

2021 Addendum to the
2019 NORTH DAKOTA
GEOGRAPHIC TARGETING SYSTEM FOR
GROUNDWATER MONITORING

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INTRODUCTION

In 1997, the North Dakota Department of Health (Radig, 1997) developed the North Dakota Geographic Targeting System for Groundwater Monitoring (GTS) as a method of assessing the pollution potential and monitoring priority for surficial (glacial drift) aquifers defined by the North Dakota State Water Commission (SWC).

Between 2016 and 2019, Kannenberg and others (2019) completed a new iteration of the GTS to reassess monitoring priorities for existing surficial aquifers, assign monitoring priorities to new aquifers, and update the methods of the GTS to include new geographic information system (GIS) capabilities. The 2019 GTS included all named aquifers in the SWC database as of July 1, 2016. It did not include unnamed aquifers or aquifers wholly or partly overlain by a shallower surficial aquifer.

Between July 2016 and November 2020, 21 aquifers that were mapped but were previously unnamed were assigned aquifer names by the SWC. This addendum assigns GTS scores to these 21 newly named aquifers, 39 unnamed aquifers, and eight aquifers that are either partly or completely covered by shallower surficial aquifers. This addendum also includes a reference table for aquifers that have had their names changed since 2016 (summarized in Table 1). Aquifer information in this addendum is current as of November 2020.

GOAL

The goal of the 2021 addendum to the 2019 GTS is to assign monitoring priorities to new aquifers named after July 1, 2016, and to unnamed aquifers not previously included in the GTS.

PROJECT DESIGN

The 2021 addendum to the 2019 GTS followed the same methods as the 2019 GTS. It includes a vulnerability, sensitivity, and risk component. Each component is assigned a value, then combined to produce the final monitoring score. A total of 68 aquifers were examined and scored for this addendum to add to the 213 aquifers examined in the 2019 GTS. The surficial aquifer dataset used for this addendum was retrieved in November 2020 and does not reflect changes after that date.

The vulnerability component, which quantifies how physically easy it is for a contaminant to enter an aquifer, was evaluated using the DRASTIC model created by the U.S. Environmental Protection Agency (EPA) in 1985. DRASTIC is an acronym that stands for **D**epth to water (or the top of confined or clay-covered aquifer), **R**echarge, **A**quifer media, **S**oil media, **T**opography, **I**mpact of the vadose zone, and hydraulic **C**onductivity (Aller et al.,1987). An aquifer is assigned a rating for each of these parameters. Each of the assigned ratings is then multiplied by a weight constant (Formula 1). This produces a final numeric value representing the aquifer's

vulnerability to contamination; a higher number indicates higher vulnerability, while a lower number represents lower vulnerability.

Formula 1: DRASTIC Formula

$$DrDw + RrRw + ArAw + SrSw + TrTw + IrIw + CrCw = \text{DRASTIC Score (Unitless)}$$

(r = rating, w = weight, D = Depth to water, R = Recharge, S = Sensitivity, T = Topography, I = Impact of vadose zone, C = hydraulic Conductivity)

Since the aquifers analyzed were not part of the County Groundwater Studies developed by the SWC, aquifer parameters for the DRASTIC model were interpreted from well logs, soil maps, annual rainfall maps, and standard values for aquifer media.

A generic DRASTIC score and a Pesticide DRASTIC score were calculated using different weightings on each aquifer parameter to account for the different environmental behavior of pesticides.

The sensitivity component, which accounts for agricultural chemical usage, was calculated using the agricultural production per farmed acre in each county as a surrogate value and calculating aquifer values based on the proportion of their area within a county. The production per farmed acre was calculated from the United States Department of Agriculture's 2012 Agricultural Census (U.S. Department of Agriculture, 2014).

The risk component accounts for the economic value of the loss of the groundwater resource should contamination occur. The appropriated groundwater per square mile in each aquifer was calculated and used to determine risk to the aquifer.

The 2019 GTS broke each of the vulnerability, sensitivity, and risk components into three equal-sized groups with a corresponding numeric score: high (3), moderate (2), or low (1). These groups were assigned by breaking the dataset into equal-sized groups. This addendum uses the same group break values as the 2019 GTS to establish continuity between the datasets. However, the method of assigning equal sizes of the groups was not maintained in this 2021 addendum, as maintaining equal group sizes would require reassigning groupings in the 2019 GTS. The component scores were totaled for each aquifer to result in a total monitoring score.

Attachment 1 includes the scoring tables used for the 2019 GTS and this 2021 addendum.

RESULTS

A total of 68 aquifers or aquifer sections were assessed in this 2021 GTS addendum. DRASTIC inputs and results can be found in Attachment 2. The GTS inputs and results can be found in Attachment 3. Based on the recent GTS evaluation, 68 aquifers, five were designated as High Priority, 30 as Moderate Priority, and 33 as Low Priority.

Four aquifers currently have different names than what they are given in the 2019 GTS. These differences are noted in Table 1.

Table 1. Aquifers with Changed Names from the 2019 GTS

2019 GTS Name	Current SWC Name
Cut Bank Creek S	Cut Bank Creek
Cut Bank Creek N	Mohall
Denbigh	Denbigh-Lake Souris
LaMoure North	LaMoure

DISCUSSION

This 2021 addendum to the 2019 GTS provides DRASTIC and monitoring scores for 68 surficial aquifers not included in the 2019 GTS. Most of these aquifers are either unnamed or were recently named by the SWC and are not included in the SWC’s county groundwater studies. As a result, many of these 68 aquifers were not subject to detailed geologic study and aquifer parameters for the DRASTIC model were not available. Consequently, many parameters were estimated from data available on well drilling logs. The details of the aquifer’s geology are only as good as the geology information provided by the driller and the number of holes drilled within the aquifer boundaries. Thus, many parameters included in the DRASTIC model are best estimates at the time of this addendum and values may be revised in the future as more detailed studies on aquifers become available. For several aquifers, only one or two wells or boreholes were available for interpretation. Depending on how the SWC defined the aquifer boundaries, this may not be enough information to accurately determine the aquifer boundaries and the aquifer’s true extent may not be reflected by the current boundaries.

