GREEN TIMBER

FOREST STEWARDSHIP PLAN

LANDOWNER:	City of Negaunee
Address:	319 W Case Street Negaunee, MI 49866
Phone:	(906) 475-7700
Signature:	

Property Locations

Lands included within this plan can be found on the maps included in the appendix, and from the geodatabase that is maintained by the landowner's consulting forester.

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PREPARED BY **Karl Ploeckelman**

Signature of Plan Writer: July 1st 2022

DNR APPROVAL

Printed Name:

Signature:

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EXECUTIVE SUMMARY

This forest management plan has been created to help current and future City of Negaunee officials in making management decisions around a select set of mainly forested parcels. The primary goal on these properties is to maintain them as natural, forested areas, and to sustainably harvest timber products from the parcels over time. Secondary goals include potential for city development, and potential for recreational use. The preparation of this plan and the associated maps provides a visual of what the sites and forest cover are as a snapshot in time, providing city officials and planners with a baseline to start from. The forest management recommendations that are described further in this summary and plan are created with the above listed goals and objectives in mind. The following paragraphs within this Executive Summary provide a summary of specific findings, details, and recommendations for individual properties. Individual properties can be located and identified by name and location from the Locator Map which is provided at the end of this summary, as well as in the Appendix with the rest of the individual parcel maps.

Business M35 Property

The Business M35 property is found south and southwest of the city's downtown area. The vast majority of the accessible and harvestable areas of this property were treated with a clearcut around 2010. The main areas that were left unharvested were well fenced in areas that are associated with what past maps identify as the South Jackson Mine and Lucy Mine. It is understood that these sites are fenced in mainly as a safety concern to prevent injury or death from caving and unpredictable ground and soil conditions. There may be a variety of other reasons that these areas are fenced off as well, some potentially being legal requirements following the closing of a mine. The exact condition of these areas today is unknown and it is beyond the extent of this forestry plan to investigate such details. Additionally, past mines may have cultural or historical significance, and disturbance of the site could damage remnants or artifacts that may be within the site. For the purposes of this plan, areas fenced off or containing evidence of past mining management will be considered unsafe for equipment operation until further evaluation and site delineation can be made. Even if safe equipment operation can be performed, it is recommended that the sites be evaluated by a qualified archeologist prior to any further disturbance.

In addition to the mining sites that were left unharvested, there are approximately eight acres of cedar dominated woodland on the west side of this parcel that were also left unharvested during the approximate 2010 operation. This cedar dominated area contains approximately 50 percent wetland and 50 percent upland soils. Bike trails and cross-country ski trails currently travel through this western cedar portion of the property. The overall low timber quality and wet soils of this cedar dominated area make it difficult to offer any financially positive timber harvesting options. Instead, it is recommended that this cedar area is maintained for the positive wildlife and aesthetic qualities it offers.

In summary, it is recommended that the Business M35 property waits for a minimum of another 30 years for the 2010 harvest areas to regrow before further harvesting opportunities are explored.

Tracy Mine Road Property

The Tracy Mine Road property is the largest parcel included in this forest management plan, and is found directly east from the Business M35 property. This parcel includes much of the land surrounding the actual Tracy Mine buildings, including some ponds and residential areas off of New Buffalo and Buffalo roads.

This parcel contains a large array of manmade features, most of which are likely related to past and historical mining operations. These include but are not limited to ponds, ditches, mine tailing pines, underground shafts, and above ground pits. Many of these features will represent equipment operation limitations during any forest management activities. Similar to the Business M35 property, there are fences on this parcel made to restrict access into unsafe or sensitive sites, but the fences are commonly in worse shape and hard to follow. The exact extent of past mining operations are very difficult to identify, and seem to cover the vast majority of the land lying north and west of the Tracy Mine buildings.

There are a number of differing forest types found on the Tracy Mine Road Property. North and west of the Tracy Mine buildings have experienced heavy disturbance in the recent past, resulting in much of this ground being dominated by primary successional species such as aspen. Pine and black cherry can also be found in these areas, along with occasional clumps of maple dominated forest where disturbance was less severe. Mixed in with the aspen dominated forested areas are areas of upland brush, where forest development is in-between the stages of a cleared grassy field and a stocked mature forest. Invasive species such as buckthorn, honeysuckle, and garlic mustard were identified in these aspen and brush dominated areas west of the mine buildings.

Directly east of the Tracy Mine buildings are a series of holding ponds. It is unclear if these were past open pit mine operations, or holding ponds for the water and byproducts produced through mining and mineral extraction procedures. Regardless, the ponds represent a non-forested area that is not eligible for any forest management, and may restrict access into certain forested areas. Continuing east from the ponds is a series of roads, railroads, powerline right-of-way's (ROW) and a residential area. There are scattered little segments of natural forestland within these infrastructure features, but much of it is poorly stocked, wet, and relatively inaccessible with equipment. This makes any sort of forest management difficult for a variety of operation and public relation reasons. Lastly, there is an area of forestland at the far eastern and southeastern portion of this property that is dominated by aspen, maple, and oak.

In summary, there is enough standing timber within this property that future timber harvesting could be explored. The far eastern and south eastern areas could be harvested with little concern regarding past mining features, although that doesn't mean that old mine shafts or other mining features don't exist in the area. Access into the southeastern timberland will likely require permission from neighboring properties to the south when ready for harvest. The western part of this parcel contains enough timber to potentially offer timber harvesting opportunities, but the extent of allowable equipment operation is not currently clear. It is recommended that the site be evaluated by a qualified archeologist or similar professional first to determine if any of the mining features have historical significance and require protection from further disturbance. It is also recommended that the city first identify and repair necessary fences to better delineate which areas can be managed, and which areas should not be managed for safety and historical disturbance concerns.

Miller Road 40 Property

The Miller Road 40 property can be found just southeast of the Tracy Mine Road property on Miller Road. This parcel was clearcut around 1990, along with a large portion of the surrounding acreage at that time, including some of the southeastern extent of the Tracy Mine Road property. Now this parcel is dominated by aspen and mixed hardwood poletimber. The aspen on the property will just be reaching its earliest harvest opportunity around 2030, and will be reaching economic maturity in around 2035-2045. It is recommended that this property is scheduled for a modified clearcut around 2040 in order to utilize the mature aspen resource, and regenerate the next crop.

This property is about 50 percent upland dry soils, and 50 percent lowland wetter soils. The lowland soils will require winter harvesting in order to sustainably operate equipment on the site and avoid excessive soil rutting and compaction. Buckthorn was spotted on this property, largely found growing in the wetter, lowland areas on the parcel.

Compost Dump Property

This property is found north of County Road 480, and is accessed via Dump Road. As the name implies, there is a cleared area on this property that was used as an old dump, and is now actively being used as a compost dump area for city residents. This parcel was recently harvested within the last two to three years using a selection treatment harvest. The area directly east of the dump site is lower on the landscape and contains saturated soil conditions. This area was harvested more aggressively than the rest of the site, and all the aspen was removed. This harvest technique was likely implemented due to the low timber potential and maturing of the shorter-lived species in that location. The result is a poorly stocked residual overstory with aspen and other hardwoods regenerating in the understory. The rest of the parcel (south of the dump site) is dominated by more upland soils and maple trees with better timber quality potential. This area was treated with a standard individual tree selection, where maturing and low-quality trees were removed to prioritize future growth on younger individual stems with better timber quality potential. This area south of the dump site will likely be ready for its next selection harvest in about 20 years, which will be at the end of the life of this plan.

Carp River Forge Property

This property is located just west of the Negaunee Cemetery, and just south of the Michigan Iron Industry Museum. The main forested area of this parcel is located on top of a bedrock ridge, making it very difficult to access and operate on with forest management equipment. Additionally, there is no current access to the forested area for management purposes. Establishing access from any direction would ultimately cost much more than any timber extraction revenue could produce.

In leu of any active management, it is recommended that this parcel is left as is from a timber management standpoint. The parcel does however offer a number of recreational features and opportunities. If legal foot access can be gained and constructed up onto the ridge, this parcel could offer hiking trails with scenic overlooks of the surrounding area. Additionally, hiking trails or foot paths already extend down to the Carp River in a few spots off of Forge Road, and from the Iron Museum, which can offer fishing and other river recreation opportunities.

North Road Property

This property is located off the west side of North Baldwin Ave, just northeast of Teal Lake. This property is covered by two forest types, one being upland maple dominated hardwoods, and the other being lowland cedar. Both stands are fully stocked and could be harvested at any time, where the cedar stand would be clearcut and the hardwood stand would be selectively thinned. That said, the acreage and timber value potential are both low across this parcel, which may make harvesting impractical from a potential cost/revenue standpoint. The cedar stand will require winter conditions to be responsibly harvested within in order to protect the sensitive soils from rutting and compaction. The upland hardwoods contain some slope and bedrock outcrops that will have to be strategically operated around. There is no current developed access into the parcel

The wet lowland soils are the only ones bordering Baldwin Road, making equipment access into the property for management all that much more of a challenge. If timber harvesting were to be pursued on this property, accessed would have to be developed, which would likely lead to increased costs on an already slim profit margin potential. Access could be gained by either gaining permission from the landowner to the south or by developing a landing right off of North Baldwin Road, but the latter option would require filling in and altering the wetland cedar habitat. If a landing was created right off of North Baldwin Road, this site could then be used as a parking area in the future, allowing the parcel to be more easily developed and used for public recreation in the future.

SECTION I: INTRODUCTION

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INTRODUCTION

This forest management plan has been prepared for the landowner, the City of Negaunee, in order to describe the current conditions of the forest and related natural resources on their property and to prescribe management activities for a period of 20 years, commencing at the date listed on the front cover of this plan.

After 20 years this plan will be considered expired and the property should again be visited by a forester in order to assess the conditions of the forest and to make recommendations for future management based on the conditions observed at that time. When the assessment of forest conditions occurs, this forest management plan should also undergo an update or complete revision; this decision should be made by the landowner with the advice of their forester. The property should undergo a brief inspection by a forester in approximately 10 years to determine if any significant changes have occurred on the property that may impact the recommendations set forth in this plan. This plan will describe:

- Goals and objectives of the landowner.
- All features and conditions observed on the land with a focus on those that relate to forest management.
- Recommended management options to fit the landowner's goals while managing the land sustainably and in accordance with current science.

Terminology that is commonly used in forest management plans, but may be unfamiliar to the reader is defined in the Glossary in Section IV.

LANDOWNER GOALS AND OBJECTIVES

The landowner has identified these properties described in this plan for the purposes of a series of similar goals. First and foremost, the landowner is interested in exploring timber harvest opportunities for revenue purposes and to maintain the health and productivity of the forest. Additionally, the landowner is interested in future opportunities on these parcels for development or recreation. The landowner intends to largely keep these properties natural and forested, with the exception of vital infrastructure that is needed to accomplish the previously listed goals. This plan has been written to meet the requirements of most forestry programs should there ever be interest in enrolling in any, including but not limited to the American Tree Farm System (ATFS) and Tree City USA. The landowner will meet the requirements of any enrolled programs by following the recommendations provided in this plan, and ultimately by harvesting timber and managing the sites using sustainable forest management practices aimed at improving timber quality and productivity, forest health, and wildlife habitat.

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SECTION II: LAND FEATURES AND DESCRIPTIONS

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GENERAL PROPERTY DESCRIPTION

LOCATION

These forested properties can be found scattered around the city limits. Varying levels of existing boundary evidence has been observed during the field inspections of these parcels. Common boundary evidence that was noted included paint and flagging of various colors designating estimated property lines. This evidence likely remains from previous harvests or management activities; foresters often use existing evidence to determine timber harvest boundaries. Any property line or corner evidence should only be considered as approximate unless it is known to have been placed by a licensed professional surveyor.

The parcel maps included in the Appendix of this plan provide a visual representation of the distribution of properties across the landscape. The parcel maps are generated from a geodatabase, which should be consistently maintained and updated by the landowner's consulting forester. Parcel maps are broken down by individual parcel, as they are described in the Executive Summary section of this plan, with three maps per parcel. Of the three maps per parcel there is one that displays the forest cover types, one that shows the recommended management years, and one that shows the recommended harvest treatment in each area. Additionally, an overview map of the recommended management years is provided to more easily view where general harvest recommendations are over time. Each parcel map also provides the cover type and density codes, as well as the acreage associated with each delineated stand. The cover type and density codes are further explained and described in the "Green Timber Consulting Foresters Timber Type-Size-Density Guide" provided in the Appendix of this plan.

LAND HISTORY AND PAST LAND USE

Humans have utilized this land and its resources for many years. There is little debate that early humans interacted with, and in many cases, modified vegetation however there is much speculation regarding the extent of human influence on the land prior to European settlement in this region. Foresters, climate scientists and others have utilized information gathered during initial government land surveys to develop a "snapshot" landscape scale maps of prevailing forest cover across Michigan at the time the surveys were completed in the late 1800's.

Following European settlement, the forests of Upper Michigan were logged in three phases during the late 19th and early 20th centuries. The first phase consisted of a focused effort to only harvest the highly sought-after white pines because lumber from these trees was in high demand at the time. When the seemingly endless supply of pines dwindled, many people left Upper Michigan for the western and southern forests. Those who stayed found opportunities in the hemlock and hardwood forests that remained, transitioning to production of hardwood lumber, railroad ties, mine timbers, charcoal for the manufacturing of iron, and chemical wood for industrial processes. This second phase of logging had the biggest impact on most of the landscape because it cleared the forests that remained after the pines were "cherry picked" out. These new uses created markets for species that were once considered useless, in addition to utilizing a higher percentage of the volume in each tree when compared with the past pine logging.

In many parts of the Upper Peninsula wildfires broke out, burning the large amounts of slash and debris that remained following the first two phases of logging. As the fires subsided, the forests began to naturally regenerate with a diverse mixture of tree species. The tree species composition and quality of the forests that regenerated were largely determined by the available seed source and soil conditions. Aspen was one of the most common species in this regenerating forest and once again, markets and utilization adapted to the change in forest composition, leading to today's highly mechanized pulp and paper industry, new products like fiberboard, and the advent of selective cutting.

More detailed information about historical forest succession and early human impacts on the forests of Upper Michigan can be found at https://www.nrs.fs.fed.us/gla/reports/history.PDF.

Many of the parcels included in this plan have continued to be managed for the natural resources they have to offer, whether that be for timber, minerals, or recreation. Moving forward under this ownership, parcels included in this forest management plan will be used mainly for timber production, but also offer many opportunities for recreation including hunting, fishing, and many more.

SPECIAL SITES

Based on a Michigan Natural Features Inventory (MNFI) review and a request of the State Historical Preservation Office (SHPO), there are a number of different potential historic sites that may be located on or in the surrounding areas around properties described within this forest management plan. Due to the sensitive nature of historical sites and potential for public degradation, much of the specific information known about these sites is not publicly available. Additionally, many of these sites have been roughly identified, but have not undergone study to verify, delineate, or evaluate its potential significance. Details, including the reported potential site boundaries, can only be disclosed to a qualified archaeologist.

The Michigan DNR Archaeologist with the State Historical Preservation Office has offered the following summary and recommendations:

- "...this area is sensitive for historic and prehistoric archaeological sites.
- Not all previously reported archaeological sites have been field-studied and their extent and potential significance have yet to be evaluated.
- The entirety of the area has not been previously archaeologically surveyed and additional sites may be present.
- One adjacent archaeological site to these properties is listed in the National Register of Historic Places and direct and indirect impacts to it and its associated landscape should be avoided.
- The complexity of the area warrants expertise beyond the general guidance you requested [for forest stewardship and management purposes]. I recommend contracting a qualified professional archaeologist for assistance in survey, site evaluation, and any appropriate site buffering from proposed work. Negaunee would benefit from having an inventory of sites that deserve preservation and stewardship, and this could also be important to community and Tribal relations. As a courtesy to those seeking expertise, the State Historic Preservation Office keeps a list of qualified archaeological consultants who work in Michigan: https://www.miplace.org/4a776e/globalassets/documents/shpo/programs-and-services/archaeology/archaeology-in-michigan/archaeologist-architectural-historian-and-historian-consultants-list.pdf.
- If current or future work in these areas is supported by federal aid, permit or license, it may be necessary to comply with Section 106 of the National Historic Preservation Act. Section 106 compliance could also trigger the need for archaeological survey."

If any evidence of these or other sites are ever located on the property, immediate steps should be taken to protect the site or sites. If a timber harvest or other activity is occurring, it should be temporarily halted until the State Historical Preservation Office (SHPO) can be contacted to determine the nature of the site. The SHPO can then provide recommendations on how to properly protect and, if necessary, document the site. If a landowner does not wish to notify the SHPO of such a site, it is still recommended that activity that may damage above-ground historical resources be avoided and that soil disturbance is minimized so that buried items are protected. Contact information for the SHPO is available online at https://www.miplace.org/historic-preservation/about-shpo/contact-shpo/.

CURRENT LAND CONDITIONS

SOILS

Soils and their orientation across the landscape can have a very significant impact on forest management on a piece of property. Obviously, the quality of a soil is one of the driving factors in timber quality and productivity but soil conditions can also impact the ability to harvest a given piece of land. Wetland soils generally can only be harvested in the winter when the soil is frozen and protected with a blanket of snow. Attempting to harvest on wetlands in the summer can damage soil productivity, leave large ruts and is often difficult from a production standpoint because machines may get stuck which costs operators time and money. Soil slope is another factor that directly impacts the ease at which a given piece of land can be harvested. It is important to be aware of the many soil properties on a property and how they impact forest management prior to trees being cut.

During timber harvest preparations, foresters will consider slope, rockiness, sandiness, depth to water table and some engineering properties of the soils to determine the best harvesting techniques to be applied. A soil that is poorly suited to harvesting equipment operation may be a good candidate for a winter harvest. The recommended season of harvest will be determined during these timber harvest preparations. If the recommended season is summer, the soil is usually an upland, well-drained site which can support timber harvesting equipment throughout the year. If the recommended season is winter, it is generally a wetland soil or a soil with a high-water table that is susceptible to rutting and other problems if it was harvested in the summer. Harvest preparation foresters will also identify other concerns that may be a problem during timber harvesting. One example of this is a severe rutting hazard. This can be addressed by using tracked machines, laying down tops on skid trails or restricting harvesting to the winter months. Another feature that may be identified as a concern is the presence of steep slopes. In some cases, the slopes are short and can be harvested by "reaching" trees from the top and bottom of the slope, but in other situations, areas may be inoperable due to hazards for operators and the potential for soil erosion. These areas and others should be addressed on a case-by-case basis during timber harvest preparations.

Due to the historical mining significance in this area, it comes as no surprise that many of the acres included in this forest management plan have had significant soil disturbance in the past. Past mining operations have led to an abundance of soil conditions that are not common within general forestry management practices, and therefore may require additional site inspection prior to future timber harvesting. Additional site inspection may be needed to evaluate site sensitivity, productivity, operability, safety, and more.

It is important to take precautions to prevent soil erosion, rutting and compaction. On this property, it is also important to take precautions to prevent disturbance and damage of potential sites with historical significance, and to maintain the safety of harvesting contractors. Activities that directly damage the soil can lead to losses in timber productivity over the long term. Soil rutting and washed-out roads are also visually unappealing and may negatively impact the desirability of the land to future owners. More information on the soil types found on this property may be obtained on the Natural Resources Conservation Service (NRCS) web site at: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

WATER & WETLANDS

Water quality is closely tied to soil conservation. Forest management can have direct negative impacts on streams, rivers and lakes if the proper precautions are not observed. It is recommended that owners of managed forest land follow all guidelines found in the Sustainable Soil and Water Quality Practices on Forest Land manual (BMP manual). The BMP manual is available online at: http://tinyurl.com/ya2yl88d. The BMP manual provides guidance on timber harvesting in wetlands and on slopes as well as specifications to build roads that are not easily eroded. One key recommendation in the BMP manual is to maintain a 100-foot-wide buffer along all streams, rivers and lakes. Within this buffer, trees can be harvested however the manual requires maintaining at least 70 percent canopy cover. The width of the buffer must also be increased in areas with steep slopes. Loggers should use care when working on their machines and when handling fuels and lubricants. Spills and leaks should be cleaned up promptly and in a manner that complies with the BMP manual. If a spill is due to a leaky hose or other component, that component should be repaired in a timely fashion. If pesticides are used for site preparation, release of a plantation, or any other purpose, they must be applied by a licensed pesticide applicator in a manner consistent with the pesticide label. Pesticide labels are mandated by federal law and provide guidance that ensures the safety of the applicator and the environment. Following these precautions will help to ensure that the negative impacts on water quality are kept to an absolute minimum.

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) oversees activities that directly impact water quality in Michigan. In forestry applications, EGLE reviews and issues permits to construct temporary and permanent crossings over streams and rivers. EGLE also handles permitting for roads constructed through wetlands if the road is to be used for non-forestry purposes. If a road is constructed through a wetland solely for forestry purposes (access, hauling, planting, silvicultural activities) it can be constructed without a permit however BMP guidelines still apply. If a road is to be used to access a camp or for other activities it must have a permit from EGLE.

WILDLIFE

There are a few passive things that can be done to benefit wildlife on this property. The first is ensuring that some large dead or hollow trees are retained on the property following a timber harvest. Retention of large cull trees, which are live trees with little to no economic value, as well as standing dead "snags" in a forest provides quality habitat for many species of wildlife. These "wildlife trees," or "den trees," are low in timber value but they still provide a range of benefits to wildlife. Raptors use these trees as nesting locations, or to perch in and hunt from. Animals such as porcupines, bats, and owls use cavities in these trees as dens. Insect larvae feed on decaying wood and many are eaten by woodpeckers. Those insects that reach maturity are a source of food for songbirds, bats, reptiles, and amphibians.

Once the trees die and fall over, other animals use the down logs, known as coarse woody debris, for various purposes. Raccoons, foxes and numerous small mammals use down logs as dens. Grouse may use the logs as drumming logs during their mating season. Coarse woody debris retains moisture and provides a crucial refuge for salamanders and other amphibians during hot summer days. When coarse woody debris has decayed to a point where it is no longer usable by most wildlife, it becomes a part of the soil. Snags and coarse woody debris can also harbor disease and insects that may grow to a large enough population to detrimentally affect the live trees on the property, however during the field inspection, no serious concerns were noted.

Proper forest management must consider the balance of providing enough snags and coarse woody debris to retain the value of the property for wildlife without posing a threat to the health of the forest. The wildlife trees retained on the property should be carefully selected to ensure that they are not harboring any serious diseases or pests that may negatively impact the overall health of the forest. Generally speaking, larger wildlife trees are more beneficial because they take longer to decay and have the capacity to support larger wildlife.

An additional step to potentially benefit wildlife in the short term is by taking care when walking in the woods during the spring months. Many species of birds construct nests on the ground or in low-growing shrubs and these nests could be easily damaged by a footstep or other traffic. Also, the survival strategy of a newborn fawn is to remain absolutely still when it is in danger, so it could be possible to injure a fawn if one does not walk with care.

Fields and other openings in the forest create edge habitat. Edge habitat occurs at the transition between two distinctly different cover types, most often the transition between forests and clearings. In addition to the herbaceous plants which provide a source of forage for many species, the trees growing along the edge of the forest form very dense crowns that extend low on the tree trunk. These dense, extensive crowns provide extra nesting habitat and produce high quantities of seed. Birds of prey including bald eagles and hawks also take advantage of these open areas for the easy hunting such areas provide.

The following tables provide a sampling of some of the wildlife that may be observed on and near the property.

The various forest types are used by migrating and non-migrating birds such as:		
Black-capped Chickadee	Kingfishers	Warblers
Blue Jay	Nuthatches	Wild Turkeys
Flickers	Ruffed Grouse	Woodcock
Finches	Sparrows	Woodpeckers
Grosbeaks	Thrushes	Wrens

The northern white cedar, mature pine and mature hardwoods found on the property and in the area offer ideal perching, hunting and nesting opportunities for owls and other raptors such as:		
Bald Eagle	Great Horned Owl	Red-Tailed Hawk
Barred Owl	Northern Goshawk	Rough-Legged Hawk
Broad-Winged Hawk	Red Shouldered Hawk	Saw-Whet Owl

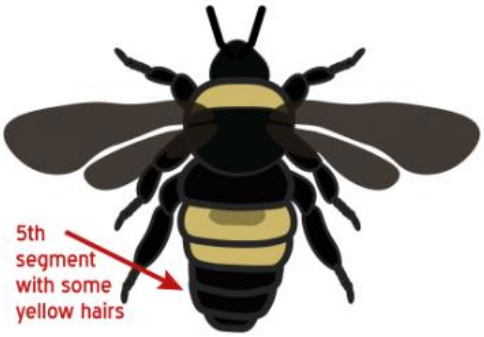
The wetlands and streams found on and near the property offer good habitat for wildlife species that require large amounts of lowland brush and water to survive. Some of the animals that may be found in these areas of the property are:		
Beaver	Frogs	Otter
Bitterns	Herons	Turtles
Fish	Muskrat	Various Waterfowl

There are many terrestrial animals that exist on the property. The vegetation provides a variety of food sources and rotten, hollow trees offer den opportunities. Some examples of the animals that benefit from the habitat of this property and the surrounding area are:		
Black Bear	Mink	Salamander
Bobcat	Pine Marten	Snakes
Chipmunks	Porcupine	Toads
Coyote	Rabbit	Weasel
Fisher	Raccoon	White-tailed Deer
Fox	Red Squirrel	Wolf

RARE, ENDANGERED, & THREATENED SPECIES

During the property inspection, no threatened or endangered plant or animal species were noted. A search of the Michigan Natural Features Inventory (MNFI) indicates that at least seven endangered, threatened, or species of special concern have been known to may make use of this property. This species list includes: Douglas' hawthorn, male fern, northern gooseberry, purple clematis, yellow banded bumblebee, northern long eared bat, and the little brown bat. Additionally, areas of these properties have been identified to have multiple bat hibernacula sites, which are caves or mines that bats can use for winter hibernation habitat. The paragraphs below provide brief summaries of these species and habitats, and more information about many of them can be found in the Appendix of this plan.

Yellow-Banded Bumblebee *(Bombus terricola)* is considered to be rare, although the exact status is uncertain. Not much is stated of its preferred habitat or food sources, except that it is most commonly found in and around wooded areas. It is said that the bee was formerly common and widespread across much of the eastern US and Canadian Provinces, but has vanished from all but isolated patches of its native range along with other North American bumblebees. Habitat loss from urbanization and agriculture use, spread of pathogens from commercial bumblebees, and widespread use of neonicotinoids are all blamed for much of the drastic population decline of the yellow banded bumblebee. Management strategies to favor this insect include scaling back the use of herbicides and pesticides, conservation of healthy habitat, and promoting native wildflower reestablishment. These management strategies largely pertain to agriculture settings, but also may pertain to aspects of forest management on this property.



Source: UW Madison

Source:https://www.ontario.ca/page/yellow-banded-bumble-bee

Figure 6: Images of the Yellow Banded Bumblebee.

The **Douglas's hawthorn** (*Crataegus douglasii*) is a medium to large shrub in the apple family. This shrub produces small fruit, roughly the size of a grape but similar to an apple. This plant may be identified as a hawthorn by the fruit, or by the presence of large thorns, up to two inches in length. Douglas's hawthorn is ranked as a species of special concern, meaning it has no legal protections. Distinguishing it from other species of hawthorn is quite difficult, therefore unless positive identification can be made, any hawthorns on the property should be preserved. Hawthorn is an important food source for many species of wildlife; bees feed on the nectar of the flowers and in turn pollinate them. The fruits are eaten by many mammals and birds. The status of this plant is primarily due to loss of habitat as areas once maintained by periodic natural disturbance have been converted to managed forestland or other uses. It is most commonly found on rocky outcrops or other areas with thin soils that are prone to periodic natural disturbance.

The **northern long-eared bat** (NLEB – *Myotis septentrionalis*), and the **little brown bat** (Mytis lucifugus) have fallen on hard times just in the past ten years due to a recently identified fungus. This fungus, *Pseudogymnoascus destructans*, causes a condition in bats known as "white nose syndrome" (WNS). White nose syndrome occurs when the bats become infected with the fungus during the winter months. The fungus irritates the bats and causes them to awaken from hibernation to scratch the fungus off. This extra activity consumes the bats' precious energy stores. They ultimately either starve to death or attempt to go outside in search of food but succumb to the harsh winter conditions which they are not adapted to.

