BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF THE APPLICATION BY CROWNED RIDGE WIND, LLC FOR A PERMIT OF A WIND ENERGY FACILITY IN GRANT AND CODINGTON COUNTIES	))))))))	EL19-003 **APPLICANT'S RESPONSES TO STAFF'S FIFTH SET OF DATA REQUESTS TO CROWNED RIDGE WIND, LLC**

5-1) Referring to Crowned Ridge's response to Staff data request 3-2, please provide a copy of the GE Safety Manual. The original response only included a copy of the operating manual.

Response: Please see Confidential Attachment 1.

Respondent: Mark Thompson, Manager of Wind Engineering

5-2) Please identify if an ice detector and/or ice detection system will be used for the wind turbines. If an ice detection system will be used, please explain what turbine parameters will be monitored and how the turbine's control system will know when ice is accumulating on the blades.

Response: Yes, an ice detector and ice detection system will be used for all Crowned Ridge Wind wind turbines. More specifically, the turbine is capable of detecting ice buildup on the blades by activating sensors that compare wind speed, ambient temperature and rotor (blade) rpm to the power output of the turbine. If the ice buildup is at a level that causes the turbine output to be outside expected limits set by GE, the turbine will automatically shut down. In addition, ice buildup can be detected through higher than normal vibration, in which case the turbines will shut down automatically.

Respondent: Mark Thompson, Manager of Wind Engineering

5-3) Will Mr. and Ms. Tim Lindgren's easement option expire prior to construction? If the easement option will expire, please identify what impact that will have on the project layout if the easement is not renewed. If the easement will not expire, please identify the expiration date.

EXHIBIT
Staff
S5
Public

Response: Yes, while the option is in effect today, assuming Crowned Ridge Wind does not exercise the option prior to it expiring and that Mr. and Ms. Lindgren do not elect to renew their easement option, the Lindgren's easement option would expire prior to construction of the Project. Upon expiration of the easement option, the two proposed turbine locations and associate facilities would be removed from the Lindgren property in its entirety and the Applicant would utilize two alternate turbine locations proposed in the Project Area.

Respondent: Tyler Wilhelm, Project Manager

5-4) Is Crowned Ridge aware of any additional easement options that may expire prior to the planned start of construction? If yes, please identify when Crowned Ridge will know if those landowners decide to renew.

Response: Yes. The Applicant expects to know if those landowners will elect to renew their easement options by June 20, 2019.

Respondent: Tyler Wilhelm, Project Manager

5-5) Provide an updated Figure 3, Project Map, that properly reflects the Thompson property as not participating and the location the underground collector line will be relocated to.

Response: See Attachment 1.

Respondent: Tyler Wilhelm, Project Manager

Dated this 23rd day of May, 2019.

Miles F. Schumacher
Attorneys for Applicant
Lynn, Jackson, Shultz & Lebrun, PC
110 N. Minnesota Ave., Suite 400
Sioux Falls, SD 57104

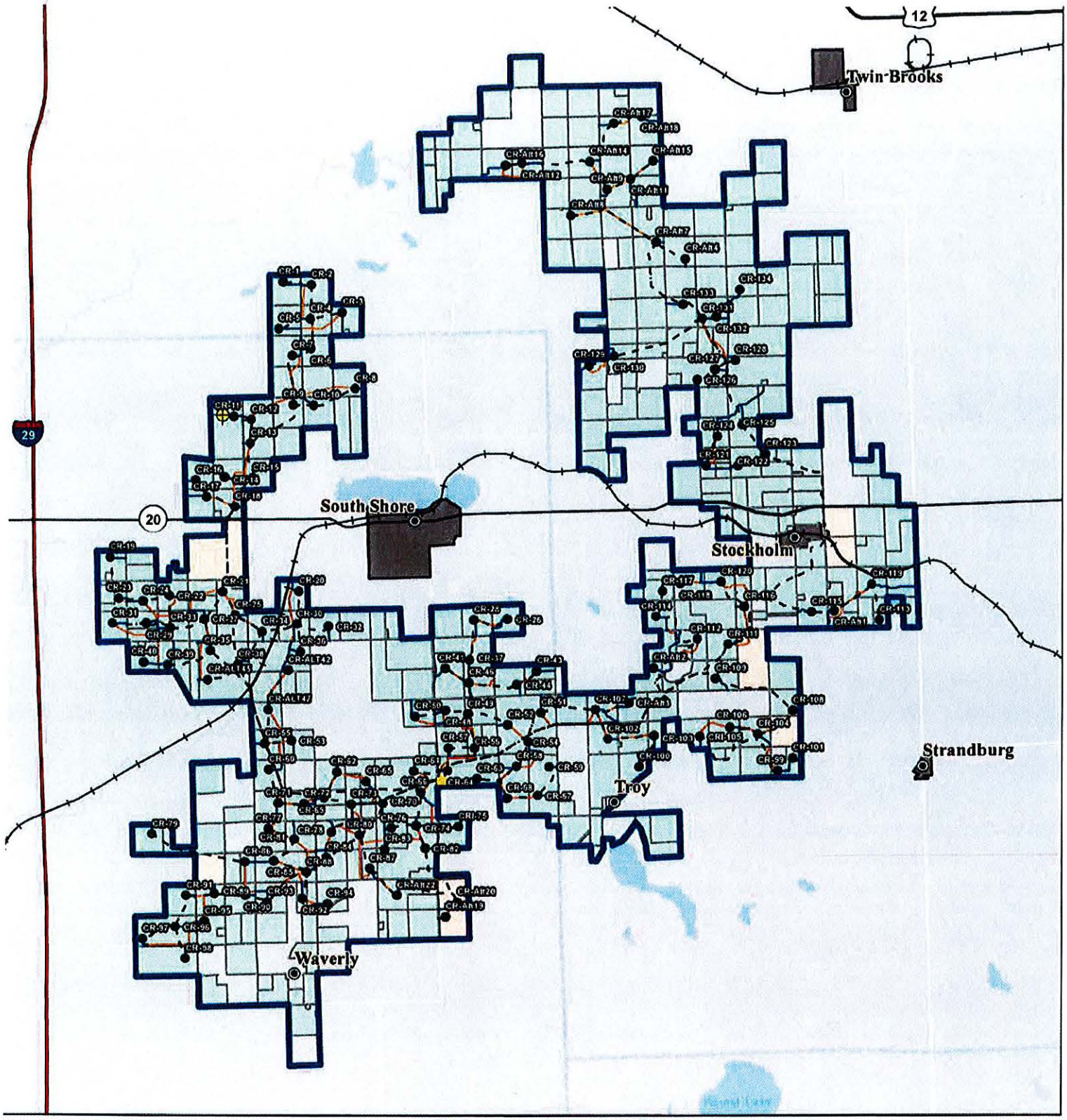


Figure 3. Project Map

Crowned Ridge Wind Farm

- MET Tower
- Turbine
- City
- Access Road
- Collector Line
- Crane Path
- Railroad
- Interstate Highway
- U.S. Highway
- State Highway
- O&M Facility/ Substation
- Town Boundary
- Project Boundary

Lease Status

- Leased, Signed
- Pending Approval

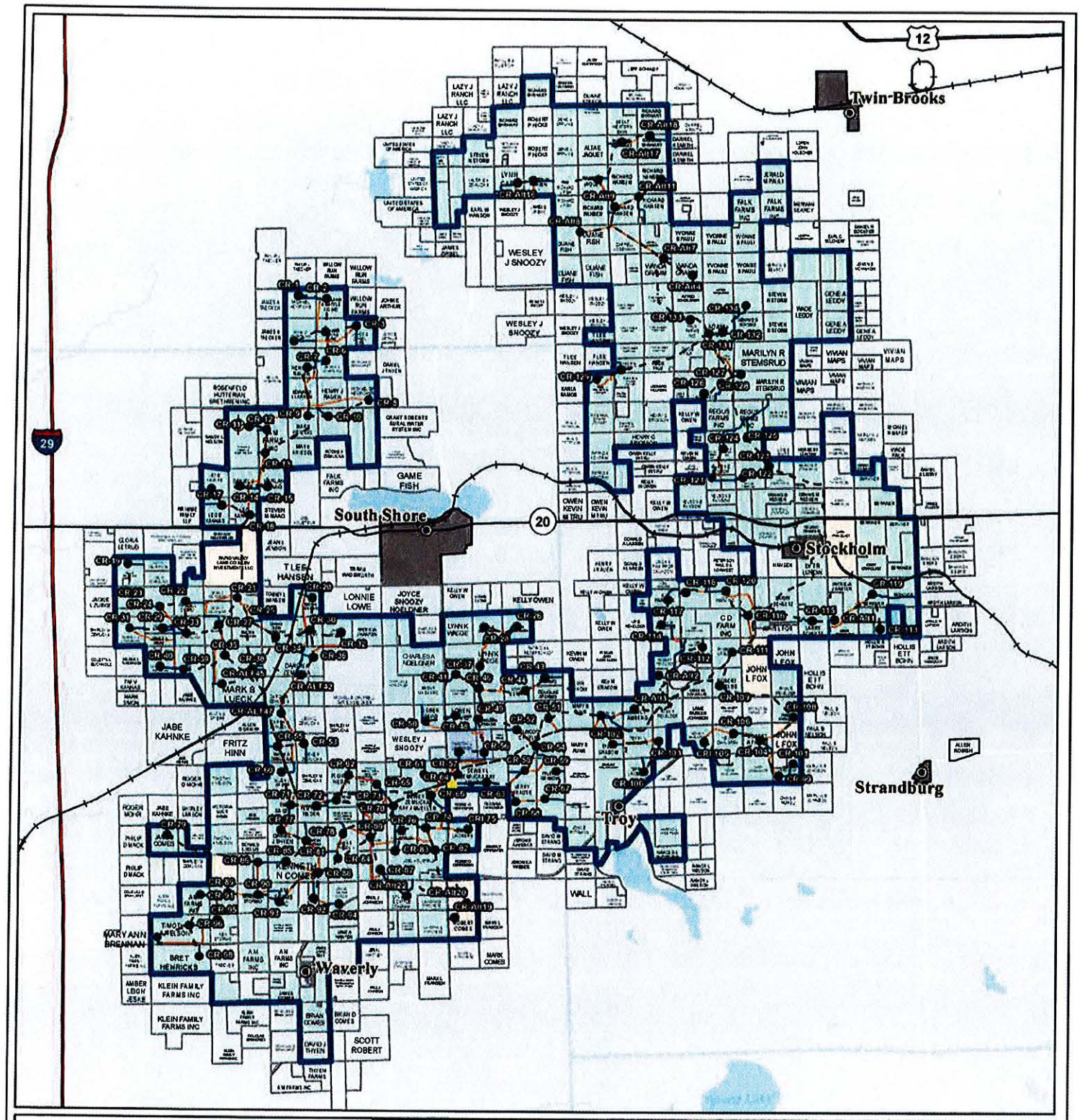
Kilometers 0 2.5 5

Miles 0 2.5 5

Base Map: World Light Gray Canvas Base
Sources: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

SWCA



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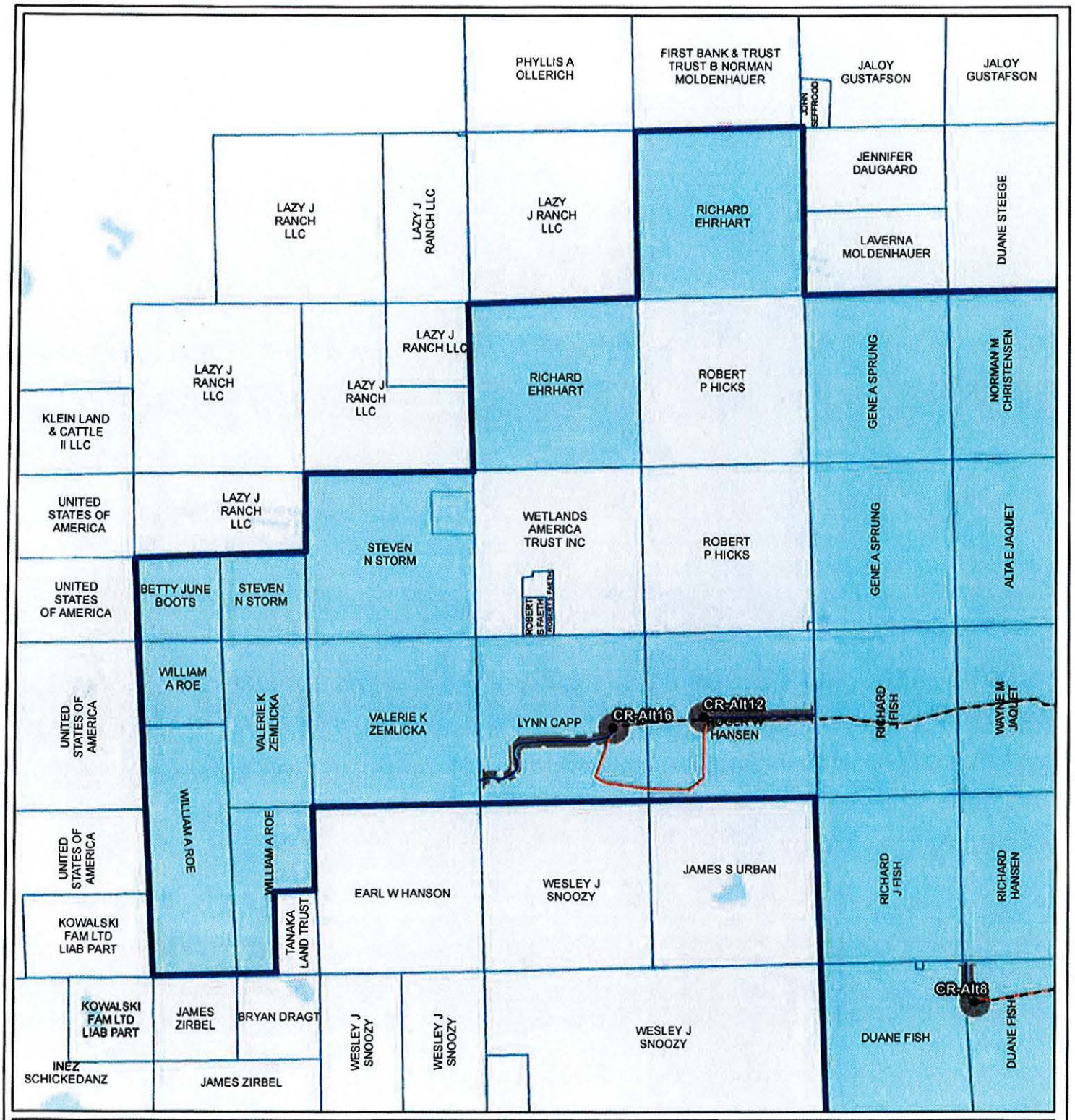

Figure 3a. Project Map

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- MFT Tower
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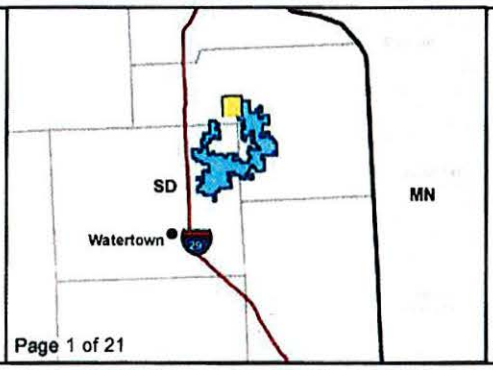

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Miles 0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

Quadrangle: Antelope Valley (1973), Twin Brooks (1973)

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Grant County, South Dakota

Projection: NAD 1983 UTM Zone 14N

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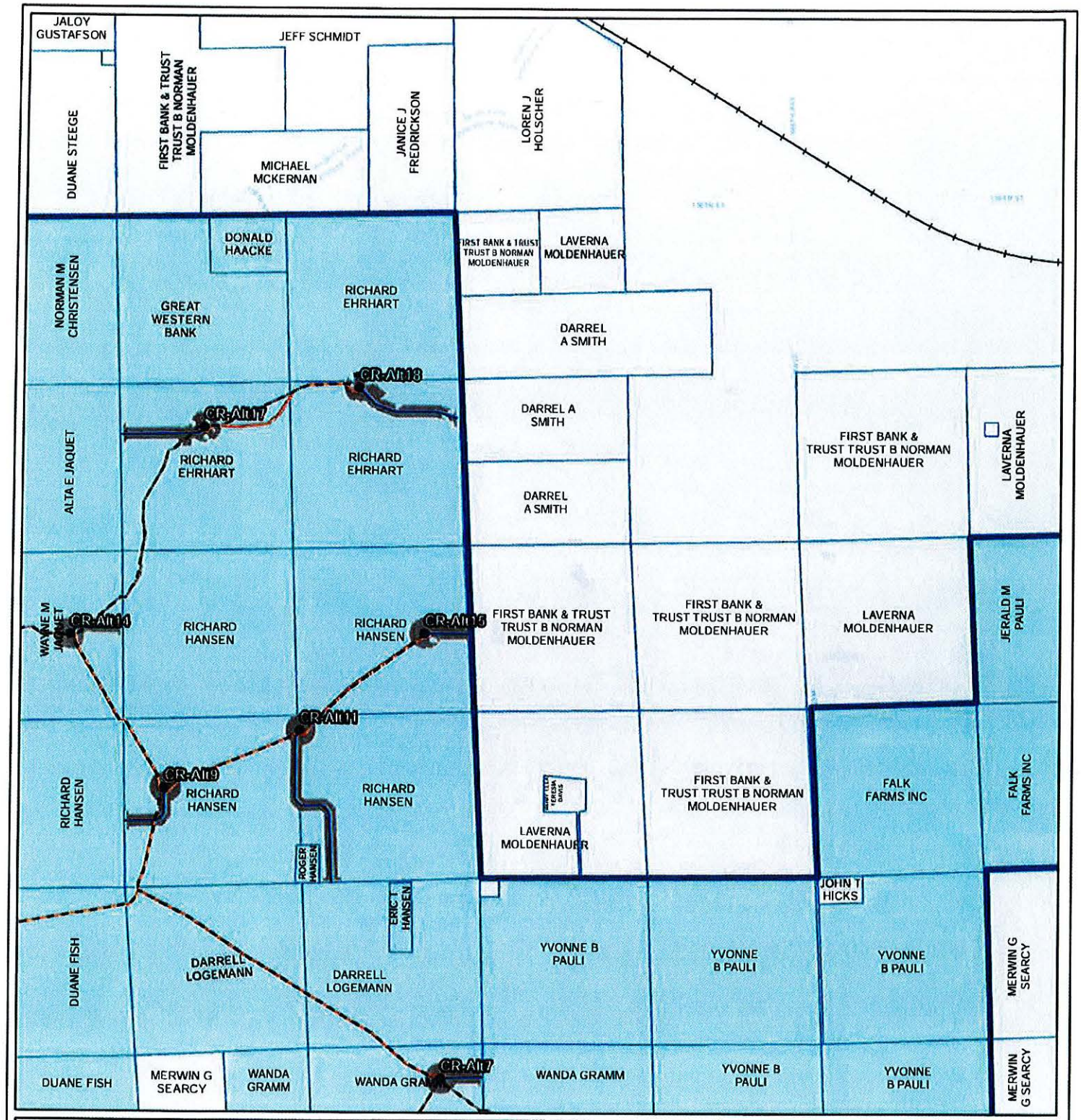

