



Summer 2020
Brown County

Sustainable Road Maintenance Options for Brown County, Wisconsin

Katie Fields, Report Author

Summer 2020

Brown County

Sustainable Road Maintenance Options for Brown County, Wisconsin

Katie Fields

Report Author • Sustainable City Year Program

Acknowledgments

The author would like to thank the following individuals for their support and contributions to the development of this report:

Michael Piacenti, Brown County Public Works Operations Manager
Paul Fontecchio, Brown County Public Works Director/Highway
Commissioner

This report represents original work and recommendations prepared by staff at the University of Oregon's Sustainable City Year Program for Brown County. Text and images contained in this report may not be used without permission from the University of Oregon.

Contents

4	About SCI
4	About SCYP
5	About Brown County
7	Executive Summary
8	Introduction
19	Case Studies
25	Cost-Benefit Analysis
29	Recommendations
30	Conclusion
31	Notes and References

About SCI

The Sustainable Cities Institute (SCI) is an applied think tank focusing on sustainability and cities through applied research, teaching, and community partnerships. We work across disciplines that match the complexity of cities to address sustainability challenges, from regional planning to building design and from enhancing engagement of diverse communities to understanding the impacts on municipal budgets from disruptive technologies and many issues in between.

SCI focuses on sustainability-based research and teaching opportunities through two primary efforts:

1. Our Sustainable City Year Program (SCYP), a massively scaled university-community partnership program that matches the resources of the University with one Oregon community each year to help advance that community's sustainability goals; and

2. Our Urbanism Next Center, which focuses on how autonomous vehicles, e-commerce, and the sharing economy will impact the form and function of cities.

In all cases, we share our expertise and experiences with scholars, policymakers, community leaders, and project partners. We further extend our impact via an annual Expert-in-Residence Program, SCI China visiting scholars program, study abroad course on redesigning cities for people on bicycle, and through our co-leadership of the Educational Partnerships for Innovation in Communities Network (EPIC-N), which is transferring SCYP to universities and communities across the globe. Our work connects student passion, faculty experience, and community needs to produce innovative, tangible solutions for the creation of a sustainable society.

About SCYP

The Sustainable City Year Program (SCYP) is a year-long partnership between SCI and a partner in Oregon, in which students and faculty in courses from across the university collaborate with a public entity on sustainability and livability projects. SCYP faculty and students work in collaboration with staff from the partner agency through a variety of studio projects and service-

learning courses to provide students with real-world projects to investigate. Students bring energy, enthusiasm, and innovative approaches to difficult, persistent problems. SCYP's primary value derives from collaborations that result in on-the-ground impact and expanded conversations for a community ready to transition to a more sustainable and livable future.

About Brown County, Wisconsin

Brown County was established in 1818. Today, it is the fourth largest county in the state of Wisconsin and home to 263,378 residents. It is composed of 13 townships, nine villages and two cities, of which Green Bay is the largest. Major employers and industries in the county include the Oneida Tribe of Indians, insurance sales, paper manufacturing, cheese processing, and recycling.

Green Bay is the largest cheese processing, concentrating and shipping center in the U.S.

convenience on all county and state highways, in addition to a number of local roads in Brown County.

Green Bay is home base for one of the nation's most recognized environmental quality paper converters and recycling companies. In fact, the recycling industry is fast becoming a sizable economic force in new jobs: paper, plastics, and wood products are all being recycled/processed locally.

General maintenance includes: patching, crack filling and replacement of pavement; shoulder maintenance, roadside mowing and brush control; bridge and culvert maintenance; litter and trash pickup; guard rail installation and repair; signing; pavement marking; traffic control; and traffic signal maintenance. Winter maintenance includes: installation of snow fence; ice control; salting and sanding; snowplowing, and snow removal.

Brown County is also the home of an internationally recognized manufacturer of custom log homes.

Other important industries are furniture factories, automobile parts plants, cold storage plants, dairy products plants, fisheries, meat processing, machinery production, transportation and national communications are all located here within.

Additionally, the department carries out road construction, pavement resurfacing (blacktopping), plus bridge and culvert repair and installation. To effectively accomplish these activities, storage, maintenance, and repair facilities are operated at various locations (Howard, Greenleaf, Langes Corners, and New Franken). Planning, engineering and administration are also functions of the department.

The Brown County Public Works Highway Department carries out general and winter maintenance in order to maintain travel safety and

Executive Summary

The Brown County, Wisconsin Public Works department engaged the University of Oregon Sustainable City Year Program to develop a cost-benefit analysis of roadside maintenance options. This report addresses specific strategies including application of aquatic herbicides, planting low-mow grass, hiring goats to graze ditches, leasing innovative equipment, and using prescribed fire to control invasive species while ideally also reducing annual maintenance costs. In addition to analysis of the costs of each strategy, this report includes information about the terrestrial invasive species of concern in Brown County (phragmites, wild parsnip, thistle, and poison hemlock) as well as case studies that describe current practices for roadside maintenance in similar counties in Wisconsin and the Midwest. Consideration of each of these elements led to a recommendation to incorporate multiple strategies into roadside maintenance based on landscape factors. Of the strategies investigated, low-mow grass and goats present the greatest potential for future cost savings while improving the landscape and minimizing risks to human and environmental health.

Introduction

CONTEXT

As part of the effort to reduce invasive species in compliance with the Wisconsin Administrative Code Chapter NR 40, which was codified September 1, 2009, Brown County's Public Works Department has undertaken various efforts to mitigate vegetation along the County's 649.75 miles of highway. Invasive species control is part of the department's overall effort to maintain county roadways along with other considerations such as visibility for safety. The Wisconsin Department of Natural Resources (DNR), which administers Chapter NR 40, stipulates that certain invasive species are either "prohibited" or "restricted" within counties in the state. In addition to the DNR, the Wisconsin Department of Transportation (Wisdom) guides some of the County's activities related to road maintenance including mowing dates required to control invasive phragmites (see below).

In an effort to identify possible cost-saving opportunities while adhering to these state agency requirements and other maintenance considerations, Brown County Public Works engaged with the University of Wisconsin – Madison UniverCity Alliance program. This project is part of a broader, three-year partnership between the County and UniverCity that began in 2019 and runs through 2022. This program is part of a national network known as Educational Partnerships for Innovation in Communities, or EPIC-N. The EPIC-N model provides a framework for large-scale connections that match multiple university classes with priority projects identified by communities. These partnerships enhance capacity and leverage university resources for communities while providing

opportunities for students to engage in experiential learning. UniverCity is among over thirty such programs within EPIC-N. When no class match at the University of Wisconsin – Madison was found for the sustainable road maintenance project, UniverCity staff reached out to their EPIC-N colleagues at the University of Oregon Sustainable City Year Program (SCYP) to engage in the project. Brown County and SCYP staff connected in Summer 2020 to develop this report synthesizing a cost-benefit analysis of maintenance options for the County's highways.

INVASIVE SPECIES IN BROWN COUNTY

The particular species of concern in Brown County as in many other parts of Wisconsin are, in order of priority as described by Public Works staff, phragmites, wild parsnip, thistle, and poison hemlock.

Phragmites australis, referred to in this report as simply "phragmites" is an invasive, perennial species of wetland grass (DNRA, 2020). It is also known as common reed grass, ditch reed, and giant reed (ibid). It can grow up to 20 feet tall and is a species of concern due to its negative impact on native vegetation, hydrology, and wildlife as well as its potential to increase fire risk. Phragmites is restricted by the DNR in most of eastern Wisconsin including Brown and surrounding counties. It is prohibited in Wisconsin's western counties. Phragmites is also considered an invasive species in other areas of North America and Europe, particularly along the East Coast of the United States (DNRb, 2007). Because of the underground rhizomal structure of the plant, it is able to propagate after being cut or burned. The DNR recommends

a combination of mechanical and chemical control (mowing and applying herbicide) to manage phragmites. Because phragmites thrives in aquatic areas, application of herbicide requires specialized aquatic formulations as

well as permitting by the DNR. In order to prevent distribution of phragmites through seeding, WisDOT requires that Brown County must complete a first mow by July 15 of each year.

