



AGENDA
BIRMINGHAM ENVIRONMENTAL SUSTAINABILITY COMMITTEE
MONDAY, AUGUST 25, 2025
BIRMINGHAM CITY HALL, 151 MARTIN ST, ROOM 202-203, BIRMINGHAM MI *
******* 5:30 PM*******

- 1) **Call to Order**
 - 2) **Roll Call**
 - 3) **Review the Minutes**
 - A. **Minutes, 6/23/2025**
 - 4) **Review of the Agenda**
 - 5) **New Business**
 - A. **Community Engagement Plan – Final Review**
 - B. **GPLE & Leafblowers – Study Session**
 - C. **Sustainability Fee – Study Session**
 - D. **Single-Family Stormwater Management – Study Session**
 - 6) **Miscellaneous Communications**
 - 7) **Open to the Public for Items Not on the Agenda**
 - 8) **Adjournment**
-

*Please note that board meetings will be conducted in person once again. Members of the public can attend in person at Birmingham City Hall, 151 Martin St., or may attend virtually at:

Link to Access Virtual Meeting: <https://bhamgov-org.zoom.us/j/84305107066>

Telephone Meeting Access: 833 928 4608 US Toll-free

Meeting ID Code: 843 0510 7066

Notice: Individuals requiring accommodations, such as interpreter services for effective participation in this meeting should contact the City Clerk's Office at [\(248\) 530-3405](tel:2485303405) at least on day in advance of the public meeting.

Las personas que requieren alojamiento, tales como servicios de interpretación, la participación efectiva en esta reunión deben ponerse en contacto con la Oficina del Secretario Municipal al [\(248\) 530-3405](tel:2485303405) por lo menos el día antes de la reunión pública. (Title VI of the Civil Rights Act of 1964).

A PERSON DESIGNATED WITH THE AUTHORITY TO MAKE DECISIONS MUST BE PRESENT AT THE MEETING.

City of Birmingham
Regular Meeting of the Environmental Sustainability Committee
June 23, 2025
Rooms 202-203
151 Martin Street, Birmingham, Michigan

Minutes of the regular meeting of the City of Birmingham Environmental Sustainability Committee held on June 23, 2025. The meeting convened at 5:30 p.m.

1) Roll Call

Present: Harvey Bell, Debra Horner, Joe Mercurio, Jess Newman, Sara Rubino, Trenton Chapman; Student Representatives Penelope Graves, Abhishek Thota

Absent: Lara Edwards

Staff: City Planner Aldred-Arens; Planning Director Dupuis, Assistant City Manager Fairbairn

2) Review of the Minutes

Motion by Mercurio

Seconded by Bell to approve the minutes from last time.

Motion carried, 6-0

VOICE VOTE

Yeas: Mercurio, Rubino, Chapman, Bell, Newman, Horner

Nays: None

3) Review of the Agenda

4) New Business

A. Leaf Blowers

PD Dupuis presented the item and answered informational questions from the ESC.

ESC members raised the following points during discussion:

- Two-stroke engines produce significantly more pollution than any automobile. The gases and particulates are not good to breathe in. It is also likely that most or all two-stroke engines operate in violation of the noise ordinance.
- A staged phase out, moving from banning two-stroke equipment to all gas-powered equipment, could likely be appropriate.
- Some sample ordinances create exceptions for equipment in instances where no comparable electric replacement exists for a piece of gas-powered equipment. This could be updated as technology improves.
- It may be necessary to grant exceptions for much larger properties, to begin. This could also be re-evaluated in the future.

- Ideas from other sample ordinances included a staged phase out with residential going first and commercial second, and/or allowed gas-powered equipment in an emergency.
- While this matter initially seemed less core to the ESC's mission, learning that gas powered lawn equipment contributes to approximately 5% of the United State's annual emissions clarified that introducing a phase out could have a significant, positive impact.
- The 5% figure is likely higher in a higher-income City where many residents contract out their lawncare. It would be helpful to know how much more significant a figure this may be in Birmingham. ICLEI might be able to assist Birmingham in that process.
- This effort could be productively combined with expediting naturalized landscapes, because it would reduce the need for moving in the first place.

B. Community Engagement Plan

CP Aldred-Arens and PD Dupuis presented the item and answered informational questions from the ESC.

ESC members raised the following points during discussion:

- Engagement was a significant priority for the City's sustainability efforts because no meaningful reduction in greenhouse gas emissions can occur within the City without resident participation.
- Some goals, such as ordinance revisions or certain policy changes, might be achieved without exhaustive community participation. Some goals necessitate community participation for achievement.
- The level of community participation required for each goal should be defined.
- Metrics should include who is being spoken to, what actions are undertaken as a result of those engagements, and what the carbon reduction, reduction in flooding, air quality, or other results of those actions are. These could be measured in part via surveys.
- Metrics should be devised for measuring 'diversity of input'.
- Resident engagement should be emphasized in this plan.
- The City recently gathered data on resident priorities for sustainability. New data should be compared to, and possibly integrated with, the data that is already available.
- These surveys will generally be convenience samples, not random samples.
- Possible 'shifts' in priorities across surveys may be more reflective of different respondents at different times than it may be of shifting priorities.
- The survey responses also may or may not reflect the priorities of the community, since the respondents will be self-selected.
- The ESC should be cautious not to overrepresent change with the survey outcomes.
- Community groups such as Scouting America or high school volunteers would likely be interested in helping serve and engage the community on these projects. The City could collaborate with a class of high school students to implement parts of the plan.
- Sustainable building certification programs would have some metrics that could be integrated into the plan.
- Requiring energy audits prior to the sale of a building might help encourage the reduction of carbon emissions from buildings.
- The SCAP had a list of groups Birmingham will be engaging with on these efforts. Defining what each engagement is expected to deliver would be helpful.

- Hiring a stormwater support specialist to engage the public on this high priority topic would be valuable.
- Targeting goals for different demographic subsets, such as businesses, single family homeowners, or renters, could be useful.
- The spelling of 'stakeholders' needed to be updated.
- Clarifying the difference between 'goals' and 'objectives' would be helpful.

Public Comment

Sam Surnow commented that the LEED certification process could provide some useful example metrics and that a community engagement program would likely lead the community in the right direction.

C. SCAP Gantt Chart

CP Aldred-Arens and PD Dupuis presented the item and answered informational questions from the ESC.

ESC members raised the following points during discussion:

- This is a significant effort.
- Any necessary engagement work should be signified by a different color on the chart for ease of tracking.
- Bringing monthly or regular check-ins to the ESC for ongoing items would be appropriate.
- There was interest lending ESC support towards the creation of the two recommended staff positions.

5) Miscellaneous Communications

A. FloodWise Communities Cohort

B. SOCRRA Recycling Magnet

The ESC briefly discussed the communications, as well as MDOT's Woodward Avenue Corridor Plan.

6) Open to the Public for Items Not on the Agenda

7) Adjournment

No further business being evident, the meeting adjourned at 7:02 p.m.



Summer Aldred-Arens, City Planner



Laura Eichenhorn, City Transcriptionist



MEMORANDUM

Planning Department

DATE: August 25, 2025

TO: Environmental Sustainability Committee

FROM: Summer Aldred-Arens, City Planner

SUBJECT: Community Engagement Plan Final Draft

Attached is the draft Community Engagement Plan developed to support implementation of the Birmingham Green Healthy Climate Plan. This document outlines a structured framework for planning, executing, and evaluating public engagement activities that advance the Plan's goals, including carbon neutrality by 2050 and a 25% reduction in greenhouse gas emissions by 2035.

The engagement strategy emphasizes equity, transparency, and adaptability, and incorporates a variety of methods including in-person outreach, digital tools, printed materials, and regional collaboration. Roles and responsibilities are clearly defined, a phased timeline provides structure, and key performance metrics are included to measure progress and impact.

This is the proposed final draft and is seeking approval of the Committee.

INFORM. LISTEN. INVOLVE. EMPOWER.



Birmingham Green Healthy Climate Plan

Community Engagement Plan





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Introduction



Purpose

The purpose of this document is to provide a comprehensive framework for planning, executing, and monitoring community engagement activities for the Birmingham Green Healthy Climate Plan. The Plan aims to achieve carbon neutrality by 2050 while fostering community ownership and actionable participation to achieve the plan's key targets by 2035. This engagement plan emphasizes meaningful two-way communication, inclusivity, and adaptability to ensure alignment with community needs and priorities.

A core component of this effort is a commitment to environmental justice, prioritizing historically underserved and frontline communities who are most vulnerable to the impacts of climate change. By centering equity in outreach and decision-making, the City seeks to ensure that all residents, regardless of background or neighborhood, have a voice in shaping a healthier and more resilient Birmingham.



Carbon Neutrality Goals

Reduce carbon
emissions by

25%

by 2035

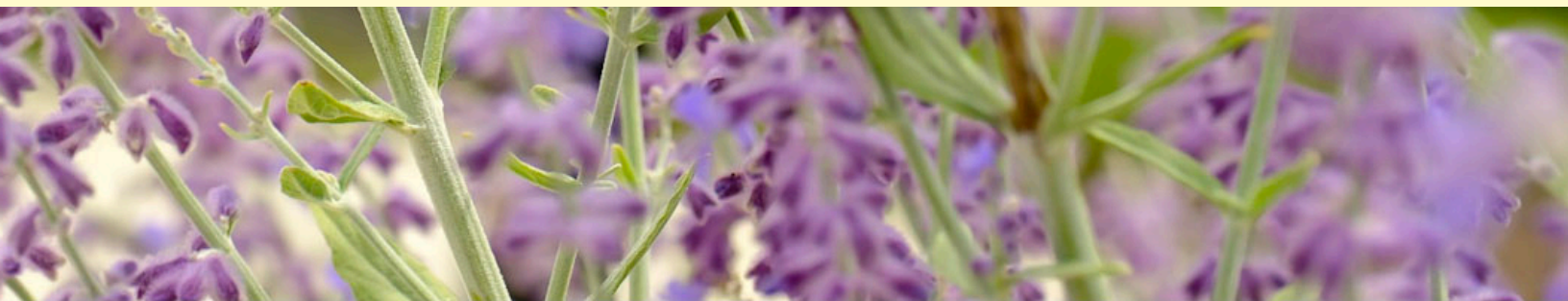
Carbon Neutral
by

2050





Plan Overview



Birmingham Green Plan Overview

The Birmingham Green Healthy Climate Plan is the City of Birmingham's comprehensive roadmap to achieve carbon neutrality by 2050, while improving environmental quality, public health, and long-term community resilience. Adopted in 2024, the Plan outlines targeted strategies across seven key areas: transportation, energy use in buildings and facilities, natural resource protection, water and stormwater management, waste reduction, municipal operations, and quality of life enhancements. It establishes near-term benchmarks, including a 25% reduction in greenhouse gas emissions by 2035, and provides a framework for integrating sustainability into everyday municipal decisions. Grounded in best practices and shaped by regional data and climate modeling, the Plan reflects Birmingham's commitment to responsible stewardship, economic vitality, and a livable, healthy future for all residents.



Birmingham Demographics

Population



21.6 K

Median Age



41.1 years;
gender evenly split (- 50/50)

Race/Ethnicity

83.8% White

Asian 5.1%

3.7% Black or African American

Two or more races 4-6%

Household Income



poverty rate - 5%

Education



-78% hold a Bachelor's degree or higher

Housing



Median home value - \$713K
homeownership - 76%

Citizenship



-10% foreign born; most are naturalized citizens

Commute & Vehicles



Typical commute - 20 minutes;
- 2 cars per household

Engagement Framework



Engagement Objectives

1

INFORM

Share clear, accessible information about the Plan.



2

LISTEN

Seek input on priorities, concerns, and proposed solutions.

3

INVOLVE

Actively involve stakeholders in decision-making processes.

4

EMPOWER

Enable community members to be involved and take on leadership in climate initiatives.

Stakeholders

- Residents
- Local Businesses
- Community Organizations: Nonprofits, schools, and advocacy groups.
- Youth and Seniors: Ensuring engagement across age demographics.
- Underserved Communities: Including low-income households and individuals with disabilities





Engagement Approach



Proposed Engagement Strategies



To ensure inclusive, transparent, and effective community participation throughout the implementation of the Birmingham Green Healthy Climate Plan, we identified a range of engagement approaches designed to meet residents where they are—both physically and digitally. These strategies emerged from a review of best practices in equitable climate planning, feedback from previous city initiatives, and the unique characteristics of Birmingham’s neighborhoods. Our approach balances in-person events, like public meetings and pop-up engagements, with digital tools such as an interactive website and online workshops to broaden accessibility. We also recognized the importance of printed materials for reaching all age groups and media preferences. Additionally, our commitment to intergovernmental collaboration ensures Birmingham remains a regional leader, with staff regularly engaging with local, state, and national networks such as the Catalyst Leaders Circle and SEMCOG’s Healthy Climate Task Force—bringing back critical updates and aligning our efforts with broader sustainability goals.

1

In-Person Engagement

- Public Meetings and Open Houses: Provide updates, seek input, and share progress.
- Focus Groups: Address specific topics like energy efficiency or public transit.
- Pop-Up Events: Outreach at community hubs like farmers' markets or libraries.

2

Digital Engagement

- Interactive Website: Host resources, surveys, and feedback forms.
- Social Media: Regular updates and event promotions.
- Online Workshops: Virtual participation for broader accessibility.

3

Printed Materials

- Flyers, brochures, posters, stickers, & other materials distributed at key locations.

4

Local/Regional/State/National Participation

- Groups like CLC, Healthy Climate Task Force, FOTR, CLWA etc.
- Bringing important info back to Birmingham residents
- Regional leader
- Recaps

Roles & Responsibilities



Roles & Responsibilities



Successful implementation of the Birmingham Green Healthy Climate Plan requires clearly defined roles and responsibilities across city departments, partner organizations, and community stakeholders. This section outlines who is accountable for advancing key actions, monitoring progress, and ensuring alignment with the plan's overarching goals. By clarifying leadership roles, support functions, and opportunities for collaboration, we aim to foster shared ownership, build internal capacity, and create accountability at every level. Establishing these responsibilities up front also helps streamline coordination, allocate resources effectively, and support long-term success across implementation phases.

Role	Responsibilities
Engagement Team	<ul style="list-style-type: none">• Includes members of city staff, Environmental Sustainability Committee (ESC), and volunteers• Plan and execute engagement activities
City Staff	<ul style="list-style-type: none">• Facilitate communication and promote activities locally.
Community Ambassadors	<ul style="list-style-type: none">• Act as liaisons to the Birmingham community, including historically underrepresented groups (youth/seniors)
Stakeholders	<ul style="list-style-type: none">• Provide feedback and advocate for community priorities.



Engagement Methods



Engagement Methods



To support meaningful and ongoing participation throughout the implementation of the Birmingham Green Healthy Climate Plan, we are deploying a variety of engagement methods tailored to inform, involve, and empower community members. These tools and techniques are designed to ensure transparency, track progress, and facilitate two-way communication. From interactive surveys and focused workshops to accessible materials and digital content, our methods aim to engage a broad cross-section of residents. Regular monitoring and reporting—through quarterly updates, newsletters, and presentations to the Environmental Sustainability Committee and City Commission—will ensure that public input remains central to the plan’s evolution and that progress is communicated clearly at every stage.