Eight of the aquifers included in this addendum are either partially or wholly covered by a shallower surficial aquifer that was scored in the 2019 GTS. These include the following aquifers: Denbigh Buried Channel, Englevale Lower, Englevale Middle, Karlsruhe Deep Channel, Pleasant Lake – Intermediate Channel, Pleasant Lake – North Deep Channel, Pleasant Lake – South Deep Channel, and Lower Wishek. In addition, with the recent naming of the Cattail aquifer in Emmons County, the Winona aquifer scored in the 2019 GTS is now overlain by the Cattail aquifer. The shallower aquifer should take precedence over the covered aquifer where there is overlap, as contaminants will likely enter the shallower aquifer first.

As in the 2019 GTS, this 2021 addendum has several limitations stemming from interpretations of available data, the use of a surrogate value for pesticide use, and the lack of consideration of the chemical fate of contaminants in aquifers. However, this addendum provides valuable information about the vulnerability, susceptibility, and risk of more surficial aquifers across North Dakota. It can be used for a variety of efforts to protect the state’s groundwater.

REFERENCES

Aller, L., T. Bennett, J.H. Lehr, R.J. Petty, and G. Hackett. 1987. *DRASTIC: A Standardized System for Evaluating Groundwater Pollution Potential Using Hydrogeologic Settings*. U.S. EPA/600/2-87/035.

Kannenber, D., A. Peterson, and C. Gleich, 2019. North Dakota Geographic Targeting System for Groundwater Monitoring.

Radig, Scott, 1997. North Dakota Geographic Targeting System for Groundwater Monitoring.

U.S. Department of Agriculture, 2014. *2012 Census of Agriculture*.

ATTACHMENT 1: 2019 GTS SCORING TABLES

ATTACHMENT 1

2019 GTS SCORING TABLES

For DRASTIC and GTS Components

DRASTIC Scoring

Depth to Water (Feet)	
Range	Rating
0 - 5	10
5 - 15	9
15 - 30	7
30 - 50	5
50 - 75	3
75 - 100	2
≥ 100	1

Net Recharge (Inches/Year)	
Range	Rating
0 - 2	1
2 - 4	3
4 - 7	6
7 - 10	8
≥ 10	9

Aquifer Media	
Range	Rating
Massive Shale	2
Glacial Till	5
Bedded Sandstone and Shale Sequences	6
Massive Sandstone	6
Sand and Gravel	8

Soil Media	
Range	Rating
Thin or Absent	10
Gravel	10
Sand	9
Peat	8
Shrinking and/or Aggregated Clay	7
Sandy Loam	6
Loam	5
Silty Loam	4
Clay Loam	3
Muck	2
Non-shrinking and Non-aggregated Clay	1

Topography (Percent Slope)	
Range	Rating
0 - 2	10
2 - 6	9
6 - 12	5
12 - 18	3
≥ 18	1

Vadose Zone Media	
Range	Rating
Confining Layer	1
Silt/Clay	3
Shale	3
Bedded Sandstone and Shale	6
Sand and Gravel w/Significant Silt and Clay	6
Sand and Gravel	8

ATTACHMENT 1: 2019 GTS SCORING TABLES

Hydraulic Conductivity (GPD/Ft²)	
Range	Rating
1 - 100	1
100 - 300	2
300 - 700	4
700 - 1000	6
1000 - 2000	8
≥ 2000	10

DRASTIC Parameter Weights		
Parameter	Generic	Pesticide
Depth to Water	5	5
Net Recharge	4	4
Aquifer Media	3	3
Soil Media	2	5
Topography	1	3
Impact of the Vadose Zone	5	4
Hydraulic Conductivity	3	2

GTS Scoring

Vulnerability Component	
Pesticide DRASTIC Score Range	Rating
0-129	1 (Low)
130-159	2 (Moderate)
160+	3 (High)

Sensitivity Component	
Production/Farmed Acre Range (dollar/farmed acre)	Rating
0-202.14	1 (Low)
202.15-356.91	2 (Moderate)
356.92+	3 (High)

Risk Component	
Appropriation Range (acre-feet/mi²)	Rating
0-1.244	1 (Low)
1.244-33.51	2 (Moderate)
33.52+	3 (High)

ATTACHMENT 2: 2021 ADDENDUM DRASTIC INPUTS AND RESULTS
Listed Alphabetically by Aquifer Name

