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June 28, 2024

Mr. Reice Haase
Deputy Executive Director
North Dakota Industrial Commission
State Capitol, 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Dear Mr. Haase:

Subject: Final Project Report Entitled "iPIPE 2.0: intelligent Pipeline Integrity Program"
Contract No. G-055-108; UND Project – Fund 41000-UND0026743;
EERC Fund 26743

Attached is the final project report for the subject project for the period January 1, 2022 – June 30, 2024.

If you have any questions, please contact me by phone at (701) 777-5201 or by email at dschmidt@undeerc.org.

Sincerely,

DocuSigned by:
Darren Schmidt
DBBB990DF8C34D8...

Darren D. Schmidt
Assistant Director for Energy, Oil, and Gas

DDS/rlo

Attachment

c/att: Brent Brannan, North Dakota Industrial Commission
Erin Stieg, North Dakota Industrial Commission

IPIPE 2.0: INTELLIGENT PIPELINE INTEGRITY PROGRAM

Final Project Report

(for the period January 1, 2022 – June 30, 2024)

Prepared for:

Reice Haase

North Dakota Industrial Commission
State Capitol, 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Contract No. G-055-108

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EXECUTIVE SUMMARY

The intelligent Pipeline Integrity Program (iPIPE) is a significant collaboration among industry, institutional research, and the North Dakota state government. Emphasized by Governor Doug Burgum, iPIPE demonstrates how innovation, in contrast with regulation, can advance solutions. iPIPE 2.0, designated regarding the second research contract with the North Dakota Oil and Gas Research Program, has advanced four technology projects that further our journey to improve pipeline integrity. The program includes industry participation from the following members: Enbridge, Energy Transfer Partners, Hess Corporation, Marathon Petroleum Logistics, ONEOK, Phillips 66, and TC Energy. The program's goal is to advance technologies that reduce the frequency and duration of pipeline releases.

iPIPE 2.0 selected projects in four separate technology areas:

- Advanced computational pipeline monitoring (CPM)
- Data integration of aerial patrol and right-of-way (ROW) inspection
- Internal pipeline inspection and preventative maintenance
- Advanced external pipeline sensors and monitoring

Unique to iPIPE 2.0 is an emphasis on advancing technologies for produced water systems. For every barrel of oil produced in North Dakota, about 1.5 barrels of saltwater are produced. Produced water is a cost to the industry and a pipeline transportation risk. Finding ways to implement cost effective monitoring technology is vital to pipeline integrity and a vibrant oil and gas industry.

iPIPE 2.0 research resulted in commercial deployment of advanced CPM systems on at least 15 pipeline systems in North Dakota over the past 2 years and on three produced water systems. The supplier of the technology would not have explored produced water application without the support of iPIPE.

iPIPE 2.0 was instrumental in advancing the concept of shared ROW inspection, which could decrease flight miles for manned aircraft inspections required by federal regulations while improving the quality of data collected with aircraft-mounted sensors and advanced data analysis.

New ways of internally inspecting pipelines were explored with acoustic technology that offers operators the ability to inspect pipelines more frequently than conventional in-line inspection methods.

iPIPE 2.0 supported the development of a new product that combines hydrocarbon detection with automatic camera inspection to reduce false positives and improve operators' ability to outfit remote locations and high-consequence areas with monitoring.

iPIPE 2.0: INTELLIGENT PIPELINE INTEGRITY PROGRAM
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BACKGROUND

The intelligent Pipeline Integrity Program (iPIPE) 2.0 builds on the success of the initial program, which began with five members in 2018. The program is a response to Governor Doug Burgum's challenge to eliminate pipeline leaks through innovation.[1] iPIPE has developed and demonstrated leak detection technologies that include in-line inspection of small-diameter gathering lines, advanced sensors external to the pipe for application in sensitive areas, remote detection from satellites, and leak prevention through machine learning (ML) and artificial intelligence (AI) analysis. Investments in these technologies have advanced the products to commercialization, resulting in applications both in North Dakota and elsewhere in North America. Notably, iPIPE's significant attention to remote monitoring from space has resulted in the application of the technology within the membership and spurred a project launching new sensors and satellites into space.

iPIPE 2.0 industry participation includes Enbridge, Energy Transfer Partners, Hess Corporation, Marathon Petroleum Logistics (MPLx), ONEOK, Phillips 66, and TC Energy.

The goal of the program is to advance technologies that reduce the frequency and duration of pipeline releases.

