



PROJECT NUMBER: 111477020

# Agricultural Soil Productivity Monitoring for the Manitoba Minnesota Transmission Project: Pre-Construction (2019) and Post-Construction Year 1 (2020)

Final Report

For: Manitoba Hydro

Date: January 10, 2022





**Agricultural Soil Productivity  
Monitoring for the Manitoba-  
Minnesota Transmission Project:  
Pre-Construction (2019) and Post-  
Construction Year 1 (2020)**

Final Report

January 10, 2022

Prepared for:

Manitoba Hydro

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Project Number: 111477020

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**AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA  
TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1  
(2020)**

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# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

## **Executive Summary**

Manitoba Hydro retained Stantec Consulting Ltd. (Stantec) and AgriEarth Consulting Ltd. (AgriEarth) to conduct monitoring of soil productivity along the portion of the Manitoba-Minnesota Transmission Project (the “Project”) under agricultural crop production. Monitoring of soil productivity during pre-construction and post-construction Project phases was a commitment made in the Project Environmental Monitoring Plan (EMP; Manitoba Hydro, 2019). This report represents the first annual report on this monitoring component and includes monitoring information on the pre-construction phase (2019) and the first year of the post-construction or operation phase (2020) of the Project. Construction was completed between the 2019 and 2020 growing seasons.

In agri-Manitoba the productivity of soils for arable agriculture is valued by agricultural producers as a primary source of income. Soil productivity on lands in the Project right of way (RoW) can be adversely affected by the use of construction machinery, including vehicles and heavy equipment, and disturbance of surface materials during grading and excavation for tower structure foundations. Effects on soil productivity are typically manifested in vegetation productivity. Therefore, a vegetation productivity indicator can be used as an effective proxy for soil productivity. As such, a vegetation productivity index, the Normalized Difference Vegetation Index (NDVI), was used as a screening tool to assess the effects on soil productivity in the Project RoW following construction activities in areas of agricultural production. The NDVI provides a relative measure of vegetation health or productivity and is calculated from remotely-sensed reflectance data captured from satellite imagery.

The objective of the monitoring program is to monitor soil productivity along portions of the Project RoW under agricultural land use to confirm the effectiveness of mitigation in the maintenance and rehabilitation of soil productivity. This objective is consistent with that presented for the soil productivity monitoring activity in the EMP.

As documented in the assessment of potential environmental effects on agriculture within the Project Environmental Impact Statement (EIS; Manitoba Hydro, 2015), physical degradation of soils from Project activities are expected, primarily due to compaction in work areas within the RoW, and those effects may result in reduced crop productivity. While effects are expected, the effects to agricultural capability class resulting in a reduced ability for the land to support crop production are expected to be minimal following mitigation. These residual effects are anticipated to be limited to localized areas within the RoW. Where degradation of land does occur due to soil compaction from construction activities, these effects are expected to extend beyond construction activities and could persist for a few years following remedial action.

Manitoba Hydro’s landowner compensation program includes a structure impact compensation which considers reduced crop productivity in an area of overlap around each tower. Beyond these areas, in the event of damage to property, including to land, Manitoba Hydro is committed to working with landowners to repair damages. This may include construction damage compensation for residual effects to soil productivity in instances where remedial work requires farm machinery and the landowner’s expertise.

To assess Project effects on soil productivity, differences in NDVI values were compared between areas within the RoW and adjacent, comparable off RoW areas within a defined agricultural evaluation area. The





## AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

agricultural evaluation area is comprised of areas of annual crop, forage (hay) and pasture (grassland, grazing) production traversed by the Project. Specific agricultural evaluation areas were delineated, including:

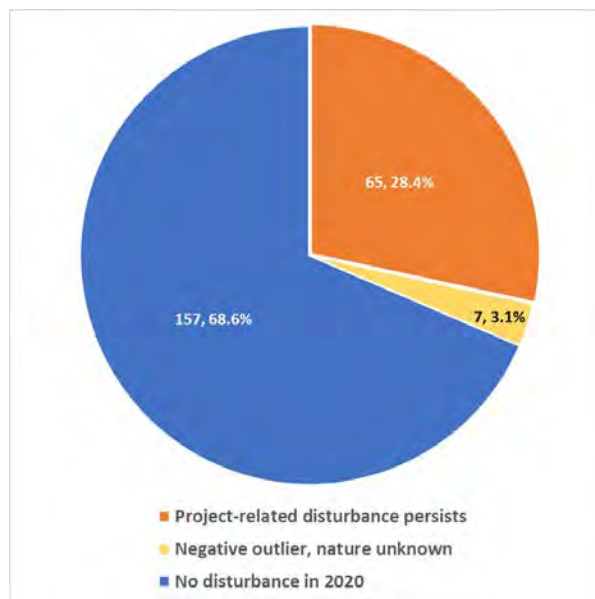
- Discrete agricultural field management units (FMUs) within a 20 m corridor centered along the transmission line (On RoW FMUs), to capture effects to soil productivity within the RoW between towers.
- Tower work areas (TWAs), or 80 m diameter buffer areas around tower structures, to capture effects to soil productivity from tower structure construction activities.

The Project includes a 213 km long transmission line and 499 tower structures. The transmission line originates at Dorsey station northwest of Winnipeg and terminates at the Manitoba to Minnesota border southeast of Piney, Manitoba. For the purposes of this evaluation:

- Of the 213 km of transmission line, a total of 114 km (53.5% of total) were determined to be within the agricultural evaluation area and a total of 229 On RoW FMUs were delineated.
- Of the 499 total tower structures, 306 tower structures (61.3 % of total) were considered within the agricultural evaluation area and a total of 338 discrete TWAs were delineated (note: the higher TWA number relative to tower structures in the agricultural evaluation area is due to field management unit splits where towers straddle more than one field management unit).

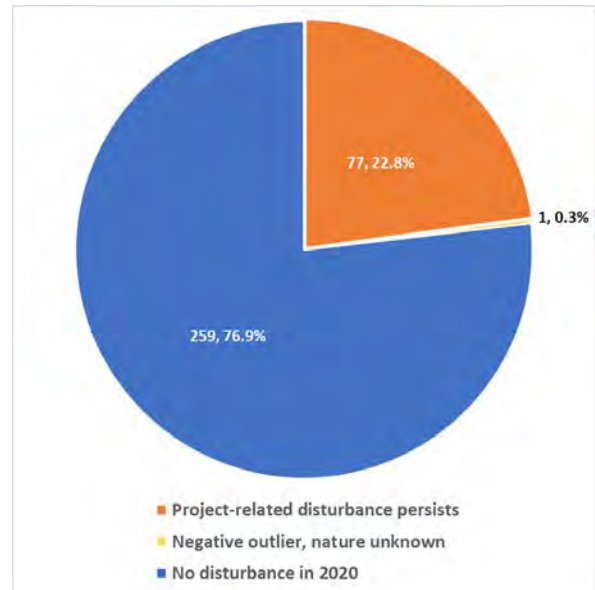
An evaluation of NDVI differences was completed for 2019 and 2020 growing seasons using NDVI values captured in July to represent peak crop growth conditions. Threshold values were determined using baseline or pre-disturbance (pre-construction) conditions represented by the 2019 NDVI values, and were used to identify negative outliers for NDVI difference values in 2019 and 2020. Negative outliers for the 2020 growing season were visually reviewed to confirm whether they were likely the result of Project-related disturbance or if differences were attributable to other factors (e.g., natural variability in soil conditions).

A summary of counts and proportions of individual On RoW FMUs in each of the disturbance categories in 2020 is found in the figure on the right. A total of 65 of the 229 On RoW FMUs (28.4% of total) were considered to have lower soil productivity due to Project-related disturbances.



## AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

A summary of counts and proportions of individual TWAs in each of the disturbance categories is provided in the figure on the right.. A total of 77 of the 338 TWAs (22.8% of total) were considered to have lower soil productivity due to Project-related disturbances.



Therefore, Project activities have resulted in disturbance to soil and crop productivity within the RoW. Negative effects were found to persist following construction, which occurred between the 2019 and 2020 growing seasons. Effects were found to be limited to the RoW and associated with areas of construction activity (e.g., tower work areas, construction access and trails) within the RoW. As documented in the EIS, effects to soil productivity due to compaction from construction activities within the RoW were anticipated, and where effects from compaction occur, they could persist for a few years following construction. Results from the monitoring program are consistent with the predictions made in the EIS. Results suggest the mitigation program has been effective as over 70% of FMUs and over 75% of TWAs were considered to not have negative effects to soil productivity following post-construction year 1 (2020). No unexpected effects were determined through the monitoring program through the 2020 monitoring season. Future monitoring will be used to confirm that areas where effects have persisted are recovering or trending to recovery.

The evaluation will continue in 2021 to track the post-construction recovery of soil and crop productivity in areas of potential Project-related disturbances. Recommendations for monitoring and evaluation in 2021 include evaluating disturbance and recovery relative to soil properties (e.g., texture, drainage) and crop type to determine relationships to these factors, as well as integration of soil-related mitigation implemented on the Project to assess the effectiveness of mitigation. Beyond these recommendations, there are currently no recommendations for additional monitoring activities (e.g., field assessment), mitigation activities or alterations to the monitoring program. Additional mitigation and monitoring will be addressed following the completion of the post construction year 2 (2021) monitoring program.



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

## Abbreviations

EMP	Environmental Monitoring Plan
FMU	Farm management unit
MMTP	Manitoba-Minnesota Transmission Project
NDVI	Normalized Difference Vegetation Index
NIR	Near-infrared
RoW	Right-of-way
TWA	Tower work area



**AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA  
TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

## **Glossary**

### Normalized Difference Vegetation Index

A quantified measure of vegetation health or productivity determined using near-infrared and red light wavelengths.

**Field management unit** An agricultural crop production area defined as being managed as a single field cropping management unit.

**Off RoW Comparable Area** A discrete comparable area located off of the right-of-way (RoW) and considered not disturbed by the Project, and used to compare against potentially-disturbed areas including On RoW field management units (FMUs) and tower work areas (TWAs).

**On RoW FMU** A discrete FMU located within the RoW, specifically within a 20 m corridor centered on the transmission line centreline.

**Outlier (NDVI difference)** A value considered to be outside of the expected normal range of variation. For the purposes of this evaluation, outliers were determined for NDVI difference values between areas within the RoW that are potentially disturbed (i.e., On RoW FMUs and TWAs) and comparable areas outside of the RoW not disturbed by the Project.

**Outlier, minor** An outlier between defined “inner fence” and “outer fence” limits using quartiles. Minor outliers are considered less extreme than major outliers. Negative outliers are of interest to this evaluation, and the negative inner fence is determined as:  $Q1 - (1.5 \times IQR)$ , where  $Q1$  = first quartile (25<sup>th</sup> percentile) and  $IQR$  = interquartile range ( $Q3$  [third quartile or 75<sup>th</sup> percentile] –  $Q1$ ).

**Outlier, major** An outlier beyond a defined “outer fence” limit using quartiles. Major outliers are considered more extreme than minor outliers. Negative outliers are of interest to this evaluation, and the negative outer fence limit is determined as:  $Q1 - (3 \times IQR)$ , where  $Q1$  = first quartile (25<sup>th</sup> percentile) and  $IQR$  = interquartile range ( $Q3$  [third quartile or 75<sup>th</sup> percentile] –  $Q1$ ).

**Threshold (NDVI difference)** Threshold values established to determine outliers in NDVI difference values between areas within the RoW that are potentially disturbed by the Project (i.e., On RoW FMUs and TWAs) and comparable areas outside of the RoW not disturbed by the Project. Negative thresholds are of interest to this evaluation to identify where soil and crop productivity within the RoW is lower than comparable areas outside of the RoW. Thresholds for minor negative outliers and major negative outliers were established using “inner fences” and “outer fences”.



**AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA  
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# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Introduction  
January 10, 2022

## 1.0 INTRODUCTION

Manitoba Hydro retained Stantec Consulting Ltd. (Stantec) and AgriEarth Consulting Ltd. (AgriEarth) to conduct monitoring of soil productivity along the portion of the Manitoba-Minnesota Transmission Project (the “Project”) under agricultural crop production. Monitoring of soil productivity during pre-construction and post-construction Project phases is a commitment made in the Project Environmental Monitoring Plan (EMP; Manitoba Hydro, 2019). This report represents the first annual report on this monitoring component and includes monitoring information on the pre-construction phase (2019) and the first year of the post-construction or operation phase (2020) of the Project.

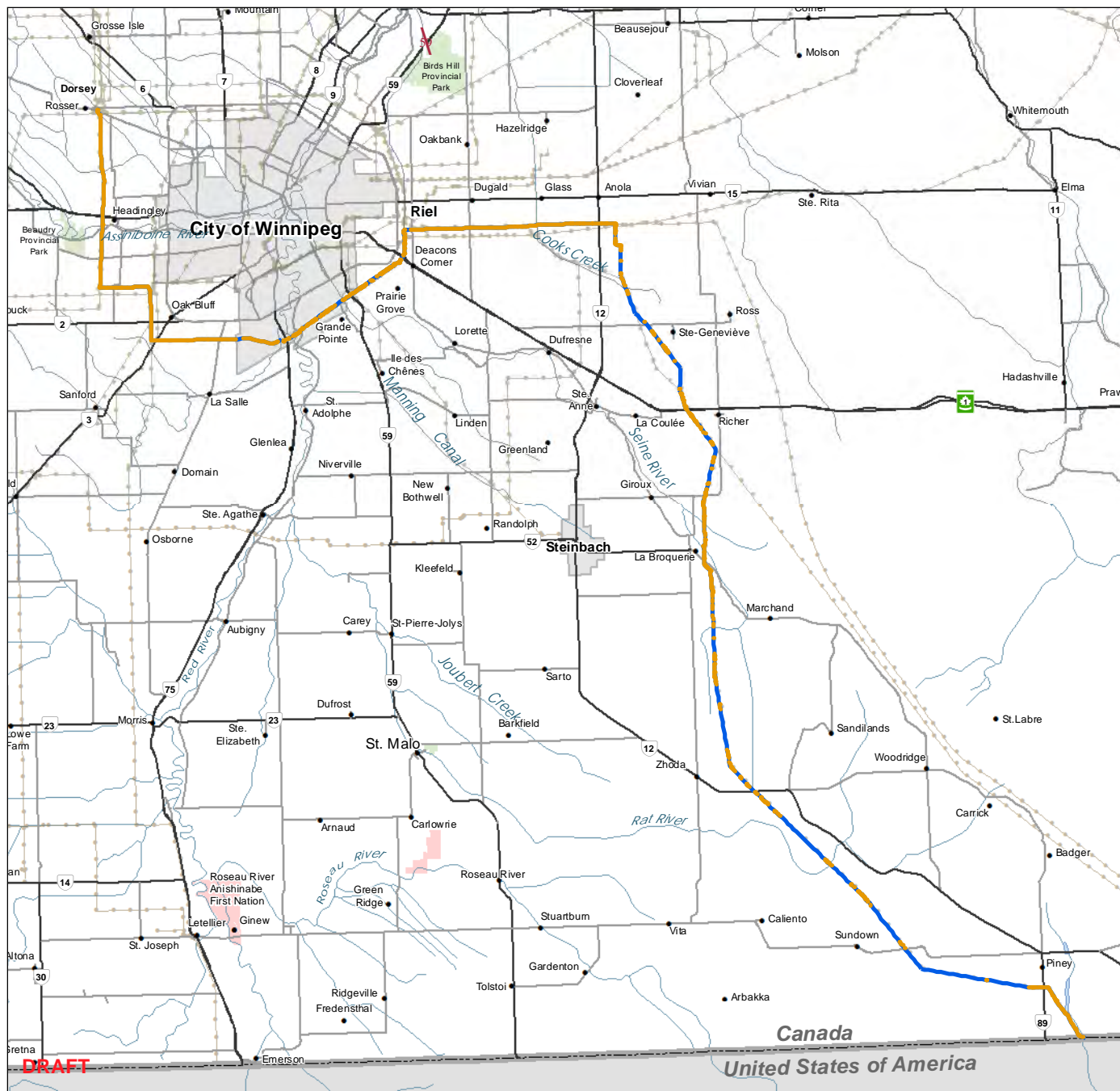
In agri-Manitoba the productivity of soils for arable agriculture is valued by agricultural producers as a primary source of income. Agricultural production is also of general benefit to society. Soil productivity on lands in the Project right of way (RoW) can be affected by the use of construction machinery, including vehicles and heavy equipment, and disturbance of surface materials during grading and excavation for tower foundations. The effects mechanisms for construction activities on soil productivity are primarily physical, but secondary or indirect effects to productivity may occur through chemical and biological changes as a result of physical disturbances. Soil productivity is a result of numerous soil environmental factors and conditions and is difficult to measure or assess. However, these direct effects on soil properties are typically manifested in vegetation productivity. Therefore, a vegetation productivity indicator can be used as an effective proxy for soil productivity. As such, vegetation productivity was used as a screening tool to assess the effectiveness of prescribed mitigation in the maintenance and reclamation of soil productivity in the Project RoW following construction activities in areas of agricultural production.

For the purposes of this evaluation, the Project consists of a transmission line 213 km in length with 499 tower structures. The transmission line originates at Dorsey station northwest of Winnipeg and terminates at the Manitoba to Minnesota border southeast of Piney, Manitoba. An overview of the Project is provided in **Map 1.1**.

As documented in the assessment of potential environmental effects on agriculture within the Project Environmental Impact Statement (EIS; Manitoba Hydro, 2015), physical degradation of soils from Project activities are expected, primarily due to compaction in work areas within the RoW, and those effects may result in reduced crop productivity. While effects are expected, the effects to agricultural capability class resulting in a reduced ability for the land to support crop production are expected to be minimal following mitigation. These residual effects are anticipated to be limited to localized areas within the RoW. Where degradation of land does occur due to soil compaction from construction activities, these effects are expected to extend beyond the construction and could persist for a few years following remedial action.

Manitoba Hydro's landowner compensation includes a structure impact compensation which considers reduced crop productivity in an area of overlap around each tower. Beyond these areas, in the event of damage to property, including to land, Manitoba Hydro is committed to working with landowners to repair damages. This may include construction damage compensation for residual effects where remedial work requires farm machinery and the landowner's expertise. More information can be found in the Manitoba-





#### Legend

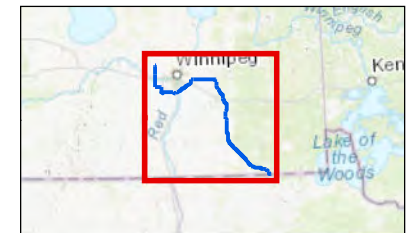
- Manitoba-Minnesota Transmission Line
- Agricultural Land Use Along the Transmission Line
- Provincial Highway
- Provincial Road
- Existing Transmission Lines
- Community
- First Nation Lands
- Provincial Park
- City



0 10 20 km  
(At original document size of 8.5x11)  
1:700,000

#### Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Government of Canada, Manitoba Hydro
3. Background: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community



#### Project Location

Winnipeg,  
Manitoba

Prepared by JH on 2021-05-15  
TR by DW on 2021-05-15  
IR Review by ABC on 2021-05-15

#### Client/Project

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Performance & Crop Performance Monitoring

#### Figure No.

1.1

#### Title

**Manitoba Minnesota  
Transmission Line - Project Overview**

# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

Introduction  
January 10, 2022

Minnesota Project Landowner Compensation Information brochure included in the EIS (Appendix 15C; Manitoba Hydro 2015).

The Project soil productivity monitoring program relies primarily on the use of the Normalized Difference Vegetation Index (NDVI), a relative measure of vegetation health or productivity. NDVI is calculated from remotely-sensed reflectance data collected through satellite imagery, and assessment is based on the difference between NDVI values on the RoW and adjacent, comparable off RoW areas.

## **1.1 OBJECTIVE**

The objective of the monitoring program is to monitor soil productivity along portions of the Project RoW under agricultural land use to confirm the effectiveness of mitigation in the maintenance and rehabilitation of soil productivity. This objective is consistent with that presented for the soil productivity monitoring activity in the EMP (Section 4.7.1, p. 64).

To achieve the commitment made in the EMP, the soil productivity monitoring program has been structured to:

- use crop performance as the parameter for evaluating soil productivity along the RoW, access roads, and other temporary project footprints within areas of agricultural land use, including annual crop, forage (hay) and grassland (grazing) production.
- include monitoring for one year prior to construction (2019), and up to two-years post-construction (2020 and 2021) or until suitable knowledge is acquired.

The monitoring approach relies on desktop-based activities, namely remote sensing of vegetative productivity based on computed NDVI values.

As identified in the EMP (Table 4-21), field assessments by resource specialists may be completed, as required. Field assessments would be completed on a site-specific basis if warranted due to residual effects to soil productivity determined through monitoring activities or as identified by landowners, and as directed by Manitoba Hydro.



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Methodology  
January 10, 2022

## 2.0 METHODOLOGY

The methods used to conduct the 2019 and 2020 soil productivity monitoring program are consistent with those presented in the EMP (Section 7.7) and are summarized below.

### 2.1 IMAGE ACQUISITION AND PROCESSING

Imagery was collected from the PlanetScope satellite constellation to support the evaluation. The PlanetScope sensors provide sufficient radiometric and spatial resolution to capture crop conditions across a broad landscape, such as the agricultural portion of the Project, in a cost-effective manner.

The PlanetScope satellites collect multispectral data, including blue (455-515  $\mu\text{m}$ ), green (500-590  $\mu\text{m}$ ), red (590-670  $\mu\text{m}$ ) and near infrared (NIR) (780-860  $\mu\text{m}$ ) wavelengths at 3 m by 3.5 m resolution. The sensors are affected by atmospheric interference such as clouds, fog, rain or smoke and requires cloud-free conditions to collect reliable surface spectral reflectance information.

Satellite image acquisition for the Project RoW required multiple orbital paths due to the extent of the area of interest. Due to cloud cover, a long repeat coverage period and a high level of orbital overlap, multiple orbital tracks were required over varying dates to compile a single, cloud-free imagery mosaic for the RoW. Acquisition dates for 2019 and 2020 were all within the month of July.

All satellite imagery was atmospherically corrected by PlanetScope's parent company Planet Labs Inc. Haze removal was performed as part of the atmospheric correction allowing for precise vegetation measurements. Planet normalized solar illumination conditions at different time periods allowing for accurate change detection analysis. Individual images were clipped and combined, creating continuous coverages of agricultural land use areas across the entire RoW.

### 2.2 NORMALIZED DIFFERENCE VEGETATION INDEX

Imagery was processed to quantify agricultural crop health by implementing the NDVI formula. NDVI is a measure of vegetative vigor or plant health using the Red and Near-Infrared (NIR) channels of the electromagnetic spectrum. NIR energy is highly reflected by healthy vegetation while Red wavelengths are highly absorbed by vibrant vegetation (**Figure 2.1**). This relationship is not as strong in stressed vegetation and is non-existent in dead vegetation. This unique vegetative property provides detail on vegetation health and is exemplified in the NDVI formula:

$$(\text{NIR} - \text{RED}) / (\text{NIR} + \text{RED}) = \text{NDVI}$$

NDVI values range from 1 (healthy vegetation) to -1 (non-vegetation). Results of the NDVI formula can vary from one landscape to another but typically areas of water, sand, or infrastructure show very low NDVI values (for example, -0.5 or less). For instance, bare soil usually scores near 0.0 on the NDVI scale range; sparse vegetation such as shrubs and grasslands or senescing crops may result in moderate

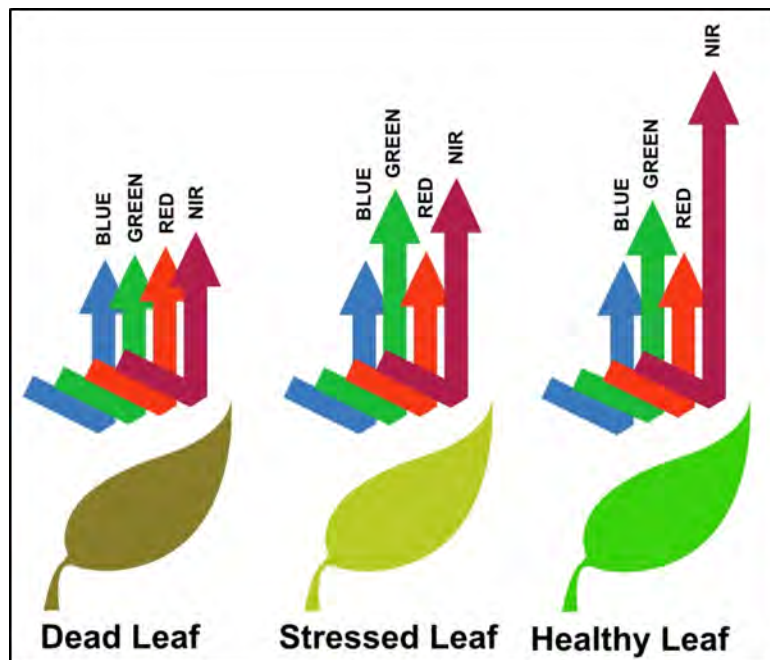




# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Methodology  
January 10, 2022

NDVI values (approximately 0.1 to 0.4); and high NDVI values (approximately 0.5 to 0.9) correspond to dense vegetation such as that found in temperate and tropical forests or crops at their peak growth stage.



**Figure 2.1** Spectral Reflectance Amount Variations for Blue, Green, Red and NIR Energy of Dead, Stressed and Healthy Crop Leaves

## 2.3 EVALUATION AREAS DEFINITION

### 2.3.1 On RoW, Tower Work Area and Off RoW Study Area Delineation

Construction activities within and along the transmission RoW vary in nature and intensity around tower structure installations and between towers. Generally, a higher degree of impact occurs around tower structures than between towers. Around tower work structures, there is a relatively high level of construction vehicle and heavy equipment activity, resulting in a potential disturbance area extending across the RoW around each tower location. Between towers, much of the activity is construction machinery (vehicles and heavy equipment) traversing from one tower to the next, hence the potential disturbance in areas between towers typically occurs in a more confined area of the RoW along a centreline or near-centerline travel corridor.



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Methodology  
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Recognizing these differences, and based on a similar evaluation conducted on a previous transmission project (Stantec, 2019)<sup>1</sup>, two evaluation areas within the RoW were established: 1) an On RoW construction corridor, and 2) tower work areas (TWAs).

Delineation of these features was completed in the ArcGIS environment using known locations of existing project components including the current transmission centreline, tower locations and Project RoW extents. The On RoW construction corridor was delineated by generating a 20 m wide corridor along the current transmission line, and TWAs were delineated by generating 80 m buffers around tower locations.

Off RoW evaluation areas were delineated by generating an 80 m buffer from the outer extents of the current Project RoW. A width of 80 m for these Off RoW evaluation areas was selected to approximate the average RoW width.

The study areas are displayed in a conceptual diagram in **Figure 2.2**.

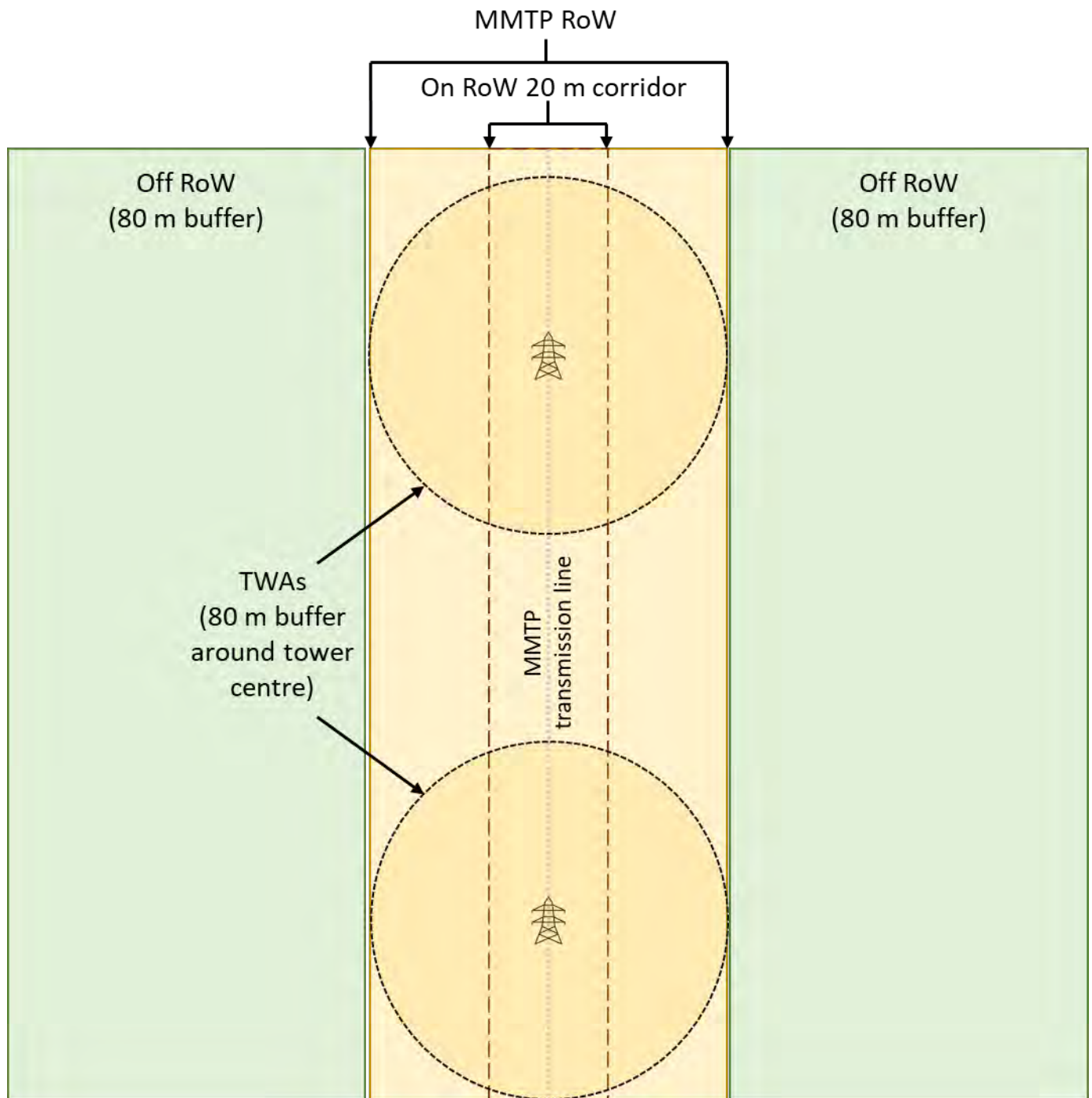
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<sup>1</sup> Stantec completed a similar evaluation the Bipole III Transmission Project. Through this evaluation, it was determined that a 20 m corridor centered on the transmission line provided a more reliable means of identifying potential effects between towers when compared with evaluating the entire RoW area.



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**Figure 2.2 Conceptual Drawing of On RoW, TWA and Off RoW Study Areas**



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## 2.3.2 Agricultural Evaluation Area Delineation

In order to analyze data and evaluate potential for effects to soil productivity within the RoW from construction activities, On RoW, TWA and Off RoW agricultural evaluation areas were established within portions of the Project traversing agricultural land. This was accomplished within the ArcGIS software environment as follows:

1. Delineating areas of agricultural land use using agricultural crop inventory data (AAFC, 2021), specifically areas of land under annual crop, forage (hay) or grassland (pasture). This resulted in the elimination of non-agricultural land uses (e.g., infrastructure such as roads, rail and other transmission lines, tree/forest/bush cover, wetlands, abandoned land, etc.).
2. Eliminating portions of On Row, TWA and Off RoW study areas in areas of non-agricultural land uses.
3. Dividing the resulting agricultural evaluation area according to discrete agricultural field management units (FMUs) using the land ownership grid (i.e., quarter section, river lots, etc.) as a basis combined with heads-up digitizing, supported with orthoimagery and agricultural crop inventory data (AAFC, 2021). This resulted in the delineation of discrete On RoW FMUs (i.e., portions of the 20 m corridor within a discrete FMU) and TWAs paired with comparable Off RoW evaluation areas within the discrete FMU area.
4. Identifying and labeling individual On RoW FMUs and TWAs, and comparable Off RoW evaluation area counterparts. In cases where multiple FMU areas were delineated within a given quarter section, these evaluation areas were labelled successively with “A”, “B”, “C”, etc. to yield unique identifiers for data management and for comparative evaluation purposes.

The establishment of On RoW FMUs, TWAs, and comparable Off RoW evaluation areas provided the basis for comparison of soil productivity within agricultural areas potentially disturbed by the Project against comparable agricultural areas not disturbed by the Project.

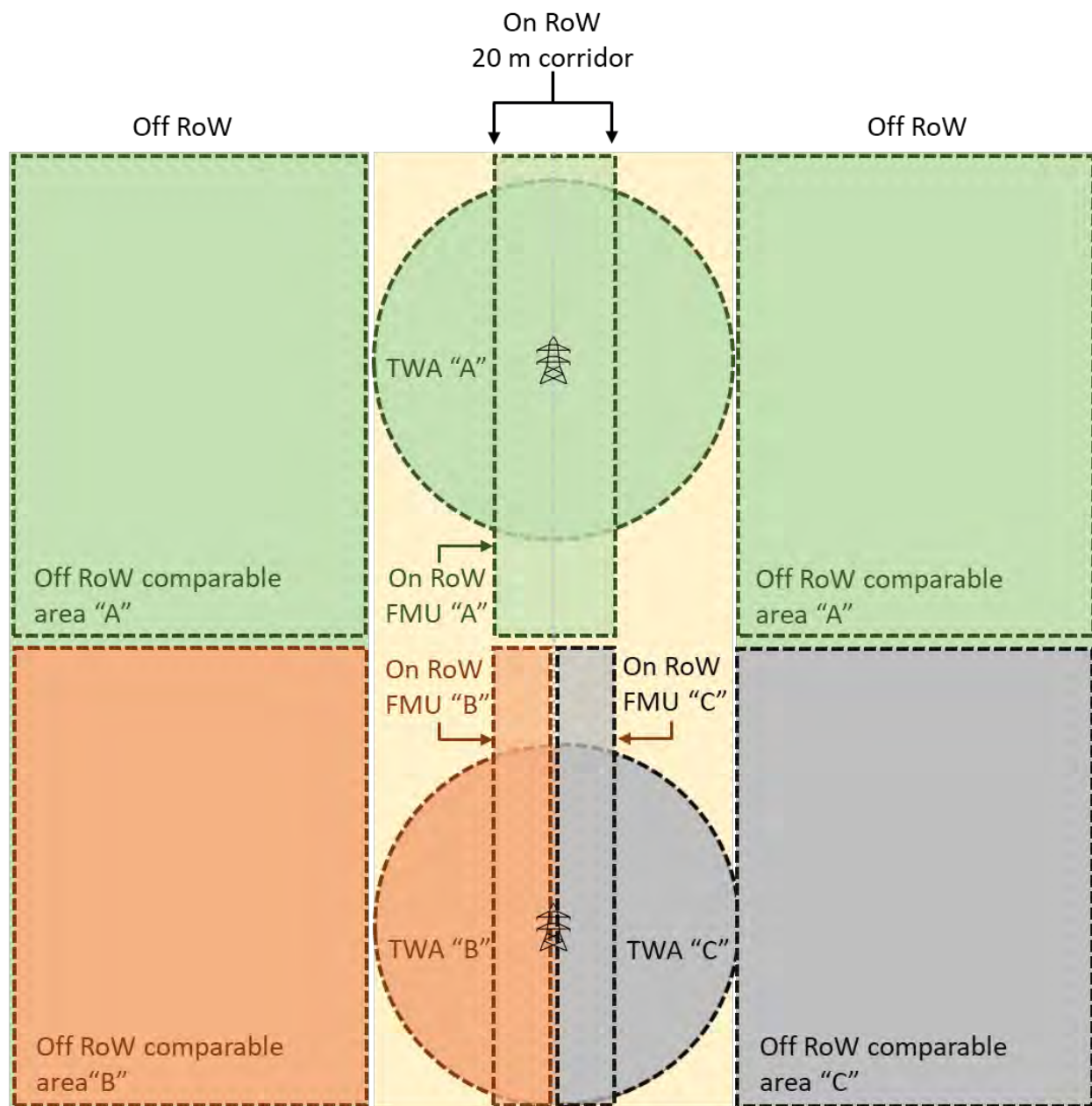
A conceptual drawing of On ROW FMUs, TWAs and Off RoW comparable areas is displayed in **Figure 2.3**.

An example of these evaluation areas for a select quarter section is presented in **Figure 2.4**.



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Within FMU "A" (dark green outline), the On RoW FMU "A" area is compared against the Off RoW comparable area "A" to determine the NDVI difference. Within FMU B (dark orange outline), the On RoW FMU "B" area is compared against the Off RoW comparable area "B" to determine the NDVI difference. Within FMU C (black outline), the On RoW FMU "C" area is compared against the Off RoW comparable area "C" to determine the NDVI difference. For TWAs, TWA "A" is compared against Off RoW comparable area "A", TWA "B" is compared against Off RoW comparable area "B" and TWA "C" is compared against Off RoW comparable area "C".

**Figure 2.3 Conceptual Drawing of On RoW FMUs, TWAs and Off RoW Comparable Areas**





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On RoW FMUs shown in solid gray and blue outlines; TWAs shown in solid gray and blue circular outlines; Off RoW FMUs shown in dashed gray outlines. Note SW-17-1-12-E has two, discrete On RoW FMUs (i.e., "A" and "B"), and On RoW FMUs and TWAs have corresponding Off RoW comparable areas denoted as "A" and "B".

**Figure 2.4** Screen Capture from ArcGIS showing On RoW FMUs, TWAs and Off RoW Comparable Areas within a Select Quarter Section



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## 2.4 DATA ANALYSIS

### 2.4.1 NDVI Evaluation

NDVI evaluation was completed for the entire agricultural portion of the Project RoW in order to develop an understanding of the differences in NDVI values between individual On RoW FMUs and TWAs, and their corresponding Off RoW comparable areas. This understanding was then used to:

- identify areas within the Project RoW where Project-related disturbances may be negatively affecting soil productivity; and
- track the post-construction recovery of soil productivity in these areas of potential Project-related disturbances.

Difference values were determined for each individual On RoW FMU and TWA as follows:

- On RoW FMU NDVI mean value – Off RoW comparable area NDVI mean value = FMU NDVI difference value
- TWA NDVI mean value – TWA comparable area mean value = TWA NDVI difference value

Statistical analyses were completed on NDVI mean values and NDVI difference values to characterize the NDVI data. The use of threshold values for NDVI differences was employed to identify potential practically-meaningful NDVI differences within individual On RoW FMUs and TWAs. Statistical analyses approaches and NDVI difference thresholds are discussed further in the sections below.

In addition, a visual assessment of imagery data was completed, as discussed below.

A total of 229 On RoW FMUs and 337 TWAs were evaluated in 2019 and 2020.

### 2.4.2 Statistical Analyses

Basic statistical analyses were conducted on NDVI mean values for On RoW FMUs and TWAs, and Off RoW comparable areas, and NDVI difference values. Statistical analyses included frequency histograms and quartile analyses to understand the character and distribution of mean values for On RoW FMUs, TWAs and Off RoW comparable areas. For difference values, values were plotted against the expected normal distribution, quartiles were determined, and percentiles were examined to characterize the data distributions.

### 2.4.3 NDVI Difference Thresholds

To support the remotely-sensed NDVI approach to identify potential Project-related disturbances to soil productivity within the RoW, thresholds for NDVI difference values were established. Difference value thresholds were used to identify individual On RoW FMUs and TWAs whose NDVI difference values were



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considered outliers relative to the normal variation in NDVI difference values expected if there were no disturbances to soil productivity.

The threshold values were established in both the positive and negative difference directions; therefore, were used to identify both positive and negative outliers in the NDVI difference values. In other words, the thresholds were established such that NDVI difference values between the positive and negative thresholds were considered to be within the normal variation of differences between On RoW and Off RoW areas. NDVI difference values for individual On RoW FMUs and TWAs exceeding the positive threshold were considered positive outliers (i.e., soil and crop productivity was higher in the On RoW area vs. Off RoW area) and values below the negative threshold were considered negative outliers (i.e., soil and crop productivity was lower in the ON RoW area vs. Off RoW area). Negative outliers are of more interest to this evaluation as they are indicative of potential Project-related disturbances resulting in reduced soil productivity On RoW relative to comparable Off RoW areas.

Threshold values were established using quartile data, specifically inter-quartile ranges. Quartiles were used to divide the NDVI difference value data into four segments according to where the values fall in relation to the overall range of values. Quartiles are defined as follows:

- Q1 (25<sup>th</sup> percentile) – 25% of values fall below this quartile value
- Q2 (50<sup>th</sup> percentile or the median value) – 50% of values are above this quartile value and 50% are below
- Q3 (75<sup>th</sup> percentile) – 25% of values fall above this quartile value

The interquartile range (IQR) is defined as  $Q3 - Q1$ , and provides an indication of the spread of the middle 50% of values, as well as a means to identify outliers (below).

Quartiles were used to identify what's called inner and outer fences for NDVI difference values, as an indicator of minor and major outliers, respectively. These inner and outer fences were determined in the negative (lower) and positive (upper) directions as follows:

- Inner lower fence (minor negative outlier threshold):  $Q1 - (1.5 \times IQR)$
- Outer lower fence (major negative outlier threshold):  $Q1 - (3 \times IQR)$
- Inner upper fence (minor positive outlier threshold):  $Q3 + (1.5 \times IQR)$
- Outer upper fence (major positive outlier threshold):  $Q3 + (3 \times IQR)$

A conceptual diagram illustrating the inner fences (minor outlier thresholds) and outer fences (major outlier thresholds) is presented in **Figure 2.5**.

Thresholds were developed based on the 2019 NDVI difference values for On RoW FMUs and TWAs. These 2019 threshold values were used to evaluate 2019 and 2020 difference values, as the 2019 values present the baseline or pre-disturbance (i.e., pre-construction) conditions.

NDVI threshold values are presented in **Table 2.1** and are visualized in **Figure 2.6**.



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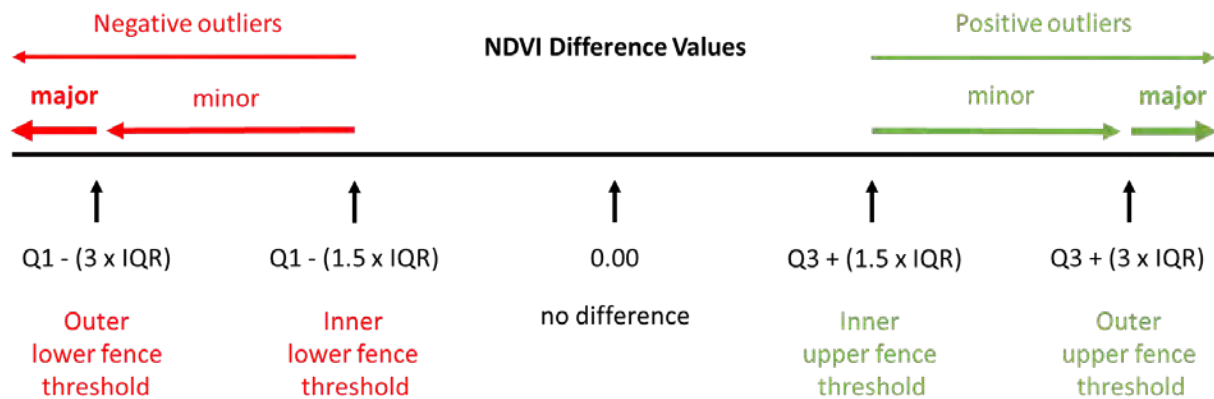


Figure 2.5 Conceptual Drawing of NDVI Difference Thresholds

Table 2.1 NDVI Difference Threshold Values for On RoW FMUs and TWAs Determined Using 2019 Results

Evaluation Component	Positive threshold		Negative threshold	
	Outer Upper Fence	Inner Upper Fence	Inner Lower Fence	Outer Lower Fence
	Major positive difference threshold	Minor positive difference threshold	Minor negative difference threshold	Major negative difference threshold
On RoW FMUs	0.090	0.052	-0.052	-0.090
TWAs	0.14	0.079	-0.084	-0.145

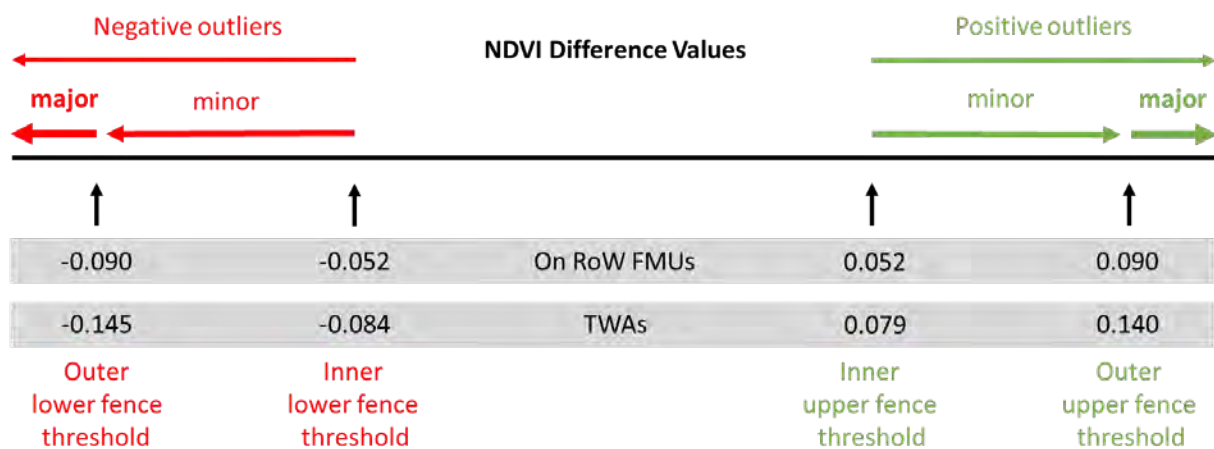


Figure 2.6 NDVI Difference Threshold Values for On RoW FMUs and TWAs Determined Using 2019 Results



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## **2.4.4 Visual Assessment**

A manual visual imagery review of all On RoW FMUs and TWAs considered to be negative outliers in 2019 and 2020 was conducted to characterize the nature of the NDVI differences and confirm visual evidence of potential construction effects to soil productivity along the agricultural portions of the Project RoW. This visual assessment was used to confirm that negative outliers were considered to be the result of Project-related disturbances to soil productivity. In some cases, the visual assessment indicated that negative outliers were the result of factors not related to Project activities, for example in cases where it was apparent that differences were due to variable status of agricultural field management within an FMU [e.g., crop partially harvested], or natural variability in soil capability or productivity [e.g., soil drainage, fertility or salinity]).

## **2.5 FIELD ASSESSMENT**

No field assessments were conducted during the 2020 post-construction monitoring season, as these were not deemed necessary to support the monitoring program.

Methods for field assessments would be developed as necessitated by the site-specific assessment requirements.





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## 3.0 RESULTS AND DISCUSSION

Summaries and discussions of NDVI soil productivity analyses are presented for On RoW FMUs in Section 3.1 and TWAs in Section 3.2. For the purposes of this evaluation:

- Of the total transmission line length of 213 km, 114 km (53.5%) were determined to be within the agricultural evaluation area and a total of 229 On RoW FMUs were delineated.
- Of the 499 total tower structures, 306 tower structures (61.3 %) were considered within the agricultural evaluation area and a total of 338 discrete TWAs were delineated (note: the higher TWA number relative to tower structures in the agricultural evaluation area is due to field management unit splits where towers straddle management units).

NDVI values for individual agricultural evaluation areas for pre-construction (2019) and post-construction year 1 (2020) monitoring seasons are located in Tables A.1 and Table A. (Appendix A). Statistical analyses are presented in the sections below and in Appendix B.

Tabular summaries, figures and discussions of results are supplemented with a mapbook displaying NDVI values and On RoW FMU and TWA outliers for the 2019 and 2020 monitoring seasons (Appendix C).

### 3.1 SOIL PRODUCTIVITY WITHIN ON RoW FMUs

#### 3.1.1 Pre-Construction (2019) Monitoring Season

A summary of basic statistics for On RoW FMUs, Off RoW comparable areas and difference values is provided in **Table 3.1**. The mean values were found to be very close and the median values identical between On RoW FMUs and Off RoW comparable areas, which resulted in difference values close to and at zero, respectively. Of the 229 On RoW FMUs, differences were found to be negative in 113 (49%) FMUs and positive in 116 (51%) FMUs.

These data indicate that soil productivity, as represented by NDVI, was similar in On RoW and Off RoW areas within the 20 m corridor along the transmission centreline in the pre-construction (2019) monitoring season. This confirms that agricultural evaluation areas including On RoW FMUs and Off RoW comparable areas were delineated well.

Further statistical support that NDVI values are similar between On RoW FMUs and comparable Off RoW comparable areas is provided in Figures B.1.1 to B.1.4 (Appendix B.1).



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**Table 3.1 Basic Statistics for 2019 NDVI Results for On RoW FMUs**

Parameter	On RoW FMU	Off RoW Comparable Areas	Difference (On RoW - Off RoW)
Count	229	229	229
Mean	0.438	0.434	0.004
Minimum	0.090	0.121	-0.117
Median	0.457	0.447	0.000
Maximum	0.688	0.681	0.181
Range	0.598	0.560	0.298
Count of Negatives	N/A	N/A	113
% Negatives	N/A	N/A	49%
Count of Positives	N/A	N/A	116
% Positives	N/A	N/A	51%

Outliers were identified using the thresholds presented in Section 2.4.3. A summary of outliers in 2019 is presented in **Table 3.2** as follows:

- there was a total of 19 positive outliers (8.3% of total), 8 of which were considered minor positive outliers (3.5% of total) and 11 of which were considered major positive outliers (4.8% of total).
- there was a total of 9 negative outliers (3.9% of total), 6 of which were considered minor negative outliers (2.6% of total) and 3 of which were considered major negative outliers (1.3% of total).

It is reasonable to expect some outliers in data, even in a pre-disturbance situation. However, it is good to understand the nature of NDVI data in the outlying On RoW FMUs. These outlying On RoW FMUs were reviewed visually, which allowed the nature of the differences in NDVI values to be evaluated. The outcome of this visual review is presented in Section 3.1.3.

**Table 3.2 Summary of NDVI Difference Outliers for 2019 NDVI for On RoW FMUs**

Outlier Direction	Outlier Category	Threshold Value	Count	% of Total	Count	% of Total
Positive	Major positive outlier	>0.091	11	4.8	19	8.3
	Minor positive outlier	>0.052 to 0.091	8	3.5		
Negative	Minor negative outlier	<-0.052 to -0.091	6	2.6	9	3.9
	Major negative outlier	<-0.091	3	1.3		



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## 3.1.2 Post-Construction Year 1 (2020) Monitoring Season

A summary of basic statistics for On RoW FMUs, Off RoW comparable areas and difference values is provided in **Table 3.3**. The mean and median values were found to be lower for On RoW FMUs relative to Off RoW comparable areas, resulting in negative difference values. Of the 229 On RoW FMUs, differences were found to be negative in 182 (79.5%) and positive in 47 (20.5%). These results demonstrate a negative “skewness” in the data, in other words, the NDVI values have shifted in a negative direction relative to the pre-construction monitoring season.

These data indicate that soil productivity, as represented by NDVI, is lower in On RoW areas relative to Off RoW areas within the 20 m corridor along the transmission centreline in the post-construction year 1 (2020) monitoring season. This suggests that Project-related disturbances have resulted in reduced soil productivity in portions of the RoW.

Further statistical support that NDVI values are lower in On RoW FMUs relative to Off RoW comparable areas is provided in Figures B.1.5 to B.1.8 (Appendix B.1).

**Table 3.3 Basic Statistics for 2020 NDVI Results for On RoW FMUs**

Parameter	On RoW FMU	Off RoW Comparable Areas	Difference (On RoW - Off RoW)
Count	229	229	229
Mean	0.447	0.482	-0.034
Minimum	0.141	0.138	-0.242
Median	0.450	0.505	-0.031
Maximum	0.692	0.746	0.193
Range	0.551	0.608	0.435
Count of Negatives	N/A	N/A	182
% Negatives	N/A	N/A	79.5%
Count of Positives	N/A	N/A	47
% Positives	N/A	N/A	20.5%

Outliers were identified using the thresholds presented in Section 2.4.3. A summary of outliers in 2020 is presented in **Table 3.4** as follows:

- there was a total of 13 positive outliers (5.7% of total), 5 of which were considered minor positive outliers (2.2% of total) and 8 of which were considered major positive outliers (3.5% of total).
- there was a total of 72 negative outliers (31.4% of total), 36 of which were considered minor negative outliers (15.7% of total) and 36 of which were considered major negative outliers (15.7% of total).



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The count of positive outliers was found to be slightly lower in 2020 relative to 2019 (i.e., 13 in 2020 vs. 19 in 2019); however, these results are not expected to be Project-related. The much higher negative outlier count in 2020 relative to 2019 (i.e., 72 in 2020 vs. 9 in 2019) suggests Project-related disturbance has persisted into the 2020 growing season within a significant portion of On RoW FMUs within the 20 m corridor along the transmission centreline.

**Table 3.4 Summary of NDVI Difference Outliers for 2020 NDVI for On RoW FMUs**

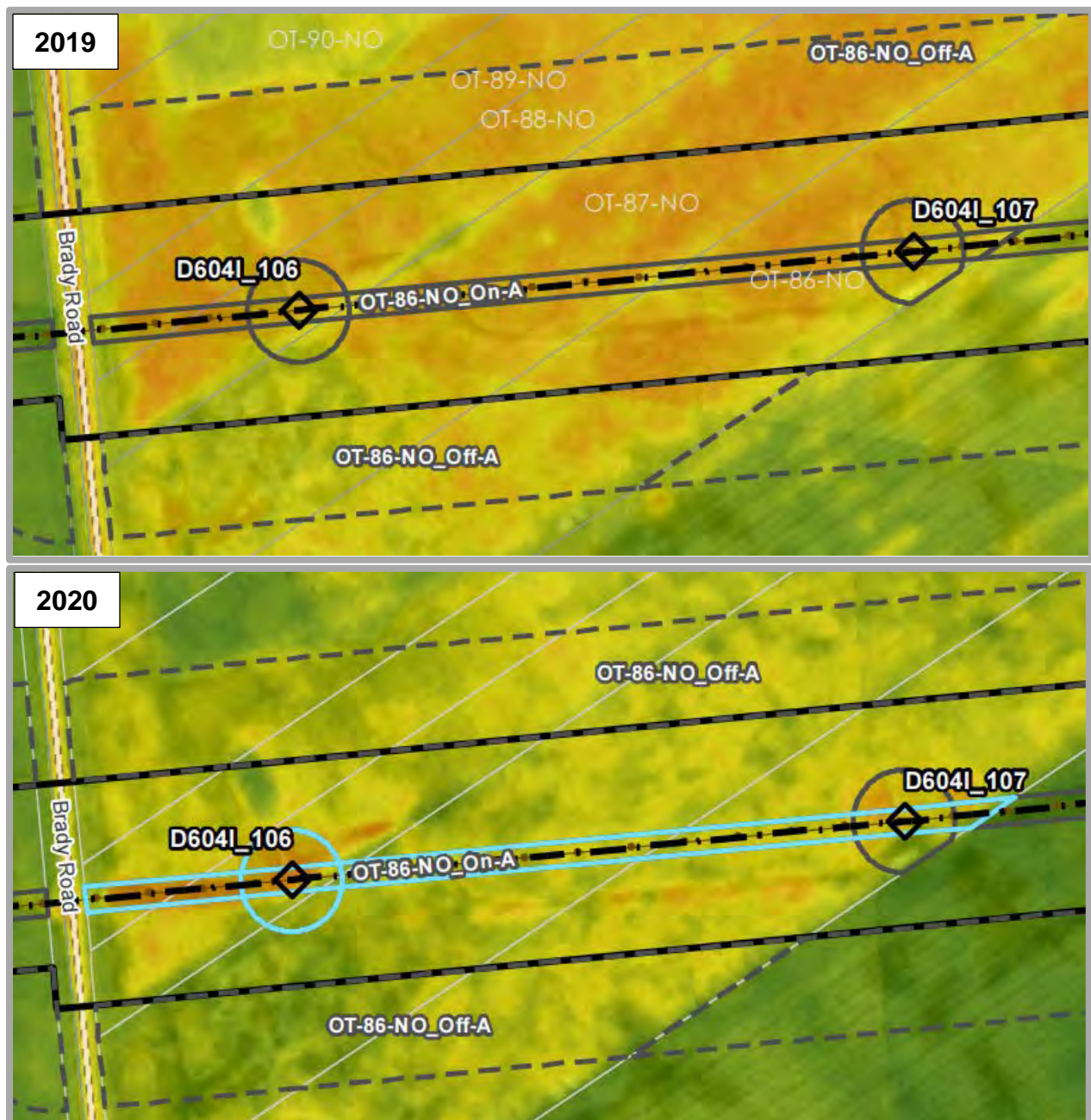
Outlier Direction	Outlier Category	Threshold Value	Count	% of Total	Count	% of Total
Positive	Major positive outlier	>0.091	8	3.5	13	5.7
	Minor positive outlier	>0.052 to 0.091	5	2.2		
Negative	Minor negative outlier	<-0.052 to -0.091	36	15.7	72	31.4
	Major negative outlier	<-0.091	36	15.7		



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An example of an On RoW FMU that is considered a minor negative outlier in 2020 is presented in **Figure 3.1**. The relatively low NDVI values (orange) are indicative of disturbance within the 20 m corridor in 2020, particularly between Brady Road and tower D604I\_106.



**Figure 3.1** Example of On RoW FMU (OT-86-NO-On-A) Considered a Minor Negative Outlier in 2020



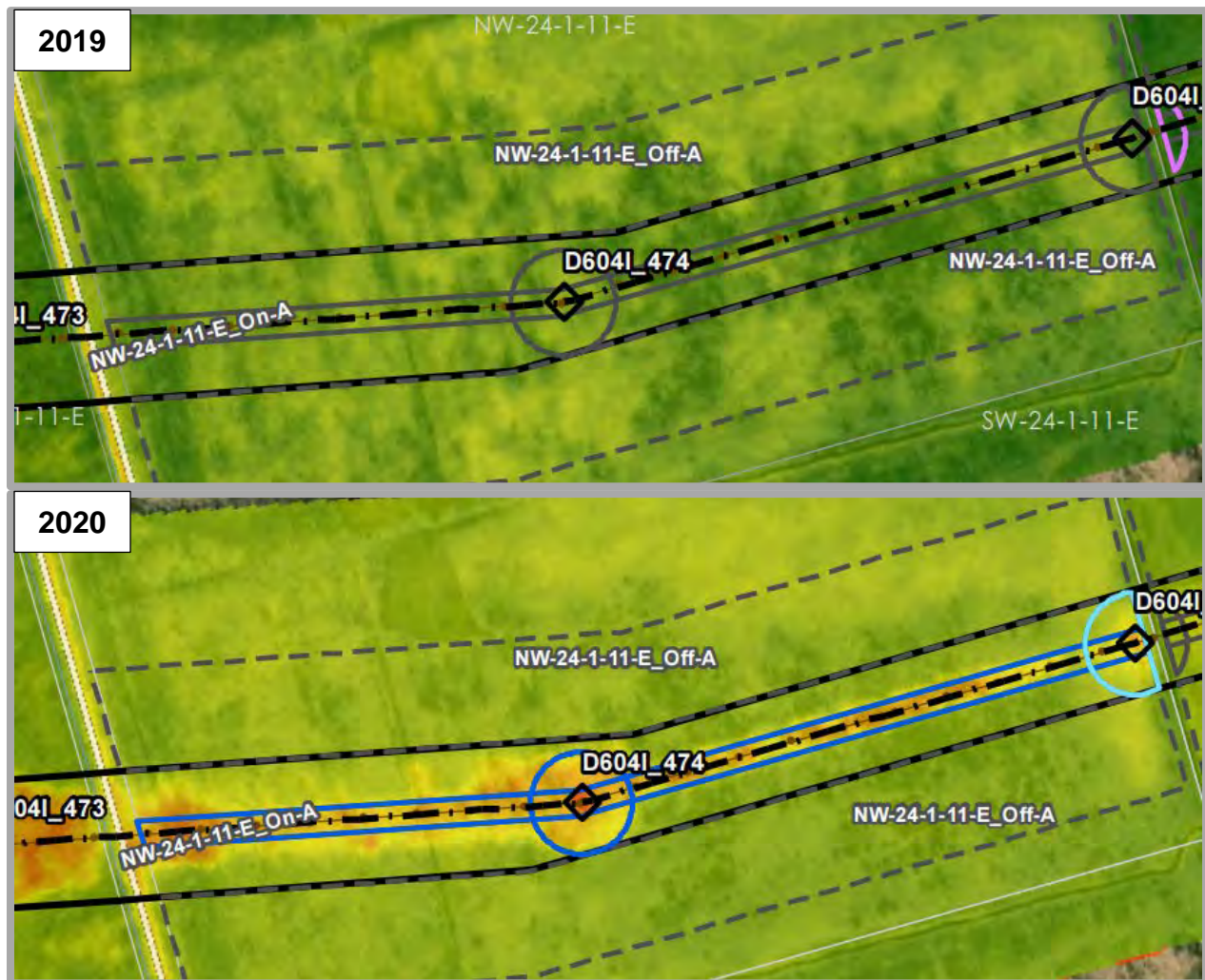


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An example of an On RoW FMU that is considered a major negative outlier in 2020 is presented in **Figure 3.2**. The relatively low NDVI values (yellow and orange) are indicative of disturbance within the 20 m corridor in 2020, and are apparent across the entire On RoW FMU.



