NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Phase 2: Preliminary Environmental Studies
SUMMARY REPORT

TOWNSHIP OF HORNEPAYNE AND AREA, ONTARIO

APM-REP-07000-0208

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Summary Report
Township of Hornepayne and Area, Ontario

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Prepared for:

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Executive Summary

The Nuclear Waste Management Organization (NWMO) is implementing Adaptive Phased Management (APM) to plan for the long-term care of used nuclear fuel. The APM Project includes a site selection process for identifying an informed and willing host for a deep geological repository. The Township of Hornepayne, located in north-central Ontario, expressed interest in participating in the site selection process.

The Phase 1 preliminary assessment provided high level descriptions of the biological and physical environment within the community and surrounding area which, along with geoscientific information, was used to evaluate the potential for a facility to be safely constructed and operated in the vicinity.

Phase 2 preliminary environmental desktop assessments advanced information and updated the environmental data compiled for the potentially suitable areas based on new information and enhanced desktop studies. The intent of the desktop assessments was to identify and map known or potential ecological features, including ecological land classification (ELC) ecosites, candidate significant wildlife habitat, stream reach classification, and species at risk.

Field verification studies were undertaken in 2016 to determine the accuracy of data collected through the described desktop assessment. These surveys included ground-truthing of the desktop ELC assessment and qualitative aquatic habitat conditions (e.g., no active sampling or surveys). Using technical and social evaluation factors, the NWMO identified three smaller potential drilling areas and surveys were completed in 2018 to collect detailed information about the biological characteristics of these three potential drilling areas. During this stage, ELC surveys, bird surveys for various guilds, aerial surveys for stick nests and mammals, bat acoustic and potential maternity roosting habitat surveys, and visual encounter surveys were completed to characterize the terrestrial environment. Aquatic habitat surveys were conducted to confirm surface water quality during multiple seasonal sampling events, presence of fish (incidental observations and non-lethal targeted sampling), general fish habitat classification, as well as stream sediment quality and benthic macroinvertebrate community sampling at locations where aquatic habitat was identified near the identified potential drilling areas.

The findings from the 2018 field surveys demonstrated that the potential drilling area labelled as HP-BH01 was composed of 71% upland habitat. Three species at risk (SAR) were confirmed using or passing through the potential drill area and there was potential for five types of SWH in the study area, although none were confirmed. Approximately 10% of potential drilling area HP-BH01 was considered suitable for supporting SAR bat maternity roosts. The study area associated with potential drilling area HP-BH02 was composed of 51% upland habitat, with two SAR confirmed using or passing through the potential drilling area. Four types of SWH had potential to occur within the potential drilling area, although none were confirmed. Approximately 6% of the total area within potential drilling area HP-BH02 had potential to support SAR bat maternity roosts. Within the potential drilling area HP-BH03, 68% of the area was composed of upland habitat. Three SAR were confirmed either using or passing through the potential drilling area, and one SAR was recorded using habitat adjacent to the potential drilling area. Six types of SWH had potential to occur, although none were confirmed within the HP-BH03 study area. Approximately 74% of the available habitat within potential drilling area HP-BH03 has potential to support SAR bat maternity roosts. It is Wood's opinion that the proposed drilling activities would not negatively impact the natural features identified in any of the three potential drilling areas, with the implementation of appropriate mitigation including timing site preparation activities outside breeding bird and bat maternity periods, maintaining a small drill pad and access route footprint, and providing SAR awareness training to contractors.

The 2018 field surveys related to aquatic studies also suggest that the three potential borehole locations are similarly suitable for borehole drilling, with limited presence of open water habitat within the areas of investigation. It is noted that access to HP-BH02 may require the reinstatement of an access road crossing at the Wabos Lake outlet stream; however, environmental management of potential risks to aquatic habitat related to the water crossings are well understood and best management practices are available to control potential effects of these activities.

This report serves as documentation of environmental investigations undertaken to date in the Hornepayne area, and includes a summary of both Phase 1 and Phase 2 studies. The effective incorporation of Indigenous Knowledge was not considered in the preparation of this report. Environmental information is useful in evaluating the overall potential to safely construct and operate the APM Project in the area. This information, along with Indigenous knowledge (not a component of this report), will be used as an input to the integrated assessment of the suitability of the areas of study for the project and to identify possible environmental risks associated with siting activities to avoid, mitigate, and/or monitor potential effects.

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1.0 Introduction

The Nuclear Waste Management Organization is responsible for implementing Adaptive Phased Management (APM), Canada's plan for the long-term management of its used nuclear fuel. APM has as its endpoint centralized containment and isolation of Canada's used fuel in a deep geological repository in an area with suitable geology and an informed and willing host community in partnership with Indigenous and municipal neighbours. The Township of Hornepayne, located in north-central Ontario, expressed interest in participating in the process.

2.0 Overview of Environmental Studies Completed to Date

The site selection process consists of a multi-phase approach, with increasingly detailed evaluations of the potential suitability of the Hornepayne area to host the APM Project. The Phase 1 preliminary assessment report (Golder 2013) provided high level descriptions of the biological and physical environment within the community and surrounding area (Figure 1), which, along with geoscientific information, was used to evaluate the potential for a facility to be safely constructed and operated in the vicinity.

Several geographically large areas (areas temporarily withdrawn from mineral staking) within the vicinity of the Township of Hornepayne were identified as potentially suitable for the long-term management of used nuclear fuel (i.e., the withdrawal areas) based on readily available geological information evaluated during Phase 1 desktop studies. Aerial geophysical surveys were completed for two of the withdrawal areas, and these two areas were the subject of investigations undertaken by Amec Foster Wheeler Environment and Infrastructure Ltd. (Amec Foster Wheeler) in 2016 as part of the Phase 2 preliminary environmental studies. The two withdrawal areas are referred to as the Black-Pic and the Quetico blocks. The purpose of the 2016 studies was to update the description of environmental features and conditions within these areas, where necessary.

During Phase 2, the preliminary desktop assessments updated the environmental information presented in the Phase 1 reports based on new information, enhanced desktop studies, and field verification studies (i.e., walk-the-land site visits). The intent of the 2016 studies was to map and delineate known or potential ecological features, including ecological land classification (ELC) ecosites (a scientific method to organize, classify and evaluate ecosystems for the purposes of land resource management), candidate significant wildlife habitat (SWH), confirm stream reach classification (a method of identifying stream hierarchy to infer stream size), and potential habitat availability and use by species at risk (SAR).

Using the data from the 2016 environmental studies, along with geoscientific and other technical and social information, the NWMO identified three geographically smaller areas within the Township of Hornepayne and surrounding area (HP_BH01, HP_BH02, and HP_BH03) to examine the potential to advance borehole drilling. These areas are referred to as potential drilling areas and require a more detailed study of the natural environment prior to initiating activities associated with drilling. Each potential drilling area consists of a 78.5 hectare (ha) circle (500 metre [m] radius) within which the specific borehole locations would be placed. The preliminary monitoring program surveys completed in 2018 specifically targeted areas within each potential drilling area, and were designed to cover an additional 200 m beyond the boundaries of the potential drilling areas as a precautionary approach to survey potential zones of influence that may extend outside of the 75.8 ha in the event that the borehole is located at the edge of the potential drilling area.

This document presents the findings of these environmental studies, which document baseline information on existing conditions within the study areas prior to preparing drill pad(s) and access routes. These data will support various environmental comparisons during and after borehole drilling activities and will allow for the identification and assessment of any potential environmental effects resulting from such activities. The 2018 monitoring program included surface water, terrestrial soil and aquatic sediment quality sampling, terrestrial plant and wildlife surveys, and fish community and aquatic habitat surveys.

This report, however, does not take into consideration Indigenous knowledge. Indigenous knowledge is a complex and sophisticated system of knowledge drawing on millennia of wisdom and experience that constantly grows and expands with the experience of each generation. The NWMO will be looking to Indigenous communities and local Indigenous Knowledge holders in the Hornepayne area to find ways to effectively and respectfully incorporate Indigenous Knowledge into the NWMO's ongoing environmental work.

3.0 Phase 1: Desktop Assessment

The Phase 1 preliminary assessment was completed in 2013 (Golder 2013) to identify any environmental features that would preclude the potential for a facility to be constructed in the vicinity of Hornepayne and surrounding area. The desktop assessment provided high level descriptions of the human and natural environment based on readily available sources of data. The following paragraphs summarize the findings of the 2013 Phase 1 report.

The Township of Hornepayne is situated in the Abitibi Uplands physiographic region, featuring the broadly rolling surfaces of Canadian Shield bedrock that occupies most of north-central Ontario. Approximately 30% of the area is covered by Quaternary deposits with the other 70% being bedrock that is either directly exposed or covered by a thin layer of ground moraine. Geologically, the Township of Hornepayne straddles the boundary between the Quetico subprovince to the north and the Wawa Subprovince to the south, which are part of the western region of the Superior Province of the Canadian Shield. The Quetico area is underlain primarily by metasedimentary rocks and the Wawa Subprovince is underlain predominantly by gneissic tonalite of the Black-Pic batholith. Both subprovinces also include subordinate granitoid intrusions and slivers of greenstone belt rocks.

Infrastructure in the area includes Highway 631, a Canadian National (CN) rail corridor, and an electrical transmission line. There are no pipelines recorded. One provincial park (Nagamisis Provincial Park) and 21 known archaeological sites occur in the area (Golder 2013).

The Hornepayne area lies in the Boreal Forest Region. Forestry is a major industry in the area and includes numerous private timber companies currently managing forestry operations. Overlapping Forest Management Units (FMU) include: Nagagami Forest (FMU 390), and Hearst Forest (FMU 601). The region's forests provide habitat for wildlife including game, furbearing mammals and fish. Woodland Caribou, Moose and Marten populations and concentration and nesting areas for raptors, herons and waterfowl are managed by the Ministry of Natural Resources and Forestry (MNRF). The Hearst Forest area contains mostly cool water fisheries on the claybelt and cold-water fisheries associated with the eskers (Golder 2013).

The Hornepayne area is located within the drainage areas of the Nagagami River tertiary watershed. Lands in the southwest Hornepayne area form part of the White River tertiary watershed of the Lake Superior drainage basin. The eastern portion of the Hornepayne area lies within the Upper Kabinakagami River tertiary watershed of the Hudson's Bay drainage basin. Water wells in the Hornepayne area obtain water from the overburden or the shallow bedrock. Air, soil and surface water quality within the Hornepayne area are expected to be within the normal range for north-central Ontario (Golder 2013).

4.0 Phase 2: 2016 Environmental Studies

Phase 2 preliminary environmental desktop assessments advanced information presented in the Phase 1 report, and summarized above, and updated the compiled environmental data based on new information and enhanced desktop studies. Studies focused on two geographically large areas that were determined to be potentially suitable following Phase 1 integrated studies and for which aerial geophysics data were collected during Phase 2 geoscientific studies. These areas are temporarily withdrawn from mineral staking and are referred to in this report as the Black Pic and Quetico withdrawal areas.

4.1 Enhanced Desktop Assessments

The intent of the enhanced desktop assessments was to identify, and map known or potential ecological features, including ELC ecosites, candidate SWH, potential SAR habitat suitability and use, and stream reach classification. The methodology of desktop studies includes the interpretation of existing and new information, mapping of polygonal (block), point and linear features of potential ecological relevance, and identification of areas with species/habitat associations (e.g. SWH). Prepared natural features maps (Figure 2a and Figure 2b) use additional information available from provincial and federal agencies. The natural features maps illustrate Boreal ELC ecosites, and infrequent candidate SWH polygons (those covering less than 10 % of the areas of study), waterbodies and stream reach classifications, steep slopes (greater than or equal to 15 %) based on topographical data, and the road network (Figure 2a and Figure 2b).

4.1.1 Ecological Land Classification

Ecological land classification (ELC) is a scientific method used to organize, classify and evaluate ecosystems (and complexes of ecosystems) for the purposes of land resource management. This method uses ELC classifications to represent "ecosites", which are landscape areas consisting of typical and recurring associations of vegetation, soil, and moisture regimes. These ecosites are used to understand resources availability (vegetation community) as well as potential wildlife habitat suitability and use.

Ecosite polygons (blocks) are primarily derived using existing Forest Resource Inventory (FRI) vegetation species composition and primary ecosite data, with interpretation using high resolution four-band digital aerial ortho-photos (where available). For a portion of the Hornepayne area being studied, species composition and ecosite information for the FRI forest stand polygon data available data from the MNRF were last updated between 2007 and 2010. These data included vegetation classification information in the form of Boreal ELC classifications as described by Banton et al. (2009). Although most of the FRI data had not been updated since between 1989 and 1996, these forest cover types are unlikely to have changed other than within areas where forest harvesting, or forest fires have occurred. Boreal ELC descriptions were not available as part of older FRI data and were therefore determined based on canopy tree information. Canopy tree information and Boreal ELC associations were available in newer FRI data and were used as a baseline for determining Boreal ELC descriptors for older FRI data, in addition to referencing canopy descriptions available in Banton et al. (2009).

Based on the desktop review, 34 distinct ecosite types were identified. Upland coniferous forests were the most commonly distributed vegetation community, followed by upland mixedwood forest communities and coniferous swamp communities. These three vegetation community types represented 95.3 % of the vegetated land area within the two withdrawal areas. Of the remaining 4.7 % vegetated land areas, 3.7 % is represented by open fen vegetation communities. Overall, upland and wetland communities represented 69.3 % and 30.7 % of the vegetated land, respectively.

4.1.2 Candidate Significant Wildlife Habitat

The *Significant Wildlife Habitat Ecoregion 3E Criterion Schedule* (MNRF 2015a) and *Significant Wildlife Habitat Technical Guide* (MNR 2000) provide criteria for identifying SWH within the area of the Township of Hornepayne. The *Significant Wildlife Habitat 3E Criterion Schedule* identifies 42 distinct wildlife habitats in Ecoregion 3E, which are separated into four categories: Seasonal Concentration Areas of Animals, Rare Vegetation Communities and Specialized Habitat for Wildlife, Habitat for Species of Conservation Concern, and Animal Movement Corridors. Based on cross-referencing Boreal ELC codes (Banton et al. 2009) within the two withdrawal areas, and ELC communities described in the *Significant Wildlife Habitat 3E Criterion Schedule* for each distinct wildlife habitat type, 22 potential or candidate SWH types were identified. It should be noted that *Significant Wildlife Habitat 3E Criterion Schedule* help to identify which SWH types are possible, based on typical habitat associations of ELC ecosites. However, field surveys are required to confirm that specific micro- or macro-habitat conditions exist and/or that select wildlife species are present. Such surveys were not undertaken during 2016 studies. Field observations noted during the 2018 field surveys were used to augment the current understanding of habitat conditions within each of the potential drilling areas. These observations are further discussed in Section 5.0.

Some potential SWH types are commonly distributed throughout the withdrawal areas, such as mast producing areas, woodland raptor nesting habitat, denning sites, and Bald Eagle and Osprey nesting habitat due to their potential to exist across a broad range of ELC ecosites. Yellow Birch Rare Treed SWH occurs in most ecosites with aspen/poplar species.

4.1.3 Species at Risk and Regionally Rare Species

Species at risk (SAR) information was obtained through the MNRF's Natural Heritage Information Centre (NHIC database; used to track SAR occurrences, rare species and habitats, as well as other natural heritage information), as provided by the NWMO. Species occurrence information was obtained to generate specific data for the Township of Hornepayne and area. Additional records of bird occurrences were obtained through the online Ontario Breeding Bird Atlas (OBBA; Cadman et al. 2007). As species occurrence data for northern Ontario are typically scarce, other secondary sources of information, including bird, herpetile (i.e., amphibians and reptiles), mammal and aquatic species atlases for Ontario (Cadman et al. 2007; Ontario Nature 2017; Dobbyn 1994; DFO 2017; respectively) and federal and provincial SAR lists and range maps (Government of Canada 2017; MNRF 2017a, respectively) were also reviewed to generate an inclusive list of SAR which have the potential to occur within the withdrawal areas being studied.

According to the review of secondary sources, the following SAR have the potential to occur within the two withdrawal areas:

- Eight (8) bird species: Bank Swallow, Barn Swallow, Eastern Whip-poor-will, Bald Eagle, Canada Warbler, Common Nighthawk, Olive-sided Flycatcher, and Rusty Blackbird;Three (3) mammal species: Woodland Caribou, Little Brown Myotis, and Northern Myotis;
- One (1) herpetile species: Snapping Turtle;
- One (1) butterfly species: Monarch; and
- One (1) aquatic species: Lake Sturgeon (Great Lakes – Upper St. Lawrence population).