The objectives to achieve this goal are as follows:

- Select at least two projects for demonstration from the technology-scouting efforts.
- Grow industry membership.
- Foster industry collaboration through monthly member meetings and an annual member forum.
- Advance technology to commercial application and demonstrate commercial deployment.

The following summarizes the program activities and results from January 1, 2022, through June 30, 2024.

[1]https://www.ndoil.org/industry-responds-to-governors-initiative-to-improve-pipeline-technology-program-funding-approved-by-north-dakota-industrial-commission (accessed December 2023).

FLOWSTATE

iPIPE's project with Flowstate is to determine if its commercial ML and AI leak detection system (LDS) developed for liquid hydrocarbon pipelines can be extended and adapted to tackle the unique challenges associated with produced water pipelines. Applying advanced LDS on produced water gathering lines is challenging because of limited data inputs and cost when compared to oil and gas pipelines because produced water systems typically have fewer monitoring points. Additionally, produced water gathering systems tend to be more complex, including pump control, intermittency, and saltwater disposal operations. North Dakota's Williston Basin, encompassing nearly 20,000 square miles of land, is networked extensively with produced water gathering systems that transport water associated with oil production from the wellhead to disposal wells that inject deep underground. North Dakota is the third largest oil-producing state in the United States. According to the Department of Mineral Resources, North Dakota produced 1.2 million barrels per day.[2] Bakken oil, which is 97% of the state's production, has a water cut of about 60%,[3] equating to 1.8 million barrels per day of produced water. Safely transporting this significant volume of produced water is vital to the continued production of North Dakota's oil resources. Since produced water is a cost to the industry, cost-effective leak detection technology is critical to advance the integrity of produced water assets.

Flowstate is a company that provides leak detection to the pipeline industry through advanced computational pipeline monitoring (CPM). The organization includes over 25 professionals with expertise in software development. Flowstate leverages the capabilities of big data and has developed proprietary AI to monitor pipelines. Flowstate's solutions decrease cost, implementation time, and simplify configuration with respect to traditional CPM systems. Flowstate began as a partnership with True Companies' Bridger pipeline to improve liquid pipeline monitoring and leak detection across the organization's operations in the Rocky Mountain West. True Companies determined that existing technologies were inadequate for efficient, effective pipeline management and for meeting increasingly stringent regulatory demands. Flowstate was created to address these challenges and in 2019 spun off as an independent company built upon a solid foundation with pipeline operations with the True Companies.

Flowstate's technology includes proprietary ML algorithms that include a variety of leak detection methods such as rupture, statistical volume balance (SVB), enhanced line balance (ELB), and signature recognition. Development work as part of iPIPE included testing the SVB and ELB models on a produced water pipeline system offered by MPLx. Flowstate was able to significantly improve its ELB capabilities to support complex gathering systems as a result. The LDS generates and uses an imbalance profile, representing the difference between total volume entering and leaving the system. This imbalance profile is used to create multiple aggregation profiles that span different time intervals. These aggregation profiles are then analyzed to establish thresholds, which are used to monitor the system and set parameters for detecting leaks. New logic was developed to improve robustness by escalating alarms based on the alignment of multiple aggregation interval alarms and included mechanisms to handle potential false alarms caused by meter or operational issues. All of this is processed continuously in the native sensor polling rate of the system. The

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[2] https://www.dmr.nd.gov/dmr/sites/www/files/documents/Director's%20Cut/06.14.24%20Directors%20Cut.pdf (accessed June 26, 2024).
[3] file:///C:/Users/dschmidt/Downloads/BakkenProducedFluidsChemistryEvolution.pdf.

newly developed enhancements are integrated into Flowstate's LDS dashboards and summarized in daily email reports, providing a comprehensive performance overview. Leak detection has been improved by developing capabilities to associate different stations with their respective pipeline laterals. Aggregating flow rates from individual stations into a single lateral flow rate allows for more efficient leak detection modeling and visualization. The approach reduces visualization complexity and simplifies parameterization, enabling leak detection on a lateral basis rather than an individual station basis. The visualization workflows now allow users to drill down to the device level, significantly improving usability for systems with numerous stations. Advancements have been integrated into Flowstate's commercially available LDS, resulting in improved efficiency, robust performance, and enhanced user experience. The system now provides more accurate leak detection on complex gathering systems, better alarm diagnosis, and streamlined visualization. These developments mark a significant step forward in leak detection for gathering systems and demonstrate a practical application.

