Minutes

Third Annual Meeting
Republican River Basin-Wide Plan

In-Person: Cambridge, NE
Virtual: Zoom
November 15, 2021
2:00 p.m. Central Time

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Attendance

23 people were in attendance. Those that signed in are listed below.

Meeting Participants

Nebraska Department of Natural Resources (NeDNR):

Kari Burgert (NeDNR)

Sam Capps (NeDNR)

Elizabeth Esseks (NeDNR)

Carol Flaute (NeDNR)

Hannah Mendez (NeDNR)

Philip Paitz (NeDNR)

Andy Pedley (NeDNR)

Natural Resources Districts (NRDs):

Alex Boyce (Middle Republican NRD)

Jasper Fanning (Upper Republican NRD)

Nate Jenkins (Upper Republican NRD)

Jack Russell (Middle Republican NRD)

Todd Siel (Lower Republican NRD)

Nick Simonson (Lower Republican NRD)

John Thorburn (Tri-Basin NRD)

Other Attendees:

Scott Dicke (Central Nebraska Public Power and Irrigation District)

Brad Edgerton (Frenchman-Cambridge Irrigation District)

Chelsea Erickson (Kansas Division of Water Resources)

Doug Hallum (University of Nebraska-Lincoln)

Dale Helms (Stakeholder)

Frank Kwapnioski (Member of the Public)

Christopher Neale (University of Nebraska-Lincoln)

Aaron Thompson (United States Bureau of Reclamation)

Ted Tietjen (Stakeholder)

Summary of Meeting

1. Welcome and introductions – Sam Capps. The meeting started at 2:05 P.M. Attendees who signed in can be found on the sign-in sheet ("Sign-in Sheet," Attachment A).
    a. Nebraska Open Meetings Act requirements
        i. A copy of the Open Meetings Act was available both in-person and online.
    b. Review agenda and meeting objectives
        i. No changes or additions were made ("Agenda," Attachment B).
    c. Introductions
        i. 12 people attended in person and 11 attended online.
2. Plan implementation progress – Sam Capps

    A draft of the annual report (*Third Annual Report for the Republican River Basin-Wide Plan* (Annual Report), Attachment C) was provided to participants. It was also available on the website (rrbwp.nebraska.gov). The purpose and location of each section of the report were provided as a reference.

    Carol Flaute: The Annual Report is a report of plan progress for 2020, including management activities and measurable hydrologic objectives, and information about water supplies and uses in the basin.

    a. Annual Report: Plan Implementation Progress 2020 – Sam Capps
        i. Water supplies and uses in the basin (page 3 of Annual Report)
            1. Information on water supplies and uses in the basin can be found in the NRD, Augmentation Pumping, and NeDNR sections.
            2. No management actions were taken for 2020 Compact compliance.
            3. Four management actions were taken for future compliance, with the effects of:
                a. reducing consumptive use of water and reducing unintended operational spills
                b. increasing reliability of surface water supplies
                c. allowing more water to be stored.
        ii. Progress toward Goals, Objectives, and Action Items – Sam Capps
            1. Management activities (page 29 of Annual Report)
                a. Upper Republican NRD (URNRD) – Nate Jenkins

i. The NRD installed approximately 450 fully automated flow meters that use a radio-based communication network to transmit collected data. 1340 total meters have been installed in the past two years.
ii. The NRD is developing a groundwater model to ensure more water will not be pumped after a groundwater transfer occurs.
iii. The NRD worked with NeDNR on a permanent buyout program of irrigated acres.
iv. 2020 groundwater levels were similar to the levels of the previous five years.

b. Middle Republican NRD (MRNRD) – Jack Russell
i. The district had approximately 200 acres of permanent irrigation land buyouts in 2020.
ii. 900 telemetry meters have been installed to date. MRNRD plans to install an additional 1,000 telemetry meters.
iii. The NRD updated its Long-Range Implementation Plan and Master Plan, specifically increasing interest in improving water quality.
iv. The NRD received Water Sustainability Funding to install soil moisture probes.

c. Lower Republican NRD (LRNRD) – Todd Siel
i. 2020 was year 4 of 5-year allocation period complete. 2020 District-wide usage was 8.15 acre-inches.
ii. The NRD is planning a telemetry flow meter project pending approval of a grant from the U.S. Bureau of Reclamation.
iii. The NRD is in the process of analyzing other potential projects.

d. Tri-Basin NRD (TBNRD) – John Thorburn
i. Thorburn reported on the Water Conservation Incentive Program and the Platte-Republican Diversion project.
ii. One township in the Republican Basin portion is under an allocation of 27 inches per acre over 3 years due to a groundwater quantity issue. Groundwater levels are gradually increasing.
iii. Water usage in 2020 was higher than average due to low precipitation.

iv. The NRD passed the annual benchmark for IMP compliance. Consumption of imported water did not exceed the amount of water imported in 2020. TBNRD tries to divert excess flows from the Platte River Basin whenever possible.

v. The NRD is partners with U.S. Fish and Wildlife Service, Central Nebraska Public Power and Irrigation District and the Rainwater Basin Joint Venture on a project that enables diversion of excess flows to federally-owned wetlands in the Platte Basin. The wetlands serve as groundwater recharge sites.

e. NeDNR – Sam Capps

i. 5-Year Technical Analysis – Carol Flaute

1. Flaute reviewed the requirements from Statute and the Basin Wide Plan.
2. Flaute is looking at the broad categories in statute and compiling a needs list for the Analysis.
3. This Analysis is our only opportunity to make necessary changes to the Plan.
4. The results of the first 5-Year Technical Analysis will be presented at the 2023 Annual Meeting.

ii. Water Market Feasibility Study – Sam Capps

1. The BWP requires that an evaluation of the feasibility of a Water Market be complete by 2023.
2. NeDNR and the NRDs are starting to investigate options and would appreciate any suggestions and guidance.
3. The test implementation analysis must be completed by 2028.

2. Measurable Hydrologic Objectives (MHOs) (page 60 of Annual Report) – Carol Flaute. MHOs B and C are evaluated in the 5-Year Technical Analysis. MHOs A, D, and E are evaluated annually.

a. For each MHO assessment, the report contains a description of the assessment and a table of results.

i. MHO A (page 60 of Annual Report) – MHO A is being achieved by all the Republican NRDs. TBNRD uses a 3-Year Net Average to establish a hydrologically balanced status, which TBNRD maintained in 2020.

ii. MHO B and C (page 64 of Annual Report) – No assessment is required for 2020.
iii. MHO D (page 64 of Annual Report) – MHO D is being achieved for 2020 in all the Republican NRDs. No portion of the rapid response area is part of the TBNRD.
iv. MHO E (page 65 of Annual Report) – Surface water was not administered in the URNRD, MRNRD, and LRNRD to ensure compact compliance, so MHO E is being achieved.

b. Drought Planning Exercise – Andy Pedley ("Drought Planning Presentation," Attachment D).
   i. Andrew Mwape was hired in July 2020 and began conducting research to help develop the Drought Planning Exercise.
   ii. The Drought Planning Exercise is projected to take place in the spring of 2022.
   iii. The full report on the Drought Planning Exercise is expected in June of 2022.

c. Feasibility and potential impacts of planned projects
   i. Platte-Republican Diversion Project – John Thorburn
      1. A hearing regarding the project was held on July 19, 2021, and TBNRD and LRNRD are awaiting a ruling from NeDNR about the status of objectors to the water right application.
   ii. Nebraska Bostwick Irrigation District (NBID) Superior Canal Project – Todd Siel
      1. NBID was recently awarded funding for the Superior Canal Project. NBID experiences conveyance loss between Harlan County Lake and the Superior Canal.
      2. This project reduces conveyance loss by putting in two separate high capacity well galleries along the Republican River in the Superior area.
      3. Yearly savings of 3,400 acre-feet are expected in Harlan County Lake.
   iii. NRCS Watershed Grants – Todd Siel
      1. LRNRD applied for three different United States Department of Agriculture Natural Resources Conservation Service Watershed and Flood Prevention Operations Program (USDA NRCS WFPO) grants, focusing on ag water supply.

2. LRNRD received approval on two of the three applications. LRNRD is hosting open houses for those two watersheds projects, which are in the Environmental Assessment phase.
3. The third watershed went to the NRCS's Preliminary Investigative Feasibility Report (PIFR). LRNRD is awaiting results.

3. Collaboration
   a. Existing and potential new water conservation programs
      i. Irrigation Buyouts – Sam Capps provided a quick summary of the buyout acres in 2020 and associated sponsor programs.
         1. Tri-Basin Water Conservation Incentive Program (WCIP) – John Thorburn – The WCIP has options for both groundwater users and commingled water users. The (voluntary) groundwater allocation option is used in the Republican River Basin, with 1,445 acres enrolled. TBNRD will buy back any unused water within an allocation for up to $5/acre-inch. Users can trade water credits with other participants. The commingled option encourages the use of canal water instead of groundwater. TBNRD reimburses irrigators for canal water use if groundwater use is below 1 in/acre/year.
   b. Information sharing about water user management practice improvements
      i. Future opportunities to encourage and support water users to share information about management practice improvements – Sam Capps
         1. Scott Dicke, CNPPID – Excess flows diverted into the Waterfowl Protection Areas helped support the imported water supply credit Nebraska received under the Republican River Compact.
      ii. Guest speaker/presentation
         1. Christopher Neale from the University of Nebraska-Lincoln presented on the Evapotranspiration data collection project being conducted in the Republican River Basin ("Expanding the Parallel 41 Flux Network in the Republican River Basin to Support Real-time Evapotranspiration Estimates for Irrigation Water Management and Water Balance Estimates," Attachment E).
         2. Brad Edgerton from Frenchman-Cambridge Irrigation District discussed the canal automation project currently in progress.
4. Conflicts Resulting from Implementation of the Plan, if any – Sam Capps (page 99 of *Republican River Basin-Wide Plan*)
   a. The Basin-Wide Plan includes conflict resolution procedures for any conflicts resulting from implementation of the Plan.

b. No conflicts were submitted for consideration prior to this meeting.

5. Public comment
   a. No public comments.

Attachment A, Sign-in Sheet

Republican River Basin-Wide Plan
Annual Meeting

November 15, 2021 | Cambridge, NE | 2:00 p.m. (CST)

SIGN-IN SHEET

	Name:	Representing (Self or Organization):
1.	John Thorburn	Tri-Basin NRD
2.	Dale Helms	Self
3.	Todd Siel	LRNRD
4.	Nick Simonson	LRNRD
5.	Nate Jenkins	UNRD
6.	Brad Edgerton	FCID
7.		Irrigator
8.		
9.		
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Attachment B, Agenda

Third Annual Meeting
Republican River Basin-Wide Plan

Monday, November 15, 2021
2:00 pm Central Time (1:00 pm Mountain Time)

Cambridge Community Building
722 Patterson Street
Cambridge, NE
Virtual participation option via Zoom
(https://us02web.zoom.us/j/84293201100; phone 1 312 626 6799, meeting ID 842 9320 1100)

Agenda

1. Welcome and introductions
    a. Nebraska Open Meetings Act requirements
    b. Review agenda and meeting objectives
    c. Introductions
2. Plan implementation progress
    a. Annual Report: Plan Implementation Progress 2020
        i. Water supplies and uses in the basin
        ii. Progress toward goals and objectives of the plan
            1. Management activities
            2. Measurable Hydrologic Objectives (MHOs)
    b. Drought planning exercise
    c. Feasibility and potential impacts of planned projects
3. Collaboration
    a. Existing and potential new water conservation programs
    b. Information sharing about water user management practice improvements
        i. Future opportunities to encourage and support water users to share information about management practice improvements
        ii. Guest speaker/presentation
4. Conflicts Resulting from Implementation of the Plan, if any (Sam)
    a. None submitted for consideration
5. Public comment

Attachment C, Annual Report

Third Annual Report for the Republican River Basin-Wide Plan

Data and Progress Updates, 2020

Presented at the Annual Meeting

November 15, 2021

Jointly prepared by
Upper Republican Natural Resources District
Middle Republican Natural Resources District
Lower Republican Natural Resources District
Tri-Basin Natural Resources District
&
Nebraska Department of Natural Resources

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Introduction

The *Republican River Basin-Wide Plan* (basin-wide plan) was developed by Nebraska Department of Natural Resources (NeDNR) and Upper Republican, Middle Republican, Lower Republican, and Tri-Basin Natural Resources Districts (NRDs), in consultation and collaboration with a Stakeholder Advisory Committee. The time frame to implement the basin-wide plan is approximately 25 years, spanning from the effective date of the basin-wide plan (March 1, 2019) to April 17, 2044, which is 30 years after the operative date of LB 1098 (2014), as specified in *Neb. Rev. Stat.* § 46-755.

Action Item 3.2.2 of the basin-wide plan specifies that NeDNR and the NRDs will annually exchange reports containing data and information about water supplies and uses in the Republican River Basin, management activities, and progress toward the goals and objectives of the basin-wide plan. This report contains the data and information about plan implementation progress for the 2020 calendar year, to be exchanged by NeDNR and the NRDs at the following year's annual meeting.

Water Supplies and Uses in the Basin

In accordance with the requirements of *Neb. Rev. Stat.* §§ 46-755 (5)(a) and 46-755 (5)(b), the basin-wide plan contains a monitoring plan, which includes a process to gather and evaluate data, information, and methodologies to increase understanding of the surface water and hydrologically connected groundwater system within the basin and to test the validity of the conclusions, information, and assumptions upon which the plan is based.

One component of the monitoring plan is a list of data on water supplies and uses in the Republican River Basin that will be reported annually by NeDNR and the NRDs (Table 3.1 of the basin-wide plan). As stated in the basin-wide plan's Monitoring section, it will take time for NeDNR and the NRDs to prepare each category of data for distribution; some of the listed data are readily available within existing data sets, while others will take significantly longer for methodology development. As a result, NeDNR and the NRDs will gradually increase the number of data items that will be reported on each year as they are able. In addition, as also noted in the plan, the list of data reported is subject to change as data needs and resources change over time.

This annual report contains data for the year 2020. The following data are included in this annual report:

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Upper Republican Natural Resources District

Current Allocations

Upper Republican NRD's allocations and related rules for the 2018–2022 allocation period are summarized in Table 1. In this context, an allocation is a regulatory measure that stipulates the amount of water available to be used for irrigation.

Table 1. Summary of current allocation for groundwater irrigation use in Upper Republican NRD, 2018–2022 allocation period.

Total Allocation	65 Inches/Acre/5 Years
Annual or Base Allocation	Allocation is over 5 Years, not annual
Maximum Annual Use	65 Inches/Acre
Carry over amount that can be used in the following allocation period	7.5 Inches/Acre (Max)
Hard Cap	None
Pooling allowed?	Yes
How are the allocations affected by surface water use?	Allocations are not affected by surface water use. Irrigators may use their full groundwater allocation, regardless of any surface water use.
Special allocations for designated groundwater management areas? Or subbasins?	None
Rapid Response Area Allocations?	Not unless augmentation projects are insufficient to meet Republican River Compact obligations will Rapid Response Area allocations be needed. Rapid Response Area allocations would depend upon projected Compact shortfalls.
Penalty for exceeding allocation	For every inch of excess use, 2 inches of allocation lost for next allocation period.
Penalty for exceeding carry over	2 inches carry-over deducted for every inch of carry-over used above 7.5 inches

Annual Groundwater Use for Irrigation

Annual groundwater use for irrigation in Upper Republican NRD, for 2020, is summarized in Table 2. This summary includes:

- The total number of certified acres within the district. For the purposes of this report, certified acres are acres certified by the NRD to be allowed to be irrigated with groundwater.
- The total number of effective acres within the district. For the purposes of this report, effective acres are acres where groundwater irrigation was possible (i.e., certified acres minus acres enrolled in a conservation program prohibiting irrigation).
- The total volume of groundwater pumped for irrigation within the district.
- The average depth of water applied for irrigation on effective acres within the district.

Table 2. Annual groundwater use for irrigation in Upper Republican NRD, 2020. The difference between certified and effective acres is described in the body of the report.

Year	Certified Acres	Effective Acres	Volume Pumped (acre-feet)	Average Depth (inches/effective acre)
2020	429,268.75	429,268.75	517,305	14.46

Conservation and Irrigation Buyout Programs

Irrigation water cannot be used on acres enrolled in a permanent or temporary irrigation buyout program. Table 3 summarizes the number of acres within Upper Republican NRD that were enrolled in buyout programs in 2020. During 2020, buyout programs in effect in this NRD included the Conservation Reserve Enhancement Program (CREP), the Agricultural Water Enhancement Program (AWEP), and a permanent irrigation buyout program jointly funded by Upper Republican NRD and the State of Nebraska. Contracts to buy out a total of 1,766 acres were signed in 2020. Many, but not all, of the acres in the new program are also enrolled in CREP; those that are will be permanently barred from being irrigated after CREP contracts expire.

Table 3. Acres within Upper Republican NRD that can no longer be irrigated due to enrollment in a permanent or temporary buyout program. During 2020, buyout programs in effect in this NRD included the Cooperative Reserve Enhancement Program (CREP), the Agricultural Water Enhancement Program (AWEP), and the NRD's own buyout program, partially funded by the State's Water Resources Cash Fund (WRCF). *CREP data are as of September 30, 2020.

Year	Acres Enrolled in CREP*	Acres Enrolled in Other Buyout Programs
2020	10,589.34	3,914.3

Groundwater Levels and Observation Well Locations

The locations of wells used to monitor groundwater levels for all NRDs in the District are shown in Figure 1. Groundwater level data are provided to NeDNR by this NRD as part of the analysis of MHO C for the

basin-wide plan. A summary of the data will be provided in the report of the next five-year technical analysis for the plan. Groundwater level data are available from the NRD upon request.

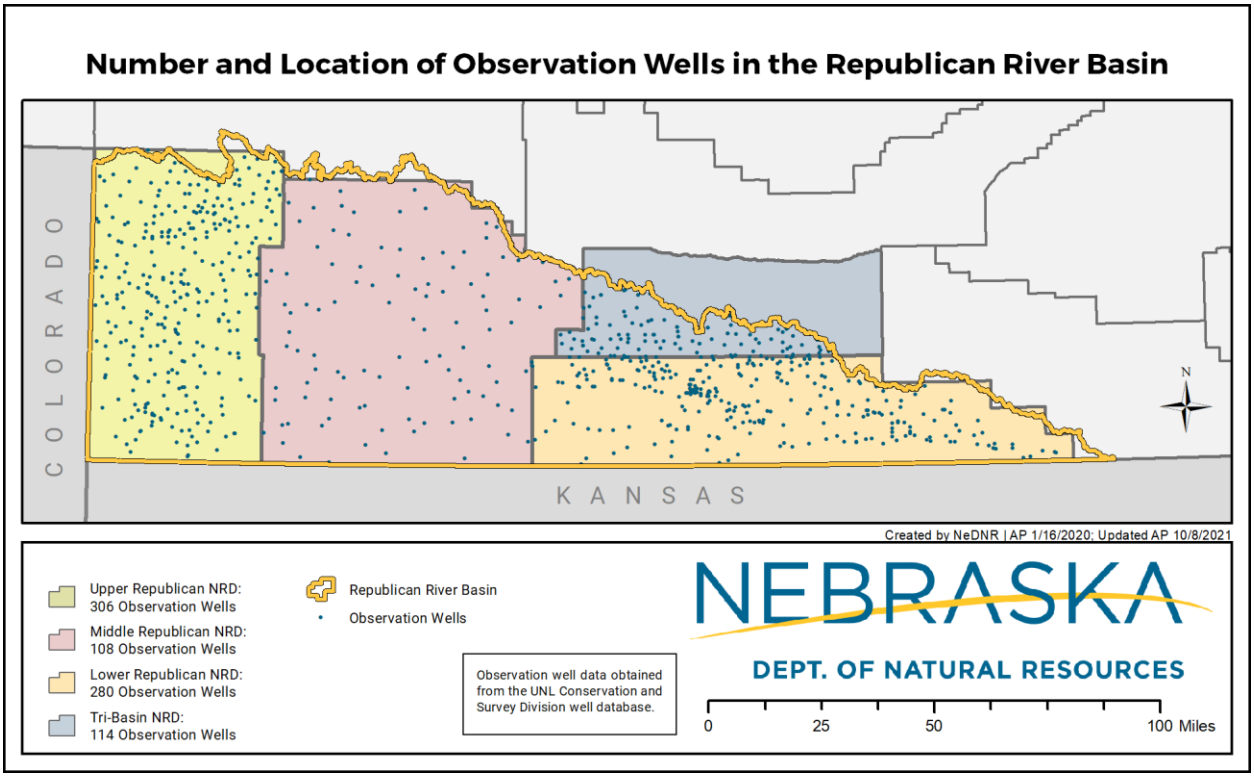

Figure 1. Location and number of groundwater observation wells within the Republican River Basin, by NRD, according to the University of Nebraska-Lincoln (UNL) Conservation and Survey Division well database.

Curtailment of Groundwater Pumping for Compact Compliance

Under the Integrated Management Plan jointly developed by Upper Republican NRD and NeDNR, curtailment of groundwater pumping in an area called the "Rapid Response Area" may be required by the NRD if necessary for compliance with Nebraska's obligations under the Republican River Compact (Compact). During 2020, Upper Republican NRD did not curtail groundwater pumping in the Rapid Response Area for Compact compliance at any time.

Middle Republican Natural Resources District

Current Allocations

Middle Republican NRD's allocations and related rules for the 2018–2022 allocation period are summarized in Table 4. In this context, an allocation is a regulatory measure that stipulates the amount of water available to be used for irrigation.

Table 4. Summary of current allocations for groundwater irrigation use in Middle Republican NRD, 2018–2022 allocation period.

Total Allocation	60 Inches/Acre/5 Years
Annual or Base Allocation	12 Inches/Acre/Year
Maximum Annual Use	60 Inches/Acre (15 Inches/Acre in a Compact Call Year)
Carry over amount that can be used in the following allocation period	12 Inches/Acre (Max)
Hard Cap	15 Inches/Acre/Year
Pooling allowed?	Yes
How are the allocations affected by surface water use?	Allocations are not affected by surface water use. Irrigators may use their full groundwater allocation, regardless of any surface water use.
Special allocations for designated groundwater management areas? Or subbasins?	None
Rapid Response Area Allocations?	None
Penalty for exceeding allocation	See explanation below*
Penalty for exceeding carry over	See explanation below*

***Middle Republican NRD Penalty for exceeding allocation:**

If an operator has exceeded his or her allocation, the allocation for the next allocation period shall be reduced by the number of acre inches, by which said allocation was exceeded in the prior

period. A penalty of 1 inch for every inch over the first 3 inches and 2 inches for every inch over 3 inches of overuse will be applied.

Overuse of the adjusted base allocation during a Compact Call Year shall result in a penalty of 2 inches for every inch over the first 3 inches and 3 inches for every inch over 3 inches of overuse will be applied. This penalty will result in a correction to the remaining allocation following the compact call year. This penalty shall be in addition to the penalties imposed by Rule 5-4.16 if the compact call year is the last year of an allocation period.

Annual Groundwater Use for Irrigation

Annual groundwater use for irrigation in Middle Republican NRD, for 2020, is summarized in Table 5. This summary includes:

- The total number of certified acres within the district. For the purposes of this report, certified acres are acres certified by the NRD to be allowed to be irrigated with groundwater.
- The total number of effective acres within the district. For the purposes of this report, effective acres are acres where groundwater irrigation was possible (i.e., certified acres minus acres enrolled in a conservation program prohibiting irrigation).
- The total volume of groundwater pumped for irrigation within the district.
- The average depth of water applied for irrigation on effective acres within the district.

Table 5. Annual groundwater use for irrigation in Middle Republican NRD, 2020. The difference between certified and effective acres is described in the body of the report.

Year	Certified Acres	Effective Acres	Volume Pumped (acre-feet)	Average Depth (inches/effective acre)
2020	296,955.13	282,268.64	273,689.77	11.64

Conservation and Irrigation Buyout Programs

Irrigation water cannot be used on acres enrolled in a permanent or temporary irrigation buyout program. Table 6 summarizes the number of acres within Middle Republican NRD that were enrolled in buyout programs in 2020. During 2020, buyout programs in effect in this NRD included the Cooperative Reserve Enhancement Program (CREP) and the Agricultural Water Enhancement Program (AWEP). In 2020, Middle Republican NRD also entered into a contract with one landowner to permanently buy out 71.44 acres from groundwater irrigation, through the NRD's own buyout program, which is partially funded through the State's Water Resources Cash Fund.

Table 6. Acres within Middle Republican NRD that can no longer be irrigated due to enrollment in a permanent or temporary buyout program. During 2020, buyout programs in effect in this NRD included the Cooperative Reserve Enhancement Program (CREP), the Agricultural Water Enhancement Program (AWEP), and the NRD's own permanent buyout program, which is partially funded by the Water Resources Cash Fund (WRCF). *CREP data are as of September 30, 2020.

Year	Acres Enrolled in CREP *	Acres Enrolled in Other Buyout Programs
2020	16,558.51	2,063.4

Groundwater Levels and Observation Well Locations

The locations of wells used to monitor groundwater levels for all NRDs in the District are shown in Figure 1 (page 7). Groundwater level data are provided to NeDNR by this NRD as part of the analysis of MHO C for the basin-wide plan. A summary of the data will be provided in the report of the next five-year technical analysis for the plan. Groundwater level data are available from the NRD upon request.

Curtailment of Groundwater Pumping for Compact Compliance

Under the Integrated Management Plan jointly developed by Middle Republican NRD and NeDNR, curtailment of groundwater pumping in an area called the "Rapid Response Area" may be required by the NRD if necessary for compliance with Nebraska's obligations under the Republican River Compact (Compact). During 2020, Middle Republican NRD did not curtail groundwater pumping in the Rapid Response Area for Compact compliance at any time.

Lower Republican Natural Resources District

Current Allocations

Lower Republican NRD's allocations and related rules for the 2018–2022 allocation period are summarized in Table 7. In this context, an allocation is a regulatory measure that stipulates the amount of water available to be used for irrigation.

Table 7. Summary of current allocations for groundwater irrigation use in Lower Republican NRD, 2018–2022 allocation period.

Total Allocation	45 Inches/Acre/5 Years
Annual or Base Allocation	9 Inches/Acre/Year
Maximum Annual Use	45 Inches/Acre (13 Inches/Acre in a Compact Call Year)
Carry over amount that can be used in the following allocation period	9 Inches/Acre (Max)
Hard Cap	13 Inches/Acre/Year (in a Compact Call Year)
Pooling allowed?	Yes
How are the allocations affected by surface water use?	Allocations are not affected by surface water use. Irrigators may use their full groundwater allocation, regardless of any surface water use.
Special allocations for designated groundwater management areas? Or subbasins?	None
Rapid Response Area Allocations?	See explanation below**
Penalty for exceeding allocation	See penalty explanation below***
Penalty for exceeding carry over	See penalty explanation below***

****Lower Republican NRD Rapid Response Area Allocations:**

During Non-Compact Call years, the Rapid Response Area has the same Allocation as the rest of the District. During a Compact Call Year, the Allocation shall be set at the maximum allowable that would not cause the District's depletions to streamflow to exceed the District's allowable Ground Water depletions after taking into consideration other actions and controls that the District would implement. As set forth in the Integrated Management Plan (IMP), NeDNR will perform all calculations relating to the District's forecasted allowable Ground Water depletions, forecasted depletions, and potential yield from implementing actions and controls.

*****Lower Republican NRD Rule 3-2 Penalties:**

3-2.1. Unless otherwise provided, imposition of penalties shall be at the discretion of the Board and may include, but are not limited to:

(a) A reduction (in whole or in part) of a Person's Allocation of Ground Water;
(b) A reduction (in whole or in part) of a Person's Certified Irrigated Acres; and
(c) Decommissioning of Water Wells.

3-2.2. Where penalties are enumerated in the Rules and Regulations, the Board may impose additional penalties, up to and including a permanent forfeiture of Certified Irrigated Acres, and/or a permanent forfeiture of all future Allocations, under the following circumstances: (1) previous violations of any Rule or Regulation, (2) multiple violations of these Rules and Regulations, (3) engaging in willful and wanton misconduct, or (4) certification by the record owner to the District of the non-irrigation status of certain Certified Irrigated Acres in order to opt-out of an Occupation Tax levied by the District, which status is later found to be false in whole or in part.

3-2.3. Any Person who violates a cease and desist order issued by the District pursuant to *Neb. Rev. Stat.* § 46-707(h) may be subject to a civil penalty assessed pursuant to *Neb. Rev. Stat.* § 46-745.

Annual Groundwater Use for Irrigation

Annual groundwater use for irrigation in Lower Republican NRD, for 2020, is summarized in Table 8. This summary includes:

- The total number of certified acres within the district. For the purposes of this report, certified acres are acres certified by the NRD to be allowed to be irrigated with groundwater.
- The total number of effective acres within the district. For the purposes of this report, effective acres are acres where groundwater irrigation was possible (i.e., certified acres minus acres enrolled in a conservation program prohibiting irrigation).
- The total volume of groundwater pumped for irrigation within the district.
- The average depth of water applied for irrigation on effective acres within the district.

Table 8. Annual groundwater use for irrigation in Lower Republican NRD, 2020. The difference between certified and effective acres is described in the body of the report.

Year	Certified Acres	Effective Acres	Volume Pumped (acre-feet)	Average Depth (inches/effective acre)
2020	320,057.39	308,890.48	209,695.18	8.15

Conservation and Irrigation Buyout Programs

Irrigation water cannot be used on acres enrolled in permanent or temporary irrigation buyout program. Table 9 summarizes the number of acres within Lower Republican NRD that were enrolled in buyout programs in 2020. During 2020, buyout programs in effect in this NRD included the Cooperative Reserve Enhancement Program (CREP) and the Agricultural Water Enhancement Program (AWEP).

Table 9. Acres within Lower Republican NRD that can no longer be irrigated due to enrollment in a permanent or temporary buyout program. During 2020, buyout programs in effect in this NRD included the Cooperative Reserve Enhancement Program (CREP) and the Agricultural Water Enhancement Program (AWEP). *CREP data are as of September 30, 2020.

Year	Acres Enrolled in CREP *	Acres Enrolled in Other Buyout Programs
2020	8,382.17	2,784.74

Groundwater Levels and Observation Well Locations

The locations of wells used to monitor groundwater levels for all NRDs in the District are shown in Figure 1 (page 7). Groundwater level data are provided to NeDNR by this NRD as part of the analysis of MHO C for the basin-wide plan. A summary of the data will be provided in the report of the next five-year technical analysis for the plan. Groundwater level data are available from the NRD upon request.

Curtailment of Groundwater Pumping for Compact Compliance

Under the Integrated Management Plan jointly developed by Lower Republican NRD and NeDNR, curtailment of groundwater pumping in an area called the "Rapid Response Area" may be required by the NRD if necessary for compliance with Nebraska's obligations under the Republican River Compact (Compact). During 2020, Lower Republican NRD did not curtail groundwater pumping in the Rapid Response Area for Compact compliance at any time.

Tri-Basin Natural Resources District

Current Allocations

Tri-Basin NRD's allocations and related rules for the 2018–2020 allocation period are summarized in Table 10. In this context, an allocation is a regulatory measure that stipulates the amount of water available to be used for irrigation.

Table 10. Summary of current allocations for groundwater irrigation use in the Tri-Basin NRD, 2018–2020 allocation period.

