CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: February 20, 2023 WPDES Permit #0059315-04-0

TO: Jeff Jackson – Wastewater Specialist, Baldwin

FROM: Ian Anderson – CAFO Hydrogeologist Program Coordinator

SUBJECT: Emerald Sky Dairy – Groundwater Monitoring Review

Background:
The Emerald Sky Dairy (ESD) production area is located in Section 22, T30N R16W, Town of Emerald, St. Croix County. The WPDES permit for Emerald Sky Dairy (Permit #59315-04-0) has been expired since 2020. There have been concerns expressed by the public about groundwater issues in the area after a manure spill in 2017 and some regional well sampling indicating elevated nitrate. The St. Croix County Land Conservation Department has conducted water supply well sampling efforts before and after 2017 to help people understand the water quality of their wells. This memo describes the site-specific information used to make the recommendation that groundwater monitoring should not be required in the upcoming permit reissuance, including local well construction reports, published county-scale geologic maps, mapping and well sampling efforts conducted by St. Croix County.

Geology/Hydrogeology:
Bedrock in the Town of Emerald is primarily Ordivician dolomite of the Prairie du Chien group, with some pockets of St. Peter sandstone (LePain, 2006). The Prairie du Chien in St. Croix County is known to have numerous sinkholes and bedrock fractures. The county has a sinkhole mapping project to help identify and remediate sinkholes.

Depth to bedrock is somewhat variable in St.Croix County, but appears to be 30 meters (97.5 feet) or more for most of the town of Emerald, getting shallower to the west (Mudrey et al. 1987). Surficial deposits are mapped as River Falls diamicton (Kostka et al. 2004). This description is confirmed by onsite soil pits, which describe soils ranging from silty fine sand (SM) with trace gravel to sandy clay (CL). Notably, surface expressions of bedrock fractures and sinkholes are visible in aerial photos, despite the thickness of unconsolidated material.

Groundwater elevation at the ESD production area is between 1060 and 1080ft MSL, based on water table elevation maps produced by the Wisconsin Geologic and Natural History Survey (WGNHS, 1974, 1981). Both maps indicate groundwater flow is generally from northeast to southwest in the vicinity of the ESD production area, with a regional divide located roughly 3 miles to the east.

Well construction reports (WCRs) at the ESD production area list clay from the surface to 83ft or more, underlain by limestone, which is consistent with what is mapped. Other WCRs show similar geology, predominantly clay over limestone, although sand and gravel deposits are occasionally found. Bedrock appears to get shallower to the north and west of the ESD production area, consistent with what is mapped by Mudrey et al. (1987). Depth to static water level in WCRs at ESD is 150ft or more, which is consistent with the mapped water table elevations (~1060ft) when subtracted from land elevation (~1200ft).

Groundwater Sampling Results:
While there is not currently groundwater monitoring at the ESD production area or on their landspreading fields, there have been groundwater samples collected from private wells as part of the county sampling program.

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St. Croix County collected three rounds of private well samples in 2016 as part of their drinking water program. Samples collected on 5/23/2016 are largely focused on the town of Emerald, which could potentially be affected by ESD production area or landspreading activities. Results from the 5/23/16 sampling event included 21 samples tested for nitrate and total coliform. Nitrate (NO_3^- + NO_2^-) concentrations ranged from 0.5-9.7mg/L, with a mean of 4.1mg/L. These concentrations suggest some impact from human activities, but none exceed the enforcement standard of 10mg/L. Twenty of the samples tested absent for total coliform and one tested present. The total coliform positive well was retested for E. coli, which is standard protocol, and came back absent for E. coli.

St. Croix County has also collected samples from the Emerald Town Hall well (Wisconsin Unique Well Number UC686) monthly since January 2021. All of the samples (n=21) have been well over the enforcement standard for nitrate, with concentrations ranging from 22.1-64.5mg/L and a mean concentration of 41.9mg/L. Well UC686 has static water level below casing depth, which is not optimal well construction, leaving the well vulnerable to contamination.

Conclusions and Recommendations:

While reports have confirmed an egregious manure spill occurred in 2017, mostly due to human error, I have not seen evidence that the spill has caused extensive groundwater quality problems.

As noted above, the county has mapped known sinkholes in the Town of Emerald and beyond. The presence of these sinkholes combined with the suboptimal well construction likely explain the water quality issues at the town hall well.

The site-specific geologic setting at ESD with roughly 80ft to bedrock, overlain by mostly clay with static water level at 150ft makes it difficult to assess the impacts of land use activities with groundwater monitoring. This particular setting in the Town of Emerald, with deeply buried bedrock fractures likely dominating the flow system is unlikely to yield useful monitoring results. As such, I do not recommend groundwater monitoring at Emerald Sky Dairy at this time.

I recommend that fields upgradient of the Town Hall be field surveyed for sinkholes. If sinkholes are located, they should be added to manure spreading restriction maps.

References:

Preliminary Geologic Map of the Buried Bedrock Surface of St. Croix Cty, WI
LePain, D., 2006. WGNHS OFR 2006-04.
https://wgnhs.wisc.edu/catalog/dataset/000870/resource/wofr200604/view/449c6eec-dfbe-42fe-9de3-68adb63c960a

Bedrock Geology of Wisconsin, Northwest Sheet. Mudrey, M. et al., 1987.
https://wgnhs.wisc.edu/catalog/publication/000406/resource/m094

Preliminary Quaterary Geologic Map of St. croix County, Wisconsin. Kostka, S.J., Hinke, H.J., Mickelson, D.M., Baker, R.W., 2004. WGNGHS WOFR 2004-22
https://wgnhs.wisc.edu/catalog/publication/000855/resource/wofr200422

Water-table map of St. Croix County, WI 1974. WGNHS IC32-plate01
https://wgnhs.wisc.edu/catalog/publication/000282/resource/ic32plate01

Generalized Water-Table Elevation Map of St. Croix County, Wisconsin. I.D. Lippelt, 1990. WGNHS Publication M113.