Tools & Techniques

Progress Tracker	Surveys & Polls	Workshops and Panels
Live look on progress of action items	Collect quantitative and qualitative input.	Deep-dive discussions on Plan elements

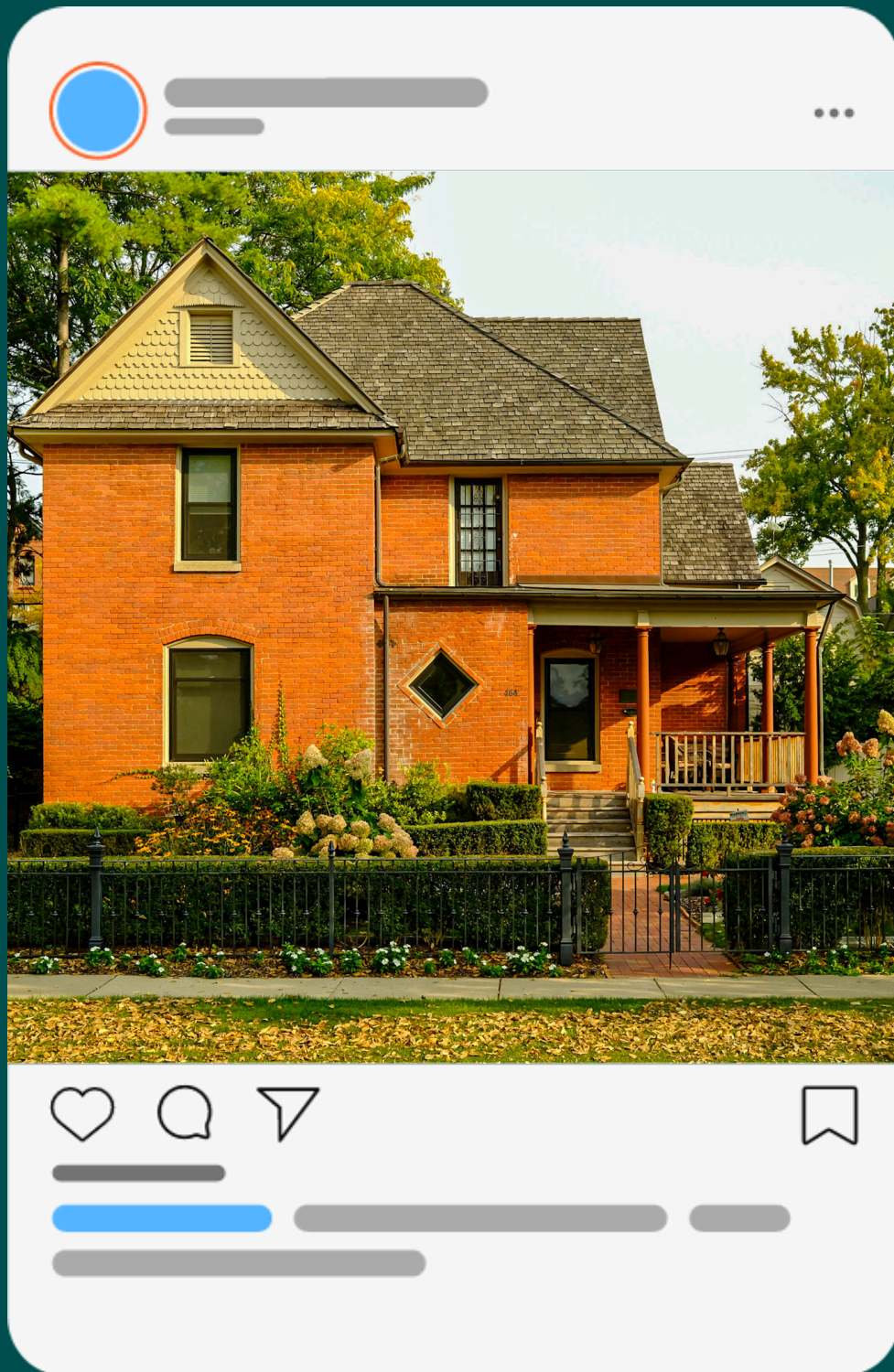
Materials

Hard-Copy Information	Social Media	Online Reports
ADA-compliant flyers and presentations.	Social media graphics and content.	Reports summarizing feedback and next steps.

Monitoring and Reporting

Progress Updates	Outcomes	Reports
Publish quarterly progress updates.	Share engagement outcomes through newsletters and online portals.	Reports to ESC & annual report to City Commission.

Social Media Examples



Instagram Post Example

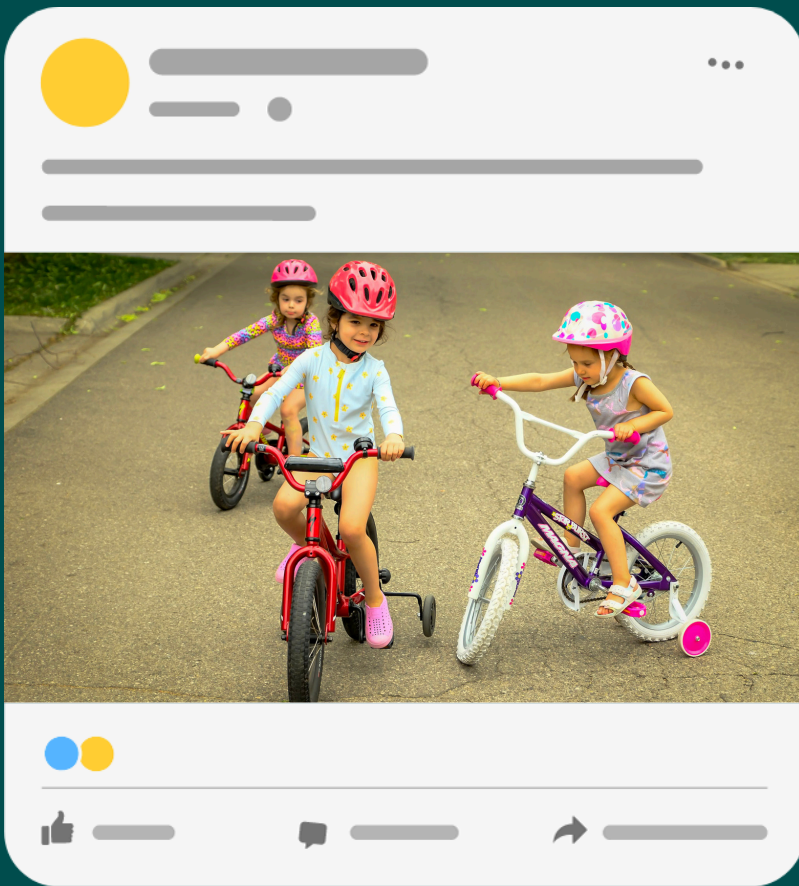
Did you know? Buildings account for nearly 40% of energy use in the U.S. 💡

In Birmingham, small changes in your home can make a big impact – like switching to LED bulbs, sealing drafty windows, or setting your thermostat just 2° lower in winter.

Together, we can make Birmingham greener, one action at a time!

Follow us for more simple sustainability tips you can use every day.

#GreenHealthyClimate
#BirminghamMI
#SustainableLiving
#EnergySmart



Social Media Examples

Facebook Post Example:

What Does Sustainability Mean for Birmingham?

Sustainability isn't just about recycling or turning off lights – it's about making thoughtful choices that protect our environment and improve the quality of life for current and future generations.

In Birmingham, that means:

- Expanding clean energy use
- Supporting walkable neighborhoods
- Promoting bike-friendly infrastructure
- Protecting our trees and green spaces

We're building a future that balances environmental health, economic opportunity, and community well-being. Want to learn more about our Green Healthy Climate Plan and how you can get involved? Visit [insert link]!

#BirminghamMI #SustainabilityMatters #GreenHealthyClimate
#ThinkGloballyActLocally #CommunityDrivenClimateAction



Metrics for Success



Metrics for Success



To ensure the Birmingham Green Healthy Climate Plan delivers meaningful results and remains accountable to the community, we have established a clear set of success metrics. These metrics will help us track progress, assess the effectiveness of our engagement strategies, and adjust our approach as needed. Centered on inclusivity, participation, and community empowerment, these benchmarks reflect our commitment to not only advancing sustainability goals, but also doing so in a way that is equitable and transparent. From tracking how many households we reach to measuring whether participants feel heard, each metric is designed to keep the plan grounded in real, measurable community impact.

Metric	Target
Participation	<ul style="list-style-type: none">Engage 30% of Birmingham households & 50% of businesses by Year 3.
Diversity of Input	<ul style="list-style-type: none">Track participation rates in wherever feasible by race, ethnicity, age, gender, income level, and neighborhood to ensure proportional representation of Birmingham’s demographic makeup.Compare demographic breakdown of participants to U.S. Census data for Birmingham to identify and address underrepresented groups in outreach and engagement efforts.
Community-Led Initiatives	<ul style="list-style-type: none">Launch 10 community-driven projects by 2029.
Sustained Engagement	<ul style="list-style-type: none">Aim to have participants who take part in multiple engagement activities over the course of the plan’s implementation.



Timeline and Milestones



Timeline and Milestones



The successful rollout of the Birmingham Green Healthy Climate Plan requires a structured, phased approach to ensure steady progress, community alignment, and the ability to adapt over time. This timeline outlines key milestones from initial preparation through implementation and ongoing refinement. Each phase builds on the last, starting with internal planning, followed by broad public outreach, launching initiatives, and evaluating outcomes. By clearly defining these stages, we aim to provide transparency, manage expectations, and create space for continuous community input and improvement. This cycle will repeat as new goals emerge and as Birmingham’s climate priorities evolve in alignment with our Plan. This phased approach will also serve as the standard procedure for each new action item that involves community engagement, ensuring consistency, responsiveness, and accountability throughout implementation.

Phase	Activity	Timeline
Participation	<ul style="list-style-type: none">Stakeholder mapping, resource allocation.	0-6 Months
Diversity of Input	<ul style="list-style-type: none">Public meetings, surveys, and focus groups.	6-12 Months
Community-Led Initiatives, if applicable	<ul style="list-style-type: none">Launch pilot community initiatives and track engagement.	12-16 Months
Satisfaction Rate	<ul style="list-style-type: none">Evaluate outcomes and refine strategies.	12+ Months

Action Items that Require All Phases of Engagement



- WS-4 Form new alliances and improve existing alliances with municipalities and organizations that address stormwater runoff to the Rouge River
- WS-7 Reduce indoor & outdoor potable water usage city-wide
- WS-9 Reduce barriers to local stormwater credit programs
- WS-10 Engage with the Clinton River Watershed Council and become a designated WaterTown.
- NR-2 Promote the transition of private gardens and landscapes to native species and remove any barriers to such.
- NR-6 Prioritize the health of the Rouge River corridor and follow and support the recommendations of the Birmingham Plan 2040 related to the Rouge River.
- QL-2 Permit community gardens in select parks and public open space.
- QL-3 Include educational opportunities in sustainability and climate action projects that are accessible to everyone.
- QL-7 Remove barriers to food production in residential zones and on residential properties.
- QL-8 Develop a green business certification program alongside the Birmingham Shopping District.
- BF-1 Develop a plan to incentivize or require the transition from natural gas to electric in residential renovation and construction.
- BF-2 Promote state and local energy efficiency programs and encourage homes and businesses to complete home energy audits and upgrades.
- BF-8 Study the feasibility and placement of a community solar facility.
- W-1 Develop a city-wide food waste composting program.
- W-3 Promote source reduction for waste to increase the practice of reducing or eliminating waste before it's created with a focus on plastics and food.
- W-4 Create a deconstruction ordinance to encourage the reuse and repurposing of building material during construction projects.
- W-5 Increase and improve quality of recyclables in curbside carts through direct education campaigns and audits.
- W-10 Engage with Oakland County on its Part 115 Solid Waste Management Plan.
- T-2 Update the City's multi-modal plan.
- T-4 Advocate for more frequent and reliable transit service.
- T-7 Advocate for a Woodward Avenue road diet.
- MO-9 Provide recycling opportunities in all public parks and other public spaces

Conclusion



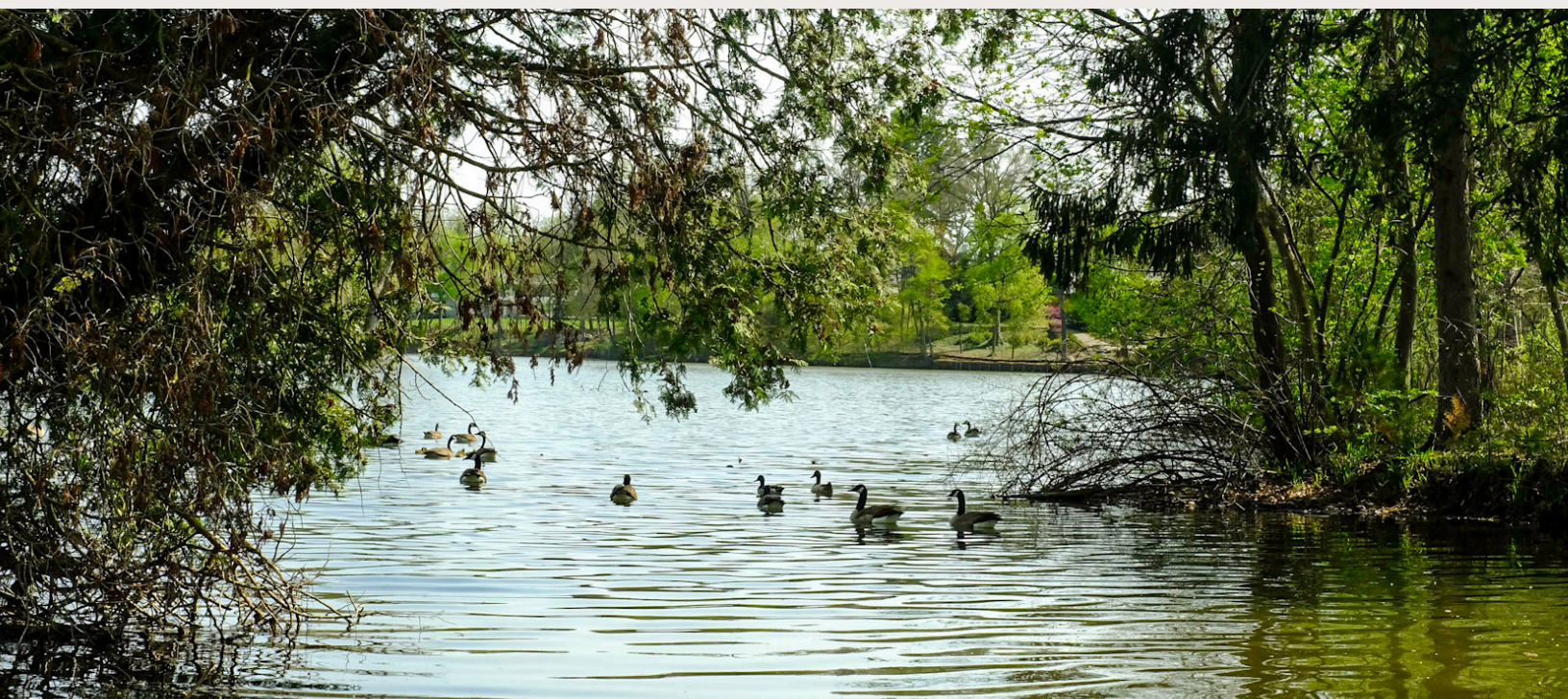
Conclusion



The Birmingham Green Healthy Climate Plan's Community Engagement Plan provides a clear, strategic roadmap for fostering inclusive, transparent, and sustained participation as the city works toward carbon neutrality by 2050. Grounded in the principles of equity and collaboration, the plan outlines engagement goals to build trust, seek diverse input, and translate community feedback into actionable policy.

This document details a multi-faceted engagement framework that includes in-person, digital, and print strategies tailored to reach a wide range of audiences—residents, youth, seniors, businesses, and community organizations. Roles and responsibilities are clearly defined to ensure accountability, with city officials, community ambassadors, and stakeholders each playing a vital part. Engagement tools such as progress trackers, surveys, and accessible materials are supported by a monitoring and reporting structure to maintain transparency and responsiveness.

Success will be measured through defined metrics, including participation rates, diversity of input, and community-led initiatives, while a phased timeline ensures structured, adaptable implementation. Ultimately, this engagement plan empowers residents to be active participants in shaping Birmingham's climate future, reinforcing that a resilient and sustainable city must be built with its community at the center.





Thank
you!

BIRMINGHAM





MEMORANDUM

Planning Department

DATE: August 25, 2025

TO: Environmental Sustainability Committee Members

FROM: Nicholas Dupuis, Planning Director

SUBJECT: Leaf Blowers and Gas Powered Lawn Equipment

On May 19, 2025 ([Agenda](#) – [Minutes](#)), the Planning Department presented an overview of the leaf blower issue and a history of actions taken at the City, which up to that point has exclusively been at the City Commission level. The City Commission eventually directed City Staff to bring this issue to the newly minted Environmental Sustainability Committee to engage in a more thorough and specialized review of the issue and eventually bring a proposal forward to the City Commission. Ultimately, the Environmental Sustainability Committee (ESC) requested that the sustainability team spend some time reviewing and discussing the positives and negatives of all gas powered lawn equipment (GPLE) to ensure that any recommendations that are provided to the City Commission may be thoroughly vetted and representative of the climate goals of the City.

On June 23, 2025 ([Agenda](#)), the ESC reviewed information from many different resources on the broader issue of GPLE as it relates to the broader sustainability and climate change implications of the tools, but also within the framework of what was directed by the City Commission. At this meeting, the ESC provided helpful general feedback and guidance for staff to work into the policy proposal. At the time, the ESC was amenable to begin reviewing some draft ordinance language, but also requested some other studies related to the carbon emissions aspect of GPLE and how we can quantify the carbon emissions of GPLE in Birmingham.

