Portsmouth
CITY COUNCIL

Testing and Evaluation of Weed Control Methods in Portsmouth City Council Parks, Gardens and Cemeteries

March 2023 to August 2023

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Introduction

Weeds are opportunistic plants that take advantage of disturbed environments, favourable conditions, and lack of competition to grow and reproduce rapidly. Effective weed management involves understanding these factors and implementing strategies to prevent or control their growth.

Unchecked weed growth damages infrastructure, leading to costly repairs. Uneven surfaces caused by weeds pose trip hazards, endangering visitors.

This report evaluates diverse weed control strategies versus current practices, assesses their environmental implications. Proactive weed management is essential for safeguarding the appeal, safety, and vitality of communal spaces.

Photo showing weed growth in paving blocks at a base of the statue.

1) Evaluation of Hot Foam Thermal Treatment as a weed control

How Hot Foam kills weeds

Water is heated to near boiling point and then mixed with the foam agent concentrate to produce foam before being applied. The foam blanket ensures that the heat is held on the plant so that the weeds experience hot, killing temperatures for a few seconds. The lance can apply large volumes of water and foam and can be used to kill larger weeds. Foam cover, and hence heat retention on weeds, is easier to achieve plants that are near the ground. Tall plants are trodden down either by foot or by using the lance outlet, to aid foam cover and heat retention. Immediately after treatment, weeds will go dark green and limp. This indicates that the machine is operating properly. The weeds will die, this becomes more obvious within the next one to seven days (depending on species and weather). If weeds fail to go limp, temperatures may be too low or treatment speed too high.

Kingston cemetery was selected to trial the Hot Foam thermal treatment and the following areas identified:

Grave tops - all grass and weeds treated to reduce strimming.
Gravel Path - whole path treated to kerb edges to remove weeds and grass.
Tarmac moss path - whole path treated for moss and algae.
Headstone bases - edges around headstone bases to reduce strimming and damage to grave memorials.

Two Grounds Operatives are required to operate safely.

Machinery loading time: 45 mins

Due to the weight of the Hot Foam machine and 780 litre water tank - a forklift was required to lift the machine onto the transport vehicle. The machine and tank were secured to the vehicle. Petrol and diesel were collected for the machine, and the foam agent loaded and secured.

Machine setup:

Filling water tank from Cemetery tap - 57 mins.
Machinery pre-start checks inc. top ups - petrol, diesel, oils -15 mins.
Machinery bleeding - removal of air from the system - 4 mins.

Notes - Water flow from the tap was slow, wait times could be reduced by the connection to main fire hydrants, there would be a cost implication to do so. Driving to another water location was not deemed feasible due to the time to travel there and back. Pre-start checks were undertaken during the filling of the water; however, this task was only undertaken by one operative.

Total setup time 1hr 46 mins

Grave top treatment:	Grounds Operatives required - x 2
Machine warm up -	Setting machine temperature before treatment - 2.5 mins, which results in a large amount of residual foam.
Treatment -	4 grave rows were treated, due to the length of the lance hose several vehicle movements were required with warmup and cool down times included.
Machine Cool down -	40 second cool down is required prior to moving locations or switching off the machine, resulting in large amounts of foam.
	Total treatment time 29m 27s

Grave top treatment showing hose hooked over graves.

Invertebrates harmed during treatment.

Notes - Two operatives are required, one to assist with hose movement around obstacles. Operators noticed hand strain from holding the trigger in one position. Worms were noted coming to the surface after treatment. Investigation concluded that all invertebrates, micro-organisms which come into contact with the treatment are harmed due to the high treatment temperatures. Scorching of grass from hot hose was also noted.

Hose scorch marks on turf.

Operative required to move hose during treatment to access around kerb sets.

Gravel Path Treatment:

Machine warm up - Setting the machine up to temperature before treatment - 2m 30s, which results in a large amount of residual foam.

Treatment - 1 .7m x 20m Type 1 subbase path was treated (34 m2)

Machine Cool down - 50 second cool down is required prior to moving locations or switching off the machine, resulting in large amounts of foam.

Water used 100L

Total treatment time 8m 30s

Operative showing trip hazard of hose and residual foam 10 mins after operation.

Notes - Operators observed that hose gets very hot after sustained use, and when dragged through the foam and puddles, the risk of scalding, from operators handling the hose, is increased as gloves get wet. Operators must hold the hose when it reels back onto the hose reel as there is no brake system on the reel system.

Tarmac moss path

Machine warm up -	Setting machine temperature before treatment- 2m 30s, which results in a large amount of residual foam.
Treatment -	Whole tarmac path was treated for moss and weeds 6m 40s.
Machine Cool down -	50 second cool down is required prior to moving locations or switching off the machine, resulting in large amounts of foam.

Total treatment time 10m 20s

Path treatment avoiding hose getting wet.

