TIVERTON SLUDGE SURVEY REPORT 2024

TIVERTON, ON WASTEWATER LAGOON

Location: Tiverton, ON

Name of lagoon cell(s): Cells 1, 2, 3 & 4

Client: Municipality of Kincardine

Client contact(s): Mark O'Leary

Report prepared by: R. Machado

Surveyors: A. McKenna, N. Gamba

Date(s) of survey: 27/06/2024

Map grid reference: Horizontal Datum: NAD83(CSRS) (2010.0), Projection: UTM, Zone 17N

Vertical datum: CGVD2013

Control points: HCP1 – (Base occupied static control point for processing with NRCAN PPP Service)

Revision number: 0

Report print size: 11x17"

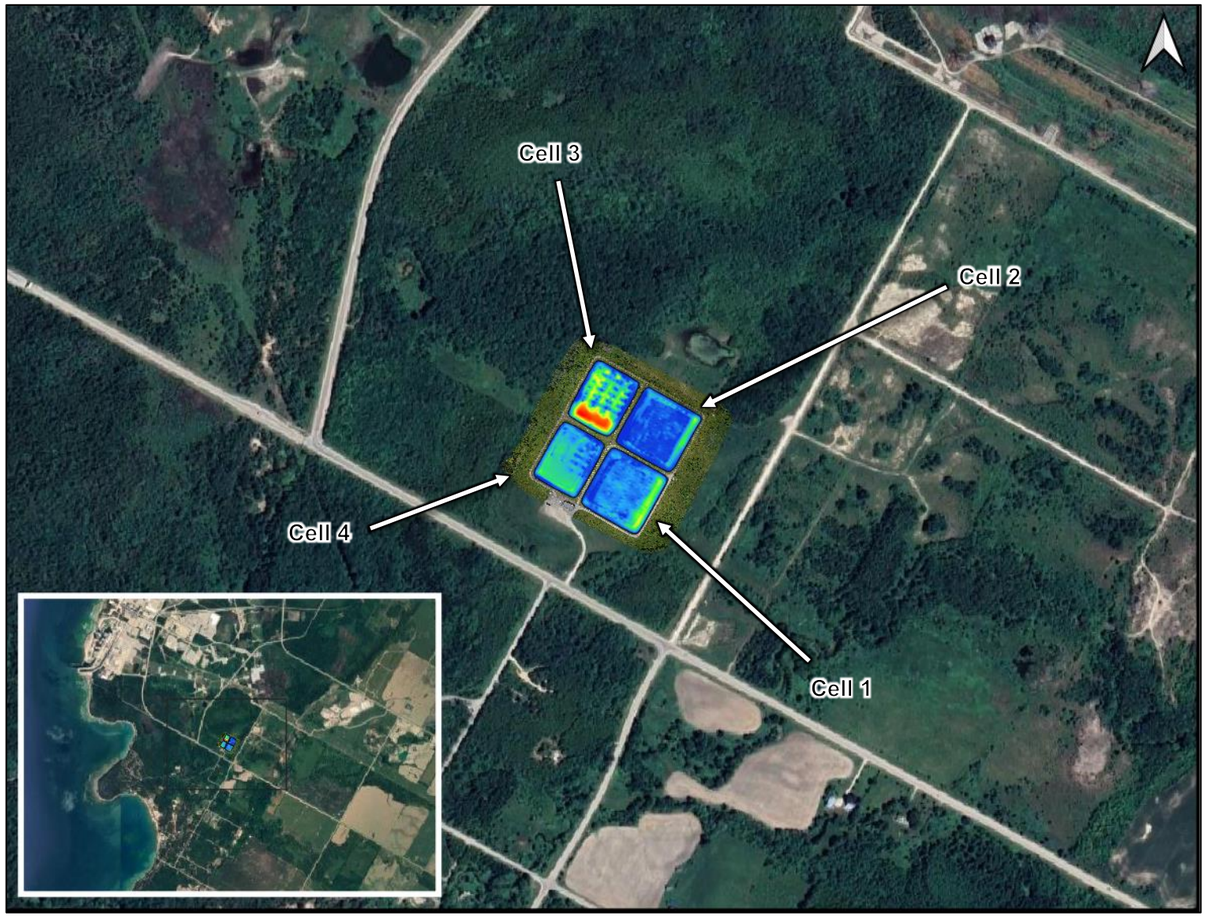

Figure 1 Tiverton, ON Wastewater Lagoon overview

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	Name	Date
Prepared by:	RM	29-07-2024
Reviewed by:	AA	30-07-2024

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FIGURES & TABLES SUMMARY

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EXECUTIVE SUMMARY

Hydrasurvey conducted sludge surveys at the **Tiverton, ON Wastewater Lagoon** for the Municipality of Kincardine on 27/06/2024. The purpose of the sludge survey and this report is to map and quantify sludge accumulation in cells 1, 2, 3 & 4. Cells 1, 2, 3 & 4 were in service with aeration shut down for all surveyed cells at the time of survey. A virtual site tour can be accessed **here**.

Cell	Date of survey	Water elevation CGVD2013 (m)	Maximum measured liner depth inside toe (m)	Current hydraulic capacity (m^3)	Freeboard (m)	Estimated sludge volume (m^3)	*Estimated dredgeable sludge volume (m^3)	Estimated bone dry tonnes (BDTs) of sludge to be removed	Estimated dredgeable bone dry tonnes (BDTs) of sludge to be removed	Percent of total cell volume occupied by sludge (at surveyed dimensions)
CELL 1	27-Jun-24	191.482	3.07	22,640	0.38	5,098	3,408	182	122	18%
CELL 2	27-Jun-24	191.481	3.09	25,386	0.21	2,488	1,216	167	82	9%
CELL 3	27-Jun-24	191.482	3.05	13,034	0.25	7,672	6,399	456	380	37%
CELL 4	27-Jun-24	191.478	3.06	16,307	0.25	4,552	3,312	282	205	22%

**Note: For details regarding dredgeable volumes please refer to Appendix A - Glossary.*

Table 1 Summary of sludge survey findings

Cells 1, 2, 3 & 4 findings:

- Cells 1, 2, 3, and 4 have 18%, 9%, 37%, and 22% of the volume occupied by sludge, respectively.
- Aerators and air supply lines in each cell are anchored on bottom.
- Duckweed is present in Cells 1, 2 & 3.
- Shoreline vegetation in Cells 1, 2, 3, 4 is overgrown (cattails, brush, tall grass).
- Cells 1 – 4 have graded impermeable bottoms.