Total Allocation	27 Inches/Acre/3 Years
Annual or Base Allocation	9 Inches/Acre/Year
Maximum Annual Use	27 Inches/Acre
Carry over amount that can be used in the following allocation period	9 Inches/Acre (Max)
Hard Cap	None
Pooling allowed?	Yes
How are the allocations affected by surface water use?	Allocations are not affected by surface water use. Irrigators may use their full groundwater allocation, regardless of any surface water use.
Special allocations for designated groundwater management areas? Or subbasins?	Allocation only required in Phase 3 groundwater quantity management areas. Current Phase 3 area is Township 5 North, Range 22 West (Union Twp.) in Gosper County.
Rapid Response Area Allocations?	None
Penalty for exceeding allocation	1.5 times the overuse amount
Penalty for exceeding carry over	1.5 times the overuse amount

Annual Groundwater Use for Irrigation

Annual groundwater use for irrigation in Tri-Basin NRD, for 2020, is summarized in Table 11. This summary includes:

- The total number of certified acres within the district. For the purposes of this report, certified acres are acres certified by the NRD to be allowed to be irrigated with groundwater.
- The total number of effective acres within the district. For the purposes of this report, effective acres are acres where groundwater irrigation was possible (i.e., certified acres minus acres enrolled in a conservation program prohibiting irrigation).
- The total volume of groundwater pumped for irrigation within the district.
- The average depth of water applied for irrigation on effective acres within the district.

Table 11. Annual groundwater use for irrigation in the Republican River Basin portion of Tri-Basin NRD, 2020. The difference between certified and effective acres is described in the body of the report.

Year	Certified Acres	Effective Acres	Volume Pumped (acre-feet)	Average Depth (inches/effective acre)
2020	190,134.45	181,840	169,145.98	10.67

Conservation and Irrigation Buyout Programs

Irrigation water cannot be used on acres enrolled in a permanent or temporary irrigation buyout program. Table 12 summarizes the number of acres within the Republican River Basin portion of Tri-Basin NRD that were enrolled in buyout programs in 2020. During 2020, the buyout program in effect in the Republican River Basin portion of this NRD included the Cooperative Reserve Enhancement Program (CREP).

Table 12. Acres within the Republican River Basin portion of Tri-Basin NRD that can no longer be irrigated due to enrollment in a permanent or temporary buyout program. During 2020, the buyout program in effect in this NRD included the Cooperative Reserve Enhancement Program (CREP). *CREP data are as of September 30, 2020.

Year	Acres Enrolled in CREP *	Acres Enrolled in Other Buyout Programs
2020	2,200.65	0

Tri-Basin NRD Water Conservation Incentive Program (WCIP) is intended to address two natural resources management issues: ensuring sustainability of groundwater supplies and protecting streamflows from diminishment due to groundwater pumping. The goal of this voluntary program is to reduce groundwater pumping and increase irrigation water use efficiency in Tri-Basin NRD. Acres enrolled in the WCIP program in 2020 are listed in Table 13.

Tri-Basin will allow landowners to enroll up to 8000 NRD-certified irrigated acres in the program. Any parcel enrolled is subject to a voluntary five-year allocation of groundwater pumping for irrigation. The allocation is equivalent to the average corn irrigation requirement, as determined by the University of Nebraska-Lincoln (UNL). Once the enrollment limit is reached, water savings to the district are expected to reach at least 650 acre-feet per year. Incentives in this program will likely be most attractive to landowners in phase two and phase three groundwater quantity management areas, so the water-use reductions

should be greatest where the need is greatest (there are approximately 30,000 certified irrigated acres in Tri-Basin NRD's phase two and phase three townships).

In exchange for their participation, if landowners use less than their full allocation, they will be paid for the equivalent of one acre-inch of water credit per acre per year, with the opportunity to sell additional unused credits to the NRD at a set price. In addition to NRD purchases, landowners will have the opportunity to sell water credits on the open market at any agreed-upon price (private transactions require NRD board approval). Landowners will also be granted flexibility to irrigate any acres within enrolled parcels and to share (pool) allocations between parcels. Pooling agreements will be required to enable sharing allocations between parcels under different ownership.

Table 13. Acres in the Republican River Basin enrolled in the Tri-Basin NRD's Water Conservation Incentive Program in 2020. The "New Acres Enrolled" column indicates the number of acres that were added to the program in the year indicated. The "Total Acres Enrolled" column indicates the total number of acres enrolled as of the year indicated.

Year	New Acres Enrolled	Total Acres Enrolled
2020	0	1,445.47

Groundwater Levels and Observation Well Locations

The locations of wells used to monitor groundwater levels for all NRDs in the District are shown in Figure 1 (page 7). Groundwater level data are provided to NeDNR by this NRD as part of the analysis of MHO C for the basin-wide plan. A summary of the data will be provided in the report of the next five-year technical analysis for the plan. Groundwater level data are available from the NRD upon request.

Nebraska Department of Natural Resources

The Republican River Basin is located at the intersection of Nebraska, Colorado, and Kansas (Table 14 and Figure 2). The Republican River Compact (Compact), administered by the Republican River Compact Administration (RRCA) is an interstate agreement that allocates consumption of the waters of the Republican River Basin among the three states. Unless otherwise indicated, the data reported in the NeDNR section of this report are either from the RRCA's approved accounting data or the data Nebraska provided to Colorado and Kansas as part of the RRCA's annual data exchange, or else they were calculated from those data using the RRCA groundwater model.

Table 14. Area of Nebraska, Kansas, and Colorado within the Republican River Basin (United States Geological Survey (USGS) Hydrologic Unit Code: 102500).

State	Republican River Basin Area (mi^2)
Colorado	7,816
Kansas	7,551
Nebraska	9,546

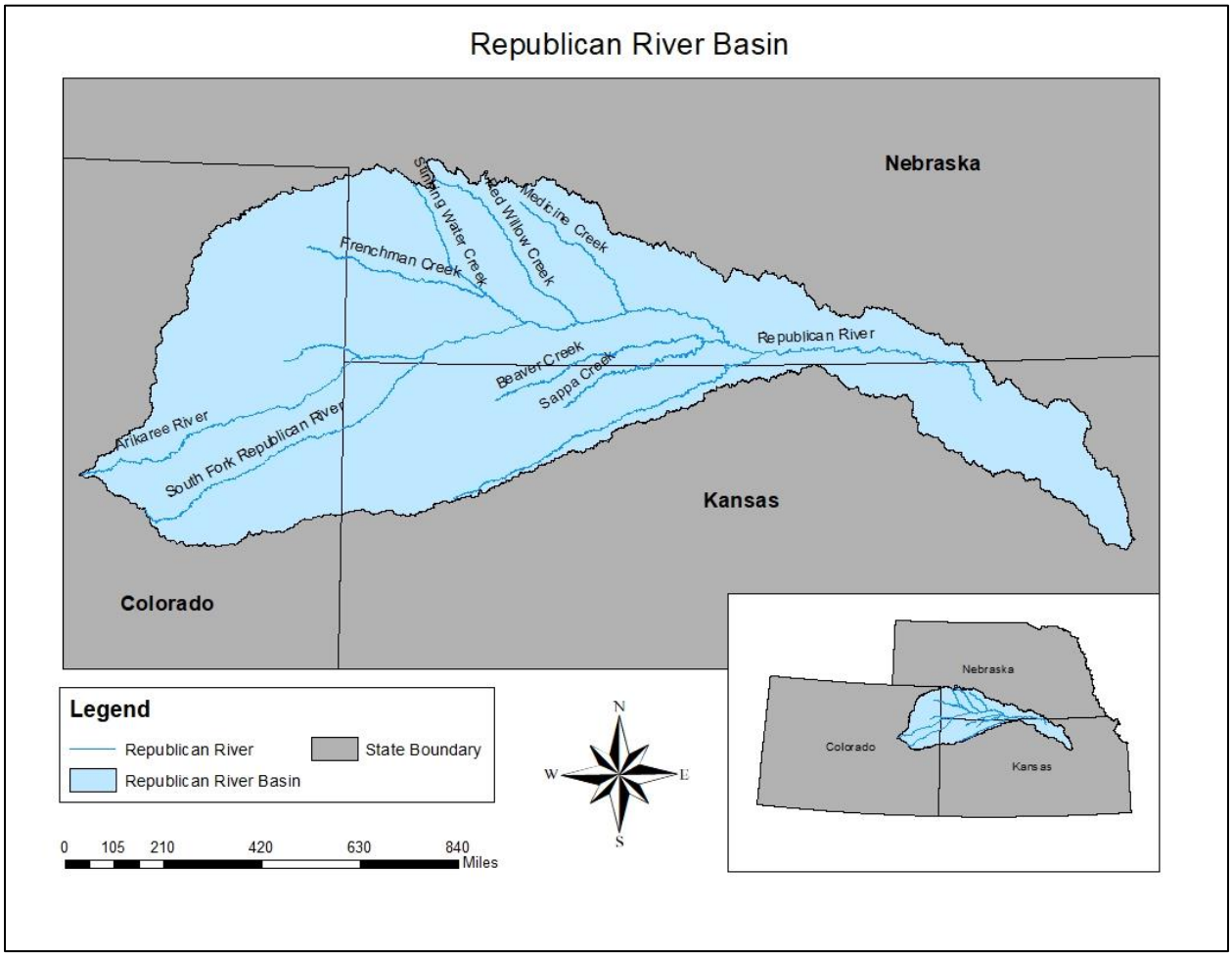

Figure 2. Extent of Republican River Basin within Nebraska, Kansas, and Colorado (USGS Hydrologic Unit Code: 102500).

Precipitation

In 2020, annual precipitation measured at National Weather Service cooperative stations across the Republican River Basin in Nebraska, quality-controlled and filled in with PRISM (Parameter-Elevation Regressions on Independent Slopes Model) data, as necessary, used in RRCA analyses, ranged from 12.52 inches to 26.85 inches. Figure 3 displays the 2020 precipitation at each of the cooperative stations used by the RRCA. Additional stations outside of Nebraska and the basin are used by the RRCA to fill in precipitation across the whole RRCA model area which extends beyond the basin boundary.

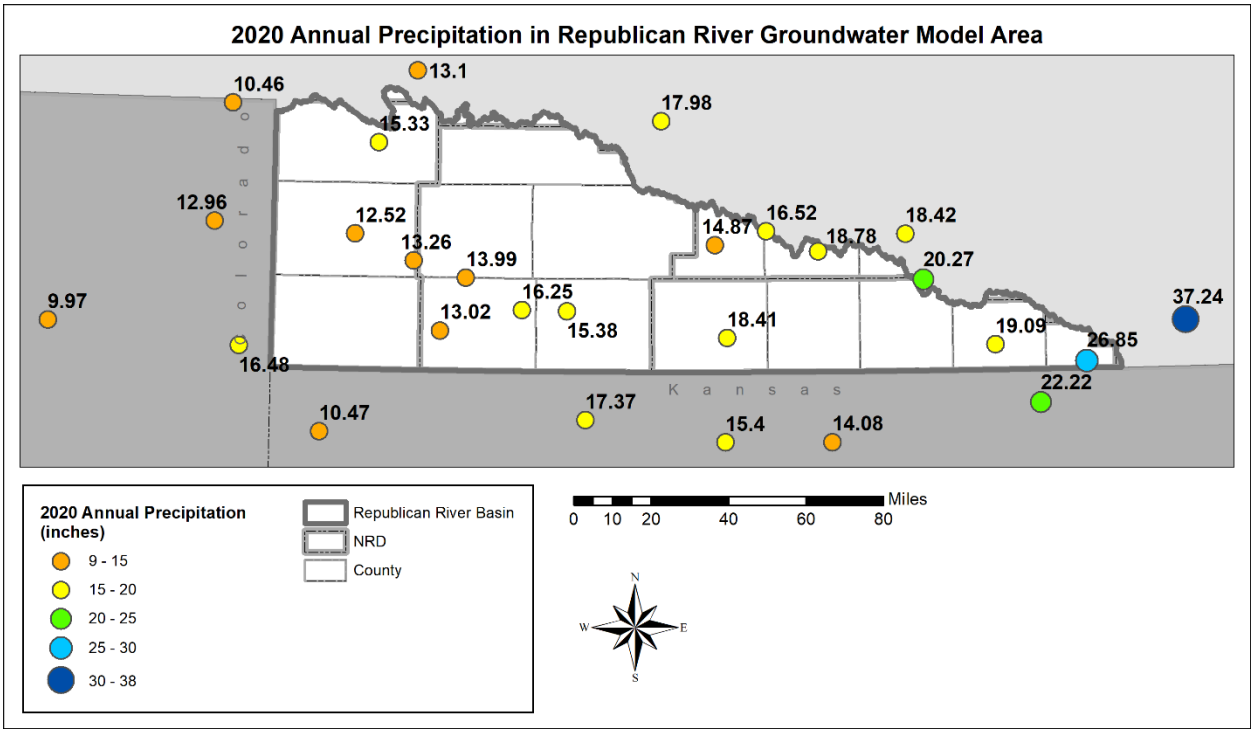

Figure 3. 2020 annual precipitation in inches from National Weather Service cooperative stations, as used in RRCA groundwater model processing.

Streamflow

Under the Republican River Compact, allocations within each Republican River subbasin include the streamflow at the downstream end of the subbasin. Subbasin streamflow is measured for the Compact by 13 USGS gages and one NeDNR gage (Figure 4 and Tables 15). The most downstream streamgages in Nebraska are on the Main Stem of the Republican River at Guide Rock and Hardy. Table 15 presents the total amount of water in acre-feet measured past each of the streamgages in 2020. For more details and to obtain continuous stream and reservoir, partial year, canal, canal return flow, and miscellaneous spot measurement data from over 250 gaging sites visit the NeDNR website: *https://nednr.nebraska.gov/RealTime/*.

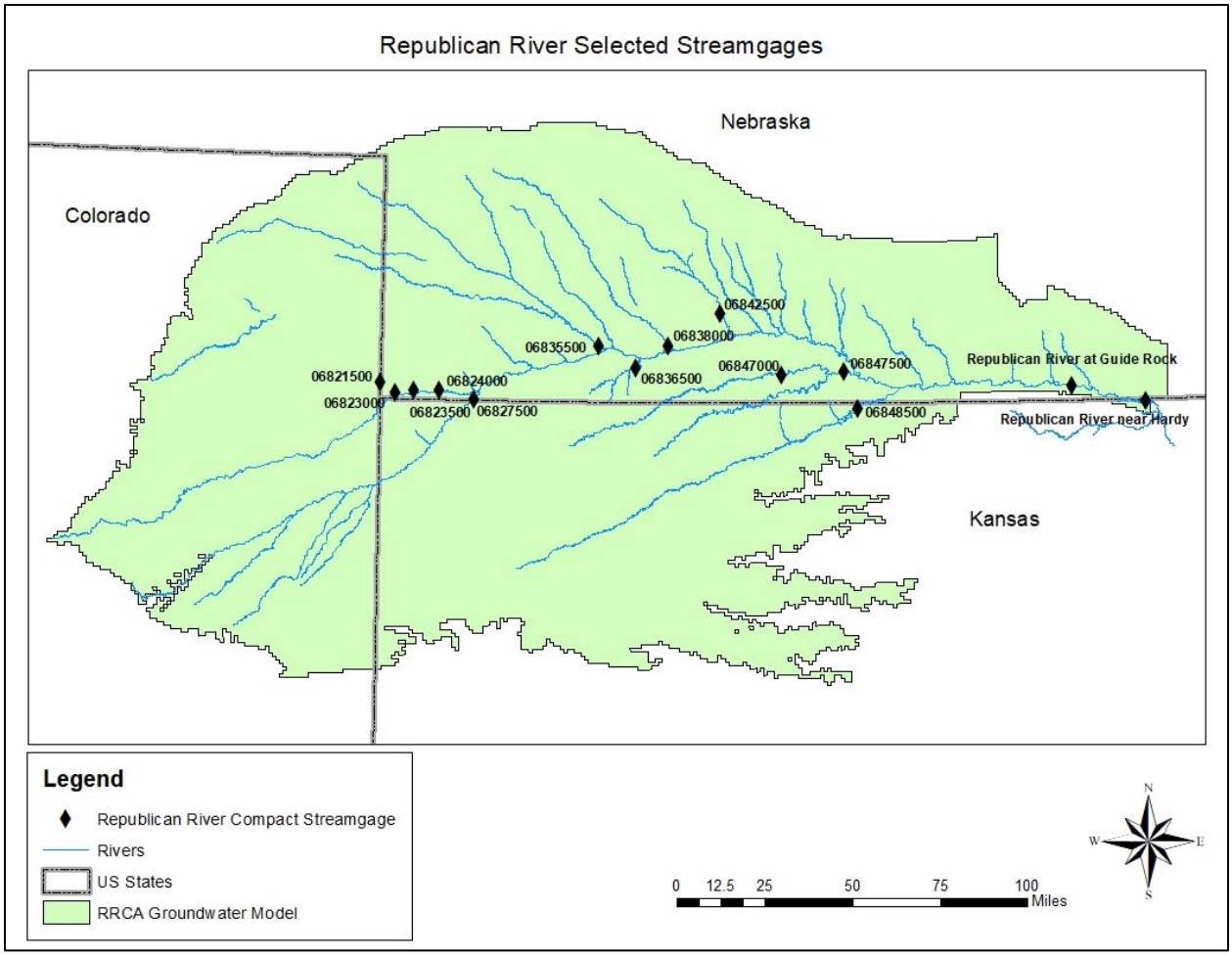

Figure 4. Location of subbasin streamgages within the Republican River Basin.

Table 15. Annual streamflow volumes in acre-feet from Republican River subbasin streamgages used in the Republican River Compact accounting.

Annual Streamflow (acre-feet)	
Streamgage	**2020**
USGS 06823000 - North Fork of the Republican River at Colorado-Nebraska State Line	22,984
USGS 06821500 - Arikaree River at Haigler	1,657
USGS 06823500 - Buffalo Creek near Haigler	2,143
USGS 06824000 - Rock Creek at Parks	4,049
USGS 06827500 - South Fork Republican River near Benkelman	7,229
USGS 06835500 - Frenchman Creek at Culbertson	19,122
USGS 06836500 - Driftwood Creek near McCook	2,492
USGS 06838000 - Red Willow Creek near Red Willow	4,284
NeDNR 06842500 - Medicine Creek below Harry Strunk Lake	39,930
USGS 06847000 - Beaver Creek near Beaver City	788
USGS 06847500 - Sappa Creek near Stamford	16,223
USGS 06848500 - Prairie Dog Creek near Woodruff, Kansas	8,282
USGS 06853020 - Republican River at Guide Rock	202,416
USGS 06853500 - Republican River near Hardy	251,239

Irrigated Acres

For the Republican River Compact Administration Groundwater Model, Nebraska currently reports irrigated acres as one of the following:

1. Groundwater-only irrigated acres.
2. Surface water-only irrigated acres or surface water and groundwater (commingled) irrigated acres.

Acres irrigated with groundwater are reported with metered pumping annually by the NRDs to NeDNR or are estimated for the portions of the RRCA model area that are in NRDs without metered pumping. Acres irrigated with surface water and commingled are flagged annually based on use from a master database developed from water right information. Annual irrigated acres within the RRCA model from 2020 have been divided into the two reporting methods and groundwater acres have been delineated by the NRD that the model cells primarily overlay (Figure 5). Nebraska annual total surface water and commingled and total groundwater irrigated acres are also presented in Table 16.

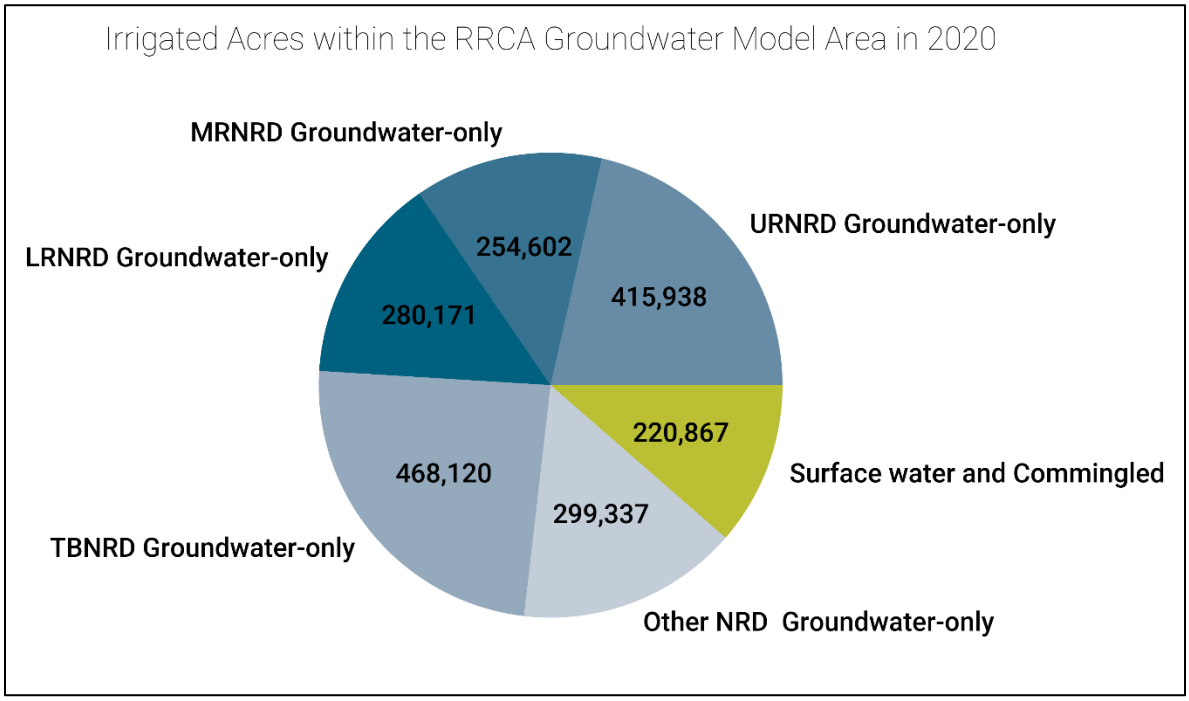

Figure 5. Annual acres irrigated by surface water and commingled (surface water and groundwater irrigated) or acres irrigated by only groundwater, delineated by the NRD that the model cells primarily overlay in the Nebraska portion of the RRCA groundwater model. Because all of Tri-Basin NRD (TBNRD) is included in the RRCA groundwater model area, the groundwater-irrigated acres shown here for Tri-Basin NRD include acres that are located in the Platte, Little Blue, and Republican River Basins.

Table 16. Annual division of acres irrigated by surface water and commingled (surface water and groundwater irrigated) or acres irrigated by only groundwater in the Nebraska portion of the RRCA groundwater model. Because all of Tri-Basin NRD is included in the RRCA groundwater model area, the groundwater-irrigated acres shown here for Tri-Basin NRD include acres located in the Platte, Little Blue, and Republican River Basins.

Area and Irrigation Type	2020
Nebraska Model Area – Surface Water and Commingled	220,867
Upper Republican NRD – Groundwater-only	415,938
Middle Republican NRD – Groundwater-only	254,602
Lower Republican NRD – Groundwater-only	280,171
Tri-Basin NRD – Groundwater-only	468,120
Other – Groundwater-only	299,337

Allocation and Computed Beneficial Consumptive Use (CBCU)

Under the Republican River Compact, the total water supply and how much of the total supply each state is entitled to beneficially use is referred to as "allocation." The allocations are calculated from the water supply of the basin if it had been undepleted by the activities of man. Each state is allotted a fixed percentage of the undepleted water supply in each of the Republican River subbasins to obtain the states' allocations. The calculated uses of the water supplies are referred to as "Computed Beneficial Consumptive Use" or "CBCU." The CBCU in the Republican River Basin includes direct surface water uses, such as reservoir evaporation and consumption of diverted water, and withdrawal or interception of streamflow by groundwater pumping (groundwater depletions to streamflow). Groundwater pumping can have a lagged effect on streamflow. The RRCA groundwater model considers the effects of pumping since early well development in the 1940s, therefore, the groundwater consumptive use of streamflow in each year is impacted by pumping in that year and all previous years. Table 17 presents total CBCU in Colorado, total CBCU in Kansas, and the breakdown of total CBCU as surface water or groundwater CBCU from Nebraska. Nebraska groundwater CBCU are presented for the effects of pumping from each basin NRD separately (Upper Republican, Middle Republican, Lower Republican, and Tri-Basin NRDs) and all other NRDs within the model area collectively (Other NRD) in Table 17. Each NRD's groundwater CBCU is equivalent to the net depletions to streamflow due to groundwater pumping within that NRD.

Table 17. Annual total Computed Beneficial Consumptive Use (CBCU) by Kansas and Colorado and annual Nebraska total surface water CBCU and division of groundwater CBCU (i.e., net depletions to streamflow) by each NRD. The sum of Nebraska CBCU presented in this table may vary slightly from the statewide CBCU in Nebraska's Compact compliance tables due to rounding.

CBCU (acre-feet)	
	2020
Colorado	26,910
Kansas	53,810
Nebraska Surface Water	73,365
Lower Republican NRD Groundwater	44,252
Middle Republican NRD Groundwater	44,906
Upper Republican NRD Groundwater	76,207
Tri-Basin NRD Groundwater	11,275
Other NRD Groundwater	2,416

Reservoir Storage and Evaporation

Federal Reservoir Storage

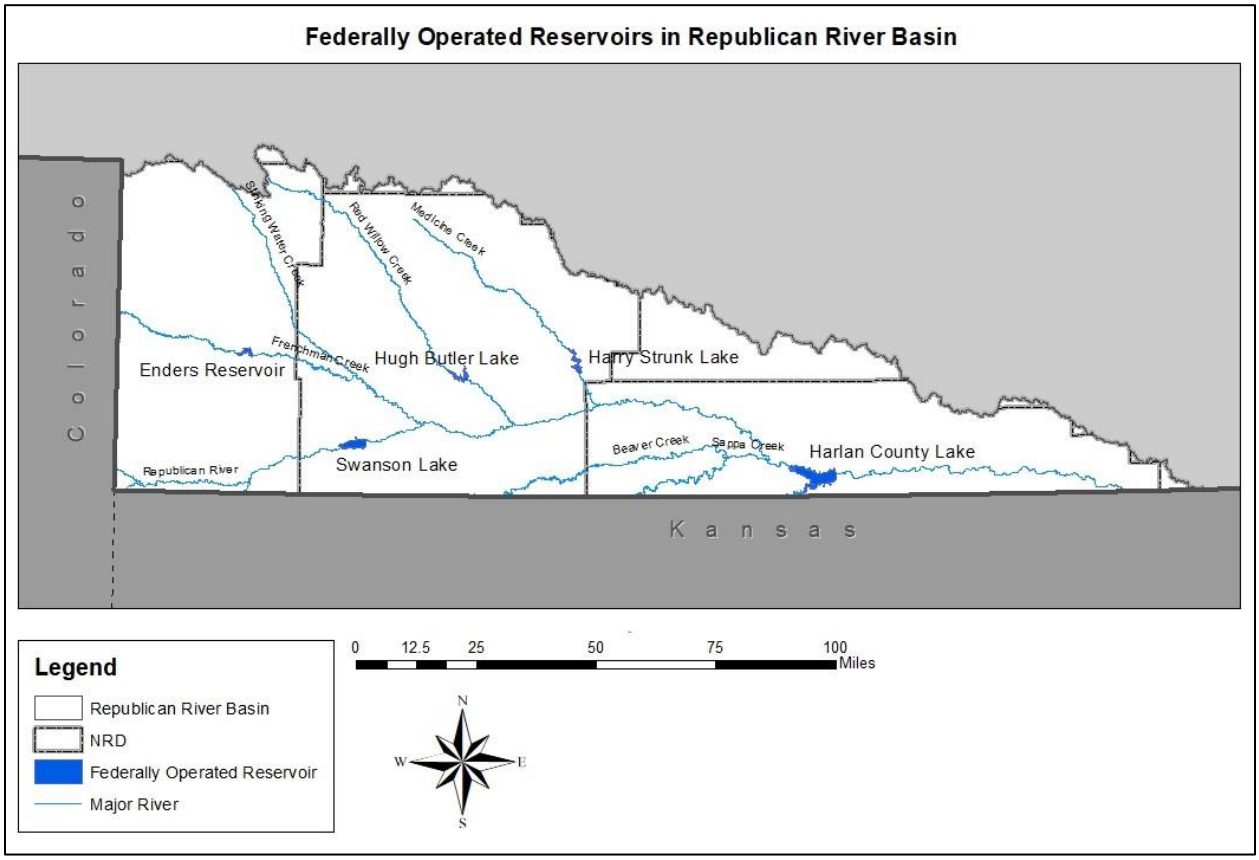

Figure 6. Location of federal reservoirs located in Nebraska portion of the Republican River Basin.

There are five federally operated reservoirs within the Republican River Basin in Nebraska: Enders Reservoir on Frenchman Creek, Hugh Butler Reservoir on Red Willow Creek, Harry Strunk Reservoir on Medicine Creek, and Swanson Lake and Harlan County Lake on the Republican River (Figure 6). Annual end of year storage volumes for 2020 for each Republican River Basin reservoir in Nebraska are shown in Figure 7. Storage data were obtained from the United States Bureau of Reclamation (USBR), which are available on the USBR's automated data system HydroMet at *https://www.usbr.gov/gp/hydromet/*.

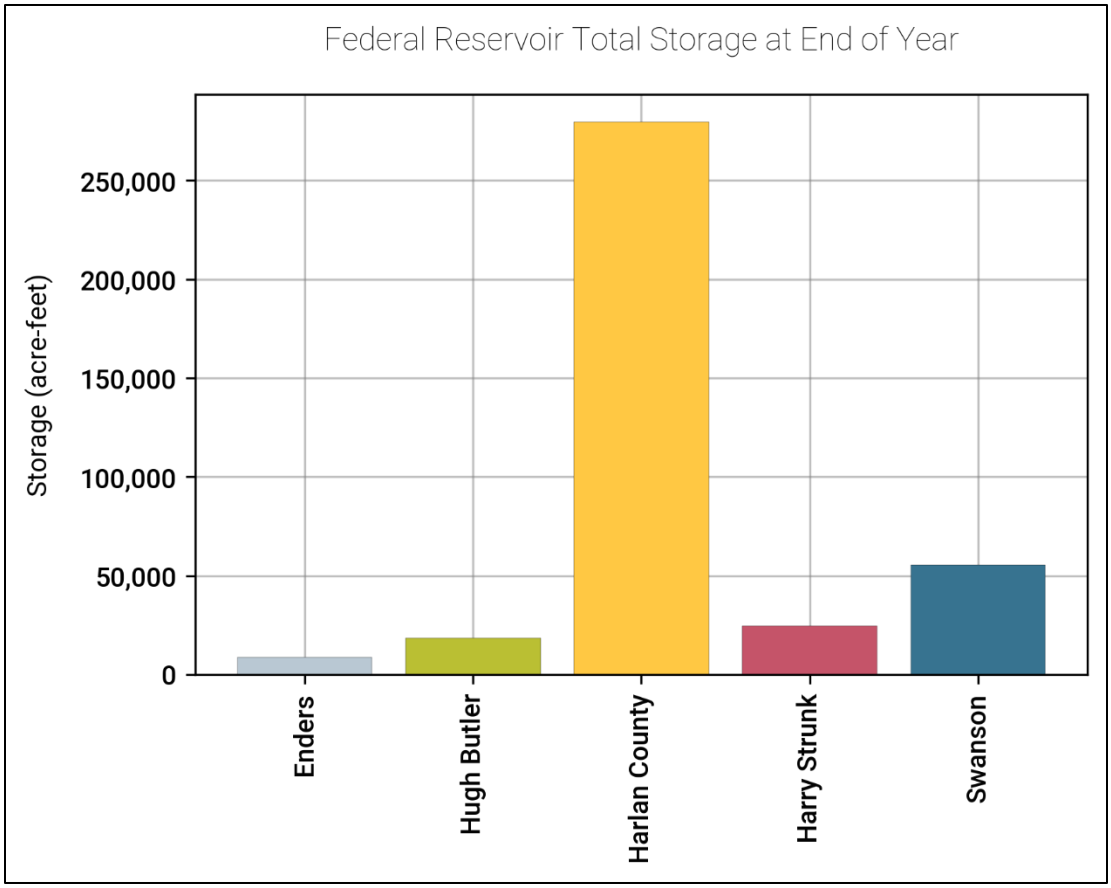

Figure 7. 2020 end-of-year reservoir contents relative to the reservoirs' active storage (i.e., capacity at the top of active conservation elevation) for the federally operated reservoirs within the Republican River Basin in Nebraska: Enders Reservoir on Frenchman Creek, Hugh Butler Reservoir on Red Willow Creek, Harry Strunk Reservoir on Medicine Creek, and Swanson Lake and Harlan County Lake on the Republican River.

