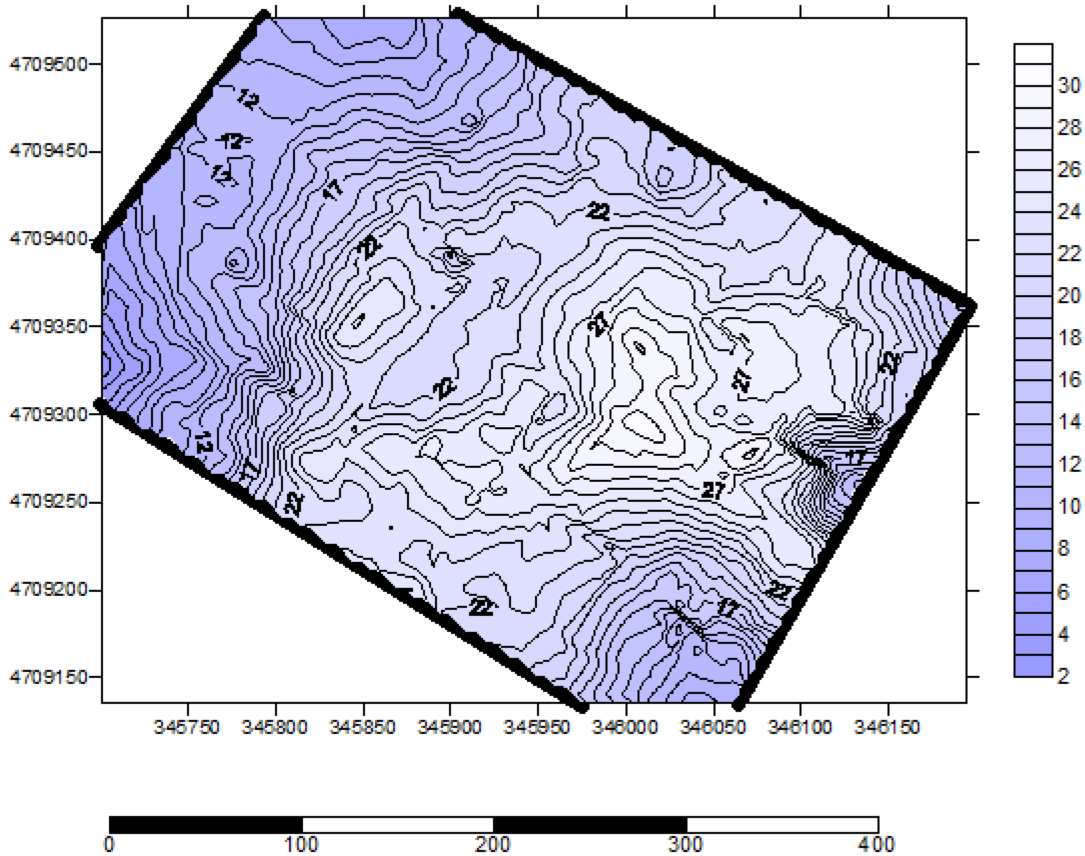


Figure 18. Isopach map made in Surfer8 of the Turning Basin Pleistocene glaciomarine sediment layer. Darker purple colors represent a thinner surface than the lighter purples. The total Holocene volume at this area was approximately 2489136.480139 cubic meters.

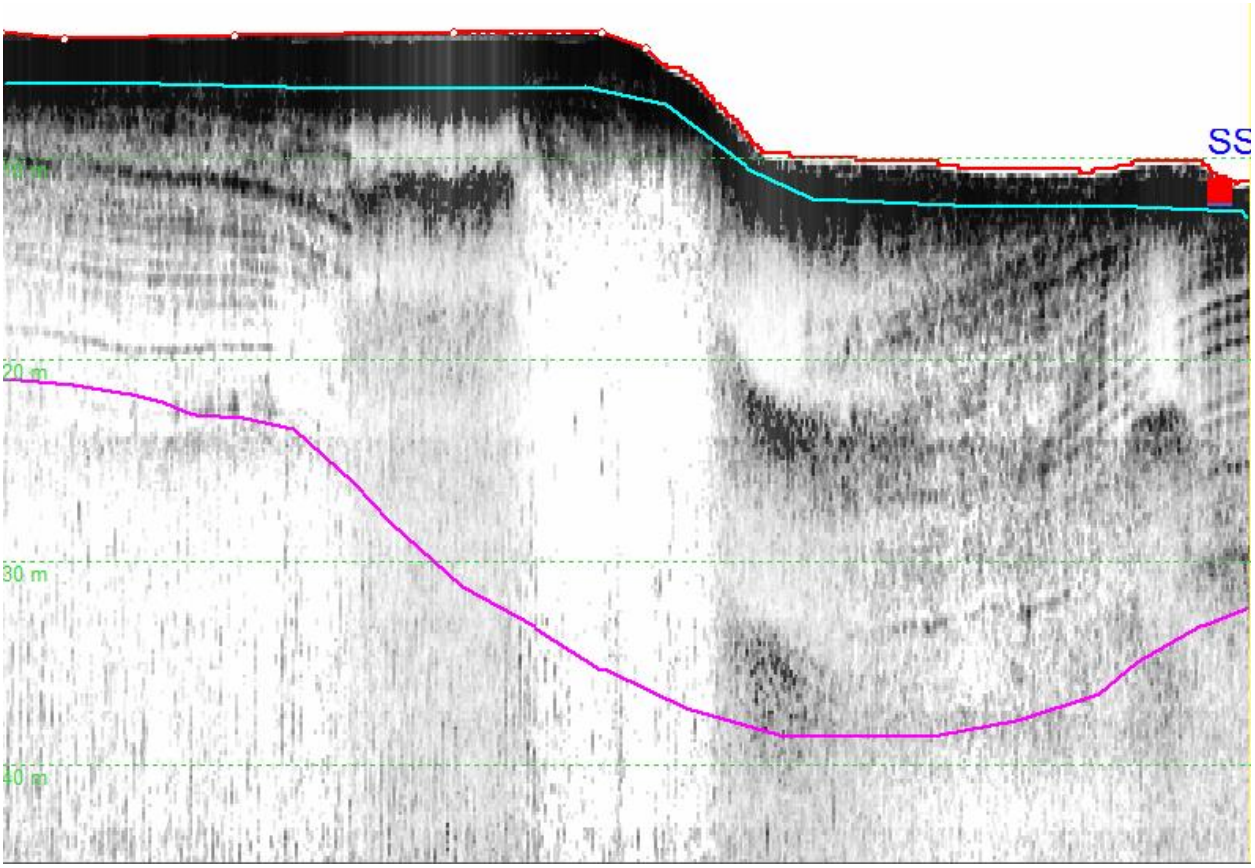


Figure 19. The sediment core labeled KC1 and KC2 was taken from Turning Basin at the UTM coordinates $42° \, 311.35587'N/70° \, 52.2180198 \, 'W$ (description in appendix B). VE= 4.3x