Figure 1 Foam remaining 2 hours after cooling down.

Headstone bases

Machine warm up - Setting machine temperature before treatment - 2m 30s, which results in a large amount of residual foam.

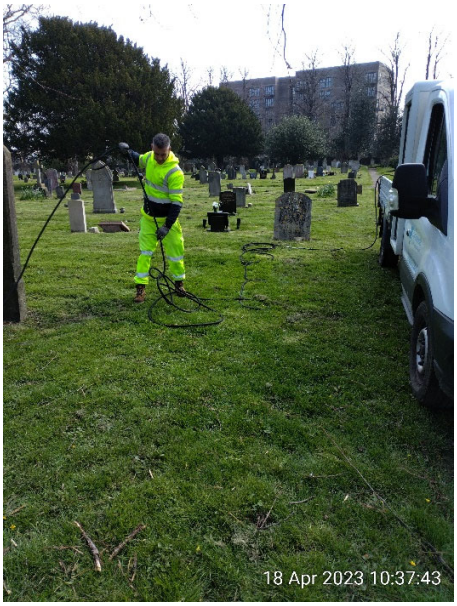
Treatment - A section of headstones bases in an open lawn area were treated. An extension hose was added to increase treatment distance. Two operatives were required to move hose around and over headstones. It was noted that the hose could not be held for long periods as it gets very hot. Thicker insulated gloves are required for operatives. Extension hose was awkward to use and required disconnection from main unit when van was required to move. Extra care was taken not to remove pipes while the pipes were hot.

50m 15s

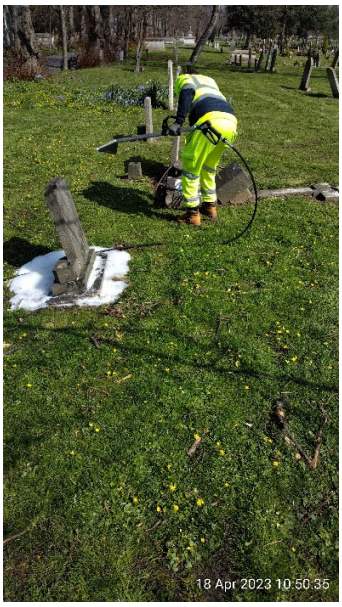
Treatment around headstone bases to reduce strimming.

Machine Cool down - 50 second cool down is required prior to moving locations or switching off the machine, resulting in large amounts of foam.

Total treatment time 53m 55s



Operative untangling hoses.



Operative moving twigs to gain access to weeds below.

Treatment day observation notes:

Benefits Noted:

Hot Foam has a few alternative lance attachments, which enable hot water pressure washing and hot foam brush cleaning.

Can be used in most weathers.

It kills moss on hard surfaces / play area surfacing.

Operator certification (spraying qualification) is not required, however full protective clothing, and specialist training is required.

Operative cleaning with brush attachment.

Foam agent is a blend of biodegradable natural plant oils and sugars, so it is safe to use around people, animals, and waterways.

Initial effects of treatment on ivy are positive.


Pressure hotwash test on paving slabs.

Issues Noted

The Hot Foam has 1hr 10 Minutes on trigger time and takes 57min to refill water tank.

Would need fire hydrant license to refill or alternate locations to source water.

Two operatives are required to operate Hot Foam.

Operation is slow moving and noisy.

Petrol engine & diesel boiler. Diesel smoke from the boiler is clearly visible.

Needs to be mounted on a flatbed truck/ utility vehicle.

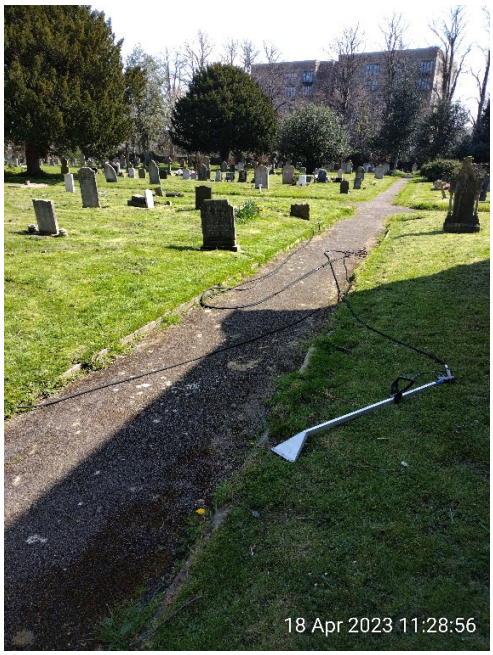
A number of machines, vehicles, and dedicated operators will be required to maintain current standards of weed control level.

