December 11, 2024
Project No. 2407911

VIA EMAIL: cortneyodonoghue@gmail.com

Ms. Cortney O'Donoghue
362480 Lindenwood Rd,
Georgian Bluffs, ON, N0H 2T0
Phone: 416-697-2573

Re: Karst Assessment and Bedrock Resource Letter of Opinion
362480 Lindenwood Rd, Georgian Bluffs, ON, N0H 2T0, Canada

Dear Ms. O'Donoghue,

This letter provides the findings of the Karst Assessment (or Karst Study) and Bedrock Resource Letter of Opinion that was conducted on the property located at 362480 Lindenwood Rd, Georgian Bluffs, ON, N0H 2T0, Canada, County of Grey, roll number 420362000422400. The location of the Site is shown on Figure 1. This letter report has been conducted in support of a proposed lot severance in the northwest portion of the property.

The subject property encompasses approximately 47.03 acres and is located approximately 10 km southeast of Wiarton, Ontario. The property is located on the north shore of Francis Lake, with access achieved from the south side of Lindenwood Road, which is situated along the northern property boundary. The Site has a single dwelling located on the southern portion of the property and will remain on the retained portion of land. The lot being proposed for severance is vacant with no municipal sanitary sewer or water services provided to it.

The subject property falls within the 'Karst' Area as outlined in Appendix 'A' of the Grey County Official Plan. Due to the potential for karst features at the Site, a review of the subsurface is conducted herein to assess risks involved with future developments on the property.

Additionally, in some instances there is potential for the extraction of sedimentary bedrock to produce dimension stone or other aggregate products. The Site is located within the areas identified to have less than 8 meters of drift thickness as outlined in the 'Bedrock Drift Thickness' of Appendix 'E' of the County Official Plan. This letter report will assess the bedrock resource potential at the Site.

The scope of this review includes:

- Review of geologic and physiographic mapping,
- Review of aerial photography,
- A site visit and reconnaissance of the study area on November 13th, 2024,
- The documentation of the nature of soil and bedrock in five excavated test pits.

The scope of work described herein relies on surface and subsurface exploration via excavated testholes that are 1 meter x 1 meter in diameter, down to bedrock or a maximum of 2 metres depth. No detailed subsurface exploration (such as drilling) or geophysical work was conducted as part of this Assessment.

Karst – Background

Karst topography is generally found in areas where carbonate rock, such as limestone or dolostone, are exposed at surface or lie beneath shallow surficial sediment or overburden. Karst is created through the chemical weathering (i.e., dissolution) of carbonate bedrock, subsequently forming a network of voids beneath the surface. At the surface, evidence of this type of weathering can be seen as irregular or hummocky rock outcrops, crevasses, or sinkhole patterns in the land topography.

The nature of the karst (i.e., how large, abundant, and connected the voids are) and the site setting (i.e., if the voids are part of an active surface water or groundwater system with significant dissolution) will determine the potential for interference with proposed development.

Geologic Setting

The Site is located within the physiographic region known as the “Bruce Peninsula” (Chapman and Putnam, 1984). The region is characterized by generally flat topography with shallow overburden, primarily as fine-textured till, scattered on grey limestone, dolostone or shale to the east and in the vicinity of Georgian Bay. In some areas, bedrock is exposed at ground surface.

Based on geologic mapping, the surface soil in the Study Area is comprised of the Osprey Loam Series. The Osprey series is described as a light buff colored stony till with a dolomitic source origin. The overburden may contain the stony rock fragments within the soils itself but can also be found at the surface. It is a fairly well drained soil containing organic matter, black, reddish brown, to yellow loam, with varying amounts of clay and/or rock fragments depending on the location. The soils observed in the testholes that were completed across the Site primarily consisted of silt, clay and fine sand bearing organic topsoil followed by light brown stony loam containing silt, clay, and fine sand (See Table 1). These observations are considered consistent with the mapped soil type.

Based on a review of the geologic setting, the potential for karstic features is considered to exist since the area is comprised of dolostone bedrock of the Guelph Formation (i.e., carbonate rock) at, or near the surface. Additionally, according to the Karsts of Southern Ontario and Manitoulin Island GIS Mapping (Ontario Geologic Survey, 2008; Brunton, Dodge), the area of the subject property is considered to be an area of known karst (as shown in Figure 2).

A review of the Ministry of Environment, Conservation and Parks (MECP) water well database was also completed as part of this investigation. One well is currently registered on the retained portion of the property, and no wells are located on the proposed severed lot. When reviewing the nearby well logs, the well located on the retained lot to the south (Well ID 7391913) reported stoney clay soils with competent bedrock is situated 6.4 meters below ground surface (mbgs). Another well located on the north side of Lindenwood Road (Well ID 2512433) also reported stony soils, with a competent bedrock depth of just 0.3 mbgs. Additionally, outcropping bedrock was identified at surface in several locations on the property implying a variable overburden thickness with several instances of bedrock at or near surface. Based on the ground elevations and expected bedrock topography in the area, the shallow groundwater system is expected to flow generally west to southwest in this area.

Site Setting and Reconnaissance

A site visit conducted by GEI Consultants Canada was conducted on November 13th, 2024. The subject property is situated on the south side of Concession Road 24 and is located approximately 10 km southeast of Wiarton, Ontario. The property falls within the zones of Known Karst from the publication Karst of Southern Ontario and Manitoulin Island, publication #GRS005 by the Ontario Geological Survey (see Figure 2).

Regionally, the area is gently sloping toward the west with escarpments located to the north and east towards Georgian Bay. Locally, the property is fairly flat with a gentle slope to the south and a slight overgrown ridge on the southmost portion of the property adjacent to TH-03. On the northernmost portion of the property adjacent to the road, some significant woodlands are mapped as identified in Appendix 'B' as part of the County Official Plan. The neighboring properties are a mix of vacant forest, farmland, and residential lots.

Based on the topography and surficial features observed at the time of the site visit, the results of the field assessment completed by GEI suggest that there is no evidence of hydraulically active karstic features, such as areas of subsidence or springs that would be expected to limit development. No evidence of streams, pooled water, running water, seeps, or sinks were identified.