Figure 3 Cell 2 overview

Figure 4 Cell 4 overview

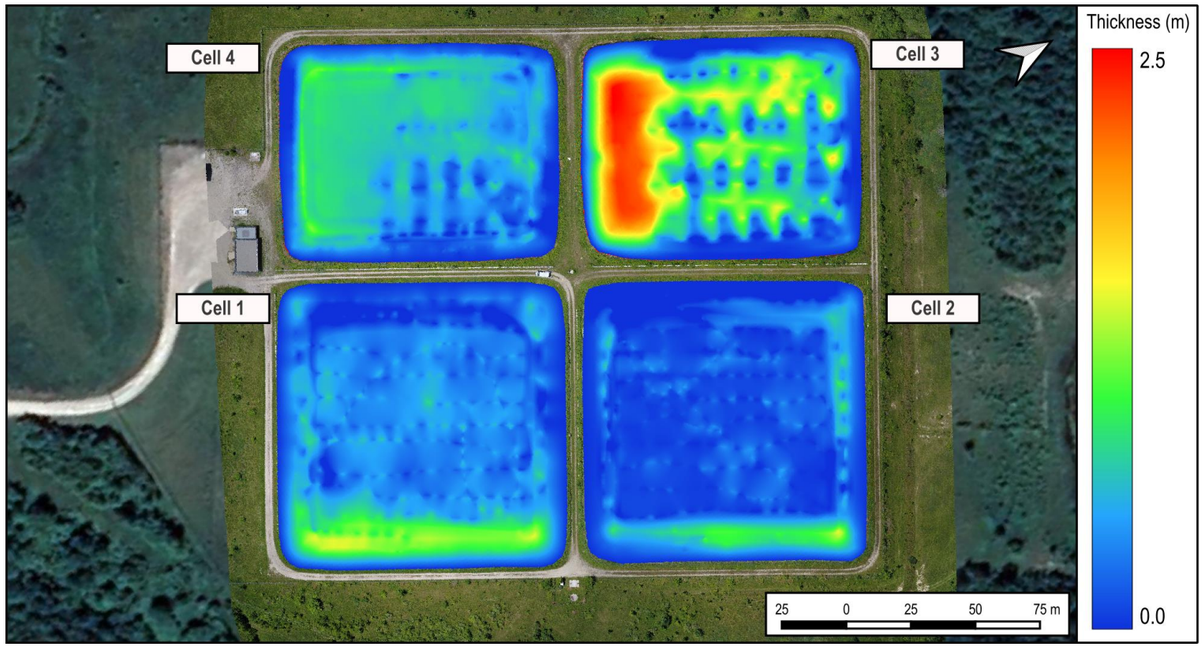

Figure 2 Tiverton, ON Wastewater Lagoon cells 1, 2, 3 & 4 sludge blanket thickness

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CELLS 1 & 2 – SLUDGE BLANKET THICKNESS

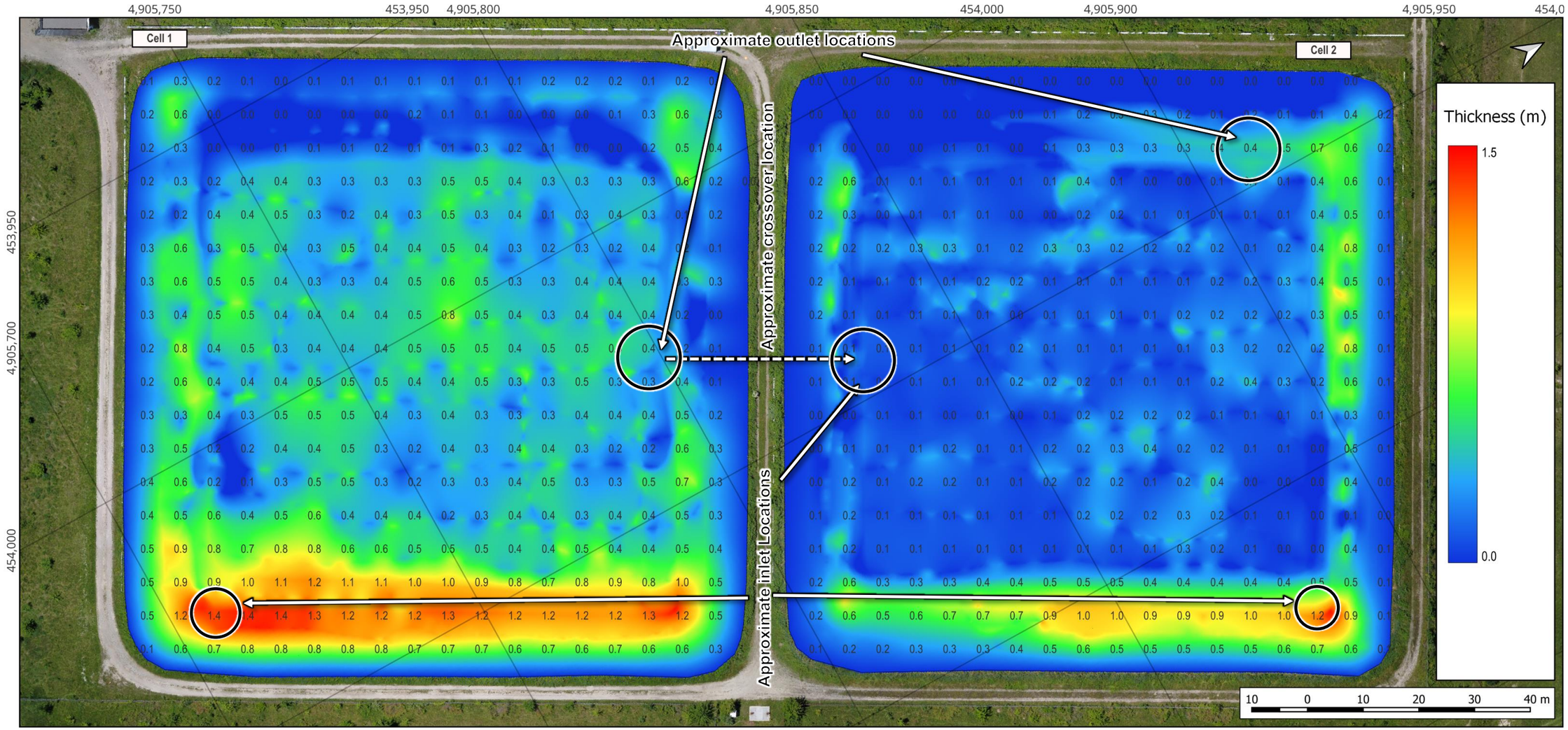

Figure 5 Cells 1 & 2 sludge blanket thickness

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CELLS 3 & 4 – SLUDGE BLANKET THICKNESS

