



# LOWER ELKHORN

## Natural Resources District



**Lower Platte River Basin Coalition Plan –  
Annual Report (March 1, 2022)**

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## 1.0 Introduction

The Lower Elkhorn Natural Resource District (LENRD) covers approximately 2,591,300 acres; with predominant land uses divided among agriculture (76%), pasture/grassland (20%), and small areas of forests, open water, wetlands, and urbanized areas (<4%).

The District's Board of Directors approved the interlocal agreement which effectively adopted the Lower Platte River Basin Water Management Plan on November 21<sup>st</sup>, 2017. This action, along with the six other Natural Resource Districts and the Nebraska Department of Natural Resources, set forth a collective effort to work cooperatively towards the management and development of the water resources within the Lower Platte Basin.

Since 2009, the Lower Elkhorn NRD has utilized a managed-growth philosophy when considering the decision to allow new groundwater uses for agricultural irrigation purposes. Prior to December of 2008, no restrictions were in place that limited property owners regarding the development of agricultural land for irrigation purposes. Current policy requires an approved variance from the District before expanding groundwater use for irrigation purposes. This requirement has been in place since April of 2009 within the LENRD. No limitations have been enacted on the approval of permits for high-capacity groundwater wells for other uses, such as commercial, industrial, livestock, or municipal wells, however, any request to construct a new well for any of those purposes is reviewed for any potential impacts to existing groundwater supplies and/or impacts to groundwater quality prior to approval.

The Lower Platte River Basin Water Management Plan provides guidance to the partners in respect to the amount of (excess) available water that can be allotted for new uses (depletions). Coalition partners have, in return, agreed to adhere to the suggested limits for the first five-year increment of the plan. Table 4.1 (below) lists the allowable depletions for each sub-basin of the Lower Platte Basin and Table 4.2 of the Plan (below) breaks it down into the available amount for each Natural Resource District. As listed in Table 4.2, the amount of water available during the first five-year increment, to be shared between the Lower Elkhorn Natural Resource District and the Nebraska Department of Natural Resources is 4,514 Acre-Feet of allowable new depletions.

<b>Basin</b>	<b>First 5-year Increment Allowable Development (Depletions) - Peak Season (AF) <sup>1/2</sup></b>
Loup Basin	8,651
Elkhorn Basin	6,018
Lower Platte Sub-basins	4,138

TABLE 4.2. FIRST 5-YEAR INCREMENT ALLOWABLE NEW DEVELOPMENT (DEPLETIONS) BY NRD			
NRD	Sub-Basin	First 5-year Increment Allowable New Development (Depletions) - Peak Season <sup>1</sup>	
		% Sub-Basin	AF
Upper Loup NRD	Loup River	32%	2,768
Lower Loup NRD	Loup River	68%	5,883
Upper Elkhorn NRD	Elkhorn River	25%	1,504
Lower Elkhorn NRD	Elkhorn River	75%	4,514
Papio-Missouri River NRD	Lower Platte River	21%	869
Lower Platte South NRD	Lower Platte River	24%	993
Lower Platte North NRD	Lower Platte River	55%	2,276

<sup>1</sup>The allowable new depletion is for all new uses. Apportionment between new surface water and groundwater uses will be made according to each individual NRD Integrated Management Plan.

This report and its content will serve to fulfill the annual data collection and reporting requirement of the Lower Platte River Basin Management Plan for the LENRD for the year 2021, as required in *Section 5.0 – Plan Review and Monitoring, Lower Platte River Basin Management Plan*.

## 2.0 Certified Irrigated Acres

The District initiated the process of certifying irrigated acres in January of 2013, and conducts public hearings to certify new irrigated acres, or modifications to existing certified acres on an annual, or as needed basis.

Rule 14 of the Lower Elkhorn Districts Rules & Regulations for the Enforcement of the Nebraska Groundwater Management and Protection Act indicates that the District will certify, as irrigated, any tract of land greater than two acres that (1) has been irrigated any one out of ten years, from 1999 to 2008, (2) is currently enrolled in a federal, state, or local conservation program and was classified as irrigated land by the local County Assessor within one year prior to being enrolled in such a program, (3) has otherwise been allowed to develop under an approval granted by the District’s Board of Directors since 2007, (4) has otherwise been allowed to develop under an approval granted by the NDNR since 2007, or (5) is irrigated by wastewater effluent from a livestock operation or municipality that is operating in compliance with a Clean Water Act permit.

**Table 1. – LENRD Certified Irrigated Acres**

<b>LENRD CERTIFIED IRRIGATED ACRES BY SOURCE</b>				
	<b>GROUNDWATER</b>	<b>SURFACE WATER</b>	<b>WASTEWATER</b>	<b>TOTAL ACRES BY COUNTY</b>
<b>ANTELOPE</b>	435.94	-	-	435.94
<b>BURT</b>	15,952.43	1,077.36	1,505.06	18,534.85
<b>CEDAR</b>	48,775.41	529.80	432.94	49,738.15
<b>COLFAX</b>	24,744.69	407.87	2,249.11	27,401.67
<b>CUMING</b>	57,426.10	2,040.74	14,171.63	73,638.47
<b>DAKOTA</b>	-	-	-	-
<b>DIXON</b>	15,401.30	422.12	191.79	16,015.21
<b>DODGE</b>	65,706.39	3,704.44	2,428.12	71,838.95
<b>KNOX</b>	11,189.86	70.00	-	11,259.86
<b>MADISON</b>	121,349.85	2,277.74	3,585.54	127,213.13
<b>PIERCE</b>	156,379.13	1,386.15	476.94	158,242.22
<b>PLATTE</b>	24,258.18	-	2,220.71	26,478.89
<b>STANTON</b>	39,499.37	1,216.11	1,789.69	42,505.17
<b>THURSTON</b>	12,098.81	373.87	634.80	13,107.48
<b>WAYNE</b>	49,257.19	913.42	1,761.00	51,931.61
<b>TOTAL IRRIGATED ACRES BY SOURCE</b>	642,475.65	14,419.65	31,447.34	
<b>TOTAL IRRIGATED ACRES</b>	688,342.64			

