

Oklahoma Water Resources Center

Virtual fencing to control cattle for improved ecosystem services EPA Project No. MX – 02D00721

Quarter no. 9 From July 1, 2023 Through September 30, 2023.

I. Abstract

Virtual fencing (VF) demonstrations and cattle movement tracking continue at the experimental ranges and at the first cooperating ranch. The base station for cooperating ranch #2 has been installed. On June 20, 2023, VF was implemented on the East Native Range so that cattle will graze rotationally and be excluded from riparian areas. Riparian assessments were conducted, and drone imageries were captured at both the experimental ranges and cooperating ranches. Water quality samples were collected and processed following runoff events at the flumes installed on the research ranges. Initial modeling results have been completed and comparisons with available data has started. Extension programs reached over 150 people this quarter, while Oklahoma Conservation Commission (OCC) soil health programs reached another 70+ producers. Our social media had a reach of almost 280,000 this quarter as well, while presentations at conferences reached another 40+ researchers. A manuscript was submitted and continued progress was made on guidance and protocols. Next quarter we will continue monitoring water quality and riparian health, tracking cattle movement, and observing the effectiveness of VF to implement best management practices.

II. Overall Progress and Results by Task

TASK 1: PROJECT ADMINISTRATION

Subtask 1.1: *OWRC will prepare electronic quarterly progress reports (QPRs) for submission to the EPA. QPRs shall document all activities performed within a quarter and shall be submitted by the 15th of October, January, April and July. QPRs shall be distributed to all Project Partners.*

The following actions have been completed during this reporting period:

- a. The 9th quarterly report was prepared and submitted by October 15, 2023.

75% Complete

Subtask 1.2: *OWRC will perform accounting functions for project funds and will submit appropriate Reimbursement Forms to EPA at least quarterly.*

The following actions have been completed during this reporting period:

- a. As of September 30, \$295,921 (41%) had been expended and another \$46,399 encumbered.
- b. A request for a no cost extension through December 31, 2024 will be submitted next quarter to allow completion of the project objectives.

41% Complete

Subtask 1.3: *OWRC will host coordination meetings, at least quarterly, with the project team to discuss project activities and schedule, communication needs, deliverables, and other requirements.*

The following actions have been completed during this reporting period:

- a. Bi-weekly calls are held among the project team to coordinate cattle management, get updates on tasks, prepare for upcoming events, and coordinate efforts.
- b. On September 12, EPA (Troy Pierce) visited project sites and received updates from all project participants.
- c. Additionally, an in-depth meeting was held on July 5th with all co-PIs to update progress on deliverables, the addition of cooperating ranch, and publications.

75% Complete

Subtask 1.4: *OWRC will develop a Final Report that summarizes activities completed and conclusions reached during the project and discusses the extent to which project goals and measures of success have been achieved.*

The following actions have been completed during this reporting period:

- a. No activity to report this quarter.

0% Complete

TASK 2: QUALITY ASSURANCE

Subtask 2.1: *OWRC will develop a QAPP consistent with the most recent versions of EPA Requirements for Quality Assurance Project Plans (QA/R-5).*

The following actions have been completed during this reporting period:

- a. The project QAPP was submitted in September 2021.

100% Complete

Subtask 2.2: *OWRC will implement the approved QAPP. OWRC will submit revisions and necessary amendments to the QAPP as needed.*

The following actions have been completed during this reporting period:

- a. No activity to report this quarter.

75% Complete

TASK 3: VIRTUAL FENCING DEMONSTRATIONS ON COOPERATING RANCHES

Subtask 3.1: *Identify cooperating ranch(es).*

The following actions have been completed during this reporting period:

- a. Research activities have officially started at cooperating ranch #2.

100% Complete

Subtask 3.2: *Install VF system on cooperating ranch(es).*

The following actions have been completed during this reporting period:

- a. Virtual fencing has been installed at 6 locations in Oklahoma (3,175 acres) including 2 cooperating ranches and 1 research ranch in the Stillwater vicinity as follows:

Ranch	Location	Acres under VF	Collars	Features	Activity
OSU BRR	Stillwater, OK	800	65	Riparian protection, rotation grazing	Deployed 2019; Samples collected under standard grazing until June 2022; Riparian protection initiated in June 2023
Demo Ranch #1	Stillwater, OK	350	90	Intensive bermudagrass, rotation grazing	Deployed 2021
	Sallisaw, OK	225	26	Sallisaw Creek	Deployed 2022
	Haskell, OK	300	38	Intensive bermudagrass	Deployed May 2023
	Minco, OK	1200	80	South Canadian River bottom	Deployed Aug 2023
Demo Ranch #2	Stillwater, OK	300	20		Deployed Sept 2023

75% Complete

Subtask 3.3: *Implement grazing management & riparian protection on demonstration ranch(es) using virtual fencing.*

The following actions have been completed during this reporting period:

- a. Demonstration of virtual fencing at cooperating ranch #1 continued this quarter.
- b. Virtual fencing was just deployed at cooperating ranch #2 at the end of this quarter.