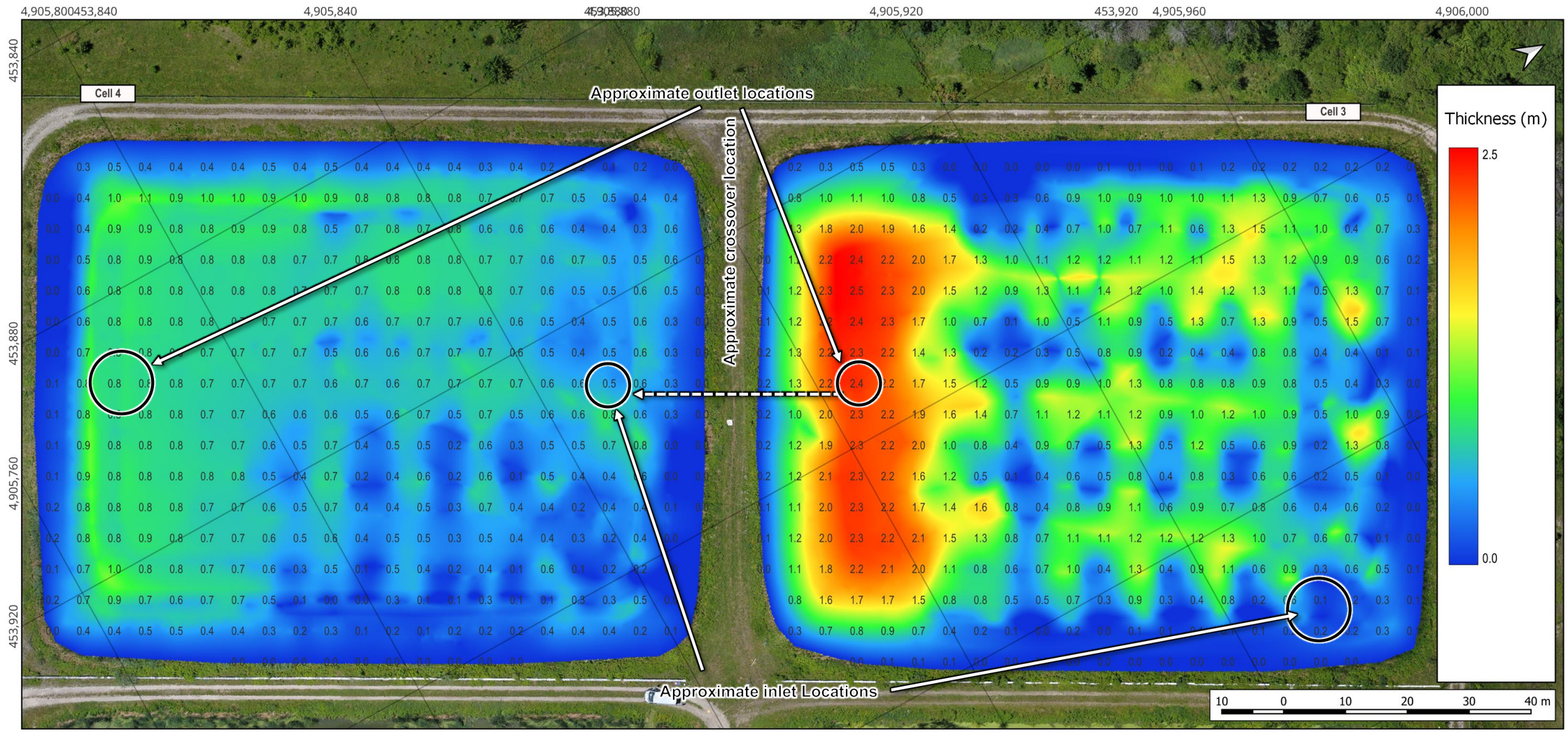

Figure 6 Cells 3 & 4 sludge blanket thickness

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CELLS 1 & 2 – TOP OF SLUDGE DEPTHS

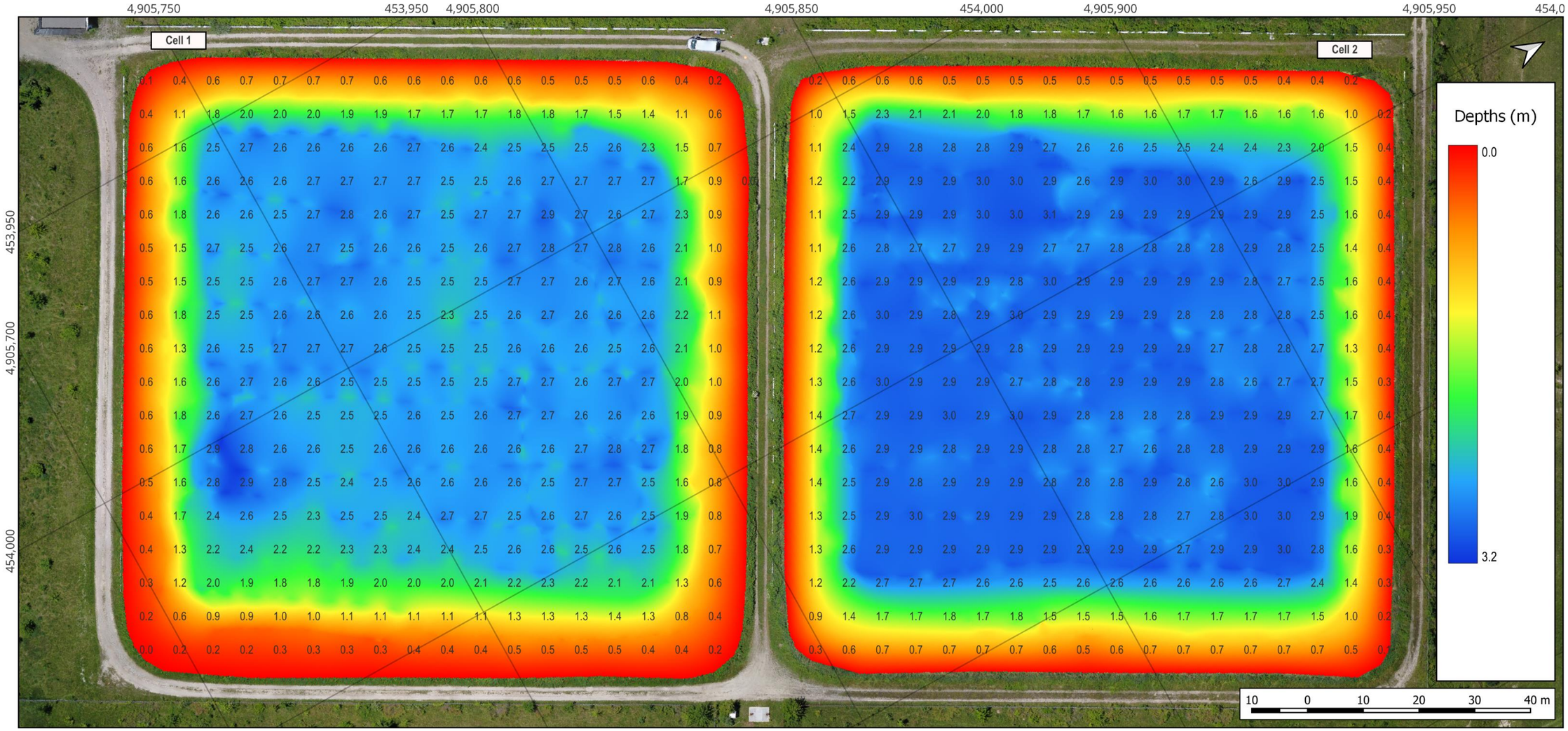

Figure 7 Cells 1 & 2 top of sludge blanket depths

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CELLS 3 & 4 – TOP OF SLUDGE DEPTHS

