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School of Engineering Science
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12th February 2023

Dr. Mike Hegedus and ENSC 405W Teaching Team
School of Engineering Science
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Re: ENSC 405W Requirements Specifications

Dear Dr. Hegedus and instructional team,

Company #06 is a team committed to providing an alternate method of groundwater level detection that allows for unmanned, long-term monitoring in remote locations. We have prepared this requirements specification document to share the criteria our product must achieve to meet the needs of our audience, which primarily consists of researchers and small teams. To get better insight into this group's needs, our team is collaborating with the head of the SFU Groundwater Resources Research Group as a user consultant.

The system we intend to develop, Hy-dar, uses Ground-Penetrating Radar to detect how far the level of the water table is below the Earth's surface, recording its measurements over time. The system is self-powered by mounted solar panels, robust to outdoor conditions, can be installed and left unattended for multiple seasons at a time, and is able to be uninstalled and relocated. Further, our solution does not require the drilling, licensing, or specialized equipment some methods of water table measurement rely on, reducing cost and logistical concerns. These factors make the Hy-dar system ideal for teams with limited resources and studies in remote wilderness locations or environmentally sensitive areas.

Enclosed, you will find a high-level overview of our system and the problem of water table detection; information about the requirements for the three product stages of the Hy-dar system; the motivation behind these requirements; and an appendix of the proof-of-concept functionalities that will be demonstrated at the end of the semester.

For any questions or concerns, please contact our Chief Communications Officer, Michael Ungureanu, at mungureanu@sfu.ca.

Sincerely,

M. U.

Michael Ungureanu

Chief Communications Officer

Company #06

Requirement Specifications

Hy-dar

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Abstract

This document describes the user-facing requirements and constraints of the Hy-dar groundwater table measurement system being developed by Company #06. A brief description of the system is given first, along with relevant background and an overview of the existing market for the system. The following requirements are split into 6 categories, with each being further categorized into one of three development stages: A pertains to the Proof-of-Concept stage, B to the Engineering Prototype stage, and C to the Production Version stage. Rationale for each requirement choice is also given.

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Glossary

Acronym	Definition
CSA	Canadian Standard Association – An association that defines safety standards in Canada for electrical appliances and equipment.
EFN	Environmental Flow Needs – The volume and timing of water flow required for proper functioning of the aquatic ecosystem.
EM radiation	Electromagnetic radiation – A kind of radiation including visible light, radio waves, gamma rays, and X-rays, in which electric and magnetic fields vary simultaneously
GPR	Ground Penetrating Radar – A geophysical method that uses radar pulses to image the subsurface.
GRRG	Groundwater Resources Research Group – Research group located at SFU.
GUI	Graphic User Interface - A visual way of interacting with a software system.
GWL	Ground Water Level - Referring to the level, either below ground or above ordnance datum, at which soil or rock is saturated.
GWT	Ground Water Table - An underground boundary between the soil surface and the area where groundwater saturates spaces between sediments and cracks in rock.
LED	A Light-Emitting Diode – A semiconductor diode which glows when a voltage is applied.
NEMA	National Electronics Manufacturers Association – Association of electrical equipment and medical imaging manufacturers that creates a set of standards and guidelines for products, technologies, and systems that are in the best interest of the users and the industry.
PCB	Printed Circuit Board - A non-conductive material with conductive lines printed or etched that holds chips and other electronic components.
PoC	Proof of Concept – A proof which ensures the methodology is correct and can be further developed.
SFU	Simon Fraser University – A public research university in British Columbia, Canada.
SWBC	South-Western British Columbia – The southwestern corner of the British Columbia, Canada mainland.
UWB	Ultra-Wideband – a communications technology that employs a wide bandwidth.

Table 1 - Glossary of terms

1. Introduction/Background

The GWT is an important feature of the environment, both ecologically and geologically. Monitoring its level can result in important insights, with short term changes reflecting weather events and potentially predicting floods or droughts, and long-term variations helping researchers map the changing climate. B.C.'s EFN policies also demonstrate the value of GWT data for the purpose of monitoring ecosystem health [1].