Hose trip hazard – potential need to close working area. Hoses easily get tangled, and operatives spend a lot of time setting up to enable works to take place. The automatic reel drum winds back very fast, and operatives must hold the hose to stop it whipping about, this is hazardous as the hose can be hot. The reel only holds 20m and the extension hose needs winding up by hand. 60m reels are available as an option.

Exposed metal fittings below lance gets very hot and scalding can occur.

Two water tank fills were required during the trial day - 1h 55 mins.

Diesel Particulates from boiler.



Hose cooling prior to packing away.

Exposed metal fittings.

Effects of Hot Foam treatment on ivy.

2) Evaluation of Glyphosate as a weed control method

How Glyphosate works

Glyphosate is a broad-spectrum systemic herbicide and has been a commercial success since its introduction in 1970. Glyphosate is a translocated, systemic weed killer which on contact moves throughout the plant, killing roots and shoots. After application, the herbicide can take a few weeks to take effect. Weeds will eventually 'die-back'. It is effective on perennial weeds and is one of the few products left available to successfully control invasive species such as Japanese Knotweed and Giant Hogweed due to its approval for use on or near water.

Weather conditions are an important factor in the use of glyphosate. As with many herbicides, any amount of rainfall soon after applications the potential to reduce absorption, translocation, and subsequent weed control. If glyphosate is applied and it rains before it is rain fast, performance will be reduced. It can therefore be very difficult to stay on top of weed control when scheduled spraying times coincide with periods of wet weather. Glyphosate usually performs well under a wide range of temperatures. Best performance usually occurs when the temperature is 15-25°C at application and remains there for a few hours afterward. This is the reason that spraying generally takes place in spring and summer. When the temperature is lower than 15°C, weed growth slows, resulting in slower herbicide uptake and translocation. This increases the required rain fast period and slows the onset of symptoms and herbicide efficacy. If the temperature is below 5°C, glyphosate application should be avoided. Wind speed is also a factor in the success of using glyphosate. Due to dangers of drift, it is not advisable to spray during periods of wind.

Areas selected for trial:

Grave tops - all grass and weeds treated to reduce strimming.
Gravel path - whole path treated to kerb edges to remove weeds and grass.
Tarmac moss path - whole path treated for moss and algae.
Headstone bases - edges around headstone bases to reduce strimming and damage to grave memorials.

Grounds Operatives required - x 1.

Equipment loading time: 10 mins.

Operative collects chemicals and equipment from a secure store, which is loaded by hand into a secure store in the vehicle. PPE is selected and loaded for the task.

Spraying setup:

Knapsack sprayer was calibrated, and nozzle selected and was matched with the product label. Application area (m^2) was estimated, and a mixture was prepared for the whole trial. 30 mins

Grave Tops:

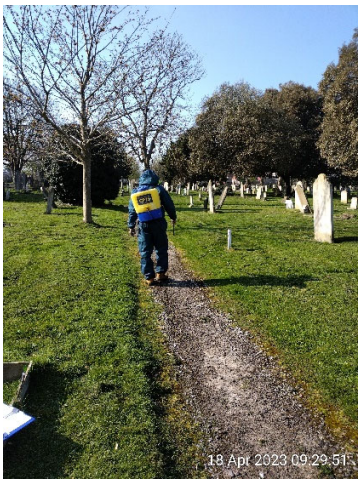
Treatment: 4 grave rows were sprayed
Treatment time 10m 04s

Operative spraying grave tops.

Gravel Path Treatment:

Treatment: A 1 .7m x 20m Type 1 subbase path was sprayed (34 m2)

Treatment time 1m 2s



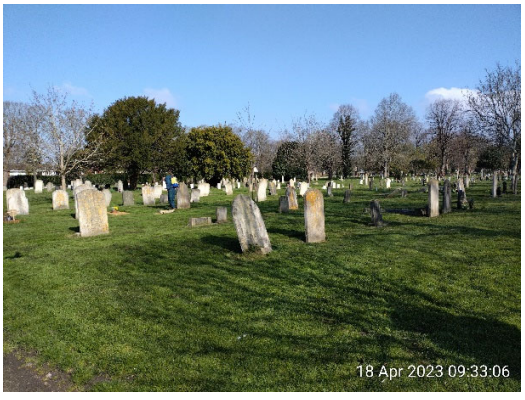
Operative spraying 20m pathway.

Headstone bases:

Treatment: A section of headstones bases in an open lawn area were sprayed.

Treatment time 13 mins

Operative accurately spraying around headstones.



Operative free to move around all headstones.

Treatment day observation notes:

Only qualified operatives are allowed to apply chemicals. Operatives were free to move around the site.

The spraying process involved the operative carefully walking along the grave rows, systematically applying the glyphosate spray to the base and immediate vicinity of each headstone base and along pathways in the selected locations. The operative demonstrated caution and precision to avoid overspray or direct contact with the headstones themselves.