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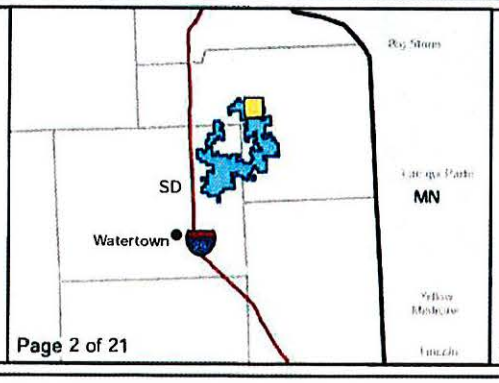

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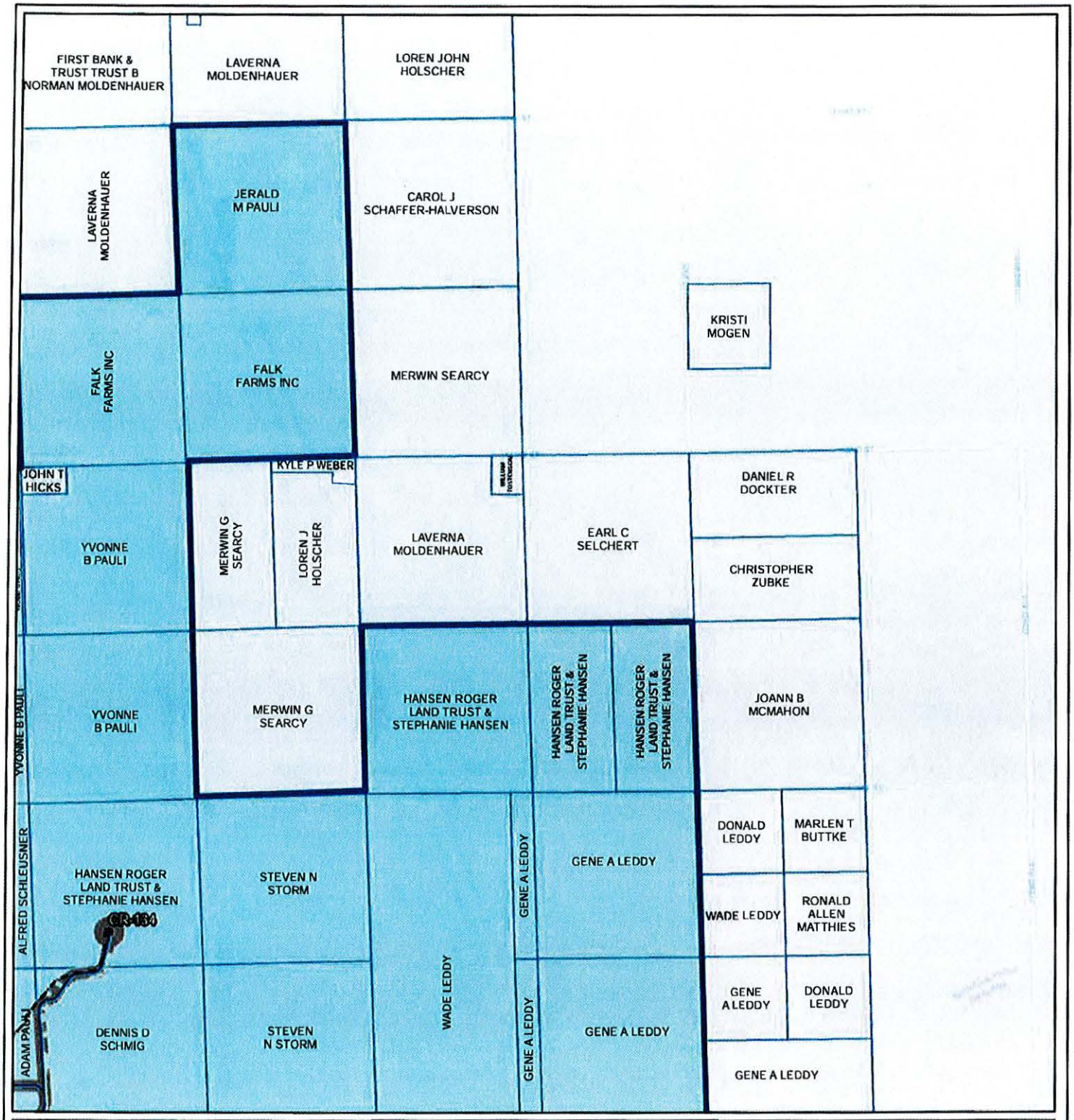

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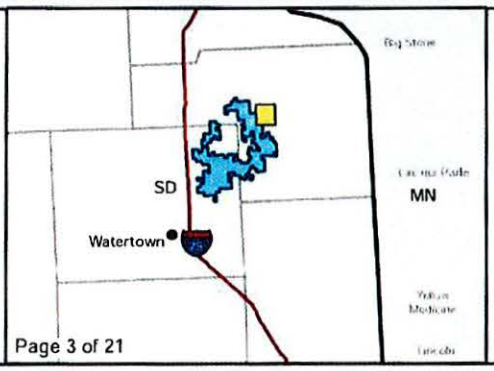

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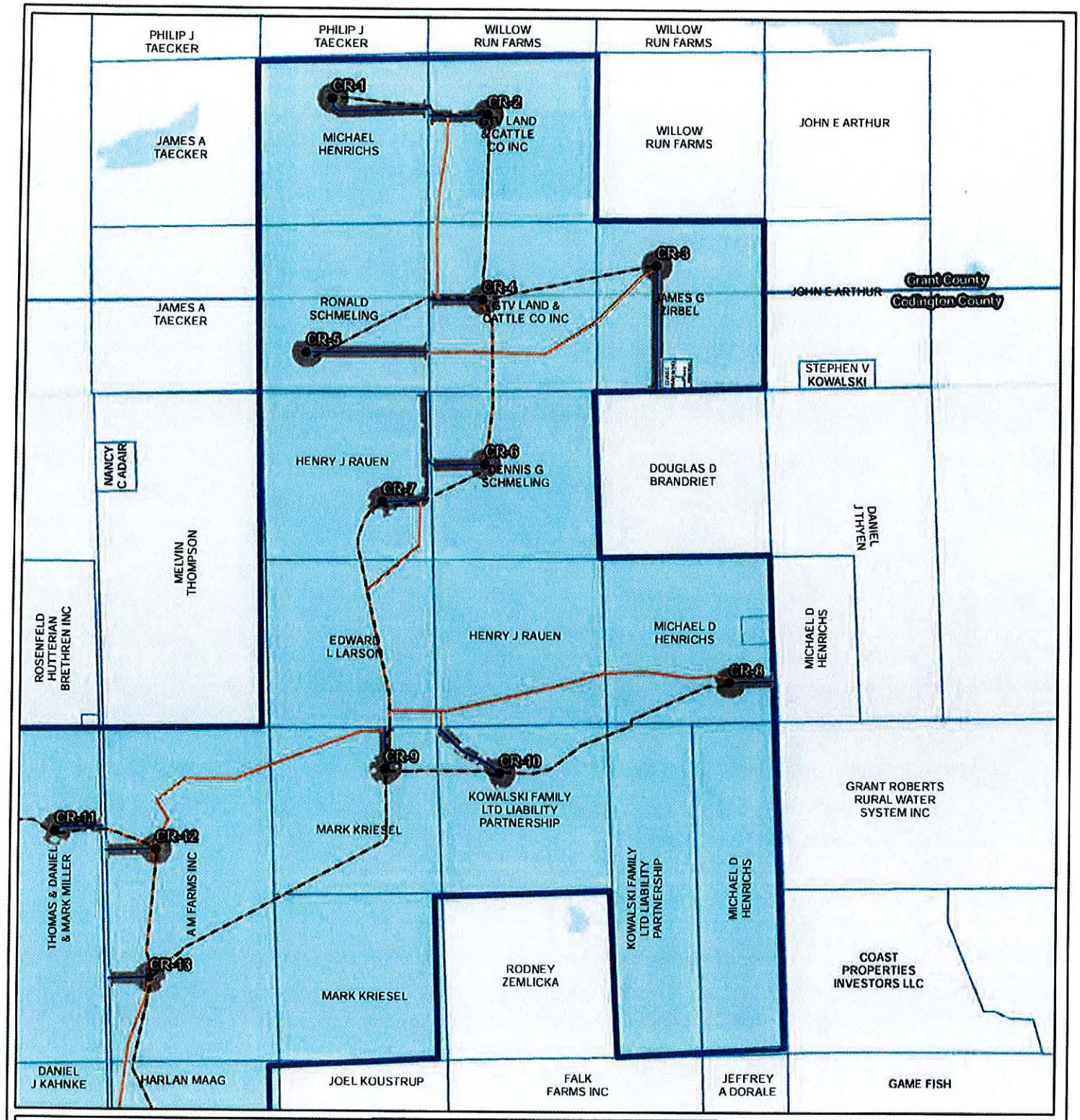

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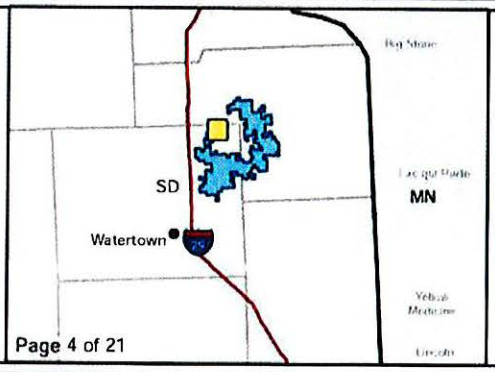

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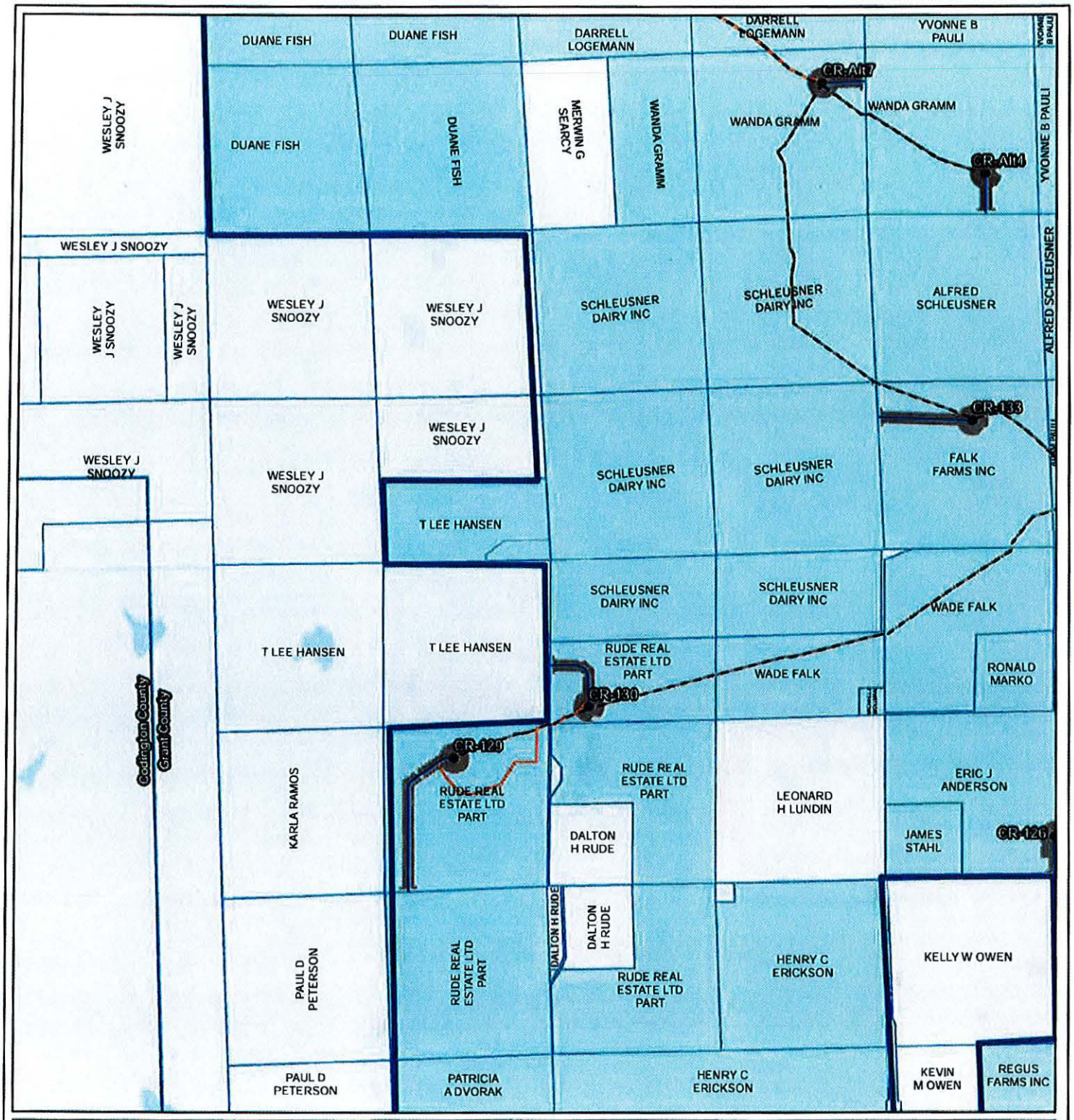

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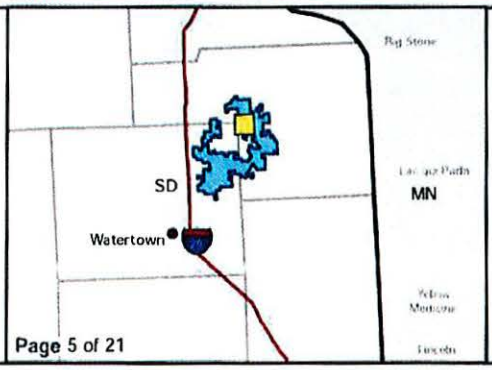

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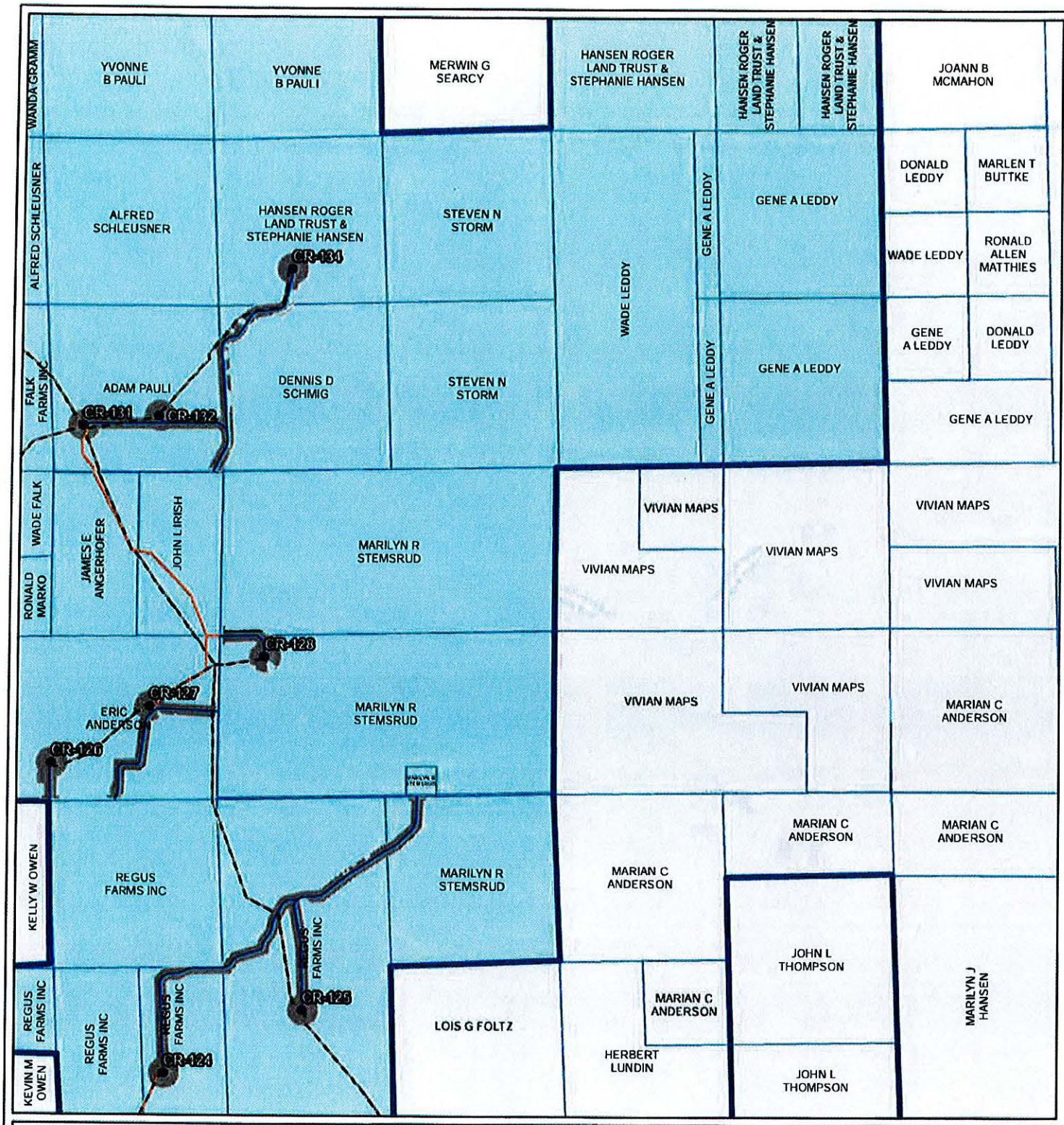

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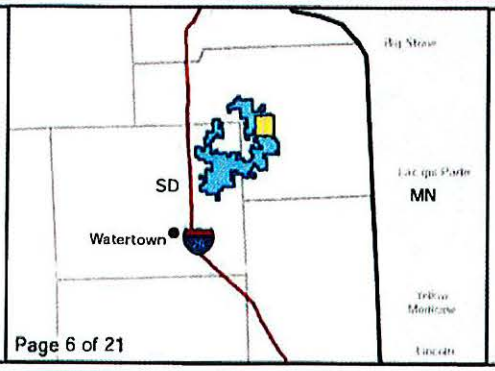

