



136 North Monroe Street
Waterloo, WI 53594-1198
Phone: (920) 478-3025
Fax: (920) 478-2021
www.waterloowi.us

PUBLIC NOTICE OF A COMMITTEE MEETING OF THE COMMON COUNCIL OF THE CITY OF WATERLOO

Pursuant to Section 19.84 Wisconsin Statutes, notice is hereby given to the public & news media, that the following meeting will be held:

COMMITTEE: PUBLIC WORKS & PROPERTY COMMITTEE
DATE: May 6, 2021
TIME: 6:00 p.m.
LOCATION: Municipal Building Council Chambers, 136 N. Monroe Street (in-person or remote)

REMOTE ACCESS DETAILS

Join Zoom Meeting: <https://us02web.zoom.us/j/83024284594?pwd=RytYYzJHNkF2Y081ZU5yY013YVhvZz09>

Meeting ID: 830 2428 4594 Passcode: 815503

Dial-in by phone

+1 312 626 6799 US (Chicago)

Meeting ID: 830 2428 4594 Passcode: 815503

1. CALL TO ORDER AND ROLL CALL
2. APPROVAL OF MEETING MINUTES – April 1, 2021 Meeting Minutes
3. CITIZEN INPUT / PUBLIC COMMENT
4. PROJECT OVERSIGHT & UPDATES
 - i. Assessor's 2020-2021 Property Revaluation
 - ii. Project Treyburn Residential Development
 - iii. 203 East Madison Street
 - iv. Adams Street Reconstruction
5. UNFINISHED BUSINESS
 - a. Contemplated Waste Treatment Plan Updates – Funding, Timing And Effect On Municipal Projects
 - i. Town & Country Engineer Ben Heidemann To Make City Council Presentation – May 20
 - ii. Waterloo Utilities' Public Hearing – June 10, 6:00 pm
6. NEW BUSINESS
 - a. Amending The Municipal Code To Require Sanitary Sewer Backflow Preventers For New Residential Construction
 - b. Weed Control And Review Of Journal Of Applied Ecology Research Article -- Roundup Causes High Levels Of Mortality Following Contact Exposure In Bumble Bees
 - c. Public Works Director's Spring Facility Inspection Report
 - d. Review/Realignment Of Progress Measures Tying Back To Comprehensive Plan
 - e. 2021 Municipal Facility Tour
7. FUTURE AGENDA ITEMS AND ANNOUNCEMENTS
 - a. Committee Calendar

8. ADJOURNMENT

Mo Hansen,
Clerk/Treasurer

*** Also, on Council Agenda. See Council materials for documentation.

Committee Members: Petts, Schoenwetter and Rhynes

posted, e-mailed & distributed: 04/30/2021.

PLEASE NOTE: IT IS POSSIBLE THAT MEMBERS OF AND POSSIBLY A QUORUM OF MEMBERS OF OTHER GOVERNMENTAL BODIES OF THE MUNICIPALITY MAY BE IN ATTENDANCE AT THE ABOVE MEETING(S) TO GATHER INFORMATION. NO ACTION WILL BE TAKEN BY ANY GOVERNMENTAL BODY OTHER THAN THAT SPECIFICALLY NOTICED. ALSO, UPON REASONABLE NOTICE, EFFORTS WILL BE MADE TO ACCOMMODATE THE NEEDS OF DISABLED INDIVIDUALS THROUGH APPROPRIATE AIDS AND SERVICES. FOR ADDITIONAL INFORMATION OR TO REQUEST SUCH SERVICES PLEASE CONTACT THE CLERK'S OFFICE AT THE ABOVE LOCATION.

CITY OF WATERLOO PUBLIC WORKS & PROPERTY COMMITTEE MEETING MINUTES: April 1, 2021

Digital audio files are archived with these written minutes additionally serving as the official record.

1. CALL TO ORDER AND ROLL CALL. Committee members present: Petts, Schoenwetter and Rhynes. Absent: none. Others attending: Utility Superintendent Barry Sorenson; Public Works Director Chad Yerges and Clerk/Treasurer Hansen.
2. APPROVAL OF MEETING MINUTES – Unapproved Minutes. MOTION: Moved by Rhynes, seconded by Schoenwetter to approve the March 4, 2021 meeting minutes. VOICE VOTE: Motion carried.
3. CITIZEN INPUT / PUBLIC COMMENT. None.
4. PROJECT OVERSIGHT & UPDATES
 - i. Assessor's 2020-2021 Property Revaluation. Hansen provided and update.
 - ii. Project Treyburn Residential Development. DISCUSSION: Sorenson asked where the project revenue was. Hansen replied it would be part of the fund balance in the capital fund. It was noted that sales occurred faster than anticipated. It was noted that debt incurred to fund public improvements were not prepayable. No action taken.
 - iii. 203 East Madison Street. Yerges said a construction meeting would take place in the next several weeks.
 - iv. Adams Street Reconstruction. Yerges noted that the completion date was September 15 or thereabouts.
5. UNFINISHED BUSINESS
 - a. Contemplated Waste Treatment Plan Updates – Funding, Timing And Effect On Municipal Projects. It was noted that Barry has signed a new e-waste contract. No action taken.
6. NEW BUSINESS
 - a. Public Works Department Purchase Of Skid Steer Equipment, Amount Not To Exceed \$17,900, Recommending 2021 Budget Amendment To The City Council. DISCUSSION: Yerges made the case for purchasing the scissor lift. MOTION: Moved by Schoenwetter, seconded by Rhynes to recommend to Council the purchase and corresponding budget amendment.
7. FUTURE AGENDA ITEMS AND ANNOUNCEMENTS
 - a. Committee Calendar. Noted.
8. ADJOURNMENT. MOTION: Moved by Schoenwetter, 2nd by Rhynes to adjourn. Motion carried. Time: 6:45 pm.



Attest:

Mo Hansen

Clerk/Treasurer

Status Report Project Name: Treyburn Farms 04/13/2021

Description:

Residential development of final phase of Bluegrass Trail. Purchase, design, subdivision public infrastructure installation, marketing and sale of 19 residential lots. Final phase of Treyburn Farms Subdivision.

Status:

Improvements completed. Municipal sales completed for 17 of 19 lots.

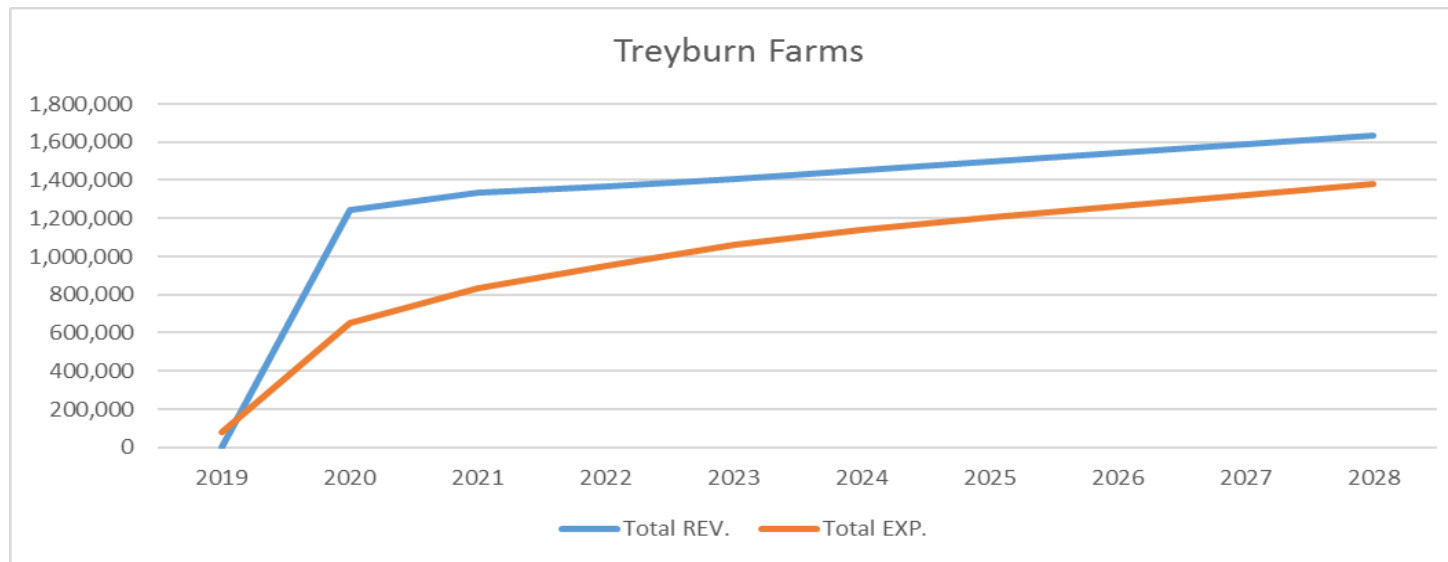
Milestone Dates

Goal/Objective Description	Start (Plan)	End (Plan)	Duration (Days)	Status	Progress	Notes
Install Public Improvements	11/15/19	07/01/20	229	Done	100%	
Market 19 residential parcels	03/01/20	07/15/20	136	Done	100%	
2020 -- Sell 5 residential parcels (Goal: 5)	03/01/20	12/31/20	305	Exceeded Goal	100%	Actual sold: 16
2021 -- Sell remaining residential parcels (Goal 2)	01/01/21	12/31/21	364	In Progress	0%	1 sale pending (#69); final lot status unclear (#2)

Sources / Uses of Funds (Projected Figures in Italics [gray])

	2019	2020	2021	2022	2023	2024	2025-2028	Total	Notes
SOURCES (Rev)									
SUBDIVISION LOT SALES	0	570,750	92,620	0	0	0	0	663,370	
DEBT PROCEEDS	0	673,690	0	0	0	0	0	673,690	
ESTIMATED PROPERTY TAX GAIN	0	0	0	28,693	40,648	45,430	181,722	296,494	Average home value: 236,154
TOTAL SOURCES	0	1,244,440	92,620	28,693	40,648	45,430	181,722	1,633,554	
USES (Exp)	2019	2020	2021	2022	2023	2024	2025-2028	Total	
DEBT SERVICE	0	0	161,799	112,710	112,068	82,025	238,480	707,082	58% of debt service for Rood/Treyburn debt issuance
RETAINAGES PAYABLE	0	0	22,827	0	0	0	0	22,827	
LEGIS SUPPORT PR & PUB	0	1,943	0	0	0	0	0	1,943	
ATTORNEY ATTORNEY FEES	4,410	2,058	0	0	0	0	0	6,468	
ENG & ADMIN PROF FEES	1,900	25,104	0	0	0	0	0	27,004	
CAPITAL PROJ STREET CONST	0	532,343	0	0	0	0	0	532,343	
CAPITAL PROJ TREYBURN	70,053	13,324	867	0	0	0	0	84,244	
TOTAL USES	76,363	574,770	185,492	112,710	112,068	82,025	238,480	1,381,909	

SOURCES LESS USES	-76,363	669,670	-92,872	-84,017	-71,420	-36,594	-56,758	251,645	
-------------------	---------	---------	---------	---------	---------	---------	---------	---------	--



Additional comments:

(a) Current & prior year data from accounting system as of report creation date.
(b) Out-year tax gain is estimated based on parcel sales, builder provided home values and current 2021 mil rate (municipal rate)
(c) 2020 debt issuance not pre-payable

§ 338-7 State code adopted.

The Wisconsin State Plumbing Code, adopted by the State Department of Safety and Professional Services, Chapters SPS 381 to 391 of the Wisconsin Administrative Code, and Chapter 145, Wisconsin Statutes, are hereby adopted as part of this chapter. The provisions thereof and of this chapter shall govern all plumbing, private wastewater disposal, and drainage work, and no plumbing, private wastewater disposal, or drainage work shall be done except in accordance with said codes and this chapter.

§ 338-8 Definitions.

Terms used in this chapter mean as follows:

BACKWATER

The unwanted reverse flow of liquids, solids or gases.

BACKWATER VALVE

A device designed to automatically prevent the reverse flow of wastewater in a drain system. Usually referred to as a palmer valve designed to protect the entire house drain system.

BASEMENT

That portion of a dwelling below the first floor or ground floor with its entire floor below grade.

CHECK VALVE

A device designed to automatically prevent the reverse flow of wastewater for a single fixture or drain.

PLUMBERS

Master and journeyman plumbers are any persons licensed by the State Department of Safety and Professional Services.

PLUMBING

- A. All piping, fixtures, appliances and appurtenances in connection with the water supply and drainage systems within a building and to a point from three feet to five feet outside of the building.
- B. The construction and connection of any drain or waste pipe carrying domestic wastewater from a point within three feet outside of the foundation walls of any building to the service lateral at the curb or other disposal terminal, including private domestic wastewater treatment and disposal systems, and the alteration of any such system, drain or waste pipe, except minor repairs to faucets, valves, pipes and appliances and removing of stoppages.
- C. The water service piping from a point within three feet to five feet outside of the foundation walls of any building to the mains in the street, alley, or other terminal and the connecting of domestic hot water storage tanks, water softeners, and water heaters to the water supply system.
- D. The water pressure system other than municipal systems as provided in Ch. 281, Wis. Stats.
- E. A plumbing and drainage system so designated and vent piping so installed as to keep the air within the system in free circulation and movement and to prevent with a margin of safety unequal air pressures of such force as might blow, siphon or affect trap seals or retard the discharge from plumbing fixtures or permit sewer air to escape.