Currently the B.C. Ministry of Environment and Climate Change monitors GWT levels using 226 observation wells that utilize pressure transducers for measurement, where most of the wells transmit data in real time through satellite communication. These wells involve drilling to depths usually greater than 50 feet and can cost over $10,000 to construct [9]. In addition, installing or decommissioning a well can only be performed by qualified well drillers, well pump installers, or professional engineers and geoscientists [2].

Alternatives available commercially that do not require well drilling instead use GPR, a technology that works by creating high frequency radio waves to penetrate the ground and measuring reflected wave intensity and propagation times in order to detect changes in material permittivity. Studies have shown that the GWT reflects up to 40% of GPR signal energy [3], which is why this technology was selected. Current products using GPR involve mobile systems with wheels (resembling a lawn mower) that are pushed around by a technician or researcher. This usually involves proprietary equipment and software, and requires manual user operation [4]. These mobile GPR systems are also costly, with prices starting well above $10,000 USD but often exceeding $20,000 USD [5], with rental costs that are also relatively high – usually in the thousands of dollars per month [6].

As stated, current methods of GWT monitoring either involve drilling wells (a non-portable and invasive method), or are not autonomous, making long-term monitoring challenging. The Hy-dar system fills this gap in functionality for long-term remote use, as shown in *Figure 1*.

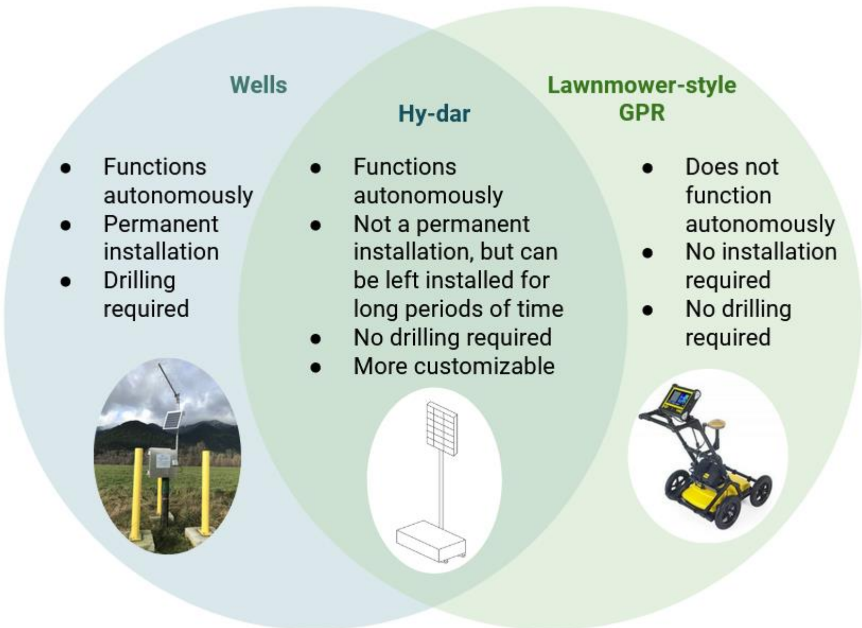

Figure 1 - System Comparison

The Hy-dar system will be a new tool in the GWT monitoring toolbox, utilizing existing non-invasive GPR technology to autonomously collect radar scans that can be used to monitor the GWT. The system will be portable but also designed to withstand long term deployment in outdoor environments, in the form of a weather-proof enclosure and external solar power source, shown in *Figure 2*. Hy-dar's robust deployment concept has also been inspired by other remote environmental monitoring systems, such as the Flowlink, a surface water monitoring system [7]. Devices such as the Flowlink utilize solar panels, guy wire supports, and durable enclosures in order to withstand harsh environments for extended periods. Similar techniques will allow the Hy-dar system to withstand the harsh environments it will operate in.