Reservoir Evaporation

In 2020 in the Republican River Basin, net evaporation from the five federal reservoirs in Nebraska was 44,584 acre-feet and 2,695 acre-feet from non-federal reservoirs. Federal and non-federal reservoir evaporation are beneficial consumptive uses of surface water. For the RRCA, federal and non-federal reservoir CBCU are calculated as net evaporation, which is evaporation from the reservoir minus precipitation directly intercepted by the reservoir.

Surface Water Municipal and Industrial CBCU

During the reporting year, there were no permitted municipal nor industrial uses of surface water in the Republican River Basin. For more information on surface water permitting, visit NeDNR's Surface Water Permitting and Data website at: *https://dnr.nebraska.gov/surface-water*.

Surface Water Administration for Compact Compliance

Under the IMPs jointly developed by NeDNR and Upper Republican, Middle Republican, and Lower Republican NRDs, NeDNR may administer and regulate surface water, if necessary, to ensure compliance

with Nebraska's obligations under the Compact during Compact Call Years. Compact Call Years are years in which NeDNR's analysis following the forecast procedures contained in the IMPs for Upper Republican, Middle Republican, and Lower Republican NRDs indicate the potential for noncompliance with the Compact if sufficient management actions are not taken. No water administration for Compact compliance due to a Compact Call occurred in 2020.

Note that only administration for Compact compliance due to a Compact Call is considered a management action for the purposes of evaluating the basin-wide plan's MHO E. Surface water is also administered under the Water-Short Year provisions of the Final Settlement Stipulation (FSS) for the Compact. This type of water administration is triggered automatically under the terms of the FSS: whenever the projected or actual irrigation supply available in Harlan County Lake is less than 130,000 acre-feet and water is needed for direct diversion at Guide Rock, Nebraska must close appropriations downstream of Harlan County Lake that are junior to February 26, 1948. Because this type of water administration is triggered automatically, it is not considered a management action for the purposes of evaluating the basin-wide plan's MHO E.

Qualitative Evaluation of Net Effect of Management Actions for Compact Compliance

Action Item 1.2.1 of the basin-wide plan is to qualitatively evaluate the net effect on water supplies of any management actions that are taken for Compact compliance. As described in the previous subsection, "Surface Water Administration for Compact Compliance," and in the subsection entitled "Curtailment of Groundwater Pumping for Compact Compliance" within each NRD's section for reporting water supplies and uses (pages 7, 10, 13), neither surface water administration nor curtailment of groundwater pumping occurred in 2020. In addition, as stated in the progress summary for Action Item 1.1.2 (page 38) no management actions were necessary as offsets in 2020. In summary, in 2020 there were no management actions taken for 2020 Compact compliance.

Some management actions were taken in 2020 that will help with Compact compliance in future years. NeDNR and all four NRDs worked to enroll or reenroll landowners in temporary or permanent irrigation buyout programs(pages 6, 9, 13, and 15). Upper Republican, Middle Republican, and Lower Republican NRDs specify district-wide allocations on groundwater usage (pages 5, 8, and 11). Tri-Basin NRD specifies allocations on groundwater usage within Phase 3 groundwater quantity management areas (page 14), and other landowners within Tri-Basin NRD are enrolled in their Water Conservation Incentive Program (WCIP) to incentivize water conservation (page 15). Both buyout programs and allocation programs are expected to have a positive effect on water supplies by reducing consumptive use of water. Additionally, in 2020 NeDNR entered into contracts with FCID and NBID to help fund automation of canal gates or headgates (page 46). When complete, these automation projects are expected to eliminate unintended operational spills, creating a more reliable supply for agricultural users and allowing for more water to be stored in Swanson and Harlan County Lake Reservoirs.

Augmentation Pumping

This section contains a summary of pumping data for the augmentation projects in the basin.

NeDNR annually evaluates the net impacts of augmentation pumping for the Nebraska Cooperative Republican Platte Enhancement project (N-CORPE) and Rock Creek Augmentation projects, to fulfill a requirement of the IMPs jointly developed by NeDNR and Upper Republican, Middle Republican, and Lower Republican NRDs. The IMPs state that "…NeDNR will annually evaluate whether offsets are necessary to mitigate new net depletions resulting from augmentation pumping or other management actions." The most recent analysis is available in the report *Augmentation Pumping Net Impacts Analysis for the Republican River Basin* (November 15, 2021), which is available on NeDNR's website (*https://dnr.nebraska.gov*).

N-CORPE Augmentation Project

The Nebraska Cooperative Republican Platte Enhancement project (N-CORPE) is operated through an interlocal cooperative agreement formed in 2012 by Upper Republican NRD, Middle Republican NRD, Lower Republican NRD, and Twin Platte NRD. A summary of N-CORPE pumping for 2020 is provided in Table 18.

Table 18. Summary of N-CORPE augmentation project pumping. The "Days Pumped for Compact Compliance" column indicates the number of days the project was pumped to augment streamflow for Republican River Compact compliance purposes. The "Total Pumped Volume" column provides the volume of water pumped in that year for all purposes, including augmentation and maintenance pumping.

Year	Days Pumped for Compact Compliance	Total Pumped Volume (acre-feet)
2020	0	3,763

Rock Creek Augmentation Project

The Rock Creek augmentation project is operated by Upper Republican NRD. A summary of Rock Creek augmentation project pumping for 2020 is provided in Table 19.

Table 19. Summary of Rock Creek augmentation project pumping. The "Days Pumped for Compact Compliance" column indicates the number of days the project was pumped to augment streamflow for Compact compliance purposes. The "Total Pumped Volume" column provides the volume of water pumped in that year for all purposes, including augmentation and maintenance pumping.

Year	Days Pumped for Compact Compliance	Pumped Volume (acre-feet)
2020	0	60

Turkey Creek Augmentation Well

The Turkey Creek augmentation well is operated by Tri-Basin NRD as part of the NRD's Republican Basin Streamflow Augmentation Project. Since construction was completed in 2016, this well has not been operated for augmentation purposes.

Progress toward Goals, Objectives, and Action Items

Progress toward the basin-wide plan's goals, objectives, and action items is described below, in two subsections. The "Management Activities" subsection summarizes progress toward the plan's goals, objectives, and action items. The "Assessment of Measurable Hydrologic Objectives (MHOs)" subsection contains the results of the MHO assessments used to evaluate overall plan progress. Specific progress report details can be found on the following pages:

Management Activities 29
Progress Snapshot 31
Progress Summaries 38
Assessment of Measurable Hydrologic Objectives (MHOs) 60
MHO A Evaluation 60
MHO A Assessment Criteria 60
MHO A Evaluation Results for 2020 61
Tri-Basin NRD Hydrologically Balanced Assessment Results for 2020 62
MHO B Evaluation 64
MHO C Evaluation 64
MHO D Evaluation 64
MHO D Assessment Criteria 64
MHO D Evaluation Results for 2020 65
MHO E Evaluation 65
MHO E Assessment Criteria 65
MHO E Evaluation Results for 2020 65

Management Activities

Under *Neb. Rev. Stat.* § 46-755 (4), the basin-wide plan was required to include a timeline of up to 30 years after April 17, 2014, to meet the plan's goals and objectives. The basin-wide plan took effect on March 1, 2019. This section summarizes progress toward the basin-wide plan's goals, objectives, and action items during the 2020 calendar year, first as a visual snapshot of overall plan progress (beginning on page 31) followed by summaries describing progress on individual action items (beginning on page 38).

Two icons are displayed beside each action item in both the visual progress snapshot and the progress summaries. One symbol indicates when the action item is to be completed, according to the implementation schedule in the basin-wide plan. The other symbol indicates progress made on that action item during 2020. Figure 8 is a key describing the meanings of the symbols used throughout the "Management Activities" section.

Republican River Basin-Wide Plan Progress Summary Key

Symbols indicating when action item is to be completed, per plan schedule

When Appropriate	Annually	Annually When Appropriate	By This Year	Every Five Years
				
To be completed when beneficial, feasible, and economically viable; at NeDNR and NRDs' discretion	To be completed every year	To be completed in every year that the triggering circumstances described in the plan occur	To be completed by a certain year; likely can be "completed indefinitely"	To be completed every five years, either corresponding with the five-year analysis or in the following year, as specified in the basin-wide plan

Symbols indicating progress during report year

Completed Indefinitely	Completed	Ongoing Progress	Not Completed	Not Started	Not Applicable This Year
					N/A
Fully complete and no longer able to be worked on in the future	Recurring task completed during report year	Work on this action item is ongoing, generally progressing	Not completed as planned during report year	Not started as planned during report year	Did not need to be completed during report year

Figure 8. Key to symbols used throughout the "Management Activities" section. The report year for this report is 2020.

Progress Snapshot

This section contains a snapshot of overall progress on the basin-wide plan's goals and objectives. Visual summaries of progress on each goal can be found in the following locations:

- Goal 1 visual summary: Table 20, beginning on page 31;
- Goal 2 visual summary: Table 21, beginning on page 33;
- Goal 3 visual summary: Table 22, beginning on page 36; and
- Goal 4 visual summary: Table 23, beginning on page 37.

Each of these four tables spans multiple pages.

Table 20. Visual summary of progress on Goal 1 during 2020. The "Time-Frame" column indicates the expected timeframe for each action item, as indicated in the basin-wide plan. The "Action Taken" column refers to whether the action item was worked on in 2020, and the "Progress" column contains more information about progress during 2020. For details about the progress on each action item, see the page number indicated in the rightmost column.

Action Item	Description	Time Frame	Action Taken	Progress	Page
Goal 1	**Maintain Nebraska's compliance with the Republican River Compact and applicable laws**				
Obj. 1.1	**Coordinate basin-wide management actions with Compact compliance efforts and adherence to state laws**				
1.1.1	*Review each basin-wide plan management action prior to implementation to ensure it does not negatively impact efforts to achieve Compact compliance in the most efficient and cost-effective way practicable while adhering to state laws.*		Yes		38
1.1.2	*Implement appropriate offsets for any basin-wide plan action that would exceed Nebraska's allocation under the Compact*		No	**N/A**	38
Obj. 1.2	**Understand effects of management actions for compact compliance on water supplies for State's water users**				
1.2.1	*Qualitatively evaluate the net effect on water supplies of any management actions that are taken for Compact compliance*		Yes		39
Obj. 1.3	**Assess progress toward meeting the goals and objectives of the Plan, and share the results of this assessment with the Public and the Nebraska Legislature**				
1.3.1	*Within five years after the adoption of this Plan, and every five years thereafter, conduct a technical analysis of the actions taken to determine the progress toward meeting the goals and objectives of the Plan*		No	**N/A**	39

Symbol Legend – See Figure 8 on page 30

Action Item	Description	Time Frame	Action Taken	Progress	Page
1.3.2	*Evaluate progress toward each of the Plan's measurable hydrologic objectives at the intermediate dates specified in the Plan for each one.*				
MHO A:	*Maintain each NRD's net groundwater depletions to streamflow within its portion of Nebraska's allowable groundwater depletions to streamflow.*		Yes		39
MHO B:	*Limit groundwater depletions to streamflow to a relatively constant level over the long-term both across the basin as a whole and within each NRD*		No	**N/A**	40
MHO C:	*Ensure there is always enough groundwater for all groundwater uses within the timeframe of this plan, either by stabilizing groundwater levels or managing declining groundwater levels*		No	**N/A**	40
MHO D:	*Continue existing and initiate new actions that reduce the need for special regulations in the Rapid Response Area for Compact compliance*		Yes		40
MHO E:	*Continue existing and initiate new actions that reduce the need for administration of surface water use for Compact compliance*		Yes		41
1.3.3	*Following each five-year technical analysis (Action Item 1.3.1), share the results of the analysis and any recommended Plan modifications with the public*		No	**N/A**	41
1.3.4	*Following each five-year technical analysis (Action Item 1.3.1) and any resulting modifications to the Plan, submit a report to the Legislature of the results of the analysis and progress made under the Plan*		No	**N/A**	41

Symbol Legend – See Figure 8 on page 30

Table 21. Visual summary of progress on Goal 2 during 2020. The "Time-Frame" column indicates the expected timeframe for each action item, as indicated in the basin-wide plan. The "Action Taken" column refers to whether the action item was worked on in 2020, and the "Progress" column contains more information about progress during 2020. For details about the progress on each action item, see the page number indicated in the rightmost column.

Action Item	Description	Time Frame	Action Taken	Progress	Page
Goal 2	**Maximize Nebraska's efficient and beneficial consumptive use of its water, increase certainty for long-range planning of water supplies to reduce the need for regulatory actions, and increase collaborative efforts among water management entities and stakeholders across the Basin**				
Obj. 2.1	**Understand potential impacts of actions and establish standard procedure for projects**				
2.1.1	*For each planned new water management project in the Plan, evaluate hydrologic and regulatory feasibility and potential economic and environmental impacts*		Yes		43
2.1.2	*For each project evaluated in accordance with Action Item 2.1.1 in a given year, include a summary of the evaluation in the annual report of that year's activities*		Yes		43
2.1.3	*For projects that are feasible and beneficial, apply for necessary permits, establish new or utilize existing infrastructure, then begin operations*		Yes		44
Obj. 2.2	**Improve the efficiency of use, availability, and reliability of water supplies for current irrigators**				
2.2.1	*Work with irrigation districts and individual groundwater and surface water irrigators to improve the efficiency of the Basin's surface water delivery systems and irrigation water use, when it is both feasible and beneficial to Nebraska's Compact accounting balance*		Yes		44
2.2.2	*Participate in projects to improve the reliability, availability, and sustainability of water supplies in the Basin, which may include but are not limited to* • *Voluntary reduction of irrigated acres (temporary or permanent)* • *Interbasin transfers* • *Conjunctive management projects such as aquifer recharge or streamflow augmentation*		Yes		46
Obj. 2.3	**Provide opportunities for collaboration among Basin's water users**				
2.3.1	*Hold an annual public meeting to discuss Plan implementation and exchange information about the Basin*		Yes		48

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Action Item	Description	Time Frame	Action Taken	Progress	Page
2.3.2	*Work cooperatively to investigate and address conflicts between water users resulting from implementation of this Plan by following the procedures for addressing conflicts that are outlined in this Plan*		No	**N/A**	48
Obj. 2.4	**Promote conservation programs available to the water users in the Basin**				
2.4.1	*Work together to identify, investigate, and discuss existing and potential new water conservation programs*		Yes		48
2.4.2	*Collaborate to promote conservation program opportunities to the Basin's water users*		No		49
Obj. 2.5	**Understand how management activities of independent decision-makers affect water supplies**				
2.5.1	*Study the effects of conservation practices on streamflow, if feasible*		No	**N/A**	49
2.5.2	*As part of each five-year technical analysis, analyze the future impacts to streamflow of past pumping to determine the lag time of these residual impacts*		No	**N/A**	49
2.5.3	*Examine and attempt to estimate the quantity of all inputs and outputs affecting the water supply balance in a small watershed, and consider using the results of this pilot study to create water use and land use guidelines for producers and other land managers, incentivize participation in recommended practices, and determine the value of completing similar studies across the Basin*		Yes		50
Obj. 2.6	**Evaluate the feasibility and potential outcomes of establishing water markets in the Basin**				
2.6.1	*Cooperate in determining the feasibility of water markets in the Basin*		No	**N/A**	50
2.6.2	*Following the water markets feasibility analysis (Action Item 2.6.1), test conclusions through implementation of a water market program in a pilot area, if feasible*		No	**N/A**	50
Obj. 2.7	**Support the NRDs in management of allocations for irrigation purposes and surface water irrigation districts in management of the allotment of their water supply**				
2.7.1	*Periodically evaluate, as part of each five-year technical analysis, the impact of the groundwater allocation and surface water allotment systems as a whole*		No	**N/A**	51

Symbol Legend – See Figure 8 on page 30

Action Item	Description	Time Frame	Action Taken	Progress	Page
2.7.2	*As needed, based on the evaluation described in Action Item 2.7.1, recommend changes or improvements to the groundwater allocation and/or surface water allotment systems*		No	**N/A**	51
Obj. 2.8	**Conserve water for future use during a drought**				
2.8.1	*Organize and participate in a Basin-wide drought planning exercise*		Yes		51
2.8.2	*Following the drought planning exercise (Action Item 2.8.1) evaluate whether to recommend any changes to the IMPs or this Plan related to conservation of water for future use during a drought*		No	**N/A**	52

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Table 22. Visual summary of progress on Goal 3 during 2020. The "Time-Frame" column indicates the expected timeframe for each action item, as indicated in the basin-wide plan. The "Action Taken" column refers to whether the action item was worked on in 2020, and the "Progress" column contains more information about progress during 2020. For details about the progress on each action item, see the page number indicated in the rightmost column.

Action Item	Description	Time Frame	Action Taken	Progress	Page
Goal 3	**Positive public relations, including information sharing, within and outside the Basin**				
Obj. 3.1	**Improve information sharing with decision-makers and public about solutions within the Basin**				
3.1.1	*Use existing resources to share information about Basin progress and activities with outside entities*		Yes		53
3.1.2	*Educate civic leaders and the public on implementation efforts within the Basin*		Yes		53
3.1.3	*Educate civic leaders and the public about the policies and institutional infrastructure that contribute to the development and implementation of solutions*		Yes		54
3.1.4	*Propose and support changes to laws, policies, and rules that would incentivize reduced water consumption*		No	**N/A**	55
Obj. 3.2	**Improve information sharing with water users who are reliant on the Basin's water supplies**				
3.2.1	*Share data and information related to the Republican River Compact with the public in an easily accessible, user-friendly format*		Yes		55
3.2.2	*Annually prepare and exchange reports containing data and information about water supplies and uses in the Basin, and make these reports publicly known*		Yes		55
3.2.3	*Regularly communicate with the Plan's former Stakeholder Advisory Committee about implementation progress and potential Plan revisions*		Yes		56
3.2.4	*Encourage and support water users to share information about their management practice improvements with other water users and the public*		Yes		56

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Table 23. Visual summary of progress on Goal 4 during 2020. The "Time-Frame" column indicates the expected timeframe for each action item, as indicated in the basin-wide plan. The "Action Taken" column refers to whether the action item was worked on in 2020, and the "Progress" column contains more information about progress during 2020. For details about the progress on each action item, see the page number indicated in the rightmost column.

Action Item	Description	Time Frame	Action Taken	Progress	Page
Goal 4	**When possible, pursue projects that not only benefit water supplies and uses, but also create benefits for fish, wildlife, recreation and conveyance within the Republican River Basin**				
Obj. 4.1	**Protect and enhance fish and wildlife habitat and recreational opportunities**				
4.1.1	*Partner with wildlife-focused organizations on projects that benefit the organizations' habitat and wildlife interests while also helping to fulfill other goals of the Plan*		Yes		58
4.1.2	*Promote public recreation on the river, when doing so can also help to fulfill other goals of the Plan*		Yes		58
4.1.3	*Cooperate in projects to assess and restore riparian wetlands while also helping to fulfill other goals of the Plan*		Yes		58
Obj. 4.2	**Where feasible and beneficial, reduce the effects of undesirable vegetation on water conveyance**				
4.2.1	*Cooperate in removing undesirable vegetation impacting water conveyance and managing reinfestation*		Yes		59

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Progress Summaries

This section contains descriptions summarizing 2020 progress on each action item. For actions marked as not applicable ("N/A") the summaries include explanations of why progress did not need to be taken on those action items in 2020. For a copy of any reference materials mentioned in these summaries, please contact NeDNR or one of the Republican Basin NRDs.

Goal 1	**Maintain Nebraska's compliance with the Republican River Compact and applicable laws**
Obj. 1.1	**Coordinate basin-wide plan management actions with Nebraska's Compact compliance efforts and adherence to applicable state laws**

1.1.1 *Review each basin-wide plan management action prior to implementation to ensure it does not negatively impact efforts to achieve Compact compliance in the most efficient and cost-effective way practicable while adhering to state laws.*

In 2020, all basin-wide plan management actions were reviewed in accordance with Action Item 1.1.1. The Republican Basin NRDs and NeDNR do not expect any 2020 basin-wide plan management actions to negatively impact efforts to achieve Compact compliance in the most efficient and cost-effective way under state law.

Based on our review of the potential future basin-wide plan management actions outlined in the basin-wide plan, we do not expect any will negatively impact Compact compliance efforts or adherence to state laws. As new management actions are proposed, we will thoroughly analyze them at that time.

1.1.2 *Implement appropriate offsets for any basin-wide plan action that would exceed Nebraska's allocation under the Compact*

N/A

For this action item, the basin-wide plan defines offsets as actions that either reduce water use or increase water supply for the purpose of staying within Nebraska's Compact allocation. Nebraska complied with the Compact in 2020 without the need for any offsets by NeDNR or the Republican Basin NRDs. Because no offsets were necessary, this action item is not applicable for 2020.

In years when offsets are required, the volume of water that each NRD needs to make up through management actions is determined through procedures described in the Integrated Management Plans (IMPs). The IMPs for Upper Republican, Middle Republican, and Lower Republican NRDs require each district's computed beneficial consumptive water use to remain within its share of Nebraska's Compact allocation. The IMP for the Republican Basin portions of Tri-Basin NRD states that the district will incrementally achieve and sustain a hydrologically balanced condition so that, in combination with imported water contributions from the Platte Basin, streamflow augmentation, and other management actions, Tri-Basin NRD water users will not cause a net depletion to

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streamflow. Through implementation of the IMPs, NeDNR and the Republican Basin NRDs will take any necessary offsetting actions to ensure that Nebraska remains in compliance with the Compact.

Obj. 1.2 **Understand the effects of management actions for Compact compliance on water supplies for Nebraska's water users**

1.2.1 *Qualitatively evaluate the net effect on water supplies of any management actions that are taken for Compact compliance*

This action item was completed during 2020. A qualitative evaluation of the net effect on water supplies of any management actions that were taken for Compact compliance during 2019 was presented at the second annual meeting to review progress on the basin-wide plan, which took place in November 2020. The qualitative evaluation can be found on page 72 of the *Second Annual Report for the Republican River Basin-Wide Plan: Data and Progress Updates, 2019 (December 7, 2020)* and can be downloaded from the basin-wide plan website, *https://rrbwp.nebraska.gov*.

The current year's qualitative evaluation of the net effect of 2020 management actions for Compact compliance on water supplies can be found under "Qualitative Evaluation of Net Effect of Management Actions for Compact Compliance" on page 26 of this report.

Obj. 1.3 **Assess progress toward meeting the goals and objectives of the Plan, and share the results of this assessment with the Public and the Nebraska Legislature**

1.3.1 *Within five years after the adoption of this Plan, and every five years thereafter, conduct a technical analysis of the actions taken to determine the progress toward meeting the goals and objectives of the Plan*

N/A

A five-year technical analysis of actions taken is not necessary at this time. Following the schedule in the basin-wide plan, NeDNR and the Republican Basin NRDs will carry out the first five-year technical analysis in 2023 and repeat it every five years thereafter for the duration of the plan implementation time frame.

1.3.2 *Evaluate progress toward each of the Plan's measurable hydrologic objectives at the intermediate dates specified in the Plan for each one.*

MHO A: *Maintain each NRD's net groundwater depletions to streamflow within its portion of Nebraska's allowable groundwater depletions to streamflow.*

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MHO A was evaluated in 2020, and the results were presented at the second annual meeting to review progress on the basin-wide plan, which took place in November 2020. The analysis and results are described beginning on page 40 of the *Second Annual Report for the Republican River Basin-Wide Plan: Data and Progress Updates, 2019 (December 7, 2020),* which can be downloaded from the basin-wide plan website, https://rrbwp.nebraska.gov.

The current year's evaluation of MHO A can be found under "MHO A Evaluation" on page 60 of this report.

MHO B: *Limit groundwater depletions to streamflow to a relatively constant level over the long-term both across the basin as a whole and within each NRD*

N/A

An assessment of MHO B is not necessary at this time. Following the schedule laid out in the basin-wide plan, MHO B will be assessed in 2023, and every five years thereafter for the duration of the plan implementation time frame, as part of the five-year technical analysis.

MHO C: *Ensure there is always enough groundwater for all groundwater uses within the timeframe of this plan, either by stabilizing groundwater levels or managing declining groundwater levels*

N/A

An assessment of MHO C is not necessary at this time. Following the schedule laid out in the basin-wide plan, MHO C will be assessed in 2023, and every five years thereafter for the duration of the plan implementation time frame, as part of the five-year technical analysis.

MHO D: *Continue existing and initiate new actions that reduce the need for special regulations in the Rapid Response Area for Compact compliance*

MHO D assesses whether groundwater pumping within the Rapid Response Area of Upper Republican, Middle Republican, or Lower Republican NRD was curtailed to ensure Compact compliance during the previous year. There is no Rapid Response Area designated within Tri-Basin NRD.

MHO D was evaluated in 2020 to review progress on the basin-wide plan. Results were presented at the second annual meeting, which took place in November 2020. The analysis and results can be found on page 45 of the *Second Annual Report for the Republican River Basin-Wide Plan: Data and Progress Updates, 2019 (December 7, 2020).* The report can be downloaded from the basin-wide plan website, https://rrbwp.nebraska.gov.

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The current year's evaluation of MHO D can be found under "MHO D Evaluation" on page 64 of this report.

The Republican Basin NRDs and NeDNR have undertaken many projects that reduce the potential future need for special regulations in the Rapid Response Area for Compact compliance. Examples of new and existing projects can be found in this report, within the summaries of progress on other plan action items.

MHO E: *Continue existing and initiate new actions that reduce the need for administration of surface water use for Compact compliance*

MHO E assesses whether surface water administration was needed during the previous year to ensure Compact compliance. Note that any administration that is automatically trigged under terms of the Final Settlement Stipulation (FSS) is not evaluated as part of MHO E.

MHO E was evaluated in 2020 to review progress on the basin-wide plan. Results were presented at the second annual meeting, which took place in November 2020. The analysis and results can be found on page 46 of the *Second Annual Report for the Republican River Basin-Wide Plan: Data and Progress Updates, 2019 (December 7, 2020),* which can be downloaded from the basin-wide plan website, *https://rrbwp.nebraska.gov*. The current year's evaluation of MHO E can be found under "MHO E Evaluation" on page 65 of this report.

NeDNR and the Republican Basin NRDs have undertaken many projects that reduce the potential future need for surface water administration for Compact compliance. Some examples are included in this report, within the summaries of progress on other plan action items.

1.3.3 *Following each five-year technical analysis (Action Item 1.3.1), share the results of the analysis and any recommended Plan modifications with the public*

N/A

As explained under action item 1.3.1 above, the five-year technical analysis was not necessary in 2020; therefore, there were also no results to share with the public in 2020. As laid out in the basin-wide plan, NeDNR and the Republican Basin NRDs will carry out the five-year technical analysis and share the results with the public every five years throughout the plan implementation period, beginning in 2023.

1.3.4 *Following each five-year technical analysis (Action Item 1.3.1) and any resulting modifications to the Plan, submit a report to the Legislature of the results of the analysis and progress made under the Plan*

N/A

A report to the legislature summarizing the results of the analysis of a five-year technical analysis is not necessary at this time. As laid out in the basin-wide plan, NeDNR and the

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Republican Basin NRDs will carry out the five-year technical analysis every five years throughout the plan implementation period, beginning in 2023. A report to the Legislature will be submitted following each five-year technical analysis, beginning in 2024.

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Goal 2	**Maximize Nebraska's efficient and beneficial consumptive use of its water, increase certainty for long-range planning of water supplies to reduce the need for regulatory actions, and increase collaborative efforts among water management entities and stakeholders across the Basin**
Obj. 2.1	**Understand the feasibility and potential impacts of Plan actions and establish a standard procedure for projects**

2.1.1 *For each planned new water management project in the Plan, evaluate hydrologic and regulatory feasibility and potential economic and environmental impacts*

and

2.1.2 *For each project evaluated in accordance with Action Item 2.1.1 in a given year, include a summary of the evaluation in the annual report of that year's activities*

Lower Republican NRD utilized a model specific for proposed new water management projects. Lower Republican NRD is evaluating three proposed locations for potential water storage. These efforts will initiate the National Environmental Policy Act (NEPA), analyzing all the components addressed in section 2.1.1. Lower Republican NRD received funding through the Watershed and Flood Prevention Operations Program (WFPO) to hire a consultant to further evaluate two of the proposed sites for water storage and other beneficial uses. The WFPO grants that the NRD received for two of the proposed sites will be completed over a 2-year period, starting in March of 2021. Contracts are being negotiated with NEPA and environmental assessment work is expected to begin by August of 2021. The third site underwent a preliminary investigative feasibility review (PIFR) by NRCS in July of 2021. The results of this review are pending. Any award of WFPO grant funding by the NRCS for this third site may take up to 18 months, beginning July 2021, to determine.

Lower Republican NRD and NeDNR worked with Nebraska Bostwick Irrigation District (NBID) in 2020, to evaluate the potential feasibility and impacts of a project to increase the efficiency of Superior Canal operations. Their evaluation and findings were summarized in NBID's WaterSMART Water and Efficiency Grant project application, which was submitted to the United States Bureau of Reclamation (USBR) in 2020.

Middle Republican NRD also submitted a WaterSMART Water and Efficiency Grant application in 2020, which included a summary of the potential feasibility and impacts of the second phase of a Remote Irrigation Meter and Irrigation Water Conservation Project. The grant will be used for telemetry-equipped water meters that will provide near real-time water usage in areas with groundwater declines. The information will help address declines and the reporting of consumptive use.

Over the last two years, Middle Republican NRD has installed more than 900 telemetry irrigation water meters within high stream flow depletion areas of the District.

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2.1.3 *For projects that are feasible and beneficial, apply for necessary permits, establish new or utilize existing infrastructure, then begin operations*

As stated in the previous section, Lower Republican NRD is currently evaluating three potential locations for water storage. The WFPO grants that the NRD received for two of the proposed sites will be completed by March of 2023. When the EA plans are completed, the next phase will be to determine preferred alternatives and proceed with additional grant applications with NRCS for project development.

In 2020, Tri-Basin and Lower Republican NRDs resubmitted their application (permit number A-19594) for a water right to divert excess flows from the Platte River for delivery to a diversion that would send water down Turkey Creek, a tributary of the Republican River. The application awaits approval by NeDNR. All ongoing and future projects will be developed in compliance with local, state, and federal permitting requirements.

