Implementation of Ammonia Criteria

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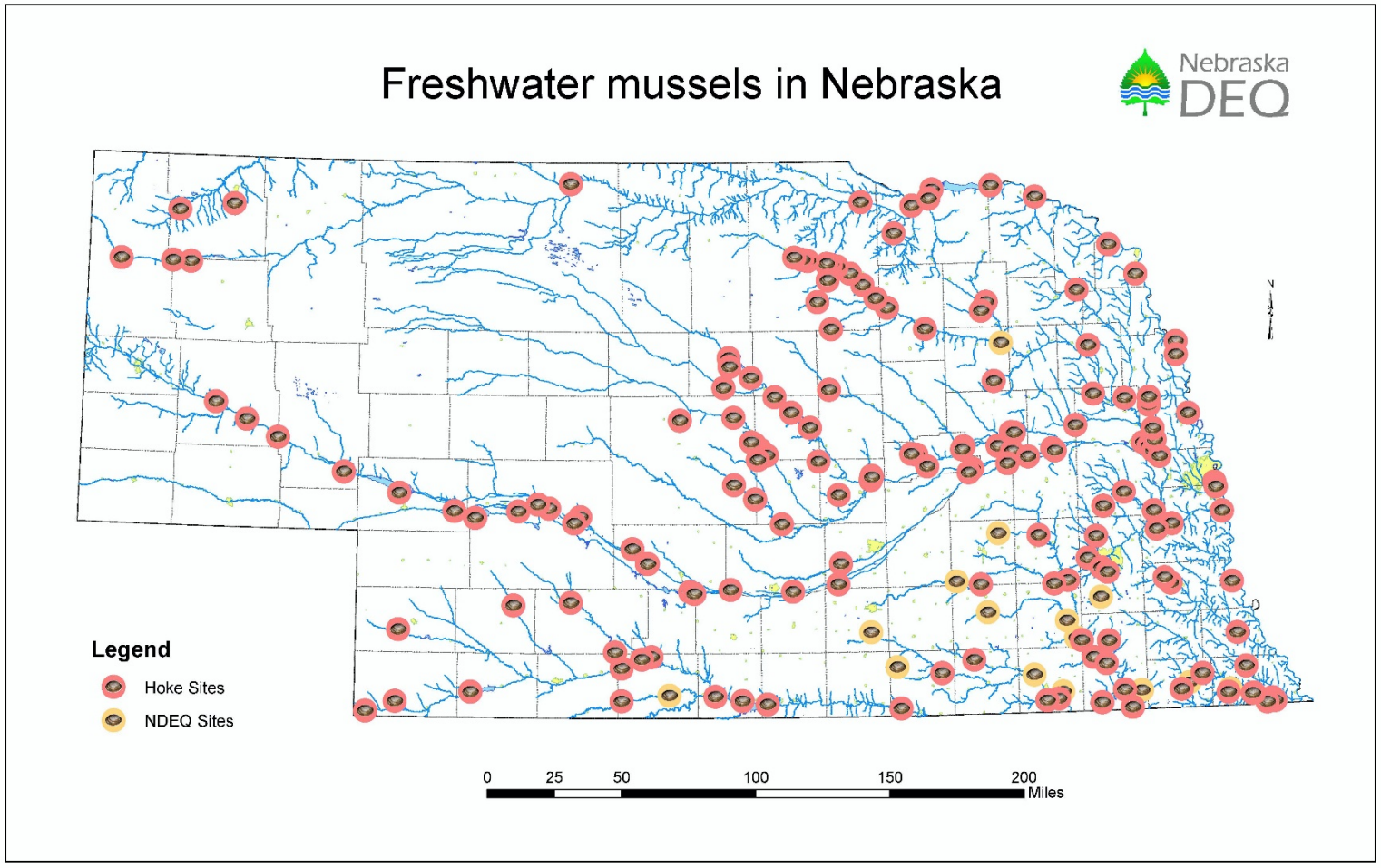
Final Aquatic Life Ambient Water Quality Criteria for Ammonia

- Freshwater ammonia criteria implemented in Federal Register August 22, 2013
- Passed in Nebraska Title 117 on December 13, 2014
- NDEQ/NDEE began to include the new criteria in NPDES permits in spring 2015
- September 2019 - Majority of Nebraska permittees with the potential to discharge ammonia have implemented the new criteria in their permit

Why Implement the Ammonia Criteria?

- Protect aquatic biota, particularly freshwater mussels (*Musculium*, *Lampsilis*, *Villosa*) – Aquatic surveys are crucial for implementation



Final 2013 ALC Criteria

2013 FINAL ALC CRITERIA FOR AMMONIA

(Magnitude, Frequency, and Duration)	
(mg TAN/L) pH 7.0, T=20 °C	
Acute (1-hour average)	17
Chronic (30-day rolling average)	*1.9

*Not to exceed 2.5 times the CCC as a 4-day average within the 30-days, i.e. 4.8 mg TAN/L at pH 7 and 20 °C more than once in 3 years on average.

Criteria frequency: Not to be exceeded more than once in 3 years on average.