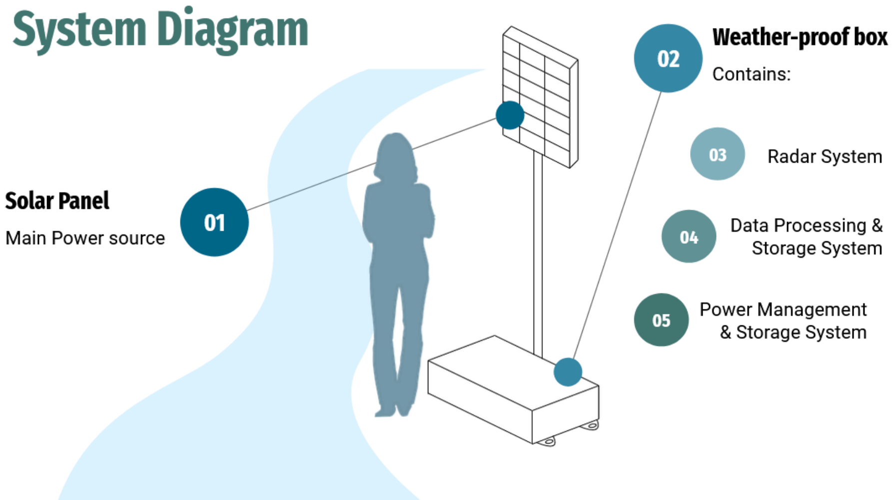

Figure 2 - System Diagram

The intended audience for this document is the supervising team, Dr. Mike Hegedus, Dr. Shervin Jannesar, and teaching assistants. Our potential clients include hydrogeology researchers, climate change researchers, and other groups who would benefit from a less expensive way to perform long term measurements of GWT in remote areas. Other potential clients include resource management groups, the province of British Columbia, and any other organizations who need a non-invasive long-term GWT measurement solution. Specifically, Dr. Diana Allen of SFU's GRRG has expressed interest in a system like this to augment their research [8].

2. Requirements

2.1 Functional Requirements

The functional requirements identify the key functions of the overall system. This includes requirements pertaining to quality of the measurement, as well as portability and customisability of the system. This section outlines the most important features of the system.

ID	Description
Req 2.1.1 – A	The system should be able to detect water table levels between 0 meters to at least 5-10 meters (greater than 10m would be ideal).
Req 2.1.2 – A	The system should be portable in weight and size, such that it can either be easily carried by one person (< 23kg) or easily broken into up to 4 subsections, each of which can be easily carried by one person (< 23kg).
Req 2.1.3 – A	The system should be able to measure water table depth to a resolution of at least 10 centimetres (10 cm is the minimum, finer then 10 cm would be ideal).

Req 2.1.4 – B	The systems data storage capacity should be sufficient for one year's worth of infrequent (daily or less frequent) measurements.
Req 2.1.5 – B	The following parameters should be tuneable by the user: • Resolution of measurement • Depth of penetration • Measurement interval (daily, hourly, etc.)
Req 2.1.6 – B	The system should be able to perform sample scans in the field in order to allow for the optimization of tuneable parameters.
Req 2.1.7 – C	The user should be able to connect an external satellite communication device to support remote data retrieval and other remote features.

Table 2 – Functional Requirements

Rationale & Constraints

The functional requirements were defined by determining the major features that the intended audience required for the system to be considered useful. For the PoC stage, the main feature to be developed is the radar itself, with *Req 2.1.1* through *2.1.3* defining the constraints of the radar's performance. *Req 2.1.1* was determined by analyzing the data provided by the British Columbia Provincial Groundwater Observation Well Network [9]. Analysis showed the majority of wells in SWBC (the planned area of testing and operation) had a GWT depth within 10 meters of the surface over the course of a year. Requiring the system to be able to measure up to at least 10m in depth ensures the majority of use cases/locations are covered. But, in situations where the soil composition may have higher attenuation (such as clay or gravel) 10 meters may not be achievable, so a range of 5-10m was specified to account for this constraint. Of course, achieving a depth of greater then 10m would be ideal as this would cover even more locations. *Req 2.1.2* was defined based on the Canada Occupational Health and Safety Regulations, which require that "No employer shall require an employee who is an office worker and whose primary tasks do not include manual lifting or carrying to manually lift or carry materials, goods or things in excess of 23 kg" [10]. Because our system is intended to be portable, it must be within safe carrying/lifting limits for researchers and government workers, both of which can be considered office workers. *Req 2.1.3* was defined after discussion with expert user Dr. Diana Allen, SFU Hydrogeology professor and head of the GRRG [8].