At this time, the Planning Department has started by developing the attached draft ordinance language regulating all GPLE based on the feedback received from the ESC. It is important to note that this ordinance language is starting as a broad approach, applying to all GPLE. Also important to note, this project is intended to be a phase-out, and potentially a multi-stage phase-out, the timing or scale of which is yet to be determined. In reviewing the attached language, the Planning Department encourages the ESC, as well as anyone else reviewing the language, to keep in mind the following, which are based on the common themes that can be extracted from research on GPLE:

- *Two-stroke engines are the worst offenders in terms of emissions.*
 - Some common GPLE tools that use 2-stroke motors are chainsaws, leaf blowers, string trimmers, and some older lawn mowers. As noted in previous reports, the main difference that puts two-stroke engines into this troublesome domain is because two-stroke engines complete the combustion and exhaust cycle in two strokes of the piston, while four-stroke engines complete the cycle in four. As we understand it, this basic design has a large impact on efficiency, which is where the principal emissions problem arises. In a two-stroke engine, not all of the fuel (which includes oil) is burned in the process, which means that the engine is emitting both burned fuel and unburned fuel into the atmosphere. These carbon dioxide and hydrocarbon-based emissions have direct impacts on climate change and public health.
- *GPLE is responsible for a significant amount of carbon emissions in the United States annually, most sources say around 5% (24%–45% of all non-road gasoline emissions).*
 - At some point in this process, the Planning Department intends to attempt to extrapolate these figures into a Birmingham context.
- *Electric powered lawn equipment is a clear solution, and although the initial costs are higher, the lifetime costs are generally less expensive.*
 - It is important to consider this issue in a homeowner/resident context, but also in the commercial context when replacing entire fleets of equipment and the cost that would come with that. For the purposes of this project, we would consider the municipal and commercial fleet as similar and equal in terms of challenge.
- *The emissions issue is directly tied to a lack of emission standards, such as those that are commonplace in passenger vehicles.*
 - Emissions standards are completely out of the control of local government, so there are really no approaches involving emissions that are realistic in this context.
- *An alternate target related to this issue is the existence and/or over maintenance of turf grass lawns.*
 - As is true in many other instances, ordinances work best when developed with consideration to other ordinances, policies, or best practices. The Birmingham Green: Healthy Climate Plan contains recommendations towards this specific purpose, and new ordinances could be developed or amended alongside the specific GPLE ordinance to ensure that they are consistent both in language and purpose. Other ordinances include (but are not limited to) [Noise](#), [Grass and Noxious Weeds](#), or [Special Treatments](#).
- The approach to eliminating the use of GPLE is dependent on the scale (i.e. whole states or regions) and economics.

- A common refrain we receive when discussing this issue in the public realm is the fear that these proposed regulations will cause landscaping companies to flee to other communities to do business due to the high costs of replacing GPLE with electric. To that end, the Planning Department is reviewing the potential to collaborate with other communities along the Woodward Corridor to promote a more regional approach to this proposal, which is intended to reduce or eliminate these concerns.

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AN ORDINANCE TO AMEND PART II OF THE CITY CODE, CHAPTER 50. – ENVIRONMENT, TO ADD ARTICLE V. – GAS POWERED LAWN EQUIPMENT.

THE CITY OF BIRMINGHAM ORDAINS:

The City Code, Part II, Chapter 50. – Environment, Article V. – Gas Powered Lawn Equipment:

ARTICLE V. – GAS POWERED LAWN EQUIPMENT

Sec. 50-211. – Purpose.

The purpose of this chapter is to protect the peace, health, safety, and welfare of persons in the City of Birmingham and to promote the City's sustainability goals by reducing noise, pollution, and other negative effects from Gas Powered Lawn Equipment.

Sec. 50-212. – Definitions.

The following words, terms and phrases, when used in this division, shall have the meanings ascribed to them in this section, except where the context clearly indicates a different meaning:

Gas powered lawn equipment means powered by an internal combustion engine, including gasoline, kerosene, diesel, propane, or other volatile fuel including but not limited to leaf blowers, string trimmers, lawnmowers, hedge trimmers and chainsaws. It does not include snow blowers

Leaf Blower means a powered portable, handheld, or backpack vacuum or blower used outdoors for the purpose of blowing or vacuuming light materials, such as dust, dirt, leaves, grass or plant clippings, stones, trash, or debris. It does not include snow blowers.

Electric means not Gas-Powered and powered from an electrical outlet or from batteries.

Electric alternative means a commercially available, functionally equivalent lawn or garden tool powered by electricity, including corded or battery-powered devices.

Functionally equivalent means an electric-powered device that is reasonably capable of performing the same task to the same standard of performance as the gas-powered version, under normal working conditions.

Sec. 50-213. Regulation of gas powered lawn equipment.

- 1) *Seasonal use.* The use of Gas-Powered Lawn Equipment is permitted from October 1 to May 30 annually.
- 2) *Initial phase-out.* Effective July 1, 2028 it shall be unlawful for any person to operate or authorize the operation of, permit, or direct another who engages in the operation of any gasoline powered leaf blower within the City limits.

- 3) *Final phase-out.* Effective July 1, 2030 it shall be unlawful for any person to operate or authorize the operation of, permit, or direct another who engages in the operation of any Gas Powered Lawn Equipment within the City limits.

Sec. 50-214. – General Exemptions

The following activities are exempted from the limitations of this division:

- 1) Emergency work necessary to restore property to a safe condition following a fire, accident or natural disaster, to restore public utilities or to protect persons or property from imminent danger.
- 2) Gas powered lawn equipment may be operated at any time within the City Limits if:
 - a. The landscape being serviced is of an area of 0.5 acres or greater.
 - b. Available electric alternatives are not reasonably capable of performing the required task due to limitations in power, battery life, or availability for specialized functions.

Sec. 50-215. – Regulation of leaf blowers generally.

- 1) *Blowing off-property prohibited.* It is prohibited to blow or sweep debris, trash, leaves, plant clippings, or yard waste into a neighboring property, street, sidewalk, drain, or public right-of-way.
- 2) *Noise.* The operation of leaf blowers shall comply with the noise limits set by Chapter 50, Article II, Division 4 of this ordinance.
- 3) *Operation.* The operation of leaf blowers shall be in a manner that is safe, courteous and responsible.

Sec. 50-216. – Penalties.

Violations of this article shall be punishable under section 1-9. Each day on which a violation of this article exists shall be deemed to constitute a separate offense.

Ordained this _____ day of _____, 2025. Effective upon publication.

Therese Longe, Mayor

Alexandria D. Bingham, City Clerk

I, Alexandria D. Bingham, City Clerk of the City of Birmingham, do hereby certify that the foregoing ordinance was passed by the Commission of the City of Birmingham, Michigan at a regular meeting held _____, 2025 and that a summary was published _____, 2024.

Alexandria D. Bingham, City Clerk

DRAFT



MEMORANDUM

Planning Department

DATE: August 25, 2025

TO: Environmental Sustainability Committee

FROM: Nicholas Dupuis, Planning Director

SUBJECT: Sustainability Fee

As the City continues to move towards its ambitious sustainability and climate action goals, the Planning Department has long recognized the need for consistent and robust funding to ensure that projects can be completed in the appropriate time frame, and that the full breadth of the [Birmingham Green: Healthy Climate Plan](#) can be explored without the need to depend on General Fund resources in a tight municipal budget.

To that end, the Planning Department is exploring a revenue generating system based on the concept of a “congestion fee” or “congestion pricing.” The Natural Resources Defense Council describes congestion pricing as “fees charged for driving on busy city roads reduce greenhouse gas emissions and improve air quality while also generating sorely needed funding for the transit systems that many people rely on for their daily commutes.” Birmingham’s approach would be similar in that the target of such a fee would be reducing carbon emissions and improving air quality, and as a consequence, incentivize other modes of transportation. This fee would be attached to parking transactions, which is where the connection is made between the fee and carbon reductions – vehicles.

To help define the issue, Downtown Birmingham has 5 parking structures (3,579 parking spaces), 3 metered municipal surface parking facilities (224 parking spaces) and 1,042 metered street parking spaces. In total, there are 4,845 publicly owned parking spaces in Downtown Birmingham. In 2023, the Birmingham Shopping District developed a retail market profile that suggested that Downtown Birmingham has a 500,000-person consumer trade area over an area of 154 square miles, received 7 million visitors, and had 59 events with 300,000+ attendees. This demonstrates not only the success of Birmingham’s Downtown, but also presents a unique opportunity.

The Planning Department first introduced the concept of a sustainability fee on January 25, 2025 ([Agenda](#) – [Minutes](#)) during the Long Range Planning meeting at the City Commission. Before bringing the idea to the City Commission, the Planning Department consulted the City Manager,

City Attorney, Parking Manager, and Finance Director to ensure that there was general support for such a tool, and that it was a viable approach. Ultimately, the concept was well received and the City Commission suggested that the Planning Department continue to do its diligence on the back-end financial processes, as well as a thorough review of the legality of a sustainability fee.

On February 10, 2025 ([Agenda](#) – [Minutes](#)), the City Commission moved to create a Sustainability and Climate Action Special Revenue Fund to house funds dedicated towards sustainability and climate action projects. In addition to creating the fund, the City Commission generously provided \$10,000 of seed funding to jumpstart the balance. The creation of this new fund allows the City to provide a municipal funding source available for specific sustainability and climate action projects, and at the same time provide a dedicated special revenue fund that will be able to accommodate any potential future revenues. This fund and any expenditures therein will be monitored closely by the City Commission, City Manager and Planning Director and it is expected that all expenditures should work directly towards meeting the goals of the Birmingham Green: Healthy Climate Plan or other sustainability and climate action projects deemed appropriate by the City Commission.

On March 24, 2025 ([Agenda](#)), the Planning Department provided the Long Range Planning report, as well as the Sustainability and Climate Action Special Revenue Fund report to the Environmental Sustainability Committee (ESC) as Miscellaneous Communications. The ESC provided high-level feedback and the Planning Department outlined general next-steps in the approval process for such a proposal.

At this time, the Planning Department has begun the formal process of instituting a sustainability fee that, as noted above, will be attached to all parking transactions in the City. As understood by the Planning Department, there are four main transaction types that may be leveraged for this fee:

1. Transient Structure or Surface Lot Parking

- These are the typical, daily transactions that come from a variety of different types of parkers. The rates for these vary based on the length of stay and a daily maximum charge. Important to note, Birmingham offers two hours of free parking in all of its parking structures. The only surface lot that experiences daily transient parking charged upon entry is Parking Lot 5, which is located behind the N. Old Woodward parking structure.

2. Monthly Structure or Surface Lot Parking

- Any person, business, or other entity can purchase monthly parking passes to be used freely over the course of a month. Monthly pass users are charged month-to-month, and are given a card to use upon entry and exit from the facilities. Each structure has a different rate based on demand. Monthly parking is limited to one structure, and cannot be used at other structures. Similar to transient parkers, the only surface lot that is available for monthly parking is Parking Lot 5, which is located behind the N. Old Woodward parking structure. Finally, it should be noted that there are a limited number of monthly parking passes issued for each structure, and some structures have significant wait lists.

3. Metered Street or Surface Lot Parking

- Metered street or surface parking is the most traditional and widely experienced form of parking. In Birmingham, parkers can use coins, credit/debit card, or the Park Mobile app to pay for their parking. Metered parking is tiered, and in some locations it is time limited. Three of the four municipal surface parking lots contain parking meters – Parking Lot 6, Parking Lot 9 and the Shain Park Parking Lot. Important to note, parking meters are limited to Downtown Birmingham only. There are no parking meters in any other area of the City.

4. Validations

- In Downtown Birmingham, a parking validation system is made available to businesses which allows them to validate parking for clients, employees or guests. These businesses are given a unique code that they can provide at their discretion to use when exiting the parking facility. Parking validation is charged monthly and is based on the same fee structure as transient parking.

When evaluating the feasibility of a sustainability fee, the Planning Department utilized parking data from 2024 that was provided by the Parking Manager. At that time, the Planning Department did not have direct data on validations, which in 2024 are reflected in the total transient parking transactions. The following table represents a breakdown of what the City may expect in terms of revenue from the sustainability fee at three different levels. Please note that after speaking with the Parking Manager, the overall implementation strategy should be to include the sustainability fee as a part of a broader rate increase. The preferred option at this time is a \$25 sustainability fee on transient structure parking, \$5 fee on transient metered parking and a \$1 per month sustainability fee on monthly parking, which is what the "Annual Total" column in the following table will reflect. For transient parking, the fee is proportional, both being about 4% of the average cost of a parking session in these areas. **This table is for demonstration purposes only, and is subject to change as the Planning Department refines the approach:**

Transaction Type	Parkers	\$0.05	\$0.10	\$0.25	\$1/Mo.	Annual Total
Transient – Structure	986,049	\$49,303	\$98,605	\$246,513	-	\$246,513
Transient – Metered	1,496,164	\$74,809	\$149,617	\$374,041	-	\$74,809
Monthly	4,652	-	-	-	\$55,824	\$55,824
						\$377,146

As the proposal for a sustainability fee is refined alongside the Parking Manager, Finance Director, City Manager and City Attorney, the Planning Department requests feedback from the ESC on the proposal as it relates to the Birmingham Green: Healthy Climate Plan, as well as the details and rate structures of the proposal. As noted above, these revenues will be captured in the Sustainability and Climate Action Special Revenue Fund, and these revenues are expected to work directly towards meeting the goals of the Birmingham Green: Healthy Climate Plan or other sustainability and climate action projects deemed appropriate by the City Commission.

It is worth noting that the sustainability fee is one of four anticipated methods of financing the City's sustainability and climate action goals. Other methods include grants, philanthropy and redistribution. The expected benefits of this multifaceted approach is that the City may not need to seek a millage or bond proposal to support these goals, and that there will be a consistent fund balance available. More on the various funding mechanisms can be viewed by following the meeting links provided above.

NEXT STEPS

Once feedback is provided by the ESC and the proposal is refined by the Planning Department, the next step is to bring the proposal to the City's Parking Advisory Committee (APC). The role of the APC is to provide guidance to the Birmingham City Commission regarding the Automated Parking System. The APC also provides guidance regarding the revenue generated by parking in the City. In relation to this proposal, the APC has a specific responsibility to provide advisory recommendations to the City Commission as to rate structures for fees for on-street parking meters, parking lot/garages fees, and monthly permit fees.

The final step in the process is to take the proposal for parking rate increases to the City Commission for approval. It is anticipated that the Planning Department will be taking concurring recommendations from both the ESC and the APC for consideration. Ultimately, the Planning Department is targeting a January 5, 2026 adoption date at the City Commission, which will allow for an opportunity for a *minimum* of 3 meetings of the APC and 4 meetings of the ESC to refine the proposal into an approach that is sound and one that all bodies support, including relevant City Departments.

PARKING DEPARTMENT	FEE
<u>Parking Meters</u>	
Hourly Meter Rates	
High Demand (<i>Areas Inside Central Core of Business District</i>)	\$1.50
Lower Demand (<i>Areas Outside Central Core of Business District</i>)	\$1.00
Meter Bags	
Daily Fee	\$18.00
Outdoor Dining Metered Space for Platform	
Monthly Outdoor Dining Meter Rental Fee for \$1.00/Hour Meter	\$360.00
Monthly Outdoor Dining Meter Rental Fee for \$1.50/Hour Meter	\$540.00
Removal of parking meter housing and/or posts - minimum fee (<i>cost</i>)	\$114.00
Removal of parking meter housing and/or posts - 1 meter space (<i>cost</i>)	\$342.00
Removal of parking meter housing and/or posts - 2 meter spaces (<i>cost</i>)	\$570.00
<u>Parking Permits</u>	
Meter Permit Parking (3 Months)	
Lot 6 - Regular	\$210.00
Lot 6 - Economy	\$150.00
Ann St. North	\$180.00
South Old Woodward	\$120.00
Residential Permit Parking (110-136 - 110-150)	
Residential parking permit per household (includes 2 resident and 3 visitor permits for a two-year period)	\$8.00
Parking Structure Permit Parking	
Nonrefundable card fee	\$20.00
Returned checks	\$30.00
Permit Parking - Chester St. Structure per month	\$70.00
Permit Parking - Pierce Structure per month	\$100.00
Permit Parking - All Other City Structures per month	\$90.00
<u>Parking Structure Rates</u>	
Less than 2 hours	free
Less than 3 hours	\$2.00
Less than 4 hours	\$4.00
Less than 5 hours	\$6.00
Less than 6 hours	\$8.00
Over 6 hours	\$10.00
Over 7 hours	\$10.00
Over 8 hours	\$10.00
<u>Parking for Valet Licenses</u>	
Valet Parking in City Owned Structures	
Valet parking card deposit, per card	\$20.00
Fees per car:	
1-100 cars, pre-paying for six months in advance, per month	\$400.00
101-200 cars, pre-paying for six months in advance, per month	\$750.00
201-300 cars, pre-paying for six months in advance, per month	\$1,000.00
301+ and above cars, will settle up based on actual usage every six months	
One-Day Valet Permit application	
Standard Application Fee	\$75.00
Late fees:	
48 business hours before event	\$75.00
24 business hours before event	\$100.00
Valet Parking Meter	
Valet Monthly Bag fee	\$216.00



MEMORANDUM

Planning Department

DATE: August 25, 2025

TO: Environmental Sustainability Committee

FROM: Summer Aldred-Arens, City Planner

SUBJECT: Single-Family Stormwater Management

Background and Purpose

The City of Birmingham recently adopted the Oakland County Water Resources Commissioner's stormwater standards for commercial and multifamily development projects that exceed 0.5 acres. These standards require on-site detention and treatment of stormwater to manage peak flows and reduce pollutant discharges into the municipal system. At present, there are no equivalent requirements for single-family residential construction.

Birmingham is approximately 85% residential. Redevelopment activity in single-family districts often involves tear-downs and rebuilds that typically increase the overall footprint of buildings and associated impervious surfaces such as driveways, patios, and walkways. The increase in impervious coverage reduces natural infiltration, increases stormwater runoff, and conveys pollutants into the Rouge River and its tributaries. As redevelopment continues, the cumulative effect of these changes increases peak flow volumes, contributes to local flooding, and introduces additional pollutants during storm events.