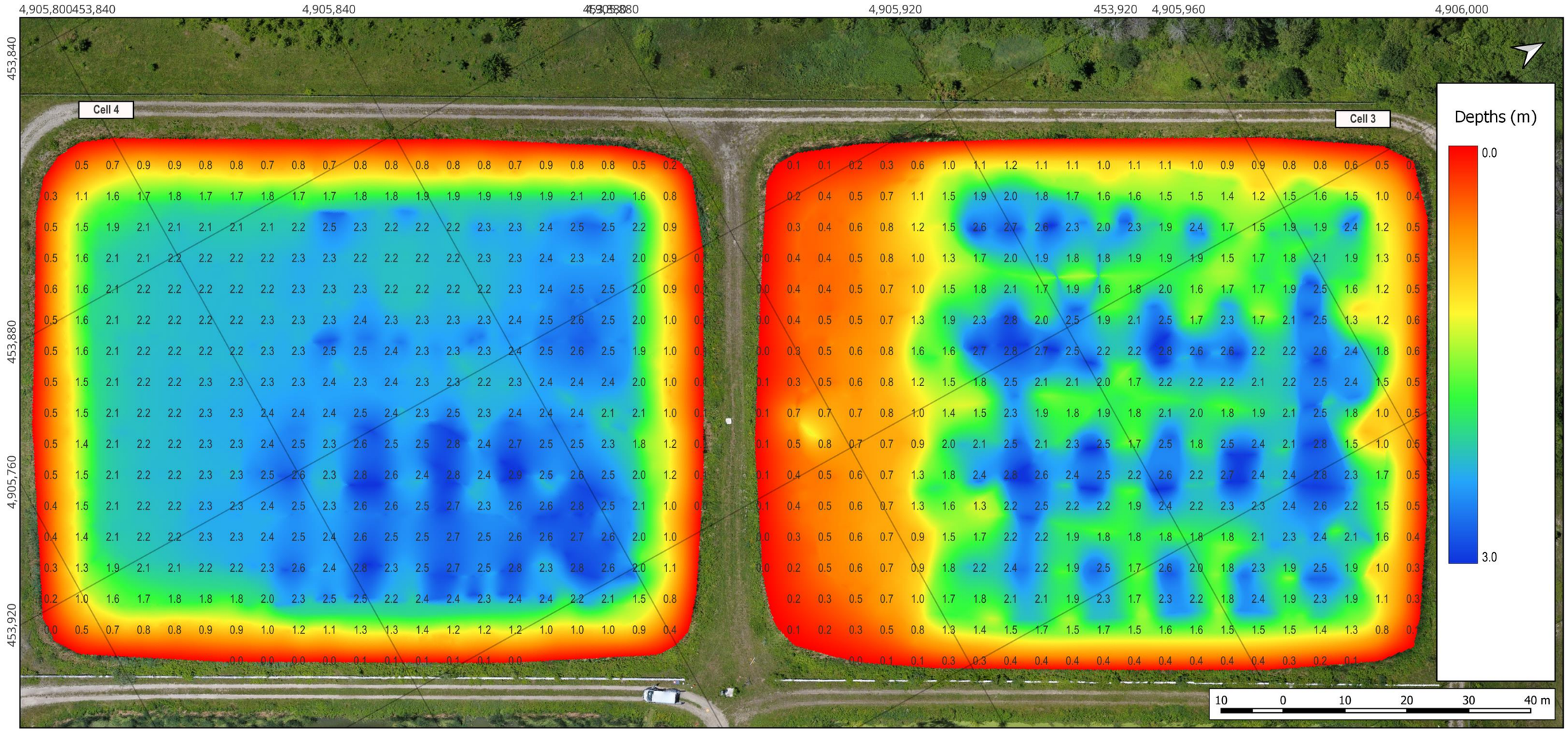

Figure 8 Cells 3 & 4 top of sludge blanket depths

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CELLS 1 & 2 – TOP OF SLUDGE ELEVATIONS

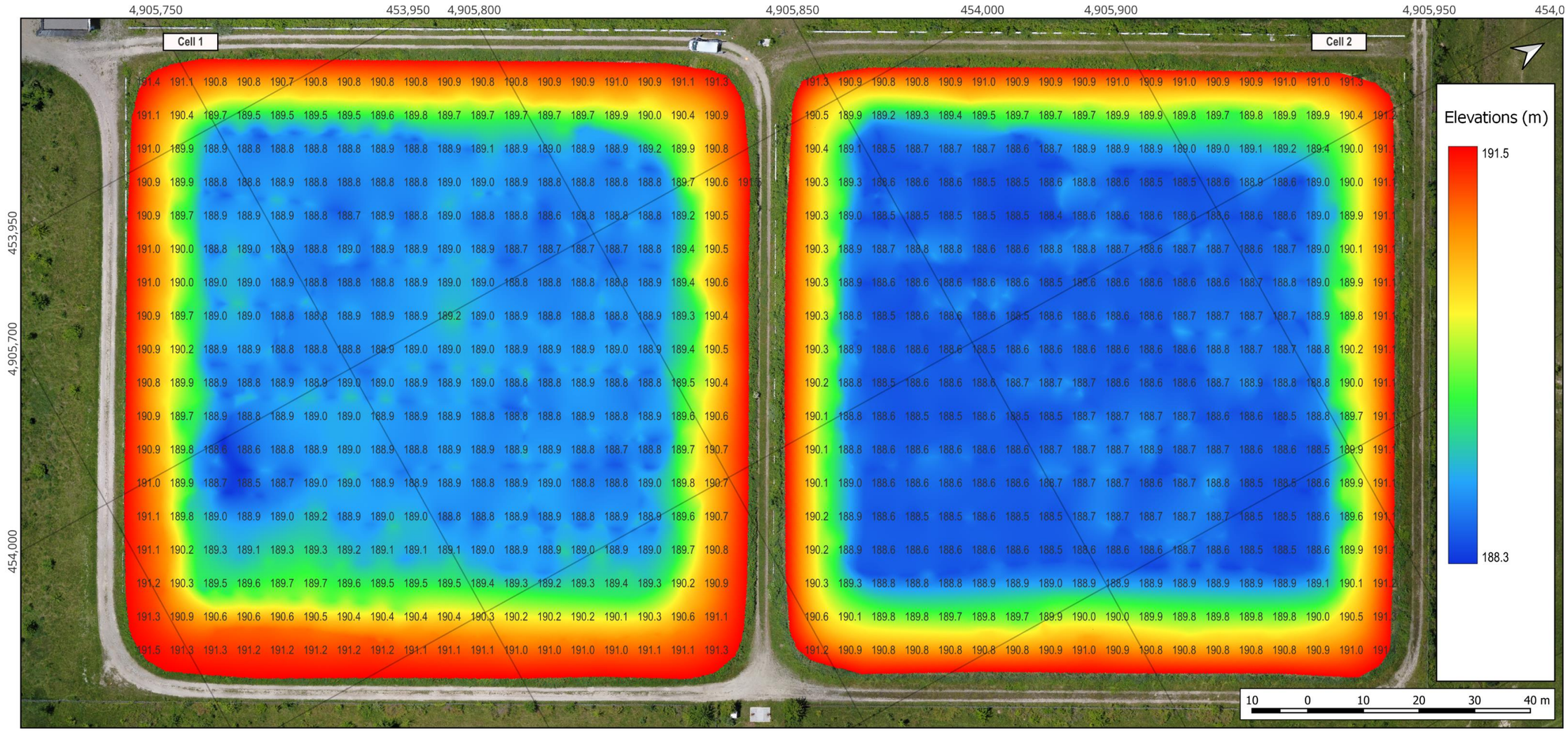

Figure 9 Cells 1 & 2 top of sludge blanket elevations

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CELLS 3 & 4 – TOP OF SLUDGE ELEVATIONS