SANITARY SEWER SERVICE LATERAL

That part of the sanitary drainage system extending from the property line to the connection with the main sewer.

§ 338-9 Backwater valve.

- A. Basement floor drains in all new construction shall be protected with a backwater valve or with sanitary sump with pumping equipment in accordance with § SPS 382.30(10), Wis. Adm. Code. Backwater valves, when fully open, shall have a capacity not less than that of the pipes in which installed and shall be located so as to be readily accessible for cleaning.
- B. Basement fixtures except lavatories, sinks and automatic washer drains with standpipes of 30 inches or more above basement floor level shall be protected by an approved type automatic backwater valve. If fixtures excepted from the

requirement for an automatic backwater valve are subject to backwater, a backwater valve of the check valve type shall be installed.

- C. The Village shall conduct a routine inspection program to identify buildings and residences that are properly protected and to require those buildings and residences that do not have adequate backwater protection to install said devices.

§ 338-10 Water supply systems.

- A. Size. The water service or building supply pipe to any building shall be of sufficient size to provide an ample flow of water under maximum use to all fixtures and points of service. Size shall be determined by standards set forth by the Wisconsin Department of Safety and Professional Services, except that no service shall be less than one inch.
- B. Material. The underground water service pipe from the main or a private water supply system to any building, and its joints and connections, shall be of polyethylene piping if a service of one inch or 1 1/2 inches or of such material and design as permitted by §§ SPS 384.30 and 384.40, Wis. Adm. Code.
- C. Valve controls. Service controls shall include a valve shutoff at the main, a curb stop or valve at the curb or privately owned pump, and a valve or stop inside the foundation wall of each building, and where a meter is installed, a valve on both sides of the meter. Service of 1 1/2 inches or over shall have a bypass around the meter. On services of one inch and less there shall be no fittings installed on the supply side of the meter which could be used to bypass such meter.
- D. Relief valves. All equipment for heating and storage of hot water for domestic or commercial purposes, when installed, repaired, replaced, relocated or reconnected, shall be equipped with an emergency protective device to prevent excessive pressure and excessive temperature. The valve shall be a combined temperature and pressure-relief valve of the test lever and extended thermometer type. These relief valves shall be listed by the American Gas Association (AGA) or American Society of Mechanical Engineers (ASME). The minimum size shall be 3/4 inch for both inlet and outlet. The discharge pipe shall be full size of relief valve outlet and shall terminate in an open fixture or not more than 10 inches from the floor as close as possible to a drain properly connected to the building drain or building sewer.
- E. Separate water service. When a water supply system is intended to serve more than one building owned by or intended for sale to different individuals or groups of individuals, the plans for such water supply system or systems shall be submitted to the Plumbing Inspector and Water Utility for approval, and the entire work must conform to these regulations. A separate water meter shall be installed for each residence.
- F. Cross-connections prohibited. No private water system shall be connected directly or indirectly to any private water main or pipe that in turn is connected to any publicly owned water main or pipe.
- G. Changes by Plumbing Inspector. The Plumbing Inspector may direct any necessary changes to be made to bring any water supply work up to prescribed standards. Failure to do so when so directed shall be sufficient cause for action to revoke a master or journeyman plumber's license as provided in § 145.10, Wis. Stats.

§ 338-11 Discharging of drains and sewers.

No person shall discharge domestic wastewater, industrial wastes or septic tank effluent onto the surface of the ground or into any drainage ditch, river or stream or any storm sewer. Black water and grey water must discharge into approved materials to the sanitary sewer according to Chapter SPS 384, Plumbing Products, of the Wisconsin Administrative Code.

§ 338-12 Clear waters.

- A. No discharge to sanitary sewer. No person shall cause, allow or permit any roof drain, surface drain, subsoil drain, drain from any mechanical device, gutter, ditch, pipe, conduit, sump pump, or any other object or thing used for the purpose of collecting, conducting, transporting, diverting, draining, or discharging clear waters from any part of the premises owned or occupied by said person to discharge, drain or be connected into a sanitary sewer.
- B. Nuisance. The discharge into a sanitary sewer from any roof drain, surface drain, subsoil drain, drain from any mechanical device, gutter, ditch, pipe, conduit, sump pump, or any other object or thing used for the purpose of collecting, conducting, transporting, diverting, draining, or discharging clear water from any part of any premises is hereby declared to be a public nuisance and a hazard to the health, safety, and well-being of the people of the Village and to the protection of property.

Roundup causes high levels of mortality following contact exposure in bumble bees

Edward A. Straw  | Edward N. Carpentier | Mark J. F. Brown 

Centre for Ecology, Evolution & Behaviour,
Department of Biological Sciences, School
for Life Sciences and the Environment, Royal
Holloway University of London, Egham, UK

Correspondence

Edward A. Straw
Email: EdwardAStraw@gmail.com

Funding information

Horizon 2020 Framework Programme,
Grant/Award Number: 773921

Handling Editor: Ian Kaplan

Abstract

1. Pollinators underpin global food production, but they are suffering significant declines across the world. Pesticides are thought to be important drivers of these declines. Herbicides are the most widely applied type of pesticides and are broadly considered 'bee safe' by regulatory bodies who explicitly allow their application directly onto foraging bees. We aimed to test the mortality effects of spraying the world's most popular herbicide brand (Roundup®) directly onto bumble bees *Bombus terrestris audax*.
2. We used three Roundup® products, the consumer products Roundup® Ready-To-Use and Roundup® No Glyphosate, the agricultural product Roundup® ProActive, as well as another herbicide with the same active ingredient (glyphosate), Weedol®. Label recommended pesticide concentrations were applied to the bees using a Roundup® Ready-To-Use spray bottle.
3. Bees exhibited 94% mortality with Roundup® Ready-To-Use® and 30% mortality with Roundup® ProActive®, over 24 hr. Weedol® did not cause significant mortality, demonstrating that the active ingredient, glyphosate, is not the cause of the mortality. The 96% mortality caused by Roundup® No Glyphosate supports this conclusion. Dose-dependent mortality caused by Roundup® Ready-To-Use, further confirms its acute toxicity. Roundup® products caused comprehensive matting of bee body hair, suggesting that surfactants, or other co-formulants in the Roundup® products, may cause death by incapacitating the gas exchange system.
4. These mortality results demonstrate that Roundup® products pose a significant hazard to bees, in both agricultural and urban systems, and that exposure of bees to them should be limited.
5. *Synthesis and applications.* Surfactants, or other co-formulants, in herbicides and other pesticides may contribute to global bee declines. We recommend that, as a precautionary measure until co-formulant identities are made public, label guidelines for all pesticides be altered to explicitly prohibit application to plants when bees are likely to be foraging on them. As current regulatory topical exposure toxicity testing inadequately assesses toxicity of herbicide products, we call for pesticide companies to release the full list of ingredients for each pesticide formulation,

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2021 The Authors. *Journal of Applied Ecology* published by John Wiley & Sons Ltd on behalf of British Ecological Society

as lack of access to this information hampers research to determine safe exposure levels for beneficial insects in agro-ecosystems.

KEYWORDS

bees, contact toxicity, herbicide, inert ingredient, pesticide, roundup, surfactants, topical toxicity

1 | INTRODUCTION

Bees provide the crucial ecosystem service of pollination (Potts et al., 2016), but are under threat, with 37% of EU bee species with known trends exhibiting population declines (Nieto et al., 2014). One apparent cause of these declines is pesticides (McArt et al., 2017; Rundlöf et al., 2015; Woodcock et al., 2016). Pesticide usage is pervasive, with 4.1 billion kilograms of active ingredient applied globally in 2017, nearly double the amount used in 1990 (FAOSTAT, 2019). Pesticides have received significant attention from the public and policymakers due to their apparent detriment to non-target organisms, such as pollinators, but this attention has largely focused on insecticides. A recent systematic review found that only 29 studies had tested the effects of herbicides on bees (Cullen et al., 2019). Additionally, research into herbicides relative to insecticides is disproportionate to their usage, with, for example, 24 times more herbicide applied in the United Kingdom than insecticide in 2018 (FERA, 2019).

For most classes of pest, pesticide usage varies by crop and region, with a range of active ingredients being employed (Garthwaite et al., 2016a,b). However, herbicides are unique in that one substance, glyphosate, is applied at a far greater rate than any alternative (FERA, 2019). In 2014, 826 million kilograms of glyphosate were applied globally (Benbrook, 2016), accounting for around 20% of all pesticide application (Benbrook, 2016; FAOSTAT, 2019). Glyphosate (applied in products called glyphosate-based herbicides—GBHs) has a favourable toxicity profile as a broad-spectrum herbicide, being the only herbicide to target the shikimate pathway (Duke, 2018). Its low toxicity to the majority of non-target organisms (EFSA, 2015a), has led to most regulatory regimes placing minimal restrictions on its application (Beckie et al., 2020). Bee exposure to glyphosate is poorly characterised, although it is known to be extensive, with surveys finding that 59% of honey samples had glyphosate present above the limit of detection, with a mean of 64 ppb (Rubio et al., 2014).

High acute doses (oral and contact) of glyphosate, applied as the active ingredient (glyphosate) alone, or in a single representative formulation (MON 52276 commercially called Roundup® Bioflow in Italian markets (EFSA, 2015b; Mesnage et al., 2021)), do not cause mortality in honeybee workers (EFSA, 2015b). Consequently, it has passed lower tier testing in the United States and Europe, facilitating its approval in both territories. However, GBHs contain additional components, called co-formulants, that can have serious, but systematically underestimated risks (Cox & Sorgan, 2006; Mesnage & Antoniou, 2018; Mullin et al., 2016).

Co-formulants are chemical additives that increase the efficiency of the active ingredient (Hazen, 2000). Without co-formulants,

pesticide formulations would be much less effective (Hazen, 2000), and more active ingredient would need to be applied, potentially leading to more environmental damage. Most co-formulants are considered 'inert' by regulatory bodies, and thus are not subject to equivalent testing to active ingredients. Consequently, there are no requirements to test their toxicity to bees (EC, 2009), meaning that potentially toxic substances are used abundantly (Cox & Sorgan, 2006; Mullin, 2015; Mullin et al., 2015). As they are not tested for in food or environmental residue monitoring programmes (Mesnage et al., 2019), our understanding of their prevalence and environmental fate is highly limited. Bee exposure to these co-formulants is likely commensurate to that of active ingredients but is poorly studied.

While our understanding of co-formulant exposure is limited, studies of hazard (i.e. the damage they cause) are more informative. Nagy et al. (2019) reported that 24 of 36 studies showed formulations to be more toxic in non-target organisms than active ingredients alone. In human cell lines and rats, Roundup® products specifically were more toxic than the active ingredient alone in five of six studies, with just one study finding equivalent toxicity (Nagy et al., 2019). While only one formulation per active ingredient is typically submitted to the full range of toxicity tests in the EU (EFSA, 2015a), dozens of formulations per active ingredient are produced, each with a unique composition posing unique hazards to non-target organisms (Mesnage et al., 2019). For glyphosate in the United Kingdom there are 284 distinct consumer or agricultural formulations (Health & Safety Executive UK, 2020), making it the most formulation diverse AI in the United Kingdom. Co-formulants present in Roundup® have been found to have sub-lethal effects in human cell lines (Defarge et al., 2016; Mesnage et al., 2013), demonstrating that they present a relevant hazard to health, although almost nothing is known of their effects on bees (Mullin, 2015; Mullin et al., 2015). One class of co-formulants, surfactants (surface acting agent), were found in 100% of American honey, pollen and beeswax samples ($n = 27$; Chen & Mullin, 2014), demonstrating their pervasiveness.

Surfactants in herbicides like Roundup® spread the sprayed droplets out over target leaves, increasing glyphosate absorption and toxicity. Surfactants are major co-formulants in Roundup® products, typically accounting for 15% of the concentrated weight (Mesnage et al., 2019). Surfactants are environmental pollutants that have been shown to have a range of negative impacts on honey bees (Ciarlo et al., 2012; Fine et al., 2017; Goodwin & McBrydie, 2000; Moffett & Morton, 1973, 1975) and solitary bees (Artz & Pitts-Singer, 2015).