The purpose of introducing single-family stormwater standards is to reduce the burden of unmanaged runoff on Birmingham's stormwater system. By requiring on-site mitigation, the City can lessen the amount of water entering municipal infrastructure, decrease localized flooding risks, and limit pollutant loads reaching the Rouge River and connected water resources. This approach extends existing stormwater requirements beyond commercial sites to address most of the land area within the city.

Single-Family Zoning Standards

All single-family residential zoning districts in Birmingham ([R1 through R3](#)) are subject to the following development standards:

- Minimum Open Space: 40% of the lot must be preserved as open space.
- Maximum Lot Coverage: 30% of the lot may be occupied by buildings and other structures.
- Additional Open Space Standards for Single-Family Residential (R1A – R3): The required 40% minimum open space for all single-family development must consist of a minimum of 75% vegetated open space. Permeable pavers or other semi-hardscape materials are not considered vegetated open space.

Definitions:

- *Open Space* is all area of a lot except the areas occupied by a building, structure or impervious surface, excluding items listed in [4.30\(C\)](#), Projections into Required Open Spaces. See [Open Space, Percent](#).
- *Lot Coverage* is the area of a lot that is covered by buildings and structures divided by the total lot area, excluding those items listed in [4.30\(C\)](#), Projections into Required Open Spaces.
- *Impervious surface* is a surface that restricts the infiltration of water into the ground such as all roofs, streets, sidewalks, driveways, parking lots, pavers, highly compacted soils, artificial turf, and other similar material, but excluding sidewalks 3 feet or less in width located in the front open space.

These zoning provisions regulate building intensity but do not specifically address stormwater infiltration or water-quality treatment. Properties can meet the open space and lot coverage requirements while still increasing impervious surface area that generates additional runoff.

Residential Stormwater Management Approaches

Residential stormwater management in Michigan commonly centers on the “first flush” concept: treating the initial portion of runoff from small, frequent storms because that volume typically conveys the highest concentration of pollutants from impervious surfaces. Several Michigan communities use a 1-inch water-quality volume as a design target; for example, [Grand Rapids](#) requires capture and treatment of the 90% annual non-exceedance storm, which is approximately 1.00 inch in Michigan Climatic Zone 8 per the state’s memorandum on “90 Percent Annual Nonexceedance Storms.” We can also reference [Ann Arbor’s](#) single/two-family standard, which triggers on-site management when a project adds 200 square feet or more of impervious area and sizes the required storage as $\text{New Impervious Area (sq ft)} \times 0.08 = \text{Storage (cu ft)}$. Together, these examples illustrate a clear, administrable path for lot-scale controls aligned with Michigan practice.

While there are limited examples of single-family management in Michigan, there are several other examples across the country, that include:

- [Fairfax County, VA](#) – Land disturbance greater than or equal to 2,500 sq ft requires stormwater management.
- [Rockville, MD](#) – Required at 5,000 sq ft disturbed or $\geq 2,000$ sq ft impervious.
- [King County, WA](#) (see pg 31.) - Single-family projects with $\geq 2,000$ sq ft new+replaced impervious or $\geq 7,000$ sq ft disturbance must provide stormwater controls.

A range of on-site best management practices (BMPs) is available for single-family parcels. Rain gardens or bioretention cells are shallow vegetated depressions that temporarily store and infiltrate roof and driveway runoff; EPA's residential guidance describes siting, sizing, and maintenance considerations suitable for homeowner implementation. Permeable pavements, including pervious concrete, porous asphalt, and permeable interlocking pavers, store and infiltrate rainfall where it lands, reducing surface discharge and providing subsurface treatment through aggregate layers. Infiltration trenches, which are gravel-filled subsurface beds, provide storage and exfiltration to surrounding soils; long-standing design manuals note the importance of pretreatment and soil permeability assessment to avoid clogging and ensure performance.

Other measures emphasize storage and evapotranspiration or controlled reuse. Rain barrels and cisterns capture rooftop runoff for delayed release or non-potable uses such as irrigation. Green roofs add growing media and vegetation to roof surfaces and have been shown in peer-reviewed literature to retain on the order of 50 to 75 percent of annual precipitation, releasing water slowly via evapotranspiration and thereby reducing peak discharge to storm conveyances. These measures can be deployed at the individual-parcel scale and combined with infiltration practices as site conditions allow.

Vegetation-based systems are also used in constrained urban settings. Tree-based stormwater systems, such as tree box filters and engineered soil cells, provide distributed interception, storage within soil media, and pollutant reduction, and federal guidance outlines siting, sizing, hydraulic components, and maintenance for these facilities in streetscape contexts. Such practices complement lot-level controls, particularly where setbacks and yard space limit conventional infiltration features.

At a watershed planning scale, Michigan guidance and local standards often reference designing systems to manage the majority of runoff-producing storms over a typical year, such as the 90th-percentile event, while parcel-scale programs like Ann Arbor's worksheet method translate that policy into a practical calculation homeowners can apply with permit submittals. This tiered approach (site-scale first-flush capture supported by broader programmatic or regional objectives) provides a consistent framework for aligning single-family requirements with existing Michigan practice.

Proposed Application in Birmingham

City staff is exploring new stormwater management requirements that would apply to all new single-family residential construction within the City of Birmingham. This would include both teardown and rebuild projects as well as newly constructed homes on previously undeveloped parcels. In addition, any new impervious surface added to an existing lot, such as driveway expansions, patios, or building additions, would be required to incorporate an on-site stormwater management strategy that is scaled to the increase in impervious area.

The intent of these requirements is to ensure that single-family parcels contribute to the same citywide stormwater goals that already apply to commercial development under Oakland County standards. By requiring on-site mitigation at the residential scale, Birmingham can reduce peak flows into the municipal stormwater system, limit pollutant loading into the Rouge River and other tributaries, and improve resilience to localized flooding. These efforts also directly advance the

goals outlined in the Birmingham Green Healthy Climate Plan (the "Plan"), which calls for reducing environmental impacts from stormwater runoff, improving water quality, and increasing community resilience to climate change. This project would tackle **WS-8**, *require stormwater retention or infiltration on all new-single family construction*. Page 74 of the Plan identifies impervious surface as a critical contributor to runoff and pollutant loading, underscoring the importance of reducing and mitigating these impacts through site-level management.

At this stage, staff is not proposing a specific method of compliance but is instead seeking to establish the principle that stormwater restrictions should apply to all new single-family construction and any expansion of impervious surfaces. The details of how these requirements will be met, reviewed, and enforced will be determined in consultation with the Environmental Sustainability Committee, City Staff, and other relevant boards and commissions.

Feedback from the Committee is requested on several key points:

- The scope of projects to which the requirements should apply, including all new single-family construction and all increases in impervious surface.
- The calculation method and sizing standard that should be adopted, such as a one-inch first flush volume or equivalent.
- The types of best management practices that should be explicitly included or incentivized.

Feedback from the Committee will inform the drafting of ordinance language and supporting guidance materials for subsequent review by the Planning Board and the City Commission.

Water & Stormwater

Increase capacity for the infiltration or capture of an additional 500,000 gallons of stormwater per rain event by 2035.

Increase capacity for the infiltration or capture of an additional 500,000 gallons of stormwater per rain event by 2035.

The City splits across two watersheds – the Rouge River watershed and the Clinton River watershed. Any and all activities that involve the water system in Birmingham, including both natural hydrologic cycles and man-made infrastructure processes, affects these watersheds and the essential potable water we use every day, stormwater runoff, sewage disposal, natural environments and public health. Many of the burdens, nuisance and negative externalities of current water management and treatment activities are borne in other areas of our region. Overall, there are no less than

10 organizations, authorities or levels of government associated with water quality and treatment in Birmingham. In addition, Birmingham, much like other communities in southeast Michigan, relies on a combined sewer system that was not designed for the significant storm events that are becoming more intense and more frequent. Through the actions in this plan, the City intends to build more resilient water systems to reduce flooding and provide opportunities for everyone to have access to sufficient, safe, acceptable, physically accessible, and affordable water.

Why 500,000 Gallons?

Issues relating to water and stormwater are far and away the top concern of Birmingham residents. In order to create a goal that rose to the occasion but was also both realistic and achievable, the City analyzed the average annual precipitation within the City of Birmingham as well as significant storm events on a daily basis for the year of 2023. The average precipitation from 1986-2023 in the City is 30.22 inches. Over the course of a year (factoring in a runoff coefficient of 0.66), that equates to 1,651,658,342 gallons of precipitation entering Birmingham's sewer system annually. However, this cumulative, annual figure does not represent the volume per precipitation event. In order to understand a capacity that can make a difference, the daily data for 1 in. of precipitation and 0.5 in. of precipitation were studied for 2023. Overall, this area experienced precipitation events at 1 in. or greater 7 times, and 0.5 in. 21 times. These storm events send 55,055,278 gallons and 27,527,639 gallons, respectively, into the sewer system per event. For a 1 in. event, an additional 500,000 gallons of infiltration or capture potential could have mitigated 3,500,000 gallons of stormwater (1%). For a 0.5 in. event, 10,500,000 gallons could have been mitigated (2%). Mitigating an additional 6% of precipitation per 1 in. event and 38% of precipitation per 0.5 in. event by 2035 will go a long way to reducing the overall impact of stormwater on the City of Birmingham.



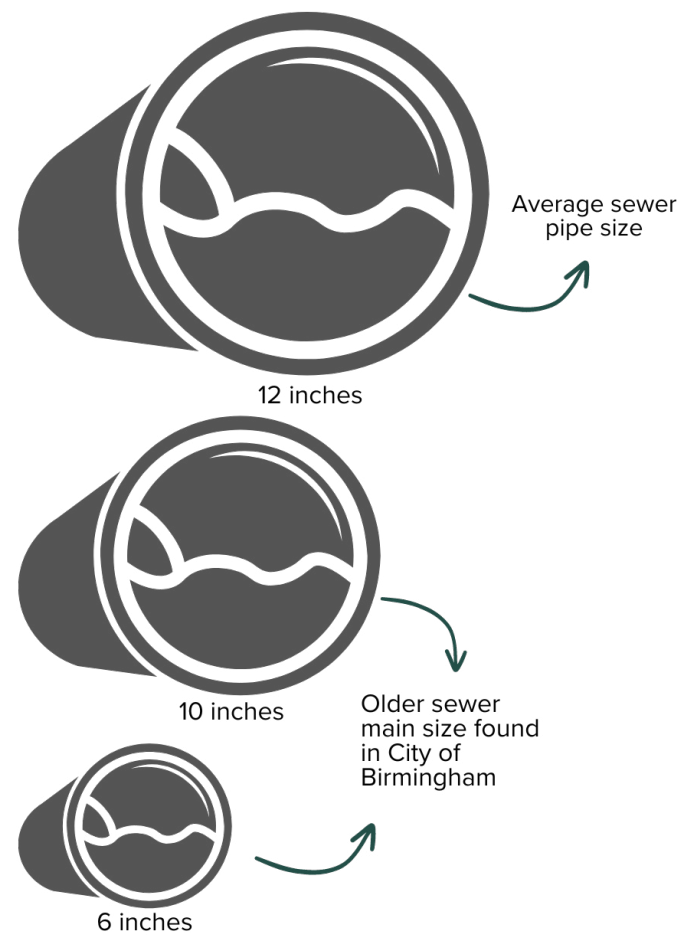
Background Material

As alluded to in previous sections, the problem of urban stormwater runoff is a compounding one. Having developed over a period of over 100 years, the City's infrastructure continues to age, and the frequency and intensity of rain events puts an overwhelming burden on a system that, in many areas of the City, was not designed for it. To get to 500,000 gallons, the Birmingham community will need to coalesce around the concept of decentralizing the responsibility for stormwater management and its related infrastructure away from government and public property alone to all property within the City. Below is an overview of four major issues related to water and stormwater in Birmingham, each crucial to understanding the overall solution.

Grey Infrastructure

The City of Birmingham owns and maintains 693,018 feet of sewer mains. Another 130,220 feet of sewer main within the City is owned and operated by the Michigan Department of Transportation, Road Commission of Oakland County, or other entities. 82% of the tributary area in the City is currently serviced by combined sewer systems in which both wastewater and stormwater flow through the same pipes. **The average diameter of sewer pipes in the City is 12 inches. However, some older sewer mains can be smaller at 10 inches, and in some places 6 inches.**

As the opportunity arises, and where feasible during road reconstruction projects, the City does separate storm and sanitary sewer lines to reduce the burden on infrastructure, but also to reduce the possibility of overwhelming combined sewer systems and discharges into waterbodies such as the Rouge River, which cause a serious hazard. According to the Environmental Protection Agency, combined sewer overflows (CSO's) are a major water pollution and public health concern and can contain bacteria, debris, and other hazardous substances that can be harmful to people, pets, and wildlife.



CSO's can also cause beach closures, shellfish bed closures, algae growth, reduced oxygen levels in waterways, and aesthetic impacts from floating debris or oil slicks.

For those areas that become separated into storm and sanitary, there still exists potential for harmful discharge. These systems do come with oversight through the states Municipal Separate Storm Sewer System (MS4) program, which itself is subject to regulation under the National Pollutant Discharge Elimination System. Birmingham maintains a permit for its MS4 areas that includes requirements for public education, illicit discharge elimination, pollution prevention, post construction stormwater runoff controls, and total maximum daily loads.

Case Study

Consider the 1,291 feet of sewer main along Westchester Way between Midvale St. and Lincoln St. The infrastructure was built in 1927 and has an average diameter of 12 inches. The maximum capacity of this stretch of sewer main is 1,014 cubic feet.

Westchester Way is a 60 ft. right-of way and runs 1,426 ft. in the same footprint. In total, the surface area of the right-of-way in this stretch alone is 85,560 square feet. Just one inch of rainfall over that surface area produces 53,336 gallons, or 7,130 cubic feet of stormwater (USGS Rainfall Calculator). Thus, one inch of rainfall could fill the entire stretch of sewer main 7 times over. For context, the National Weather Service recorded the last significant rain event on August 24, 2023 which produced an average of 1.86 inches of stormwater in Oakland County, which is nearly double that amount.



Impervious Surface

The City of Birmingham is 4.8 square miles. Although considered a suburban community, there are many areas of the City such as Downtown that have a denser urban form. Other than Birmingham's three major commercial areas, the City is comprised of predominantly single family detached housing. In fact, the land area dedicated to single family detached housing is 2.4 square miles, which is exactly half of the property area in the City. The next highest land area is rights-of-way at 1.1 square miles, followed by public property at 0.5 square miles and commercial at 0.3 square miles.

When it comes to impervious surface, there is a considerable difference between the different land areas noted above. Single family residential properties are required to have minimum open space of 40%. Open space is defined as all area of a lot except the areas occupied by a building, structure or impervious surface. Conversely, many of Birmingham's commercial areas are not required to have any open space or impervious area, save a few parking lot landscaping requirements. In terms of public space, rights of way are often unforgiving and expansive impervious areas, sometimes with greenspace on the sides or within a boulevard. The other public portions are predominantly park space.

Considering residential and commercial land areas and the differences in their relative imperviousness, there must be different approaches to stormwater for each. At a high level, if all single family properties maximized their impervious area, it would represent 1.44 square miles

of impervious area, which is greater than all of the commercial and right-of-way area combined. On a standard 40 ft. by 100 ft. lot, it represents 2,880 square feet of impervious surface that has the potential to reach the city's sewer system. Using the example of a 1-inch rain event that was explored above, that translates to nearly 1,800 gallons of water. Alternatively, a significant majority of stormwater runoff on commercial property goes straight into the sewer system without the opportunity to be infiltrated by any required open space. However, there are stormwater detention requirements for commercial properties in the City, which were updated in 2024. Historically, these detention requirements have been met through underground storage as opposed to infiltration or pervious open space.

Although open space is considered pervious, not all open space is made equal in that regard. A 2010 report from the U.S. Geological Survey concluded that turf grass has a lower infiltration rate than native plants or landscapes.¹⁰ Although it can generally be understood that the role of turf grass is not to perform significant infiltration functions, it can be inferred that turf grass can add to the urban stormwater problem, especially when considering the predominant soil composition in Birmingham, which is clay based.

Of particular interest to the City should be addressing the public right-of-way, which consists of predominantly impervious surface (sidewalk, roads, etc.), but also often small greenspaces which are typically turf grass which as noted above do not perform at the same level as other potential options. Existing programs like

Grand Rapids' Vital Streets Program can provide an easy starting point to rethinking how we approach right-of-way projects in the City to include more sustainable options where there is clearly opportunity available.