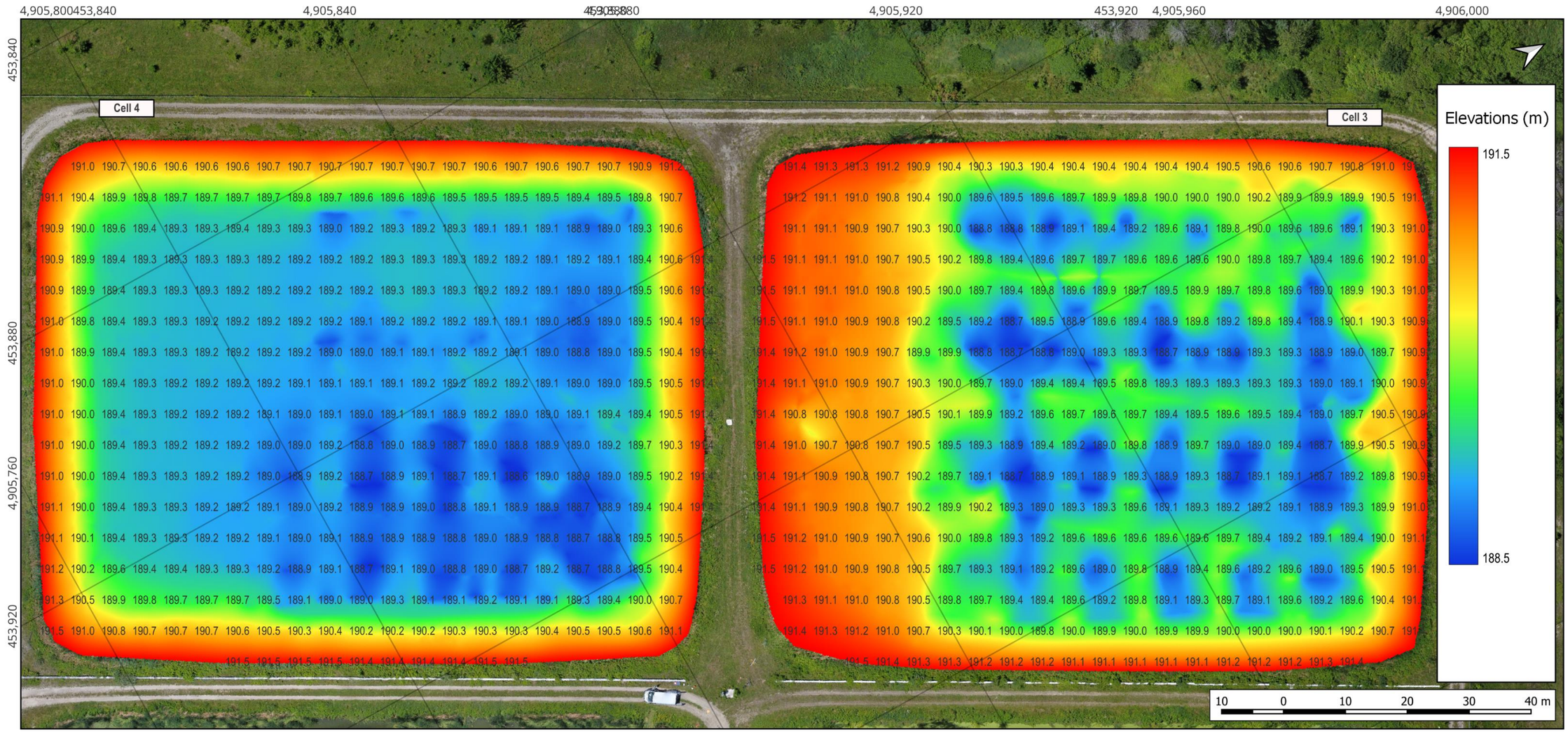

Figure 10 Cells 3 & 4 top of sludge blanket elevations

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CELLS 1 - 4 – RELEVANT FEATURES

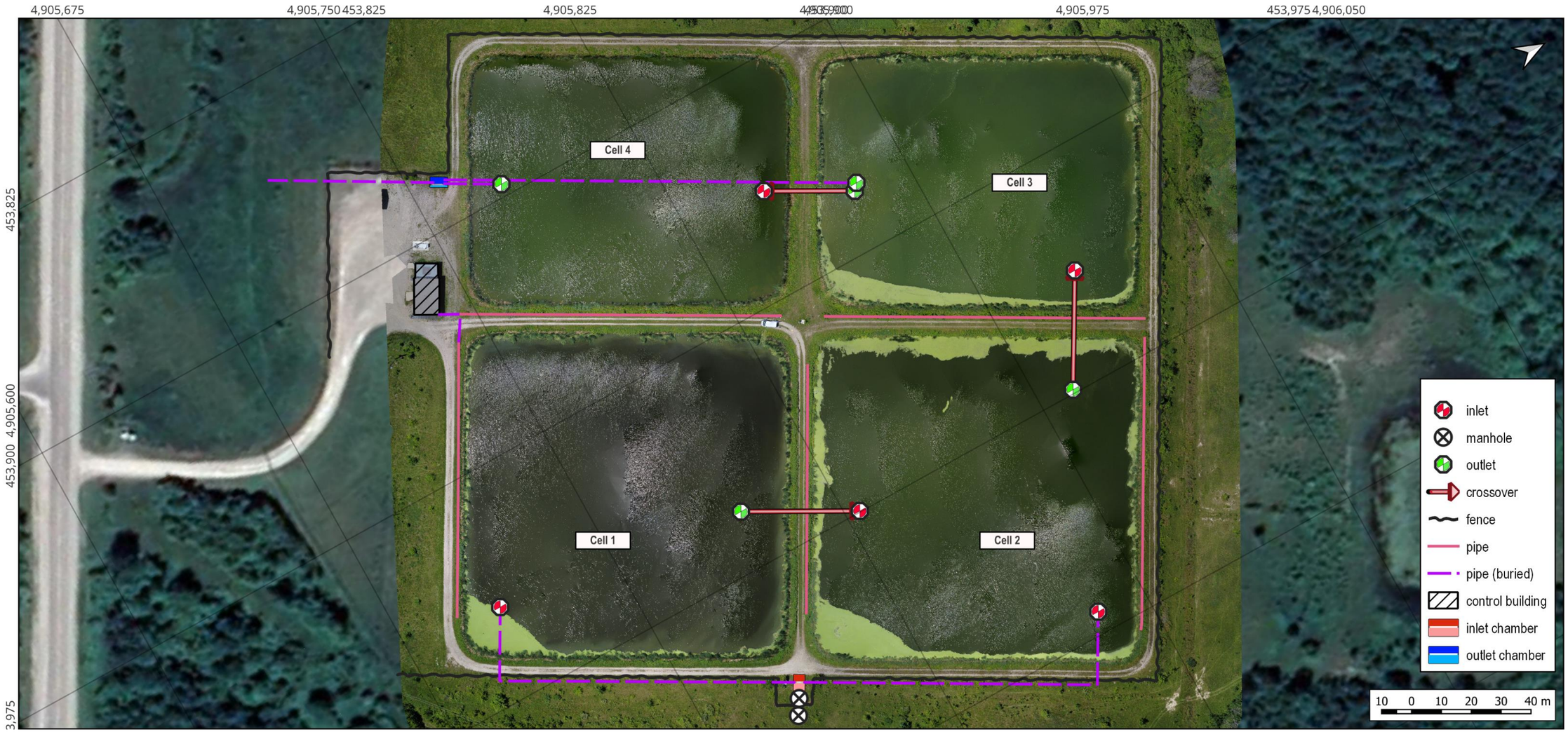

Figure 11 Cells 1, 2, 3 & 4 relevant features (infrastructure locations are approximate)

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CELL 1 VOLUMES

CELL 1 ESTIMATED SLUDGE QUANTITY

Estimated sludge volume is calculated using software that compares the measured and interpolated sludge depths with the depths of the lagoon liner obtained from engineered drawings and/or field measurements. A sludge sample is taken for lab analysis to determine total solids and total volatile solids and to obtain dry volume.

CELL 1:

TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (WET) =	**5,098**	**m^3**
TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (DRY) =	**153**	**m^3**
SPECIFIC GRAVITY (DRY AS SAMPLED) =	**1.19**	
TOTAL ESTIMATED MASS OF SLUDGE TO BE REMOVED =	**182**	**BDT (Bone Dry Tonnes)**
TOTAL ESTIMATED VOLATILE SOLIDS QUANTITY (DRY) =	**76**	**m^3**
IN-SITU SLUDGE DENSITY =	**1,005**	**kg/m^3**

CELL 1 HYDRAULIC CAPACITY AT PRESENT SLUDGE LOADING

Hydraulic capacity calculations for each lagoon are performed by comparing the water level at the time of survey to the sludge profile with results shown below.