- TAN – total ammonia nitrogen
- CMC – criterion maximum concentration – acute criterion
- CCC – criterion continuous concentration – chronic criterion

Nebraska – Site-Specific Criteria

- 40 CFR Part 131.11(b)(1)(ii) – allows for site-specific conditions
- Nebraska has warmwater and coldwater criteria (coldwater <25 °C)
- CW Acute – One Hour Average Concentration - Based on 1Q10 Conditions

003.03A Total Ammonia (as nitrogen).

003.03A1 One-hour average concentration in mg/l not to exceed the numerical value given by

$$\text{AV=Minimum of } \left\{\left(\frac{0.275}{1+10^{7.204-pH}}+\frac{39.0}{1+10^{pH-7.204}}\right), \text{ or}\right.$$

$$\left. 0.7249\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\left(23.12\times 10^{0.036(20-Temp)}\right)\right\}$$

where Temp is °C

- CW Chronic – Thirty-Day Average Concentration - Based on 30Q5 Conditions

003.03A2 Thirty-day average concentration in mg/l not to exceed the numerical value given by

$$CV = 0.8876\left(\frac{0.0278}{1+10^{7.688-pH}}+\frac{1.1994}{1+10^{pH-7.688}}\right)\left(2.126\times 10^{0.028\times(20-\text{Maximum of }\{Temp,\text{ or }7\})}\right)$$

where Temp is °C

Acute Warmwater Criteria

003.04A1 One-hour average concentration in mg/l not to exceed the numerical value given by

$$AV = 0.7249\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right) \times \text{Minimum of}\left\{51.93, \text{ or } 23.12\left(10^{0.036(20-Temp)}\right)\right\}$$

where Temp is °C

ONE-HOUR AVERAGE CRITERIA FOR TOTAL AMMONIA (mg/l)
Warmwater Aquatic Life Use Classes

Temperature (°C) \ pH	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0	8.2	8.4	8.6	8.8	9.0
0.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
2.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
4.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
6.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
8.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
10.0	48.86	43.80	37.65	30.81	23.96	17.77	12.66	8.77	5.97	4.05	2.77	1.92	1.38
12.0	42.22	37.85	32.53	26.62	20.70	15.35	10.94	7.58	5.16	3.50	2.39	1.66	1.19
14.0	35.77	32.07	27.56	22.56	17.54	13.01	9.27	6.42	4.37	2.97	2.02	1.41	1.01
16.0	30.30	27.17	23.35	19.11	14.86	11.02	7.85	5.44	3.71	2.51	1.72	1.19	0.86
18.0	25.67	23.02	19.78	16.19	12.59	9.34	6.65	4.61	3.14	2.13	1.45	1.01	0.73
20.0	21.75	19.50	16.76	13.72	10.67	7.91	5.64	3.90	2.66	1.80	1.23	0.86	0.62
22.0	18.43	16.52	14.20	11.62	9.04	6.70	4.78	3.31	2.25	1.53	1.04	0.73	0.52
24.0	15.61	14.00	12.03	9.85	7.66	5.68	4.05	2.80	1.91	1.29	0.88	0.62	0.44
26.0	13.23	11.86	10.19	8.34	6.49	4.81	3.43	2.37	1.62	1.10	0.75	0.52	0.37
28.0	11.21	10.05	8.64	7.07	5.50	4.08	2.90	2.01	1.37	0.93	0.63	0.44	0.32
30.0	9.50	8.51	7.32	5.99	4.66	3.45	2.46	1.70	1.16	0.79	0.54	0.37	0.27

Warmwater Chronic Criteria

003.04A2 Thirty-day average concentration in mg/l not to exceed the numerical value given by

$$CV = 0.8876\left(\frac{0.0278}{1+10^{7.688-pH}}+\frac{1.1994}{1+10^{pH-7.688}}\right)\left(2.126\times 10^{0.028\times(20-\text{Maximum of }\{Temp,\text{ or }7\})}\right)$$

where Temp is °C

003.04A2a The highest four-day average concentration within a thirty-day period shall not exceed 2.5 times the thirty-day criterion.

003.04A2b The following table shows thirty-day average criteria for total ammonia at various temperatures and pHs.

THIRTY-DAY AVERAGE CRITERIA FOR TOTAL AMMONIA (mg/l)
Warmwater Aquatic Life Use Classes