FIG. 1

**Photograph of
*Phragmites australis***

Source: [https://commons.wikimedia.org/wiki/File:Phragmites_australis_\(inflorescences\).jpg](https://commons.wikimedia.org/wiki/File:Phragmites_australis_(inflorescences).jpg)



Pastinaca sativa, or wild parsnip, is restricted in Brown County and throughout Wisconsin. As a monocarp, wild parsnip dies after producing seed. It is a species of concern because it interferes with native vegetation in a broad range of habitats in Wisconsin and other parts of the midwest (DNRc, 2020). The DNR-prescribed treatment for wild parsnip, as with phragmites, is a combination of mechanical and chemical control. Unlike phragmites, wild parsnip does not grow in wetland

areas. Therefore, special permitting and herbicide formulas are not required. The DNR does not require that mechanical or chemical control of wild parsnip be completed by a specific date. However, the DNR recommends that cutting be completed before seeds set and that herbicide be applied between mid-May and mid-June. One unique factor to consider for managing wild parsnip is that it can cause severe skin reactions with direct contact.



FIG. 2

**Photograph of
*Pastinaca sativa***

Source: <https://www.pikist.com/free-photo-xiozm>

Cirsium vulgare, also known as common thistle or bull thistle, is not regulated by the Wisconsin Department of Natural Resources as an invasive species. However, it is a species of concern in Brown County. Because it is not restricted or prohibited by the DNR, a fact sheet is not available with the same categories of information as for the other species of concern discussed in this report. Another type of thistle, *Cirsium arvense*, or Canada thistle, is restricted in all Wisconsin counties. Suggested management of Canada thistle may provide some useful management insights for bull thistle, although Brown County Public

Works staff indicated that Canada thistle is simpler to control than bull thistle because Canada thistle can be easily dug up as a method of control. The Canada thistle is a perennial plant that reproduces through cloning via laterally-spread roots (DNRd, 2020). It invades a similar range of habitats as wild parsnip including prairie and cropland. The DNR recommends mechanical intervention at least three times during the growing season to effectively control thistle. The agency recommends that mowing be completed after buds have formed but before they have opened, and they stipulate that burning should be done

in both the late spring and later on in the growing season to inhibit seedling growth. Herbicide can be applied during the budding phase or in the fall.

One additional control method that the DNR recommends for thistle but not for phragmites or wild parsnip is biological control using insects such as weevils.

FIG. 3

Photograph of bull
(common) thistle

Source: <https://www.pikist.com/free-photo-xazix>



Poison hemlock (scientific name *Conium maculatum*) is prohibited throughout northern Wisconsin including Brown County (DNRe, 2020). This plant is toxic to humans and animals and invades a broad range of aquatic and riparian landscapes. The DNR recommends a combination

of mechanical and chemical control to manage the plant. The agency recommends hand pulling or mowing close to the ground several times per season for multiple seasons. The chemical 2, 4-D with dicamba is the herbicide recommended for management of poison hemlock.



FIG. 4

Photograph of poison hemlock

Source: <https://pixabay.com/photos/plant-plant-hemlock-poisonous-plant-5502061/>

CURRENT MAINTENANCE PRACTICES

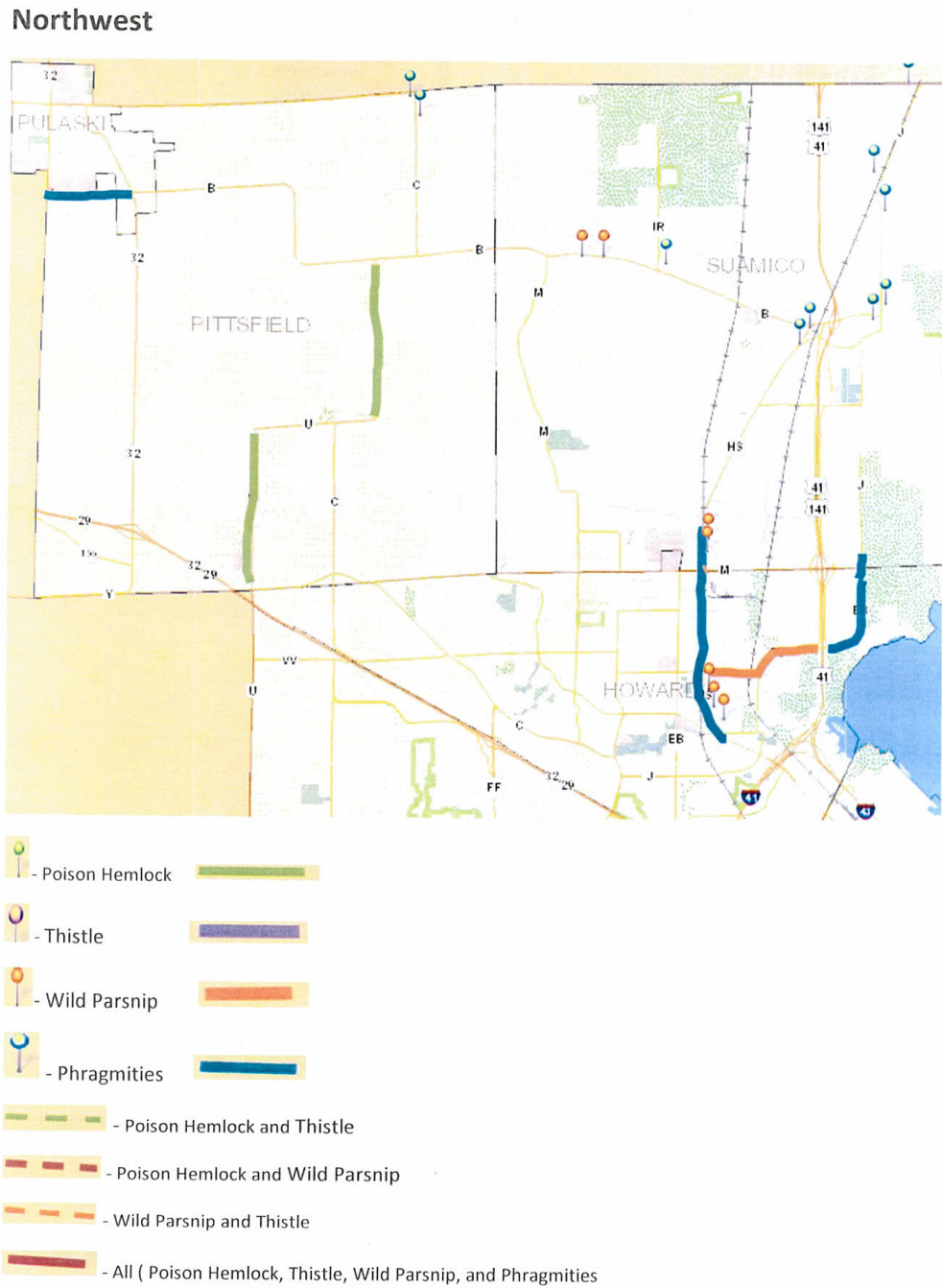
Brown County currently utilizes both mechanical and chemical methods to control vegetation along roadways. The Public Works department conducts three mows each year in rural areas totaling 617.04 miles. The first and only mow of county-maintained state highway trunk takes place no later than July 15 per the WisDOT requirement for phragmites, and no additional mowing is done on these roadways unless there are line-of-site obstructions. The first mowing of the county's highways is typically completed well before the state phragmites date. Typically, this

first mow involves a single pass with a 15-foot batwing mower and takes six to seven weeks (approximately 340 hours per tractor) to complete with the County operating as a contractor for the Wisconsin state trunk highway system as well as maintain the County's highways. The second mow generally takes eight to ten weeks to complete (440 hours per tractor), and employees use rear and side mowers in addition to batwings to cut back vegetation to 23 feet from the roadway. This second mow is the most intensive of the three, and it is usually completed by mid-September. During this round of

mowing, any vegetation that would be more difficult to remove from ditches later on, such as saplings, is removed. The third and final phase is a top-cut mow that is conducted from mid-October until snowfall reaches four

inches. This includes approximately 280 hours of use per tractor. On the 32.71 miles of urban medians within the Public Works department's jurisdiction, mowing takes place every three weeks.