Req 2.1.4 through *2.1.6* belong to the Engineering Prototype stage due to being connected to other subsystems that will not be developed until this stage. *Req 2.1.4* and *2.1.5* were defined after discussion with expert user Dr. Diana Allen [8], and *Req 2.1.6* was added after identifying the challenge of determining a good installation location without any prior GPR data of the location.

Req 2.1.7 was also desired by Dr. Allen [8], but this feature was pushed to the Production Version development stage due to the constrained time and scope of the PoC and Engineering Prototype stages of the project.

2.2 Power Requirements

The power requirements detail the methods and capabilities of the subsystem responsible for providing electricity to the rest of the system. This includes requirements related to the collection, storage, and dispersal of power by/to components both internal and external to the system.

ID	Description
Req 2.2.1 – A	The system should be powered via 120 V wall plug.
Req 2.2.2 – A	The system should be supplied with power of a noise level sufficient such that the function of the GPR is not handicapped.

Req 2.2.3 – B	The system should be battery powered and able to power its own operations for a reasonable amount of time given specific user tunable parameters.
Req 2.2.4 – B	The system should be able to finish the current cycle of data processing and storing even when power is suddenly cut-off.
Req 2.2.5 – B	User should be able to disconnect power generation source and run the system on a single battery charge for short term operations.
Req 2.2.6 – B	The system's battery should be rechargeable by either 120 V wall plug or solar power.
Req 2.2.7 – B	The system should provide feedback to the user on how long the battery will last given the user-tunable parameters.
Req 2.2.8 – B	The system's battery should be replaceable.
Req 2.2.9 – C	User should be able to add battery capacity to the system.
Req 2.2.10 – C	User should be able to connect external power sources or power capturing devices to support higher power measurements and satellite communications.

Table 3 – Power Requirements

Rationale & Constraints

The system's power supply is crucial to its functionality and allows it to fulfill the intended purpose of long-term data collection in remote locations with little to no electrical infrastructure present at the site of deployment.

For the PoC, the power supply should simply meet the needs of the GPR by supplying power via a standard 120V wall outlet; *Req 2.2.1* constrains the power sub-system's capabilities for developmental purposes. Additionally, to ensure the usability of the power supply, *Req 2.2.2* defines the intent to maintain a reasonable noise level as to not hinder the operation of the device.

As the product moves into the engineering prototype phase, the scope of the demands of the power supply grow to meet the needs of the system, while further constraining the design such that the product's feature set is marketable and appropriate for in-field usage. In order to meet the needs of prospective clients, Dr. Diana Allen expressed the importance of the device to provide the capability to collect long term data in remote locations [8]. *Req 2.2.3* encompasses the obligation for the system's power supply to be self-sufficient to meet such constraints, and subsequently *Req 2.2.4* is derived from the mission critical nature of such applications. Since the system will also support the use case involving short term measurements, requirements *Req 2.2.5* and *Req 2.2.6* define the extent of the power system's configurability to support varying energy needs. Additionally, *Req 2.2.7* was defined to confirm that the power supply would not hinder the operation of the GPR given the flexibility of the system's operation. Related to flexibility and to support long term usage of the device, *Req 2.2.8* defines the ability to maintain the system's battery as it degrades over time.

The increased maturity of the system as it reaches the production phase is described by furthering the customizability initiated in the prototype phase. For advanced use cases involving the potential expansion of the system to include external satellite communicators for relaying data in real-time, increased power storage and collection are necessary. Both *Req 2.2.9* and *Req 2.2.10* ensure that interfaces allowing for external expansion of the system are implemented.

2.3 Durability Requirements

The durability requirements define the measures necessary to protect the device from environmental harm in remote outdoor settings for extended periods of time. This section also specifies the acceptable environmental parameters for operation of the system, such a temperature range and humidity range.