**Figure 3.2** Example of On RoW FMU (NW-24-1-11-E\_On-A) considered a major negative outlier in 2020



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### 3.1.3 Trend Analysis

As noted in Section 2.4, NDVI difference values that exceed the positive threshold are considered positive outliers and are likely the result of factors not related to Project activities. For example, they may be due to incorrect FMU delineation or natural variability in soil capability or productivity, such as differing soil drainage, fertility, or salinity conditions in the On RoW and Off RoW evaluation areas. These positive outliers are of little interest to this evaluation and are not discussed further.

NDVI difference values for individual FMUs that are below the negative threshold are likely the result of a Project-related disturbance within the RoW reducing soil productivity. However, it is possible that even the negative outliers may be the result of other factors, hence the need for further evaluation of data for individual FMUs where NDVI difference values are below the negative threshold.

Applying the negative threshold values yielded 72 negative outlier values (31.4% of FMUs), including 36 (15.7%) considered minor outliers and 36 (15.7%) considered major outliers (**Table 3.5**). Notably but as expected, there was an increase in On RoW FMUs with NDVI differences below the negative threshold from the pre-disturbance monitoring (2019; 9 On RoW FMUs) to post-construction year 1 (2020; 72 On RoW FMUs). A summary of counts of On RoW FMUs with NDVI differences considered negative outliers is presented in **Figure 3.3** and **Figure 3.4**.

These data suggest that Project disturbances have affected soil productivity On RoW and have persisted through the post-construction year 1 monitoring season. However, review of individual On RoW FMUs was required to confirm the nature of disturbances, specifically if negative outliers are the result of Project-related disturbances.

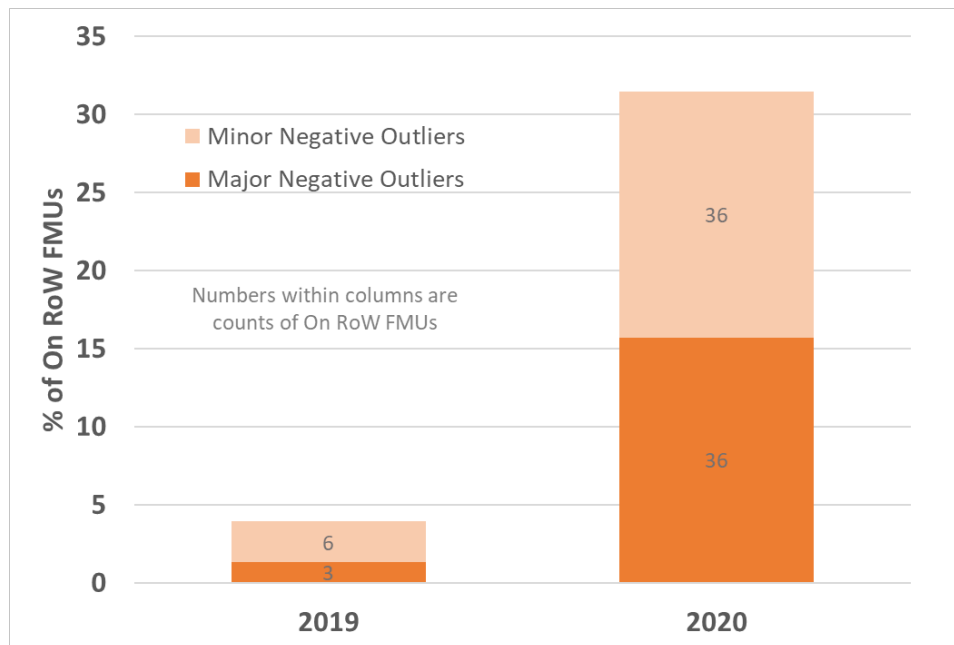
**Table 3.5 On RoW FMUs with NDVI Difference Below Negative Thresholds in 2019 and 2020**

Year	Total count	Negatives		Total Negative Outliers		Minor Negative Outliers		Major Negative Outliers	
		Count	%	Count	%	Count	%	Count	%
<b>2019</b>	229	113	49.3	9	3.9	6	2.6	3	1.3
<b>2020</b>	229	599	261.6	72	31.4	36	15.7	36	15.7

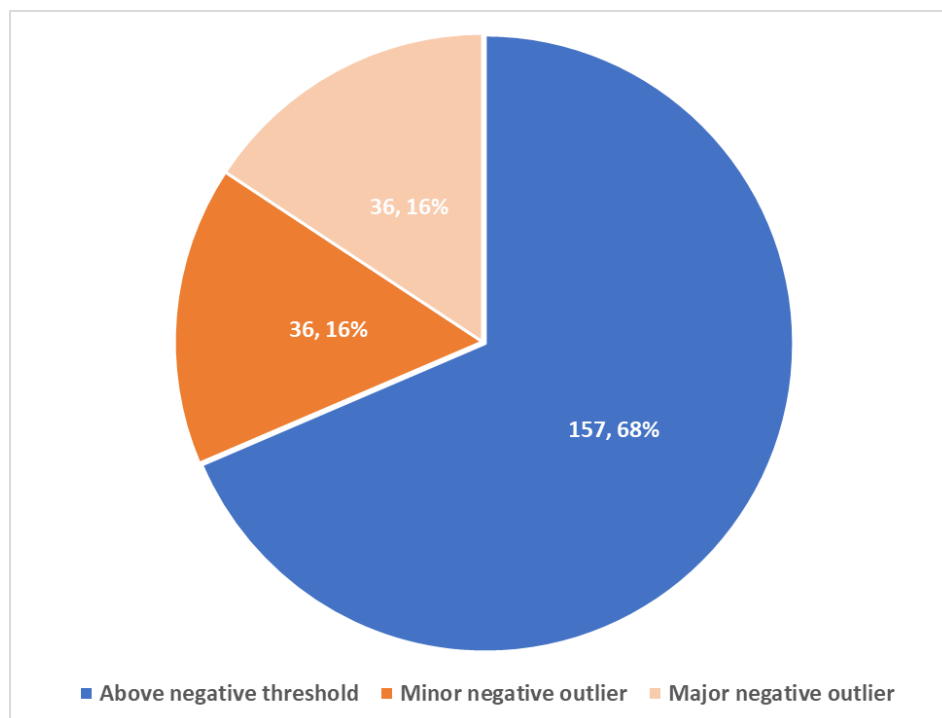


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**Figure 3.3 On RoW FMUs below the Negative Thresholds in 2019 and 2020**



**Figure 3.4 On RoW FMUs Considered Negative Outliers in 2020**





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A visual review and evaluation of negative outliers in 2020 was completed to classify On RoW in the following negative outlier categories:

- **Project-related disturbance persists** – Project-related disturbance has resulted in a difference below negative threshold in 2020, in the minor negative outlier category or major negative outlier category; or
- **Negative outlier, nature unknown** – difference below negative threshold in 2020, but does not appear to be a result of the Project (i.e., related to other factors, such as variable status of agricultural field management with the FMU [e.g., crop partially harvested], or natural variability in soil capability or productivity [e.g., soil drainage, fertility or salinity]).

A summary of counts and proportions of individual On RoW FMUs in each of the disturbance categories is found in **Table 3.6** and **Figure 3.5**. Following visual review and evaluation of negative outliers, 7 On RoW FMUs (3.1%) were found to have been negative outliers in 2019, and therefore are not considered to have lower productivity On RoW due to the Project (i.e., negative outlier, nature unknown). A total of 65 On RoW FMUs (28.4%) are considered to have lower soil productivity due to Project-related disturbances, 36 of which (15.7%) are considered major negative outliers and 29 of which (12.7%) are considered minor negative outliers.

**Table 3.6 Summary of Disturbance Status for On RoW FMUs**

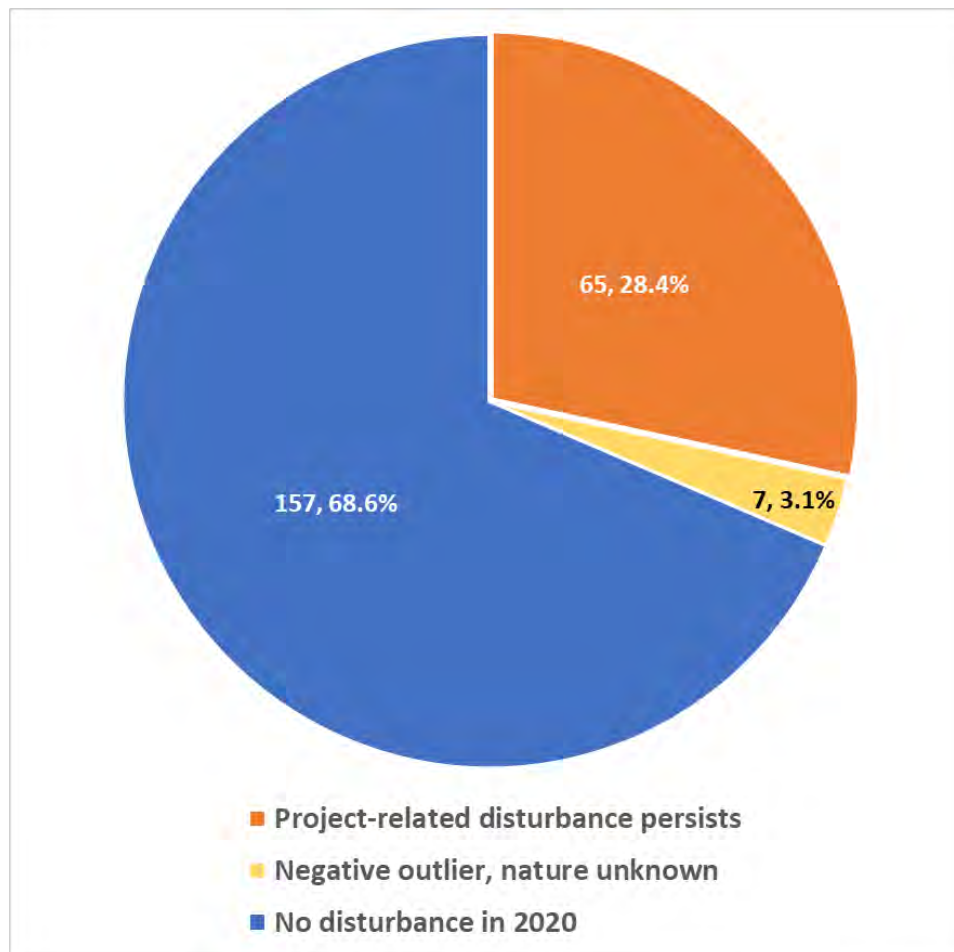
Disturbance Category	On RoW FMU Count	% of Total FMUs
<b>Project disturbance persists</b>	<b>65</b>	<b>28.4</b>
<i>Disturbed (minor negative outlier)</i>	29	12.7
<i>Disturbed (major negative outlier)</i>	36	15.7
<b>No disturbance</b>	<b>164</b>	<b>71.6</b>
<i>Negative outlier, nature unknown</i>	7	3.1
<i>No disturbance</i>	157	68.6
<b>Total</b>	<b>229</b>	<b>100.0</b>



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**Figure 3.5** Proportion of On RoW FMUs by Recovery Category

## 3.2 SOIL PRODUCTIVITY WITHIN TWAs

### 3.2.1 Pre-Construction (2019) Monitoring Season

A summary of basic statistics for TWAs, Off RoW comparable areas and difference values is provided in **Table 3.6**. The mean and median values were found to be very close between TWAs and Off RoW comparable areas resulting in difference values close to zero. Of the 337 TWAs, differences were found to be negative in 165 (49%) and positive in 172 (51%).

These data indicate soil productivity, as represented by NDVI, is similar in TWA and Off RoW areas in the pre-construction (2019) monitoring season. This confirms that agricultural evaluation areas including TWAs and Off RoW comparable areas were delineated well.



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Further statistical support that NDVI values are similar between TWAs and comparable Off RoW comparable areas is provided in Figures B.2.1 to B.2.4 (Appendix B).

**Table 3.6 Basic Statistics for 2019 NDVI Results for TWAs**

Parameter	TWAs	Off RoW Comparable Areas	Difference (On RoW - Off RoW)
Count	337	337	337
Mean	0.424	0.427	-0.003
Minimum	0.107	0.121	-0.252
Median	0.442	0.450	0.001
Maximum	0.698	0.681	0.211
Range	0.591	0.560	0.463
Count of Negatives	N/A	N/A	165
% Negatives	N/A	N/A	49.0%
Count of Positives	N/A	N/A	172
% Positives	N/A	N/A	51.0%

Outliers were identified using the thresholds presented in Section 2.4.3. A summary of outliers in 2019 is presented in **Table 3.7** as follows:

- there was a total of 13 positive outliers (3.9% of total), 11 of which were considered minor positive outliers (3.3% of total) and 2 of which were considered major positive outliers (0.6% of total).
- there was a total of 16 negative outliers (4.8% of total), 14 of which were considered minor negative outliers (4.2% of total) and 2 of which were considered major negative outliers (0.6% of total).

It is reasonable to expect some outliers in data, even in a pre-disturbance situation, as discussed for On RoW FMUs, above. Outlying TWAs were reviewed visually, which allowed the nature of the differences in NDVI values to be evaluated. The outcome of this visual review is presented in Section 3.2.3.

**Table 3.7 Summary of NDVI Difference Outliers for 2019 NDVI for TWAs**

Outlier Direction	Outlier Category	Threshold Value	Count	% of Total	Count	% of Total
Positive	Major positive outlier	>0.140	2	0.6	13	3.9
	Minor positive outlier	>0.079 to 0.140	11	3.3		
Negative	Minor negative outlier	<-0.084 to -0.145	14	4.2	16	4.8
	Major negative outlier	<-0.145	2	0.6		



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### 3.2.2 Post-Construction Year 1 (2020) Monitoring Season

A summary of basic statistics for TWAs, Off RoW comparable areas and difference values is provided in **Table 3.8**. The mean and median values were found to be lower for TWAs relative to Off RoW comparable areas resulting in negative difference values. Of the 337 TWAs, differences were found to be negative in 273 (81.0%) and positive in 64 (19.0%). These results demonstrate a negative “skewness” in the data, in other words, the NDVI values have shifted in a negative direction relative to the pre-construction monitoring season.

These data indicate soil productivity, as represented by NDVI, is lower in areas represented by TWAs relative to Off RoW areas in the post-construction year 1 (2020) monitoring season. This suggests that Project-related disturbances have resulted in reduced soil productivity across TWAs.

Further statistical support that NDVI values are lower in TWAs relative to Off RoW comparable areas is provided in Figures B.2.5 to B.2.8 (Appendix B.2).

**Table 3.8 Basic Statistics for 2020 NDVI Results for TWAs**

Parameter	TWAs	Off RoW Comparable Areas	Difference (On RoW - Off RoW)
Count	337	337	337
Mean	0.449	0.496	-0.048
Minimum	0.102	0.138	-0.409
Median	0.475	0.521	-0.041
Maximum	0.737	0.755	0.213
Range	0.634	0.617	0.623
Count of Negatives	N/A	N/A	273
% Negatives	N/A	N/A	81.0%
Count of Positives	N/A	N/A	64
% Positives	N/A	N/A	19.0%

Outliers were identified using the thresholds presented in Section 2.4.3. A summary of outliers in 2020 is presented in **Table 3.9** as follows:

- there was a total of 11 positive outliers (3.3% of total), 8 of which were considered minor positive outliers (2.4% of total) and 3 of which were considered major positive outliers (0.9% of total).
- there was a total of 78 negative outliers (23.1% of total), 47 of which were considered minor negative outliers (13.9% of total) and 31 of which were considered major negative outliers (9.2% of total).

The count of positive outliers was found to be slightly lower in 2020 relative to 2019 (i.e., 13 in 2020 vs. 11 in 2019); however, these results are not expected to be Project-related. The much higher negative outlier



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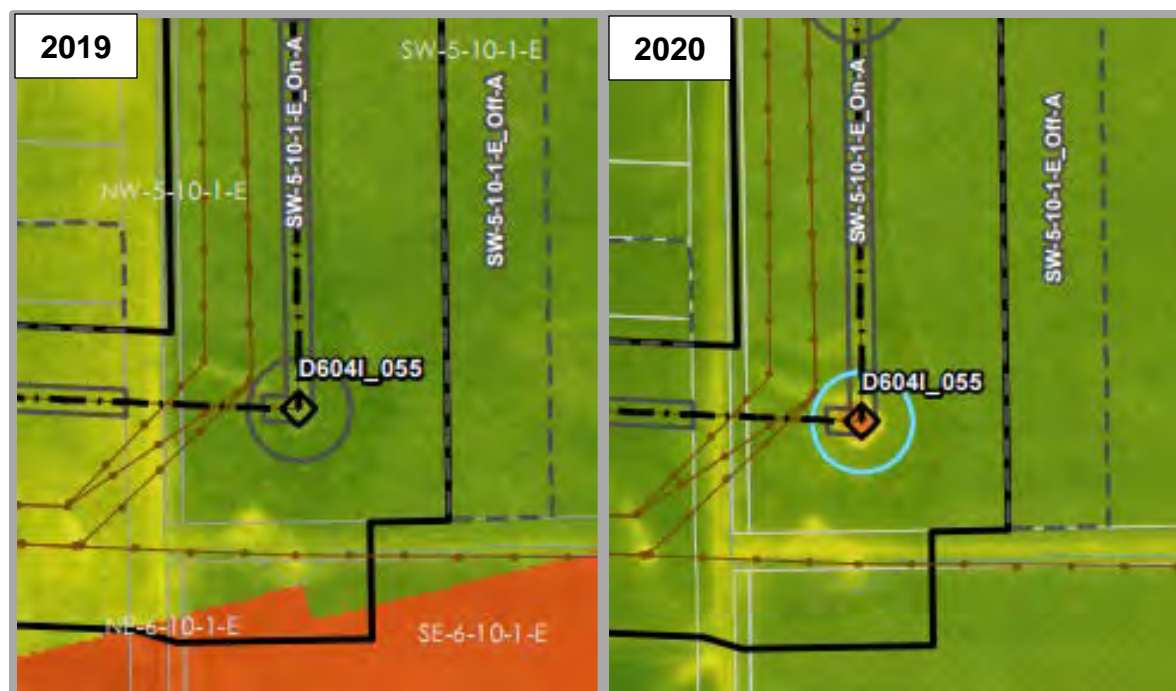
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count in 2020 relative to 2019 (i.e., 78 in 2020 vs. 16 in 2019) suggests Project-related disturbance has persisted into the 2020 growing season within a significant portion of TWAs.

**Table 3.9 Summary of NDVI Difference Outliers for 2020 NDVI for TWAs**

Outlier Direction	Outlier Category	Threshold Value	Count	% of Total	Count	% of Total
Positive	Major positive outlier	>0.140	3	0.9	11	3.3
	Minor positive outlier	>0.079 to 0.140	8	2.4		
Negative	Minor negative outlier	<-0.084 to -0.145	47	13.9	78	23.1
	Major negative outlier	<-0.145	31	9.2		

An example of TWA that is considered a minor negative outlier in 2020 is presented in **Figure 3.6**. The relatively low NDVI values (yellow, orange and red) around the angle tower structure are indicative of a higher degree of disturbance from tower construction activities relative to along the corridor between towers.



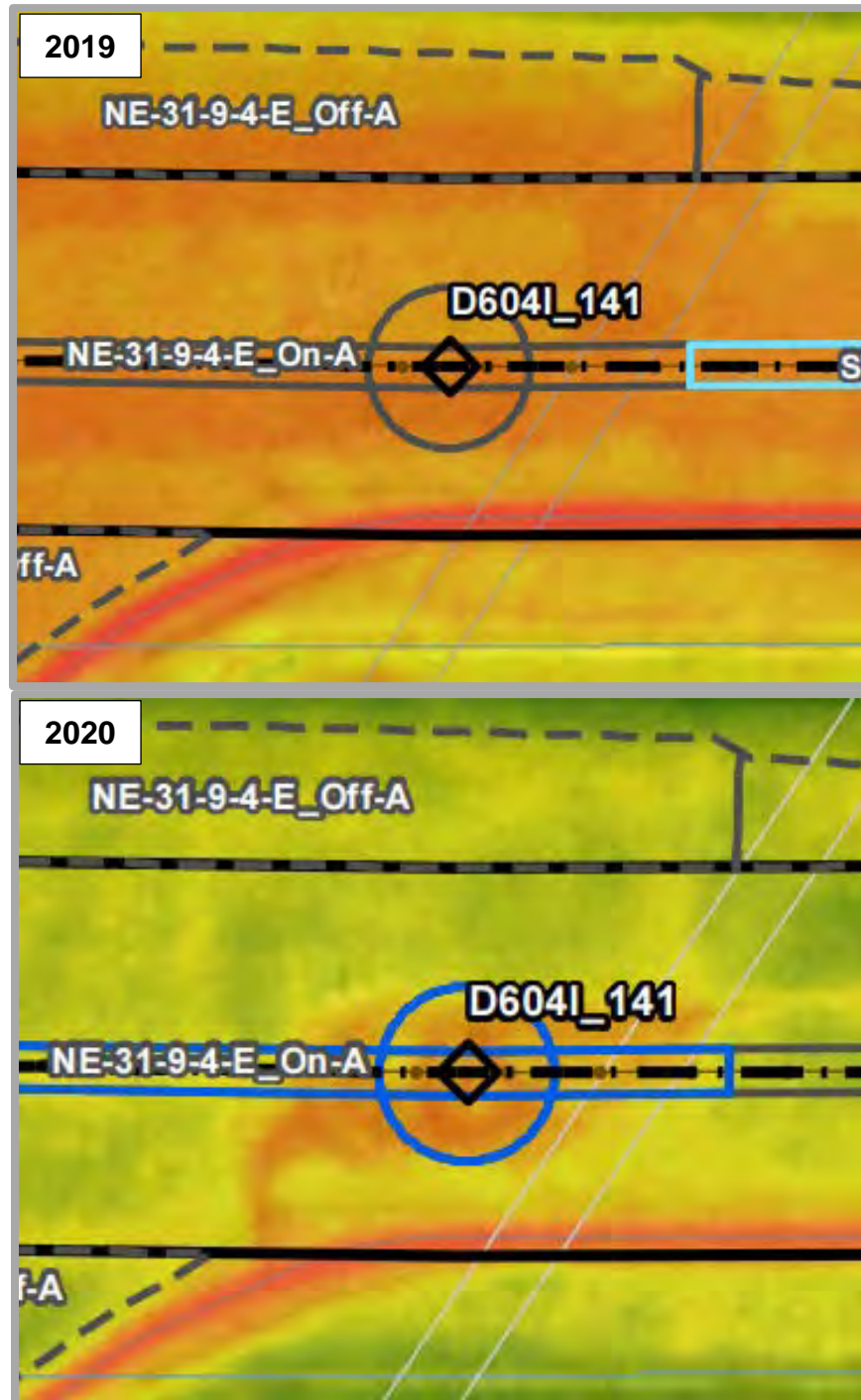
**Figure 3.6 Example of TWA (D604I\_055) Considered a Minor Negative Outlier in 2020**

An example of TWA that is considered a major negative outlier in 2020 is presented in **Figure 3.7**. The relatively low NDVI values (orange and red) are indicative of a large area of disturbance around the tower structure, suggesting intensive tower construction activity and potentially a laydown area or other construction activity beyond the TWA.



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**Figure 3.7** Example of TWA (D604I\_141) Considered a Major Negative Outlier in 2020



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### 3.2.3 Trend Analysis

As noted in Section 2.4, NDVI difference values that exceed the positive threshold are considered positive outliers and are likely the result of factors not related to Project activities. For example, they may be due to incorrect delineation of Off RoW comparable areas relative to TWAs, variable management of the land within the TWA and corresponding Off RoW comparable area, or natural variability in soil capability or productivity, such as differing soil drainage, fertility, or salinity conditions in the On RoW and Off RoW evaluation areas. These positive outliers are not of interest to this evaluation and are not discussed further.

NDVI difference values for individual TWAs that are below the negative threshold are likely the result of a Project-related disturbance within TWAs reducing soil productivity. However, it is possible that even the negative outliers may be the result of other factors, hence the need for further evaluation of data for individual TWAs where NDVI difference values are below the negative threshold.

Applying the negative threshold values yielded 78 negative outlier values (23.1% of TWAs), including 47 (13.9%) considered minor outliers and 31 (9.2%) considered major outliers (**Table 3.10**). Notably, but as expected, there was a significant increase in TWAs with NDVI differences below the negative threshold from the pre-disturbance monitoring (2019; 16 TWAs) to post-construction year 1 (2020; 78 TWAs). A summary of counts of TWAs with NDVI differences considered negative outliers is presented in **Figure 3.8** and **Figure 3.9**.

These data suggest that Project disturbances have affected soil productivity within TWAs and have persisted through the post-construction year 1 monitoring season. However, review of individual TWAs was conducted to confirm the nature of disturbances, specifically if negative outliers are a result of Project-related disturbances.

**Table 3.10 TWAs with NDVI Difference Below Negative Thresholds in 2019 and 2020**

Year	Total Count	Negatives		Total Negative Outliers		Minor Negative Outliers		Major Negative Outliers	
		Count	%	Count	%	Count	%	Count	%
2019	337	165	49.0	16	4.7	14	4.2	2	0.6
2020	337	273	81.0	78	23.1	47	13.9	31	9.2

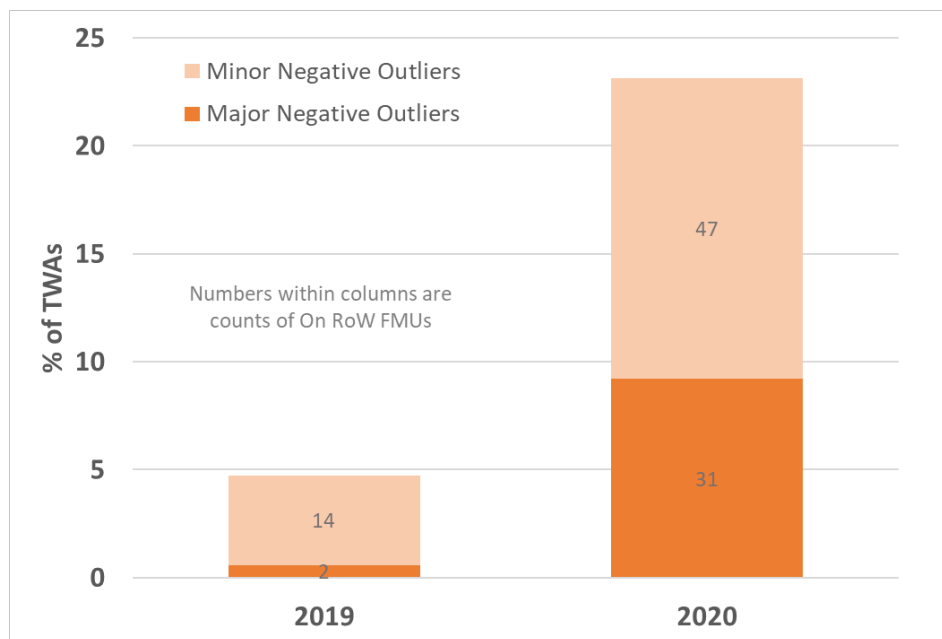




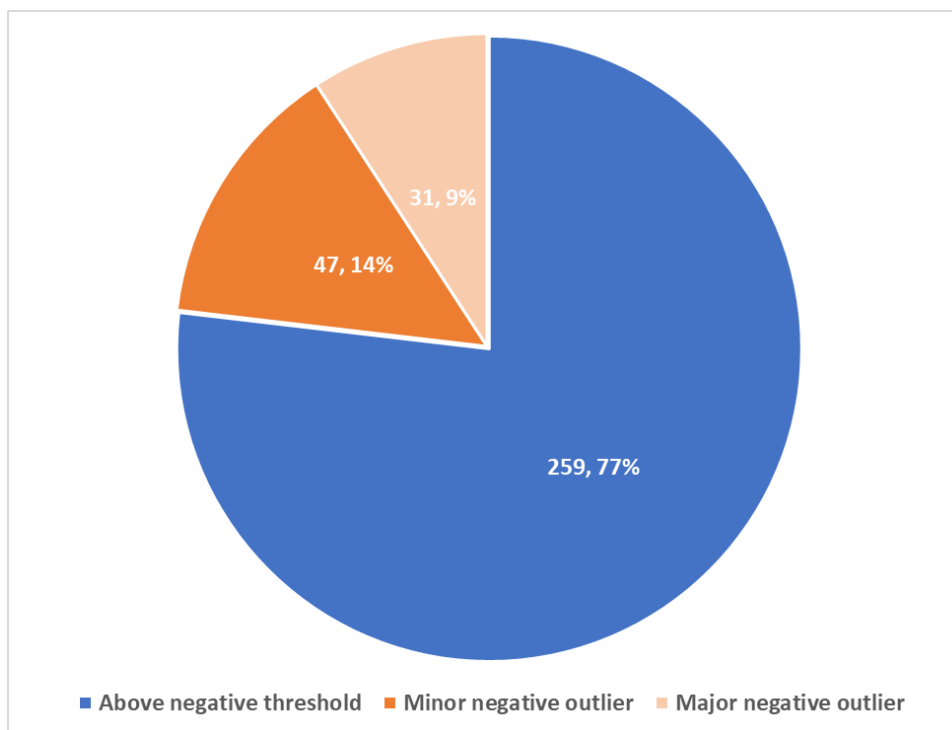
# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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**Figure 3.8 TWAs Below the Negative Thresholds in 2019 and 2020**



**Figure 3.9 TWAs Considered Negative Outliers in 2020**



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A visual review and evaluation of negative outliers in 2020 was completed to classify TWAs in the following negative outlier categories:

- **Project-related disturbance persists** – Project-related disturbance has resulted in a difference below negative threshold in 2020; or
- **Not Project-related** – difference below negative threshold in 2020 but does not appear to be the result of the Project (i.e., related to other factors, such as variable status of agricultural field management with the TWA and corresponding Off RoW comparable area [e.g., crop partially harvested], or natural variability in soil capability or productivity [e.g., soil drainage, fertility or salinity]).

A summary of counts and proportions of individual TWAs in each of the disturbance categories is provided in **Table 3.11** and **Figure 3.10**. Following visual review and evaluation of negative outliers, only 1 TWA (0.3%) was determined to be not disturbed by the Project (i.e., negative outlier, nature unknown). A total of 77 TWAs (22.8%) are considered to have lower soil productivity due to Project-related disturbances, 47 of which (13.9%) are considered minor negative outliers and 30 of which (8.9%) are considered major negative outliers.

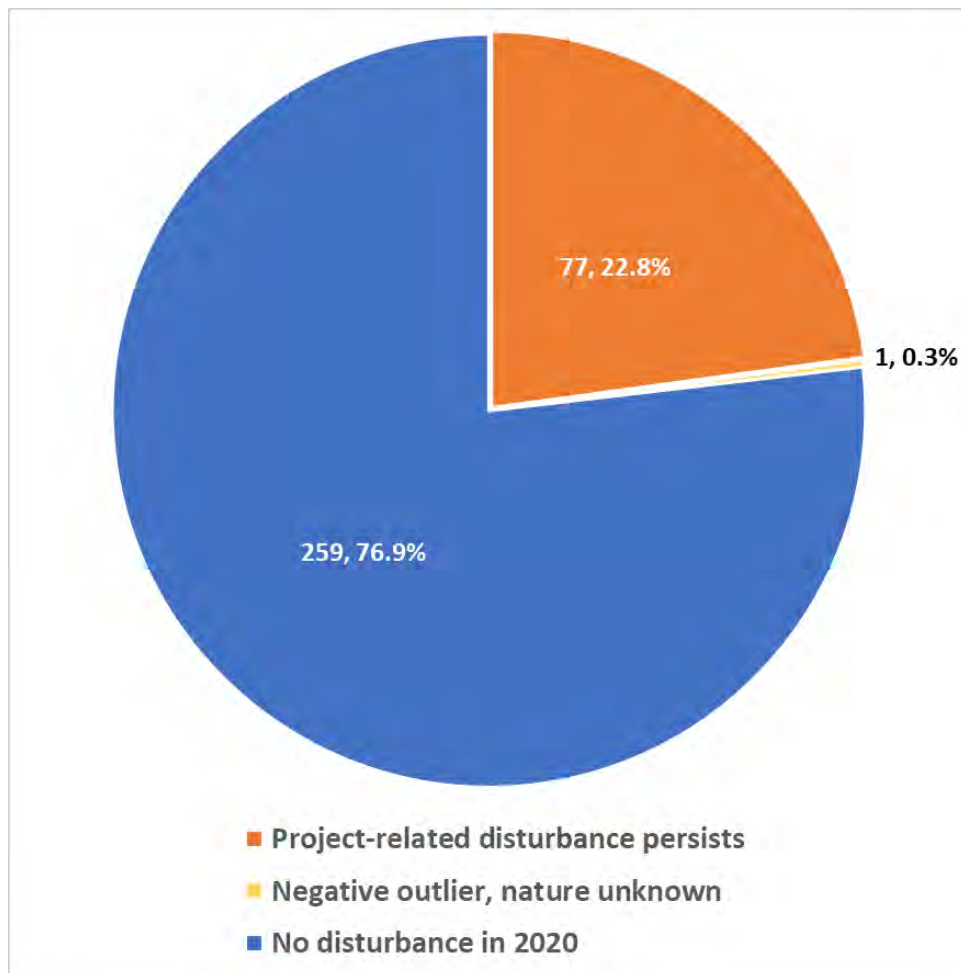
**Table 3.11 Summary of Disturbance Status for TWAs**

Disturbance Category	On RoW FMU Count	% of Total FMUs
<b>Project disturbance persists</b>	<b>77</b>	<b>22.8</b>
<i>Disturbed (minor negative outlier)</i>	47	13.9
<i>Disturbed (major negative outlier)</i>	30	8.9
<b>No disturbance</b>	<b>260</b>	<b>77.2</b>
<i>Negative outlier, nature unknown</i>	1	0.3
<i>No disturbance</i>	259	76.9
<b>Total</b>	<b>337</b>	<b>100.0</b>



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**Figure 3.10** Proportion of TWAs by Disturbance Category

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## Summary and Conclusions

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### 4.0 SUMMARY AND CONCLUSIONS

The analysis and evaluation of NDVI values have demonstrated reductions in soil productivity in On RoW areas in the first year, post-construction. Reductions were found in NDVI in On RoW FMUs, as measured within a 20 m corridor along the transmission centreline, and in TWAs, relative to comparable areas Off RoW.

Thresholds were established from pre-construction (2019) NDVI analysis to be used to identify negative outliers in differences between On RoW FMUs and TWAs, and Off RoW comparable areas.

A total of 229 On RoW FMUs were evaluated and 72 (31.4%) were considered to be negative outliers as follows:

- 36 On RoW FMUs (15.7%) were considered minor negative outliers.
- 36 On RoW FMUs (15.7%) were considered major negative outliers.

A total of 337 TWAs were evaluated and 78 (23.1%) were considered to be negative outliers as follows:

- 47 TWAs (13.9%) were considered minor negative outliers.
- 31 TWAs (9.2%) were considered major negative outliers.

While these results strongly suggest that Project-related disturbances have negatively affected soil and crop productivity in areas within the RoW, further evaluation was completed to confirm the nature of differences in NDVI values to confirm that results were Project-related. Individual On RoW FMUs and TWAs were visually evaluated to provide this confirmation.

Following confirmation, the following conclusions are presented on Project-related disturbances to On RoW FMUs and TWAs in the post-construction year 1 (2020) monitoring season:

- 65 On RoW FMUs (28.4%) were considered to have persisting Project disturbances, including:
  - 29 On RoW FMUs (12.7%) in the minor negative outlier category
  - 36 On RoW FMUs (15.7%) in the major negative outlier category
- 77 TWAs (22.8%) were considered to have persisting Project disturbances, including:
  - 47 TWAs (13.9%) in the minor negative outlier category
  - 30 TWAs (8.9%) in the major negative outlier category

Therefore, Project activities have resulted in disturbance to crop productivity and soil productivity within the RoW. Negative effects were found to persist following construction, which occurred between monitoring conducted during the 2019 and 2020 growing seasons.



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Effects were found to be limited to the RoW and associated with areas of construction activity (e.g., tower work areas, construction access and trails) within the RoW. As documented in the EIS, effects to soil productivity due to compaction from construction activities within the RoW were anticipated, and where effects from compaction occur, they could persist for a few years following construction. Results from the monitoring program are consistent with the predictions made in the EIS. Results suggest the mitigation program has been effective as over 70% of FMUs and over 75% of TWAs were considered to not have negative effects to soil productivity following post-construction year 1 (2020). No unexpected effects were determined through the monitoring program through the 2020 monitoring season. Future monitoring will be used to confirm that areas where effects have persisted are recovering or trending to recovery.

No field assessments were conducted during the 2020 post-construction monitoring season, as these were not deemed necessary to support the monitoring program.



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Recommendations

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## 5.0 RECOMMENDATIONS

The following recommendations are presented for the post-construction year 2 (2021) soil productivity monitoring program:

- Continue to review and revise On RoW FMUs, TWAs and Off RoW comparable areas using NDVI data and up-to-date orthoimagery, as available. Delineations that are kept current relative to agricultural field management units will provide more reliable soil productivity evaluation results.
- Evaluate NDVI values in 2021 relative to 2020 to confirm that soil productivity in On RoW FMUs and TWAs is trending towards recovery (i.e., pre-construction levels).
- Review disturbance and recovery relative to soil properties (e.g., texture, drainage) and crop type (e.g., annual crop, forage, pasture/grassland) during evaluation of 2021 soil productivity data.
- Integrate information on soil-related mitigation implemented on the Project relative to 2020 and 2021 soil productivity evaluation results to assess effectiveness of mitigation.
- Implement object-based image analysis of individual NDVI pixels to identify and delineate areas within On RoW FMUs and TWAs that are considered disturbed by the Project. These delineated areas could be monitored over time to track recovery and return to pre-disturbance crop and soil productivity levels.

There are currently no recommendations for additional monitoring activities (e.g., field assessment), mitigation activities or alterations to the monitoring program, except for those items noted above. Additional mitigation and monitoring will be addressed following the completion of the post construction year 2 (2021) monitoring program.



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## Appendix A TABLES



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
E-8-1-12-E-A	0.580	0.584	-0.004	0.618	0.638	-0.021		No disturbance in 2020
N-17-5-8-E-A	0.434	0.361	0.073	0.414	0.252	0.162		No disturbance in 2020
NE-10-9-7-E-A	0.384	0.400	-0.016	0.446	0.464	-0.018		No disturbance in 2020
NE-13-9-1-E-A	0.548	0.515	0.033	0.579	0.583	-0.003		No disturbance in 2020
NE-13-9-1-E-B	0.360	0.344	0.016	0.556	0.595	-0.040		No disturbance in 2020
NE-14-9-1-E-A	0.497	0.496	0.001	0.550	0.579	-0.029		No disturbance in 2020
NE-14-9-1-E-B	0.555	0.559	-0.004	0.530	0.589	-0.058	twa and corridor dist	Project related disturbance persists
NE-14-9-1-E-C	0.321	0.328	-0.007	0.566	0.619	-0.053	twa and access dist	Project related disturbance persists
NE-15-9-2-E-A	0.332	0.329	0.004	0.606	0.634	-0.028		No disturbance in 2020
NE-15-9-7-E-A	0.420	0.395	0.025	0.344	0.388	-0.044		No disturbance in 2020
NE-16-9-2-E-A	0.556	0.557	-0.001	0.500	0.533	-0.033		No disturbance in 2020
NE-17-9-2-E-A	0.328	0.327	0.001	0.543	0.566	-0.023		No disturbance in 2020
NE-17-9-2-E-B	0.331	0.331	0.000	0.536	0.566	-0.029		No disturbance in 2020
NE-18-1-12-E-A	0.535	0.548	-0.013	0.286	0.298	-0.011		No disturbance in 2020
NE-18-1-12-E-B	0.494	0.490	0.004	0.360	0.421	-0.061	corridor and twa disturbance	Project related disturbance persists
NE-18-7-8-E-A	0.361	0.478	-0.117	0.581	0.603	-0.022		No disturbance in 2020
NE-18-7-8-E-B	0.488	0.508	-0.020	0.643	0.679	-0.036		No disturbance in 2020
NE-18-9-2-E-A	0.321	0.321	-0.001	0.552	0.596	-0.043		No disturbance in 2020
NE-18-9-2-E-B	0.346	0.345	0.002	0.567	0.613	-0.046		No disturbance in 2020
NE-20-5-8-E-A	0.523	0.481	0.042	0.443	0.318	0.125		No disturbance in 2020
NE-23-9-1-E-A	0.506	0.506	0.001	0.351	0.362	-0.010		No disturbance in 2020
NE-24-1-11-E-A	0.564	0.538	0.026	0.456	0.492	-0.036		No disturbance in 2020
NE-24-8-7-E-A	0.444	0.446	-0.001	0.450	0.481	-0.031		No disturbance in 2020
NE-26-9-1-E-A	0.506	0.505	0.002	0.349	0.380	-0.032		No disturbance in 2020



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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
NE-3-10-1-E-A	0.392	0.397	-0.006	0.537	0.557	-0.020		No disturbance in 2020
NE-31-9-4-E-A	0.090	0.135	-0.045	0.308	0.414	-0.106	marshalling yard (?) and twa	Project related disturbance persists
NE-31-9-4-E-B	0.286	0.236	0.049	0.426	0.396	0.030		No disturbance in 2020
NE-32-4-8-E-A	0.539	0.570	-0.031	0.409	0.558	-0.149	corridor dist	Project related disturbance persists
NE-32-5-8-E-A	0.481	0.503	-0.022	0.386	0.226	0.160		No disturbance in 2020
NE-32-5-8-E-B	0.366	0.371	-0.006	0.169	0.284	-0.115	corridor and twa dist	Project related disturbance persists
NE-32-5-8-E-C	0.544	0.517	0.028	0.483	0.512	-0.028		No disturbance in 2020
NE-32-9-7-E-A	0.529	0.515	0.014	0.479	0.519	-0.040		No disturbance in 2020
NE-34-3-8-E-A	0.466	0.421	0.045	0.249	0.333	-0.084	small fmu corner of field; corridor dist	Project related disturbance persists
NE-35-9-1-E-A	0.488	0.496	-0.008	0.514	0.538	-0.025		No disturbance in 2020
NE-4-3-9-E-A	0.525	0.535	-0.010	0.373	0.444	-0.071	doesn't appear project related	Negative outlier, nature unknown
NE-4-3-9-E-B	0.667	0.658	0.008	0.483	0.515	-0.033		No disturbance in 2020
NE-5-1-12-E-A	0.605	0.647	-0.042	0.537	0.576	-0.039		No disturbance in 2020
NE-5-6-8-E-A	0.549	0.625	-0.076	0.421	0.309	0.113		No disturbance in 2020
NE-5-6-8-E-B	0.474	0.358	0.116	0.438	0.539	-0.102	sliver fmu adjacent to bush clearing	Project related disturbance persists
NE-6-7-8-E-B	0.512	0.550	-0.038	0.592	0.660	-0.068	some corridor and twa dist	Project related disturbance persists
NE-7-7-8-E-A	0.507	0.495	0.012	0.578	0.610	-0.032		No disturbance in 2020
NE-7-7-8-E-B	0.614	0.619	-0.005	0.322	0.368	-0.046		No disturbance in 2020
NE-7-8-8-E-A	0.464	0.472	-0.008	0.313	0.308	0.005		No disturbance in 2020
NE-8-5-8-E-A	0.549	0.367	0.181	0.446	0.426	0.020		No disturbance in 2020
NE-8-5-8-E-B	0.380	0.384	-0.004	0.473	0.461	0.012		No disturbance in 2020
NE-8-6-8-E-A	0.418	0.324	0.093	0.390	0.511	-0.121	twa and corridor dist adjacent to bush clearing	Project related disturbance persists



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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
NE-9-4-8-E-A	0.555	0.554	0.001	0.247	0.253	-0.006		No disturbance in 2020
NW-13-9-1-E-A	0.581	0.586	-0.004	0.561	0.574	-0.012		No disturbance in 2020
NW-13-9-1-E-B	0.572	0.573	-0.001	0.522	0.571	-0.049		No disturbance in 2020
NW-14-10-4-E-A	0.275	0.266	0.009	0.284	0.264	0.020		No disturbance in 2020
NW-14-9-2-E-A	0.555	0.549	0.005	0.617	0.643	-0.026		No disturbance in 2020
NW-15-9-2-E-A	0.555	0.554	0.001	0.531	0.558	-0.028		No disturbance in 2020
NW-15-9-2-E-B	0.446	0.447	-0.001	0.341	0.344	-0.003		No disturbance in 2020
NW-16-9-2-E-A	0.435	0.432	0.004	0.506	0.535	-0.029		No disturbance in 2020
NW-17-10-7-E-A	0.439	0.465	-0.026	0.344	0.488	-0.144	corridor dist and twa dist	Project related disturbance persists
NW-17-11-1-E-A	0.544	0.399	0.144	0.558	0.555	0.003		No disturbance in 2020
NW-17-11-1-E-B	0.512	0.478	0.033	0.503	0.521	-0.017		No disturbance in 2020
NW-17-11-1-E-C	0.361	0.333	0.028	0.399	0.516	-0.117	small FMU centered on TWA	Project related disturbance persists
NW-17-6-8-E-A	0.443	0.443	0.000	0.587	0.632	-0.046		No disturbance in 2020
NW-17-9-2-E-A	0.334	0.348	-0.013	0.526	0.440	0.086		No disturbance in 2020
NW-18-9-2-E-A	0.541	0.539	0.002	0.367	0.407	-0.039		No disturbance in 2020
NW-20-10-7-E-A	0.333	0.324	0.009	0.202	0.352	-0.150	large TWA and wide ROW dist	Project related disturbance persists
NW-20-10-7-E-B	0.402	0.408	-0.006	0.308	0.395	-0.087	corridor dist	Project related disturbance persists
NW-20-11-1-E-A	0.490	0.477	0.013	0.512	0.608	-0.096	dist along FMU	Project related disturbance persists
NW-20-6-8-E-A	0.483	0.441	0.042	0.692	0.631	0.060		No disturbance in 2020
NW-20-6-8-E-B	0.345	0.335	0.011	0.572	0.615	-0.043		No disturbance in 2020
NW-23-10-4-E-A	0.170	0.121	0.049	0.272	0.285	-0.013		No disturbance in 2020
NW-23-9-1-E-A	0.510	0.520	-0.010	0.411	0.366	0.045		No disturbance in 2020
NW-24-1-11-E-A	0.513	0.499	0.013	0.268	0.510	-0.242	corridor dist and TWA; bush clearing in pasture	Project related disturbance persists



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Appendix A Tables

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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
NW-26-9-1-E-A	0.443	0.491	-0.048	0.412	0.394	0.018		No disturbance in 2020
NW-29-11-1-E-A	0.561	0.562	-0.001	0.539	0.578	-0.038		No disturbance in 2020
NW-29-6-8-E-A	0.334	0.221	0.113	0.337	0.316	0.021		No disturbance in 2020
NW-3-10-1-E-A	0.374	0.374	0.000	0.531	0.562	-0.031		No disturbance in 2020
NW-3-10-1-E-B	0.362	0.377	-0.014	0.534	0.555	-0.022		No disturbance in 2020
NW-31-9-4-E-A	0.296	0.256	0.041	0.357	0.397	-0.040		No disturbance in 2020
NW-32-11-1-E-B	0.536	0.537	-0.001	0.649	0.661	-0.012		No disturbance in 2020
NW-32-11-1-E-C	0.545	0.542	0.004	0.641	0.657	-0.016		No disturbance in 2020
NW-32-11-1-E-D	0.540	0.543	-0.004	0.659	0.669	-0.010		No disturbance in 2020
NW-32-5-8-E-A	0.383	0.370	0.013	0.203	0.309	-0.106	corridor and twa dist	Project related disturbance persists
NW-32-6-8-E-A	0.329	0.346	-0.017	0.422	0.478	-0.056	doesn't appear project related	Negative outlier, nature unknown
NW-3-3-9-E-A	0.585	0.591	-0.006	0.384	0.374	0.010		No disturbance in 2020
NW-35-3-8-E-A	0.525	0.528	-0.003	0.397	0.442	-0.045		No disturbance in 2020
NW-4-1-12-E-A	0.559	0.554	0.005	0.606	0.643	-0.037		No disturbance in 2020
NW-4-2-10-E-A	0.531	0.568	-0.037	0.371	0.505	-0.134	twa dist in small FMU	Project related disturbance persists
NW-5-10-7-E-A	0.479	0.424	0.054	0.309	0.257	0.052		No disturbance in 2020
NW-5-12-1-E-A	0.234	0.241	-0.007	0.333	0.451	-0.118	dist adjacent to dorsey incl tower	Project related disturbance persists
NW-5-12-1-E-B	0.575	0.572	0.003	0.506	0.607	-0.102	dist along entire corridor	Project related disturbance persists
NW-5-12-1-E-C	0.448	0.398	0.050	0.235	0.220	0.016		No disturbance in 2020
NW-5-6-8-E-A	0.573	0.594	-0.021	0.531	0.570	-0.039		No disturbance in 2020
NW-8-10-7-E-A	0.605	0.530	0.075	0.411	0.482	-0.072	small fmu; corridor dist	Project related disturbance persists
NW-8-10-7-E-B	0.558	0.553	0.005	0.438	0.483	-0.046		No disturbance in 2020
NW-8-1-12-E-A	0.688	0.681	0.007	0.539	0.521	0.018		No disturbance in 2020



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
NW-8-1-12-E-B	0.619	0.643	-0.024	0.416	0.526	-0.110	small FMU, shallow angle TWA dist	Project related disturbance persists
NW-8-6-8-E-A	0.477	0.373	0.104	0.417	0.618	-0.201	corrid dist adjacent to bush clearing	Project related disturbance persists
NW-9-4-8-E-A	0.569	0.607	-0.038	0.440	0.390	0.050		No disturbance in 2020
OT-172-NO_A	0.234	0.319	-0.085	0.321	0.478	-0.157	twa and constr trail (not all captured in corr)	Project related disturbance persists
OT-174-NO-A	0.293	0.230	0.063	0.297	0.376	-0.080	construction trail	Project related disturbance persists
OT-26-HE-A	0.524	0.521	0.003	0.561	0.584	-0.023		No disturbance in 2020
OT-27-HE-A	0.427	0.432	-0.005	0.563	0.587	-0.025		No disturbance in 2020
OT-80-NO-A	0.162	0.148	0.015	0.581	0.585	-0.004		No disturbance in 2020
OT-81-NO-A	0.389	0.367	0.022	0.616	0.637	-0.021		No disturbance in 2020
OT-83-NO-A	0.334	0.361	-0.027	0.594	0.555	0.039		No disturbance in 2020
OT-85-NO-A	0.427	0.408	0.019	0.615	0.617	-0.002		No disturbance in 2020
OT-86-NO-A	0.231	0.254	-0.023	0.342	0.430	-0.088	access and twa dist	Project related disturbance persists
RL-174-NO_A	0.264	0.255	0.008	0.376	0.415	-0.039		No disturbance in 2020
RL-174-NO_B	0.234	0.264	-0.030	0.298	0.415	-0.117	twa and uncertain corridor dist	Project related disturbance persists
RL-177-NO-A	0.300	0.285	0.015	0.453	0.460	-0.007		No disturbance in 2020
RL-178-NO-B	0.304	0.308	-0.004	0.356	0.370	-0.014		No disturbance in 2020
RL-179-NO-A	0.167	0.174	-0.007	0.413	0.427	-0.014		No disturbance in 2020
RL-179-NO-B	0.220	0.221	-0.001	0.478	0.427	0.051		No disturbance in 2020
RL-179-NO-C	0.387	0.379	0.008	0.575	0.577	-0.002		No disturbance in 2020
RL-27-HE-A	0.485	0.478	0.007	0.538	0.553	-0.015		No disturbance in 2020
RL-27-HE-B	0.543	0.544	-0.001	0.577	0.612	-0.035		No disturbance in 2020
RL-38-HE-A	0.533	0.536	-0.003	0.443	0.538	-0.096	tower and corridor dist	Project related disturbance persists



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
RL-39-HE-A	0.506	0.481	0.025	0.518	0.532	-0.014		No disturbance in 2020
RL-39-HE-B	0.461	0.447	0.015	0.618	0.666	-0.048		No disturbance in 2020
RL-39-HE-C	0.471	0.462	0.009	0.610	0.654	-0.043		No disturbance in 2020
RL-73-NO-A	0.214	0.215	-0.002	0.302	0.328	-0.026		No disturbance in 2020
RL-74-NO-A	0.401	0.488	-0.087	0.465	0.602	-0.137	twa and other irregular dist patters	Project related disturbance persists
RL-80-NO-A	0.435	0.448	-0.013	0.473	0.463	0.010		No disturbance in 2020
S-17-5-8-E-A	0.451	0.451	0.000	0.404	0.484	-0.080	corridor and twa dist	Project related disturbance persists
SE-15-9-7-E-A	0.354	0.386	-0.033	0.342	0.447	-0.104	TWA and some corridor dist	Project related disturbance persists
SE-17-6-8-E-A	0.438	0.450	-0.011	0.501	0.668	-0.167	long sliver fmu; twa and corridor dist	Project related disturbance persists
SE-18-7-8-E-A	0.426	0.416	0.010	0.608	0.597	0.011		No disturbance in 2020
SE-19-1-12-E-A	0.629	0.628	0.001	0.466	0.481	-0.015		No disturbance in 2020
SE-19-7-8-E-A	0.556	0.568	-0.013	0.664	0.718	-0.054	ltd twa and corridor dist adj to bush clearing	Project related disturbance persists
SE-20-5-8-E-A	0.488	0.376	0.112	0.391	0.238	0.153		No disturbance in 2020
SE-20-5-8-E-B	0.472	0.375	0.097	0.304	0.291	0.013		No disturbance in 2020
SE-23-9-1-E-A	0.477	0.474	0.003	0.497	0.528	-0.031		No disturbance in 2020
SE-24-8-7-E-A	0.313	0.316	-0.003	0.451	0.477	-0.026		No disturbance in 2020
SE-24-8-7-E-B	0.361	0.347	0.014	0.502	0.514	-0.013		No disturbance in 2020
SE-24-8-7-E-C	0.392	0.362	0.030	0.501	0.549	-0.048		No disturbance in 2020
SE-25-10-6-E-A	0.376	0.349	0.028	0.347	0.304	0.043		No disturbance in 2020
SE-25-2-9-E-A	0.535	0.518	0.017	0.293	0.400	-0.107	corridor and twa dist	Project related disturbance persists
SE-26-10-4-E-A	0.214	0.153	0.062	0.316	0.266	0.050		No disturbance in 2020
SE-26-10-6-E-A	0.586	0.581	0.005	0.496	0.532	-0.036		No disturbance in 2020
SE-26-9-1-E-A	0.385	0.396	-0.011	0.499	0.516	-0.017		No disturbance in 2020





# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
SE-26-9-1-E-B	0.340	0.368	-0.028	0.420	0.437	-0.018		No disturbance in 2020
SE-27-10-5-E-A	0.449	0.452	-0.003	0.527	0.551	-0.023		No disturbance in 2020
SE-27-10-6-E-A	0.420	0.454	-0.033	0.255	0.293	-0.037		No disturbance in 2020
SE-28-10-5-E-A	0.179	0.196	-0.017	0.387	0.305	0.082		No disturbance in 2020
SE-28-10-6-E-A	0.447	0.459	-0.011	0.526	0.519	0.007		No disturbance in 2020
SE-29-10-6-E-A	0.235	0.260	-0.025	0.518	0.548	-0.031		No disturbance in 2020
SE-30-10-5-E-B	0.353	0.381	-0.028	0.569	0.605	-0.037		No disturbance in 2020
SE-30-10-6-E-A	0.408	0.515	-0.107	0.167	0.188	-0.021		No disturbance in 2020
SE-30-10-7-E-A	0.444	0.432	0.012	0.396	0.384	0.011		No disturbance in 2020
SE-30-10-7-E-B	0.369	0.371	-0.001	0.300	0.264	0.036		No disturbance in 2020
SE-3-4-8-E-A	0.359	0.360	-0.001	0.310	0.335	-0.025		No disturbance in 2020
SE-35-3-8-E-A	0.444	0.432	0.012	0.305	0.362	-0.058	corridor const trail dist	Project related disturbance persists
SE-35-3-8-E-B	0.428	0.517	-0.089	0.294	0.388	-0.095	access, twa and corridor dist	Project related disturbance persists
SE-35-9-1-E-B	0.547	0.559	-0.012	0.612	0.638	-0.026		No disturbance in 2020
SE-4-10-1-E-A	0.424	0.430	-0.006	0.542	0.560	-0.018		No disturbance in 2020
SE-4-10-1-E-B	0.536	0.524	0.012	0.552	0.571	-0.019		No disturbance in 2020
SE-5-10-1-E-A	0.506	0.510	-0.004	0.524	0.563	-0.038		No disturbance in 2020
SE-5-10-7-E-A	0.382	0.396	-0.014	0.263	0.384	-0.122	major corridor dist	Project related disturbance persists
SE-5-5-8-E-A	0.621	0.621	0.000	0.395	0.554	-0.159	access and twa dist	Project related disturbance persists
SE-5-6-8-E-A	0.586	0.430	0.156	0.360	0.276	0.085		No disturbance in 2020
SE-5-6-8-E-B	0.508	0.485	0.024	0.356	0.511	-0.156	sliver fmu; may be pr adjacent to clearing	Project related disturbance persists
SE-6-7-8-E-A	0.454	0.464	-0.011	0.524	0.605	-0.081	TWA and corridor dist	Project related disturbance persists



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Appendix A Tables  
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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
SE-6-7-8-E-B	0.504	0.493	0.011	0.566	0.624	-0.058	shelterbelt removal; other corridor and TWA dist	Project related disturbance persists
SE-7-7-8-E-A	0.624	0.634	-0.010	0.141	0.138	0.003		No disturbance in 2020
SE-7-7-8-E-B	0.502	0.410	0.092	0.429	0.409	0.019		No disturbance in 2020
SE-7-7-8-E-D	0.506	0.445	0.062	0.459	0.519	-0.060	doesn't appear project related	Negative outlier, nature unknown
SE-8-1-12-E-A	0.524	0.520	0.004	0.360	0.406	-0.046		No disturbance in 2020
SE-8-6-8-E-A	0.507	0.529	-0.022	0.447	0.510	-0.064	twa and corridor dist	Project related disturbance persists
SE-8-6-8-E-B	0.532	0.507	0.025	0.424	0.507	-0.082	corrid dist	Project related disturbance persists
SE-8-6-8-E-D	0.572	0.453	0.118	0.677	0.746	-0.068	sliver fmu no obvious dist	Project related disturbance persists
SE-8-6-8-E-E	0.522	0.545	-0.023	0.599	0.721	-0.122	twa dist primarily	Project related disturbance persists
SE-8-6-8-E-F	0.525	0.509	0.016	0.601	0.688	-0.086	twa dist	Project related disturbance persists
SE-9-10-4-E-A	0.224	0.238	-0.013	0.294	0.462	-0.168	TWAs and centreline trail	Project related disturbance persists
SE-9-4-8-E-A	0.511	0.429	0.082	0.150	0.308	-0.158	small fmu, corr dist adjacent to bush clearing	Project related disturbance persists
SE-9-4-8-E-B	0.557	0.601	-0.044	0.372	0.500	-0.128	small fmu, corr dist adjacent bush clearing	Project related disturbance persists
SW-10-10-4-E-A	0.276	0.255	0.021	0.352	0.429	-0.077	TWAs; MISSED CONSTRUCTION TRAIL	Project related disturbance persists
SW-10-10-4-E-B	0.314	0.312	0.002	0.326	0.389	-0.062	MISSED CONST TRAIL; some TWA; some not PR	Project related disturbance persists
SW-10-4-8-E-A	0.557	0.566	-0.009	0.426	0.498	-0.072	dist bush clearing in portion of corridor	Project related disturbance persists
SW-11-9-7-E-B	0.412	0.402	0.011	0.433	0.458	-0.025		No disturbance in 2020
SW-11-9-7-E-C	0.378	0.392	-0.014	0.507	0.492	0.016		No disturbance in 2020
SW-14-10-4-E-A	0.285	0.281	0.003	0.319	0.431	-0.112	small FMU with TWA dist	Project related disturbance persists



