White Pine Springs
Evart, Michigan
Assessment of Wetland Effects

Prepared for:

Nestlé Waters North America Inc.
Stanwood, Michigan

Prepared by:

Environmental Consulting & Technology, Inc.

2200 Commonwealth Blvd., Suite 300
Ann Arbor, MI 48105

ECT No. 160258

July 15, 2016

DOCUMENT REVIEW

The dual signatory process is an integral part of Environmental Consulting & Technology, Inc.'s (ECT's) Document Review Policy No. 9.03. All ECT documents undergo technical/peer review prior to dispatching these documents to any outside entity.

This document has been authored and reviewed by the following employees:

Martin J. Boote	Matthew E. Carmer
Author	Peer Review
[signature]	[signature]
Signature	Signature
July 15, 2016	July 15, 2016
Date	Date

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

dbh	diameter at breast height
ECT	Environmental Consulting & Technology, Inc.
gpm	gallons per minute
GS	ground surface
GW	groundwater
MNFI	Michigan Natural Features Inventory
NWNA	Nestlé Waters North America Inc.
NLEB	northern long-eared bat
NRCS	Natural Resources Conservation Service
PEM	palustrine emergent wetland
PFO	palustrine forested wetland
POW	palustrine open water wetland
PSS	palustrine scrub-shrub wetland
SSPA	S.S. Papadopulos & Associates, Inc.
T&E	Threatened and Endangered
TAI	Tilton & Associates, Inc.
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey

1.0 EXECUTIVE SUMMARY

Nestlé Waters North America Inc. (NWNA) has applied to the Michigan Department of Environmental Quality for approval under Section 17 of the Safe Drinking Water Act (1976 P.A. 399) to increase its pumping rate from a groundwater source aquifer near Evart, Michigan in Osceola County (Figure 1). NWNA originally permitted and installed a well at its White Pine Springs production well site in 2001 at 150 gpm. NWNA's Section 17 application is to obtain approval to increase pumping from the baseline rate of 150 gpm to 400 gpm. To complete its Section 17 application documents, NWNA has asked Environmental Consulting & Technology, Inc. (ECT) to conduct a review of potential wetland effects similar to that conducted in 2003 by TAI.

To conduct its assessment of potential wetland effects associated with an increase in NWNA's pumping rate to 400 gpm, ECT specifically assessed 16 wetlands within the vicinity of NWNA's production well (Figures 2 through 9) to 1) determine if the wetland is connected to the regional groundwater source aquifer and 2) assess whether drawdown of the regional groundwater source aquifer would affect the wetlands connected to it. In addition, ECT assessed whether potential wetland effects could have direct or indirect effects on Threatened and Endangered species that could potentially be present in the aquifer-connected wetlands. To complete its assessment of potential effects, ECT relied upon wetland assessment data, maps, and report prepared by Tilton & Associates, Inc. (TAI) in 2003 and 2004; 2015-2016 groundwater modeling and reports prepared by S.S. Papadopulos & Associates (SSPA); Michigan Natural Features Inventory Natural Heritage Database (threatened and endangered species); ECT's 2011 to 2015 annual wetland qualitative monitoring observations and data; and field observations and data recorded by ECT staff in April 2016.

ECT has determined that Wetlands A, G, H, R, CC, PP, FF, and OO are likely connected to the regional groundwater source aquifer (i.e., the ground water aquifer from which NWNA is pumping), or receive water from that groundwater aquifer as part of their annual water balance. All of the other wetlands mapped by TAI in 2003 are perched wetlands due to the presence of a low-permeability confining soil layer, such as silt or clay that restricts vertical movement of water, and/or two to several feet of vertical separation between the wetland ground surface and regional groundwater table. ECT confirmed the presence of a low-permeability clay soil under the perched wetlands where it conducted field investigations in 2016. In addition, the land surface at the perched wetlands is typically on the order of 2 to 50 feet higher in elevation than the regional groundwater table. Perched wetlands receive water from surface runoff, direct precipitation, and possibly shallow perched groundwater moving along a confining layer that is not part of the regional groundwater source aquifer. The hydrology and functional ecology of perched wetlands will not be affected by a drawdown of the regional groundwater table.

Wetlands A, G, H, R, CC, PP, FF, and OO are connected to the regional groundwater source aquifer based on the lack of a confining soil layer or recorded regional groundwater table elevations just below (within two feet of the ground surface), at, or, above the ground surface at the wetlands. These wetlands receive groundwater from the source aquifer where the groundwater table intersects the land surface, and groundwater associated with the source aquifer provides at least part of the annual water budget of the wetlands. Of those wetlands, Wetlands PP, FF, and OO fall outside of the SSPA model-predicted 0.5-foot drawdown contour. Therefore, those wetlands will not be affected by the drawdown. Drawdown of the regional groundwater source aquifer of 0.5 to 1-foot is predicted by SSPA modeling in the vicinity of Wetlands A, G, H, R, and CC. The 0.5-foot drawdown contour is located along the west edge of Wetland A and north edge of Wetland CC. The 1-foot drawdown contour is located near Wetland H, while Wetland G lies between the 0.5 and 1-foot drawdown contours. The 0.5 and 1-foot drawdown contours intersect the east and north edges of Wetland R, and the northern lobe of Wetland R along East Branch Twin Creek, which is entirely located between the 0.5 and 1-foot drawdown contours. The 1-foot drawdown contour is located just west of the eastern edge of Wetland R.

The actual drawdown within the wetland soil profile of wetlands A, G, H, R, and CC is expected to be less than the model predicted groundwater source aquifer drawdown, and may only have an effect on the duration of wetland soil saturation at the surface during summer drought periods when precipitation is low and evapotranspiration is high. Actual drawdown within the wetland soil profile is controlled by fine textured glacial till under the wetlands and peat (resistance to vertical flow and capillary action); lateral groundwater flow-through driven by high groundwater gradients; and wetting from adjacent streams and seeps in the case of Wetlands R, G, A, and CC. In general, groundwater flows into and through the wetlands when they are connected to the groundwater source aquifer due to the hilly topography and steep groundwater gradients. Furthermore, drawdown of the regional groundwater table by 0.5 to 1-foot would likely not affect seasonal high water levels in the wetlands, with the exception of Wetland H. A drawdown of 1-foot in Wetland H is possible, which could eliminate seasonal surface inundation caused by seasonally high ground water table elevations that are above the bottom of Wetland H. Still, the regional groundwater table would result in saturation of soils within 12 inches of the ground surface. Eliminating seasonal surface inundation could result in a plant community shift, but is not likely to result in a reduction in wetland area. Sedges, which depend on fluctuating water levels associated with intermittent wetlands, may decrease in abundance, while facultative grass and forb species may increase in Wetland H. Thus, a plant community composition shift is possible, with no loss in ecological function.

If wetland soil profile saturation occurs for a shorter period of time than the wetlands experience naturally, peat oxidation and wetland surface subsidence (a lowering of elevation) may occur. However, subsidence is expected to be minimal and may actually compensate for the lower groundwater surface potential within the wetlands. A reduction in the duration of wetland soil saturation at the surface during summer may allow an increase in germination of woody shrubs and trees. An increase in woody shrubs and trees in forested and scrub-shrub wetland areas is not likely to affect the functional ecology of those wetlands, but invasive shrubs exist in some of the wetlands. Therefore, the potential for colonization of invasive shrubs may increase slightly. A slight increase in the abundance and distribution of native shrubs along the margins and in high areas of sedge meadow wetland areas of Wetland R and Wetland H is also possible if the duration of wetland soil saturation in those areas is reduced. However, the increase in shrubs is not expected to be substantial enough to alter the overall functional ecology of those wetlands. Furthermore, most of the sedge meadow area of Wetland R is believed to have been historically forested wetland based on the numerous dead ash trees.

ECT assessed potential effects on three terrestrial Threatened and Endangered (T&E) plant and animal species that were reported in databases to have been observed in Osceola County; have the potential to be present in wetlands based on habitat requirements; and have the potential to be directly or indirectly affected by changes in wetland plant communities and hydrology. The short-eared owl, Vasey's rush, and northern long-eared bat are the only species that have been recorded in Osceola County that could be present in the wetlands or affected by wetland changes. Habitat is not present for the short-eared owl in any of the wetlands. Vasey's rush could potentially exist in Wetlands A, H, and R based on existing plant community characteristics in those wetlands, but given potential wetland changes are minimal and may actually favor Vasey's rush due to its affinity for intermittent wetland habitat (wetlands with fluctuating water levels), Vasey's rush is not likely to be affected. Only positive effects on northern long-eared bat associated with a potential increase in tree density are expected.

In conclusion, given the level of groundwater drawdown and reduced duration of wetland soil saturation expected, measurable effects on the functional ecology of wetlands connected to the regional groundwater source aquifer are not expected.

2.0 INTRODUCTION

Nestlé Waters North America Inc. (NWNA) has applied to the Michigan Department of Environmental Quality for approval under Section 17 of the Safe Drinking Water Act (1976 P.A. 399) to increase its pumping rate from a groundwater source aquifer near Evart, Michigan in Osceola County (Figure 1). NWNA originally received approval for its production well at White Pine Springs in 2001 at 150 gpm. NWNA's Section 17 application is to obtain approval to increase pumping from the baseline rate of 150 gpm to 400 gpm. To complete its Section 17 application documents, NWNA has asked Environmental Consulting & Technology, Inc. (ECT) to conduct a review of potential wetland effects.

To conduct its assessment of potential wetland effects associated with an increase in NWNA's pumping rate to 400 gpm, ECT specifically assessed 16 wetlands within the vicinity of NWNA's production well (Figures 2 through 9) to 1) determine if the wetland is connected to the regional groundwater source aquifer and 2) assess whether drawdown of the regional groundwater source aquifer would affect the wetlands connected to it. In addition, ECT assessed whether potential wetland effects could have direct or indirect effects on Threatened and Endangered species that could potentially be present in the aquifer-connected wetlands. To complete its assessment of potential effects, ECT relied upon wetland assessment data, maps, and report prepared by Tilton & Associates, Inc. (TAI) in 2003 and 2004; 2015-2016 groundwater modeling and reports prepared by S.S. Papadopulos & Associates (SSPA); Michigan Natural Features Inventory Natural Heritage Database (threatened and endangered species); ECT's 2011 to 2015 annual wetland qualitative monitoring observations and data; and field observations and data recorded by ECT staff in April 2016.