The operative displayed a commendable commitment to safety throughout the observation. The use of personal protective equipment (PPE) was in line with industry standards, ensuring minimal exposure to glyphosate and potential harm. The operative consistently maintained a safe distance from the headstones and exercised care to prevent accidental contact with the sprayed areas.

Signage was strategically placed at entrances and along pathways, warning individuals about the application of herbicides and advising them to avoid the treated areas temporarily.

3) Evaluation of Pelargonic Acid as a weed control method

How pelargonic acid works

Pelargonic acid is present in many plants. It is used as an herbicide to prevent growth of weeds both indoors and outdoors, and as a blossom thinner for apple and pear trees. The U.S. Food and Drug Administration (FDA) has approved this substance for use in food. No risks to humans or the environment are expected when pesticide products containing pelargonic acid are used according to the label directions.

Pelargonic acid is a chemical substance that is found in almost all species of animals and plants. Because it contains nine carbon atoms, it is also called nonanoic acid. It is found at low levels in many of the common foods we eat. It is readily broken down in the environment.

Pelargonic acid causes extremely rapid and non-selective burn-down of green tissues of the treated plants and flowering weeds.

Areas selected for trial:

Grave top - all grass and weeds treated to reduce strimming.
Gravel path - left hand side treated to kerb edges to remove weeds and grass.

Grounds Operatives required - x 1.

Equipment loading time: 10 mins.

Operative collects chemicals and equipment from a secure store, which is loaded by hand into a secure store in the vehicle. PPE is selected and loaded for the task.

Spraying setup:

Knapsack sprayer was calibrated, and nozzle selected and was matched with the product label. Application area (m^2) was estimated, and a mixture was prepared for the whole trial. 30 mins

Grounds Operative spraying grave tops with Pelargonic acid.

Grave Tops:

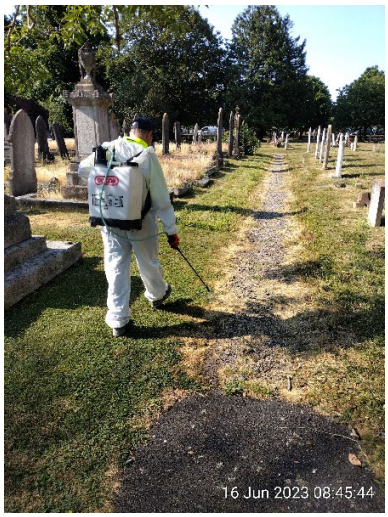
Treatment: 1 grave row was sprayed

Treatment time 10min 31s

Gravel Path Treatment:

Treatment: A 850mm x 20m Type 1 subbase path was sprayed 17m2)

Treatment time 35s



Grounds Operative spraying Pelargonic acid on path edges.

Treatment day observation notes:

Only qualified operatives are allowed to apply chemicals. Operatives were free to move around the site.

The spraying process involved the operative carefully walking along the grave rows, systematically applying the Pelargonic acid spray to the grave tops and along the left-hand side of the pathway in the selected location. The operative demonstrated caution and precision to avoid overspray or direct contact with the headstones themselves.

The operative displayed a commendable commitment to safety throughout the observation. The use of personal protective equipment (PPE) was in line with industry standards, ensuring minimal exposure to the Pelargonic acid and potential harm. The operative consistently maintained a safe distance from the headstones and exercised care to prevent accidental contact with the sprayed areas.

Signage was strategically placed at entrances and along pathways, warning individuals about the application of herbicides and advising them to avoid the treated areas temporarily. A distinct odour was detected after spraying and lingered until the spray had dried on the plant.

4) Evaluation of Acetic acid as a weed control method

How Acetic acid works

A fast-acting, non-selective herbicide which is active against most soft tissue it comes into contact with. The product controls grasses, broad-leaved weeds, and mosses. It produces discolouration and browning of the foliage within a few hours of treatment. Perennial weeds generally require more than one application, but annual weeds are normally controlled with one treatment. It is a weedkiller for all weeds and moss suitable for hard surfaces, natural surfaces without vegetation and permeable surfaces overlying soil derived from natural ingredients it offers an alternative to glyphosate.

Areas selected for trial:

Grave top - all grass and weeds treated to reduce strimming.
Gravel path - right hand side treated to kerb edges to remove weeds and grass.

Grounds Operatives required - x 1.

Equipment loading time: 10 mins.

Operative collects chemicals and equipment from a secure store, which is loaded by hand into a secure store in the vehicle. PPE is selected and loaded for the task.

Spraying setup:

Knapsack sprayer was calibrated, and nozzle selected and was matched with the product label. Application area (m^2) was estimated, and a mixture was prepared for the whole trial. 30 mins

Grounds Operative spraying grave tops with Acetic acid.