FIG. 5
 Northwest sections of Brown County with invasive species indicated.
 Source: Brown County Public Works



Southwest

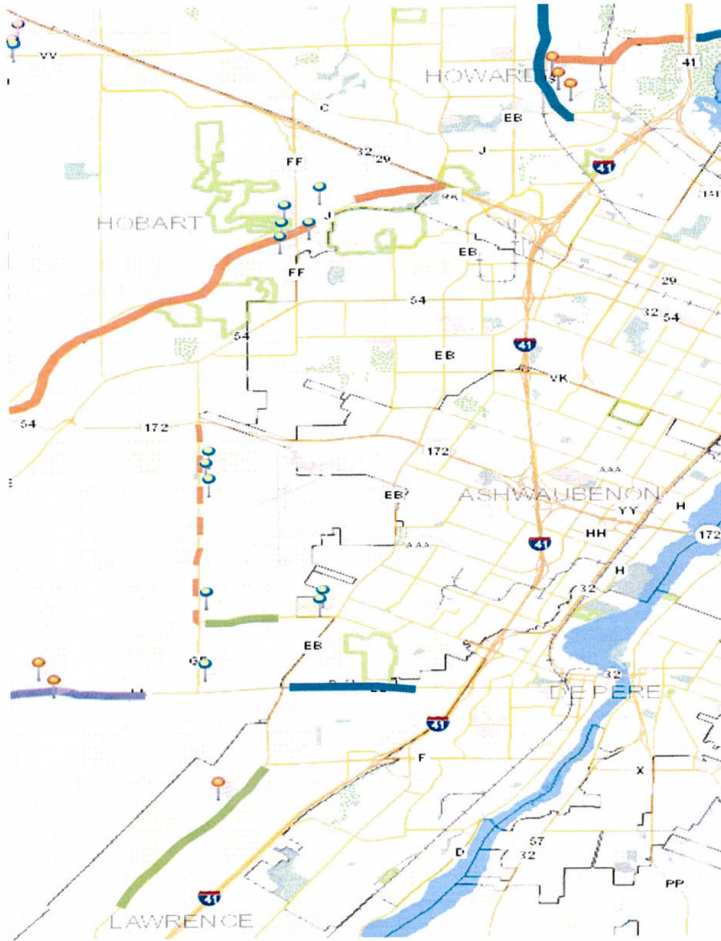


FIG. 6
Southwest sections
of Brown County
with invasive species
indicated.