Testhole Investigation Findings

As part of the field investigations, five testholes (TH-01 to TH-05) were excavated on November 13th, 2024. The testhole locations were chosen to assess the property as whole while limiting the disturbance to the natural environment as much as reasonably possible. The client was responsible for arranging a contractor and completing the testholes using an excavator at the discretion of GEI staff. Each of the four testhole locations were selected in order to provide spatial coverage of the property. The location of each of the testholes is provided in Figure 3 along with the locations of the outcropping bedrock (bedrock located at surface). Four testholes TH-01, TH-02, TH-04 and TH-05 were advanced to the bedrock.

In general, the results can be summarized as follows:

1. TH-01, TH-02, TH-04, and TH-05 were advanced to bedrock at depths of 0.46 mbgs, 0.51 mbgs, 0.91 mbgs, and 1.40 mbgs respectively. Soils encountered were a black organic and rich, stony loam containing clay, silt, and fine sand. Below this unit was a light brown stony loam with clay, silt, sand with a variable amount of stones and cobbles, with some larger tabular bedrock fragments up to 0.40 metres in diameter. No standing or running water visible across all four testholes. Bedrock was a grey dolostone unit, identified as the Guelph Formation.
2. In TH-03, bedrock was not encountered. The soils were similar the other testholes, but it contained a higher percentage of larger boulders which made it difficult for the excavator to continue. Bedrock was not clearly reached, and the machine was not advancing further. After TH-03 was stopped at 0.91 mbgs, another hole was advanced just to the south – TH-04.
3. Several locations of bedrock outcropping at surface were identified (shown on Figure 3). Bedrock was a grey dolostone with typical surface weathering and organic growth covering the outcrop. It appeared to be Guelph Formation similarly to the testholes, with no fissile textures, fissures, or major karst features evident.

Bedrock Resource Potential

The Guelph formation, being the bedrock encountered on the subject property, forms part of the upper bedrock sequence defining the Niagara Escarpment, and is a common component of aggregate resources in the Grey County. It is a provincially significant resource and because of its high chemical purity, is used to produce various aggregate products including dolomitic lime, quicklime, and high quality hydrated lime. Geologically speaking, the Guelph Formation lies above the Amabel Formation (and subsequently the Eramosa Member), which is used for a wider variety of high quality aggregate products including stone, granular, asphalt, and concrete.

A review of the Grey-Sauble Conservation Authority (GSCA) regulated areas noted through the Grey County Official Plan indicates that portions of the Site are regulated to ensure environmental protections are in place to prevent developments that may adversely affect ecologic areas of interest, the quality and character of natural streams and wetlands, and the protected natural scenery in the area as per O. Reg 151/06 under the Ontario Conservation Authorities Act (1990). Under this regulation, development may not proceed if the control of flooding, erosion, pollution, or conservation of the land will be affected as a result.

The property contains both Provincially Significant Wetlands and Protected Woodlands as shown in Appendix B listed under ‘County Official Plan – Conservation Authorities’ which each require a minimum of 120 meters of setback from the regulated land. The Provincially Significant Wetlands provide restriction on what developments and activities are permitted on or close-by to these areas. The GSCA regulations prohibit developments where the potential exists to interfere with the hydrologic function of a wetland. The amount of land remaining after taking into account the GSCA setbacks would be approximately 43% of the overall property footprint.

Additionally, these areas overlap with the Hazard Lands as designated by Schedule A of the Grey County Official Plan, which states:

> *These [Hazard Lands] lands can be impacted by flooding, erosion, and/or dynamic beach hazards or have poor drainage, or any other physical condition that is severe enough to pose a risk for the occupant, property damage, or social disruption if developed. While these lands are intended to be regulated so as to avoid natural hazards, they also contribute to the natural environment within the County. Permitted uses in the Hazard Lands land use type are forestry and uses connected within the conservation of water, soil, wildlife, and other natural resources.*

The Significant Woodlands provide additional constraints in which no development may occur within the feature and adjacent buffer areas unless it can be proven that no negative impacts will occur as a result of development demonstrated through an environmental impact study. The portions of the subject property that contain these protected natural features encompass a large area of the parcel. It is reasonable to expect that the maximum extractable area would become limited, not including any setbacks from existing onsite developments, road rights-of-way, and neighboring lots. These features would likely further reduce the extraction limits and extractable volume of subsurface resources below what was already reduced as a result of the GSCA setbacks noted above.

Additionally, based on a review of the adjacent well records, the depth to bedrock varying from 0.3 mbgs to 6.4 mbgs) and the overlying soils contain a high degree of silt and clay. The stripping of overburden material and sloping from the buffer zones associated with the protected areas would even further limit viability and add costs to operations.

One important consideration when analyzing the feasibility of a property for bedrock extraction is the thickness of overburden, the thickness of bedrock that lies above the water table, and the depth to the water table. Under the ARA regulations, a quarry with an “above the water table” license requires a 2 m separation from the “high” water table. When the extractable bedrock is situated below this 2 m separation, or is located below the water table, a “below the water table” license would be required. This type of license is not only more complicated, but there is additional risk to the natural environment if de-watering is required in order to operate.

When looking at the surface elevation of the Site, it varies from approximately 251 meters above sea level (masl) in the northeastern corner down to 233 masl in the southwestern corner, with the elevation of Francis Lake at approximately 229 masl. It can be inferred that the groundwater level in the area would be comparable, or shallower, to the elevation of Francis Lake. When considering the water supply well records noted earlier, the thickness of overburden can be inferred to be approximately zero in the north and up to approximately 7m in the south.

Furthermore, the depth at which water was intercepted in the well records was much shallower in the south. When using the elevation of Francis Lake as an approximation, the ‘inferred’ water table elevation of 229 masl roughly correlates with the well records. In the north, this would suggest at least 15-20 meters of “dry” bedrock above the water table. In the south, it would suggest the water table is at, or near, the elevation of bedrock and would subsequently suggest the need for a “below the water table quarry”.

Based on the information above, it is unlikely that the use of the subject property would be feasible to operate as a quarry (i.e., for bedrock extraction). The primary reason is related to the limited areal extent of extractable bedrock once the protected natural features (i.e., wetland and woodlands) and associated setbacks from these features, setbacks from property boundaries and sensitive off-site receptors are considered. In combination with the requirement for a "below water" license, a quarry is not considered to be viable.

Conclusions and Recommendations

Based on the findings of this investigation, no evidence of significant karst features, or hydraulically active karst were identified across the proposed severed property. Additionally, no evidence of active karst features was encountered in any of the testholes completed as part of this investigation. Karst features are not expected to affect or compromise future onsite developments that will be located on the proposed lot, nor are they expected to affect local water resources due to karst.

