Examining Thermal Pollution and Exploring Environmental Injustice in Holyrood, NL

Thermal Flashlight Project

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Executive Summary

Statement of Problem

In what ways does the environmental pollution of industrial corporations affect the communities in which they are situated?

Our research is specifically concerned with the Holyrood Thermal Generating Station in Holyrood, Newfoundland and its Cooling Water Outfall, hereafter referred to as "the site." The effluent flows at a rate of 40,000 to 150,000 gallons of water per minute directly into the waters of Conception Bay and is located on public land next to a small community. We believe the pollution emitted from the plant can have negative impacts on the surrounding environment and human populations.

Aspects of Problem

- thermal pollution into surrounding ocean
- possible harm to fish and aquatic environment due to warmer temps
- local people using the effluent area for fishing
- contamination
- accessibility of site and technological limitations (problem as researchers)

Methodology

We used a thermal flashlight, which is a LED flashlight with an infrared sensor that "paints" the temperature on the surface of the water directly. By using the thermal flashlight, we believe we could gain a better understanding of environmental damage by testing for increases in surface water temperature, which could indicate the presence of thermal pollution.

Main Findings

<u>Technological</u>
There are site-specific limitations to using this technology: the presence of water and salt spray in the air, the wind chill, and the rough terrain. After adapting the thermal flashlight for measurement of surface water temperature, we experienced some technical difficulties, which we hypothesize were a result of exposure to salt water or particles or salt in the air.

<u>Environmental</u>
The surface water temperature of the site's effluent ranged from 11 – 23°F (6.11 – 12.77°C) above our control temperature (see Technological Findings, p. 7). We were told fish are attracted to the area due to the warm temperatures. Acute lethality tests (ALT) were conducted in the plant's other effluent site in Indian Pond, and failed these tests five out of eight times in 2013. We also discovered 14 tonnes of sulphuric acid were discharged directly into Conception Bay in 2012.

<u>Social</u>
Based on our conversations with locals and environmental officials, the local population uses the site for fishing. We believe thermal pollution is present, but are unsure of the extent to which it affects the site's aquatic environment.

Research Question

In what ways does the environmental pollution of industrial corporations affect the communities in which they are situated?

Our group began examining our research question by conducting research at the Holyrood Thermal Generating Station, which is operated by Nalcor Energy. The plant is located in Holyrood, Newfoundland, a small community of approximately 2000 people. The plant currently generates 15-25% of the island's electricity and at peak times, it can burn up to 18,000 barrels of oil each day (NL Department of Natural Resources [NLDNR], 2012). The government acknowledges the plant poses environmental problems, but information on the specific thermal pollution it generates is inadequate (see Appendix, Section 5, p. 41). We believe aquatic pollution can have adverse effects on both the natural environment and the community's use of these resources. Our study also has implications on a broader scale, as resource extraction and global unsustainable development cause environmental injustices and impact local communities around the world.

Methodology

Our project is exploratory in nature, only examining one indicator of aquatic health. We understand our conclusions are limited.

Materials/Equipment

- Thermal flashlight - a LED flashlight with a infrared sensor that "paints" the temperature of the surface directly on the water (http://publiclab.org/wiki/thermal-camera)
- Casing - the casing was built from a small, inexpensive (~ $1) plastic container. We cut out an opening for the sensor and light, and an opening for the power connect. The battery pack was mounted on the exterior for ease of access. We fastened an interchangeable-length handle to extend the reach. We secured a clear plastic bag around the unit with waterproof tape. The sensor could detect temperature through the plastic with a .25 degree difference at 1 inch above water (see Appendix, Field Notes, p. 27).
- Camera - DSLR camera with tripod, iPhone camera/video

Data Collection

- We conducted online research of environmental reports pertaining to Holyrood specifically and industrial thermal pollution generally, as well as into the social implications and effects of public land use by large industry and the governance of the land - the “commons”.
- Site visits - We made three separate visits to our site: First, to make a general assessment of feasibility and access. Second, to calibrate our equipment to the effluent temperature and to take measurements of effluent and ocean temperatures. Third, at night in order to capture good photos of the flashlight while re-taking the temperatures (See Appendix, Field Notes).
- Measurements - by hovering the unit approximately 1 inch above the surface of the water, we took a baseline/control temperature of the ocean outside of the area affected by the effluent. By the same method, we then took the temperature of the two different effluent pipes and calibrated our flashlight on-site to reflect these temperatures.

- Data visualization - we documented the process with photographs and video (see Appendix, Section 3, p. 17).
- Interviews - spoke to one of the environment experts at Holyrood, spoke with the effluent expert at the Department of Environment and Conservation, and we spoke to a fisherman on site about his (and others') interaction with the effluent site and his perceptions of levels of contamination of the water.

Limitations of Data Collection

- Wind chill - can affect accuracy of temperature readings.
- Technology and Water - difficult to get water temperatures with equipment not designed specifically for water -we had to hack it as best we could with waterproofing the unit.
- Terrain - long trek over uneven, rocky ground to the site. To access the site itself, we had to negotiate large boulders and steep slopes.
- Tech failure - difficult to troubleshoot out in the field, no internet access.
- Accessibility - in addition to the physical issues of access, our own assumptions about accessibility impeded our project. On our first visit to Holyrood, we noted that the entire station is fenced, with security personnel, and we came to the conclusion that the effluent would be behind the fence. We assumed that we would faced with bureaucratic resistance and initially decided to focus our research on (what we thought would be) a more accessible place. The imposing nature of the station and lack of knowledge of public land access can be a major factor in stopping people from taking action.

Spectacle

- The Holyrood station effluent site is in an isolated location away from populated areas, therefore, we chose to make a video, playing up our issues with accessibility and technical problems.
- Dissemination - The "spectacle" will be in the dissemination of the video to environmental or climate justice groups, both locally, nationally and internationally such as: NLEN (Newfoundland and Labrador Environment Network http://www.nlen.ca), Pollution Watch (http://www.pollutionwatch.org), MUN Oxfam, Conservation Corps of NL. In addition, we have posted the video to youtube (http://youtu.be/UZ_3m8QwdqE) and the MUN Sociology Facebook page.

"Doing" Sociology with a Thermal Flashlight

"Communities lack access to the tools and techniques needed to participate in decisions being made about their communities, especially when facing environmental hazards." (http://publiclab.org/home)

- Feminist design - The flashlight is DIY, with lots of online support and help available. It is an accessible piece of technology and we made every effort to keep our casing simple; inexpensive, readily available materials were used. It is easy to open/access to repair/hack - indeed, the casing encourages it - rejecting any notion of technophobia based in the assumption that certain publics dislike or are fearful of technology (van Oost, 2005). With this in mind, we also strove to keep the casing non-gendered.

- Data visualization - Seeing heat directly in this way may enable an individual to think about concepts such as one's interactions with technology in a new way.
- Social justice - Due to the feminist, and therefore accessible nature of our technology, our research can - quite literally - put technology in the hands of the people. The design discussed above allows non techies to “do” their own research. This is a big part of giving the people the ability and knowledge to participate in governing the commons. Putting technology in the hands the people - not having to rely on the “experts,” can lead to a new social dynamic, a changing of the power balance. By removing the barriers to act - to be an activist - we can expose power relations, which then allows people to hold industry accountable for their land use by making visible the physical and human impact (Wajcman, 2009). “When we recognize the role of human choice...we must recognize [that] technology is about power: social, cultural, economic, political.” It is these powers that “shape opportunity and access” (McGraw, 1996, p. 7).

Findings

Technological Findings

The technological findings in our research study show how certain types of technologies, such as the thermal flashlight, that haven’t been thoroughly tested can present obstacles when trying to quantify results. For instance, when testing heat temperature of water such technologies tend to be fragile when they come into contact with water. Initially in our research study, we had been given a thermal fishing bob that we had intended to use to do our research study. However, through testing the technology we came to the realization that it had many technical faults such as the sensor not working, which presented a major problem given our goal of reading surface water temperature. We ended up having to use the thermal flashlight which we had to adjust according to certain temperatures in order to give us accurate readings of what the water temperature was in the particular areas we were testing.

Site Specifications:

The thermal flashlight has not been tested to measure surface water temperature. Through our research at Holyrood, it could indicate how such a technology can be useful under such circumstances. Initially before proceeding with using our thermal flashlight, we had to conduct our own test in a controlled environment, such as the bathroom tub, in which we used tap water and tested cold, warm and hot water to see if we could get any readings. Based on our testing in a controlled environment our data visualization was successful and we had hoped it would be similar with the data visualization at the Holyrood site. To ensure that such a technology would be useful, we had to build a casing for it, using a plastic box casing that would not only fit the sensor, but also made sure it was waterproof to avoid any sorts of damages that would affect our readings and technology. With such a casing we had for the technology, we had to wrap it around a plastic bag and ensure no water would enter inside and affect the results we had been anticipating when testing the various water temperatures.

