

**Development of the Integrated Platform to Host Downhole Well Abandonment
Risk Analysis Module and Additional Future Analytical Modules**

Prædicō

Alberta Innovates File #212201523 - DICE

Public Final Report
Submitted on: July 15, 2023

Prepared for
Alberta Innovates, Dallas Johnson

Prepared by
CLOSURE LIABILITY MANAGEMENT INC.

Alex Cook, Project Manager
403-620-1762 alex.cook@closurelm.com



CLEAN RESOURCES FINAL PUBLIC REPORT TEMPLATE

1. PROJECT INFORMATION:

Project Title:	Development of the Integrated Platform to Host Downhole Well Abandonment Risk Analysis Module and Additional Future Analytical Modules (Prædicō)
Alberta Innovates Project Number:	212201523
Submission Date:	July 24, 2023
Total Project Cost:	\$659,845.54
Alberta Innovates Funding:	\$250,000
AI Project Advisor:	Dallas Johnson

2. APPLICANT INFORMATION:

Applicant (Organization):	Closure Liability Management Inc. (Closure)
Address:	1930, 520 – 5 Avenue SW, Calgary AB T2P 3R7
Applicant Representative Name:	Alex Cook
Title:	Project Manager
Phone Number:	403-620-1762
Email:	alex.cook@closurelm.com

Alberta Innovates and Her Majesty the Queen in right of Alberta make no warranty, express or implied, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information contained in this publication, nor for any use thereof that infringes on privately owned rights. The views and opinions of the author expressed herein do not reflect those of Alberta Innovates or Her Majesty the Queen in right of Alberta. The directors, officers, employees, agents and consultants of Alberta Innovates and The Government of Alberta are exempted, excluded and absolved from all liability for damage or injury, howsoever caused, to any person in connection with or arising out of the use by that person for any purpose of this publication or its contents.

3. PROJECT PARTNERS

Please provide an acknowledgement statement for project partners, if appropriate.

RESPOND BELOW

Closure was provided development support from Analytika and was supported by several industry partners that contributed time and knowledge in the form of product testing and input.

A. EXECUTIVE SUMMARY

Provide a high-level description of the project, including the objective, key results, learnings, outcomes and benefits.

RESPOND BELOW

It is known throughout the energy industry, and the public, that there is a mounting problem of inactive wells just waiting to be abandoned. In Western Canada, the number of inactive wells exceeds 100,000 and is growing at an estimated 6% per year. With this inventory growing year-over-year, the environmental, social, and governance (ESG) problems are evident, including potentially contaminated land and water, unusable land, and leaving a legacy of environmental negligence for future generations. While regulators are increasing the number of wells that producing companies are required to abandon annually, the processes for abandonment are often antiquated and supported without specially designed tools.

This has created an opportunity for Closure, with the support of Alberta Innovates and other partners, to create a new software platform that is specifically designed to expedite the assessment and abandonment of inactive wells. This was done by creating a web application capable of ingesting and processing massive amounts of public data, analyzing the wells for abandonment risks, and facilitating abandonment planning. The application was built with the ability to house modules for the entire abandonment process, starting with downhole abandonment (which was completed as a part of this project).

The application was named Prædicō based on its internal philosophy of leveraging data and advanced analytics (including ML/AI) to make oilfield restoration more predictable. Prædicō is now being leveraged internally to improve Closure's consulting engineering, and discussions are active with potential industry early adopters as Prædicō moves towards a full SaaS launch. The project was successfully completed on scope and on budget. The project start was delayed approximately two months with completion being delayed an additional month. This delay was deemed to be immaterial, and accepted by Closure and Alberta Innovates.

While the project was successful, there were a few key pivots and challenges that yielded lessons learned. These lessons learned will be carried into the next phase of development, helping Closure to use communication, extensive planning, and strong partnerships to successfully develop the Rapid Phase 1 Environmental Site Assessment module.

As Prædicō 's usage increases, initially by Closure and later as a full SaaS release, the benefits to the energy industry, the environment, and Albertans as a whole will increase. The benefits include positive impacts on ESG, locally developed innovative technology, and diversified and highly skilled personnel (HQSP) jobs in Alberta.

Overall, this project was a success, and Closure plans to work with its partners to follow it up with the development of the Rapid Phase 1 Environmental Site Assessment module for Prædicō.

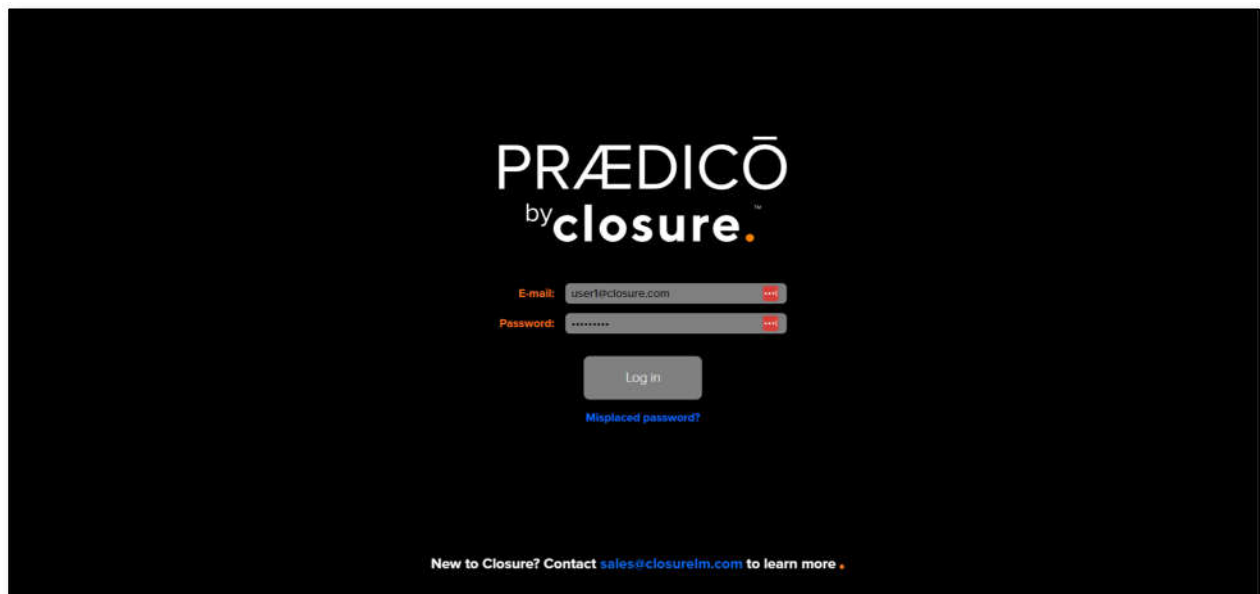


Figure 1: Prædicō Login Page

B. INTRODUCTION

Please provide a narrative introducing the project using the following sub-headings.

- **Sector introduction:** Include a high-level discussion of the sector or area that the project contributes to and provide any relevant background information or context for the project.
- **Knowledge or Technology Gaps:** Explain the knowledge or technology gap that is being addressed along with the context and scope of the technical problem.