No plant SAR were found to have potential to occur within the two withdrawal areas. As this information is based primarily from species range maps, targeted field studies were needed to confirm habitat suitability and/or species presence. Such studies were undertaken in 2018 and will be discussed further in Section 5.0.

4.1.4 Fisheries Resources

Historically, MNRF district-wide fisheries management plans were developed to manage the commercial and recreational fisheries, and to establish and regulate sustainable harvest levels. One such example is the Wawa District Fisheries Management Plan 1988-2000, published as a draft in 1989. These district fisheries management plans typically used a lake-by-lake management strategy which has largely been replaced by the landscape approach management strategies developed for the more recently mapped MNRF Fisheries Management Zones (FMZ) as part of the Broadscale Scientific Monitoring Program in 2008 (MNRF 2016). The FMZ planning and management process includes advisory councils that consult with angling groups, scientists and researchers, conservation groups and interested community members. Consultation allows the advisory councils to share stakeholder ideas and expertise with the MNRF and to help develop and implement management strategies.

The Hornepayne withdrawal areas fall within MNRF Fisheries Management Zone 7 which encompasses a long stretch of Lake Superior shoreline, important recreational and tourism-based fisheries, fisheries for sportfish species including Walleye, Northern Pike, Lake Trout and Brook Trout, stocked Brook Trout lakes, as well as Pukaskwa Provincial Park and the Chapleau Crown Game Preserve (MNRF 2014a). No advisory council has been established for Fisheries Management Zone 7, and communication with MNRF indicate no action with regard to development of a Fisheries Management Zone 7 management plan or advisory council is planned. As such, the MNRF Land Information Ontario (LIO) data, fish species occurrence records and habitat information were used for the desktop studies.

4.1.5 Stream Reach Classification

4.1.5.1 Stream Reach Order

Stream order classifies stream hierarchy from its source (headwaters) downstream and was determined through digital elevations models (from LIO) and the application of the Strahler stream order classification. Stream order provides a measure of the relative size of streams, which relates to the amount of water moving off the watershed into the stream channel. Water volume as well as velocity influence water quality and, therefore, health of living organisms and habitats associated with the stream (USEPA 2012). The Strahler method for classification assigns each headwater perennial stream an order of 1 (Strahler 1952; Strahler 1954; Strahler 1957). The meeting of two 1^{st}-order streams assigns the downstream reach an order of 2. The meeting of two 2^{nd}-order streams results in a downstream reach of order 3, and so on (Diagram 1). Generally, a lower stream order represents a smaller stream (i.e. a stream order of 1 is smaller than a stream order of 6). Within the areas being studied, a maximum of a 6^{th} order stream was classified.

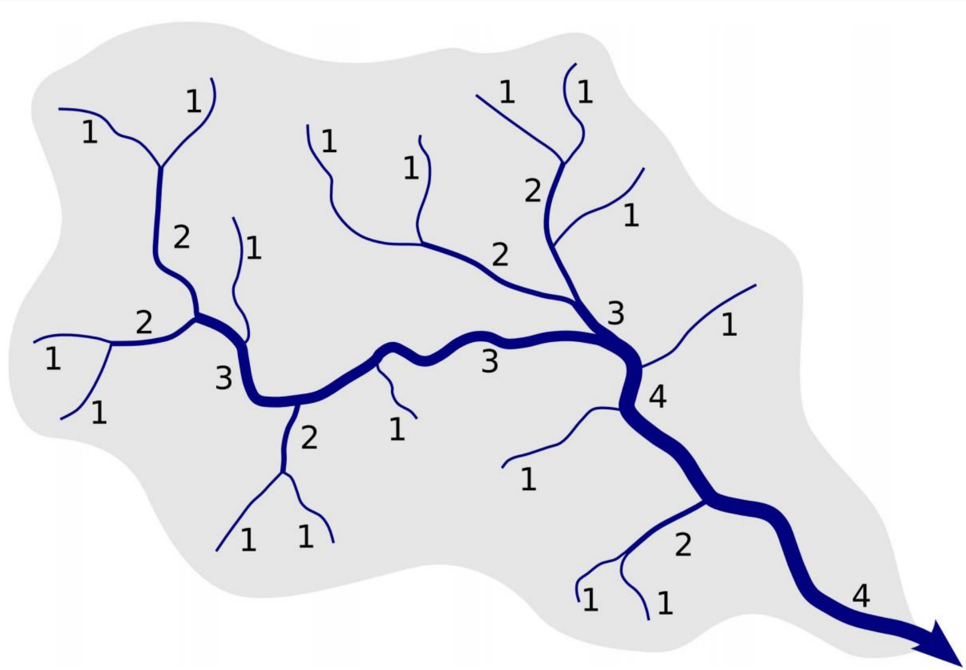

Diagram 1: Stream order based on the Strahler (1952) classification.

4.1.5.2 Thermal Regime

Thermal regime directly influences the aquatic environment including potential fish species present (which have specific thermal tolerances) as well as other biological elements. In this way, thermal regime can be used to provide a high-level screening of candidate areas with species of interest such as sportfish (e.g., Brook Trout, Walleye, Northern Pike). Where fish species information was available but thermal regime data was missing, the thermal regime was inferred based on Minns (2010), which describes the thermal preference of Ontario stream fish groups. Where neither fish species nor thermal regime data was available, thermal regime was inferred based on Strahler stream order, as described above. Low order streams (1st to 3rd) are typically headwaters within watersheds characterized by generally cooler, faster flowing conditions. As such, the 1st to 3rd order stream reaches that did not have associated thermal regime data were classified as cold-water environments. Stream reaches identified as 4th to 6th order streams were classified as cool-water environments in the absence of thermal regime data.

4.1.5.3 Stream Morphology

Stream morphology (form) is the shape of a river channel and how it changes in shape and direction over time. Stream morphology is a factor in stream classification systems, with initial classifications using basin characteristics such as slope (Rosgen 1996). Other morphological factors include the shape of the channel, channel patterns, entrenchment (vertical containment of a stream and the degree to which it is cut into the surrounding land), and channel material. Most of this information is typically acquired through the interpretation of high-resolution aerial imagery and field data, with the exception of slope. As such, slope was used in the desktop screening to estimate stream morphology. Digital elevation models were used to approximate the average percent slope for each watercourse segment, and the Rosgen Stream Classification (Rosgen 1996) framework was applied to guide probable stream morphology as follows: a slope of ≤1% was classified as 'pool', >1-5% as 'glide/run', 5-12% as 'riffle', and >12% as 'cascade/waterfall'.

It is understood that additional morphological data may change initial classifications; however, the use of slope provided a useful screening tool that can then be verified in the field using the Ontario Stream Assessment Protocol (OSAP; Stanfield 2013).

4.2 2016 Field Verification Studies

Field verification studies were initially undertaken within the two potential withdrawal areas to establish the accuracy of data collected through the described desktop assessment in 2016. The field verification study areas within the potential withdrawal areas were determined through a visual assessment of the area using ArcGIS and were chosen for:

- Optimum road accessibility;
- A diverse topography;
- The presence of a rare vegetation community;
- Diverse stream reach categories and fish communities; and/or
- Potential SAR habit.

The dates of the 2016 field verification studies are presented in Table 4-1. Table 4-1 also includes dates for the 2018 detailed studies completed in the identified potential drilling areas; these studies are described in Section 5.0.

4.2.1 Ecological Land Classification

Terrestrial field surveys were undertaken between September 27 and October 5, 2016. Verification of the ELC information consisted of walking the land to check the accuracy and classification of ecosite polygons (blocks). Ecosite communities are based on dominant plant species and soil characteristics (Banton et al. 2009). As such, plant species lists were compiled for each separate ecosite type. Determination of soil characteristics was completed through visual inspection and an estimation of organic soil (comprised mainly of plant material) versus mineral soil (derived of minerals/rocks). As environmental field studies in the area were at a preliminary stage, surveys focused efforts in representative communities (based on pre-mapped ELC polygons), to the extent possible, through predetermined field survey routes. Such survey methodology is widely used and accepted sampling protocol. In ecological studies, especially when one of the main objectives is to maximize the coverage of the area of interest. Predetermined field routes were followed to the extent possible. However, minor deviations and rarely major deviations were necessary due to health and safety considerations related to accessibility and wildlife encounters. Natural features were field verified and mapped concurrently with vegetation community surveys.

A total of 106 plant species were recorded, ranging between 98 to 100 species recorded within each of the areas of study. Common species occurring in upland coniferous forests include Black Spruce, Jack Pine, Balsam Fir, and White Spruce, with Bunchberry, Labrador-tea, and blueberry species in the ground layer. Mixedwood forest communities included Trembling Aspen and White Birch, with Mountain Maple, Bush Honeysuckle, Blue-bead Lily, Twinflower, and Goldthread in the ground layer. Coniferous swamp communities consisted of Black Spruce, Tamarack, and White Cedar, with Leatherleaf and sedge species. Other species recorded in thicket swamp, fen and marsh wetland communities include Speckled Alder, Sweet Gale, and Blue-flag Iris. All of these species are provincially ranged as S5 (Secure) or S4 (Apparently Secure); no rare or SAR plant species were recorded.

Table 4-1 Field Survey Dates

Survey Type	2016	2018
Surface Water Quality	-	May 14 to 17 June 21 to 26 August 8 to 9
Sediment Quality and Substrate Composition	-	May 14 to 17
Soil Quality Sampling	-	June 20 to 26
Vegetation Communities and Botanical Inventories	September 27 to October 5	August 8 to 11
Breeding Bird Surveys	-	May 24 to June 4
Crepuscular Bird Surveys	-	May 23 to 26 June 21 to 28
Aerial Surveys for Mammals and Raptor Stick Nest	-	March 6 to 7 March 20 to 21 April 24 to 25 June 7
Herpetofaunal and Owl Surveys	-	May 23 to 26 June 21 to 28
Bat Surveys (1)	-	May 28 to August 12
Visual Encounter Surveys	September 27 to October 5	(2)
Significant Wildlife Surveys	-	(2)
Species at Risk Habitat	-	(2)
Aquatic Monitoring Program	October 13 to 17	May 14 to 17 June 21 to 26 August 8 to 9

Notes:

1. Bat detectors were moved on various dates throughout this timeframe.
2. Surveys were completed in conjunction with species-specific surveys throughout the field program.

A total of 101 polygons (blocks) representing 15 Boreal ecosite types were surveyed in the Hornepayne withdrawal areas. Plant species lists and field notes were collected for each polygon and used to determine the accuracy of the predetermined ELC information derived from desktop assessments. Where predetermined ELC codes were not deemed accurate, a new ELC classification was suggested/assigned. Large polygons, to a certain extent, are commonly composed of a mosaic of community types due to some variances in topography or hydrology. In these cases, a single "best fit" ELC classification was assigned to the polygon. More accurate ELC classifications were suggested for 40 of the 101 surveyed polygons, which suggests an overall accuracy rate of 60% accuracy of ELC data collected though desktop assessments.

Rationale for a revised ELC classification was most often attributed to a change in proportion of the same canopy tree species or due to a difference in soil type, with no difference in canopy description. Most suggested revisions for coniferous swamp community types were due a higher understory species richness, which resulted in no change to the community type. Overall, most of the suggested revisions did not indicate meaningful errors in the desktop assessment data. Only four suggested revisions were attributed to both a difference in canopy composition and a difference in soil moisture regime (upland versus wetland), which could not be explained by logging activities.

The difference between the overall accuracies of newer and older FRI data by area of study was not notable, suggesting that estimated data was not significantly less accurate. Ecosite boundaries were determined to be accurate for most of the polygons surveyed. Most boundary discrepancies were minor, ranging up to 15 m and explained by ecotones (transition zones between ecosites) which typically occur between community types. In some cases, discrepancies of up to 100 m were recorded. However, these were uncommon, and in some cases, could be attributed to logging activities.

Incidental wildlife observations were recorded broadly across all study areas. Evidence of mammals was mainly confirmed by the presence of scat and/or tracks. Mammal species documented include Black Bear, Moose, Red Squirrel, Snowshoe Hare, and Beaver. These species were observed in both withdrawal areas. No SAR were recorded.

4.2.2 Stream Reach Classification

Stream reach classification field assessments were guided by the Ontario Stream Assessment Protocol (OSAP; Stanfield 2013), the Ministry of Transportation / Ministry of Natural Resources Fisheries Protocol, and the Ontario Stream Fishes Habitat Assessment Models as published by Fisheries and Oceans Canada (Minns 2010). The 2016 field verification study objective was to verify the presence of fish habitat using characteristics that were used in the desktop studies to define individual stream reaches and their corresponding habitat type. At the stream reaches selected for the 2016 field verification studies, physical and habitat characteristics were recorded within a randomly selected site of 100 m length or ten times the channel width, as determined by in-field conditions.

Aquatic field studies were undertaken on October 13 and 17, 2016. Predetermined waypoints representing a variety of stream morphology (forms) and waterbody permanence (permanent or temporary) within the areas of study were visited for verification. However, the Black-Pic withdrawal area was not surveyed due to accessibility issues. The 2016 aquatic field verification studies included non-invasive observations, producing a snapshot of the existing conditions documented by field notes and photographs (i.e., no aquatic biota sampling was undertaken). The field notes included general habitat observations, stream morphology measurements and measurements of water quality (temperature, dissolved oxygen, pH, and conductivity) with an objective to verify waterbody permanence and stream morphology (shape, size, stream flow, etc.). Confirmation of other aspects such as fish community and thermal regime would require more detailed assessments such as sampling (trapping/fishing effort) and long-term temperature monitoring and was not completed at this time.

A minimum of one study transect (survey line across the stream) was completed at each waypoint to describe and verify the above-noted characteristics. Additional transects were positioned upstream and/or downstream of the initial waypoint, to further assess natural variability and verify classifications. A total of 11 study locations were visited in 2016, and 19 transects were completed to support the field verifications. The stream morphology and permanence estimated through desktop assessments did not differ greatly from the actual conditions observed in the field. Only two transects with different stream morphology classifications (measured using hydraulic head; a measure of stream flow). As such, these field verification results show the estimate stream permanence and flow morphology data were largely correct (89% accurate).

4.3 Summary of 2016 Environmental Studies

Field verification studies were undertaken to determine the accuracy of data collected through the described desktop assessment. Results suggest an overall rate of 60% accuracy of ELC data collected through desktop assessments, and most of the revisions to the desktop assessment data based on the field verification data were attributable to minor differences in forest canopy or soil type. Stream reach classification was verified through field studies focusing on waterbody permanence (permanent or temporary) and stream morphology (shape, size, stream flow, etc.). Comparisons of the desktop data with the actual ground conditions provided confidence that the desktop data were relatively good predictors of ground conditions, and therefore were appropriate tools to further refine the locations of the potential drilling areas.

5.0 Phase 2: 2018 Environmental Studies

Using data from the 2016 environment studies, along with geoscientific and other technical and social information, the NWMO identified three geographically smaller areas within the Township of Hornepayne and surrounding area (HP_BH01, HP_BH02, and HP_BH03) to examine the potential to advance borehole drilling. These potential drilling areas were the focus of detailed study of the natural environment prior to initiating activities associated with drilling. Each potential drilling area consists of a 78.5 hectare (ha) circle (500 metre; m radius) within which the specific borehole locations will be placed. The preliminary monitoring program surveys completed in 2018 specifically targeted areas within each potential drilling area and were designed to cover an additional 200 m beyond the boundaries of the potential drilling areas to survey potential zones of influence that may extend beyond the identified potential drilling area.

The following surveys were completed as part of the 2018 preliminary monitoring program:

- Surface water, aquatic sediment and terrestrial soil quality sampling (including data evaluation quality assurance and control);
- Ecological land classification (vegetation community, soil types, and moisture regimes);
- Breeding bird surveys (songbirds, crepuscular birds and owls);

- Aerial surveys for mammals (Moose, Woodland Caribou, Lynx, River Otter and Gray Wolf) and raptor stick nests (eagle, hawk, falcon and owl nests);
- Herpetofaunal (Amphibian and Reptile) surveys;
- Bat and supplementary mammal surveys;
- Visual encounter surveys (opportunistically detecting wildlife through visual observation, tracks, scat or vocalizations);
- Candidate SWH identification;
- Potential SAR habitat identification; and
- Aquatic habitat surveys at all areas, and benthic macroinvertebrate and fish community surveys at one of the three potential drilling areas.

The methods for each of the surveys completed in 2018 are summarized in Section 5.1 below with summary of findings for each of the potential drilling areas presented in Section 5.2.