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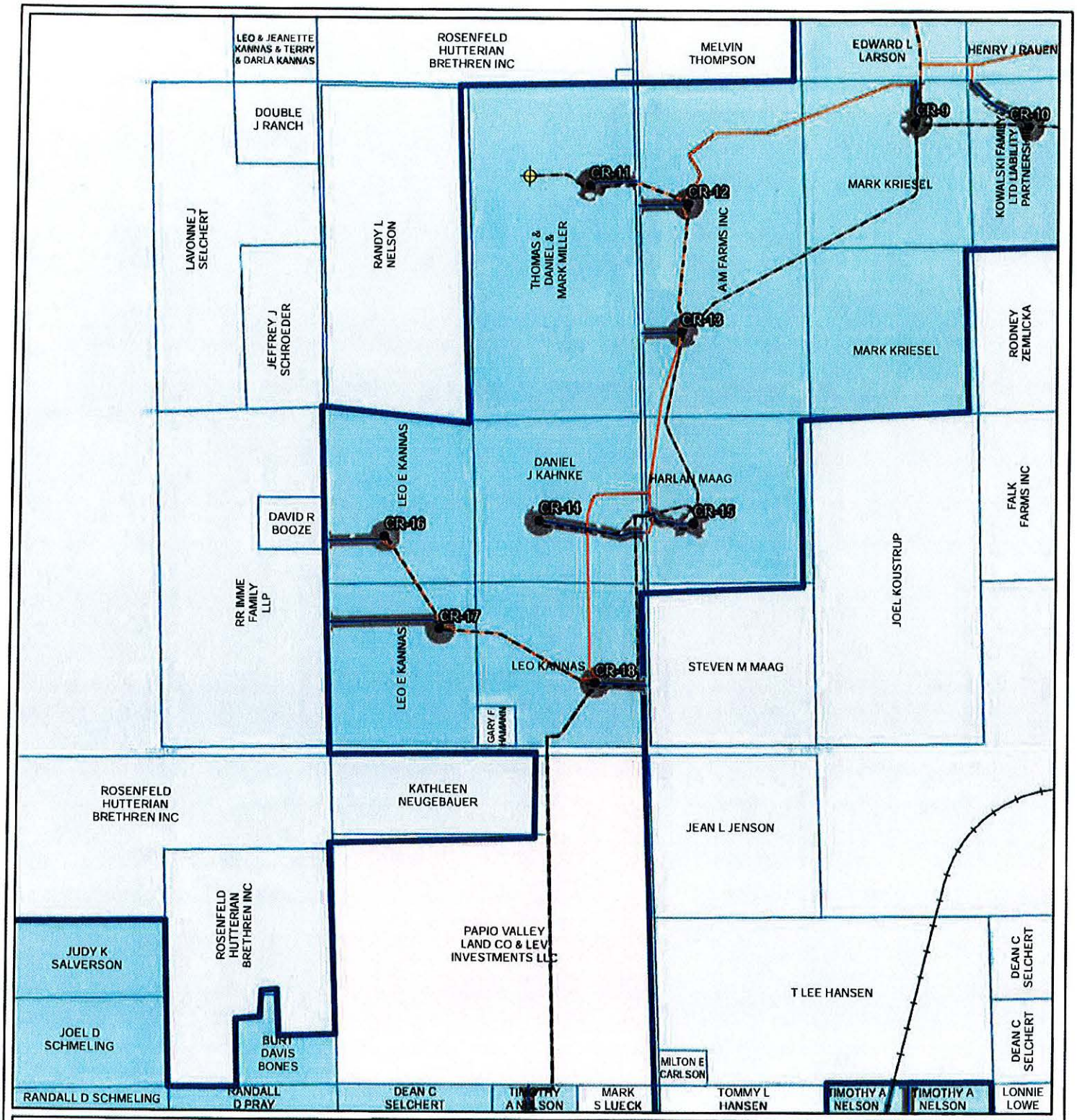

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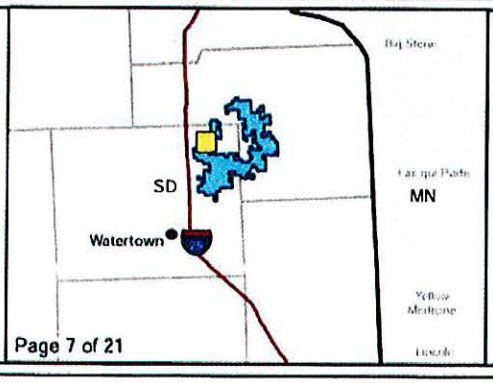

Kilometers: 0 – 0.5 – 1

Miles: 0 – 0.25 – 0.5

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Quadrangle: Still Lake NE (1970), Antelope Valley (1973), Still Lake SE (1970), South Shore (1973)

Township/Range: T119N, R52W, T119N, R51W

Codington County, South Dakota

Projection: NAD 1983 UTM Zone 14N

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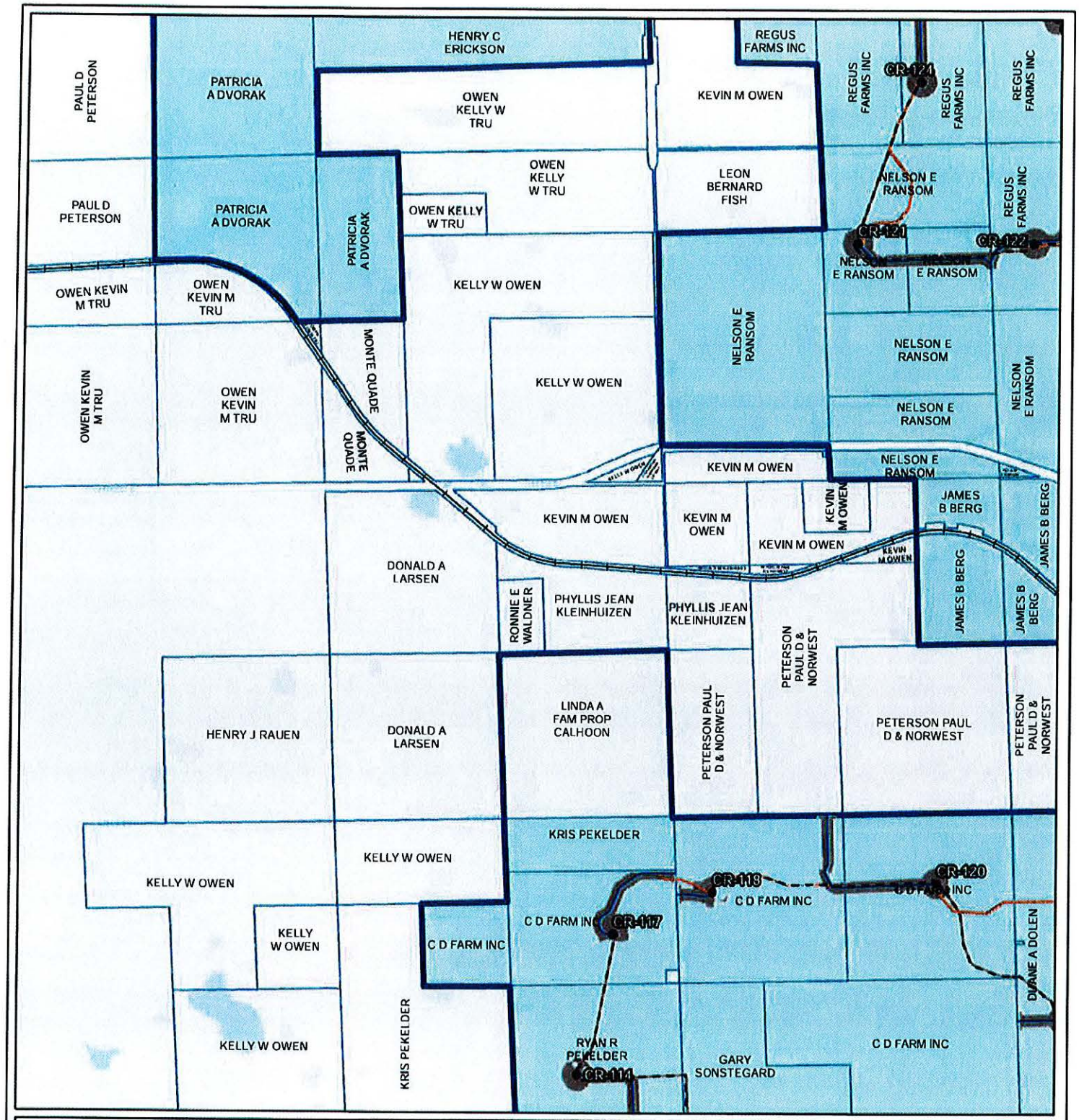

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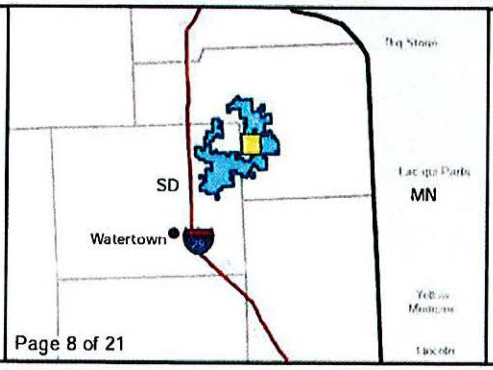

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Miles 0 0.25 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

Quadrangle: Stockholm (1973), Antelope Valley (1973), Twin Brooks (1973), South Shore (1973)

Township/Range: T119N, R50W

Grant County, South Dakota

Projection: NAD 1983 UTM Zone 14N

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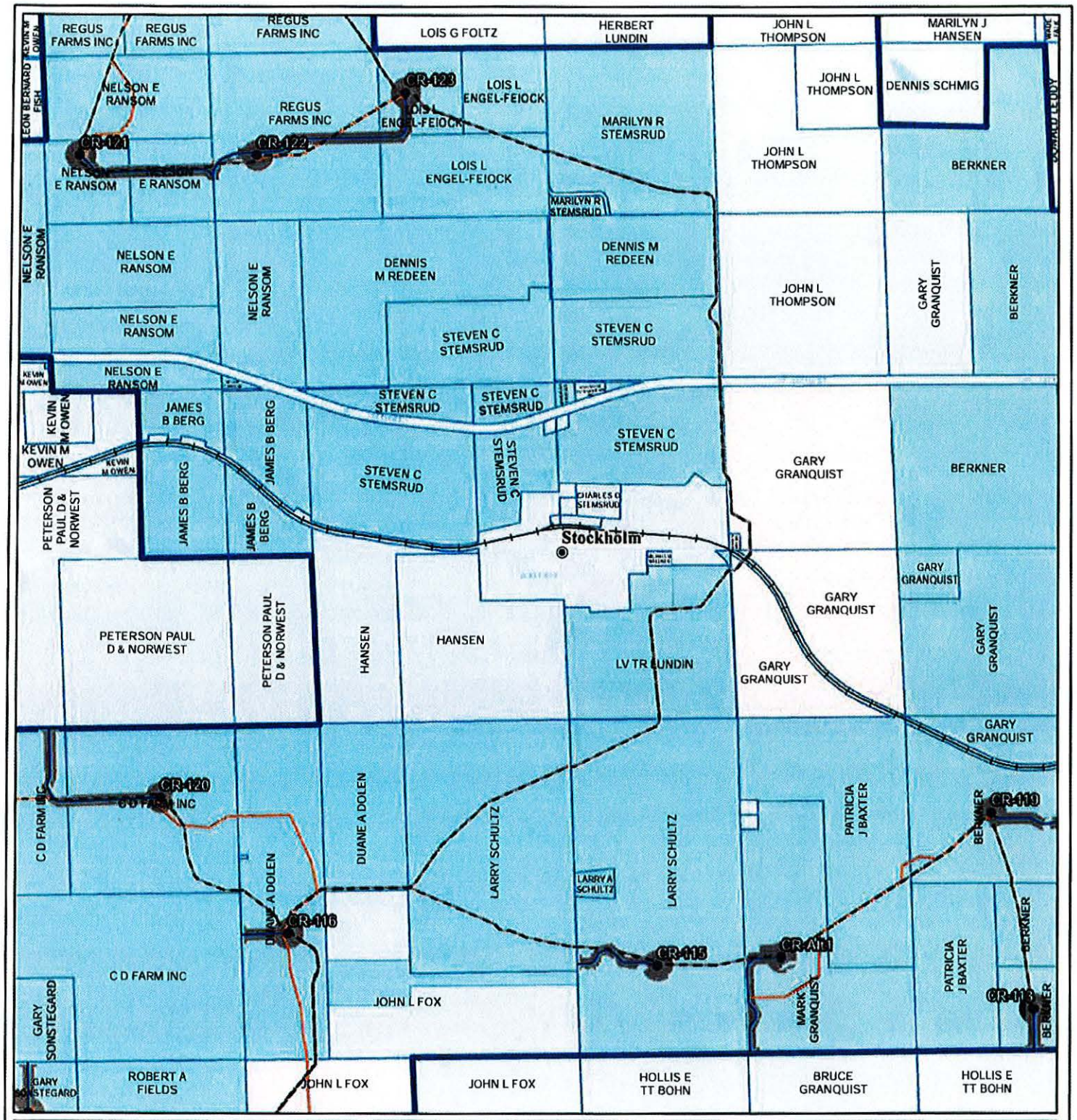

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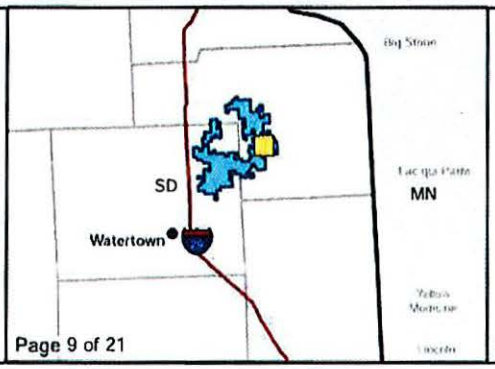

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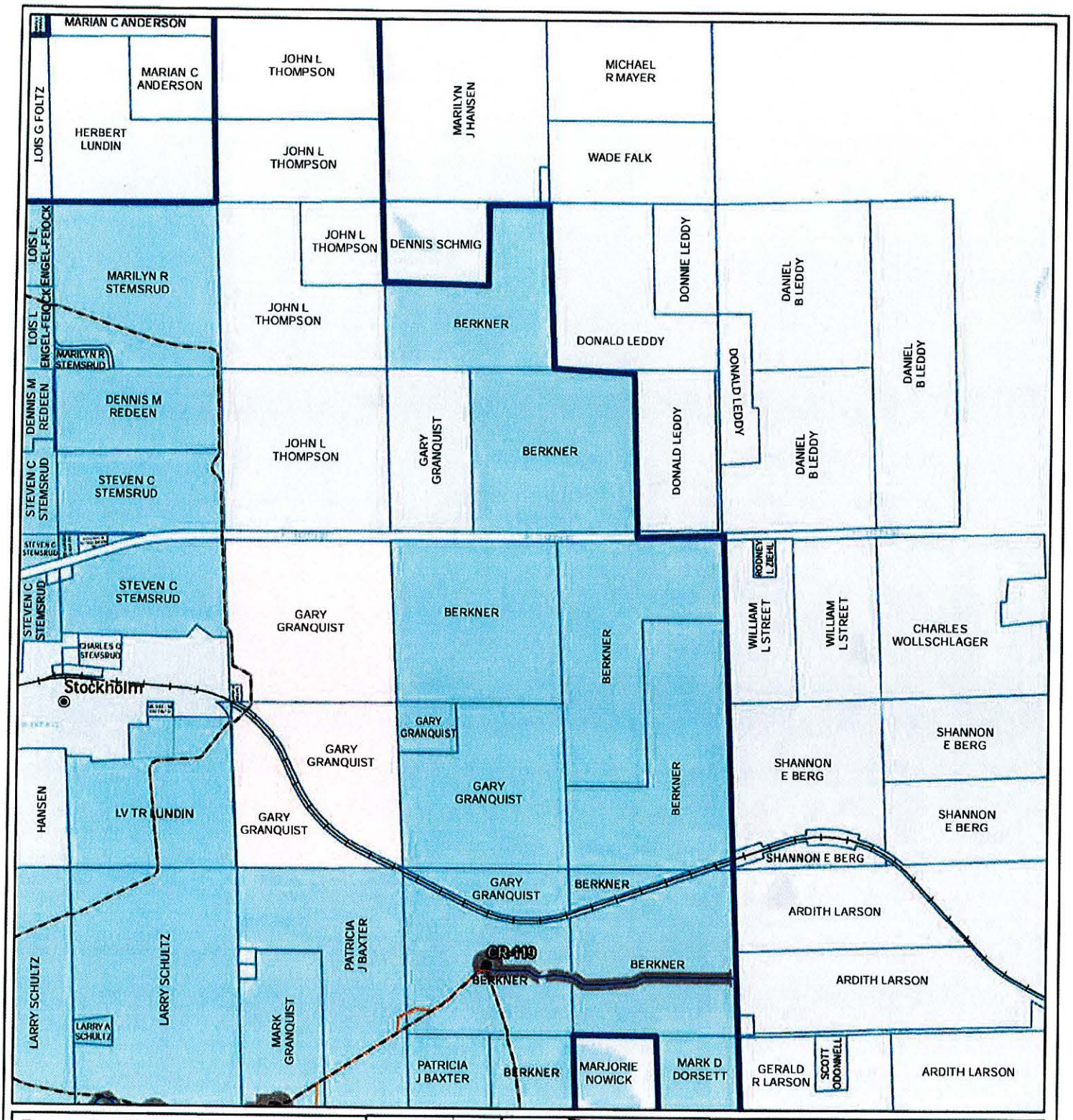

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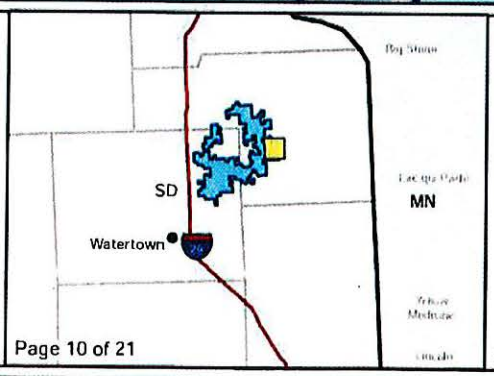

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Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

Quadrangle: Twin Brooks (1973), Stockholm (1973)