RESPOND BELOW

1. SECTOR INTRODUCTION

The inactive oilfield well inventory in Western Canada exceeds 100,000 sites and is growing at an estimated 6% per year. The cost to address the issue, Asset Retirement Obligations (ARO), in Western Canada have accumulated over its productive history to an estimated range of \$60 - \$260B. Since 2014, a sharp increase in bankrupted assets transferred to the Alberta's Orphan Well Association has revealed a need for a response from social, legal and regulatory stakeholders. The threat of substantial unremediated wells and land disturbance becoming an unfunded taxpayer liability has grown increasingly visible.

Awareness of the societal risk has seen three forces for change emerge: First is accelerated global attention to environment, social and governance (ESG) matters, effected by the rise of stakeholder capitalism which demands a broader responsibility from corporations beyond just their shareholders' interests. The resulting focus on operator reputation with environmental stewardship, has become a basic requirement for social license-to-operate and retaining shareholder support. Second, the Supreme Court of Canada Redwater Decision affirmed the principle of "polluter pays". After bankruptcy, an oil and gas company must fulfill provincial environmental obligations prior to paying out creditors or shareholders. Third, the regulators in the western provinces have implemented the regulation of annual minimum spend requirements in each jurisdiction, with an overall intention to draw down ARO inventories by an average of approximately 4% per year, translating to a cleanup campaign that may take 30 - 40 years.

Producers have maintained their capital focus on cash generating activities using their best available talent, meanwhile Asset Retirement Obligations ("ARO") activities have received minimal attention. Producers have been ad hoc in meeting regulatory or fiduciary ARO requirements, resulting in labour-intensive and unsystematic efforts. The ability to scale up ARO activity by 10-20X historical spending (for some companies) to address the 4% per year objectives of the regulators is not easily achievable. Until recently, the tendency has been to actively defer closure activities or to divest of ARO liabilities, culminating in a critical risk level that requires a step change in approach.

2. KNOWLEDGE OR TECHNOLOGY GAPS

To meet the recently mandated increases in ARO activities, producers must quickly increase their capacity without a significant increase in costs. As this precludes the mass hiring of scarce human resources, another capacity-building solution is required.

ARO processes vary widely, from well honed, to pieced together on the side of a desk. This includes the tools used for planning ARO activities. Producers are often struggling to pull data together to plan their ARO activities, and once they have, they are often using manual processes to plan the individual jobs. The energy industry lacks standardized processes and tools to enable producers to assess their liabilities, and effectively plan and execute their ARO activities. The industry is also lacking purpose-built technology, leaning heavily on Microsoft Excel, instead of developing machine learning, artificial intelligence and other analytical techniques that can open the door to increased automation.

C. PROJECT DESCRIPTION

Please provide a narrative describing the project using the following sub-headings.

- **Knowledge or Technology Description:** Include a discussion of the project objectives.
- **Updates to Project Objectives:** Describe any changes that have occurred compared to the original objectives of the project.
- **Performance Metrics:** Discuss the project specific metrics that will be used to measure the success of the project.

RESPOND BELOW

1. KNOWLEDGE OR TECHNOLOGY DESCRIPTION:

Prædicō is designed to create a streamlined process through data accumulation and integration to risk assessment, prioritization, and job planning. This is only possible by using leading-edge technology to integrate all aspects of this process, which are otherwise disconnected in the oil & gas industry. Beyond just taking the existing oil & gas Excel sheets and putting them together, Prædicō enables the use and sharing of industry best practices and beyond by incorporating them into the platform. Machine learning and AI will be used to push the envelope of industry best practices and to improve abandonments in Alberta beyond the capacity of humans alone.

To do this, the end user will open Prædicō and begin to build a project. They can select wells on a map, import a well list, or find wells using a query. Those wells can be added to the project, allowing the user to customize their experience with the platform. The data that has been generated by the platform or pulled in from data providers is available for the end user. They can look at the raw risk for that well and validate it by updating the data if necessary. The user edited data is stored in a separate location so the raw data is never lost.

With the data repaired, the end user can immediately export deliverables including Well Details, Risk Assessments, Schematics, or certain map views. They can also decide whether they want to proceed with

abandoning this well and can use the Program Generator to create a plan for abandonment. This includes cost estimates and actuals, enabling an important piece of the ML/AI being built for this project. While the ML/AI work completed in this phase of development is only the beginning. This platform will give users a considerable advantage.

Prædicō is a foundational platform with Closure’s downhole abandonment features built in from the initial Prædicō prototype (to enable commercial application of the platform). It has been designed so that this foundation can be leveraged for a multitude of future modules.

2. UPDATES OF PROJECT OBJECTIVES:

The objectives of this project remained unchanged and can be written succinctly as:

- Providing users the technology and knowledge to streamline the process, from well prioritization to abandonment planning by creating a leading-edge web-based platform that can:
 - Ingest disparate data sources from multiple providers.
 - Enable users to manage well lists and projects.
 - Enable users to view their projects or search for wells on a map.
 - Enable users to follow the process from prioritization to abandonment.
 - Enable users to view raw data and make data overrides. Overrides will be stored by users in separate tables from the raw data to ensure no data is lost, and that no user can have unauthorized access to data.
 - Enable advanced validation and calculations (e.g. risk calculations).
 - Enable machine learning to determine risk factors/cost drivers based on all available variables, as well as develop the foundation of the AI loop to create, review, and revise well abandonment programs. ML/AI work has been initiated already, but its progress will depend on the availability of training data.

3. PERFORMANCE METRICS

The following metrics were established at the beginning of the project to help ensure the project would be successful.

Clean Resources Metrics

Metric	Project Target
TRL advancement	TRL level 8
New products/services created	Platform that can provide and manage SaaS
Jobs: Actual new jobs created from project	3 HQPs
Practices informed/influenced	Integrated public/Closure databases and establishment of machine learning

Program Specific Metrics

GHG emissions: Actual reductions from project	Project Target
Clean tech companies with HQ in AB	Calgary HQ

Project Success Metrics

Metric	Project Target
Optimized run time	<25 seconds (prototype speed)
Data Availability	All publicly available data from Closure's data supplier
Machine Learning	Capabilities to apply machine learning

D. METHODOLOGY

Please provide a narrative describing the methodology and facilities that were used to execute and complete the project. Use subheadings as appropriate.

RESPOND BELOW

To ensure the most efficient development of the Closure Platform, Closure adopted an Agile development methodology. This approach allowed for an iterative, adaptive, and collaborative approach between the business project sponsors, and the development team. The teams were able to test incremental software iterations, and pivot focus based on user feedback.

Closure utilized a hybrid waterfall-agile approach to project management. The waterfall methodology was used for global planning, to ensure that the platform development fit Closure's overall needs and supported Closure's business model. It was also used for high-level risk management and management of the triple-constraint (time, scope, and cost).

Closure took an end-user focused, design thinking approach to its application development. The technology was initially developed to bring efficiency and scalability to Closure's field execution of abandonment and reclamation products. As such, the engineering team was a critical contributor to the detailed requirements gathering phase of development. In addition, Closure's various industry collaborators also provided input to the design process.

