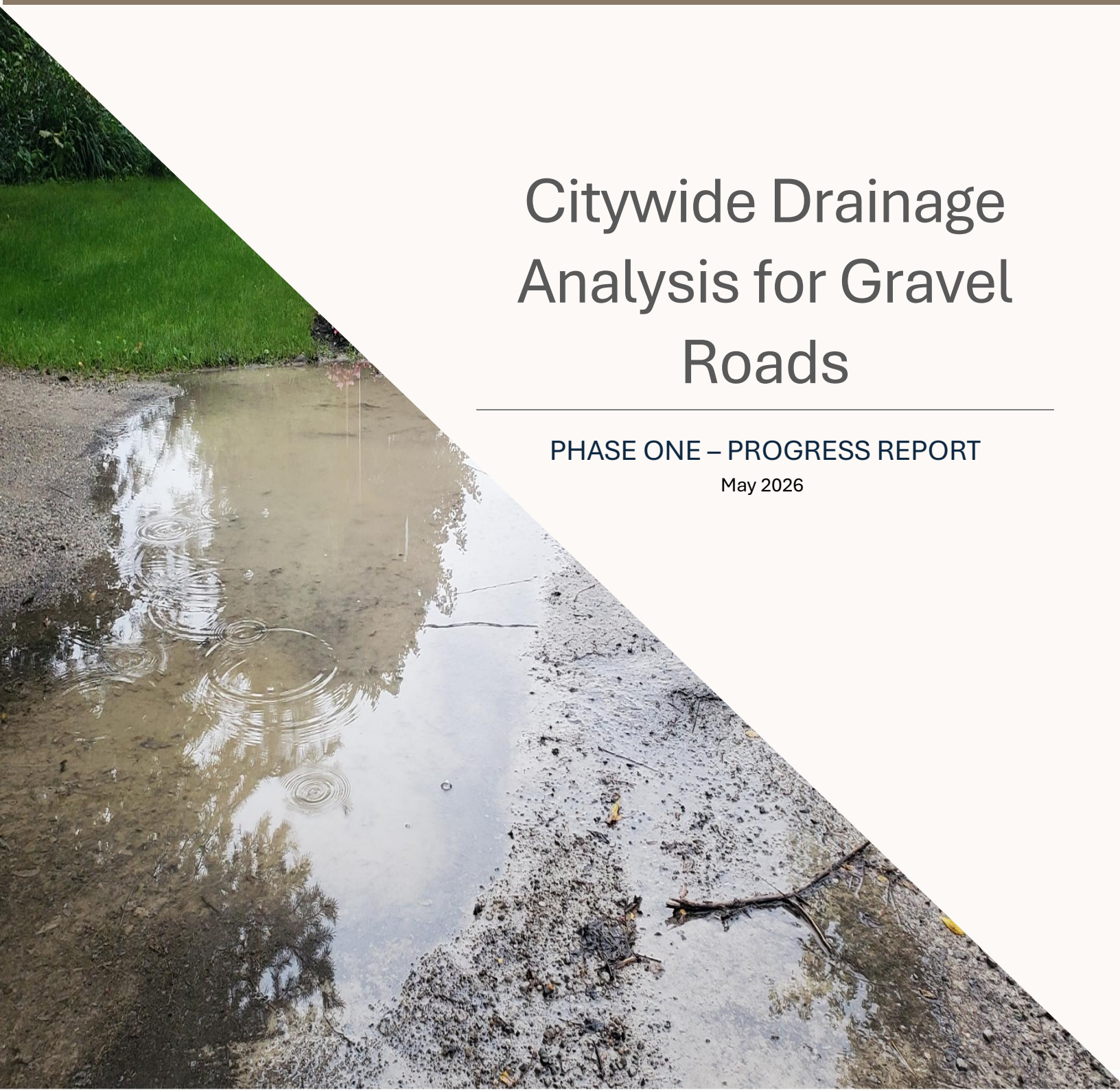

Citywide Drainage Analysis for Gravel Roads

PHASE ONE – PROGRESS REPORT

May 2026

ENGINEERING. ENVIRONMENT. EXCELLENCE.

