Water Committee Meeting
Wednesday, November 2, 2022 6:00 PM
Lower Platte North NRD Office
P.O. Box 126
Wahoo, NE 68066

1. UNFINISHED BUSINESS

2. REGULATORY

2.A. GROUND WATER MANAGEMENT AREA

2.A.1. Variance Request in the Hydrologically Connected Area (Limited Development Area)

Roland Otte contacted staff and has declined variance LPN-V-021-0555 for 5.79 Acre Feet of depletion credit.

Staff have contacted and reviewed variance from 2017 to 2020. A list of variances that were not developed is attached, with a letter being sent out to these producers explaining that their variance is expired and a new variance application would be required if they wanted to develop in the future. In the V-IMP report for the Coalition, staff would be taking credit for 259.89 AF of water .

2.A.2. Special Quantity Subareas

August Runge would like approval to complete the circle on the pivot. He is working with Bill Bos on projects within Shell Creek Watershed.

Does the Committee feel that staff and the Committee should discuss with a group of producers in the SQS # 2 area UNL study and management strategies? Does the NRD want to re-consider new wells and expansion of acres for certain parts of the management area? This will be an item for discussion at the Water Committee Retreat on November 30.

2.A.3. Well Permit (SQS #2)

Attached is a livestock well permit for a new well in SQS #2 for Robert Foltz. The well legal description is NW NW 12-19-2W for 1200 head of cattle. The well will pump 300- 500 GPM. A construction permit was approved by DEE in August of 2022 which includes debris basins, holding ponds and a storage pit. Mr Foltz's nutrient management plan approved in 2011 was for 1200 head. Apparently, a well under 50 GPM has been used.

The committee pointed out that 50 GPM well might be a challenge for watering larger cattle in the middle of the summer.

2.A.4. Groundwater Management Plan

Attached is the original Groundwater Management Plan from 1994. GW Rules

and Regulations are adopted from the Management Plan. Is it time to update the management plan?
More discussion at the retreat on November 30th.

2.A.5. Well Permit Program

2.A.5.a. Well Permits Approved

2.A.5.b. Wells Permits Approved: #

2.A.5.c. **Landowner**	2.A.5.d. **Number of Wells**	2.A.5.e. **Number of New Irrigated Acres**	
2.A.5.i. Robert & Kelli Foltz	2.A.5.j. 1	2.A.5.k. 0	
2.A.5.o.	2.A.5.p.	2.A.5.q.	
2.A.5.u.	2.A.5.v.	2.A.5.w.	
2.A.5.aa.	2.A.5.bb.	2.A.5.cc.	
2.A.5.gg.	2.A.5.hh.	2.A.5.ii.	

2.A.5.mm.

2.A.5.nn.
2.A.5.oo.
2.A.5.pp.
2.A.5.qq.
2.A.5.rr.
2.A.5.ss. The total number of approved permits for 2022 is #

Location of Approved Well Permits for 2022: Correct as of ####

2.A.5.tt. **County**	2.A.5.uu. **Irrigation - New**	2.A.5.vv. **Irrigation - Replacement**	
2.A.5.bbb. **Butler**	2.A.5.ccc.	2.A.5.ddd.	
2.A.5.jjj. **Colfax**	2.A.5.kkk.	2.A.5.lll.	
2.A.5.rrr. **Dodge**	2.A.5.sss.	2.A.5.ttt.	
2.A.5.zzz. **Boone**	2.A.5.aaaa.	2.A.5.bbbb.	
2.A.5.hhhh. **Madison**	2.A.5.iiii.	2.A.5.jjjj.	
2.A.5.pppp. **Platte**	2.A.5.qqqq.	2.A.5.rrrr.	

2.A.5.xxxx. **Saunders**	2.A.5.yyyy.	2.A.5.zzzz.	
2.A.5.fffff. **Total**	2.A.5.ggggg.	2.A.5.hhhhh.	

2.A.6. Certified Irrigated Acre Transfer

A transfer application is attached for Duane Johnson. Annette Rogers has agreed to transfer 67 irrigated acres (SE NE & NE SE S11-14N-9E, Saunders Co.) from Yutan South Aquifer Region to the Duane Johnson tract (N1/2 NE S25-14N-7E, Saunders Co.) located on the east edge of the Swedeburg Aquifer Region.

Assessor shows 64.81 irrigated acres and NRD has 65.51 certified irrigated acres for the Roger's tract. In the past, the Board allowed a 5 acre allowance without an additional variance. Duane plans on irrigating 70 acres total with 2 small pivots.

The tract for the Annette Rogers is where the solar farm will be going and she plans on decommissioning the irrigation well.

If the transfer is approved acre for acre, there will be an increase of 1.62 acre feet of depletion. If approved based on acre feet, the transfer would decrease to 57.71 acres.

Discussion at the Committee meeting was about soil types and scoring in the transfer application process onto the receiving tract of land. Soil types are classified as low bottom with occasional flooding as a Class 6-8 soil type which receives 0 points on the scoring sheet. Staff will review the soil type scoring with NRCS with a potential recommendation and change at the Board Meeting. A motion from the floor could be needed on the scoring sheet policy, if staff bring forward a soil type recommendation change.

2.A.7. Cost Share Programs

2.A.7.a. Flow Meter Maintenance Program

Tri City Meters out of Alda is preparing for year 3 of flow meter maintenance. Maintenance is scheduled to begin in Mid-November or maybe sooner due to an early harvest this year. All of the west township flow meters are scheduled to be maintained next month. There are 348 flow meters in this area. Each site visit for the mechanical meters is $60.00 and each site visit for the battery powered meters is $75.00. Mechanical meters will be re-greased and checked to make sure they are operating correctly and don't have any damage. If the mechanical meter needs to be repaired, that is at the expense of the landowner and is billed directly from Tri City Meters. The batteries in the electronic flow meters will be replaced. The upfront cost of the batteries is absorbed by the NRD and then in turn we bill the producer for the expense of the battery and then receive reimbursement.

2.A.8. Bellwood Phase 2 Area

2.A.9. 2022 is the twentieth year for this Phase 2 Area.

2.	2.A 2.A	2.A 2.A 2.A	2.A 2.A 2.A	2.A 2.A 2.A	2.A 2.A 2.A
2.	2.A	2.A	2.A	2.A	2.A

2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A

2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A

2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A

2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A
2.	2.A	2.A	2.A	2.A	2.A

2.A.139. Richland - Schuyler Phase 3 Area

2.A.140. 2021 is the seventh year of this Phase 3 Area. This Phase 3 area went into effect September 1, 2015. The 55 sections of this area first went into a Phase 2 Area in 2004. The ten sections that were in Phase 2 are now in Phase 3. As such, the 2020, 2021 and 2022 numbers (at bottom of table) are for 65 sections.

2.A.141. **Year**	2.A.142. **Nitrate-nitrogen Range**	2.A.143. **Percent** 2.A.144. **Nitrate-nitrogen** 2.A.145. **0 to 8.0 ppm**	2.A.146. **Percent** 2.A.147. **Nitrate-nitrogen** 2.A.148. **8.01 to 10.00 ppm**

2.A.155. 2004	2.A.156. 0 to 47 ppm	2.A.157. 30% (42 of 139)	2.A.158. 10% (14 of 139)
2.A.161. 2005	2.A.162. 0 to 120 ppm	2.A.163. 31.3% (74 of 236)	2.A.164. 10.2% (24 of 236)
2.A.167. 2006	2.A.168. 0 to 53 ppm	2.A.169. 28% (50 of 181)	2.A.170. 14% (26 of 181)
2.A.173. 2007	2.A.174. 0 to 99 ppm	2.A.175. 32% (75 of 231)	2.A.176. 10% (22 of 231)
2.A.179. 2008	2.A.180. 0 to 46 ppm	2.A.181. 28% (53 of 190)	2.A.182. 12% (23 of 190)
2.A.185. 2009	2.A.186. 0 to 57 ppm	2.A.187. 33% (72 of 216)	2.A.188. 6% (13 of 216)
2.A.191. 2010	2.A.192. 0 to 57.5 ppm	2.A.193. 31% (70 of 229)	2.A.194. 7% (15 of 229)
2.A.197. 2011	2.A.198. 0 to 65.8 ppm	2.A.199. 28% (67 of 241)	2.A.200. 9% (21 of 241)
2.A.203. 2012	2.A.204. 0 to 52.6 ppm	2.A.205. 29% (70 of 241)	2.A.206. 9% (21 of 241)
2.A.209. 2013	2.A.210. 0 to 94.0 ppm	2.A.211. 25% (63 of 252)	2.A.212. 9% (23 of 252)
2.A.215. 2014	2.A.216. 0 to 101.0 ppm	2.A.217. 27% (68 of 251)	2.A.218. 9% (22 of 251)
2.A.221. 2015	2.A.222. 0 to 53.3 ppm	2.A.223. 23% (55 of 238)	2.A.224. 12% (29 of 238)
2.A.227. 2016	2.A.228. 0 to 50.5 ppm	2.A.229. 25% (58 of 228)	2.A.230. 10% (22 of 228)
2.A.233. 2017	2.A.234. 0 to 53.4 ppm	2.A.235. 25% (60 of 238)	2.A.236. 6% (14 of 238)
2.A.239. 2018	2.A.240. 0 to 56.9 ppm	2.A.241. 26.5% (50 of 189)	2.A.242. 6.3% (12 of 189)
2.A.245. 2019	2.A.246. 0 to 39.4 ppm	2.A.247. 25% (53 of 209)	2.A.248. 11% (22 of 209)
2.A.251. 2020	2.A.252. 0 to 50.8 ppm	2.A.253. 26% (69 of 261)	2.A.254. 6% (15 of 261)
2.A.257. 2021	2.A.258. 0 to 43.0 ppm	2.A.259. 25.5% (67 of 263)	2.A.260. 8.4% (22 of 263)
2.A.263. 2022	2.A.264. 0 to 58.5 ppm	2.A.265. 23.0 % (57 of 248)	2.A.266. 6.45 % (16 of 248)

2.A.269. LPNNRD Operator Certification

Staff and UNL are starting to set up meetings for Nitrogen Certification

Classes. The first meeting is planned for December 20th at the Oak Ballroom in Schuyler, starting at 1 pm. This meeting is designed for producers that have let their certification lapse. It would be appreciated to encourage producers to show the value of the meetings.

Purpose of the meetings

- Open up lines of communication with NRD and UNL staff
- Able to discuss issues arising within the NRD
- Get up-to-date information on nitrogen and irrigation management

2.B. CHEMIGATION

Chemigation totals for the 2022 growing season:

Attached is the full report

-57 new applications were applied for, inspected, and approved.

-1 emergency permit was applied for, inspected, and approved. This is no longer an active permit.

-185 renewal permits were inspected this year.

-21 re-inspections.

-5 renewal permits that were cancelled.

-264 total inspections were completed this year.

-727 active permits within the LPNNRD.

2.C. GROUND WATER ENERGY LEVELS

The staff has completed Fall Water Levels with some wells from SQS #1 attached showing spring and fall levels. Should the staff/committee have a discussion with producers in this area?

The committee requested that staff develop a graph to display the saturated water bearing formation compared to water levels in determining how low water levels were at the bottom of the saturation zone.

2.D. GROUND WATER QUALITY SAMPLING

UNL and NRD staff conducted a NRD approved denitrification study within the Schuyler-Richland Management Area. An invoice is attached from UNL with results shown to the Committee after staff review.

3. GROUND WATER PROGRAMS

3.A. DECOMMISSIONED WELL PROGRAM

Staff have discussed the possibility of one staff member obtaining a pump installer or well driller license to decommission wells. Sean Elliott has agreed to take the test to oversee the decommissioning of wells.

3.A.1. Well Estimates

3.A.2. # new wells has been reviewed and approved for decommissioning since the last Committee meeting.

3.A.3. **Well Owner**	3.A.4. **Type of Well**	3.A.5. **Cost Share Estimate**	3.A.6. **County**
3.A.7. Randall E Nelson	3.A.8. Domestic	3.A.9. $819.20	3.A.10. Madison
3.A.11.	3.A.12.	3.A.13.	3.A.14.
3.A.15.	3.A.16.	3.A.17.	3.A.18.

3.A.19. Plugged Wells

3.A.20. # wells have been plugged, reviewed, and ready for cost share payment approval this month.

3.A.21. **Well Owner**	3.A.22. **Type of Well**	3.A.23. **Cost Share Estimate**	3.A.24. **County**
3.A.25.	3.A.26.	3.A.27.	3.A.28.
3.A.29.	3.A.30.	3.A.31.	3.A.32.
3.A.33.	3.A.34.	3.A.35.	3.A.36.

3.B. LOWER PLATTE NORTH NRD GROUND WATER STUDIES

3.B.1. Phase Area Update

More discussion on this item will occur at Water Retreat on November 30th.

Information is attached on nitrogen management and the possibility of a Phase 4 area. The WSF grant, that was submitted by the NRD, was approved for best management practices and hydrological assessment for the whole district. Staff will be starting the RFQ process for the Assessment when the grant papers are signed with the Commission. The Committee/ Board will need to set up cost-sharing procedures for these practices.

The grant for age dating of groundwater did not get out of the NET review for scoring. Staff and USGS are in contact to understand the reasoning.

It is encouraged to check out this article on nitrates. https://flatwaterfreepress.org/our-dirty-water-nebraska-water-nitrates/

3.B.2. Phoenix Database

Attached is the second half of the payment for the approved agreement with Phoenix Webgroup at the June Board Meeting. An invoice for $5,000 will be sent to Nebraska DEE for their portion. This project will streamline LPNNRD water quality data into the Clearinghouse, which is used for an annual report to the State Legislature.

3.B.3. Lower Platte River Consortium

The next ILCA meeting is scheduled for 10 a.m. on Thursday, November 17. This meeting will be **in person** at the MUD Platte West Water Treatment Plant, 21212 Q St, Elkhorn, NE 68022. We will be continuing the drought mitigation projects discussion. It is encouraged for Committee or Board members to attend.

Attached is the drought plan that was developed in 2019. Does LPN want to add to the drought plan with drought management protocols?   At the present time, the plan is designed for awareness and public outreach. Migration projects will continue to be discussed.

Lower Loup NRD draft drought plan is attached.

3.C. Modeling Inter-local Agreement

The modeling grant between NeDNR, Papio and LPS NRDs was not approved for a WSF grant. At the October Board meeting, the agreement was approved with the stipulation of a WSF grant approval. Staff held off on getting signatures until a final copy was received and in that time period a decision was determined on the grant. Papio and the LPS Board did approve the inter-local, knowing that an amendment would be needed to adjust the dollar amounts. Does the NRD want to proceed with an inter-local agreement? The plan is to re-apply in March, as the Commission has set an earlier date for WSF grant approvals.

3.D. Water Committee Retreat

The staff and Water Committee is planning a retreat on November 30th from 3 to 5:30 pm at the NRD Board Room in Wahoo. This is open to all Board members. The Water Committee meeting will be at 6 pm.

Tentative Discussion Items

- Groundwater Quality
    - Phase Areas
    - Triggers
    - Cost-share Practices
- Groundwater Quantity
    - Management Area Adjustments
    - Allocations
    - Flow Meters
- Nitrogen/Irrigation Certifcation

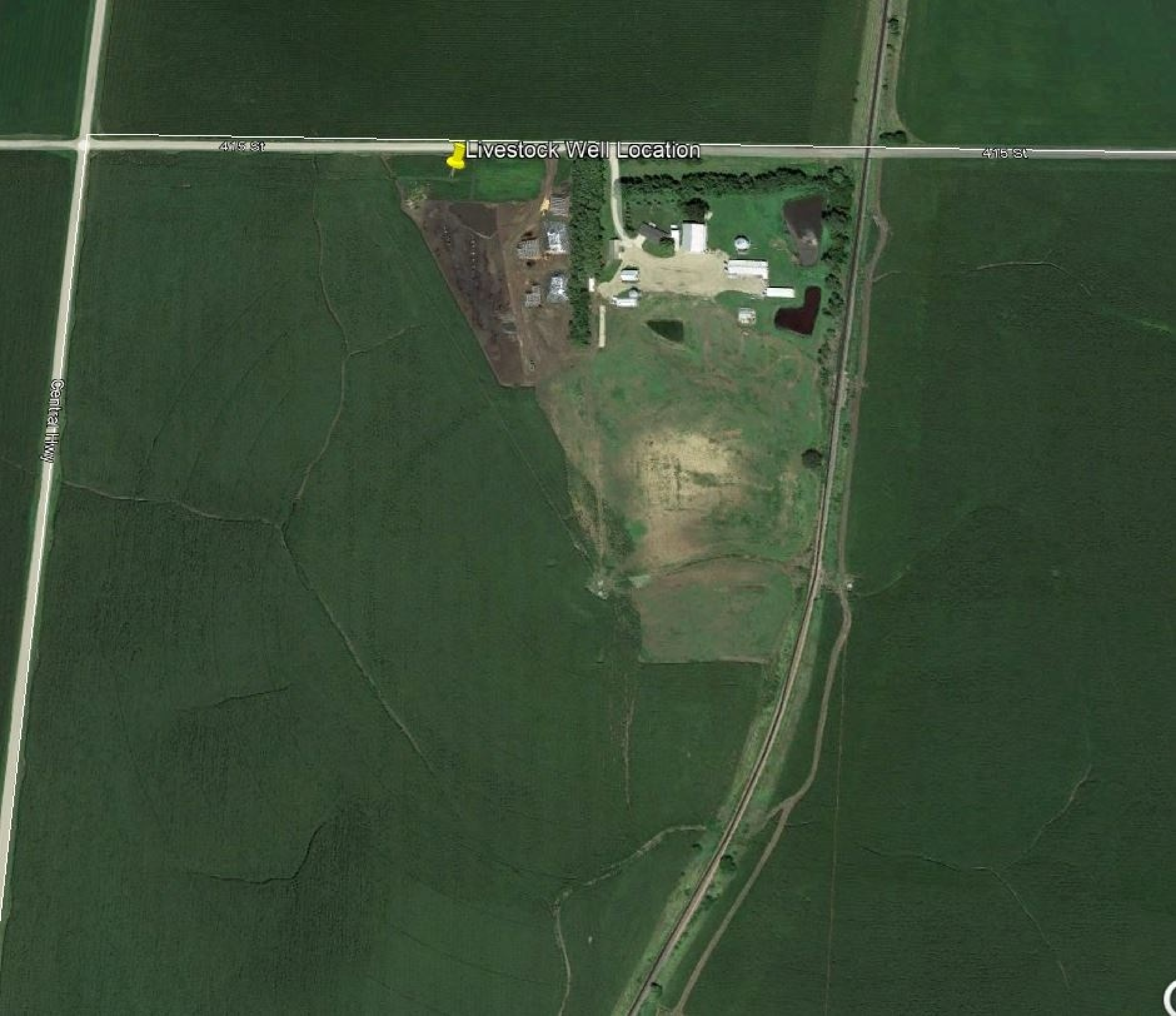
- 1994 Groundwater Managment Plan
- Other items?

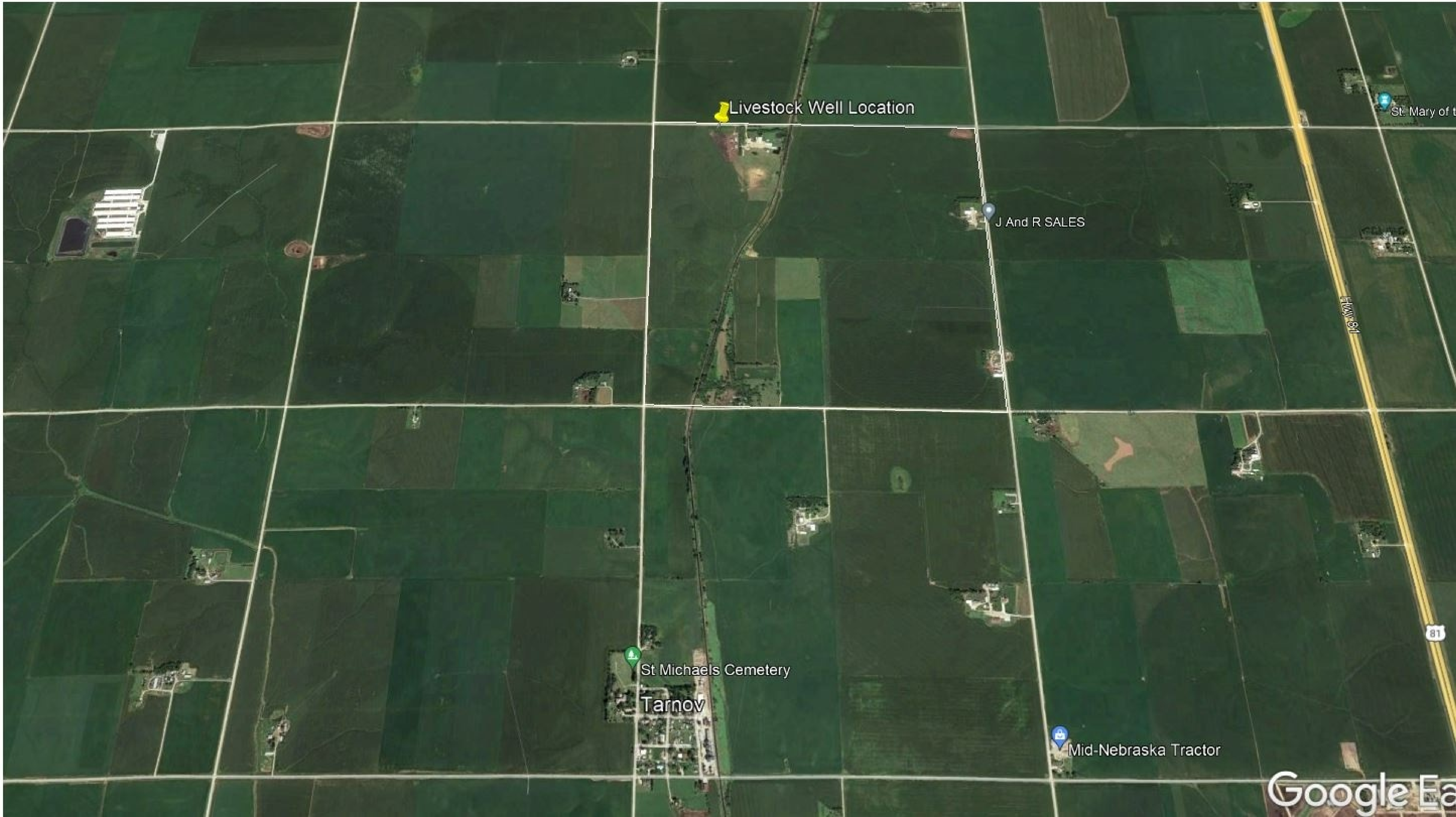
4. SURFACE WATER PROGRAMS

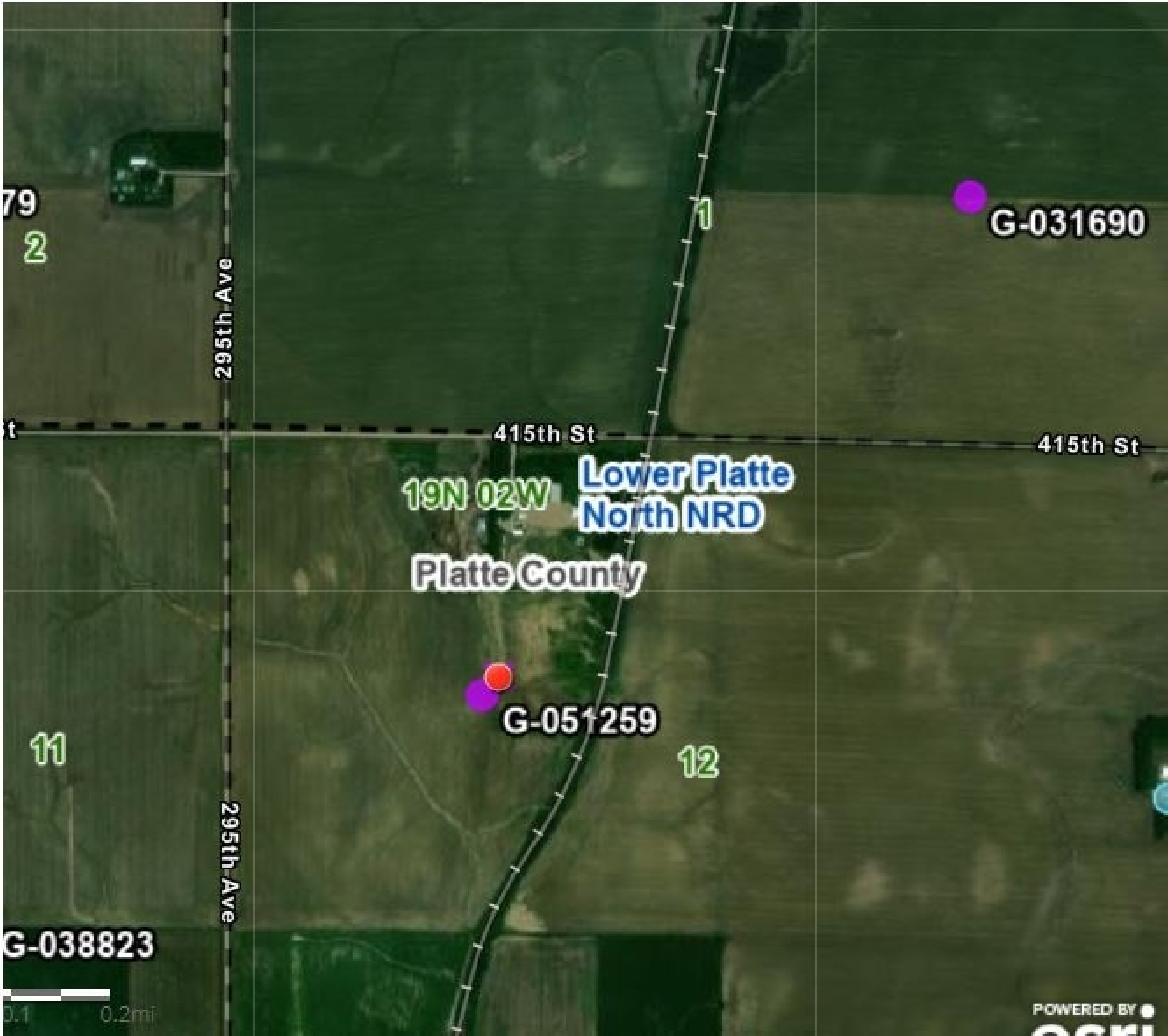
5. OTHER
   GMDA Winter Conference in Georgia January 23-26, which is the same time as the NARD Legislative Conference.
   5.A. COMMENTS FROM THE PUBLIC

Application #	Applicant	type (new or expansion)	Acres	Subarea	SDF	Total Depletion	Variance Approval Year
LPN-V-013-0308	Dean Ellermeier (deceased)	New	70	North Benc	0.73	10.2711	2017
LPN-V-015-0432	Eugene Volnek	New	53	Fremont Ea	0.96	10.22688	2017
LPN-V-014-0401	John Becker	New	74	Upper New	0.589	8.760786	2017
LPN-V-012-0189	Gerald McPhillips	New	130	Lower New	0.691	18.05583	2017
LPN-V-013-0325	John Snover	New	100	North Benc	0.717	14.4117	2017
LPN-V-013-0304	Ross Nelson	New	78	Newman G	0.686	10.755108	2017
LPN-V-014-0391	Windmill Management LLC	New	117	Todd Valley	0.895	21.047715	2017
LPN-V-013-0279	John J Vybiral	New	65	Todd Valley	0.779	10.177635	2017
LPN-V-017-0466	Frank Vech	Expansion	40	Todd Valley	0.783	6.29532	2017
LPN-V-017-0455	Randy Kavan	Expansion	15	Todd Valley	0.851	2.565765	2017
LPN-V-014-0370	Alex Kavan	Expansion	25	Weston	0.96	4.824	2017
LPN-V-016-0436	Gary Mausbach	New	90	Middle She	0.553	10.00377	2017
LPN-V-013-0337	Roland Langemeier	Expansion	5.45	Schuyler	0.96	1.1772	2018
LPN-V-013-0247	Mark Kavan	New	100	Weston	0.87	19.575	2018
LPN-V-013-0275	Ernest Osantowski	Expansion	30	Bellwood	0.928	6.264	2018
LPN-V-013-0355	Anthony L Vogel	Expansion	36	North Benc	0.811	6.5691	2018
LPN-V-013-0287	Bryan Ritthaler	New	85	Leshara Up	0.912	17.442	2018
LPN-V-013-0248	Randall Bundy	New	65	Todd Valley	0.895	13.089375	2018
LPN-V-013-0281	James Macholan	New	36	Schuyler	0.897	7.2657	2018
LPN-V-012-0194	Donald Gasper	Expansion	54	Upper New	0.806	9.7929	2018
LPN-V-013-0362	Joe Houska	New	130	Swedeburg	0.792	23.166	2018
LPN-V-019-0494	Clayton Wacker	New	108	North Benc	0.135	3.402	2019
LPN-V-012-0159	Fred Fehringer	New	85	Lower New	0.688	13.14	2019
LPN-V-020-0509	Alan Kettelson	New	120	Upper New	0.43	11.61	2020
					Total	259.89	


NE141-1801E7-0001
175th Ave
175th Ave
175th Ave
Sander Cir
Sander Dr
310th St


415 St
Livestock Well Location
415 St
Central Hwy


Livestock Well Location
J And R SALES
St. Mary of t
Hwy 81
81
St Michaels Cemetery
Tarnov
Mid-Nebraska Tractor
Google Ea



79
2
295th Ave
1
G-031690
415th St
415th St
19N 02W
Lower Platte North NRD
Platte County
G-051259
11
12
295th Ave
G-038823
0.1
0.2mi
POWERED BY

APPLICATION FOR A PERMIT TO CONSTRUCT A WATER WELL
IN THE *LOWER PLATTE NORTH NATURAL RESOURCES DISTRICT*

DNR & NRD USE ONLY		
Permit No. ________	Date Approved/Denied ________	NRD Representative ________
Permit Type: New, Replacement or Late	Date Received ________	Paid: Cash or Check
Date Post-inspected ________	Registration No. ________	

ALL APPLICANTS SEEKING A WATER WELL PERMIT MUST COMPLETE PAGES 1 AND 2, AND THE APPROPRIATE SECTION BASED ON THE PURPOSE OF THE WELL. (CLASS 1 – 4 WELL PERMIT)
WATER WELL PERMITS FOR IRRIGATED ACRES GREATER THAN 160 ACRES IN SIZE OR TOTAL ANNUAL WATER USE BETWEEN 150 AND 300 ACRE FEET PER YEAR MUST COMPLETE PAGES 1, 2, AND 3, AND THE APPROPRIATE SECTION BASED ON THE PURPOSE OF THE WELL. (CLASS 3 WELL PERMIT)
WATER WELL PERMITS FOR TOTAL ANNUAL WATER USE EQUAL TO OR GREATER THAN 300 ACRE FEET PER YEAR, REGARDLESS OF NUMBER OF IRRIGATION ACRES, MUST COMPLETE PAGES 1, 2, AND 4, AND THE APPROPRIATE SECTION BASED ON THE PURPOSE OF THE WELL. (CLASS 4 WELL PERMIT)

1. NAME AND ADDRESS OF **LAND OWNER:**
Robert A & Kelli Foltz
26993 430th St
Humphrey NE 68642
Phone: 402-920-0391

NAME AND ADDRESS OF **CONTACT:**
____
Phone: ________

2. PURPOSE OF NEW WATER WELL (indicate one):
__ Irrigation (Complete section A)
X Livestock (Complete section C)
__ Industrial (Complete section E)
__ Recovery or Remediation (Complete section G)
__ Other (specify) ________ (Complete section H)
__ Dewatering (Over 30 days, Complete section B)
__ Domestic (Irr. on one acre or larger, Complete section D)
__ Public Water Supply (Complete section F)

3. IDENTIFY LOCATION OF PROPOSED WELL:
A. Platte County, NW ¼ of the NW ¼ of Section 12, Township 19 North, Range 2 East/West (circle one)

B. The box at the right represents one square mile, (section). Indicate with an "X", the proposed location of the well. Outline the proposed water use area. If the water is to be used outside the above written legal description, give legal description of water use area,
____ ¼ of the ____ ¼ of Section ____,
Township ____North, Range ____ East/West.

NWNW X	NENW	NWNE	NENE
SWNW	SENW	SWNE	SENE
NWSW	NESW	NWSE	NESE
SWSW	SESW	SWSE	SESE

1 mile, ½ mile, ¼ mile, 1320', 2640', 5280', N

C. The well will be located 70 feet from the North/South section line, and will be 1100 feet from the East/West section line. Or enter Lat. / Long.
Latitude Degree ______ Minute ______ Second ______
Longitude Degree ______ Minute ______ Second ______

4. REPLACEMENT AND ABANDONED WELL INFORMATION:
A. Is this a replacement well? __ Yes, X No If yes, fill out the rest of this section.
B. Registration number of well to be replaced: ________
C. Well to be replaced was last operated (month/year): ________
D. Replacement well is ________ feet from original well.
E. Decommissioning of Original well on (month/day/year): ________
F. If water use is for irrigation, list the number of acres watered by the original well: ________
G. If water use is for irrigation, will replacement well, water the same tract of land as the decommissioned well?
__ Yes, __ No: If No, list the number of additional acres ________ and legal description ____ ¼ of the ____ ¼ of Section ____, Township ____ North, Range ____ East/West. (circle one)

- A replacement water well must deliver water to the same tract of land as the original water well, pump from a comparable aquifer, and yield approximately the same gallons per minute and total annual water use as the original water well.

APPLICATION FOR A PERMIT TO CONSTRUCT A WATER WELL
IN THE *LOWER PLATTE NORTH NATURAL RESOURCES DISTRICT*

PURPOSE OF WELL

IRRIGATION WELLS (SECTION A)

A. How many acres will be irrigated? ___________ acres
B. Crops to be planted: ______________________ Crop rotation schedule ______________________
C. Type of irrigation system. __ Center Pivot, __ Gravity, __ Other (specify) ______________________
D. The irrigation system is to be powered by __ Electric __ Fuel
E. Expected total annual consumptive water use in Acre Inches / Year ___________ or
Total Gallons / Year ______________
F. Will Fertilizer, Chemicals or Animal waste be applied through the system? __ Yes, __ No

DEWATERING WELLS OVER 30 DAYS (SECTION B)

A. Purpose of dewatering well, such as installation of building foundation, etc. ______________________
B. Expected total number of days the dewatering well will be in use __________
C. Approximate dates (month/day/year) in operation: Start ______________ End ______________
D. Legal description of water discharge location: ____ ¼ of the ____ ¼ of Section ____, Township ____North, Range ____ East/West and name of river, stream or water body ______________________
E. Will discharge water be used for another purpose, such as livestock, irrigation, etc.? __ Yes, __ No
If Yes, list purpose, location and expected total amount of water use in acre-inches / year or total gallons / year.

LIVESTOCK WELLS (SECTION C)

A. Name of facility Robert A + Kelli Foltz
B. Type of Livestock: X Feeder Cattle, ___ Dairy Cattle, ___ Swine over 55 lbs., ___ Swine under 55 lbs., ___ Sheep, ___ Poultry, ___ Horses
C. Average number of livestock per year 1200 ? and average weight per animal 1200 lbs.
D. Peak number of livestock 1200 and time of year ______________
E. Is facility approved by Nebraska Department of Environmental Quality? X Yes, __ No. If Yes, list NDEQ certification IIS number __________ If No, complete the rest of this section.
F. Type of facility: X Open lot, ___ Covered Building
G. If facility is Open lot, list soil type clay
H. Estimated depth to ground water under feedlot 104 ft.
I. Describe manure collection system of feedlot lagoon
J. Name and distance of nearest surface watercourse from feedlot Tracy Creek ? 200'
K. For each manure land application site, list legal description and size in acres, method of application, and distance from feedlot operation. ______________________

DOMESTIC WELLS WITH IRRIGATION ON ONE ACRE OR MORE (SECTION D)

A. Check all that apply:
   a. Water use: ___ Lawn and number of acres to be irrigated __________ acres.
   b. Water use: ___ Commercial garden and number of acres to be irrigated __________ acres.
   c. Water use: ___ Tree Farm and number of acres to be irrigated __________ acres.
   d. Water use: ___ Type of livestock ______________ and number ___________
B. Type of irrigation system. __ Sprinkler, __ Drip Tape, __ Other (specify) ______________________
C. If applicable, give Street address and town ______________________

* One acre equals 43,560 square feet.

5. **SPECIFICATIONS OF INTENDED WELL AND PUMP:**
   A. Approximate date when construction will begin (month/day/year): Oct 2022
   B. Expected total well depth: 266 feet.
   C. Well Casing Diameter: 12 or 16 inches.
   D. Pump Column Diameter: 4 or 6 inches.
   E. Estimated pumping capacity: 300-500 GPM.
   F. Expected total annual water use in Acre Inches / Year ______ or Total Gallons / Year ______
   G. The system is to be powered by __ Electric __ Fuel
   H. Will the well be used in a system with other wells? __ Yes, X No. If Yes, How many ______
      List well registration number and legal description of each well in Section 6 below.
   I. Name of Well Driller: Grosch Irrigation - Albion (Please attach test hole log, if available.)

6. List additional information requested in this Section or attached additional sheet.

7. Addition information and requirements for Lower Platte North NRD review.

   - Attach current tax assessor records including map, parcel number, and current land use such as irrigated acres.
   - Attach aerial photo showing location of water source(s) and area water or reuse water is to be used.
   - All new and replacement water wells must install a District approved flow meter and report water pumped annually to the LPNNRD by January 31st of the following year. See approved list in this packet.
   - Water well permit conditions maybe required for approval by the Lower Platte North NRD for each individual well.

8. I certify that I am familiar with the information contained in this application, and it's restrictions, rules and regulations and that to the best of my knowledge and belief such information is true, complete and accurate.

   Date 10/14/22 Signature of Applicant Robert A. Fotz
   Signature of Well System Operator, if different than Applicant ______
   NRD Certification Number of Landowner or Operator ______ (Required for irrigation, livestock, domestic (with irrigation on one acre or more of land), industrial, and public water supply wells.)

9. **Lower Platte North NRD Use Only. Comments by District Representative.**

File: WellPermit2008_050908.doc

LOWER PLATTE NORTH
NATURAL RESOURCES DISTRICT
P.O. BOX 126, COMMERCIAL PARK ROAD, WAHOO, NEBRASKA 68066
PHONE (402) 443-4675 • FAX (402) 443-5339

LOWER PLATTE NORTH NRD BOARD OF DIRECTORS

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1	Frank Williams
2	David Shelso, Secretary
2	Mary Sendgraff
3	Steven Grueber
3	Gene Hansen
4	Raymond Kracl
4	Melvin Sahs
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RECEIVED GROUND WATER MANAGEMENT PLAN
OCT 26 1994
DEPARTMENT OF WATER RESOURCES

LOWER PLATTE NORTH NRD STAFF

Raymond Hartung	General Manager
John Miyoshi	Assistant Manager
Larry Angle	Water Resources Manager
Bob Heimann	Operations & Maintenance Manager
Jill Breunig	Administrative Assistant
Ann Slater	Secretary/Bookkeeper
Ann Youngberg	Information Specialist
Kristen Gottschalk	Education Specialist
Shaula Burger	Water Resources Specialist
Dan Ludwig	Water Resources Specialist
Frank Albrecht	Water Resources Specialist
Sam Barlean	Field Technician
Joe Sabata	Field Technician
Bill Warner	Recreation Facility Manager

Some animals, fish, and birds that previously existed in large numbers in the District are now infrequently present or completely gone. The use of pesticides and loss of habitat has had an extremely negative impact for a variety of species. Some of the endangered or threatened species known to be or may have been in the District include: bald eagle, least tern, piping plover, peregrine falcon, swift fox, black footed ferret, river otter, pallid sturgeon, and blacknose shiner (Nebraska Game and Parks Commission). Much of this wildlife depends heavily upon habitat, food, and water supported by groundwater supplies in the District.

The grasslands, woodlands, and waters of the District support many animals, birds, insects, and aquatic life that are too extensive to mention in this short section. One endangered plant species which has been identified as possibly inhabiting the NRD is the Western Prairie fringed orchid. While this plant species has been observed to be present in Southern Dodge County, it may also be present in other areas of the NRD. The southern Dodge County site is located on an upland in a perched water table setting, which would not be considered part of the manageable groundwater reservoir (Personal Communication - Mike Fritz- Nebraska Game and Parks Commission, April 1994). In this area, land use changes would be more of a threat to the orchid than changes in water quantity in the principal aquifer. As development encroaches upon remaining natural grasslands, the potential for extinction of this species increases greatly. The NRD has embarked upon a program to protect and preserve some of the valuable wetland and grassland resources within it boundaries, because it is aware of the need for such preservation for future generations. The general protection of groundwater quality and quantity is important to preservation of habitats of indigenous and threatened and endangered plant and animal species. Any NRD actions to manage the groundwater resources within District boundaries will be evaluated as it may impact these valuable resources. If adverse effects on sensitive resources are identified from changing groundwater quantity or quality, the NRD will evaluate the need for modification of its Groundwater Management plan as allowed under the

Nebraska Groundwater Management and Protection Act, to reduce adverse affects. The NRD will continue to support hydrologic and hydrogeologic studies which will contribute to the foundation of knowledge needed to locate and identify orchid habitat and other water related sensitive habitats.

collected, a better picture of the long-term trend in water levels in the District aquifers will develop. The "index" year can be adjusted over time to more closely approximate a "normal" year.

The levels shown in Exhibit 25 can be placed into perspective by consideration of their relationship to the saturated thickness of the aquifer. Exhibit 20 is a map of saturated thickness of the various coarse grained aquifers of the District from the 1985 Plan and Table 5 summarizes the net water level changes as a percentage of saturated thickness.

Table 5

Net Water Level Change as a Percentage of Saturated Thickness, Selected Wells: Lower Platte North NRD Groundwater Level Data; Spring 1987 - Spring 1993

Well #	County	Aquifer	Long-Term Net Change (feet)	Estimated Saturated Thickness (ft)	Approximate % of Saturated Thickness
6	Platte	Shell Creek	-5.0	50 - 100	5 - 10
8	Platte	Shell Creek	-5.2	75 - 100	5 - 7
12	Platte	Shell Creek	-4.4	100 - 150	3 - 4
17	Platte	Shell Creek	+2.2	75 - 100	2 - 3
21	Colfax	Shell Creek	-2.5	75 - 100	2 - 3
24	Butler	Platte Valley	-6.1	75 - 100	6 - 8
25	Butler	Platte Valley	-6.7	75 - 100	6 - 9
66	Dodge	Platte Valley	-6.5	25 - 50	13 - 26
27	Butler	Uplands	-3.3	150	2
30	Butler	Uplands	-10.9	100 - 150	7 - 11
31	Butler	Uplands	-7.2	150 - 200	3 - 5
34	Saunders	Uplands	-0.4	100 - 150	<1
43	Saunders	Uplands	-2.4	75 - 100	2 - 3
48	Saunders	Uplands	-7.3	75 - 100	7 - 10
49	Butler	Uplands	-4.0	150 - 200	2 - 3
53	Butler	Uplands	-9.4	0 - 25	>38
57	Saunders	Todd Valley	-6.3	100 - 150	4 - 6

As shown in Table 5, a water level decrease in Well No. 31 (saturated aquifer thickness of 150 to 200 feet) does not carry the same implications as a 10 feet decrease in Well No. 53 (saturated aquifer thickness of 0 to 25 feet). The water level decline in the former well is less than 5 percent of aquifer saturated thickness, while in the latter just 6 miles to the north, it is over 35 percent.

Platte River Results of monitoring in this reservoir show slight declines (<5 feet) from predevelopment (U.S.G.S. data) and slightly greater declines (still less than 5 feet on average) against the index year.

Todd Valley Results of monitoring in the Todd Valley show slight declines (<5 feet) from both predevelopment and the index year. One well in upper Clear Creek shows a water level decline approaching 10% of saturated thickness.

General

1) The current monitoring network includes 79 wells. Expansion of the network in areas where few wells are presently monitored (e.g., Shell Creek) and in areas where problems may be present or will be in the near future is planned. In 1993, the NRD plans to expand the network to include 120 wells.

2) Determination of well elevations are necessary for all wells so that water table elevation maps can be constructed and regional and local changes in groundwater flow direction can be assessed.

3) Refinement of the LPN NRD groundwater computer model is needed to predict vulnerable areas to groundwater decline.

4) More information is needed on aquifer recharge rates and discharge (including water use).

5) A consistent scheme for evaluation of water level changes is needed to quantify their significance. The NRD has established an "Index" year of 1987 to reference changes. As time progresses and more data is acquired, appropriate "index" levels may be adjusted to more closely approximate "predevelopment" water levels.

THE PLAN FOR GROUNDWATER MANAGEMENT IN THE LOWER PLATTE NORTH NATURAL RESOURCES DISTRICT

Section A
Framework for Groundwater Management

The Lower Platte North NRD prepared a Master Plan for resources management in the late 1980's, which serves as a parent document to the 1994 updated Groundwater Management Plan. The Master Plan is the foundation from which individual resource planning occurs, and guides the allocation of financial and manpower resources. The Water Quality, Supply, and Pollution Abatement goal and subsequent objectives to support the goal which are present in the Master Plan follows:

GOAL

ASSURE ADEQUATE QUANTITY AND QUALITY OF STREAM FLOW, GROUNDWATER, AND SURFACE RESERVOIRS WITHIN THE DISTRICT FOR BENEFICIAL USES AS PRESCRIBED BY LAW.

OBJECTIVE 1

Insure that all chemigation users are properly trained and comply with state rules and regulations so as to reduce the occurrence of groundwater contamination through the application of pesticides and fertilizers.

OBJECTIVE 2

Actively pursue the proper use of chemigation criteria and assure that all who chemigate have permits to do so.

OBJECTIVE 3

Develop and maintain rural landowner and community reporting stations for well monitoring, water usage, and rainfall statistics.

OBJECTIVE 4

Insure proper local management of ground and surface water resources through cooperation with local community governments, agencies and private firms, which may involve development of Special Protection Areas and groundwater management and control areas.

OBJECTIVE 5

Comply with the District's Groundwater Management Plan as well as state standards and regulations in order to meet proper conservation requirements.

OBJECTIVE 6

Assist federal and state agencies in the protection of ground and surface waters from non-point and point sources of pollutants.

OBJECTIVE 7

Maintain groundwater quality and quantity monitoring programs.

OBJECTIVE 8

Encourage and develop programs to assist users in reducing irrigation water needs through best management practices.

OBJECTIVE 9

Develop instream flow requirements that will assist in providing a stable development climate within the District.

OBJECTIVE 10

Develop best management alternatives for chemical use in areas where susceptibility to groundwater pollution is high.

OBJECTIVE 11

Cooperate with state and federal agencies to provide adequate methods of testing groundwater for pollutants.

OBJECTIVE 12

Assist in the development of rural water districts with other applicable entities as required.

OBJECTIVE 13

Develop criteria and data for wellhead protection standards to allow District urban areas to participate in this program.

The goals, objectives, policies, and programs set forth in this Groundwater Management Plan Update were developed in support of the LPN NRD Master Plan, and provide further detail regarding ways to accomplish the intent of the Master Plan. It is the intent of the Lower Platte North NRD to wisely and proactively manage the groundwater resources within the District, while maintaining local control over management and use.

Since the NRD's first Groundwater Management Plan was adopted in 1985, many significant changes have occurred regarding regulatory requirements, responsibilities, and options for groundwater management. The Nebraska Legislature, through the Nebraska Groundwater Management Act and its amendments has offered NRDs the opportunity to manage groundwater at the local level if they choose to accept such responsibility. The Act however, also provides options for intervention at the State level should the NRDs require assistance. To recognize a problem or potential problem and do nothing to prevent or alleviate it is no longer a viable option. An NRD must have a plan of action ready to retain total local control and resource protection.

A summary of "Identified Present Known Problem Areas With Consideration of Potential Problem Areas and Information Deficiencies" has been presented in this plan. It is evident from information presented in the plan that there are several areas of concern which warrant extensive action to meet the goals of both the Master Plan and the Groundwater Management Plan's adopted goals and objectives for resource management.

In the area of groundwater quality, the most significant area of concern is the increase of nitrate concentrations. In the uplands of Saunders and Butler Counties, the data base may not allow for a broad interpretation of the areal distribution. In the Shell Creek reservoir, elevated nitrate levels may not be present but a more comprehensive and definitive monitoring network is needed. Areas along the Platte River do exhibit elevated levels of nitrate contamination. This finding is consistent with the DRASTIC vulnerability index, which suggests this reservoir is highly vulnerable to pollution. The Todd Valley reservoir is also showing areas where nitrates are becoming higher. A report by Roy Spalding and Mary Exner indicated areas along the Platte River in Butler, Platte, Colfax, and Dodge Counties, the Todd Valley and Shell Creek exhibit an overall nitrate increase about 1 part per million per year from 1978/79 to 1988/89. Along with the higher nitrate concentrations is the potential problem of pesticide contamination. Surface runoff from the agricultural areas in the District are known to carry extremely high levels of pesticides, particularly during spring rainfall events.

As the State moves to recognize the interrelationship of surface and groundwater laws, an area needing extensive analysis is that of the physical surface/groundwater relationship. Some areas of the District demonstrate a potential for significant deterioration of a groundwater aquifer caused by surface water problems. Deep soil samples in the District also point out very high levels of nitrates in the soil profile just below the root zone moving into the groundwater aquifer.

The rate of development of irrigation wells in the District illustrates densely developed aquifers in many areas, which could result in overdraft. This trend is evident in a report from the Nebraska Department of Water Resources showing a steady increase in the number of new well registrations per year. Recharge rates and abilities to recover from overdraft of the aquifer and declines due to climatic changes must be understood for the entire District. Management of the physical system must reflect the ability of the system to respond to natural changes. Water level monitoring must be increased to provide a more comprehensive assessment of the systems responses to stress situations.

The Lower Platte North NRD recognizes the need for comprehensive, practical, and effective systems of groundwater management, combining both non-regulatory and regulatory approaches. Non-regulatory options such as data collection, public education, encouragement of voluntary use of best management practices, demonstration programs, and others have been used by the NRD as primary management tools prior to development of this plan. The District intends to expand its management scheme to include regulatory options available to the NRD under the Groundwater Management Act. Regulatory tools authorized under this Act include:

1) Allocating the total permissible withdrawal of groundwater;

2) Rotation of use of groundwater;

3) Well-spacing requirements pursuant to Section 46-673.12;

4) Requiring the use of flow meters on wells;

5) Best management practices;

6) Requiring the analysis of water or deep soils for fertilizer and chemical content;

7) Educational programs designed to protect water quality; or

8) Moratorium on new well drilling (Control Area only).

(*Source*: Laws 1982, LB375, 11; Laws 1986, LB894, 30; Laws 1991, LB 51,4.)

In order for the NRD to legally utilize the tools outlined above, a Groundwater Management Area must be established with definable boundaries. The LPN NRD intends to establish the entire NRD as a Groundwater Management Area, allowing for utilization of the regulatory tools (listed above) as appropriate for overall management and for problem (subarea) management. Details are provided in Sections B and C of this Plan.

RECEIVED GROUND WATER MANAGEMENT PLAN

OCT 26 1994

DEPARTMENT OF WATER RESOURCES

PLAN FOR GROUNDWATER MANAGEMENT IN THE LOWER PLATTE NORTH NATURAL RESOURCES DISTRICT

Section B
Goals, Objectives, and Policies

In 1985, the Lower Platte North Natural Resources District developed, in accordance with the Groundwater Management and Protection Act of 1975, a Groundwater Management Plan. At that writing, little water quality or water quantity data existed in the NRD. The Plan, as a result of the lack of information, set forth a vigorous course of action which included sixty-four (64) actions designed to provide the District a dataset upon which proper management decisions could be based. Since 1985, the District has placed into action or has completed, 85% of those action items. The remaining 12 are actions which relied upon the database in order to be implemented, and are incorporated into this Groundwater Management Plan.

Goals established in 1985 also reflected the lack of a sufficient database and were adopted in order to assist in the building of such a dataset. With passage of LB 51, the District was in a position to analyze the considerable water information gathered since 1985. The analysis revealed a distinct set of needs for program realignment. The following goals, objectives, and policies or program components will serve to guide the District over the next several years.

GOAL #1 : Groundwater Reservoir Life

TO PROVIDE A SUSTAINED GROUNDWATER SUPPLY OF QUALITY WATER ADEQUATE TO SUPPORT REASONABLE AND BENEFICIAL USES, AND MAINTAIN LONG-TERM QUALITY YIELDS.

OBJECTIVE

Designate the entire Lower Platte North Natural Resources District as a Groundwater Management Area, consistent with Nebraska State Statutes 46-673.01 - 46-673.06.

Policy - Within two years of the date of approval of the Groundwater Management Plan by the Director of Water Resources, the Lower Platte North Natural Resources District shall establish a District-wide Groundwater Management Area.

Policy - A phased approach to water quality management based upon a Maximum Contaminant Levels (MCL) and Lifetime Health Advisory Levels (LHAL) trigger scheme, and water-level management with triggers based on water level declines with appropriate management actions, will be implemented (triggers and controls are set forth in Section C of this Plan).

Policy - Prior to establishing the Groundwater Management Area, the NRD will perform the necessary analysis to delineate subarea management boundaries for specific problem area management.

Policy - Establish and implement a Groundwater Management Area education program, to include proper fertilizer and pesticide application, irrigation scheduling and water use efficiency, urban fertilizer and pesticide use, water quality and chemical health risks, agricultural reporting needs, crop water efficiency, pump plant efficiency, adopted groundwater management triggers, and other groundwater issues as applicable.

Policy - Implement an education program to inform the public regarding the need for developing the LPN NRD as a Groundwater Management Area, with special emphasis on the adopted Management Schemes (outlined in Section C of this document).

Policy - Expand the NRD newsletter to include more information on groundwater activities.

Policy - Develop a network of demonstration farms, by aquifer, to exhibit water use efficiency benefits and solicit cooperation for voluntary metering and reporting to the NRD.

Policy - Increase the awareness of effective long-term conservation and utilization of the groundwater aquifer.

Policy - Coordinate education and information program with NDEQ, NNRC, NDOH, NDWR, and applicable local and federal agencies, to include the above items and other items such as proper well locations, number of wells per area, and new well construction.

GOAL #2: Management Systems Development

PROVIDE A SYSTEM OF GROUNDWATER MANAGEMENT TO SUPPORT THE GROUNDWATER RESERVOIR LIFE GOAL, BASED UPON AN ADEQUATE TECHNICAL FOUNDATION AND PUBLIC AWARENESS OF GROUNDWATER ISSUES.

OBJECTIVE

Provide technically accurate and updated water <u>quantity</u> data upon which to base management decisions.

Policy - Update the saturated thickness map by recording and mapping thickness from all new registered well logs, to assist in further delineation of groundwater aquifers.

Policy - Update water level contour maps that coincide with groundwater data received from monitoring. Contour maps will be used to monitor changes in direction of groundwater flow and saturated thickness.

Policy - Enhance data collection in confined aquifers by monitoring at least 5% of the total registered wells in each confined aquifer. Use the data to evaluate predevelopment pressure head levels and changes from predevelopment to the present.

Policy - Develop a methodology to statistically analyze water level fluctuations, evaluate the significance of the changes, and relate to the management scheme developed for the GMA.

Policy - Increase the number of observation/monitoring wells in District groundwater reservoirs to provide greater coverage for early problem area detection. The actual number of wells and locations will be based upon the intensity of development of the aquifer and the dependence on the aquifer water supply for various uses. Ultimately the NRD's system will include at least 120 wells.

Policy - Support and perform studies to aid in groundwater model development to predict the amount of water which may be withdrawn from each groundwater aquifer to support the Groundwater Reservoir Life Goal.

Policy - Continue coordination of data collection, storage and analysis with other local, state and federal agencies and groups.

OBJECTIVE

Provide the most technically accurate and updated water quality data upon which to base management decisions.

Policy - Adjust the density of the groundwater quality monitoring network for each aquifer, providing data adequate to evaluate long-term trends and identify present and potential problem areas. The number of wells to be monitored is dependent on the percent of irrigated acres and the number of wells needed to irrigate those acres in each groundwater reservoir to establish and reaffirm baseline conditions.

Policy - Perform trend and random monitoring every 2 years in the most vulnerable areas and problem areas, and every 4 years in less vulnerable areas and areas not presently exhibiting water quality problems.

Policy - Continue coordination of data collection, storage and analysis with other local, state and federal agencies and groups relating to pollution spills (Nebraska Department of Environmental Quality - NDEQ), public water supplies and regulatory notices (NDOH), and results of special investigations (Conservation and Survey Division - C&SD, Department of Water Resources - DWR, NDEQ, Nebraska Department of Health - NDOH, U.S. Geological Survey - USGS, Environmental Protection Agency - EPA, Corps of Engineers - COE, etc.).

Policy - Continue to perform and/or support isolated water quality investigations in NRD aquifers as conditions dictate and the need arises.

Policy - Support nitrogen isotope studies where necessary to determine the source of a nitrate problem and its areal extent for problem boundary definition.

Policy - Support deep soil sampling in areas where suspected over-application of commercial fertilizer and/or animal manure has occurred.

Policy - Perform triazine screen testing of selected wells within the most vulnerable areas of each groundwater reservoir.

Policy - Perform studies to assess needs, benefits, costs, etc. when requested, for possible development of regional or rural drinking water supply systems.

Policy - Develop a program to assist in monitoring rural drinking water wells in cooperation with other agencies.

Policy - Coordinate the NRD's groundwater programs with the Nebraska Department of Agriculture in support of the State of Nebraska's Federal Insecticide, Fungicide, Rodenticide Act and farm management plans.

OBJECTIVE

Further develop and enhance the NRD's computer database management system to provide continual support for program advancements.

Policy - Increase the hardware capabilities of the NRD for data storage, retrieval and analysis, and interfacing with other program needs. Adapt the systems components to be compatible with local, state and federal systems.

Policy - Identify software needs to support: trend analysis; predict impacts of management decisions; and provide mapping capabilities. Acquire software to complement the NRD's hardware.

Policy - Refine the LPN NRD groundwater computer model to provide adequate prediction of vulnerable areas of decline.

Policy - Establish a QA/QC program for data entry to eliminate database errors.

Policy - Utilize the hardware and software capabilities to produce required periodic reports in a standard and meaningful format.

OBJECTIVE

To develop a coordinated NRD program to assist in implementation of the State of Nebraska's wellhead protection program. The NRD program will be targeted toward assisting the District's communities and supportive of the District's efforts in managing ground and surface water.

Policy - Further develop the information needs and assist in the continuance and upgrading of the present LPN NRD well decommissioning program.

Policy - The District will assist any community in the NRD with proper development of a Wellhead Protection Program.

Policy - The District will be the central repository for District water supply contamination information as received from the NDOH and NDEQ.

Policy - Make NRD database information on pollution and water quality readily available to all District communities for use in planning for Wellhead Protection.

Policy - If a Wellhead Protection Area is established due to non-point source pollution, the District may set boundary areas that are less than 9 square miles in size.

Policy - The District will develop a process to locate, identify, and catalogue past, present, and potential point and non-point sources of contamination (to include present and abandoned feedlots, landfills, dumps, industrial sources, etc.), which will be utilized in all ground and surface water program analysis and management.

OBJECTIVE

To support and conduct special studies, research, and data gathering activities that will assist the District in its understanding and management of groundwater.

Policy - Perform sandpit studies when appropriate, to address the locations of such pits, their fluctuations, evaporation/transpiration, and estimated effect on the groundwater table.

Policy - Continue to evaluate the adequacy of the Districts precipitation network and expand where appropriate.

Policy - Support studies/research and refinement of the DRASTIC program to further identify and understand recharge characteristics and areas vulnerable to pollution in the District.

Policy - Support and perform percolation studies to understand the recharge potential of groundwater reservoirs, particularly those areas where known or suspected contamination occurs.

Policy - Develop a water balance model for the NRD considering the effect of phreatophytic growth on the groundwater table and wetlands.

Policy - Participate in and perform instream flow studies which identify the streams dependence upon groundwater for base flow.

Policy - Participate in studies and research to quantify and qualify the interconnection between ground and surface water.

Policy - Support geologic and hydrogeologic studies which will contribute to the foundation of knowledge needed to locate and identify areas where changes in groundwater quality/quantity may impact environmentally sensitive resources.

OBJECTIVE

To adequately support the Groundwater Management Plan through proper application of District resources.

Policy - Provide sufficient qualified personnel, funding, and equipment to fully support the groundwater management system and the needs of the program.

Policy - Annually re-evaluate and upgrade the Districts Groundwater Management Plan and the resulting Groundwater Management Area designations.

Policy - Develop background information and a methodology to address potential NRD cost share programs for meter application, assistance with collection of irrigation and drinking water samples for analysis and deep soil sampling. The NRD will only cost-share with landowners that have registered wells with the Department of Water Resources. If wells are unregistered, proper registration forms will be provided by the NRD and a 6-month period will be allowed for registration before the illegal well will be reported to the Department of Water Resources. Chemigation permits will only be issued on registered wells.

PLAN FOR GROUNDWATER MANAGEMENT IN THE LOWER PLATTE NORTH NATURAL RESOURCES DISTRICT

Section C
Action Plan

The Lower Platte North NRD is strongly aware prevention is extremely less costly than correction of a groundwater problem after it has developed. Knowledge of this principle has required the District to develop a groundwater program emphasizing protection based on a proactive approach rather than on a reactive, corrective approach. Data gathered by the District, the USGS, NDEQ and the University of Nebraska since 1985 has indicated areas where groundwater quality nitrate conditions have deteriorated beyond those established as health standards. Other data also indicate problem areas are presently developing which need to be intercepted in order to bring about a clean up of the reservoir and to halt a continuing trend of increased pollution.

The District did not enter into this activity without developing a method to arrive at what is felt to be a consistent planning and implementation strategy aimed at protection of the resource. Within two years of the date of approval of the Groundwater Management Plan by the Director of Water Resources, the District will establish a District-wide Groundwater Management Area. The quality component of the plan is a phased approach based on a Maximum Contaminant Levels (MCL) and health-based standards trigger scheme, addressing Nitrate, pesticides, and other human non-point source contaminant levels in the system. The quantity component of the plan is developed around triggers based on water level declines with appropriate management actions for confined and unconfined aquifers.

Prior to establishing the Groundwater Management Area, the NRD will perform necessary analysis sufficient to delineate subarea management boundaries for specific problem areas associated with levels of concern. A major component of the plan is the implementation of an education program which includes, but is not limited to: proper fertilizer application (both commercial and private), irrigation scheduling and water use efficiency, water quality and chemical health risks, agricultural reporting needs, adopted groundwater management triggers, social/economic aspects, and other issues as applicable. An essential item of the education program is the development of demonstration farms, by aquifer, exhibiting water use efficiency benefits, irrigation scheduling, crop water efficiency, and fertilizer and pesticide application. Another essential item of the education program will be development of educational materials to address proper application of fertilizers, pesticides, and other chemicals on lawns and other non-commercial applications in urban areas.

Groundwater Quality Management Program

The Groundwater Quality Management Program is based on a set of contaminant level triggers designating the Phase of the program in which a particular area must be placed. Phase I nitrate triggers are set at 0 to 8 parts per million in the Groundwater reservoir and includes the entire District. Phase II triggers are from 8.01 to 10 parts per million nitrate concentration in the groundwater while Phase III trigger levels range from 10.01 parts per million or greater. "Other" human-induced non-point source contaminants, such as pesticides have phased trigger levels based upon Maximum Contaminant Levels (MCL) or Lifetime Health Advisory Levels (LHAL). Phase I triggers are set at 0 to 80% of the contaminants MCL/LHAL and includes the entire NRD. Phase II areas will be established when contaminants are present at 80-100% of the

MCL/LHAL. Phase III areas will be established when the MCL/LHAL is exceeded (>100%). Currently, no "other" contaminated areas have been identified that are approaching the upper limit of a Phase I area. As "other" contaminants approach the Phase I area limit, contaminant-specific programs and regulations will be adopted, similar to the nitrate regulations which are based upon increasing levels of management and actions.

For the purpose of implementing the Phases of groundwater management, the LPN NRD has established some guidelines by which a problem area is identified, and phase area boundary setting studies will be initiated. Groundwater management units will be reservoir specific. Within the same reservoir, boundary setting studies will be initiated when: water quality analytical results, within a minimum 9 square mile area are at identified trigger levels, over a minimum of 2 consecutive sampling events. The 9 square mile area must contain a minimum of 10 high yield wells pumping over 100 gpm and contaminant trigger levels must be exceeded in over 50% of the wells. Initial investigation by the NRD will be to determine if the contamination is a result of point-source or non-point source pollution. If non-point source is concluded more intensive investigation for boundary setting will ensue.

If a Wellhead Protection Area should be established due to non-point source pollution, the District may set boundaries that are less than 9 square miles.

Data derived from the monitoring network established by the District, combined with special studies, monitoring studies performed by the USGS, University of Nebraska, NDEQ, County Extension programs, and others as applicable, will be used as the database on which to formulate Phase II and Phase III area boundaries.

Upon confirmation of the GWMP by the Department of Water Resources, the District will move immediately into the process of evaluating Phase boundaries by performing a series of confirmation studies aimed at boundary setting. The District will also begin the development and implementation of the education program. This program will become progressively more intense as an area shifts from one Phase to another higher Phase.

Within two-years of the acceptance of the GWMP, the District will designate the entire NRD in Phase I of the program. The reasoning for this action is in keeping with the Districts goal "to provide a sustained Groundwater supply of quality water adequate to support reasonable and beneficial uses, and maintain long-term quality yields."

PHASE I CONTROLS:

- All operators in Phase I areas within the District, who use any type of fertilizer, either commercial or organic, are required to be certified by the District every four (4) years. Certification will be consistent with the Districts chemigation program and applicable to the State FIFRA program. The education/certification program will be developed with the assistance of the Cooperative Extension personnel and others, as applicable.

- A groundwater analysis for nitrogen (nitrate nitrogen) content for all wells pumping greater than 100 gpm and used for irrigation of commercial crop production must be made every four years using NRD approved analysis methods, and results submitted to the NRD by December 31 of the fourth year. This analysis is deemed necessary to both assist the NRD in their monitoring program and to aid the operator in developing a knowledge of their particular groundwater nitrate level. This knowledge can readily be translated into a decrease of nitrogen usage by the operator and thus a financial incentive to properly use that nitrate in the system. A methodology for sample collection and proper analysis procedures will be a part of the education program.

- A soil analysis (3-4 feet in depth) for nitrogen (nitrate nitrogen) content for each field under control of the operator used for commercial crop production are encouraged every four years. NRD approved analysis methods should be used, and results submitted to the NRD by December 31 of the fourth year. This analysis is likewise considered necessary to aid the operator in developing a knowledge of their pending useable soil profile nitrogen and of that amount already inaccessible to the crops. A methodology for sample collection and proper analysis procedures will be a portion of the education program.

- All operators are encouraged to submit a Fertilizer Application Report to the NRD once every four years on a form provided by the District, which indicates the pounds per acre of nitrogen (commercial and organic) applied to each field under their control for the past four years. The quantity in pounds per acre of pesticides applied for each field where applied, will also be encouraged. Such reports will incorporate, if applicable, those reports required under the NRD chemigation program and such reporting requirements resulting from the implementation of the State assumption of the Federal Insecticide, Fungicide, Rodenticide Act (FIFRA). These reports will also remain consistent with changes resulting from reauthorization of the Clean Water Act which affects such reports.

- Passage of LB-981 by the Nebraska Legislature in 1994, requires all new wells to be drilled in any management area which will pump greater than 50 gpm to have a permit prior to construction. The cost of the permit will be consistent with conditions of the law. Penalties applied under this Law will be in accordance with the law.

- Application of organic fertilizer (liquid manure, dried manure, sludge or composted organic waste) is very diversified and poses management problems relative to the size of the operation. The desire of the District is to allow farming operations to continue, yet not allow the N concentration in the groundwater to increase. Not all organic waste contains the same amount of N per unit of measurement, as such the amount/acre/year allowed to be applied in Phase I areas will be based on method of collection and storage, land application method, types of crops or cover crop, soil types, landscape features, source of manure, and previous manure application rates. Amount/acre/year of manure applied on each field is encouraged to be reported on the Fertilizer Application Report and submitted to the NRD once every four years.

- No fall applications of N fertilizer (commercial) will be allowed on non-sandy or fine textured soils until after November 1. Such determination of non-sandy soils or fine textured soils will also be determined and identified in the same manner as sandy soils.

- Fall and winter applications of N fertilizer (commercial) will be prohibited on sandy soils. Sandy soils will be designated utilizing the USDA Soil Conservation Service Soil Surveys for the counties in the District. Such determination will be set forth prior to designation and identified prior to confirming the GWMA Phase I program. Commercial fertilizer can be applied on sandy soils after March 1 of the crop year.

Present data indicates that some of the areas in the District may be placed in the Phase II category upon designation of the GWMA in the District. Phase II areas will be delineated via the above noted procedure of delineating boundaries. Such delineation will cause extended activities to be brought into play. Those additional requirements are:

PHASE II CONTROLS:

- A continuation of Phase I activities as they apply.

- A Groundwater analysis for nitrogen (nitrate) content for all wells pumping greater than 100 gpm irrigating commercial crops must be made annually and reported to the NRD by December 31.

- Annual soil samples in the root zone (3' to 4' in depth) on each field used for commercial crop production are required for Phase II and Phase III areas. This information will be used in conjunction with use of proper best management practices. The results of the soil samples will accompany the annual report made to the NRD by December 31.

- All operators will submit a Fertilizer Application Report to the NRD at the end of each crop year or prior to December 31 of each year. Submittal will be on a form(s) developed by the NRD. Reporting of Application of Pesticides will be encouraged on this form.

- Commercial nitrogen-fertilizer as anhydrous ammonia will be permitted on non-sandy or fine textured soils from November 1 to March 1, provided that an approved inhibitor is used and applied as recommended. After March 1 an inhibitor is not needed.

- In order to assure use of an approved inhibitor, the operator will be required to furnish certification from a dealer that an approved inhibitor was used and applied as recommended. Methodology for this activity will be developed as part of the education program.

- The District will begin a voluntary fertilizer calibration program addressing all applications and will strongly encourage operators to participate in the process. The District may, as conditions warrant, choose to develop a cost share program with operators.

- Monitoring (meters or time totalizers) of water applications will be required to allow operators to better manage fertilizer applications and control excessive nitrate leaching into the aquifer. If time totalizers are used then well output must be certified by the NRD. This activity will be phased in over a period of six (6) years.

- In Phase II and Phase III areas, amount per acre per year of organic fertilizer allowed to be applied (liquid manure, dried manure, sludge, or composted organic waste) will be based on method of collection and storage, land application method, types of crops or cover crop, soil types, landscape features, source of manure, and previous manure application rates. The Nebraska Cooperative Extension Service Bulletin EC 89-117 "Fertilizing Crops with Animal Manure" shall be used as guidance unless more current guidelines are available. Amount/acre/year of manure applied on each field is to be reported on the Fertilizer Application Report and submitted to the NRD by December 31 of each year. The amount and timing of application must be adjusted to the N concentration in the soil profile and groundwater content. Application is allowed to frozen soils and is to be determined on a site-by-site basis as this is a prime cause of both groundwater and surface water degradation.

- The education program will be expanded to assist the Phase II operators and other personnel in the area to realize that continued increases of nitrate and/or other non-point source contamination could cause the area to be elevated to a Phase III area.

Phase III areas are characterized by contaminant levels exceeding the MCL or LHAL in the groundwater. Present data indicates the potential to delineate areas in the District where nitrate levels are consistently in this range. Areas designated as Phase III areas are further constrained in order to more fully protect the citizens of the area and to remediate the aquifer.

PHASE III CONTROLS:

- Phase I and Phase II controls remain in effect.

- Monitoring (meters or time totalizers) of water applications to allow operators to better manage fertilizer applications and control leaching of nitrates is to be phased in over 4 years. If time totalizers are used then well output is to be certified by the NRD.

- The application of commercial nitrogen fertilizer is prohibited in the fall and winter on all soils until after March 1. Spring applications of commercial nitrogen fertilizer will require split applications (pre-plant and sidedress) or the use of an approved inhibitor applied as recommended. If a split application is used and 50 percent or more is applied as a pre-plant, the use on an approved inhibitor applied as recommended is still required.

- If 50% or more of commercial nitrogen fertilizer is applied to pre-plant then operators are required to furnish certification from the dealer that an inhibitor was used at recommended rates. Methodology for this process will be developed as part of the education program.

- Require fertilizer calibration monitors on applications >50 lbs./acre. The application of fertilizer (>50 lbs/acre) would be required to be calibrated to the results of soil and water tests and monitored for compliance. The District may choose to develop or increase a cost share program.

Groundwater Quantity Management Programs

The District is composed of both confined and unconfined aquifers. Confined aquifers being generally defined as those aquifer areas where there is a pressure such that the water tends to rise in the well casing. This rise is termed the potentiometric head. Unconfined aquifers are those which do not exhibit this characteristic. The two differing types, due to their varying characteristics, are treated differently in the designation of Levels in the management of the system.

The LPN NRD has defined subareas within the District that have similar aquifer conditions. When greater than 50% of the LPN NRD monitoring wells in a subarea has reached or exceeded the trigger level, then a control area can be established. As more information becomes available in the future, these subareas can be further defined.

LPN NRD monitoring wells are established by a cooperative agreement with the current landowners on a voluntary basis. Due to hydrologic considerations LPN NRD monitoring wells are not to be located on municipal well field property.

Unconfined Aquifers

Unconfined aquifer management subareas are to be designated within the District when conditions, taking into consideration climatic variables, indicate a 10% drop in the saturated thickness of the aquifer. Assessment of percentage drop will be calculated utilizing the spring readings of the wells over a three (3) year period assessed against the 1987 well levels or to comparable year well levels. When this condition is noted to be developing, the District will enhance the education program which may assist in correcting the situation. If this type of action does not provide the needed results the following will occur.

LEVEL 1 CONTROLS:

- The area will be designated a Level 1 Quantity Area and all operators of well systems that pump greater than 100 gpm must attend education classes designed by the District and in agreement with applicable other agency input. Certification of all operators is required every four years.
- A permit will be required for all new wells to be drilled in the area which will pump greater than 50 gpm.
- The District will encourage a well metering program (meters or time totalizers) to be established on all wells pumping >100 gpm. This voluntary well metering program will be established with possible incentives available to operators. Incentives may include a variety of options and will be developed prior to designation of a Level 1 area.
- Encourage an acre-inch allocation system that will be developed per commercial crops planted that are dependent on that particular aquifer.
- The District will encourage submission of the Water Use Report to the NRD prior to December 31 of the fourth year.

As conditions become more severe the District will utilize a 15 percent drop in the saturated thickness as the trigger to move into Level 2 quantity programs.

LEVEL 2 CONTROLS:

- The same requirements as in Level 1 but enhanced.
- Well meters or time totalizers will be a requirement on all wells pumping greater than 100 gpm. If time totalizers are used then well output must be certified by the NRD.
- An acre-inch allocation per crop planted will be put into place and will be based on the aquifer and the use of the aquifer.
- The District will require annual submission of the Water Use Report to the NRD by December 31.
- Well spacing requirements will be applied in the Level 2 area pursuant to Section 46-673.12 of the State Statutes. (Well spacing will vary with % of decline in the aquifer.)
- Best management practices will be required to conserve water and will be developed prior to designation of the area as a Level 2 Area.

Confined Aquifers

The sensitivity of the confined aquifers has led the District to the decision to manage them in a different manner than the unconfined aquifers. The triggers are based on a reduction in the potentiometric-aquifer thickness. The potentiometric surface is defined as an "imaginary" surface representing the total head of groundwater in a confined aquifer that is defined by the level to which water will rise in a well. The potentiometric-aquifer thickness (PAT) is defined as the distance from the potentiometric surface to the base of the principal aquifer. The use of this procedure requires the data derived from the well drilling operation as the total aquifer thickness will need to be determined.

Three Levels have been assigned to the confined aquifer designations. Level 1A is triggered by a 7 percent drop in potentiometric-aquifer thickness. Assessment of percentage drop will be calculated utilizing the spring readings of the wells over a three (3) year period assessed against the 1987 well levels or to comparable year well levels. This program is one of primarily education and the controls applied are:

LEVEL 1A CONTROLS:

- All operators of well systems that pump greater than 100 gpm are required to attend education classes as designed by the District. These classes will be developed prior to any area being designated. All operators are to be certified every four years.
- Permits are required for all new wells to be drilled in the area which will pump greater than 50 gpm.
- The District will encourage a well metering program (meters or time totalizers) to be established on all wells pumping greater than 100 ppm.

- Encourage adoption of acre-inch allocations on crops planted that are dependent on the aquifer.
- The District will encourage submission of the Water Use Report to the NRD prior to December 31 of the fourth year.

Level 2A is triggered by a 10 percent drop in the potentiometric-aquifer thickness of the aquifer and the following controls are applied.

LEVEL 2A CONTROLS:

- The same controls as set forth in Level 1A apply.
- Well meters or time totalizers are required to be installed and used on all wells pumping greater than 100 gallons per minute. If time totalizers are used then well output must be certified by the NRD.
- The District will develop and assess acre-inch allocations per crops planted. These allocations will be developed according to data assessments, wells in the area, use of the wells, and other pertinent factors leading to the proper assessment of the available resource.
- The District will require an annual submission of the Water Use Report to the NRD prior to December 31.

The trigger for the Level 3A Area is a 15 percent drop in the potentiometric-aquifer thickness. This level signals the need for extreme measures as the aquifer is under considerable stress.

LEVEL 3A CONTROLS:

- Same conditions as applied in Level 1A and Level 2A as applicable.
- As required, the District will further adjust the acre-inch allocations. Such adjustment will be commensurate with the data developed from implementation of Level 2A area designation.
- The District will adopt a well spacing requirement pursuant to Section 46-673.12 Nebraska statues and implement such a system. Well spacing will vary with % decline in the aquifer.

AGRICULTURAL RESEARCH FACILITIES

Agricultural Research Facilities within the LPN NRD may apply to the Board of Directors for a modification of the individual requirements within the groundwater management areas, that specifically affects the land they own or operate. Such requests will be reviewed on a case-by-case basis.

APPEAL PROCESS

In implementing the LPN NRD Groundwater Management Plan, all those affected are provided with an administrative appeal process whereby they may address the Board of Directors to present their case. The incorporation and functioning of the appeals process is carried out with the same manner as other administrative appeals processes utilized by the District (i.e., sediment and erosion control program appeal process).

SUMMARY

In pursuing the goals of this Groundwater Management Plan, the District will orient its programs in support of accomplishing the goals, objectives and policies of the plan. Provisions will be incorporated in the process to allow for Areas and Levels to change over time in response to changes in either nitrate levels, chemical constituent levels, or water levels.

PLAN FOR GROUNDWATER MANAGEMENT IN THE LOWER PLATTE NORTH NATURAL RESOURCES DISTRICT

Section D
Public Participation

Public knowledge of the ideas and designs included in the Groundwater Management Plan is crucial to the successful implementation of the plan. Therefore, the Board of Directors felt that a series of public hearings and meetings to present and discuss the changes to the adopted Groundwater Management Plan would be beneficial. Public hearings and meetings were held at the following locations:

July 26, 1993	Public Hearing - Fremont Public Hearing - Schuyler Public Hearing - Wahoo
July 28, 1993	Public Hearing - Platte Center Public Hearing - David City
August 25, 1993	Press Conference - Wahoo
September 8, 1993	Public Meeting - Wahoo
August 29, 1994	Public Hearing - Wahoo
August 31, 1994	Public Hearing - Platte Center

During each public meeting the plan was presented by NRD staff. Public comments, questions, and concerns were recorded for consideration by the Board and possible incorporation into the Plan. Overall the meetings were very beneficial, and provided guidance to the Board of Directors and NRD staff. Appropriate comments were incorporated into the Plan.

In addition to the public meeting process, public awareness was fostered through a series of 17 news articles in local papers, 5 radio spots, and presentations at 7 area meetings during 1993 and 1994. The LPN NRD board and staff is grateful to those who took the time to participate in this process.

TABLE 1
QUALITY

AREA	DATE TO BEGIN	PHASE	TRIGGERS	CONTROLS
Lower Platte North Natural Resources District		Phase I Area	0-8 ppm NO_3-N in groundwater, or <80% of MCL/LHAL of "other" man-induced, non-point source contaminants.	a) All operators using any type of fertilizer must attend the education/ certification classes established by the District to become certified, every 4 years. b) A groundwater analysis for nitrogen (NO_3-N) content for all wells pumping greater than 100 gpm and irrigating commercial crops must be made every 4 years and reported to the NRD by December 31 of the fourth year. c) A soil (3-4 ft. depth) analysis for nitrogen (NO_3-N) content on each field growing commercial crops are encouraged every 4 years and results reported to the NRD by December 31 of the fourth year. d) All operators are encouraged to submit a Fertilizer Application Report to the NRD prior to December 31 once every 4 years which indicates the pound per acre of nitrogen (commercial and organic) and quantity per acre of pesticides applied to each field on crop lands under their use for the reporting period. Such reports will incorporate, if applicable, those reports required under the NRD chemigation program and such reports resulting from implementation of the State assumption of the Federal Insecticide Fungicide, Rodenticide Act (FIFRA). e) Require permits for all new wells to be drilled which will pump greater than 50 gpm. f) Amount/acre/year of organic manure allowed (liquid manure, dried manure, sludge or composted organic waste) will be based on method of collection and storage, land application method, types of crops or cover crop, soil types, landscape features, source of manure, and previous manure application rates. g) No Fall application of N fertilizer (commercial) on non-sandy or fine textured soils until after November 1. h) Fall and Winter applications of N fertilizer (commercial) is prohibited on sandy soils. Commercial fertilizer can be applied on sandy soils after March 1.

TABLE 2
QUALITY

AREA	DATE TO BEGIN	PHASE	TRIGGERS	CONTROLS
Lower Platte North Natural Resources District		Phase II Area	8.01-10 ppm NO_3-N in groundwater, or >80% but <100% of MCL/LHAL of "other" man-induced, non-point source contaminants.	a) Same as Phase I b) A groundwater analysis for Nitrogen (NO_3-N) content for all wells pumping greater than 100 gpm and irrigating commercial crops must be made annually, and reported to the NRD by December 31. c) A soil (3-4 ft. depth) analysis for nitrogen (NO_3-N) content on each field growing commercial crops are required annually and results reported to the NRD by December 31. d) The Fertilizer Application Report must be submitted to the Lower Platte North NRD each crop year prior to December 31. e) Commercial Nitrogen Fertilizer will be permitted on non-sandy or fine textured soils from November 1 to March 1 provided that an approved inhibitor is used at recommended rates. After March 1 inhibitor is not needed. f) Require operators applying commercial fertilizer from November 1 to March 1 to furnish certification from dealer that an approved inhibitor was used as recommended. g) Encourage fertilizer calibration monitors on all applications and develop cost-share programs. h) Monitor (meters or time totalizers) water applications to allow operators to better manage fertilizer applications and control leaching of Nitrates. (Phase in over 6 years) i) Amount/acre/year of organic manure allowed (liquid manure, dried manure, sludge or composted organic waste) will be based on method of collection and storage, land application method, types of crops or cover crop, soil types, landscape features, source of manure, and previous manure application rates. (Use of Nebraska Cooperative Extension Service Bulletin EC-89117 is recommended.) Amount and timing of application must be adjusted to the N concentration in the soil profile and groundwater content. Application to frozen soils on a site-by-site basis. j) Expand education programs.

TABLE 3
QUALITY

AREA	DATE TO BEGIN	PHASE	TRIGGERS	CONTROLS
Lower Platte North Natural Resources District		Phase III Area	greater than 10.01 ppm NO_3-N in groundwater, or >100% of MCL/LHAL of "other" man-induced, non-point source contaminants.	a) Same as Phase I and Phase II b) Monitor (meters or time totalizers) water applications to allow operators to better manage fertilizer applications and control leaching of Nitrates (Phase in over 4 years). c) Application of commercial nitrogen fertilizer is prohibited in the fall and winter on all soils until after March 1. Spring applications of commercial nitrogen fertilizer will require split applications (pre-plant and sidedress) or the use of an approved inhibitor applied as recommended. (On split application, if 50% or more is applied as a pre-plant the use of an approved inhibitor applied as recommended is still required). d) If 50% or more of commercial nitrogen fertilizer is applied at pre-plant then operators are required to furnish certification from the dealer that an inhibitor was used at recommended rates. e) Require fertilizer calibration monitors on applications of > 50 lbs. per acre.

TABLE 4
UNCONFINED AQUIFERS
QUANTITY

AREA	DATE TO BEGIN	LEVEL	TRIGGERS	CONTROLS
Lower Platte North Natural Resources District		Level I	10% drop in the saturated thickness.	a) All operators of well systems that pump greater than 100 gpm must attend education classes designed by the District. All operators to be certified every 4 years. b) Permits required for all new wells to be drilled which will pump greater than 50 gpm. c) Encourage well metering program (meters or time totalizers) to be established on all wells pumping greater than 100 gpm. d) Encourage adoption of acre-inch allocations per crops planted that are dependant on the aquifer. e) Encourage submission of the Water Use Report to NRD prior to December 31 of the fourth year.

TABLE 5
UNCONFINED AQUIFERS
QUANTITY

AREA	DATE TO BEGIN	LEVEL	TRIGGERS	CONTROLS
Lower Platte North Natural Resources District		Level II	15% drop in the saturated thickness.	a) Same as Level I. b) Require well meters or time totalizers to be installed on all wells pumping greater than 100 gpm. c) Require adoption of acre-inch allocations per crops planted that are dependent on the aquifer. d) Require annual submission of the Water Use Report to the NRD prior to December 31. e) Requirement of well-spacing pursuant to Section 46-673.12 - Nebraska Statutes. (Will vary with % of aquifer decline.) f) Require use of best management practices to conserve water.

TABLE 6
CONFINED AQUIFERS
QUANTITY

AREA	DATE TO BEGIN	LEVEL	TRIGGERS	CONTROLS
Lower Platte North Natural Resources District		Level 1A	7% drop in potentiometric-aquifer thickness.	a) All operators of well systems that pump greater than 100 gpm must attend education classes designed by the District. All operators to be certified every 4 years. b) Permits required for all new wells to be drilled which will pump greater than 50 gpm. c) Encourage well metering program (meters or time totalizers) to be established on all wells pumping greater than 100 gpm. d) Encourage adoption of acre-inch allocations per crops planted that are dependent on the aquifer. e) Encourage submission of the Water Use Report to NRD prior to December 31 of the fourth year.

1) The potentiometric surface is defined as an "imaginary" surface representing the total head of groundwater in a confined aquifer that is defined by the level to which water will rise in a well.

2) The potentiometric-aquifer thickness (PAT) is defined as the distance from the potentiometric surface to the base of the principal aquifer.

TABLE 7
CONFINED AQUIFERS
QUANTITY

AREA	DATE TO BEGIN	LEVEL	TRIGGERS	CONTROLS
Lower Platte North Natural Resources District		Level IIA	10% drop in potentiometric-aquifer thickness.	a) Same as level IA. b) Require well meters or time totalizers to be installed on all wells pumping greater than 100 gpm. c) Require adoption of acre-inch allocations per crops planted that are dependant on the aquifer. d) Require annual submission of the Water Use Report to the NRD prior to December 31.

TABLE 8
CONFINED AQUIFERS
QUANTITY

AREA	DATE TO BEGIN	LEVEL	TRIGGERS	CONTROLS
Lower Platte North Natural Resources District		Level IIIA	15% drop in potentiometric-aquifer thickness.	a) Same as level IA and IIA. b) Further adjust acre-inch allocations. c) Require well-spacing pursuant to section 46-673.12 Nebraska Statutes. (Will vary with % of aquifer decline) d) Require use of best management practices to conserve water.

TABLE 9
LPNNRD's - GROUNDWATER QUALITY MANAGEMENT PROGRAM

RULES AND REGULATIONS	Phase I	Phase II	Phase III
1. Phase areas will be established on Nitrate-Nitrogen (NO_3-N) concentration found in the groundwater.	0-8 ppm	8.01-10 ppm	10.01 ppm or >
2. Phase areas can be established on other non-point source contaminants found in the groundwater or soil.	0-80% MCL/LHAL	80-100% MCL/LHAL	>100% MCL/LHAL
3. Operators using any type of fertilizer are required to become certified every 4 years.	X	X	X
4. A groundwater analysis for Nitrogen (NO_3-N) content for all wells pumping greater than 100 gpm irrigating commercial crop production must be made and reported to the NRD by December 31.	Once every 4 yrs.	Annually	Annually
5. Soil samples in the root zone (3 to 4 ft. deep) are to be taken and reported to the NRD by December 31.	Encouraged	Annually	Annually
6. Fertilizer Application Report (both commercial and organic fertilizers) to NRD prior to December 31.	Encouraged	Annually	Annually
7. Permit for all new wells to be drilled which will pump greater than 50 gpm.	X	X	X
8. Amount/acre/year of organic fertilizer allowed (liquid manure, dried manure, sludge or composted organic waste) will be based on method of collection and storage, land application method, types of crops or cover crop, soil types, landscape features, source of manure, and previous manure application rates.	X		
9. No fall application of N fertilizer (commercial) on non-sandy soils until after November 1 .	X		
10. Fall and winter applications of commercial nitrogen fertilizer is prohibited on sandy soils. Commercial fertilizer can be applied on sandy soils after March 1.	X	X	
11. Commercial nitrogen fertilizer permitted on non-sandy soils from November 1 to March 1 provided an approved inhibitor is used at recommended rates.		X	
12. Require operators applying commercial fertilizer from November 1 to March 1 to furnish certification from dealer that an approved inhibitor was used as recommended.		X	
13. Encourage fertilizer calibration monitors on all applications and develop cost-share programs.		X	
14. Monitor water applications to allow operators to better manage fertilizer application and control leaching of Nitrogen.		phase in over 6 yr.	phase in over 4 yr.
15. Amount/acre/year of organic fertilizer allowed (liquid manure, dried manure, sludge or composted organic waste) will be based on method of collection and storage, land application method, types of crops or cover crop, soil types, landscape features, source of manure, and previous manure application rates. Amount and timing of application must be adjusted to the N concentration in the soil profile and groundwater content. Application to frozen soils on a site-by-site basis.		X	X
16. Expand Education program.		X	X
17. Application of commercial nitrogen fertilizer is prohibited in the fall and winter on all soils until after March 1. Spring applications of commercial nitrogen fertilizer will require split application (pre-plant and sidedress) or the use of an approved inhibitor applied as recommended. (On split applications, if 50% or more is applied as a pre-plant, the use of an approved inhibitor applied as recommended is still required.)			X
18. If 50% or more of commercial nitrogen fertilizer is applied at pre-plant then operators are required to furnish certification from dealer that an inhibitor was used at recommended rates.			X
19. Require fertilizer monitors on all applications greater than 50 lbs/acre.			X

TABLE 10
LOWER PLATTE NORTH NRD
GROUNDWATER QUANTITY MANAGEMENT PROGRAM

UNCONFINED AQUIFER		
Rules and Regulations	**Level I 10% drop in saturated thickness**	**Level II 15% drop in saturated thickness**
1. All operators of well systems that pump greater than 100 gpm must attend education classes and be certified every 4 years.	X	X
2. Permit required for all new wells to be drilled which will pump greater than 50 gpm.	X	X
3. Well metering program established on all wells pumping greater than 100 gpm.	Encouraged	Required
4. Adopt acre-inch allocations per crops planted dependent on aquifer.	Encouraged	Required
5. Water Use Report to NRD prior to December 31.	Encouraged	Annually
6. Require well-spacing pursuant to section 46-673.12 (will vary with % decline)		X
7. Require use of best management practices.		X

CONFINED AQUIFERS			
Rules and Regulations	**Level IA 7% drop in potentiometric-aquifer thickness**	**Level IIA 10% drop in potentiometric-aquifer thickness**	**Level IIIA 15% drop in potentiometric-aquifer thickness**
1. All operators of well systems that pump greater than 100 gpm must attend education classes and be certified every 4 years.	X	X	X
2. Permits required on all new wells to be drilled which will pump greater than 50 gpm.	X	X	X
3. Well metering program established on all wells pumping greater than 100 gpm.	Encouraged	Required	Required
4. Adopt acre-inch allocations per crops planted dependant on aquifer.	Encouraged	Required	Required
5. Water Use Report to NRD prior to December 31.	Encouraged	Annually	Annually
6. Require well spacing pursuant to Section 46-673.12. (Will vary with % decline)			X
7. Require use of best management practices.			X

RECEIVED GROUND WATER MANAGEMENT PLAN
OCT 26 1994
DEPARTMENT OF WATER RESOURCES

LOWER PLATTE NORTH NATURAL RESOURCES DISTRICT

Exhibit 49B

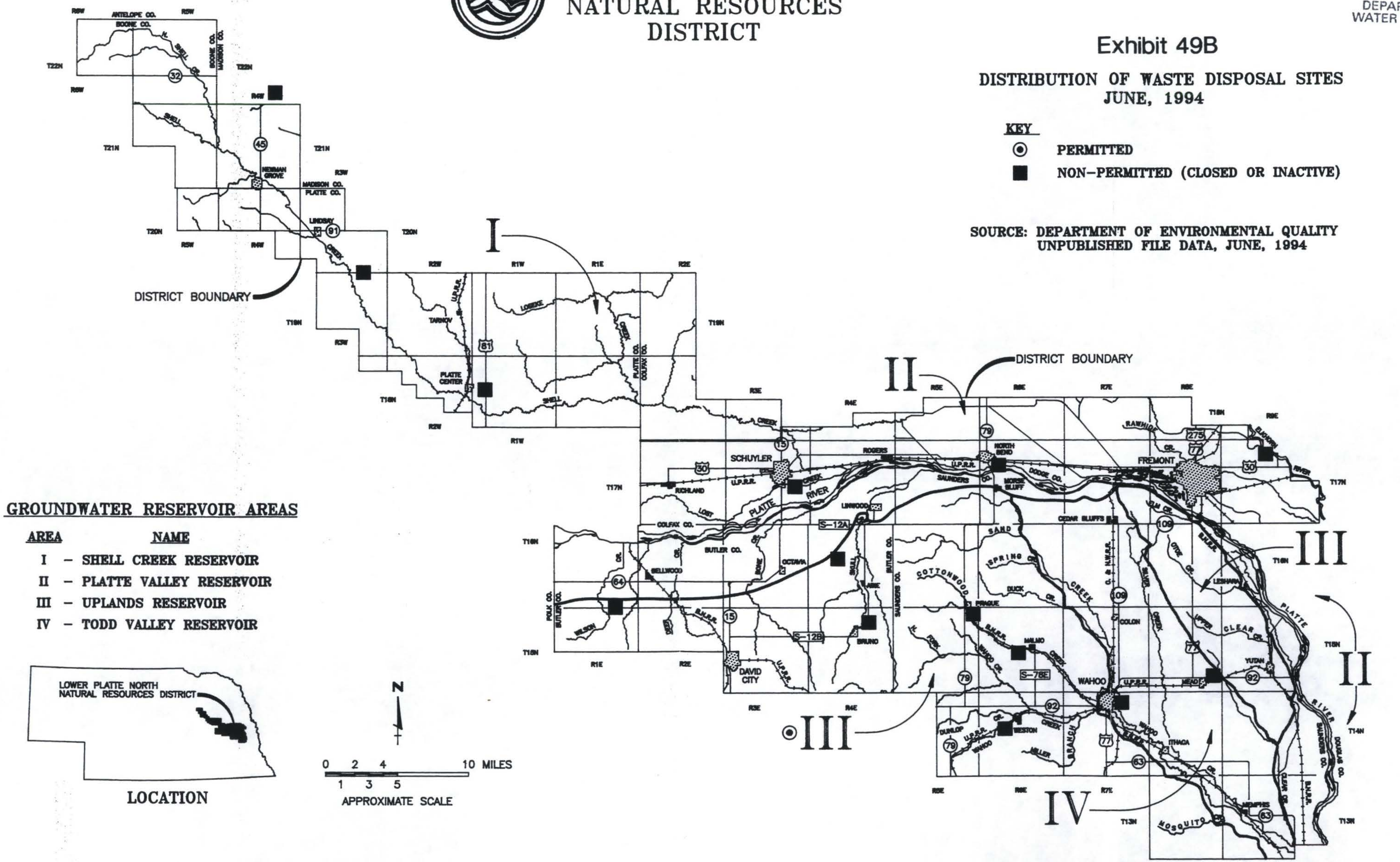
DISTRIBUTION OF WASTE DISPOSAL SITES JUNE, 1994

KEY
- ◉ PERMITTED
- ■ NON-PERMITTED (CLOSED OR INACTIVE)

SOURCE: DEPARTMENT OF ENVIRONMENTAL QUALITY UNPUBLISHED FILE DATA, JUNE, 1994

GROUNDWATER RESERVOIR AREAS

AREA	NAME
I	– SHELL CREEK RESERVOIR
II	– PLATTE VALLEY RESERVOIR
III	– UPLANDS RESERVOIR
IV	– TODD VALLEY RESERVOIR



Parcel Information

Parcel ID	001725000
Links	
Area #	3
Current Owner	JOHNSON, DUANE E & CHERYL K
Mailing Address	1388 COUNTY ROAD 12 MEAD, NE 68041-4043
Situs Address	
Tax District	126
School District	6130 (WAHOO 39)
Legal Description	N 1/2 NE 25-14-7 (80 ACRES)
Class	Agricultural

Current Value Information

Land Value	Dwelling Value	Improvement Value	Total Value
$352,716	$0	$0	$352,716

Prior Year Value Information

Year	Land Value	Dwelling Value	Improvement Value	Total Value
2021	$586,906	$0	$0	$586,906

Yearly Tax Information

Year	Amount	Levy
2021	$8,437.12	1.566607

2021 Tax Levy

Description	Rate
COUNTY GENERAL	0.218116
COUNTY BLDG	0.002337
COUNTY FLOOD CONTROL	0.001793
COUNTY-BONDS ONLY	0.023800
WAHOO 39 GENERAL	0.898161
WAHOO 39 SPECIAL BLDG	0.139987
WAHOO 39 QUAL CAP PURPOSE K-12	0.019134
ESU #2 GENERAL	0.015000
SOUTHEAST COMMUNITY COLLEGE GENERAL	0.073700
SOUTHEAST COMMUNITY COLLEGE CAP IMPT FUND	0.020000
PLATTE NORTH GENERAL	0.033450
ITHACA GENERAL	0.040000
STOCKING TWP GENERAL	0.073524
AG SOCIETY	0.006742
AG SOCIETY IMPROVEMENT FUND	0.000863

Sales Information

Sale Date	Sale Price	Book & Page	Seller	Buyer	Other Parcels
02/18/2022	$431,180.00	576 / 204	CHRISTENSEN CORPORATION	JOHNSON, DUANE E & CHERYL K	

Agricultural Land Information

Soil Symbol	Soil Desc	Landuse	LVG	Spot LVG	Unit Value	Acres	Total Value
8145	8145-POHOCCO PAHUK COMPLEX 6-11% SLOPES-ERODED	DRY	3D		3,855	14.59	56,244
ROAD	ROAD	ROAD			0	2.97	0
7049	7049-KENRIDGE SILTY CLAY LOAM-OCCASIONALLY FLOODED	DRY	2D1		4,790	38.9	186,331
8110	8110-OLMITZ LOAM 2-6% SLOPES	DRY	1D		4,885	1.93	9,428
8145	8145-POHOCCO PAHUK COMPLEX 6-11% SLOPES-ERODED	GRASS			600	0.3	180
7105	7105-YUTAN SILTY CLAY LOAM-TERRACE 2-6% SLOPES-ERODED	DRY	1D		4,885	17.39	84,950
7280	7280-TOMEK SILT LOAN 0-2% SLOPES	GRASS			600	0.14	84
7280	7280-TOMEK SILT LOAN 0-2% SLOPES	DRY	1D1		5,055	2.97	15,013
7105	7105-YUTAN SILTY CLAY LOAM-TERRACE 2-6% SLOPES-ERODED	GRASS			600	0.81	486
					Totals	80	352,716

Photo

TRANSFER POLICY OF CERTIFIED IRRIGATED ACRES
May 10, 2022

TRANSFER APPLICATION INFORMATION

Lower Platte North Natural Resources District
PO Box 126, 511 Commercial Park Road
Wahoo, Nebraska 68066-0126
Phone (402) 443-4675
www.lpnnrd.org

Landowner Receiving Irrigated Acres from Transfer: *Please list name as it appears on the Title.*
Landowner: Duane & Cheryl Johnson Phone#: (402) 443-8357
Address: 1388 Co. Rd. 12 Email: dcfarms9989@gmail.com
Contact if other than listed above:
Field Information: N 1/2 NE
25 Section 14 Township 17 Range E County Saunders

Do you intend to drill a well for these acres? Yes [X] No [ ]

Landowner Providing Irrigated Acres for Transfer: *Please list name as it appears on the Title.*
Landowner: Annette K. & Keith Rogers Phone#: (402) 625-2665
Address: 704 4th St. P.O. Box 86 Email: akrogers@windstream.net
Contact if other than listed above: Yutan, NE 68073
Field Information: SE NE & NE SE
11 Section 14 Township 9 Range E County Saunders
Explanation of Transfer Request: Include number of acres. Use additional pages if needed.
The Rogers 80 will be part of the solar farm south of Yutan and will be decomissioning their irrigation well and won't need the irrigated acres on the 80 for at least 30 years which is the length of the solar farm contract with a 5 year option after that.

Please include

- Aerial photo with the proposed field(s), well(s), pipeline(s).
- Irrigation plan for gaining property, if pivot model is available it must be submitted with the application.
- Copies of your trust, partnership and/or closely held business records should ownership be in any such form.

I have 2 2013 Valley 7000 4 tower pivots on the solar farm that I would be moving to this property they both have select 2 panels that are VRI ready and GPS.

TRANSFER POLICY OF CERTIFIED IRRIGATED ACRES
May 10, 2022

Application for the Transfer of Irrigated Acres between Landowners

This application is for the transfer of irrigated acres between landowners in the Lower Platte North Natural Resources District (LPNNRD). For acres to be transferred, the following conditions must be met (in addition to all others as requested by either District staff of the board of directors): The land must be Acre Certified; the relevant parties must have current Nitrogen and Water Certification or have a tenant with such certification; The originating certified irrigated parcel, as well as the gaining parcel, must be in LPNNRD. The originating landowner must provide proof, in the form of legible FSA maps and Form 578s, that the ground to be transferred was irrigated crop prior to the initiation of the request; The land to which the transfer will occur must pass LPNNRD inspection as quality irrigable ground; Once transferred the new irrigated parcel must be Acre Certified by LPNNRD; A fee, in the amount of $300.00 to initiate the transfer request. Any deviations from these conditions are at the discretion of the Lower Platte North NRD's Board of Directors. Management Area rules and regulations and policies are subject to change without notice. Once these conditions are met, a title search, conducted by a title company selected by LPNNRD and billed to the landowner(s) of record as an additional cost will be performed. When all relevant information relating to this transfer is complete, a separate form will be generated authorizing the transfer of acres. Such form will be notarized; and filed, by LPNNRD with the Register of Deeds of the relevant county.

Transferor:

I, Annette K. & Keith Rogers (Landowner Name) do hereby request the transfer of 67 (Certified Acres) Certified Irrigated Acres from 0003688500 (Parcel I.D.), a parcel I own, located in SENE & NESE 11-14-9 (Legal Description) consisting of 67 (Certified Acres) Certified Irrigated Acres, leaving a balance of 0 (Certified Acres) Certified Irrigated Acres in this parcel.

I acknowledge, that if the transfer is approved, I relinquish all rights to these irrigated acres. I further acknowledge that I am in compliance with all LPNNRD conditions relating to this transfer. Signature authorizes LPNNRD to access any federal records required to satisfy the transfer requirements. Signatory acknowledges that all titleholders of record understand and agree to the terms of the Irrigated Acre Transfer referred to herein.

Annette K. Rogers 10/31/2022
Signature Transferor Date

Transferee:

I, Duane E & Cheryl K Johnson (Landowner Name) do hereby request the receipt of 67 (Number of Acres) irrigated acres, to be granted by LPNNRD, applied to 0017250000 (Parcel I.D.) a parcel I own, located in N 1/2 NE 25-14-7 (Legal Description).

I acknowledge, that if approved, these irrigated acres shall become my property and that I must remain in compliance with all LPNNRD conditions relating to this transfer request or I may suffer the relinquishment of these transferred acres to LPNNRD. Signature authorizes LPNNRD to access any federal records required to satisfy the transfer requirements. Signatory acknowledges that all titleholders of record understand and agree to the terms of the Irrigated Acre Transfer referred to herein.

Duane E Johnson 10/31/2022
Signature Transferee Date

Terri L LaHair
Notary Signature and Stamp

GENERAL NOTARY - State of Nebraska
TERRI L LAHAIR
My Comm. Exp. Jan. 26, 2025

TRANSFER POLICY OF CERTIFIED IRRIGATED ACRES
May 10, 2022

I. <u>Draft Policy to transfer certified irrigated acres</u>

A. All transfer applications require a non-refundable application fee of three hundred dollars ($300.00).

B. Approved transfer applications received prior to March 1st, if approved, will be effective that year. Applications received after March 1st, if approved, will not be effective until the following year.

C. Transfers within the Lower Platte North Natural Resources District (District) must satisfy the following criteria:

1. The originating certified irrigated parcel, as well as the gaining parcel, must be within LPNNRD.

2. Relevant landowner, or their tenant, must have current Nitrogen and Water Certification.

3. The submission of a completed application is required prior to any consideration of the transfer of irrigated acres. Applications will be provided by the District.

4. Application must include:

   a. Explanation of the proposed activities;

   b. Aerial photo with the proposed field(s), well(s), pipeline(s);

   c. Legal description and parcel IDs of affected properties;

   d. Landowner(s) signature(s);

   e. Irrigation plan for gaining property, if pivot model is available, it must be submitted with the application;

   e. Copies of all trust documents and/or corporate records should title to either affected property be owned in trust, by a partnership or by a closely held business;

   f. Notarization by Notary Public.

5. Parcel is currently listed with the District and County Assessor as certified irrigated acres

6. Transfers of irrigated acres from a parcel requires a title search. All applicable lien holders of the property from which the acres are being transferred from, must agree to the transfer. Fees associated with these actions will be billed to the landowner(s).

7. Consideration will not be given to incomplete or incorrect applications until such time as the deficiencies are rectified.

8. Review of the transfer application will be performed by staff and LPN Water Committee. Final approval will be conferred by approved board motion by the LPN Board of Directors.

9. Transfers will not be granted in areas with a greater restricted development area than the parcel upon which the transfer originates.

10. The gaining parcel must meet the minimum threshold of the variance process for the transfer to be approved.

11. Transfers will be based, in part, on NeDNR Stream Depletion Factors, which will be reviewed on all applications.

12. At District's request, applicant(s) will allow access to their property for the purposes of inspection by District personnel.

13. Once transferred, the irrigated acres become the property of the gaining parcel(s). The originating parcel(s) will be certified as dryland acres by the District. After 10 years, the original parcel will be eligible for a variance consideration to allow irrigation except in restricted development areas or as otherwise provided by District regulations.

14. The gaining parcel may not increase irrigated acres by more than the transferred amount.

15. Acres may only be transferred to or from a property once every 10 years.

16. A transfer will not be allowed to increase the number of irrigated acres within a designated wellhead protection area, without approval from the wellhead management area designated by the community and as approved by the District.

17. Management Area Rules and Regulations are subject to change. As per the Groundwater Management Area Rules & Regulations, any new irrigated acres or irrigation well developed after June 15, 2018, may be subject to additional restrictions as the Board of Directors deems appropriate.

18. Both landowners transfer paperwork will be sent to the Register of Deeds to reflect the transfer.

19. If the land in question is Highly Erodible Land (HEL) and has to follow an NRCS Conservation Plan in order for this transfer to occur, this will be noted on the form.

20. Once transferred the new irrigated parcel must be Acre Certified by LPNNRD.

21. The District retains the right to request an applicant provide any additional information and/or documentation deemed relevant by the District prior to its decision on a pending application.

D. The application for a transfer will be denied or conditioned to:

1. Ensure the consistency of the transfer with the purpose or purposes for which the management area was designated.

2. Prevent possible adverse effects on existing groundwater users or surface water appropriators.

3. Prevent possible conflict with any regulations or controls adopted by the District;

4. Ensure the proposed transfer to be a reasonable and beneficial use; or

5. For all other reasons needed reasonably necessary and appropriate by the District.

E. An approved transfer will not vest in any person the right to violate a District rule, regulation, or control in effect on the date of issuance, or to violate any rule, regulation, or control properly adopted after such date. It is the responsibility of the applicant to ensure compliance with other rules and regulations. Such violation could result in loss of an approved transfer.

F. An approved transfer will not vest in any person the right to violate any statute, state agency or other jurisdictional agency's rule, regulation, or control in effect on the date of issuance of the transfer or to violate any rule, regulation, or control properly adopted after such date. It is the responsibility of the applicant to ensure compliance with other rules and regulations. Such violation could result in loss of an approved transfer.

AWS WELL COMPANY

Invoiced 27Dec21

DRILLING LOG

Date: 11-30-21

Owner: Duane Johnson

Driller:

Well Location:

Latitude 41 Minute 09 Second 36

Longitude 96 Minute 34 Second 13

PURPOSE OF WELL: Test Hole IRR

Test Hole Depth 212' Well Depth

Test Hole Dia. 6" Bore Hole Dia

Loop Depth ___ # of Loops ___ Size ___

Casing Length ___ O.D ___" I.D ___"

Wall Thickness ___" Type of Material

Trade Name ___ Screen Length ___"

Screen O.D ___" I.D ___" Slot ___ Type

Gravel From ___' To ___' Pack Sand ___' to

Betonite Seal from ___' to ___'

Static Water Level ___'

Pumping Water Level ___' at ___ gpm

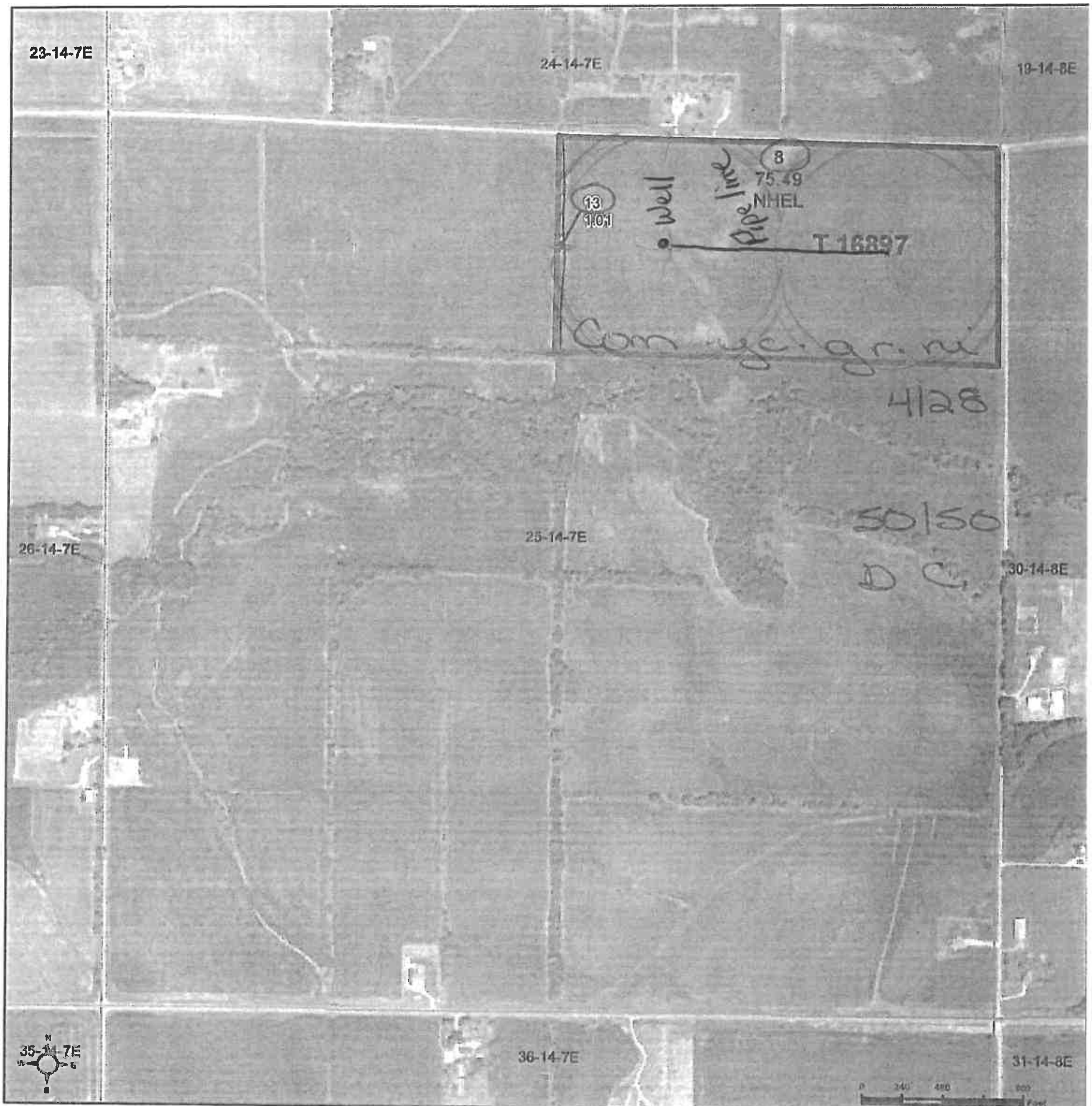
Estimated Capacity of well ___ gpm

middle of Field

DEPTH IN FEET FROM	TO	MATERIAL DRILLED / COLOR	HARDNESS
0	10	Brown clay	
10	11	Rocky	
11	50	Med Brown Sand	
50	60	Med To Course Brown Sand	
60	75	Med Green Sand & orange	
75	80	Yellow & orange clay	
80	90	Fine Brown Sand	
90	100	Tan & Gray clay	
100	120	Fine Sandstone white	
120	140	Blue Shale	
140	145	Fine White Sandstone	
145	170	Strips of Blue Shale + Sandstone	
170	212	Sandstone with strips of harder Blue shale, Fine Sandstone	
212		Limestone	

United States Department of Agriculture

Saunders County, Nebraska



Common Land Unit

Non-Cropland

Cropland

Tract Boundary

PLSS

Wetland Determination Identifiers

- Restricted Use
- Limited Restrictions
- Exempt from Wetland Provisions

2020 NAIP Ortho Imagery

2023 Program Year

Map Created April 19, 2022

Farm **14558**

25-14-7E

Parcel Information	
Parcel ID	003688500
Links	
Area #	2
Current Owner	ROGERS, ANNETTE K & KEITH ** CO TRUSTEES **
Mailing Address	P O BOX 86 YUTAN, NE 68073-0086
Situs Address	
Tax District	206
School District	6108 (YUTAN 9)
Legal Description	SE NE & NE SE 11-14-9 (80 ACRES)
Class	Agricultural

Current Value Information

Land Value	Dwelling Value	Improvement Value	Total Value
$498,182	$0	$0	$498,182

Prior Year Value Information

Year	Land Value	Dwelling Value	Improvement Value	Total Value
2021	$520,707	$0	$0	$520,707

Yearly Tax Information		
Year	**Amount**	**Levy**
2021	$8,025.36	1.670290

2021 Tax Levy	
Description	**Rate**
COUNTY GENERAL	0.218116
COUNTY BLDG	0.002337
COUNTY FLOOD CONTROL	0.001793
COUNTY-BONDS ONLY	0.023800
YUTAN 9 GENERAL	0.995903
YUTAN 9 SPECIAL BLDG	0.043772
YUTAN 9 QUALITY CAP PUR K-12	0.010268
YUTAN 9 BOND	0.078430
ESU #2 GENERAL	0.015000
SOUTHEAST COMMUNITY COLLEGE GENERAL	0.073700
SOUTHEAST COMMUNITY COLLEGE CAP IMPT FUND	0.020000
PLATTE NORTH GENERAL	0.033450
YUTAN GENERAL	0.025318
YUTAN BOND	0.034485
YUTAN SINKING FUND	0.014682
MARBLE TWP GENERAL	0.071631
AG SOCIETY	0.006742
AG SOCIETY IMPROVEMENT FUND	0.000863

99 Year Sales History

No previous sales information Is available.