Tech Specifications:

The technology requires a lot of patience and proper timing in order to get the needed results. We came to the realization that once the technology comes into contact with surface water it can be troublesome in trying to get accurate and quantifiable results. We managed to get the results we needed and also the lighting to reflect the temperature of the areas we were testing. Also such a technology works well in controlled environments, as there tends to be less chances of having results read way higher than what is expected. For instance, after testing the surface of water temperature in a bathroom tub compared to that of a high pressure water source, we realized that if such a technology is not properly covered and comes into contact with water it would jeopardize any sort of accurate readings and would need replacement, which is a process in itself when working in a short period of time and trying to meet certain deadlines.

Surface Water Temperature Readings

We visited the Holyrood site and recorded the temperature of the coolant effluent on November 25, 2014, to determine if thermal pollution may be present. The air temperature was approximately 13°C on the day we visited and it was very windy. Before collecting data at the effluent, we took a control temperature of the surface water away from the site, which we recorded as approximately 42°F (5.56°C). We found two discharge areas at the effluent site, one of which was approximately 53°F (11.67°C) and the other of which was 65°F (18.33°C). We measured the surface temperature of the water around the entire site, noting that at the mouth of the effluent, where the water enters Conception Bay, the temperature was still around 60°F (15.56°C), significantly warmer than our control site (see Appendix, Temperature Maps, p. 15).

<u>Social Findings</u>

Environmental Impacts of the Holyrood Thermal Generating Station

Through our detailed research online about the Holyrood plant's effluent, we found very little information about our specific point of data collection, which is known as the Cooling Water Outfall. Detailed information was available about the Continuous Basin and Periodic Basin effluents, which run into Indian Pond (see Appendix, Site Maps, p. 13). According to the NL Department of Environment and Conservation's (2013) “Industrial Effluent Compliance 2012 Annual Report,” both basins passed a number of measurement tests for pH levels, various chemicals, and the amount of total suspended solids (p. 45-47). However, the Continuous Basin failed its acute lethality tests (ALT) for rainbow trout five out of eight times throughout the year (NL Department of Environment and Conservation [NLDEC], 2013, p. 46). Environment Canada (2007) uses this test for “measuring and assessing the aquatic biological effects of toxic substances.” To pass this test, more than 50% of the rainbow trout being examined must remain alive after 96 hours of exposure to the effluent water (Environment Canada, 2007).

The report notes, however, that this test is for monitoring purposes only and does not impact the facility's compliance with effluent regulation (NLDEC, 2013, P. 45). According to personal communication with an environmental scientist at the Department of Environment and Conservation, if failure occurs on a number of occasions, the department investigates with the company. Interestingly, this test is the only one that directly measures the effects of the plant's effluent on the health of the aquatic environment and yet its failure does not negatively impact the plant's compliance with effluent regulations and therefore its subsequent operations. Although one employee of the Holyrood plant admits this test is “not ideal science” and sometimes it is unclear what causes the ALT tests to fail, this test continues to be one source of measuring aquatic health.

We chose our site based on the relatively little data available on its outflow, as well as our belief that the water would be warmer here and therefore conducive to research with our thermal flashlight. This effluent site releases 40,000 to 150,000 gallons of effluent per minute directly into Conception Bay and is on public land. Information about the coolant effluent is somewhat limited based on our internet research. According to one employee of the Holyrood plant, detecting metal concentrations in partial brackish water, such as our site, is difficult and so he is not entirely confident what is being released into Conception Bay. However, according to Environment Canada's (2014) "Facility & Substance Information" 2013 report, 14 tonnes of sulphuric acid was released through discharge into Conception Bay from the plant throughout the year. Sulphuric acid has moderate short- and long-term toxicity on aquatic life, demonstrating the potential for ill effects on the environment due to this outflow (Australian Government Department of the Environment, 2014).

By using our thermal flashlight, we wanted to gain a better understanding of further environmental damage by testing for the presence of thermal pollution. Thermal pollution refers to the adverse effects resulting from human-induced changes to the temperature or natural bodies of water (John, 1971). We hypothesized that thermal pollution would exist at our site because coolant effluents often cause water temperatures to rise (John, 1971). Research shows that the consistent natural water temperature is crucial for ecosystem equality, as many aquatic animal species have a limited temperature tolerance (Verones et al., 2010, p. 9364). Impacts on aquatic animal life include changes in metabolic rates, reproduction, and growth; death; and the destruction of species (John, 1971). For example, as water temperature increases, the amount of oxygen in the water decreases,. This change can increase the metabolic rate of fish and cause them to use more oxygen, the combination of which can be detrimental to the species (John, 1971, p. 290). As our findings in the previous section indicate, the water temperature was significantly warmer in our site than our control temperature. Therefore, we believe that thermal pollution exists in the direct vicinity of the Cooling Water Outfall. We acknowledge the limitations of our findings, such as the technology's inability to measure water temperature below the surface and our inability to detect the full impact of the thermal pollution on the aquatic environment. However, we believe further research should be made readily available to the public on this effluent's effects on the aquatic environment of Conception Bay, including the precise substances in the effluent and the extent and effect of the thermal pollution.

Social and Cultural Impacts of the Holyrood Thermal Generating Station

We believe using literature on environmental justice and governing the commons is most effective when examining the potential impacts of thermal pollution on local communities, as Newfoundland's history is strongly tied to aquatic resource governance. The culture of our province is heavily influenced by the fishing industry and reliance on the ocean. For hundreds of years, the cod fishery has had a huge impact on the Newfoundland economy and Newfoundland culture; the socio-economic structure of the province, the geographical location in which people lived, and people's ability to sustain themselves all depended on the fishery and the ability to access natural resources in the ocean (Ommer, 2002). However, in 1992, the federal government declared a moratorium on the cod fishery due to depleted resources from overfishing. This moratorium impacted 9,000 fisherman and 10,000 plant workers, according to conservative estimates (Schrank and Roy, 2013). Therefore, central to Newfoundland culture and identity is the reliance on the commons, or common pool resources, which refer to natural resources to which everyone has a right, such as the ocean, but which institutions often try to govern (Ostrom, 1990). As the collapse of the cod fishery shows, tensions exist between Newfoundlanders' capacity to live sustainably and industrial development that promotes resource exploitation.

Equitable governance of a commons through the maintenance of healthy aquatic environments is especially important for our site at the Holyrood plant because it is a known fishing spot, according to both a Holyrood employee and a local fisherman. On our site visits, we saw many boats in Indian Pond and on our walk back from the site during our second visit we spoke to a local fisherman. While the fisherman believes the warmth of the effluent makes the site conducive to sea-going trout, both environmental officials said they were unsure if the relationship was causative. These opinions present a paradoxical finding; if the warm temperatures have created an environment that is suitable for sea-going trout, the plant is inadvertently responsible for the development of an area for recreational fishing, allowing for the perpetuation of a traditional Newfoundland activity. However, despite the lack of test results publicly available on the aquatic health of our specific site, our research and personal findings illustrate the adverse effects to aquatic health and ecosystems that thermal pollution and sulphuric acid have on fish being consumed by local people.

As a result of our findings and observations, we view the thermal pollution as an environmental justice issue rooted in unequal power dynamics between industry and local communities. Environmental injustice occurs when particular groups bear disproportionate environmental burdens or have unequal access to environmental goods, such as clean water and healthy fish (Shrader-Frechette, 2006). The issue of air pollution has been brought up by the residents of Holyrood and the surrounding area, and this unequal burden has been lessened (but by no means eliminated) through facility upgrades (NLDNR, 2012). However, anyone who fishes in these waters continues to experience environmental injustice, as the health of their catch has a relatively higher chance of being contaminated with various chemicals and metals discharged from the plant. Furthermore, the failed ALT tests of 2012 demonstrate the toxic environment in which fish in the surrounding waters struggle to survive.

While it is impossible to extrapolate from our brief conversation with one fisherman, he offered insight into these environmental injustices and power inequalities. He spoke with some skepticism about the health of the aquatic environment and acknowledged that the effluent contains chemicals, but is unsure which ones. He also stated that this fact is widely known and accepted among locals. Despite the acceptance of the potential ill health of the aquatic environment, the man acknowledges the seemingly arbitrary nature of the government's environmental assessments. He told us he knows environmental officials monitor and test the water and say it is acceptable, but then asked us rhetorically, “Acceptable to whom?” This quotation illustrates the divide that exists between the local population who use this public space and its natural resources and government officials who ultimately control the health of the environment through industrial development and waste.