https://wgnhs.wisc.edu/catalog/publication/000425/resource/m113

Attachments:

Figure 1 – Aerial Photo of Emerald Sky Dairy Production Area
Figure 2 – Figure 1 -Topographic Map of Emerald Sky Dairy Production Area
Figure 3a – Modified from Preliminary Geologic Map of the Buried Bedrock Surface of St. Croix Cty
Figure 3b – Map Legend from Geologic Map of of the Buried Bedrock Surface of St. Croix County
Figure 4 – Depth to Bedrock Map of Northwest Wisconsin
Figure 5a – Quaternary Geologic Map of St. Croix County
Figure 5b – Map Legend of Quaternary Geologic Map of St. Croix County
Figure 6 – Water Table Map of St. Croix County, WI 1974
Figure 7 – Map of Well Locations Sampled by St. Croix County in 2016.
Figure 8 – Map of Nitrate Results from Wells Sampled by St. Croix County in Town of Emerald
Figure 9 – Locations of Sinkholes in Town of Emerald, as mapped by St. Croix County
Figure 10 – Inset of Sinkhole Map, zoomed in on area of Emerald Sky Dairy
Figure 11 – Well Construction Report for Emerald Town Hall

Figure 2 – Aerial photo of Emerald Sky Dairy production area

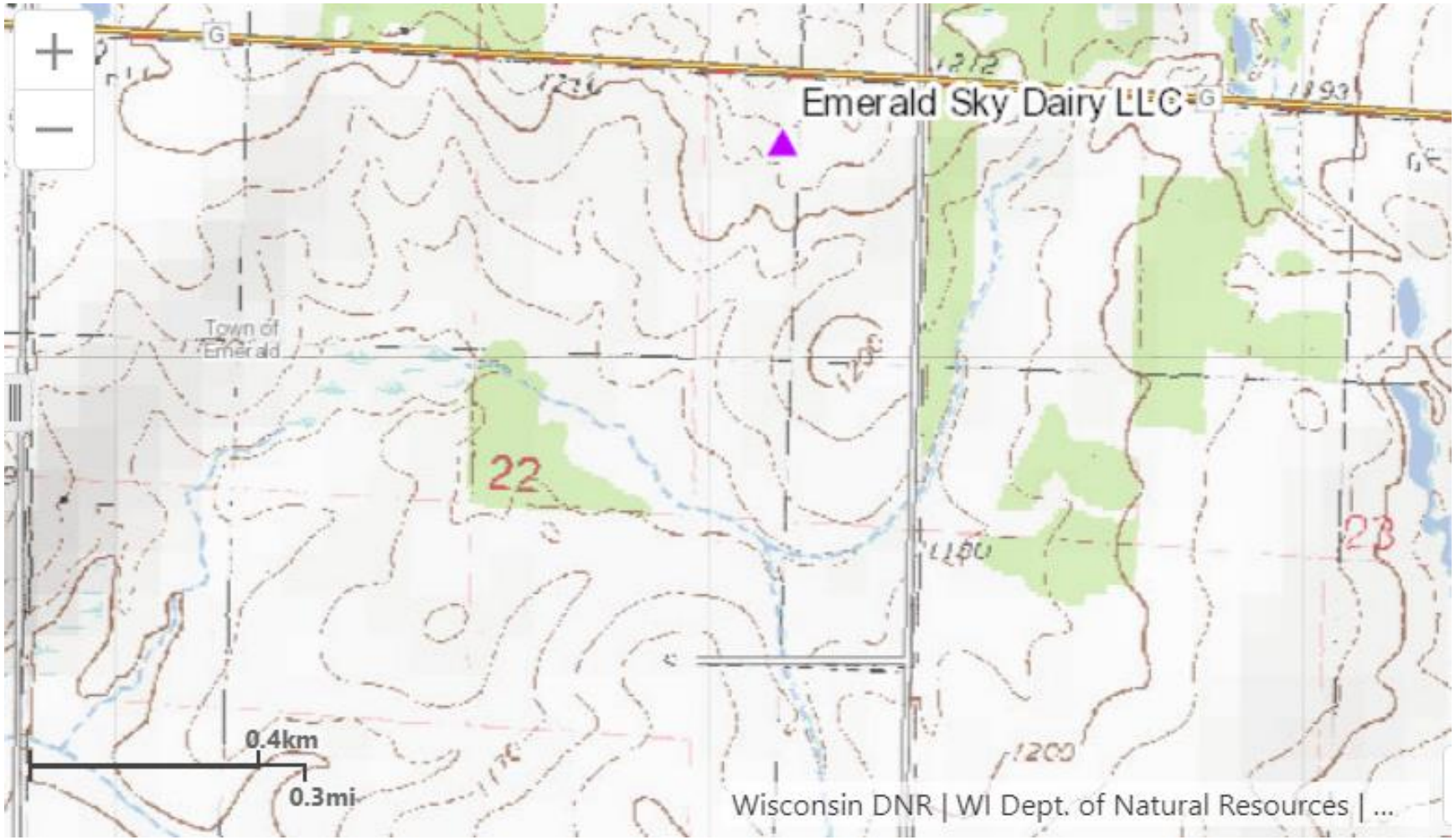


Figure 3 -Topographic Map of Emerald Sky Dairy production area

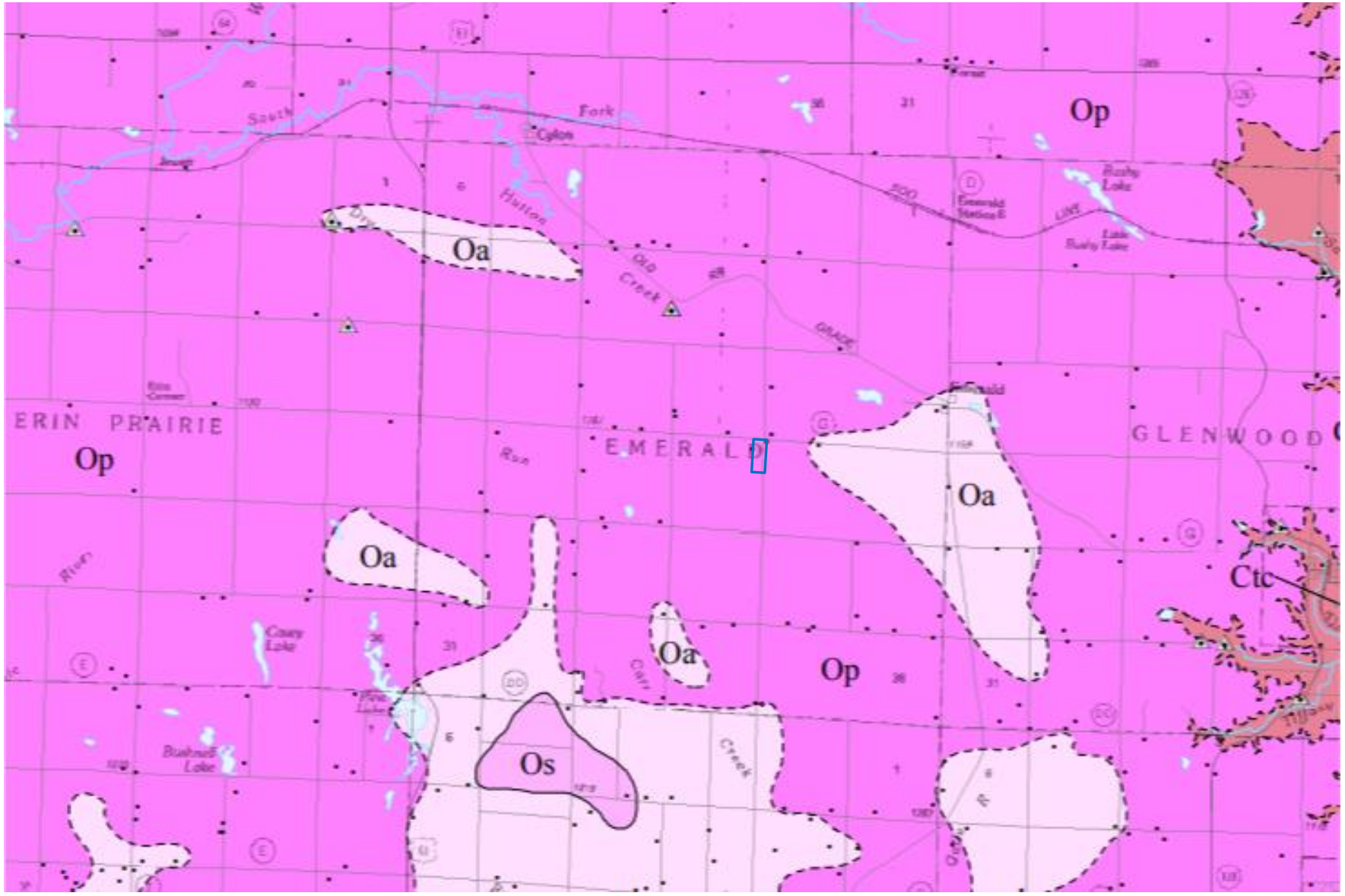


Figure 4a – Excerpt from Preliminary Geologic Map of the Buried Bedrock Surface of St. Croix Cty, WI LePain, D., 2006. WGNHS OFR 2006-04. Blue rectangle is approximate location of Emerald Sky Dairy production area.