5.1 Preliminary Monitoring Program Methods

The methods used for each of the 2018 surveys have been summarized below.

5.1.1 Surface Water Quality

Surface water samples were collected at waterbodies or watercourses within 200 m of the potential drilling areas, as well as locations further away from these areas, thereby providing 'reference' data to better understand local surface water quality (Figure 3). Samples were collected in laboratory containers (jars and bottles) and shipped to the analytical laboratory for analysis. Standardized surface water collection protocols were followed to ensure each sample was collected in the same manner and the results were compared.

The surface water parameters (analytes) for laboratory analyses were designed to collect a comprehensive suite of baseline data thereby established a predevelopment dataset for comparison against possible future data post-drilling. These analytes included typical parameters for the assessment of baseline conditions (metals and inorganics), as well as project-specific parameters requested by the NWMO and parameters which have the potential to be introduced or elevated in the potential drilling areas as a result of the borehole advancement and the equipment used (Volatile Organic Carbons [VOCs], Petroleum Hydrocarbon Fractions 1 to 4 and Polycyclic Aromatic Hydrocarbons [PAHs]). Of note, the inclusion of some radionuclides at this stage of investigation is solely to get an understanding of the background concentrations in area lakes and streams, and how those concentrations compare with existing measurements from other locations throughout the Canadian Shield. In-field surface water quality parameters were also measured using portable water quality instruments. These instruments measured water temperature, pH, dissolved oxygen concentration and conductivity.

The surface water quality in-field measurements and laboratory results were compared to the Ontario Provincial Water Quality Objectives (PWQO; Ministry of Environment and Energy [MOEE] 1999), and the Canadian Environmental Quality Guidelines (CEQG; Canadian Council of Ministers for the Environment

[CCME] 2014) for the protection of freshwater aquatic life. These comparisons characterized the existing conditions (pre-drilling) and identified analyte concentrations that did not satisfy the quality criteria for aquatic biota. Nearly all analytes were within the appropriate concentration range to support aquatic biota quality criteria, with the exception of a few samples that contained naturally elevated iron concentrations, as well as some low dissolved oxygen concentrations representing site-specific conditions that were expected.

Surface water sampling quality assurance and quality control (QA/QC) included the collection and analysis of field duplicate (split) samples at a frequency of approximately 10% of the total number of samples to permit assessment of field precision (Environment Canada [EC] 2012). Field QC samples are used to establish whether any errors are being introduced during the sampling process so that corrective action can be taken if necessary. Field QC samples are distinct from laboratory QC samples in that they measure sampling effects rather than laboratory effects. The analytical laboratory also performs duplicate analyses (for assessment of laboratory precision), as well as analyses of blank samples, matrix spikes and certified reference materials (for assessment of accuracy) concurrent with sample analyses to satisfy their internal QC and as part of the laboratory accreditation.

5.1.2 Sediment Quality and Substrate Composition

Soft sediment in the aquatic environment provides substrate to support growth of aquatic plants and algae, shelter and food for benthic macroinvertebrates, as well as shelter, spawning and foraging habitat for fish species living near the bottom of streams, rivers and lakes. These sediments can act as a sink and source for contaminants and are commonly sampled to help characterize the health of aquatic systems.

Surficial soft sediment samples (upper 3 to 5 centimetres [cm]) were collected using a grab sampler (Petite Ponar) at two locations on the outlet stream of Wabos Lake, near potential drilling area HP-BH02. The type of substrate (e.g., rock, gravel/sand, organic muck) dictated appropriate sample collection areas since some localized areas may not have provided sufficient sediment deposition or other habitat characteristics were unsuitable for sampling (e.g., dense root masses, hard-packed bottom). Five replicate sample transects per sample near potential drilling areas HP-BH02 were identified. One surficial sediment sample from each replicate transect was collected as a product of three pooled field sub-samples (grabs) to account for natural variability. A total of five individual sediment samples were collected from each sample area, which were shipped to the laboratory for analysis. Each sediment sample was catalogued on field forms with the associated local physical environment parameters, such as depth of water, flow and velocity (as able), physical appearance, and depth of sampler penetration. Particle size distribution analysis was also performed on each sample to characterize the physical nature of the sediment, and support interpretation of the benthic invertebrate community data. Sampling occurred from downstream to upstream to negate disturbance of sediment prior to subsequent sample collection upstream.

The sediment quality parameters (analytes) for laboratory analyses were designed to meet the immediate study needs, while providing adequate baseline data for possible future site activities. The sediment quality analytes included typical parameters for the assessment of baseline conditions (metals and inorganics), as well as project-specific parameters requested by the NWMO and parameters that have the potential to be introduced or elevated in the potential drilling areas as a result of the borehole advancement and the equipment used (VOCs, Petroleum Hydrocarbon Fractions 1 to 4 and PAHs).

The laboratory analytical results were compared to the Ontario Ministry of Environment Provincial Sediment Quality Guidelines (PSQGs; MOE 1993) and Canadian Sediment Quality Guidelines (CSQG; CCME 2001). Through comparison to the PSGQs, a comparison to the Ontario Regulation 153/04: Records of Site

Condition – Part XV.1 of the *Environmental Protection Act* Table 1 background site conditions for sediment (MOECC 2011) was also made since these quality criteria are the same.

The PSQGs are guidelines which promote the protection of aquatic life and are based on sound scientific information. According to the PSQG document, three levels of effects are prescribed that reflect potential chronic and long-term effects of contaminants on benthic invertebrates. The three levels are:

- **No Effect Level:** Fish and sediment-dwelling organisms are not affected by chemicals in the sediment; the sediment is considered clean;
- **Lowest Effect Level (LEL):** Level of sediment contamination that can be tolerated by the majority of the sediment-dwelling benthic invertebrates; the sediment is considered to be clean to marginally contaminated; and
- **Severe Effect Level (SEL):** Level of sediment contamination at which pronounced disturbance of the sediment-dwelling community can be expected; the sediment is considered heavily contaminated.

The CSQG criteria are established based on formal federal protocol to evaluate potential adverse biological effects in aquatic environments. They prescribe a level of contamination at which there are probable effects (Probable Effect Level, PEL).

Sediment quality sampling QA/QC included collection of field duplicate (split) samples at a frequency of approximately 10% of the total number of samples to permit assessment of field precision (EC 2012). The relative percent difference in concentrations was compared to evaluate field sample homogenization, as well as the precision of laboratory analyses.

5.1.3 Soil Quality Sampling

Soils are critical components of terrestrial ecosystems and healthy or good quality soils are essential for ecosystems to remain intact or recover from disturbances, such as drought, climate change, pest infestation, pollution, and human uses (e.g., agriculture, forest resource management).

Soil quality monitoring was conducted within the 78.5 ha circle (500 m radius) that represents the potential drilling areas shown on Figures 4a to 4c. This 78.5 ha circle was split into four quadrants and within each quadrant four composite soil samples were collected, meaning the composite samples were comprised of three homogenized (well mixed) soil grabs to be submitted for laboratory analysis. Each composite soil sample was catalogued on field forms with the associated local physical environment parameters, such as physical appearance (colour), description of soil particle sizes, staining, odours, waste materials, debris, compactness and consistency, and depth of sample. This approach allowed for determination on the overall soil conditions of each area prior to potential drilling activities, which can be compared to post-drilling soil conditions to assess changes in soil quality.

The soil quality parameters (analytes) for laboratory analyses were designed to meet the immediate needs of the advancement of the potential drilling areas, while providing adequate baseline data for possible future site activities. The analytes included typical parameters for the assessment of baseline conditions (metals and inorganics), as well as parameters which have the potential to be introduced or elevated in the study area as a result of the borehole advancement and the equipment used (VOCs), Petroleum Hydrocarbon Fractions 1 to 4 and PAHs.

The laboratory sample results were compared to the Canadian Sediment Quality Guidelines (CSQG) for the Protection of Environmental and Human Health, specifically the Soil Quality Guidelines for Environmental Health (SQG_E) for Residential and Parkland soils (CCME 2006) and were compared to the O. Reg. 153/04: Records of Site Condition – Part XV.1 of the *Environmental Protection Act* Table 1 background site conditions for Residential/Parkland/Institutional/Industrial/Commercial/Community Property land use (MOECC 2011).

Soil quality sampling QA/QC included collection of field duplicate samples at a frequency of approximately 10% of the total number of samples to permit assessment of field sampling precision (EC 2012). As such, at least one duplicate soil sample was collected in each potential drilling area.

5.1.4 Data Evaluation Quality Assurance and Control

To ensure accurate data were collected during the surface water, sediment and terrestrial soil quality programs, the recommended analytical laboratory criteria for comparison of field (blind) duplicates to evaluate laboratory QC, homogenization procedures and field collection techniques were used (Maxxam 2015). These criteria identify differences in sample concentration that are five times the reportable detection limit (RDL) for each sample concentration to calculate relative percent difference (RPD). This criterion results in less uncertainty for concentrations measured close to the reportable detection limit RDL. The acceptable limit of RPDs are specific to the analytical parameter group (e.g., Metals and Inorganics, VOCs, PAHs, etc.), as well as the sample media (water or soil).

5.1.5 Ecological Land Classification

Additional ELC surveys completed in the potential drilling areas between August 8 and 11, 2018, with the goal of targeting the most representative ecosites (i.e., FRI polygons that covered the greatest proportions of the potential drilling areas). Since the desktop records review and 2016 field verification studies revealed that rare plants were unlikely to occur in withdrawal areas , this method was deemed suitable.

During the 2018 plant community surveys, ecosites were confirmed through both a plot-based assessment (10 square meter [m^2] plots within each ecosite) and meandering transects along pre-selected survey routes (Figure 4a to Figure 4c). The plot size was based on standard methods for classifying plant communities (Chambers et al. 1997; Taylor et al. 2000; Sims et al. 1997). As each of the polygons was surveyed, a detailed vegetation inventory was collected. At each survey plot, soil was described using guidance provided by the Substrates of Ontario manual (MNRF 2015b). Where the FRI mapping was deemed inaccurate, vegetation and soil information collected in the field were used to reclassify the polygon to a more suitable ecosite, following guidance provided by the *Ecosites of Ontario, Operational Draft* (Banton et al. 2009). Polygon boundaries that did not reflect current conditions were revised based on field observations. Photographs were taken to document field conditions at each of the survey plots.

During the vegetation community surveys, incidental signs of wildlife or wildlife activity encountered were recorded. Natural features (e.g., SWH and wetlands) were field verified and mapped concurrently with vegetation community surveys.

5.1.6 Breeding Bird Surveys

Surveys were completed in 2018 for breeding songbirds, crepuscular birds (i.e., birds active at dawn and dusk), and owls at each of the potential drilling areas. While marsh bird surveys were proposed, no suitable marsh habitat was identified in the potential drilling areas and no marsh bird surveys were completed. The following subsections outline the various breeding bird survey protocols for different guilds of birds.

5.1.6.1 Morning Bird Surveys

Morning bird point count surveys were undertaken in accordance with the protocols described for the OBBA (2001). These surveys are designed to target the majority of breeding birds, including SAR birds. Each survey station was surveyed twice, with at least 10 days separating the early and the late survey rounds. Survey dates are presented in Table 4-1.

The surveys were initiated no earlier than thirty minutes prior to sunrise and extended to no later than five hours after sunrise in suitable conditions (i.e., in low winds with no precipitation). Surveys were conducted for 10 minutes at each station and all birds heard or observed were recorded at intervals of 0 to 50 m, 50 to 100 m, >100 m, or flyovers (i.e., birds seen flying overhead) and at intervals of 0 to 3 minutes, 3 to 5 minutes, and 5 to 10 minutes.

5.1.6.2 Crepuscular Bird Surveys

Crepuscular bird surveys designed to target Common Nighthawks were undertaken in accordance with the protocols described in the *Draft Canadian Nightjar Survey Protocol* (Knight et al. 2018). Two rounds of crepuscular bird surveys were completed between late May and late June, with at least 10 days between survey rounds. Surveys commenced 30 minutes before sunset and extended up to 90 minutes after sunset, when the moon was at least 50% illuminated, and when weather conditions were optimal for detecting crepuscular birds (i.e., in low winds with no precipitation). Over a period of six minutes, birds heard were recorded at intervals of 0 to 100 m, 100 to 200 m, and greater than 200 m at each station.

Surveys designed to target Eastern Whip-poor-will were undertaken in accordance with the protocols described in the *Draft Survey Protocol for Eastern Whip-poor-will (Caprimulgus vociferous) in Ontario* (MNRF 2014b). Whip-poor-will detectability has been shown to double on nights when the moon is at least half illuminated, above the horizon, and not obscured by clouds (Wilson and Watts 2006). The protocols are similar to the Common Nighthawk protocols described above, except the following:

- Surveys began 30 minutes after sunset and under favourable conditions, extended until as late as 15 minutes before sunrise; and
- Surveys were five minutes in length at each survey point.

5.1.6.3 Nocturnal Owl Surveys

The nocturnal owl surveys were conducted using the protocols outlined in the OBBA (2001): Standardized Owl Survey Instruction Manual (Takats et al. 2001). Calls of Boreal Owl and Barred Owl were broadcast in that order to correspond with increasing owl size. Surveys began 30 minutes after sunset and concluded no later than midnight. One round of nocturnal owl surveys were conducted over a two-day period in late-May (Table 4-1).

5.1.6.4 Marsh Bird Surveys

No suitable marsh bird habitat was evident in the potential drilling areas, based on the 2017 desktop survey habitat classification . No marsh habitats were observed during 2018 field investigations other than a small area (6.52 ha) of marsh habitat which was observed in HP-BH01. This habitat was considered poor quality and unlikely to support breeding birds; species diversity was low, there was a lack of cover to provide cover or nesting habitat, and emergent vegetation was lacking. Due to these factors it was deemed unlikely this marsh habitat would be utilized by marsh species for breeding and no marsh bird surveys were completed.

5.1.7 Aerial Surveys for Mammals and Raptor Stick Nests

Two aerial surveys for large mammals (e.g., Moose, Woodland Caribou, Lynx, River Otter and Gray Wolf) were conducted by drone at the three potential drilling areas between March 20 to 21 (Survey 1) and April 24 to 25 (Survey 2). Two aerial surveys for raptor stick nests (e.g., eagle, hawk, falcon and owl nests) were also conducted by drone at all three potential drilling locations, between April 24 to 25 (Survey 1) and June 7 (Survey 2), respectively. A single aerial survey was conducted by drone over all potential access roads on March 6 and 7 (Figure 5a to Figure 5c).

Videos recorded by the drone were analysed by a Wood biologist skilled at identifying mammals visually and by tracks, and identifying raptors and their stick nests. The videos were viewed on a 27-inch computer screen, were slowed down to 50% of the real-time speed, and were paused for closer examination with a 6x magnifying glass whenever necessary (e.g., when tracks were observed).

5.1.8 Herpetofaunal (Amphibian and Reptile) Surveys

Amphibian surveys were completed over two spring/summer site visits in habitats with potential to support amphibians (e.g., wetlands, vernal pools, beaver ponds, or man-made water structures). The amphibian surveys were conducted in accordance with the MNR's *Amphibian Road Call Count* program (Konze and McLaren 1997) and were completed concurrently with crepuscular bird surveys and nocturnal owl surveys (Figure 4a to Figure 4c). Surveys involve the surveyor standing at each selected station and listening for three minutes. All calling activity was ranked using one of the following three abundance code categories:

- **Level 1**: Indicates that individuals could be counted, and calls were not simultaneous.
- **Level 2**: Indicates that calls were still distinguishable with some simultaneous calling.
- **Level 3**: Indicates a full chorus where calls were continuous and overlapping.

Wetland and vernal pool surveys were conducted during the daytime hours to document any evidence of breeding activity (e.g., egg masses). Because of the limited number of wetlands in the potential drilling areas, all areas with potential to support breeding herpetofaunal species were examined.

Incidental surveys for reptile species and potential hibernacula and nesting sites were conducted concurrently with these surveys, as well as during the vegetation community mapping and inventory surveys. The majority of SAR turtle ranges are south of the potential drilling areas. However, Snapping Turtles have potential to occur, and are designated as special concern.

5.1.9 Bat and Supplementary Mammal Surveys

5.1.9.1 Bat Maternity Roost Surveys

Bat maternity roost habitat surveys were completed to identify the presence of either of the two types of bat maternity roost habitat that have potential to occur in the potential drilling areas:

- SWH bat maternity roost habitat; and
- SAR bat maternity roost habitat.