Grave Tops:

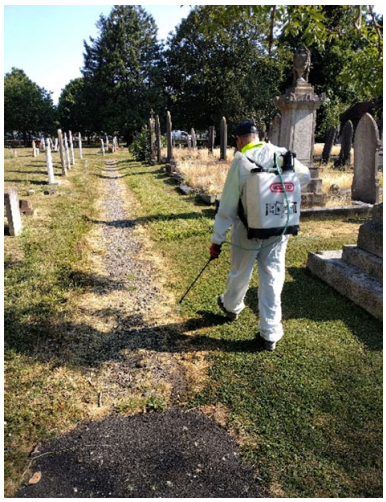
Treatment: 1 grave row was sprayed

Treatment time 10 min 05s

Gravel Path Treatment:

Treatment: A 850mm x 20m Type 1 subbase path was sprayed 17m2)

Treatment time 40s



Grounds Operative spraying Acetic acid on path edges.

Treatment day observation notes:

Only qualified operatives are allowed to apply chemicals. Operatives were free to move around the site.

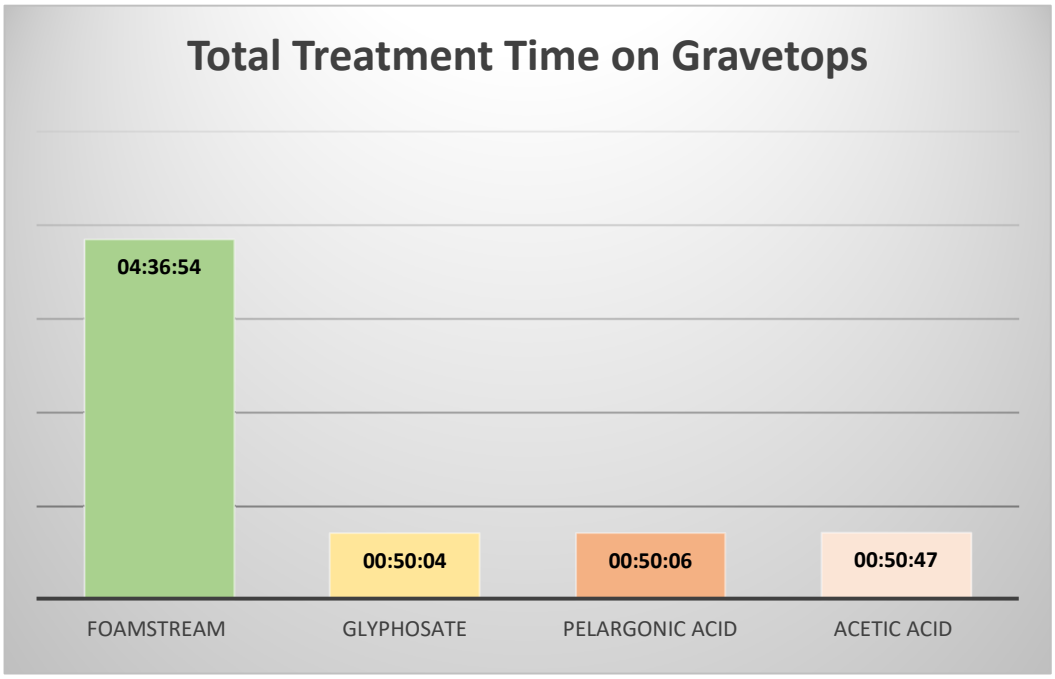
The spraying process involved the operative carefully walking along the grave rows, systematically applying the Acetic acid spray to the grave tops and along the right-hand side of the pathway in the selected location.

The operative displayed a commendable commitment to safety throughout the observation. The use of personal protective equipment (PPE) was in line with industry standards, ensuring minimal exposure to the acetic acid and potential harm. The operative consistently maintained a safe distance from the headstones and exercised care to prevent accidental contact with the sprayed areas.

Signage was strategically placed at entrances and along pathways, warning individuals about the application of herbicides and advising them to avoid the treated areas temporarily. A distinct "strong vinegar" odour was detected after spraying and lingered until the spray had dried on the plant.

Time trial comparison of the evaluated treatments

The grave top trial area was selected to give a like for like timed trial for the selected alternative treatments versus the current methods. The table below shows a timed comparison for each of the methods. There was a 450% increase time required to treat the same area using the Hot Foam compared to conventional knapsack spraying.



5) Evaluation of Wire Weed Brush

How the Wire weed brush works

The Wire Weed Brush is a versatile and widely used tool in alternative weed management. Designed to mechanise the process of weed removal, this equipment employs rotating wire brush attachment to dislodge and uproot unwanted vegetation. The kerb edges around the fountain were selected for the trial of the weed brush and hand weeding. The purpose of this observation was to assess the effectiveness of using a Wire Weed Brush for the removal of kerb weeds. The focus was on evaluating the equipment's performance, the efficiency of weed removal, and any limitations encountered during the process.