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SECTION 1.0 – INTRODUCTION

Hubbell, Roth, and Clark, Inc. (HRC) and our project partners, LimnoTech and Spicer Group, are pleased to submit this report summarizing the phase one tasks for the Citywide Drainage Analysis for Gravel Roads. The goal of this project is to address drainage issues on an estimated thirteen miles of publicly owned gravel roads within the City of Ann Arbor. With the collaboration of LimnoTech Inc. and Spicer Group Inc., our collective firms developed recommendations to address a wide range of concerns for each area. At the end of the project, each area will have specific recommendations that address:

- Current precipitation patterns
- Climate resiliency factors
- Water quality as a tangent issue to conveyance
- Maintenance implications
- Watershed development pressures
- Neighborhood character and aesthetics
- Costs to achieve long-term resolution of the issue

1.1 PHASE ONE STUDY AREA

This report outlines the phase one study area located in the Valley Drive/Evergreen Subdivisions in Ward 5. This area contains 30% of the City maintained gravel roads and requires the largest percentage of the overall budget. As this area is the first to be examined, it required the most flexibility and provides a solid foundation for the later phases.

The extra tasks in phase one resulted in a more significant effort. The project start-up tasks included project initiation, administration, developing templates, preparing a PR toolkit, getting the model running, and additional team coordination. Templates for plans, reports, and modeling were developed in phase one and will be used throughout the later study areas.

Additionally, all data available from the City was collected and managed to limit mobilization costs, and initial inspections were conducted to understand the area without input from property owners or stakeholders. The public engagement tools were developed during this phase and were revised and improved throughout the project. Finally, areas of success and any potential changes were discussed with the City and pertinent Stakeholders to refine the program to work more effectively in the following phases.



Figure 1: Phase one study area - Valley Drive/Evergreen Subdivision.

SECTION 2.0 - RECOMMENDATIONS

To address the drainage issues seen in the area, the team developed a comprehensive set of recommendations across multiple scales – individual, local, regional, and neighborhood-wide. These tiers reflect a strategic framework: individual actions target specific properties; local measures address particular streets or blocks; regional recommendations benefit multiple neighborhoods or entire drainage districts; and neighborhood-wide efforts encompass the entire phase one study area. Each recommendation was created with the goal of including different maintenance and mitigation activities to improve drainage performance. The full list of these targeted maintenance and mitigation strategies can be found in Appendix B.

2.1 INDIVIDUAL SCALE

Individual-scale recommendations target specific properties and emphasize smaller-scale strategies to effectively manage stormwater. These strategies include tasks such as maintaining ditches and existing culverts, which are important in facilitating proper drainage. In certain cases, the City may also consider adding features like catch basins, bioswales, or stormwater pipes to enhance water management in specific areas. Some recommendations may involve maintenance in the public right-of-way that, if deemed appropriate and within scope, could be addressed by the City without the need for new infrastructure design. This focus on maintenance ensures that current systems function efficiently, helping to prevent localized flooding issues. By concentrating on these manageable projects, residents can tackle immediate drainage challenges while benefiting from the expertise and resources provided by municipal services.

These smaller scale projects may offer quicker results and increased community engagement, encouraging residents to take responsibility with regular maintenance activities such as clearing ditches and culverts that can immediately improve drainage. However, individual-scale improvements come with disadvantages as well. Focusing only on specific properties can limit the effectiveness of drainage improvements, as larger systemic issues—such as upstream or downstream flow problems—may go unaddressed. Additionally, while initial costs for these projects may be lower due to the smaller size, long-term costs could rise if systems are not maintained, become outdated, or vary in quality and effectiveness across different properties.

In addition to the advantages and disadvantages of individual scale stormwater management practices, there are limitations to the recommendations that may prevent the systems working as intended. The stormwater flows across property lines; therefore, any actions taken on individual properties can impact adjacent areas, resulting in isolated improvements not yielding the desired result. Additional, larger community focused solutions can integrate grey infrastructure and natural drainage systems that may not be accounted for on individual properties.

The overall cost for implementing the individual scale recommendations is approximately $566,000, as seen in Table 1. This figure does not include long-term maintenance costs or improvements that fall under the responsibility of private property owners. Implementation of any recommendation will depend on available funding, feasibility, prioritization by the City, and further evaluation during future project planning stages.

Property Owner Responsibilities

Property owners also play a significant role in effective stormwater management on and around their properties. Those with wells are encouraged to contact the County Health Department to discuss the proper procedures for well abandonment to ensure safety and compliance. It is important to note that not all drainage concerns originate from or fall within the public right-of-way. In such instances, the responsibility to address those concerns may lie with the property owner, as observed at the following addresses:

- 785 Kuehnle Avenue
- 713 Kuehnle Avenue

Additionally, private property owners are encouraged to explore onsite regrading measures to manage water runoff more effectively. These may include reshaping the landscape, adjusting slopes, and installing small drainage features to ensure water flows away from structures and critical areas. These measures could significantly improve drainage and reduce erosion issues. Specifically, three property owners should consider regrading their yards to mitigate flooding issues in their areas:

- 2855 Dexter Road: Water runoff from Dexter Road and Glenwood Street appears to collect in the driveway and side yard. The functionality of a cross culvert under Dexter Road should be further evaluated. The property owner may consider regrading the side yard to direct drainage toward a nearby outfall.
- 421 Parkwood Street: The southern property should be regraded to direct stormwater to the road to prevent further erosion to the gravel driveway.
- 315 Barber Avenue: The property may benefit from regrading to ensure water flows to an existing catch basin located within the public right-of-way.