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ATTACHMENT 2: 2021 ADDENDUM DRASTIC INPUTS AND RESULTS

Listed Alphabetically by Aquifer Name

Aquifer Name	Depth to Water (Feet)	Score	Recharge (Inches/Year)	Score	Aquifer Media	Score	Soil Media	Score	Topography (% Slope)	Score	Impact of Vadose Zone	Score	Hydraulic Conductivity (GPD/FT ²)	Score	DRASTIC	Pesticide DRASTIC
Austin	75	3	1.26	1	Sand and Gravel	8	Loam	5	8.5	5	Silt/Clay	3	1200	8	97	111
Bicker	48	5	1.18	1	Sand and Gravel	8	Loam	5	3.7	9	Silt/Clay	3	1500	8	111	133
Big Coulee	23	7	3.06	3	Sand and Gravel	8	Loam	5	5.9	9	Sd/Grvl W Sig Slt/Cl	6	1500	8	144	163
Cattail	14	9	4.12	6	Sand and Gravel	8	Sandy Loam	6	2.9	9	Sd/Grvl W Sig Slt/Cl	6	1200	8	168	190
Clayton	195	1	0.00	1	Sand and Gravel	8	Loam	5	9.8	5	Confining Layer	1	1200	8	77	93
Clearwater	26	7	3.86	3	Sand and Gravel	8	Loam	5	10.2	5	Sd/Grvl W Sig Slt/Cl	6	1200	8	140	151
Cleary	74	3	1.15	1	Sand and Gravel	8	Loam	5	16.6	3	Silt/Clay	3	1200	8	95	105
Crane Creek	133	1	0.00	1	Sand and Gravel	8	Loam	5	10.3	5	Confining Layer	1	900	6	71	89
*Denbigh Buried Channel	125	1	0.00	1	Sand and Gravel	8	Sandy Loam	6	2.9	9	Confining Layer	1	1500	8	83	110
Edgemont	115	1	0.00	1	Sand and Gravel	8	Loam	5	12.3	3	Confining Layer	1	1200	8	75	87
*Englevale Lower	96	2	1.18	1	Sand and Gravel	8	Loam	5	0.7	10	Silt/Clay	3	1200	8	97	121
*Englevale Middle	53	3	1.11	1	Sand and Gravel	8	Loam	5	1.4	10	Silt/Clay	3	1200	8	102	126
Fillmore	44	5	3.02	3	Sand and Gravel	8	Loam	5	4.9	9	Sd/Grvl W Sig Slt/Cl	6	1500	8	134	153
Foothills	88	2	1.24	1	Sand and Gravel	8	Loam	5	16.6	3	Silt/Clay	3	1200	8	90	100
Foothills South	131	1	1.24	1	Sand and Gravel	8	Loam	5	12.4	3	Silt/Clay	3	1200	8	85	95
*Karlsruhe Deep Channel	105	1	1.13	1	Sand and Gravel	8	Loam	5	2.6	9	Sd/Grvl W Sig Slt/Cl	6	900	6	100	121
Little Stoney	8	9	3.66	3	Sand and Gravel	8	Loam	5	1.9	10	Sand and Gravel	8	1200	8	165	184
*Lower Wishek	79	2	1.04	1	Sand and Gravel	8	Loam	5	5.3	9	Silt/Clay	3	1200	8	96	118
Lucy	83	2	1.23	1	Sand and Gravel	8	Loam	5	14.8	3	Silt/Clay	3	1200	8	90	100
McClusky	229	1	0.00	1	Sand and Gravel	8	Loam	5	6.9	5	Confining Layer	1	900	6	71	89
Oberon	15	9	3.58	3	Sand and Gravel	8	Loam	5	4.7	9	Sand and Gravel	8	1500	8	164	181
*Pleasant Lake - Intermediate Channel	55	3	1.13	1	Sand and Gravel	8	Sandy Loam	6	3.1	9	Silt/Clay	3	900	6	97	124
*Pleasant Lake - North Deep Channel	92	2	0.00	1	Sand and Gravel	8	Sandy Loam	6	3.0	9	Confining Layer	1	900	6	82	111
*Pleasant Lake - South Deep Channel	100	2	0.00	1	Sand and Gravel	8	Sandy Loam	6	8.0	5	Confining Layer	1	900	6	78	99

ATTACHMENT 2: 2021 ADDENDUM DRASTIC INPUTS AND RESULTS

Listed Alphabetically by Aquifer Name

Aquifer Name	Depth to Water (Feet)	Score	Recharge (Inches/Year)	Score	Aquifer Media	Score	Soil Media	Score	Topography (% Slope)	Score	Impact of Vadose Zone	Score	Hydraulic Conductivity (GPD/FT ²)	Score	DRASTIC	Pesticide DRASTIC
Roosevelt	217	1	0.00	1	Sand and Gravel	8	Loam	5	1.4	10	Confining Layer	1	900	6	76	104
Shealy	70	3	1.12	1	Sand and Gravel	8	Sandy Loam	6	5.9	9	Silt/Clay	3	900	6	97	124
Stoneview	63	3	1.11	1	Sand and Gravel	8	Loam	5	14.4	3	Silt/Clay	3	1500	8	95	105
Tiffany Flats	8	9	1.66	1	Sand and Gravel	8	Loam	5	1.2	10	Sd/Grvl W Sig Slt/Cl	6	900	6	141	164
Tolgen North	25	7	3.41	3	Sand and Gravel	8	Loam	5	19.0	1	Sd/Grvl W Sig Slt/Cl	6	900	6	130	135
Unnamed Benson-Eddy 1	19	7	2.53	3	Sand and Gravel	8	Sandy Loam	6	5.9	9	Sd/Grvl W Sig Slt/Cl	6	900	6	140	164
Unnamed Bottineau 1	48	5	1.22	1	Sand and Gravel	8	Loam	5	9.6	5	Silt/Clay	3	1200	8	107	121
Unnamed Bottineau 2	29	7	1.06	1	Sand and Gravel	8	Silty Loam	4	1.7	10	Silt/Clay	3	900	6	114	137
Unnamed Bottineau 3	60	3	1.08	1	Sand and Gravel	8	Silty Loam	4	0.8	10	Silt/Clay	3	1200	8	100	121
Unnamed Bottineau 4	92	2	0.00	1	Sand and Gravel	8	Sandy Loam	6	1.4	10	Confining Layer	1	900	6	83	114
Unnamed Bottineau 5	17	7	2.36	3	Sand and Gravel	8	Silty Loam	4	2.9	9	Sd/Grvl W Sig Slt/Cl	6	1200	8	142	158
Unnamed Bottineau 6	9.8	9	3.79	3	Sand and Gravel	8	Sandy Loam	6	1.0	10	Sd/Grvl W Sig Slt/Cl	6	1500	8	157	181
Unnamed Bottineau 7	23	7	3.42	3	Sand and Gravel	8	Sandy Loam	6	6.7	5	Sd/Grvl W Sig Slt/Cl	6	1200	8	142	156
Unnamed Bottineau-Rolette 1	13	9	2.11	3	Sand and Gravel	8	Sandy Loam	6	2.7	9	Sd/Grvl W Sig Slt/Cl	6	900	6	150	174
Unnamed Cavalier 1	71	3	1.01	1	Sand and Gravel	8	Loam	5	1.7	10	Silt/Clay	3	1500	8	102	126
Unnamed Dickey 1	65	3	1.07	1	Sand and Gravel	8	Loam	5	11.0	5	Silt/Clay	3	1200	8	97	111
Unnamed Divide 1	48	5	1.03	1	Sand and Gravel	8	Loam	5	4.8	9	Silt/Clay	3	1200	8	111	133
Unnamed Divide 2	275	1	0.00	1	Sand and Gravel	8	Loam	5	5.4	9	Confining Layer	1	1200	8	81	105
Unnamed Divide 3	14	9	3.49	3	Sand and Gravel	8	Silty Loam	4	1.6	10	Sd/Grvl W Sig Slt/Cl	6	900	6	147	167
Unnamed Divide 4	167	1	0.00	1	Sand and Gravel	8	Loam	5	4.7	9	Confining Layer	1	1200	8	81	105
Unnamed Divide 5	66	3	1.14	1	Sand and Gravel	8	Loam	5	8.4	5	Silt/Clay	3	1200	8	97	111
Unnamed Divide 6	40	5	0.97	1	Sand and Gravel	8	Sandy Loam	6	4.4	9	Silt/Clay	3	1200	8	113	138
Unnamed Divide 7	42	5	0.97	1	Sand and Gravel	8	Loam	5	10.6	5	Silt/Clay	3	1500	8	107	121
Unnamed Divide 8	248	1	0.00	1	Sand and Gravel	8	Loam	5	4.7	9	Confining Layer	1	900	6	75	101
Unnamed Divide 9	258	1	0.00	1	Sand and Gravel	8	Loam	5	8.6	5	Confining Layer	1	900	6	71	89