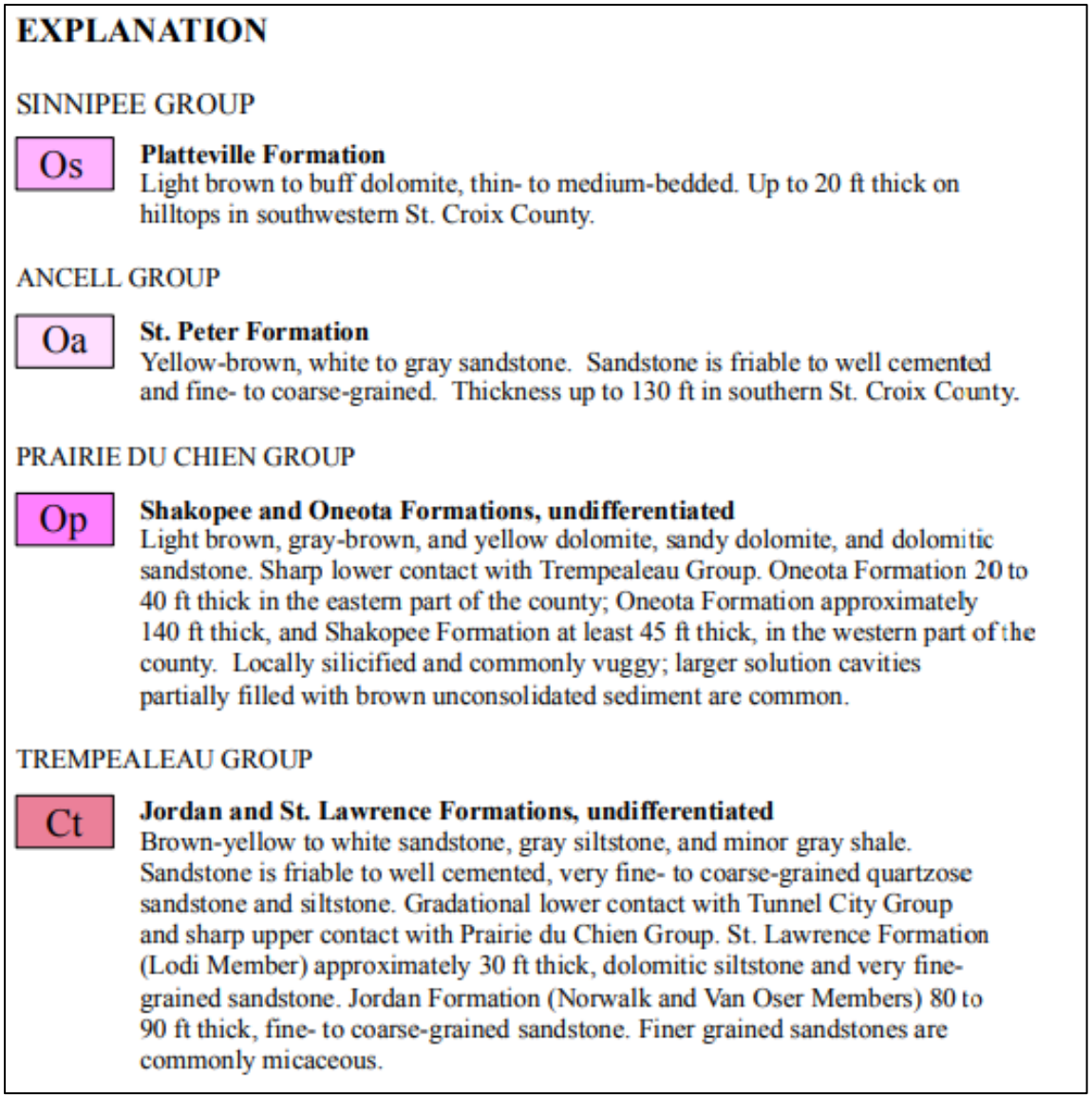


Figure 3b – Map Legend excerpted from WGNHS Open-File Report 2006-04, providing explanation of map symbology and general description of geologic units

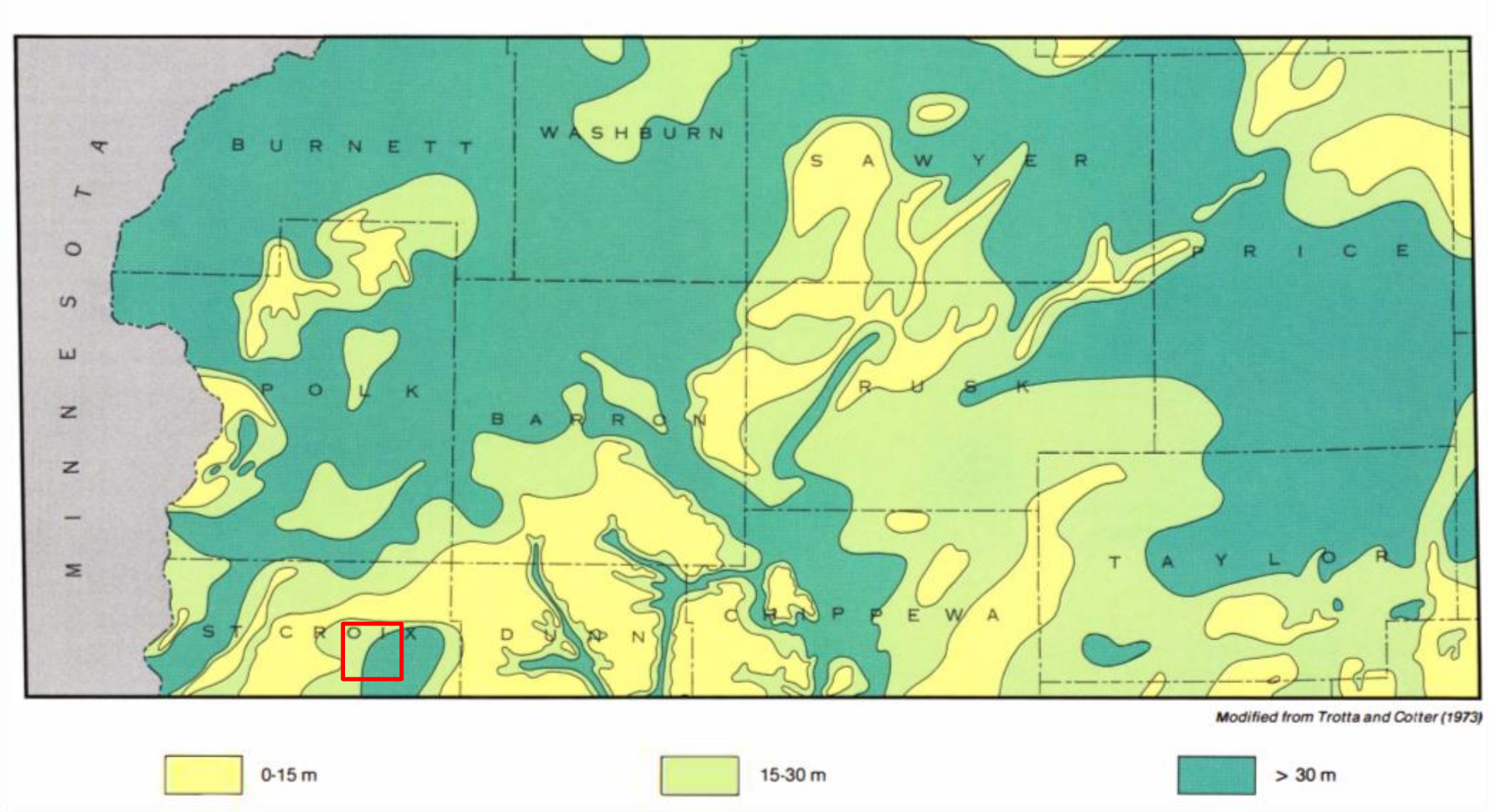


Figure 4 – Excerpt from Bedrock Geology of Wisconsin, Northwest Sheet, Depth to bedrock Inset. Mudrey, M. et al., 1987. Red Box is approximate location of Town of Emerald.