As indicated by the data in Table 1, groundwater is the primary water source for agricultural irrigation in the Lower Elkhorn NRD with current inventory totaling **642,475.65** acres irrigated by this source. **Note: This current inventory only includes a portion of the total new irrigated acres approved in conjunction with the Lower Platte River Basin Management Plan, since only a portion of the new irrigated acres have been formally certified as irrigated acres by the District.**

The LENRDS is also home to many livestock operations; species include: beef cattle (feedlot and cow/calf), dairy, swine, and poultry operations (both egg and meat-bird production). Current production trends for livestock and poultry operations indicate that large numbers of animals are situated on individual farms, which will require large volumes of water necessary for production. Many of these operations are also required to have operating permits to comply with the Clean Water Act requirements. Some of these locations will apply groundwater, as necessary, alongside animal waste/lagoon effluent for irrigation of growing crops.

To date, certification records show that surface water irrigation comprises the smallest increment of the total irrigated acreage in the District, estimated at **14,419.65**. Commingled sources of water have also been tracked through the process of certification of acres, and

current data indicates there are approximately **14,386** acres of land that are listed as utilizing both groundwater and surface water for irrigation sources.

### **3.0 Municipal, Water-Use Data**

Table 2 (below) contains municipal water-use data from public water supply systems located within the LENRD.

<b>Table 2: LENRD_Municipal Water-Use Data_2021</b>			
<b>System Name</b>	<b>2020 Pop.</b>	<b>2021 Usage/Gal.</b>	<b>Gal/Capita/Day</b>
City of Battle Creek	1215	73,616,850.00	166.00
City of Clarkson	631	74,095,117.09	321.71
City of Hooper	775	111,489,524.00	394.13
City of Humphrey	896	86,959,936	265.90
City of Laurel	1111	68,438,000	168.77
City of Lyons	818	50,712,114.50	169.85
City of Madison	2561	109,235,453	116.86
City of Norfolk	24424	1,333,650,356	149.60
City of Oakland	1556	102,569,964.00	180.60
City of Osmond	873	36,229,936.50	113.70
City of Pierce	2013	206,610,294.00	281.20
City of Plainview	1398	273,708,828.00	526.40
City of Randolph	1010	51,537,270.00	139.80
City of Scribner	754	54,381,496.00	197.60
City of Stanton	1632	125,092,800.00	210.00
City of Tilden	1105	150,395,859.00	372.89
City of Wakefield	1545	123,950,715	219.80
City of Wayne	5557	583,523,065.00	287.69
City of West Point	3301	191,175,930.00	158.67
City of Wisner	1257	93,687,981.00	204.20
Village of Beemer	610	39,097,340.00	175.60
Village of Belden	127	Served by WauColRWS	NA
Village of Bancroft	458	44,333,854	265.20
Village of Carroll	237	16,608,960	192.00
Village of Concord	162	5,972,130	101.00
Village of Craig	187	8,895,674.00	130.33
Village of Creston	206	8,346,090.00	111.00
Village of Dixon	125	21,033,125.00	461.00
Village of Dodge	550	38,845,125.00	193.50
Village of Emerson	902	50,174,652.00	152.40
Village of Hoskins	281	13,643,196.30	133.02
Village of Howells	657	65,035,116.00	217.20
Village of Leigh	396	4,690,980.00	357.00
Village of Magnet	54	Served by WauColRWS	NA
Village of McLean	25	Served by WauColRWS	NA
Village of Meadow Grove	249	12,468,528.92	137.19
Village of Nickerson	334	12,434,820.00	102.00
Village of Pender	1204	76,466,040	174.00
Village of Pilger	305	23,202,356.50	208.42
Village of Snyder	327	17,664,540.00	148.00
Village of Tilden	1105	107,284,450.00	266.00
Village of Uehling	271	15,064,754.50	152.30
Village of Wausa	562	19,673,947.61	95.91
Village of Winside	574	50,915,120.20	243.02
Woodland Park CDP	1588	51,629,087.23	<u>89.07</u>
			<b>208.35 Avg.</b>
Logan East Rural Water District	NA	155,018,214.00	
Cardinal Health	NA	50,090,803.36	
Henningsen Foods Inc	NA	211528.42	