The bulk of the project work was executed internally in the Closure offices in Calgary and with Closure's development partner SME Analytika (also Calgary-based and an Alberta Innovates supported company). The development and technology hosting was, and is, on Amazon Web Services.

E. PROJECT RESULTS

Please provide a narrative describing the key results using the project's milestones as sub-headings.

- Describe the importance of the key results.
- Include a discussion of the project specific metrics and variances between expected and actual performance.

RESPOND BELOW

1. MILESTONE 1 - PLANNING PHASE

Milestone 1 Description	
Task Description	Deliverable
Sensemaking workshop	Workshops to capture user stories and clarify value streams
User story creation	Clearly articulated user stories to guide development sprints
Project Management and detailed planning	Scope / detailed planning / validate each step

Planning for this project started prior to the official kickoff to the DICE project with Alberta Innovates. Closure established the need for this project through industry consultation and developed a prototype as a proof of concept. This prototype captured user stories that could then be applied to final development, ensuring end user needs would be met by the final product. When the DICE project was started, Closure was able to complete detailed planning to transform the prototype into a commercial product. Due to the nature of agile development, planning continued throughout the project, but the overall project management foundation was laid during this phase.

closure.
program generator.

Well Import Instructions

If you want to import a new well list click "Clear" to clear this template.

WARNING: This cannot be undone so make sure you have a backup.

Clear Template

1. Copy and paste the well list you want to import into the list on the right, then click "Import Well List":

- Each well imported is one API pull from Petro Ninja (Closure Max = 10k/month)

Import Well List

2. Once the well list is imported, click "Review Wells" to review wells one by one to edit the data

- This step is optional to export an initial risk assessment.
- This step is required to export an engineer reviewed risk assessment.

Review Wells

3. Export documents based on the selection on the right

Active Well

Select which well you want to display...
 100060903802W500

Deliverable Export Instructions

Select what you would like to Export...

Export Risk Assessment

☐ Display Well Numbers
☒ Display UWIs

Export Well...

What...
As...
For...

☐ Program
 ☐ Individual PDFs
 ☐ Active Well

☒ Well Details
 ☒ Merged PDFs
 ☒ Select Wells

☐ Schematic
 ☐
☐

UWI List	Status			Time (s)
	Formatted UWI List	Import Status	Export	
100060903802W500	100060903802W500	Done	Yes	48.18
100060207413W600	100060207413W600	Done	Yes	36.46
102060207413W600	102060207413W600	Done	Yes	33.02
10007-15-045-27W400	100071504527W400	Done	Yes	38.36
103060207413W600	103060207413W600	Done	Yes	34.25
100011804813W400	100011804813W400	Done	Yes	29.87

Figure 2: Closure Platform Prototype

2. MILESTONE 2 - DEVELOPMENT SPRINT #1

Milestone 2 Description	
Task Description	Deliverable
Establish AWS Infrastructure	Configure framework architectural environment
Establish Data structure	Establish data ingestion engine, configure data retention policies, configure non-relational DB
Configure AWS Services	Configure app services and cognitive services for AI/ML. Test/validate architecture, roles and permissions

Prædicō's base infrastructure was established on Amazon Web Services (AWS). This was done following an evaluation of Microsoft Azure and AWS to determine that AWS was the best solution for this project. The initial infrastructure was set up including the raw data in an RDS database, Lambda for the calculation of frontend functions, S3 for storage, and Cognito for user authentication/management. The foundation was programmed in Python on the backend and Angular on the frontend. Basic functionality for frontend/backend data saving/retrieval was enabled. Prædicō was built with a serverless design. All design decisions were made to use modern software design best practices to fulfill Prædicō's needs.

3. MILESTONE 3 - DEVELOPMENT SPRINT #2

Milestone 3 Description	
Task Description	Deliverable
Establish user interface	Link backend data base to the front-end User Interface (UI)
Configure GIS environment	Apply visual, spatial, map-based interface to enable ARO specific workflow. Integrate DLS and NTS
Enable core UI functional tools	Enable functional interface tools such as click select, lasso, list build, query tool,

Graphic user interfaces (GUIs) were developed to create the primary workflow through the system as well as specific functionality (queries, pop-up dialogues, etc.). GUI development and refinement continued throughout the entire build to evolve with end user feedback. Prædicō's map was created using MapBox. While some limitations were found with MapBox, it has sufficient capability to meet the scope requirements for this project. Both the map and the other GUIs were linked with the backend to enable the flow of data from the database to the user efficiently and effectively.