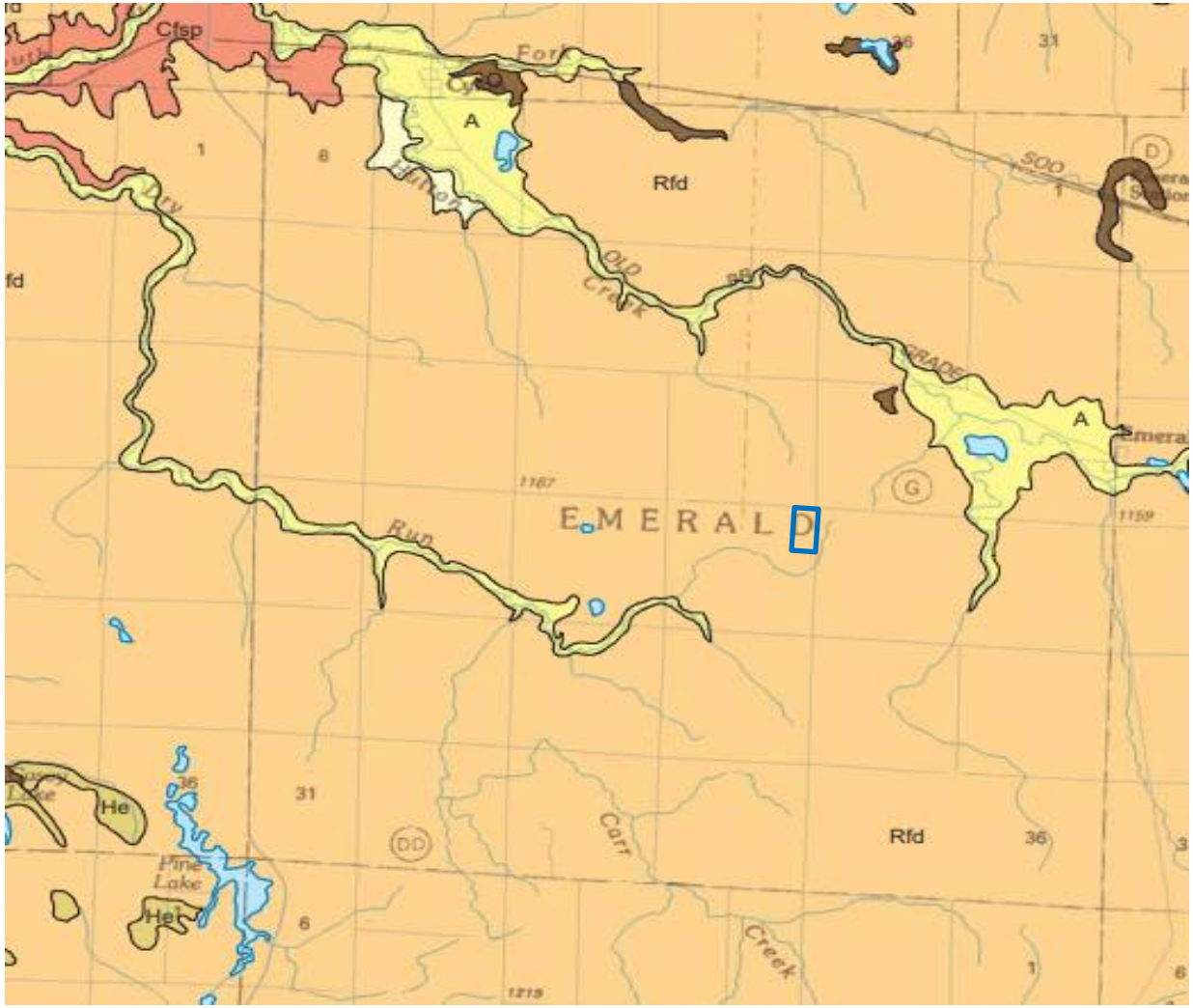


Figure 5a –Excerpt from Preliminary Quaternary Geologic Map of St. Croix County, Wisconsin. Kostka, S. et al., 2004. WGNHS WOFR 2004-22. Blue rectangle is approximate location of Emerald Sky Dairy production area.