Township/Range: T119N, R50W, T119N, R49W

Grant County, South Dakota

Projection: NAD 1983 UTM Zone 14N

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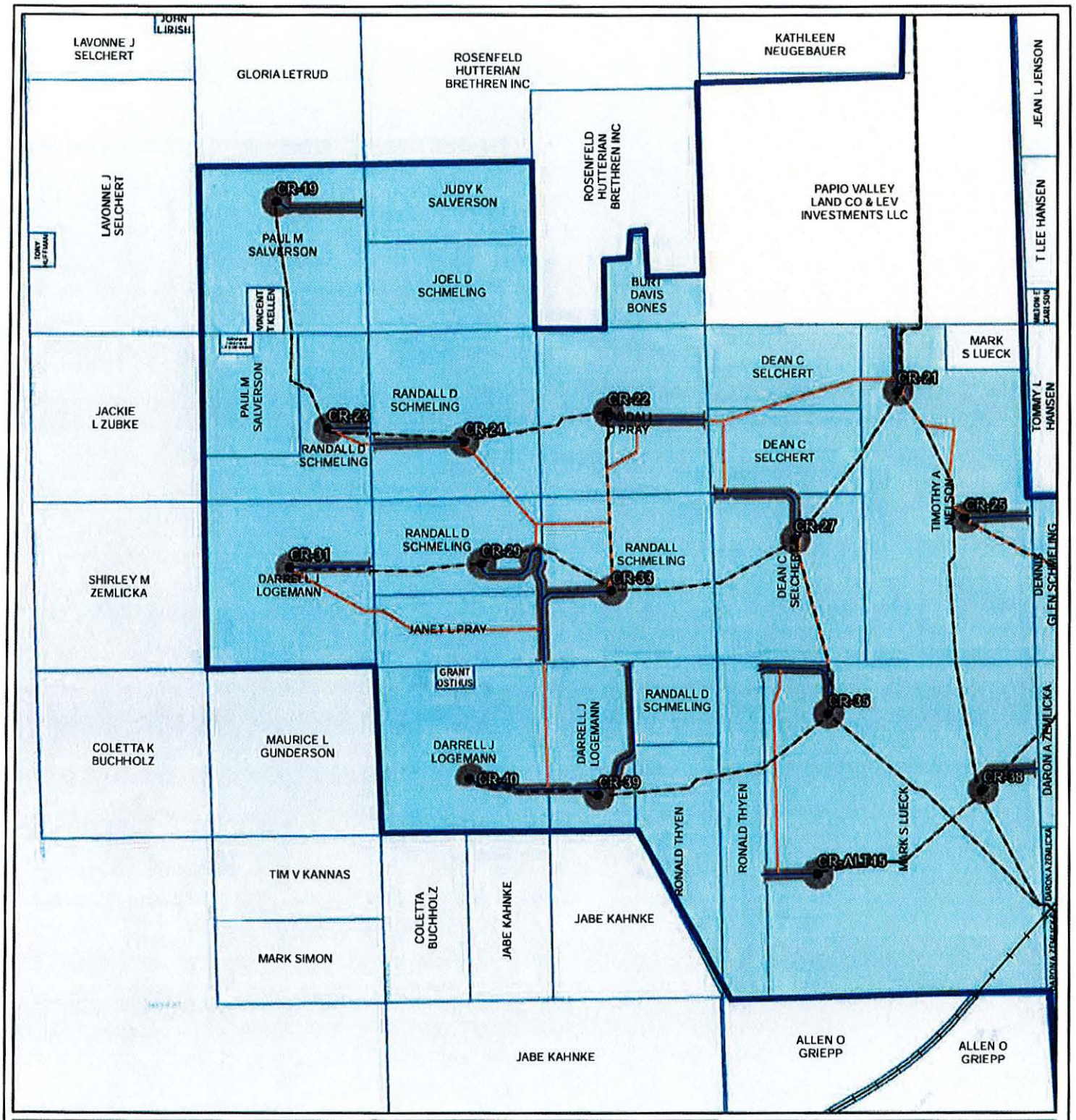

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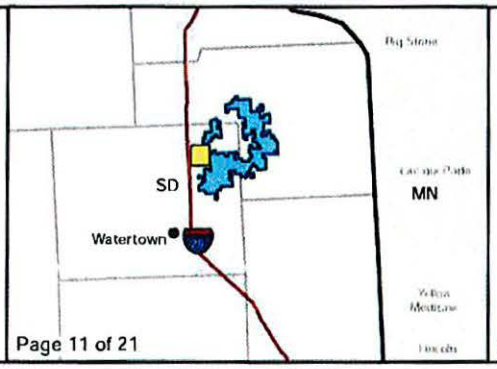

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Codington County, South Dakota

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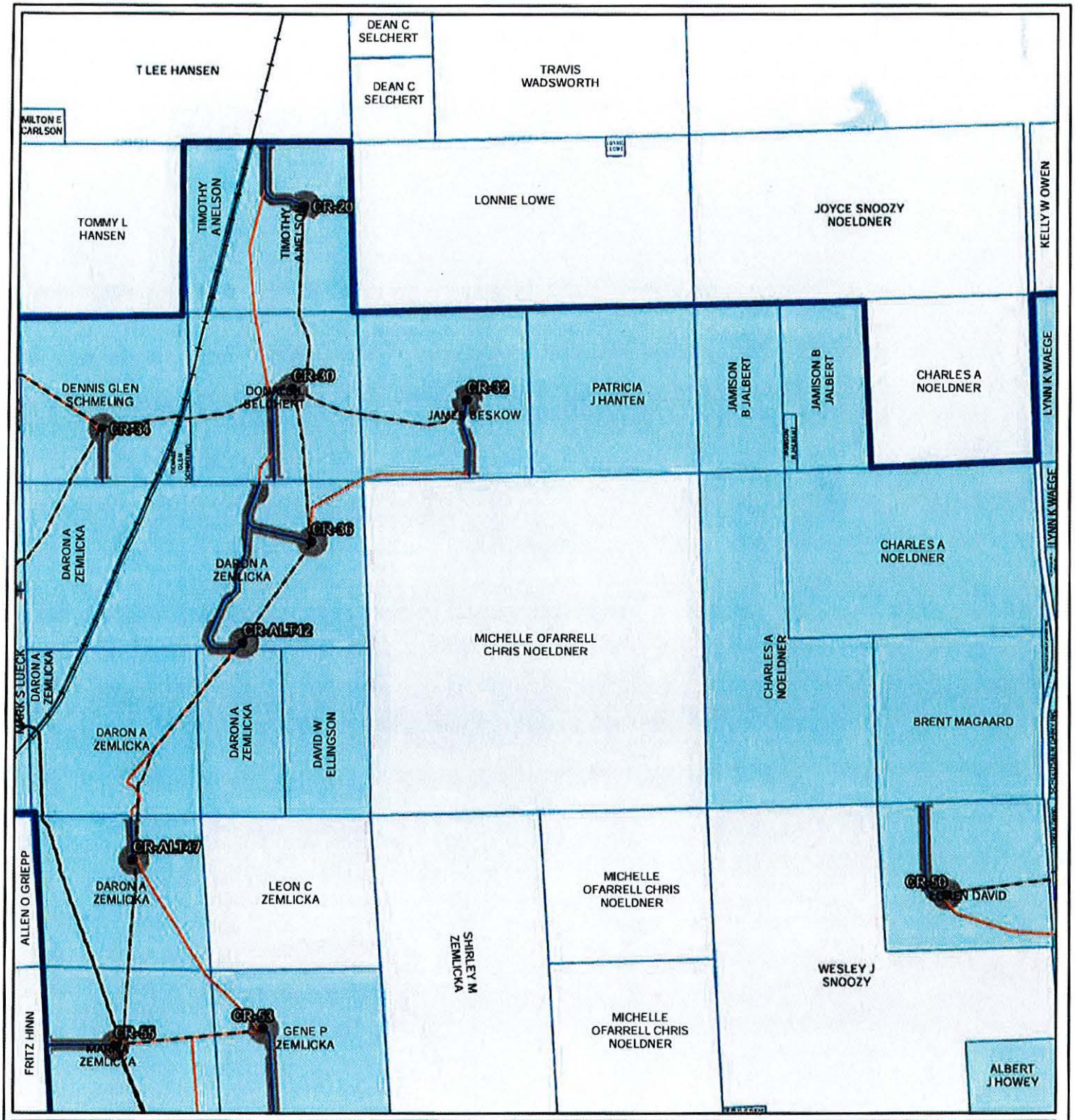

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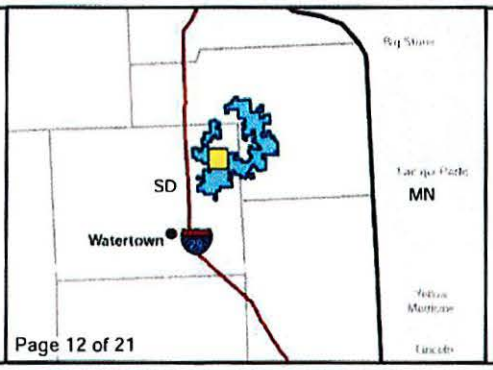

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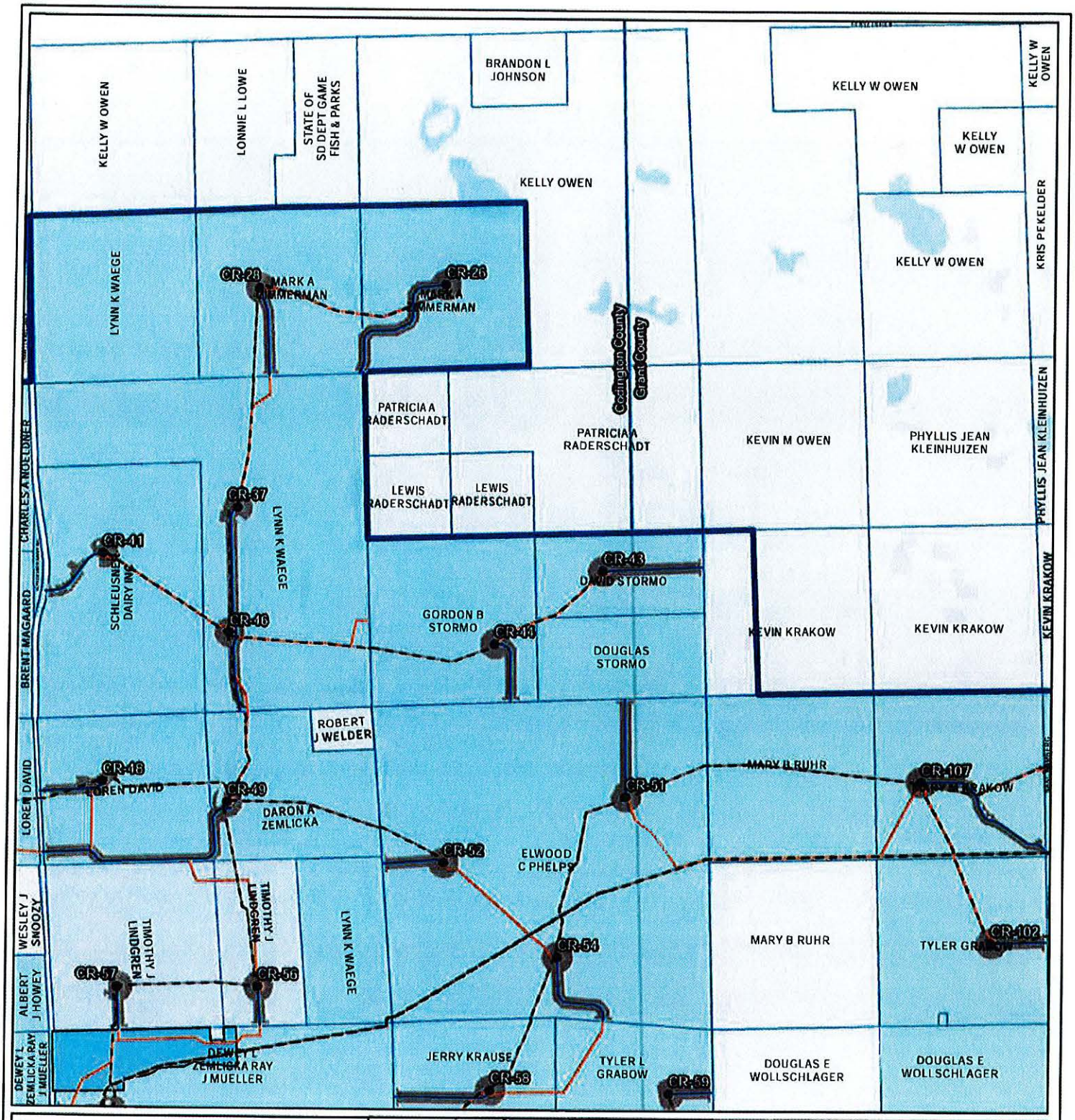

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- County Boundary

Lease Status

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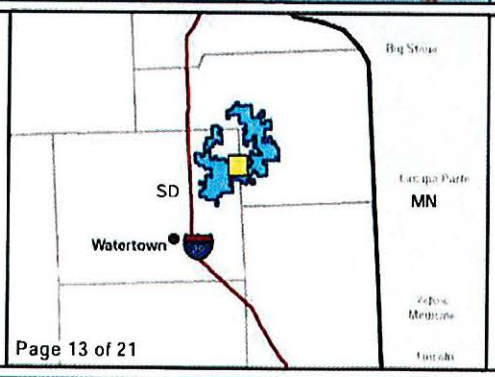
- Pending
- Under Option but Likely to Expire/Not Resign



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Miles: 0 – 0.25 – 0.5

Service Layer Credits: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

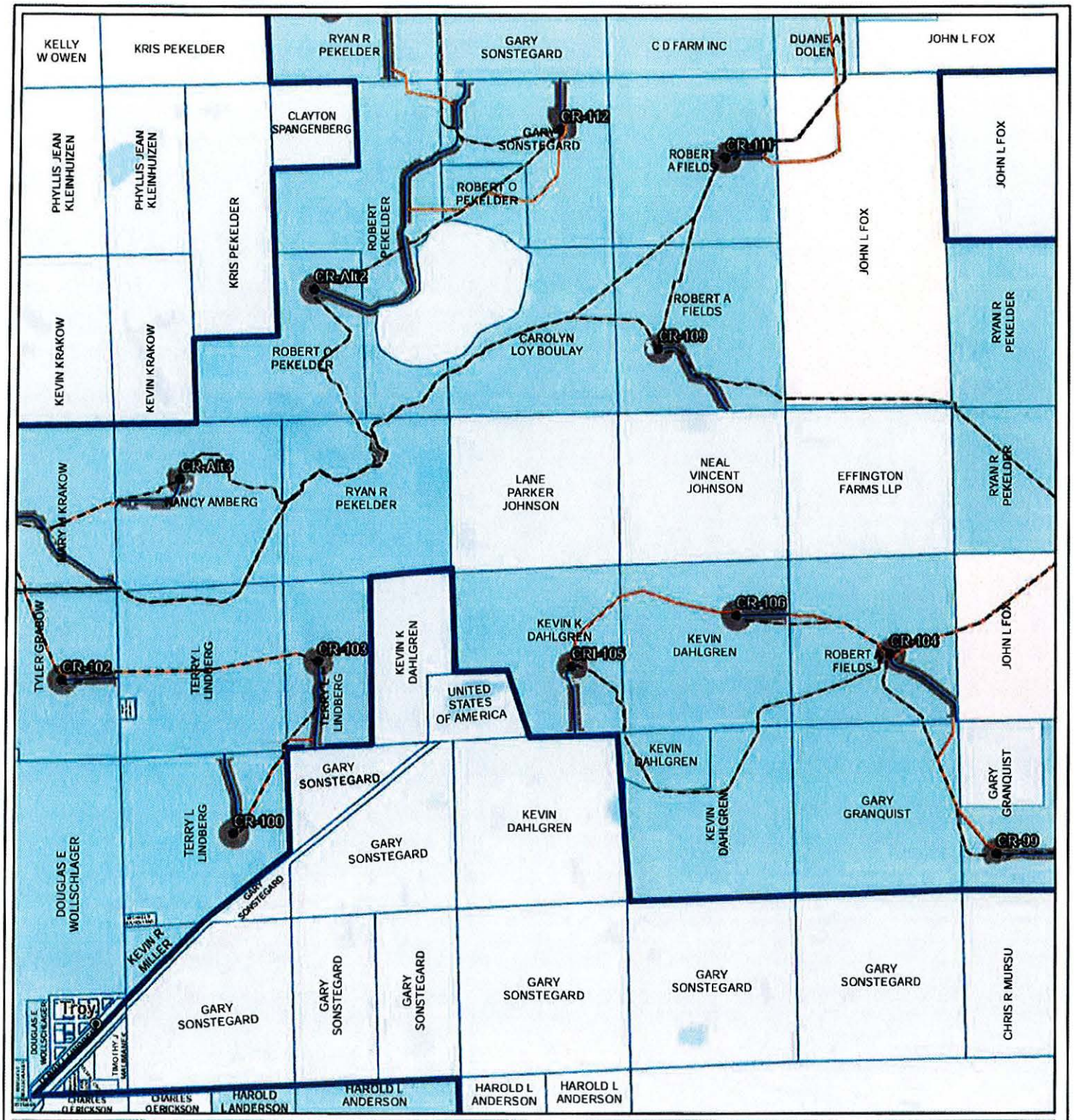
Quadrangle: South Shore (1973), Stockholm (1973)

Township/Range: T119N, R51W, T119N, R50W, T118N, R51W, T118N, R50W

Codington and Grant Counties, South Dakota

Projection: NAD 1983 UTM Zone 14N

SWCA ENVIRONMENTAL CONSULTANTS



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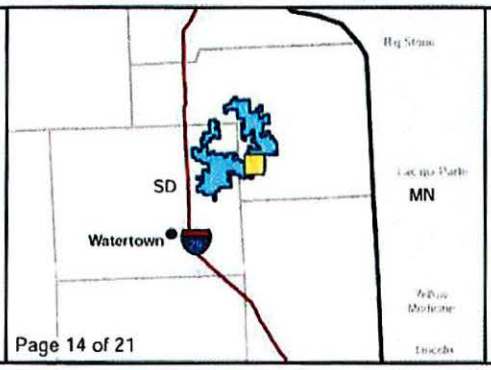