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

Appendix A Tables  
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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
SW-17-1-12-E-A	0.553	0.548	0.005	0.298	0.323	-0.025		No disturbance in 2020
SW-17-1-12-E-B	0.573	0.574	-0.001	0.323	0.384	-0.061	twa and some corridor dist	Project related disturbance persists
SW-17-6-8-E-A	0.506	0.526	-0.019	0.551	0.627	-0.077	limited corridor dist related to bush clearing	Negative outlier, nature unknown
SW-17-6-8-E-B	0.479	0.443	0.036	0.529	0.545	-0.016		No disturbance in 2020
SW-18-8-8-E-A	0.346	0.348	-0.002	0.275	0.305	-0.031		No disturbance in 2020
SW-20-10-7-E-A	0.495	0.486	0.008	0.409	0.486	-0.077	small FMU corridor dist	Project related disturbance persists
SW-20-11-1-E-A	0.470	0.476	-0.006	0.598	0.635	-0.037		No disturbance in 2020
SW-20-6-8-E-A	0.523	0.593	-0.069	0.485	0.543	-0.058	not project related dist	Negative outlier, nature unknown
SW-20-6-8-E-B	0.587	0.561	0.026	0.510	0.535	-0.024		No disturbance in 2020
SW-2-10-1-E-A	0.404	0.403	0.000	0.512	0.612	-0.099	twa and corridor dist	Project related disturbance persists
SW-23-10-4-E-A	0.277	0.319	-0.042	0.358	0.165	0.193		No disturbance in 2020
SW-25-10-4-E-A	0.281	0.289	-0.008	0.565	0.681	-0.116	TWAs and corridor dist	Project related disturbance persists
SW-25-10-5-E-A	0.369	0.401	-0.032	0.489	0.503	-0.015		No disturbance in 2020
SW-25-10-6-E-A	0.380	0.471	-0.091	0.396	0.485	-0.090	neg outlier in 2019; no obvious dist beyond tower	Negative outlier, nature unknown
SW-26-10-5-E-A	0.476	0.488	-0.013	0.369	0.409	-0.041		No disturbance in 2020
SW-26-10-6-E-A	0.354	0.370	-0.015	0.332	0.349	-0.017		No disturbance in 2020
SW-27-10-5-E-A	0.236	0.276	-0.040	0.551	0.568	-0.017		No disturbance in 2020
SW-27-10-5-E-B	0.237	0.259	-0.022	0.327	0.343	-0.017		No disturbance in 2020
SW-27-10-6-E-A	0.230	0.269	-0.039	0.431	0.445	-0.014		No disturbance in 2020
SW-28-10-5-E-A	0.366	0.348	0.018	0.532	0.519	0.013		No disturbance in 2020
SW-28-10-6-E-A	0.470	0.495	-0.024	0.508	0.519	-0.011		No disturbance in 2020
SW-29-10-5-E-A	0.487	0.491	-0.005	0.621	0.640	-0.019		No disturbance in 2020



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

Appendix A Tables  
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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
SW-29-10-6-E-A	0.170	0.187	-0.017	0.512	0.525	-0.013		No disturbance in 2020
SW-29-10-7-E-A	0.378	0.398	-0.020	0.207	0.296	-0.089	small fmu; unknown dist	Project related disturbance persists
SW-29-10-7-E-B	0.393	0.392	0.001	0.267	0.409	-0.142	large TWA dist and large access (laydown?) area	Project related disturbance persists
SW-29-6-8-E-A	0.394	0.390	0.003	0.445	0.428	0.017		No disturbance in 2020
SW-29-6-8-E-B	0.325	0.316	0.009	0.395	0.388	0.008		No disturbance in 2020
SW-29-6-8-E-C	0.458	0.463	-0.005	0.420	0.287	0.132		No disturbance in 2020
SW-30-10-5-E-A	0.398	0.433	-0.035	0.517	0.535	-0.019		No disturbance in 2020
SW-30-10-6-E-A	0.560	0.551	0.008	0.149	0.158	-0.009		No disturbance in 2020
SW-30-10-7-E-A	0.618	0.615	0.003	0.248	0.231	0.016		No disturbance in 2020
SW-31-9-4-E_A	0.255	0.222	0.033	0.308	0.361	-0.053	twa and corridor dist	Project related disturbance persists
SW-31-9-4-E_B	0.329	0.344	-0.015	0.456	0.465	-0.009		No disturbance in 2020
SW-31-9-4-E_C	0.273	0.229	0.044	0.417	0.405	0.011		No disturbance in 2020
SW-32-11-1-E-A	0.538	0.534	0.004	0.551	0.580	-0.028		No disturbance in 2020
SW-32-6-8-E-A	0.515	0.528	-0.013	0.601	0.620	-0.019		No disturbance in 2020
SW-32-6-8-E-B	0.362	0.397	-0.035	0.446	0.590	-0.144	TWA and corridor dist	Project related disturbance persists
SW-32-6-8-E-C	0.412	0.424	-0.012	0.442	0.499	-0.057	not obvious project-related dist	Negative outlier, nature unknown
SW-32-6-8-E-D	0.457	0.397	0.060	0.412	0.418	-0.006		No disturbance in 2020
SW-4-10-1-E-A	0.542	0.545	-0.004	0.508	0.521	-0.014		No disturbance in 2020
SW-4-10-1-E-B	0.522	0.521	0.001	0.502	0.565	-0.063	appears mainly twa dist	Project related disturbance persists
SW-4-1-12-E-A	0.586	0.578	0.009	0.621	0.663	-0.041		No disturbance in 2020
SW-4-1-12-E-B	0.553	0.551	0.001	0.558	0.624	-0.065	small fmu, corridor dist adjacent to bush removal?	Project related disturbance persists
SW-5-10-1-E-A	0.515	0.509	0.006	0.523	0.568	-0.045		No disturbance in 2020



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

Appendix A Tables  
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**Table A.1 On RoW FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

On ROW FMU Label	2019 ON NDVI MEAN	2019 OFF NDVI MEAN	2019 Diff OnROW - OffROW	2020 ON NDVI MEAN	2020 OFF NDVI MEAN	2020 Diff OnROW-OffROW	2020 Difference Evaluation Comment	2020 Disturbance Category
SW-5-10-4-E-A	0.115	0.181	-0.065	0.455	0.410	0.045		No disturbance in 2020
SW-5-10-4-E-B	0.136	0.184	-0.048	0.346	0.421	-0.075	TWAs, access and some centreline	Project related disturbance persists
SW-5-12-1-E-A	0.331	0.310	0.021	0.561	0.604	-0.043		No disturbance in 2020
SW-5-12-1-E-B	0.482	0.520	-0.038	0.504	0.572	-0.069	small sliver FMU; dist assoc with TWAs	Project related disturbance persists
SW-8-6-8-E-B	0.550	0.546	0.004	0.596	0.487	0.109		No disturbance in 2020
SW-8-6-8-E-C	0.382	0.364	0.018	0.636	0.632	0.004		No disturbance in 2020
W-19-1-12-E-A	0.639	0.617	0.023	0.420	0.396	0.024		No disturbance in 2020
Notes: NDVI difference outliers are indicated as follows:								
			Major negative outlier	Minor negative outlier	Minor positive outlier	Major positive outlier		



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

Appendix A Tables

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_001--NW-5-12-1-E_On-A	0.236	0.241	-0.005	0.281	0.451	-0.170	two disturbance	Project-related disturbance persists
D604I_002--NW-5-12-1-E_On-B	0.570	0.572	-0.002	0.498	0.607	-0.109	two disturbance	Project-related disturbance persists
D604I_003--SW-5-12-1-E_On-A	0.514	0.520	-0.007	0.496	0.604	-0.108	two disturbance	Project-related disturbance persists
D604I_003--SW-5-12-1-E_On-B	0.348	0.310	0.038	0.496	0.572	-0.076		No disturbance in 2020
D604I_004--SW-5-12-1-E_On-A	0.523	0.520	0.002	0.545	0.604	-0.059		No disturbance in 2020
D604I_004--SW-5-12-1-E_On-B	0.339	0.310	0.028	0.560	0.572	-0.013		No disturbance in 2020
D604I_005--SW-5-12-1-E_On-A	0.319	0.310	0.009	0.565	0.604	-0.039		No disturbance in 2020
D604I_006--NW-32-11-1-E_On-B	0.528	0.537	-0.009	0.647	0.661	-0.014		No disturbance in 2020
D604I_007--NW-32-11-1-E_On-C	0.544	0.542	0.002	0.634	0.657	-0.023		No disturbance in 2020
D604I_008--NW-32-11-1-E_On-D	0.522	0.534	-0.012	0.641	0.669	-0.028		No disturbance in 2020
D604I_008--SW-32-11-1-E_On-A	0.500	0.543	-0.043	0.530	0.580	-0.049		No disturbance in 2020
D604I_009--SW-32-11-1-E_On-A	0.556	0.534	0.022	0.532	0.580	-0.048		No disturbance in 2020
D604I_010--NW-29-11-1-E_On-A	0.489	0.562	-0.073	0.495	0.578	-0.083		No disturbance in 2020
D604I_011--NW-29-11-1-E_On-A	0.569	0.562	0.007	0.531	0.578	-0.047		No disturbance in 2020
D604I_012--NW-29-11-1-E_On-A	0.562	0.562	0.000	0.541	0.578	-0.037		No disturbance in 2020
D604I_013--NW-29-11-1-E_On-A	0.564	0.562	0.002	0.524	0.578	-0.054		No disturbance in 2020
D604I_014--NW-20-11-1-E_On-A	0.397	0.477	-0.080	0.383	0.608	-0.225	two disturbance	Project-related disturbance persists
D604I_015--NW-20-11-1-E_On-A	0.493	0.477	0.017	0.364	0.608	-0.243	two disturbance	Project-related disturbance persists
D604I_015--SW-20-11-1-E_On-A	0.501	0.476	0.026	0.446	0.635	-0.189	two disturbance	Project-related disturbance persists
D604I_016--NW-20-11-1-E_On-A	0.483	0.477	0.006	0.567	0.608	-0.041		No disturbance in 2020
D604I_016--SW-20-11-1-E_On-A	0.475	0.476	-0.001	0.590	0.635	-0.045		No disturbance in 2020
D604I_017--NW-20-11-1-E_On-A	0.474	0.477	-0.003	0.553	0.608	-0.054		No disturbance in 2020
D604I_017--SW-20-11-1-E_On-A	0.467	0.476	-0.009	0.564	0.635	-0.071		No disturbance in 2020
D604I_018--NW-17-11-1-E_On-A	0.577	0.465	0.112	0.572	0.555	0.017		No disturbance in 2020
D604I_019--NW-17-11-1-E_On-A	0.498	0.465	0.033	0.559	0.555	0.005		No disturbance in 2020
D604I_020--NW-17-11-1-E_On-C	0.360	0.333	0.027	0.435	0.516	-0.081		No disturbance in 2020



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

## Appendix A Tables

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_021--NW-17-11-1-E_On-B	0.490	0.478	0.011	0.513	0.521	-0.008		No disturbance in 2020
D604I_021--RL-39-HE_On-A	0.490	0.481	0.010	0.519	0.532	-0.013		No disturbance in 2020
D604I_022--RL-39-HE_On-A	0.508	0.481	0.027	0.511	0.532	-0.021		No disturbance in 2020
D604I_023--RL-39-HE_On-A	0.563	0.481	0.082	0.490	0.532	-0.042		No disturbance in 2020
D604I_024--RL-39-HE_On-A	0.524	0.481	0.043	0.529	0.532	-0.004		No disturbance in 2020
D604I_025--RL-39-HE_On-A	0.515	0.481	0.034	0.509	0.532	-0.023		No disturbance in 2020
D604I_026--RL-39-HE_On-A	0.502	0.481	0.021	0.528	0.532	-0.005		No disturbance in 2020
D604I_027--RL-39-HE_On-A	0.484	0.481	0.004	0.537	0.532	0.005		No disturbance in 2020
D604I_028--RL-39-HE_On-A	0.522	0.481	0.041	0.505	0.532	-0.027		No disturbance in 2020
D604I_029--RL-39-HE_On-B	0.463	0.447	0.016	0.610	0.666	-0.057		No disturbance in 2020
D604I_030--RL-39-HE_On-B	0.477	0.447	0.031	0.607	0.666	-0.059		No disturbance in 2020
D604I_031--RL-39-HE_On-C	0.479	0.462	0.017	0.587	0.654	-0.067		No disturbance in 2020
D604I_032--RL-39-HE_On-C	0.477	0.462	0.015	0.607	0.654	-0.047		No disturbance in 2020
D604I_033--RL-39-HE_On-C	0.489	0.462	0.027	0.611	0.654	-0.042		No disturbance in 2020
D604I_034--RL-39-HE_On-C	0.452	0.462	-0.010	0.600	0.654	-0.054		No disturbance in 2020
D604I_035--RL-38-HE_On-A	0.537	0.536	0.001	0.391	0.538	-0.147	twa disturbance	Project-related disturbance persists
D604I_036--RL-38-HE_On-A	0.542	0.536	0.006	0.455	0.538	-0.084		No disturbance in 2020
D604I_037--RL-38-HE_On-A	0.527	0.536	-0.009	0.451	0.538	-0.087	twa disturbance	Project-related disturbance persists
D604I_040--RL-27-HE_On-A	0.493	0.478	0.015	0.537	0.553	-0.015		No disturbance in 2020
D604I_041--RL-27-HE_On-A	0.492	0.478	0.014	0.535	0.553	-0.018		No disturbance in 2020
D604I_042--RL-27-HE_On-A	0.476	0.478	-0.002	0.518	0.553	-0.035		No disturbance in 2020
D604I_043--RL-27-HE_On-B	0.544	0.544	0.000	0.561	0.612	-0.050		No disturbance in 2020
D604I_044--RL-27-HE_On-B	0.540	0.544	-0.004	0.585	0.612	-0.027		No disturbance in 2020
D604I_045--RL-27-HE_On-B	0.536	0.544	-0.008	0.571	0.612	-0.041		No disturbance in 2020
D604I_046--RL-27-HE_On-B	0.549	0.544	0.004	0.575	0.612	-0.036		No disturbance in 2020
D604I_047--OT-26-HE_On-A	0.490	0.521	-0.031	0.527	0.584	-0.057		No disturbance in 2020





# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Appendix A Tables  
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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_048--OT-26-HE_On-A	0.529	0.521	0.007	0.566	0.584	-0.018		No disturbance in 2020
D604I_049--OT-26-HE_On-A	0.532	0.521	0.010	0.572	0.584	-0.013		No disturbance in 2020
D604I_050--OT-26-HE_On-A	0.537	0.521	0.015	0.559	0.584	-0.026		No disturbance in 2020
D604I_051--OT-27-HE_On-A	0.430	0.432	-0.002	0.559	0.587	-0.028		No disturbance in 2020
D604I_052--OT-27-HE_On-A	0.423	0.432	-0.009	0.567	0.587	-0.021		No disturbance in 2020
D604I_053--OT-27-HE_On-A	0.437	0.432	0.005	0.561	0.587	-0.026		No disturbance in 2020
D604I_054--OT-27-HE_On-A	0.421	0.432	-0.011	0.535	0.587	-0.052		No disturbance in 2020
D604I_055--SW-5-10-1-E_On-A	0.497	0.509	-0.012	0.427	0.568	-0.141	twa disturbance	Project-related disturbance persists
D604I_056--SW-5-10-1-E_On-A	0.526	0.509	0.017	0.550	0.568	-0.018		No disturbance in 2020
D604I_058--SE-5-10-1-E_On-A	0.449	0.510	-0.061	0.532	0.563	-0.030		No disturbance in 2020
D604I_059--SW-4-10-1-E_On-B	0.498	0.521	-0.022	0.475	0.565	-0.090	twa disturbance	Project-related disturbance persists
D604I_060--SW-4-10-1-E_On-A	0.544	0.545	-0.001	0.517	0.521	-0.004		No disturbance in 2020
D604I_061--SE-4-10-1-E_On-A	0.533	0.430	0.103	0.536	0.560	-0.024		No disturbance in 2020
D604I_062--SE-4-10-1-E_On-B	0.531	0.524	0.007	0.534	0.571	-0.036		No disturbance in 2020
D604I_063--NW-3-10-1-E_On-A	0.355	0.374	-0.020	0.517	0.562	-0.045		No disturbance in 2020
D604I_064--NW-3-10-1-E_On-A	0.408	0.374	0.033	0.541	0.562	-0.021		No disturbance in 2020
D604I_065--NW-3-10-1-E_On-B	0.363	0.377	-0.013	0.542	0.555	-0.013		No disturbance in 2020
D604I_066--NE-3-10-1-E_On-A	0.364	0.397	-0.033	0.526	0.557	-0.030		No disturbance in 2020
D604I_067--SW-2-10-1-E_On-A	0.395	0.403	-0.009	0.530	0.612	-0.082		No disturbance in 2020
D604I_068--SW-2-10-1-E_On-A	0.390	0.403	-0.014	0.473	0.612	-0.139	twa disturbance	Project-related disturbance persists
D604I_069--SW-2-10-1-E_On-A	0.413	0.403	0.010	0.445	0.612	-0.166	twa disturbance	Project-related disturbance persists
D604I_070--SW-2-10-1-E_On-A	0.431	0.403	0.028	0.443	0.612	-0.169	twa disturbance	Project-related disturbance persists
D604I_071--SW-2-10-1-E_On-A	0.394	0.403	-0.009	0.483	0.612	-0.129	twa disturbance	Project-related disturbance persists
D604I_072--NE-35-9-1-E_On-A	0.490	0.496	-0.005	0.505	0.538	-0.034		No disturbance in 2020
D604I_073--NE-35-9-1-E_On-A	0.486	0.496	-0.009	0.517	0.538	-0.022		No disturbance in 2020
D604I_074--SE-35-9-1-E_On-B	0.549	0.559	-0.010	0.615	0.638	-0.022		No disturbance in 2020



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

Appendix A Tables  
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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_075--SE-35-9-1-E_On-B	0.532	0.559	-0.027	0.600	0.638	-0.038		No disturbance in 2020
D604I_076--NE-26-9-1-E_On-A	0.510	0.505	0.006	0.356	0.380	-0.024		No disturbance in 2020
D604I_077--NW-26-9-1-E_On-A	0.358	0.396	-0.039	0.392	0.394	-0.001		No disturbance in 2020
D604I_077--SE-26-9-1-E_On-A	0.434	0.491	-0.057	0.476	0.516	-0.040		No disturbance in 2020
D604I_078--SE-26-9-1-E_On-A	0.392	0.396	-0.004	0.537	0.516	0.021		No disturbance in 2020
D604I_079--NE-23-9-1-E_On-A	0.514	0.506	0.009	0.373	0.362	0.012		No disturbance in 2020
D604I_080--NE-23-9-1-E_On-A	0.507	0.506	0.002	0.366	0.362	0.004		No disturbance in 2020
D604I_081--SE-23-9-1-E_On-A	0.479	0.474	0.005	0.508	0.528	-0.019		No disturbance in 2020
D604I_082--SE-23-9-1-E_On-A	0.483	0.474	0.009	0.494	0.528	-0.034		No disturbance in 2020
D604I_083--NE-14-9-1-E_On-A	0.492	0.496	-0.003	0.545	0.579	-0.034		No disturbance in 2020
D604I_084--NE-14-9-1-E_On-B	0.558	0.559	-0.001	0.502	0.589	-0.087	twa disturbance	Project-related disturbance persists
D604I_085--NE-14-9-1-E_On-B	0.554	0.559	-0.004	0.543	0.589	-0.046		No disturbance in 2020
D604I_086--NE-14-9-1-E_On-C	0.332	0.328	0.004	0.576	0.619	-0.043		No disturbance in 2020
D604I_087--NW-13-9-1-E_On-B	0.573	0.573	0.000	0.551	0.571	-0.020		No disturbance in 2020
D604I_088--NE-13-9-1-E_On-A	0.551	0.515	0.035	0.555	0.583	-0.028		No disturbance in 2020
D604I_088--NW-13-9-1-E_On-B	0.568	0.573	-0.005	0.533	0.571	-0.038		No disturbance in 2020
D604I_089--NE-13-9-1-E_On-A	0.544	0.515	0.029	0.603	0.583	0.020		No disturbance in 2020
D604I_090--NW-18-9-2-E_On-A	0.542	0.539	0.003	0.360	0.407	-0.047		No disturbance in 2020
D604I_091--NW-18-9-2-E_On-A	0.542	0.539	0.002	0.363	0.407	-0.043		No disturbance in 2020
D604I_092--NE-18-9-2-E_On-A	0.323	0.321	0.002	0.544	0.596	-0.052		No disturbance in 2020
D604I_093--NE-18-9-2-E_On-B	0.362	0.345	0.017	0.581	0.613	-0.032		No disturbance in 2020
D604I_094--NW-17-9-2-E_On-A	0.331	0.348	-0.017	0.535	0.440	0.095		No disturbance in 2020
D604I_095--NE-17-9-2-E_On-A	0.361	0.348	0.013	0.548	0.566	-0.017		No disturbance in 2020
D604I_095--NW-17-9-2-E_On-A	0.358	0.327	0.030	0.531	0.440	0.091		No disturbance in 2020
D604I_096--NE-17-9-2-E_On-B	0.310	0.331	-0.021	0.550	0.566	-0.015		No disturbance in 2020
D604I_097--NW-16-9-2-E_On-A	0.495	0.432	0.064	0.495	0.535	-0.040		No disturbance in 2020



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

Appendix A Tables

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_098--NW-16-9-2-E_On-A	0.425	0.432	-0.007	0.476	0.535	-0.059		No disturbance in 2020
D604I_099--NE-16-9-2-E_On-A	0.556	0.557	-0.001	0.505	0.533	-0.028		No disturbance in 2020
D604I_100--NE-16-9-2-E_On-A	0.550	0.557	-0.007	0.507	0.533	-0.026		No disturbance in 2020
D604I_101--NW-15-9-2-E_On-A	0.559	0.554	0.004	0.538	0.558	-0.020		No disturbance in 2020
D604I_102--NW-15-9-2-E_On-B	0.449	0.447	0.002	0.316	0.344	-0.028		No disturbance in 2020
D604I_103--NE-15-9-2-E_On-A	0.329	0.329	0.000	0.619	0.634	-0.015		No disturbance in 2020
D604I_104--NW-14-9-2-E_On-A	0.555	0.549	0.006	0.629	0.643	-0.014		No disturbance in 2020
D604I_105--NW-14-9-2-E_On-A	0.556	0.549	0.006	0.610	0.643	-0.033		No disturbance in 2020
D604I_106--OT-86-NO_On-A	0.267	0.254	0.013	0.329	0.430	-0.101	two disturbance	Project-related disturbance persists
D604I_107--OT-86-NO_On-A	0.263	0.254	0.009	0.362	0.430	-0.068		No disturbance in 2020
D604I_108--OT-85-NO_On-A	0.411	0.408	0.003	0.631	0.617	0.014		No disturbance in 2020
D604I_109--OT-83-NO_On-A	0.315	0.361	-0.046	0.622	0.555	0.066		No disturbance in 2020
D604I_110--OT-80-NO_On-A	0.149	0.148	0.001	0.544	0.585	-0.041		No disturbance in 2020
D604I_111--OT-80-NO_On-A	0.132	0.148	-0.016	0.611	0.585	0.026		No disturbance in 2020
D604I_112--OT-81-NO_On-A	0.394	0.367	0.027	0.629	0.637	-0.008		No disturbance in 2020
D604I_113--RL-80-NO_On-A	0.455	0.448	0.007	0.502	0.463	0.039		No disturbance in 2020
D604I_114--RL-80-NO_On-A	0.429	0.448	-0.019	0.473	0.463	0.010		No disturbance in 2020
D604I_115--RL-80-NO_On-A	0.449	0.448	0.001	0.489	0.463	0.027		No disturbance in 2020
D604I_116--RL-74-NO_On-A	0.410	0.488	-0.078	0.519	0.602	-0.083		No disturbance in 2020
D604I_119A--RL-73-NO_On-A	0.253	0.215	0.038	0.309	0.328	-0.019		No disturbance in 2020
D604I_119B--RL-73-NO_On-A	0.222	0.215	0.007	0.344	0.328	0.016		No disturbance in 2020
D604I_122--RL-179-NO_On-B	0.236	0.221	0.015	0.472	0.427	0.044		No disturbance in 2020
D604I_123--RL-177-NO_On-A	0.360	0.285	0.075	0.498	0.460	0.038		No disturbance in 2020
D604I_124--RL-174-NO_On-A	0.295	0.255	0.039	0.357	0.415	-0.058		No disturbance in 2020
D604I_125--RL-174-NO_On-A	0.318	0.255	0.062	0.461	0.415	0.046		No disturbance in 2020
D604I_126--RL-174-NO_On-A	0.273	0.255	0.018	0.424	0.415	0.009		No disturbance in 2020



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Appendix A Tables

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_127--RL-174-NO_On-A	0.218	0.255	-0.038	0.307	0.415	-0.108	twa disturbance	Project-related disturbance persists
D604I_128--RL-174-NO_On-B	0.175	0.264	-0.089	0.218	0.415	-0.197	twa disturbance	Project-related disturbance persists
D604I_129--OT-174-NO_On-A	0.291	0.230	0.061	0.371	0.376	-0.005		No disturbance in 2020
D604I_130--OT-174-NO_On-A	0.266	0.230	0.036	0.254	0.376	-0.122	twa disturbance	Project-related disturbance persists
D604I_131--OT-174-NO_On-A	0.282	0.230	0.052	0.382	0.376	0.006		No disturbance in 2020
D604I_132--OT-172-NO_On-A	0.257	0.319	-0.063	0.423	0.478	-0.054		No disturbance in 2020
D604I_133--OT-172-NO_On-A	0.213	0.319	-0.106	0.242	0.478	-0.235	twa disturbance	Project-related disturbance persists
D604I_134--OT-172-NO_On-A	0.193	0.319	-0.126	0.306	0.478	-0.172	twa disturbance	Project-related disturbance persists
D604I_135--OT-172-NO_On-A	0.241	0.319	-0.078	0.343	0.478	-0.135	twa disturbance	Project-related disturbance persists
D604I_136--OT-172-NO_On-A	0.214	0.319	-0.105	0.323	0.478	-0.155	twa disturbance	Project-related disturbance persists
D604I_137--SW-31-9-4-E_On-B	0.293	0.344	-0.051	0.382	0.465	-0.083		No disturbance in 2020
D604I_138--SW-31-9-4-E_On-A	0.256	0.222	0.034	0.313	0.361	-0.048		No disturbance in 2020
D604I_139--NW-31-9-4-E_On-A	0.314	0.256	0.058	0.372	0.397	-0.025		No disturbance in 2020
D604I_140--NE-31-9-4-E_On-B	0.220	0.236	-0.016	0.347	0.396	-0.049		No disturbance in 2020
D604I_141--NE-31-9-4-E_On-A	0.107	0.135	-0.028	0.192	0.414	-0.222	twa disturbance	Project-related disturbance persists
D604I_142--SW-5-10-4-E_On-A	0.115	0.181	-0.066	0.463	0.410	0.053		No disturbance in 2020
D604I_143--SW-5-10-4-E_On-B	0.141	0.184	-0.043	0.382	0.421	-0.039		No disturbance in 02020
D604I_144--SW-5-10-4-E_On-B	0.133	0.184	-0.051	0.358	0.421	-0.064		No disturbance in 2020
D604I_145--SW-5-10-4-E_On-B	0.146	0.184	-0.038	0.345	0.421	-0.076		No disturbance in 2020
D604I_146--SE-9-10-4-E_On-A	0.155	0.238	-0.083	0.385	0.462	-0.077		No disturbance in 2020
D604I_147--SE-9-10-4-E_On-A	0.214	0.238	-0.024	0.319	0.462	-0.143	twa disturbance	Project-related disturbance persists
D604I_148--SE-9-10-4-E_On-A	0.261	0.238	0.023	0.315	0.462	-0.147	twa disturbance	Project-related disturbance persists
D604I_149--SE-9-10-4-E_On-A	0.289	0.238	0.052	0.291	0.462	-0.171	twa disturbance	Project-related disturbance persists
D604I_150--SW-10-10-4-E_On-A	0.296	0.255	0.041	0.290	0.429	-0.139	twa disturbance	Project-related disturbance persists
D604I_151--SW-10-10-4-E_On-A	0.275	0.255	0.019	0.309	0.429	-0.120	twa disturbance	Project-related disturbance persists
D604I_152--SW-10-10-4-E_On-A	0.278	0.255	0.022	0.291	0.429	-0.137	twa disturbance	Project-related disturbance persists



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_153--SW-10-10-4-E_On-A	0.271	0.255	0.015	0.281	0.429	-0.148	twa disturbance	Project-related disturbance persists
D604I_154--SW-10-10-4-E_On-B	0.290	0.312	-0.022	0.308	0.389	-0.080		No disturbance in 2020
D604I_155--SW-10-10-4-E_On-B	0.330	0.312	0.018	0.442	0.389	0.053		No disturbance in 2020
D604I_156--SW-14-10-4-E_On-A	0.304	0.281	0.023	0.366	0.431	-0.065		No disturbance in 2020
D604I_157--NW-14-10-4-E_On-A	0.283	0.266	0.017	0.264	0.264	0.000		No disturbance in 2020
D604I_158--NW-14-10-4-E_On-A	0.300	0.266	0.034	0.330	0.264	0.066		No disturbance in 2020
D604I_159--NW-14-10-4-E_On-A	0.269	0.266	0.003	0.237	0.264	-0.027		No disturbance in 2020
D604I_160--NW-14-10-4-E_On-A	0.272	0.266	0.006	0.266	0.264	0.001		No disturbance in 2020
D604I_161--SW-23-10-4-E_On-A	0.270	0.319	-0.049	0.378	0.165	0.213		No disturbance in 2020
D604I_163--NW-23-10-4-E_On-B	0.166	0.121	0.045	0.248	0.285	-0.037		No disturbance in 2020
D604I_166--SE-26-10-4-E_On-A	0.192	0.153	0.039	0.267	0.266	0.001		No disturbance in 2020
D604I_167--SE-26-10-4-E_On-A	0.218	0.153	0.065	0.356	0.266	0.090		No disturbance in 2020
D604I_168--SW-25-10-4-E_On-A	0.252	0.289	-0.037	0.545	0.681	-0.136	twa disturbance	Project-related disturbance persists
D604I_169--SW-25-10-4-E_On-A	0.284	0.289	-0.005	0.494	0.681	-0.187	twa disturbance	Project-related disturbance persists
D604I_170--SW-25-10-4-E_On-A	0.297	0.289	0.008	0.553	0.681	-0.128	twa disturbance	Project-related disturbance persists
D604I_171--SW-25-10-4-E_On-A	0.272	0.289	-0.017	0.401	0.681	-0.280	twa disturbance	Project-related disturbance persists
D604I_172-SW-30-10-5-E_On-A	0.399	0.433	-0.034	0.522	0.535	-0.013		No disturbance in 2020
D604I_173-SW-30-10-5-E_On-A	0.399	0.433	-0.034	0.513	0.535	-0.022		No disturbance in 2020
D604I_174-SE-30-10-5-E_On-B	0.366	0.381	-0.015	0.548	0.605	-0.057		No disturbance in 2020
D604I_175--SE-30-10-5-E_On-B	0.350	0.381	-0.031	0.555	0.605	-0.050		No disturbance in 2020
D604I_176--SW-29-10-5-E_On-A	0.467	0.491	-0.025	0.638	0.640	-0.002		No disturbance in 2020
D604I_177--SW-29-10-5-E_On-A	0.443	0.491	-0.049	0.607	0.640	-0.032		No disturbance in 2020
D604I_178--SW-29-10-5-E_On-A	0.471	0.491	-0.020	0.605	0.640	-0.034		No disturbance in 2020
D604I_179--SW-29-10-5-E_On-A	0.470	0.491	-0.021	0.579	0.640	-0.060		No disturbance in 2020
D604I_180--SW-28-10-5-E_On-A	0.270	0.348	-0.078	0.531	0.519	0.012		No disturbance in 2020
D604I_181--SE-28-10-5-E_On-A	0.295	0.196	0.099	0.472	0.305	0.166		No disturbance in 2020



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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_181--SW-28-10-5-E_On-A	0.352	0.348	0.003	0.447	0.519	-0.072		No disturbance in 2020
D604I_182--SE-28-10-5-E_On-A	0.159	0.196	-0.037	0.385	0.305	0.080		No disturbance in 2020
D604I_183--SE-28-10-5-E_On-A	0.182	0.196	-0.013	0.383	0.305	0.077		No disturbance in 2020
D604I_184--SW-27-10-5-E_On-A	0.207	0.276	-0.070	0.520	0.568	-0.047		No disturbance in 2020
D604I_185--SE-27-10-5-E_On-A	0.240	0.276	-0.036	0.475	0.551	-0.076		No disturbance in 2020
D604I_185--SW-27-10-5-E_On-A	0.368	0.452	-0.085	0.465	0.568	-0.102	twa disturbance	Project-related disturbance persists
D604I_186--SE-27-10-5-E_On-A	0.417	0.452	-0.035	0.513	0.551	-0.038		No disturbance in 2020
D604I_187--SE-27-10-5-E_On-A	0.414	0.452	-0.038	0.515	0.551	-0.036		No disturbance in 2020
D604I_188--SW-26-10-5-E_On-A	0.484	0.488	-0.005	0.368	0.409	-0.041		No disturbance in 2020
D604I_189--SW-26-10-5-E_On-A	0.494	0.488	0.005	0.397	0.409	-0.012		No disturbance in 2020
D604I_190--SW-26-10-5-E_On-A	0.498	0.488	0.010	0.364	0.409	-0.046		No disturbance in 2020
D604I_191--SW-26-10-5-E_On-A	0.481	0.488	-0.007	0.313	0.409	-0.097	twa disturbance	Project-related disturbance persists
D604I_192--SW-25-10-5-E_On-A	0.371	0.401	-0.030	0.448	0.503	-0.055		No disturbance in 2020
D604I_193--SW-25-10-5-E_On-A	0.315	0.401	-0.086	0.468	0.503	-0.035	below negative threshold in 2019; not outlier in 2020	No disturbance in 2020
D604I_194--SW-25-10-5-E_On-A	0.351	0.401	-0.050	0.516	0.503	0.012		No disturbance in 2020
D604I_195--SW-25-10-5-E_On-A	0.362	0.401	-0.040	0.477	0.503	-0.026		No disturbance in 2020
D604I_196--SW-30-10-6-E_On-A	0.578	0.551	0.027	0.186	0.158	0.027		No disturbance in 2020
D604I_197--SW-30-10-6-E_On-A	0.562	0.551	0.010	0.190	0.158	0.032		No disturbance in 2020
D604I_198--SE-30-10-6-E_On-A	0.437	0.515	-0.077	0.166	0.188	-0.022		No disturbance in 2020
D604I_199--SE-30-10-6-E_On-A	0.383	0.515	-0.132	0.171	0.188	-0.017	below negative threshold in 2019; not outlier in 2020	No disturbance in 2020
D604I_200--SE-30-10-6-E_On-A	0.408	0.515	-0.106	0.182	0.188	-0.006	below negative threshold in 2019; not outlier in 2020	No disturbance in 2020



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_201--SW-29-10-6-E_On-A	0.198	0.187	0.011	0.486	0.525	-0.039		No disturbance in 2020
D604I_202--SW-29-10-6-E_On-A	0.204	0.187	0.017	0.503	0.525	-0.022		No disturbance in 2020
D604I_203--SE-29-10-6-E_On-A	0.223	0.260	-0.037	0.509	0.548	-0.039		No disturbance in 2020
D604I_204--SE-29-10-6-E_On-A	0.238	0.260	-0.022	0.455	0.548	-0.093	tw a disturbance	Project-related disturbance persists
D604I_205--SW-28-10-6-E_On-A	0.412	0.495	-0.082	0.497	0.519	-0.022		No disturbance in 2020
D604I_206--SE-28-10-6-E_On-A	0.422	0.459	-0.036	0.514	0.519	-0.006		No disturbance in 2020
D604I_206--SW-28-10-6-E_On-A	0.348	0.495	-0.147	0.472	0.519	-0.046	below negative threshold in 2019; not outlier in 2020	No disturbance in 2020
D604I_207--SE-28-10-6-E_On-A	0.423	0.459	-0.036	0.501	0.519	-0.018		No disturbance in 2020
D604I_208--SE-28-10-6-E_On-A	0.447	0.459	-0.012	0.497	0.519	-0.022		No disturbance in 2020
D604I_209--SW-27-10-6-E_On-A	0.265	0.269	-0.004	0.367	0.445	-0.078		No disturbance in 2020
D604I_210--SE-27-10-6-E_On-A	0.181	0.269	-0.088	0.333	0.293	0.041	below negative threshold in 2019; not outlier in 2020	No disturbance in 2020
D604I_210--SW-27-10-6-E_On-A	0.202	0.454	-0.252	0.404	0.445	-0.041	below negative threshold in 2019; not outlier in 2020	No disturbance in 2020
D604I_211--SE-27-10-6-E_On-A	0.451	0.454	-0.003	0.212	0.293	-0.080		No disturbance in 2020
D604I_212--SE-27-10-6-E_On-A	0.408	0.454	-0.045	0.239	0.293	-0.053		No disturbance in 2020
D604I_213--SW-26-10-6-E_On-A	0.341	0.370	-0.029	0.282	0.349	-0.067		No disturbance in 2020
D604I_214--SW-26-10-6-E_On-A	0.456	0.370	0.086	0.357	0.349	0.007		No disturbance in 2020
D604I_218--SW-25-10-6-E_On-A	0.408	0.471	-0.063	0.402	0.485	-0.083		No disturbance in 2020
D604I_219--SE-25-10-6-E_On-A	0.408	0.349	0.060	0.416	0.304	0.112		No disturbance in 2020
D604I_220--SE-25-10-6-E_On-A	0.372	0.349	0.023	0.288	0.304	-0.016		No disturbance in 2020
D604I_221--SW-30-10-7-E_On-A	0.634	0.615	0.019	0.253	0.231	0.022		No disturbance in 2020
D604I_222--SE-30-10-7-E_On-A	0.593	0.615	-0.022	0.358	0.384	-0.027		No disturbance in 2020





# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_222-SW-30-10-7-E_On-A	0.479	0.432	0.047	0.243	0.231	0.012		No disturbance in 2020
D604I_223--SE-30-10-7-E_On-B	0.393	0.371	0.023	0.246	0.264	-0.018		No disturbance in 2020
D604I_224--SE-30-10-7-E_On-B	0.366	0.371	-0.005	0.275	0.264	0.011		No disturbance in 2020
D604I_225--SW-29-10-7-E_On-B	0.405	0.392	0.013	0.102	0.409	-0.307	twa disturbance	Project-related disturbance persists
D604I_226--NW-20-10-7-E_On-A	0.313	0.324	-0.011	0.141	0.352	-0.211	twa disturbance	Project-related disturbance persists
D604I_227--NW-20-10-7-E_On-B	0.426	0.408	0.018	0.299	0.395	-0.096	twa disturbance	Project-related disturbance persists
D604I_228--NW-20-10-7-E_On-B	0.489	0.408	0.081	0.393	0.395	-0.002		No disturbance in 2020
D604I_230--NW-17-10-7-E_On-A	0.442	0.420	0.022	0.392	0.488	-0.096	twa disturbance	Project-related disturbance persists
D604I_231--NW-17-10-7-E_On-A	0.437	0.420	0.016	0.325	0.488	-0.163	twa disturbance	Project-related disturbance persists
D604I_232--NW-17-10-7-E_On-A	0.397	0.420	-0.023	0.379	0.488	-0.109	twa disturbance	Project-related disturbance persists
D604I_233--NW-17-10-7-E_On-A	0.482	0.420	0.061	0.326	0.488	-0.162	twa disturbance	Project-related disturbance persists
D604I_242--SE-5-10-7-E_On-A	0.354	0.396	-0.042	0.248	0.384	-0.136	twa disturbance	Project-related disturbance persists
D604I_243--NE-32-9-7-E_On-A	0.529	0.515	0.014	0.500	0.519	-0.020		No disturbance in 2020
D604I_258--NE-15-9-7-E_On-A	0.442	0.395	0.047	0.407	0.388	0.019		No disturbance in 2020
D604I_259--SE-15-9-7-E_On-A	0.402	0.386	0.016	0.283	0.447	-0.164	twa disturbance	Project-related disturbance persists
D604I_263--SW-11-9-7-E_On-B	0.358	0.402	-0.043	0.266	0.458	-0.192	twa disturbance	Project-related disturbance persists
D604I_278--NE-24-8-7-E_On-A	0.456	0.446	0.010	0.422	0.481	-0.060		No disturbance in 2020
D604I_279--NE-24-8-7-E_On-A	0.454	0.446	0.009	0.419	0.481	-0.062		No disturbance in 2020
D604I_285--SW-18-8-8-E_On-A	0.391	0.348	0.042	0.236	0.305	-0.070		No disturbance in 2020
D604I_286--NE-7-8-8-E_On-A	0.421	0.472	-0.051	0.346	0.308	0.038		No disturbance in 2020
D604I_305--SE-19-7-8-E_On-A	0.571	0.568	0.002	0.603	0.718	-0.115	twa disturbance	Project-related disturbance persists
D604I_306--SE-19-7-8-E_On-A	0.513	0.568	-0.055	0.669	0.718	-0.049		No disturbance in 2020
D604I_307--NE-18-7-8-E_On-B	0.501	0.508	-0.007	0.632	0.679	-0.046		No disturbance in 2020
D604I_308--NE-18-7-8-E_On-A	0.374	0.478	-0.105	0.637	0.603	0.034	below negative threshold in 2019; not outlier in 2020	No disturbance in 2020



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## Appendix A Tables

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_308--SE-18-7-8-E_On-A	0.417	0.416	0.001	0.665	0.597	0.068		No disturbance in 2020
D604I_309--SE-18-7-8-E_On-A	0.410	0.416	-0.006	0.625	0.597	0.028		No disturbance in 2020
D604I_310--SE-18-7-8-E_On-A	0.419	0.416	0.003	0.566	0.597	-0.030		No disturbance in 2020
D604I_311--NE-7-7-8-E_On-A	0.524	0.495	0.029	0.589	0.610	-0.021		No disturbance in 2020
D604I_312--SE-7-7-8-E_On-A	0.629	0.634	-0.005	0.108	0.138	-0.030		No disturbance in 2020
D604I_313--SE-7-7-8-E_On-B	0.504	0.410	0.094	0.449	0.409	0.040		No disturbance in 2020
D604I_313--SE-7-7-8-E_On-C	0.477	0.517	-0.040	0.501	0.587	-0.087	two disturbance	Project-related disturbance persists
D604I_314--NE-6-7-8-E_On-A	0.327	0.461	-0.134	0.308	0.718	-0.409	appears natural low productivity in field corner	Negative outlier, nature unknown
D604I_314--NE-6-7-8-E_On-B	0.477	0.550	-0.073	0.462	0.660	-0.198	two disturbance	Project-related disturbance persists
D604I_315--NE-6-7-8-E_On-A	0.435	0.461	-0.026	0.656	0.718	-0.061		No disturbance in 2020
D604I_316--SE-6-7-8-E_On-A	0.446	0.464	-0.018	0.556	0.605	-0.049		No disturbance in 2020
D604I_317--SE-6-7-8-E_On-B	0.479	0.493	-0.014	0.526	0.624	-0.098	two disturbance	Project-related disturbance persists
D604I_317--SE-6-7-8-E_On-B	0.479	0.493	-0.014	0.526	0.624	-0.098	two disturbance	Project-related disturbance persists
D604I_319--NW-32-6-8-E_On-A	0.325	0.346	-0.020	0.430	0.478	-0.048		No disturbance in 2020
D604I_320--SW-32-6-8-E_On-A	0.514	0.528	-0.014	0.613	0.620	-0.007		No disturbance in 2020
D604I_321--SW-32-6-8-E_On-B	0.374	0.397	-0.023	0.481	0.590	-0.110	two disturbance	Project-related disturbance persists
D604I_322--NW-29-6-8-E_On-A	0.432	0.221	0.211	0.448	0.316	0.132		No disturbance in 2020
D604I_323--NW-29-6-8-E_On-A	0.373	0.221	0.152	0.346	0.316	0.030		No disturbance in 2020
D604I_324--SW-29-6-8-E_On-B	0.312	0.316	-0.004	0.412	0.388	0.025		No disturbance in 2020
D604I_325--SW-29-6-8-E_On-C	0.485	0.463	0.022	0.370	0.287	0.083		No disturbance in 2020
D604I_326--NW-20-6-8-E_On-B	0.337	0.335	0.002	0.567	0.615	-0.047		No disturbance in 2020
D604I_327--NW-20-6-8-E_On-A	0.495	0.441	0.055	0.591	0.631	-0.041		No disturbance in 2020
D604I_328--NW-20-6-8-E_On-A	0.511	0.441	0.070	0.704	0.631	0.072		No disturbance in 2020
D604I_329--SW-20-6-8-E_On-B	0.535	0.561	-0.026	0.472	0.535	-0.062		No disturbance in 2020
D604I_330--SW-20-6-8-E_On-B	0.606	0.561	0.045	0.430	0.535	-0.104	two disturbance	Project-related disturbance persists



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Appendix A Tables

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_331--NW-17-6-8-E_On-A	0.425	0.443	-0.017	0.620	0.632	-0.013		No disturbance in 2020
D604I_332--NE-17-6-8-E_On-A	0.487	0.443	0.044	0.737	0.755	-0.018		No disturbance in 2020
D604I_332--NW-17-6-8-E_On-A	0.271	0.338	-0.067	0.542	0.632	-0.091	twa disturbance	Project-related disturbance persists
D604I_333--SE-17-6-8-E_On-A	0.468	0.450	0.018	0.551	0.668	-0.117	twa disturbance	Project-related disturbance persists
D604I_334--SE-17-6-8-E_On-A	0.344	0.450	-0.106	0.581	0.668	-0.087	limited project dist	Project-related disturbance persists
D604I_334--SW-17-6-8-E_On-B	0.437	0.443	-0.006	0.499	0.545	-0.046		No disturbance in 2020
D604I_335--NE-8-6-8-E_On-A	0.474	0.373	0.100	0.494	0.511	-0.016		No disturbance in 2020
D604I_335--NW-8-6-8-E_On-A	0.334	0.324	0.010	0.555	0.618	-0.063		No disturbance in 2020
D604I_336--SE-8-6-8-E_On-A	0.432	0.427	0.005	0.394	0.510	-0.117	twa disturbance	Project-related disturbance persists
D604I_336--SW-8-6-8-E_On-A	0.509	0.529	-0.020	0.518	0.673	-0.155	twa disturbance	Project-related disturbance persists
D604I_337--SE-8-6-8-E_On-E	0.455	0.546	-0.091	0.629	0.721	-0.092	additional project dist	Negative outlier, nature unknown
D604I_337--SE-8-6-8-E_On-F	0.471	0.509	-0.039	0.619	0.688	-0.069		No disturbance in 2020
D604I_337--SW-8-6-8-E_On-B	0.509	0.545	-0.037	0.519	0.487	0.032		No disturbance in 2020
D604I_338--NE-5-6-8-E_On-A	0.575	0.594	-0.019	0.282	0.309	-0.027		No disturbance in 2020
D604I_338--NW-5-6-8-E_On-A	0.577	0.625	-0.047	0.501	0.570	-0.069		No disturbance in 2020
D604I_339--NE-5-6-8-E_On-B	0.432	0.358	0.073	0.435	0.539	-0.105	twa disturbance	Project-related disturbance persists
D604I_340--NE-5-6-8-E_On-B	0.443	0.358	0.085	0.466	0.539	-0.074		No disturbance in 2020
D604I_341--SE-5-6-8-E_On-A	0.562	0.430	0.132	0.374	0.276	0.098		No disturbance in 2020
D604I_342--NE-32-5-8-E_On-B	0.319	0.370	-0.052	0.114	0.284	-0.170	twa disturbance	Project-related disturbance persists
D604I_342--NW-32-5-8-E_On-A	0.338	0.371	-0.033	0.186	0.309	-0.123	twa disturbance	Project-related disturbance persists
D604I_349--NW-20-5-8-E_On-A	0.499	0.552	-0.052	0.489	0.467	0.022		No disturbance in 2020
D604I_350--SE-20-5-8-E_On-A	0.436	0.376	0.060	0.276	0.238	0.038		No disturbance in 2020
D604I_350--SW-20-5-8-E_On-A	0.510	0.522	-0.013	0.260	0.273	-0.013		No disturbance in 2020
D604I_351--SE-20-5-8-E_On-B	0.421	0.428	-0.007	0.221	0.291	-0.070		No disturbance in 2020
D604I_351--SW-20-5-8-E_On-B	0.426	0.375	0.051	0.254	0.240	0.015		No disturbance in 2020
D604I_352--N-17-5-8-E_On-A	0.370	0.361	0.009	0.326	0.252	0.074		No disturbance in 2020
D604I_353--N-17-5-8-E_On-A	0.439	0.361	0.078	0.435	0.252	0.183		No disturbance in 2020



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

## Appendix A Tables

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_354--S-17-5-8-E_On-A	0.480	0.451	0.030	0.375	0.484	-0.110	twa disturbance	Project-related disturbance persists
D604I_355--S-17-5-8-E_On-A	0.451	0.451	0.000	0.400	0.484	-0.084		No disturbance in 2020
D604I_356--NE-8-5-8-E_On-B	0.410	0.384	0.026	0.508	0.461	0.048		No disturbance in 2020
D604I_357--NE-8-5-8-E_On-B	0.400	0.384	0.016	0.360	0.461	-0.100	twa disturbance	Project-related disturbance persists
D604I_362--SE-5-5-8-E_On-A	0.622	0.621	0.000	0.405	0.554	-0.149	twa disturbance	Project-related disturbance persists
D604I_363--NE-32-4-8-E_On-A	0.480	0.570	-0.090	0.397	0.558	-0.160	twa disturbance	Project-related disturbance persists
D604I_378--NE-9-4-8-E_On-A	0.570	0.554	0.016	0.277	0.253	0.024		No disturbance in 2020
D604I_379--SE-9-4-8-E_On-A	0.496	0.429	0.067	0.188	0.308	-0.120	twa disturbance	Project-related disturbance persists
D604I_381--SW-10-4-8-E_On-A	0.544	0.566	-0.022	0.470	0.498	-0.028		No disturbance in 2020
D604I_386--NW-35-3-8-E_On-A	0.528	0.528	-0.001	0.381	0.442	-0.062		No disturbance in 2020
D604I_387--NW-35-3-8-E_On-A	0.586	0.528	0.058	0.393	0.442	-0.049		No disturbance in 2020
D604I_389--SE-35-3-8-E_On-B	0.439	0.517	-0.078	0.287	0.388	-0.101	twa disturbance	Project-related disturbance persists
D604I_390--SE-35-3-8-E_On-B	0.451	0.517	-0.066	0.217	0.388	-0.171	twa disturbance	Project-related disturbance persists
D604I_411--NE-4-3-9-E_On-B	0.648	0.658	-0.010	0.475	0.515	-0.041		No disturbance in 2020
D604I_424--SE-25-2-9-E_On-A	0.539	0.518	0.021	0.318	0.400	-0.081		No disturbance in 2020
D604I_440--NW-4-2-10-E_On-A	0.584	0.568	0.016	0.366	0.505	-0.139	twa disturbance	Project-related disturbance persists
D604I_474--NW-24-1-11-E_On-A	0.491	0.499	-0.008	0.251	0.510	-0.259	twa disturbance	Project-related disturbance persists
D604I_475--NE-24-1-11-E_On-A	0.642	0.538	0.104	0.440	0.492	-0.052		No disturbance in 2020
D604I_475--NW-24-1-11-E_On-A	0.529	0.499	0.029	0.405	0.510	-0.106	twa disturbance	Project-related disturbance persists
D604I_476--NE-24-1-11-E_On-A	0.563	0.538	0.025	0.438	0.492	-0.055		No disturbance in 2020
D604I_478--W-19-1-12-E_On-A	0.674	0.617	0.057	0.430	0.396	0.034		No disturbance in 2020
D604I_479--SE-19-1-12-E_On-A	0.611	0.617	-0.006	0.425	0.481	-0.056		No disturbance in 2020
D604I_479--W-19-1-12-E_On-A	0.640	0.628	0.011	0.459	0.396	0.063		No disturbance in 2020
D604I_480--SE-19-1-12-E_On-A	0.632	0.628	0.003	0.417	0.481	-0.064		No disturbance in 2020
D604I_481--NE-18-1-12-E_On-A	0.511	0.548	-0.037	0.297	0.298	0.000		No disturbance in 2020
D604I_482--NE-18-1-12-E_On-B	0.500	0.490	0.010	0.332	0.421	-0.088	twa disturbance	Project-related disturbance persists
D604I_484--SW-17-1-12-E_On-A	0.558	0.548	0.010	0.272	0.323	-0.051		No disturbance in 2020
D604I_485--SW-17-1-12-E_On-B	0.564	0.574	-0.010	0.265	0.384	-0.120	twa disturbance	Project-related disturbance persists
D604I_486--NW-8-1-12-E_On-A	0.698	0.681	0.017	0.476	0.521	-0.045		No disturbance in 2020



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

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**Table A.2 TWA FMU NDVI Values for 2019 and 2020, and 2020 Disturbance Categories**

TWA ID	2019 TWA NDVI Mean	2019 Off NDVI Mean	2019 Diff TWA-Off ROW	2020 TWA NDVI Mean	2020 Off NDVI Mean	2020 Diff TWA-Off ROW	2020 Evaluation Comment	2020 Disturbance Category
D604I_487--NW-8-1-12-E_On-A	0.620	0.643	-0.023	0.528	0.521	0.007		No disturbance in 2020
D604I_487--NW-8-1-12-E_On-B	0.597	0.681	-0.084	0.497	0.526	-0.029		No disturbance in 2020
D604I_488--E-8-1-12-E_On-A	0.613	0.584	0.028	0.595	0.638	-0.044		No disturbance in 2020
D604I_489--E-8-1-12-E_On-A	0.561	0.584	-0.023	0.558	0.638	-0.080		No disturbance in 2020
D604I_490--SE-8-1-12-E_On-A	0.530	0.520	0.010	0.317	0.406	-0.089	two disturbance	Project-related disturbance persists
D604I_491--NW-4-1-12-E_On-A	0.560	0.554	0.005	0.622	0.643	-0.020		No disturbance in 2020
D604I_492--NW-4-1-12-E_On-A	0.567	0.554	0.012	0.606	0.643	-0.037		No disturbance in 2020
D604I_493--SW-4-1-12-E_On-A	0.599	0.578	0.021	0.609	0.663	-0.054		No disturbance in 2020
Notes:								
NDVI difference outliers are indicated as follows:								
	Major negative outlier	Minor negative outlier	Minor positive outlier	Major positive outlier				



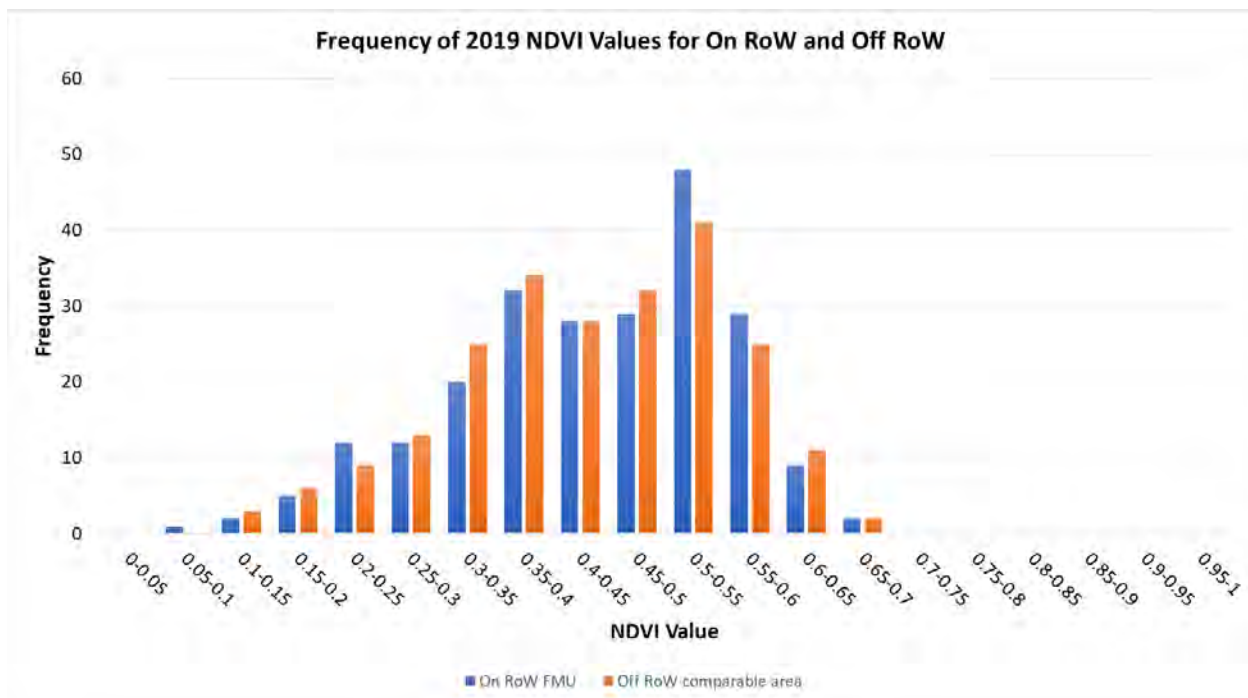
# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Appendix B Statistical Analyses  
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## Appendix B STATISTICAL ANALYSES

### B.1 ON RoW FIELD MANAGEMENT UNITS (ON RoW FMUs)

#### B.1.1 Pre-Construction (2019)



The frequency histogram above shows that there is a similar frequency of NDVI values over the range of NDVI value classes for On RoW FMUs and Off RoW comparable areas. This demonstrates similar soil productivity On RoW and Off RoW.