The 16 wetlands assessed by ECT were selected based on information and data from previous assessments conducted by TAI in 2003, and determinations of GW source aquifer connections by TAI and SSPA. Wetlands that were previously determined to be connected to the aquifer were included in ECT's current assessment (Wetlands A, G, H, R, and CC). In addition, ECT assessed wetlands that may be connected to the aquifer based on landscape position and land surface elevation relative to the GW table, but that were not previously identified as being connected to the aquifer (Wetlands FF, PP, and OO). Wetland Q was assessed because TAI had reported that part of it was a beaver pond and flow continued northeast toward Decker Pond. ECT assessed Wetland Q due to this reported flow component. Lastly, ECT chose to assess several wetlands located within the 0.5-foot drawdown contour that appeared to have inconclusive information about the presence of GW and confining soil layers under the wetlands (Wetlands B, C, D, I, J, L, and X).

2.1 Supporting Information

ECT relied upon a 2004 wetland assessment report prepared by TAI, GW drawdown modeling completed by SSPA, monitoring well data provided by Arcadis, and spatial data obtained from those and other sources; GW drawdown contours; potentiometric GW surface contours developed from monitoring well data; monitoring well and production well locations; one-foot land surface contours derived from the 2013 U.S. Geological Survey (USGS) National Elevation Database; aerial photography; and mapped wetland boundaries.

The 2004 TAI report and data files available to ECT contain soil probing data, vegetation data, and documented observations of indicators of wetland hydrology that ECT used as an initial characterization and understanding of the 16 wetlands ECT assessed.

The SSPA modeling report contains a description of GW modeling methods and results. Portions of the SSPA report pertaining specifically to wetlands were used by ECT to assess the potential effects of aquifer drawdown on wetland water levels and soil saturation, and functional wetland ecology. In addition, ECT used modeled drawdown contours provided by SSPA in shapefile format for mapping and spatial analysis.

Arcadis provided monitoring well data for the period of record to ECT in Excel®. ECT used the well data to compare recorded GW table elevations to land surface elevations at the wetlands ECT assessed. Rather than using the maximum GW table elevations recorded, ECT used the calculated 75th-percentile elevation for all of the monitoring wells with sufficient data to calculate the statistic. Maximum elevations are not necessarily reflective of a typical seasonally high GW elevation, but may rather reflect a single point in time affected by above average rainfall or other antecedent, short-term conditions. On the other hand, the median elevation would not necessarily reflect seasonally high GW table elevations. Arcadis also provided potentiometric GW surface contours derived from the monitoring well data that ECT used in mapping and spatial analysis. Combined with the well data 75th-percentile elevations, the contours allowed ECT to assess GW elevations relative to land surface elevations at the wetlands.

2.2 Methods

ECT used the supporting information described above to conduct spatial analyses in GIS software and determine if the GW table is above, at, or near the ground surface (GS) at the 16 wetlands ECT assessed (Figure 2). ECT presumed that where the regional GW table intersects the land surface at wetlands (or close enough to be within the root zone of plants), the wetlands are hydrologically connected to the GW source aquifer. That is, the wetlands receive at least part of their annual water budget from the GW source aquifer. In addition, ECT conducted field work to observe and record vegetation, indicators of wetland hydrology, and soils within the wetlands (ECT did not observe wetlands FF and OO due to their distance outside of the 0.5-foot drawdown contours).

To evaluate soils, ECT used a hand auger to bore a hole in the wetland soil. Soil horizon color, texture, moisture, and redoximorphic features (an indicator of wetland hydrology based on soil chemistry) were observed and recorded wherever such conditions existed and changed through the soil boring profile. The depth below GS was estimated and recorded for each horizon. Low-permeability soil layers such as clay, silt, and silt/clay were noted at the depth first observed. The thickness of such confining soil layers was not investigated.

Plants observed in the wetlands by ECT that could be identified in dead or dormant condition were identified and recorded to document general plant species composition and wetland plant community type. Indicators of hydrology as described in the U.S. Army Corps of Engineers' (USACE) *Wetlands Delineation Manual – Technical Report Y-87-1* (1987) and *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region* (2012) were also observed and recorded (e.g., surface inundation, soil saturation, and bodies of water).

3.0 PUMPING EFFECTS ON WETLANDS

The following sections describe ECT's general characterization of wetlands it visited in April of 2016, and assessment of potential effects to the 16 wetlands using resources described in Section 2.1, and ECT's spatial analysis and field work described in Section 2.2. Representative wetland photographs taken during ECT's field work on April 13, 2016 are provided in Appendix B.

3.1 Wetland A

Wetland A is classified as four different wetland cover types: Palustrine Forested wetland (PFO), Palustrine Open Water wetland (POW), Palustrine Emergent wetland (PEM), and Palustrine Scrub-Shrub wetland (PSS) surrounded by upland deciduous forest and mixed deciduous and coniferous forest (Cowardin *et al.* 1979). The wetland is dominated by hydrophytic (wetland) vegetation in all strata (trees, shrubs, and herbaceous or groundcover layers). Plant species include black ash (*Fraxinus nigra*), yellow birch (*Betula alleghaniensis*), red maple (*Acer rubrum*), Eastern hemlock (*Tsuga canadensis*), willow species (*Salix* spp.), glossy buckthorn (*Frangula alnus*; a non-native, invasive species), broad-leaved cattail (*Typha latifolia*), sedge species (*Carex* spp.), cinnamon fern (*Osmunda cinnamomea*), and goldenrod species (*Solidago* spp.).

Wetland hydrology was evident through soil saturation at the surface, shallow inundation, and GW seeps (GW flowing onto the land surface). Hydric (wetland) soils are present, including an organic soil layer called a histic epipedon. Histic epipedons are eight to sixteen-inch thick soils that are formed by incomplete decomposition of plant matter under prevailing saturated soil conditions (resulting in a lack of oxygen within the soil profile, USDA-NRCS 2010). Histic epipedons are often called peat or muck, and further characterized by the degree of plant matter decomposition. Wetland A contains an eight-inch histic epipedon of sapric muck (highly decomposed organic material) over low chroma (10YR 3/2) sand and gravel coated with organic matter. A low-permeability confining layer was not observed to a depth of 20 inches below GS.

Wetland A is located between the 1080 (east) and 1095-foot (west) regional GW table contours (Figure 3). The nearest monitoring well is SW-8-DP, located in the north central portion of Wetland A (Figure 3). The GS at SW-8-DP is approximately 1081.09 feet. The 75th-percentile GW elevation is 1080.93 ft. GS at Wetland A ranges from approximately 1085 feet in the west to 1079 in the east. This information suggests that the regional GW table is at or very near the GS at Wetland A, and that Wetland A is likely connected to the GW table given the lack of a confining soil layer. The proximity of the GW table to the GS near Wetland A explains why GW seeps are present along the west edge of Wetland A. In addition, the presence of a thick layer of muck indicates relatively constant saturation, which is typical of GW based wetland hydrology. ECT's recent observations of indicators of wetland hydrology are consistent with ECT's annual qualitative monitoring events since 2011, which take place in the drier month of August. Even during August, soil saturation at the surface and flowing GW seeps have been consistently observed by ECT.

Wetland A is located immediately east of the 0.5-foot drawdown contour modeled by SSPA (Figure 2); the contour intersects the western forested wetland edge of Wetland A. Given the movement of GW laterally through Wetland A from the northwest toward the southeast and upward movement through the soil profile caused by high GW gradients, it is expected that the wetland soils will remain saturated. However, it is possible that the duration of soil saturation at the surface could be reduced during peak summer months when precipitation is low and evapotranspiration is high. A decrease in the duration of soil saturation within the histic epipedon could allow for organic matter decomposition, causing soil subsidence. Soil subsidence could result in exposing tree roots and increased incidence of windthrow. However, the degree to which the duration of soil saturation could be reduced, and subsequent soil surface subsidence, is expected to be low based on wetland hydrological conditions.

A decrease in the duration of soil surface saturation in the forested wetland component along the west edge of Wetland A could also result in increased tree and shrub seed germination and seedling development, leading to an increase in shrub and tree densities. In the forested portion of Wetland A, an increase in the density of native shrubs and trees is not a negative effect. However, the spread of invasive shrubs like glossy buckthorn and autumn olive (*Elaeagnus umbellata*), both of which have been observed in Wetland A, is also possible. Invasive species establishment within the wetland will be limited, however, due to the fact that invasive species tend to colonize more readily on disturbed ground where native vegetation does not exist, and NWNA's proposed pumping rate increase will not cause such disturbances in Wetland A.

3.2 Wetland B

Wetland B is classified as PEM with a narrow forested wetland fringe surrounded by upland deciduous forest. The wetland is dominated by hydrophytic vegetation including northern white-cedar (*Thuja occidentalis*), American elm (*Ulmus americana*), red maple, green ash (*Fraxinus pennsylvanica*), sedge species, and sensitive fern (*Onoclea sensibilis*).

Wetland hydrology was evident through standing water up to 18 inches deep. This standing water was observed actively draining into Wetland A. Soil borings revealed the presence of hydric soils and a low-permeability confining layer under the wetland. Hydric soils consisted of a four to ten-inch histic epipedon of sapric muck over low chroma (10YR 5/1) clayey coarse sand up to 40 inches below GS. The low-permeability confining layer consisted of low chroma (10YR 5/1) clay with high chroma redoximorphic concentrations (10YR 5/6 and 5/8) up to 34 inches below GS.

Wetland B is located at the 1095-foot regional GW contour (Figure 3). The nearest monitoring well is MW-111d (GS 1110.98; 75th-percentile GW elevation 1098.69). See Figure 3 for the location of this well in relation to the wetland. GS at Wetland B is approximately 1097 feet. This information suggests that the regional GW table may be near the GS at Wetland B to a few feet below the GS. Regardless, the presence of a confining soil layer consisting of clayey coarse sand would effectively separate Wetland B from the regional GW aquifer. Therefore, drawdown of the regional GW table would not affect the hydrology or functional ecology of Wetland B.

3.3 Wetland C

Wetland C is classified as PEM and PSS surrounded by upland deciduous forest with a wetland forest fringe. The wetland is dominated by hydrophytic vegetation including Michigan holly (*Ilex verticillata*), red maple, Eastern hemlock, paper birch (*Betula papyrifera*), and sedge species.

Evidence of wetland hydrology included standing water up to 30 inches deep. Based on field observation of a topographic drainage feature on the southern edge of the wetland, Wetland C drains into Wetland B during high water levels. Hydric soils are present, consisting of one inch of sapric muck, 22 inches of clayey sand with low chroma (10YR 5/1), and a confining clay layer with low chroma (10YR 5/1) and high chroma redoximorphic concentrations (10YR 5/6 and 5/8) to a depth greater than 22 inches below GS.