Temperature (°C) \ pH	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0	8.2	8.4	8.6	8.8	9.0
0.0	4.85	4.65	4.36	3.98	3.49	2.94	2.35	1.80	1.32	0.95	0.68	0.49	0.36
2.0	4.85	4.65	4.36	3.98	3.49	2.94	2.35	1.80	1.32	0.95	0.68	0.49	0.36
4.0	4.85	4.65	4.36	3.98	3.49	2.94	2.35	1.80	1.32	0.95	0.68	0.49	0.36
6.0	4.85	4.65	4.36	3.98	3.49	2.94	2.35	1.80	1.32	0.95	0.68	0.49	0.36
8.0	4.54	4.36	4.09	3.73	3.28	2.75	2.20	1.68	1.24	0.89	0.64	0.46	0.34
10.0	3.99	3.83	3.60	3.28	2.88	2.42	1.94	1.48	1.09	0.78	0.56	0.40	0.30
12.0	3.51	3.37	3.16	2.88	2.53	2.13	1.70	1.30	0.96	0.69	0.49	0.35	0.26
14.0	3.09	2.96	2.78	2.53	2.23	1.87	1.50	1.14	0.84	0.61	0.43	0.31	0.23
16.0	2.71	2.60	2.44	2.23	1.96	1.64	1.32	1.01	0.74	0.53	0.38	0.27	0.20
18.0	2.38	2.29	2.15	1.96	1.72	1.44	1.16	0.88	0.65	0.47	0.33	0.24	0.18
20.0	2.10	2.01	1.89	1.72	1.51	1.27	1.02	0.78	0.57	0.41	0.29	0.21	0.16
22.0	1.84	1.77	1.66	1.51	1.33	1.12	0.89	0.68	0.50	0.36	0.26	0.19	0.14
24.0	1.62	1.55	1.46	1.33	1.17	0.98	0.79	0.60	0.44	0.32	0.23	0.16	0.12
26.0	1.42	1.37	1.28	1.17	1.03	0.86	0.69	0.53	0.39	0.28	0.20	0.14	0.11
28.0	1.25	1.20	1.13	1.03	0.90	0.76	0.61	0.46	0.34	0.25	0.18	0.13	0.09
30.0	1.10	1.05	0.99	0.90	0.79	0.67	0.53	0.41	0.30	0.22	0.15	0.11	0.08

Creating Limits using the Ammonia ALC

- Every state develops limits differently
- Technical Support Document for Water Quality-based Toxics Control (TSD)
- Limits may be developed with:
  - End-of-pipe limits based on criteria
  - Wasteload allocations
  - Mixing zones
  - Dye studies
  - Software
    - CORMIX
    - OpenFOAM
    - Visual Plumes

Nebraska Two Value Steady-State WLAs

Facility	Seward WWTF
Program ID	NE0023876
Receiving Water	Plum Creek
Segment	BB4-20600
Stream Flow Source	Stream Calculation
Confidence	Low
Background pollutant source	BB4-20800
Confidence	Med
Effluent data source	ICIS
Confidence	High

	Spring		Summer		Winter
1q10 cfs	6.14		0.45		4.30
7q10 cfs	8.90		0.91		5.48
30q5 cfs	10.96		3.93		8.05
Chronic NH3 background mg/L	0.1		0.12		0.05
Acute NH3 background mg/L	0.564		0.221		0.193
Other Chronic background mg/L					
Other Acute background mg/L					
Effluent Median MGD	0.792		0.841		0.73
Effluent Median cfs	1.225		1.301		1.129

	Known Stream Flow (cfs)	Known Average Velocity (ft/s)	Known Average Depth (ft)	Known Average Width (ft)	Stream Slope (ft/mile)	Ls/Lv	Chronic Mixing Zone to 5000 Ft?
Receiving Stream Characteristics	5.46	0.65	0.7	12	6	1.5	N

Spring			Summer			Winter		
Chronic NH3 Criteria	Chronic NH3 WLA	% Stream	Chronic NH3 Criteria	Chronic NH3 WLA	% Stream	Chronic NH3 Criteria	Chronic NH3 WLA	% Stream
0.984	**8.89**	**100.0**	0.978	**3.57**	**100.0**	2.759	**22.07**	**100.0**
Acute NH3 Criteria	Acute NH3 WLA	%Stream	Acute NH3 Criteria	Acute NH3 WLA	% Stream	Acute NH3 WLA	Acute NH3 WLA	%Stream
12.717	**39.37**	**43.8**	8.099	**9.46**	**50.00**	13.793	**34.08**	**39.2**

Nebraska Water Quality Limits

General Data	
Facility Name:	Seward WWTF
Permit Number:	NE0023876
Date:	3-Apr-18
Permit Writer:	Patrick Ducey
Receiving Stream:	Plum Creek
Title 117 ID:	BB4-20600
Aquatic Use:	WWB
Pollutant of Concern:	NH3
Coefficient of Variation (CV):	
Spring	0.729
Summer	0.362
Winter	1.274
Samples/Month (N):	4
Chronic (N) day average:	4