The research project scope of work included the following:

1. Connect Flowstate's LDS to a produced water gathering system operated by MPLx.

2. Provide data quality analysis to determine any challenges in operating the LDS on the customer pipeline.

3. Validate leak detection capability. This work was accomplished with simulated leaks and a withdrawal simulation in cooperation with the operator.

Flowstate installed its LDS to monitor approximately 32 miles of produced water pipeline operated by MPLx. There are 26 flow inputs to the pipeline and one flow output. Data connection with the pipeline system resulted in 81 data tags. The existing supervisory control and data acquisition (SCADA) system provides a poll rate of 5 seconds.

The data quality for this project was sufficient. Devices on the system are evaluated with respect to sampling resolution, noise, sampling range, time calibration, and data quality with respect to successful LDS analysis. A good evaluation indicates that device and sensor data do not hiner leak detection. An okay evaluation could result in degraded leak detection in terms of minimum time to detection or leak size, whereas a poor evaluation indicates significant degradation in the ability to detect leaks. Most inputs and outputs resulted in a good evaluation, while some inputs evaluated as okay. No sensor input was poor.

Tests were completed to evaluate the performance of SVB and ELB models. Detection times were determined for the SVB model by producing target volume curves for a wide range of leak sizes. To verify expectations, 185 digital leak simulations ranging from 8 to 70 bph were used. Leak rates of over 20 bph are generally detected within 1 hour, matching expectations. Larger leak rates can be detected with the SVB model in less than 10 minutes. The ELB model is designed to detect small leaks. Sixty digital leak simulations with sizes of 1–8 bph were conducted to evaluate the ELB model. The ELB model was able to detect all digital leak simulations, with the majority alarming in hours from the simulation start. One false positive was observed in coincidence with an identified communication failure.

Flowstate used a digital leak detection simulator to validate newly developed leak detection models for the MPLx system. Results were comparable to previous experience with crude oil pipeline systems. Large (60 bph) and small (40 bph) leak sizes were simulated to verify the leak detection model. The simulation resulted in a system imbalance and subsequent alarms. The flow decreased within 3 minutes, simulating a realistic release scenario. The larger leak had a detection time of 4 minutes, 10 seconds. The smaller leak had a detection time of 5 minutes. Both simulations resulted in acceptable detection times and provided accurate estimated leak statistics.

Fluid withdrawal tests from the pipeline were conducted to verify the operational performance of the LDS. A series of three tests were conducted: 1) leak rate of 30 bph with an estimated time to detection of 25 minutes, 2) leak rate of 12 bph with an estimated time to detection of 45 minutes, and 3) leak rate of 6 bph with an estimated time to detection of 90 minutes. A detailed report of all work, including a presentation of results, has been prepared by Flowstate and delivered to iPIPE members. The respective results of the tests are as follows: 1) 30 bph – detection time 15 minutes and 40 seconds, 2) 12 bph – detection time 33 minutes and 30 seconds, and 3) 6 bph – detection time 70 minutes and 10 seconds. The software detected the leaks faster than anticipated and predicted the leak volume within less than 3 bbl of actual.

Flowstate’s work with iPIPE has enabled significant enhancements to the leak detection algorithms for produced water systems and is now part of commercial offerings providing real-time, efficient, and robust leak detection. During the project, Flowstate applied its leak detection technology commercially on large commercial produced water systems in North Dakota and crossed over from crude oil systems to produced water gathering pipelines. Prior to the iPIPE project, Flowstate’s LDS was operating on one pipeline system in North Dakota. Flowstate has since expanded to over 15 pipeline systems within the state plus three produced water systems. Flowstate indicated it would not have been able to expand its capability to produced water systems without the support of iPIPE. The project has advanced cost-effective LDS for produced water systems and achieved first implementation to improve asset integrity in North Dakota.

FLYSCAN

Midstream operators are required to frequently inspect the pipeline right-of-way (ROW) under federal regulations. Much of the present work is conducted by aircraft with visual inspection completed by the pilot. Flyscan is a company that offers electronic inspection with advanced sensors onboard the aircraft to completely automate the process and combine AI and human interaction to identify and record anomalies within the pipeline ROW. The technology aboard the aircraft includes visual cameras and processing, which can automatically detect pipeline threats such as vehicles or changes in soil conditions and vegetation. Combined with a hyperspectral camera, the presence of hydrocarbons on the surface of the soil can be detected. Flyscan proposed that with advanced technology and automation a pilot may be able to fly a single mission over a pipeline ROW that is shared by a multitude of operators to increase efficiency and reduce flight miles while improving the quality of the ROW inspection. Furthermore, the hyperspectral camera may be able to detect produced water. Flyscan conducted a research project for iPIPE 2.0 to determine if its threat detection and hyperspectral oil and gas leak detection technology could operate in a shared ROW application and include produced water detection.