In agriculture, direct spraying of insecticides onto bees, or bee attractive flowers, is banned as part of their mitigation strategy (EFSA, 2013) in order to prevent bees contacting the pesticide as it is

being sprayed, or the residues on flowers after it is sprayed. No such restrictions apply for herbicides, with the Environmental Information Sheet for Roundup® ProActive stating "Roundup ProActive is of low toxicity to honeybees; there is no requirement to avoid application of the product when bees are foraging on flowering weeds in treated crops" (Roundup® ProActive Environmental Information Sheet, 2020). Consequently, with both glyphosate and the co-formulants/surfactants in GBHs being considered safe by regulators (EFSA, 2015a), there should not be lethal effects from GBHs when used following label guidelines. Abraham et al. (2018) however, found significant mortality through indirect exposure to a GBH, Sunphosate 360 SL (Zhejiang Xinan Chemical Industrial Group, Zhe-jiang, China), which is a generic GBH available in Ghana. The study found that honeybees *Apis mellifera* and stingless bees *Hypotrigona rufopoli* exposed to the formulation via a branch of a flowering tree *Senna siamea* that had previously been sprayed with Sunphosate 360 SL suffered 28% and 23% mortality respectively, which was significantly higher than the 4% and 6% mortality for the water control. As glyphosate does not cause such mortality via contact or oral exposure (EFSA, 2015b), the mortality seen in this experiment is likely to be driven by co-formulants.

Risk assessment of the threat a pesticide poses to bees relies on the Risk = Hazard × Exposure model, where Hazard is a measure of toxicity, and Exposure is a measure of environmental contact. GBHs are currently believed to combine low to no hazard and high exposure, because they can be directly applied to bees, making them low to intermediate risk. Here we test how hazardous a range of GBHs, including Roundup® products are to bumble bees. We use a study design that can distinguish between the effects of co-formulants and the active ingredient, to allow us to test how these factors affect mortality. We predict that the GBHs will cause moderate mortality with direct exposure, in line with Abraham et al. (2018).

2 | MATERIALS AND METHODS

Ten commercial bumble bee, *Bombus terrestris audax*, colonies were used in the experiments (Agralan). On arrival 10 workers per colony were removed and their faeces screened for micro-parasites. No infections were detected, and all colonies were thus retained in the experiment.

In all experiments over 50 bees were exposed per treatment (excluding the control treatment in Experiment 4) in groups of five or six, as detailed in Table S2. Bees were sprayed in groups for efficiency and because an even coating could still be achieved with this number of bees in a box. For each experiment multiple source colonies were used to account for inter-colony variation, allocating them evenly across treatments. Workers were moved from source colonies into clear acrylic boxes (6.7 × 12.7 × 4.9 cm), with a plastic mesh grate bottom (6.7 × 7.3 cm). Within each box, bees were only taken from one source colony and were left to acclimatise for 10 min prior to exposure.

A mortality check was carried out prior to exposure. Mortality was defined as any moribund bee being entirely unresponsive to physical

agitation with a pair of forceps. Following this, the acrylic box was sprayed in a X shape from corner to corner with two squeezes of the trigger of a Fast Action Roundup® Ready-To-Use bottle (Roundup® Ready-To-Use; total exposure = 1.327 ± 0.005 ml SE); the spray came out as a cone of droplets which ensured consistent and even coverage across the whole box. This amount was chosen to ensure the bees were evenly coated while keeping control mortality <10%, pilot work found this methodology to deliver the treatment evenly to all bees sprayed when visually assessed. Roundup® Ready-To-Use and Roundup® No Glyphosate are sold in these spray bottles, and Weedol® in a similar bottle. Bees were sprayed under red light to prevent flying, we did not attempt to influence their behaviour beyond this, and they were exhibiting normal resting behaviour when sprayed. This methodology is not designed to replicate field realistic exposure (spraying conditions or label recommended application rates), it is instead designed to assess the lethality (hazard) the herbicide products pose to bumble bees. One investigator performed the spraying and mortality checks. A series of practice sprays were performed to ensure consistency. Mortality was recorded immediately after spraying, and at 10, 20 and 30 min. After 30 min a source of sucrose (50% w/w) and small portion of pollen (1–2 g) was added. At 24 hr post-exposure mortality was recorded for a final time. Boxes that flooded due to sugar water spillage between 30 min and 24-hr observations were excluded ($n = 2$, both in Experiment 2, Control), as were individual bees who drowned themselves in the sucrose gravity feeder ($n = 1$, Experiment 5, Control).

We used a total of four herbicide products across our experiments. Fast Action Roundup® Ready-To-Use (MAPP 14481; henceforth referred to as Roundup® Ready-To-Use), Roundup® Speed Ultra (MAPP 18692; henceforth referred to as Roundup® No Glyphosate; both Scotts Miracle-Gro Company, Surrey, UK under licence from Monsanto, Cambridge, UK), and Weedol® Gun! Rootkill Plus (MAPP 14554; henceforth referred to as Weedol®, Scotts Miracle-Gro Company, Surrey, UK) are all consumer products that can be bought in supermarkets. Consumer products require no licence or training in the United Kingdom and are intended for garden use. Roundup® ProActive (MAPP 17380, Monsanto, Cambridge, UK) can be bought online without a licence in the United Kingdom, but a licence is required to spray the substance in agriculture or horticulture (Roundup® ProActive Label, 2019). All products were purchased in 2019 online or in person in the United Kingdom (full details of all products used are provided in Table S1). Table 1 shows the glyphosate and other active ingredient concentrations, as reported on the product labels, and the dilutions for the test solutions used across experiments. For pre-mixed consumer products, we used the concentration as sold, or diluted it further as in Experiments 2 and 3. For the agricultural product Roundup ProActive we used field realistic concentrations of the treatment solutions, with the product diluted as directed on the label to produce a concentration equivalent to that used in agricultural spraying. This is distinct from the rate of application, which is the amount of substance applied per area, typically expressed as AI g/ha or L/ha of a pesticide mixture. We did not attempt to replicate field realistic application rates for the agricultural product Roundup

Experiment	Treatment	Product concentration used (%)	Glyphosate concentration g/L
All	Control	0	0.0
1	Roundup® Ready-To-Use	100	7.2
1	Roundup® ProActive	6.25	22.5
2	Roundup® Ready-To-Use 50%	50	3.6
3	Roundup® Ready-To-Use 25%	25	1.8
4	Weedol®	100	7.2 (0.02 g/L pyraflufen-ethyl)
5	Roundup® No Glyphosate	100	0.0 (60 g/L acetic acid)

TABLE 1 The concentrations of the products used, based on the amount of water added to dilute them to, or below, label concentrations, and respective glyphosate concentrations. Concentrations of other active ingredients present in formulations given in parentheses

ProActive for the following reasons. While we know the application rates for this product based on ground surface area (from 1 to 6 L/ha of formulation, 0.6%–33% product concentration and 10–400 L/ha of mixed solution), the exposure, or application rate on bees will be a function of the height from which the product is sprayed, the height of either crop or weed flowers and the height at which bees are present when the product is applied (which may be either the same as the flowers, or above or below this if bees are flying between flowers). As each of these factors will vary both within crops, and from crop to crop, and as the only one for which good data exist are crop height, it is currently impossible to extrapolate from surface area application rate to bee exposure. Similarly, in the absence of label guidance on application rates for consumer products, we cannot compare our exposure to usage in gardens. Fundamentally, our experiment was designed to enable the detection of hazardous effects from substances previously reported to be non-hazardous. More complex designs using field realistic apparatus and application rates could determine the risk these substances pose.

Controls throughout were pure distilled water and were sprayed from an identical Roundup® Ready-To-Use bottle at room temperature. Both the Weedol® and Roundup® products tested (Experiments 1 and 2) contain glyphosate at equivalent concentrations. Because Weedol® is likely to have a different co-formulant composition to the Roundup® products it served as a glyphosate control. A series of five independent experiments were conducted to answer the following questions:

Experiment 1: Are the impacts of consumer and agricultural Roundup® products comparable?

Bumble bees in three treatment groups were sprayed with either the consumer product Roundup® Ready-To-Use (at its pre-mixed concentration), the agricultural product Roundup® ProActive at the highest label recommended concentration of 6.25%, which covers a range of applications, or the water control.

Experiment 2: Does mortality still occur with a 1:1 dilution of consumer Roundup®?

Bumble bees in two treatment groups were sprayed with either the consumer product (Roundup® Ready-To-Use) diluted 1:1 with pure distilled water, or the water control.

Experiment 3: Does mortality still occur with a 1:3 dilution of consumer Roundup®?

Bumble bees in two treatment groups were sprayed with either the consumer product (Roundup® Ready-To-Use) diluted 1:3 with pure distilled water, or the water control.

Experiment 4: Does an alternative GBH (Weedol®) cause mortality?

Bumble bees in two treatment groups were sprayed with either the generic consumer product GBH Weedol® at its pre-mixed concentration, or the water control.

Experiment 5: Does the Roundup® formulation without glyphosate cause mortality?

Bumble bees in two treatment groups were sprayed with either the consumer product (and GBH alternative) Roundup® No Glyphosate at its pre-mixed concentration, or the water control.

All statistical analyses were carried out in 'R' programming software version 3.6.2 (R Core Team, 2019). Plots were produced using the package 'GGPLOT2' version 3.2.1 (Wickham, 2016) and 'SURVMINER' version 0.4.6 (Kassambara et al., 2019). Mixed effects Cox proportional hazards models were used to analyse mortality, utilising 'SURVIVAL' version 3.1-8 (Therneau, 2020a), 'COXME' version 2.2-16 (Therneau, 2020b) and 'MuMIn' version 1.43.17 for model averaging (Bartoń, 2020). AIC model simplification was used, with model averaging where no single model had $\geq 95\%$ AIC support. The candidate set of models was chosen by adding the next best supported model until a cumulative $\geq 95\%$ support was reached. Parameter estimates and 95% confidence intervals are reported. The full model used was (Survival ~ Treatment + Colony of Origin + (1|Box ID)). There was no correlation between variables. For comparisons between Roundup® Ready-To-Use concentrations in Experiments 2 and 3 Colony of Origin was not included as a variable, as it correlated with Treatment owing to different colonies being used for each experiment. Consequently, the final model was (Survival ~ Treatment + (1|Box ID)). Model parameters, AIC weights and final models are presented in Tables S3. Proportionality of hazards was checked for each experiment to validate the Cox proportional hazards assumption,

where this was violated (Experiments 4 and 5) a Chi-squared Test of Independence was used with the model (Survival ~ Treatment).

3 | RESULTS

3.1 | Experiment 1: Comparing the impacts of consumer and agricultural Roundup® products

There was a significant difference in mortality between both Roundup® products (Ready-To-Use and ProActive) and the control (Cox proportional hazards model: parameter estimate (PE) = 5.17, 95% CI [3.52-6.82], and PE = 2.18, 95% CI [0.52-3.84] respectively), with 94% and 30% mortality respectively compared to 4% mortality in the control treatment (Figure 1). There was also a significant difference between Roundup® Ready-To-Use and Roundup® ProActive (Cox proportional hazards model: (PE) = 2.95, 95% CI [1.93-3.96]), with the Roundup® Ready-To-Use causing faster and higher mortality. Of the Roundup® Ready-To-Use treated bees, 38% died immediately after exposure compared to just 7% of Roundup® ProActive and 0% of control bees. Ad hoc behavioural observations also noted bees in all Roundup® treatments spent considerable time self-grooming after exposure. This may have been in response to, and potentially exacerbated, the matting of bee body hair that can be seen in Figure 4.

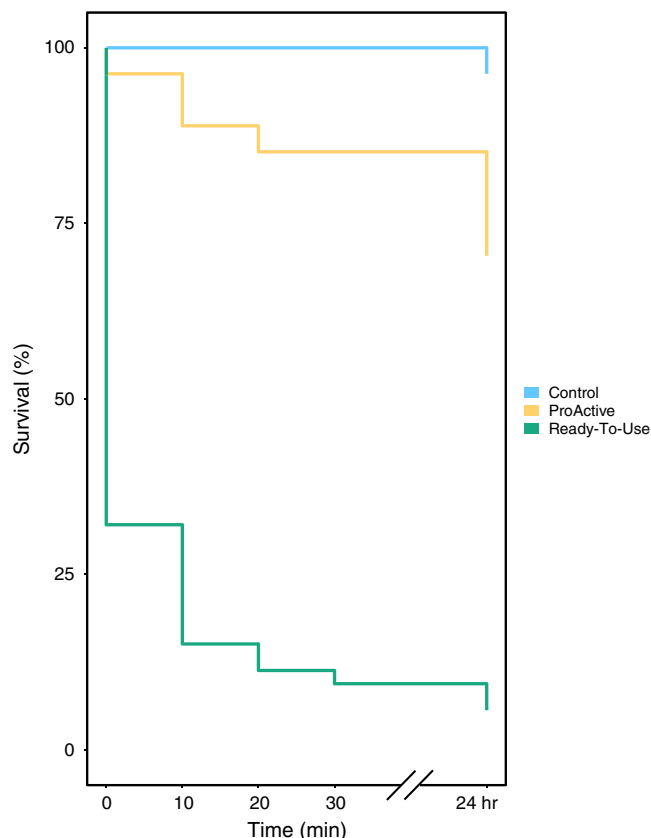


FIGURE 1 Experiment 1: Comparing the impacts of consumer and agricultural Roundup® products against the control, demonstrating high mortality with the Ready-To-Use treatment and intermediate mortality with the ProActive treatment

3.2 | Experiment 2: Does mortality still occur with a 1:1 dilution of consumer Roundup®?