Agricultural Land Information

Soil Symbol	Soil Desc	Landuse	LVG	Spot LVG	Unit Value	Acres	Total Value
7280	7280-TOMEK SILT LOAN 0-2% SLOPES	IRRIGA	1A1		6,888	49.83	343,229
ROAD	ROAD	ROAD			0	2.01	0
7105	7105-YUTAN SILTY CLAY LOAM-TERRACE 2-6% SLOPES-ERODED	IRRIGA	2A		5,919	11.99	70,969
7340	7340-FILBERT SILT LOAM 0-1% SLOPES	IRRIGA	2A1		6,394	0.1	639
7105	7105-YUTAN SILTY CLAY LOAM-TERRACE 2-6% SLOPES-ERODED	DRY	1D		5,566	6.06	33,730
7340	7340-FILBERT SILT LOAM 0-1% SLOPES	DRY	2D1		5,390	0.59	3,180
8145	8145-POHOCCO PAHUK COMPLEX 6-11% SLOPES-ERODED	DRY	3D		4,626	3.89	17,995
7280	7280-TOMEK SILT LOAN 0-2% SLOPES	DRY	1D1		5,684	0.04	227
8110	8110-OLMITZ LOAM 2-6% SLOPES	DRY	1D		5,566	2.52	14,026

7049	7049-KENRIDGE SILTY CLAY LOAM-OCCASIONALLY FLOODED	DRY	2D1		5,390	0.08	431
8145	8145-POHOCCO PAHUK COMPLEX 6-11% SLOPES-ERODED	IRRIGA'	4A1		4,760	2.89	13,756
					Totals	80	498,182

Photo	

Calendar Year 2022
(January 1 – December 31, 2022)
Chemigation Annual Report – As Required by
Nebraska Chemigation Act § 461123 and
Title 195 – Rules and Regulations Pertaining to Chemigation

Natural Resources District: Lower Platte
Headquarters City: Wahoo

	New	Renewal	Emergency	Special	Total
Applications Received	57	675	1		733
Applications Approved	57	670	1		728
Fees Collected	5,130	20,250	300		25,680

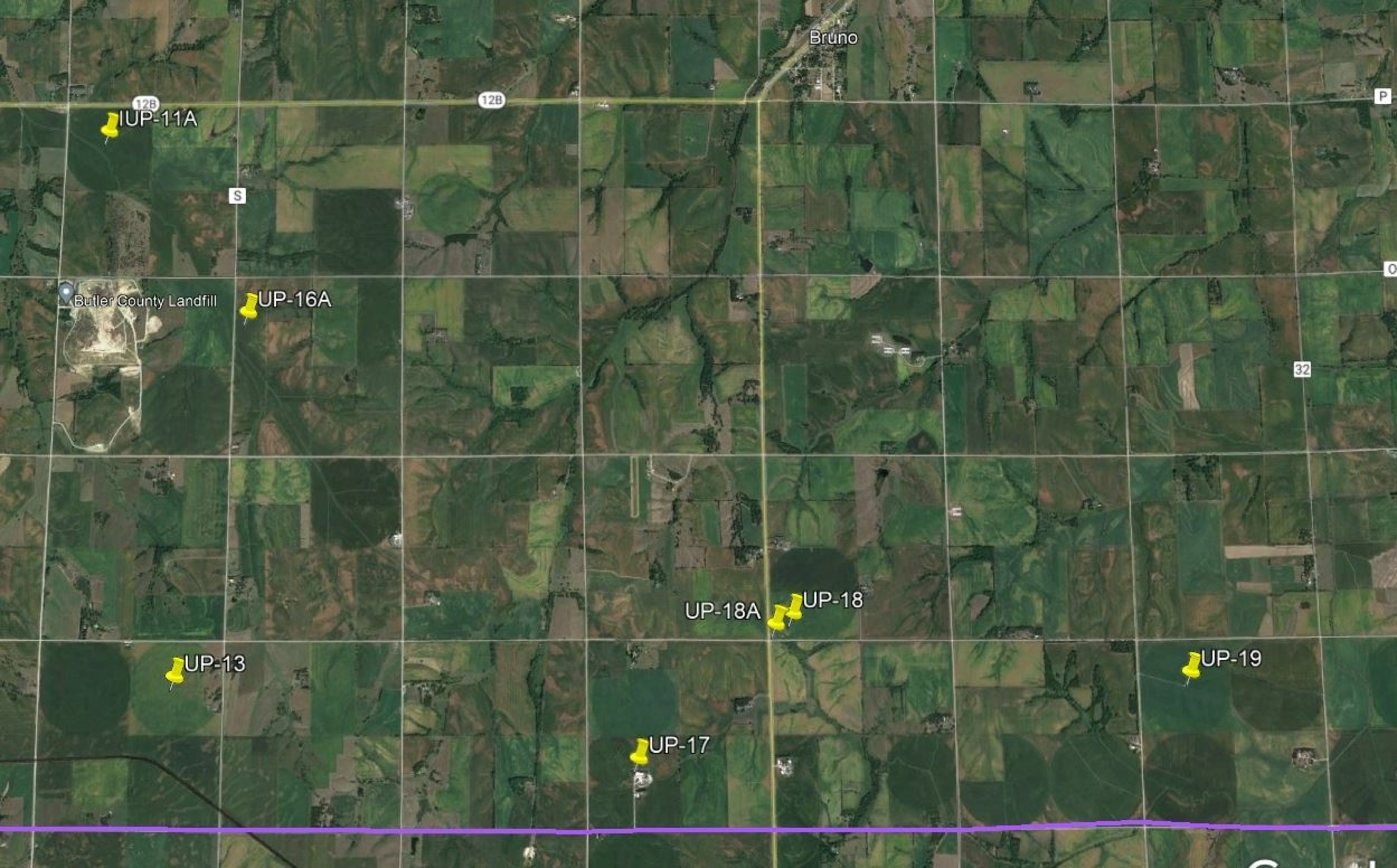
	Initial	Emergency	Routine	Follow-up	Equipment Replacement or Repair	Total Inspections
Inspections	57	1	185	21	21	264

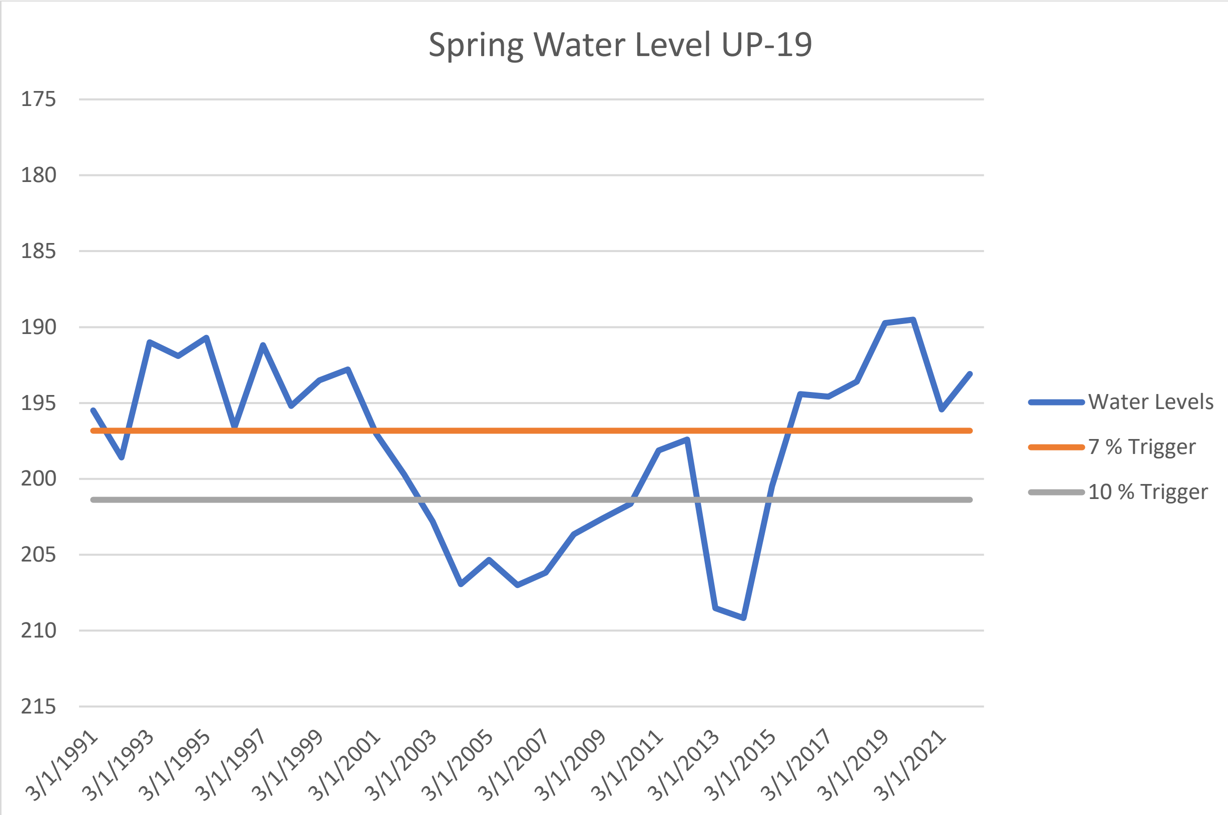
Fertilizer/Pesticide Used Crop Season 2021	Total Amount Applied – gallons	Total Amount Applied – pounds	
Thiosulfate	0 &	12127	
32% & Thiosul	0 &	40362.2	
32%	565617 &	2205601.24	
thiosul	846 &	2480	
KQ353	0 &	87558	
headline amp	171.7 &	0	
12-0-0-26 thiosul	866 &	2532	
25-0-0-6	0 &	15175	
28%	21898 &	71942	
20-0-3-2	0 &	35200	
thiosul 26%	39696 &	0	
propaz	50.05 &	0	
miditsh	1.3 &	0	
8-0-0-9	0 &	17600	
28-0-0-5	330 &	0	
Kugler KQ353	6848 &	0	
12-0-0-26 sulfur	0 &	13042	
0-0-25-17	2128 &	0	
sulfur	408 &	2210	
KTS	0 &	22000	
KTS 0-0-27-17s	0 &	1041.3	
Lombda	4.06 &	0	
Cynergy	126 &	0	
Affiance	15.2 &	0	
Silencer	3.62 &	0	
k flex	240 &	0	
32% w/sulfer	0 &	13260	
cucento	0 &	6750	
Sulfur	313 &	0	
26%	950 &	1616	
25-0-2-4	5980 &	0	
headline SC	17.7 &	0	

8.20-3-5	0 &	21200	
ATS	0 &	650	
midash	0.54 &	0	
midish	1.9 &	0	
hero	3.04 &	0	
headline Amp	10.6 &	0	
ats 12-0-0-26S	0 &	923.5	
nitrogen-sulfur	0 &	15000	
sufer	135 &	0	
domark	1.4 &	0	
Efficent	0 &	55.21	
fungicide	0 &	2500	
cacento	0 &	2500	
quilt	8.35 &	0	
selenca	2 &	0	
Lambda	4.63 &	0	
26-0-3-5	3900 &	0	
90-10	0 &	4503	
Total Treated Acres	41057.38		

1. Quantity of fertilizer/pesticide can be reported in either gallons **<u>or</u>** pounds. Does not have to be reported in both.

Additional Information:


Bruno
12B
12B
P
IUP-11A
S
O
Butler County Landfill
UP-16A
32
UP-18
UP-18A
UP-13
UP-19
UP-17


Spring Water Level UP-19
175
180
185
190
195
200
205
210
215
3/1/1991
3/1/1993
3/1/1995
3/1/1997
3/1/1999
3/1/2001
3/1/2003
3/1/2005
3/1/2007
3/1/2009
3/1/2011
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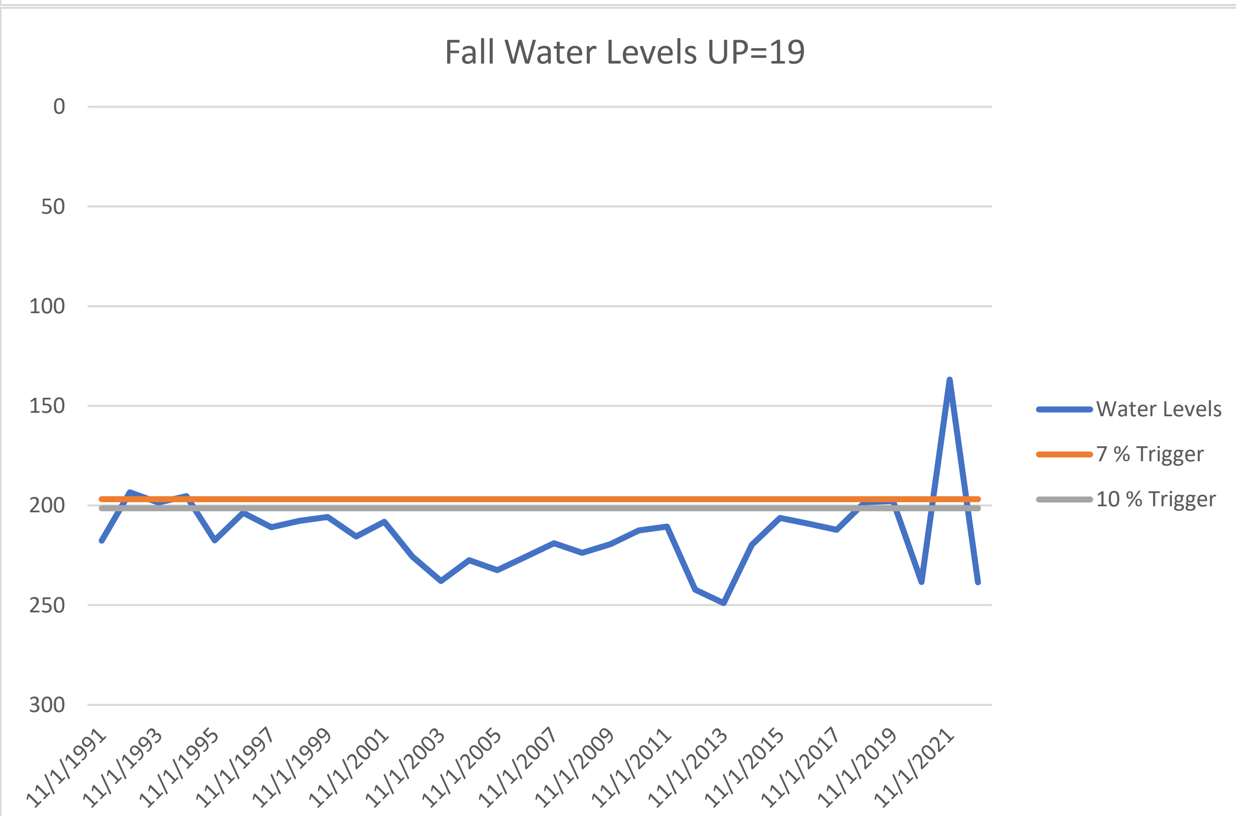
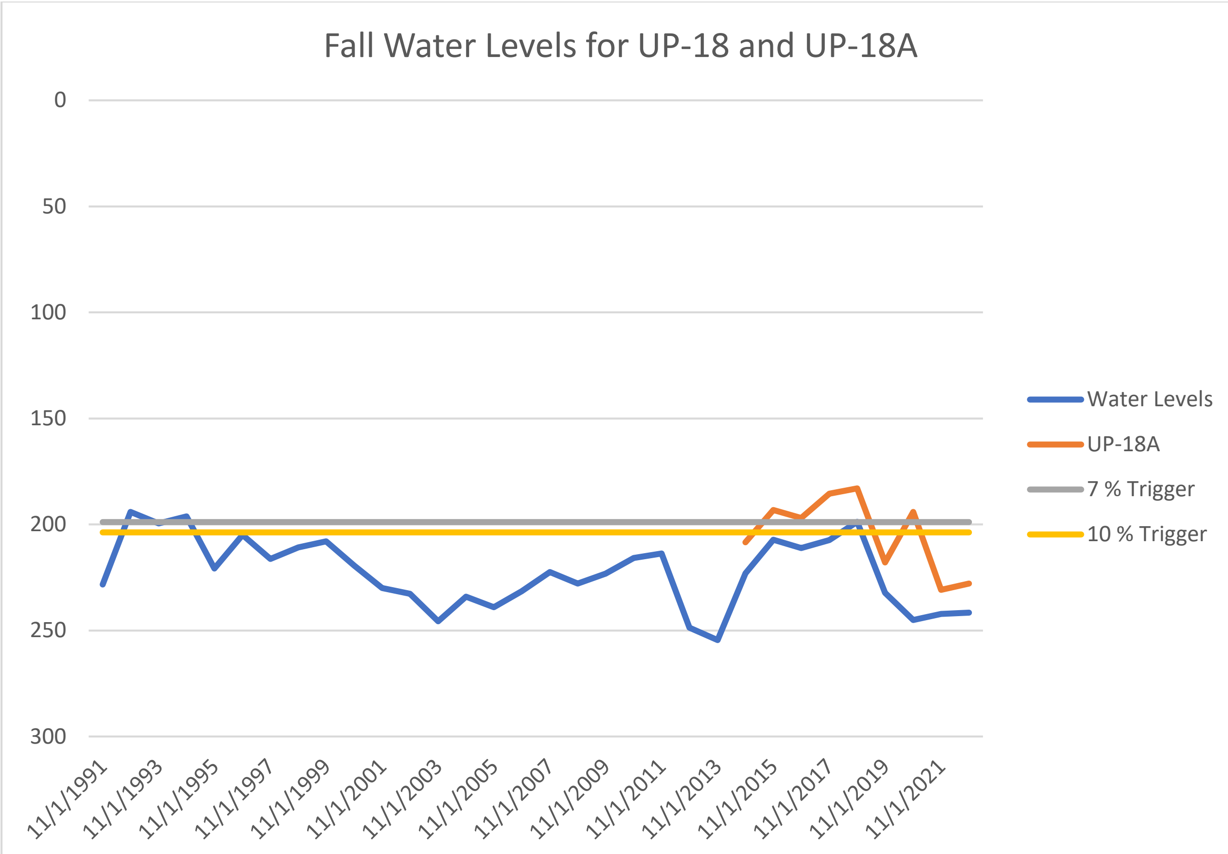
3/1/2015
3/1/2017
3/1/2019
3/1/2021
Water Levels
7 % Trigger
10 % Trigger


Fall Water Levels UP=19
0
50
100
150
200
250
300
11/1/1991
11/1/1993
11/1/1995
11/1/1997
11/1/1999
11/1/2001
11/1/2003
11/1/2005
11/1/2007
11/1/2009
11/1/2011
11/1/2013
11/1/2015
11/1/2017
11/1/2019
11/1/2021
Water Levels
7 % Trigger
10 % Trigger


Fall Water Levels for UP-18 and UP-18A
0
50
100
150
200
250
300
11/1/1991
11/1/1993
11/1/1995
11/1/1997
11/1/1999
11/1/2001
11/1/2003
11/1/2005
11/1/2007
11/1/2009
11/1/2011
11/1/2013
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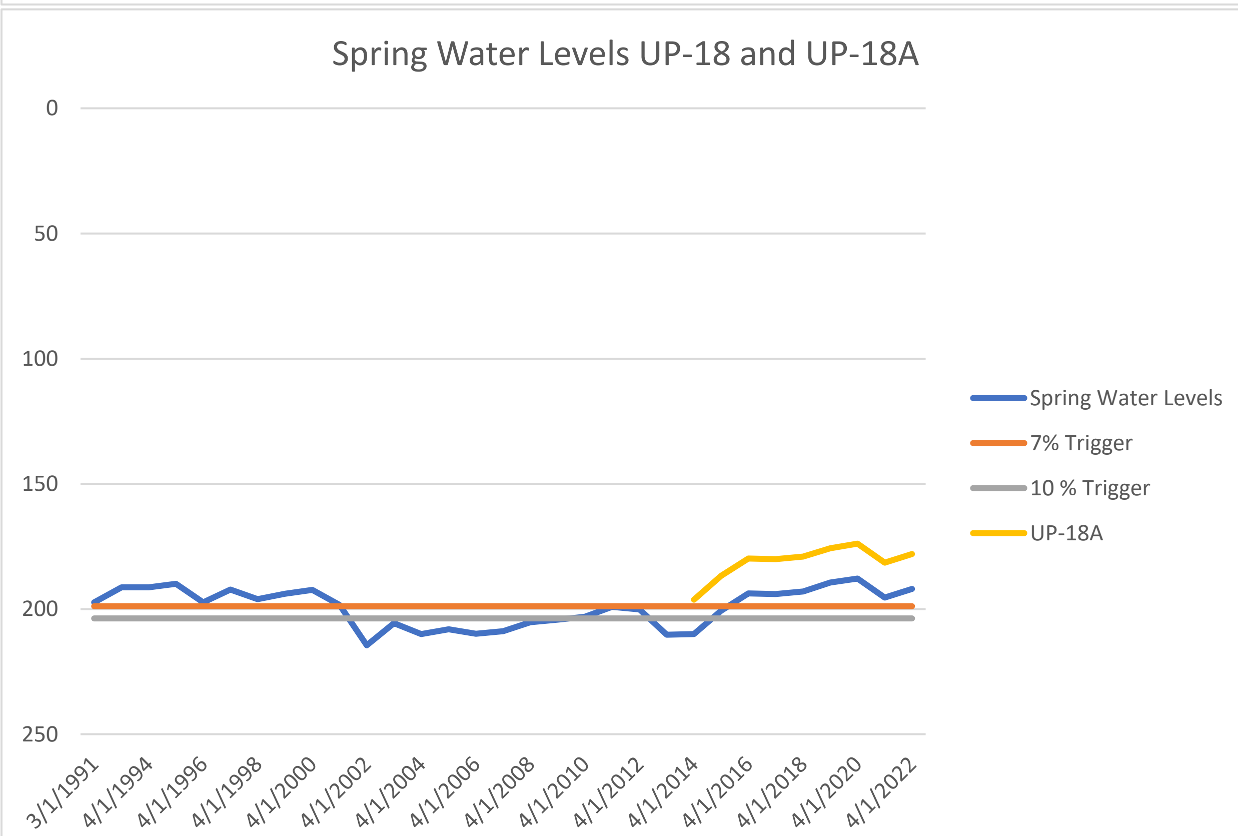
11/1/2017
11/1/2019
11/1/2021
Water Levels
UP-18A
7 % Trigger
10 % Trigger


Spring Water Levels UP-18 and UP-18A
0
50
100
150
200
250
3/1/1991
4/1/1994
4/1/1996
4/1/1998
4/1/2000
4/1/2002
4/1/2004
4/1/2006
4/1/2008
4/1/2010
4/1/2012
4/1/2014
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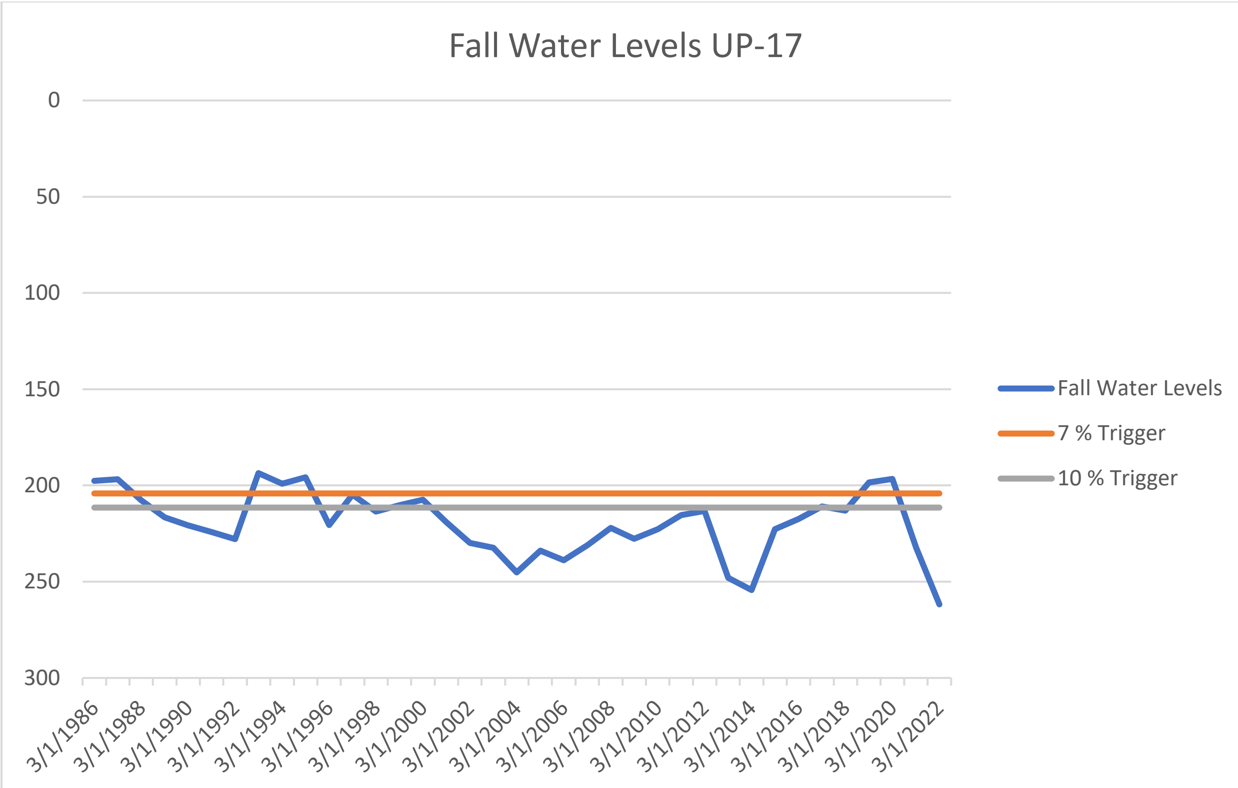
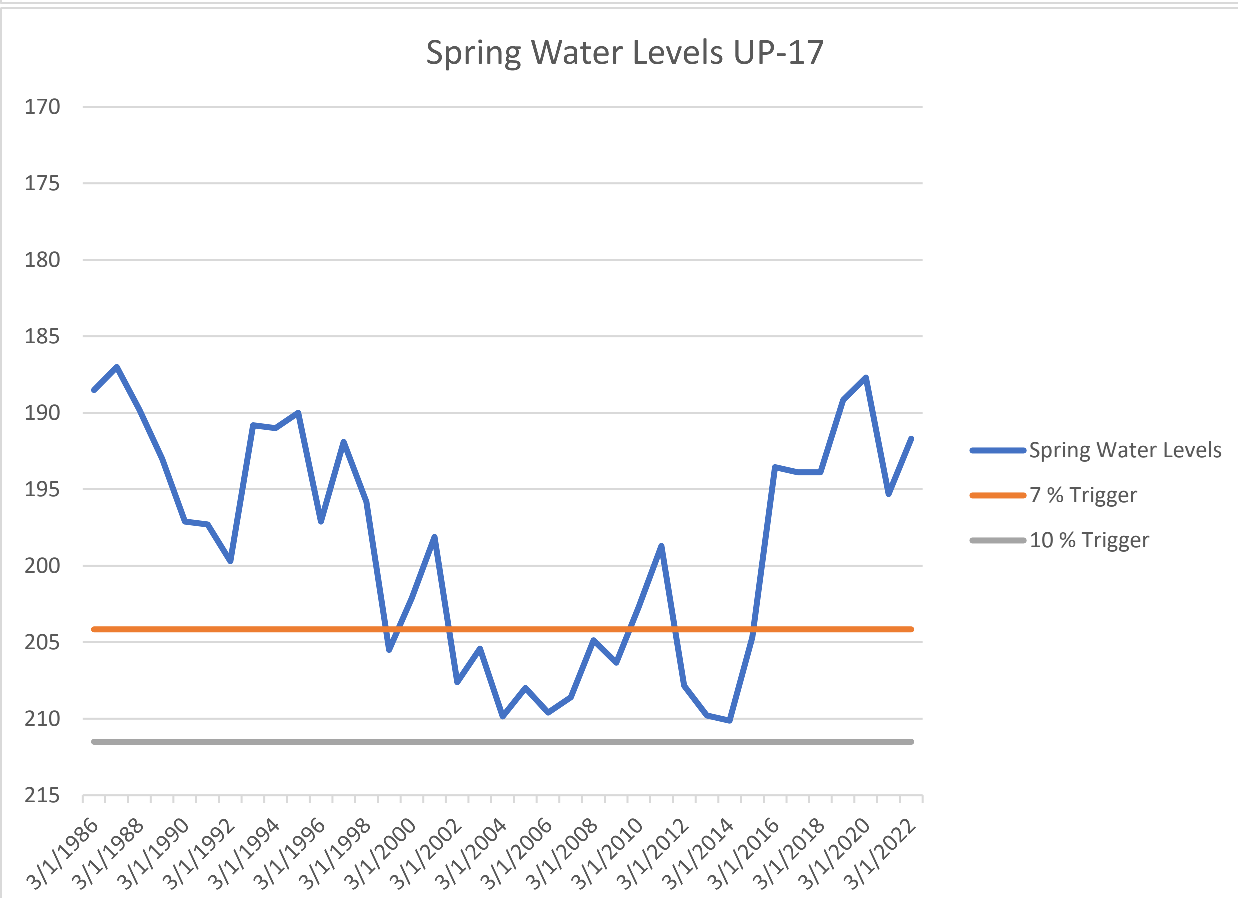
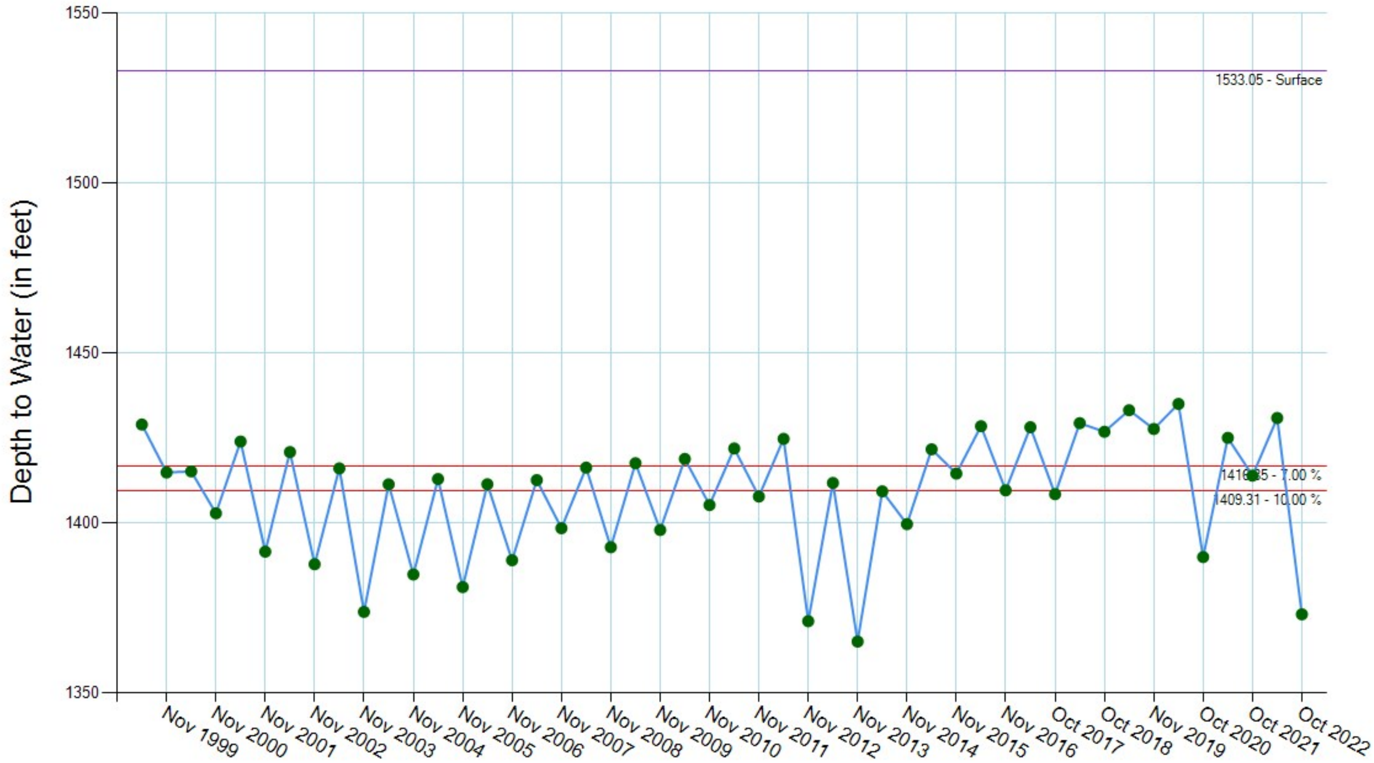
4/1/2018
4/1/2020
4/1/2022
Spring Water Levels
7% Trigger
10 % Trigger
UP-18A


Fall Water Levels UP-17
0
50
100
150
200
250
300
3/1/1986
3/1/1988
3/1/1990
3/1/1992
3/1/1994
3/1/1996
3/1/1998
3/1/2000
3/1/2002
3/1/2004
3/1/2006
3/1/2008
3/1/2010
3/1/2012
3/1/2014
3/1/2016
3/1/2018
3/1/2020
3/1/2022
Fall Water Levels
7 % Trigger
10 % Trigger

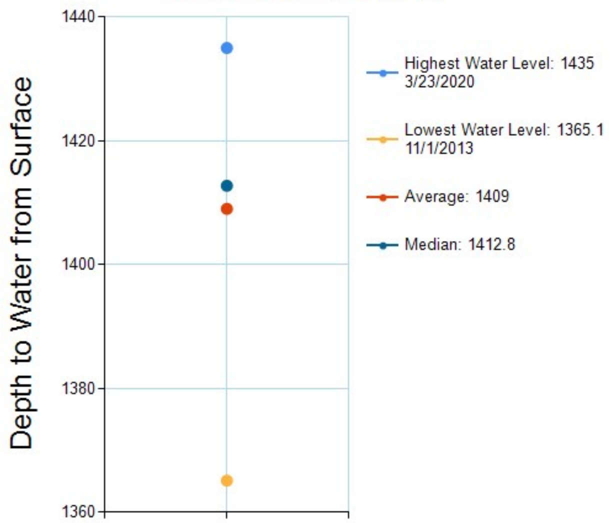

Spring Water Levels UP-17
170
175
180
185
190
195
200
205
210
215
3/1/1986
3/1/1988
3/1/1990
3/1/1992
3/1/1994
3/1/1996
3/1/1998
3/1/2000
3/1/2002
3/1/2004
3/1/2006
3/1/2008
3/1/2010
3/1/2012
3/1/2014
3/1/2016
3/1/2018
3/1/2020
3/1/2022
Spring Water Levels
7 % Trigger
10 % Trigger

RegCD: G-065822 **Well #:** UP-11A
Region: Uplands **County:** Butler
Legal: 15-3E-13 **Owner Name:** Rudolph A and Harriet J Jakub Trustees

Water Level Readings



Record Results

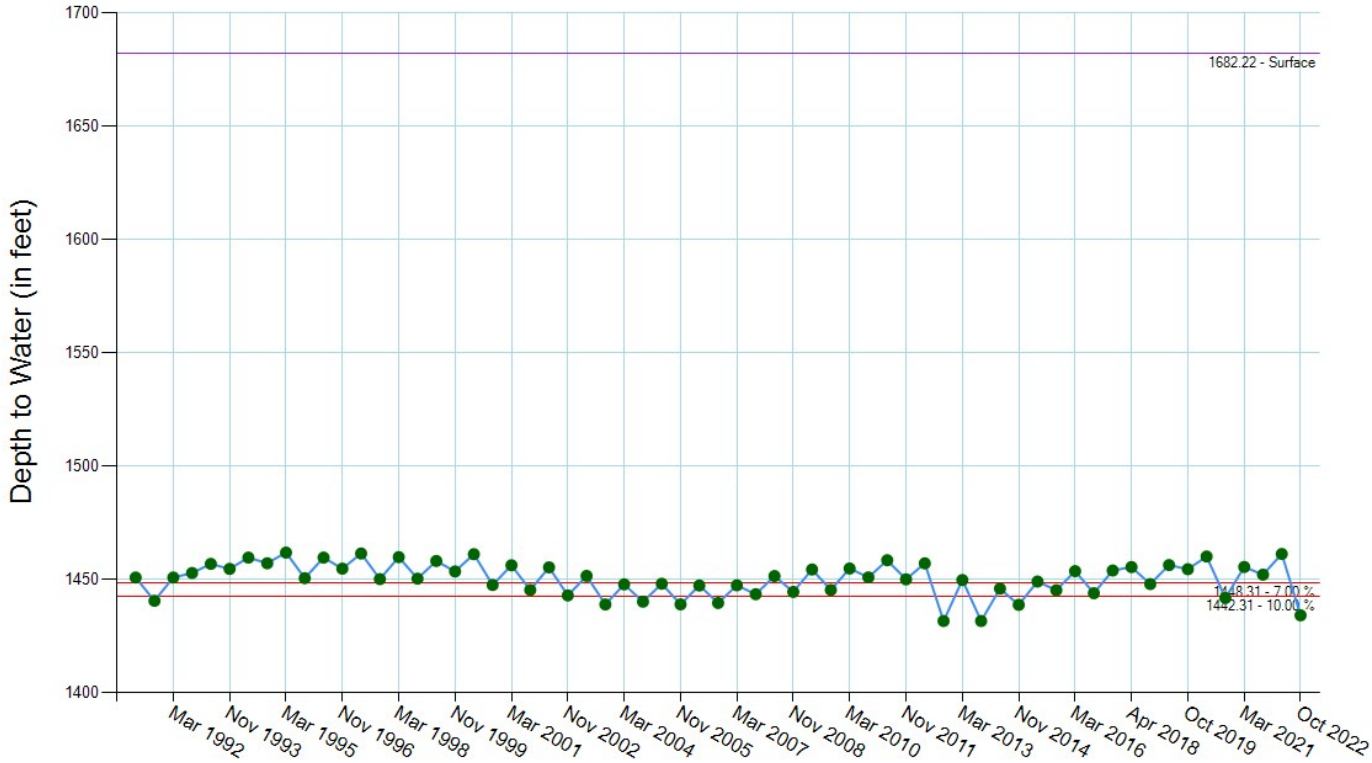


Historical Readings (date - reading)

03/01/1999 - 1429	03/01/2005 - 1412.9	03/01/2011 - 1421.9	03/01/2017 - 1428.2
11/01/1999 - 1414.9	11/01/2005 - 1381.1	11/01/2011 - 1407.8	10/23/2017 - 1408.5
03/01/2000 - 1415.2	03/01/2006 - 1411.4	03/01/2012 - 1424.7	03/21/2018 - 1429.4
11/01/2000 - 1402.9	11/01/2006 - 1389	11/01/2012 - 1371.1	10/22/2018 - 1426.8
03/01/2001 - 1424	03/01/2007 - 1412.6	03/01/2013 - 1411.8	03/28/2019 - 1433.2
11/01/2001 - 1391.6	11/01/2007 - 1398.5	11/01/2013 - 1365.1	11/04/2019 - 1427.6
03/01/2002 - 1420.9	03/01/2008 - 1416.3	03/01/2014 - 1409.3	03/23/2020 - 1435
11/01/2002 - 1387.9	11/01/2008 - 1392.9	11/01/2014 - 1399.7	10/19/2020 - 1390
03/01/2003 - 1416.1	03/01/2009 - 1417.6	03/01/2015 - 1421.7	03/29/2021 - 1425
11/01/2003 - 1373.9	11/01/2009 - 1397.9	11/01/2015 - 1414.5	10/18/2021 - 1413.9
03/01/2004 - 1411.4	03/01/2010 - 1418.8	03/01/2016 - 1428.5	03/18/2022 - 1430.9
11/01/2004 - 1384.9	11/01/2010 - 1405.3	11/01/2016 - 1409.6	10/17/2022 - 1373.1

RegCD:	G-049997	**Well #:**	UP-13
Region:	Uplands	**County:**	Butler
Legal:	15-3E-36	**Owner Name:**	Prochaska Family Trust

Water Level Readings



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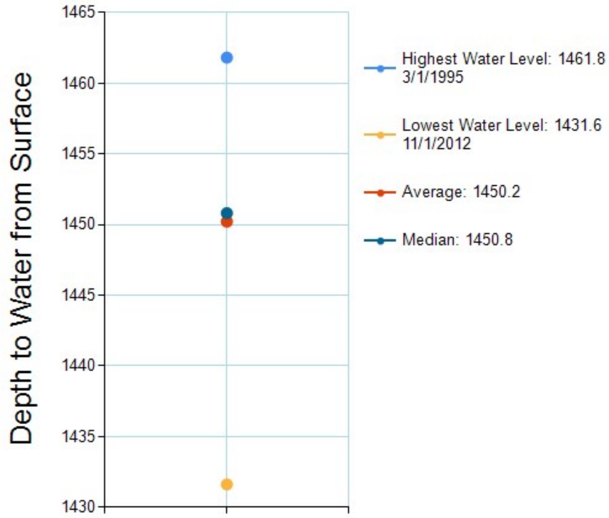

Historical Readings (date - reading)

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11/01/1991 - 1440.5	11/01/1999 - 1453.5	11/01/2007 - 1443.4	11/01/2015 - 1445.2
03/01/1992 - 1450.8	03/01/2000 - 1461.1	03/01/2008 - 1451.5	03/01/2016 - 1453.6
11/01/1992 - 1452.8	11/01/2000 - 1447.5	11/01/2008 - 1444.5	11/01/2016 - 1443.9
03/01/1993 - 1456.8	03/01/2001 - 1456.2	03/01/2009 - 1454.4	03/01/2017 - 1453.9
11/01/1993 - 1454.6	11/01/2001 - 1445.3	11/01/2009 - 1445.3	04/12/2018 - 1455.4
03/01/1994 - 1459.6	03/01/2002 - 1455.3	03/01/2010 - 1454.8	10/18/2018 - 1447.9
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03/01/1995 - 1461.8	03/01/2003 - 1451.5	03/01/2011 - 1458.4	10/21/2019 - 1454.5
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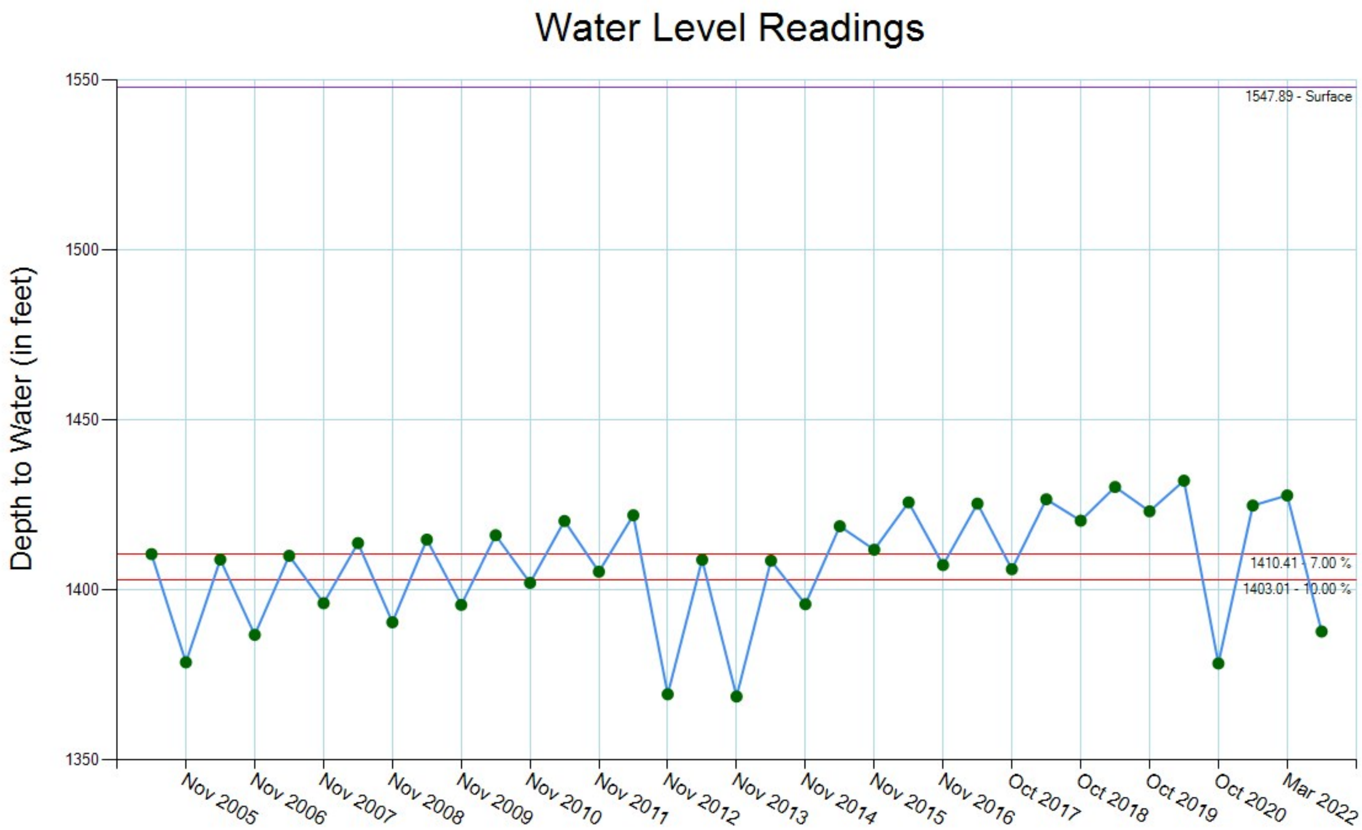
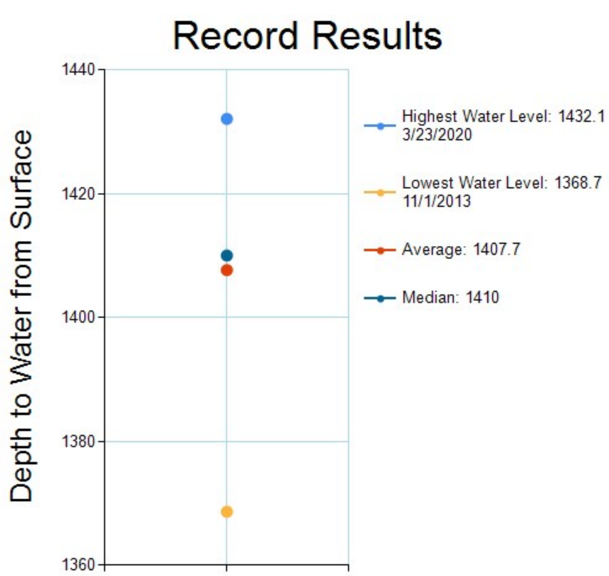
RegCD:	G-048980	**Well #:**	UP-16A
Region:	Uplands	**County:**	Butler
Legal:	15-4E-19	**Owner Name:**	Ronald D Hotovy





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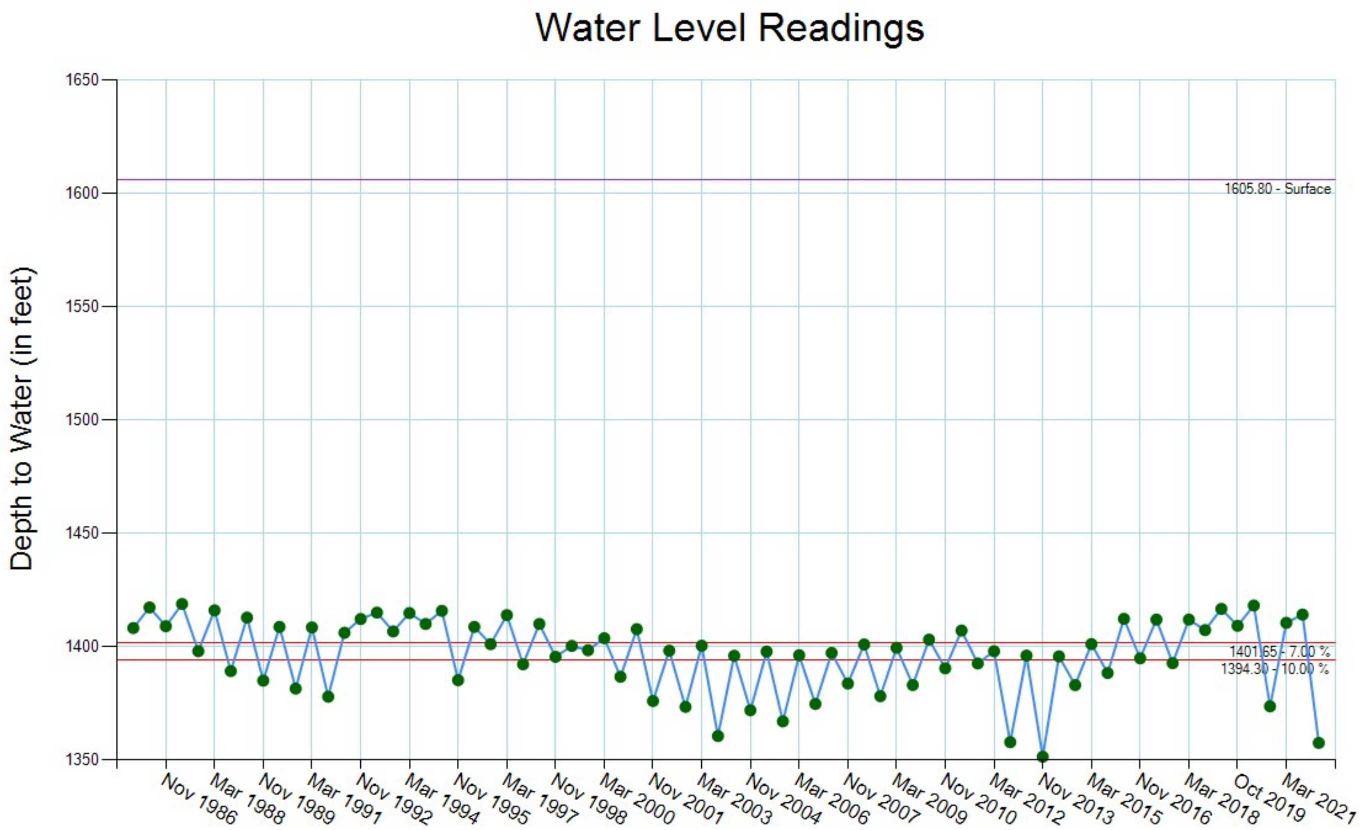
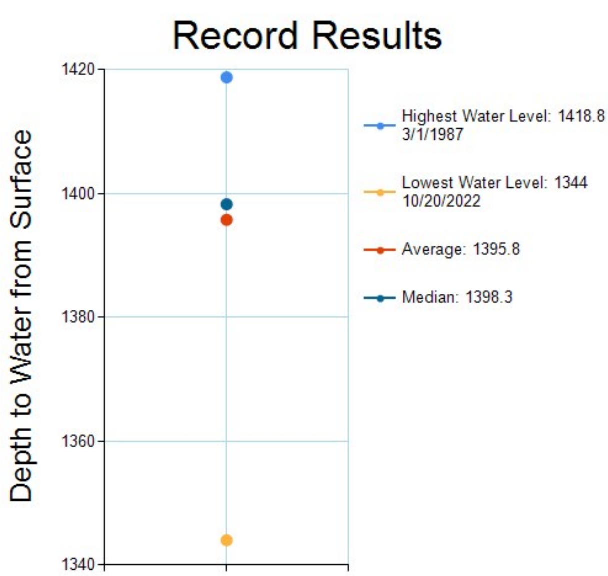
03/01/2006 - 1408.9	11/01/2010 - 1402.1	03/01/2015 - 1418.7	10/21/2019 - 1423.1
11/01/2006 - 1386.8	03/01/2011 - 1420.3	11/01/2015 - 1411.8	03/23/2020 - 1432.1
03/01/2007 - 1410	11/01/2011 - 1405.4	03/01/2016 - 1425.8	10/19/2020 - 1378.4
11/01/2007 - 1396.1	03/01/2012 - 1422	11/01/2016 - 1407.3	03/29/2021 - 1424.8
03/01/2008 - 1413.8	11/01/2012 - 1369.3	03/01/2017 - 1425.4	03/18/2022 - 1427.8
11/01/2008 - 1390.5	03/01/2013 - 1408.9	10/23/2017 - 1406.1	10/17/2022 - 1387.8
03/01/2009 - 1414.8	11/01/2013 - 1368.7	03/21/2018 - 1426.7	

RegCD: G-063179 **Well #:** UP-17
Region: Uplands **County:** Butler
Legal: 15-4E-33 **Owner Name:** Janak Farms





Historical Readings (date - reading)

11/01/1985 - 1408.2
03/01/1986 - 1417.3
11/01/1986 - 1409
03/01/1987 - 1418.8
11/01/1987 - 1398
03/01/1988 - 1416
11/01/1988 - 1389.2
03/01/1989 - 1412.8
11/01/1989 - 1385
03/01/1990 - 1408.7
11/01/1990 - 1381.5
03/01/1991 - 1408.5
11/01/1991 - 1377.9
03/01/1992 - 1406.1
11/01/1992 - 1412.2
03/01/1993 - 1415
11/01/1993 - 1406.7
03/01/1994 - 1414.8
11/01/1994 - 1410
03/01/1995 - 1415.8
11/01/1995 - 1385.2
03/01/1996 - 1408.7
11/01/1996 - 1401.1
03/01/1997 - 1413.9
11/01/1997 - 1392.2
03/01/1998 - 1410
11/01/1998 - 1395.5
03/01/1999 - 1400.3
11/01/1999 - 1398.4
03/01/2000 - 1403.7
11/01/2000 - 1386.7
03/01/2001 - 1407.7
11/01/2001 - 1376
03/01/2002 - 1398.2
11/01/2002 - 1373.4
03/01/2003 - 1400.4
11/01/2003 - 1360.5
03/01/2004 - 1396
11/01/2004 - 1371.9
03/01/2005 - 1397.8
11/01/2005 - 1367
03/01/2006 - 1396.2
11/01/2006 - 1374.7
03/01/2007 - 1397.2
11/01/2007 - 1383.7
03/01/2008 - 1400.9
11/01/2008 - 1378.1
03/01/2009 - 1399.5
11/01/2009 - 1383.1
03/01/2010 - 1403.1
11/01/2010 - 1390.4
03/01/2011 - 1407.1
11/01/2011 - 1392.6
03/01/2012 - 1398
11/01/2012 - 1357.9
03/01/2013 - 1396
11/01/2013 - 1351.4
03/01/2014 - 1395.7
11/01/2014 - 1383
03/01/2015 - 1401.1
11/01/2015 - 1388.4
03/01/2016 - 1412.3
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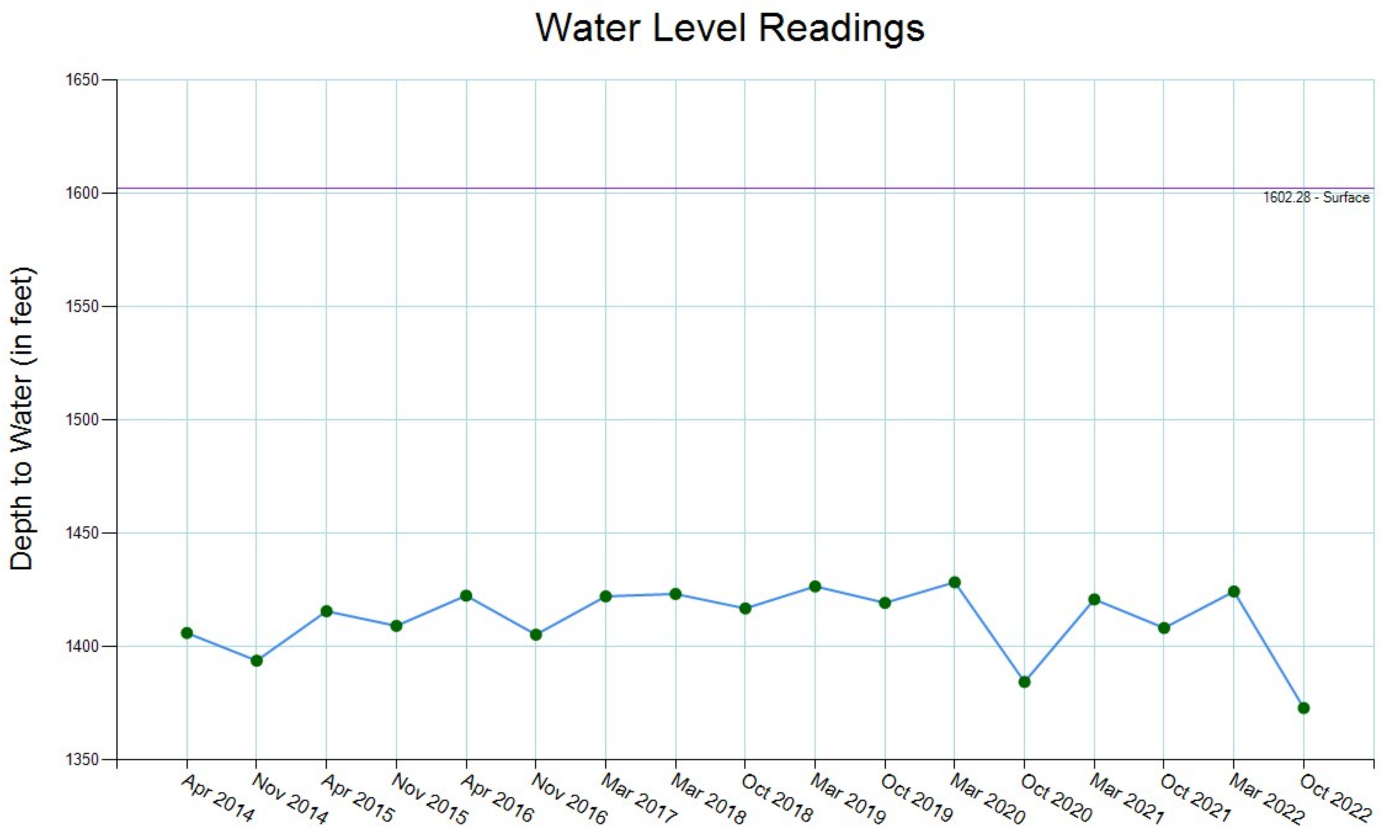
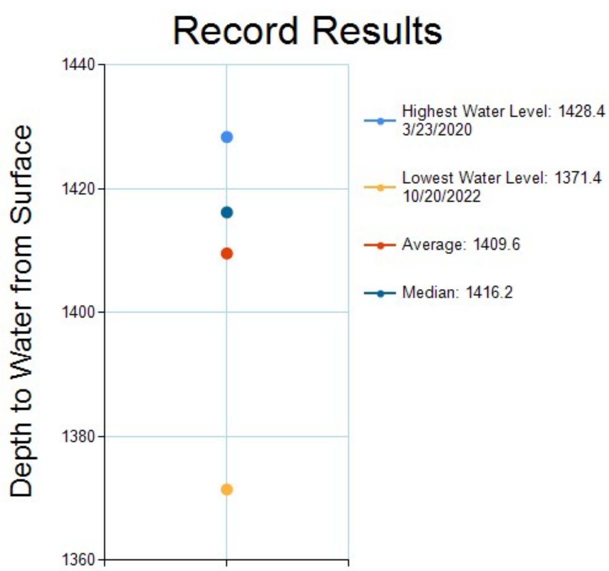
03/01/2017 - 1411.9
10/23/2017 - 1392.7
03/21/2018 - 1411.9
10/18/2018 - 1407.3
03/25/2019 - 1416.7
10/21/2019 - 1409.2
03/23/2020 - 1418.1
10/19/2020 - 1373.7
03/29/2021 - 1410.5
03/21/2022 - 1414.1
10/20/2022 - 1344
10/25/2022 - 1364.1
10/26/2022 - 1364.5

RegCD:	G-168104	**Well #:**	UP-18A
Region:	Uplands	**County:**	Butler
Legal:	15-4E-27	**Owner Name:**	Jane A Stara Revocable Trust

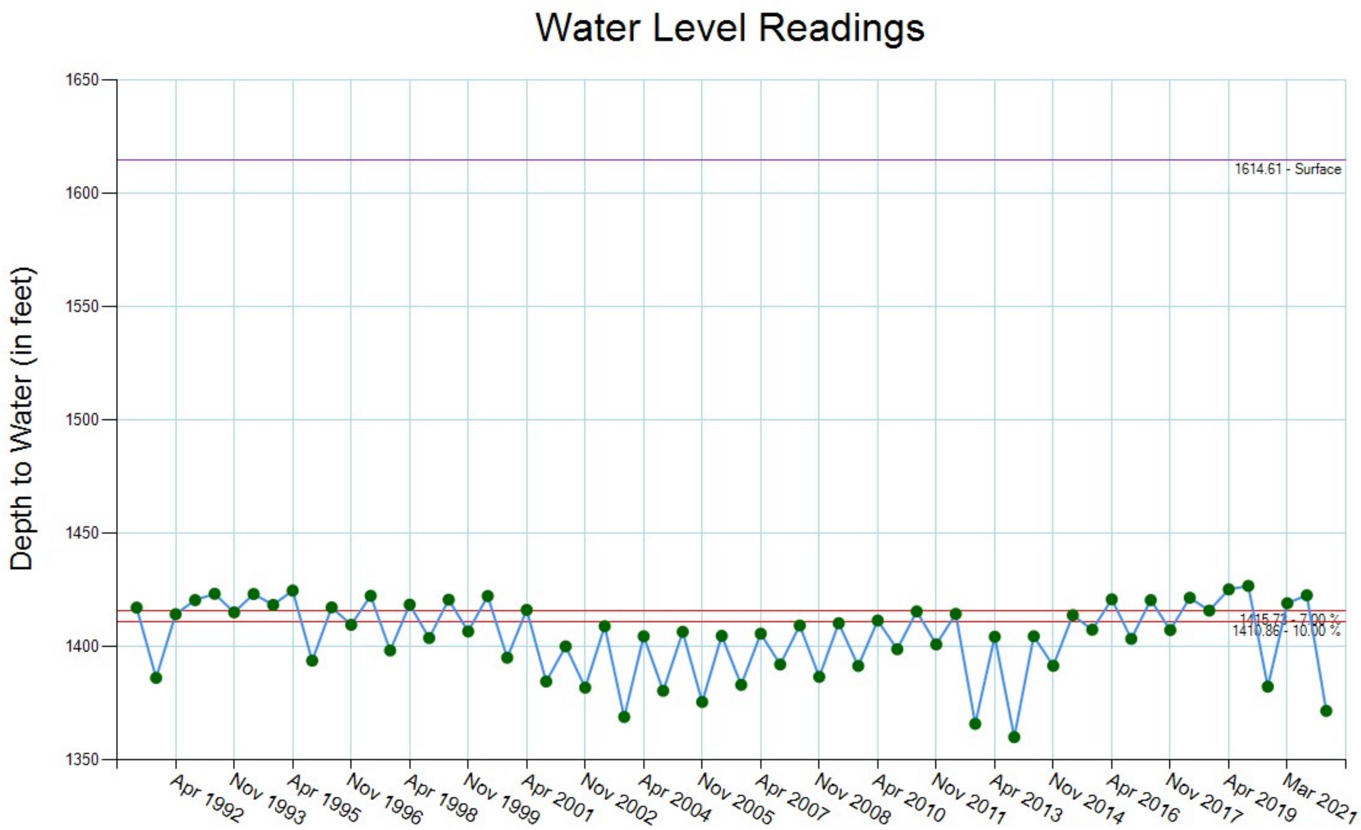


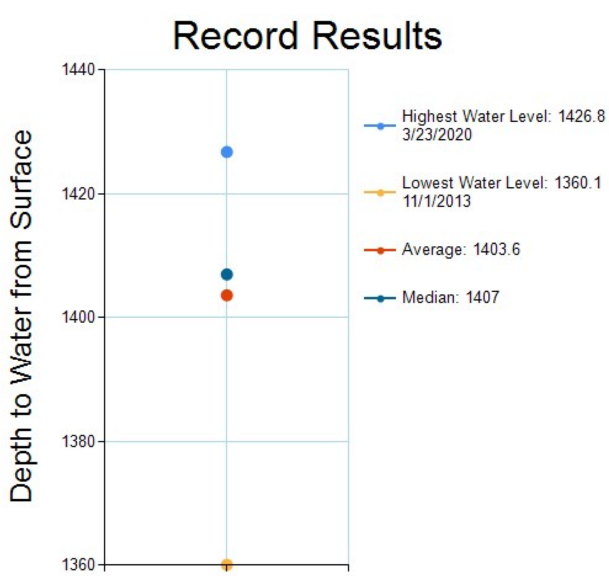


Historical Readings (date - reading)

04/01/2014 - 1406
11/01/2014 - 1393.8
04/01/2015 - 1415.6
11/01/2015 - 1409.1
04/01/2016 - 1422.5
11/01/2016 - 1405.3
03/01/2017 - 1422.2
03/21/2018 - 1423.2
10/18/2018 - 1416.8
03/21/2019 - 1426.6
10/21/2019 - 1419.3
03/23/2020 - 1428.4
10/19/2020 - 1384.4
03/29/2021 - 1420.8
10/20/2021 - 1408.2
03/21/2022 - 1424.3
10/20/2022 - 1371.4
10/25/2022 - 1374.4

RegCD: G-057242 **Well #:** UP-18
Region: Uplands **County:** Butler
Legal: 15-4E-27 **Owner Name:** Ernest L Stara





Historical Readings (date - reading)

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04/01/1992 - 1414.3	04/01/2000 - 1422.3	04/01/2008 - 1409.3	04/01/2016 - 1420.8
11/01/1992 - 1420.5	11/01/2000 - 1395.1	11/01/2008 - 1386.7	11/01/2016 - 1403.4
04/01/1993 - 1423.3	04/01/2001 - 1416.2	04/01/2009 - 1410.3	04/01/2017 - 1420.5
11/01/1993 - 1415.1	11/01/2001 - 1384.6	11/01/2009 - 1391.5	11/01/2017 - 1407.3
04/01/1994 - 1423.2	04/01/2002 - 1400.1	04/01/2010 - 1411.5	04/01/2018 - 1421.5
11/01/1994 - 1418.4	11/01/2002 - 1381.9	11/01/2010 - 1398.9	11/01/2018 - 1415.9
04/01/1995 - 1424.7	04/01/2003 - 1409	04/01/2011 - 1415.5	04/01/2019 - 1425.2
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04/01/1996 - 1417.3	04/01/2004 - 1404.5	04/01/2012 - 1414.4	10/19/2020 - 1382.3
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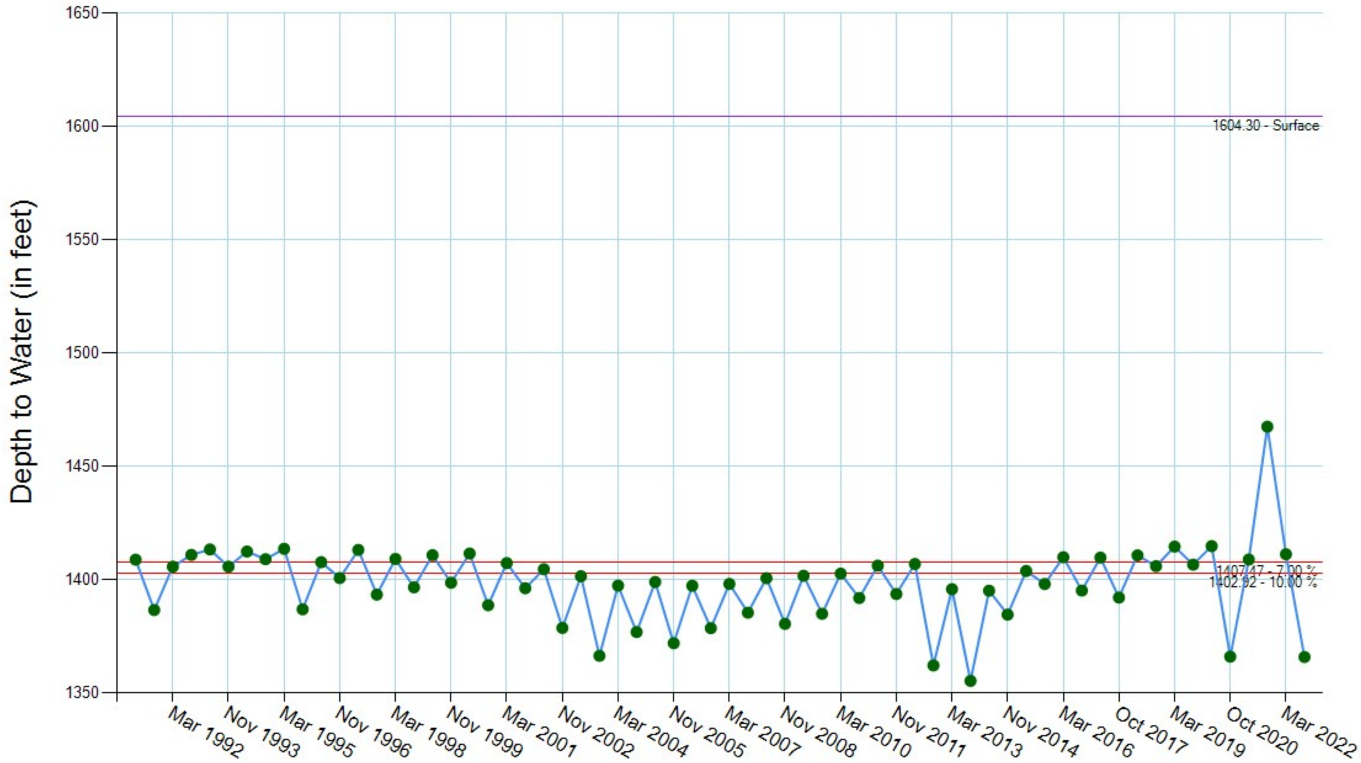
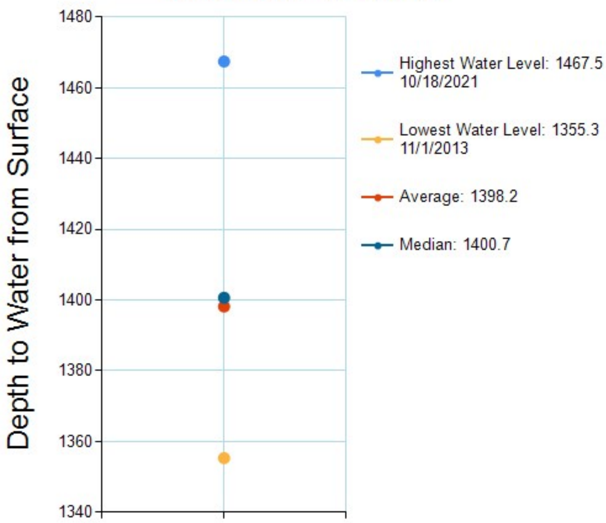
04/01/1997 - 1422.4	04/01/2005 - 1406.5	04/01/2013 - 1404.3	03/21/2022 - 1422.7
11/01/1997 - 1398.3	11/01/2005 - 1375.6	11/01/2013 - 1360.1	10/20/2022 - 1369.5
04/01/1998 - 1418.5	04/01/2006 - 1404.8	04/01/2014 - 1404.6	10/25/2022 - 1372.3
11/01/1998 - 1403.8	11/01/2006 - 1383.1	11/01/2014 - 1391.5	10/26/2022 - 1373.1

RegCD: G-062859 **Well #:** UP-19
Region: Uplands **County:** Butler
Legal: 15-4E-36 **Owner Name:** Frances Kastl Trust

Water Level Readings



Record Results



Historical Readings (date - reading)

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03/01/1993 - 1413.3	03/01/2001 - 1407.3	03/01/2009 - 1401.7	03/01/2017 - 1409.7
11/01/1993 - 1405.7	11/01/2001 - 1396.2	11/01/2009 - 1384.9	10/23/2017 - 1392.1
03/01/1994 - 1412.4	03/01/2002 - 1404.6	03/01/2010 - 1402.7	03/21/2018 - 1410.7
11/01/1994 - 1409	11/01/2002 - 1378.7	11/01/2010 - 1391.9	10/18/2018 - 1406
03/01/1995 - 1413.6	03/01/2003 - 1401.5	03/01/2011 - 1406.2	03/28/2019 - 1414.6
11/01/1995 - 1386.9	11/01/2003 - 1366.4	11/01/2011 - 1393.7	10/31/2019 - 1406.6
03/01/1996 - 1407.7	03/01/2004 - 1397.4	03/01/2012 - 1406.9	03/23/2020 - 1414.8
11/01/1996 - 1400.7	11/01/2004 - 1376.9	11/01/2012 - 1362.2	10/19/2020 - 1366
03/01/1997 - 1413.1	03/01/2005 - 1399	03/01/2013 - 1395.8	03/29/2021 - 1408.9
11/01/1997 - 1393.4	11/01/2005 - 1371.9	11/01/2013 - 1355.3	10/18/2021 - 1467.5
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11/01/1998 - 1396.6	11/01/2006 - 1378.6	11/01/2014 - 1384.6	10/25/2022 - 1365.8

Water Sciences Laboratory

University of Nebraska-Lincoln
202 Water Sciences Laboratory
Lincoln, NE 68583-0844

e: dsnow1@unl.edu | p: 1 402.472.7539
f: 1 402.472.9599 | c: 1 402.304.3748

Federal ID # 47-0049123

Bill To: Daryl Andersen
Lower Platte North NRD
511 Commercial Park Road
Wahoo, NE 68066-0126

Invoice #	21105
Date	10/28/2022
Terms	NET

Business ID:

Project: **22_AndD_LPNNRD_GWDenitrification_L**
Groundwater Denitrification Samples

Customer Number:

Discount: 0 %

Qty	*Unit*	*Description*	*Batch*	*Unit Cost*	*# Elements*	*Total*	*# Priority*
2	**ea.**	**Nitrogen-15 and Oxygen-18 in Nitrate Isotopes using azide reduction and Trace gas Preconcentrator**	**W22796**	**$115.50**	**1**	**$231.00**	**0**
2	**ea.**	**Cd reduction with nitrite subtraction (NO3N only)**	**W22797**	**$14.40**	**1**	**$28.80**	**0**
2	**ea.**	**Sulfanilamide colorimetric Analysis - EPA 353.2**	**W22798**	**$17.30**	**1**	**$34.60**	**0**
2	**ea.**	**ICP-MS Dissolved Elements (No digestion) 6020A (per element)**	**W22799**	**$18.90**	**4**	**$151.20**	**0**
4	**ea.**	**Total Organic Carbon SM5310 Persulfate Oxidation**	**W22800**	**$23.10**	**1**	**$92.40**	**0**
4	**ea.**	**N2O, CO2, CH4 by Headspace Gas Chromatography**	**W22808**	**$28.90**	**1**	**$115.60**	**0**
10	**ea.**	**Nitrogen-15 and Oxygen-18 in Nitrate Isotopes using azide reduction and Trace gas Preconcentrator**	**W22830**	**$115.50**	**1**	**$1,155.00**	**0**

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Lincoln, NE 68583-0844

e: dsnow1@unl.edu | p: 1 402.472.7539
f: 1 402.472.9599 | c: 1 402.304.3748

Nebraska Water Center
Daugherty Water*for*Food Global Institute

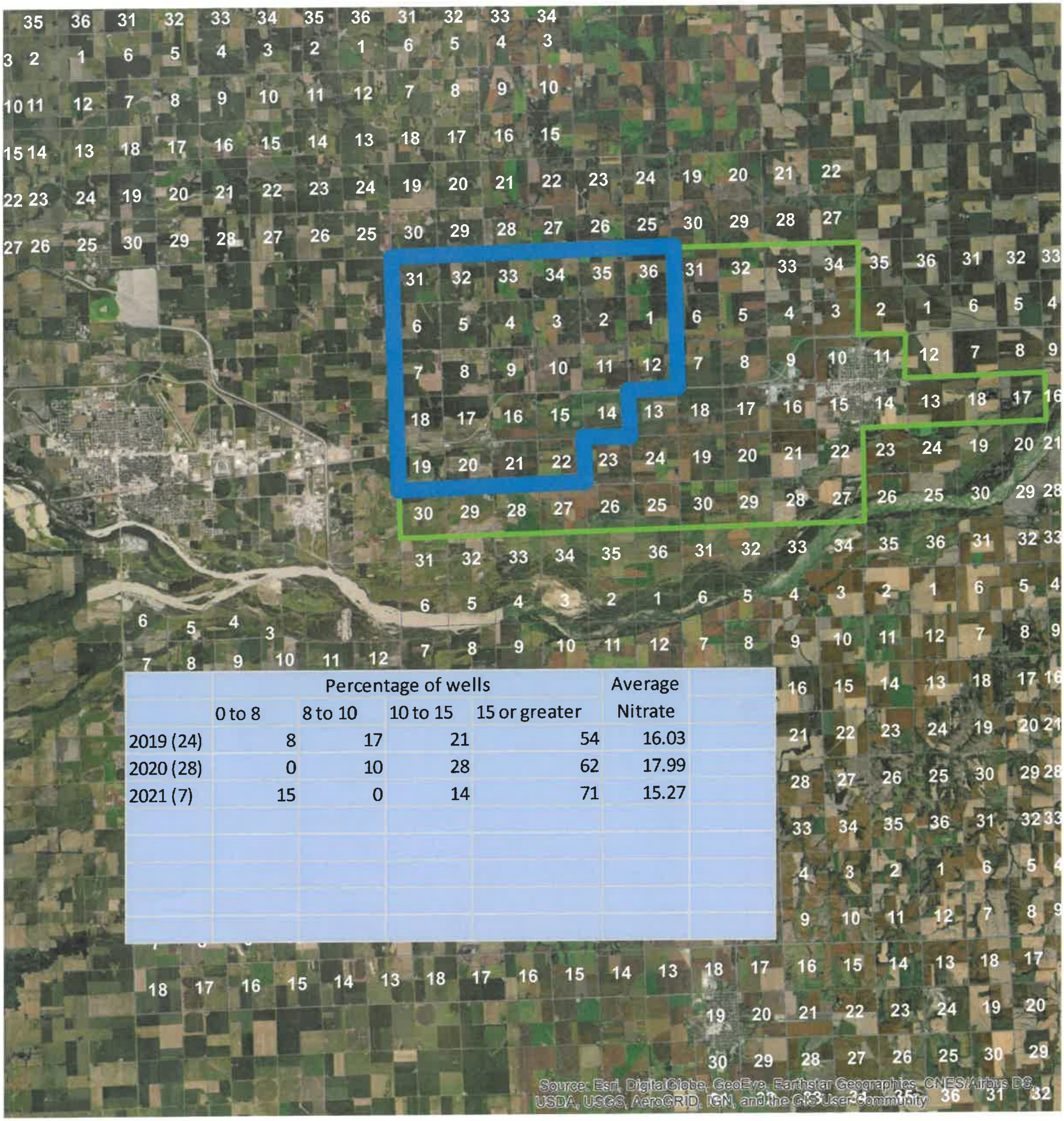
Federal ID # 47-0049123

10	ea.	Cd reduction with nitrite subtraction (NO3N only)	W22831	$14.40	1	$144.00	0
10	ea.	Sulfanilamide colorimetric Analysis - EPA 353.2	W22832	$17.30	1	$173.00	0
10	ea.	ICP-MS Dissolved Elements (No digestion) 6020A (per element)	W22833	$18.90	4	$756.00	0
10	ea.	Total Organic Carbon SM5310 Persulfate Oxidation	W22834	$23.10	1	$231.00	0
10	ea.	N2O, CO2, CH4 by Headspace Gas Chromatography	W22835	$28.90	1	$289.00	0
2	ea.	Nitrogen-15 and Oxygen-18 in Nitrate Isotopes using azide reduction and Trace gas Preconcentrator	W22864	$115.50	1	$231.00	0
2	ea.	Cd reduction with nitrite subtraction (NO3N only)	W22867	$14.40	1	$28.80	0
2	ea.	Sulfanilamide colorimetric Analysis - EPA 353.2	W22868	$17.30	1	$34.60	0
2	ea.	ICP-MS Dissolved Elements (No digestion) 6020A (per element)	W22869	$18.90	4	$151.20	0
4	ea.	Total Organic Carbon SM5310 Persulfate Oxidation	W22870	$23.10	1	$92.40	0
3	ea.	N2O, CO2, CH4 by Headspace Gas Chromatography	W22871	$28.90	1	$86.70	0

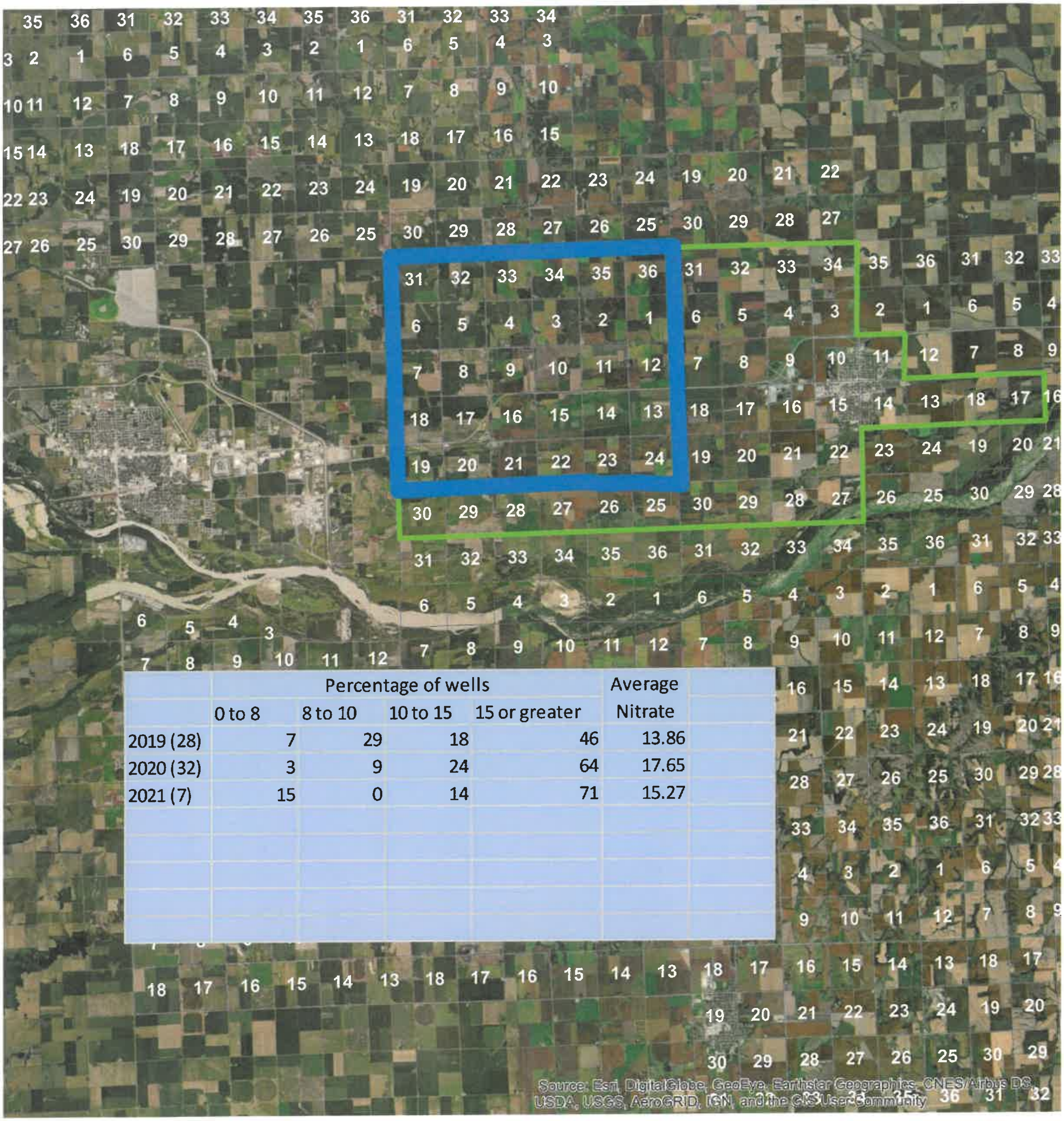
Total Amount Due	**$4,026.30**

Invoice payment by check or credit card. Please send check, payable to University of Nebraska-Lincoln, to 202 Water Sciences Laboratory, University of Nebraska, Lincoln, NE 68583-0844.

If paying by credit card, contact Jeanne Bonnett (402-472-6959) with credit card information.



	Percentage of wells				Average	
	0 to 8	8 to 10	10 to 15	15 or greater	Nitrate	
2019 (24)	8	17	21	54	16.03	
2020 (28)	0	10	28	62	17.99	
2021 (7)	15	0	14	71	15.27	



	Percentage of wells				Average
	0 to 8	8 to 10	10 to 15	15 or greater	Nitrate
2019 (28)	7	29	18	46	13.86
2020 (32)	3	9	24	64	17.65
2021 (7)	15	0	14	71	15.27

Rule 4 Record that District Approved Inhibitor was Used

If 50% or more of commercial nitrogen fertilizer is applied at pre-plant, then operators are required to furnish the District a record from the fertilizer dealer that a District inhibitor was used at recommended rates. This record shall accompany the Fertilizer Application report made to the District by December15 of each year.

Section I Groundwater Quality Management Area - Phase Four

Rule 1 Phase Four Criteria

When levels of nitrate-nitrogen exceed 15.01 parts per million, or levels of other human induced non-point source contaminants exceed 100% of the MCL or LHAL, a Phase Four area will be declared. Within the same aquifer; boundary setting for Phase Four Areas will be initiated when: water quality analytical results within a minimum 9 square mile area are at identified trigger levels for a minimum of 2 sampling events. The area must contain a minimum of 10 registered wells and contaminant trigger levels must be exceeded in over 50% of the wells. When irrigation wells are not available, other wells may be used. Initial investigation by the District will be to determine if the contamination is a result of point-source or non-point source pollution. If non-point source pollution is found to be the reason, more intensive investigation for boundary setting will ensue. If a Wellhead Protection Area should be established due to non-point source pollution, the District may set boundaries that are less than 9 square miles. After the establishment of a Phase Four Area, if non-point source contamination levels should decline, two consecutive sampling events below the trigger levels are needed before the Area could be placed in Phase Three, Phase Two or Phase One.

Rule 2 Continuation of Phase One, Two and Three Rules

A continuation of Phase One Rules as defined in Section E, Rules 1-6, Section F, Rule 2, Phase Two Rules as defined in Section G, Rules 3, 4, 5, 8, 9, 10 and 11, Phase Three Rules as defined in Section H, Rule 4.

Rule 3 Fertilizer Application On All Soils

Split application of commercial nitrogen fertilizer is required with 80 pounds maximum applied before May 1.

Rule 4 Nitrogen Recommendations

Nitrogen applications must not exceed District Recommendations. Application data may be required to verify the amount of nitrogen that is applied to the field(s) within the management area.

Rule 5 Well Metering

Flow meters are required on all high capacity wells.

Rule 6 Acre-Inch Allocations

A rolling acre-inch allocation, in 3-year increments, will be put into place by the District and will be based on the aquifer subarea, crop planted, irrigation distribution system, percent decline of the aquifer, water use of the aquifer, climatic conditions, net corn crop requirements, and discretionary factors.

Rule 7 Staff Assistance

NRD Staff will work directly with individuals on Best Management Practices. Staff may spot check fields before May 1 by collecting a soil sample to monitor Rule 3.

Section F Groundwater Quality Management Area - Phase One

Rule 1 Phase One Criteria

Phase One triggers are set at 0 to 80% of the contaminants MCL/LHAL and includes the entire District. Phase One nitrate-nitrogen triggers are set at 0 to 8 parts per million in the aquifer with other human-induced non-point source contaminants, such as pesticides, based upon 0 to 80 % of the Maximum Contaminant Levels (MCL) or Lifetime Health Advisory Levels (LHAL).

Rule 2 Natural Resources District Certification

All operators in Phase One areas within the District, who use any type of fertilizer, either commercial or organic, are required to obtain NRD certification by attending NRD education classes or by passing a take home test designed by LPNNRD and in agreement with applicable other agency input every four (4) years. Certification will be consistent with the District's chemigation program and applicable to the State FIFRA program.

Rule 3 Groundwater Analysis Once Every Four Years Encouraged

A groundwater analysis for nitrogen (nitrate-nitrogen) content for irrigation, municipal, and industrial wells is encouraged at least once every four years using the District's approved analysis methods. Results may be submitted to the District by December 15 of the year tested. This rule is waived for wells that are on inactive status, as defined in Nebraska State Statutes, during the entire four year cycle.

Rule 4 Soil Analysis Encouraged

Prior to the planting of corn, potatoes, or grain sorghum, a soil analysis 3 feet in depth for nitrogen (nitrate-nitrogen) content for each field at least 40 acres in size, under control of the operator is encouraged at least once every four years. District approved analysis methods should be used, and results are encouraged to be submitted to the District by December 15 of the year tested.

Rule 5 Fertilizer Application Report Encouraged

All operators are encouraged to submit a Fertilizer Application Report for each field 19 acres in size or larger, to the District at least once every four years on a form provided by the District, which indicates the pounds per acre of nitrogen (commercial and organic) applied to each field under their control for the past four years. The quantity in pounds per acre of pesticides applied for each field will also be encouraged. Such reports will incorporate, if applicable, those reports required under the District's chemigation program and such reporting requirements resulting from the implementation of the State assumption of the Federal Insecticide, Fungicide, Rodenticide Act (FIFRA).

Rule 6 Manure Application

Application of organic fertilizer (liquid manure, dried manure, sludge or composted organic waste) is very diversified and poses management problems relative to the size of the operation. Not all organic waste contains the same amount of N per unit of measurement, as such the amount/acre/year allowed to be applied in Phase I areas will be based on method of collection and storage, land application method, types of crops or cover crop, soil types, landscape features, source of manure, and previous manure application rates. Amount/acre/year of manure applied on each field is encouraged to be reported on the Fertilizer Application Report and submitted to the District once every four years.

Rule 7 Fertilizer Application on Non-Sandy Soils

No fall applications of N fertilizer (commercial) for row crops will be allowed on non-sandy or fine textured soils until after November 1.

Rule 8 Fertilizer Application on Sandy Soils

Fall and winter applications of N fertilizer (commercial) for row crops will be prohibited on sandy soils. Commercial fertilizer can be applied on sandy soils after March 1 of the crop year.

Section G Groundwater Quality Management Area - Phase Two

Rule 1 Phase Two Criteria

Phase Two triggers are from 8.01 to 10 parts per million nitrate-nitrogen concentration in the groundwater or when other non-point source contaminants are present at 81-100% of the MCL/LHAL. Within the same aquifer, boundary setting for Phase Two Areas will be initiated when: water quality analytical results, within a minimum 9 square mile area, are at identified trigger levels for a minimum of 2 sampling events. The Area must contain a minimum of 10 registered wells and contaminant trigger levels must be exceeded in over 50% of the wells. When irrigation wells are not available, other wells may be used. Initial investigation by the District will be to determine if the contamination is a result of point-source or non-point source pollution. If non-point source pollution is found to be the reason, more intensive investigation for boundary setting will ensue. If a Wellhead Protection Area should be established due to non-point source pollution, the District may set boundaries that are less than 9 square miles. After the establishment of a Phase Two Area, if non-point source contamination levels should decline, two consecutive sampling events below the trigger levels are needed before the Area could be placed in Phase One.

Rule 2 Continuation of Phase One Rules

A continuation of Phase One Rules as defined in Section E, Rule 1-6, Section F, Rules 2, 6 and 8 shall apply.

Rule 3 Groundwater Analysis Annually

A Groundwater analysis for nitrogen (nitrate-nitrogen) content for all irrigation, municipal, and industrial wells must be made annually and reported to the District by December 15 of each year. This rule is waived for wells that are on inactive status as defined in Nebraska State Statutes.

Rule 4 Soil Samples

Prior to the planting of corn, potatoes, or grain sorghum, annual soil samples in the root zone, 3 feet in depth, for nitrogen (nitrate-nitrogen) content on each field at least 40 acres in size are required for Phase Two and Phase Three Areas. The results of the soil samples will accompany the annual report made to the District by December 15 of each year.

Rule 5 Fertilizer Application Report

All operators will submit a Fertilizer Application Report to the District for each field 19 acres in size or larger, at the end of each crop year or by December 15 of each year. Submittal will be on a form(s) developed by the District. Reporting of the application of pesticides will be encouraged on this form.

Rule 6 Fertilizer Applications on Non-Sandy Soils with Approved Inhibitor

Commercial nitrogen-fertilizer, such as anhydrous ammonia, will be permitted on non-sandy or fine textured soils from November 1 to March 1, provided that an approved inhibitor is used and applied as recommended. After March 1, an inhibitor is not needed.

Rule 7 Furnish Record from Fertilizer Dealer that District Approved Inhibitor was Used

In order to assure use of an approved inhibitor, the operator will be required to furnish the District the record from a fertilizer dealer that a District approved inhibitor was used and applied at recommended rates. This record shall accompany the Fertilizer Application report made to the District by December 15 of each year.

Rule 8 Fertilizer Calibration Encouraged

The District will begin a voluntary fertilizer calibration program addressing all applications and will strongly encourage operators to participate in the process. The District may, as conditions warrant, choose to develop a cost share program with operators.

Rule 9 Monitoring of Water Applications

Flow meters will be required on all irrigation wells in Phase 2 or 3 management areas to monitor water applications to allow operators to better manage fertilizer applications and control excessive nitrate leaching into the aquifer. This activity will be phased in over a period of four (4) years after a Phase management area has been implemented by the Board. Total water use during the growing season will be recorded on the Fertilizer Application Report that is to be submitted by December 15 of each year.

Rule 10 Manure Applications

In Phase Two and Phase Three Areas, amount per acre per year of organic fertilizer allowed to be applied (liquid manure, dried manure, sludge, or composted organic waste) will be based on method of collection and storage, land application method, types of crops or cover crop, soil types, landscape features, source of manure, and previous manure application rates. The Nebraska Cooperative Extension Service Bulletin EC 89-117 "Fertilizing Crops with Animal Manure" shall be used as guidance unless more current guidelines are available. Amount/acre/year of manure applied on each field is to be reported on the Fertilizer Application Report and submitted to the District by December 15 of each year. The amount and timing of application must be adjusted to the N concentration in the soil profile and groundwater content. Application is allowed to frozen soils and is to be determined on a site-by-site basis as this is a prime cause of both groundwater and surface water degradation.

Rule 11 Education Program Expanded

The education program will be expanded to assist the Phase Two operators and other personnel in the area to realize that continued increases of nitrate and/or other non-point source contamination could cause the area to be elevated to a Phase Three Area.

Section H Groundwater Quality Management Area - Phase Three

Rule 1 Phase Three Criteria

Phase Three Areas will be established when the Maximum Contaminant Levels (MCL) or Lifetime Health Advisory Levels (LHAL) is exceeded. Phase Three trigger levels range from 10.01 to 15 parts per million or greater for nitrate-nitrogen, with other human-induced non-point source contaminants, based upon greater than 100% of the MCL or LHAL.. Within the same aquifer, boundary setting for Phase Three Areas will be initiated when: water quality analytical results within a minimum 9 square mile area are at identified trigger levels for a minimum of 2 sampling events. The area must contain a minimum of 10 registered wells and contaminant trigger levels must be exceeded in over 50% of the wells. When registered wells are not available, other wells may be used. Initial investigation by the District will be to determine if the contamination is a result of point-source or non-point source pollution. If non-point source pollution is found to be the reason, more intensive investigation for boundary setting will ensue. If a Wellhead Protection Area should be established due to non-point source pollution, the District may set boundaries that are less than 9 square miles. After the establishment of a Phase Three Area, if non-point source contamination levels should decline, two consecutive sampling events below the trigger levels are needed before the Area could be placed in Phase Two or Phase One.

Rule 2 Continuation of Phase One and Two Rules

A continuation of Phase One Rules as defined in Section E, Rules 1-6, Section F, Rule 2 and in Phase Two Rules as defined in Section G, Rules 3, 4, 5, 8, 9, 10 and 11 shall apply.

Rule 3 Fertilizer Application On All Soils

The application of commercial nitrogen fertilizer is prohibited in the fall and winter on all soils until after March 1. Spring applications of commercial nitrogen fertilizer will require split applications (pre-plant and side-dress) or the use of an approved inhibitor applied as recommended. If a split application is used and 50 percent or more of nitrogen fertilizer is applied as a pre-plant, the use of an approved inhibitor, applied as recommended, is still required.

Rule 4 Record that District Approved Inhibitor was Used

If 50% or more of commercial nitrogen fertilizer is applied at pre-plant, then operators are required to furnish the District a record from the fertilizer dealer that a District inhibitor was used at recommended rates. This record shall accompany the Fertilizer Application report made to the District by December15 of each year.

Section I Groundwater Quality Management Area - Phase Four

Rule 1 Phase Four Criteria

When levels of nitrate-nitrogen exceed 15.01 parts per million, or levels of other human induced non-point source contaminants exceed 100% of the MCL or LHAL, a Phase Four area will be declared. Within the same aquifer; boundary setting for Phase Four Areas will be initiated when: water quality analytical results within a minimum 9 square mile area are at identified trigger levels for a minimum of 2 sampling events. The area must contain a minimum of 10 registered wells and contaminant trigger levels must be exceeded in over 50% of the wells. When irrigation wells are not available, other wells may be used. Initial investigation by the District will be to determine if the contamination is a result of point-source or non-point source pollution. If non-point source pollution is found to be the reason, more intensive investigation for boundary setting will ensue. If a Wellhead Protection Area should be established due to non-point source pollution, the District may set boundaries that are less than 9 square miles. After the establishment of a Phase Four Area, if non-point source contamination levels should decline, two consecutive sampling events below the trigger levels are needed before the Area could be placed in Phase Three, Phase Two or Phase One.

Rule 2 Continuation of Phase One, Two and Three Rules

A continuation of Phase One Rules as defined in Section E, Rules 1-6, Section F, Rule 2, Phase Two Rules as defined in Section G, Rules 3, 4, 5, 8, 9, 10 and 11, Phase Three Rules as defined in Section H, Rule 4.

Rule 3 Fertilizer Application On All Soils

Split application of commercial nitrogen fertilizer is required with 80 pounds maximum applied before May 1.

Rule 4 Nitrogen Recommendations

Nitrogen applications must not exceed District Recommendations. Application data may be required to verify the amount of nitrogen that is applied to the field(s) within the management area.

Rule 5 Well Metering

Flow meters are required on all high capacity wells.

Rule 6 Acre-Inch Allocations

A rolling acre-inch allocation, in 3-year increments, will be put into place by the District and will be based on the aquifer subarea, crop planted, irrigation distribution system, percent decline of the aquifer, water use of the aquifer, climatic conditions, net corn crop requirements, and discretionary factors.

Rule 7 Staff Assistance

NRD Staff will work directly with individuals on Best Management Practices. Staff may spot check fields before May 1 by collecting a soil sample to monitor Rule 3.

Daryl Andersen

From: Chris Poole <cpoole@lpnnrd.org> on behalf of Chris Poole
Sent: Friday, July 22, 2022 2:36 PM
To: Daryl Andersen
Subject: RE: Charts

Here's what I have for the Project Tasks and Timeline:

LPNNRD proposes a series of projects over the course of three years to help address nitrate contamination in the Phase III Groundwater Area. It is anticipated that some years will see more activity than others so it is difficult to quantify the rate at which grants funds will be expended. LPNNRD will assume a yearly one-third depletion of funds, though actual amounts may vary significantly based on popularity. The following table is a summary of projects and funding by year.

	Funding Years			
Task	Year 1	Year 2	Year 3	Total
Iron Chlorosis	$12,000.00	$12,000.000	$12,000.00	$36,000.00
Cover Crops	$8,000.00	$8,000.00	$8,000.00	$24,000.00
Fertigation	$1,666.67	$1,666.67	$1,666.67	$5,000.00
Variable Rate Nitrogen	$6,666.67	$6,666.67	$6,666.67	$20,000.00
Gravity Conversion	$16,666.67	$16,666.67	$16,666.67	$50,000.00
Soil Sampling	$6,666.67	$6,666.67	$6,666.67	$20,000.00
Soil Moisture Sensors	$2,500.00	$2,500.00	$2,500.00	$7,500.00
Water Flow Meters	$56,666.67	$56,666.67	$56,666.67	$170,000.00
Hydrological Assessment	$18,666.67	$18,666.67	$18,666.67	$56,000.00
Totals	$129,500.00	$129,500.00	$129,500.00	$388,500.00

From: Daryl Andersen <dandersen@lpnnrd.org>
Sent: Friday, July 22, 2022 12:08 PM
To: Chris Poole <cpoole@lpnnrd.org>
Subject: RE: Charts

Grant would be 3 years as some of the projects are going to take time.

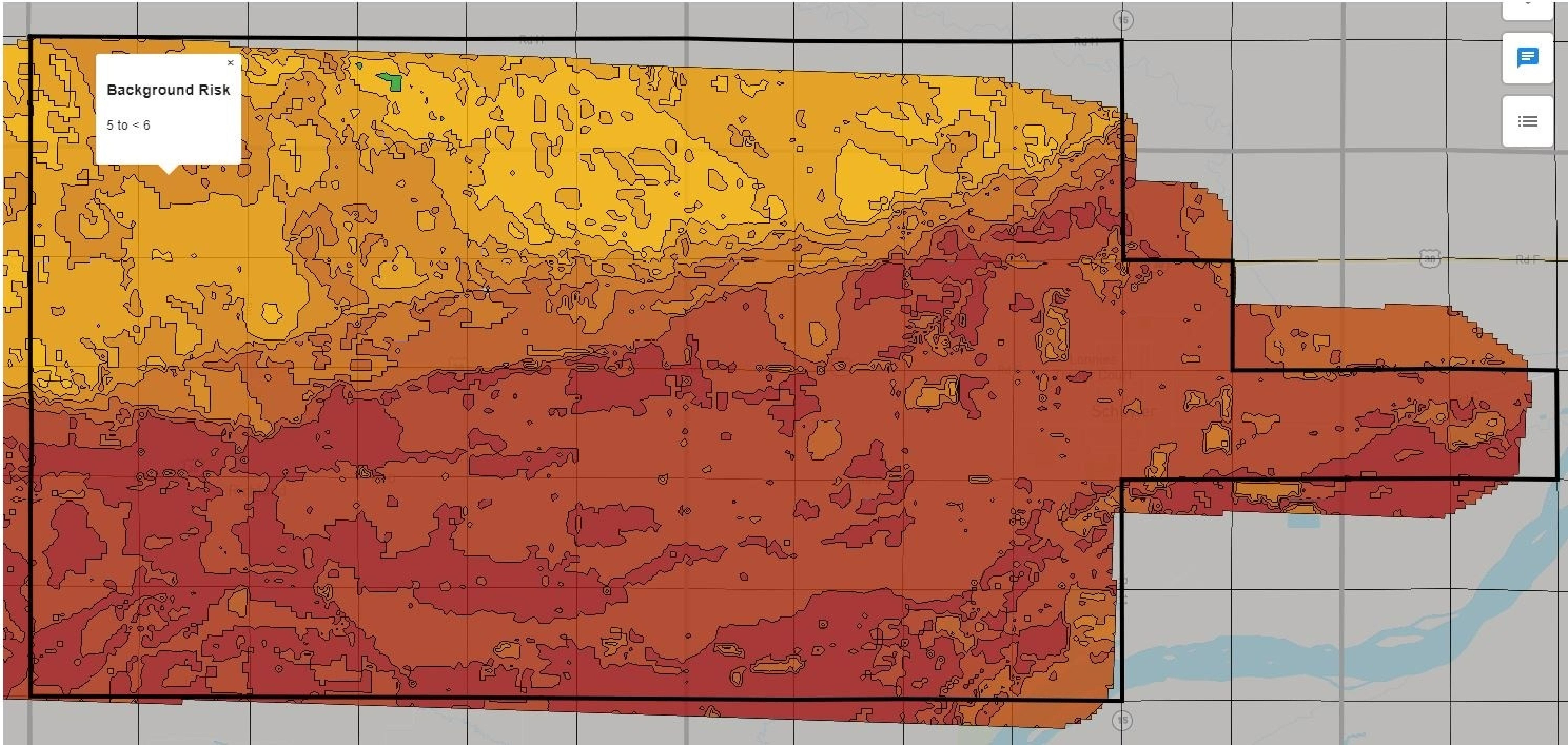
- Water Sampling around Platte Center and further west with analysis of the extent of nitrate contamination.

3.B.2. Phase Area Update

Rationale: Potential Best Management Practices for a grant.

- Buffer Strips - eligible for the Nebraska Buffer Strip Program
- Iron Chlorisis products for high Ph soil to encourage crop rotations. Cost-share $15/acre (Total $36,000)
  - 1200 acres a year over a 2-year period
- Cover crops - Add an additional $5/acre with NRCS contract (Total $24,000)
  - 2400 acres a year over a 2-year period
- Fertigation - $500 per site (Total $5,000)
  - 10 new sites
- Variable rate Nitrogen - additional $10/acre over NRCS contract (Total $20,000)
  - 1000 acres per year over a 2-year period
- RO units for households - $500 per household (Total $20,000)
  - 40 households.
- Gravity to pivot or SDI - additional $10,000 per conversion over NRCS contract (Total $50,000)
  - 5 conversions over a 2-year period
- Soil Sampling - $10/acre over a NRCS contract ($20,000)
  - 1000 acres per year over a 2-year period.
- Soil Moisture Sensors with advanced technology - $750 per site ($7,500)
  - 10 sites
- Water Flow Meters $1,000 per meter ($170,000)
  - 170 meters with one per site.
  - 130 total wells in Bellwood Area with 15 with installed meters.
  - 436 total wells in Richland-Schuyler Area with 56 with installed meters.
  - Voluntary installation
  - Coordinate with NRCS flow meter cost-share (irrigation management)

The total cost for the Best Management Grant would be $352,500 and with a 60-40 split, LPN match would be $141,000.


Background Risk
5 to < 6

Nitrate Discussion with Staff and DEE

List of thoughts and ideas from discussion. Please keep coming up with more information and ideas.

Items that were discussed: (please list things that I missed)

- Make sure goals and objectives are concise and achievable
- Statistical analyst of nitrates per section
- Involve commodity groups on the issues
- What agronomic rate is correct to use
- Trigger changes for Phase 2 from 8 to 5 PPM
- Change the reporting date deadline to twice a year or later in the spring
- Sample domestic wells and possibility including them in the analysis
- Emphasis education on health issues or more focus topics
- Adult education and age of producers
- Require soil sampling and reporting district wide for awareness
- Emphasis best management practices
    - Cover Crops
    - Irrigation system conversions
    - Variable rate application of nitrogen
- Require nitrogen certification cards to purchase nitrogen
- Increase carbon source will decrease nitrogen
    - Demonstration fields
- Analysis screen levels and geological formations
- Soil types
- Modeling of nitrate movement
- Government subsidy for corn
- Update management plans and/or rules and regulations
- Livestock waste management
    - Application sites
- Analysis of soil and manure samples

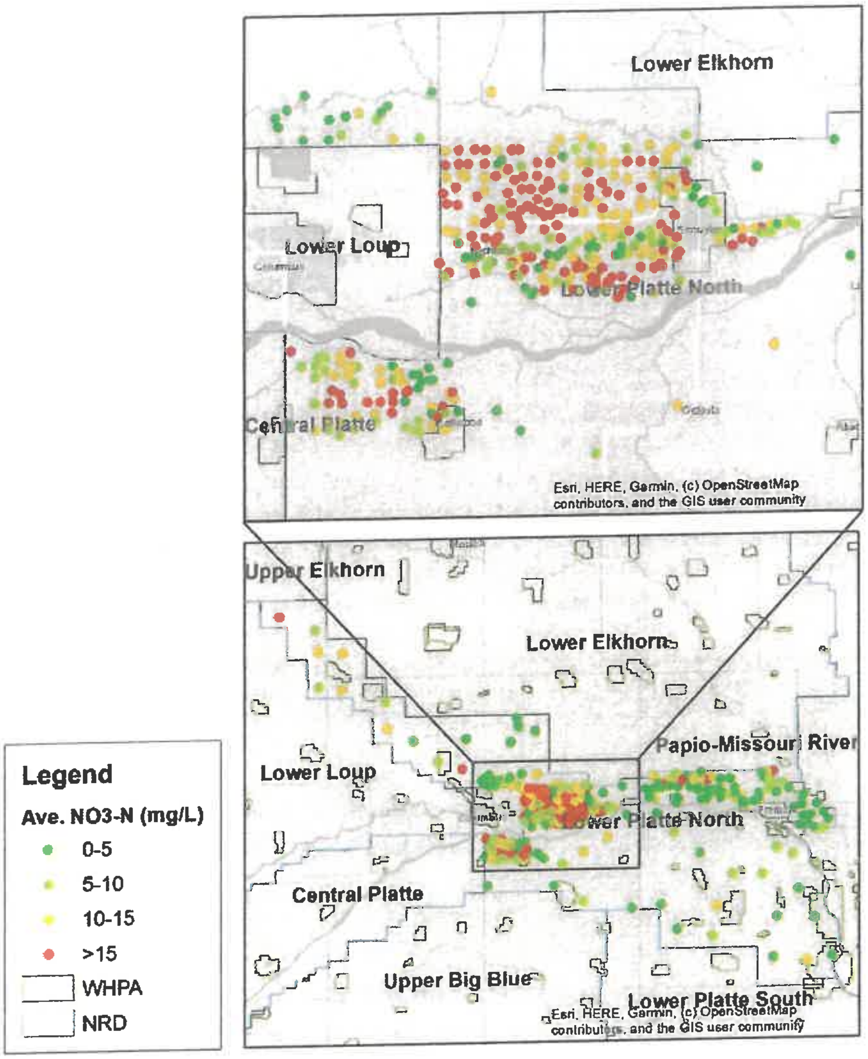


Figure 7. Distribution of groundwater nitrate-N concentrations based on data supplied by the LPNNRD in the present study area (upper map) and across the district.

Nitrate Isotope Trends from Study Area

Table 6 Summarizes the well water sample nitrate concentrations are summarized together with the nitrogen isotope composition. Nitrate-N concentrations averaged 16.7(±11.4) mg/L while the $\delta^{15}N-NO_3$ and $\delta^{18}O-NO_3$ composition averaged +5.59 ‰ and +5.97‰ respectively.

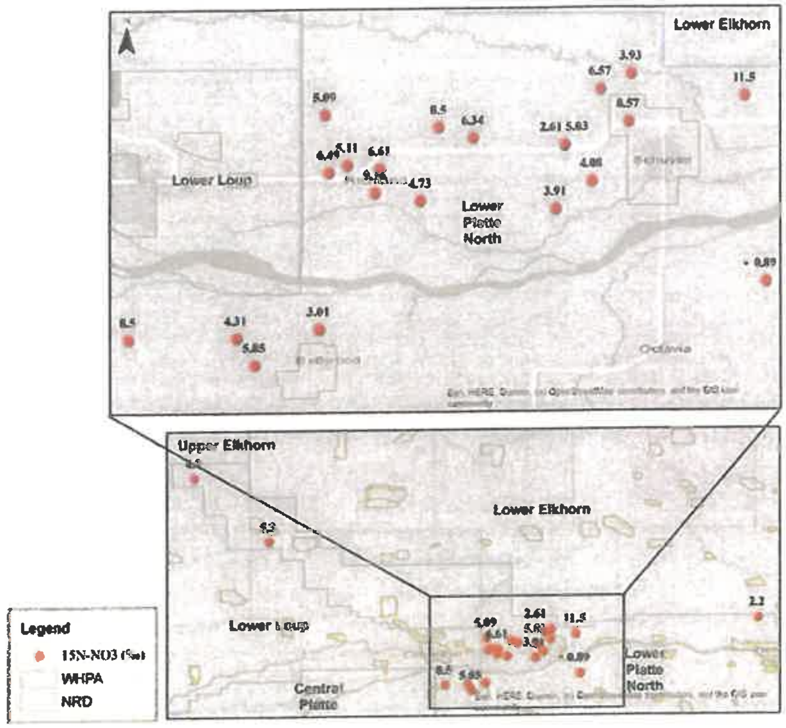


Figure 11. Distribution of 15N-nitrate isotope composition in all groundwater samples collected for this study.

Conclusions

Based on the trends of groundwater and vadose zone nitrate levels in this area of the LPNNRD, there is clearly continued loading of nitrate to the water table. The Bellwood Phase 2, Richland and Schuyler Phase 2 and 3 Groundwater Management Areas have some of the highest groundwater nitrate concentrations of the district. Analysis of six deep vadose zone samples shows pore water nitrate concentrations with location averages ranging 8.82 from 42.55 mg/L, similar to local groundwater concentrations. Vadose zone nitrate was highest beneath cropland with continuous corn and soybeans, while alfalfa, grass, and cover crops had much lower nitrate levels. Except for 2 wells, arsenic and uranium concentrations in groundwater samples were generally below the maximum contaminant level for drinking water. Stable isotope analysis of nitrate in the groundwater and vadose zone samples indicates over half of nitrate nitrogen is likely from the overapplication of commercial fertilizer. Several samples show evidence of enrichment by denitrification, especially grab samples taken near the water table, and several have nitrogen isotope composition characteristic of a mixture of organic (manure) nitrogen and commercial fertilizer. Comparison of sites with enriched nitrogen to manure application can help confirm the importance of this source. The majority of samples, however, have nitrogen isotope composition similar to commercial (inorganic) nitrogen, and thus efforts to limit the application of fertilizer is

Appendix 1: Graphs of Results by Core

DS-31-2019

Total N load= 19 lbs-N/Acre

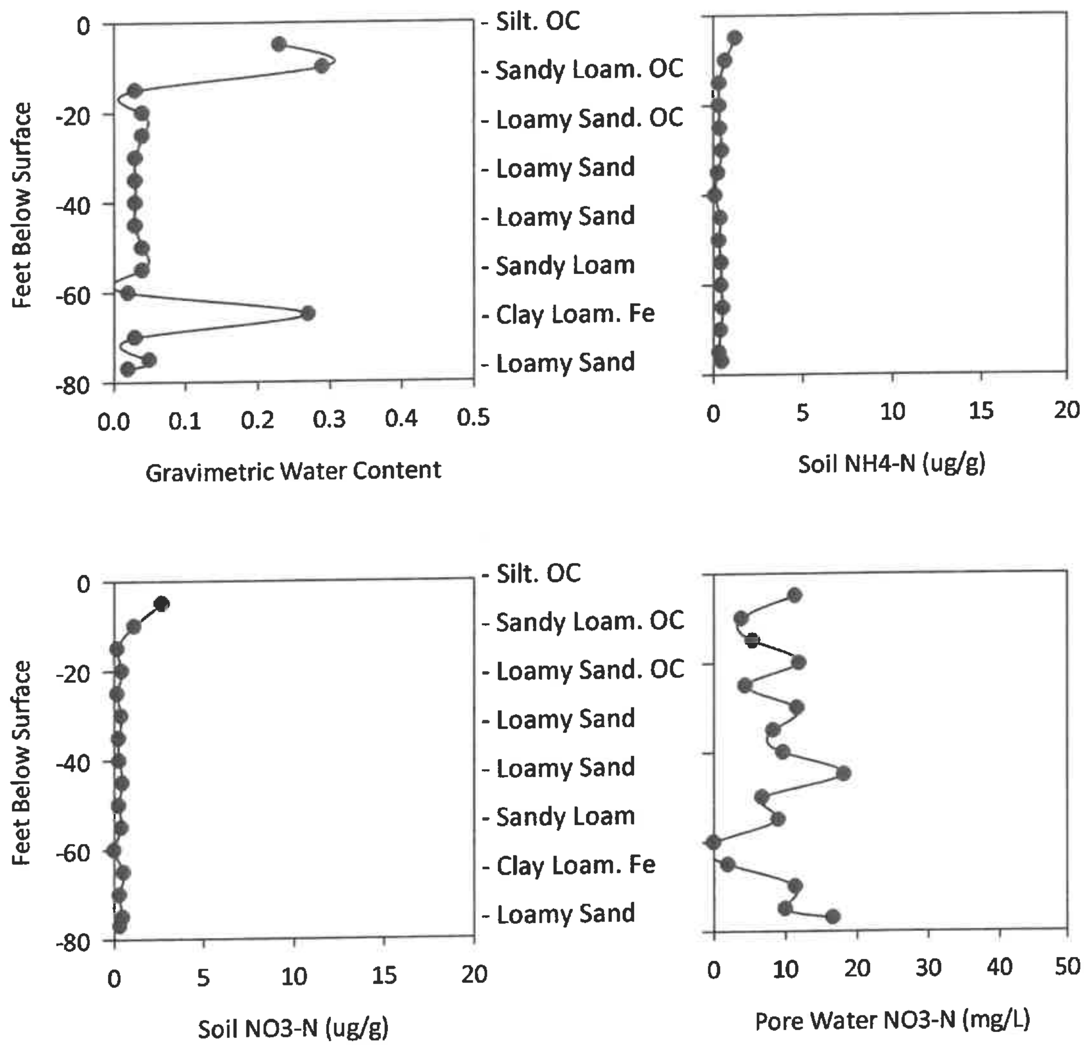


Figure A1. DS-31-2019 Graphs.

Notes: DS-31-2019 : small pivot on 40 acres, irrigated from G-065523. Crop has been harvested.

DS-32-2019

Depth to water: 49 feet, indicated below in dash lines

Total N load= 28 lbs-N/Acre

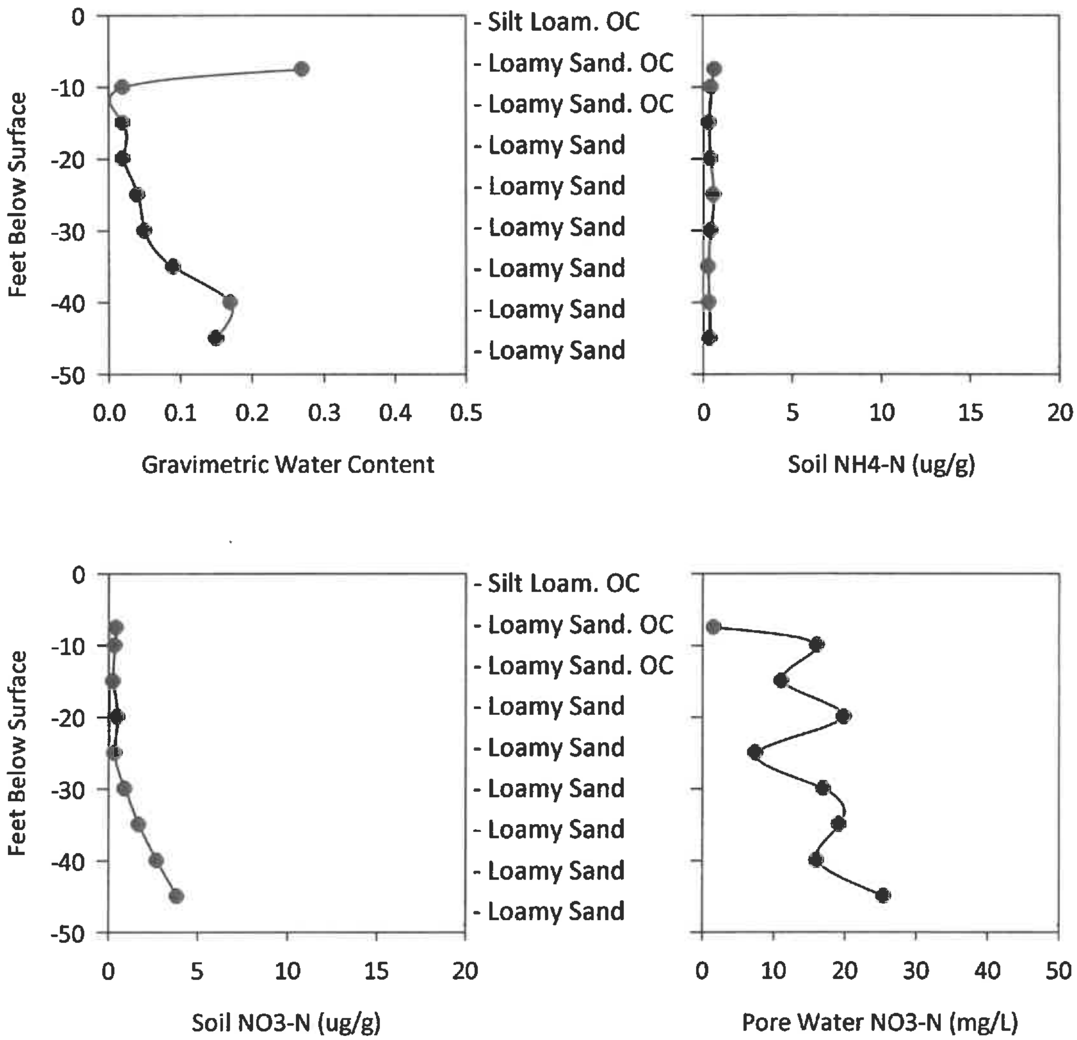


Figure A2. DS-32-2019 Graphs.

Notes: DS-32-2019: irrigated from G-053560 and uses feedlot lagoon water from Kluck's feedlot in section 9. Corn has been harvested.

DS-33-2019

Depth to water: 13 feet, indicated below in dash lines
Total N load= 59 lbs-N/Acre

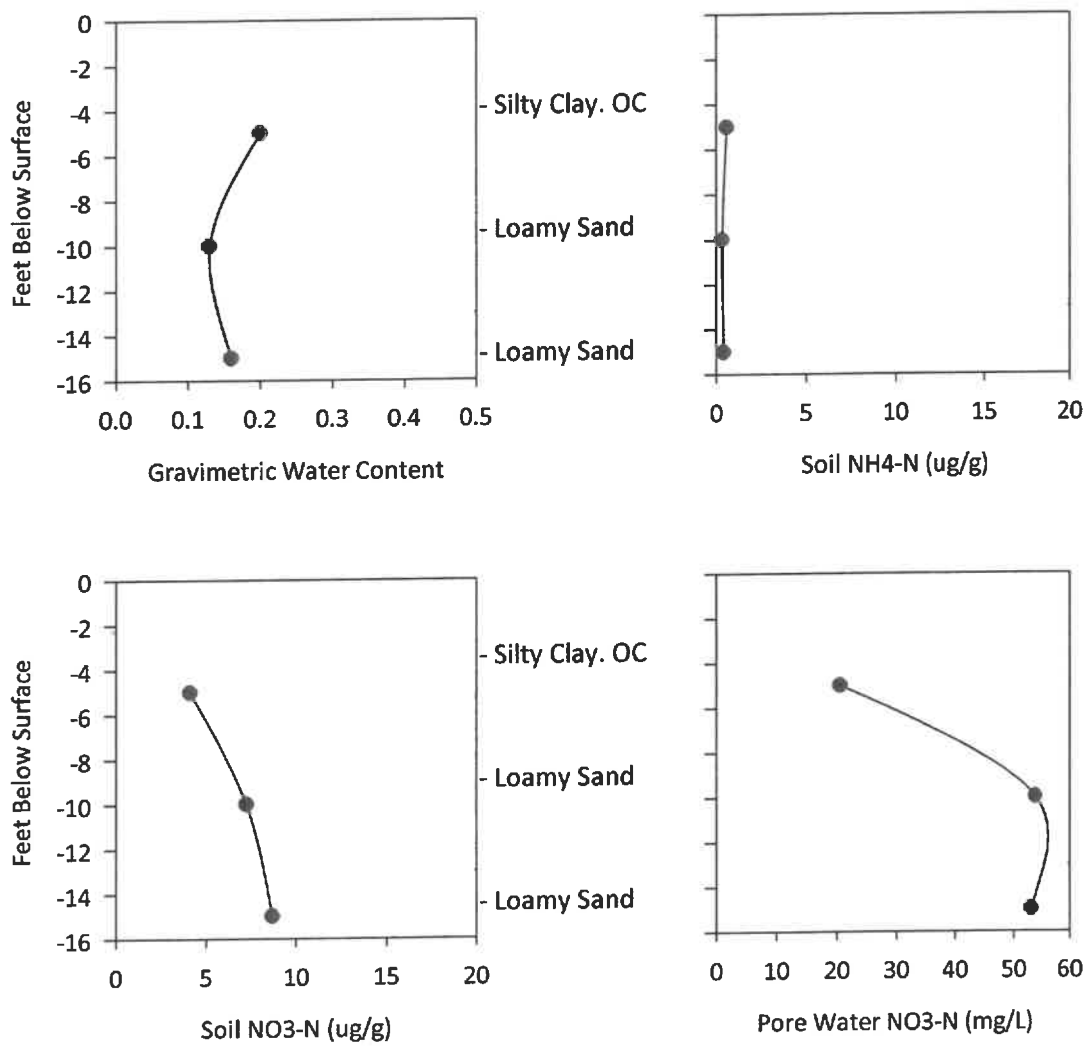


Figure A3. DS-33-2019 Graphs.

Notes: DS-33-2019: near middle of section. Corn has been harvested. On the old map, it seems to show an old paleo valley which goes through the middle of the section from west to east.

