**North 40 Technologies, LLC**

*Bringing Tech Projects to Life*

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# Automated Gated Pipe Field Trials, Final Report

## CWCB Grant POGG1 2024-3371

Presented by North 40 Technologies, LLC

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## Description

Field trials as proposed in the automated gated pipe grant application have been completed during summer 2024 in areas near Longmont and Ft Lupton, CO. The grant proposal was approved by the South Platte Basin Roundtable in Oct of 2023, with the state board approving it at their meeting in March of 2024. This report outlines the timeline and activity that was completed and presents results from the study.

The grant contract was awarded April 30, 2024. Hardware orders for grant fulfillment commenced starting May 2, 2024.

During the spring months of May – June orders were placed and managed for the components necessary for field trials and for the eventual solution that would be available to farmers. Parts were received by the end of July and assembly of systems began immediately after that.

Two versions of automated (motorized) gated pipe were deployed. The first was a retrofit version with motorized gate valve modules that mount directly into the existing rectangular holes of existing gated PVC pipe, replacing the existing slide gates.

The second version was a custom pre-assembled 8” pipe that would be delivered to the farmer’s field with the motorized gate valves and pipe control unit fully installed, integrated and ready to deploy in the irrigation line.

Both versions share common electronics and software.

*Figure 1 Retrofit Gate Valve (left), Pre-assembled Gate Valve (right)*

Three farmers were identified who were willing to allow the automated systems to be installed and to provide feedback on overall operation. One farmer invited us to install 2 systems on his fields.

| System | Farmer | Location | Crop | Version | # Pipes |
|---|---|---|---|---|---|
| 1 | Jason Condon | South of Longmont | Corn for silage | Pre-assembled | 27 |
| 2, 3 | Patrick Hladkey | North of Ft. Lupton | Corn for grain (2 fields) | Retrofit | 10, 16 |
| 4 | Rob Lindow, Town of Erie | West of Erie | Hay | Pre-assembled | 10 |

## System Deployments

### System 1 – Jason Condon Farm

Thirty pre-assembled pipe units were built July 27 – Aug 12. These pipes were delivered to Mr. Condon's corn field Aug 13. Twenty-seven pipes were set Aug 16, and water began flowing Aug 23. During build process various assembly issues were noted to be corrected for factory mass-production build. Suggestions for improvements to the irrigation application were also received.

For convenience, these PVC pipes were laid on top of the flat flexible pipe Mr. Condon used previously to irrigate the field. The irrigation line was partly in the field, so the corn and grass gave partial shade to some of the solar panels on the pipe controllers. Despite the partial shade, the solar panels continued to provide adequate power for running the gate valves.

*Figure 2 Pipe assembly process (left), thirty completed pre-assembled pipes (right)*

*Figure 3 Pre-assembled pipe ready for placement (right), automated gated pipe replacing existing lay-flat (left)*

*Figure 4 Pre-assembled pipe in operation (left), with field controller radio unit (right)*

## System 2 – Patrick Hladkey Farm

System 2, a retrofit system, was installed on Mr. Hladkey's first corn field Aug 17 and 19 using 10" pipe that was currently set and in use on the field. Installation was accomplished with the existing pipe in place. The pipe was rotated up for better access to the openings during assembly, and then rotated back into position afterward. Wiring issues in the cables from manufacturing were discovered during install and will be corrected for future orders. Water began flowing Aug 20 with continued watering cycles into October. This line has unusually high head pressure, and we closely monitored this for any performance issues.

*Figure 5 System 2 Ten-pipe retrofit install and operation*

## System 3 – Patrick Hladkey Farm

System 3, also a retrofit system, was installed on Mr. Hladkey's second corn field Aug 23 with 11 pipes automated. Irrigation cycles began Aug 25. An additional 5 pipes were added to the automation Sept 12 for a total of 16. These were all 10" pipes, and the install was performed with the pipe in place.

*Figure 6 System 3 Sixteen Pipe Installation*

### System 4 – Rob Lindow Farm

Ten more pre-assembled pipes for System 4 at Mr. Lindow's hay field were built Aug 27 – 31 and included some of the process improvements that were identified while building the pipes for System 1. The pipes for System 4 were delivered to the field and connected Aug 31. An irrigation cycle ran Sept 2-3 with 32 inches of water instead of the normal 40-60 inches. Several experiments were conducted during this irrigation cycle testing anti-erosion socks as well as 100m 2" perpendicular lines with slits that provide more targeted delivery of water over uneven terrain.