The Keweenaw Peninsula's copper mining legacy and iron veins found around Negaunee and Ishpeming provide a large amount of bat habitat. This is because there are a number of old mine entrances located on or within a few miles of this property. Mines are crucial habitat for all species of bat found in Michigan. Bats sleep in mines and caves during the day, coming out at night to feed on insects. A bat is said to eat more than its weight in insects every single night, helping to keep mosquito populations in check. The bats also hibernate over winter in these same caves and abandoned mines. Caves and mines remain at a fairly constant temperature year-round, making excellent shelter for bats. The moist conditions in caves and mines coupled with the dense crowding of bats in these areas create the ideal environment for the transmission of the fungus across a large number of bats very rapidly.

In an effort to protect bats, the Fish and Wildlife Service has set forth a set of rules that pertain to activities in close proximity to bat habitat. These rules focus on protecting bats during their breeding season in order to maximize the likelihood that the bats that do reproduce are able to raise offspring that successfully reach adulthood. Although forest management typically has little to no direct impact on bats, any activity that may damage the entrance to mines or otherwise degrade roosting habitat is thought to be detrimental to bats. The following rules are in place governing forest management near the entrance to a cave or mine.

- Rule 1: Activity avoids occurring more than 0.25 miles from a known, occupied hibernaculum year-round.
- Rule 2: Activity avoids cutting or destroying known, occupied roost trees during the pup season (June 1–July 31).
- Rule 3: Activity avoids clearcuts (and similar harvest methods, e.g. seed tree, shelterwood and coppice) within 0.25 miles of known, occupied roost trees during the pup season (June 1–July 31).
- Rule 4: prohibits incidental take that may occur from tree removal activities within 150 feet of a known occupied maternity roost tree during the pup season (June 1 through July 31) or within 0.25 miles of a hibernation site, year-round. More discussion of this rule is addressed in the Appendix of this plan.

"Roost trees" are large hollow trees or trees with very deeply furrowed bark that may be used by bats during the spring and summer months to give birth to and raise their young. Any **known** roost trees should be protected from harvest. In addition to protecting the known roost trees, avoid the cutting or destroying of any other trees within a 150-foot radius from the known, occupied maternity roost tree during the pup season (June 1 through July 31).

Leaving a buffer of other trees around the maternity roost tree will help to protect the roost tree from damage or destruction that may be caused by other nearby trees being removed as well as helping protect the roost tree from wind throw and microclimate changes.

In the spring of 2022, the US Fish and Wildlife Service has proposed to reclassify the northern long-eared bat as endangered under the Endangered Species Act. Due to the ongoing nature of this situation and process, rules and regulations are subject to changes overtime. It is important that active and planned forest management activities stay up to date on rules and regulations in order to maintain compliance and avoid offences.

The **Northern Gooseberry** (*Ribes oxyacanthoides*) is a small prickly shrub that is often found on rock outcroppings in the Western Upper Peninsula. This species, which is of special concern, requires the protection of these open bedrock outcroppings and can sometimes even benefit from prescribed fire. Northern Gooseberry can sometimes provide an alternative host to white pine blister rust, a canker that forms on the branches of white pine trees, eventually leading to mortality. The protection of this species can seem somewhat contradictory where overstory white pine exists, but allowing the continual growth of gooseberry will aid in the protection of low populations.

The **Male Fern** (*Dryopteris filix-mas*) is a medium sized fern with fronds ranging in length from 20 to 120 centimeters in length. Many of the distinguishing characteristics require an amount of terminology and definition understanding to accurately describe and differentiate from other fern species. For specific descriptions, additional research of Michigan's MNFI website and Wisconsin's DNR website are recommended. It may also be necessary to consult with botanist professionals in the field to accurately identify this plant on the ownership.

The male fern is most commonly found on rocky, sheltered sites (cliffs, sinkholes, ravines, and crevices) in mixed northern hardwood forests. It often is found on limestone bedrock but is not restricted to calcareous substrates. The plant prefers shady understories, so the removal of overstory canopy is not recommended where this plant is found, known to exist, or potential habitat is located. Common associated plants include large-leaved aster, intermediate woodfern, choke cherry, and thimbleberry.

The **Purple Clematis** (clematis occidentalis) is a perennial climbing vine that occupies rocky forested areas, glades and cliffs. The leaves of this plant are divided into three ovate leaflets. The flowers are light purple in color and hang down in an attractive bell like shape. These flowers bloom very early in the growing season, likely being late May or early June in this area of the Upper Peninsula. This plant is not federally listed, but is a species of special concern in a number of Midwest and eastern US states, due to the rarity of its habitat in this region. Disturbance of its habitat should be mitigated to reduce potential damage to its local populations.

By nature, surveys for rare, threatened, and endangered species are not comprehensive, and it is beyond the scope of a forest management plan to survey a property for such species. Because of this fact, it is possible that other unreported threatened or endangered species may use the property. If any such species are encountered on the property, it may be necessary to alter the management prescribed in this plan. The changes will depend on the type of species found, individual habitat requirements of each species, and the degree to which they make use of the property. More information about the MNFI is available online at https://mnfi.anr.msu.edu/.

FOREST HEALTH

Forest health is a broad term and may have different meanings to individual landowners as well as forest managers. In this section, specific threats to forest health and the resilience of the forests growing on this property are listed. Special emphasis is given to "pest" problems in the form of both native and non-native insects and diseases, such as fungi, that are most relevant to this property and parcel locations.

Generally speaking, much of the forest on this ownership is healthy and due to the biodiversity in many natural forested stands, there is little concern for major disease and insect outbreaks. Plantations can create monocultures of a single species, making disease or insect outbreaks within that tree species high risk. Specific disease and insect issues that should be monitored for during inspections includes but is not limited to, the following:

-Emerald Ash Borer

-Spruce Budworm

-Maple Dieback

-Oak Wilt

If any of these or other forest health problems are found during property inspections, the appropriate parties should be notified so they can assist in diagnosing the issue and provide management recommendations at that time.

It is important to recognize that insects and fungi are a natural part of all forests. The forests in this region have evolved over thousands of years in concert with a particular suite of organisms. In an unmanaged forest, these organisms serve to rid the forest of less vigorous trees and those that are stressed by other factors such as physical damage caused by wind or fire. The death of these weaker trees frees up growing space, nutrients and water for the most vigorous trees; dead fallen trees are recycled into the soil. Given favorable conditions, it is possible for native organisms to reach such high populations that they are capable of damaging and even killing perfectly healthy trees. In a catastrophic outbreak the damaging agent eventually runs out of habitat, essentially "eating itself out of house and home" at which time its population returns to normal levels allowing the forest to redevelop, usually in a younger state. In other cases, conditions may change, becoming unfavorable for the damaging agent, or predators arrive and bring its population back in check.

As a general rule, younger trees and those that are growing vigorously are the most resilient to damage caused by insects and diseases. Trees do not "heal" damage, rather they rely on their ability to compartmentalize, or "seal off" damage caused by fire, insects, fungus and wind. Rapidly sealing off a wound minimizes the chances that insects or diseases can enter the tree through the wound. Young trees and vigorously growing older trees are the most capable of compartmentalizing damage and growing new wood over the damaged areas; slow growing trees are less able to fend off subsequent attacks. Additionally, certain species are better at surviving damage. White birch, balsam fir and aspen are naturally very short-lived trees with wood that is very susceptible to decay, as a result physical damage to these trees is typically more likely to lead to major problems than equivalent damage to a white pine, cedar or sugar maple.

Forest health does not necessarily equate to timber quality. A large, vigorously-growing white pine may have many large branches that are undesirable for the production of quality timber. Conversely, when a stand is selectively harvested, trees with dieback or physical damage may still be capable of yielding quality sawlogs if they are harvested in a timely manner, before the disease or decay has had a chance to progress. Maintaining a healthy forest involves periodic observation; this can be as simple as a landowner noting an unusual condition and contacting a forester to assess it. Annual monitoring is not always necessary unless a particular severe insect or disease is threatening the forest on the property.

Invasive plant species can also create concerns in forest management including regeneration issues and loss of natural biodiversity. Positive identification of some of these invasive species were made on parcels within this ownership at this time, and more may exist. Where invasive species are found and identified on a parcel, special management operations and actions should be considered in order to eradicate, or prevent the spread of the invasive species detected. In areas where invasive spread is beyond reasonable control, management strategies will focus on maintaining as much natural forest cover and understory as reasonably feasible and possible. Specific invasive species that should be monitored for during inspections includes but is not limited to the following:

-Buckthorn *(identified on Business M35 parcel, Tracy Mine Road parcel, and Miller Road 40)*

-Garlic Mustard *(identified on Tracy Mine Road parcel)*

-Bush Honeysuckle *(identified on Business M35 parcel and Tracy Mine Road parcel)*

-Japanese Barberry

-Reed Canary Grass

-Scotch Pine *(identified on Tracy Mine Road Parcel)*

FORESTS OF RECOGNIZED IMPORTANCE

Forests of Recognized Importance (FORI) are defined by the American Tree Farm System as "globally, regionally, and nationally significant large landscape areas of exceptional ecological, social, cultural, or biological values." FORI occur at the landscape level, not the individual stand or ownership level. A FORI on private forest land mostly consist of critical wildlife habitat (such as habitat used by endangered species), rare forest types, corridors of unique rivers, and Great Lakes coastlines. Important wildlife habitat is any forest that provides habitat required by state and federally listed threatened or endangered species. Rare forest types include primarily old growth forests but may include other exceptional forest communities. Corridors of unique rivers include the portions of those rivers designated as "Natural Rivers" or "Wild and Scenic Rivers."

The Natural River and Wild and Scenic River designations created prohibitions on dam building and other development supported by the Federal Government on sections of river. These designations do not explicitly prevent development, nor do they give the Federal Government control over private property. That being said, owners of property along Wild and Scenic Rivers and Natural Rivers are encouraged to manage the land in a fashion that preserves the aesthetic values of the river. The Great Lakes coastlines include all those properties located within one mile of a Great Lake shoreline.

When management is implemented on a property known to be within a FORI it is vital that it is done so in a fashion that protects its ecological integrity. Most properties in this ownership are not within a known FORI but it is still extremely important all Best Management Practices are followed when conducting a timber sale or establishing or maintaining roads, trails, and stream crossings. Properties that are within a known FORI must also follow Best Management Practices when conducting timber sales and may even require exclusions of particularly sensitive ecosystems. Strictly adhering to the Best Management Practices guidelines will drastically reduce or eliminate the potential for runoff and sedimentation to enter and degrade nearby water features. More information on Best Management Practices can be found in the "Sustainable Soil and Water Quality Practices on Forest Land" manual. This manual can be found on the Michigan DNR website at https://www.michigan.gov/documents/dnr/IC4011_SustainableSoilAndWaterQualityPracticesOnForestLand_268417_7.pdf

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SECTION III: VEGETATION DESCRIPTIONS AND MANAGEMENT RECOMMENDATIONS

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VEGETATION ASSESSMENT

METHODS

In the spring of 2022, field inspections were conducted across all parcels included in this plan. Prior to each visit, preliminary stand lines were delineated on an aerial photograph of the property. These lines were also loaded onto a field GPS receiver to allow the forester to navigate throughout the property and visit each stand. Within each stand, basic observations were made. These observations include:

Tree Species Composition	Tree Quality and Health	Predominant Tree Size Class
Tree Stocking (Basal Area[1])	Regeneration Stocking	Harvest History
Potential for Future Harvesting	Seasonal Restrictions to Harvesting	Ground Vegetation
Exotic and Invasive Plant Species	Soil Conditions	Wildlife and Endangered Species

In addition to making these observations, the forester verified the preliminary stand lines and adjusted them where necessary. These verified stand lines were then used to determine stand acreage. Within each stand, a timber type was identified. Timber types are determined by examining the tree species composition, size class and stocking density of the forest within each unique stand. This information is then used to develop the management recommendations set forth later in this section.

For the purpose of categorizing different vegetation size classes in the stand descriptions that follow, trees are divided into overstory, understory and regeneration size classes. The overstory tree size class is any tree five inches or greater in diameter at breast height (DBH). DBH is measured at four and one-half feet up from the soil surface. The understory tree size class is any tree three to five inches in DBH as well as suppressed trees which have little chance of growing into the overstory. Additionally, the regeneration size class is any tree one-inch-tall up to three inch in DBH.

The distribution of forest stands across each parcel of this ownership is depicted on the corresponding Parcel Maps that are included with this plan. The management recommendations that have been developed for each forest type are discussed in the next section. Some forest types may have varying management recommendations or additional considerations depending on the exact on the ground conditions. The Parcel Maps and geodatabase also provide a visual representation of the harvest recommendations and associated harvest dates across each parcel of the ownership.

[1] Basal area is a measurement used by foresters to identify the relative density of the forest and reflects the cross-sectional area of all trees five inches in diameter and larger, as measured at four- and one-half feet above the ground, and expressed in units of square feet per acre. The higher the basal area, the more densely stocked a stand is. Basal area is one of the most useful measurements in determining when many timber types are ready to be harvested, and is closely related to timber volume.

MANAGEMENT RECOMMENDATIONS

Proper land management must take many factors into account such as past land use, current land use, desired land use, conditions of the land and the potential of the land. Because nature does not consider property lines, land management must consider the landscape as a whole (landscape management). The options recommended in this plan consider each forest type being described and how it fits into the surrounding landscape. Management of each forest type is designed to benefit the land being managed, without negatively impacting the adjacent and surrounding natural ecosystems.

PRE-TREATMENT ACTIVITY

Prior to the implementation of any treatment, the following details should be considered:

- Property boundaries should be checked or established if needed. This should be done either by or with the aid of a knowledgeable professional.
- Sensitive sites should be identified, and clearly labeled or marked. This can include but is not limited to threatened and endangered species and their habitats, historically significant sites, past mining caves and pits, manmade ditches, drainages, and mining ventilation features.
- Roads should be properly established or at least flagged in prior to being built. This should be done either by or with the aid of a knowledgeable professional. If any roadwork near drainages or wet areas is required, the Department of Environment, Great Lakes, and Energy (EGLE) should be contacted. The condition of roads should be documented, preferably with photographs, so that there is recourse if the roads are left in unacceptable condition following the completion of logging.
- Prescription implementation should be conducted either by or with the aid of a knowledgeable professional. If the prescription involves timber management, an experienced consulting forester should be involved.
- Soil conditions found in individual stands should be closely examined prior to implementing any of the recommended management practices detailed in this plan. If harvesting is recommended on wet sensitive soils the timing of the harvest should be restricted to winter only to protect the soils from damage caused by rutting and compaction.
- To remain in compliance with BMP restrictions, the timing of some of the harvests recommended later in this plan may have to be delayed if soil conditions are exceptionally wet and susceptible to excessive rutting at the time the harvest is recommended.

FOREST TYPE DESCRIPTIONS AND RECOMMENDED MANAGEMENT

The following pages describe the various forest types found across the ownership and the management techniques that should be implemented within them. The geographic location of each forest type and the individual stands are depicted on the Parcel Maps included with this management plan, and in the geodatabase that is maintained by the landowner's forester. In addition, the Parcel Maps and geodatabase also depict the timing that forest management is recommended to occur within each individual stand and the specific management that is recommended for each stand.

Forest Type: **A (Aspen) Am (Aspen-Northern Hardwoods)**

Management Objective: **Sustainably harvest timber and maintain aspen forest type through natural regeneration where feasible. Artificially regenerate sites where invasives prevent successful natural regeneration.**

Prescribed Management: **Modified Clearcut**

FOREST TYPE DESCRIPTION:

The aspen forest types comprise a significant portion of the total acreage of this ownership. This forest type is specifically common on the Business M35 and Tracy Mine Road properties, which is no surprise due to the past mining activity these sites experienced. This forest type consists of stands with varying stocking levels and size classes ranging from dense young regeneration to well stocked stands of mature timber. The typical mix of tree species found within the aspen forest type consists of the following:

DOMINANT		CO-DOMINANT	
Quaking Aspen	Black Cherry	White Spruce	White Pine
Red Maple		Balsam Fir	Paper Birch
		Sugar Maple	

Quaking aspen is by far the most common tree species found within the aspen forest type. The vast majority of the quaking aspen trees found within this forest type are healthy and vigorously growing. However, in the mature stands and in areas with severe past soil disturbance the quaking aspen trees present are displaying poor growth rates and in some cases are beginning to show signs of decline due to old age. Commonly mixed with quaking aspen is a significant amount of red maple and/or black cherry. The red maples are generally healthy however their growth rates and timber quality is somewhat low due to the soil conditions present throughout most of the aspen forest type. The black cherry trees are also of poor quality, presenting very little opportunity for the production of sawlogs. Balsam fir, white spruce, and paper birch are also common associates within the aspen forest type, but are generally only found in scattered pockets on this property. Many of the associated species are found in the sapling and small poletimber size classes ranging from roughly two to six inches in DBH. They are typically healthy and often are a beneficial source of habitat and shelter for a range of wildlife species. Other tree species commonly noted within the aspen forest type but at much lower frequencies can be seen in the list of co-dominant species above.

MANAGEMENT RECOMMENDATIONS:

The management objective for the aspen forest type is to maintain aspen as the predominant cover type while producing income through the implementation of timber sales. To meet this objective, stands categorized as the aspen forest types found across the ownership should be treated with a modified clearcut harvest when the individual stands range from 35 to 45 years of age. The modified clearcut harvest recommended will consist of cutting all hardwood trees two inches in DBH and greater and all conifer trees five inches in DBH and greater with a few exceptions. Any white pine, red pine, hemlock, cedar, red oak or American elm encountered within the harvest areas should be retained unless a large component of any of these species is present within a localized area of the aspen forest type. If locally dense "pockets" of these less common species are present, they should be harvested to promote aspen regeneration however at least five trees per acre of each species should be retained to provide a seed source and diversify wildlife habitat. Following these harvest guidelines will fully open the canopy and stimulate the cut aspen trees to regenerate from root sprouts. The resulting root sprouts will provide an excellent source of food and cover for many wildlife species, especially ruffed grouse and white-tailed deer. When possible, the modified clearcut harvests conducted within the aspen forest type should be conducted during the winter. Conducting a winter harvest when the aspen trees are storing their energy and nutrients in their root systems will ensure that the resulting root sprouts will have an added "boost" of energy and nutrients in the spring when they begin to grow. This boost will maximize the growth rates of the resulting root sprouts.

Additional and specific considerations

Some stands within the aspen cover type also contain a mentionable amount of northern hardwood stems including red maple and sugar maple. These areas are generally found on the Business M35 property. These specific stands are too young for any management considerations within the next 20 years. That said, it should be known that these areas may be eligible to be transitioned back to hardwood dominated stands in the future. This action would take place beyond the 20-year scope of this forest management plan, and should therefore be further explored during future property re-evaluations and management plan updates.

Many of the aspen stands on this ownership contain some invasive species within the understory, including but not limited to buckthorn, garlic mustard, and honeysuckle. Infestation levels range from scattered individual invasive stems, to complete domination of the understory layer. This may lead to challenges in regeneration when it comes time to harvest and regenerate these stands. In general, it is still recommended that a modified clearcut take place when recommended. In the following years, the site should be periodically inspected to ensure that the aspen regeneration is acceptable enough that it will be able to repopulate the site and provide complete canopy coverage upon maturity. If aspen regeneration is stagnant and becomes outcompeted by invasive species, it may be necessary to artificially replant the site in order to maintain its forested nature.

In occasions where replanting becomes necessary, the following guidelines and steps should be used. First, the identified site should be sprayed with herbicide in order to knock back the invasives and competing vegetation. This herbicide treatment should take place during the growing season, and be performed by a qualified and knowledgeable professional. Depending on the species present and expected seed bank within the soil, it may be necessary to herbicide the site more than once to help temporarily exhaust the site of aggressive competing vegetative growth. In the spring or fall of the year following the final herbicide treatment, the site should be prepared and planted. Mechanically site preparations include trenching the soils to provide adequate planting sites. Once the site is trenched, it can then be planted. The exact species to be planted can be identified in an individual planting project plan, but based on the young and disturbed soils found on the properties, Norway spruce and red pine will be likely candidates for these reforestation efforts. Seedlings should be planted at an approximate spacing of eight-by-eight feet, which will result in the planting of about 700 seedlings per acre.

Forest Type: **C (Cedar)**

Management Objective: **Sustainably manage timber and encourage natural regeneration. Consider maintaining aesthetics near recreational sites**

Prescribed Management: **Patch Clearcut or Strip Clearcut**

FOREST TYPE DESCRIPTION:

The cedar forest type is most commonly located on flat terrain with generally wet or excessively wet, muck-textured soils. Although, some areas of cedar on these properties are actually upland and dry with reasonably decent drainage. Tree species commonly observed in the cedar forest type include:

DOMINANT		CO-DOMINANT	
Cedar	Balsam Fir	White Spruce	Paper Birch
Red Maple	Black Spruce	White Pine	Black Ash
		Sugar Maple	Tag Alder

Cedar is by far the most common tree species found within this forest type. The cedars are well adapted to the specific soil conditions associated with this forest type and therefore they are generally healthy and productive. However, the growth of cedars within this forest type may be inhibited on the wettest sites. Mixed with the cedars are lesser amounts of black spruce, and balsam fir in the wetter areas, and red maple in the more upland sites. Even less common, but still typically present are white spruce, white pine, black ash, paper birch, and sugar maple. Like the cedars, the swamp conifers listed above (black spruce and balsam fir) are generally displaying desirable growth rates, although some spruce and fir are showing signs of mortality due to old age. However, the hardwoods, which are not as well adapted to the wet soil conditions, are typically displaying poor quality and growth characteristics. Black ash is at significant risk of mortality in the near future from the continuation of emerald ash borer moving across the landscape. The overall densities of ash on the property and within these cedar stands is relatively low, so the loss of the species will not represent a substantial loss in revenue.

MANAGEMENT RECOMMENDATIONS:

Within the properties covered by this plan, there are only two main areas dominated by cedar stands. Within each, the cedar cover type areas are relatively small, and very likely won't be able to support economical timber harvesting operations. What this means, is that the costs of setting up a timber harvest and mobilizing equipment to the site, would likely outweigh the potential revenues the landowner would experience. For this and other reasons described elsewhere in plan, it is not recommended that any of the cedar cover type is targeted for harvest within the 20-year timeframe that this plan covers. That said, we are still offering the following timber harvesting guidelines so that future readers and city officials can still understand general cedar management should the opportunity to manage an individual cedar stand arises.

During the winter months and when soil conditions allow, the cedar stands can be cut by implementing the strip clearcut or patch clearcut harvest method, whichever is preferred. In either case the objective is to remove one-third of a stand's volume per entry. If the strip clearcut method is used the strips should be 75-150 feet wide. The objective is to cut one strip and leave two. This will result in one-third of the stand being harvested. The strips should be oriented in an east to west fashion. If the patch clearcut method is used, patches that range from one-half acre to five acres in size should be clearcut. They should be randomly placed, but evenly distributed across the stand, making sure that one-third of the stand is cut. All trees present that are two inches in diameter and greater that fall either in the patches or the strips should be harvested. Any white pines that are found in the stand should be reserved to contribute to the diversity of the future stand. The initial harvest should occur when the individual stands are fully stocked at a basal area of 80 to 120 square feet per acre. Roughly ten years after the first set of strips or patches have been harvested, the cut areas should be inspected to check for the presence of adequate regeneration. After the regeneration has adequately established itself, it is then time to cut the second one-third of the stands volume in the same manner as the first one-third was removed. The third and final cut should then take place roughly ten years after the second harvest and once adequate regeneration is established. The third harvest will remove all remaining merchantable timber in the stand that has been left after the first two harvests were completed. The result will be a well-stocked stand of cedar regeneration with a varying mix of other species.

It may not be economically feasible to harvest only one-third of the small stands found within this forest type per harvest entry. These situations may require cutting a larger portion of the stand or possibly conducting a modified clearcut harvest to ensure the harvest is economically feasible. If a stand is scheduled for a more aggressive harvest to meet economic restrictions, it should be inspected by a forester prior to the harvest to ensure there is a viable seed source available to regenerate the cut area. Furthermore, the forester should inspect the stand to ensure the harvest will not impact the water table in a fashion that will result in wetter soil conditions that inhibit tree regeneration and result in the establishment of lowland brush.

Forest Type: **Km (Oak-Northern Hardwoods),**

Management Objective: **Maintain oak forest type and promote timber production through sustainable timber management.**

Prescribed Management: **Thinnings-Individual Tree Selection Harvests / Seed Tree Harvest**

FOREST TYPE DESCRIPTION:

The oak-northern hardwood forest type consists of stands of hardwoods where northern red oak trees are the dominate tree species. These sites are generally found in areas of variable and rocky terrain where bedrock is close to the soil surface, if not exposed as rock outcrops. The soils found on top of the bedrock are commonly shallow and sandy, offering very well drained soils. Common tree species observed in the oak dominated forest types include the following:

DOMINANT		CO-DOMINANT	
Red Oak	Red Maple	Quaking Aspen	Bigtooth Aspen
Sugar Maple		Basswood	White Spruce
		Ironwood	Balsam Fir

Red oak is the most common tree species within this forest type, but is then also associated with varying levels of sugar maple and red maple. The red oaks, which are well adapted to the soil conditions associated with this forest type, are commonly displaying reasonable growth rates and timber quality. That said, some spots have soils that are too shallow and rocky to support adequate timber growth, making these areas either slow to mature, or unsuitable for timber production all together due to the poor height growth and low stem quality. Other species commonly associated with the red oak-northern hardwood forest type but at lower frequencies include basswood, balsam fir, white spruce, aspen, and ironwood.

MANAGEMENT RECOMMENDATIONS:

The management objective for the red oak dominated forest types is to maintain the red oak component for timber production and wildlife habitat. To meet this objective the red oak forest type should be treated with a combination of an individual tree selection harvests (thinnings) and final cut seed tree harvests. The individual tree selection harvests should be conducted when the individual stands reach a basal area of 110 square feet per acre or greater and the average diameter at breast height (DBH) of the dominant oak trees is less than 18 inches. The purpose of the individual tree selection harvest is to remove the poorer quality individuals and concentrate the growth of the stand on the highest quality trees to produce future timber products. Trees to be harvested should be designated by a forester adhering to the following order of removals:

1. Risk - Cut high risk trees that are likely to die or significantly decline in product grade between harvests. This includes diseased trees and those with tight "V" shaped forks that have a high risk of splitting and large trees with significant economic value that are at risk of declining in value in the next 15 years.
2. Release crop trees - Cut poorer quality competitors to provide crown growing space around 40-60 crop trees per acre promoting growth and quality development. Apply two-sided release in sawtimber sized trees and full release in pole and sapling sized trees.
3. Vigor - Cut low vigor trees, based on crown size and condition, crown class, and potential stem decay.
4. Stem form and quality - Cut poorly formed stems, based on usable log length and potential decay.
5. Undesirable species - Cut tree species that interfere with management objectives of landowner and species that interfere with growth of more desired species.
6. Improve Spacing - Create more uniform spacing between the healthiest trees to distribute growth more evenly throughout the stand.

Using an order of removals helps to ensure uniform tree selection throughout the forest. This will help the forest continue to grow in a relatively predictable fashion while providing a range of other benefits, including wildlife habitat and water quality preservation. The residual basal area of a harvested stand should average approximately 70 to 80 square feet per acre. This will provide adequate space to allow the highest quality trees that are retained to achieve their maximum growth rates.

The individual tree selection harvest should be repeated every 15 to 25 years until the average DBH of the dominant red oaks in the stand exceeds 18 inches. Once this occurs, the individual stands should be treated with a seed tree harvest to encourage red oak regeneration. The seed tree harvest will consist of cutting all merchantable trees from the stand with a few exceptions. Roughly 3 to 5 red oak trees should be retained per acre to provide a seed source to regenerate the stand. Furthermore, all white pine and hemlock should be retained for diversity and wildlife habitat. If possible, this harvest should be conducted during the summer and the loggers should be instructed to scarify the soils to the best of their ability with their logging equipment.

This will help expose a mineral soil seed bed which will increase the chances of successful red oak regeneration. Retained trees will be left on the site following natural regeneration to add vertical structure and diversity to the sites. The regeneration following a seed tree harvest is expected to include a mix of species including red oak.

Following the seed tree harvest, it may be necessary to perform timber stand improvement treatments to ensure the survival and success of the oak regeneration. Initially, the stand should be evaluated every couple of years to make sure the oak saplings aren't being outcompeted by aspen or other hardwoods such as red maple stump sprouts. If this is the case, there may be potential to hire a pesticide applicator contractor to individually treat competing species with herbicide. This will help to set back the competing species, and ensure that the red oak saplings obtain the necessary sunlight and soil nutrients necessary to survive.

Oak wilt is currently a concern in the southern Upper Peninsula and is expected to become more widespread as time passes. Harvesting in oak stands should be avoided during the months of April, May and June as the fungus is most readily transmitted during this period and can infect trees through fresh logging scars. Additionally, oak roots graft together underground and therefore the fungus can enter a cut stump and move into a live tree through a graft. Oak wilt should be monitored for within these stands at all times. Any signs multiple oak trees all dying within an area within a couple years should be evaluated by a forester for treatment recommendations.