Obj. 2.2 Improve the efficiency of use, availability, and reliability of water supplies for current irrigators

2.2.1 *Work with irrigation districts and individual groundwater and surface water irrigators to improve the efficiency of the Basin's surface water delivery systems and irrigation water use, when it is both feasible and beneficial to Nebraska's Compact accounting balance*

Upper Republican NRD, Middle Republican NRD, Lower Republican NRD, and NeDNR each made progress on this action item in 2020.

In 2020, Upper Republican NRD staff installed telemetry units on approximately 500 irrigation wells in the district, making progress towards the NRD's goal of allowing farmers and Upper Republican NRD staff to get real-time water usage from all 3,300 irrigation wells in the district (Figure 9). Real, or near-real, time usage will help farmers apply needed amounts of water based on soil-moisture and evapotranspiration data with more precision and reduce instances of over-watering. Additionally, usage reports will be constantly adjusted based on most recent water applications to reflect remaining allocation, carry-forward, etc., at the time the report is generated.

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Figure 9. Two different mounting systems for Upper Republican NRD telemetry project.

Upper Republican NRD continued to work with the Daugherty Water for Food Global Institute at the University of Nebraska-Lincoln (UNL) to collect data from an existing eddy-covariance evapotranspiration (ET) tower in the district and develop a network of other such towers, to eventually develop tools to improve farmers' irrigation scheduling. The data from the towers will be used to refine ET inputs in a model that also utilizes satellite imagery that estimates ET; the ultimate goal is to develop an easy-to-use application for farmers to get field-specific ET estimates and forecasts to improve their irrigation scheduling.

Middle Republican NRD partnered with the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) in obtaining a WaterSMART Grant from the USBR. This grant runs through the NRCS, targeting the Middle Republican NRD Republican River Rapid Response Area. The project mirrors the Middle Republican NRD WaterSMART Telemetry project, cost-sharing telemetry soil moisture probes, conversion to subsurface drip irrigation and other water conservation projects. NeDNR also contributed to this project through the Water Resources Cash Fund (WRCF).

Middle Republican NRD has an ongoing project with the Frenchman Valley Irrigation District (FVID) to conduct recharge through their surface delivery system and use the water for compact compliance if necessary. NeDNR also began discussions with FVID in 2020 about potential improvements to FVID's infrastructure.

Lower Republican NRD has an agreement with NBID that establishes water savings through the placement of automated gates. Lower Republican NRD and NeDNR provided a letter of support for NBID's 2020 grant application for water delivery to the Superior Canal, and assisted with developing NBID's application.

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NeDNR signed a contract with the Frenchman-Cambridge Irrigation District (FCID) in 2020 to install upgraded flow measurement and control gates on the Meeker-Driftwood Canal and integrate them into a Supervisory Control and Data Acquisition (SCADA) radio telemetry network (Figure 10). NeDNR also signed a contract with the Nebraska Bostwick Irrigation District (NBID) in 2020 to install automated headgates on the Courtland and Superior Canals. The goals of these projects are to eliminate unintended operational spills. The projects also include conjunctive management commitments from FCID and NBID. NeDNR's contribution to these projects is funded through the WRCF. Construction and installation of the FCID project began in 2020.

Figure 10. New Rubicon gates on canal operated by Frenchman-Cambridge Irrigation District.

2.2.2 *Participate in projects to improve the reliability, availability, and sustainability of water supplies in the Basin, which may include but are not limited to:*

- *Voluntary reduction of irrigated acres (temporary or permanent)*
- *Interbasin transfers*
- *Conjunctive management projects such as aquifer recharge or streamflow augmentation*

All four Republican River Basin NRDs participate in the Conservation Reserve Enhancement Program (CREP), which provides federal funding for the temporary removal of environmentally sensitive land from production. Three of the districts also have acres enrolled in the Agricultural Water Enhancement Program (AWEP). Summaries of acres enrolled in CREP and AWEP within each NRD can be found on pages 6, (Upper Republican NRD), page 10 (Middle Republican NRD), page 13 (Lower Republican NRD), and page 15 (Tri-Basin NRD).

Upper Republican NRD entered into agreements with 11 landowners in 2020 to buy out irrigation rights or appropriations on approximately 2,040 acres with an average 50-year stream flow depletion factor of 72%. This program is funded by Upper Republican NRD and the WRCF, which is administered by NeDNR. Upper Republican NRD and NeDNR (via the Water Sustainability Fund) also provided cost share for 160 soil moisture probes on approximately 20,800 acres in 2020. Both actions will mitigate stream depletions caused by groundwater pumping.

Middle Republican NRD has a program to buy out irrigation rights or appropriations on cropland. This program is funded by Middle Republican NRD and the WRCF, which is

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administered by NeDNR. Specific details about the number of contracts entered into with landowners and the number of acres bought out in 2020 are reported under "Conservation and Irrigation Buyout Programs" on page 6.

In 2016, Lower Republican NRD established an ongoing program through the Regional Conservation Partnership Program (RCPP). As part of this program, Lower Republican NRD provided for soil moisture sensors, end gun removal and the conversion of gravity irrigation to subsurface drip. The five-year program will end in 2021.

Lower Republican NRD and Tri-Basin NRD submitted an application to NeDNR for an interbasin transfer permit to divert excess flows from the Platte Basin to the Republican Basin as the Platte to Republican Basin High Flow Diversion (PRD) project (permit number A-19594, Figure 11). As filed, it was proposed to always be junior in priority to existing and future Platte River water uses. The permitting process for this project is ongoing. Permitting aspects of this project are described under action item 2.1.3.

Figure 11. Prescribed burn on Platte-Republican Diversion land, April 20, 2020, courtesy of Tri-Basin NRD.

Lower Republican NRD has agreements with NBID to use water stored in Harlan County Lake for Compact compliance. The stored water is a result of water savings derived from automated gate installations, which received a million dollars from Lower Republican NRD. Additionally, the NRD provided a letter of support for the Superior Canal WaterSMART grant. The grant application was successful, and planning is now underway.

Some additional potential conjunctive management projects NeDNR and the NRDs were involved in with the basin's irrigation districts are described under action item 2.2.1.

Obj. 2.3 Provide opportunities for collaboration among Basin's water users

2.3.1 *Hold an annual public meeting to discuss Plan implementation and exchange information about the Basin*

The first basin-wide plan annual meeting was held in February 2020, which was within the first year of plan implementation.

Another opportunity to exchange information about the Basin occurred during a separate basin-wide meeting that was held in November 2020, in fulfillment of the IMPs for Upper Republican, Middle Republican, and Lower Republican NRDs. The main purpose of that meeting was to discuss the preliminary forecast of available water supplies for the Republican River Basin.

2.3.2 *Work cooperatively to investigate and address conflicts between water users resulting from implementation of this Plan by following the procedures for addressing conflicts that are outlined in this Plan*

N/A

The Republican River NRDs and NeDNR intend to work cooperatively to investigate and address conflicts between water users resulting from implementation of the Basin-Wide Plan by following the procedures for addressing conflicts that are outlined in the Plan. In 2020, no conflicts resulting from implementation of the basin-wide plan were brought to the attention of NeDNR or the NRDs to address.

Obj. 2.4 Promote conservation programs available to the water users in the Basin

2.4.1 *Work together to identify, investigate, and discuss existing and potential new water conservation programs*

Throughout 2019, the Republican Basin NRDs and NeDNR discussed and shared information with each other about existing and potential new water conservation programs as new information became available or new questions were raised by one of the parties. For example, they promoted the use of new technology that has the potential to reduce water use.

Lower Republican NRD is in partnership with the NRCS under the RCPP which was initiated through partnerships with Upper Republican and Middle Republican Natural Resources Districts. Lower Republican NRD also has an agreement with the NBID to use a portion of water savings from automated gates for compact compliance. The NRD provided funding for the gates. Currently, Lower Republican NRD has indicated support to work with NeDNR on the Superior Canal WaterSMART grant and is currently utilizing a WaterSMART grant from the USBR to implement a pilot program for telemetry-enabled flowmeters.

Tri-Basin NRD created the Water Conservation Incentive Program (WCIP) to encourage irrigators to accept limits on their water use in exchange for receiving cash payments

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when they save water within their allocation. Agreements last five years. There were no new WCIP contracts in the Republican Basin in 2020.

2.4.2 *Collaborate to promote conservation program opportunities to the Basin's water users*

The Republican River Basin NRDs and NeDNR are open to opportunities to collaborate with neighboring NRDs, state and federal government agencies and constituents on programs and projects that promote and incentivize water conservation. Each of the Republican Basin NRDs is actively involved in CREP. Additionally, the NRDs participate in the Southwest Weed Management District (SWMD). The SWMD had been reformed and rejuvenated in recent years and has successfully acquired grants to remove invasive species in stream corridors that consume water and impede stream flow.

Obj. 2.5 Understand how various water management activities of independent decision-makers affect water supplies

2.5.1 *Study the effects of conservation practices on streamflow, if feasible*

N/A

This action item is to be completed by 2028, when and if funding and staff resources allow. NeDNR and the NRDs have some analytical tools available to them to assist with studies of the effects of conservation practices on streamflow, as described below.

Lower Republican NRD will study the effects of conservation practices on streamflow through the Lower Republican NRD Management Action Opportunity (MAO) model. The Republican River Compact Administration (RRCA) model is run to determine the quantitative effect of a proposed land use change through the MAO model.

Tri-Basin NRD has the most extensive groundwater level monitoring network in Nebraska. Groundwater level data is critical to accurately determining impacts of groundwater pumping on streamflows. Data are shared with state and federal agencies and made available to the public.

NeDNR uses the RRCA model to estimate stream depletions resulting from groundwater pumping, stream accretions resulting from recharge projects, and other parameters.

2.5.2 *As part of each five-year technical analysis, analyze the future impacts to streamflow of past pumping to determine the lag time of these residual impacts*

N/A

Following the schedule in the basin-wide plan, NeDNR and the Republican Basin NRDs will carry out the first five-year technical analysis in 2023 and repeat it every five years thereafter for the duration of the plan implementation time frame.

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2.5.3 *Examine and attempt to estimate the quantity of all inputs and outputs affecting the water supply balance in a small watershed, and consider using the results of this pilot study to create water use and land use guidelines for producers and other land managers, incentivize participation in recommended practices, and determine the value of completing similar studies across the Basin*

This action item is to be completed by 2028.

In 2020, Upper Republican NRD continued discussions with the Daugherty Water for Food Global Institute at the University of Nebraska-Lincoln and the Nebraska Water Balance Alliance about how to fund or otherwise pursue a water balance study within the HUC-12 watershed of Perkins County. NeDNR also participated in informational discussions with the research team for this project. The team presented information about their project at the February 2020 annual meeting to review progress on the basin-wide plan.

Middle Republican NRD has a Water Sustainability Grant to use airborne electromagnetic (AEM) technology to model water supply balance in the western portion of Middle Republican NRD. In 2020, the AEM project was successful in flying the area in the decline area of the NRD. Middle Republican NRD is currently working with UNL in data analysis. Lower Republican NRD will examine the effort required to complete action item 2.5.3 in the coming years and will consider using the results of this pilot study to create water use and land use guidelines for producers and other land managers, incentivize participation in recommended practices, and determine the value of completing similar studies across the Basin.

Obj. 2.6 Evaluate the feasibility and potential outcomes of establishing water markets in the Basin

2.6.1 *Cooperate in determining the feasibility of water markets in the Basin*

N/A

This action item is to be completed by 2023. Two large action items from the plan are scheduled to be completed by 2023: this feasibility study and the drought planning exercise described in Action Item 2.8.1, and it was not feasible in 2020 to begin both projects. At this time, NeDNR and the NRDs have been focusing efforts on the drought planning exercise.

2.6.2 *Following the water markets feasibility analysis (Action Item 2.6.1), test conclusions through implementation of a water market program in a pilot area, if feasible*

N/A

As stated in the basin-wide plan, this action item is contingent upon the findings from the feasibility study in Action Item 2.6.1. If the evaluation in Action Item 2.6.1 indicates that water markets in the Basin would be feasible, and if sufficient funding and staff resources

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are available to do so, then NeDNR and the NRDs will work cooperatively with the US Bureau of Reclamation, the Basin's irrigation districts, and water users in the Basin to conduct a water market pilot program within a portion of the Basin by 2028.

Obj. 2.7 Support the NRDs in management of allocations for irrigation purposes and surface water irrigation districts in management of the allotment of their water supply

2.7.1 *Periodically evaluate, as part of each five-year technical analysis, the impact of the groundwater allocation and surface water allotment systems as a whole*

N/A

Following the schedule in the basin-wide plan, NeDNR and the Republican Basin NRDs will carry out the first five-year technical analysis in 2023 and repeat it every five years thereafter for the duration of the plan implementation time frame.

The NRDs individually review pumping and allocations on a regular basis to comply with the IMPs and groundwater management plans while balancing the allocations so as not to restrict the economic vitality of the NRD or the region, as is consistent with the mission of the *Republican River Basin-Wide Plan*.

Tri-Basin NRD has only one township in the Republican Basin that is subject to allocation. This allocation was imposed to protect groundwater levels in the local area from diminishment. The allocation requirement is tied to local groundwater levels. If a three-year average of groundwater levels rises above the 1981–1985 average springtime levels for that township, the allocation will be suspended. The other three NRDs have allocations district-wide.

2.7.2 *As needed, based on the evaluation described in Action Item 2.7.1, recommend changes or improvements to the groundwater allocation and/or surface water allotment systems*

N/A

Following the schedule in the basin-wide plan, NeDNR and the Republican Basin NRDs will carry out this action item by the year following each iteration of Action Item 2.7.1. Therefore, this action will be completed for the first time by 2024 and then repeated every five years thereafter for the duration of the plan implementation timeframe.

Obj. 2.8 Conserve water for future use during a drought

2.8.1 *Organize and participate in a Basin-wide drought planning exercise*

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This action item is to be completed by 2023.

In 2020 the four NRDs and NeDNR partnered with UNL to hire a Graduate Research Assistant to conduct a basin-wide drought planning exercise. The NRDs and NeDNR agreed to share the cost of supporting the graduate student, with NeDNR responsible for 50% and the NRDs collectively responsible for the other 50%. The assistantship is expected to continue through May 2022.

In 2020, the Graduate Research Assistant researched options for possible frameworks for the drought planning exercise and gave a presentation about the future drought planning exercise at the November 2020 annual meeting to review basin-wide plan progress. Following the November annual meeting, and in consultation with the four NRDs, it was decided that the drought planning exercise will use a tabletop exercise framework to look closely at existing planning documents in the Basin and identify any gaps in management practices that may arise in times of drought.

In addition to participating in the basin-wide drought planning exercise, Lower Republican NRD is interested in pursuing a plan to reserve flood water for irrigation use within existing structures, which would be beneficial for water supplies during drought periods. Many reservoirs in the USACE Kansas City District have lake management plans that allow additional water to be held back above conservation pools. Additionally, regulatory changes that allow for the modification or change in a reservoir operating plan allowing flood water retention above current levels would conserve water for future use.

Tri-Basin NRD and Central Nebraska Public Power and Irrigation District are also in the early stages of developing a drought management and mitigation plan for the entire NRD.

2.8.2 *Following the drought planning exercise (Action Item 2.8.1) evaluate whether to recommend any changes to the IMPs or this Plan related to conservation of water for future use during a drought*

N/A

This action item will be completed by the year following completion of the drought planning exercise, and no later than 2024.

In addition to participating in the basin-wide drought plan, Tri-Basin NRD and Central Nebraska Public Power and Irrigation District are in the early stages of developing a drought management and mitigation plan for the entire NRD. Once these efforts are complete an evaluation of recommended changes to Tri-Basin NRD's IMP or the basin-wide plan will be considered.

Symbol Legend – See Figure 8 on page 30

Goal 3	Positive public relations, including information sharing, within and outside the Basin
Obj. 3.1	**Improve information sharing with decision-makers and public about solutions within the Basin**

3.1.1 *Use existing resources to share information about Basin progress and activities with outside entities*

The Republican River Basin NRDs and NeDNR use existing information dissemination resources such as newsletters, radio programs, public meetings, websites, social media, and education/outreach events. Some of these resources were used in 2020 to share information about Basin progress and activities with outside entities. Examples are described under Action Item 3.1.2 and 3.1.3.

In 2020 Upper Republican NRD began work on a document for distribution within and outside of the Basin that summarizes historical and current efforts by Upper Republican NRD, Lower Republican NRD, and Middle Republican NRD to manage groundwater and help the State maintain compliance with the Republican River Compact.

3.1.2 *Educate civic leaders and the public on implementation efforts within the Basin*

NeDNR and the Republican Basin NRDs participated in education and outreach about plan implementation efforts in 2020. The basin-wide plan identifies some examples of potential outreach topics related to this objective such as efficiency improvements, the NRDs' allocation systems and resulting successes, other management activities and successes, factors that have contributed to streamflow reduction in the Basin, variations in groundwater management that reflect natural wet/dry cycles, realistic expectations for outcomes of projects and policy changes. The following paragraphs provide specific examples of 2020 education and outreach activities related to implementation efforts within the basin.

NeDNR hosts a website about the Republican River Basin-Wide Plan, http://rrbwp.nebraska.gov. The website is a tool for conveying information about basin-wide plan implementation and includes background information about the plan and plan implementation resources such as data, annual meeting materials, and annual reports. Plan development meeting materials are also available on the website.

Upper Republican NRD described augmentation and other water management programs to members of the Legislature's Natural Resources Committee and University of Nebraska officials. Locally, the NRD shared information about Compact compliance forecasts by posting information on the district's website. Upper Republican NRD also helped publicize efforts by Southwest Weed Management District to control invasive species in stream corridors throughout the Basin.

Lower Republican NRD co-hosts the South-Central Nebraska Water Conference with Tri-Basin NRD and the Central Nebraska Public Power and Irrigation District to inform the public on the happenings of the water world within South Central Nebraska. NeDNR hosted

Symbol Legend – See Figure 8 on page 30

a booth at this conference. All four NRDs produce newsletters for the public containing information about their activities, including water management activities in the Republican Basin. Lower Republican NRD also provides articles and radio publications on a regular basis to keep constituents informed.

Each fall, NeDNR publishes an annual report to the Governor and Legislature, entitled Annual Report and Plan of Work for the State Water Planning and Review Process. The report includes a section summarizing activities in the Republican River Basin for the prior fiscal year, as well as a four-year work projection for the basin. The report is available on NeDNR's website, *https://dnr.nebraska.gov*. NeDNR also annually submits a report to the Legislature each fall summarizing WRCF expenditures and accomplishments. Many of the projects described in the report are in the Republican River Basin.

Very few in-person outreach events occurred in 2020 due to the COVID-19 pandemic, so there were few opportunities in 2020 for face-to-face outreach about these topics.

3.1.3 *Educate civic leaders and the public about the policies and institutional infrastructure that contribute to the development and implementation of solutions*

NeDNR and the Republican Basin NRDs participated in education and outreach about policies and institutional infrastructure in 2020. The basin-wide plan identifies some examples of potential outreach topics related to this objective as correlative groundwater rights; integrated management plans; the *Republican River Basin-Wide Plan*; the Republican River Compact; other aspects of Nebraska's surface water and groundwater statutes; and other NRD rules, regulations, and plans. The following paragraphs provide specific examples of 2020 education and outreach activities related to the policies and institutional infrastructure that contribute to the development and implementation of solutions.

The NRDs and NeDNR communicate regularly with their legislative representatives and other state senators, as needed. They work to educate civic leaders and the public about the policies and institutional infrastructure that contribute to the development and implementation of solutions, through public outreach such as articles, conferences, and radio news briefs. All four NRDs produce newsletters for the public containing information about their activities, some of which included articles about policies and institutional infrastructure in 2020. In addition, Lower Republican NRD provides education and outreach with conferences and radio news briefs.

NeDNR and colleagues from Kansas and Colorado maintain a website with information about the Republican River Compact (*http://republicanriver.org/*), which includes background information about the Republican River Compact Administration (RRCA), annual reports, and other RRCA meeting materials. Upper Republican NRD website is updated with Compact developments and provides a layman's explanation of the Compact and compliance efforts. Both Upper Republican NRD and NeDNR's websites include links

Symbol Legend – See Figure 8 on page 30

to the Compact, the Final Settlement Stipulation, and other important Compact-related documents.

NeDNR and the NRDs also addressed these topics in 2020 at some of the other outreach events described under action item 3.1.2. Very few in-person outreach events occurred in 2020 due to the COVID-19 pandemic, so there were few opportunities in 2020 for face-to-face outreach about these topics.

3.1.4 *Propose and support changes to laws, policies, and rules that would incentivize reduced water consumption*

N/A

In 2020 there were no proposed changes to laws, policies, and rules that would incentivize reduced water consumption within the Basin. NeDNR and the Republican River Basin NRDs are committed to evaluating all proposals that offer incentives to reduce groundwater use, with the intention of supporting any changes that do not reduce the economic vitality of the region in accordance with the mission of the Basin-Wide Plan.

Obj. 3.2 Improve information sharing with water users who are reliant on the Basin's water supplies

3.2.1 *Share data and information related to the Republican River Compact with the public in an easily accessible, user-friendly format*

All four NRDs and NeDNR exchange water use and groundwater level data annually for Republican River Compact Administration (RRCA) accounting purposes. RRCA annual reports and final RRCA accounting data are available at *http://republicanriver.org/*, and RRCA groundwater model information is available at the RRCA's data site, *https://www.republicanrivercompact.org/*. Information about the Republican River Compact is also available on NeDNR's website and Upper Republican NRD's website. Some RRCA data are also available on NeDNR's INSIGHT (Integrated Network of Scientific Information & GeoHydrologic Tools) website (*http://nednr.nebraska.gov/INSIGHT/*).

NeDNR and the NRDs have worked to make some data from the RRCA annual accounting and groundwater model more easily accessible and user-friendly by including data from these sources each year in the basin-wide plan annual report. In 2020, NeDNR also added some accounting data to the basin-wide plan webpage for the first time (*https://rrbwp.nebraska.gov*), and NeDNR will continue to work to improve the availability and format of RRCA data on this website.

3.2.2 *Annually prepare and exchange reports containing data and information about water supplies and uses in the Basin, and make these reports publicly accessible*

All four NRDs and NeDNR share data and information about water supplies and uses in the basin as part of the annual report for the basin-wide plan. This information is shared with the public at the basin-wide plan's annual meeting and through the *Republican River*

Symbol Legend – See Figure 8 on page 30

Basin-Wide Plan website (*http://rrbwp.nebraska.gov*). NeDNR and the NRDs published the first and second annual reports in 2020. Both reports were first presented at the annual meeting (February 2020 and November 2020, respectively) and then published on the basin-wide plan website.

Lower Republican NRD also supports gathering information such as groundwater measurements with the United States Geological Survey and Nebraska Conservation and Survey Division. Information is publicized in annual reports. Lower Republican NRD further provides relevant water balance information at the South-Central Nebraska Water Conference.

Tri-Basin NRD and NeDNR also exchange information about water supplies and uses annually in fulfillment of the IMP for the Republican Basin portion of Tri-Basin NRD. These reports can be downloaded from the NeDNR website (*https://dnr.nebraska.gov*).

3.2.3 *Regularly communicate with the Plan's former Stakeholder Advisory Committee about implementation progress and potential Plan revisions*

All four NRDs and NeDNR work to keep former Stakeholder Advisory Committee members informed about implementation progress and potential plan revisions. This information is primarily shared at the annual meeting for the basin-wide plan.

Information about plan implementation is also shared via email through a GovDelivery contact list for people interested in receiving updates about the basin-wide plan. All stakeholders from the plan development process were added to the list when it was created. One former stakeholder does not have an email account, so printed copies of updates posted to the GovDelivery list are mailed to that individual.

In 2020, NeDNR and Upper Republican NRD, Middle Republican NRD, and Lower Republican NRD worked together on updates to the Integrated Management Plans (IMPs) jointly developed by NeDNR and each of the three NRDs, including some changes related to ensuring consistency between the IMPs and basin-wide plan. The NRDs kept former basin-wide plan stakeholders informed about proposed IMP revisions and input from stakeholders was requested throughout the update process. Update efforts continued into 2021.

Notification about the Basin-wide Plan annual meetings is provided on website all of the NRD's and NeDNR, as well as the basin-wide plan website

3.2.4 *Encourage and support water users to share information about their management practice improvements with other water users and the public*

All four NRDs and NeDNR encourage and support water users to share information about their management practice improvements with other water users and the public. In 2020, Upper Republican NRD, Middle Republican NRD and Lower Republican NRD provided annual water usage data to UNL from wells within the District. UNL aggregates the data

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and shares it with neighboring landowners so they understand how their water usage compares to usage in the immediate area.

NeDNR and the NRDs also supported and participated in UNL's Testing Ag Performance Solutions (TAPS) program, an annual competition that provides teams from all over the state with an opportunity to learn from each other about irrigation water management practices and other aspects of crop production. A substantial portion of past TAPS award winners has been from the Republican River Basin. All of the NRD's have had district representation on TAPS teams who've won or placed in the top three of various categories across multiple TAPS competitions.

Information sharing about water user management practice improvements is a standing agenda item for the basin-wide plan annual meeting. At the first annual meeting, in February 2020, stakeholders were led in a discussion about ideas for how they would like to see this topic addressed at future meetings. They were asked whether they were aware of upcoming events that should be promoted and how NeDNR and the NRDs might be able to help promote those events. They were asked whether there was interest in doing a basin-wide water user peer-to-peer event. And they were asked for ideas about water users or programs that could be invited to speak at future annual meetings. The second annual meeting, in November 2020, took place as a virtual meeting due to the COVID-19 pandemic; therefore, this agenda item was kept brief, and no external speakers were invited to present about management practice improvements. Instead, NeDNR staff summarized the discussion from the previous year and asked whether anyone had new ideas about potential future speakers or topics to add to the previous year's suggestions.

Symbol Legend – See Figure 8 on page 30

Goal 4	**When possible, pursue projects that not only benefit water supplies and uses, but also create benefits for fish, wildlife, recreation and conveyance within the Republican River Basin**
Obj. 4.1	**Where feasible and beneficial, protect and enhance fish and wildlife habitat and public outdoor recreational opportunities**

4.1.1 *Partner with wildlife-focused organizations on projects that benefit the organizations' habitat and wildlife interests while also helping to fulfill other goals of this Plan*

The Republican Basin NRDs continued to partner with wildlife-focused organizations on projects to benefit habitat and wildlife interests in the Basin in 2020. Upper Republican NRD has opened approximately 2,500 acres it owns near the Rock Creek Augmentation project in Dundy County to public hunting and manages the property to successfully re-establish native grass on formerly irrigated cropland. Lower Republican NRD continues to support Nebraska Game and Parks Commission (NGPC) through the lease of office space. Lower Republican NRD provides cost sharing on corners for wildlife. The NRDs also provide support to the Twin Valley Weed Management and Southwest Weed Management Districts for the removal of invasive vegetation throughout the Basin, as described under Action Items 4.1.3 and 4.2.1.

4.1.2 *Promote public recreation on the river, when doing so can also help to fulfill other goals of the Plan*

Lower Republican NRD supports NGPC through lease of office space. Through the Lower Republican NRD office, the NGPC provides public information regarding public recreation on the River and open lands within the Basin.

4.1.3 *Cooperate in projects to assess and restore riparian wetlands while also helping to fulfill other goals of the Plan*

The NRDs provide financial support to weed management districts for the removal of invasive vegetation and noxious weeds throughout the Basin, including for restoration of riparian wetlands. Upper Republican NRD and Middle Republican NRD financially support the Southwest Weed Management District. Lower Republican NRD and Tri-Basin NRD financially support the Twin Valley Weed Management District. The NRDs have also worked with the weed management districts on projects across the basin to restore riparian areas.

Upper Republican NRD has a representative on the board of the Southwest Weed Management District and has been actively involved in the weed district's activities. SWMD utilizes grants to cost-share the removal of invasive species such as Russian olive and Eastern red cedar trees in stream corridors and in 2020 worked in multiple locations

Symbol Legend – See Figure 8 on page 30

across the Basin. In 2020, Upper Republican NRD provided $5,000 to aid SWMD's operations.

Through Lower Republican NRD's financial support of the Twin Valley Weed Management district which eradicates invasive and noxious weeds along the Republican River, both native and desirable species are provided restoration opportunity to succeed as riparian wetlands rather than forested, shrubbed, or palustrine wetlands.

Obj. 4.2 Where feasible and beneficial, reduce the effects of undesirable vegetation on water conveyance

4.2.1 *Cooperate in removing undesirable vegetation impacting water conveyance and managing reinfestation*

As described under Action Item 4.1.3, the NRDs provide financial support to the Southwest and Twin Valley Weed management districts for the removal of invasive vegetation and noxious weeds throughout the Basin. Upper Republican NRD has a representative on the board of the Southwest Weed Management District and has been actively involved in the weed district's activities. SWMD utilizes grants to cost-share the removal of invasive species such as Russian olive and Eastern red cedar trees in stream corridors and in 2020 worked in multiple locations across the Basin. In 2020, Upper Republican NRD provided $5,000 to aid SWMD's operations. Lower Republican NRD financially supports the Twin Valley Weed Management district which eradicates invasive and noxious weeds in the Republican River Basin.

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Assessment of Measurable Hydrologic Objectives (MHOs)

Under *Neb. Rev. Stat.* § 46-755 (4)(b), this basin-wide plan is required to include measurable hydrologic objectives (MHOs) to ensure that reasonable progress is being made toward achieving the goals and objectives of the plan. The basin-wide plan includes five MHOs, which will each be evaluated either annually or every five years, as specified in the basin-wide plan. The MHOs and their assessment schedules are summarized in Table 24. Results of the MHO evaluations are described beginning on page 60.

In the table summarizing the results of each MHO, possible results of the assessment are described, including whether the results indicate that further discussion is required or not. If a result indicates that discussion of next steps is required, this means that NeDNR and the NRDs will discuss the test results and determine what actions will be taken to achieve the MHO in the future, as described in the basin-wide plan.

Table 24. Measurable Hydrologic Objectives (MHOs) agreed to during plan development and adoption. During plan implementation, each MHO is to be evaluated either annually or every 5 years, as specified in the basin-wide plan.

Measurable Hydrologic Objective (MHO)	Evaluation Frequency
MHO A: Maintain each NRD's net groundwater depletions to streamflow within its portion of Nebraska's allowable groundwater depletions to streamflow	Annually
MHO B: Limit groundwater depletions to streamflow to a relatively constant level over the long-term both across the basin as a whole and within each NRD	Every 5 years, beginning in 2023
MHO C: Ensure there is always enough groundwater for all groundwater uses within the timeframe of this plan, either by stabilizing groundwater levels or managing declining groundwater levels	Every 5 years, beginning in 2023
MHO D: Continue existing and initiate new actions that reduce the need for special regulations in the Rapid Response Area for Compact compliance	Annually
MHO E: Continue existing and initiate new actions that reduce the need for administration of surface water use for Compact compliance	Annually

MHO A Evaluation

MHO A Assessment Criteria

MHO A is to maintain each NRD's net groundwater depletions to streamflow within its portion of Nebraska's allowable depletions to streamflow. For the purposes of MHO A, "net groundwater depletions to streamflow" includes augmentation and other management actions.

The basin-wide plan defines the MHO A assessment as follows: for the previous Compact averaging period (2 or 5 years, as determined by Compact accounting procedures), has each NRD's net groundwater

depletions to streamflow for the RRCA model area remained within its portion of Nebraska's allowable groundwater depletions to streamflow, as specified in the IMPs? This MHO is being achieved if the answer to that question is yes for each NRD. The results of this assessment are described in the next subsection.