*Figure 7 Hayfield Installation of pre-assembled 8" pipe*

*Figure 8 Anti-erosion sock attachment (left), 2" lay-flat slitted pipe extensions (right)*

## Web Application

Mr. Condon and Mr. Hladkey were provided with 8" tablet computers with cellular connections for controlling their irrigation systems using the provided custom cloud-based web application for automated gated pipe management. The system could also be accessed from a desktop/laptop computer, as well as a browser running on a smartphone.

Gate valve control is implemented in two sets on each pipe. The gates on the left half operate in tandem with a single control, and the gates on the right half operate in tandem with a single control.

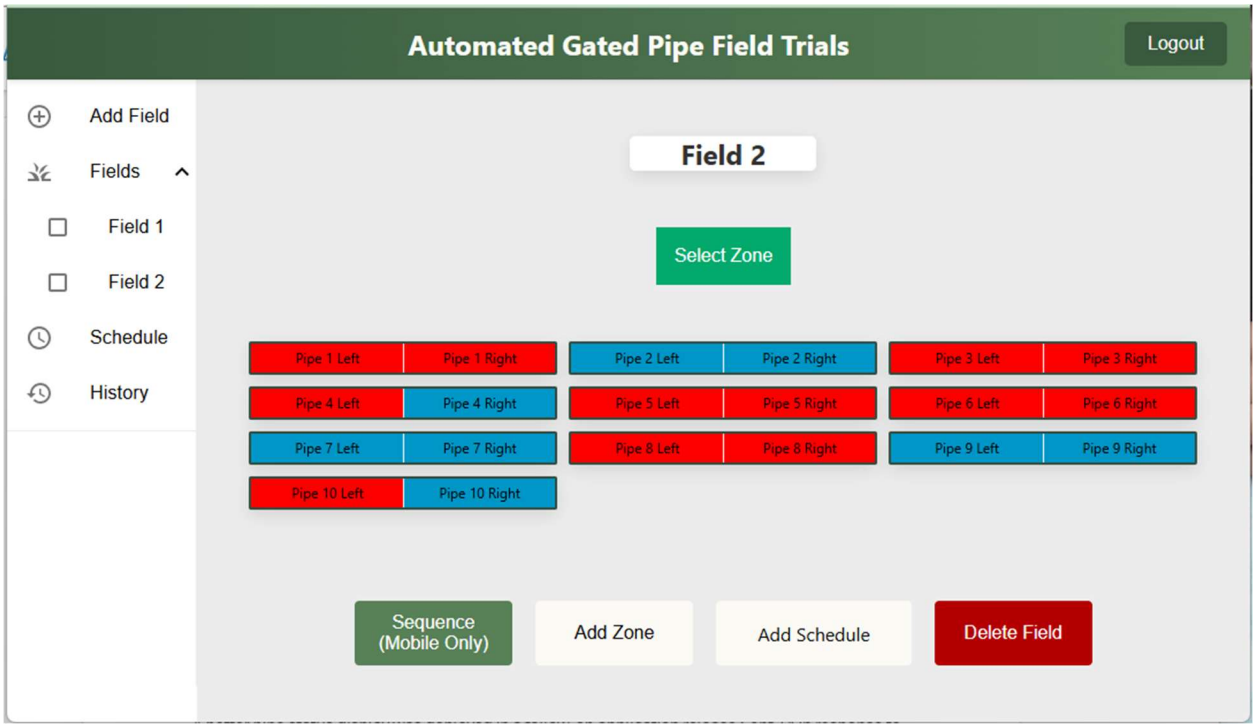


*Figure 9 Web Application Pipes Display, red = closed, blue = open*

A better pipe status display was deployed in a follow-on application release Sept 14 in response to initial feedback on the irrigation application. The planned feature improvements including an Android mobile application and the ability to group pipes into zones for one-button management were delivered at the conclusion of the field trial period.

Overall, the farmers were able to conveniently control the automated gates successfully. The irrigation cycles were completed under full automation.

## Installation Experience

Since August is a very busy time for farmers, the pipe installation was handled by North 40 Technologies personnel.

The installation of pre-assembled pipe was the same as laying down and connecting traditional gated pipe. After the pipe was placed, a configuration step was performed whereby the pipe controllers were scanned with a cell phone in sequence to read the identifying information and build an ordered pipe list (1 to n) in the application software. This sequencing process mates the pipe controllers to their parent field controller.

Installation of retrofit systems required removal of the existing slide gates and insertion of the motorized gate valves. No modifications are made to the pipe itself. The gate valves were then wired to the pipe controller. As with the pre-assembled version, the pipe controllers were scanned with a cell phone in sequence to build an ordered pipe list and mated to their parent field controller.

Installation of the retrofit systems took about 45 minutes per pipe for one person.