Forest Type: **M (Northern Hardwoods), Ma (Northern Hardwoods-Aspen), Mb (Northern Hardwoods-Birch), Mk (Northern Hardwoods-Oak)**

Management Objective: **Sustainably manage and harvest timber products while promoting forest health, quality, and productivity**

Prescribed Management: **Individual Tree Selection**

FOREST TYPE DESCRIPTION:

The northern hardwood forest types are found scattered across this ownership. This is a very diverse forest type that has been influenced by a significant amount of past forest management. The northern hardwood forest type ranges from young stands stocked with poletimber and thick regeneration to mature stands of sawtimber sized trees with a dense canopy and little regeneration. Additionally, some stands within the northern hardwood forest types are displaying excellent quality and growth rates, while others, typically found on lower quality sites or after severe disturbance are displaying slow growth rates and a significant amount of defect. Because of the diversity of this forest type, a number of management techniques will be implemented over time to optimize the productivity and value of each unique site. The species composition of this forest type is rather diverse and consists of the following tree species:

DOMINANT		CO-DOMINANT	
Sugar Maple	Red Maple	Basswood	Ironwood
Yellow Birch		Red Oak	White Pine
		Paper birch	Black Cherry

Sugar maple and red maple are by far the most common tree species observed in the northern hardwood forest type. Yellow birch, red oak and quaking aspen are present but are generally not common. The quaking aspens are generally found in small groups or clones ranging from roughly one-quarter to one-half acre in size. The hardwood species found in most of the individual stands that make up the northern hardwood forest type are commonly in good health and displaying average timber quality, especially the maples. However, some individual stands are displaying a significant amount of top dieback and other defects. Mixed with the hardwoods at rather low frequencies are balsam fir, white spruce, and white pine. The balsam fir and white spruce trees are typically found in the sapling and poletimber size class. White pine trees are typically found as scattered individual trees, many ranging from 10 to 20 inches in DBH.

Terrain is highly variable across the northern hardwood forest type. The vast majority of the terrain within this forest type is flat to gently rolling and easily harvestable with modern logging equipment. However, there are instances where the terrain is rather steep and will limit logging operability.

MANAGEMENT RECOMMENDATIONS:

The management objective for the northern hardwood forest types is to sustainably manage the timber resource and maximize the productivity of a particular site while promoting tree quality, growth, and health. To meet this objective the majority of the northern hardwood forest type stands should be treated with an individual tree selection harvest. Individual tree selection harvests in northern hardwoods help to accelerate the natural process of thinning, freeing up space for the most desirable trees in the stand and generating revenue for the landowner. Thinning hardwood stands also helps to create conditions more conducive to the establishment and growth of regeneration, thereby ensuring continued growth of the forest into the future. Foregoing timber harvests eventually leads to natural mortality of trees as they compete for sunlight, nutrients, and water. Trees to be harvested should be designated by a forester adhering to the following order of removals:

1. Risk - Cut high risk trees that are likely to die or significantly decline in product grade between harvests. This includes diseased trees and those with tight "V" shaped forks that have a high risk of splitting and large trees with significant economic value that are at risk of declining in value in the next 15 years.
2. Reduce overall stocking of ash to no more than 10 square feet per acre in order to minimize the future impact of emerald ash borer.
3. Release crop trees - Cut poorer quality competitors to provide crown growing space around 40-60 crop trees per acre promoting growth and quality development. Apply two-sided release in sawtimber sized trees and full release in pole and sapling sized trees.
4. Vigor - Cut low vigor trees, based on crown size and condition, crown class, and potential stem decay.
5. Stem form and quality - Cut poorly formed stems, based on usable log length and potential decay.
6. Undesirable species - Cut tree species that interfere with management objectives of landowner and species that interfere with growth of more desired species.
7. Improve Spacing - Create more uniform spacing between the healthiest trees to distribute growth more evenly throughout the stand.

Using an order of removals helps to ensure uniform tree selection throughout the forest. This will help the forest continue to grow in a relatively predictable fashion while providing a range of other benefits, including wildlife habitat and water quality preservation. Individual stands should be treated with a harvest when they reach a basal area of roughly 110 square feet per acre. Following the timber harvest, the residual basal area should average approximately 70 to 80 square feet per acre. This stocking level allows adequate amounts of sunlight to reach the forest floor to stimulate the growth of regeneration, and recruitment of established regeneration into the poletimber size class. This stocking level also maintains enough overstory trees to prevent windthrow and loss of large limbs. The shade cast by the residual overstory will also help to limit the growth of brush that can outcompete regeneration of desirable tree species. All aspen and white birch should be harvested, and most hemlocks, white pine and red oak should be retained for diversity. Large snags and cull trees should be retained, unless they appear to be harboring some significant insect or disease problem. The benefits of snags and culls are detailed in the wildlife section of this Forest Management Plan.

Northern hardwood stands have an excellent capacity for natural regeneration, especially of the more shade-tolerant species such as sugar maple, red maple, balsam fir, and hemlock. This characteristic makes it possible to conduct periodic timber harvests which remove the low quality and high-risk trees and open up space for the higher quality trees. Provided that harvesting is done properly and no severe disturbances occur, this process can be repeated every 15 to 25 years without the need to completely clearcut the stand.

Due to the proximity of some of these stands to established areas of invasive species, uneven aged management and regeneration may become infeasible over time. If this becomes the case in the future, it may be necessary to fully clearcut maturing overstories and artificially replant sites. If a clearcut northern hardwood stand is planted with red pine, or any other species, it should follow the same planting guidelines that are provided for in the Management Recommendations Section for the aspen forest types.

The specific management technique to use in each individual northern hardwood stand is depicted on the Parcel Maps included with this management plan.

Forest Type: **Pa (Mixed Pine-Aspen)**

Management Objective: **Sustainably manage timber to improve forest quality, health, and productivity. Encourage continued growth and expansion of white pine**

Prescribed Management: **Species Removal**

FOREST TYPE DESCRIPTION:

The pine-aspen forest type is only identified on the north side of the Tracy Mine Road property. The natural mixed pine forest type is found growing on varied terrain however it is most common on sandy upland sites. It is comprised of a diverse mixture of upland tree species that include the following:

DOMINANT		CO-DOMINANT	
White Pine	Quaking Aspen	Balsam Poplar	Sugar Maple
Red Maple		Paper Birch	White Spruce
		Scotch Pine	Balsam Fir

Of the species listed above white pine and quaking aspen are the most common. Both of these species have originated naturally from seed. They are reasonably well suited to the site conditions and past disturbance associated with this area and therefore they are displaying reasonable growth rates and average quality. Mixed with the pines are lesser amounts of white spruce, balsam fir, red maple, sugar maple, and scotch pine. Due to the sandiness of the soils present, and past disturbance that this area has experienced, many of these associated tree species are displaying relatively poor timber quality and growth.

Much of the acreage within this forest type is dominated by scattered white pine trees that are mostly found in the sawtimber size class, with younger and smaller associated species mixed into the understory. This is likely the case due to pine individuals being the first species to seed into the area after it was abandoned at the end of mining activities on the site. Following the white pine seeding in on the site, many of the other species then started to grow up in the understory and gaps in the overstory. These understory species are more commonly found in the sapling or poletimber size classes.

MANAGEMENT RECOMMENDATIONS:

The management objective for this forest type is to produce timber products while encouraging natural regeneration of the white pine trees present. To meet this objective the stands within this forest type should be treated with a species removal harvest when the pines within the stand average 12 to 16 inches in DBH or when the basal area of the stands exceeds 140 square feet per acre. The species removal harvest will entail harvesting all aspen, maple, birch, spruce, fir, and scotch pine. All white pine should then be retained to continue to dominate the site, and distribute seed to the surrounding area and gaps that are made from the harvest. Additionally, all hemlock, cedar, American elm and red oak that may be encountered shall be retained for diversity and wildlife habitat. If possible, any timber harvesting that is conducted within this forest type should occur during the summer and the loggers should be instructed to scarify the soils as much as reasonably possible with their machines to create a seed bed to help ensure successful regeneration.

Forest Type: **Wk (White Pine-Oak)**

Management Objective: **Preserve forest cover and positive aesthetics on scenic landscape, explore potential for future recreational uses.**

Prescribed Management: **NA**

FOREST TYPE DESCRIPTION:

The white pine-oak forest type is currently found exclusively on the Carp River Forge property. The forested area of the parcel is largely landlocked to management equipment and activities, and also contains very steep slopes with rock outcrops. This forest type is made up of a mixture of upland conifer and hardwood tree species which include the following:

DOMINANT		CO-DOMINANT	
White Pine	Red Oak	Paper Birch	Sugar Maple
Red Maple		Quaking Aspen	Balsam Fir
		White Spruce	

Because this cover type is found largely perched on top of a rock outcrop on this ownership, it has experienced very little management. Additionally, the shallow and rocky soils provide a site that is slow growing and not conducive to growing high quality timber products. Because of the shallow, well drained soils, drought tolerant species such as white pine and red oak appear to be in the best of health and offer the most longevity. Paper birch and aspen are also commonly seen on the ridge where common disturbance takes place, likely due to windthrow and uprooting of trees overtime in the shallow soil conditions. Maple species are commonly found in the small depressions where soil is allowed to build up a bit more, and soil moisture is more commonly found throughout the summer months.

MANAGEMENT RECOMMENDATIONS:

In areas where this forest type is able to be managed, it would likely undergo similar harvest treatments as are described for the mixed pine forest types and the oak dominated forest types. On this ownership however, none of the white pine-oak forest type is currently accessible. In leu of timber harvesting within the current boundaries of this forest type, the stands should instead be allowed to follow natural succession for the time being. Natural disturbances such as wind throw, single tree mortality, or fire will occasionally result in the death of overstory trees over time, and new regeneration will fill their space. This forest type should still be re-evaluated every ten years to ensure that invasive species are not taking hold within the area.

Forest Type:	**O (Open)**
Management Objective:	**Maintain openings for timber harvesting and city operations or allow them to develop naturally.**
Prescribed Management:	**No Active Timber Management**

FOREST TYPE DESCRIPTION:

The open areas of this ownership consist primarily of past log landings, the city compost dump, and other forest openings that have been cleared of forest for mining or city operations. Some of these areas are continuously utilized, preventing the natural regrowth of the forest. Sites that are used less frequently are starting to seed in with scattered pine and aspen seedlings that will reclaim the site if allowed to continue to grow and mature.

MANAGEMENT RECOMMENDATIONS:

There is no active management recommended for this forest type. Instead, it should be allowed to develop naturally and when needed, utilized again to facilitate timber harvesting or city operations. Utilizing the old landings for future timber sales will minimize future disturbance to the forest and soil while also maintaining the areas as openings.

Forest Type:	**XL (Lowland Brush) XW (Water)**
Management Objective:	**Protect soil and water quality**
Prescribed Management:	**No Active Timber Management**

FOREST TYPE DESCRIPTION:

The lowland brush forest type occurs on some of the wettest soils on this property and includes a unique and diverse range of tree and shrub species. This forest type is found in low-lying sites of varying sizes across the entire ownership. Generally speaking, these areas have one feature in common: they are located in close proximity to surface water bodies, or in areas where the water table is located at or very near the surface of the soil. These areas generally prohibit the growth of all upland tree species, and in many instances, they are too wet to support significant growth of even wetland tree species like black spruce and tamarack. In the absence of a forest canopy, brush and herbaceous vegetation often dominate in these areas. Some areas of lowland brush exist due to beaver activity; the subsequent flooding eventually kills trees growing in the flooded areas and may even kill those trees growing in close proximity due to the saturated soils. In an unmanaged forest, this is a natural occurrence however in a managed forest where the primary objective is timber production, this activity represents a long-term loss in productivity and potential revenue. Tree species observed in the lowland brush forest type consist mainly of scattered, poor-quality tamarack, black spruce, black ash, balsam fir and white cedar.

Interspersed throughout some areas of the lowland brush forest type are some small lakes and flooded areas. The wet soils in this stand will not support significant stocking of merchantable tree species in the near future. When adjacent stands are harvested, logging equipment should be excluded from areas of lowland brush in order to limit the chances of soil rutting and compaction. Areas of lowland brush are important to maintaining water quality as they help to filter impurities and nutrients out of the water as it flows across the landscape into streams and other bodies of water.

MANAGEMENT RECOMMENDATIONS:

No active forest management is recommended in the lowland brush forest type. During harvest operations in adjacent stands, the wetland boundaries should be clearly delineated and designated as equipment-free areas. These areas of the property should be reevaluated occasionally in order to ensure that they have not been drastically impacted by any disease or invasive species.

Forest Type: **XU (Upland Brush)**

Management Objective: **Maintain site conditions for wildlife habitat**

Prescribed Management: **No Active Timber Management**

FOREST TYPE DESCRIPTION:

The upland brush forest type is found primarily on the Tracy Mine Road parcel. Typically, the soils in these areas were disturbed and retained as cleared area for past mining operations, and are now populated with brush species such as tag alder, buckthorn, service berry, hawthorn, and choke cherry. Tree species can also be found growing in amongst the brush, with species such as aspen, black cherry, balsam poplar, and mixed pine. In some instances, these small areas were created when past management activities removed the timber and tree regeneration either failed or was prevented. These areas also include old paved roads and other land formations that were created by human activity. They may also consist of areas where the soils are extremely thin, over exposed bedrock or mine tailings; trees are sometimes unable to grow to merchantable size in these areas.

MANAGEMENT RECOMMENDATIONS:

No active forest management is recommended in the upland brush forest type. During harvest operations in adjacent stands, these areas could be cleared and used as landings if needed. These areas of the property should be reevaluated occasionally in order to ensure that they have not been drastically impacted by any disease or invasive species.

Forest Type:	**ROW (Right-of-Way)**
Management Objective:	**Allow utilities to maintain the Right-of-Ways as necessary**
Prescribed Management:	**No Active Management**

FOREST TYPE DESCRIPTION:

A couple of utility Right-of-Ways (ROW) occupied by various utilities are found across this ownership. This portion of the property is not managed or maintained by the landowner.

MANAGEMENT RECOMMENDATIONS:

There is no recommended forest management required for this forest type. In lieu of forest management the landowner should allow the owners of the ROW to continue to maintain the ROW to suit their needs. Furthermore, when forest management is being conducted adjacent to the ROW the forester overseeing the management should take precautions to ensure the ROW and the utilities it provides are not damaged. This typically involves making sure that trees designated for harvest do not threaten power lines. Also, the forester should check to ensure that there are not any buried utilities that might be damaged by operating heavy logging equipment within the ROW. If these buried utilities exist, precautions such as designating crossing areas and bringing in fill or skid mats to lessen the impact from the harvesting equipment might be necessary.

Forest Type:	**RES (Residential)**
Management Objective:	**Allow residents to maintain their lots, and allow the surrounding forest and natural features to develop naturally.**
Prescribed Management:	**No Active Timber Management**

FOREST TYPE DESCRIPTION:

This forest type is found in areas where human residences and their immediate surrounding yards and infrastructure are located. On this ownership and within the acreage that is included and described in this plan, this forest type is found on the Tracy Mine Road parcel. Stands within this forest type include not only the buildings and infrastructure surrounding residential homes, but also the surrounding relatively inaccessible areas. Due to past and present ROW and railroad construction and use, some of the forested areas around the residences are virtually inaccessible to modern timber harvesting equipment. Additionally, much of the natural areas within this forest type have experienced frequent disturbance in the past, resulting in poorly stocked timber of poor quality, offering very little opportunity for forest management at this time.

MANAGEMENT RECOMMENDATIONS:

There is no recommended forest management for this forest type. Instead, the city should allow the natural areas around the residences and infrastructure to develop naturally. The natural development will allow for continued development of positive aesthetics in the area, which is valuable to the citizens that reside in the immediate vicinity. Additionally, foregoing any equipment operation and management will help protect the historical sites found scattered around the area, and the soil and water quality of the wetter locations.

RECOMMENDED TREATMENTS SUMMARY TABLE

The following table lists the unique forest types found on this ownership and the type of forest management activities that are recommended in each. Specifics on the timing of each recommended harvest can be found on the Parcel Maps included with this plan, or in the geodatabase maintained by the landowner's forester.

Forest Type	Prescribed Management
A, Am	Modified Clearcut
C	Patch Clearcut or Strip Clearcut
Km	Individual Tree Selection / Seed Tree
M, Ma, Mb, Mk	Individual Tree Selection
Pa	Species Removal
Wk	No Active Management
O	No Active Management
XL, XW	No Active Management
XU	No Active Management
ROW	No Active Management
RES	No Active Management

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SECTION IV: GLOSSARY AND APPENDICES

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GLOSSARY

Agroforestry - a land-use system that combines both agriculture and forestry in one location.

Basal Area (Tree) - cross sectional area of a tree at 4.5 feet off ground in units of square feet (ft_2).

Basal Area (Forest) - basal area of all trees per acre summed up, in units of ft_2/acre; measure of density.

Biomass - harvesting and using whole trees or parts of trees for energy production.

Birdseye or **Bird-eye -** an abnormality in the grain of wood, most commonly sugar maple, that creates a propensity of small knots visible throughout sawn lumber. Birdseye was once a defect but now is a high-value product when found in quality sawlogs. The mere presence of birdseye in a log does not automatically increase its value exponentially, buyers of birdseye consider many factors when setting prices.

Board Foot - a measure of volume 1 foot by 1 foot by 1 inch or 144 cubic inches of wood.

Bolt - 8-foot-long piece of wood of a quality that can be sawn into lumber but not meeting agreed-upon standards to be classified as a sawlog. Bolts typically either have a smaller diameter than standard sawlogs, or do not have the grading faces to meet sawlog standards.

Browse - parts of woody plants, including twigs, shoots, and leaves, eaten by forest animals.

Bucking - the process of cutting a felled tree into merchantable segments, usually at least 8 feet in length. Careful bucking decisions by an experienced operator can maximize the yield of quality sawlogs

Buncher or **Feller-Buncher** - a harvesting machine, typically on tracks, that can cut multiple trees and lay them in bunches in the woods to be brought to the landing by a skidder. The cut trees may be delimbed by chansaw operators in the woods, or may be limbed at the landing by a slasher, processor, or delimber. A buncher may also be called a **hot saw**.

Canopy - the top layer of leaves and branches in the forest, consisting of the overstory trees.

Carbon Cycle - the biogeochemical cycle to exchange carbon between the biosphere and atmosphere by means of photosynthesis, respiration, and combustion.

Clay Soil - soil textural class consisting of mineral fragments (less than or equal to 0.002 millimeters in diameter). Clay soils are very fine and poorly drained. This means that they hold excessive water during wet times of the year.

Clearcut - the harvest of all the trees in an area to reproduce trees that require full sunlight. Reproduction following a clearcut may consist of stump and root sprouts (as in the case of red maple and aspen, respectively), seed (as in the case of spruce and fir) or artificial (as in the case of a red pine plantation).

Coarse Woody Debris - down and decaying trees on the forest floor. Coarse woody debris is generally larger than eight inches in diameter and eight feet long.

Cord - a unit of wood cut for fuel or fiber that is equal to a stack 4 x 4 by 8 feet long or 128 cubic feet; however a cord does not actually contain 128 cubic feet of wood due to bark and empty space between logs. A **Face Cord** is a unit of measurement consisting of a stack of wood measuring 4 feet high x 8 feet wide x a shorter length, typically between 12 and 24 inches and cut for fuelwood. A **Lake States Cord** is a cord of wood having a length of 100 inches (8.33 feet). The Lake States Cord

was developed at a time when the extra volume was intended to pay for the costs of hauling the wood to the mill.

Cordwood - small diameter or low-quality wood suitable for firewood, pulp, or chips.

Crop Tree - a young tree of a desirable species with certain desired characteristics, typically a tree that is capable of producing at least one Grade 2 or better sawlog.

Crown - the uppermost branches and foliage of a tree.

Cruise - a forest survey used to obtain inventory information and develop a management plan.

Cull - a tree that has no timber value as a result of poor shape or damage. Large cull trees may have high value for wildlife or aesthetics.

Curl - a grain abnormality, often found associated with birdseye, that creates a wavy appearance in cut lumber. Curl is eye catching but not quite as valuable as birdseye. Curl is most commonly found in red maple and sugar maple but may be found in other species as well. Like birdseye, the mere presence of curl does not automatically increase the value of a log.

Cut-to-Length Logging - modern, and typically highly mechanized, system of logging which typically consists of one processor and one forwarder. The processor cuts the trees down and then cuts them into segments based on quality and product specifications, and the forwarder hauls them to the landing. In high-value northern hardwood, oak, or pine stands, chainsaw operators may be involved in the felling and bucking of trees in order to maximize value.

Dendrochronology - the study of forest growth, climate patterns, and past forest fires using the scars and other evidence observed in the annual growth rings of trees.

Diameter at Breast Height (DBH) - diameter of a tree trunk taken at 4 1/2 feet off the ground.

Diameter-Limit Harvest - a timber harvest in which all trees over a specified DBH may be cut. Diameter-limit harvests do not consider tree quality and may harvest excellent-quality trees with potential to increase in value while retaining poor-quality smaller trees. Diameter-limit harvests are generally not considered an acceptable silvicultural method.

Ecology - the study of how living things interact with each other and the non-living parts of their environment.

Ecosystem - the living and non-living components that make up a biological community.

Endangered Species - a species in danger of extinction.

Even-Aged Stand - a stand in which the age difference between the oldest and youngest trees is minimal (<10 years).

Forest Stand Improvement (FSI) - any practice that increases the health, composition, value, or rate of growth in a stand. Also called Timber Stand Improvement when the focus is on increasing timber volume and value**.**

Forwarder - a logging machine, typically on rubber tires that has a grapple boom to pick up cut logs in the woods and carry them to the landing. Forwarders are typically paired with processors and have relatively low impact on a site compared to a conventional skidder.

Group Selection - harvesting groups of trees to open the canopy and encourage development of uneven-aged stands that include species with moderate to high sunlight demands.

Habitat - the ecosystem in which a plant or animal lives and obtains food and water.

Habitat Type – A particular association of trees and plants that is commonly associated with, or indicative of, a unique set of site conditions and potential for forest growth. Analysis of the habitat type of a particular stand can help inform management decisions. The concept of habitat types has been developed to assess the true potential of a site regardless of past forest management, this is why it is heavily connected to the assemblage of understory plants.

Hardwoods - a general term encompassing broadleaf, deciduous trees.

High Grading - to remove all good quality trees from a stand and leave only inferior trees. This practice is not considered sound forestry because it focuses only on maximizing current revenue without consideration of future quality and value.

Intolerance - characteristic of certain tree species that does not permit them to survive in the shade. Examples of intolerant species include aspen, white birch, red pine, jack pine, and red oak.

Landing - cleared area where logs are processed, piled, and loaded for transport to a sawmill.

Landscape Management – Management that considers how different parts of the landscape interact to provide wildlife habitat, clean water, and other outcomes. Landscape management must often occur above the individual property ownership level and therefore is difficult to coordinate.

Loam – soil textural class consisting of a mix of clay, silt, and no more than 50% sand.

Log Rule - a method for estimating the volume of lumber (in board feet) that may be sawn from a particular tree or log by using its diameter and length. Scribner, Doyle and the International 1/4-inch rule are common log rules used in Michigan. A log that scales a certain volume may yield more or less lumber than the rule estimates due to variations in the log, skill of the sawyer, and even inaccuracies of the rule being used. Log rules were devised in the early days of logging to create a basis on which to measure logs and set prices.

Lump-Sum Sale - a timber sale in which an agreed-on price for all standing trees designated for harvest is set before the wood is removed (as opposed to a scaled, mill tally or unit sale).

Mast - nuts and seeds such as acorns, beechnuts, and chestnuts that serve as food for wildlife.

Mid-Tolerant - tree species that can regenerate under partial forest canopy. Examples of mid-tolerant species include yellow birch, basswood, white pine, and red maple.

Mature – the point in a tree's life cycle at which it has reached optimal age, size, quality, vigor, or some combination of these attributes. The definition of maturity is dependent upon tree species, site conditions, and landowner objectives. In an industrially-managed aspen forest, 40-year-old trees may be considered mature, while on a parcel being managed for production of coarse woody debris for wildlife habitat, 40 years old is not even halfway to the target age.

Merchantable – tree that meets size or quality specifications to be sold for a particular product.

Muck – soil texture consisting of poorly-decomposed organic matter that is typically saturated with water for all or most of the year. Muck forms in areas where the biological processes of decomposition are very slow due to low oxygen and highly acidic conditions.

Northern Hardwoods – forest type consisting primarily of sugar maple or beech with lesser amounts of red maple, basswood, yellow birch, white ash, red oak, and other species.

Overmature - trees that have declined in growth rate because of old age and loss of vigor.

Overstocked - trees are so closely spaced that they are not growing at their full potential due to competition for resources.

Poletimber - trees having a DBH ranging from 5 to 11 inches.

Prescribed Fire - an intentional and controlled fire used as a management tool used to reduce hazardous fuels or unwanted understory plants (invasive, undesirable species, etc.).

Processor - A timber harvesting machine that may have steel tracks or rubber tires and that is capable of cutting down trees, delimbing them, and cutting them into pieces of a given length to be sold.

Productive Forest - forest capable of producing 20 cubic feet of wood per acre per year.

Pulpwood - wood suitable for use in paper manufacturing.

Regeneration - the process by which a forest is reseeded and renewed, or the size class of a forest consisting of trees having a DBH of less than 5 inches.

Riparian Forest Buffers - strips of land along stream banks where trees, shrubs and other vegetation are planted and managed to capture erosion from agricultural fields. Also known as **Riparian Management Zone (RMZ)** or **Streamside Management Zone (SMZ)**.

Salvage Harvest - the removal of dead, damaged, or diseased trees to recover value. In the event of a fire or other natural disaster, or severe insect or disease outbreak, salvaging should occur as soon as possible to minimize losses to staining and decay. Oftentimes a significant portion of volume is lost in a fire or other event that warrants a salvage harvest.

Sapling - a tree at least 4 1/2 feet tall and between 1 inch and 4 inches in DBH.

Sawlog - log large enough to be sawn into lumber, usually larger than 10 inches in diameter on the small end and at least 8 feet long.

Sawtimber Stand - a stand of trees having an average DBH greater than 11 inches.

Scaled Sale or **Unit Sale** - a timber sale in which the buyer makes regular payments based on mill tally and receipts.

Scarification - The act of physically disturbing the surface of the soil to encourage regeneration of species with light seeds that require contact with mineral soil to germinate and grow. Jack pine, white birch, and red pine benefit from scarification.

Sealed-Bid Sale - a timber sale in which buyers submit secret bids for a predetermined harvest area and volume of timber. Sealed-Bid Sales should always have a clear deadline and bid opening time. Bids submitted after the deadline should be rejected to be fair to all bidders.

Seed Tree Harvest - harvest that retains only a few trees per acre (generally less than 20 per acre depending on species and landowner objectives). Those trees retained should be healthy, vigorous, and capable of producing seed to regenerate the stand. The objective of a seed tree harvest is to regenerate an even-aged stand of trees with high sunlight demands. In some cases, the seed trees that are retained may never be harvested.

Selection Harvest - harvesting single trees or groups at regular intervals to maintain uneven-aged forest. Selection harvesting allows land managers a great deal of control over site conditions to regenerate shade tolerant or mid-tolerant species. In many selection harvests, each tree to be harvested is marked with paint.

Shelterwood Harvest - a two-staged harvest method intended to regenerate species with moderate to low shade tolerance. The first harvest in a shelterwood system is known as a prep cut; typically, this harvest brings canopy cover down to approximately 50 percent. When regeneration reaches adequate density and size, the overstory is removed to give the regeneration full sunlight to develop into a new stand. In Michigan, the shelterwood harvest is most commonly used to regenerate red oak, but may have applications for other species as well.

Silvopasture - planted trees and improved forages to provide suitable pasture for grazing livestock.

Silviculture - the practice of controlling forest composition, structure, and growth to maintain and enhance the forest's utility for a given purpose. Silviculture must consider a range of factors including management goals and objectives, site conditions, species characteristics, and a bit of guesswork to account for unforeseeable events.

Site Index - measure of quality of a site based on the height of a dominant tree species at a given age. In Michigan most site indices are based on the average tree height at age 50.

Site Preparation - treatment of an area prior to reestablishment of a forest stand to control vegetative competition or expose a suitable seed bed for the desired species. Site preparation may consist of herbicide application, scarification, or manual cutting of competing vegetation with a chainsaw or other hand tools.