Discussion

After gathering and examining all the data for the three different sites in Salem Harbor, I think that Turning Basin would be the best spot in the harbor to put the contaminated sediment from South River. I think Turning Basin would make a good CAD cell location because there is an excess of clean, Pleistocene, glaciomarine sediment in this area, with areas reaching about 30 meters thick. Because of all this excess glaciomarine material, there will be no problem with concealing the contaminated sediments. If we do a 60m by 60m square CAD cell in the deepest part of Turning Basin (*fig. 20)* there should be plenty of room in the glaciomarine cell to put the estuarine sediments in and top it off with a 5.65 m thick cap. In the 60m long, 60m wide, and 29m deep CAD cell at the location I chose in the middle of Turning Basin *(fig. 21)*, there is 104400 cubic meters of glaciomarine sediment, and 7920 cubic meters of estuarine sediment that must be buried with the 76153.35 cubic meters of soiled sediment from South River. The cons of dredging in this area of Salem Harbor, is it is right next to the mooring field and the navigation channel, which could cause minor inconveniences for the public; but this is the most ideal and safe place to dispose of the contaminated sediments in Salem Harbor.

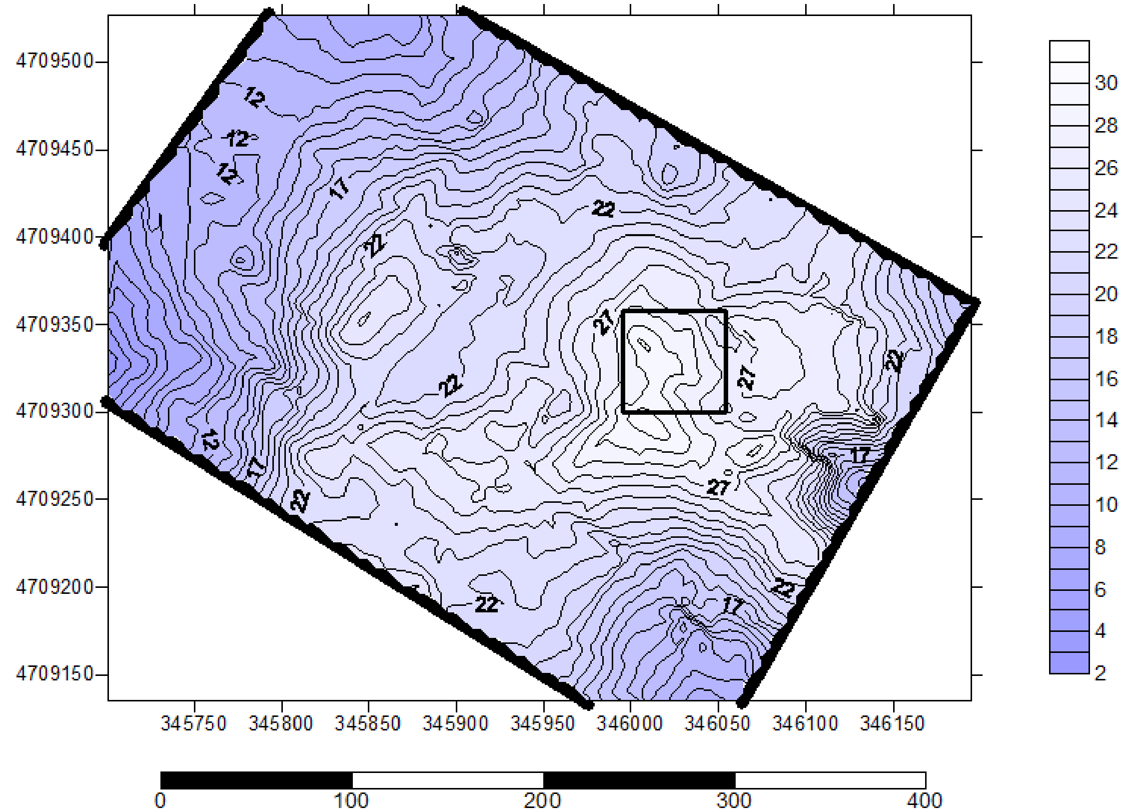


Figure 20. An estimate on where I would like to put my CAD cell in Turning Basin. The square in the middle of the map is approximately 60m long, 60m wide, and 29m deep making a total CAD cell volume of 104400 cubic meters.