This fisherman's skepticism about vague information from environmental officials and whose needs and wants are being addressed demonstrates the necessity of equitably governing of a commons, as outlined by Elinor Ostrom. Ostrom (1990) challenges the theory of the “Tragedy of the Commons,” which states that privatization is the most effective way to protect finite resources from depletion. By contrast, Ostrom contends that a commons can be governed equitably and sustainably, a quality which would work to mend environmental injustice issues, such as degraded aquatic environments around the Holyrood plant (Walljasper, 2011).

Among the characteristics of successfully governing a commons, Ostrom argues that local needs and decision-making must be acknowledged and accepted by outside authorities, such as the Holyrood plant operators, through effective interaction and information dissemination (Ostrom, 1990; Walljasper, 2011). Environmental justice literature also emphasizes the need for participative justice, defined as "equal rights to self-determination in societal decision-making," demonstrating the importance that must be placed on the opinions and decisions of local people most impacted, such as fishermen (Shrader-Frechette, 2006, p. 24). Based on the fisherman's comment and our own research, we believe government-produced environmental reports are biased and/or lack contextual information to explain the significance of their findings, which may be indicative of a disconnect between industry and the local community (see Appendix, Section 5, p. 41). Although we acknowledge our inability to understand the nature of the relationship between local fishermen and the Holyrood plant administration, the comments of the fisherman we spoke with demonstrate the importance of ensuring public right to participatory governance of the commons.

Conclusion

It is clear that thermal pollution is present at the site, but we are unsure of the extent to which it affects the area's aquatic environment. More in-depth testing should be done for both thermal pollution and water contaminants and on aquatic species, specifically fish, in the area.

Because of Newfoundland's history of industrial dominance of the commons, we believe developing an equitable relationship between the operators of the Holyrood plant and local fishermen would work to create a healthier aquatic environment for the community, ultimately reducing environmental injustices in the area. To this end, emphasis should be place on participatory research methods, engaging and encouraging local involvement. Existing and further research should be transparent, by disseminating all information in an accessible manner to the public.

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Two Research Postings

1. http://publiclab.org/notes/ckenny/12-16-2014/thermal-flashlight-data-collection-in-holyrood-nl

2. http://publiclab.org/notes/acnud/12-17-2014/thermal-flashlight-tech-failure-spectacle

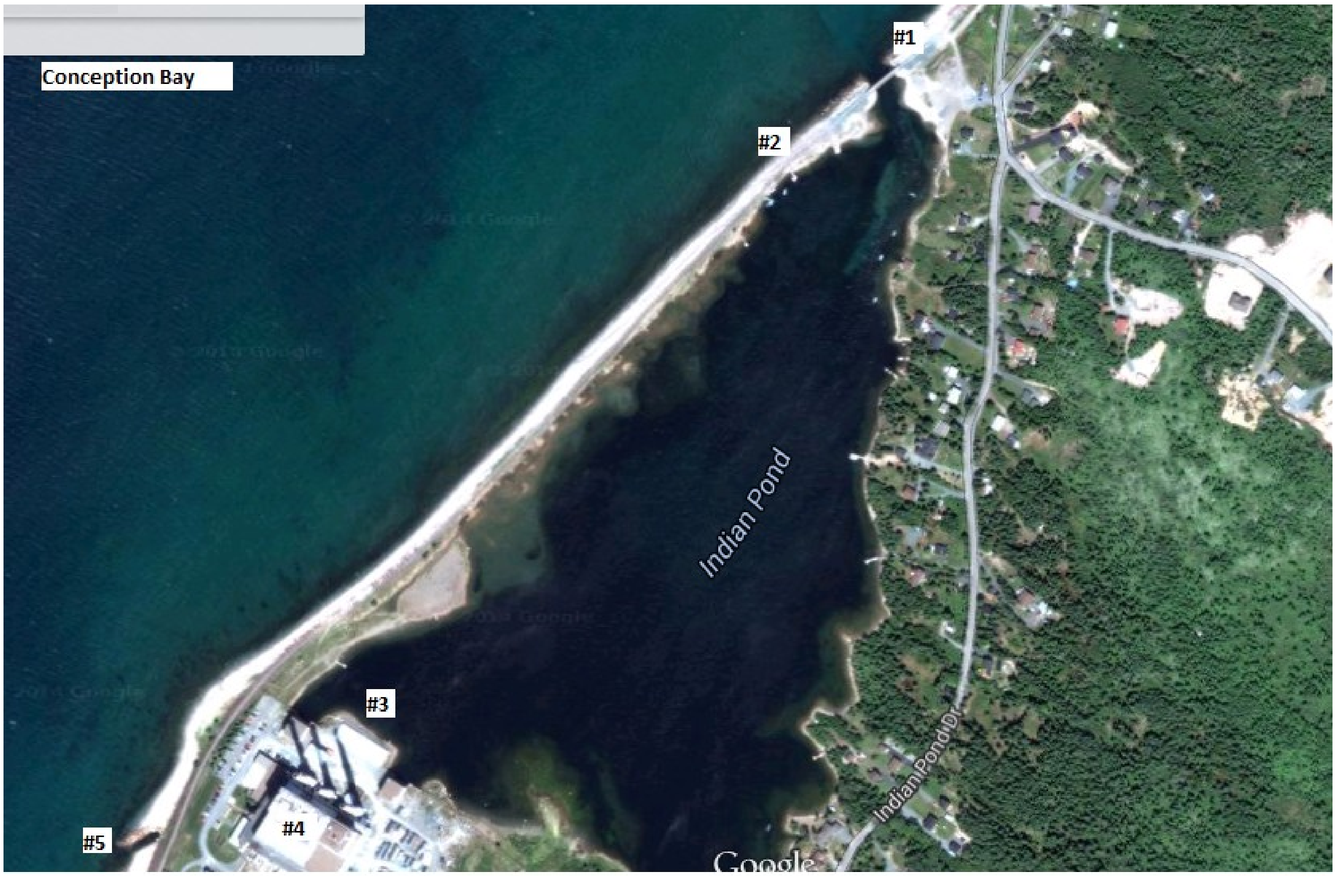
YouTube Video – Spectacle

https://www.youtube.com/watch?v=UZ_3m8QwdqE&feature=youtu.be

Appendix

Section 1: Site Maps

Site Map 1 – Aerial picture of the generating station from Google Maps



Map Key

#1 – Where we started our journey/parked the car
#2 – Approximate location of control temperature collection
#3 – Indian Pond: location of Continuous Basin and Periodic Basin
#4 – Holyrood Thermal Generating Station
#5 – Cooling Water Outfall: our site