ID	Description
Req 2.3.1 – A	The system should be able to be tested in a damp environment without deterioration of equipment or harm to tester.
Req 2.3.2 – B	All electronic enclosures should be sealed from water intrusion and follow the NEMA 4X standard.
Req 2.3.3 – B	The system should be able to reasonably withstand the blunt force expected from objects such as falling tree branches, or wildlife.
Req 2.3.4 – B	The system should be fastened to the ground such that it cannot be easily reoriented by wildlife or weather.
Req 2.3.5 – B	The system should be reasonably tamper-proof: the system enclosure should not be able to be opened by anyone other than authorized personnel.
Req 2.3.6 – C	The system should be able to withstand wind speeds up to 102.96 km/h.
Req 2.3.7 – C	The system should function in environments experiencing temperatures ranging from -40°C to 85°C.
Req 2.3.8 – C	The system should be able to maintain normal operations with snowfall and ice accumulation and low depth submersion and follow the NEMA 6 standard.

Table 4 – Durability Requirements

Rationale & Constraints

The operating conditions used to guide the durability requirements come from the team's experiences living in SWBC. Being based in this region, and having to test the system safely, necessitated the inclusion of *Req 2.3.1* for the PoC stage.

As the scope is expanded in the Engineering Prototype stage, the durability requirements are augmented to reflect the increased stresses on the system. *Req 2.3.2* describes an industry standard for protection against water ingress [11]. NEMA4X was chosen as it reflects the conditions the system would experience in rainy weather common to SWBC, while *Req 2.3.3* and *Req 2.3.4* are designed to account for a more general range of environmental factors the system could be subjected to. To ensure normal operation throughout the measurement period, the system will also have to be resistant to tampering, and so *Req 2.3.5* is specified to achieve this.

When the system enters production stage, it will have to withstand an even more intense set of conditions. *Req 2.3.6* is defined to ensure the system can maintain proper operation in exposed locations where windspeeds are higher [12]. In this stage, the device will be considered consumer electronics for outdoor use, so *Req 2.3.7* ensures it meets the operational temperature standards that commercial electronics follow [13]. In ideal use, the system could be placed anywhere to measure the GWT. Near streams and rivers, or in areas of high average GWT levels, the GWT could reasonably exceed the Earth's surface and flood the device. Thus, *Req 2.3.8* is designed to ensure the system can be deployed in areas where submersion could occur without compromising the system.

2.4 Software/Firmware Requirements

The software/firmware requirements specify all functions performed solely by the computing subsystem, the main goal of which is to be able to compile, process, and store the measurement data. This section also includes the requirements for a GUI and program "preview" to allow for improved system customizability and accessibility.

ID	Description
Req 2.4.1 – A	The software/firmware should compile measurement data into a common file format that can be saved to a computer.
Req 2.4.2 – A	The software should perform appropriate signal processing such that the data is comparable to existing GPR data.
Req 2.4.3 – B	The software should provide a preview feature that gives the user feedback on expected performance given the selected tunable parameters, and either sample scan results or user inputted estimates.
Req 2.4.4 – B	The firmware should have power management features to put the processing unit to sleep and wake up as needed as a power saving measure.
Req 2.4.5 – B	The software should be able to import user settings and save the current settings to a readable file.
Req 2.4.6 – C	The software should include a GUI to make operations such as data viewing or system setup more accessible.
Req 2.4.7 – C	The software should be able to interface with certain external devices to support satellite communications.

Table 5 – Software/Firmware Requirements

Rationale & Constraints

In the PoC stage, *Req 2.4.1* and *Req 2.4.2* ensure that output data can be easily transported, stored and interpreted by users accustomed to typical data file formats (ex. csv) and GPR data, allowing for easier validation of the system against pre-existing GWT data. Further, it allows compatibility with pre-existing data processing and visualization tools developed for GPR.

For the engineering prototype, the tuneable parameters feature becomes relevant. *Req 2.4.3* was included to make sure the user is aware of how changing certain parameters affects their experiment, particularly how long the system can collect data for based on the tuned parameters. This feature was specifically requested by Dr. Allen [8]. *Req 2.4.5* was specified to make the tuneable parameters feature more user-friendly. Lastly, *Req 2.4.4* was included to limit the power usage of the system when it is not actively taking a measurement, an important constraint as the system may have limited power resources if it is deployed remotely.

The production stage is made easier to use with *Req 2.4.6* and *Req 2.4.*7. While *Req 2.4.6* makes the system interface more user-friendly and easy to learn, *Req 2.4.7* allows the user the convenience of collecting data without needing to visit the installation site. As the Hy-dar system may be installed in remote locations, this is quite valuable (particularly for winter, when weather conditions may make site access impossible). Unfortunately, working satellite communication between the device and user is out of scope for the engineering prototype stage due to constraints on budget, time for software/firmware development, and the challenges of working with the proprietary protocols of commercial satellite communication networks.