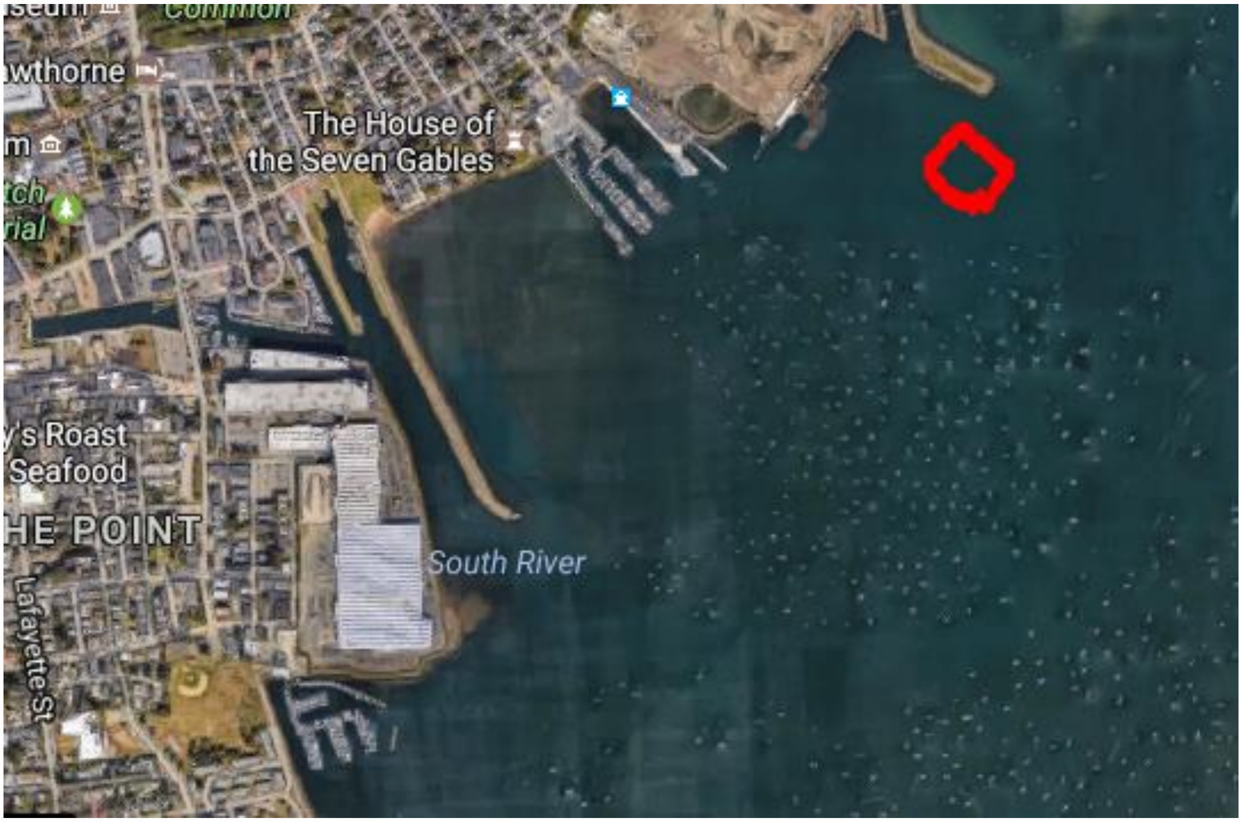


Figure 21. Google Map of Salem Harbor with my proposed CAD cell location in the red box located at Turning Basin. 60m by 60m.

Conclusion

After sub-bottom surveying Cat Cove, Turning Basin, and Derby Wharf, processing and interpreting the lines recorded on the boat, recording sediment volumes and depths, studying core samples and reading other articles on this subject; I think that Turning Basin would be the best candidate in Salem Harbor to host a CAD cell holding contaminated estuarine sediments from South River. Although there may be some setbacks with the public through navigation and boat moorings, this is the easiest and safest place to put a CAD cell without a large probability of failure due to its large volume of clean glaciomarine sediment.

References Cited

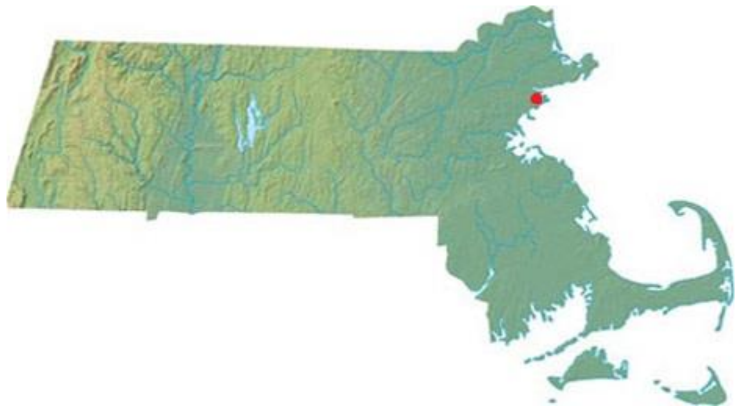
Annadale, M., Hubeny, B., Monecke, K., 2017, Determining the Late Quaternary Geologic and Relative Sea Level History of Salem Harbor Using Dated Sediment Cores and Sub-bottom Geophysics, Geological Society of America Abstracts with Programs. Vol. 49, No. 2.

Fredette, T.J., French, G.T., 2004, Understanding the Physical and Environmental Consequences of Dredged Material Disposal: History in New England and Current Perspectives, US Army Corps of Engineers, New England District, 696 Virginia Rd., Concord, MA 01742, USA

Long, E., Macdonald, D., Smith, S., Calder, F., 1995, Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments, Environmental Management Vol. 19, No. 1.

NOAA, 1999, Sediment Quality Guidelines Developed for the National Status and Trends Program.

Appendix A



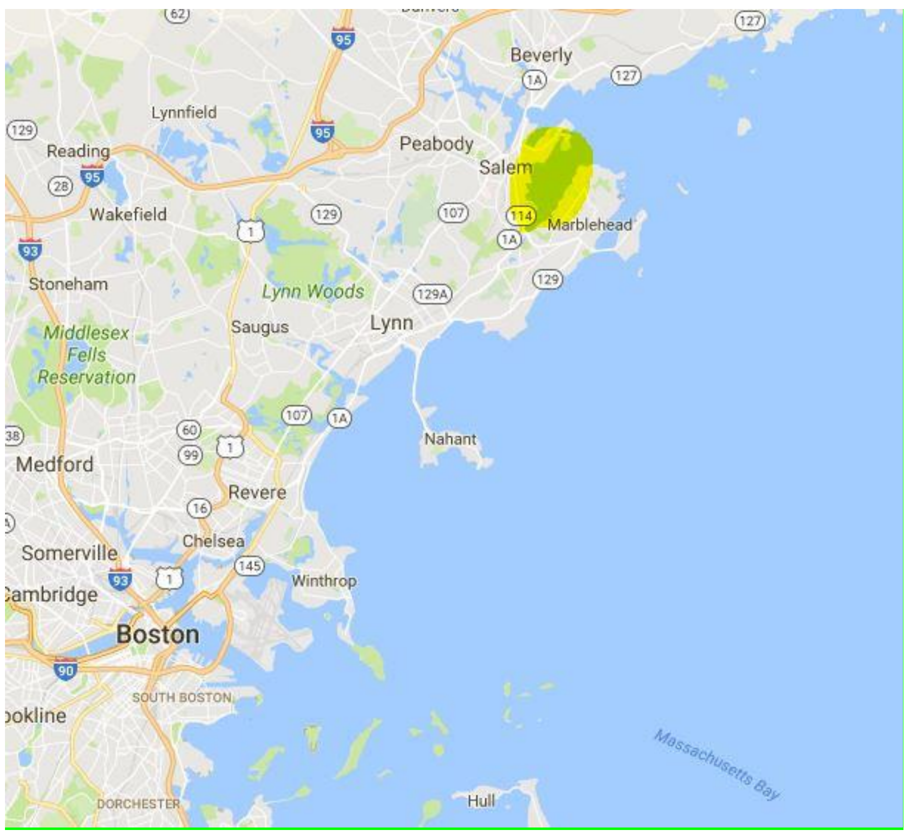


Figure 1. This is the index map of the location under consideration for this surveying project. The yellow highlight on the map indicates the exact location of Salem Harbor we are mapping in Salem, MA.