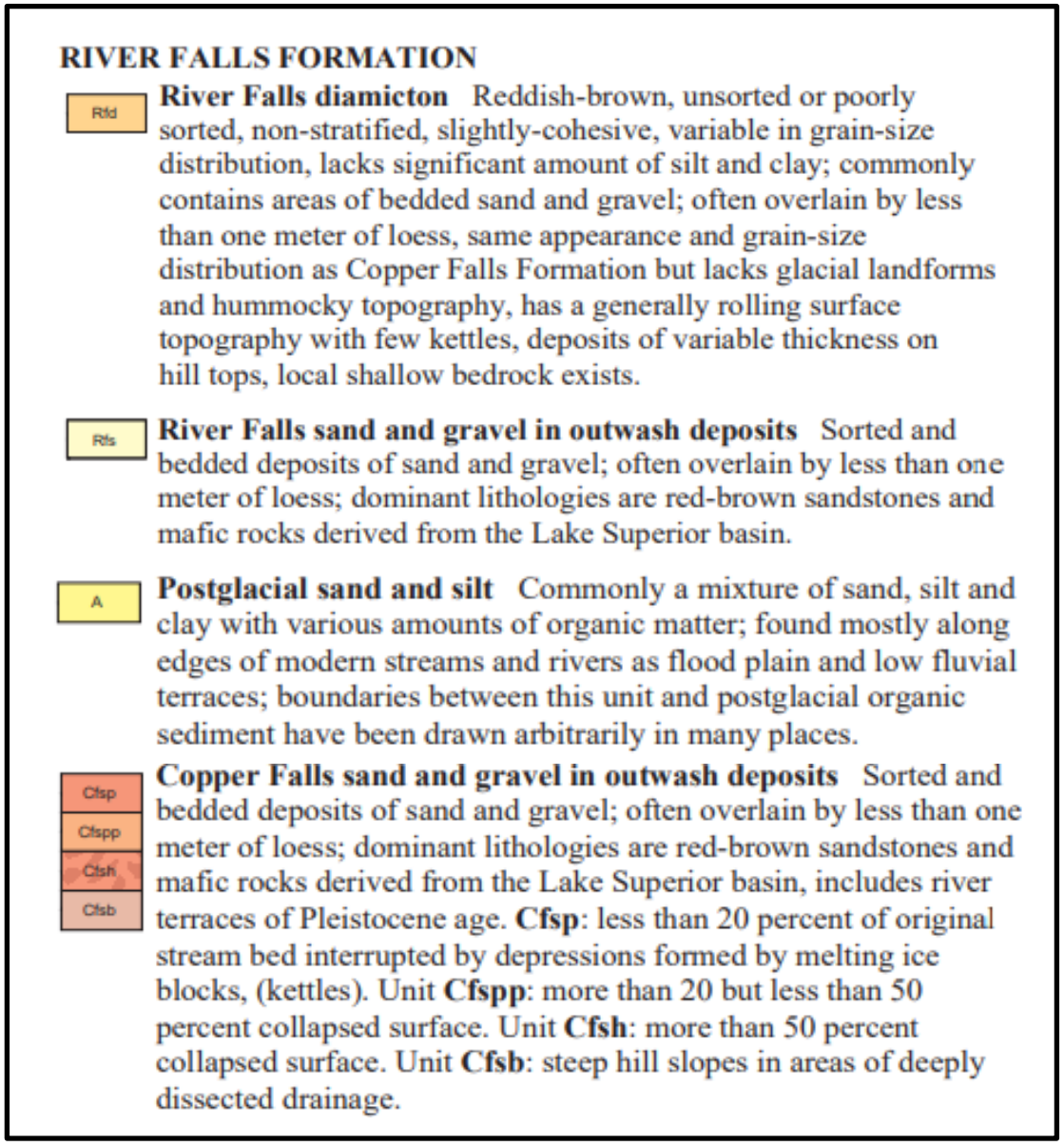


Figure 5b –Map Legend excerpted from WGNHS WOFR 2004-22 providing map symbology and brief explanation of units.

Figure 6 – Excerpt from Water table Map of St. Croix County, WI 1974. WGNHS IC32-plate01. Blue rectangle is approximate location of Emerald Sky Dairy production area. Blue arrows were added to illustrate regional groundwater flow.

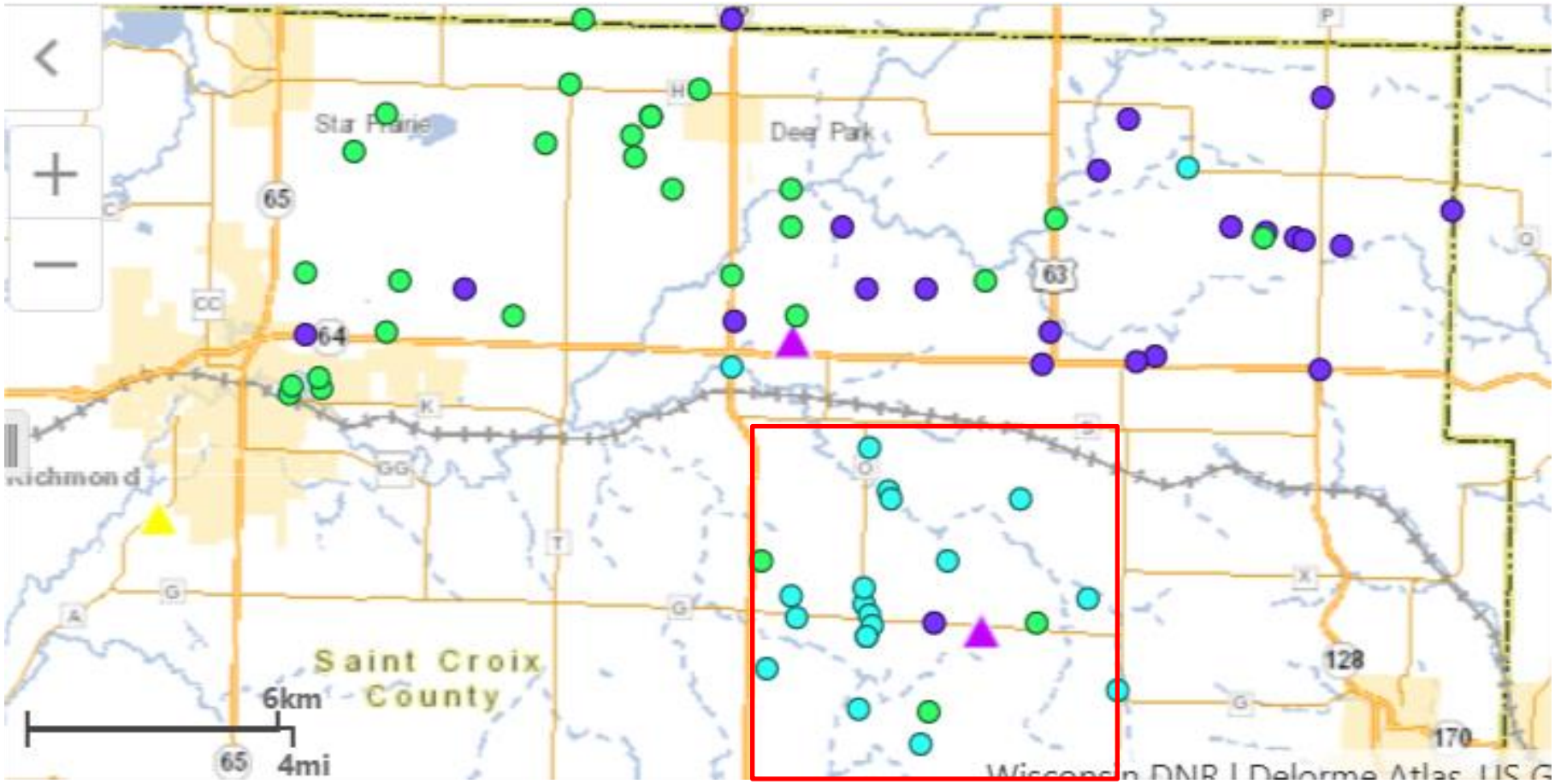


Figure 7 – Locations of wells sampled by St. Croix County in vicinity of ESD in 2016, color coded by sampling date. Light blue circles are samples from May 23, 2016 sampling event, with numerous samples in the Town of Emerald, outlined in red.