DS-35-2019

Depth to water: 63 feet, indicated below in dash lines
Total N load= 93 lbs-N/Acre

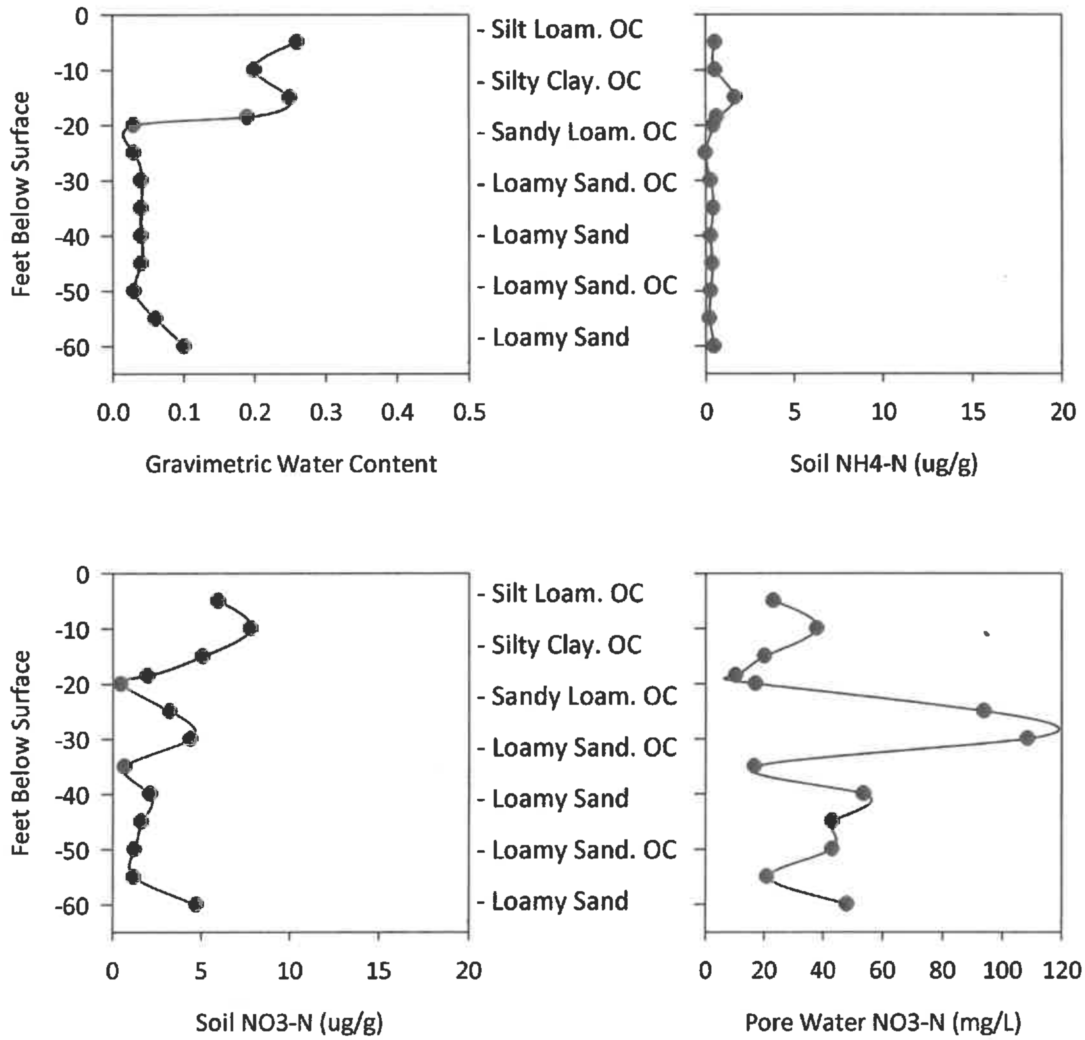


Figure A4. DS-35-2019 Graphs.

Notes: DS-35-2019: sample northwest of the pivot point, east of bins. Crop has been harvested. Irrigation well G-074435. Priority site – near NRD boundaries with feedlot up gradient.

DS-38-2019

Depth to water: 63 feet, indicated below in dash lines
Total N load= 96 lbs-N/Acre

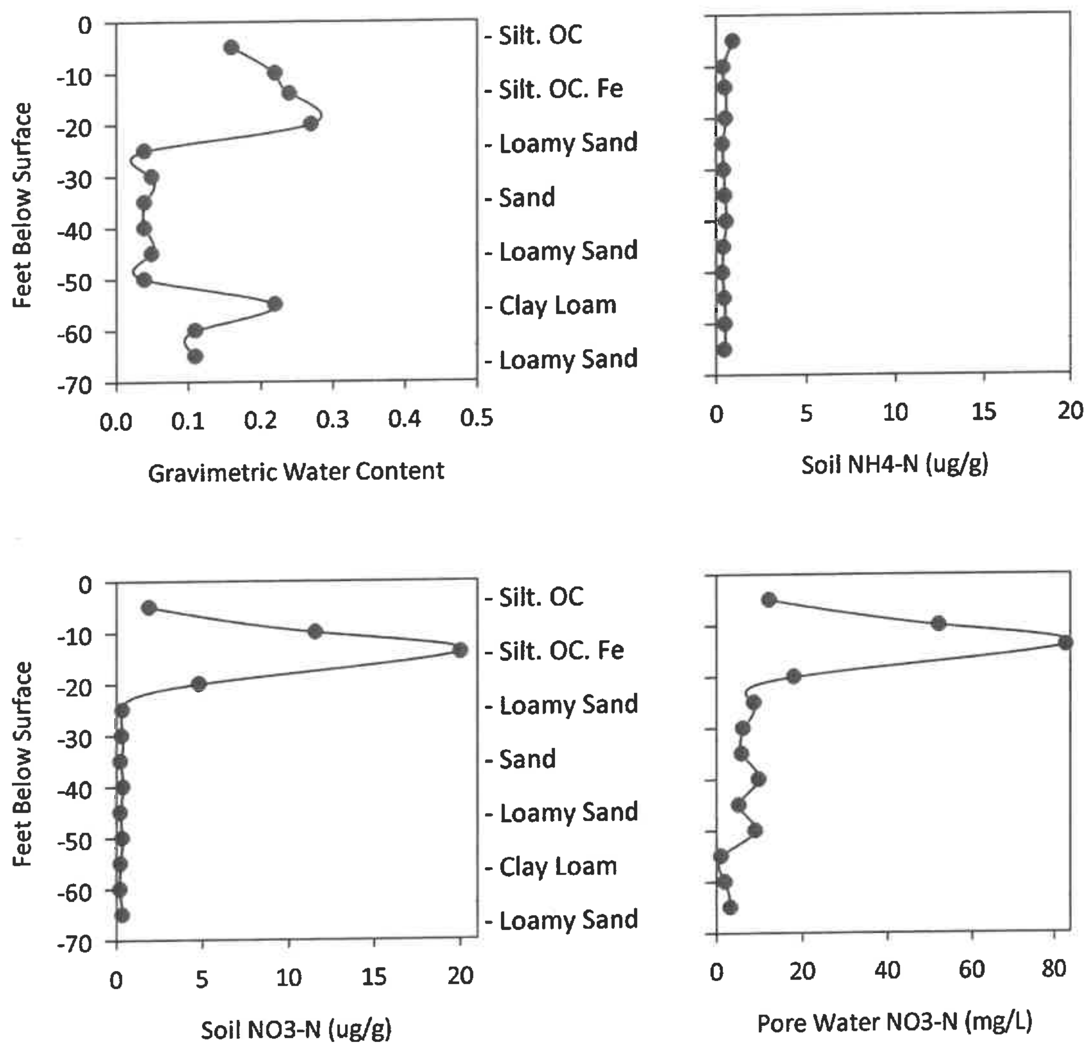


Figure A5. DS-38-2019 Graphs.

Notes: DS-38-2019: irrigation well G-072430 near center of NW¼, also near NRD boundaries.

DS-39-2019

Depth to water: 75 feet
Total N load= 41 lbs-N/Acre

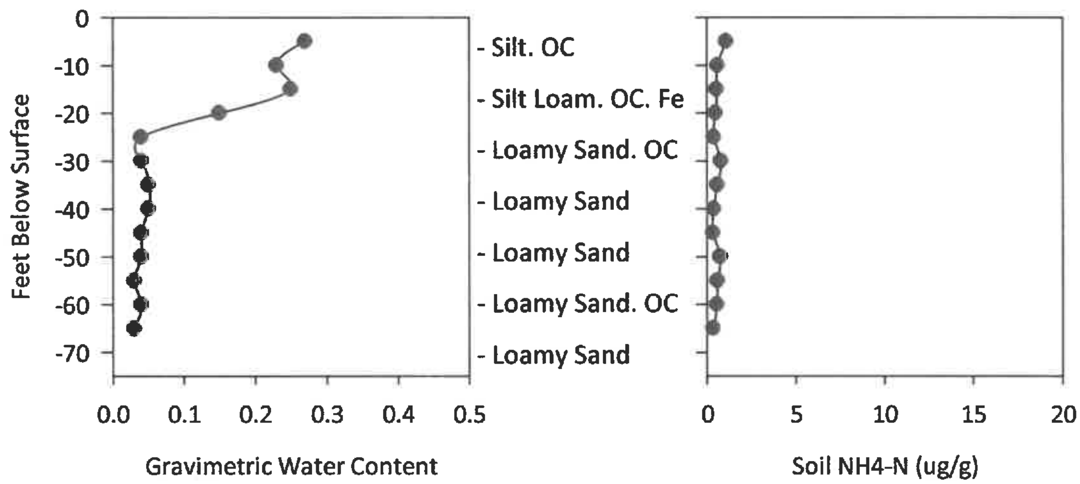


Figure A5. DS-39-2019 Graphs.

Notes: DS-39-2019: corn has been harvested; irrigation well G-039544 near center of NW¼, also near NRD boundaries.

Thoughts on Water Flow Meters from Committee Meeting January 2020

- Grants usually only go for 3 years and normally 2.
- Grants usually are designed for a designated management area.
- Is a Water Flow Meter the Cost of Doing Business?
- All High-Capacity Wells including livestock and industrial?

This was last proposal from last Committee Meeting

- Year 1 - All wells in Nitrate Management Areas
  - $1000 cost-share for the flow meter and extra $500 for a check valve if needed.
  - Second year $600 cost-share only, with Year 2 in new area would be occurring also.
- Year 2 - Dodge, Colfax and Butler County
  - $1000 cost-share for the flow meter and extra $500 for a check valve if needed.
  - Second year $600 cost-share only, with Year 3 in new area would be occurring also.
- Year 3 - Platte, Boone and Madison
  - $1000 cost-share for the flow meter and extra $500 for a check valve if needed.
  - Second year $600 cost-share only, with Year 4 in new area would be occurring also.
- Year 4 - Saunders County
  - $1000 cost-share for the flow meter and extra $500 for a check valve if needed.
  - Second year $600 cost-share only,
- After the fifth year no cost share available and all meters not installed would be required to install at their cost.

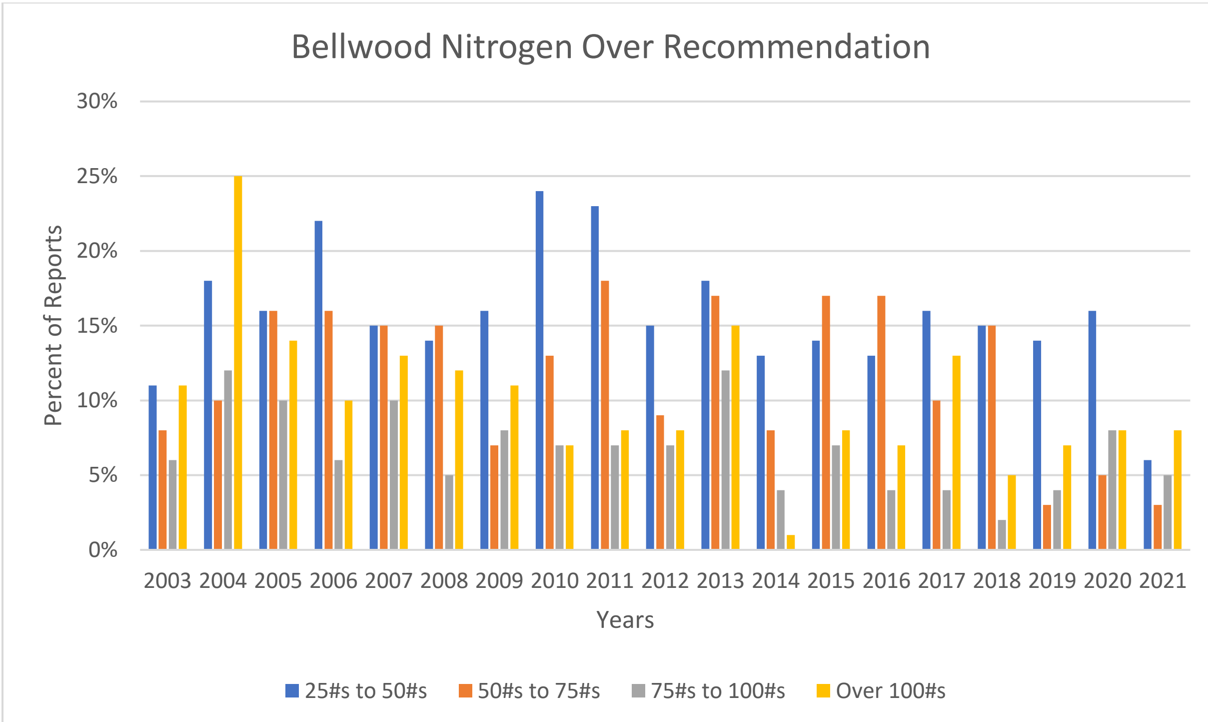
LPNNRD would set a date that all high-capacity wells are required to have meters during the fifth year.

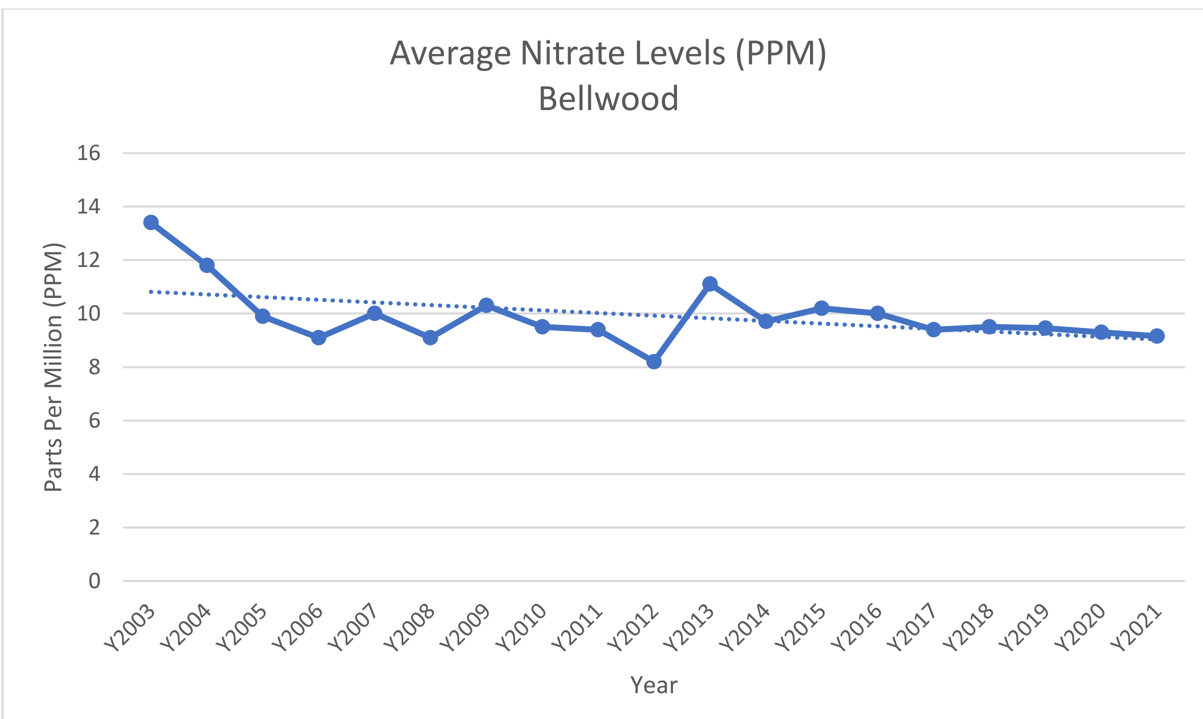
Meter Details (this would stay the same)

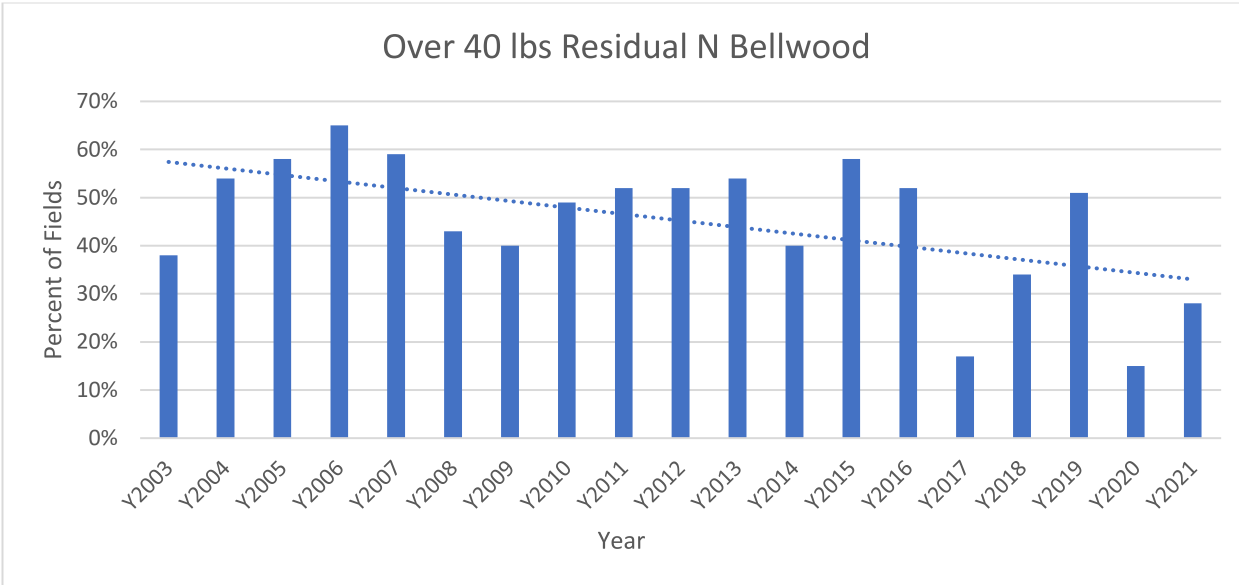
- Meter Installation handled by Private Companies
- Meter Maintenance will be contracted out with about 1000 meters a year.

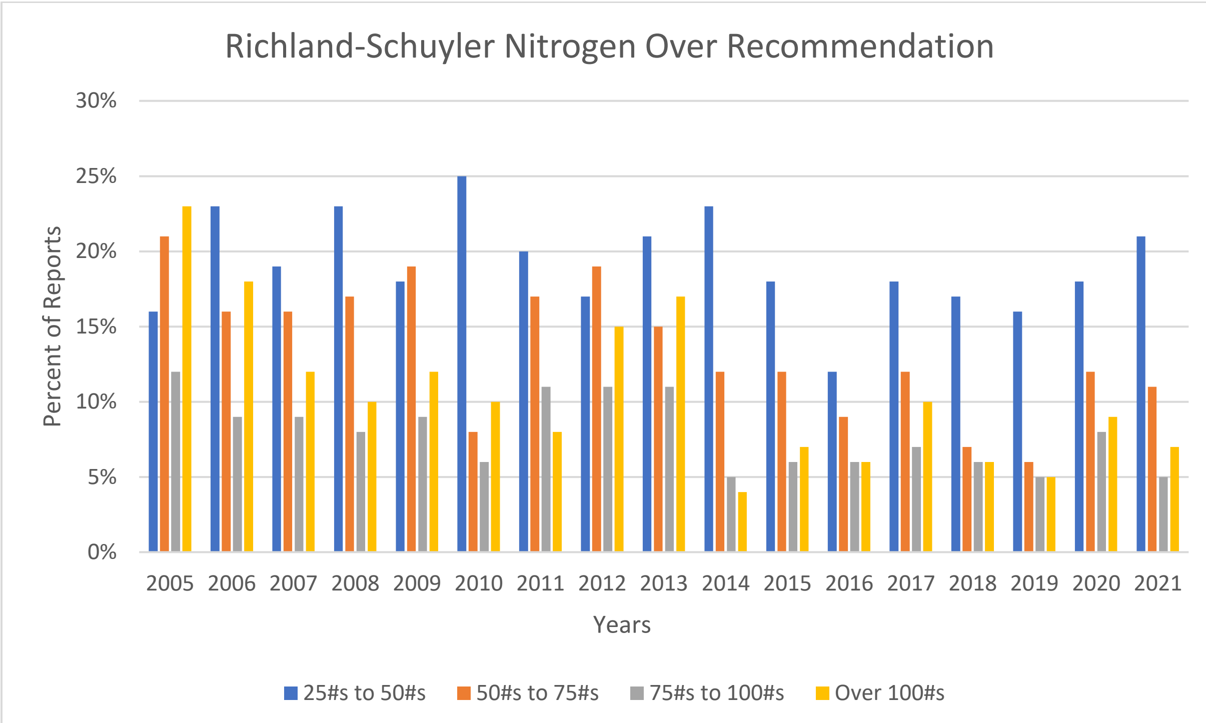
Quote seen at a water conference "If water is not measured it can't be managed."

The purpose of installing flow meters for the LPNNRD is to get a better understanding of sustainable aquifers for future generations.   This will also allow the LPNNRD to be pro-active instead of re-active if water consumption becomes an issue. A producer can utilize the flow meter on how the well is actually performing and increase irrigation management efficiency. The Committee recommended to start setting aside funding, like $200,000 a year, into a sinking fund for the purpose of a grant match.

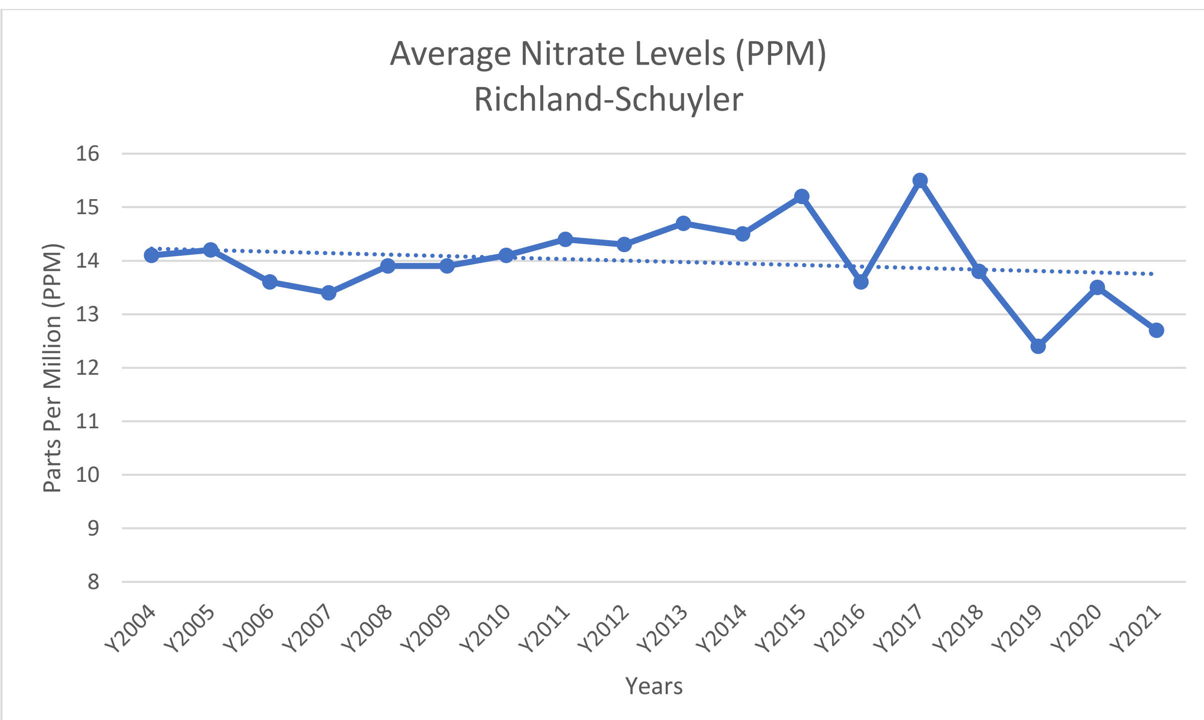

Bellwood Nitrogen Over Recommendation
30%
25%
20%
15%
10%
5%
0%
Percent of Reports
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Years
25#s to 50#s
50#s to 75#s
75#s to 100#s
Over 100#s


Average Nitrate Levels (PPM)
Bellwood
16
14
12
10
8
6
4
2
0
Parts Per Million (PPM)
Y2003 Y2004 Y2005 Y2006 Y2007 Y2008 Y2009 Y2010 Y2011 Y2012 Y2013 Y2014 Y2015 Y2016 Y2017 Y2018 Y2019 Y2020 Y2021
Year

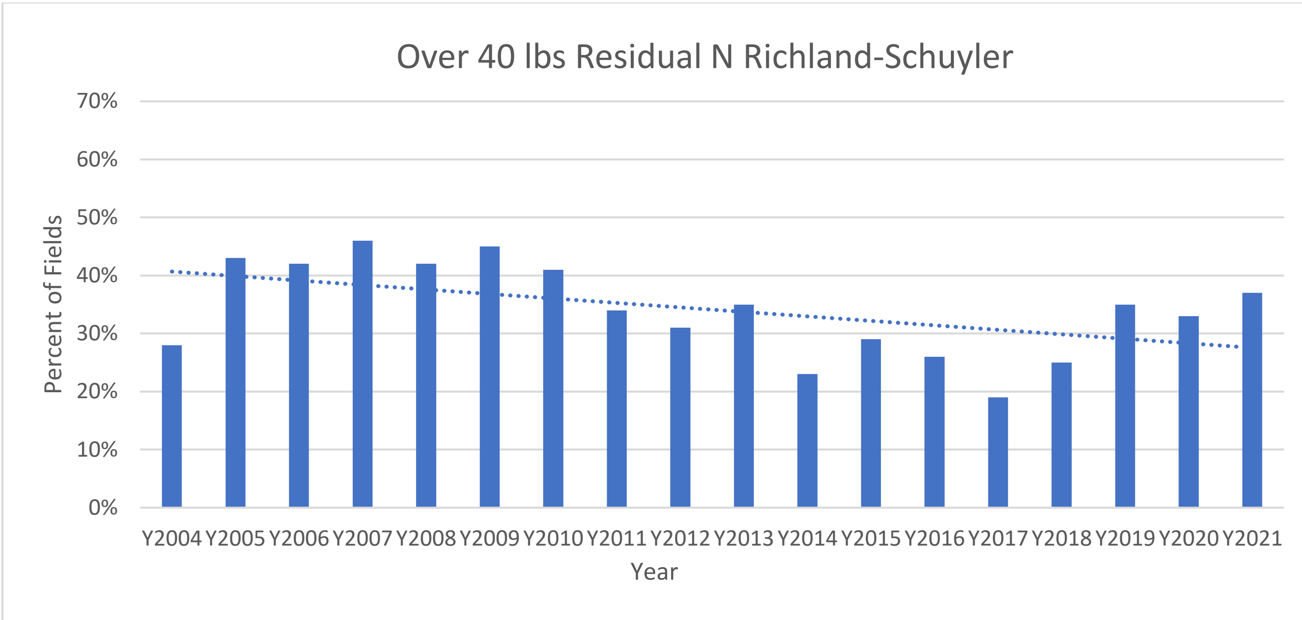

Over 40 lbs Residual N Bellwood
Percent of Fields
70%
60%
50%
40%
30%
20%
10%
0%
Y2003
Y2004
Y2005
Y2006
Y2007
Y2008
Y2009
Y2010
Y2011
Y2012
Y2013
Y2014
Y2015
Y2016
Y2017
Y2018
Y2019
Y2020
Y2021
Year

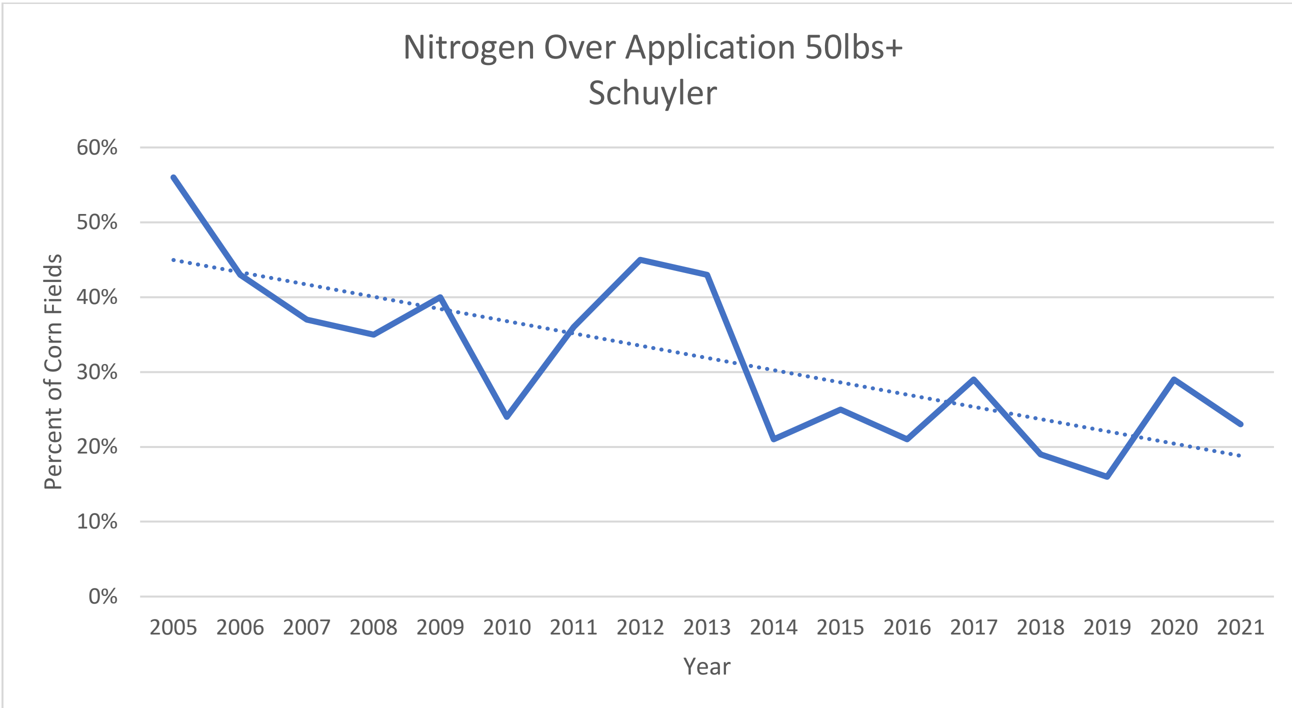


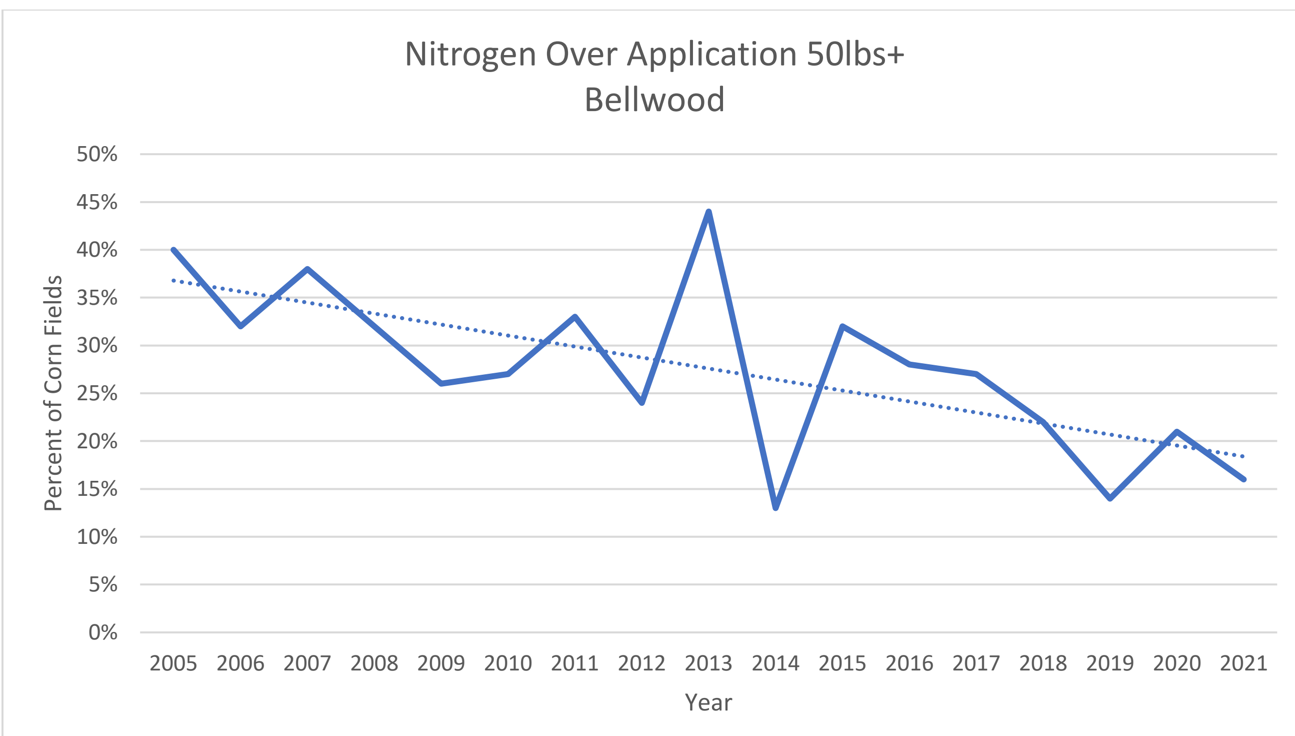
Richland-Schuyler Nitrogen Over Recommendation
Percent of Reports
30%
25%
20%
15%
10%
5%
0%
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Years
25#s to 50#s
50#s to 75#s
75#s to 100#s
Over 100#s



Average Nitrate Levels (PPM)
Richland-Schuyler
Parts Per Million (PPM)
16
15
14
13
12
11
10
9
8
Y2004 Y2005 Y2006 Y2007 Y2008 Y2009 Y2010 Y2011 Y2012 Y2013 Y2014 Y2015 Y2016 Y2017 Y2018 Y2019 Y2020 Y2021
Years


Over 40 lbs Residual N Richland-Schuyler
Percent of Fields
70%
60%
50%
40%
30%
20%
10%
0%
Y2004 Y2005 Y2006 Y2007 Y2008 Y2009 Y2010 Y2011 Y2012 Y2013 Y2014 Y2015 Y2016 Y2017 Y2018 Y2019 Y2020 Y2021
Year


Nitrogen Over Application 50lbs+
Schuyler
60%
50%
40%
30%
20%
10%
0%
Percent of Corn Fields
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Year


Nitrogen Over Application 50lbs+
Bellwood
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Percent of Corn Fields
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Year

Phoenix Web Group, Inc
10824 N. 142nd Street, P.O. BOX 307
Waverly, NE 68462
402-786-5111

Invoice 130781

BILL TO
Eric Gottschalk
Lower Platte North NRD
P.O. Box 126
Wahoo, NE 68066

DATE	PLEASE PAY	DUE DATE
10/03/2022	**$6,025.00**	10/03/2022

DATE	ACTIVITY	QTY	RATE	AMOUNT
10/03/2022	**Services** Nebraska Clearinghouse EDD Export - Final Payment	1	6,025.00	6,025.00

Thank you for your business.

SUBTOTAL	6,025.00
TAX	0.00
TOTAL	6,025.00

TOTAL DUE	$6,025.00

THANK YOU.

HDR




THE FLATWATER GROUP INC.


Lower Platte River Drought Contingency Plan - DRAFT

July 2019

Lower Platte South Natural Resources District

Papio-Missouri River Natural Resources District, Omaha, NE

Lower Platte North Natural Resources District

Nebraska Department of Natural Resources

City of Lincoln Nebraska

Metropolitan Utilities District. Live Green. Think Blue.

Executive Summary Contents

Executive Summary

The Lower Platte South Natural Resources District (NRD), Papio-Missouri River NRD, Lower Platte North NRD, Metropolitan Utilities District (MUD), Lincoln Water System (LWS), and Nebraska Department of Natural Resources (NeDNR), collectively referred to as the Lower Platte River Consortium (Consortium), have embarked on a collaborative effort to develop a drought contingency plan for the Lower Platte River Basin in Nebraska. Each of the Consortium members have important roles in water management in the Lower Platte River amongst their identified authorities and missions: NRDs are authorized by statute to regulate the use of groundwater while the NeDNR regulates the use of surface water; MUD provides water for the majority of the Omaha metropolitan area; and LWS provides water to the City of Lincoln.

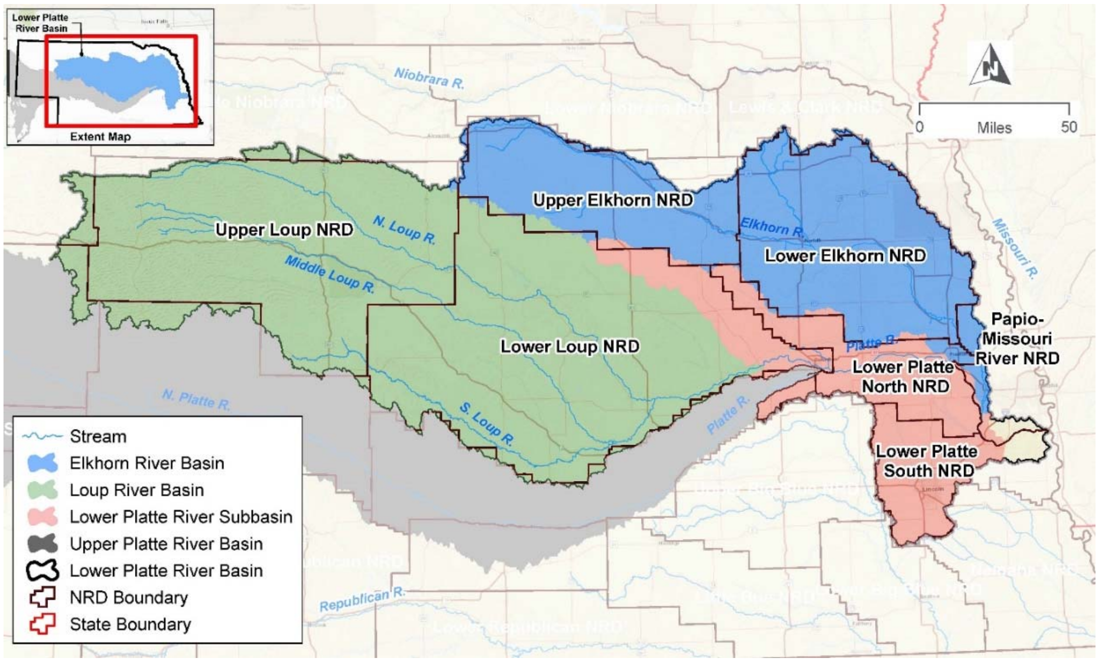
The Lower Platte River, its tributaries, and aquifers serve approximately 80 percent of Nebraska's population, thousands of businesses and industries, includes more than two million irrigated acres, and provides streamflows for threatened and endangered species. The drought-driven risks are diverse and a potential drought in the region would pose serious risk to public health, economy, and fish/wildlife. It is believed that in addressing the water supply shortages during droughts in the Lower Platte River, ancillary benefits to the remaining sectors would accrue including: irrigation, power, environmental, and recreational benefits.

The focus of this first increment of the Drought Plan is to establish a framework for coordination and communication amongst Consortium members to address droughts in the Lower Platte River. In addition a wide range of alternatives for augmenting surface water supplies in the Lower Platte River near Ashland were investigated. This Drought Plan will supplement the current authorities and activities of the Consortium members and is not intended to replace or duplicate efforts (i.e. NRDs address water conservation through their individual groundwater management plans at this time; LWS has a drought management plan prescribing drought triggers and response actions specific to their system operations). With the framework established by this Drought Plan, it is anticipated that Consortium members will continue to evaluate monitoring and communication protocols, mitigation measures, and response actions and revise the plan as necessary.

There are a wide-range of stakeholder interests in the Lower Platte River Basin. The Consortium solicited stakeholder input throughout the planning effort. Two stakeholder workshops and two public open houses were held, and written comments were accepted via comment forms and a project email posted on the project website open to the public.

Member participation in the Consortium is voluntary and member agencies shall not be bound by any initiatives, recommendations or decisions made by the Consortium without a subsequent written agreement or resolution approved by the respective bodies. While represented agencies may elect to seek approval of the Plan by their respective elected officials, formal adoption of the Plan is not required for future participation in the Consortium.

Figure ES-1: Map of Lower Platte River Basin



Drought Contingency Plan Background

In 2017, the Lower Platte River Basin Coalition, which includes the seven NRDs[1] in the Loup, Elkhorn, and Lower Platte River Basins, and NeDNR, adopted the *Lower Platte River Coalition Basin Water Management Plan (Basin Plan)*. The Basin Plan evaluated supplies and demands in the Lower Platte River Basin (Basin) and set criteria for managing new water development, and goals and objectives that work to protect the existing domestic, agricultural, and industrial water uses in the Basin. The Basin Plan found that annual water supplies in the Basin generally tend to be sufficient for most water uses; however, peak demands in the summer months can create water shortages. These shortages are further exacerbated by drought periods when summer flows become most critical in supporting water demands. This planning effort for the *Lower Platte River Drought Contingency Plan* (Drought Plan) followed the development of the Basin Plan to further address water supply shortages during drought periods, when peak demands overlap periods of low streamflows.

Lower Platte River Basin

Basin Water Demands

The water demands and water uses in the Lower Platte River are diverse; they include municipal, domestic, and agricultural uses, instream flows, and hydropower. The water utilities for the municipalities of Omaha and Lincoln, Nebraska, serve the two primary metropolitan areas in Nebraska, constituting approximately 60 percent of Nebraska's population. Both municipalities hold induced recharge permits (permits that protect streamflows adjacent to their well-fields) and municipal groundwater transfer permits (permits where groundwater is transferred from the water well site for use in another location). The Nebraska Game and Parks Commission holds instream flow appropriations for much of the Platte River and specifically in the areas of municipal well-field operations. The Loup Public Power District

[1] This includes the three NRD members of the Consortium (Lower Platte North NRD, Lower Platte South NRD, and Papio-Missouri River NRD).

holds a hydropower appropriation for off-channel hydroelectric power generation. In addition, thousands of individual water rights or groundwater permits are held to support irrigation from both surface water and hydrologically connected groundwater sources.

Basin Water Supplies

Water supplies of the Lower Platte River are driven by snowmelt, rainfall runoff, and aquifer baseflow contributions. Supplies can be highly variable, with annual flows ranging from 2 million acre-feet per year to more than 10 million acre-feet per year.

During low-flow years, the Upper Platte River becomes disconnected from the Lower Platte River with flows at Duncan, Nebraska, representing a negligible portion of flows observed in the Lower Platte River. During these times, most of the flow in the Lower Platte River originates from the groundwater-fed Loup River, Elkhorn River, and Platte River tributaries downstream from Duncan. The water supplies of the Loup River and Elkhorn River subbasins tend to be more reliable because of significant baseflow contributions. During drought periods, these water supplies reliant on baseflow contributions are stressed in support of irrigated agricultural production (primarily corn and soybeans).

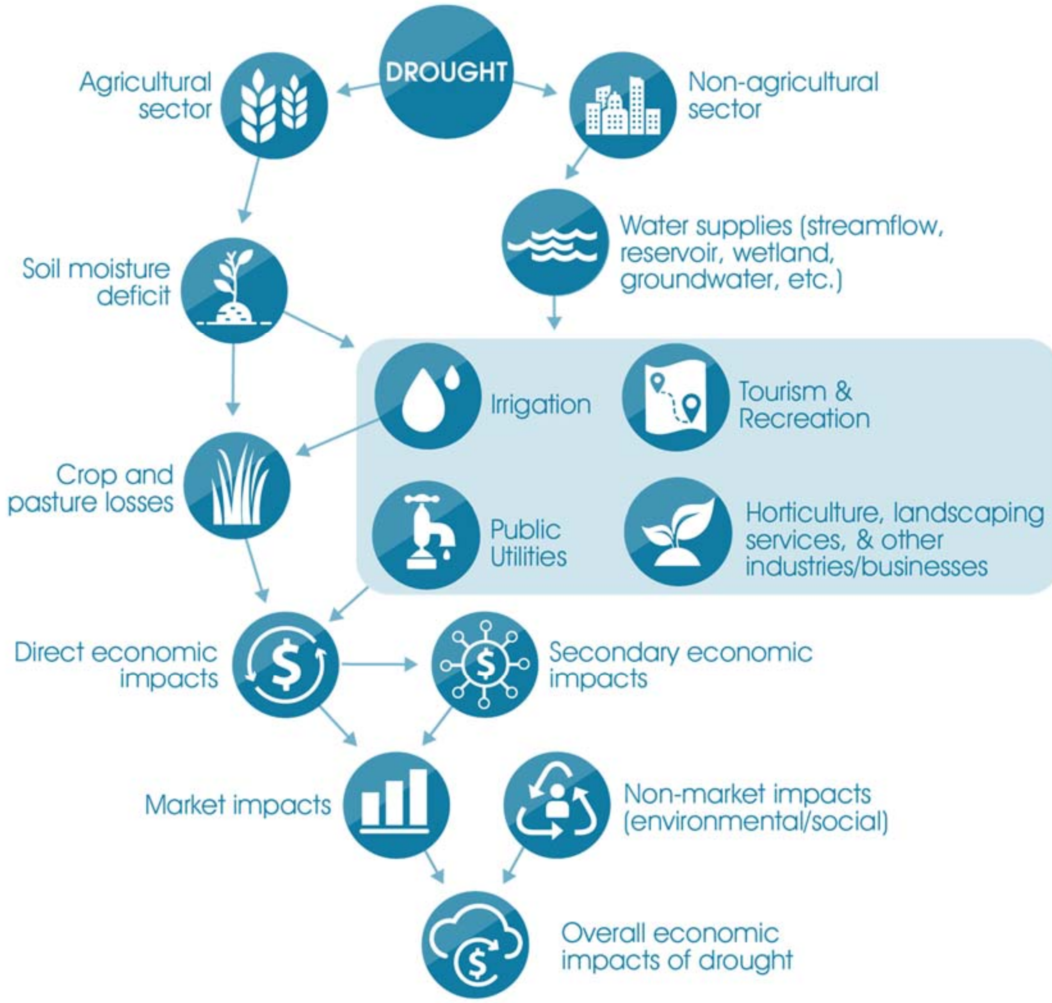
While annual water supplies in the Lower Platte River generally tend to be sufficient for most water uses, peak demands in the summer months can create water shortages, typically in July and August. These shortages are further exacerbated by drought periods when summer flows become most critical in supporting water demands.

Vulnerability Assessment

"[V]ulnerability to drought is the product of numerous interrelated factors such as population growth and shifts, urbanization, demographic characteristics, water use trends, social behavior, and environmental susceptibilities…. The degree to which a population is vulnerable hinges on the ability to anticipate, to deal with, resist, and recover from the drought" (Commission on Water Resource Management 2003).

The effects from drought can be classified as direct and indirect. Direct effects include physical destruction of property, crops, natural resources, as well as public health and safety. Indirect effects are consequences of that destruction, such as temporary unemployment and business interruption (National Academy of Sciences 1999). "The most vulnerable portions of the state in terms of economic impact are cropland, pasture land for animals, recreational areas, and businesses that depend on agricultural industries for the bulk of their business. However, all areas of the state can be impacted by drought events" (Nebraska Emergency Management Agency [NEMA] 2014). Figure ES-2 summarizes sectors that are affected by drought (both agriculture and non-agriculture).

Figure ES-2: An Overview of Drought Economic Effects



Source: Adapted from Ding, Hayes, and Widhalm 2010

Public water systems along the Lower Platte River are largely dependent on aquifers hydrologically connected to the river and its tributaries, and dependent on streamflow for recharge. Omaha and Lincoln, Nebraska's two largest municipalities, rely heavily on water supplies in the Lower Platte River to support well-field operations adjacent to the river. MUD's water system receives roughly half of its capacity from the Lower Platte River and the other half is received from the Missouri River. The capacity of Lincoln Water Systems' Ashland Well-field is directly dependent on flows in the Lower Platte River adjacent to the well-field. The vulnerability of public water supply during drought is amplified in the Lower Platte River Basin due to the lack of redundant water sources. With the exception of MUD, public water systems along the Lower Platte River rely solely on the aquifers hydrologically connected to the Platte River and are reliant on its flows for recharge.

The Lower Platte River provides habitat for numerous species, including federally listed threatened and endangered species, which are dependent on sustained flows. In addition, this reach of the river provides recreational amenities for the eastern portion of the state, including the primary population centers.

Drought Monitoring

Hydroclimatic indices assess drought severity and are essential for tracking and anticipating droughts as well as providing historical reference. Indices provide useful triggers to help direct decision-makers toward proactive risk management. For this increment of the Drought Plan, the Palmer Drought Severity Index (PDSI) will be utilized in combination with streamflow observations for drought determination in the Lower Platte River Basin. The PDSI reflects recent precipitation and the soil moisture balance. Zero or near zero PDSI values indicate normal conditions, a negative PDSI value indicates below normal (drought conditions); and a positive value represents above normal (wetter periods).

Four categories of drought have been identified for the Drought Plan. These levels of drought remain consistent with the National Drought Monitor definitions of drought. These categories and corresponding PDSI and streamflow thresholds are presented in Table ES-1.

The following lists the levels of drought and their corresponding definition:

- A Level 0, "Abnormally Dry"[2] indicates an area may be experiencing "short-term dryness slowing planting, growth of crops or pastures" indicating the onset of drought or may be coming out of drought and experiencing lingering effects of drought.
- A Level 1, "Moderate Drought" involves "some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; and voluntary water-use restrictions requested."
- A Level 2, "Severe Drought" means that "crop or pasture losses likely; water shortages common; and water restrictions imposed."
- A Level 3, "Extreme Drought" involves "major crop/pasture losses" and "widespread water shortages or restrictions."

Table ES-1: Drought Triggers

Category	Level	Palmer Drought Severity Index (PDSI)	Platte River Stream flow at Ashland
Mild Drought	Level 0	-1.0 to -1.99	--
Moderate Drought	Level 1	-2.0 to -2.99	3,000-1,500 cfs
Severe Drought	Level 2	-3.0 to -3.99	1,500-500 cfs
Extreme Drought	Level 3	-4.0 and below	Less than 500 cfs

Notes: PDSI = Palmer Drought Severity Index

Analysis of historic PDSI values from the last 116 years reveal that mild, moderate, severe, and extreme droughts have historically occurred in the Lower Platte River Basin on average once every three, six, nine, and fourteen years, respectively.

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[2] An "Abnormally Dry" classification by the National Drought Monitor corresponds to a PDSI "mild drought" classification. The "Moderate Drought", "Severe Drought" and "Extreme Drought" classifications are the same between the National Drought Monitor and PDSI.

It should be noted that no groundwater trigger is included in Table ES-1. Each NRD has some form of drought monitoring and triggers for response actions in defined areas of their District. The intent of the Drought Plan is not to replace each members' groundwater monitoring and management plans, but rather to provide consistent, basin-scale data and information that can be used by NRDs, while maintaining locally-based management frameworks. The individual NRD plans are discussed in detail in Appendix A.

Understanding the behavior of the Platte River at Ashland as flows recede is important to the ability of the Consortium to forecast and properly time the implementation of response actions. Using the Platte River at Ashland Recession Tool allows the user to enter the current observed flow in the Platte River at Ashland and predict the flow decay behavior for the next 30 days, assuming no further inputs to the system (precipitation runoff or upstream storage releases). The resulting recession curve can be used to estimate the days until a critical threshold is reached. The development of the Platte River at Ashland Recession Tool is discussed in detail in Appendix E. Figure ES-3 is a schematic of the functional utility of the Platte River at Ashland Recession Tool in drought forecasting and response.

Figure ES-3: Platte River at Ashland Recession Tool

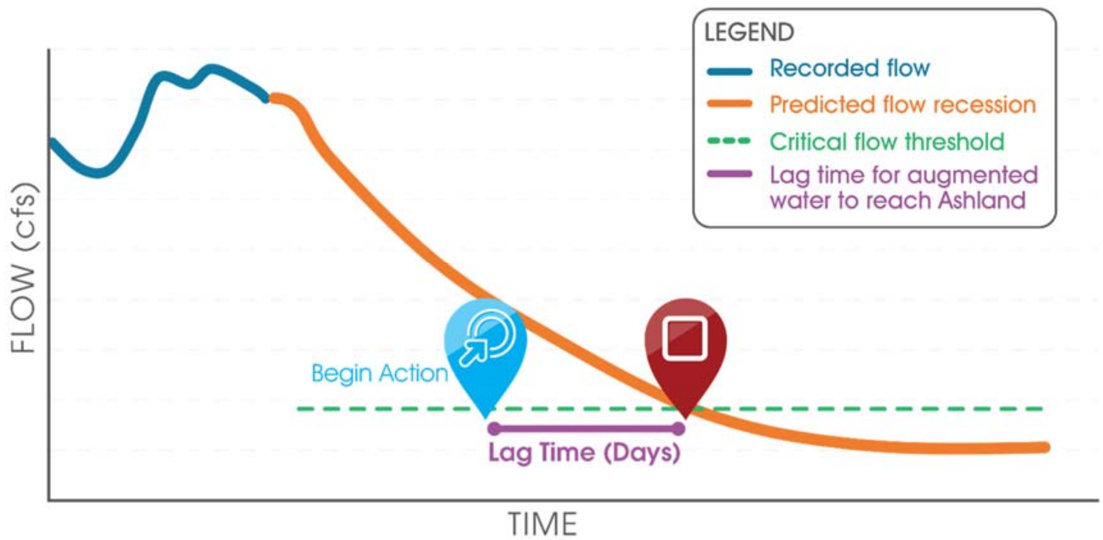
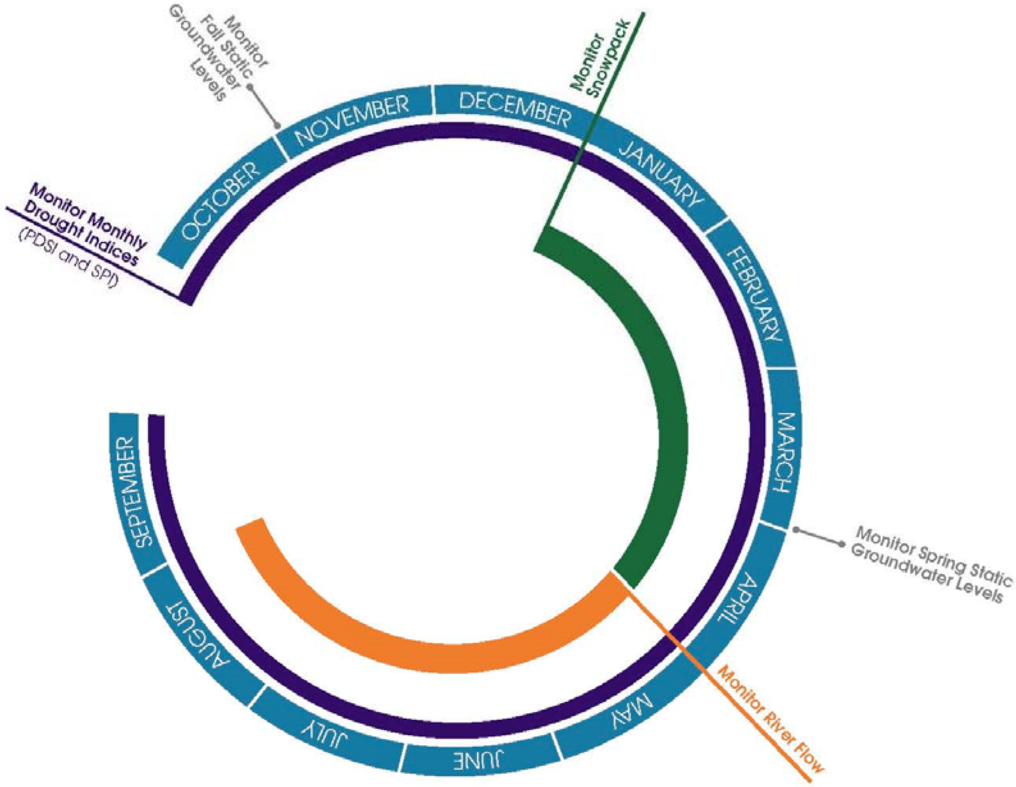


Figure ES-4: Drought Monitoring Continuum



The recommended timeline for drought monitoring is displayed in Figure ES-4. Hydroclimate indices (Standardized Precipitation Index (SPI) and PDSI) should be monitored year round. Groundwater levels are monitored by NRDs in the spring and fall of each year in accordance with their individual groundwater management plans. Snowpack volumes should be monitored from the beginning of the calendar year through the runoff season. Streamflows should be monitored starting in late spring through the summer when water use for irrigation, cooling, and lawn watering is at its peak.

Drought Management

Drought Mitigation Measures

Drought mitigation measures are actions, programs, and strategies implemented during non-drought periods to address potential risks and effects and to reduce the need for response actions; implementation of drought mitigation measures improves long-term resilience and reliability of the regional water supply.

Nine mitigation measures, and variations or combinations thereof, were evaluated as part of the Drought Planning effort to estimate potential increases in regional water supply. These measures include the following and are summarized in Tables ES-2A and ES-2B:

- Installing an alluvial well-field adjacent to the Missouri River and pumping water to a tributary of the Elkhorn River for availability on demand (two alternatives considered in Tables ES-2A and ES-2B: one that discharges directly into Bell Creek and a second that discharges into the proposed Bell Creek Reservoir);
- Purchasing storage in the existing Sherman Reservoir and releasing water on demand (two release volumes considered in Table ES-2A);

- A new surface water storage reservoir on Skull Creek near Linwood for releasing water on demand;
- A new surface water storage reservoir on Bell Creek east of Winslow for releasing water on demand;
- Capture of Middle Loup River water in the non-irrigation season and diversion into the Middle Loup Canal system for intentional recharge and increase baseflow(two demand scenarios evaluated in Tables ES-2A and ES-2B: one that considers the historic Loup hydropower operations downstream and a second that considers the full Loup hydropower appropriation downstream);
- Installing a well-field to tap into groundwater aquifers with limited connection to streamflow that can be pumped to the river to augment flows;
- Pumping from alluvial sandpits directly to the river to augment flows; and
- A rapid response area/dry-year-lease agreement with farmers irrigating lands adjacent to the main channel of the Platte River from the alluvial aquifer.
- Interconnection of MUD and LWS finished water supplies, providing LWS access to the Missouri River as a source of potable water

Conceptual design of infrastructure requirements and anticipated operational characteristics were defined for each mitigation measure. In addition, the estimated project yield to the Lower Platte River at the Ashland gage was determined. For projects upstream in the basin, a routing tool was used to estimate the losses that occur during conveyance to the Ashland gage. This routing tool utilizes historic reach loss data during low-flow periods to estimate conveyance losses (see Appendix D). As part of this planning effort, continuous recording monitoring wells paired with stage recorders were installed to foster a better understanding of losses in the Lower Platte River under varying hydrologic conditions.

For comparison of alternative costs and benefits, a 20-year period was evaluated to reflect the relative reliability of water from the mitigation action, i.e. for some mitigation actions water will not be available every year. A 15-day operation period, targeting the typical late-July/early-August critical low-flow period in the Lower Platte River, was assumed for project operations. For developing cost/acre-foot estimates included in Table ES-2A, costs were estimated over a 20-year period without using a discount rate or otherwise accounting for the time value of money. Benefits were based on acre-feet of water estimated to be delivered at the Ashland gage during the 15-day target period over the 20-yr period. Assumptions for each mitigation action are described in Section 5.0 and Appendix C.

Table ES-2A: Evaluation of Potential Mitigation Measures (cost estimate versus volume of water added)

	Volume Added at Source			Volume Increase at Ashland			
Alternative	Cumulative AF/15 days	Ave Daily cfs	Where Added	Cumulative AF/15 days	Ave Daily cfs	Cost Estimate	Cost per acre-foot added at Ashland
Import Missouri River Water (via alluvial well-field) to Bell Creek (no reservoir)	59,400	100	Waterloo	46,300	80	$76,572,840	$1,654
Sherman Release (400 cfs at St Paul)	47,520	400	St. Paul	15,720	132	$9,628,000	$612
Sherman Release (250 cfs at St. Paul)	29,700	250	St. Paul	9,800	83	$6,955,000	$710
Skull Creek Res. Rel. (100 cfs at Linwood)	59,400	100	Linwood	46,300	80	$32,630,000	$705
Bell Creek Reservoir (Release 100 cfs at Waterloo)	59,400	100	Waterloo	46,300	80	$81,520,000	$1,761
Pump Missouri River water (vial alluvial well-field) into Bell Creek Reservoir	59,400	100	Waterloo	46,300	80	$129,564,000	$2,798
Middle Loup Canal Recharge (Historic Loup Canal Operations)	7,525	13	Arcadia	2,525	4	$16,360,000	$6,478
Middle Loup Canal Recharge (Full Hydropower Right downstream)	2,034	3	Arcadia	634	1	$5,225,000	$8,238
Alluvial sandpit pumping	14,850	100	Leshara	14,850	100	$5,980,000	$403
Augmentation Well-field	59,400	100	TBD	59,400	100	$81,008,040	$1,364
Rapid Response Area/ Dry-year Lease	4,000	33	Columbus to Louisville	4,000	33	$248,500,800	$62,125
Interconnection of MUD and LWS finished water supplies	See notes	See notes	See notes	See notes	See notes	See notes	See notes

Notes:

- This list is not intended to be all-inclusive. Potential mitigation measures may be further evaluated in future increments of the Drought Plan
- AF = acre-feet; cfs = cubic feet per second;
- 20-year period evaluated to reflect relative reliability of each measure;
- Fifteen-day operating period, targeting late July/early August critical low-flow period;
- Routing tool used to estimate reach gains/losses;
- Cost per acre-foot based on water that makes it to Ashland (common point). Reach losses for evaluation assume 66% loss from the Loup River to Ashland, 20% loss from the Elkhorn River to Ashland, and 20% loss from North Bend to Ashland;
- Interconnection would directly link of MUD and LWS finished water supplies without utilizing the Platte River for conveyance and would directly address impacts of drought on potable water supplies. A more detailed analysis of feasibility and costs associated with this alternative is being conducted as a separate study.

Table ES-2B: Evaluation of Potential Mitigation Measures (advantages, disadvantages, and uncertainties)

Alternative	Advantages	Disadvantages	Uncertainties
Import Missouri River Water (to Bell Creek/no reservoir)	• Secondary source of water outside of Platte River basin increases reliability of supply. • Operational every year & year-round	• Larger construction cost than many alternatives • Implementation - 5-10 years	• Future regulation on Missouri River • Well field siting
Sherman Release (400 cfs at St Paul)	• Utilizes existing facilities (no construction cost; ability to pilot study) • Produces large volume of water on-demand • Loup River historically a reliable water supply source. • Implementation: 1-2 years	• Likely limitation on frequency of call on storage water • Significant conveyance losses from release point to Lower Platte River	• Requires cooperation and agreements with existing facility owners. • Negotiations will dictate price. • Cost estimates based on similar agreements in state.
Sherman Release (250 cfs at St. Paul)			
Skull Creek Res. Rel. (100 cfs at Linwood)	• Produces large volume of water on demand • Potential for multi-purpose facility	• Larger construction cost than many alternatives • Land requirements, involving multiple landowners • Implementation: 5-10 years	• Runoff volume varies year to year • Land use impacts on runoff • Implementation (permitting, land purchase, etc.)
Bell Creek Reservoir (Release 100 cfs at Waterloo)			
Pump Missouri River water (via alluvial well-field) into Bell Creek Reservoir	• Secondary source of water outside of Platte River basin increases reliability. • Operational every year & year-round. • Importing into Bell Creek Reservoir requires a lower capacity system for importing water - saving money	• Larger costs associated with combining alternatives that require both land and infrastructure. • Implementation: 5-10 years	• Future regulation on Missouri River • Well field siting • Implementation (permitting, land purchase, etc.)
Middle Loup Canal Recharge (Historic Loup Canal Operations)	• The canal recharge and dry-year lease projects are passive mitigation measures whose benefits (passive baseflow returns) accrue throughout the year, adding to the overall supply reliability. • Existing infrastructure – no initial construction costs • Implementation: 1-2 years	• Unavailable to release a pulse of water volume "on-demand". • Takes time for the full benefit to be realized in river (lag effect) and some attenuation	• Requires cooperation and agreements with existing facility and/or landowners. • Negotiations will dictate price. • Cost estimates based on similar agreements in state. • Amount of improvement of overall system supply reliability from year around accretions
Middle Loup Canal Recharge (Full Hydropower Right downstream)			
Alluvial sandpit pumping	• Minimal infrastructure costs (pumps from existing sandpits) • Utilizes existing sandpits (no construction costs) • Implementation: 3-5 years	• Limited operation window as pumping this close to the river may cause depletions to the stream (lag effect) that amplify impacts during extended drought • Logistics of securing agreements with multiple landowners • Likely limitation on the number of calls allowed in a 20-year period	
Augmentation Well-field	• Available every year & year-round • Can be located closer to critical reach to reduce losses compared to alternatives producing similar volumes upstream in the Basin.	• Land & infrastructure costs make this one of the more expensive alternatives. • Adds to overall depletions • Implementation: 5-10 years	• Siting to avoid interference with existing wells. • Long-term reliability of aquifer
Rapid Response Area/ Dry-year Lease	• No infrastructure or construction necessary.	• Logistics of securing agreements with thousands of producers • Likely limitation on the number of calls allowed in a 20-year period • Most expensive of all the alternatives by an order of magnitude based on assumptions. • Crop insurance likely affected in years when agreement enforced	• Negotiations will dictate price. • Cost estimates based on similar agreements in state, and factors such as cost differential between irrigated and dry land rental rates. • Uncertain how many producers would participate (benefits assume 100% participation which is unlikely)
Interconnection of MUD and LWS finished water supplies	• Directly and efficiently addresses drought impacts on potable water supplies • Provides access to the drought-resistant Missouri River as a source • Implementation: 3-5 years	• Does not directly address low flow conditions on the Platte River during drought; however may reduce pumping demands on municipal wells adjacent to the Platte River during drought conditions • Infrastructure costs associated with linking finished water supplies	• Feasibility of linking water supplies (water chemistry, system hydraulics, legal framework, etc.) • A more detailed feasibility study is currently being undertaken

Note: This list is not intended to be all-inclusive. Potential mitigation measures may be further evaluated in future increments of the Drought Plan

Drought Response Actions

Drought response actions are near-term actions triggered during specific stages of drought to manage the limited supply and to decrease the severity of immediate effects of drought periods on the regional water supply. In this first increment of the Drought Plan, potential mitigation measures (Table E-2) have been evaluated, but preferred measures have not been determined or constructed; therefore, the primary drought response action available to the Consortium at this time is communication and outreach. Individual members of the Consortium have specific drought response actions that each will continue to implement in response to drought conditions.

Consistent and coordinated messaging to basin water users (municipal, industrial, domestic, irrigation, etc.), as well as the general public, raises awareness of the current water supply conditions, allows water users to proactively alter their demand and usage based on limited water supplies, and defines expectations of forecasted conditions and potential actions in response to the drought.

Operational and Administrative Framework

Future Lower Platte River Drought Contingency Plan Updates

The Drought Plan and associated planning is meant to be part of an adaptive process that is routinely updated to reflect the needs of the basin. The Consortium will hold meetings each year and will evaluate the need for updating the Drought Plan every five years. The following list provides information related to the anticipated frequency of Consortium actions and steps taken in regard to updating the Drought Plan:

- On an annual basis, the Consortium will gather information and make any necessary updates to the Vulnerability Assessment.
- On an annual basis, the Consortium will review any changes in the Vulnerability Assessment, determine the need for new and revised actions, update the status of existing actions, and add new actions (as needed).
- Every five years, the Consortium will assess the need for and prepare an updated Drought Plan (as needed).

It should be noted that the Consortium may identify planning and technical efforts outside those anticipated that need to be undertaken based on changed conditions or a potential need.

Continued Communication and Outreach

The Consortium will consider the only drought response action available to it at this time, which is communication and outreach. The following list provides information related to communication and outreach:

- The Consortium will keep the project website updated and will send emails to keep interested stakeholders informed of meetings, new materials, and other information related to the Drought Plan and its implementation.
- The Consortium will post drought monitoring information and drought status information on the project website as needed and as conditions change.
- Each individual agency in the Consortium will be responsible for informing its constituents, customers, and the public of any actions initiated and related progress and results.

- Coordination and information sharing with other ongoing efforts will be mutually beneficial (Missouri Basin Plan, Nebraska Emergency Management Agency, etc.). It is anticipated that this coordination and information sharing with other ongoing efforts and agencies will occur on an as-needed basis.

Contents

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Appendices

1.0 Background

In 2017, the Lower Platte River Basin Coalition, which includes the seven NRDs[3] in the Loup, Elkhorn, and Lower Platte River Basins, and NeDNR, adopted the *Lower Platte River Coalition Basin Water Management Plan (Basin Plan).* The Basin Plan evaluated supplies and demands in the Lower Platte River Basin (Basin) and sets criteria for managing new water development , and goals and objectives that work to protect the existing domestic, agricultural, and industrial water uses in the Basin. The Basin Plan found that annual water supplies in the Basin generally tend to be supportive of most water uses; however, peak demands in the summer months can create water shortages. These shortages are further exacerbated by drought periods when summer flows become most critical in supporting water demands.

The governing philosophy in developing the criteria for new water development in the Basin Plan was to responsibly allow new development based on average peak season supplies and not forego opportunities for new development based on the potential for low flows to occur a few weeks each year. The Consortium's efforts then build upon the Basin Plan by developing a Drought Plan aimed at mitigating water supply shortages during drought periods, when peak demands overlap periods of low streamflows.

The Lower Platte South Natural Resources District (NRD), Papio-Missouri River NRD, Lower Platte North NRD, Metropolitan Utilities District (MUD), Lincoln Water System (LWS), and Nebraska Department of Natural Resources (NeDNR), collectively referred to as the Lower Platte River Consortium (Consortium), embarked on a collaborative effort to develop a drought contingency plan for the Lower Platte River Basin in Nebraska (*Lower Platte River Drought Contingency Plan* [Drought Plan]).

The Lower Platte River, its tributaries, and aquifers serve approximately 80 percent of Nebraska's population, thousands of businesses and industries, including more than two million irrigated acres, and provides streamflows for threatened and endangered species. It was recognized that a potential drought in the region would pose serious risk to public health, economy, and fish/wildlife. The drought-driven risks are diverse and the alternatives for resolving them were investigated through this planning effort.

MUD provides drinking water to more than 600,000 customers while LWS provides drinking water to more than 265,000 customers. Both MUD and LWS have water supply well-fields near Ashland, Nebraska, on the Lower Platte River. While MUD has alternate sources of water supply, LWS's sole source of water for its public water supply is the Platte River. While the Drought Plan assesses the water supplies, demands, and vulnerabilities in the Lower Platte River Basin as a whole, the mitigation measures and response actions presented herein are focused on augmenting surface water supplies in the Lower Platte River while referencing additional drought management resources available through the University of Nebraska, National Drought Mitigation Center, and other sources. It is believed that in addressing the water supply shortages in the Lower Platte River, ancillary benefits to the remaining sectors should accrue including irrigation, power, environmental, and recreational benefits.

Member participation in the Consortium is voluntary and member agencies shall not be bound by any initiatives, recommendations or decisions made by the Consortium without a subsequent written agreement or resolution approved by the respective bodies. While represented agencies may elect to seek approval of the Plan by their respective elected officials, formal adoption of the Plan is not required for future participation in the Consortium.

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[3] This includes the three NRD members of the Consortium (Lower Platte North NRD, Lower Platte South NRD, and Papio-Missouri River NRD).

1.1 Plan Purpose

The focus of this first increment of the Drought Plan is to establish a framework for coordination and communication amongst Consortium members to address droughts in the Lower Platte River. The Drought Plan will refine the Consortium's collective understanding of drought vulnerabilities while developing more robust monitoring and forecasting tools coupled with timely triggers, new mitigation strategies, and responsive actions to create a sound, operational framework and to improve critical water supply needs of the area through drought periods. A wide range of alternatives for augmenting surface water supplies in the Lower Platte River near Ashland were also investigated.

This Drought Plan will supplement the current authorities and activities of the Consortium members and is not intended to replace or duplicate efforts (i.e. NRDs address water conservation through their individual groundwater management plans at this time; LWS has a drought management plan prescribing drought triggers and response actions specific to their system operations). With the framework established by this Drought Plan, it is anticipated that Consortium members will continue to evaluate monitoring and communication protocols, mitigation measures, and response actions and revise the plan as necessary.

1.2 Pre-Lower Platte River Drought Contingency Plan Activities

Prior to starting the Drought Plan development, the Consortium members (Lower Platte South NRD, Papio-Missouri River NRD, Lower Platte North NRD, MUD, LWS, and NeDNR) completed the following three required activities:

1. Development of detailed Work Plan.

   The Work Plan guided the Drought Plan development process. It described the specific planning tasks and the manner in which each would be completed, the associated schedule, and the roles and responsibilities. The Work Plan included four sections:

   a. Section A: Introduction – Description of the scope and purpose of the Drought Plan, the planning area, and background information.

   b. Section B: Planning Approach – Description of the project schedule for Drought Plan development, scope of work to complete the six required Drought Plan elements, planning oversight structure, decision-making process, roles and responsibilities, and coordination.

   c. Section C: Documentation and Reporting – Description of deliverables and documentation requirements, reporting requirements and responsibilities, and review process.

   d. Section D: Communication and Outreach Plan – Description of anticipated stakeholder and public involvement and schedule.

   The Drought Plan Work Plan was accepted by the Bureau of Reclamation in May 2017.

2. Establishment of a Drought Planning Task Force (DPTF).

   The Consortium members serve as the active participants for the DPTF. The Consortium members are key water management agencies that represent the Municipal and Industrial (M&I) and agricultural water suppliers in the Lower Platte River Basin. The NRDs are political sub-divisions within Nebraska with broad jurisdictional authorities in flood control, soil erosion, irrigation runoff, groundwater quantity and quality regulation, and integrated management planning. Each NRD is composed of local officials from business, industry, agriculture, planning/zoning, academia, and environmental backgrounds elected to the board. NRDs serve as key focal points for local input on a variety of water-related issues.

3. Development of a Communication and Outreach Plan to maximize stakeholder involvement during development of the Drought Plan.
    a. Section A: Introduction
    b. Section B: Goals for Stakeholder and Public Involvement
    c. Section C: Communications and Outreach Approach, Activities, and Tools

1.3 Lower Platte River Drought Contingency Plan Development and Public Outreach Efforts

The Consortium's stakeholder and public outreach efforts continued throughout the development of the Drought Plan. All Consortium meetings were given public notice and were held at the offices of Lower Platte South NRD in Lincoln, Nebraska.

1.3.1 Consortium Meetings

The following is a list of Consortium meetings and dates those meetings were held (public notice was given for all meetings).

- Kickoff Meeting – November 9, 2016
- Project Meeting – December 15, 2016
- Project Meeting – February 23, 2017
- Project Meeting – March 27, 2017
- Project Meeting – May 2, 2017
- Project Meeting – August 22, 2017
- Project Meeting – November 28, 2017
- Project Meeting – February 22, 2018
- Project Meeting – March 30, 2018
- Project Meeting – May 9, 2018
- Project Meeting – July 17, 2018
- Project Meeting – September 20, 2018
- Project Meeting – October 29, 2018
- Project Meeting – November 26, 2018
- Project Meeting – February 25, 2019

1.3.2 Stakeholder and Public Outreach Efforts

Several activities were undertaken to encourage stakeholder and public participation, including the following:

- Consortium Project Meetings – All Consortium meetings were open to the public.

- Website updates – A website with Drought Plan-related content is managed by Lower Platte South NRD so that interested stakeholders could track Drought Plan progress: https://www.lpsnrd.org/lower-platte-river-consortium
- NRD Briefings – Elements for the draft plan were provided to the participating NRDs on October 30, 2018 (Lower Platte North NRD), November 7, 2018 (Papio-Missouri River NRD), and November 14, 2018 (Lower Platte South NRD). These NRD meeting were open to the public.

1.3.3 Consortium Workshops

Two technical workshops were held in May 2017 and June 2018, respectively. These technical workshops targeted industry experts and NRD, LWS, and MUD personnel.

- Consortium Workshop 1 – May 16, 2017; (26 stakeholders in attendance)
- Consortium Workshop 2 – June 19, 2018 (31 stakeholders in attendance)

1.3.4 Public Open Houses

The first public open house was held June 19, 2018, in which 35 stakeholders attended. The following lists the public outreach efforts related to Public Open House 1:

- "Know Your NRD" Summer 2018 newsletter distributed electronically the week of June 4 and inserted into five district newspapers, including the *Lincoln Journal Star*, *Ashland Gazette*, *Hickman Voice*, *Plattsmouth Journal*, and *Waverly News* the week of June 11. Total distribution of the newsletter was 148,497.
- Legal notices of technical workshop and open house published two times in June, prior to June 19 in *Lincoln Journal Star*.
- Notice posted on Lower Platte South NRD Facebook page on June 14 and June 18.
- Notice posted on Lower Platte South NRD website home page from June 4 through June 19.
- Workshop and open house notices and agenda posted on Consortium and Lower Platte South NRD webpage.
- News release sent to local media in early June by HDR.

The second public open house was held December 5, 2018, in which approximately 50 stakeholders attended. The following lists the public outreach efforts related to Public Open House 2:

- Legal notices of open house published two times in November in *Lincoln Journal Star*.
- Notice posted on Lower Platte South NRD Facebook page.
- Notice posted on Lower Platte South NRD website home page...
- Open house notices and agenda posted on Consortium and Lower Platte South NRD webpage.
- News releases were sent to local media in November by HDR. The Omaha World-Herald ran an article on the Drought Plan efforts that was published on December 2, 2018.

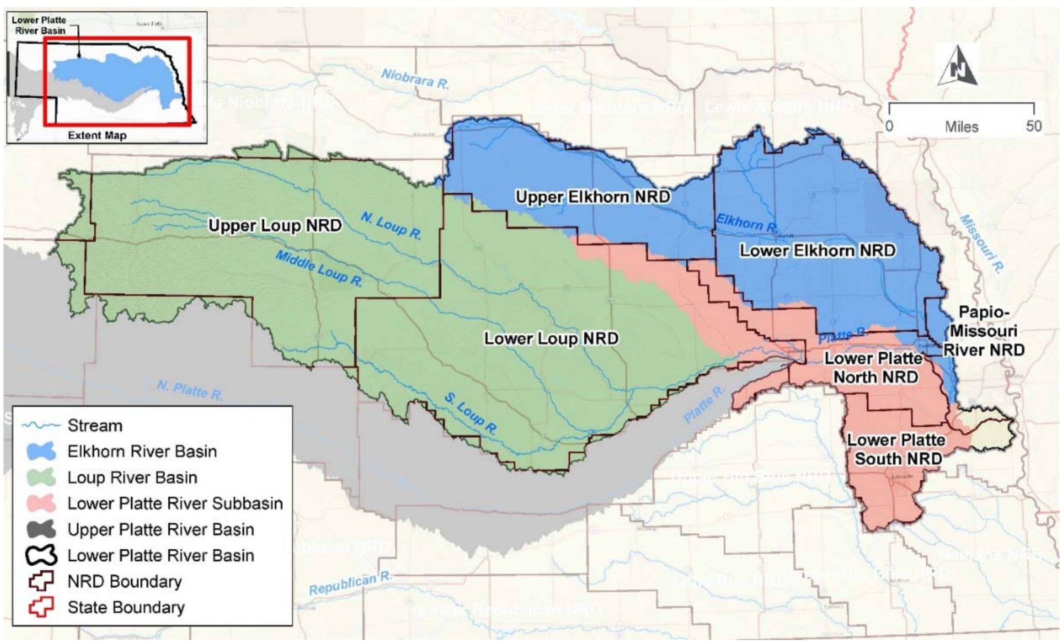
Meeting materials and public comments received from the Open House meetings are included in Appendix F.

2.0 Lower Platte River Basin

The Lower Platte River Basin is defined as all surface areas that drain into the Lower Platte River, including those areas that drain into the Loup River and the Elkhorn River and all aquifers that affect surface water flows of the basin (Figure 1). The total area of the Lower Platte River Basin is approximately 25,400 square miles, which encompasses both the Loup River subbasin and the Elkhorn River subbasin. NRDs with significant area in the basin include Lower Platte South NRD, Lower Platte North NRD, Upper Elkhorn NRD, Lower Elkhorn NRD, Upper Loup NRD, Lower Loup NRD, and Papio-Missouri River NRD (NeDNR 2017).

The Upper Platte River Basin is located immediately upstream of the Lower Platte River Basin and is contributor of streamflow to the Lower Platte River Basin; therefore, discussion is included to characterize the Upper Platte River Basin and its behavior during times of drought and how this may affect the Lower Platte River Basin.

Figure 1: Map of Lower Platte River Basin



The Nebraska Legislature passed Nebraska Legislative Bill 962 (LB 962) on July 16, 2004, to address conflicts between surface water and groundwater users and to provide a framework for joint management of water resources. As required under LB 962, NeDNR must evaluate the expected long-term availability of hydrologically connected water supplies each year (Figure 2) to meet both existing and new surface water and groundwater uses for each river basin in the state.

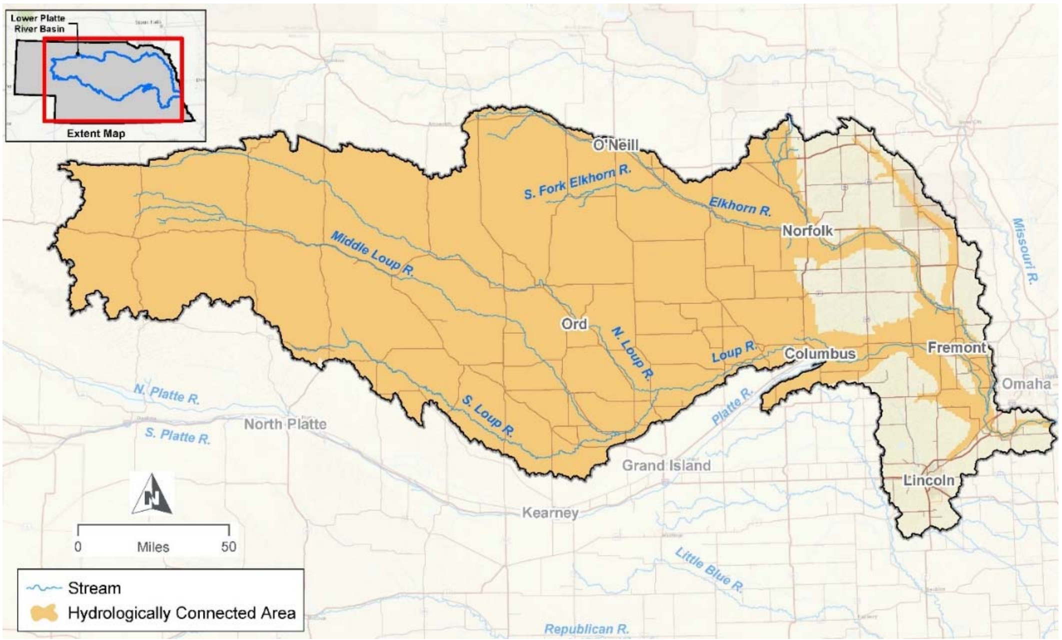
Under Nebraska Revised Statutes § 46-713(3), a basin is considered fully appropriated when certain conditions for hydrologically connected surface water and groundwater are met, namely the following:

> When "then-current uses of hydrologically connected surface water and groundwater […] will in the reasonably foreseeable future cause:
>
> (a) the surface water supply to be insufficient to sustain over the long term, the beneficial or useful purposes for which existing natural-flow or storage appropriations were granted and the beneficial or useful purposes for which, at the time of approval, any existing instream appropriation was granted.

(b) the streamflow to be insufficient to sustain over the long term the beneficial uses from wells constructed in aquifers dependent on recharge from the river or stream involved.

(c) reduction in the flow of a river or stream sufficient to cause noncompliance by Nebraska with an interstate compact or decree, other formal state contract or agreement, or applicable state or federal laws" (Nebraska Revised Statutes § 46-713[3]).

Figure 2: Lower Platte River Basin – Hydrologically Connected Area



Source: Map layer provided by Nebraska Department of Natural Resources (Obtained 2016)

On December 16, 2008, NeDNR made a preliminary determination that the Lower Platte River Basin was fully appropriated. Following the preliminary determination, NeDNR held four public hearings on February 17, February 24, March 11, and March 12, 2009, where new information was brought forward. On April 8, 2009, NeDNR reversed its preliminary determination, making the determination that the Lower Platte River Basin was not yet fully appropriated.

Subsequent to the reversal of the preliminary determination, Nebraska Governor Dave Heinemann signed LB 483, which established procedures to limit new irrigation development in areas such as the Lower Platte River Basin. In accordance with LB 483, whenever NeDNR reverses the preliminary determination that a basin is fully appropriated, the NRDs subject to LB 483 adopt a 4-year plan to limit the number of new wells, so that the basin remains "not yet fully appropriated".

Together with NeDNR, the seven NRDs in the Lower Platte River Basin[4] entered into an Interlocal Cooperative Agreement in April 2013 to form the Lower Platte River Basin Water Management Plan Coalition (Coalition). The Coalition recognizes the interrelation of water resources inherent within the basin and has embarked on a critical mission to manage new uses while protecting and sustaining the long-term balance between the water uses and water supplies throughout the basin within the seven represented NRDs.

[4] Upper Loup NRD, Lower Loup NRD, Upper Elkhorn NRD, Lower Elkhorn NRD, Lower Platte South NRD, Lower Platte North NRD, and Papio-Missouri River NRD, along with NeDNR

For the first 5-year increment of the *Lower Platte River Basin Water Management Plan* (through 2022), each Coalition member agreed to limit the total depletive effect of allowable new surface water and groundwater uses during the peak season (that is, June, July, and August). The allowable new depletions shown in Table 1 correspond to the effect new development (both agricultural and non-agricultural uses) would have on a stream in 50 years. Depletion estimates for new uses will be made using the best available data and models.

Table 1: First 5-Year Increment Allowable Development (Depletions) by Subbasin for New Surface and Groundwater Uses

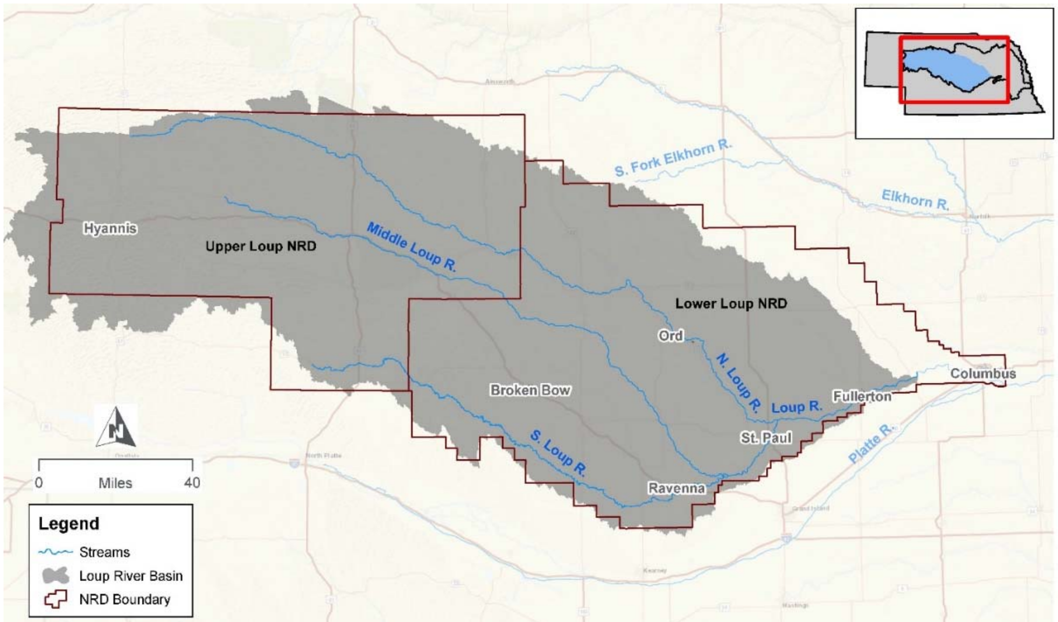
NRD	Subbasin	First 5-year Increment Allowable Development (Depletions) – Peak Season	
		Acre-feet/90-day season	Cubic feet per second
Upper Loup NRD	Loup River subbasin	2,768	15.5
Lower Loup NRD		5,883	33.0
Upper Elkhorn NRD	Elkhorn River subbasin	1,504	8.4
Lower Elkhorn NRD		4,514	25.3
Papio-Missouri River NRD	Lower Platte River subbasin	869	4.9
Lower Platte South NRD		993	5.6
Lower Platte North NRD		2,276	12.8
Total	Full Basin	18,807	105.5

Source: Basin Plan; Note: NRD = Natural Resources District

2.1 Loup River Subbasin

The Loup River subbasin is located in central Nebraska, and primarily includes the Upper Loup NRD and the Lower Loup NRD. The Loup River subbasin has an area of approximately 14,900 square miles (Figure 3).

Figure 3: Loup River Subbasin



At its farthest western extent, the Loup River subbasin boundary is about halfway between Alliance, Nebraska, and Hyannis, Nebraska, in Sheridan and Garden Counties. The Loup River headwaters are about seven miles northwest of Hyannis. The Loup River subbasin is defined as draining to the confluence of the Loup River and Platte River at Columbus, Nebraska. The Loup Hydropower facility, a major water user in the Loup River subbasin, is located near the bottom of the Loup River subbasin, approximately 32 miles upstream of the Loup River and Platte River confluence.

According to the 2010 U.S. Census, the largest city in the Loup River subbasin is Columbus, with a population of about 22,000. In descending order, the next largest cities in the Loup River subbasin in Nebraska include Broken Bow (3,600), St. Paul (2,300), Ord (2,100), Ravenna (1,400), and Fullerton (1,300).

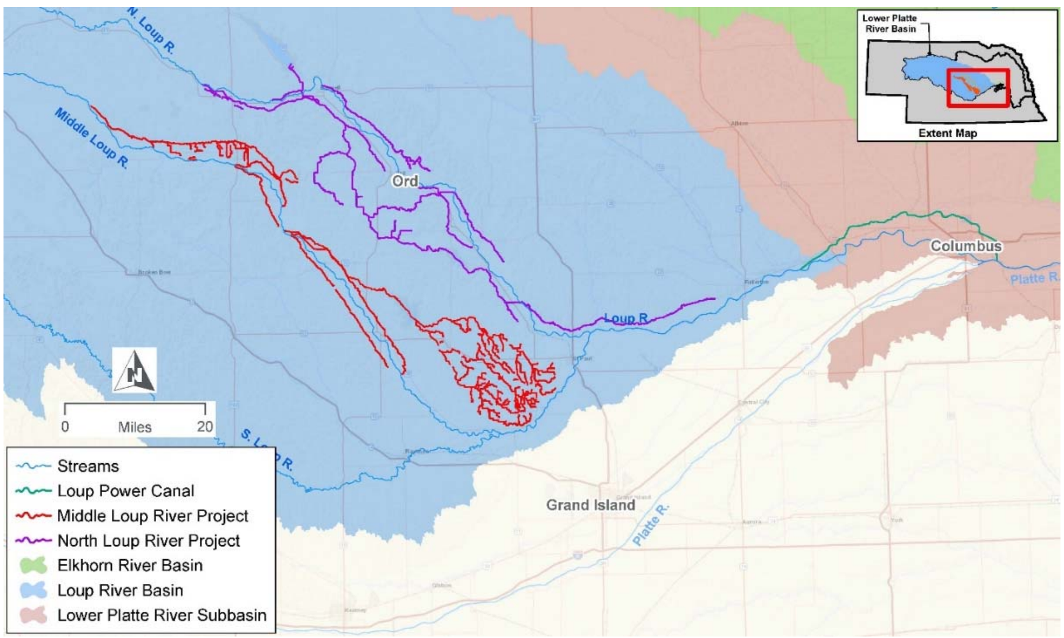
Encompassing portions of the Sandhills, most of the upper portion of the Loup River subbasin is used as pasture and rangeland; water table lakes and wetlands are common, especially in the north and west portions of the subbasin. In the remainder of the subbasin, mostly in river valleys, the primary crop grown is corn, followed by soybeans.

The primary aquifer in the Loup River subbasin is the Ogallala Group, which is part of a vast system of related sediments that make up the High Plains Aquifer. Early spring snowmelts contribute to high aquifer recharge. The highly permeable soils of the sand dunes limit runoff, enhance infiltration, and recharge the groundwater system. Large saturated thicknesses, high porosity and yield, and high hydraulic conductivity are common in the subbasin. The eastern margin of the subbasin is underlain by undivided Quaternary-aged units of the Great Plains Aquifer. In contrast to the western subbasin, rivers in the eastern subbasin are wide and shallow and groundwater contributes less to total streamflow with these streams showing more seasonal fluctuation.

There are three reservoirs with normal pool surface area greater than one square mile in the Loup River subbasin. The Calamus Reservoir has a normal storage volume of almost 130,000 acre-feet, Sherman Reservoir has a normal storage volume of almost 70,000 acre-feet, and the Davis Creek Reservoir has a normal storage volume of more than 47,000 acre-feet.

There are five surface water irrigation districts (Sargent, Farwell, Middle Loup, North Loup, and Twin Loups) that serve approximately 129,000 acres of the approximately 1,081,481 total irrigated acres within the subbasin. Loup Public Power District is a hydropower district located within the Loup River subbasin with a natural flow appropriation of 3,500 cubic feet per second (cfs). The Loup Power Canal diverts Loup River flows upstream of Genoa, Nebraska, and the canal returns flow to the Platte River downstream of Columbus. Irrigators along the Loup Power Canal divert surface water from the Loup Canal to irrigate approximately 7,500 acres. These individual appropriations are independent and junior to Loup Public Power District's appropriation and the appropriators have entered into interference agreements with Loup Public Power District to fulfill their appropriation (Figure 4).

Figure 4: Loup River Subbasin Canals

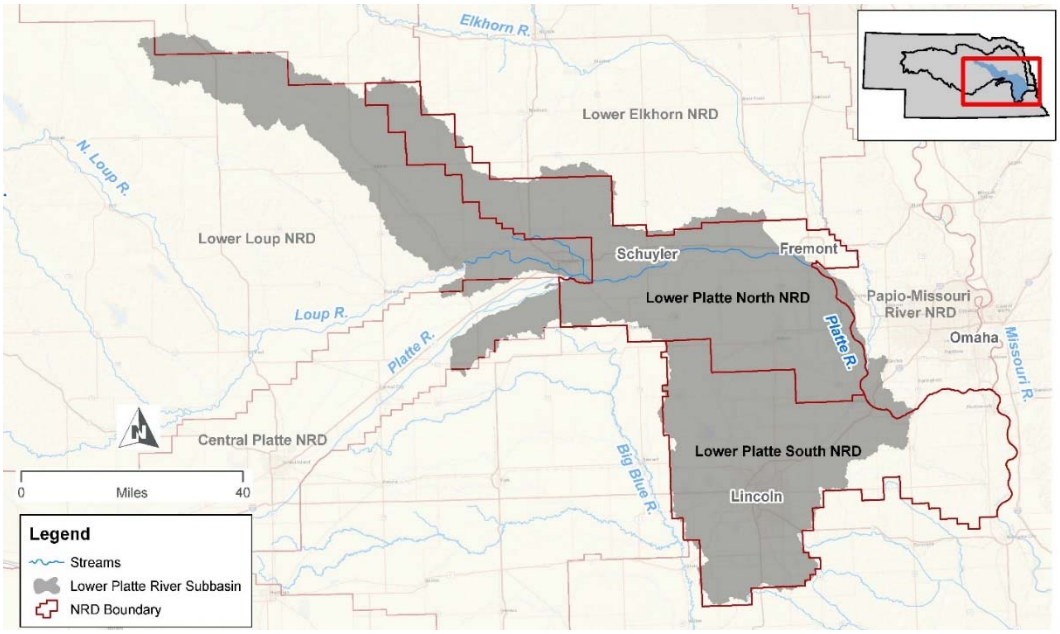


Average annual precipitation varies from 16 to 18 inches per year in the westernmost end of the subbasin and up to 28 inches per year in the easternmost end of the subbasin. The Loup River subbasin has an average subbasin water supply of 2.2 million acre-feet per year, an average near-term demand of 1.4 million acre-feet per year, and an average long-term demand of 1.8 million acre-feet per year (excluding hydropower demand).

2.2 Lower Platte River Subbasin

The Lower Platte River subbasin includes the Lower Platte River and its tributaries (except the Elkhorn River) beginning at the confluence of the Loup River and Platte River at Columbus. It primarily includes a majority of the Lower Platte South NRD and Lower Platte North NRD, as well as a smaller portion of the Papio-Missouri River NRD. Approximately 3,400 square miles comprise the Lower Platte River subbasin. The subbasin extends from northeastern Boone County downstream to the Louisville, Nebraska, gage location (Figure 5).

Figure 5: Lower Platte River Subbasin



Lincoln, the capital of Nebraska, is the largest city wholly contained within the Lower Platte River subbasin, with a 2010 U.S. Census population of almost 260,000. The next largest city intersecting the Lower Platte River subbasin is Fremont, Nebraska, with about 26,000 citizens (Fremont is also in the Elkhorn River subbasin). The next largest city in the Lower Platte River subbasin in Nebraska is Schuyler (6,200). While Omaha is not contained within the Lower Platte River subbasin, several municipal well-fields that serve the metropolitan area are located within the subbasin.

In the northwestern corner and along the southwestern margins of the Lower Platte River subbasin, the land is primarily used as pasture and rangeland. The remainder of the subbasin is primarily agricultural production, with corn and soybeans as the primary crops.

Part of the Lower Platte River sub-basin between the Elkhorn and Platte Rivers is considered to be within the High Plains Aquifer system which consists of several geologic units including the Ogallala group and more recent Quaternary-Aged alluvial sediments. The Ogallala Group sediments generally do not extend east into the Lower Platte River Sub-Basin. Instead, alluvial unconsolidated sand and gravel aquifers in hydrologic connection with the Platte and Elkhorn Rivers are the High Plains aquifer sediments found in the sub-basin. Nearly all irrigation and major municipal well fields draw groundwater from this interconnected alluvial aquifer. The eastern portion of the subbasin is also underlain by the Great Plains aquifer system (which includes the Dakota Formation).

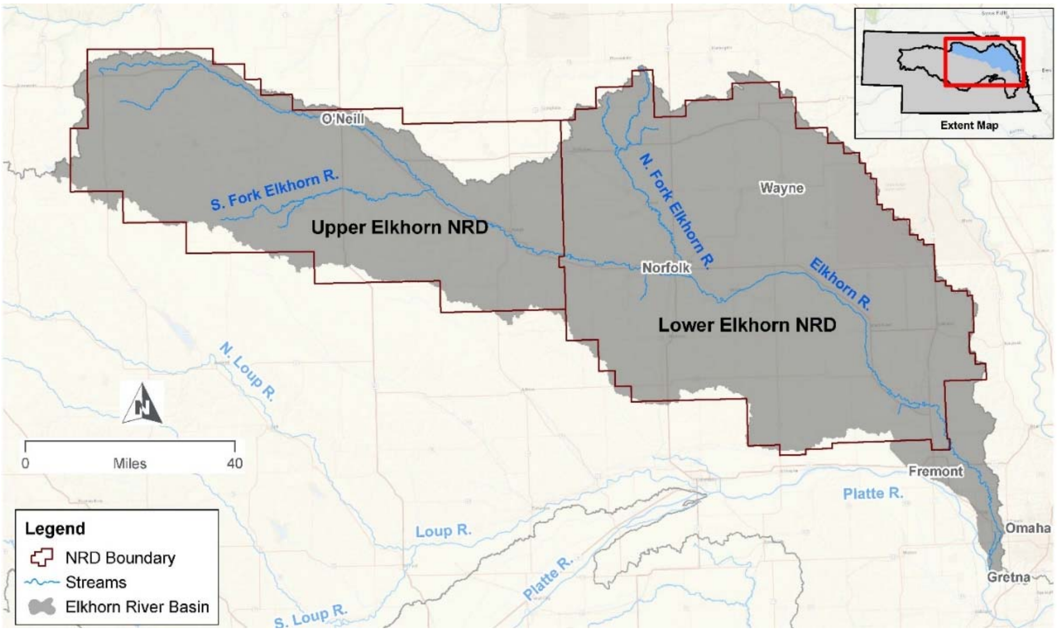
There are approximately 460,500 irrigated acres within the Lower Platte River subbasin. Average annual precipitation varies from 26 inches per year in the westernmost end of the subbasin up to 32 inches per year in the easternmost end of the subbasin. Based on the 25-year average (water year 1988 to 2012), the Lower Platte River subbasin has an average basin water supply of 2.66 million acre-feet per year, an average near-term demand of 2.55 million acre-feet per year, and an average long-term demand of 2.64 million acre-feet per year.

Three reservoirs exist in the subbasin with normal pool surface area greater than one square mile, Branched Oak Lake, Pawnee Lake, and Lake Wanahoo.

2.3 Elkhorn River Subbasin

The Elkhorn River subbasin is located in northeastern Nebraska, and primarily includes the Upper Elkhorn NRD and Lower Elkhorn NRD. Approximately 7,000 square miles comprise the Elkhorn River subbasin (Figure 6).

Figure 6: Elkhorn River Subbasin



At its farthest western extent, the Elkhorn River's headwaters feed into three major tributaries all in Rock County, Nebraska. The Elkhorn River extends to its junction with the Platte River just west of Gretna, Nebraska.

The largest city intersecting the Elkhorn River subbasin is Omaha, with some of its western suburbs located within the subbasin. A portion of Fremont is also within the subbasin. Based on the 2010 U.S. Census, Norfolk, Nebraska (24,000), is the largest city entirely within the subbasin, followed by Wayne, Nebraska (5,700), and O'Neill, Nebraska (3,700).

A majority of the subbasin is underlain by the High Plains aquifer (which includes the Ogallala Group). Pleistocene sand and gravel units overlie the Ogallala Group and comprise the primary aquifer unit in the western half of the Elkhorn River subbasin. The eastern portion of the subbasin is mostly underlain by the Great Plains aquifer system (which includes the Dakota Formation). The High Plains aquifer and alluvial sand and gravel aquifers are generally characterized by large saturated thicknesses, high porosity and yield, and high hydraulic conductivity, capable of supporting high capacity well development. Much of the Dakota aquifers groundwater availability remains unknown; however, there is generally adequate quantity in areas with sandstone dominant formations that are readily recharged by surface water. Glacial loess and till cover much of the eastern third of the subbasin, and where saturated, have much lower porosity and hydraulic conductivity and are not usually suitable as aquifers (Korus et al. 2013).

In the western third of the Elkhorn River subbasin, the land is primarily used as pasture and rangeland; water table lakes and wetlands are common. In the remainder of the subbasin, the primary crop grown is corn, followed by soybeans, with small amounts of alfalfa and open pasture and range lands.

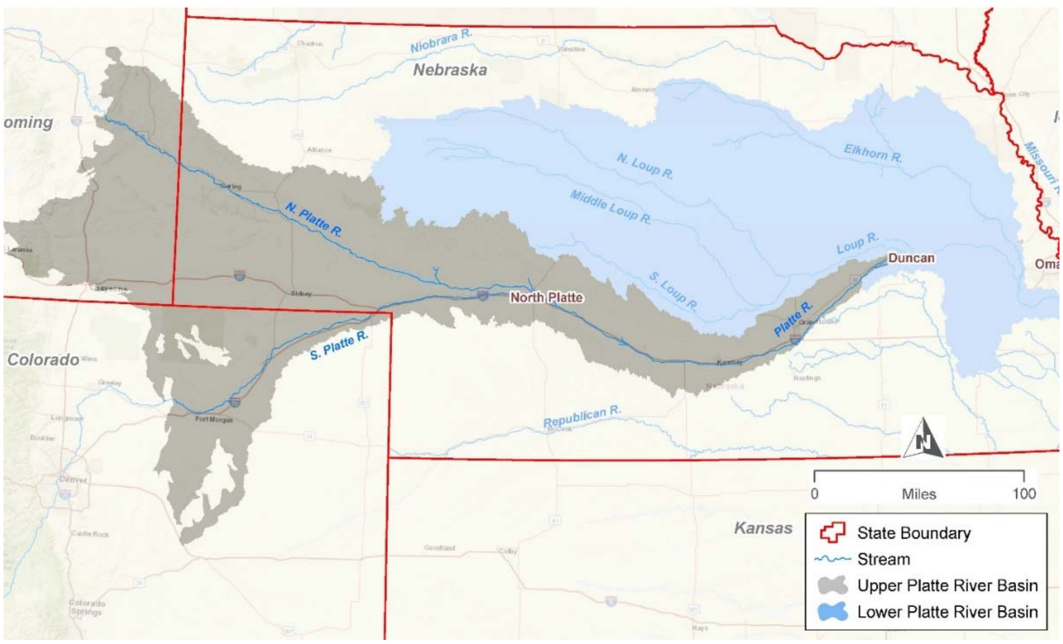
One reservoir exists in the Elkhorn River subbasin with normal pool surface area greater than one square mile; Willow Creek Reservoir on Willow Creek in Pierce County with more than 6,800 acre-feet of normal storage.

Approximately 900,000 irrigated acres exist within the Elkhorn River subbasin. Average annual precipitation varies from 20 inches per year in the westernmost end of the subbasin up to 30 inches per year in the easternmost end of the subbasin. The Elkhorn River subbasin has an average subbasin water supply of 1.39 million acre-feet per year, an average near-term demand of 0.8 million acre-feet per year, and an average long-term demand of 1.0 million acre-feet per year.

2.4 Upper Platte River Basin

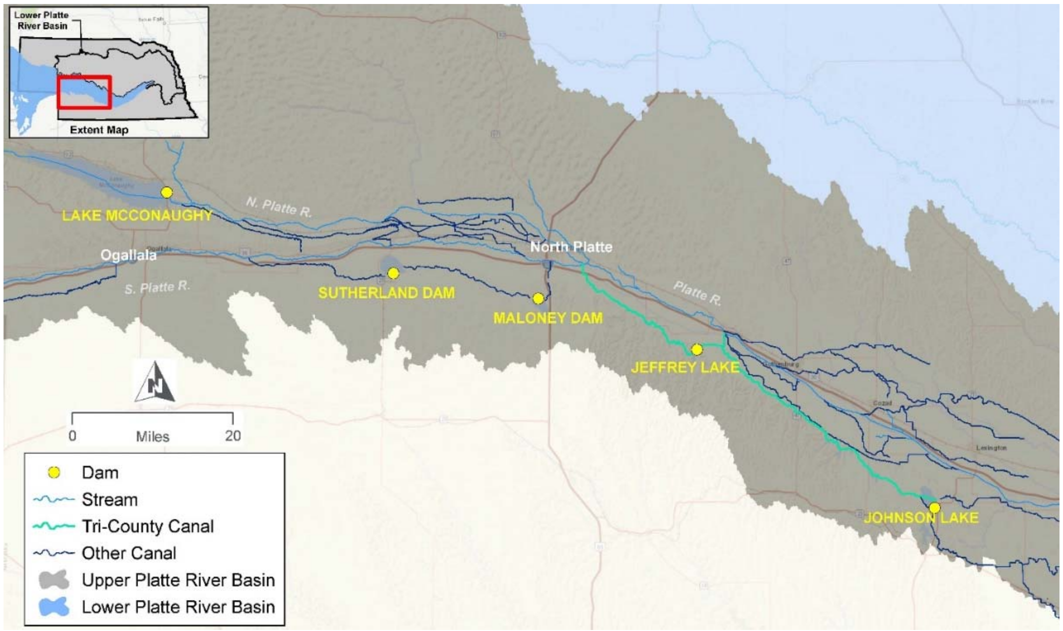
The Upper Platte River Basin is located immediately upstream of the Lower Platte River Basin and is a contributor of streamflow to the Lower Platte River Basin; therefore, it is important to understand the characteristics of the Upper Platte River Basin and its behavior during times of drought. The Upper Platte River Basin includes the North Platte River, South Platte River, and the Platte River from the confluence to Duncan as shown in Figure 7.

Figure 7: Upper Platte River Basin and Lower Platte River Basin



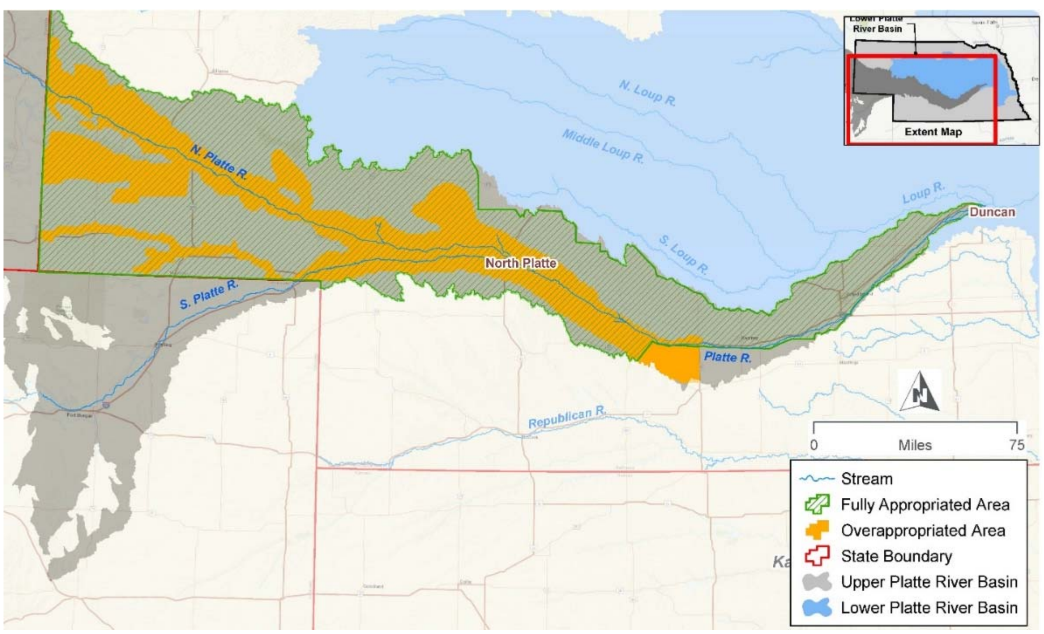
Multiple hydropower demands exist within the Upper Platte River Basin. The Central Nebraska Public Power and Irrigation District (CNPPID) owns and operates multiple hydropower facilities in the Upper Platte River Basin. CNNPID diverts water released from Nebraska's largest reservoir, Lake McConaughy (35,700 acres), into the Tri-County Canal, directs the water through Jeffrey Lake and Johnson Lake (regulating reservoirs), through three hydroelectric plants (Jeffrey, J-1, J-2), and then delivers it to the irrigation system (during the irrigation season) or back to the Platte River (non-irrigation season) (CNPPID n.d.) (Figure 8).

Figure 8: Upper Platte Hydropower and Canal Operation



As defined in LB 962 (and outlined in Section 2.0 of this document), the Upper Platte River Basin above Elm Creek, Nebraska, was declared overappropriated and the area from Columbus to Elm Creek was designated as fully appropriated; meaning, any additional uses would cause water supply to be out of balance with demand (Figure 9). With those designations, the NRDs and NeDNR developed Integrated Management Plans (IMPs) calling for no new uses in the river basin above Columbus that would adversely affect an existing surface water right or groundwater use. New uses are allowed, but any depletion to existing rights and uses must be offset with water.

Figure 9: Upper Platte River Basin Hydrologically Connected and Overappropriated Areas



Source: Map layer provided by Nebraska Department of Natural Resources (Obtained 2016)

Flow in the Upper Platte River originates from snowmelt in the Rocky Mountains of Colorado and Wyoming, as well as from precipitation runoff and baseflow contributions from the underlying aquifer.

Results from a 2007 U.S. Geological Survey (USGS) study pointed to difference in streamflow regimes between the central Platte River system and the Lower Platte River system (Ginting, Zelt, and Linard 2008). Reservoirs upstream and diversions for power generation and irrigation control the majority of flow in the Upper Platte River. Many of the tributary streams upstream of Grand Island, Nebraska, where annual precipitation is less than 25 inches, are intermittent and most flow in those tributaries is from snowmelt and precipitation runoff. Therefore, Platte River flows near Grand Island and Duncan are extremely variable (Huntzinger and Ellis 1993).

A review of the minimum streamflow gage data for the Platte River at Duncan (Table 2) reveals that the Platte River has gone dry at Duncan during historical drought periods, effectively disconnecting the Upper Platte River Basin from the Lower Platte River Basin. During these times of drought, the water supply for the Lower Platte River Basin is dependent on the more reliable groundwater-fed Loup River subbasin (Section 2.1) and Elkhorn River subbasin (Section 2.3).

Table 2: Minimum Daily Discharge in Platte River at Duncan

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2000	2,430	2,400	2,530	1,870	1,050	736	460	209	248	498	502	640
2001	960	1,200	1,820	1,790	734	226	125	156	373	709	399	608
2002	700	840	660	449	514	21	0	0	0	76	120	349
2003	270	520	608	508	554	342	0	0	0	0	0	0
2004	194	627	384	185	37	3	2	0	0	0	0	561
2005	669	925	500	474	346	430	13	0	0	0	211	303
2006	510	375	414	446	26	0	0	0	0	39	240	180
2007	150	500	1,070	1,060	1,070	948	463	656	229	253	559	432
2008	440	583	841	896	906	1,350	662	225	227	257	1,160	266
2009	678	869	821	823	516	521	378	222	172	678	2,140	1,290
2010	1,150	955	1,570	1,280	1,320	2,540	2,130	957	948	1,170	1,330	1,670
2011	832	1,500	3,030	3,940	3,440	7,400	5,630	3,300	4,000	3,350	2,740	2,110
2012	1,720	2,410	1,490	1,270	399	64	0	0	0	14	55	197
2013	229	438	553	582	622	259	1	5	0	1,510	700	716
2014	454	298	749	731	283	293	134	74	575	508	323	1,010

Note: Measurements are in cubic feet per second.

2.4.1 Platte River Recovery Implementation Program

In 1997, the governors of Nebraska, Colorado, and Wyoming and the Secretary of the Interior entered into a Cooperative Agreement to address the needs of four threatened or endangered species[5] using the Platte River system—forming the *Platte River Recovery Implementation Program* (PRRIP). The long-term goal of the PRRIP is to improve and maintain the associated habitats, which includes the following:

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[5] The four threatened or endangered species are the least tern, piping plover, whooping cranes, and pallid sturgeon.

1. Improving and maintaining migration habitat for whooping cranes and reproductive habitat for least terns and piping plovers;
2. Reducing the likelihood of other species found in the area being listed under the Endangered Species Act; and
3. Testing the assumption that managing water flow in the central Platte River also improves the pallid sturgeon's Lower Platte River habitat.

The PRRIP is led by an 11-member governance committee consisting of representatives of Colorado, Wyoming, Nebraska, the Bureau of Reclamation, the U.S. Fish and Wildlife Service, South Platte River water users, North Platte River water users, downstream water users, and environmental groups. The first increment of the PRRIP is for 13 years, from 2007 to 2019.

The PRRIP's objective is to use incentive-based water projects to provide sufficient water to and through the central Platte River habitat area to assist in improving and maintaining habitat for the target species. During the first increment, the PRRIP focus will be on re-timing and improving flows to reduce target flow shortages by an average of 130,000 to 150,000 acre-feet per year. In addition to the improved flow conditions, small pulse flows in the spring are intended to create vegetation-free sand bars suitable for plover and tern nesting (PRRIP 2018).

Flow re-timing will be accomplished in part by releases from the Environmental Account in Lake McConaughy. The Environmental Account is a portion of the water stored in Lake McConaughy that is set aside and managed by the U.S. Fish and Wildlife Service for the benefit of the target species. Other actions will include slightly revised operations of other water systems; general re-timing of Platte River system water projects and other project management actions; and implementation of new water supply and conservation projects in the Upper Platte Basin. Success of the PRRIP relies on implementation of agreed-upon New Depletions Plans in Colorado, Wyoming, and Nebraska and by the federal government in accordance with the PRRIP goal of offsetting new depletions to the Platte River that occurred after July 1997 (PRRIP 2018).[6]

2.5 Surface Water and Groundwater Interaction

Many of the municipal, industrial, and domestic wells in the Lower Platte River draw on this alluvial aquifer. In the Platte River valley and its tributaries, the alluvial aquifers are highly connected to the streams, relying almost exclusively on streamflow for recharge. Drought effects on streamflow have a direct effect on groundwater users relying on the alluvial aquifers, as well as surface water users (Figure 10 and Figure 11).

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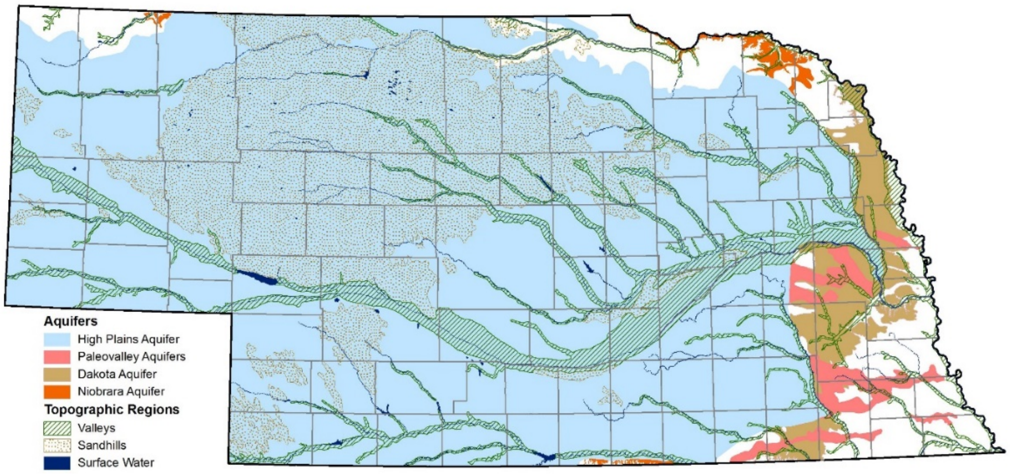
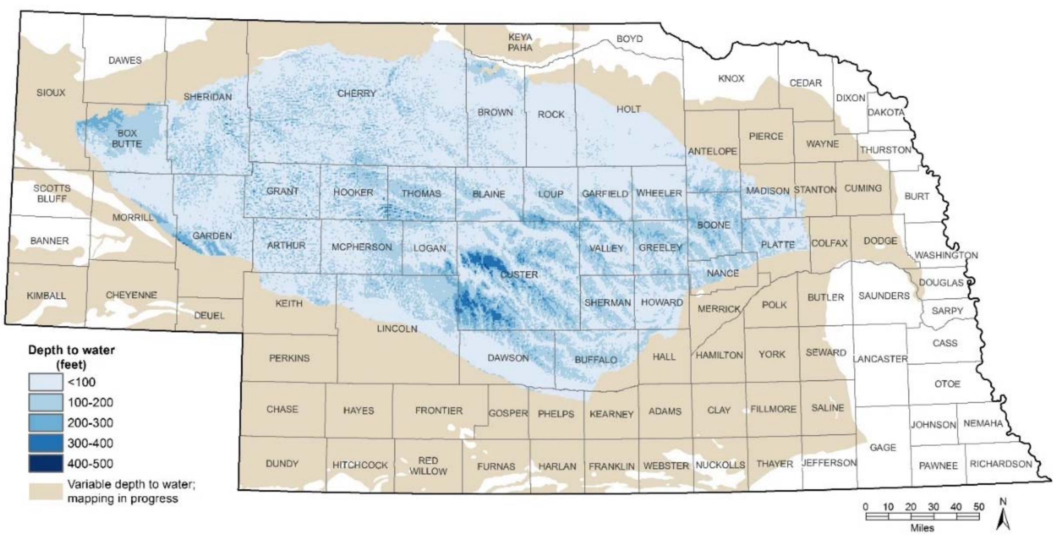
[6] https://www.platteriverprogram.org

Figure 10: Nebraska Topographic Regions and Principal Aquifers



Source: University of Nebraska–Lincoln, Conservation and Survey Division

Figure 11: Depth to Groundwater

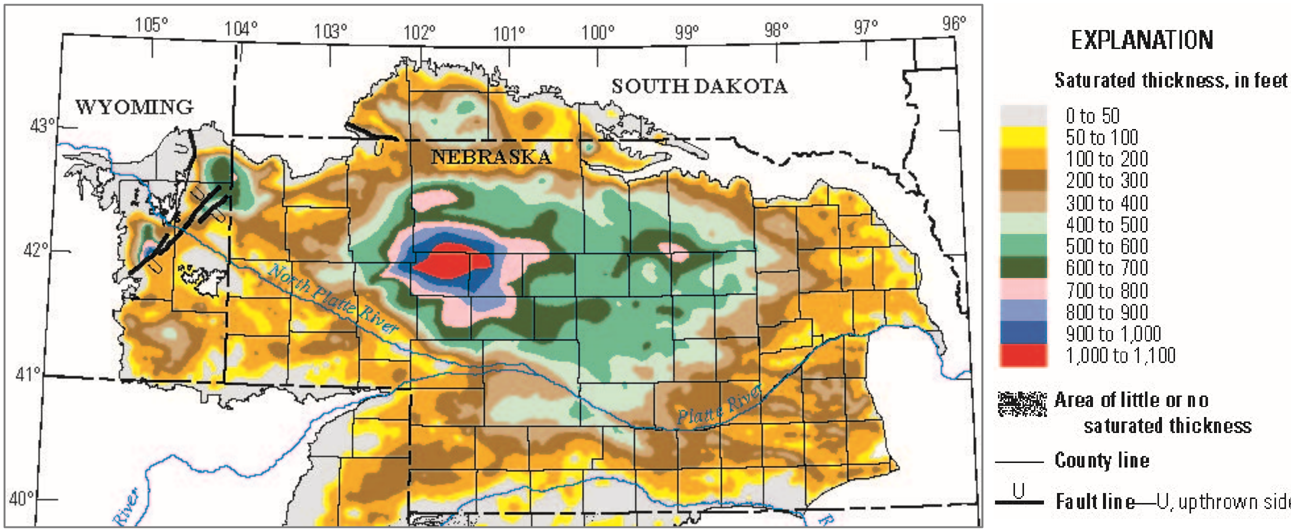


Source: University of Nebraska–Lincoln, Conservation and Survey Division (obtained August 2018)

The Nebraska Sandhills cover portions of the western Elkhorn River subbasin. Streamflow in the western region of the Elkhorn River subbasin stems from a combination of interflow and groundwater. Flows in the downstream reaches of the Elkhorn River, its tributaries, Salt Creek, and some downstream tributaries to the Platte River are affected by large runoff in spring and fall that result from more intense storms on steeper slopes and less permeable soil than occur farther west. Sixty-six percent of the annual flow in the Elkhorn River is derived by the groundwater discharge (USGS 2008).