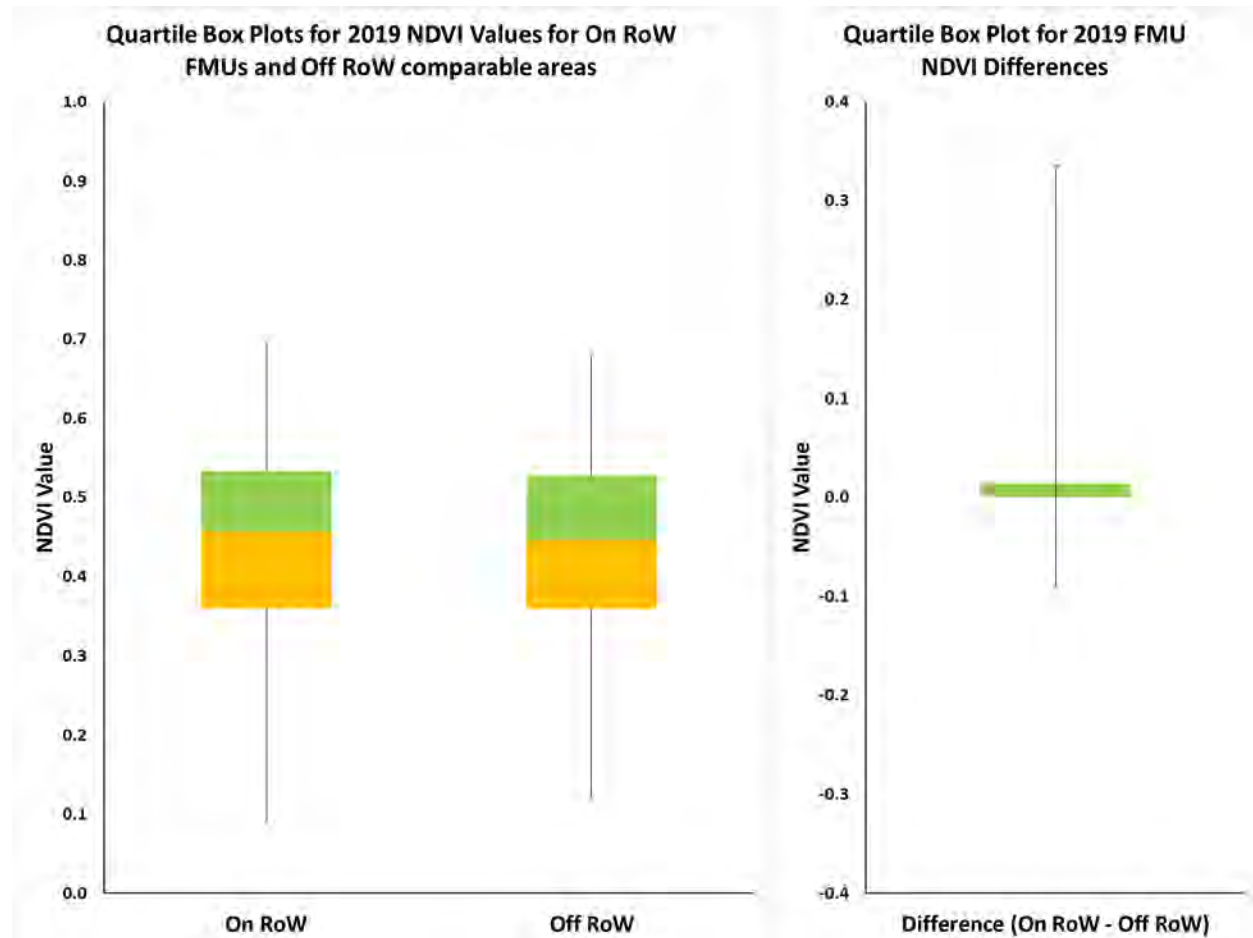
**Figure B.1.1** Frequency of 2019 NDVI Values for On RoW and Off RoW



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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The quartile box plots for On RoW and Off RoW indicate that the ranges (between minimum and maximum values shown by the “whiskers”) are fairly similar between On RoW FMUs and Off RoW comparable areas. The median value (centre of box) as well as the first quartile (25<sup>th</sup> percentile; orange) and third quartile (75<sup>th</sup> percentile; green) are also similar between On RoW FMUs and Off RoW comparable areas. When the box plot for NDVI differences is examined, it shows the median is zero and 50% of the data (between 25<sup>th</sup> and 75<sup>th</sup> percentile) are in a very tight range (narrow distribution), while the maximum and minimum values are much wider ranging, particularly in the positive direction (suggests “extreme” values).

**Figure B.1.2** Quartile Box Plots for 2019 NDVI Values for On RoW FMUs, Off RoW Comparable Areas, and for NDVI Differences Values

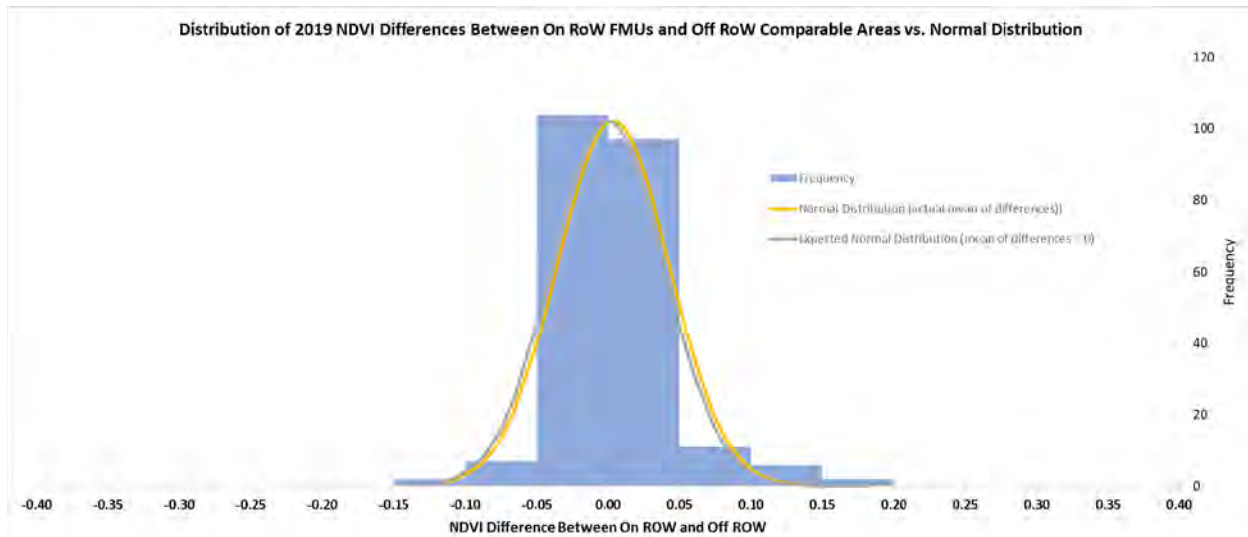




# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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The frequency of difference values is displayed in columns (blue bars) relative to the:

- normal distribution curve (orange line; based on actual data around the actual mean value of 0.004), and,
- “expected” normal distribution curve (grey line; assumed mean difference of 0 and same shape of curve as the actual normal distribution).

These data demonstrate that the actual difference values are a very close fit to the expected normal distribution.

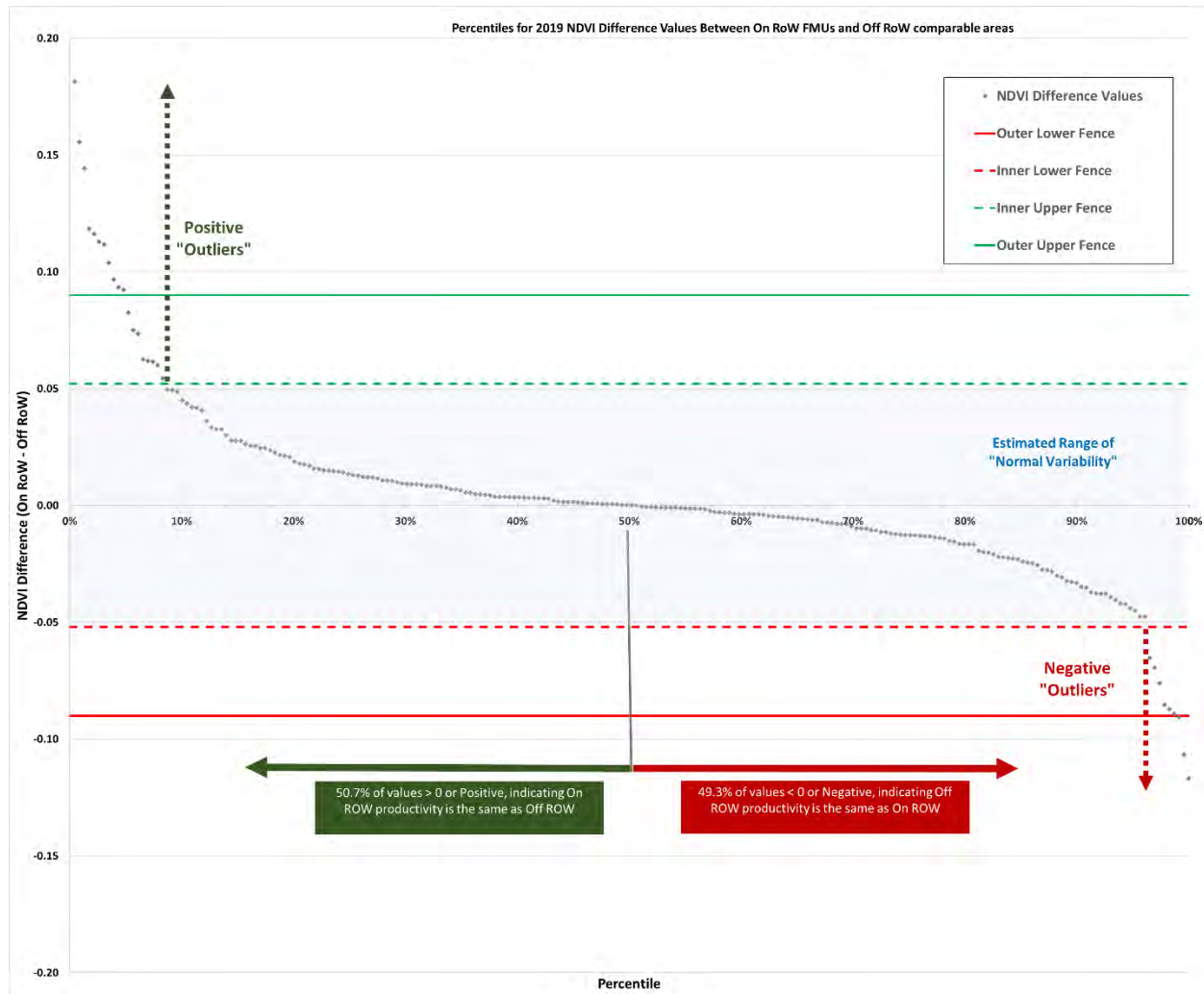
**Figure B.1.3** Distribution of 2019 NDVI Differences Between On RoW FMUs and Off RoW Comparable Areas



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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The percentiles chart provides a visual display of the difference values for individual FMUs. Approximately 51% of differences were found to be positive (On RoW FMU – Off RoW comparable area = >0), while 49% were found to be negative (On RoW FMU – Off RoW comparable area = <0). This is further evidence of the similarity of the data. The estimated range of “normal variability” around an expected difference of 0 is estimated to be -0.052 to +0.052. Therefore, values above 0.052 can be considered “positive outliers” while values below -0.052 can be considered “negative outliers”. Approximately 3.9% of On RoW FMUs (9) are considered in the “negative outlier” range, while 8.3% of On RoW FMUs (19) are considered in the “positive outlier” range.

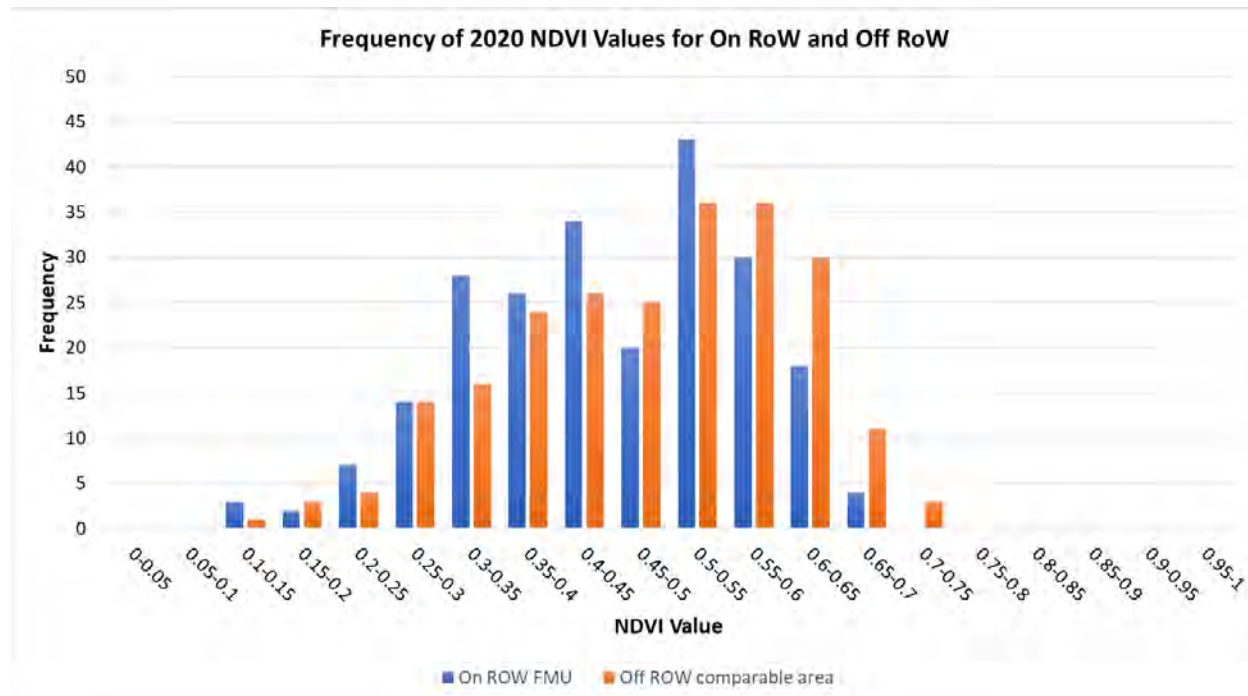
**Figure B.1.4 Percentiles for 2019 NDVI Differences Between On RoW FMUs and Off RoW Comparable Areas**



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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## B.1.2 Post-Construction Year 1 (2020)



The frequency histogram above shows that there is a higher frequency of NDVI values in lower NDVI value classes for On RoW FMUs relative to Off RoW comparable areas. This demonstrates reduced soil productivity On RoW relative to Off RoW.

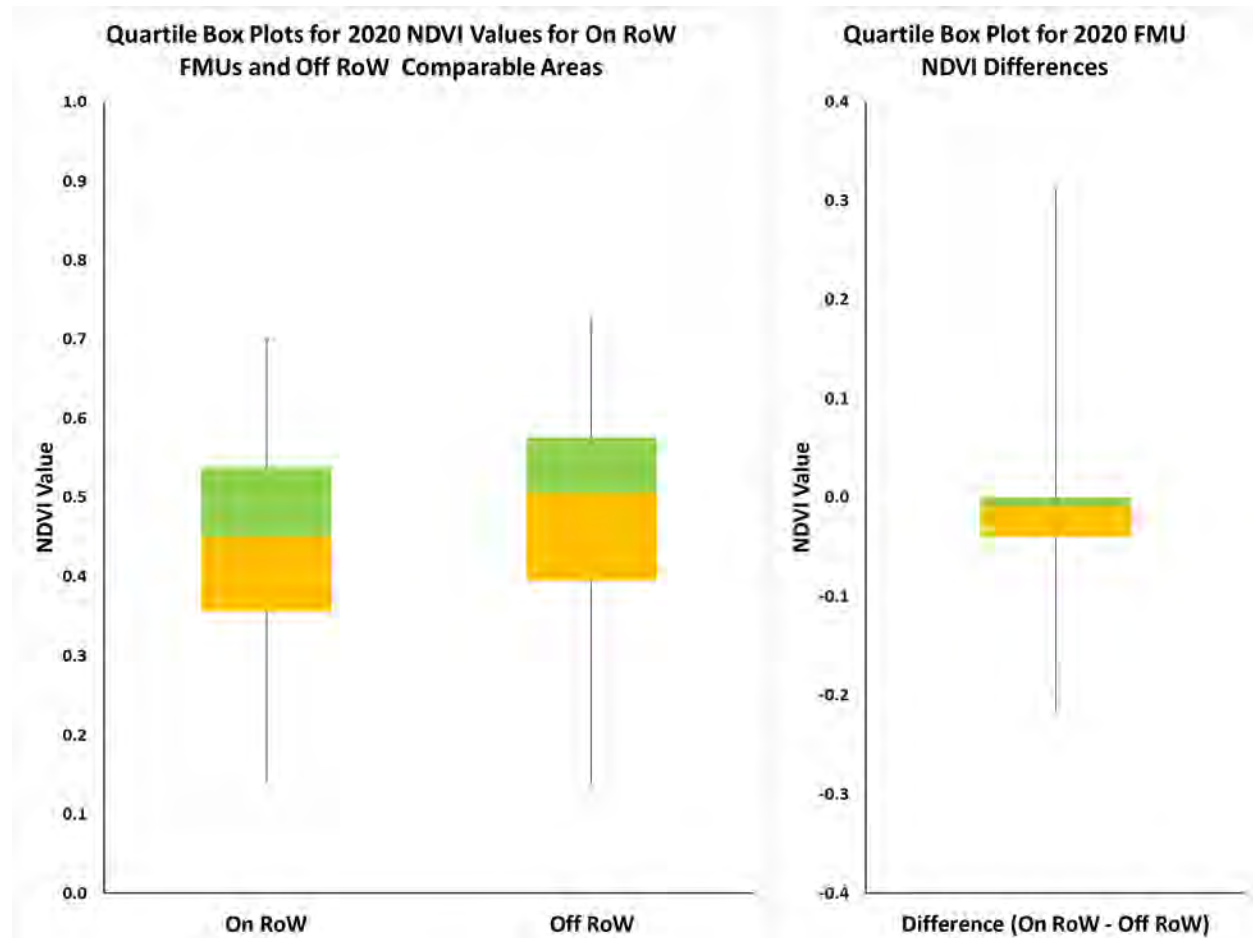
**Figure B.1.5** Frequency of 2020 NDVI Values for On RoW and Off RoW



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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The quartile box plots for On RoW and Off RoW indicate that the ranges (between minimum and maximum values shown by the “whiskers”) are lower for On RoW FMUs than Off RoW comparable areas. The median value (centre of box) as well as the first quartile (25<sup>th</sup> percentile; orange) and third quartile (75<sup>th</sup> percentile; green) are lower for On RoW FMUs than Off RoW comparable areas. When the box plot for NDVI differences is examined, it shows the median is below zero and 50% of the data (between 25<sup>th</sup> and 75<sup>th</sup> percentile) are below zero, indicating a strong negative skew in the NDVI difference data.

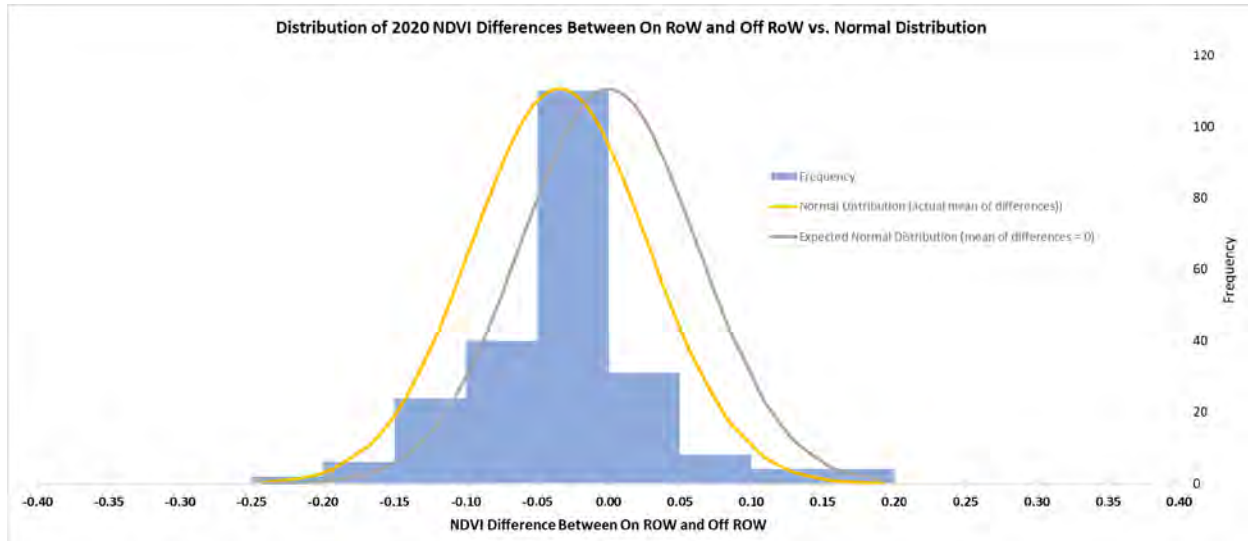
**Figure B.1.6** Quartile Box Plots for 2020 NDVI Values for On RoW FMUs, Off RoW Comparable Areas, and for NDVI Differences Values



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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The frequency of difference values is displayed in columns (blue bars) relative to the:

- normal distribution curve (orange line; based on actual data around the actual mean value of -0.034), and,
- “expected” normal distribution curve (grey line; assumed mean difference of 0 and same shape of curve as the actual normal distribution).

These data demonstrate that the actual difference values shifted in the negative difference direction relative to the expected normal distribution.

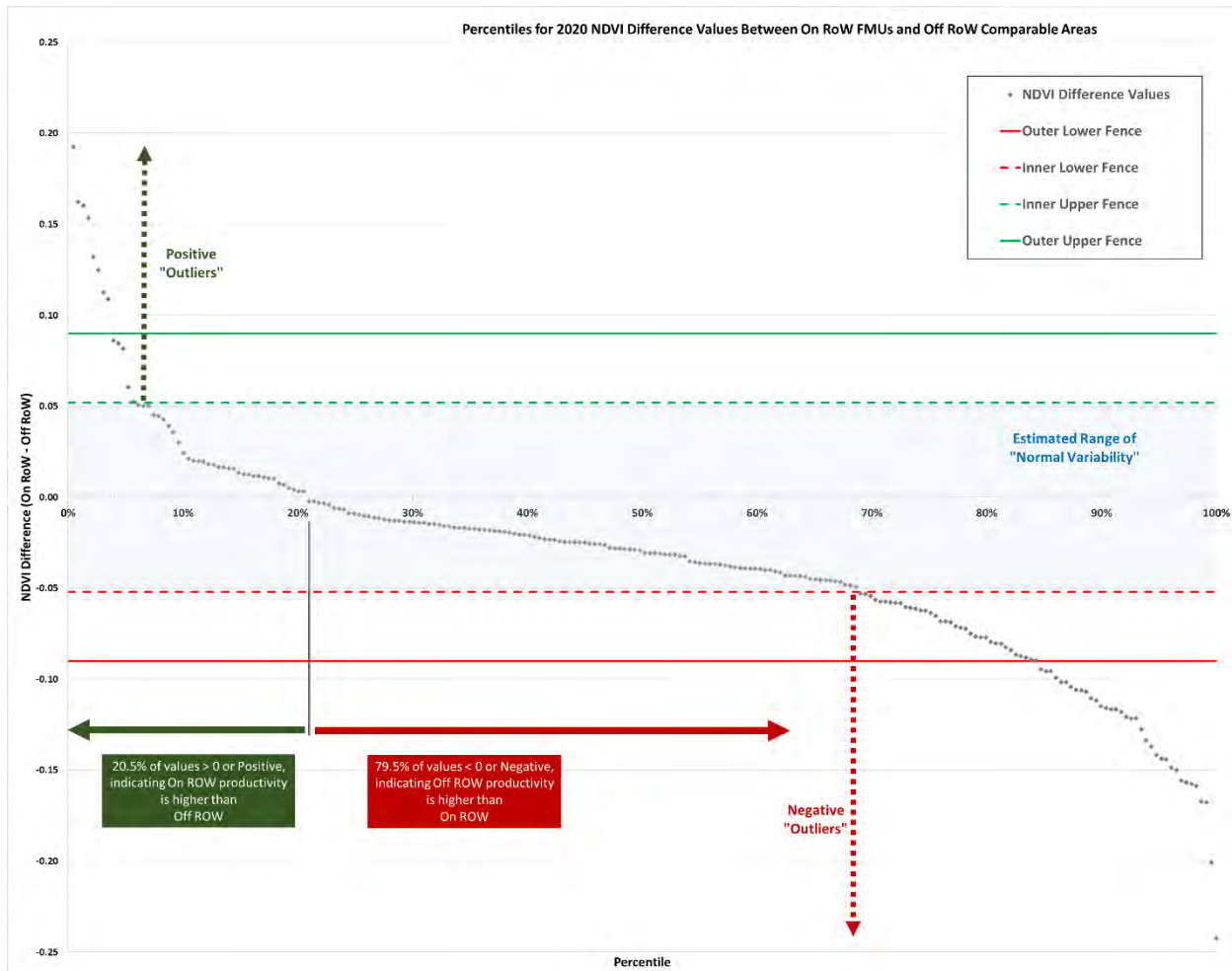
**Figure B.1.7** Distribution of 2020 NDVI Differences Between On RoW FMUs and Off RoW Comparable Areas



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

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The percentiles chart provides a visual display of the difference values for individual FMUs. Approximately 20.5% of differences were found to be positive (On RoW FMU – Off RoW comparable area = >0), while 79.5% were found to be negative (On RoW FMU – Off RoW comparable area = <0). This is further evidence of the negative skewness of the data. The estimated range of “normal variability” around an expected difference of 0 is estimated to be -0.052 to +0.052. Therefore, values above 0.052 can be considered “positive outliers” while values below -0.052 can be considered “negative outliers”. Based on this analysis there are many more “negative outliers” than “positive outliers”. Approximately 31.4% of On RoW FMUs (72) are considered in the “negative outlier” range, while 5.7% of On RoW FMUs (13) are considered in the “positive outlier” range.

**Figure B.1.8 Percentiles for 2019 NDVI Differences Between On RoW FMUs and Off RoW Comparable Areas**

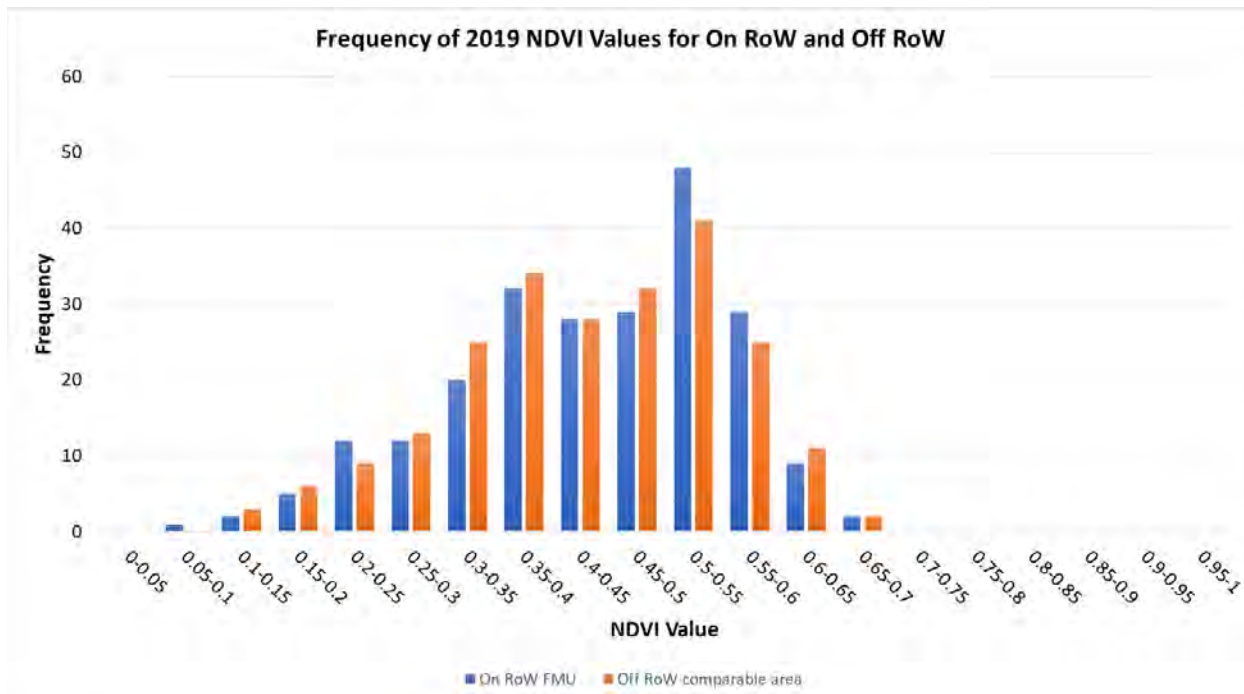


# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Appendix B Statistical Analyses  
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## B.2 TOWER WORK AREAS (TWAs)

### B.2.1 Pre-Construction (2019)



The frequency histogram above shows that there is a similar frequency of NDVI values over the range of NDVI values classes for On RoW FMUs and Off RoW comparable areas. This demonstrates similar soil productivity On RoW and Off RoW.

**Figure B.2.1** Frequency of 2019 NDVI Values for On RoW and Off RoW

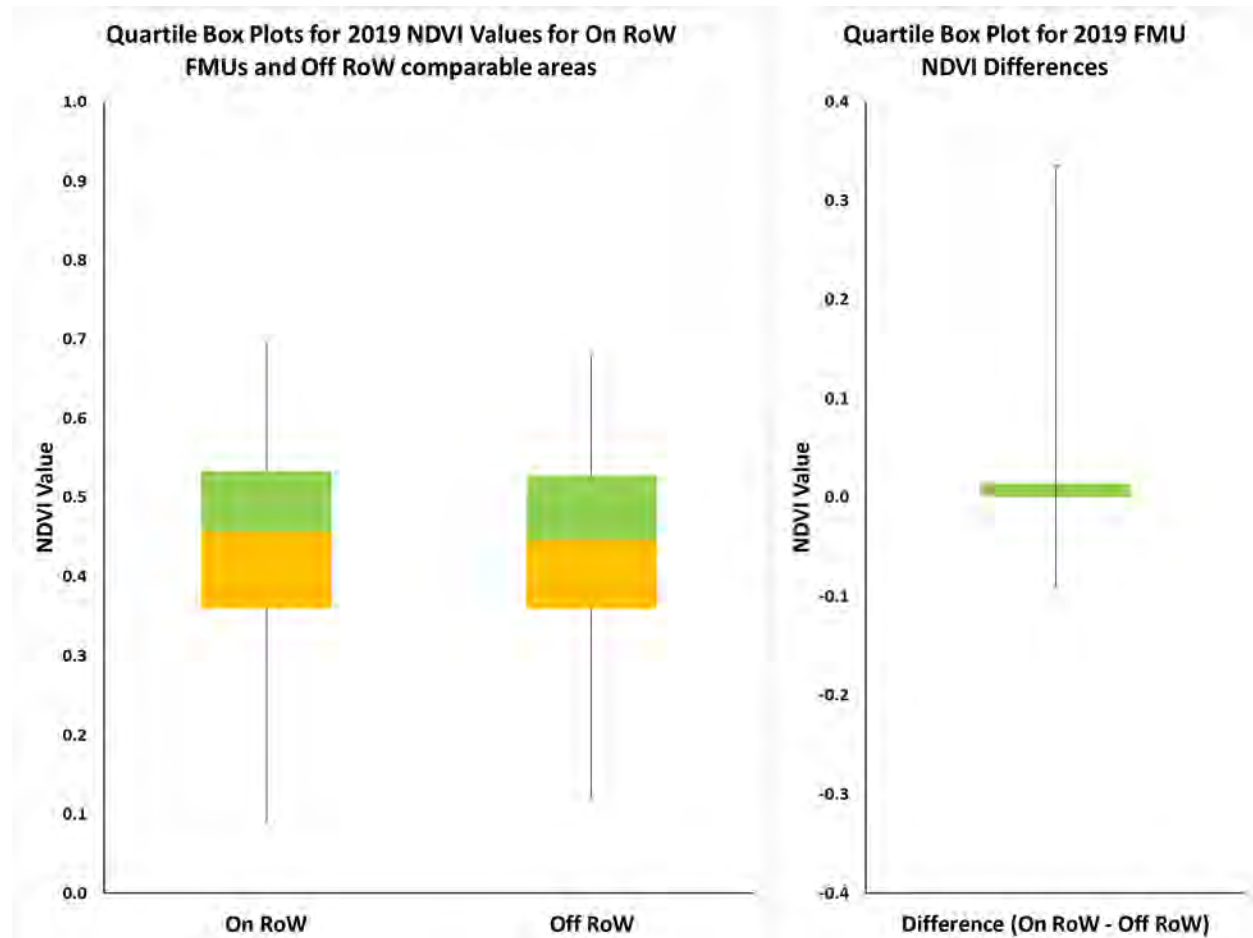




# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

## Appendix B Statistical Analyses

January 10, 2022



The quartile box plots for On RoW and Off RoW display the ranges (between minimum and maximum values shown by the “whiskers”) are fairly similar between On RoW FMUs and Off RoW comparable areas. The median value (centre of box) as well as the first quartile (25<sup>th</sup> percentile) and third quartile (75<sup>th</sup> percentile) are also similar between On RoW FMUs and Off RoW comparable areas. When the box plot for NDVI differences is examined, it shows the median is zero and 50% of the data (between 25<sup>th</sup> and 75<sup>th</sup> percentile) are in a very tight range (narrow distribution), while the maximum and minimum values are much wider ranging, particularly in the positive direction (suggests “extreme” values).

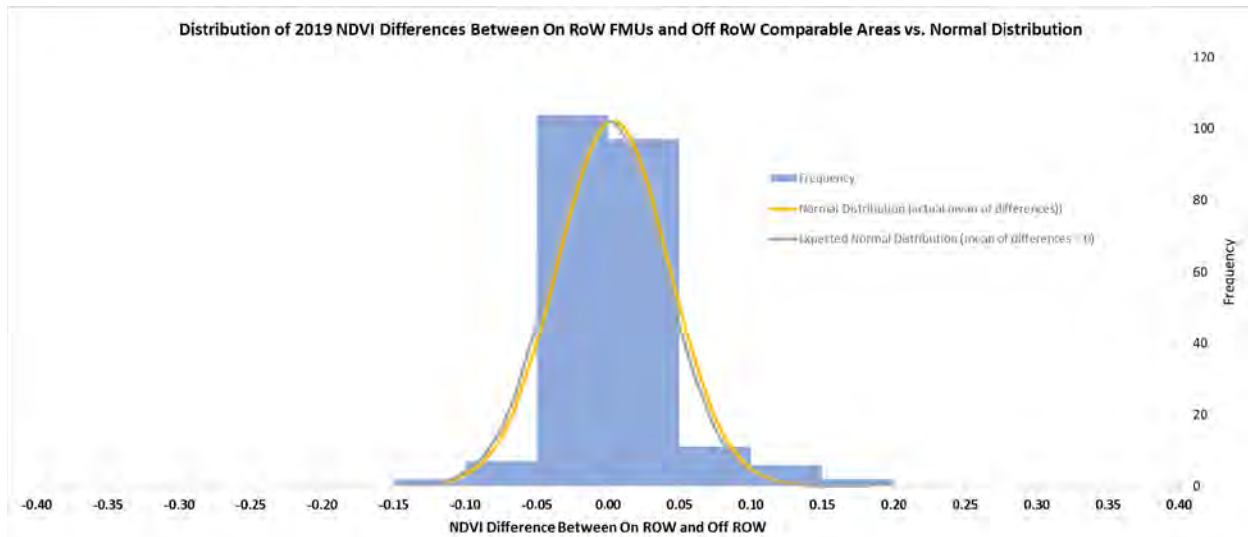
**Figure B.2.2** Quartile Box Plots for 2019 NDVI Values for On RoW FMUs, Off RoW Comparable Areas, and for NDVI Differences Values



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

## Appendix B Statistical Analyses

January 10, 2022



The frequency of difference values is displayed in columns (blue bars) relative to the:

- normal distribution curve (orange line; based on actual data around the actual mean value of 0.004), and,
- “expected” normal distribution curve (grey line; assumed mean difference of 0 and same shape of curve as the actual normal distribution).

These data demonstrate that the actual difference values are a very close fit to the expected normal distribution.

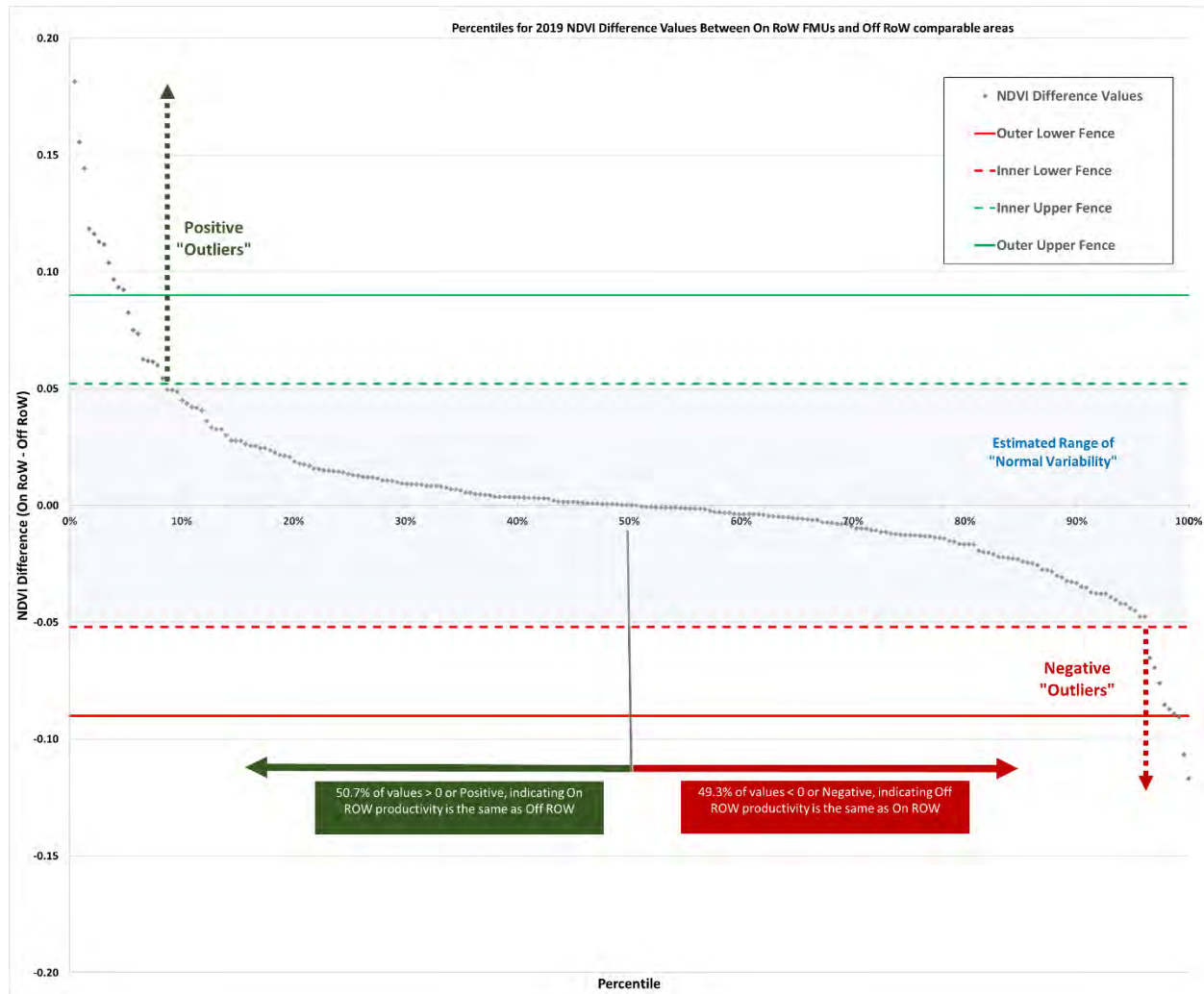
**Figure B.2.3** Distribution of 2019 NDVI Differences Between On RoW FMUs and Off RoW Comparable Areas



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

## Appendix B Statistical Analyses

January 10, 2022



The percentiles chart provides a visual display of the difference values for individual FMUs. Approximately 51% of differences were found to be positive (On RoW FMU – Off RoW comparable area = >0), while 49% were found to be negative (On RoW FMU – Off RoW comparable area = <0). This is further evidence of the similarity of the data. The estimated range of “normal variability” around an expected difference of 0 is estimated to be -0.052 to +0.052. Therefore, values above 0.052 can be considered “positive outliers” while values below -0.052 can be considered “negative outliers”. Approximately 3.9% of On RoW FMUs (13) are considered in the “positive outlier” range, while 4.8% of On RoW FMUs (16) are considered in the “negative outlier” range.

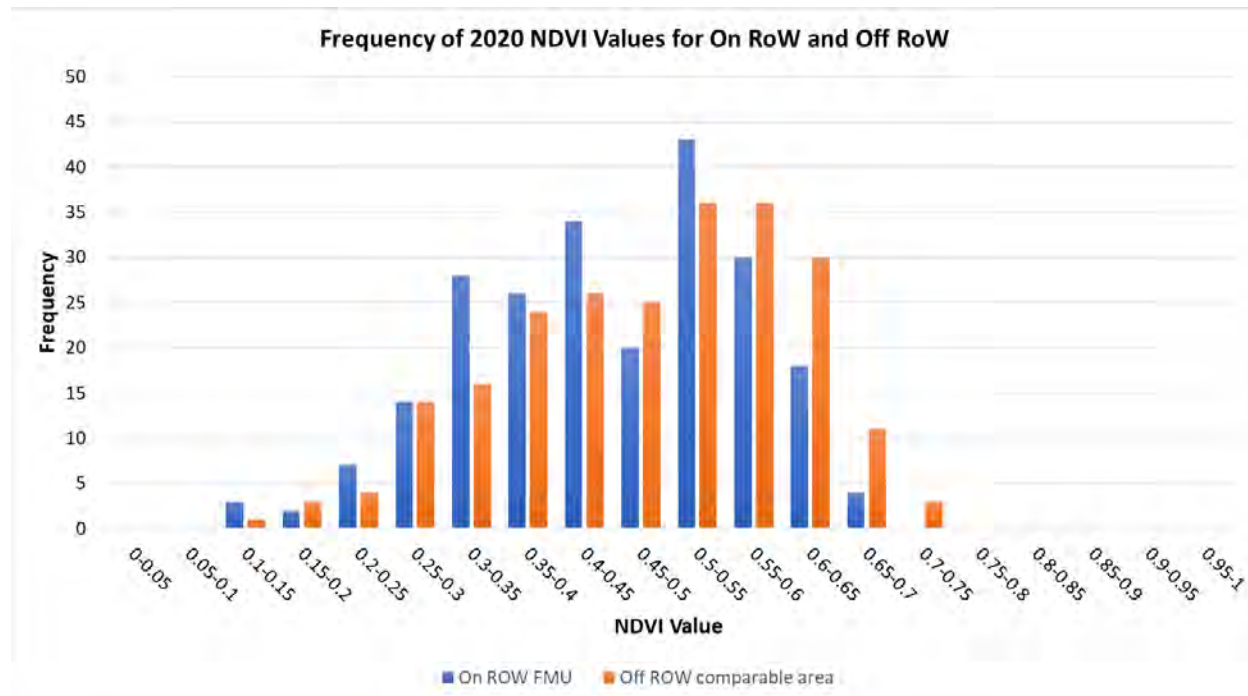
**Figure B.2.4 Percentiles for 2019 NDVI Differences Between On RoW FMUs and Off RoW Comparable Areas**



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

Appendix B Statistical Analyses  
January 10, 2022

## B.2.2 Post-Construction Year 1 (2020)



The frequency histogram above shows that there is a higher frequency of NDVI values in lower NDVI value classes for On RoW FMUs relative to Off RoW comparable areas. This demonstrates reduced soil productivity On RoW relative to Off RoW.

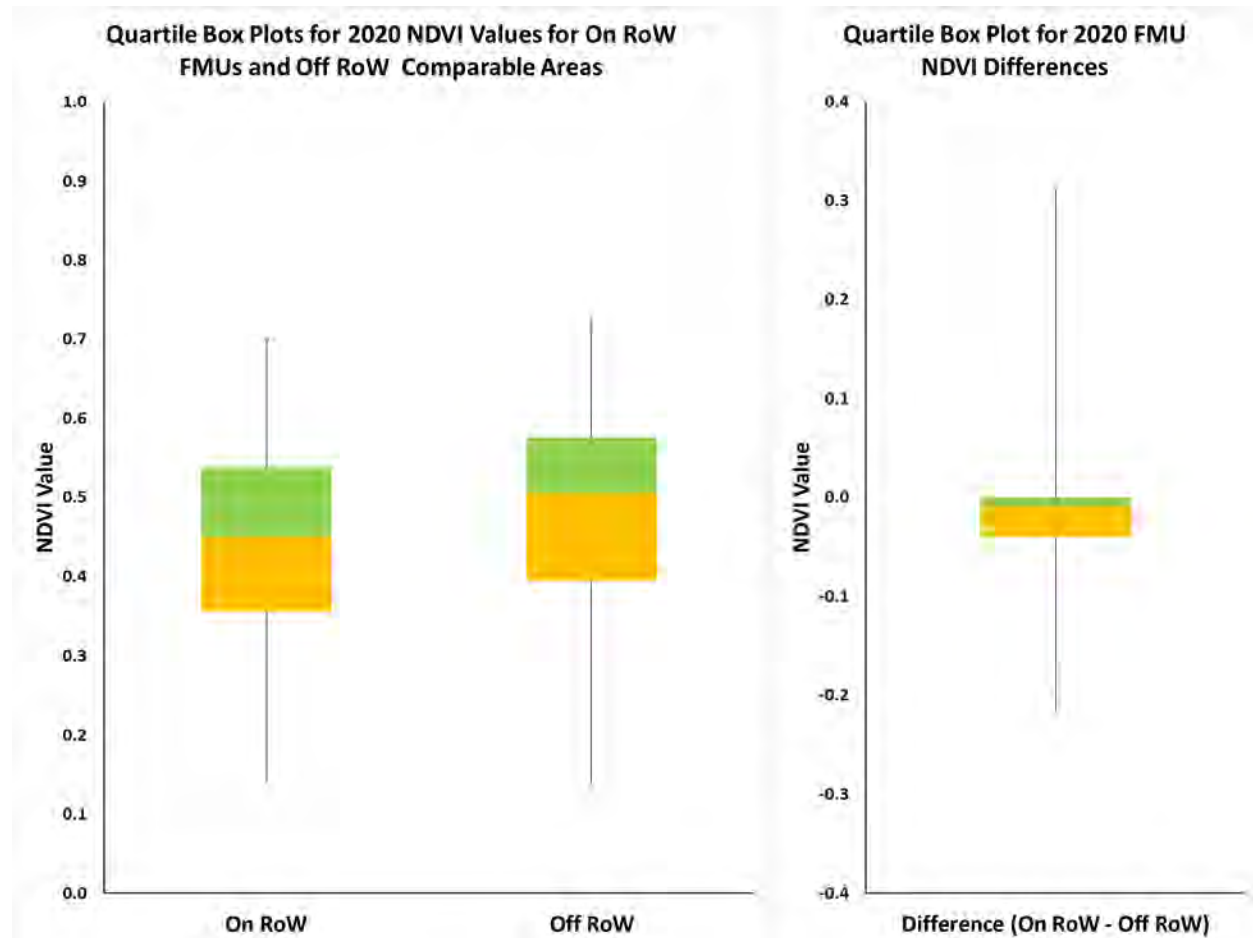
**Figure B.2.5** Frequency of 2020 NDVI Values for On RoW and Off RoW



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

## Appendix B Statistical Analyses

January 10, 2022



The quartile box plots for On RoW and Off RoW indicate that the ranges (between minimum and maximum values shown by the “whiskers”) are similar for On RoW FMU and Off RoW comparable areas. However, the median value (centre of box) as well as the first quartile (25<sup>th</sup> percentile; orange) and third quartile (75<sup>th</sup> percentile; green) are lower for On RoW FMUs than Off RoW comparable areas. When the box plot for NDVI differences is examined, it shows the median is below zero and 50% of the data (between 25<sup>th</sup> and 75<sup>th</sup> percentile) are below zero, indicating a strong negative skew in the NDVI difference data.

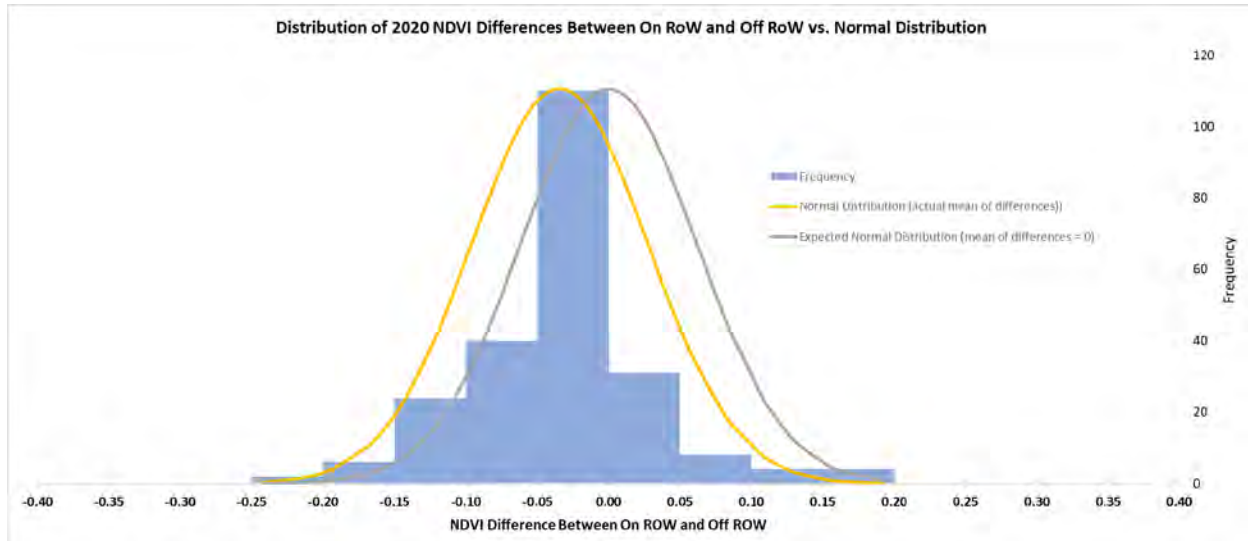
**Figure B.2.6** Quartile Box Plots for 2020 NDVI Values for On RoW FMUs, Off RoW Comparable Areas, and for NDVI Differences Values



# AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)

## Appendix B Statistical Analyses

January 10, 2022



The frequency of difference values is displayed in columns (blue bars) relative to the:

- normal distribution curve (orange line; based on actual data around the actual mean value of -0.034), and,
- “expected” normal distribution curve (grey line; assumed mean difference of 0 and same shape of curve as the actual normal distribution).

These data demonstrate that the actual difference values shifted in the negative difference direction relative to the expected normal distribution.

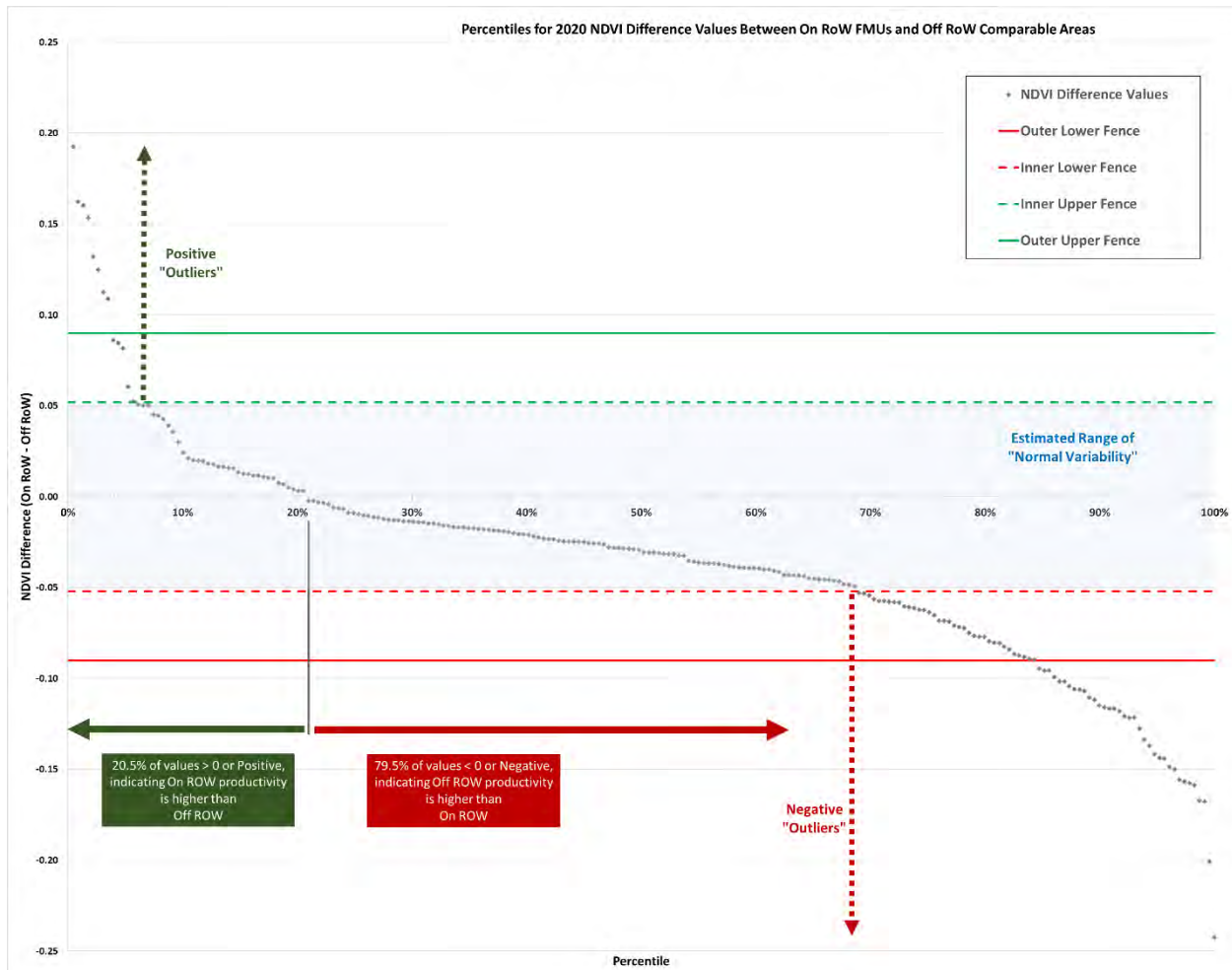
**Figure B.2.7** Distribution of 2020 NDVI Differences Between On RoW FMUs and Off RoW Comparable Areas



# **AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1 (2020)**

## Appendix B Statistical Analyses

January 10, 2022



The percentiles chart provides a visual display of the difference values for individual FMUs. Approximately 19.0% of differences were found to be positive (On RoW FMU – Off RoW comparable area = >0), while 81.0% were found to be negative (On RoW FMU – Off RoW comparable area = <0). This is further evidence of the negative skewness of the data. The estimated range of “normal variability” around an expected difference of 0 is estimated to be -0.052 to +0.052. Therefore, values above 0.052 can be considered “positive outliers” while values below -0.052 can be considered “negative outliers”. Based on this analysis there are many more “negative outliers” than “positive outliers”. Approximately 23.1% of On RoW FMUs (78) are considered in the “negative outlier” range, while 3.3% of On RoW FMUs (11) are considered in the “positive outlier” range.