#### **4.0 New Groundwater Allocations and Depletion Impact**

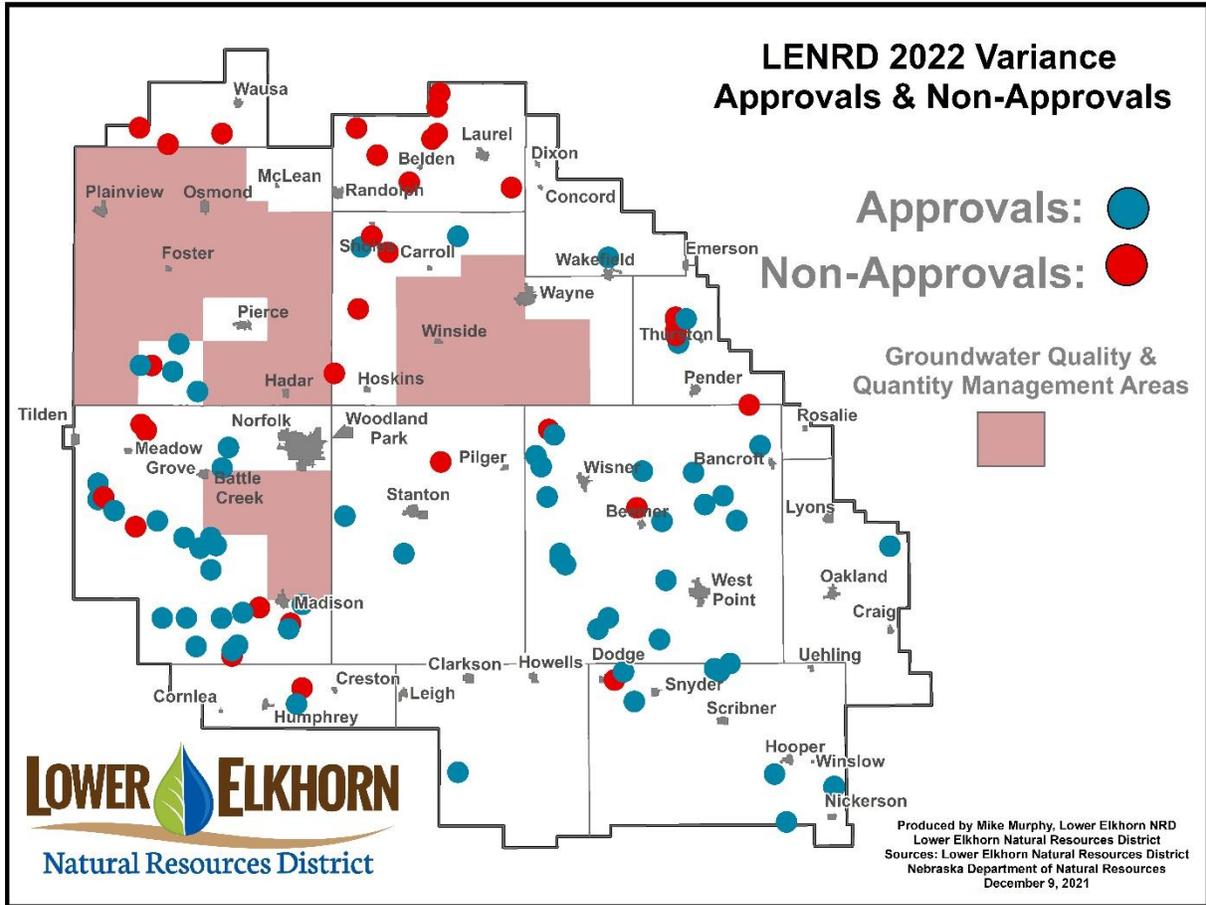
Previous to participation in the Lower Platte River Basin Management Plan, the only accounting for new groundwater consumptive uses by the Lower Elkhorn Natural Resource District would be the new irrigated acres located within the hydrologically connected areas authorized by an approved Variance from the District, and most importantly those acres approved under the prior requirements of LB 483. The LENRD has required an approved variance to expand irrigated acres districtwide since early 2009. A variance is required for both the Hydrologically Connected and Non-Hydrologically Connected portions of the District, which under the current boundaries (as recognized by the District and the Nebraska Department of Natural Resources) equals approximately a 1/3<sup>rd</sup> (Hydrologically Connected) and 2/3<sup>rd</sup> (Non-Hydrologically Connected) split.

In September of 2021, the Lower Elkhorn Board of Directors once again authorized a sign-up period to receive applications for Standard Variances to Expand Irrigated acres within the District. This authorization would allow for the development of up to 295.00 AF of new peak season depletions within the hydrologically connected portion of the district and up to 2,500 new irrigated acres in the non-hydrologically connected area.

In November of 2021, the Board of Directors voted to allow up to **292.00** acre feet of new peak season depletions in the *hydrologically connected portion* of the District, and up to **2542.15** new groundwater irrigated acres in the *non-hydrologically connected* portion of the District. ***For accounting purposes, (at this time) only the new depletions located with the current hydrologically connected portion of the LENRD are accounted for and reported to the Coalition. Any future boundary amendment will require the LENRD to account for any new depletions approved outside of the current hydrologically connected area, dating back to the beginning of the first increment (2016).***

**Table 3: New Groundwater Depletions by Location\_LENRD\_2021**

Application ID	County	Township	Range	Section	New Acres	SDF		New Depletion
						Value	NIR (ft.)	
21-063	Madison	22	3W	2	82.27	14	0.75	2.59
21-076	Dodge	19	8E	36	17.6	91.01	0.58	2.79
21-033	Dodge	18	8E	17	23.18	69.94	0.58	2.82
21-087	Madison	22	3W	12	62.41	13.4	0.75	1.88
21-086	Madison	22	2W	5	66.26	12.74	0.75	1.90
21-025	Madison	24	2W	21	31.59	69.39	0.75	4.93
21-043	Madison	22	2W	19	134.9	12.55	0.75	3.81
21-065	Dodge	19	7E	25	151.25	78.71	0.67	23.93
21-032	Madison	24	2W	32	39.92	84.29	0.75	7.57
21-031	Madison	21	2W	8	68.16	24.02	0.75	3.68
21-078	Madison	23	4W	22	66.85	26.26	0.75	3.95
21-082	Madison	23	3W	29	57.19	20.77	0.75	2.67
21-079	Cuming	22	6E	29	54.51	95.06	0.67	10.42
21-006	Pierce	25	3W	15	55.64	46	0.75	5.76
21-053	Pierce	25	3W	25	67.18	54	0.75	8.16
21-048	Madison	22	2W	6	121.1	13	0.75	3.54
21-051	Cuming	24	4E	32	53.5	82.1	0.67	8.83
21-016	Madison	21	3W	25	53.3	66.91	0.75	8.02
21-059	Thurston	25	6E	4	29.32	79.13	0.67	4.66
21-067	Madison	21	3W	11	132.3	25.39	0.75	7.56
21-018	Madison	23	4W	9	126.27	38.26	0.75	10.87
21-035	Stanton	22	2E	7	39.6	74.69	0.67	5.95
21-028	Madison	23	4W	16	67.77	32	0.75	4.88
21-055	Pierce	25	3W	18	136.43	38.2	0.75	11.73
21-022	Cuming	24	7E	22	43.94	96	0.67	8.48
21-027	Madison	21	3W	9	105.82	19.53	0.75	4.65
21-040	Madison	24	3W	7	117.43	80.32	0.75	21.22
21-056	Dixon	27	5E	29	67	89.71	0.67	12.08
21-007	Pierce	25	3W	3	65.4	46	0.75	6.77
21-036	Stanton	23	1E	29	136.33	26.2	0.75	8.04
21-020	Cuming	24	4E	29	62.07	96	0.67	11.98
21-075	Madison	21	2W	10	133.16	18.24	0.75	5.46
21-042	Madison	21	2W	27	134.32	93.12	0.75	28.14
21-077	Cuming	23	4E	16	60.55	65.25	0.67	7.94
21-047	Madison	21	2W	28	117.58	92	0.75	24.34
<b>Total Acres:</b>					<b>2782.1</b>	<b>Total New Depletions:</b>		<b>292.00</b>