2.5 User Experience Requirements

The user experience requirements highlight how the user interacts with the system. The main goal of these requirements is to ensure that no user facing aspect of the system is unnecessarily complex or inaccessible. This includes considerations such as pre-requisite knowledge to operate and install the system, as well as system cost.

ID	Description
Req 2.5.1 – A	The system should be operated and configured through input from a laptop.
Req 2.5.2 – B	Power up/down, start/stop sample scan, start/stop measurement, and other basic functions should be controlled via button input.
Req 2.5.3 – B	The system should display status changes via LEDs.
Req 2.5.4 – B	The system should be straightforward to install and use after reading the user manual.
Req 2.5.5 – B	The system should be able to be installed/uninstalled in less than 4 hours.
Req 2.5.6 – B	The user should be able to perform parameter tuning in the field via an external device (eg. laptop or tablet) that can be connected to the system.
Req 2.5.7 – C	The user should be able to customize the GUI.
Req 2.5.8 – C	The user should be able to receive system alerts, retrieve data and configure the system remotely via external satellite communications.
Req 2.5.9 – C	The total system cost should be below $10,000.00 CAD.
Req 2.5.10 – C	The system should be able to do self-diagnoses and guide the operator to check/replace specific parts.

Table 6 – User Experience Requirements

Rationale & Constraints

For the PoC user experience, only some form of operation via laptop is required, as the users are the design engineers with assumed knowledge of the inner workings of the device. For the engineering prototype, additional requirements are introduced in order to allow the target audience (for example: a geologist with undergraduate or higher knowledge of GPR) to install and operate the device in an efficient manner (*Req 2.5.4*) while also being able to tune the device parameters (*Req 2.5.6*). *Req 2.5.2* was specified in order to allow for basic operation without a laptop connection. *Req 2.5.3* was specified in order to provide real time visual feedback to the user, so that the user can understand what general state the device is in without having to use a laptop.

For the production version, it is expected that the system can be further refined for further customisation by the user, increased capability (via satellite communications), and fault prevention. *Req 2.5.8* is particularly useful, as a requested feature by Dr. Allen [8]. This requirement would lower operating costs for the user, by preventing them from having to access the device as often (in some cases by helicopter). In addition, real time data access would increase the functionality of the device for use cases such as wildfire and slope hazard detection. This feature was not included in the engineering prototype due to time constraints during development, as the added feature would be complicated to integrate into the system. Similarly, *Req 2.5.10* was specified in order to reduce system downtime, maintenance scheduling complexity, and operating costs. Finally, system cost (*Req 2.5.9)* was specified in order to be a less expensive option than commercially available mobile GPR systems, which typically cost more than $14,000.00 USD [5][6].

2.6 Regulatory, Safety, and Sustainability Requirements

The regulatory, safety, and sustainability requirements outline the operational constraints the system employs to ensure relevant regulations are met, including the safety of those operating and/or installing the device. This section will also detail measures taken to protect the environment implemented in the system, and aspects of sustainable design taken into consideration.

ID	Description
Req 2.6.1 – A	System (not components) should be reusable and repairable/maintainable, such that it is expected to last at least 5 years.

Req 2.6.2 – B	System components (PCBs, batteries) should not leach chemicals or heavy metals outside of the enclosure and into environment.
Req 2.6.3 – B	System does not emit toxic or poisonous gases or fluids.
Req 2.6.4 – B	The system should operate solely on renewable energy and not emit greenhouse gasses.
Req 2.6.5 – B	External components and outer coatings of the system should be non-toxic or physically difficult for creatures to consume.
Req 2.6.6 – B	The system should automatically shutoff in the case of abnormal operation.
Req 2.6.7 – B	The system should leave no permanent damage or mark on the area it was installed after it has been uninstalled or moved.
Req 2.6.8 – C	The system should be able to report and self-diagnose cause for abnormal operation, alerting the user via external satellite communications and allowing for remote shutoff.
Req 2.6.9 – C	The system should not have a significant negative impact on soil health and organisms living in the soil beneath the device.
Req 2.6.10 – C	The system should conform to Canadian Standard Association (CSA) code CSA C61427-1:17, Secondary cells and batteries for renewable energy storage, specifically part 1 including photovoltaic off-grid applications.
Req 2.6.11 – C	The system should conform to Industry Canada Radio Standards Specification RSS-220, Devices Using Ultra-Wideband (UWB) Technology.
Req 2.6.12 – C	The system should meet Health Canada Safety Code 6 for EM radiation exposure in the case of continuous human exposure to the EM radiation source, e.g. an individual working beside the GPR station on a regular basis.
Req 2.6.13 – C	The system should be made of reusable or recyclable components and materials whenever possible.