**Figure B.2.8 Percentiles for 2019 NDVI Differences Between On RoW FMUs and Off RoW Comparable Areas**



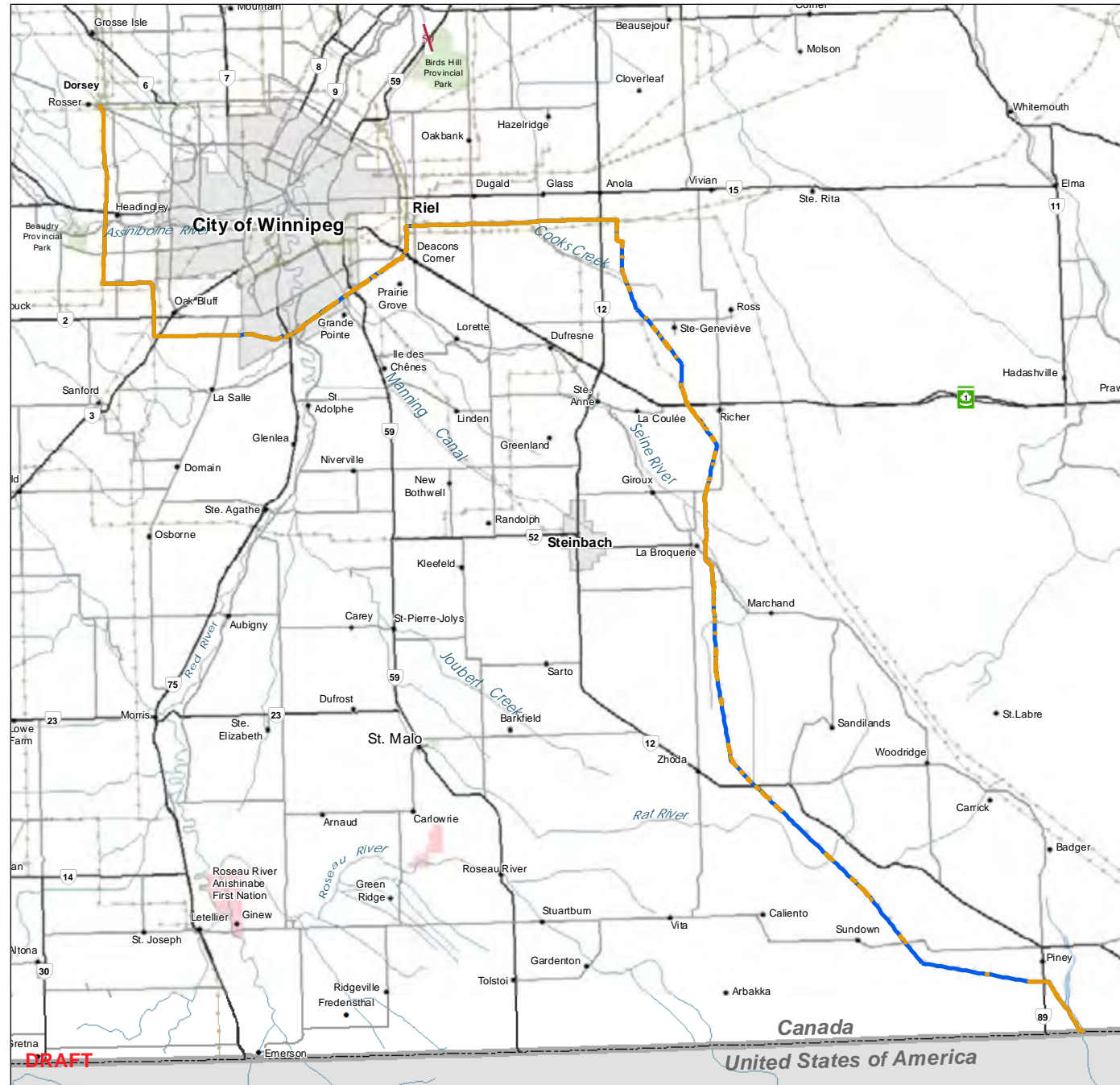
**AGRICULTURAL SOIL PRODUCTIVITY MONITORING FOR THE MANITOBA-MINNESOTA  
TRANSMISSION PROJECT: PRE-CONSTRUCTION (2019) AND POST-CONSTRUCTION YEAR 1  
(2020)**

Appendix C MapBook  
January 10, 2022

## **Appendix C   MAPBOOK**







#### Legend

- Manitoba-Minnesota Transmission Line
- Agricultural Land Use Along the Transmission Line
- Provincial Highway
- Provincial Road
- Existing Transmission Lines
- Community
- First Nation Lands
- Provincial Park
- City



0 10 20 km  
(At original document size of 8.5x11)  
1:700,000

#### Notes

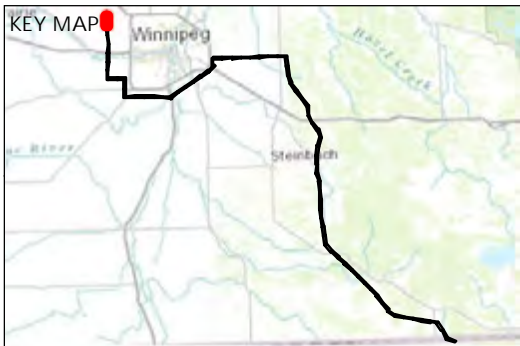
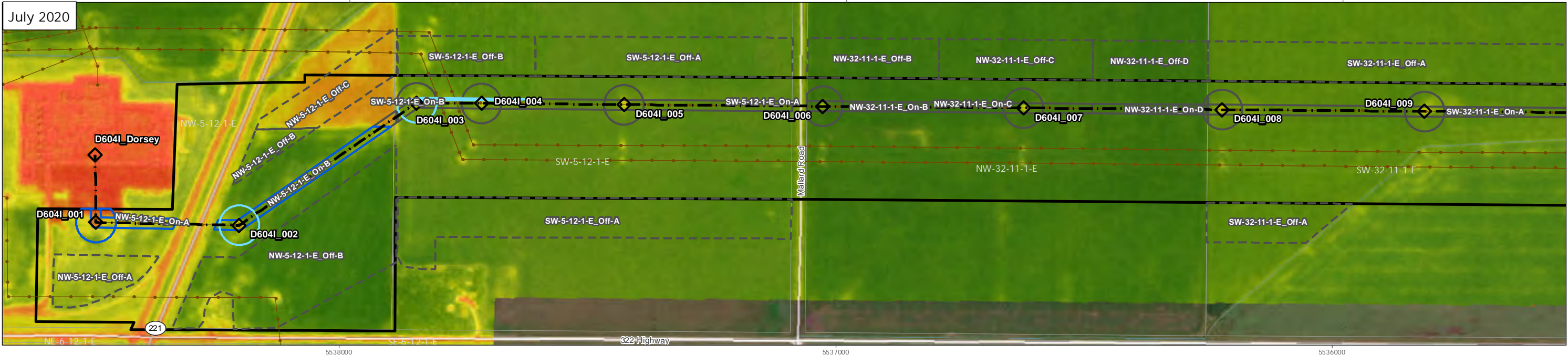
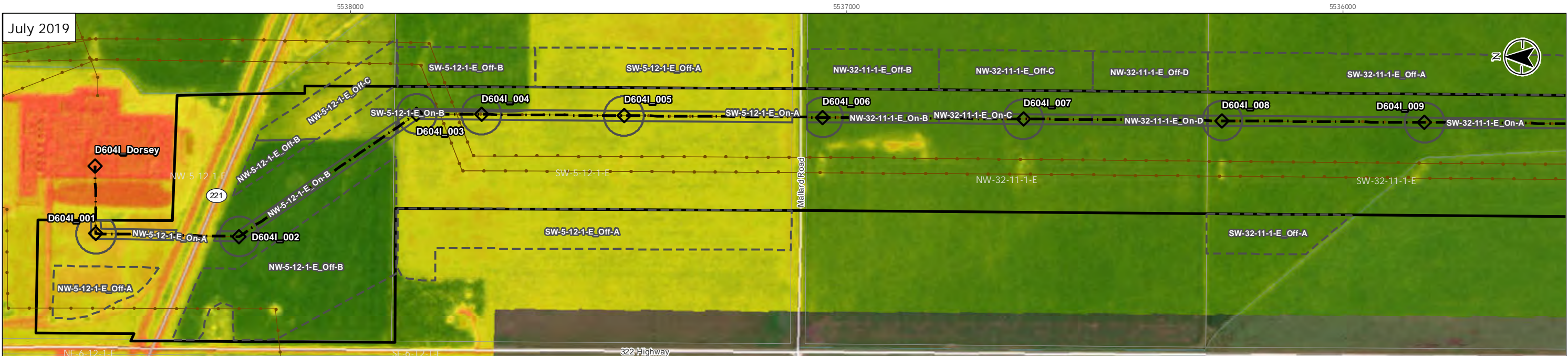
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Government of Manitoba, Government of Canada, Manitoba Hydro
3. Background: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community



Project Location Winnipeg, Manitoba	Prepared by JH on 2021-05-15 TR by DW on 2021-05-15 IR Review by ABC on 2021-05-15
Client/Project Manitoba Hydro Manitoba-Minnesota Transmission Line Soil Performance & Crop Performance Monitoring	111477020-003 REV3
Figure No. <b>1.1</b>	

Title  
**Manitoba Minnesota  
Transmission Line - Project Overview**





**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

Existing Transmission Lines

Highway

Major Road

Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

Client/Project

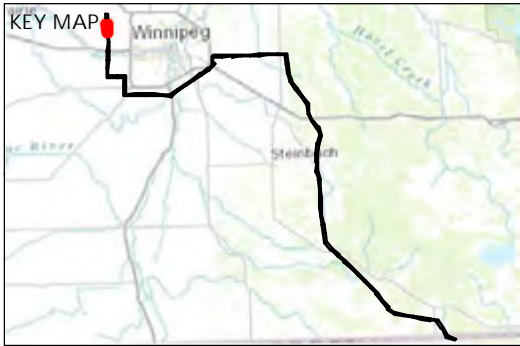
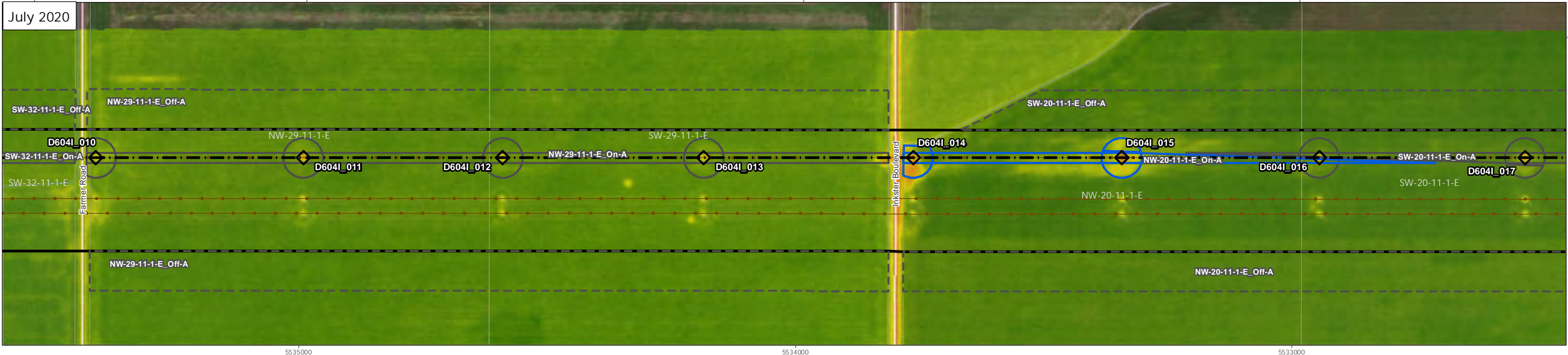
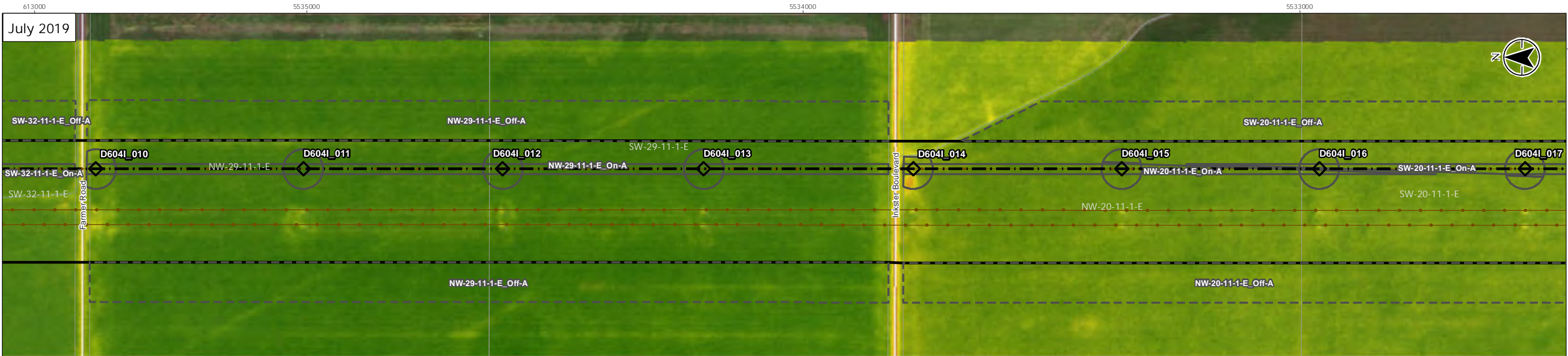
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

**C.2-1**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

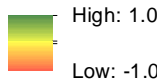
#### Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

#### Normalized Difference Vegetation Index (NDVI)



#### NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

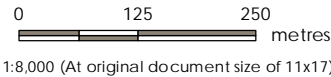
□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse



**DRAFT**

#### Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

#### Client/Project

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

111477020-002-REVC

#### Map No.

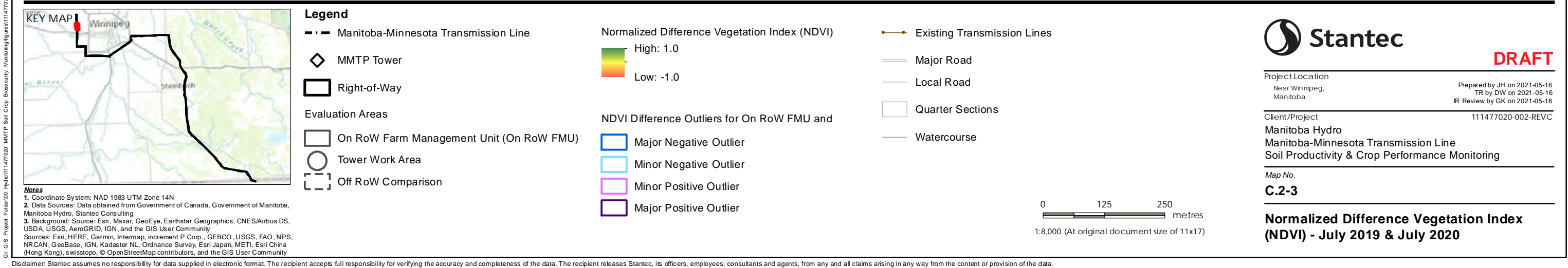
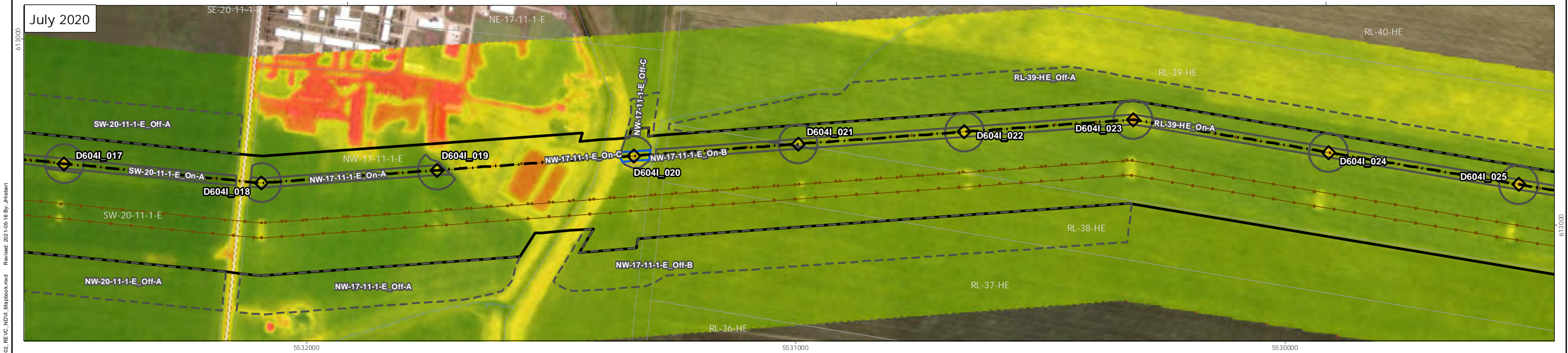
**C.2-2**

### Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020

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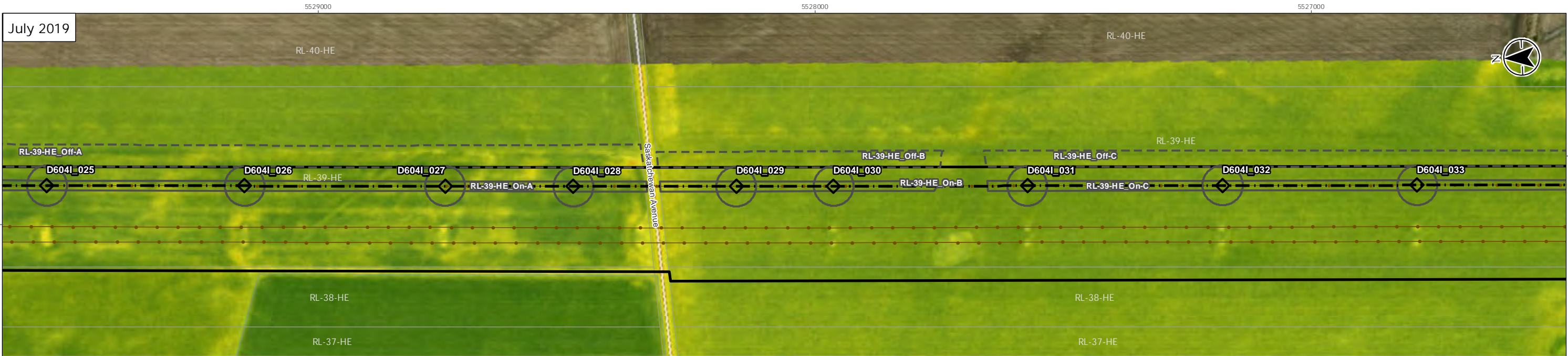
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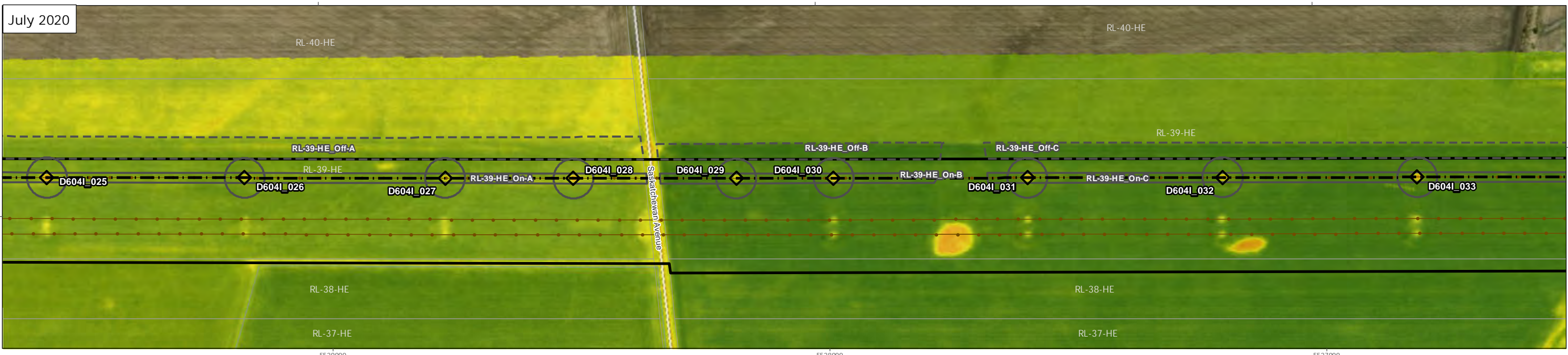




July 2019



July 2020



**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
4. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

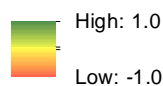
**Evaluation Areas**

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**



**NDVI Difference Outliers for On RoW FMU and**

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

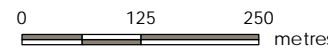
□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse



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**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

Client/Project  
**Manitoba Hydro**  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

**C.2-4**

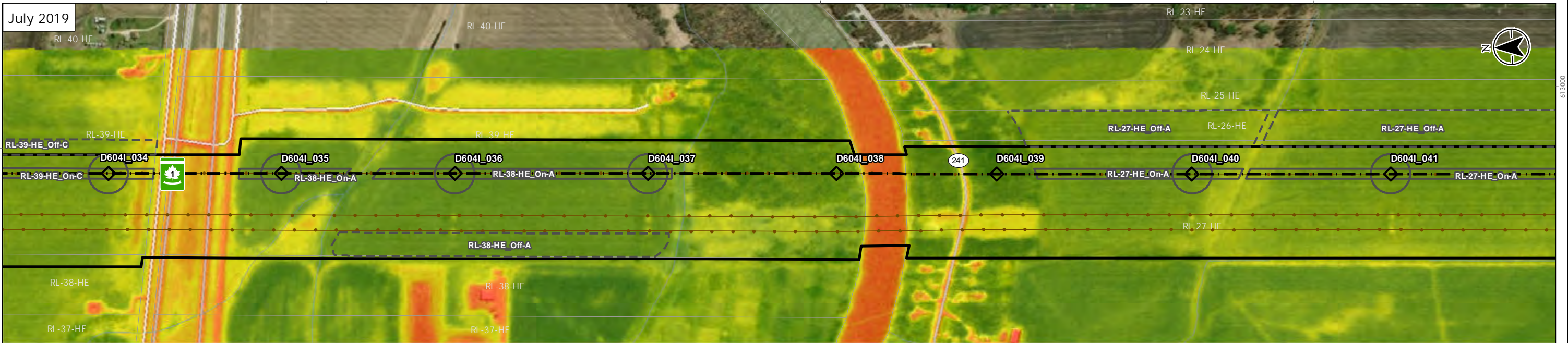
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

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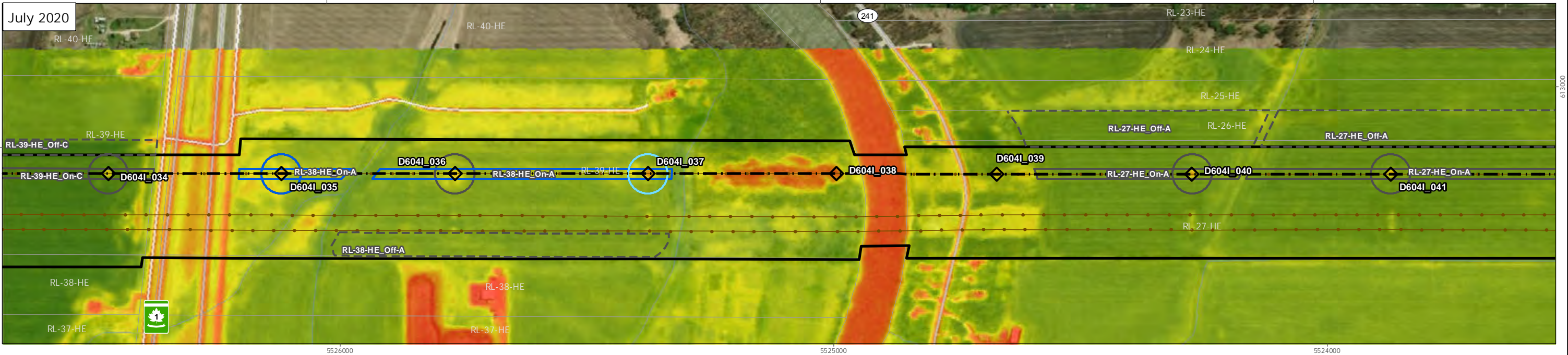
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July 2019



July 2020



#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Highway

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro

Manitoba-Minnesota Transmission Line

Soil Productivity & Crop Performance Monitoring

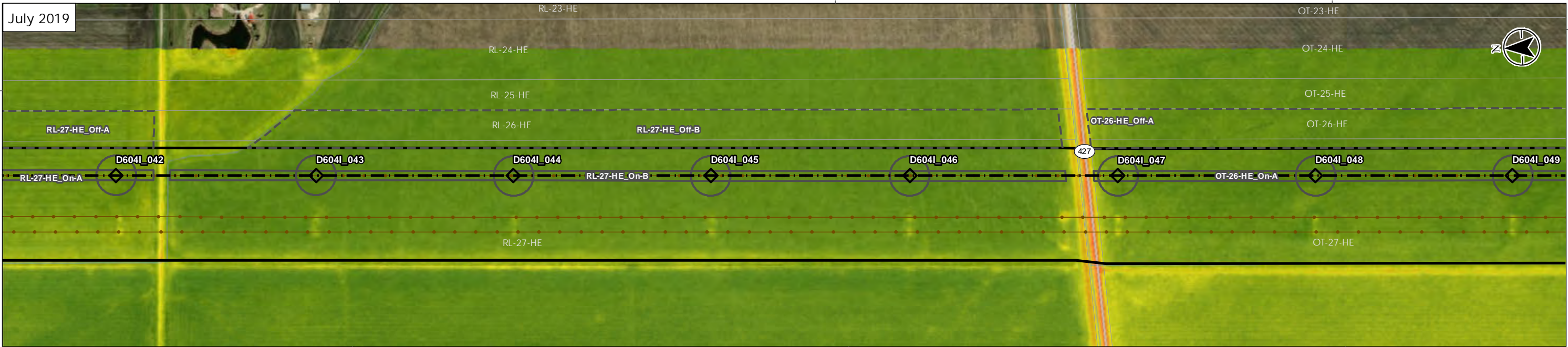
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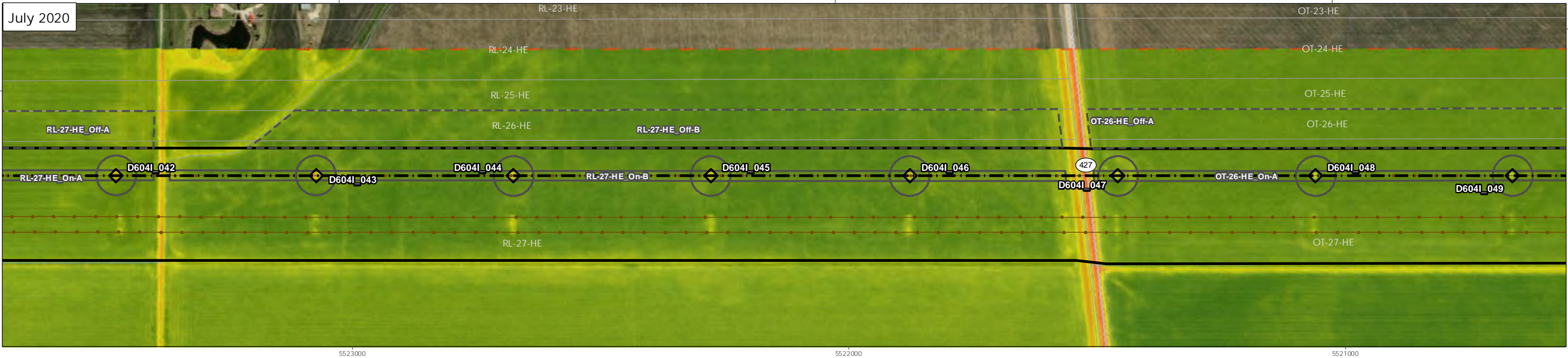
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**



July 2019



July 2020



**Notes**  
1. Coordinate System: NAD 1983 UTM Zone 14N  
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting  
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community  
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

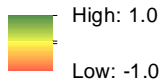
**Evaluation Areas**

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**



**NDVI Difference Outliers for On RoW FMU and**

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

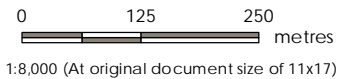
□ Major Positive Outlier

— Existing Transmission Lines

— Highway

□ Quarter Sections

— Watercourse



**DRAFT**

**Project Location**

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

**Client/Project**

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

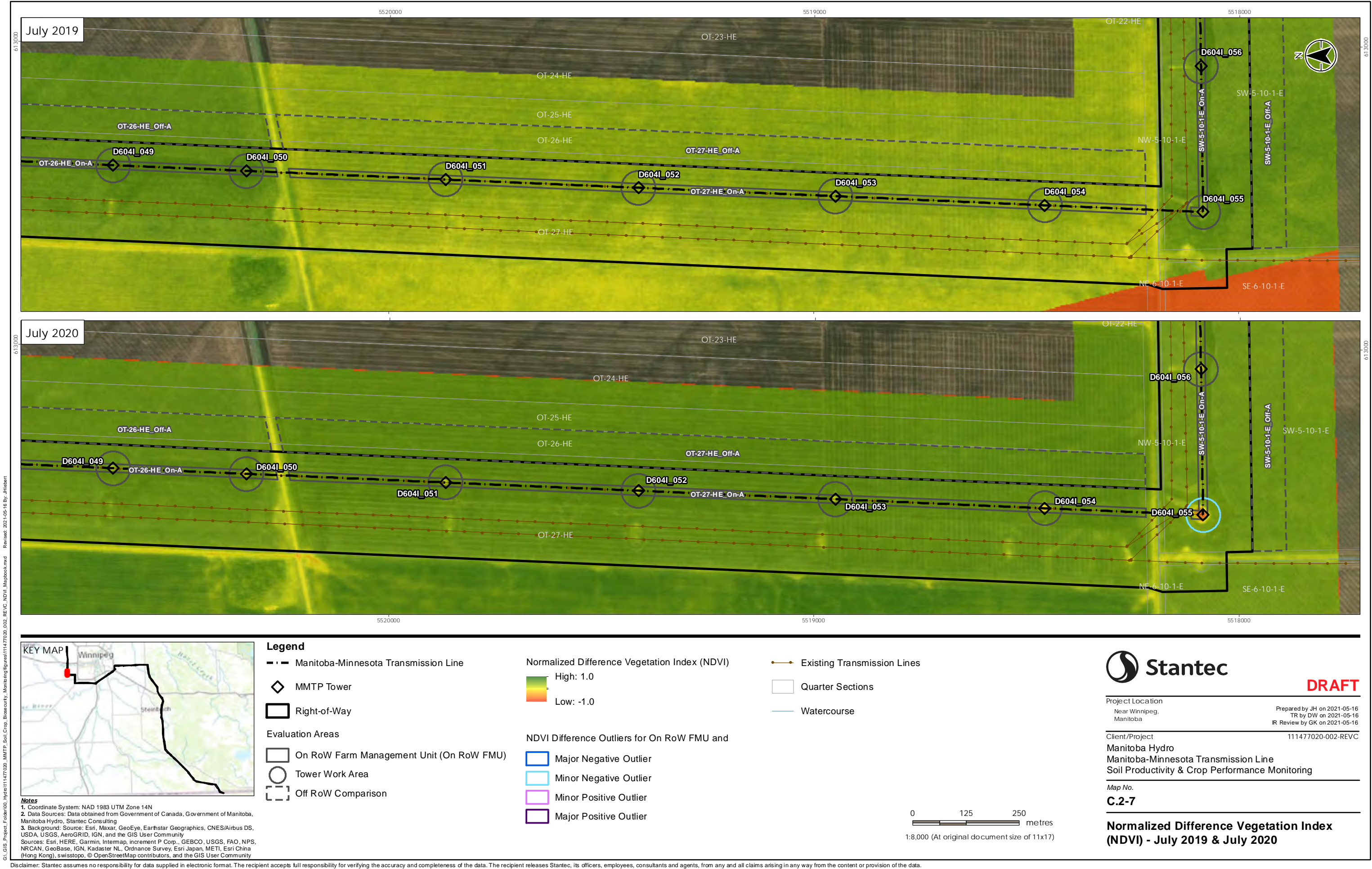
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**Map No.**

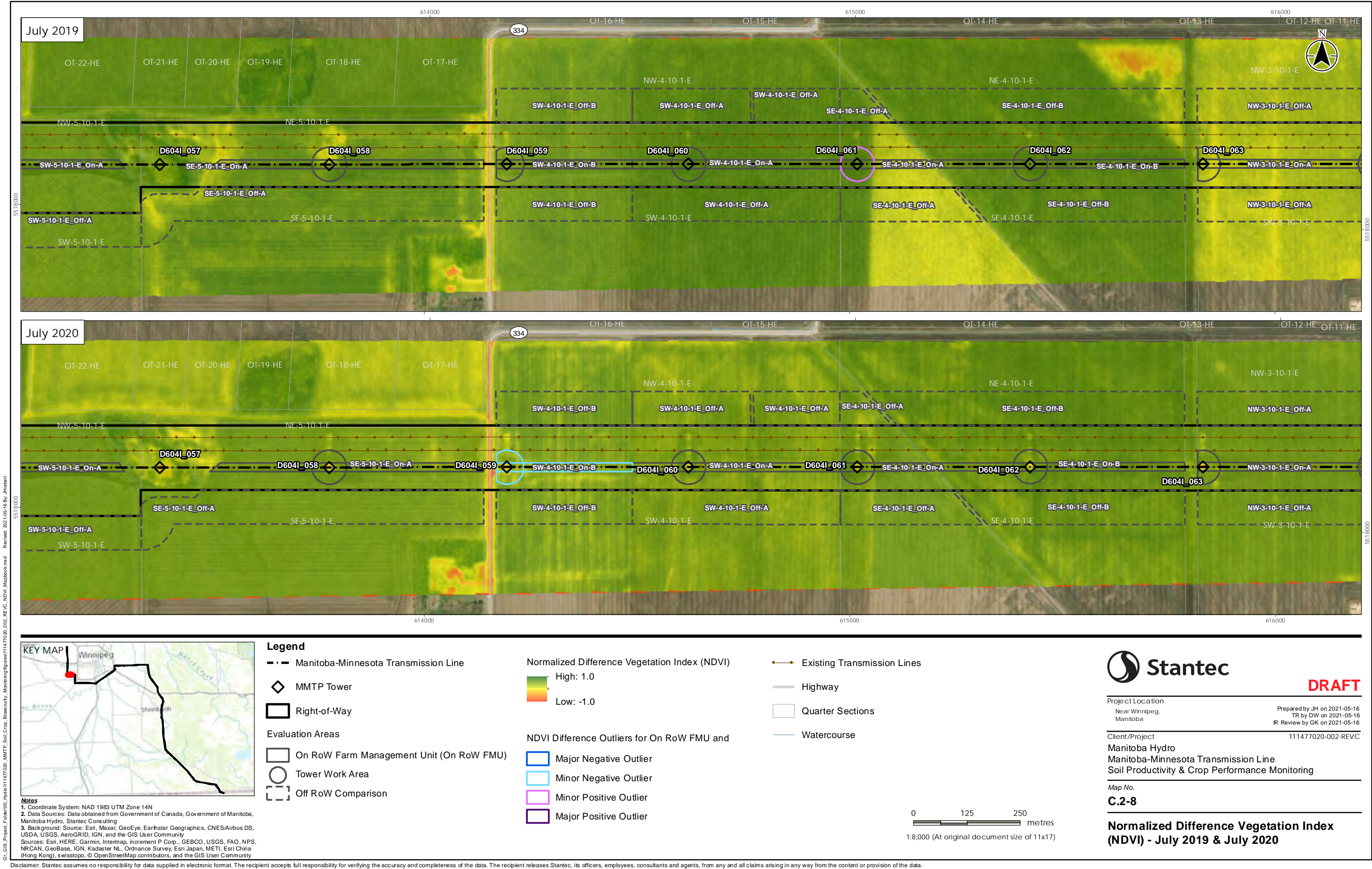
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**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

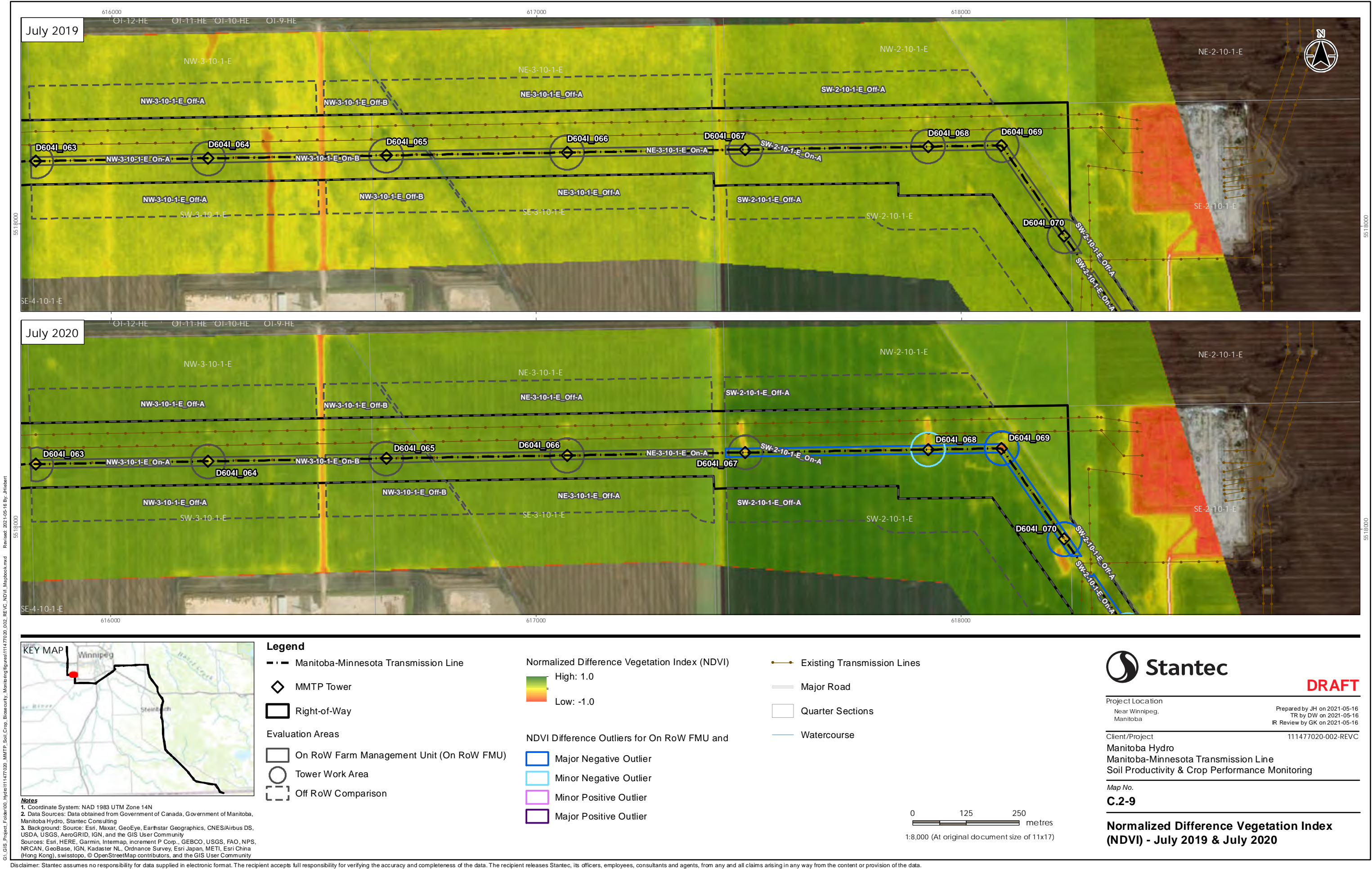




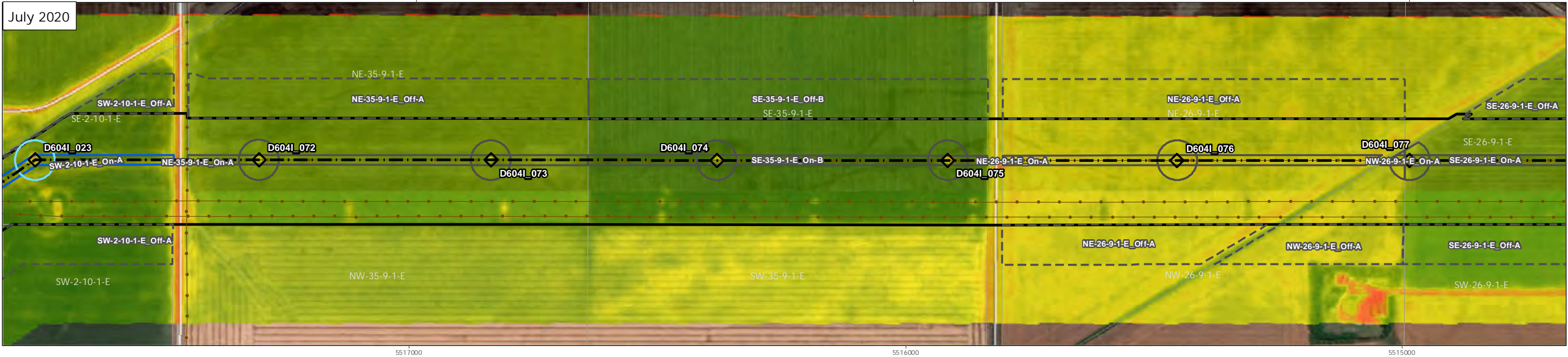
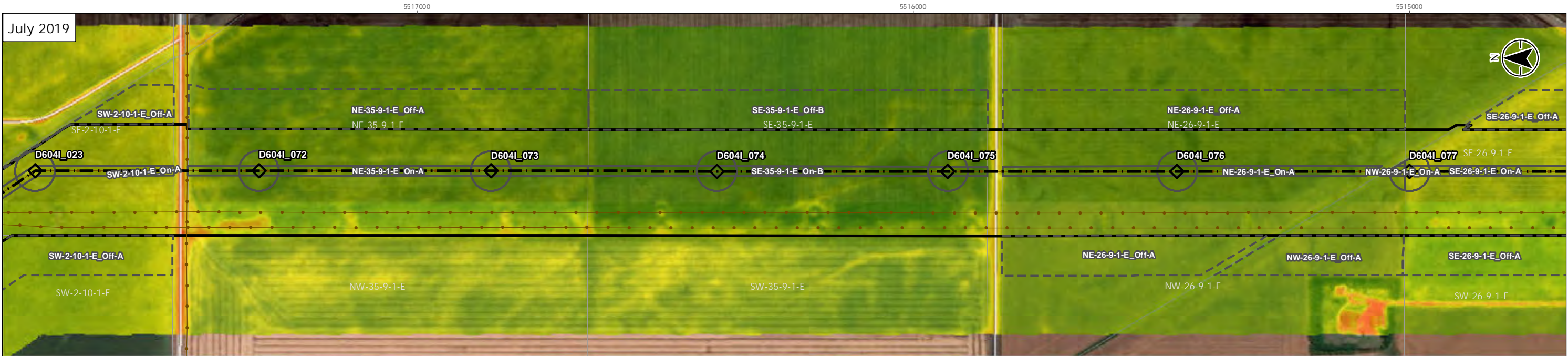












**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

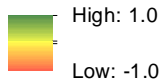
**Evaluation Areas**

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**



**NDVI Difference Outliers for On RoW FMU and**

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

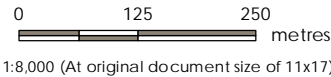
□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse



**DRAFT**

**Project Location**

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

**Client/Project**

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

111477020-002-REVC

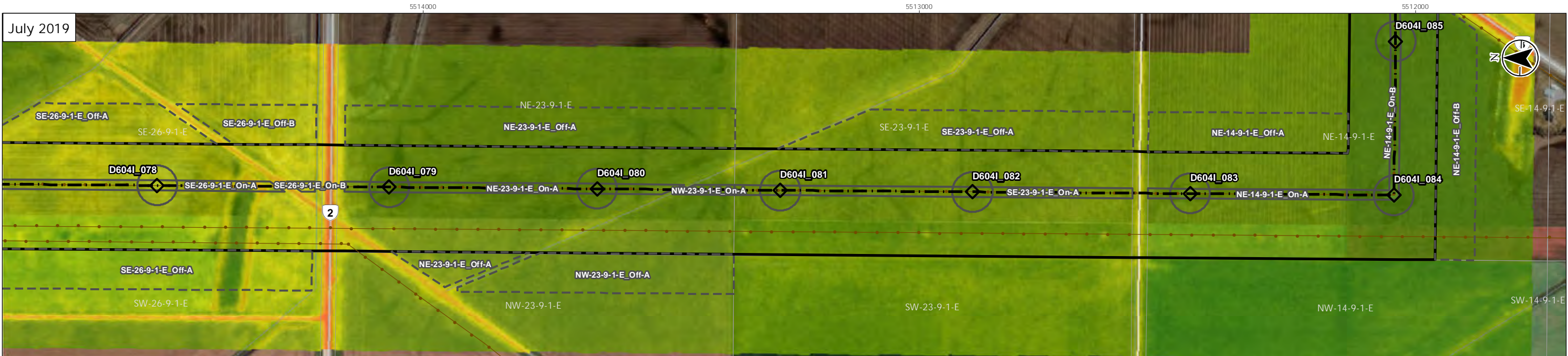
**Map No.**

**C.2-10**

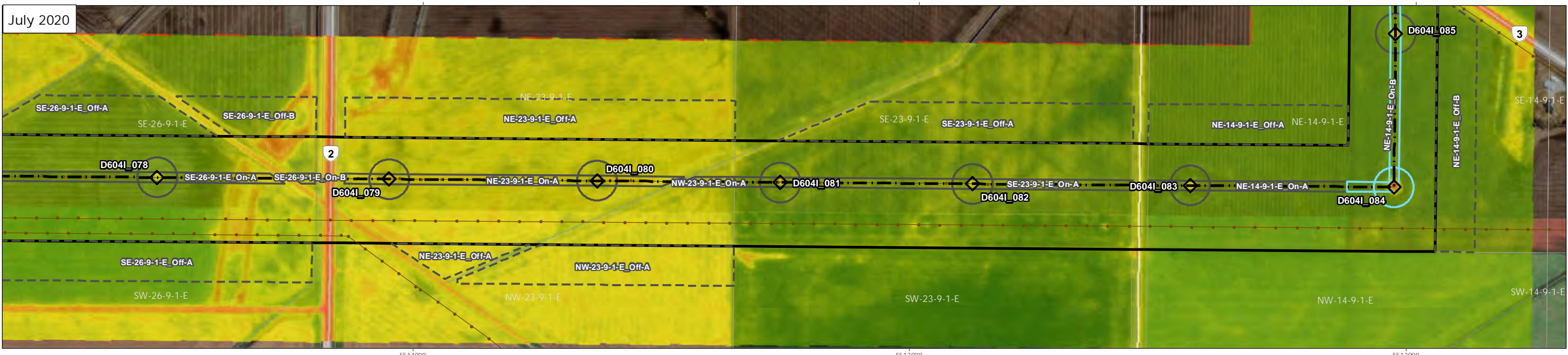
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**



July 2019



July 2020



#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

Existing Transmission Lines

Highway

Major Road

Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

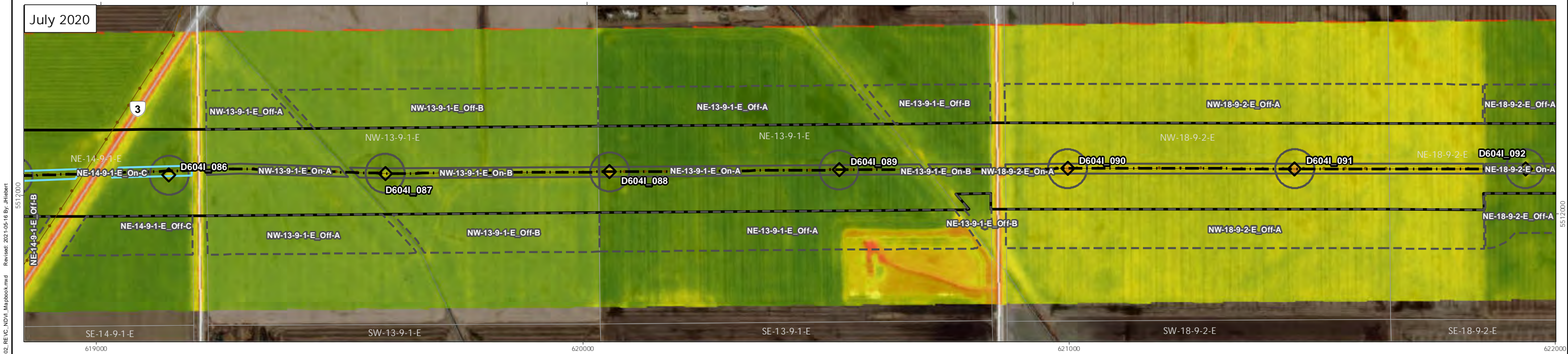
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

**C.2-11**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

- Highway
- Major Road
- Quarter Sections
- Watercourse

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

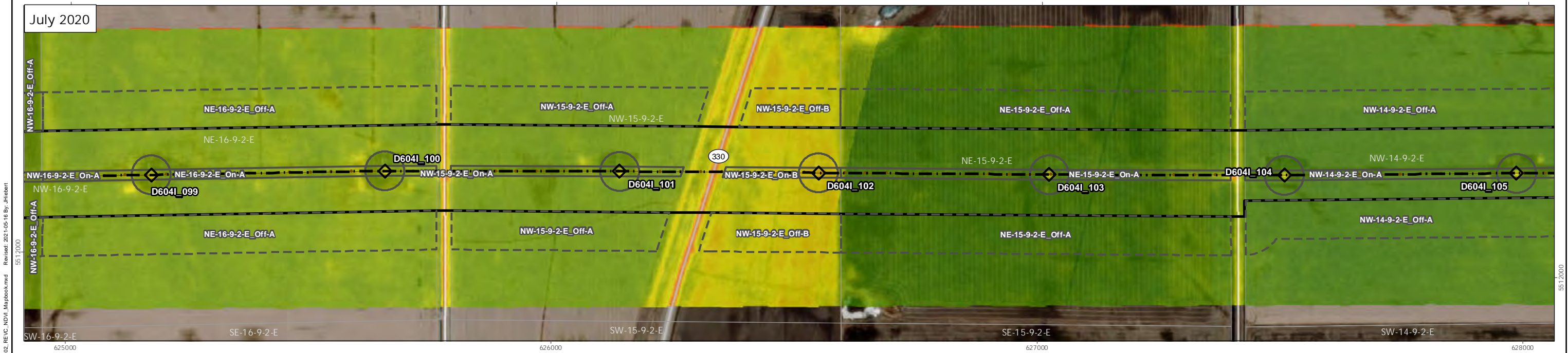
Map No.  
**C.2-12**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**









#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

Major Negative Outlier

Minor Negative Outlier

Minor Positive Outlier

Major Positive Outlier

Existing Transmission Lines

Highway

Major Road

Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

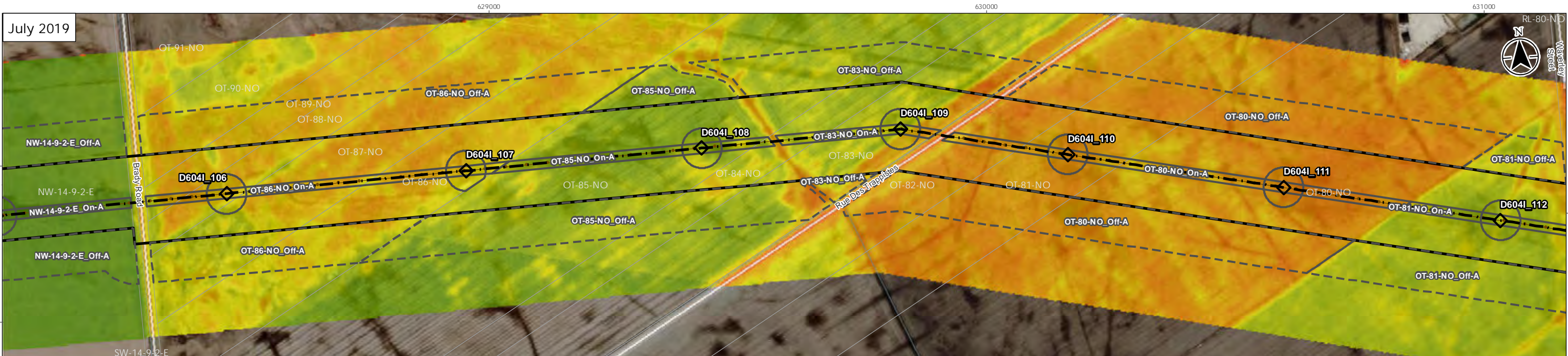
Map No.

**C.2-14**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**



July 2019



July 2020



#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

#### Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

#### Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

#### NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres  
1:8,000 (At original document size of 11x17)



**DRAFT**

#### Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

#### Client/Project

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

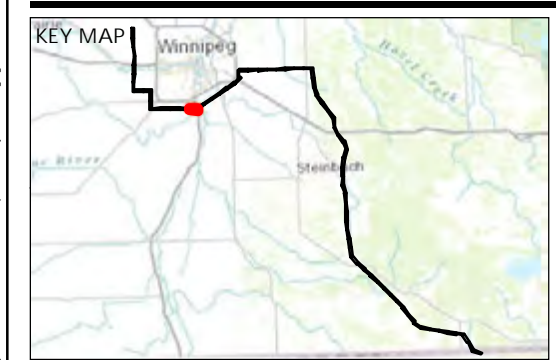
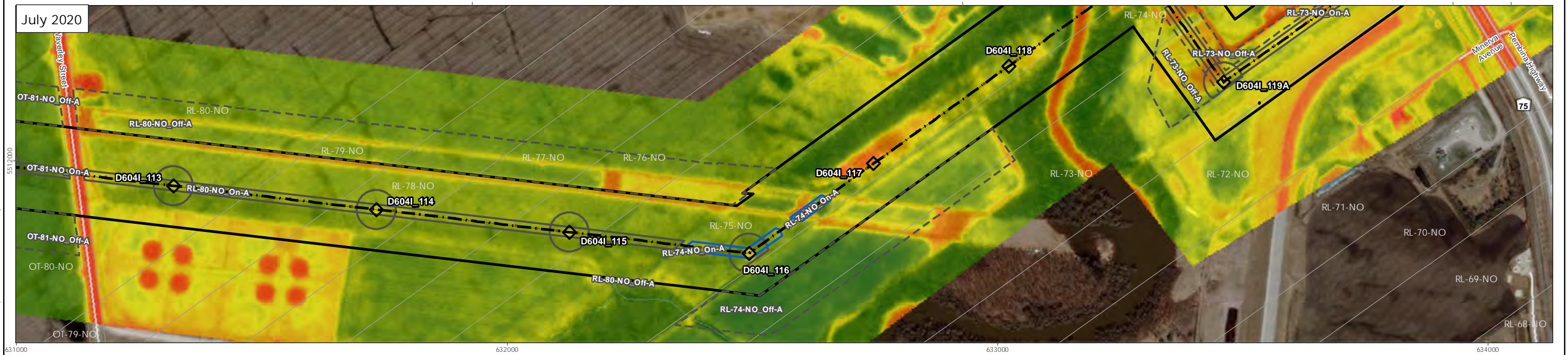
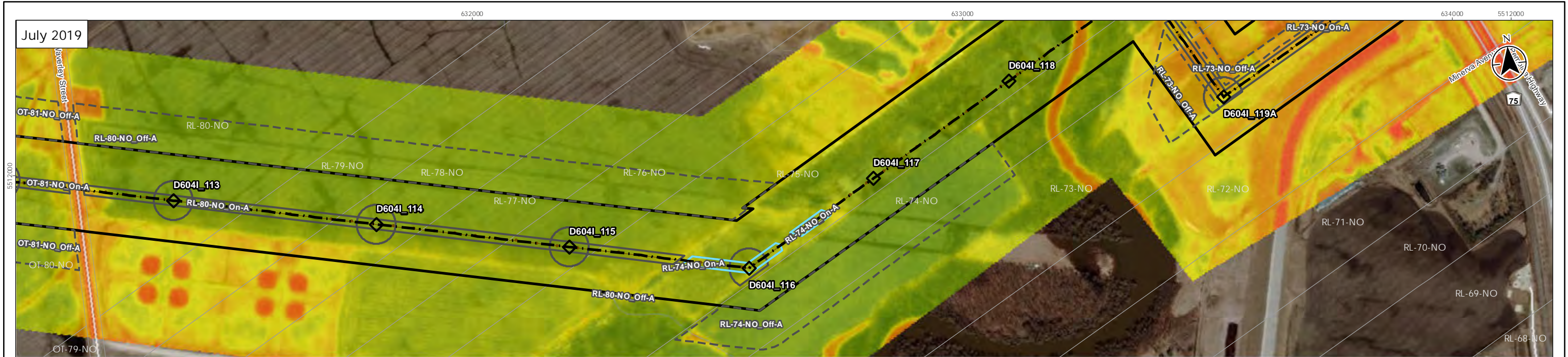
111477020-002-REVC

#### Map No.

**C.2-15**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison
- Normalized Difference Vegetation Index (NDVI)
  - High: 1.0
  - Low: -1.0
- NDVI Difference Outliers for On RoW FMU and
  - Major Negative Outlier
  - Minor Negative Outlier
  - Minor Positive Outlier
  - Major Positive Outlier
- Existing Transmission Lines
- Highway
- Major Road
- Quarter Sections
- Watercourse

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

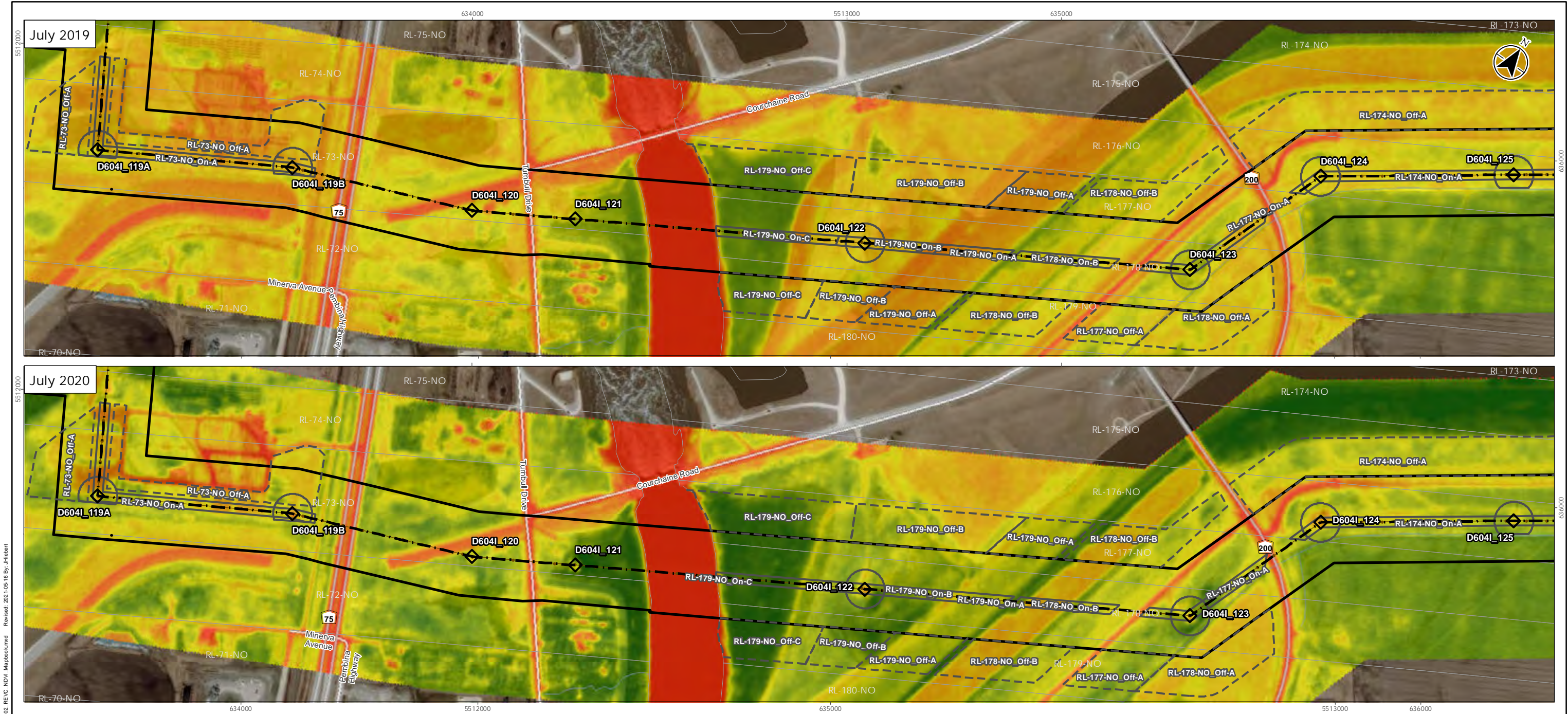
Map No.  
**C.2-16**

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
R Review by GK on 2021-05-16

111477020-002-REVC

0 125 250 metres  
1:8,000 (At original document size of 11x17)





**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

- Highway
- Major Road
- Quarter Sections
- Watercourse

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-17**

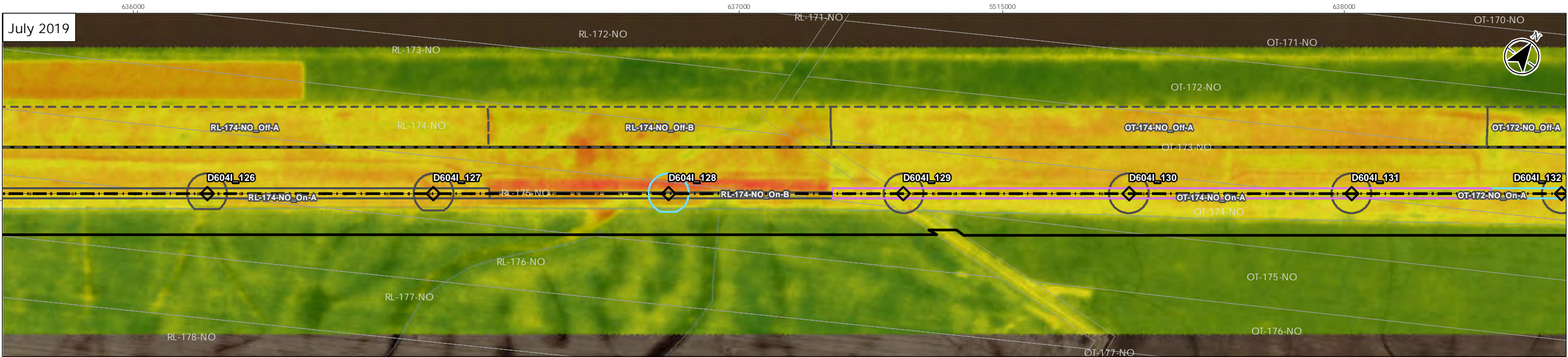
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TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

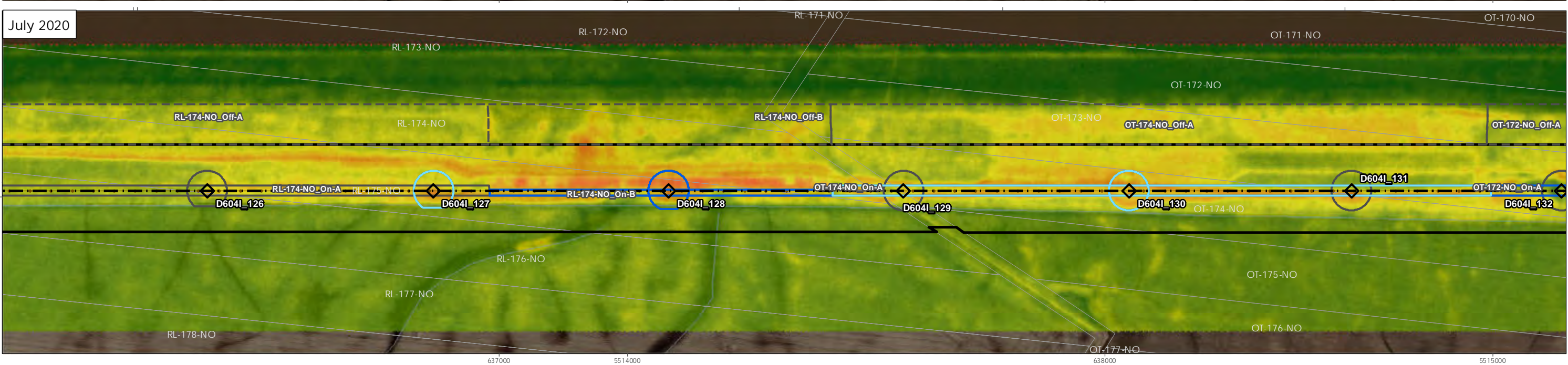
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**



July 2019



July 2020



**Notes**  
1. Coordinate System: NAD 1983 UTM Zone 14N  
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting  
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community  
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

□ Quarter Sections

— Watercourse

0 125 250 metres

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Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
R Review by GK on 2021-05-16