The MHO A assessment as described above applies only to Upper Republican, Middle Republican, and Lower Republican NRDs, because these are the three NRDs that receive a portion of Nebraska's allowable groundwater depletions to streamflow under the terms of their IMPs. The equivalent test from the IMP for the Republican Basin portion of Tri-Basin NRD is the hydrologically balanced assessment, which evaluates whether Tri-Basin NRD's depletions from groundwater pumping exceeded accretions from the groundwater mound caused by seepage from Platte River canals within in the district, when calculated on a three-year rolling average basis. The results from that analysis are included below, beginning on page 61.

MHO A Evaluation Results for 2020

MHO A evaluation results are summarized in Table 25. For 2020, MHO A is being achieved for Upper Republican, Middle Republican, and Lower Republican NRDs. Each NRD's groundwater net depletions to streamflow remained within its portion of Nebraska's allowable depletions to streamflow, as specified in the IMPs. The evaluation and results for each NRD are described below the summary table.

Table 25. Summary of MHO A results for 2020.

Key to Possible Test Results	 MHO is being achieved. NRD's actual depletions were within its allowable depletions. No further discussion is needed.  MHO is not being achieved. NRD's actual depletions exceeded its allowable depletions. Discussion of next steps is required.		
NRD	**Upper Republican**	**Middle Republican**	**Lower Republican**
NRD's Results for 2020			

According to the Compact accounting procedures, the averaging period applicable to 2020 is five-year averaging.

Allowable groundwater depletions to streamflow for each NRD are defined in the *Monitoring & Studies Technical Memorandum for the URNRD, MRNRD, and LRNRD IMPs*. Each NRD's groundwater depletions to streamflow is calculated using the RRCA groundwater model. An NRD's net depletions are the sum of groundwater depletions and the impacts to Nebraska's Compact balance from management actions taken.

Altogether, the difference between an NRD's allowable groundwater depletions to streamflow and the NRD's groundwater net depletions to streamflow is equivalent to the sum of the NRD's annual balances over the appropriate averaging period where an annual balance is calculated as:

*(Nebraska Allocation + Nebraska Credits – $SWCBCU_{NE}$ – Other NRD CBCU – All NRD Management Actions) * NRD's Applicable Baseline Depletion Percentage – NRD GwCBCU + NRD Management Actions*

The results of the five-year average evaluation for MHO A for 2020 for each NRD are shown in Table 26. Two-year averaging was not evaluated this year as part of MHO A because, under RRCA Accounting Procedures, two-year averaging does not apply for 2020.

Table 26. MHO A evaluation results for 2020, with five-year averaging. Positive values indicate that allowable groundwater depletions to streamflow exceeded actual groundwater net depletions to streamflow. The five-year averaging period for MHO A is evaluated based on the average of the evaluation year (2020) and the previous four years, in conformance with RRCA Accounting Procedures.

	Difference between allowable depletions an actual groundwater net depletions (acre-feet)		
Year	**Lower Republican NRD**	**Middle Republican NRD**	**Upper Republican NRD**
2016	8,676	9,724	5,175
2017	3,862	14,687	17,291
2018	540	-1,919	2,922
2019	40,262	46,951	65,758
2020	14,844	28,487	26,355
5-year average (2016–2020)	**13,637**	**19,586**	**23,496**
5-year average positive?	**Yes**	**Yes**	**Yes**

Tri-Basin NRD Hydrologically Balanced Assessment Results for 2020

The hydrologically balanced assessment from the IMP for the Republican Basin portion of Tri-Basin NRD evaluates whether Tri-Basin NRD's depletions from groundwater pumping and accretions from the mound are hydrologically balanced when calculated on a three-year rolling average basis. This assessment is performed by NeDNR each fall, following finalization of RRCA data for the prior calendar year.

Hydrologically balanced assessment results for 2020 are summarized in Table 27. The analysis and results are explained below the summary table.

Table 27. Summary of results of hydrologically balanced assessment for Tri-Basin NRD for 2020.

Key to Possible Test Results	In compliance with IMP. On a three-year rolling average basis, depletions from groundwater pumping did not exceed accretions from the mound. Also, sufficient management actions were taken in 2020 to offset net depletions from previous year's test, if any. No further discussion is needed. Caution. On a three-year rolling average basis, depletions from groundwater pumping exceeded accretions from the mound. Under the terms of the IMP, management actions are required to maintain a hydrologically balanced condition. Discussion of next steps is required. Insufficient management actions were taken in 2020 to offset net depletions from previous year's assessment. Discussion of next steps is required.
Tri-Basin NRD's Results for 2020	

Full details of the hydrologically balanced assessment for 2020 are included in NeDNR's report for the IMP for the Republican Basin portion of Tri-Basin NRD, entitled *2021 Annual Report of 2020 Data by the Nebraska Department of Natural Resources to Meet the Requirements of the Integrated Management Plan for Those Portions of the Tri-Basin Natural Resources District within the Republican River Basin* (September 29, 2021). The three-year average net effect is positive for 2020 (Figure 12), meaning that mound accretions exceeded groundwater depletions from pumping on a three-year average basis; therefore, no offsets are required in the future as a result of the 2020 test. In addition, no management actions were required to be taken by Tri-Basin NRD in 2020 to offset the results of a previous year's test.

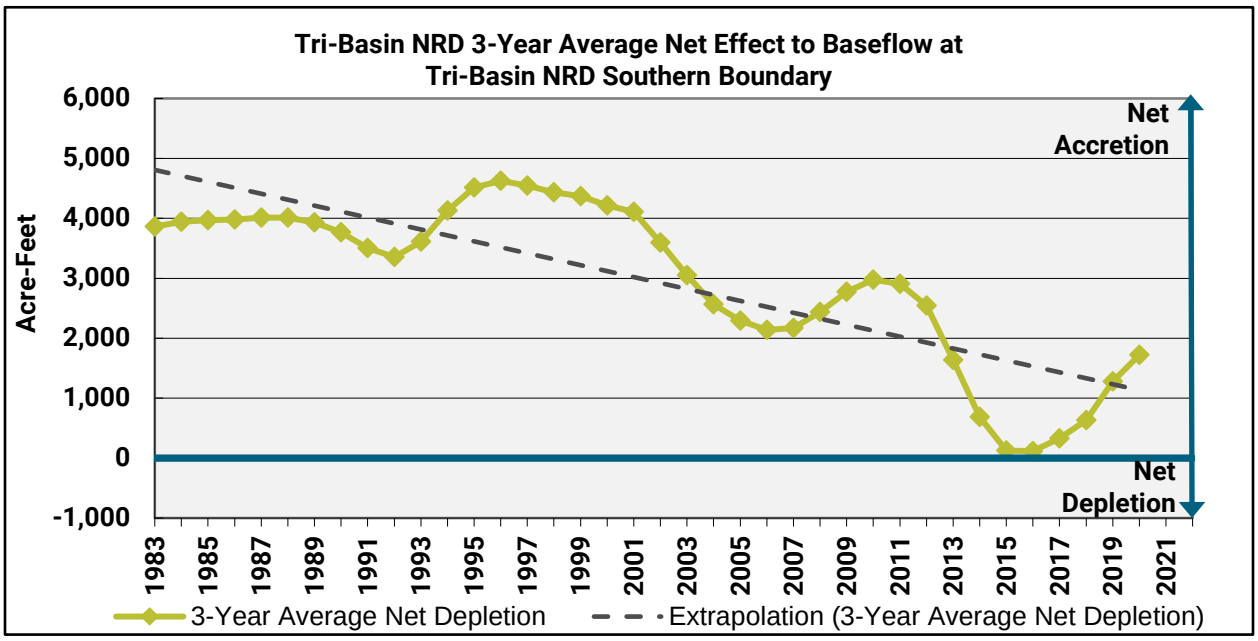


Figure 12. Rolling three-year average net effect to baseflow as the total of modeled values of streamflow depletion and mound accretions, using the August 2020 RRCA Accounting Procedures and the RRCA groundwater model.

MHO B Evaluation

MHO B is evaluated every five years as part of the basin-wide plan's five-year technical review. No MHO B evaluation is required this year.

MHO C Evaluation

MHO C is evaluated every five years as part of the basin-wide plan's five-year technical review. No MHO C evaluation is required this year.

MHO D Evaluation

MHO D Assessment Criteria

MHO D is to continue existing and initiate new actions that reduce the need for special regulations in the Rapid Response Area for Compact compliance.

The basin-wide plan defines the MHO D assessment as follows: during the previous year, has groundwater pumping within the Rapid Response Area of any NRD been curtailed to ensure Compact compliance? This MHO is being achieved if the answer to that question is no for each NRD. The results of this assessment are described in the next subsection.

Note that this assessment only applies to Upper Republican, Middle Republican, and Lower Republican NRDs. The IMPs for those NRDs state that in Compact Call Years, if management actions taken by the NRD are insufficient to ensure compliance, the NRD will implement additional ground water controls and regulations to make up for any expected shortfall, which will include curtailment of groundwater pumping

within the Rapid Response Area (10 Percent/5-Year Area) of the NRD. The purpose of this MHO is to ascertain whether such curtailment occurred.

MHO D Evaluation Results for 2020

MHO D evaluation results are summarized in Table 28. For 2020, MHO D is being achieved for Upper Republican, Middle Republican, and Lower Republican NRDs, as none of the NRDs curtailed pumping within the Rapid Response Area in 2020 to ensure Compact Compliance.

Table 28. Summary of MHO D results for 2020.

Key to Possible Test Results	MHO is being achieved. NRD did not curtail groundwater pumping within the Rapid Response Area to ensure Compact compliance. No further discussion needed. MHO is not being achieved. NRD curtailed groundwater pumping within the Rapid Response Area to ensure Compact Compliance. Discussion of next steps is required.		
NRD	**Upper Republican**	**Middle Republican**	**Lower Republican**
NRD's Results for 2020			

MHO E Evaluation

MHO E Assessment Criteria

MHO E is to continue existing and initiate new actions that reduce the need for administration of surface water use for Compact compliance.

The basin-wide plan defines the MHO E assessment as follows: During the previous year, has surface water use within the basin been administered to reduce surface water use to ensure Compact compliance? This MHO is being achieved if the answer to that question is no. The results of this assessment are described in the next subsection.

Note that for the purposes of MHO E, only surface water administration that occurs to fulfill Nebraska's Compact obligations as described in the IMPs for Upper Republican, Middle Republican, and Lower Republican NRDs is included. Surface water administration that is required by the terms of the Final Settlement Stipulation (FSS) is excluded from MHO E. For more information, see "Surface Water Administration for Compact Compliance," page 25.

MHO E Evaluation Results for 2020

MHO E evaluation results are summarized in Table 29. For 2020, MHO E is being achieved, as surface water use within the basin has not been administered for Compact Compliance. For further details, see "Surface Water Administration for Compact Compliance," page 25.

Table 29. Summary of MHO E results for 2020.

Key to Possible Test Results	MHO is being achieved. NeDNR did not administer surface water to ensure Compact compliance, except as required under the Final Settlement Stipulation (FSS). No further discussion needed. MHO is not being achieved. NeDNR administered surface water to ensure Compact Compliance. Discussion of next steps is required.
Results for 2020	

Attachment D, Drought Planning Presentation

Republican River Drought Scenario Exercise

Republican River Basin-Wide Plan Annual Meeting
11/15/2020

Andy Pedley, Environmental Specialist, NeDNR

NEBRASKA
Good Life. Great Water.
DEPT. OF NATURAL RESOURCES

Basin-Wide Plan Goals and Objectives

- **Action Item 2.8.1:** Organize and participate in a basin-wide drought planning exercise
  - Increasing understanding of the needs for and logistics of storing water for use during a drought
  - Evaluating existing and potential new management actions to determine the long-term availability trends that provide carry-over storage to meet crop-water needs during drought
  - Developing metrics that could be used to evaluate whether conservation of water for future use during a drought is successful.

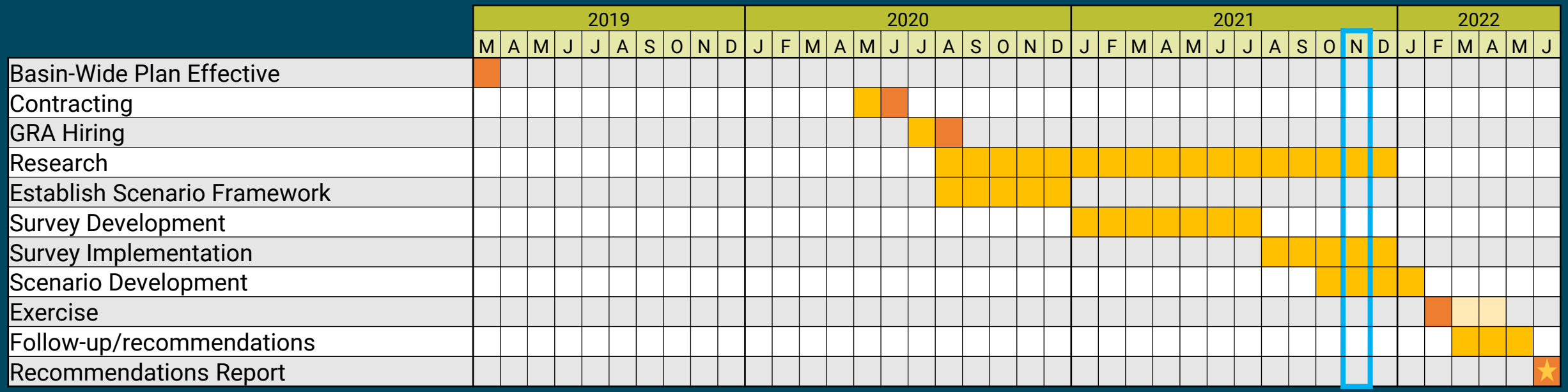
- **Action Item 2.8.2:** Following the drought planning exercise evaluate whether to recommend any changes to the IMPs or this Plan related to conservation of water for future use during a drought.

- **Any recommended changes will need to be addressed as part of the 5yr technical analysis.**

Partners

- Republican River Basin NRDs
  - URNRD, MRNRD, LRNRD, TBNRD
- Nebraska Department of Natural Resources
- National Drought Mitigation Center
  - Graduate Research Assistant, Andrew Mwape

Project Timeline



2020-2021 Progress

- Exercise Framework
  - Hybrid workshop/tabletop exercise
    - Workshop: Identify and prioritize uncertainties in water resource planning
    - Tabletop: Review existing planning documents and apply them to hypothetical scenarios
      - Basin-Wide Plan
      - IMPs
      - Republican River Compact
      - NRD documents
        - Rules & Regulations
        - Groundwater Management Plans

- Drought Impacts Survey
  - Developed Spring/Summer 2021
  - Distributed Fall 2021 (Through 11/30/21)
    - NRDs
    - Municipal water
    - Emergency management
    - NeDNR social media
    - Basin-Wide Plan mailing list
  - https://go.unl.edu/rrbdimpacts

- Scenario Development
  - Currently ongoing

Moving Forward

- December 2021 / January 2022
  - Develop scenarios using Basin-Wide forecasting methods
    - Based on historical data
      - 2012 drought (“flash drought” characteristics)
      - “Dust Bowl” (extended drought)
  - Schedule exercise
  - Identify and invite participants
    - NRDs
    - NeDNR (Surface Water)
    - Irrigation Districts
    - Municipal Water
    - Emergency Management
    - Producers
- February – April 2022
  - Drought Planning Exercise
    - One day event
      - 3-hour morning session
      - Working lunch
      - 3-hour afternoon session
    - Areas of Focus
      - Potential for water storage
      - Communication between water users and regulatory agencies
      - Identify gaps or deficiencies in existing management tools
      - Identify potential points of conflict
- After Exercise – June 2022
  - Exercise recap and recommendations report

NEBRASKA

Good Life. Great Water.

DEPT. OF NATURAL RESOURCES

THANK YOU

Andy Pedley

Environmental Specialist, Water Planning Division NeDNR

Attachment E, Expanding the Parallel 41 Flux Network in the Republican River Basin Presentation

Expanding the Parallel 41 Flux Network in the Republican River Basin to Support Real-time Evapotranspiration Estimates for Irrigation Water Management and Water Balance Estimates

Christopher M. U. Neale
Director of Research
Babak Safa, Ashish Masih, Jessica Garcia Nascimento, Dayle McDermitt
Daugherty Water for Food Global Institute
University of Nebraska

Water for Food
DAUGHERTY GLOBAL INSTITUTE
at the University of Nebraska

Parallel 41 Flux Network Concept

- A network of Eddy Covariance Flux towers to provide real-time energy balance fluxes and evapotranspiration of different crops and vegetated surfaces, to be used for water balance and crop water productivity estimates in different watersheds and agricultural systems.
- Provide real-time crop actual evapotranspiration for irrigation water management to farmers and water managers
- Use the data for improving the accuracy of spatially distributed satellite-based estimates of evapotranspiration

Parallel 41 Flux Network

- DWFI is leveraging funding from FFAR through the Irrigation Innovation Consortium (IIC), in-kind support from LiCOR, and project grant funds and equipment from The Climate Corporation (TCC) to expand the Parallel 41 Flux Network.
  - Equipment for networking 6 Stations was acquired through IIC
  - 1 Station at Grant NE in partnership with URNRD
  - TCC has donated 5 additional stations in 2020, 1 was set up in URNRD in HUC-12, 1 installed in Holbrook in LRNRD and third will be installed in MRNRD. Location has been determined

https://parallel41.nebraska.edu/#/

FFAR

IRRIGATION INNOVATION CONSORTIUM

THE CLIMATE CORPORATION

LI-COR

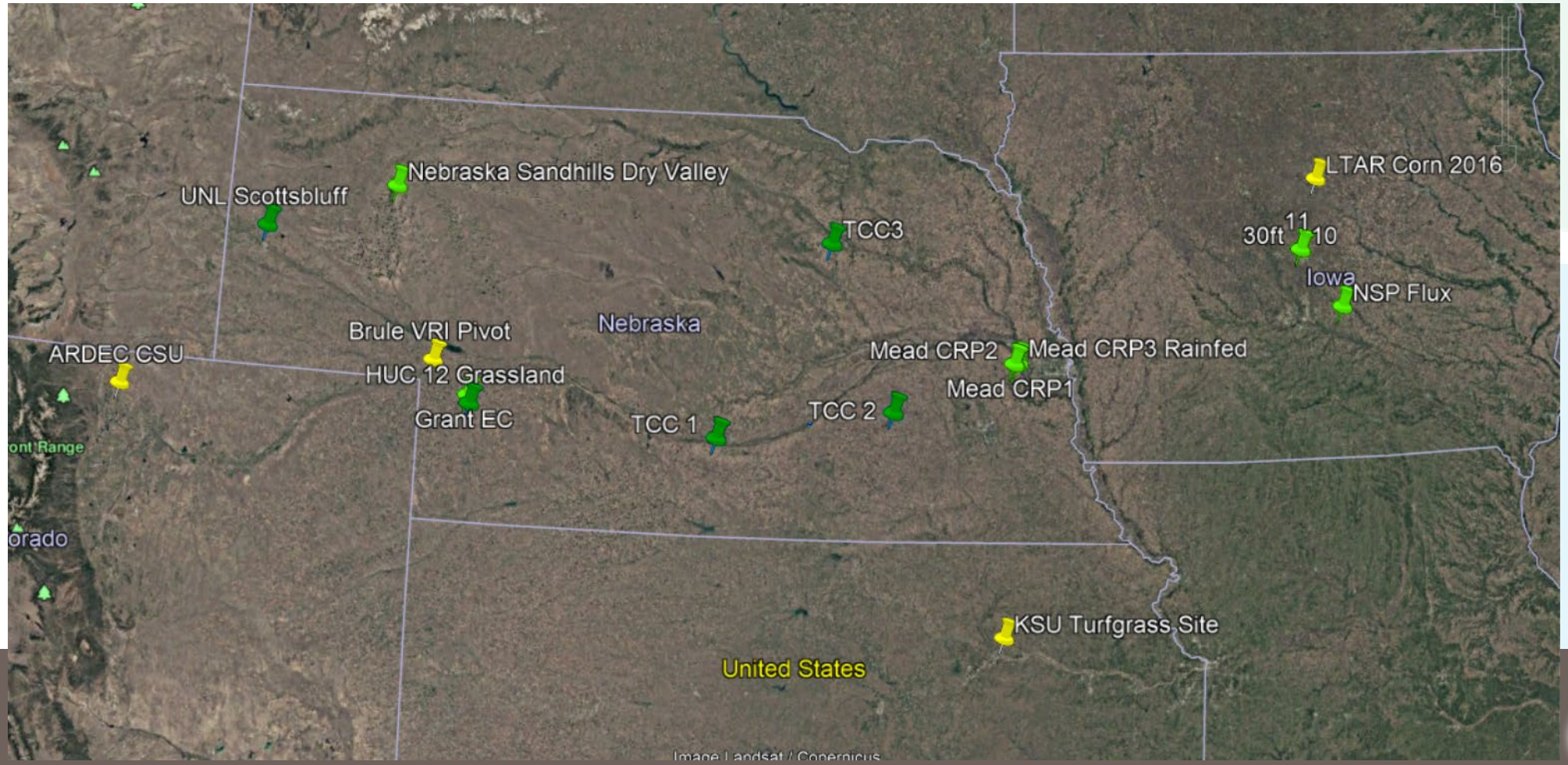
UPPER REPUBLICAN NRD

NEBRASKA WATER BALANCE ALLIANCE

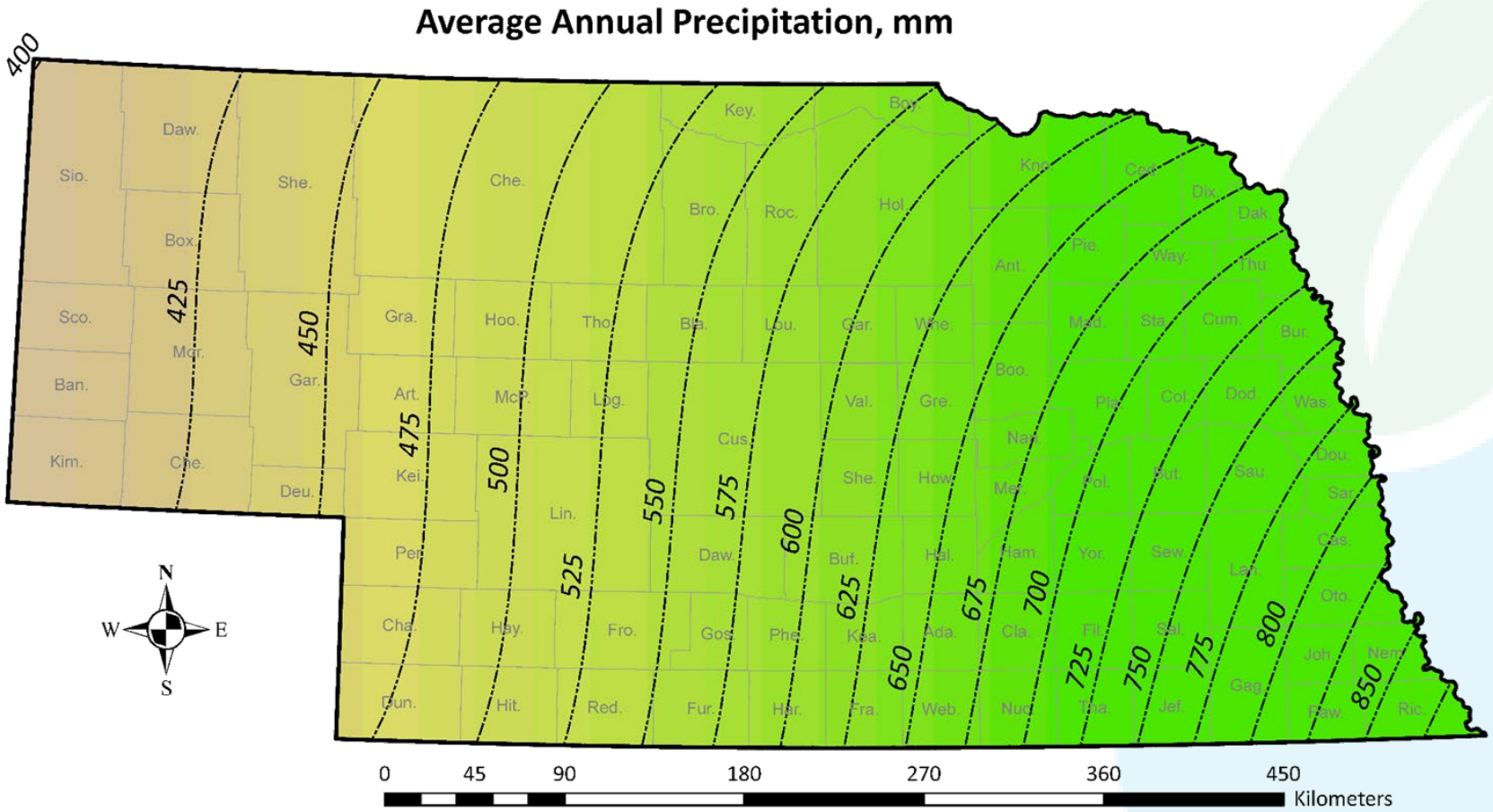
USDA

Parallel 41 Flux Network: Real Time Crop Evapotranspiration

- Year 1: 7 Eddy Covariance Flux stations with **SmartFlux** and networked with **FluxSuite**: 5 in NE, 2 in IA
- Year 2: 3 stations: 1 NE, 1 IA, 1 KS, 1 CO
- Year 3 & 4: 5 additional stations from The Climate Corporation, location to be determined



Precipitation is the Ultimate Water Source



Average Annual Precipitation Increases at About 75 mm per 100 km from West to East

Parallel 41 Flux Network Details

- The Eddy Covariance Flux towers are equipped with the LiCOR SmartFlux system, that runs EddyPro in real time and conducts all the necessary corrections to the time-series data.
- Towers are networked together with FluxSuite software, through cell phone modems, allowing for real-time quality control of data and to provide estimates of ET
- Public access through the Parallel 41 website.
- Present crops being monitored:

IA: Rainfed corn/soybean rotation

NE: Irrigated and rainfed corn/soybean rotation (east), natural short grass prairie, irrigated corn (central and west)

KS: turfgrass, sorghum

CO: TBD

FLUXSUITE | Map | Stations | Welcome, George Burba | Setup | Support | Logout

Grant NE 01 Station Info

All Stations | Dashboard | Information | Manage Alerts

Name: Grant NE 01

Abbreviation: NE01

Institute:

Location: Grant, NE

Latitude/Longitude:
40.793°, -101.624°

Ecosystem:
irrigated field corn

Elevation: 1026.8 m

Generate Station Key | Deactivate Station

Station Notebook

Show 10 entries | add entry

Search:

Note	Author	Timestamp
No data available in table		

Showing 0 to 0 of 0 entries

Instruments

Posted At: 2018-10-18 10:40:06 (UTC)

Company	Model	Serial Number	Software Version	Details
LI-COR	LI-7550	smart3-00184	8.8.15	
LI-COR	LI-7500A	75D-4088	8.8.15	
gill	hs_50	Y122708	2329-114-01	
Sutron	9210B	1106494	3.22.0.19	
LI-COR	SMARTFlux2	smart3-00184	2.2.16	

FLUXSUITE | Map | Stations | Welcome, George Burba | Setup | Support | Logout

Grant NE 01

Broadcasting Information

All Stations | Dashboard | Information | Manage Alerts

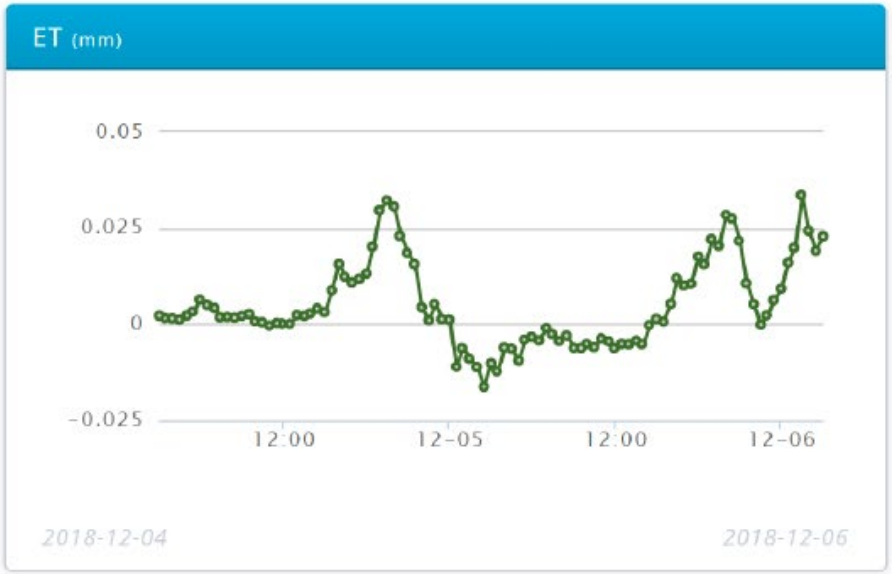
Communications

Storage

Biomet | LI-7500RS | SmartFlux2 | Anemometer

13 errors and 195 warnings in the last 7 days.