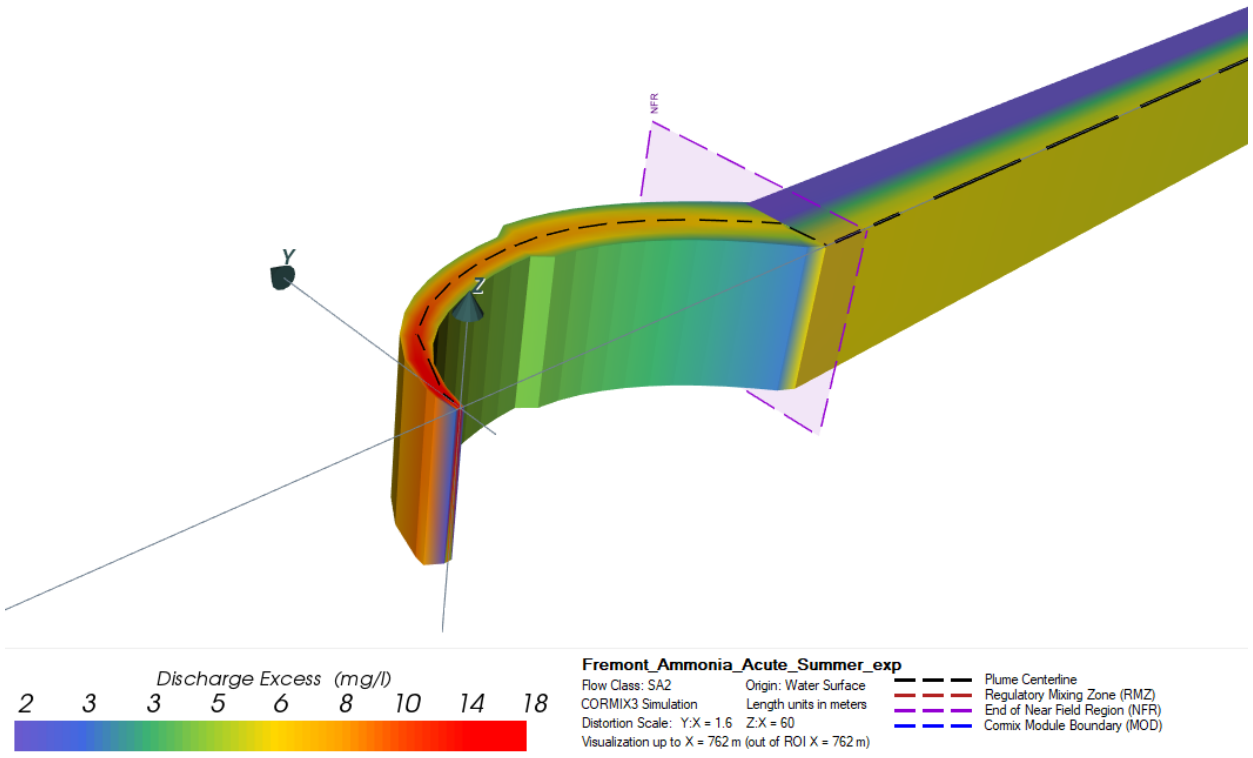
Data from WLA Worksheet	Spring	Summer	Winter
Effluent Flow in cfs:	1.225	1.301	1.129
1q10 Stream Flow in cfs:	6.14	0.45	4.3
7q10 Stream Flow in cfs:	8.9	0.91	5.48
30q5 Stream Flow in cfs:	10.96	3.93	8.05
% 1q10 used for mixing:	43.776	50.000	39.182
% 7q10 used for mixing:	100.000	100.000	100.000
% 30q5 used for mixing:	100.000	100.000	100.000
Acute WLA:	39.37	9.46	34.08
Chronic WLA:	8.89	3.57	22.07

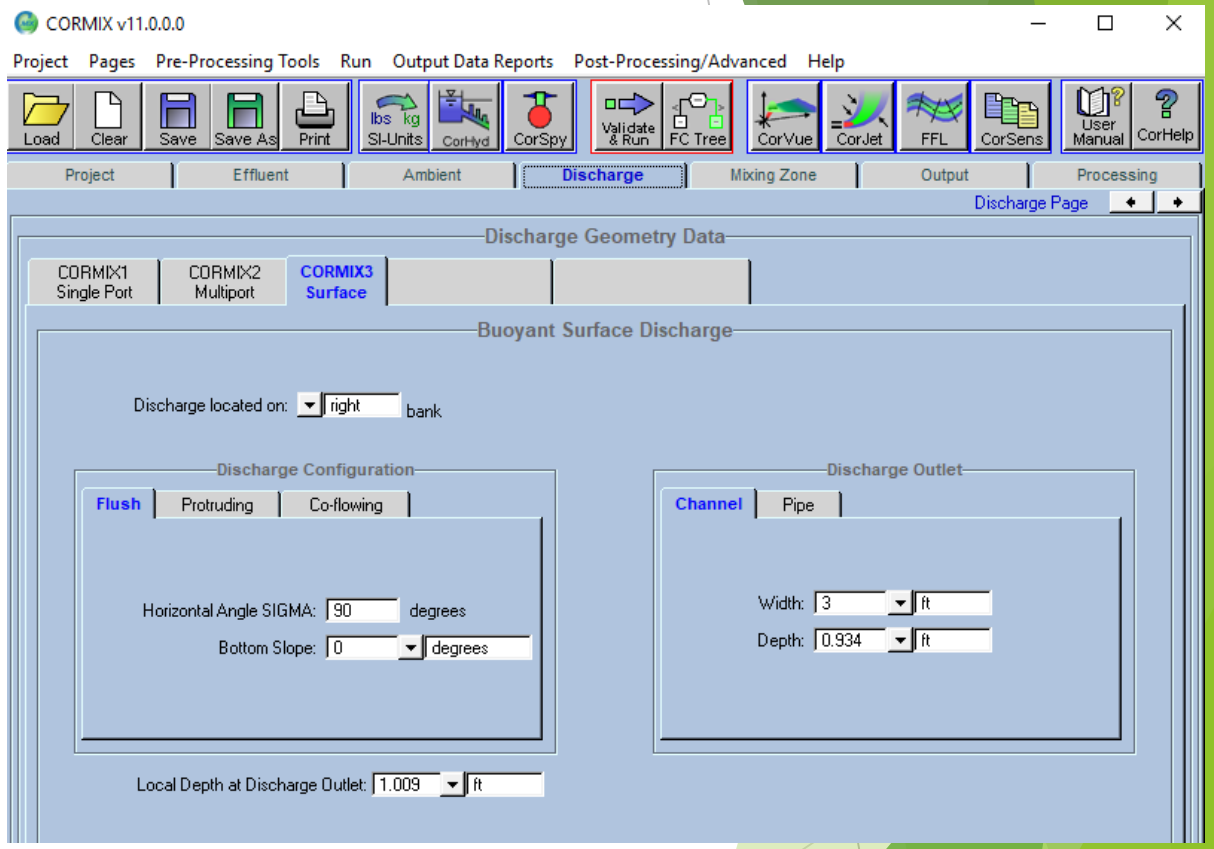
Calculated WLA Multipliers	Spring	Summer	Winter
acute WLA multiplier:	0.271	0.470	0.165
chronic WLA multiplier:	0.468	0.669	0.305
MDL LTA multiplier:	3.69	2.13	6.06
AML LTA multiplier:	1.68	1.32	2.20