With regards to the bedrock resource potential at Site, although stone and mineral aggregate resources derived from crushed stone can be sourced from dolostone bedrock of the Guelph formation present, the bedrock across the Site is expected to have significant challenges and/or limitations with respect to a potential quarry operation and would likely require extensive studies to be completed. Due to the high probability of requiring a below the water table license, further, financial and logistical challenges associated with required dewatering and discharge are expected to reduce the potential for the bedrock extraction on this Site to be profitable. Additionally, environmental protection/mitigation measures may pose additional limitations due to the presence of GSCA regulated Wetlands and Hazard Lands located on the property. The Natural Environment features and associated setbacks combined with limited thickness of bedrock above the water table result in a limited area/volume for bedrock extraction. These factors suggest that a quarry operation at this property would be difficult and uneconomical (i.e., not viable).

Based on the findings of this report, the following recommendations are made:

1. That at the time of construction when bedrock is encountered, that the bedrock surface be inspected in areas where it is exposed and in the locations of the proposed footings in order to confirm the nature of the bedrock and the presence (or absence) of any fractures or dissolution features that may pose structural limitations or potential for mass wasting under sewage systems.
2. The thickness of overburden be confirmed where sewage systems are constructed to ensure that the requirements of the Ontario Building Code are met. Should excavations encounter significant fractures or karst features, a qualified person should be retained for further inspection.

Limitations

The information in this report is intended for the sole use of Cortney O'Donoghue. GEI Consultants Canada accepts no liability for use of this information by third parties. Any decisions made by third parties based on this report are made at the sole risk of the third parties.

The conclusions and recommendations in this report are based on information gathered at the testhole locations and on available geological information. Sub-surface conditions between and beyond the testholes may differ from those encountered at the testhole locations and evidence of different conditions may become apparent during construction, which may not have been detected or anticipated at the time of the investigation. Further investigation would be required to comment on the potential for Karst in the locations beyond the study area.

The conclusions pertaining to the condition of soils and/or bedrock identified at the site are based on the visual observations at the locations of the investigative testholes. GEI cannot guarantee the condition of soil and/or bedrock that may be encountered at the site in locations that were not specifically investigated. Boundaries or property limits shown in the figures are approximations.

If you have any questions, please feel free to contact me at 519-369-4082.

Sincerely,

GEI Consultants Canada Ltd.

Gerhard Kiessling, P.Geo.
Technical Specialist

Figures

Figure 1	Property Location
Figure 2	Karst Mapping by the OGS
Figure 3	Testholes and Outcrop Locations

Tables

Table 1	Testhole Logs and Locations

Appendices

Appendix A	Site and Testhole Photographs
Appendix B	Property Report and County Official Plan Maps

Karst Assessment and Bedrock Resource Letter of Opinion
2407911

GEI Consultants

Legend

- Proposed Severance
- Retained Property

0 100 200 m

Figure 1

Property Location

December, 2024
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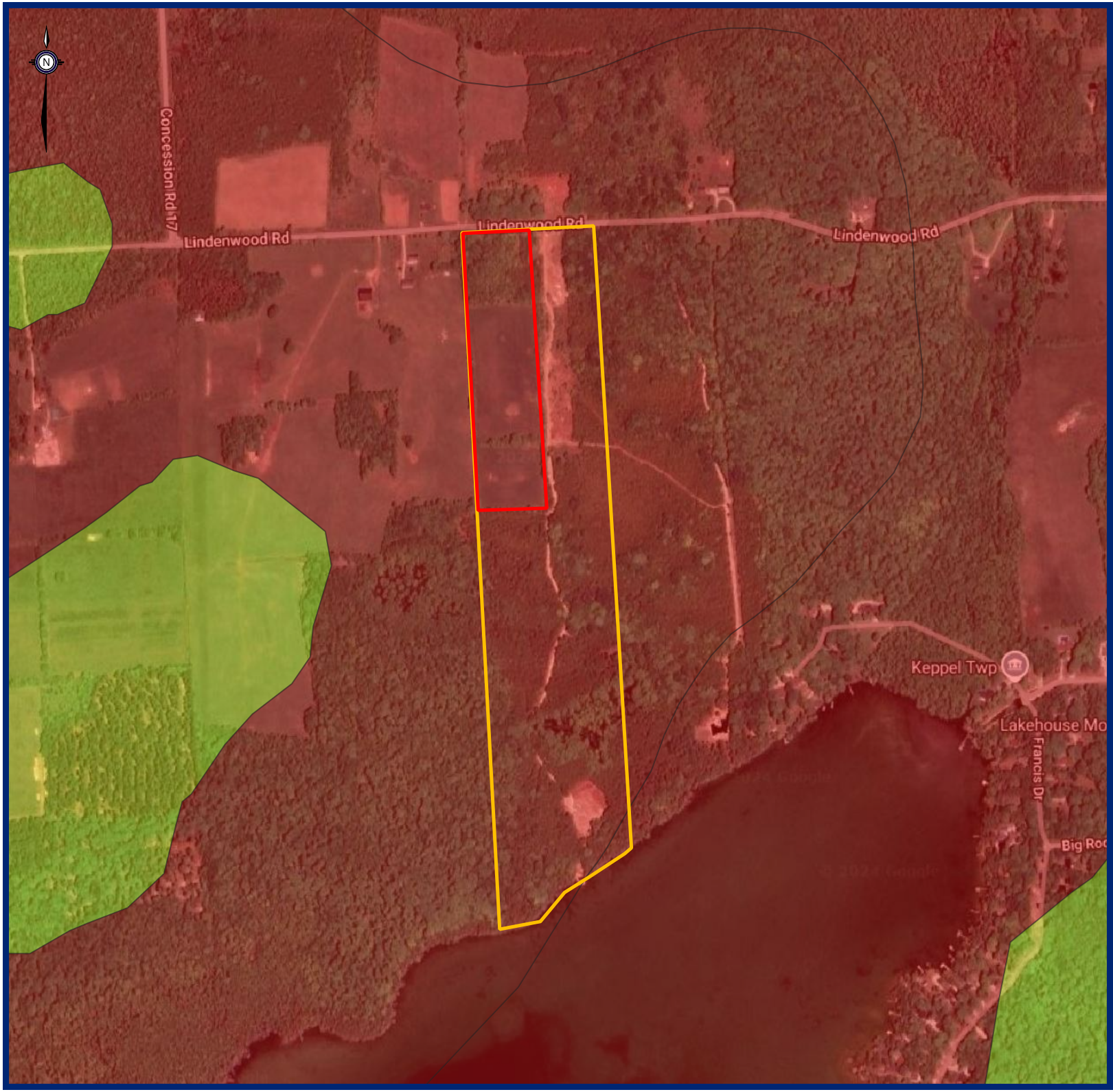