Flyscan is a spin-off of the National Optics Institute (INO), Canada's largest research and development lab in laser technology and is backed by investors and development partners such as Enbridge Pipelines, Sustainable Development Technology Canada, Business Development Bank of Canada, and the Fraunhofer Institute. Located in Quebec, Flyscan was founded in September 2015 to commercialize a technology for liquid pipeline leak detection developed by INO following a Pipeline and Hazardous Materials Safety Administration research grant. While Flyscan introduced this technology to the market, customer feedback indicated a need for lower-cost visual inspection and remote sensing surveillance platforms. As such, Flyscan is now integrating off-the-shelf sensors on small aircrafts to automate relevant data capture and visual inspection of pipeline ROWs. Using its expertise in remote sensing and AI applications, Flyscan offers customers the ability to prevent and detect pipeline hazards at a higher sensitivity than regular SCADA systems while automating all visual inspection functions performed today by human observation onboard planes or helicopters.

Flyscan's threat detection system uses red–green–blue (RGB) images to identify potential third-party encroachments. Using an onboard computer, the images are analyzed in real time with a ML object-detection algorithm. When a threat is detected, it is categorized into one of several categories. The information is then presented to the pilot, who can assign it a priority level. Depending on the priority level, regional managers can be notified with an RGB image of the threat and its coordinates. Thanks to a highly precise navigation system, a complete 2D orthomosaic and a 3D point cloud of the surveyed area can be created.

Flyscans's passive LDS uses hyperspectral data to detect potential leaks recorded from a shortwave infrared push broom sensor. The generated dataset is analyzed using a mix of spectral reidentification methods coupled with ML algorithms. By using these approaches, the same sensor can detect a variety of products. The ML algorithms help reduce the false alarm rate while increasing the sensitivity. Flyscan's passive LDS, developed for the detection of crude oil and refined products, is being expanded for detection of produced water through the iPIPE partnership.

Flyscan's online portal provides pipeline operators the ability to plan, track, and review surveys over their assets. Reporting of threats and potential leaks is available through the portal and can be displayed with a corresponding RGB image of the area. Data can be tracked over time. With many pipeline operators often sharing the same ROWs, the portal allows, under specific and agreed-upon guidelines, for a single survey to provide information to the different operators sharing a specific ROW section. The status of a threat or a leak and actions being taken to remediate are displayed on the portal.

The project scope included the following elements:

- Flight mission planning to inspect a grid of varied pipeline ROW ownership
- Develop the pilot display, guidance, and real-time processing for ROW application
- Develop data management tools for threat detection and passive leak detection for a shared ROW application
- Develop a hyperspectral algorithm for produced water

- Conduct small-scale flight tests for produced water detection
- Conduct a shared ROW flight over iPIPE member assets to demonstrate threat detection and crude oil leak detection capability for various-sized surface targets
- Optimize oil hyperspectral detection algorithms for the mission

Flyscan used its mission planning tools to create a flight mission over shared assets in the Williston region. Three client accounts were created on the Flyscan online portal. A survey was completed on May 28, 2024, over about 120 square miles near Williston. The survey achieved over 95% coverage of the area, including a 140-meter swath (70 meters on each side of the pipeline). Detections totaled 359, including 47 commercial trucks, 51 mechanical trucks, 244 moveable objects, 16 oversize passenger vehicles, and one swimming pool. Thirty-nine notifications were generated from the total detections, 10 of which, or about 25%, were within shared ROWs. The test flight demonstrated shared ROW capability at all product levels, including mission planning, execution, live notifications, and postflight reporting. Flyscan is confident to offer this new feature to operators for maintaining regulatory compliance while improving inspection efficiency. A few bugs were identified, which Flyscan can improve. Flyscan recommends upgrading cameras and optics to allow for higher survey altitude, which will improve flight efficiency by providing a larger survey swath while maintaining sufficient resolution. Hyperspectral data were collected in the shared ROW mission, resulting in seven reported events. The postprocessing required 16 hours and demonstrated liquid hydrocarbon leak detection capability for shared ROW application.