Water Quality Based Permit Limit Calculations for: NH3	Spring	Summer	Winter
Acute WLA	39.37	9.46	34.08
Chronic WLA	8.89	3.57	22.07
Acute LTA	10.67	4.45	5.62
Chronic LTA	4.16	2.39	6.73
Concentration Based Permit Limits:			
Maximum Daily (mg/L)	***15.35***	***5.08***	***34.08***
Average Monthly (mg/L)	***6.99***	***3.16***	***12.38***
Mass Based Permit Limits:			
Maximum Daily (kg/day)	***46.02***	***16.17***	***94.17***
Average Monthly (kg/day)	***20.95***	***10.05***	***34.22***

Whole Effluent Toxicity Limits **Based on CV of 0.6	Spring	Summer	Winter
Acute WLA	0.96	0.35	0.75
Chronic WLA	8.26	1.70	5.85
Acute LTA	0.31	0.11	0.24
Chronic LTA	4.36	0.90	3.09
Acute Toxicity (TUa)	0.96	0.35	0.75
Chronic Toxicity (TUc)	13.57	2.79	9.61
Permit Limits:			
Acute Toxicity (TUa)	***1.00***	***1.00***	***1.00***

CORMIX





- Advantages: More accurate, limits are higher than steady-state but still protective of water quality
- Disadvantages: Cannot be used for very low flow and ephemeral streams

Limits Implemented in Nebraska NPDES Permits

- Monitoring frequency dependent on effluent flow rate, compliance history for ammonia, reasonable potential
- Sample type dependent on type of facility
- Most facilities have been able to meet new limits

Table 2: Seasonal Discharge Limits and Monitoring Requirements

Parameters	Storet #	Units	Discharge Limits		Monitoring Frequency	Sample Type
			Monthly Average	Daily Maximum		
Spring Ammonia (March 1 – May 31)	00610	mg/L	2.47	4.96	Weekly	24-Hour Composite
		kg/day	5.86	11.77		
Summer Ammonia (June 1 – Oct. 31)	00610	mg/L	1.99	3.99	Weekly	24-Hour Composite
		kg/day	4.66	9.35		
Winter Ammonia (Nov. 1 – Feb. 28 [29])	00610	mg/L	4.62	9.26	Weekly	24-Hour Composite
		kg/day	10.59	21.23		
Acute Toxicity *Ceriodaphnia sp*	61425	TUa	Report	1.00	Annually[a]	24-Hour Composite
Acute Toxicity *Pimephales promelas*	61427	TUa	Report	1.00	Annually[a]	24-Hour Composite