Karst Assessment and Bedrock Resource Letter of Opinion
2407911

GEI Consultants

Legend

OGS Karst Mapping

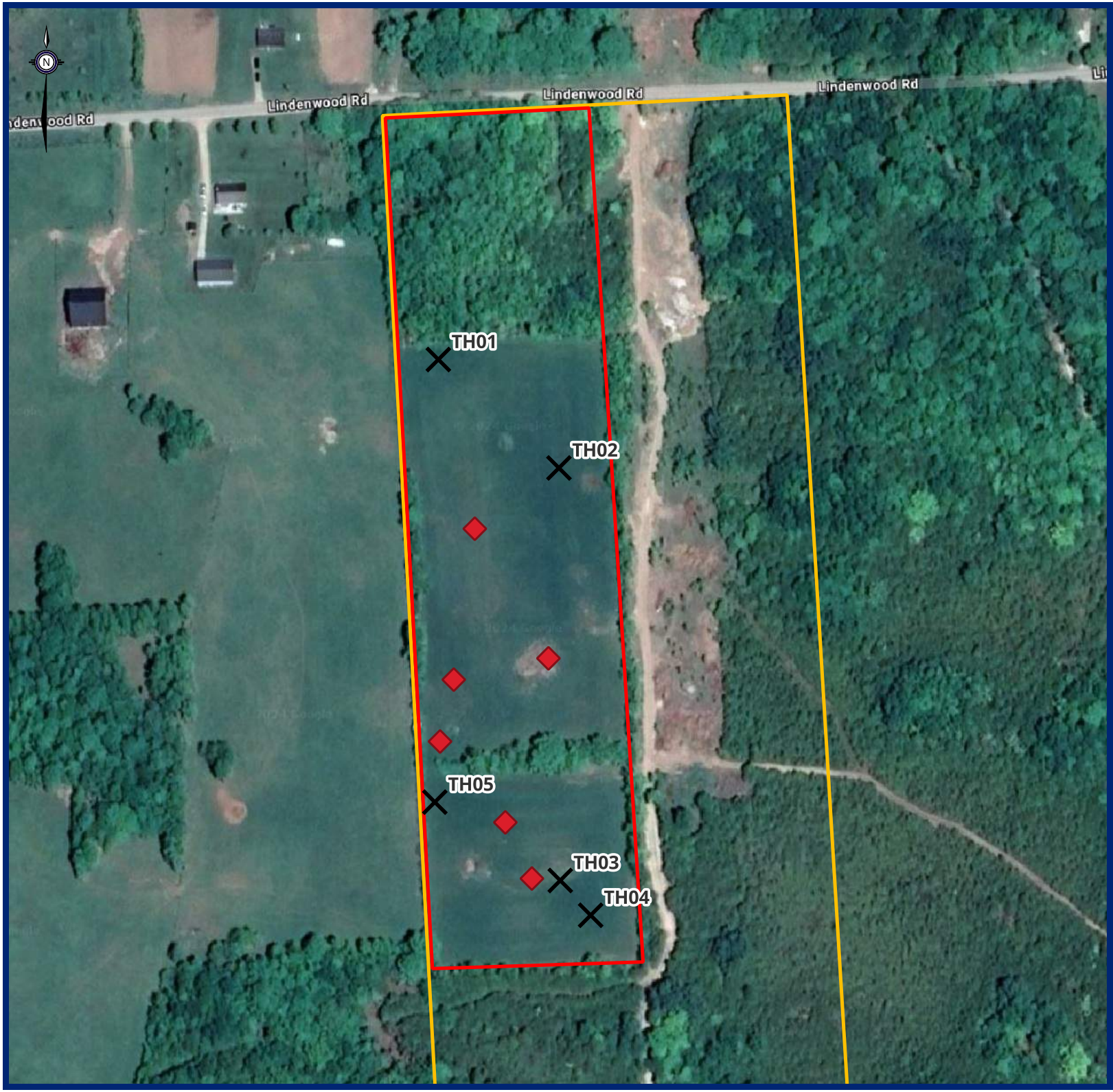
- Known Karst
- Potential Karst
- Proposed Severance
- Retained Property