Skidder - a rubber-tired machine with a cable winch or grapple to drag logs out of the forest. Skidders are usually used only in whole-tree harvest operations and can have very high impacts on some sites. In certain forest types, especially white birch, jack pine, and red pine, using skidders can help to create a seed bed for regeneration. Skidders may also be modified to use for other treatments including pesticide application, firefighting, and scarification.

Slash - branches and other woody material left on a site after logging.

Slasher - A logging machine that typically operates at the log landing. Skidders bring trees to the landing and the slasher cuts them into merchantable segments based on quality and product specifications. A slasher typically consists of a grapple boom and a large rotating sawblade.

Snag - a dead tree that is still standing and that may provide food and cover for a variety of wildlife species.

Softwood - any gymnosperm tree including pines, hemlocks, larches, spruces, firs, and junipers.

Species of Special Concern - not threatened or endangered yet, but has low or declining populations.

Species Removal Harvest - A harvest in which all trees of a given species are designated for harvest. Typical species designated for harvest include aspen, spruce, and fir in a hardwood stand.

Stand - a group of forest trees of sufficiently uniform species composition, age, and condition to be considered a homogeneous unit for management purposes. An individual stand is typically geographically contiguous, but may consist of multiple units, or polygons, on a parcel of land.

Stand Density - the quantity of trees per unit area, evaluated in basal area, crown cover, or stocking.

Stocking - the number and density of trees in a forest stand. Classified as poorly-stocked, overstocked, or well-stocked.

Stumpage Price - the price paid for standing forest trees and paid prior to harvest.

Succession - the replacement of one plant community by another over time in the absence of disturbance.

Sustainable - a practice that, based on current understanding of a natural system, may be repeated over and over at a particular interval without damaging the ability of a site to continue to meet the desired outcomes. What is considered sustainable on a particular site may change with time due to changes in landowner objectives, environmental conditions, or economic values. In this regard, sustainability may be thought of as a three-legged stool with the legs represented by economic outcomes, social values, and ecological concerns. If one of the three legs is compromised, the stool will not stand.

Sustained Yield - concept in forestry that considers the productive capacity of a site or stand, and losses due to natural mortality. In an economically and ecologically sustainable forest management system, harvest volume will not exceed total growth minus losses to mortality. **Maximum Sustained Yield** is a condition in which removals and mortality are approximately equal to growth.

Thinning - partial cut in an immature, overstocked stand of trees to increase the stand's value and growth. Thinning is typically implemented in even-aged stands.

Threatened Species - a species whose population is so small that it may become endangered.

Tolerance - the capacity of a tree species to grow in shade

Understocked - trees so widely spaced, that even with full growth, crown closure will not occur. Trees growing in understocked conditions often develop large branches which is undesirable from a timber production standpoint. From an economic standpoint, an understocked stand is not making full use of the site, and therefore is not growing to its full potential.

Understory - the level of forest vegetation beneath the canopy.

Uneven-Aged Stand - three or more age classes of trees represented in a single stand.

Veneer Log - a high-quality log of a desirable species suitable for conversion to veneer. Specifications for veneer logs may differ from those for standard sawlogs, and in some cases, veneer logs may be of a shorter length or smaller diameter than what is standard for a conventional sawlog.

Well-Stocked - stand where growing space is effectively occupied but there is still room for growth.

Whole-Tree Logging - Logging system that typically consists of a buncher, skidder, and slasher. Chainsaw operators may also be involved in various stages of this system depending on the quality and species of timber being cut.

Windbreaks - rows of trees to provide shelter for crops, animals or farm buildings.

APPENDIX

- Green Timber Consulting Foresters Timber Type-Size-Density Guide
- Parcel Maps
- Northern Long-Eared Bat Information
- Forest Health/Invasive Species Information

GTCF Timber Type Guide

Timber Types

A – Aspen
B – Birch
M – Northern Hardwoods
D – Central Hardwoods
E – Lowland Hardwoods
K – Oak
H – Hemlock
F – Spruce / Fir
C – Cedar
Q – Lowland Conifer
T – Bog Conifer
P – Natural Mixed Pine
W – Natural White Pine
Wp – Planted White Pine
R – Natural Red Pine
Rp – Planted Red Pine
J – Natural Jack Pine
Jp – Planted Jack Pine
S – Natural White Spruce
Sp – Planted White or Black Spruce
L – Planted Larch
O – Open
XL – Lowland Brush
XU – Upland Brush
XW – Water
XR – Road

1. Capital letter represents dominant timber type.
2. Lower case letter represents co-dominant timber type.
3. First number represents size / density of all merchantable stocking.
4. Second number describes the significance of co-dominant type
5. Co-dominant type only to be used if the presence of co-dominant type alters prescribed management.
6. **Size Class** is determined by the class with the highest basal area representation.
7. Stands with less than 20 ft^2/acre of merchantable stems should be considered seedling stands (size classes 1, 2 or 3).
8. **Density** is determined by the total basal area of **all** merchantable stems.

Example

Mf 6-2 – Represents an over stocked northern hardwood pole stand (majority of the basal area represent by trees ranging from 5-10 inches at DBH) with a total merchantable basal area greater than 100 ft^2/acre. Spruce / Fir well stocked regeneration (stems 1-4 inches at DBH) is the co-dominant type.

Size / Density

Seedling Stands: Determined by average DBH of tree stocking (1-4 inch DBH)
1 – Poorly Stocked Regeneration: 1-4 inch DBH (< 20 ft^2/acre) = <5 cords per acre
2 – Moderately Stocked Seedlings: 1-4 inch DBH (< 20 ft^2/acre) = <5 cords per acre
3 – Well-Stocked Seedlings: 1-4 inch DBH (< 20 ft^2/acre) = <5 cords per acre
Pole Stands: Determined by average DBH of basal area (5-10 inch DBH)
4 – Poorly Stocked Poletimber: 5-10 inch DBH (20-59 ft^2/acre) = ~5-15 cords per acre
5 – Well-Stocked Poletimber: 5-10 inch DBH (60-99 ft^2/acre) = ~15-25 cords per acre
6 – Overstocked Poletimber: 5-10 inch DBH (100+ ft^2/acre) = ~25+ cords per acre
Saw Stands: Determined by average DBH of basal area (11+ inch DBH)
& over 50% of basal area contains at least one, 8 ft. grade 3 sawlog
7 – Poorly Stocked Sawtimber: 11+ inch DBH (20-59 ft^2/acre) = ~5-10 cds & ~1-2 MBF / ac
8 – Well-Stocked Sawtimber: 11+ inch DBH (60-99 ft^2/acre) = ~10-20 cds & ~2-3 MBF / ac
9 – Overstocked Sawtimber: 11+ inch DBH (100+ ft^2/acre) = ~20+ cds & 3+ MBF / ac

CITY OF NEGAUNEE PROPERTIES LOCATOR

Marquette County, Michigan

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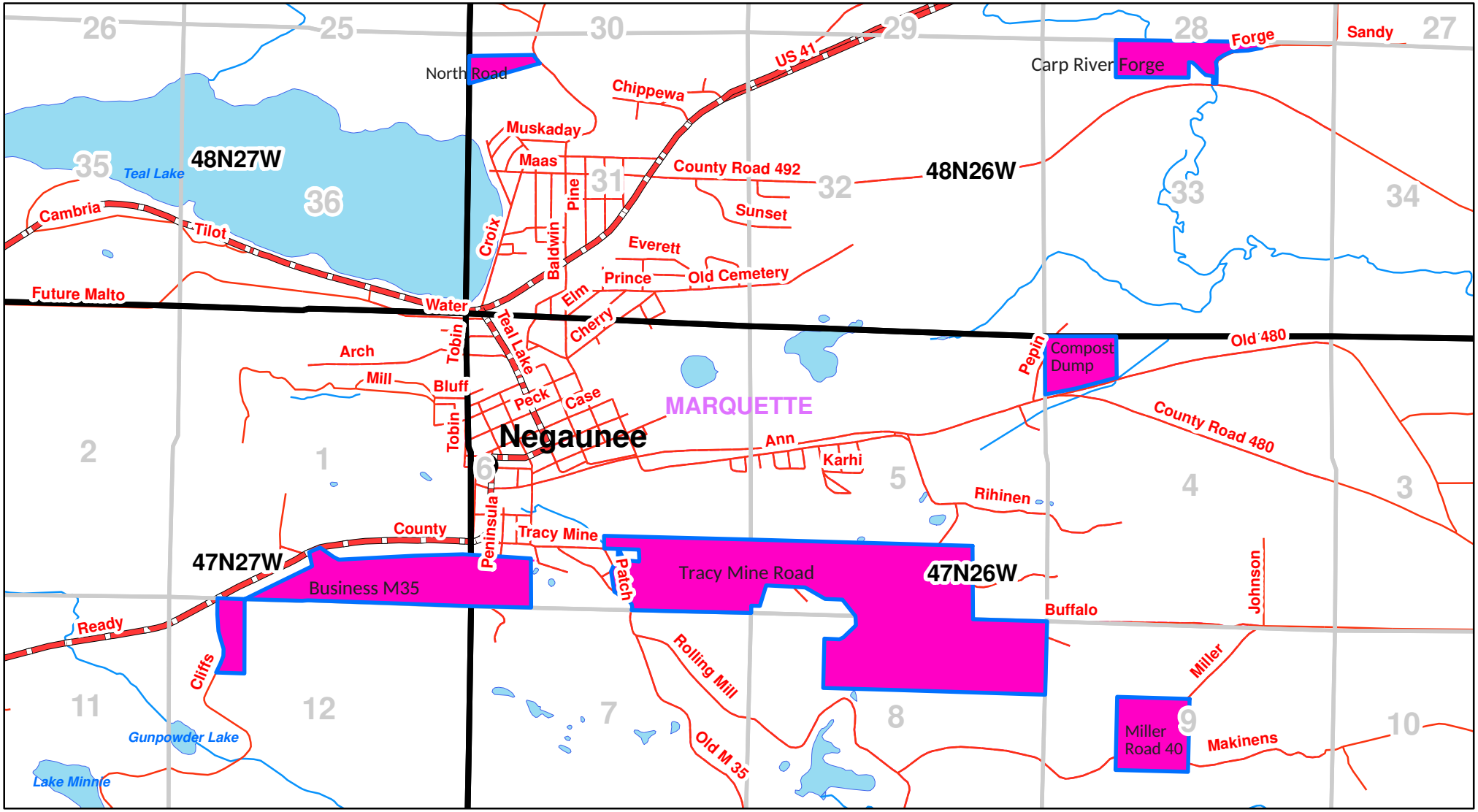

Legend

- Property Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River
- Lake

N

0 0.5 1 2 Miles

GREEN TIMBER

CITY OF NEGAUNEE TIMBER TYPE MAP

T47N R27W Sec 1 and 12, T47N R26W Sec 6

Portions of: S1/2 Sec. 1, NW1/4 NW1/4 Sec. 12, SW1/4 SW1/4 Sec. 6

Marquette County, Michigan

Business M35 Property

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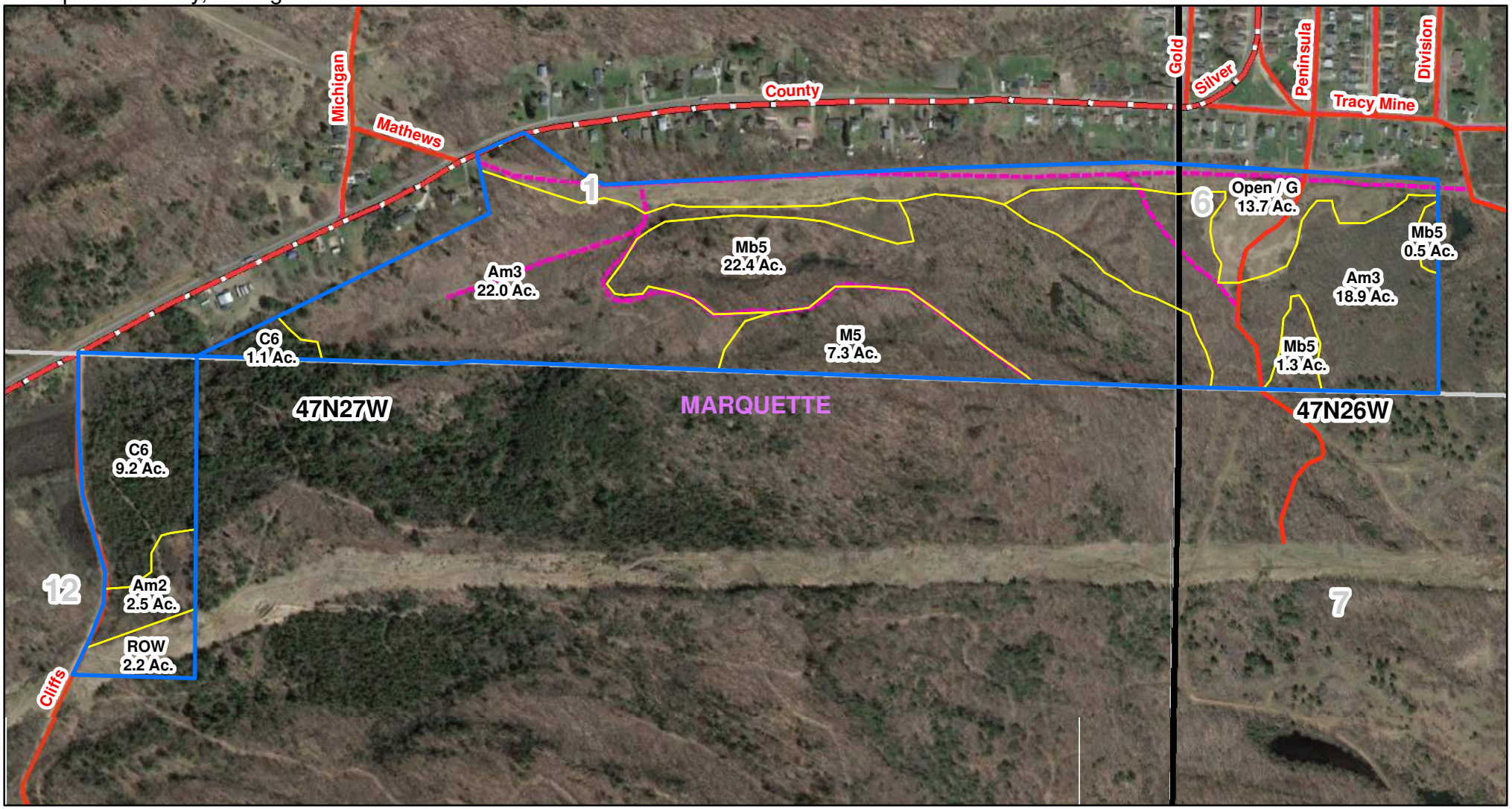

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

N

0 0.05 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 Miles

GREEN TIMBER

CITY OF NEGAUNEE TIMBER TYPE MAP

T48N R26W Sec 33

N1/2 NE1/4 NW1/4, Portion of NW1/4 NE1/4

Marquette County, Michigan

Carp River Forge Property

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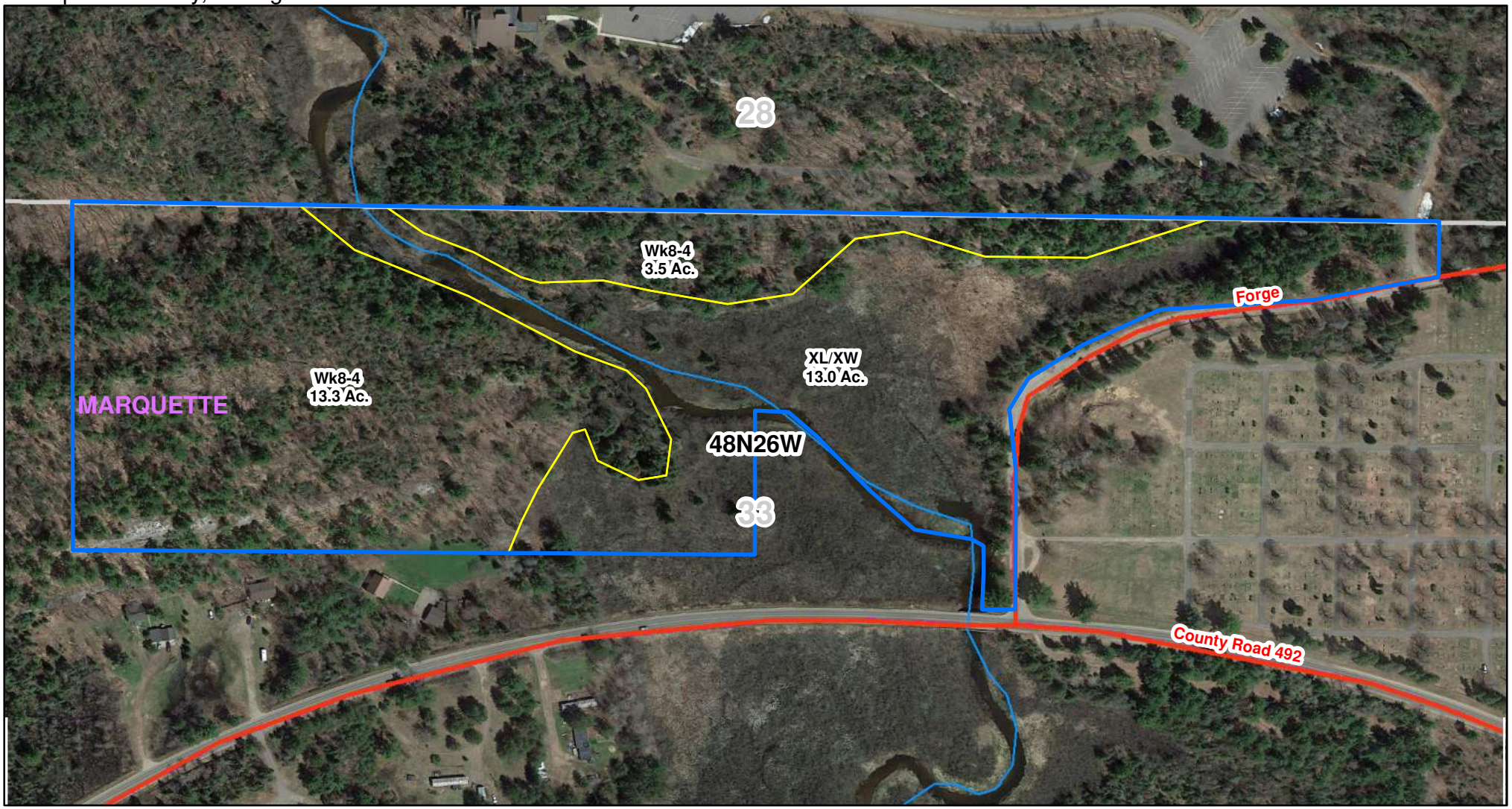

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

N

0 0.05 0.1 0.2 0.3 Miles

GREEN TIMBER

CITY OF NEGAUNEE TIMBER TYPE MAP

T47N R26W Sec 4

NW1/4 NW1/4 North of Co. Rd 480

Marquette County, Michigan

Compost Dump Property

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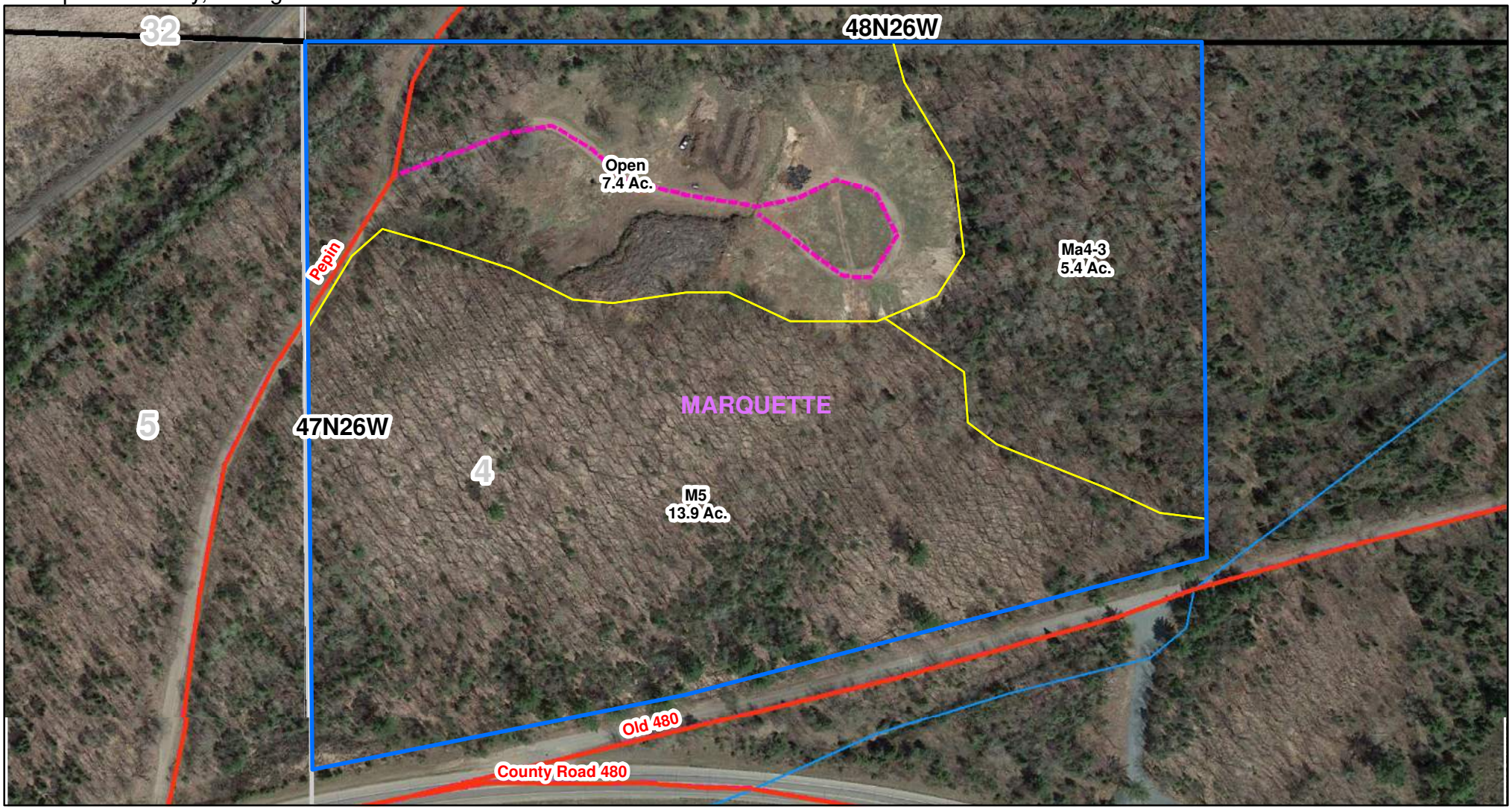

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

N

0 0.05 0.1 0.2 Miles

GREEN TIMBER

CITY OF NEGAUNEE TIMBER TYPE MAP

T47N R26W Sec 9

SE1/4 NW1/4

Marquette County, Michigan

Miller Road 40 Property

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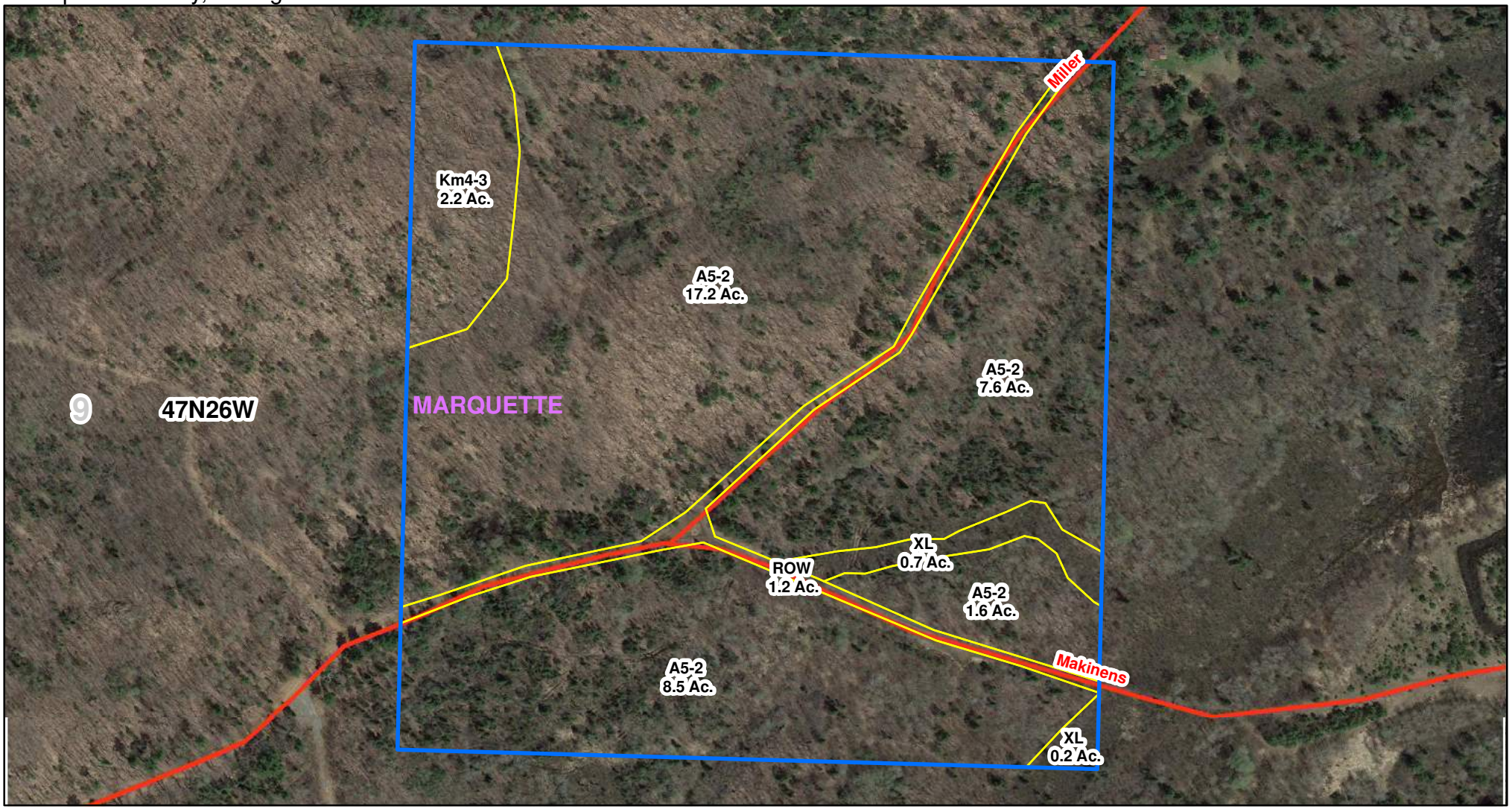

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

N

0 0.05 0.1 0.2 0.3 Miles

GREEN TIMBER

CITY OF NEGAUNEE TIMBER TYPE MAP

T48N R26W Sec 31

Portion of N1/2 NW1/4

Marquette County, Michigan

North Road Property

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Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

N

0 0.05 0.1 Miles

GREEN TIMBER

CITY OF NEGAUNEE TIMBER TYPE MAP

T47N R26W Sections 5, 6 and 8

Portions of: S1/2 SE1/4 Sec 6, S1/2 SW1/4 & SW1/4 SE1/4 Sec 5, N1/2 NE1/4 & frl NE1/4 NW1/4