Four field tests were conducted to develop and improve hyperspectral detection capability. Three of the tests were conducted in Canada and one within North Dakota. All tests included flying over various sizes of ground-based targets to test detection limits. The first flight assisted in establishing performance at various altitudes. The higher the altitude, the more ground coverage can be achieved in a single pass. An optimal flight elevation of 1100 feet was identified. The second test included camera upgrades, enabling more precise and diverse detections and the ability to discern detections with regard to shadows cast on the ground. A new hyperspectral camera and algorithm were commissioned because of the test. The third test examined spectral diversity and geometry, testing targets as small as 1 square meter, including produced water, diesel, crude oil jet fuel, gasoline, and variations of vegetation and soil types. The campaign revealed interference in detections from plastic materials and reinforced the new algorithm and camera capabilities for hydrocarbon detection. The final test was conducted in North Dakota and included eight targets: three with various concentrations of produced water, three with various concentrations of crude oil, one crude oil target less than 1 square meter, and one blind target. All crude oil targets were detected, and the blind target was successfully not detected. However, the produced water targets provided some uncertainty, and detection is not viable with present methods.

Flyscan concluded that the hyperspectral LDS is robust and in commercial operation at a technology readiness level (TRL) of 9. The iPIPE work increased performance significantly over the project duration. The commercial lower limit for hydrocarbon detection is 1 square meter at 550 feet and 2 square meters at 1000 feet. However, in practice, targets as small as 0.6 square meter at 500 feet and 1 square meter at 1100 feet were detected. During the test in North Dakota, a 0.68-square-meter target was reliably detected at 1100 feet. The LDS can detect liquid hydrocarbons on any substrate, is resilient to partial shadows and partial line of sight, and tolerates other ground interferences (such as vegetation/sticks). Although an extensive amount of work was performed to develop algorithms and sensor capabilities to detect produced water, the efforts did not yield results good enough for commercialization. Salts contained in produced water do not yield a spectral signature unique enough to discriminate from the spectral diversity of a typical ROW. Flyscan's algorithms to detect stressed vegetation are recommended as a proxy to find produced water leaks as an alternative to direct detection.

SEISMOS

Seismos Inc. (Seismos), based in Austin, Texas, is a pioneer in AI-powered acoustic sensing systems enabling real-time, nonintrusive, cost-effective quality control and monitoring. The company, backed by Quantum Energy Partners and Javelin Venture Partners, operates in the United States, Canada, and China. Since being founded in 2013, Seismos has become an industry leader in acoustic sensing for tubular systems, including pipes filled with various media. In upstream oil and gas applications, the Seismos MWF (Measurements While Fracturing) system leverages acoustics that propagate via the wellbore (3–5-in. pipe), revealing characteristics of the subsurface. The company has demonstrated the ability to locate anomalies inside of a pipeline from miles away without physical intervention. Seismos has a significant track record in monitoring and optimizing hydraulic fracturing operations with acoustic technology. Seimos was selected by iPIPE to determine if this expertise can translate to monitoring pipelines in preventative maintenance applications.

A scope of work was developed to investigate the ability of Seismos predictive pipeline health management technology to identify over time, via quasicontinuous measurements, pipeline leaks, geometric deformation, scale buildup, and other pipeline irregularities. A 49-mile pipeline segment owned by ONEOK that carries gas and gas liquids was selected for field testing. The pipeline is 14 in. in diameter and includes five riser locations for attaching Seismos acoustic inspection technology. The plan included three field data collections, the first a baseline followed by two repeat monitoring runs. ONEOK scheduled an in-line inspection (ILI) or smart pig operation during the second data collection. Seismos initially compared 2015 ILI data with the baseline acoustic data followed by comparing ILI data and acoustic data collected simultaneously during the second data collection. The final and third inspection was conducted in April 2024, with a presentation to iPIPE members scheduled for June 28, 2024. Since the final presentation from Siesmos is not available as of the writing of this report, results and conclusions are not finalized. Results of the second data collection identified acoustic signatures that match ILI data, suggesting areas in which to concentrate inspection. Acoustic results are qualitative versus quantitative, although pinpoint locations pose higher risk. The acoustic techniques offer a means to obtain internal pipeline data at lower cost, potentially increasing inspections versus waiting longer times between smart pig operations to obtain internal data.