Tributaries to the Loup River are sustained by shallow groundwater in the Sandhills and have an extremely consistent baseflow. The surficial material of the Sandhills region is very permeable resulting in nearly no overland runoff. The baseflows of the Loup tributaries and runoff in the eastern part of the Loup River watershed combine to produce larger and more consistent flows in the Platte River at North Bend (Figure 12).

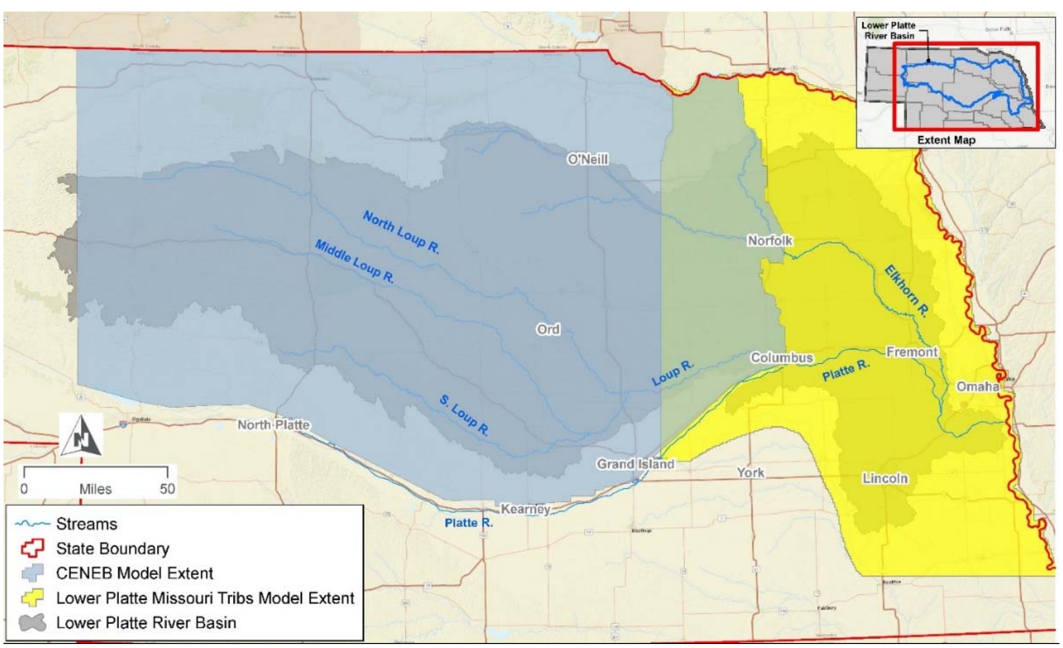
Figure 12: Saturated Thickness of the High Plains Aquifer, 2009



Source: USGS Scientific Investigations Report 2012-5177

Three main groundwater water models are encompassed by the Lower Platte River Basin. These include the Central Nebraska Model (CENEB) and Elkhorn-Loup Model (ELM) models in the western and central portions of the basin and the Lower Platte Missouri Tributaries Model (LPMT), currently under development, covering the eastern portion of the basin. These models analyze the surface and groundwater interaction in the basin (Figure 13). Background on these models is discussed in more detail in Appendix D.

Figure 13: Groundwater Modeling Studies

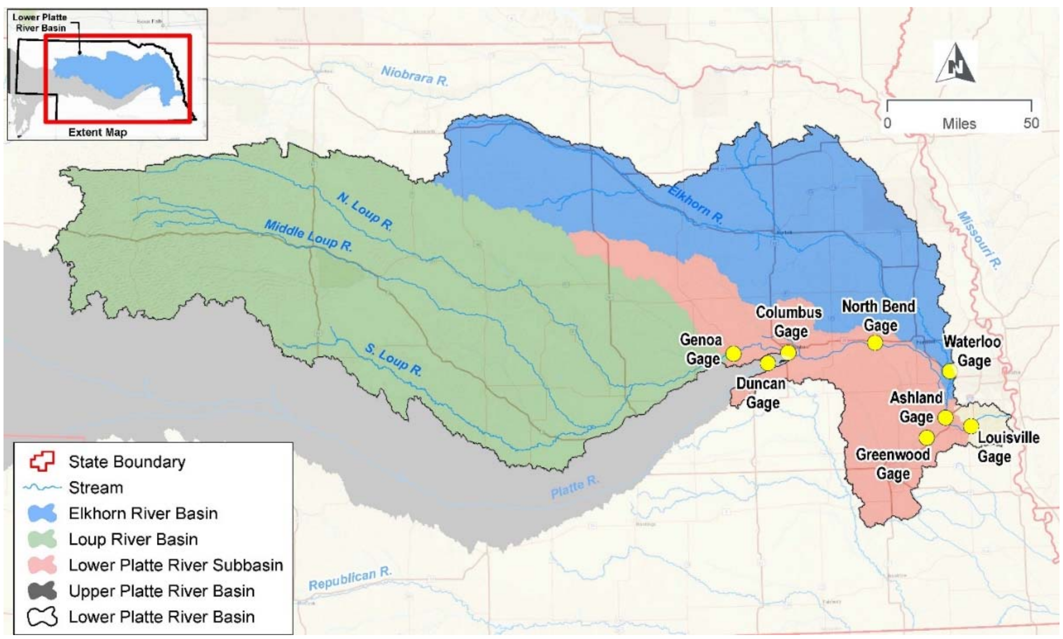


2.6 Water Supply

The Lower Platte River is a key source of water supply for more than 80 percent of Nebraska's population, thousands of businesses and industries, and more than two million irrigated acres. Streamflows of the Lower Platte River also support habitat for threatened and endangered species. Water supplies of the Lower Platte River can be highly variable, with annual flows ranging from 2 million acre-feet per year to more than 10 million acre-feet per year.

For the period 1954 through 2004, the Elkhorn River at Waterloo gage comprised, on average, about 21 percent of the annual mean flows recorded at the Platte River at Louisville gage while the Salt Creek at the Greenwood gage comprised, on average, 5 percent of the annual flow recorded at the Platte River at Louisville gage (Dietsch, Godberson, and Steele 2009). For the same period, about 37 percent of annual mean flows recorded at the Platte River at Louisville gage were measured in the Loup River near Genoa and an average of 26 percent were recorded in the Platte River at the Duncan gage (Figure 14).

Figure 14: USGS Stream Gage Locations

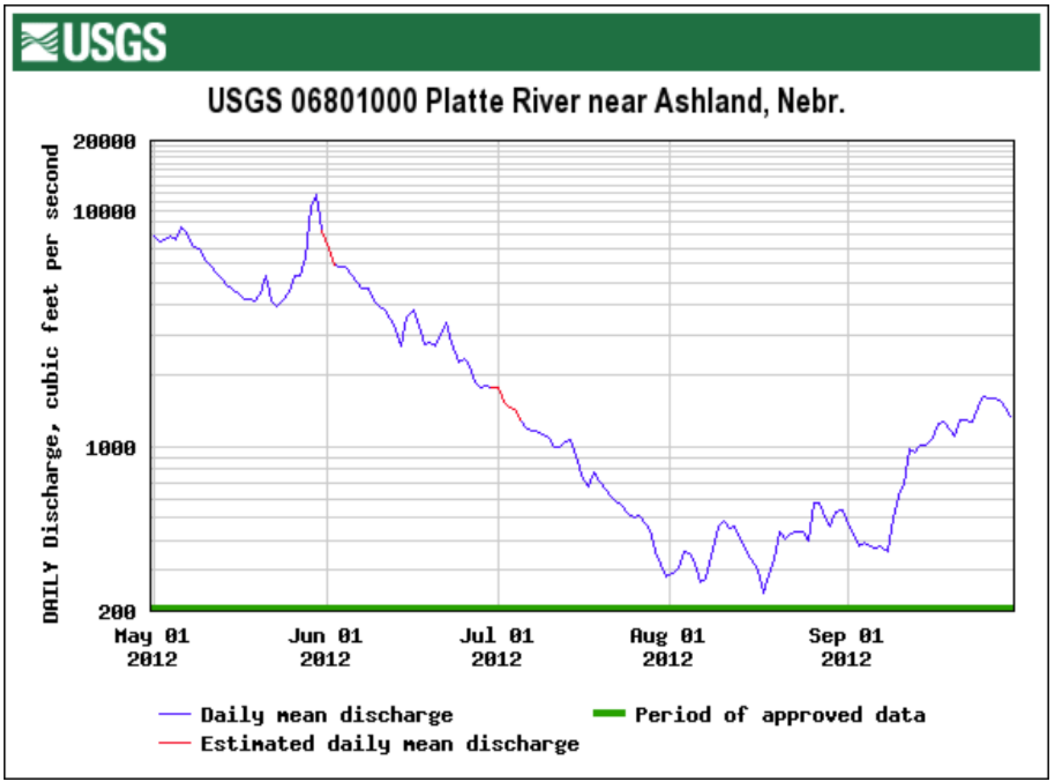


The water supplies of the Loup River subbasin and Elkhorn River subbasin tend to be more reliable because of more significant baseflow contributions. During drought periods, these upstream water supplies are stressed in support of irrigated agricultural production (primarily corn and soybeans). During low-flow years, the Upper Platte River becomes disconnected from the Lower Platte River with observed flows at Duncan, representing a negligible portion of flows observed on the Platte River at Duncan (see Section 2.4 for discussion). During these times, most of the flow in the Lower Platte River originates from the groundwater-fed Loup River, Elkhorn River, and other tributaries downstream from Duncan.

While annual water supplies in the Lower Platte River generally tend to be supportive of most water uses, peak demands in the summer months can create water shortages. These shortages are further exacerbated by drought periods when summer flows become the most critical in supporting water demands.

Figure 15 shows the daily discharge for the Platte River at Ashland during the drought of 2012. These low-flows directly affected the City of Lincoln (discussed further in Section 3.4).

Figure 15: Streamflow data for the Lower Platte River near Ashland



2.7 Water Demand

The water demands and uses in the Lower Platte River are diverse. They include municipal and domestic uses, agriculture, instream flows, and hydropower. The water utilities for the municipalities of Omaha and Lincoln serve the two primary metropolitan areas in Nebraska. Both municipalities hold induced recharge permits (permits that require streamflows adjacent to their well-fields) and municipal groundwater transfer permits (permits where groundwater is transferred from the water well site for use in another location). The Nebraska Game and Parks Commission holds instream flow appropriations for much of the Platte River and specifically in the areas of municipal well-field operations. The Loup Public Power District holds a hydropower appropriation for off-channel hydroelectric power generation. In addition, thousands of individual water rights are held to support irrigation from both surface water and hydrologically connected groundwater sources. Table 3 lists key water rights and water demands in the Lower Platte River Basin.

Table 3: List of key water rights and water demands in the Lower Platte River Basin

Water Right Holder	Appropriation Type	Grant Amount
Metropolitan Utilities District, Omaha – Platte West	Induced Recharge (1993)	1,000 cfs Population: 600,000
Metropolitan Utilities District, Omaha – Platte South	Induced Recharge (1970)	500 cfs Population: 600,000
Lincoln Water System, Lincoln	Induced Recharge (1964)	704 cfs Population: 265,000

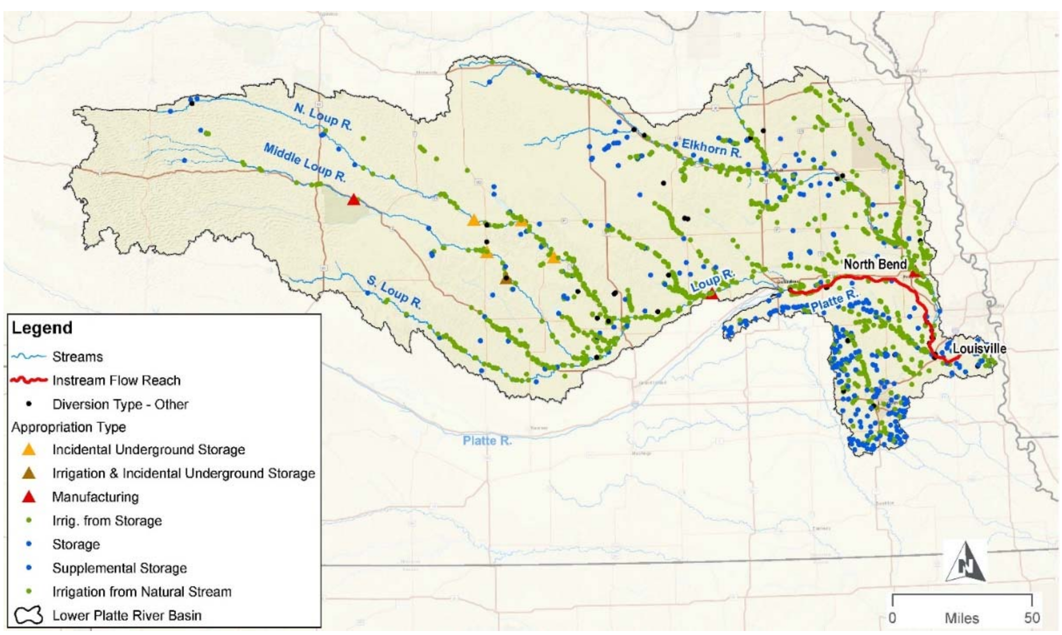
Water Right Holder	Appropriation Type	Grant Amount
Metropolitan Utilities District, Omaha – Platte South	Municipal Transfer	60 MGD
Metropolitan Utilities District, Omaha – Platte West	Municipal Transfer	104 MGD
Lincoln Water System, Lincoln	Municipal Transfer	110 MGD
Nebraska Game and Parks Commission	Instream flow Protection at the Platte River/Missouri River confluence	3,100 – 3,700 cfs
North Loup Division (USBR)	Irrigation	53,000 acres
Sargent/Farwell Irrigation Districts	Irrigation	67,000 acres
Loup Public Power District	Hydropower	3,500 cfs
Total irrigation in the Lower Platte River Basin	Both surface water and groundwater sources	Greater than 2,000,000 acres

Notes: cfs = cubic feet per second; MGD = million gallons per day; USBR = U.S. Bureau of Reclamation.

2.7.1 Surface Water Demands

As of December 31, 2015, there were 2,250 surface water appropriations held in the Lower Platte River Basin. Table 4 summarizes these appropriations by type: irrigation, storage, manufacturing, or other. Most of the surface water appropriations are for irrigation use and tend to be located on the major streams (Figure 16). In addition, two instream flow appropriations are held in the basin. The instream flow appropriations are located on the Platte River and are measured at North Bend and Louisville and are discussed in more detail in Section 2.8 (NeDNR 2017).

Figure 16: Surface Water Point of Diversions



Source: NeDNR Map layer (obtained 2014)

Table 4: Surface Water Appropriations by Number of Diversion Points, Lower Platte River Basin

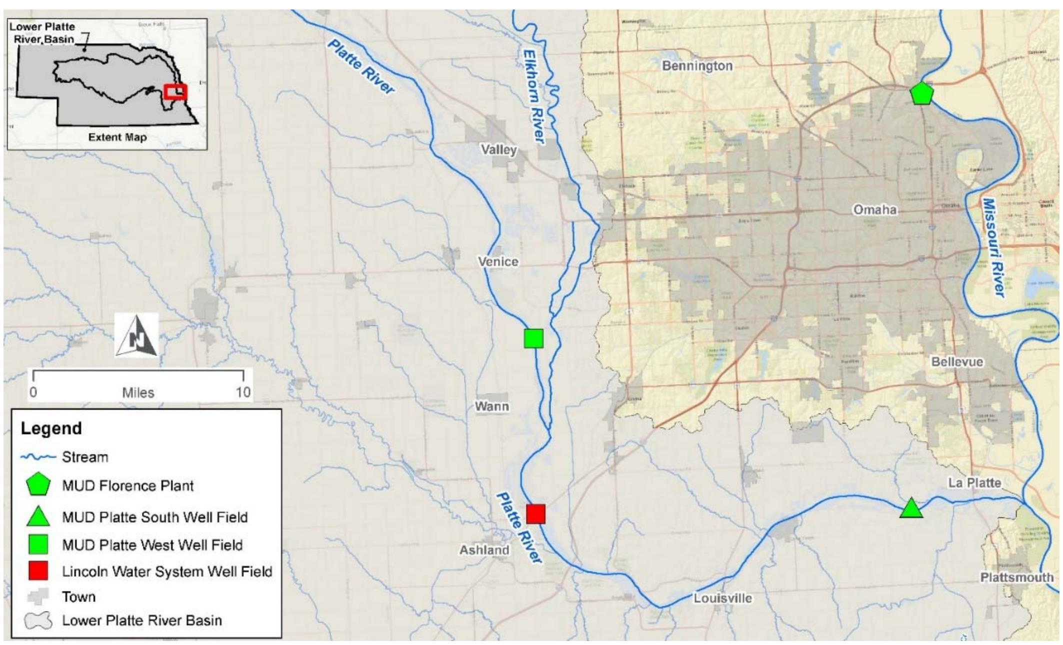
Type	Number of Appropriations
Irrigation from Natural Stream	1,667
Storage	490
Manufacturing	4
Other	89

Source: NeDNR Fully Appropriated Basin Analysis (NeDNR 2017)
Note: 2,250 appropriations as of December 31, 2015.

2.7.2 Induced Groundwater Recharge Permits (Lincoln and Omaha Public Water Utilities)

MUD has three supply locations: 1) Florence Plant in north Omaha that obtains its water from the Missouri River with a capacity of 160 million gallons per day (MGD); 2) Platte West well-field located south of Venice, Nebraska, that obtains its water from the Platte River with a capacity of 100 MGD; and 3) Platte South well-field located near La Platte, Nebraska, that obtains water from the Platte River with a capacity of 60 MGD. Total system output for MUD from all three facilities is 320 MGD. MUD has the ability to use all three of their facilities interchangeably to meet their demand (Figure 17).

Figure 17: Metropolitan Utilities District and Lincoln Water System Municipal Well-field Locations



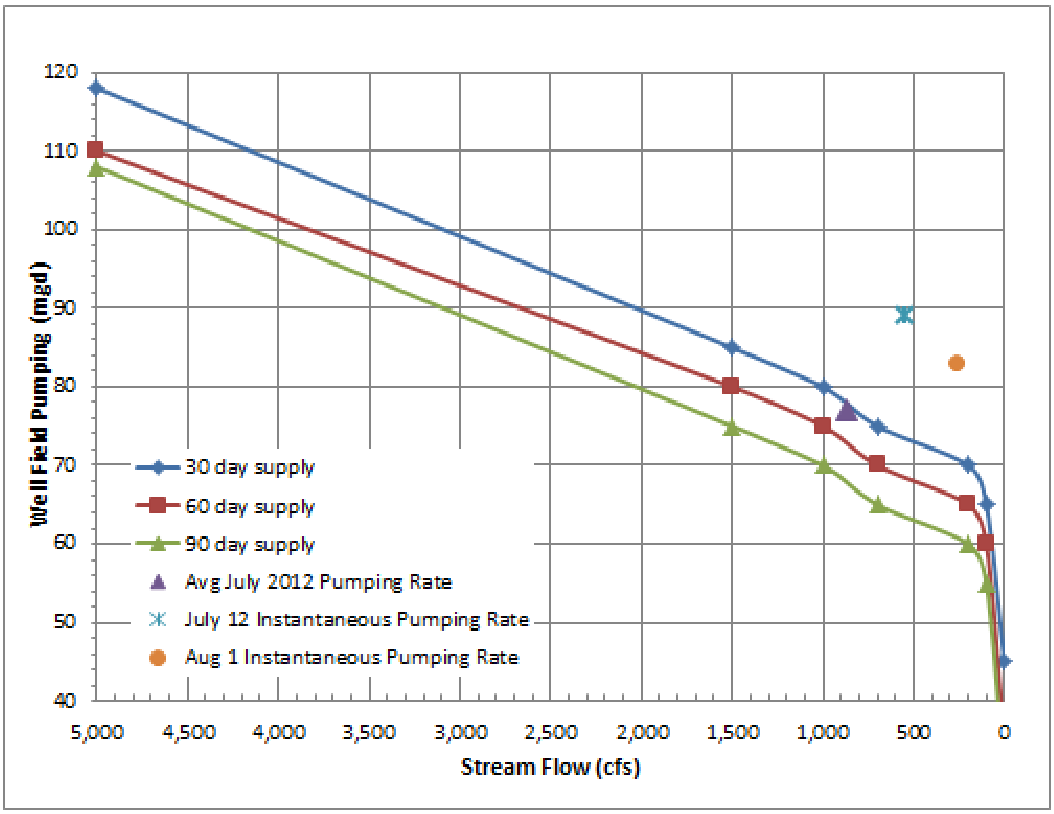
LWS serves the City of Lincoln. Currently, LWS's only source of water is the Platte River. LWS's well-field consists of 40 vertical wells, four (4) existing horizontal collector wells. LWS's well-field has a maximum instantaneous pumping capacity of between 135 MGD and 145 MGD, depending on streamflow conditions. The summer seasonal capacity of the well-field for 50- and 90-day production capacity ranges from 85 to 90 MGD when streamflow in the Platte River at Ashland is less than 1,000 cfs. (City of Lincoln 2018).

LWS maintains two types of water rights permits through NeDNR: an induced recharge permit and groundwater transfer permits. The induced recharge permit allows LWS to induce groundwater recharge from the Platte River for municipal use. LWS maintains two groundwater transfer permits maintained by the City of Lincoln (totaling 110 MGD) (City of Lincoln 2014b)[7].

The *LWS Facilities Master Plan* projected the future water demand using demand projections (City of Lincoln 2014b). The anticipated future seasonal peak water demand is approximately 84 MGD by 2040 and approximately 116 MGD by 2060.

Figure 18 shows that the model-predicted maximum availability of groundwater that can be pumped from the well-field varies based on streamflow and decreases with increased pumping duration. These model predictions were developed using LWS's well-field configuration as of 2003 and do not include the third horizontal collector well (City of Lincoln 2014b).

Figure 18: Model-Predicted Well-field Capacity and 2012 Pumping Conditions



Source: LWS Facilities Master Plan (City of Lincoln 2014b)

There is a nearly linear relationship between the well-field yield and change in streamflow over a large range of streamflow values. When streamflow is below 200 cfs, the relationship between streamflow and well-field yield changes dramatically, which indicates that, based on the model results, 200 cfs is a critical streamflow value for Lincoln's well-field. At this streamflow condition, it appears that the source of water to the well-field changes from predominantly induced recharge of the Platte River to predominantly

[7] The groundwater transfer permits are optional permits. There is no limitation to only pump within the terms of these permits. The maximum daily withdrawal under permit A-10367 is 60 MGD and under permit A-16917 is 50 MGD. If LWS pumps more groundwater than the permitted amount, the portion that exceeds their permitted amounts is simply being withdrawn without a specific permit tied to that portion of pumping.

groundwater in aquifer storage. A daily streamflow of 200 cfs has never been observed at the Ashland gage. The lowest daily streamflow observed at the Ashland gage is 237 cfs, and the lowest monthly average streamflow observed at this gage is 368 cfs. Both of these record low streamflow values were observed in August 2012 (City of Lincoln 2014b).

It should be noted that the wellfield capacity is dependent on duration of pumping as well as the location of the river channel during low flow conditions.

2.7.3 Groundwater Demands

Groundwater in the Lower Platte River Basin is used for a variety of purposes: domestic, industrial, livestock, irrigation, and other uses (Table 5). As of December 31, 2015, 49,092 groundwater wells had been registered within the basin (NeDNR 2016). Nebraska leads the nation in irrigated acres accounting for one acre of every six acres of irrigated land in the U.S. in 2007 (UNL 2009).

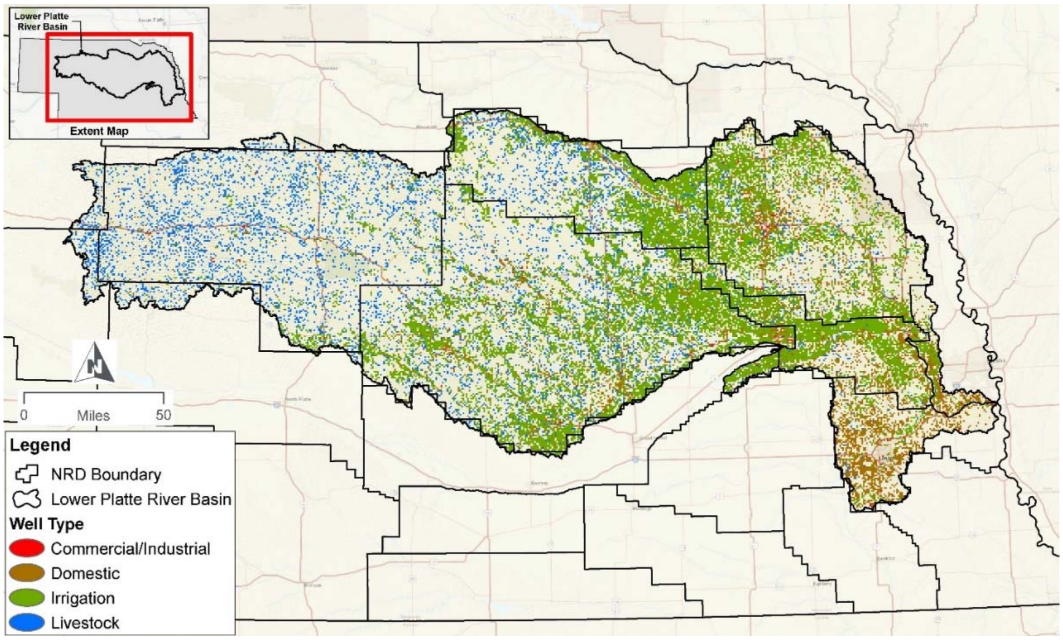
Table 5: Current Groundwater Well Development by Number of Registered Groundwater Wells, Lower Platte River Basin

Type	Percentage of Wells
Irrigation	51.2
Domestic	26.9
Livestock	17.4
Commercial/Industrial	10.9
Public Water Supplies	2.1
Other	1.5

Source: NeDNR Fully Appropriated Basin Report (NeDNR 2017)
Note: 49,092 wells as of December 31, 2015.

Figure 19 shows the distribution of groundwater wells in the Lower Platte River basin by type. The Sandhills of the Upper Loup subbasin are dominated by livestock wells.

Figure 19: Distribution of Groundwater Wells in Lower Platte River Basin



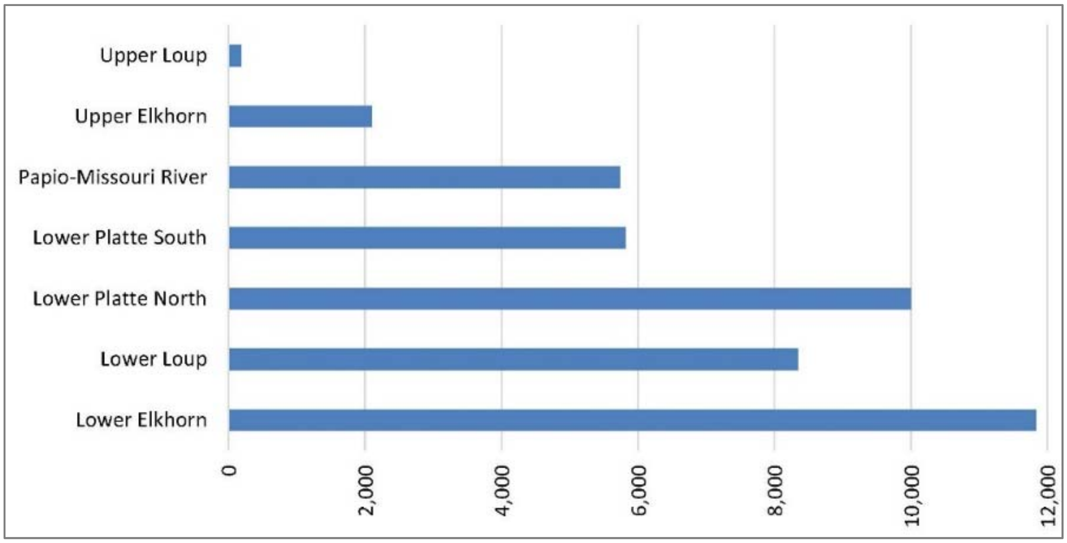
Source: NeDNR Map layer (obtained February 2018)

The majority of the commercial and industrial wells are located in the larger population centers, as expected. There are noticeably less irrigation wells located in the eastern portion of the Lower Platte River Basin where the irrigation is primarily located in the hydrologically connected areas.

2.7.3.1 Municipal Groundwater Demands

The Flatwater Group (TFG), under contract with the NeDNR, estimated 2012 municipal water use for Nebraska. The estimated pumping for municipal (with the exception of MUD and LWS), governmental, and educational wells was developed using monthly per capita pumping estimates and 2012 population estimates. A summary of LWS and MUD demand was previously discussed in Section 2.7.2. Outside of MUD and LWS, the top five public water suppliers are the cities of Fremont, Papillion, Columbus, Norfolk, and Schuyler. Those areas not served by public water providers are assumed served by domestic groundwater wells. Figure 20 shows the estimated municipal groundwater demand by NRD (excluding MUD and Lincoln well-fields). Outside of Omaha and Lincoln, the largest municipal groundwater demand is located in the Lower Elkhorn NRD followed by the Lower Platte North NRD, Lower Loup NRD, Lower Platte South NRD, Papio-Missouri River NRD, and Upper Loup NRD, respectively.

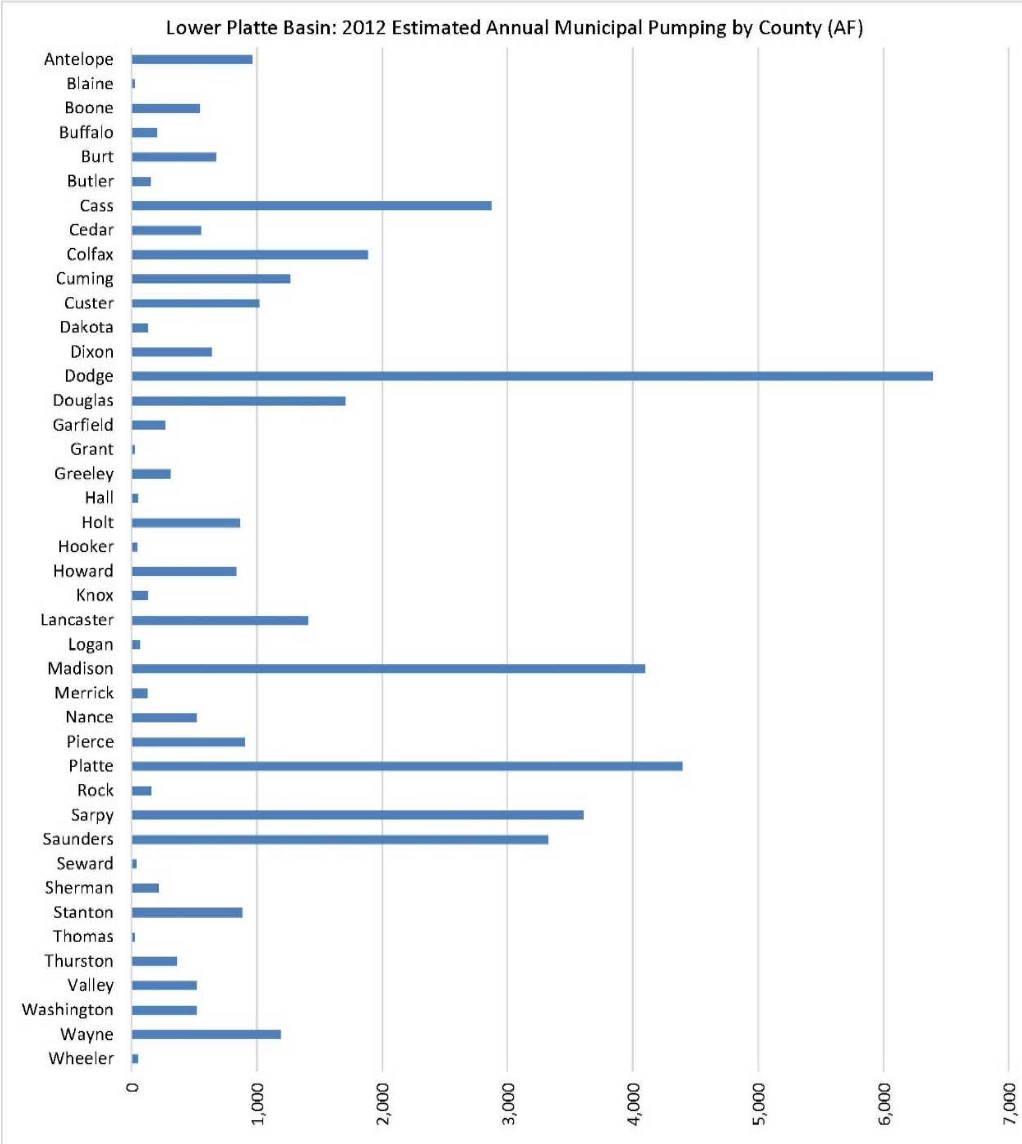
Figure 20: 2012 Estimated Municipal Groundwater Demands by Natural Resources District



Source: Municipal and Industrial Pumping, TFG, January 2014.
Notes: Measurements are in acre-feet. This figure only reflects groundwater demands. This figure does not reflect the demand of the Lincoln or MUD well-fields.

Figure 21 shows the same information aggregated by county. It should be noted that the demands are accounted for at the point of extraction, which does not necessarily correspond to the point of use. This figure does not reflect the demands of the Lincoln or MUD well-fields.

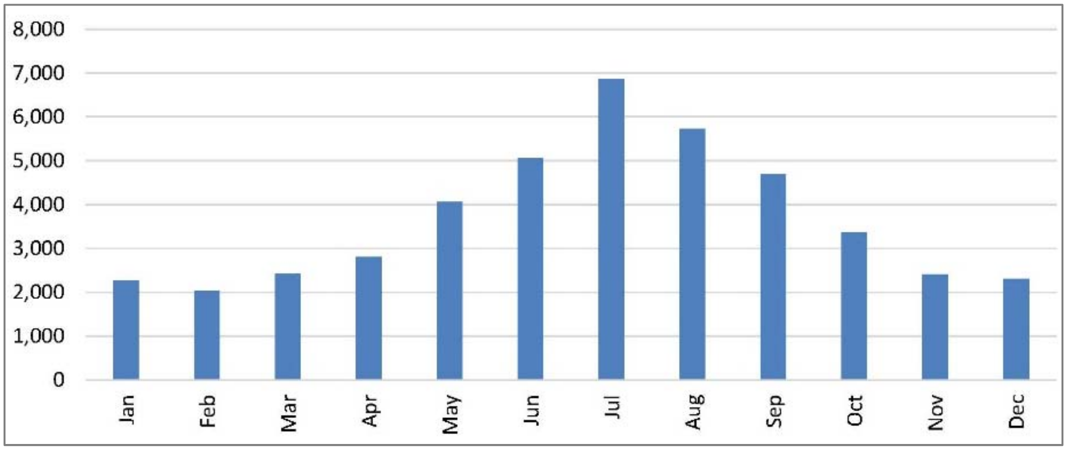
Figure 21: 2012 Estimated Municipal Groundwater Demands by County (Not including Lincoln or MUD well-fields)



Source: Municipal and Industrial Pumping, TFG, January 2014.
Notes: Measurements are in acre-feet. This figure only reflects groundwater demands. This figure does not reflect the demands of the Lincoln or MUD well-fields. The Dodge County demand corresponds to the demand for Fremont.

Figure 22 shows the estimated municipal demands as they occur over a calendar year. As expected, the largest demands occur in the summer months when the temperatures are highest and the demand increases for air-conditioning and lawn watering.

Figure 22: 2012 Estimated Municipal Groundwater Demands by Month

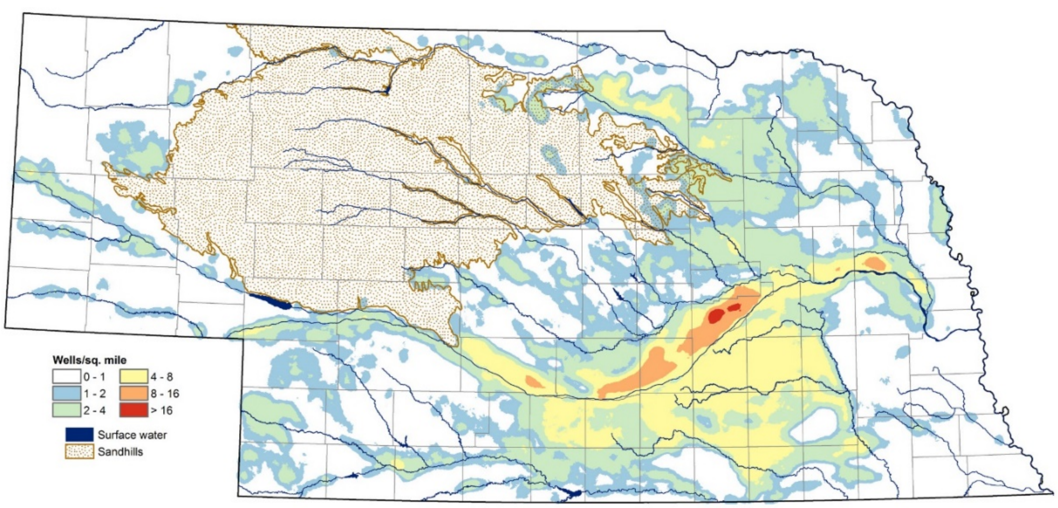


Source: Municipal and Industrial Pumping, TFG, January 2014.
Notes: Measurements are in acre-feet. This figure only reflects groundwater demands. This figure does not reflect the demands of the Lincoln or MUD well-fields.

2.7.3.2 Irrigation Groundwater Demands

Figure 23 displays the density of only the irrigation wells (the largest category of groundwater wells).

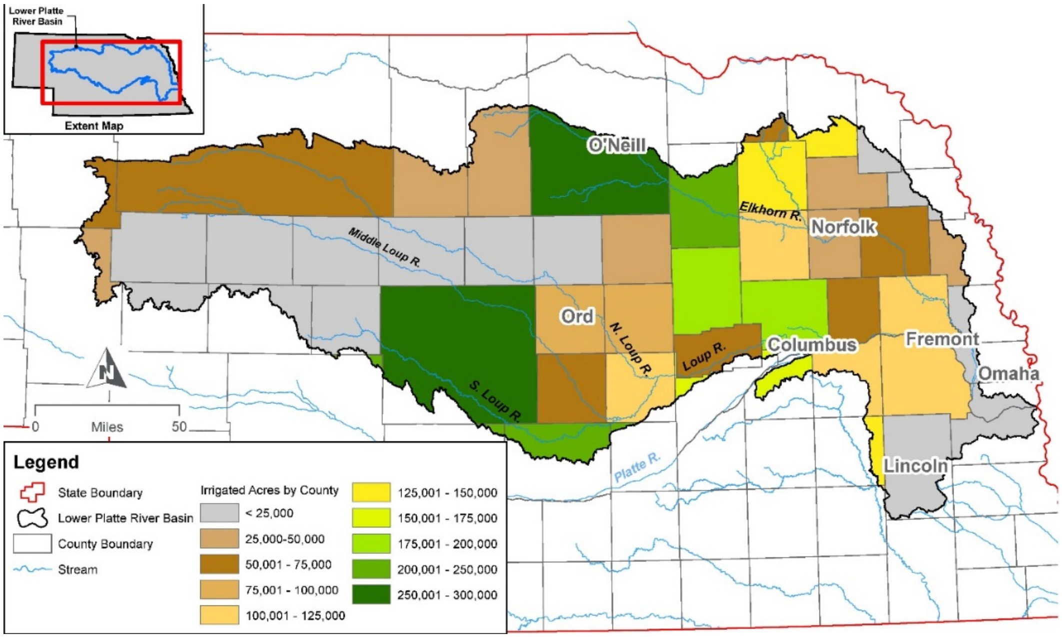
Figure 23: Density of Active Irrigation Groundwater Wells



Source: Nebraska Statewide Groundwater-Level Monitoring Report (University of Nebraska–Lincoln Conservation and Survey Division 2017)

Figure 24 shows irrigated acres by county. It can be seen that there is little to no irrigation in the northwestern portion of the Lower Platte River Basin, which is predominately Sandhills. The bulk of the irrigated acres occurs in the central portions of the Lower Platte River Basin.

Figure 24: Number of Irrigated Acres by County



Source: 2012 Census of Agriculture, U.S. Department of Agriculture, National Agricultural Statistics Service

Table 6: Number of irrigated acres by NRD

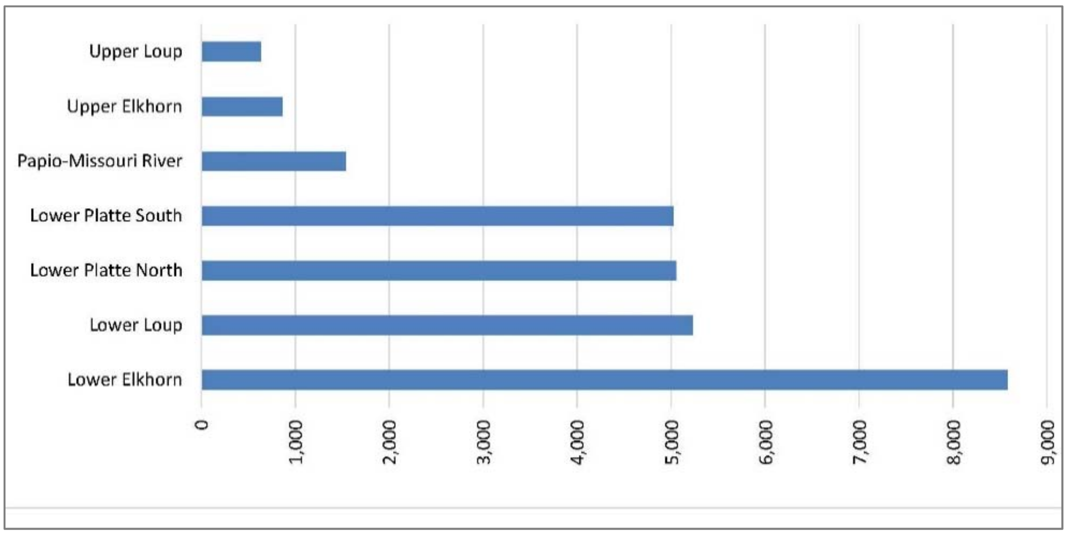
NRD	Number of Irrigated Acres				
	Total	Groundwater	Surface Water	Comingled	Wastewater
Upper Loup	82,858	82,858	0	0	--
Lower Loup	1,222,485	1,019,096	155,181	48,209	--
Upper Elkhorn	465,317	465,317	0	0	--
Lower Elkhorn	671,633	626,183	15,807	0	29,643
Lower Platte North	373,433	364,456	4,195	4,782	--
Lower Platte South	3,267[1]	3,267[1]	0	0	--
Papio-Missouri River	Estimated 25,000[2]	--	--	--	--

[1]LPSNRD acres listed are irrigated acres hydrologically connected to the Platte River. There are approximately 20,000 groundwater irrigated acres total within the lower Platte River basin in the LPSNRD.
[2]P-MRNRD has not yet completed certifying irrigated acres.
Source: Basin Plan (2017 Annual Reports)

2.7.3.3 Industrial Groundwater Demands

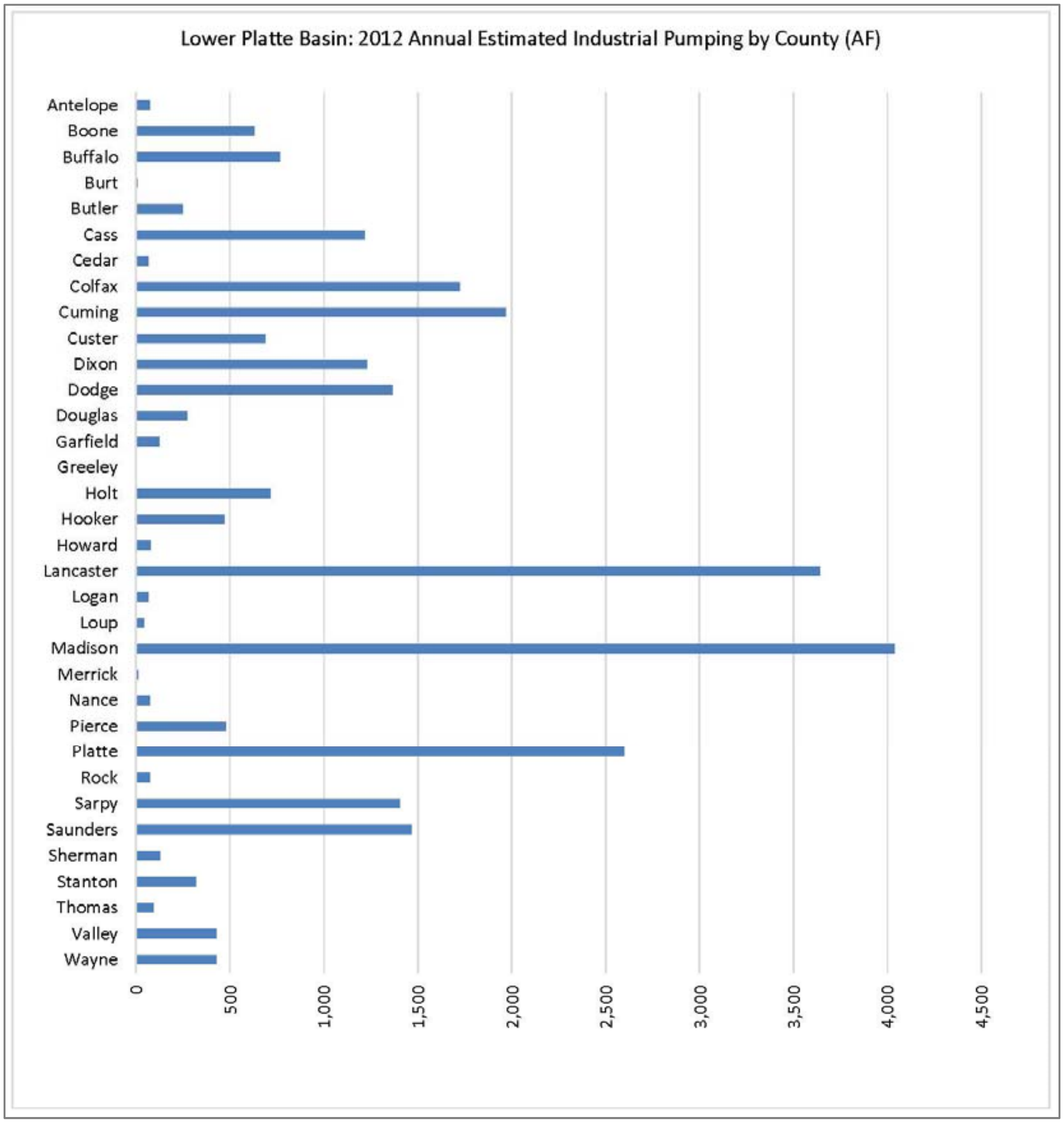
TFG, under contract with NeDNR, estimated self-supplied industrial groundwater use for Nebraska for 2012 using historical and industrial surveys provided by NeDNR. This study does not include industrial uses served by public water supply. The survey results provided water use information for 50 different industrial sites. TFG categorized these industrial sites into 12 industrial classes based on similar types of water use (average annual volume of water usage and the average monthly pumping distribution). Figure 25 shows the estimated industrial groundwater demands for industries served by self-supplied groundwater by NRD. The largest collective industrial use occurs in the Lower Elkhorn NRD followed by the Lower Loup NRD, Lower Platte North NRD, Lower Platte South NRD, Upper Elkhorn NRD, and Upper Loup NRD, respectively. Figure 26 displays the same information for industrial uses aggregated by county.

Figure 25: 2012 Estimated Industrial Groundwater Demands by NRD



Source: Municipal and Industrial Pumping, TFG, January 2014.
Note: Measurements are in acre-feet.

Figure 26: 2012 Estimated Industrial Groundwater Demands by County



Source: Municipal and Industrial Pumping, TFG, January 2014.
Note: Measurements are in acre-feet.

Figure 27 shows the estimated annual distribution of industrial demands. The demand peaks during the summer months but remains relatively stable throughout the year.

Figure 27: 2012 Estimated Industrial Groundwater Demands by Month

Source: Municipal and Industrial Pumping, TFG, January 2014.
Note: Measurements are in acre-feet.

2.8 Non-consumptive use demands

Non-consumptive use demands are demands on the water supply that are available to meet other demands. Examples of non-consumptive use demands are hydropower demands and induced groundwater recharge demands.

The Nebraska Game and Parks Commission holds instream flow appropriations for the protection of fish and wildlife. The instream flow rights have a priority date of November 30, 1993[8]. The instream flow appropriations are measured at the North Bend gage and the Louisville gage, although the appropriations extend to the confluence with the Missouri River. Figure 28 lists the instream flow appropriations by location. Section 5.4.4 discusses in more detail the administration of these instream flow appropriations by the NeDNR.

[8] The instream flow appropriation has a priority date of 11/30/1993; however, it was not approved until 6/26/1998. The NeDNR has placed a priority call on the Lower Platte River for the instream flow right a total of 23 times between 1999 and 2018. See Section 5.4.4.5 for discussion of surface water administration in Nebraska.

Figure 28: Total Platte River instream flow appropriations

Total Platte River Instream Flow Needs
For Purposes of Water Administration
All Quantities in CFS

Central Platte figures in blue (Priority date of 7-25-1990)
Game & Parks figures in red (Priority date of 11-30-1993)
Totals in black

TIME PERIOD	OVERTON GAGE	ODESSA GAGE	GRAND ISLAND GAGE	DUNCAN GAGE	NORTH BEND GAGE	LOUISVILLE GAGE
January	500	500	500	500	1,800	3,100
February	500	500	500	500	1,800	3,700
March	1,100	1,100	1,100	500	1,800	3,700
April 1-14	1,300	1,350 (1,300 + 50)	1,350 (1,300 + 50)	500	1,800	3,700
April 15-30	1,500	1,500	1,500	500	1,800	3,700
May 1-3	1,500	1,500	1,500	500	1,800	3,700
May 4-10	500	1,350 (includes 500)	1,350 (includes 500)	500	1,800	3,700
May 11-31	500	500	500	500	1,800	3,700
June 1-23	500	1,000 (500 + 500)	1,000 (500 + 500)	1,000 (500 + 500)	1,800	3,700
June 24-30	600	1,000 (600 + 400)	1,000 (600 + 400)	1,000 (600 + 400)	1,800	3,700
July 1-31	600	1,000 (600 + 400)	1,000 (600 + 400)	1,000 (600 + 400)	1,800	3,700
August 1-22	600	800 (600 + 200)	800 (600 + 200)	900 (600 + 300)	1,800	3,500
August 23-31	500	800 (500 + 300)	800 (500 + 300)	900 (500 + 400)	1,800	3,500
September	500	500	500	500	1,800	3,200
October 1-11	1,100	1,350 (includes 1,100)	1,350 (includes 1,100)	500	1,800	3,700
October 12-31	1,500	1,500	1,500	500	1,800	3,700
November 1-10	1,500	1,500	1,500	500	1,800	3,700
November 11-30	500	500	500	500	1,800	3,700
December	500	500	500	500	1,800	3,700

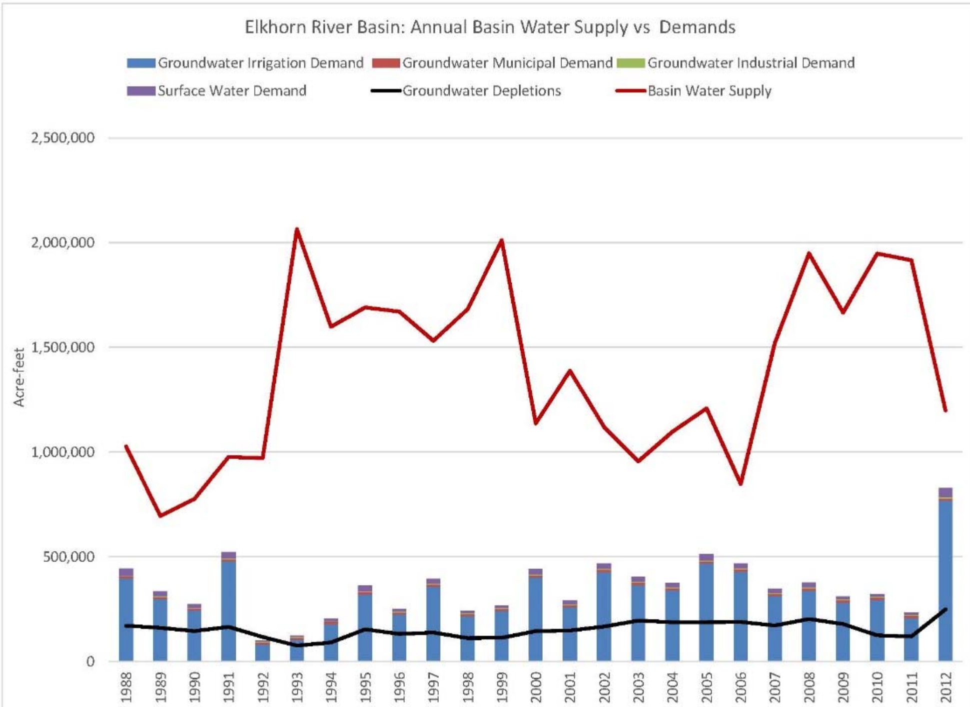
Source: NeDNR

2.9 Supplies versus Demands

As previously mentioned, the Basin Plan quantified basin supplies and basin demands. Section 2.6 described the sources of water supply in the Basin while Sections 2.7 and 2.8 discussed each demand component in detail. This section evaluates the comparison of basin supplies versus demands, in addition to observed daily flows versus existing appropriations..

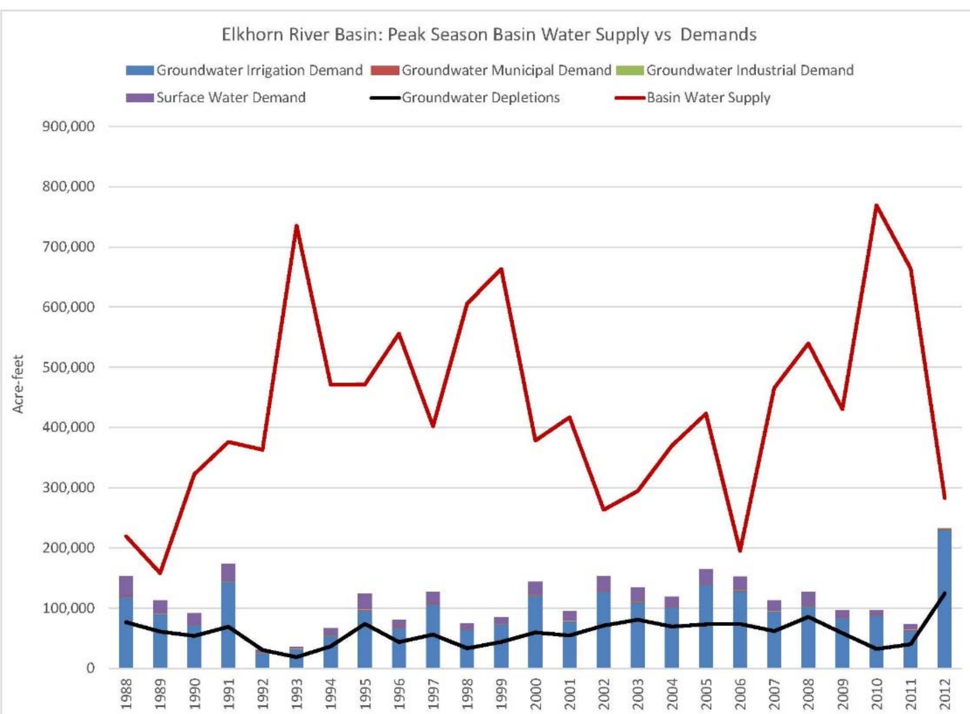
Figure 29 through Figure 34 illustrate the basin supply and demand comparisons used in developing the Basin Plan. For this effort, the basin water supply is inclusive of the historic surface water diversions and groundwater depletions to recreate the water supply in the absence of human depletions. This is then compared to full permitted demand (which may be greater than what was historically consumed). In general, basin water supplies are have been historically adequate to meet subbasin demand on a seasonal basis.

Figure 29: Estimated annual supply vs. demands in the Elkhorn River Basin (1988-2012)



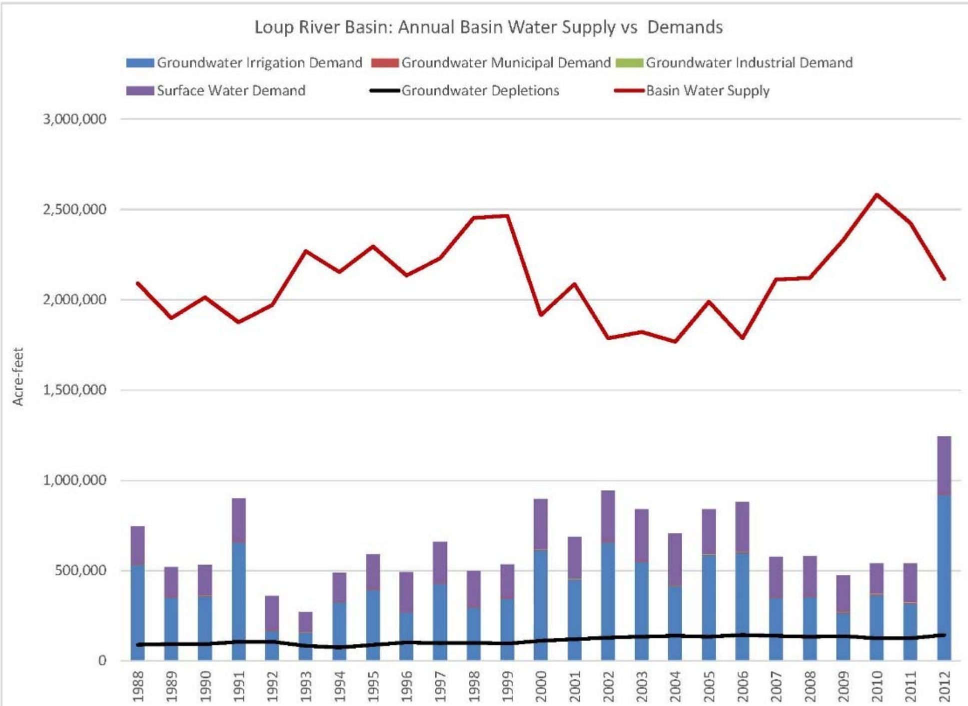
Source: Basin Plan accounting

Figure 30: Estimated peak season supply vs. demands in the Elkhorn River Basin (1988-2012)



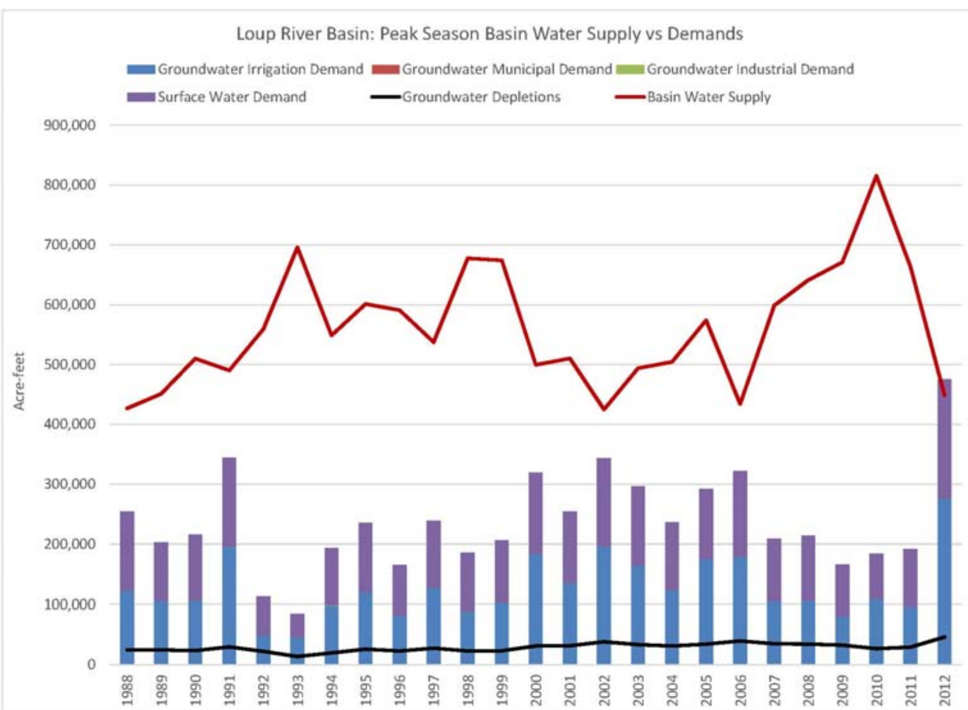
Note: Peak Season corresponds to June 1 through August 31.
Source: Basin Plan accounting

Figure 31: Estimated annual supply vs. demands in the Loup River Basin (1988-2012)



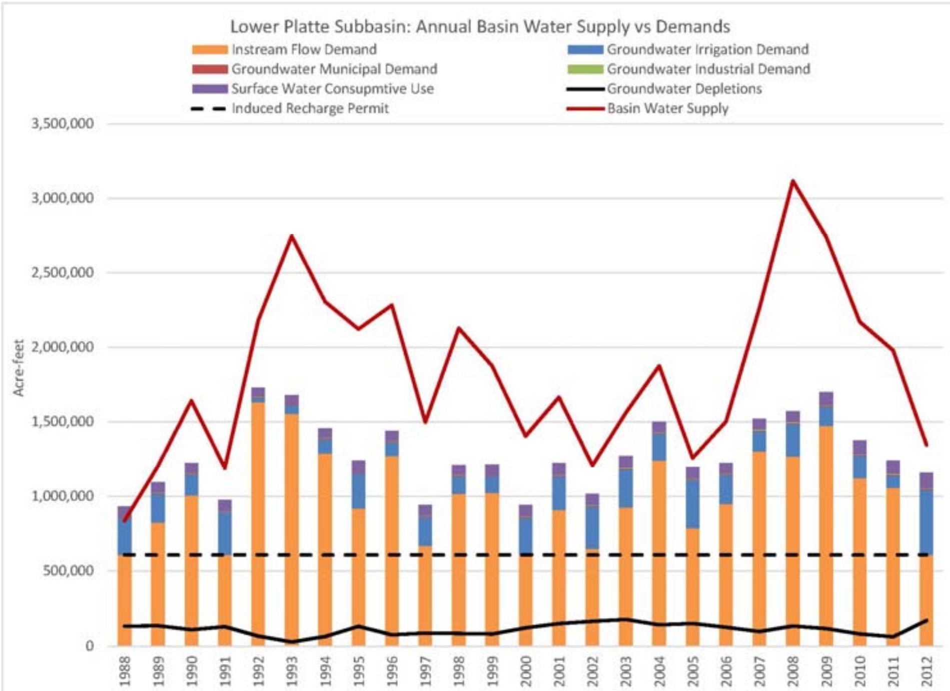
Source: Basin Plan accounting

Figure 32: Estimated peak season supply vs. demands in the Loup River Basin (1988-2012)



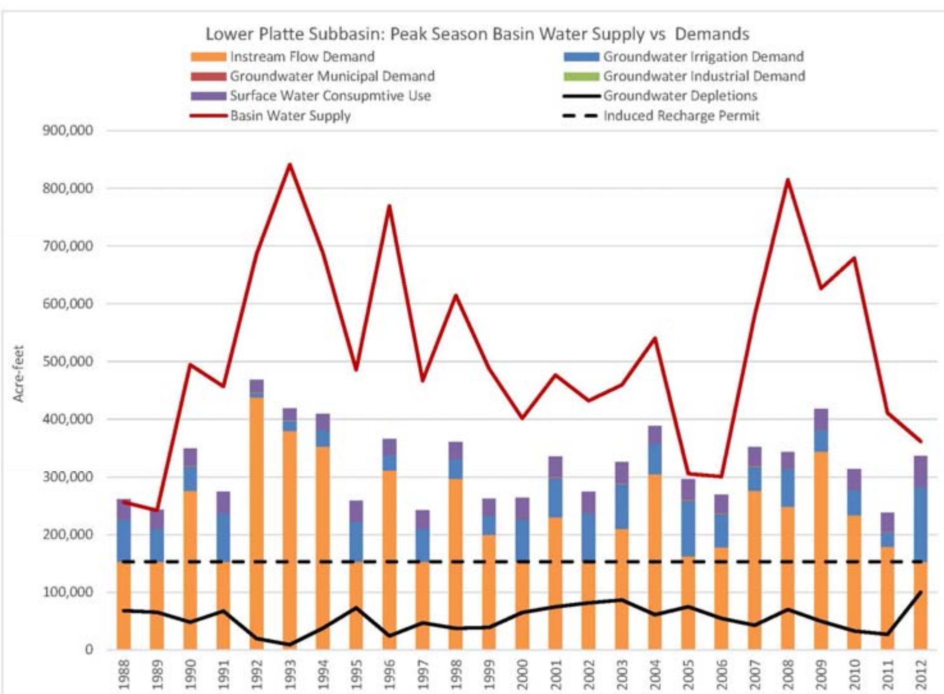
Note: Peak Season corresponds to June 1 through August 31.
Source: Basin Plan accounting

Figure 33: Estimated annual supply vs. demands in the Lower Platte River subbasin (1988-2012)



Source: Basin Plan accounting

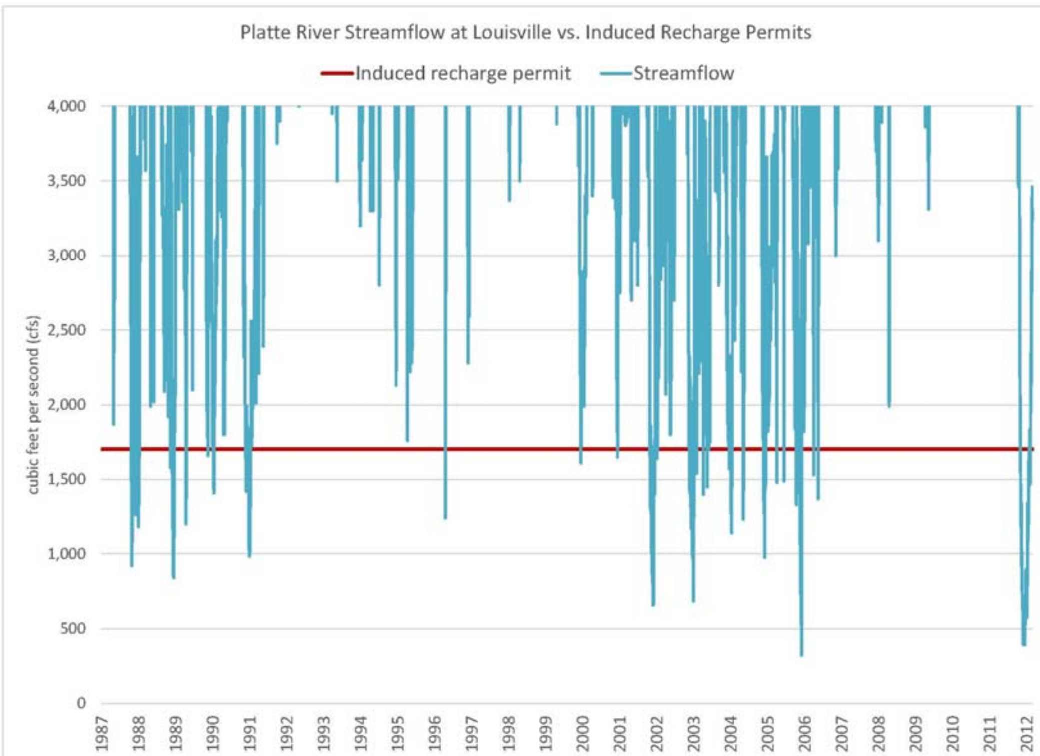
Figure 34: Estimated peak season supply vs. demands in the Lower Platte River Subbasin (1988-2012)



Note: Peak Season corresponds to June 1 through August 31.
Source: Basin Plan accounting

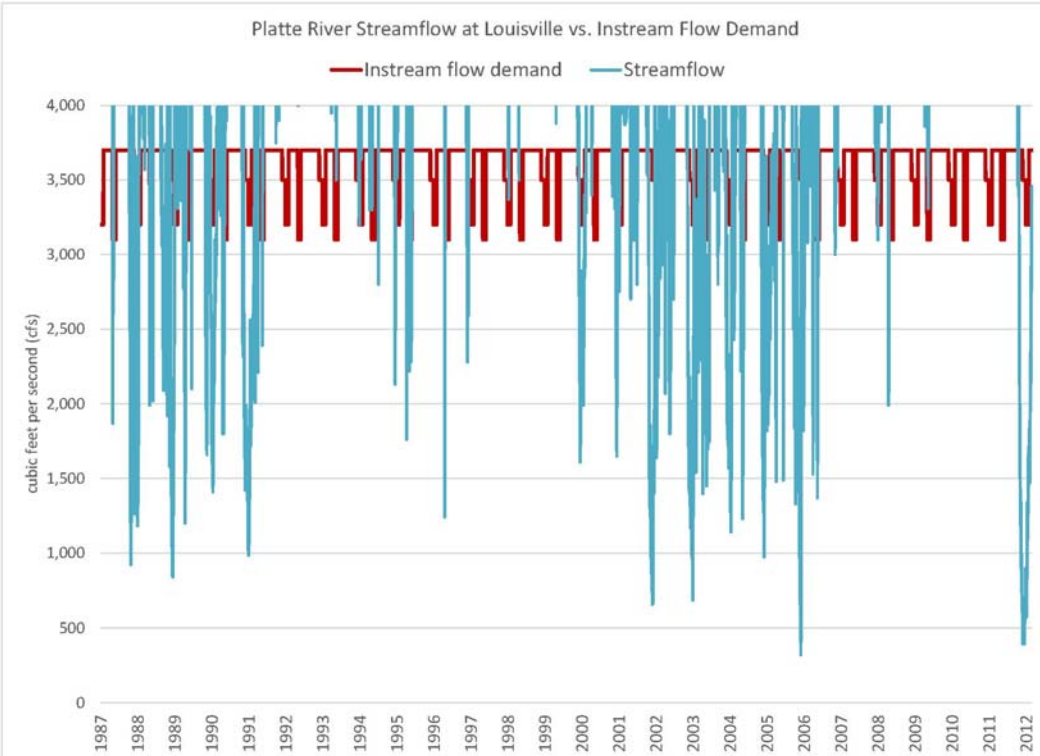
Figure 29 through Figure 34 considered basin water supplies versus demands on a seasonal basis. These plots reveal that, in general, basin supplies are adequate to meet basin demands on a seasonal basis. However, this generalization does not always hold when considering observed flows versus appropriations on a daily basis. Figure 35 and Figure 36 compare observed Platte River streamflow at Louisville against the induced groundwater recharge appropriation (1,704 cfs/day for MUD Platte West and LWS well fields) and the daily instream flow appropriation. Comparing streamflow versus appropriations on a daily basis reveals that at times the streamflow in the Lower Platte River has not been adequate to meet these appropriations.

Figure 35: Platte River Streamflow at Louisville versus MUD and LWS induced groundwater recharge permits (1988-2012)



Note: MUD Platte West well field has an induced recharge permit of 1,000 cfs/day. LWS well field has an induced recharge permit of 704 cfs/day.
Source: Louisville daily stream flow was obtained from USGS.

Figure 36: Platte River streamflow at Louisville versus daily instream flow demand (1988-2012)



Source: Louisville daily stream flow was obtained from USGS.

2.10 Consideration of Future Demands

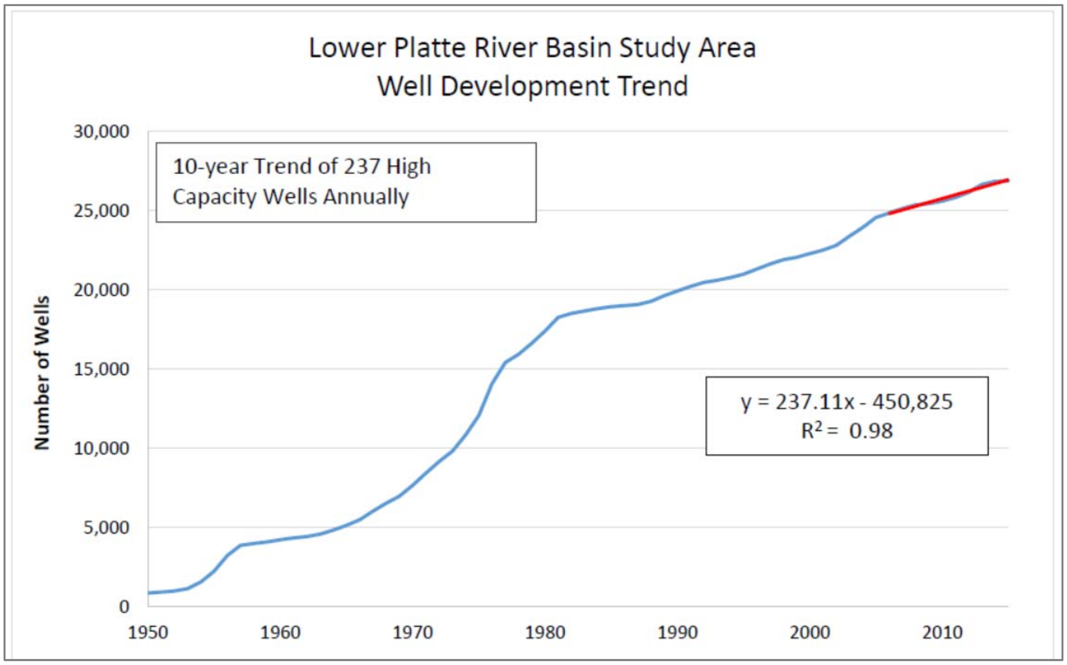
Several factors influence future water demands. Population growth and expansion of irrigated acres are the two largest contributors to growth in new water use demands. In addition, climate change over the next century is project to increase demand for current and future uses.

The growth in future demands was addressed through the basin-wide planning effort by the Lower Platte Basin Coalition described in Section 2.0 of this Plan. The Coalition's Basin Plan contains accounting methodologies that considers demands from future population growth and establishes controls to manage the growth in future demands to protect existing uses. As such, future growth in demands is not explicitly addressed in this Drought Contingency Plan.

2.10.1 Estimated Growth of Groundwater Development

Estimates of the number of high capacity groundwater wells (wells pumping greater than 50 gallons per minute [gpm]) that would be completed over the next 25 years, if no new legal constraints on the construction of such wells were imposed, were calculated based on extrapolating the present-day rate of increase in well development into the future (Figure 37). The present-day rate of development is based on the linear trend of the previous 10 years of development. Based on the analysis of the past 10 years of development, the rate of increase in high capacity wells is estimated to be 237 wells per year in the Lower Platte River Basin (NeDNR 2016).[9]

Figure 37: High Capacity Well Development, Lower Platte River Basin



Source: NeDNR Fully Appropriated Basin Report (NeDNR 2017)

2.10.2 Population Growth

Figure 38 includes population ranges for each county located within the Lower Platte River Basin. It should be noted that the populations presented are for the entire county, even though portions of the county may lie outside the boundaries of the Lower Platte River Basin. It is important to understand population trends to understand where growth is occurring, and consequently, increased municipal water use. It is equally important for drought preparedness to understand the population centers. The largest population centers in the Lower Platte River Basin are located in Douglas County, followed by Lancaster and Sarpy Counties.

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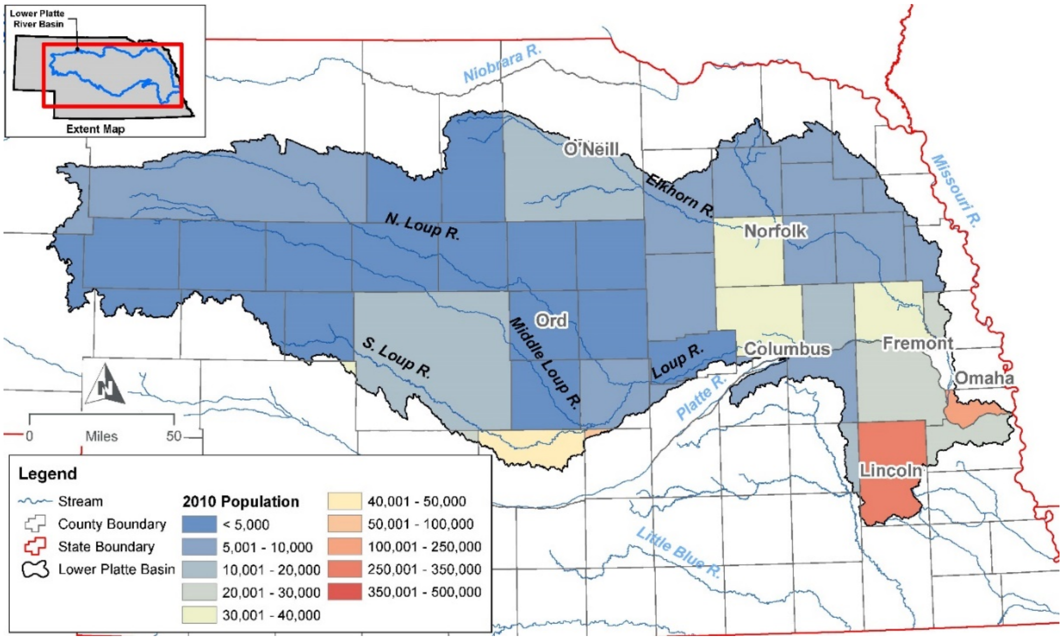
[9] See Section 2.0 on Lower Platte River Basin Coalition Basin Water Management Plan and limits of future groundwater and surface water development in the Lower Platte River Basin.

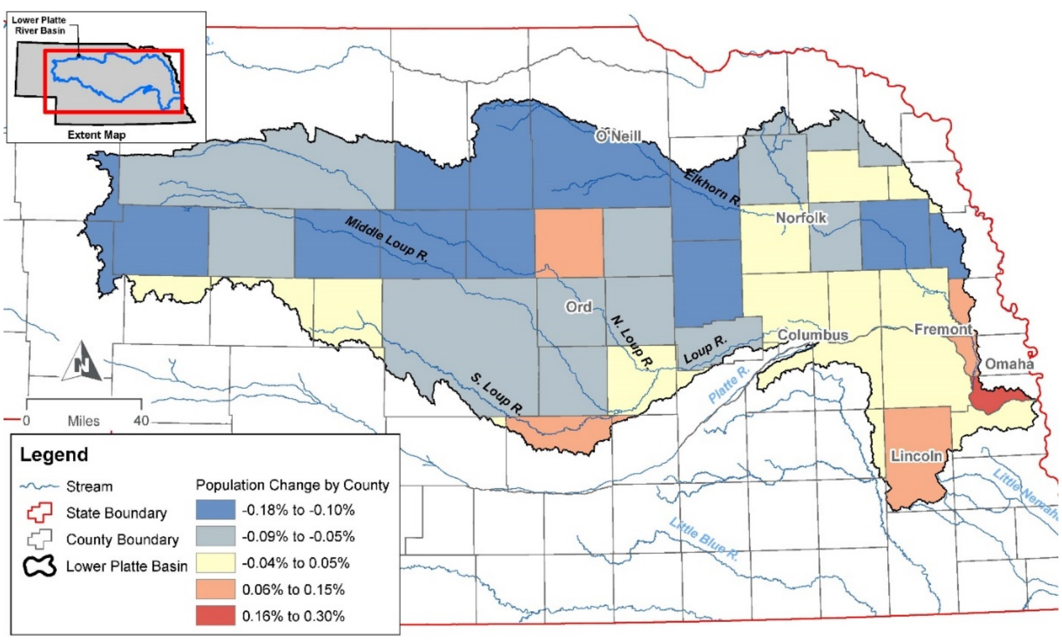
Figure 38: 2010 Population by County



Source: United States Census Bureau

Figure 39 shows the population growth by county between the 2000 and 2010 Census. In general, the rural areas of the Lower Platte River Basin have seen a decline in population (up to a maximum of 18 percent decline in certain areas) and population has increased by as much as 6 to 30 percent around major metropolitan areas (Washington, Douglas, Lancaster, and Sarpy Counties).

Figure 39: 2000 – 2010 Population Change by County



Source: United States Census Bureau

Water conservation measures implemented by MUD, LWS, and other municipal and industrial water suppliers, as well as their customers, have been successful in offsetting much of the water demands associated with increased population served within the Lower Platte River basin.

"Contrary to an ongoing discourse around urbanization as a key driver of regional water stresses, urban water withdrawals for Lincoln have decreased over time even as the population has increased. Whereas drought prompted an increase in well installations [. . .] in the agricultural sector, outdoor water use restrictions rapidly curtailed water withdrawals in the urban sector, where water conservation has gradually decoupled total withdrawals from population growth. [R]ather than exacerbating inter-sectoral conflict, cities may introduce a high-value and flexible water use that can be rapidly curtailed during drought." (Zipper et. Al, 2017)

2.10.3 Projected Future Water Change in Lower Platte River Basin

Founded in 1988 by the World Meteorological Organization and United Nations, the Intergovernmental Panel on Climate Change (IPCC) is the international body for assessing the science related to climate change. In 2007, IPCC published its *Fourth Assessment: Climate Change 2007,* which includes projected future climate change based on various future emission scenarios.

"Projected Freshwater Withdrawals in the United States under a Changing Climate" (Brown, Foti, and Ramirez 2013) utilizes three of these future emission scenarios in their analysis: A-1B, A-2, and B-2. These are described as follows:

- "The A-1B scenario expects a high level of technological change and rapid spread of new and efficient technologies, with a balanced emphasis on all energy sources. This scenario most closely extends historic population and economic growth patterns".
- "The A-2 scenario expects a lower rate of technological change and higher population growth". "Of the three scenarios, the A-2 scenario results in the highest […] atmospheric CO_2 concentration".
- "The B-2 scenario expects slower population growth but also a lower rate of technological change, with more emphasis on environmental protection". Of the three scenarios, […] B-2 [results in] the lowest atmospheric CO_2 concentration".

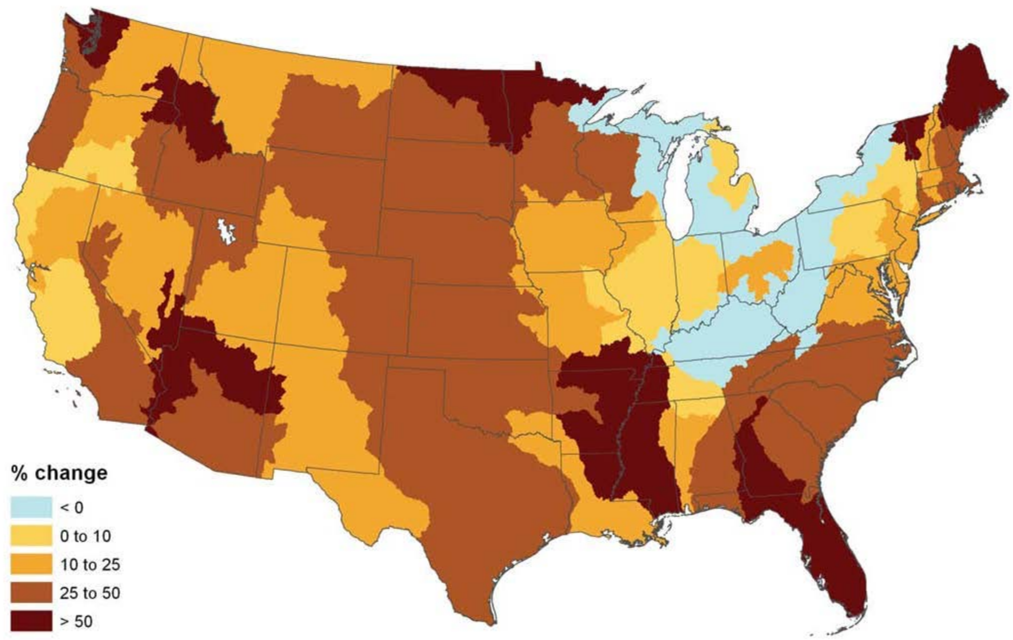
"Projected Freshwater Withdrawals in the United States under a Changing Climate" (Brown, Foti, and Ramirez 2013) investigated the effects of population growth effects on water withdrawals both with and without climate change to isolate plausible impacts from climate change alone.

> This assessment found that despite an expected 70 percent increase in population from 2005 to 2090 with the A-1B scenario, in the absence of future changes in climate, total water withdrawals in the U.S. would increase by only 13 percent, assuming water supply were no more limiting to growth in withdrawal than it has been in the recent past. (Brown, Foti, and Ramirez 2013)

This projection assumes "future gains in water use efficiency and reductions in irrigated area in the west" (2013). However, when climate change is considered, significant increases in water demand occur. "The U.S. withdrawals are projected to increase from 2005 to 2060 by 26 percent, 34 percent, and 5 percent for the A-1B, A-2, and B-2 scenarios, respectively; corresponding increases from 2005 to 2090 are 42 percent, 82 percent, and 12 percent respectively" (2013).

Figure 40 shows the geographic distribution of the projected increases in water withdrawal based on the A-1B scenario. It is shown that the Midwest is expected to have a 25 to 50 percent increase in water withdrawals under this scenario.

Figure 40: Projected Percent Change in Future Water Use in the United States from 2005 to 2060 for the A-1B Climate Scenario



Source: "Projecting Freshwater Withdrawals in the United States Under a Changing Climate" (Brown, Foti, and Ramirez 2013)

The study analyzed the increases isolated to climate change by evaluating effects of increasing temperature (T), decreasing precipitation (P), and increased evapotranspiration (ET_p).

A decrease in precipitation results in increases in agricultural irrigation and landscape watering. "Although specific regions of the U.S. are projected to experience increases or decreases in precipitation, at the national scale, little change in precipitation is projected" (Brown, Foti, and Ramirez 2013). As temperatures increase, there is an "increase[s] in water use at thermoelectric plants to accommodate the electricity needed to satisfy increasing space cooling demands that occur with rising temperatures" (2013). Increasing ET_p (corresponding to increased temperatures) results in increased agricultural irrigation and landscape watering "as plant water use responds to changes in atmospheric demand" (2013).

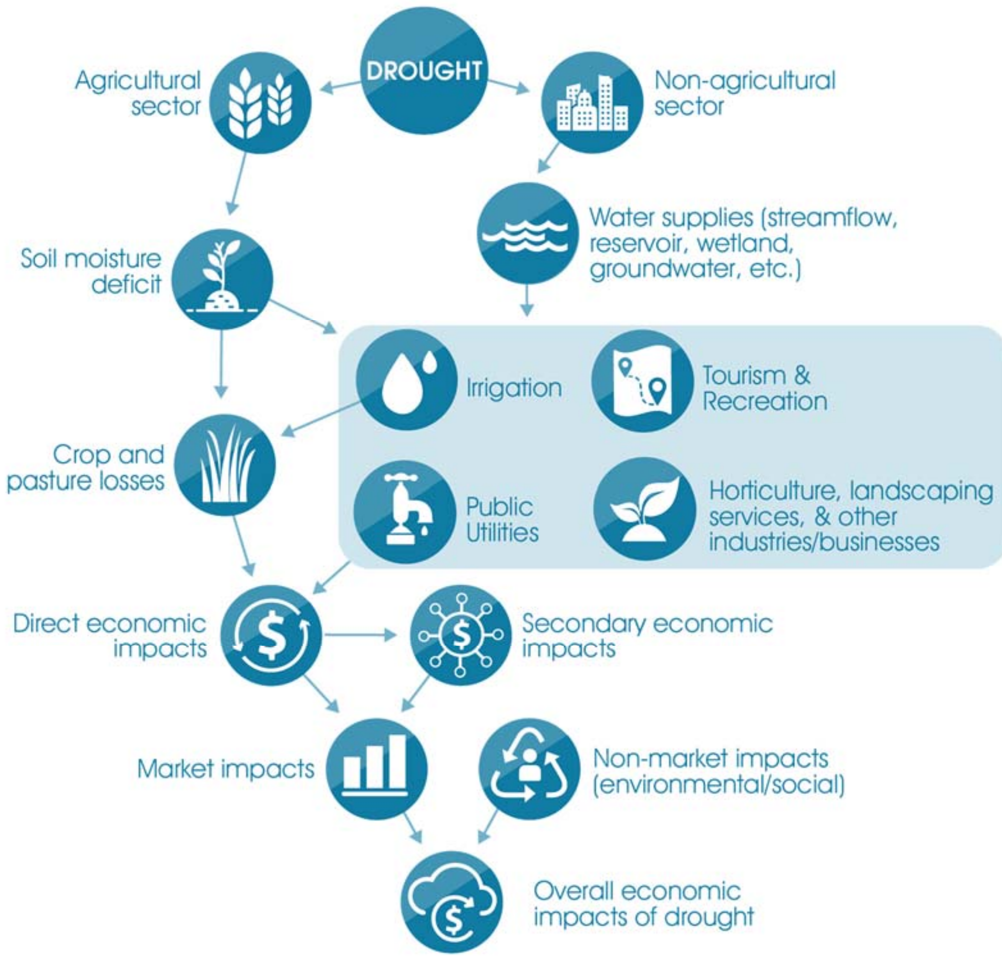
"The temperature effect is slightly larger than the precipitation effect, reaching 3 percent in 2060 and 5 percent in 2090" (2013). "The ET_p effect is [much larger], reaching 16 percent in 2055 and 23 percent in 2090" (2013). "The combined (temperature, precipitation, ET_p) effect of a changing climate is to increase total withdrawal in the U.S. by about 20 percent in 2060 and by about 30 percent in 2090, as compared to a future without climate change" (2013).

3.0 Vulnerability Assessment

"Factors influencing drought vulnerability are numerous, and their inclusion may depend on data availability" (Wilhelmi and Wilhite, 2002) "[V]ulnerability to drought is the product of numerous interrelated factors such as population growth and shifts, urbanization, demographic characteristics, water use trends, social behavior, and environmental susceptibilities" (Commission on Water Resource Management 2003). "The degree to which a population is vulnerable hinges on the ability to anticipate, to deal with, resist, and recover from the drought" (Commission on Water Resource Management 2003).

The effects from drought can be classified as direct and indirect. Direct effects include physical destruction of property, crops, natural resources, as well as public health and safety. Indirect effects are consequences of that destruction, such as temporary unemployment and business interruption (National Academy of Sciences 1999). "The most vulnerable portions of the state in terms of economic impact are cropland, pasture land for animals, recreational areas, and businesses that depend on agricultural industries for the bulk of their business. However, all areas of the state can be impacted by drought events" (Nebraska Emergency Management Agency [NEMA] 2014). Figure 41 summarizes sectors that are affected by drought (both agriculture and non-agriculture).

Figure 41: An Overview of Drought Economic Effects

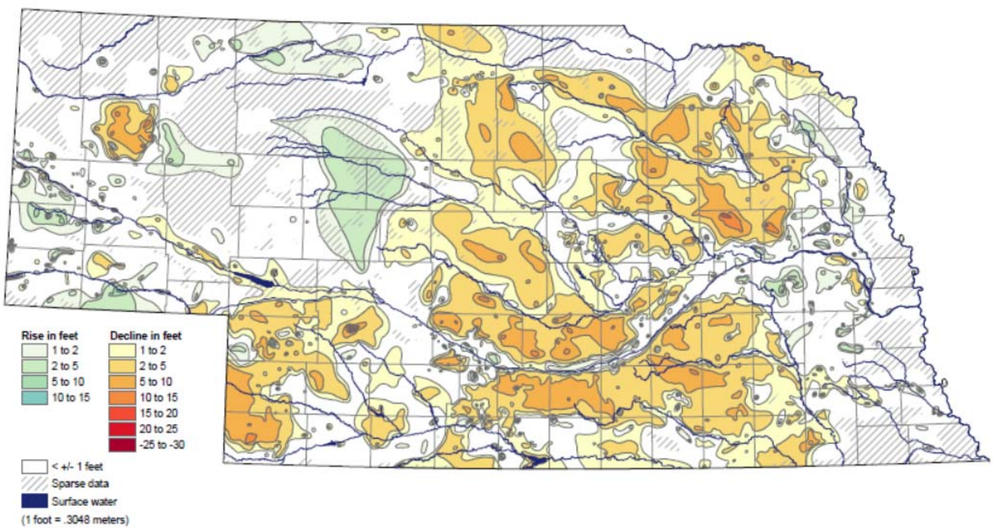


Source: Adapted from Ding, Hayes, and Widhalm 2010

The drought of 2012 was considered the most severe single-year drought on record for Nebraska, with the driest May-to-September on record coupled with extreme heat. From the spring of 2012 to the spring of 2013, most wells in Nebraska experienced declines ranging from 1 foot to more than 20 feet. The increased demand for irrigation water combined with slower rates of recharge resulted in some of the greatest recorded 1-year water-level declines in Nebraska (Young, Burbach, and Howard 2013).

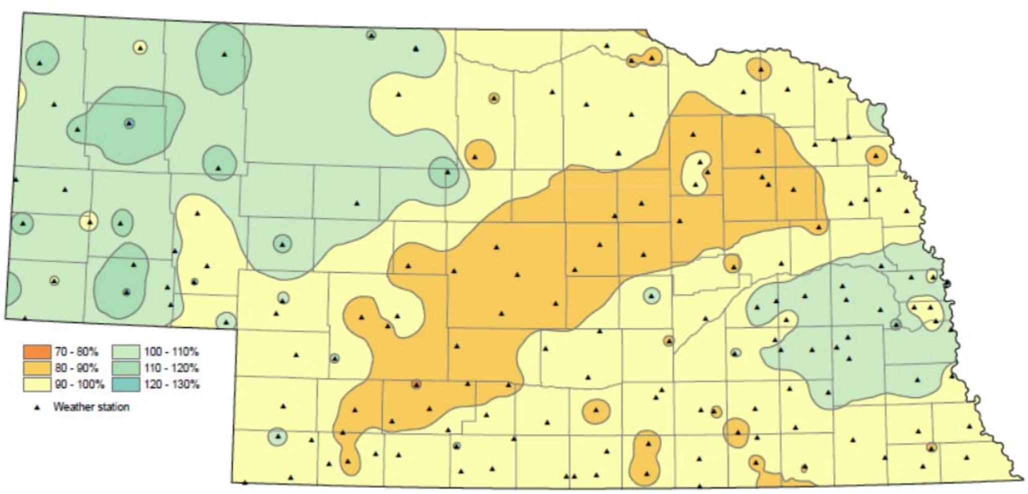
Streamflows respond more quickly to drought than to groundwater. "[T]he lag time between the beginning of a drought and the start of declining ground-water levels is longer than for streamflows. This time-lag pattern continues following the end of a drought when streamflows are returning to normal and ground-water levels may still be declining" (USGS 2005). Figure 42 shows the groundwater-level changes between 2011 and 2016. It can be seen that the groundwater levels in the majority of the Lower Platte River Basin have not fully recovered with groundwater levels 1 to 15 feet below 2011 levels. Figure 43 shows that precipitation for the same period was 70 to 100 percent of normal across the basin.

Figure 42: Groundwater-Level Changes in Nebraska – Spring 2011 to Spring 2016



Source: Nebraska Statewide Groundwater-Level Monitoring Report (Young et al. 2016)

Figure 43: Percent of Normal Precipitation – January 2011 to January 2016



Source: Nebraska Statewide Groundwater-Level Monitoring Report (Young et al. 2016)

3.1 Agricultural Sector

Nebraska is the nation's third largest producer of corn (USDA NASS 2017). "Relatively little corn in the US is used for direct human consumption. Close to 40% is used for livestock feed. So higher corn prices translate to higher feed costs and higher beef prices, and ultimately to higher food prices." (Reed 2015)

In 2012, Nebraska was the fourth largest consumer of crop insurance and the fifth largest recipient of indemnity payments (Reed 2015). During the drought of 2012, the total Nebraska indemnities were at $544 million, with $502 million due to drought, heat, and dry wind on more than two million acres of cropland. (Reed 2015) "Governors and some members of Congress urged the EPA to ease the Renewable Fuel Standard, requiring increased production of ethanol, a biofuel commonly produced from corn. The leaders argued that the mandate exacerbated the corn shortage, and in turn, increased costs for food producers." (Reed 2015)

"Crop failures and pasture losses are the primary direct economic impact of drought within the agricultural sector. Drought-induced production losses cause negative food supply shocks, but the amount of incurred economic impacts and distribution of losses depends on the market structure and interaction between the supply and demand of agricultural products" (Ding, Hayes, and Widhalm 2010).

"Drought causes losses in crop yields and quality, insect infestation, disease and wildlife damage, and damage to grazing lands" (NEMA 2014). Drought causes long-term impacts on perennial crops and livestock productions that can last for years.

"During the long-term and/or severe droughts, farmers may have a higher cost of crop production because of increased water and energy cost for irrigation. In some cases, farms may temporarily lose water rights because of seniority and this could result in reduced crop yields. However, in most cases, and especially, during a short-term drought, irrigated farming provides more security for crop grower" (Wilhemli & Wilhite, 2002) "[W]here available, irrigated was being effectively used as a tool for creating agricultural drought resistance. Taken in aggregate, [this] point[s] to an "all eggs in one basket" approach: irrigating as the sole means of agricultural drought resistance. [Continued] reliance on agricultural irrigation as a drought mitigation measure may leave the Basin vulnerable to future multiyear drought." (Zipper et al, 2017)

"Drought-induced losses are not completely borne by farmers; instead, a portion of the losses [is] passed on to consumers through increased prices. […] Additionally, farmers purchasing crop insurance will get part of their losses compensated by insurance companies, and some eligible farmers may receive direct disaster aid from the government" (Ding, Hayes, and Widhalm 2010). Additional indirect effects include reduced supplies to downstream industries, reduced fertilizer sales, and diminished expenditures (2010).

3.2 Non-agricultural Groundwater Users (Domestic, Commercial, Industrial)

In addition to irrigation, groundwater supplies businesses and industries. The effect of drought on business depends on the importance of water for operations. Businesses such as grocers and food production, nurseries, car washes, and construction can be especially hit hard. For industries, key components of operations are dependent on water at a specific time. Droughts affect production, sales, and operations of these industries. Drought can lead to lost production, lost revenue, and increased costs to consumers.

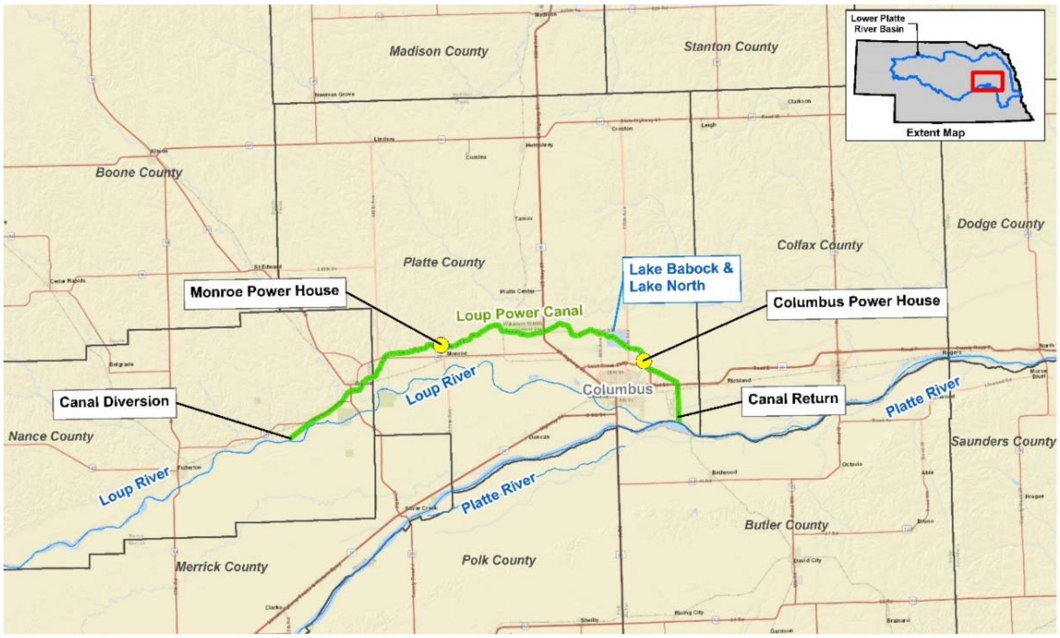
As these industries increase pumping during a drought, they may cause the groundwater level to be drawn down, which can directly affect domestic groundwater users, potentially drawing the water table below their domestic wells and effectively cutting off their domestic water supply.

3.3 Energy Sector

The Loup River Public Power District, headquartered in Columbus, is a public power electric utility serving Boone, Colfax, Nance, and Platte Counties as well as a small portion of Madison County. Loup River Public Power District's Columbus Powerhouse is one of the largest hydro-generating houses in Nebraska. Loup River Public Power District Hydropower's service area covers approximately

2,028 square miles (Figure 44). Total population within Loup River Public Power District's service area numbers about 50,000. The canal diverts water from the Loup River into the Loup Power Canal to the Monroe powerhouse. The canal then carries water from the Monroe plant to two regulating reservoirs north of Columbus that feed the Columbus powerhouse. These lakes have enough storage capacity for 48 hours of emergency hydro-generation. The Loup Power Canal then returns to the Platte River. Less water flowing to the hydro-generating facilities limits the ability to generate energy.

Figure 44: Loup Public Power Canal System



3.4 Public Water Supply

Public water systems along the Lower Platte River are largely dependent on aquifers hydrologically connected to the river and its tributaries and dependent on streamflow for recharge. Omaha and Lincoln, Nebraska's two largest municipalities, rely heavily on water supplies in the Lower Platte River to support well-field operations adjacent to the river. MUD's water system receives roughly half of its capacity from the Lower Platte River and the other half is received from the Missouri River. The capacity of Lincoln Water Systems' Ashland Well-field is directly dependent on flows in the Lower Platte River adjacent to the well-field. The vulnerability of public water supply during drought is amplified in the Lower Platte River Basin due to the lack of redundant water sources. With the exception of MUD, public water systems along the Lower Platte River rely solely on the aquifers hydrologically connected to the Platte River and reliant on its flows for recharge.

3.4.1 Water Supply Capacity Limitations

The supply capacity of the Lincoln well-field has a maximum instantaneous capacity of between 135 MGD and 145 MGD, depending on streamflow conditions (City of Lincoln 2018). The summer seasonal capacity of the well-field for 60- to 90-day production capacity ranges from 85 to 90 MGD when streamflow in the Platte River at Ashland is less than 1,000 cfs. Figure 19 (Section 2.7.2) relates the projected demand to the river flow-dependent pumping capacity of Lincoln well-field. There is a projected supply deficit with the instantaneous and short-term pumping capacity of the well-field, where it is projected that the well-field may not be able to meet the maximum day demand as early as 2030 during low-flow periods. In addition to water quantity stresses on these well-fields, previous droughts have provided indications that the well-fields may become more vulnerable to water quality issues during these periods of prolonged drought.

MUD has three supply locations: 1) Florence Plant in north Omaha that obtains its water from the Missouri River with a capacity of 160 MGD; 2) Platte West well-field located south of Venice that obtains its water from the Platte River with a capacity of 100 MGD; and 3) Platte South well-field located near La Platte that obtains water from the Platte River with a capacity of 60 MGD. Total system output for MUD from all three facilities is 320 MGD. MUD has the ability to use all three of their facilities interchangeably to meet their demand.

MUD is currently undergoing an analysis of both its Platte West and Platte South well-fields capacities under drought conditions. According to MUD, their system capacity is not expected to be a concern for the foreseeable future. During the 2012 drought, MUD voluntarily reduced operations at Platte West to 30 to 40 MGD and increased operations at the Florence plant.

3.4.1.1 Infrastructure Failure or Needed Upgrades

Extreme heat during drought can cause increased water main breaks due to dry soil conditions and increase water volumes being pumped through the distribution system. In the summer of 2012 (June, July, and August), 217 water main breaks were reported by MUD officials in Omaha. For comparison, the 10-year average from 2007 to 2016 was 118 breaks for the same period. LWS experienced similar increases in 2012 with a record 234 water main breaks for the year, or a 65 percent increase in breaks.

3.4.1.2 Increased Water Treatment Costs

Drought conditions that result in significant declines in groundwater elevations have the potential to negatively affect water quality; specifically related to iron, manganese, and levels in the water supplies.

Salt Creek is a smaller tributary to the Platte River in terms of flow, can affect water quality in the lower reach of the Platte River as it becomes a larger portion of the total streamflow because of large dissolved solids concentrations in shallow groundwater originating from mineralized areas of the Dakota Sandstone.

3.4.1.3 Single-Source Supply and Lack of Redundancy

An additional risk to the water supply in the Lower Platte River Basin is the lack of redundant surface water sources. While Lake McConaughy, a major surface water reservoir, is located in the Upper Platte River Basin, the Platte River often becomes disconnected during times of low-flow (see Section 2.4). Additionally, LWS does not hold a water right to storage water from Lake McConaughy. There are no major surface water supply storage water reservoirs in the Lower Platte River Basin downstream of Duncan. The sole water source for the LWS is the Platte River.

3.5 Recreational and Environmental Sector

Droughts can be detrimental to the recreational and environmental sectors. The result of sustained drought conditions is decreased streamflow. Streamflows support threatened and endangered species that can become vulnerable during drought periods. The endangered species that could be the most affected by drought include the interior least tern, the piping plover, and the pallid sturgeon. Instream-flow targets represent discharge conditions that are intended to result in favorable habitat for pallid sturgeon in the Lower Platte River. For the pallid sturgeon, the U.S. Fish and Wildlife Service identified favorable river conditions, including the presence of sandy bottoms, islands or bars, and sediment-rich waters. Factors contributing to the decline in abundance of pallid sturgeon are diverse and in some cases incompletely documented. High water temperatures and loss of connectivity during years of low discharge may be important limiting factors (National Research Council 2005).

“The piping plover is endangered due to the loss of suitable nesting areas. During prolonged droughts, grasses and vegetation can begin growing on the beaches and sandbars along the Platte River making these areas unsuitable for plover nesting. The interior least tern prefers the sandbars along the Platte River for nesting. The same issue that causes a problem for the plover may also present a problem for the least tern” (Ehrman et al. 2015).

Low streamflows are associated with higher water temperatures and degraded water quality that can lead to fish kills and increased water treatment costs. The 2012 drought and extended high air temperatures caused a number of Nebraska’s rivers and stream to be reduced to low-flow, and in some instances, no flow. As a result, a large number of fish kills were caused by thermal stress. These same weather conditions likely caused many of the “low dissolved oxygen” fish kills that were reported in ponds, lakes, and reservoirs (NDEQ 2013).

Lower lake levels are associated with droughts. Lower lake levels have higher water temperatures and are correlated with blue-green algae blooms (NDEQ 2013). Lower lake levels result in decreased boating, fishing, and tourism.

Fish kills in lakes are typically caused by low dissolved oxygen concentrations stemming from eutrophic conditions. Eutrophication is a term that describes water quality conditions as a lake or reservoir ages, which is common during droughts when fresh inflows into the lake or reservoir are limited or non-existent. Lakes or reservoirs that are eutrophic tend to be shallow with high nutrient concentrations and exhibit frequent algae blooms, warmer water temperatures, and lower dissolved oxygen concentrations. “As water warms, its ability to retain dissolved oxygen is lessened. If warm water conditions persist, the demand for oxygen will eventually surpass the supply and a fish kill will occur” (NDEQ 2013).

3.6 Public Health Sector

The public health sector is adversely affected by drought through soil erosion and wildfires, which: degrade air quality; result in toxins in water bodies; increase presence of mosquitos and rodents; and adversely affects public mental health. The Center for Disease Control and Prevention (CDC) has assessed previous droughts and identified the following possible public health implications due to drought (CDC 2012):

- “compromised quantity and quality of drinking water;
- increased recreational risks;
- effects on air quality;
- diminished living conditions related to energy, air quality, and sanitation and hygiene;
- compromised food and nutrition; and
- increased incidence of illness and disease”. (CDC 2012)

During a drought, effects on air quality “make chronic respiratory illnesses worse and increase the risk for respiratory infections like bronchitis and pneumonia” (CDC 2012).

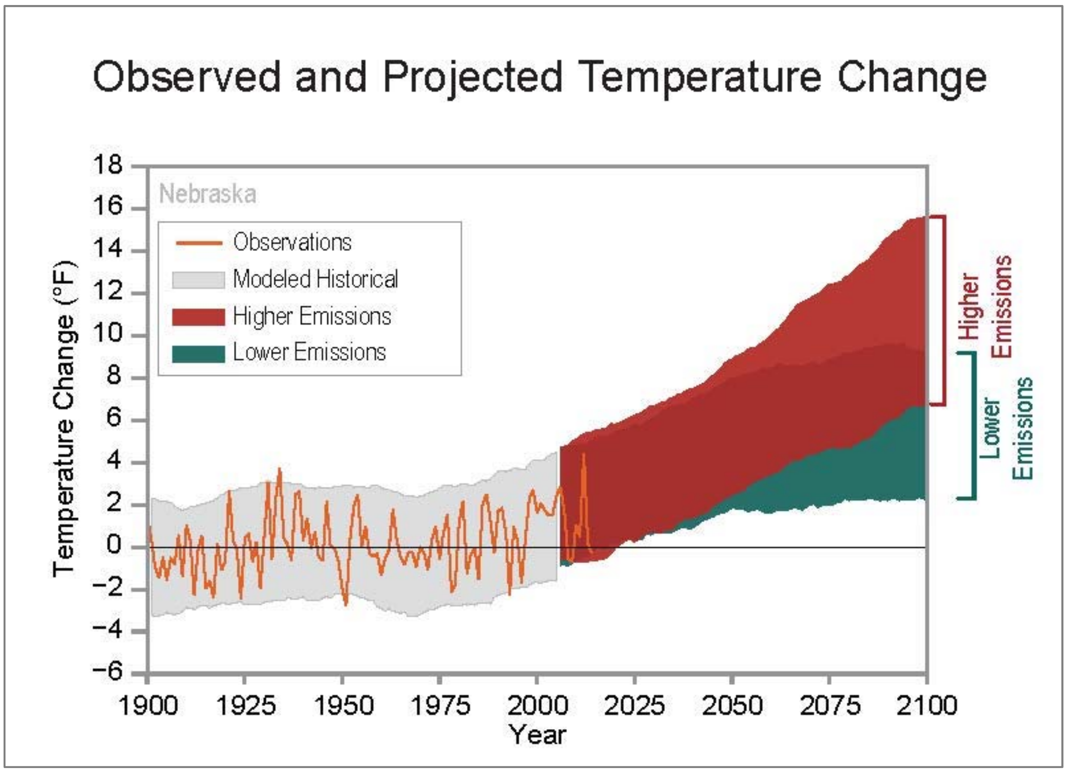
3.7 Potential Future Vulnerabilities attributable to Climate Change

Changes in extreme weather and climate events, such as heat waves and droughts, are the primary way that most people experience climate change. Human-induced climate change has already increased the number and strength of some of these extreme events. Over the last 50 years, much of the U.S. has seen increases in prolonged periods of excessively high temperatures, heavy downpours, and in some regions, severe floods and droughts (Melilo, Richmond, and Yohe 2014).

Section 2.10.3 discusses potential increases in groundwater withdrawals that are attributed to climate change.

Nebraska has experienced an overall warming of about 1 degree Fahrenheit (°F) since 1895. The vast majority of this warming has occurred during the winter months. The 10 warmest years on record have occurred since 1997 (Bathke et al. 2014).

Figure 45: Observed and Projected Temperature Change in Nebraska



Source: NOAA National Centers for Environmental Information 2017.

Figure 45 shows observed and projected changes (compared to 1901-1960 average) in near surface air temperature in Nebraska. Unprecedented warming is projected during the twenty-first century. Less warming is expected under lower emissions future (the coldest years being about as warm as the warmest years in the historical record; shown in green in the figure) and more warming under a higher emissions future (the hottest years being about 11°F warmer than the hottest year on historical record; shown in red in the figure).

A major concern for Nebraska and other central Great Plains states is the current and continued large projected reduction in snowpack for the central and northern Rocky Mountains. This is due to both a reduction in overall precipitation (rain and snow) and warmer conditions, meaning more rain and less snow, even in winter. Summer flows could be greatly reduced in coming years (Bathke et al. 2014).

The study presented in "Why Do Different Drought Indices Show Distinct Future Drought Risk Outcomes in the U.S. Great Plains?" suggests potential for chronic drought across the Great Plains in the future (Feng et al. 2017). Of particular concern is the potential for climate change to increase the severity, frequency, and duration of future droughts, presenting greater challenges for managing basin water resources and mitigating drought impacts. These potential future drought conditions was considered in developing and evaluating the drought mitigation actions described in Section 5.1. Mitigation actions were evaluated using 2012 (the historic drought of record) conditions in evaluating alternative performance. In addition, a 4-year recurrence of such drought conditions was evaluated– which is more frequent than historical drought occurrences. Finally, as described in Section 5.2, during implementation of this Plan, Coalition members will conduct a table-top exercise that considers more severe droughts, including extended duration droughts (4 to 6 months of 2012 river conditions during the peak of the drought), as well as back-to-back years of severe, extended drought occurrence.

While the Drought Plan assesses the vulnerabilities in the Lower Platte River Basin as a whole, the mitigation measures and response actions presented herein are focused on augmenting surface water supplies in the Lower Platte River primarily for public water supplies, while referencing additional drought management resources available through the University of Nebraska, National Drought Mitigation Center, and other sources. It is believed that in addressing the water supply shortages in the Lower Platte River, ancillary benefits to the remaining sectors, including irrigation, power, environmental, and recreational, would be realized.

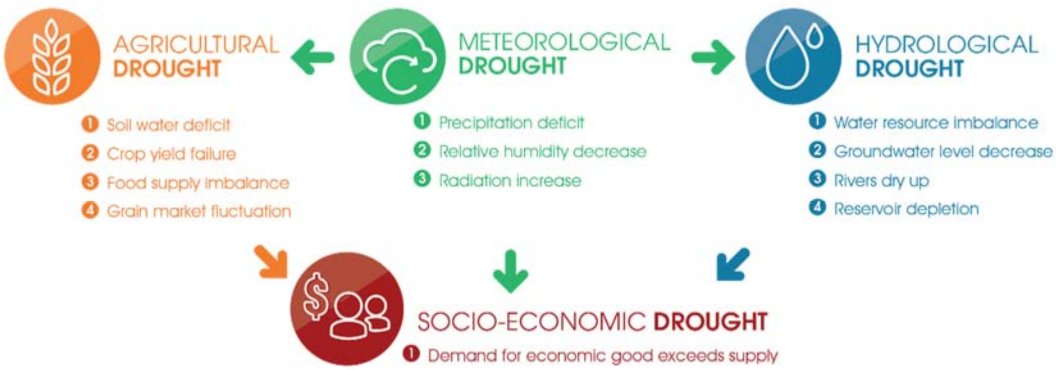
4.0 Drought Monitoring

Each of the Consortium members has some form of drought monitoring and triggers for response actions. These individual plans are discussed in detail in Appendix A. A summary of the types of drought monitoring available is discussed in the following sections.

4.1 Defining a Drought

There are many definitions for drought, but all definitions include periods of dryness and below average precipitation. The National Drought Mitigation Center (NDMC) lists four types of droughts: meteorological drought, agricultural drought, hydrological drought, and socioeconomic drought. "Meteorological drought is defined usually based on the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period." "Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced groundwater or reservoir levels, and so forth." "Hydrological drought is associated with the effects of periods of low precipitation events (including snowfall) on surface or subsurface water supply (that is, streamflow, reservoir and lake levels, and groundwater levels). The frequency and severity of a hydrological drought is often defined on a watershed or river basin scale." "Socioeconomic drought occurs when the demand for an economic good exceeds water supplies available to produce the quantity of economic good needed because of a weather-related shortfall in water supply" (for example, a hydropower plant that relies on streamflow whose production may be limited during low streamflow events) (NDMC 2018) (Figure 46).

Figure 46: Drought Transfer Process and Interactions



Source: Adapted from National Drought Mitigation Center 2018

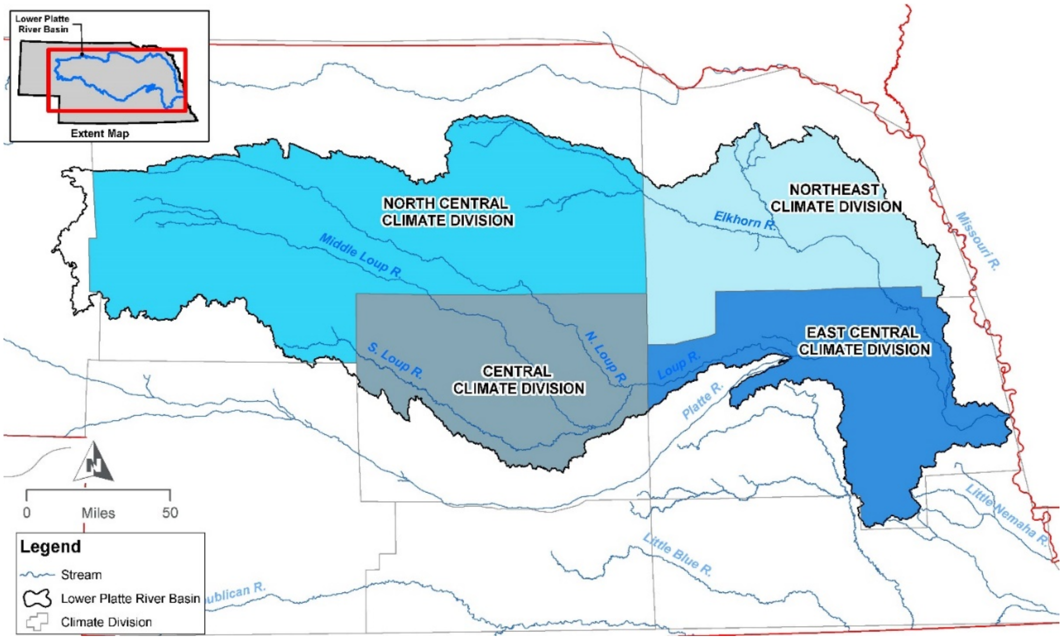
4.2 Hydro Climate Indices

Hydro climate indices assess drought severity using inputs such as precipitation, temperature, streamflow, groundwater and reservoir levels, soil moisture, or snowpack. Indices are essential for tracking and anticipating droughts as well as providing historical reference. Indices provide useful triggers to help direct decision-makers toward proactive risk management. Drought severity is best evaluated based on multiple indicators.

Two hydro climate indices were evaluated ~~have been selected~~ for ~~as~~ appropriateness for drought determination in the Lower Platte River Basin. The first index is the Palmer Drought Severity Index (PDSI). Based on USGS streamflow record data, monthly streamflow on the Platte River from Duncan to Louisville, correlated significantly with the monthly PDSI. (USGS 2008) The second index is the Standardized Precipitation Index (SPI). The World Meteorological Organization and the NDMC endorse the SPI as the standard for determining the existence of meteorological drought (Hayes et al. 2011).

The National Oceanic and Atmospheric Administration (NOAA) climate divisions for Nebraska are shown in Figure 47. The Lower Platte River Basin encompasses portions of the North Central, Northeast, Central, and East Central climate divisions. A weighted average of the indices for these four climate divisions should be used for evaluating drought conditions in the Lower Platte River Basin.

Figure 47: National Oceanic and Atmospheric Administration Climate Divisions for Nebraska



Source: Map layer downloaded from Climate Prediction Center 2018.