Detail View | Chart Order | Download Summary Report | QA/QC



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All Stations | Dashboard | Information | Manage Alerts

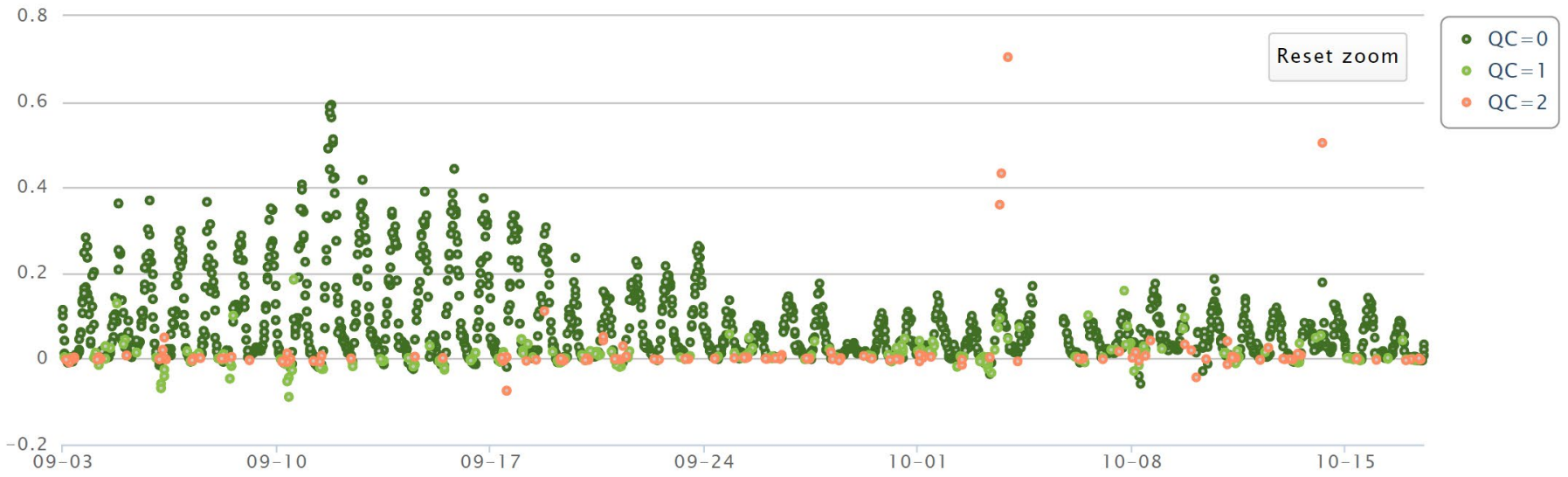
ET (mm)

Field: ET

Start Date: 2018-09-03

End Date: 2018-10-18

QA/QC



ET

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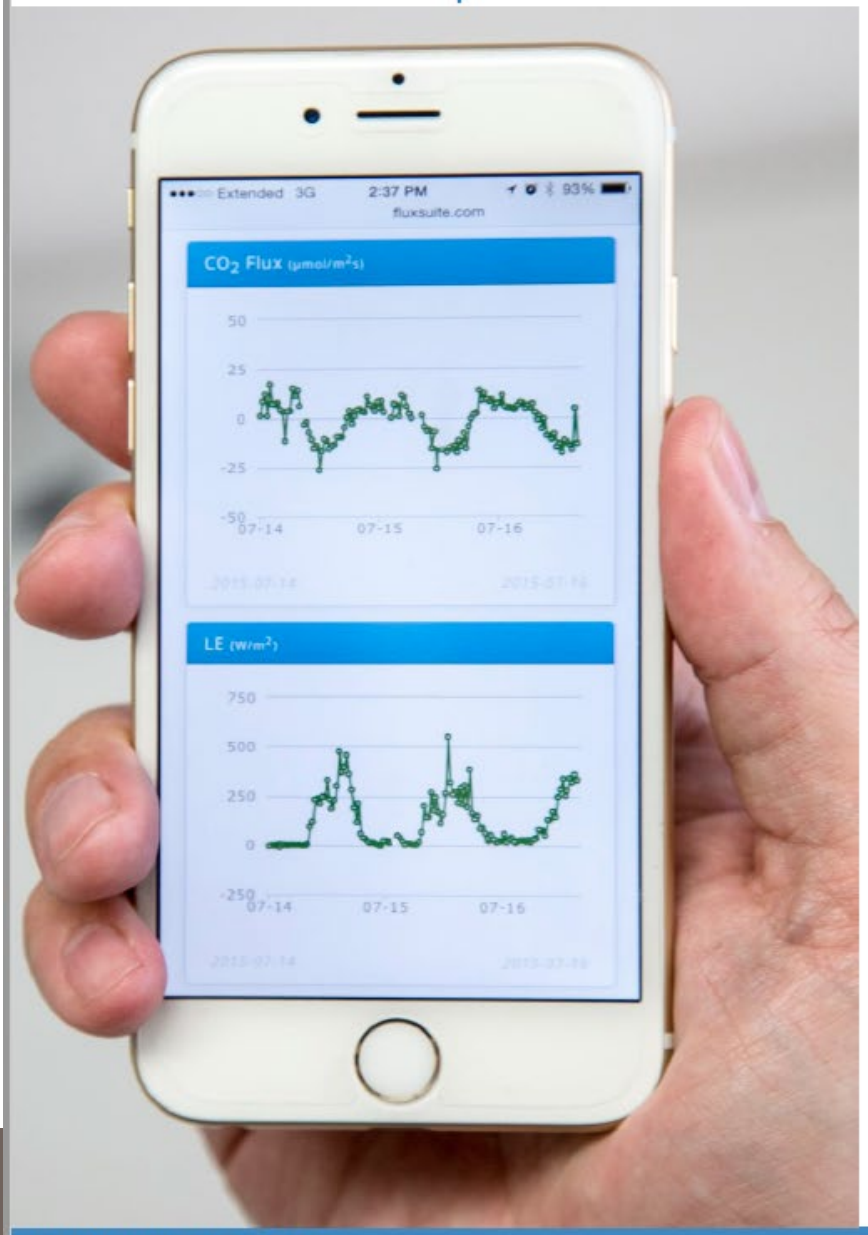
at the University of Nebraska

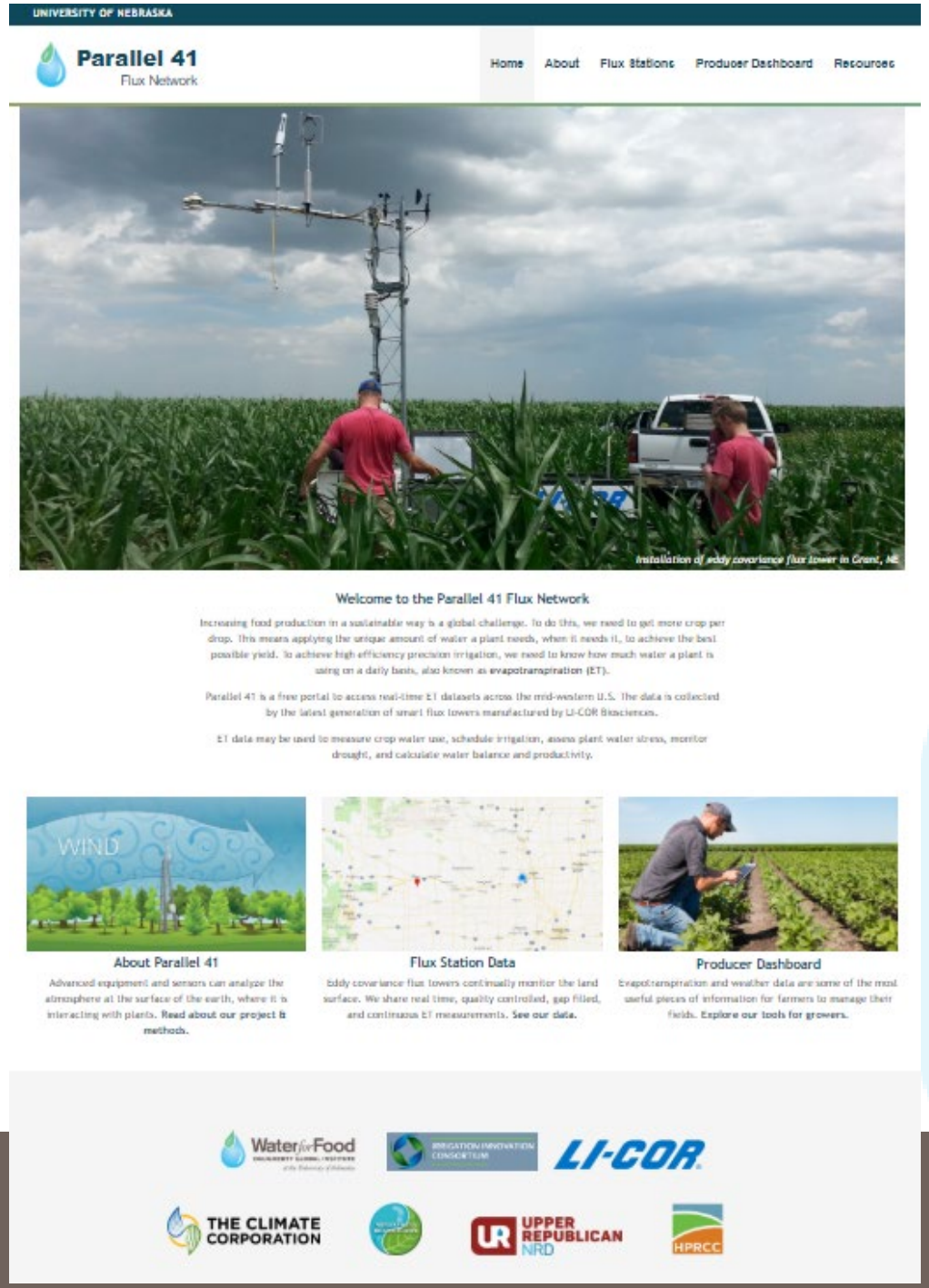
Station snapshot



Flux details

Quality-controlled fluxes

https://parallel41.nebraska.edu/#/

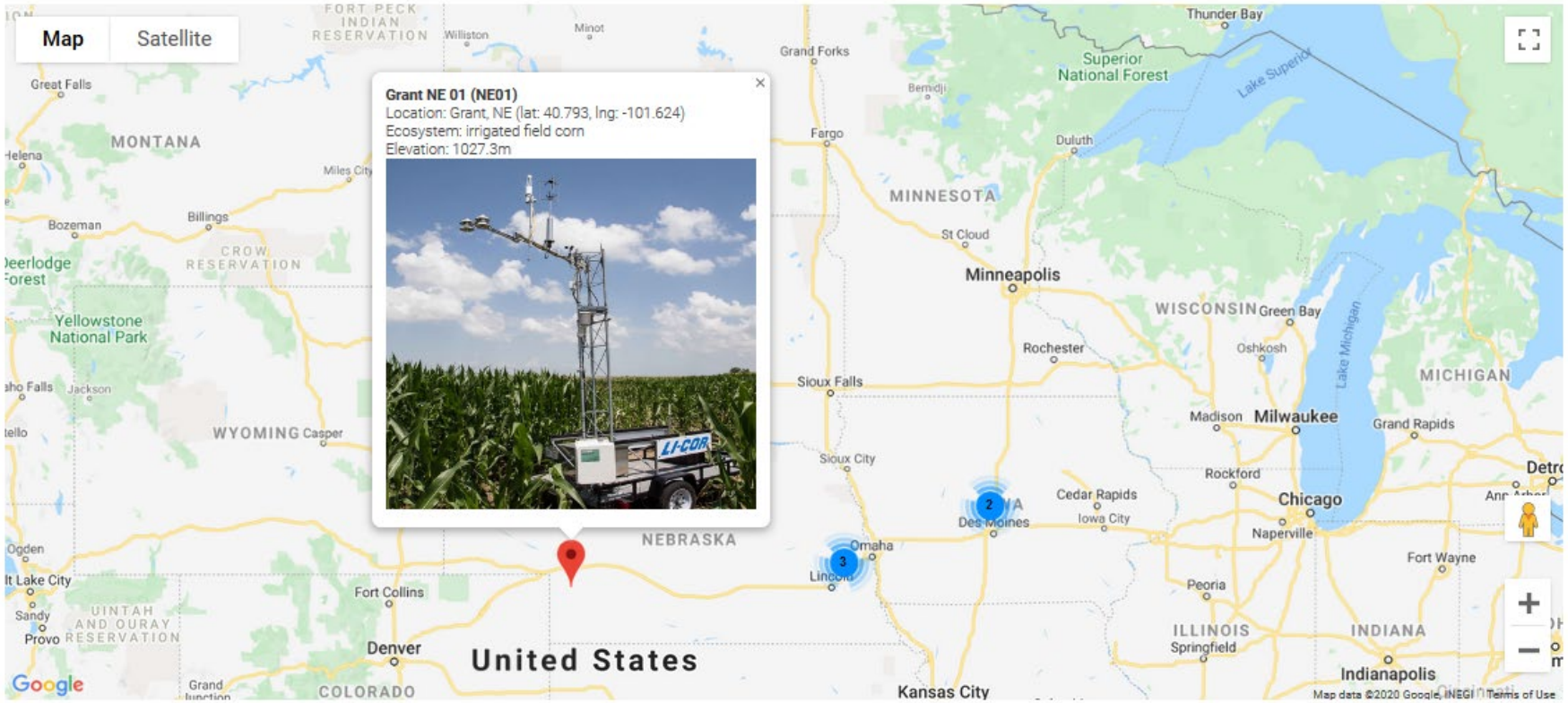


Parallel 41
Flux Network

Home | About | Flux Stations | Producer Dashboard | Resources

Get Started

Pins on the map represent flux station locations. Click a point to view data. Data and graphs will appear below the map.



Lincoln to Grant:
480 Km

https://parallel41.nebraska.edu/#/map-data

Grant NE 01

Date	2019-07-31
ET Units	mm / inches
Daily Measured ET (ETc) Value	0.16 inches

ETc of Previous 7 Days	2019-07-25	2019-07-26	2019-07-27	2019-07-28	2019-07-29	2019-07-30	2019-07-31
	0.22	0.23	0.21	0.24	0.24	0.21	0.16

Grant, NE

University of Nebraska

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Wind Rose (Grant,NE)
Legend
> 7
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
Grant
N40°47'42"
W101°37'30"
Grant
Road 333
Google Earth
N
2000 ft

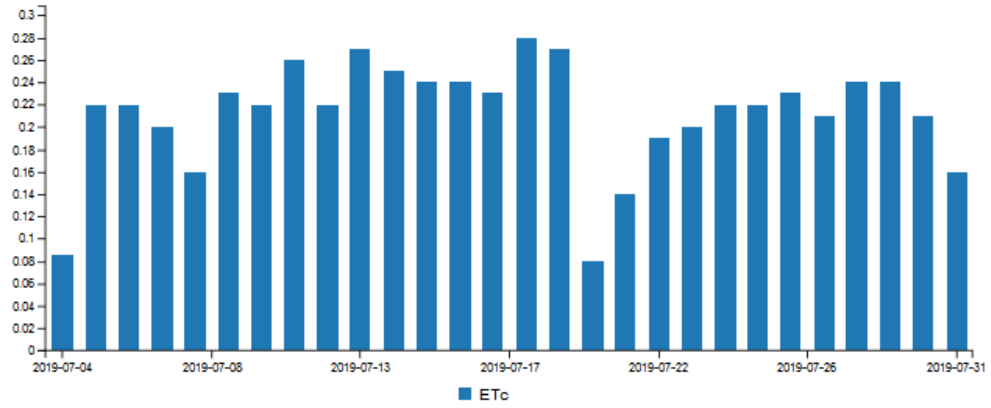
Grant NE 01

Date	2019-07-31
ET Units	mm / inches
Daily Measured ET (ETc) Value	0.16 inches

ETc of Previous 7 Days

2019-07-25	2019-07-26	2019-07-27	2019-07-28	2019-07-29	2019-07-30	2019-07-31
0.22	0.23	0.21	0.24	0.24	0.21	0.16

Graph of Daily ETc Values for Date Selected and Previous 28 Days

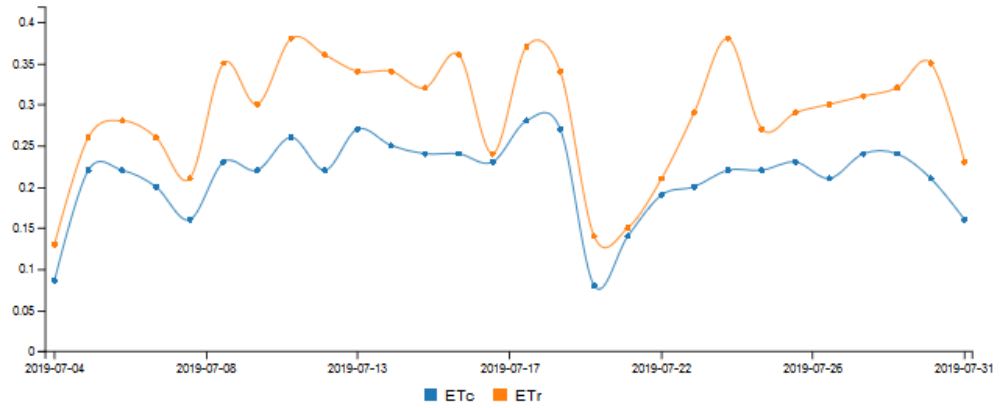


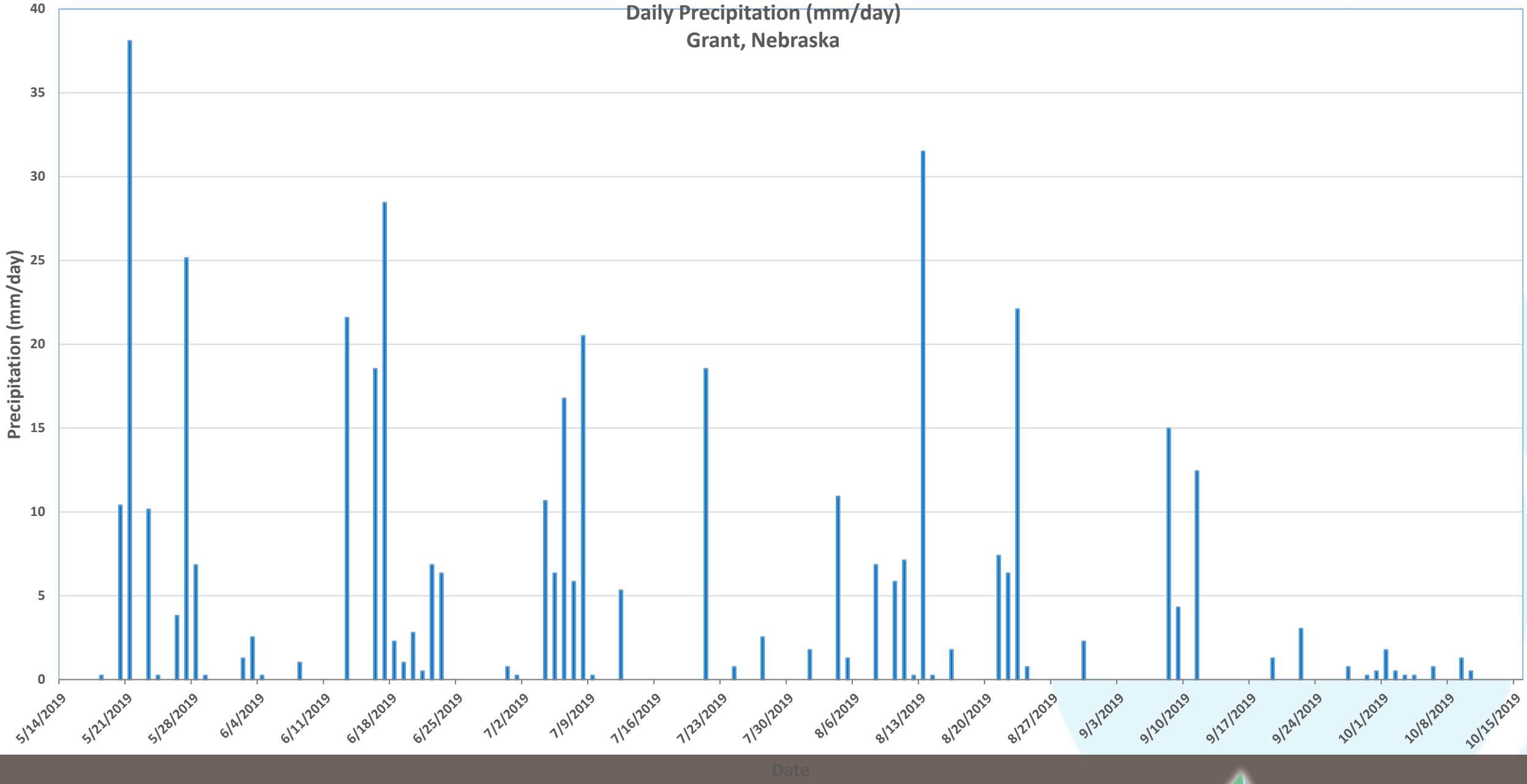
Daily Reference ET (ETr) Value Source: HPRCC	0.23 inches

ETr of Previous 7 Days Source: HPRCC

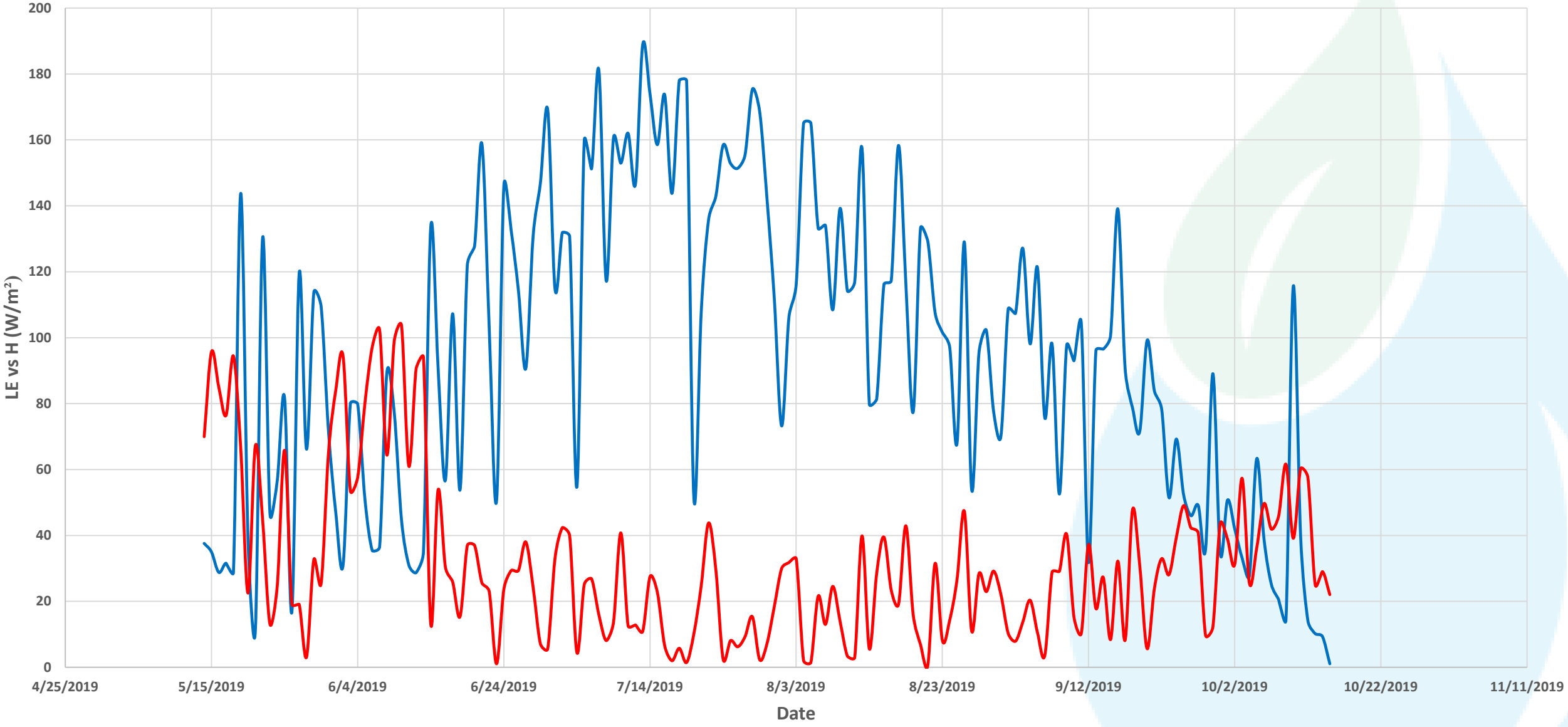
2019-07-25	2019-07-26	2019-07-27	2019-07-28	2019-07-29	2019-07-30	2019-07-31
0.27	0.29	0.3	0.31	0.32	0.35	0.23

Graph of Daily ETc & ETr Values for Date Selected and Previous 28 Days




Daily Precipitation (mm/day)
Grant, Nebraska
Precipitation (mm/day)
40
35
30
25
20
15
10
5
0
5/14/2019
5/21/2019
5/28/2019
6/4/2019
6/11/2019
6/18/2019
6/25/2019
7/2/2019
7/9/2019
7/16/2019
7/23/2019
7/30/2019
8/6/2019
8/13/2019
8/20/2019
8/27/2019
9/3/2019
9/10/2019
9/17/2019
9/24/2019
10/1/2019
10/8/2019
10/15/2019
Date

Daily Average Latent Heat (LE) vs Sensible Heat (H) Fluxes Measured above Irrigated Maize (Grant, Nebraska)



University of Nebraska

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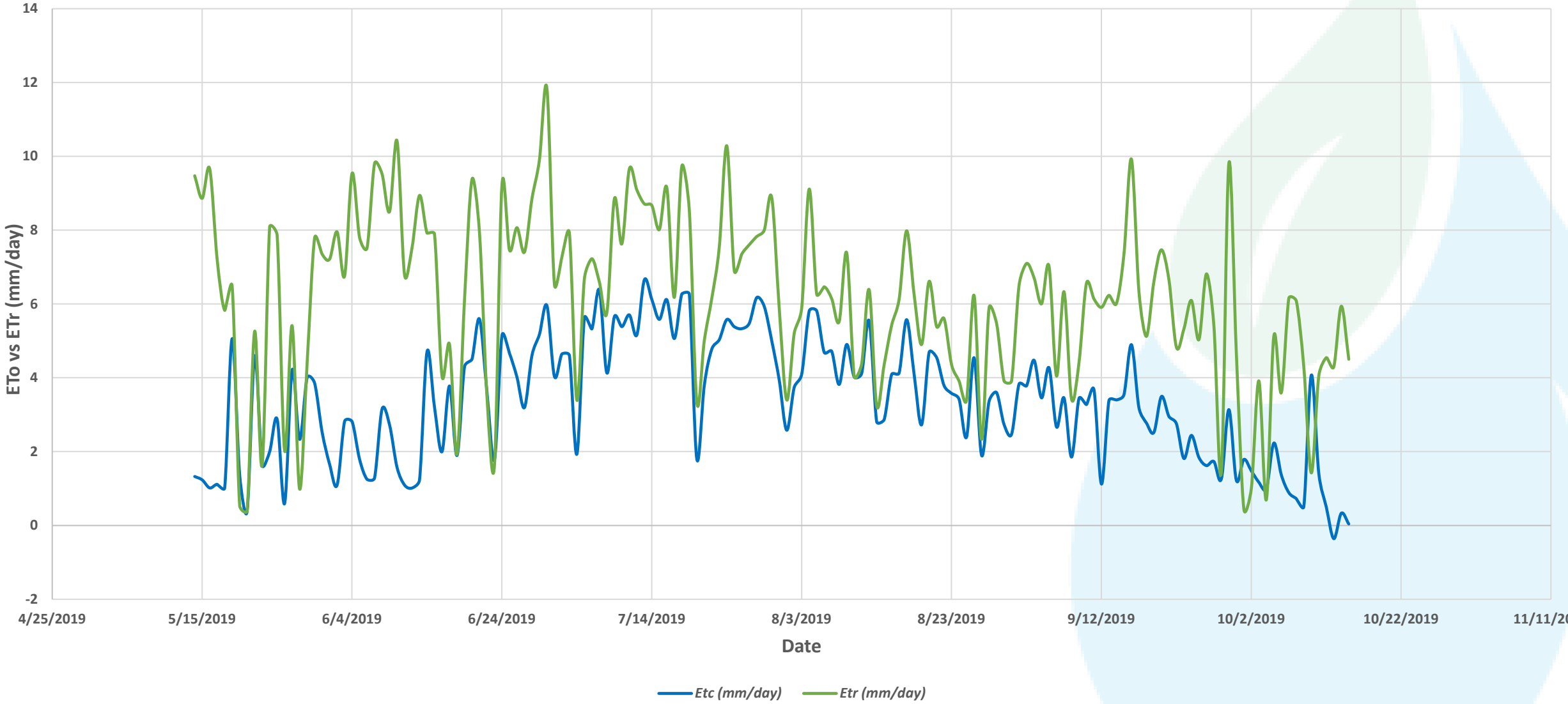
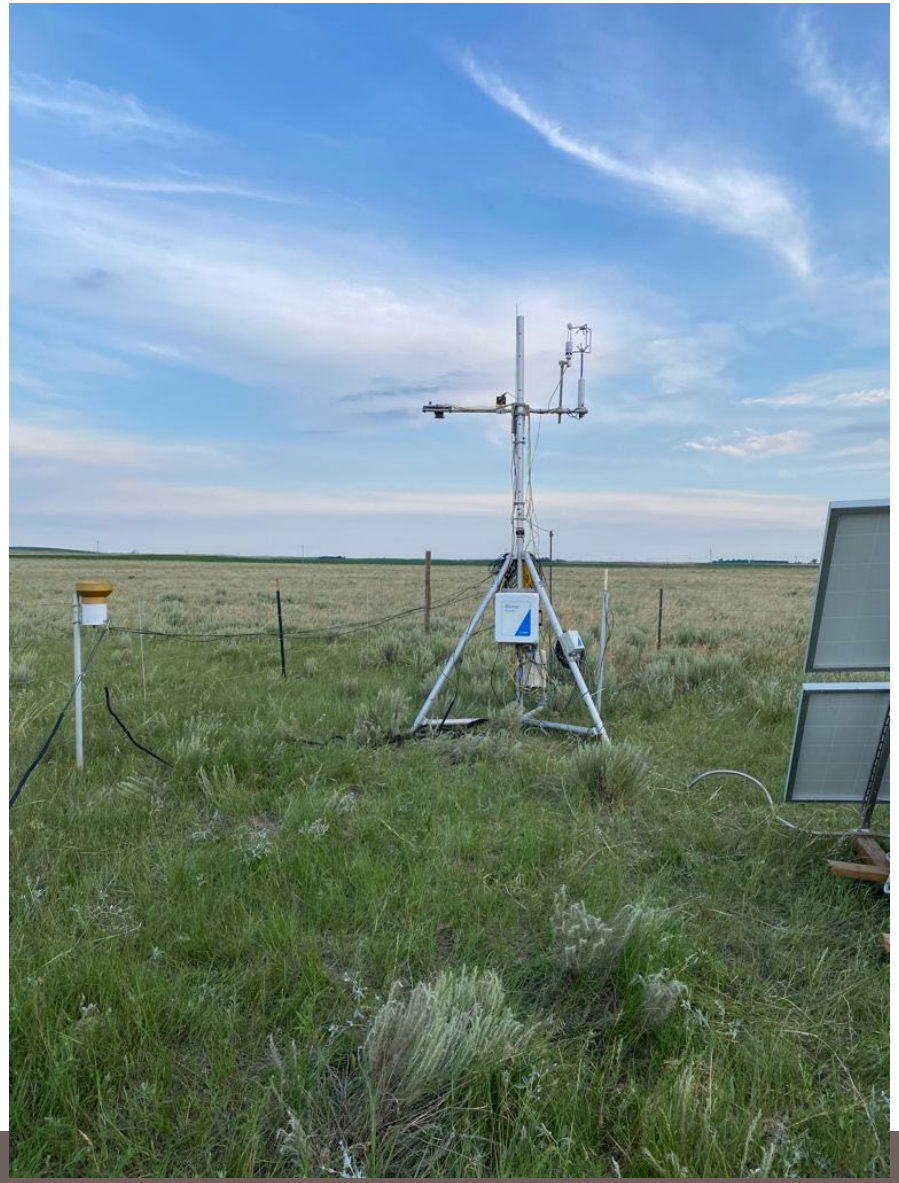
Daugherty Global Institute
at the University of Nebraska

Daily Average Actual Evapotranspiration (ETc) vs Reference Evapotaranspiration (ETr) (Grant, Nebraska)