Green Infrastructure

A solution to the urban stormwater problem that has been growing in popularity over the last 10 or so years is green infrastructure. Green infrastructure reduces and treats stormwater at its source while delivering other environmental, social, and economic benefits. The 2019 United States Water Infrastructure Improvement Act defines green infrastructure as "the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspire stormwater and reduce flows to sewer systems or to surface waters."¹¹

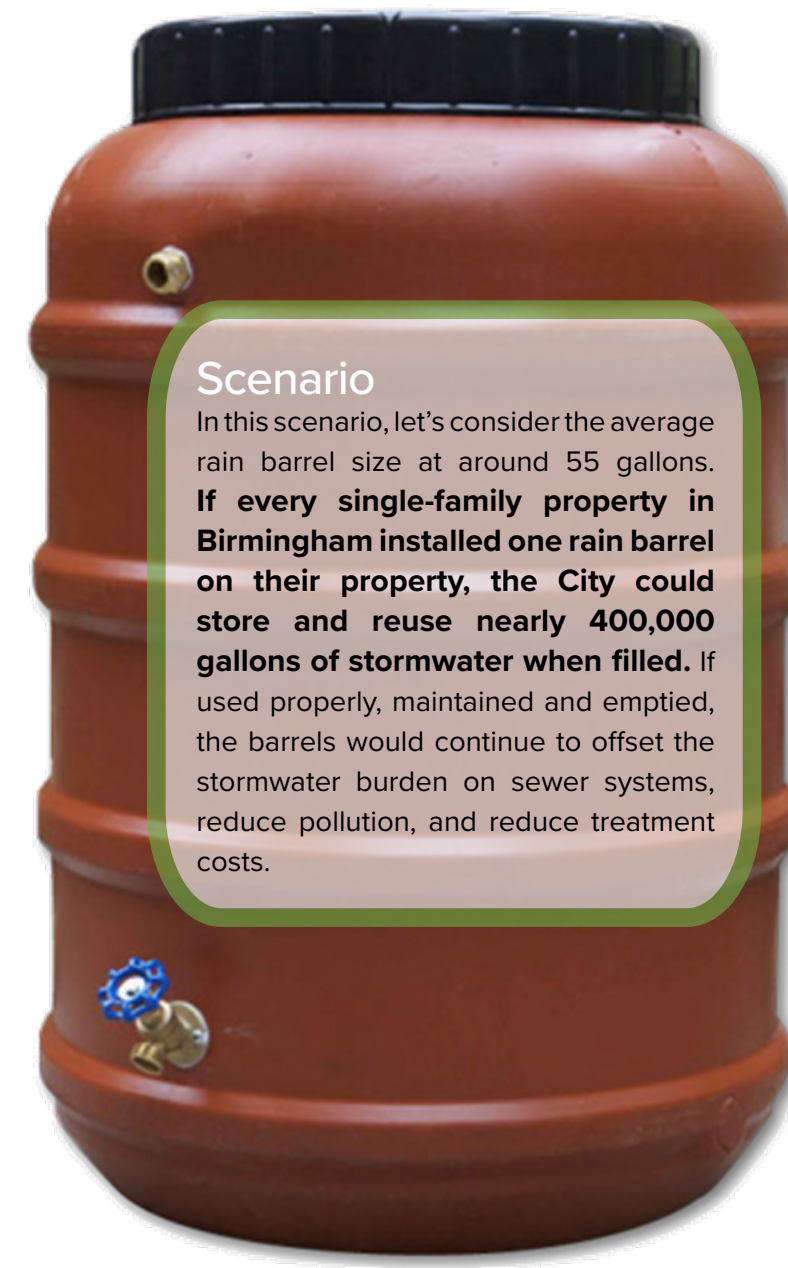
Although a viable part of the solution, it is not a replacement to traditional grey infrastructure, rather a supplement to it. Green infrastructure can come in many forms, including bioswales, green roofs, tree canopy, rain barrels, or permeable pavements. Although each type provides an infrastructure service of its own, part of the benefit of green infrastructure is its flexibility and adaptability to different settings or preferences. In dense urban settings such as Downtown Birmingham, streetscape bioswales, private green roofs, or permeable pavement may be a more viable solution. Alternatively, single family properties may elect to transition some of their open space and enjoy the many benefits of a rain garden or rain barrel, or a combination of the two.

In terms of metrics, the City does not have or collect much data on green infrastructure

to understand the true benefits of existing installations. According to SEMCOG's Southeast Michigan Green Dashboard, green infrastructure network components in the City of Birmingham consist of 1,195 acres of tree canopy coverage (39%), 37.4 acres of wetland, 238 acres of parks and conservation land, and 33 acres of riparian corridors.¹² The Friends of the Rouge hosts a Sustainability Mapper tool that allows residents to report different green infrastructure installations on their properties, which shows several rain garden and rain barrel installations in Birmingham. No data exists for bioswales or rain gardens that have been recently installed in the City's right-of-ways.

Scenario

In this scenario, let's consider the average rain barrel size at around 55 gallons. **If every single-family property in Birmingham installed one rain barrel on their property, the City could store and reuse nearly 400,000 gallons of stormwater when filled.** If used properly, maintained and emptied, the barrels would continue to offset the stormwater burden on sewer systems, reduce pollution, and reduce treatment costs.



Currently, Birmingham offers a Stormwater Utility Credit. These credits are offered to provide the opportunity for all property owners in Birmingham to reduce the amount of storm water that enters the sewer system from their property through green infrastructure. Credit applications require an application and are subject to renewal. Although useful, these credits have not resulted in significant changes in private property, and only one successful application for credits has been processed in 2024.

Potable Water

From 2022 to 2023, the City of Birmingham purchased 913,874 gallons of water from the Great Lakes Water Authority (GLWA), which was an increase in 10% from the previous year. For the 21,738 residents of Birmingham, clean, safe water is an essential part of a healthy and high quality life. The GLWA sources its water from Lake Huron & Great Lakes tributary, and the Detroit River to provide water to 112 communities in southeast

Michigan. Current statistics indicate that the GLWA is pumping 400-500 million gallons of water per day through 816 miles of transmission mains operated and maintained by the GLWA.¹⁴ According to the EPA, the average American family uses 300 gallons of water per day at home, 70% of which is indoors.¹⁵

Considering the vital importance of accessible, reliable clean water, as well as the energy, infrastructure, and capital it takes to manage clean water systems, the Birmingham community should take great strides to avoid wasting such a precious resource, along with the time and money it takes to bring it here. Solutions range from high dollar and high impact projects such as greywater recycling systems to small things like Energy Star rated appliances or regular maintenance of fixtures and plumbing to ensure that no leakages are occurring. According to the Energy & Environmental Building Alliance, greywater recycling for a family of 6 could conserve around 30,000 gallons of water a year.¹⁶

Scenario



Rain gardens are designed to capture and infiltrate all of the stormwater runoff from a certain area of property. Typically, rain gardens are designed to accept flow from downspouts, and thus their size is based on the roof area of a given residential building. The average footprint of buildings on a single family property in Birmingham is 2,208 square feet. To infiltrate the stormwater runoff from this area, the area of rain garden(s) would need to total roughly 450 square feet. In that 2,208 square feet, 1-inch of rainfall amounts to 1,378 gallons. According to the National Weather Service, the Detroit area received 37 inches of rain in 2023.¹³ Thus, over the course of a year, **rain garden(s) collecting the runoff from the roof of the average single-family residential building in Birmingham could have infiltrated up to 51,000 gallons of water in 2023.**

Conclusion

When considering the challenges of reducing reliance and stress on grey infrastructure, reducing the impact of impervious surfaces on stormwater, and maintaining clean and safe water systems, the corresponding action plan provides solutions that range in breadth and approach while remaining tangible and realistic through the 2035 timeframe that was set for this goal. It is also important to set expectations for the stakeholders that will play a role in each solution, while also estimating implementation costs, a general timeframe, and other benefits that may come from successfully achieving this water goal. In addition, it should be understood that there must be an underlying theme of education, promotion and partnerships throughout these actions that may not be mentioned explicitly in this plan, but will be relied upon in its implementation.



Action Plan

WS-1 Study the hydrology and topography of the City and produce recommendations toward targeting stormwater infrastructure improvements in areas that have the largest impact in reducing the negative effects of stormwater.

- Description – Before the City spends significant time and resources installing stormwater infrastructure across the City, the land in and around Birmingham should be studied to understand where there are low points, problem areas, or other issues caused by topography, hydrology, or other contributors to the broader stormwater problem in the City. Ultimately, this study should produce recommendations that may be used when considering locations for new installations when funds become available.
- Stakeholders – Planning Department, Engineering Department, Department of Public Services
- Start-Up Cost – Medium
- Timeframe – Short
- Benefit – Substantial; This action will have major economic and equity benefits based on the results allowing the City to target resources where they will have the most impact.

WS-2 Adopt a residential rain garden program.

- Description – Single family property is the predominant land type in the City of Birmingham while also being one of the only land classifications with required open space, which presents a unique opportunity for residents to provide infrastructure services on private property.
- Stakeholders – Residents, Planning Department, Engineering Department
- Start-Up Cost – Very Low
- Timeframe – Short
- Benefit – Moderate; Increasing the amount of green infrastructure on private property will have economic and equity impacts.

WS-3 Develop a tracking system for green stormwater infrastructure.

- Description – To better understand and quantify the effects of any green stormwater infrastructure installations, the City will need to develop a tracking system with the relevant details of the size and scope of each installation. This tracking system would focus on public installations and private installations where it is feasible to gather data such as stormwater credit applications, rain garden program applications, or commercial installations.
- Stakeholders – Planning Department, Engineering Department
- Start-Up Cost – Very Low
- Timeframe – Short; A new tracking system will not have direct benefits, but will contribute to the broader economic and equity benefits that green stormwater infrastructure presents.
- Benefit – Narrow; A new tracking system will not have direct benefits, but will contribute to the broader economic and equity benefits that green stormwater infrastructure presents.

WS-4 Form new alliances and improve existing alliances with municipalities and organizations that address stormwater runoff to the Rouge River.

- Description – Birmingham is only one of 48 communities within the Rouge River watershed. The activities that take place in Birmingham follow the flow of the Rouge all the way through its delta at the Detroit River. Organizations such as the Alliance of Rouge Communities and the Friends of the Rouge provide an opportunity for Birmingham to engage and to improve the health of the entire river, including the roughly 4 miles of river that runs through Birmingham.
- Stakeholders – Planning Department, Engineering Department, Department of Public Services, City Management
- Start-Up Cost – Very Low
- Timeframe – Medium
- Benefit – Narrow; Forming these alliances will contribute to the broader health of the Rouge River and the economic, equity, and carbon reduction benefits that come with it.

WS-5**Require green infrastructure installations in every public infrastructure and public development project.**

- Description – In order to be a leader in the implementation of green infrastructure practices, the City must practice what it preaches. With 1.1 square miles of public right-of way and 0.5 square miles of public property, there is ample opportunity to build green infrastructure into all construction projects that the City embarks upon, whether it be a road improvement or building.
- Stakeholders – Planning Department, Engineering Department, Department of Public Services, City Management.
- Start-Up Cost – Medium
- Timeframe – Medium
- Benefit – Moderate; Increasing green infrastructure installations on road projects, which are becoming more frequent, will have equity and economic benefits in the reduction of grey infrastructure.

WS-6**Require, through ordinance, green stormwater infrastructure installations on commercial properties.**

- Description – Currently, the City’s Zoning Ordinance does not require green infrastructure in any form on commercial properties. In fact, landscaping in general is only required in rare instances on commercial property. In order to contribute to the goal, the City will need to require commercial properties to install green infrastructure in the form of trees, green roofs, bioswales, rain gardens, or other forms.
- Stakeholders – Planning Department, Property Owners, Engineering Department
- Start-Up Cost – Low
- Timeframe – Medium
- Benefit – Moderate; Introducing greenspace with an infrastructure function on commercial properties will have equity and economic benefits.

Reduce indoor & outdoor potable water usage City-wide.**WS-7**

- Description – Sufficient, safe, acceptable, physically accessible, and affordable water is an essential facet of a healthy community, and is often taken for granted. Efficient and responsible water usage will ensure that Birmingham’s water system, which depends on a larger overall system, can remain resilient and affordable into the future.
- Stakeholders – Engineering Department, City Management, Finance Department, Department of Public Services
- Start-Up Cost – Low
- Timeframe – Medium
- Benefit – Moderate; Based on the cost and growing scarcity of potable water, being more responsible at the tap will have an economic and equity benefit.

Require stormwater retention or infiltration on all new single-family construction.**WS-8**

- Description – The construction of new single-family homes in Birmingham is a common occurrence. In fact, since 2015, the City has issued an average of 100 demolition permits per year to build new single family homes. The construction of new houses affords an opportunity for the city to require the capture of stormwater to reduce the impact of decreased open space and the compaction of soils.
- Stakeholders – Building Department, Engineering Department
- Start-Up Cost – Low
- Timeframe – Medium
- Benefit – Substantial; Due to the rate at which homes are being demolished and rebuilt, this action could have major equity benefits while also contributing an economic benefit.

WS-9 Reduce barriers to local stormwater credit programs.

- Description – The City’s stormwater credit program is a good way to incentivize the installation of several different green infrastructure approaches. However, if the cost and complexity of the process to apply for credits outweighs the benefit for a majority of the residents in the City, it will remain underutilized and will not contribute to the City’s overall goal.
- Stakeholders – Residents, Engineering Department, City Management
- Start-Up Cost – Very Low
- Timeframe – Short
- Benefit – Narrow; The stormwater credits already exist, but reducing any barriers will provide an equity benefit.

WS-10 Engage with the Clinton River Watershed Council and become a designated WaterTown.

- Description – Although the Rouge River runs directly through Birmingham, it is important not to forget that a significant portion of the City also exists within the Clinton River watershed. Thus, the importance of improving water quality and alleviating climate change impacts are just as important in this watershed as they are in the Rouge River watershed. The WaterTowns program is managed by the Clinton River Watershed Council, and aims to make improvements through promoting and implementing green infrastructure and advancing water-oriented community and recreation opportunities.
- Stakeholders – Planning Department, Engineering Department
- Start-Up Cost – Low
- Timeframe – Short
- Benefit – Moderate; Becoming a WaterTown will open the door to economic benefits and will produce equity benefits.

Produce a feasibility study for strategic use of public easements to manage stormwater and create naturalized areas.

WS-11

- Description – The public rights-of-way within the City are a major opportunity for improvement due to the significant impervious area and its sheer footprint within the City in terms of land area (692 acres). In rethinking the easement areas of this land, the opportunities could include reduced flooding of streets/sidewalks, high visibility, large absorption value, and reducing direct runoff into the Rouge River. The strategy could start with a pilot, but ultimately should be constructed as a network.
- Stakeholders – Planning Department, Engineering Department, Department of Public Services, Residents
- Start-Up Cost – High
- Timeframe – Long
- Benefit – Substantial; Rethinking these significant portions of the right-of-way will have economic and equity benefits.

What can I do as a...

Individual?

- Review historical water quality reports
- Learn about Birmingham’s Stormwater Credit program
- Take the 10 Minute WaterSense Challenge
- Read about the Great Lakes Water Authority
- Sign up for emails from the Friends of the Rouge
- Sign up for e-news from the Clinton River Watershed Council
- Build or adopt a rain garden
- Replace failed or worn out fixtures with low-flow fixtures
- Reduce excessive irrigation habits
- Purchase and install a rain barrel
- Save money on water bills by using outdoor irrigation systems only in dry periods and by updating your system with water saving controls
- Learn about greywater reuse
- Make sure your storm drains are clear of debris

Business Owner?

- Invest in stormwater capture
- Replace failed or worn out fixtures in commercial buildings
- Act as conduit for customers to information on water programs from City of Birmingham
- Reduce excessive irrigation habits
- Replace failed or worn out fixtures with low-flow fixtures
- Learn about greywater reuse



City of Ann Arbor
PLANNING & DEVELOPMENT SERVICES — CONSTRUCTION SERVICES

301 E. Huron Street | P.O. Box 8647 | Ann Arbor, Michigan 48107
p. 734.794.6263 | f. 734.994.8460 | building@a2gov.org

**IMPERVIOUS AREA WORKSHEET CHECKLIST
ONE AND TWO FAMILY HOMES**

www.a2gov.org/StormResidentialConstruction

This guideline is a supplement to the Grading/SESC permit application for one and two family projects that are adding impervious area. If the new impervious area is greater than 200 sq ft you must provide stormwater management.

All one and two family submissions are reviewed under Chapter 55, Section 5.22 of City Code for conformance with stormwater management requirements that went into effect March 1, 2011.

Please complete this checklist prior to submittal:

- Completed Impervious Area Worksheet
- Sign and Date the Impervious Area Worksheet
- Grading Permit Application
- Two sets of Grading Plans that also show:
 - All existing impervious area
 - The impervious area to be constructed
 - The impervious area to be removed
 - The proposed stormwater treatment measure(s), if any
 - Any necessary downspout disconnections

Failure to include all required items may result in rejection of the plan or delays in approval.

Purpose of the Impervious Area Worksheet

In compliance with the City's Federal Stormwater Permit requirements, new and redeveloped projects within the City of Ann Arbor must incorporate stormwater treatment measures or Best Management Practices (BMPs) to minimize the discharge of pollutants to storm drain systems and local waterways. Stormwater BMPs include source controls, design measures and post-construction stormwater treatment controls.