Estimated Cost: N/A

Regrading and Drainage Control

Regrading is a common stormwater management practice involving the adjustment of land slopes to promote proper water flow. When implemented appropriately, it can help reduce risks of ponding, erosion, and structural water damage. Without adequate grading, water may collect in low areas, leading to standing water and related concerns.

- 2840 Dexter Road: The ditch adjacent to the side yard along Dexter Road may benefit from regrading, which could help reduce pooling caused by over-excavation.
- 305 Glenwood Street: Adjusting grading between the road edge and greenbelt may facilitate stormwater runoff entering the curb inlet more effectively.

Estimated Cost: $33,000

Stormwater Management Solutions

In areas prone to flooding or water accumulation, implementing comprehensive stormwater management solutions could aid in effective water control. By using a combination of traditional drainage infrastructure and green solutions, such as through culverts and bioswales, stormwater can be effectively captured, conveyed, and treated before impacting vulnerable areas.

One effective stormwater management technique involves installing catch basins at strategic locations. Catch basins are designed to capture surface runoff, filter out debris, and direct stormwater into underground drainage systems. Properly placed catch basins can prevent water from pooling on streets, in yards, and around structures, reducing the risk of erosion. Within the phase one study area, several areas can benefit from replacing or installing culverts:

- 466 Evergreen Drive: A catch basin could potentially be installed to manage a low point and connect with the existing storm sewer.
- 3261 Ravenwood Avenue: Consideration could be given to installing a catch basin in the side yard and repairing or replacing the existing culvert.
- 421 Parkwood Street: Construction of a stone retaining wall in the south neighbor's yard is causing the owners gravel driveway to regularly erode. Installing a catch basin connected to the Dexter stormwater pipe may help manage runoff.
- 2651 Hollywood Drive: The installation of a catch basin with a dry well that is connected to the existing storm sewer could help store and infiltrate water before it enters the storm system, potentially reducing local flooding. The dry well would provide temporary water storage, allowing gradual infiltration into the ground and reducing the load on the storm sewer system.

In addition to the use of catch basins, incorporating green infrastructure can further enhance stormwater control by promoting natural infiltration, reducing runoff volume, improving water quality, and mitigating the risk of flooding.

- 466 Evergreen Drive: A bioswale with an underdrain may help manage water accumulation near the sidewalk due to the intermediate low point in the road causing standing water at the foot of the driveway and sidewalk.
- 486 Barber Avenue: Runoff challenges are causing flooding in the garage and basement which may be addressed by extending the stormwater pipe from the northern culvert to nearby dry wells to mitigate overflows and protect surrounding properties from flooding.
- 460 Parkwood Street: A low point in the road is causing water to collect at the bottom of the residents' driveway. By running a stormwater pipe to Dexter and connecting it to the Dexter ditch, a drainage system can be developed to aid in runoff management, even during intense rainfall events.

Estimated Cost: $533,000

Maintenance and Inspections

Regular maintenance and inspections are important components of a functional drainage system. The following locations may benefit from continued or enhanced maintenance efforts. These suggestions are subject to feasibility, available resources, and further assessment:

- 2840 Dexter Road: To prevent blockages and maintain proper water flow caused by an over excavated ditch, the ditch on the north side of Dexter Road should be regularly cleaned out.
- 2750 Valley Drive: Drainage flows to the low points in the right of way and maintaining the existing buried culvert could prevent blockages and maintain efficient drainage during heavy rainfall.

- 460 Parkwood Street: Grading within the greenbelt may help water be directed to the nearby catch basins and mitigate flooding that is remaining in the residents' driveway due to low points in the road.
- 3261 Ravenwood Avenue: Stormwater is accumulating in the rear side yard and eventually spilling to the low points of Ravenwood Avenue which involves further examining the downstream path to check for any potential problems.
- 2651 Hollywood Drive: The catch basin may benefit from frequent video inspections to monitor its condition and identify any blockages or damage that may hinder its functionality and cause the stormwater from neighbors draining to the east side of the property.