4.2.1 Palmer Drought Severity Index

The PDSI is calculated weekly by the NOAA Climate Prediction Center (CPC). Zero or near zero PDSI values indicate normal conditions, a negative PDSI value indicates drought, and a positive PDSI value indicates a wet period. Table 7 lists the PDSI classifications for drought.

Table 7: Palmer Drought Severity Index Classifications

Index Value	Description	Index Value	Description
4.0 or above	Extremely wet	-0.99 to -0.5	Incipient dry spell
3.00 to 3.99	Very wet	-1.99 to -1.00	Mild drought
2.00 to 2.99	Moderately wet	-2.99 to -2.00	Moderate drought
1.00 to 1.99	Slightly wet	-3.00 to -3.99	Severe drought
0.5 to 0.99	Incipient wet spell	-4.00 or less	Extreme drought
-0.49 to 0.49	Near normal	---	---

Source: NOAA National Weather Service Climate Prediction Center 2005.
Note: The U.S. Drought Monitor includes one additional category "exceptional drought" for index values less than -5.

4.2.2 Standardized Precipitation Index

The SPI is based on precipitation only, and does not consider soil moisture balance like PDSI. Similar to PDSI, zero or near zero SPI values indicate normal conditions, a negative SPI indicates drought, and a positive value for a wet period. Table 8 lists the SPI classification for drought.

Table 8: SPI Classifications

Index Value	Description	Index Value	Description
2.0 or greater	Extremely wet	-1.49 to -1.00	Moderate drought
1.50 to 1.99	Severely wet	-1.99 to -1.50	Severe drought
1.00 to 1.49	Moderately wet	-2.0 or less	Extreme drought
-0.99 to 0.99	Near normal	---	---

Source: National Oceanic Atmospheric Administration National Weather Service, Climate Prediction Center

The historic PDSI from 1900 to 2017 was compared to the historic 1-month, 3-month, 6-month, and 12-month SPI from the preceding months back through July of the previous year to determine if SPI correlated well with PDSI. These plots, as well as further discussion of how the PDSI and SPI are derived, are found in Appendix B. Ultimately, PDSI was selected as an appropriate index for tracking drought conditions in the Lower Platte River Basin based on its good correlation with historic drought occurrences and increased robustness as it considers additional factors beyond solely precipitation. The SPI should still be monitored and considered in evaluating the potential for drought, similar to the indicators described in Section 4.2.3.

4.2.3 Other Drought Indicators

Several other drought indicators should be considered when evaluating the potential for drought conditions to occur in the Lower Platte River. These indicators are more qualitative in nature with respect to flows in the Lower Platte River and may not have triggers associated with them, but they can provide valuable insight into Basin hydrologic conditions. These include:

- Mountain snowpack in the South Platte and North Platte River Basins: During the most severe droughts in the Lower Platte River Basin the Platte River has run dry upstream of Duncan, essentially disconnecting the Upper Platte River Basin. Snowpack can then provide insight into the likelihood of Platte River flow contributions from the Upper Platte River Basin being maintained past Duncan. This is particularly true for the South Platte River Basin snowpack, where flows are largely unregulated by reservoirs, etc., and snowmelt runoff in high snowpack years can sustain flows in the Lower Platte River into July.
- Plains snowpack: Plains snowpack in the Platte River Basin can be used to anticipate soil moisture conditions for the coming growing season, particularly in areas of irrigated agriculture where the initiation of crop irrigation early in the growing season can affect streamflows later in the growing season.
- Reservoir levels: Several large reservoirs on the North Platte River regulate flows for purposes of irrigated agriculture, hydropower generation, and environmental purposes. Monitoring storage levels in these reservoirs throughout the year can inform anticipated releases, and ultimately, potential flow contributions to the Lower Platte River.

- Static Aquifer Levels: Fall and spring static aquifer levels provide insight into the cyclical aquifer drawdown and recovery as a result of irrigation during the peak season. Monitoring these levels can assist in anticipating potential conflicts and well interference that may occur due to groundwater irrigation in the coming peak season. In addition, the static levels can inform estimates of drought effects on anticipated baseflow gains.

4.3 Historic Occurrences of Drought

The Platte River July streamflow at Louisville was plotted as a percentage above or below the median July flow for the period 1953 to 2017 against the historic PDSI to understand the historic droughts. The PDSI value in these plots is a composite of the value for the four climate divisions encompassing the Lower Platte River Basin: East Central, Northeast, Central and North Central divisions; these plots are located in Appendix B.

The U.S. Drought Risk Atlas (a product of the NDMC) summarizes the occurrence of drought by climate division, hydro climate indices, and severity as a percentage of the period-of-record. The historic occurrence of drought for the four climate divisions that encompass the Lower Platte River Basin are shown in Table 9 through Table 12. It is noted that historical accounts (mid-1890's drought, for example) as well as analytic approaches such as tree ring analysis and subsurface geology interpretation, indicate the occurrence of even more severe and long-term droughts than that captured in the 1900-2016 period of record included in the U.S. Drought Risk Atlas.

Table 9: North Central Climate Division (Division 02): Percent of Time Spent in Drought – 1900 to 2016

PDSI Index Value	Percent of Time Spent in Drought	Drought Severity	Recurrence Interval
-2 < PDSI ≤ -1	34%	Mild	1 out of 3 years
-3 < PDSI ≤ -2	21%	Moderate	1 out of 5 years
-4 < PDSI ≤ -3	12%	Severe	1 out of 8 years
PDSI ≤ -4	6%	Extreme	1 out of 17 years

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)
Notes: PDSI = Palmer Drought Severity Index.

Table 10: Northeast Climate Division (Division 03): Percent of Time Spent in Drought – 1900 to 2016

PDSI Index Value	Percent of Time Spent in Drought	Severity	Recurrence Interval
-2 < PDSI ≤ -1	26%	Mild	1 out of 4 years
-3 < PDSI ≤ -2	16%	Moderate	1 out of 6 years

PDSI Index Value	Percent of Time Spent in Drought	Severity	Recurrence Interval
-4 < PDSI ≤ -3	10%	Severe	1 out of 10 years
PDSI ≤ -4	7%	Extreme	1 out of 14 years

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)
Notes: PDSI = Palmer Drought Severity Index.

Table 11: Central Climate Division (Division 05): Percent of Time Spent in Drought – 1900 to 2016

PDSI Index Value	Percent of Time Spent in Drought	Severity	Recurrence Interval
-2 < PDSI ≤ -1	31%	Mild	1 out of 3 years
-3 < PDSI ≤ -2	18%	Moderate	1 out of 6 years
-4 < PDSI ≤ -3	11%	Severe	1 out of 9 years
PDSI ≤ -4	8%	Extreme	1 out 0f 13 years

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)
Notes: PDSI = Palmer Drought Severity Index.

Table 12: East Central Climate Division (Division 06): Percent of Time Spent in Drought – 1900 to 2016

PDSI Index Value	Percent of Time Spent in Drought	Severity	Recurrence Interval
-2 < PDSI ≤ -1	28%	Mild	1 out of 4 years
-3 < PDSI ≤ -2	17%	Moderate	1 out of 6 years
-4 < PDSI ≤ -3	10%	Severe	1 out of 10 years
PDSI ≤ -4	6%	Extreme	1 out of 17 years

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)
Notes: PDSI = Palmer Drought Severity Index.

In general, the PDSI and SPI compare reasonably well; however, the SPI does appear to predict fewer occurrences of severe and extreme droughts than the PDSI. This is likely because the SPI and PDSI tell different stories. The PDSI considers the water balance and gives a more complete representation of conditions; however, the PDSI is a cumulative function, where the PDSI from previous months can affect the PDSI of a current month making it harder to predict flash droughts. The SPI considers only precipitation anomaly compared to historic normal precipitation. Therefore, if precipitation returns to normal conditions, the SPI may indicate the drought is over whereas the PDSI may not.

For these reasons, both the SPI and PDSI should be considered together when evaluating drought conditions.

Analysis of historic PDSI values from 116 years of data reveal that mild, moderate, severe, and extreme droughts can be expected to occur in the Lower Platte River Basin once every three, six, nine, and fourteen years, respectively.

From 1900 to 2016, the most severe droughts occurred in the 1930's, 1950's, 1980's, early 2000's and 2012-2013. Table 13 through Table 16 list the number of months spent in specific drought periods by category.

Table 13: North Central Climate Division (Division 02): Number of Months Spent in Specific Drought Periods

		Number of Months in Drought			
PDSI Index Value	Severity	1933-1941	1953-1958	2002-2004	2012-2014
-2 < PDSI ≤ -1	Mild	101	40	31	12
-3 < PDSI ≤ -2	Moderate	85	28	28	10
-4 < PDSI ≤ -3	Severe	56	24	23	9
PDSI ≤ -4	Extreme	37	19	3	9

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)
Notes: PDSI = Palmer Drought Severity Index.

Table 14: Northeast Climate Division (Division 03): Number of Months Spent in Specific Drought Periods

		Number of Months in Drought			
PDSI Index Value	Severity	1933-1941	1953-1958	2002-2004	2012-2014
-2 < PDSI ≤ -1	Mild	100	28	11	14
-3 < PDSI ≤ -2	Moderate	93	25	9	12
-4 < PDSI ≤ -3	Severe	62	23	2	10
PDSI ≤ -4	Extreme	44	21	0	9

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)
Notes: PDSI = Palmer Drought Severity Index.

Table 15: Central Climate Division (Division 05): Number of Months Spent in Specific Drought Periods

		Number of Months in Drought			
PDSI Index Value	Severity	1933-1941	1953-1958	2002-2004	2012-2014
-2 < PDSI ≤ -1	Mild	101	58	29	24
-3 < PDSI ≤ -2	Moderate	83	50	26	19
-4 < PDSI ≤ -3	Severe	75	38	12	14
PDSI ≤ -4	Extreme	68	26	3	8

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)
Notes: PDSI = Palmer Drought Severity Index.

Table 16: East Central Climate Division (Division 06): Number of Months Spent in Specific Drought Periods

		Number of Months in Drought			
PDSI Index Value	Severity	1933-1941	1953-1958	2002-2004	2012-2014
-2 < PDSI ≤ -1	Mild	100	47	34	15
-3 < PDSI ≤ -2	Moderate	92	40	22	10
-4 < PDSI ≤ -3	Severe	77	26	0	9
PDSI ≤ -4	Extreme	55	23	0	8

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)
Notes: PDSI = Palmer Drought Severity Index.

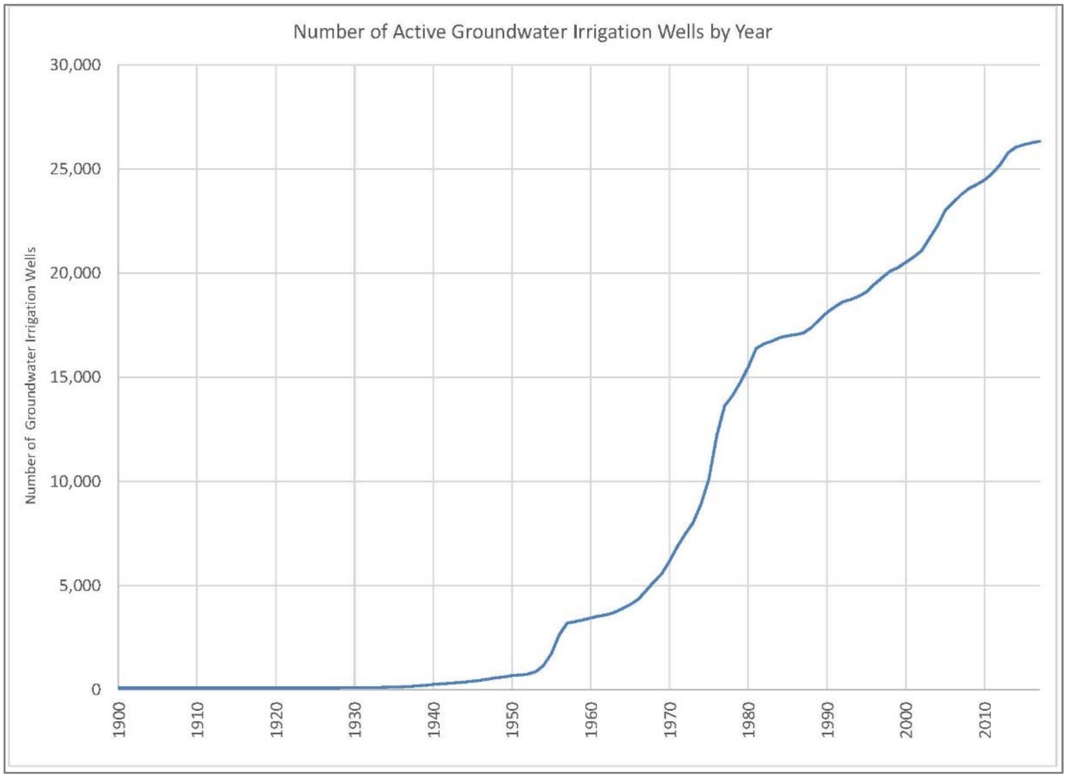
The longest drought post-1900 was the Dust Bowl (1933-1941) that resulted from severe drought and poor farming practices without crop rotation, cover crops, or other erosion control. Deep plowing displaced natural grasses leading to wind erosion and dust storms. Grasshopper infestation and the Great Depression occurred in the same period making it difficult to quantify economic impacts directly attributed to drought. While the drought effects were remembered as agricultural, it also negatively impacted wildlife, plant life, domestic supply, and undoubtedly other sectors. Dust pneumonia claimed the lives of many. The number of farms decreased by 50 percent[10] during the Dust Bowl and millions of people migrated to the west. In response to the drought, Congress passed the Soil Conservation Act of 1935 to combat soil erosion and preserving natural resources, as well as established the Natural Resources Conservation Service (originally named the Soil Conservation Service).

Soil conservation practices such as wind breaks, crop rotation, strip farming, contour plowing, terracing, and other conservation measures were employed. Evaluating historic PDSI values, the drought of the

[10] https://journalstar.com/news/state-and-regional/nebraska/of-the-deadliest-disasters-in-nebraska-history/collection_6ae50d55-7d8a-5B-6f-B-1c3-b0B-54cfe84f0.html#12

1950's was "worse" than the Dust Bowl. However, due to improved farming practices and increased reliance on groundwater, the impacts were less severe. Figure 48 shows that the number of irrigation wells dramatically increases post-1950.

Figure 48: Number of Active Groundwater Irrigation Wells by Year



Source: Groundwater well Map layer obtained from Nebraska Department of Natural Resources (downloaded 2018)

While groundwater irrigation is an invaluable resource during drought, over-pumping can deplete the aquifer and deplete streamflow. The drought of 2012-2013 is considered the worst single year drought in recent history. As of 2016, the groundwater-level changes in the Lower Platte River Basin have not recovered to 2011 levels (CSD 2017).

The drought of 2012 was considered a "flash drought" in that its onset was unusually quick. Crop damages led to corn export prices 128 percent above the 20-year historic average (AghaKouchak et al. 2013). Crop production decreased with hay production down 28 percent, corn production down 16 percent, and soybean production down 21 percent. Ranchers culled their herds by 25-60 percent as forage production was down 28-65 percent of normal (Central Drought Assessment 2012).

4.4 Drought Indicators for the Lower Platte River Basin

Many indicators and indices exist to help identify drought conditions in the Lower Platte River Basin. These include hydroclimate indices, streamflow levels, groundwater aquifer levels, Rocky Mountain snowpack, and Lake McConaughy reservoir storage levels. Additionally, as previously stated, the focus of this first increment of the Drought Plan is on augmenting surface water supplies in the Lower Platte River near Ashland. It is believed that in addressing the water supply shortages in the Lower Platte River, ancillary benefits to the remaining sectors would exist including: irrigation, power, environmental, and recreational. Table 17 identifies four drought levels recommended for the Drought Plan (mild drought, moderate drought, severe drought, and extreme drought) as well as the associated index ranges that define these levels.

Each NRD has some form of drought monitoring and triggers for response actions. Each NRD maintains its own individual groundwater management plans and the intent of this Drought Plan is not to replace each members' groundwater monitoring and management plans; rather, to provide consistent, basin-scale data and information that can be used by NRDs, while maintaining locally-based management frameworks.. The individual NRD plans are discussed in detail in Appendix A. For this reason, the drought triggers identified for this Drought Plan are triggers associated with surface water supply.

Additionally, as previously stated, the focus of this first increment of the Drought Plan will focus on augmenting surface water supplies in the Lower Platte River near Ashland. It is believed that in addressing the water supply shortages in the Lower Platte River, ancillary benefits to the remaining sectors would exist including irrigation, power, environmental, and recreational.

Table 17: Drought Triggers

Category	Level	Palmer Drought Severity Index (PDSI)	Platte River Stream flow at Ashland
Mild Drought	0	-1.0 to -1.99	
Moderate Drought	1	-2.0 to -2.99	3,000-1,500 cfs
Severe Drought	2	-3.0 to -3.99	1,500-500 cfs
Extreme Drought	3	-4.0 and below	Less than 500 cfs

Notes: PDSI = Palmer Drought Severity Index

The following lists the levels of drought, remaining consistent with the US Drought Monitor definitions of drought.

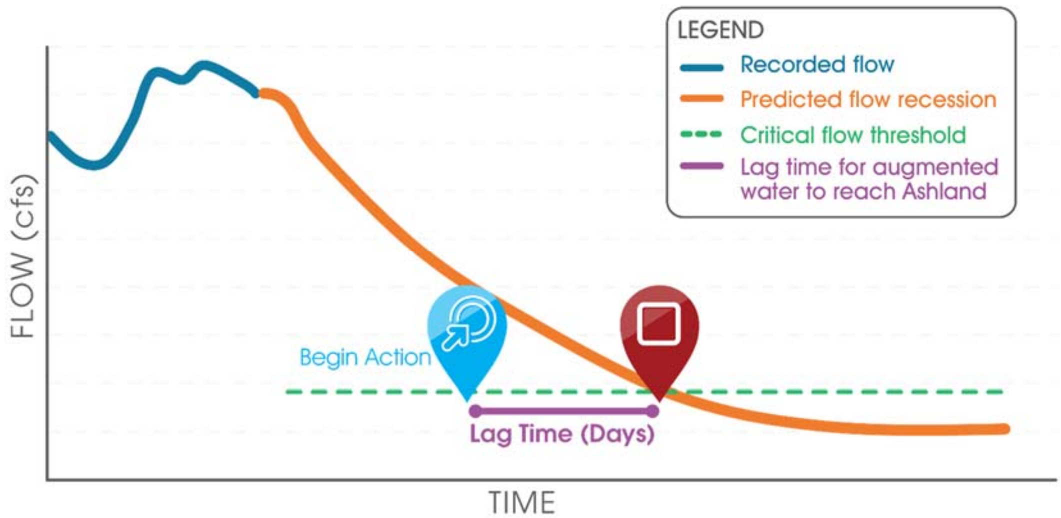
- A Level 0, "Abnormally Dry"[11] indicates an area may be experiencing "short-term dryness slowing planting, growth of crops or pastures" indicating the onset of drought or may be coming out of drought and experiencing lingering effects of drought.
- A Level 1, "Moderate Drought" involves "some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; and voluntary water-use restrictions requested."
- A Level 2, "Severe Drought" means that "crop or pasture losses likely; water shortages common; and water restrictions imposed."
- A Level 3, "Extreme Drought" involves "major crop/pasture losses" and "widespread water shortages or restrictions."

[11] An "Abnormally Dry" classification by the National Drought Monitor corresponds to a PDSI "mild drought" classification. The "Moderate Drought", "Severe Drought" and "Extreme Drought" classifications are the same between the National Drought Monitor and PDSI.

4.4.1 Platte River at Ashland Recession Tool

Understanding the behavior of the Platte River at Ashland as flows recede is important to the ability of the Consortium to forecast and properly time the implementation of response actions. Using the Platte River at Ashland Recession Tool allows the user to enter the current observed flow in the Platte River at Ashland and predict the flow decay behavior for the next 30 days, assuming no further inputs to the system (precipitation runoff or upstream storage releases). The resulting recession curve can be used to estimate the days until a critical threshold is reached. The development of the Platte River at Ashland Recession Tool is discussed in detail in Appendix E. Figure 49 is a schematic of the functional utility of the Platte River at Ashland Recession Tool in drought forecasting and response.

Figure 49: Platte River at Ashland Recession Tool



4.4.2 U.S. Drought Monitor

The U.S. Drought Monitor is a component of the National Integrated Drought Information System and produced jointly by NOAA, the U.S. Department of Agriculture (USDA), and NDMC. The U.S. Drought Monitor is a weekly product that provides a general summary of current drought conditions: http://www.cpc.ncep.noaa.gov/products/Drought/.

Multiple drought indicators, including various indices, outlooks, field reports, and news accounts are reviewed and synthesized. In addition, numerous experts from agencies and offices across the country are consulted. The result is the consensus assessment presented on the U.S. Drought Monitor map. The U.S. Drought Monitor website can be used as a tool to supplement the drought monitoring by the Consortium. The U.S. Drought Monitor information is usually summarized in the North Central and U.S. Monthly Climate and Drought Summary Outlooks.

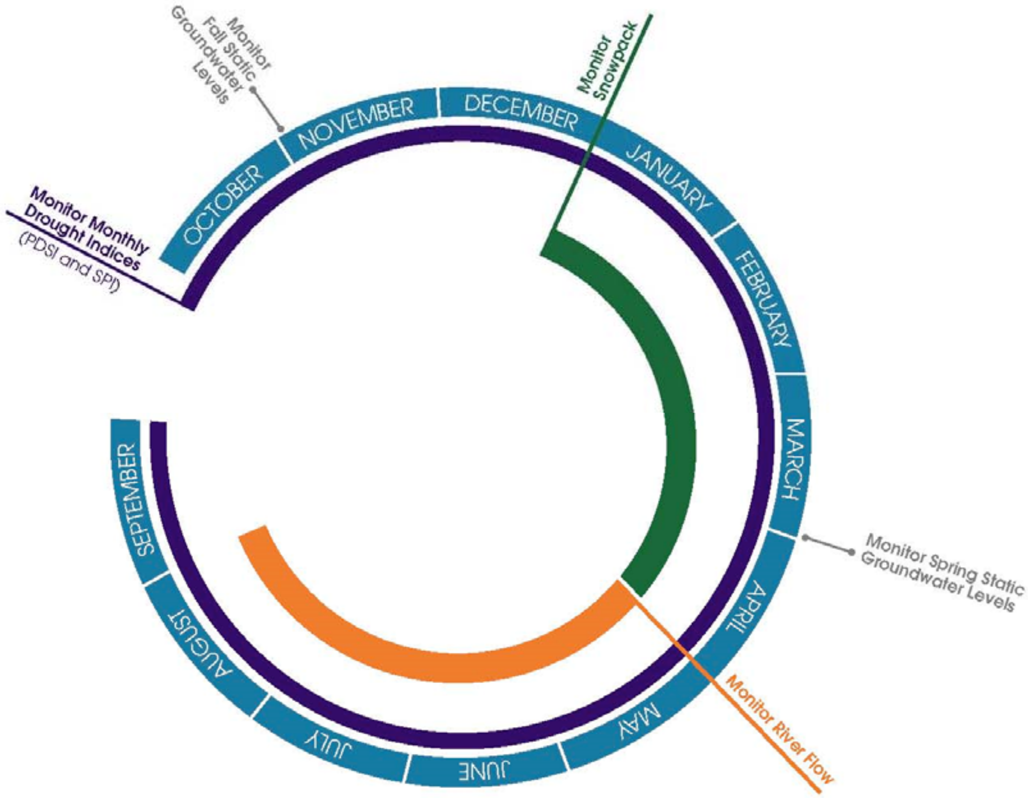
4.4.3 North Central U.S. Monthly Climate and Drought Summary Outlook

NOAA and its climate partners host monthly webinars on the website: https://www.drought.gov/drought/calendar/events/

This monthly briefing covers the region from the Rockies to the Great Lakes. Subject matter includes a summary of past and current conditions in terms of many climate variables such as snowpack, temperatures, and precipitation. In addition, potential and ongoing effects from climate phenomena will be considered across sectors (agriculture, water resources, etc.). Finally, outlook information from 2 weeks to the next few months and seasons are discussed.

As part of its drought monitoring, the Consortium should participate in these monthly webinars to gain expert interpretation of the state of drought and drought predictions.

Figure 50: Drought Monitoring Continuum



The recommended timeline for drought monitoring is displayed in Figure 50. Hydroclimate indices SPI and PDSI should be monitored year round. Groundwater levels are monitored by NRDs in the spring and fall of each year in accordance with their individual groundwater management plans. Snowpack volumes should be monitored from the beginning of the calendar year through the runoff season. Streamflows should be monitored starting in late spring through the summer when water use for irrigation, cooling, and lawn watering is at its peak.

5.0 Drought Management

Drought management includes actions taken in preparation for, and/or in response to drought conditions to reduce potential risks and effects associated with drought. Currently, response actions are taken by members of the Consortium independently to address drought conditions. Combined, these independent activities form a No-Action alternative for the Drought Plan. Included in the No-Action alternative are the following:

- LWS and MUD Water Use Restrictions: In response to drought conditions, each utility has the ability to implement water restrictions on its users to preserve available water supplies to maintain service.
- Administrative call: An administrative call on junior surface water appropriators may be made by NeDNR at the request of a senior surface water appropriator who is not receiving their full appropriation.
- NRD Groundwater Regulation: The NRDs have statutory authority to manage groundwater usage through regulation, allocations, etc. In response to declining aquifer levels or increased well interference the NRDs may place limits on aquifer usage.

Considerations and limitations of the No-Action alternative include:

- LWS has an appropriation priority date of January 21, 1964. There are approximately 128,000 irrigated acres with appropriations junior to LWS's appropriation in the Platte, Loup, and Elkhorn River basins subject to an administrative call on behalf of LWS. Restricting irrigation water supply to these lands could have substantial regional economic impacts for a single drought event, likely on par or exceeding the mitigation alternatives' costs described in this section.
- An administrative call placed during a drought may not produce adequate streamflow as many of the appropriators may be experiencing shortages themselves due to the drought conditions.
- Water use restrictions have several potential impacts: 1) Lost production by customers who rely on water delivery for commercial and industrial use; 2) Reduced revenues for the utilities from water deliveries; 3) Restricted growth and lost growth opportunities due to potential for water shortages
- The No-Action alternative is reactive in that the actions occur after the effects of the drought are being realized, and have limited ability to mitigate these effects.

To address the shortcomings of the No-Action alternative, the Consortium investigated mitigation alternatives that could provide proactive approaches to reduce impacts of drought.

5.1 Mitigation Alternatives

Drought mitigation measures are actions, programs, and strategies implemented during non-drought periods to address potential risks and effects and reduce the need for response actions; implementation of drought mitigation measures improves long-term resilience.

While the Drought Plan assesses the water supplies, demands, and vulnerabilities in the Lower Platte River Basin as a whole, the focus of this increment of the Drought Plan is on augmenting surface water supplies in the Lower Platte River near Ashland. It is believed that in addressing the water supply shortages in the Lower Platte River, ancillary benefits to the remaining sectors would exist including irrigation, power, environmental, and recreational.

~~Eight mitigation measures were evaluated as part of the Drought Planning effort to estimate potential increases in regional water supply.~~ Mitigation actions for each potential type of mitigation project were initially screened and prioritized based on anticipated costs (both capitol and O&M) and general feasibility/logistics of the mitigation action. These screened alternatives by project type were then evaluated for their general effectiveness in mitigating drought conditions based on predicted performance during occurrence of 2012 drought conditions and concept level cost estimates developed. Eight mitigation measures (and combinations thereof) were evaluated and ~~These measures~~ include the following:

- Installing an alluvial well-field adjacent to the Missouri River and pumping water to a tributary of the Elkhorn River for availability on demand;
- Purchasing storage in the existing Sherman Reservoir and releasing water on demand;

- A new surface water storage reservoir on Skull Creek near Linwood for releasing water on demand;
- Capture of Middle Loup River water in the non-irrigation season and diversion into the Middle Loup Canal system for intentional recharge and baseflow augmentation;
- Installing a well-field to tap into groundwater aquifers with limited connection to streamflow that can be pumped to the river to augment flows;
- Pumping from alluvial sandpits directly to the river to augment flows; ~~and~~
- A dry-year-lease agreement with farmers irrigating lands adjacent to the main channel of the Platte River from the alluvial aquifer; and~~.~~
- Interconnection of MUD and LWS finished water supplies, providing LWS access to the Missouri River as a source of potable water.

5.1.1 Additional Supply – Missouri River

Streamflow in the Missouri River is regulated by a system of upstream reservoirs to serve a variety of federally authorized purposes. One of the federally authorized purposes is to provide flows adequate for maintaining navigation March through November in the reach from Sioux City to its confluence with the Mississippi River. The full service navigation target at the Omaha gage is 31,000 cfs, while the minimum service navigation target is 25,000 cfs. The system of reservoirs and the authorized purposes they service provide a reliable supply to Missouri River streamflows during periods of drought. As an example, the *2014 Lincoln Water Master Plan* showed the Missouri River would be able to support a 75 million gallons per day demand even during significant drought conditions (City of Lincoln 2014).

Installation of a well-field in the alluvial aquifer adjacent to the Missouri River was investigated as a drought mitigation action. The hydrologic connection of the alluvial aquifer to the Missouri River would provide a reliable source of recharge and maintain its capacity, even during the severest drought periods. The analysis considered delivering 50-100 cfs from the well-field to the Platte River basin on demand. One alternative was a well-field adjacent to the Missouri River near Blair, with a force main extending westward approximately 10 miles over the ridge and into the Bell Creek watershed along existing Highway 91. The second alternative considered a well-field adjacent to the Missouri River near Decatur, with a force main extending westward approximately eleven miles over the ridge and into the upper reaches of the Bell Creek watershed along existing Highway 51. Once discharged flows would be conveyed by tributaries to Bell Creek and the Elkhorn River before eventually reaching the Platte River. For the alternative near Decatur, an estimated 22 percent conveyance loss occurs between the point of discharge and the Ashland gage on the Platte River under low-flow conditions.

Potential constraints and considerations include location of well-field, obtaining right-of-way for well-field and transmission main, potential utility conflicts/constraints along transmission main alignment, obtaining necessary environmental clearances, and protection of discharged water from use via conveyance appropriation from NeDNR. Project costs would primarily include the well-field, transmission, and discharge infrastructure costs, ROW for project facilities, and annual operating expenses.

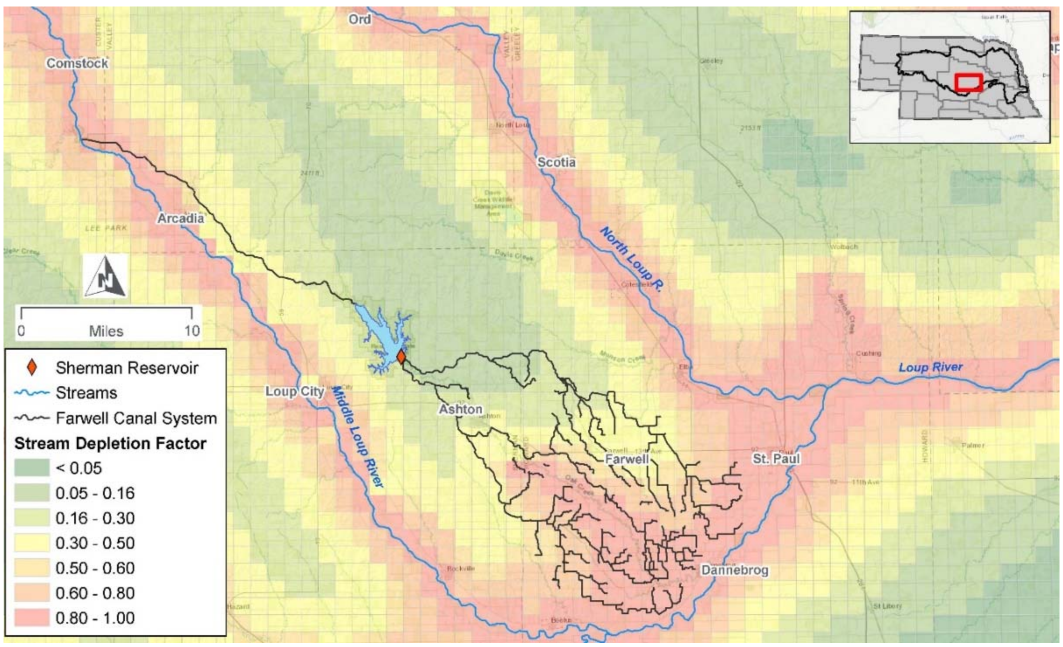
5.1.2 Surface Water Storage Alternatives

Two new surface water storage reservoirs and one existing surface water storage reservoir were considered as mitigations measures to increase water supply to the Lower Platte River Basin during drought conditions.

5.1.2.1 Sherman Storage Reallocation

The Sherman Storage Reallocation would reallocate a portion of stored water in Sherman Reservoir to be managed for re-timing and augmenting streamflows. Sherman Reservoir is owned by the Farwell Irrigation District and stores flows diverted from the Middle Loup River for storage and delivery to its producers during the irrigation season. Reallocating storage in Sherman Reservoir could provide benefits to the Lower Platte River using two operational patterns: 1) the stored water could be actively managed to augment flows during droughts through releases from reservoir storage and conveyance through the canal and natural systems to the Platte River; and 2) the stored water could be released during the non-irrigation season and intentionally recharged using the existing Farwell Irrigation District canal system infrastructure, resulting in increased baseflow accretions passively occurring throughout the year. While this effort focused on Sherman Reservoir, a similar approach could be used on the Davis Creek Reservoir (Figure 51).

Figure 51: Sherman Reservoir and Farwell Canal System



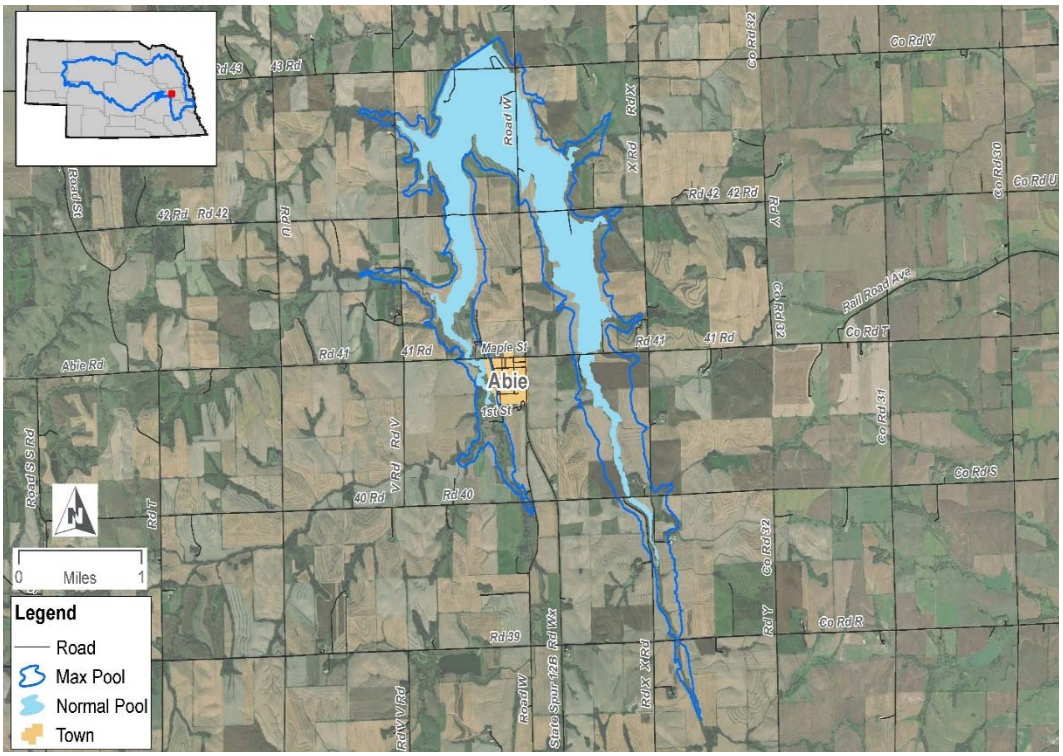
Reallocating or repurposing the upper 3 to 4 feet of Sherman Reservoir's normal storage pool would provide approximately 8,000 to 10,000 acre-feet of water. Active releases would provide 100 percent benefit to streamflow at the point of discharge, with benefits decreasing downstream as conveyance losses are incurred. Estimated conveyance losses from point of release to the Ashland gage on the Platte River is approximately 65 percent during drought conditions.

Potential constraints and considerations include obtaining a storage agreement with owners of Sherman Dam for storage and release of flows for the benefit of the Lower Platte River, adverse effects on current Farwell Irrigation District producers, potential high groundwater tables resulting from intentional recharge activities, and protection of releases from use via conveyance appropriation from NeDNR. Project costs would primarily include the purchase or lease of storage water agreement with the owner and compensatory elements for use of their irrigation infrastructure in the delivery of flows.

5.1.2.2 Skull Creek Reservoir

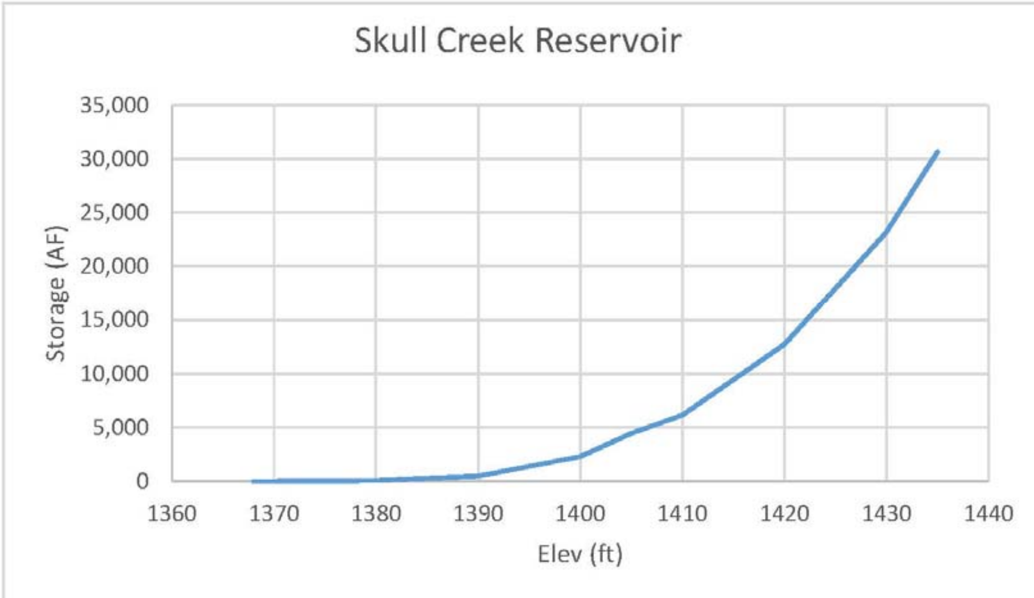
The first new reservoir considered was previously evaluated by the U.S. Army Corps of Engineers in 1965 and again by Lower Platte North NRD in 1985. These analyses investigated multiple locations within the watershed. For purposes of this analysis, the new reservoir considered would be located on Skull Creek (a tributary to the Platte River) near Linwood, Nebraska, located in the Lower Platte North NRD (Figure 52). Other potential sites upstream of this location were previously evaluated; however, upstream locations would reduce the volume for capture and lessen project benefits.

Figure 52: Skull Creek Reservoir Proposed Location



The purpose of the Skull Creek Dam Project would be to store and re-time flows, which are primarily available during the nonpeak season, to be available on demand for release to the Platte River just upstream of North Bend. The area draining to this location is approximately 42,000 acres. The Skull Creek Reservoir investigated would have a top of dam at elevation 1435. The maximum normal pool elevation is 1420 corresponding to a surface area of 880 acres and a volume of approximately 12,700 acre-feet (Figure 53).

Figure 53: Skull Creek Reservoir Stage-Storage



The analysis used a water budget approach and looked at capturing watershed runoff and storing during days when excess flows are available on the Platte River (that is, the instream flow appropriation on the Platte River at both North Bend and Louisville are satisfied). Evaporative and seepage losses were estimated on a daily basis based on reservoir stage and surface area. It then considered a July release for each year to augment Platte River flows. The estimated daily reservoir storage from the routing analysis, both with and without this July release, is shown in Figure 54 and the resultant average monthly volume is shown in Figure 55.

Figure 54: Skull Creek Reservoir Routing

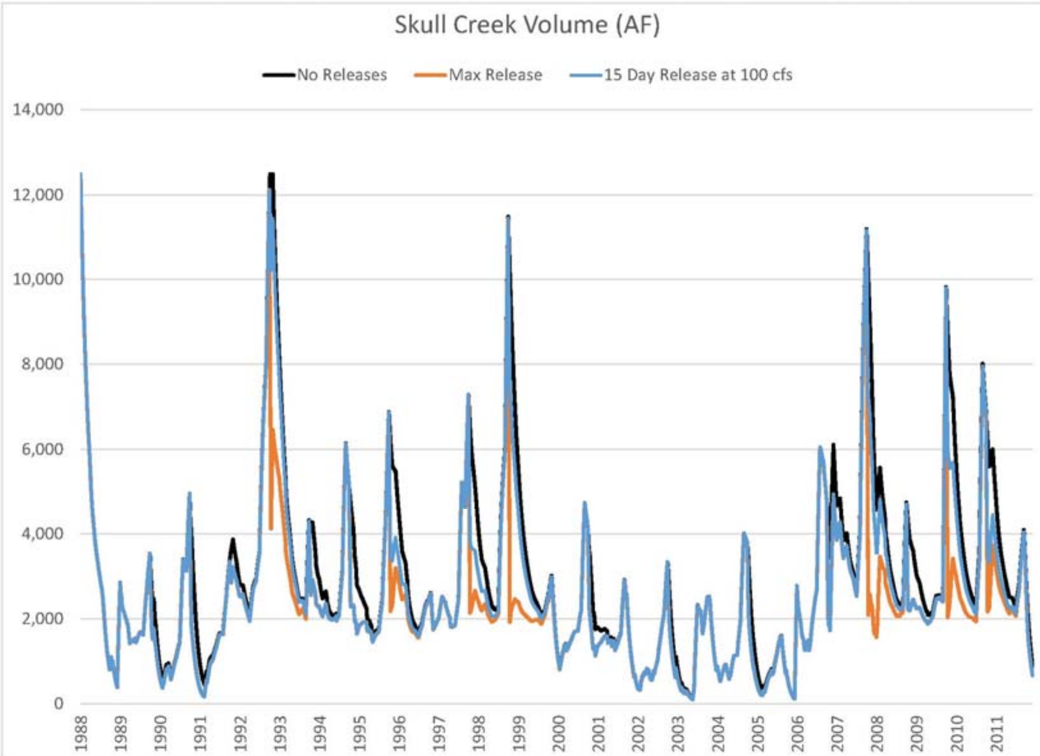
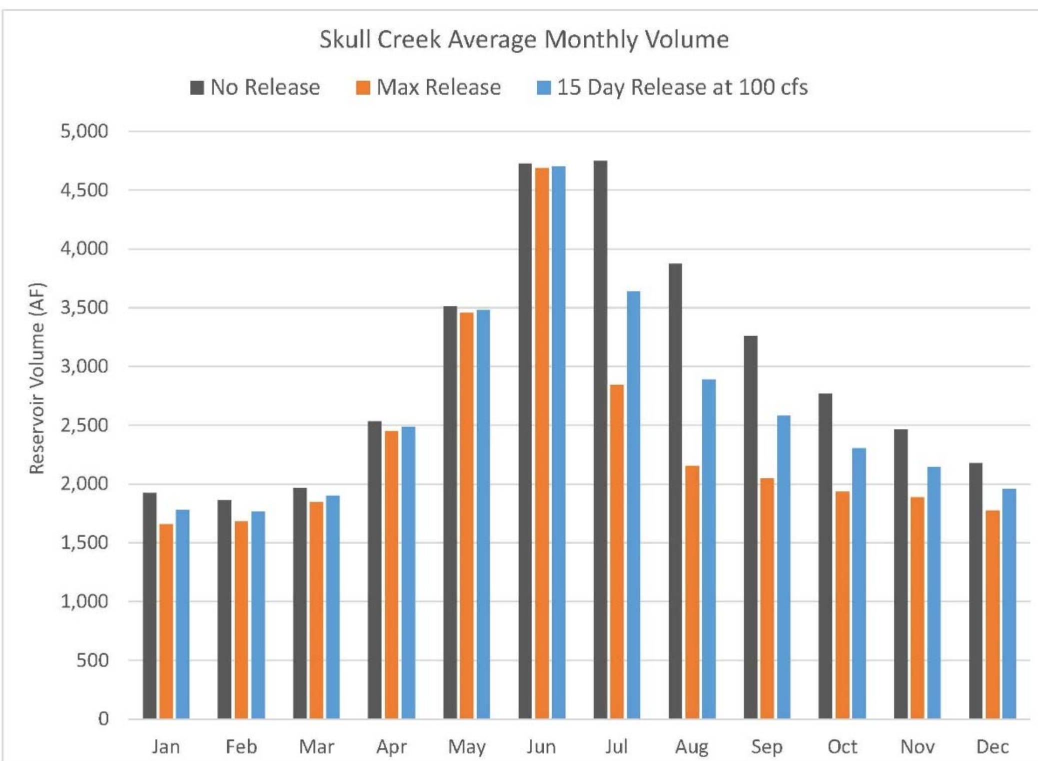


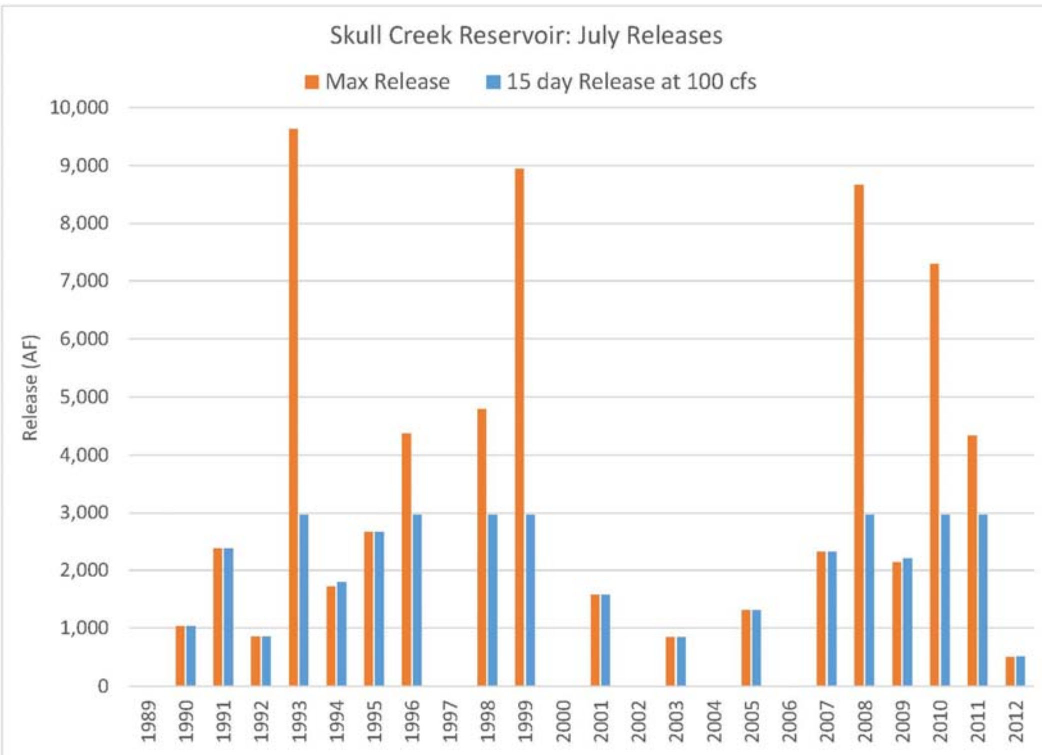
Figure 55: Skull Creek Average Monthly Volume



The estimated annual release that would have occurred during the 1988 to 2011 period is shown in Figure 56. A maximum release scenario evacuates all storage above the dead pool (assumed as 10 percent of normal pool) while a 15-day release at 100 cfs was used in this analysis for comparison with other alternatives.

It should be noted that the seepage loss estimates used in the water budget analysis were based on typical permeability values of prevailing soil types present at the site and likely overestimate losses that could be expected once the reservoir is constructed and natural seasoning of the pool area occurs. In addition the runoff values used for inflow were derived from monthly volumes and are not event-based, likely underestimating inflow volumes. The normal pool surface area is approximately two percent of the total drainage area. Reservoirs in eastern Nebraska with pool areas of two percent to four percent of their drainage area are typically sustainable. For these reasons, the routing results produce conservative estimates of expected yield.

Figure 56: Skull Creek Estimated July Releases



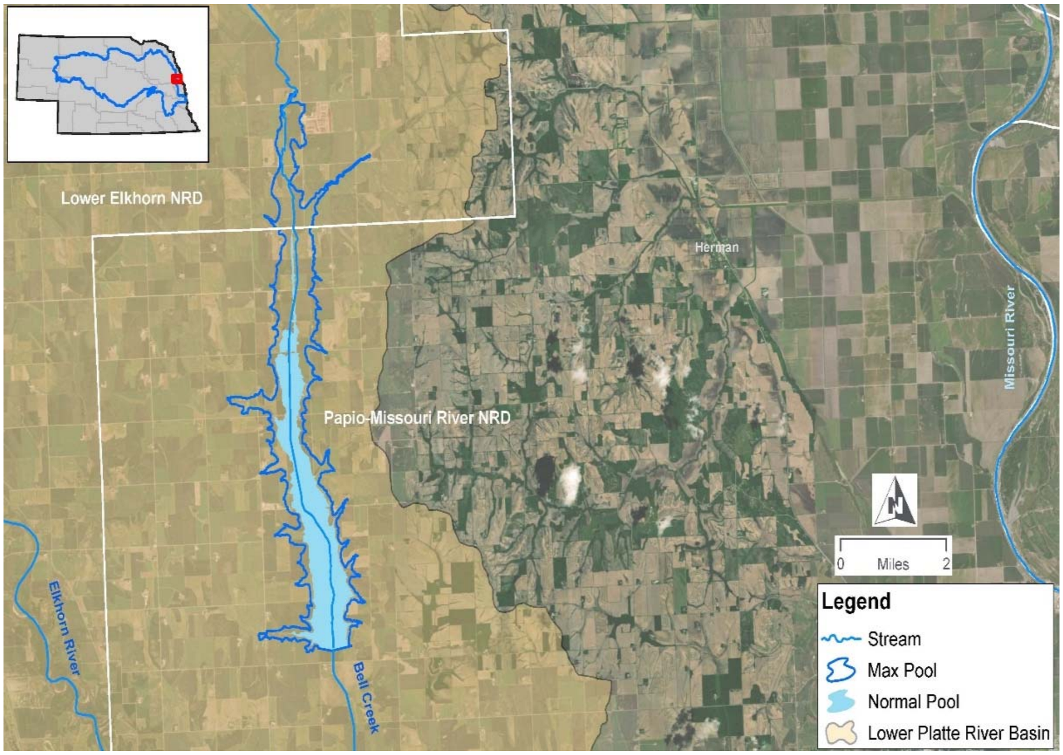
Potential constraints and considerations for a new reservoir include third-party effects due to increased groundwater elevations in the reservoir vicinity, acquisition of land for the reservoir, relocated homes, impacts to roadways adversely affecting connectivity and emergency services, environmental permitting constraints, and managing the reservoir to fulfill multiple project purposes (if necessary).

Project costs would include engineering costs, site construction, land acquisition, mitigation of impacts, and annual operations and maintenance.

5.1.2.3 Bell Creek Reservoir

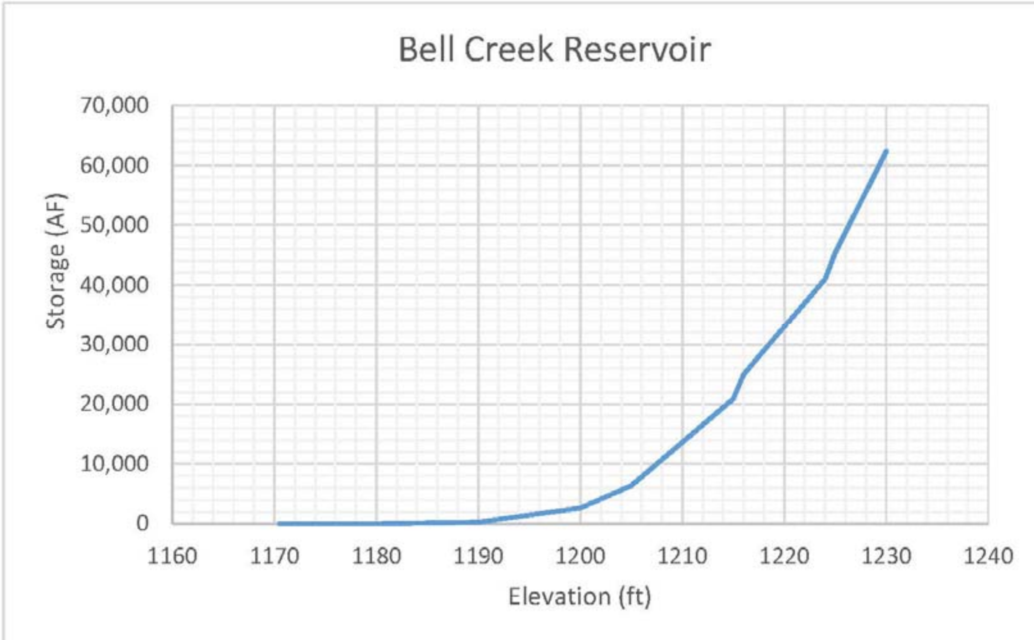
The second potential new reservoir was identified by the 2016 Lower Elkhorn NRD Reservoir Evaluation Project. The new dam would be located on Bell Creek (a tributary to the Elkhorn River) east of Oakland, Nebraska, located in the Papio-Missouri River NRD and extending into the Lower Elkhorn NRD. The location of the potential reservoir for purposes of the Drought Plan is located further downstream than that of the Lower Elkhorn evaluation in order to maximize project benefits (Figure 57).

Figure 57: Bell Creek Reservoir Proposed Location



The purpose of the Bell Creek Dam Project would be to store and re-time flows, which are primarily available during the nonpeak season, to be available on demand for release, joining the Elkhorn River just upstream of Waterloo. The area draining to this location is 85,000 acres. The Bell Creek reservoir investigated would have a top of dam at elevation 1230 corresponding to a normal pool at elevation 1210 with a surface area of 1,720 acres and a volume of approximately 13,600 acre-feet (Figure 58).

Figure 58: Bell Creek Reservoir Stage-Storage



The analysis used a water budget approach and looked at capturing watershed runoff during days when excess flows are available on the Platte River (that is, the instream flow appropriation on the Platte River at Louisville is satisfied). Evaporative and seepage losses were estimated on a daily basis based on reservoir stage and surface area. It then considered a July release for each year to augment Platte River flows. The estimated daily reservoir storage from the routing analysis, both with and without this July release, is shown in Figure 59 and the resultant average monthly volume is shown in Figure 60.

Figure 59: Bell Creek Reservoir Routing (Runoff as only inflow)

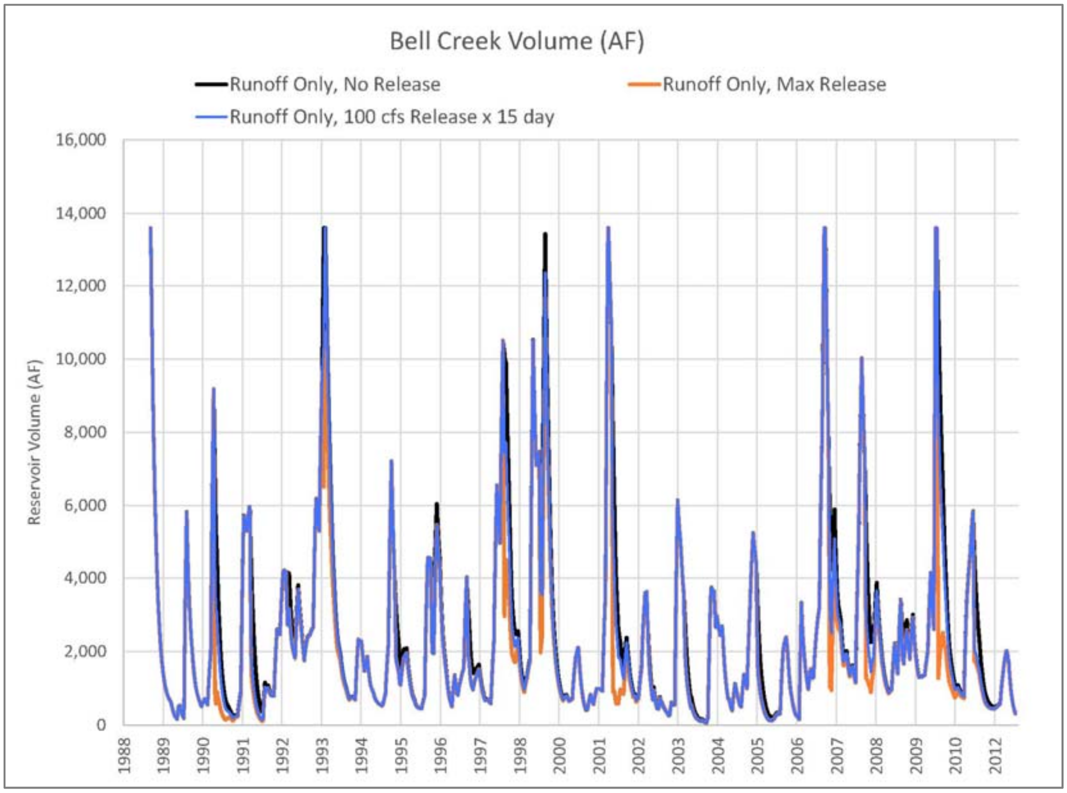
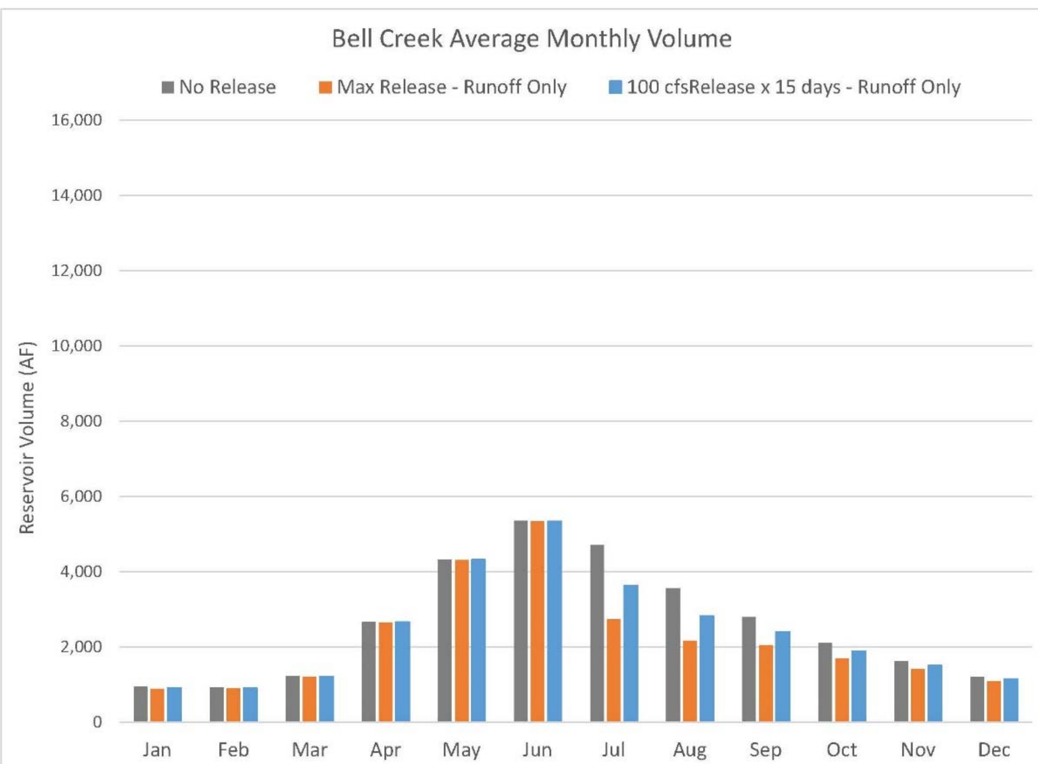


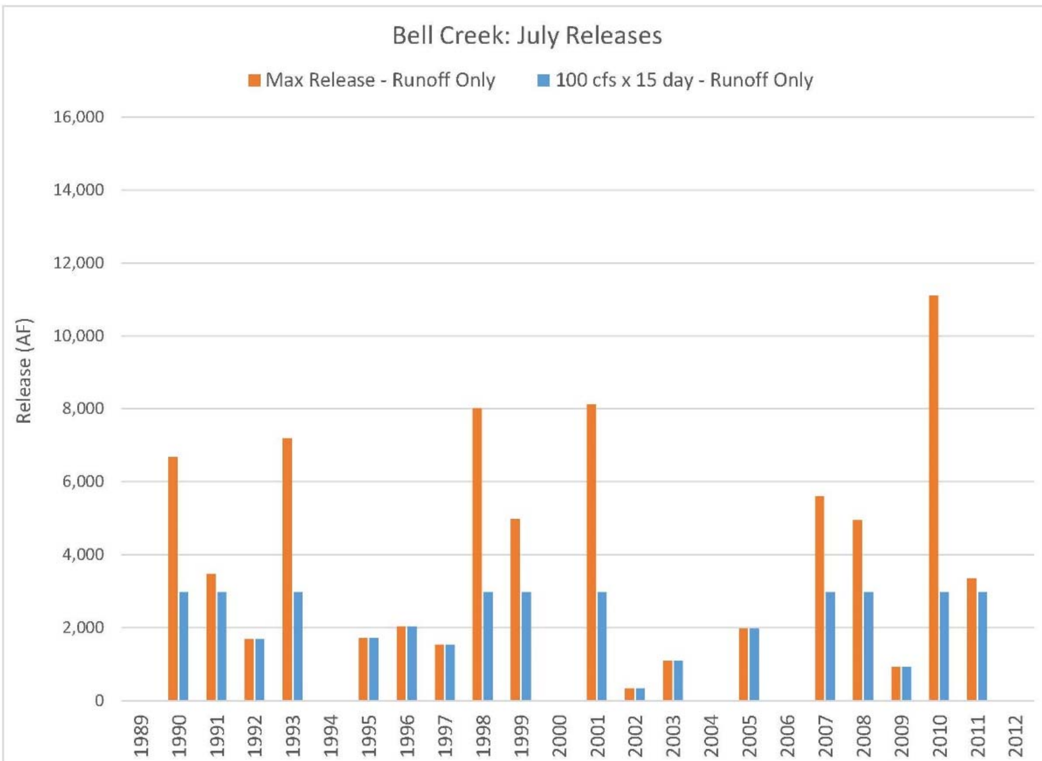
Figure 60: Bell Creek Reservoir Average Monthly Storage Volume based on Runoff



The estimated annual release that would have occurred during the 1988 to 2011 period is shown in Figure 61. A maximum release scenario evacuates all storage above the dead pool (assumes as 10 percent of normal pool) while a 15 day release at 100 cfs was used in this analysis for comparison with other alternatives.

It should be noted that the seepage loss estimates used in the water budget analysis were based on typical permeability values of prevailing soil types present at the site and likely overestimate losses that could be expected once the reservoir is constructed and natural seasoning of the pool area occurs. In addition the runoff values used for inflow were derived from monthly volumes and are not event-based, likely underestimating inflow volumes. The normal pool surface area is approximately 2 percent of total drainage area. Reservoirs in eastern Nebraska with pool areas of 2 percent to 4 percent of their drainage area are typically sustainable. For these reasons, the routing results produce conservative estimates of expected yield.

Figure 61: Bell Creek Estimated July Releases (Runoff as only inflow)



As shown in Figure 59, Figure 60, and Figure 61, capturing runoff and baseflow alone provides a limited volume for release. Therefore, an analysis for a reservoir on Bell Creek was considered in conjunction with the alternative of importing water from the Missouri River. It then considered a July release for each year to augment Platte River flows.

The estimated daily reservoir storage volume for this combined alternative, both with and without a July release, is shown in Figure 63 and the resultant average monthly volume is shown in Figure 63.

Figure 62: Bell Creek Reservoir Routing (importing Missouri River water)

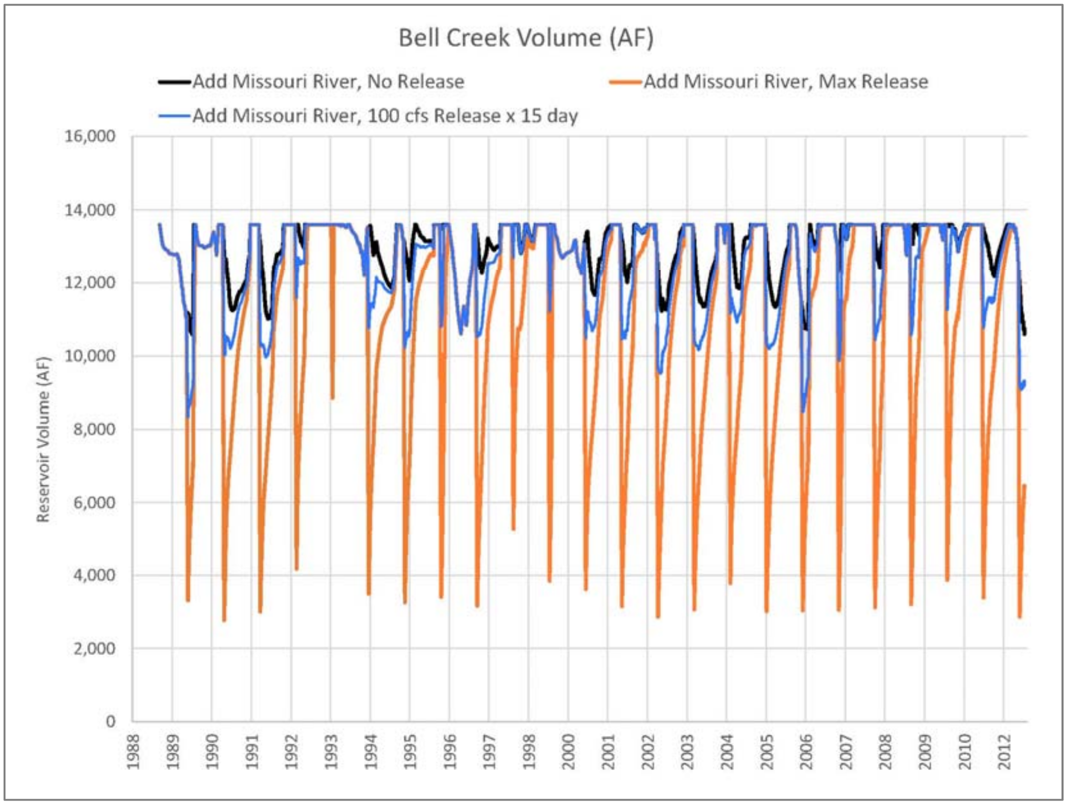
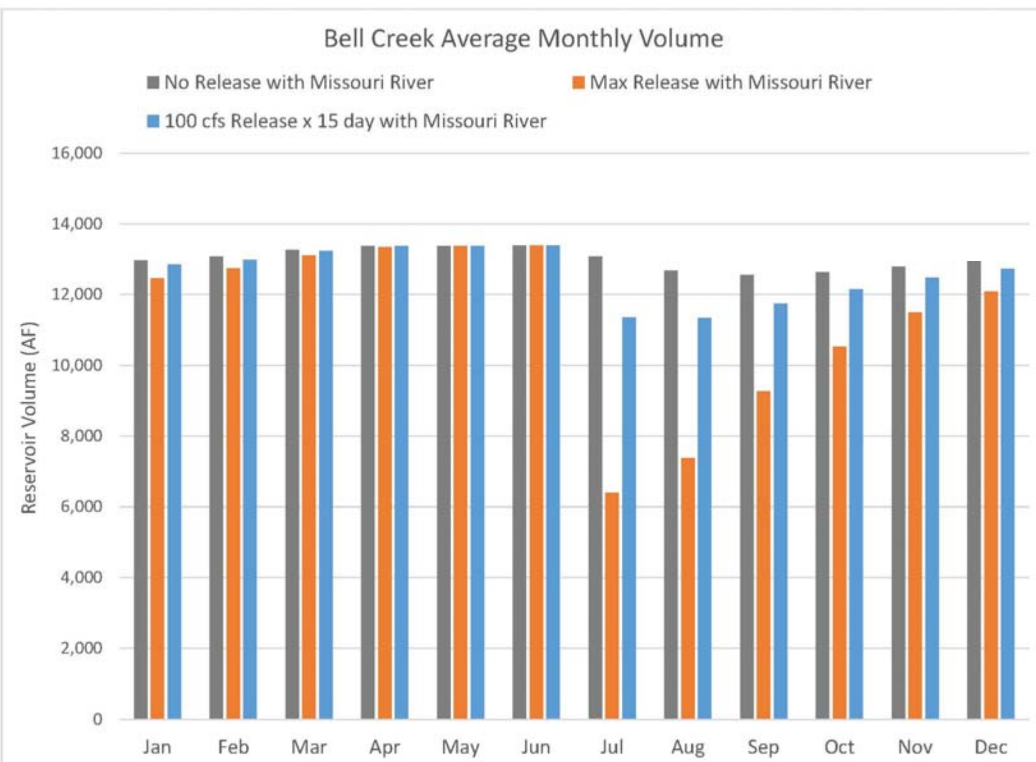
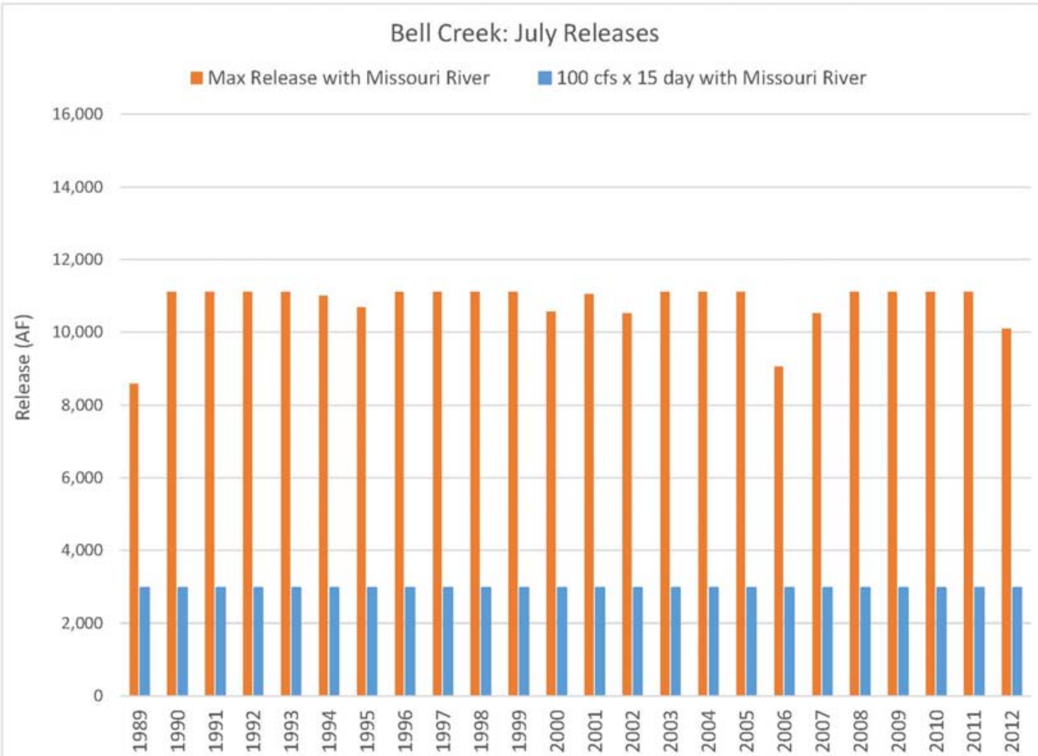


Figure 63: Bell Creek Average Monthly Volume importing Missouri River water



The estimated annual release that would have occurred during the 1989 to 2011 period is shown in Figure 64. A maximum release scenario evacuates all storage above the dead pool (assumes as ten percent of normal pool) while a 15-day release at 100 cfs was used in this analysis for comparison with other alternatives

Figure 64: Bell Creek Estimated July Releases (importing Missouri River water)



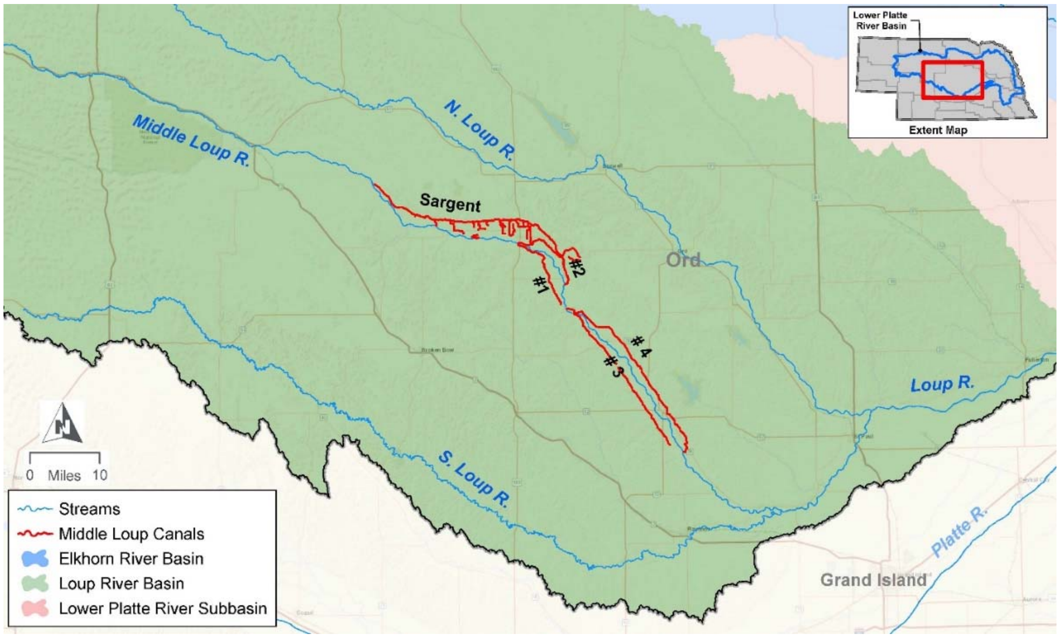
Potential constraints and considerations for a new reservoir include third-party effects due to increased groundwater elevations in the reservoir vicinity, acquisition of land for the reservoir, relocated homes, impacts to roadways adversely affecting connectivity and emergency services, environmental permitting constraints, and managing the reservoir to fulfill multiple project purposes (if necessary).

Project costs would include engineering costs, site construction, land acquisition, mitigating impacts, and annual operations and maintenance.

5.1.3 Canal Recharge through Canal Seepage

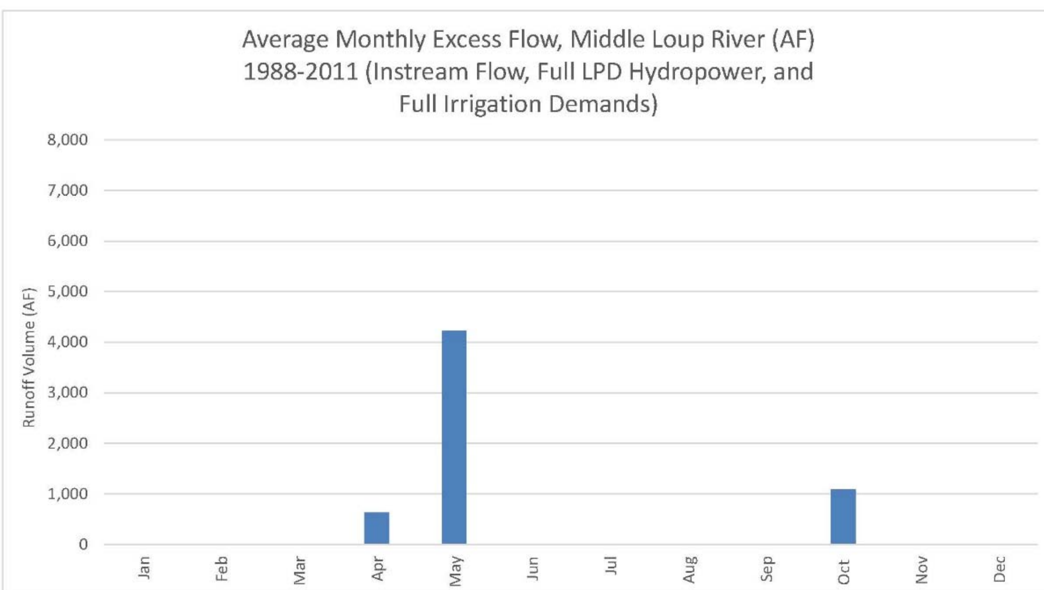
A potential mitigation measure considered the use of existing surface water infrastructure on the canal system in the Middle Loup River basin for intentional recharge of excess flows (Figure 65). Excess flow is defined as the quantity of surface water in excess of the existing state protected flows. An excess flow analysis is useful in determining the location, duration of excess flows, and frequency of excess flows on a monthly time-step when evaluating the volume of water available for capture in support of potential conjunctive management projects.

Figure 65: Middle Loup Canals



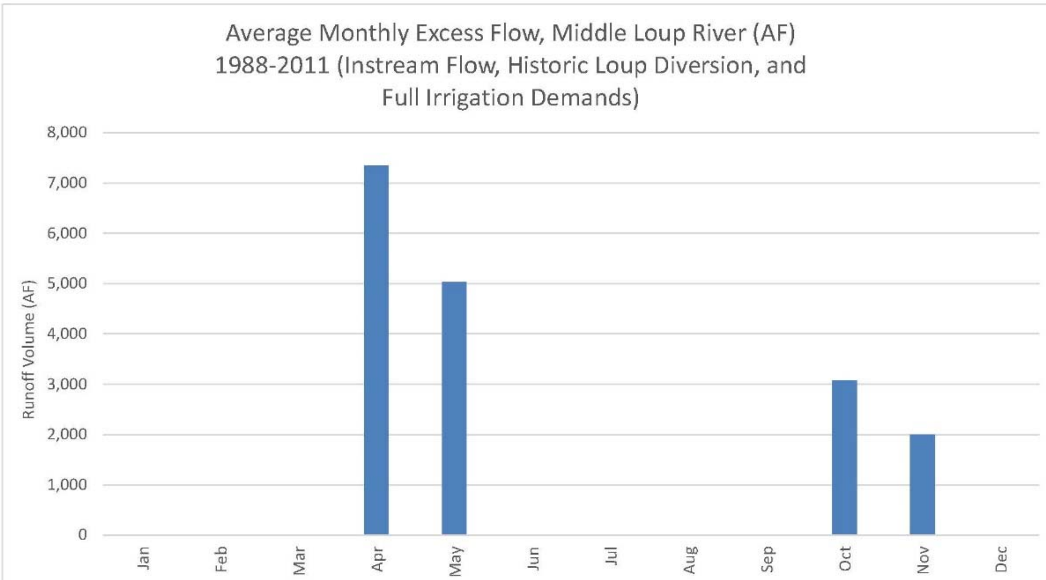
An excess flow evaluation was conducted for the Loup River system that first evaluated excess flows in the Lower Platte River, then working upstream into the Loup River basin. Two demand scenarios were considered when evaluating available excess flows in the Loup River. The first demand scenario considers the full Loup River Public Power District hydropower appropriation placed on the Loup subbasin. The average monthly flow available for diversion on the Middle Loup River for this demand scenario is shown in Figure 66.

Figure 66: Average Middle Loup River Excess Flow (based on Loup Power Surface Water Appropriation)



The second demand scenario considers the historic Loup Power Canal diversion. This demand scenario is considered the historic demand that was actually placed on the basin. The average monthly flow available for diversion on the Middle Loup River for this demand scenario is shown in Figure 67.

Figure 67: Average Middle Loup River Excess Flow (based on historic Loup Power Canal diversion)



Canal recharge alternatives that were considered would re-time flows during the non-peak season (times of low demands) to be available in the peak season (times of high demand) by diverting excess flows from the Middle Loup River into existing canals (Sargent Canal and Middle Loup Canals 1, 2, 3, and 4) during the months of April, May, October, and November. Return flows will passively accrete to the Middle Loup River throughout the year and will be available for use.

Figure 68 shows that when considering historic Loup Canal Diversions, approximately 450,000 acre-feet would have been available for capture and diversion between 1988 and 2011 in the months of April, May, October, and November. The seepage would return to the river naturally throughout the calendar year, with only a portion of this water returning during the peak summer months when drought effects are most severe.

Figure 68: Cumulative Middle Loup Canal Diversions versus Cumulative Returns to Middle Loup River (assuming historic Loup Power Canal diversion)

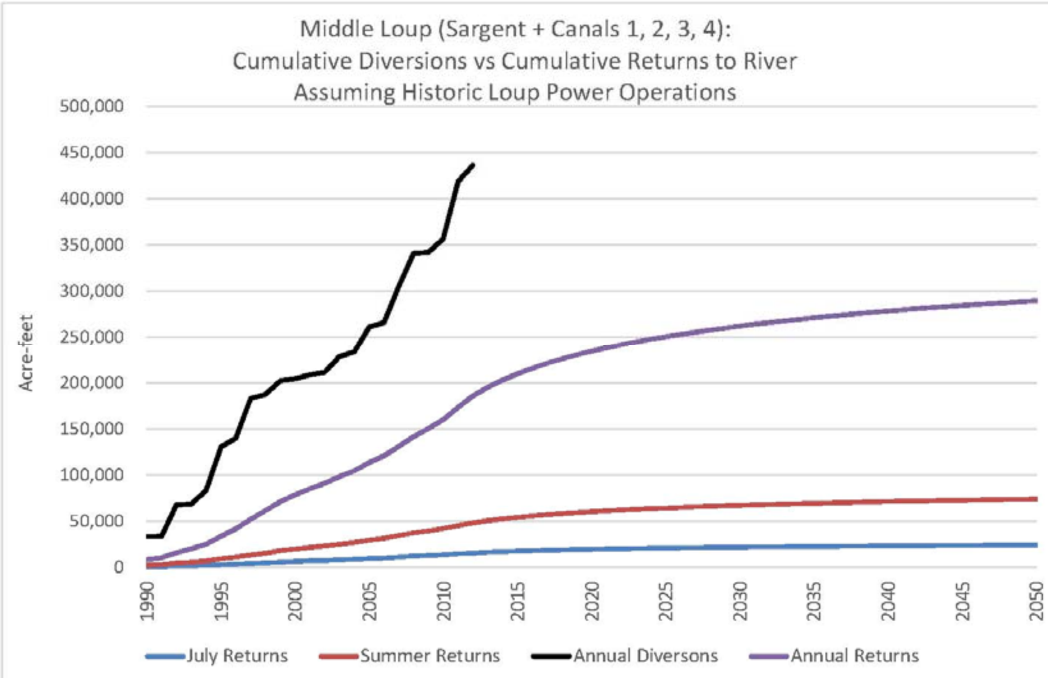
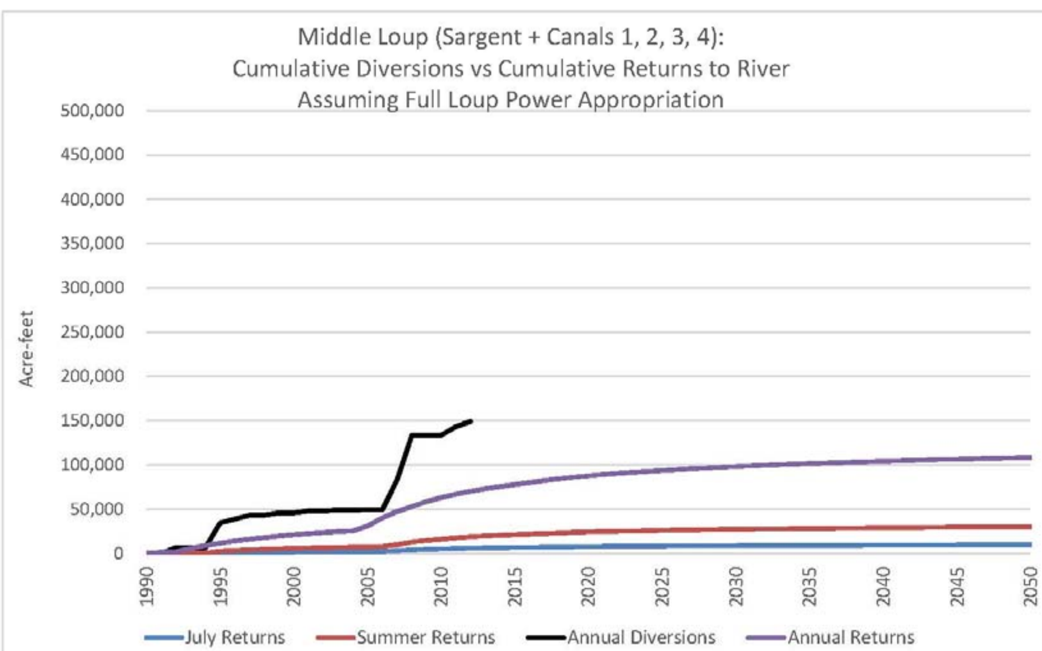


Figure 69 shows that when considering the full Loup River Public Power District hydropower appropriation, a much smaller volume of water is available for capture and diversion (approximately 150,000 acre-feet).

Figure 69: Cumulative Middle Loup Canal Diversions vs Cumulative Returns to Middle Loup River (assuming Loup Power Surface Water Appropriation)



In general, 20 percent of the seepage recharge on the Middle Loup system would return in the first year, 40 percent after 5 years, 60 percent after 20 years, and 80 percent after 90 years. After 20 years of operation, the average summer accretion to the river is 12-15 cfs per day (target season) while the annual accretion to the river is estimated to be over 9,000 AF; improving supply to the stream year-round.

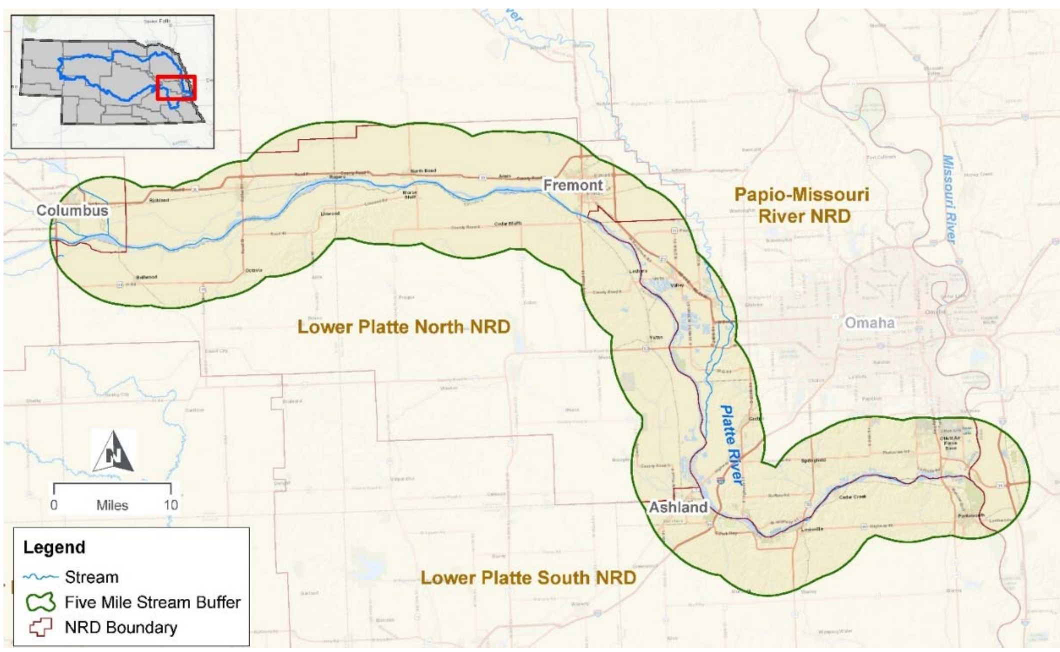
Potential constraints and considerations include third-party effects due to elevated groundwater elevations, coordination with annual canal maintenance activities, and existing operations and agreements amongst existing surface water irrigation districts on the Middle Loup River that may affect the ability to operate the system for intentional recharge in the non-peak season.

Project costs would include the increased operation and maintenance costs of the canal system and compensation through leasing agreements to use the existing canal facilities.

5.1.4 Dry-year Lease Option

The dry-year lease option would limit irrigation in areas adjacent to the Platte River during drought conditions. A rapid response area was defined in the Lower Platte River below the Loup River confluence by placing a 5-mile buffer on either side of the main channel of the Platte River (Figure 70). Irrigation wells in the alluvial aquifer of this area are most directly connected to streamflow in the Platte River and therefore have the quickest and largest depletive effects.

Figure 70: Platte River – Five Mile Buffer – Columbus to Louisville



Approximately 310,000 irrigated acres are located within this area, served by over 3,000 wells according the NeDNR well registration database. Average annual pumping during the irrigation season is approximately 167,500 acre-feet. Analytical analysis using current estimates of stream depletion factors for the area estimates an average daily increase in Lower Platte River flows of approximately 25-30 cfs per day during July and August.

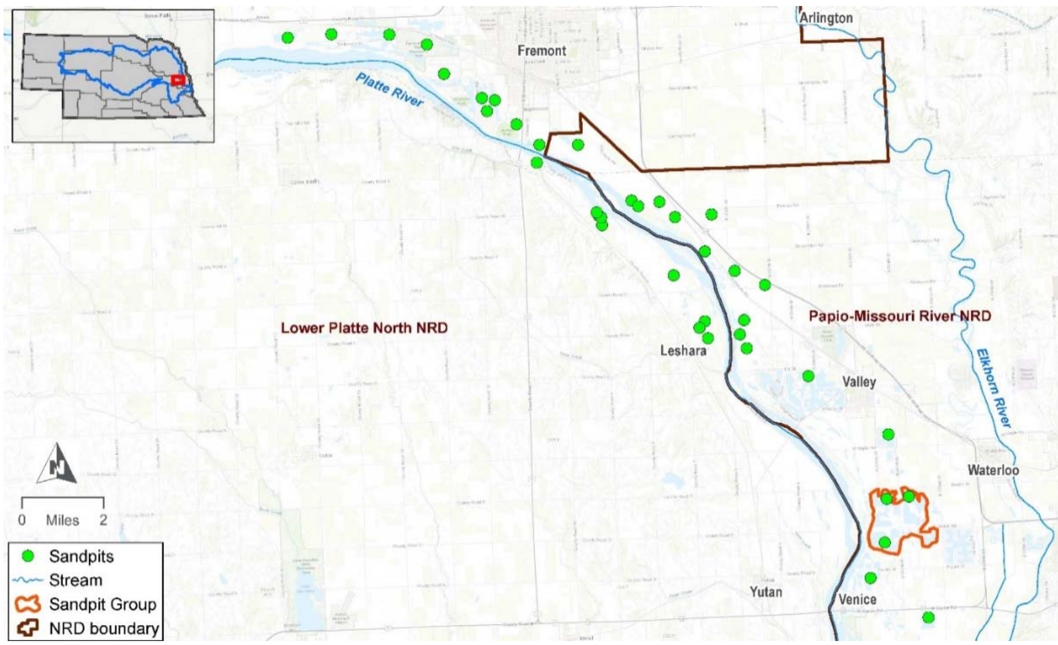
Implementing the dry-year lease option would require agreements with existing producers to forego irrigation in exchange for financial compensation. Typical format and content of these types of agreements vary, but may include a required lead time for notifying producers of intent to exercise the dry-year lease option and a limit on number of times option may be exercised during the agreement term.

Financial terms may include a set annual compensation, or an annual retainer with an escalator clause when option is exercised. The escalator may also vary based on the lead time of notice, as producers may be able to adjust crop type or production inputs accordingly if sufficient lead time is provided.

5.1.5 Alluvial Groundwater Pumping

Alluvial groundwater pumping would involve use of wells to augment streamflow during times of shortage, with aquifer levels recovering during the non-peak season through natural recharge from river flows. The wells may pump surface water from sandpits located adjacent to the river, or from the alluvial aquifer near the river – both have similar depletive effects to streamflow in the Platte River (Figure 71). For analyzing this option, pumping of surface water from adjacent sandpits was investigated.

Figure 71: Platte River Alluvial Sandpits



A series of four small, interconnected sandpits in western Douglas County adjacent to the Platte River was evaluated to estimate project benefits. The total area of the system of sandpits is approximately 1,150 acres. This option would include financial compensation for the ability to drawdown the sandpit 4-ft in the event of a drought, yielding approximately 4,600 AF of water (equivalent to 100 cfs of augmented flows for a duration of 23 days). It is noted that this option would have an operational constraint to be considered. Because of the proximity and high degree of connection to the river, depletive effects of augmentation pumping would begin to be reflected in Platte River streamflow in a matter of days or weeks. Therefore, use of this option early in the peak season during a drought (June or July, for example), could potentially exacerbate drought conditions and decrease streamflow in the Platte River later in the peak season (August, for example).

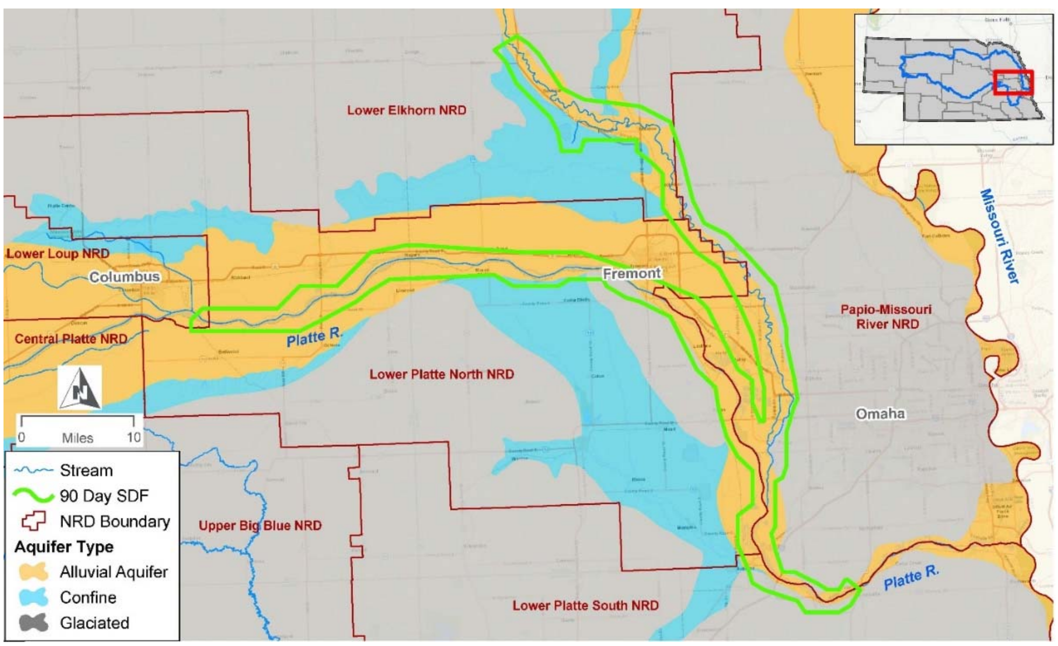
Costs associated with this option would include financial compensation to sandpit owners for the right to use the water from the sandpits as well as capital and O&M costs for the infrastructure to pump and deliver water to the river.

5.1.6 Groundwater Well-field Augmentation Project

The purpose of a well-field augmentation project would be to develop a well-field at a location with significant and accessible groundwater supplies, preferably at a considerable distance from the stream (low connectivity). New wells would draw water primarily from the aquifer, so as not to rely on induced recharge from the nearby surface water sources in the short term. This requires balancing the distances of the new wells from the river with the infrastructure costs for delivery (if pipe is used for conveyance) or conveyance losses (if natural channel conveyance is used). Ideally, new wells would be spread out to minimize interference with neighboring wells. The well-field could be used to pump water on demand that could be delivered to augment surface water flows, primarily for short durations during times of low-flows.

While specific sites were not investigated in detail, potential locations for a well-field augmentation project include the alluvial aquifers of the Platte and Elkhorn River systems (located outside the 90-day stream depletion factor (SDF) line); and in the Todd Valley in the Lower Platte River area. Figure 72 depicts the 90-day SDF line, which corresponds to the offset from the stream at which effects of pumping would take 90 days to deplete streamflow. This lag effect should be considered when locating any potential augmentation well sites. Sites should be located outside of this 90-day SDF line to delay depletion of the streamflow until the peak demand summer months have passed.

Figure 72: 90-Day Stream Depletion Factor Line



Potential constraints and considerations include third-party effects due to well-field pumping, well interference, discharge capacity of the receiving tributary (should one be used in lieu of direct conveyance to the river), and managing depletive effects of well-field pumping so as not to exacerbate low-flow conditions.

Project costs would include the development of the wells and well-field infrastructure, conveyance infrastructure, right-of-way, and annual operation and maintenance expenses.

5.1.7 Interconnection of MUD and LWS Finished Water Supplies

The interconnection of MUD and LWS finished water supplies would provide LWS access to the Missouri River as a source of potable water. MUD currently has three water treatment plants (WTP) with a total capacity of approximately 320 million gallons per day (MGD). These treatment plants are diversified in their sources with the Missouri river serving the Florence WTP (160 MGD), and Platte River well fields serving both the Platte South (60 MGD) and Platte West (100 MGD) WTPs. The interconnection would include moving water within MUD's system from the Florence WTP to the Platte South WTP area. where the interconnection with LWS would be made. Required infrastructure would include pipelines, pump stations, and appurtenances for conveying water through the interconnection.

Independent of this planning effort, LWS and MUD have engaged in a joint study to review the feasibility of an interconnection between the two water providers. The Purpose of the study was to complete an initial evaluation of the potential interconnection between MUD and LWS by reviewing the following items: finished water chemistry compatibility; water supply and modeling evaluation to determine how much water can be moved from the Florence WTP to the Platte South area; options for transferring water from the MUD system to LWS's system; a conceptual design and cost forecast for the connection facilities, pipelines and pump stations needed for the project; and a financial/governance evaluation. Preliminary results indicated that the water chemistries are initially compatible, and there is adequate capacity within MUD's system to provide water to LWS. The financial governance evaluation is on-going.

This alternative would utilize closed conveyance systems targeted to address potable water for municipal and industrial uses. While Platte River flows would not be directly augmented by this alternative, the interconnection could potentially provide reduced pumping from the Platte River alluvial aquifer – and therefore reduced stream flow depletions - during droughts.

5.2 Evaluation of Potential Mitigation Measures

Drought mitigation measures are actions, programs, and strategies implemented during non-drought periods to address potential risks and effects and to reduce the need for response actions; implementation of drought mitigation measures improves long-term resilience and reliability of the regional water supply.

Eight mitigation measures, and variations or combinations thereof, were evaluated in the Drought Plan that could increase regional water supply reliability. These include the following and are summarized in Table 18 and Table 19:

- Installing an alluvial well-field adjacent to the Missouri River and pumping water to a tributary of the Elkhorn River for availability on demand (two alternatives considered in Table 18 and Table 19: one that discharges directly into Bell Creek and a second that discharges into the proposed Bell Creek Reservoir);
- Purchasing storage in the existing Sherman Reservoir and releasing water on demand (two release volumes considered in Table 18);
- A new surface water storage reservoir on Skull Creek near Linwood for releasing water on demand;
- A new surface water storage reservoir on Bell Creek east of Winslow for releasing water on demand;
- Capture of Middle Loup River water in the non-irrigation season and diversion into the Middle Loup Canal system for intentional recharge and increase baseflow (two demand scenarios evaluated in Table 18 and Table 19: one that considers the historic Loup hydropower operations downstream and a second that considers the full Loup hydropower appropriation downstream);

- Installing a well-field to tap into groundwater aquifers with limited connection to streamflow that can be pumped to the river to augment flows;
- Pumping from alluvial sandpits directly to the river to supplement flows; and
- A rapid response area/dry-year-lease agreement with farmers irrigating lands adjacent to the main channel of the Platte River from the alluvial aquifer.
- Interconnection of MUD and LWS finished water supplies, providing LWS access to the Missouri River as a source of potable water

Conceptual design of infrastructure requirements and anticipated operational characteristics were defined for each mitigation measure. In addition, the estimated project yield to the Lower Platte River at the Ashland gage was determined. For projects upstream in the basin, a routing tool was used to estimate the losses that occur during conveyance to the Ashland gage. This routing tool utilizes historic reach loss data during low-flow periods to estimate conveyance losses (see Appendix D). As part of this planning effort, continuous recording monitoring wells paired with stage recorders were installed to foster a better understanding of losses in the Lower Platte River under varying hydrologic conditions.

For comparison of alternative costs and benefits, a 20-year period was evaluated to reflect the relative reliability of water from the mitigation action, i.e. for some mitigation actions water will not be available every year. A 15-day operation period, targeting the typical late-July/early-August critical low-flow period in the Lower Platte River was assumed for project operations. For developing cost/acre-foot estimates included in Table 18, costs were estimated over a 20-year period without using a discount rate or otherwise accounting for the time value of money. Benefits were based on acre-foot of water estimated to be delivered at the Ashland gage during the 15-day target period over the 20-yr period. Assumptions for each mitigation action are described in Appendix C.

During implementation of the Plan, the Consortium intends to further prioritize the identified alternatives for construction and incorporation into the Plan's mitigation and response actions. A table-top drought exercise will be used to evaluate alternatives that considers more severe droughts. These conditions include extended duration droughts (4 to 6 months of 2012 river conditions during the peak of the drought), as well as back-to-back years of severe, extended drought occurrence to fully test mitigation alternatives. This exercise will be used to prioritize mitigation actions for implementation based on criteria such as:

- Reliability of water supply during drought conditions
- Ability to address extended drought durations
- Ability to mitigate drought effects on all three identified sectors impacted by drought
- Costs of the action – both capital costs and operation and maintenance expenses
- Operational constraints of the alternative that may limit effectiveness during droughts
- Feasibility of alternative – accounting for elements such as required permits, infrastructure or ROW agreements, public acceptance, etc.

Table 18: Evaluation of Potential Mitigation Measures (cost estimate versus volume of water added)

	Volume Added at Source			Volume Increase at Ashland			
Alternative	Cumulative AF/15 days	Ave Daily cfs	Where Added	Cumulative AF/15 days	Ave Daily cfs	Cost Estimate	Cost per acre-foot added at Ashland
Import Missouri River Water to Bell Creek (via alluvial well-field ; no reservoir)	59,400	100	Waterloo	46,300	80	$76,572,840	$1,654
Sherman Release (400 cfs at St Paul)	47,520	400	St. Paul	15,720	132	$9,628,000	$612
Sherman Release (250 cfs at St. Paul)	29,700	250	St. Paul	9,800	83	$6,955,000	$710
Skull Creek Res. Rel. (100 cfs at Linwood)	59,400	100	Linwood	46,300	80	$32,630,000	$705
Bell Creek Reservoir (Release 100 cfs at Waterloo)	59,400	100	Waterloo	46,300	80	$81,520,000	$1,761
Pump Missouri River water (via alluvial well-field) into Bell Creek Reservoir	59,400	100	Waterloo	46,300	80	$129,564,000	$2,798
Middle Loup Canal Recharge (Historic Loup Canal Operations)	7,525	13	Arcadia	2,525	4	$16,360,000	$6,478
Middle Loup Canal Recharge (Full Hydropower Right downstream)	2,034	3	Arcadia	634	1	$5,225,000	$8,238
Alluvial sandpit pumping	14,850	100	Leshara	14,850	100	$5,980,000	$403
Augmentation Well-field	59,400	100	TBD	59,400	100	$81,008,040	$1,364
Rapid Response Area/ Dry-year Lease	4,000	33	Columbus to Louisville	4,000	33	$248,500,800	$62,125
Interconnection of MUD and LWS finished water supplies	See notes	See notes	See notes	See notes	See notes	See notes	See notes

Notes:

- This list is not intended to be all-inclusive. Potential mitigation measures may be further evaluated in future increments of the Drought Plan
- AF = acre-feet; cfs = cubic feet per second;
- 20-year period evaluated to reflect relative reliability of each measure;
- Fifteen-day operating period, targeting late July/early August critical low-flow period;
- Routing tool used to estimate reach gains/losses;
- Cost per acre-foot based on water that makes it to Ashland (common point). Reach losses for evaluation assume 66% loss from the Loup River to Ashland, 20% loss from the Elkhorn River to Ashland, and 20% loss from North Bend to Ashland;
- Interconnection would directly link of MUD and LWS finished water supplies without utilizing the Platte River for conveyance and would directly address impacts of drought on potable water supplies. A more detailed analysis of feasibility and costs associated with this alternative is being conducted as a separate study.

Table 19: Evaluation of Potential Mitigation Measures (advantages, disadvantages, and uncertainties)

Alternative	Advantages	Disadvantages	Uncertainties
Import Missouri River Water (via alluvial well-field to Bell Creek/no reservoir)	• Secondary source of water outside of Platte River basin increases supply reliability. • Operational every year & year-round	• Larger construction cost than many alternatives • Implementation - 5-10 years	• Future regulation on Missouri River • Well field siting
Sherman Release (400 cfs at St Paul)	• Utilizes existing facilities (no construction cost) • Produces large volume of water on-demand • Historically Loup River supply adequate to fill reservoir every year. • Implementation: 1-2 years	• Likely limitation on frequency of call on storage water • Significant conveyance losses from release point to Lower Platte River	• Requires cooperation and agreements with existing facility owners. • Negotiations will dictate price. • Cost estimates based on similar agreements in state.
Sherman Release (250 cfs at St. Paul)			
Skull Creek Res. Rel. (100 cfs at Linwood)	• Available every year & year-round • Produces large volume of water on demand • Potential for multi-purpose facility	• Larger construction cost than many alternatives • Land requirements, involving multiple landowners • Implementation: 5-10 years	• Runoff volume varies year to year • Land use impacts on runoff • Implementation (permitting, land purchase, etc.)
Bell Creek Reservoir (Release 100 cfs at Waterloo)			
Pump Missouri River water (via alluvia well-field) into Bell Creek Reservoir	• Secondary source of water outside of Platte River basin increases supply reliability. • Operational every year & year-round. • Importing into Bell Creek Reservoir requires a lower capacity system for importing water - saving $$	• Larger costs associated with combining alternatives that require both land and infrastructure. • Implementation: 5-10 years	• Future regulation on Missouri River • Well field siting • Implementation (permitting, land purchase, etc.)
Middle Loup Canal Recharge (Historic Loup Canal Operations)	• The canal recharge and dry-year lease projects are passive mitigation measures whose benefits (passive baseflow returns) accrue throughout the year, adding supply reliability to the overall system. • Existing infrastructure – no initial construction costs • Implementation: 1-2 years	• Unavailable to release a pulse of water volume "on-demand". • Takes time for the full benefit to be realized in river (lag effect) and some attenuation	• Requires cooperation and agreements with existing facility. • Negotiations will dictate price. • Cost estimates based on similar agreements in state. • Amount of improvement of overall system supply from year around accretions
Middle Loup Canal Recharge (Full Hydropower Right downstream)			
Alluvial sandpit pumping	• Minimal infrastructure costs (pumps from existing sandpits) • Utilizes existing sandpits (no construction costs) • Implementation: 1-2 years	• Limited operation window as pumping this close to the river may cause depletions to the stream (lag effect) that amplify impacts during extended drought • Likely limitation on the number of calls allowed in a 20-year period	
Augmentation Well-field	• Available every year & year-round • Can be located closer to critical reach to reduce losses compared to alternatives producing similar volumes upstream in the Basin.	• Land & infrastructure costs make this one of the more expensive alternatives. • Adds to overall depletions • Implementation: 5-10 years	• Siting to avoid interference with existing wells. • Long-term reliability of aquifer
Rapid Response Area/ Dry-year Lease	• No infrastructure or construction necessary.	• Logistics of securing agreements with thousands of producers • Likely limitation on the number of calls allowed in a 20-year period • Most expensive of all the alternatives by an order of magnitude based on assumptions. • Crop insurance likely affected in years when agreement enforced	• Negotiations will dictate price. • Cost estimates based on similar agreements in state, and factors such as cost differential between irrigated and dry land rental rates. • Uncertain how many producers would participate (benefits assume 100% participation which is unlikely)
Interconnection of MUD and LWS finished water supplies	• Directly and efficiently addresses drought impacts on potable water supplies • Provides access to the drought-resistant Missouri River as a source • Implementation: 3-5 years	• Does not directly address low flow conditions on the Platte River during drought; however may reduce pumping demands on municipal wells adjacent to the Platte River during drought conditions • Infrastructure costs associated with linking finished water supplies	• Feasibility of linking water supplies (water chemistry, system hydraulics, legal framework, etc.) • A more detailed feasibility study is currently being undertaken

Notes: This list is not intended to be all-inclusive. Potential mitigation measures may be further evaluated in future increments of the Drought Plan

5.3 Response Actions

Drought response actions are near-term actions triggered during specific stages of drought to manage the limited supply and decrease the severity of immediate effects. Response actions can be quickly implemented and can provide rapid benefits.

In this first increment of the Drought Plan, potential mitigation measures (Table 18 and Table 19) have been evaluated, but preferred measures have not been determined or constructed; therefore, the primary drought response action available to the Consortium at this time is communication and outreach.

Consistent and coordinated messaging to basin water users (municipal, industrial, domestic, irrigation, etc.), as well as the general public, raises awareness of the current water supply conditions, allows water users to proactively alter their demand and usage based on limited water supplies, and defines expectations of forecasted conditions and potential actions in response to the drought.

5.3.1 Coordinated Public Messaging Effort

Consistent and coordinated messaging to basin water users (municipal, industrial, domestic, irrigation, etc.), as well as the general public, raises awareness of the current water supply conditions, allows water users to proactively alter their demand and usage based on limited water supplies, and defines expectations of forecasted conditions and potential actions in response to the drought.

The internet and other digital sources capture a wide audience and it is important that the right information out. The Consortium website should include drought stage, an explanation of the drought stage, links to water efficiency and conservation information, and a link to drought plan.

The Consortium should maintain directions for directing media inquiries. A list of media contact is provided in Table 20. A draft press release follows.

Table 20: Media Contact Information

Contact Information	
Washington County Pilot-Tribune & Enterprise Mark Rhoades PO Box 328, Blair, NE 68008 (402) 426-2121 editor@enterprisepub.com	Columbus Telegram & Fremont Tribune Vincent Laboy 1254 27th Ave, Columbus, NE 68601 (402)753-9000 vincent.laboy@lee.net
Lincoln Journal Star Dave Bundy 926 P Street, Lincoln, NE 68508 (402) 473-7334 dbundy@journalstar.com	Norfolk Daily News Cristina Anderson 525 Norfolk Ave, Norfolk, NE 68701-0977 (402) 371-1020 canderson@norfolkdailynews.com
Omaha World Herald Jeff Hartley 1314 Douglas Street, Omaha, NE 68102 (402) 444-1000 Jeff.hartley@owh.com	Wahoo Newspaper Lisa Brichacek 564 N. Broadway Street, Wahoo, NE 68066 (402) 443-4162 Lisa.brichacek@wahoonewspaper.com
Bilingual Media Contacts	

Contact Information	
El Perico Clay Seaman PO Box 7360, Omaha, NE 68107 (402) 341-6967 clay@el-perico.com	Buenos Dias Nebraska (online) Oscar Erives 120 W. 3rd St, Grand Island, NE 68801 (308) 381-7777 oscarerives@yahoo.com
KBBX Radio (97.7 FM) J. Timm 11128 John Galt Blvd, Omaha, NE 68137 (402) 884-0968 jtimm@connoisseurmedia.com	KHUB PO Box 669, Fremont, NE 68025 (402) 721-5012 khub@nrgmedia.com

Press Release Template:

For Immediate Release

Contact: Name, phone, email

Headline (7-10 words that describe major point of the release)

City, Date

Main Paragraph (quickly answers who, what, where is it taking place, when and why is this important of the story)

Quote (from pre-determined spokesperson. Quote should say action Consortium is taking, tell people what actions they should be taking, etc.)

Key Message 1 (supporting points)

"The Lower Platte River Basin has been experiencing an extended period of drought conditions which results in declining levels .. . . In accordance with Drought Contingency Plan, once the [drought indicator], drought condition declared.

Key Message 2 (supporting points)

- Level 1, "Moderate Drought:" This level of drought involves "some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; and voluntary water-use restrictions requested," according to the monitor.
- Level 2, "Severe Drought:" This level means that "crop or pasture losses likely; water shortages common; and water restrictions imposed," the monitor states.
- Level 3, "Extreme Drought:" This is the second-highest level of drought, with "major crop/pasture losses" and "widespread water shortages or restrictions."

Key Message 3 (supporting points)

The situation continues to evolving and may change (better or worse) depending on future weather conditions. Update as new information becomes available.

More information (Name, phone, web site, other ways to get information)

In order to maintain consistent public messaging, a scripted message template is included.

Table 21: Scripted Message Template

NOTE: Direct all media inquiries to ________________ (or his/her designee): Phone: Email: Revised: (date)		
Contact/Target Audience	Sample Question	Consortium Response
General Public	"When will water flow return to normal?"	
	"Is my water use restricted now? When will the restrictions be lifted?"	
	"What are you doing to prevent this from happening again?"	
Government Regulator	"What are the impacts?"	
Elected Official	"What is the impact on the community? The environment? The economy?"	
News Media	"What are the current water supply conditions?"	
	"What is the status of the community demand reduction response?"	
	"What is the status of conservation measures?"	
	"What is the estimated loss?"	
	"What caused the incident?"	
	"What are you going to do to prevent this from happening again?"	

5.4 Additional Drought Resources

In addition to the specific monitoring, mitigation, and response actions identified in development of this plan, additional resources and actions of national, state, and local programs exist to aid in preparing for and responding to drought conditions. While not part of this plan's actions, the programs and actions described in this section are available to the Consortium and its constituents to aid in times of drought.

5.4.1 National Drought Mitigation Center

The NDMC website (https://drought.unl.edu/droughtplanning/PlanningHome.aspx) provides a wealth of information and actions to take before, during, and after a drought for a variety of impacted water users. In addition, the University of Nebraska Institute of Agricultural and Natural Resources has specific drought information and resources for Nebraska at the following website: (https://droughtresources.unl.edu/)

5.4.2 Nebraska Soil and Water Conservation Program

The Nebraska Soil and Water Conservation Program, established in 1977, provides state financial assistance to Nebraska landowners for the installation of approved soil and water conservation measures that improve water quality, conserve water, and help control erosion and sedimentation. Among the eligible practices for cost-share assistance are; terraces, terrace outlets (grassed or mechanical), irrigation reuse pits, grade stabilization structures, dams, diversions, grassed waterways, control basins, pasture and range seeding, planned grazing systems, irrigation water management, and windbreaks and windbreak renovations.

The Nebraska Natural Resources Commission determines the list of eligible practices, establishes operating procedures for the fund, and allocates the funds annually among the State's 23 NRDs. The USDA Natural Resources Conservation Service (NRCS) provides the technical assistance needed in planning and installing the approved conservation measures. Each NRD is responsible for the administration of the program at the local level including accepting applications from landowners, setting priorities, and working with the landowners and contractors to complete the practices.

Table 22: Nebraska Soil and Water Conservation Program – Drought Relevant Practices

Practice ID	Practice Name	Purpose
NC-1	Constructing Terrace Systems	To control erosion on cropland, to conserve water and to reduce pollution
NC-3	Constructing Water Impoundment Dams	To impound runoff, conserve water, prevent erosion, prevent pollution, and to enhance groundwater recharge
NC-5	Constructing Irrigation Tailwater Recovery Pits with or without Underground Return Pipe	To impound runoff from irrigated fields for reuse; hence, conserving groundwater
NC-6	Constructing Diversions	To divert water from areas where it is in excess to sites where it can be used or disposed of safely
NC-8	Constructing Water-and-Sediment-Control Basins	To reduce on-site erosion, reduce sediment, reduce sediment content in water, intercept and conduct surface runoff through subsurface conduits to stable outlets, reduce peak rate or volume of flow at downslope locations, reform the land surface, and improve farmability

Practice ID	Practice Name	Purpose
NC-9	Constructing Dugouts for Livestock Water (runoff collection only)	To create an impoundment for livestock water use by excavating to collect runoff in grassland.
NC-10	Pasture Planting or Range Seeding (land use conversions)	To establish grass on land being converted from other uses or the renovation of existing pasture or range
NC-11	Critical Area Planting (grass)	To stabilize the soil, reduce damage from sediment and runoff to downstream areas
NC-12	Windbreaks	To establish a stand of trees to conserve soil and moisture and to prevent erosion
NC-13	Constructing Underground Return Pipe from Irrigation Tailwater Recovery Pits	To provide a permanent conveyance facility for water impounded by an approved tailwater recovery pit to the water supply that created the tailwater.
NC-14	Planned Grazing Systems	To reduce erosion and improve water quality by maintaining or improving plant cover for increased forage production, enhanced wildlife habitat, grazing uniformity and water use efficiency
NC-16	Windbreak Renovation	To provide for the restoration of farmstead or field windbreaks that have been rendered substantially ineffective due to the death of trees or other windbreak plantings as a result of weather, disease, or other natural causes
NC-17	Irrigation Water Management	To conserve groundwater and surface water by improving water use efficiency on irrigated lands
NC-19	Repair of Practices	To repair the following practices or practice elements when the damage to the practice is due to natural cause(s) rather than improper or inadequate maintenance; terraces, dams, diversions, grade stabilization structures, and livestock water supply pipelines. Any repair work must return the practice to a condition that meets technical specifications of the NRCS.

5.4.3 Education Programs

Many NRDs participate in school outreach programs to help teach children about the importance of conserving natural resources and ways they can contribute to a safe, clean environment. Elementary students attend water and natural resources festivals across the state, while older students benefit from outdoor classroom development, contests for land, range, and soil judging, and other activities.

Many NRDs help teachers develop tools to pass the conservation message on to the next generation. NRDs assist universities and colleges in developing natural resources opportunities. Workshops for farmers and urban landowners provide practical information on a variety of ways to care for natural resources.

5.4.4 Administrative Actions

5.4.4.1 MUD Shift Operations to utilize Missouri River

The MUD Platte West well-field is designed to operate at 100 MGD. In 2012, MUD shifted operations to its Florence plant (Missouri River surface water source), reducing pumping at the Platte West well-field in August. The coordination framework provided by the Consortium will help facilitate the desire to implement this type of action in future droughts. When dealing with future drought conditions there are a myriad of factors MUD would need to consider before again shifting water production between its three water treatment plants. These factors include, but are not limited to: plant capacities, water quality, streamflow on both the Platte and Missouri River, customer demand and/or operational efficiencies.

5.4.4.2 MUD and LWS Interconnection

As noted in the Mitigation Alternatives, MUD and LWS are independently investigating the feasibility of an interconnection between their finished water systems. Conceptually this interconnection would provide LWS treated water from MUD's system originating from the Missouri River. Access to imported water from the Missouri River would provide LWS access to a second water source largely unaffected by drought conditions. The interconnection may also provide water for future growth in demands on the LWS system.

5.4.4.3 Urban Water Use Restrictions

Many water utilities implement water use restrictions during various stages of drought. MUD and LWS both implement voluntary and mandatory water use restrictions during various stages of drought. These restrictions are described in detail in Appendix A.

5.4.4.4 Urban Water Rate Pricing

In combination with water use restrictions, many water utilities implement inclining block rates. LWS has an inclining block rate structure in place year round. More recently, LWS implemented a "water shortage rate" policy whereby the rate blocks are further increased to curtail outdoor water use. MUD's inclining block rate structure is utilized during summer months only. LWS and MUD implement water rate pricing as described in Appendix A.