Site Map 2 – Closer aerial shot of our site

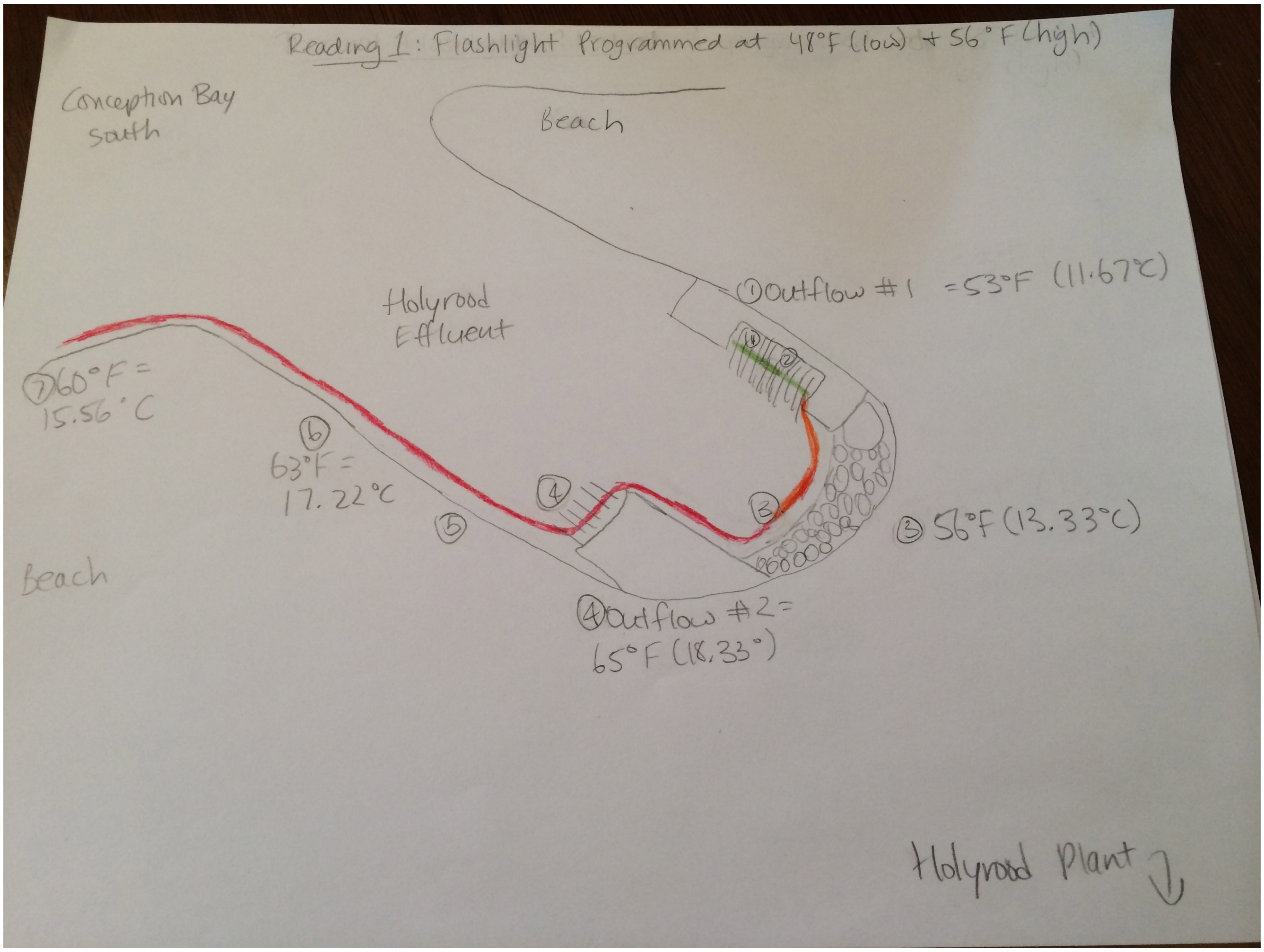
Map Key

Numbers correspond to numbers on the following temperature maps. Key information is available below for locations where temperatures were collected.

#1 – 53°F (11.67°C)
#3 – 56°F (13.33°C)
#4 – 65°F (18.33°C)
#6 – 63°F (17.22°C)
#7 – 60°F (15.56°C)

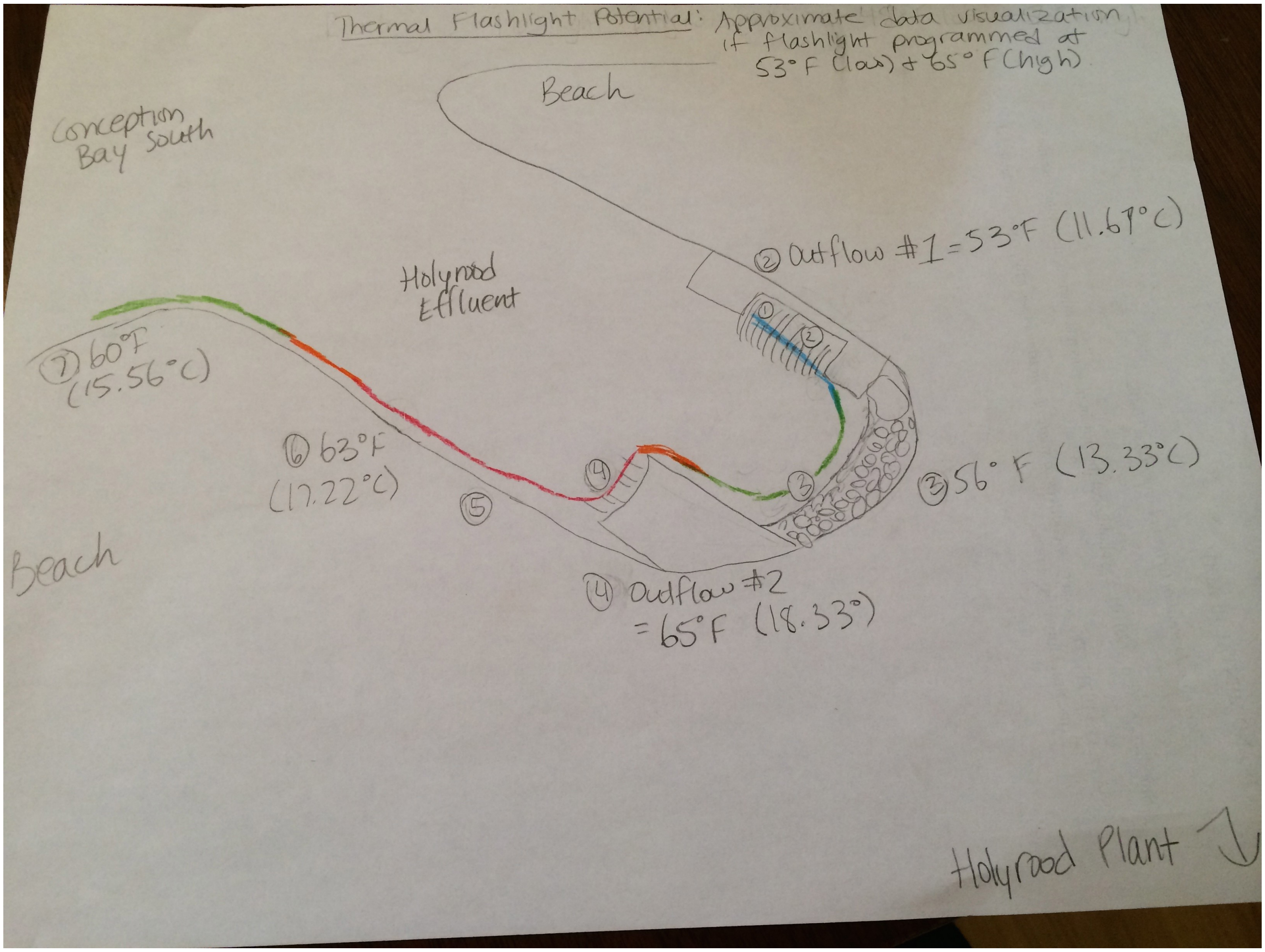
Section 2: Data Visualization - Temperature Maps

Temperature Map 1 – Actual recorded flashlight colours



The colours shown here illustrate what our flashlight actually recorded (see Field Notes 9) based on our flashlight calibration.

Temperature Map 2 – Hypothetical Data Visualization



The colours shown here illustrate what we hoped our flashlight could record if calibrated more effectively (see Field Notes 9 for more detail).

Section 3: Data Visualization – Composite Photos and Manipulated Photos

Photograph 1

This composite image is composed of three still images. We took our initial data during the daytime, and the light shows a red light, demonstrating the heat of these locations. This corresponds to locations #4, #5, and #6 on the temperature map of the previous page.

We could have further manipulated this image to draw out the light from the bulb, showing the temperature readings. This form of visualization could be beneficial if one can only reach a location during the daytime, though it is a limited form of visualization.

We decided not to manipulate this image further because we visited our site at night at a later date in an attempt to capture long-exposure photographs of our flashlight's readings.

Thanks to our professor, Dr. Max Liboiron, for photoshopping this image together for us.

Photograph 2

This is a composite of photos we took at dusk at our site. Our technology stopped working, so these blue lines do not represent the temperature of the water. Rather, this photograph shows what data visualization would look like when testing surface water temperature using this technology.

Photograph 3

This image shows what we hoped to accomplish with our thermal flashlight. This imaged was created with Photoshop. Based on the bathtub photos (see Field Notes 8) and our daytime data collection, we believed we could capture colour over a broader area of the water. However, as Photograph 2 shows, the flashlight realistically shows streaks of light, rather than light diffused evenly over the surface. We believe if we had put some sort of diffuser of the lightbulb itself (and had our tech not failed), we could have achieved this result.

Section 4: Field Notes

Field Notes 1 – October 23, 2014

This was our group’s initial meeting.

Our purpose for this meeting was to share our ideas and brainstorm about the project.

Everyone shared their mid-terms in order to look at site possibilities and discuss our thoughts and ideas on ideal group characteristics.

Potential sites discussion:

- rental housing
- Holyrood
- harbour
- airport (security screening)
- residence
- temperature in Business Building study room

We talked about accessibility and justice issues

- what was feasible
- do we want to go in the direction of awareness? (Andrea’s school idea)
- Harbour as a site is a concrete, political issue (waste water going in the harbour)
- school idea not as concrete - not an “issue” in itself

Discussed Strategic planning on how to arrive together at a project site and how to “do” the project:

- how to proceed?
- what approaches would work better?
- spectacle and data circulation - could be part of the same
    - possible collect data at one location and have the spectacle/data circulation at another - ie. collect data at a power generating station and present the spectacle at Harbourside Park
- Keep in mind the “continuum” - from awareness to understanding

We talked about different designs for casings - how to make it waterproof?

Possible next step - visit to Holyrood

Actions:

- research generating stations (locations, accessibility)
- talk to Max regarding the thermal bob?
- see if we can access residences (Simba)

Field Notes 2 – November 2, 2014 - Holyrood visit

The group met mid-morning to visit the Holyrood Thermal Generating Station, one of the sites we were scouting for our thermal flashlight/fishing bob project.