Table 7 - Regulatory, Safety, and Sustainability Requirements

Rationale & Constraints

The Hy-dar system aims to be as eco-friendly as possible while remaining within budget constraints and following applicable regulations and safety standards. Due to the limited time and scope of the project, the majority of regulatory and sustainability requirements are deferred to the Prototype and Production stages. In the PoC stage, *Req 2.6.1* supports repair over replacement and prevents working parts from ending up in a landfill. *Req 2.6.13* extends this in the Production stage so even non-working parts do not enter the waste stream when possible.

In the Prototype stage, *Req 2.6.4* supports system sustainability, allowing operation free of greenhouse gas emissions or fuel re-supply trips. *Req 2.6.2, 2.6.3, and 2.6.7* support 'leave no trace' principles and protect the installation site from the device, which is a high priority as clients may install it in environmentally sensitive areas. As measuring yearly leaching, off-gassing or fluid secretion rates is outside the scope of this project, the company makes a best effort to design a system that doesn't actively produce gaseous, liquid, or solid waste and fully seals electronic components (batteries, PCBs) against the surrounding environment. *Req 2.6.5* was chosen to prevent negative impacts to animals that come in close contact with the system and is extended to protect microorganisms in the soil in the Production stage with *Req 2.6.9*.

Safety concerns are addressed with *Req 2.6.6* in the prototype stage, which mitigates hazards from system damage like electrical fires or shocks. *Req 2.6.8* extends this in the Production stage to warn the system owner of abnormal system behaviour and allow them to take immediate action to prevent harm. The remaining Production stage requirements come from Canadian standards, such as *Req 2.6.10* and *Req 2.6.11,* which are standards for safe and efficient renewable energy storage and appropriate radio spectrum use, respectively [14][15]. Lastly, while not critical to device function, *Req 2.6.12* expands the system's use case to close-contact situations such as construction sites, ranger stations, and university campuses in compliance with Health Canada's regulation of continuous human exposure to EM radiation [16].

3. Conclusion

The Hy-dar system sets out to bridge the gap between the existing GWT measurement methods of wells and mobile GPRs by implementing a robust system to sustain long-term, remote deployments, while being versatile enough to enable convenient re-location. Subsequently, such a system must meet the scientific needs of its intended users, which involves conforming to various data collection, data storage and overall customizability constraints to prove the system useful. Due to the potential of long-term deployments, the power supply and enclosure must be able to sustain the system for such a duration of measurement collection, but additionally a dichotomy of weather conditions and environmental stresses. The Hy-dar system will provide the software necessary to ensure water table data collection parameters are configurable for researchers to fine-tune while offering a suitable user experience. In addition, the non-intrusive nature of the system while deployed will provide users with valuable environmental data over time while conforming to provincial regulations and ultimately following suit with British Columbia's sustainability efforts.

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5. PoC Appendix

For the PoC, the system should be able to demonstrate the ability to finish a full cycle of the following tasks: Transmit an appropriate GPR signal and receive the reflected signal, convert the analog signal to a digital signal, filter and process the raw digital data, generate a file in a common file format containing the processed data, and plot the data on a fixed scale. A block diagram of the PoC system that will perform these tasks is given is figure 3.