0 100 200 m

Figure 2

Karst Mapping by the OGS

December, 2024
Projection EPSG:2958



Karst Assessment and Bedrock Resource Letter of Opinion
2407911

GEI Consultants

Legend

- Proposed Severance
- Retained Property
- Bedrock Outcrop
- Testhole Locations

0 50 100 m

Figure 3

Testholes and Outcrop Locations

December, 2024
Projection EPSG:2958

TABLE 1 : Testhole Logs and Locations

Hole ID	Easting	Northing	From (mbgs)	To (mbgs)	Unit	Notes/Log
TH01	497792	4947777	0.00	0.23	TOPSOIL	Black topsoil. Loam containing clay, silt, and fine sand. Mixed with rocks and gravel, organic matter and roots from vegetation. Dry.
			0.23	0.46	LOAM	Light brown to almost tan coloured soils. Loam. Clay rich with silt and fine sand present. Occassional cobbles up to 25cm in diameter are present but vary in size signficantly, most appear to be similar lithology to bedrock. Dry.
			0.46	N/A	BEDROCK	Grey dolostone, competent. Flat surface at bottom of testhole. No hummucky or fissures/fractures evident. No standing or running water.
TH02	497849	4947726	0.00	0.28	TOPSOIL	Black topsoil. Loam containing clay, silt, and fine sand. Mixed with rocks and gravel, organic matter and roots from vegetation. Dry.
			0.28	0.51	LOAM	Light brown to almost tan coloured soils. Loam. Clay rich with silt and fine sand present. Occassional cobbles up to 15cm in diameter are present but vary in size signficantly, most appear to be similar lithology to bedrock. Dry.
			0.51	N/A	BEDROCK	Grey dolostone, competent. Flat surface at bottom of testhole. No hummucky or fissures/fractures evident. No standing or running water.
TH03	497849	4947532	0.00	0.25	TOPSOIL	Black topsoil. Loam containing clay, silt, and fine sand. Mixed with rocks and gravel, organic matter and roots from vegetation. Dry.
			0.25	0.91	LOAM	Light brown to almost tan coloured soils. Loam. Clay rich with silt and fine sand present. Occassional cobbles up and several boulders are present but vary in size signficantly, most appear to be similar lithology to bedrock from what came to surface. Testhole halted due to difficulty removing larger boulders and stony soils, not clearly at bedrock and no clear view of base. Testhole restarted further south as TH-04.
TH04	497864	4947515	0.00	0.25	TOPSOIL	Black topsoil. Loam containing clay, silt, and fine sand. Mixed with rocks and gravel, organic matter and roots from vegetation. Dry.
			0.25	0.91	LOAM	Light brown to almost tan coloured soils. Loam. Clay rich with silt and fine sand present. Occassional cobbles up to 15cm in diameter are present but vary in size signficantly, most appear to be similar lithology to bedrock, including some tabular shapes ones. Dry.
			0.91	N/A	BEDROCK	Grey dolostone, competent. Slightly wavy/irregular surface at bottom of testhole. No hummucky or fissures/fractures evident. No standing or running water.
TH05	497790	4947568	0.00	0.40	TOPSOIL	Black topsoil. Loam containing clay, silt, and fine sand. Mixed with rocks and gravel, organic matter and roots from vegetation. Dry.
			0.40	1.40	LOAM	Light brown to almost tan coloured soils. Loam. Clay rich with silt and fine sand present. Occassional cobbles are present but vary in size signficantly, most appear to be similar lithology to bedrock. Some tabular shaped ones up to 40cm in diameter. Dry.
			1.40	N/A	BEDROCK	Grey dolostone, competent. Flat surface at bottom of testhole. No hummucky or fissures/fractures evident. No standing or running water.

Notes:

1) mbgs = meters below ground surface

2) Co-ordinate system UTM NAD 83 17T, accuracy of +/- 4 meters.

Picture 1: TH-01 - Overhead view.

Picture 2: TH-01 – Close up view of bedrock surface.

Picture 3: TH-01 – Side view showing soil profile.

Picture 4: TH-02- Overhead view.

Picture 4: TH-02 – Close up view of bedrock surface.

Picture 6: TH-02 –Side view showing soil profile.

Picture 7: TH-03 – Overhead view.

Picture 8: TH-03 - Close up view of testhole.

Picture 9: TH-03 – Side view showing soil profile.

Picture 10: TH-04 – Overhead view.

Picture 11: TH-04 - Close up view of bedrock surface.

Picture 12: TH-04 – Side view showing soil profile.

Picture 10: TH-05 – Overhead view.

Picture 11: TH-05 - Close up view of bedrock surface.

Picture 12: TH-05 – Side view showing soil profile.

Picture 13: Looking north from the general area of TH-02.

Picture 14: Looking south from the general area of TH-02.

Picture 15: Looking north from the general area of TH-05, near the south property limit.

Picture 16: Example of bedrock outcrop in center of property, southeast of TH-02.

Picture 17: Another example of bedrock outcrop in the south portion of the property.

Property Report

Data Sources: Grey County, Municipal Property Assessment Corporation, Teranet, King's Printer

Report Generated 12/03/2024 23:08:21

Roll Number	Address	Assessed Value	Acreage
420362000422400	362480 Lindenwood Road	$521000	47.03