Client/Project

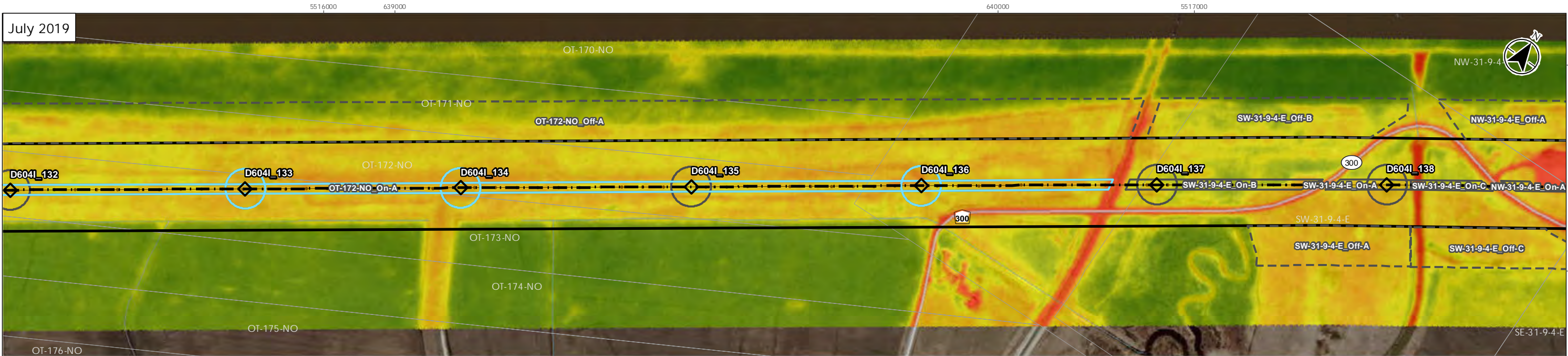
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

**C.2-18**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
4. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

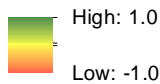
Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)



NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

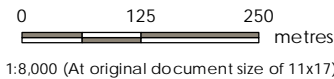
□ Major Positive Outlier

— Existing Transmission Lines

— Highway

□ Quarter Sections

— Watercourse



**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

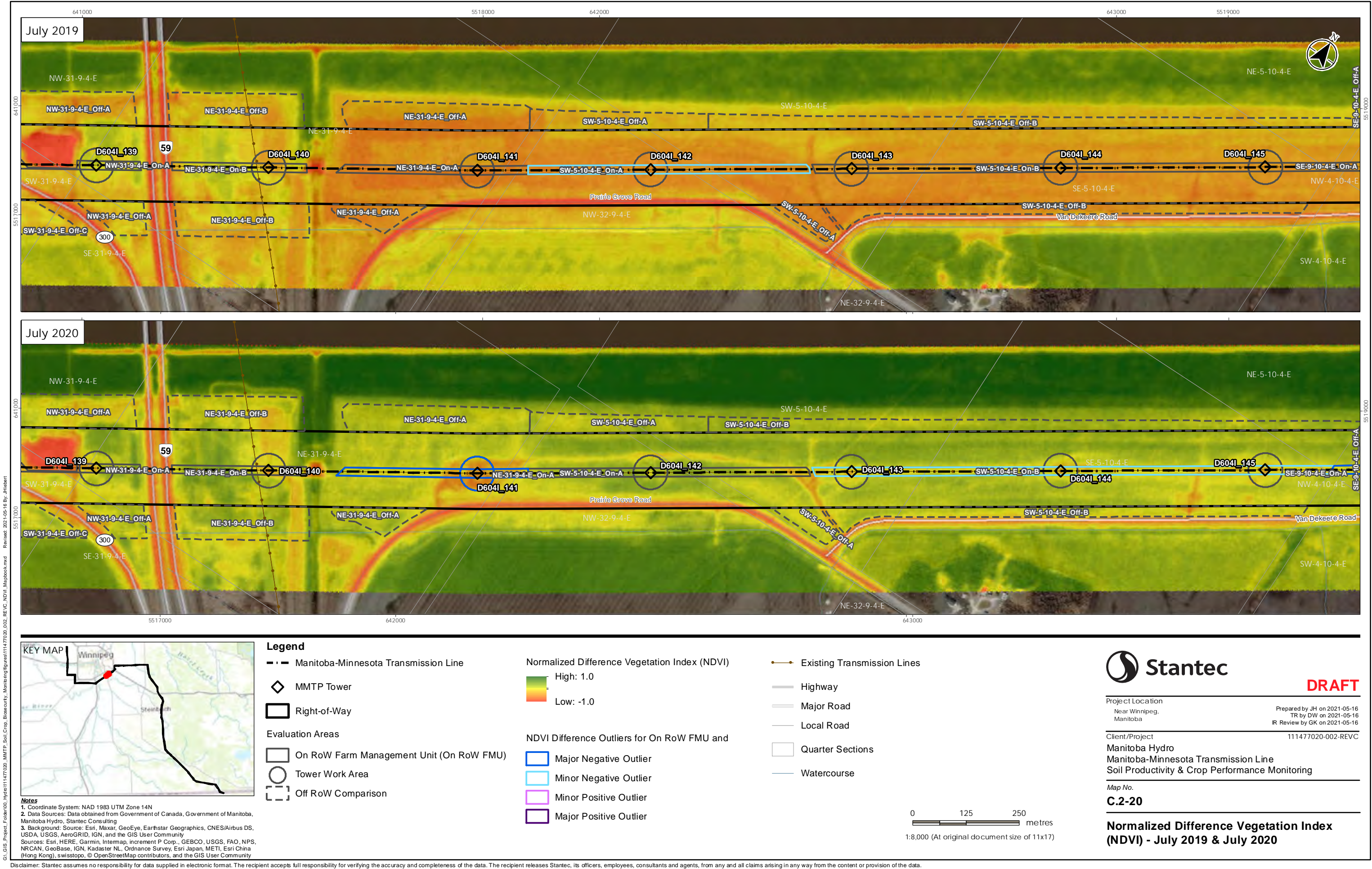
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TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

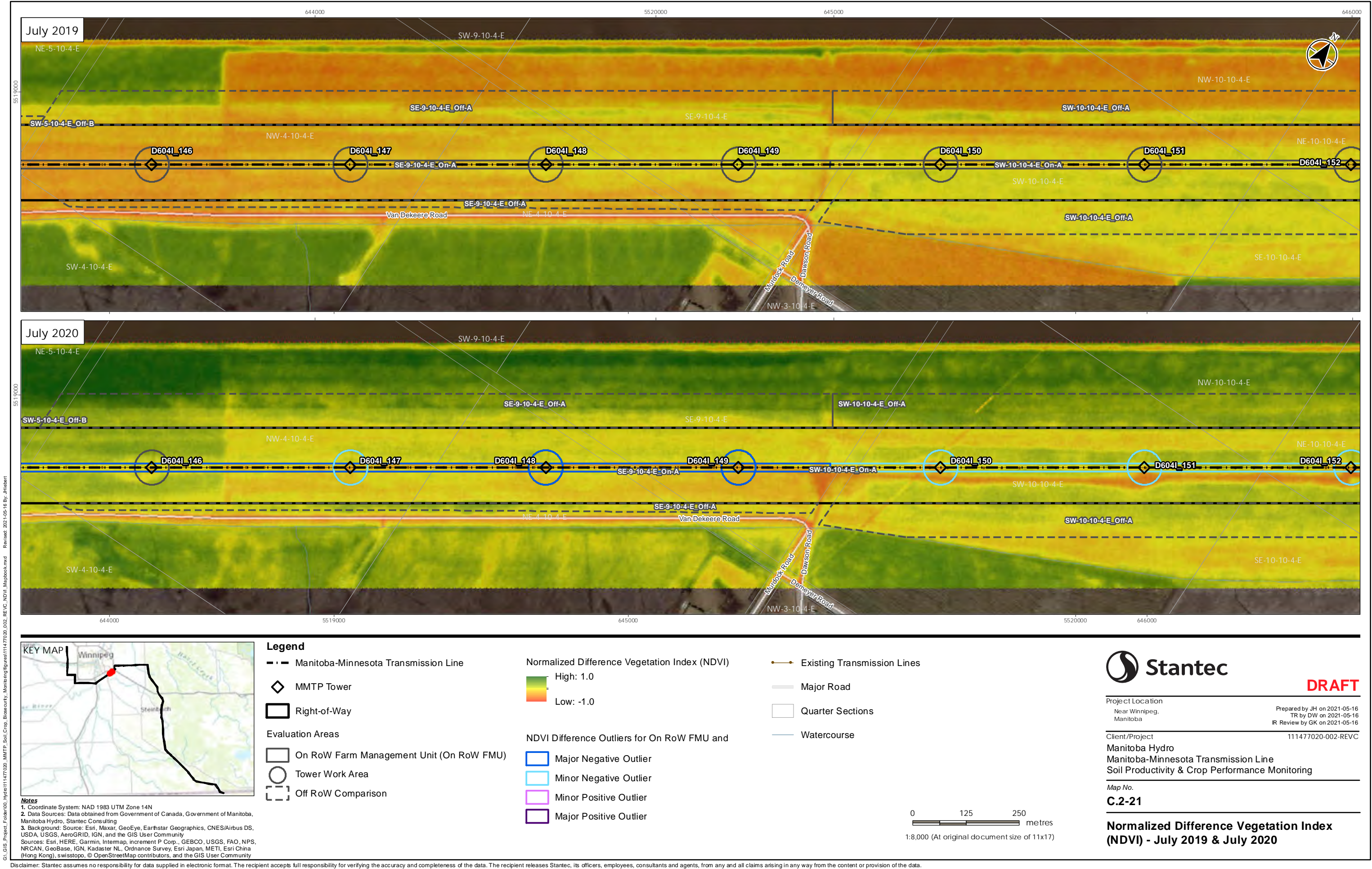
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**C.2-19**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

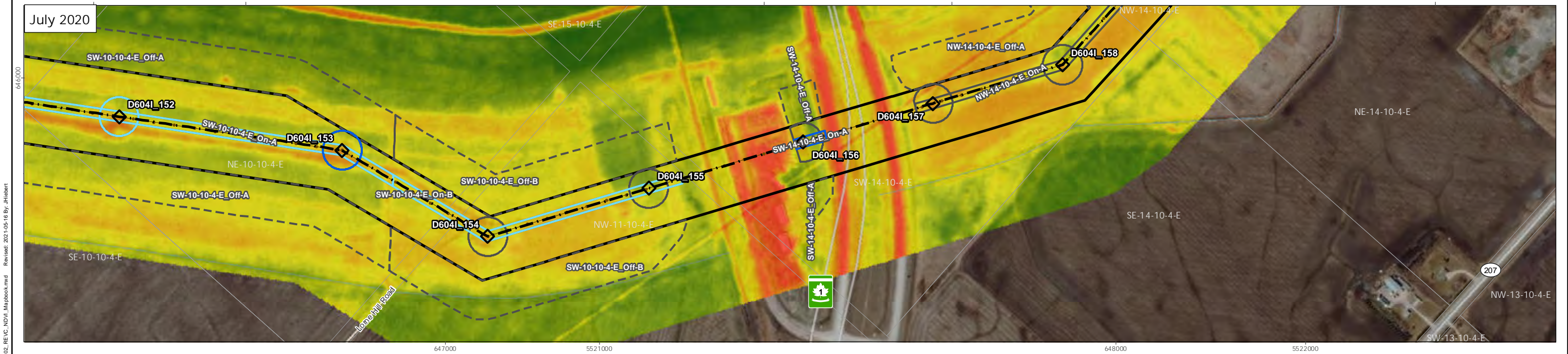
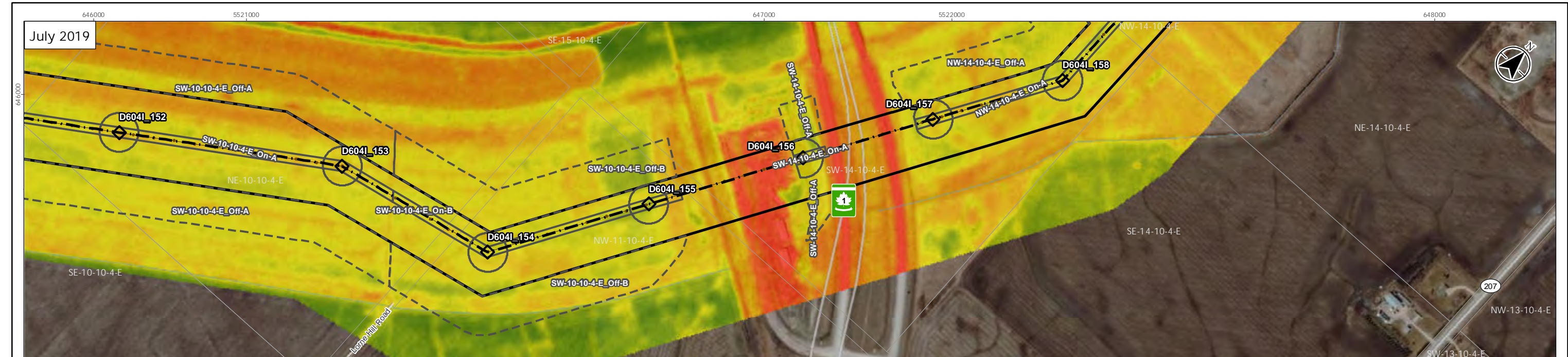












**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison
- Normalized Difference Vegetation Index (NDVI)
  - High: 1.0
  - Low: -1.0
- NDVI Difference Outliers for On RoW FMU and
  - Major Negative Outlier
  - Minor Negative Outlier
  - Minor Positive Outlier
  - Major Positive Outlier
- Existing Transmission Lines
- Highway
- Major Road
- Quarter Sections
- Watercourse

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-22**

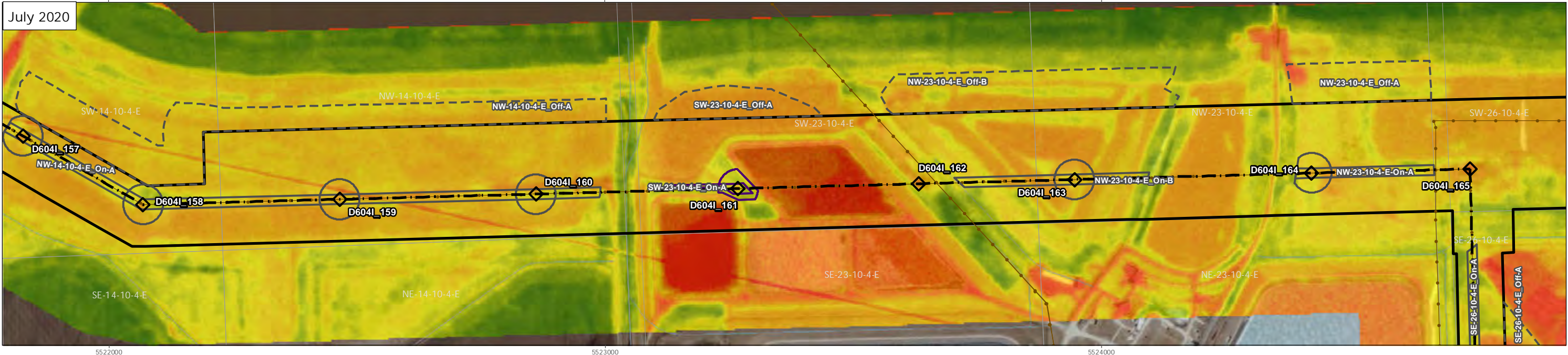
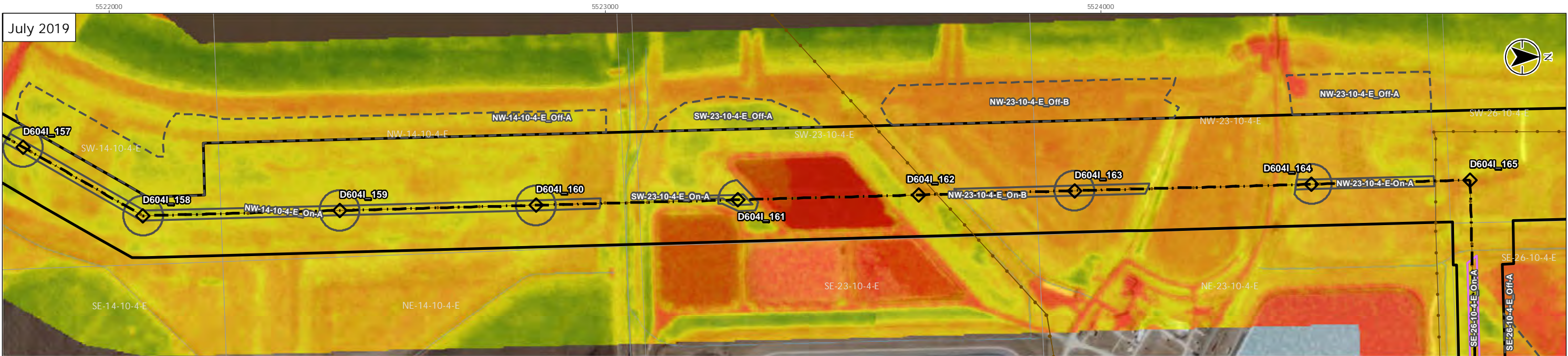
Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

0 125 250 metres  
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**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
4. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Highway

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

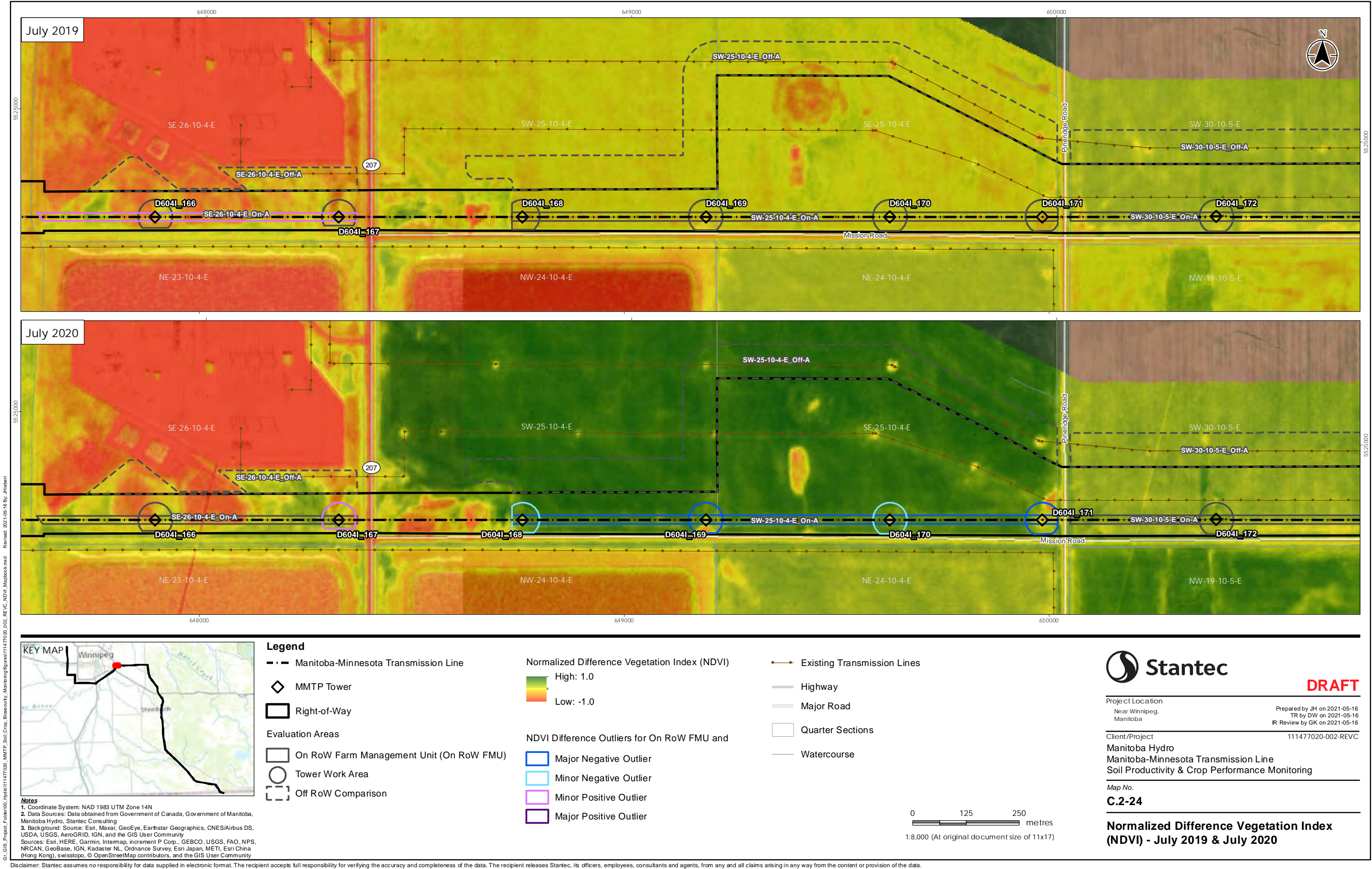
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

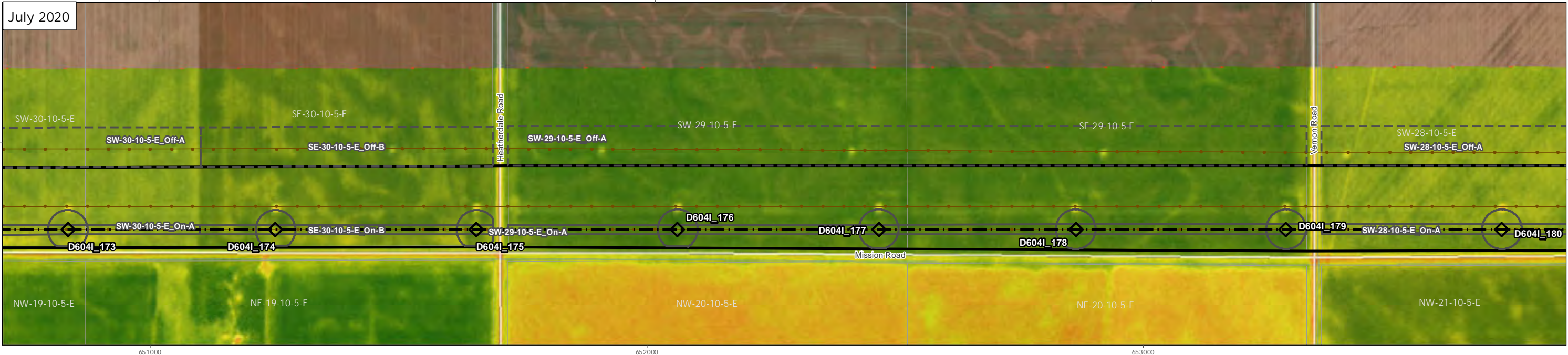
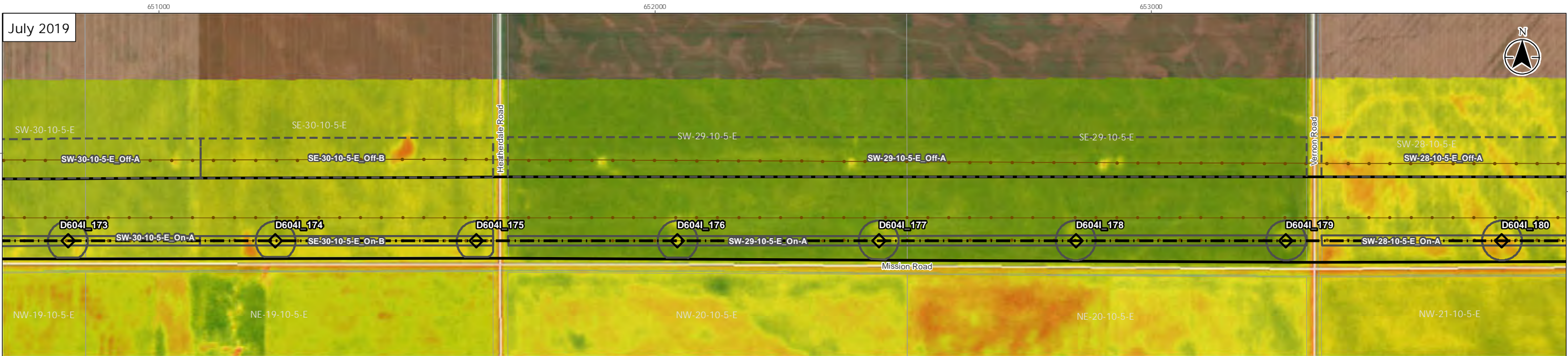
**C.2-23**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**









**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
4. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

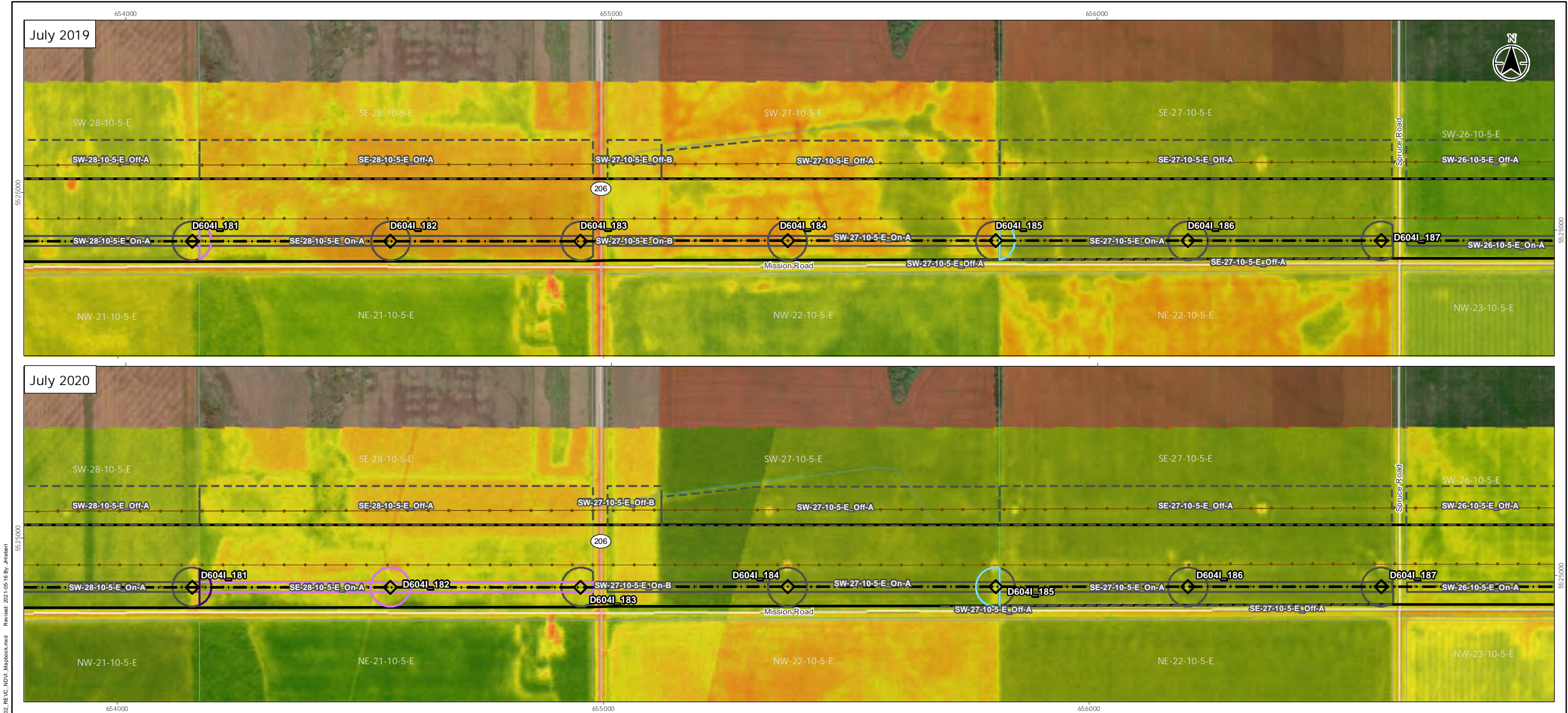
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

**C.2-25**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

Existing Transmission Lines

Highway

Major Road

Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro

Manitoba-Minnesota Transmission Line

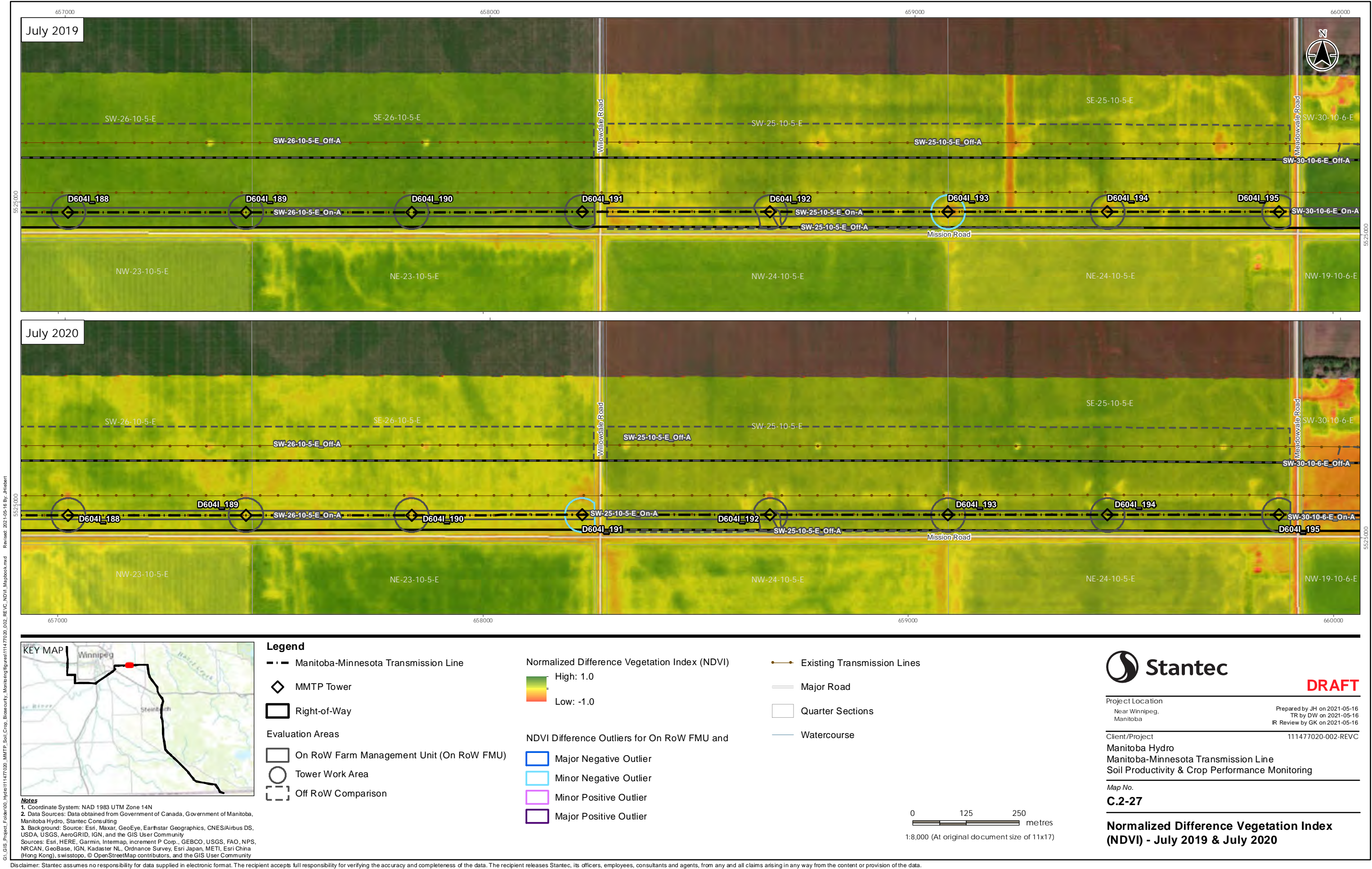
Soil Productivity & Crop Performance Monitoring

Map No.

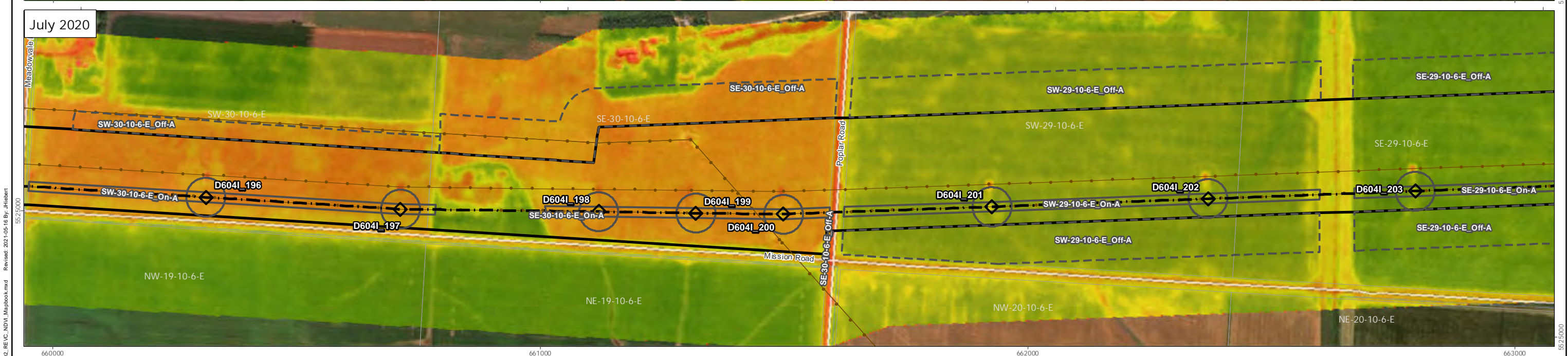
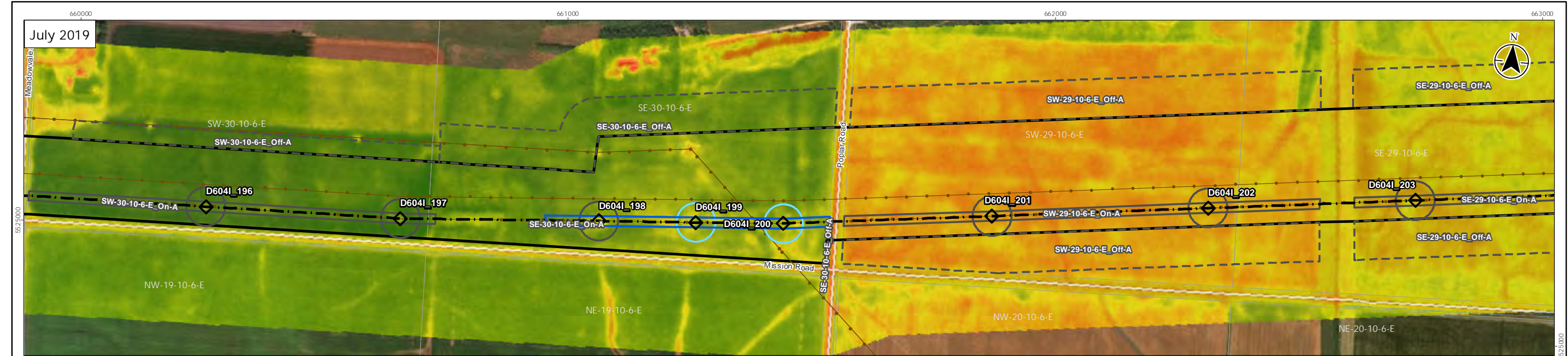
**C.2-26**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**









#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

#### Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

#### Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

#### NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

#### Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

#### Client/Project

111477020-002-REVC

Manitoba Hydro

Manitoba-Minnesota Transmission Line

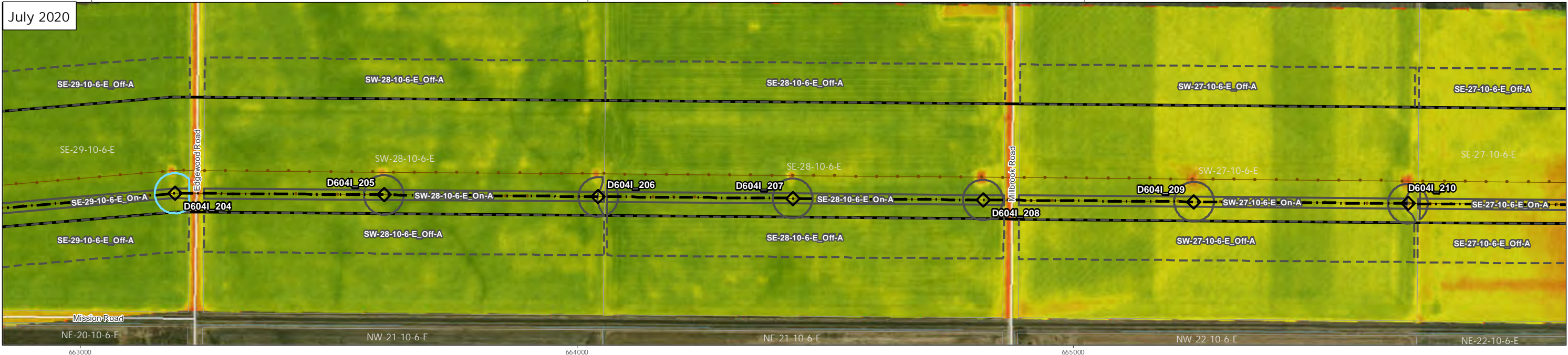
Soil Productivity & Crop Performance Monitoring

#### Map No.

**C.2-28**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

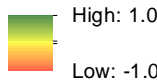
Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)



NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

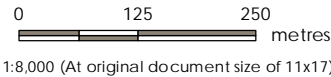
□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse



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**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
R Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

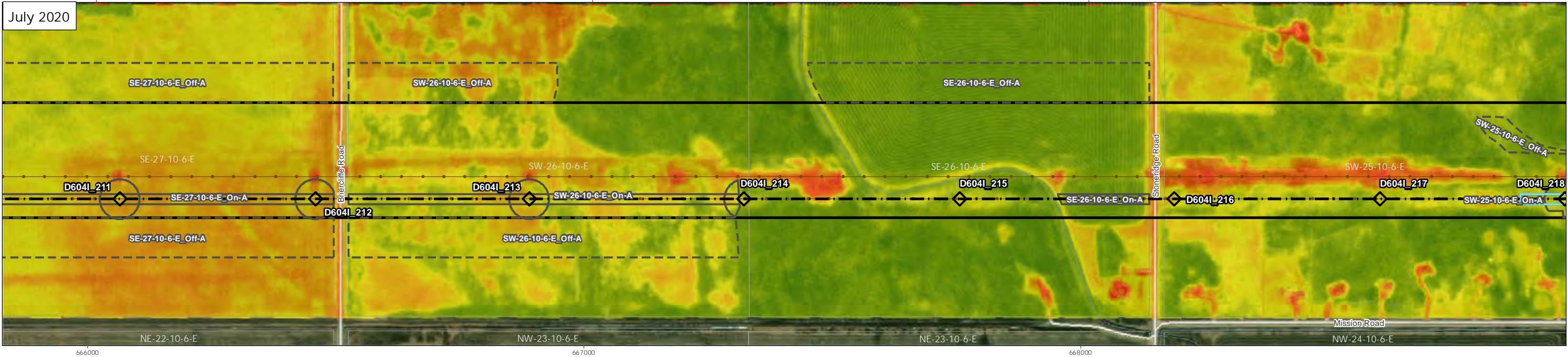
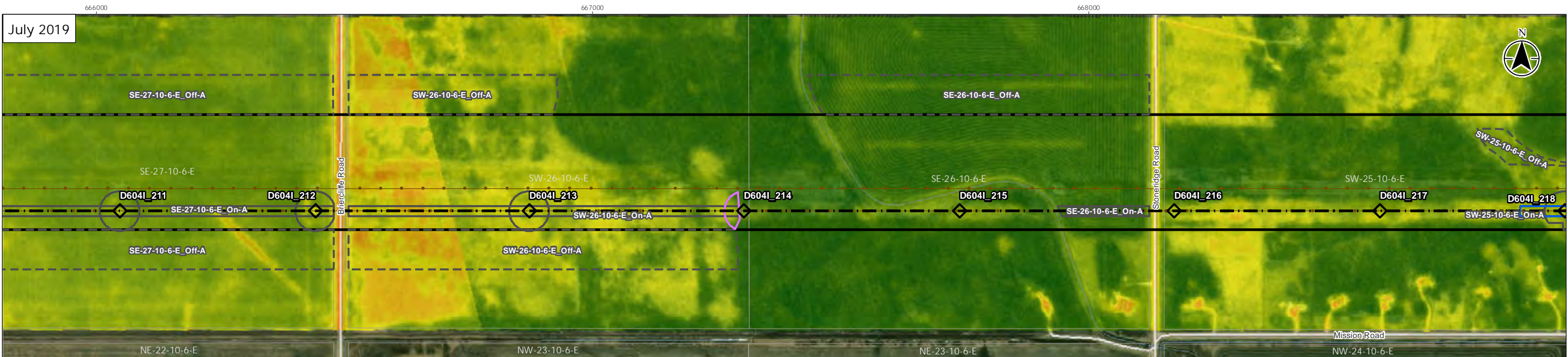
**C.2-29**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

G:\GIS\Project\_Folder\00\_Hydro\11477020\_MMTP\_Soil\_Crop\_Performance\_Monitoring\Figures\111477020\_002\_REV.C\_NDVI\_Mapbook.mxd Revised: 2021-05-16 By: JHiebert

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**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
4. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro

Manitoba-Minnesota Transmission Line

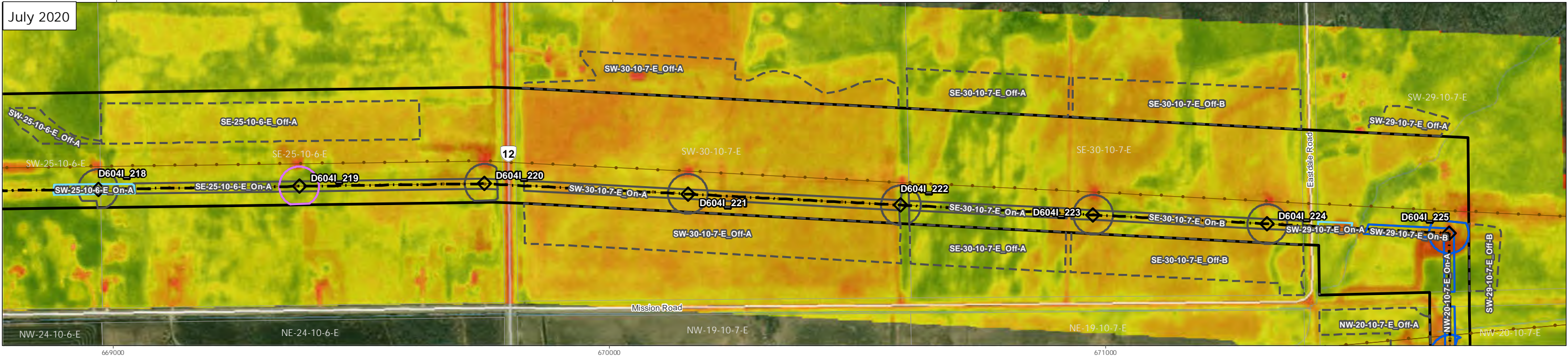
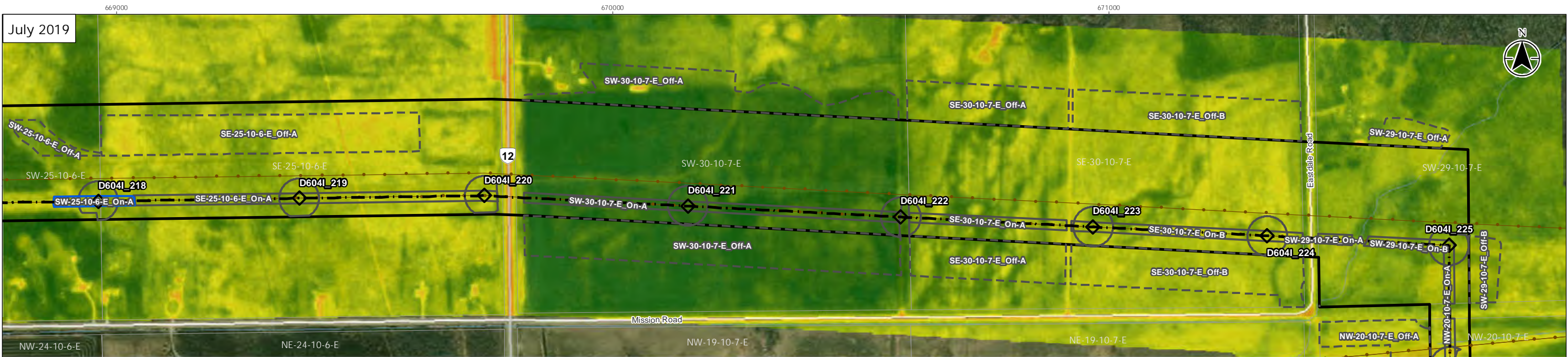
Soil Productivity & Crop Performance Monitoring

Map No.

**C.2-30**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

Major Negative Outlier

Minor Negative Outlier

Minor Positive Outlier

Major Positive Outlier

Existing Transmission Lines

Highway

Major Road

Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Client/Project

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

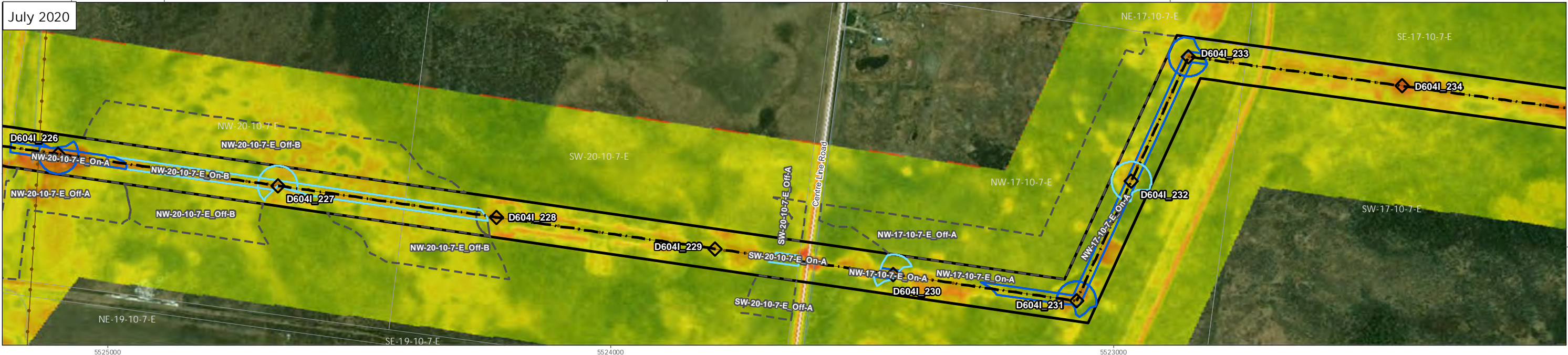
**C.2-31**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC





Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

Existing Transmission Lines

Major Road

Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



DRAFT

Project Location

Near Winnipeg,  
Manitoba

Client/Project

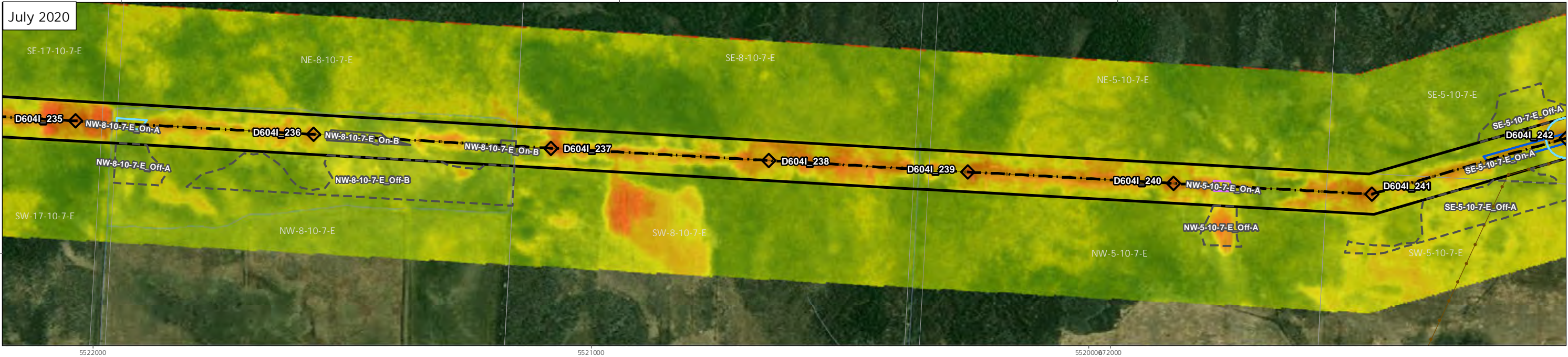
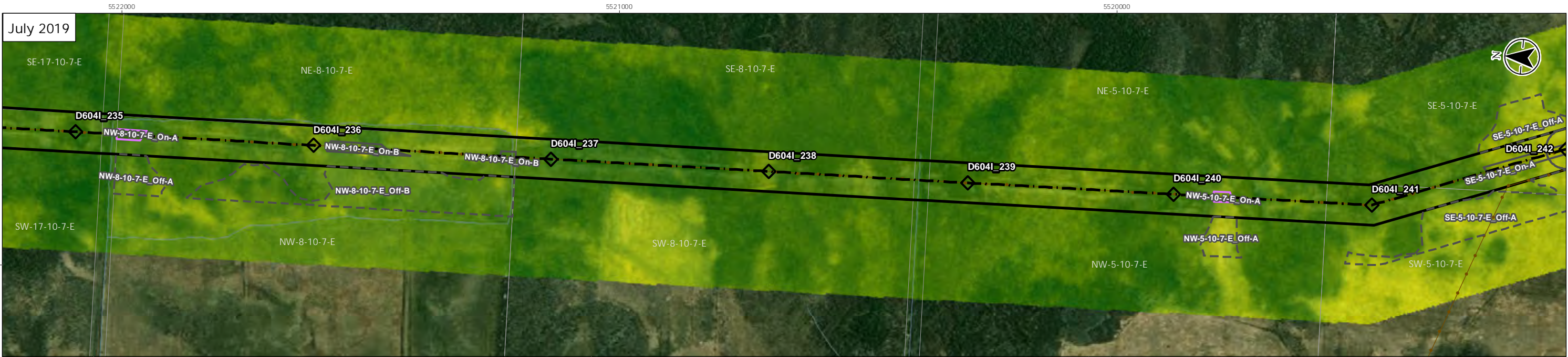
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

C.2-32

Normalized Difference Vegetation Index  
(NDVI) - July 2019 & July 2020





**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

Existing Transmission Lines

□ Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Client/Project

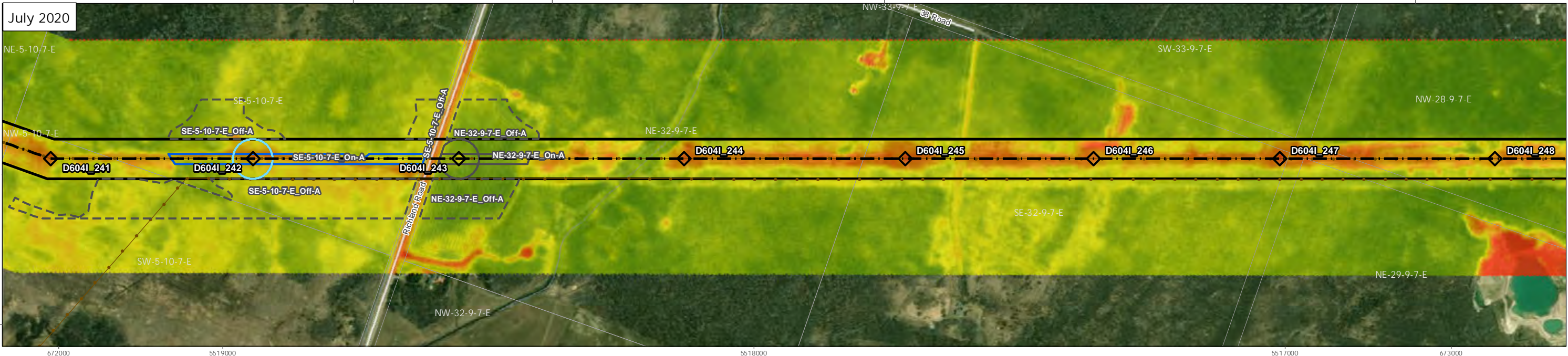
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

**C.2-33**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
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**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

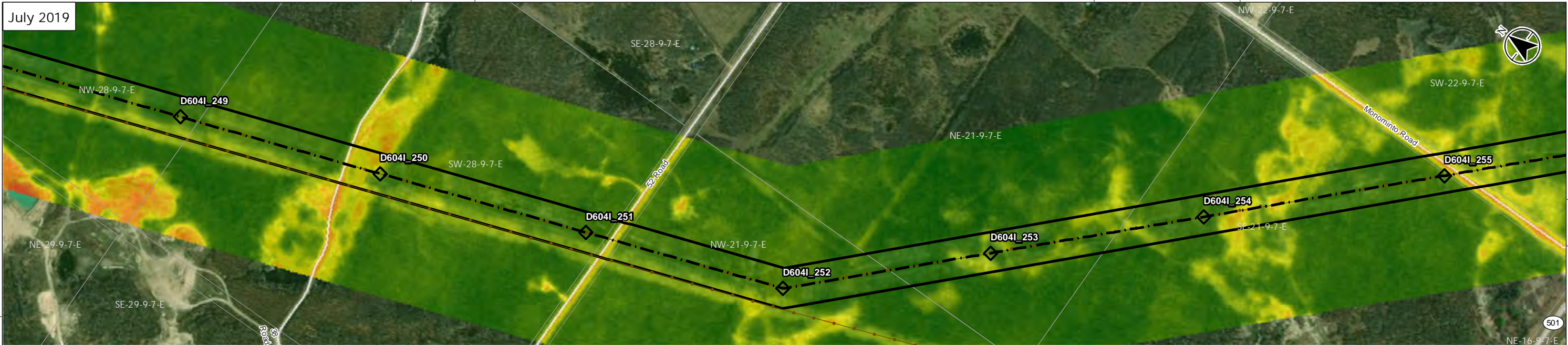
111477020-002-REVC

Map No.

**C.2-34**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Highway

— Major Road

□ Quarter Sections

0 125 250 metres

1:8,000 (At original document size of 11x17)



DRAFT

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro

Manitoba-Minnesota Transmission Line

Soil Productivity & Crop Performance Monitoring

Map No.

C.2-35

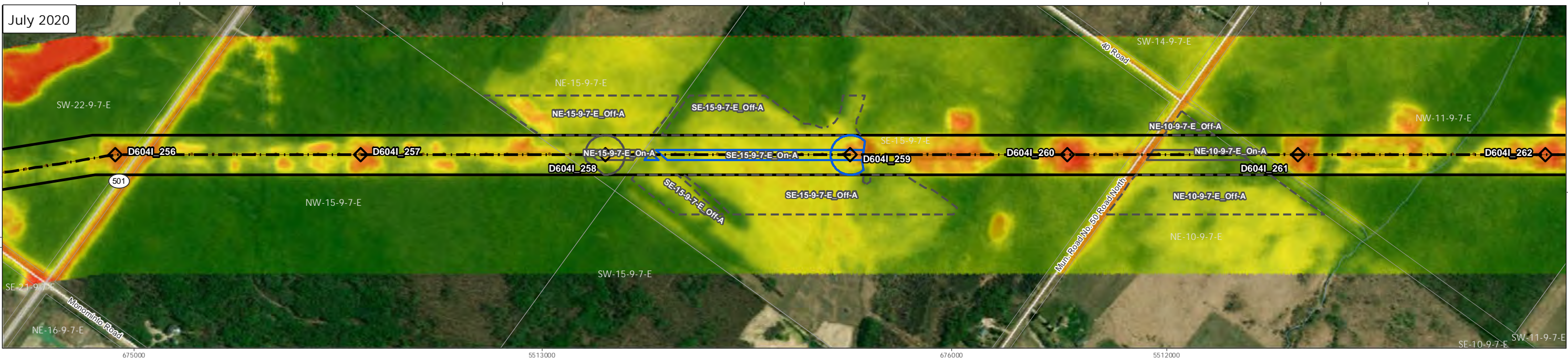
Normalized Difference Vegetation Index  
(NDVI) - July 2019 & July 2020



July 2019



July 2020



#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Highway

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



DRAFT

Project Location  
Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

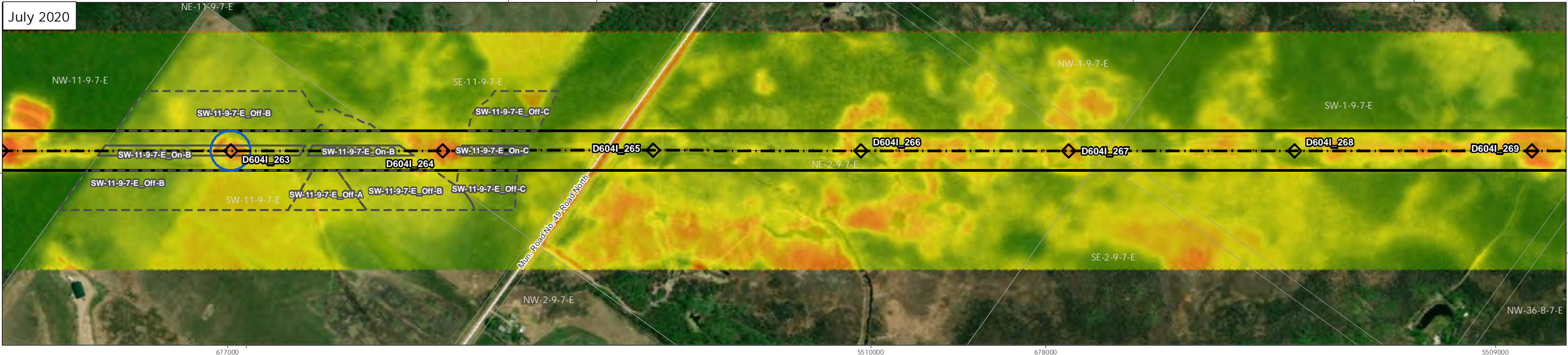
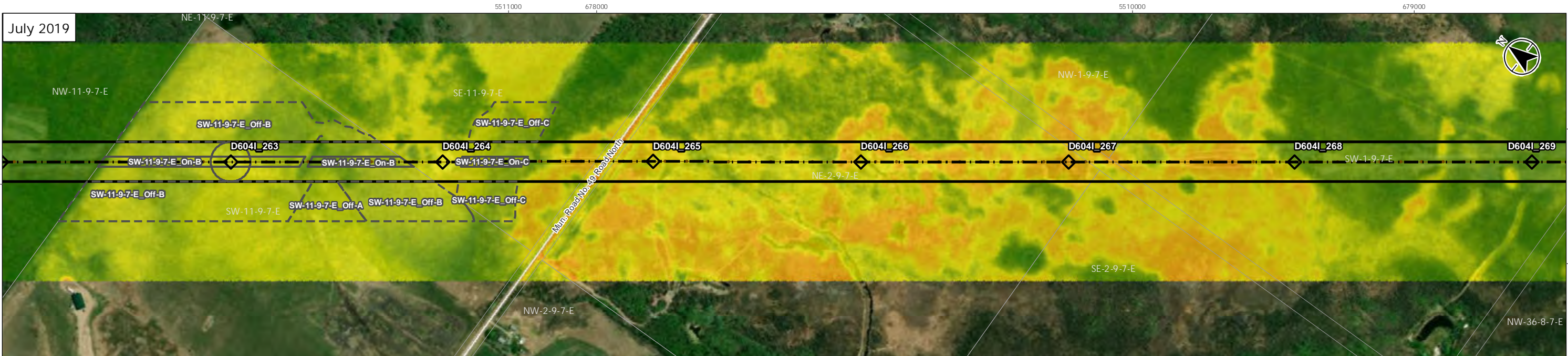
Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

C.2-36

Normalized Difference Vegetation Index  
(NDVI) - July 2019 & July 2020





**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community  
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**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

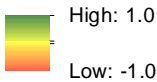
**Evaluation Areas**

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**



**NDVI Difference Outliers for On RoW FMU and**

□ Major Negative Outlier

□ Minor Negative Outlier

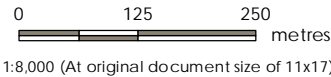
□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections



**DRAFT**

**Project Location**

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

**Client/Project**

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

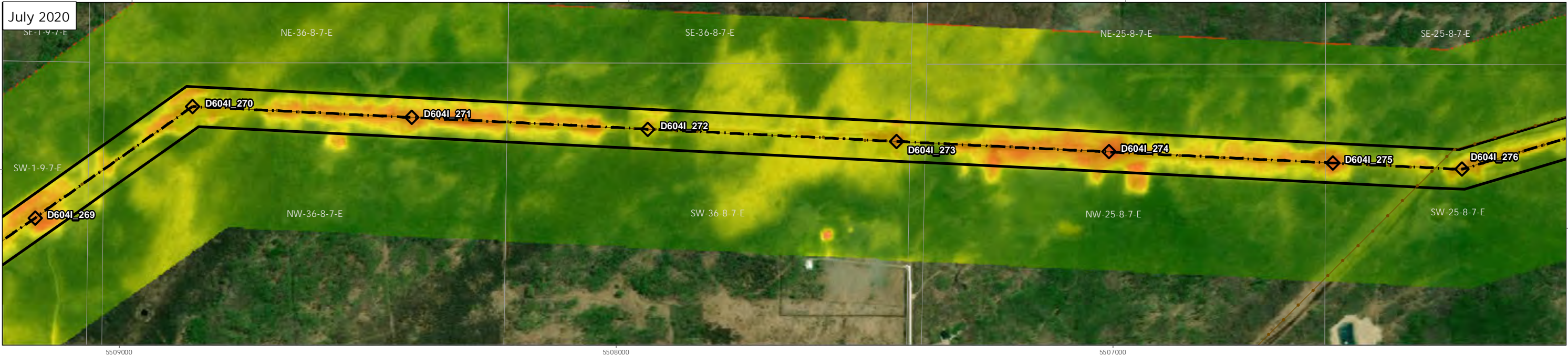
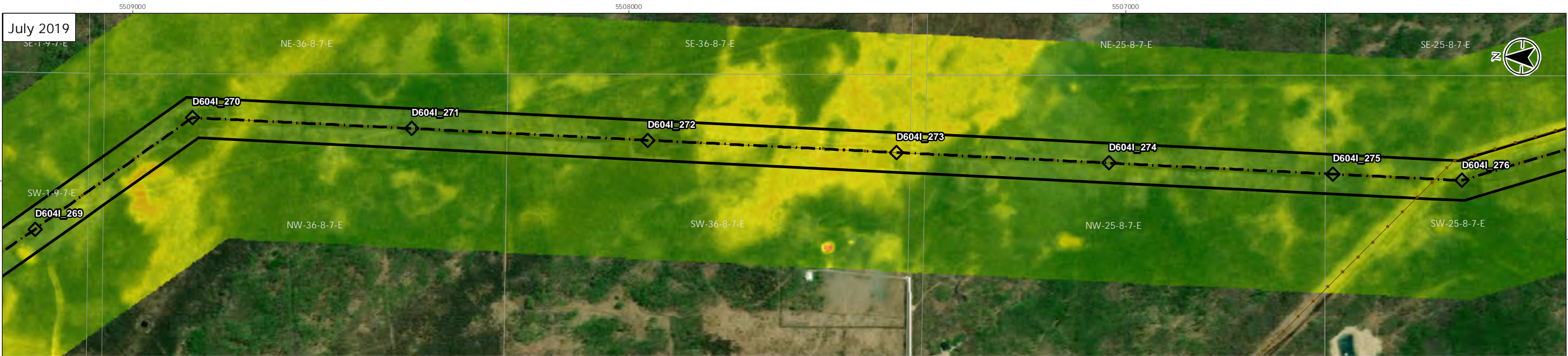
111477020-002-REVC

**Map No.**

**C.2-37**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
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3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

0 125 250 metres

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**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

Client/Project

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

111477020-002-REVC

Map No.