SYSCOR

Pipeline operators' assets are often in remote locations or high-consequence areas in which remote monitoring is advantageous to identify leaks. These assets can be facilities or pipelines. One method of remote sensing includes polymer absorption sensors (PAS) installed external to the pipeline or equipment. The PAS, once in contact with crude oil, will provide detection and send an alarm. A particular challenge with remote locations is when the detection system generates a false positive alarm, resulting in mobilization, shutdown, and other activities that raise operational costs. To alleviate this concern, Syscor proposed combining a PAS system with camera operations to eliminate false positives and provide more information to the system operator for remote inspection at the sensor location. Additionally, Syscor developed the sensor package to float in water for oil-sheen detection on water bodies. Syscor's project with iPIPE includes product development in prealpha, alpha, and beta stages followed by laboratory testing to ready a product for the next level of investment relative to commercialization.

Syscor was incorporated in 2008 and develops safety solutions for petroleum applications with a focus on hydrocarbon leak detection. Syscor's major customers include Enbridge, TC Energy, Irving Oil, Flint Hills Resources, INEOS, and others. The company has 13 technical employees and a well-established manufacturing supply chain. Syscor is registered as an ISO-9001:2015 company and licensed to manufacture intrinsically safe equipment through Canadian Standards Association and ATEX certifications. Syscor's expertise is in the development of turnkey sensor systems using industrial standards that are adopted by the petroleum industry. Syscor has commercialized a number of wireless sensor products and Industrial Internet of Things systems for remote service.

The scope of work for the project includes the following activities:

- Prealpha prototype – Develop a sensor for water bodies; build a multispectral camera; develop image processing; test sensors, camera, and imaging.

- Alpha prototype – Improve the hydrocarbon sensor; refine the camera; integrate imaging; test sensors, camera, and imaging.

- Beta prototype – Integrate the sensor and multispectral camera and field test.

Syscor completed all three product development steps and provided presentations to iPIPE members throughout the project. Beta prototype testing demonstrated a fully integrated PAS floating in a laboratory water containment and the ability to detect hydrocarbons and automatically generate multispectral camera images. Additionally, Syscor continued development of AI analysis of the images to assist with image analysis. The project was successful, ending at TRL 6 with prototype testing in a relevant environment.

MEMBERSHIP AND FINANCIAL INFORMATION

iPIPE 2.0 has continued to demonstrate the shared commitment among industry, North Dakota, and technology innovators to produce and transport cleaner energy. The six iPIPE members matched the $400,000 funding from the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program with an additional $1,050,000, as shown in Table 1. The combined cash commitment allowed iPIPE to subcontract to four technology providers totaling $690,350. Financial support for iPIPE advances leak detection and prevention technology, assists in procuring projects and project management, and facilitates an industry consortium fostering discussion and knowledge sharing around common pipeline integrity and facility challenges. Industry members provide robust participation, offer assets in which to test, attend meetings and forums, and provide feedback to the technology developers. The four technology providers each demonstrated further commitments with over $525,000 in in-kind cost share, resulting in a nearly $2,000,000 project, respective of the state's investment (Tables 2 and 3).

Table 1. iPIPE 2.0 Original Budget

Sponsors	Contribution
NDIC – Cash	$400,000
Industry – Cash	$1,050,000
Total	**$1,450,000**

Table 3 presents details on actual expenses incurred through the financial reporting period ending June 15, 2024. The remaining budget balance reflects payments due to technology providers for deliverables already achieved. All subcontract milestones and deliverables are anticipated by the end of the contract period.

Table 2. iPIPE 2.0 Updated Budget

Sponsors	2022	2023	2024	Total
NDIC – Cash	$400,000	$0	$0	$400,000
Industry – Cash	$1,050,000	$0	$0	$1,050,000
In-Kind Contributions	$0	$418,453	$108,150	$526,603
Total	**$1,450,000**	**$418,453**	**$108,150**	**$1,976,603**

Table 3. iPIPE 2.0 Expected Budget and Expenses to Date

Sponsors	Cash Budget	Actual Expenses as of 6/15/2024		Balance Remaining of Cash Budget
NDIC Share – Cash	$400,000		$396,448	**$3,552**
Industry Share – Cash	$1,050,000		$712,193	**$337,807**
Technology Providers – In-Kind	$0	*Flowstate*	*$25,708*	
		Flyscan	*$291,456*	
		Seismos	*$21,212*	
		Syscor	*$188,227*	
		TOTAL	**$526,603**	
Total	**$1,450,000**		**$1,635,244**	**$341,359**