Some reasons we were initially interested in the site:

- We discussed the ethics of doing a project with social housing/rental properties and noted our project could cause potential problems between a landlord and tenant. This is something we wanted to avoid, but we still wanted our project to be related to a social justice issue.
- We liked Holyrood because it's already a contentious site for the public and the government admits that it is not environmentally friendly in any way. Whatever "problems" we created with our discussion/spectacle were not of concern to us.
- We liked the idea of working with water, and the scale of this site has the potential for negatively impacting the aquatic environment around it, thereby increasing the potential for getting good data.

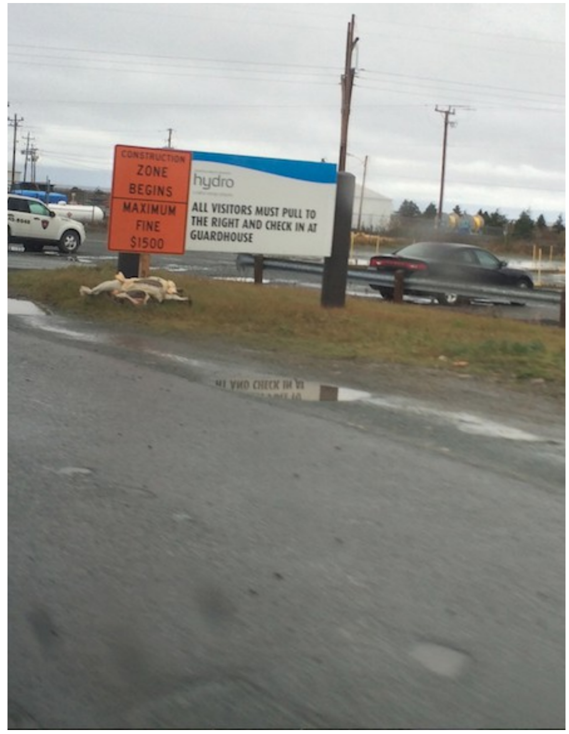
Some realizations upon visiting the site:

- Access was a huge issue. There is a fence all the way around the site, which I suspected through my searches on Google Earth. However, we checked in with security, like the front gate told us to, and were informed that we would have to call back and speak with someone. I had previously tried twice to call a woman who gives guided tours of the facility, but had not heard back. I have not called anyone else at Holyrood because we weren't sure of the logistics of the project at this point - would we have the fishing bob? How could we do our data collection at night if we needed to be accompanied?
- We then drove around to the other side of Indian Pond, which is where the water goes into the Holyrood station and walked along a makeshift causeway. It seemed as though we could potentially get access to the outflow that goes into Conception Bay, but there were still a few issues:
    - 1. We weren't sure how close (if at all) we could get to the exact point where the effluent leaves.
    - 2. The scary reality of the waves hit me hard, and I became unsure of putting our technology into that ocean.
- We discussed getting a boat to go on Indian Pond instead because apparently there is an input and output point in the lake, but we couldn't determine exactly where it was. This would need to be done by boat because the points of discharge were not accessible by people's backyards or public land. Again, the thought of collecting data in the middle of the winter in a boat was not super appealing, so the site had a few strikes against it.

We left the site, thinking about and discussing issues of access to technology. Access had been hampered at many levels, from the unreturned phone calls to the intimidating fence surrounding the site, to the levels of bureaucracy we would need to crawl through to reach the Environmental Department, to the very geography of Newfoundland. Although Holyrood will likely not be our site for this project, the trip was interesting for me as a wake-up call as to what we can realistically accomplish given our short timeline, available resources, and limited access to important sites.

<u>Pictures from November 2, 2014:</u>

NL Hydro welcomes us!



Or do they? "All visitors must pull to the right and check in at the guardhouse."

Our team and the Holyrood Thermal Generating Station

<u>Field Notes 3 – November 6, 2014 – Test Pictures</u>

- done to get a feel for the tech, how to move a casing to get good pictures
- 30 second exposure time
- used a tissue box as a makeshift casing

Tips for next time:

- make sure to record calibration of temperatures, or the pictures don't mean much (this is crucial when data collection begins)
- try to get tripod/make sure the image is as stable as possible
- test out how quickly to move the casing and the exposure time to get the most vibrant images
- ensure casing does not affect temperature reading (or that it affects it consistently and we record this)

I turned the heat on and just opened the window, to try to capture the heat around the heater and some cold around the window.

Less vibrant than the picture above because the window was open for longer, so cold air was coming in and heat was escaping.

Field Note 4 – November 8, 2014

The purpose of the meeting was discussing about the possibility of testing the Thermal Bob along Renee's river close to the Dominion Store and the Power Station.

Discussed Issues:

- The results that were coming out of the Thermal Bob were too high and possibly believed something was wrong with the sensor that caused to produce such negative high numbers..
- Due to the bad weather and the issues of the readings coming from the Thermal Bob, we decided we would pursue to meeting up with the professor on Monday 12 November, 2014 to find out what the issue could possibly have been that caused problems with testing the Thermal Bob.
- We discussed about possible alternative sites, just in cases the water testing didn't workout as planned and keeping room for alternative sites to conduct tests.

We had to wait to hear from the Professor what she had to say and the possibility of getting a new sensor to see if there was a problem with the old sensor and a new arduino kit to test if there was any possible changes.

November 12: Meeting with the Professor and Rubric/ Contract due.

<u>Field Notes 5 – November 12, 2014</u>

Main purpose of this meeting was to work on the group contract and rubric

- most of the meeting was taken up by this (see Group Document)

We discussed how to make our work transparent

- keep “field notes”
- rotate responsibility for note-taking
- post notes in Google Docs so all have access/can edit/make changes

Catherine will be in charge of the “tech” itself as she has the software on her computer

Andrea will be in charge of the “dry land” casing

Discussed the importance of being clear in our expectation of each other - knowing what you are expected to do and letting others know what you expect them to do - is that clear? ;)

We are in a bit of a holding pattern as we wait for a meeting with Max to troubleshoot the Thermal Bob - can’t really do any testing at our site

Spoke about the possibility of having a group spectacle (with other groups) at MUN to present our data

- Creation of a timeline for the project - keep us on track:

Nov 12 - Rubric/contract work

Nov 17 - Due: Rubric/contract
casing
2 “dry land” ideas each
troubleshoot bob with Max

Nov19 - Meet to discuss how we will proceed now that the bob is out of the picture…

Dec 17 - Final due date for project!!!

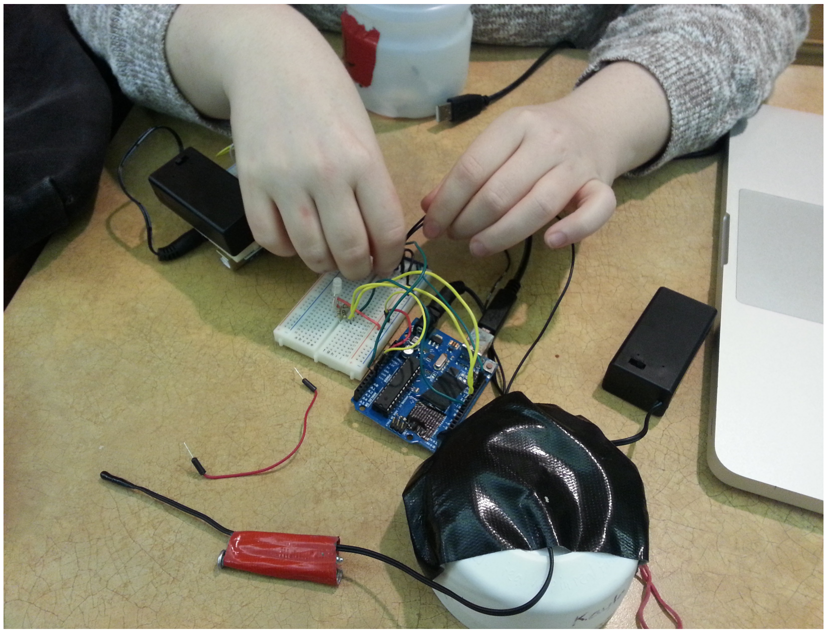
<u>Field Notes 6 - November 16, 2014 – Working Class</u>

Our group shifted focus slightly during this class, so I feel it's worthy of documentation.

Our goal for this class period was to determine the problem with our thermal fishing bob. When we connected the thermistor to the old fishing bob, it either wouldn't connect (with a reading of about -450 degrees fahrenheit), or it would seem to be connecting and the temperature would change, but never seemed right (it hovered between 90 and 100 degrees fahrenheit, which was warmer than the room we were in). When we put the end of the thermistor into hot liquids, it wouldn't change the way we expected it to. It would change when we touched wires though, so we assumed it was a connection issue.