Marquette County, Michigan

Tracy Mine Road Property

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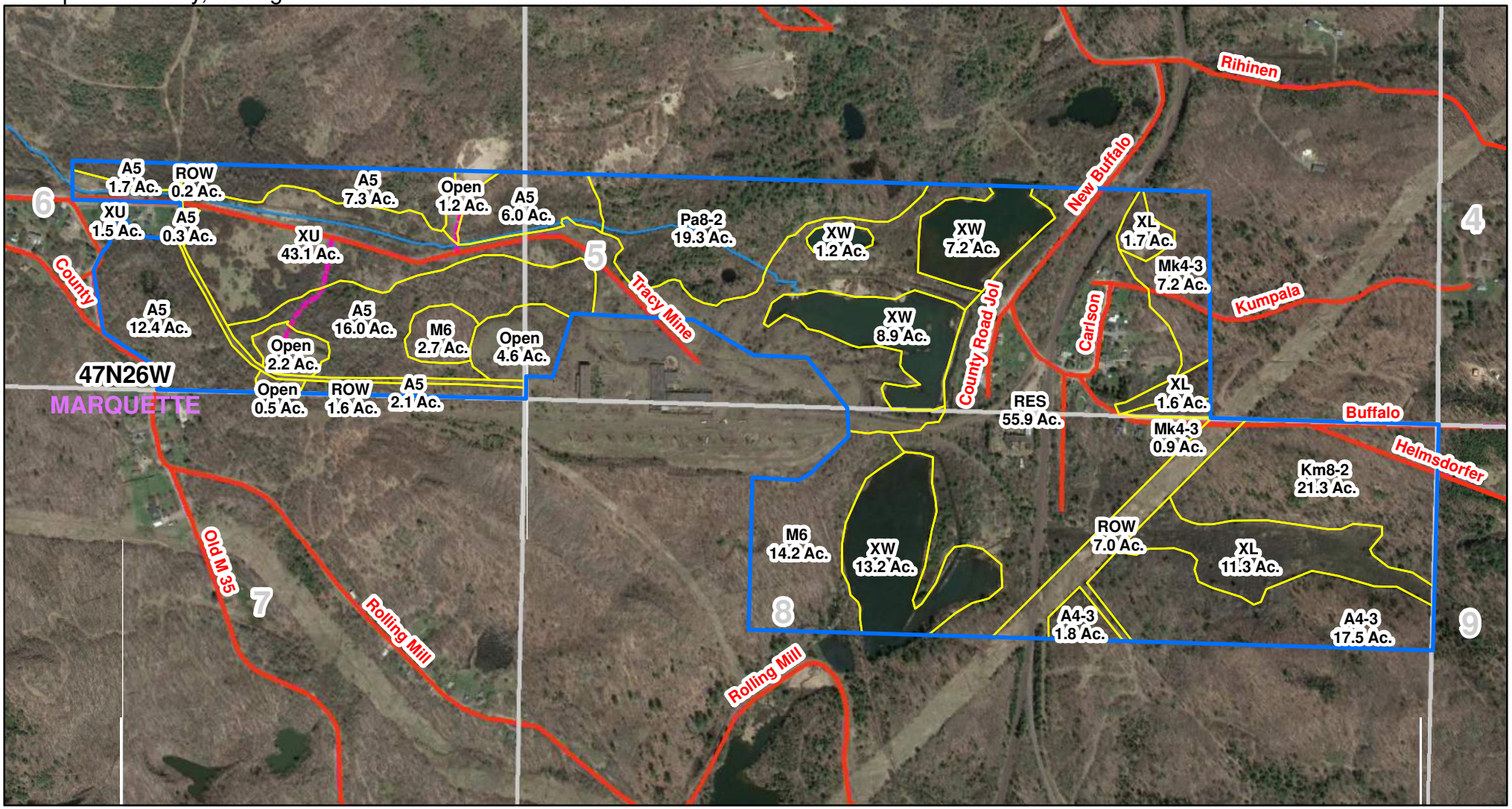


Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

N

0 0.05 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 Miles

GREEN TIMBER

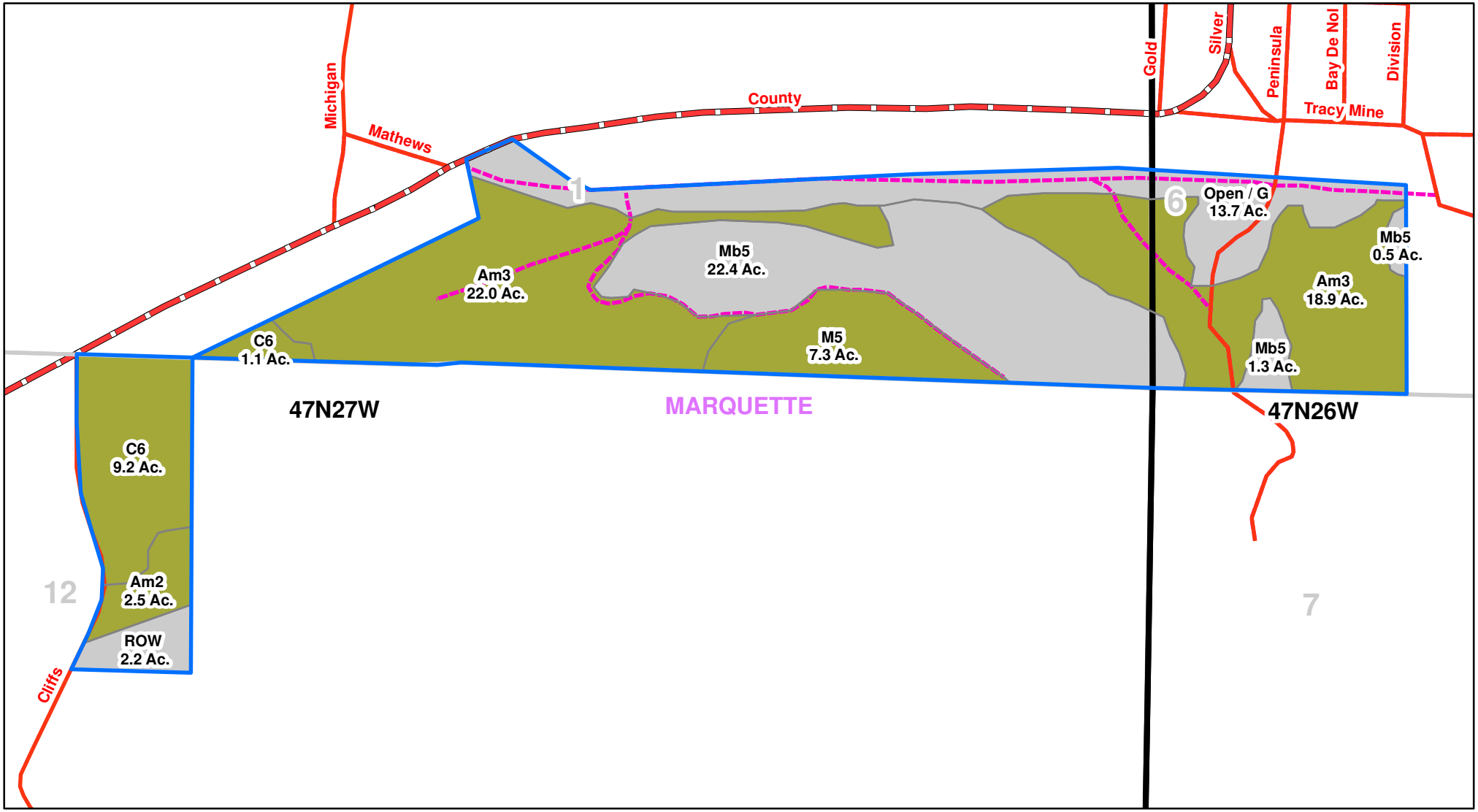
CITY OF NEGAUNEE HARVEST TYPES MAP

T47N R27W Sec 1 and 12, T47N R26W Sec 6

Portions of: S1/2 Sec. 1, NW1/4 NW1/4 Sec. 12, SW1/4 SW1/4 Sec. 6

Marquette County, Michigan

Business M35 Property



Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Types

- Individual Tree Selection
- Modified Clearcut
- Patch Cleacuts
- Species Removal
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TYPES MAP

T48N R26W Sec 33

N1/2 NE1/4 NW1/4, Portion of NW1/4 NE1/4

Marquette County, Michigan

Carp River Forge Property

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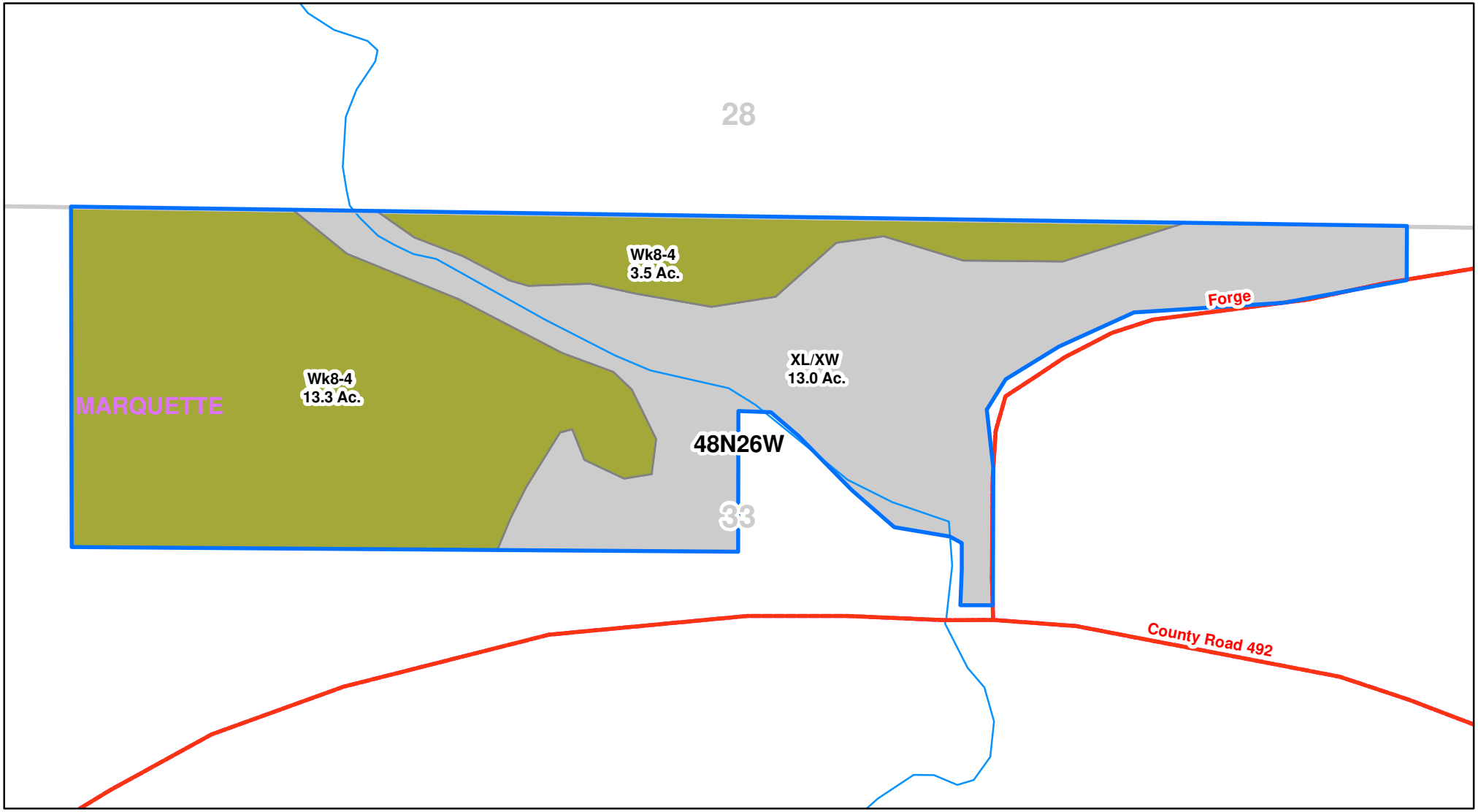

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Types

- Individual Tree Selection
- Modified Clearcut
- Patch Cleacuts
- Species Removal
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 0.2 0.3 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TYPES MAP

T47N R26W Sec 4

NW1/4 NW1/4 North of Co. Rd 480

Marquette County, Michigan

Compost Dump Property

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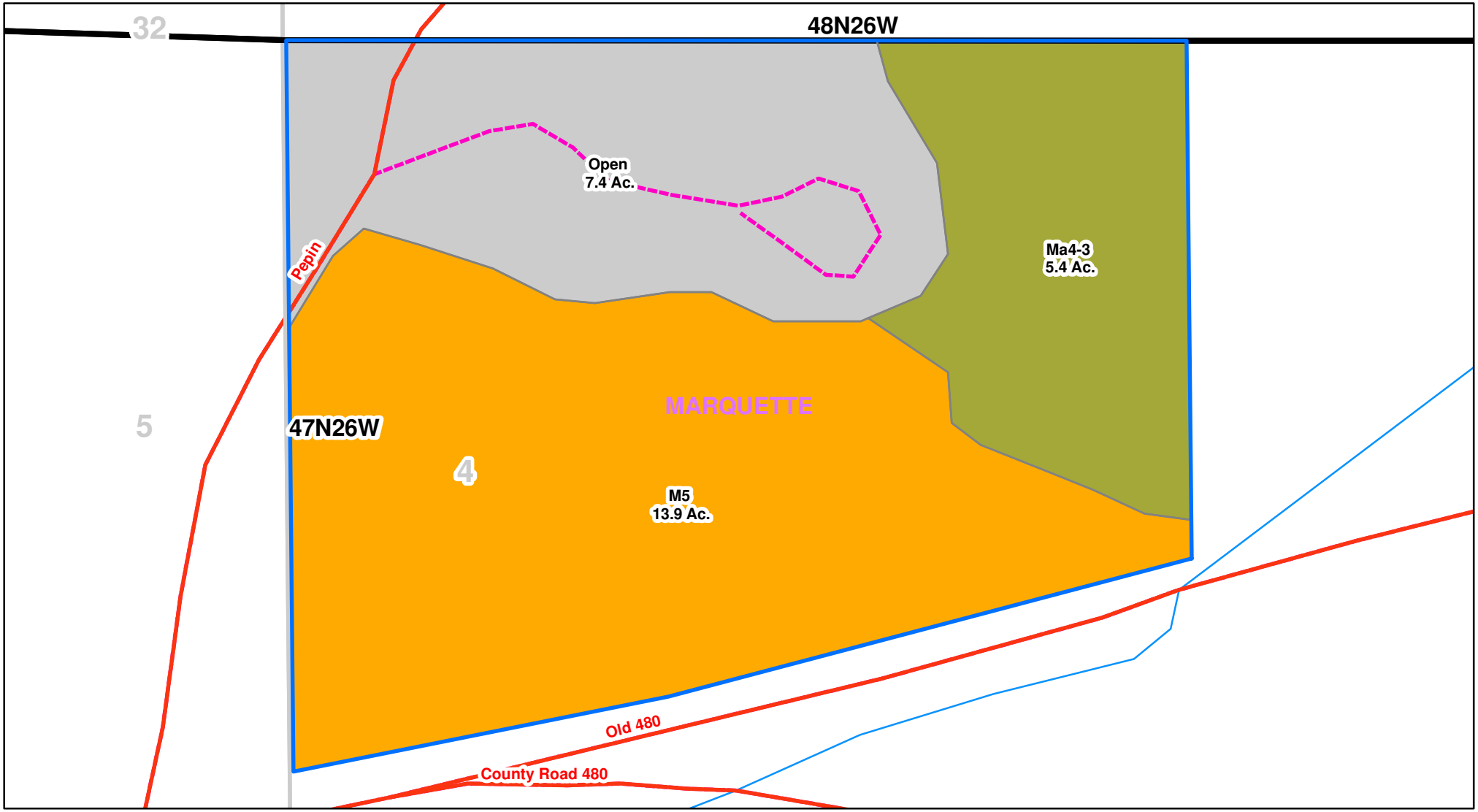

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Types

- Individual Tree Selection
- Modified Clearcut
- Patch Cleacuts
- Species Removal
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 0.2 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TYPES MAP

T47N R26W Sec 9

SE1/4 NW1/4

Marquette County, Michigan

Miller Road 40 Property

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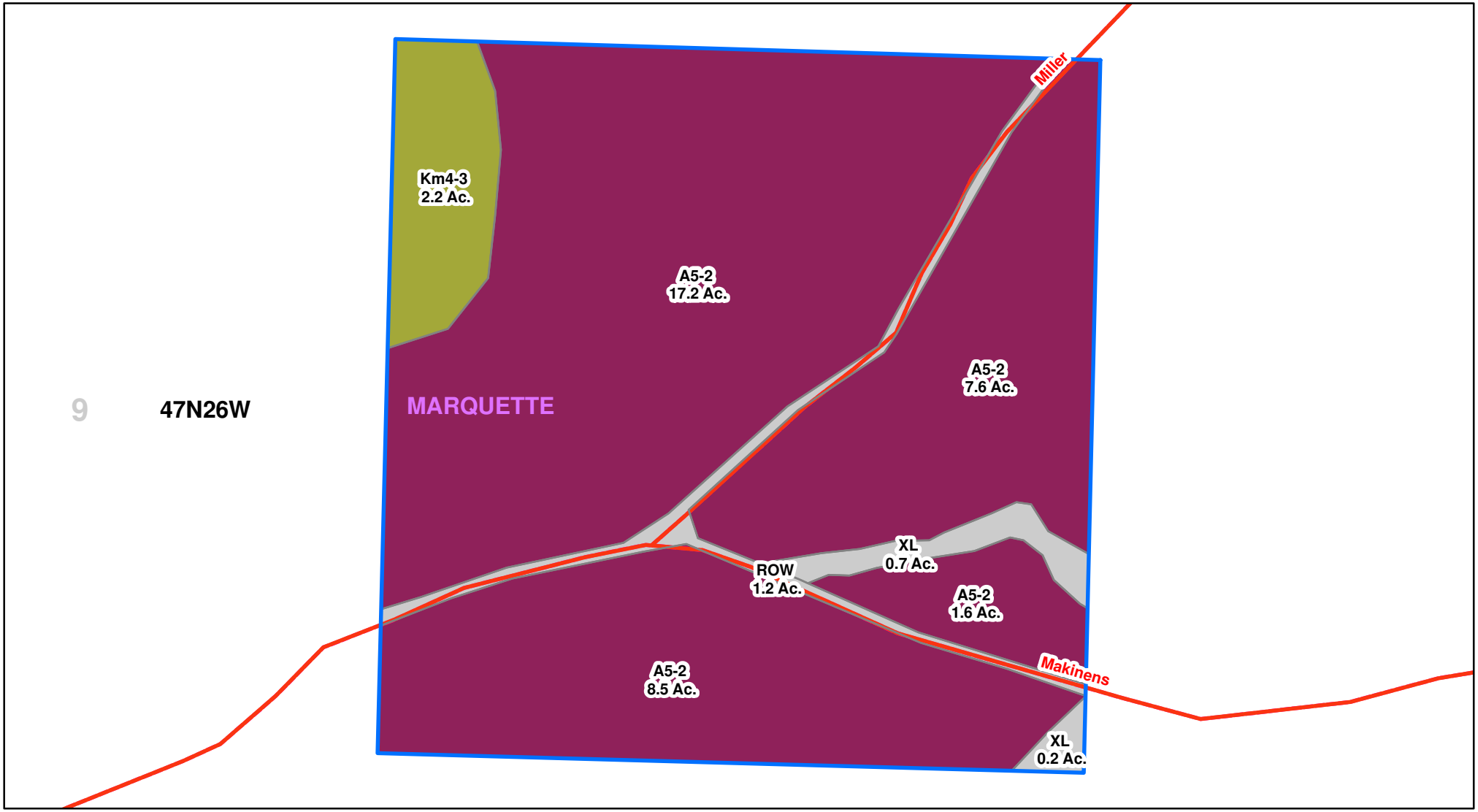

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Types

- Individual Tree Selection
- Modified Clearcut
- Patch Cleacuts
- Species Removal
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 0.2 0.3 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TYPES MAP

T48N R26W Sec 31

Portion of N1/2 NW1/4

Marquette County, Michigan

North Road Property

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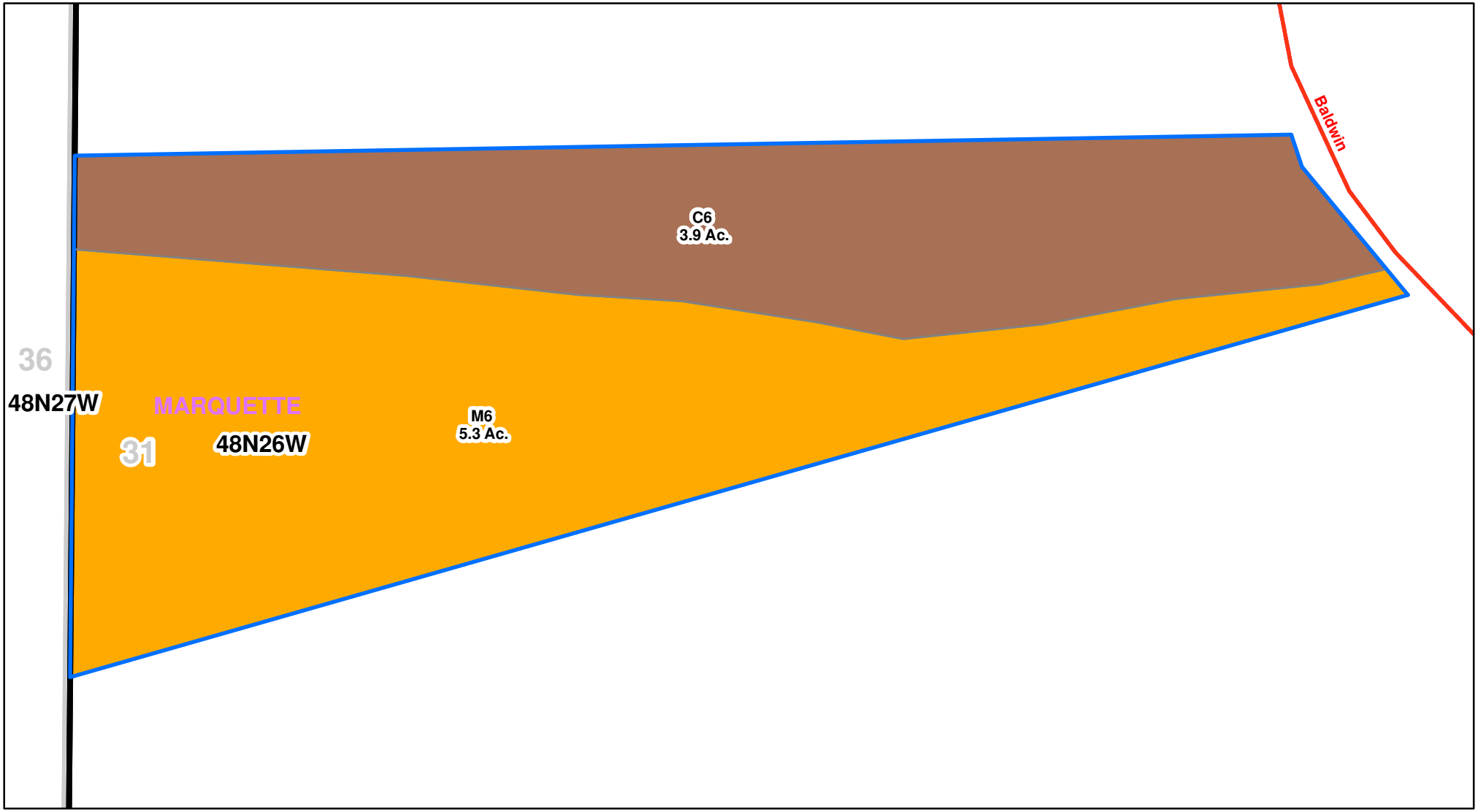

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Types

- Individual Tree Selection
- Modified Clearcut
- Patch Cleacuts
- Species Removal
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TYPES MAP

T47N R26W Sections 5, 6 and 8

Portions of: S1/2 SE1/4 Sec 6, S1/2 SW1/4 & SW1/4 SE1/4 Sec 5, N1/2 NE1/4 & frl NE1/4 NW1/4

Marquette County, Michigan

Tracy Mine Road Property

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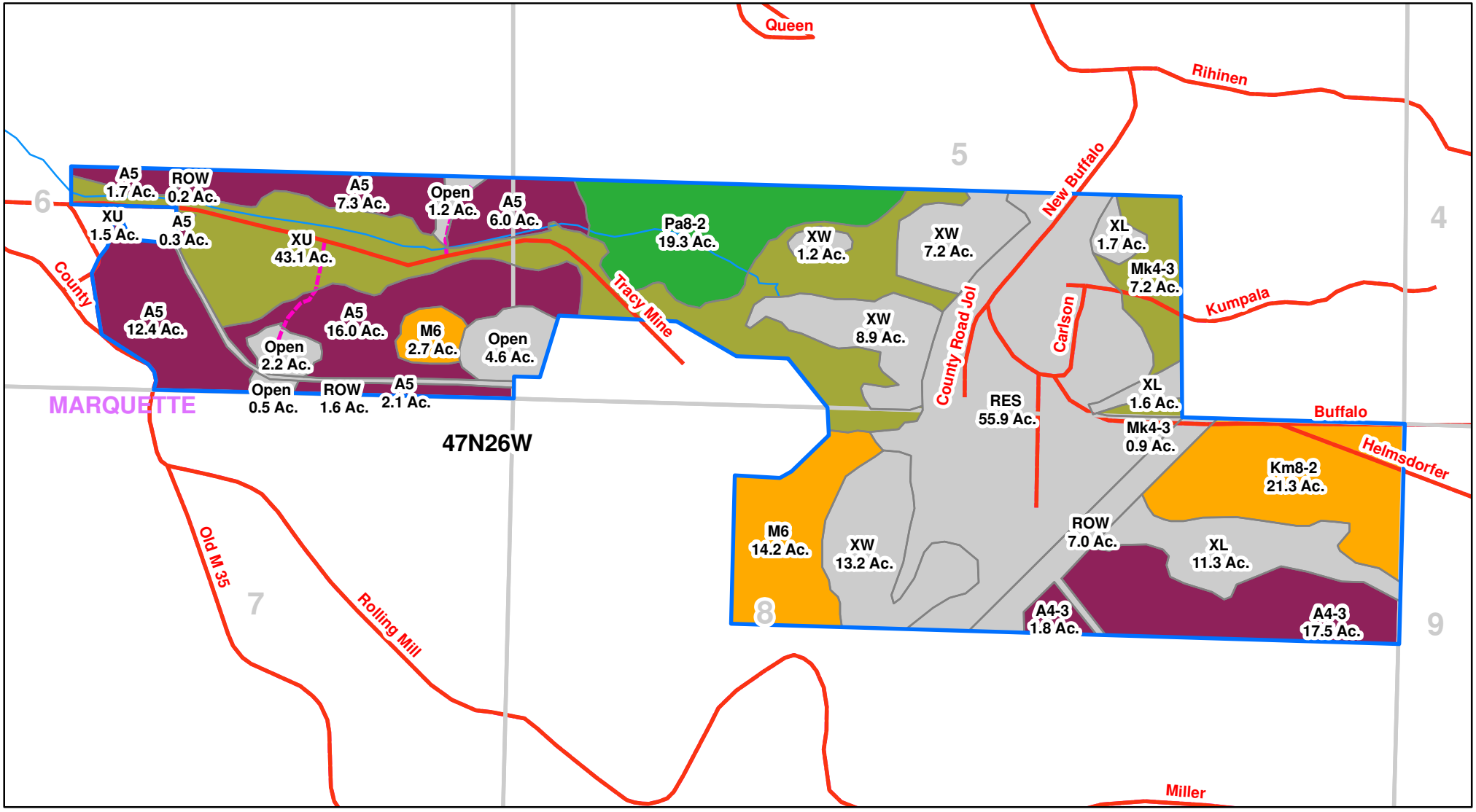

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Types

- Individual Tree Selection
- Modified Clearcut
- Patch Cleacuts
- Species Removal
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TIMES MAP