ESTIMATED HYDRAULIC CAPACITY - WATER LEVEL @ 191.482 m = **22,640 m^3**

CELL 1 APPROXIMATE DIMENSIONS AND VOLUMES
(AS SURVEYED)

Shape / Sides	Square
Length	110 **m**
Width	110 **m**
Area	12232 **m^2**
Max. Depth	3.07 **m**
Total Volume	27737 **m^3**
Total Potential Volume (high water level)	32373 **m^3**
Average Sludge Thickness	0.42 **m**

REMAINING CAPACITY OF CELL BASED ON SURVEYED SLUDGE VOLUME

Stage	Depth (m)	Volume (m^3)	Area (m^2)
1	0.0	22,640	12,232
2	0.7	14,995	9,823
3	1.4	8,653	8,379
4	2.1	3,241	6,990
5	2.8	18	174
6	3.5	-	-

Figure 12 Cell 1 volumes

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CELL 2 VOLUMES

CELL 2 ESTIMATED SLUDGE QUANTITY

Estimated sludge volume is calculated using software that compares the measured and interpolated sludge depths with the depths of the lagoon liner obtained from engineered drawings and/or field measurements. A sludge sample is taken for lab analysis to determine total solids and total volatile solids and to obtain dry volume.

CELL 2:

TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (WET) =	**2,488**	**m^3**
TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (DRY) =	**152**	**m^3**
SPECIFIC GRAVITY (AS SAMPLED) =	**1.10**	
TOTAL ESTIMATED MASS OF SLUDGE TO BE REMOVED =	**167**	**BDT (Bone Dry Tonnes)**
TOTAL ESTIMATED VOLATILE SOLIDS QUANTITY (DRY) =	**57**	**m^3**
IN-SITU SLUDGE DENSITY =	**1,006**	**kg/m^3**

CELL 2 HYDRAULIC CAPACITY AT PRESENT SLUDGE LOADING

Hydraulic capacity calculations for each lagoon are performed by comparing the water level at the time of survey to the sludge profile with results shown below.

ESTIMATED HYDRAULIC CAPACITY - WATER LEVEL @ 191.481 m = **25,386 m^3**

CELL 2 APPROXIMATE DIMENSIONS AND VOLUMES
(AS SURVEYED)

Shape / Sides	Square	
Length	110	**m**
Width	110	**m**
Area	11739	**m^2**
Max. Depth	3.09	**m**
Total Volume	27874	**m^3**
Total Potential Volume (high water level)	30375	**m^3**
Average Sludge Thickness	0.21	**m**

REMAINING CAPACITY OF CELL BASED ON SURVEYED SLUDGE VOLUME

Stage	Depth (m)	Volume (m^3)	Area (m^2)
1	0.0	25,386	11,739
2	0.7	17,689	10,282
3	1.4	10,977	8,886
4	2.1	5,238	7,536
5	2.8	489	4,912
6	3.5	-	-

Figure 13 Cell 2 volumes

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CELL 3 VOLUMES

CELL 3 ESTIMATED SLUDGE QUANTITY

Estimated sludge volume is calculated using software that compares the measured and interpolated sludge depths with the depths of the lagoon liner obtained from engineered drawings and/or field measurements. A sludge sample is taken for lab analysis to determine total solids and total volatile solids and to obtain dry volume.

CELL 3:

TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (WET) =	**7,672**	**m^3**
TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (DRY) =	**422**	**m^3**
SPECIFIC GRAVITY (AS SAMPLED) =	**1.08**	
TOTAL ESTIMATED MASS OF SLUDGE TO BE REMOVED =	**456**	**BDT (Bone Dry Tonnes)**
TOTAL ESTIMATED VOLATILE SOLIDS QUANTITY (DRY) =	**153**	**m^3**
IN-SITU SLUDGE DENSITY =	**1,004**	**kg/m^3**

CELL 3 HYDRAULIC CAPACITY AT PRESENT SLUDGE LOADING

Hydraulic capacity calculations for each lagoon are performed by comparing the water level at the time of survey to the sludge profile with results shown below.

ESTIMATED HYDRAULIC CAPACITY - WATER LEVEL @ 191.482 m = **13,034** **m^3**

CELL 3 APPROXIMATE DIMENSIONS AND VOLUMES
(AS SURVEYED)

Shape / Sides	Rectangular	
Length	108	**m**
Width	86	**m**
Area	9006	**m^2**
Max. Depth	3.05	**m**
Total Volume	20706	**m^3**
Total Potential Volume (high water level)	22939	**m^3**
Average Sludge Thickness	0.85	**m**

REMAINING CAPACITY OF CELL BASED ON SURVEYED SLUDGE VOLUME

Stage	Depth (m)	Volume (m^3)	Area (m^2)
1	0.0	13,034	9,006
2	0.7	7,481	6,731
3	1.4	3,394	5,102
4	2.1	679	2,366
5	2.8	4	76
6	3.5	-	-

Figure 14 Cell 3 volumes

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CELL 4 VOLUMES

CELL 4 ESTIMATED SLUDGE QUANTITY

Estimated sludge volume is calculated using software that compares the measured and interpolated sludge depths with the depths of the lagoon liner obtained from engineered drawings and/or field measurements. A sludge sample is taken for lab analysis to determine total solids and total volatile solids and to obtain dry volume.

CELL 4:

TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (WET) =	**4,552**	**m^3**
TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (DRY) =	**269**	**m^3**
SPECIFIC GRAVITY (AS SAMPLED) =	**1.05**	
TOTAL ESTIMATED MASS OF SLUDGE TO BE REMOVED =	**282**	**BDT (Bone Dry Tonnes)**
TOTAL ESTIMATED VOLATILE SOLIDS QUANTITY (DRY) =	**86**	**m^3**
IN-SITU SLUDGE DENSITY =	**1,003**	**kg/m^3**

CELL 4 HYDRAULIC CAPACITY AT PRESENT SLUDGE LOADING

Hydraulic capacity calculations for each lagoon are performed by comparing the water level at the time of survey to the sludge profile with results shown below.

ESTIMATED HYDRAULIC CAPACITY - WATER LEVEL @ 191.478 m = **16,307** **m^3**

CELL 4 APPROXIMATE DIMENSIONS AND VOLUMES
(AS SURVEYED)

Shape / Sides	Rectangular	
Length	108	**m**
Width	86	**m**
Area	8897	**m^2**
Max. Depth	3.06	**m**
Total Volume	20858	**m^3**
Total Potential Volume (high water level)	20769	**m^3**
Average Sludge Thickness	0.51	**m**

REMAINING CAPACITY OF CELL BASED ON SURVEYED SLUDGE VOLUME

Stage	Depth (m)	Volume (m^3)	Area (m^2)
1	0.0	16,307	8,897
2	0.7	10,525	7,645
3	1.4	5,572	6,528
4	2.1	1,395	5,216
5	2.8	3	78
6	3.5	-	-