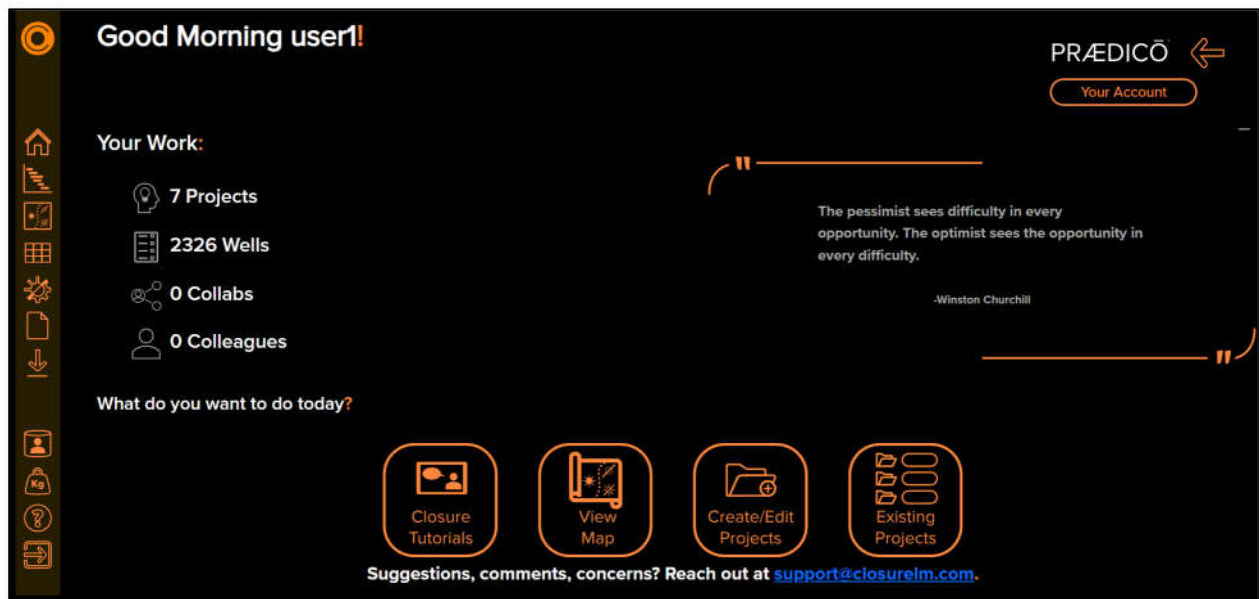


Figure 3: Basic Workflow 1 - User Dashboard/Landing Page

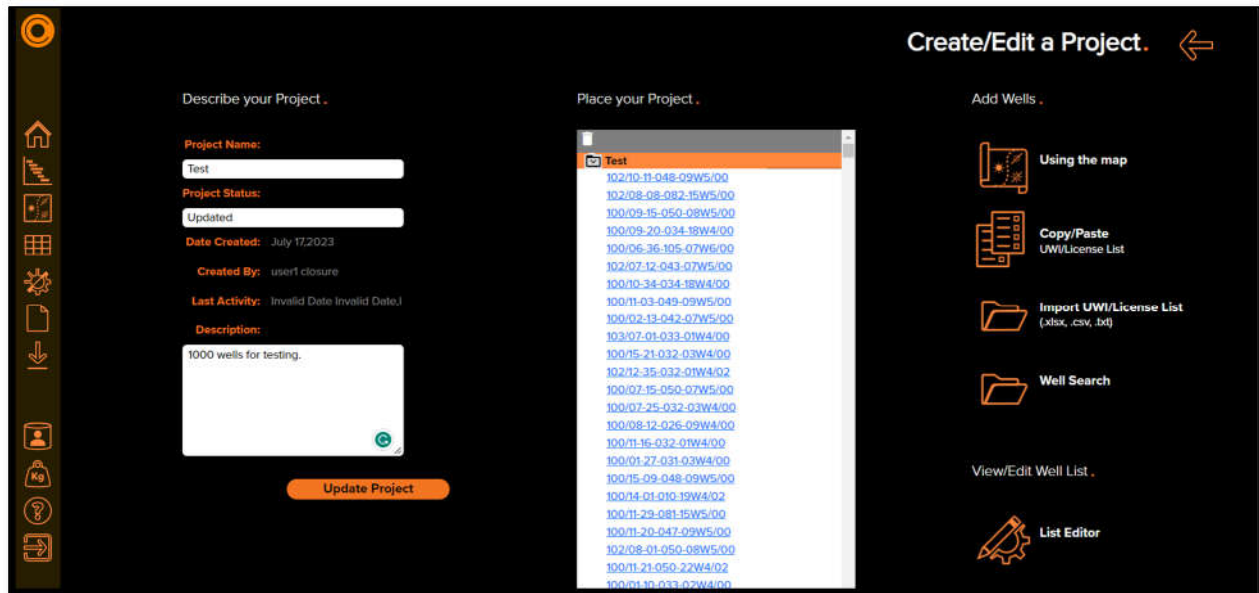


Figure 4: Basic Workflow 2 - Create Projects

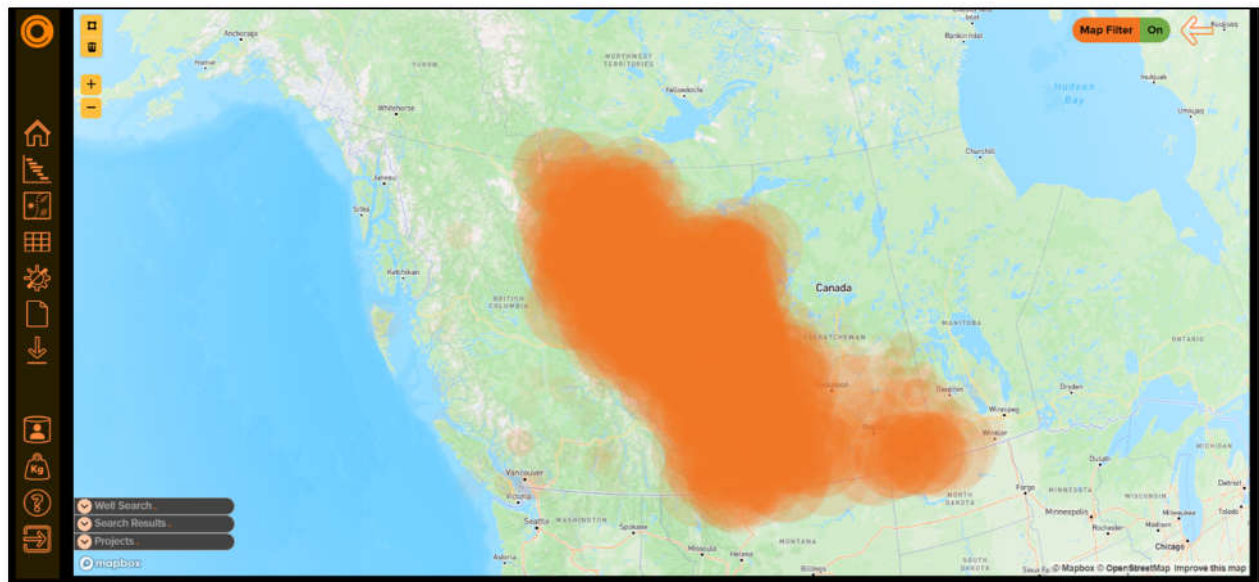


Figure 5: Basic Workflow 3 - Map to Locate and Select Wells

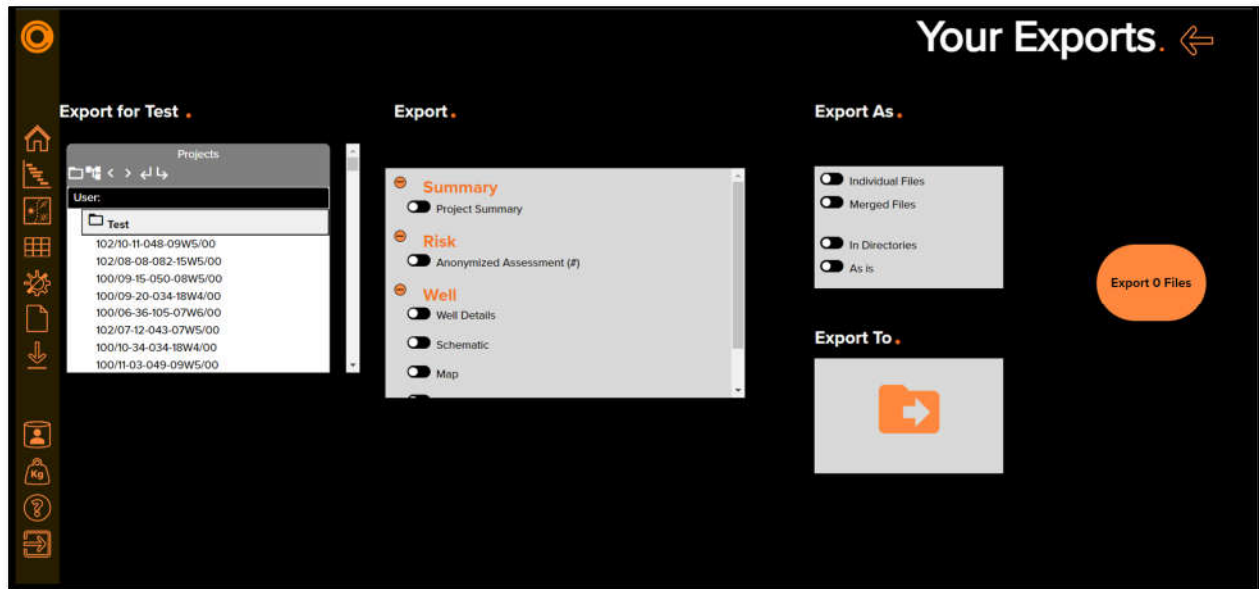


Figure 6: Basic Workflow 4 - Exporting Deliverables

4. MILESTONE 4 - DEVELOPMENT SPRINT #3

Milestone 4 Description	
Task Description	Deliverable
SaaS scope	profile and subscription management features, in addition to tutorial and help functions
Predictive analytics	AI introduced via Predictive Analytics capabilities
Module Integration	users created 'well lists' or work packages that can be shared across modules on the platform
User Story execution	develop and address user stories specific to DS3