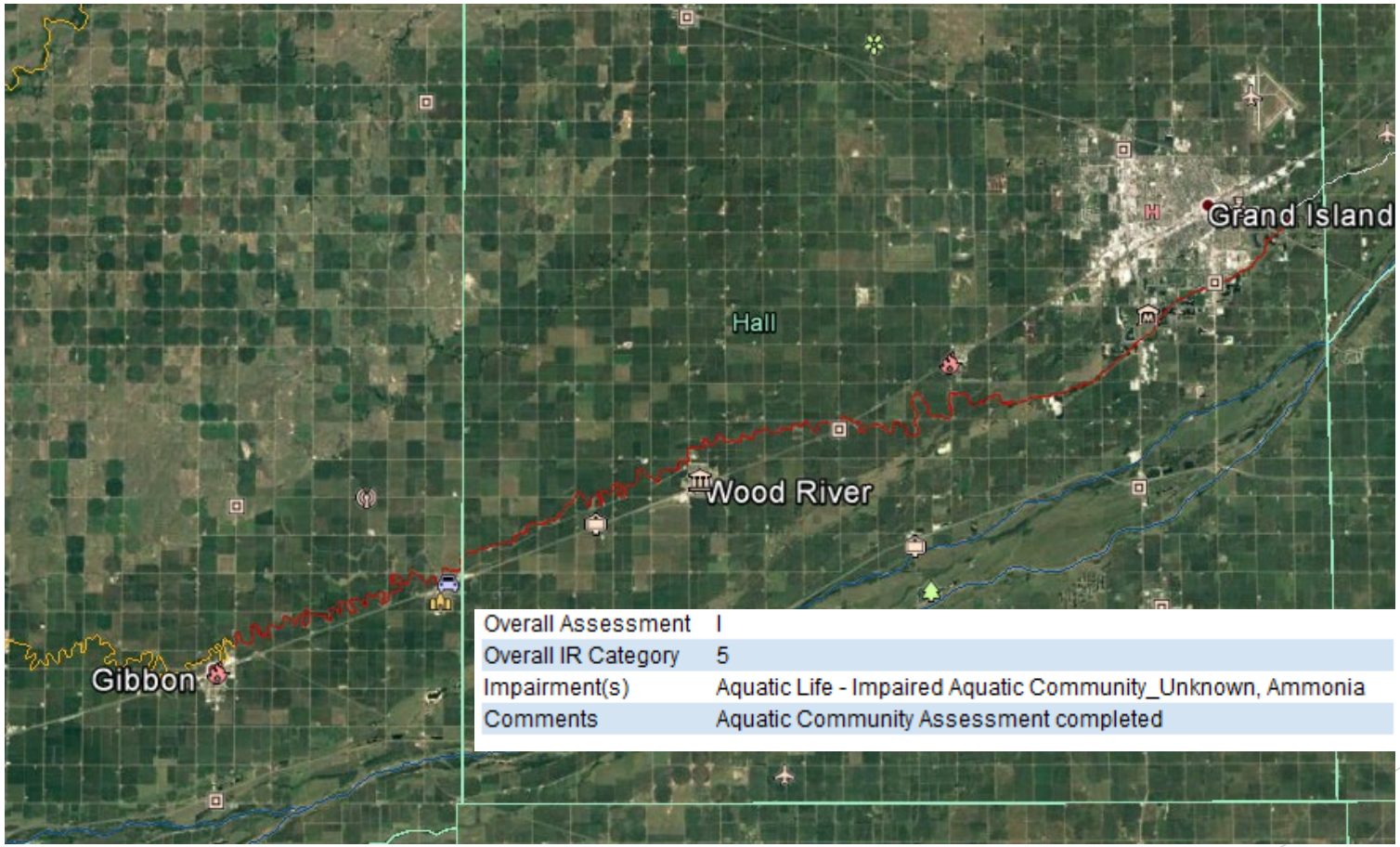
Footnotes:

[a] Sampling shall be conducted seasonally. One year testing shall be conducted in spring, one in summer, one in winter, etc.

Abbreviations: mg/L – milligrams per liter kg/day – kilograms per day TUa – acute toxic units

Stream Impairments

- In Nebraska, the Wood River was designated as impaired by ammonia
- Ammonia ALC implementation for the Gibbon POTW addresses the impairment