T47N R27W Sec 1 and 12, T47N R26W Sec 6

Portions of: S1/2 Sec. 1, NW1/4 NW1/4 Sec. 12, SW1/4 SW1/4 Sec. 6

Marquette County, Michigan

Business M35 Property

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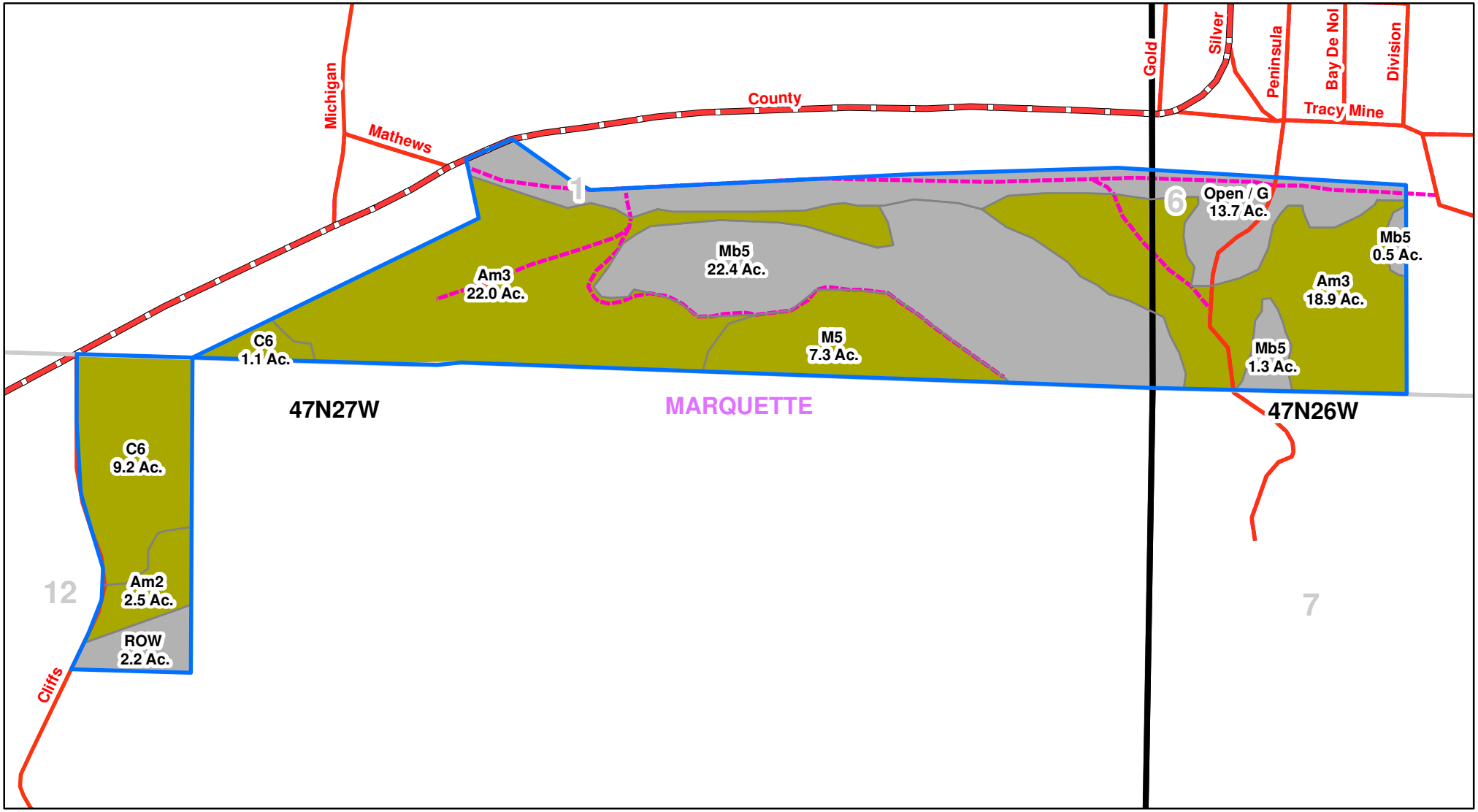

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Times

- 2023-2028
- 2037-2042
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TIMES MAP

T48N R26W Sec 33

N1/2 NE1/4 NW1/4, Portion of NW1/4 NE1/4

Marquette County, Michigan

Carp River Forge Property

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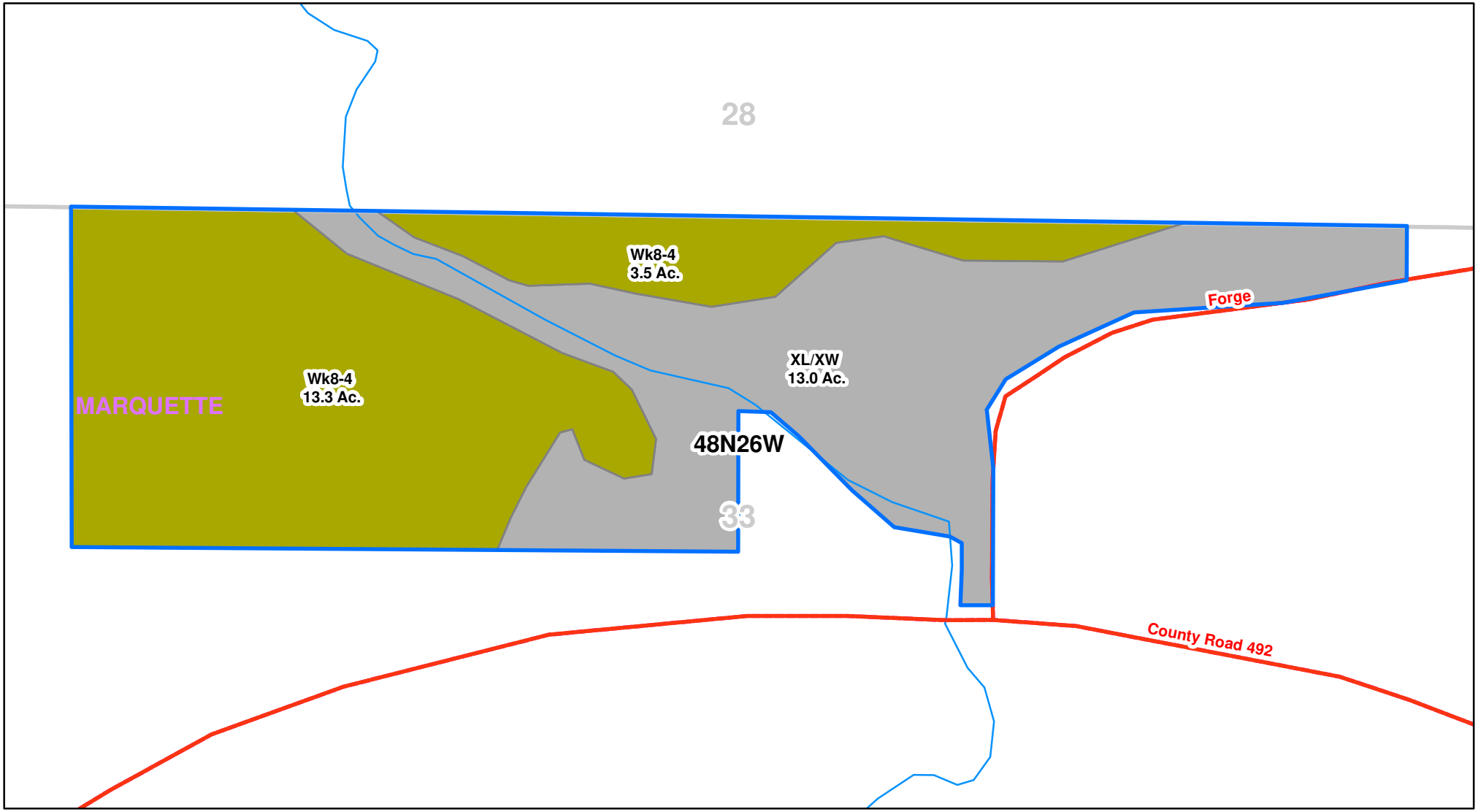

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Times

- 2023-2028
- 2037-2042
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 0.2 0.3 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TIMES MAP

T47N R26W Sec 4

NW1/4 NW1/4 North of Co. Rd 480

Marquette County, Michigan

Compost Dump Property

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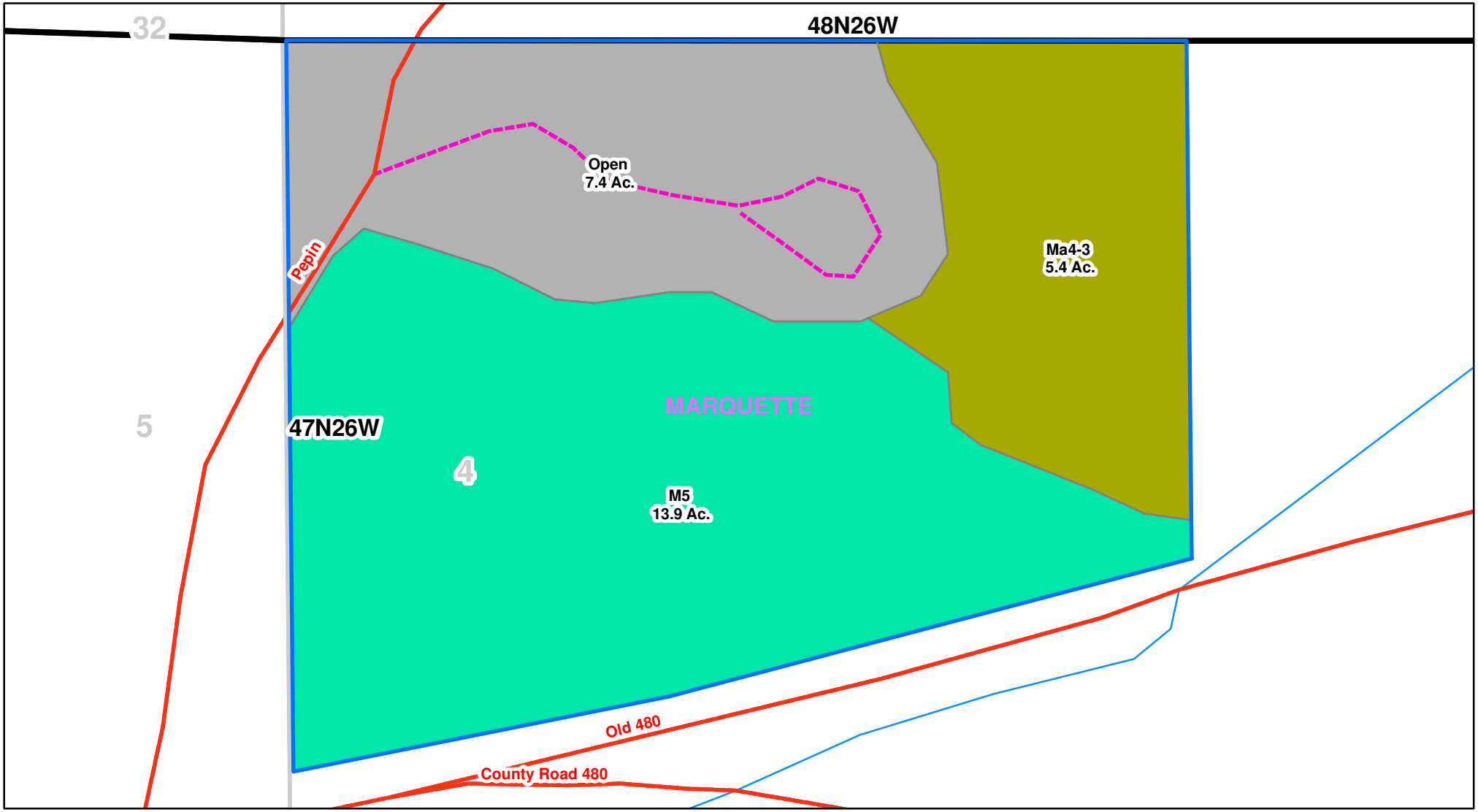

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Times

- 2023-2028
- 2037-2042
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 0.2 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TIMES MAP

T47N R26W Sec 9

SE1/4 NW1/4

Marquette County, Michigan

Miller Road 40 Property

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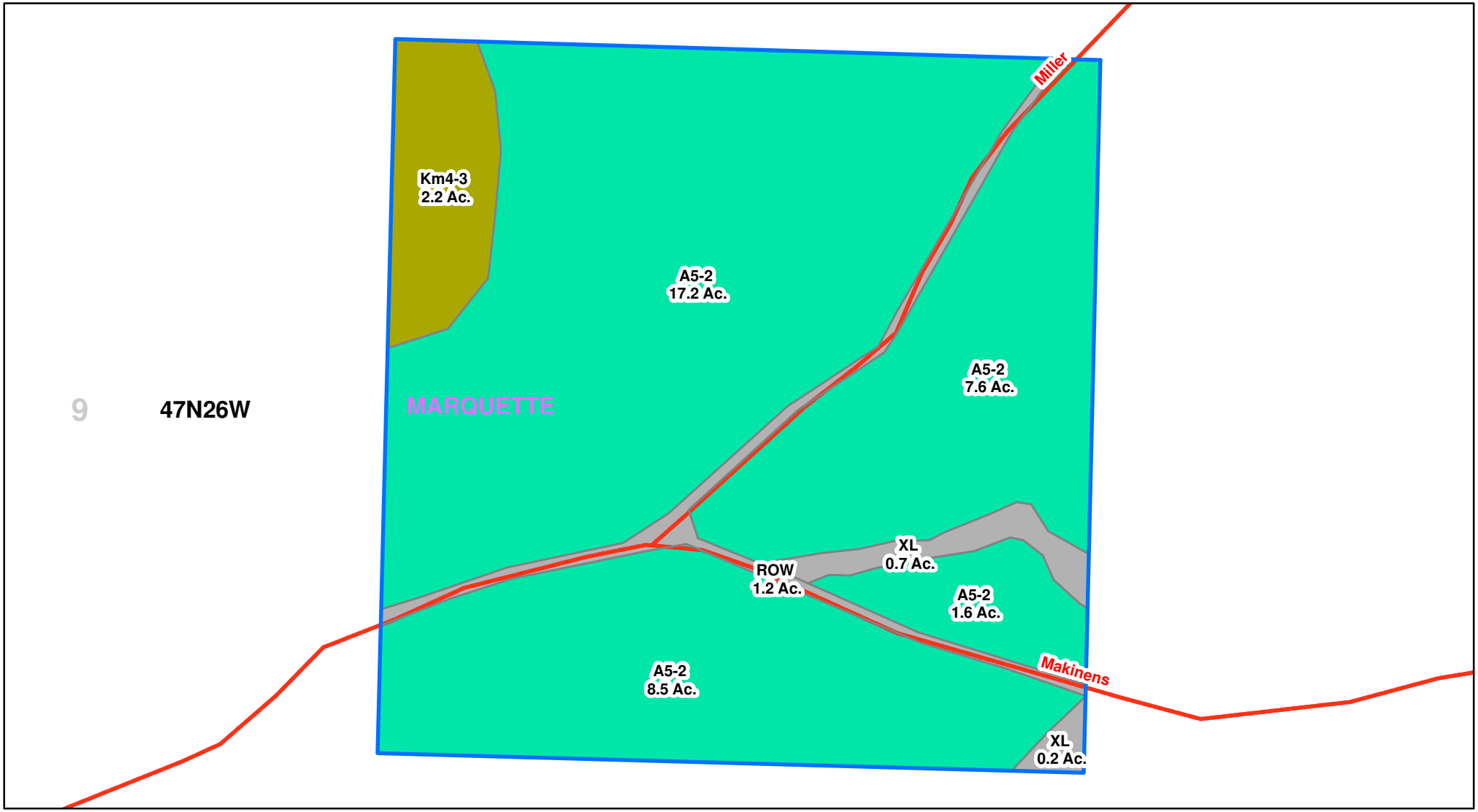

Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Times

- 2023-2028
- 2037-2042
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 0.2 0.3 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TIMES MAP

T48N R26W Sec 31

Portion of N1/2 NW1/4

Marquette County, Michigan

North Road Property

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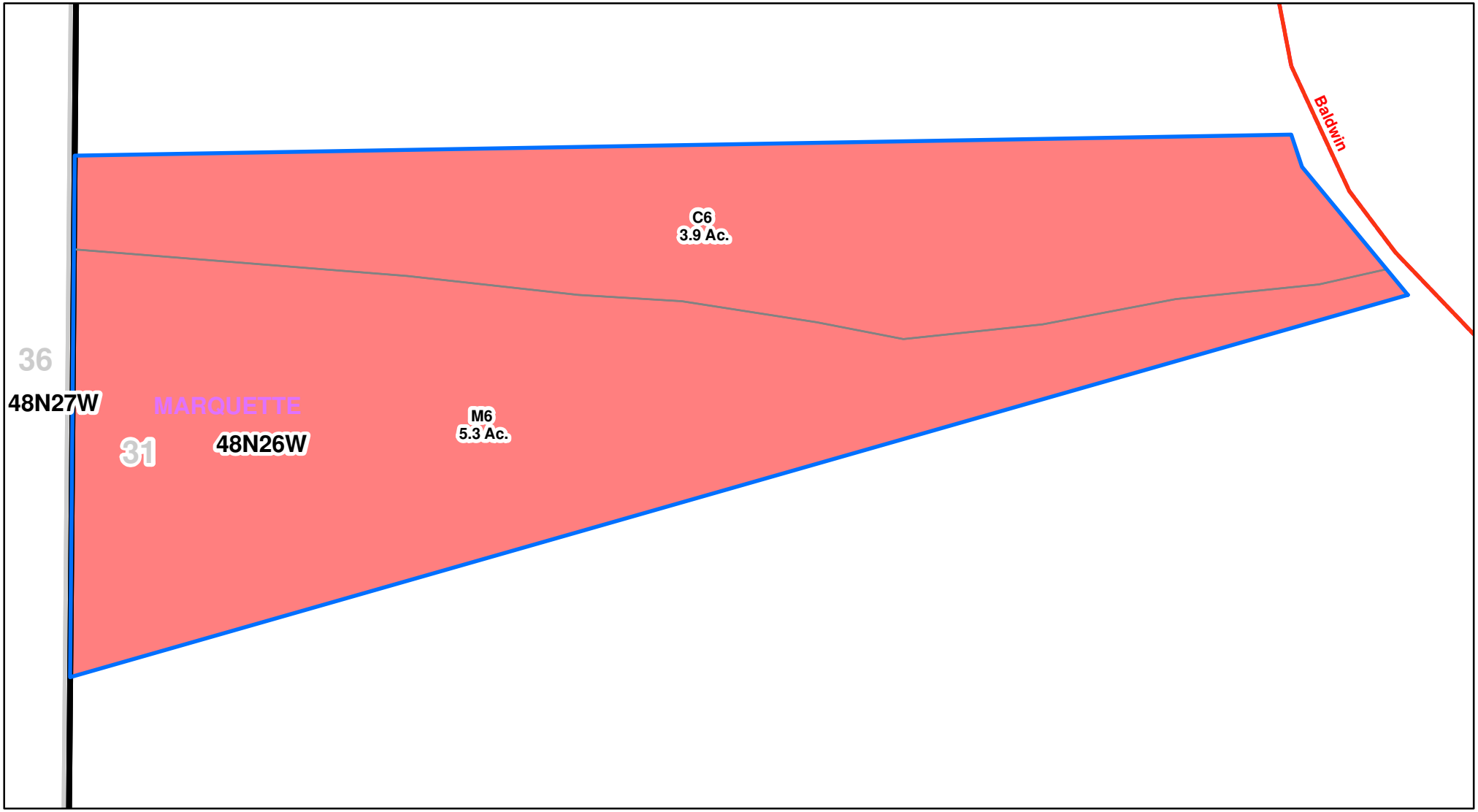


Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Times

- 2023-2028
- 2037-2042
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 Miles

GREEN TIMBER

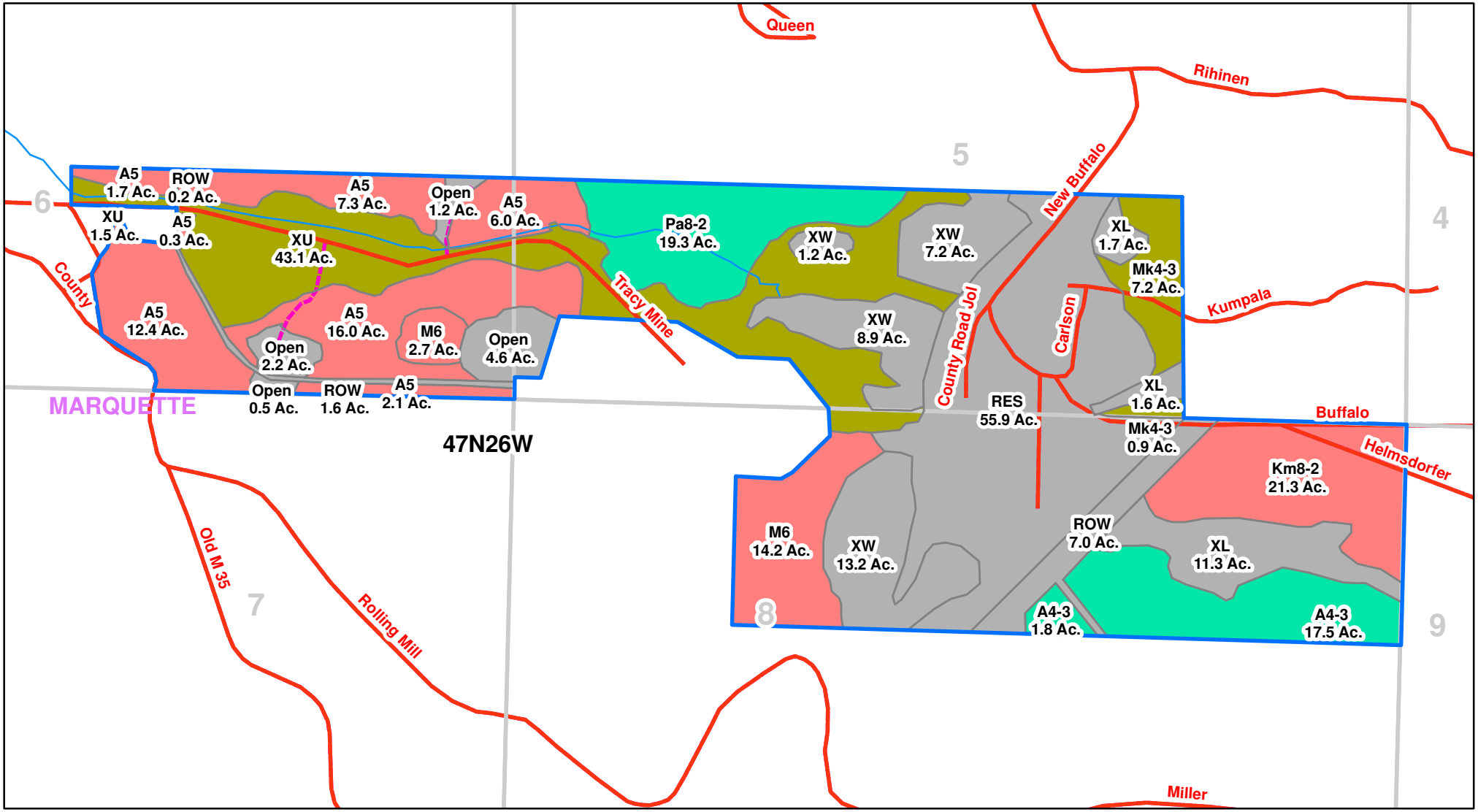
CITY OF NEGAUNEE HARVEST TIMES MAP

T47N R26W Sections 5, 6 and 8

Portions of: S1/2 SE1/4 Sec 6, S1/2 SW1/4 & SW1/4 SE1/4 Sec 5, N1/2 NE1/4 & frl NE1/4 NW1/4

Marquette County, Michigan

Tracy Mine Road Property



Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River

Recommended Harvest Times

- 2023-2028
- 2037-2042
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.05 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 Miles

GREEN TIMBER

CITY OF NEGAUNEE HARVEST TIMES OVERVIEW

Marquette County, Michigan

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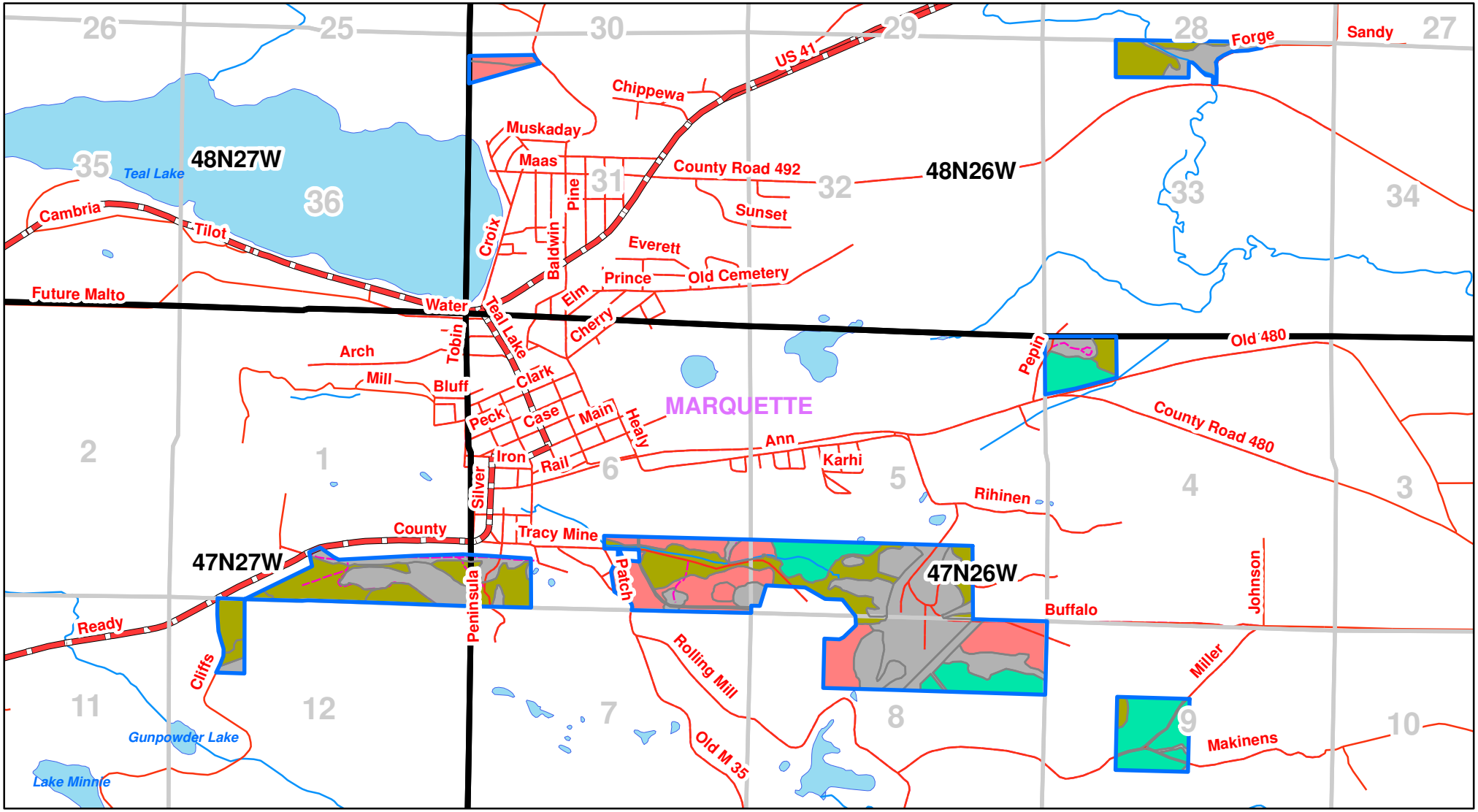


Legend

- Property Boundary
- Forest Type Boundary
- Town / Range
- Section
- Highway
- County Road
- Access Roads
- River
- Lake

Recommended Harvest Times

- 2023-2028
- 2037-2042
- Re-evaluate 2032, 2042
- No Active Management

N

0 0.5 1 2 Miles

GREEN TIMBER

United States Department of the Interior

FISH AND WILDLIFE SERVICE
East Lansing Field Office (ES)
2651 Coolidge Road, Suite 101
East Lansing, Michigan 48823-6316

IN REPLY REFER TO:

January 13, 2016

Dear Interested Party,

On January 14, 2016, the U.S. Fish and Wildlife Service will publish a final 4(d) rule in the *Federal Register* for the northern long-eared bat, a threatened species under the Endangered Species Act (ESA). This special rule under section 4(d) of the ESA provides flexibility to landowners, land managers, government agencies and others as they conduct activities in northern long-eared bat habitat. Northern long-eared bats were listed under the ESA as threatened in April 2015 due to the impacts of a deadly disease, white-nose syndrome, which has killed millions of cave-hibernating bats in the East, Midwest and Southeast.

The ESA protects threatened and endangered wildlife from "take," which includes harming, harassing or killing a listed species. However, the Service may implement 4(d) rules for wildlife listed as threatened that focus protections on those that are "necessary and advisable to provide for the conservation of such species." We held two public comment periods totaling 150 days on our proposed and interim 4(d) rules, during which we received more than 40,000 comments.

Our approach to regulatory prohibitions through the 4(d) rule reflects the significant role white-nose syndrome plays as the central threat to the species. Because this disease is the major threat and the sole cause of the bat's threatened status, we chose not to apply broad protections across the bat's entire range. Instead, we focused protections on specific periods in the bat's life history and areas near hibernacula within the area currently affected by white-nose syndrome and areas within 150 miles of hibernacula where the causative fungus has been detected.

Under the final 4(d) rule all purposeful take is prohibited across the entire range of the northern long-eared bat, except under these circumstances:

- Defense of human life (includes for public health monitoring)
- Removal of hazardous trees for protection of human life and property
- Removal of bats from human structures
- Limited research permit exemption through May 3, 2016

In areas outside the WNS Zone, incidental take is not prohibited. These are the areas that have not yet been impacted by WNS or are further than 150 miles from hibernacula where the causative fungus has been detected. See the White-nose Syndrome Zone Map (attached).