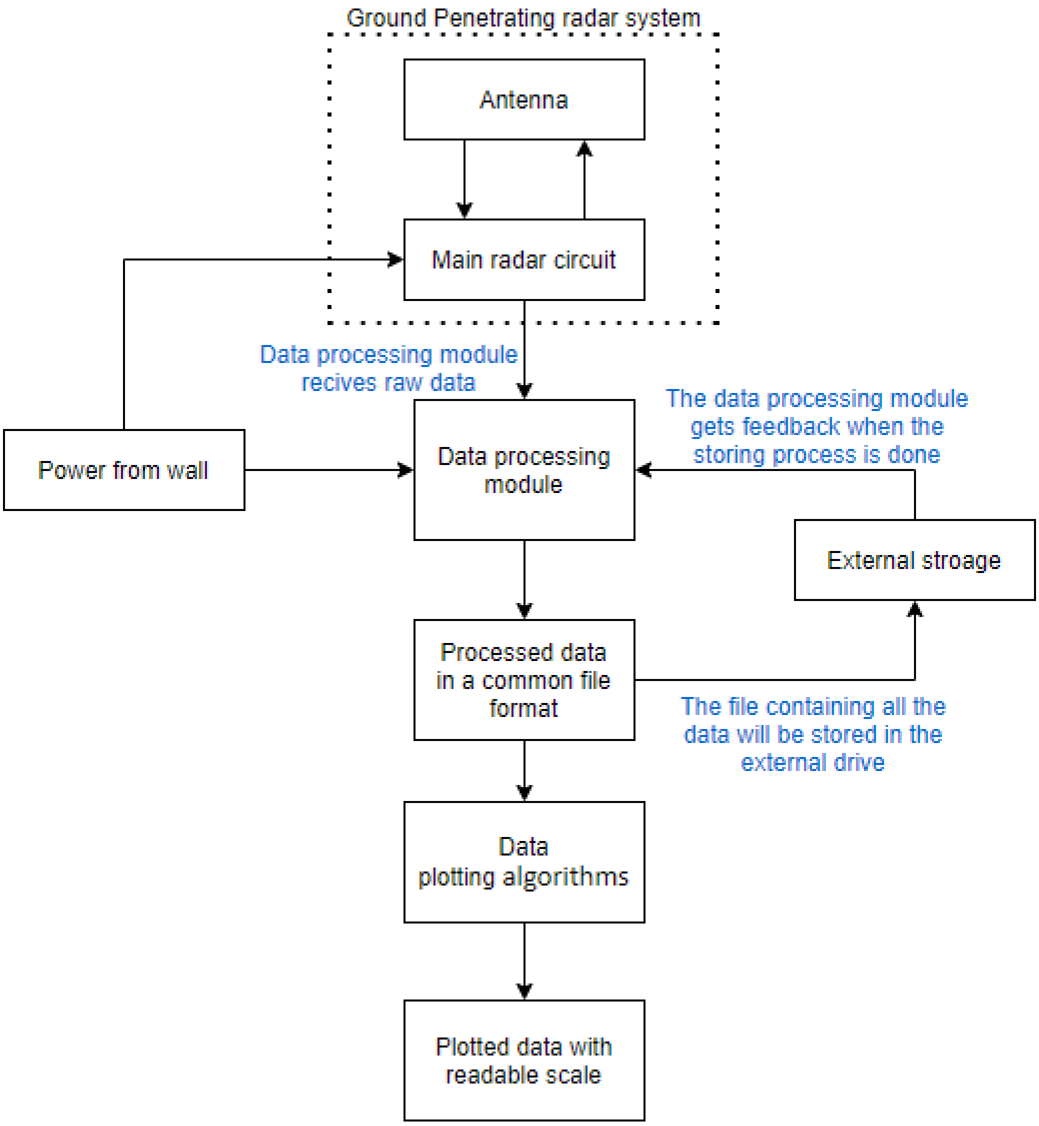

Figure 3 - PoC Deliverables

The PoC system does not include a developed power or data storage system, nor does it include the weather-proof enclosure that will be developed during the engineering prototype stage. The PoC stage solely develops the radar functionality, and basic functions of the software system (mainly data processing). The PoC should also be tested against currently existing GWT measurement methods. Dr. Diana Allen has offered to allow testing of the Hy-dar system against an existing well-based GWT sensor on SFU Burnaby Campus [1.1]. This will ensure a controlled scenario from which we can derive the accuracy of the Hy-dar system.