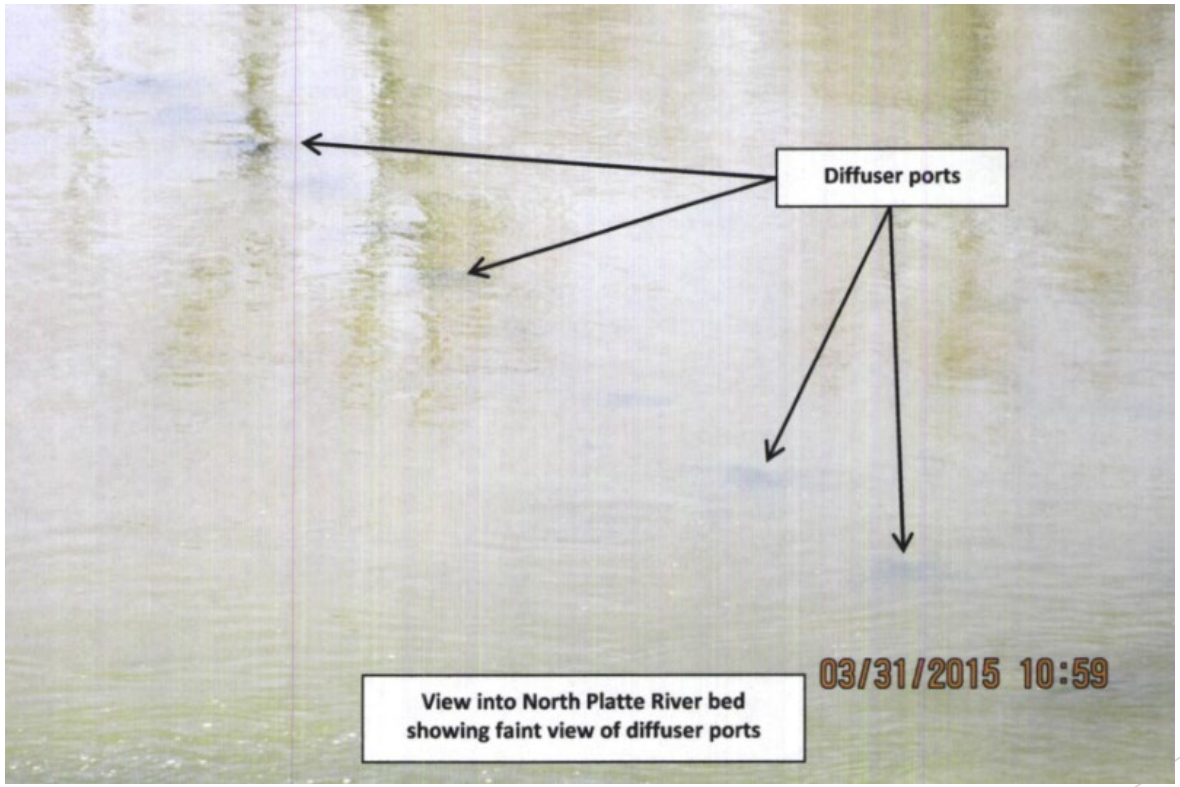


What if Facilities Cannot Meet Proposed Limits?

- Permitting Tools
  - Compliance Schedules – rules set forth in 40 CFR Part 122.47
  - More accurate data
  - Variances – Nebraska considering controlled discharge lagoon variance
- Facility improvements, new treatment technologies
- Other methods to meet ammonia ALC
  - Ceasing to discharge
  - Land application of treated effluent
  - Consent Orders

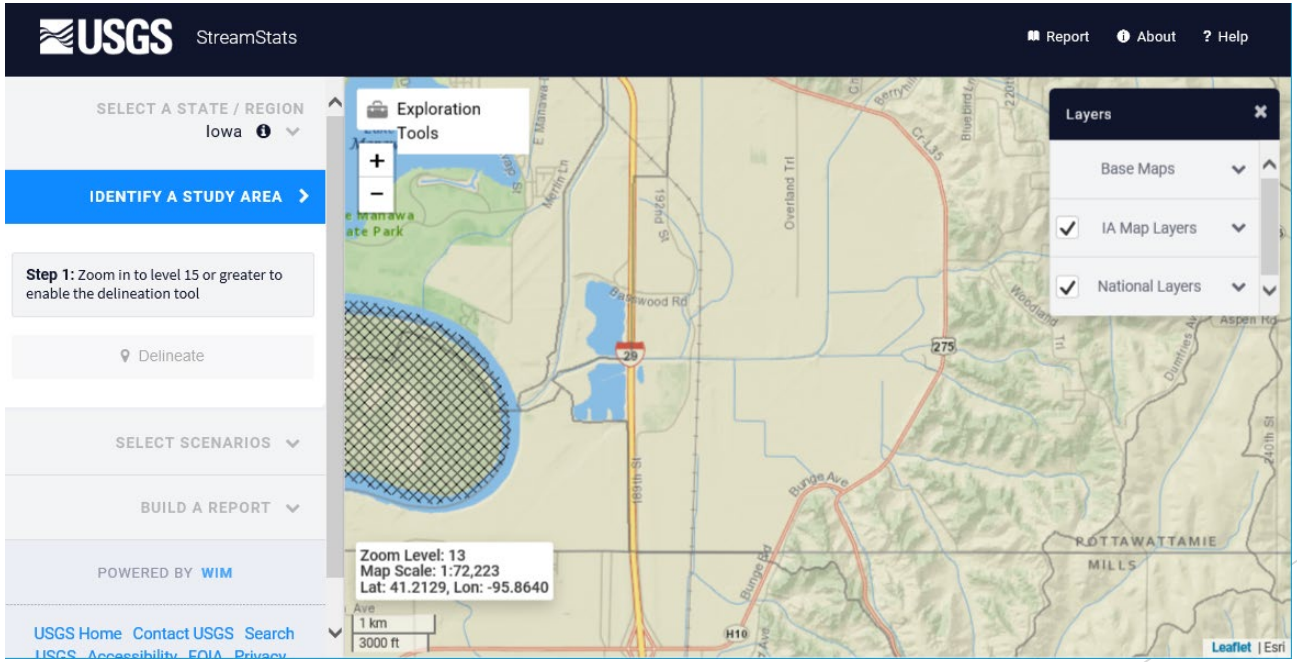
New Technologies and Engineering

- Some municipalities need to construct new WWTFs to meet limits – expensive
- York Water Reclamation Facility – newest POTW in state – BNR
- Some POTWs installing diffusers to increase mixing



Challenges to ALC Implementation - Data

- EPA permit writers do not have comprehensive access to state databases
- Lack of data (Temperature, pH, ammonia content, flow rate)
- Receiving stream flow might be difficult to determine
  - USGS gages – might not be available (Nebraska also has DNR gages)
  - StreamStats – not available in every state



Changing River Conditions

- The ammonia criteria is dependent on temperature and pressure, what if those are changing?
- In Nebraska, the receiving stream is basis for chronic criteria, some facilities have limits based on the chronic criteria
- In many Nebraska streams, pH is increasing