“Impervious surface” means that part of a developed parcel that has been modified to reduce the land's natural ability to absorb and hold rainfall. It includes hard surfaces which cause water to run off the surface in greater quantities or at an increased rate of flow from the flow that existed under natural conditions prior to development. For example, common impervious surfaces include, but are not limited to, rooftops, walkways, patios, courtyards, driveways, parking lots, storage areas, concrete or asphalt paving, gravel roads, or any cleared, graded, graveled or compacted surfaces, or other surfaces which similarly impede the natural infiltration of surface water into the soil.

Notice

The City of Ann Arbor Stormwater Utility rate structure provides credits for the installation of rain gardens, rain barrels, drywells, and cisterns on single and two family properties. In some cases the stormwater management volume required by Chapter 55 may be less than the minimum requirements for the City's residential stormwater credits. If you are interested in receiving a credit on your quarterly stormwater bill for treatment measure included in your project, please visit <http://www.a2gov.org/storm> to verify your treatment measure will meet those minimum requirements before the design is complete and plans are submitted.

Stormwater Code Requirements

On Nov. 4, 2010, City Council approved an ordinance (Ordinance No. ORD-10-36) to amend the stormwater code (Chapter 55) to require stormwater management on single and two-family residential properties when properties increase impervious area by 200 or more square feet. Examples of impervious surfaces include, but are not limited to, rooftops, walkways, patios, courtyards, driveways, parking lots, storage areas, concrete or asphalt paving, gravel roads, or any cleared, graded, graveled or compacted surfaces, or other surfaces which similarly impede the natural infiltration of surface water into the soil.

All grading permit applicants for projects creating new impervious areas must complete an impervious area worksheet and submit it to the Planning and Development Services Unit along with their grading permit application. If the new impervious area is greater than 200 square feet then stormwater management must be provided. If the new impervious area is less than 200 square feet then no further information is necessary to obtain a grading permit.

Frequently Asked Questions

Who do I contact if I have questions?

For general permit questions, contact the City's Permit Desk at (734) 794-6267.

For specific permit or project questions contact:

Peter Stephens

Land Development Coordinator

Email - PStephens@a2gov.org

Phone - (734) 794-6000 ext. 42592

For questions about the residential stormwater code requirement program, call:

Jerry Hancock

Stormwater and Floodplain Programs Coordinator

Email - JHancock@a2gov.org

Phone - (734) 794-6430 ext. 43709

What were the amendments to Chapter 55?

The amendments to Chapter 55 require control of stormwater runoff from the "first flush" storm event on single and two-family residential property when adding 200-square feet or more of impervious area to the property. The "first flush" is the runoff from the first inch of rain during any storm event and carries approximately 90 percent of pollutants.

The new requirement would only apply to the increase in impervious area. Examples of impervious surfaces include, but are not limited to, rooftops, walkways, patios, courtyards, driveways, parking lots, storage areas, concrete or asphalt paving, gravel roads, or any cleared, graded, graveled or compacted surfaces, or other surfaces which similarly impede the natural infiltration of surface water into the soil.

How can I find out more information about stormwater management?

Single Family Residential storm water management information and forms:

www.a2gov.org/StormResidentialConstruction

Stormwater Utility Rates and Credits:

www.a2gov.org/storm



City of Ann Arbor
Planning & Development Services
 Phone: 734.794.6263 Fax: 734.994.8460

Impervious Area Worksheet
For Single Or Two-Family Residential
Development

Applicants for all projects creating new impervious area must fill out this worksheet and submit it to the Planning and Development Services Unit with their Grading permit application. If the new impervious area is greater than 200 sq ft you must provide stormwater management.

Property Address _____ Date _____

Applicant Name _____

Homeowner Name (If Different than Applicant) _____

IMPERVIOUS AREA CALCULATION

Impervious Area to be Constructed

Structures (measure from outer edge of eaves)	+ _____ sq ft
Parking/storage areas (including on-site driveways)	+ _____ sq ft
Walkways	+ _____ sq ft
Patios and Courtyards	+ _____ sq ft
Other (specify _____)	+ _____ sq ft

Constructed Impervious Area Subtotal

+ _____ sq ft

Existing Impervious Area to be Removed

Structures (measure from outer edge of eaves)	- _____ sq ft
Parking/storage areas (including on-site driveways)	- _____ sq ft
Walkways	- _____ sq ft
Patios and Courtyards	- _____ sq ft
Other (specify _____)	- _____ sq ft

Removed Impervious Area Subtotal

- _____ sq ft

+ _____ sq ft	Minus	- _____ sq ft	=	_____ sq ft
Constructed Impervious Area		Removed Impervious Area		New Impervious Area

If the “**New Impervious Area**” is less than 200 sq ft, no further information is necessary. Include this worksheet with the Grading Permit Application.

If the “**New Impervious Area**” is greater than 200 sq ft, storage of the First Flush (the first inch of runoff during a storm event) is required for the net new impervious area. Continue to the next calculation on the reverse side of this worksheet.

The Rules of the Washtenaw County Water Resources Commissioner have been used to derive the following formula for the required First Flush storage:

$$\text{Square Footage of New Impervious area} \times 0.08 = \text{Cubic Feet of storage volume required}$$

Multiply your "New Impervious Area" by 0.08 to determine the volume of storage required for your site.

sq ft	x	0.08	=	cubic feet	
New Impervious Area				Required Volume	

STORMWATER TREATMENT MEASURE INFORMATION

As with all grading permit applications, you will need to include a plan that shows: all existing impervious area, impervious area to be constructed, impervious area to be removed, proposed stormwater treatment measure(s), and any necessary downspout disconnections. The following stormwater treatment measures can be utilized to manage the "Required Volume". The "Total Capacity" of the proposed storm water treatment measure must be greater than or equal to the "Required Volume". Please indicate below the size of the proposed storm water management treatment measure that is chosen for this project:

Treatment Measures	Conversion Formula	Storage Volume
Rain Barrel	gallons x 0.13369 =	cubic feet
Rain Garden/Bioretenion	ft (length) x ft (width) x 0.75 ft (average depth) =	cubic feet
Drywell (with pea stone)	ft (length) x ft (depth) x ft (depth) x 0.3(stone void) =	cubic feet
Cistern	_____ gallons x 0.13369 OR ft (radius) x ft (radius) x 3.14 x ft (depth)=	_____ cubic feet
Swale	ft (length) x ft (width) x ft (average depth) =	cubic feet
Storage Basin	ft (length) x ft (width) x ft (average depth) =	cubic feet
Porous Pavement (30% of subgrade infiltration area)	_____ ft (length) x _____ ft (width) x _____ ft (average depth) x 0.3 =	_____ cubic feet
Other:		cubic feet
Total Capacity***		_____ cubic feet

Links to information about these treatment measures are available at www.a2gov.org/storm. For specific numeric sizing criteria used for their design, please reference The Rules of the Washtenaw County Water Resources Commissioner, www.ewashtenaw.org/government/drain_commissioner/dc_webPermits_DesignStandards/dc_Rules or the Low Impact Development Manual for Michigan, www.semcog.org/LowImpactDevelopment.aspx.

Chapter 55, Section 5.22.2 also requires all downspouts to be directed to vegetated areas. If existing downspouts are connected to the City's storm water management system or are directed to impervious area, please show how these downspouts will be redirected to vegetated areas.

*** Notice: The required stormwater management volume for residential development projects may or may not meet the minimum requirements for the City's residential stormwater credits. Please visit <http://www.a2gov.org/storm> to verify your treatment measure will meet those minimum requirements if you are interested in receiving a credit on your quarterly stormwater bill.

Signature of Applicant _____ Date _____

Signature of Homeowner _____ Date _____

Optional - Watershed (Circle one) Direct Drainage to Huron Traver Millers Allen Malletts Honey Swift Run Fleming Other

STAFF ONLY

Grading Permit # _____	Reviewer _____	Date _____
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3. For *lots* zoned for nonresidential use: A permanent recorded unobstructed access and utility easement that is a minimum of 30 feet in width as shown on an approved site plan may serve as the sole means of access to a *public right-of-way* or private street. The easement shall include provisions for the maintenance of improvements and utilities. For such *lots*, the *lot line* most parallel with the *public right-of-way* or private street shall be designated as the *front lot line*. Other *lot lines* shall be determined as provided in this ordinance. *Required setbacks* shall be provided in accordance with the Schedule of Area, Height, and Placement regulations in this ordinance, with the exception that if the distance between the *front lot line* and the *public right-of-way* or private street is more than the *front required setback* for the zoning district in which the *lot* is located, no *front required setback area* shall be required.
4. For *lots* zoned solely for *single-family dwelling* use: A permanent recorded unobstructed access and utility easement that is a minimum of 30 feet in width may serve as the only means of access to a *public right-of-way* or private street for a maximum of two *lots* or parcels subject to the following:
 - a. *Driveways* within the easement shall meet all applicable ordinances, including but not limited to Section 5.19 .
 - b. The easement shall include provisions for the maintenance of the *driveway* and any other improvements and utilities.
 - c. For *lots* where the easement is the only means of access, either the *lot line* most parallel with the *public right-of-way* or private street, or most perpendicular with the *public right-of-way* or private street, shall be designated by an *applicant* as the *front lot line*, and the minimum *front required setback area* shall be provided for the entire length of that *front lot line*.

5.22 Stormwater Management and Soil Erosion

No Person shall conduct activity for which a permit under this Section 5.22 or related Section 5.29.3 is required without first having obtained the required permit. After the permit has been obtained, no Person shall conduct any activity in violation of any condition of that permit, or without having the permit and plans on *site*. Throughout this section, the Washtenaw County Water Resources Commissioner, and the Commissioner's office, are referred to as "WCWRC".

5.22.1 Stormwater Management

A. Purpose

1. The City Council recognizes and is concerned that excessive quantities of soil are eroding from certain areas that are undergoing *development* for non-agricultural uses such as housing developments, industrial areas, recreational uses, and roads. This *erosion* makes necessary costly repairs to gullies, washed out Fills, roads, and embankments. The resulting *sediment* clogs storm sewers and road ditches, muddies *watercourses* and

silts-in lakes and reservoirs, and is considered a major water pollutant, which degrades the natural environment within its jurisdiction and is costly to remedy.

2. Water quality and quantity within the water resources of the City is a public concern. As the City is developed, natural vegetation is removed and replaced with *impervious surfaces*. As a result the hydrology of *watercourses*, ponds and *wetlands* is changed. These changes in quantity, speed, and timing of water runoff transform Ann Arbor's *watercourses*. As the volume and speed of water increases, so does the erosive action of runoff on hillsides, stream banks and bottoms. As more soils are transported down waterways and as more damage occurs to stream banks and bottoms, natural systems are destroyed or diminished throughout the watershed. Urban activity also contaminates the land's surface. Contaminants are carried with runoff into all aquatic habitats, where they poison wildlife and contribute to the decline of aquatic resources. For people, the combination of these effects diminishes the quality of drinking water, inhibits healthy fisheries, reduces recreation and lessens scenic beauty. The City recognizes the relationship between land use and water quality; and by doing so, desires to control non-point source water pollution. Strategies to control stormwater quantity are different from the strategies to improve water quality. This section intends to improve the effectiveness of *stormwater management systems*, bring greater effort to control the sources of runoff, and to improve water quality.
3. The purpose of this Section 5.22 is to control soil *erosion* and the resulting *sediment*; and to control the impact on water quality and quantity resulting from *development* and *impervious surfaces* within the City by requiring proper provisions for water disposal and the protection of soil surfaces during and after construction, in order to promote the safety, public health, convenience and general welfare of the community. Compliance with Part 91 of Act No. 451 of the Public Acts of 1994, as amended, (MCL 324.9101 to 324.9123) and the rules promulgated under this part of the Michigan Compiled Laws, is fully intended.

B. Applicability

A *stormwater management system* meeting the criteria of this section is required for:

1. Any form of construction or removal or disturbance of any *natural feature* that requires approval for any site plan, final preliminary plat, or PUD site plan.
2. When a *Grading Permit* is required but not a site plan, final preliminary plat, or PUD site plan, except *Grading Permits* solely for vegetation *clearing*, *building demolition*, removal of *impervious surfaces*, or other activities approved by the PSA Administrator.

C. Review

1. For *sites* within the jurisdiction of the WCWRC; or *sites* with existing or proposed *stormwater management systems* under multiple ownership or for multiple parcels, including but not limited to site condominiums; or residential developments containing greater than four *dwelling units* within two or more detached *structures*; or *sites* with *stormwater management systems* serving more than one parcel.
2. Any site that is not in the review responsibility of the WCWRC per paragraph 1 above.

D. Requirements

A *stormwater management system* shall be provided based on the requirements provided in Table 5.22-1.

TABLE 5.22-1: STORMWATER MANAGEMENT REQUIREMENTS				
SITE TYPE	SITE AREA	IMPERVIOUS SURFACE IMPACT	STORMWATER MANAGEMENT REQUIREMENT	EXCEPTIONS OR ALTERNATIVES
SINGLE AND TWO-FAMILY RESIDENTIAL	Any size	Adding 200 sq. ft. or more of <i>impervious surface</i>	First flush for the total net increase in <i>impervious surface</i> , and all downspouts directed to vegetated areas or approved point in compliance with Chapter 100 of City Code "Drainage Nuisances and Complaints section.	Not required for new homes in a site planned development with compliant development-wide system.
ALL OTHER TYPES	Over 1 acre (>43,560 sq. ft.)	Not applicable	As required by the Rules of the WCWRC.	See Section 5.22.1G
	1 acre or less (≤43,560 sq. ft.)	No net increase in <i>impervious surface</i>	Not required with Site Plan for Planning Manager, as required by the Rules of WCWRC for Site Plans for Planning Commission or City Council.	See Section 5.22.1G
		Any increase in <i>impervious surface</i>	As required by the Rules of the WCWRC.	See Section 5.22.1G

E. Standards and Procedures

Applicable *sites* within the City of Ann Arbor review shall provide a *stormwater management system* meeting the design criteria stated in the Rules of the WCWRC as provided in Table 5.22-2 unless an alternative as provided in paragraph E below is approved.

TABLE 5.22-2: STORMWATER MANAGEMENT THRESHOLDS	
IMPERVIOUS SURFACE	STANDARD
Less than 10,000 sq. ft.	Retention/infiltration of first flush storm event.
10,000 sq. ft. or more and less than 15,000 sq. ft.	Retention/infiltration only of first flush and detention only of bankfull events.
15,000 sq. ft and greater	Retention/infiltration of the first flush, and detention of bankfull and 100-year storm event. Detention facilities for the 100-year storm event shall include a sediment forebay.

1. On a *site* that requires the installation of a *stormwater management system*, the facility shall be installed and stabilized prior to the issuance of building permits. The PSA Administrator may deem it necessary to modify the timing of installation of the facility when conditions, such as a facility that is integral to the *structure* of a new *building*, prevent installation prior to building permits. As-built verification from a *Professional Engineer* shall be submitted to the PSA Administrator for approval prior to issuance of any certificate of occupancy. The as-built verification shall include: elevations and volumes, outlet sizes and elevations, stabilization information, and signature and seal of the *Professional Engineer*.
2. Existing *wetlands* shall not be modified for the purposes of *stormwater management systems* unless it is determined that the existing *wetland* is not regulated by Sections 5.23 and 5.29.4. Where modifications to *wetland* areas are allowed, the existing storage shall be maintained and shall not count toward meeting the requirements of this section.
3. When residential *lots* or units are proposed to be created, the runoff coefficients shall take into account the future *impervious surfaces* of these building *sites* within the stormwater management calculations.
4. *Stormwater management systems* facilities shall be designed so that any discharge of stormwater from the facility, which does not empty directly into a drain, shall be converted to sheet flow over the ground through the use of an energy dissipater, in a manner which will preclude *erosion*, or other approved method as determined by the PSA Administrator.
5. Prior to the issuance of a *Grading Permit*, the *development* of the *stormwater management system* shall provide the City with an agreement, satisfactory to the City Attorney, that if maintenance is not performed to the reasonable satisfaction of the PSA Administrator, the City may, after posting reasonable notice, on the *site*, perform the maintenance activities and charge all costs to the benefited properties. If the costs remain unpaid for 60 days, the City may assess those costs to the benefited properties as a single lot assessment under City Code Section 1:292.

F. Approval**1. When Reviewed by WCWRC**

Stormwater management systems reviewed by the WCWRC shall receive preliminary plan approval from the WCWRC prior to site plan, final preliminary plat, or PUD site plan approval by the City, and a permit or letter of final plan approval from the WCWRC shall be obtained prior to issuance of a *Grading Permit* by the City.

2. When Reviewed by City of Ann Arbor

Stormwater management systems reviewed by the City of Ann Arbor shall be reviewed and receive approval from the PSA Administrator or their designee.