Figure 15 Cell 4 volumes

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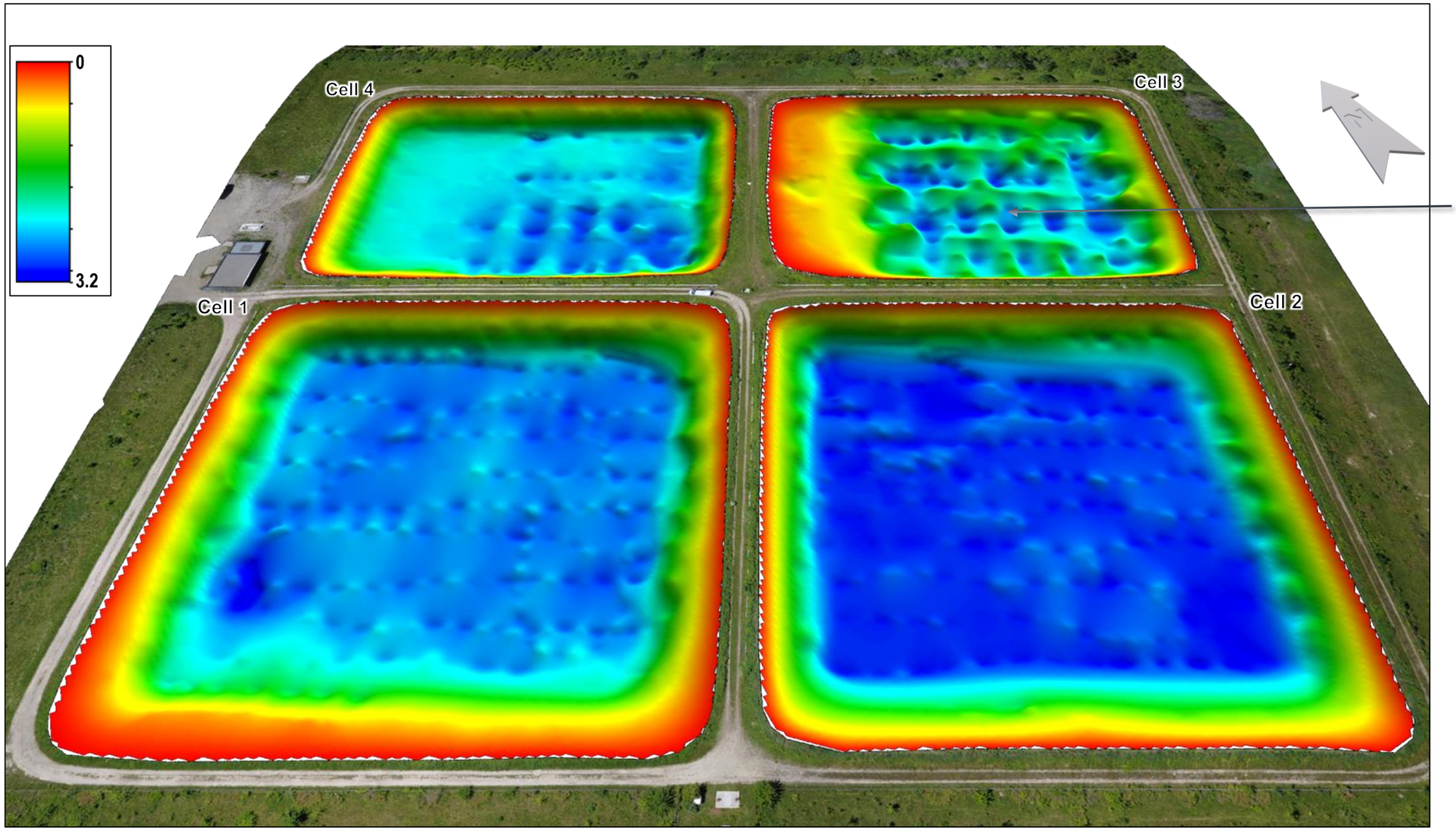
CELLS 1 - 4 – TOP OF SLUDGE 3D PROFILE



A 3x vertical exaggeration has been applied to the 3D isometric drawing to highlight bottom features.

Top of sludge depths are unevenly distributed for all cells due to the influence of aeration, which is more noticeable in Cell 3.

The average top of sludge depths for Cells 1, 2, 3 & 4 are, respectively, 2.27 m, 2.37 m, 2.30 m & 2.34 m.

Figure 16 Cells 1, 2, 3 & 4 top of sludge 3D isometric drawing – southeast to northwest

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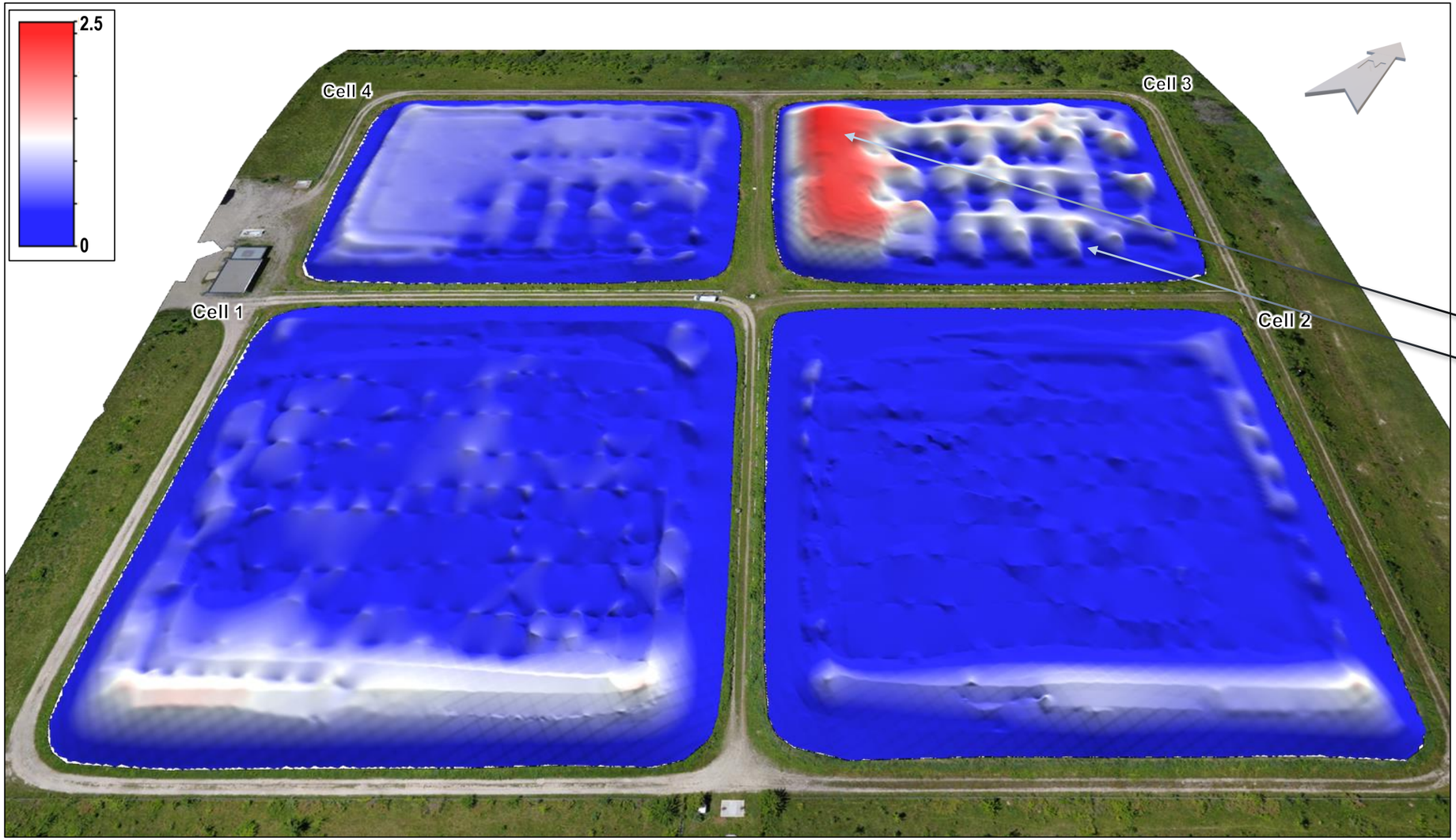
CELLS 1 - 4 – SLUDGE THICKNESS 3D PROFILE



A 3x vertical exaggeration has been applied to the 3D isometric drawing to highlight bottom features.

Sludge build-up is lower for cells 1, 2 and 4.

For Cell 3, sludge accumulation is higher and concentrated in the southwestern portion as well as in the non-aerated zones.