To investigate the presence of SWH bat maternity roost habitat, surveys were conducted to identify bat maternity roost habitat that met the definition for SWH as described in the *SWHTG Criteria Schedule for Ecoregion 3E* (MNRF 2015a). MNRF (2015a) defines candidate SWH bat maternity roost habitat as mixedwood and/or deciduous forests with a cavity tree density of more than 10 cavity trees with over 25 cm DBH (MNR 2011). Additional attributes were noted to provide an assessment of the quality of candidate maternity roost habitat, including:

- Trees with large amounts of loose peeling bark;
- Trees in areas where the canopy was relatively open; and
- Trees in an early stage of decay (decay class 1 - 3; Watt and Caceres 1999).

SAR bats with ranges that overlap the potential drilling areas include Little Brown Myotis and Northern Myotis. As such, searches for SAR bat maternity roost habitat were also conducted using the protocol for SAR bats within tree habitats (MNRF 2017b). Within them, SAR bat maternity roost habitat is defined as mixedwood and/or deciduous forests with a cavity tree density of more than 10 cavity trees with over 10 cm DBH (MNRF 2017b).

Candidate maternity roosting habitat with trees that have large amounts of loose peeling bark and open canopies are considered higher quality habitat as they provide ample opportunity for roosting and foraging. However, these are not part of the defining criteria established by MNRF (MNR 2011).

Both surveys were completed prior to spring leaf out to allow for ease of identifying suitable maternity roosting trees. Surveys were plot-based and consisted of searching for trees with features and characteristics capable of supporting maternity brooding habitat. Plots measuring 0.05 ha were placed throughout available mature forest habitat within each of the potential drilling areas. Up to 35 plots per suitable ecosite type were established within suitable habitat, as appropriate (MNR 2011; Figure 4a to Figure 4c). In choosing the plot locations, consideration was given to maximizing their spatial distribution with each ecosite where feasible. For each ecosite type, the cavity tree density was calculated by dividing the total number of suitable cavity trees within that ecosite type by the total area of the plots surveyed within that ecosite type.

The density of cavity trees was calculated within suitable habitats as defined by the *SWHTG Criteria Schedule for Ecoregion 3E* (MNRF 2015a) and MNRF (2017b) to confirm the presence of significant maternity bat roost habitat within the potential drilling areas. Potential bat maternity roost sites were also opportunistically noted concurrently with other terrestrial vegetation and wildlife surveys.

5.1.9.2 Bat Acoustic Surveys

Bat acoustic surveys were conducted to detect nocturnal bat activity during the maternal brood rearing period in June. Detectors were deployed at the end of May to capture the first evidence of activity in June. These detectors were deployed for at least 10 days during this period. Nocturnal bat activity was recorded from 30 minutes before sunset to 30 minutes after sunrise using Songmeter SM2Bat+ (Wildlife Acoustics Inc.) ultrasonic recording detectors. The detectors were positioned 3 to 4 m above ground where higher levels of bat activity are likely to occur (Frick 2013). The dates of the detector deployment and collection are provided in Table 4-1.

The focus for this survey was to detect SAR bats, which can all be classified as high-frequency species (species that emit calls with an average minimum frequency above 35 kHz). Recordings underwent an initial automated classification, followed by manual classification of a select subset of calls. Calls that could not be classified to a single species were placed in a group named after the two or more species most likely to have produced the call. For example, many variants of Silver-haired Bat calls closely resemble certain Big Brown Bat calls. Therefore, during classification, calls that could belong to either species were placed in a separate class (LANO/EPFU). Similarly calls that could belong to either Little Brown Myotis or Eastern Red Bat were placed into a MYLU/LABO class.

5.1.10 Visual Encounter Surveys

Visual Encounter Surveys (VES) were completed concurrently with other targeted surveys (e.g., bird surveys, herptile surveys, vegetation and wetland surveys) within the three potential drilling areas. They consisted of opportunistically detecting wildlife through visual observation, tracks, scat or vocalizations at each of the survey stations and en-route between stations. The purpose of the VES was to capture additional species inhabiting the potential drilling areas that were not already captured in the species-specific surveys listed above.

Visual Encounter Surveys (VES) for invertebrate species were conducted concurrently with vegetation and wildlife surveys, although identification of invertebrate species was restricted to Lepidoptera (butterflies) and Odonata (dragonflies and damselflies) which could be readily identified without capture.

5.1.11 Candidate Significant Wildlife Habitat

The confirmation of candidate SWH identified through desktop studies was completed concurrently with the species-specific surveys described in the sections above. The presence, diversity and density of wildlife documented during these species-specific surveys, as well as incidental field observations, were compared against the criteria for significance defined in the *SWH Criteria Schedule for Ecoregion 3E* (MNRF 2015a). High-potential candidate SWH was mapped to illustrate potential natural feature constraints to the proposed drilling and routing activities. The criteria described within the *SWH Criteria Schedule for Ecoregion 3E* (MNRF 2015a) are unique for each type of SWH.

Candidate SWH is categorized into probabilities of occurrence, these are defined as: ‘High’, ‘Moderate’, ‘Low’, and ‘None’. These probabilities are determined based on quantitative factors such as the proportion of suitable habitat to the overall potential drilling areas and the presence/absence of relevant features (i.e., plant communities, floral or faunal species, floral or faunal types). In addition, professional opinion was used to qualify habitat suitability based on field observations, the proximity to other candidate or confirmed SWH, the density of relevant features, as well as the reasonable likelihood of those species being detected during the field investigations.

5.1.12 Species at Risk Habitat

The 2018 species-specific surveys to target SAR were developed based on the findings from the 2016 enhanced desktop assessment and observations of habitat availability. Prior to initiating the 2018 field studies, the potential for occurrence was evaluated for each of the SAR identified as having a range that overlaps with the potential drilling areas (see Section 4.1.3). The assessment of potential for occurrence was based on the presence of habitat suitable for supporting each of the SAR within the three potential drilling areas (based on desktop assessment) and confirmation of the species occurring there (based on available occurrence records). Each species was assessed as having a low, moderate, or high potential for occurrence using the criteria for each category defined as:

- **Low Potential:** No suitable habitat for that species is present in the potential repository-scale areas and no individuals have been confirmed in the potential repository-scale areas.
- **Moderate Potential:** Suitable habitat for that species is present in the potential repository-scale areas, but no individuals have been confirmed in the potential repository-scale areas.
- **High:** Suitable habitat for that species is present, and individuals have been confirmed in potential repository-scale areas.

Note that the absence of species observations throughout the surveys does not necessarily indicate that the species is not present, as many of the SAR identified are transient and/or have ranges that exceed the size of the potential drilling areas.

5.1.13 Aquatic Monitoring Program

Aquatic habitat at the surface water quality sample locations was documented to characterize existing conditions of these aquatic environs. Most of these locations were greater than 150 m from the potential drilling areas shown on Figure 3 and the associated potential drilling program activities would not likely have potential pathways of interaction with the aquatic environment due to the substantial overland distance that drill site effluent would need to travel before entering a waterbody or watercourse. Environmental management of potential risks to aquatic habitat related to the water crossings (culvert installation) and working near water are well understood, and best management practices are available to control potential effects of these activities.

Community discussions relating to the APM Project demonstrated the importance of preserving water quality and the health of aquatic species. Accordingly, the 2018 field studies included benthic invertebrate community and fish community sampling within the unnamed outlet watercourse from Wabos Lake that borders the southeastern limit of the HP-BH02 study area (Figure 3). Sample locations were located upstream (reference) and downstream (potential exposure) of the possible crossing (HP-BH02-AQ1 and HP-BH02-AQ2).

Benthic macroinvertebrates are mainly exposed to contaminants in the surface water, meaning the tube-dwelling organisms that actively circulate overlying water through their tubes and those deposit feeders that are active bioturbators, effectively mixing the upper strata of the sediments (Warren et al. 1998; Hare et al. 2001; Wang et al. 2000 and 2001). However, organisms that do not pump overlying water through their tubes or burrows may take up significant amounts of contaminants from digested sediments and predators of those species will accumulate contaminants from their prey (Lee et al. 2000; Ahrens et al. 2001). Additionally, deposit feeders are typically less sensitive to toxicants than those that are exposed mainly via surface water, and higher abundance of these 'tolerant' taxa are used to indicate environmental degradation. Consequently, the benthic macroinvertebrate community are commonly used as a barometer of aquatic ecosystem health and changes in these communities can indicate changes of environmental quality.

Benthic macroinvertebrate samples were collected at the same time as the soft sediment quality samples within the unnamed outlet watercourse of Wabos Lake. A total of ten samples were collected; five upstream (HP-BH02-AQ1) of the West Beaton Road and five downstream (Figure 3; HP-BH02-AQ2). Each replicate benthic sample consisted of three surface grab sub-samples using a Petite Ponar dredge sampler. Sub samples were placed together in the field for each replicate station and sieved in the field to remove fine sediments and inorganic material. These samples were then preserved with 10% buffered formalin in the field to maintain sample integrity and prevent within-sample predation. The preserved samples were analyzed by a benthic macroinvertebrate taxonomist and all individuals were identified to the lowest practical level (typically genus and species). These taxonomy results were used to calculate community metrics that measure community complexity and can provide an indication of community health including:

- Total invertebrate density (number of individuals per square metre);
- Taxon richness (number of taxa groups or families);
- Simpson's diversity Index (probability that two individuals randomly selected from a sample will belong to different taxa groups);
- Simpson's evenness Index (how evenly taxa are distributed within the community);
- Taxa proportion (dominant taxa groups representing most of the community);
- Community proportion represented by typically stress tolerant taxa – % Chironomids (midges); and
- Community proportion represented by typically stress intolerant taxa – % Ephemeroptera Plecoptera and Trichoptera (mayflies, stoneflies and caddisflies; EPT).

A non-lethal fish community survey within the unnamed outlet watercourse of Wabos Lake was conducted. This survey non-lethally sampled fish size and weight and identified each individual to species to describe the fish community. Sampling equipment included fyke nets and baited minnow traps. All fish were live released near their point of capture following species identification and processing, with the exception of few incidental mortalities that were disposed of per MNRF guidelines. Incidental observations of fish presence were recorded at other surface water quality sample locations, and where diagnostic identification features of these fish were in clear view the species was documented.

Another sample location, originally proposed upstream of Highway 631 (HP-BH02-AQ4) located southeast of the HP-BH02 study area, was also planned for sampling to further characterize benthic invertebrate community reference conditions (Figure 3). The HP-BH02-AQ4 habitat was substantively different from the Wabos Lake outlet watercourse, and fast flowing, deep water did not allow safe collection of benthic macroinvertebrate community and sediment quality samples. As such, the HP-BH02-AQ4 location was sampled for surface water quality and qualitative fish habitat during the field verification studies.

5.2 Preliminary Monitoring Program Summary of Findings

The sections below present a summary of the relevant findings resulting from the 2018 preliminary monitoring program for each of the three potential drilling areas near the Township of Hornepayne. Highlights from the 2018 surface water, terrestrial soil and aquatic sediment quality sampling, terrestrial plant and wildlife surveys, fish community and aquatic habitat surveys are presented below and illustrated on Figure 6a through Figure 6c.

5.2.1 Hornepayne Potential Drilling Area HP-BH01 (Figure 6a)

- In-situ measurements and laboratory surface water quality analysis showed cool water fish habitat and water quality that met both the PWQO and CEQG values.
- A total of 16 soil sampling locations were visited with an average organic substrate depth of 8.4 cm and approximately 60% of the mineral soil samples were described as silty sand.
- Physical and chemical soil parameters met both the SQG_E and O. Reg. 153/04 values for background condition in Residential and Parkland settings.
- Upland and wetland ecosites represent approximately 71% and 28% of the potential drilling area, respectively.
- SAR confirmed in the potential drilling area include Canada Warbler, Common Nighthawk, Little Brown Myotis, and unidentified Myotis species.
- Woodland Raptor Nesting Habitat, Denning Sites for Furbearers (i.e., American Mink, River Otter, Gray Wolf, Canada Lynx, American Marten, Fisher, and Black Bear), Amphibian Breeding Habitat (Wetlands), and Mast Producing Areas were assessed as having high potential to occur in this potential drilling area. Amphibian movement corridors were assessed as having a moderate to high potential to occur in this potential drilling area.
- Ecosites B049 and B055 were identified as candidate SAR Bat Maternity Roost Habitat.
- Two of the three waterbodies visited were pond-like habitats with various submergent, emergent and floating aquatic macrophytes, and were poorly connected to surrounding drainages (fish were not observed).
- Sample location HP-BH01-AQ3 was an unnamed lake with submergent, emergent and floating aquatic macrophytes nearshore, small and large bodied fish, as well as fish-eating waterfowl were observed.

5.2.2 Hornepayne Potential Drilling Area HP-BH02 (Figure 6b)

- In-situ measurements and laboratory surface water quality analysis showed cool to cold water fish habitat and water quality that generally met both the PWQO and CEQG values, with the exception of total iron at two of four sample locations.

- Sediment samples collected from the Wabos Lake outlet stream generally met the PSQG, O. Reg. 153/04 and the CSQG guideline values with some exceptions including TOC, TKN, and arsenic.
- A total of 16 soil sampling locations were visited with an average organic substrate depth of 3.4 cm and approximately 63% of the mineral soil samples were described as either very fine sandy silt or silt.
- Physical and chemical soil parameters generally met both the SQG_E and O. Reg. 153/04 values for background condition in Residential and Parkland settings, with the exception of acetone in one sample.
- Upland and wetland ecosites represent approximately 51% and 48% of the potential drilling area, respectively.
- SAR confirmed in the potential drilling area include Common Nighthawk, Little Brown Myotis, and unidentified Myotis species.
- Woodland Raptor Nesting Habitat, Denning Sites for Furbearers (i.e., American Mink, River Otter, Gray Wolf, Canada Lynx, American Marten, Fisher, and Black Bear), Amphibian Breeding Habitat (Wetlands), Bat Maternity Roost Habitat, and Mast Producing Areas were assessed as having high potential to occur in this potential drilling area. Amphibian movement corridors were assessed as having a moderate to high potential to occur in this potential drilling area.
- Ecosites B055 and B065 were identified as candidate SAR Bat Maternity Roost Habitat
- Benthic invertebrate community samples were collected from the Wabos Lake outlet stream with Chironomids and Sphaeriidae contributing the highest relative taxa group proportions in the upstream and downstream samples, respectively.
- Non-lethal fish community sampling was completed within the Wabos Lake outlet stream, capturing six species including Finescale Dace, Northern Redbelly Dace, Brook Stickleback, Iowa Darter, as well as juvenile White Sucker and Northern Pike (all cool water species).
- The Wabos Lake outlet stream contained pond-like habitat associated with beaver dams and an entrenched channel meandering through a floodplain.
- The only other aquatic habitat sampled was an unnamed pond with a broad riparian floating vegetation mat. The nearshore open water habitat contained submergent, emergent and floating aquatic macrophytes, and small bodied fish were observed.

5.2.3 Hornepayne Potential Drilling Area HP-BH03 (Figure 6c)

- In-situ measurements and laboratory surface water quality analysis showed cool water fish habitat and water quality that met both the PWQO and CEQG values.
- A total of 16 soil sampling locations were visited with an average organic substrate depth of 6.7 cm and approximately 44% of the samples were described as silty fine sand, while another 44% of the samples were described as sandy silt or silt.
- Physical and chemical soil parameters generally met both the SQG_E and O. Reg. 153/04 values for background condition in Residential and Parkland settings, with the exception of hexavalent chromium in one sample.
- Upland and wetland ecosites represent approximately 68% and 29% of the potential drilling area, respectively.

- SAR confirmed in the potential drilling area include Canada Warbler, Common Nighthawk, Eastern Wood Pewee, Little Brown Myotis, and unidentified Myotis species.
- Woodland Raptor Nesting Habitat, Denning Sites for Furbearers (i.e., American Mink, River Otter, Gray Wolf, Canada Lynx, American Marten, Fisher, and Black Bear), Amphibian Breeding Habitat (Wetlands), Bat Maternity Roost Habitat, and Mast Producing Areas were assessed as having high potential to occur in this potential drilling area. Amphibian movement corridors were assessed as having a moderate to high potential to occur in this potential drilling area.
- Ecosites B049, B055, and B128 were identified as candidate SAR Bat Maternity Roost Habitat.
- Beavertrap Lake was the only aquatic sample location within this potential drilling area and contained nearshore submergent, emergent and floating aquatic macrophytes. Small bodied fish were also observed.