## Enhancements Introduced During Trials

Several improvements were introduced during the field trial period, although not all were fully deployed due to the shortness of the remaining growing season.

1. Improved web application one-page display of open and closed gates.
2. Improved reporting of possible gate valve limited movement
3. Grouping pipes into zones for simple one-button control of multiple pipe units
4. Introduction of a water sensor unit

## Noted Issues and Future Enhancements

Notes were kept during the course of the field trials to record any issues and possible enhancements. These items included:

- Occasional gaps in field controller communication with web application
- Four pipe controller service interruptions occurred requiring reset
- Some closed valves became stuck in that position after some time making it difficult to open again. One-time manual assistance restored normal function.
- Water flow through the retrofit gate valves is slightly reduced compared to the slide gates
- Needed more accurate fault reporting for failed gate moves, especially when gates do not fully close
- Debris in the water stream potentially interferes with water flow in the gate or prevents full gate close. Screening at the water intake is recommended. Frequent flushing of the pipe is also recommended.
- Cellular data usage was higher than expected for the connection between the Web Application and the tablet computer.

## Operational Data and Farmer Feedback

Overall the systems operated well for the time in use. Farmer feedback was positive. The following are comments received from the farmers in response to various questions.

What has been your operational experience?

- The system was easy to work with, did not need to ask questions about how to operate the system.
- Consider adding a Spanish language option to the web application

Does automated gated pipe reduce your labor or help manage time more efficiently?

- Being able to change irrigation sets from my kitchen table is a big advantage. I can then organize my day more efficiently and work in the irrigation checks as time allows.
- Being able to change the set from my truck eliminates the need to run back and forth from the bottom of field to top.

When in use for a full season, would you expect to reduce water use?

- Yes, especially with a water sensor at the end of the row to let me know when the water is through
- Likely would have less runoff, but needs to be used efficiently. This is difficult to quantify.
- Individual gate control would help to reduce water use, especially during the first couple of irrigation cycles as the water pushes through trash in the rows

Does the grouping of gate valves left and right per pipe provide adequate control? Is individual gate control important?

- Left and right halves are fine, I normally change sets in full pipe increments anyway
- Individual gate control would help push through rows that have more trash or have a different wheel-pack
- Controlling individual gates may make things too complicated

How would you rate the equipment's durability?

- Satisfied
- Good for the time it was in use on my field

How would you rate the equipment's reliability?

- Adequate, although this is a key point. I need more time to fully assess.
- I lost signal to the field controller once and had to power cycle it. The gates operated on command as expected.

Might having automated gated pipe change your irrigation practices?

- It would allow me to do flood/furrow irrigation in a little more scientific way
- I would consider surging if it can be monitored well enough to adjust to variations

Post-mortem analysis of the retrofit gate valves showed no leakage into the motor area. Manufacturing procedures for the pre-assembled gate valves will be modified to eliminate some potential leak points.

The systems are being left on-field over winter for continued testing and durability studies.

All farmer participants have expressed continued interest in automated gated pipe technology and are open to using these systems for further study during the 2025 growing season.

## Value to the Farmer

There are many facets to the question of value to the farmer. Available subsidies are a key factor as well. Automated gated pipe is a fraction of the cost of both sprinkler and drip systems, allowing the farmer to benefit from automation with a relatively small investment. Automated gated pipe is also portable and transferrable, which helps to preserve the farmer's investment.

Farmer feedback indicated that the availability of subsidies would be a primary factor in their decision whether to invest in automated gated pipe.

## Cash Match and In-Kind Contributions

All cash match commitments totaling more than $15,000 were fulfilled through equipment purchases and labor expenses required to execute the field trials.

In-kind contributions from North 40 Technologies went well beyond the $15,000 budgeted amounts and also fulfilled the grant requirements. These additional hours beyond budget were required for proper assembly of the pre-assembled pipe units, testing of the water sensors, and monitoring and support of system usage during field trial activity. Lessons learned from these additional hours will be applied to manufacturing process refinement as well as software feature improvements.

## Conclusion

Automated gated pipe systems have been successfully deployed on fields with various crops and conditions giving farmers the ability to open and close gate valves remotely from any location with an internet data connection. Four separate systems were installed with an aggregate total of 63 pipes sections. Farmer feedback has been positive, and participants are interested in ongoing involvement in the continued maturation of the product. Issues such as system connectivity, debris interfering with water flow through the gates, and debris interfering with gate close will be addressed before the 2025 growing season. End of row water sensors and a scheduling feature will be added to enable automatic advancement of irrigation sets during the watering cycle. The equipment will be monitored over winter for resiliency to harsh storage conditions and will be used again in spring of 2025.

## Acknowledgements

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