Estimated Cost: N/A



Figure 2: Catch basin full of blockages at 2651 Hollywood Drive.

Table 1: Individual scale issues and recommendations. *

Location	Issues	Recommendation	Estimated Cost
2840 Dexter	Ditch along Dexter was re-graded to low in August 2023 causing water to sit before flowing out.	Clean out ditch on the north side of Dexter Road.	Maintenance
2750 Valley	Drainage from Valley pools in the low point in the right of way. Unable to take advantage of existing culvert since it is buried.	Maintain existing culvert.	Maintenance
460 Parkwood	The bottom of the driveway holds standing water due to low point in road.	Grade greenbelt to direct water into catch basins.	Maintenance
3261 Ravenwood	The property owner reports that stormwater accumulates in the east rear/side yard during storm events and eventually spills north toward Ravenwood. The portion of Ravenwood at northeast corner of property appears to be low point.	Look at the downstream path to check for problems	Maintenance
2651 Hollywood	Stormwater from neighbors to the south and east drain into east side of property.	Catch basins would need video inspection to increase frequency of maintenance.	Maintenance
785 Kuehnle	Abandoned well in the southwest corner of property discharges water and causes standing water.	Property owner to contact the County Health Department to discuss well abandonment.	Property Owner Responsibility
713 Kuehnle		Not in public right of way or caused by public right of way.	
2855 Dexter	Drainage off Dexter and Glenwood pools in resident's driveway and side yard and holds standing water. The cross tube under Dexter is unclear if it is still functioning.	Regrade side yard to direct drainage into outfall.	Property Owner Responsibility
421 Parkwood	Construction of a stone retaining wall by south neighbor is causing upstream water to concentrate at a poor location, causing gravel driveway to erode	Regrade southern property to direct stormwater to road.	Property Owner Responsibility
315 Barber	Property is not graded to convey water to the existing catch basin in the right of way.	Private property owners could explore on-site regrading.	Property Owner Responsibility
2840 Dexter	Ditch along Dexter was re-graded to low in August 2023 causing water to sit before flowing out.	Regrade Dellwood ditch to allow for better drainage.	$20,000
305 Glenwood	Edge of road not draining to catch basin in greenbelt.	Fix grading to structure from roadway to curb inlet.	$13,000
466 Evergreen	Intermediate low point in road results in stormwater collecting at foot of property owner's driveway and sidewalk (and foot of south neighbor's driveway). Dry well/pump access in right of way in front of house.	Add a catch basin to connect low point with stormwater pipe.	$113,000
		Add a bioswale (with underdrain) next to the sidewalk.	$20,000
3261 Ravenwood	The property owner reports that storm water accumulates in the east rear/side yard during storm events and eventually spills north toward Ravenwood. The portion of Ravenwood at northeast corner of property appears to be low point.	Repair or replace culvert.	$10,000
		Catch basin in the side yard on the south side; connect to stormwater pipe.	$110,000
421 Parkwood	Construction of a stone retaining wall by south neighbor is causing upstream water to concentrate at a poor location, causing gravel driveway to erode	Install a catch basin and connect to Dexter stormwater pipe.	$100,000
2651 Hollywood	Storm water from neighbors to the south and east drain into east side of property.	Install a new catch basin with Dry Well in the side yard, then connect to existing sewer.	$35,000
486 Barber	Basement and garage flooding.	Reclaim right of way for drainage and extend stormwater pipe from the north culvert to City dry wells.	$35,000
460 Parkwood	Bottom of driveway holds standing water due to low point in road	Run stormwater pipe up Dexter and connect to Dexter ditch.	$110,000
		TOTAL ESTIMATED COST:	***$566,000***

** Prices are estimated using 2025 rates.*

2.2 LOCAL SCALE

Local-scale recommendations identify specific intersections and roadway segments where stormwater issues may potentially be addressed through mid-scale maintenance and mitigation strategies. These could include grading, lowering roadway elevations, reclaiming public right-of-way for drainage ditches and culverts, installing curbs and gutters, adding catch basins, or creating detention areas to help manage flooding and standing water. In certain cases, the City may consider maintenance activities.

Advantages of performing local scale solutions include allowing areas to be examined, and more efficiently eliminating flooding in connecting areas. It targets specific intersections and road segments allowing for detailed examination of areas of concern that may not be met with broader community initiatives. By concentrating on specific areas, local strategies can additionally be implemented more effectively and can lead to significant reductions in standing water and flooding. Connecting culverts and reclaiming the right-of-way for ditches can enhance the flow of stormwater and minimize blockages that may contribute to flooding. However, there are still many disadvantages to local solutions in comparison to more wide scale solutions. Local solutions are still lacking in properly being able to manage broader hydrological dynamics and upstream or downstream drainage may result in flooding. Inconsistency between areas can vary in quality and effectiveness which may result in patchy improvements or areas may need ongoing maintenance from the City which may not be met.