5.2.4 Borehole Drilling Suitability Summary

The findings from the 2018 field surveys demonstrated that the potential drilling area labelled as HP-BH01 was composed of 71% upland habitat. Three species at risk (SAR) were confirmed using or passing through the potential drill area and there was potential for five types of SWH in the study area, although none were confirmed. Approximately 10% of potential drilling area HP-BH01 was considered suitable for supporting SAR bat maternity roosts. The study area associated with potential drilling area HP-BH02 was composed of 51% upland habitat, with two SAR confirmed using or passing through the potential drilling area. Four types of SWH had potential to occur within the potential drilling area, although none were confirmed. Approximately 6% of the total area within potential drilling area HP-BH02 had potential to support SAR bat maternity roosts. Within the potential drilling area HP-BH03, 68% of the area was composed of upland habitat. Three SAR were confirmed either using or passing through the potential drilling area, and one SAR was recorded using habitat adjacent to the potential drilling area. Six types of SWH had potential to occur, although none were confirmed within the HP-BH03 study area. Approximately 74% of the available habitat within potential drilling area HP-BH03 has potential to support SAR bat maternity roosts. It is Wood's opinion that the proposed drilling activities would not negatively impact the natural features identified in any of the three potential drilling areas, with the implementation of appropriate mitigation including timing site preparation activities outside breeding bird and bat maternity periods, maintaining a small drill pad and access route footprint, and providing SAR awareness training to contractors. The 2018 field surveys related to aquatic studies also suggest that the three potential borehole locations are similarly suitable for borehole drilling, with limited presence of open water habitat within the area of investigation. It is noted that access to HP-BH02 may require the reinstatement of an access road crossing at the Wabos Lake outlet stream; however, environmental management of potential risks to aquatic habitat related to the water crossings are well understood and best management practices are available to control potential effects of these activities.

6.0 Closure

We trust this Phase 2: Environmental Studies Final Report meets NWMO's expectations. Should you require further information relative to specific field survey details, please do not hesitate to contact the undersigned.

Yours truly,

Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited

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Senior Biologist

Signature: ______________________ Date: April 15, 2019

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Signature: ______________________ Date: April 15, 2019

Reviewed by: Matt Evans, Ph.D.
Senior Ecologist/Project Manager

Signature: ______________________ Date: April 15, 2019

Approved by: Jeff Balsdon, M.Sc.
Senior Ecologist/Assistant Project Manager

Signature: ______________________ Date: April 15, 2019

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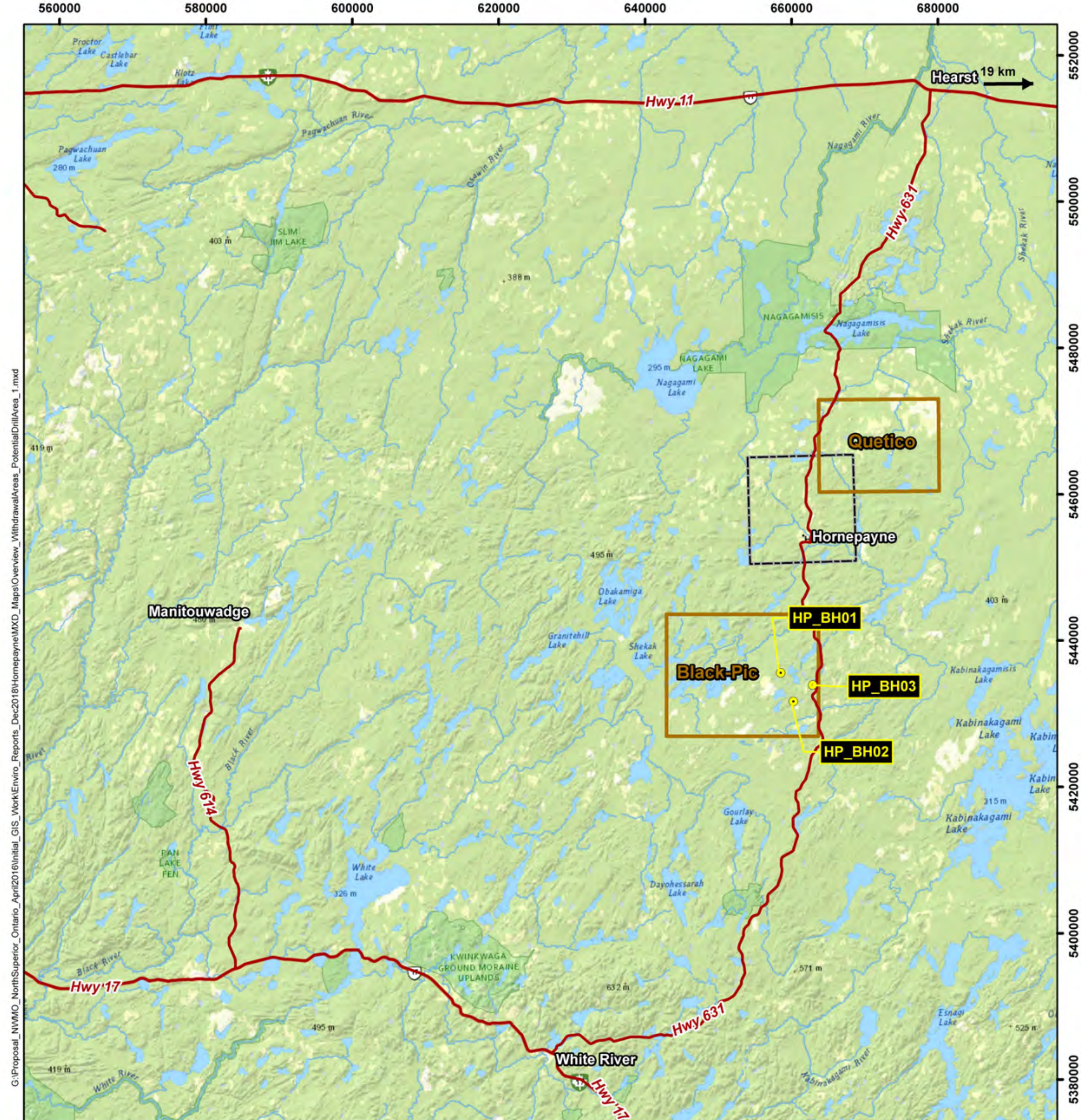
Attachment A

Figures



LEGEND

- Regional Highways
- Municipal Boundary (Hornepayne)
- Potential Drill Area Locations (labelled with ID)

Withdrawal Areas (labelled with name)

- Hornepayne

NOTES:
- Highways and municipal boundaries and Ecoregions extracted from Land Information Ontario (MNRF) Queen's printer for Ontario, 2015-2016
- Backgroup topographic map information extracted from ESRI Base Map Services

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ADAPTIVE PHASED MANAGEMENT
PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

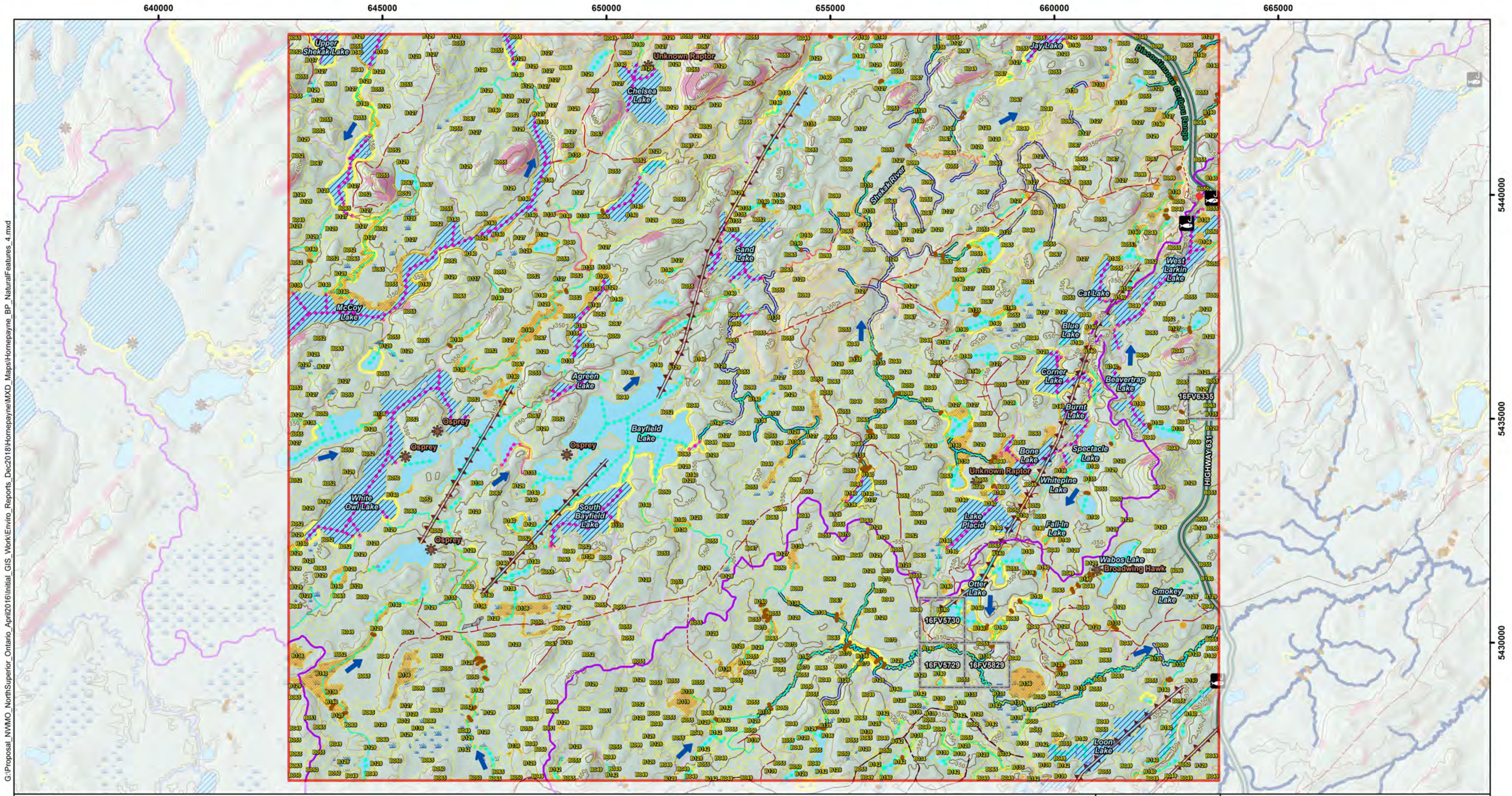
Overview Map of Withdrawal Areas and Potential Drill Areas

Datum: NAD83
Projection: UTM Zone 16N

N E S W

0 5 10 20 30 40 50 Kilometres

PROJECT N°: TB161019	FIGURE: 1
SCALE: 1:700,000	DATE: January 2019



LEGEND

- NHIC Species at Risk 1 km Square (refer to table for species information)
- Fishing Access Point
- Avian Nesting Site
- Flow Direction
- Active Aggregate Site
- Waste Management Site
- Moose Aquatic Feeding Area
- Caribou Range Boundary
- Research Plot
- Highway
- Local Road
- Resource / Recreation Road
- Forestry Road (MNRF)
- Major Contour (50 metre interval)
- Minor Contour (10 metre interval)
- Esker
- Beaver Dam
- Waterbody
- Wetland
- Wooded Area
- Watershed Boundary
- Aquatic Resource Area Information (Waterbody)
- Aquatic Resource Area Information (Watercourse)
- Ecological Land Classification (labelled with Boreal ELC code)
- Infrequent Candidate Significant Wildlife Habitat
- Steep Slope Area (>= 15% slope)

Watercourse Reach Classification Morphology and Regime

- Cascade / Waterfall, Cold
- Glide / Run, Cold
- Glide / Run, Cool
- Pool, Cold
- Pool, Cool
- Pool, Warm
- Riffle, Cold
- Riffle, Cool

Watercourse Class

- Intermittent Watercourse
- Permanent Watercourse
- Open Water

NHIC Species at Risk

NHIC Square ID	Species
16FV5729	Common Nighhawk, Eastern Whip-poor-will
16FV5829	Common Nighhawk, Eastern Whip-poor-will
16FV5730	Common Nighhawk, Eastern Whip-poor-will
16FV6335	Woodland Caribou

0 2.5 5 10 15 20 Kilometres

NOTES:
- Base data and aquatics resource area information on this map was extracted form Land Information Ontario (MNRF), Queen's Printer for Ontario, 2015 - 2016.
- Quaternary geology features from Ontario Geological Survey, MNDM.

NHIC Species at Risk sensitive data:
Source: Data provided by Ontario MNRF
Copyright: Queen's Printer for Ontario [May-June 2014 and 1990]
This derivative product of the sensitive data does not constitute endorsement by MNRF

Datum: NAD83
Projection: UTM Zone 16N

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PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

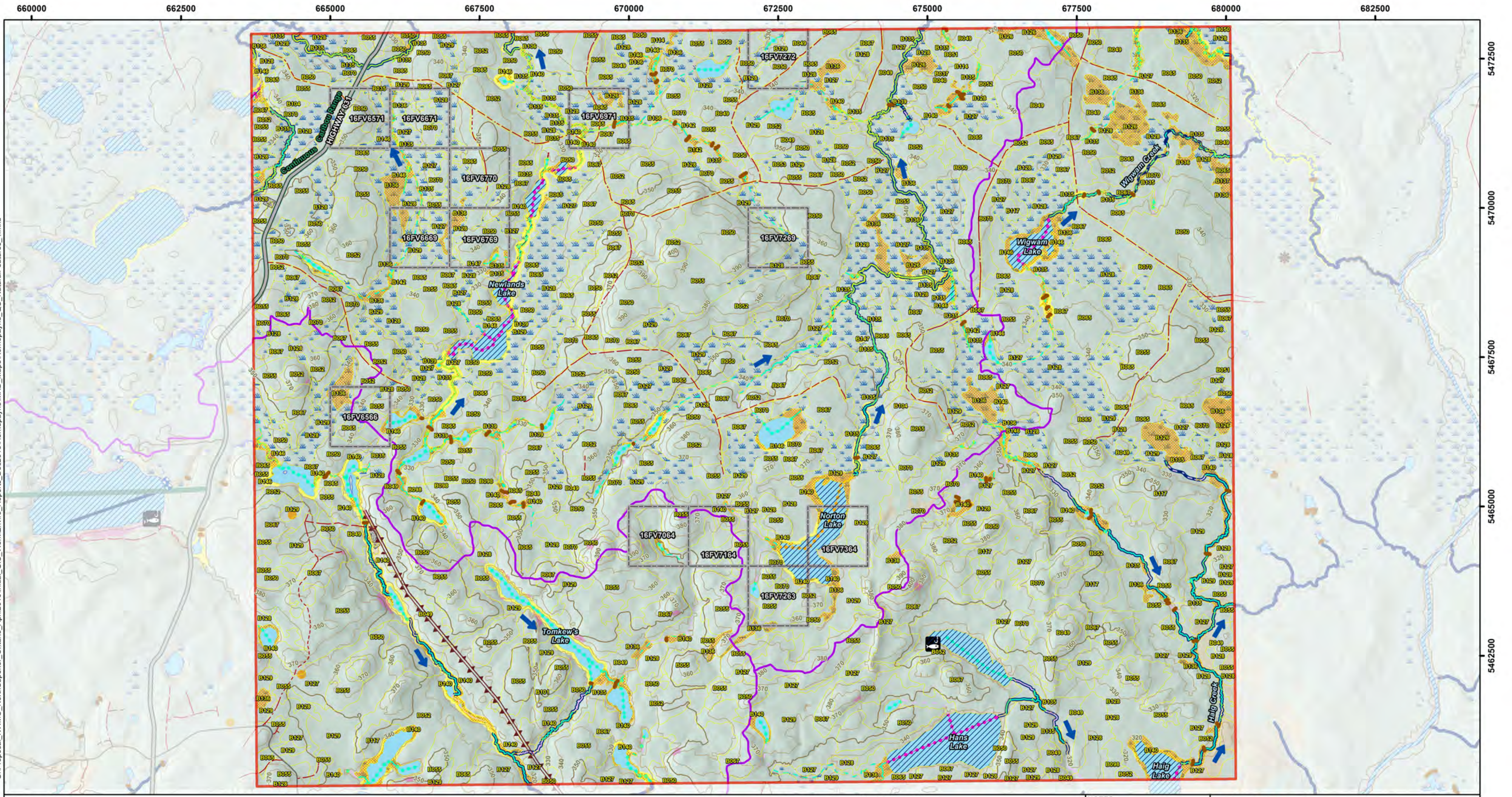
Hornepayne Black-Pic Withdrawal Area Natural Features Map

PROJECT N°: TB161019

FIGURE: 2a

SCALE: 1:80,000

DATE: January 2019



LEGEND

- NHIC Species at Risk 1 km Square (refer to table for species information)
- Fishing Access Point
- Avian Nesting Site
- Water Well
- Flow Direction
- Active Aggregate Site
- Moose Aquatic Feeding Area
- Caribou Range Boundary
- Research Plot
- Highway
- Local Road
- Forestry Road (MNRF)
- Major Contour (50 metre interval)
- Minor Contour (10 metre interval)
- Esker
- Beaver Dam
- Waterbody
- Wetland
- Wooded Area
- Watershed Boundary
- Aquatic Resource Area Information (Waterbody)
- Aquatic Resource Area Information (Watercourse)
- B055 Ecological Land Classification (labelled with Boreal ELC code)
- Infrequent Candidate Significant Wildlife Habitat
- Steep Slope Area (>= 15% slope)

Watercourse Reach Classification

Morphology and Regime

- Cascade / Waterfall, Cold
- Glide / Run, Cold
- Glide / Run, Cool
- Pool, Cold
- Pool, Cool
- Pool, Warm
- Riffle, Cold
- Riffle, Cool

Watercourse Class

- Intermittent Watercourse
- Permanent Watercourse
- Open Water

NHIC Species at Risk

NHIC Square ID	Species
16FV6566	Woodland Caribou
16FV6669	Woodland Caribou
16FV6769	Woodland Caribou
16FV6571	Woodland Caribou
16FV6671	Woodland Caribou
16FV6770	Woodland Caribou
16FV6971	Woodland Caribou

NHIC Square ID	Species
16FV7064	Woodland Caribou
16FV7164	Woodland Caribou
16FV7263	Woodland Caribou
16FV7269	Woodland Caribou
16FV7364	Woodland Caribou
16FV7272	Woodland Caribou

0 1 2 4 6 8 10 Kilometres

NOTES:
- Base data and aquatics resource area information on this map was extracted form Land Information Ontario (MNRF), Queen's Printer for Ontario, 2015 - 2016.
- Quaternary geology features from Ontario Geological Survey, MNDM.