Wetland C is located between the 1090 and 1095-foot regional GW contours. The nearest monitoring well is MW-111d (GS 1110.98; 75th-percentile GW elevation 1098.69. See Figure 3 for the location of this well in relation to the wetland. The approximate GS elevation at Wetland C is 1101 feet. This information suggests that the GS at Wetland C is 2 to 10 feet above the regional GW table. Furthermore, ECT observed a confining soil layer under Wetland C. This information suggests that Wetland C is not connected to the regional GW source aquifer. Therefore, drawdown of the regional GW table would not affect the hydrology or functional ecology of Wetland C.

3.4 Wetland D

Wetland D is classified as PEM and POW surrounded by upland deciduous forest with a wetland forest fringe. The wetland is dominated by hydrophytic vegetation including sedge species and Michigan holly with a fringe of red maple, American beech (*Fagus grandifolia*), eastern hemlock, trembling aspen (*Populus tremuloides*), and green ash.

Wetland hydrology was evident through standing water up to 26 inches deep. Based on a topographic drainage feature on the southwestern edge of the wetland, Wetland D drains into Wetland C during high water levels. Hydric soils are present, consisting predominantly of coarse sand and clayey sand with low chroma (10YR 5/1) to 20 inches deep. A confining clay layer was observed at 20 inches below GS with low chroma (10YR 5/1) and high chroma redoximorphic concentrations (10YR 5/6) to a depth of 23 inches below GS.

Wetland D is located at the 1095-foot contour of the regional water table. The nearest monitoring well is MW-111d (GS 1110.98; 75th-percentile GW elevation 1098.69). See Figure 3 for the location of this well in relation to the wetland. The approximate GS elevation at Wetland D is 1102 feet. The GS at Wetland D is approximately 2 to 10 feet above the regional GW table.

Given the surface of Wetland D is perched above the GW elevation documented in nearby monitoring wells, and the presence of a confining clay layer, Wetland D is not connected to the regional GW aquifer. Therefore, drawdown of the regional GW table would not affect the hydrology or functional ecology of Wetland D.

3.5 Wetland G

Wetland G is classified as PFO and PEM surrounded by upland deciduous forest. This wetland is dominated by hydrophytic vegetation including American elm, Eastern hemlock, paper birch, black ash (dead from emerald ash borer infestation), northern white-cedar, glossy buckthorn, and sensitive fern. Wetland hydrology was evident through standing water up to 18 inches deep. Based on topography, Wetland G may drain to the west into Wetland R during high water levels.

Hydric soils are present. They consist of three inches of sapric muck over four inches of low chroma (10YR 3/2) clayey sand, subtended by over 23 inches of low chroma (10YR 5/3) fine sand. ECT did not observe a confining layer of clay or other low-permeability soils to a depth of 30 inches below GS, although the clayey sand will reduce the rate of vertical water movement.

Wetland G is located between the 1080 and 1085-ft. contours of the regional GW table. Three monitoring wells exist along the northern edge of Wetland G: DP-1 (GS 1085.21; 75th-percentile GW elevation 1084.96), DP-2 (GS 1085.02; 75th-percentile GW elevation 1084.18), ad DP-3 (GS 1085.14; 75th-percentile GW elevation 1083.79). See Figure 4 for the location of these wells in relation to the wetland. The approximate GS elevation at Wetland G is 1082 feet. This information suggests that the regional GW table is at or very near the GS at Wetland G. Given the proximity of the GW table to the GS and the lack of a confining soil layer, it appears Wetland G is directly connected to the regional GW source aquifer. The three monitoring wells along the northern edge of the wetland, show mean GW elevations of 0.8 feet (approximately 10 inches) below the GS at the wells. The wells are located higher than the standing water portion of the wetland, indicating that the standing water portion is likely an expression of the regional GW table. Furthermore, the presence of muck indicates relatively constant soil saturation.

Wetland G is located between the 0.5 and 1-foot drawdown contours modeled by SSPA (Figure 4). The hydrology of Wetland G is similar to that of the forested portion of Wetland A expect for the presence of seasonal surface inundation in Wetland G. Given the movement of GW laterally through Wetland G from the northwest toward the southeast and upward movement through the soil profile caused by high GW gradients, it is expected that the wetland soils will remain saturated. However, it is possible that the duration of soil saturation at the surface could be reduced due to loss of saturation during peak summer months when precipitation is low and evapotranspiration is high, and the duration of surface inundation may also be reduced. Reduced duration of soil saturation within the histic epipedon could allow for organic matter decomposition, causing soil subsidence. Soil subsidence could result in exposing tree roots and increased incidence of windthrow. However, ECT only observed a few inches of muck, suggesting that surface inundation rather than saturation is the primary source of water supporting wetland hydrology, and that hill slope runoff may be a large component of the wetland hydrology. The degree to which the duration of soil surface saturation and surface inundation are reduced is expected to be low based on wetland hydrological conditions.

Decreased duration of soil surface saturation and inundation in Wetland G could result in increased tree and shrub seed germination and seedling development, leading to an increase in shrub and tree densities. In the forested portion of Wetland G, an increase in the density of native shrubs and trees is not a negative effect. However, the spread of invasive shrubs like glossy buckthorn and autumn olive (*Elaeagnus umbellata*) in Wetland G is possible. Invasive species establishment within the wetland will be limited, however, due to the fact that invasive species tend to colonize more readily on disturbed ground where native vegetation does not exist, and NWNA's proposed pumping rate increase will not cause such disturbances in Wetland G.

3.6 Wetland H

Wetland H is classified as PEM and PSS surrounded by upland mixed deciduous and coniferous forest, and scrub-shrub vegetation. The wetland is dominated by hydrophytic vegetation including wool grass (*Scirpus cyperinus*), sensitive fern, meadowsweet (*Spiraea alba*), and red-osier dogwood (*Cornus sericea*).

Wetland hydrology was evident through soil saturation at the surface and shallow inundation. Based on topography, Wetland H may drain into Wetland G during high water levels. Hydric soils are present, consisting of two inches of low chroma (10YR 3/2) clayey sand above more than 34 inches of low chroma (10YR 5/3) coarse sand. ECT did not observe a confining soil layer up to a depth of 36 inches below the wetland surface, but the clayey sand may decrease vertical movement of water through the soil profile.

Wetland H is located at the 1090-foot contour of the regional water table (Figure 4). The nearest monitoring wells are MW-4u (GS 1091.83; 75th-percentile GW elevation 1088.13) and DP-1 (GS 1085.21; 75th-percentile GW elevation 1084.96). See Figure 4 for the location of these wells in relation to the wetland. GS at Wetland H is approximately 1090. Despite the nearest monitoring well to the east of the wetland reporting a GW elevation of 3.7 feet below the GS at the time of the field investigation, soil saturation at the surface and shallow inundation was observed. Based on the surface elevation of the wetland, the monitoring well data, and the lack of a confining layer, it appears that Wetland H is directly connected to the regional GW aquifer. However, a lack of muck or peat in Wetland H indicates that water levels drop below the GS seasonally, allowing for organic material to decompose at a rate faster than it can accumulate.

The 1-foot drawdown contour modeled by SSPA bisects Wetland H with an east-west orientation. Given the movement of GW laterally through Wetland H from the north toward the south, and upward movement through the soil profile caused by high GW gradients, it is expected that actual drawdown within the wetland would be less than one foot. Still, it is possible that the duration of soil saturation at the surface could be decreased due to loss of saturation during peak summer months when precipitation is low and evapotranspiration is high; the duration of surface inundation may likewise be reduced. It is possible that upland vegetation may encroach into the margins and higher GS elevations of Wetland H if the maximum lateral extent of seasonal inundation and soil saturation at the surface are reduced. Because surface saturation is naturally not present in Wetland H during the summer, spread of woody shrubs that already exist in the wetland is not expected. Under worst case, surface inundation in Wetland H could be permanently lost, with soil saturation to the surface occurring only seasonally, resulting in a plant community shift from sedges toward more facultative grasses, forbs, and shrubs.

3.7 Wetland I

Wetland I is classified as PEM with some small shrub patches surrounded by upland scrub-shrub vegetation. The wetland is dominated by hydrophytic vegetation including sensitive fern, sedge species, wool grass, blue vervain (*Verbena hastata*), willow species, glossy buckthorn, and gray dogwood (*Cornus foemina*).

Wetland hydrology was evident through standing water up to 15 inches deep. Hydric soils are present, consisting of four inches of hemic muck (moderate organic matter decomposition) subtended by a low chroma (10YR 2/1) clay that extends more than 14 inches below GS.

Wetland I is located between the 1120 and 1125-foot contours of the regional water table (Figure 5). The nearest monitoring wells are MW-107d (GS 1180.68; 75th-percentile GW elevation 1127.51) and MW-107i (GS 1180.75; 75th-percentile GW elevation 1127.51). See Figure 5 for the location of these wells in relation to the wetland. The approximate GS elevation at Wetland I is 1163 feet, on the order of 30 to 40 feet above the regional GW table.

Given the surface of Wetland I is located 30 feet or more above the regional GW table and the presence of a clay confining layer, Wetland I is a perched wetland and is not connected to the regional GW source aquifer. Therefore, drawdown of the regional GW table would not affect the hydrology or functional ecology of Wetland I.

3.8 Wetland J

Wetland J is classified as PEM surrounded by upland scrub-shrub vegetation. This wetland is dominated by hydrophytic vegetation including sensitive fern, wool grass, and sedge species, with scattered willow species.

Wetland hydrology was evident through standing water up to 8 inches deep. During high water events, this wetland drains into Wetland L via a narrow topographic drainage feature. Hydric soils are present, consisting of two inches of hemic muck over a low-permeability clay with low chroma (10YR 2/1) that is more than five inches deep.

Wetland J is located near the 1125-foot contour of the regional water table (Figure 5). The nearest monitoring wells are MW-107d (GS 1180.68; 75th-percentile GW elevation 1127.51) and MW-107i (GS 1180.75; 75th-percentile GW elevation 1127.51). See Figure 5 for the location of these wells in relation to the wetland. The GS elevation at Wetland J is approximately 1171 feet, on the order of 40 feet above the regional GW table. This information along with the presence of a confining soil layer indicates that Wetland J is not connected to the regional GW source aquifer.