The estimated cost for the proposed local scale improvements is approximately $497,000, as seen in Table 2, not including any additional maintenance activities that may be performed by the City.

Roadway Grading and Drainage Improvements

Grading and drainage improvements play a vital role in preventing flooding, erosion, and water damage to roads, properties, and infrastructure. Proper grading ensures that surfaces are sloped appropriately, directing water away from roads, buildings, and low-lying areas toward designated drainage systems. By managing the flow of stormwater, grading, and drainage measures safeguard communities from costly damage, enhance public safety, and promote long-term sustainability in urban and rural environments.

- Dexter Road and Dellwood Drive intersection: Standing water in the ditch is contributing to localized yard flooding. The area could potentially be regraded to promote positive drainage from the road into the adjacent ditch system, which connects to the Glenwood stormwater pipe. Recontouring the ditch, if feasible, may help manage stormwater volumes more effectively. Continued routine maintenance, such as ditch and culvert cleaning and periodic video inspections, may also help prevent future blockages.
- Clarendon Drive and Valley Drive intersection: Persistent flooding in the area may be addressed by regrading the roadway to remove intermediate low points that have developed over time, particularly near driveways. The regrading process should create a continuous slope that channels stormwater toward designated drainage outlets, reducing the potential for standing water. Additionally, lowering the overall roadway surface elevation, where appropriate, will facilitate more efficient runoff while ensuring a gradual transition to surrounding areas.

Estimated Cost: $335,000

Water Retention/Detention and Grading Strategies

Water retention and detention strategies can help manage runoff, reduce flooding, and protect infrastructure by temporarily capturing, storing, and gradually releasing stormwater to prevent sudden surges in drainage systems during heavy rainfall. To potentially help alleviate flooding issues, grading should be revised and detention or retention solutions that can significantly reduce standing water could be implemented at the following locations:

- East of Clarendon Drive: Runoff from Valley Drive appears to drain into yards and cause ice and algae growth in the winter and summer months, respectively.
- West side of Rose Drive: Water flowing from Dupont Circle is reported to cause excess standing water in the backyards of properties during storm events.

Regrading the area to establish proper slope may be beneficial to the area as it will ensure that stormwater flows efficiently toward designated outlets, eliminating low points where water tends to accumulate. Installing detention basins can temporarily store runoff and slowly release it into the drainage system, preventing floods and easing the load on downstream infrastructure. Retention ponds or bioretention systems could also be used to naturally infiltrate water into the ground, promoting groundwater recharge and filtering pollutants. These solutions would require further engineering analysis to determine design needs and cost.

Estimated Cost: Further Investigation Required

Stormwater Infrastructure Enhancement

Enhancing stormwater infrastructure — such as adding curbs, gutters, and catch basins—can improve stormwater capture and redirection, minimizing impacts to adjacent properties. Strategic upgrades at key intersections can significantly enhance stormwater control and resilience in flood-prone areas.

- Evergreen Drive and Valley Drive intersection: The addition of curbs and gutters will guide stormwater to designated drainage points and reduce the runoff that is currently being caused from the water flowing from the west of Valley Drive and into neighboring yards due to the lower elevation.
- Glenwood Street and Valley Drive intersection: Curbs and gutters, along with a catch basin at the intersection, could provide earlier stormwater capture, reducing surface accumulation and mitigating flood risks. The catch basin would also help intercept debris and reduce the likelihood of blockages.

Estimated Cost: $108,000

Right of Way and Connectivity Improvements

Maintaining and reclaiming public right-of-way is important for long-term stormwater management. Restoring ditches and culverts within the right-of-way may support improved stormwater flow and infrastructure access.

- Clarendon Drive and Valley Drive intersection: Reclaiming the public right-of-way in this area may allow for the restoration of ditches and the addition of connecting culverts. This would involve clearing overgrown vegetation, removing obstructions, and reshaping ditches to their original design specifications. Properly sized and maintained ditches and culverts would facilitate the efficient conveyance of stormwater away from roadways and properties, reducing the risk of pooling and erosion. Reclaiming the right-of-way would additionally provide easier access for routine inspections, cleaning, and repairs, which are essential for the long-term performance of stormwater infrastructure.