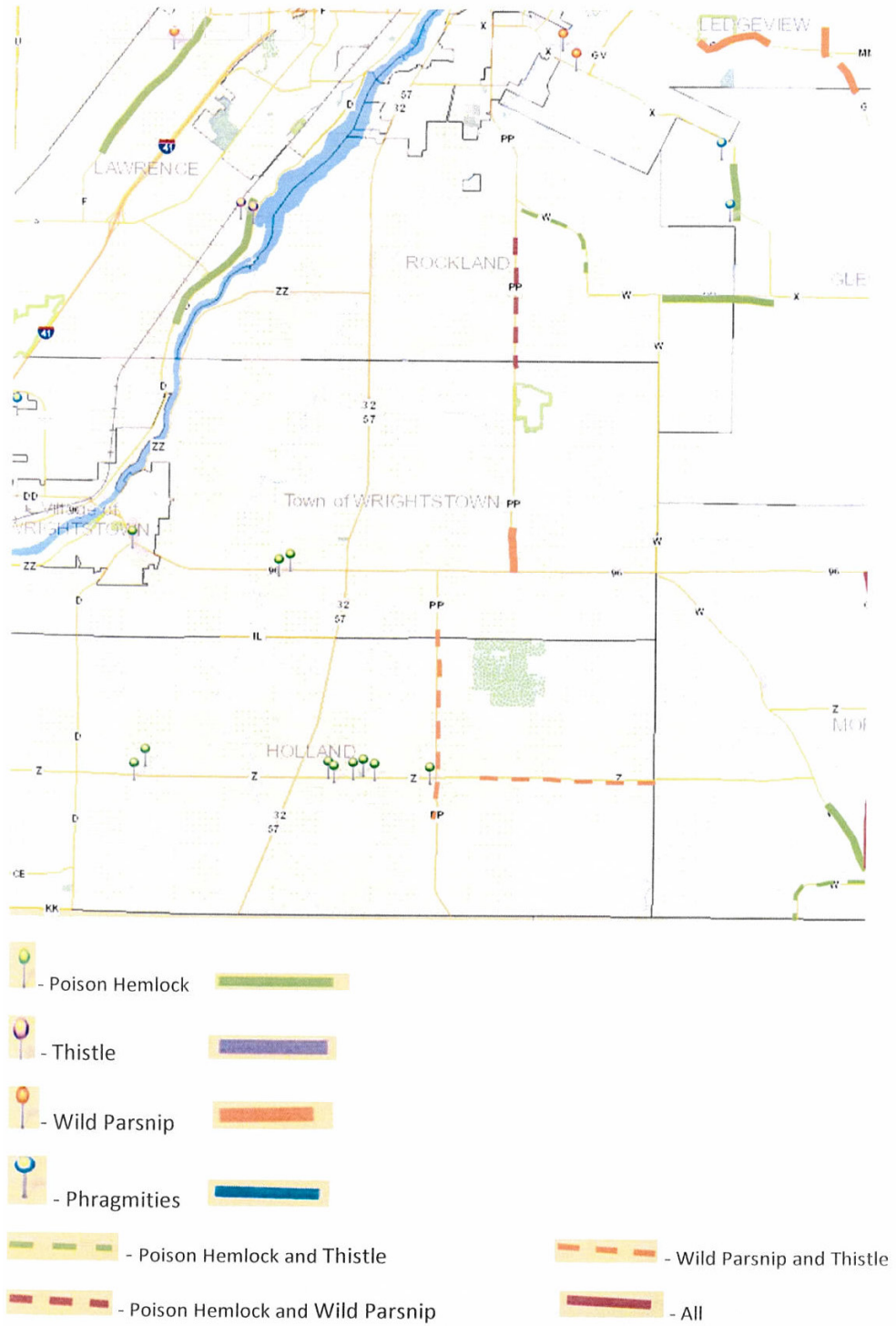
Source: Brown County Public Works



FIG. 7
**Central sections of
 Brown County with
 invasive species
 indicated.**

Source: Brown County Public
 Works

Central



Southeast

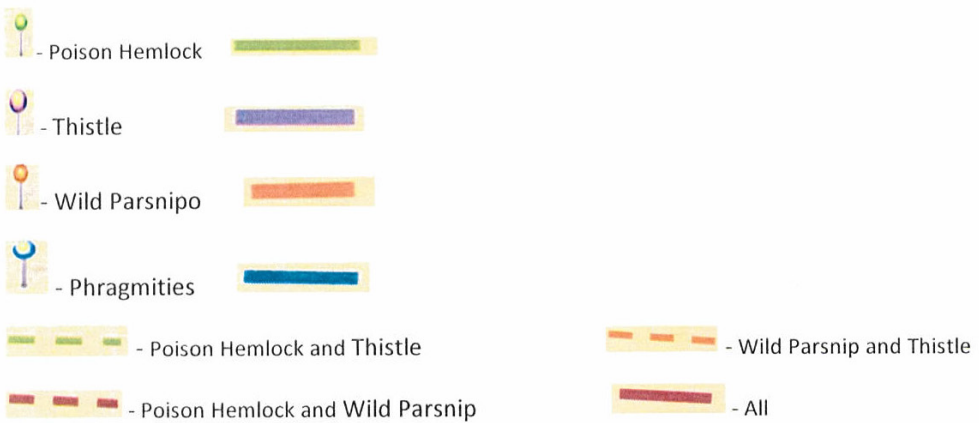
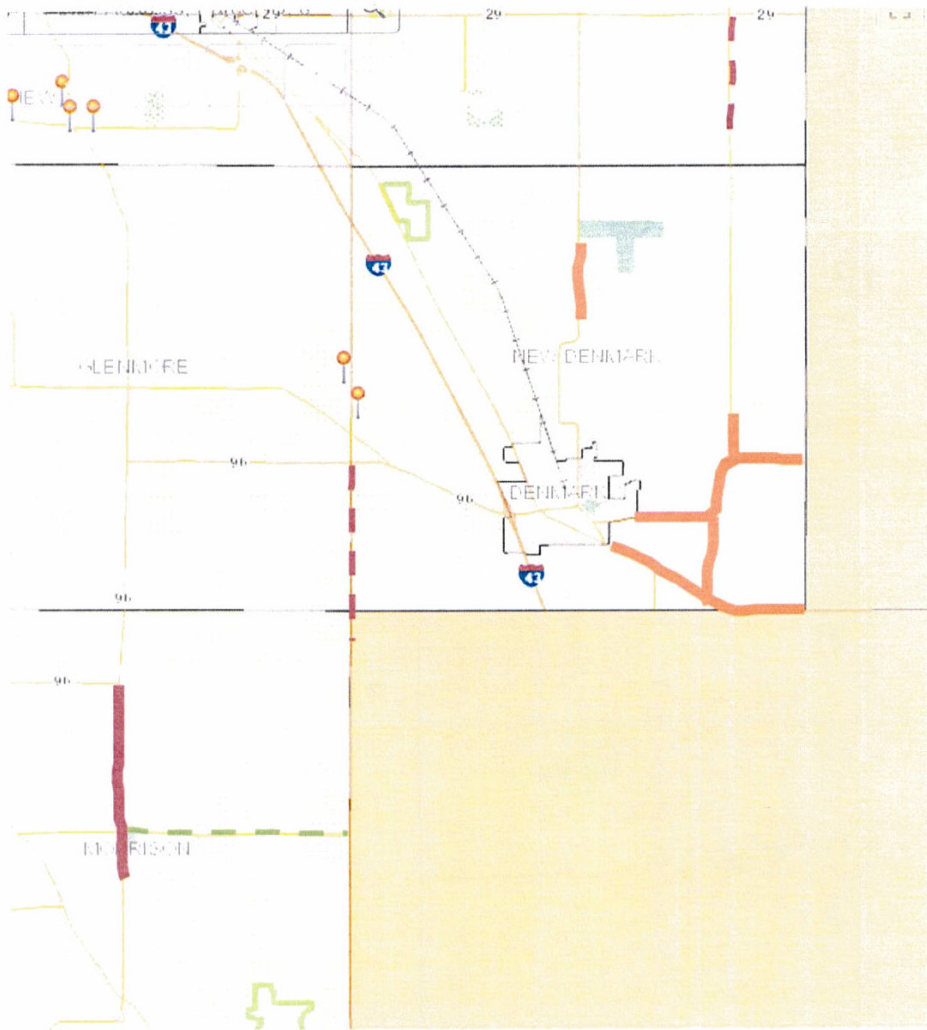


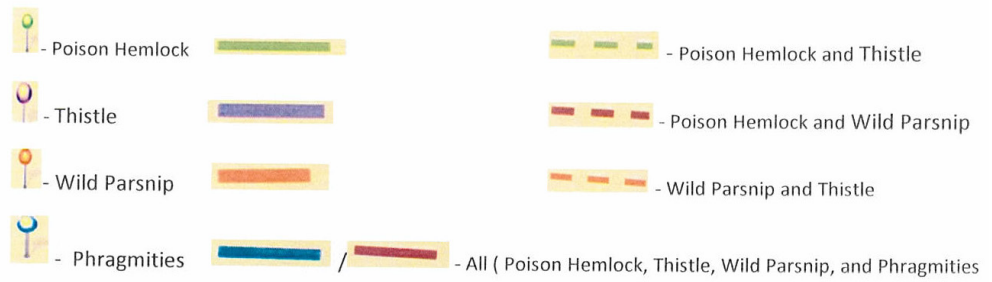
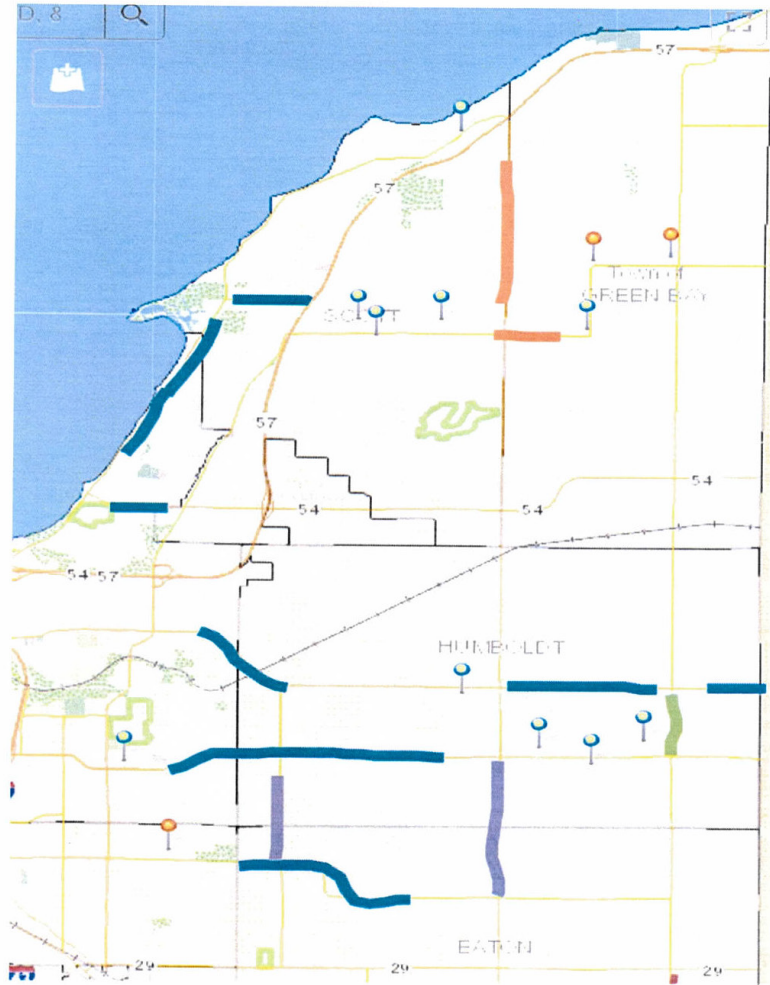
FIG. 8
Southeast sections
of Brown County
with invasive species
indicated.

Source: Brown County Public Works

FIG. 9
 Northeast sections
 of Brown County
 with invasive species
 indicated.

Source: Brown County Public
 Works

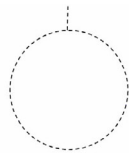
Northeast



In addition to these annual mowing phases, the County uses terrestrial herbicides to control the invasives on dry land. The common herbicides used include imazapyr, glyphosate, and metsulfuronmethyl. At this time Public Works does not use aquatic herbicides but considering incorporating them into their maintenance practices.