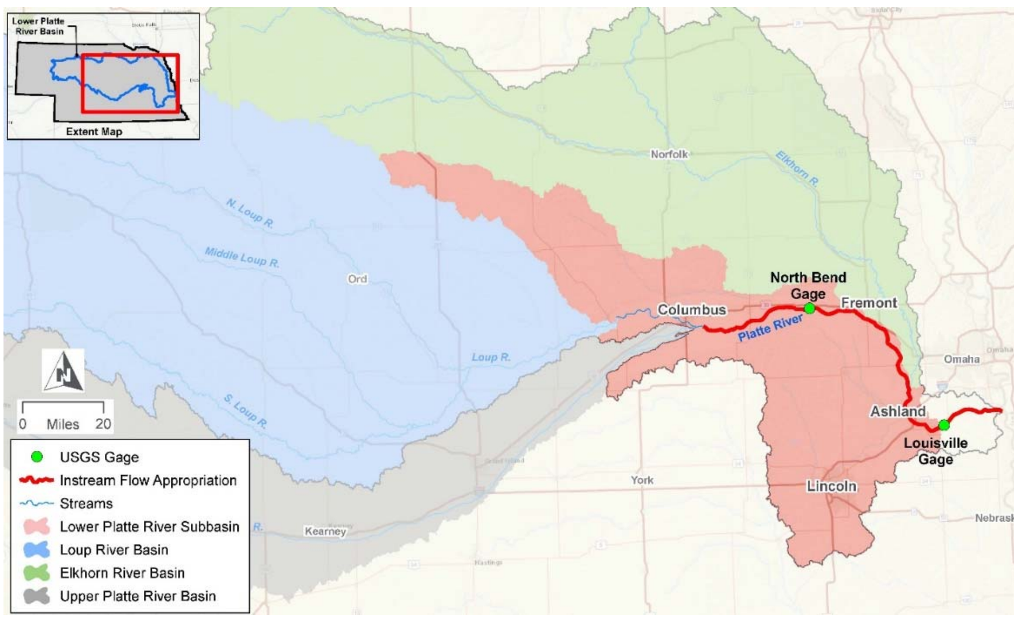
5.4.4.5 Surface Water Right Administration

Nebraska surface waters are governed by the prior appropriation (first-in-time, first-in-right) doctrine, which allows diversion of water from the surface waters of the state based on the date the water right was obtained. This system protects those who received their water rights first during periods when the overall water supply is insufficient to meet all appropriated water rights. Thus, the entity with the earliest priority date (first-in-time) is entitled to their full appropriation (first-in-right) before a later priority date entity receives any water. An exception to the priority doctrine is preferences. Under Nebraska appropriation law, domestic surface water use is considered to be superior to all other uses, and agriculture is inferior to domestic but superior to industry. If a junior superior user takes water from a senior inferior user, the senior must be paid for the water.

One of the mitigation measures available to the City of Omaha (MUD) and the City of Lincoln (LWS) during periods of drought is to exercise a priority call on the Lower Platte River, affecting hundreds of upstream junior irrigation appropriations, likely during peak irrigation demand periods. This disruption to irrigation supplies would leave many of those junior irrigation users vulnerable to crop loss during a prolonged drought. Regulation or interference with these irrigation demands can be costly should this type of priority call be necessary.

The Nebraska Game and Parks Commission holds instream flow appropriations for the protection of fish and wildlife. The instream flow rights have a priority date of November 30, 1993. The instream flow appropriations are measured at the North Bend gage and the Louisville gage, although the appropriations extend to the confluence with the Missouri River. When instream flow appropriations are not met at the North Bend gage, all junior surface water appropriations above that gage, including those in the Loup River subbasin, are closed to diversion. When instream flow appropriations are not met at both the North Bend and the Louisville gages, all junior surface water appropriations above both gages, including those in both the Loup and Elkhorn River subbasin, are closed to diversion. In circumstances where the instream flow appropriation is being met at the North Bend gage but not at the Louisville gage, all junior appropriations above the Louisville gage, including those in both the Loup and Elkhorn River subbasins, are closed to diversion (NeDNR 2016) (Figure 73).

Figure 73: Instream flow Trigger Locations



5.4.5 Rural Water Supply

Each rural water agency is required to provide the Nebraska Department of Health and Human Services (DHHS) with a Water Shortage Emergency Response Plan. Each plan must identify stages and criteria of a water shortage, alternate or emergency water sources, a communication plan, and water shortage response actions.

For those domestic users who use self-supplied domestic groundwater wells, *NebGuide* “G1536” makes recommendations for storing an emergency supply of water. Recommendations include the following (Skipton, Dvorak, and Albrecht 2010):

- Replace pressure tanks with larger tanks or using supplemental tanks to provide additional storage.
- Reduce demand during high water use periods by storing water extracted during low use periods
- Deepen existing well or drill new well
- Bottle or haul water from near-by public water supply

5.4.6 Agricultural Sector Response Actions

5.4.6.1 Groundwater Controls

The Nebraska Legislature, under Nebraska Revised Statutes 46-701 to 46-754 of the Nebraska Groundwater Management and Protection Act, grants the NRDs authority to protect the quantity and quality of water, and to resolve conflicts between surface water and groundwater users. The NRD may adopt one or more controls, which may include the following:

- Allocations of the amount of groundwater users may withdraw
- System of rotation for use
- Well spacing requirements
- Well meter requirements
- Reduction of irrigated acres
- Limits on or prevention of expansion of irrigated acres or beneficial use of water
- NRD approval of transfer of groundwater off overlaying land
- NRD approval of transfer of rights to use groundwater that result from NRD-imposed allocations or other NRD restrictions
- Prevention of adverse effects on other groundwater or surface water users

Each NRD maintains a Groundwater Management Plan with water quality area designation criteria and water quantity area designation criteria, which include use well spacing, allocations, and stays on new development depending on which phase is triggered. These plans are summarized in Appendix A.

5.4.6.2 National Drought Mitigation Center

The NDMC provides guidance for ranchers during drought including pasture management, finding feed, reducing feed demand, and lessening risk of heat stress: http://drought.unl.edu/ranchplan/DuringDrought.aspx.

5.4.6.3 University of Nebraska–Lincoln CropWatch

CropWatch provides guidance for managing crop production during drought conditions, including articles related to corn, sorghum, soybeans, dry beans, forages, silage, and wheat production. It also provides information on farm management during drought, harvest, storage, irrigation practices, soil management, and weed management: https://cropwatch.unl.edu/crop-management-drought

6.0 Operational and Administrative Framework, and Plan Update Process

The Consortium will have two scheduled meetings each year to: (1) prepare for the monitoring and evaluation effort for the current year; (2) discuss evolving needs in the region, any triggers, and issues to be addressed; (3) evaluate and prioritize identified mitigation projects to implement as future funding opportunities arise; (4) identify funding needs and sources for the following year's activities, and develop a plan to pursue identified funds; and (5) discuss progress and results of the Drought Plan monitoring and evaluation effort, other items brought forth by the Consortium, and review content from the updated Drought Plan (every 5 years). These two scheduled meetings will be concurrent with the fall and spring monitoring meetings illustrated in Figure 74. The Consortium chairperson is the NeDNR representative who will be responsible for setting the agenda, public noticing the meetings, and conducting the meetings. The chairperson will house and maintain the files and information of the Consortium.

6.1 Plan Implementation

On an ongoing basis and at the approximate frequency illustrated in Figure 74, the Consortium shall monitor indicators and indices for trigger levels that may indicate the onset of drought conditions. Table 23 lists the drought monitoring roles and responsibilities assigned to each Consortium member.

Table 23: Drought Monitoring Roles/Responsibilities

Drought Indicator	Consortium Member	Contact
Website Hosting/Maintenance	Lower Platte South NRD	General Manager
PDSI/SPI	NeDNR	Water Planning Division Manager
Streamflow & recession tool	NeDNR	Water Planning Division Manager
Snowpack/Reservoir Levels	NeDNR	Water Planning Division Manager
Monthly climate webinars & review US Drought Monitor website	LWS	Superintendent of Water Production
Groundwater Levels	Each entity individually in accordance with their groundwater management plans (NRDs) and aquifer monitoring protocol (LWS/MUD)	Lower Platte North NRD- Water Resources Manager Papio-Missouri River NRD- Ground Water Management Engineer Lower Platte South NRD- Water Resources Specialist MUD-Director, Water Production & Pumping LWS- Superintendent of Water Production NeDNR-Water Planning Division Manager
Notification drought triggers reached	NeDNR will notify Consortium members when drought triggers have been reached; Consortium will initiate response actions according to drought level.	NeDNR -Water Planning Division Manager

Figure 74: Lower Platte River Drought Contingency Plan Implementation Actions

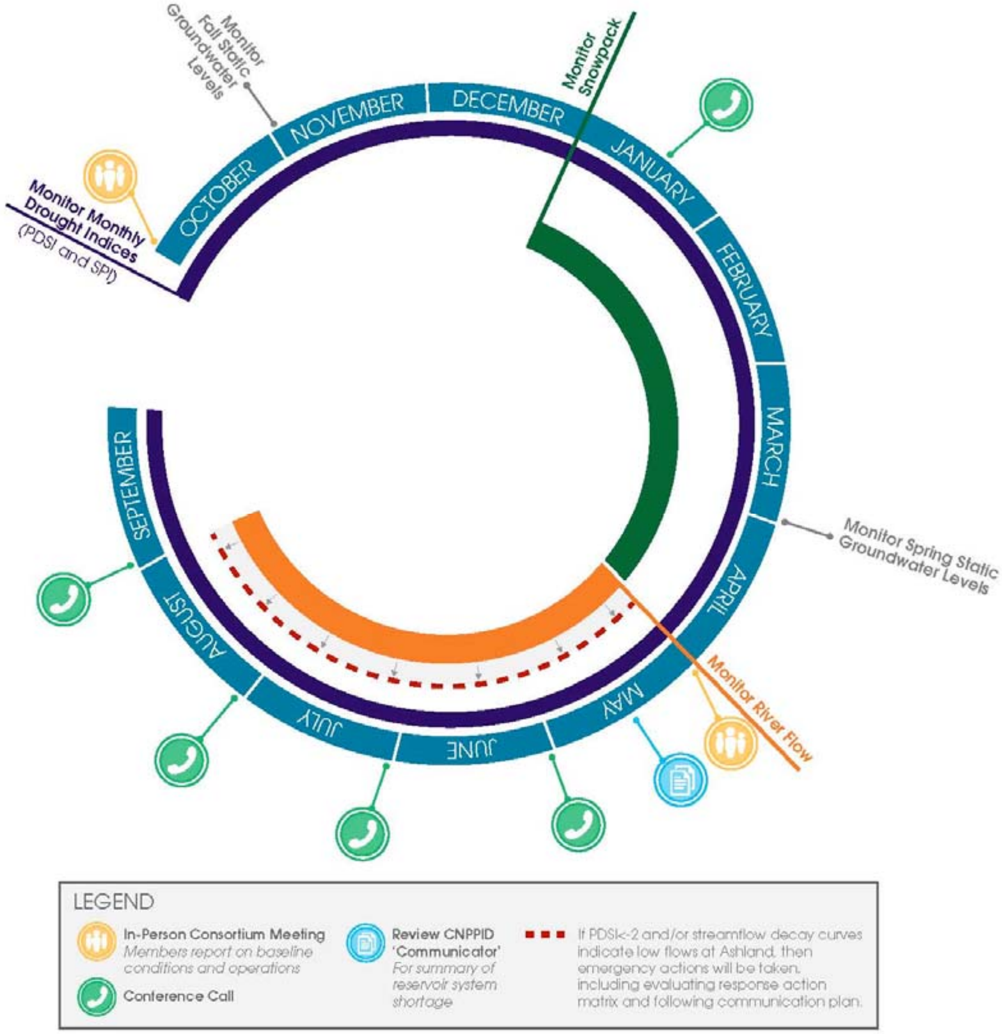


Table 24 lists the implementation plan actions over the calendar months.

Table 24: Drought Monitoring Continuum

Month	Activities
November - March	Monitoring: - PDSI/SPI indices - Mountain and plains snowpack - CNPPID operating plan - River flows
April/May meeting	Meeting to review following: - PDSI/SPI indices - Mountain and plains snowpack - NRD Spring static aquifer levels - Upper Platte River/Loup River reservoir storage - River flows - CNPPID operating plan - Well-field aquifer levels - Conveyance tool projections
June/July/August/September	Monitoring and potentially meetings, depending on conditions: - PDSI/SPI indices - River flows - Well-field aquifer levels - Conveyance tool projections - Response actions
October/November meeting	Post-peak season evaluation meeting. Items for review/discussion: - Past season operations - Well-field aquifer levels - NRD fall static aquifer levels - PDSI/SPI indices - Upper Platte River/Loup River reservoir storage

6.2 Plan Update Process

The Drought Plan and associated planning are meant to be part of an adaptive process that is routinely updated to reflect the needs of the Lower Platte River Basin and its water users. The Consortium will evaluate the need for updating the Drought Plan every five years, or as conditions warrant (such as implementation of a response action project).

- On an annual basis, the Consortium will gather information and make any necessary updates to the Vulnerability Assessment.
- On an annual basis, the Consortium will review any changes in the Vulnerability Assessment, determine the need for new and revised actions, and update the status of existing actions and add new actions (as needed).
- The Consortium may identify planning and technical efforts outside those anticipated that need to be undertaken based on changed conditions or a potential need.
- Every five years, the Consortium will assess the need for and prepare an updated Drought Plan (as needed).

6.3 Continued Communication and Outreach

In addition to internal plan maintenance and implementation, it important that the Consortium maintains a relationship with stakeholders and the public and serves as a resource to water users in the Lower Platte River. The following communication and outreach activities have been identified:

- The Consortium will keep the project website updated to keep interested stakeholders informed of meetings, new materials, and other information related to the Drought Plan and its implementation. An email distribution list of interested stakeholders will be maintained and used for distribution of information and notices of website content updates.
- Each individual agency will be responsible for informing its constituents, customers, and the public of any actions initiated and related progress and results.
- Coordination and information sharing with other ongoing efforts will be beneficial to both the Drought Plan and the other drought monitoring and planning efforts (Missouri Basin Plan, NEMA, etc.). At this time there is no set protocol or timing identified for this coordination efforts, rather it is anticipated this coordination will occur on an as needed basis.

7.0 Glossary of Terms

Term	Definition
Accretion	Addition of streamflow that results from an offset or mitigation measure or project.
Acre-Foot (AF)	Volume of water required to cover 1 acre of land (43,560 square feet) to a depth of 1 foot, equivalent to 325,851 gallons.
Appropriation	See Surface Water Appropriation
Aquifer	A geological formation or structure of permeable rock or unconsolidated materials that stores and/or transmits water, such as to wells and springs.
Baseflow	The portion of streamflow that is not runoff and results from seepage of water from the ground into a channel slowly over time.
Cubic feet per second (cfs)	The rate of discharge representing a volume of 1 cubic foot passing a given point during one second. It is equivalent to 7.48 gallons per second, or 4,448.8 gallons per minute.

Term	Definition
Drought	There are many definitions for drought, but all definitions include periods of dryness and below average precipitation. The National Drought Mitigation Center (NDMC) lists four types of droughts: meteorological drought, agricultural drought, hydrological drought, and socioeconomic drought as described in Section 4.1. For this Drought Plan, the three drought levels identified remain consistent with NDMC definitions of "moderate", "severe", and "extreme" droughts: • A Level 0, "Abnormally Dry" or "Mild Drought" indicates an area may be experiencing "short-term dryness slowing planting, growth of crops or pastures" indicating the onset of drought or may be coming out of drought and experiencing lingering effects of drought. • A Level 1, "Moderate Drought" involves "some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; and voluntary water-use restrictions requested." • A Level 2, "Severe Drought" means that "crop or pasture losses likely; water shortages common; and water restrictions imposed." • A Level 3, "Extreme Drought" involves "major crop/pasture losses" and "widespread water shortages or restrictions."
Depletion	See Groundwater Depletion
Evapotranspiration (ET)	The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.
Excess Flow	The historic quantity of surface water in the Lower Platte River Basin in excess of the state protected flows in the Platte River.
Fully Appropriated	From Nebraska Revised Statutes 46-713, subsection (3): "A river basin, subbasin, or reach shall be deemed fully appropriated if NeDNR determines based upon its evaluation conducted pursuant to subsection (1) of this section and information presented at the hearing pursuant to subsection (4) of section 46-714 that then current uses of hydrologically connected surface water and groundwater in the river basin, subbasin, or reach cause or will in the reasonably foreseeable future cause (a) the surface water supply to be insufficient to sustain over the long term the beneficial or useful purposes for which existing natural-flow or storage appropriations were granted and the beneficial or useful purposes for which, at the time of approval, any existing instream appropriation was granted, (b) the streamflow to be insufficient to sustain over the long term the beneficial uses from wells constructed in aquifers dependent on recharge from the river or stream involved, or (c) reduction in the flow of a river or stream sufficient to cause noncompliance by Nebraska with an interstate compact or decree, other formal state contract or agreement, or applicable state or federal laws".
Gallon per capita per day (gpcd)	A term generally used to approximate the average amount of water used per day, per person, in one year.
Groundwater	Water which occurs in or moves, seeps, filters, or percolates through ground under the surface of the land, and shall include groundwater which becomes commingled with waters from surface sources.

Term	Definition
Groundwater Depletion	Reduction to streamflow that results from a new use of either groundwater or surface water.
Groundwater Recharge	The addition of water to the zone of saturation. Infiltration of precipitation and its movement to the water table is one form of natural recharge.
Hydraulic Conductivity	A property of vascular plants, soils and rocks, that describes the ease with which a fluid (usually water) can move through pore spaces or fractures. It depends on the intrinsic permeability of the material, the degree of saturation, and on the density and viscosity of the fluid.
Hydrologically Connected	Describes a geographic area designated by the NeDNR where the existing amount of groundwater and surface water each has significant influence on the other and where appropriate regulation exists.
Induced Groundwater Recharge	An indirect method of artificial recharge involving pumping from an aquifer hydrologically connected with surface water such as perennial streams. The heavy pumping lowers the groundwater level and a cone of depression is created. Lowering of water levels induces the surface water to replenish this groundwater. This method is effective where a streambed is connected to aquifer by sandy formation.
Instream flow Demand	Demands for streamflow taking place within the stream and is not withdrawn from a surface water source. These demands are based on current appropriations held by the Nebraska Game and Parks Commission or any local Natural Resources Districts.
Integrated Management Plan (IMP)	A plan cooperatively developed by NeDNR and individual NRDs for a specific area. The objective of an integrated management plan is to manage such river basin, subbasin, or reach to achieve and sustain a balance between water uses and water supplies for the near and long term.
LB 483	On December 12, 2008, the NeDNR reached a preliminary determination that the Lower Platte River Basin was fully appropriated. Subsequent to this determination, NeDNR reached a final determination that the Lower Platte River Basin was not fully appropriated. Following this reversal, on April 6, 2009 the Legislature passed LB 483 which requires that when a basin status change occurs, the affected NRDs must adopt rules and regulations that: 1) allow a limited number of total new groundwater irrigated acres annually; 2) are created with the purpose of maintaining the status of not fully appropriated based on the most recent determination; 3) be for a term of not less than four years; and 4) limit the number of new permits so that total new groundwater irrigated acres do not exceed the number set in the rules and regulations.
LB 962	A bill passed by Nebraska Legislature in 2004 that allows leases of surface water, changes administration of surface water rights, establishes a proactive approach to the integrated management of hydrologically connected groundwater and surface water and creates funds to direct money towards data gathering, research, conservation and implementation of integrated management plans in fully and overappropriated basins.

Term	Definition
Lower Platte River Basin	The Lower Platte River Basin is defined as all surface areas that drain into the Lower Platte River, including those areas that drain into the Loup River and the Elkhorn River, and all aquifers that impact surface water flows of the basin.
Lower Platte River Basin Coalition (Coalition)	Formed through an Interlocal Cooperation Act agreement among the NeDNR and the following seven Natural Resources Districts (NRDs) that encompass the Lower Platte River Basin: Upper Loup NRD; Lower Loup NRD; Upper Elkhorn NRD; Lower Elkhorn NRD; Lower Platte North NRD; Lower Platte South NRD; Papio-Missouri River NRD
Lower Platte River Consortium (Consortium)	Beginning in 2016, the Lower Platte South NRD, Papio-Missouri River NRD, Lower Platte North NRD, Metropolitan Utilities District (MUD), Lincoln Water System (LWS), and Nebraska Department of Natural Resources (NeDNR), collectively referred to as the Lower Platte River Consortium (Consortium), embarked on an effort to develop a drought contingency plan for the Lower Platte River Basin in Nebraska.
Lower Platte River Drought Contingency Plan (Drought Plan)	The purpose of the Drought Plan is to refine the collective understanding of drought vulnerabilities, while developing more robust monitoring and forecasting tools coupled with timely triggers, new mitigation strategies and responsive actions to create a sound operational framework and improve critical water supply needs of the area through drought periods.
Million gallons per day (MGD)	A rate of flow of water equal to 133,680.56 cubic feet per day, or 1.5472 cubic feet per second, or 3.0689 acre-feet per day.
Natural Resources District (NRD)	A political subdivision of the State that governs the natural resources within the subdivision.
Nebraska Department of Natural Resources (NeDNR)	Nebraska Department of Natural Resources; a State Agency.
Ogallala Aquifer	A shallow water table aquifer surrounded by sand, silt, clay and gravel located beneath the Great Plains in the United States. One of the world's largest aquifers, it underlies an area of approximately 174,000 sq mi in portions of eight states (South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas). The aquifer is part of the High Plains Aquifer System, and rests on the Ogallala Group, which is the principal geologic unit underlying 80% of the High Plains.

Term	Definition
Overappropriated	From 46-713, subsection (4a): A river basin, subbasin, or reach shall be deemed overappropriated if, on July 16, 2004, the river basin, subbasin, or reach is subject to an interstate cooperative agreement among three or more states and if, prior to such date, NeDNR has declared a moratorium on the issuance of new surface water appropriations in such river basin, subbasin, or reach and has requested each natural resources district with jurisdiction in the affected area in such river basin, subbasin, or reach either (i) to close or to continue in effect a previously adopted closure of all or part of such river basin, subbasin, or reach to the issuance of additional water well – permits in accordance with subdivision (1)(k) of section 46-656.25 as such section existed prior to July 16, 2004, or (ii) to temporarily suspend or to continue in effect a temporary suspension, previously adopted pursuant to section 46-656.28 as such section existed prior to July 16, 2004, on the drilling of new water wells in all or part of such river basin, subbasin, or reach.
Palmer Drought Severity Index (PDSI)	The Palmer Drought Severity Index (PDSI) uses readily available temperature and precipitation data to estimate relative dryness. It is a standardized index that spans -10 (dry) to +10 (wet). It has been reasonably successful at quantifying long-term drought.
Sandhills	A region of mixed-grass prairie on grass-stabilized sand dunes in north-central Nebraska, covering just over one quarter of the state. The dunes were designated a National Natural Landmark in 1984.
Saturated Thickness	The vertical thickness of the hydrogeologically defined aquifer unit in which the pore spaces are filled (saturated) with water.
Streamflow	The discharge that occurs in a natural channel of a surface stream course.
Standardized Precipitation Index (SPI)	A widely used index to characterize meteorological drought on a range of timescales. It quantifies observed precipitation as a standardized departure from a selected probability distribution function that models the raw precipitation data.
Surface Water	Water that occurs or moves on the surface of the planet such as in a stream, river, lake, wetland, or ocean.
Surface Water Appropriation	A permit granted by NeDNR to use surface water for a beneficial use in a specific amount, purpose and location, and is based on first-in-time, first-in-right
Transfer	To allow for the historic consumptive use of water to be changed, in location and/or purpose. Impacts of a transfer may include an increase in depletions to the river or an impact to existing surface water or groundwater uses.
Upper Platte River Basin	The Upper Platte River Basin includes the North Platte River, South Platte River, and Platte River from the confluence to Duncan.

8.0 References

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Appendix A: Current Drought Monitoring and Drought Plans

This appendix summarizes the existing drought monitoring efforts, existing drought plans, or other relevant local plans that address water supply management. Each of the drought plans included in Appendix A have been developed by entities with individual authorities and responsibilities, and have been developed to address those responsibilities. Currently there is not a direct correlation between this Plan's drought triggers and those found in each of the existing plans of the individual entities. It is anticipated that as the entities update their existing drought plans, drought triggers and stages from this Plan – either wholly or in part, as appropriate – will be incorporated, as appropriate into the updated individual plans to add consistency basin-wide.

A.1 State of Nebraska Current Monitoring and Response Actions

Established in 1991 by Legislative Bill (LB) 274 to replace the Drought Assessment and Response Team (DART), the Nebraska Climate Assessment Response Committee (CARC) serves as a steering committee for the state's *Drought Mitigation and Response Plan* and other climate-related activities. CARC membership consists of the U.S. Department of Agriculture (USDA), Nebraska Department of Natural Resources (NeDNR), Nebraska Health and Human Service (NHHS) System – Office of Regulation and Licensure, Nebraska Emergency Management Agency (NEMA), University of Nebraska–Lincoln (UNL) Cooperative Extension Service, UNL Conservation and Survey Division (CSD), and Governor's Policy Research Office. By statute, NEMA is charged with responding to emergencies, such as drought or floods, at the direction of the Governor.

Nebraska's *Drought Mitigation and Response Plan* was last updated in June 2000 (revised May 2004). Presently, Nebraska (through NEMA) is in the process of updating its *Hazard Mitigation Plan*, of which the Drought Plan will become a component. Going forward, the *Hazard Mitigation Plan* will replace the 2000 *Drought Mitigation and Response Plan*. The *Hazard Mitigation Plan* is scheduled to be completed and submitted to the Federal Emergency Management Agency (FEMA) in the spring of 2019. NEMA will collaborate with the National Drought Mitigation Center (NDMC), CARC, and USDA to update the drought component of the *Hazard Mitigation Plan*. The *Hazard Mitigation Plan* will include a drought assessment, vulnerabilities assessment, triggers and strategic actions, response actions and mitigation measures, research, technical assistance, and workshops.

Table A-1: 2004 Nebraska Drought Mitigation and Response Plan – Planned Mitigation Activities

Prioritized Impacts	Prioritized Planned Actions	Assistance Agencies
Due to drought, many public water supply systems experience potable water demand problems.	Emphasize, and evaluate, long and short-term drought contingency plans for all systems. Emphasize indoor and outdoor water conservation measures. Maintain list of "problem systems", with history or potential for drought-related problems. Develop programs to educate the public on the potential uses of wastewater. Develop partnerships with utility companies and others who can help distribute drought-related information.	NHHS, League of Municipalities, NRDs, Nebraska Rural Water Association, NDEQ, AWWA, CED/UNL
Many rural water districts and small public water systems (under 10,000 population) develop operational (mechanical) problems when operating for extended periods of drought.	Maintain a list of "problem systems" with history or potential for drought-related problems. Continue work with systems to develop a plan of long-term drought mitigation and short-term drought response actions. Maintain communication means and use Nebraska Rural Water Associations (NeRWA) newsletter and training sessions to address drought-related issues. Explore, as needed, emergency funds.	NRWD, NEMA, Nebraska Section of AWWA, Nebraska Department of Economic Development (NDED), USDA Rural Development, League of Municipalities, NHHS, Midwest Assistance Program, NDEQ, UNL Extension, NRDs, Groundwater Foundation, Nebraska Department of Natural Resources, NeRWA, EPA
Due to drought, private wells experience water quality and quantity problems.	Encourage NRDs to evaluate situation. Emphasize indoor and outdoor water conservation measures.	NRDs, CSD/UNL, CED/UNL

Prioritized Impacts	Prioritized Planned Actions	Assistance Agencies
Increased irrigation may overdraft available aquifer and affect municipal and rural water supplies during drought.	Promote groundwater-metering efforts and establish an emergency allocation program. Encourage statewide water level measurement program to effectively monitor aquifer levels.	NRDs, Bureau of Reclamation, DOE, CSD/UNL, CED/UNL, USGS.
Drought induced mental anguish of farmers and ranchers resulting in increased suicides, social and family problems.	Use local TV and radio outlets to implement public information program directed at reducing drought-induced mental stress. Implement and/or maintain farm/crisis hotline(s). Develop working partnerships with local ministerial alliances and local health office as to develop social counseling and support programs. Public service announcements for hotline numbers and mediation services.	NHHS, local health offices, local ministerial alliances, CED/UNL, NEDA, Centers for Rural Affairs, national public health services, Mediation Service, Farm Crisis Council
Increased presence of large, industrial, independent water users may overdraft available aquifers during drought.	Maintain a list of large, industrial, independent water users. Enhance communication between large, independent water users and municipal suppliers to implement water conservation measures and drought-preparedness guidelines.	NRDs, NDED, CSD/UNL, Nebraska Department of Natural Resources, League of Municipalities, CED/UNL
Increased health problems for residents of areas experiencing blowing dust problems for drought-affected agricultural lands.	Communicate with state medical allergy and asthma experts to develop recommendations. Establish education programs to increase awareness of dust-related respiratory problems and how soil and land conservation practices can improve air quality. Develop funded initiatives to explore mitigation of health effects.	NHHS, UNMC, CED/UNL, NRDs, NRCS, Nebraska Emergency Management Agency (NEMA), local health offices, environmental health fund.
Drought-induced temperature extremes produce extreme living conditions for both rural and urban residents. Increased electrical usage may create overloads on available electrical grid network.	Develop information program to provide living guidelines and alternatives to enable residents to cope with extreme conditions. Develop working partnerships with local urban and rural power suppliers to cooperate in providing energy and water conservation guidelines to public. Develop an education program. Learn about electrical bill assistance programs. Learn about fan distribution programs.	NHHS, HUD, CED/UNL, Nebraska Energy Office, Salvation Army, League of Women Voters, medical professionals, local utility companies, Nebraska Rural Electric Association, Nebraska Power Association, Nebraska Energy Office, League of Municipalities.
General Impacts	Promote the use of water efficient plumbing fixtures and appliances.	AWWA, League of Municipalities, Builders and Plumbers Associations, EPA.

Source: Nebraska Drought Mitigation and Response Plan, Appendix A

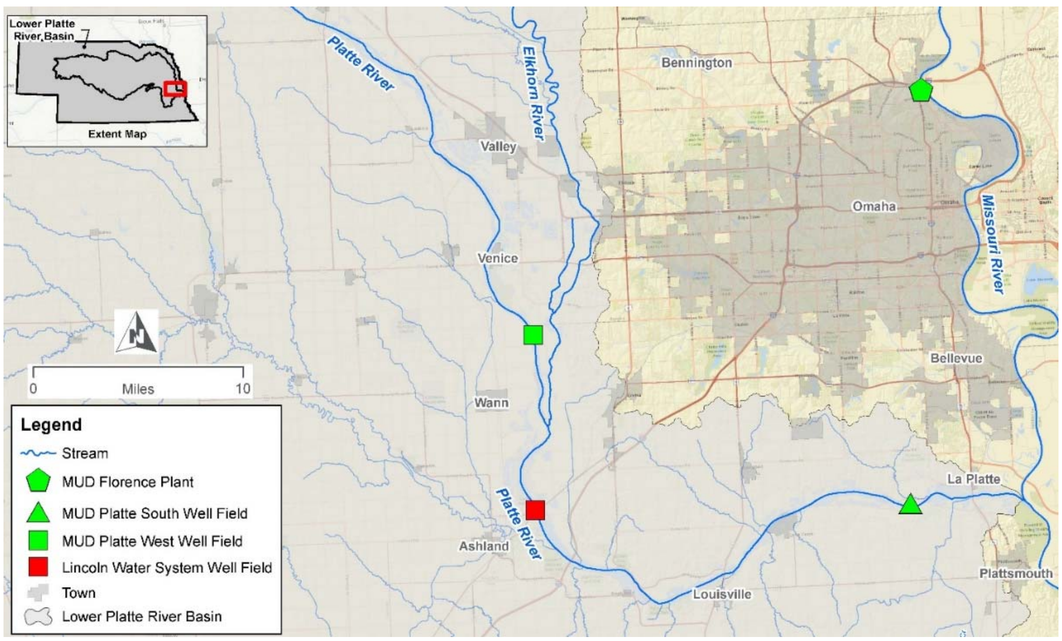
Notes: AWWA = American Water Works Association; CED/UNL = Cooperative Extension Division – University of Nebraska-Lincoln; CSD/UNL = Conservation and Survey Division- University of Nebraska – Lincoln; NDED = Nebraska Department of Economic Development; NDEQ = Nebraska Department of Environmental Quality; DOE = Department of Energy; EPA = Environmental Protection Agency; HUD = Housing and Urban Development; NEDA = Nebraska Department of Agriculture; NEMA = Nebraska Emergency Management Agency; NHHS = Nebraska Health and Human Services; NRCS = Natural Resource Conservation Service; NRDs = Natural Resource Districts; NRWD = Nebraska Rural Water Districts; UNMC = University of Nebraska Medical Center; USGS = United States Geological Survey.

A.2 Metropolitan Utilities District Current Monitoring and Response Actions

The Metropolitan Utilities District (MUD) has three supply intake locations: 1) Florence Plant in north Omaha, Nebraska, that obtains its water from the Missouri River with a capacity of 160 million gallons per day (MGD); 2) Platte West well-field located south of Venice, Nebraska, that obtains its water from the Platte River with a capacity of 100 MGD; and 3) Platte South well-field located near La Platte, Nebraska, that also obtains water from the Platte River with a capacity of 60 MGD. Total system output for MUD from all three facilities is 320 MGD. MUD has the ability to use all three of their facilities interchangeably to meet their demand.

The induced recharge right for the Platte West well-field is 1,000 cubic feet per second (cfs) and for Platte South is 500 cfs. MUD is currently undergoing an analysis of both its Platte West and Platte South well-field capacities under drought conditions. According to MUD, their system capacity is not expected to be a concern for the foreseeable future. During the 2012 drought, MUD voluntarily reduced operations at Platte West to 30 to 40 MGD and increased operations at the Florence plant.

Figure A-1: Municipal Well-field Locations



MUD maintains a water conservation and emergency plan on the MUD website (Table A-2). The water conservation and emergency plan includes voluntary and mandatory conservation measures, which have not been imposed since the early 2000s and have not been imposed since the Platte West well-field was constructed. MUD imposes conservation measures when consecutive days have a demand at or above 300 MGD.

Table A-2: MUD Water Alert Levels

Alert Level	Trigger	Action
Level 1: Voluntary Alternate Day Watering	Water consumption reaches 95 percent (about 300 million gallons per day) of available supply or system capacity, or any of the water storage reservoirs cannot be refilled from day to day, or low pressure jeopardizes firefighting or causes numerous customer complaints.	Press release to notify public of alert. Press release will include basic list of water conservation tips. Limit hydrant flushing and main filling, comply with alternate day water restrictions, and shut down decorative fountains at the Florence Plant and the Headquarters Building. All customers asked to voluntarily adhere to alternate day watering. Customers told what to expect if Level 2 Alert issued. All customers asked to voluntarily discontinue hosing down driveways, shut off decorative fountains, discontinue filling swimming pools, and other actions deemed appropriate by MUD City of Omaha and other municipalities served by MUD asked to voluntarily comply with alternate day watering restrictions; curtail sewer flushing, lake filling, firefighting drills, street washing and other non-essential uses of water. Enforcement: None
Level 2: Voluntary No Watering Days	Specified no-watering days will allow MUD to fill water system reservoirs. Trigger: Water consumption reaches 95 percent of available supply or system capacity, or any of the water storage reservoirs cannot be refilled from day to day, or low pressure jeopardizes firefighting or causes numerous customer complaints.	Press release to notify public of alert. Press release will include basic list of water conservation tips. Limit hydrant flushing and main filling, comply with alternate day water restrictions, and shut down decorative fountains at the Florence Plant and the Headquarters Building. All customers asked to voluntarily discontinue all outdoor water use on days determined by MUD. Customers told what to expect if Level 2 Alert issued. All customers asked to voluntarily discontinue hosing down driveways, shut off decorative fountains, discontinue filling swimming pools, and other actions deemed appropriate by MUD City of Omaha and other municipalities served by MUD asked to voluntarily comply with alternate day watering restrictions; curtail sewer flushing, lake filling, firefighting drills, street washing and other non-essential uses of water. Enforcement: None
Level 3: Water Alert	Water consumption meets or exceeds available supply or system capacity, or useable water storage has been reduced 50 percent, or there are widespread pressure problems.	Issue press release to notify public that voluntary requirements of Level 1 or Level 2 alerts have become mandatory. Stop hydrant flushing and main filling, comply with designated restrictions, including shut down of decorative fountains at the Florence Plant and the Headquarters Building. All customers required to adhere to water restrictions. All customers required to discontinue hosing down driveways, shut off decorative fountains, discontinue filling swimming pools, and other actions deemed appropriate by MUD. City of Omaha and other municipalities served by MUD will be required to comply with water restrictions, stop sewer flushing, lake filling, firefighting drills, street washing and other non-essential uses of water. Enforcement: Customers who do not comply with water restrictions will be subject to having their water shut off until mandatory restrictions are lifted. The current turn-on fee will be charged to restore service. Exceptions: Exceptions may be made for new sod less than three weeks old and other circumstances deemed appropriate by MUD

Alert Level	Trigger	Action
Level 4: Water Emergency	Water use exceeds production or distribution capacity due to emergency situations.	Issue press release to notify public a Water Emergency is in effect. All non-sanitary, non-essential use must be discontinued. Enforcement: Customers who do not comply with water restrictions will be subject to having their water shut off until mandatory restrictions are lifted. The current turn-on fee will be charged to restore service.
Level 5: Water Emergency (Water Quality)	Water quality for human consumption cannot be assured due to a contamination or suspected contamination.	Issue press release to notify public that water cannot be consumed safely unless it is boiled or cannot be consumed safely at all. This will include water used in food preparation. MUD, in cooperation with DHHS, will take action to make water safe for consumption and conduct tests to assure it is safe. Issue press release to inform customers water is safe for consumption. Enforcement: None

Source: MUD Water Alert Emergency Plan, Rev. 2012

In combination with water use restrictions, MUD implements inclining block rates as described in Table A-3.

Table A-3: MUD Commodity Charges

cubic feet	Nov-May ($ per 100 cubic feet)	Jun-Oct ($ per 100 cubic feet)
0 to 900	1.2632	1.2632
901 to 3,000	1.2632	1.7685
Over 3,000	1.2632	2.2738

Source: Provided by MUD 2018

A.3 City of Lincoln Current Monitoring and Response Actions

Lincoln Water System (LWS) updated its *Water Management Plan* in 2013. This plan manages water use to maintain consumption within the system's production, pumping, and delivery capacities. When water use cannot be maintained within the system's capacity, the plan defines procedures and provides guidance for imposing water restrictions. The plan includes phases for management of the City of Lincoln, Nebraska, water supplies through various circumstances, including drought conditions or other catastrophic events that would result in a water shortage.

The extent to which drought restrictions are implemented is primarily based on the flows in the Lower Platte River at Ashland, Nebraska, and water usage. Watering restrictions are implemented through the City of Lincoln's Municipal Code. The various phases of watering restrictions start as voluntary and then increase to mandatory as the severity of the drought increases. Tiered water shortage rates are applied during periods when *Water Management Plan* restrictions are implemented. The water shortage rates were developed on the basis that customers practicing conservation techniques would see little or no increase in their summer water bills. The water shortage rates begin with the voluntary restrictions and are increased if stricter plan phases are enacted.

Table A-3: City of Lincoln Drought Phases

Phase	Signal River Flow	Signal Water Use	Possible Action
Moderate Shortage	3,000 – 1,500 cubic feet per second (cfs)	Greater than 75 million gallons per day (MGD)	Voluntary restrict certain water use activities to three (3) designated days per week
Severe Shortage	1,500 – 200 cfs	Greater than 65 MGD	Certain water use activities may be mandatorily restricted to three (3) designated days per week
Critical Shortage	Less than 200 cfs	Greater than 55 MGD	In addition to restricted imposed under severe shortage, also limits outdoor water use; may result in either mandatorily restricting certain water use activities to two (2) or one (1) designated day or no outside water use

Source: City of Lincoln's Water Management Plan 2013

Reduced water usage equates to reduced sales. Reduced sales equates to reduced revenues to cover costs of water treatment and delivery, and costs of infrastructure repair and replacement.

The City of Lincoln monitors several sources in an attempt to monitor impending drought conditions. Through the winter and spring months, LWS monitors aquifer levels, National Oceanic Atmospheric Administration (NOAA) 90-day precipitation and temperature forecasts, the NOAA Seasonal Drought Outlook, the U.S. Drought Monitor and previous 90-day precipitation and makes a Phase 1, Phase 2, or No Restriction recommendation to the Mayor on May 15 of each year as described in Table A-4.

Table A-4: City of Lincoln Drought Indicators – Spring (prior to May 15)

Indicator	No Restriction	Phase 1	Phase 2
Remaining Operational Volume	>80%	60%-80%	40%-60%
NOAA 90-day precipitation forecast (% probability below normal)	Equal chance (above, below, normal)	33%-40% (below normal)	33%-40% (below normal)
NOAA 90-day temperature forecast (% probability above normal)	Equal chance (above, below, normal)	33%-40% (above normal)	33%-40% (above normal)
NOAA Seasonal Drought Outlook	None predicted-improvement	On-going	Intensify
U.S. Drought Monitor Rating	No Rating-moderate	Severe	Extreme
Previous 90 day precipitation (from High Plains Regional Climate Center) (% of normal)	>90%	70%-90%	50%-70%

Source: City of Lincoln's Water Management Plan, 2013

After May 15, and throughout the summer months, LWS switches to NOAA 30-day outlooks and previous 30-day precipitation totals to designate drought phases as well as adds a Phase 3 category for very extreme drought conditions, as summarized in Table A-5. LWS implements conservation measures based on the designated drought phases. The existing conservation measures focus almost entirely on reducing outdoor water use.

Table A-5: City of Lincoln Drought Indicators – May 15 through September

Indicator	No Restriction	Phase 1	Phase 2	Phase 3
Remaining Operational Volume	>80%	60%-80%	40%-60%	<40%
NOAA 30-day precipitation forecast (% probability below normal)	Equal chance (above, below, normal)	33%-40% (below normal)	33%-40% (below normal)	>40% (below normal)
NOAA 30-day temperature forecast (% probability above normal)	Equal chance (above, below, normal)	33%-40% (above normal)	33%-40% (above normal)	>40% (above normal)
NOAA Seasonal Drought Outlook	None predicted-improvement	On-going	Intensify	Intensify
U.S. Drought Monitor Rating	No Rating-moderate	Severe	Extreme	Exceptional
Previous 30 day precipitation (from High Plains Regional Climate Center) (% of normal for Lower Platte River Basin)	>90%	70%-90%	50%-70%	<50%

Source: City of Lincoln's Water Management Plan 2013

LWS implements accelerated water shortage rates during periods when *Water Management Plan* restrictions are implemented, beginning with Phase 1 and increasing if stricter plan phases are enacted (Tables A-6 and A-7). Water shortage rates were developed on the basis that customers choosing to practice water conservation techniques, primarily targeted at outdoor water use reduction, may see little or no increase in their rates.

If a natural disaster, such as a tornado, fire, blizzard, ice, or flood, or catastrophic failure of LWS facilities occurs, the City of Lincoln will enact restrictions under the Catastrophic Water Shortage Levels, separate from Phase 1 through Phase 3. Such restrictions would be based on the varying circumstances as adjudged necessary and appropriate by the Mayor and the Director of Public Works and Utilities Department.

Table A-6: Residential Water Shortage Charges for 2016

	Normal Water Conditions (no rate increase)	Voluntary Restrictions Phase 1	Mandatory Restrictions Phase 2	Mandatory Restrictions Phase 3	Mandatory Restrictions Catastrophic
Demand Goal	0%	Up to 10%	10% - 20%	20% - 30%	30% - 50%
Block 1: 0 – 8 CCF (up to 6,000 gallons)	\$1.344	\$1.344	\$1.559	\$1.855	\$2.873
Block 2: 8 – 23 CCF (6,000 – 17,200 gallons)	\$1.911	\$2.624	\$2.771	\$3.726	\$5.446

	Normal Water Conditions (no rate increase)	Voluntary Restrictions Phase 1	Mandatory Restrictions Phase 2	Mandatory Restrictions Phase 3	Mandatory Restrictions Catastrophic
Block 3: Over 23 CCF (over 17,200 gallons)	$2.961	$4.587	$5.635	$7.249	$10.393

Source: Lincoln Water System 2017.

Table A-7: Non-Residential Water Shortage Charges for 2016

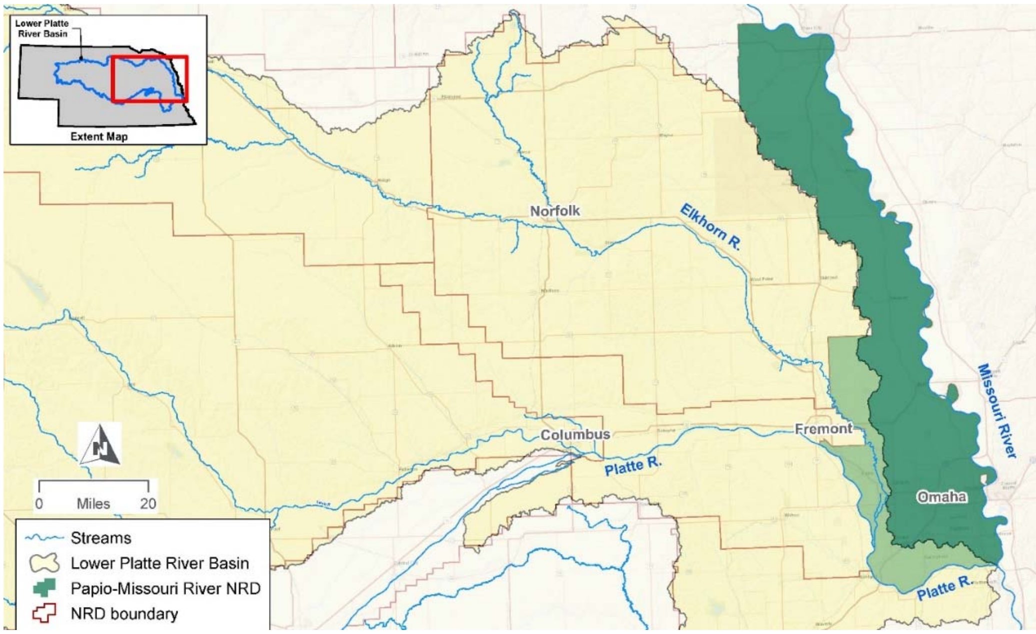
	Normal Water Conditions (no rate increase)	Voluntary Restrictions Phase 1	Mandatory Restrictions Phase 2	Mandatory Restrictions Phase 3	Mandatory Restrictions Catastrophic
Demand Goal	0%	Up to 10%	10% - 20%	20% - 30%	30% - 50%
Block 1: 0 – 80 CCF	$1.344	$1.496	$1.688	$1.934	$2.714
Block 2: Over 80 CCF	$1.911	$2.128	$2.400	$2.750	$3.858

Source: Lincoln Water System 2017.

A.4 Papio-Missouri River Natural Resources District Current Monitoring and Response Actions

The Papio-Missouri River Natural Resources District (NRD) has a biannual static groundwater level monitoring program to establish a baseline and to continue monitoring the groundwater levels in the aquifer areas of the Papio-Missouri River NRD. Trigger levels for each alluvial monitoring well are in the process of being developed using the recommendations presented in an analysis conducted by a collaboration of Papio-Missouri River NRD, the other five NRDs, and cooperating agencies including NeDNR, UNL-CSD, and USGS (Papio-Missouri River NRD 2017). In accordance with the report, the current water levels are compared to a running average baseline with a standard deviation value. This method of comparing to running average baselines is consistent with surrounding NRD's in developing a groundwater level triggers as a basis for evaluating and responding to drought conditions. Triggers for confined aquifers will be developed as monitoring data becomes available.

Figure A-2: Papio-Missouri River Natural Resources District



The following levels have been established for the unconfined areas of the Papio-Missouri River NRD for drought response action:

- A Level I Groundwater Management Area (GMA) is currently established for the entire NRD. Require well permits for all pumps over 50 gallons per minute (gpm).
- A Level II GMA is established if an average of 10 percent decline in saturated thickness of an unconfined aquifer in 50 percent of the wells occurs for 3 consecutive years. Require water meters on wells that pump over 50 gpm.
- A Level III GMA will be established if an average of 15 percent decline in saturated thickness of an unconfined aquifer in 50 percent of the wells occurs for 3 consecutive years. Annual allocations to be set by the Board of Directors.

Although currently there are no areas with significant groundwater level declines, the 2017 Papio-Missouri River NRD *Groundwater Management Plan* recommends response actions based on Water Quantity Program Level designation as shown in Table A-8.

Table A-8: Papio-Missouri River Natural Resources District Water Controls Based on Declines

Water Quantity Control Descriptions	Level I (Entire NRD)	Level II Average 10% decline in saturated thickness of an unconfined aquifer	Level III Average 15% decline in saturated thickness of an unconfined aquifer
Offer water conservation education for rural and urban users	X	X	X
Cost-share water meters and encourage annual water use reporting	X	X	X
Require irrigation acre certification per IMP requirements	X	X	X

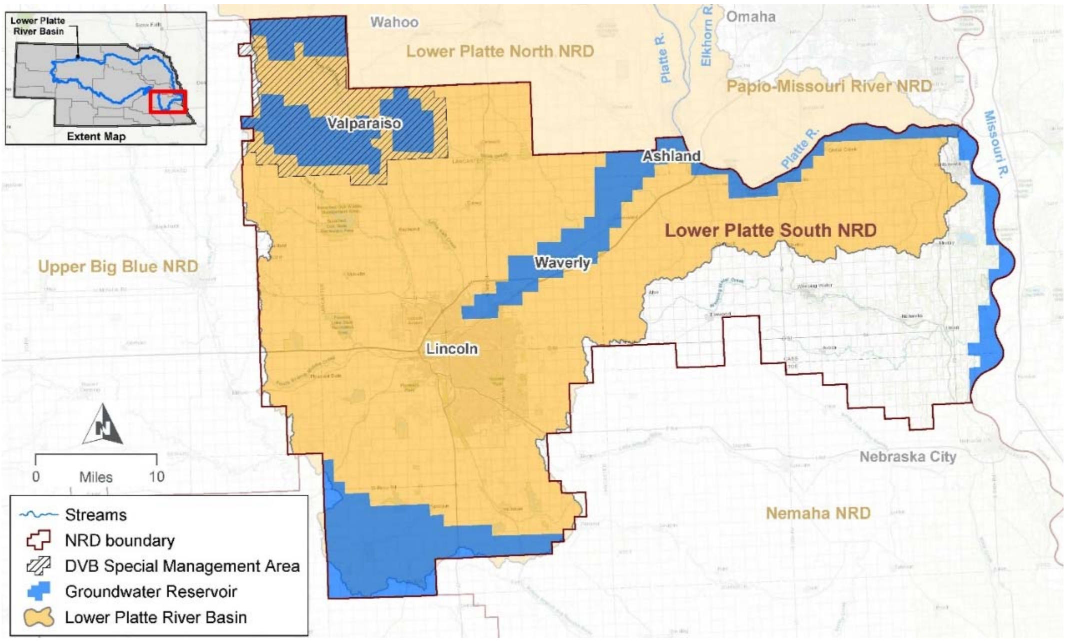
Water Quantity Control Descriptions	Level I (Entire NRD)	Level II Average 10% decline in saturated thickness of an unconfined aquifer	Level III Average 15% decline in saturated thickness of an unconfined aquifer
Limit expansion of irrigated acres per IMP requirements	X	X	X
Require minimum well spacing (600 feet from registered domestic well)	X	X	X
Require high-capacity well evaluations and permits for wells pumping greater than 300 acre-feet per year	X	X	X
Enable water banking transactions through basin-wide plan	X	X	X
Enforce irrigation runoff rules	X	X	X
Encourage water conservation through support of urban and rural cost-share programs	X	X	X
Require well permits for new wells that pump greater than 50 gpm	X	X	X
Require irrigation management certification		X	X
Require water meters and annual water use report		X	X
Evaluate effects of reducing irrigated acres		X	X
Encourage implementation of rural and urban BMPs		X	X
Require acre-inch allocations and eliminate use of end-guns on pivots			X
Require reduction of irrigated acres in selected areas			X
Require implementation of two water efficiency BMPs			X

Source: Papio-Missouri River NRD 2017

A.5 Lower Platte South Natural Resources District Current Monitoring and Response Actions

The Lower Platte South NRD's *Groundwater Management Plan* specifies three types of areas in which Lower Platte South NRD can pursue various drought management activities. These three types of areas include Groundwater Reservoirs (GWRs), the Remaining Area (RA), and Community Water Supply Protection Areas (CWSPAs).

Figure A-3: Lower Platte South Natural Resources District Groundwater Reservoirs



Source: Adapted from Ehrman et. al. 2015

The Lower Platte South NRD has designated five major GWRs, as shown in Figure A-3, within the NRD with the remainder of the district designated as the RA, which generally corresponds to areas that are variable in both groundwater quality and quantity. The Lower Platte South NRD monitors the well levels in each of the GWRs.

- Lower Platte South NRD's groundwater rules and regulations have the entire NRD designated as a Phase I Quality and Quantity Groundwater Management Area.
- A Phase II Groundwater Quantity Area is triggered when spring static water elevations in 30 percent of monitoring network wells have declined from the established upper elevation of the saturated thickness to an elevation that represents greater than or equal to a percent reduction in saturated thickness and has remained below that elevation for 2 consecutive years.
- A Phase III Groundwater Quantity is triggered when spring static water elevations in 50 percent of the monitoring network wells have declined from the established upper elevation of the saturated thickness to an elevation that represents greater than or equal to a percent reduction in saturated thickness and has remained below that elevation for 2 consecutive years."(Ehrman et al. 2015).

Table A-9 summarizes targeted reductions in pumping associated with each phase.

Table A-9: Lower Platte South Natural Resources District Phase II and Phase III pumping reduction triggers based on Groundwater Reservoir based on reduction in saturated thickness

Groundwater Reservoir	Phase II (water level decline in 30% of the wells)	Phase III (water level decline in 50% of the wells)
Lower Salt Creek	15%	30%
Missouri River	8%	15%
Platte River	8%	15%
Crete-Princeton	8%	15%

Groundwater Reservoir	Phase II (water level decline in 30% of the wells)	Phase III (water level decline in 50% of the wells)
Dwight Valparaiso	8%	15%
Remaining Area	8%	15%

Source: Lower Platte South NRD, Groundwater Rules and Regulations 2017
Note: Lower Platte South NRD's groundwater rules and regulations have the entire NRD designated as a Phase I Quality and Quantity Groundwater Management Area.

The Lower Platte South NRD includes CWSPAs around the groundwater supply wells for the 30 public water suppliers within their jurisdiction. CWSPA boundaries correspond with the Wellhead Protection Area boundaries as delineated by the Nebraska Department of Environmental Quality (NDEQ), and are defined as the area that encompasses the 20-year time-of-travel zone around a given well-field. Lower Platte South NRD samples each public water supplier at least annually for water quality.

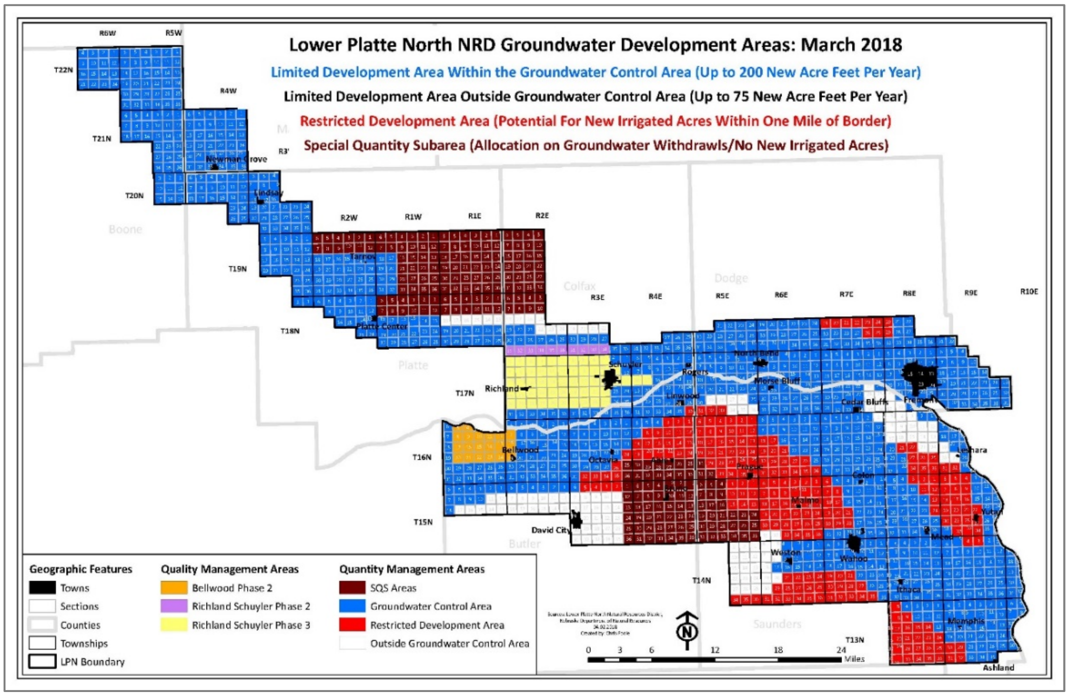
As a response to the drought conditions of 2012 and 2013, the Lower Platte South NRD created the Dwight-Valparaiso-Brainard (DVB) Special Management Area (SMA), shown in Figure A-3, and drafted new rules and regulations for the area including a stay on new irrigated acres, allocations on irrigation, required certification classes for irrigators, establishment of cost-share programs, new well depth requirements as well as formed an advisory group to evaluate progress of the SMA. The groundwater allocations on irrigated acres included 21 acre-inches per 3 years with a maximum of 9 inches applied in any 1 year for pivots or sprinklers and 30 acre-inches per 3 years with a maximum of 12 acre-inches applied in any 1 year for gravity/flood irrigation.

A.6 Lower Platte North Natural Resources District Current Monitoring and Response Actions

The Lower Platte North NRD may designate a Special Quantity Subarea (SQS) for the protection of groundwater quantity in a portion of the district where additional controls are deemed necessary. Additional controls in these areas may include stays on new irrigation wells, allocations, mandatory education classes for irrigators, well metering for all wells pumping greater than 50 gpm, mandatory acre certification, and static level measurements semi-annually (spring and summer).

There are currently two SQS areas in the Lower Platte North NRD, Butler/Saunders County SQS and Colfax/Platte County SQS; both of which have groundwater allocations based on a 3-year Rolling Allocation (Figure A-4). The Rolling Allocation shall specify the total number of acre-inches of irrigation water per irrigated acre for the rolling term. If the Lower Platte North NRD Board of Directors fails to adopt a Rolling Allocation by December of any given year, the Rolling Allocation for the following 3-year term shall be 27 acre-inches per irrigated acre. The Board may establish timing or rotation restrictions for the SQS.

Figure A-4: Lower Platte North Natural Resources District Special Quantity Subareas



Source: Map provided by Lower Platte North NRD (obtained 2018)

Additionally, the Lower Platte North NRD maintains a groundwater management plan (Lower Platte North NRD 2018). This groundwater management plan sets criteria for establishing Level 1, 2, and 3 areas based on groundwater trigger levels.

Level I Criteria

Level I aquifer management areas are designated for the entire Lower Platte North NRD. As more information becomes available, subareas shall be further refined. Any changes in water use, location of water use, number of gallons pumped, or changes in water source shall be reviewed and approved by the Lower Platte North NRD before those changes can take effect. Due to hydrologic conditions, Lower Platte North NRD monitoring wells are not to be located on municipal well-field property.

Level II Criteria

Confined Aquifer

- Unconfined aquifer management subareas are to be designated within the Lower Platte North NRD's when conditions indicate a 10 percent drop in the saturated thickness of the aquifer.
- Assessment of percentage drop will be calculated using the spring readings of Lower Platte North NRD monitoring wells over a consecutive 3-year period assessed against the 1987 baseline groundwater levels or a more recent baseline year groundwater level, adopted by the Lower Platte North NRD Board of Directors and revised in the Groundwater Management Rules and Regulations.
- When greater than 50 percent of the area within a subarea has reached, or exceeded the trigger level, then a Level II management area can be established. Assessment of the percentage of a sub-area will be determined by applying an area-weighting method to Lower Platte North NRD groundwater monitoring wells.

- After the establishment of a Level II Area, if groundwater levels should recover, two consecutive spring readings below the trigger levels are needed before the Groundwater Quantity Management Area could be placed as a Level I management area.

Unconfined Aquifer

- Confined aquifer management subareas are to be designated within the Lower Platte North NRD when conditions, indicate a 7 percent drop in potentiometric-aquifer thickness.
- Assessment of percentage drop will be calculated using the spring readings of Lower Platte North NRD's monitoring wells over a consecutive3-year period assessed against the 1987 baseline groundwater levels or a more recent baseline year groundwater level, adopted by the Lower Platte North NRD Board of Directors and revised in the Groundwater Management Rules and Regulations.
- When greater than 50 percent of the area within a subarea has reached, or exceeded the trigger level, then a Level II management area can be established.
- Assessment of the percentage of a sub-area will be determined by applying an area-weighting method to Lower Platte North NRD's groundwater monitoring wells.
- After the establishment of a Level II Area, if groundwater levels should recover, two consecutive spring readings below the trigger levels are needed before the Groundwater Quantity Management Area could be placed as a Level I management area.

Level III Criteria

Unconfined Aquifer

- Unconfined aquifer management subareas are to be designated within the Lower Platte North NRD when conditions indicate a 15 percent drop or greater in the saturated thickness of the aquifer.
- Assessment of percentage drop will be calculated using the spring readings of Lower Platte North NRD's monitoring wells over a consecutive 3-year period assessed against the 1987 baseline groundwater levels or a more recent baseline year groundwater level, adopted by the Lower Platte North NRD Board of Directors and revised in the Groundwater Management Rules and Regulations.
- When greater than 50 percent of the area within a subarea has reached or exceeded the trigger level, then a Level III management area can be established. Assessment of the percentage of a sub-area will be determined by applying an area-weighting method to Lower Platte North NRD groundwater monitoring wells.
- After the establishment of a Level III Area, if groundwater levels should recover, two consecutive spring readings below the trigger levels are needed before the Groundwater Quantity Management Area could be placed as a Level II or Level I management area.

Confined Aquifer

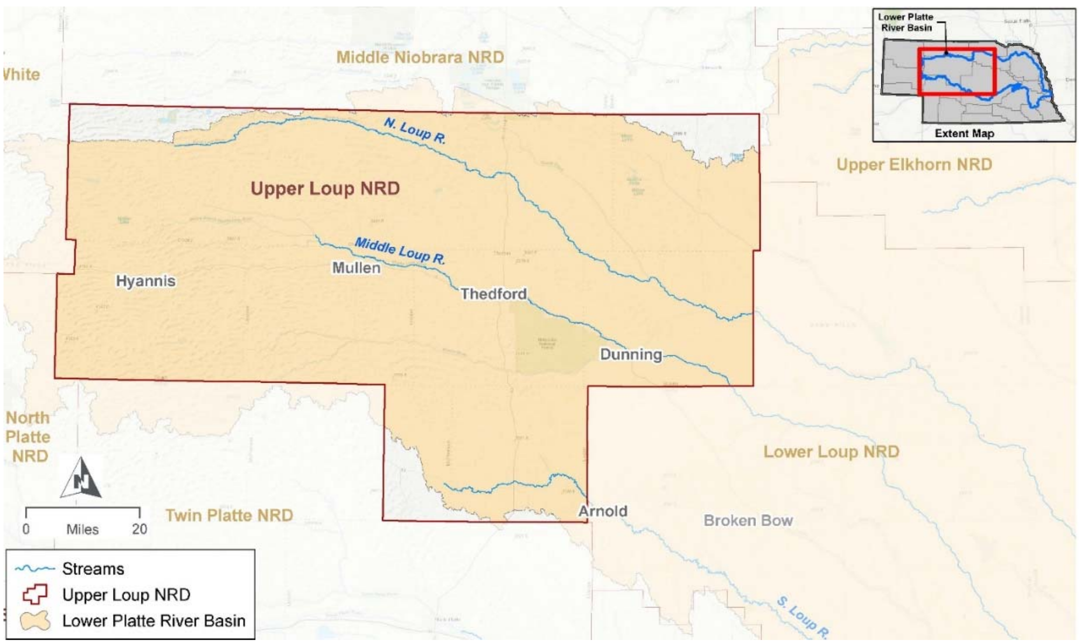
- Confined aquifer management subareas are to be designated within the Lower Platte North NRD when conditions, indicate a 10 percent or greater drop in the potentiometric-aquifer thickness.
- Assessment of percentage drop will be calculated using the spring readings of Lower Platte North NRD monitoring wells over a consecutive 3-year period assessed against the 1987 baseline groundwater levels or a more recent baseline year groundwater level, adopted by the Lower Platte North NRD Board of Directors and revised in the Groundwater Management Rules and Regulations.
- When greater than 50 percent of the area within a subarea has reached or exceeded the trigger level, then a Level III management area can be established. Assessment of the percentage of a

sub-area will be determined by applying an area-weighting method to Lower Platte North NRD groundwater monitoring wells.
- After the establishment of a Level III Area, if groundwater levels should recover, two consecutive spring readings below the trigger levels are needed before the Groundwater Quantity Management Area could be placed as a Level II or Level I management area.

A.7 Upper Loup Natural Resources District Current Monitoring and Response Actions

The Upper Loup NRD is located in the Sandhills and there is very little irrigation within the Upper Loup NRD. The Upper Loup NRD has an active groundwater quality monitoring program and has the ability to designate an area with impacted water quality as a Phase 1, Phase 2, or Phase 3 area depending on severity.

Figure A-5: Upper Loup Natural Resources District



The Upper Loup NRD monitors groundwater quantity through a monitoring well network. Network wells are measured each spring. The Upper Loup NRD has the ability to implement the following measures to protect groundwater quantity; however, no specific triggers have been identified to trigger these actions:

1. Establish a sub-area;
2. Temporary moratorium on new irrigated acres in the established sub-area; and
3. Initiate a study during which, as a minimum, water levels in surrounding wells will be measured to determine the severity, the geographical extent, and the boundaries of the affected area.

The Upper Loup NRD will offer workable solutions and/or voluntary controls, by which any water quantity problems may be addressed. Solutions may include but not limited to the following:

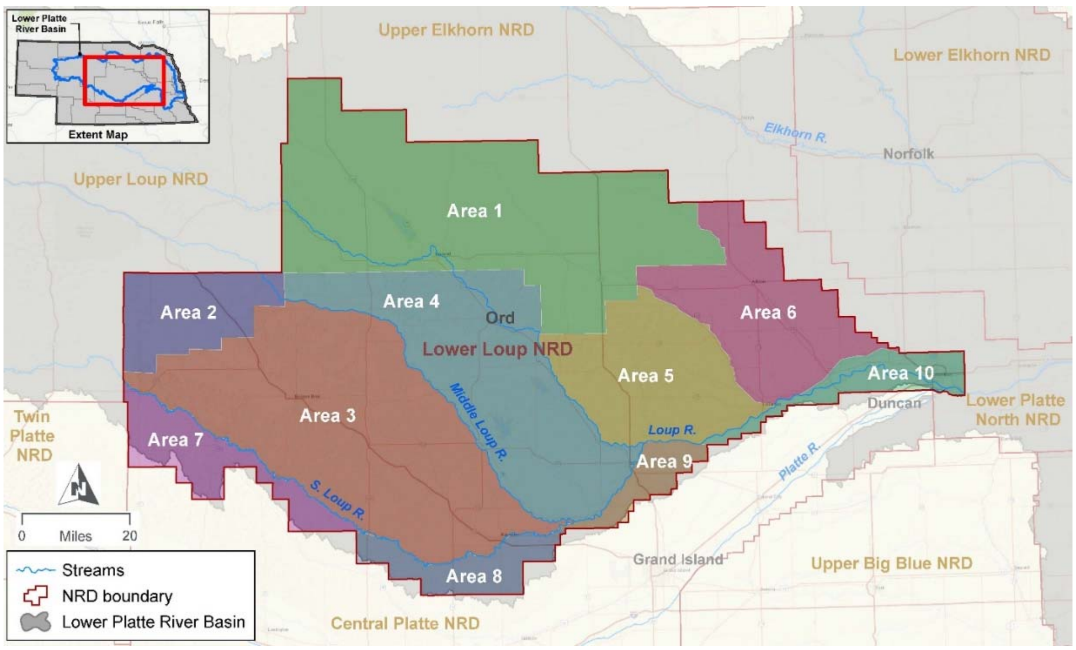
- irrigation scheduling,
- reduction of irrigated acres,
- adopt a system of rotation of use of groundwater,
- allocate groundwater withdraw on an acre-inch basis, and
- any other reasonable regulations to protect the quantity of groundwater in the sub-area.

A.8 Lower Loup Natural Resources District Current Monitoring and Response Actions

The Lower Loup NRD is divided into 28 Groundwater Quality Management Sub-Areas. Each Sub-Area may be subject to water quality controls in three separate Phases. Each phase is dependent on median nitrate nitrogen levels. Prior to any Sub-Area entering a higher or lower water quality control phase, a public hearing shall be held by the Board of Directors. The entire Lower Loup Natural Resources District Groundwater Management Area is a designated Phase I.

The Lower Loup NRD is divided into 10 Groundwater Quantity Management Sub-Areas (Figure A-6). The criteria for groundwater management is established in the Lower Loup NRD Groundwater Management Plan of 1985.

Figure A-6: Lower Loup NRD Water Quantity Areas



Source: Adapted from Lower Loup NRD Groundwater Management Plan 1985

As part of the Lower Loup NRD Groundwater Management Plan (Lower Loup NRD 1985):

1. The Lower Loup NRD adopted the Spring 1982 static water levels as the base line top of the groundwater reservoir;
2. Adopted 10 subdivisions as areas in which management plans will be implemented under declining conditions;
3. Continue monitoring within the Lower Loup NRD. In the event any well or group of wells has maintained a 10-foot decline below the Spring 1982 base line for 3 consecutive years, it shall be designated as a critical well or wells;
4. In all areas with a designated critical well, the Lower Loup NRD will expand the static well monitoring program to provide needed data for management area designation;
5. The Lower Loup NRD will simultaneously, with #3 notify water users within a 36 square mile area projecting 3 miles in all directions of the critical well or wells of the conditions. The Lower Loup NRD shall then assess the land use, water usage, number of active irrigation wells, and any other pertinent factors to make recommendations on voluntary water conservation practices;

6. In any groundwater reservoir that has a saturated thickness of less than 100 feet, the trigger to begin the process in #3 shall be 10 percent of the saturated thickness;
7. In the case of #3 or #5, if declines continue at the rate to equal 30 percent of the initial decline in the critical well and in other wells within the 36 square mile area over a 3-year period, the Lower Loup NRD shall establish a groundwater management area. Said management area shall extend not less than an area projecting 9 miles in all directions from any critical well or wells. In no case will management area boundaries cross into adjacent subdivisions or NRDs. Boundaries greater than 9 miles in radius can be adopted at the Lower Loup NRD's discretion;
8. In the case where declines appear to cross NRD boundaries, the affected NRDs shall be notified of the conditions and the Lower Loup NRD's actions;
9. Once a groundwater management area has been established, through due process, the Lower Loup NRD may require a combination of any of the following options:
    a. Well spacing
    b. Require water meters and report usage
    c. Develop an allocation system for groundwater withdrawal
    d. Adopt a system of rotation among groundwater users
    e. Initiate complaints for improper runoff
    f. With concurrence from the Nebraska Department of Natural Resources, establish groundwater control areas with the possibility of invoking well drilling moratoriums
10. Management area designations for subdivisions 7, 8, 9, and that part of 10 south of the Loup River will be established through coordination with the Central Platte NRD. The Lower Loup NRD reserves the right to exercise independent judgment if it determines that the management options proposed are too lenient or severe;
11. At any time it becomes apparent to the Lower Loup NRD that a management area designation will not bring declines into conformance with the goals of their Groundwater Management Plan, the Lower Loup NRD will take appropriate actions to create a control area in accordance with the appropriate statutes.

A.9 Lower Elkhorn Natural Resources District Current Monitoring and Response Actions

The Lower Elkhorn NRD manages groundwater through its 2015 Groundwater Management Plan. Additionally, Lower Elkhorn NRD published its Drought Management Plan in 2017.

The Lower Elkhorn NRD Drought Management Plan includes Drought Monitoring using the Palmer Drought Severity Index (PDSI) and Standardized Precipitation Index (SPI) in addition to monitoring streamflows at specific locations and groundwater levels through its monitoring program.

Streamflow locations are USGS gages for Elkhorn River at West Point, Elkhorn River at Norfolk, Logan Creek near Uehling, and North Fork Elkhorn River near Pierce, Nebraska. Historical data from each stream as collected and measurements were separated by month in order to establish drought indicators. Percentiles were calculated by month to account for the rivers' natural fluctuation throughout the year and period of record.

Lower Elkhorn NRD monitors groundwater quantity by measuring the depth of the groundwater in approximately 240 privately owned irrigation wells each spring in addition to transducers deployed in the Lower Elkhorn NRD monitoring well network. Historical groundwater level data from Lower Elkhorn NRD's transducers was collected and separated by month. Monthly percentiles were calculated in order to account for the typical fluctuation in groundwater levels throughout the calendar year.

Table A-10 shows the drought categories and criteria used by the Lower Elkhorn NRD.

Table A-10: Lower Elkhorn Natural Resources District Drought Monitoring Tool

Drought Level	PDSI	SPI 1, 3, 6, 12	Streamflow (West Point, Norfolk, Uehling, and Pierce)	Groundwater
Drought Watch	-2.00 to -2.99	<-1.0 and >-1.5 for all timescales	Streamflows between the 25th and 10th percentile	Groundwater level between the 25th and 10th percentile
Drought Warning	-3.00 to -3.99	<-1.5 and >-2.0 for all timescales	Streamflows between the 10th and 5th percentile	Groundwater level between the 10th and 5th percentile
Drought Emergency	-4.00 and below	<-2.0 for all timescales	Streamflows below the 5th percentile	Groundwater level below the 5th percentile

Source: Lower Elkhorn NRD 2017

PDSI = Palmer Drought Severity Index; SPI = Standardized Precipitation Index.

The current Groundwater Management Plans existing triggers do not provide protection of in-season groundwater level declines.

Lower Elkhorn NRD's Groundwater Management Plan provides guidance for managing both groundwater quantity and quality as described in the following sections.

Groundwater Quantity Management

Triggers for groundwater quantity protection consist of several phases, called action levels, which respond to worsening conditions with increasingly rigorous corrective measures. Each action level has its own triggering mechanism, so that changing conditions will trigger new action levels.

Flexibility has been built into the triggers and action levels because of the complex hydrogeology of the district. The current triggers and actions are used for the entire district, which may be too protective in some areas and may under-protect other areas. As our knowledge of the district's hydrogeology increases, the triggering mechanisms and actions will be 'fine-tuned' to improve the effectiveness of our groundwater quantity protection efforts. The Lower Elkhorn NRD will develop unique triggers and actions for different regions of the district as more local hydrogeologic information becomes available.

Action Level 1: The Lower Elkhorn NRD will initiate the following actions when, in 2 years of any 3-year period, the spring groundwater level of any well in the routine groundwater quantity monitoring program drops 15 or more feet below predevelopment estimates for groundwater levels in that area. When this trigger is actuated, the Lower Elkhorn NRD will take the following actions:

1. Intensify educational efforts in the area including, but not limited to, information concerning:
    a. Groundwater conservation practices;
    b. Potential regulatory actions of the 2nd and 3rd Action Levels (see below);
    c. The status of the groundwater supply in the area.
2. Formation of a local citizen's advisory committee.
3. Increase the number of wells monitored in the area to determine the extent of the problem, to serve as a basis for triggering Action Level 2, and to obtain the hydrogeologic information necessary to delineate a management area. The intensified monitoring program described below applies to the entire district. The actual monitoring program for each problem area may vary according to the local hydrogeologic characteristics of the area.

The district will determine a rudimentary area to be monitored. The shape and size of the area may change as more information is gathered. A minimum area of 9 square miles will be monitored.

a. The minimum number of monitoring sites will be 50 percent of the number of registered irrigation wells in the area that are suitable for use as groundwater level observation wells (taking into account criteria such as quality of well construction and screened intervals). The district will also consider using registered industrial, livestock, monitoring, observation, public water supply, and domestic wells that would be suitable as monitoring sites.

   b. The intensified monitoring will begin no later than the spring after the trigger was actuated for Action Level 1.
   c. If, after 5 years of the intensified monitoring, the trigger for Action Level 2 has not been actuated, the district may return to the routine groundwater level monitoring program for the area.
4. Determine the necessary control measures, rules, and regulations for Action Levels 2 and 3.

Action Level 2: An area will be placed into Action Level 2 when the spring groundwater levels in 80 percent of the wells monitored in the intensified monitoring program conducted in Action Level 1 drop 15 or more feet below predevelopment estimates for groundwater levels in those wells for 3 years out of any 4-year period of time. The area affected by this drop must be a minimum of 9 square miles in size.

a. The Lower Elkhorn NRD will actively seek public opinion while developing the rules and regulations for the area.
b. The district will require volume metering of wells used for any or all of the following categories of groundwater use: domestic, agricultural, manufacturing, commercial, or industrial.
c. The district will also require owners of these wells to submit an annual report to the district.

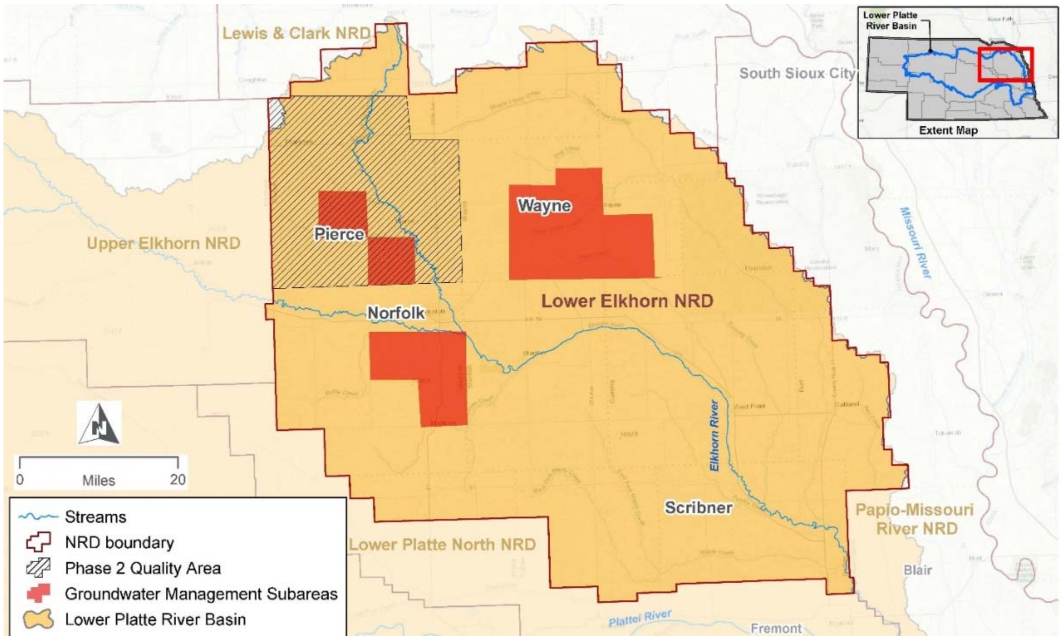
Additionally, the district will choose at least one of the following authorized controls:

a. Allocate groundwater withdrawal on an acre-inch basis, specifying the total number of acre-inches of irrigation water per irrigated acre per year or an average number of acre-inches of irrigation water per irrigated acre over any reasonable period of time not to exceed 5 years.
b. Adopt a system of rotation of use of groundwater by utilizing a recurring series of use and nonuse of irrigation wells on an hourly, daily, weekly, or monthly basis or of irrigated acres on an annual basis.
c. Adopt well spacing requirements
d. Require the reduction of irrigated acres, where the nonuse of irrigated acres will be a uniform percentage reduction of each landowner's irrigated acres.
e. Require the use of flow meters on wells.
f. Require best management practices including irrigation scheduling.
g. Require groundwater users to submit annual reports to the district. The district will also continue the educational efforts and the groundwater level monitoring of Action Level 1.

Action Level 3: An area will be placed into Action Level 3 when the spring groundwater levels in 80 percent of the wells monitored in Action Level 2 drop 20 or more feet below predevelopment estimates for groundwater levels in those wells for 3 years out of any 4-year period of time. The area affected must be a minimum of 9 square miles in size. In addition to any of the controls of Action Level 2, the district may require any of the following controls for an Action Level 3 area:

a. Require the use of tensiometers, soil moisture blocks, or other irrigation scheduling devices.
b. Require annual reports with water level measurements and quantifying the total withdrawal from wells.
c. Close the area to the issuance of any additional new well permits for a period of one year. The district will also continue the educational efforts and the groundwater level monitoring of the first two Action Levels.
d. The Lower Elkhorn NRD has three (3) Quantity Subareas with allocations: 1) Eastern Madison County Quantity Subarea; 2) Wayne County Quantity Subarea; and 3) Pierce County.

Figure A-7: Lower Elkhorn Natural Resources District Groundwater Management Areas



Source: Adapted from Lower Elkhorn NRD Groundwater Management Plan (LENRD 2015)

Groundwater Quality Management

The Lower Elkhorn NRD maintaining a network of 81 irrigation wells for the district-wide groundwater quality monitoring that are on a 5-year sampling cycle. Specialized monitoring is also performed to evaluate local conditions on a concentrated basis.

The Lower Elkhorn NRD groundwater quality portion of the management area will be divided into subareas to more effectively manage areas where different conditions exist (such as areas with high or low groundwater contamination concentrations, different soil types, or different land uses). Borders for these subareas will be determined primarily, but not exclusively, by groundwater contamination concentration. These subareas will be referred to as phases. An area may move from one phase to another (either up or down) according to groundwater concentration and/or any of the listed additional criteria that are deemed appropriate by the Board. Borders for the subareas will follow either natural or political boundaries. NRDs are required to address all nonpoint source contaminants in their groundwater management plans. Because of the diversity of potential nonpoint source contaminants that the management area could address, the controls listed in this section are somewhat generic. This is so that contaminants other than nitrate-nitrogen may be addressed if necessary.

For those contaminants that have an established Maximum Contaminant Level, the following criteria and controls will be used to delineate and treat subareas (the subareas will be called 'phases'):

Phase 1 Area: Areas that are not designated as either Phase 2 or Phase 3.

a. Persons installing new wells must obtain a permit from the NRD in accordance with § 46-659.
b. The district will encourage operators to attend educational programs sponsored by the district concerning the contaminant (such as fertilizer and irrigation water management), to perform deep soil testing for the contaminant(s), to test irrigation water for the contaminant(s) and to submit an annual report (similar to the report required in phases 2 and 3) to the district.

Phase 2 Area: Areas that have from 50 percent to 90 percent of the Maximum Contaminant Level for a contaminant. An area will be placed into a Phase 2 area when at least 20 percent of the registered wells in an area are at or above the trigger level and the contamination is the result of nonpoint source groundwater contamination. Phase 2 areas must be a minimum of 9 square miles in size.

a. Persons installing new wells must obtain a permit from the NRD in accordance with § 46-659.
b. All operators applying fertilizer or (other possible sources of contaminants that the management area is addressing) must attend educational programs sponsored by the district.
c. Soil must be tested for residual quantities of the contaminant(s) (such as nitrate-nitrogen).
d. Irrigation water must be tested for the contaminant(s) (such as nitrate-nitrogen).
e. All operators applying fertilizer or (other possible sources of contaminants that the management area is addressing) must periodically submit reports to the district that will include soil test results, irrigation water test results, and other information required by the Board of Directors.
f. Contaminants other than nitrate-nitrogen may require controls that are different from those listed above for Phase 2 areas.

If these controls will not be effective in preventing or remediating groundwater contaminant(s) other than nitrate-nitrogen, the Board of Directors may choose to not use some or all of the controls listed above.

Phase 3 Area: Areas with greater than 90 percent of the Maximum Contaminant Level for a contaminant. An area will be placed into a Phase 3 area after being in a Phase 2 area for a minimum of 5 years, and when 50 percent of the registered wells in the area are at or above the trigger level. Phase 3 areas must be a minimum of 9 square miles in size.

a. Persons installing new wells must obtain a permit from the NRD in accordance with § 46-659.
b. All operators applying fertilizer or (other possible sources of contaminants that the management area is addressing) must attend educational programs sponsored by the district.
c. Soil must be tested for residual quantities of the contaminant(s) (such as nitrate-nitrogen).
d. Irrigation water must be tested for the contaminant(s) (such as nitrate nitrogen).
e. All operators applying fertilizer or (other possible sources of contaminants that the management area is addressing) must submit a report to the district that includes soil test results, irrigation water test results, and other information required by the Board of Directors annually.
f. All irrigation wells must have the volume output certified by the district.
g. All irrigators must employ some form of irrigation scheduling
h. Contaminants other than nitrate-nitrogen may require controls that are different from those listed above for Phase 3 areas.

If these controls will not be effective in preventing or remediating groundwater contaminant(s) other than nitrate-nitrogen, the Board of Directors may choose to not use some or all of the controls listed above.

Additional criteria: The district Board of Directors, at its discretion, may designate an area as, or include an area in, either Phase 2 or Phase 3, when the triggers are not met, under the following conditions:

1) Areas with similar soil and land use conditions as an existing Phase 2 or Phase 3 area.
2) Areas that may be vulnerable to groundwater contamination.
3) Areas that have vadose zone contamination that indicates a potential for groundwater contamination.
4) Areas that are within Public Water Supply Wellhead Protection Areas.
5) Other areas deemed necessary by the Board of Directors consistent with the Groundwater Reservoir Life Goal and the Nebraska Groundwater Management and Protection Act.

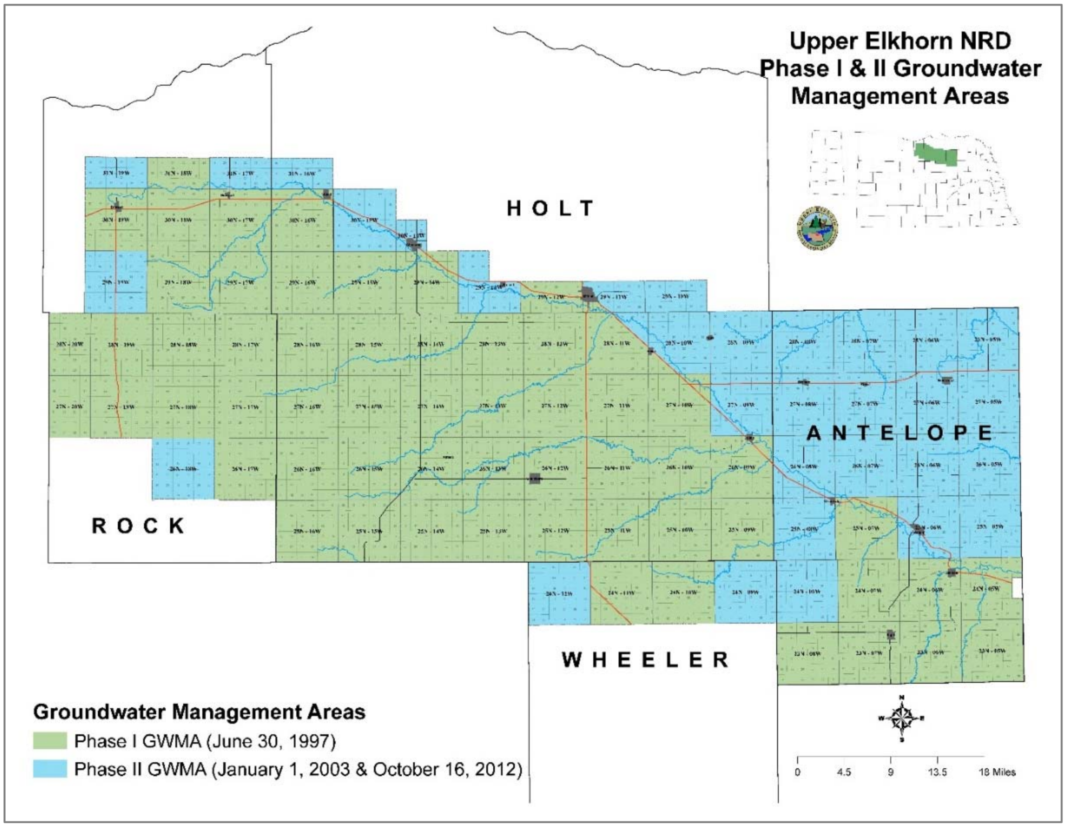
Additional Controls: Any of the following controls may be required by the Board of Directors in a Phase 1, Phase 2, or Phase 3 area if deemed necessary to fulfill the Groundwater Reservoir Life Goal:

a. All operators applying fertilizer or (other possible sources of contaminants that the management area is addressing) must attend educational programs sponsored by the district.
b. Soil must be tested for residual quantities of the contaminant(s) (such as nitrate-nitrogen).
c. Irrigation water must be tested for the contaminant(s) (such as nitrate nitrogen).
d. Using realistic yield goals
e. Irrigation water scheduling.
f. Meter irrigation water application volume.
g. Ban fall and/or winter fertilizer application.
h. Require the use of nitrification inhibitors.
i. Allowing nutrient credit for legume crops.
j. Performing chemical and/or physical analysis of contaminant sources being land applied (such as manure, compost, sewage sludge, and other waste products).
k. Allowing nutrient credit for manure, compost, sewage sludge, and other waste products.
l. Performing nutrient analysis of manure, compost, sewage sludge, and other waste products. Confined animal production facilities must prepare and implement a plan for the disposal of animal wastes that determines the amount of manure that will be land applied, the area of land required for that amount of manure (complying with UNL recommendations), and the location(s) of that area of land.

A.10 Upper Elkhorn Natural Resources District Current Monitoring and Response Actions

The Upper Elkhorn NRD measures the static water level in approximately 380 wells annually to keep track of water quantity across the NRD. The Upper Elkhorn NRD also has an extensive water quality monitoring network throughout the NRD. The Upper Elkhorn NRD samples approximately 600 irrigation wells annually for nitrate-nitrogen, and 58 dedicated monitoring wells for nitrate-nitrogen and selected pesticides.

Figure A-8: Upper Elkhorn Natural Resources Phase II Management Areas



Source: Upper Elkhorn NRD Phase II Area Map (downloaded 2018)

Groundwater Quality

The Upper Elkhorn NRD manages groundwater quality through the three phases that are based on nitrate-nitrogen levels. The entire Upper Elkhorn NRD was designated a Phase I Groundwater Quality Management Area.

Groundwater Quantity

The Upper Elkhorn NRD has developed sub-districts throughout the Upper Elkhorn NRD management area to manage groundwater. As part of such management, Upper Elkhorn NRD has determined a baseline static water level within each of the sub-districts, which will be the lowest static water level reading prior to 2014.

Triggering Mechanisms:

1) When spring static water levels within a sub-district are determined to be between 24 inches and 12 inches above the lowest spring reading, the following shall occur:
    a) The Upper Elkhorn NRD will conduct an informational and educational campaign for landowners that own and operate irrigation distribution systems that are supplied by individual or commingled high capacity wells yielding more than 50 gpm. Landowners will be informed within that sub-district that this level has been reached and upon subsequent spring static water level readings, additional regulations may be warranted the following year.
    b) Historical certified irrigated acres that were not being irrigated by groundwater prior to this trigger will not be allowed to be developed for irrigation as long as these criteria are met.

2) When spring static water levels in a sub-district are determined to be within 12 inches above the lowest spring static reading, the following shall occur:
   a) Flowmeters will be required on 10 percent of the landowner's irrigation distribution systems within that sub-district that are supplied by individual or commingled high capacity wells yielding more than 50 gpm.
   b) Installation of flowmeters must be installed to manufacturer's specifications. A legal description must be submitted to Upper Elkhorn NRD and flowmeters must be installed by December 31 of the current year of meeting the above static water level.
   c) If the groundwater irrigation distribution system owner owns less than 10 groundwater irrigation distribution systems, they will be required to install one flowmeter if the above criteria is met.
   d) If the groundwater irrigation distribution system owner already has 10 percent of their groundwater irrigation distribution systems equipped with flowmeters within this sub-district, this requirement will be satisfied.
   e) Flowmeter readings will need to be submitted to Upper Elkhorn NRD by December 31 each year on forms developed by Upper Elkhorn NRD and may be spot-checked for compliance.
   f) Any groundwater irrigation distribution system that is currently equipped or is to be equipped with a flowmeter must certify their irrigated acres if they have not already been certified.
   g) Historical groundwater certified irrigated acres that were not being irrigated prior to this trigger will not be allowed to be developed for irrigation as long as the above criteria is met.
3) When spring static water levels in a sub-district remain and are determined to be within 12 inches above the lowest spring static reading in subsequent or non-subsequent years, the following shall occur:
   a) Flowmeters will be required on an additional 10 percent of the landowner's irrigation distribution systems within that sub-district that are supplied by individual or commingled high capacity wells yielding more than 50 gpm.
   b) Installation of flowmeters must be installed to manufacturer's specifications. A legal description must be submitted to Upper Elkhorn NRD and flowmeters must be installed by December 31 of the current year of meeting the above static water level.
   c) If the groundwater irrigation distribution system owner owns less than 10 groundwater irrigation distribution systems, they will be required to install an additional flowmeter within this sub-district.
   d) Flowmeter readings will need to be submitted to Upper Elkhorn NRD by December 31 each year on forms developed by Upper Elkhorn NRD and may be spot-checked for compliance.
   e) Historical groundwater certified irrigated acres that were not being irrigated prior to this trigger will not be allowed to be developed for irrigation as long as the above criteria is met.
4) When spring static water levels in a sub-district are determined to be 12 inches above the lowest reading, the flowmeter installation requirement will discontinue until the spring static water levels are determined to be within 12 inches above the lowest static water level reading.
5) When spring static water levels in a sub-district are determined to be within 12 inches below the lowest spring static water level reading, the following shall occur:
   a) Flowmeters will be required on 60 percent of the landowner's irrigation distribution systems within that sub-district that are supplied by individual or commingled high capacity wells yielding more than 50 gpm.
   b) Installation of flowmeters must be installed to manufacturer's specifications. A legal description must be submitted to Upper Elkhorn NRD and flowmeters must be installed by December 31 of the current year of meeting the above static water level.
   c) Flowmeter readings will need to be submitted to Upper Elkhorn NRD by December 31 each year on forms developed by Upper Elkhorn NRD and maybe spot-checked for compliance.
   d) Historical groundwater certified irrigated acres that were not being irrigated prior to this trigger will not be allowed to be developed for irrigation as long as the above criteria is met.

6) When spring static water levels in a sub-district remain and are determined to be within 12 inches below the lowest spring static reading in subsequent or non-subsequent years, the following shall occur:
    a) Flowmeters will be required on 100 percent of the landowner's irrigation distribution systems within that sub-district that are supplied by individual or commingled high capacity wells yielding more than 50 gpm. No allocation will be implemented at this time.
    b) Installation of flowmeters must be installed to manufacturer's specifications. A legal description must be submitted to Upper Elkhorn NRD and flowmeters must be installed by December 31 of the current year of meeting the above static water level.
7) When the spring static water levels in a sub-district are determined to be below 12 inches of the lowest spring static water level reading, then an allocation system will be implemented within that sub-district and the following shall occur:
    a) Flowmeters will be required on 100 percent of the landowner's irrigation distribution systems within that sub-district that are supplied by individual or commingled high capacity wells yielding more than 50 gpm.
    b) Installation of flowmeters must be installed to manufacturer's specifications. A legal description must be submitted to Upper Elkhorn NRD and flowmeters must be installed by December 31 of the current year of meeting the above static water level.
    c) Variances may be granted upon a demonstration of good cause.
    d) Allocations will be allotted the following year of the spring reading reaching this static water level. Each groundwater certified irrigation distribution system will be allocated for a period of 5 years and receive 75 acre inches.
    e) Flowmeter readings will need to be submitted to Upper Elkhorn NRD by December 31 each year on forms developed by Upper Elkhorn NRD and may be spot-checked for compliance.
    f) Historical groundwater certified irrigated acres that were not being irrigated prior to this trigger will not be allowed to be developed for irrigation as long as the above criteria is met.
8) When spring static water levels in a sub-district are determined to be below 12 inches of the lowest spring static water level in one spring static water level measuring cycle, the following shall occur:
    a) Flowmeters will be required on 100 percent of the landowner's irrigation distribution systems within that sub-district that are supplied by individual or commingled high capacity wells yielding more than 50 gpm and an allocation will be enforced on all groundwater irrigation distribution systems within the sub-district.
    b) Allocations will be allotted the following year of the spring reading reaching this static water level.
    c) Allocations will be maintained for a minimum of 5 years. Any time within this period the Upper Elkhorn NRD board of directors reserves the right to adjust the allocation amount based on static water levels, trend lines, and weather conditions.
    d) Flowmeter readings will need to be submitted to Upper Elkhorn NRD by December 31 each year on forms developed by Upper Elkhorn NRD and may be spot-checked for compliance.
    e) Historical groundwater certified irrigated acres that were not being irrigated prior to this trigger will not be allowed to be developed for irrigation as long as the above criteria is met.
9) Upon static water levels reaching Subpart 8 above:
    a) Expansion of groundwater irrigated acres will not be allowed.
    b) Each groundwater certified irrigation distribution system will be allocated for a period of 5 years and receive 75 acre inches.
    c) New helper wells will not be allowed once a sub-district has been determined to be triggered.
    d) Transfers of historical or active groundwater irrigated acres will not be allowed.
    e) Inactive certified historical acres that are not currently irrigated upon a sub-district being triggered will not receive an allocation.
    f) Historical certified irrigated acres that began irrigating within the five years prior to being triggered will only receive 15 acre inches multiplied by the number of years documented by

Farm Service Agency or County Assessor records. (For example, if documentation demonstrates land was irrigated 3 out of the previous 5 years, such land would receive only 45 acre inches for the 5-year allocation starting the year it was triggered.)

g) Situations where groundwater historical irrigated acres are utilized to complete circle or add to a certified irrigation distribution system will be calculated as such. I. (For example, if 5 acres were added to a 127-acre pivot and 3 years' worth of documentation are available, 5 acres x 45 inches = 225 acre inches. 127 acres have 75 acre inches, or 9,525 acre inches. So, add (225 acre in + 9,525 acre in) /132 acres = 73.86 acre inches for the 5-year allocation.)

h) Balance of allocations will be based on an annual allocation of 15 acre inches.

i) Once levels rise two feet above the lowest level, the Upper Elkhorn NRD Board will decide as to whether a sub-district can sustain more consumptive use and determine if groundwater historical acres that are not being currently irrigated will be allowed to be irrigated.

j) Allocation Carry-Over:
    - i) Any unused allocation at the end of the 5-year period would only be allowed to carry 5 acre inches into the next allocation. (Starting with a new 75 acre inch allocation + 5 acre inches of carry over = 80 acre inches for next 5-year time period.)
    - ii) Landowners would have to notify on a form provided by Upper Elkhorn NRD the amount and location where a portion of an allocation is to be moved. This notification would have to occur by January 15 of each year.
    - iii) Moving of allocation as stated above would only be allowed when:
        - (1) Properties are within the same ownership;
        - (2) Within sub-districts developed by Upper Elkhorn NRD; and
        - (3) Are to a lower stream depletion factor within the same hydrologic unit code (HUC) within the same sub-district. Allocation would be allowed to move within 2 miles of adjacent HUC meeting above criteria.

k) Penalties:
    - i) At the end of the 5-year allocation, any amount of groundwater used over the 75 acre inch allocation will be rounded to the next consecutive inch, multiplied by 5, and subtracted from the next new subsequent allocation.
    - ii) If the district removes the sub-district from an allocation, those groundwater irrigation distribution systems that was to be penalized by a reduction will remain with an allocation for another year. This 1-year allocation will be based on the annual 15 acre inch allocation minus the penalty. (For example, if a landowner used 1.2 acre inches more than the 75 acre inch allocation, 1.2 acre inches rounded to 2 acre inches times 5 equals 10 acre inches. 15 acre inches (annual) minus 10 acre inches (penalty) = 5 acre inches for year 6.)
    - iii) Acres that are being irrigated that have not been certified by the groundwater irrigation distribution owner with Upper Elkhorn NRD will have their allocation reduced on their certified groundwater irrigated acres for that groundwater distribution irrigation system. Certified irrigated acres will be reduced by a multiplier of 10. (For example, landowner has 127 acres and irrigated 3 acres more that was not certified as irrigated. Landowner would be penalized 3 (acres) x 10 (multiplier) = 30 acres of reduction on that impacted irrigation distribution system for a minimum of 1 year. If this violation occurs during an allocation period, penalty will carry on for completion of existing allocation period and on to next full allocation. If allocation for that subbasin is removed then the penalty will be enforced for 1 year.

Appendix B: Evaluation of Hydroclimate Indices

B.1 Palmer Drought Severity Index

The Palmer Drought Severity Index (PDSI) is calculated weekly by the National Oceanic Atmospheric Administration (NOAA) Climate Prediction Center (CPC). The PDSI reflects recent precipitation and the soil moisture balance. PDSI does not consider human impacts on the water balance, such as irrigation. Zero or near zero PDSI values indicate normal conditions, a negative PDSI value indicates drought and a positive value for a wet period.

Table B-1: PDSI Classifications

Index Value	Description	Index Value	Description
4.0 or above	Extremely wet	-0.99 to -0.5	Incipient dry spell
3.00 to 3.99	Very wet	-1.99 to -1.00	Mild drought
2.00 to 2.99	Moderately wet	-2.99 to -2.00	Moderate drought
1.00 to 1.99	Slightly wet	-3.00 to -3.99	Severe drought
0.5 to 0.99	Incipient wet spell	-4.00 or less	Extreme drought
-0.49 to 0.49	Near normal	---	---

Source: NOAA National Weather Service Climate Prediction Center 2005.
Note: The U.S. Drought Monitor includes one additional category "exceptional drought" for index values <-5

Mathematically, the PDSI is calculated as follows:

$$PDSI_i = \sum_{m=0}^{i} \frac{0.897^m}{3} Z_{i-m} \qquad \text{Equation (B-1)}$$

where *i* and *i-1* indicate current and previous months at some arbitrary time, respectively, and $PDSI_0 = 0$. The Z_i in Equation (B-1), called the monthly Z-index, is defined as

$$Z_i = (Kd)_i \qquad \text{Equation (B-2)}$$

where K is a coefficient and

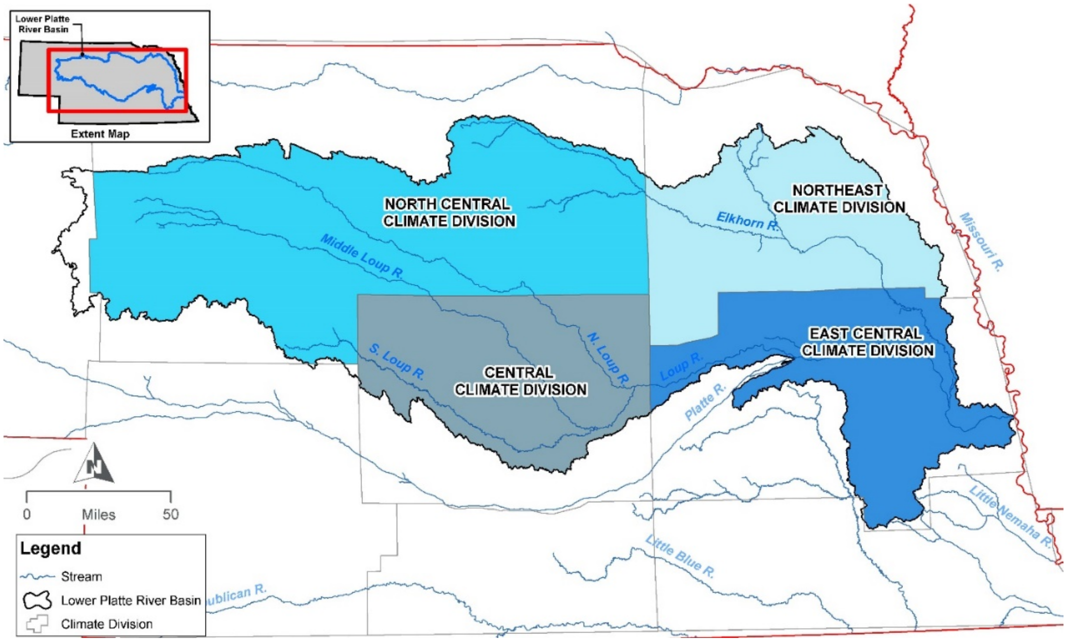
$$d = P - (\alpha_i PE + \beta_i PR + \gamma_i PRO - \delta_i PL) \qquad \text{Equation (B-3)}$$

where $\alpha_i = \overline{ET}_i/\overline{PE}_i$, $\beta_i = \bar{R}_i/\overline{PR}_i$, $\gamma_i = \overline{RO}_i/\overline{PRO}_i$, $\delta_i = \bar{L}_i/\overline{PL}_i$

In Equation (B-3), P is actual monthly precipitation. The terms in the parenthesis on the right-hand-side of Equation (B-3) combine to yield monthly 'climatologically appropriate rainfall'. In particular, PE is potential evapotranspiration, PR is potential water recharge to soil, and PRO potential runoff. Wayne C. Palmer used a two-layer soil model consisting of a surface layer, 'plow layer', and underlying layer, 'root zone', and defined PL as the sum of soil water of the two layers available for evapotranspiration. He called this term 'potential loss of soil water to evapotranspiration' (Palmer 1965).

Equation (B-1) is a cumulative formula, the PDSI from previous months affects the current month. As the number of months increase, the effect of previous months gradually decrease. However, because previous months affect the PDSI of a current month, there could be a lag in the PDSI identifying rapidly emerging droughts. Based on USGS streamflow record data, monthly streamflow on the Platte River from Duncan to Louisville, Nebraska, correlated significantly with the monthly PDSI (USGS 2008). The NOAA climate divisions for Nebraska are shown in Figure B-1.

Figure B-1: NOAA Climate Divisions for Nebraska



Source: Map layer downloaded from Climate Prediction Center 2018.

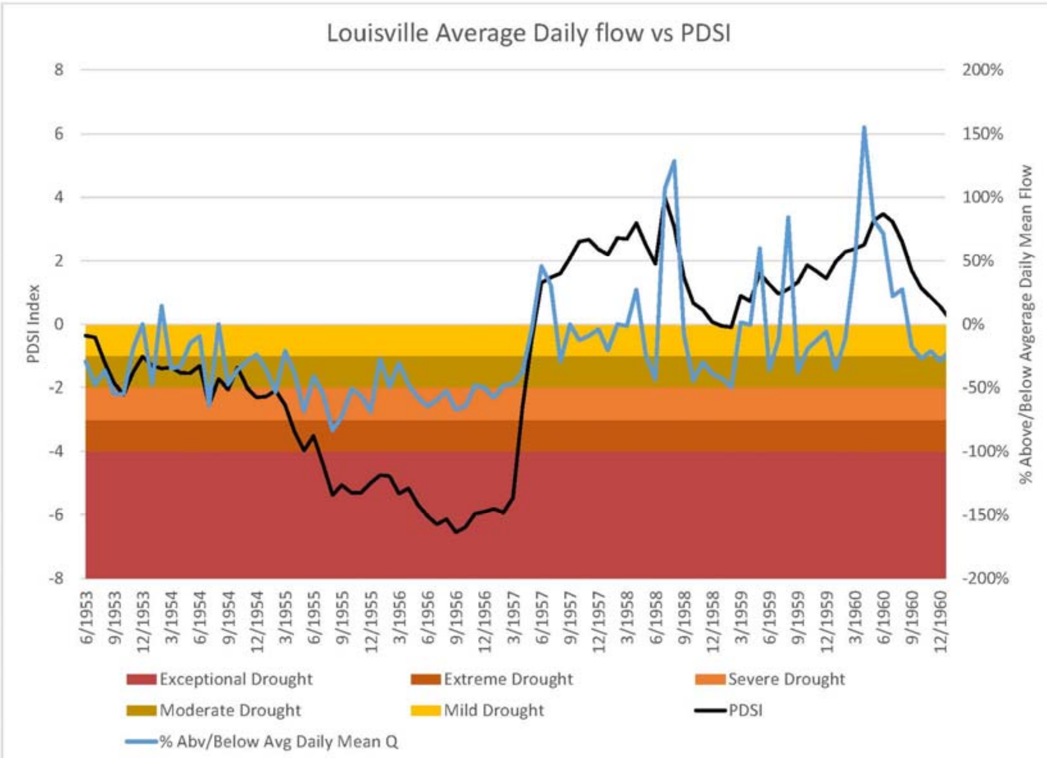
Figures B-1 through B-8 plot the Platte River July streamflow at Louisville as a percentage above or below the median July flow for the period 1953 to 2017 (Table B-2) against the historic PDSI to understand the historic droughts. The PDSI value in these plots is a composite of the value for the four climate divisions encompassing the Lower Platte River Basin: East Central, Northeast, Central, and North Central divisions).

Table B-2: Platte River at Louisville – 50 percent flow exceedance values by month

Month	50% Exceedance Flow (cfs)	Month	50% Exceedance Flow (cfs)
January	4,309	July	4,994
February	6,922	August	3,149
March	9,287	September	3,523
April	8,292	October	4,490
May	8,033	November	5,062
June	9,287	December	4,629

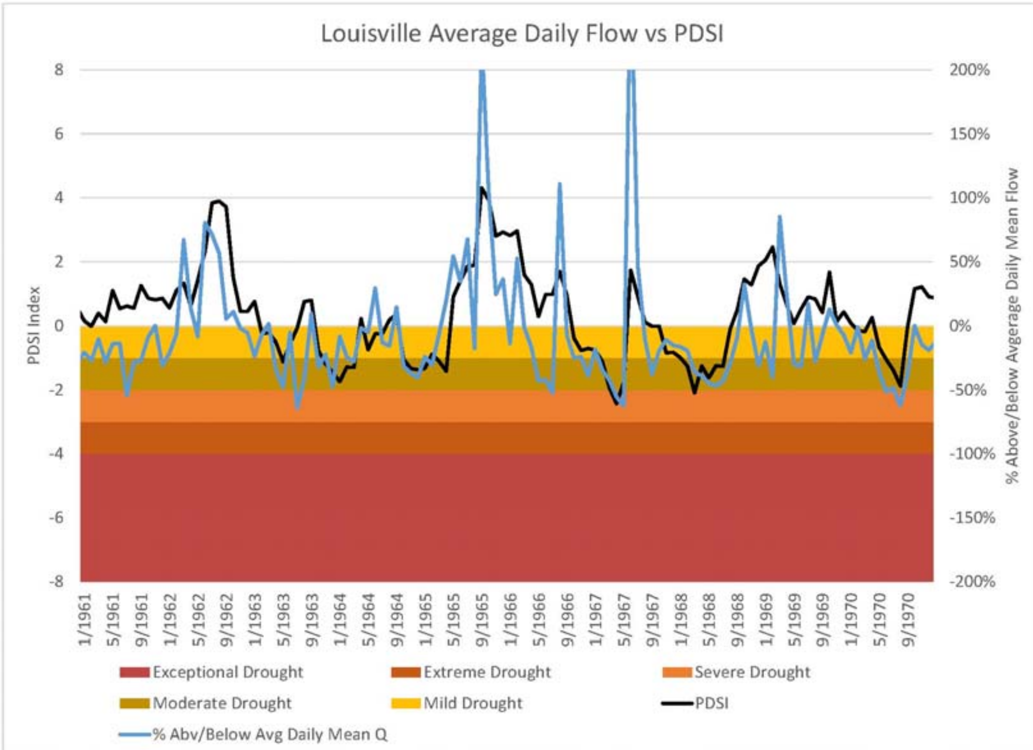
Note: Based on USGS gage #06805500 Platte River at Louisville, Nebr. (6/1953 to 12/2017 mean daily flow)

Figure B-2: Composite PDSI versus Above/Below Average Flow at Louisville – 1953 to 1960



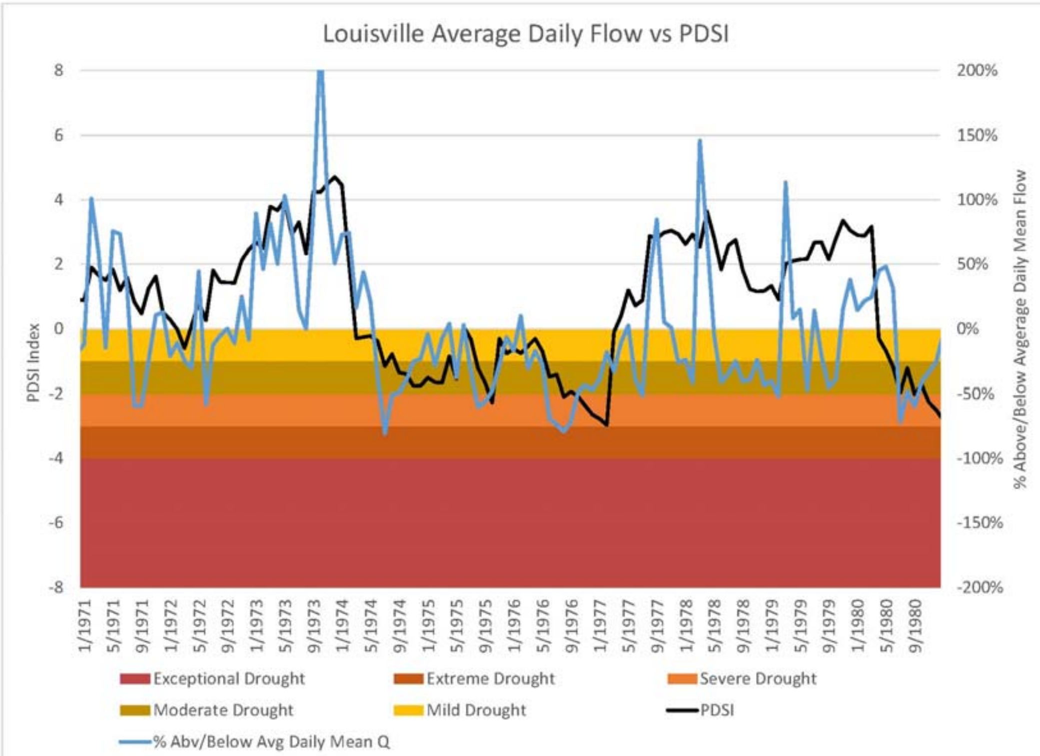
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-3: Composite PDSI versus Above/Below Average Flow at Louisville – 1961 to 1970



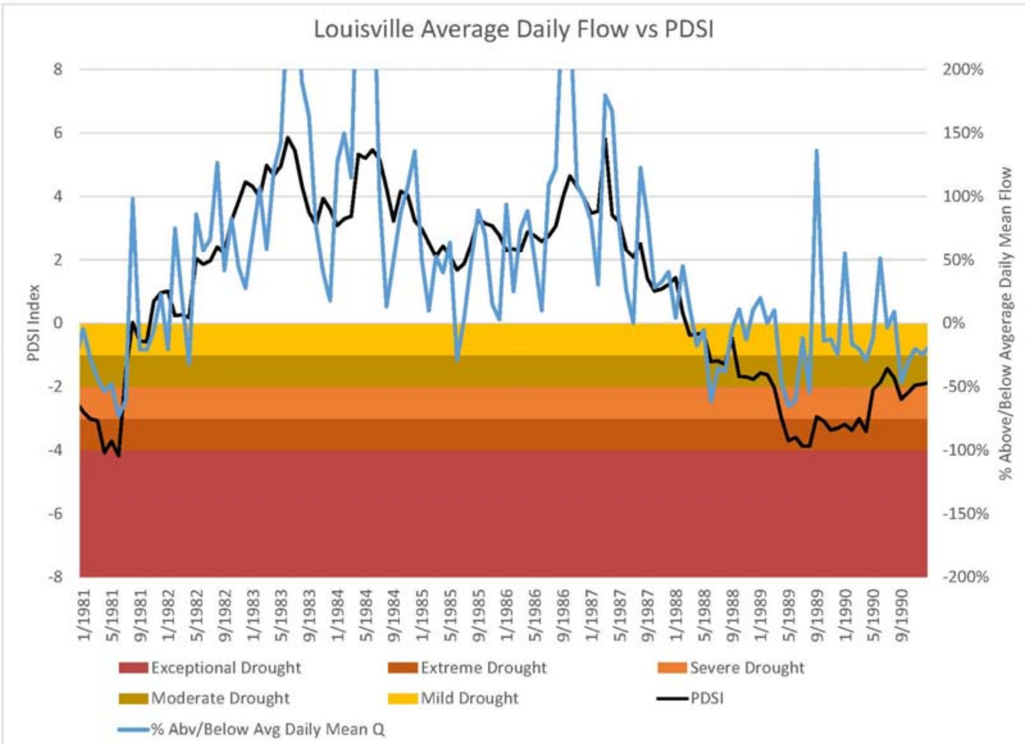
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-4: Composite PDSI versus Above/Below Average Flow at Louisville – 1971 to 1980



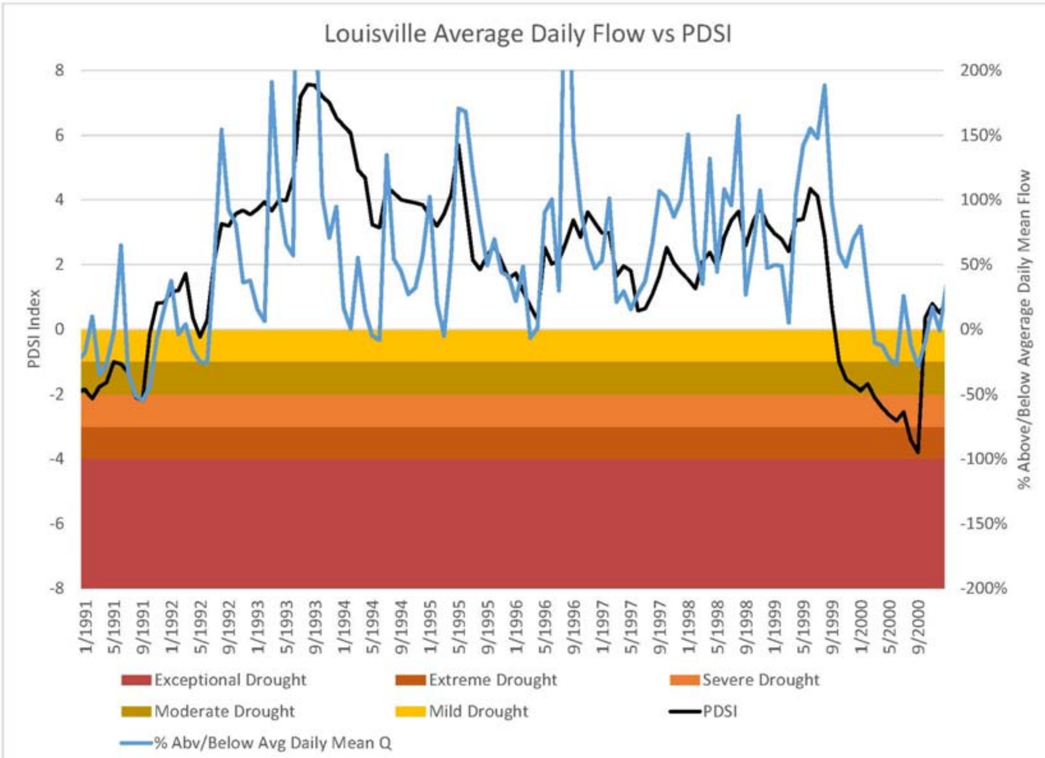
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-5: Composite PDSI versus Above/Below Average Flow at Louisville – 1981 to 1990



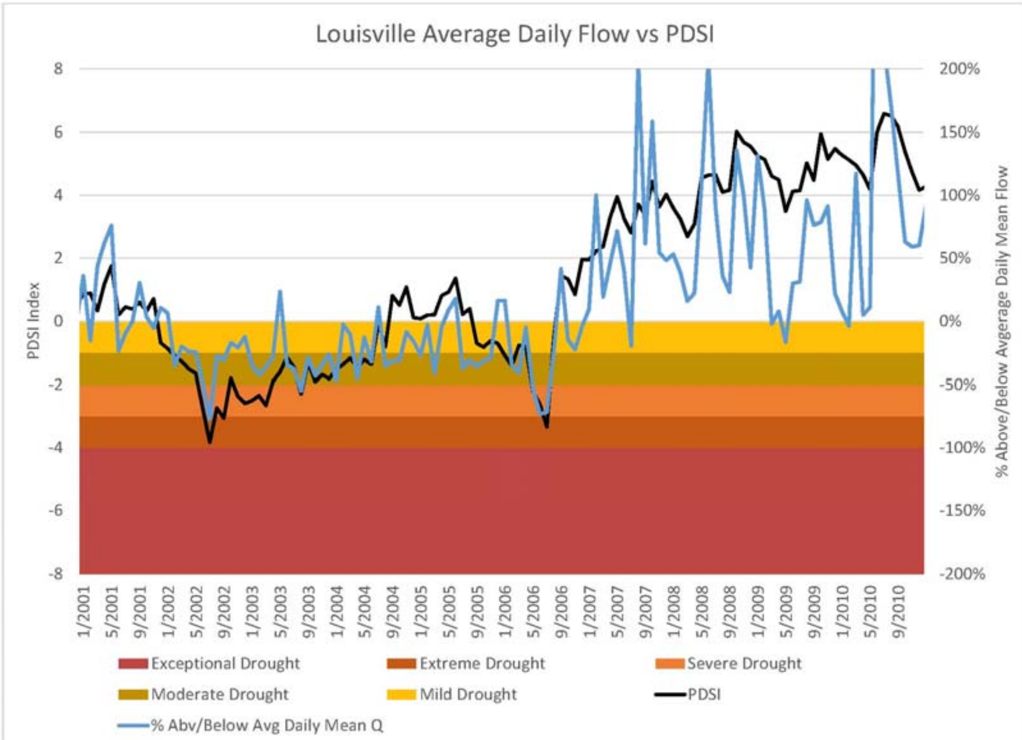
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-6: Composite PDSI versus Above/Below Average Flow at Louisville – 1991 to 2000



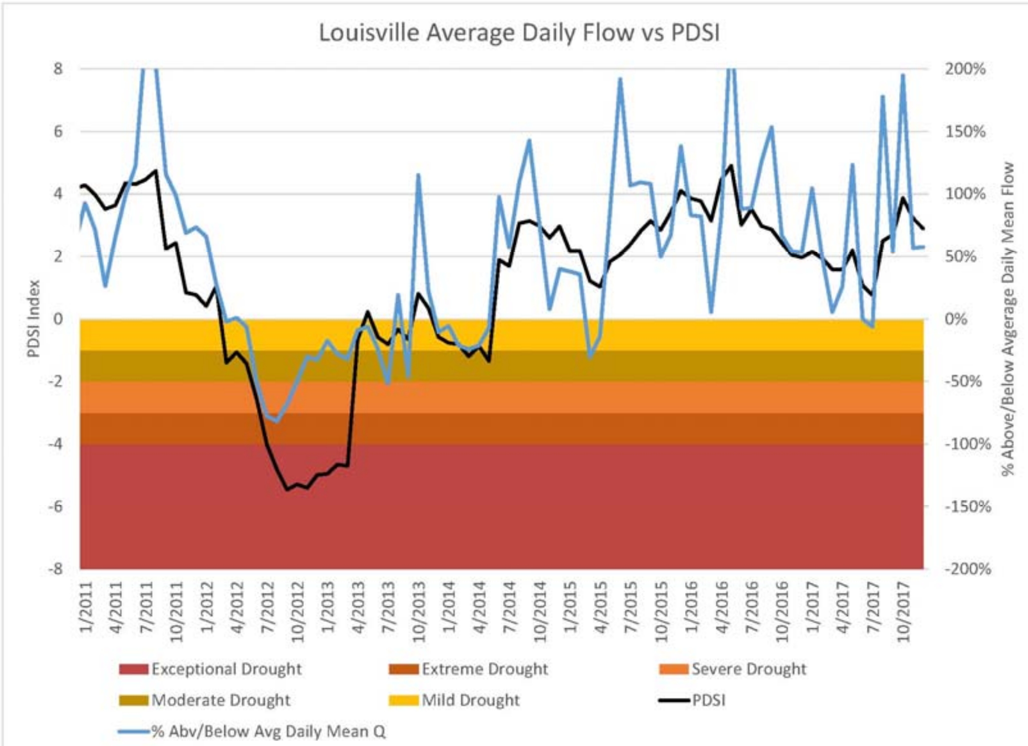
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-7: Composite PDSI versus Above/Below Average Flow at Louisville – 2001 to 2010



Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-8: Composite PDSI versus Above/Below Average Flow at Louisville – 2011 to 2017



Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

B.2 Standardized Precipitation Index

The Standardized Precipitation Index (SPI) is the internationally preferred index for meteorological drought (Hayes et al. 2011). Similar to PDSI, Zero or near zero SPI values indicate normal conditions, a negative SPI indicates drought and a positive value for a wet period. Table B-3 lists the SPI classification for drought.