Estimated Cost: $54,000

Maintenance and Inspections

Routine maintenance and inspections may be necessary to maintain the functionality of existing infrastructure and reduce flood risks. The following locations have been identified where such efforts might be beneficial:

- Evergreen Drive and Valley Drive intersection: The storm drain at the edge of the intersection is blocked and needs to be maintained to be able to effectively manage runoff towards the low points in neighboring yards.
- Dexter Road and Dellwood Drive intersection: The culverts and ditches need to be cleaned out as well as the downstream pipes. Video inspections of the downstream pipes will be needed regularly to ensure there are no blockage or maintenance requirements.

Estimated Cost: N/A



Figure 3: Over-excavated ditch at the Dexter Road and Dellwood Drive intersection.

Table 2: Local scale issues and recommendations. *

Location	Issues	Recommendation	Estimated Cost
Dexter Road & Dellwood Drive Intersection	Water sitting in ditch causing front yards to hold standing water due to inadequate drainage.	Clean out culverts/ditches. Video and clean downstream pipes, as necessary.	Maintenance
Evergreen Drive & Valley Drive Intersection	Water flowing from west of Valley Drive pools in neighboring yards due to its low elevation. The storm drain at the edge of the intersection is also blocked.	Maintain storm structures.	Maintenance
East of Clarendon Drive	Water from Valley Drive drains in yards causing solid ice and algae growing in winter and summer months.	Revise grading and/or provide detention/retention to minimize or eliminate standing water.	See Regional Recommendation
Rose Drive - West side	During storm events, water from Dupont Circle flows into the backyards of houses causing excessive standing water.	Revise grading and/or provide detention/retention to minimize or eliminate standing water.	Further Investigation Required
Dexter Road & Dellwood Drive Intersection	Water sitting in ditch causing front yards to hold standing water due to inadequate drainage.	Grade to ensure positive drainage away from the road into ditch, which drains into Glenwood stormwater pipe	$15,000
Clarendon Drive & Valley Drive Intersection	Standing water in driveway when it rains due to road being built up over time.	Regrade the local roadway to eliminate intermediate low point.	$135,000
		Lower the roadway surface elevation.	$185,000
		Reclaim right of way for ditches and connecting culverts.	$54,000
Evergreen Drive & Valley Drive Intersection	Water flowing from west of Valley Drive pools in neighboring yards due to its low elevation. The storm drain at the edge of the intersection is also blocked.	Add curbs to keep water on the road and out of yards.	$26,000
Glenwood Street & Valley Drive Intersection	Water flows down Valley Drive from the west causing roadway drainage in front yards.	Upgrade intersection with curb and gutter to keep stormwater on road.	$28,000
		Add a catch basin to allow water to enter system sooner.	$54,000
		TOTAL ESTIMATED COST:	**$497,000**

** Prices are estimated using 2025 rates.*

2.3 REGIONAL SCALE

Regional-scale recommendations focus on broader areas of concern, such as entire road segments or multiple intersections, where flooding may be addressed through large-scale stormwater management strategies. Potential improvements could include enlarging or installing stormwater pipes, regrading roadways, adding curbs and gutters, and constructing detention basins. However, implementation of such infrastructure typically requires detailed investigation to determine feasibility, effectiveness, and appropriate stormwater routing.

Advantages of working at a regional scale compared to local or neighborhood wide include addressing larger areas to interconnect sub watersheds, resulting in more effective management of flooding. Larger scale stormwater management practices can also be more effective against increased rainfall and extreme weather conditions that may take place. However, there are disadvantages to working at a regional level, which include large upfront costs, longer implementation timelines, and increased complexity in permitting, public coordination, and maintenance. Additionally, limitations to the design can include community resistance to a larger construction process around their properties, as well as any potential gaps in data that may hinder the overall development.

The total estimated cost of implementing all the current recommendations for regional solutions is $2,760,000, as seen in Table 3. This does not include costs associated with further investigation, design, or ongoing maintenance.

Stormwater Infrastructure

To address persistent flooding issues, several stormwater infrastructure upgrades are proposed throughout the area:

- Dexter Avenue: Installation of a new, larger-diameter stormwater pipe extending westward toward M-14 is being considered to accommodate higher water volumes and enhance drainage. This work may potentially be coordinated with planned sidewalk construction in the right-of-way to reduce disruption and maximize efficiency.
- Dupont Circle and Barber Avenue area: Stormwater currently flows west down Dexter, then south along Barber, and eventually accumulates in low-lying sections of Dupont Circle. To manage this, an extended stormwater pipe is recommended to be constructed through Barber Avenue and the cul-de-sac, connecting to an outlet south of Valley Drive, which would intercept and redirect water earlier in its course.
- Rose Drive, south of Kingwood Street: A new stormwater pipe could be extended south toward I-94 to provide an outlet for trapped runoff and alleviate standing water near the dead end of Rose Drive. This improvement would be subject to design review, right-of-way constraints, and downstream capacity analysis.