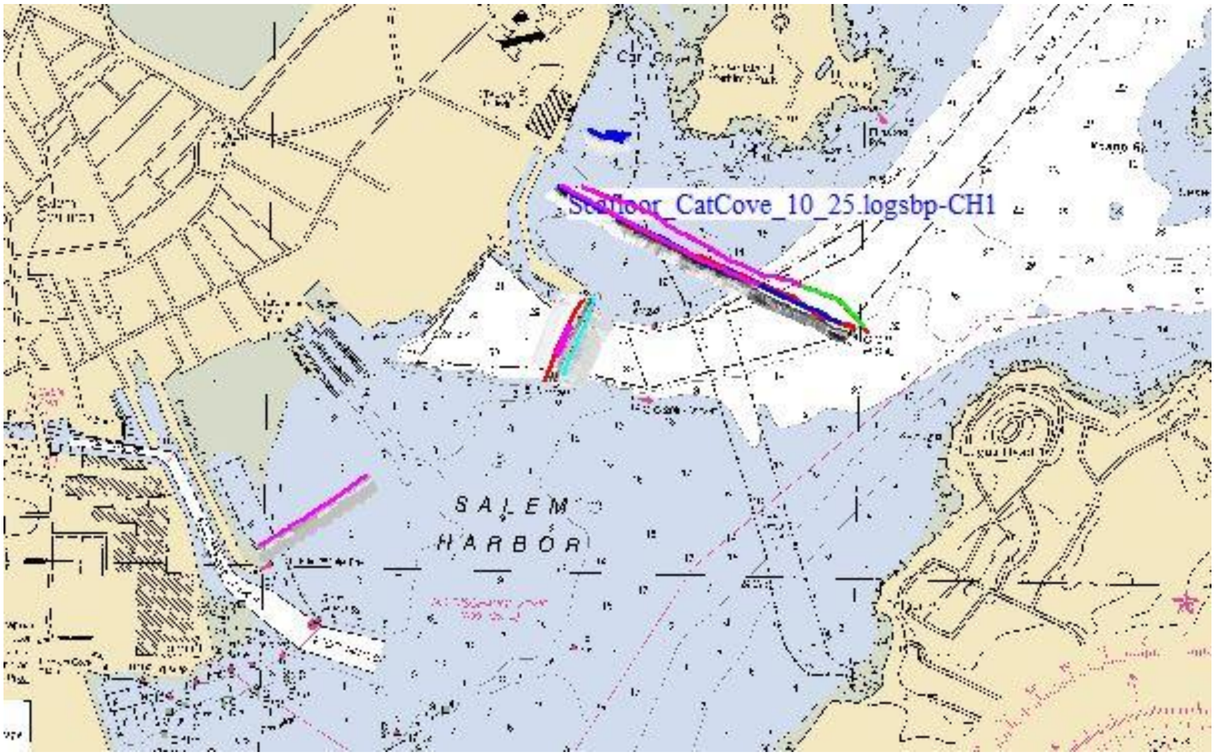


Figure 2. This is a locus map of Salem Harbor, Salem, MA. The three areas of study; Cat Cove, Derby Wharf, and Turning Basin are shown here with the pink and blue lines on the map. These lines represent the interpretable lines used for this project at each target area.

Introduction

Viking Consulting LLC is proposing a potential dredging project in Salem Harbor (*fig.1)* in hopes to extend the shoreline and board walks for tourism purposes. Salem Harbor is said to have contaminated sediments from the industrial age when Peabody, MA was notorious for its tanning factories. These tanning factories in Peabody disposed of their contaminated wastes in Salem Harbor. Dredging and removing these contaminated sediments could be hazardous if not done properly. This surveying project is allowing us to use seismology to identify the stratigraphy of the sub-bottom sea floor, depths and relative age of sediments, and what sediments are contaminated. By doing this, we can also identify one or more places that could be used as a CAD cell to dispose of the contaminated sediments properly. This project was a preparation for the class to be able to properly tune the sub-bottom system and to understand what different frequencies, power, and gain values would work best for each target area; Cat Cove, Turning Basin, and Derby Wharf, based on the lines given to us for this exercise (*fig.2)*.

Methodology

Five lines at each configuration of 3.5kHz/600W, 3.5kHz/200W, and 10kHz/300W and 55dB, 45dB, 35dB, 25dB were given to us as an exercise to be able to understand how each configuration can either give better or worse data based on a specific target area. We used SonarWiz to construct our maps and edit the lines given to us. SonarWiz allows you to draw lines for the sediment-water interface, the acoustic basement, and the Pleistocene-Holocene disconformity. SonarWiz also allows you to edit the resolution, intensity, gain, and stacking of the particular line being interpreted, making it easier to see these boundaries when the data isn't clear.

Results

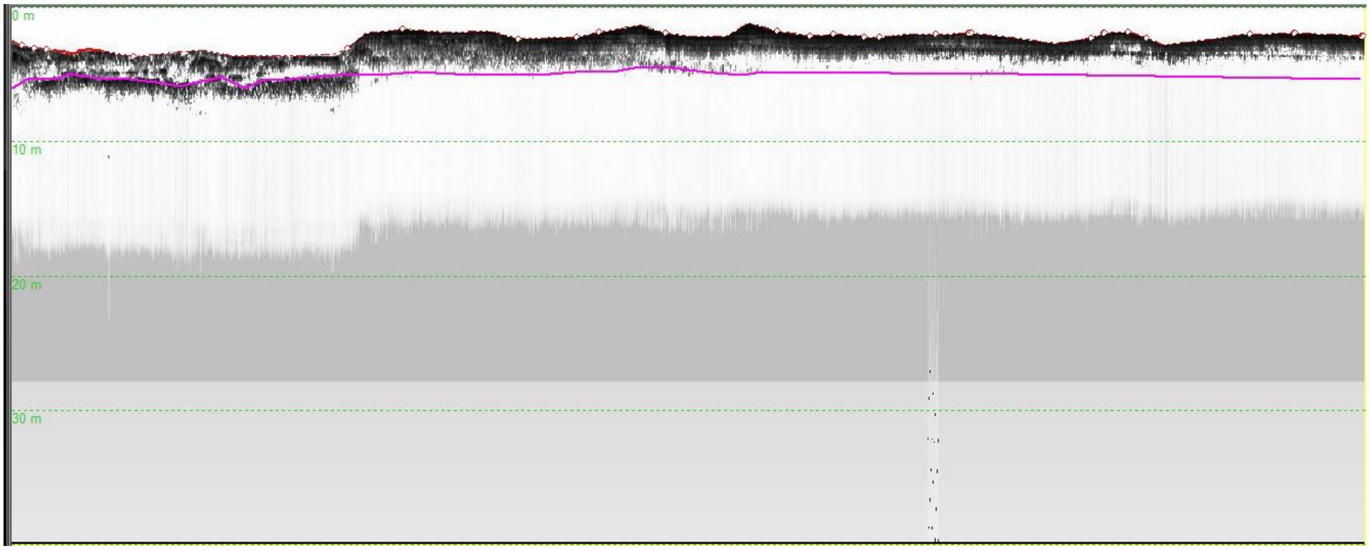


Figure 3. Line taken at Derby Wharf at 10kHz, 300 watts, and 15dB. The red line displays the sediment-water interface, and the pink line displays the disconformity.

The line taken at Derby Wharf (*fig.3)* was the only clear line I could properly interpret without inferring data. Although the acoustic basement is not shown here, the sediment-water interface and disconformity are clearly shown.