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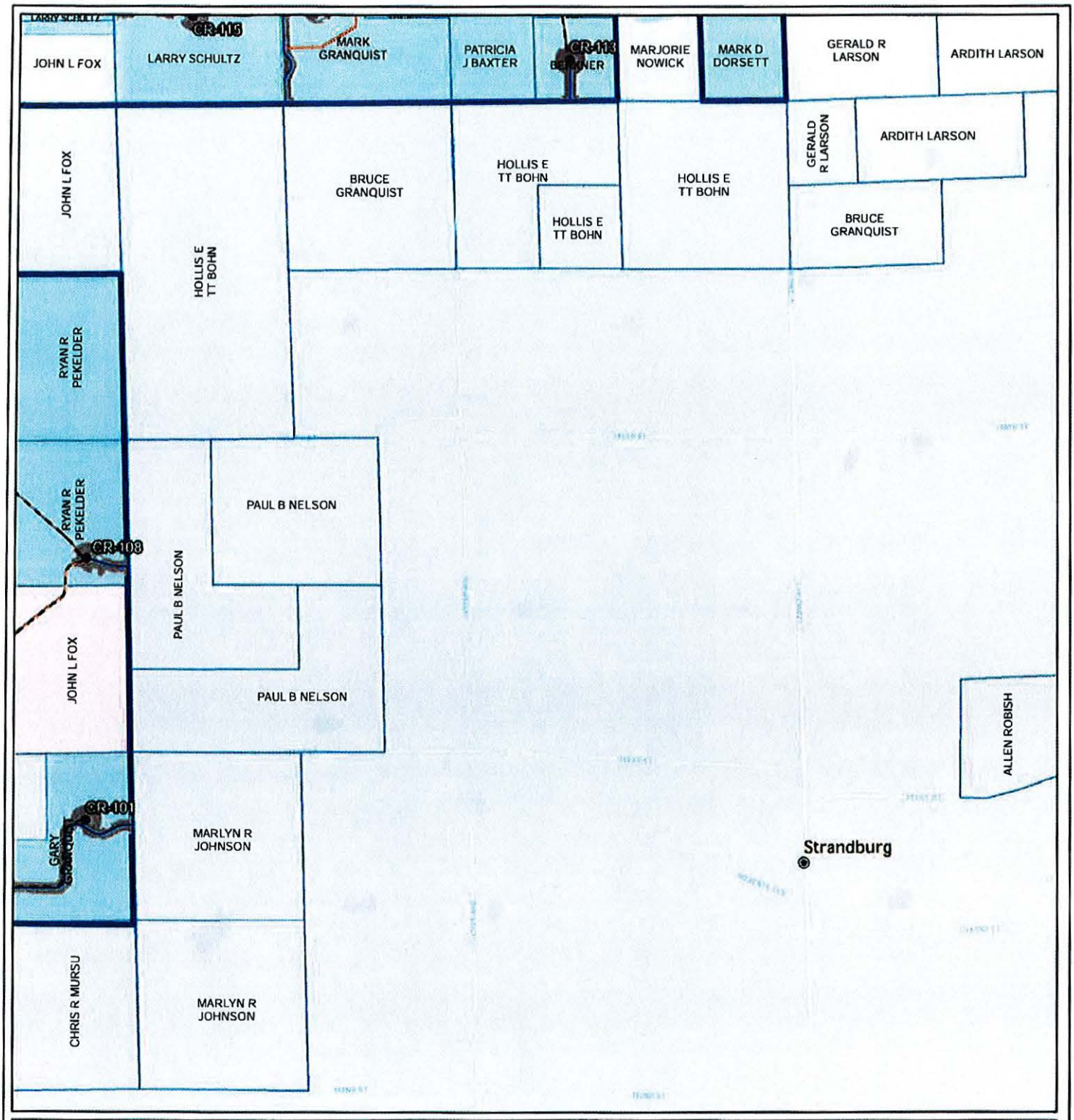

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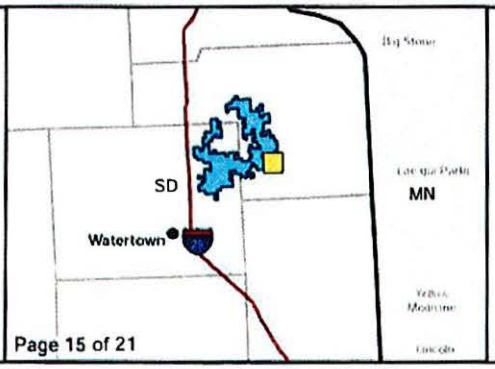

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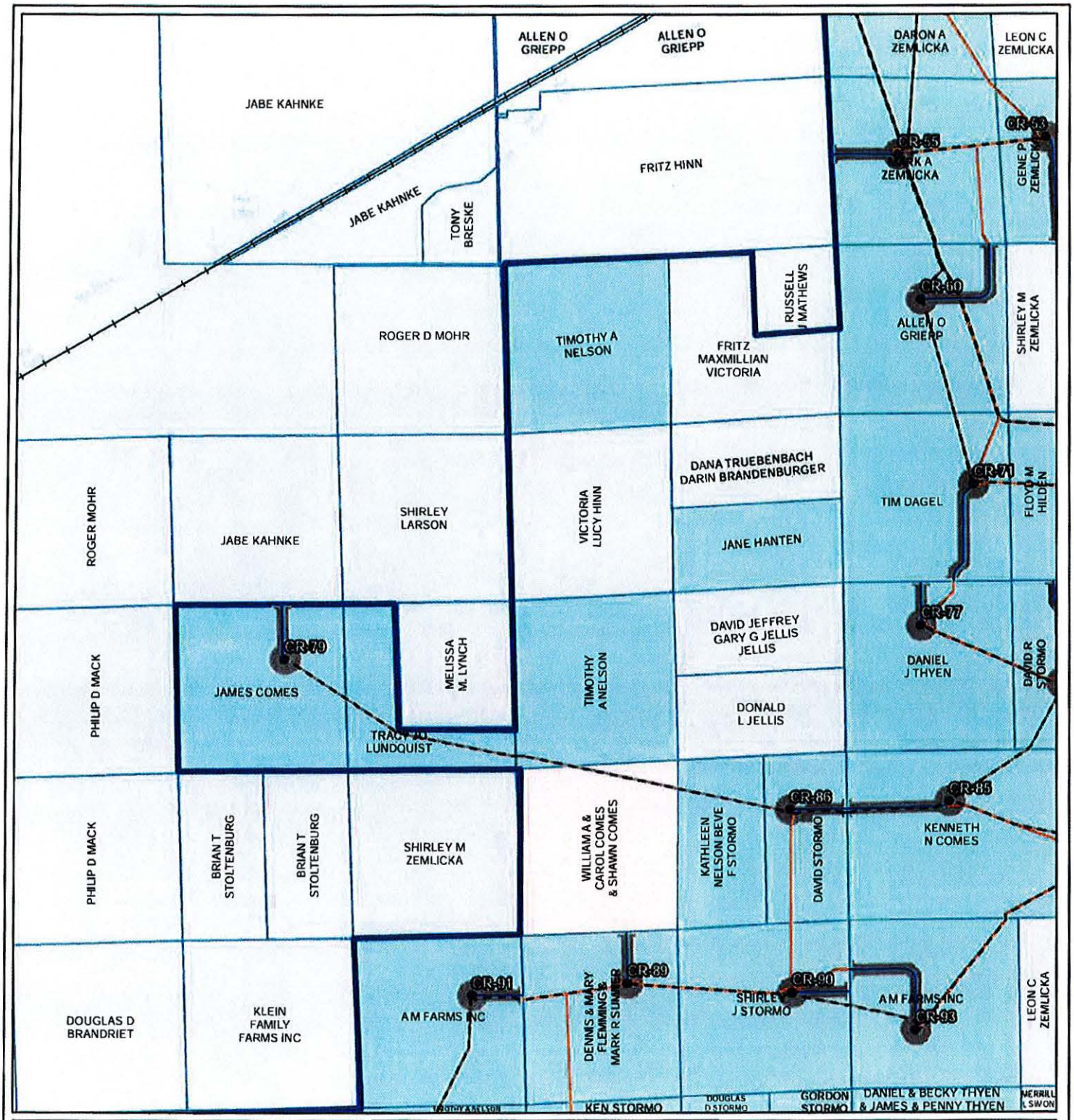

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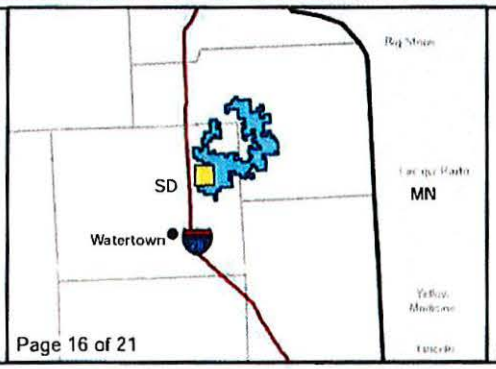

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Codington County, South Dakota

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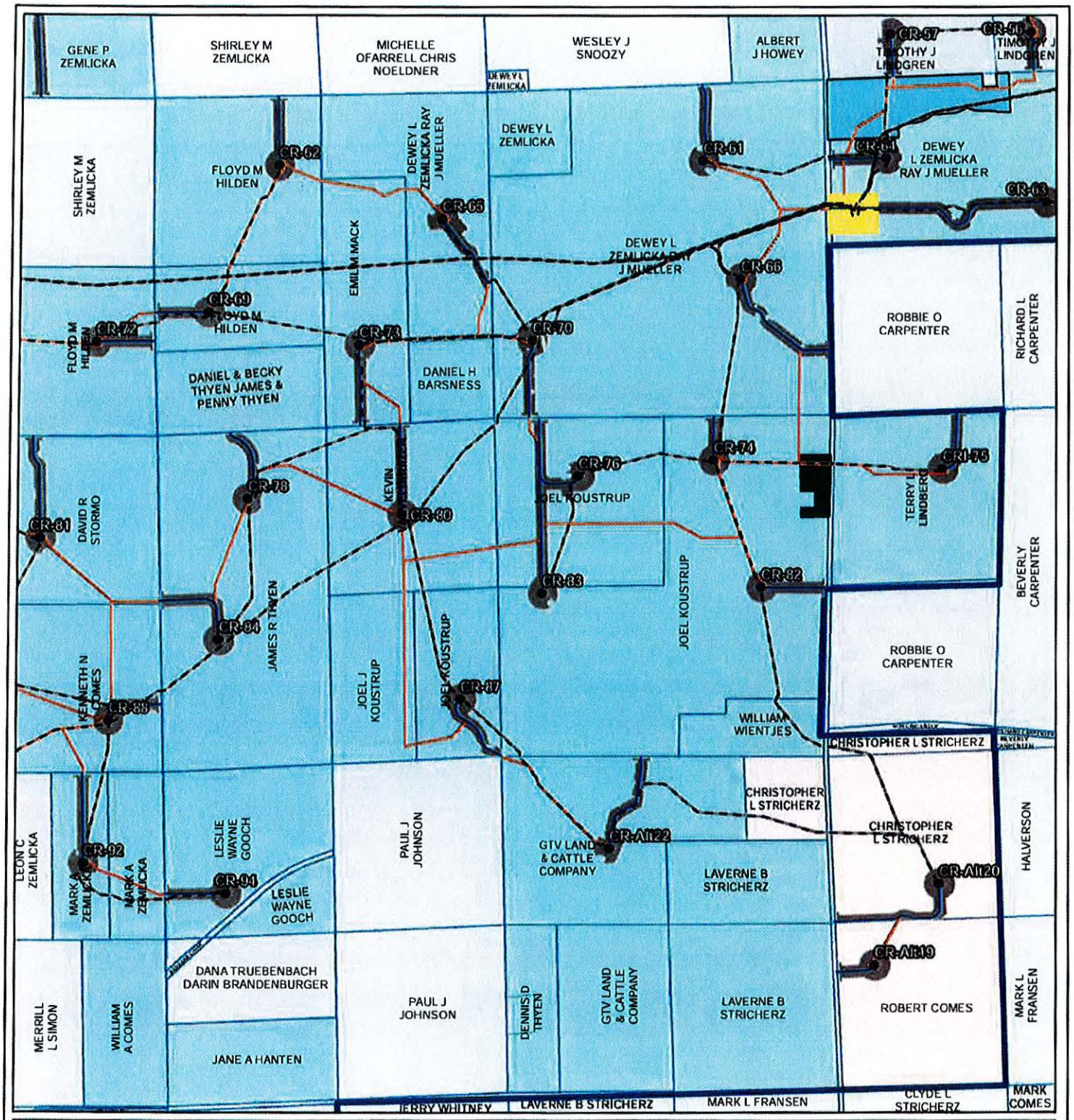

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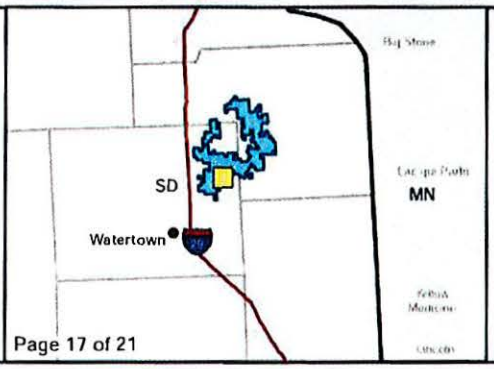

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Township/Range: T118N, R51W

Codington County, South Dakota

Projection: NAD 1983 UTM Zone 14N

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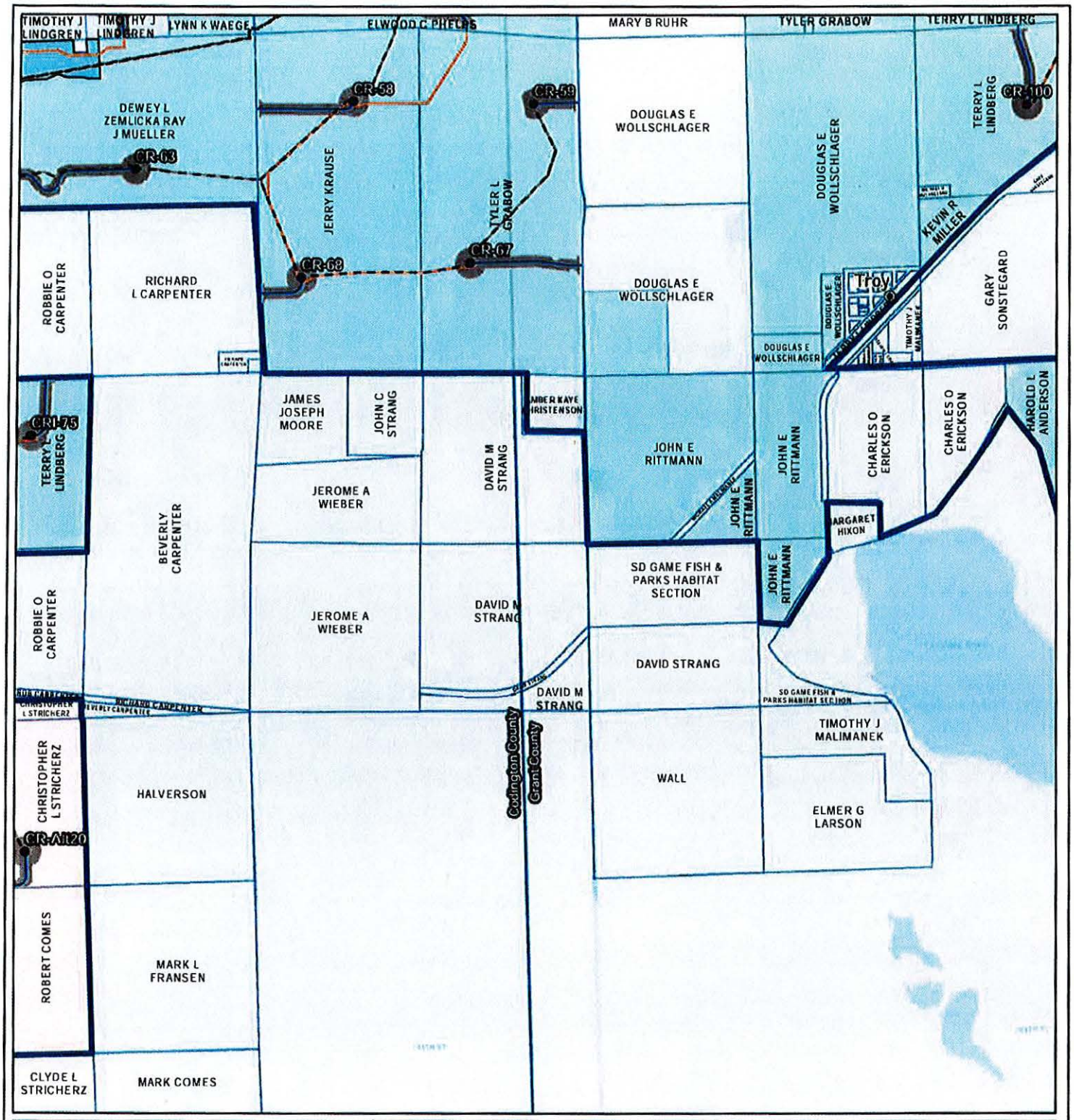

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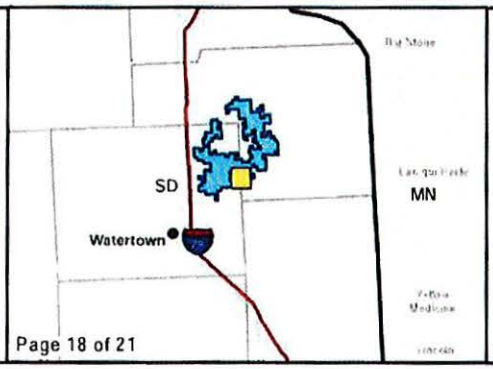