The department also provides outreach materials to landowners

(see Figure 10). These doorhangers inform landowners about the County’s efforts to control phragmites, steps they can take individually to assist in control efforts including chemical and mechanical management options, and resources for identifying the plant and finding additional information. The Public Works department is working on developing a similar door hanger for wild parsnip.



SORRY WE MISSED YOU

The Brown County Public Works Department has performed ditch cleaning along the County Highway in front of your property. As part of the cleaning, we have mechanically removed (cut or excavated) the phragmites, an invasive species. To help ensure the phragmites doesn't return along your property, we could use your help.

To help control phragmites you can:

- Mow/cut any growing stands during the growing season.
- Be careful not to spread the cut material to new areas to prevent seeding additional locations – especially the seed heads and roots.
- Be sure to clean any equipment used to prevent the spread of the phragmites.
- Spray areas with an aquatic herbicide containing imazapyr from June to September.
- Check out the WisDNR website for more information:

https://dnr.wi.gov/topic/Invasives/documents/phragmite_control_management.pdf



If you have any questions or concerns, please contact:

Phone: (920) 662-2160

Email: BC_Highway@browncountywi.gov

Address: 2198 Glendale Avenue
Green Bay, WI 54303

FIG. 10
Phragmites doorhanger

The current overall cost for roadside maintenance, including labor and equipment, comes to \$326,036.80 per year for rural roadways and \$57,600.00 annually for urban areas. These numbers include two full-time employees, two-part time employees, two batwing tractors, and two rear/

side mowers. Equipment costs are determined by the Wisconsin Bureau of Highway Maintenance as published in Chapter 2 – Administration of the Highway Maintenance Manual. The rates established in this document were most recently updated in August 2020.

ALTERNATIVE MAINTENANCE OPTIONS

Discussions between SCYP and Brown County staff led to the development of a list of alternative maintenance options for consideration. The options include the potential to reduce mowing costs using grazing and/or low-mow grass as well as additive procedures including application of aquatic herbicides.

Supplemental mechanical control options including fire, flooding, and use of underwater cutting equipment are also addressed. The advantages and disadvantages of each of these options are described in detail in the cost-benefit analysis section of this report along with estimated costs (see page 26).

Case Studies

The following case studies were identified in order to identify potential maintenance solutions for Brown County. These include other Wisconsin counties with similar population sizes, county-maintained highway miles, and invasive species of concern as well as one Illinois county with nearly-identical miles maintained and examples of phragmites control in other parts of the United States.

Table 1
Case Study Summary

	Miles managed	Invasives controlled	Phragmites Mow Date	Maint. cost per mile
Brown County, WI	649.75	Phragmites, wild parsnip, and thistle	July 15	\$590
Outagamie County, WI	531	Phragmites, garlic mustard, reed canary grass, and buckthorn	July 15	unknown
Dane County, WI	923	Phragmites, buckthorn, and honeysuckle	July 1	unknown
Racine County, WI	320	unknown	July 1	unknown
Waukesha County, WI	953	Phragmites	July 1	\$500
McHenry County, IL	525	phragmites, wild parsnip, and poison hemlock	n/a	unknown

OUTAGAMIE COUNTY

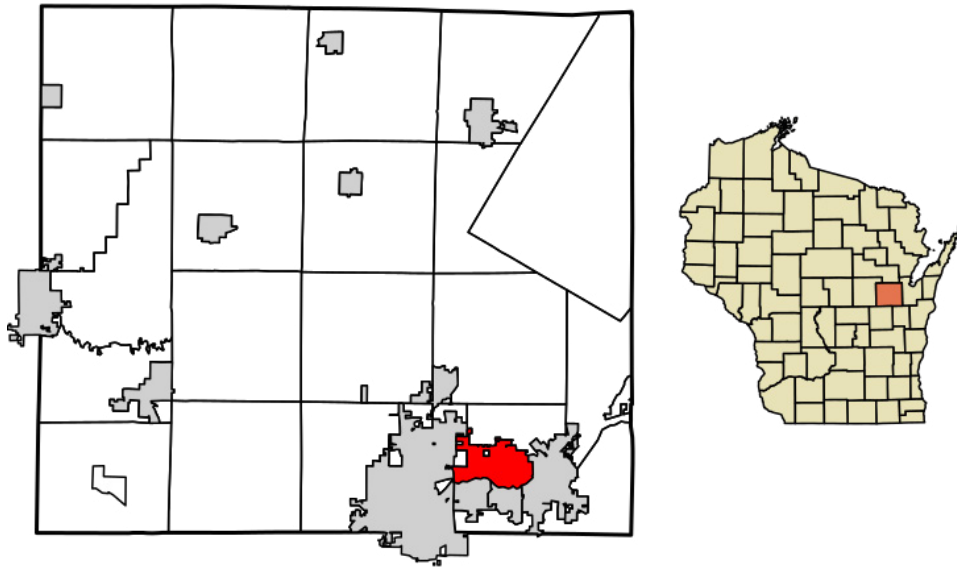


FIG. 11
Map of Outagamie County with incorporated and unincorporated areas.

Source: https://commons.wikimedia.org/wiki/File:Outagamie_County_Wisconsin_Incorporated_and_Unincorporated_areas_Little_Chute_Highlighted.svg

Population: 184,754

Area: 637.4 square miles

Median household income: \$63,536

Outagamie County’s Highway department provides maintenance for 344 miles of county trunk highways and 187 miles of state highway. The department’s activities are advised by the county’s Highway, Recycling, and Solid Waste committee, which meets twice monthly. As of June 2020, the department employs 14 seasonal employees, most of whom work on mowing activities, although they also support other highway activities such as flagging and supporting the engineering department.

Like Brown County, Outagamie’s phragmites first mow date as mandated by the Wisconsin Department of Transportation is July 15 of each year. Other invasive species noted in county

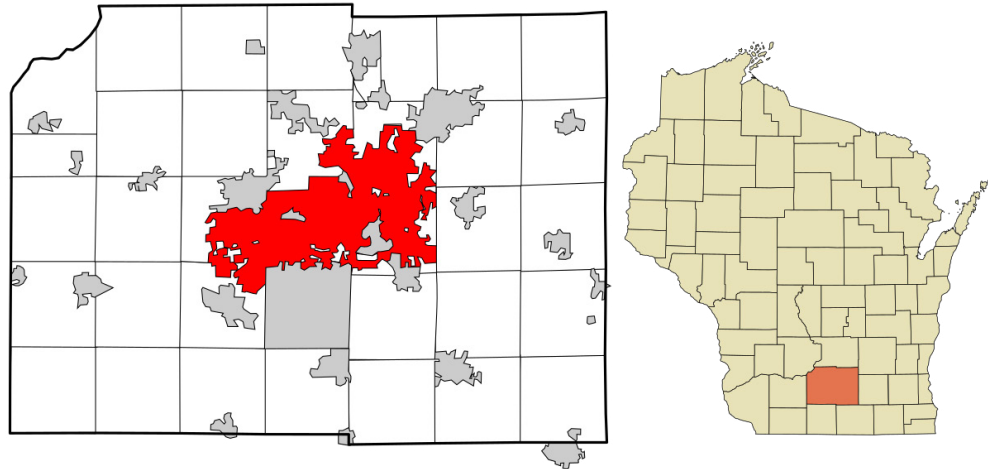
documents as existing in the area include garlic mustard, reed canary grass, and buckthorn (Comprehensive Plan, p. 76). On at least one occasion, goats have been used within the county to help manage invasive plants. In October 2018, pygmy goats from Mulberry Lane Farm in Calumet County were brought into the 1000 Islands Environmental Center on a 12-day trial basis with approval from the Kaukauna Common Council (Wideman, 2018). An article about the goat trial noted that students at Kaukauna High School analyzed the grazed area before and after the goats were brought onsite, but the outcome of their research is not available. The City of Kaukauna website indicates that the goats from Mulberry Lane Farm were brought back to the site again in September 2019 and June 2020, primarily to address buckthorn.