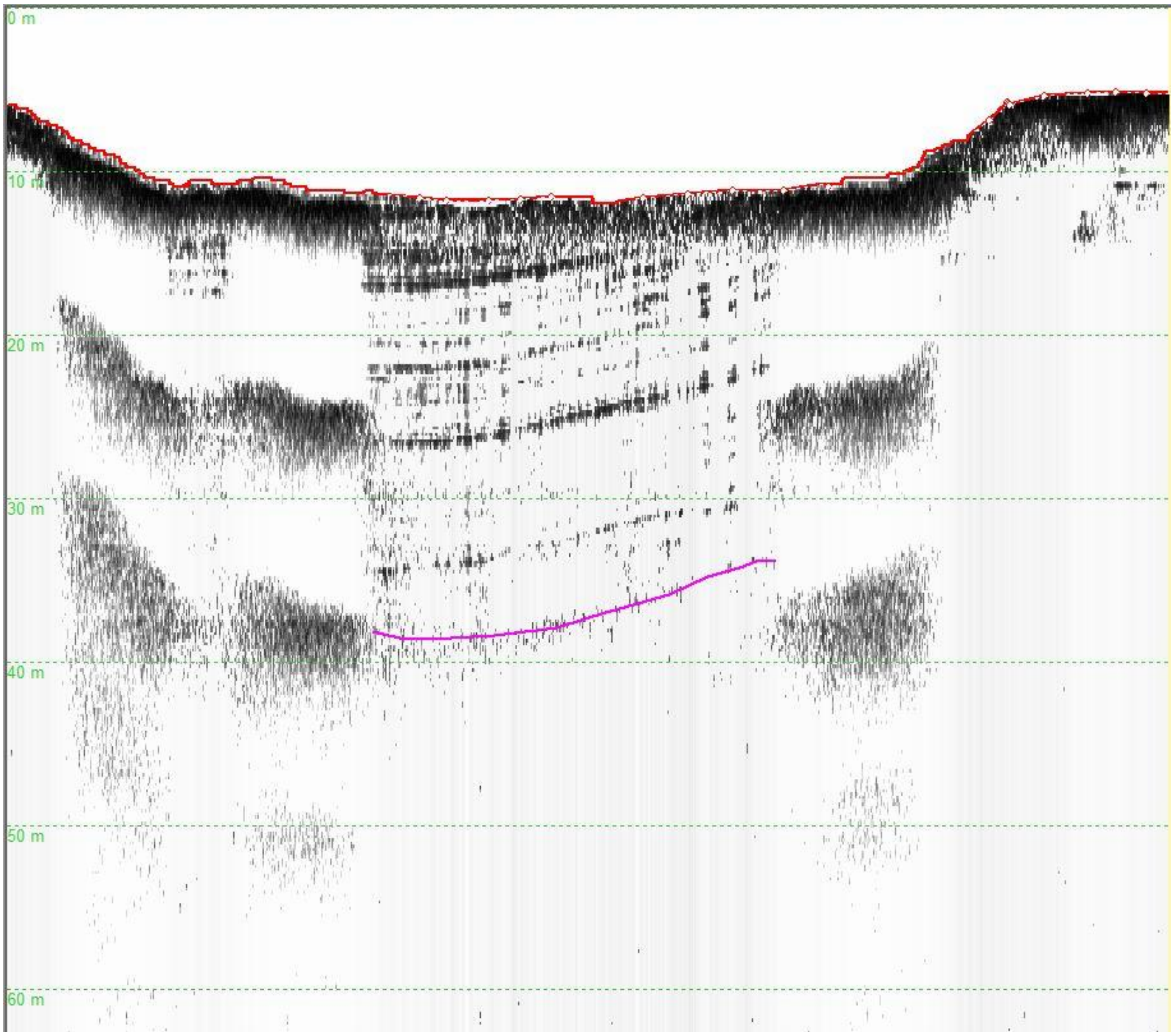


Figure 4. Line 1 taken at Turning Basin at 10kHz, 300 watts, and 25dB. The red line displays the sediment-water interface, and the pink line displays the acoustic basement.

Line 1 taken at Turning Basin (*fig.4)* displays a clear sediment-water interface but no disconformity. I had to interpret and infer data for the acoustic basement since it isn't clearly shown in this particular line at this particular configuration.