Within the white-nose syndrome zone, all incidental take within hibernacula is prohibited.

All other incidental take is allowed, unless it is caused by tree removal that occurs in specific locations. These specific locations are:

- within 1/4 mile of a known hibernaculum, at any time of year
- within a 150-foot radius of a known occupied maternity roost tree during the pup season (June 1 through July 31)

Location information for northern long-eared bat hibernacula and maternity roost trees is generally kept in state Natural Heritage Inventory databases; the availability of this data varies state-by-state. Many states provide online access to their data, either directly by providing maps or by providing the opportunity to make a data request. In some cases, to protect those resources, access to the information may be limited. A web page with links to state Natural Heritage Inventory databases is available at www.fws.gov/midwest/endangered/mammals/nleb/nhisites.html.

To clarify, only incidental take within hibernacula or caused by tree removal activities is prohibited; incidental take from other sources of mortality is allowed, such as incidental take caused by wind turbines. Also, take caused by tree removal that is not within 1/4 mile of hibernacula or within 150 feet of a known occupied maternity roost tree is allowed. This includes tree removal for any reason, such as clearing for rights-of-way, energy projects, or housing developments.

We encourage people with a project that includes removing trees near hibernacula or a maternity roost tree to contact the nearest Ecological Services Field Office for help determining if the project is unlikely to take bats or if the project can be adjusted to avoid taking bats. If needed, a permit can be applied for that would allow the project to proceed.

For more information about the northern long-eared bat, the final 4(d) rule and related information, visit the Service's web site at www.fws.gov/midwest/endangered/mammals/nleb. For more information about white-nose syndrome, visit www.whitenosesyndrome.org.

If you have questions or wish to discuss the listing or the final 4(d) rule, please contact this office at 517/351-2555.

Sincerely,

Scott Hicks
Field Supervisor

U.S. Fish & Wildlife Service

Key to the Northern Long-Eared Bat 4(d) Rule for Non-Federal Activities

A separate key is available for Federal Actions

This key will help you determine if your planned activity may cause prohibited take of northern long-eared bats as defined in the 4(d) rule under the Endangered Species Act and if a permit may be necessary. For more information about the northern long-eared bat and 4(d) rule go to www.fws.gov/midwest/endangered/nleb.

1. Will your activity **purposefully take** (see Definitions below) northern long-eared bats? For example, are you removing bats from a human structure or capturing bats for research?

Yes, my activity includes purposefully taking northern long-eared bats.

- ***Removing bats from human structures is not prohibited***; if you are removing bats from a human structure, you may proceed without a permit and you do not need to contact the U.S. Fish and Wildlife Service.

- ***Research that involves handling bats does require a permit*** after May 4, 2016; if you are conducting research that includes capturing and handling northern long-eared bats, you should contact the U.S. Fish and Wildlife Service to apply for a permit. www.fws.gov/endangered/regions

- ***Other purposeful take*** (see Definitions below) of northern long-eared bats is prohibited.

No, my activity does not include purposefully taking northern long-eared bats.
Continue to #2.

2. Is your activity located **outside the White-nose Syndrome Zone?** For the current White-nose Syndrome Zone map, please see www.fws.gov/midwest/endangered/mammals/nleb/pdf/WNSZone.pdf

Yes, my activity is located outside the white-nose syndrome zone.
Incidental take (see Definitions below) of northern long-eared bats is not prohibited in areas outside the White-nose Syndrome Zone. You may proceed with your activity, you do not need a permit and you do not need to contact the U.S. Fish and Wildlife Service.

No, my activity is located inside the white-nose syndrome zone.
Continue to #3

3. Will your activity take place **within a cave or mine where northern long-eared bats hibernate** (i.e., hibernaculum) **or could it alter the entrance or the environment (physical or other alteration) of** a hibernaculum?

Yes, my activity will take place within a northern long-eared bat hibernaculum or it could alter the entrance or the environment (physical or other alteration) of a hibernaculum.
All take (see Definitions below) of northern long-eared bats within hibernacula is prohibited, including actions that may change the nature of the hibernaculum's environment or entrance to it, even when the bats are not present. If your activity includes work in a hibernaculum or it could alter its entrance or environment, please contact the Service's Ecological Services Field Office located nearest the project area. To find contact information for the Ecological Services Field Offices, please see www.fws.gov/offices.

No, my activity will not take place within a northern long-eared bat hibernaculum or alter its entrance or environment.
Continue to #4

4. Will your action involve **tree removal** (see definition below)?

No, my activity does not include tree removal.
Incidental take (see Definitions below) from activities that do not involve tree removal and do not take place within hibernacula or would not alter the hibernaculum's entrance or environment (see Question #3), are not prohibited, and a permit is not necessary. You may proceed with your activity, you do not need a permit and you do not need to contact the U.S. Fish and Wildlife Service.

Yes - continue to #5

5. Is your activity the **removal of hazardous trees** for protection of human life or property?

Yes, my activity is removing hazardous trees.
Incidental take (see Definitions below) of northern long-eared bats as a result of hazardous tree removal to protect human life or property is not prohibited. You may proceed with your activity, you do not need a permit and you do not need to contact the U.S. Fish and Wildlife Service.

No, my activity is not removing hazardous trees.
Continue to #6

6. Will your tree removal activities include one or both of the following: **1) removing a northern long-eared bat known occupied maternity roost tree or any trees within 150 feet of a known occupied maternity roost tree from June 1 through July 31; or 2) removing any trees within 0.25 miles of a northern long-eared bat hibernaculum at any time of year?**

No
Incidental take (see Definitions below) from tree removal activities is not prohibited unless it results from removing a known occupied maternity roost tree or from tree removal activities within 150 feet of a known occupied maternity roost tree from June 1 through July 31 or results from tree removal activities within 0.25 mile of a hibernaculum at any time. You may proceed with your activity, you do not need a permit and you do not need to contact the U.S. Fish and Wildlife Service.

Yes
Incidental take (see Definitions below) of northern long-eared bats is prohibited if it occurs as a result of removing a known occupied maternity roost tree or removing trees within 150 feet of a known occupied maternity roost tree during the pup season from June 1 through July 31 or as a result of removing trees from within 0.25 mile of a hibernaculum at any time of year. This does not mean that you cannot conduct your activity. Please contact your nearest Ecological Services Field Office and we will work with you to determine if your activity can proceed without harming or killing northern long-eared bats or if you need to apply for a permit. To find contact information for the Ecological Services Field Offices, please see www.fws.gov/offices

How do I know if there is a maternity roost tree or hibernacula on my property or in my project area?
We acknowledge that it can be difficult to determine if a maternity roost tree or a hibernaculum is on your property or in your project area. Location information for both resources is generally kept in state Natural Heritage Inventory databases – the availability of this data varies state-by-state. Many states provide online access to their data, either directly by providing maps or by providing the opportunity to make a data request. In some cases, to protect those resources, access to the information may be limited. Links to state Natural Heritage Inventory databases are available at www.fws.gov/midwest/endangered/mammals/nleb/nhisites.html.

When looking for information on the presence of maternity roost trees or hibernacula within your project area, our expectation is that a project proponent will complete due diligence to determine available data. If information is not available, document your attempt to find the information and move forward with your project.

We do not require private landowners to conduct surveys on their lands. However, surveys can reduce uncertainties and facilitate project planning. Recommended survey methods are available at www.fws.gov/midwest/endangered/mammals/nleb.

Definitions

"Incidental take" is defined by the Endangered Species Act as take that is "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." For example, harvesting trees can kill bats that are roosting in the trees, but the purpose of the activity is not to kill bats.

"Known hibernacula" are defined as locations where one or more northern long-eared bats have been detected during hibernation or at the entrance during fall swarming or spring emergence. Given the challenges of surveying for northern long-eared bats in the winter, any hibernacula with northern long-eared bats observed at least once, will continue to be considered "known hibernacula" as long as the hibernacula remains suitable for northern long-eared bat.

"Known occupied maternity roost trees" is defined in the 4(d) rule as trees that have had female northern long-eared bats or juvenile bats tracked to them or the presence of female or juvenile bats is known as a result of other methods. Once documented, northern-long eared bats are known to continue to use the same roosting areas. Therefore, a tree will be considered to be a "known occupied maternity roost" as long as the tree and surrounding habitat remain suitable for northern long-eared bat. The incidental take prohibition for known occupied maternity roosts trees applies only during the during the pup season (June 1 through July 31).

"Purposeful take" is when the reason for the activity or action is to conduct some form of take. For instance, conducting a research project that includes collecting and putting bands on bats is a form of purposeful take. Intentionally killing or harming bats is also purposeful take and is prohibited.

"Take" is defined by the ESA as 'to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any endangered species. Purposeful take is when the reason for the activity or action is to conduct some form of take. For instance, conducting a research project that includes collecting and putting bands on bats is a form of purpose*f*ul take.

"Tree removal" is defined in the 4(d) rule as cutting down, harvesting, destroying, trimming, or manipulating in any other way the trees, saplings, snags, or any other form of woody vegetation likely to be used by northern long-eared bats.

Northern Long-Eared Bat - Final 4(d) Rule
Questions and Answers

1. What action is the U.S. Fish and Wildlife Service taking?
The Service is announcing a final rule that identifies Endangered Species Act protections for the northern-long eared bat. The final 4(d) rule, published in the *Federal Register* on January 14, 2016, identifies prohibitions that focus on protecting the bat's sensitive life stages in areas affected by white-nose syndrome.

The Service listed the northern long-eared bat as a threatened species under the Endangered Species Act (ESA) in April 2015 and established an interim 4(d) rule. At the same time we opened a 90-day public comment period on the interim rule to gather additional information as we worked to refine and finalize it.

2. When will the final 4(d) rule be in effect?
The final 4(d) rule will go into effect on February 16, 2016, which is 30 days after it publishes in the *Federal Register*.

3. What prohibitions does the final 4(d) rule set in place for the northern long-eared bat?

Purposeful Take *(The terms "take," "purposeful take" and "incidental take" are defined below.)*

For all areas within the range of the northern long-eared bat, all purposeful take is prohibited except:

- Removal of northern long-eared bats from human structures.
- Defense of human life (e.g., public health monitoring for rabies).
- Removal of hazardous trees for the protection of human life and property.

Incidental Take

For areas of the country not affected by white-nose syndrome (WNS) (i.e., areas outside the WNS zone), there are no prohibitions on incidental take.

For areas of the country impacted by WNS (i.e., areas inside the WNS zone), incidental take is prohibited under the following circumstances:

- If it occurs within a hibernacula.
- If it results from tree removal activities and
    - the activity occurs within 0.25 mile (0.4 km) of a known, occupied hibernacula; or,
    - the activity cuts or destroys a known, occupied maternity roost tree or other trees within a 150 foot radius from the maternity roost tree during the pup season from June 1 through July 31.

4. What is purposeful take and what is incidental take?

- "Take" is defined by the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any endangered species.

- "Purposeful take" is when the reason for the activity or action is to conduct some form of take. For instance, conducting a research project that includes collecting and putting bands on bats is a form of purposeful take. Intentionally killing or harming bats is also purposeful take and is prohibited.

- "Incidental take" is defined by the ESA as take that is "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." For example, harvesting trees can kill bats that are roosting in the trees, but the purpose of the activity is not to kill bats.

5. How does the final 4(d) rule differ from the interim 4(d) rule?

The final 4(d) rule is a streamlined version of the interim rule that is easier to understand and follow; the final rule also reduces the scope of incidental take prohibitions that were in the interim rule.

For both the final and interim rules, most purposeful take is prohibited except to protect human life and property. Both rules differentiate protections geographically, with no prohibition of incidental take outside the WNS zone under both rules. Inside the WNS zone, the interim rule identified specific actions that were exempted from the take prohibitions, whereas the final rule identifies the specific incidental take that is prohibited.

The interim rule applied broad prohibitions against all incidental take and then exempted specific activities from incidental take prohibitions. Activities exempted from take prohibitions in the interim rule were: forest management practices, maintenance and limited expansion of transportation and utility rights-of-way, prairie habitat management, and limited tree removal projects. In contrast, the final rule prohibits incidental take that results from tree removal activities, under specific circumstances, or results from activities that take bats within hibernacula.

The interim rule, like the final rule, protected maternity roost trees and hibernacula but the incidental take prohibitions were much broader. The final rule allows incidental take that results from operating wind turbines, as well as incidental take resulting from permanent conversion of forested lands to other uses (e.g., rights-of-way creation or expansion, urban development); whereas incidental take caused by those activities was prohibited under the interim rule. The final rule only prohibits incidental take that occurs in hibernacula or that results from tree removal activities near maternity roost trees or hibernacula within the WNS zone.

6. What is a 4(d) rule?

Section 4(d) of the ESA directs the Service to issue regulations deemed "necessary and advisable to provide for the conservation of threatened species." It allows the Service to promulgate special

rules for species listed as threatened (not endangered) that provide flexibility in implementing the ESA.

We use 4(d) rules to target the take prohibitions to those that provide conservation benefits for the species. This targeted approach can reduce ESA conflicts by allowing some activities that do not harm the species to continue, while focusing our efforts on the threats that make a difference to the species' recovery.

In general, a 4(d) rule ensures that private landowners, state agencies and others are not unduly burdened by regulations that do not further the conservation of a species. Such a rule is often used to clarify or simplify what forms of "take" are prohibited for a threatened species.

For more information about 4(d) rules, please see
www.fws.gov/mountain-prairie/factsheets/ESA SpecialRules Factsheet_020714.pdf

7. Why did the Service publish a 4(d) rule for the northern long-eared bat?
The Service determined that WNS is such an overwhelming threat to the northern-long-eared bat that regulating most other sources of harm or mortality will not help conserve the species at this time. Focusing on WNS will allow the Service and our partners to concentrate on finding a solution to the disease. Applying blanket prohibitions on all forms of take across the 37-state range of the bat would not slow the spread and impact of WNS nor would it benefit the northern long-eared bat at the population level. Therefore, the 4(d) rule focuses prohibitions on protecting bats when and where they are most vulnerable: maternity roost trees during June and July pup-rearing and at hibernation sites.

8. Why does the Service believe that allowing incidental take of northern long-eared bats caused by activities other than tree removal protects the species?
For many threatened species, habitat loss or other limiting factors contribute to their decline. In those situations, regulations to address either habitat loss or the other limiting factors can assist in recovery of the species. Populations of the northern long-eared bat, however, are not habitat-limited and the species uses a wide variety of habitats within its range. For example, before WNS, this bat lived in both highly fragmented forests as well as large contiguous forest blocks from the southern United States to Canada's Yukon Territory. Land management and development have been ongoing for centuries (e.g., forest management, forest conversion), yet the northern long-eared bat appears to have been healthy across its range.

As WNS moves across its range, northern long-eared bat populations have declined and will continue to decline. The declines are so severe that the bat is now rare on WNS-affected landscapes in the Northeast and parts of the Midwest. The conservation benefit from regulating the entire landscape for those few remaining bats is questionable. This is particularly true because the current monitoring limitations do not allow us to pinpoint locations of surviving northern long-eared bats in the WNS affected area. Regulating all sources of mortality across the bat's range would not help conserve the species until we find measures to remediate WNS and improve our surveying and monitoring techniques. In areas where WNS has not yet caused severe population declines, implementing blanket prohibitions would not slow the spread of the disease or the magnitude of disease's impact on the northern long-eared bat's population.

The take prohibitions identified in this final rule help protect the most critical parts of the bat's life cycle, namely maternity colonies, hibernating bats and the areas that bats use as they enter and leave hibernation in spring and fall. The 4(d) rule allows take from certain activities that have not been the cause of the species imperilment, while still promoting conservation of the species across its range.

9. Why does the Service believe it is necessary to prohibit incidental take due to tree removal activities near maternity roost trees and hibernacula within the WNS Zone?
The northern long-eared bat depends on both caves and forests. It typically roosts in trees from late spring through early fall and hibernates in caves and mines from late fall through early spring. Female northern long-eared bats and young are particularly vulnerable in June and July when the young are unable to fly. Therefore, we tailored the regulatory provisions toward activities that may impact roost trees and hibernacula at the most sensitive periods of the bats' life cycle.

Hibernacula and nearby forests play critical roles in the life cycle of the northern long-eared bat, even beyond the time when the bats are hibernating. In early spring and fall, hibernacula and surrounding forested areas are the focus of bat activity during "spring staging" and "fall swarming." During spring staging, bats gradually emerge from hibernation, exit the hibernacula to feed, but re-enter the same or alternate hibernacula to resume daily bouts of torpor until they migrate to summer areas. Fall swarming is a time of heightened activity in and around hibernacula. It is an especially critical time in the life cycle of the northern long-eared bat because it is during this time that they mate and they build up their fat reserves, allowing them to survive hibernation.

In summary, we believe that northern long-eared bat conservation is best served by focusing the take prohibitions on the following:

- Areas within the WNS zone
- The most vulnerable life stages (hibernation, when young cannot fly, spring staging, fall swarming)
- Activities that are most likely to affect the bat, tree removal in particular

10. Why does the 4(d) rule include measures to protect hibernating bats and the sites where they hibernate?
Within the WNS zone, the 4(d) rule prohibits all incidental take that occurs within hibernacula because hibernation is a particularly critical and vulnerable time. Northern long-eared bats are insectivorous and use hibernation to survive the seasons when their prey are not available. To hibernate and survive winter, bats must maintain their body temperature above freezing, minimize water loss, meet energetic needs until prey again become available and respond to disturbance or disease. Only certain caves and mines provide the environment where bats can meet these physiological demands.

Cave-dwelling bats are vulnerable to human disturbance while hibernating. Because bats congregate at hibernacula, impacts to a single site can affect a large number of bats. Even healthy bats use up their energy stores when disturbed during hibernation and may not survive winter, or

females may not successfully give birth or rear young. Bats within the WNS zone may be even more vulnerable because the fungus may have caused a weakened condition. Because of the importance of hibernation in the bat's life cycle and their vulnerability during that time, all incidental take within hibernacula is prohibited.

11. How do I know if my activity is in an area within the WNS zone?
The Service has identified the counties within 150 miles of the boundaries of U.S. counties or Canadian districts where WNS or its causative fungus *Pseudogymnoascus destructans* (*Pd*) have been detected. If any portion of a county falls within 150 miles of a county or district where the fungus or disease has been detected, the entire county will be considered affected. To minimize confusion we use county boundaries to delineate the WNS zone because they are clearly recognizable.

The most recent map of such areas is at the website: http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/WNSZone.pdf This map is updated on the first of every month, if there are new counties with verified occurrences of WNS or the fungus. You may also contact your local U.S. Fish and Wildlife Service Ecological Services Field Office for assistance in determining if your activity is within the WNS zone. Visit www.fws.gov/offices to find your local office.

12. Does the 4(d) rule allow me to remove a northern long-eared bat from my home?
Yes. On rare occasions, northern long-eared bats have roosted in human-made structures including buildings, barns, pavilions, sheds and cabins. The Service considers that removing northern long-eared bats from these structures is not expected to adversely affect the species' conservation or recovery.

Removal activities must comply with any applicable state laws. The Service recommends that anyone who has bats in their home or outbuildings minimize using pesticides and avoid sticky traps around bat roosts. If you exclude bats from where they are roosting, we recommend that those exclusions be done in the spring or fall if possible. The Service also recommends you contact a nuisance wildlife specialist for humane exclusion techniques.

13. How are private landowners affected by the final 4(d) rule?
The 4(d) rule prohibits incidental take that may occur from tree removal activities within 150 feet of a known occupied maternity roost tree during the pup season (June 1 through July 31) or within a 0.25 miles of a hibernation site, year round. If a landowner intends to remove trees near a maternity roost tree during the pup season or near a hibernation site, we suggest that they contact the nearest Ecological Services Field Office. Visit www.fws.gov/offices to find your local office. We may be able to recommend measures that will allow the work to go forward and also protect northern long-eared bats.

We acknowledge that it can be difficult to determine if a maternity roost tree or a hibernaculum is on your property or in your project area. Location information for both resources is generally kept in state Natural Heritage Inventory databases – the availability of this data varies state-by-state. Many states provide online access to their data, either directly by providing maps or by providing the opportunity to make a data request. In some cases, to protect those resources,

access to the information may be limited. A web page with links to state Natural Heritage Inventory databases is available at www.fws.gov/midwest/endangered/mammals/nleb/nhisites.html.

When looking for information on the presence of maternity roost trees or hibernacula within your project area, our expectation is that a project proponent will complete due diligence to determine available data. However, if information is not available, we recognize that a project proponent who has made reasonable efforts to determine whether there are known maternity roost trees or hibernacula on their property or project area is in the position of not "knowing" if no data has been provided. If that is the case, document your attempt to find the information and move forward with your project.

We do not require private landowners to conduct surveys on their lands. However, surveys can reduce uncertainties and facilitate project planning. Recommended survey methods are available at www.fws.gov/midwest/endangered/mammals/nleb. Also, see question #16 for suggestions on conservation actions that industry and other interested partners could take to help conserve the northern long-eared bat.

14. How are states and tribes affected by the 4(d) rule?

The situation is the same for states and tribes as it is for private actions on private lands. If a landowner or land manager intends to remove trees, first check the state's Natural Heritage Inventory database to determine if a maternity roost tree or hibernaculum is present on the property. If either is present and the work will be done during the pup season within 150 feet of a maternity roost tree or at any time within 0.25 mile of a hibernaculum, we suggest that they contact the nearest Ecological Services Field Office (www.fws.gov/offices). We may be able to recommend measures that will allow the work to go forward and protect northern long-eared bats. If neither resource is present, proceed with the work. See question #16 for suggestions on conservation actions that states and tribes could take to help northern long-eared bats.

15. How are federal agencies affected by the 4(d) rule?

Under section 7 of the Endangered Species Act, federal agencies must consult with the Service to ensure that any action they authorize, fund, permit or carry out does not jeopardize the existence of a listed species. This requirement does not change when a 4(d) rule is implemented. However, for this 4(d) rule, the Service has completed a non-jeopardy biological opinion on our actions of finalizing this rule and proposing an optional framework to streamline section 7 consultations when federal actions may affect the northern long-eared bat but will not cause prohibited take. Federal agencies can rely upon the finding of this biological opinion to fulfill their project-specific section 7 responsibilities by using the optional framework. The framework requires the agency to notify the Service 30 days prior to implementing an action that may affect the northern long-eared bat. The notification would include a determination that the action would not cause prohibited incidental take. Service concurrence is not required, but the Service may advise the agency whether additional information indicates project-level consultation is required. If the Service does not respond within 30 days, the action agency may consider its section 7 responsibilities fulfilled with respect to the northern long-eared bat. If prohibited take may occur, standard section 7 procedures will apply.

16. How can federal agencies, states, tribes and industry help conserve northern long-eared bats?
In addition to participating on the WNS team, government agencies, tribes, industry and others can help conserve northern long-eared bats by:

- Surveying in areas where they are planning tree removal projects.
- Initiating or continuing monitoring for bats (including northern long-eared bats) on their properties or project areas.
- Carrying out or funding research on the impact of WNS on northern long-eared bats.
- Supporting research on aspects of this bat's life history that are not well understood.

The more we know about this bat and how it responds to WNS, the better we can focus conservation actions on those that provide the most benefit to the species and avoid actions that provide little benefit.

17. What are examples of a 4(d) rule aiding in the conservation of a threatened species?
In 2014, the Service listed the Dakota skipper, a prairie butterfly, as threatened and implemented a 4(d) rule. The listing prohibits actions that threaten the Dakota skipper, but the 4(d) rule also provides flexibility to non-federal landowners for specific activities that do not negatively affect the species' conservation. The rule exempts from take prohibitions some actions associated with ranching, such as grazing, fencing, watering livestock and haying after July 15. Although some of these activities may impact individual Dakota skippers, some of the activities have negligible impact and others are used to manage the butterfly's prairie habitat. For more information, see www.fws.gov/midwest/endangered/insects/dask/DASKfinal4dRuleFAQs22Oct2014.html.

In August 2015, the Service finalized a 4(d) rule for the Georgetown salamander. This 4(d) rule enables development activities that may affect the threatened salamander to continue as long as they comply with the City of Georgetown's Universal Development Code (UDC). The UDC is directed at reducing the threat of water quality degradation to the Georgetown salamander from urban development by requiring a variety of conservation measures, including stream and spring buffer areas, throughout the city's jurisdiction. The measures in Georgetown's UDC are expected to limit water quality degradation throughout watersheds that support the Georgetown salamander, thereby contributing to the conservation of the species. For more information, please visit:
www.fws.gov/southwest/es/AustinTexas/ESA_Sp_Salamanders.html#Georgetown_4d_final

18. Where can I find more information?
For more information about the northern long-eared bat, the final listing as threatened, the 4(d) rule and related information, visit the Service's web site at
www.fws.gov/midwest/endangered/mammals/nleb

Excerpt from the Minnesota DNR Website

Common, or European, buckthorn, and glossy buckthorn are the two non-native, invasive buckthorn species found in Minnesota. These buckthorn species were first brought here from Europe as a popular hedging material. They became a nuisance plant, forming dense thickets in forests, yards, parks and roadsides. They crowd out native plants and displace the native shrubs and small trees in the mid-layer of the forest where many species of birds nest. Glossy buckthorn has been sold by the nursery trade in three different forms, so its appearance can vary. The cultivar *Frangula alnus* 'Columnaris' is narrow and tall; the cultivars *Frangula alnus* 'Asplenifolia' and 'Ron Williams' have narrow leaves that give them a fern-like texture.

Identification

Common buckthorn *(Rhamnus cathartica)*

Appearance: Tall understory shrub or small tree up to 20' high with a spreading loosely branched crown, often multiple stems at the base. Brown bark with elongate silvery corky projections (**Caution:** native plums or cherries have a similar bark). Female and male plants.

Branches: Buds and leaves are sub-opposite, opposite, or alternate. Cut branch exposes yellow sapwood and orange heartwood. Twigs often end in small, sharp, stout thorns.

Leaves: Alternate, sometimes opposite; broadly elliptic pointed at the tip, smooth, dark glossy and small-toothed. Leaves stay green late into fall.

Flowers: Inconspicuous, appear in May or June, clustered in the axils of leaves.

Fruit: Clusters of black 1/4 inch fruit ripen on female plants in August and September. Seeds are viable for 2 - 3 years in the soil. Each berry has three to four seeds.

Roots: Extensive fibrous root system.

Glossy buckthorn *(Frangula alnus)*

Appearance: Tall understory shrub or small tree, grows up to 20' high, has a spreading loosely branched crown, often multiple stems at the base. Brown bark with elongate silvery corky projections (**Caution:** native plums or cherries have a similar bark).

Branches: Buds and leaves are alternate. No thorn at tip of twig. Cut branch exposes yellow sapwood and orange heartwood.

Leaves: Alternate, think, and ovate or elliptic smooth, dark glossy, margins are not toothed. There are eight to nine pair of leaf veins. Leaves stay green late into fall.

Flowers: Inconspicuous, appear in May or June, clustered in the axils of leaves.

Fruit: Ripens progressively from a distinctive red to a dark purple in August and September. Each berry has two to three seeds. Seeds are viable for two to three years in the soil.

Roots: Extensive fibrous root system.

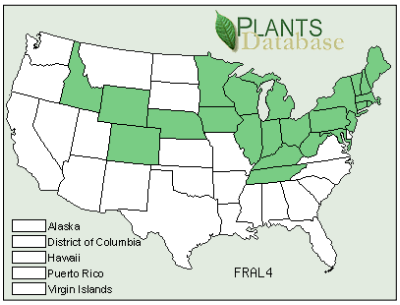
Glossy Buckthorn *Rhamnus frangula*,

syn. *Fragua alnus*

Common Names: glossy buckthorn, alder, tallhedge, columnar, fernleaf, fen buckthorn, European alder

Native Origin: Eurasia; introduced as ornamentals around 1849 to the Midwestern states

Description: A shrubby or small tree in the buckthorn family, (*Rhamnaceae*) growing to a height of 10-25 feet. Trunks grow up to 10 inches in diameter, and the bark is gray or brown with prominent, closely spaced lenticels. Simple, alternate leaves are ovate to elliptic with toothless margins. The papery, dark green leaves have a shiny upper surface and a dull, hairy or smooth lower surface. Pale yellow flowers have 5 petals, grow solitarily or in clusters of two to eight in the leaf axis, and bloom from May to first frost. Red to dark purple pea-size fruit ripen from July to September. Seeds remain viable in the soil for 2 to 3 years.



Habitat: It is located in a wide variety of habitats including nutrient-poor soils, full sun, and dense shade. It is found along forest edges, riverbanks, lakesides, marshy land, and wet soil but also drier areas.