**C.2-38**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

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July 2019



July 2020



Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

Major Negative Outlier

Minor Negative Outlier

Minor Positive Outlier

Major Positive Outlier

Existing Transmission Lines

Highway

Major Road

Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



DRAFT

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

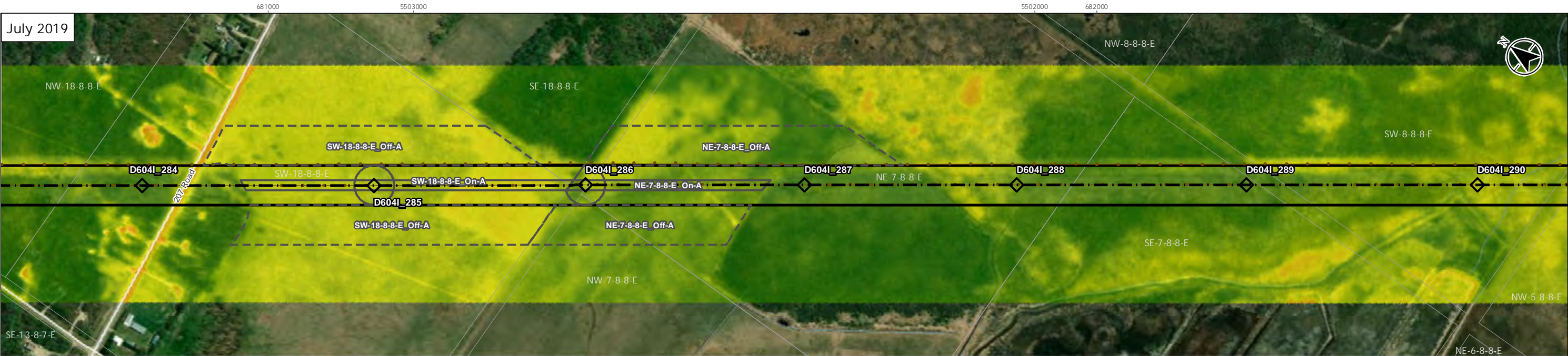
Map No.

C.2-39

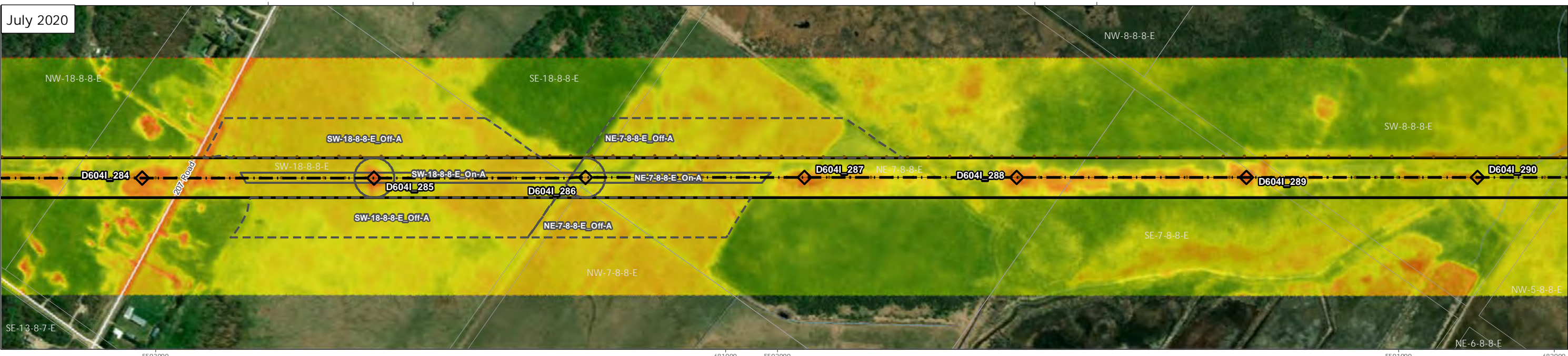
Normalized Difference Vegetation Index  
(NDVI) - July 2019 & July 2020



July 2019



July 2020



**Notes**  
1. Coordinate System: NAD 1983 UTM Zone 14N  
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**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

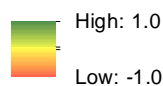
**Evaluation Areas**

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**



**NDVI Difference Outliers for On RoW FMU and**

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

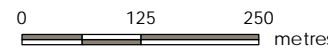
□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse



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**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

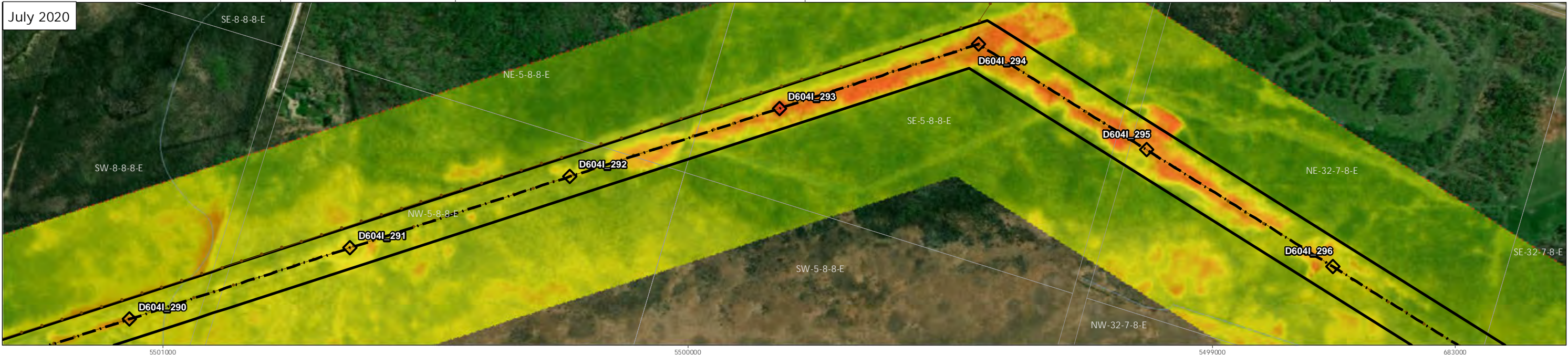
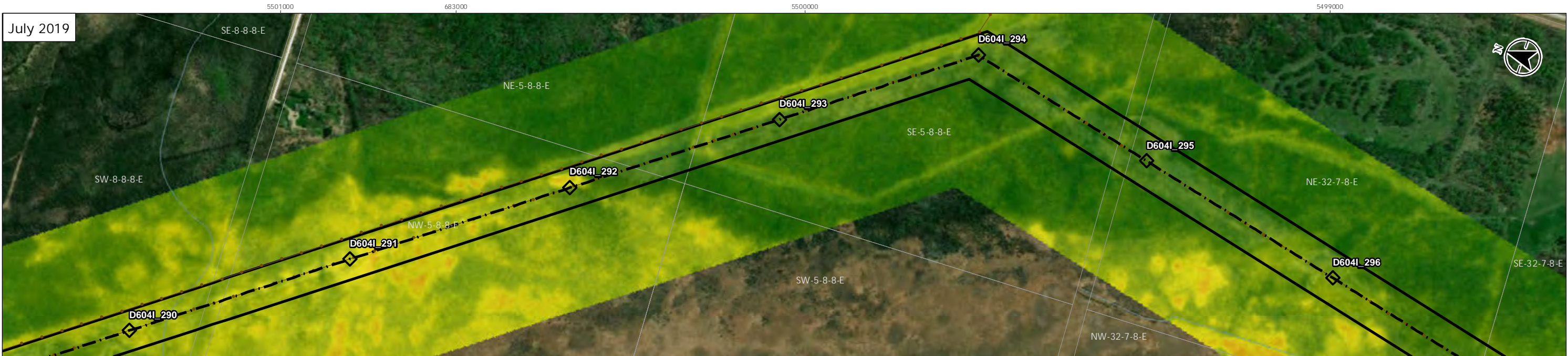
Map No.  
**C.2-40**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

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**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

Existing Transmission Lines

Highway

Major Road

Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

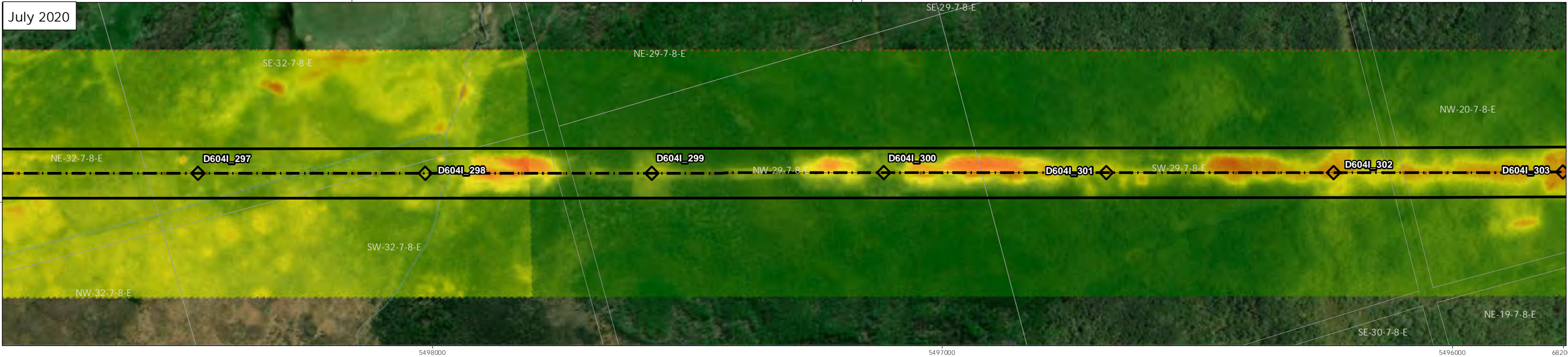
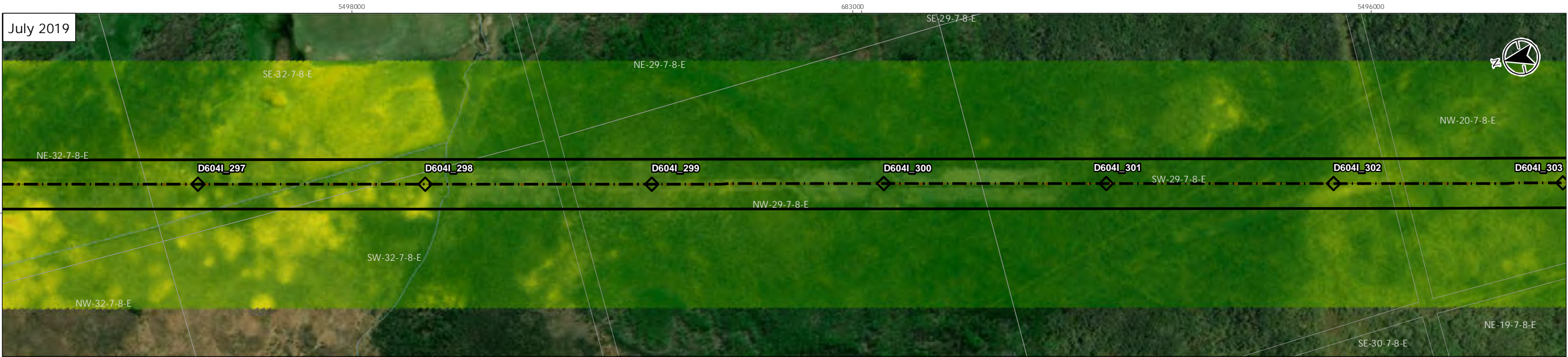
**C.2-41**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

**C.2-42**

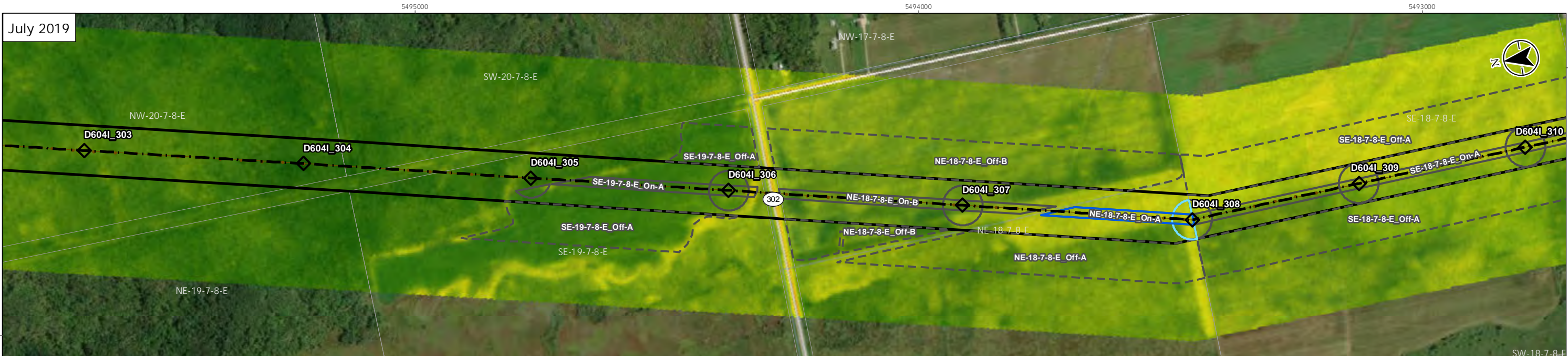
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

G:\GIS\Project\_Folder\00\_Hydro\11477020\_MMTP\_Soil\_Crop\_Biosecurity\_Monitoring\Figures\111477020\_002\_REV\_C\_NDVI\_Mapbook.mxd Revised: 2021-05-16 By: JHiebert

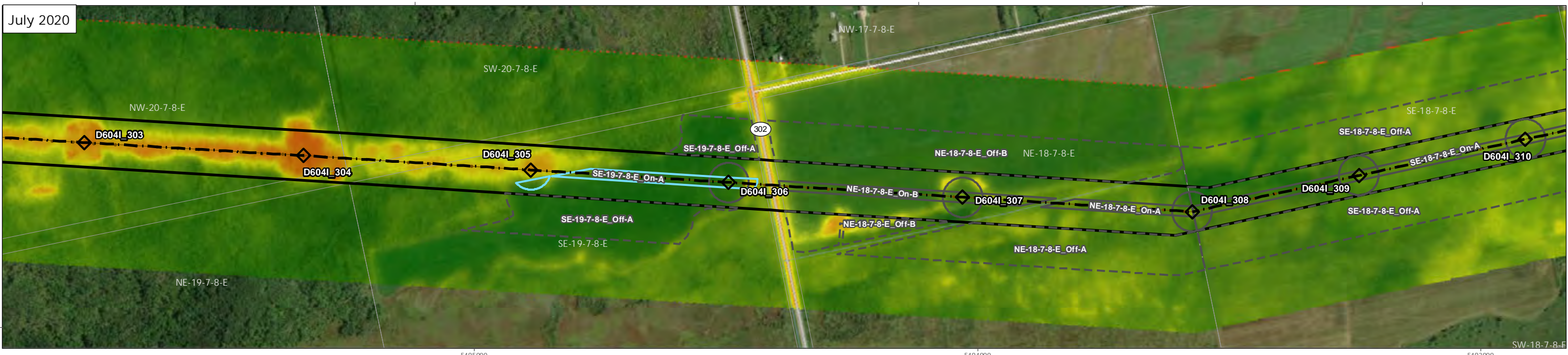
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July 2019



July 2020



#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

Major Negative Outlier

Minor Negative Outlier

Minor Positive Outlier

Major Positive Outlier

Existing Transmission Lines

Highway

Major Road

Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



DRAFT

Project Location

Near Winnipeg,  
Manitoba

Client/Project

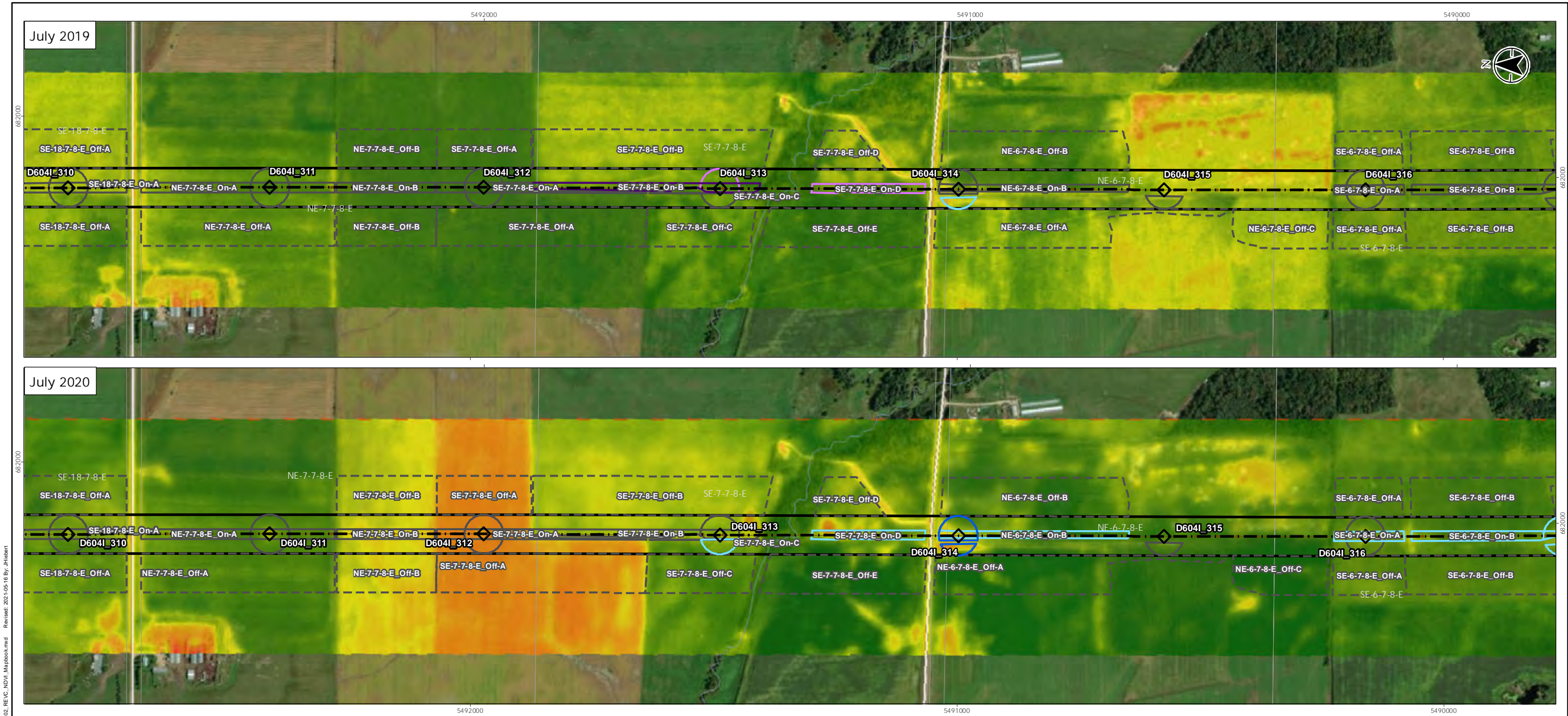
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

C.2-43

Normalized Difference Vegetation Index  
(NDVI) - July 2019 & July 2020





**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

- Major Road
- Quarter Sections
- Watercourse

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-44**

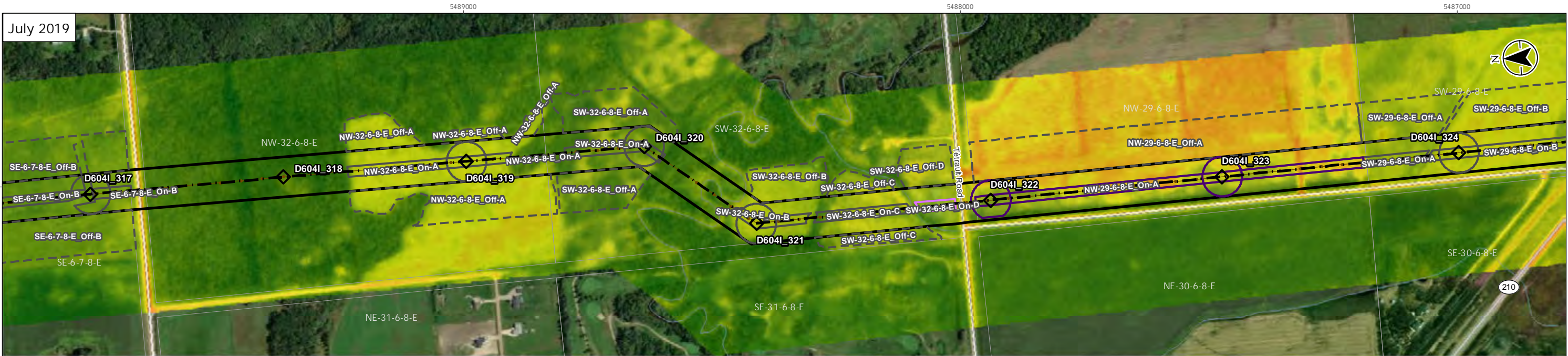
Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

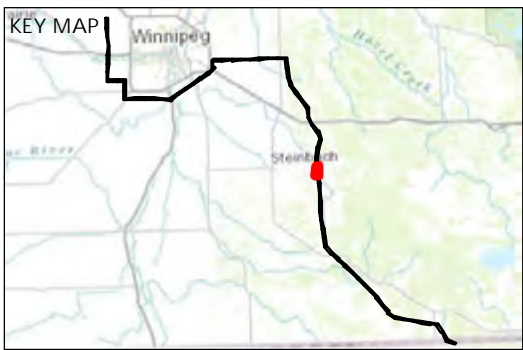
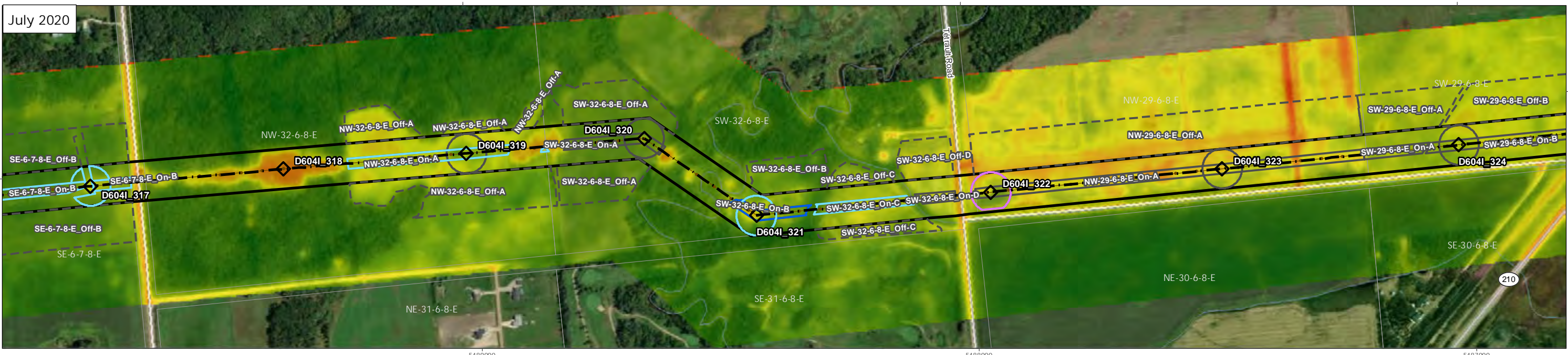
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**



July 2019



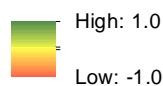
July 2020



Legend

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

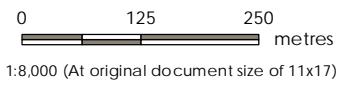
Normalized Difference Vegetation Index (NDVI)



NDVI Difference Outliers for On RoW FMU and

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

- Existing Transmission Lines
- Highway
- Major Road
- Quarter Sections
- Watercourse



DRAFT

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-45**

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

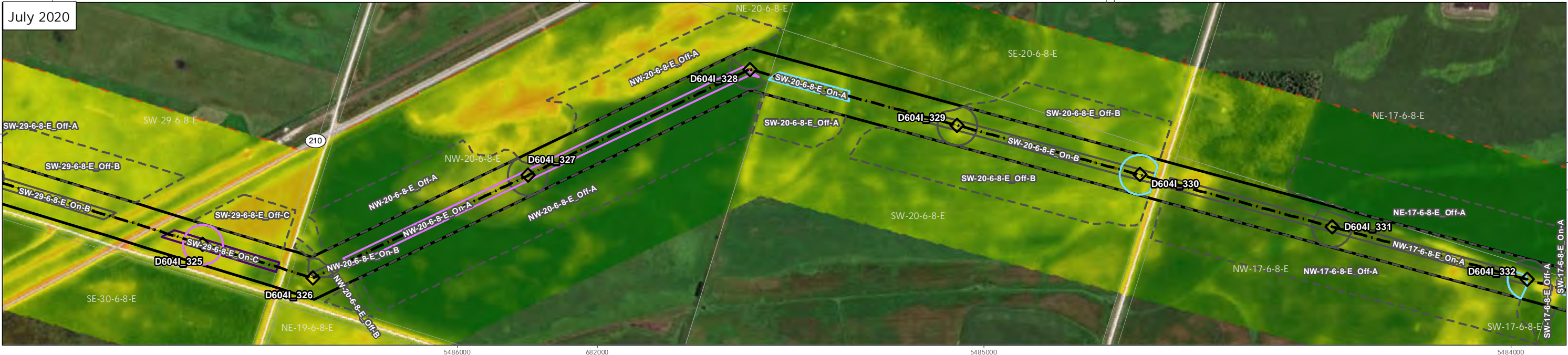
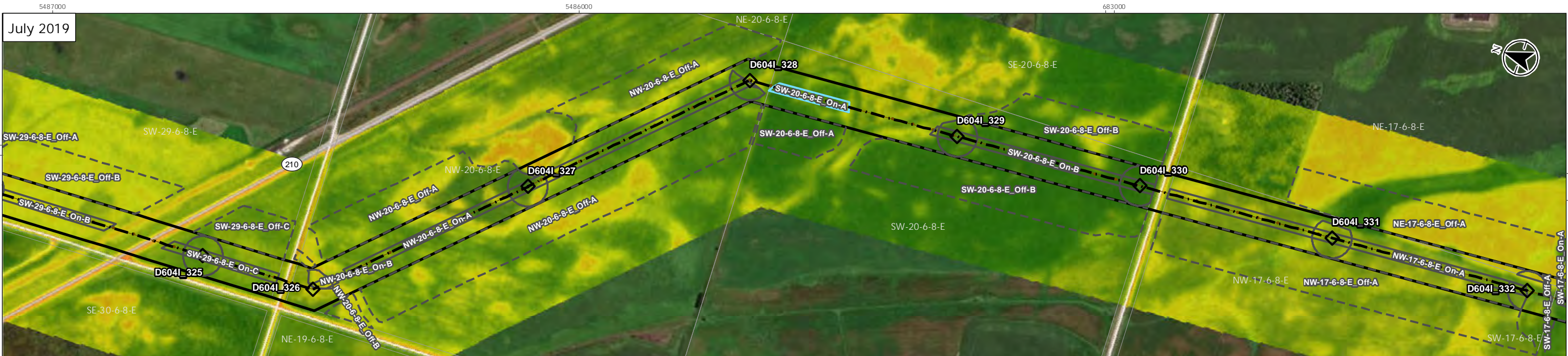
111477020-002-REVC

Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020

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**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
4. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Highway

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

Client/Project 111477020-002-REVC

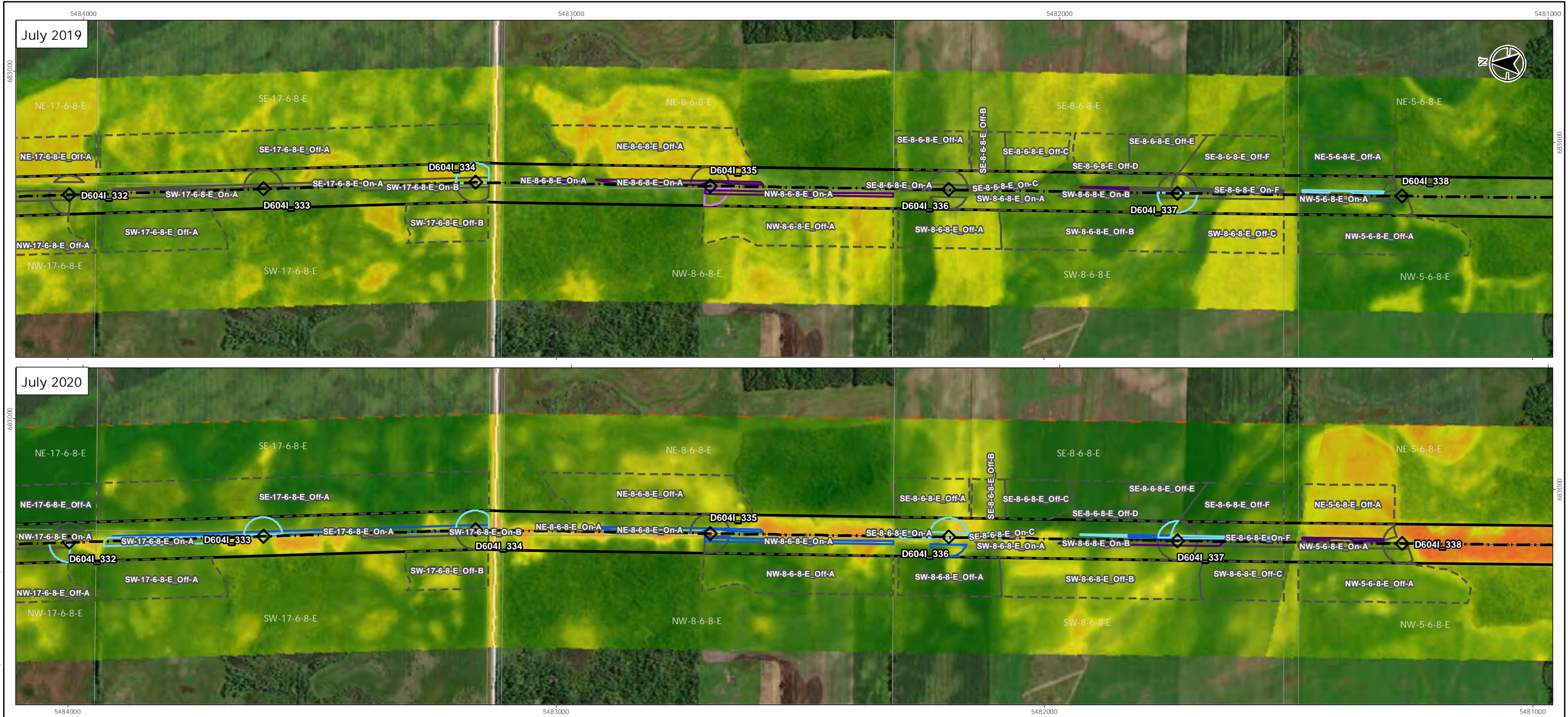
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

**C.2-46**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





Legend

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

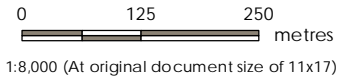
Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

- NDVI Difference Outliers for On RoW FMU and
- Major Negative Outlier
  - Minor Negative Outlier
  - Minor Positive Outlier
  - Major Positive Outlier

- Existing Transmission Lines
- Major Road
- Quarter Sections
- Watercourse



DRAFT

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-47**

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

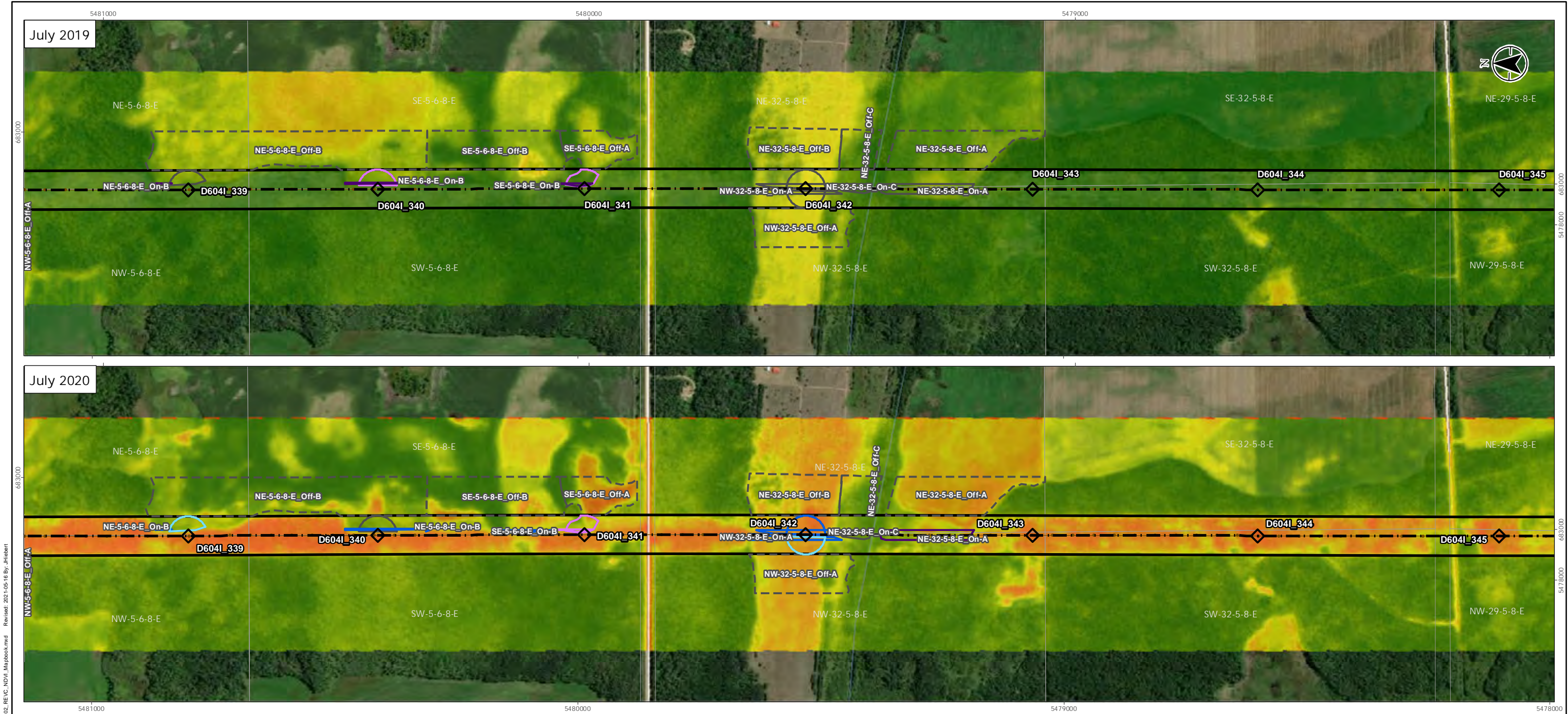
Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020

Notes

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison
- Normalized Difference Vegetation Index (NDVI)
  - High: 1.0
  - Low: -1.0
- NDVI Difference Outliers for On RoW FMU and
  - Major Negative Outlier
  - Minor Negative Outlier
  - Minor Positive Outlier
  - Major Positive Outlier
- Existing Transmission Lines
- Major Road
- Quarter Sections
- Watercourse

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-48**

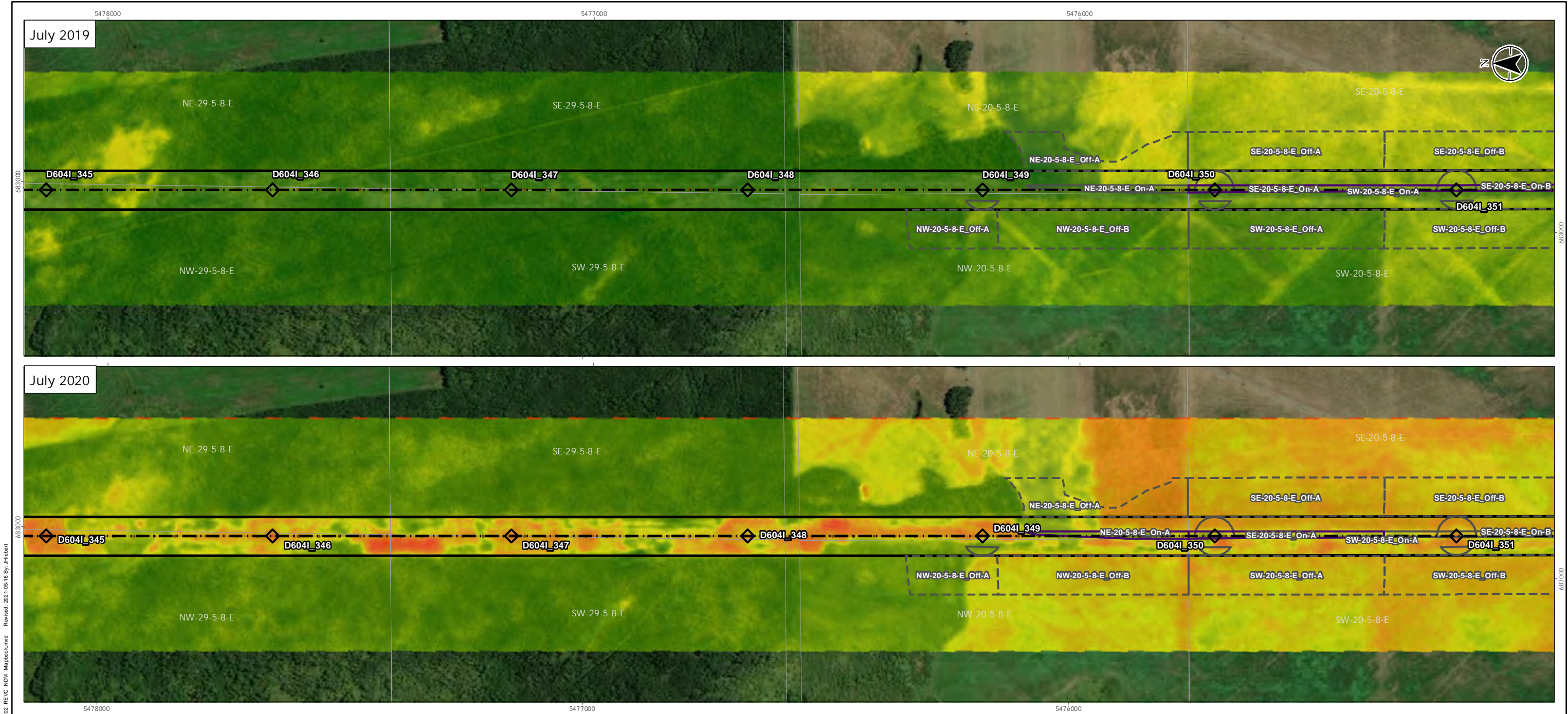
Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

0 125 250 metres  
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**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

Quarter Sections

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

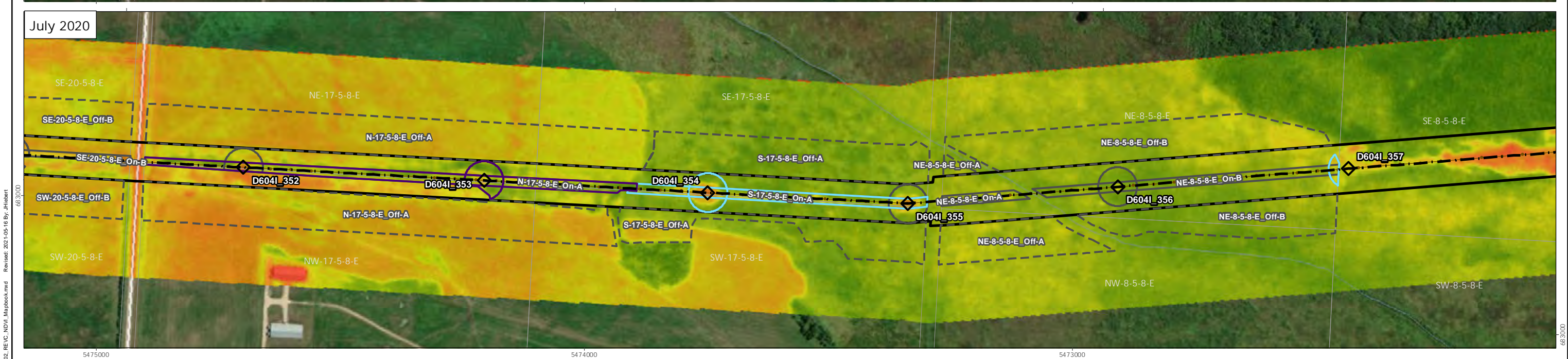
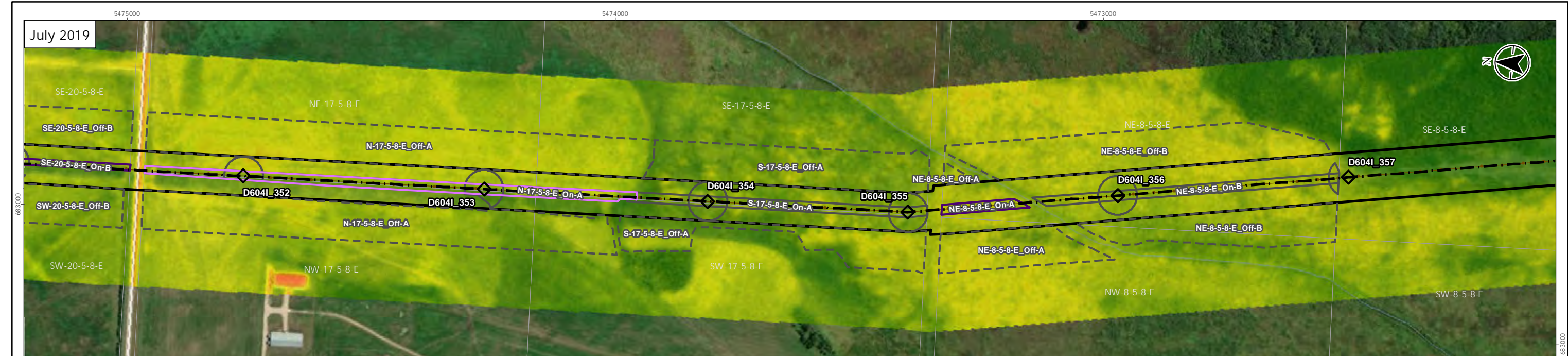
Map No.  
**C.2-49**

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro

Manitoba-Minnesota Transmission Line

Soil Productivity & Crop Performance Monitoring

Map No.

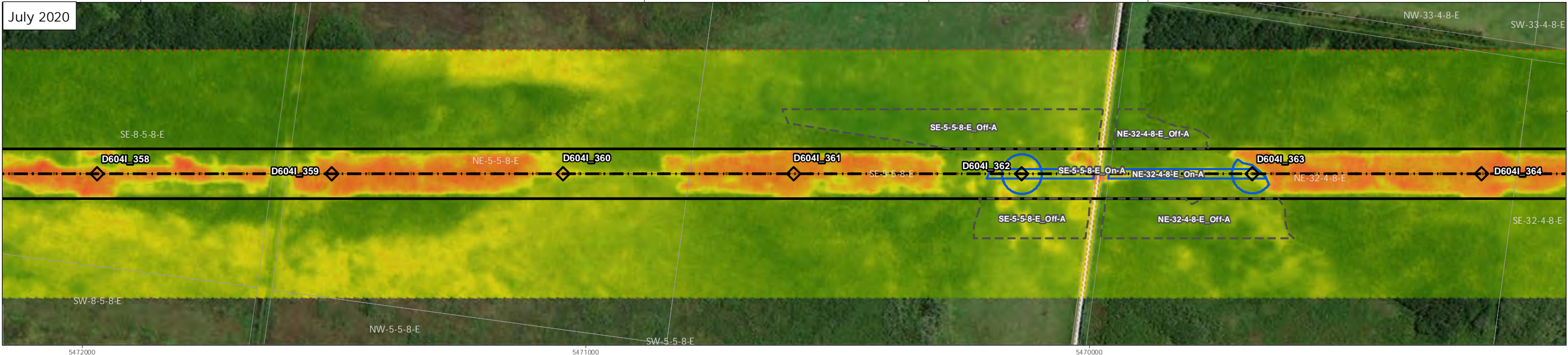
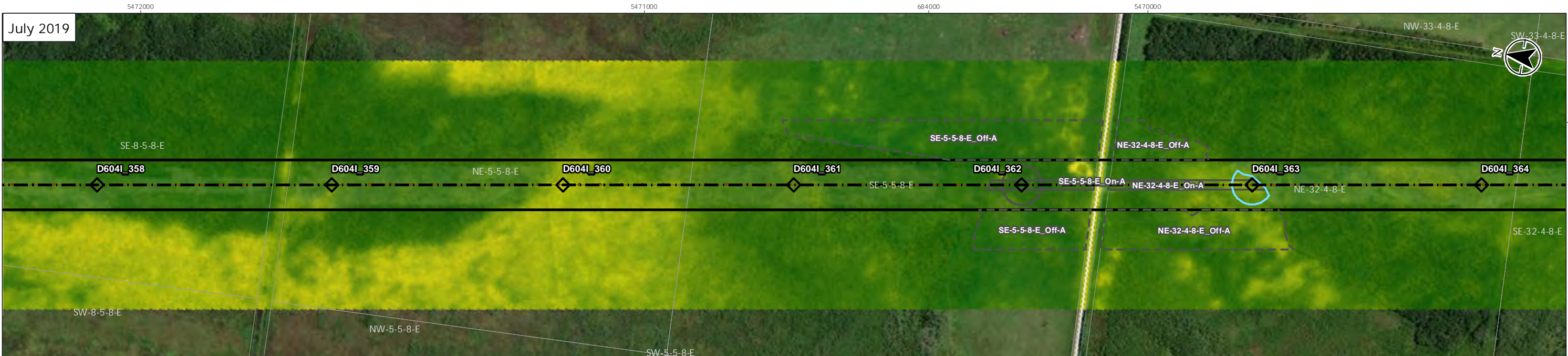
**C.2-50**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

Notes  
1. Coordinate System: NAD 1983 UTM Zone 14N  
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting  
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community  
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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**Notes**

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3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

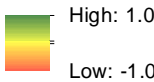
Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)



NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

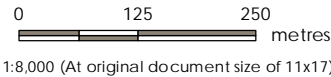
□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Client/Project

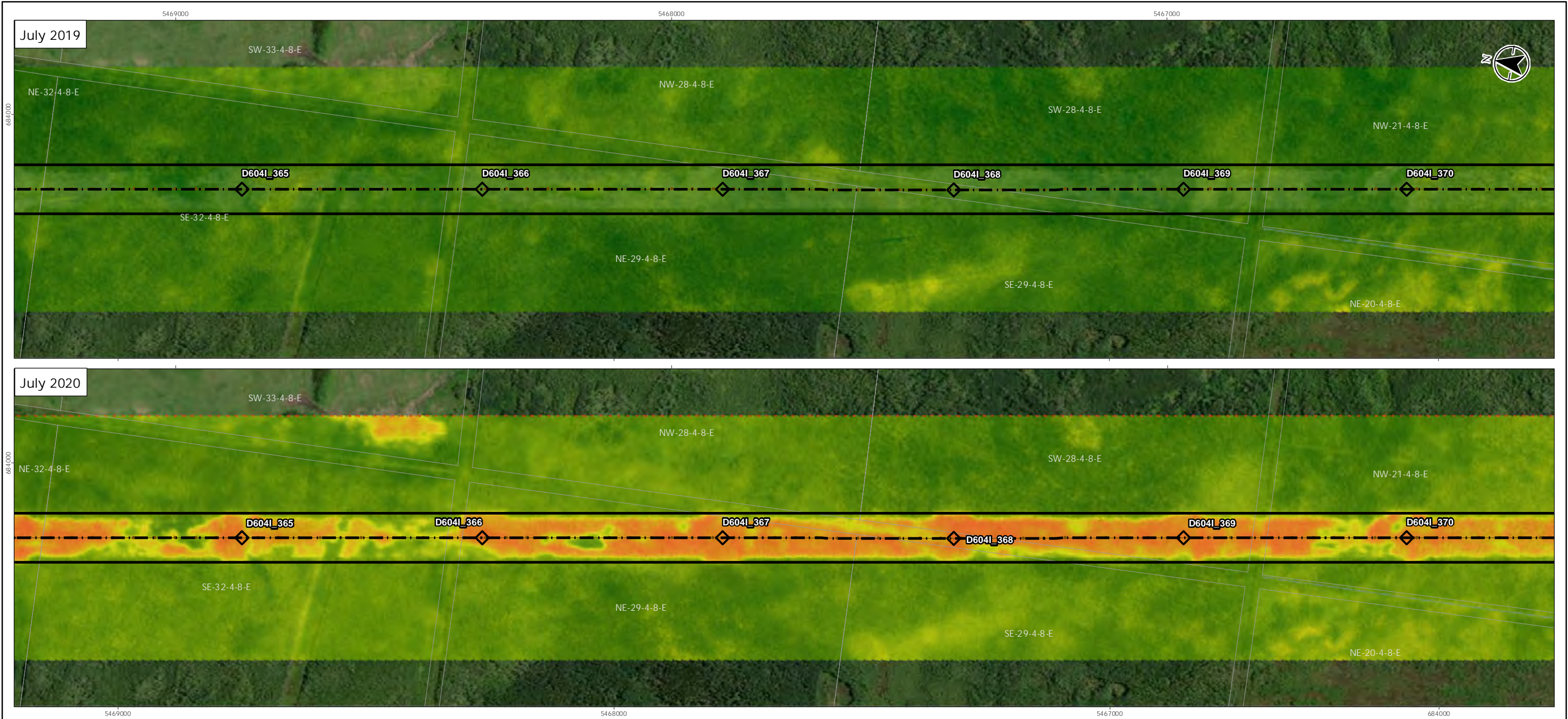
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

**C.2-51**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0

Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

- Quarter Sections
- Watercourse

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-52**

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

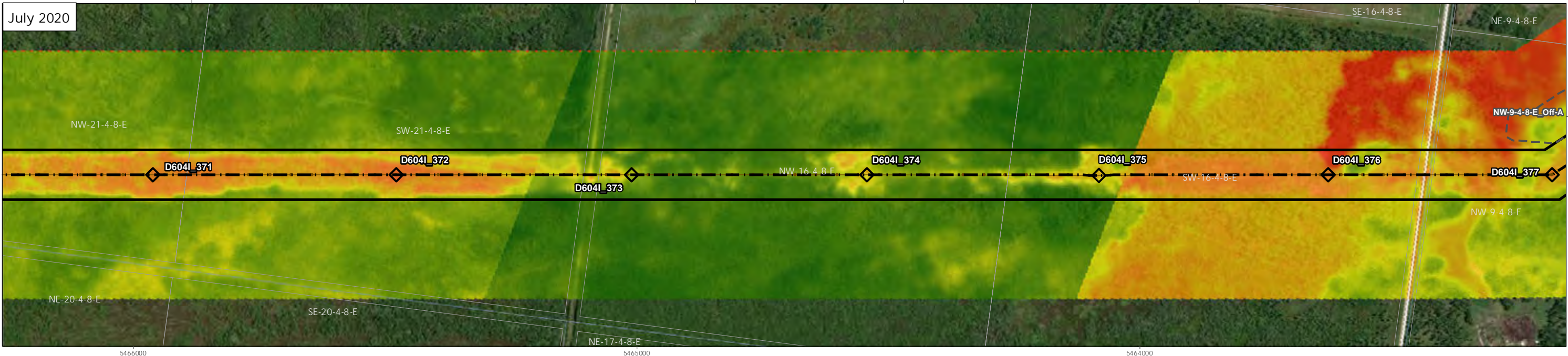
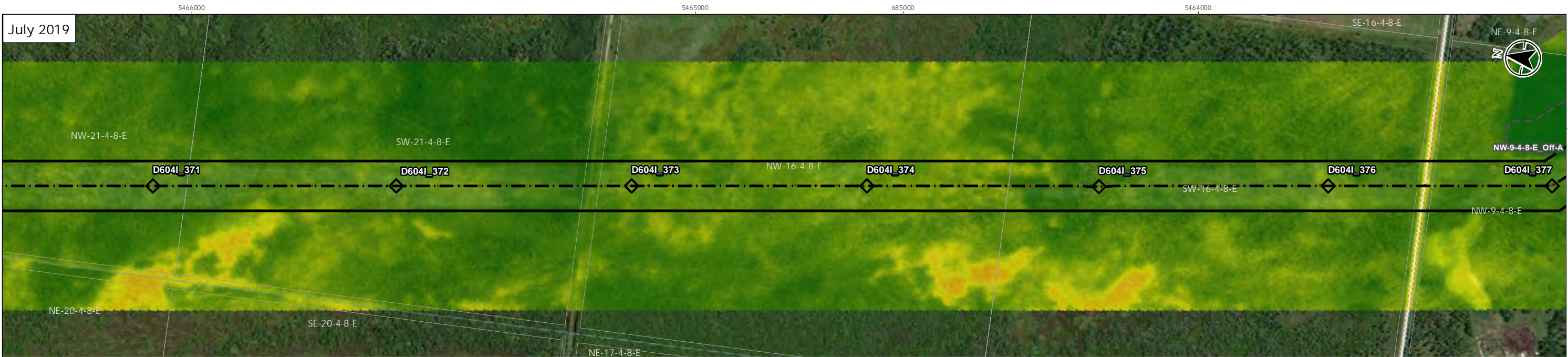
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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**Notes**

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3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community  
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

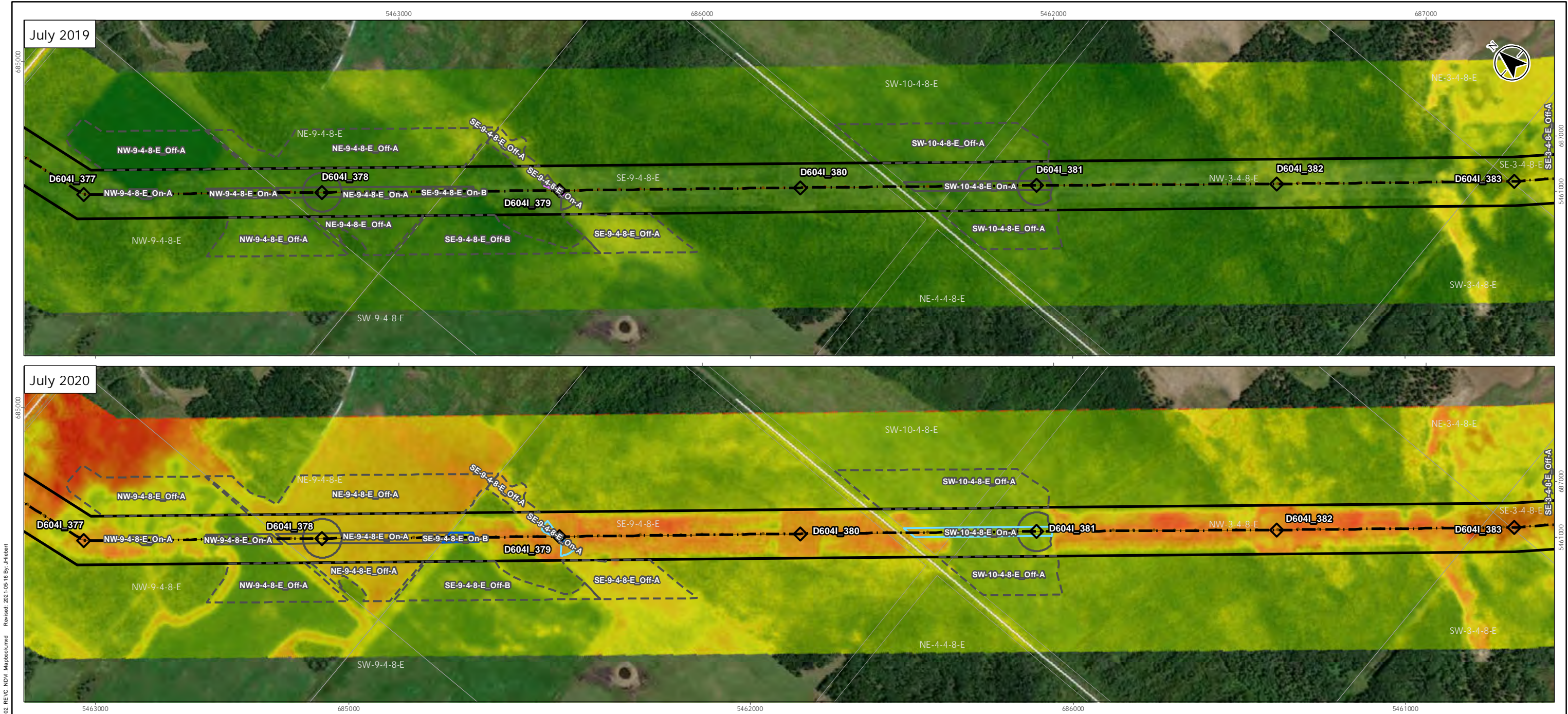
**C.2-53**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