Figure 8 – Aerial photo with locations and results of May 23, 2016 sampling event. Results are nitrate (NO2- + NO3-) concentrations in mg/L. ESD Production area is outlined in blue.

Figure 9 – Locations of sinkholes in the Town of Emerald, as mapped by St. Croix County.

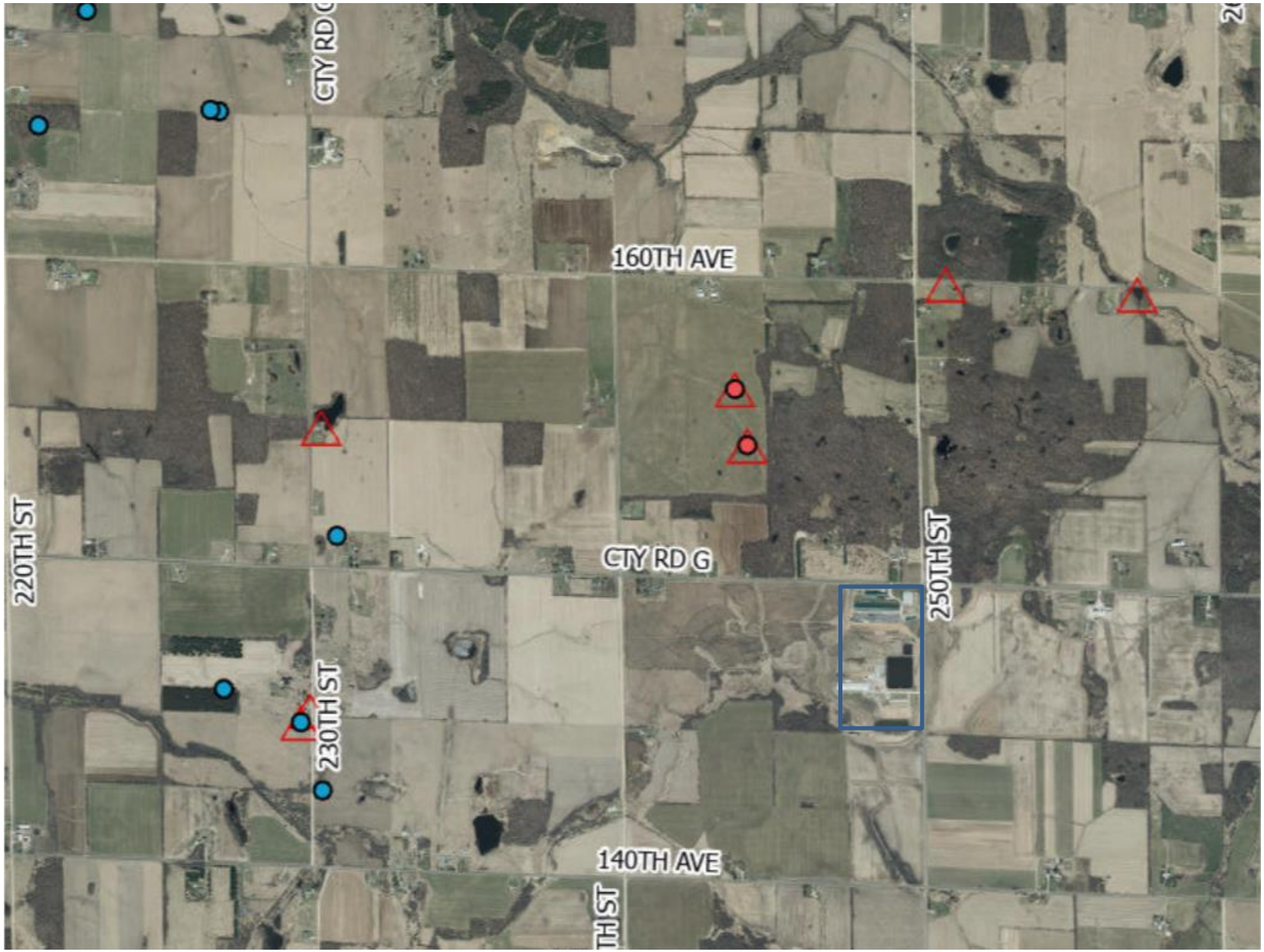
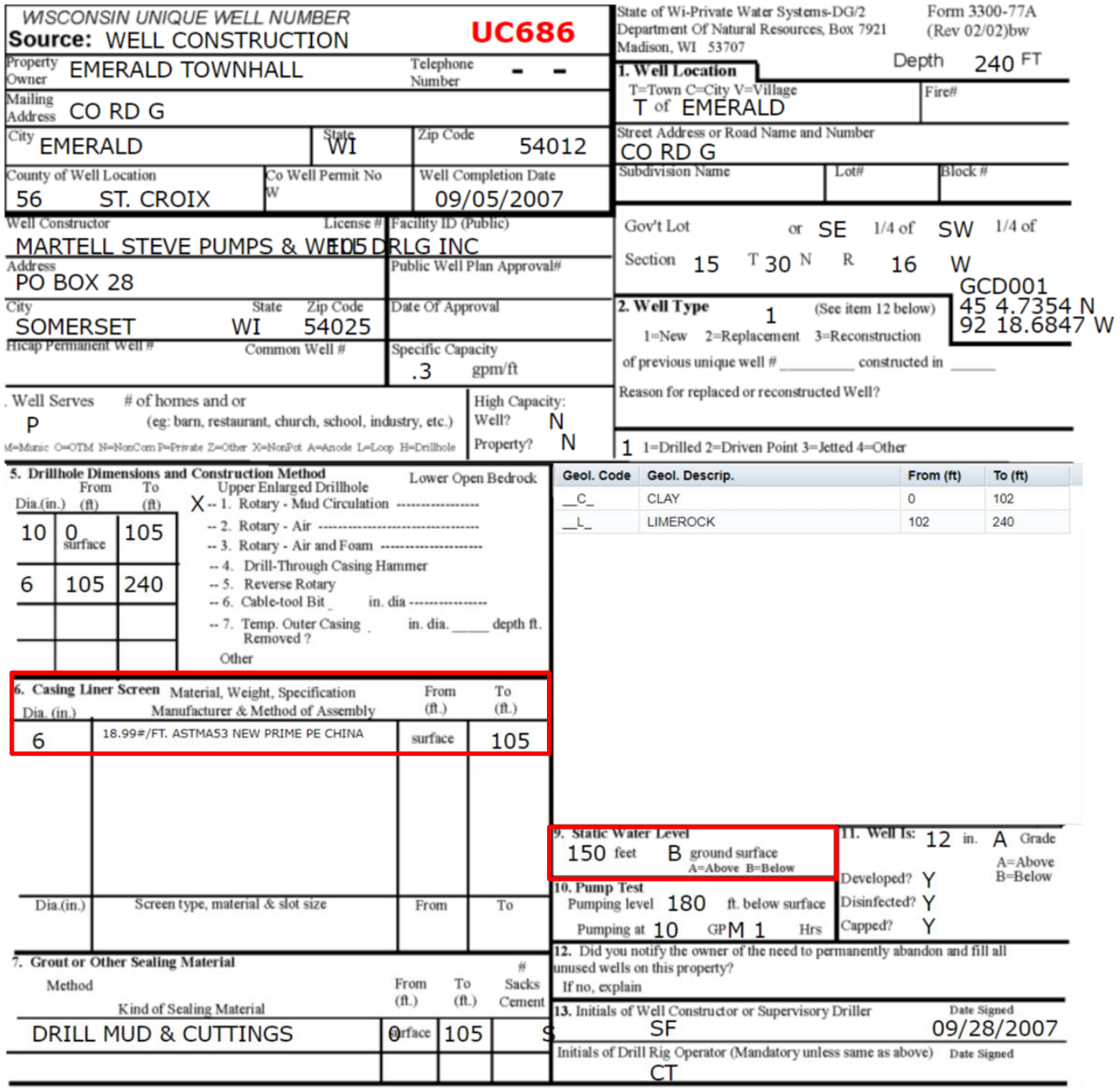