The preceding map shows the geographic distribution of approved and denied requests for variances for the October 2021 signup period, for ALL locations in the District.

## 5.0 Transfers

The Lower Elkhorn Natural Resource District did not process any groundwater use transfer requests from within the hydrologically connected boundary area (in the LENRD) during this reporting period, and therefore no data is provided for this section.

## 6.0 Permits for High-Capacity Wells

Permits are only required to construct a high capacity well (any well constructed or equipped to pump greater than 50 gallons per minute) in the Lower Elkhorn NRD. Table 4 (below) lists the well permits issued for construction of high-capacity wells in the Lower Elkhorn NRD between January 1, 2021 through December 31, 2021. A breakdown of this inventory includes permits for: irrigation (97) (35 replacement well permits), commercial/industrial (0), livestock (2), public water supply (1), and other (4).

**Table 4.**

High Capacity Well Permit Type	Number of Approved Permits	Average Capacity (GPM)
Irrigation (New wells)	62	800
Irrigation (Replacement)	35	825
Livestock	2	270
Other (Test well for public water supply)	1	1000
Other (Fire suppression and relief)	1	200
Other (Pressure relief well)	2	2000
Public Water Supply	1	1200
Commercial/Industrial	0	NA
<b>Total</b>	<b>104</b>	

## 7.0 Retirement of Groundwater Consumptive Uses

During the 2021 reporting period, there were no retirements of groundwater uses inventoried or reviewed within the Lower Elkhorn NRD.

## 8.0 Flow Meter Data

As of January 1, 2019, all active high-capacity wells are required to be equipped with a flow meter to measure the total annual groundwater withdrawal, and to report water-use readings to the LENRD by December 1 of each calendar year. The water use information is inventoried into a central data management system that was developed for the LENRD by Phoenix Webgroup (PWG) of Waverly, NE. This data management system, which houses the information from over 5,000 flow meters, also contains a user interface that allows well owners or operators to submit their information using a web-based interface.

The summary table below captures the preliminary information collected from flow meter reports for irrigation wells in the Lower Elkhorn NRD for the 2021 irrigation pumping season.

The entry labeled “Irrigation” represents information from irrigation wells located throughout the entire District, and the QM Subarea information is gathered from irrigation wells located

in two Quantity Management Subareas (Eastern Madison and Wayne Counties), in which irrigation wells are subject to an annual groundwater allocation.

Also included in Table 5 is pumping data from well uses identified as Commercial/Industrial, and Livestock.

Table 5: LENRD_2021 Flow Meter Data_Irrigation_Commercial/Industrial_Livestock					
Well Use or Management Area	Number of Locations	Min. Withdrawal	Max. Withdrawal	Tot. Withdrawal	Average Use/AI
Irrigation	5,129	0 Acre In.	5,243 Acre In.	3,813,777 Acre In.	5.54 Acre In./Acre
<b>Quantity Management Subareas</b>					
Eastern Madison County	96	0 Acre In.	12.58 Inches/Acre		6.23 Acre In./Acre
Wayne County	77	0 Acre In.	8.53 Inches/Acre		4.43 Acre In./Acre
<b>Commercial/Industrial</b>					
Golf course, ready-mix plants, food processing, ethanol prod., industry	52			46,709 Acre In.	898.23 Acre In.
<b>Livestock</b>					
	33	0 Acre In.	1,617 Acre In.	7,647.43 Acre In.	231.74 Acre In.

## 9.0 Water Banking Activities

The Lower Elkhorn NRD does not currently participate in any water banking activities and therefore no data exists for this reporting requirement.