G:\GIS\Project\_Folder\00\_Hydro\11477020\_MMTP\_Soil\_Crop\_Biosecurity\_Monitoring\Figures\111477020\_002\_REV.C\_NDVI\_Mapbook.mxd Revised: 2021-05-16 By: JHiebert

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**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

- Major Road
- Quarter Sections
- Watercourse

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

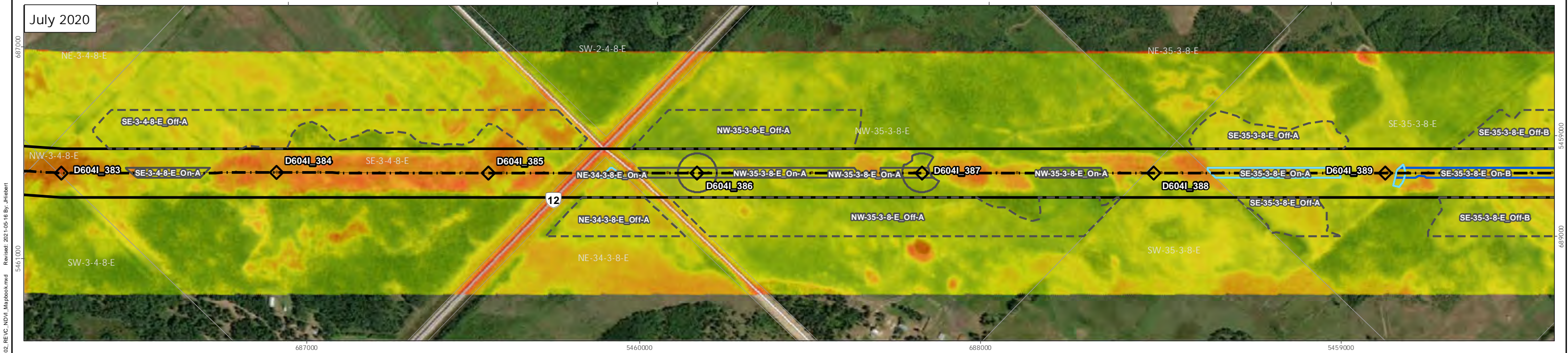
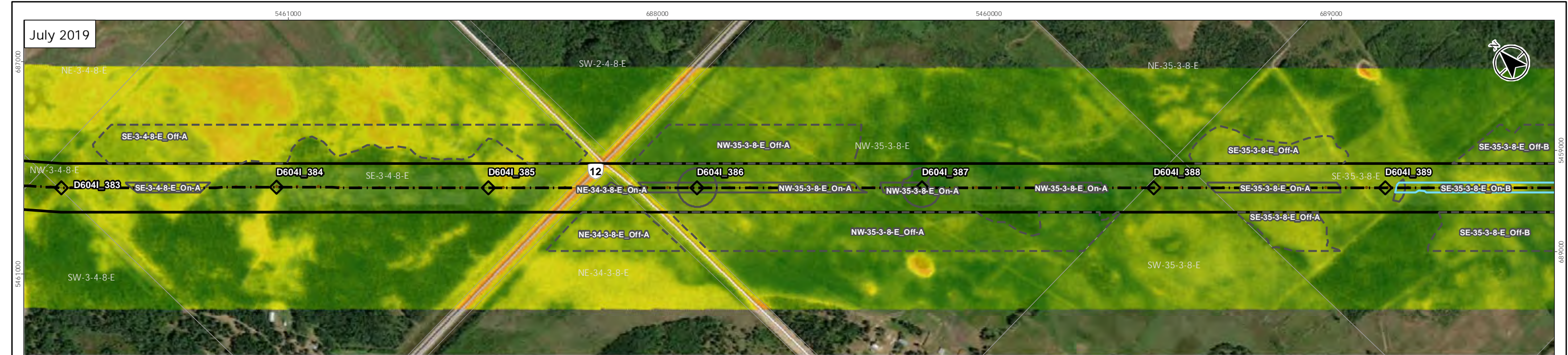
Map No.  
**C.2-54**

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

- Highway
- Major Road
- Quarter Sections
- Watercourse

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-55**

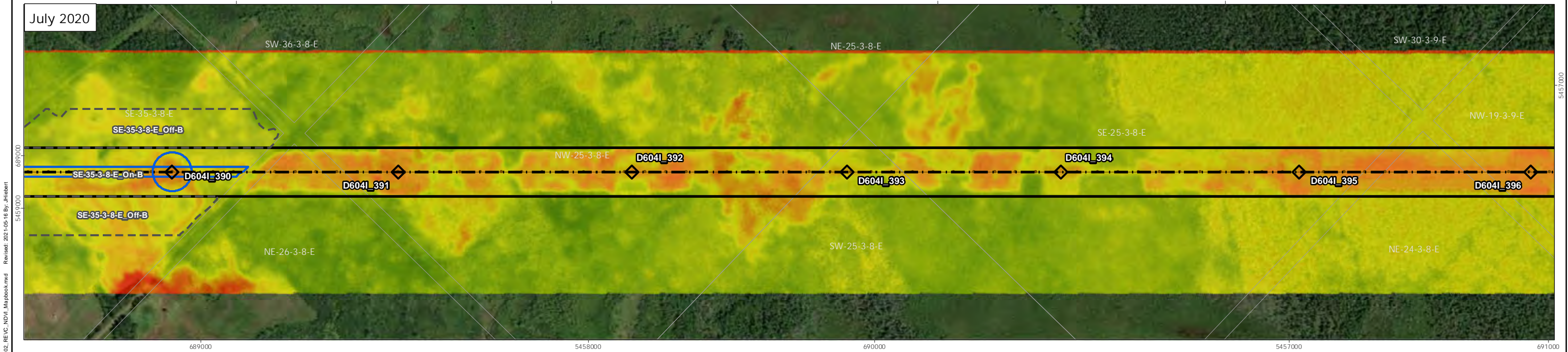
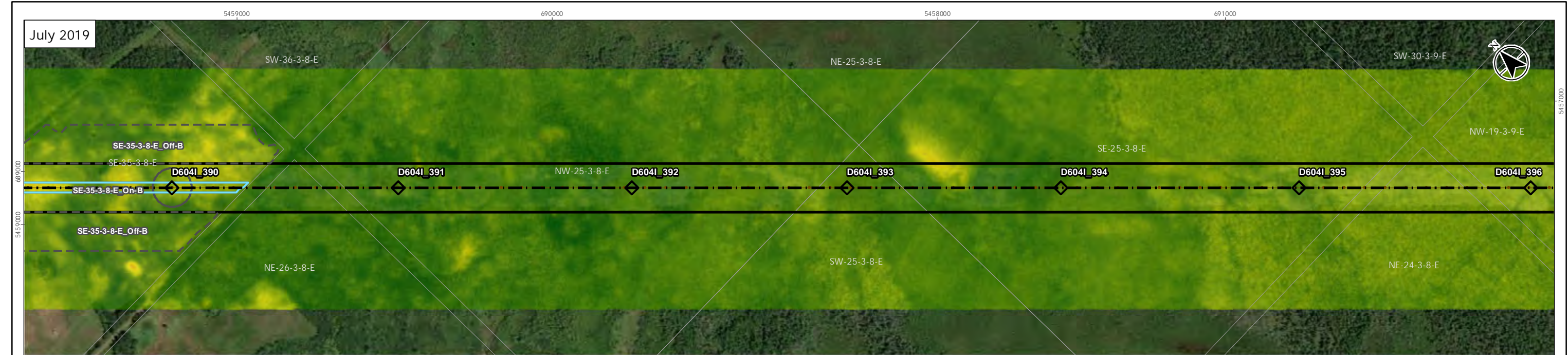
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
4. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

#### Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

#### Normalized Difference Vegetation Index (NDVI)

High: 1.0  
Low: -1.0

#### NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

□ Quarter Sections

0 125 250 metres  
1:8,000 (At original document size of 11x17)



**DRAFT**

#### Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

#### Client/Project

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

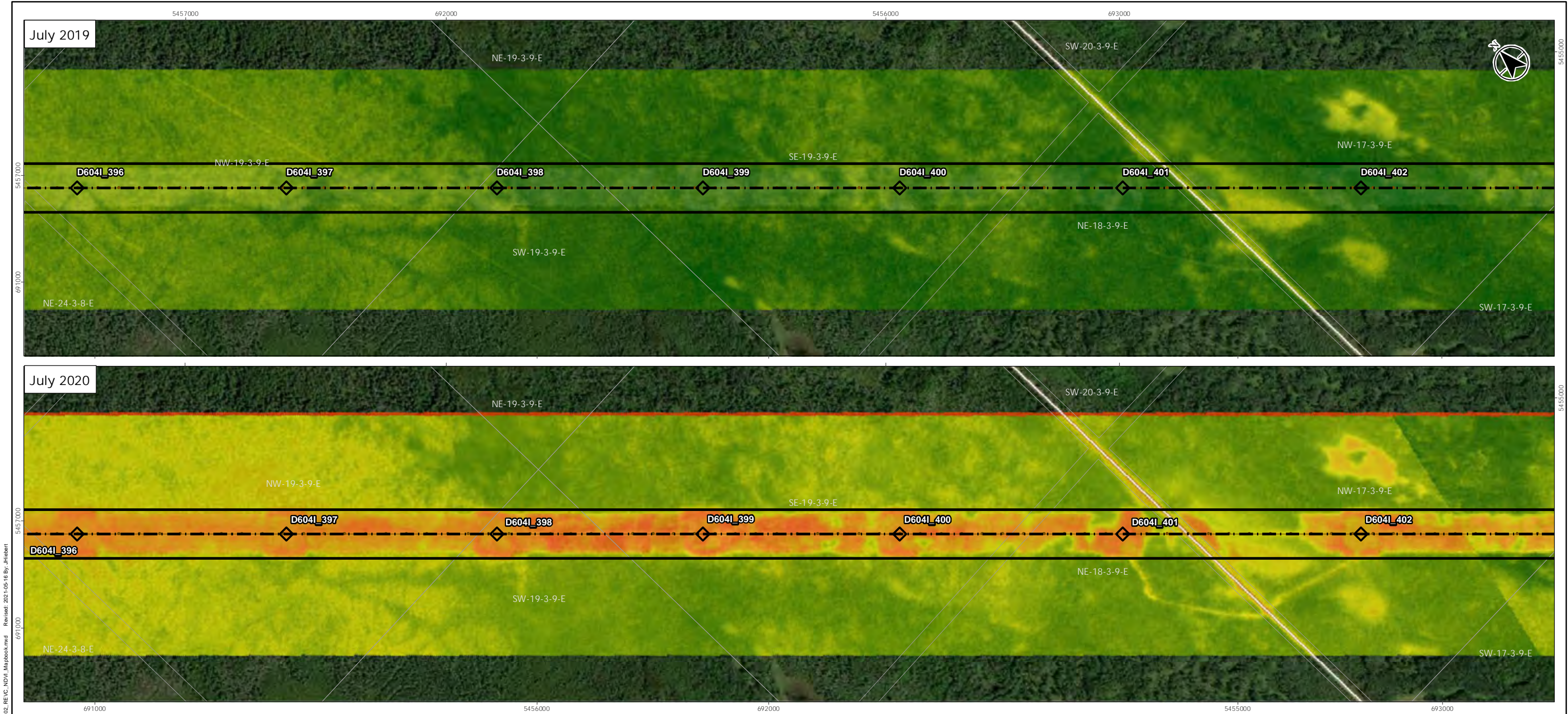
111477020-002-REVC

#### Map No.

**C.2-56**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

- Major Road
- Quarter Sections

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

**Project Location**  
Near Winnipeg,  
Manitoba

**Client/Project**  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

**Map No.**  
**C.2-57**

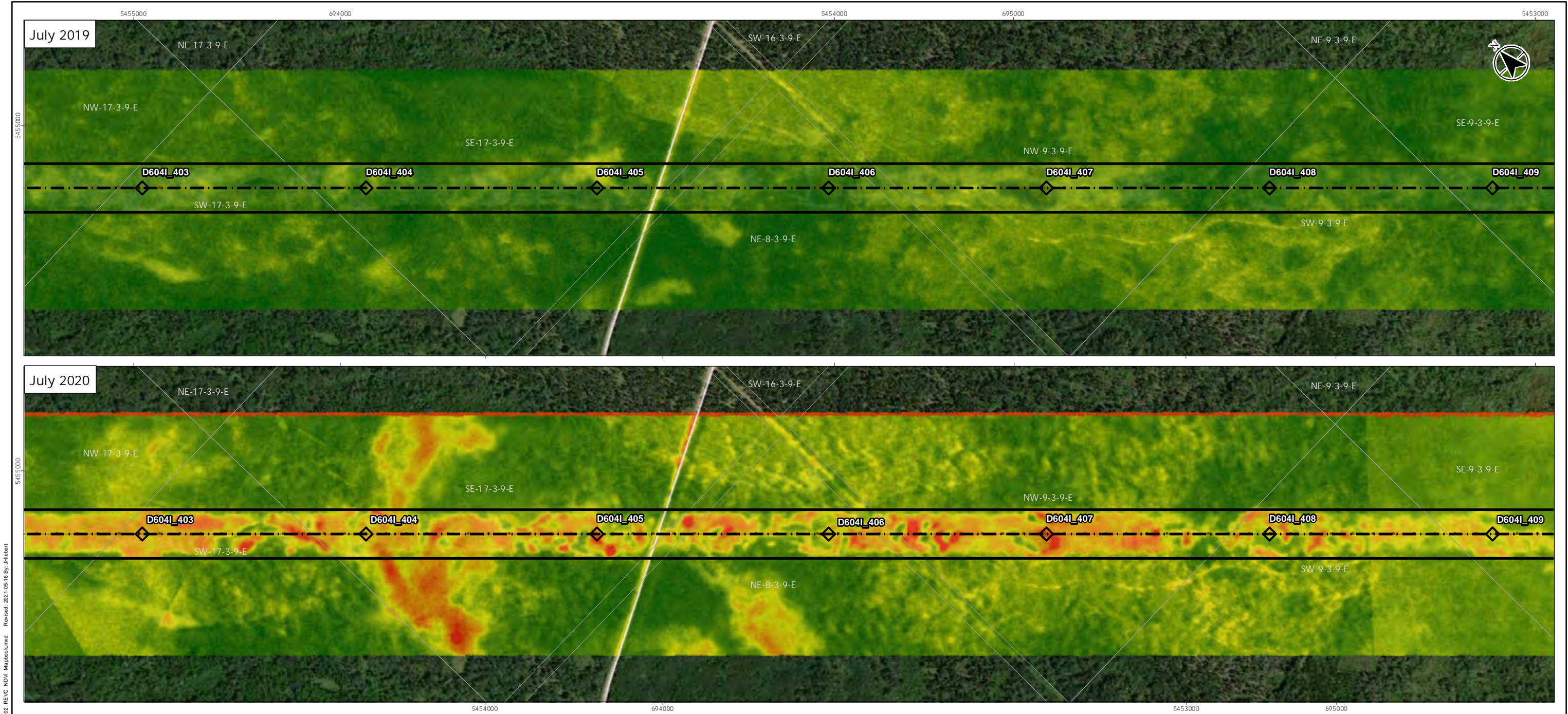
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0



Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

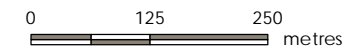
□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections



1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro

Manitoba-Minnesota Transmission Line

Soil Productivity & Crop Performance Monitoring

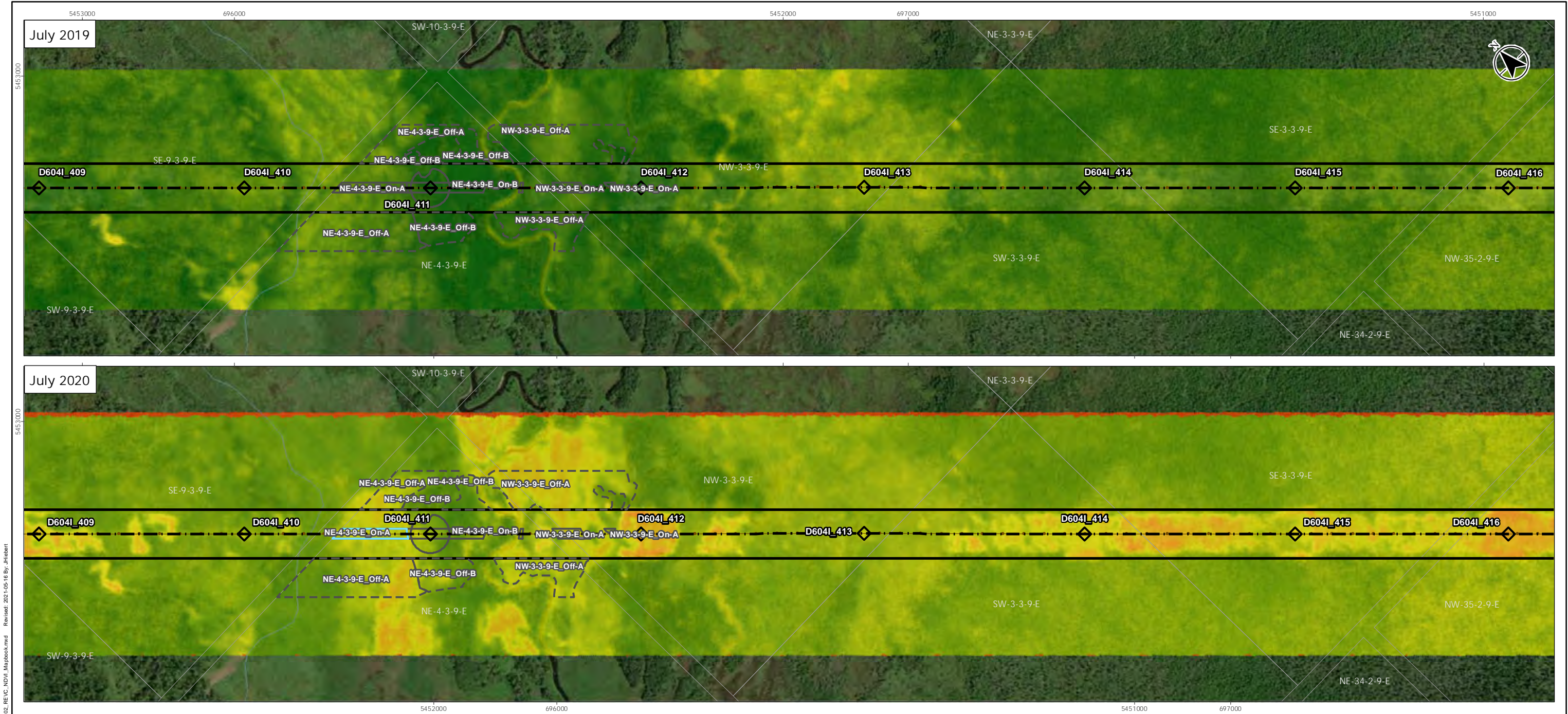
Map No.

**C.2-58**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

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**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

- Quarter Sections
- Watercourse

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-59**

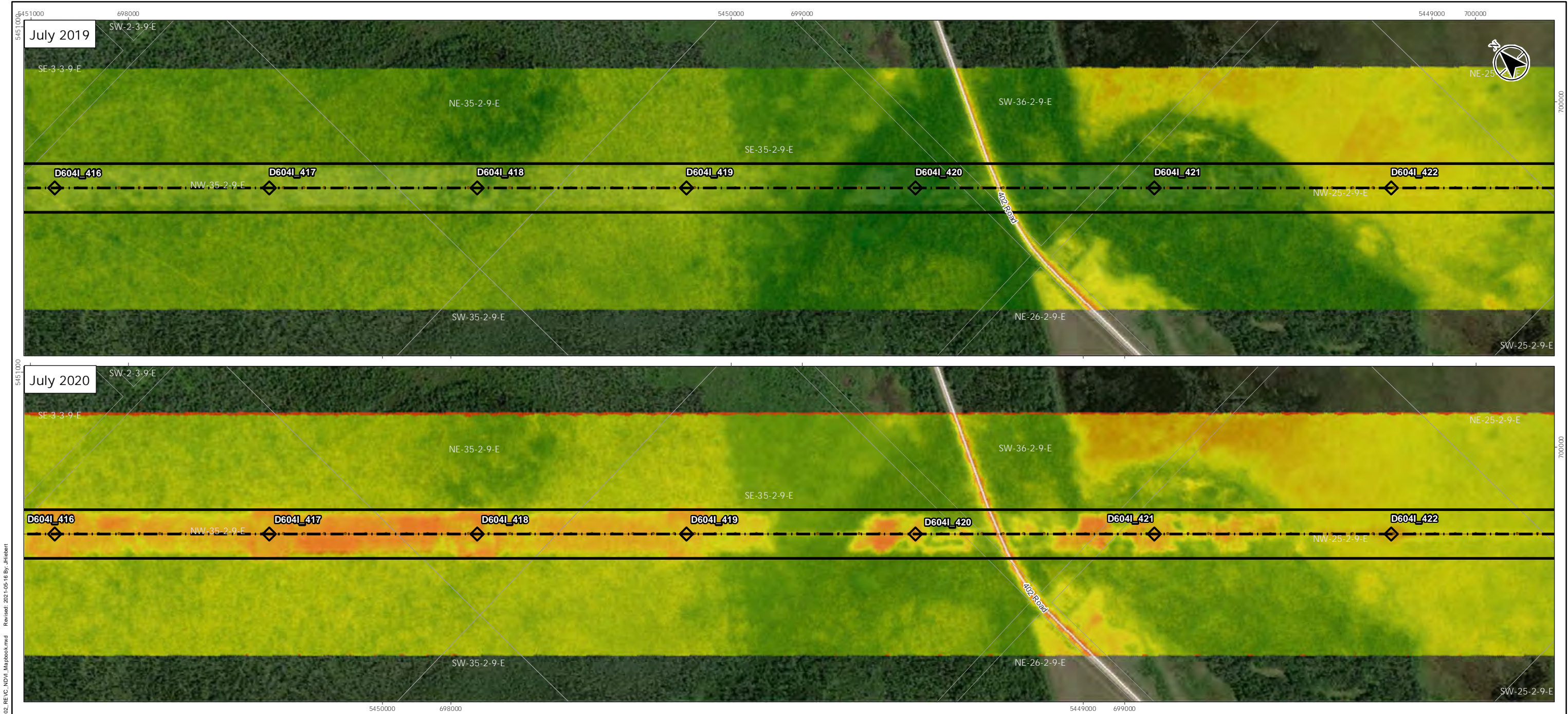
Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

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**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

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**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0

Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

Major Road

Quarter Sections

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

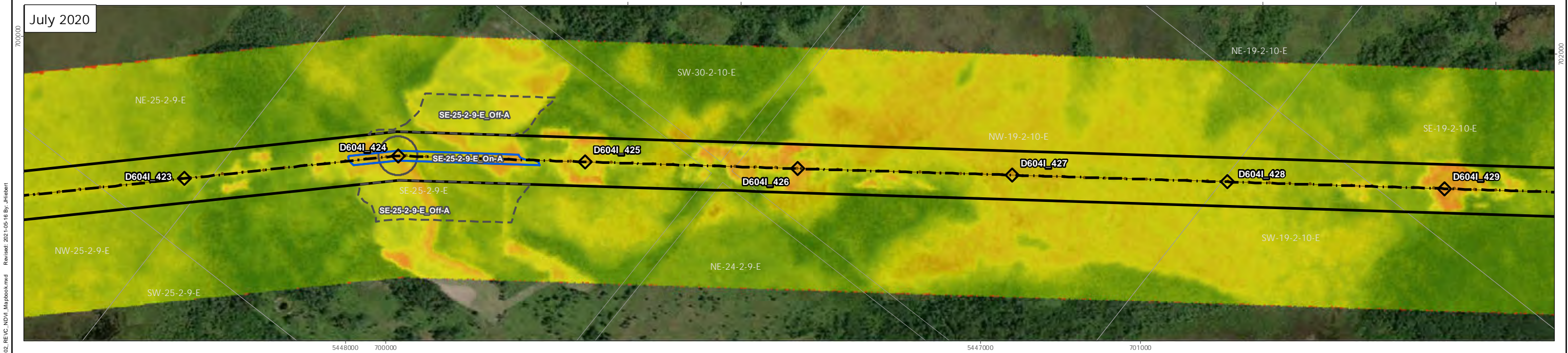
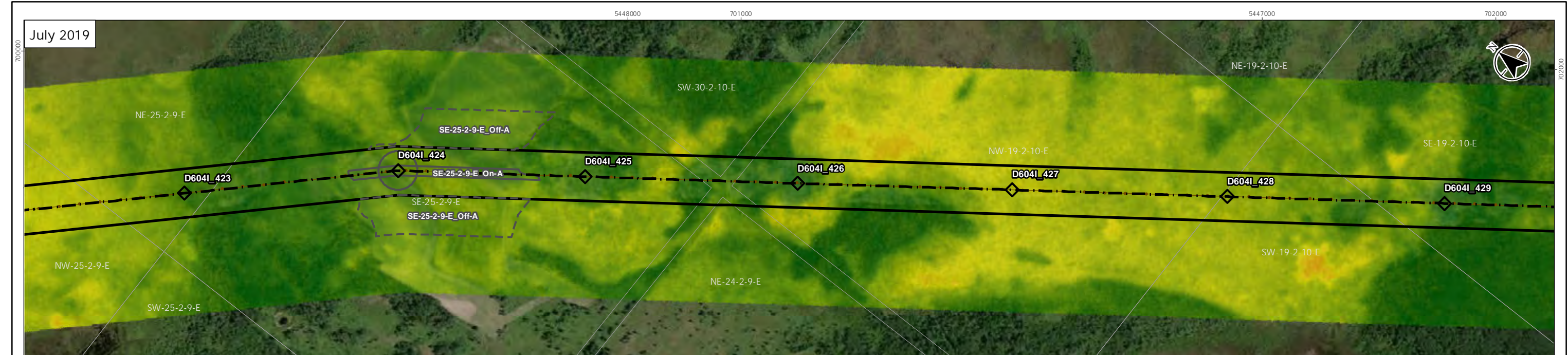
Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-60**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

Quarter Sections

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

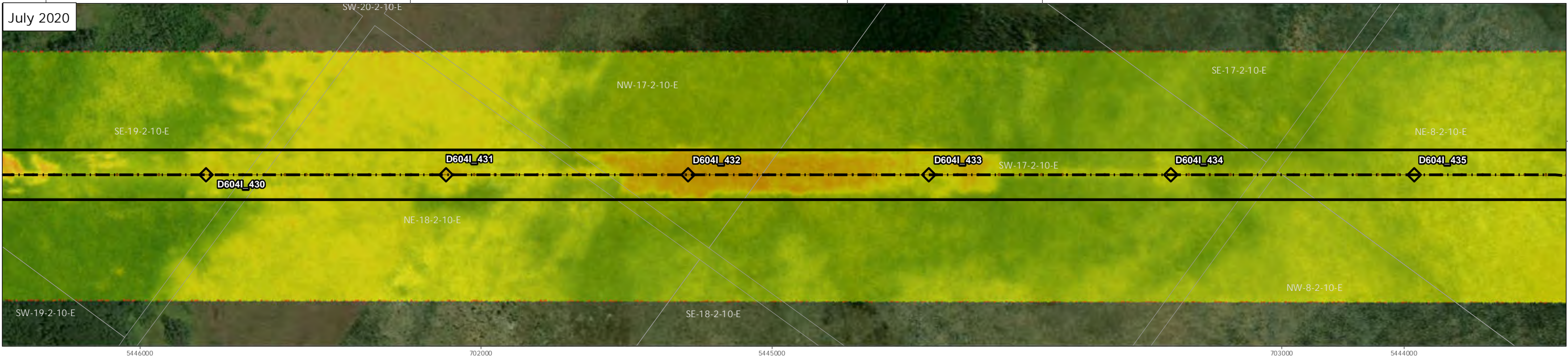
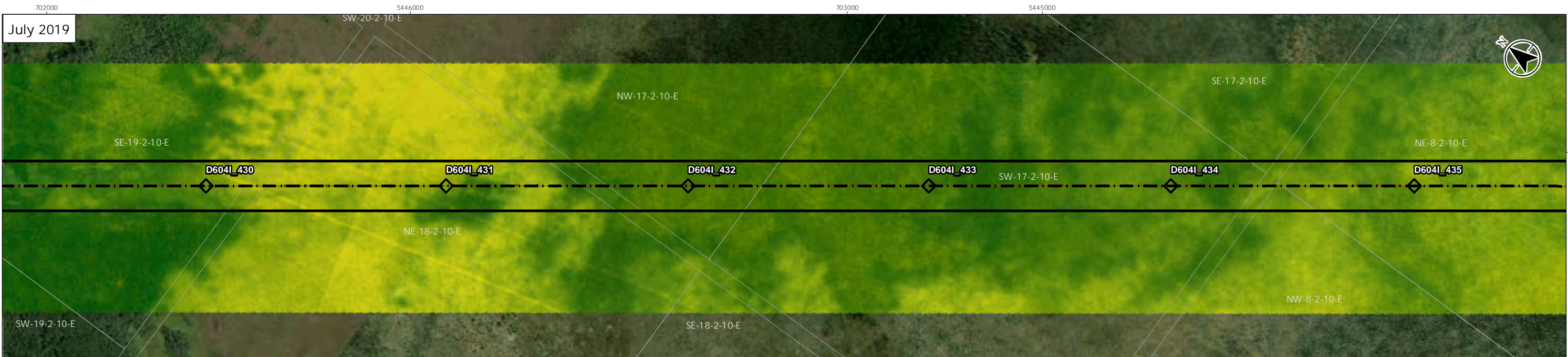
Map No.  
**C.2-61**

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

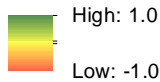
**Evaluation Areas**

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**



**NDVI Difference Outliers for On RoW FMU and**

□ Major Negative Outlier

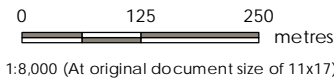
□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

□ Quarter Sections



**DRAFT**

**Project Location**

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

**Client/Project**

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

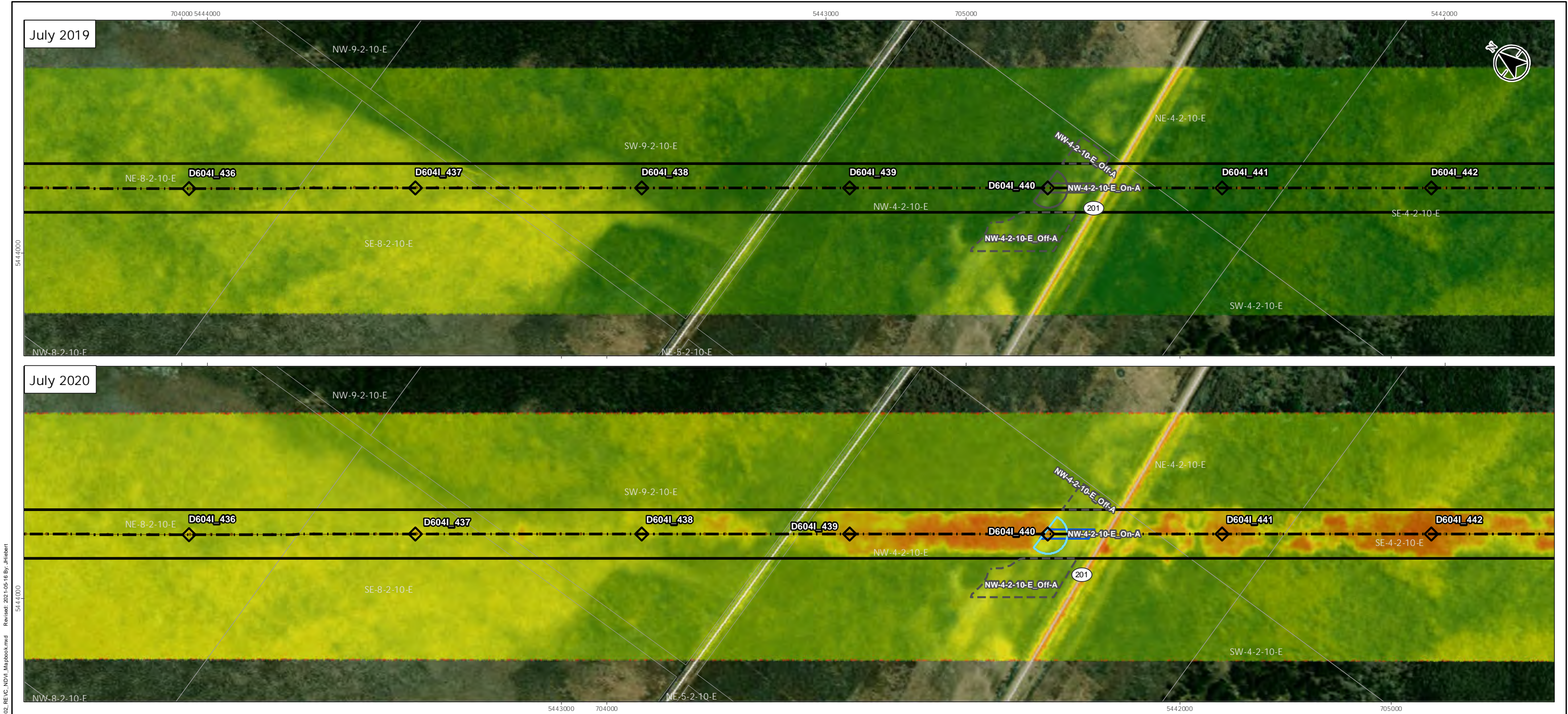
111477020-002-REVC

**Map No.**

**C.2-62**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**





GIS Project Folder\00\_Hydro\11477020\_MMTP\_Soil\_Crop\_Biosecurity\_Monitoring\Figures\11477020\_002\_REV1C\_NDVI\_Mapbook.mxd Revised: 2021-05-16 By: JHiebert



**Notes**

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
4. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

**Evaluation Areas**

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0



Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

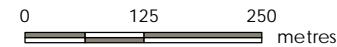
— Existing Transmission Lines

— Highway

— Major Road

□ Quarter Sections

— Watercourse



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**DRAFT**

**Project Location**

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

**Client/Project**

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

111477020-002-REVC

**Map No.**

**C.2-63**

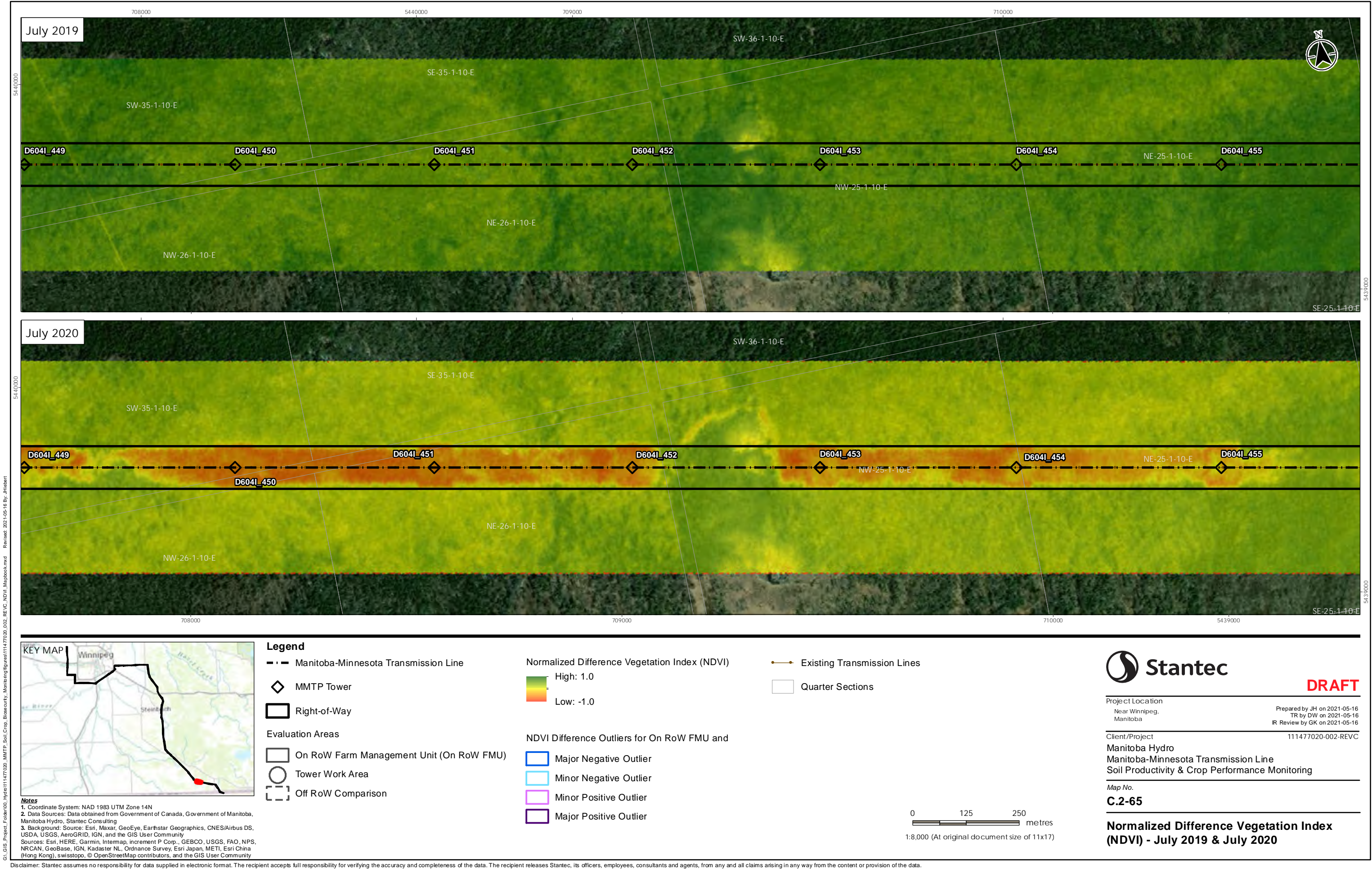
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

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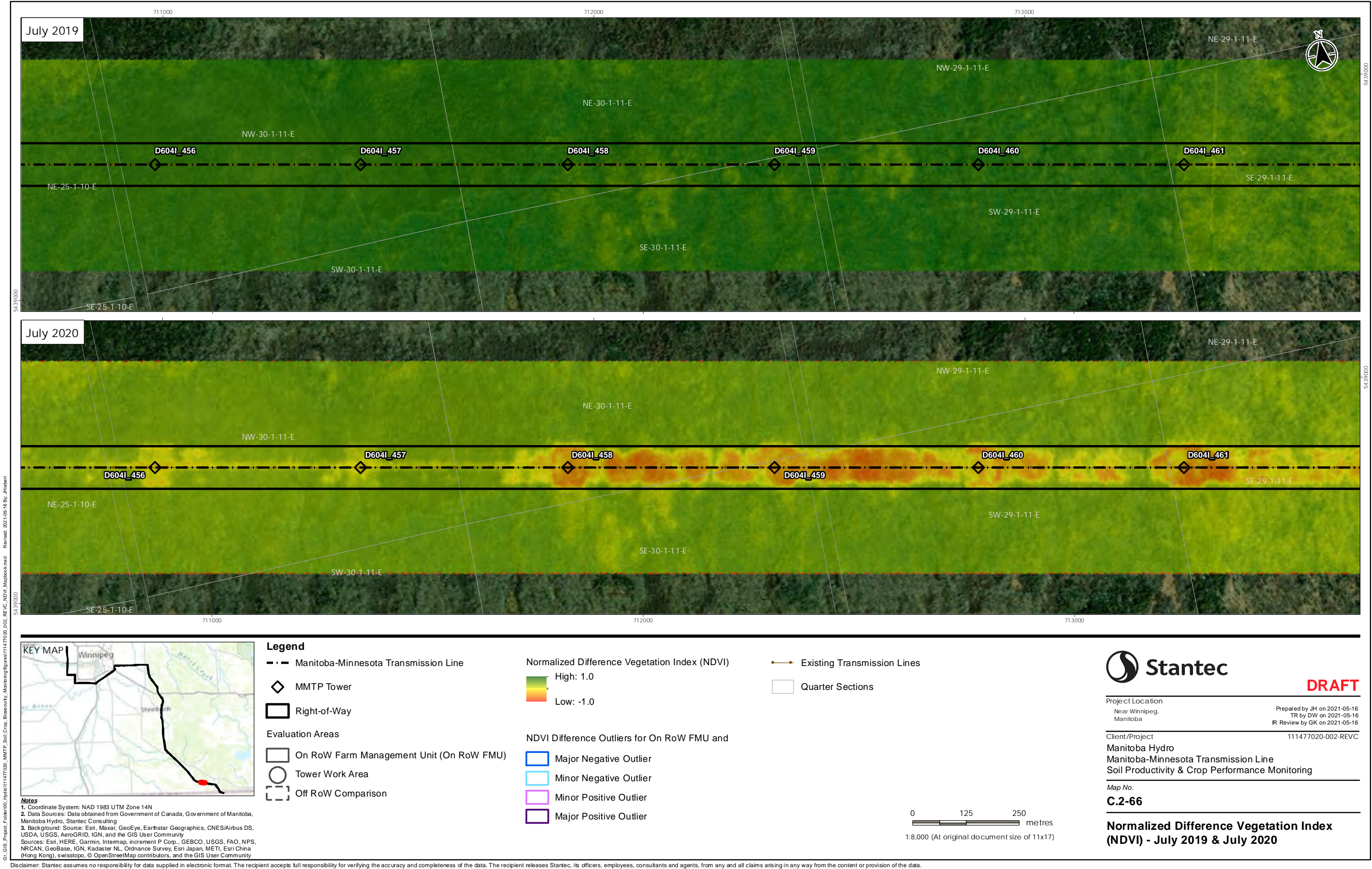




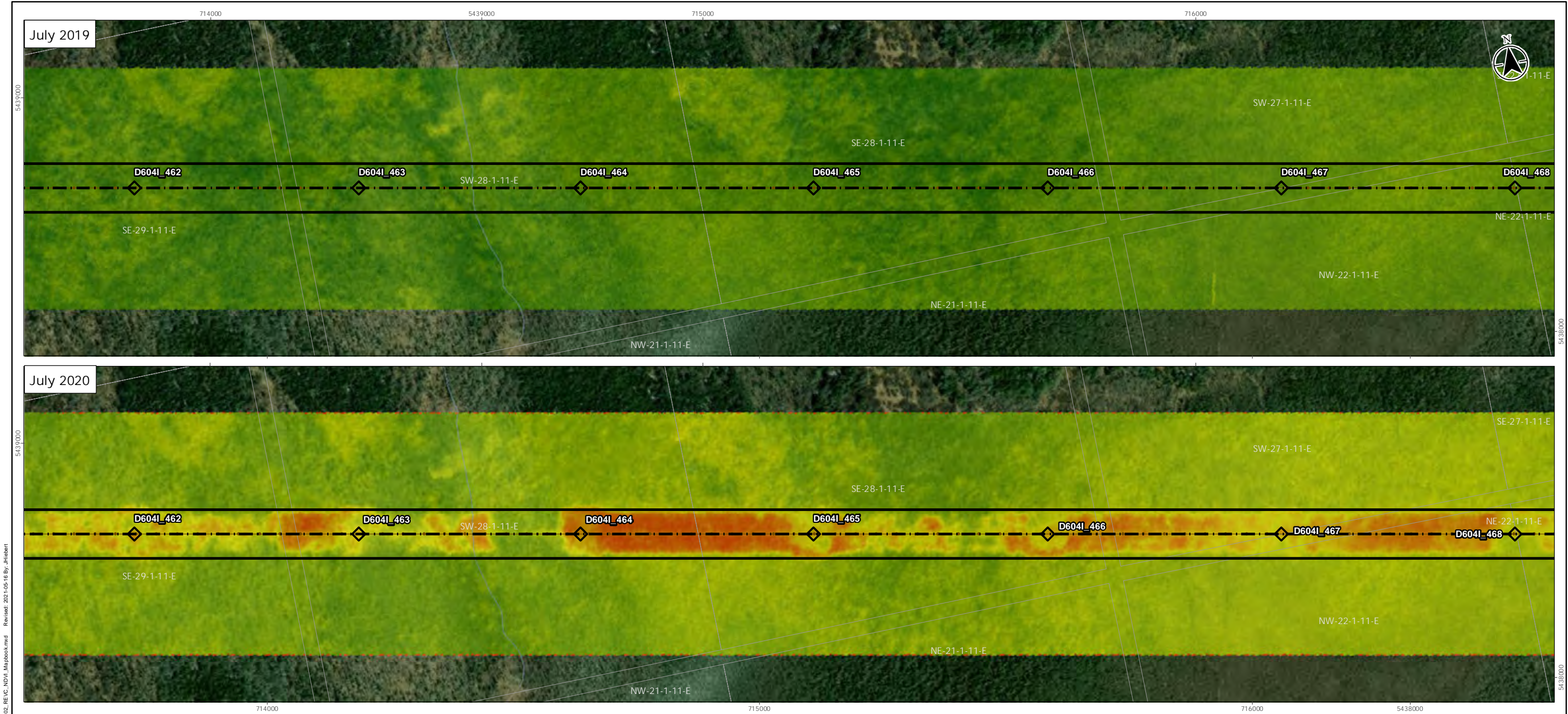












**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

- Quarter Sections
- Watercourse

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-67**

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

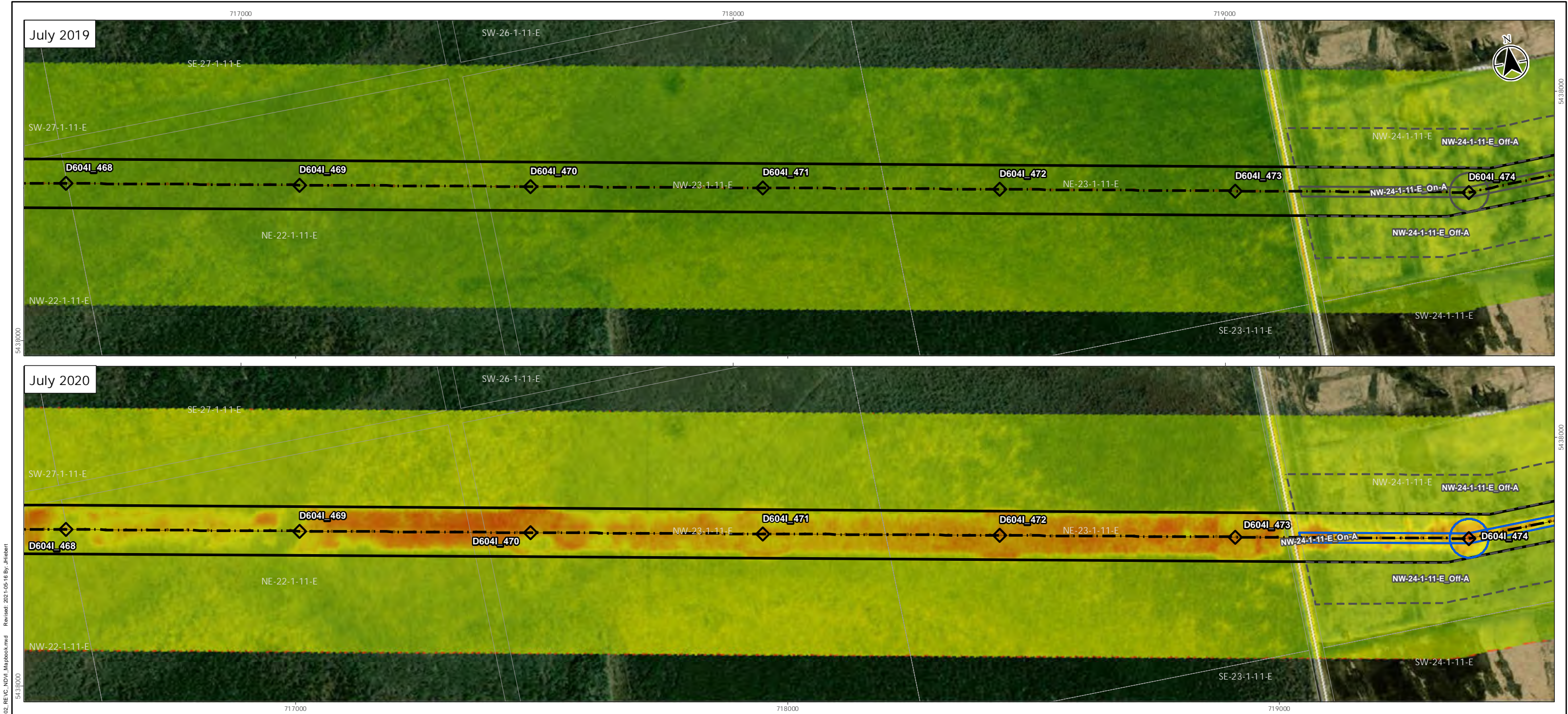
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0  
Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

- Major Road
- Quarter Sections
- Watercourse

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
- Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-68**

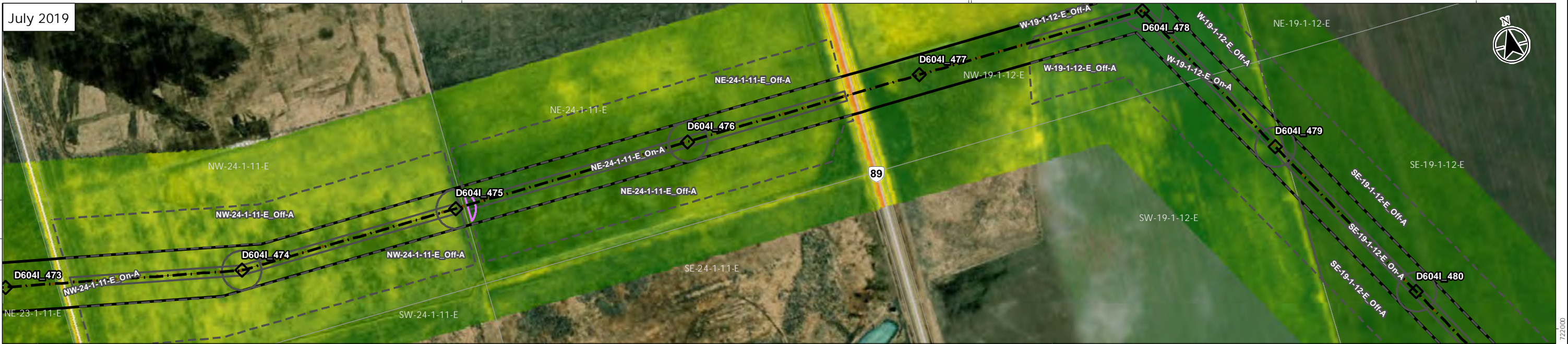
Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**



July 2019



July 2020



#### Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Highway

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location

Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16

TR by DW on 2021-05-16

IR Review by GK on 2021-05-16

Client/Project

111477020-002-REVC

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

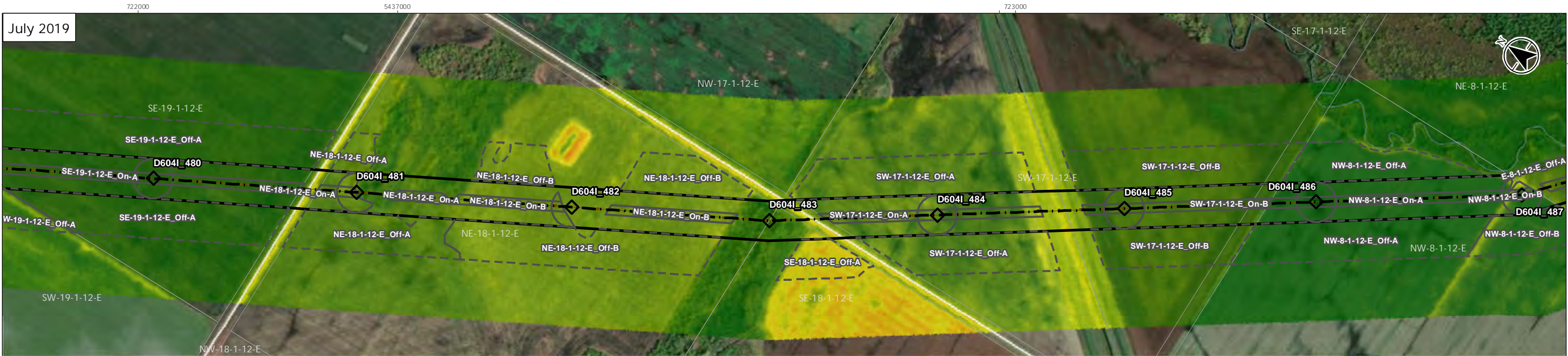
Map No.

**C.2-69**

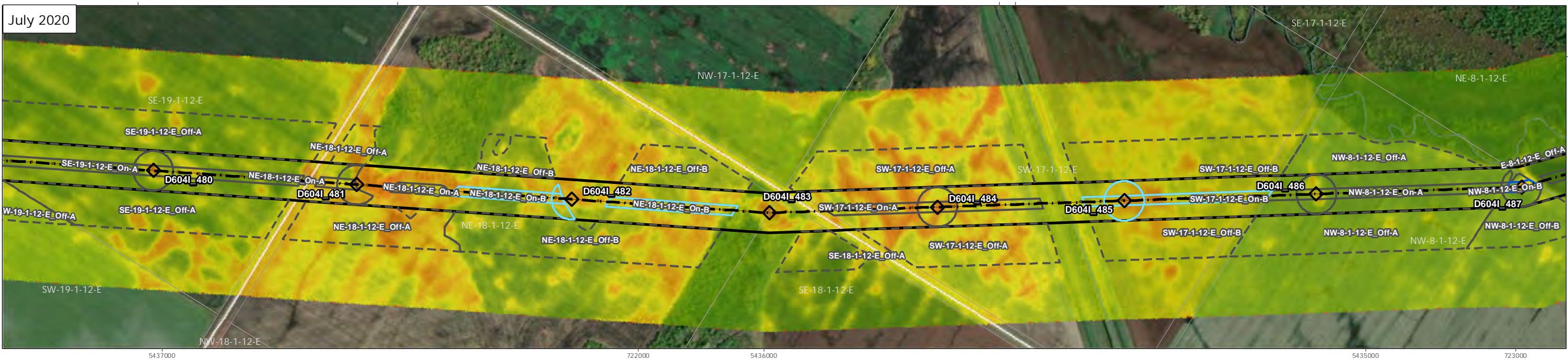
**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**



July 2019



July 2020



**Notes**  
1. Coordinate System: NAD 1983 UTM Zone 14N  
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting  
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community  
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

**Legend**

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

— Existing Transmission Lines

— Major Road

□ Quarter Sections

— Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
R Review by GK on 2021-05-16

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

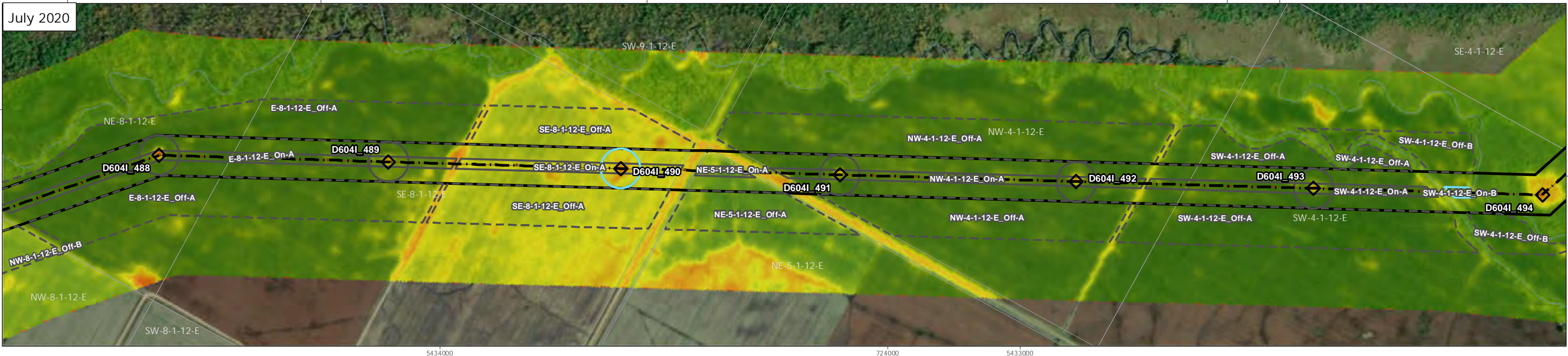
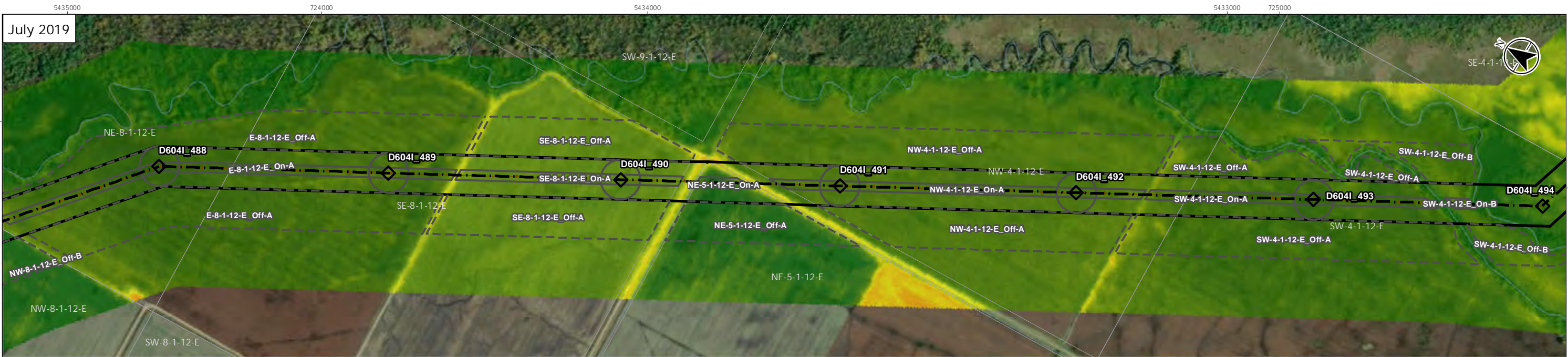
**C.2-70**

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**

G:\GIS\Project\_Folder\00\_Hydro\11477020\_MMTP\_Soil\_Crop\_Biosecurity\_Monitoring\Figures\11477020\_002\_REV.C\_NDVI\_Mapbook.mxd Revised: 2021-05-16 By: JHiebert

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Legend

--- Manitoba-Minnesota Transmission Line

◇ MMTP Tower

□ Right-of-Way

Evaluation Areas

□ On RoW Farm Management Unit (On RoW FMU)

○ Tower Work Area

□ Off RoW Comparison

Normalized Difference Vegetation Index (NDVI)

High: 1.0

Low: -1.0

NDVI Difference Outliers for On RoW FMU and

□ Major Negative Outlier

□ Minor Negative Outlier

□ Minor Positive Outlier

□ Major Positive Outlier

Existing Transmission Lines

□ Quarter Sections

Watercourse

0 125 250 metres

1:8,000 (At original document size of 11x17)



DRAFT

Project Location

Near Winnipeg,  
Manitoba

Client/Project

Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.

C.2-71

Normalized Difference Vegetation Index  
(NDVI) - July 2019 & July 2020

Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
3. Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
4. Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community





**KEY MAP**

**Legend**

- Manitoba-Minnesota Transmission Line
- MMTP Tower
- Right-of-Way
- Evaluation Areas
  - On RoW Farm Management Unit (On RoW FMU)
  - Tower Work Area
  - Off RoW Comparison

**Normalized Difference Vegetation Index (NDVI)**

High: 1.0

Low: -1.0

**NDVI Difference Outliers for On RoW FMU and**

- Major Negative Outlier
- Minor Negative Outlier
- Minor Positive Outlier
- Major Positive Outlier

**Existing Transmission Lines**

Quarter Sections

Watercourse

**Notes**

- Coordinate System: NAD 1983 UTM Zone 14N
- Data Sources: Data obtained from Government of Canada, Government of Manitoba, Manitoba Hydro, Stantec Consulting
- Background: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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**Scale**

0 125 250 metres

1:8,000 (At original document size of 11x17)

**Stantec**

**DRAFT**

Project Location  
Near Winnipeg,  
Manitoba

Client/Project  
Manitoba Hydro  
Manitoba-Minnesota Transmission Line  
Soil Productivity & Crop Performance Monitoring

Map No.  
**C.2-72**

Prepared by JH on 2021-05-16  
TR by DW on 2021-05-16  
IR Review by GK on 2021-05-16

111477020-002-REVC

**Normalized Difference Vegetation Index (NDVI) - July 2019 & July 2020**