Given the surface of Wetland J is approximately 40 feet above the regional GW table and the presence of the confining clay layer, Wetland J is a perched wetland that is not connected to the regional GW source aquifer. Therefore, drawdown of the regional GW table would not affect the hydrology or functional ecology of Wetland J.

3.9 Wetland L

Wetland L is classified as PEM and PSS with smaller PFO and POW components surrounded by upland deciduous forest. This wetland is dominated by hydrophytic vegetation including sensitive fern, goldenrod species, willow species, green ash, American elm, meadowsweet, trembling aspen, wild red raspberry (*Rubus strigosus*), wool grass, and glossy buckthorn.

Wetland hydrology was evident by up to 12 inches of standing water at the south end, a seep flowing from the western finger of the wetland, and water flowing through a narrow drainage feature in the northern PFO portion of the wetland. Hydric soils are present over a low chroma (10YR 2/1) clay layer at the surface that forms a confining layer.

Wetland L is located between the 1120 and 1125-foot contours of the regional GW table (Figure 5). The nearest monitoring wells are MW-107d (GS 1180.68; 75th-percentile GW elevation 1127.51) and MW-107i (GS 1180.75; 75th-percentile GW elevation 1127.51). See Figure 5 for the location of these wells relative to the wetland. The GS elevation at Wetland L ranges from 1158 (southwest) to 1171 (northeast), on the order of 30 to 40 feet above the regional GW table. This information and the presence of a confining soil layer indicate that Wetland L is not connected to the regional GW source aquifer. GW seeps observed by ECT are due to shallow lateral GW flow perched on top of the confining soil layer. This GW hydrology is similar to nearby Wetland X.

Given the surface elevation of Wetland L is much higher in elevation than the regional GW table and the presence of a confining clay layer, Wetland L is a perched wetland that is not connected to the regional GW source aquifer. While a seep is present, this flow appears to be shallow subsurface flow moving along the clay confining layer. Therefore, drawdown of the regional GW table would not affect the hydrology or functional ecology of Wetland J.

3.10 Wetland Q

Wetland Q is classified as POW with a smaller PEM component surrounded by upland deciduous forest, mixed upland coniferous and deciduous forest, and a gravel roadway. This wetland is dominated by hydrophytic vegetation including soft rush (*Juncus effusus*), wool grass, sedge species, water lily (*Nuphar* sp.), broad-leaved cattail, with willow species and glossy buckthorn on the edge.

Wetland hydrology was evident through soil saturation at the surface on the edge to deep standing water in the center. TAI characterized this wetland as a beaver flooding and classified it as predominantly POW with floating-leaf vegetation in 2003. Hydric soils are present with a deep histic epipedon. Sixteen inches of histic epipedon lays over two inches of low chroma (10YR 6/1) coarse sand, subtended by a minimum of four inches of low permeability clay with low chroma (10YR 5/1) and high chroma redoximorphic features (10YR 5/8) to a depth of greater than 20 inches below GS.

Wetland Q is located between the 1075 and 1080-foot contours of the regional GW table (Figure 6). The nearest monitoring well is SW-8-DP (GS 1081.09; 75th-percentile GW elevation 1080.93). See Figure 6 for the location of this well in relation to the wetland. The GS elevation at Wetland Q is approximately 1091 feet. This elevation is much higher than GW elevations recorded at SW-8-DP and several feet higher than the nearest regional GW table contour.

Given the wetland surface appears to be higher in elevation than the regional GW table and the presence of a confining soil layer, Wetland Q is a perched wetland that is not connected to the regional GW source aquifer. Therefore, drawdown of the regional GW table would not affect the hydrology or functional ecology of Wetland Q. In addition, Wetland Q is located east of the 0.5-foot drawdown contour modeled by SSPA.

3.11 Wetland R

Only the portion of Wetland R southeast of the intersection of 9 Mile Road and 110th Avenue was reviewed as virtually all of Wetland R north of 9 Mile Road is outside of the 0.5-foot drawdown contour. In particular, only the portions within the 0.5 to 2-foot drawdown contours were investigated, with the main focus on the northern leg of the wetland extending to 9 Mile Road that runs parallel with the drawdown contours and along East Branch Twin Creek.

Wetland R is classified as PFO and PEM with a POW impoundment at the northern end (south of 9 Mile Road) surrounded by upland deciduous forest. This wetland is dominated by hydrophytic vegetation including Eastern hemlock, northern white-cedar, black and green ash (predominantly dead from emerald ash borer infestation), red maple, glossy buckthorn, *Sphagnum* moss species, swamp goldenrod (*Solidago patula*), cinnamon fern, goldthread (*Coptis trifolia*), various sedge species, yellow birch, tag alder (*Alnus incana*), and broad-leaved cattail.

Wetland hydrology was evident through GW seeps, soil saturation at the surface, shallow surface inundation, and East Branch Twin Creek which flows through the center of Wetland R. Hydric soils are present with sapric muck histosol greater than three feet deep. This hydrologic evaluation is consistent with ECT's annual qualitative monitoring events since 2011 which take place in the drier month of August when surface saturation and flowing seeps have been consistently observed by ECT.

The GW table along the northern leg of Wetland R slopes from 1115 feet south to 1080 feet near the 0.5-foot drawdown contour (Figure 2). Throughout the wetland, GW elevations recorded at monitoring wells are consistent with the regional GW table contours and topographical contours; most of the 75th-percentile GW elevations are just below to just above the GS elevation at the wells. Numerous monitoring wells exist within and adjacent to Wetland R; however, the most pertinent monitoring wells are SW-1-DP (GS 1090.01; 75th-percentile GW elevation 1090.85) and SW-2-DP (GS 1083.73; 75th-percentile GW elevation 1082.97) located along the 1-foot drawdown contour within the northern leg of Wetland R. See Figure 7 for the location of these wells in relation to the wetland. The 75th-percentile GW elevations recorded in those wells averaged 0.08 ft. (approximately 1 inch) above GS at the wells. The GS elevation of Wetland R slopes from approximately 1115 feet near 9 Mile Road south to 1080 feet near the 0.5-foot drawdown contour, which roughly mimics the GW table contours and slope. This information suggests that Wetland R is connected to the regional GW source aquifer.

Roughly half of Wetland R south of 9 Mile Road to the west and south is located outside of the 0.5-foot drawdown contour. The remainder of Wetland R is primarily located between the 0.5 and 1-foot drawdown contours. The northern leg of Wetland R is nearly completely within the 0.5-foot drawdown contour, with the 1-foot drawdown contour approximately bisecting this northern leg, but the 1-foot drawdown contour is located just west of the eastern edge. Therefore, drawdown of the regional GW table along the eastern edge of Wetland R could be approximately 1 to 1.5 feet. The thickness of peat (i.e. histosol muck) in the wetland is greater than the degree of drawdown modeled by SSPA within the regional GW table under Wetland R. Therefore, the GW table, even if drawn-down by as much as one foot, would still be within the wetland peat profile and within the active plant root zone. However, the actual drawdown within Wetland R is expected to be much less than the modeled GW table drawdown, and may actually be inconsequential. This is due in part to the fact that East Branch Twin Creek is a major source of water for the adjacent wetlands and its elevation will not be altered by the modeled GW table drawdown. Additionally, lateral GW movement from the northeast toward the southwest through Wetland R is driven by high GW gradients, resulting in movement of GW upward through the wetland soils. Lastly, the fine-grained organic soil present in Wetland R typically supports approximately 2 to 3 inches of capillary fringe.

While seasonal high water levels and soil saturation will not likely be affected, a reduction in the duration of saturation at the soil surface may occur during the summer when precipitation is low and evapotranspiration is high, particularly during periods of below normal precipitation. Reduced duration of soil saturation near the soil surface could allow for drying of organic matter, increasing the rate of decomposition and causing soil subsidence. Soil subsidence could result in exposing tree roots and an increased incidence of windthrow. A drawdown of one to 1.5-feet along the eastern wetland edge could allow some encroachment of upland plants into the wetland area, but a measurable loss of wetland area is not expected. If the duration of soil saturation at the surface decreases, tree and shrub seed germination and seedling development may increase in some areas of Wetland R where trees and shrubs are most abundant, including upland trees and shrubs along the margins of Wetland R. In addition to a potential increase in the abundance and distribution of native shrubs and trees in the wetland, woody invasive shrubs like glossy buckthorn and autumn olive may spread, both of which have been observed in Wetland R. Invasive species further establishing within the wetland will be limited, however, due to the fact that existing native vegetation will not be removed, and the soil surface will not be disturbed. Areas with exposed soils are most susceptible to invasive species colonization.

3.12 Wetland X

Wetland X is classified PFO and PEM surrounded by upland deciduous forest and scrub-shrub vegetation. This wetland is dominated by hydrophytic vegetation including sensitive fern, wild red raspberry, trembling aspen, green ash, American elm, glossy buckthorn, goldenrod species, and wool grass.

Wetland hydrology was evident through saturation at the soil surface and a flowing seep at the west end of the wetland. Hydric soils are present, consisting of a four inch layer of fine sand (10YR 5/4) above a low permeability clay layer with low chroma (10YR 2/1) greater than 15 inches below GS.

Wetland X is located between the 1120 and 1125-foot contours of the regional GW table (Figure 5). The nearest monitoring wells are MW-107d (GS 1180.68; 75th-percentile GW elevation 1127.51) and MW-107i (GS 1180.75; 75th-percentile GW elevation 1127.70). See Figure 5 for the location of these wells in relation to the wetland. The GS elevation at Wetland X ranges from approximately 1138 feet (southwest) to 1161 feet (northeast), on the order of 10 to 20 feet above the regional GW table.

Given the wetland surface appears to be higher in elevation than the regional GW table and the presence of a confining soil layer, Wetland X is a perched wetland that is not connected to the regional GW aquifer. While a seep is present, this flow appears to be shallow GW flowing along a clay confining layer. Therefore, drawdown of the regional GW table would not affect the hydrology or functional ecology of Wetland X.

3.13 Wetland CC

Wetland CC is classified as PEM and PSS, with a smaller component of PFO, surrounded by upland deciduous forest and open water. This wetland is dominated by hydrophytic vegetation including sensitive fern, red-osier dogwood, glossy buckthorn, red maple, green ash, paper birch, trembling aspen, American elm, tag alder, broad-leaved cattail, northern white-cedar, and sedge species.

Wetland hydrology was evident through soil saturation at the surface, shallow inundation, and a flowing GW seep. Hydric soils are present with histosol to 43 inches below GS over a coarse sand layer with low chroma (10YR 5/3) and high chroma redoximorphic features (7.5YR 5/8).