DANE COUNTY

FIG. 12

Caption: Map of Dane County with incorporated and unincorporated areas.

Source: https://commons.wikimedia.org/wiki/File:Dane_County_Wisconsin_incorporated_and_unincorporated_areas_Madison_highlighted.svg



Population: 529,843

Area: 1,196.1 square miles

Median household income: \$70,541

The Dane County Highway and Transportation department maintains 542 miles of county highway and 381 miles of state and federal highway. The County does not provide a per-mile cost for mowing or other maintenance activities, nor does the budget indicate the FTE engaged in maintaining these roadways.

Per state regulations, Dane County mows for phragmites by July 1 each year. In addition to phragmites, buckthorn and honeysuckle are plant species of concern in Dane County. The county's policies prohibit mowing to the fence line more than once annually. Additionally, staff are to consult with the Highway and Transportation botanist regarding vegetation control and mowing in areas with sensitive species such as wildflowers and prairie grass.

The Dane County Land and Water Resources department also engages in mowing as a mechanism of invasive

plant control. That department uses 15-foot batwing mowers to control primarily wild parsnip, Canada thistle, and sweet clover. The county developed an integrated pest management plan (IPMP) in 2011 that describes strategies for control of invasive plants including "mowing, hand pulling/digging, mulching, trimming, farming, burning and the use of herbicides" (IPMP, p. 2-3). While the IPMP pertains primarily to parks within Dane County, it refers to county-wide policies regarding the types of herbicides that can be used and protocols for their application. In addition to mowing and application of herbicides, burning is used as a control method for woodier plant species. In the 2019 actual modified budget, the county's invasive species management through the Land and Water Resources department totaled \$12,013 with \$7,431 for limited-term employment related to those activities. However, these amounts likely also include funding of aquatic invasive species control (Budget, p. 676).

RACINE COUNTY

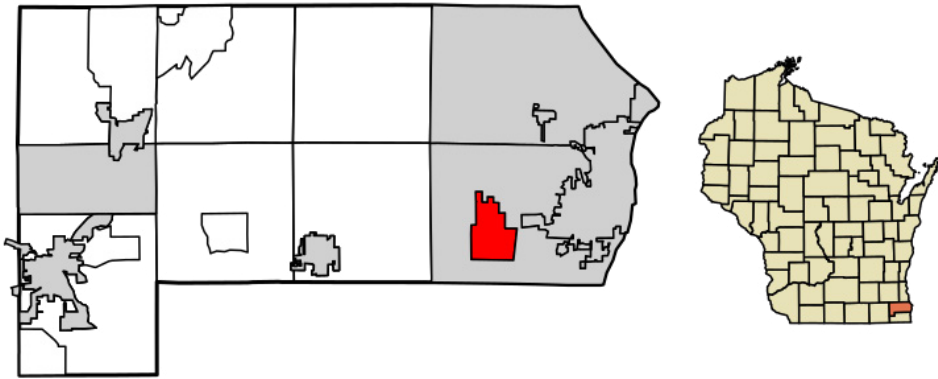


FIG. 13
Map of Racine County with incorporated and unincorporated areas.
 Source: https://commons.wikimedia.org/wiki/File:Racine_County_Wisconsin_Incorporated_and_Unincorporated_areas_Sturtevant_Highlighted.svg

Population: 195,398
Area: 332.4 square miles
Median household income: \$59,749

Racine County manages 164 county highway miles and 156 state highway miles through its public works department. As of September 2017, the county conducted two mowings of the county highways and one for state highways (Summary Minutes, p. 3). Information about per-mile cost of mowing is not available within the

county budget, although they do indicate that they employ 17.5 FTE of machine operators (Budget, p. 179). This employee category includes all machine operators rather than exclusively mower operators.

The county is required to mow for phragmites by July 1 each year. Additional details about specific control efforts or species of concern are not available through the public works department’s meeting minutes or budget documents.

WAUKESHA COUNTY

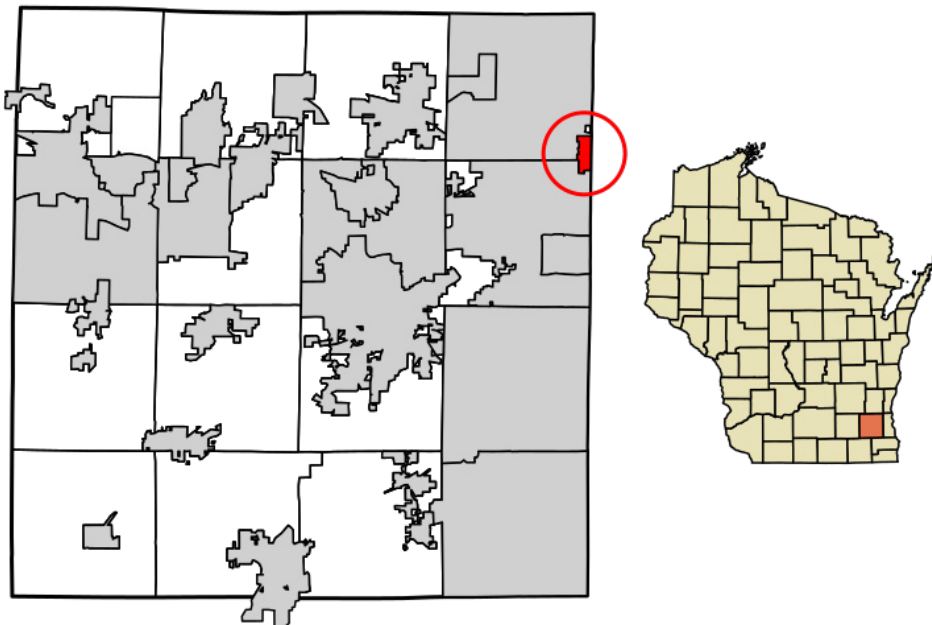


FIG. 14
Map of Waukesha County with incorporated and unincorporated areas.
 Source: https://commons.wikimedia.org/wiki/File:Waukesha_County_Wisconsin_Incorporated_and_Unincorporated_areas_Butler_Highlighted.svg

Population: 398,879

Area: 549.5 square miles

Median household income: \$84,331

Waukesha County's roadsides are maintained by the highway operations division of the public works department. The County manages 401 miles of county roads and 325 other road miles within its county road program. It maintains an additional 227 miles of state highway. The county budgeted \$500 per mile for mowing in the county road program in its 2019 budget, with actual numbers for the costs coming in in the \$450-500 range over the previous five years. The budget

does not distinguish cost per mile for mowing state highways.

The Wisconsin Department of Transportation requires a first mow for phragmites by July 1 of each year in Waukesha County. While the Public Works Department does not mention any control methods beyond "mowing of roadsides" (2019 Budget, p. 337) for invasive species, the Parks and Land Use department has developed a strategic plan for control of aquatic invasives including phragmites. They also offer a range of programs to students in K-12 schools to identify invasive species.

*Waukesha and Racine Counties are part of the Southeastern Wisconsin Invasive Species Consortium. This working group has an active management plan to control a number of plants including the phragmites and wild parsnips that are of concern in Brown County as well as common and cut-leaved teasels and Japanese Knotweed (Roadside Invasive Plant Management Plan, p. 1). SEWISC recommends two different control methods, each of which is applicable to one of the two primary Brown County invasives. For the monocarp wild parsnips, SEWISC recommends chemical control and/or mowing. For perennials like phragmites, SEWISC suggests herbicide as the exclusive method for eradication (p. 2). They advocate avoiding mowing phragmites if possible or ensuring equipment is clean, whereas wild parsnips should be mowed when they are in bloom without mature seeds, typically before mid-July (p. 3). SEWISC's roadside maintenance efforts are funded through the Environmental Protection Agency's Great Lakes Restoration Initiative, although of the two case study counties, the current EPA funding only supports Racine County's invasive plant control efforts.