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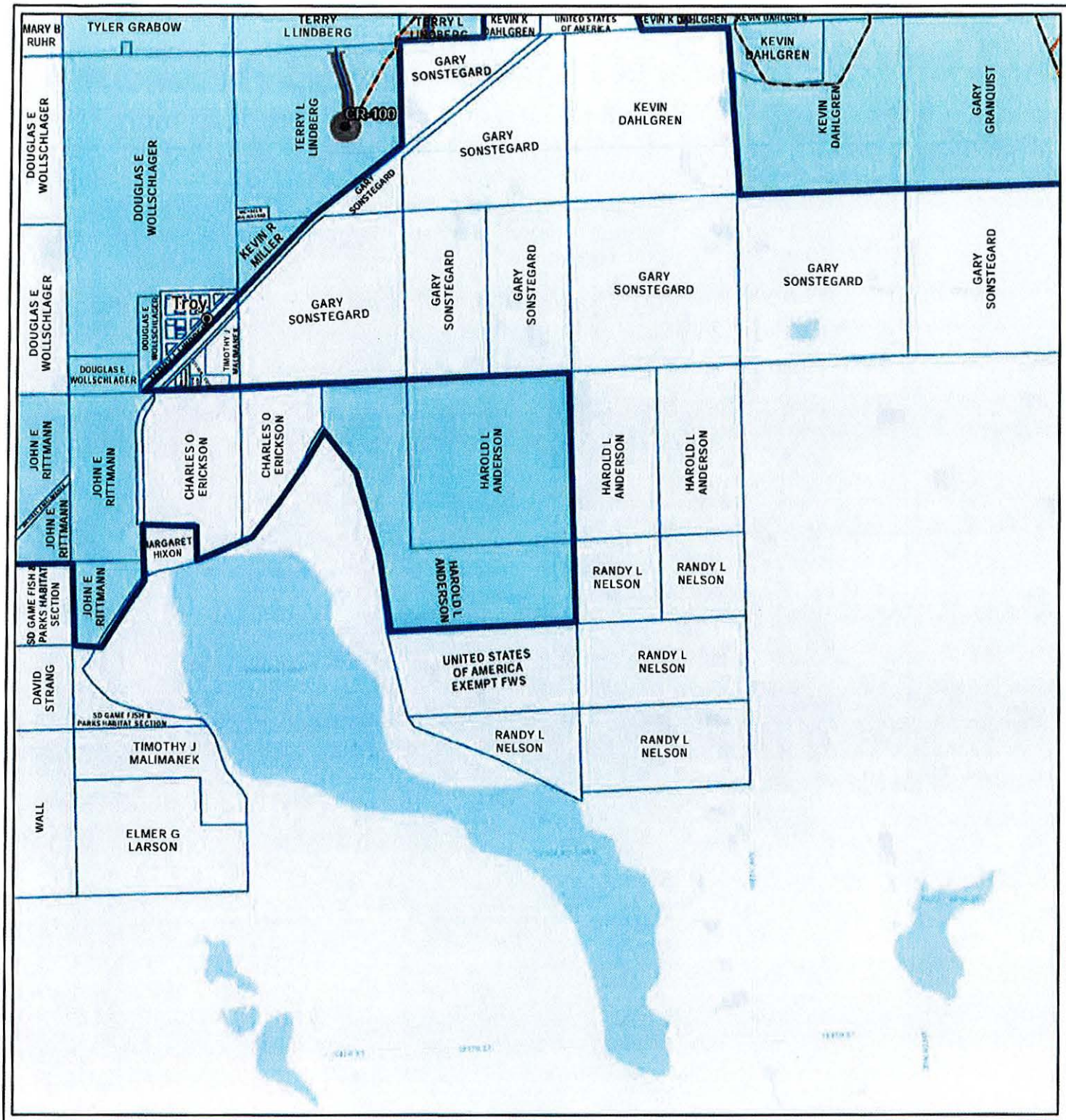

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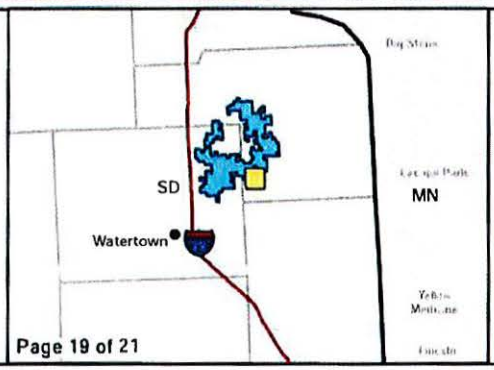

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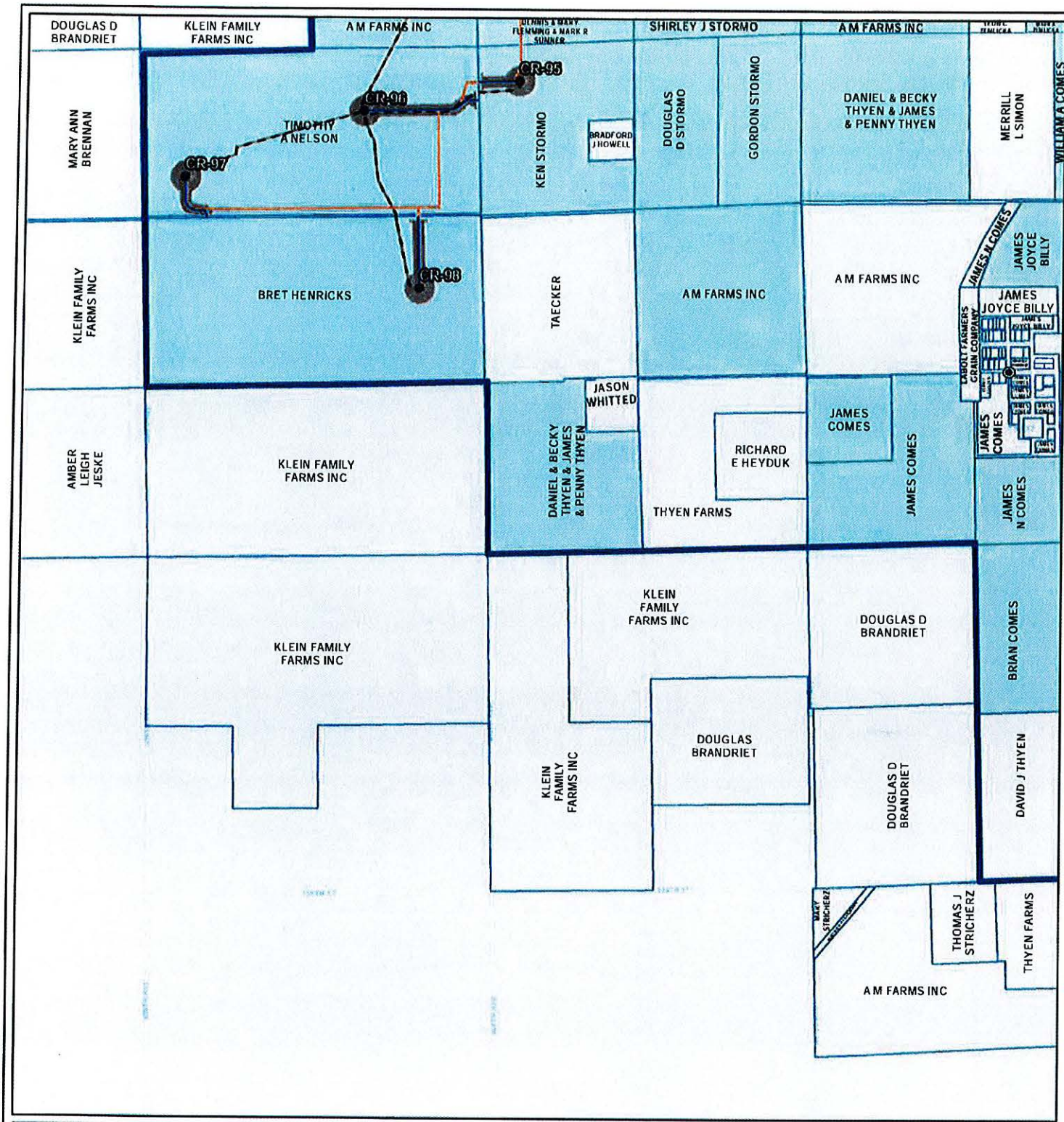

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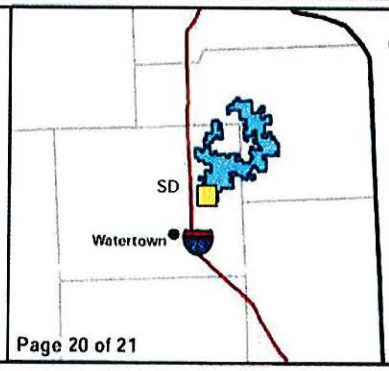

Kilometers
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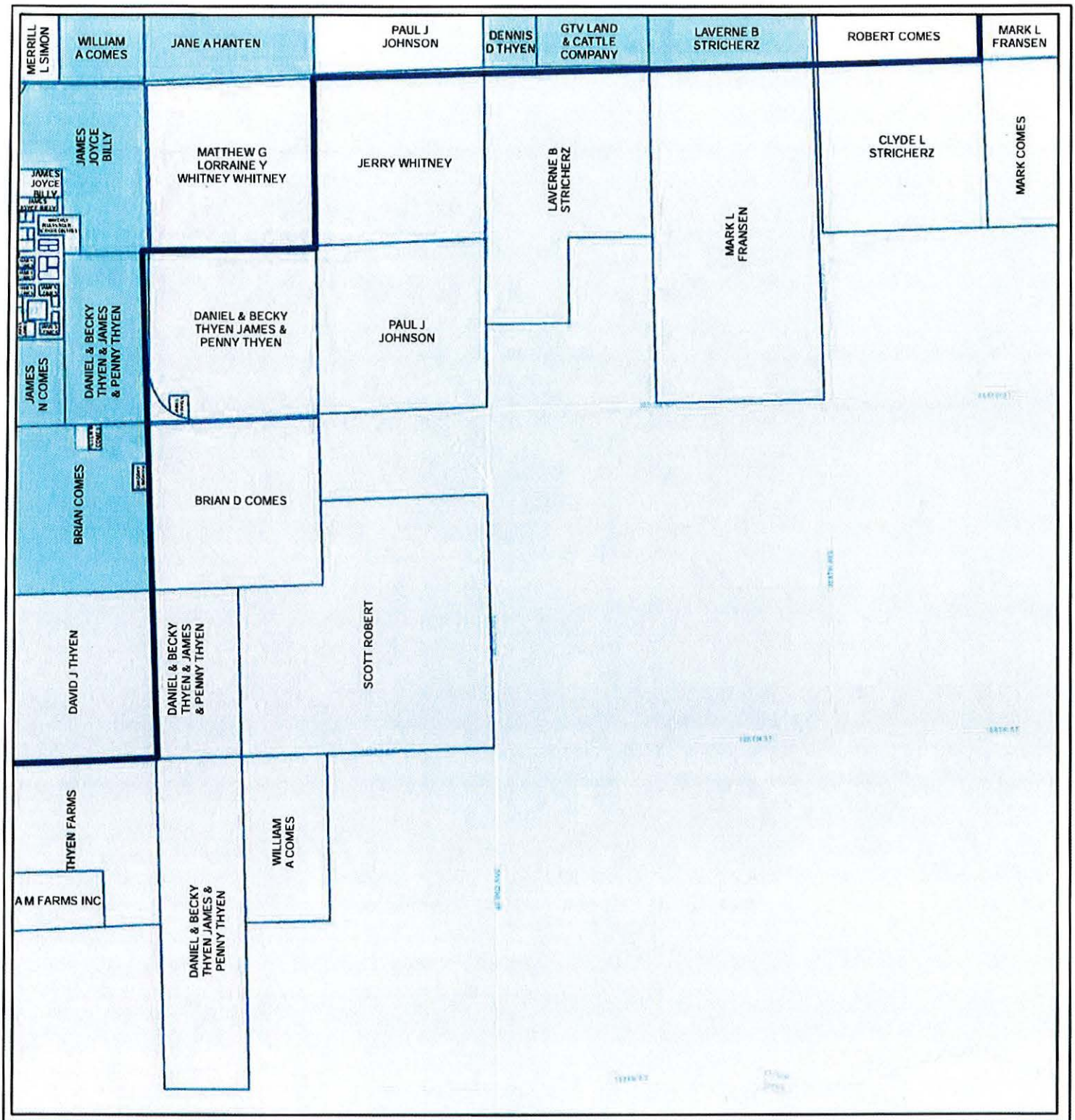

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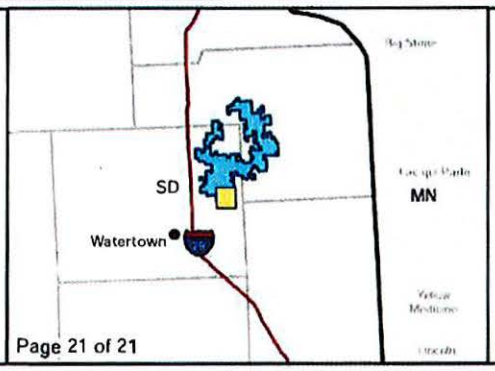

Page 21 of 21

Kilometers
0 0.5 1

Miles
0 0.25 0.5

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SWCA ENVIRONMENTAL CONSULTANTS

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF THE APPLICATION BY CROWNED RIDGE WIND, LLC FOR A PERMIT OF A WIND ENERGY FACILITY IN GRANT AND CODINGTON COUNTIES	)))))	EL19-003 **CERTIFICATE OF SERVICE**

I hereby certify that a true and correct copy of the non-confidential portions of Applicant's Responses to Staff's Fifth Set of Data Requests in this matter were served electronically to the party listed below on the 23rd day of May, 2019, addressed to:

Mr. David Ganje
Representing Intervenors Mr. Allen Robish,
Ms. Amber Christenson, Ms. Kristi Mogen,
Ms. Melissa Lynch and Mr. Patrick Lynch
Ganje Law Offices
davidganje@ganjelaw.com

Miles F. Schumacher
Attorneys for Applicant
Lynn, Jackson, Shultz & Lebrun, PC
110 N. Minnesota Ave., Suite 400
Sioux Falls, SD 57104

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF THE APPLICATION BY CROWNED RIDGE WIND, LLC FOR A PERMIT OF A WIND ENERGY FACILITY IN GRANT AND CODINGTON COUNTIES	)))))))	EL19-003 **APPLICANT'S RESPONSES TO STAFF'S SIXTH SET OF DATA REQUESTS TO CROWNED RIDGE WIND, LLC**

Attached, please find Applicant's Responses to Staff's Sixth Set of Data Requests to Crowned Ridge Wind, LLC.

6-1) Referring to page 3, line 14 of Mr. Thompson's rebuttal testimony, please provide a copy of the recent studies conducted in February 2017 that demonstrate large turbines have a lower probability of longer throwing distances.

Response: Please see Attachment 1.

Respondent: Mark Thompson, Manager of Wind Engineering

6-2) Referring to page 3, lines 20-23 of Mr. Thompson's rebuttal testimony, please confirm that the "ice detector" referenced in his testimony is the same as the "ice detector" contemplated in the GE Safety Manual provided in response to Staff Data Request 5-1.

Response: Not confirmed. The 2015 GE Safety Manual has been superseded by the 2018 Setback Manual, which was attached to my rebuttal testimony as Exhibit MT-R-3. Attached is a letter from GE that explains the 2018 Setback Manual supersedes the 2015 Safety Manual for purposes of ice throw and

setbacks of wind turbines. See Attachment 1. The ice detection that will be used for the Crowned Ridge Wind is explained in MT-R-2.

Respondent: Mark Thompson, Manager of Wind Engineering

6-3) Referring to Mr. Haley's rebuttal testimony and exhibits, please explain why the Lindgren residence and property was not analyzed as a non-participant for the opinions offered in Mr. Haley's testimony.

Response: Crowned Ridge Wind witness Haley rebuttal testimony considered the Lindgren receptor as a participant who was unlikely to resign their option easement agreement.

Respondent: Tyler Wilhelm, Project Manager;
Jay Haley, Wind Engineer

6-4) Since the Lindgrens, receptor CR1-C37-P, will be treated as non-participants for all regulatory and compliance purposes, including but not limited to noise, shadow flicker, and setbacks, please identify all turbines that will be affected by this change in participation status.

Response: Turbines CR-56 and CR-57 will be affected as they will not be sited on the Lindgren property. Other turbines that may be affected include turbines CR-48, CR-49 and CR-50. The Applicant could elect either of the following options to ensure compliance with noise, shadow flicker, and setbacks requirements: (1) drop CR1-48 or CR1-50 or (2) drop CR-49 and make a minor shift to CR-48 or CR-50.

Respondent: Tyler Wilhelm, Project Manager

6-5) Please explain how the Lindgren's modeled noise of 46.5 dbA at the residence complies with the Codington County zoning ordinance and, further, how the modeled 46.5 dbA is consistent with past permits issued by the PUC that required a noise limit of 45 dbA for non-participating residences.

Response: Please see response to 6-3.

For clarity, the 46.5 dBA referenced in the question pertains to the noise level at the occupied structure on the property. There is no Codington noise ordinance limiting the noise level at the structure.

Respondent: Jay Haley, Wind Engineer

6-6) For each of four landowners listed as "pending participation", if the landowner chose not to renew the easement, which turbines would be effected if the landowner were to be treated as a non-participant as described in the previous question? For any landowner listed as a pending participant for whom Applicant can provide assurance of participation and/or project support, Applicant need not answer this question with respect to that landowner.

Response: The turbines that will no longer be used if the pending landowners do not resign are Alt 19 and Alt 20. The Applicant is still evaluating what other turbines may need to be moved or dropped if the pending landowners do not resign.

Respondent: Tyler Wilhelm, Project Manager

6-7) Other than those five landowners identified in attachments to the rebuttal testimony of Jay Haley, are there any other landowners with easements that will expire prior to September 1, 2019[1].

Response: The following are landowners who have easement options that will expire prior to September 1, 2019:

Darrell and Coleta Logeman;

Dennis D. Thyen;

Kyro R. LantsBerger;

Dean A. Bruinsma; and

La Verne B and Barbara J Stricherz.

[1] Given the deadline for the Commission's final Order (if the permit is granted) and typical conditions requiring 30-day notice prior to construction, this date is identified as it is the earliest construction might occur.

Respondent: Tyler Wilhelm, Project Manager

6-8) In the rebuttal testimony of Wilhelm and Massey, it is argued that the sixteen turbines Staff witness Hessler proposes to relocate to alternate sites should not be moved because of loss to the landowner. What would be the corresponding gain to the landowners at the alternate sites?

Response: If the sixteen turbines Staff witness Hessler proposes to relocate to alternate sites are moved, the alternative turbine landowners would receive payments consistent with their easement agreements.

Respondent: Sam Massey, Director of Renewable Development
Tyler Wilhelm, Project Manager

6-9) Referring to page 8, lines 4-14 of Mr. Ollson's rebuttal testimony, is it Crowned Ridge's position that noise impacts to non-participating receptors should not be optimized to the lowest extent possible for the project?

Response: Crowned Ridge Wind believes that the site has been optimized to reduce sound impacts on non-participating receptors as its design keeps sound levels 25 feet from the non-participant residences at or below 45 dBA as well as compliance with the county ordinances on sound. To lower the sound level further for non-participants is not supported by the scientific and medical literature for the reasons set forth in the testimonies of Crowned Ridge Wind witnesses Ollson and McCunney.

Additionally, to redesign the Crowned Ridge Wind project, such as using alternative turbines locations, for the purpose of lower sound levels to the lowest extent possible for non-participants is constrained by numerous factors, including setback distances for receptors, landowner preferences, municipal boundaries, property lines and roadways, environmental constraints, capturing maximum wind resource, engineering considerations, and cultural resources, amongst many others.