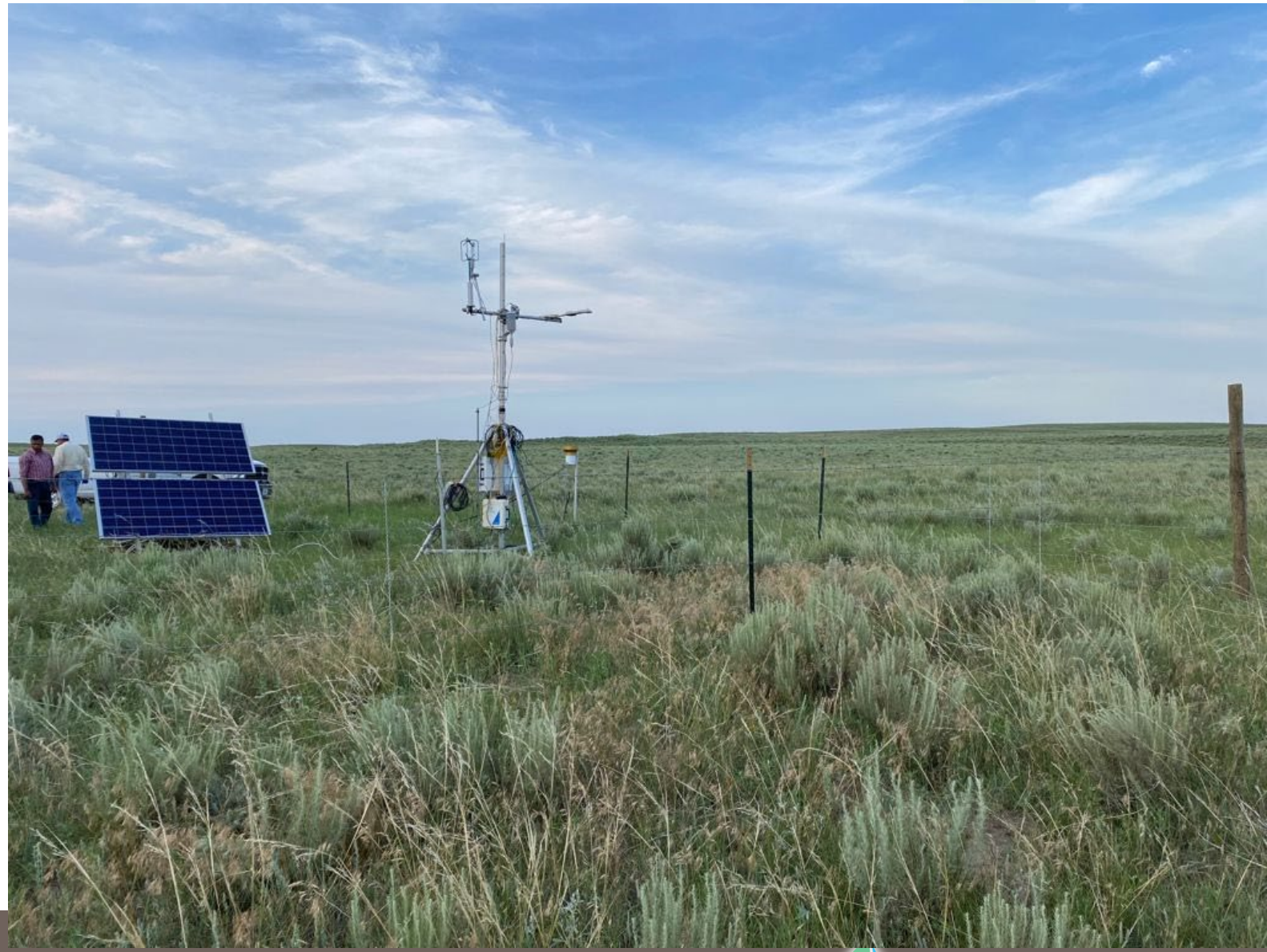


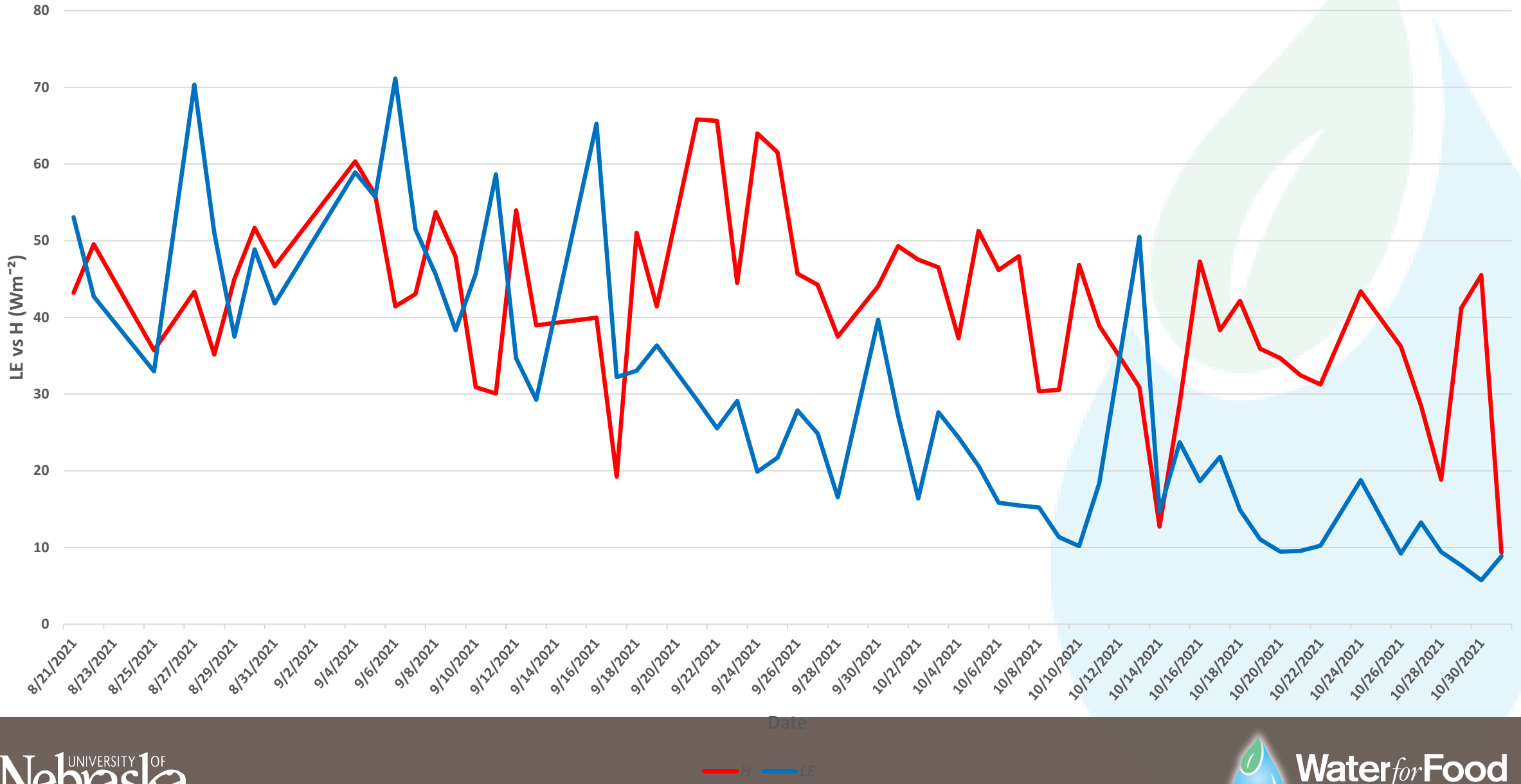
HUC-12 Tower Installation on Short Grass Prairie
Operational since July 1, 2021

South View

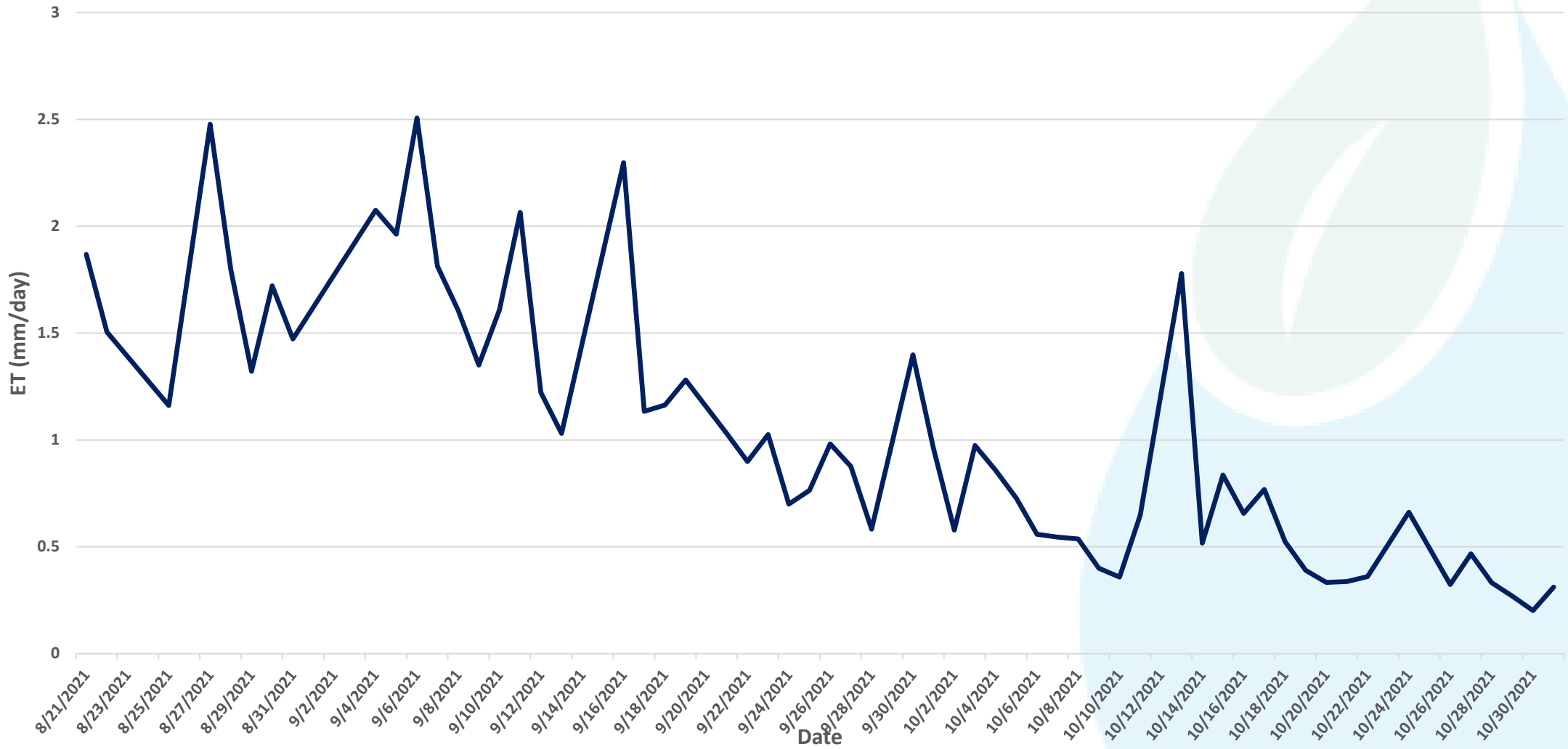


North View



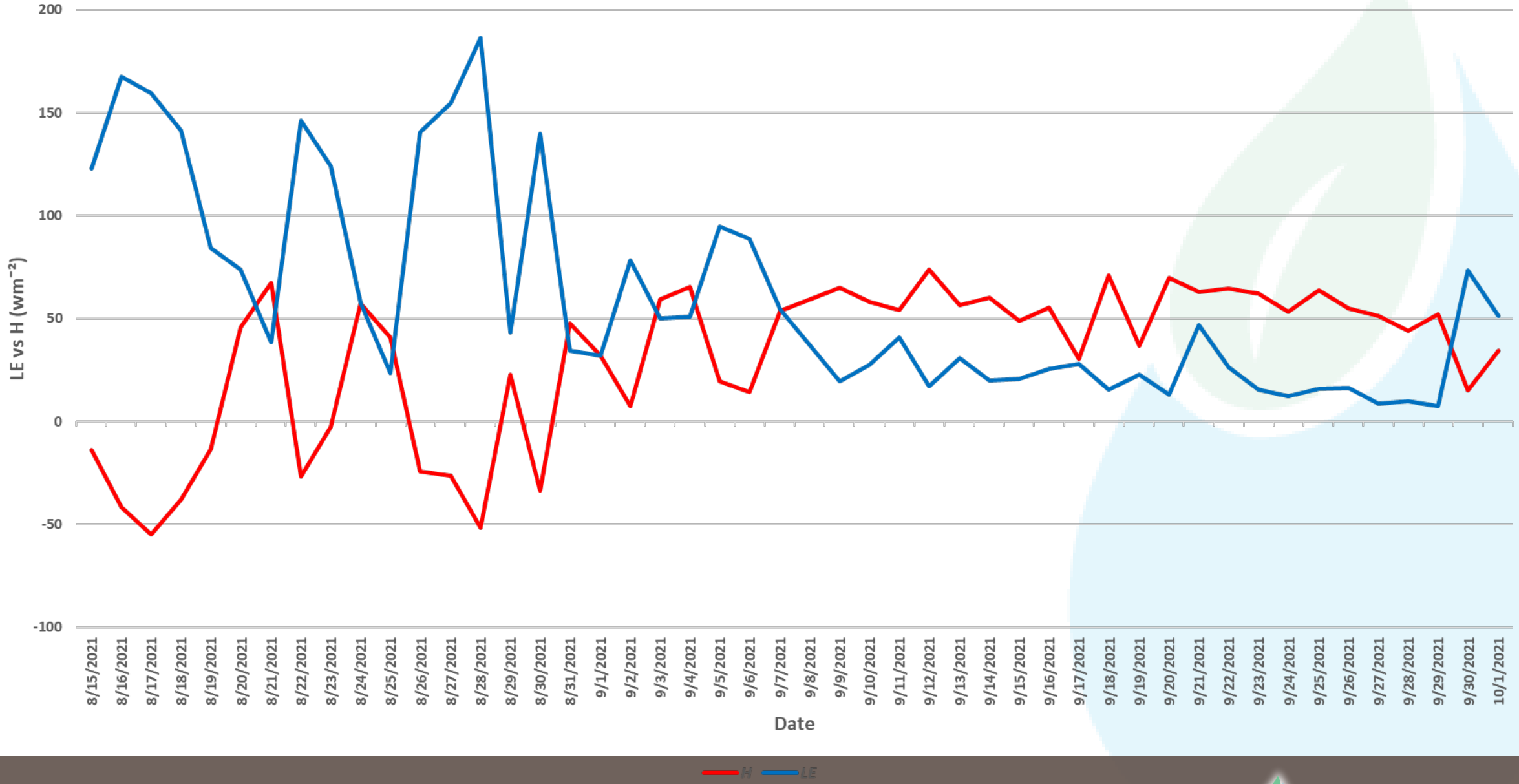

Latent Heat (LE) vs Sensible Heat (H) over Short Grass Priaire in Grant (HUC-12), Nebraska
LE vs H (Wm⁻²)
80
70
60
50
40
30
20
10
0
8/21/2021
8/23/2021
8/25/2021
8/27/2021
8/29/2021
8/31/2021
9/2/2021
9/4/2021
9/6/2021
9/8/2021
9/10/2021
9/12/2021
9/14/2021
9/16/2021
9/18/2021
9/20/2021
9/22/2021
9/24/2021
9/26/2021
9/28/2021
9/30/2021
10/2/2021
10/4/2021
10/6/2021
10/8/2021
10/10/2021
10/12/2021
10/14/2021
10/16/2021
10/18/2021
10/20/2021
10/22/2021
10/24/2021
10/26/2021
10/28/2021
10/30/2021
Date
H
LE

Actual Evapotranspiration (ETc) over Short Grass Priaire in Grant (HUC-12), Nebraska

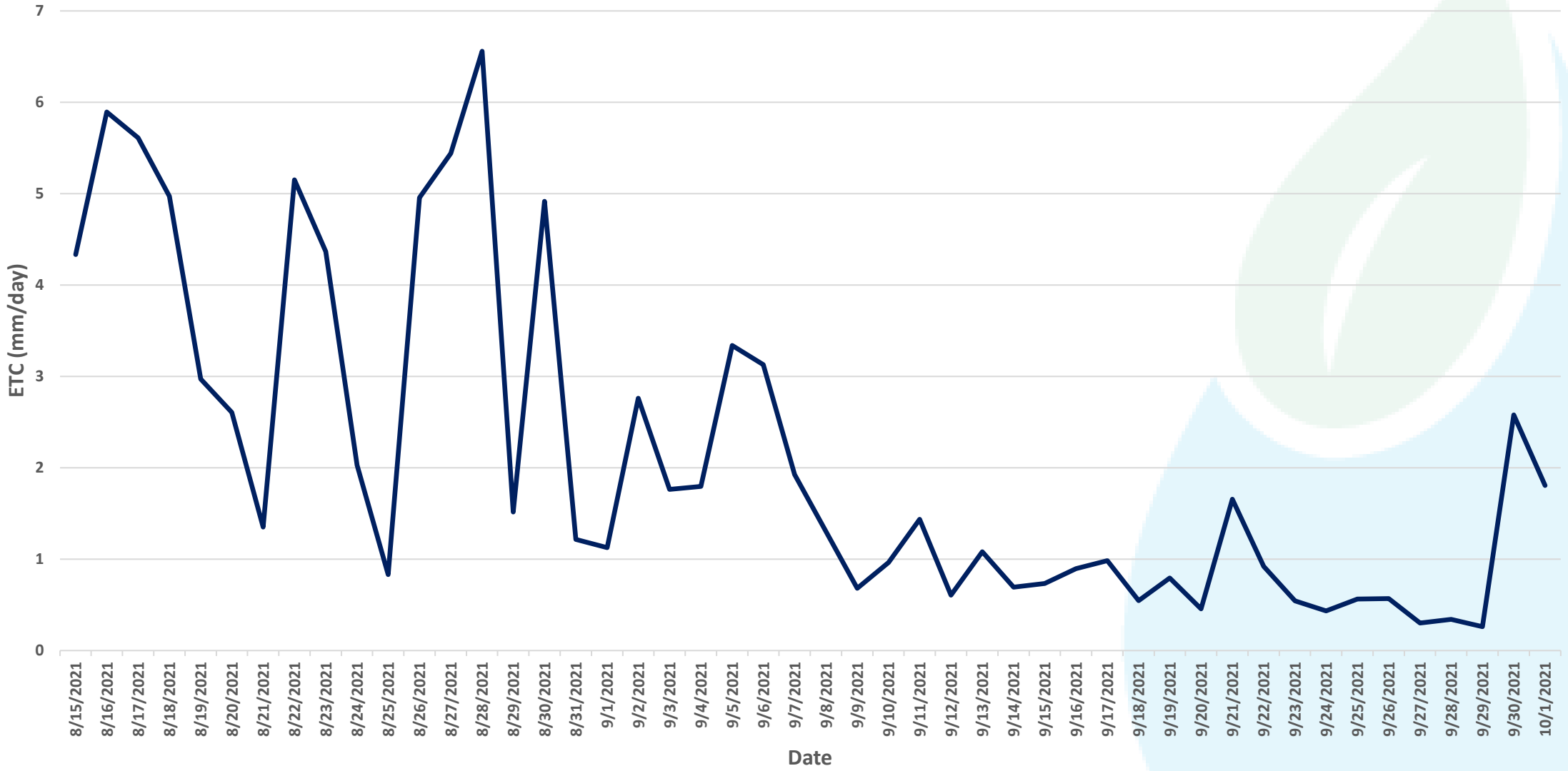


Lower Republican River NRD Holbrook EC Tower Installation on Irrigated Corn/Soy rotation. Operational since August 11, 2021

Latent Heat vs Sensible Heat over Irrigated Soybean in Holbrook, Nebraska

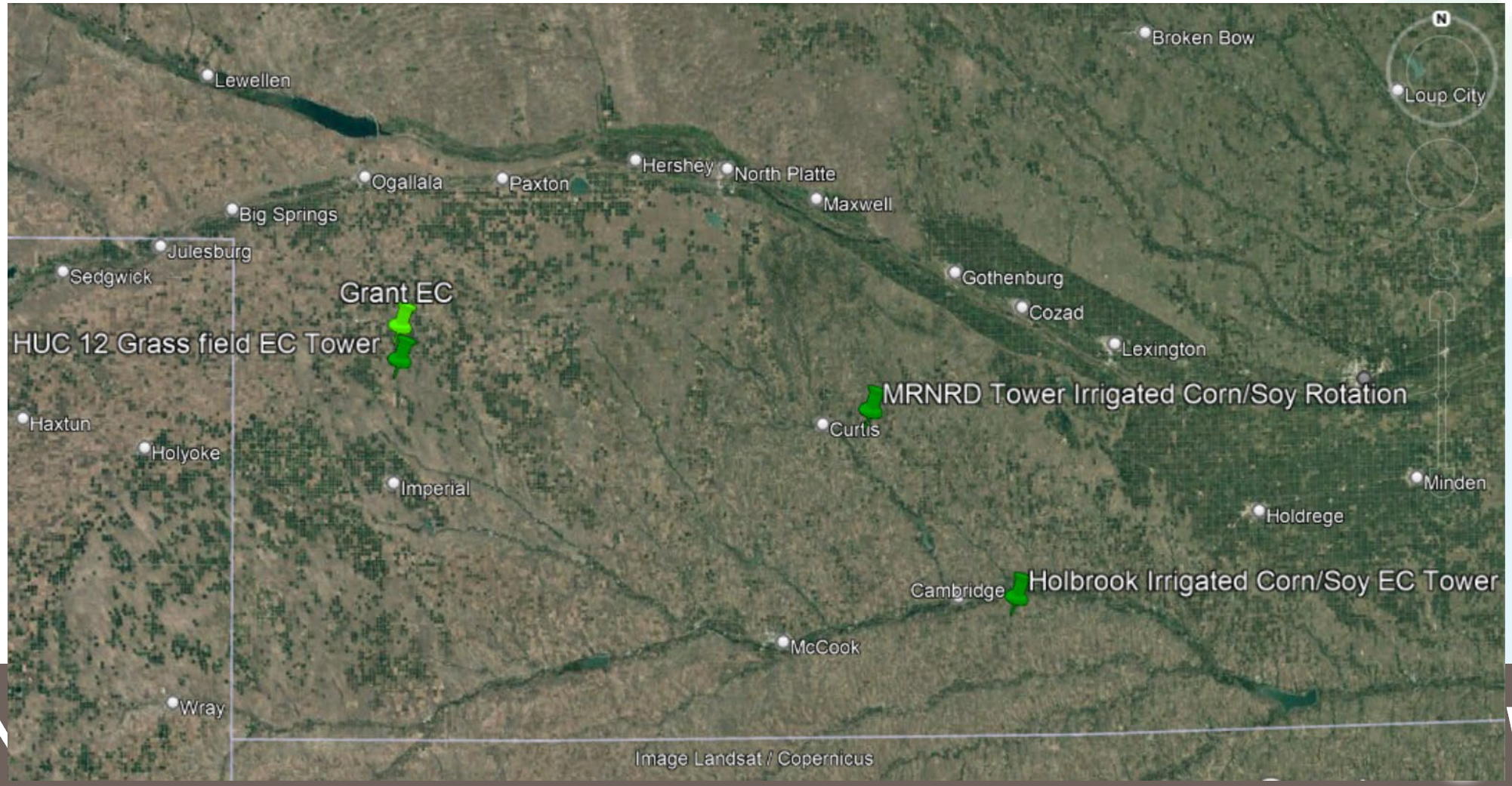


Daily Evapotranspiration over Irrigated Soybean in Holbrook, Nebraska



Parallel 41 Flux Network: Ground Truthing of Spatial ET

- Year 1: 7 Eddy Covariance Flux stations with **SmartFlux** and networked with **FluxSuite**: 5 in NE, 2 in IA
- Year 2: 3 stations: 1 NE, 1 IA, 1 KS, 1 CO
- Year 3 & 4: 3 additional stations from The Climate Corporation, in the Republican River Basin in NE



Operational Evapotranspiration Determination in the NENA Region for Evaporative Stress Index and Water Productivity

Christopher Neale
Daugherty Water for Food Global Institute
University of Nebraska

Christopher Hain
NASA Marshall Spaceflight Center, Huntsville, Alabama

Martha C. Anderson
USDA-Agricultural Research Service, Hydrology and Remote Sensing Laboratory

Mitch Schull, Yun Yang
ESSIC, University of Maryland

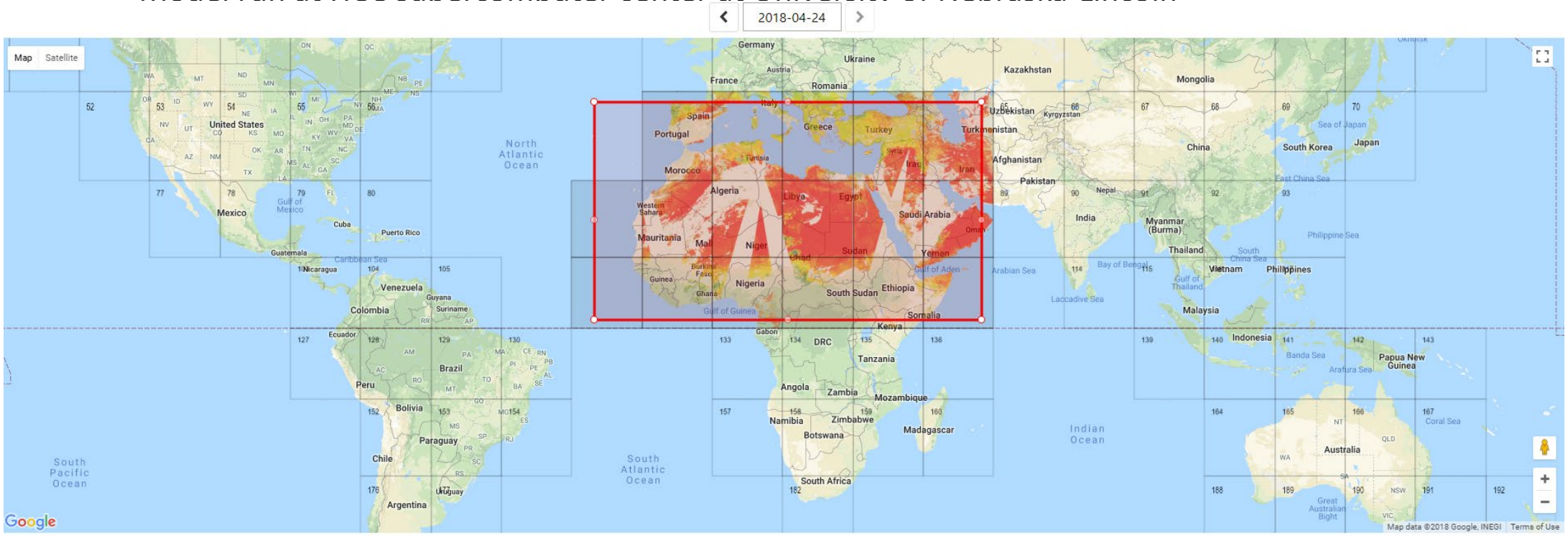
Sami Akasheh
Daugherty Water for Food Global Institute

Screenshot of daily ET overlaid on map for Spain (7/18/17)

ALEXI/VIIRS Satellite Global Daily ET Product (GLODET) WEB Interface

- Users will register to view and download the product
- Updates, track the applications and research using the product
- Model run at HCC supercomputer center at University of Nebraska-Lincoln

https://glodet.nebraska.edu/index.html#/

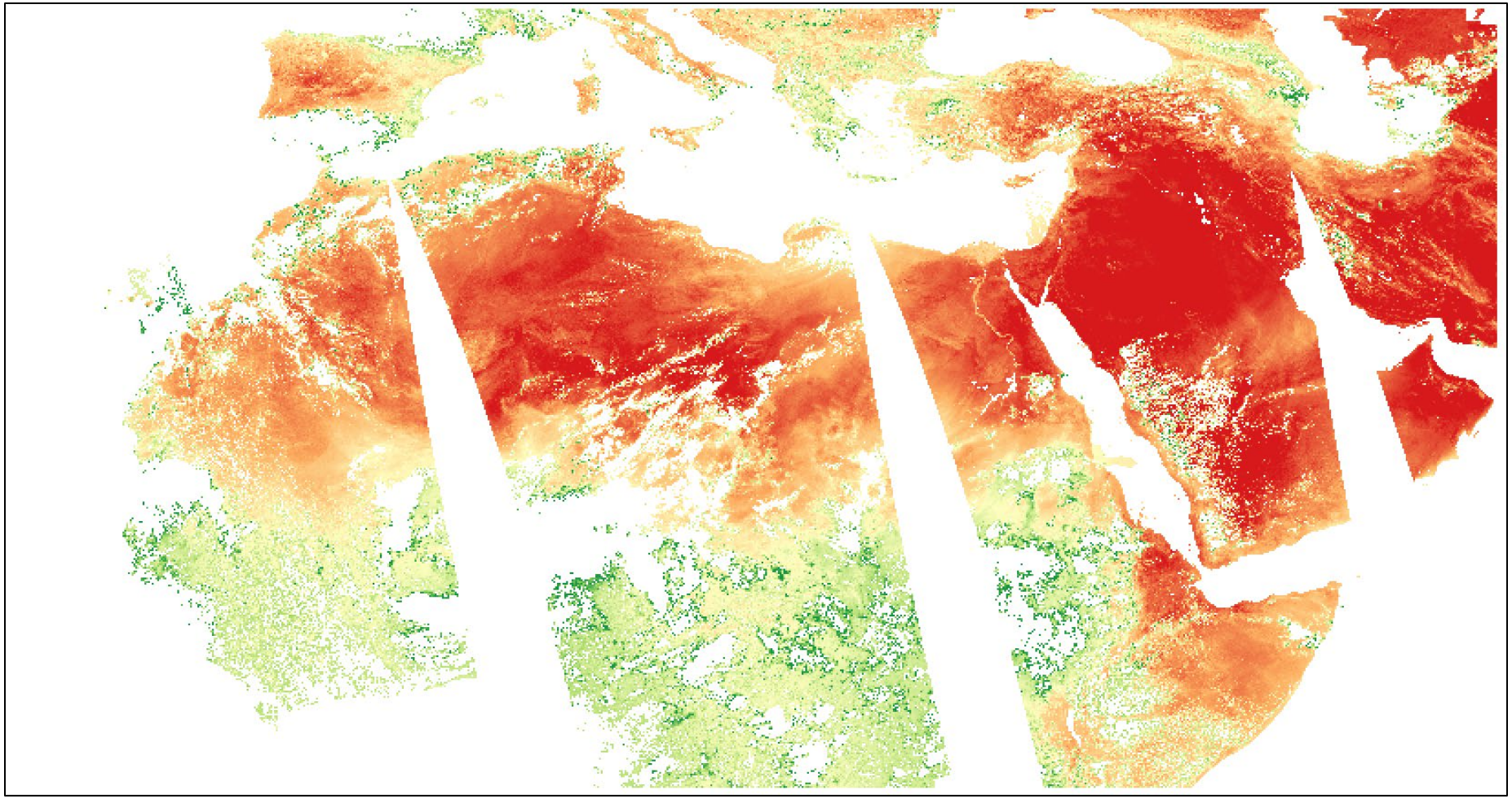


W -25.· N 43.3. E 57.5 S 1.78

Water for Food Daugherty Global Institute at the University of Nebraska
USDA Agricultural Research Service
NASA
Earth System Science Interdisciplinary Center ESSIC University of Maryland
NDMC National Drought Mitigation Center University of Nebraska
USAID From the American People
ICBA Agriculture for Tomorrow
IWMI

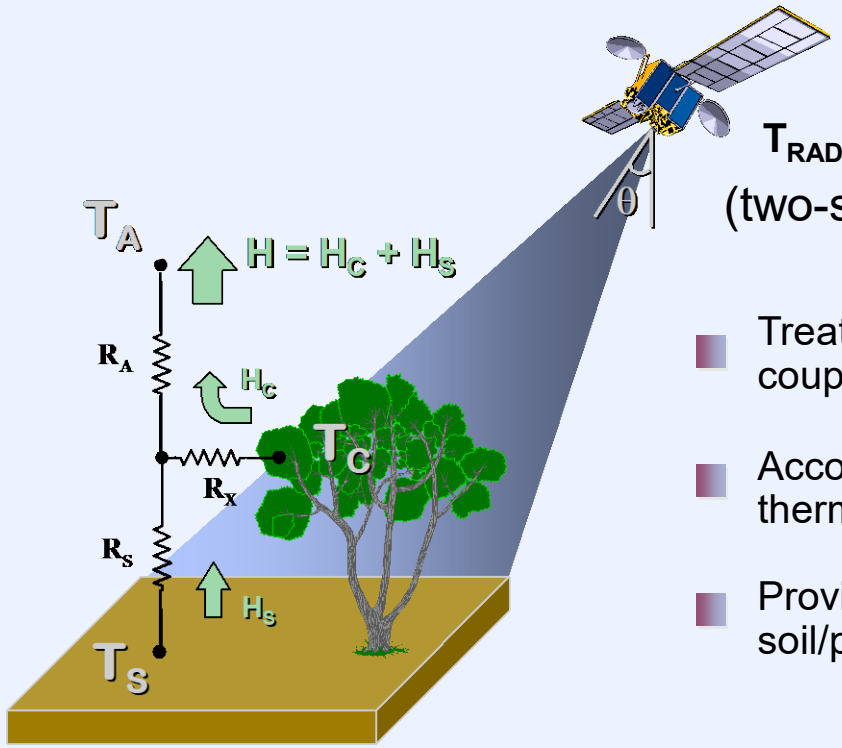
Clear Sky Land Surface Temperature from VIIRS

Clear-sky land surface temperature valid at 0900 UTC on 1 August 2015. LST and cloud masks were generated from VIIRS I5 BT band. LST was computed using a single channel retrieval based on an atmospheric correction of the I5 band with CFSR atmospheric water vapor data. Thermal IR band spatial resolution is 375 m.