Wetland CC is located between the 1085 and 1080-foot contours of the regional GW table (Figure 8). No GW monitoring wells exist within the vicinity. Wetland CC originates from a spring fed creek at a GS elevation of approximately 1101 feet, sloping toward the south to a GS elevation of approximately 1081 feet near Decker Pond. The spring fed creek at the northern end of Wetland CC is believed to be an expression of the regional GW table where it intersects the GS. Due to the steep land surface slope and high GW table gradient, it appears that the GW table intersects the land surface along the entire slope, causing saturation of the soil surface throughout the sloping wetland. This information suggests that Wetland CC is connected to the regional GW source aquifer.

The 0.5-foot drawdown contour intersects Wetland CC at is northernmost end (Figure 8), which consists of the PFO portion of the wetland and a flowing GW seep. During the field investigation, the water was approximately 0.5-foot deep within the flowing GW seep. A projected 0.5-foot drawdown could result in a flow reduction in these seeps of 10 to 15 percent based on SSPA modeled flow reductions in other spring seeps at White Pine. A reduction in seep flow between the 1095 and 1000 GS contours could result in reduced duration of soil surface saturation in the upslope, forested portion of the wetland. Increased occurrence and density of upland herbaceous plants and woody seedlings could occur. The lower, flatter portion of Wetland CC located south of the 0.5-foot drawdown contour is not likely to be affected by an increase in pumping rate to 400 gpm. This portion of the wetland contains a deep histosol of sapric muck, indicating relatively constant saturation. The potentially affected upslope area is small relative to the overall wetland area; therefore, the overall wetland hydrology and functional ecology should not be affected.

3.14 Wetland PP

Wetland PP is classified as PEM with scattered shrub clusters surrounded by upland deciduous forest and an asphalt roadway. This wetland is dominated by hydrophytic vegetation including broad-leaved cattail, glossy buckthorn, willow species, pussy willow (*Salix discolor*), wild red raspberry, marsh-marigold (*Caltha palustris*), sedge species, watercress (*Nasturtium* sp.), and sensitive fern.

Wetland hydrology was evident through soil saturation at the surface, shallow surface inundation, and a flowing GW seep at the north end. Hydric soils are present with 63 inches of sapric muck histosol over coarse sand (10YR 5/4). There are no monitoring wells within the vicinity of Wetland PP. The GS at Wetland PP is approximately 1092 feet. Based on the presence of such a deep histosol, lack of a confining soil layer, and a flowing GW seep, it appears the regional GW table intersects the GS at Wetland PP. Furthermore, plant species such as marsh-marigold and watercress are often found in wetlands with GW influence.

Although Wetland PP may be connected to the regional GW source aquifer, it is located east of the 0.5-foot drawdown contour. Therefore, an increase in the rate of pumping to 400 gpm should not affect Wetland PP.

3.15 Wetlands FF and OO

Wetlands FF and OO were not visited by ECT personnel in April 2016, but were mapped and assessed by TAI in 2003. They were not visited by ECT in 2016 because they are located southeast of the 0.5-drawdown contour. They are included in this report to document their potential connection to the GW source aquifer.

Wetland FF is approximately 60% POW with a PEM fringe consisting primarily of purple loosestrife. Wetland OO consists of a narrow vegetated PEM fringe adjacent to a small impoundment (POW). The pond is equipped with an outlet structure associated with the mill building on the south side. The pond receives surface flow from the north. Emergent vegetation growing in the PEM was dominated by broad-leaved cattail, sedges, and purple loosestrife. Chara species (a filamentous algae growing on substrates) dominated the POW area.

The water level of Wetland FF appears to be the same as Decker Pond, which is believed to be an expression of the regional GW table. Wetland FF is basically a shallow extension of Decker Pond. Wetland OO is connected to a pond formed by a dam. While the waterbody is an artificial impoundment, it is created by damming a small creek that is likely fed by the regional GW source aquifer based on GS elevations relative to the regional GW table.

Although Wetlands FF and OO may be connected to the regional GW source aquifer, they are located more than 1,000 feet south of the 0.5-foot drawdown contour.

Therefore, those wetlands will not be affected by the GW table drawdown associated with an increase in pumping rate.

4.0 THREATENED & ENDANGERED SPECIES REVIEW

4.1 Database Query Results

ECT conducted a query of the Michigan Natural Features Inventory (MNFI database within a 1.5-mile radius of the 0.5-foot drawdown contour modeled by SSPA. (the standard distance recommended by MNFI for T&E species review). Because T&E species occurrences are often under reported in rural areas where surveys are seldom performed, ECT also elected to conduct a county-wide MNFI database query to incorporate more T&E species that could potentially inhabit the project area. The United States Fish and Wildlife Service (USFWS) Osceola County federal T&E species list was also consulted. ECT identified terrestrial T&E species obtained from the above queries with the potential of inhabiting wetlands assessed by ECT based on species-specific habitat requirements or had the potential to be indirectly affected by wetland effects. Three T&E species were identified: Vasey's rush (*Juncus vaseyi*, a state threatened plant); short-eared owl (*Asio flammeus*, a state endangered bird); and northern long-eared bat (*Myotis septentrionalis*, NLEB, a federal threatened mammal). Brief species-specific habitat requirements for those three species are provided below.

4.1.1 Vasey's Rush

Vasey's rush is a perennial plant of moist sandy and muck-over-sand soils that typically occurs in intermittent wetlands, northern wet meadow, wet and wet-mesic prairies, moist sandy barrens, and open marshy areas (MNFI 2007).

4.1.2 Short-eared Owl

Short-eared owl has very few breeding records in Michigan and is not known to overwinter in Osceola County. It utilizes large expanses (75 to 250-acre minimum) of open grassland, wet meadow, or emergent marsh for breeding and a variety of habitats with open and low vegetation to hunt for small mammals (MNFI 2007).

4.1.3 Northern Long-eared Bat

NLEB hibernates in caves and mines during winter months, swarming in surrounding wooded areas in autumn. Suitable summer habitat for NLEB consists of a wide variety of forested/wooded habitats where they are able to roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats, such as emergent wetlands, edges of agricultural fields, old fields, and pastures. NLEB roosts singly or in colonies under loose bark or crevices in live trees and snags (dead standing trees) as small as three inches diameter at breast height (dbh) in late spring and summer (USFWS 2015, 2016).

4.2 Assessment of Potential Effects on T&E Species

4.2.1 Vasey's Rush

Most of the wetlands evaluated did not contain suitable habitat for Vasey's rush, either due to the effect of trees and shrubs providing too much shade, the overall water regime not being favorable (i.e. the wetlands being too consistently saturated or inundated), or a combination of both conditions. Wetlands A, H, I J, L, and R contain potential habitat for the rush based on plant associations and hydrology, but only Wetlands A, H, and R have evidence of a connection to the regional GW aquifer.

Wetlands A, H, and R have PEM components which may provide suitable habitat for Vasey's rush. Because this species can tolerate fluctuating water levels, the projected GW table drawdown between 0.5 and 1-foot is not likely to affect Vasey's rush if it were present in the PEM portion of those wetlands. Because the portion of Wetland A crossed by the 0.5-foot drawdown contour is PFO that does not contain suitable habitat for Vasey's rush, the rush would not be present, or affected if it was present in PEM portions of Wetland A. Decreased soil saturation at the surface could affect the species if present in Wetlands H and R and if an increase in shrubs and trees occurred. Vasey's rush was not observed in Wetland H or R by TAI in 2003, nor during annual qualitative monitoring conducted by ECT between 2011 and 2015. Considering this and the fact that the wet meadow portions of Wetland R were formerly forested and have recently opened up due to emerald ash borer infestation and beaver damming activities, historically rendering much of the wetland too shady for the rush, the likelihood of Vasey's rush currently being present and affected by the proposed increase in GW pumping is very low for Wetlands H and R.

4.2.2 Short-eared Owl

No suitable short-eared owl habitat was found in any of the evaluated wetlands. Most of the wetlands and any open PEM components evaluated are too small to support hunting or nesting by this species. Many wetlands are also forested or immediately surrounded by forest rendering them unsuitable owl breeding habitat. Wetland R is the only wetland that is large enough to potentially support the owl; however, the potentially suitable wet meadow habitat within Wetland R contains a high density of snags, rendering it unsuitable for use by the owl. Snags inhibit the owl's flight; the species prefers completely open grassland and wet meadow habitats. Therefore, no potential effects are anticipated for this species from the proposed increase in GW pumping.

4.2.3 Northern Long-eared Bat

All of the 16 evaluated wetlands contained either a forested portion or trees immediately along the periphery of the wetland. Suitable habitat includes live trees and snags with crevices and/or exfoliating bark. Based on ECT's field observations, suitable summer roosting habitat for NLEB is present in or directly adjacent to all 16 wetlands. The projected GW table drawdown of 0.5 to 1-foot within those wetlands believed to be connected to the regional GW source aquifer is likely to positively affect this federal threatened species via increased establishment of tree species. The result of the modeled regional GW table drawdown is unlikely to cause significant tree mortality, though wetlands with potential soil subsidence could have increased incidence of windthrow. Windthrow would remove trees and snags from the canopy stratum, therefore decreasing potential NLEB habitat. However, the potential increase in tree seedling establishment would eventually provide additional roosting habitat for NLEB over time.

5.0 CONCLUSIONS

Most wetlands located within the vicinity of NWNA's production well are perched wetlands that are underlain by a confining soil layer, are vertically separated from the GW source aquifer by an unsaturated zone, and receive water from direct precipitation, surface runoff, and shallow ground water flowing over the confining soil layer. Perched wetlands do not receive water from the GW source aquifer. Wetlands A, G, H, R, CC, PP, FF, and OO located within the vicinity of NWNA's White Pine production well are likely connected to the GW source aquifer from which NWNA is pumping. Those wetlands do receive water from the GW source aquifer for at least part of their annual water budget.

Wetlands PP, FF, and OO are located outside and southeast of the estimated 0.5-foot aquifer drawdown contour modeled by SSPA. Hence, measurable effects on the hydrology and functional ecology of those wetlands are not expected. Drawdown of the regional GW table ranging from 0.5 to 1.5 feet in the vicinity of wetlands A, G, H, R, and CC may have a measurable effect on surface inundation or soil saturation (i.e., wetland hydrology). Due to the geological and hydrological conditions, drawdown of the regional GW table will likely only result in decreased duration of inundation and soil saturation at the surface rather than a compete loss of wetland hydrology. Some soil subsidence may occur due to aerobic decomposition near the soil surface, but may also compensate for the slightly lower water elevation. Woody shrubs and trees may increase in some of the wetlands due to seed germination on the unsaturated soil surface. A plant community shift may occur in Wetland H. However, none of these potential wetland effects will measurably affect the functional ecology of the wetlands connected to the GW source aquifer.