The half strength Roundup® Ready-To-Use solution significantly increased mortality (Chi-squared test of Independence: $\chi^2 = 78.26$, $p < 0.0001$), with 98% mortality respectively compared to 3% mortality in the control treatment (Figure S1).

3.3 | Experiment 3: Does mortality still occur with a 1:3 dilution of consumer Roundup®?

The quarter strength Roundup® Ready-To-Use solution also produced significantly higher mortality than the control (Chi-squared test of Independence: $\chi^2 = 47.16$, $p < 0.0001$), with 78% mortality as opposed to 8% mortality in the control treatment (Figure S2). However, the mortality was less than either half or full strength (98% and 94% respectively; Figure 1; Figures S1 and S2). Furthermore, the mortality was delayed with only 10% of bumble bees dying within 30 min.

There was a significant difference between full-strength and both half and quarter-strength Roundup® Ready-To-Use solutions in their effects on mortality (Cox proportional hazards model: (PE) = 1.23, 95% CI [0.766-1.70], and 2.33, 95% CI [1.54-3.20] respectively), with the highest and fastest mortality in the whole strength treatment, followed by the half strength.

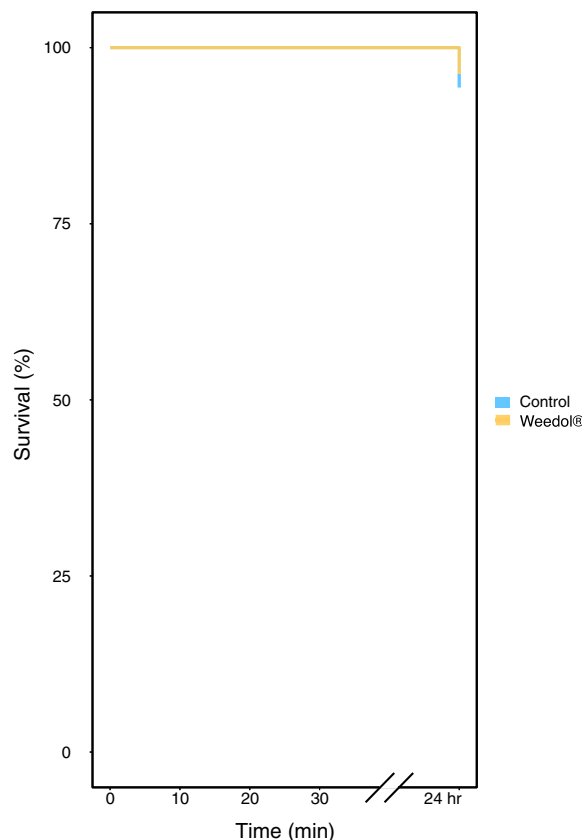


FIGURE 2 Experiment 4: Consumer product, and GBH alternative, Weedol® does not cause mortality relative to the control

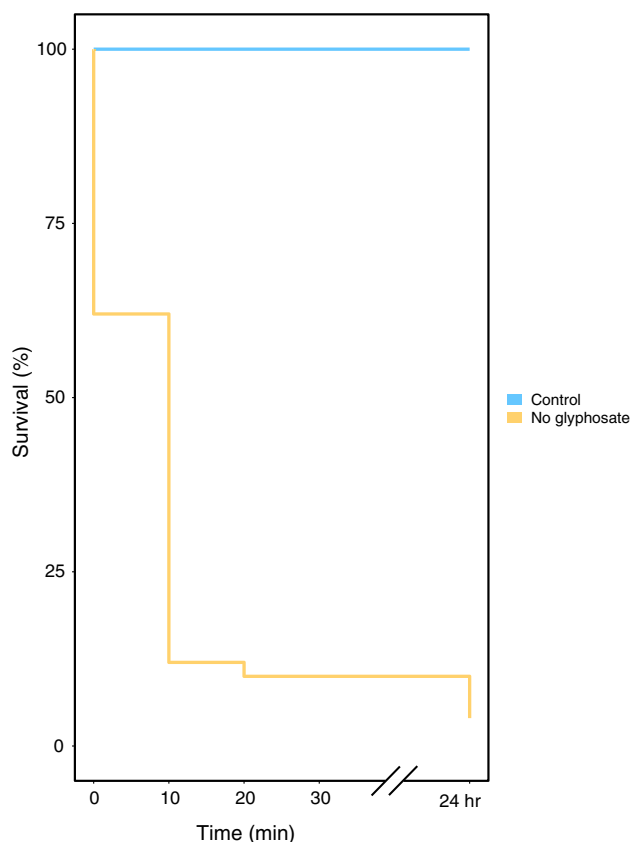


FIGURE 3 Experiment 5: The consumer product, and alternative to GBHs, Roundup® No Glyphosate causes high mortality

3.4 | Experiment 4: Does an alternative GBH (Weedol®) cause mortality?

Weedol® did not cause a significant difference in mortality relative to the control.

(Chi-squared test of Independence: $\chi^2 = 0.00$, $p = 0.983$), with 4% and 6% mortality respectively (Figure 2).

3.5 | Experiment 5: Does the roundup® formulation without glyphosate cause mortality?

Roundup® No Glyphosate produced significantly higher mortality than the control (Chi-squared test of Independence: $\chi^2 = 87.51$, $p < 0.0001$), with 96% mortality respectively compared to 0% mortality in the control treatment (Figure 3).

4 | DISCUSSION

Our results are the first to show that contact exposure to either consumer or agricultural Roundup® products at label recommended concentrations can cause high levels of mortality in bumble bees. The consumer product Roundup® Ready-To-Use caused 94% mortality at the pre-mixed concentration, and still caused significant

mortality at a quarter strength. The agricultural product Roundup® ProActive also caused significant mortality, although over a longer time period. Interestingly, Roundup® No Glyphosate caused 96% mortality while the generic GBH Weedol® did not significantly increase mortality. Together, this demonstrates that the co-formulants in these Roundup® products, not the active ingredient glyphosate, are driving mortality. We suggest that the mechanism driving this mortality may be surfactants in the formulations blocking the tracheal system of the bees, which is essential for gas exchange. Given the hazard demonstrated here with all tested Roundup® products, and the extensive exposure of bees to such GBHs world-wide, GBHs may pose a high risk to bees, and thus may be an as yet unidentified driver of the bee declines that are occurring around the globe.

At a quarter strength, the consumer product Roundup® Ready-To-Use still caused 78% mortality, demonstrating that the formulation is sufficiently toxic to cause mortality despite being 75% water. The dose dependency shown in our experiments confirms the products' toxicity and aids our understanding of how to use them safely. At a quarter strength the mortality seen is equivalent to the double strength Sunphosate 360 SL used in Abraham et al. (2018), suggesting that Roundup® Ready-To-Use would also cause indirect contact mortality as even exposure to a severely reduced concentration caused high mortality. While consumer herbicides are unlikely to be applied directly to bees, they are likely to be applied to bee-attractive weeds which could drive mortality, with the Roundup® Ready-To-Use label even advising 'Treat established perennial weeds at the start of flowering to give best results' (Roundup® Ready-To-Use Label, 2019). Consequently, label restrictions should explicitly caution against application to flowering plants. While the agricultural product Roundup® ProActive requires a licence to spray, and has clear label instructions, the product label of Roundup® Ready-To-Use has no guidance pertaining to bees. A first step should be to amend household product labels to reflect the hazard posed to bees. Finally, whether consumers need access to potent pesticides, especially when nearly half of consumers either do not follow or take no notice of label recommendations (Grey et al., 2005), requires re-visiting by policymakers; consumer pesticide products should not be overlooked in policy initiatives to reduce pesticide use.

The consumer product Roundup® Ready-To-Use caused more and faster mortality than the agricultural product Roundup® ProActive, but the latter still caused 30% mortality over 24 hr. The Material Safety Data Sheet (MSDS) for Roundup® ProActive MSDS (2020) lists Nitroryl (CAS no. 226563-63-9) and Alkylpolyglycoside (CAS no. 68515-73-1) as ingredients, possibly acting as surfactants (US Patent 20100113274A1, 2010; US Patent 5266690A, 1993), although we do not know what, or if, other surfactants are in the formulation. If these substances are driving the mortality in the Roundup® ProActive treatment, this would be concerning as they are common in recently introduced products (Mesnage et al., 2019). We would suggest that the topical toxicity of these substances be assessed by regulatory agencies, to allow judgement to be made on their safety for inclusion in products bees are exposed to. This Roundup® ProActive driven mortality is in contrast to the guidance in the product's UK

Environmental Information Sheet stating, "Roundup ProActive is of low toxicity to honeybees; there is no requirement to avoid application of the product when bees are foraging on flowering weeds in treated crops" (Roundup® ProActive Environmental Information Sheet, 2020). This means that on-label guidance explicitly allows application directly onto bees, along with spraying onto flowering weeds, which are frequently visited by bees (Wood et al., 2019). This means that the exposure bees will face is incredibly high, with no attempt being made to mitigate their exposure. Furthermore, in the United States, Roundup® products can be directly applied to genetically modified glyphosate resistant (Roundup® Ready) crops, in order to knockdown weeds growing among the crop (Roundup® Ready Plus Information Sheet, 2020). For Roundup® Ready Soybeans this includes allowing application to the crop during flowering (Roundup® Ready Plus Information Sheet, 2020). As soybean flowers are an attractive floral resource for bees (EFSA, 2013), this will lead to direct exposure of bees to Roundup® products, which we have shown can drive significant mortality. Exposure through such herbicide tolerant crops is likely to be significantly higher than through flowering weeds, with herbicide tolerant soybeans covering 84.5 million hectares globally in 2014 (James, 2014 cited in Benbrook's, 2016, Supporting Information). Agricultural labels should preclude application to flowering plants or bees to reduce exposure.

Previous studies have examined the contact toxicity of surfactant adjuvants and Roundup® products. Results vary for studies testing similar surfactant spray adjuvants, with Goodwin and McBrydie (2000) finding 100% mortality below label recommended concentrations, while Donovan and Elliott (2001) found no mortality even in their highest treatments. This is likely explained by the different methodologies, with the former using a Potter spray tower which is close to field realistic spray conditions and the latter using pipette application using OECD 214 (OECD, 1998). Following OECD 214 1–2 µl of a solution is pipetted onto the backs of anaesthetised bees and then mortality assessed for 48 hr (OECD, 1998). This protocol is appropriate to assess the toxicity of AI, particularly potent insecticides, but inappropriate for assessing the toxicity of more dilute surfactant solutions. Due to EU law protecting co-formulant composition (EC, 2009), we do not know if the components of the adjuvants used in either study are present in any of the formulations tested here.

Our study diverges from the previously described results of Abraham et al. (2018) by using direct application onto bees, rather than indirect exposure (spraying flowers for the bees to then visit). We also used bumble bees, not honeybees or stingless bees, and still found high mortality suggesting the effects of GBH formulations on bees is widespread. The results presented here expand our understanding of how GBH formulations can cause mortality through contact exposure by isolating the co-formulants as driving the mortality and suggesting a mechanism behind the mortality. Recent work suggests similar mortality impacts in honey bees using a different Roundup® formulation (Motta et al., 2020).

The only regulatory studies of contact mortality with GBHs have used honey bees and the protocol OECD 214 (see above, OECD, 1998). This protocol does not accurately assess contact

toxicity for formulations like Roundup® products, which can be sprayed directly onto bees. Regulatory testing should assess the contact toxicity of all formulations prior to approval/renewal using more field realistic methodologies than OECD 214, incorporating label recommended spraying apparatus and concentrations.

Our results clearly show that Weedol® does not produce higher mortality than the water control, and together with results from regulatory assessments (EFSA, 2015b), this confirms that the mortality seen in our experiments is not driven by glyphosate. This is supported by the findings of Motta et al. (2020), who found spraying honeybees with glyphosate did not cause mortality. Furthermore, Roundup® No Glyphosate caused 96% mortality, which demonstrates that the co-formulants in Roundup® products are toxic, and that the mortality we see does not derive from an interaction between co-formulants and glyphosate. This is encouraging, as it indicates the mortality could be eliminated entirely with a change to the co-formulants, without affecting the active ingredient content. The contrast between Weedol® and Roundup® products, which both use glyphosate as their active ingredient, demonstrates that co-formulants and formulations as well as active ingredients should be tested and regulated individually. This is especially true as active ingredient registrations have been greatly outstripped by novel formulation production, as pesticide manufacturers improve the efficiency of their products through changes to their co-formulants (Green & Beestman, 2007). That two of the three GBH's tested here produced significant mortality is concerning given that there are 281 other GBH's currently licenced for use in the United Kingdom.

The three Roundup® substances tested produced significant mortality, which shows that the current regulatory testing for contact toxicity is inadequate to detect mortality effects. While the testing performed here was not agriculturally field realistic, it highlights that these products pose a legitimate hazard that requires risk assessment through field realistic testing. These results contradict the regulatory assessment that GBHs are entirely bee-safe and do not require mitigation measures. Finally, for each active ingredient only a single representative formulation is mandated for testing at an EU level (EFSA, 2013). The only contact toxicity testing on bees with whole formulations presented in the EFSA, 2015 renewal assessment report is on the original version of Roundup® (MON 2139) in 1972 and the representative formulation Roundup® Bioflow (MON 52276), which lacks the alkylamine ethoxylates common in other GBH's, instead using a quarternary ammonium compound (EFSA, 2015b).