Figure 10 – Inset of mapped sinkhole locations shown in Figure 10, zoomed in on area near Emerald Sky Dairy (outlined in blue).



WISCONSIN UNIQUE WELL NUMBER **UC686**
Source: WELL CONSTRUCTION

State of Wi-Private Water Systems-DG/2
Department Of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-77A
(Rev 02/02)bw

Property Owner: EMERALD TOWNHALL — Telephone Number: - -
Mailing Address: CO RD G
City: EMERALD — State: WI — Zip Code: 54012
County of Well Location: 56 ST. CROIX — Co Well Permit No: W — Well Completion Date: 09/05/2007

Well Constructor: MARTELL STEVE PUMPS & WELL DRLG INC — License #: 1105 — Facility ID (Public):
Address: PO BOX 28 — Public Well Plan Approval#:
City: SOMERSET — State: WI — Zip Code: 54025 — Date Of Approval:
Hicap Permanent Well # — Common Well # — Specific Capacity: .3 gpm/ft

Well Serves: P (eg: barn, restaurant, church, school, industry, etc.) — # of homes and or
M=Munic O=OTM N=NonCom P=Private Z=Other X=NonPot A=Anode L=Loop H=Drillhole
High Capacity: Well? N — Property? N

1. Well Location
T=Town C=City V=Village: T of EMERALD — Fire#:
Street Address or Road Name and Number: CO RD G
Subdivision Name — Lot# — Block #
Gov't Lot — or SE 1/4 of SW 1/4 of
Section 15 T 30 N R 16 W
GCD001
45 4.7354 N
92 18.6847 W

Depth 240 FT

2. Well Type 1 (See item 12 below)
1=New 2=Replacement 3=Reconstruction
of previous unique well # _____ constructed in _____
Reason for replaced or reconstructed Well?

1 1=Drilled 2=Driven Point 3=Jetted 4=Other

5. Drillhole Dimensions and Construction Method — Lower Open Bedrock

Dia.(in.)	From (ft)	To (ft)
10	0 surface	105
6	105	240

X -- 1. Rotary - Mud Circulation
-- 2. Rotary - Air
-- 3. Rotary - Air and Foam
-- 4. Drill-Through Casing Hammer
-- 5. Reverse Rotary
-- 6. Cable-tool Bit _ in. dia
-- 7. Temp. Outer Casing _ Removed ? in. dia. _____ depth ft.
Other

Geol. Code	Geol. Descrip.	From (ft)	To (ft)
_C_	CLAY	0	102
_L_	LIMEROCK	102	240

6. Casing Liner Screen Material, Weight, Specification / Manufacturer & Method of Assembly

Dia. (in.)		From (ft.)	To (ft.)
6	18.99#/FT. ASTMA53 NEW PRIME PE CHINA	surface	105

Dia.(in.)	Screen type, material & slot size	From	To

9. Static Water Level
150 feet B ground surface
A=Above B=Below

10. Pump Test
Pumping level 180 ft. below surface
Pumping at 10 GPM 1 Hrs

11. Well Is: 12 in. A Grade
A=Above B=Below
Developed? Y
Disinfected? Y
Capped? Y

7. Grout or Other Sealing Material

Method / Kind of Sealing Material	From (ft.)	To (ft.)	# Sacks Cement
DRILL MUD & CUTTINGS	0 surface	105	S

12. Did you notify the owner of the need to permanently abandon and fill all unused wells on this property?
If no, explain

13. Initials of Well Constructor or Supervisory Driller: SF — Date Signed: 09/28/2007
Initials of Drill Rig Operator (Mandatory unless same as above): CT — Date Signed

Figure 11 – Well Construction Report for the Emerald Town Hall. Highlighted are the depth of casing and static water level. Having well casing shallower than static water level can potentially affect water quality.