Notice: Assessed value may not reflect current market value MPAC

NEC Designation

Outside the Niagara Escarpment Plan Area

Legal Description

KEPPEL CON 15 PT LOT 22 RP;16R11310 PART 1

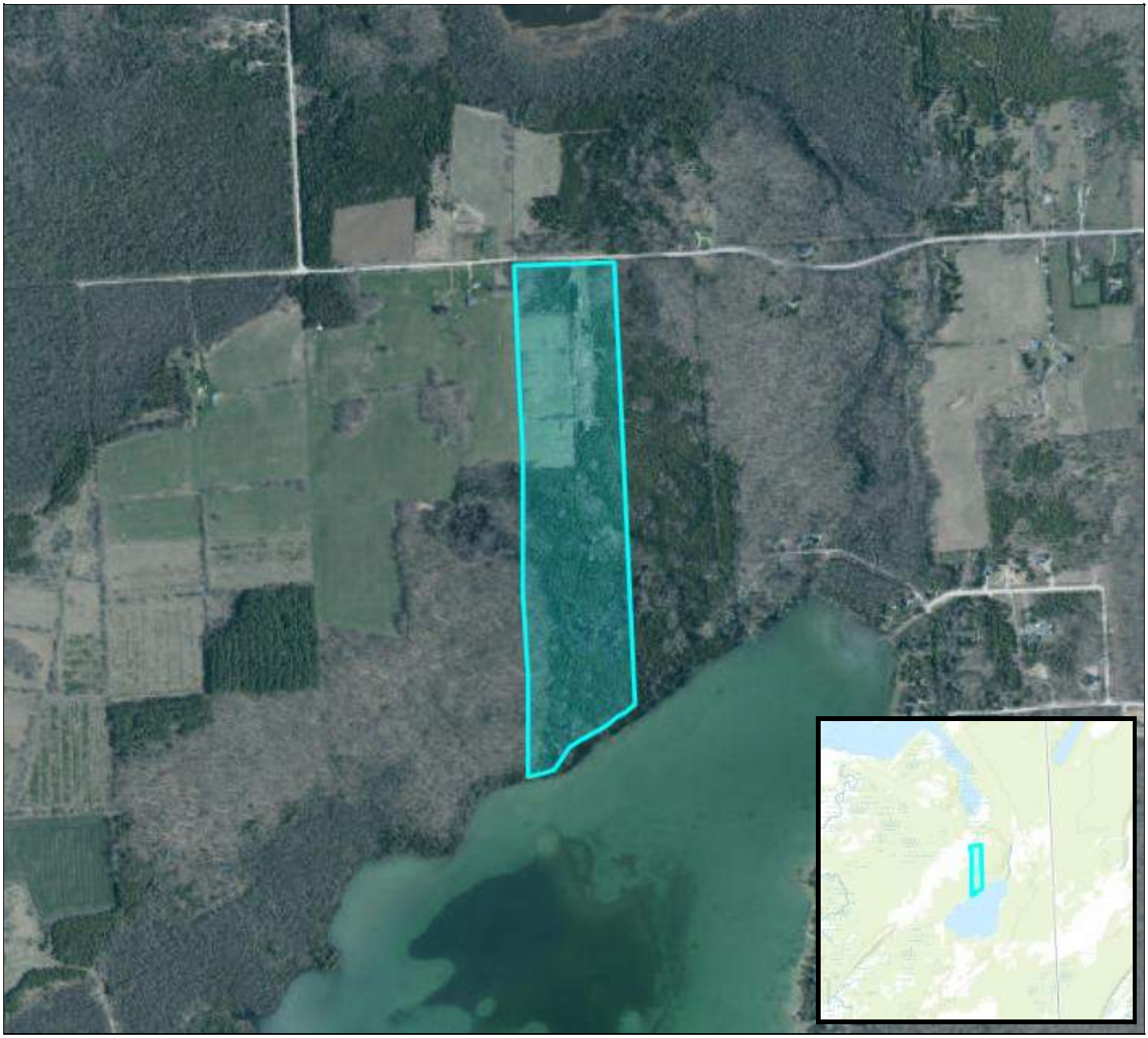
Property Use

Farm with residence - with or without secondary structures; with farm outbuildings

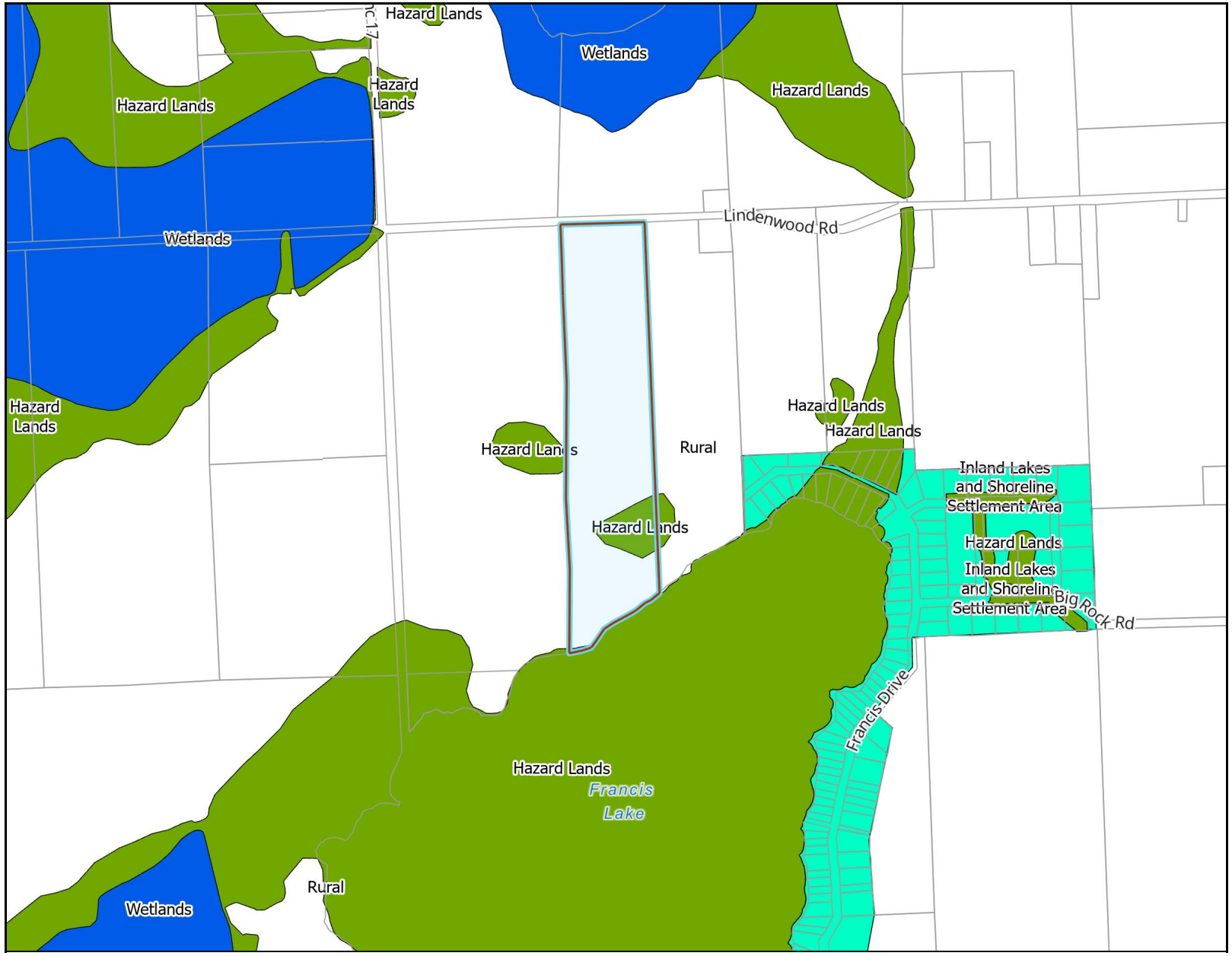
Zoning*

Rural,Environmental Protection

* Zoning may not be accurate. Confirm with local municipal zoning bylaw.