G. Alternatives

When *site* constraints make it infeasible to meet the requirements provided in Table 5.22-2, the PSA Administrator may approve an alternative standard if each of the following conditions are met:

1. Control of the first flush storm event has been provided.
2. A determination is provided by a *Professional Engineer* that *stormwater management systems* will be provided on-site to the maximum extent feasible and that it is not feasible to provide any additional detention volume due to *site* constraints including but not limited to groundwater conflicts, soil contamination, existing *building(s)* or protection of *natural features*.
3. The proposed method of stormwater management is consistent with the intent of this section and the goals of the Rules of the WCWRC, as determined by the PSA Administrator.
4. The proposed method of stormwater management and reason for not meeting the full detention volume is documented on a *Grading Permit*, site plan, final preliminary plat, or PUD site plan.

Ordinance No. ORD-21-37, January 30, 2022; Ordinance No. ORD-23-02, February 26, 2023; Ordinance No. ORD-24-20, November 10, 2024.

5.22.2 Soil Erosion**A. Grading Operation Responsibility**

Any Person engaged in *grading* operations and/or the permittee shall be responsible for:

1. Installing *temporary soil erosion and sedimentation control measures* before any *earth change* activity, and maintaining the measures on a daily basis.
2. Preventing damage to any *public utilities* or *private utilities* or the interruption of utility services within the limits of *grading* and along any routes of travel of the equipment.
3. Preventing damage to adjacent property. No Person shall *grade* land so close to the *lot line* as to endanger any adjoining public Sidewalk, Alley or



Opportunity Costs of Residential Best Management Practices for Stormwater Runoff Control

Hale W. Thurston¹

Abstract: Excess stormwater runoff is a serious problem in a large number of urban areas, causing flooding, water pollution, groundwater recharge deficits, and ecological damage to urban streams. Solutions currently proposed to deal with this problem often involve large centralized infrastructure and high expense. Phase II of the Environmental Protection Agency's stormwater regulation is now requiring smaller communities nationwide to make important decisions about the potentially expensive management of excess stormwater runoff. This paper builds on research investigating the use of economic incentives to promote dispersed placement of smaller-scale best management practices (BMPs) for water detention to control excess runoff. We estimate a hedonic price function for houses in the area of a pilot project, and include the estimated part worth of yard area as our lower bound for opportunity cost in the cost function of the residential BMPs. We then show the effects of the inclusion of opportunity cost on two potentially useful incentive-based policy instruments available to communities.

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Introduction

The effects of stormwater runoff on stream ecosystems are exacerbated by urbanization and the coincident increase in impervious surface in a watershed. Proliferation of impervious surface allows more water from rain events to reach a stream faster, causing higher peak flows that can lead to stream alteration and habitat degradation. Where impervious surface prevents rainfall from infiltrating the soil, less water is available for groundwater recharge, which reduces stream base flow. Depending upon the land use in the watershed, nutrients and toxics can be scrubbed off roadways and parking lots and transported overland and through storm drains into waterways causing toxic loading of the stream.

Phase Two of the Environmental Protection Agency's National Pollution Discharge Elimination System stormwater regulations requires communities smaller than 100,000 residents to meet new criteria for stormwater runoff reduction. In many cases these smaller communities have no established stormwater utility, and are investigating alternatives for complying with these new, sometimes expensive requirements. In a previous study, Thurston et al. (2003) hypothesized that a dispersed set of simple water retention technologies would control the negative impacts of runoff for an urban area at a lower cost than large engineering infra-

structural projects. In that paper we suggest that a market-based tradable allowance mechanism for trading runoff reductions would be a practical and cost-effective method to assign dispersed runoff control throughout urbanized areas. However, we added several caveats to our analysis, not the least of which was ignoring opportunity costs of dedicating land area to the best management practices (BMPs). In this study we turn our attention to estimation of those opportunity costs for the most prevalent land use and BMP types in our pilot study watershed. Specifically we use hedonic modeling techniques to estimate residential homeowners' valuations of the land that makes up their parcel, and assume that the negative of this value represents a lower bound for the opportunity cost of a BMP. We then employ that value in a numerical exercise that compares two different incentive-based policies for stormwater control: tradable allowances and a fee-with-rebate approach.

This paper proceeds as follows. The second section introduces the market mechanisms of interest, and discusses their appropriateness. In the third section we discuss the importance of the inclusion of opportunity costs in these market-based incentive policies, and how we estimate the opportunity costs in this study using the hedonic price estimation technique. The fourth section outlines how we apply the estimates from the section preceding it in a numerical example in the Shepherd Creek area of Cincinnati. The last section concludes.

Economic Incentive Mechanisms

Fee and Rebate

Known as a Pigouvian tax, the optimal tax on pollution should be a direct tax equaling the marginal external damages caused by the pollution (Pigou 1962). But directly taxing pollution is sometimes hard, especially when monitoring is difficult (such as with a nonpoint source) or when there are institutional barriers to imposing differing taxes on people in the same area. Fullerton and

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Wolverton (1999, 2003) note that when directly taxing the pollution is not an option, the policy maker can exploit a relationship the optimal pollution tax has with income tax and rebates on products that are related to, and relatively cleaner than, the polluting good. This relationship is derived mathematically by the authors, and describes the conditions whereby a uniformly applied increase in the local tax on income in conjunction with a rebate for some desirable behavior, act together to exactly mimic the Pigouvian tax. We do not pretend to achieve optimality in this paper; rather we investigate the realism of a few ad hoc fee/rebate levels.

This type of policy is already in place in many municipalities in the United States (Doll et al. 1998; Doll and Lindsey 1999). Unfortunately these programs are almost exclusively for commercial not residential properties, and where applicable, residential fees are too small to warrant a rebate. For example, monthly residential stormwater fees in Columbus, Ohio, St. Louis, Missouri, and Indianapolis, Indiana are about \$2.70, \$0.24, and \$1.25, respectively. Many agree that the existing programs have not encouraged the desired behavior because the fees and rebates are simply too low (Doll and Lindsey 1999; Parikh et al. 2006). We show in the next section that if the fee and the rebate are high enough to make households reflect their true underlying preferences, based on our knowledge of the costs facing the residential property owner, a stormwater runoff reduction goal can be met using dispersed BMPs and a two-part instrument at a relatively low cost to the utility and the stakeholders.

Tradable Allowances

The cost effectiveness of the tradable allowance approach to pollutant reduction in air sheds is well established in the literature (Tietenberg 2000; Baumol and Oates 1988; Eheart 1980), and the SO₂ trading program in the United States has been operating successfully for several years. Watersheds differ from air sheds, however, in key aspects, like the confinement to a channel, nonuniform mixing, and downstream accumulation, and these present new challenges for the establishment of tradable allowance systems. Watershed trading is not a new concept, but the specific application explored in this paper is. For those interested in other applications, the EPA's *Draft Framework for Watershed-Based Trading* (1996) provides an overview of some 20 tradable allowance programs across the United States. Several of these grew out of cooperative agreements with the EPA, the Water Environment Research Foundation, and various local stakeholder groups. These programs focus on reducing concentrations of nutrients or toxics, and most rely upon an organizational effort similar to EPA's total maximum daily load process to drive stakeholder involvement.

Two necessary conditions for tradable allowance regimes to be cost reducing are that (1) transaction costs of such programs be no greater than the gains achieved and (2) there be sufficient difference in abatement cost across parcel owners so that potential cost savings can be realized through market exchange of runoff control. With these conditions satisfied, a tradable allowance system can efficiently assign runoff control to dispersed locations and may avoid the larger cost of centralized approaches. I thank one anonymous reviewer for pointing out that in some cases the low-transaction cost condition may not be achieved. This will be true in some areas of the country; however, in those municipalities where an established stormwater utility has access to an up-to-date geographic information system (GIS) (most do), citizens have access to the Internet, and a "clearinghouse" type of program such as that proposed by Woodward and Kaiser (2002) can

be established, transactions costs will probably be low enough to take advantage of trading. Empirical testing of this hypothesis is currently being investigated by researchers in EPA's Sustainable Environment Branch.

The usefulness of inclusion of opportunity costs can hardly be overstated in this application. We use the results of our opportunity cost estimation to inform a tradable allowances system much like those currently used in water quality trading programs around the country (EPA 1996), and much like the one specific to stormwater abatement that we describe elsewhere (Thurston et al. 2003).

Opportunity Costs

Under either of our proposed policy choices the costs to the homeowner must be known for the planner to be able to predict the success of the program with any accuracy.

There are multiple components of cost facing each parcel owner: the construction of BMPs, their maintenance, and the opportunity cost of land taken out of other uses. A corner of the backyard has other utility-generating uses: gardens, sandbox, swing set, etc., and so the homeowner dedicating an increasing proportion of his backyard to water detention incurs an opportunity cost. Together these form the marginal (or incremental) cost of abating a given unit of runoff.

If $CT=f(Q)$ is the total cost of abating runoff then the marginal abatement costs (MC) are given as

$$\partial CT / \partial Q = MC$$

where Q =volume of runoff abated. MC are assumed to increase monotonically with quantity abated such that

$$\partial MC / \partial Q \geq 0$$

primarily due to increasing opportunity cost of land. That is, although the specific abatement technologies may exhibit decreasing costs to scale over the relevant size of the BMP, we assume that an individual property owner faces increasing opportunity costs for land taken out of other uses and dedicated to BMPs. A negative sign on the quadratic term for land area in our hedonic price curve estimation confirms that this is the case with residential properties.

Making the standard assumption that property owners facing explicit costs for managing runoff from their properties will be cost minimizers, we can predict the effects of changes in fee and rebate rates or allowance prices and in land use (e.g., increased impervious surface) on runoff flow and stream loading in the watershed.

Estimating Opportunity Costs of BMPs

It has recently been recognized that when considering other-than-engineering solutions to stormwater management, the inclusion of other-than-engineering costs is imperative, and that these costs are usually not known. For example, Sample et al. (2003) note that in the vast literature on costs of facilities for stormwater detention and retention, including costs of length of pipes, manholes, etc., "data on BMPs are probably the least reliable." In an attempt to include opportunity costs in their life cycle cost analysis of BMPs, the authors focus on a case study found in the work on sewer design done by Tchobanoglous (1981). Sample et al. (2003) use the discounted stream of benefits, based on real estate appraisals of land value forgone by dedicating land to BMPs.

While this approach is unique, and considers the time dimension of the opportunity cost, we choose a different approach based not on land value data from realtors, but extracted through hedonic analysis from market transactions. It is argued in the economics literature that hedonic estimation is superior to assessors' estimates because the hedonic method relies on actual (revealed preference) sales data, allows for marginal analysis and is immune to biases of an assessor (Leggett and Bockstael 2000; Mooney and Eisgruber 2001). Additionally since the multivariate regression separates out the constituents that make up the total price of the good in question we can focus on marginal effects. Future research might focus on the use of the Sample et al. (2003) method in conjunction with the hedonic method to more fully inform a policy about on-site residential BMPs and associated opportunity costs.

Hedonic models exploit the existence of heterogeneity in attributes that make up a given item that is traded in the market to estimate the portion each attribute adds to the value of the good. We estimate a hedonic price function that includes various elements of properties sold in Hamilton County, Ohio, in postal zip codes near the Shepherd Creek area. Estimation of hedonic price function for housing is commonplace (Haab and McConnell 2002).

Econometrically, estimation is fairly straightforward. Covariates usually include things such as number of bathrooms, fireplaces, the existence of central air conditioning, etc. Some neighborhood characteristics are usually also included such as school quality and proximity of parks. Our focus is on the value homeowners place on their yards; if square footage is dedicated to an on-site stormwater detention facility such as a sand trench or rain garden it is lost to other uses. To get at this we include a covariate *NETLOT*, which is area of property alone (lot size minus footprint of house) in square feet.

We estimate the hedonic price function

$$p = h(z, \alpha)$$

where p =price of the house; z =vector of attributes such as those mentioned above; and α =vector of parameters that define the shape of the price function. We assume the standard approach that the household budget constraint is given by

$$b = h(z) + x$$

where x =all other goods, and maximizing utility subject to the budget constraint implies optimal conditions for each attribute

$$\frac{\partial u(x, z; \beta)}{\partial z_l} = \lambda \frac{\partial h(z)}{\partial z_l}, \quad l = 1, \dots, L$$

If equilibrium conditions hold in the housing market the value owners place on the attribute *NETLOT* is expressed as

$$wt\hat{p} = \Delta z_l \frac{\partial h(z)}{\partial z_l}$$

where z_l =covariate *NETLOT* and the result is the amount of land dedicated to a BMP multiplied by, in the case of linear estimation of the hedonic price function, the estimated coefficient on the land variable. The log-linear estimated coefficients are interpreted as percent of parcel sale price due to the attribute in question. It follows that, if land is dedicated to a BMP, the negative of the above represents the opportunity cost of land in the BMP.

Table 1. Variables Used in Regression Analysis

Variable ($n=24,218$)	Mean	Definition
<i>HALFBAT</i>	0.44322	Number of half bathrooms
<i>FULLBAT</i>	1.5114	Number of full bathrooms
<i>SFTFIN</i>	1,551.8	Area of the house finished in square feet
<i>NETLOT</i>	0.32064	Area of property alone (lot size minus footprint of house) in square feet
<i>NETLOTS</i>	0.75029	Net square footage of property squared
<i>SCHRANK</i>	15.159	School rank in Hamilton County based on statewide aptitude test pass ^a (percent)
<i>FIRE</i>	0.46061	Number of fireplaces
<i>COND</i>	3.4385	Condition rating assigned by realtor, 1–5
<i>SALEPRIC</i>	107,370	Sale price of property in current dollars
<i>COOL</i>	0.72108	Dummy variable that takes the value 1 if central air conditioning, 0 otherwise

^aFrom Skertic (1997).

Data

Publicly available data on over 100,000 house sales from the period 1998–2001 were downloaded from the Hamilton County, Ohio, County Auditor's web site. Data included 103 columns of information, including sale price, parcel numbers, address, name of buyer, date of the sale, school district, etc. Also included is information on attributes of the property number of bathrooms, square footage, central air conditioning, etc. Only residential, nonvacant properties that were sold in zip codes adjacent to the pilot project site were used, and we culled incomplete and obviously erroneous entries resulting in 24,218 observations. Variables used in ordinary least square (OLS) estimation are listed in Table 1, along with their means and definitions.

Results

Estimation results are presented in Table 2. A quadratic term for square footage of lawn is included to reflect decreasing marginal utility.

We test the choice of the linear versus log-linear specification using the Box-Cox test statistic under the null hypothesis that the two are equivalent, and we reject the null hypothesis and conclude the models are not observably equivalent, and determine that the log-linear model provides better estimates. We use the Box-Cox test because the transformation of the dependent variable renders R^2 values incomparable (Griffiths et al. 1993). The coefficients estimated in the log-linear specification are interpreted as percent of parcel sale price due to the attribute in question. Regression results in each yield coefficient signs as expected and all estimated coefficients are significant at the 95% confidence interval.

The coefficient of most interest for our purposes is that on *NETLOT*. The regression results tell us that the part worth of an additional square foot of yard is worth 1.17×10^{-6} times the sale price of the house. Our regression is run on data on houses that have sold in zip codes in and adjacent to our pilot study watershed. Since we do not have enough observations on sales in the pilot area to return statistical significance, we take the average of the regression sample to represent the average house in the pilot study area. The mean value from Table 1 is \$107,370 making the estimated part worth 12.6 cents. The interpretation of the linear coefficient is of course much simpler as the coefficient is the part worth—in this case 28 cents. How do we translate this into op-

Table 2. Regression Results

Characteristic	Parameter estimates (standard errors in parentheses)	
	Linear	Log-linear
<i>HALFBAT</i>	11,168 (642)	0.11511 (0.00597)
<i>FULLBAT</i>	14,065 (693)	0.11219 (0.00645)
<i>SFTFIN</i>	44.7 (0.745)	0.000256 (0.0000693)
<i>NETLOT</i>	0.278 (0.0137)	1.17×10^{-6} (1.28×10^{-7})
<i>NETLOTS</i>	-9.39×10^{-8} (7.88×10^{-9})	-4.44×10^{-13} (7.33×10^{-14})
<i>SCHRANK</i>	-1,908 (56.1)	-0.0169 (0.000522)
<i>FIRE</i>	15,800 (655)	0.155 (0.00609)
<i>COND</i>	6,820 (416)	0.115 (0.00387)
<i>COOL</i>	8,280 (723)	0.199 (0.00672)
<i>CONSTANT</i>	294 (2,200)	10.4 (0.0204)
R^2	0.5464	0.4567

portunity costs? Either of the BMP technologies available to the land owner in the pilot area will require a certain amount of yard space be taken out of other uses. To get an idea of the scale of the proposed BMPs, it is not unrealistic to assume that, in the case of a small-scale residential BMP or porous pavement, the footprint (that is, the square footage of the BMP on the property) is the same as the volume capacity. That is, a 1.0 m (3.3 ft) deep sand trench BMP would have to measure 6.1 m \times 3.0 m

(20 ft \times 10 ft) to capture 5.7 m³ (200 ft³) of stormwater runoff (to accommodate the sand filler with typical porosity of around 35%, this is thrice the necessary empty void space).