6.0 LITERATURE CITED

Cowardin LM, Carter V, Golet FC, LaRoe ET. 1979. *Classification of Wetlands and Deepwater Habitats in the United States*. U.S. Department of Interior, Fish and Wildlife Service, Office of Biological Services, Washington, DC.

ECT. 2011-2015. White Pine Springs Qualitative Wetland Monitoring: field notes and collected data.

Lichvar RW, Butterwick M, Melvin NC, Kirchner WN. 2014. *The National Wetland Plant List*: 2014 Update of Wetland Ratings. Phytoneuron 2014-41: 1-42.

MNFI. 2007. Rare Species Explorer (Web Application). Available online at http://mnfi.anr.msu.edu/explorer [Accessed Apr 19, 2016].

Reznicek AA, Voss EG, Walters BS. 2011. *Michigan Flora Online* (Web Application). University of Michigan. Available online at http://michiganflora.net [Accessed Apr 19, 2016].

SSPA. 2016. *Evaluation of Groundwater and Surface Water Conditions in the Vicinity of Well PW-101*. March 2016.

TAI. 2004. *Draft Wetland Assessment White-Cedar-Osceola Project*. February 6, 2004.

USACE. Environmental Laboratory. 1987. *Corps of Engineers Wetlands Delineation Manual – Technical Report Y-87-1*. United States Army Engineers Waterways Experiment Station, Vicksburg, MS.

USACE. 2011. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual*: *Northcentral and Northeast Region (Version 2.0*), ERDC/EL TR-12-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

USACE. 2014. National Wetland Plant List, version 3.2 (Web Application). Available online at http://wetland_plants.usace.army.mil/ [Accessed Apr 19, 2016].

USDA, NRCS. 2010. *Field Indicators of Hydric Soils in the United States, Version 7.0.* Vasilas LM, Hurt GW, Noble CV (eds.). USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils.

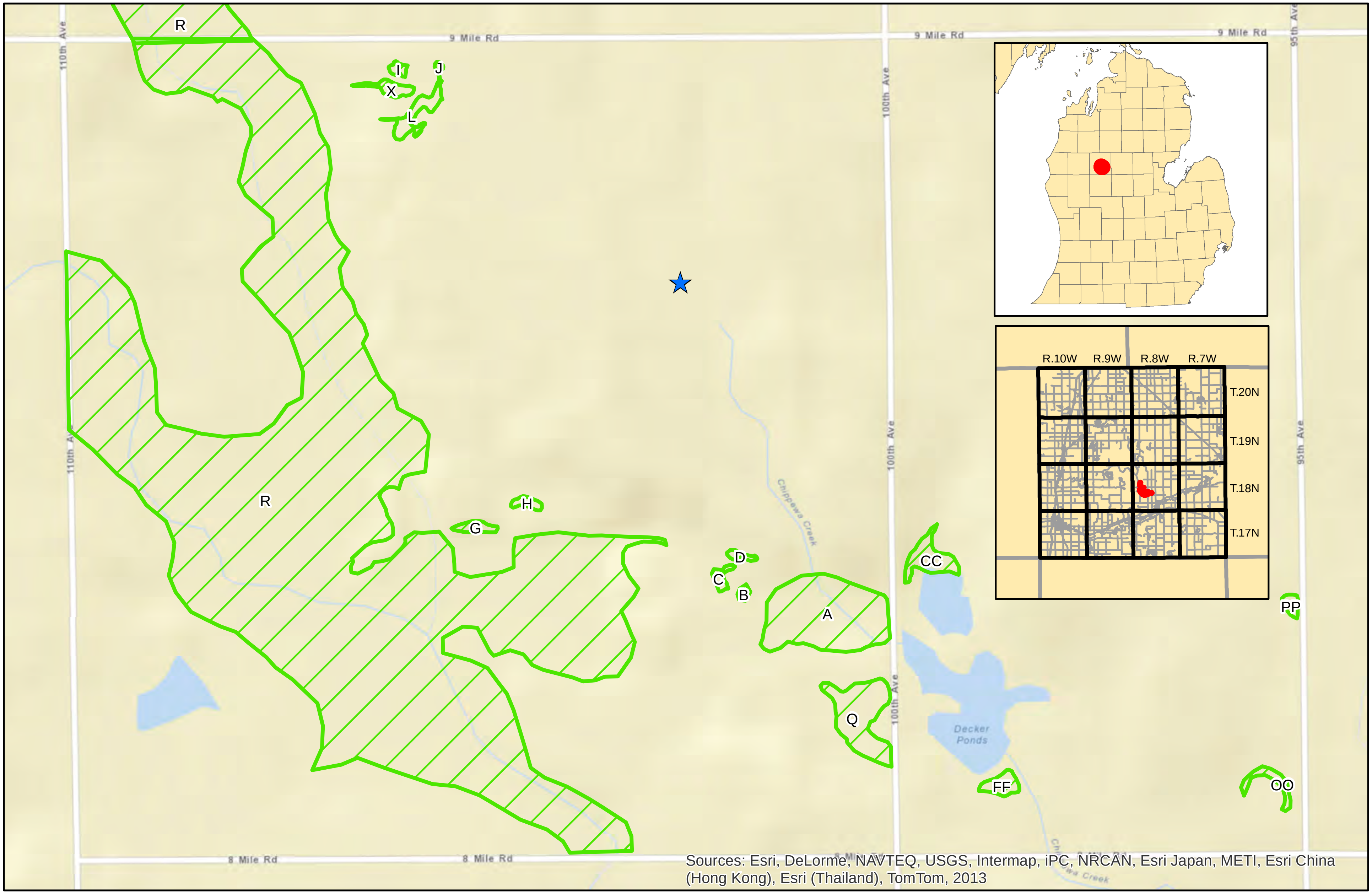
USFWS. 2016. Northern Long-Eared Bat (*Myotis septentrionalis*) Status: Threatened with 4(d) Rule. Available online at http://www.fws.gov/Midwest/endangered/mammals/nleb/index.html [Accessed Apr 19, 2016].

USFWS. 2015. Northern Long-Eared Bat (*Myotis septentrionalis*). Available online at http://www.fws.gov/Midwest/endangered/mammals/nleb/nlebFactSheet.html [Accessed Apr 19, 2016].

USGS. 2013. National Elevation Dataset. n44w086 1/3 arc-second 2013 1 x 1 degree ArcGrid. [Accessed Apr 1, 2016].

USGS. 2013. National Elevation Dataset. n45w086 1/3 arc-second 2013 1 x 1 degree ArcGrid. [Accessed Apr 1, 2016].

7.0 APPENDIX A: SITE MAPPING



N W E S

★ Production Well (PW-101)