Grey County GIS | County Official Plan - Schedule A



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Assessment Parcel

County Official Plan (20

Land use

Hazard Lands

Inland Lakes a

Shoreline Set

Area

Rural

Provincially S

Wetlands

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Notes

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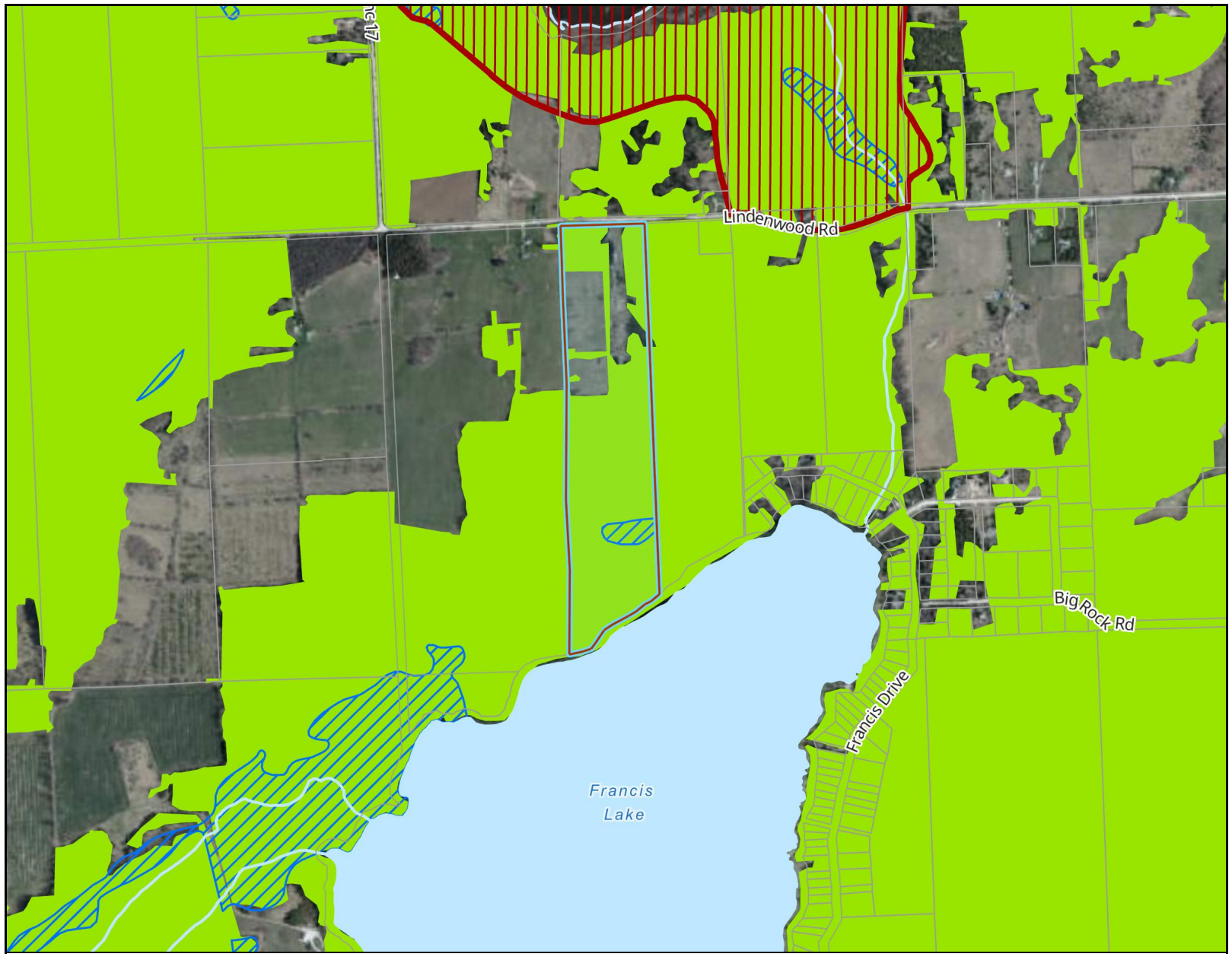
Grey County GIS | County Official Plan - Appendix B



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Assessment Parcel

County Official Plan (2018)

ANSI

ANSI, Life Science

Streams

Lakes and Rivers

Other Wetlands

Significant Woodlands

[redacted]

[redacted]

Notes

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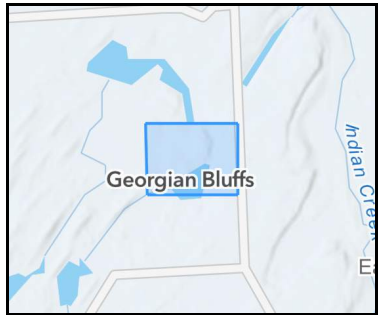
Grey County GIS | County Official Plan - Appendix A



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Assessment Parcel

County Official Plan (2018)

Wildland Fire (Hazardous Forest Types)

Extreme

High

Karst Area

[redacted]

Notes

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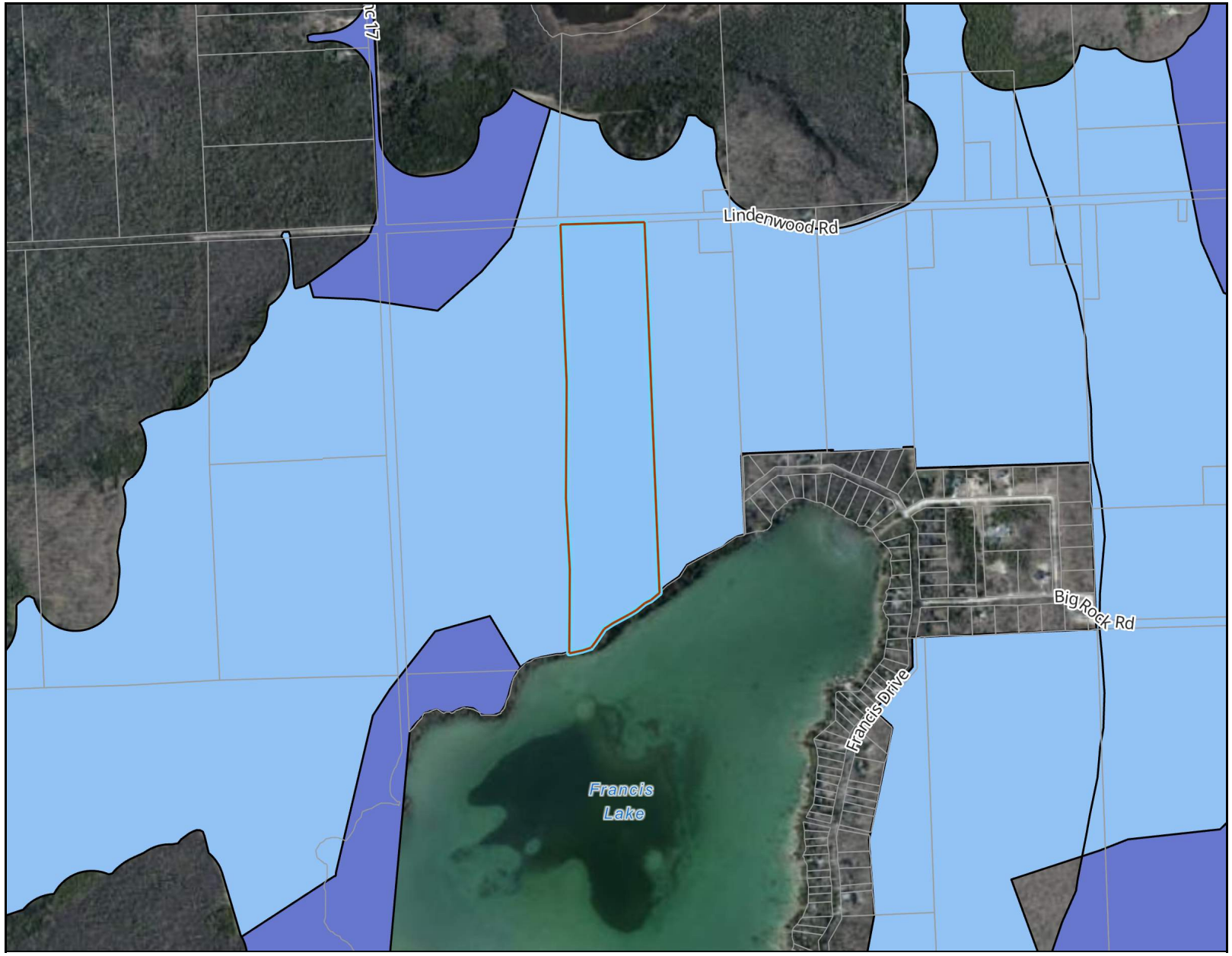
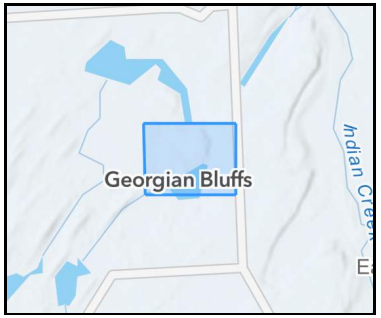
Grey County GIS | County Official Plan - Appendix E