60% Complete

Subtask 3.4: *Perform Stream Visual Assessment.*

The following actions have been completed during this reporting period:

- a. Stream visual assessments are conducted quarterly to capture seasonal variation and changes due to virtual fencing
- b. Stream visual assessments were conducted this quarter at cooperating ranches on July 18, 2023, representing summer conditions.
- c. The stream conditions this quarter were poor (5.21 and 5.48, respectively) at both cooperating ranches.

65% Complete

Subtask 3.5: *Remote assessment of wildlife & pollinator habitat.*

The following actions have been completed during this reporting period:

- a. Drone imagery was flown at cooperating ranch #1 on August 16, 2023.

40% Complete

TASK 4: VIRTUAL FENCING EVALUATION AT OSU RESEARCH RANGE(S)

Subtask 4.1: *Implement grazing management and riparian protection via VF*

The following actions have been completed during this reporting period:

- a. Background data collection on cattle movement continued until June 19, 2023.
- b. Virtual fencing for best management practices began on June 20, 2023 on the East Native Range and cattle will continuously graze the Lake Carl Blackwell Range for comparison.

70% Complete

Subtask 4.2: *Perform Stream Visual Assessment at OSU Research Range(s).*

The following actions have been completed during this reporting period:

- a. Stream visual assessments are conducted quarterly to capture seasonal variation and changes due to virtual fencing
- b. Stream visual assessments on the four experimental range riparian areas were conducted this quarter on July 13, 2023.
- c. Streams at EN 1, EN2, and LCB2 were in fair condition with overall scores of 7.22, 7.19, and 7.33, respectively. The stream condition at LCB 1 was good with an overall score of 8.12.

60% Complete

Subtask 4.3: *Install ISCO samplers at paired watersheds at OSU Research Range(s).*

The following actions have been completed during this reporting period:

- a. No activity to report this quarter.

100% Complete

Subtask 4.4: *Monitor water quality at OSU Research Range(s).*

The following actions have been completed during this reporting period:

- a. 8 samples were collected this quarter with 2 samples on July 7 (LCB 1&2), 2 on July 9 (LCB 1&2), and 4 on July 11 (EN1&2, LCB 1&2).
- b. Regularly scheduled maintenance for ISCO samplers was conducted July 28, 2023 and August 31, 2023.

75% Complete

Subtask 4.5: *Remote assessment of wildlife & pollinator habitat at OSU Research Range(s).*

The following actions have been completed during this reporting period:

- a. During the last quarter we completed the following drone flights:
 - East Native: 9/7/23
 - Lake Carl Blackwell: started 8/31/23; completed 9/2/23
 - West Native: started 9/26/23; completed 10/10/23
- b. The imagery was used to develop natural color and color infrared images of the pastures. We also developed NDVI raster layers for these pastures

60% Complete

TASK 5: WATERSHED MODELING

Subtask 5.1: *Gather input data*

The following actions were underway during this reporting period:

- a. Data was gathered and procedures reviewed for APEX modeling.
- b. Different soil data was gathered including STATSGO and Polaris.
- c. Data inconsistencies addressed in meetings on June 8, 2023 and June 20, 2023.

70% Complete

Subtask 5.2: *Model development*

The following actions have been completed during this reporting period:

- a. Baseline APEX models have been created for watersheds at East Native 1 East Native 2, and Lake Carl Blackwell 1 watersheds.
- b. Continuous and Rotational grazing scenarios have been defined in model.
- c. Different interfaces of APEX model including, ArcAPEX, APEXeditor and different versions including APEX 1501 and 1905 have been tested to see which one gives better results.
- d. Ms. Afsaneh Kaghazchi visited APEX model developers at the Texas A&M AgriLife Blackland Research & Extension Center in Temple, Texas from 30th of July to 11th of August to debug the developed APEX model.

70% Complete

Subtask 5.3: *Model calibration*

The following actions have been completed during this reporting period:

- a. Water quality and quantity values from the East Native 1 and East Native 2 watersheds are being compared with modeled values.
- b. Manual and Automatic Calibration (APEX-Cute) is being done on the model.

30% Complete

Subtask 5.4: *Model validation*

The following actions have been completed during this reporting period:

- a. No activity to report this quarter.

20% Complete

Subtask 5.5: *Perform long-term simulations*

The following actions have been completed during this reporting period:

- a. No activity to report this quarter.