Wetland

0 500 1,000 1,500 Feet

ECT

Figure 1. Site Location

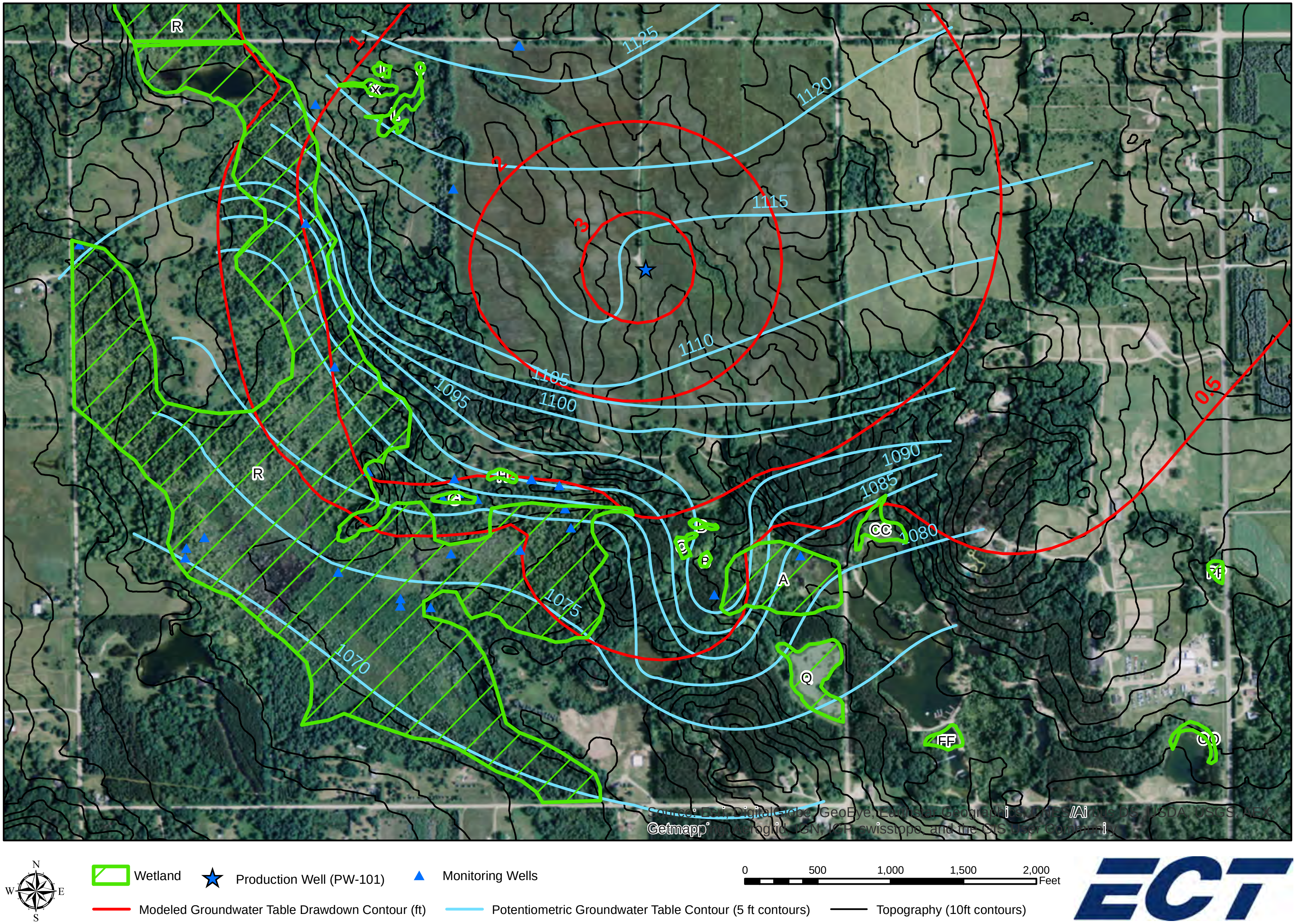


Figure 2. Site Properties

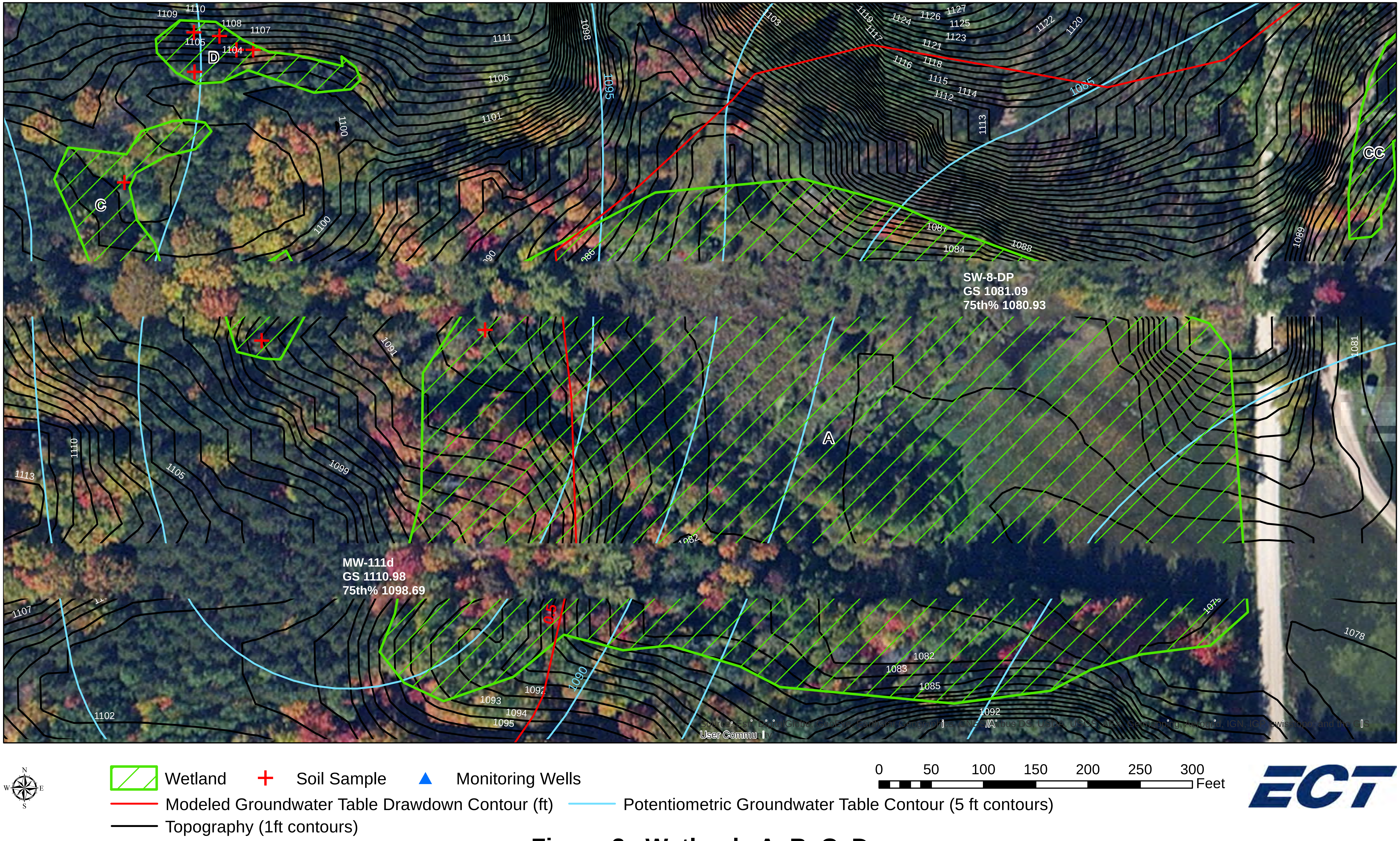


Figure 3. Wetlands A, B, C, D

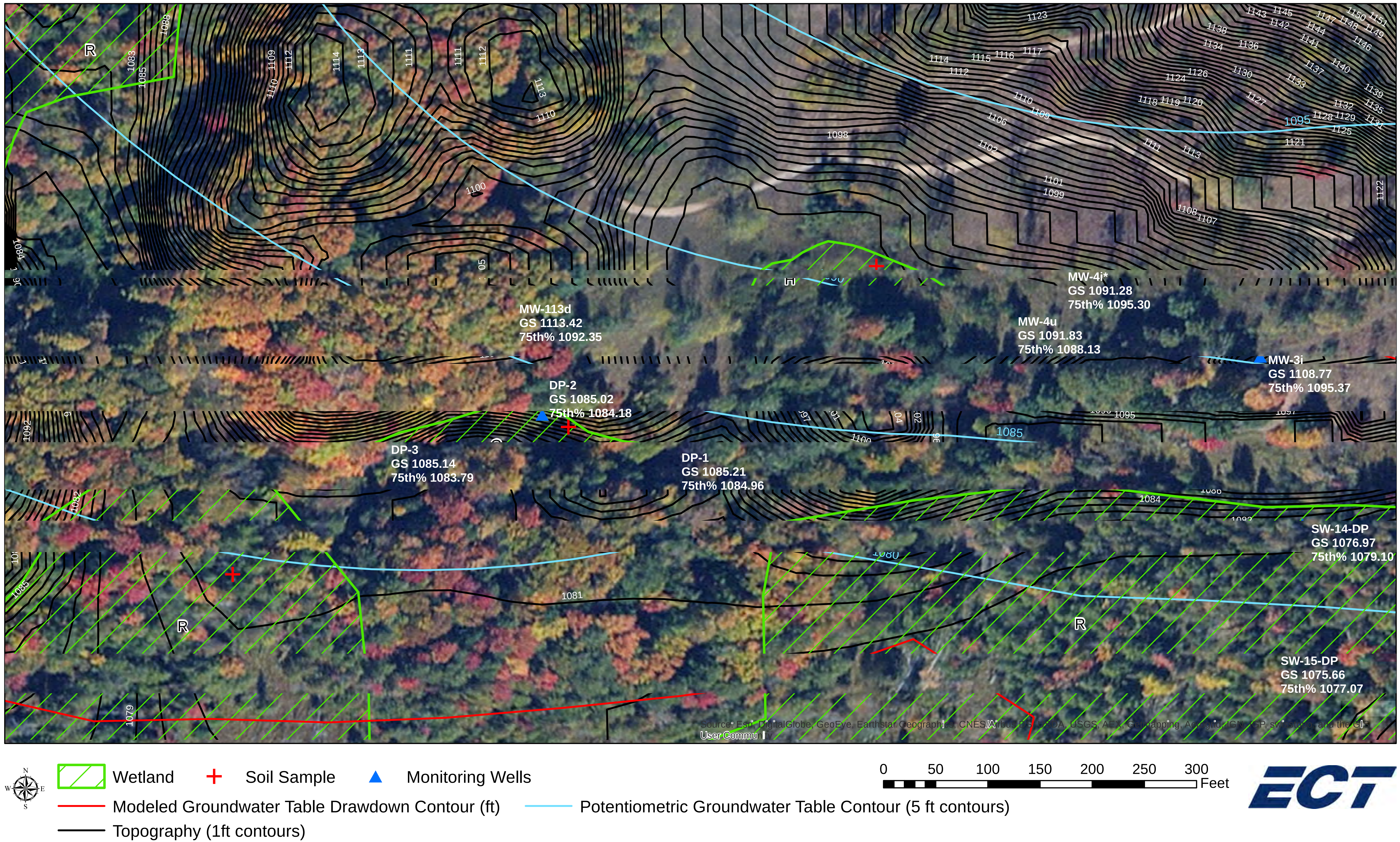


Figure 4. Wetlands G, H, R

Figure 5. Wetlands I, J, L, X

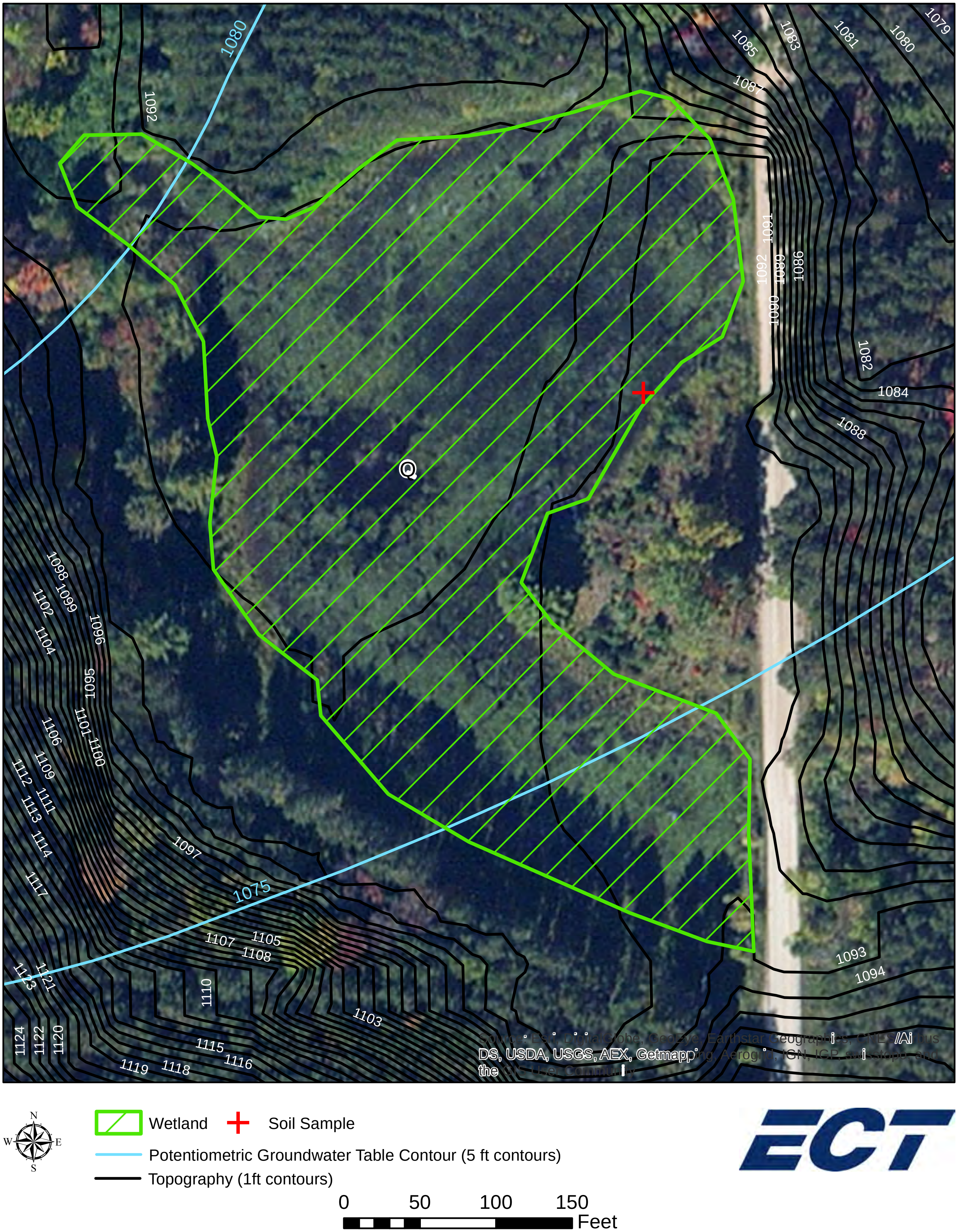


Figure 6. Wetland Q

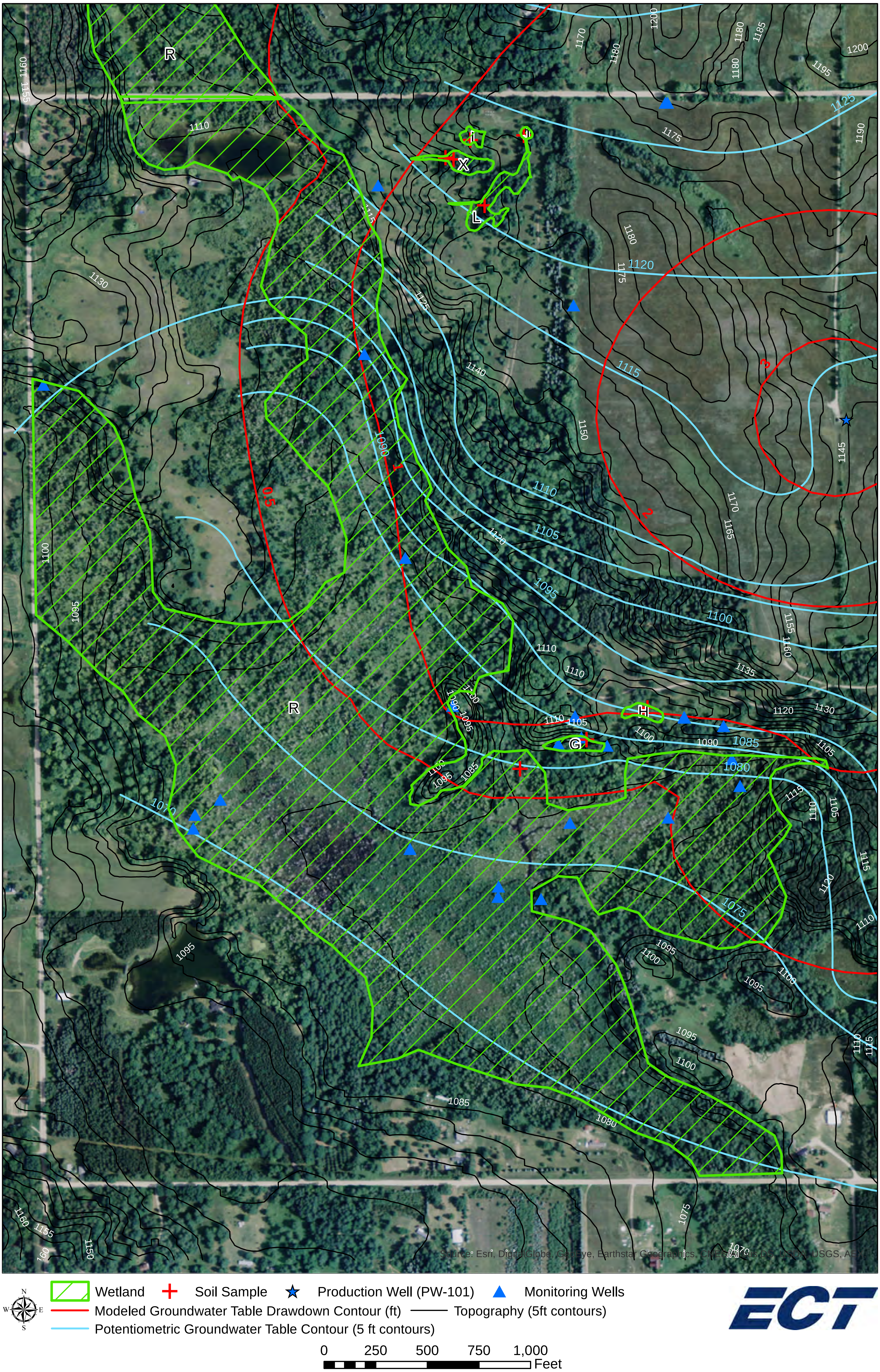
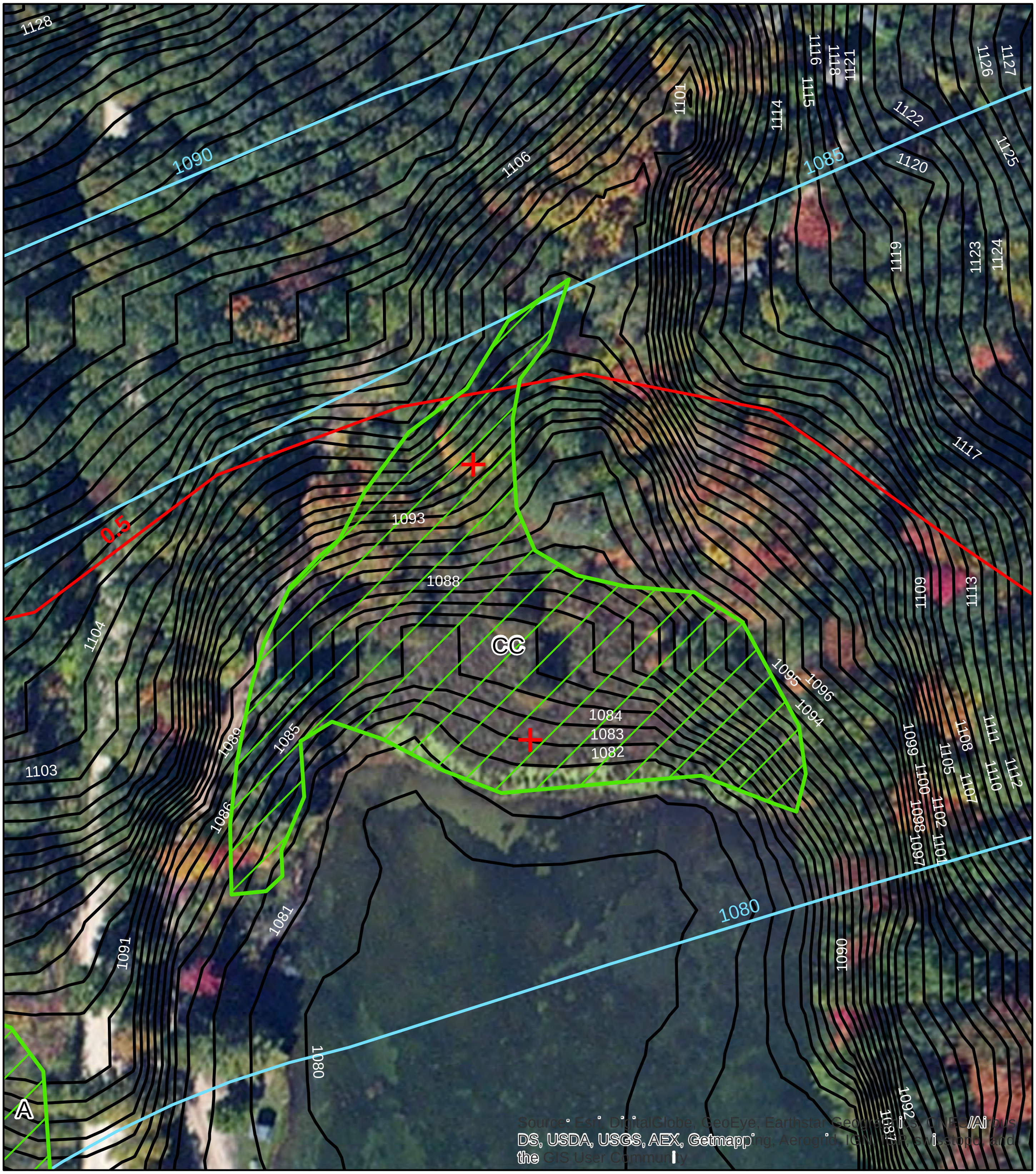


Figure 7. Wetland R



Wetland
Soil Sample
Monitoring Wells
Modeled Groundwater Table Drawdown Contour (ft)
Potentiometric Groundwater Table Contour (5 ft contours)
Topography (1ft contours)

N S W E

0 50 100 150 Feet

ECT

Figure 8. Wetland CC

Wetland
Soil Sample
Topography (1ft contours)

0 50 100 150 Feet

ECT

Figure 9. Wetland PP

8.0 APPENDIX B: SITE PHOTOGRAPHS

1. Wetland A east side looking south

2. Wetland A west side looking east

3. Wetland B looking northwest

4. Wetland C looking north-northwest

5. Wetland D looking east

6. Wetland G looking east

7. Wetland H looking west

8. Wetland I looking north

9. Wetland J looking east

10. Wetland L seep looking east

11. Wetland L open water looking south

12. Wetland Q looking southwest

13. Wetland R near SW-6-DP looking south

14. Wetland R looking west

15. Wetland R north arm looking north

16. Wetland R north arm rivulet looking north

17. Wetland R north arm looking south from SW-1-DP

18. Wetland R impoundment at north end looking west

19: Wetland R impoundment culvert outfall to the south

20: Wetland X looking east

21. Wetland X seep

22. Wetland CC looking east

23. Wetland CC looking south

24. Wetland PP looking west