MCHEMRY COUNTY (ILLINOIS)

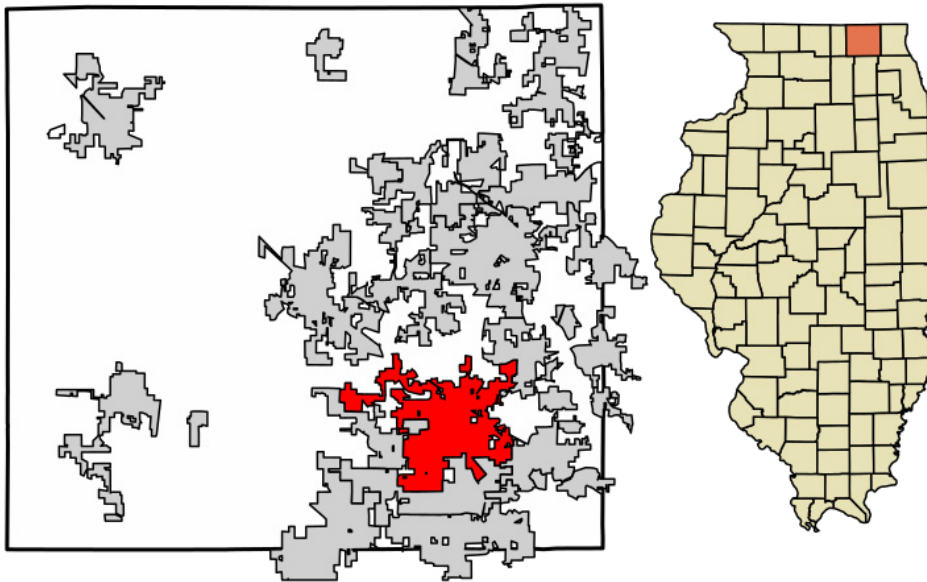


FIG. 15

Map of McHenry County with incorporated and unincorporated areas.

Source: https://commons.wikimedia.org/wiki/File:McHenry_County_Illinois_Incorporated_and_Unincorporated_areas_Crystal_Lake_Highlighted.svg

Population: 307,789

Area: 603.1 square miles

Median household income: \$84,803

The McHenry County highway system includes 525 miles of roadway. As of 2019, finish mowing on medians in McHenry County are completed through contracting services. For the 2020-2024 maintenance program, these services are anticipated to total \$310,000 (Transportation Program, p. 24). The county also provides a roadside planting program that will cost \$260,000 from 2020-2024. This program is intended for purchase and planting of native vegetation along county roadways (p. 37).

A draft “Land Uses and Best Management Practices – Transportation” chapter dated January 29, 2020 outlines strategies for controlling invasive species including phragmites, wild parsnip, poison hemlock, and others. This document emphasizes the importance of identifying and controlling invasive plants early along state, county, and township rights-of-way before the plants can become established (p. 8). The chapter also points out that improper timing of mowing or cleaning of mowing equipment can contribute to the proliferation of invasives.

Cost-Benefit Analysis

For each vegetation management option, six evaluation criteria are considered in the cost-benefit analysis. These criteria include four costs (labor, equipment, start-up costs, and a cost total), which are supplemented with an equipment replacement timeline (as defined by the Wisconsin Bureau of Highway Maintenance) and an overall efficiency rating as a control method for the invasive species of concern. A detailed description of each option including advantages and disadvantages follows the summary table shown in Table 2.

The estimates presented in this table reflect the total acreages affected by invasive species in the county. Presumably the county will not fully implement any one strategy on all 201.93 acres currently affected by these plants. The purpose of presenting the costs in this manner is to indicate a maximum anticipated cost of implementation to be able to show an “apples to apples” comparison of

costs. The geography and vegetation of each acre will guide the best management strategies along with the actual costs; goats will be able to access steep roadsides that may not be reachable using traditional maintenance equipment, while targeted herbicide application may be most appropriate for areas prone to flooding and standing water.

	Labor	Equipment	Start-up costs	Total Cost (Annual)	Equipment Replacement Timeline	Efficiency Rating (1-3, 3=best)
Baseline	\$118.66 hourly (2 FT, 2 PT)	\$256.12 hourly (2 batwing tractors, 2 rear/side mowers)	n/a	\$383,637	10 years	-
Aquatic Herbicide	\$4,271.76 (\$118.66 Hourly)	\$515.52 (\$14.32/hour – sprayer)	Permitting** \$5,128	-	10 years	-
			Glyphosate** \$5,595-7,580	\$15,510-17,495	-	1.5
			Imazapyr* \$11,393-20,836	\$21,308-30,751	-	2
Goats	n/a	\$250-750 per day for 120-250 goats	n/a	\$50,483-151,445	n/a	3
Low-mow	Same as baseline	\$3,825-7,650 (\$13.66/hour for spreader, 280 hours per tractor)	Grass seed \$166,600-186,600	\$170,425-194,250	10 years	3
Prescribed Fire	\$118.66 hourly (2 FT, 2 PT)		Training hours at \$118.66 hourly		-	1
Underwater mowing	\$118.66 hourly (2 FT, 2 PT)	Truxor DM 5000	Data not available		n/a (leased)	1

Table 2
Cost-Benefit Summary

* Costs calculated based on a rural acreage of approximately 202 acres based on maps provided by Brown County Public Works showing species of concern along rural highway miles and the largest mowing distance of 23 feet. Costs are for a single application.

† Glyphosate must be used with a surfactant in aquatic applications. This calculation includes the cost of the surfactant.

** Wisconsin DNR only permits up to 50 acres for treatment under a single permit. This calculation assumes multiple permits (4) to total the 202 rural acres. Each permit includes a \$20 base fee plus \$25 per acre treated.

HERBICIDES

In the context of this analysis, changes to current management practices pertain to incorporating chemical control in aquatic environments. As the only wetland species of concern for the purposes of this report, phragmites are the primary focus of any modification of herbicide implementation. Brown County currently utilizes terrestrial herbicides, but aquatic herbicides require specialized permits from the Wisconsin DNR. Two primary aquatic herbicides are used and recommended by the DNR: glyphosate and imazapyr. For aquatic applications, glyphosate must be accompanied by a surfactant.

The Wisconsin DNR links to a guide developed by the Michigan DNR describing control of phragmites that describes the comparative advantages of these two herbicides: “The cost per gallon of imazapyr can be significantly higher than glyphosate, though some studies suggest that imazapyr used alone or in combination with glyphosate can control Phragmites for a longer period of time.” (p. 11, *A Guide to the Management and Control of Phragmites*, 3rd ed., 2014). Per the Michigan guide, both glyphosate and imazapyr should be applied in a concentration of four to six pints per acre (six pints were assumed for these calculations). The guide also recommends that herbicides be used along with mechanical control options.

Advantages of aquatic herbicides include the potential to reduce development of the phragmites rhizomes that allow them to reproduce despite mechanical control. However, because sprayers are attached to mowing equipment, specialized equipment may be necessary to apply herbicides to steep or flooded areas. The staff time required to prepare and submit permits for aquatic herbicide

application are another drawback. While going through the permitting process and adhering to DNR guidelines helps to mitigate potential environmental consequences of herbicide use, aquatic application has the potential to cause negative impacts to human and environmental health.