After switching the breadboard for a new one, we still had no luck. The only thing that changed was that the temperature stayed consistent at about -450 degrees, which we assumed to mean it wasn't not functioning at all (otherwise it would be fluctuating at least a little bit). We switched up the Arduino for a new one and nothing changed. At this point, we concluded that it was an issue with the thermistor itself. We took the little connector piece off the end of the thermistor and cut off about a centimetre of the wire and stripped it a little and tried that. Still no luck. Collectively, we decided to scrap the thermal fishing bob.

So, we're on a slightly different path now. I don't want to speak for anyone else, but I was a bit disappointed. It seems our project is going to be very tech-focused now, which isn't a bad thing, but not necessarily what I was expecting. The goal right now is to see how or if we can adapt the regular thermal flashlight to measure water temperature, identify any weaknesses it might have for this, or determine if there's an area where it might be particularly useful to use this tech instead of the fishing bob to determine water surface temp.



Troubleshooting the thermal fishing bob

<u>Field Notes 7 - November 19, 2014</u>

The purpose of the meeting was discussing about the re-editing of the rubric/group contract to hand back in and also finding areas around the Harbour that are accessible to become a testing site for the project.

Discussed Issues:

- Scouting areas along Harbour Drive around the Harbour, that would become the potential area to proceed with the project.
- Also taking pictures of the areas we find at the Harbour that could potentially become the feasible testing areas.
- How we plan to divide tasks before Monday 24, November class.
- Waterproofing the casing around Saturday 22, November before proceeding to test it in the Harbour.

Also the topic regarding timeline and how we plan on completing the project before the deadline scheduled for December 17, 2014.

Next Step: Scouting areas along Harbour Drive around Sunday.

Field Notes 8 - November 22, 2014

Purpose of this meeting was to work on the waterproofing of the Thermal Flashlight casing and to do some testing of the waterproofed casing with water. We also calibrated the flashlight to a digital thermometer.

We had two different types of clear plastic - of varying thicknesses - to test to see if and how the thermistor reads temperature change through them.

We measured the range needed for the thermistor to detect a change in temperature as we are now going to test surface temperature and need to hover the flashlight over water.

We first tested “dry”:

1. **no plastic barrier** over the thermistor
    - thermistor detected temperature change at 3”

2. Plastic # 1 - thicker plastic
    - temperature detection at 3.5”

3.Plastic # 2 - thinner plastic
    - temperature detection at 3.25”

We then took out the flashlight and filled the casing with tissues to test the actual waterproof capabilities of the plastic. We submerged the casing wrapped in plastic in water.

Thinner plastic (#2) had a little bit of leakage - the tissues did get a bit wet in spots
The thicker plastic (#1) had no leakage.

Next we did hover (we hovered the flashlight over a bathtub filled with water) test with the flashlight with and without plastic in place:

Hovering ½” over water:

No Bag - 49.8 degrees
Plastic # 1 (thick) - 52.5 degrees
Plastic #2 (thin) - 53.3 degrees

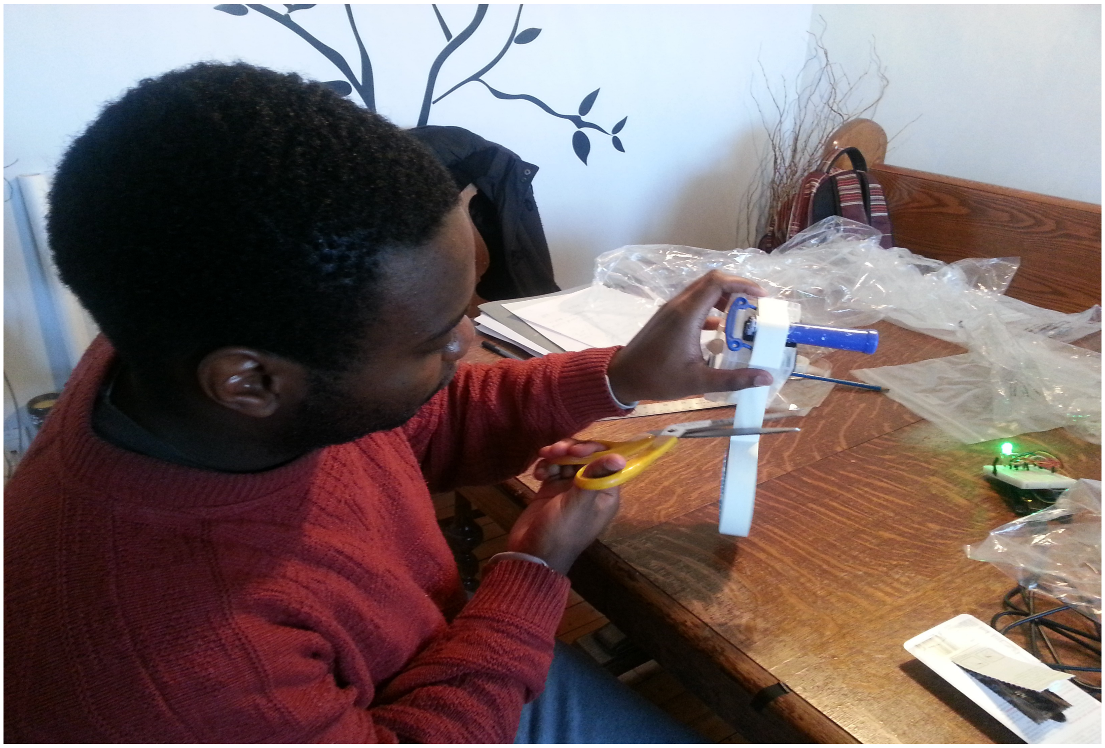
Based on waterproofing capabilities, we decided to go with the thicker plastic #1. There was minimal difference in the temperature detection range.

Our test pictures from these experiments look promising.

Pictures:

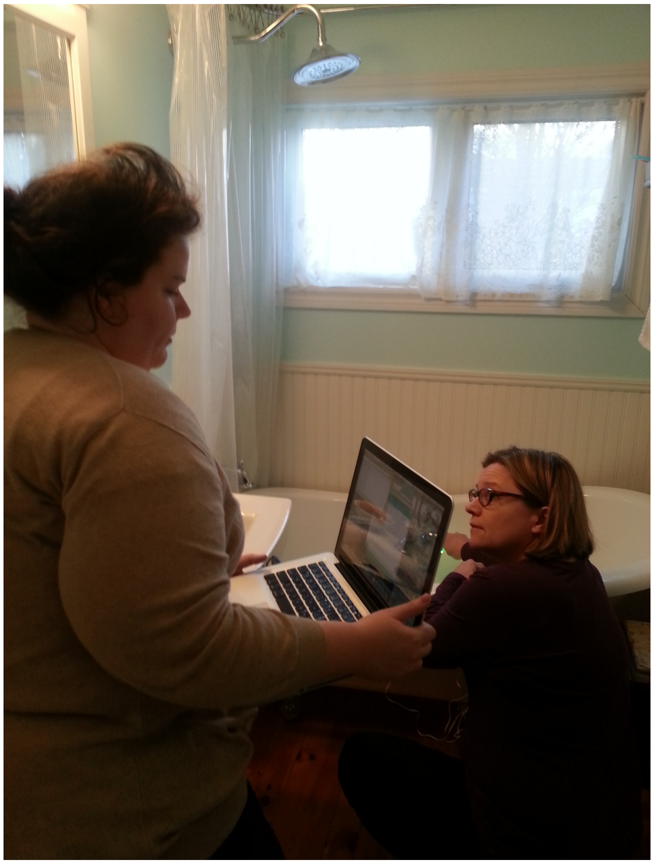
Verifying temperatures

Checking temperature readings with and without plastics covering the sensor



Attaching the handle to the casing

Checking water temperatures



Checking the accuracy of the flashlight with plastic covering it

The results...

Putting hot water into cold water

Putting cold water into hot water

Field Notes 9 – November 25, 2014 – Holyrood Visit

On Monday, November 24 I called Holyrood, and eventually got through to Mike Manuel, one of the environment guys. After our first trip to Holyrood, we experienced the menacing fence and walked down the beach a bit without seeing the effluent, so we decided not to pursue Holyrood any further. We assumed there would be bureaucratic limitations and decided to focus our attention on a more accessible place. Through our group discussions, we engaged in group reflexivity, and determined that our own assumptions about inaccessibility of technology actually impeded our project a little bit.

My conversation with Mike Manuel was the opposite of what I expected it to be. I expected a flat "No, you cannot get to the effluent." However, Holyrood's effluent goes into Conception Bay and so it is on public land. After looking at Google Earth, I thought I knew where the effluent would be (and this is the path that guided our first trip halfway down the beach, but we stopped before we reached the effluent). I assumed there would be some sort of fence blocking us off from the actual part where the outflow is. However, Mr. Manuel told me that people go there to fish and it's pretty accessible. He told me the effluent is around 20-21 degrees Celsius, and that there are between 40 000 and 150 000 gallons of water per minute coming from the outflow points. After this conversation, we decided as a group to re-focus our project on Holyrood because this sounded more promising/interesting than Rennie's River.