## 10.0 Stream-flow Accretion Activities

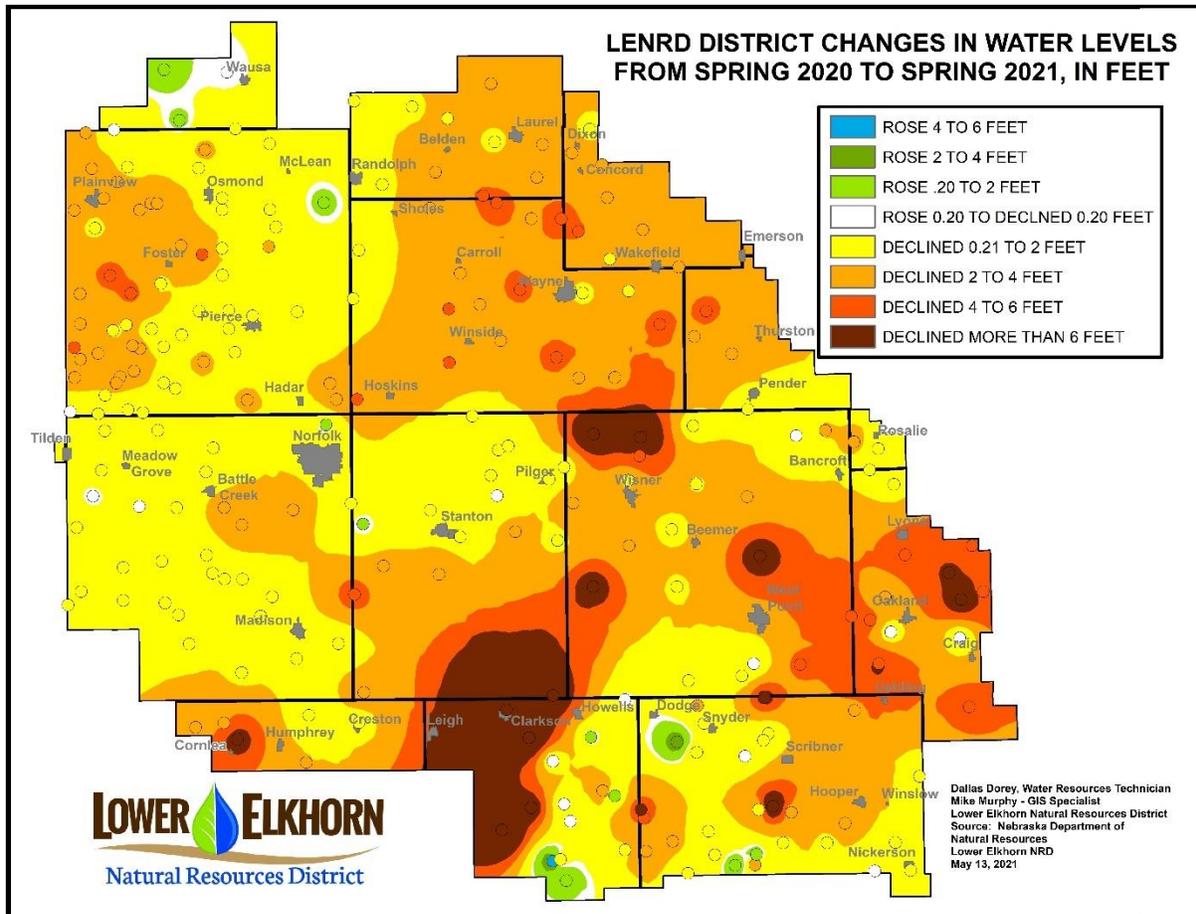
Within the Lower Elkhorn NRD there are currently no operating projects that would create reporting data associated with stream flow augmentation or to compensate for any conjunctive management requirements.

## 11.0 Groundwater Elevation Observations

Groundwater level observations were collected from 240 privately owned irrigation wells during 2021. Data collection typically occurs during March of each calendar year and the map below illustrates the changes in groundwater elevation data between the Spring of 2020 and the Spring of 2021.

A summary of the observation data collected during 2021 is as follows:

- 240 Wells measured
- On average, depth to groundwater decreased 2.42 ft. (District-wide)
- 211 locations decreased (88%)
- 16 locations unchanged (7%)
- 12 locations increased (5%)
- 1 new location



As illustrated by the map above, the aquifer systems in the Lower Elkhorn NRD are geologically diverse, and subsequently the groundwater levels react differently by location. This phenomenon presents a situation where the year-to-year water level data will vary significantly at the local level. That being stated, groundwater levels have generally been very resilient in the Lower Elkhorn NRD and have (in the past) recovered from periods of deficit precipitation coupled with increased groundwater demand.

## 12.0 Stream-gage Measurements

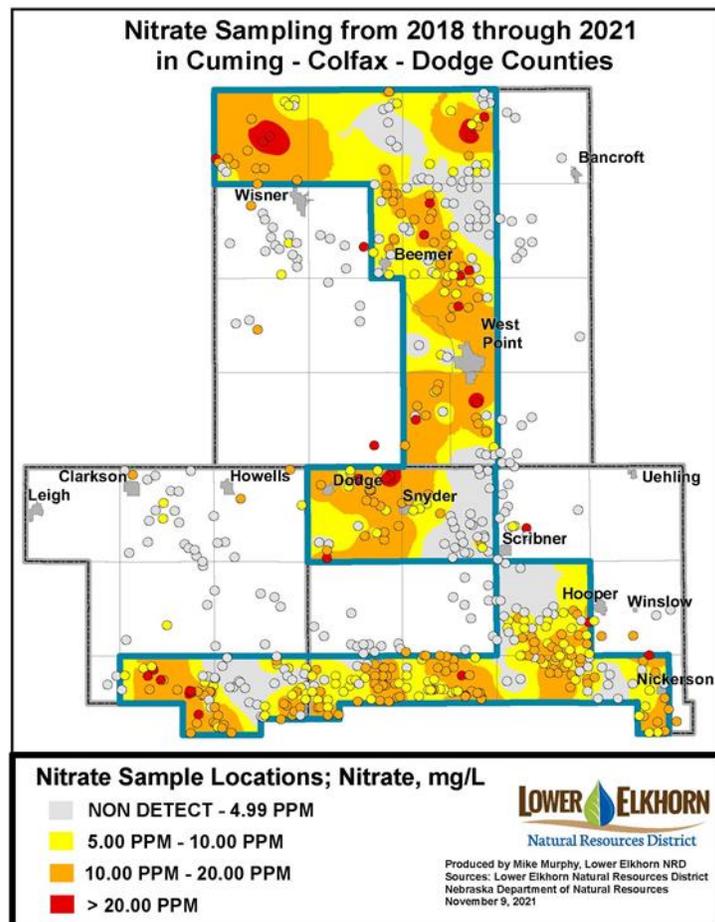
The Lower Elkhorn NRD does not maintain any stream gages within the District that are independent of gage-data collected by the United States Geological Survey (USGS) or the Nebraska Department of Natural Resources (NDNR).