NHIC Species at Risk sensitive data:
Source: Data provided by Ontario MNRF
Copyright: Queen's Printer for Ontario [Mar. 2009 - Oct. 2014]
This derivative product of the sensitive data does not constitute endorsement by MNRF

Datum: NAD83
Projection: UTM Zone 16N

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ADAPTIVE PHASED MANAGEMENT
PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

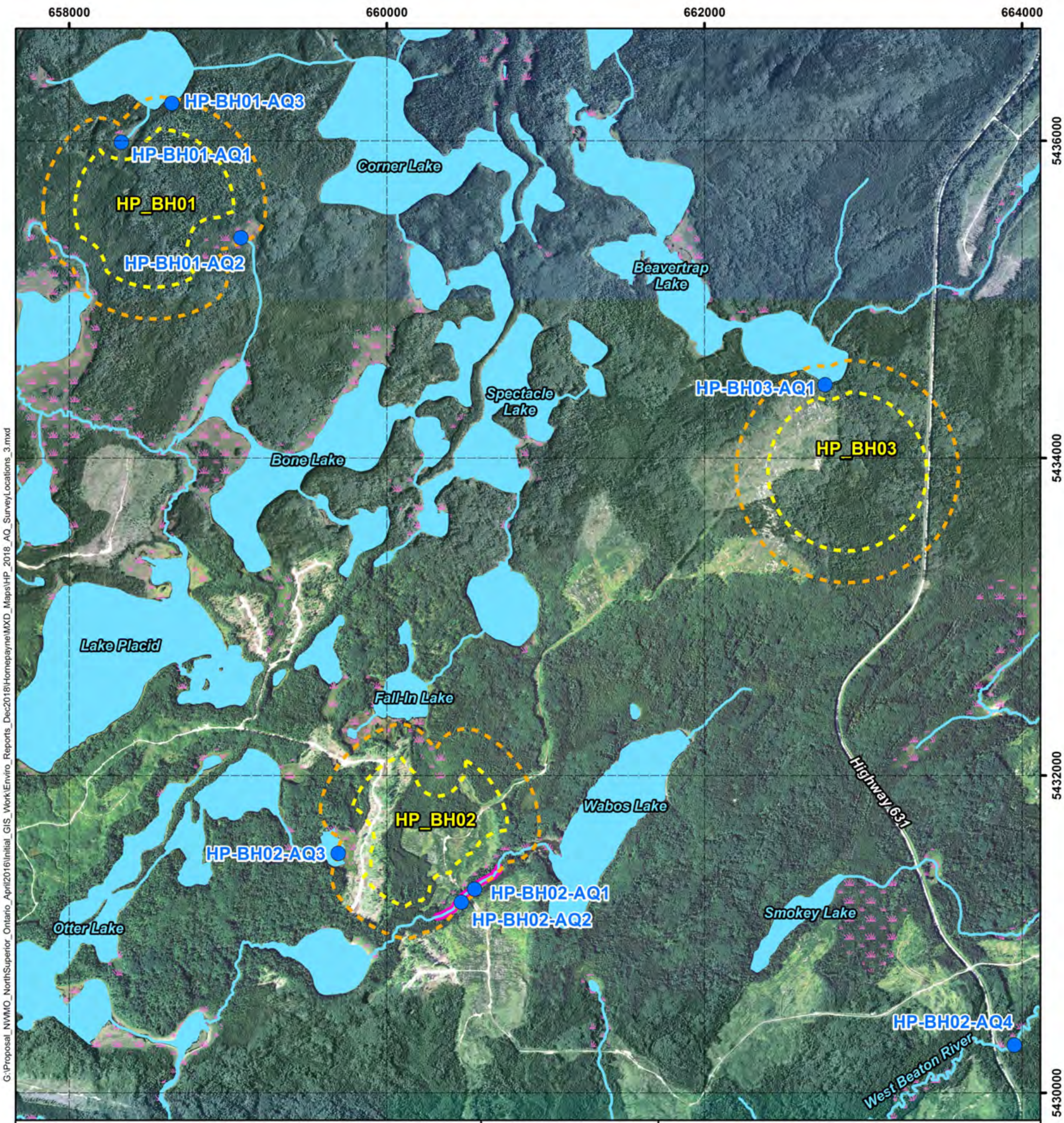
Hornepayne Quetico Withdrawal Area Natural Features Map

PROJECT N°: TB161019

FIGURE: 2b

SCALE: 1:60,000

DATE: January 2019



LEGEND

- Aquatic Survey Location (labelled with ID)
- Fish Community Survey Location
- Potential Drill Areas (labelled with ID)
- Field Investigation Areas (potential drill area + 200 m)
- Watercourse
- Wetland
- Waterbody

0 200 400 800 1,200 1,600 2,000 Metres

NOTES:
- Watercourse, wetland and waterbody information extracted from Land Information Ontario (MNRF) Queen's printer for Ontario, 2015-2016.
- Background imagery from MNRF Forest Resource Inventory, provided by NWMO, scene date is 2010

Datum: NAD83
Projection: UTM Zone 16N

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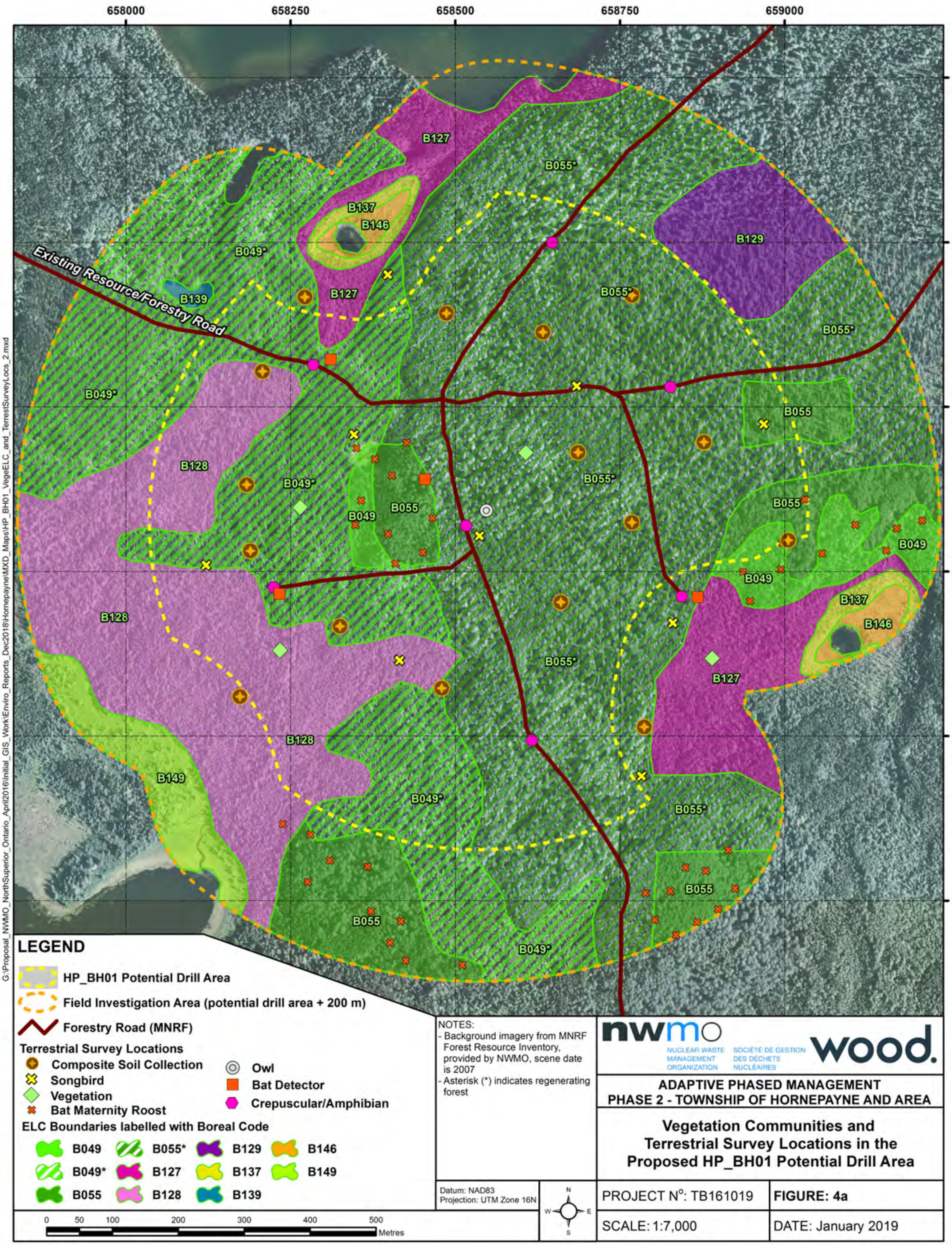
ADAPTIVE PHASED MANAGEMENT
PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

2018 Aquatic Survey Locations in the Hornepayne Potential Drill Areas

PROJECT N^{o}: TB161019	**FIGURE: 3**
SCALE: 1:32,000	DATE: January 2019



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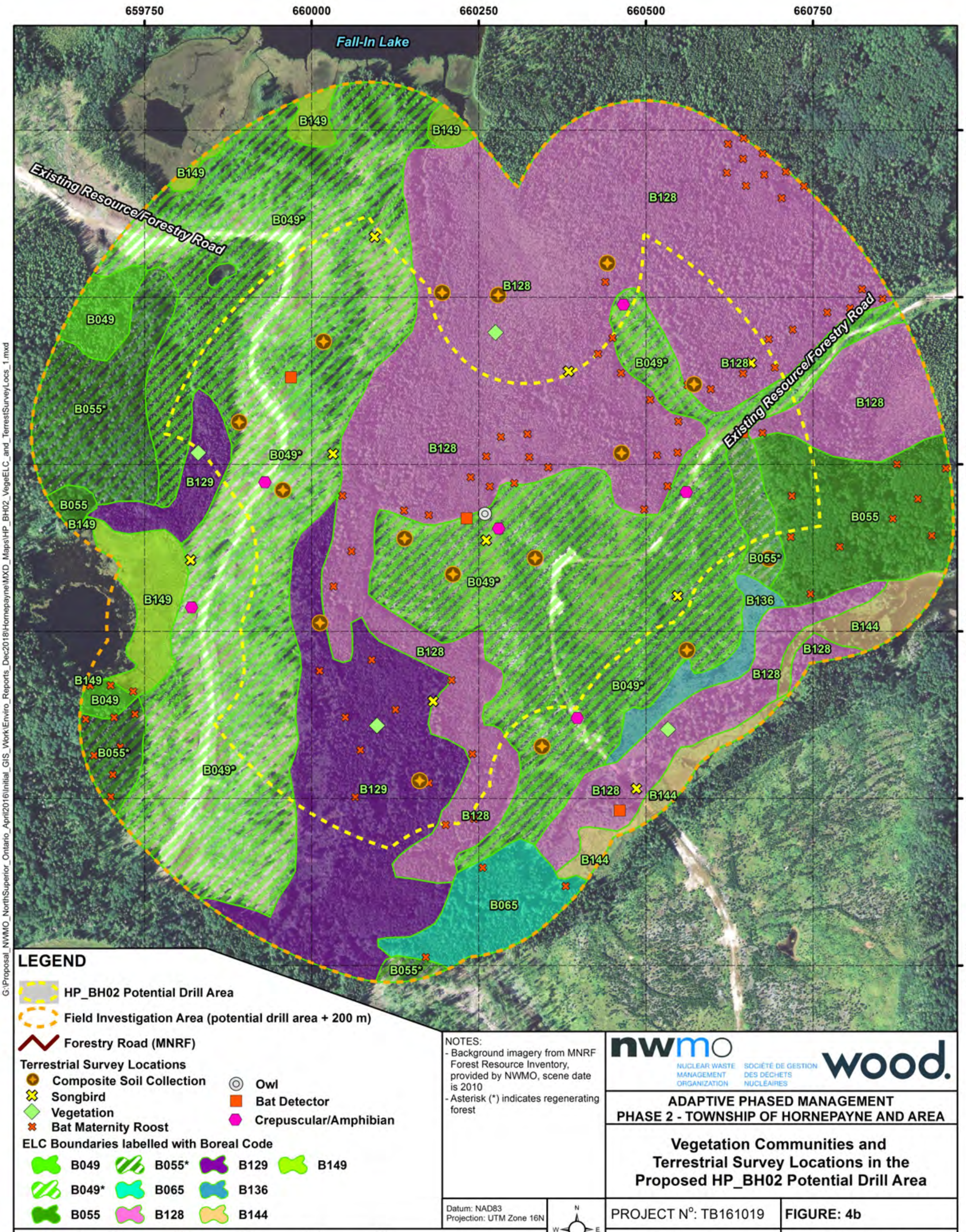
ADAPTIVE PHASED MANAGEMENT PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

Vegetation Communities and Terrestrial Survey Locations in the Proposed HP_BH01 Potential Drill Area

PROJECT N^{o}: TB161019	**FIGURE: 4a**
SCALE: 1:7,000	DATE: January 2019



NOTES:
- Background imagery from MNRF Forest Resource Inventory, provided by NWMO, scene date is 2010
- Asterisk (*) indicates regenerating forest