ATTACHMENT 2: 2021 ADDENDUM DRASTIC INPUTS AND RESULTS
Listed Alphabetically by Aquifer Name

Aquifer Name	Depth to Water (Feet)	Score	Recharge (Inches/Year)	Score	Aquifer Media	Score	Soil Media	Score	Topography (% Slope)	Score	Impact of Vadose Zone	Score	Hydraulic Conductivity (GPD/FT ²)	Score	DRASTIC	Pesticide DRASTIC
Unnamed Dunn 1	75	3	1.24	1	Sand and Gravel	8	Loam	5	4.7	9	Silt/Clay	3	900	6	95	119
Unnamed Eddy 1	14	9	1.67	1	Sand and Gravel	8	Sandy Loam	6	2.5	9	Sd/Grvl W Sig Slt/Cl	6	900	6	142	166
Unnamed LaMoure 1	140	1	0.00	1	Sand and Gravel	8	Loam	5	2.7	9	Confining Layer	1	900	6	75	101
Unnamed LaMoure 2	279	1	0.00	1	Sand and Gravel	8	Silty Loam	4	1.7	10	Confining Layer	1	1200	8	80	103
Unnamed LaMoure 3	211	1	0.00	1	Sand and Gravel	8	Loam	5	4.1	9	Confining Layer	1	900	6	75	101
Unnamed McIntosh 1	41	5	1.10	1	Sand and Gravel	8	Loam	5	3.7	9	Silt/Clay	3	1500	8	111	133
Unnamed Mercer 1	54	3	4.03	6	Sand and Gravel	8	Loam	5	9.3	5	Sd/Grvl W Sig Slt/Cl	6	900	6	126	139
Unnamed Morton 1	17	7	2.81	3	Sand and Gravel	8	Silty Loam	4	5.2	9	Silt/Clay	3	900	6	121	142
Unnamed Morton 2	10	9	3.05	3	Sand and Gravel	8	Clay Loam	3	3.9	9	Silt/Clay	3	900	6	129	147
Unnamed Pierce 1	41	5	1.04	1	Sand and Gravel	8	Loam	5	3.0	9	Silt/Clay	3	900	6	105	129
Unnamed Pierce-McHenry 1	12	9	1.94	1	Sand and Gravel	8	Sandy Loam	6	3.4	9	Sd/Grvl W Sig Slt/Cl	6	600	4	136	162
Unnamed Ransom 1	103	1	0.00	1	Sand and Gravel	8	Loam	5	2.8	9	Confining Layer	1	900	6	75	101
Unnamed Rolette-Pierce 1	56	3	1.12	1	Sand and Gravel	8	Loam	5	2.2	9	Silt/Clay	3	900	6	95	119
Unnamed Sargent-Ransom 1	152	1	0.00	1	Sand and Gravel	8	Loam	5	1.7	10	Confining Layer	1	1500	8	82	108
Unnamed Stutsman 1	155	1	0.00	1	Sand and Gravel	8	Loam	5	7.1	5	Confining Layer	1	1200	8	77	93
Unnamed Towner 1	106	1	1.19	1	Sand and Gravel	8	Loam	5	2.9	9	Silt/Clay	3	1200	8	91	113
Unnamed Towner 2	16	7	1.12	1	Sand and Gravel	8	Loam	5	3.0	9	Silt/Clay	3	1500	8	121	143
Unnamed Towner 3	22	7	1.15	1	Sand and Gravel	8	Loam	5	2.9	9	Silt/Clay	3	1500	8	121	143
Unnamed Wells 1	154	1	0.00	1	Sand and Gravel	8	Loam	5	2.1	9	Confining Layer	1	1200	8	81	105