While we have not explicitly tested the mechanism through which this mortality is generated, we suggest that the surfactants in the formulations are interfering with the action of the spiracles, or tracheal system more broadly. Insects conduct gas exchange through the tracheal system, with spiracles (surface holes on the thorax and abdomen) enabling airflow into the tracheal system, and the tracheae carrying air to tissues and cells where gas exchange occurs (Bailey, 1954). Our observations show that the Roundup® products are spreading the formulation over the surface of the bumble bees, possibly limiting gas exchange. This spread may have been exacerbated by the self-grooming behaviour observed in the

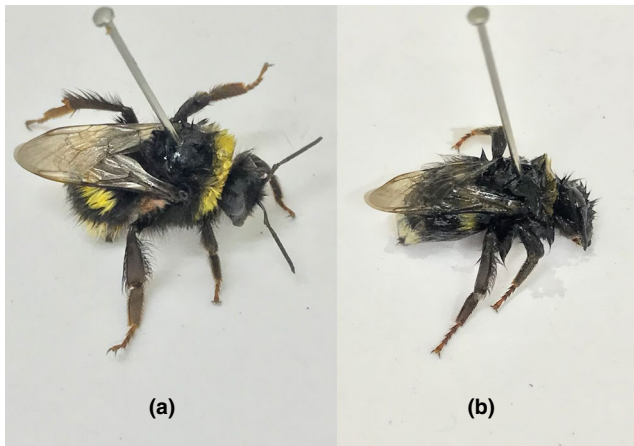


FIGURE 4 (a) Control and (b) Roundup® Ready-To-Use full concentration bumble bees sprayed and photographed within 5 min. Matting of the hairs over the bee's whole body can be seen in (b)

Roundup® treatments, and future research should formally assess this. This could be through a range of mechanisms, either by matting hairs down over the spiracles and physically smothering them, by blocking narrow sections in the respiratory system, or by coating the surface of the whole system in a non-permeable lining (see Figure 4; Figure S3). Stevens (1993) noted that insect spiracles are similar in size to plant stomata, which GBHs are designed to penetrate, and suggested therefore that the surfactants allow water penetration into the tracheal system, causing drowning. It is unlikely that the immediate mortality seen most prominently in the standard strength Roundup® Ready-To-Use treatment is caused by oral ingestion as even high doses of potent insecticides require several hours to produce mortality (Edward Straw, pers. obs.). We do not know if the mechanism driving the 38% immediate mortality in the Roundup® Ready-To-Use treatment is the same mechanism driving the further 56% mortality in the 30 min to 24-hr timeframe. Surfactant driven mortality in honeybees, which typically act as a sentinel for all beneficial insects, is unlikely to have been detected by beekeepers as the knockdown of bees is so fast they are unlikely to return to the hive before dying; this would mean the only symptom beekeepers would see is a reduced worker population (Goodwin & McBrydie, 2000).

Further work is required to elucidate the mechanism by which these products produce mortality. However, a significant difficulty in isolating this mechanism is that formulation composition is protected under EU law (EC, 2009), preventing researchers from knowing the identity and concentration of the surfactants involved, or what other co-formulant groups are present (Cox & Surgan, 2006). This severely impedes our ability to understand what mechanism(s) is/are at play and hinders academic testing of relevant ecological pollutants. If the MSDS that accompanies a product included a list of all the components, then each component could be tested individually to isolate the compounds (or interaction of compounds) causing the observed mortality. We suggest that the necessity to properly test pesticide effects on wildlife outweighs company rights to withhold proprietary information.

ACKNOWLEDGEMENTS

Thanks to A. Linguadoca, R. Riesch, S. J. Portugal, S. G. Potts, J. R. de Miranda, S. Hodge, J. C. Stout, three anonymous reviewers, and the editors for their comments on the manuscript, to E. Leadbeater for her comments on the manuscript and analysis, O. P. Vaughan for translating the abstract and to L. J. Thompson, V. L. Blanchard and J. Abraham for discussing the project. This project received funding from the European Horizon 2020 research and innovation programme under grant agreement no.773921.

AUTHORS' CONTRIBUTIONS

E.A.S. and E.N.C. carried out the experiment, and E.A.S. performed the statistical analyses; E.A.S., E.N.C. and M.J.F.B. designed the experiment and wrote the paper; E.A.S. and M.J.F.B. conceived the project. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

Data available from the Dryad Digital Repository <https://doi.org/10.5061/dryad.80gb5mkqn> (Straw et al., 2021).

ORCID

Edward A. Straw  <https://orcid.org/0000-0003-3205-9157>

Mark J. F. Brown  <https://orcid.org/0000-0002-8887-3628>

REFERENCES

- Abraham, J., Benhotons, G. S., Krampah, I., Tagba, J., Amissah, C., & Abraham, J. D. (2018). Commercially formulated glyphosate can kill non-target pollinator bees under laboratory conditions. *Entomologia Experimentalis et Applicata*, 166, 695–702. <https://doi.org/10.1111/eea.12694>
- Artz, D. R., & Pitts-Singer, T. L. (2015). Effects of fungicide and adjuvant sprays on nesting behavior in two managed solitary bees, *Osmia lignaria* and *Megachile rotundata*. *PLoS ONE*, 10, e0135688. <https://doi.org/10.1371/journal.pone.0135688>
- Bailey, L. (1954). The respiratory currents in the tracheal system of the adult honey-bee. *Journal of Experimental Biology*, 31, 589–593. <https://doi.org/10.1111/mpp.12151>
- Bartoń, K. (2020). *MuMIn: Multi-model inference*. R package version 1.0.0. Retrieved from <https://CRAN.R-project.org/package=MuMIn>
- Beckie, H. J., Flower, K. C., & Ashworth, M. B. (2020). Farming without glyphosate? *Plants*, 9, 1–15. https://doi.org/10.1142/9789813148994_0036
- Benbrook, C. M. (2016). Trends in glyphosate herbicide use in the United States and globally. *Environmental Science Europe*, 28, 1–15. <https://doi.org/10.1186/s12302-016-0070-0>
- Chen, J., & Mullin, C. A. (2014). Determination of nonylphenol ethoxylate and octylphenol ethoxylate surfactants in beehive samples by high performance liquid chromatography coupled to mass spectrometry. *Food Chemistry*, 158, 473–479. <https://doi.org/10.1016/j.foodchem.2014.03.004>
- Ciarlo, T. J., Mullin, C. A., Frazier, J. L., & Schmehl, D. R. (2012). Learning impairment in honey bees caused by agricultural spray adjuvants. *PLoS ONE*, 7, e40848. <https://doi.org/10.1371/journal.pone.0040848>
- Cox, C., & Surgan, M. (2006). Unidentified inert ingredients in pesticides: Implications for human and environmental health. *Environmental Health Perspectives*, 114, 1803–1806. <https://doi.org/10.1289/ehp.9374>
- Cullen, M. G., Thompson, L. J., Carolan, L. C., Stout, J. C., & Stanley, D. A. (2019). Fungicides, herbicides and bees: A systematic review of

- existing research and methods. *PLoS ONE*, 14, e0225743. <https://doi.org/10.1371/journal.pone.0225743>
- Defarge, N., Takács, E., Lozano, V. L., Mesnage, R., de Vendômois, J. S., Séralini, G. E., & Székács, A. (2016). Co-formulants in glyphosate-based herbicides disrupt aromatase activity in human cells below toxic levels. *International Journal of Environmental Research and Public Health*, 13, 264. <https://doi.org/10.1016/j.toxrep.2017.12.025>
- Donovan, B. J., & Elliott, G. S. (2001). Honey bee response to high concentrations of some new spray adjuvants. *New Zealand Plant Protection*, 54, 51–55. <https://doi.org/10.30843/nzpp.2001.54.3739>
- Duke, S. O. (2018). The history and current status of glyphosate. *Pest Management Science*, 74, 1027–1034. <https://doi.org/10.1002/ps.4652>
- EC. (2009). Regulation (EU) No 1107/2009. *Official Journal of the European Union*, 309, 1–50.
- EFSA. (2013). EFSA Guidance document on the risk assessment of plant protection products on bees (*Apis mellifera*, *Bombus* spp. and solitary bees). *EFSA Journal*, 11, 3295. <https://doi.org/10.2903/j.efsa.2013.3295>
- EFSA. (2015a). Conclusion on the peer review of the pesticide risk assessment of the active substance glyphosate. *EFSA Journal*, 13, 4302. <https://doi.org/10.2903/j.efsa.2015.4302>
- EFSA. (2015b). Appendix to the conclusion on the peer review of the pesticide risk assessment of the active substance glyphosate. *EFSA Journal*, 13, 4302. <https://doi.org/10.2903/j.efsa.2015.4302>
- FAOSTAT. (2019). FAOSTAT pesticides use dataset. Retrieved from <http://www.fao.org/faostat/en/#data/RP>. Version updated September 2, 2019
- FERA. (2019). UK pesticide usage data. Retrieved from <https://secure.fera.defra.gov.uk/pusstats/surveys/>
- Fine, J. D., Cox-Foster, D. L., & Mullin, C. A. (2017). An inert pesticide adjuvant synergizes viral pathogenicity and mortality in honey bee larvae. *Scientific Reports*, 7, 1–9. <https://doi.org/10.1038/srep40499>
- Garthwaite, D., Barker, I., Ridley, L., Mace, A., Parrish, G., MacArthur, R., & Luet, Y. (2016a). Orchards in the United Kingdom 2016. *Pesticide Usage Survey Report*, 273, 1–68.
- Garthwaite, D., Barker, I., Ridley, L., Mace, A., Parrish, G., MacArthur, R., & Luet, Y. (2016b). Arable crops in the United Kingdom 2016. *Pesticide Usage Survey Report*, 284, 1–68.
- Goodwin, R. M., & McBrydie, H. M. (2000). Effects of surfactants on honey bee survival. *New Zealand Plant Protection*, 53, 230–234. <https://doi.org/10.30843/nzpp.2000.53.3694>
- Green, J. M., & Beestman, G. B. (2007). Recently patented and commercialized formulation and adjuvant technology. *Crop Protection*, 26, 320–327. <https://doi.org/10.1016/j.cropro.2005.04.018>
- Grey, C. N. B., Nieuwenhuijsen, M. J., Golding, J., & the ALSPAC Team. (2005). The use and disposal of household pesticides. *Environmental Research*, 97, 109–115. <https://doi.org/10.1016/j.envres.2004.07.008>
- Hazen, J. L. (2000). Adjuvants – terminology, classification, and chemistry. *Weed Technology*, 14, 773–784. [https://doi.org/10.1614/0890-037x\(2000\)014\[0773:atcac\]2.0.co;2](https://doi.org/10.1614/0890-037x(2000)014[0773:atcac]2.0.co;2)
- Health and Safety Executive UK. (2020). Plant protection products with authorisation for use in the UK database search. Retrieved from <https://secure.pesticides.gov.uk/pestreg/ProdSearch.asp>
- James, C. (2014). Global status of Commercialized biotech/GM Crops: 2014. *ISAAA Briefs*, 18.
- Kassambara, A., Kosinski, M., & Biecek, P. (2019). *survminer: Drawing survival curves using 'ggplot2'*. R package version 0.4.6. Retrieved from <https://CRAN.R-project.org/package=survminer>
- McArt, S. H., Urbanowicz, C., McCoshum, S., Irwin, R. E., & Adler, L. S. (2017). Landscape predictors of pathogen prevalence and range contractions in US bumblebees. *Proceedings of the Royal Society B: Biological Sciences*, 284, 20172181. <https://doi.org/10.1098/rspb.2017.2181>
- Mesnage, R., & Antoniou, M. N. (2018). Ignoring adjuvant toxicity falsifies the safety profile of commercial pesticides. *Frontiers in Public Health*, 5, 1–8. <https://doi.org/10.3389/fpubh.2017.00361>
- Mesnage, R., Benbrook, C., & Antoniou, M. N. (2019). Insight into the confusion over surfactant co-formulants in glyphosate-based herbicides. *Food Chemistry and Toxicology*, 128, 137–145. <https://doi.org/10.1016/j.fct.2019.03.053>
- Mesnage, R., Bernay, B., & Séralini, G. E. (2013). Ethoxylated adjuvants of glyphosate-based herbicides are active principles of human cell toxicity. *Toxicology*, 313, 122–128. <https://doi.org/10.1016/j.tox.2012.09.006>
- Mesnage, R., Teixeira, M., Mandrioli, D., Falcioni, L., Ducarmon, Q. R., Zwitter, R. D., Mazzacuva, F., Caldwell, A., Halket, J., Amiel, C., Panoff, J.-M., Belpoggi, F., & Antoniou, M. N. (2021). Use of shotgun metagenomics and metabolomics to evaluate the impact of glyphosate or Roundup MON 52276 on the gut microbiota and serum metabolome of Sprague-Dawley rats. *Environmental Health Perspectives*, 129, 017005. <https://doi.org/10.1289/EHP6990>
- Moffett, J. O., & Morton, H. L. (1973). Surfactants in water drown honey bees. *Environmental Entomology*, 2, 227–231. <https://doi.org/10.1093/ee/2.2.227>
- Moffett, J. O., & Morton, H. L. (1975). Repellency of surfactants to honey bees. *Environmental Entomology*, 4, 780–782. <https://doi.org/10.1093/ee/4.5.780>
- Motta, E. V. S., Mak, M., De Jong, T. K., Powell, E., O'Donnel, A., Suhr, K. J., Riddington, I. M., & Moran, N. A. (2020). Oral or topical exposure to glyphosate in herbicide formulation impacts the gut microbiota and survival rates of honey bees. *Applied and Environmental Microbiology*, 86, e01150–e1220. <https://doi.org/10.1128/AEM.01150-20>
- Mullin, C. A. (2015). Effects of 'inactive' ingredients on bees. *Current Opinion in Insect Science*, 10, 194–200. <https://doi.org/10.1016/j.cois.2015.05.006>
- Mullin, C. A., Chen, J., Fine, J. D., Frazier, M. T., & Frazier, J. L. (2015). The formulation makes the honey bee poison. *Pesticide Biochemistry and Physiology*, 120, 27–35. <https://doi.org/10.1016/j.pestbp.2014.12.026>
- Mullin, C. A., Fine, J. D., Reynolds, R. D., & Frazier, M. T. (2016). Toxicological risks of agrochemical spray adjuvants: Organosilicone surfactants may not be safe. *Frontiers in Public Health*, 4, 1–8. <https://doi.org/10.3389/fpubh.2016.00092>
- Nagy, K., Duca, R. C., Lovas, S., Creta, M., Scheepers, P. T. J., Godderis, L., & Ádám, B. (2019). Systematic review of comparative studies assessing the toxicity of pesticide active ingredients and their product formulations. *Environmental Research*, 181, 108926. <https://doi.org/10.1016/j.envres.2019.108926>
- Nieto, A., Roberts, S. P. M., Kemp, J., Rasmont, P., Kuhlmann, M., García Criado, M., Biesmeijer, J. C., Bogusch, P., Dathe, H. H., De la Rúa, P., De Meulemeester, T. (2014). *European red list of bees*. Publication Office of the European Union. <https://doi.org/10.2779/77003>
- OECD. (1998). Honeybees, acute contact toxicity test. *OECD Guidelines for the Testing of Chemicals*, 214, 1–7. <https://doi.org/10.1787/9789264203785-en>
- Potts, S. G., Ngo, H. T., Biesmeijer, J. C., Breeze, T. D., Dicks, L. V., Garibaldi, L. A., Hill, R., Settele, J., & Vanbergen, A. (Eds.). (2016). *The assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production*. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.
- R Core Team. (2019). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Retrieved from <https://www.R-project.org>
- Roundup® ProActive Environmental Information Sheet. (2020). Retrieved from <https://www.monsanto-ag.co.uk/media/2029/roundup-proactive-eia.pdf>
- Roundup® ProActive Label. (2019). Retrieved from <https://www.monsanto-ag.co.uk/media/1950/roundup-proactive-label-november-2016.pdf>
- Roundup® ProActive MSDS. (2020). Retrieved from <https://www.monsanto-ag.co.uk/media/1947/msds-roundup-proactive-04052017.pdf>