GOATS

In addition to maintaining a broad range of invasive plants, goats are able to help re-establish native vegetation. They can also graze on steep ditches that mowers and other machinery may not be able to access. According to the DNR, goats may be used to manage phragmites, wild parsnip, and thistle as well as kudzu, garlic mustard, spotted knapweed, cypress and leafy spurge, white and yellow sweet clover, tansy, yellow starthistle, giant and Japanese knotweed, black locust, common buckthorn, honeysuckle, Japanese barberry, multiflora rose, autumn and Russian olive, Oriental bittersweet, and crown vetch (DNRf, 2020).

One of the biggest potential hurdles to using goats as part of a roadside maintenance plan is finding a contractor in close proximity with the capacity to manage Brown County’s roads. Liberation Farmers is one of the closest herds, but the herd is small. Mulberry Lane Farm, which supplied goats to manage vegetation at Outagamie County’s 1000 Islands Environmental Center, also has a very small herd. Neither of these local options list pricing for local government. Elsewhere in the country, costs can range from \$250-750 per day for herds of 120 to 250 goats. Another logistical consideration for using goats is preparing to request exceptions from cities to allow goats to graze on urban medians.

LOW-MOW GRASS SEEDING

In addition to reducing the need for mowing, low-mow grass seed can help reduce erosion, promote drought tolerance, and prevent growth of undesirable plants. Planting is recommended in the fall. Broadcast seeding could be done in conjunction with the final annual mow, which confers a cost savings over other mechanical control strategies since no additional labor is needed. In order to ensure that seeding is effective, as much existing vegetation should be removed through mechanical and chemical treatment as possible.

PRESCRIBED FIRE

Prescribed burning is an option that can supplement other control methods for roadside maintenance. Fire can be beneficial insofar as it returns nutrients to soil and promotes the growth of certain native plant species while reducing overall vegetation density. It is not a recommended method for controlling the invasive species of concern, but it can be used as a supplemental technique. Burning must be carefully timed to ensure that it does not interfere with growth of desirable

plants such as wildflowers. Planning is also required to ensure that weather conditions are appropriate. The DNR recommends consulting with local DNR office for training prior to using fire as a control method. Burning in Brown County does not require a permit.

UNDERWATER EQUIPMENT

According to the Great Lakes Phragmites Collaborative (GLPC), cutting phragmites underwater is more advantageous in preventing its spread than terrestrial cutting. This is because cutting the plant underwater cuts off its oxygen supply (Management Techniques, 2017). Underwater cutting can be accomplished using either specialized amphibious machinery or using hand cutters. The type of machinery used by the GLPC is called a Truxor DM 5000. These machines are manufactured in Europe, but a vendor in Delavan, Wisconsin called Hockney Company provides sales and leasing options for the equipment. They also manufacture their own line of underwater weed cutters. These machines cost upwards of \$100,000 used. Leasing costs are unknown as estimates could not be obtained.

Recommendations

None of the strategies is intended for consideration as a standalone management practice.

However, both planting of low-mow grasses and bringing in goats for roadside maintenance are good options for supplementing Brown County's existing maintenance plan to specifically target the species of concern discussed in this report. Over time, these methods can reduce maintenance needs while simultaneously helping to reestablish native species. Furthermore, these low-cost options do not create a need for expensive, difficult-to-find equipment nor do they present potential risks to human and environmental health. Due to their low cost and high benefit, these methods are ranked highest among possible options for Brown County to consider implementing.

In some cases, low-mow grass and grazing will not adequately control invasive species. On a case-by-case, targeted basis, seeking permits for aquatic herbicide application may be most appropriate. Because of the high risk, cost of training, and low efficacy associated with prescribed burning, this method is not recommended for further consideration by Brown County. Use of specialized underwater mowing equipment presents a less toxic alternative to use of aquatic herbicides, but because the equipment is highly specialized and not readily accessible, it is also not recommended at this time. Brown County may want to seek bids for renting such equipment in the future if other management practices fail to produce desired outcomes in terms of both direct cost savings and invasive plant control.

Conclusion

A variety of innovative solutions for roadside maintenance and invasive species control are becoming more mainstream and therefore more accessible. As Brown County considers long-term cost savings solutions while complying with state requirements to manage terrestrial invasive species, low-mow grass and use of goats for grazing emerge as options with high potential for future cost savings and a healthier ecosystem. This cost-benefit analysis can aid Brown County in anticipating costs of changes to management practices to foster economically and environmentally sustainable maintenance of roadways throughout the county in the coming years. In addition to this report, Brown County is in the process of internally developing an integrated pest management plan that will further guide decision-making about best practices for roadside maintenance.

Notes and References:

CASE STUDIES

Baseline - Brown County

- Population: 259,786
- Area: 529.6 square miles
- Median household income: \$59,963
- Vegetation managed by: Public Works
- Phragmites restricted
- WisDOT mow date: July 15
- Rural Miles – 617.04; \$326,036.80/year
- Urban Miles – 32.71: \$57,600.00 / year

Outagamie

- <https://www.outagamie.org/Home/ShowDocument?id=68840>
- <https://www.outagamie.org/government/departments-f-m/highway>
- <https://www.outagamie.org/how-to/about-us/county-board-of-supervisors/standing-county-board-committees/highway-recycling-and-solid-waste>
- <https://data.census.gov/cedsci/profile?q=Outagamie%20County,%20Wisconsin&g=0500000US55087&tid=ACSDP1Y2018.DP05>
- https://www.leadertelegram.com/country-today/front-page/goats-going-after-invasive-plant-species/article_c758b2e9-9ca4-5673-860d-0a6ee4be3d6a.html

Dane

- <https://highway.countyofdane.com/policies/mowing>
- <https://admin.countyofdane.com/documents/PDFs/Budgets/2020/2020-Executive-Budget.pdf>
- <https://highway.countyofdane.com/policies/trimming>
- <https://lwr.d.countyofdane.com/About-Dane-County-Lands-and-Waters>
- <https://parks-lwr.d.countyofdane.com/documents/PDFs/IPMP-November-2011.pdf>

Racine

- <https://www.racinecounty.com/Home/ShowDocument?id=17548>
- <https://www.racinecounty.com/government/all-board-and-committees/public-works-parks-and-facilities-committee/-toggle-allpast>

Waukesha

- <https://www.waukeshacounty.gov/DPW/dpw-divisions/>
- <https://www.waukeshacounty.gov/globalassets/administration/budget/2019-adopted-budget/9-button-pdfs/2019-adopted-budget-book-with-bookmarks-and-links.pdf> p. 336

McHenry (Illinois)

- <https://www.mchenrycountyil.gov/home/showdocument?id=95916>
- <https://www.mchenrycountyil.gov/county-government/departments-j-z/transportation/maintenance-section>

Wisconsin Department of Natural Resources

- DNRa: <https://dnr.wisconsin.gov/topic/Invasives/fact/Phragmites.html>
- DNRb: https://dnr.wisconsin.gov/sites/default/files/topic/Invasives/LR_Phragmites_australis.pdf
- DNRc: <https://dnr.wisconsin.gov/topic/Invasives/fact/WildParsnip.html>
- DNRd: <https://dnr.wisconsin.gov/topic/Invasives/fact/CanadaThistle.html>
- DNRe: <https://dnr.wisconsin.gov/topic/Invasives/fact/PoisonHemlock.html>
- DNRf: <https://dnr.wisconsin.gov/topic/Invasives/control.html>

Additional References

- https://www.michigan.gov/documents/deq/wrd-ais-guide-phragmites_622427_7.pdf
- <https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2016/05/20/grazing-goats-get-government-work>
- <https://www.greatlakesphragmites.net/management/techniques/>

SCI Directors and Staff

Marc Schlossberg	SCI Co-Director, and Professor of Planning, Public Policy and Management, University of Oregon
Nico Larco	SCI Co-Director, and Professor of Architecture, University of Oregon
Megan Banks	SCYP Director, University of Oregon
Sean Vermilya	Report Coordinator
Katie Fields	SCYP Manager
Danielle Lewis	Graphic Designer