10% Complete

TASK 6: OUTREACH

Subtask 6.1: *Develop Extension programs and materials.*

The following actions have been completed during this reporting period:

- a. Videos have been created to show the various steps for installing virtual fencing and how the cattle react to collar cues.

35% Complete

Subtask 6.2: *Deliver Extension programs to producers.*

The following actions have been completed during this reporting period:

- a. Virtual fence presentation in OCC Crossroads Meeting July 19, 2023 (Enid, OK) – 41 landowners
- b. Reuter and Goodman had a booth at the trade show featuring VF research – Oklahoma Cattlemen’s Association Convention, Norman, OK July 20-21, 2023
- c. Extension In-service training August 2, 2023 at the Bluestem Research Range (Stillwater, OK) - 37 Extension educators
- d. Oklahoma Virtual Fencing Advisory board meeting. 23 attendees. Stillwater, OK. Aug 25, 2023
- e. Working Ranch Magazine Podcast episode on August 26, 2023:
<https://workingranch.podbean.com/e/ep-133-virtual-fencing-%e2%80%93-what-s-the-research-saying/>
- f. Co-hosted VF Field Day with New Mexico State University and the USDA Climate Hub at Clayton, NM on Sept 26, 2023 - 44 in attendance including 15 ranchers & 29 researchers, agencies & students
 - Reuter provided a “Collaring demonstration”

55% Complete

Subtask 6.3: *Develop standards, specifications, and guidance.*

The following actions have been completed during this reporting period:

- a. A draft of a guidance document entitled, “The Application of Virtual Fencing for Cattle Management and Environmental Sustainability” has been shared among project personnel.
- b. A white paper document entitled, “Installing Vence VF (Virtual Fencing) collars on cattle” outlines the protocols for properly installing the base stations and collars required for implementing virtual fencing.

30% Complete

Subtask 6.4: *Deliver results to producers via Soil Health programs.*

The following actions have been completed during this reporting period:

- a. Presentation materials have been developed and shared with the Oklahoma Conservation Commission Soil Health team.
- b. Via consults, education events, exhibitions, and other events, results were delivered by the Oklahoma Conservation Commission to >70 producers in 14 counties across Oklahoma this reporting period.

35% Complete

Subtask 6.5: *Communicate results via social media, newsletter, webpage.*

The following actions have been completed during this reporting period:

- a. Oklahoma Water Resources Center
 - Analytics for the Oklahoma Water Resources Center social media posts are as follows.

	Posts	Reach/Impressions	Engagements	Reactions
Facebook	3	524	104	42
Twitter	3	249	14	N/A
Total	6	773	118	42

- b. OSU Natural Resources Extension
 - Analytics for the 10 OSU Natural Resources Extension social media posts are as follows.

	Posts	Reach/Impressions	Engagements
Facebook	5	274,300	1,554
Instagram	3	2,162	116
Twitter	2	2,016	111
Total	10	278,478	1,781

75% Complete

Subtask 6.6: *Deliver presentations at conferences.*

The following actions have been completed during this reporting period:

- a. Modeling results were presented on 12th of July in the 2023 Annual International Meeting of the American Society of Agricultural and Biological Engineers (ASABE). There were 40 researchers in attendance

50% Complete

Subtask 6.7: *Publish manuscripts in peer reviewed journals.*

The following actions have been completed during this reporting period:

- a. Submitted/In Review:
 - Ehlert, K., J. Brennan, H. Menendez, J. Beard, R. Reuter, L. Vandermark, M. Stephenson, D. Hoag, P. Meiman, R. O'Connor, and S. Noelle. 2023. Forum: What's in a name? Agreed-upon terminology for virtual fencing benefits the scientific community, dissemination to producers, virtual fence companies, and public perception. *J. Range Mgt.* IN REVIEW.
- b. In Development
 - We completed the spatial analysis on the effectiveness of virtual fencing in excluding cows from riparian areas, small high-use areas, and large areas of pastures. We are aiming to submit the manuscript to *Rangeland Ecology and Management* by 12/1 to be included in the virtual fencing special issue.

30% Complete

III. Related Issues/Current Problems and Favorable or Unusual Developments

- Vence changed the data they provide, and shock and sound counts are no longer available. That restricts the types of analysis we can do on the data to determine effectiveness of training methods and VF overall. We will now have to focus exclusively on cow location as a measure of effectiveness.
- Continued drought resulted in very few water quality samples being collected.

IV. Projected Work for Next Quarter

- Continued data collection for water quality sampling, riparian/stream visual assessments, and cattle movement using GPS collars.
- UAV flights and vegetation sampling continue to address pollinator and wildlife habitat assessments (2-3 annually)
- Progress on model development using available data sets and incorporating runoff data