Table B-3: SPI Classifications

Index Value	Description	Index Value	Description
2.0 or greater	Extremely wet	-1.49 to -1.00	Moderate drought
1.50 to 1.99	Severely wet	-1.99 to -1.50	Severe drought
1.00 to 1.49	Moderately wet	-2.0 or less	Extreme drought
-0.99 to 0.99	Near normal	---	---

Source: NOAA National Weather Service Climate Prediction Center 2005.

The SPI is based on precipitation only, and does not consider soil moisture balance like PDSI. The SPI uses historical precipitation records for any location to develop a probability of precipitation that can be computed at any number of timescales, from 1 month to 48 months or longer.

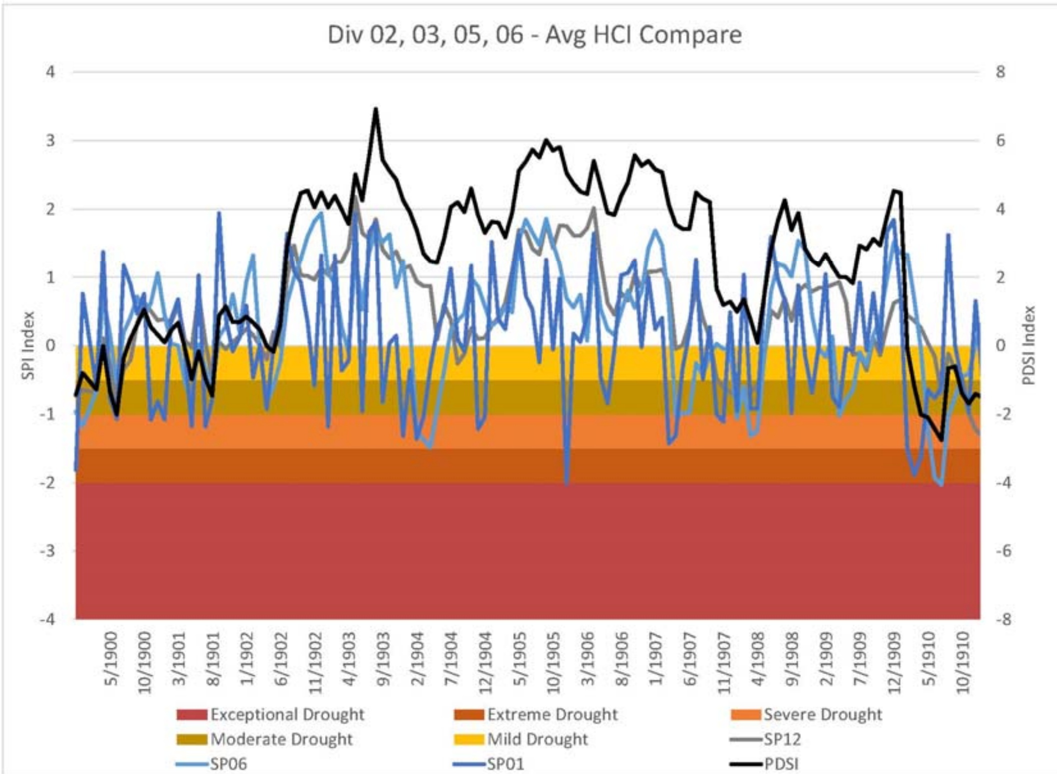
With precipitation as the only input, SPI is deficient when accounting for the temperature component, which is important to the overall water balance and water use of a region. This drawback can make it more difficult to compare events of similar SPI values but different temperature scenarios. Mathematically, the SPI is calculated as follows:

$SPI = (P - P^*)/\sigma_p$ (Equation B-4)

where P = precipitation, P* = mean precipitation, and σ_p = standard deviation of precipitation.

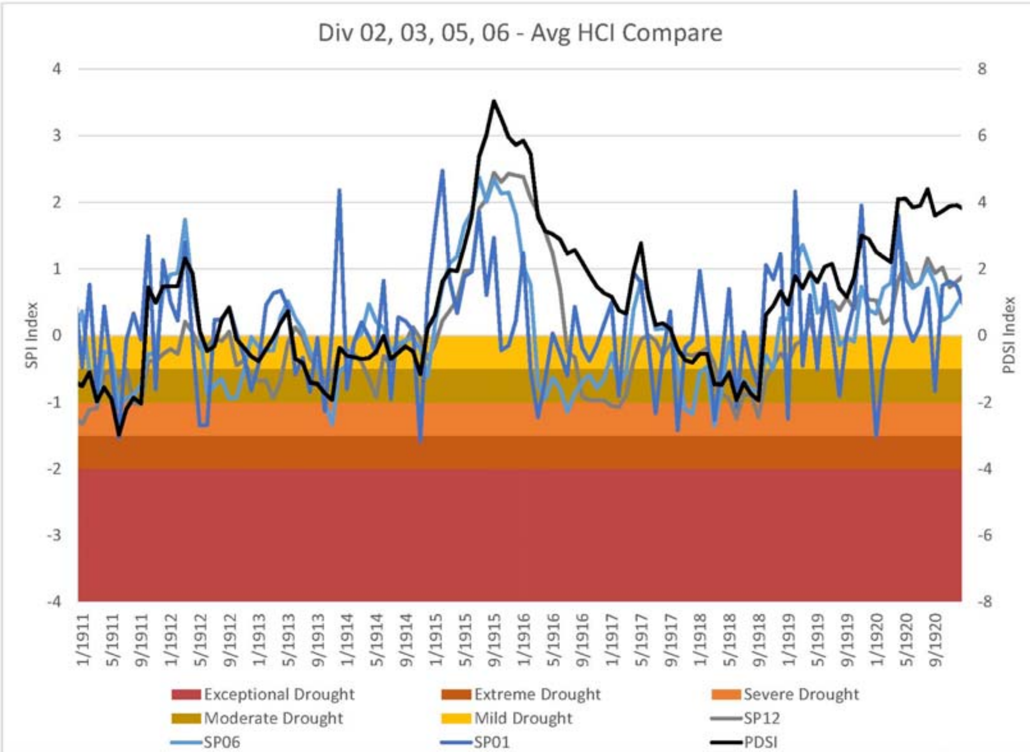
To compare historic SPI to historic PDSI, the composite of each (North Central, Northeast, Central, and East Central climate divisions) were plotted in Figures B-9 through B-20 for the period-of-record 1900 – 2017.

Figure B-9: Composite SPI Index versus Composite PDSI Index – 1900 to 1910



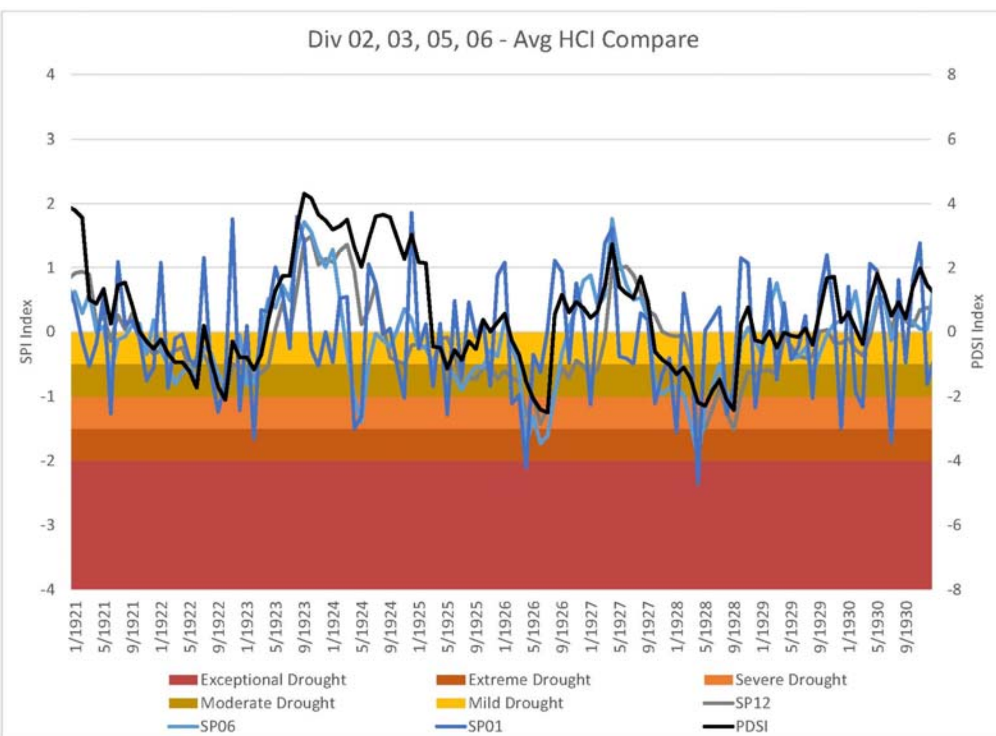
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-10: Composite SPI Index versus Composite PDSI Index – 1911-1920



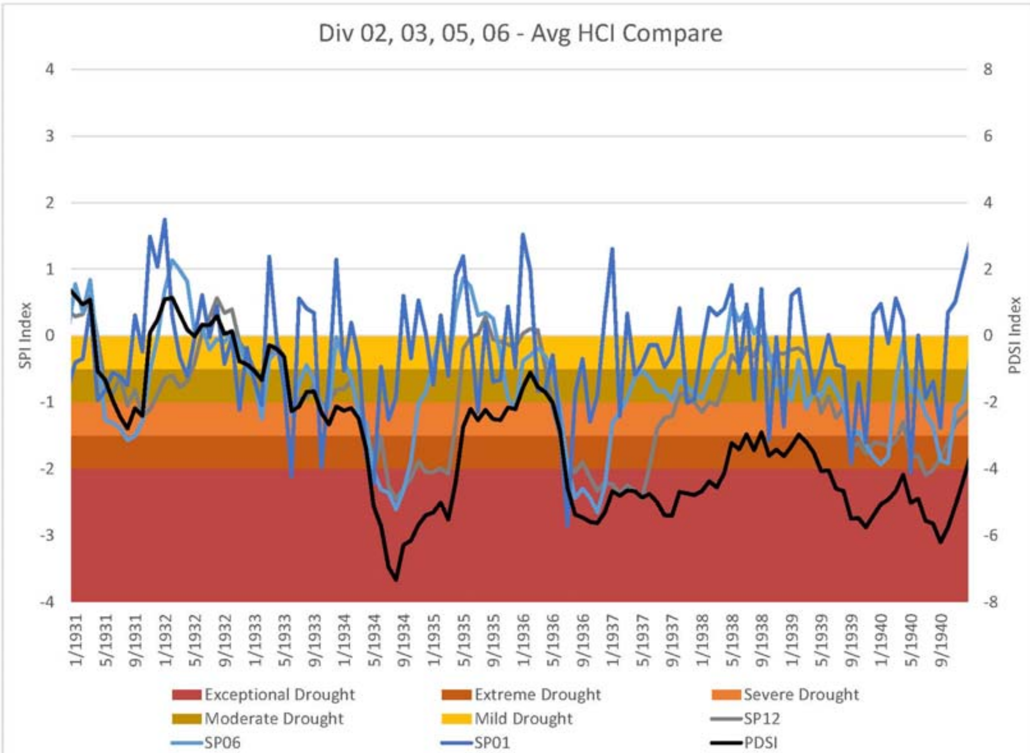
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-11: Composite SPI Index versus Composite PDSI Index – 1921 to 1930



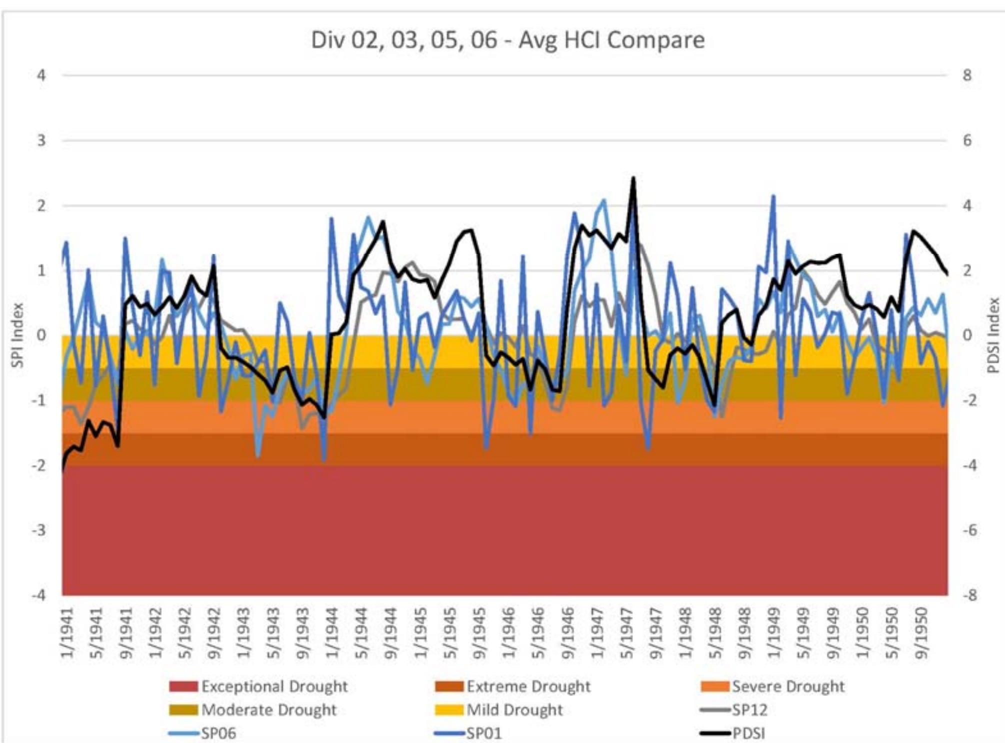
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-12: Composite SPI Index versus Composite PDSI Index – 1931 to 1940



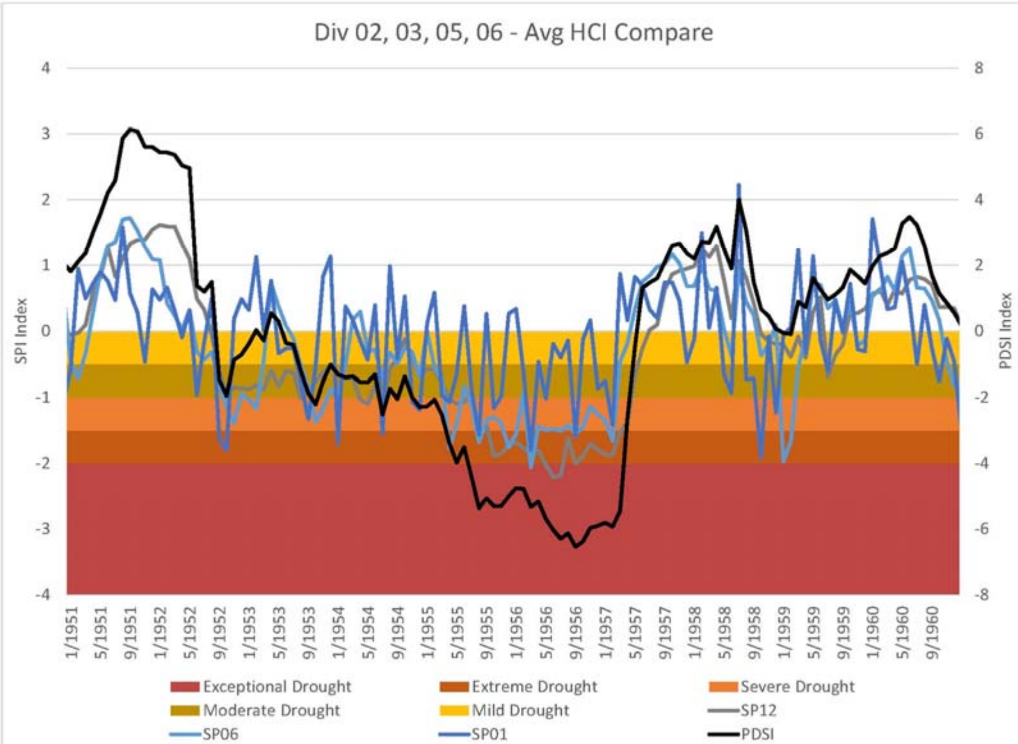
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-13: Composite SPI Index versus Composite PDSI Index – 1941 to 1950



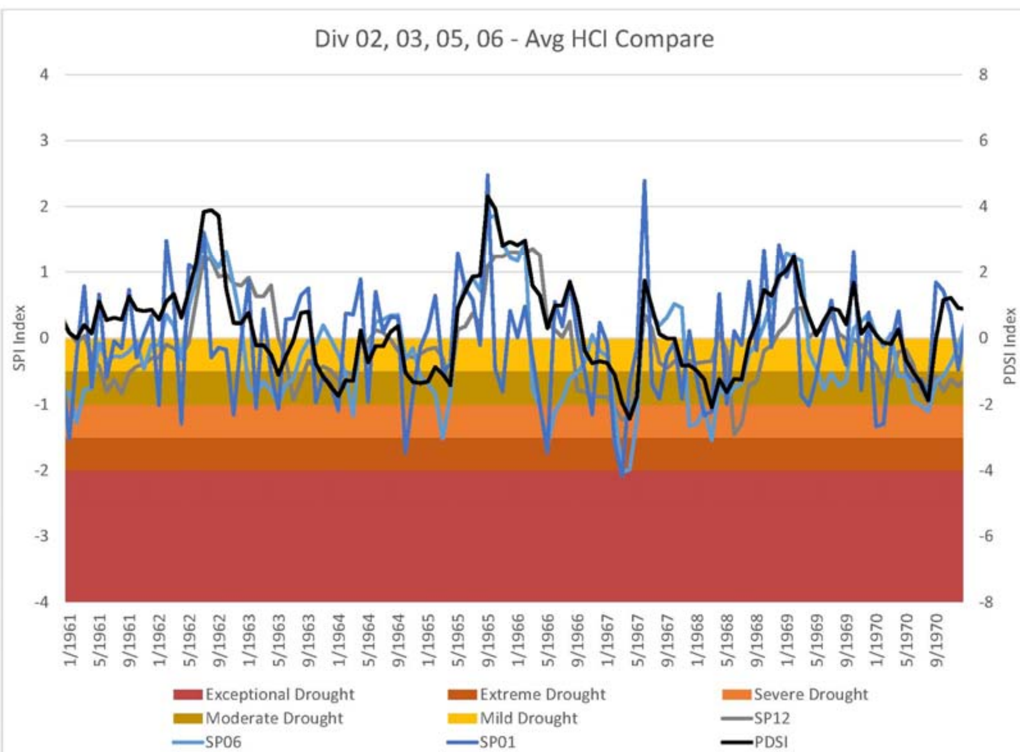
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-14: Composite SPI Index versus Composite PDSI Index – 1951 to 1960



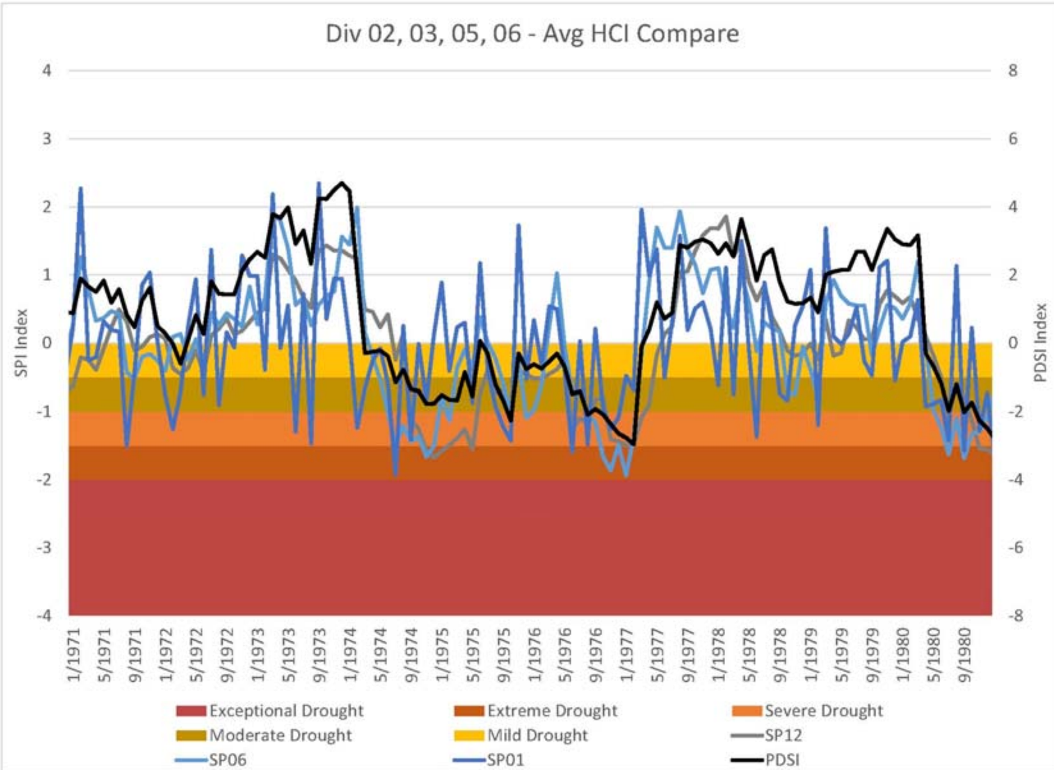
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-15: Composite SPI Index versus Composite PDSI Index – 1961 to 1970



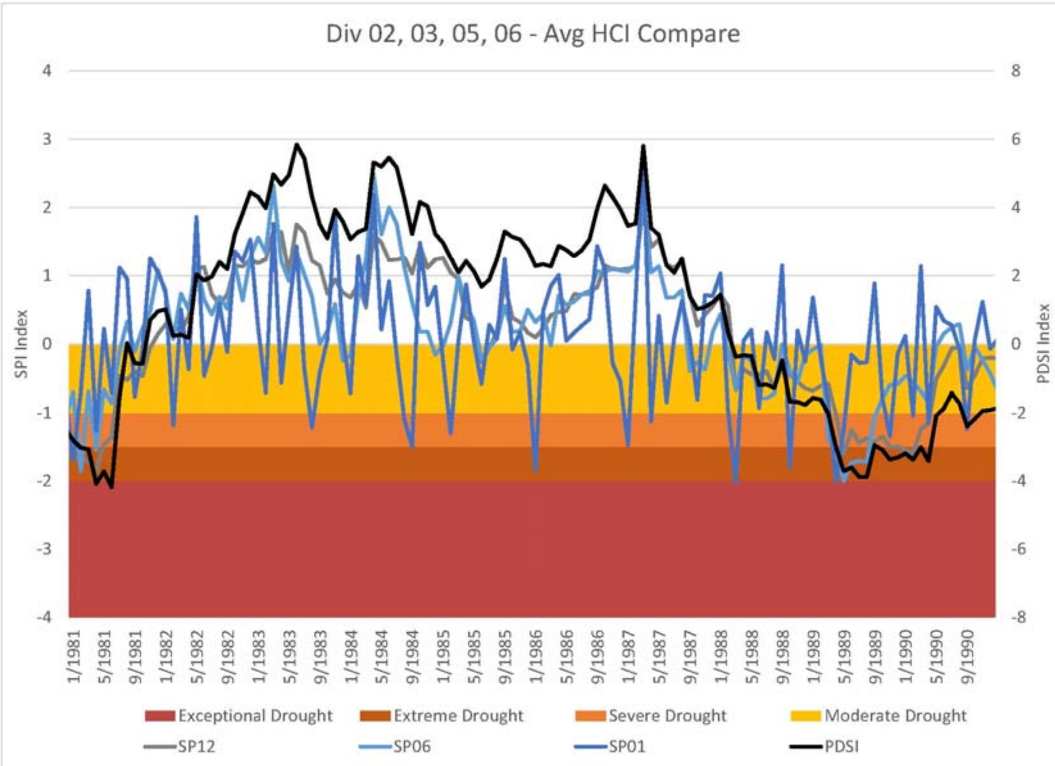
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-16: Composite SPI Index versus Composite PDSI Index – 1971 to 1980



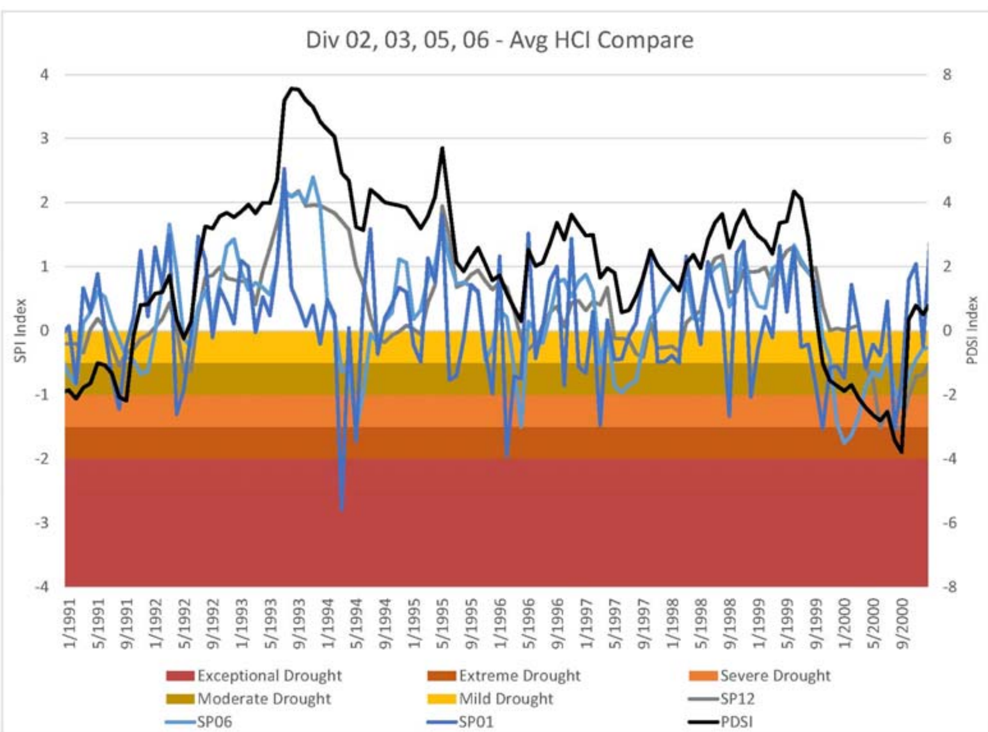
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-17: Composite SPI Index versus Composite PDSI Index – 1981 to 1990



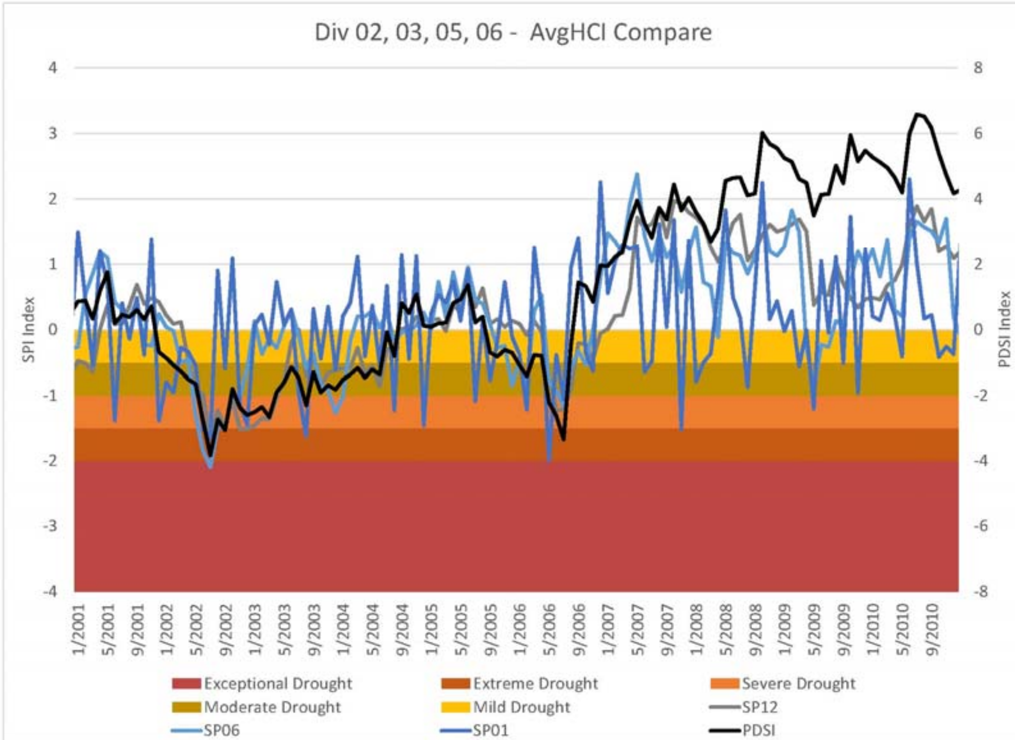
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-18: Composite SPI Index versus Composite PDSI Index – 1991 to 2000



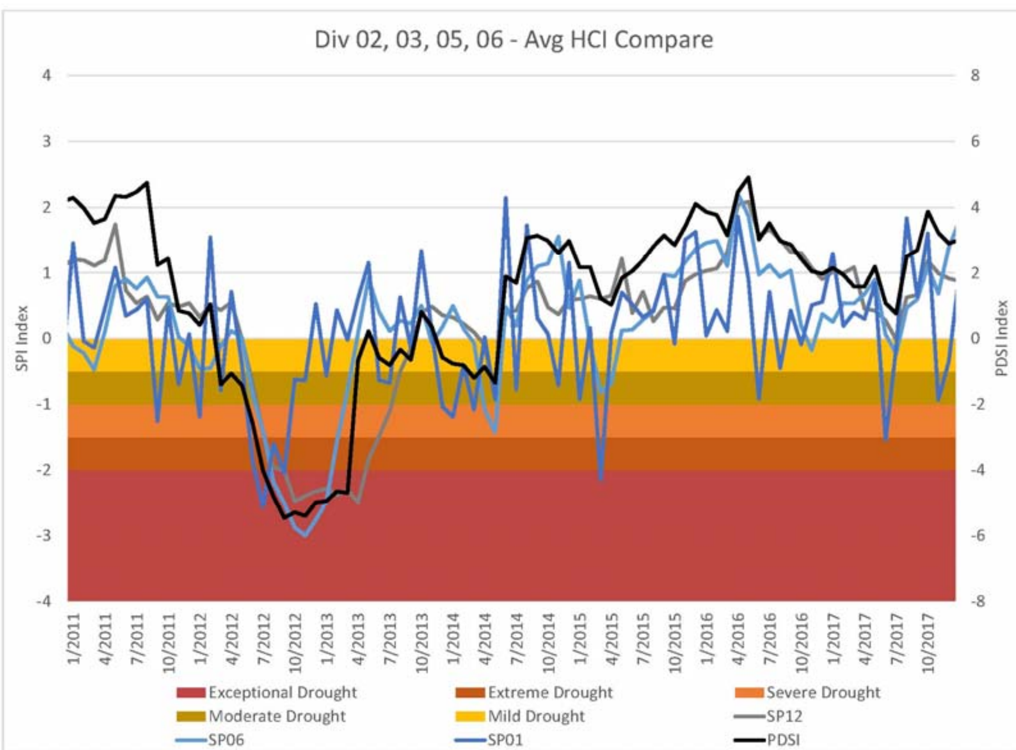
Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-19: Composite SPI Index versus Composite PDSI Index – 2001 to 2010



Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

Figure B-20: Composite SPI Index versus Composite PDSI Index – 2011 to 2017



Source: Supporting Data downloaded from National Climatic Data Center (obtained 2018)

The U.S. Drought Risk Atlas (a product of the National Drought Mitigation Center [NDMC]) summarizes the occurrence of drought by climate division, hydro climate indices, and severity as a percentage of the period-of-record. The historic occurrence of drought for the four climate divisions that encompass the Lower Platte River Basin are shown in Tables B-4 through B-7.

Table B-4: Climate Division 02: Percent of Time Spent in Drought – 1900 to 2016

PDSI Index Value	Percent of Time Spent in Drought	Drought Severity	Recurrence
-2 < PDSI ≤ -1	34%	Mild	1 out of 3 years
-3 < PDSI ≤ -2	21%	Moderate	1 out of 5 years
-4 < PDSI ≤ -3	12%	Severe	1 out 8 years
PDSI ≤ -4	6%	Extreme	1 out 0f 17 years

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)

Table B-5: Climate Division 03: Percent of Time Spent in Drought – 1900 to 2016

PDSI Index Value	Percent of Time Spent in Drought	Severity	Recurrence
-2 < PDSI ≤ -1	26%	Mild	1 out of 4 years
-3 < PDSI ≤ -2	16%	Moderate	1 out of 6 years
-4 < PDSI ≤ -3	10%	Severe	1 out of 10 years
PDSI ≤ -4	7%	Extreme	1 out of 14 years

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)

Table B-6: Climate Division 05: Percent of Time Spent in Drought – 1900 to 2016

PDSI Index Value	Percent of Time Spent in Drought	Severity	Recurrence
-2 < PDSI ≤ -1	31%	Mild	1 out of 3 years
-3 < PDSI ≤ -2	18%	Moderate	1 out of 6 years
-4 < PDSI ≤ -3	11%	Severe	1 out of 9 years
PDSI ≤ -4	8%	Extreme	1 out of 13 years

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)

Table B-7: Climate Division 06: Percent of Time Spent in Drought – 1900 to 2016

PDSI Index Value	Percent of Time Spent in Drought	Severity	Recurrence
-2 < PDSI ≤ -1	28%	Mild	1 out of 4 years
-3 < PDSI ≤ -2	17%	Moderate	1 out of 6 years
-4 < PDSI ≤ -3	10%	Severe	1 out of 10 years
PDSI ≤ -4	6%	Extreme	1 out of 17 years

Source: U.S. Drought Risk Atlas (frequency statistics obtained 2018)

In general, the PDSI and SPI compare reasonably well; however, the SPI does appear to predict fewer occurrences of severe and extreme droughts than the PDSI. This is likely due to the fact that the SPI and PDSI tell different stories. The PDSI considers the water balance and gives a more complete representation of conditions; however, the PDSI is a cumulative function where the PDSI from previous months can affect the PDSI of a current month making it harder to predict flash droughts). The SPI only considers precipitation anomaly compared to historic normal precipitation. Therefore, if precipitation returns to normal conditions, the SPI may indicate the drought is over whereas the PDSI may not.

For these reasons, both the SPI and PDSI should be considered together when evaluating drought conditions.

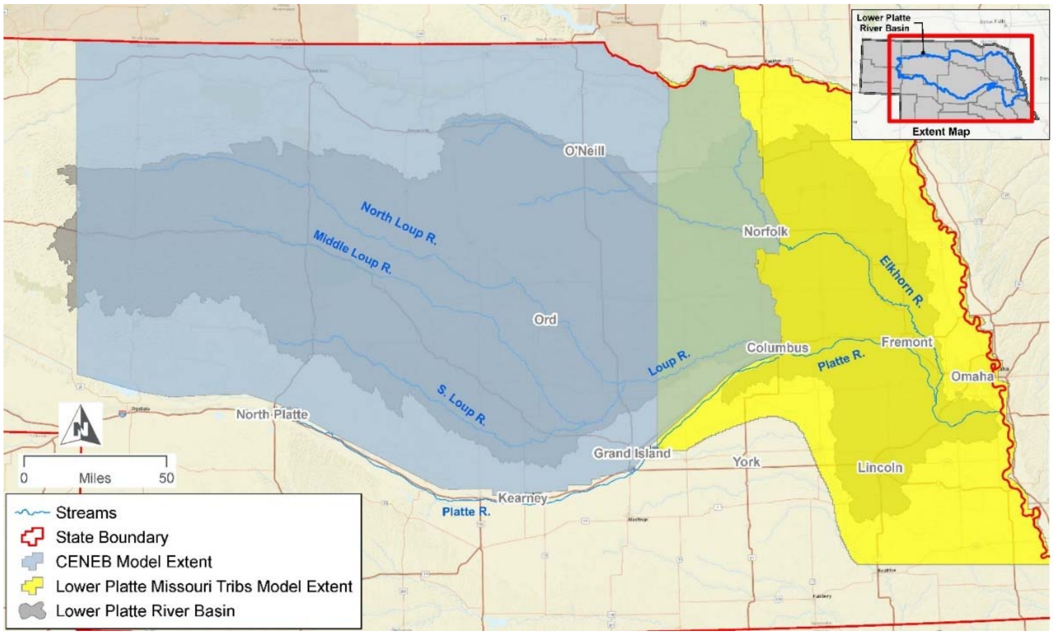
Analysis of historic PDSI values from the last 116 years reveal that mild, moderate, severe, and extreme droughts can be expected to occur in the Lower Platte River Basin once every three, six, nine, and fourteen years, respectively.

Appendix C: Cost-Estimate of Potential Mitigation Actions

Appendix D: Modeling Tools

There are three main groundwater water models that are encompassed by the Lower Platte River Basin. These include the Central Nebraska Model (CENEB) and Elkhorn-Loup Model (ELM) in the western and central portions of the basin and the Lower Platte Tributaries Model (currently under development) covering the eastern portion of the basin. These models analyze the surface and groundwater interaction in the basin.

Figure D-1: Groundwater Modeling Studies



Lower Platte Missouri Tributaries Model

The Lower Platte Missouri Tributaries (LPMT) Groundwater Model is being developed to assist the Nebraska Department of Natural Resources (NeDNR) in performing its annual evaluation of the expected long-term availability of surface water supplies and hydrologically connected groundwater supplies in both the Lower Platte River and Missouri River Tributaries basins.

This numerical groundwater model will be used as a tool to calculate the groundwater depletion component of the NeDNR's evaluation of the appropriation status in the Lower Platte River and Missouri River Tributaries basins by evaluating the effect of well pumping on stream baseflow.

The LPMT Model covers a large portion of eastern Nebraska, assessing the central and northern parts of the study areas. See Figure D-1 for the geographical extent of the modeling area in relation to the Lower Platte River Basin.

Central Nebraska Model

The CENEB was developed as a modeling tool for simulating surface water-groundwater interactions by reproducing long-term trends under varying hydrologic and hydrogeologic conditions in the region, in support of the Department's annual evaluation of the availability of each basin's hydrologically connected water supplies.

The CENEB expands on the geographic area of a previous model, the ELM. The ELM encompassed the entire Loup River Basin and the lands draining to the Elkhorn River above Norfolk. The CENEB includes the same areas as the ELM, and adds portions of the Niobrara River Basin in north central Nebraska and the Lower Niobrara River and Ponca Creek drainages in South Dakota. See Figure D-1 for the geographic extent of the modeling area with relation to the Lower Platte River Basin.

The CENEB was developed to characterize water supplies, uses, and demands in portions of the Niobrara, Loup, and Elkhorn Basins. The CENEB incorporates a groundwater model developed using MODFLOW-NWT and CROPSIM. A surface water operations model was not included as part of this model because there are few surface water demands in this region.

Elkhorn-Loup Model

The ELM, is a U.S. Geological Survey (USGS) Nebraska Water Science Center project is designed to assist the Natural Resources Districts (NRDs) and NeDNR by characterizing the groundwater system within the Elkhorn River and Loup River Basins and by providing a regional groundwater-flow model.

The ELM, a multi-phase project, is a study of surface-water and groundwater resources in the Elkhorn River basin upstream from Norfolk, Nebraska, and the Loup River basin upstream from Columbus, Nebraska. The study area is approximately the same as the CENEB (see Figure D-1).

The first phase included construction of a groundwater-flow model using previously collected data. The calibrated groundwater-flow model was used to assess current and future impacts of groundwater pumping on surface water, and could be used to provide information to the NRDs for groundwater-management planning.

The second phase was part of a larger, ongoing effort to enhance the current knowledge of hydrogeology, improve the understanding of stream-aquifer interactions, and compile reliable data describing hydrogeologic properties such groundwater recharge, groundwater pumpage for irrigation, and groundwater discharge to evapotranspiration in the study area.

The third phase of the study continues to use new methods and data to refine the groundwater-flow model developed in phases one and two. Implementation of these new methods and data will increase the understanding of the availability of groundwater and the effect of anthropogenic stresses on the groundwater and surface-water resources in the Elkhorn and Loup River basins.

Finally, the results of the phase-three model will undergo calibration via parameter estimation similar to the calibration done for phase two, as well as the completion of additional analysis runs.

Lower Platte River Consortium Conveyance Tool

The Lower Platte River Consortium Conveyance Tool (CONSORV) was developed by The Flatwater Group as a resource to estimate stream losses along different portions of the Lower Platte Basin, and to evaluate potential management actions in terms of estimated river flow changes at certain critical locations. CONSORV is a surface water model, built using the Stella modeling platform developed by isee Systems, which operates on a daily timestep, and covers the Loup River basin downstream of St. Paul (along with a portion of the Middle Loup downstream of Dunning), the Elkhorn River downstream of Norfolk, and the Lower Platte River from Duncan to Louisville.

CONSORV primarily uses data from USGS and Nebraska DNR stream gages, focusing on the 2004 to 2015 time period, but can be used to project potential stream conditions and conveyance losses under various hydrologic and operational scenarios. The Stella framework used in CONSORV uses stocks, flows, and convertors to represent the storage, movement, and management decisions associated with water supplies in a river basin setting. Historic gains and losses within the model's river segments serve as the foundation for estimating changes to river flows under modified hydrologic conditions.

CONSORV takes advantage of the user-friendly, object-oriented nature of Stella to provide simple and intuitive interfaces, serving as dashboards for quickly constructing the conditions under a particular scenario, or set of scenarios, and then providing model output in an easily understood format. Simple buttons, dials, and sliders are included to allow the user to rapidly adjust the modeled conditions and run the model. Results are included in tabular, graphical, and map-based formats, allowing for quick and straightforward analysis of the output. Several of the key scenarios developed with input from the

Coalition are “built-in” to the model, but can also be easily modified to test for sensitivity and to evaluate alternative management actions. Flow at the Ashland gage serves as one of the primary evaluation metrics, and the volume of any additional estimated flow at Ashland resulting from alternative management actions is displayed via bar graphs, line charts, and tabular entries.

Appendix E: Platte River at Ashland Recession Tool

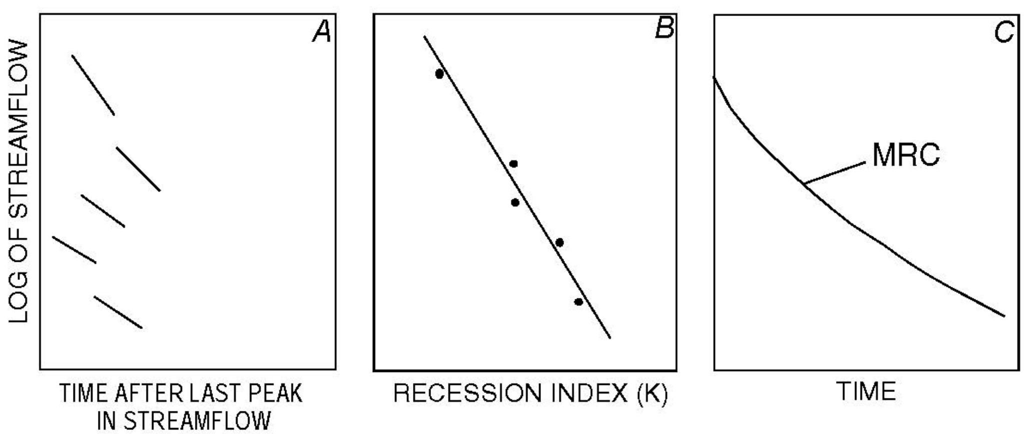
Flow Recession Analysis for the Platte River at Ashland

Understanding the behavior of the Platte River at Ashland as it recedes is important to the ability of the Consortium to properly time the implementation of response actions. Using the Platte River at Ashland Recession Tool allows the user to enter in a flow in the Platte River at Ashland and predict the decay behavior for 30 days assuming no further inputs to the system (precipitation or upstream storage releases). The tool plots the recession curve and the user can determine the estimated days until a critical threshold is reached. The following discussion explains the analysis behind the Platte River at Ashland Recession Tool.

The USGS program RECESS was used to generate the Master Recession Curve (MRC). The program RECESS (USGS 1998) is available free from USGS and determines the MRC of streamflow recession during times when all flow can be considered to be groundwater discharge and when the profile of the groundwater head distribution is nearly stable. The program uses a repetitive interactive procedure for selecting several periods of continuous recession, determines the best-fit equations for the rate of recession as a function of the logarithm of flow, then uses the coefficients of this equation to derive the MRC, which is an equation of time as a function of the logarithm of flow.

The basic steps for determining the MRC are illustrated in Figure E-1. First, the program locates periods of streamflow recession and allows the user to select nearly linear segments (Figure E-1[A]). Then, for each segment, the program determines the best linear equation for time as a function of LogQ (logarithm of flow), and extracts from this equation a coefficient that is the recession index (K) of the segment (data points, Figure E-1[B]). Coefficients of this equation are used to obtain the MRC (Figure E-1[C]), which is a second-order polynomial expression for time as a function of LogQ.

Figure E-1: Schematic representation of the method used to determine the master recession curve



Source: USGS 1998.
Notes: (A) selected regression segments; (B) recession index (K) (time per log cycle of streamflow recession) and best-fit line, and (C) the master recession curve, obtained from coefficients of function in B.

The analysis using RECESS utilized the mean average daily flow for the Platte River at Ashland from 1988 to 2015. The year was split into a summer period (April through September) and a winter period (October through March). The resultant MRC for both summer and winter are shown in Figure E-2 and Figure E-3, respectively.

Figure E-2: Summer Master Recession Curve for Platte River at Ashland

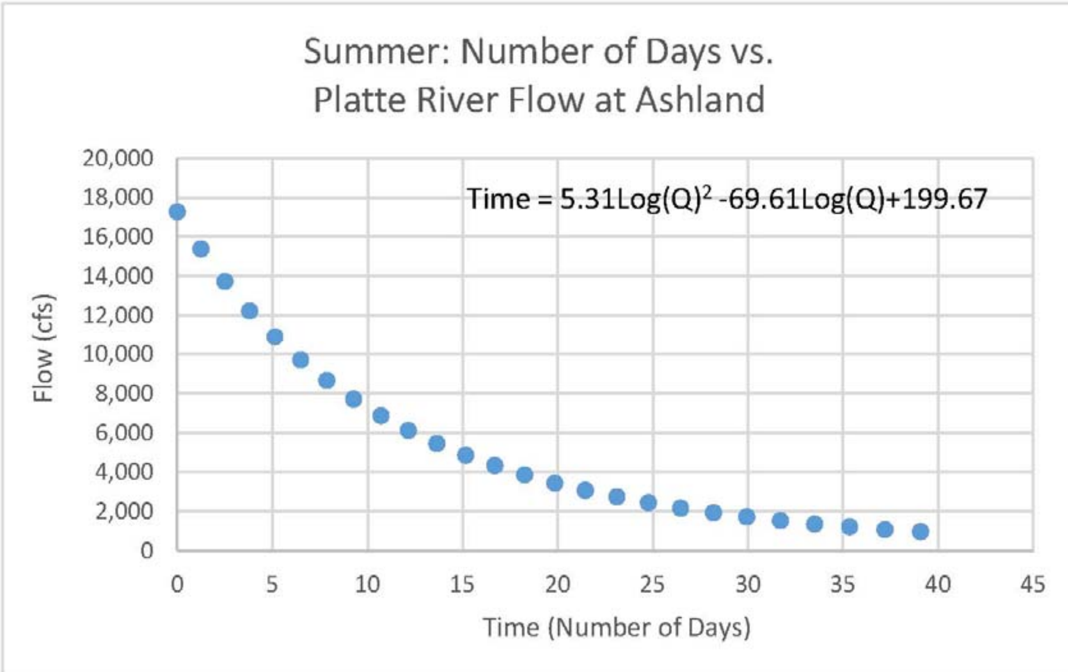
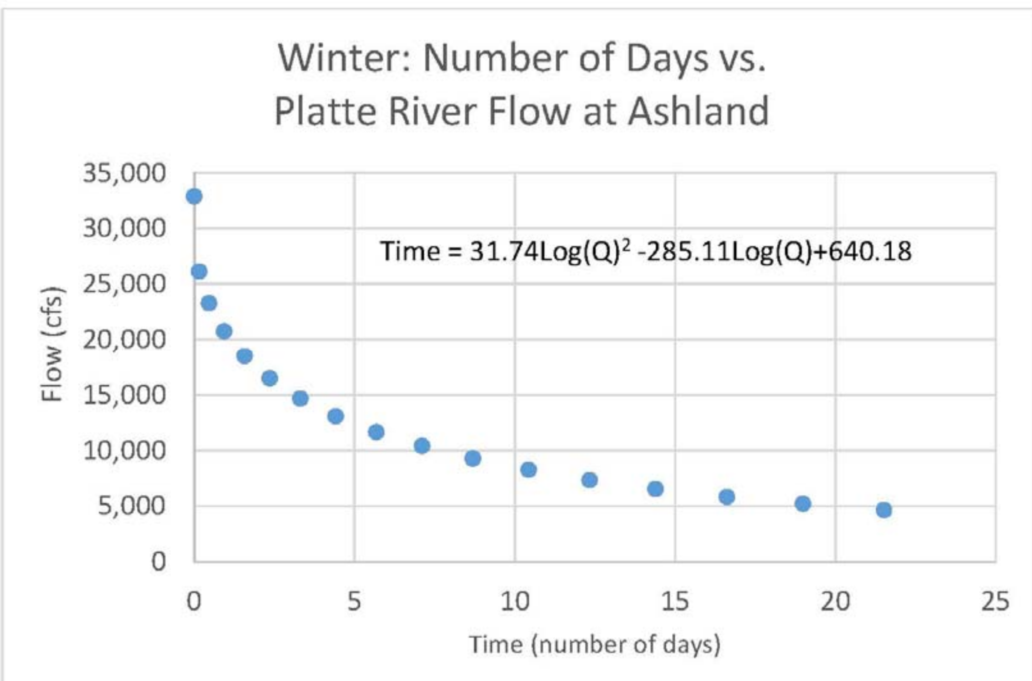
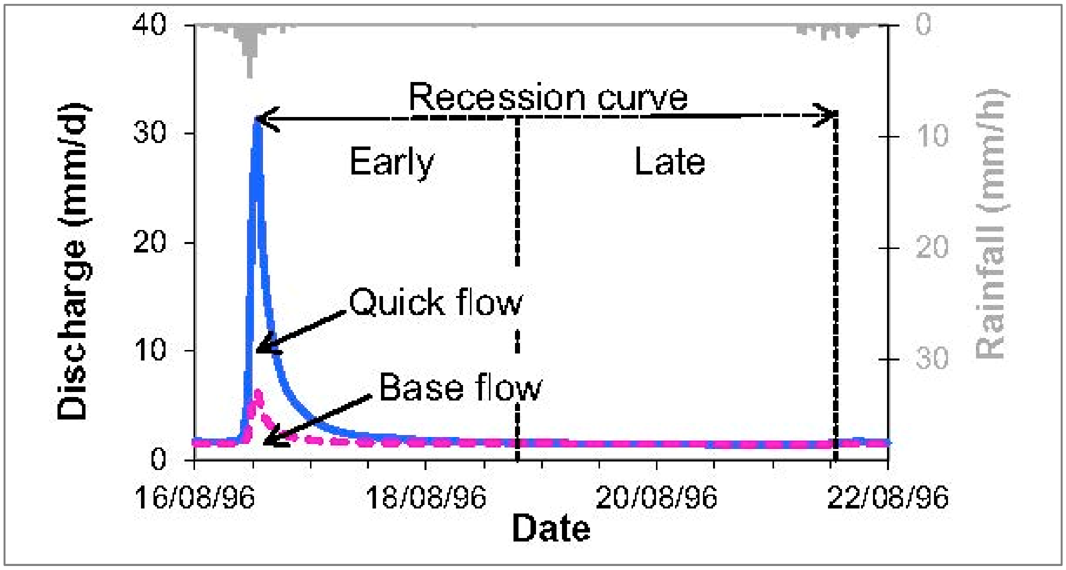


Figure E-3: Winter Master Recession Curve for Platte River at Ashland



As shown in Figure E-4, the total recession curve for a consists of both quick flow and baseflow. The USGS RECESS program results show the behavior of the MRC for the baseflow. Baseflow is the portion of streamflow that is not runoff and results from seepage of water from the ground into a channel slowly over time. For the analysis, it is necessary to understand the behavior of the early part of the recession known as quick flow. Quick flow occurs immediately after a rainfall/runoff event where the streamflow peaks. If no other system inputs occur (no additional rainfall), then the streamflow will recede until it reaches baseflow.

Figure E-4: Quickflow and baseflow components of streamflow



Source: Stewart, M.K. 2015. "Promising new baseflow separation and recession analysis methods applied to streamflow at Glendu Catchment, New Zealand." Hydrology and Earth System Sciences. *19:2587–2603. Doi: 10.5194/hess-19-2587-2015.*

For the Platte River at Ashland, the recession of the quick flow generally follows the behavior of Equation E-1 for the first 1-2 days. After which, the recession generally follows the behavior of Equation E-2.

$$Q_n = Q_{(n-1)}2^{(-0.55)} \ for\ 1 \leq n \ \leq 2 \qquad \text{Equation E-1}$$

where Q is the flow in the Platte River at Ashland n corresponds to day n (the number of days after the start of the recession).

$$Q_n = 10^{[LogQ_{(n-1)}-(\frac{k}{K})]} \ for\ n\ > 2 \qquad \text{Equation E-2}$$

where $k = recession\ constant = 10^{\frac{-1}{K}}$ and $K = storage\ delay\ factor = 10.61LogQ_{(n-1)} - 69.91$ for months April through September and $K = storage\ delay\ factor =\ 63.49LogQ_{(n-1)} - 285.11$ for months October through March.

The storage delay factor, K, is defined as the time taken for discharge to recede by a factor of 10 (i.e. one log cycle). This factor is determined by RECESS and is provided in tabular output. The Platte River at Ashland Recession Tool uses the lookup function on these tables to obtain the K-value.

Figure E-5 through Figure D-9 show plots of randomly selected recession periods on the Platte River at Ashland and compares the historic streamflow versus the forecasted streamflow. In general, the forecasted streamflow reasonably matches the historic recession behavior.

Figure E-5: Forecasted versus Historic Flow for the Platte River at Ashland (June/July 2005)

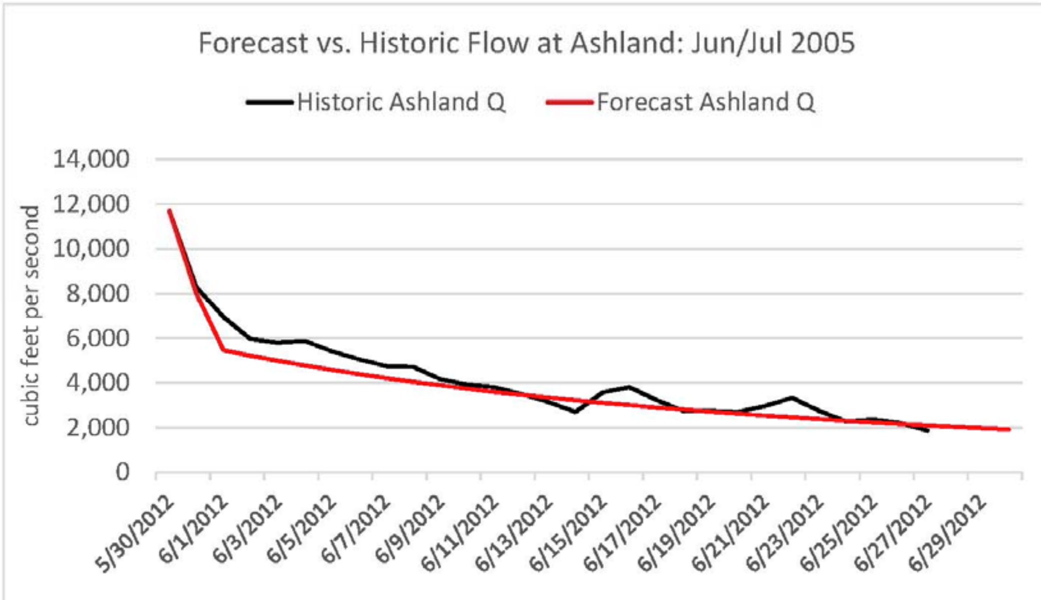


Figure E-6: Forecasted versus Historic Flow for the Platte River at Ashland (August/September 2007)

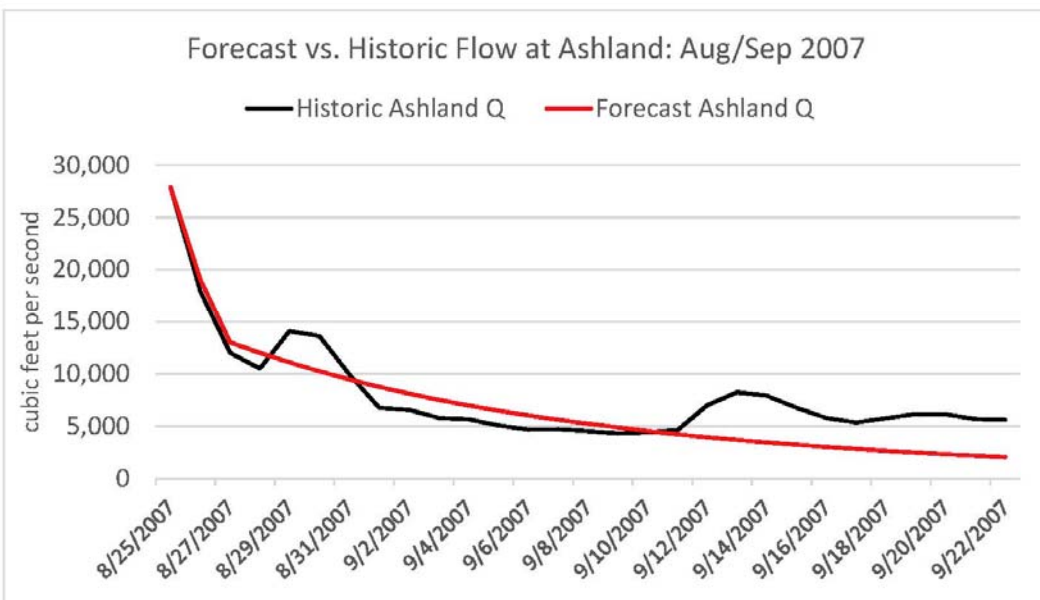


Figure E-7: Forecasted versus Historic Flow for the Platte River at Ashland (June/July 2008)

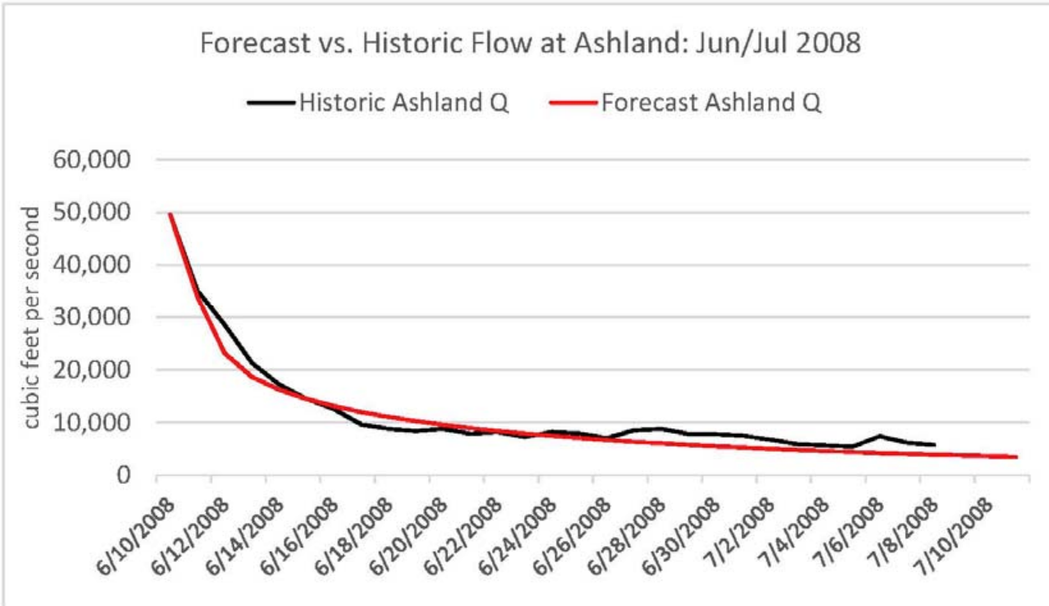


Figure E-8: Forecasted versus Historic Flow for the Platte River at Ashland (February/March 2009)

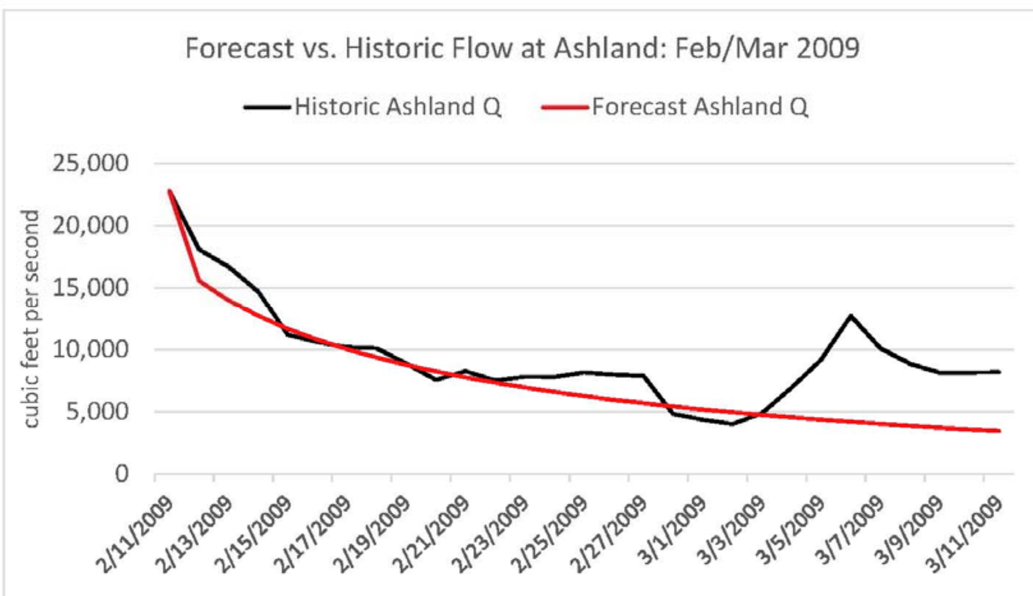
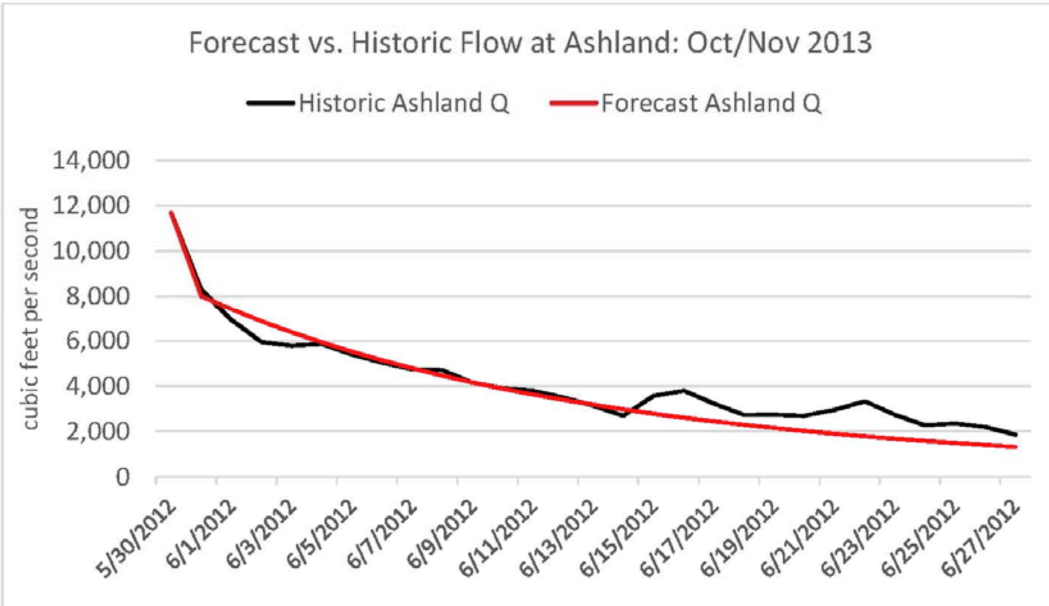


Figure E-9: Forecasted versus Historic Flow for the Platte River at Ashland (October/November 2013)

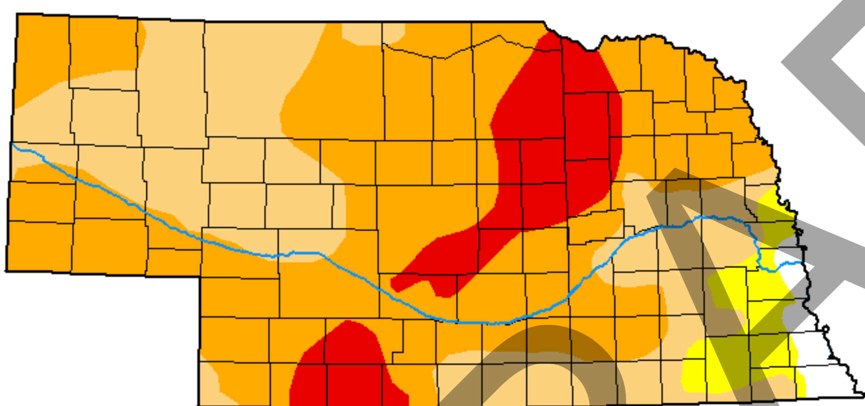


Appendix F: Public Outreach and Stakeholder Involvement

DROUGHT MANAGEMENT PLAN

LOWER LOUP NATURAL RESOURCES DISTRICT

AUGUST 2022



U.S. Drought Monitor Effective Map for May 3, 2022

Plan developed by
JEO Consulting Group

JEO CONSULTING GROUP

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Lower Loup
Natural Resources District

Drought Management Plan

DRAFT
Prepared: August 2022
Adopted: INSERT DATE

ACKNOWLEDGEMENTS

This drought management plan was prepared by JEO Consulting Group to help guide the Lower Loup Natural Resources District (Lower Loup NRD) in developing and implementing future projects to improve resilience to future droughts across the district. While a planning team consisting of project staff guided the effort, significant efforts were taken to involve a wide array of stakeholders to provide input and feedback during plan development.

Preparation of this plan was made possible with funding assistance provided by the Nebraska Water Sustainability Fund (WSF), which is administered by the Natural Resources Commission (Commission) to provide financial assistance to eligible projects, programs or activities that lead to sustainability of Nebraska's water resources.

PLANNING TEAM

The following individuals consisted of the project planning team:

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- Russell Callan, General Manager
- Tylr Naprstek, Assistant General Manager
- Cam Conrad, Water Modeling Coordinator

JEO Consulting Group

- Adam Rupe, CERP, Project Manager
- Nicole Wall, Senior Planner
- Phil Luebbert, Senior Planner

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JEO project number: 171969.00

Adam Rupe, Natural Resources Specialist
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Lincoln, Nebraska 68503
(402) 435-3080
arupe@jeo.com

LOWER LOUP NRD BOARD OF DIRECTORS

The Lower Loup Natural Resources District Board of Directors is made up of 21 members. The Directors are elected for four-year terms on a non-partisan basis.

The Lower Loup NRD Board of Directors meets at 5:00 p.m. on the fourth Thursday of the month at the NRD Headquarters, 2620 Airport Drive, in Ord, Nebraska. The meetings are open to the public.

At the time this plan was prepared, the following individuals were serving as Directors.

- Sub-District 1
  - Tim Bartak
  - Jim Adams
- Sub- District 2
  - Alan Petersen
  - Henry Thoene (Secretary)
- Sub-District 3
  - Todd Nitsch
  - Rollie Amsberry (Treasurer)
- Sub-District 4
  - Randy Kauk
  - Rick Vlach
- Sub-District 5
  - Dean Thede
  - Matt Lukasiewicz
- Sub-District 6
  - Jerry Smith
  - Jim Eschliman (Vice-Chairman and Nebraska Association of Resources Districts (NARD) Representative)
- Sub-District 7
  - Larry Mohrman
  - Gary Kruse
- Sub-District 8
  - Alan Vlach
  - Chad Podolak
- Sub-District 9
  - Bob Bauer
  - Beth Boesch
- Sub-District 10
  - Darwin Anderson
  - John Coffey
- At-Large
  - N. Richard Hadenfeldt (Natural Resources Commission – Loup Basin)

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AEM	Airborne Electromagnetic
BMP	Best Management Practice
BOR	Bureau of Reclamation
CFS	Cubic Feet per Second
Commission	Natural Resources Commission
CRP	Conservation Reserve Program
DAG	Drought Advisory Group
DI	Drought Indicators
DL	Drought Level
DMP	Drought Management Plan
DZ	Drought Zone
ELM SDF	Elkhorn-Loup Model Stream Depletion Factor
FEMA	Federal Emergency Management Agency
FSA	Farm Service Agency
GW	Groundwater
HMA	Hazard Mitigation Assistance
HPA	High Plains Aquifer
HUC	Hydrologic Unit Code
IAP2	International Association of Public Participation
JEO	JEO Consulting Group, Inc.

Lower Loup NRD	Lower Loup Natural Resources District
MAR	Managed Aquifer Recharge
NARD	Nebraska Association of Resources Districts
NCEI	National Centers for Environmental Information
NDEE	Nebraska Department of Environment and Energy
NDMC	Nebraska Drought Mitigation Center
NeDNR	Nebraska Department of Natural Resources
NET	Nebraska Environmental Trust
NGPC	Nebraska Game and Parks Commission
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRD	Natural Resources District
PDSI	Palmer Drought Severity Index
RMA	Risk Management Agency
SDF	Stream Depletion Factor
SWL	Static Water Level
UNL	University of Nebraska-Lincoln
USDA	United States Department of Agriculture
USDM	United States Drought Monitor
USGS	United States Geologic Survey
VIMP	Voluntary Integrated Management Plan
WSF	Water Sustainability Fund
WFPO	Watershed and Flood Prevention Operations

EXECUTIVE SUMMARY

BACKGROUND

Drought is the second costliest natural disaster in the United States, and rural communities are especially at risk of drought's negative impacts. Drought is defined as a natural hazard resulting from a substantial period of a lack of precipitation. Although many incorrectly consider it a rare and random event, drought is, in fact, a normal, recurrent feature of climate.

This drought plan has been prepared to assist the Lower Loup Natural Resources District (Lower Loup NRD), prepare for, and mitigate against future drought. While preparation of this plan was a voluntary action taken by the NRD, it clearly falls within the 12 areas of responsibility granted to NRDs across Nebraska, by the State Legislature. Authority to implement the recommendations within this plan are also well established by Nebraska statutes, and mitigation actions identified within are in-line with other policies, plans, projects, and regulations the Lower Loup NRD has implemented.

PLAN COMPONENTS

This drought plan provides an overarching review of the risks and vulnerabilities that drought presents to the district (See Section 4), and lays out two very important components to help the NRD become more drought resilient:

1. **A Drought Response and Monitoring Protocol** (See Section 5). Identifying and responding effectively to droughts as they occur is both technically and politically challenging. This pre-established protocol will enable the NRD to proactively monitor and predict when drought conditions threaten the district, as well as better enable the district to respond in an informed, predictable, and transparent way. The protocol was developed using stakeholder input and recommendations to ensure it is specific to the needs of the residents within the NRD.
2. **Mitigation and Management Actions** (See Section 6). Drought mitigation actions were identified through stakeholder input, review of other NRD planning documents, and identification of other best management practices. These actions are presented not as a required set of actions, but as a "playbook" of options and ideas for the Lower Loup NRD to consider to increase drought resilience.

It should be noted that while Lower Loup NRD staff continuously monitor drought indicators and may recommend drought declarations or management actions, the ultimate responsibility and authority of declaring drought levels and corresponding responses rest with the Lower Loup NRD Board of Directors. This plan provides the board a guide to help make those decisions.

PUBLIC INVOLVEMENT

Development of this plan received significant guidance and feedback from the public – especially in the development of the response and monitoring protocol, and in identifying mitigation actions. The overarching purpose of these efforts were to craft recommendations that have public buy-in.

The planning process utilized industry-leading principles and strategies from the International Association of Public Participation (IAP2), which allowed for multiple levels and opportunities for stakeholder input and led to a diverse representation of perspectives throughout the planning process.

Robust stakeholder engagement and participation took place across multiple meetings (see below), where 42 stakeholders participated and provided feedback (See Section 2). Not only did this group give a good representation of the district geographically it also had varying backgrounds to give diverse perspectives. Stakeholders represented included farmers, ranchers, biologists, communities, industry, irrigation districts, emergency managers, regulatory agencies, and others.

- September 9, 2021: Drought scenario workshop
- November 30, 2021: Establishing drought monitoring and response protocols
- February 17, 2022: Establishing mitigation actions and timelines

Ultimately, this comprehensive approach has helped to strengthen and enhance relationships between stakeholders (Figure 1) that will ease implementation of drought mitigation actions and serve the district during response to future periods of drought.

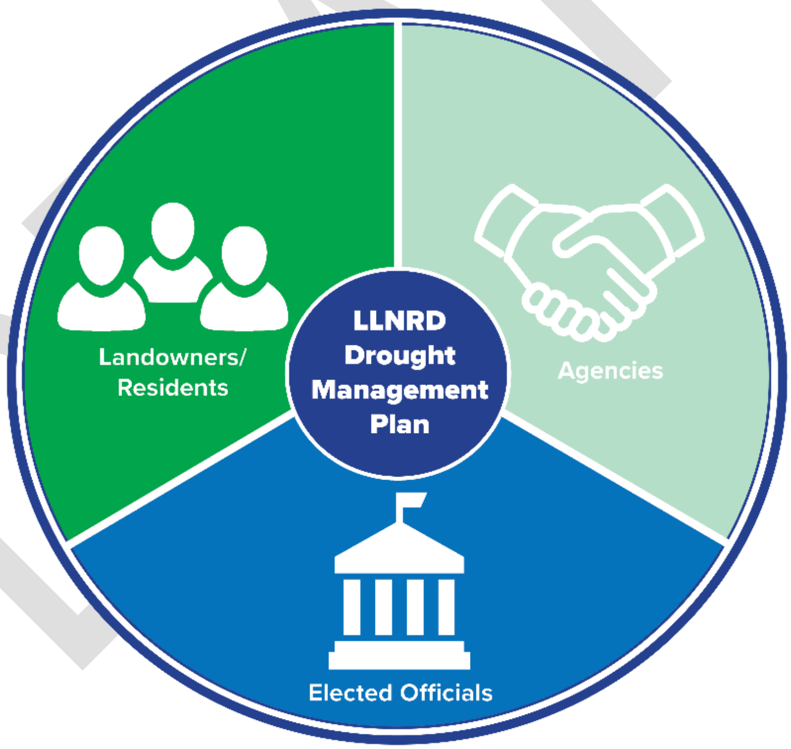

Figure 1: Relationships Established by the Planning Process

SECTION 1. INTRODUCTION

1.01 HYDRO-ILLOGICAL CYCLE

The Lower Loup Natural Resources District (Lower Loup NRD) has taken meaningful steps toward reducing vulnerability to drought since it was created by legislation in 1972. From their responsive groundwater management practices tailored to each part of their jurisdiction to numerous studies examining water quality and quantity, Lower Loup NRD leaders have prioritized drought mitigation. The development of the Lower Loup NRD Drought Management Plan (DMP) is another effort the district has undertaken to better prepare for drought.

Traditionally, many water users have reacted to drought in the manner shown in Figure 2. During normal or wet years, people are often apathetic to the possibility of drought. When a drought does occur, people are not sufficiently prepared and often respond too late. As a result, drought impacts are much more severe than if people had planned ahead. Once the drought is over, people are glad to resume business as usual. The Lower Loup NRD is attempting to break the hydro-illogical cycle by taking a proactive approach to drought planning.

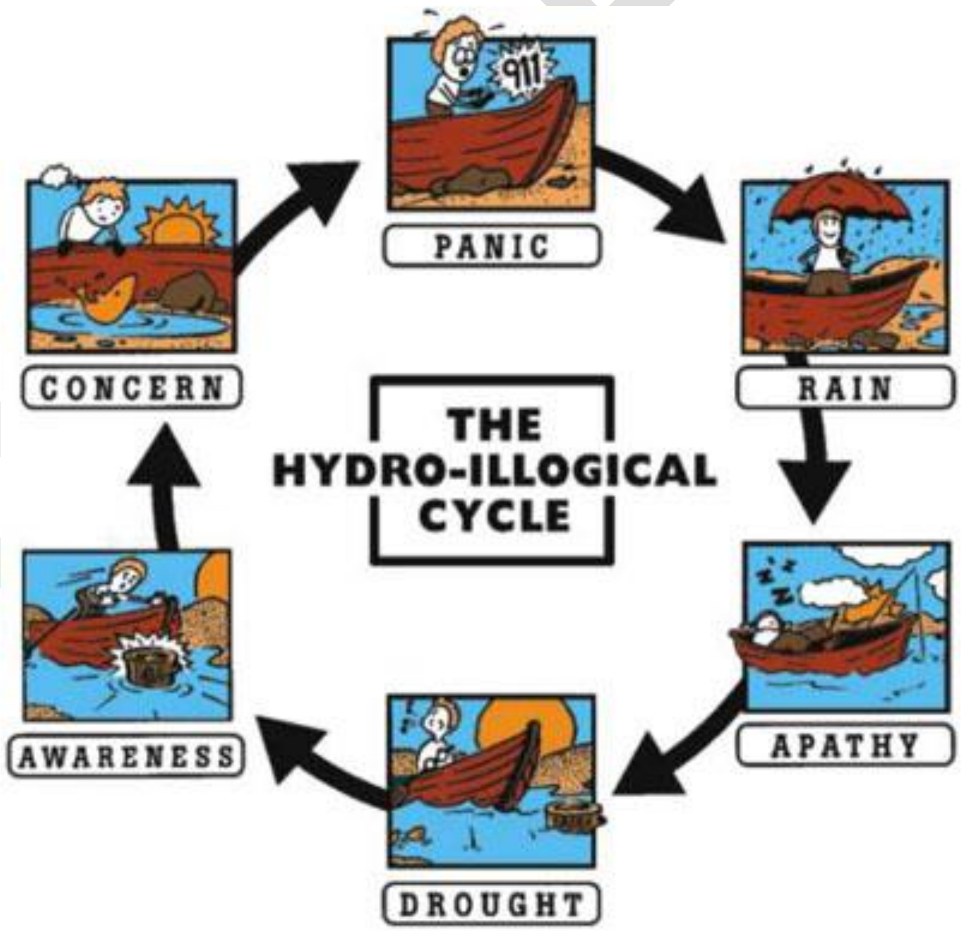

Image Source: National Drought Mitigation Center

Figure 2: The Hydro-Illogical Cycle

1.02 PLAN PURPOSE

The Lower Loup NRD Drought Management Plan's purpose is to define drought locally and identify processes to effectively respond to and manage the impacts of future drought events. The Drought Management Plan is a tool that will assist the Lower Loup NRD in long-term resource management and policy development.

This plan is intended to be a district-wide plan, thus, the analysis and management tools are presented at relatively high level. However, the recommendations and protocols have been more finely detailed to assist in the implementation of this plan and be useful at multiple jurisdictional levels.

1.03 DEFINING DROUGHT

Drought is the second costliest natural disaster in the United States with each event costing the US economy approximately 9.7 billion dollars[1]. Because of their unique features, rural communities are especially at risk of drought's negative impacts. Compared to urban areas, rural communities may have a less diversified economic base. Livelihoods often center on natural resources and ecosystem services, so a decline in water resources can have disastrous and far-reaching consequences. A lack of government capacity, limited fiscal resources for planning and mitigation actions, antiquated public infrastructure, and a limited demographic base can amplify the difficulties that smaller and more rural communities face in preparing for and responding to disasters. On the other hand, the self-reliant nature, keen sense of community, tightly connected family networks, and knowledge of and ties to natural resources—characteristics common in rural communities—can enhance drought resilience[2].

Drought is defined as a natural hazard resulting from a substantial period of a lack of precipitation. Although many incorrectly consider it a rare and random event, drought is, in fact, a normal, recurrent feature of climate. It occurs in all climatic zones, but its characteristics vary significantly from one region to another. A drought often coexists with periods of extreme heat, which together can cause significant social stress, economic losses, and environmental degradation.

Drought is typically a slow-onset, creeping phenomenon, and its impacts are environmental rather than structural. Drought normally affects more people than other natural hazards, with impacts spread over a larger geographical area. As a result, the detection and early warning signs of drought conditions and the subsequent assessment of impacts are more difficult to identify than quick-onset natural hazards (e.g., flood and severe thunderstorms) that result in more immediate impacts. In addition, drought has more than 150 definitions. The lack of a universal definition

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[1] Smith, A.B., Katz, R.W. "US billion-dollar weather and climate disasters: data sources, trends, accuracy and biases." Nat Hazards 67, 387–410 (2013). https://doi.org/10.1007/s11069-013-0566-5

[2] Jedd, Theresa; Bathke, Deborah J.; Gill, Duane; Paul, Bimal; Wall, Nicole; Bernadt, Tonya K.; Petr, Jacob; Mucia, Anthony James; and Wall, Milan, "Tracking Drought Perspectives: A Rural Case Study of Transformations Following an Invisible Hazard" (2018). Papers in Natural Resources. 1277. https://digitalcommons.unl.edu/natrespapers/1277

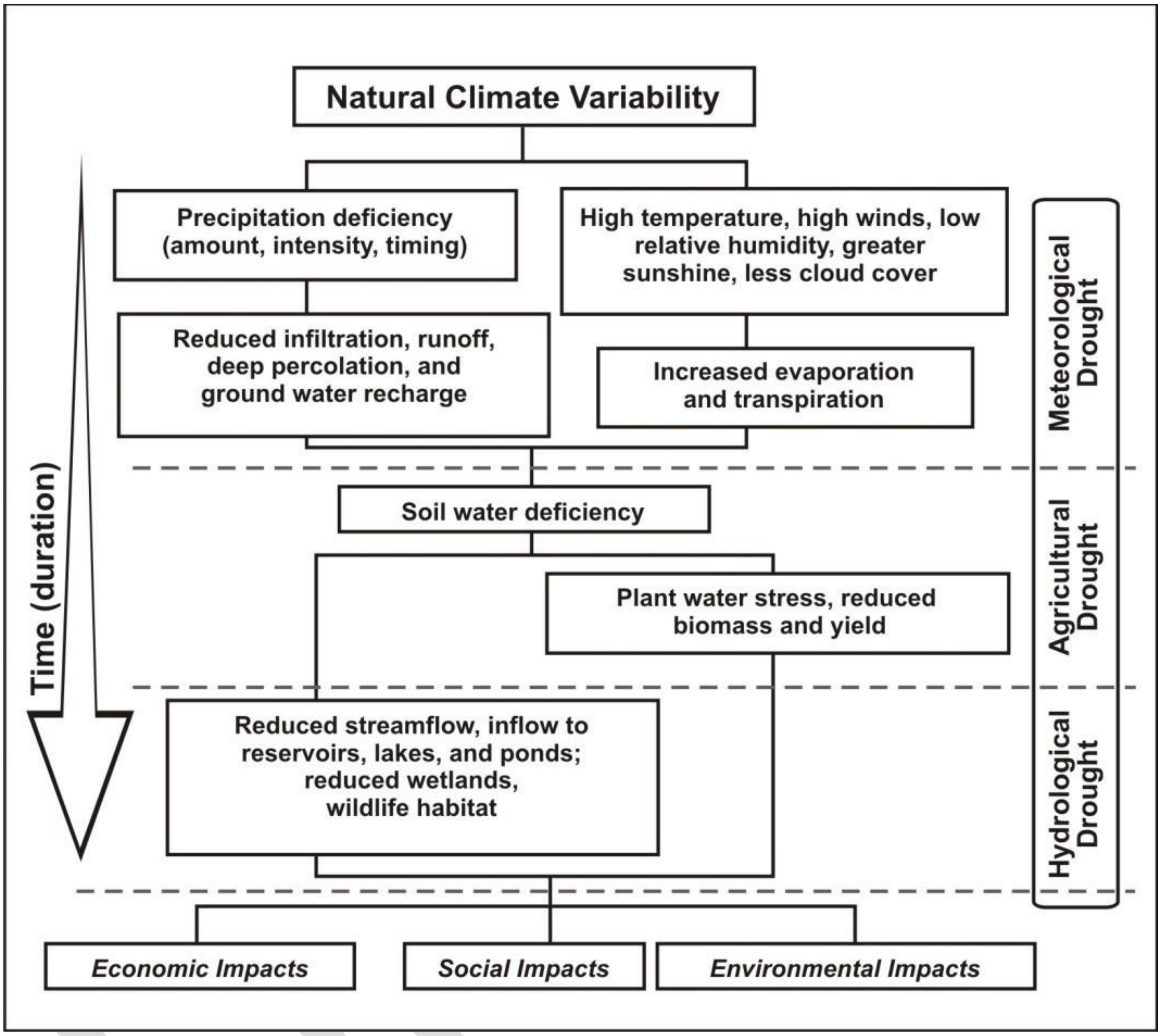
makes it even harder to indicate drought's onset and ending. According to the National Drought Mitigation Center (NDMC), droughts are classified into four major types:

- Meteorological drought is defined by the degree of dryness and the duration of the dry period. Meteorological drought is often the first type of drought to be identified and should be defined regionally as precipitation rates and frequencies ("norms") vary.
- Agricultural drought occurs when there is deficient moisture that hinders plant germination, leading to low plant population per hectare and a reduction of final yield. Agricultural drought is intricately linked with meteorological and hydrological drought as agricultural water supplies are contingent upon the two types.
- Hydrological drought occurs when water available in aquifers, lakes, and reservoirs falls below the statistical average. This situation can arise even with average precipitation. This is due to water reserves diminishing from increased water usage, usually from agricultural use or elevated levels of evapotranspiration, resulting from prolonged hot temperatures. Hydrological drought often is identified later than meteorological and agricultural drought. Impacts from hydrological drought may manifest themselves in decreased hydropower production and loss of water-based recreation.
- Socioeconomic drought occurs when the demand for economic goods exceeds supply due to a weather-related shortfall in water supply. The supply of many economic goods includes, but is not limited to water, forage, food, grains, fish, and hydroelectric power.

While most droughts occur over extended periods, flash drought is the rapid onset or intensification of drought set in motion by lower-than-normal rates of precipitation, accompanied by abnormally high temperatures, winds, and radiation. Flash droughts can cause extensive damage to agriculture, economies, and ecosystem goods and services. The flash drought of 2012 was a multi-billion-dollar disaster that is believed to be the worst drought (in terms of moderate to extreme drought coverage) since the 1950s[3].

Drought can also exacerbate the impacts of other hazards or increase their likelihood. The damage caused by these other hazards is understood as cascading impacts from drought. Drought, for example, might increase wildfire risk due to the resulting dry conditions. Drought conditions can also lead to flooding, since overly dry soil cannot absorb moisture quickly, increasing the amount of runoff, and leading to flash flooding. Droughts can also weaken trees and result in greater damage during high wind events. Figure 3 illustrates the diverse types of droughts, their temporal sequence, and the several types of effects they can have on a community.

[3] Rippey, Bradley R. "The U.S Drought of 2012." 2015. Weather and Climate Extremes. Volume 10. Part A. Pages 57-64. https://doi.org/10.1016/j.wace.2015.10.004



Source: National Drought Mitigation Center

Figure 3: Sequence and Impacts of Drought Types

SECTION 2. PLANNING & STAKEHOLDER ENGAGEMENT PROCESS

2.01 PLANNING PROCESS

Development of this plan began in 2021, following a delayed start due to the Covid-19 pandemic. The importance of stakeholder engagement in the planning process was recognized from the beginning, therefore, the planning effort did not start in earnest until in-person meetings could be safely held (Figure 4 and Figure 5). To garner robust stakeholder engagement and participation, the planning process utilized industry-leading principles and strategies from the International Association of Public Participation (IAP2).

Figure 4: Stakeholders at the Drought Management Workshop Meeting

Figure 5: Discussion Taking Place at Stakeholder Meeting #2

STAKEHOLDER SUMMARY

The stakeholder list was developed by the Lower Loup NRD staff after first reviewing stakeholder lists from previous LLNRD planning efforts (multiple watershed plans, hazard mitigation plan, and the voluntary integrated management plan). JEO staff provided input on types of stakeholders to include, such as water users, water suppliers, community leaders, regulatory agencies, and others throughout the district. LLNRD staff then recruited and led communication with the stakeholders.

A total of 42 stakeholders participated, representing a diverse cross section of district residents and natural resource professionals. A record of all stakeholders that attended meetings is presented in Table 1 (based on sign-in sheets). Invitations for each meeting were provided via mailed letters, with email and phone call follow-ups as needed.

Table 1: Summary of Stakeholder Meeting Attendees

Name	Title/Jurisdiction/Organization
Alan Bartels	Information Specialist, Lower Loup NRD
Allen Chlopek	City Administrator, Fullerton
Allen Volf	Farmer/Rancher
Andy Pedley	Environmental Specialist, NeDNR
Bill Luckey	Farmer
Bryan O'Connor	Biologist, NGPC
Caitlin Kingsley	NeDNR
Chris Hobza	Lead Hydrologist, USGS
Craig Frenzen	Farmer
David Ciancio	Farmer, Fullerton
Dick Harrington	Farmer, Loup City
Don Masten	Sales Manager, Downey Drilling Inc
Doug Reiter	Emergency Manager, Wheeler County
Hank Thoene	Director, Lower Loup NRD
Hilary Maricle	Engagement Zone Coordinator, UNL Extension
Jeramie VanLeer	Utilities Superintendent, Ord
Jerry Carder	Farmer
Jerry Smith	Director, Lower Loup NRD
Jim Adams	Director, Lower Loup NRD
Jim Janda	Field Representative, Nebraska Board of Educational Lands and Funds (BELF)
Joe Novotny	Farmer, Elyria
John Krohn	Farmer, Albion
Kirk Foster	Farmer, Janesville Farm
Lex Jeffres	Farmer, Jeffres & Sons, Inc
Logan Govier	Farmer, Broken Bow
Luke Zangger	Vice President, Zangger Popcorn

Madeline Hoffer	Office Services Manager, NeDNR
Mark McGuire	Farmer
Mark Schreiber	Farmer
Matt Jeffres	Partner, Jeffres Sand and Gravel
Matt Lukasiewicz	Director, Lower Loup NRD
Michaela Wetovick	Farmer/Rancher, Fullerton
Mick Kozeal	Mayor, Sargent
Mike Archer	Biologist, NDEE
Neal Suess	President, Loup Power District
Randy Kauk	Director, Lower Loup NRD
Reece Jensen	Administrator/Utilities Superintendent/Fire Chief, Sargent
Rich Woollen	Forester
Ryan Kelly	Integrated Water Management Coordinator, NeDNR
Skip Amsberry	Director, Lower Loup NRD
Tom Klanecky	Supervisor, NeDNR, Ord Field Office
Troy Ingram	Nebraska Ag

SUMMARY OF STAKEHOLDER MEETINGS

Multiple meetings were held throughout the planning process:

1. September 9, 2021: Drought scenario workshop
2. November 30, 2021: Establishing drought monitoring and response protocols
3. February 17, 2022: Establishing mitigation actions and timelines

The overarching purpose of stakeholder involvement is to craft recommendations that are largely identified and/or refined by stakeholder input. Stakeholder-led recommendations, particularly for drought planning, generally lead to public buy-in when the plan is implemented.

Following the IAP2 framework, the level of engagement with stakeholders increased at each meeting. This approach began with informing stakeholders about the planning process and developed to collaborating and getting feedback on recommendations within the draft plan. This process is illustrated in Figure 6. The final IAP2 level of empowerment is reserved for the Lower Loup NRD Board of Directors who will make the final decision on plan adoption and implementation.

Summaries of each meeting are provided below. Copies of meeting materials (sign-in sheets, notes, presentations, etc.) can be found in Appendix A.

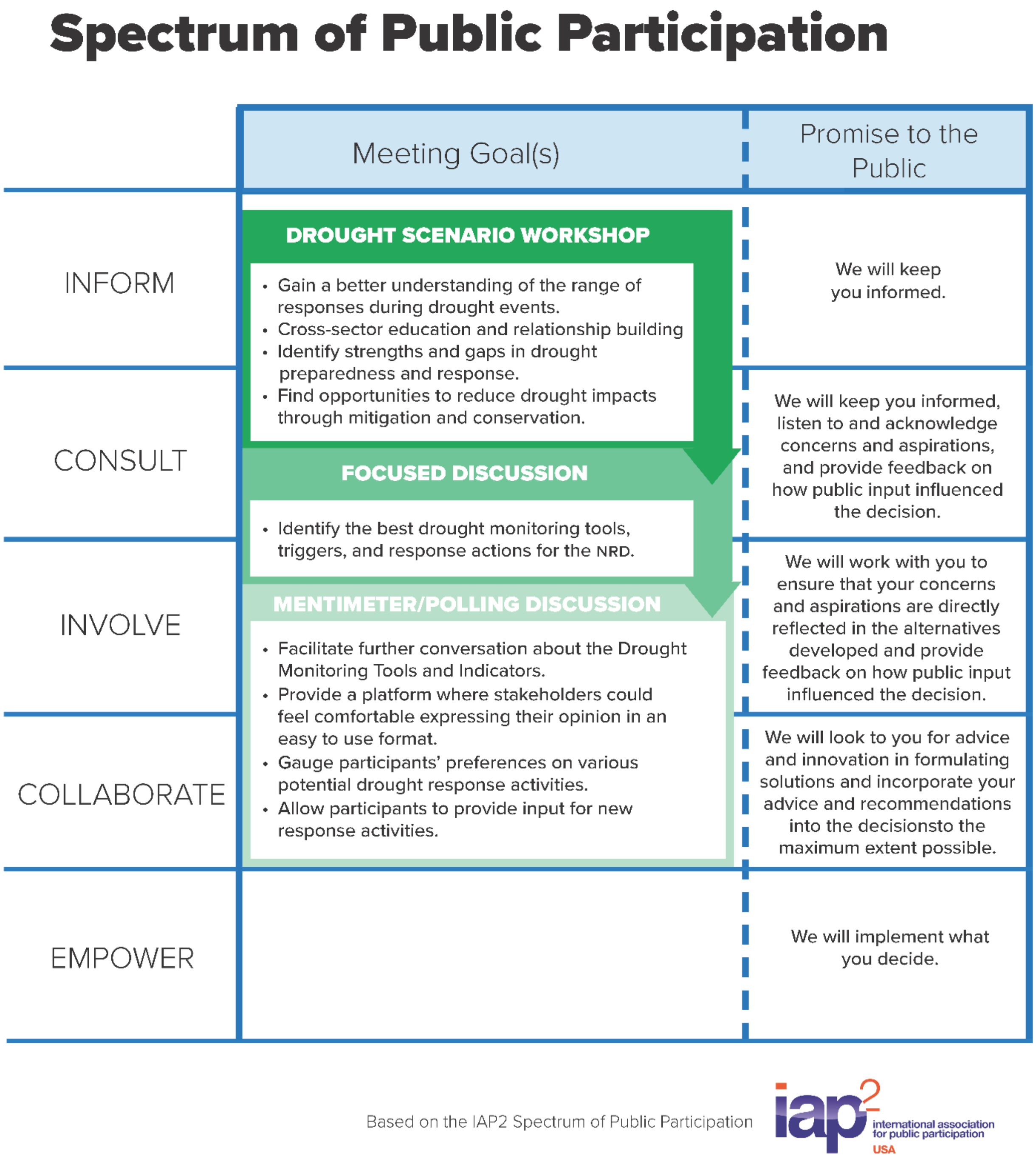


Figure 6: Illustration of the Enhanced Stakeholder Engagement Process Used

2.02 STAKEHOLDER MEETING #1

BACKGROUND

The planning team held the first stakeholder meeting, a drought scenario workshop, on September 9, 2021, in Ord, Nebraska. A total of 17 stakeholders attended the meeting. Copies of meeting materials (sign-in sheets, notes, presentations, etc.) can be found in Appendix A.

Drought scenario exercises are an innovative way to engage a wide variety of stakeholders in the planning process, especially those who do not usually participate in planning. Exercises (e.g., workshops, tournaments, tabletop exercises, games) that use scenarios—structured accounts of conditions and events—gather people together to plan and manage activities for a hypothetical event, in this case, drought. These exercises offer a way to identify and prioritize uncertainties; stimulate creative thinking for mitigation, response, and adaptation strategies; learn about differing views and perspectives of drought; and foster better communication and relationships among stakeholders[4]. The hands-on nature of these exercises make learning and collaboration more fun and compelling than a typical presentation style meeting format. What is more, they can provide a safe environment for learning, experimenting with decisions, negotiation, and consensus building among diverse stakeholders.

DROUGHT SCENARIO DEVELOPMENT

The planning team developed the drought scenario for this event based on historical data from the 2002-2003 and 2012-2013 droughts in the region. Real world data (United States Drought Monitor (USDM), USGS stream flow, etc.) were adapted for use in the scenario. Planning for this meeting centered on meeting the following objectives:

- Gain a better understanding of the range of responses during drought events
- Achieve cross-sector education and build relationships
- Identify strengths and gaps in drought preparedness and response
- Find opportunities to reduce drought impacts through mitigation and conservation
- Assist in developing a long-term vision and approach for managing natural resources

DISCUSSION SUMMARY

The planning team presented stakeholders with the drought scenario and then asked a series of questions for group discussion related to the impacts felt. Stakeholders were tasked to think about and record important response/management actions. The following questions were posed to the stakeholders.

- What is the typical response from your agency/group/entity given these circumstances?

[4] Bathke, Deborah; Haigh, Tonya; Bernadt, Tonya; and Wall, Nicole, "Drought Scenario-Based Exercises: A Research- and Experience-Based Reference Document" (2019). Publications of the National Drought Mitigation Center. https://digitalcommons.unl.edu/ndmcpub/19

- What agencies/groups do you coordinate with when drought is occurring?
- Is water conservation being encouraged at this time? If so, how and by whom?
- What actions are being taken to mitigate potential drought impacts?
- Is your entity monitoring water supplies? If so, by what means?
- What policies are enacted when drought is occurring?
- Does the price of commodities or fuel change your response and day-to-day operations?
- What management actions from various agencies are expected or necessary to mitigate drought impacts at this point?

The planning team facilitator supplemented these questions as the workshop progressed to foster a constructive conversation. The workshop consisted of five rounds of discussion as the drought scenario progressed, followed by one round of debrief discussion focused on how the regional approach to managing drought could be revised.

The following list comprises a selection of stakeholder feedback, observations, or other comments received during the first meeting. This selection represents some of the key stakeholder feedback that was used to develop the plan. For a more comprehensive summary, see Appendix A. While this is not a list of agreed-upon strategies, is a compilation of the topics or ideas brought up by one or more of the stakeholders.

- NRD is a trusted voice and needs to continue extensive data and outreach actions.
- Stakeholders need to stay in contact during drought periods.
- The more methods of communication used, the better (social media, texts, emails, phone calls, newspaper, radio, word of mouth, etc.).
- Ensure decisions are fair, equitable, and based on data.
- Producers are looking for water storage options, but dams are a polarizing topic.
- Engagement and collaboration across agencies would improve information dissemination and drought response.
- US Drought Monitor D2 drought is a trigger point for some producers to talk to the FSA office.
- Crop insurance assistance or programs are positive during times of drought – livestock feed resources can be a difficulty and relief is needed.
- Producers may not plant dryland crops and order fewer seeds.
- Conflicts potential: City vs. Urban, more control requested on urban water users.
- Technology is crucial. If technology is not being used, you are going to be behind in managing your operations during drought.
- Short term CRP option and fallowing of acres.
- Small grains may see a resurgence depending on ability to plant/harvest.
- Mental health is a continual concern.
- Continued monitoring includes phone calls, weather forecast, wind, stream gages.
- Request to not change allocation after it is officially set.

STAKEHOLDER RECOMMENDATIONS

Following the drought scenario activities and stakeholder discussion, the planning team worked with stakeholders to improve drought mitigation and response. The ideas generated by stakeholders are listed below, and as they reflect the goals and strategies of diverse stakeholders across the district, were crucial in developing the Lower Loup NRD Drought Management Plan.

- Producers and other stakeholders want access to more data and information.
- Communication during drought events will reduce conflicts and improve response.
- Common messaging is important. If multiple groups are saying the same thing, the message is validated.
- Create a group of agencies and stakeholders to coordinate drought response/management efforts.
- Work with urban areas to improve regional response.
- Push NRCS, NRD, and other agencies' available programs.
- Water storage.
- Allow producers to see how they compare to others.

2.03 STAKEHOLDER MEETING #2

BACKGROUND

The planning team held the second stakeholder meeting on November 30, 2021, in Ord, Nebraska. A total of 25 stakeholders attended the meeting. Copies of meeting materials (sign-in sheets, notes, presentations, etc.) can be found in Appendix A.

STAKEHOLDER FEEDBACK

The second stakeholder meeting focused on identifying potential drought monitoring tools, triggers, and response actions for the Lower Loup NRD. The planning team presented an overview of the planning process, as well as the following topics, to provide context for group discussion. The following is a selection of stakeholder feedback by topic, with a focus on key stakeholder feedback that was used in the development of this plan.

- Drought Monitoring Tools
  - Water quality measurements (when water quantity drops so does water quality).
  - Looking at the local economy in terms of a drop in visitors and customers.
- General Drought Response Actions
  - Actions should be implemented on a tiered basis, depending on the trigger.
  - A focus on the importance of checking the pumping rate and static water levels is important.
  - Measuring aquifer saturated thickness.
  - Collaboration among towns regarding their own water-use restriction ordinances.
  - Suggestion that the Lower Loup NRD release information on best management practices (BMPs) specific to their district.

- Lower Loup NRD Drought Response Actions
    - Would like more outreach and communication from the Lower Loup NRD (especially as part of an early warning).
    - Allocations could be used, but are not popular.
    - More metering.
    - Certified Irrigated Acres (not a preferred option).
    - Better technology and the availability of data.
    - Stream buffers and CRP are examples of true mitigation actions.
    - Potentially reduced end-gun lengths on pivots.
    - Take out some irrigated acres and provide incentives.
    - Actions should be equitable and spread around during mitigation and response, especially regarding agricultural users and manufacturing users. Also, "do not go overboard with a decision because the aquifer rebounds."
    - Actions triggered during specific stages of drought should be identified ahead of time and then followed.
- Other Feedback
    - The suggestion to ensure the Lower Loup NRD considers input from stakeholders during the implementation of drought management actions, a "drought management group," was repeatedly brought up.
        - A drought management group would be a group of stakeholders that meet when certain drought levels are hit and provide feedback on drought conditions and proposed management actions.
    - Discussion on the timing of decisions and communication of drought actions was brought up several times. The idea is to provide producers with as much warning as possible ahead of a drought or possible restrictions they will need to plan for in their business operations. The following suggestions were noted:
        - Ask for voluntary reduction in July/August and communicate that water table is dropping.
        - The timing for indicators should be March 1 or April 1.

Based on the robust discussion and input received, the planning team decided a third stakeholder meeting would be beneficial. The third stakeholder meeting would allow further discussion and refinement of ideas presented during the first two meetings.

2.04 STAKEHOLDER MEETING #3

BACKGROUND

After the second stakeholder meeting, the planning team drafted drought monitoring protocols, indicators, and response actions based on stakeholder input. A third and final stakeholder meeting was held on February 17, 2022, in Ord, Nebraska, to solicit feedback on these draft materials before they were integrated into this drought plan. A total of 26 stakeholders attended the meeting. Copies of meeting materials (sign-in sheets, notes, presentations, etc.) can be found in Appendix A.

STAKEHOLDER FEEDBACK

To help facilitate discussion about the drought monitoring protocols and response actions, the planning team used the facilitation tool Mentimeter. Mentimeter is an anonymous question and polling tool that is accessed through each participant's smartphone and provides live results for discussion during the meeting.

Stakeholders were shown the draft management actions that would be implemented by the Lower Loup NRD for each drought level. The stakeholders then voted on whether the management actions were "Not Strict Enough," "Just Right," or "Too Strict." After the voting, a discussion took place regarding any additions, changes, or thoughts people had about the various management actions. Table 2 summarizes stakeholder feedback. Overall, stakeholders supported the presented monitoring and response protocol.

Table 2: Stakeholder Polling Results

Stakeholder Response to the "Appropriateness" of the Management Actions Associated with Each Drought Level			
Drought Level	**Not Strict Enough**	**Just Right**	**Too Strict**
0: Watch	2 (8%)	22 (92%)	0 (0%)
1: Moderate	10 (40%)	14 (56%)	1 (4%)
2: Severe	14 (58%)	9 (38%)	1 (4%)
3: Extreme	7 (32%)	14 (64%)	1 (4%)

Following each round of polling, the planning team led a discussion with the stakeholders for more robust input. The following is a selection of stakeholder feedback, observation, or other comments received. This selection represents some of the key stakeholder feedback that was used in the development of this plan. For a more comprehensive summary, see Appendix A.

- The group discussed the timing of when decisions on drought actions are made and/or communicated, as a follow-up to the previous stakeholder meeting. The planning team asked stakeholders if June 1 for Drought Levels 0, 1, and 2 and March 1 for Drought Levels 3 and 4 were appropriate. Stakeholders agreed that these deadlines were appropriate and are necessary to allow irrigators and other stakeholders within the Lower Loup NRD enough time to take appropriate actions during drought periods.
- The group discussed a "drought management group" made up of stakeholders that would be activated during drought periods to help inform the Lower Loup NRD's management decisions. Stakeholders indicated their interest this group be comprised of individuals from the Farm Service Agency (FSA), UNL Extension, emergency management, Nebraska Department of Natural Resources (NeDNR), concerned citizens, irrigation districts, Loup Power District, large industries, well drillers, ground and surface water irrigators, and the National Drought Mitigation Center (NDMC).
- Additional points of discussion and stakeholder feedback included cost-share programs for flow meters, consideration of the different management zones and their levels of drought, and a reminder to consider mental health assistance during times of drought.

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SECTION 3. LOWER LOUP NRD PROFILE

3.01 LOWER LOUP NRD

The Lower Loup NRD is one of Nebraska's 23 Natural Resources Districts (NRDs). Unlike the county-wide districts found in most states, Nebraska's NRDs are based on river basin boundaries, enabling them to approach natural resources management on a watershed basis. The Lower Loup NRD is autonomous, governed by a locally elected Board of Directors. While NRDs share a common set of responsibilities, each district sets its own priorities and develops its own programs to serve local needs. The Lower Loup NRD has 12 areas of responsibility:

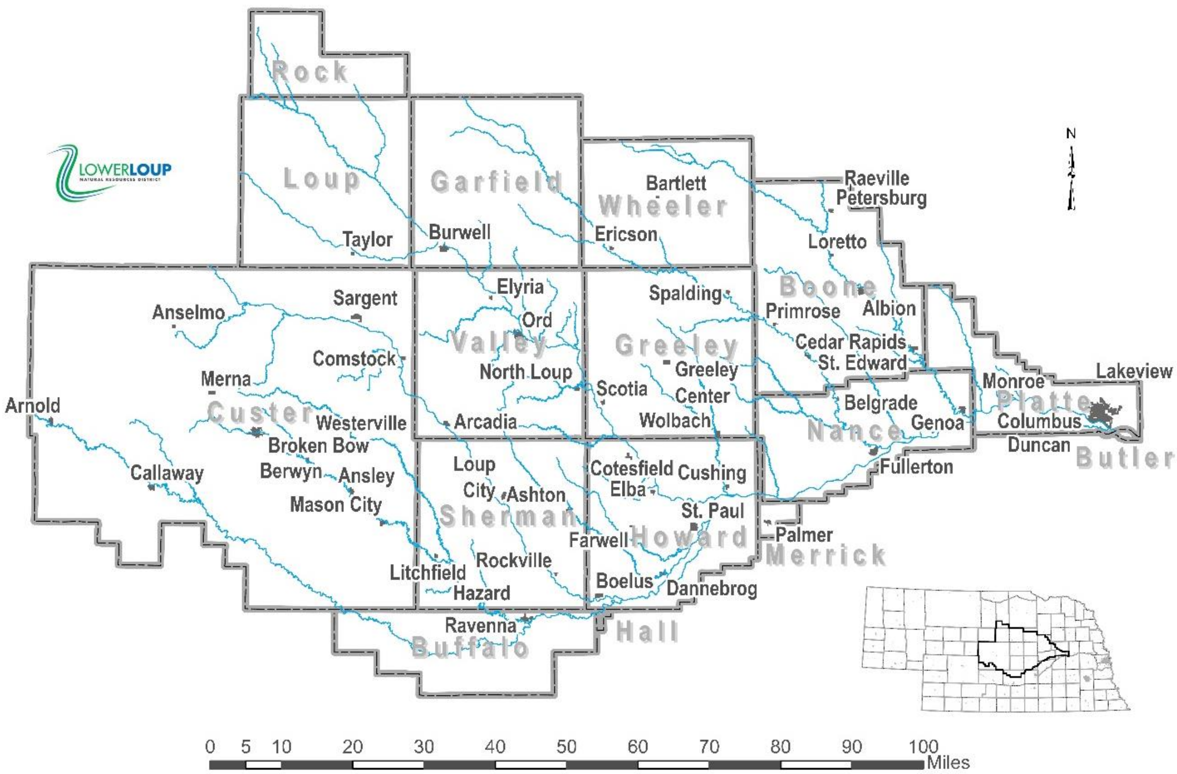
1) Erosion prevention and control
2) Prevention of damages from flood water and sediment
3) Flood prevention and control
4) Soil conservation
5) Water supply for any beneficial uses
6) Development, management, utilization, and conservation of groundwater and surface water
7) Pollution control
8) Solid waste disposal and sanitary drainage
9) Drainage improvement and channel rectification
10) Development and management of fish and wildlife habitat
11) Development and management of recreation and park facilities
12) Forestry and Range management

Nebraska Statute, Chapter 2, Article 32 establishes Nebraska's NRDs and grants them the powers and authorities that assist in their district's functioning. The Lower Loup NRD has the authority to levy property taxes to fund the district's functioning, which includes a variety of programs and incentives to facilitate the implementation of resource management activities.

The Lower Loup NRD has a wide range of statutory responsibilities and authorities, including, but not limited to, Nebraska Revised Statutes §2-3,201 through 2-3,243 and the Groundwater Management and Protection Act (Nebraska Rev. Statutes §46-701 through 46-756). Specifically, Nebraska Rev. Statutes §46-707(f) confer to the NRDs the power to "conduct investigations and cooperate or contract with ...public or private corporations, or any association or individual on any matter relevant to the administration of the [Groundwater Management and Protection] act."

The Lower Loup NRD is the largest NRD in the state (Figure 7). It is located in central Nebraska and covers 5,088,565 acres—10.3% of Nebraska—in all or parts of the following counties: Boone, Buffalo, Butler, Custer, Garfield, Greeley, Hall, Howard, Loup, Merrick, Nance, Platte, Rock, Sherman, Valley, and Wheeler. The district encompasses 514 miles of rivers, including the drainage systems of the lower reaches of the North, Middle, and South Loup River systems, as well as the Cedar and Calamus Rivers. Other major tributaries include Beaver Creek and Mud Creek.

The Lower Loup NRD is largely made up of two topographic regions: dissected plains and sandhills. Dissected plains are represented by hilly land with moderate to steep slopes and sharp ridge crests. Sandhills are hilly lands comprised of low to high dunes of sand stabilized by a grass cover.



Source: www.llnrd.org

Figure 7: Location of the Lower Loup NRD

3.02 POPULATION

Table 3 provides a summary of population trends within the Lower Loup NRD from 2010 to 2020. The percent change was used to demonstrate the general population trend across the Lower Loup NRD. This is a relatively simple method to predict population change, and it does not account for predominant age cohorts in the community, birth and death rates, or in and out migration which will likely impact the rate of growth or decline. In Table 3, the entire population of counties within the Lower Loup NRD were provided despite the fact that the district boundary only includes portion of many of these counties. This was done because the US Census Bureau does not organize data by the NRD level. The Lower Loup NRD estimates its population to be around

69,000[5] rather than the total population in Table 3.. It is important to address population trends because water use and population are positively correlated; meaning that as population increases there also is likely to be an increase in water use.

Table 3: Population Trends 2010 - 2020

County	2010 Population	2020 Population	Percent Change
Boone County	5,505	5,379	-2.3%
Buffalo County	46,102	50,084	8.6%
Custer County	10,939	10,545	-3.6%
Garfield County	2,049	1,813	-11.5%
Greeley County	2,538	2,188	-13.8%
Howard County	6,274	6,475	3.2%
Loup County	632	607	-4.0%
Merrick County	7,845	7,668	-2.3%
Nance County	3,735	3,380	-9.5%
Platte County	32,237	34,296	6.4%
Rock County	1,526	1,262	-17.3%
Sherman County	3,152	2,959	-6.1%
Valley County	4,260	4,059	-4.7%
Wheeler County	818	774	-5.4%
Total	**127,612**	**131,489**	**-**

Source: United States Census Bureau – 2000-2020[6]

**Butler, Hall, Buffalo, and Rock Counties represent very small areas of the Lower Loup NRD*

3.03 WATER SOURCES AND USE

Approximately 90% of the water consumed within the Lower Loup NRD is sourced from groundwater, whereas surface water accounts for approximately 10% of water consumption. Lower Loup NRD Figure 8 shows the location of surface water appropriations throughout the district.

[5] "LLNRD Sub-Districts 2020 Census." Lower Loup Natural Resources District. https://www.llnrd.org/assets/site/SubDistricts_2020Census_Poster24x36.pdf

[6] "Population Data." United States Census Bureau, 2000-2020. https://www.census.gov/topics/population/data.html

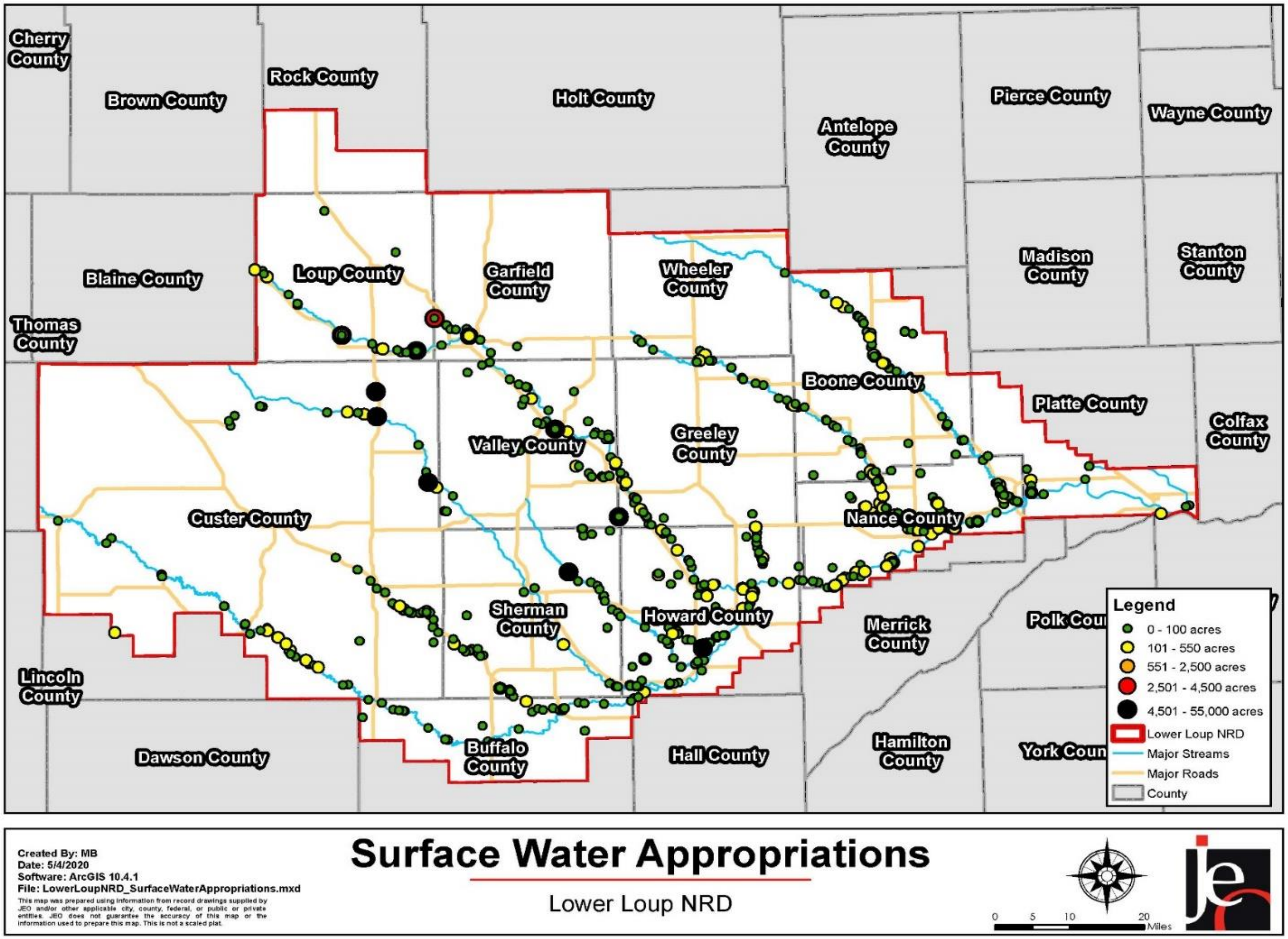
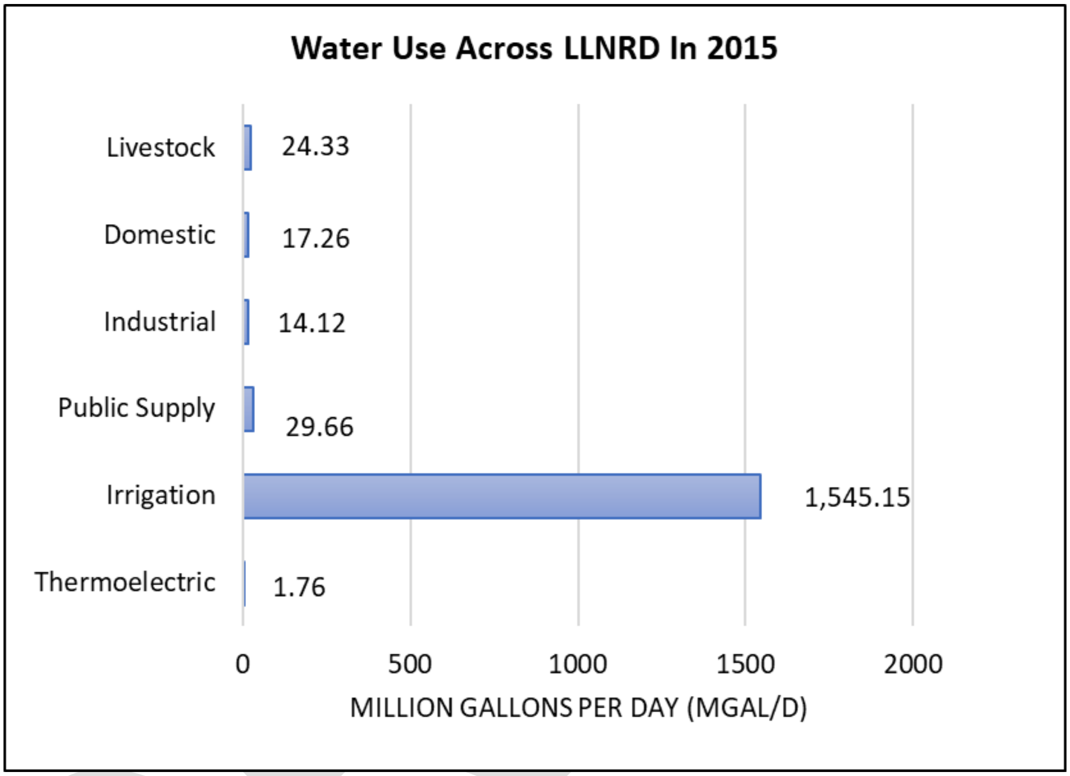


Figure 8: Surface Water Appropriations

As shown in Figure 9, the total water used in the Lower Loup NRD is 1,632.28 million gallons per day (Mgal/d). Irrigation use accounts for the overwhelming majority of water use within the Lower Loup NRD, followed by public supply. Irrigation use is seasonal in nature, with peak demands occurring (depending upon the year) during the timeframe of late June through mid-September.