Datum: NAD83
Projection: UTM Zone 16N

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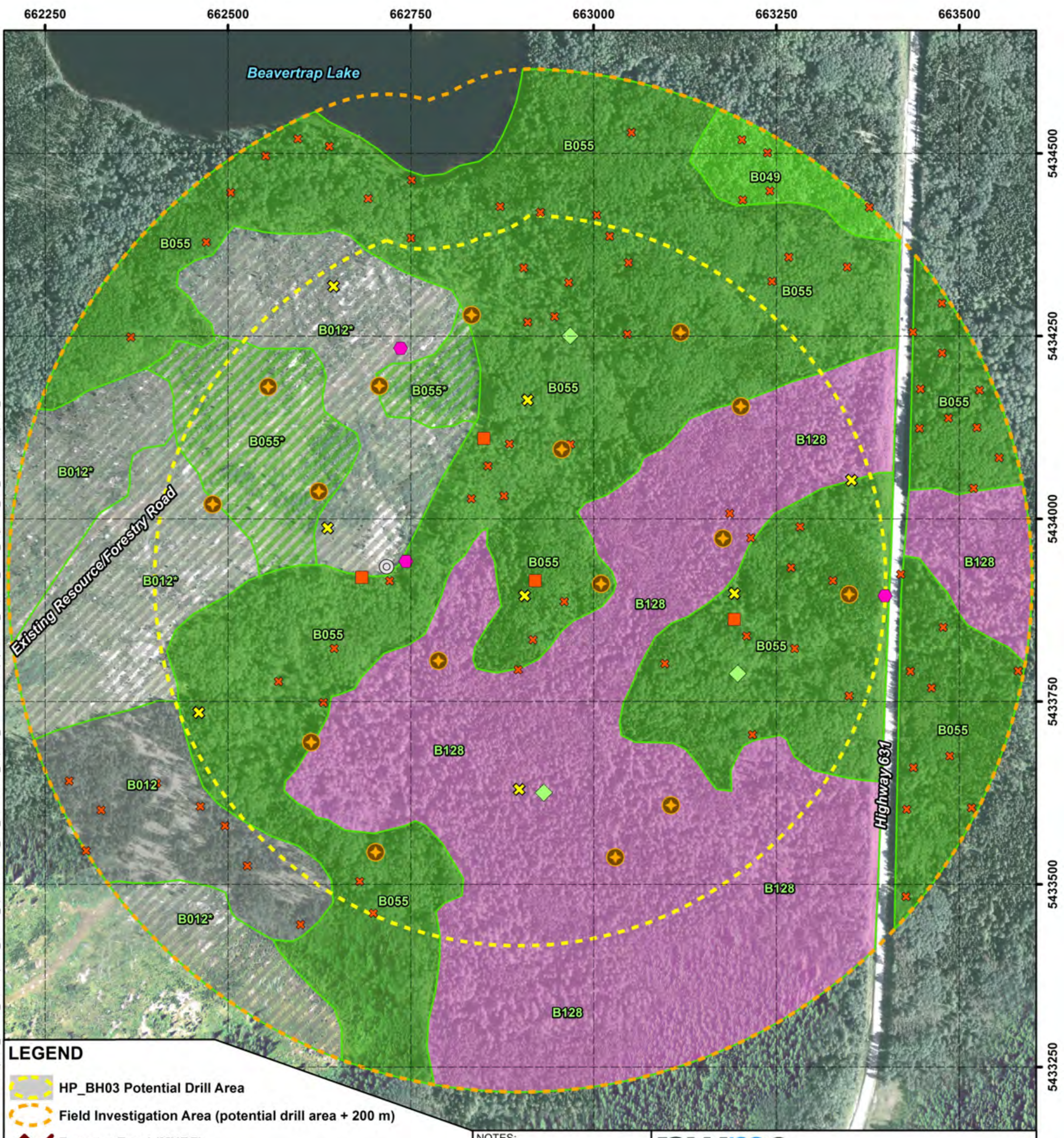
ADAPTIVE PHASED MANAGEMENT
PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

Vegetation Communities and Terrestrial Survey Locations in the Proposed HP_BH02 Potential Drill Area

PROJECT N°: TB161019	FIGURE: 4b
SCALE: 1:7,000	DATE: January 2019



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LEGEND

- HP_BH03 Potential Drill Area
- Field Investigation Area (potential drill area + 200 m)
- Forestry Road (MNRF)

Terrestrial Survey Locations

- Composite Soil Collection
- Songbird
- Vegetation
- Bat Maternity Roost
- Owl
- Bat Detector
- Crepuscular/Amphibian

ELC Boundaries labelled with Boreal Code

- B012
- B012*
- B049
- B055
- B055*
- B128

0 50 100 200 300 400 500 Metres

NOTES:
- Background imagery from MNRF Forest Resource Inventory, provided by NWMO, scene date is 2010
- Asterisk (*) indicates regenerating forest

Datum: NAD83
Projection: UTM Zone 16N

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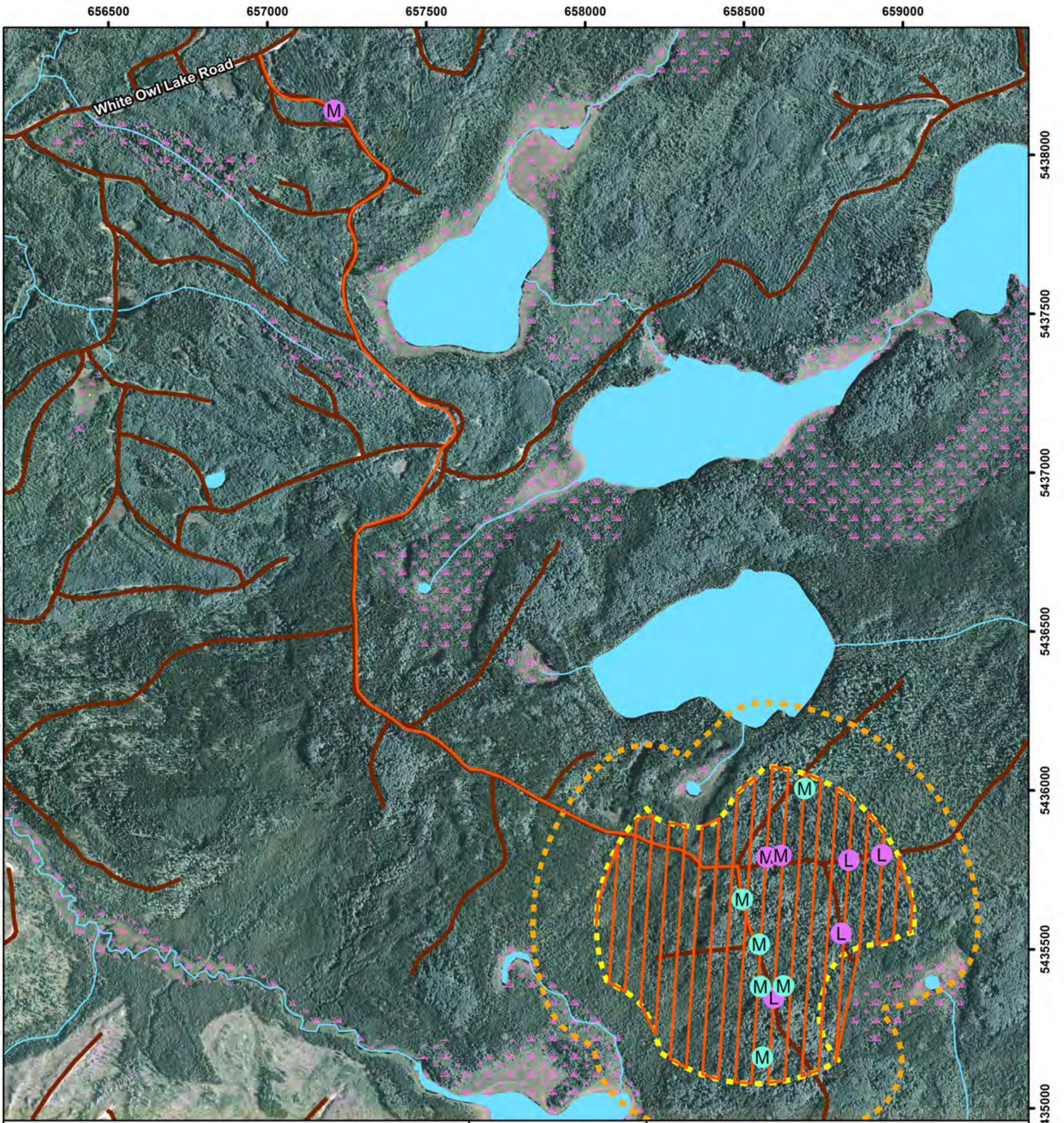
ADAPTIVE PHASED MANAGEMENT
PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

Vegetation Communities and Terrestrial Survey Locations in the Proposed HP_BH03 Potential Drill Area

PROJECT N°: TB161019	FIGURE: 4c
SCALE: 1:7,000	DATE: January 2019



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LEGEND

- HP_BH01 Potential Drill Area
- Field Investigation Area (potential drill area + 200 m)
- Forestry Road (MNRF)
- Watercourse
- Waterbody
- Wetland
- Drone Aerial Survey Flight Path

Drone Survey 1

- M Moose Tracks Observed
- L Lynx Tracks Observed

Drone Survey 2

- M Moose Tracks Observed

0 120 240 480 720 960 1,200 Metres

NOTES:
- Watercourse, wetland and waterbody information extracted from Land Information Ontario (MNRF) Queen's printer for Ontario, 2015-2016.
- Background imagery from MNRF Forest Resource Inventory, provided by NWMO, scene date is 2007

Datum: NAD83
Projection: UTM Zone 16N

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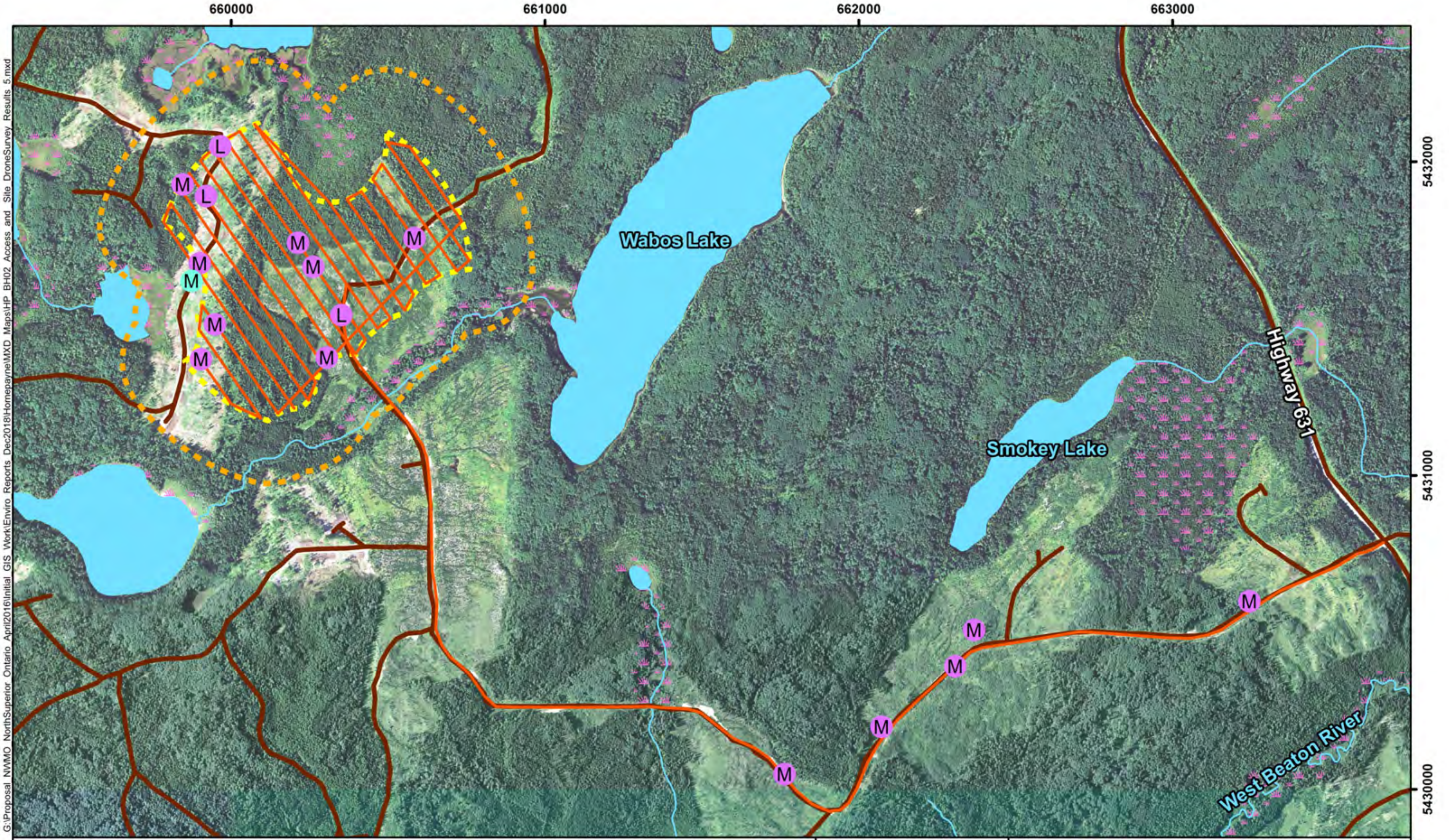
ADAPTIVE PHASED MANAGEMENT
PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

2018 Drone Aerial Survey Results in the Proposed HP_BH01 Potential Drill Area and Potential Access Road Locations

PROJECT N°: TB161019	**FIGURE: 5a**
SCALE: 1:16,000	DATE: January 2019



LEGEND

- HP_BH02 Potential Drill Area
- Field Investigation Area (potential drill area + 200 m)
- Forestry Road (MNRF)
- Watercourse
- Waterbody
- Wetland
- Drone Aerial Survey Flight Path

Drone Survey 1

- M Moose Tracks Observed
- L Lynx Tracks Observed

Drone Survey 2

- M Moose Tracks Observed

NOTES:
- Watercourse, wetland and waterbody information extracted from Land Information Ontario (MNRF) Queen's printer for Ontario, 2015-2016.
- Background imagery from MNRF Forest Resource Inventory, provided by NWMO, scene date is 2007

Datum: NAD83
Projection: UTM Zone 16N

0 1 2 Kilometres

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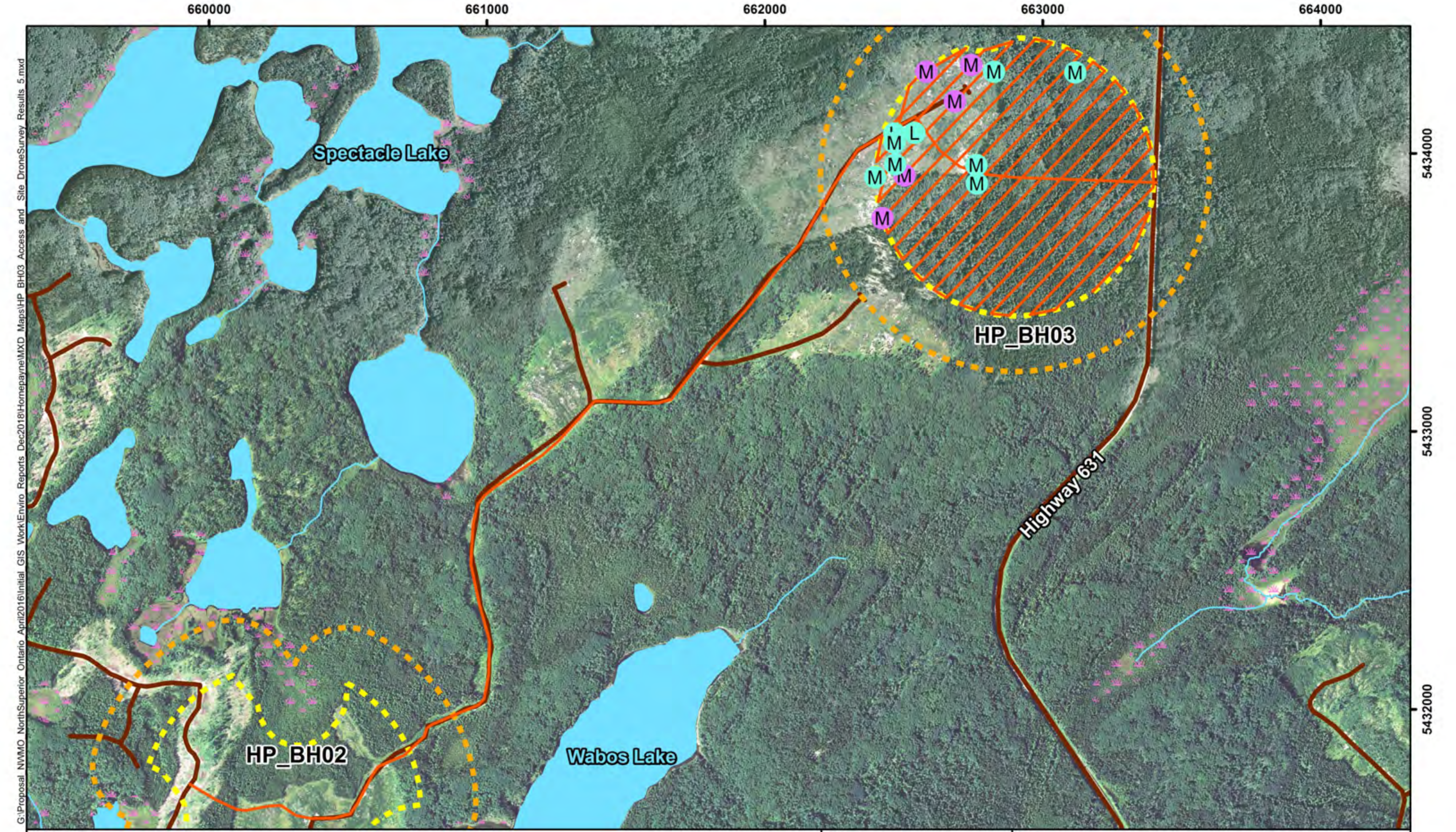
ADAPTIVE PHASED MANAGEMENT
PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