Fountain Kerb path

Machine set up -	Loading machinery, pre-start checks, and setup of brushes 30 mins.
Treatment -	Whole tarmac and kerb edges was swept for weeds 16m 20s.
Sweep and tidy -	Kersten sweeper was used to collect debris created from the weeding process. 4m 20s
Total treatment time	50m 40s

Operative using Wire weed brush.

Operative using Kersten debris sweeper.

Description of the Activity:

During the trial, the operative used the Wire Weed Brush to remove kerb weeds along the fountain kerb edges. The Wire Weed Brush is a machine designed to mechanically remove weeds by rotating wire brush attachment, which is meant to dislodge and uproot the unwanted vegetation.

The operative manually directed the machine along the kerb, moving it back and forth to cover the weed-infested areas. The rotating brushes appeared to make contact with the weeds, causing them to be dislodged from the surface. However, upon closer examination, it became apparent that the Weed Brush's effectiveness in completely removing the weeds was limited.

After brushing, showing remaining weeds.

Assessment of Equipment Performance: The performance of the Wire Weed Brush during the trail was found to be insufficient for effective removal of kerb weeds. Despite the rotating brush attachments making contact with the weeds, the machine struggled to uproot them entirely. As a result, many weeds remained partially intact or were merely pushed aside rather than being completely eradicated. The brushes' design and rotation speed seemed inadequate for tackling well-established and deeply rooted kerb weeds. Moreover, the Weed brush's lack of precision made it challenging to target specific weeds without causing damage to tarmac pavement or other surrounding features.

Limitations and Considerations:

Weed Type and Root Depth: The Wire Weed brush may be better suited for shallower rooted or younger weeds. Kerb weeds, often mature and deeply rooted which proved to be challenging for the brush to handle effectively.

Precision and Targeting: The lack of precise control over the brushes' movement made it difficult to selectively target individual weeds, resulting in potential damage to nearby pavement or other desired vegetation.

Grasses remaining after brushing.

Efficiency and Time: Due to the equipment's limited effectiveness, the Weed brush required multiple passes over the same areas to achieve partial weed

removal. This resulted in increased time and effort expended by the operator, reducing overall efficiency. It was noted that the repetitive pushing and pulling motions required to manoeuvre the Weed brush can put strain on the operator's muscles and joints, particularly in the arms, shoulders, and back. Without proper body mechanics and technique, the operator may be at risk of developing muscle fatigue, discomfort, or even musculoskeletal injuries over time.

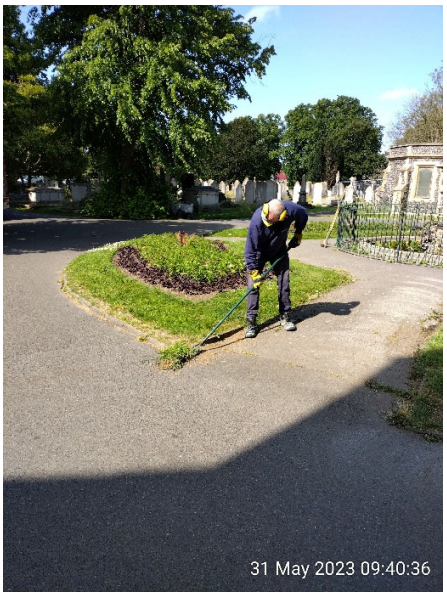
Overall Conclusion: Based on the observation, the use of a Wire Weed brush proved to be ineffective for the complete removal of kerb weeds. The equipment's limitations, including inadequate uprooting capabilities and imprecise targeting, hindered its overall performance.

6) Evaluation of hand weeding as a weed control method

The process of kerb edge hand weeding, carried out manually using specialized tools, is a labour intensive grounds maintenance method.

Fountain Kerbs

Loading tools -	Selecting and loading tools for the workday, namely long handle hoe, half-moon edger, shovel, broom, and wheelbarrow. 10 mins.
Treatment -	Whole tarmac and kerb edges was edged using the half-moon, and then weeds were removed by using the hoe 15m 20s.
Sweep and tidy -	A hand broom was used to sweep up debris created from the weeding process and load into the wheelbarrow. 8m 40s
Total treatment time	34mins



Operative removing weed with hoe.

While manual tools provide a targeted and precise approach to weed removal, it is crucial to recognize the physical strains and challenges placed on the operative. The repetitive nature of this task, combined with the need for bending, kneeling, and exerting force, can lead to physical discomfort and potential strain. Therefore, understanding the demands placed on the operative and implementing proper ergonomic practices becomes essential to ensure their well-being and optimise the efficiency of hand weeding operations.

By substituting the handheld half-moon edger for a petrol edger treatment time was reduced by 16 mins, however, noise and vibration management will be required.

Treatment time was 18m 51s.

Neat edge created by half-moon edging.