The one thing we were unsure about was how accessible the effluent would be in the dark. Mr. Manuel had mentioned large rocks and told me multiple times to be careful. We decided to check it out in the daytime first and get some preliminary readings and then decide if we would pursue it in the dark, as well. We knew the likelihood of getting pictures in the daylight was slim.

We visited on Tuesday, November 25 and were there from about 1:30 to 3. It was a fairly warm day (around 12-13C) but the wind was very chilly. Our high reading was around 65F (by the second outflow) and our low reading was 53F (by the first outflow). We calibrated our thermal flashlight based on the first outflow, which ended up being the colder of the two.

Because it was day, we could only get still shots and were not able to produce very good data vis, but I made a rough map of what we accomplished and what we hope to accomplish next time we go out there (hopefully Saturday).

See Appendix: Field Notes 8b for pictures and maps of our data.

On the way out, we saw a man next to Indian Pond. We stopped and talked to him a bit and told him about our project. Andrea asked if he ever fished down there, because this was something we found very interesting. Our hypothesis was that warm effluent and chemicals would destroy an aquatic environment, and while this still might be the case, it is fascinating that it has become a fishing ground as a result of the generating station and thermal pollution. The man told us he fished there from time to time because there are sea-going trout there. He mentioned the chemicals that were in the water, and seemed skeptical about their regulation. He noted that "they" check it from time to time and say it's acceptable, but then he asked, "Acceptable to who?" It was an interesting dynamic to see: he still fishes there, even though he seemed skeptical about the safety of the water.

At this point, the group was still talking about issues of access. Even though this was public land, it requires a lot of effort to go out there and isn't the safest site to examine.

Based on our experience and through our discussion in class today (Wednesday, Nov. 26), we have decided to focus our project on the Holyrood site exclusively. Because we have spent so much time on technological issues, we have decided to focus much of our research on the risks of using this technology, especially in places like Newfoundland, and the difficulties associated with access to our test site. These issues will likely make up the portion that will go on PublicLab. However, because we feel that this is still an environmental justice issue, part of our paper will focus on the effect of thermal pollution and of Holyrood itself, as this was our original intention.

PICTURES: OUR FIRST SITE VISIT

Our site with the plant in the background.

Simba, looking like a warrior, but actually just researching.

Too much technology around too much water.

DATA COLLECTION AT HOLYROOD: Raw Data

Date: November 25, 2014
Conditions: Apparently around 13C, but the thermal flashlight read 25F (-5.56C) away from the water – it was an extremely windy day, so wind chill is a factor.

Image One = #1 on map

Light = Green

Picture Two = #2 on map

Light = Green
Temp = 53°F (11.67°C)

Image Three = #3 on map **Light = Orange**
Temp = 56°F (13.33°C)

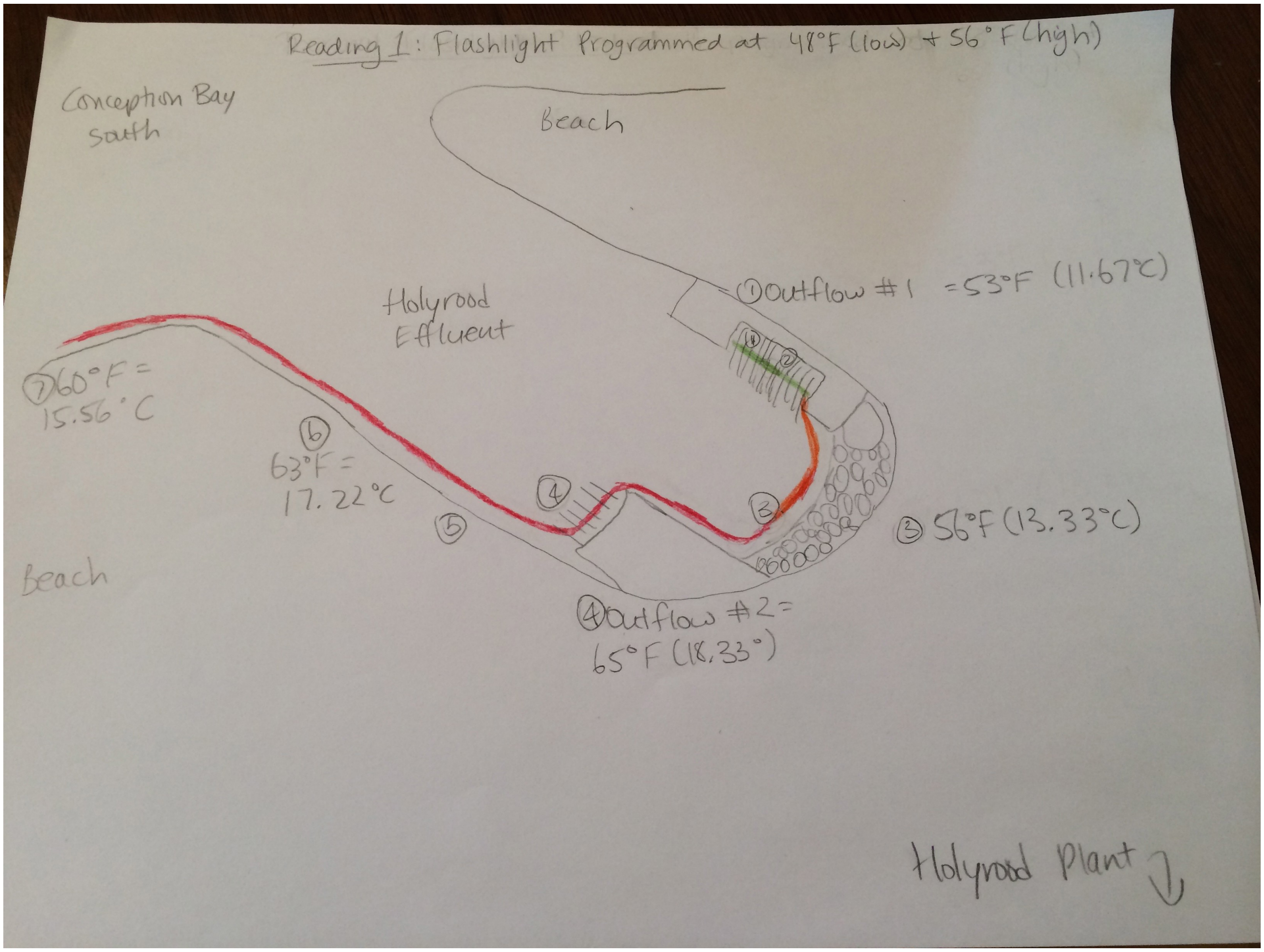
Image Four = #4 on map **Light = Red**
Temp = 65°F (18.33°C)

Image Five = #5 on map **Light = Red**

No image for #6 on map
Light = Red
Temp = 63°F (17.22°C)