## 13.0 NRD Regulations and Management Activities

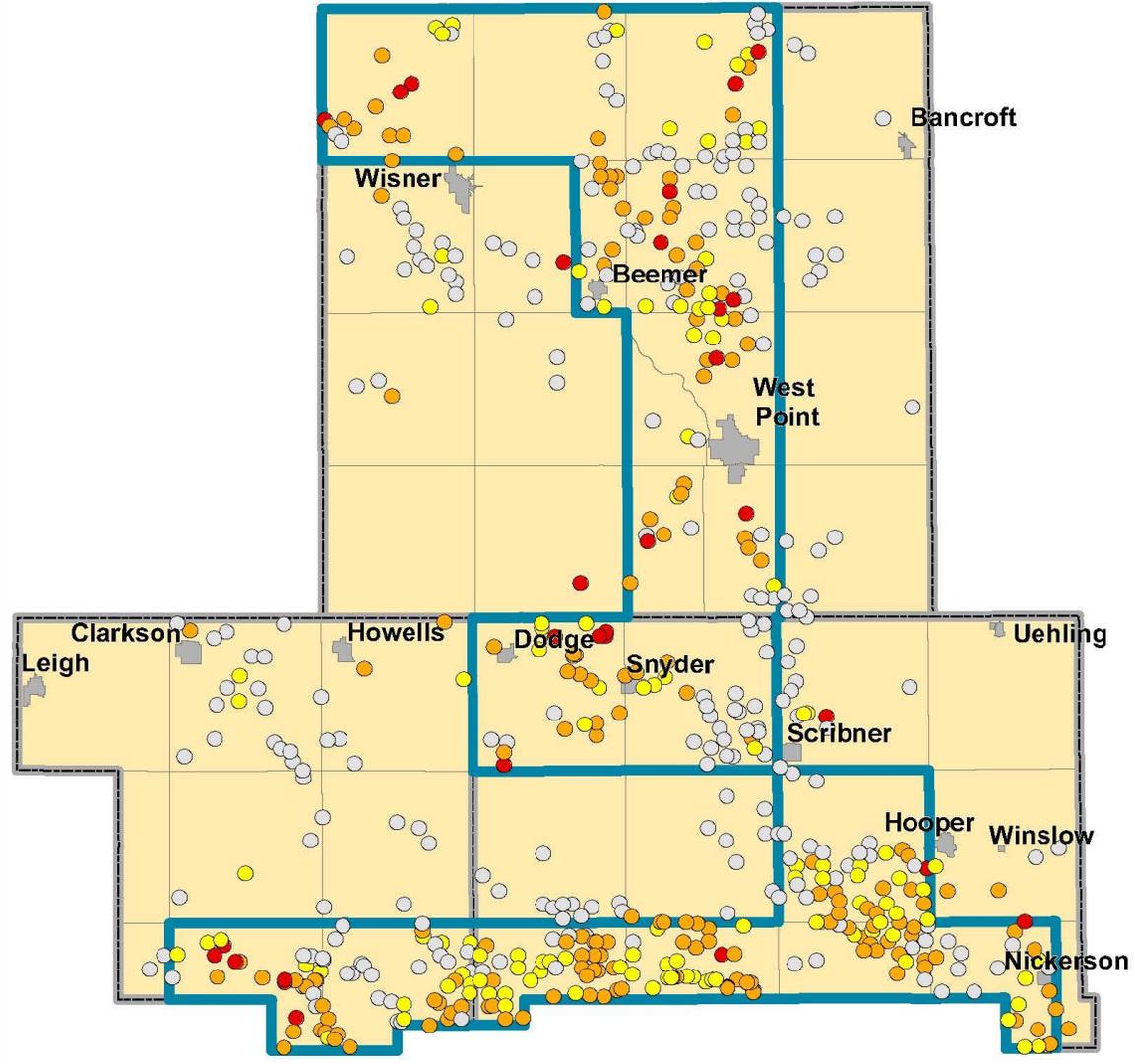
There were no amendments to the Groundwater Management Area Rules and Regulations during 2021, however the District has proposed the delineation of a Phase 2 Area in portions of Cuming, Colfax, and Dodge Counties within the LENRD. Well sampling studies conducted during 2018, 2019, 2020, and 2021 provide sufficient data to effectively evaluate groundwater nitrate concentrations in these areas, and there are enough wells within these areas that contain the minimum threshold of nitrate concentration per location to warrant the delineation of a management area for the protection of groundwater quality.

Maps of the proposed management area, along with information regarding the nitrate concentrations are displayed to the right and below.

During the Summer of 2021, District staff collected nitrate samples from over 600 locations geographically distributed in Pierce, northern Madison, Dixon, Thurston, Burt, Cuming, Colfax, and Dodge Counties.