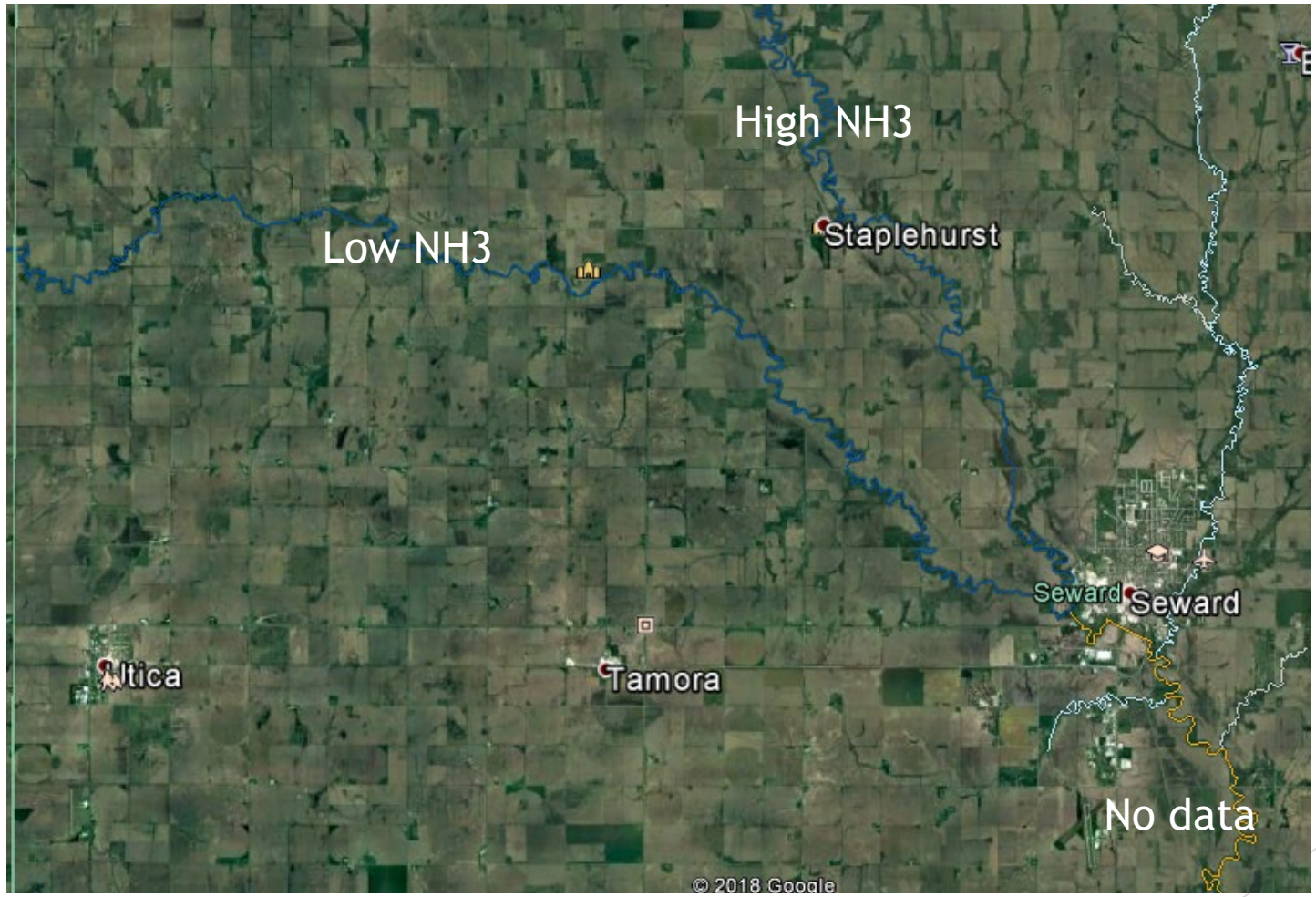
Big Blue River - BB1-10000 Median pH		
2005-2008		
Spring	Summer	Winter
7.8	8.03	7.55
2011-2014		
Spring	Summer	Winter
8.5	8.5	7.93

- Temperature – Do states have data regarding changing temperatures? Higher temperature means lower criteria for facilities.

Ammonia Residuals in Streams

- High background ammonia – from other point sources and non-point sources can create lower limits
- Example: Gering - Western Sugar – Scottsbluff

Choosing Data – Background Ammonia



Controlled Discharge Lagoon Facilities

- Have high pH (often over 9.0 standard units)
- Low ammonia limits
- Many facilities are encouraged to land apply
- Nebraska is looking into a variance for CDLs

NPDES Permits

- 40 CFR Part 122.44 – Gives authority to establish limitations and standards
- Antidegradation and protection of beneficial uses is important tool to implement the ALC
- Use TMDLs if available
- Anti-backsliding can be useful for some facilities to maintain limits
  - Facilities may be exempt from anti-backsliding if they cannot meet the new limits
  - Exemptions may be useful for variances
  - New facilities may be exempt if proxy data is used

Questions/Comments?

- What are your solutions to implementing the ammonia criteria?
- What if a facility cannot meet limits?

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