*Partly or completely overlain by another surficial aquifer

ATTACHMENT 3: 2021 ADDENDUM GEOGRAPHIC TARGETING SYSTEM RESULTS

ATTACHMENT 3

2021 ADDENDUM GEOGRAPHIC TARGETING SYSTEM RESULTS

Listed by Total Monitoring Score

ATTACHMENT 3: 2021 ADDENDUM GEOGRAPHIC TARGETING SYSTEM RESULTS

Aquifer	Vulnerability Value (Pesticide DRASTIC)	Vulnerability Score	Vulnerability Rating	Sensitivity Value (dollars/farmed acre)	Sensitivity Score	Sensitivity Rating	Risk Value (acre-feet/mi ²)	Risk Score	Risk Rating	Total Monitoring Score	Total Monitoring Priority Rating
Little Stoney	184	3	HIGH	401.75	3	HIGH	68.98	3	HIGH	9	HIGH
Cattail	190	3	HIGH	230.24	2	MODERATE	173.26	3	HIGH	8	HIGH
Unnamed Bottineau 6	181	3	HIGH	282.44	2	MODERATE	282.27	3	HIGH	8	HIGH
Unnamed Eddy 1	166	3	HIGH	265.54	2	MODERATE	35.48	3	HIGH	8	HIGH
Unnamed Benson-Eddy 1	164	3	HIGH	277.52	2	MODERATE	97.55	3	HIGH	8	HIGH
Big Coulee	163	3	HIGH	300.01	2	MODERATE	6.45	2	MODERATE	7	MODERATE
Unnamed Bottineau 5	158	2	MODERATE	282.44	2	MODERATE	38.95	3	HIGH	7	MODERATE
Unnamed Bottineau 7	156	2	MODERATE	282.44	2	MODERATE	395.00	3	HIGH	7	MODERATE
*Englevale Middle	126	1	LOW	435.87	3	HIGH	2127.9	3	HIGH	7	MODERATE
*Englevale Lower	121	1	LOW	474.68	3	HIGH	302.24	3	HIGH	7	MODERATE
Unnamed LaMoure 2	103	1	LOW	402.87	3	HIGH	73.66	3	HIGH	7	MODERATE
Unnamed Ransom 1	101	1	LOW	357.37	3	HIGH	285.66	3	HIGH	7	MODERATE
Oberon	181	3	HIGH	300.01	2	MODERATE	0.00	1	LOW	6	MODERATE
Unnamed Bottineau-Rolette 1	174	3	HIGH	246.77	2	MODERATE	0.00	1	LOW	6	MODERATE
Tiffany Flats	164	3	HIGH	269.37	2	MODERATE	0.00	1	LOW	6	MODERATE
Unnamed Pierce-McHenry 1	162	3	HIGH	222.98	2	MODERATE	0.00	1	LOW	6	MODERATE
*Lower Wishek	118	1	LOW	244.65	2	MODERATE	148.48	3	HIGH	6	MODERATE
*Pleasant Lake - North Deep Channel	111	1	LOW	237.45	2	MODERATE	387.31	3	HIGH	6	MODERATE
Unnamed Wells 1	105	1	LOW	368.45	3	HIGH	13.57	2	MODERATE	6	MODERATE
Unnamed Divide 3	167	3	HIGH	166.00	1	LOW	0.00	1	LOW	5	MODERATE
Fillmore	153	2	MODERATE	300.01	2	MODERATE	0.00	1	LOW	5	MODERATE
Clearwater	151	2	MODERATE	160.72	1	LOW	20.87	2	MODERATE	5	MODERATE
Unnamed Towner 2	143	2	MODERATE	305.03	2	MODERATE	0.00	1	LOW	5	MODERATE
Unnamed Towner 3	143	2	MODERATE	304.93	2	MODERATE	0.00	1	LOW	5	MODERATE
Unnamed Divide 6	138	2	MODERATE	166.00	1	LOW	11.98	2	MODERATE	5	MODERATE
Unnamed Bottineau 2	137	2	MODERATE	282.44	2	MODERATE	0.00	1	LOW	5	MODERATE
Tolgen North	135	2	MODERATE	255.72	2	MODERATE	0.00	1	LOW	5	MODERATE
Unnamed McIntosh 1	133	2	MODERATE	237.01	2	MODERATE	0.00	1	LOW	5	MODERATE
Unnamed Bottineau 1	121	1	LOW	282.44	2	MODERATE	25.69	2	MODERATE	5	MODERATE
*Karlsruhe Deep Channel	121	1	LOW	186.77	1	LOW	1148.1	3	HIGH	5	MODERATE
Unnamed Rolette-Pierce 1	119	1	LOW	220.35	2	MODERATE	11.12	2	MODERATE	5	MODERATE
Unnamed Dickey 1	111	1	LOW	421.33	3	HIGH	0.00	1	LOW	5	MODERATE

ATTACHMENT 3: 2021 ADDENDUM GEOGRAPHIC TARGETING SYSTEM RESULTS

Aquifer	Vulnerability Value (Pesticide DRASTIC)	Vulnerability Score	Vulnerability Rating	Sensitivity Value (dollars/farmed acre)	Sensitivity Score	Sensitivity Rating	Risk Value (acre-feet/mi ²)	Risk Score	Risk Rating	Total Monitoring Score	Total Monitoring Priority Rating
Unnamed Sargent-Ransom 1	108	1	LOW	458.57	3	HIGH	0.00	1	LOW	5	MODERATE
Unnamed LaMoure 3	101	1	LOW	402.87	3	HIGH	0.00	1	LOW	5	MODERATE
Unnamed LaMoure 1	101	1	LOW	402.87	3	HIGH	0.00	1	LOW	5	MODERATE
Unnamed Morton 2	147	2	MODERATE	184.62	1	LOW	0.00	1	LOW	4	LOW
Unnamed Morton 1	142	2	MODERATE	184.62	1	LOW	0.00	1	LOW	4	LOW
Unnamed Mercer 1	139	2	MODERATE	149.85	1	LOW	0.00	1	LOW	4	LOW
Unnamed Divide 1	133	2	MODERATE	166.00	1	LOW	0.00	1	LOW	4	LOW
Bicker	133	2	MODERATE	160.72	1	LOW	0.00	1	LOW	4	LOW
Unnamed Pierce 1	129	1	LOW	237.45	2	MODERATE	0.00	1	LOW	4	LOW
Unnamed Cavalier 1	126	1	LOW	355.76	2	MODERATE	0.00	1	LOW	4	LOW
*Pleasant Lake - Intermediate Channel	124	1	LOW	237.45	2	MODERATE	0.00	1	LOW	4	LOW
Shealy	124	1	LOW	255.72	2	MODERATE	0.00	1	LOW	4	LOW
Unnamed Bottineau 3	121	1	LOW	282.44	2	MODERATE	0.00	1	LOW	4	LOW
Unnamed Bottineau 4	114	1	LOW	282.44	2	MODERATE	0.00	1	LOW	4	LOW
Unnamed Towner 1	113	1	LOW	304.97	2	MODERATE	0.00	1	LOW	4	LOW
Unnamed Divide 4	105	1	LOW	166.00	1	LOW	9.04	2	MODERATE	4	LOW
Roosevelt	104	1	LOW	312.83	2	MODERATE	0.00	1	LOW	4	LOW
*Pleasant Lake - South Deep Channel	99	1	LOW	298.93	2	MODERATE	0.00	1	LOW	4	LOW
Unnamed Stutsman 1	93	1	LOW	356.64	2	MODERATE	0.00	1	LOW	4	LOW
McClusky	89	1	LOW	209.88	2	MODERATE	0.00	1	LOW	4	LOW
Edgemont	87	1	LOW	209.88	2	MODERATE	0.00	1	LOW	4	LOW
Unnamed Divide 7	121	1	LOW	166.00	1	LOW	0.00	1	LOW	3	LOW
Unnamed Dunn 1	119	1	LOW	120.99	1	LOW	0.00	1	LOW	3	LOW
Unnamed Divide 5	111	1	LOW	166.00	1	LOW	0.00	1	LOW	3	LOW
Austin	111	1	LOW	160.72	1	LOW	0.00	1	LOW	3	LOW
*Denbigh Buried Channel	110	1	LOW	186.77	1	LOW	0.00	1	LOW	3	LOW
Stoneview	105	1	LOW	168.18	1	LOW	0.00	1	LOW	3	LOW
Unnamed Divide 2	105	1	LOW	166.00	1	LOW	0.00	1	LOW	3	LOW
Clary	105	1	LOW	176.68	1	LOW	0.00	1	LOW	3	LOW
Unnamed Divide 8	101	1	LOW	166.00	1	LOW	0.00	1	LOW	3	LOW
Foothills	100	1	LOW	176.68	1	LOW	0.00	1	LOW	3	LOW
Lucy	100	1	LOW	176.68	1	LOW	0.00	1	LOW	3	LOW