GUIs were refined with the workflow through the system, essentially creating a flow of: identify wells, assess raw risk, fix missing data, assess user risk, plan/program abandonment jobs, export for use in the field. This process is far superior to current manual methods but can be further augmented with additional automation. Advanced analytics were used to help fill in data gaps through techniques such as 3-dimensional plane interpolation, while risk calculations were performed to predict the complexity of downhole abandonment.

Closure's risk assessment algorithm has been created based on the analysis of previous abandonment work, and the expertise and experience of Closure's engineering department. The analysis is built by

evaluating eight different risk factors that impact the complexity of abandonment jobs. Some risk factors are based on readily available data, while others require detailed calculation. For example, through the combination of data from several tables, and a proprietary algorithm, Prædicō can assess if the base of groundwater is protected from the production fluids in the well, or if all formations are hydraulically isolated by the well's casing and cement. These types of analyses normally require an engineer to complete.

The risk factors are given individual risk rankings and are then combined in an overall risk calculation. The overall risk calculation enables the user to assess the overall complexity of abandoning the well, while the individual risk factors highlight specific issues that may arise during the job. The greater the complexity, the greater the cost. Users can use this information, as well as any of the other information contained within Prædicō, to help them prioritize the wells. They can choose the least complex wells, or the most complex, based on their corporate and individual priorities. While this is often done by looking at tens of wells, Prædicō makes it easy to assess thousands of wells at a time.

The Program Generator and Cost Estimate have been designed to facilitate task/cost data collection and lay the foundation for Closure's AI work around the automatic programming and cost estimation of downhole abandonment. The system is SaaS capable through manual operation. Additional automated SaaS features were pushed into the next round of development (see Key Learnings).

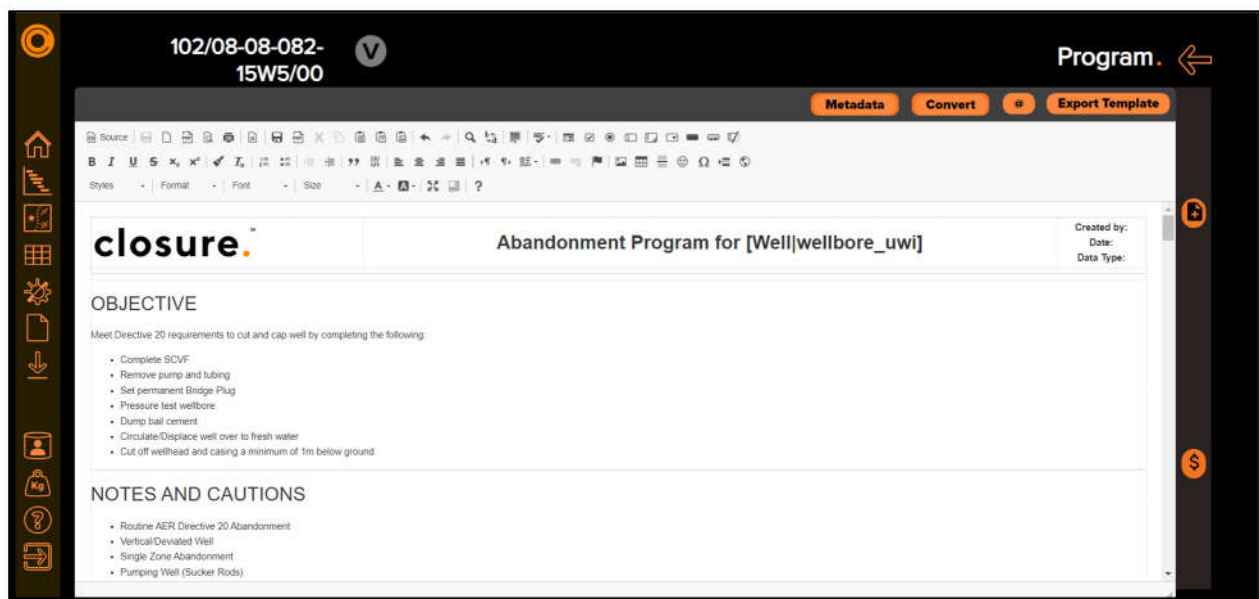


Figure 7: Program Generator

Program Estimate. ⬅					
Account	Description	Estimate Costs	Actual Costs	Variance	
0	Field Supervision	0	0	0	
0	Consulting and Advisory	0	0	0	
Consulting and Advisory +		+	Unit	Rate	Total
0	Estimate				
	Actuals				
	Variance				
0	Site Access	0	0	0	
0	Well Servicing	0	0	0	
0	Production Testing	0	0	0	
0	Cementing	0	0	0	
0	Wireline	0	0	0	
0	Consumables	0	0	0	
0	Fluid Handling	0	0	0	
0	Waste Disposal	0	0	0	
0	Equipment & Materials Hauling	0	0	0	
0	Safety Services	0	0	0	
0	Surface Equipment & Services	0	0	0	
0	Subsurface Equipment & Services	0	0	0	
0	Other	0	0	0	
	Subtotal	\$0	\$0	\$0	
0	Overhead	0	0	0	
0	Taxes	0	0	0	
	Total Costs	\$0	\$0	\$0	

Figure 8: Cost Estimator



Figure 9: Risk Assessment

5. MILESTONE 5 - QA/QC AND FIELD TRIALS

Milestone 5 Description	
Task Description	Deliverable
Test Scripts	Detailed test scripts executed by both Closure personnel and Project Partner personnel
Prototype parallel testing	Platform outputs benchmarked against known/validated data generated in prototype environment and from engineer generated outputs on previously successful projects
Field Trials	Platform tested in field for live project execution. Automated platform outputs A/B tested against manually derived (status quo) engineer outputs

While the testing of individual features was completed throughout development, final testing was performed to ensure the system performed as expected. Both non-systematic and systematic testing approaches were taken, utilizing a qualitative comparison with the wireframe and User Acceptance Testing (UAT) scripts respectively. Risk calculations were validated successfully against Closure's prototype and users can complete the entire workflow.

Please note that while the platform is materially complete, it is expected that there will be an ongoing discovery of bugs and refinement of features based on end user feedback.