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Assessment Parcel

County Official Plan (20

Bedrock Drift Thickne

Less than 1 m

1 m to 8 m

[redacted]

Notes

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0 0.5 1 km

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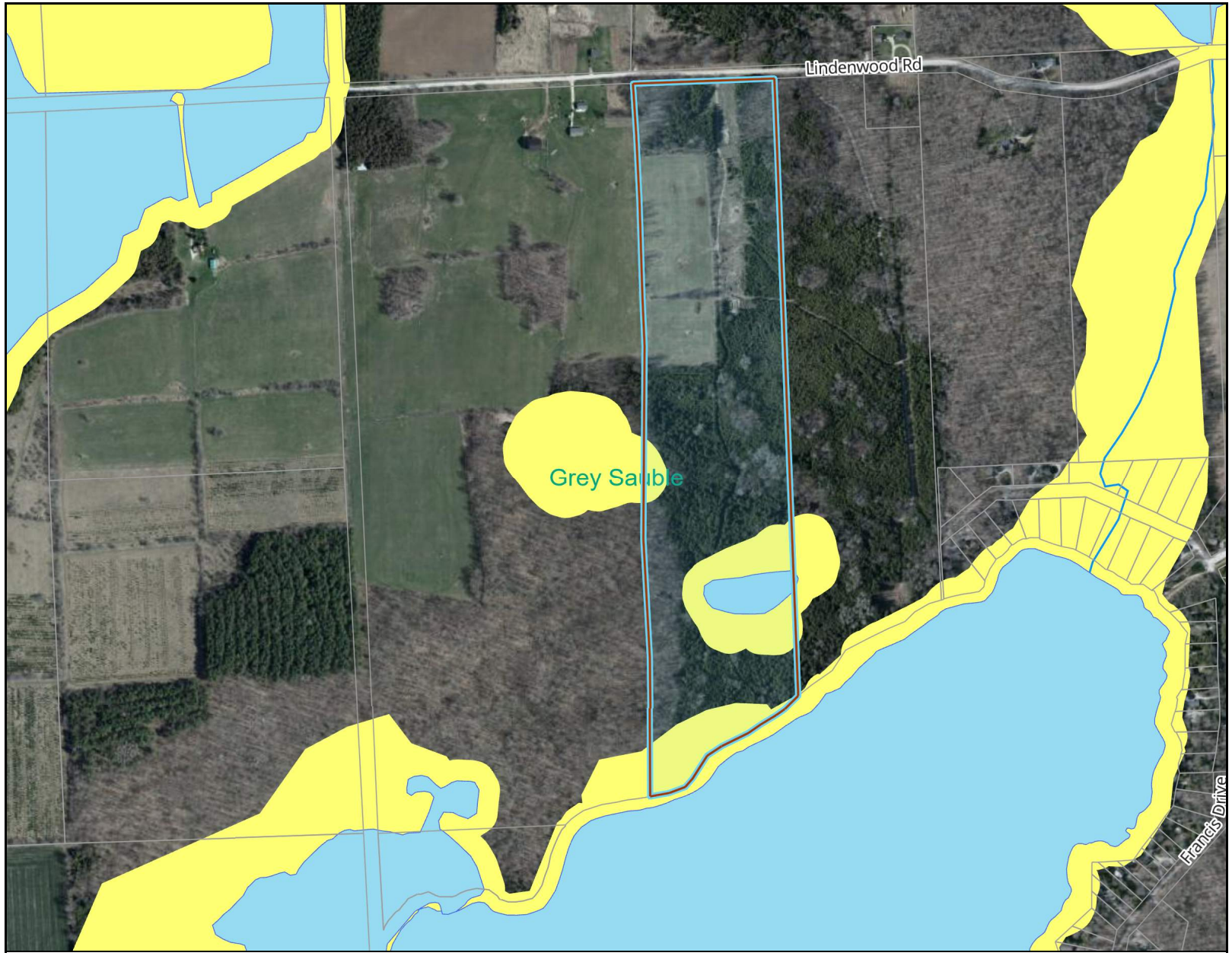
Grey County GIS | County Official Plan - Conservation Authorities



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Assessment Parcel

Conservation Authorities

CA Boundaries

Sub-Watershed Bour

Wet Areas - GSCA

Watercourses

0

Regulations - GSCA

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Notes

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County of Grey, Township of Southgate, Township of Georgian Bluffs, Municipality of Grey Highlands, Municipality of West Grey, Grey Sauble Conservation Authority, Nottawasaga Valley Conservation Authority, Saugeen Valley Conservation Authority, Grand River Conservation Authority