Source: USGS, 2015 Water Use by County[7,8]

Figure 9: Water Use in the Lower Loup NRD (Mgal/d)

While irrigation uses the most water, it also benefits the Lower Loup NRD. The number of irrigated acres has increased across the district over time. As more acres are irrigated, recharge occurs on that irrigated ground. Because of this, irrigation can be seen as a useful tool for resource managers, as it can be allocated or restricted according to drought conditions.

The Lower Loup NRD had 19,196 active registered wells (all uses) as of March 2022 (Table 4). The registration of newly constructed domestic wells was not required until 1993; therefore, the actual number of wells within the district is likely higher, as many of the older constructed wells have never been registered but are still in service. Most wells are used for irrigation (53.64%), domestic use (18.28%), livestock (16.33%), and monitoring (6.32%).

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[7] Dieter, Cheryl A., Molly A. Maupin, Rodney R. Caldwell, Melissa A. Harris, Tamara I. Ivahnenko, John K. Lovelace, Nancy L. Barber, and Kristin S. Linsey. “Estimated Use of Water in the United States in 2015.” United States Geologic Survey, June 19, 2018. https://pubs.er.usgs.gov/publication/cir1441.

[8] “USGS Water Use Data for Nebraska.” National Water Information System. United States Geologic Survey. https://waterdata.usgs.gov/ne/nwihttps://waterdata.usgs.gov/ne/nwis/.

Table 4: Registered Wells in the Lower Loup NRD

Registered Well Type	Percentage of Wells by Use	Number of Wells by Type
Irrigation	53.64%	10,294
Domestic	18.28%	3,509
Livestock	16.33%	3,136
Monitoring (Groundwater Quality)	6.32%	1,213
Ground Heat Exchanger	1.66%	318
Injection	0.93%	178
Other	0.78%	150
Commercial/Industrial	0.72%	139
Observation (Groundwater Levels)	0.59%	114
Recovery	0.44%	84
Heat Pump Well	0.10%	19
Pit (Excavation)	0.08%	15
Aquaculture	0.07%	13
Dewatering	0.07%	13
Geothermal	0.01%	1

Source: NeDNR, 2022[9]

3.04 INSTREAM FLOW RIGHTS

Nebraska's administrative system overseeing the orderly use of the State's surface water resources is administered by the NeDNR. All uses require a water right, which is granted through a state permit, and which has certain limitations and conditions associated with it. There are multiple types of surface water diversions, however, most are for irrigation, hydropower, and industrial use. There is also a certain type of water right that can be used to protect the flow of streams for recreation, fish, and wildlife – these are known as instream flow water rights. There are two instream flow water rights, located within or downstream of the Lower Loup NRD that need to be taken into account by this plan

- Platte River near Louisville, NE - held by NGPC
- Loup River near Cushing, NE - held by Lower Loup NRD.

[9] "Registered Groundwater Wells." Groundwater Data. Nebraska Department of Natural Resources, 2022. https://dnr.nebraska.gov/data/groundwater-data

NGPC's instream flow right on the Platte River begins at the confluence of the Platte River and the Elkhorn River and ends at the mouth of the Platte River. The priority date of the water right is November 30, 1993. The flow at USGS stream gage 06805500 near Louisville is used to monitor and administer this water right. The flows administered under this right vary by season but range from 3,100 CFS to 3,700 CFS; and are used to maintain fish communities.

Lower Loup NRD's instream flow right on the Loup River (Figure 10) begins at the confluence of the North and Middle Loup Rivers (near Cushing) and ends at the Loup Power Canal Diversion (west of Genoa). The priority date of the water right is July 28, 2017. The combined flows of USGS stream gages 06790500 and 0678500 near St. Paul are used to monitor and administer this water right. The flows administered under this right vary by season but range from 1,600 CFS to 2,400 CFS; and are used to maintain the fish community and for recreation.

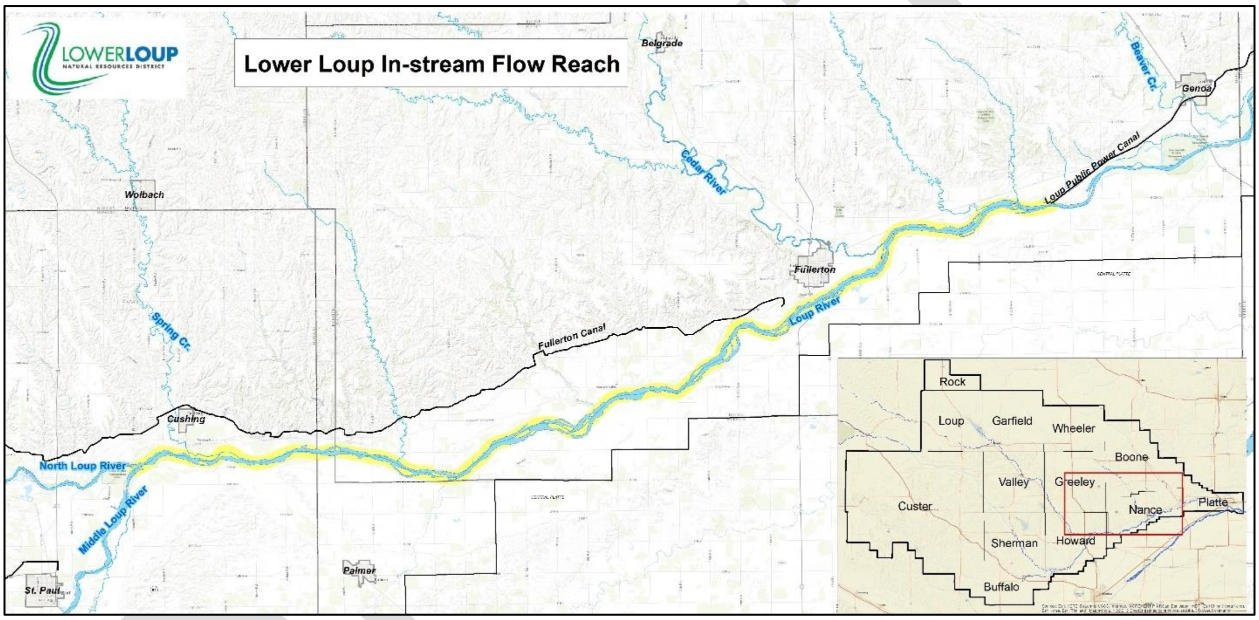


Figure 10: Location of the Lower Loup NRD Instream Flow Right on the Loup River

3.05 DROUGHT RELATED PLANNING EFFORTS

Below are actions, projects, and programs that the Lower Loup NRD has already, or is in the process of, taking to reduce the negative impacts from drought; directly or indirectly. Many of these projects serve multiple purpose objectives on top of reducing drought impacts and show how actions can have wide ranging benefits. Unless specified below, copies of each of the following reports, plans, or studies can be obtained by contacting NRD staff, or through the Lower Loup NRD's website:

https://www.llnrd.org/forms/regulations-and-plans.html

SPRING STATIC WATER LEVEL MONITORING PROGRAM

The Lower Loup NRD collects groundwater level data annually every spring. Data from 1982 represents the benchmark year to compare groundwater level changes. The most recently available data are available within the *2022 Spring Static Water Level Report*. That report found that the largest concentration of decreasing water levels is in southern Custer County and northern Buffalo County, south of the Loup River. Conversely, it shows major increases in water levels in Valley County where recharge is abundant. Additional discussion and data are presented in Section 4 of this plan.

MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN

The *Lower Loup Natural Resources District Multi-Jurisdictional Hazard Mitigation Plan* was prepared in 2022 and specifically addresses hazards including drought, and subsequently proposes mitigation actions to reduce the risk from drought at the regional and local level.

MASTER PLAN

The *Lower Loup Natural Resources District Master Plan (2012 – 2022)* describes the district and outlines the NRD's goals and objectives. Actions within the Master Plan aim to address the 12 areas of responsibility previously presented. Projects identified within the Master Plan will be consistent with the projects identified within this Drought Management Plan. The Master Plan is updated by the Lower Loup NRD every ten years.

LONG-RANGE IMPLEMENTATION PLAN

The *Long-Range Implementation Plan* is updated yearly and gives the goals and objectives from the Lower Loup NRD's Master Plan timelines for completion, priority ranking, and necessary financial obligation. The Long-Range Implementation Plan is updated on an annual basis.

GROUNDWATER MANAGEMENT PLAN

The *Groundwater Management Plan (1985)* serves as a foundation for decision-making and managing groundwater resources within the district. The plan creates rules and regulations for the enforcement of the Nebraska Groundwater Management and Protection Act. Sections within the plan include groundwater use in fully and over appropriated areas, groundwater quality management controls, groundwater supply management controls, and the chemigation program. The plan also separates the district into 30 groundwater quality management areas to better identify specific groundwater issues and implement controls. The plan covers groundwater, surface water, groundwater monitoring, water quality, and conservation.

Lower Loup NRD Groundwater Rules and Regulations allow any person to transfer groundwater irrigation rights from one location to another if the acres are certified by the district. Transfers can only occur downstream or to the adjacent section and cannot have a net increase impact on any stream. Acre transfers are only allowed to occur once per year. The deadline for application for transfer is March 1 of each year.

LOWER PLATTE RIVER BASIN-WIDE WATER MANAGEMENT PLAN

The first increment of the *Lower Platte River Basin Coalition Basin-Wide Water Management Plan* was prepared in 2017. The plan, annual reports, and other related materials can be found on the DNR website: https://dnr.nebraska.gov/water-planning/lower-platte-basin-wide-plan

The plan was developed by the Lower Platte South NRD, Lower Platte North NRD, Lower Elkhorn NRD, Upper Elkhorn NRD, Lower Loup NRD, Upper Loup NRD, and Papio-Missouri NRD to provide guidance and a framework for water-use policies and practices that protect existing surface and groundwater resources, while allowing for future water development. Goals of the plan include:

- Provide guidance and a framework for Coalition members to develop water use policies and practices that contribute to the protection of existing surface and groundwater uses, while allowing for future water development.
- Assist in the development and maintenance of a water supply and use inventory, based on the best available data and analysis.
- Provide consistency and information for incorporation into individual NRD Integrated Management Plans.

Every year the Lower Loup NRD prepares a report documenting water use activities in the district as they relate to the coalition's plan. This report also identifies several of the NRD's management protocols that have been useful in returning and protecting flows to the lower Platte River and its tributaries, including, but not limited to:

- Water transfers
- Water banking
- Conversion of surface to groundwater irrigation
- Acre rotations
- Depletion accounting
- Other projects and studies

In 2022, an addendum to the Basin Plan was adopted which added a new drought related objective and four action items, under Goal 2:

Objective 4. Evaluate impacts of new development during drought condition.

A) Evaluate the balance of water supplies and uses during droughts and the potential impacts of new uses on this balance.
B) Evaluate the hydrologic impacts of drought planning activities in the basin (NRD drought plans and mitigation strategies and other plans).
C) Evaluate the hydrologic impacts of surface water administration activities through examination of closing notices issued by NeDNR.
D) Evaluate other management tools that may be available to mitigate impacts from new water uses during droughts.

VOLUNTARY INTEGRATED MANAGEMENT PLAN

The *Voluntary Integrated Management Plan* (VIMP), completed in 2016, provides a framework for how the Lower Loup NRD and NeDNR will work collaboratively to manage groundwater and surface water within the district. Unlike other districts, the Lower Loup NRD volunteered to initiate an IMP. Since the Lower Loup NRD is not in a fully appropriated basin, the goals, objectives, and action items were written with their unique designation in mind. Should their appropriation designation change, the VIMP will be updated. The plan works toward attaining or maintaining a balance between water users and water supplies.

The VIMP identifies two main action items to help the district manage ground and surface water. First, the Groundwater Action Item establishes a limit on the expansion of groundwater irrigated acres. Those in the district must contact the Lower Loup NRD to apply for new groundwater irrigated acres or to increase existing groundwater irrigated acres. Per the VIMP:

> *The limit established on the expansion of groundwater irrigated acres is for agricultural production land irrigated from a new groundwater source, typically an irrigation well, and does not include test holes, replacement wells, water wells constructed to pump 50 gallons per minute or less, monitoring or observation wells, wells constructed for the purpose of contamination treatment, municipal, industrial, or commercial wells. (9)*

Secondly, the VIMP details the Surface Water Action Item that establishes a limit on the expansion of surface water irrigated acres:

> *The annual limit on the expansion of surface water irrigated acres shall be a maximum of one-third of the amount the Lower Loup NRD will allow for the expansion of groundwater irrigated acres. NeDNR will utilize the number of additional groundwater irrigated acres in place in the VIMP area as of January 1 of each year for determining the number of additional acres for surface water irrigated for each calendar year. The limit established on the expansion of surface water irrigated acres is for agricultural production land irrigated from a new surface water appropriation and does not include other types of irrigation use, municipal use, or industrial use. (9-10)*

WATERSHED MANAGEMENT PLANS

The Lower Loup NRD has developed several watershed management plans. While the goals of these plans is to improve water quality within each respective watershed, they recognize the connection between water quantity and water quality. These plans provide a strategy for the voluntary implementation of agricultural best management practices (BMP). These BMPs can both improve water quality, water use efficiency, and have an impact on groundwater and surface water use. The following plans have been prepared to date:

- *Clear Creek-Pibel Lake Watershed Water Quality Management Plan* (2016)
- South Loup River Watershed Management Plan (2017)

3.06 COMMUNITY PLANNING EFFORTS

Community level planning efforts are largely the responsibility of cities and villages located within the district. However, coordination or consistency between efforts of these local jurisdictions with Lower Loup NRD policies can help to increase the drought resilience of the whole area. The following types of community plans were identified, and each should be considered for future opportunities to integrate plans with those of the Lower Loup NRD, such as this drought plan.

EMERGENCY RESPONSE PLANS FOR COMMUNITY WATER SYSTEMS

An Emergency Response Plan is a documented strategy describing actions that a community water system would take in response to various major events, including drought. The list of Emergency Response Plans from community water systems reviewed can be found in Appendix B.

COMPREHENSIVE PLANS

A comprehensive plan sets forth a vision and goals for a community's future and provides the overall foundation for all land use regulation within their jurisdiction. They commonly contain references to water quality and quantity and outline how communities plan to respond in case of drought or during an emergency. The list of comprehensive plans reviewed can be found in Appendix B.

Comprehensive plans are generally developed independently from one another and do not require coordination with the Lower Loup NRD. While wide-ranging in their scope, these comprehensive plans do not include enforcement mechanisms, limiting their utility, unless additional zoning regulations or other accompanying ordinances are also adopted.

Most of these local plans do not include defined triggers for drought, making the decisions to declare drought and enforce water restrictions more difficult. Drought declarations are typically politically challenging decisions as the declaration may impact some in the community economically. Pre-established triggers can help ease political pressure and enable decision makers to formulate an informed decision regarding a drought declaration. As most communities have diverse (or lacking) definitions of drought or triggers for water-use emergencies, the Lower Loup NRD Drought Management Plan could act as a comprehensive tool to coalesce these disparate efforts, improving plan integration and drought mitigation implementation.

WELLHEAD PROTECTION PLANS

Wellhead protection plans attempt to proactively protect and manage the source of community drinking water from potential contaminants. Wellhead protection plans often recommend specific actions that can be taken to protect water quality. Table 5 shows communities within the Lower Loup NRD that have a state-approved wellhead protection plan, as of May 2013.

Table 5: Wellhead Protection Plans in the Lower Loup NRD

Community	Date Approved
City of Albion	6/18/2004
Village of Ansley	1/29/2007
City of Loup City	12/17/2002
Village of Palmer	5/1/2006
Village of Primrose	6/7/2004
City of Ravenna	11/24/2004

Source: NDEE, State Approved Wellhead Protection[10]

[10] "Wellhead Protection (WHP)." Focus on Water. Department of Environment and Energy. http://deq.ne.gov/NDEQProg.nsf/OnWeb/WHPA

SECTION 4. RISK AND VULNERABILITY ASSESSMENT

This section describes the unique characteristics of the Lower Loup NRD that affect its risk and vulnerability to future drought events. The risk assessment provides the factual basis for developing specific strategies to mitigate drought impacts. This section contains a description of historical drought occurrence and extent, previous drought impacts and damages, probability of future occurrences, and a vulnerability assessment.

4.01 HISTORICAL DROUGHT OCCURRENCE AND EXTENT

PALMER DROUGHT SEVERITY INDEX

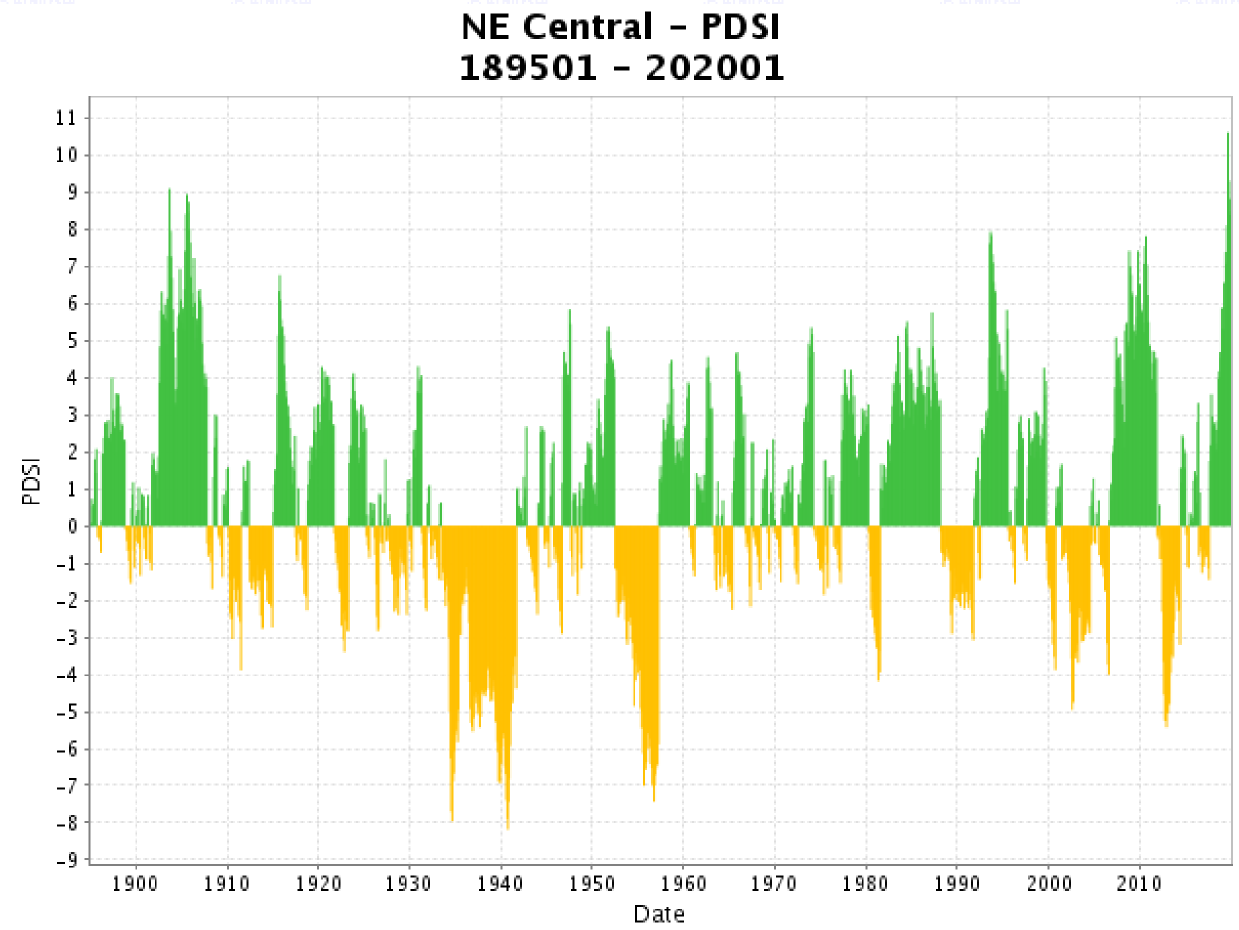
The Palmer Drought Severity Index (PDSI) was used to document historical occurrence and extent of drought across the Lower Loup NRD since 1895 (Figure 11). Among the various indices, the PDSI has been widely used by state and local governments in the United States. Table 6 depicts the percentage of months the district has experienced each level of drought classification, as defined by PDSI. An interesting observation from the PDSI data is that "Exceptional Drought" occurs more frequently than either "Extreme" or "Severe" drought. To help put level in context - the last occurrence of an exceptional drought in the district took place in 2012. Following that drought groundwater took several years to recover, which highlights the incredible impacts drought can have.

Table 6: Historical Drought Occurrence in the Lower Loup NRD

Drought Classification	PDSI Range	Total Occurrences in Month	Percent of Months
Drought	-1.0 or Less	224/1,504	14.9%
Mild Drought	-1.0 to -1.99	188/1,504	12.5%
Moderate Drought	-2.0 to -2.99	100/1,504	6.6%
Severe Drought	-3.0 to -3.99	49/1,504	3.3%
Extreme Drought	-4.0 to -4.99	41/1,504	2.7%
Exceptional Drought	-5.0 or Less	66/1,504	4.4%

Source: NCEI, PDSI 1895 to 2020[11]

[11] "Palmer Drought Severity Index Divisional Data." Historic Palmers. National Centers for Environmental Information. https://www.ncei.noaa.gov/access/monitoring/historical-palmers/



Source: PSDI 2020[12]

Figure 11: Palmer Drought Severity Index for Central Nebraska

USDA SECRETARIAL DISASTER DESIGNATIONS

Past drought events across the Lower Loup NRD have resulted in United States Department of Agriculture (USDA) Secretarial Disaster Designations, most recently in the following areas:

- In 2012 and 2013, drought was designated in all counties (Figure 12 and Figure 13).
- In 2014, drought was designated in all counties except Boone, Platte, and Nance Counties (Figure 14).
- In 2016, Buffalo County was the only county included in a designation.

[12] "Nebraska, Climate Division 2 Palmer Drought Severity Index (PDSI)." Climate at a Glance: Divisional Time Series. National Centers for Environmental Information: National Oceanic and Atmospheric Administration. https://www.ncei.noaa.gov/cag/divisional/time-series/2502/pdsi/1/7/1895-2020

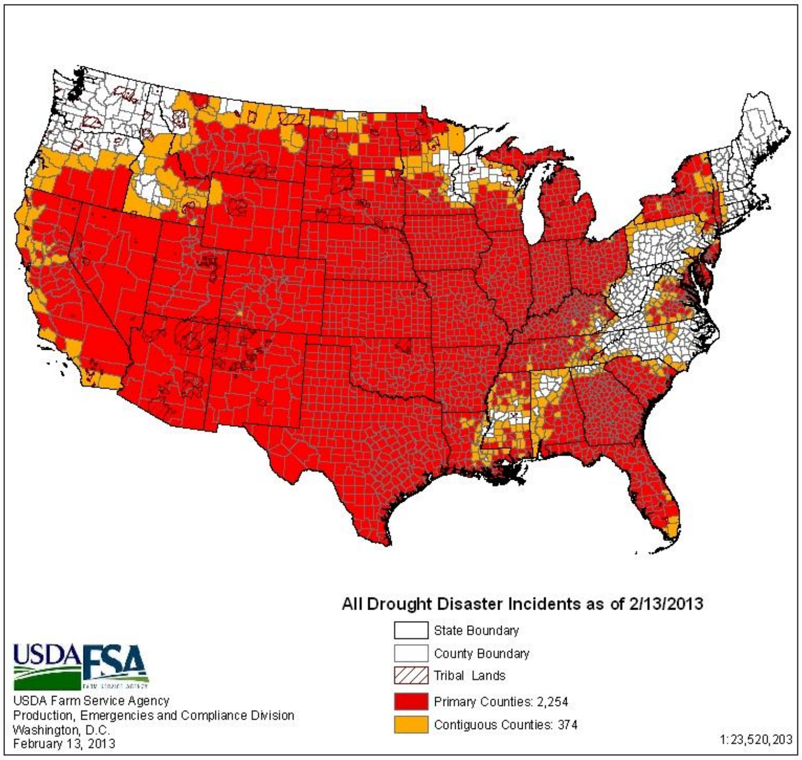


Figure 12: 2012 USDA Drought Designations

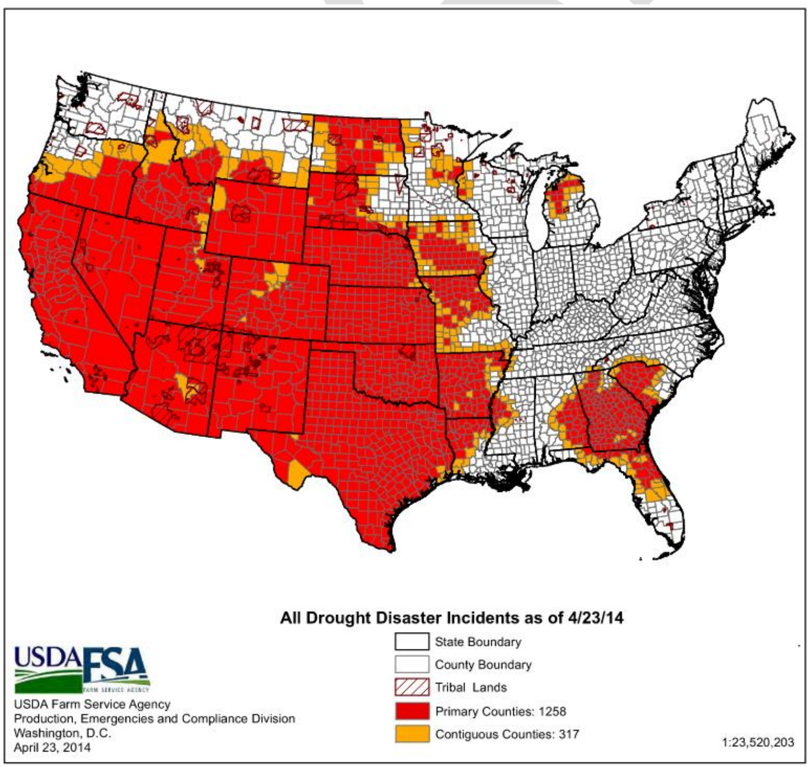


Figure 13: 2013 USDA Drought Designations

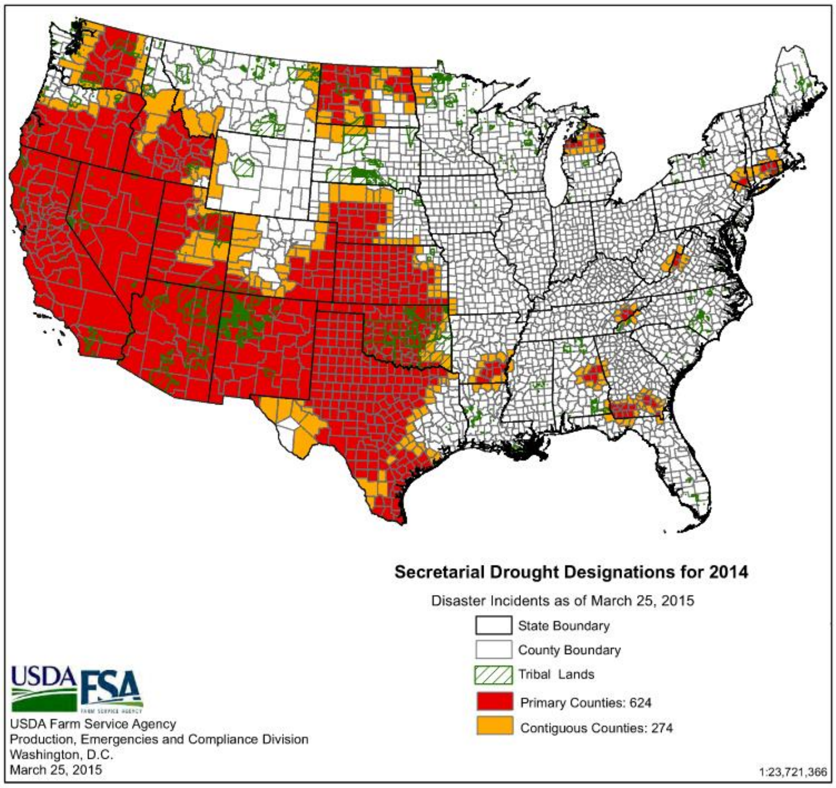


Figure 14: 2014 USDA Drought Designations

4.02 PAST DROUGHT IMPACTS

Drought causes significant economic, environmental, and social impacts. Drought impacts several sectors including agriculture, rural and municipal water supplies, fish and wildlife, tourism, recreation, water quality, soil erosion, the incidence of wildfires, electricity demand, and other sectors. Drought can also indirectly impact personal and business incomes, tax revenues, unemployment, and other areas as well.

The National Drought Mitigation Center's (NDMC) Drought Impact Reporter documents the impacts of drought throughout the United States. Table 7 summarizes, by category, the impacts within the Lower Loup NRD from 2010 to 2020. Many of these reported impacts have been in the agricultural sector.

Table 7: Reported Drought Impacts (2010 to 2020) within the Lower Loup NRD

Agricultural	Business & Industry	Energy	Fire	Plant & Wildlife	Relief, Response, & Restrictions	Society & Public Health	Tourism & Recreation	Water Supply & Quality
32	0	0	5	18	29	6	5	16

Source: NDMC – Drought Impact Reporter[13]

According to the Drought Impact Reporter, from 2010 to 2020 there have been 111 impacts reported in the Lower Loup NRD. During the 2012 drought, more than 1,100 surface irrigators across the state received a notice from NeDNR to stop pumping surface water.[14] However, the Lower Loup NRD did not receive any reports of well issues during the 2012 drought.

[13] "Drought Impact Reporter Dashboard." National Drought Mitigation Center, University of Nebraska. https://www.arcgis.com/apps/dashboards/46afe627bb60422f85944d70069c09cf

[14] Laukaitis, Algis. "State Orders Irrigators to Stop Pumping Water." Lincoln Journal Star, July 13, 2012. https://journalstar.com/news/state-and-regional/govt-and-politics/state-orders-irrigators-to-stop-pumping-water/article_98391404-9487-50b1-9820-323a19f94f42.html.

GROUNDWATER LEVEL IMPACTS

While the Lower Loup NRD did not receive reports of well issues, the drought of 2012 clearly affected water levels across the district. When considering extreme drought scenarios, this event demonstrates the hazard's ripple effects. Figure 15 shows the changes in water levels from 1982 until 2013.

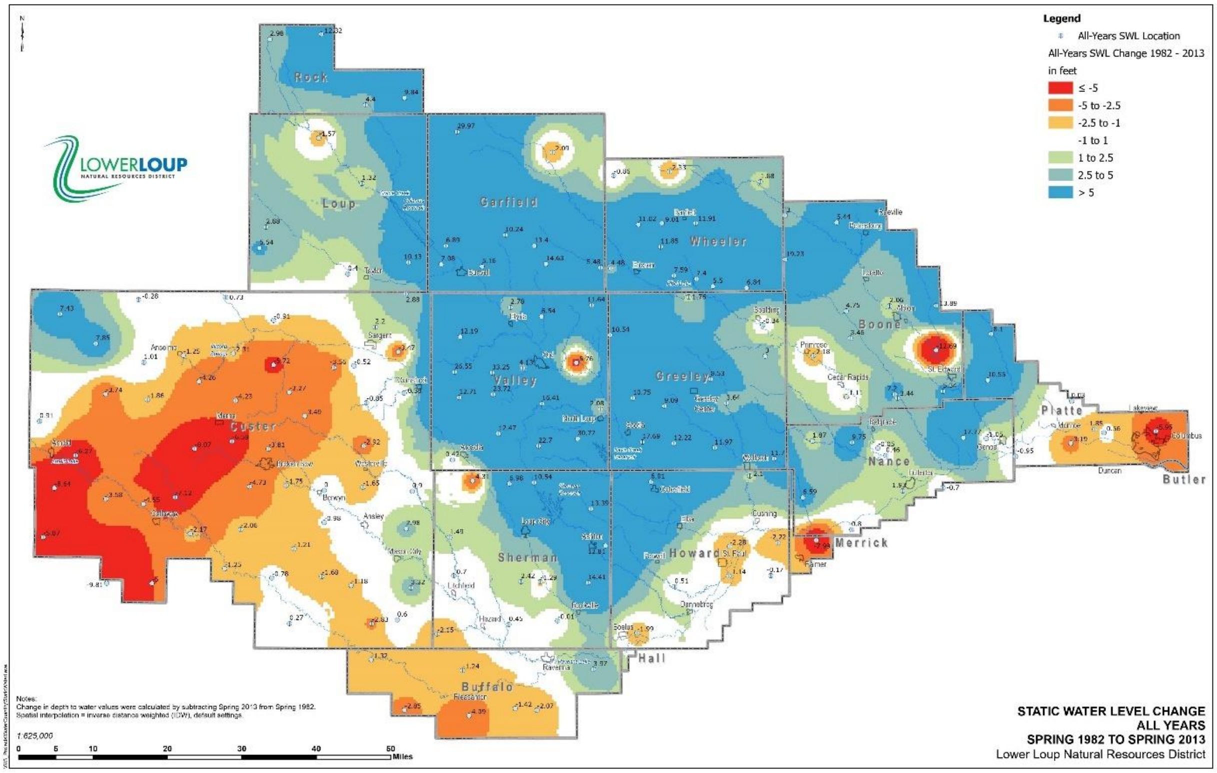


Figure 15: Groundwater Level Change Map (1982 – 2013)

STREAMFLOW IMPACTS

Because the Lower Loup NRD is comprised of diverse landscapes, each region can experience unique drought impacts. Table 8 summarizes information on all the stream gages located within the NRD.

Table 8: Stream Gages within the Lower Loup NRD

Stream Gage	Nearest City	Active	Owner	Years Operable
Beaver Creek	Genoa	Yes	USGS	1940
Beaver Creek	Loretto	Yes	DNR	1944
Calamus River	Harrop	Yes	DNR	1932
Calamus River	Burwell	Yes	DNR	1940
Cedar	Spalding	Yes	DNR	1945-1953, 1957-present
Cedar River	Fullerton	Yes	DNR	1931-1932, 1940-present
Loup River	Columbus	Yes	DNR	1894-1915, 1931, 1933-1978, 2008-present
Loup River Power Canal	Genoa	Yes	USGS	1937
Loup River Power Canal Return	Columbus	Yes	DNR	2000
Middle Loup River	St. Paul	Yes	USGS	1928
Middle Loup River	Rockville	Yes	DNR	1955-1964, 1967-1975, 2015-present
Mira Creek	North Loup	Yes	DNR	1979
Mud Creek	Sweetwater	Yes	DNR	1946
North Loup River	St. Paul	Yes	USGS	1928
North Loup River	Taylor	Yes	USGS	1936
North Loup River	Ord	Yes	DNR	1936-1938, 1948-present
South Loup at Arnold	Arnold	Yes	USGS	2010
South Loup River	Saint Michael	Yes	USGS	1943
Turkey Creek	Dannebrog	Yes	DNR	1966
Burwell-Sumter Canal	Burwell	No	DNR	1939-present
Calamus Fish Hatchery Inlet	Calamus Reservoir	No	DNR	1994-present
Canal No. 1 Pump	Sargent	No	DNR	1987-present
Canal No. 2	Sargent	No	DNR	1938-present
Canal No. 3	Comstock	No	DNR	1938-present
Canal No. 4	Arcadia	No	DNR	1986-present
Canal No. 4	Comstock	No	DNR	1938-present

Farwell Main Canal	Sherman Reservoir	No	DNR	1964-present
Farwell Sherman Feeder	Comstock	No	DNR	1963-present
Farwell South Canal	Sherman Reservoir	No	DNR	1965-present
Fullerton Canal from Davis Creek	North Loup	No	DNR	1992-present
Inlet to Davis Creek Res.	North Loup	No	DNR	1991-present
Kent Canal from North Loup	Taylor	No	DNR	1995-present
Middle Loup Canal No. 1	Sargent	No	DNR	1938-present
Mirdan Canal	Calamus Reservoir	No	DNR	1987-present
Ord-North loup Canal	Ord	No	DNR	1939-present
Platte River	Duncan	No	USGS	1895-present
Shell Creek	Columbus	No	USGS	1947-present
Sherman Reservoir	Middle Loup River	No	Farwell Irrig. District	1963-present
Taylor-Ord Canal	Taylor	No	DNR	1939-present
Taylor-Ord Canal Inlet	Elyria	No	DNR	1989-present
Taylor-Ord Canal Outlet	Elyria	No	DNR	1989-present

Low streamflow levels harm aquatic life, wildlife, natural habitat, and the communities near them. Stream gages from regionally diverse streams were selected to show the differences in stream flow during the 2012 drought as compared to 2020. Observations (discussed below) were made using the following stream flow gages (note that in corresponding streamflow figures, the y-axis values are not the same, as they represent diverse discharge levels):

- South: South Loup River at Saint Michael (USGS 06784000)
- West: South Loup River at Arnold (USGS 06781600)
- East: Loup River near Genoa (USGS 06793000)
- North: North Loup River at Taylor (USGS 06786000)

A few general observations can be seen in all the stream gages:

- Each stream experienced severely reduced flows during the 2012 drought, even leaving a dry riverbed near Saint Michael and Genoa several times.
- The 2020 streamflow readings offer higher discharge levels
- Maximum discharge levels between the two years were offered stark contrasts:
  - In 2020 the maximum discharge amounts were able to leap high above their minimum measurements.
  - In 2012, the drought kept even the maximum discharge levels barely above the minimum discharge levels, indicating the importance that rainfall has on these largely groundwater derived streams.

Data from the southern portion of the Lower Loup NRD, the South Loup River stream gage at Saint Michael, Nebraska, illustrates the impact of drought on streamflow (Figure 16). The Saint Michael gage from the drought summer of 2012 and the summer of 2020 are markedly different, even with normal variations in flow.

As the Saint Michael stream gage readings indicate, in the summers of both 2012 and 2020, the discharge levels of the South Loup River varied. The 2020 readings show significantly more cubic feet per second (cfs) of streamflow, as well as higher levels of maximum discharge, topping out around 1,800 cfs in May, and not dipping below 200 cfs. In contrast, 2012 summer readings did not reach much above 500 cfs at maximum discharge, and instead, steadily declined until the South Loup River at Saint Michael ran dry near the end of July.

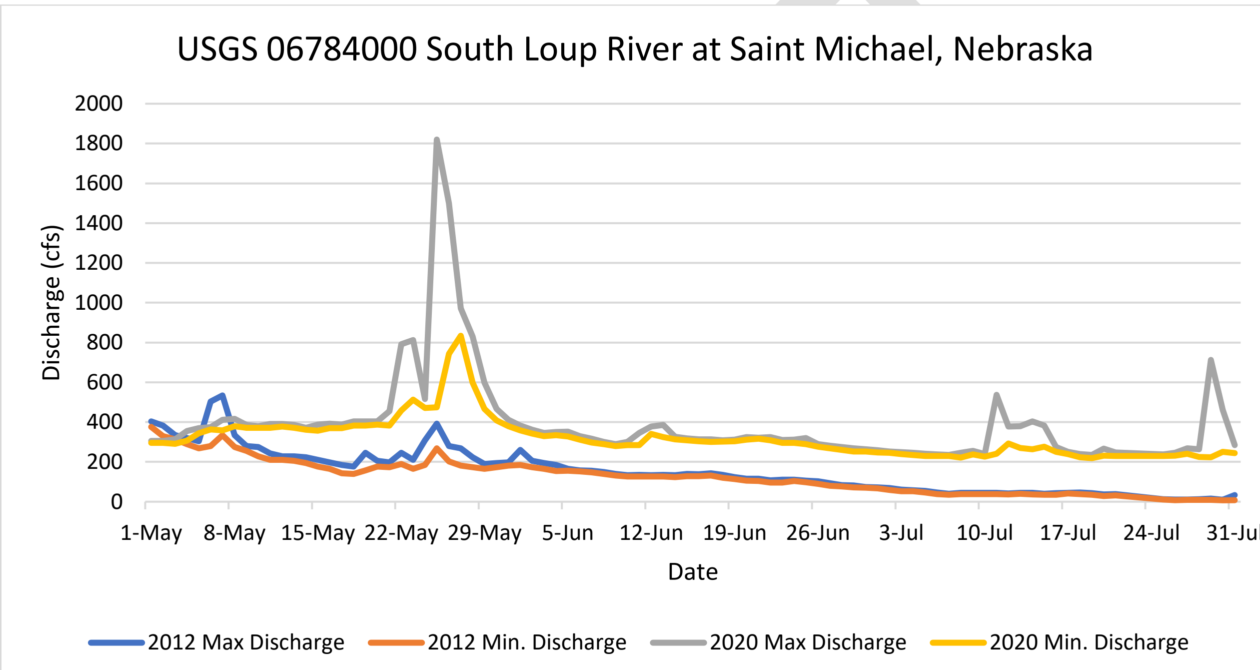


Figure 16: Saint Michael Stream Gage

On the Lower Loup NRD's western edge, the South Loup River stream gage at Arnold, Nebraska, shows streamflow levels significantly lower than at Saint Michael (Figure 17). However, the summer 2012 readings again show a slow decline in discharge, and the 2020 readings, while not drastically higher, are more dynamic than at Saint Michael.

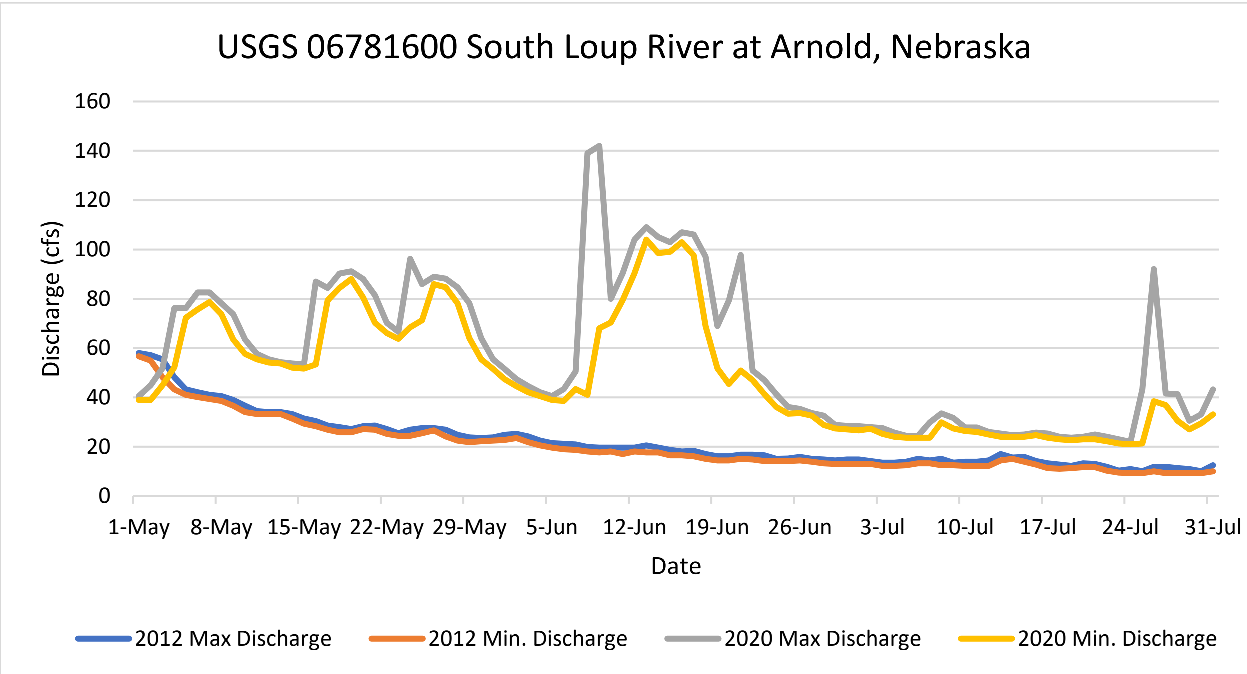


Figure 17: Arnold Stream Gage

The Loup River at Genoa, Nebraska, follows a similar discharge pattern as the Arnold stream gage, with 2012 flows from the Loup River starting relatively high, but still eventually dropping down near zero as summer progressed (Figure 18). 2020 flows at Genoa are significantly lower than stream gages, but still show much higher, and more frequent, discharge peaks than in 2012. Near the end of May 2020, maximum discharge levels towered above 12,000 cfs.

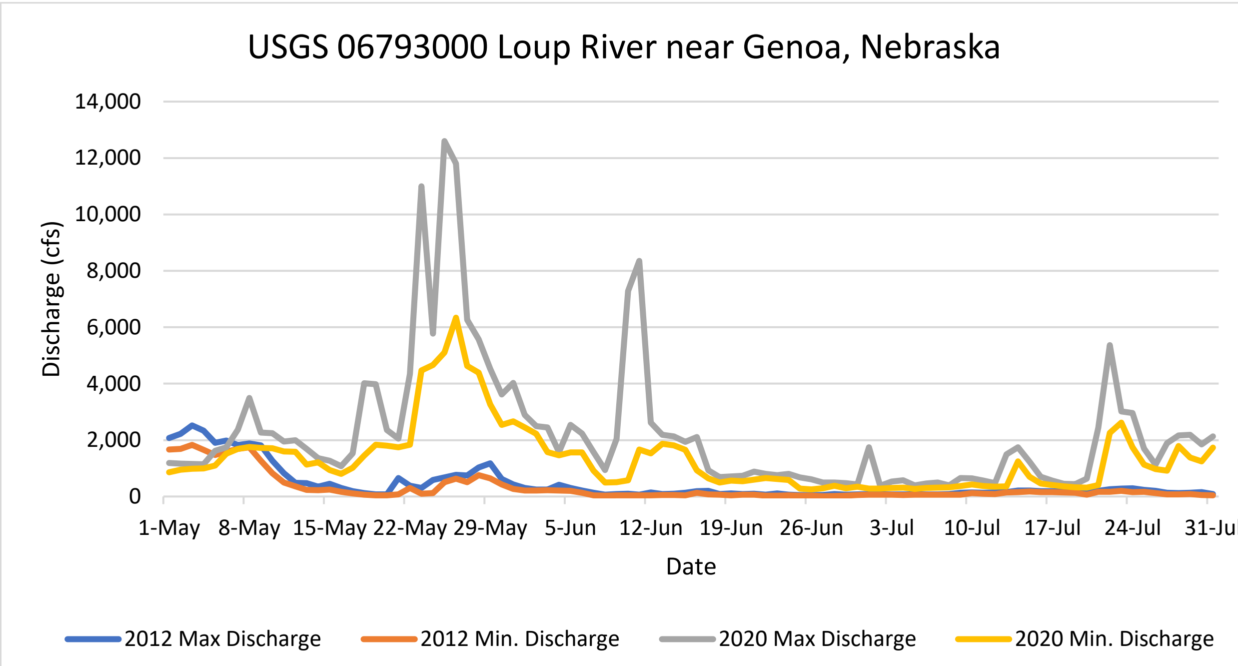


Figure 18: Genoa Stream Gage

Finally, near Taylor, Nebraska, in the northern portion of the Lower Loup NRD, the North Loup River saw more consistent flows in the summer of 2012 (Figure 19). Although the amount of discharge gradually decreased, flows did not bottom out. Streamflow measurements during the summer of 2020 varied, similar to the other featured stream gages in the district. In June, maximum discharge levels jumped above 3,250 cfs.

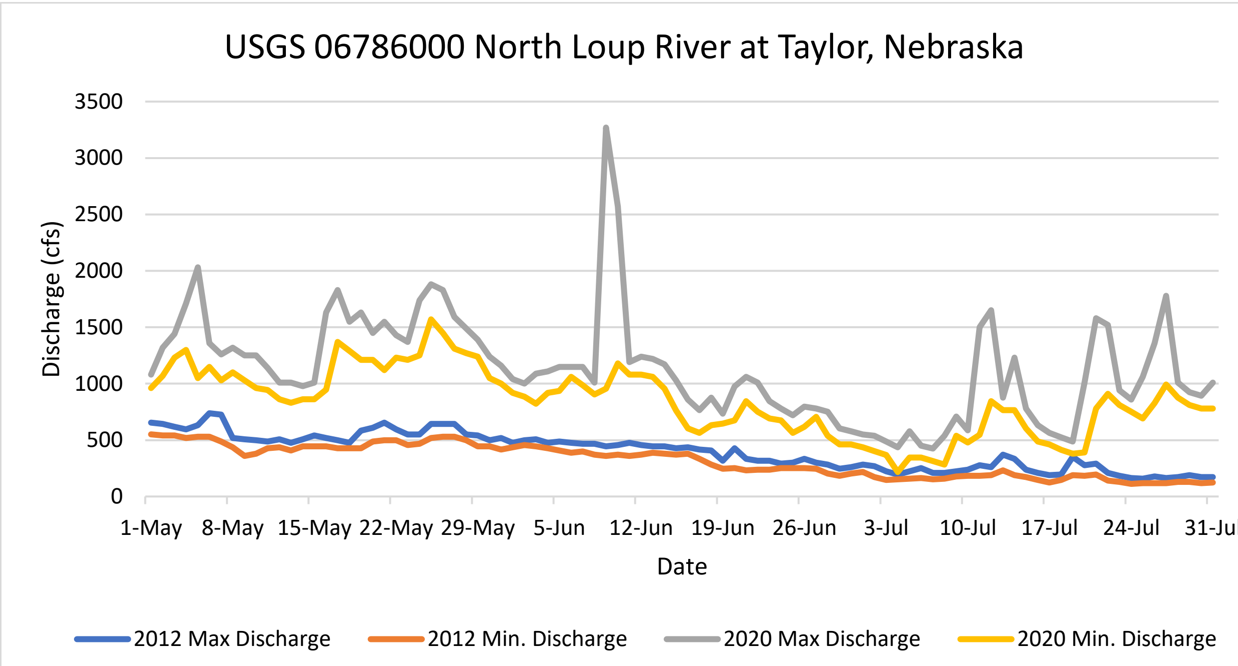


Figure 19: Taylor Stream Gage

COSTS OF DROUGHT

Drought's consequences make it one of the costliest hazard events. According to the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI), there have been 27 billion-dollar-disasters in the United States attributed to drought since 1980. Table 9 shows the damage that drought causes in the Lower Loup NRD each year. This table does not include losses from displacement, functional downtime, economic loss, injury, or loss of life.

Table 9: Average Annual Drought Damages Across the Lower Loup NRD

Total Property Loss[1]	Average Annual Property Loss[1]	Total Crop Loss[2]	Average Annual Crop Loss[2]
$34,000,000	$1,360,000	$288,729,299	$14,436,465

Source: 1 Indicates the data is from NCEI (January 1996 to June 2020); 2 Indicates data is from USDA RMA (2000 to 2019)

4.03 FUTURE PROBABILITY OF OCCURRENCE AND VULNERABILITY ASSESSMENT

The probability for future drought events was calculated by the previous number of months in drought divided by the total months on record. The Lower Loup NRD area experienced drought 444 out of 1,504 months on record; resulting in a 29.5% chance of drought occurring each month within the Lower Loup NRD. However, according to the University of Nebraska-Lincoln report *Understanding and Assessing Climate Change: Implications for Nebraska*, the State of Nebraska can expect an increase in drought frequency and severity in the future.

As drought is a normal, recurrent feature of climate, the entirety of the area is susceptible to its impacts. However, there are some areas, industries, and populations that may experience greater impacts due to the vulnerabilities described below.

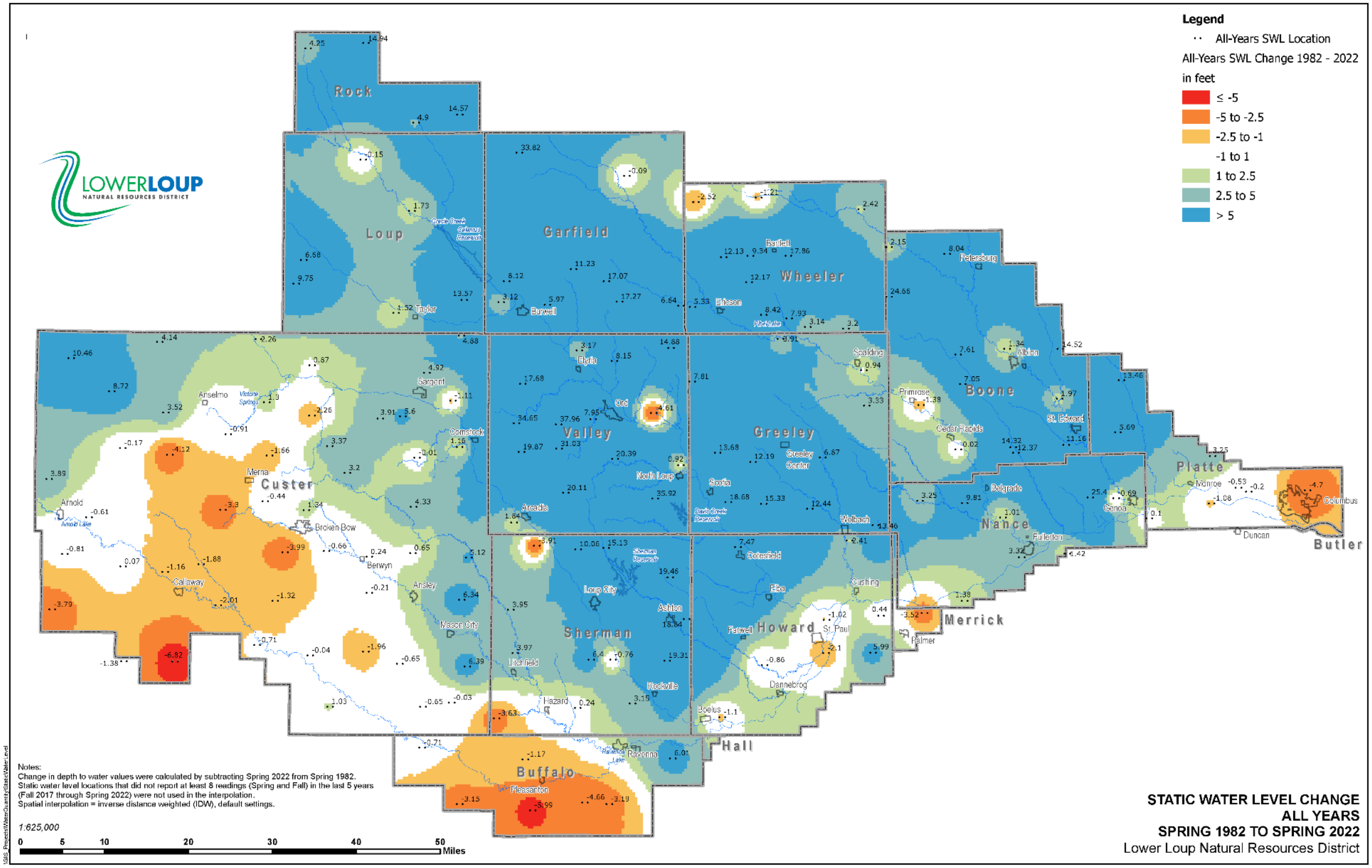
4.04 WATER QUANTITY CONCERNS

Drought conditions have a major impact on water quantity conditions for both surface water and groundwater. The effects of drought can be especially difficult on areas where there are already water quantity concerns. In 2002, the Lower Loup NRD created ten water quantity areas to monitor groundwater levels. These water quantity areas are classified by phase depending on the water quantity. These ten water quantity areas are expected to be updated to match the new drought zones from this report.

Groundwater levels in 1982 have been used by NRD as the benchmark year to compare groundwater level changes. In 2022, the Lower Loup NRD collected readings from 454 irrigation and monitoring wells during the annual spring static water collection. These data can be used to show accumulated change in groundwater levels from 1982 to 2022. While there are no overappropriated or fully appropriated areas within the Lower Loup NRD, these data underscore how drastic the drought effects of 2012 were.

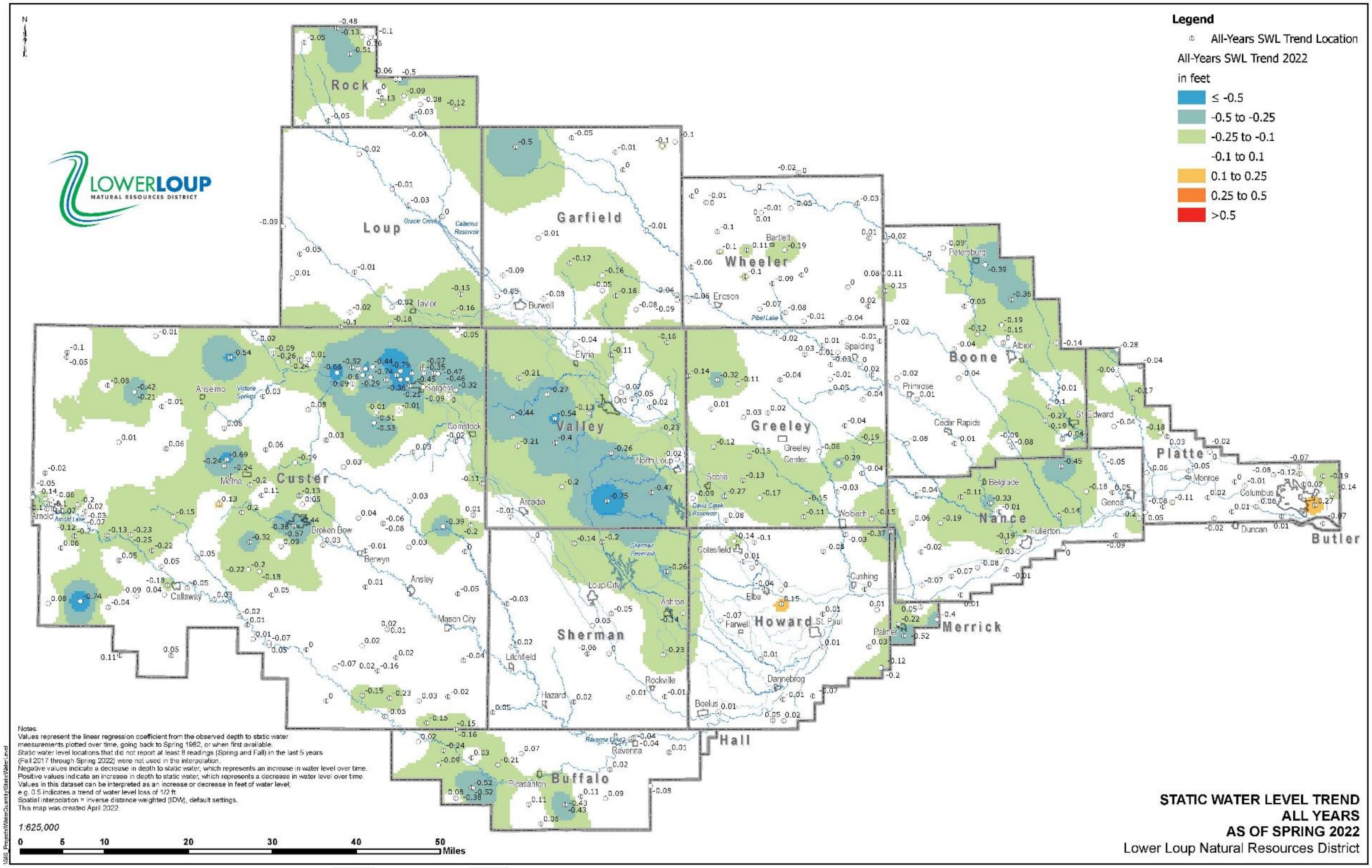
Based on 2022 well sampling, the following observations can be made:

- The largest concentration of decreasing water levels is in southern Custer and northern Buffalo Counties, which is consistent with historical readings (Figure 20). Two declines of six+ feet were located south of the South Loup River, one near Callaway and one near Pleasanton. However, there have been some major increases in water levels (30+ feet) in Valley County.
- The overall trend across the NRD shows static water levels increasing (Figure 21). However, Custer County, northern Buffalo County, and eastern Platte County have seen declines in static water level.



Source: Lower Loup NRD

Figure 20: Static Water Level Changes (1982-2022)



Source: Lower Loup NRD

Figure 21: Static Water Level Trends (1982-2022)

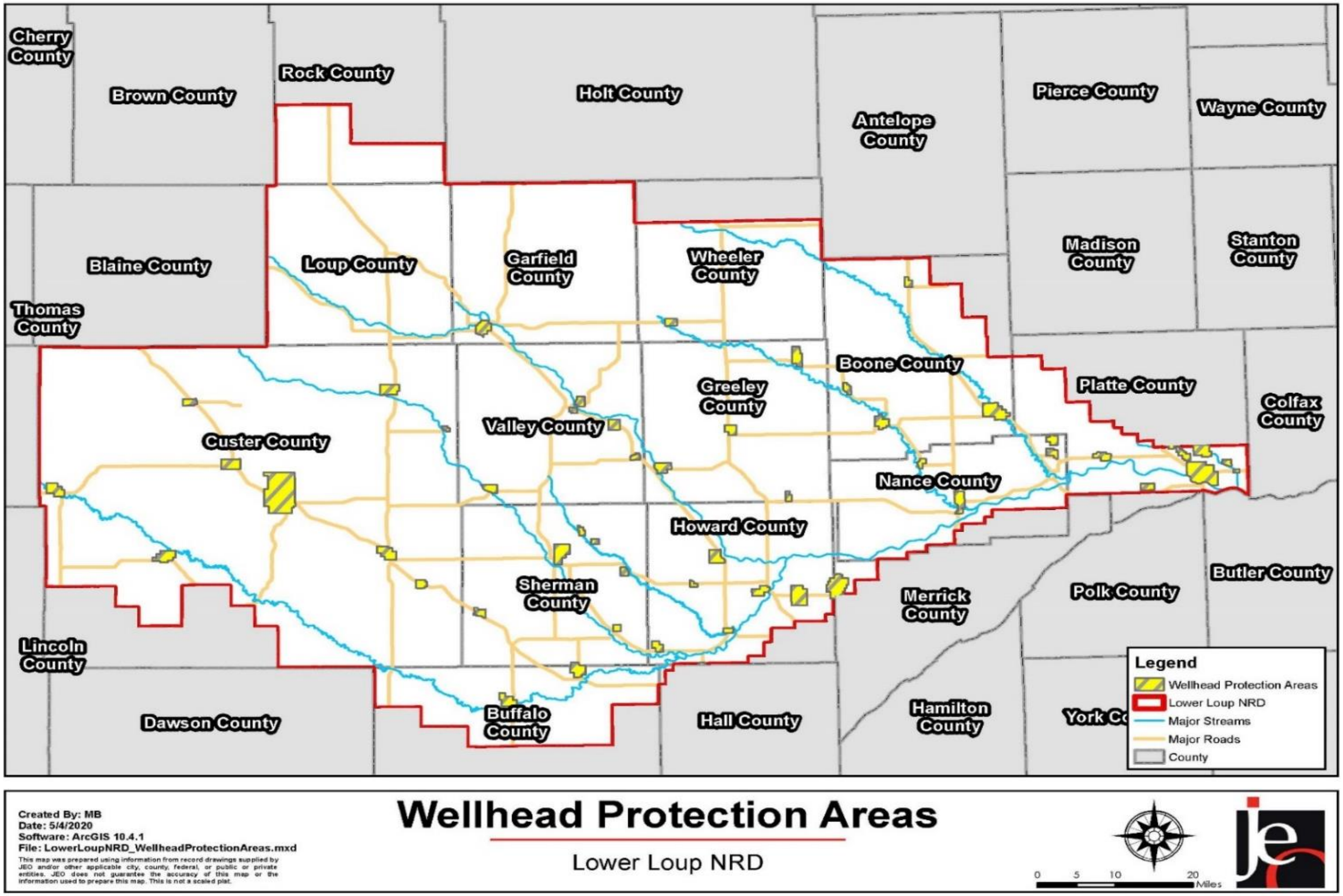
Stream depletion is the reduction in the flow rate as a result of pumping in an aquifer that is hydraulically connected to a river. The district uses Stream Depletion Factor (SDF) to represent the percentage of impact the pumping of a theoretical well in each section would have on the baseflow to a stream over a 50-year time period. The closer a section is to a stream, the higher the impact. The State of Nebraska considers anything over "10% depletion, over a 50-year time period" to be hydraulically connected to a surface water source.

Stream depletion is an important factor in determining the allocation of irrigation acres, as well as the sustainability of water resources in the region. Analyzing static water level changes as well as stream depletion can identify areas within the region that have an increased vulnerability to drought impacts. Further information can be found in the Phase 3 SDF study for the Elkhorn and Loup Basins conducted by the USGS.

4.05 WATER QUALITY CONCERNS

Water quality concerns are often exacerbated under drought conditions because contaminants can become more concentrated in a diminished water supply. Additionally, Nitrates are subject to increased mobility through groundwater due to higher levels of irrigation demand and pumping during times of drought. The Lower Loup NRD has created 30 groundwater quality management areas to monitor and manage groundwater quality. There are three potential phases which can be used to manage those activities affecting groundwater quality.

Wellhead protection areas have been mapped across the district (Figure 22). A wellhead protection area is defined by the geographic area (and flow direction) contributing water to the well or well field of a municipal water system. Maps are created for each community/public water system within this delineated area, which also include the estimated direction and time-of-travel of the groundwater as it flows towards the wellhead. Identifying the wellhead protection area allows a community to proactively protect and manage the source of community drinking water.



Source: NDEE, 2020

Figure 22: Wellhead Protection Areas

4.06 ECONOMIC CONCERNS

Agriculture is a major industry and economic driver within the Lower Loup NRD. Drought can cause significant economic impacts in agriculturally based economies. According to the USDA Risk Management Agency (RMA), drought accounted for $288,729,299 in crop losses within the Lower Loup NRD from 2000 through 2019. Reduced income for farmers ripples into other sectors, as their ability to purchase goods and services is reduced. The State of Nebraska's economic status is heavily influenced by the Lower Loup NRD region, with agricultural production in the area accounting for $4,502,538,000 of the state's economy according to the 2017 US Census of Agriculture. For additional information on the agricultural sector's impact on the economy in the Lower Loup NRD, see Appendix B.

Outdoor-based recreational activities can also be hard hit when drought occurs. Specifically, in the Lower Loup NRD, Residents currently enjoy water-based recreation like fishing and boating in reservoirs within the district (Calamus, Davis Creek, Sherman). Other businesses and industries can also be impacted by drought, particularly if they are water-intensive, which are particularly vulnerable. Within the Lower Loup NRD, examples of these include ethanol plants, power plants, meat production, dairy production, and breweries. Finally, it is also important to point out that preparing for drought in the Lower Loup River Basin would also likely result in positive water supply effects on the downstream Lower Platte River Basin.

4.07 SEASONAL VULNERABILITIES

Seasonal vulnerabilities related to water availability and high-water demand exist across the state. The Lower Loup NRD area will also be more vulnerable to drought during these periods. These seasonal vulnerabilities may impact when a drought stage is declared. Agricultural irrigation is one key consideration directly related to monitoring and managing water use and water needs for the Lower Loup NRD. The phenology for crop development provides insight regarding times of increased water demand.

The development cycle for corn crops (Figure 23) provides an important illustration of this concept, as corn is more water intensive than the other primary crops for the region. The ideal time to sow crops in the region ranges from April 25 to May 10. Clearly, moisture is necessary throughout the growth cycle, but the most critical times for adequate soil moisture are during the pre-tasseling and tasseling phases. Critical moisture management times for 113-day maturing corn occur between weeks 10 and 15. If the assumed sowing date is May 1, critical periods with adequate soil moisture for would be during July and August. While monitoring water supplies throughout the year is helpful, it is most important for agricultural, municipal, commercial, and industrial water users to manage and develop contingency plans in case of shortage, during periods of peak demand.

The amount of irrigation required to bring crops to their full yield potential is primarily driven by rainfall and varies based on location within the Lower Loup NRD. The northwestern portion of the NRD requires a much higher level of net irrigation to produce corn (Figure 24). Data in this map is based on NeDNR's Net Corn Crop Irrigation Requirement Map, which identifies the net amount of irrigation water that must be applied for a full yield of an irrigated corn crop.[15]

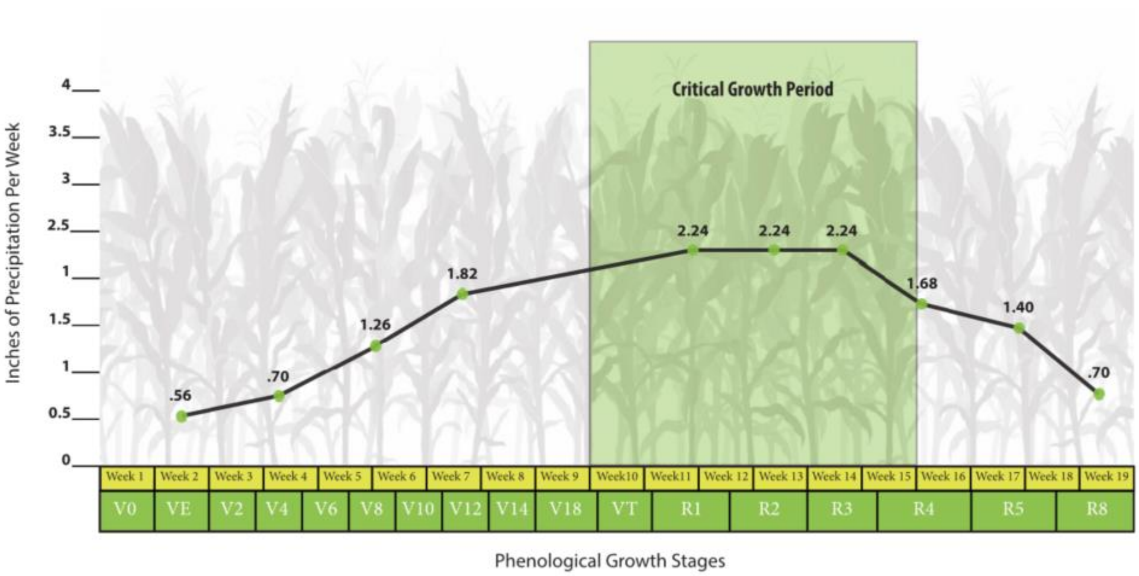
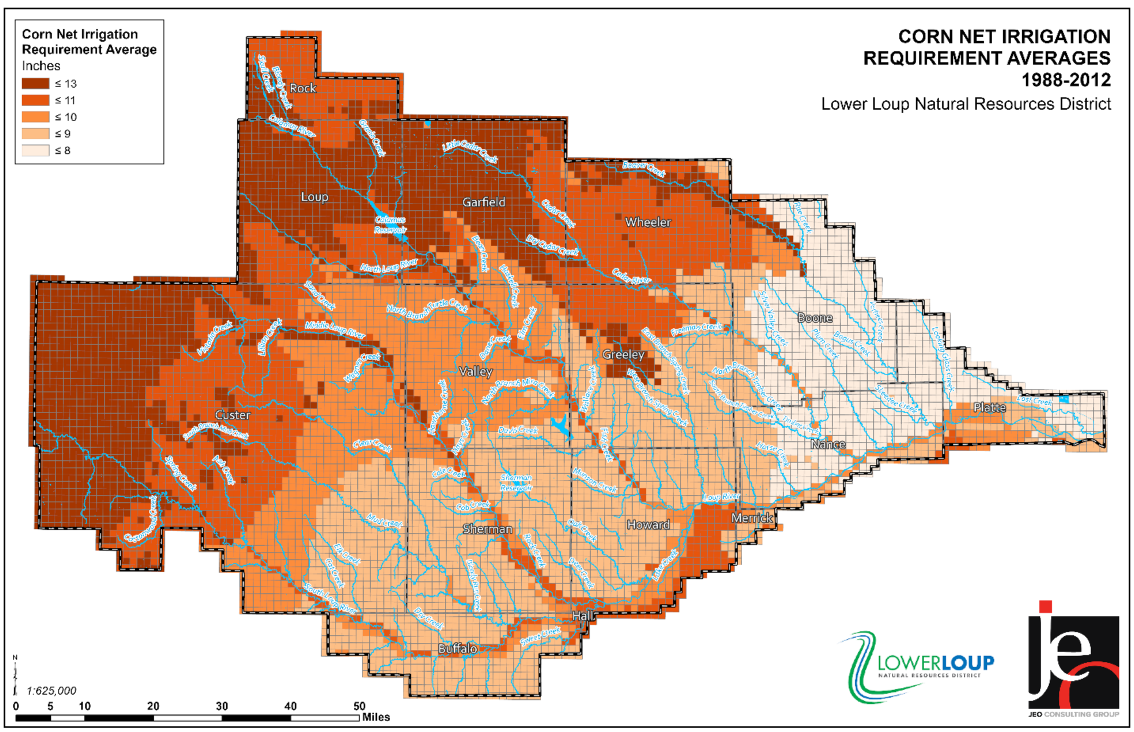


Figure 23: Example of Crop Water Use by Growth Stage (113-Day Maturity Corn)



Source: NeDNR, Lower Loup NRD

Figure 24: Average Net irrigation Requirement for Corn

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[15] Martin, D., 2005, Net Irrigation Requirement: A Summary of the CROPSIM Modeling Performed to Develop the Net Corn Crop Irrigation Requirements Map for the State of Nebraska.

4.08 THREATENED OR ENDANGERED SPECIES

There are 13 species with ranges in the Lower Loup NRD that are on either the state or federal threatened and endangered species list:

- Small White Lady's Slipper
- Sturgeon Chub
- Western Prairie Fringed Orchid
- American Burying Beetle
- River Otter
- Blowout Penstemon
- Finescale Dace
- Piping Plover
- Rufa Red Knot
- Interior Least Tern
- Northern Long-eared Bat
- Northern Redbelly Dace
- Whooping Crane

Although drought will impact each species differently, in general, species will become more vulnerable during drought conditions. When a drought occurs, critical habitat and food supplies may become damaged or scarce. Certain species may also find it difficult to find adequate supplies of drinking water. Piping Plovers, the River Otter, the American Burying Beetle, and Whooping Cranes are all especially vulnerable to drought conditions affecting their habitat.

4.09 HEALTH IMPLICATIONS

In periods of limited rainfall, water bodies may become reduced in size, causing them to become stagnant. Inadequate water supplies can also cause people to collect rainwater which can lead to additional bodies of water. These stagnant water bodies provide an excellent breeding ground for certain types of types of mosquitoes (e.g., *Culex tarsalis*) which carry West Nile Virus. Outbreaks of West Nile Virus, which is transmitted to humans via mosquitoes, have an increased likelihood of occurring during drought conditions.[16]

Drought conditions may impact air quality causing acute issues as well as negatively impacting individuals who have certain chronic health conditions such as asthma. Fire and dry soil can increase the number of particulates in the air such as dust, pollen and smoke. These substances can increase the risk for acute respiratory infections like bronchitis and bacterial pneumonia.[17]

[16] "Drought and Health." Centers for Disease Control and Prevention. August 2017. https://www.cdc.gov/nceh/drought/default.htm
[17] "Drought and Health." Centers for Disease Control and Prevention. August 2017. https://www.cdc.gov/nceh/drought/default.htm

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SECTION 5. DROUGHT MONITORING AND RESPONSE PROTOCOL

5.01 INTRODUCTION

Every drought event is different with varying impacts. Identifying and responding effectively to droughts as they occur is both technically and politically challenging. A pre-established plan, developed before a drought occurs, can help ease these pressures and enable decision makers to respond in an informed, predictable, and transparent way.

This section of the plan establishes a framework for drought monitoring and response for the Lower Loup NRD to follow. Modifications and updates to this framework may be necessary as it is implemented, and as unique situations arise. The planning team recommends that after each drought event the Lower Loup NRD review how the framework was utilized and, as applicable, update it based on lessons learned.

The Lower Loup NRD Drought Monitoring and Response Protocol (protocol) identifies the specific tools the NRD will utilize to monitor drought conditions. The planning team identified specific conditions (triggers) to assist the Lower Loup NRD in declaring the severity and extent of the drought. Each drought level has corresponding management actions. To enhance the Lower Loup NRD's response efforts, the district has been divided into smaller zones to allow for a more nuanced approach to declaring drought levels and taking management actions. Additionally, based on stakeholder feedback during the development of this plan, the protocol includes the formation of a stakeholder group to provide local feedback and enhance agency coordination during droughts.

Importantly, it should be clarified again that the ultimate responsibility and authority for declaring drought levels are the responsibility of the Lower Loup NRD Board of Directors. This protocol acts as a guide to help make those decisions.

DEFINITION OF TERMS

The following list defines terms utilized within the protocol, which are discussed later in more detail:

- **Drought Zone (DZ):** Twenty zones have been mapped based on the unique features found across the Lower Loup NRD, which is a large and diverse district. At any given time, each zone could be in a different drought level declaration, allowing for nuanced and locally informed management actions, rather than a one-size-fits-all approach. To provide further management capabilities, the Lower Loup NRD reserves the right to further dive DZs into sub-zones, on an as needed basis.
- **Drought Level (DL):** Five drought levels have been identified for the Lower Loup NRD. While these levels are based on the US Drought Monitor, for purposes of this drought plan, the drought levels have been modified based on the specific water resources and other unique aspects across the district.
- **Drought Indicators (DI):** Both primary and secondary drought indicators, or monitoring tools, have been identified to provide monitoring data on drought levels within the district

at any given time. These indicators are based on the status of groundwater/surface water readings, and regional short-term and long-term drought forecasting models.

- **Drought Advisory Group (DAG):** This group will comprise local stakeholders and government agency staff and assemble during specific times of drought. The DAG will provide supplementary input and review drought conditions and management actions for the Lower Loup NRD to consider and help to enhance interagency coordination and response.
- **Triggers:** These are a set criterion that, when reached, may necessitate a change in drought level declarations. The triggers are based on the primary drought indicators, but the Board of Directors has discretion on which drought indicator to base their decision.
- **Decision Dates:** Annual dates by which the NRD will make declarations on drought levels. These are set to allow adequate time for producers and other sectors impacted by drought and management actions to adjust their own management decisions.
- **Management Actions:** These are specific short- and long-term actions the Lower Loup NRD may take based on the drought level for each individual drought zone.

5.02 DROUGHT ZONES

Twenty drought zones have been identified (Figure 25) based on multiple input factors listed below:

- Soil type, rainfall, net irrigation requirement, irrigated acres density, Elkhorn-Loup Model Stream Depletion Factor, High Plains Aquifer (HPA) saturated thickness, HPA transmissivity, GW surplus/mounding, topographic region, river basins, and stream locations.
- Consistency with existing district management: The drought zones are similar to the existing 10 Groundwater Quantity Management Areas. The planning team recommends that the drought zones replace the existing Groundwater Management Areas in a future version of the Lower Loup NRD Groundwater Management Plan.

To provide further flexibility for management actions, a DZ can also be further subdivided (as needed) into sub-zones.

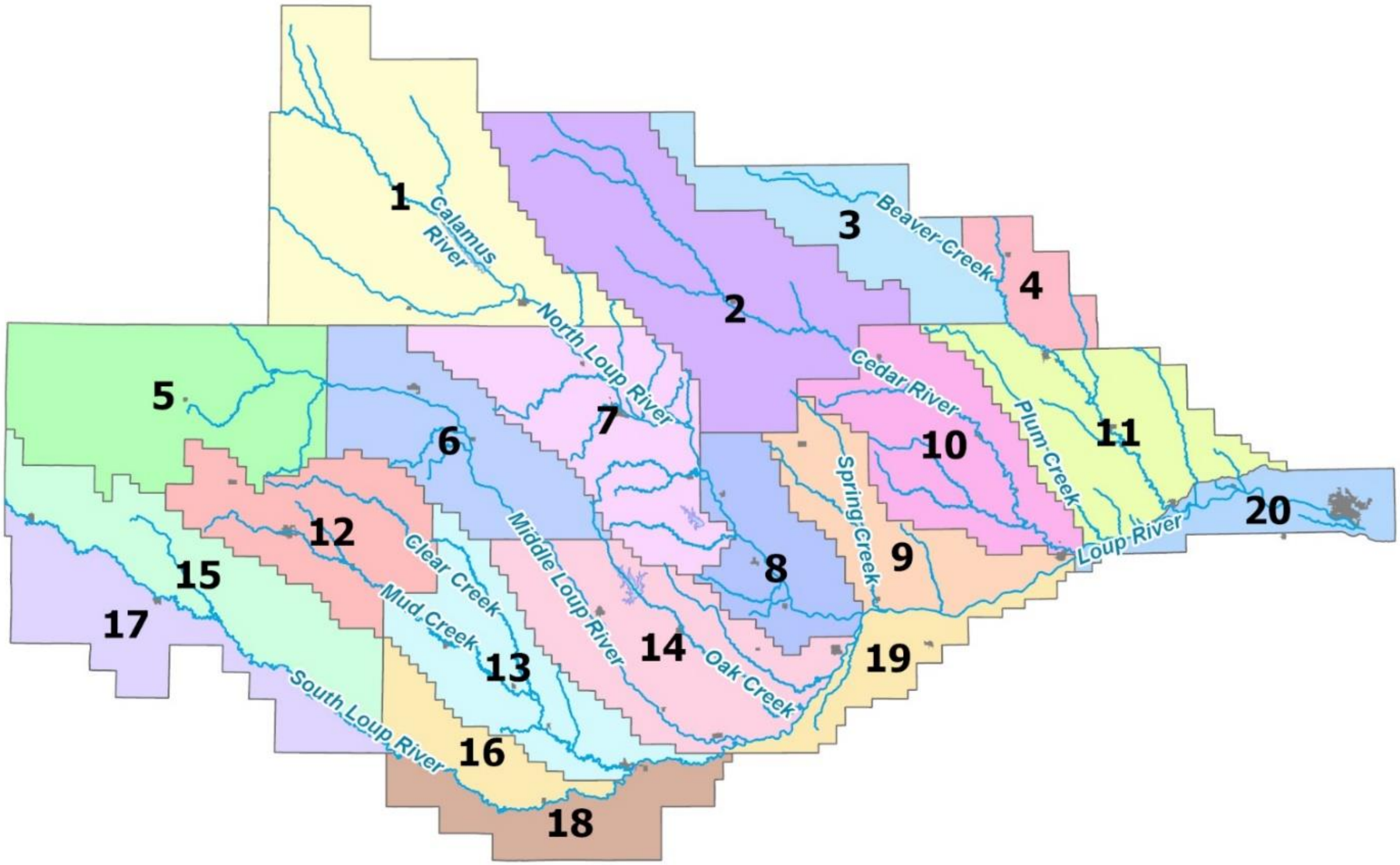

Figure 25: Proposed Drought Management Zones for Lower Loup NRD

5.03 DROUGHT LEVELS

Five drought levels have been identified for the Lower Loup NRD. While based on the US Drought Monitor, for purposes of this drought plan, the drought levels have been modified based on the unique water resources and features across the district.

At all times, the "default level" of drought within the Lower Loup NRD is set to DL00 (Monitor), unless an elevated level of drought is declared. Following the declared end of any drought, the drought level of each DZ will be returned to DL00 (Monitor).

00) Monitor
0) Watch
1) Moderate
2) Severe
3) Extreme

5.04 DROUGHT INDICATORS

Both primary and secondary drought indicators, or monitoring tools, have been identified to provide monitoring data on drought levels within the district at any given time. These include both regional and local indicators, and short-term and long-term indicators. Data from each monitoring source will be reported (or summarized) unique to each data source, but generally by drought zone when possible.

Lower Loup NRD staff will regularly monitor primary DIs and report on an annual basis (at a minimum). When an elevated drought level is declared, staff will begin reporting Primary DIs on a weekly basis. Once the Drought Advisory Group is activated, Lower Loup NRD staff will begin monitoring secondary DIs with assistance from the DAG.

PRIMARY DROUGHT INDICATORS

A) Regional Short-Term Drought Status
   1) **<u>Tool:</u> US Drought Monitor**
      a. The US Drought Monitor (USDM) relies on experts to synthesize the best available data and work with local observers to interpret the information.
         i. Numeric inputs include: the Palmer Drought Severity Index, the Standardized Precipitation Index, USGS weekly streamflow, and other climatological inputs; the Keech-Byram Drought Index for fire, satellite-based assessments of vegetation health, and various indicators of soil moisture; and hydrologic data, particularly in the West, such as the Surface Water Supply Index and snowpack.
         ii. It incorporates ground truthing and information about how drought is affecting people, via a network of more than 450 observers across the country, including state climatologists, National Weather Service staff, Extension agents, and hydrologists.
      b. Updated map is released weekly, on Thursdays, on [USDM website]

        c. Regional indicator that will be overlaid with Lower Loup NRD Drought Zones and summarized by zone
    2) Other tool: Lower Platte River Drought Contingency Plan online dashboard.

B) Local Long-Term Groundwater Status
    1) **Tool: Lower Loup NRD Annual Spring Static Water Levels (SWL)**
        a. Spring measurements of SWLs over last 25 years, with 80% of the measurements available
        b. Following the year's spring measurements, data will be analyzed **annually by May 1** and used for the next year's status
    2) Consider adding another tool, if needed, like real-time transducers, to supplement the SWLs.
    3) Local indicator will be summarized directly by Lower Loup NRD Drought Zones.

SECONDARY DROUGHT INDICATORS

C) Local Surface Water Status
    1) **Tool: USGS Daily Streamflow Gages**
        a. Daily measurements of USGS gages within Lower Loup NRD using the interactive WaterWatch Streamflow Map or the National Water Dashboard
    2) Local indicator to be summarized by USGS HUC 8 basins, then overlaid with Lower Loup NRD Drought Zones and summarized by zone, such that intersection is >50%. Each HUC 8 basin that intersects the district will have a representative USGS gage, if available, that will be used for reporting streamflow measurements.

D) Local Reporting of Drought Impacts
    1) **Tool: Includes the following issues reported directly to Lower Loup NRD from residents or other stakeholders:**
        a. Within Lower Loup NRD: Well interference, crop impacts, soil moisture, livestock impacts, NeDNR stream gages, water quality issues, community water restrictions, and Loup River streamflows (related to instream flow rights)
        b. Outside Lower Loup NRD: NeDNR stream gages, reservoir / lake levels, snowpack, monthly climate summaries and quarterly reports from the Nebraska State Climate Office, Platte River streamflows at Louisville (related to instream flow rights
    2) A form for identifying and submitting local impacts is available at the Lower Loup NRD and will be made available to the Drought Advisory Group and other residents.

E) Regional Drought Forecasting
    1) **Tool: NOAA's Seasonal Drought Outlook**
        a. The long-term drought forecast will be examined using the online map and assessment.

5.05 DROUGHT ADVISORY GROUP

The Drought Advisory Group will be organized and managed by the Lower Loup NRD. Their purpose is to assist the Lower Loup NRD in information gathering, resource sharing, and identifying mitigation or response opportunities during drought. During the declaration of DLs 2 or

3 (Severe or Extreme) in any one of the DZs within the district, the DAG will be formed and begin to meet periodically to:

- Evaluate secondary DIs,
- Provide input on elevating or downgrading DLs within DZs,
- Provide input on drought management actions, and
- Provide general input to Lower Loup NRD during prolonged drought.

The exact membership of the DAG will be identified when it is formed, however, it will likely consist of the following stakeholders:

- Irrigation districts
- Loup Power District
- Large industries
- Well drillers
- Groundwater irrigators
- Surface water irrigators
- Concerned citizens
- Coordinating government agencies:
    - Cities and villages within Lower Loup NRD
    - Farm Service Agency
    - UNL Extension
    - Local and state emergency management
    - NeDNR
    - National Drought Mitigation Center
- Others as identified

5.06 DROUGHT LEVEL TRIGGERS

Triggers are a set criterion that, when reached, may necessitate a change in drought level declarations. The triggers are based on the primary drought indicators, but the Lower Loup NRD Board of Directors has discretion on which drought indictor to base their decision.

00) Monitor

A) This is considered the "default level" status unless another drought level is declared. The NRD will always be monitoring for drought in the district, which also helps to identify baseline status.

0) Watch

A) Regional Short-Term Drought Status
   i) D0, Abnormally Dry, intensity or higher (D1-4) is >50% coverage calculated in each DZ.

B) Local Long-term Groundwater Status
   i) Static Water Level of majority (>=50%) measurement wells within each DZ at or below 50% of the well's measured SWL range (min to max), over last 25 years.

C) Local Surface Water Status

   - i) N/A for this DL.
- D) Local Reporting of Drought Impacts
   - i) Situational. Consult Lower Loup NRD Board.
- E) Regional Drought Forecasting
   - i) N/A for this DL.

1) Moderate

- A) Regional Short-Term Drought Status
   - i) D1, Moderate, intensity or higher (D2-4) is >50% coverage calculated in each DZ.
- B) Local Long-term Groundwater Status
   - i) Static Water Level of majority (>=50%) measurement wells within each DZ at or below 25% of the well's measured SWL range (min to max), over last 25 years.
- C) Local Surface Water Status
   - i) N/A for this DL.
- D) Local Reporting of Drought Impacts
   - i) Situational. Consult Lower Loup NRD Board.
- E) Regional Drought Forecasting
   - i) N/A for this DL.

2) Severe

- A) Regional Short-Term Drought Status
   - i) D2, Severe, intensity or higher (D3-4) is >50% coverage calculated in each DZ.
- B) Local Long-term Groundwater Status
   - i) Static Water Level of majority (>=50%) measurement wells within each DZ at or below 10% of the well's measured SWL range (min to max), over last 25 years.
- C) Local Surface Water Status
   - i) Streamflows are below 10% of the site's full historical range on the measured day of the year.
- D) Local Reporting of Drought Impacts
   - i) Situational. Consult Drought Stakeholders and Lower Loup NRD Board.
- E) Regional Drought Forecasting
   - i) Situational. Consult Drought Stakeholders and Lower Loup NRD Board.

3) Extreme

- A) Regional Short-Term Drought Status
   - i) D3, Extreme, intensity or higher (D4) is >50% coverage calculated in each DZ.
- B) Local Long-term Groundwater Status
   - i) Static Water Level of majority (>=50%) measurement wells within each DZ at or below 0% of the well's measured SWL range (min to max), over last 25 years; i.e. the minimum SWL within 25 years.
- C) Local Surface Water Status
   - i) Streamflows are at or below 0% of the site's full historical range on the measured day of the year.
- D) Local Reporting of Drought Impacts
   - i) Situational. Consult Drought Stakeholders and Lower Loup NRD Board.
- E) Regional Drought Forecasting
   - i) Situational. Consult Drought Stakeholders and Lower Loup NRD Board.

5.07 DROUGHT DECLARATION GUIDANCE

The following is general guidance for the use of drought indicators during consideration of drought level designations for each drought zone. Additionally, decision dates have been developed in consultation with stakeholders. These are annual dates by which the NRD will attempt to make declarations on drought levels for the upcoming year. This is intended to give adequate time to producers and other sectors, which may be impacted by drought and management actions, as they adjust their own management decisions.

It should be noted that while Lower Loup NRD staff continuously monitor drought indicators and may make recommendations as to drought declarations or management actions, the final authority to implement this monitoring and response protocol is reserved by the Lower Loup NRD Board of Directors, who can also change a designation at any time.

USE OF INDICATORS

- If both primary drought indicators A and B fall into the same or higher drought level 0-3 (Watch-Extreme) within a drought zone, then a composite DL can be assigned to each DZ.
- Secondary drought indicators C-D-E will be evaluated if one of the primary indicators A-B trigger a DL 2 (Severe) in any DZ, and possibly used to level-up a current DL, or even assign a DL to a sub-zone within a zone. The DAG, organized during a triggering of a DL 2, will be consulted regarding use of a secondary indicator to assign a final DL 2-3.
- The exception to these rules is that the secondary drought indicator D, Local Reporting of Drought Impacts, with consultation by the Lower Loup NRD Board, can trigger a DL 0-3 by itself within a DZ or Sub-DZ.

DECISION DATES

- For drought level 3 (Extreme), a final determination will be made by **March 1** to prepare residents for current year management actions.
- For drought levels 0-1-2 (Watch-Moderate-Severe) a final determination will be made by **June 1** to prepare residents for upcoming management actions, specifically, suspending new irrigated acres development (DL 1) and flow meter requirements (DL 2).
- Before assigning final drought levels by the listed dates for the current year, Lower Loup NRD staff will make a recommendation to the Lower Loup NRD Board of Directors to accept the final drought levels.
- If approved by Lower Loup NRD Board, specific management actions related to each final drought level will be implemented in the drought zones for the calendar year.
- The Lower Loup NRD Board of Directors can, at any time, declare a change in a drought level. This gives the board needed flexibility, especially in flash drought situations where a sudden change in drought indicators or triggers can be experienced, or where drought indicators may be delayed in hitting trigger levels by the recommended decision dates.

5.08 DROUGHT LEVEL MANAGEMENT ACTIONS

These are specific short- and long-term actions the Lower Loup NRD may take based on the drought level for each individual drought zone, triggers, and DAG input. Ultimately, the implementation decision rests with the Lower Loup NRD Board of Directors.

00) Monitoring

- Drought-focused communication and public outreach in the district will occur on an as-needed basis.
- Impacts and vulnerability information related to the status of the Lower Loup NRD will be addressed during this time.

0) Watch

- *All actions inherited from DL 00 (Monitoring).*
- Information & education (I&E) activities will begin to emphasize drought and be focused towards impacted drought zones or stakeholders. Information on possible next steps (drought indicators, levels, management actions, etc.) should be provided to help producers make informed decisions.
- Increased media releases and events will take place.
- A new drought-focused newsletter will be created with the help of board members who represent areas impacted by updated drought designation.
- Increase education and outreach to encourage voluntary water conservation and best management practices, like flow meter education, voluntary flow meter installation, soil moisture sensors, and preventative or alternative planting education.

01) Moderate

- *All actions inherited from DL 0 (Watch).*
- Prohibit new irrigated acres development for current year.
- Prohibit transfer of irrigated acres into zone; variances to be considered.
- Prohibit supplemental wells; variances to be considered.

02) Severe

- *All actions inherited from DL 1 (Moderate).*
- Identify members of the Drought Advisory Group.
- Flow meters required for the DZ within the next two years, determined by Lower Loup NRD Board.
- Strongly encourage preventative or alternative planting.
- Urge other jurisdictions that manage water use to enforce their own water restrictions.

03) Extreme

- *All actions inherited from DL 2 (Severe).*
- DAG will meet regularly on drought reporting and status update.
- Water-use restrictions enacted for upcoming season.
    - Fields with flow meters will be allocated for current year.
    - Fields without flow meters will be required to install one within the next two years and will have a percentage reduction in irrigated acres allowed or other

comparable reduction (e.g., end-gun removal, cease gravity irrigation) for current year.

- Additional restrictions will be determined by the Lower Loup NRD Board and based on the net irrigation corn requirement and other available data.

SECTION 6. MITIGATION AND MANAGEMENT ACTIONS

Below are actions, projects, and programs that the Lower Loup NRD is already taking to reduce the negative impacts from drought; both directly or indirectly. Many of these projects serve multiple purposes on top of reducing drought impacts, showing how actions can have wide ranging benefits.

- Annual review and update of Groundwater Management Plan & Annual Groundwater Monitoring
- Flow Meter Cost-Share Program
- Airborne Electromagnetic (AEM) Survey
- Annual budget with $1.5 million allocated for water quantity projects
- Columbus Area Water Resources Assessment Study
- Some water quality projects and plans may also address drought or water quantity, and are discussed in Section 4

6.01 OPERATIONAL AND ADMINISTRATIVE FRAMEWORK

To manage surface and groundwater, the Lower Loup NRD must operate within the framework provided by the State of Nebraska. Below is a brief explanation of some of the frameworks for surface water administration and groundwater allocation.

SURFACE WATER ADMINISTRATION

The NeDNR governs the use of surface water in the State of Nebraska and has the authority to restrict its use. The state governs surface water through the prior appropriation doctrine which states that the oldest water rights holders get their full allocation of water before any junior rights holders can get their water.

As drought conditions develop, a senior water rights holder can contact the local NeDNR field office and request a hold to be placed on junior rights holders because the senior water right holders are not receiving their full allocation. The field office will then analyze the situation and determine how they can adjust water consumption to ensure that the senior rights holder will be able to get the water they need. If the senior water rights holder, or appropriator, is in fact not receiving the allocated amount, other surface water users whose priority date is junior will be required to cut back, or cease usage, in order to satisfy the senior appropriator.

GROUNDWATER ALLOCATION

The Lower Loup NRD is authorized by the state to manage and govern groundwater within the district per the Nebraska Revised Statute 46-739. This authority provides the NRD with the means to restrict the use of groundwater, if conditions warrant. As drought conditions develop, the Lower Loup NRD will ensure that groundwater is not being overpumped, thereby causing potential long-term harm to the aquifer.

The Lower Loup NRD will consider the climatic information from the previous year, current year, and any future forecasted drought conditions when determining any changes to the groundwater allocation for the upcoming year, as applicable.

6.02 MITIGATION ACTIONS

This section outlines drought mitigation actions identified during the development of this plan through stakeholder input and review of other planning documents, such as the 2022 Lower Loup NRD Multi-Jurisdictional Hazard Mitigation Plan. No specific priority, timeline, or costs have been identified for these actions. Those would be developed as projects are selected and detailed project plans developed.

These actions are presented not as a plan of action, but as a "playbook" of options and ideas for the Lower Loup NRD to consider during plan implementation to increase drought resilience.

PUBLIC INFORMATION AND EDUCATION (I&E) ACTIONS

Public outreach and education are a cornerstone of the implementation of this plan. This multifaceted education approach includes targeting multiple stakeholders with relevant information, attending various events, and distributing information in various formats. Two general types of actions were identified: 1) those that would be completed to assist in the general usability or execution of this plan, and 2) those that would be completed as resources to be used or delivered to stakeholders during specific drought level designations.

The Lower Loup NRD currently has an education and outreach budget of approximately $160,000 annually. The Lower Loup NRD utilizes their website, a monthly newspaper column, social media, and newsletters to conduct outreach efforts. It is anticipated that most of these actions could be completed with current I&E staff or resources that the Lower Loup NRD already has and/or with the support of other partners such as UNL Extension.

The following actions were identified:

1. Develop materials specifically related to this plan and the monitoring and response protocol, such as a "simplified" or "visually-driven" brochure that could be made available at events or available as a handout to stakeholders.
2. Create an executive summary poster that can be hung in the board room, offices, and posted online.
3. Obtain, update, or develop new materials (specific to the Lower Loup NRD) about drought and its many cascading impacts such as wildfires, water shortages, or increased flood risks following droughts.
4. Work with UNL Extension, National Drought Mitigation Center, or other stakeholders to provide I&E materials targeted to specific sectors (ranchers, irrigators, communities, etc.). This may include utilizing existing materials, modifying those to be more relevant to the Lower Loup NRD, or creating new materials. Examples of existing materials can be found here:
    a. https://droughtresources.unl.edu/

   b. https://www.ag.ndsu.edu/publications/livestock/strategies-for-managing-drought-in-the-northern-plains/r1819.pdf

5. Make stakeholders aware of existing resources that help them deal with an ongoing drought or impacts from drought. This could be a targeted action when Lower Loup NRD begins to declare elevated drought levels or even as a follow-up action after a drought passes.
   a. Examples include drought assistance funding, tax programs, emergency hay resources, herd culling, etc.
6. Develop materials, hold workshops, or field days that educate producers on various irrigation best management practices or other water management strategies.
7. Organize a yearly “Drought Awareness Week” which would include a “blitz” of media coverage, outreach events and distribution of materials to raise awareness of this plan, water conservation activities, and related resources.
8. Develop a drought dashboard on the Lower Loup NRD website, where links to monitoring tools and other mitigation or response resources can be centrally located.
9. Hold periodic drought management training workshops with UNL Extension Educators and others as needed.
10. Identify, develop, and provide targeted educational and training materials or opportunities to the Drought Advisory Group.

WATER MANAGEMENT ACTIONS

These actions include those that can be undertaken relatively easily, with minimal study or research. While the Lower Loup NRD and partners have some funding sources to implement them (such as cost-share for BMPs), additional funding resources would be required to implement them across the district or even to targeted geographical areas. Targeted I&E efforts should be paired with each one of these to increase voluntary adoption or implementation. These mitigation actions improve drought resilience through one or more of the following modes of action:

- Reduce demand
- Improve use/efficiency
- Increase supplies

The following actions were identified:

1. Identify the most vulnerable areas to groundwater declines via hydrogeologic data (AEM surveys, water level monitoring, etc.) and proactively work to increase adoption of irrigation BMPs and other water management practices.
2. Develop sample irrigation allocation guidance specific to each drought zone. This could be used during any season if producers wish, however, targeted awareness of this tool would be utilized as drought zones begin moving into worsening levels of drought.
   a. This could be paired with a pilot project or issuing a voluntary challenge to a group of producers to practice managing through an allocation system.
   b. The use or availability of flow meters may be necessary for this action to be feasible.
3. Increase adoption of flow meters through policy enhancements and grant funds to use for cost-share. This could be prioritized in areas more vulnerable to drought or that are facing other groundwater management concerns. This should be proactively completed before installation of flow meters becomes a regulatory action, which may make the activity ineligible for grant funds.

4. Identify new or existing groundwater wells to add real-time water level transducers to supplement spring water level measurements and improve drought monitoring capabilities.
5. Obtain grant funding and/or increase local levels of cost-share assistance to increase adoption rates of irrigation BMPs and other water management practices.
6. Conduct or partner with stakeholders to perform studies to:
    a. Utilize areas that have high groundwater as water sources.
    b. Capture, store, and use excess stream flow during flood events. Pairing drought management with flood management effort is a way to accomplish both of these objectives.
    c. Identify locations for stream augmentation or retiming, surface or groundwater storage, or groundwater recharge projects.
    d. Identify opportunities to use existing infrastructure (i.e. canals) to recharge groundwater supplies.
    e. Complete water balance studies in high-risk areas to identify excess supplies, activities that are overusing water, or where well interference is common (leveraging AEM data in these areas will be very beneficial).
    f. Proactively evaluate existing water storage facilities for drought resilience (low water conditions, etc.). These effects can impact the local tourism economy, irrigation, or other economic development opportunities.
    g. Complete a study to further identify and evaluate Managed Aquifer Recharge (MAR) locations using hydrogeologic framework data from the 2019 Lower Loup NRD AEM Survey Report, or future AEM studies. In addition to a review of geologic data, work to develop an MAR site may include: new boreholes with detailed geologic and geophysical logs, aquifer tests, analysis of groundwater travel times, and a determination of the suitability of MAR sites to meet the Lower Loup NRD Groundwater Management Plan goals.

PLANNING, STUDY, OR OTHER SUPPORTING POLICY ACTIONS

These actions include steps the Lower Loup NRD should consider to enhance the district's ability to implement this plan and work with outside agencies or partners. It is important to work with stakeholders prior to a drought event so that the training, relationships, and resources are ready to go when drought actually occurs. This proactive stance will make the Lower Loup NRD more effective at responding to drought and recovering more quickly. The following actions were identified:

1. Develop a schedule to routinely evaluate and update this drought plan, specifically the monitoring and response protocol.
2. Train/cross train additional team members on drought monitoring tools, such as the National Drought Monitor, drought impact reporting, etc.
3. Develop standardized or scheduled/routine meetings with National Drought Mitigation Center or other agencies to develop relationships and share new data, best practices, etc.
4. Conduct a "test" of the drought plan with active stakeholder group (hold a workshop approximately every three to four years).
5. Assist local jurisdictions in water conservation planning or drought response planning (this could also be done as part of a wellhead protection plan).
6. Develop or share example ordinances with cities and villages that encourage water conservation or water use restrictions.

7. Integrate the drought plan into other Lower Loup NRD planning and policy documents such as the Groundwater Management Plan, Voluntary Integrated Management Plan, and the Lower Platte River Basin Coalition – Basin-Wide Water Management Plan.
8. Proactively develop a protocol for reading flow meters and enforcing their use when that action is triggered through the monitoring and response protocol (DL2: Severe).

6.03 VOLUNTARY BEST MANAGEMENT PRACTICES

The Lower Loup NRD will encourage, educate, and at times provide cost-share to increase the adoption of best management practices that improve irrigation or conserve water. These practices include, but are not limited to:

- Soil moisture probes
- Sub-surface irrigation
- Variable rate irrigation
- Pivot nozzle package conversion
- Flow meters
- Irrigation scheduling
- Conversion from flood irrigation to center pivot
- Farm weather stations (rain sensors, evapotranspiration sensors, etc.)
- Water reuse systems
- Diversified or drought tolerant crop rotations
- Preventative planting (non-corn/bean rotation) during times of drought

6.04 POTENTIAL FUNDING SOURCES

The following programs or funding sources may be able to assist with plan implementation:

- General funds from Lower Loup NRD
- Funds from other local partners (villages, cities, counties, or state)
- Watershed and Flood Prevention Operations (WFPO) funding from Natural Resources Conservation Service (NRCS)
- Water Sustainability Fund (WSF) from State of Nebraska
- Bureau of Reclamation (BOR) WaterSMART grant program
- Source Water Protection grants from Nebraska Department of Environment and Energy (NDEE)
- Section 319 grant program from NDEE
- Nebraska Environmental Trust (NET)
- United States Department of Agriculture (USDA) Rural Development (various funding programs)
- Hazard Mitigation Assistance (HMA) grant program from the Federal Emergency Management Agency (FEMA)
- National Integrated Drought Information Systems (NIDIS) from National Oceanic and Atmospheric Administration (NOAA)

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SECTION 7. PLAN MAINTENANCE AND UPDATES

The Lower Loup NRD will be responsible for monitoring, evaluating, and updating this plan. Support and suggestions from stakeholders and the public will influence and enhance this process. Plan review should be conducted on an annual basis with an update occurring at least every five years. The plan may be updated more frequently at the discretion of the Lower Loup NRD Board, especially in the event of a major drought. If new, innovative mitigation strategies arise that could impact the Lower Loup NRD or elements of this plan, a plan amendment may be proposed and considered separate from the annual review.

7.01 CONTINUED PUBLIC INVOLVEMENT

To ensure plan support and input from the public as well as other stakeholders, public involvement should remain a top priority for the Lower Loup NRD. Notices for public meetings involving the discussion of or action on plan updates should be published and posted at least two weeks in advance.

LOWER PLATTE RIVER BASIN SUB-REGIONAL GROUNDWATER MODELING INTERLOCAL COOPERATION AGREEMENT

This Lower Platte River Basin Sub-Regional Groundwater Modeling Interlocal Cooperation Agreement ("Agreement") is entered into by and between the Nebraska Department of Natural Resources ("Department"); Lower Platte South Natural Resources District ("LPSNRD"); Lower Platte North Natural Resources District ("LPNNRD"); and Papio-Missouri River Natural Resources District ("PMRNRD"); all of which are an agency or political subdivisions of the State of Nebraska, each sometimes hereinafter individually referred to as "Party" or collectively referred to as "Parties." The natural resources districts are sometimes collectively referred to as "NRDs."

WHEREAS, the Parties desire to work together, under the Interlocal Cooperation Act ("Act"), Neb. Rev. Stat. §§ 13-801 to 13-827, to make the most efficient use of their respective authorities and other powers by enabling them to cooperate with one another on a basis of mutual advantage and thereby to provide services and facilities in a manner and pursuant to forms of governmental organization that will accord best with geographic, economic, population, and other factors influencing the needs and development of each Party; and

WHEREAS, the Parties desire to form a joint agreement under Neb. Rev. Stat. § 13-807 authorized by the governing body of each Party to the agreement, and which shall set forth fully as provided in the Act the purposes, powers, rights, objectives, and responsibilities of the contracting parties; and

WHEREAS, the Department has certain statutory authorities and responsibilities pertaining to the surface water of the State, and also authorities and responsibilities granted under the Nebraska Ground Water Management and Protection Act ("GWMPA"), Neb. Rev. Stat. §§ 46-701 to 46-754 for integrated management of hydrologically connected ground water and surface water; and

WHEREAS, the NRDs are organized pursuant to Neb. Rev. Stat. §§ 2-3201 et seq. and have certain statutory authorities and responsibilities, particularly pertaining to the ground water in their respective districts of the State, and also authorities and responsibilities granted by the GWMPA for integrated management of hydrologically connected ground water and surface water; and

WHEREAS, the Lower Platte River Basin ("Basin") is geographically large and diverse in its geology, land use, ground and surface water supplies, and water uses. Each of the Parties are charged with responsibilities for planning and managing water resources. In furtherance of those responsibilities, each of the Parties has an interest in the development of a baseline sub-regional groundwater flow model of the combined area of the Basin that will help establish groundwater and surface water management criteria for NDNR, the Lower Platte River Basin-wide Plan and each NRD's Integrated Management Plan; and

WHEREAS, the Department developed the Lower Platte Missouri Tributaries Model in 2018. The existing model is not based on Airborne Electromagnetic ("AEM") data which has recently been obtained by the NRDs over the last few years; and

WHEREAS, the Parties desire to enter into a new Agreement to contribute financially, provide the necessary data, technical support, and administer contracts necessary to develop the baseline sub-regional groundwater flow model of the Basin.

NOW, THEREFORE, in consideration of the mutual covenants and promises of the Parties, it is agreed by and among the Parties hereto as follows:

1. PARTIES:

1.01 All Parties to this Agreement are public agencies within the meaning of Neb. Rev. Stat. §13-803(2).

2. AUTHORITY:

2.01 Neb. Rev. Stat. § 13-807 authorizes any two (2) or more public entities to enter into agreements with one another to perform any governmental service, activity, or undertaking, which at least one (1) of the public agencies entering into the agreement is authorized by law to perform.

2.02 The Parties enter into this Agreement pursuant to the authority conferred on each of them under the Act.

2.03 No part of this Agreement shall be interpreted as relieving the Department of any obligation or responsibility it may have to regulate water use or to compel compliance with any laws, regulations, interstate compacts or interstate agreements or as a delegation of its responsibilities and obligations to the Parties of this Agreement. No part of this Agreement may be or shall be interpreted as relieving the NRDs of any obligation or responsibility it may have to regulate water use or to compel compliance with any laws, regulations, interstate compacts or interstate agreements or as a delegation of its responsibilities and obligations to the Parties of this Agreement.

3. COLLECTIVE:

3.01 The Parties hereby create the Lower Platte River Groundwater Modeling Collective ("Collective"). The Collective shall be created immediately upon the execution of this Agreement by all Parties. The Collective shall be governed by the terms of this Agreement and applicable law. The Collective shall carry out the purposes as set forth in Section 5 of this Agreement. The Collective shall not be considered a joint entity separate and distinct from the respective Parties to this Agreement, but rather a collaborative working arrangement of the Parties.

4. DURATION:

4.01 The duration of this Agreement shall be for a period from the execution date of this Agreement by the last Party to December 31, 2025. This Agreement may be extended for successive one (1) year terms by the mutual written agreement of all Parties hereto.

5. PURPOSES:

5.01 The purposes of this Agreement pursuant to Neb. Rev. Stat. § 13-804 (3)(c) are: (1) to form a Collective to financially support, provide the necessary data, technical support, and administer contracts necessary to develop the baseline sub-regional groundwater flow model of the Basin.

5.02 This Agreement shall provide the organizational and administrative structure and enumeration of the powers, privileges, and authority of the Collective and the financial cooperative effort necessary to carry out the purposes in Subsection 5.01 of this Agreement. The powers, privileges, and authorities of the Collective shall not be used in a manner that is in violation of any of the Parties' public purposes.

6. MANNER OF FINANCING AND OF ESTABLISHING AND MAINTAINING A BUDGET:

6.01 The manner of financing and expenditure accounting of the Collective pursuant Neb. Rev. Stat. §13-804(3)(d) shall be as follows:

6.01.1 The Collective will be financed by the Parties and a contribution from the Nebraska Natural Resources Commission through a grant from the Water Sustainability Fund ("WSF") as follows:

Department:	$188,500.00
WSF:	$282,900.00
LPSNRD:	$62,866.67 ($20,956 to be paid annually for three years)
LPNNRD:	$62,866.67 ($20,956 to be paid annually for three years)
PMRNRD:	$62,866.67 ($20,956 to be paid annually for three years)

There are no other financial obligations of the Parties except those set forth above, unless otherwise consented to by the Parties.

6.01.2 The Collective shall have the authority to authorize applications for financial grants, to include use of Collective funds and in-kind services for match. Such applications shall be made by the Administrator on behalf of the Collective.

6.01.3 No bonds will be issued and no taxes will be levied or collected jointly by the Parties. Individual Parties may contribute funds derived from tax levies or bonds but these shall not be considered a tax levy or bond issuance by the Collective.

6.02 The manner of establishing and maintaining a budget pursuant to Neb. Rev. Stat. §13-804(3)(d) shall be as follows:

6.02.1 The Administrator as designated in Subsection 7.01.6 of this Agreement shall prepare, establish, adopt, and maintain a budget of revenues and expenditures annually for each fiscal year. Such annual budget shall be adopted by formal resolution on or before April 15th of each year for the upcoming fiscal year by the Board of the Collective. The fiscal year will be July 1 through June 30 of the succeeding year.

6.02.2 Upon completion of each annual budget, the Administrator will determine whether any payments need to be made by each Party for such fiscal year.

6.02.2.1 Each payment obligation of a Party is subject to the availability of government funds which are appropriated or allocated for the payment of the obligations incurred by signing this Agreement. If funds are not apportioned or appropriated and available for the continuance of the obligations incurred, the Agreement may be terminated at the end of the period for which funds are available. A Party shall notify the other Parties at the earliest possible time of the obligations which will or may be affected by a shortage of funds. No penalty shall accrue to any Party if this provision is exercised.

7. ADMINISTRATION:

7.01 The Collective shall be composed of one (1) representative from each of the Parties.

7.01.1 Each representative on the Collective shall be entitled to one (1) vote by either the representative or alternate for each Party.

7.01.2 All decisions shall be made by unanimous consensus of the Collective Parties.

7.01.3 A quorum, which shall be the presence of a representative or alternate representative of each Party shall be required to transact any official discussions or business.

7.01.4 All meetings of the Collective shall follow the requirements of the Open Meetings Act.

7.01.5 Meetings of the Collective shall occur when the Collective Chair determines a meeting is necessary and schedules such meeting after input from the Collective's representatives. The Collective shall meet, at least, once a year.

7.01.6 The PMRNRD shall serve as the Administrator as required under Neb. Rev. Stat. § 13-804(4)(a). As Administrator, its responsibilities include: serving as the financial administrator, which includes collecting and holding the contributions from the Parties and other revenues, making the disbursements for expenses related to the Collective activities, and as grant applicant and administrator; serving as contracting member on behalf of the Collective and serving as day-to-day administration for the Collective, including information dissemination to members and the general public, scheduling and organization of meetings, record-keeping, and coordination of Collective activities. The PMRNRD Representative shall serve as Chair for the Collective and as Collective Chair, shall preside at all Collective meetings and shall develop agendas for each meeting.

7.02 The Collective shall have such powers, privileges, and authority as authorized by the Parties, and as necessary to achieve the purposes of the Collective as set forth in this Agreement. Such powers, privileges, and authority shall include but not be limited to the following.

7.02.1 Schedule and conduct meetings to transact business.

7.02.2 Hold public meetings.

7.02.3 Enter into contracts and agreements with other public agencies and private sector vendors.

7.02.4 Undertake studies, investigations, or surveys and do research as may be necessary, and publish and disseminate the results.

7.02.5 Access private land, which will be coordinated with the landowner.

7.02.6 Procure and contract with legal and other professional services.

7.03 Any Party may withdraw from this Agreement and from representation on the Collective upon written notification to the Collective Chair. Such withdrawal shall be effective upon receipt of the written notification. There will be no financial reimbursement of remitted funds unless specifically authorized by the Collective.

7.04 New members can be added to the Collective with a vote of the Collective. Eligible entities shall be limited to political subdivisions or agencies of the State of Nebraska.

8. PROPERTY:

8.01 The manner of acquiring, holding, and disposing of real and personal property pursuant to Neb. Rev. Stat. § 13-804 (4)(b) is as follows.

8.01.1 In the event it becomes necessary for the Collective to purchase any property, either real or personal, the Collective will vote to determine how the property will be disposed of.

9. <u>TERMINATION</u>:

9.01 The permissible method or methods to be employed in accomplishing the complete or partial termination of this Agreement under Neb. Rev. Stat. §13-804(3)(e) shall be as follows.

9.01.1 This Agreement and the Collective created hereby shall be terminated upon the earlier of the completion of its purposes and objectives described herein or upon unanimous vote for the complete or partial termination of the Collective and this Agreement. Upon action to terminate the Collective, all outstanding debts and obligations of the Collective shall be paid and all unused funds and appropriations shall be returned to the remaining Parties in such proportions as represented by the pro rata share paid by each Party.

10. <u>MISCELLANEOUS PROVISIONS</u>:

10.01 All of the Parties' books, records, and documents relating to work performed or monies received or spent under this Agreement shall be subject to audit at any reasonable time after reasonable notice by the NRDs, Department, and the State Auditor or as required by any grant agreements, donations or other source of funds. The Administrator shall maintain all of such records throughout the existence of this Agreement and for a period of ten (10) full years from the date of termination of the Agreement, or until all issues related to an audit, litigation or other action are resolved, whichever is longer. All records shall be maintained in accordance with generally accepted accounting principles and record retention as required by the Secretary of State, Records Management Division.

10.02 Any governing body as defined in Neb. Rev. Stat. § 13-503 which is a Party to this Agreement shall provide information to the Auditor of Public Accounts regarding this Agreement as required in Neb. Rev. Stat. § 13-513.

10.03 No Party may assign its contractual rights or obligations under this Agreement without the prior written consent of all other Parties to this Agreement.

10.04 Each Party shall have taken, prior to the execution of this Agreement by such Party, appropriate action by ordinance, resolution, or otherwise pursuant to the law of the governing body of such Party so that this Agreement may enter into force consistent with the provisions of Neb. Rev. Stat. § 13-804(2).

10.05 This Agreement may be amended in a writing duly executed all of the Parties.

10.06 This Agreement contains the entire agreement of the Parties with respect to the Basin groundwater modeling. All prior and contemporaneous negotiations, discussions, memorandums of understanding and other writings are merged and incorporated herein, it being the intention of the Parties that this Agreement is a final and full expression of their agreement. No representations were made or relied upon by any Party other than those expressly set forth herein.

10.07 This Agreement is governed by the laws of the State of Nebraska.

10.08 This Agreement becomes effective upon execution by all Parties.

10.09 This Agreement may be executed in any number of counterparts, each of which shall be an original, but all such counterparts shall constitute one and the same instrument.

IN WITNESS WHEREOF, the Parties have signed and executed this Agreement on the dates shown next to their respective signatures:

NEBRASKA DEPARTMENT OF NATURAL RESOURCES

BY:____

DATE:____

LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT

BY:____

DATE:____

LOWER PLATTE NORTH NATURAL RESOURCES DISTRICT

BY:____

DATE:____

PAPIO-MISSOURI RIVER NATURAL RESOURCES DISTRICT

BY:____

DATE: 10-18-22