Estimated Cost: $1,260,000

Water Retention and Detention Strategies

To effectively manage excess runoff and reduce localized flooding, several water retention and detention strategies are being considered across key areas.

- Evergreen Park: The installation of detention basins and other best management practices are proposed to address standing water issues, particularly in the eastern portion of the park. The site has the potential to be regraded and engineered to split drainage—diverting half of the water northwest and the other half eastward — thereby improving water distribution and minimizing pooling.
- Intersection of Barber Avenue and Kingwood Street: Additional detention or retention features are recommended to manage stormwater that naturally flows from surrounding areas and Evergreen Park into low-lying private parcels. This area is prone to water accumulation and would benefit from improved storage capacity, though further site evaluation is required to determine optimal design solutions.
- South of Valley Drive and Barber Street: Plans include the construction of a detention basin and accompanying stormwater infrastructure to capture and convey runoff from the adjacent neighborhood to an outlet under I-94. The land south of this intersection is currently underutilized and offers a strategic opportunity for stormwater storage. Runoff could be directed to the highway ditch south of I-94, which has the capacity to accept additional water and help relieve persistent standing water problems in the southwestern portion of the neighborhood.

Estimated Cost: Further Investigation Required

Grading and Drainage Control

Proper grading and drainage ensure stormwater is effectively directed away from roads and structures. Proposed grading improvements target areas where existing elevations contribute to water pooling and drainage inefficiencies.

- Valley Drive: Regrading is proposed to correct current elevation issues where the roadway sits higher than adjacent driveways, which causes stormwater to pool and remain trapped in residential areas during rain events. By lowering the road elevation relative to surrounding properties and installing curb and gutter systems, surface water may be more efficiently collected and directed into the stormwater network, reducing the risk of flooding and improving safety for pedestrians and vehicles.
- Barber Avenue and Kingwood Street intersection: Grading revisions are being considered to address drainage problems caused by uneven terrain and low-lying areas. While further site investigation is needed to determine the extent and type of grading adjustments required, early assessments suggest that recontouring the land could help redirect stormwater away from problem areas and toward designated retention or detention systems.

Estimated Cost: $1,500,000

Table 3: Regional scale issues and recommendations.

Location	Issues	Recommendation	Estimated Cost
Evergreen Park	Existing pathways divide drainage issues, with the potential to drain half of the standing water in park area to the northwest and half to the east.	Install detention basins and/or other best management practices to manage local standing water in east of park.	Further Investigation Required
Barber Avenue & Kingwood Street	Drainage flows to a natural low spot on these parcels from the surrounding area and Evergreen Park.	Revise grading and/or provide detention/retention to minimize or standing water.	Further Investigation Required
South of Valley Drive & Barber Avenue	The highway ditch to the south is underutilized and could accept water from the neighborhood to alleviate standing water issues in the southwest.	Add detention basins and storm infrastructure to route water from neighborhood and outlet under I-94.	Further Investigation Required
Dexter Avenue - West Outlet	The City is adding sidewalk along the right of way of Dexter. This presents an opportunity to add drainage improvements while the area is already disturbed.	Add stormwater pipe up Dexter to the highway and enlarge the existing stormwater pipe to handle the increased flow.	$600,000
Valley Drive	Road is higher than surrounding driveways and properties, but the general vicinity is a low point.	Regrade (lower) all of Valley to eliminate standing water. Add curb and gutter.	$1,500,000
Dupont Circle & Barber Avenue	Standing water found in two yards in the neighborhood from water flowing across Barber and heading down Dupont Circle.	Extend the stormwater pipe through Barber and the cul-de-sac to the outlet south of Valley.	$410,000
Rose Drive - South of Kingwood	Between the dead end of Rose Drive and Kingwood, water remains for extended periods of time.	Run a stormwater pipe to the south from Kingwood intersection to discharge near I-94.	$250,000
		TOTAL ESTIMATED COST:	***$2,760,000***

** Prices are estimated using 2025 rates.*

2.4 NEIGHBORHOOD-WIDE SCALE

Pave All Roads and Add Stormwater Infrastructure

Recommendations at the neighborhood-wide scale, which encompass the entire study area, represent the most extensive approach to mitigate flooding in the phase one study area. The issue at large stems from rain events causing standing water on main roads and properties, which may lead to unsafe driving conditions. The main recommendation for the area is pave all roads and add curb, gutters, and stormwater pipes. Preliminary estimates suggest that implementing this strategy may cost approximately $7,500,000. If completed as designed, these improvements may significantly reduce the presence of standing water across the area.