6. MILESTONE 6 - DEVELOPMENT SPRINT #4 – QA/QC SYSTEM IMPROVEMENTS

Milestone 6 Description	
Task Description	Deliverable
Address deficiencies identified in QA/QC/Field Trails	Iterative bug fixing process
Address new ideas identified throughout project phase, etc.	Incorporating in-scope ideas after planning is complete, adjustments based on end user feedback, etc.

This project is on scope and on budget, however, the schedule was delayed. Deliverables in Milestone 6 covered three core steps:

- Extension of the project development timeline used to continue to fund the project team during QA/QC iterative bug fixes.

- Based on user feedback, elaboration was required on the cost estimate features. This required additional effort from the developers.
- Improvements to the grade of in scope features utilizing the continuity of SME resources.

F. KEY LEARNINGS

Please provide a narrative that discusses the key learnings from the project.

- Describe the project learnings and importance of those learnings within the project scope. Use milestones as headings, if appropriate.
- Discuss the broader impacts of the learnings to the industry and beyond; this may include changes to regulations, policies, and approval and permitting processes

RESPOND BELOW

1. VENDOR REVIEW - SELECTING THE RIGHT PARTNERS

Closure's early prototypes were built using Microsoft Azure. The capabilities of the prototypes were limited, but the cost was significant. Even though it was the incumbent vendor, Closure underwent a full analysis of potential cloud providers. In the review it was determined that Amazon Web Services (AWS) could provide the same level of service but at a much more reasonable price. Closure switched to AWS and has not only benefited from the lower price, but through AWS' many resources, such as Systems Architects that can help review your application and provide valuable feedback. Closure underwent a similar vendor analysis for its development partner Analytika, but unlike MS Azure, Analytika did prove to be the vendor that was most capable of meeting Closure's needs. While these vendor reviews could have been deemed unnecessary as there were already incumbent vendors, they proved invaluable.

2. COMMUNICATION, COMMUNICATION, COMMUNICATION

In general, it is the client's job to tell the vendor "What" needs to be done, and the vendor determines "How." Closure successfully took this approach for much of the development process; however, specific capabilities were not fully understood by the developers, resulting in limited instances of sub-optimal features and re-work. Closure had used a detailed wireframe and performed reviews with the developers to avoid this risk but some re-work was still required. The biggest learning from this has been that while you can show someone how it works, it is not as effective as having them work it. For example, Closure demonstrated the workflow through the software, but did not have the developers work through that same workflow to understand the true end-user experience (this has happened partly because the developers are not subject matter experts). In the future, Closure will use the detailed wireframe, ensure there is consultation before developing any key features, and ensure that the developers are able to use the software as end-users.

3. EXTENSIVE PLANNING

While Closure wireframed the majority of Prædicō, not every single pop-up/dialogue/feature was wireframed or thought through. This resulted in a few features that were ambiguous in their function, requiring planning on the spot. The impact of this was largely minimal, but some features required additional work and had to use contingency. Time pressure rushed wireframe development, but the project could have benefitted from further planning. This also became evident in small ways, such as not having icons prepared in earlier stages, so Prædicō was developed with temporary icons that required replacing (re-work) later. More time spent upfront in planning will lead to a smoother project and reduce re-work.

It is important to note that on grant projects much of the planning has been completed prior to the grant application. This can be a challenge for organizations who lack the funding to support the entire planning phase. Additional support that funding organizations can provide at the planning stage will result in more, and better, projects.

4. SAAS TIMELINE

It is Closure's intent to launch Prædicō as a SaaS offering to the open market. During the project it became evident that Closure would require commercialization resources specific to product launch. Developing a marketing plan, branding, sales collateral, and a pricing matrix was an entirely new project in itself. Closure also made a strategic choice to use Prædicō for Closure's consulting arm, to immediately benefit from the innovation while working through any potential bugs or workflow issues. This would give Closure a competitive advantage while refining Prædicō for a future full SaaS product launch. Closure is targeting Q1 2024 for a full SaaS launch of this product.

5. INTERIM PRODUCTS

This project was planned to develop Prædicō as a single web application, developing many aspects of the platform in parallel. While this approach captured some efficiencies, it also caused unforeseen issues. The largest issue was that few features were fully ready for use mid-project. This meant that Closure was unable to demonstrate the capabilities to potential end users or partners to garner interest and engagement. Closure was able to use the wireframes/plans for this purpose, but it would have been far more valuable if Prædicō was able to produce viable risk assessments halfway through the project instead of having to wait until all aspects were completed. This lesson learned has been incorporated into planning for the next module, the Rapid ESA1 project.

G. OUTCOMES AND IMPACTS

Please provide a narrative outlining the project's outcomes. Please use sub-headings as appropriate.

- **Project Outcomes and Impacts:** Describe how the outcomes of the project have impacted the technology or knowledge gap identified.
- **Clean Energy Metrics:** Describe how the project outcomes impact the Clean Energy Metrics as described in the *Work Plan, Budget and Metrics* workbook. Discuss any changes or updates to these metrics and the driving forces behind the change. Include any mitigation strategies that might be needed if the changes result in negative impacts.
- **Program Specific Metrics:** Describe how the project outcomes impact the Program Metrics as described in the *Work Plan, Budget and Metrics* workbook. Discuss any changes or updates to these metrics and the driving forces behind the change. Include any mitigation strategies that might be needed if the changes result in negative impacts.
- **Project Outputs:** List of all obtained patents, published books, journal articles, conference presentations, student theses, etc., based on work conducted during the project. As appropriate, include attachments.

RESPOND BELOW

1. PROJECT OUTCOMES AND IMPACTS

This project has resulted in the creation of Prædicō, a web application that is specifically designed to support and streamline the oilfield restoration process for inactive well sites. This means that industry will now have access to a solution to increase their capacity for downhole abandonments and expedite the retirement of their inactive wells. Depending on adoption, Prædicō could have an enormous social, economic, and environmental impact on the energy industry. This project has created the host foundation and the first of many digital tools to enable the industry to address the inactive well inventory.

2. CLEAN RESOURCES METRICS

Metric	Project Target	Project Outcome
TRL advancement	TRL level 8	Achieved – TRL Level 8
New products/services created	Platform that can provide and manage SaaS	Achieved
Jobs: Actual new jobs created from project	3 HQPs	Achieved – one HQP has since left Closure, but will be replaced
Practices informed/influenced	Integrated public/Closure databases and establishment of machine learning	Achieved

This project has advanced the Prædicō technology to a technology readiness level (TRL) of 8 as Prædicō has been tested and is proven to work in its expected conditions. Closure is actively seeking early adopters to be the first to benefit. Prædicō is an innovative new product. It has created three new jobs for development and operations, and is ready to scale into other markets, including Saskatchewan and British Columbia, as well as the internationally to the United States. Prædicō has maximized the use of public data from the Alberta Energy Regulator (AER) and is prepared to ingest more, further increasing the benefit to Albertans from the use of the province's data.