Respondent: Tyler Wilhelm, Project Manager

Miles F. Schumacher
Attorneys for Applicant
Lynn, Jackson, Shultz & Lebrun, PC
110 N. Minnesota Ave., Suite 400
Sioux Falls, SD 57104

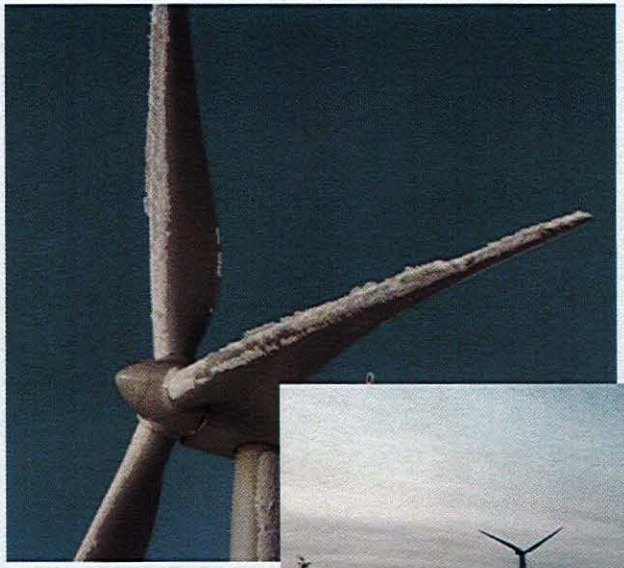
ICETHROWER

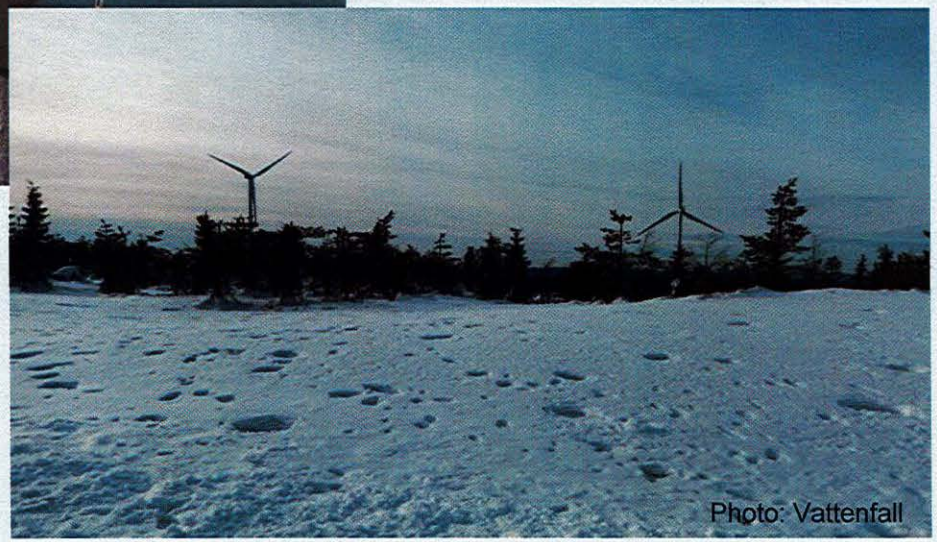
Mapping and tool for risk analysis

Winterwind, Skellefteå 7 February 2017
Jenny Lundén, Pöyry Sweden

PÖYRY

WHAT IS THE PROBLEM?





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WHAT IS THE PROBLEM?

1. Wind turbines drop ice pieces occasionally

2a. The emotional conclusion is “often” and “long distance” (km!)
2b. The pragmatic approach is ”now and then” and “within 1D”

3. Risk level is generally poorly investigated and hard to calculate

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IS THERE A SOLUTION TO THE PROBLEM?

Level of confidence can be increased by more observations

Discrepancies between different turbines can be investigated

A generic tool to increase the possibility to calculate and communicate risk both for service personnel and for the public

ICETHROWER – mapping and tool for risk analysis

Project:

- Mapping ice throws in Sweden
- Develop a model to simulate ice throw and assess health & safety risks
- Client: Swedish Energy Authority
- Partners: Dala Vind, Vattenfall Vindkraft and Skellefteå Kraft
- Location: 3 wind farms in Sweden
- Field study: 2013 – 2016

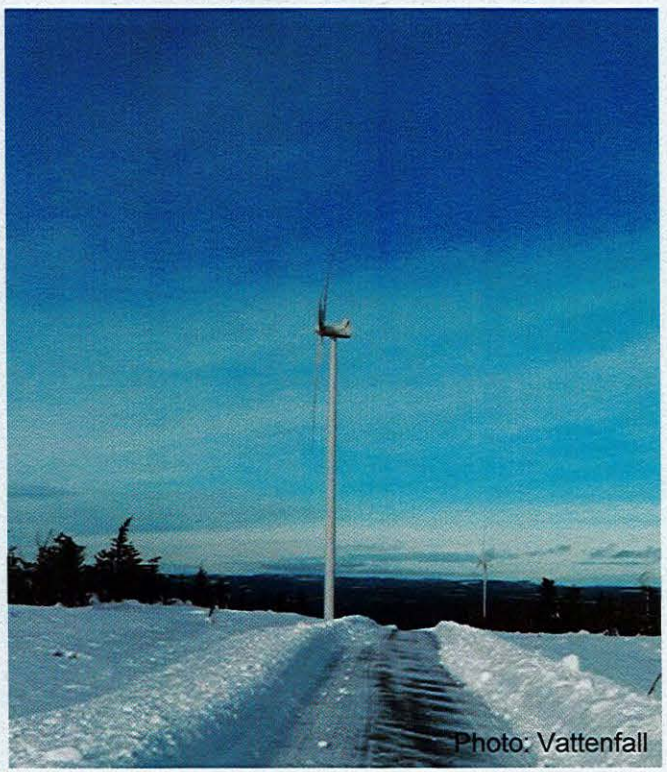
Photo: Vattenfall

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WHICH IS OUR APPROACH?

Joint research project within Energimyndigheten's research program "Wind power in cold climate"

Pöyry Sweden
Project leader
Data analysis / development of statistical ice throw model

ProgramoGrafik
Validation KASTIS model

Dala Vind
Field study
1 turbine in mid-Sweden forest
without blade heating

Skellefteå Kraft
Field study
2 turbines in northern Sweden mountain terrain
with blade heating

Vattenfall Vindkraft
Field study
1 turbine in northern Sweden forest
without blade heating

THE ICETHROWER PROJECT

The project is divided into three parts:

- Field study to collect ice data from 3 wind farms in Sweden and create a database for common use
- Verify and integrate the existing tool KASTIS into a common tool box
- Develop a usable simulation tool for risk evaluation based on collected data

Photo: B. Göransson

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THE FIELD STUDY - METHOD

Three wind farms in Sweden
Collect information:

- Physical properties of ice lumps
- Throwing distance
- Meteorological data at the time of ice throw

Data collection during winter 2013 - 2016

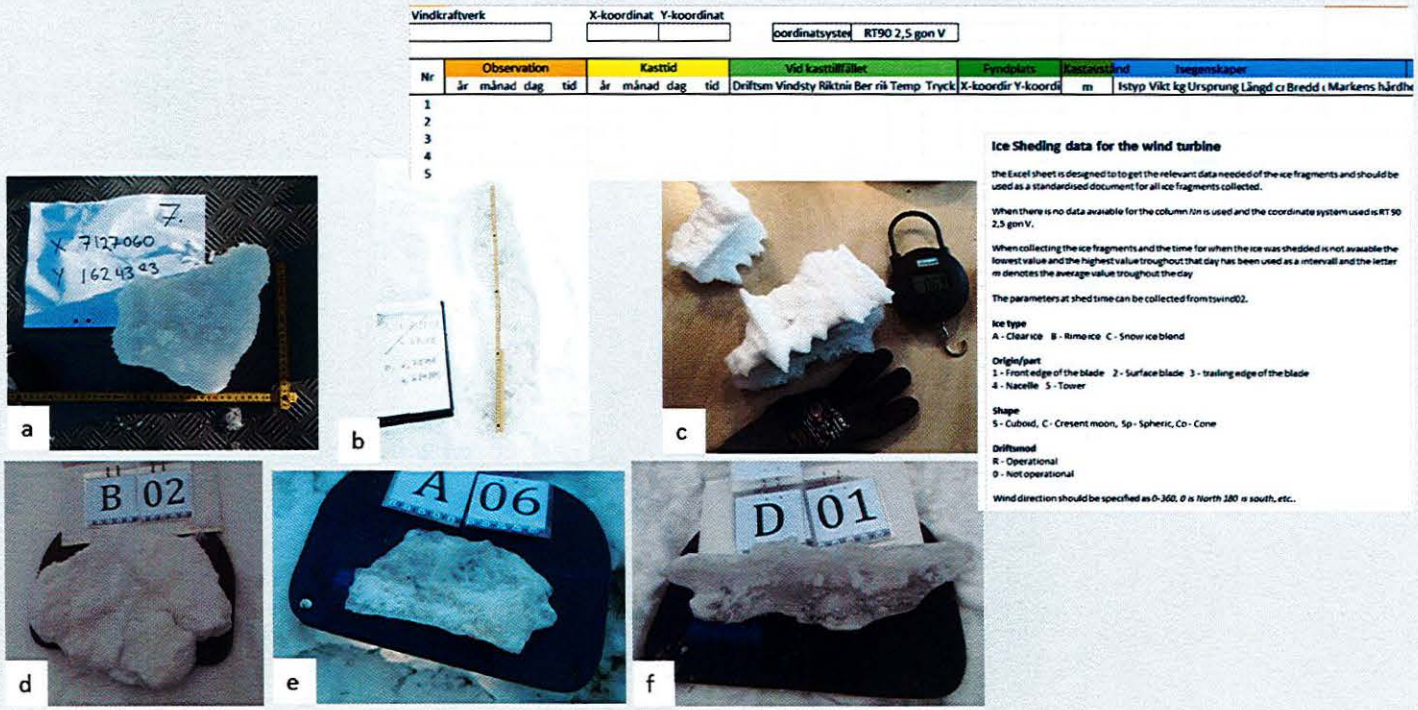
Challenges in field work:

- Severe winters -> increased risk
- Mild winters -> less data

THE FIELD STUDY - METHOD

Systematic approach in the search for ice lumps

- Ice lump measurement and classification
- Location of ground impact and throwing distance
- Photographs



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THE FIELD STUDY - METHOD

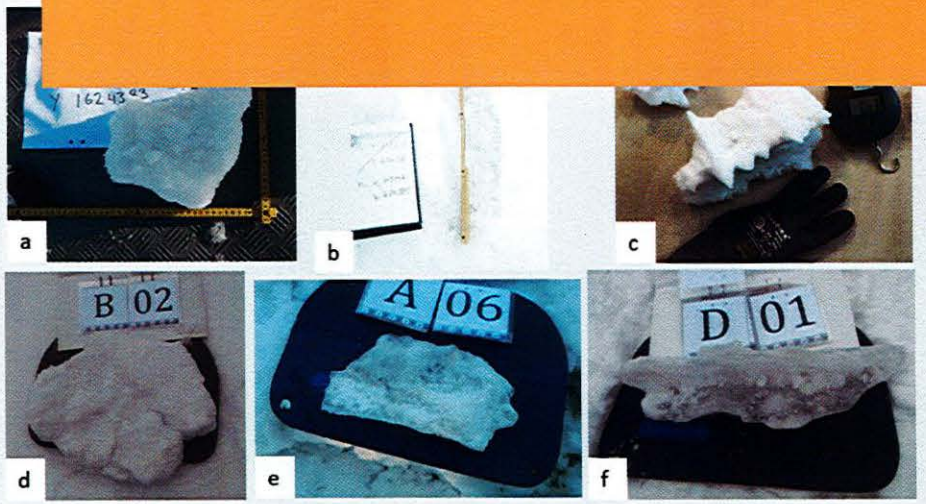
Three wind farms in Sweden

Collect information:

- Physical properties of ice lumps
- Throwing distance
-

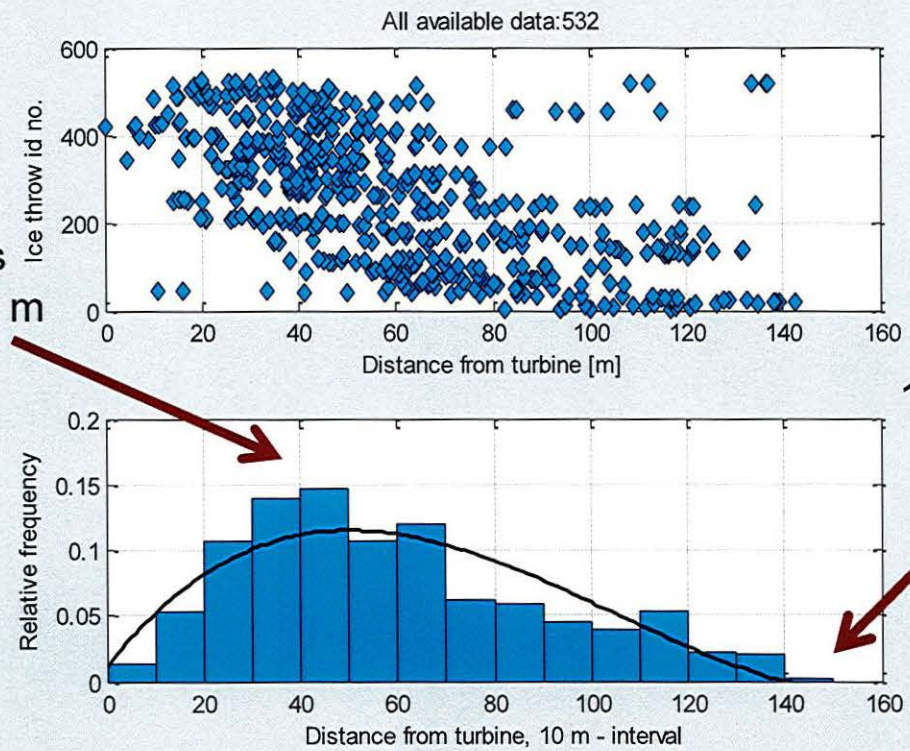
D

Over all data from 530 ice lumps was collected!



THE FIELD STUDY – RESULTS (ALL DATA)

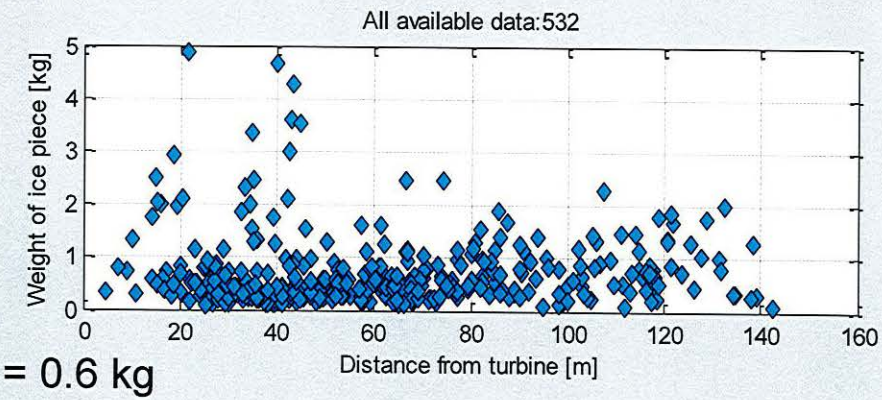
75% of ice lumps between 20 – 90 m



140 m = 1.55 RD

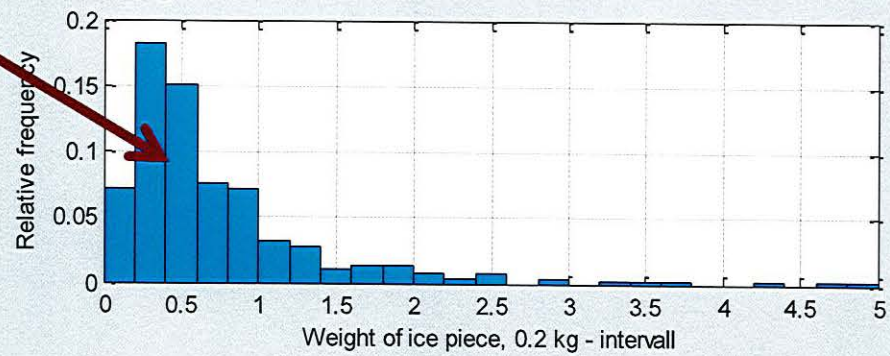
Turbines in the field study had 90 m rotor and 95 m tower (no de-icing system)

THE FIELD STUDY – RESULTS (ALL DATA)



No trend between distance and ice mass

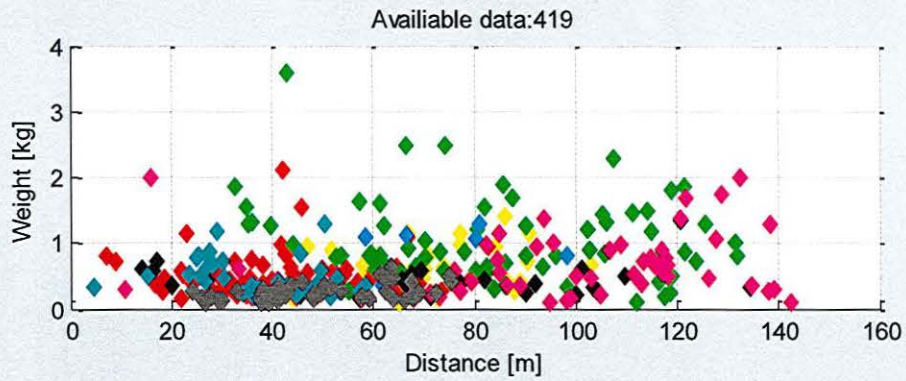
Average ice mass = 0.6 kg



Turbines in the field study had 90 m rotor and 95 m tower (no de-icing system)

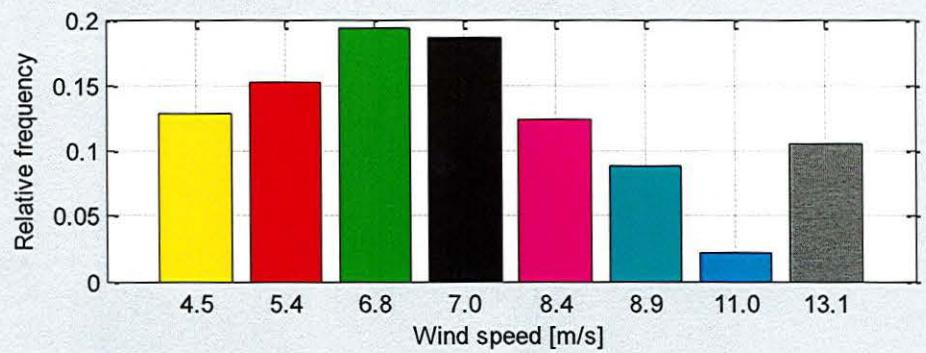
THE FIELD STUDY – RESULTS (CASE STUDY)