ATTACHMENT 3: 2021 ADDENDUM GEOGRAPHIC TARGETING SYSTEM RESULTS

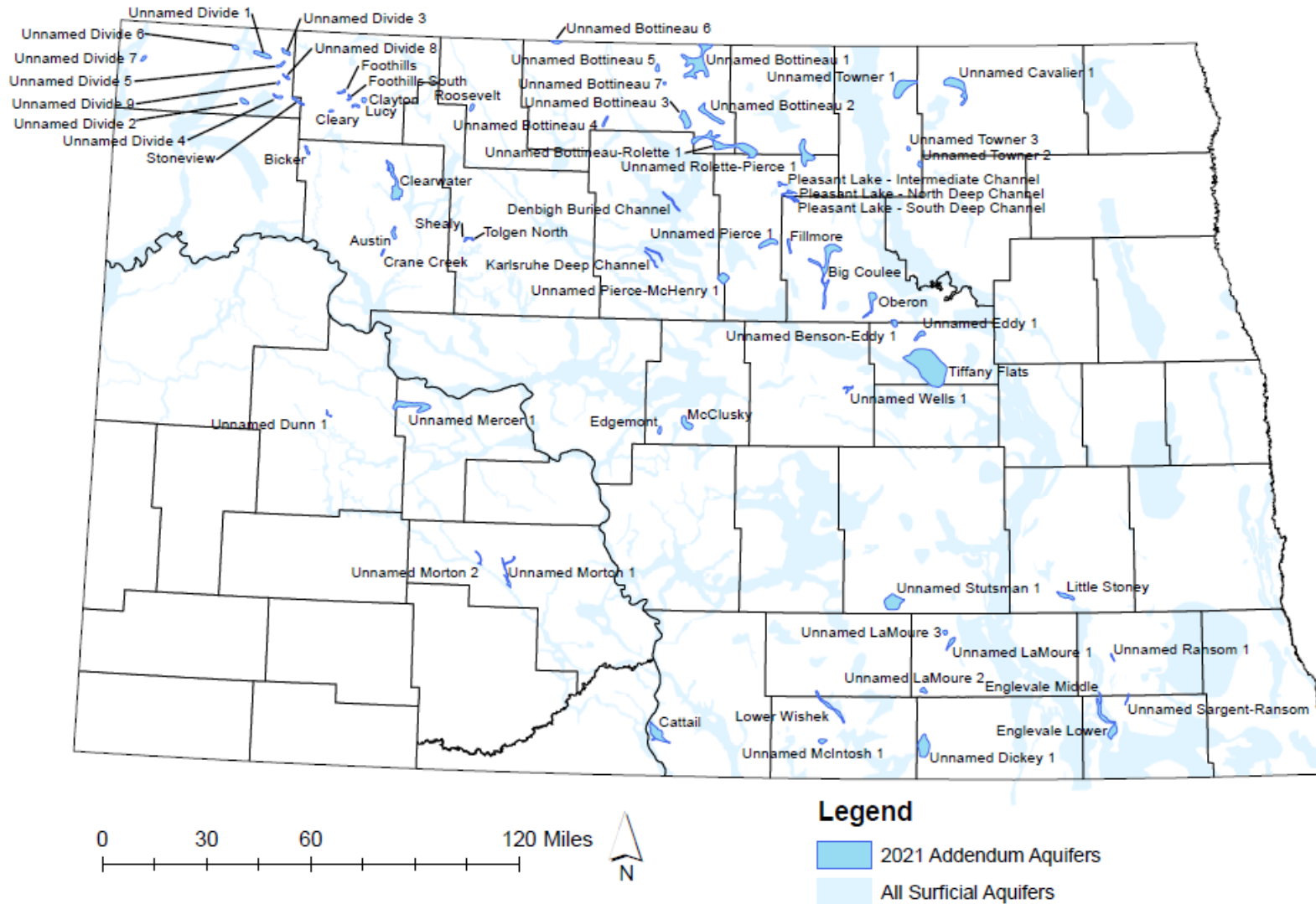
Aquifer	Vulnerability Value (Pesticide DRASTIC)	Vulnerability Score	Vulnerability Rating	Sensitivity Value (dollars/farmed acre)	Sensitivity Score	Sensitivity Rating	Risk Value (acre-feet/mi ²)	Risk Score	Risk Rating	Total Monitoring Score	Total Monitoring Priority Rating
Foothills South	95	1	LOW	176.68	1	LOW	0.00	1	LOW	3	LOW
Clayton	93	1	LOW	176.68	1	LOW	0.00	1	LOW	3	LOW
Unnamed Divide 9	89	1	LOW	166.00	1	LOW	0.00	1	LOW	3	LOW
Crane Creek	89	1	LOW	160.72	1	LOW	0.00	1	LOW	3	LOW