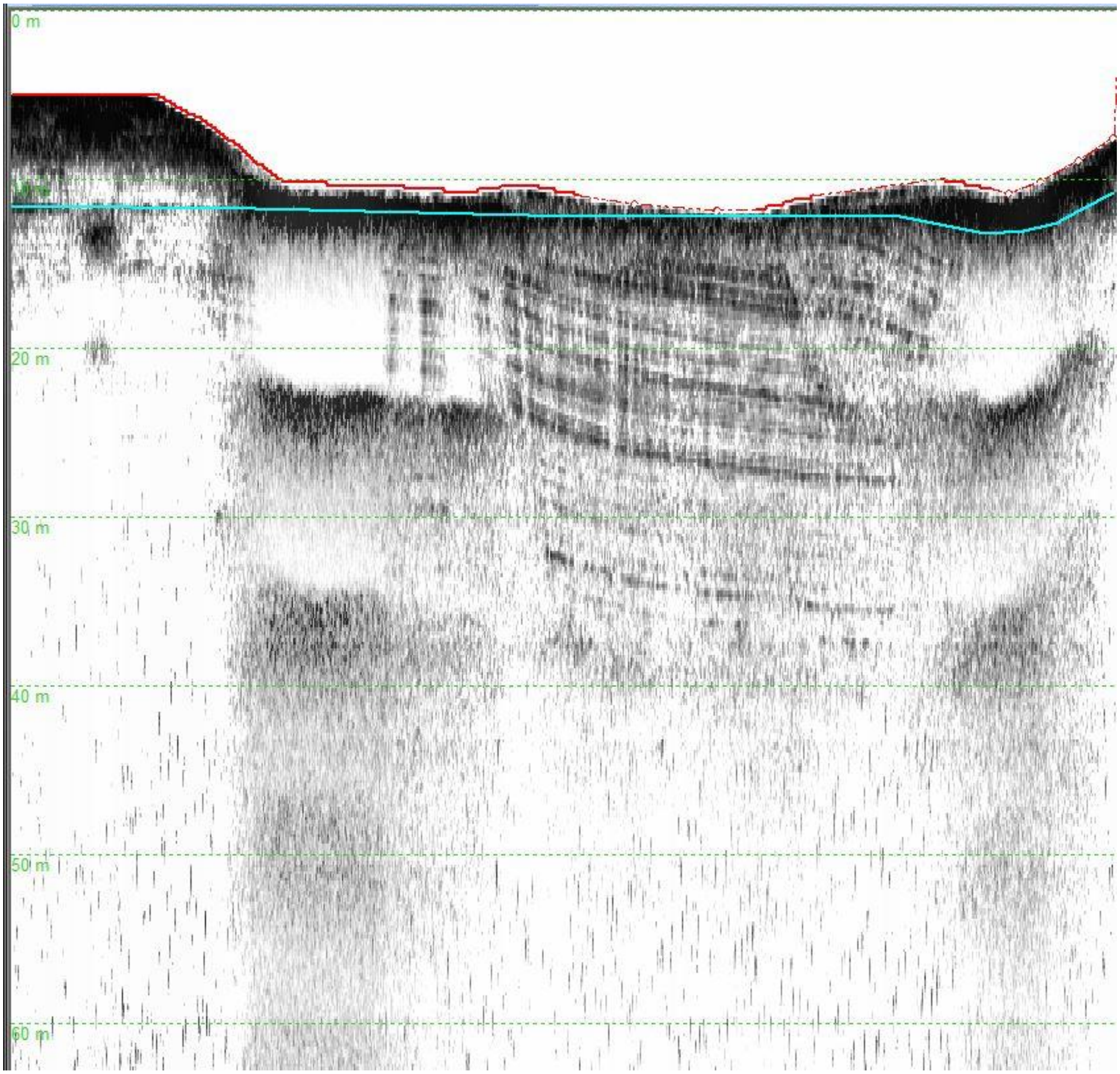


Figure 5. Line 2 taken at Turning Basin at 10kHz, 300 watts, and 35dB. The red line displays the sediment-water interface, and the blue line displays the disconformity.

Line 2 taken at Turning Basin (*fig.5)* displays a clear sediment-water interface and a fairly clear disconformity. No definite acoustic basement at this particular configuration and line is shown here without inferring data.

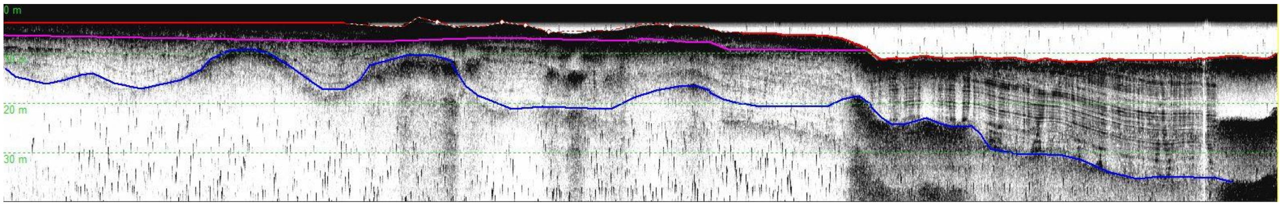


Figure 6. Line 1 taken at Cat Cove at 3.35kHz, 200 watts, and 55dB. The red line displays the sediment-water interface, the pink line represents the disconformity, and the blue line represents the acoustic basement.

Line 1 taken at Cat Cove (*fig.6)* shows very good features. All three sub-bottom features are displayed really well here at this particular sonar configuration.

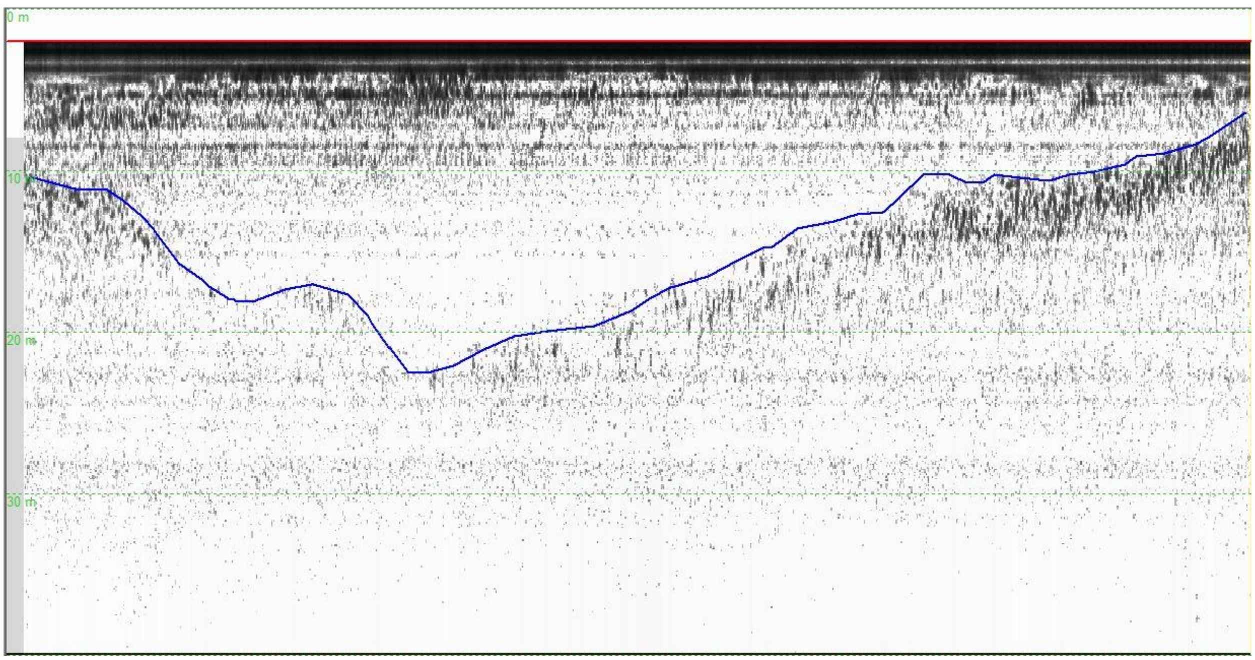


Figure 7. Line 2 taken at Cat Cove at 3.5kHz, 200 watts, and 55dB. The red line displays the sediment-water interface and the blue line displays the acoustic basement.

Line 2 taken at Cat Cove *(fig. 7)* doesn't show a detailed sediment-water interface or disconformity, but shows a clear acoustic basement at this particular configuration at this target area.