Application to a Case Study

Cincinnati's Mill Creek and its tributaries occupy some 44,000 ha (170 square miles) in 23 municipalities in the counties of Hamilton and Butler, Ohio. Mill Creek is considered by the Ohio Environmental Protection Agency (OEPA) to be the most polluted waterway in the state (OEPA 1994). Stormwater runoff is a major direct and indirect contributor to the pollution of Mill Creek. To investigate the usefulness of our cost estimates for an incentive program we proceed as follows: we delineate the boundaries of the Shepherd Creek subwatershed using established hydrology. The subwatershed is divided into parcels; then characteristics such as soil type, land use, and parcel boundaries are entered into an *ArcView* GIS project. Fig. 1 shows the area in detail, illustrating the headwaters, parcels, different soils, and impervious surfaces.

We chose this section of Mill Creek for our study area because of the diverse land use, topography, and soil types. Mount Airy Forest is a protected area that occupies a large piece of the study area, and proposed and ongoing subdivision developments provide us with heterogeneous land use and the opportunity to research a dynamic system. The impact of a rainfall event on the study area was determined using the Natural Resource Conservation Service's Technical Release (TR-55) bulletin, which provides the methodology to calculate stormwater runoff volume for a given storm event. The storm event we use in our model is the 1.5-year storm. In the case of Hamilton County, Ohio, that rainfall amount is 3.12 cm (1.23 in.). Our choice of the illustrative rainfall event is based on expert opinion on low impact development design such as outlined in Prince George's County, Maryland (2000). Use of these storm events as opposed to using larger,

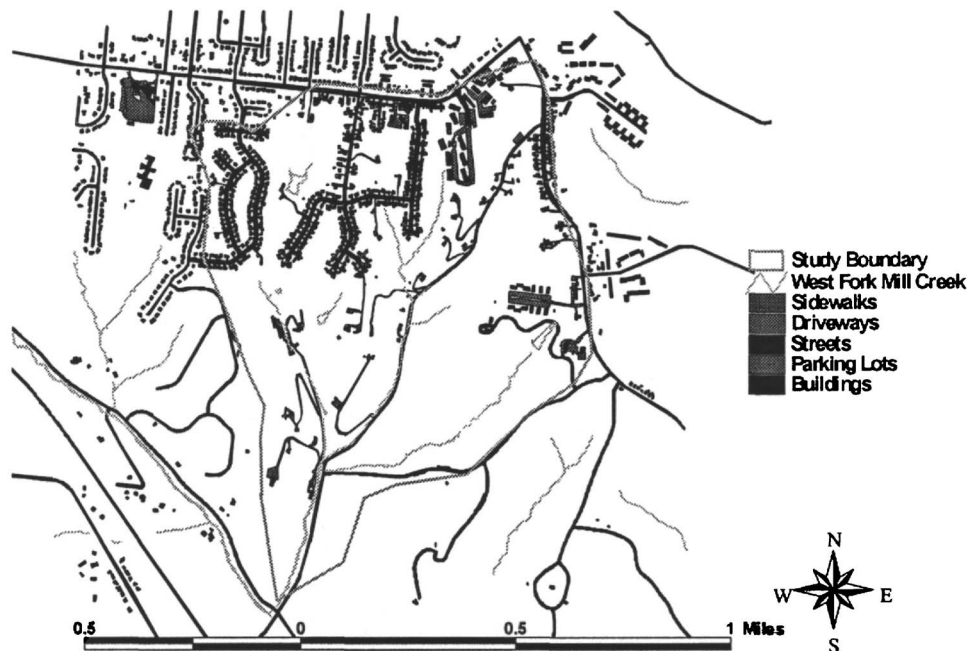


Fig. 1. Impervious area in Shepherd Creek



Fig. 2. Excess stormwater runoff

more infrequent storms goes back to Wolman and Miller (1960) who conclude that smaller, frequent floods have greater impact in the long run on sediment transport and therefore on habitat alteration than do large infrequent floods.

It is assumed the stormwater utility has either determined the ecological limits of streams and sewers in the relevant watersheds, or, as is the case in our exposition, imposes a reasonable ad hoc reference level (such as runoff in predevelopment conditions), and grandfathers each parcel owner an allowed flow of water from each parcel. Runoff volume in excess of the grandfathered amounts will be subject to the stormwater fee.

Rain event runoff is calculated using the TR-55 methodology for each parcel in the watershed, taking into account the existing impervious surface. We identify this as the postdevelopment runoff. Runoff is calculated again using the same rain event, but modeled in the absence of the impervious surface and with a forested land cover. This result is identified as the predevelopment runoff. Excess stormwater runoff then is the postdevelopment runoff minus the predevelopment runoff. We use the event-based simulation to keep illustration of our proposed policy simple. Ongoing research includes the application of the USDA's *AnnAGNPS* continuous runoff model. The main improvement this offers is the explicit acknowledgment that soils become saturated during periods of frequent storms.

Mathematical calculation of the property owners' runoff responsibilities is implemented in Microsoft *Excel*, and then exported to *ArcView* for visualization. Real-time linking via structure query language (SQL) connection or other means is possible and may be used in the future as a tool by a stormwater utility, for example. An *ArcView* representation of excess stormwater runoff caused by the design storm in Shepherd Creek is shown in Fig. 2.

We created a spreadsheet database that contains physical and hydrologic features of parcels in the Shepherd Creek subwatershed. The database also includes the cost of different BMPs as a function of their capacity. The costs include construction and the costs estimated as opportunity costs from our hedonic price function. Each property has associated with it a parcel identification

number, a land use type classification (multifamily, industrial, etc.), a soil type, and quantity of excess stormwater runoff in cubic feet as calculated from the TR-55 methodology outlined above.

Numerical Example

We use 402 single-family residential parcels from the Shepherd Creek subwatershed delineated above, in our numerical example. The soil is of hydrologic soil group (HSG) B, C, or D and the terrain ranges from forested to grassy to impervious. Parcel owners in the case study area are assumed to choose the most suitable BMP for their land use and soil type from among a variety of BMPs that exist for different applications.

For the computational exercise, the type of BMP, concomitant detention cost (DC) functions and inverse cost functions, were assigned to parcels in the sub-basin based on land use and soil type as follows:

- Parcels with residential land use and HSG B are assumed to employ sand filters. The cost function is $DC_{ResB} = 26.6Q^{0.64} + 0.126Q$; and
- Residential parcels with HSG C or D are assumed to use rain gardens/grassed swales, the relevant cost function of which is $DC_{ResC} = 4.94Q + 0.126Q$.

Here Q =quantity of stormwater runoff detained in cubic feet; and the second term in each is the log-linear estimated opportunity cost of land. We choose not to include the quadratic term estimated because while it is statistically significant, it is not economically significant at the BMP sizes we are concerned with. The cost functions are modified from Schueler (1987) and Heaney et al. (2002).

For this exercise, some properties, such as public schools and public rights of way, were not included. While these do contribute a significant amount of stormwater runoff and toxic loadings to streams, we do not include public agency responsibility in the present analysis. The area of the roads in this watershed is 4% of the total land area. According to TR-55, the contribution to the

Table 3. Per Unit Cost of Detention Using Fee and Rebate

Scenario	No opportunity costs			With opportunity costs		
	Cost per cubic foot detained (to average homeowner) (\$/ft ³)	Quantity detained (ft ³)	Net utility revenue (\$)	Cost per cubic foot detained (to average homeowner) (\$/ft ³)	Quantity detained (ft ³)	Net utility revenue (\$)
Scenario			Command and control			
No rebate	4.62	82,767	N/A	6.49	82,767	N/A
Scenario			Fee= \$ 1,000			
\$1,000 rebate	7.97	38,809	136,000	11.45	27,967	191,000
\$1,500 rebate	2.41	61,283	(130,500)	4.04	47,311	(48,000)
\$2,000 rebate	(0.55)	71,864	(368,000)	0.48	58,689	(286,000)
Scenario			Fee= \$ 500			
\$1,000 rebate	2.79	38,809	(65,000)	4.26	27,967	(10,000)
\$1,500 rebate	(0.87)	61,283	(331,500)	(0.21)	47,311	(249,000)
\$2,000 rebate	(3.35)	71,864	(569,000)	(2.94)	58,689	(487,000)
Scenario			Fee= \$ 1,500			
\$1,000 rebate	13.15	38,809	337,000	18.64	27,967	392,000
\$1,500 rebate	5.69	61,283	70,500	8.29	47,311	153,000
\$2,000 rebate	2.24	71,864	(167,000)	3.91	58,689	(85,000)

runoff volume from rain that falls directly on the roads is 15% of the total runoff volume. This is partially mitigated by extant requirements for BMP construction for public infrastructure (CAGIS, personal communication, June 20, 2001).

Average excess runoff for the design storm from the properties in the Shepherd Creek study area is 8.27 m³(292 ft³) of stormwater. Some small or undeveloped properties have virtually no excess runoff while large multifamily apartment-covered properties with multiple driveways and rooftops can have as much as 85–142 m³(3,000–5,000 ft³) of stormwater runoff due to the design storm.

First we calculate what the cost would be, in the absence of any market incentives, to control the subwatershed's excess stormwater runoff. To calculate the cost of a dispersed set of BMPs to store on site all of the excess runoff from a storm event of 3.12 cm (1.23 in.), the design storm, we assign the appropriate least-cost BMP technology on a parcel-by-parcel basis in our small case area and solve each landowner's cost equation. This calculation presumes that the parcel owner is responsible for *all* the runoff over and above that which would result if the parcel were in its undeveloped state. This in effect is a command-and-control regime with no rebate and the water detained with this constraint is 2,344 m³ (82,767 ft³), at an average cost of \$950 per homeowner. Considering only construction costs of BMPs results in an average cost of \$4.62 per cubic foot of stormwater runoff detained via BMPs over all properties in the study area. We now calculate including the opportunity cost of land, estimated from the hedonic price functions noted in the cost functions above, the log-linear case is \$0.126 per ft². Assuming again that command-and-control policy is implemented that causes all parcel owners to use BMPs to manage all excess stormwater runoff, the cost is \$6.49 per ft³, at an average cost per homeowner of \$1,337. We would assume costs to be higher for all price levels of allowances due simply to the increased cost of BMPs (recognition of opportunity costs).

Incentives I: Fee and Rebate

Now we apply a two-part tariff that makes the construction of BMPs voluntary, but payment of the stormwater fee mandatory. Armed with the cost functions for the homeowners in the parcel area (and with a visualization of that in the GIS platform) the stormwater utility can use any spreadsheet program to try various combinations of fees and rebates to determine what combination thereof will achieve the predetermined hydroecologic limit on excess runoff and at what price. In our *Excel* spreadsheet each parcel is defined by various columns. Each has associated with it the quantity of excess stormwater runoff responsibility (as calculated above), soil type, land use, the appropriate BMP technology, the BMP cost function, and the fee and rebate facing the parcel. At different user-entered fee and rebate levels and based on simple "if/then" analysis of the costs, the parcel is assigned either a BMP and rebate or the cost of the fee. Summation across the subwatershed's 402 parcels yields the results presented in Table 3.

For Shepherd Creek we give examples in Table 3 showing the per unit cost of detention assuming some different levels of fee and rebate, with and without the inclusion of opportunity cost of land for residential BMPs.

The very small, or even negative (designated in parentheses), cost to homeowner figures come about because some homeowners can build a BMP sufficient to control all their runoff for significantly less than the amount of the fixed rebate. Net utility revenue ignores almost all the costs a real utility would incur—here it simply is the difference of revenues from fees minus rebates given out. The total excess runoff in the subwatershed is 2,344 m³(82,767 ft³). The stormwater utility, it is assumed would consult with hydrologists and ecologists to set its limit on excess stormwater runoff. Obviously the quantity controlled will be positively correlated to the size of the rebate. But since the quantity controlled is independent of the fee charged the utility will be hard pressed to operate in the black long with the superhigh rebates required if the fees are small. These fees and rebates are

Table 4. Per Unit Cost of Detention Using Tradable Allowances

Scenario allowance price/cubic foot (not) detained	Without opportunity costs			With opportunity costs		
	Average cost per cubic foot detained (\$/ft ³)	Quantity detained (ft ³)	Allowance revenue (\$)	Average cost per cubic foot detained (\$/ft ³)	Quantity detained (ft ³)	Allowance revenue (\$)
\$8.00 allowances	4.62	82,574	1,544	7.16	70,060	101,656
\$5.00 allowances	4.65	81,721	5,230	12.98	29,784	264,915
\$4.00 allowances	24.01	13,517	277,000	27.86	11,706	284,244
\$2.50 allowances	N/A	0	206,917	N/A	0	206,918
Command and control	4.62	82,767	0	6.49	82,767	0

Note: N/A=not applicable.

colossal compared to those currently offered in stormwater programs around the country, although they would probably only be assessed once during the lifetime of a BMP, while the fees currently being charged by utilities are in perpetuity. In this subwatershed the most stormwater runoff the utility can cause to be detained without net revenues being negative is 1,340 m³ (47,311 ft³) if one accounts for the opportunity costs. If the utility misspecified cost functions and did not include opportunity costs it might estimate it could control 1,735 m³ (61,283 ft³) of stormwater runoff and remain in the black.

Incentives II: Tradable Allowances

Now we look at the imposition of the policy where homeowner chooses to buy a credit or allowance from the stormwater utility or build an appropriately monitored and sized BMP of the correct technology on their parcel. The trading proposed here, as is the case with in most water trading programs around the nation, is a "clearinghouse" approach. For a good overview of this and other market structures for water trading programs in the United States, see Woodward and Kaiser (2002). In part to reduce transaction costs, instead of freely traded allowances on an open market, an authority, such as a stormwater utility, sets the price of allowances and this price is known to all participating parties. Parcel owners then choose to pay the fee or build a BMP to control their runoff. Those in the subwatershed who build the BMPs will be partially or wholly reimbursed by the stormwater utility from proceeds of allowances sold to parcel owners who chose not to build BMPs.

The sample is the same 402 residences in the Shepherd Creek area. The appropriate BMPs, and therefore appropriate cost functions (with the opportunity costs), are the same as in the fee and rebate case. The only difference here is that the "fee" is the purchase of an allowance and is voluntary, but is functionally tied to the excess runoff of the property. The alternative is to pay no fee, but install a sufficiently sized BMP on the property. We are concerned mostly with retrofit opportunities for established communities here, so we do not consider the alternative that is currently incorporated in newer housing developments: a central stormwater control facility. Elsewhere (Thurston et al. 2003), we found that the per unit cost of dispersed on-site retention compared favorably to that of a large-scale detention facility. The model of the parcel owner's choice is again carried out in an *Excel* spreadsheet. Each parcel is faced with a user-entered allowance price and will choose to buy the allowance when the price is below the cost of building a BMP according to the cost function facing him. When the cost of the allowance is above the cost of the BMP the homeowner builds the BMP. When making this decision, the homeowner will, of course, want to take into consideration the

opportunity cost of the BMP. A more thorough overview of this unique stormwater control application, but without the opportunity costs, is presented by Thurston et al. (2003). Applying the decision matrix presented above yields the varied results presented in Table 4.

These calculations were made assuming that the parcel owner chooses to retain *all* the excess runoff, or to retain *none* of it and purchase allowances. We can obtain values higher than the allowance price because the figure has quantity detained as the denominator. When we do not consider the opportunity costs of the BMPs, even \$8 per ft³ price of allowance is considered high by the property owners, reflected in the minuscule number who bought them (almost all the excess runoff is detained, signifying many BMPs were built). Only somewhere between \$5.00 and \$4.00 is there a switching point when the allowances become almost uniquely attractive (by \$2.50 no BMPs are built, because all homeowners buy allowances). But when we consider the opportunity costs to the parcel owner of the BMPs, allowances naturally become more attractive.

Conclusions

This study is a part of an ongoing effort to fully describe a realistic market-based mechanism to alleviate the problems caused by increased stormwater runoff in urban and urbanizing areas. As impervious surface grows relative to natural landscapes the problem will increase, and municipal authorities will look for ways to deal with it that are both practical from a political standpoint and ecologically effective. We have outlined how employment of BMPs in a subwatershed would reduce stormwater runoff substantially, but need to prove our assumptions about the policy that would bring this about are not unrealistic. To this end we show that inclusion of the opportunity cost of residential land dedicated to particular stormwater control practices increases the overall cost of stormwater control in a pilot study area. Using hedonic modeling techniques we have estimated the value parcel holders place on their land area, and used that information in our incentive schemes. While in some cases we show that the incentive schemes are more cost effective than command and control, the evidence is weaker when the cost functions more realistically include the opportunity cost. Nevertheless, command-and-control costs are presented primarily as a hypothetical benchmark since it is probably unrealistic to think that a stormwater utility would have the regulatory might to impose such a regulation. Further research includes the collection of experimental auction data from homeowners to validate some of our assumptions about decision

making we model, and the actual implementation of BMPs for the purpose of measuring effectiveness. With this implementation will come the opportunity to measure heretofore ignored, as noted by one anonymous reviewer, costs of operation and maintenance. These costs, while we assume them to be small due to the low-tech nature of the BMPs, should be considered in an overall assessment of the cost effectiveness of a dispersed detention program.

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