## Nitrate Sampling from 2018 through 2021 in Cuming - Colfax - Dodge Counties

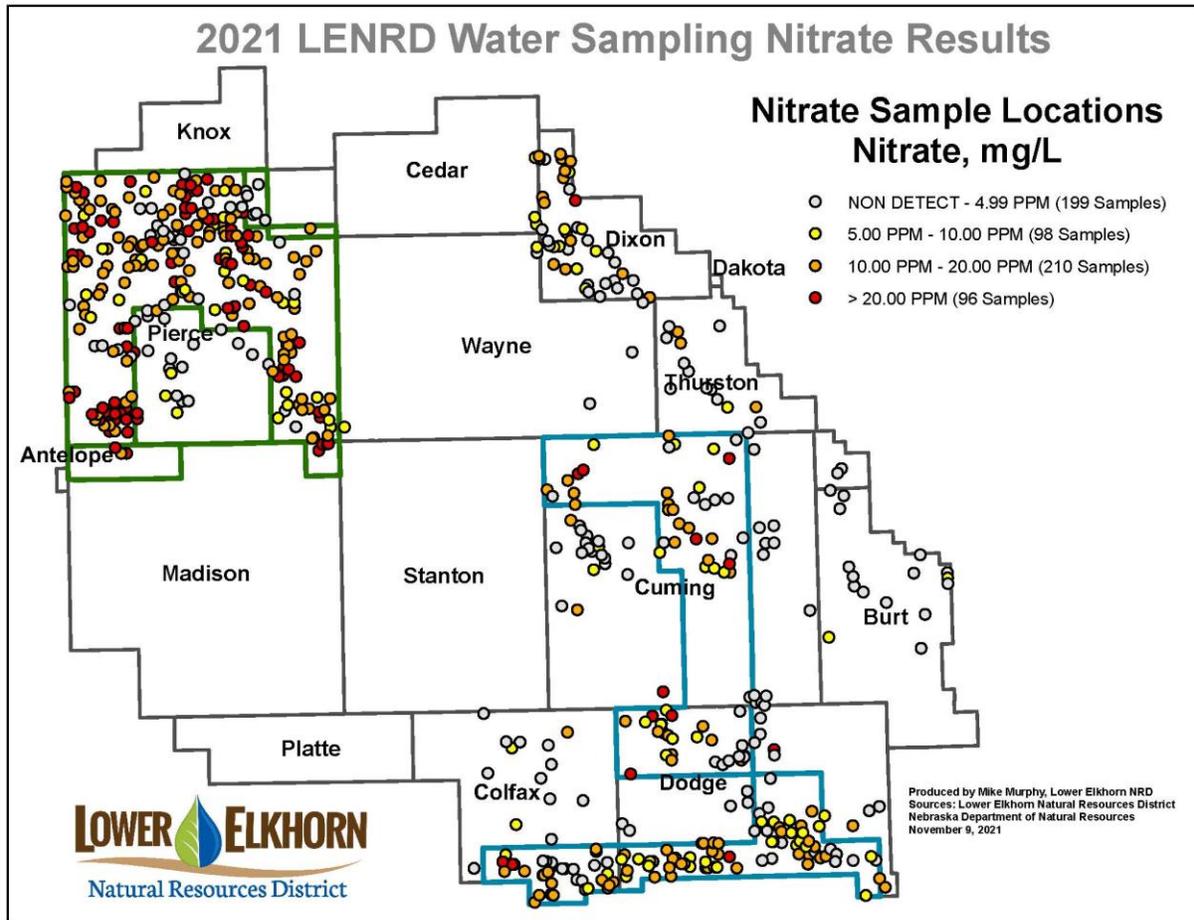


### Nitrate Sample Locations; Nitrate, mg/L

- NON DETECT - 4.99 PPM
- 5.00 PPM - 10.00 PPM
- 10.00 PPM - 20.00 PPM
- > 20.00 PPM



Produced by Mike Murphy, Lower Elkhorn NRD  
 Sources: Lower Elkhorn Natural Resources District  
 Nebraska Department of Natural Resources  
 November 9, 2021



For reference, the LENRD currently has a Phase 2 and 3 Management Area delineated in Pierce and northern Madison Counties. In 2021, District staff collected nitrate samples to provide additional baseline data to evaluate changes in groundwater quality. As depicted by the location data on the above map, the situation is still acute in Pierce County, and nitrate levels are not yet improving.

The LENRD also initiated a groundwater quality study in Dixon, Thurston, and Burt Counties, and while some of the preliminary data shows elevated nitrates in portions of Dixon and Thurston County, additional data will be necessary to properly assess groundwater quality in those locations.

To extend its collection of information in Cuming, Colfax, and Dodge Counties, the LENRD collected additional samples in those areas, and the information confirms the recommendation for delineation of a management area for the protection of groundwater quality, but a decision on that topic is still pending.

## 14.0 New Depletions Accounting Report

Table 6 below inventories the amounts for peak-season depletions allowed within the LENRD for each year of the first increment (2016-2021).

<b>Table 6: LENRD Summary of Allowable Depletions</b>				
<b>Depletion Description</b>		<b>Peak Season Depletion (AF)</b>		<b>Balance (AF)</b>
<b>LENRD 2016/2021 Allowable Dep.</b>				4514.00
2016/2017 LENRD			223.10	4290.90
2016/2017 NeDNR			117.00	4173.90
2017/2018 LENRD			292.00	3881.90
2017/2018 NeDNR			97.00	3784.90
2018/2019 LENRD			292.20	3492.70
2018/2019 NeDNR			70.00	3422.70
2019/2020 LENRD			286.40	3136.30
2019/2020 NeDNR			-103.60	3239.90
2020/2021 LENRD			292.00	2947.90
2020/2021 NeDNR			94.65	<u>2853.25</u>
<b>Remaining Balance 3/1/2022</b>				<b>2853.25</b>

## 15.0 New Data Collected Through Models or Studies

### *LENRD Hydrogeologic Groundwater Model*

For assessing the condition of a complex groundwater system and to understand its response to groundwater pumping stress, numerical groundwater modeling techniques are generally applied because they are recognized as the best available science available. The Lower Elkhorn Natural Resources District (LENRD) groundwater modeling project was undertaken to develop a semi-regional groundwater model that can simulate the three-dimensional (3D) groundwater flow of the historic conditions and quantify changes in the groundwater levels and aquifer storage from recharge to and pumping of the aquifer, and simulate its effects on stream baseflows.

The foundation for the development of the LENRD groundwater model includes the watershed model data developed by the Flatwater Group, Inc. for the Lower Platte Missouri Tributaries (LPMT) groundwater model, and the 3D geologic framework developed based on the Airborne Electromagnetic (AEM) data for the LENRD area by Leonard Rice Engineers, Inc. (LRE). Additional existing data available from various sources were incorporated subsequently during construction and calibration of the LENRD groundwater model by Long Spring Consulting, LLC (Long Spring).