- Roundup® Ready Plus Information Sheet. (2020). Retrieved from http://www.roundupreadyplus.com/resourcecenter/postemergence_herbicide_applications_in_soybean
- Roundup® Ready-To-Use Label. (2019). Retrieved from https://www.lovethegarden.com/sites/default/files/content/products/documents/pack_label/UK_017829_RUP_PL.pdf
- Rubio, F., Guo, E., & Kamp, L. (2014). Survey of glyphosate residues in honey corn and soy products. *Journal of Environmental and Analytical Toxicology*, 5, 1000249. <https://doi.org/10.4172/2161-0525.1000249>
- Rundlöf, M., Andersson, G. K., Bommarco, R., Fries, I., Hederström, V., Herbertsson, L., Jonsson, O., Klatt, B. K., Pedersen, T. R., Yourstone, J., & Smith, H. G. (2015). Seed coating with a neonicotinoid insecticide negatively affects wild bees. *Nature*, 521, 77–80. <https://doi.org/10.1038/nature14420>
- Stevens, P. J. G. (1993). Organosilicone surfactants as adjuvants for agrochemicals. *Pesticide Science*, 38, 103–122. <https://doi.org/10.1002/ps.2780380206>
- Straw, E. A., Carpentier, E. N., & Brown, M. J. F. (2021). Data from: Roundup Causes High Levels of Mortality Following Contact Exposure in Bumble Bees. *Dryad Digital Repository*, <https://doi.org/10.5061/dryad.80gb5mkqn>
- Therneau, T. M. (2020a). *A package for survival analysis in R*. Version 3.1-11. Retrieved from <https://CRAN.R-project.org/package=survival>
- Therneau, T. M. (2020b). *coxme: Mixed effects Cox models*. R package version 2.2-5. Retrieved from <https://CRAN.R-project.org/package=coxme>
- US Patent 20100113274A1. (2010). *Glyphosate formulations containing amidoalkylamine surfactants*. Retrieved from <https://patents.google.com/patent/US20100113274A1/en>
- US Patent 5266690A. (1993). *Preparation of alkylpolyglycosides*. Retrieved from <https://patents.google.com/patent/US5266690A/en>
- Wickham, W. (2016). *ggplot2: Elegant graphics for data analysis*. Springer-Verlag. Retrieved from <https://CRAN.R-project.org/package=ggplot2>
- Wood, T. J., Kaplan, I., Zhang, Y., & Szendrei, Z. (2019). Honeybee dietary neonicotinoid exposure is associated with pollen collection from agricultural weeds. *Proceedings of the Royal Society B: Biological Sciences*, 286, 20190989. <https://doi.org/10.1098/rspb.2019.0989>
- Woodcock, B. A., Isaac, N. J. B., Bullock, J. M., Roy, D. B., Garthwaite, D. G., Crowe, A., & Pywell, R. F. (2016). Impacts of neonicotinoid use on long-term population changes in wild bees in England. *Nature Communications*, 7, 1–8. <https://doi.org/10.1038/ncomms12459>

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Straw EA, Carpentier EN, Brown MJF. Roundup causes high levels of mortality following contact exposure in bumble bees. *J Appl Ecol*. 2021;00:1–10. <https://doi.org/10.1111/1365-2664.13867>

COMPREHENSIVE PLAN

2021-2026 Plan Update





The City Of Waterloo
Comprehensive Plan Update 2021 – 2030
Five Year Plan 2021 -2026

This Statutory Plan (Section 66.1001 (2)(i) update is the first addition to the original document adopted on August 7, 2008, reaffirming the vision statement, community health description, and future land use maps.

After the annual budget, the Comprehensive Plan is meant to be the second most important municipal document. This Plan will only have value if it is used, understood, and supported. To this end, efforts may include:

- Display the vision statement, community health description, and future land use maps in council chambers and the city's website
- Ensure materials are easily accessible on the city's website
- Encourage all city committees and staff to become familiar with and use the Plan in decision making process
- Incorporate Plan implementations in the annual budget
- Regularly present implementation progress to the City Council, Plan Commission, and Community Development Authority

This update contains key elements of the Comprehensive Plan, focusing on a limited number of top priorities and goals. The following information is provided in this five year plan update:

The City Of Waterloo

A Green and Healthy Community

The City of Waterloo intends to become a Green and Healthy Community. Being a Green and Healthy community means taking a system-wide perspective for resolving community issues and promoting community growth and health. The color **green** is symbolic of growth. The following components of a Green and Healthy community are addressed and reinforced throughout this Comprehensive Plan. Advancing each of these components will be a long-term and on-going endeavor.

Environmental Health: Waterloo's viability relies on the health of its natural systems. The quality of water we drink, the air we breathe as well as the integrity of the soils, natural areas, and wildlife populations provide the essential foundation for economic, social and personal health. In Waterloo, environmental health also helps to define the community's sense of place. The City is defined, linked, and bounded by natural features like the wetlands, the Maunesha River, natural and wildlife areas, and wooded drumlines. Paying attention to how growth and development affects these resources, and how these resources are an asset to community growth, will contribute significantly to the achievement of Waterloo's future vision.

Economic Health: is defined by the availability of opportunities for residents to efficiently meet their day-to-day employment, service, shopping, and entertainment needs within the community by fostering the growth of existing businesses and encouraging the establishment of new, community-compatible businesses to broaden the tax base and provide reliable jobs.

Social Health: includes access to a range of affordable housing types, quality education, jobs, variety of transportation options, and healthy and affordable food. A socially healthy community is one that celebrates its local culture and fosters community interaction and involvement.

Personal Health: by fostering an environment that facilitates a healthy lifestyle for residents through physical activity, social interaction, and access to natural resources. The city will strive to increase opportunities for: outdoor activities, community events, community and neighborhood design techniques (such as mixing compatible land uses), and promoting safe and fun walking and cycling environments.

The principles of implementation to advance a Green and Healthy community remain:

- Connectedness – all aspects of a community should be thought of as connected
- Diversity – a variety in all things; housing, businesses, land use, recreation
- Adaptability – the city's ability to change and adapt over time; new strategies or goals

Note: This update will include only limited chart data as this information can be found online as needed with up-to-date information. Data included will be for specific reference and a means to monitor change for future updates and reporting.

City of Waterloo Goals:

Agricultural Resources:

Respect the agricultural character of the community.

Natural Resources:

Protect and enhance natural features and ecological systems in the City's planning area.

Cultural Resources:

Preserve, enhance, and promote Waterloo's small-town, historic character.

Land Use:

Promote a future land use pattern in and around the City that is in harmony with the natural landscape, helps maintain property values, encourages well-planned and attractive development, and minimizes land use conflicts.

Transportation:

Provide a safe and efficient transportation system that meets the needs of multiple users in and around the City.

Develop and maintain a comprehensive system of bicycle and pedestrian facilities in and around the City to encourage alternative transportation and a healthy, active lifestyle.

Utilities and Community Facilities:

Promote an effective and efficient supply of utilities, community facilities, and public services that meet the expectations of City residents and business owners.

Coordinate utility and community facilities planning with land use, transportation, natural resource, and recreation planning.

Ensure the provision of a sufficient number of parks, recreational facilities, and open space areas to enhance the health and welfare of City residents and visitors.

Housing and Neighborhood Development:

Provide a variety of housing types at a range of densities and costs to accommodate the needs and desires of existing and future residents.

Economic Development:

Retain and attract businesses that can capitalize on Waterloo's regional position, enhance the City's character and appearance, strengthen and diversify the non-residential tax base and employment opportunities, serve the day-to-day needs of residents, and help create a desirable place to live, work, and visit.

Support the long-term growth and expansion of existing businesses.

Intergovernmental Cooperation:

Develop and maintain mutually beneficial relationships with adjacent governments, counties, and the School District.

5 Year Priorities

This update will serve as the priorities for the next five years, focusing on three main elements and outcomes. However, this does not discard or exclude the other elements of the Plan, rather this puts more focus on the priorities and current department plans as listed in the attachments. Each chapter listed in the Plan has several overlapping goals; addressing an issue in one chapter may also accomplish a goal in another.

1) Economic Development

- a. Downtown W. Madison Street – Tax Increment Funding (TIF) #2
- b. Portland Road/Hwy 19 Corridor – TIF #3
- c. Sheehy Land – New TIF possibility

2) Land Use, Housing and Neighborhoods

- a. Single family, multi-family, senior housing
- b. Remedy of blight within the city (businesses, housing, roads)

3) Utilities & Community Facilities

- a. Continue to invest in Firemen’s park; advancing park & recreational facilities, programming (Waterloo Youth Sports Organization & Fund 80); increase connectivity/paths; expand access to the Mauneshia River
- b. Supporting utility upgrades & creative funding options

This information provides the basis for all subsequent information in the plan.