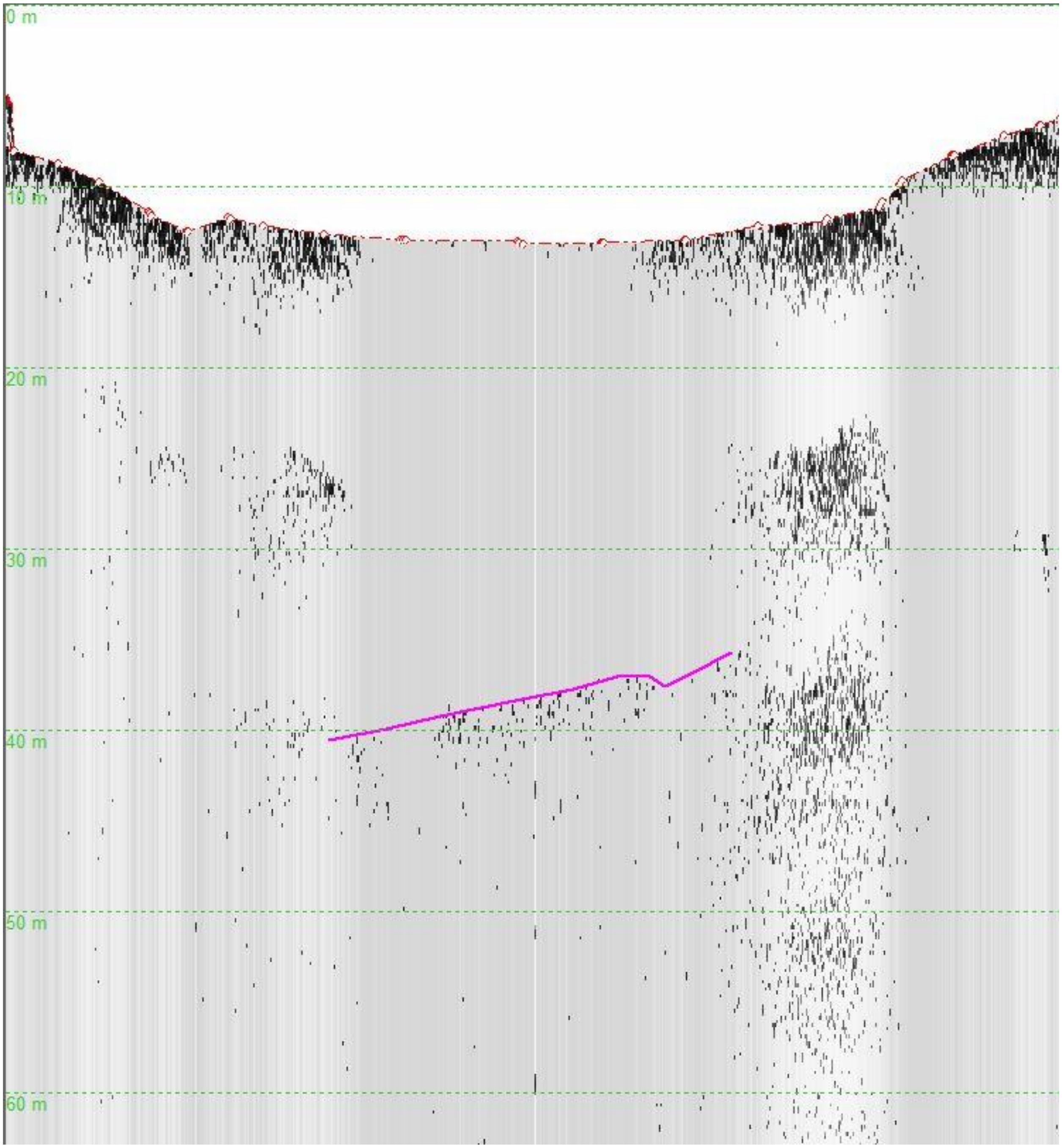


Figure 8. Line 3 taken at Cat Cove at 3.5kHz, 200 watts, and 55dB. The red line shows the sediment-water interface and the pink line displays the acoustic basement.

Line 3 taken at Cat Cove (*fig.8)* displays a fairly clear sediment-water interface and a little portion of the acoustic basement. With adjusting the gain settings, it was possible to interpret this data a little better.

Discussion

The only line on Derby Wharf that was relatively interpretable was at a configuration of 10 kHz, 300 watts, and 15dB; but only showed the sediment-water interface and disconformity but no acoustic basement. In order to get a line that shows the acoustic basement, we may need to use the 3.5 kHz frequency instead.

The first line at Turning Basin has a configuration of 10 kHz, 300 watts, and 25dB; but only showed the sediment-water interface clearly. Some of the acoustic basement was interpretable when I edited the gain settings on SonarWiz. The second line at Turning Basin has a configuration of 10 kHz, 300 watts, and 35dB; but only showed the sediment-water interface and disconformity clearly, but no acoustic basement. In order to get an interpretable acoustic basement at this particular target area, we need to lower the frequency from 10 kHz to 3.5 kHz.

The first line taken at Cat Cove had a configuration of 3.5 kHz, 200 watts, and 55dB and showed all three sub-bottom features very well. The second line taken at Cat Cove had a configuration of 3.5 kHz, 200 watts, and 55dB didn’t show the sediment-water interface or disconformity well but displayed the acoustic basement very well. In order to get a clear sediment-water interface and disconformity at this target area, we may need to use a 10 kHz frequency. The third line taken at Cat Cove had a configuration of 3.5 kHz, 200 watts, and 55dB and showed a clear sediment-water interface but no clear disconformity or acoustic basement; although I interpreted the little bit of acoustic basement that was visible on the line. At this specific target area, we may need to use the higher frequency to see a clear disconformity and sediment-water interface but a lower frequency to see the acoustic basement.

Conclusion

At Derby Wharf, we should use the sonar configuration of 10 kHz, 300 watts, and 15dB to get a clear sediment-water interface and disconformity; but we may need to use a 3.5 kHz frequency here in order to see the acoustic basement.

At Turning Basin, we should use the configuration of 10 kHz, 300 watts, and 25dB to see the sediment-water interface clearly, but we may want to use a configuration of 10 kHz, 300 watts, and 35dB to see a clear disconformity. In order to see the acoustic basement clearly at this target area, a 3.5 kHz frequency must be used.

At Cat Cove, we should use the configuration of 3.5 kHz, 200 watts, and 55dB to get clear features in this target area.

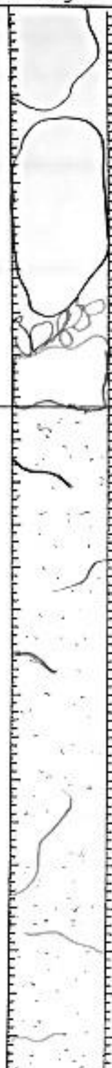
Appendix B

INITIAL CORE DESCRIPTION

LAKE ________ CORE ID SHVC 15A|B

SECTION LENGTH (cm) ###.# mblf top ###.# Describer Laura B.