No trend between
- distance and wind speed
- distance and ice mass



2013: 2 ice days
2014: 2 ice days
2015: 1 ice day
2016: 3 ice days

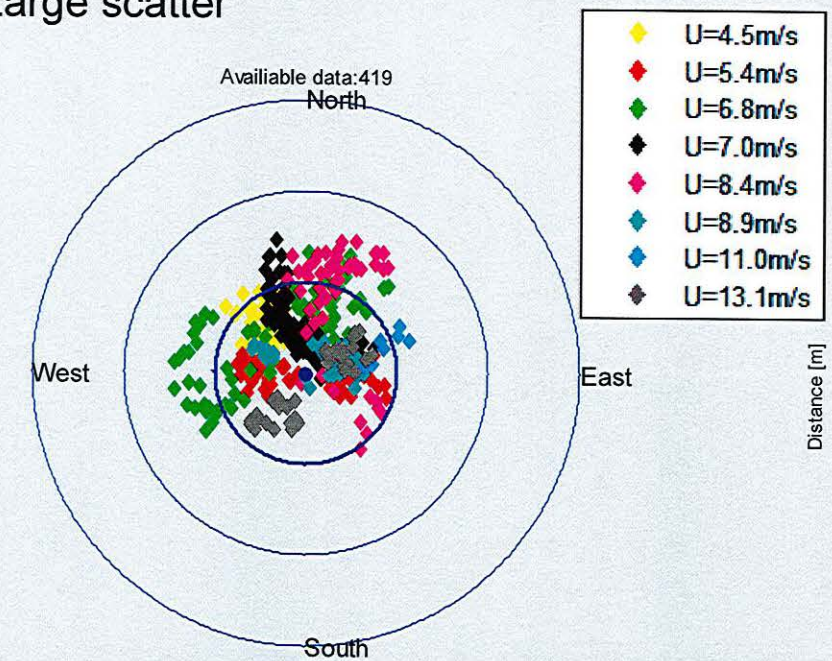
10 – 80 ice lumps / ice event



Turbine in the case study had 90 m rotor and 95 m tower (no de-icing system)

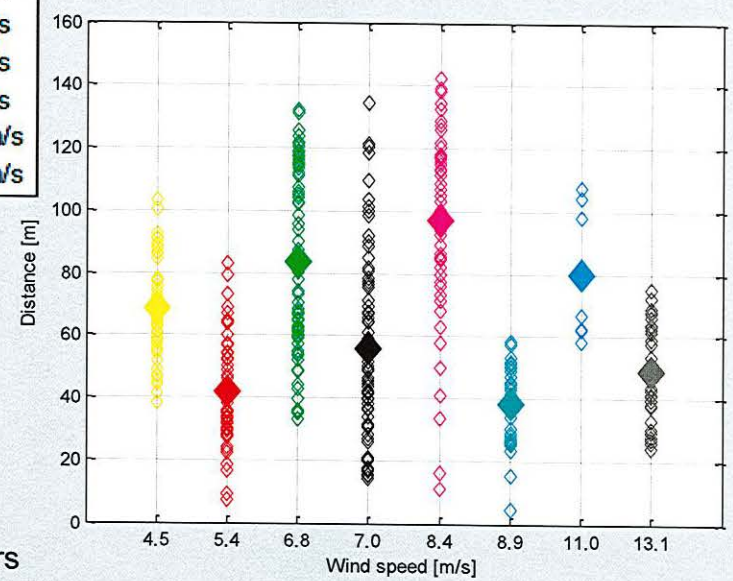
THE FIELD STUDY - RESULTS (CASE STUDY)

Ice lumps fall in the wind ward direction.
All ice lumps were found within 2 RD
Large scatter



The blue circles show one, two respective three rotor diameters (e.g. 90, 180 and 270 m)

Wind speed between 4.5 – 13 m/s at the time of ice release



Turbine in the case study had 90 m rotor and 95 m tower (no de-icing system)

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THE KASTIS MODEL – SELECTED OUTCOME

Purpose: calibrate and tune the previously developed model KASTIS.

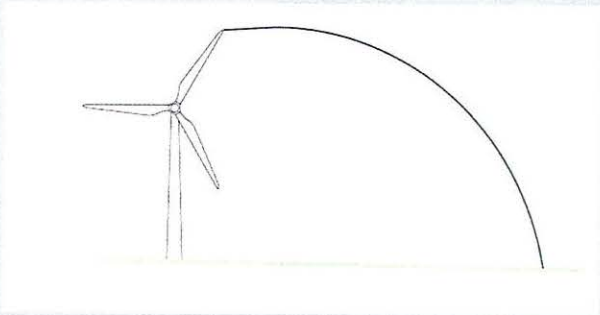
- A developed version of KASTIS was derived in the project, called iceThrow
- The program calculates trajectories for ice lumps released from wind turbine blades during operation using very detailed information of the ice lump

Result:

- The iceThrow model showed that most of the ice lumps in the range 0.1 – 0.4 kg hit the ground with a speed, converted to energy, in the potential lethal region i.e. in excess of 40 J

THE ICE THROW MODEL - METHOD

A statistical ice throw model was developed using the equations of motion in combination with Monte Carlo simulations.



$$M\frac{d^2x}{dt^2} = -\frac{1}{2}\rho C_D A\left(\frac{dx}{dt} - U\right)|V| \; Eq.3$$

$$M\frac{d^2y}{dt^2} = -\frac{1}{2}\rho C_D A\left(\frac{dy}{dt}\right)|V| \; Eq.4$$

$$M\frac{d^2z}{dt^2} = -Mg - \frac{1}{2}\rho C_D A\left(\frac{dz}{dt}\right)|V| \; Eq.5$$

The relative wind speed is given by,

$$|V| = \sqrt{\left[\left(\frac{dx}{dt} - U\right)^2 + \left(\frac{dy}{dt}\right)^2 + \left(\frac{dz}{dt}\right)^2\right]} \; Eq.\ 6$$

Where M is the mass of the ice fragment, C_D is the drag coefficient, ρ is air density, $U(z)$ is the wind speed with x-axis parallel to the wind and g is the gravity.

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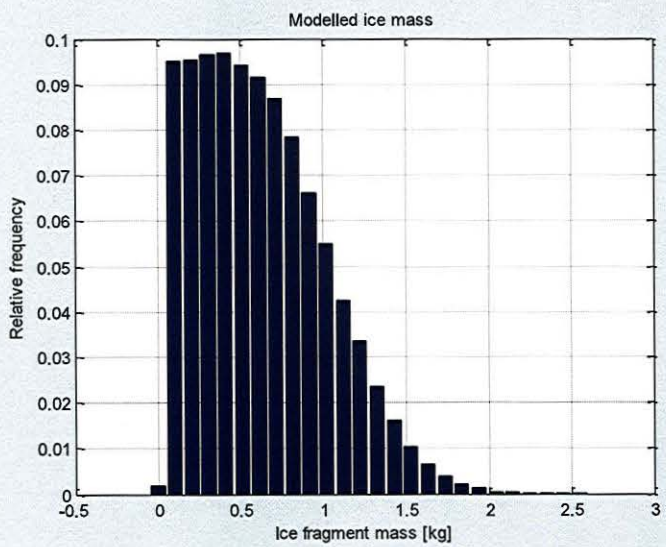
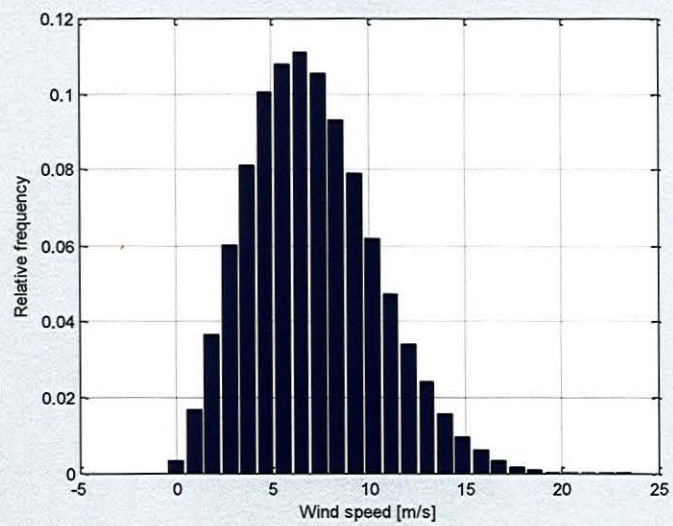
THE ICE THROW MODEL - ASSUMPTIONS

Assumptions used in the ice throw simulations

- Random normal distribution of mass
- Random Weibull distribution based on wind speed and direction
- Turbine specifics (rotor radius, hub height, rotor revolution)





Turbine used in the simulation had 90 m rotor and 95 m tower

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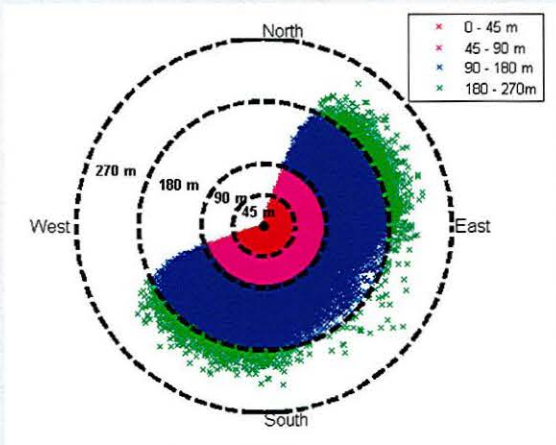
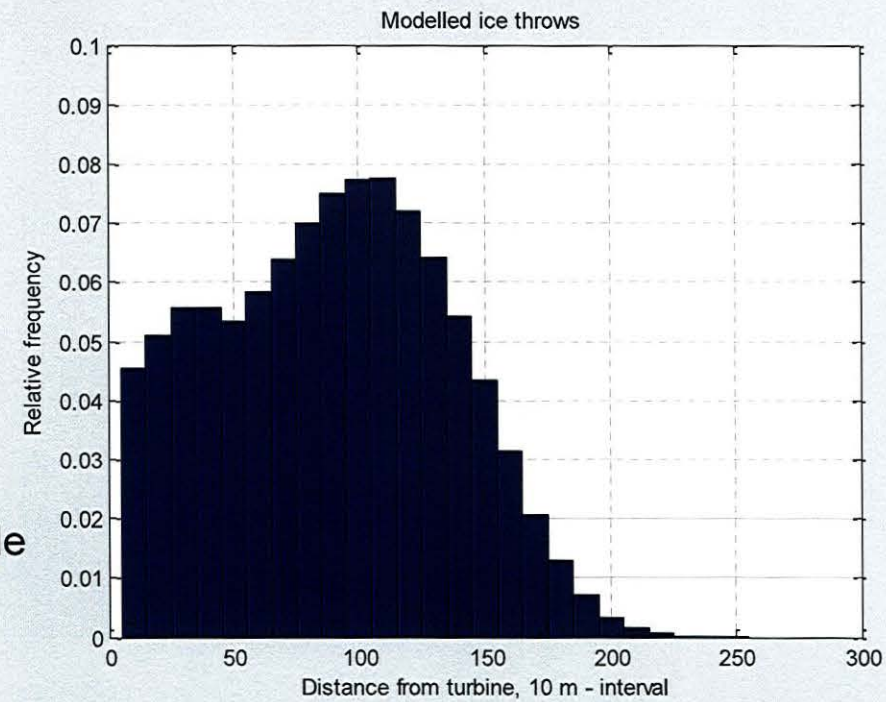
THE ICE THROW MODEL - RESULTS

Example:
Turbine with 90 m rotor diameter and 95 m hub height
Only using wind from the prevailing wind direction (WNW & NNW)

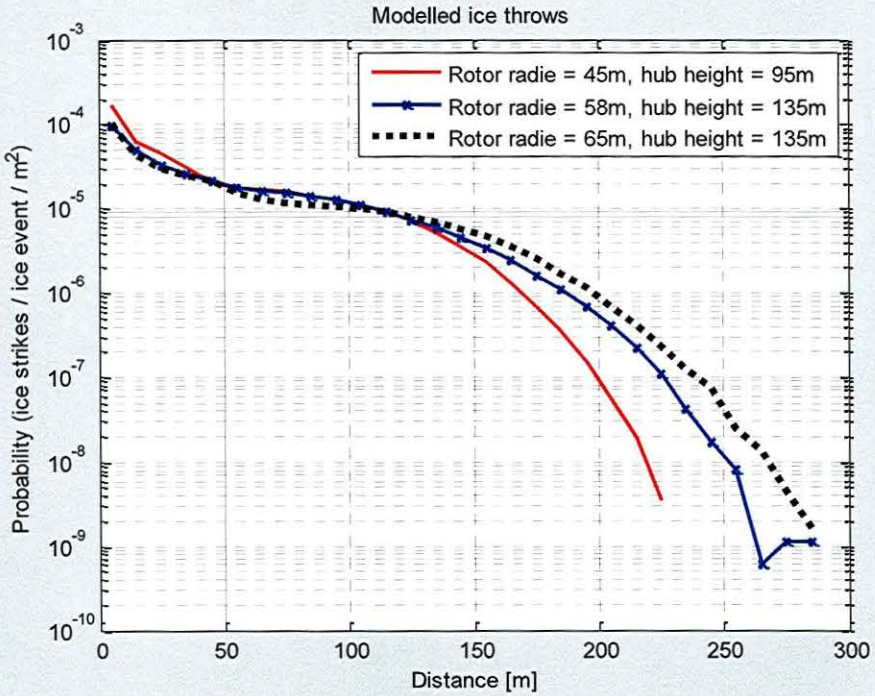


Ice lumps land on the wind ward side



The furthest modelled throwing distance: 250 m

THE ICE THROW MODEL - RESULTS



Larger wind turbine -> longer throwing distance
However the probability rapidly decreases with distance

Based on 100 000 simulated ice throws, all wind directions included

EXAMPLE OF RISK ESTIMATE

Two service personnel visit wind farm after indication of icing on the turbines.

- Park the car 10 m from entrance
- Get tools, walk to the turbine (5 min)
- Work for 1 hour inside the turbine
- Walk back to the car, load tools (5 min)

During a working day they visit 5 turbines.

The estimated total risk is then

- 0.009 for the car or 1 in 115 year
- $1.5*10^{-4}$ for 2 service personnel on one working day or 1 in 6 900 years.

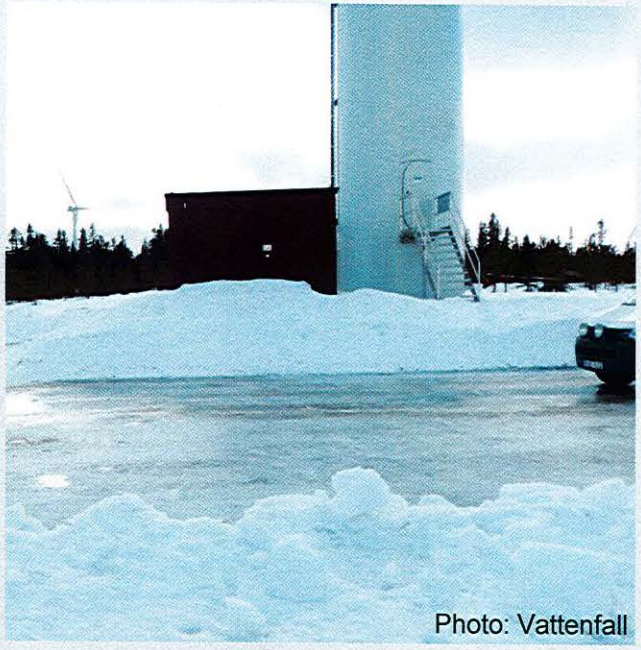


Photo: Vattenfall

Assumptions: car = 10m^2, one person = 0.5 m^2
70 ice lumps released per icing day and turbine.
Probability from the red curve on previous slide.

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EXAMPLE OF RISK ESTIMATE CONT.

High or low risk?

In the example the total risk (one working day)

- $1.5*10^{-4}$ for 2 service personnel
  or 1 in 6 900 years.
- In comparison the risk of car accident is $5*10^{-5}$

The estimated risk is considerable high and not acceptable without certain safety provisions.

For the public the risk is lower since they do not know if the turbine are affected by ice.

(e.g. the number of ice day / the winter season)

It is important to have warnings signs at the wind farm entrance to alert the public of the potential hazard.

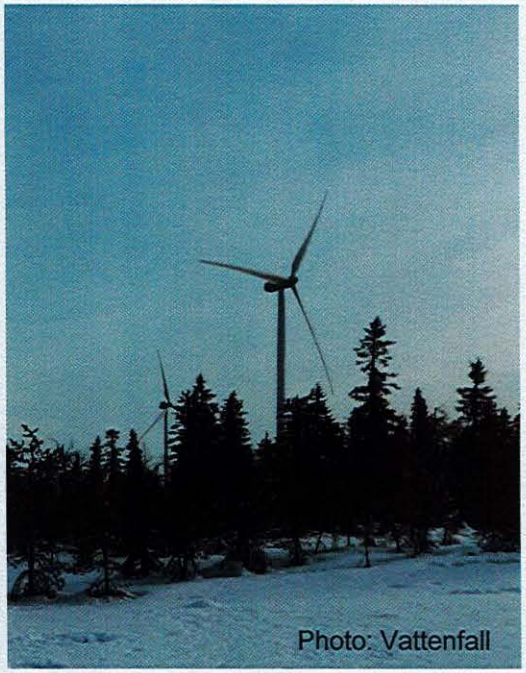
Photo: Vattenfall

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Thank you!

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Engineering balanced sustainability™

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May 30, 2019

NextEra Energy Resources, LLC
700 Universe Blvd.
Juno Beach, FL 33408

Subject: Crowned Ridge Wind Project – Setback Requirements

Reference:
1. Safety Manual 2015 (GE Reference: Operating_Manual_1-2MW_Safety_EN_r02
2. Setback Considerations for Wind Turbine Siting 2018 (GE Reference: Setback_Considerations_Generic_xxHz_EN_r04)

To Whom It May Concern:

This is to confirm that the GE document Setback Considerations for Wind Turbine Siting, 2018, supersedes the GE document titled Safety Manual 2015 for purposes of ice throw safety and GE setback standards.

Please feel free to contact me if any additional information is required.

Sincerely,

Kevin Burns
Commercial Director

CC: Donald Karwisch, Integrated Supply Chain, NextEra Energy Resources, LLC