Community needs:

- Maintain small-town atmosphere, quaint & quiet charm
- Preserve natural resources and open spaces
- Restore and preserve Waterloo’s historic downtown
- Connect Firemen’s Park, a significant and attractive asset, with the downtown
- Housing stock and neighborhoods should be a blend of single family, townhouses, and condos; with pedestrian friendly bike paths and sidewalks
- Design standard/appearance for commercial and residential properties supported, along with trees and well-maintained roads and sidewalks
- Supports industrial development
- Focus on daily needs; grocery store, laundromats, restaurants, specialty shops, entertainment

Key planning issues:

- Community Character: Firemen’s park and Mauneshia River significantly contribute to Waterloo’s character. City’s image, aesthetics and health have declined. Benefits would include a unified vision or theme
- Land use: Identify appropriate locations for business, ensure new developments adhere to design guidelines, protect public places and open spaces
- Pace of Development: Improve the aesthetics of downtown, increase business diversity, and increase connectivity between downtown and the community

- Environment: Protect natural resources, river cleanliness, wetlands, stormwater flow
- Housing: Need greater diversity, concern with aesthetics of neighborhoods
- Economic Development: Downtown commercial redevelopment; condos upper levels, community building, and efforts to beautify downtown
- Transportation: Roadway resurfacing and streetscaping; lighting and trees
- Facilities and Services: Leadership in organizing community events (Parks & Library) for all ages and a unifying theme for all city facilities and buildings

Supporting Information

Figure 1: Population

Municipality	Comp Plan 2000	Plan Projected 2020	Census 2010	Final Est 2020	Percent Change
Waterloo	3,259	3,868	3,333	3,341	.024%

Reference: https://doa.wi.gov/Pages/LocalGovtsGrants/Population_Estimates.aspx

Goal #1: Economic Development

Goals (Reference 2008 Plan, Chapter 2)

- Engage in proactive economic growth (pg 41)
 - 333 Portland Rd TIF 3
 - Redevelop Portland Rd/Hwy 89 – expand TIF 3
 - Revitalize downtown (empty store fronts 2021 =9)
- CDA, equip with professional support, utilize TIF for development

Supporting Information

Figure 2: Downtown 1st Floor Occupancy Rates Over Time

DOWNTOWN 1ST FLOOR OCCUPANCY RATES OVER TIME					
As Of	1st Fl. Commercial (Cnt)	Vacant (Cnt)	Occupied (Cnt)	Occupancy %	Vacancy %
4/28/2021	45	9	36	80%	20%
3/23/2018	45	10	35	78%	22%
9/15/2016	45	12	33	73%	27%

Figure 3: Major Employers Over Time

Employer	Product or Service	# of Employees 2008	# of Employees 2021
Trek Bicycle	Bicycle Manufacturing	175	900
Waterloo School District	Education		135
Sussek Machine Corporation	Manufacturer	110	125
Van Holten's Inc	Pickle Production	75	105
McKay Nursery *	Nursery, Landscaping	70	70
Piggly Wiggly	Groceries		60
Municipal Government	Government		50
Lipari Foods	Cheese Manufacturing		40
F&M Bank	Financial		32
Kwik Trip	Convenience store/gas		25
Regius Rubber	Rubber Manufacturer		20
Ab E Manufacturing	Egg Products		13
Avestar	Financial		12
Custom Plastic	Plastic Fabrication		10
Metal Worx/Technicut	Metal		7
EVO	trucking		Closed 2021
Briess Industries	Producer of Malt	15	Closed 2021
Sheehy Mail Contractor	Trucking	150	Sold to EVO
Pallet One	Pallet Manufacturing	95	Closed 2019
*seasonal workers			

Goal #2: Land Use, Housing and Neighborhoods

Goals (Reference 2008 Plan Chapters 6 and 9)

- Minimize land use conflicts where family homes abut industrial properties, primarily along Hwy 19 & 89 and the rail corridor, through thoughtful planning, implementation, and strategic redevelopment
- Plan for adequate amount of land to accommodate a variety of uses; residential, industrial, commercial and community facilities
- Direct new development to surrounding existing development
- Utilize existing infrastructure and utilities wherever practical
- Require all new development in the city to connect to sanitary sewer and public water systems, discourage development outside city limits until services are available
- Promote walkability, road, paths, sidewalks, parks, and trail connections between existing and new development
- Provide sidewalks or walking paths along all streets throughout the neighborhood; add where absent to address safety needs

- Downtown; increase access to the Mauneshia River by promoting more rear building and yard uses and entries, capturing small open space connections, and promoting rear façade rehabilitation
- Avoid rezoning any area designated for General Industrial development until public sanitary sewer and water service is available, and a specific development proposal is offered, or the city approves a business/industrial park layout and/or covenants
- Consider reserving future sites for public facilities by identifying these areas on an official map
- Encourage a blend of housing options, including waterfront condominium developments
- Encourage tree planting along new streets

Supporting Information

Figure 4: Building Permits Issued (1995-2019)

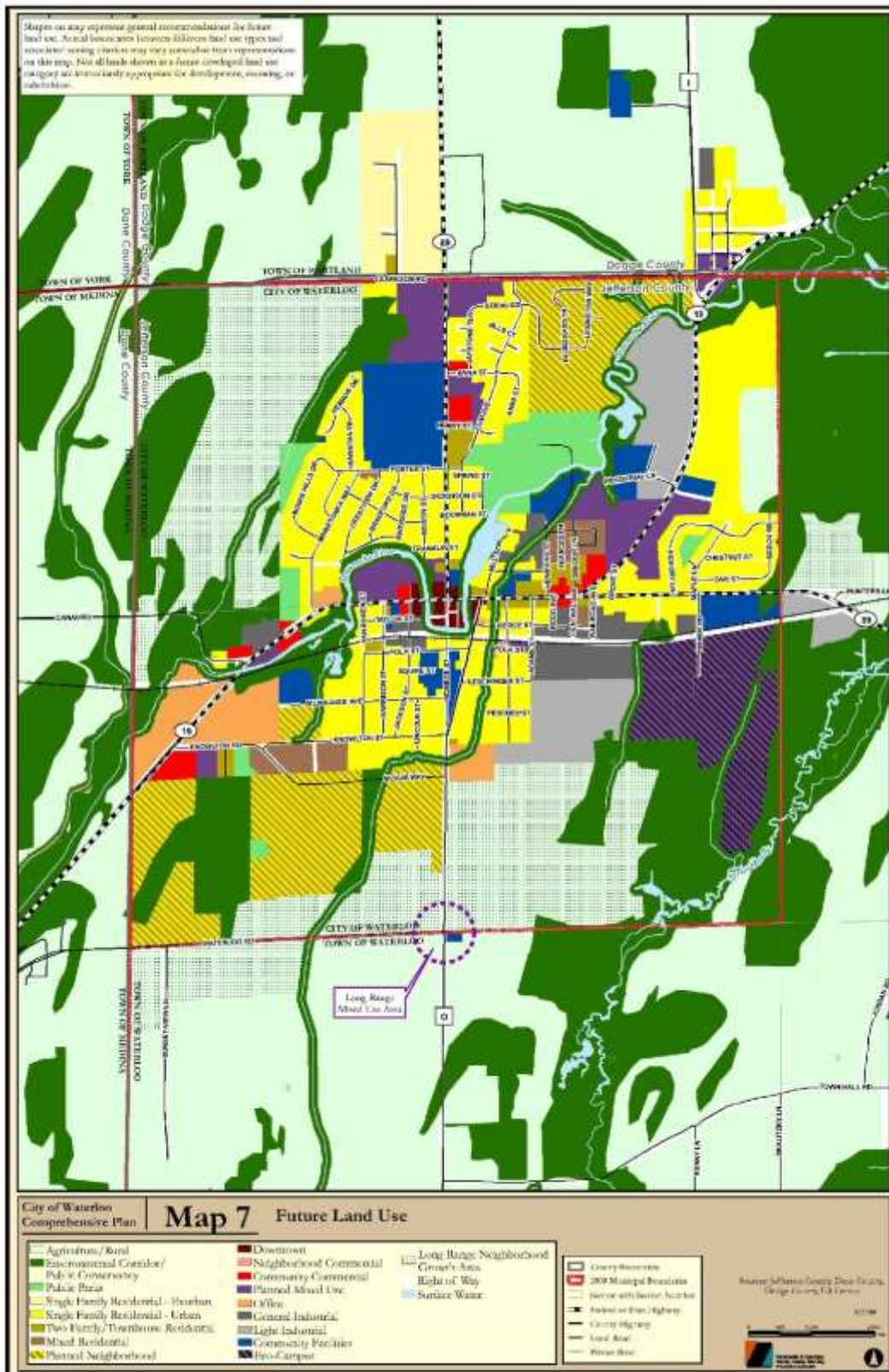
Type	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Single Family Homes	29	18	15	10	2	7	15	7	9	6	3	7	2	3
Duplexes	2	2	2	2	0	1	1	3	1	0	2	1	1	2
Multi-Family	0	0	2	4	2	0	0	0	0	0	0	0	1	0
Community Based Residential Facilities	1	1	1	0	0	0	0	0	0	2	0	0	0	0
Commercial	3	1	0	0	1	1	1	1	1	1	0	3	0	1

Type	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Single Family Homes	2	5	2	1	2	3	0	1	2	2	3	133
Duplexes	0	0	0	0	0	0	0	0	0	0	0	20
Multi-Family	0	0	0	0	0	0	1	0	0	0	0	9
Community Based Residential Facilities	0	0	0	0	0	0	0	0	0	0	1	5
Commercial	0	0	0	0	0	0	2	0	0	2	0	14

Figure 5: Housing Types

	1990 Units	1990 %	2000 Units	2000 %	2010 Units	2010 %	2019 ACS estimate	2019 Est.
Single Family (detached & attached)	686	66%	861	66%	911	61%	979	65%
Multi-Family	267	26%	338	26%	397	27%	424	28%
Mobile Home	78	8%	96	8%	180	12%	111	7%
Totals	1031	100%	1295	100%	1488	100%	1514	100%
<i>* 2010 US Selected Housing Characteristics</i>								

Figure 6: Future Land Use Map



Goal #3: Utilities and Community Facilities

Goals (Reference 2008 Plan Chapter 8)

- Advance park and recreational facilities and programming in collaboration with the School District
- Expand facilities, activities, and events in Firemen's Park and build a trail to downtown
- Provide quality accessible park, recreation, library & open space facilities & services for all age groups
- Invest in Firemen's Park, increase community-wide use of the Park for events, and identify ways to further capitalize on this significant community asset
- Improve and expand access to the Mauneshia River without impairing the river ecosystem
- Support utility upgrades, and creative funding options, to meet the needs of current and future residents and businesses and to facilitate economic growth
- Coordinate utilities and community facilities with land use, transportation, natural resources, and recreation planning
- Ensure that basic public services are available to all residents

Supporting Information

Figure 7: Utilities and Community Facilities Timetable

Utility/Facility	Timetable	Comments
Solid Waste & Recycling Services	Ongoing	Consider waste reduction education programs and promote recycling as a way to advance the City's goal of becoming a <i>Green and Healthy</i> community.
Stormwater Management	Ongoing	Continue to explore options for better city-wide management of stormwater infiltration into sanitary sewer lines for the purposes of managing peak flows within treatment plant capacity. Explore options for better city-wide management of stormwater infiltration into sanitary sewer lines for the purposes of managing peak flows within treatment plant capacity. Explore creating Stormwater Utility as part of the Public Works Department to the Utility District."
Police Station	Ongoing	Continue annual squad car replacement program. Update equipment (e.g. radios, computers) as needed
Medical Facilities	Ongoing	Continue to cooperate with the private sector in providing these essential services.
Sanitary Sewer Service On-Site Wastewater Treatment (Septic) Systems	Ongoing	Continue program of replacement and enhancement of utility lines with street reconstruction projects.
Sanitary Sewer Service On-Site Wastewater	Ongoing	Ensure the proper ongoing maintenance of existing on-site wastewater treatment systems in the City, do not allow additional systems for new development in the City.
Water	Ongoing	Work to close loops in water mains. Continue program of replacement and enhancement of utility lines with street reconstruction projects.
Water	To Be Determined	Pursue the construction of a new water tower, likely on the existing site.

City Hall	--	City Hall facilities are expected to be sufficient through the planning period. Roof replaced in 2020.
Public Works, Police Station & Fire Department	--	Facilities are expected to be sufficient for planning period. Update equipment and vehicles using a multi-year planning approach
Library	--	Facilities are expected to be sufficient for planning period with possible drive-up service addition.
Schools	--	2020 Renovations completed
Park & Recreation Facilities	--	See Parks Comprehensive Outdoor Recreation Plan

Implementation And Follow-up

(Reference 2008 Plan Chapter 11)

- Plan for annual updates as needed with action and input from municipal boards, committees and commissions. New update due 2026.