3. PROGRAM SPECIFIC METRICS

GHG emissions: Actual reductions from project	Project Target	Project Outcome
Clean tech companies with HQ in AB	Calgary HQ	Achieved

Closure was founded as a liability management company based out of Calgary, Alberta servicing the energy industry in engineering consulting and advisory services for well site restoration. Calgary was a logical hub given the abundance of energy company head offices and access to the ARO engineers responsible for well site restoration. The DICE program goals of transitioning Alberta's industry towards innovation and clean technology development presented a challenge. Would the Calgary headquarters work for software and platform development which would involve attracting HQSP in the fields of data science, software developers, SMEs in software, and environmental sciences? In working with Alberta Innovates, Closure has found the business landscape suitable for ongoing operations and the R&D and development of clean technology. The company leverages hybrid work environments and communications technology that connect professionals throughout Alberta to coordinate efforts on the project. The provinces natural beauty, relative affordability, access to high skilled labor, and high-quality

communications infrastructure all contribute to the decision to maintain corporate headquarters in Calgary, AB.

4. PROJECT SUCCESS METRICS

Metric	Project Target	Commercialization / Mobilization Target
Optimized run time	<25 seconds (prototype speed)	Achieved – Prædicō is able to display hundreds of wells/second
Data Availability	All publicly available data from Closure's data supplier	Achieved – The data is now available withing Prædicō
Machine Learning	Capabilities to apply machine learning	Achieved – Initial ML learning inquires completed, and foundation for advanced ML/AI is in place

This project was able to meet all objectives that were set forth and all individual metrics. Prædicō has exponentially improved the performance over Closure's prototype reducing the time it takes to pull the well specific data and calculate the risk analysis from approximately 1 well per 25 seconds to 100 wells per second. There is also increased functionality created that will greatly assist Prædicō's end users.

Advanced analytical techniques were used during this project to help analyze abandonment risks in the development of Closure's proprietary risk assessment, as well as to calculate data elements that did not exist in the public data (missing formation data, calculating the number of open zones, etc.).

The bulk of the machine learning and artificial intelligence work for Prædicō is around the prediction of bottom-up abandonment costs for wells. The initial analysis involved using machine learning to analyze work done by Closure, working to determine what steps needed to be taken to abandon different types of wells, and what costs would be associated with that work. This analysis produced a successful model, but with relatively low accuracy due to the small sample size. This work highlighted a gap between job planning and costing which creates barriers for future ML/AI. How programs are drafted, and abandonment estimates are tracked, needed to be re-imagined to create a system capable of collecting linked cost/effort data. This resulted in a new process for writing abandonment programs that would link job tasks to the cost estimate. This is the foundation of Closure's eventual AI driven program generator that will create abandonment programs and estimates for every well. As Prædicō moves into its next round of development, data will be collected to drive the advanced analytics, as the machine learning and artificial intelligence are developed.

5. PROJECT OUTPUTS

The Prædicō application is the primary output from this project, however, in developing the application, Closure set up a framework for, and completed significant data analysis, especially around the risk assessment of inactive wells in Alberta. Closure was invited, as a content expert, to round table discussions with the Premier's Advisory Council on Alberta's Energy Future on strategies for the acceleration of ARO reduction in Alberta. The analysis of Alberta inactive well data has not been published, but it is Closure's intent to author one, or several, white papers based on Prædicō's capability and analysis.

Please provide a narrative outline the project's benefits. Please use the subheadings of Economic, Environmental, Social and Building Innovation Capacity.

- **Economic:** Describe the project's economic benefits such as job creation, sales, improved efficiencies, development of new commercial opportunities or economic sectors, attraction of new investment, and increased exports.
- **Environmental:** Describe the project's contribution to reducing GHG emissions (direct or indirect) and improving environmental systems (atmospheric, terrestrial, aquatic, biotic, etc.) compared to the industry benchmark. Discuss benefits, impacts and/or trade-offs.
- **Social:** Describe the project's social benefits such as augmentation of recreational value, safeguarded investments, strengthened stakeholder involvement, and entrepreneurship opportunities of value for the province.
- **Building Innovation Capacity:** Describe the project's contribution to the training of highly qualified and skilled personnel (HQSP) in Alberta, their retention, and the attraction of HQSP from outside the province. Discuss the research infrastructure used or developed to complete the project.

RESPOND BELOW

H. BENEFITS

1. ECONOMIC

Beyond the three new highly qualified and skilled personnel (HQSP) that were hired directly for the development and operation of Prædicō, Prædicō's release opens up the door to many other economic benefits. Companies looking to abandon their wells will be able to increase the capacity of their staff. As an industry benchmark, companies are completing 30 – 50 wellbore abandonments a year per ARO engineer. By leveraging the Prædicō platform, initially as the prototype, Closures' engineers doubled that capacity with automation. This led to higher margins on skilled labor and de-bottlenecked the planning and program writing process. Prædicō enables portfolio risk assessment and evaluation of inactive inventories for the user to select synergistic projects which share equipment and logistical benefits.

Closure's consulting group has realized up to a 25% savings in project costs through efficiencies made possible by the software which can be replicated by other producers. This means ARO budgets can be stretched further to restore more sites per year for the same cost. The Alberta mandatory ARO spending requirement is increasing year over year from \$443MM/year when it was introduced in 2022 up 58% to \$700MM/year just one year later. The province's ARO spend is quickly approaching \$1B/year. The increase in spending creates an enormous opportunity to demonstrate efficiencies with Prædicō and will warrant growth in the environmental technology and services sector, creating more jobs in the province.

The project generates direct economic benefits such as rising revenues by adding capacity to the existing engineering team at Closure and by creating a new revenue stream through commercialization of the Saas product. Forecasted Saas revenues for the first 1yr after commercialization are estimated at \$200,000 growing in 5 years to over \$2 million per year for the base subscription.

The company's additional revenues will be re-invested in future module development on the Prædicō platform. Prædicō has an extensive product roadmap following the end-of-life assets from well abandonment through to completed surface reclamation. Future modules will be marketed to broader user groups and create the potential for export to other energy jurisdictions and industries.

2. ENVIRONMENTAL

Prædicō's users will be able to better understand their well inventories, allowing them to strategically abandon their wells to align with their ESG objectives. De-bottlenecking engineering capacity in the planning and program writing will allow producers to achieve operational efficiencies which can translate to 25% more wells per year being abandoned for the same cost. Each inactive well is estimated to release 8 tonnes per year Co2e in fugitive methane emissions. Taking this one step further, at the current annual regulatory minimum spend budget the existing inventory of inactive wells is estimated at 40 years to complete. Therefore, each additional well you abandon in the current year has a multiplier of 40. Suddenly each well abandoned today is worth 320 tonnes of GHG over 40 years. Based on 10,800 wells abandoned in the year 2022, the opportunity cost of the current inefficiencies can be staggering. Because of this, Prædicō's greatest environmental impact is that it will accelerate the rate of downhole abandonment in Alberta. Increasing the rate of subsurface abandonment will accelerate the cadence of surface reclamation and the return of well sites to their natural state and reduce the industrial footprint of the energy industry. Increasing the cadence of land restoration also reduces the risk of contamination migration from well sites into nearby wetlands which could negatively impact wildlife.