*Partly or completely overlain by another surficial aquifer

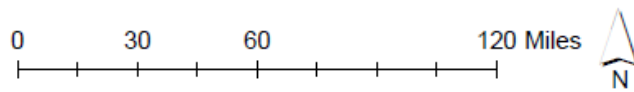
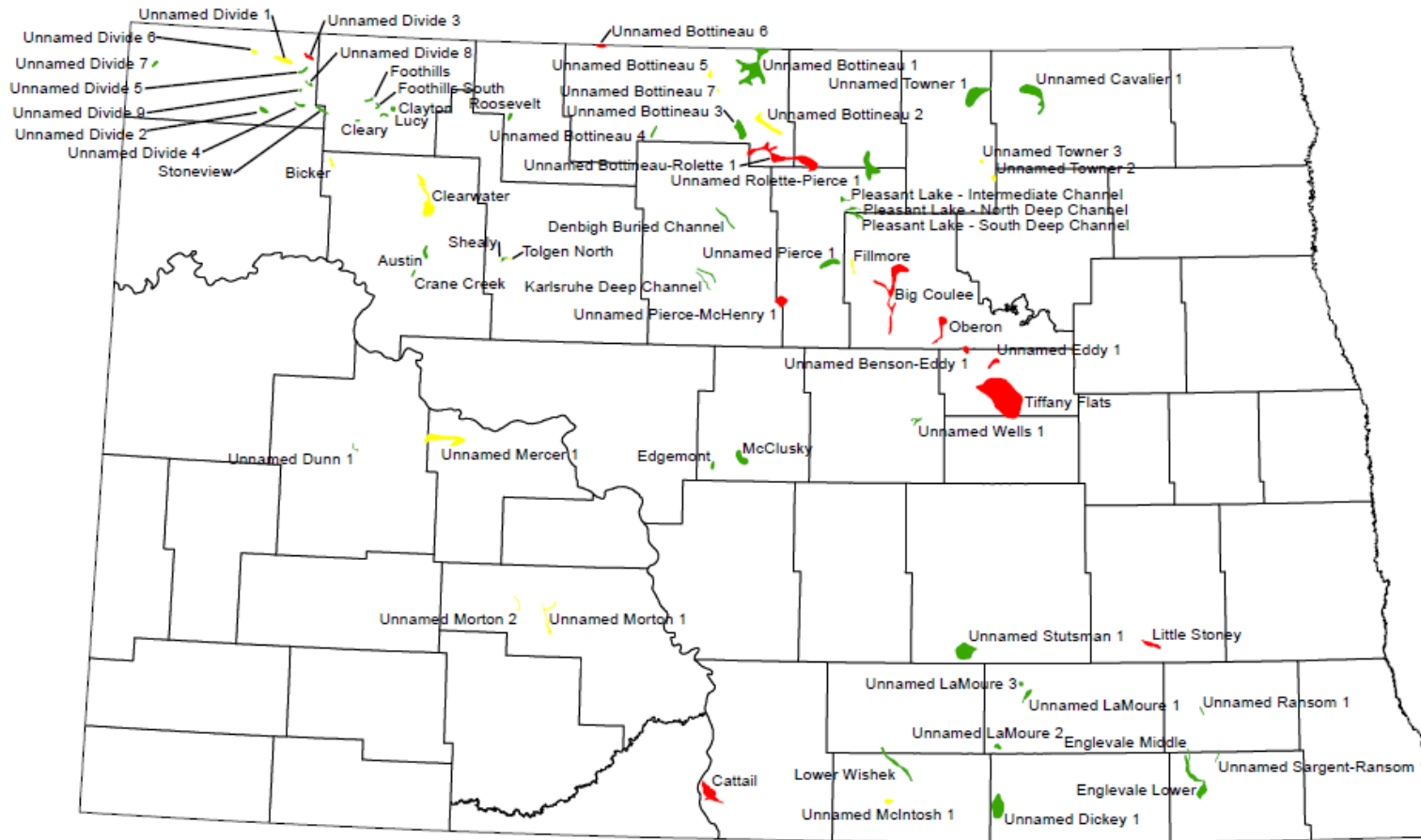
ATTACHMENT 4

2021 ADDENDUM MAP FIGURES

2021 Addendum Surficial Aquifers



2021 Addendum Vulnerability Results Pesticide DRASTIC Model

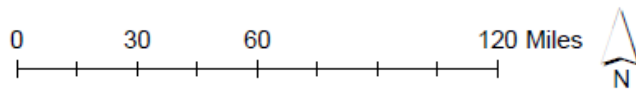
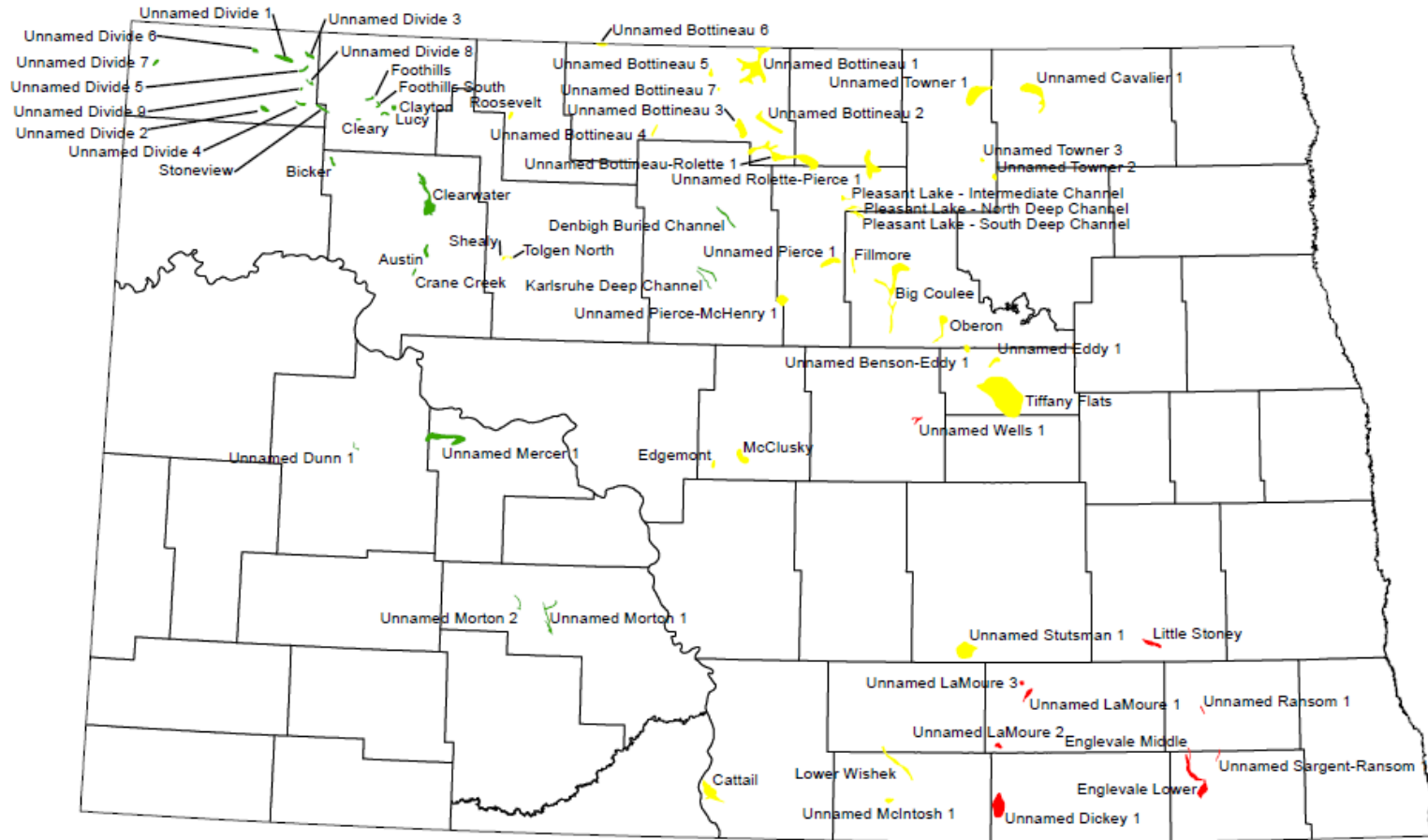