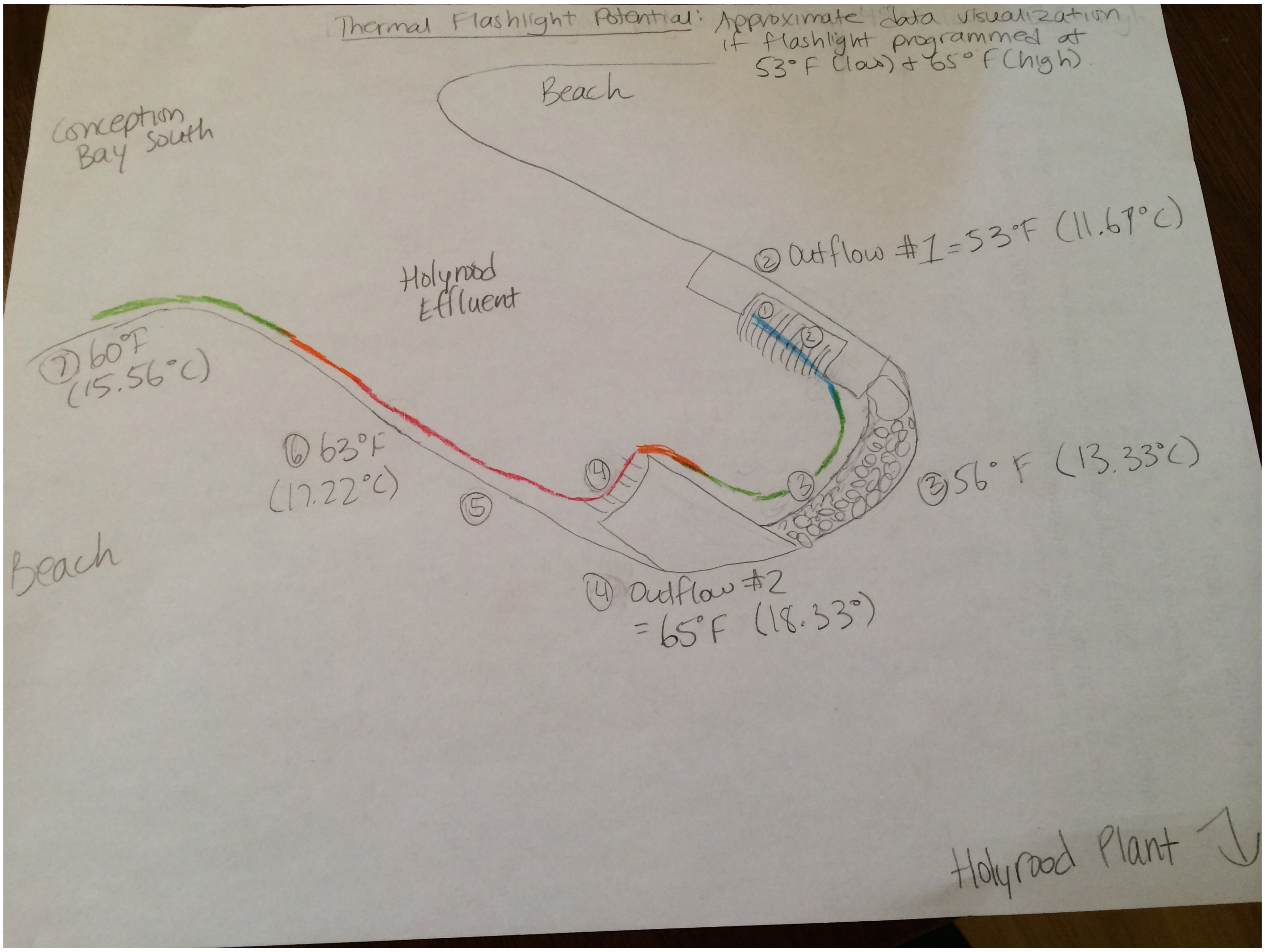
No image for #7 on map
Light = Red
Temp = 60°F (15.56°C)

Temperatures Maps for Data Collection



<u>Temperature Map 1: Actual Colours Recorded</u>

If we had done our readings at nighttime, this is what our data vis would look like mapped onto the effluent. Since we didn't have our flashlight calibrated very well, the entire left coast was red light because it was between 60-65°F.



Temperature Map 2: Goal for next time

Based on our readings from our site visit, this is what we think we'll be able to capture if we have the flashlight calibrated correctly. This is what we hope to accomplish. We're hopefully going for another site visit on Saturday evening.

Field Notes 10 – December 4, 2014 - Night Data Collection Visit to Site

The purpose of this visit was to do a second data collection at night in order to take some night time photos of our flashlight at work.

We also used this visit to document the “spectacle” part of our project. We played up the “danger” aspect that our site presented - that is, doing research outside, in December in Newfoundland, along a rocky, windy, and cold shoreline. We outfitted ourselves in outdoor gear, used reflective material, flashlights, headlamps, rope - and ridiculous hats.

We set out for the site as the sun was setting, in order to give us some daylight hours to take some temperatures, calibrate our flashlight, and get set up with cameras and tripods before it got dark.

Before we reached the site, we took a control temperature of the ocean surface water.

We reached the site and proceeded to set up, take pictures, and do some initial calibration of the flashlight.

Tech Failure
As it started to get dark, we began our preparations to take our night time photos - only to have the flashlight fail to work. The light would come on, but it seemed the sensor was not reading. When connected to the computer, we could not get a temperature reading.

We attempted to troubleshoot, but without an internet connection, any spare parts or tools, or even a flat, dry surface to work on, it was difficult to asses the problem.

Our suspicion was that the unit somehow got wet with sea salt spray.

After some time of trying to get the flashlight working, we decided to take pictures anyways with just the blue light.

Video Spectacle
Please watch the video here: https://www.youtube.com/watch?v=UZ_3m8QwdqE&feature=youtu.be

Here is a composite image with our flashlight:

Pictures of our journey:

Reflective gear and safety rope.

Watch out for the washouts!

The Holyrood plant in the dark

Section 5: Limitations of Governmental Reporting on the Environmental Impacts of the Holyrood Thermal Generating Station

As mentioned in our report, Holyrood's environmentally damaging effects are well-known. In November 2012, the Department of Natural Resources released a document entitled "Environmental Benefits of Closing the Holyrood Thermal Generating Station" (NLDNR, 2012). Among the key facts presented, the report notes that the plant releases about 1.1 million tonnes of greenhouse gas emissions and approximately 11,610 tonnes of sulphur dioxide annually, and that closing the plant "is the equivalent of taking 300,000 cars off the road" (NLDNR, 2012, p. 1). The effects of the plant's effluent are unexamined and the impacts on water are largely ignored in this report, except to mention that sulphur dioxide interacts with water to produce acid rain (NLDNR, 2012, p. 3).

However, in promoting environmentalism, the government perpetuates the importance placed on economic savings for the consumer and popular climate change rhetoric over nuanced environmental understanding. The report is written in non-scientific language and is intended for a generalized audience, demonstrating the government's attempt to make this information accessible and easy to understand. The environmental information is presented in climate change rhetoric, emphasizing how closing the Holyrood plant can help Canada meet its goals in reducing greenhouse gas emissions. Coupled with this rhetoric is the sub-theme of economic savings for ratepayers with the closing of the plant. For instance, if the plant remains open, the annual cost of oil is expected to double between 2011 and 2017, making the plant more expensive to run. As well, upgrading the plant to become "environmentally friendly" will cost hundreds of millions of dollars, for which ratepayers are responsible (NLDNR, 2012, p. 1). The government contrasts the Holyrood plant with its new proposed development project, Muskrat Falls, which "will be powered by 98% clean, renewable energy" (NLDNR, 2012, p. 6). The report focuses on highly recognizable climate change goals and economic savings, while blatantly ignoring how much Muskrat Falls will cost economically and environmentally. For instance, the current estimated capital cost of the project is $6.99 billion, which has risen since the project was first announced and which means ratepayers will pay, on average, $46 more per month for electricity when the project begins running (Antle, 2014).

Although the end result of the project aims for "cleaner" energy, since its proposal many environmental concerns have arisen. These include potential loss of habitat for various animal species; concern over mercury contamination of Labrador Inuit water supplies; and destruction of a river and its watershed (Bailey, 2012; Erskine, 2013; Devet, 2014). According to Gail Baikie, an Inuit with roots in Labrador, "Nobody with influence and power is accountable to the local population" and the potential impact of this project is a loss of connection with the environment for the people of Labrador (Devet, 2014). Therefore, in trading the Holyrood plant for Muskrat Falls, the environmental burden shifts, but is not eradicated, demonstrating the shift of environmental injustice to the Inuit of Labrador. This emphasis on "clean energy" ultimately presents new development in a positive manner. The report therefore demonstrates the biased information the government presents to its public, helping to further their own development goals under the guise of environmentalism.

In contrast, the provincial Department of Environment and Conservation and Environment Canada released reports that offer specific scientific information focusing on emission levels and substance releases, but which include relatively little analysis on how these levels impact the environment. For instance, in Environment Canada's "Facility & Substance Information" report from 2013, they list seven substances released into the air, water and/or land. Only one was reported as being discharged into the water: the 14 tonnes of sulphuric acid discharged into Conception Bay that we discussed in our paper (Environment Canada, 2014). From the report, it is difficult to know if this is the only substance being discharged in the effluent that can be damaging to the aquatic environment because little information is offered beyond the measurements of each substance.

Furthermore, the “Industrial Effluent Compliance 2012 Annual Report” measured the levels of a number of chemicals, the pH levels, and the amount of total suspended solids throughout the year, with no reported failures. However, the department also conducted acute lethality tests (ALT) on rainbow trout eight times, with five reported failures (NLDNR, 2012, p. 46). Interestingly, despite these five failures, the report notes that “the ALT is a monitoring analysis only” for the plant and that this measurement therefore has no bearing on effluent compliance (NLDNR, 2012, p. 45). These test failures are not explained in the report; our group only understood their significance by contacting someone at the Department of Environment and Conservation, where they explained that a failure occurs if over 50% of the fish die throughout the test. The lack of context will potentially make the report unhelpful to the general public seeking information.

The various limitations of these government-released reports demonstrate that despite ratepayers supporting the Holyrood plant's operations, the environmental assessments are inadequate in explaining environmental impacts to the public in both unbiased and comprehensive manners. We strongly believe that environmental impacts of government-owned public utilities should be transparent, with both in-depth scientific and easy-to-read information available to the public.