Appendix. Additional Information

Supplemental Tables:

- Accomplishments since 2008
- Priorities carried forward
- Current department plans

PRIOR YEARS ACCOMPLISHMENTS

Item #	Category	Committee	Plan Recommendation	Year	Accomplishment	2008 Plan Page
2.01	Environment	Utilities	Quality Water	2019 thru 2021	Private Lead Line Service Loan Program	i
2.02	Economic Development	CDA	Environmental health, Recruit new business	2019	Clean Up of Brownfield Sites (333 Portland Rd)	ii/42
2.03	Redevelopment	CDA	Convenient downtown parking	2008 & 2021	2008: post flood, restructured dead-end, more parking 2021: 203 E Madison Street parking	18/39
2.04	Economic Development	CDA	Restaurants	2021	Facilitated re-use of former restaurant, 122 S Monroe, Monroe Street Pizza	18
2.05	Community Facilities & Services	DPW/PARKS	Take advantage of River & Firemen's Park	2000 +	Multiple paths follow the river, started 2000; 203 E Madison/Youker Park path planned 2022	18
2.06	Economic Development	CDA	Community Center	2017	Facilitated resale of Gauthier properties	18
2.07	Community Facilities & Services	WHS	Focused on Improving Aging School Facilities	2018 & 2019-20	August 14, 2018 Referendum passed, construction new gym and facilities 2019 - opened 2020	18
2.08	Community Facilities & Services	CDA	Develop City Park & Recreation department	2016	Hired Park Director March 1, 2016	18
2.09	Transportation	DPW/PARKS	Road Projects/utilities/paths	2008 & 2017	North Monroe Street (Hwy 89) Reconstruction - Madison Street (Hwy 19) Reconstruction (TIF 1 funds)	18
2.10	Community Facilities & Services	PARKS	Promote community events	on going	City website, Facebook pages, Park & Rec banners in city hall windows, newspapers	18
2.11	Redevelopment	CDA	Perry Judds Development	2013 - April 18th	Purchase & facilitated re-use: office building, Riverwalk Senior Living, additional housing options (plant area) TIF #3 Resolution 2013-09	18
2.12	Economic Development	CDA	Pro-active Business recruitment	2008 TIF #1 plus	Re-opening Briess Malting, Regius Rubber; Custom Plastic; Hometown Pharmacy; Dollar General; Ab E Manufacturing	18
2.13	Housing	CDA	Community Benefit/taxes	2019	Residential Development - Treyburn Farms, Hedtcke properties, DeYoung Farms, Find Your Path Here Program 2012	18
2.14	Community Character	CDA	Aesthetics; Building materials	2017	Facade grants, ongoing downtown use	18
2.15	Community Character	DPW/PARKS	Aesthetics; Landscaping	2019	Custom Downtown Streetscape Planters donation, 2020 Christmas decor donation, Wayfinding signs	17/18
2.16	Economic Development	CDA	Upgrade CDC to CDA	2019	Combined CDC to CDA only, annual budgets, professional support	33/42
2.17	Economic Development	CDA	Retail opportunities	2019	Coffee/sandwich shop, Florist, Ice Cream/Specialty shop (Photography studio, Auto repair - multiple)	40
2.18	Community Facilities & Services	PARKS	Support & sponsor community events	2016	Park Director taking on Chamber events along with other park festivities & concerts	83
2.19	Community Facilities & Services	PARKS	Community Facilities	2016	Implemented and formalized a Parks & Recreation department at City Hall	143
2.20	Community Facilities & Services	PARKS	Promote community events	2015	Volunteer inspired installation of community dog park located at Firemen's Park	18

DRAFT
Comprehensive Plan Update
PRIORITIES CARRIED FORWARD FROM 2008
1:07 PM 4/22/2021

Item	Category	Committee	2008 PLAN ITEM - CARRIED FORWARD	PURPOSE	2008 PLAN REFERENCE
4.01	Economic Development	CDA	Pursue a More Assertive Approach to Economic Development/Utilize TIF	Invest time and resources in a pro-active and assertive economic development programs, hire consultant	Ch 2 pg 42 & 46 - Item 2 & 7
4.02	Economic Development	CDA	Work with Existing Local Businesses to Promote Economic Growth	To facilitate and encourage growth at existing site or new sites in the city	Ch 2 pg 43 - Item 3
4.03	Economic Development	CDA	Encourage Entrepreneurial Efforts and Small Business Start-Ups	Foster new business creation	Ch 2 pg 44 - Item 4
4.04	Economic Development	CDA	Recruit New Businesses to Fill Unmet Local Needs	See updated land use map for targeted geographical areas. Options include laundry, car wash, sporting goods store/rental, optometrist etc.	Ch 2 pg 45 - Item 5, also Ch 1 pg 20-21
4.05	Economic Development	Plan Commission	Enforce High-Quality Design Standards	To ensure the development of non-residential and mixed-use projects	Ch 2 pg 47 - Item 8
4.06	Economic Development	CDA	Redevelopment of Underutilized Lands	Promote downtown empty storefronts, eliminate blight and other underutilized land to revitalize business growth	Ch 2 pg 50 - Item 9, also Ch 6 Land Use pg 87+
4.07	Housing	Plan Commission/ CDA	Limit Residential Development within the City's Extraterritorial Jurisdiction/Manage Development	Maintain "hard-edge" between City and countryside; Long range neighborhood growth (w/updated Map 5)	Ch 3 pg 55 Item 1-3, pg 56 Items 1-2
4.08	Community Character	Parks/DPW	Natural Resources	Protect & enhance environmental corridors, Maunesh River, Garman's Woods; linking city-wide trail	Ch 4 pg 63, 67 Goals
4.09	Environment	Parks	Take a Leadership Role In Promoting City-wide Environmental Health	Link the preservation of natural resources with recreational and economic opportunities for residents and visitors	Ch 4 pg 70-71, & 75, Items 4-5 & 10
4.10	Community Character	CDA	Preserve Historically Significant Buildings	Promote restoration and rehab of historic buildings	Ch 5 pg 81 Item 1
4.11	Facilities and Services	CDA/Staff	Promote Businesses and Services that Cater to Different Groups	Promote a diverse population; promote/support Public Library learning center	Ch 5 pg 81 Item p6, pg 82 Item 2
4.12	Facilities and Services	Parks	Support & Sponsor City Events	Build a Waterloo specific sense of community	Ch 5 pg 83 Item 3
4.13	Facilities and Services	Parks/CDA	Signage & Streetscaping features	Identify theme for wayfinding within the city for driving, walking, biking. Select streetscaping features; lighting, benches	Ch 5 pg 84-85 Item 4
4.14	Land Use	Plan Commission/ CDA	Promote land use that is in harmony with the natural landscape; maintains property values; preserves the communities predominantly residential character, encouraging well-planned and attractive development minimizing land use conflicts	Ensure adequate room to grow; desirable and varied residential opportunities. Promote compact new development that utilizes existing infrastructure and utilities wherever practicable.	Ch 6 pg 94-95 Goal
4.15	Community Character	DPW	Preserve Community Character	City should be walkable, with path, sidewalks, benches, landscaping, lighting, remain orientated around the downtown as the focal point/hub of Waterloo	Ch 6 pg 116 Item K
4.16	Transportation	DPW/Utilities	Continue to make upgrades to existing City roadways; Become a Bicycle Friendly Community	Maintain a five-year Improvement Program; consider path and bike lanes in designs	Ch 7 pg 131-133 Item 1 & 4
4.17	Transportation	CDA	Promote the Use of Railways for Local Use	Support rail spur extensions if demanded by potential users	Ch 7 pg 131 Item 3
4.18	Facilities and Services	Parks/DPW	Implement A Plan For the Old Mill Pond Area	Finalize bike/ped connectivity from downtown 203 E Madison to Firemen's Park via Youker Park	Ch 8 pg 146 Item 5
4.19	Facilities and Services	Parks/Plan Commission	Include School District in future planning decisions	Coordinate land use decisions, community needs	Ch 8 pg 146 Item 6

DRAFT
Comprehensive Plan Update
PRIORITIES CARRIED FORWARD FROM 2008
1:07 PM 4/22/2021

Item	Category	Committee	2008 PLAN ITEM - CARRIED FORWARD	PURPOSE	2008 PLAN REFERENCE
4.20	Facilities and Services	Staff	Plan for a Board of Police & Fire Commissioners	Required when population reaches 4,000	Ch 8 pg 147 Item 8
4.21	Facilities and Services	Utilities	Upgrade Public Utilities as Needed	Coordinate utility growth with overall municipal growth; Update Chart 8.3	Ch 8 pg 147 Item 9
4.22	Housing	CDA/Plan Commission	Support the Provision of Affordable Housing	Promote the maintenance of older neighborhoods & programs to provide new affordable housing	Ch 9 pg 154 Item 1
4.23	Inter-governmental Cooperation	DPW/Staff	Pursue Intergovernmental Discussions with the Town of Portland; Coordinate with adjoining towns Medina & Waterloo	Examine difference between the two jurisdiction's plans; future development on the SW side access to Waterloo Road, Need agreements	Ch 10 pg 169 & 171, Item 1 & 4
4.24	Inter-governmental Cooperation	Staff	Remain Involved in Regional Initiatives	Maintain active and open dialogue with neighbors and the region	Ch 10 pg 171 Item 3
4.25	Inter-governmental Cooperation	Staff	Rigorously reference this update and follow prescribed implementation steps	Implementation follow up & review, per WI State Statutes requirements	Ch 11 pg 173-178

2021-2025 Plan
UPDATE (draft)
CURRENT DEPARTMENT PLANS

ITEM	DEPARTMENT	EXISTING DEPARTMENT PLAN ITEM	PURPOSE	COMP PLAN REFERENCE	SOURCE
3.01	Electric Utility	Installation of Hwy O Electric Substation	Electric service redundancy meeting expectations of business owners	Pg. 105 Goal: promote efficient supply of utilities... that meeting expectations of City residents and business owners	Waterloo Utilities
3.02	Electric Utility	Electric Service Pole Replacements; Electric Meter Replacements and Funding Transportation Fund	Maintain electric system infrastructure	Pg. 105 Goal: promote efficient supply of utilities... that meeting expectations of City residents and business owners	Waterloo Utilities
3.03	Electric Utility	Funding Transportation Fund	Maintain Waterloo Utilities service fleet	Pg. 106 Policy 1: "maximize the use of existing utilities and plan for order expansion of utilities"	Waterloo Utilities
3.04	Electric, Water & Sewer Utility	Repair/reconstruct existing municipal utilities in coordination with multi-year Street & Utility Schedule	Maintain water, sewer and electric system	Pg. 106 Policy 1: "maximize the use of existing utilities and plan for order expansion of utilities"	Waterloo Utilities
3.05	Sewer Utility	Upgrade waste treatment plant to size for future and comply with state/fed wastewater standards	Upgrades sewer system and treatment plant	none	Waterloo Utilities
3.06	Sewer Utility	Replace remaining lead public water laterals in coordination with municipal property owner assistance programs	Eliminate 100% of public lead water laterals	Pg. 105 Goal: promote efficient supply of utilities... that meeting expectations of City residents and business owners	Waterloo Utilities
3.07	Clerk/Treas	Manage/operate municipal programs to aid private property owners in removal of private lead water lines	Eliminate 100% of private lead water lines	Pg. 105 Goal: promote efficient supply of utilities... that meeting expectations of City residents and business owners	Clerk/Treasurer
3.08	Water Utility	Well improvements	Well improvements as projected by engineer	Pg. 105 Goal: promote efficient supply of utilities... that meeting expectations of City residents and business owners	Waterloo Utilities
3.09	Parks and Recreation	Firemen's Park (a) Develop master plan and strategic improvement plan; (b) develop programs and events to bring the community together and engaged; and (c) Sand Volleyball Court development and camping area	Multiple		Parks & Rec Dept Comprehensive Outdoor Recreation Plan
3.10	Parks and Recreation	Waterloo Regional Trailhead – (a) Design and locate appropriate signage for the Trailhead and Park; (b) Fundraising for park improvements; and (c) Educational opportunities	Multiple		Parks & Rec Dept Comprehensive Outdoor Recreation Plan
3.11	Parks and Recreation	Morrison Field – (a) Morrison Way street and parking improvements; (b) Bleacher and spectator improvements; (c) Field improvements; (d) Restrooms; (e) North side pavilion, parking and play structure; (f) Pedestrian path through park	Multiple		Parks & Rec Dept Comprehensive Outdoor Recreation Plan
3.12	Parks and Recreation	Veteran's Memorial Park – (a) Improvements to Maunsha Business Center; (b) Connection to city parking lot; (c) Improvements to existing memorial and stage	Multiple		Parks & Rec Dept Comprehensive Outdoor Recreation Plan
3.13	Parks and Recreation	Youker Park – (a) Mowing of interpretive path; (b) improve street parking; design and implement interpretive nodes; and (c) design & building bridge connecting to City Hall	Multiple		
3.14	Parks and Recreation	DeYoung Farms -- (a) Clearing of invasive plants; (b) connecting paths to internal mulch paths; (c) path grading and re-mulching improvements; and (d) design and implement interpretive nodes, (e) design & implement entrance signs	Multiple		
3.15	Library (KJML)	In a world of rapidly changing technology, KJML will provide access and training for devices, programs and tools to meet the various information needs of the community	Access to educational tools		Karl Junginger Memorial Library 2017-2020 Strategic Plan
3.16	Library (KJML)	The KJML will provide comfortable and inviting space for leisure, technology access and work	Access to educational tools		Karl Junginger Memorial Library 2017-2020 Strategic Plan
3.17	Library (KJML)	The library will set about doing the hard work of community coordination, acting as an ambassador not just for the library but for the larger Waterloo community.	Promote Social Health		Karl Junginger Memorial Library 2017-2020 Strategic Plan
3.18	Library (KJML)	KJML will seek intentional interaction through educational, language and cultural exchanges that will encourage Hispanic community members to more fully use the library and feel safe and truly part of the larger Waterloo community.	Promote Social Health		Karl Junginger Memorial Library 2017-2020 Strategic Plan
3.19	Library (KJML)	The library will provide diverse opportunities for learning, engagement and exploration for all community members.	Promote Social Health		Karl Junginger Memorial Library 2017-2020 Strategic Plan