Distribution: This species is reported from states shaded on Plants Database map. It is reported invasive in CT, IL, IN, MA, MD, ME, MI, MN, MS, NH, NJ, NY, OH, PA, RI, VA, VT, and WI.

Ecological Impacts: Glossy buckthorn grows at a rapid rate and is particularly aggressive plant in wet areas. It produces dense shade that eliminates native tree seedlings, saplings, and ground layer species. The ability of forest to regenerate and remain healthy can be severely limited as buckthorns multiply. Glossy buckthorn is a prolific producer of berries that attract birds that spread the seeds.

Control and Management:

- **Manual-** Pull plants before they begin to produce fruit and when soil is damp; use leveraging tool for large plants; girdling is successful if herbicides are applied to the girdled surface; controlled burning is effective when a large number of buckthorn seedlings are present; repeat burning maybe necessary to deplete seed bank; caution should be taken so the native plant community is not adversely affected
- **Chemical-** It can be effectively controlled using any of several readily available general use herbicides such as glyphosate or triclopyr. In areas of standing water, use herbicides approved for aquatic habitats. Apply herbicides in fall when plants are going dormant and chemicals are drawn down into the roots with natural sap flow. Follow label and state requirements.
- **Biocontrol and Natural Enemies-** Fifteen species of fungi and 20 arthropods have been recorded on the genus *Rhamnus*, but none attack glossy buckthorn. In Europe, researchers are conducting tests for the potential use of insects for biocontrol. Early release of insects in North America is targeted for 2007 and 2010.

References: www.forestimages.org, http://plants.usda.gov, www.nps.gov/plants/alien, www.fs.fed.us, Elizabeth J. Invasive Plants of the Upper Midwest, An Illustrated Guide to their Identification and Control, 2005 p. 35-41, Invasive Plants Established in the United States that are Found in Asia and their Associated Natural Enemies, USDA, FHTET 2005-15 Vol. 2, p. 92

Weed of the Week

Exotic Bush Honeysuckles

- *Lonicera maackii* (Amur honeysuckle)
- *Lonicera morrowii* (Morrow's honeysuckle)
- *Lonicera tatarica* (Tartarian honeysuckle)

Figure 1- *Lonicera maackii*
Amur honeysuckle

Figure 2- *Lonicera morrowii*
Morrow's honeysuckle

Figure 3- *Lonicera tatarica*
Tartarian honeysuckle

Native Origin: Eurasia (Japan, China, Korea, Manchuria, Turkey and southern Russia); introduced to US for use as ornamentals, for wildlife cover and for soil erosion control.

Description: Exotic bush honeysuckles are upright, generally deciduous shrubs that range from 6 to 15 feet in height. The 1-2 ½ inch, egg-shaped leaves are opposite along the stem and short-stalked. Older stems are often hollow. Pairs of fragrant, tubular flowers less than an inch long are borne along the stem in the leaf axils. Flower color varies from creamy white to pink or crimson in some varieties of Tartarian honeysuckle. The fruits are red to orange, many-seeded berries. Native bush honeysuckles may be confused with these exotic species and cultivars, so proper identification is necessary. Unlike the exotics, most of our native bush honeysuckles have solid stems. Plants reproduce by birds feed on the persistent fruits and widely disseminating seeds across the landscape. Vegetative sprouting also aids in the persistence of these exotic shrubs.

Habitat: : Exotic bush honeysuckles are relatively shade-intolerant and most often occur in forest edge, abandoned field, pasture, roadsides and other open, upland habitats. Woodlands, especially those that have been grazed or otherwise disturbed may also be invaded by exotic bush honeysuckles. Morrow's honeysuckle is capable of invading bogs, fens, lakeshores, sand plains and other uncommon habitat types.

Distribution: Amur, Tartarian, and Morrow's honeysuckle generally range from the central Great Plains to southern New England and south to Tennessee, North Carolina, and Georgia as shaded on the map.

Ecological Impacts: Exotic bush honeysuckles can rapidly invade and overtake a site, forming a dense shrub layer that crowds and shades out native plant species. They can alter habitats by decreasing light availability, by depleting soil moisture and nutrients, and possibly by releasing toxic chemicals that prevent other plant species from growing in the vicinity. Exotic bush honeysuckles may compete with native bush honeysuckles for pollinators, resulting in reduced seed set for native species. In addition, the fruits of exotic bush honeysuckles, while abundant and rich in carbohydrates, do not offer migrating birds the high-fat, nutrient-rich food sources needed for long flights, that are supplied by native plant species.

Control and Management: Control methods should be initiated prior to seed dispersal (late summer to early autumn) to minimize reinvasion of treated habitats.
Manual- Hand remove seedlings or small plants for light infestation; repeat yearly
Chemical- apply systemic herbicides
Burning- prescribed burning may be effective for exotic bush honeysuckles growing in open habitats.

References: www.nps.gov/plants/alien/map/loni1.htm, www.nps.gov/plants/alien/fact/loni1.htm, www.hort.uconn.edu/plants

Produced by the USDA Forest Service, Forest Health Staff, Newtown Square, PA.
Invasive Plants website: http://www.na.fs.fed.us/fhp/invasive_plants

Garlic mustard

Alliaria petiolata

Garlic mustard is native to Europe and parts of western Asia. It was likely introduced to North America for medicinal and herbal uses as well as erosion control. It was first recorded in 1868 at Long Island, NY, and there were likely multiple introductions. It has spread to at least 37 states and six Canadian provinces. Eight states list it as a noxious weed. It is one of few non-native invaders in North America that can tolerate shade, and it thrives in the forest understory. It grows in a variety of soil types but does best in moist, well drained soils. It begins its spring growth before natives emerge and forms dense populations by outcompeting native species for sunlight, moisture, nutrients and space. It is allelopathic, and chemicals released from its roots alter mycorrhizal communities that are critical for many native species including economically valuable trees. Unlike many invaders, garlic mustard reproduces only from seed. It has been implicated in local extirpations of toothworts, which are the primary food source for caterpillars of the West Virginia white butterfly. Chemicals in the plant appear to be toxic, as eggs laid on garlic mustard failed to hatch.

Identification

Habit:

Garlic mustard is a cool season herbaceous biennial. During its first year it produces low clusters of leaves (basal rosettes) which remain green through winter. The second year, it sends up a flowering stalk and can grow up to 1 m (3 ft) tall.

Leaves:

First year garlic mustard leaves are basal; they grow from a central point at ground level. They are kidney-shaped and toothed. After the plant sends up a flowering stem in its second year, the leaves alternate on the stem and are triangular, toothed and stalked. The leaves smell of garlic when crushed.

Stems:

Usually, garlic mustard sends up one flowering stem per rosette, but occasionally there are more.

Flowers:

Garlic mustard has numerous small, white flowers held in clusters at the tops of stalks or in leaf axils. Like all members of the mustard family, the flowers have four petals. They bloom from late April into early June.


Suzan Campbell, MNFI

Fruits/Seeds:

Garlic mustard's seeds are small, shiny, dark brownish-black, and they are held in long narrow capsules. A single plant can produce thousands of seeds. The seeds are viable within a few days of flowering and remain viable for many years.

Habitat:

Garlic mustard is found in upland and floodplain forests, savannas, along trails, roadsides and disturbed areas. It is shade tolerant but is also found in full sun.


Leslie J. Mehrhoff, University of Connecticut, Bugwood.org


Suzan Campbell, MNFI


Suzan Campbell, MNFI


Chris Evans, River to River CWMA, Bugwood.org

Root

The slender, white taproot of garlic mustard is distinctive, forming an S- or J-shape near the top, just below the stem.

Similar Species

Garlic mustard seedlings can be confused with the basal leaves of kidney leaf buttercup (*Ranunculus abortivus*); however, garlic mustard leaves are more evenly round-toothed on their margins. Upon bolting, the upper leaves of garlic mustard are triangular and sharply toothed, whereas those of buttercup are smooth edged and lanceolate or divided.

Kidney leaf buttercup basal leaves (left); whole plant (right)

Henbit (*Lamium purpureum*) and creeping Charlie (*Glechoma hederacea*) have similary shaped leaves, but they are typically smaller with opposite leaves and square stems. Henbit leaves are usually more pointed or triangular while creeping Charlie leaves have more broadly rounded, larger teeth. Large creeping Charlie leaves closely mimic garlic mustard—check for the creeping stem. Unlike garlic mustard, neither of these species send up tall flowering stalks and their flowers are purple and irregular.

Henbit (*Lamium purpurea*)

Creeping Charlie (*Glechoma hederacea*)

Many violet (*Viola spp*.) leaves are similar; however, most are not so regularly kidney-shaped and have acute tips and shallower teeth. Their roots are not white and lack the characteristic S-shape.

Dog violet

Occasionally, white avens (*Geum canadense*) can be mistaken for garlic mustard before the leaves are fully mature. However, the basal leaves of avens are typically trifoliate and on long petioles. The white flowers have 5 petals.

Other small, white-flowered woodland herbs are sometimes confused with garlic mustard, including toothwort (*Dentaria spp*.) and sweet cicely (*Osmorhiza spp*.). Toothwort flowers have four petals like garlic mustard, but the leaves are divided, with three leaflets. Sweet cicely flowers have five petals and the leaves are divided with many leaflets.

Two-leaved toothwort

Sweet cicely

Garlic mustard can be distinguished from all other woodland herbs before fall by the characteristic garlic odor of the leaves when crushed. If in doubt, checking for the white, S-shaped taproot can usually rule out other species.

Reproduction/Dispersal

Garlic mustard is a biennial herb that reproduces by seed. It emerges early in the spring from a slender, white tap root and produces basal rosettes of rounded kidney-shaped leaves over the summer. The leaves remain green during the winter and bolt rapidly the following spring to produce flowering stems. These reach about 2-4 feet in height and bear alternate, triangular leaves. Flowers are produced from May through June. Garlic mustard can reproduce by both

cross- and self-pollination, but self-pollination is probably more common. Flowers mature into long, slender capsules filled with a row of many, tiny brown to black seeds by mid-summer. They burst when they are mature, and the seeds rain down onto the ground from July to October, leaving the empty, light brown capsules. The plant dies by late fall.

The seeds get buried where they fall or are dispersed by animals, humans, vehicles, equipment and possibly wind moving through the population. Garlic mustard colonizes floodplain forests as well as upland forests, and seeds can also be dispersed through water flow. They can be distributed upstream as well as downstream by seeds becoming lodged on animals, vehicles or watercraft that travel in many directions. Seed production is very high, and seeds can remain viable in the seedbank for many years.

Garlic mustard does not reproduce by rhizome fragments, but if the root crowns are left in the ground during hand pulling, they may grow new stalks and produce flowers and seed. *If flowering plants are pulled, they can often still produce seed and must be disposed of properly.*

Best survey period

Detecting garlic mustard is easiest in early spring and late fall because they green-up earlier and senesce later than most native plants. After native species have emerged, it is easiest to detect garlic mustard when in flower during May and June. The distinctive knee-high clusters of leafy, flowering stalks topped with small white flowers stand out. It can be distinguished later in the season by the long, slender capsules; however, these are more difficult to see than flowers.

Planning a control program

Resources for invasive species control invariably fall short of the actual need, so it is important to prioritize sites for treatment and plan carefully. Assessing the scope of the problem is a critical first step:

- Map known populations.
- Identify leading edges and outliers.
- Is the species widely dispersed throughout the region or is it just beginning to appear?
- How is the species behaving in your area? Is it spreading rapidly?
- Identify potential dispersal pathways and monitor them; is the population along a pathway or stream?
- Does it lie in the path of road-mowing crews that might spread it further? Are there construction sites in the area where it might be introduced in fill dirt?
- Does it occur in high-quality habitat or on important recreational, hunting or fishing lands?

Given this information, develop a strategy for control:

1. Prioritize high-value sites where treatment success can be achieved.
2. Prevent further spread by monitoring leading edges and outliers; focus on second year plants before they go to seed.
3. Choose appropriate control methods given site conditions and available resources.
4. Determine whether any permits are required (e.g., herbicide application in wetlands, prescribed burning).
5. Eradicate smaller, satellite populations.
6. Treat larger, core infestations.
7. Monitor to ensure desired results are being achieved; adapt management to improve success.

Documenting occurrences

In order to track the spread of an invasive species on a landscape scale, it is important to report populations where they occur. The Midwest Invasive Species information Network (MISIN) has an easy-to-use interactive online mapping system. MISIN I-phone and android phone apps are also available. Links to MISIN and its phone apps are provided in the "Online Resources" section. Herbaria also provide a valuable and authoritative record of plant distribution. The University of Michigan Herbarium's database can be searched online for county records of occurrence, for example. When garlic mustard is first encountered in a county where it has not been documented previously, specimens should be submitted to the Herbarium to document its presence. Check the "Online Resources" section for links to both of these resources.

Control

Garlic mustard control has been occurring for decades with differing levels of success, primarily tied to the amount of resources available to do the work and the ability to maintain treatment over many years. The primary goals are to prevent second-year plants from producing seed, prevent new seeds from arriving from nearby populations and deplete the seed bank.

Using a variety of techniques including mechanical and chemical control is usually more efficient and effective, and should be tailored to the specific conditions of the site. It is critical to monitor treatment sites for many

years, perhaps indefinitely in some situations, to ensure depletion of the existing seed bank and prevention of seed bank replenished from nearby populations.

Some studies show that initiating garlic mustard control without the ability to maintain the effort over time may do more harm than good. Disturbance from short term control efforts may directly harm native species and facilitate germination of garlic mustard seeds that will compete with native species. Most studies show short-term control efforts do not result in long-term control. Do not get fooled by years in which garlic mustard appears to be in low abundance. As a biennial, it only flowers during the second year of its life cycle and is a good seed banker. More plants are likely to emerge in the following year. Vigilant monitoring is required.

Hand pulling

Hand pulling over repeated years can be an effective means of control, particularly for small populations. It has also been employed for larger populations with remarkable success, when there are adequate resources for long term control and maintenance.

Hand pulling is typically done in spring and early summer and should target second year plants before they go to seed. Second year plants are easier to pull than first year rosettes and are more important because they are the seed producers. Pulling seedlings usually is not cost-effective except for very small infestations because many seedlings fail to survive.

Plants should be pulled only if the entire root can be removed. Roots remaining in the ground can re-sprout and produce flowers and seed. *Plants may also flower and produce seed after they have been pulled.* They should be bagged and taken to a landfill or dried and then burned or buried deep in the ground.

If second year plants are pulled too close to seed maturation, it will facilitate seed dispersal. Soil disturbance by hand-pulling also stimulates seed germination. Deliberate stimulation in this way, may expedite depletion of the seed bank thereby speeding up long-term control. However, this will only be effective if follow-up management of new sprouts is undertaken before new seeds are produced. Follow-up treatment will be required until the seed bank is exhausted.

A recent study supports the hypothesis that second year garlic mustard plants are important competitors with juvenile garlic mustard plants by shading them and taking up space and nutrients. Extensive management of adult garlic mustard early in the season may increase survival of juveniles that might otherwise be out-competed by second year plants. They will then have to be managed the following year. Some practitioners recommend hand pulling adult plants later in the season to take advantage of this natural control. Further study is needed to ascertain whether shifting pulling efforts to later in the season provides a significant advantage.

Root slicing

A sharp spade can be used to slice the taproot completely, approximately 1-2” below the surface. However, this will be even more labor intensive than hand pulling as the roots are small and difficult to target. This method can sometimes provide an alternative where plants cannot be easily pulled. It is important to slice the root below the crowns and remove the sliced plants with the root crowns and properly dispose of them.

After slicing roots, monitoring for and treating new sprouts is critical. It is difficult to get all plants during the initial treatment, and even tiny, overlooked plants with only a few flowers will produce new seeds.

Clipping

For small populations, the flowering tips can be clipped, bagged and removed. However, this is also more labor intensive than hand pulling and must be conducted multiple times during the growing season to capture all the flowers before seed production. Monitoring and clipping additional flowers as they emerge is critical.

Mowing

Mowing is not usually suitable for garlic mustard infestations, because it will harm associated native species and increase risk of spreading seeds.

Chemical control

Chemical controls are typically used for large garlic mustard infestations where hand pulling alone is impractical. It is often employed in conjunction with hand pulling or spot treatment with chemicals or hand-held propane torches.

General considerations

Anyone applying herbicides as part of their employment must become a certified pesticide applicator. In addition, certification is required for the use of some herbicides under any circumstances. The exam is administered by the Michigan Department of Agriculture and Rural Development and a link to their website is included in the “Online Resources” section.

A permit from the Michigan Department of Environmental Quality is usually required to apply herbicide where standing water is present—in wetlands, along streams, rivers or lakes, or over open water. A permit is also required for herbicide use below the ordinary high water mark along the Great Lakes or Lake St. Clair shoreline, whether or not standing water is present. A link to their website is included in the "Online Resources" section.

A number of adjuvants or additives may be used with herbicides to improve their performance including mixing agents, surfactants, penetrating oils and dyes. Some are included in premixed products while others must be added. Adjuvants do not work with all products; consult the product label to determine which adjuvants may be used with a specific herbicide formulation.

Dyes are useful in keeping track of which plants have been treated, as well as detecting spills on clothing or equipment. Some premixed herbicides include dyes. Clothing dyes such as Rit® can be added to water soluble herbicides, while other products require oil-based dyes. Consult the product label for specific instructions.

Crop Data Management Systems, Inc. (CDMS) maintains a database of agro-chemicals that includes herbicide labels for specific products. Herbicide labels contain information on application methods and rates, specific weather conditions, equipment types, nozzles etc., to provide the desired coverage and minimize the potential for volatilization or drift. They also contain critical information about the potential for damage to valuable non-target species. A link to the CDMS website is included in the "Online Resources" section.

Read the entire pesticide label before use. Follow all directions on the label.

Herbicide specifics

Glyphosate (e.g., Roundup®, Rodeo®, Accord®) can provide effective control of garlic mustard. It should be applied as a foliar spray in the spring to rosettes and bolting plants, well before seeds ripen. It can also be applied to first year rosettes in the fall. Fall treatment will not control seedlings that emerge in the spring and dry conditions may inhibit translocation of herbicide to roots. Fallen leaves can also limit effectiveness. Non-target impacts will be minimized if applications are made while native species are still dormant or after they have senesced.

Glyphosate should be used with a vegetable oil-based, multi-purpose adjuvant (e.g. SprayTech® Oil) on upland sites or a wetland-approved, non-ionic surfactant (e.g., Cygnet Plus®) in wetlands. Glyphosate is not selective and will kill desirable non-target species through over-spray and drift, in some cases leading to increased erosion on site. Glyphosate works best at temperatures above 50 degrees.

Triclopyr provides effective control of broad-leaved plants including garlic mustard but does not kill grasses or some conifers, making it particularly useful in grasslands, pastures and old fields. It is available in both amine (e.g., Garlon 3A®) and ester (e.g., Garlon 4 Ultra®) formulations. The amine formulation can be safely used in wetlands.

Triclopyr can be used as a foliar spray once per season. The ester formulation should be used with a vegetable oil-based, multi-purpose adjuvant (e.g. Spray- Tech® Oil), and the amine formulation should be used with a wetland-approved non-ionic surfactant (e.g., Cygnet Plus®).

Do not apply herbicides during a drought, as plants will not translocate chemicals effectively.

Foliar application

The product label for the specific herbicide being used provides essential information on coverage - how much of the foliage should be treated and how wet it should be. Herbicide labels also contain information on specific weather conditions, application modes, equipment types, nozzles, etc., to provide the desired coverage and minimize the potential for volatilization or drift.

The herbicide applicator is responsible for managing drift and damage to non-target vegetation. Wind speeds between 3 and 10 miles per hour are best for foliar herbicide spraying. At higher wind speeds, herbicide may be blown onto adjacent vegetation or water bodies.

At lower wind speeds, temperature inversions can occur, restricting vertical air movement. Under these conditions, small, suspended droplets of herbicide can persist in a concentrated cloud and be blown off-target by variable gusts of wind. Ground fog indicates the presence of a temperature inversion, but if no fog is present, smoke movement on the ground can also reveal inversions. Smoke that layers and remains trapped in a cloud at a low level indicates an inversion, while smoke that rises and dissipates indicates good air mixing.

In hot, dry weather, herbicide can evaporate rapidly. Setting equipment to produce large droplets can help compensate for this. If wind and temperature conditions allow, use a finer spray for larger patches. In contrast, spot treatment should occur with a confined spray pattern in order to minimize impacts to adjacent native plants. In general, follow all directions on the label of the specific herbicide being used in order to prevent damage to non-target vegetation or water bodies.

Prescribed Fire

General considerations

Permits are usually required before a prescribed fire. The Michigan Department of Natural Resources (DNR) is responsible for issuing burn permits in the Upper Peninsula and Northern Lower Peninsula unless a municipality wishes to do so. Municipalities located in the Southern Lower Peninsula issue burn permits under authority of the state law. A link to the DNR local fire contacts web page is included in the "Online Resources" section. In the Southern Lower Peninsula, contact the local fire marshal for permits and more information. In many situations, insurance is required before a permit is issued to cover the cost of damages if the fire should escape.

Before initiating a program of prescribed fire, a written burn plan establishing the criteria necessary for starting, controlling, and extinguishing a burn is required. The burn plan includes details such as specific weather conditions, locations of fire control lines, ignition pattern, equipment and personnel needed, contingency plans and important phone numbers. The burn plan is essentially the prescription for how to conduct the burn safely while accomplishing the management objectives.

Fire specifics

Spring burning of garlic mustard can be useful in fire-adapted communities, but prescribed burning alone does not provide effective control of garlic mustard. Fire will typically control seedlings; however, its impact to rosettes and second year plants is variable, depending upon fire intensity and specific burn timing. If fire intensity is not high enough, seedling management will be necessary until the seed bank is exhausted.

Fire also stimulates seed germination, ultimately increasing garlic mustard competition with desirable native species. However, deliberate planning to manage seedlings intensively after a burn can be an effective means of more rapidly depleting the seed bank.

Seedlings can be managed by hand-pulling, spot treatment with herbicide or burning with a hand-held torch.

Prescribed fire is best conducted in spring after garlic mustard seedlings have emerged but before desired vegetation begins growth.

Prescribed burning should be implemented to meet specified management goals in accordance with specific site conditions. Fire may pose a risk to desirable plants; however, it may benefit other fire-adapted species such as prairie grasses, resulting in improved competition with garlic mustard. This should be considered during planning.

Hand-held propane torch

Freshly emerged seedlings can be quickly killed with a handheld propane torch, but this should be done when conditions are not too dry, to minimize risk of unintended fire. As the first-year plants develop taproots, this method becomes less effective.

Interseeding

In some situations, native seeding may improve success of garlic mustard control by increasing competition with garlic mustard seedlings. Assessment of the native seed bank prior to control efforts will help determine whether interseeding may be useful.

Manipulation of the forest canopy

Garlic mustard typically gets a foothold in forests where the canopy is disturbed, and it can take advantage of increased light penetration. It can be advantageous to manage these openings by restoring the canopy quickly. However, garlic mustard is shade tolerant and will persist under full canopy once established.

Biological control

Currently, four weevil species are being tested for potential use as garlic mustard biocontrol agents: two stem-miners (*Ceutorhynchus alliariae, C. roberti),* a root-miner (*C. constrictus*) and a crown-miner (*C. scrobicollis*). Studies are currently underway to determine the specificity of these agents and likelihood of impact to native species in North America.

Integrated control

Integrated control first requires understanding the site management goals, the biology of garlic mustard and the environment in which it is growing to select a combination of actions that collectively reduces its impact. Removal of garlic mustard is but one action amidst other changes that likely need to occur to

increase biological integrity or ecological health of the area.

An effective approach is to hand pull outliers and work along the leading edges of an infestation first, pushing the infestation back towards its core, thereby concentrating the infestation and subsequent seed production into a smaller area. Depending upon time and resources available, the site can continue to be hand pulled, or chemical treatment can be applied to the smaller core area, minimizing non-target impacts. Repeated follow-up spot treatments of surviving plants by hand pulling, spot treatment with herbicide, or burning with a hand-held propane torch will be needed.

Vigilance is required to manage any live plants in the kill zone and ensure that other invasive species do not emerge or colonize. Native seeding may improve success, particularly in sites where garlic mustard has been long-established.

Disposal of plant parts

Root crowns and pulled plants should not be left on site or composted as they may re-sprout and still produce seed. They should be disposed of in a manner that will ensure that their roots will dry out completely. If flowers are present, they should be burned or bagged and placed in a landfill. Where this is not possible, any resulting seedlings will require monitoring and control.

Although landscape waste cannot generally be disposed of in landfills, Michigan law permits the disposal of invasive species plant parts. See the "Online Resources" section for a link to the relevant legislation.

Online resources:

CDMS - herbicide labels
http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=v

Fire Effects Information System, *Alliaria petiolata*
http://www.fs.fed.us/database/feis/plants/forb/allpet/all.html

Invasive.org
http://www.invasive.org/

Michigan Department of Agriculture and Rural Development—Pesticide Certification
http://www.michigan.gov/pestexam

Michigan Department of Environmental Quality—Aquatic Nuisance Control
http://www.michigan.gov/deqinlandlakes http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3710---,00.html

Michigan Department of Natural Resources—Local DNR Fire Manager contact list
http://www.michigan.gov/dnr/0,4570,7-153-30301_30505_44539-159248--,00.html

Michigan Invasive Species Coalition:
http://www.michiganinvasives.org/

Michigan Invasive Species Program:
http://www.michigan.gov/invasives

Michigan's Invasive Species Legislation
Natural Resources and Environmental Protection Act 451 of 1994, Section 324.4130
http://legislature.mi.gov/doc.aspx?mcl-324-41301

Michigan Legislation—landscape waste, disposal of invasive species plant parts
Natural Resources and Environmental Protection Act 451 of 1994, Section 324.11521, 2 (d)
http://legislature.mi.gov/doc.aspx?mcl-324-11521

Midwest Invasive Species Information System:
https://www.misin.msu.edu/

MIPN Invasive Species Control Database
https://mipncontroldatabase.wisc.edu/

MISIN Mapping Phone Apps:

http://www.misin.msu.edu/apps/

The Nature Conservancy's Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas
http://www.invasive.org/gist/handbook.html

University of Michigan Herbarium - Michigan Flora Online
http://michiganflora.net/

Quick reference - Garlic mustard

This chart has been provided as a convenience, to summarize the pros and cons of each herbicide and to present details on adjuvants, concentrations, etc., that do not fit into the discussion in the preceding sections. Although every attempt has been made to ensure accuracy, the product labels for the listed herbicides are the ultimate authority for their usage. Where there are conflicts, always follow the label directions. Techniques are listed in order of general preference by MDNR Wildlife Division staff but not all are suitable for wetlands or sensitive sites. Site conditions vary—choose a method that is best suited to conditions on the site being treated.

Anyone using herbicides in the course of their employment is required to be a certified pesticide applicator. Treatment in wetlands or over open water requires a permit from the Michigan Department of Environmental Quality.

These chemicals are available in a variety of formulations and concentrations. Concentration is listed below as a percentage of the active ingredient (AI) to facilitate use of different products/brands. Always follow all directions on the product label including mixing instructions, timing, rate, leaf coverage and the use of personal protective equipment.

	Herbicide	% A.I.	Adjuvant	Timing	Pros	Cons
Foliar Spray	Triclopyr ester (e.g., Garlon 4 Ultra®)	1.5-3%	Use a vegetable oil based multi-purpose adjuvant (e.g., SprayTech® Oil)	Target rosettes (first year plants) in October-November if there aren't too many fallen leaves, or in March- April, prior to emergence of natives. Best at temperatures above 50 degrees.	Broad-leaf specific--will not harm sedges and grasses. Extremely effective.	Not approved for use in wetlands.
Foliar Spray	Triclopyr amine (e.g., Garlon 3A®, Renovate®)	2-3%	Use a multi-purpose adjuvant (e.g., SprayTech® or Cygnet Plus in wetlands)	Target rosettes (first year plants) in October - November if there aren't too many fallen leaves, or in March-April, prior to emergence of natives. Best at temperatures above 50 degrees.	Safe for use in wetlands. Broad-leaf specific--will not harm sedges and grasses.	May be slightly less effective at a given percentage than the ester formulation.
Foliar Spray	Glyphosate (e.g., Roundup®, Rodeo®, Accord®)	1-3%	Some products already contain a surfactant - if not, add one (e.g., Cygnet Plus®, NuFilm IR®).	Target rosettes (first year plants) in October-November if there aren't too many fallen leaves, or March-April, prior to emergence of natives. Best at temperatures above 50 degrees.	Some products approved for use in wetlands.	Non-selective! Use only when few or no natives are present.
Note: Hand-pull survivor seedlings in May or June, whether you apply herbicide in spring or fall. Be sure to remove the entire root.						