Legend

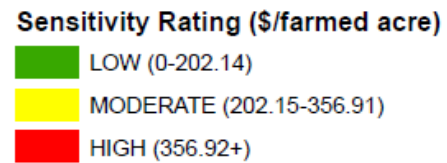
Vulnerability Rating (Pesticide DRASTIC)

- LOW (0-129)
- MODERATE (130-159)
- HIGH (160+)

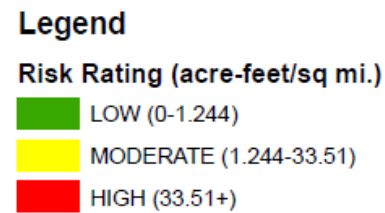
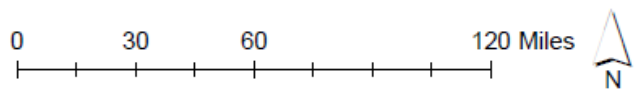
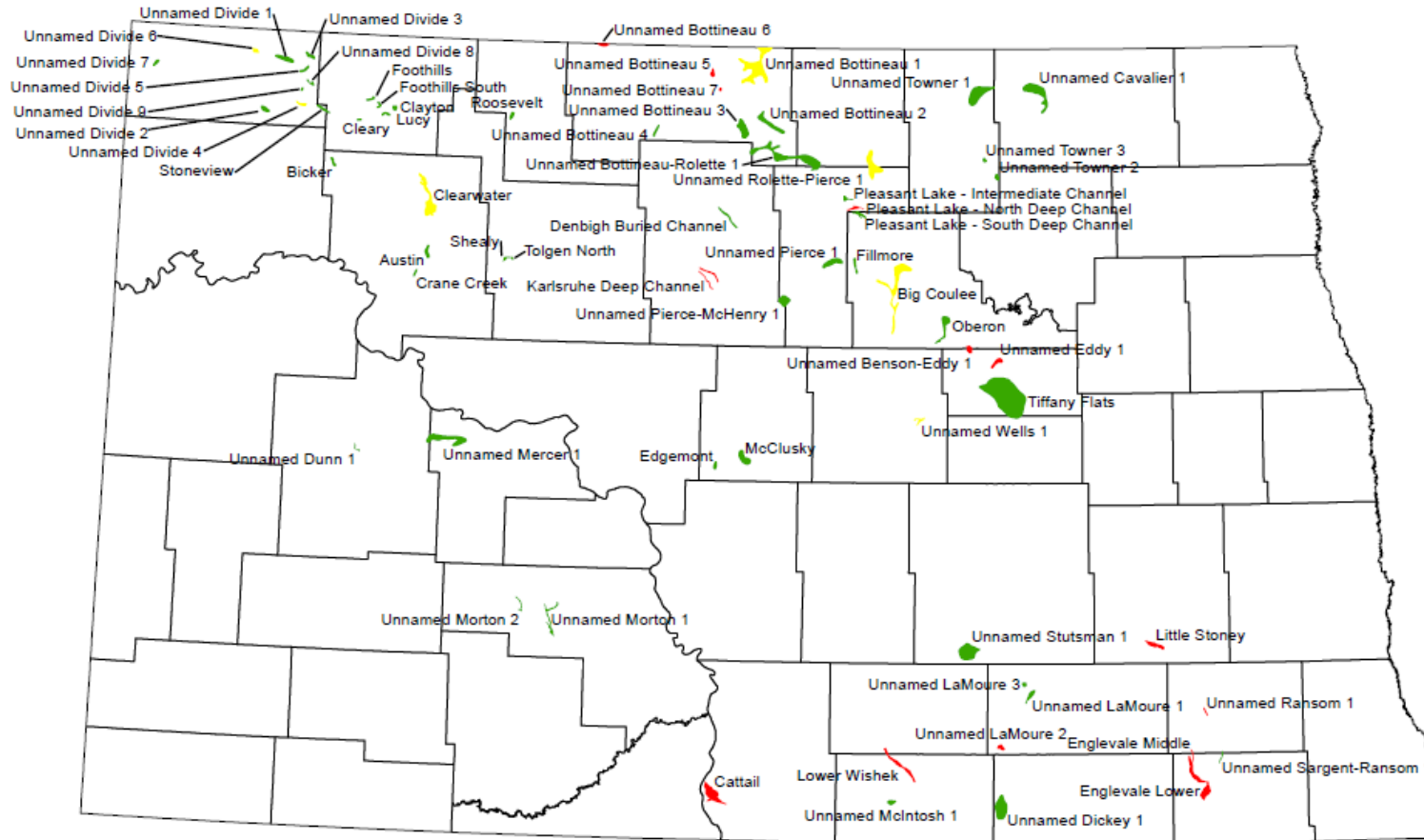
2021 Addendum Sensitivity Results Agricultural Sales per Farmed Acre



Legend



2021 Addendum Risk Results Appropriated Aquifer Water per Square Mile



2021 Addendum Total Monitoring Score