Operative sweeping by hand.

Operative using a petrol edger.

Monitoring the weed regrowth from the Hot Foam, Glyphosate, Pelargonic, and Acetic weed control methods

1) Pictorial evaluation photos and descriptions for Hot Foam

Hot Foam Treatment Day

Hot Foam 1 day after treatment

Hot Foam 14 days after treatment

Hot Foam Day 62 (1st treatment) day 27 (second treatment) showing weeds growing back.

Hot Foam Day 78 (1st treatment) (centre) all grown back.

Hot Foam Second treatment

Hot Foam (second treatment) day 12 in foreground, 1st treatment day 48 between foreground and Glyphosate treatment

Day 43 Hot Foam (second treatment) showing weeds growing back.

Hot Foam Day 108 (1st treatment), Day 68 (2nd treatment) showing grass and weeds almost grown back.

Hot Foam Day 141 (1st treatment), Day 106 (2nd treatment) showing grass and weeds grown back.

Hot Foam Evaluation Conclusion

While Hot Foam has been considered as an alternative to traditional herbicides in weed control, there are several significant factors to consider. First, the cost of implementing Hot Foam as a weed management method can be relatively high, requiring initial investment in specialised equipment and ongoing maintenance expenses.

Additionally, the effectiveness of Hot Foam in long-term weed suppression has shown limitations, as weed growth tends to resurface after 4 weeks. This would necessitate frequent and repeated applications, thus adding to the overall expense and time and resource commitment.

The use of diesel-powered equipment to generate the necessary hot foam can contribute to the emissions of harmful nitrogen oxide (NOx) gases, which have environmental implications. The use of Hot Foam can also introduce noise pollution, especially when large-scale applications are carried out. The noise generated during the process may cause disturbances in residential or sensitive areas, impacting the overall quality of the environment.

There were several safety concerns associated with Hot Foam application, as the high temperatures involved in the application process can pose risks to both operators and members of the public. There are risks of tripping hazards associated with the hoses used for application. The hoses, which are necessary to transport the hot foam mixture, can create obstacles on the ground that operators and members of the public may inadvertently trip over.

2) Pictorial Evaluation photos and descriptions for Glyphosate application

Glyphosate Day 17 showing signs of translocation of herbicide.

Glyphosate Day showing total translocation of herbicide on targeted area.

Glyphosate Day 68 showing some germination of new weeds, ivy, and bindweed growth.

Glyphosate Evaluation Conclusion

The use of glyphosate in the trial area of virgin ground was found to be an effective method for weed control, particularly when considering the benefits of limited labour required and targeted application.

Glyphosate, a non-selective herbicide, is known for its ability to control a wide range of weeds with relatively low labour input. Compared to manual weeding or other methods, glyphosate allows for more efficient and timesaving weed control. This is especially advantageous when dealing with large areas of weedy ground, where manual labour may be impractical or cost prohibitive.

Glyphosate Day 125 showing further germination of new weeds, ivy, and bindweed growth.

While glyphosate is considered effective and efficient, it is crucial to acknowledge potential environmental concerns. Glyphosate is a chemical herbicide, and its use should be accompanied by responsible application practices to minimize any negative impacts on non-target organisms and water sources. Following proper safety guidelines and avoiding overspray or runoff into sensitive areas can mitigate potential environmental risks.

3) Pelargonic Acid and Acetic Acid evaluation photos and descriptions

Day 25 Pelargonic acid showing some effect on grass species.

Day 25 Acetic Acid showing some effect on grass species.

Day 63 Pelargonic Acid - showing need for further treatments.

Day 63 Acetic Acid - showing further treatment required.

Pelargonic and Acetic Acid evaluation conclusion

The utilization of pelargonic acid and acetic acid presents an initial avenue for weed suppression, showcasing notable short-term efficacy. These organic compounds, known for their herbicidal properties, exhibit a capacity to swiftly curtail weed growth and impede their proliferation. Their rapid mode of action and environmentally friendly nature contribute to their appeal as potential tools in the arsenal of weed management strategies.

It is imperative to acknowledge the inherent limitations that emerge upon closer scrutiny. Despite their immediate impact, both pelargonic acid and acetic acid reveal a deficiency in conferring a sustained, long-term effect on weed suppression.

4) Weed brush and Hand weeding evaluation photos and descriptions

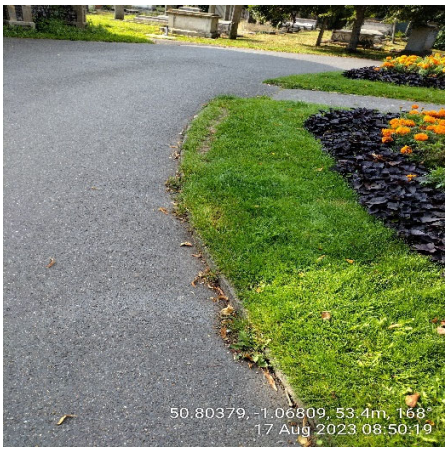
Day 16 Wire weed brush showing weed growth returning.