2018 Drone Aerial Survey Results in the Proposed HP_BH02 Potential Drill Area and Potential Access Road Locations

PROJECT N°: TB161019	**FIGURE: 5b**
SCALE: 1:17,000	DATE: January 2019



LEGEND

- HP_BH03 Potential Drill Area
- Field Investigation Area (potential drill area + 200 m)
- Forestry Road (MNRF)
- Watercourse
- Waterbody
- Wetland
- Drone Aerial Survey Flight Path

Drone Survey 1

- M Moose Tracks Observed

Drone Survey 2

- M Moose Tracks Observed
- L Lynx Tracks Observed

NOTES:
- Watercourse, wetland and waterbody information extracted from Land Information Ontario (MNRF) Queen's printer for Ontario, 2015-2016.
- Background imagery from MNRF Forest Resource Inventory, provided by NWMO, scene date is 2007

Datum: NAD83
Projection: UTM Zone 16N

N / E / S / W

0 — 1.25 — 2.5 Kilometres

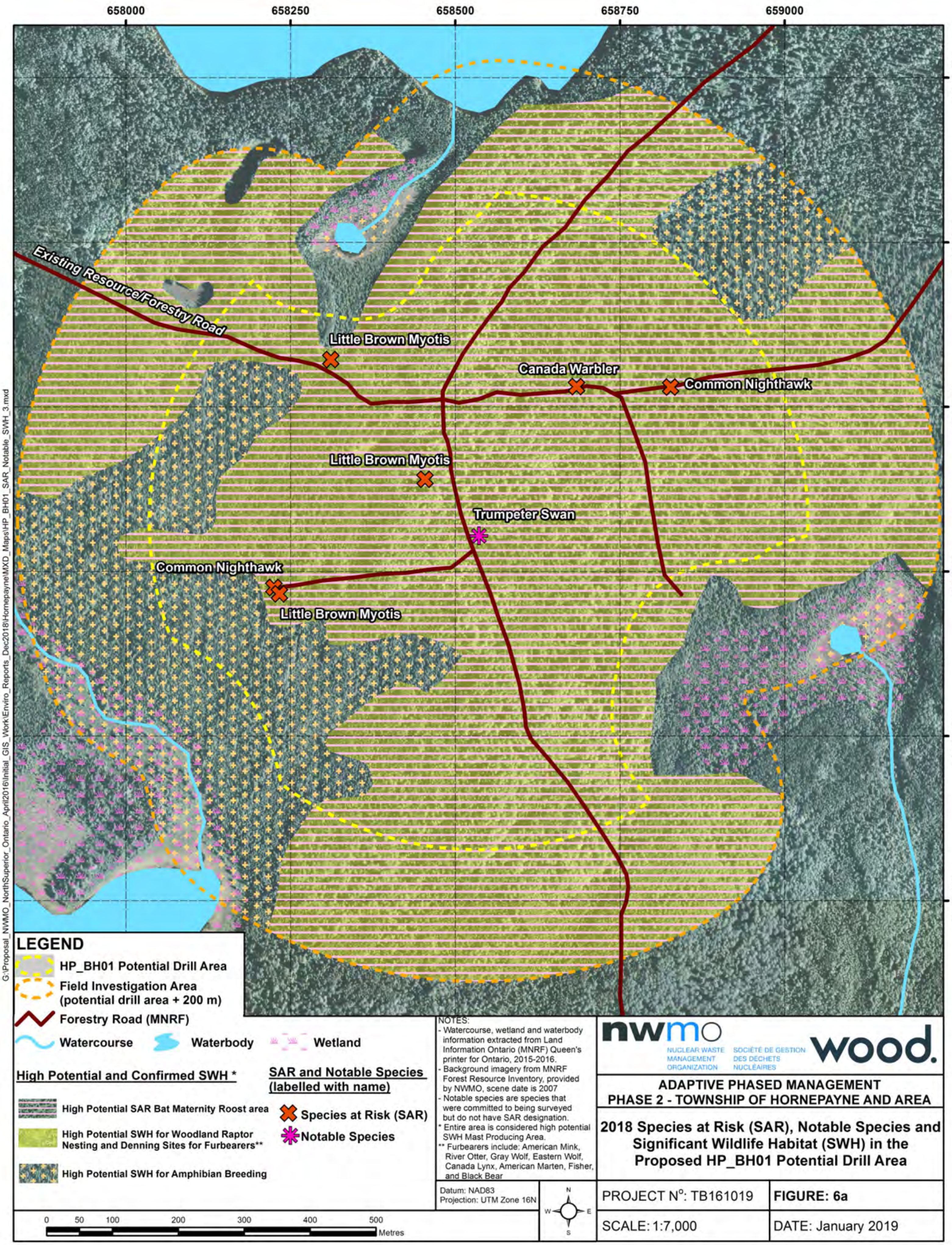
nwmo NUCLEAR WASTE MANAGEMENT ORGANIZATION / SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

wood.

ADAPTIVE PHASED MANAGEMENT
PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

2018 Drone Aerial Survey Results in the Proposed HP_BH03 Potential Drill Area and Potential Access Road Locations

PROJECT N°: TB161019	**FIGURE: 5c**
SCALE: 1:19,000	DATE: January 2019



NOTES:
- Watercourse, wetland and waterbody information extracted from Land Information Ontario (MNRF) Queen's printer for Ontario, 2015-2016.
- Background imagery from MNRF Forest Resource Inventory, provided by NWMO, scene date is 2007
- Notable species are species that were committed to being surveyed but do not have SAR designation.
* Entire area is considered high potential SWH Mast Producing Area.
** Furbearers include: American Mink, River Otter, Gray Wolf, Eastern Wolf, Canada Lynx, American Marten, Fisher, and Black Bear

Datum: NAD83
Projection: UTM Zone 16N

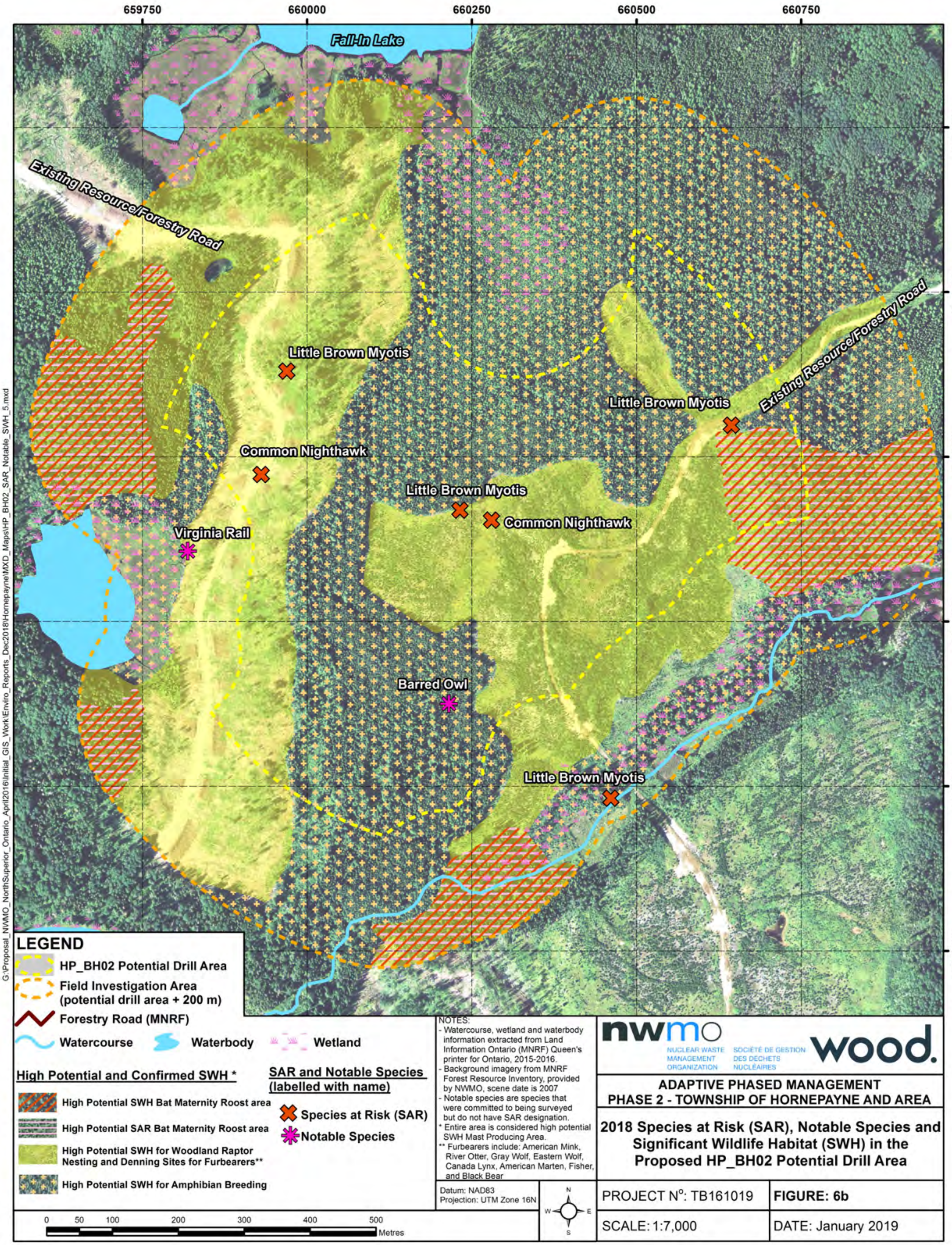
nwmo NUCLEAR WASTE MANAGEMENT ORGANIZATION / SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

wood.

ADAPTIVE PHASED MANAGEMENT
PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

2018 Species at Risk (SAR), Notable Species and Significant Wildlife Habitat (SWH) in the Proposed HP_BH01 Potential Drill Area

PROJECT N°: TB161019	**FIGURE: 6a**
SCALE: 1:7,000	DATE: January 2019



NOTES:
- Watercourse, wetland and waterbody information extracted from Land Information Ontario (MNRF) Queen's printer for Ontario, 2015-2016.
- Background imagery from MNRF Forest Resource Inventory, provided by NWMO, scene date is 2007
- Notable species are species that were committed to being surveyed but do not have SAR designation.
* Entire area is considered high potential SWH Mast Producing Area.
** Furbearers include: American Mink, River Otter, Gray Wolf, Eastern Wolf, Canada Lynx, American Marten, Fisher, and Black Bear

Datum: NAD83
Projection: UTM Zone 16N

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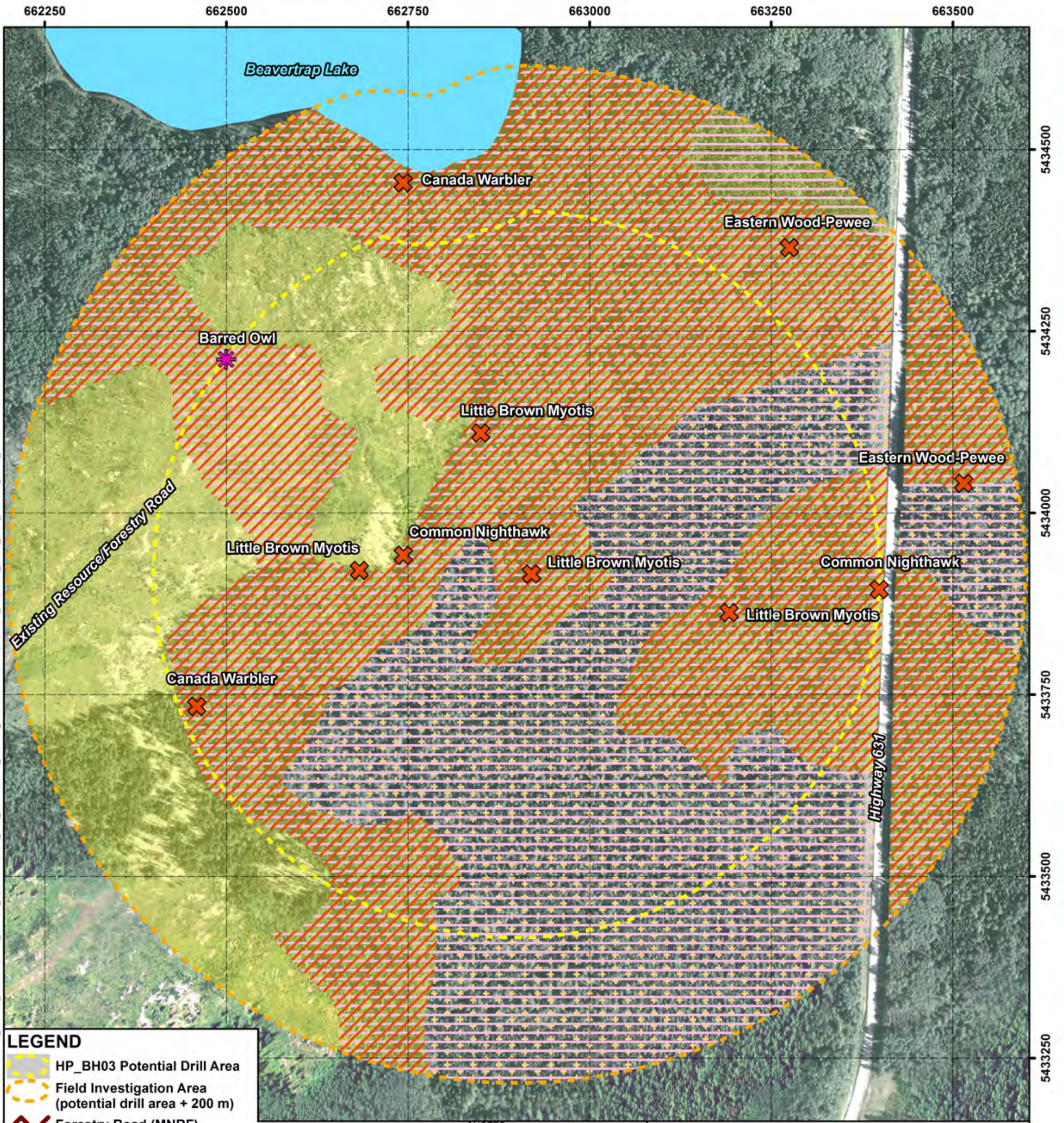
wood.

ADAPTIVE PHASED MANAGEMENT
PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

2018 Species at Risk (SAR), Notable Species and Significant Wildlife Habitat (SWH) in the Proposed HP_BH02 Potential Drill Area

PROJECT N°: TB161019	FIGURE: 6b
SCALE: 1:7,000	DATE: January 2019



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LEGEND

- HP_BH03 Potential Drill Area
- Field Investigation Area (potential drill area + 200 m)
- Forestry Road (MNRF)
- Watercourse
- Waterbody
- Wetland

High Potential and Confirmed SWH *

- High Potential SWH Bat Maternity Roost area
- High Potential SAR Bat Maternity Roost area
- High Potential SWH for Woodland Raptor Nesting and Denning Sites for Furbearers**
- High Potential SWH for Amphibian Breeding

SAR and Notable Species (labelled with name)

- Species at Risk (SAR)
- Notable Species

0 50 100 200 300 400 500 Metres

NOTES:
- Watercourse, wetland and waterbody information extracted from Land Information Ontario (MNRF) Queen's printer for Ontario, 2015-2016.
- Background imagery from MNRF Forest Resource Inventory, provided by NWMO, scene date is 2007
- Notable species are species that were committed to being surveyed but do not have SAR designation.
* Entire area is considered high potential SWH Mast Producing Area.
** Furbearers include: American Mink, River Otter, Gray Wolf, Eastern Wolf, Canada Lynx, American Marten, Fisher, and Black Bear

Datum: NAD83
Projection: UTM Zone 16N

N W E S

nwmo NUCLEAR WASTE MANAGEMENT ORGANIZATION SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

wood.

ADAPTIVE PHASED MANAGEMENT PHASE 2 - TOWNSHIP OF HORNEPAYNE AND AREA

2018 Species at Risk (SAR), Notable Species and Significant Wildlife Habitat (SWH) in the Proposed HP_BH03 Potential Drill Area

PROJECT N°: TB161019	**FIGURE: 6c**
SCALE: 1:7,000	DATE: January 2019