The average sludge thickness for Cells 1, 2, 3 & 4 are, respectively, 0.42 m, 0.21 m, 0.85 m & 0.51 m.

Figure 17 Cells 1, 2, 3 & 4 top of sludge 3D isometric drawing – southeast to northwest

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APPENDIX A – GLOSSARY

Bone dry tonnes (BDT): The in-situ sludge volume reduced to an ideal dry mass in metric tonnes (all moisture removed).

CGVD2013: Canadian Geodetic Vertical Datum of 2013

CGVD28: Canadian Geodetic Vertical Datum of 1928

Dredgeable area: The area of a lagoon or pond that is accessible to be cleaned by a floating dredge. Features that restrict dredge access include excessive shoreline vegetation (cattails), riprap,

infrastructure, etc.

Dredgeable volume: The volume of sludge in the dredgeable area adjusted to account for the cutterhead guard and sludge-liner interface by raising the liner surface by 15 cm and by applying an offset from the shoreline of 3 m for cells 1, 2, 3 & 4.

Echogram: A visualization of acoustic returns displayed as a vertical cross section (elevation view) or ‘slice’ of the entire water column (waterline down to sludge) that shows the bottom profile and basic underwater features.

Floating crust: A layer of material (made up of biosolids and synthetic debris) which is less dense and therefore floats on the surface of the effluent and forms a crust.

Freeboard: Distance from the surveyed cell water elevation to the cell level of capacity or overflow.

In-situ sludge density: The calculated density of the in-situ sludge.

Sludge accumulation: The amount of sludge (in depth or volume) that accumulates over a period of time.

Sludge blanket thickness: The amount of sludge that has accumulated on the bottom of the pond.

Sludge volume: The in-situ sludge volume that exists between the liner and the top of the sludge surface.

Top of sludge depths: The vertical measurement from the water surface down to the top of the sludge layer.

Top of sludge elevations: The elevations mapped at the top of the sludge layer. By tracking these elevations overtime sludge accumulation can be accurately monitored or dredging progress can be assessed even with varying pond levels.

Water volume / hydraulic capacity: Volume of water/effluent in the pond at the time of survey. This value represents the hydraulic capacity on top of the settled sludge blanket.

	Name	Date
Prepared by:	RM	29-07-2024
Reviewed by:	AA	30-07-2024

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Tiverton, ON Wastewater Lagoon Sludge Surveys 2024 Report	
Project Number	24049B	
Revision	0	
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APPENDIX B – A NOTE ON VOLUME CALCULATIONS

This Sludge Survey Report has been prepared by Hydrasurvey Ltd. (“HS”) for the Municipality of Kincardine (herein referred to as the “Client”). It is intended to provide the Client with an estimate of sludge quantity and lagoon hydraulic capacity.

This report is based on data and information obtained by measuring pond depths with the Single Beam Echosounder, or Infrared Sludge Interface Detector and verified using manual checks. Estimated sludge volumes and dry tonne amounts are calculated using software that creates interpolations between the sounding lines measured in the field.

The Client recognizes and acknowledges that estimated sludge volumes will vary from actual sludge volumes and that this report should be used only as a general guideline for planning maintenance desludging or dredging and should not be assumed to be an exact quantification of sludge volume. HS shall not be liable for any damages resulting from any difference between estimated sludge volumes and actual sludge volumes.

Furthermore, the liability of HS to the Client and to all third parties shall be limited to injury or loss caused by the negligent acts, errors or omissions of HS. Notwithstanding the foregoing, the total aggregate liability of HS shall not exceed the lesser of the actual damages incurred, or the total fee of HS for services rendered on this project.

The Client agrees to defend, indemnify, and hold harmless HS, its affiliates, officers, directors, employees, and agents from any and all liabilities, in excess of the limits of HS’ entire liability set out above, incurred by HS or any other party, in connection with the services provided. Such indemnity shall include the costs of the time spent and expenses incurred by HS and its affiliates in connection with the defence of any claims.

	Name	Date
Prepared by:	RM	29-07-2024
Reviewed by:	AA	30-07-2024

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Tiverton, ON Wastewater Lagoon Sludge Surveys 2024 Report	
Project Number	24049B	
Revision	0	
Sheet	18	OF 21

APPENDIX C – TIVERTON, ON WASTEWATER LAGOON SLUDGE SAMPLE TEST RESULTS

	Name	Date
Prepared by:	RM	29-07-2024
Reviewed by:	AA	30-07-2024

Unless otherwise specified all dimensions are in meters

HYDRASURVEY

Project Title	Tiverton, ON Wastewater Lagoon Sludge Surveys 2024 Report	
Project Number	24049B	
Revision	0	
Sheet	19	OF 21

Unit# 288, 2880 45 Ave S.E.
Calgary, AB, T2B 3M1
Phone (403) 297-0868
Fax: (403) 297-0869

KaizenLAB

ANALYTICAL REPORT

Client: Hydrasurvey Ltd.
4030 8 Street SE
Calgary T2G 3A7

Attention: Andrew Ambrocichuk

KaizenLAB JOB #:	**338752**
DATE RECEIVED:	02-Jul-2024
DATE REPORTED:	09-Jul-2024
PROJECT ID:	24049B Tiverton, ON
LOCATION:	Tiverton, ON

KaizenLAB Sample #: 338752_001 **Sample ID:** 24049b Cell 1
Date Sampled: 27-Jun-2024 **Matrix:** SLUDGE

Parameter Description	Units	Result	Detection Limit
Specific Gravity (Dry)	g/mL	1.19	
Volatile and Total Solids (gravimetric) in soil			
Total and Volatile Solids in Soil			
Total Solids	%	3.0	0.1
Volatile Solids	%	1.5	0.1

KaizenLAB Sample #: 338752_002 **Sample ID:** 24049b Cell 2
Date Sampled: 27-Jun-2024 **Matrix:** SLUDGE

Parameter Description	Units	Result	Detection Limit
Specific Gravity (Dry)	g/mL	1.10	
Volatile and Total Solids (gravimetric) in soil			
Total and Volatile Solids in Soil			
Total Solids	%	6.1	0.1
Volatile Solids	%	2.3	0.1

KaizenLAB Sample #: 338752_003 **Sample ID:** 24049b Cell 3
Date Sampled: 27-Jun-2024 **Matrix:** SLUDGE

Parameter Description	Units	Result	Detection Limit
Specific Gravity (Dry)	g/mL	1.08	
Volatile and Total Solids (gravimetric) in soil			
Total and Volatile Solids in Soil			
Total Solids	%	5.5	0.1
Volatile Solids	%	2.0	0.1

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e-Mail: kaizenlab@kaizenlab.ca

KaizenLAB Sample #: 338752_004 **Sample ID:** 24049b Cell 4

Date Sampled: 24-Jun-2024 **Matrix:** SLUDGE

Parameter Description	Units	Result	Detection Limit
Specific Gravity (Dry)	g/mL	1.05	
Volatile and Total Solids (gravimetric) in soil			
Total and Volatile Solids in Soil			
Total Solids	%	5.9	0.1
Volatile Solids	%	1.9	0.1

Test Methodologies

Specific Gravity / Bulk Density in Soil/Sludge (Non-Accredited): Modified from Soil Sampling & Methods of Analysis, M.R. Carter, 2008 and Directive 05(of the Alberta Energy Regulator, August 2019
Total and Volatile Solids in Soil (Non-Accredited): Modified from SM 2540 B and E

Final Review by:

Irene De Leon
Client Services Representative

Test methodologies are accredited in accordance with ISO/IEC 17025 via CALA, unless otherwise specified in the description of the methods .
[1]This analyte is not accredited, even though analyzed by an accredited methodology.