Day 16 Hand weeding on left and weed brush on right showing weed growth returning.

Day 16 Pedestrian edger and hand weeding showing weed growth returning, area still looks tidy after edging.

Wire weed brush showing full weed growth on path edge.

Hand weeding on left and weed brush on right showing weed growth.



Pedestrian edger and hand weeding showing weed growth returning.

Weed brushing and hand weeding evaluation conclusion

Both weed brushing and hand weeding have proven to be ineffective methods for long-term weed control, as the weeds tend to grow back quickly after the initial removal. While weed brushing utilises mechanical means to dislodge weeds, and hand weeding involves targeted manual removal, neither approach addresses the underlying issues that contribute to weed growth, such as root regrowth or seed dispersal.

The inability of these methods to provide lasting weed suppression can result in recurring weed infestations, leading to a continuous and labour-intensive cycle of weed management. Additionally, the repeated application of weed brushing or hand weeding can be time-consuming costly and damage to infrastructure, making them less viable options for large-scale weed control projects.

Trial Conclusion

In evaluating the selected weed control methods, it becomes evident that each approach possesses its own set of advantages and limitations. Foamstream, glyphosate, pelargonic acid, acetic acid, and manual weeding all offer unique mechanisms to address the persistent challenge of weed management.

While Hot Foam is promoted as an eco-friendly weed control method using heat and bio-chemicals, its effectiveness hinges on weather conditions and the necessity for multiple applications. It's worth considering that the use of diesel-powered equipment for hot foam generation can emit harmful nitrogen oxides (NOx) and lead to noise pollution, especially in extensive applications.

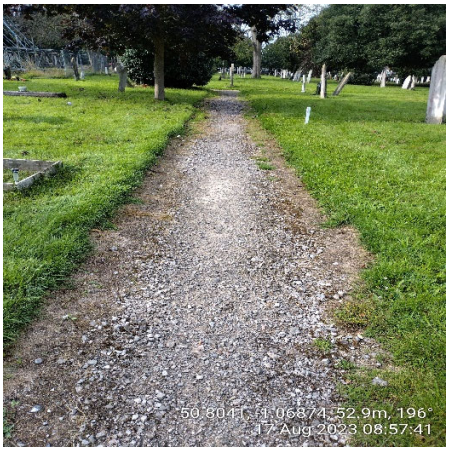
Similarly, the use of pelargonic acid and acetic acid reflects a more sustainable choice, yet their short-term impact prompts questions about long-term efficacy.

In contrast, glyphosate continues to stand out as the most economical method for weed control. Its broad-spectrum nature and reliable outcomes make it a widely adopted choice, despite concerns about environmental impacts. However, the growing emphasis on ecological considerations necessitates exploring alternatives.

Weed control Methods evaluated	How quick was the method	Effectiveness of weed control method	Labour inputs	Cost	Number of treatments per annum
Hot Foam	Slow	Partial	High	High	4
Glyphosate	Quick	Very good	Low	Low	2
Pelargonic Acid	Quick	Partial	Low	Medium	3
Acetic Acid	Quick	Partial	Low	Medium	4
Manual	Slow	Partial	High	High	1 per month
Wire brush	Slow	Partial	High	High	1 per month

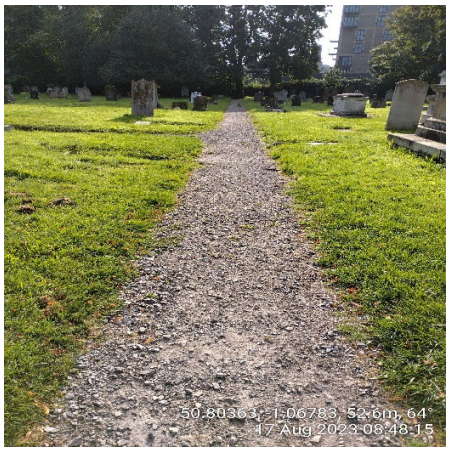
Transitioning to alternatives such as Foamstream, pelargonic acid, and acetic acid necessitates a significant investment in machinery, technology, and staffing levels. While these alternatives may align better with sustainable practices, their successful implementation requires a commitment to training, equipment procurement, and operational adjustments.

In light of these considerations, it's evident that the decision to shift from glyphosate to alternative methods requires a delicate balance between environmental stewardship and economic feasibility.



Pathway showing effectiveness of Glyphosate.

Pelargonic and Acetic acid showing grass growing back over the verge.



Hot Foam showing grass growing back over verge.

Photos comparing one Glyphosate application versus Hot Foam, Pelargonic an Acetic acids on path edges.