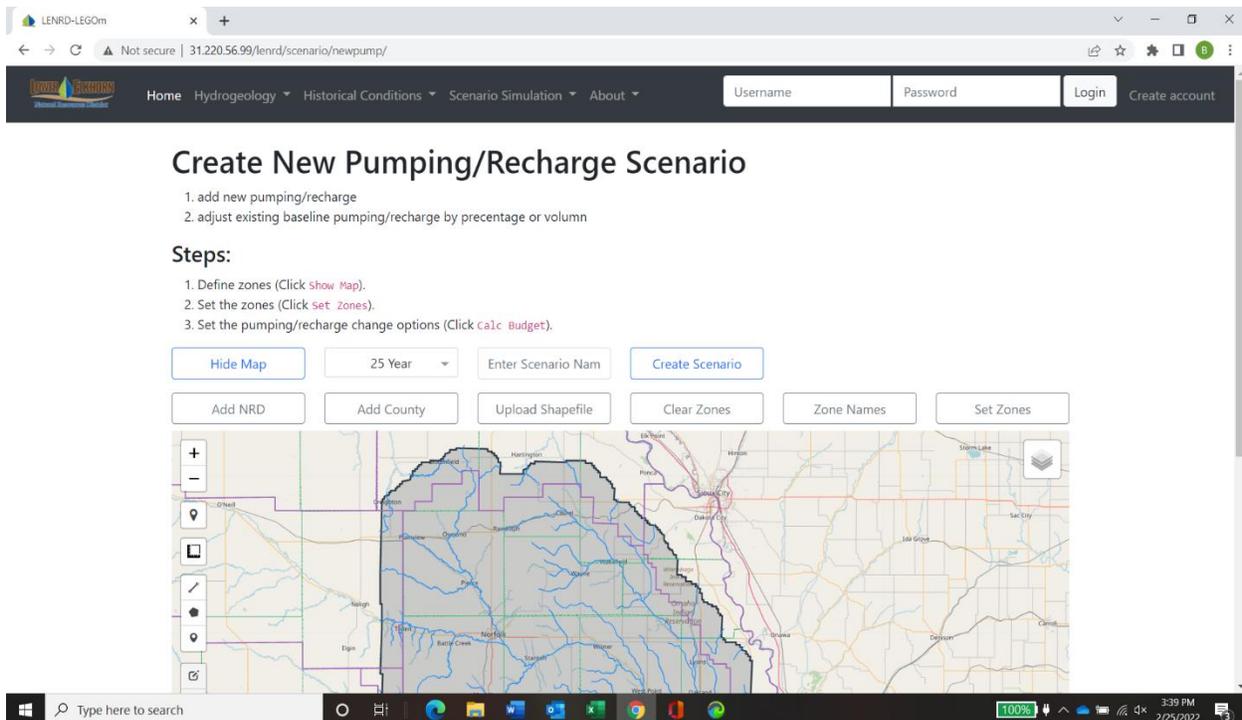
The LENRD groundwater model development effort began in 2018, after its approval by LENRD board. At the time Nebraska Department of Natural Resources (NeDNR) committed to partner with LENRD by funding part of the budget of model development. JEO

Consulting Group, Inc. (JEO) formed a working team with Long Spring and LRE to lead the construction and calibration of LENRD groundwater model.

In the past, NeDNR had finished developing a two-layer regional groundwater model for the LPMT domain, which covered the entire LENRD area. **Figure 1.1** shows the spatial extent of LPMT model in relation to the LENRD boundary. During the model development process, geologic information from the University of Nebraska Conservation and Survey Division (CSD) test holes data and NeDNR well logs data were applied to represent the principal and bed rock aquifer systems of the model area. The scope of this modeling study was not to reproduce every detail of the hydrogeologic system, and the development of the regional model focused on generalized hydrogeologic characteristics within the study area (HDR, 2018). The values of model parameters were then adjusted during the model calibration process.

As of this writing, the construction and calibration of the model is considered complete, and an initial draft of the Lower Elkhorn Natural Resources District Groundwater Model Report has been provided for review, and comments were provided that will be integrated into version 2.0.

In addition, a cloud-based Graphic User Interface (GUI) has been developed that will allow District staff to utilize the model for evaluation of multiple groundwater and surface water scenarios (see screenshot below). A virtual training was recently conducted that included NRD, NeDNR, and UNL CSD staff members. Participants were encouraged to continue to run test scenarios and to provide the developers with feedback.



## LENRD Vadose Sampling and Characterization of Isotopes

In 2021, the LENRD entered into contracts with the UNL Water Sciences Laboratory to collect vadose cores from locations within the Phase 3 area in Pierce County to be analyzed and stratified for residual soil nitrate, and a later amendment added the characterization of isotopes from those soil cores. Cores were initially collected from eleven (11) locations and a preliminary results report was provided by Dan Snow in January of 2022. Copied below is information from one of his slides which shows a wide range of residual Vadose NO<sub>3</sub>-N still stored in the soil profile. This project will continue in 2022 and will likely be expanded to other portions of the LENRD.

### Averages and totals

Core ID#	Gravimetric Water Content (gH <sub>2</sub> O/g sed)	pH	NH <sub>4</sub> -N (μg/g)	NO <sub>3</sub> -N (μg/g)	Pore Water NO <sub>3</sub> -N (mg/L)	Soil NO <sub>3</sub> -N (lbs- N/ Acre-Ft)	Total Stored Vadose NO <sub>3</sub> -N (lbs-N/acre)
LENRD-1	0.15	7.68	0.13	1.6	10.7	4.35	217.4
Friedrich	In process						
Thomsen	In process						
Mozer	0.09	8.18	1.08	1.33	14.8	3.61	252.9
Pendergast	In process						
Hilk	0.2	8.15	0.55	3.22	16.1	8.75	568.7
BELF	0.1	7.98	1.19	1.11	11.1	3.02	316.7
Byrons	0.12	7.28	1.05	0.65	5.4	1.77	35.3
RWE	0.17	9.19	2.2	1.16	6.8	3.15	236.4
K-L	0.22	7.9	7.33	2.32	10.5	6.30	126.1
Gutzmann	0.09	8.26	1.78	0.33	3.7	0.90	26.9

An additional project aimed to provide information for groundwater quality management is the collection of irrigation water samples for characterization of isotopes. 30 locations were sampled during 2021, and a preliminary view of the data from these samples is contained in the slide below.

Groundwater nitrate isotope compared to source ranges