The ALEXI model runs the TSEB

Two-Source Energy Balance Model (TSEB)



$$T_{RAD}(\theta) \sim f_c(\theta)T_c + [1-f_c(\theta)]T_s$$

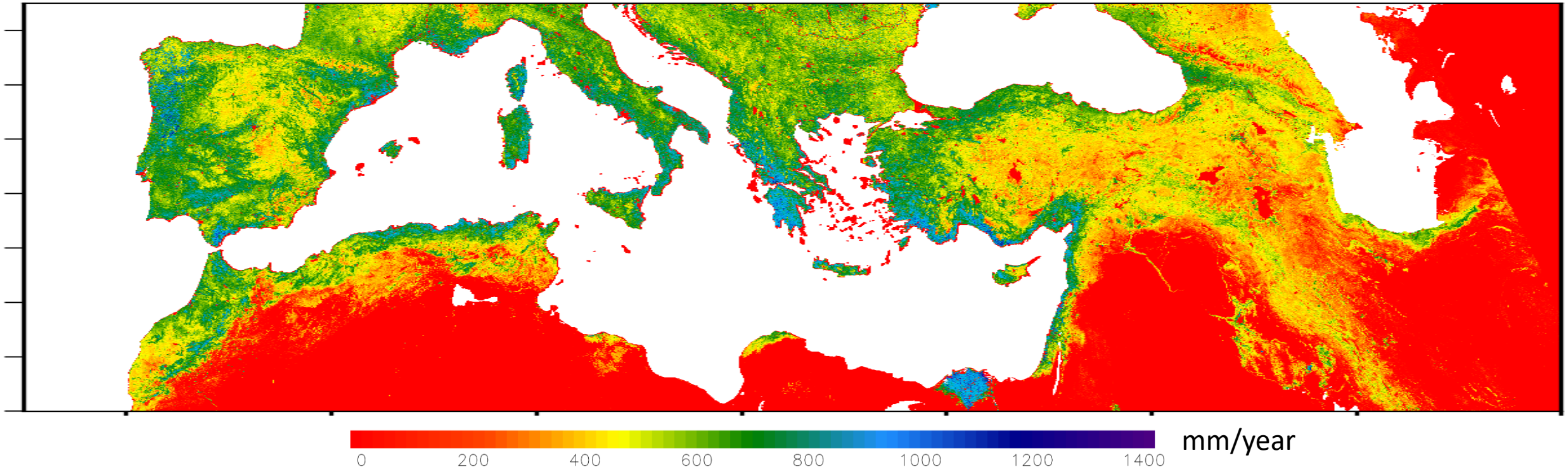
(two-source approximation)

Norman, Kustas et al. (1995)

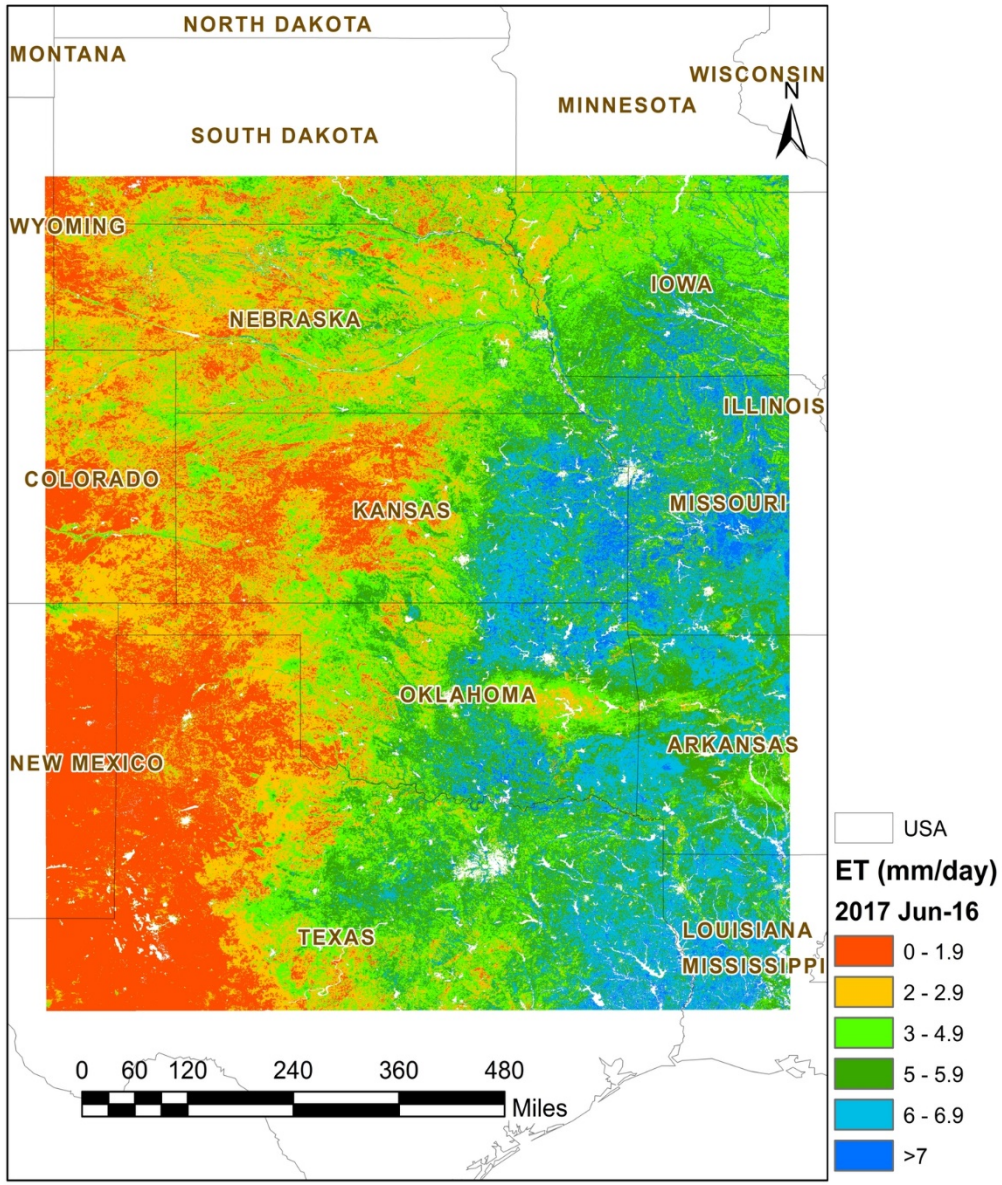
- Treats soil/plant-atmosphere coupling differences explicitly
- Accommodates off-nadir thermal sensor view angles
- Provides information on soil/plant fluxes and stress

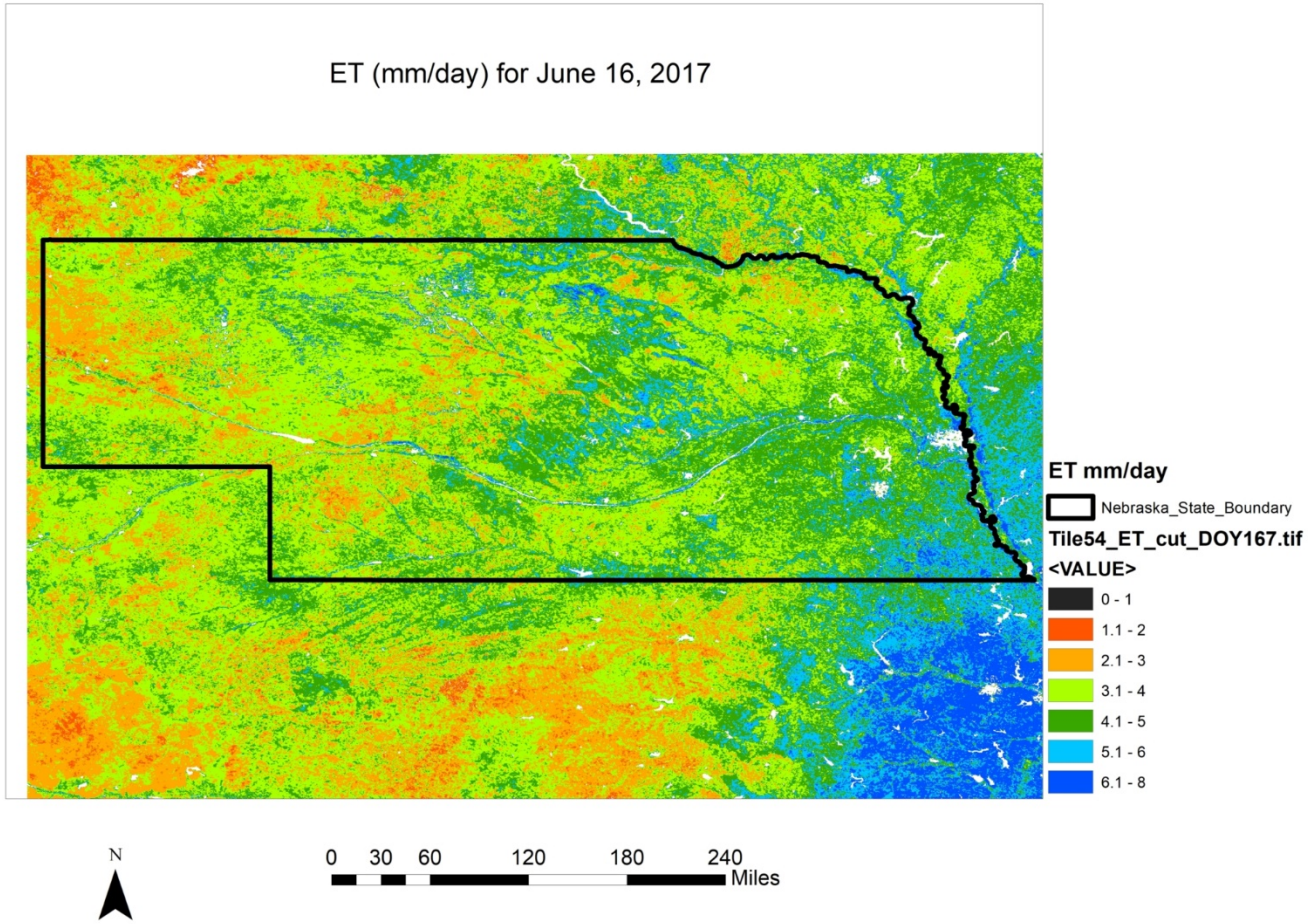
Development of a High-Resolution (375-m) VIIRS ET Product

Annual ET estimated from integrating daily values for 2018

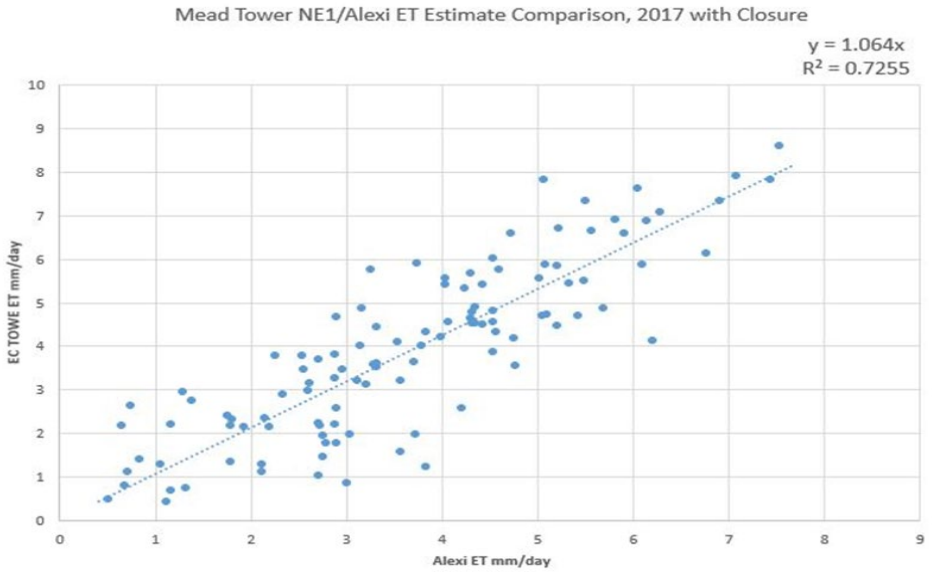


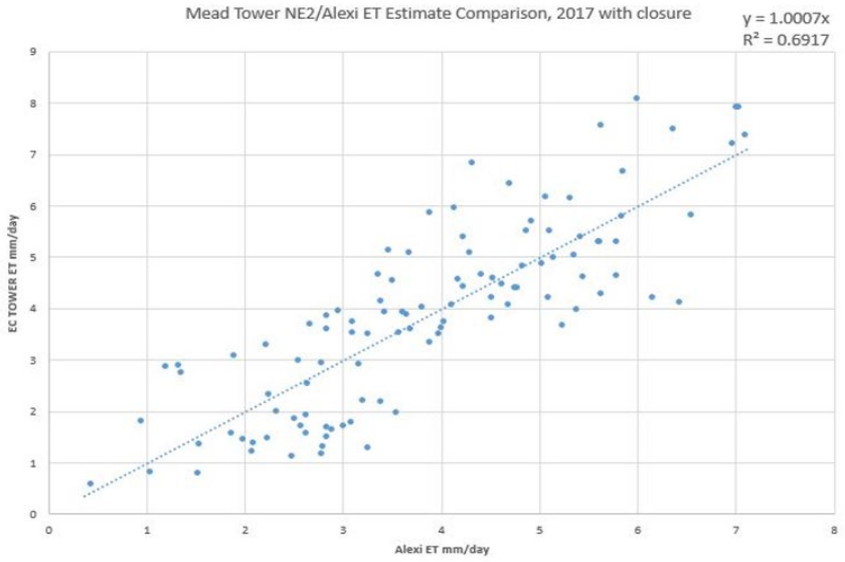
VIIRS ALEXI Daily ET for Tile 54 at 400 m pixel resolution

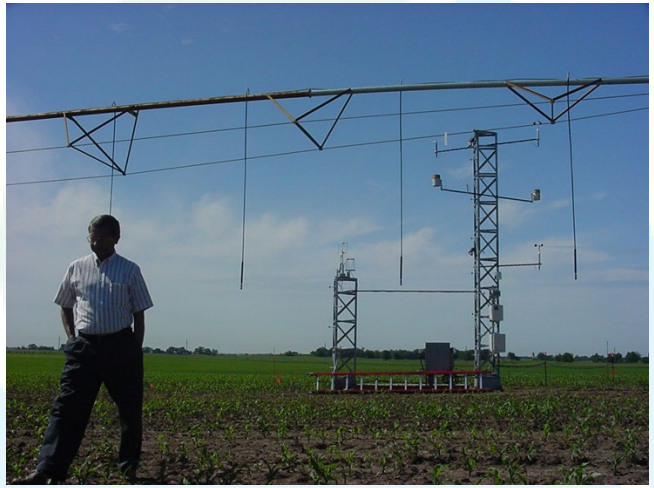


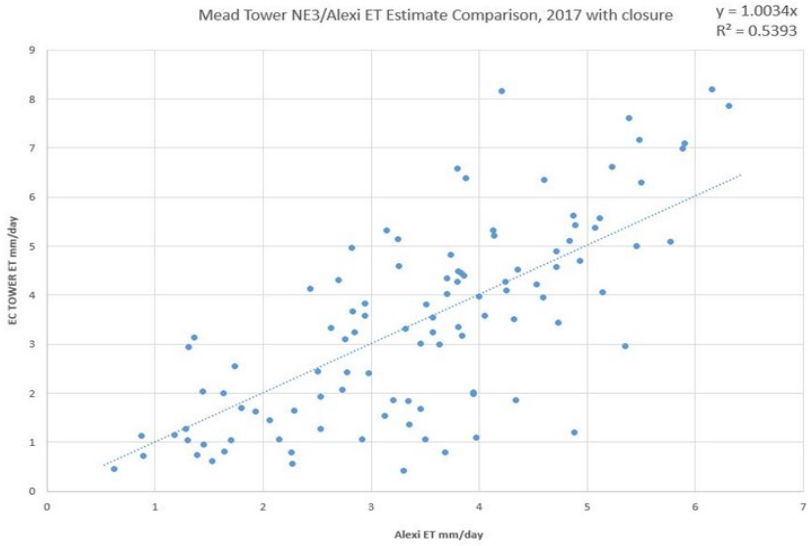


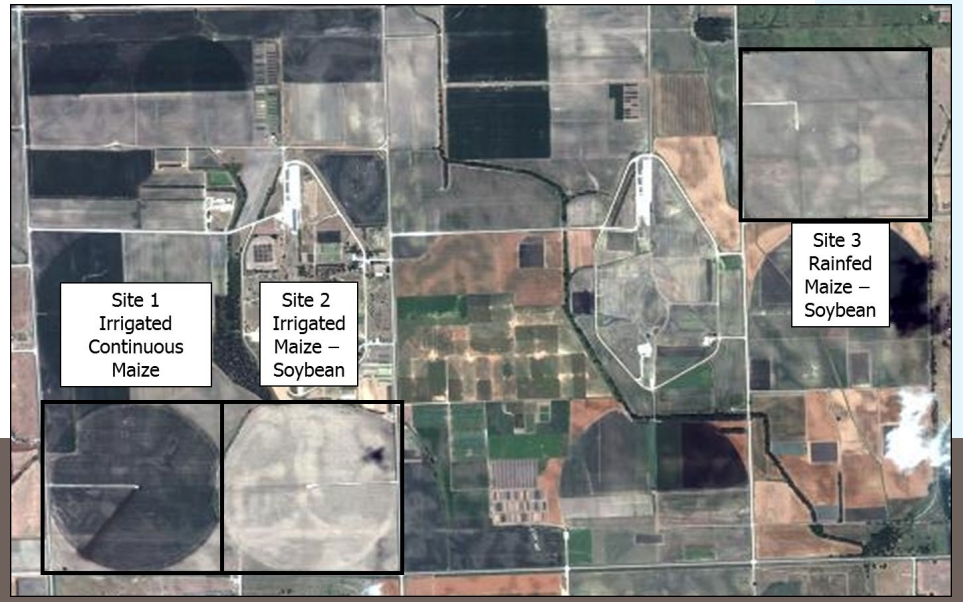
Preliminary Ground Verification of ALEXI VIIRS ET Values @375 m, Tile 54, Carbon Sequestration Ameriflux Site, Mead NE











NE1 Continuous maize crop: RMSE= 1.09, MAE=0.87;
NE2 Soybean/Maize rotation with Maize:
RMSE= 1.0, MAE=0.81
NE3 Rainfed Soybean/Maize rotation with Maize:
RMSE= 1.34, MAE=1.03.

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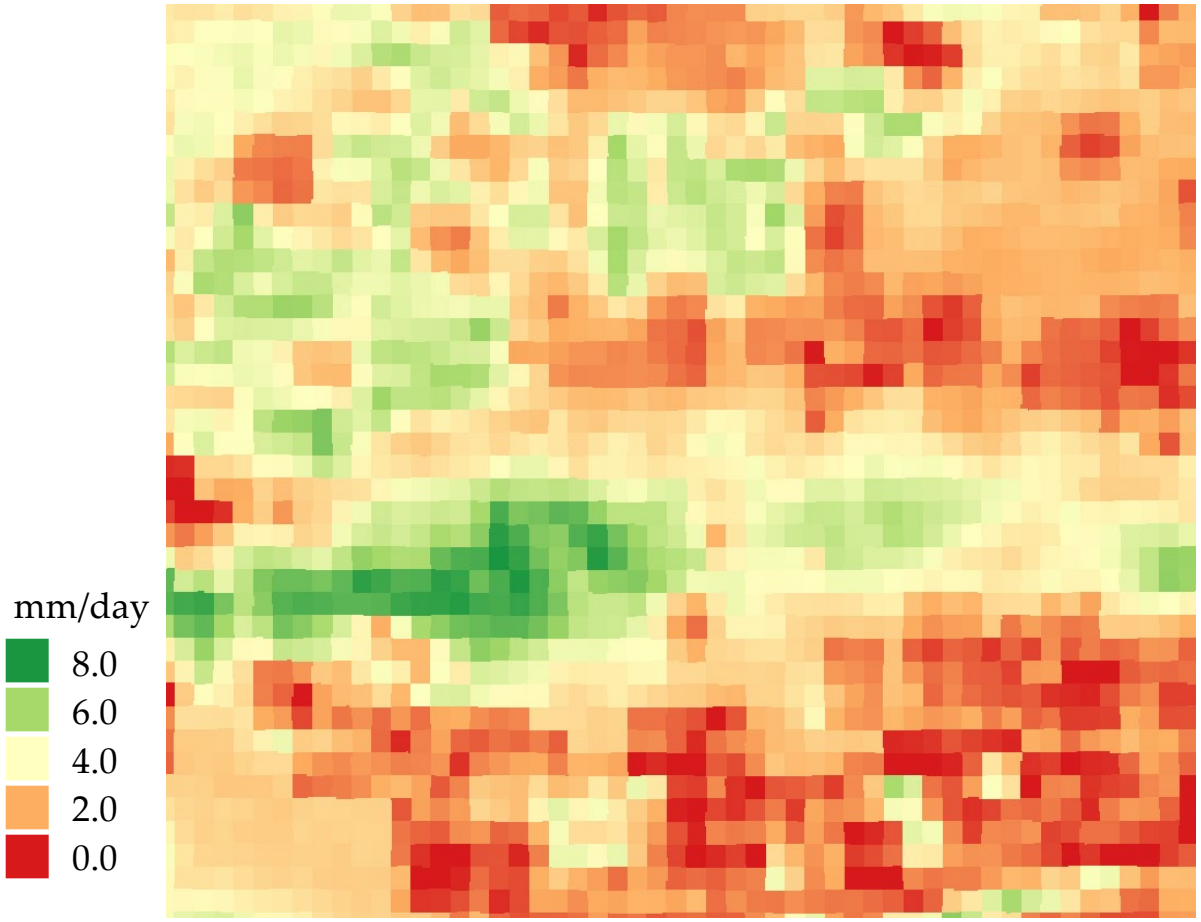
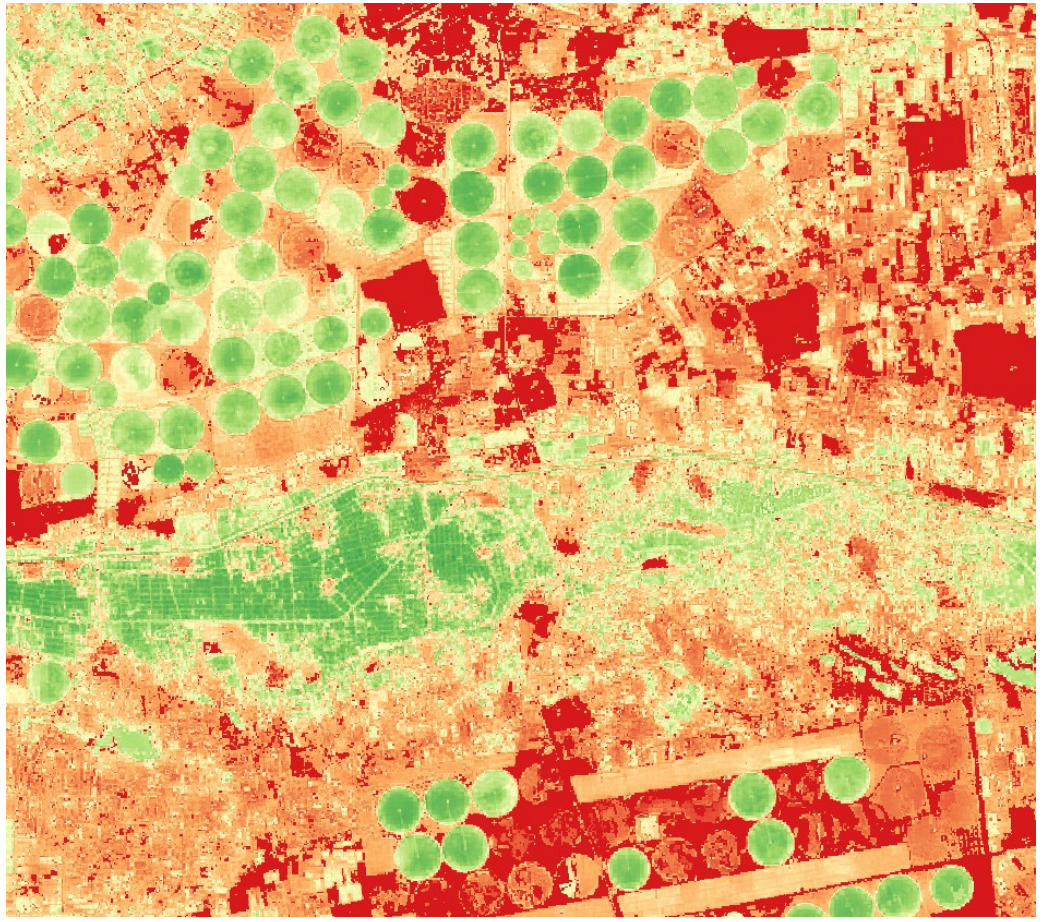
Nile Delta Irrigation

VIIRS daily ET mm/d

Daily ET calculated at VIIRS 375 m using the ALEXI model.



Daily ET downscaled from ALEXI using the PyDisALEXI model and Landsat Imagery.



EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER ESSIC UNIVERSITY OF MARYLAND

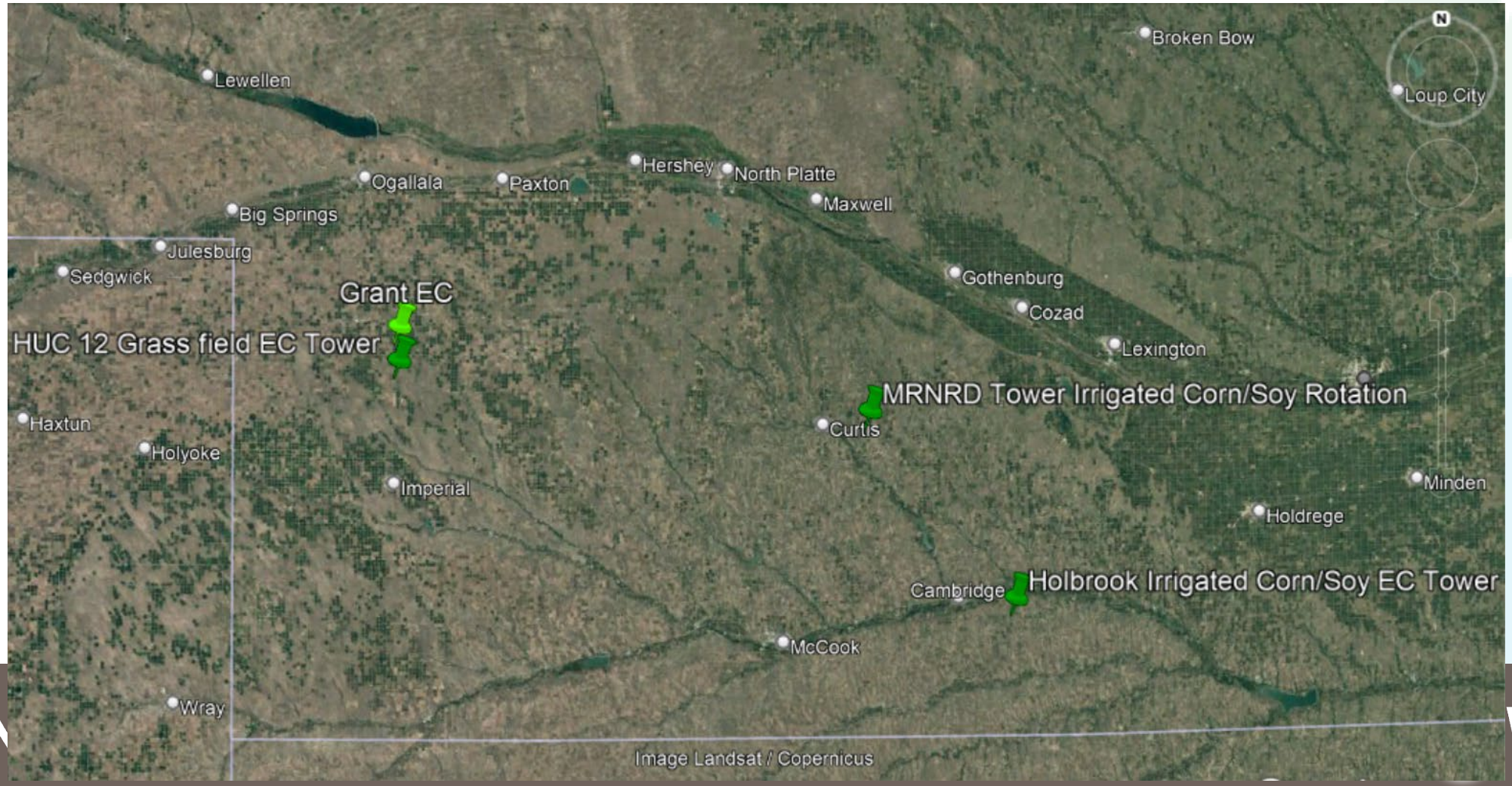
USDA

Water for Food ROBERT B. DAUGHERTY INSTITUTE at the University of Nebraska

NASA

Parallel 41 Flux Network: Ground Truthing of Spatial ET

- Year 1: 7 Eddy Covariance Flux stations with **SmartFlux** and networked with **FluxSuite**: 5 in NE, 2 in IA
- Year 2: 3 stations: 1 NE, 1 IA, 1 KS, 1 CO
- Year 3 & 4: 3 additional stations from The Climate Corporation, in the Republican River Basin in NE



Final Comments

- 8 towers operational in Parallel 41, three in Republican River Basin
- 1 additional towers to be installed in MRNRD during the 2022 season from TCC contribution
- Add additional towers in KS, CO and IA
- Develop method for anchoring remote sensing estimates and provide spatial ET through online tools and cell phone app

Goal: Install additional flux towers in different locations around the state of NE partnering with Natural Resource Districts

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