SED. LENGTH (cm) ###.# mblf bot ###.# Date ________

Depth (cm)	STRUC	UNIT	MS (SI)	Image	LITHOLOGIC DESCRIPTION
0–45 (SHVC 15-A)					tan (2.5YR 8/2), massive, fine-grained sand, moderately sorted, sand to silt.
45–125 (SHVC 15-A)					tan (2.5 YR 8/3), massive, rounded well-sorted silt.
125–155					

INITIAL CORE DESCRIPTION

LRC

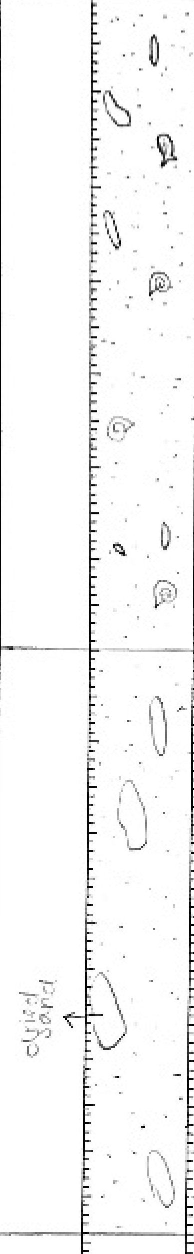
LAKE:

CORE ID: SHVC 11

SECTION LENGTH (cm): ###.#   mblf top: ###.#   Describer: Laura Budrow

SED. LENGTH (cm): ###.#   mblf bot: ###.#   Date:

Depth (cm) | STRUC | UNIT | MS (SI) | Image | LITHOLOGIC DESCRIPTION



grayish brown (2.5Y 6/2), massive, poorly sorted very fine sand with peat and hash (shell) fragments.

light yellowish brown (2.5Y 6/4), massive, well sorted very fine sand with small hash fragments (shells).

10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

INITIAL CORE DESCRIPTION

LRC

LAKE ______ SECTION LENGTH (cm) ###.# mblf top ###.# Describer Laura Budrow

CORE ID SHVC -13 A|B SED. LENGTH (cm) ###.# mblf bot ###.# Date ______

Depth (cm)	STRUC.	UNIT	MS (SI)	Image	LITHOLOGIC DESCRIPTION
0–10					light yellowish brown (2.5Y 6/4), massive, well-sorted very fine sand.
10–55					light olive brown (2.8Y 5/3), massive, poorly sorted fine sand with pebbles and granules.
55–155			dried clumps of sand (approx. 95–135 cm)		light yellowish brown (2.5Y 6/4), massive, well-sorted very fine sand.

INITIAL CORE DESCRIPTION

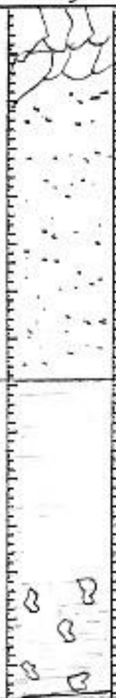
LRC

LAKE ______ CORE ID SHVC - 09

SECTION LENGTH (cm) ###.# mblf top ###.# Describer Laura Bidrow

SED. LENGTH (cm) ###.# mblf bot ###.# Date ______

Depth (cm)	STRUC	UNIT	MS (SI)	Image	LITHOLOGIC DESCRIPTION
0–40					Light Olive brown (2.5Y 6/4), massive, well-sorted very fine sand
40–73					Light brownish grey (2.5Y 6/2), massive, poorly sorted, medium grained sand with small pebbles and angular granuales.



INITIAL CORE DESCRIPTION

LRC

LAKE ______ SECTION LENGTH (cm) ###.# mblf top ###.# Describer Laura Buckow

CORE ID SS16 KC1 and 2 SED. LENGTH (cm) ###.# mblf bot ###.# Date ______

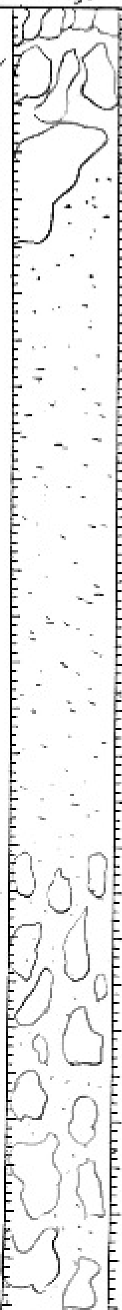
Depth (cm)	STRUC	UNIT	MS (SI)	Image	LITHOLOGIC DESCRIPTION
0–60 (KC2)	ESTUARINE				Green-grey (5Y 3/1), massive, silt, muddy sand with peat and hash fragments
60–137 (KC1)	ESTUARINE				Green-brown (5Y 3/2), massive, silt, muddy sand, with hash fragments.
137–150 (KC1)	GLACIO MARINE				Green-grey (5Y 4/2), massive, well-sorted clay.

INITIAL CORE DESCRIPTION

LAKE ______ CORE ID SHVC 02A | B

SECTION LENGTH (cm) ###.# mblf top ###.# Describer Laura Budrow

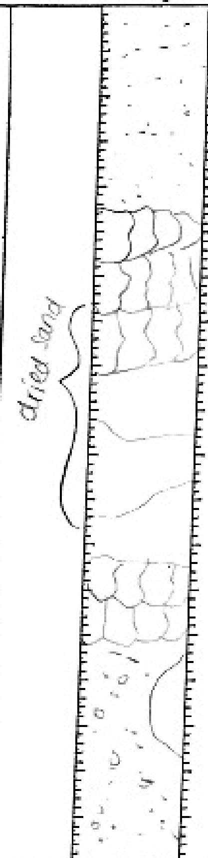
SED. LENGTH (cm) ###.# mblf bot ###.# Date ______

Depth (cm)	STRUC	UNIT	MS (SI)	Image	LITHOLOGIC DESCRIPTION
			dried sand		Pale yellow (2.5Y 7/4), massive, well-sorted very fine sand to silt.
			dried sand clumps		

INITIAL CORE DESCRIPTION

LAKE ____________ SECTION LENGTH (cm) ###.# mblf top ###.# Describer Laura Budrow

CORE ID SHVC-14 SED. LENGTH (cm) ###.# mblf bot ###.# Date ____________

Depth (cm)	STRUC	UNIT	MS (SI)	Image	LITHOLOGIC DESCRIPTION
					Pale yellow (2.5Y 7/3), massive, very fine sand at top; coarser as you move down the core, with few pebbles and granules.

INITIAL CORE DESCRIPTION

LRC

LAKE ______ SECTION LENGTH (cm) ###.# mblf top ###.# Describer Laura

CORE ID SHVC - 21 SED. LENGTH (cm) ###.# mblf bot ###.# Date ______

Depth (cm)	STRUC	UNIT	MS (SI)	Image	LITHOLOGIC DESCRIPTION
0–108	ESTUARINE		Aluminum trash (~62–92)		light Olive brown (2.5y 5/3), massive, poorly sorted sub-angular medium to very coarse sand with granules, pebbles, aluminum trash and small peat fragments peat (~102–108)
108–150	GLACIOMARINE				Grey-tan (2.5y 6/2), massive, poorly sorted Sub-angular silt to very fine sand.