In the future, Prædicō will help protect safe ground water supply by identifying inactive wells with suspected groundwater isolation concerns in proximity to residential drinking water wells. This would allow the regulator to identify and prioritize these sites to protect safe drinking water.

3. SOCIAL

As ESG has become a critical factor in the eyes of the multitude of stakeholder groups, producing companies are paying closer attention to the social impact of their operations than ever before. Stakeholders are concerned about the environmental impact and the legacy they will leave behind for their children. Prædicō will help producers tackle this problem in a more systematic, responsible, and reliable way. Efficient producer lead clean-up, in the spirit of polluter pay policy, reduces the taxpayer risk and cost of orphaned wellsites. Prædicō is a “Made in Alberta” clean technology that creates jobs, demonstrates Alberta is a leader in innovative technology, and showcases the opportunities for technology development targeted at the energy sector. Accelerating oilfield restoration results in lands being returned to productive uses in agriculture and supports property values for clean remediated sites. Plugged wells and reclaimed sites reduce fugitive emissions, risk to drinking water and soil contamination which all have societal health benefits. Collectively, Prædicō is a step towards a legacy of environmental stewardship.

4. BUILDING INNOVATION CAPACITY

Closure has a long product roadmap for future modules to be hosted on the Prædicō platform. In development of Prædicō, Closure hired a full stack developer, a data scientist, and content experts working on state of the art AWS services. Closure expects to continue to work with Analytika as a development partner (also a Calgary, AB, based company), which will also require a growth in their capacity. To meet Closure’s internal needs, as well as customers’ needs, Closure will need to expand its human resources. This growth is expected to be largely in the form of HQSP personnel, from designers, to developers, data scientists, engineers, sales, and project managers. The functions to be furthered and developed in Prædicō are largely of a technical nature. These will require increased in-house technical capability to manage the analyses, draft white papers, and perform the ML/AI work.

Building out clean technology software development capabilities in Alberta is part of the transition towards modernizing the workforce. Hiring bright, young, highly educated workers creates opportunities in the province to attract and retain scarce talent and add valuable taxpayers. As closure activity accelerates with the adoption of Prædicō, oilfield services demands will increase for skilled labor and technological advancements in downhole abandonment, site remediation and restoration.

Alberta’s broader Innovation capacity has also been increased through the liberation of data. The Alberta Government is in possession of data sets that are technically public but are not made available in forms that are accessible to end users. During this project, valuable subsurface cement data was secured from the Alberta Government and published by Closure’s data provider at the direction of the project team. This information is now in the public realm and accessible to all industry users. Closure continues to seek out and liberate isolated, restricted, and private data sets to increase the innovation capacity of the industry.

I. RECOMMENDATIONS AND NEXT STEPS

Please provide a narrative outlining the next steps and recommendations for further development of the technology developed or knowledge generated from this project. If appropriate, include a description of potential follow-up projects. Please consider the following in the narrative:

- Describe the long-term plan for commercialization of the technology developed or implementation of the knowledge generated.
- Based on the project learnings, describe the related actions to be undertaken over the next two years to continue advancing the innovation.
- Describe the potential partnerships being developed to advance the development and learnings from this project.

RESPOND BELOW

1. COMMERCIALIZATION

Closure will start using Prædicō immediately to further its engineering consulting business. This will help improve Closure's capabilities, competitive advantage, grow revenues and increase margins. At the same time, Closure is looking for early adopters in industry to begin to use Prædicō. This soft launch will help Closure polish the product by quickly integrating customer feedback. Closure is planning a product launch for Prædicō and has applied to Alberta Innovates Commercialization Associate program with a comprehensive product marketing and branding strategy.

2. PRÆDICŌ CONTINUOUS IMPROVEMENTS

Based on market feedback, Prædicō will undergo continuous improvement. Several items for improvement have already been identified through this first stage of development and will be addressed in the continuous improvement phase. As a host platform for developing modules, Prædicō will continue to increase its capacity along the lines of this DICE scope (additional deliverables, more data, various forms of accepted data, better features, new analysis).

3. PRÆDICŌ NEXT MODULE – RAPID PHASE 1 ENVIRONMENTAL SITE ASSESSMENT (ESA1)

Prædicō's product roadmap already identifies the next module for development. The Rapid Phase 1 Environmental Site Assessment project is already in its planning stages and will build an additional workflow onto Prædicō. The downhole/DICE workflow will be leveraged to springboard development in the next stage of well abandonment (following downhole comes ESA 1, then ESA 2, etc.).

Closure is currently working to align partners to pursue this work including SDTC, IRAP, Alberta Innovates, Analytika, and industry partners.

J. KNOWLEDGE DISSEMINATION

Please provide a narrative outlining how the knowledge gained from the project was or will be disseminated and the impact it may have on the industry.

RESPOND BELOW

The knowledge gained from this project will be absorbed into Closure to improve Closure's product development process, product design, and performance. As Prædicō is opened to early adopters, and for SaaS, the goal is to have a user experience so profound they question how they ever accomplished the task without this product. Once the industry is capable of looking at inventories of hundreds or thousands of sites at once, the growth in liability intelligence will fundamentally change the approach to ARO planning and liability appraisal. Prædicō is positioned to become the defacto standard in ARO software and users will benefit from the systematic processes, continuity in workflows and ongoing best practices.

Prædicō has also amassed a significant amount of data, and Closure's machine learning analysis has identified very interesting information about abandonment risk. While not part of this project scope, Closure intends to pursue white papers to disseminate these learnings to the energy industry.

K. CONCLUSIONS

Please provide a narrative outlining the project conclusions.

- Ensure this summarizes the project objective, key components, results, learnings, outcomes, benefits and next steps.

RESPOND BELOW

The overall objective of this project was to "Provide users the technology and knowledge to streamline the process, from well prioritization to abandonment planning by creating a leading-edge web-based platform." This included the ability to ingest massive amounts of public data, organize that data for use, analyze the wells and their associated risks, facilitate planning, and provide users with deliverables needed on the ground for well abandonment.

This project was designed specifically to fulfill this objective. Project Management Institute (PMI) best practices were used in a hybrid waterfall-agile project management approach to ensure it was successful. The project came in on cost and on scope, though it was met with approximately two months of delays. Analysis performed during the project determined that of the triple constraint, time was the most flexible variable. Discussed between Alberta Innovates and Closure, it was determined that the delays did not jeopardize the success of the project. With this in mind, this project is considered a success.

While the project was successful, there were a few key pivots and challenges that yielded lessons learned. These lessons learned will be carried into the next project for development, helping Closure to use communication, extensive planning, and strong partnerships to successfully develop the Rapid Phase 1 Environmental Site Assessment module.

As Prædicō increases users, both internally in Closure and as a full SaaS release, there will be more and more benefits to the energy industry, and Alberta as a whole. The benefits have the potential to be widespread, making a huge impact on ESG, development of additional technologies, and HQSPs in Alberta.

Overall, this project was a success. Closure plans to work with its partners to follow it up the development of another revolutionary product, the Rapid Phase 1 Environmental Site Assessment module, to be launched on the Prædicō platform.