The major disadvantages to this recommendation are the large cost and long construction process. The pavement can also increase surface runoff and contribute to urban heat island effect, causing environmental impacts. Paving all the roads could additionally require more frequent repairs due to extreme temperatures and increased noise pollution in the area that many property owners may be concerned about. The property owners in the area may also object to a long construction process that will increase traffic and disrupt local businesses. Despite these challenges, such improvements may offer significant benefits. These could include enhanced road safety due to smoother surfaces, improved stormwater drainage, and reduced flooding and erosion risks. Additionally, the elimination of unpaved roads may contribute to better air quality by reducing dust and debris.

Estimated Cost: $7,500,000

Table 4: Neighborhood-wide scale issues and recommendations.

Location	Issues	Recommendation	Estimated Cost
Phase One Study Area	Rain events cause standing water on main roads and on homeowners' property leading to unsafe driving conditions.	Pave all roads, add curbs, gutters, and stormwater pipes.	$7,500,000
		TOTAL ESTIMATED COST:	***$7,500,000***

SSECTION 3.0 - PROJECT HISTORY

3.1 PROJECT BACKGROUND

The City of Ann Arbor received complaints regarding drainage issues on the gravel roads under their jurisdiction. The roads were designed before these areas were annexed into the City, resulting in many not adhering to the City design standards. While localized efforts have been made to address these drainage issues, there had not yet been a comprehensive approach to stormwater management.

In response to these ongoing concerns, the City of Ann Arbor initiated a four-phase study aimed at evaluating the existing drainage systems along the 13 miles of unpaved City streets. This project involved a dedicated study team tasked with gathering data, engaging with residents, and formulating recommendations for each phase to enhance current conditions.

The proposed recommendations vary widely, potentially including traditional options such as paving and storm pipe installation, as well as innovative approaches that incorporate green infrastructure. The focus for the four-phase study is on unconventional recommendations, such as grading for drainage control, implementing stormwater infrastructure, creating local retention and detention basins, and reclaiming the right of way for connectivity improvements. The goal is to develop recommendations that align with the designed storm intervals; however, in instances where this is unfeasible, smaller-scale issues may still be addressed and alleviated.

The recommendations also aim to address climate adaptation and resiliency. In the past decade, severe flooding has increased across central North America, resulting in widespread damage. Specifically, since 1951, there has been a 14% increase in precipitation across the Great Lakes region causing a 35% increase in the frequency of heavy storms and major widespread flooding. Snow falls later in the year and melts earlier, resulting in rapidly melting snow on frozen ground, which causes flooding that carries road salt, sediment, and other contaminants towards streams.

Throughout the four-phase duration of the study, different segments of the 13 miles of gravel roads are being systematically examined, as detailed in Table 5. This comprehensive approach is intended to create a more sustainable and effective drainage system for the community.

Table 5: Area of interest over the four-phase project duration.

General Location	Phase	% of City Maintained Gravel Roads
Valley Drive/Evergreen Subdivision	1	30%
Kimberley, Alexandra, Swift Run Area	2	26%
North and South Geddes Area, Westover/Park Lake Area	3	26%
Chalmers, Elmwood, Other Areas	4	18%

3.2 PUBLIC ENGAGEMENT HISTORY

With over 400 calls from residents about road conditions and stormwater related concerns, the study team developed a public engagement process to ensure the residents had the opportunity to discuss specific concerns for their properties. For each phase of the study, the following process is followed:

- Open the Gravel Roads Drainage Observation Report (mapping tool) and provide a link to the City's project website.
- Send postcards to residents to notify them of the study and future opportunities for input.
- Host a public listening session to introduce the study scope and engage resident feedback.
- Schedule in-person, one-on-one discussions with residents over a one to three-day period.
- Schedule open office hours over a 1 to 2 day period.
- Schedule an Open House to discuss phase one recommendations.

Throughout the public engagement process, the study team collected photo documentation of locations of specific concerns, and other vital information to help the City staff and officials to make the best informed decisions for future stormwater management systems. Locations of concerns were submitted by the residents through a GIS web base, as well as identified by the projects study team during one-on-one meetings with the residents.

Public Listening Session

The public listening session for phase one of the Gravel Road assessment took place on November 30, 2022. This virtual meeting was held to present information on the Gravel Roads Drainage Management Study for the City of Ann Arbor. The meeting was conducted by Community Engagement Specialists, Michelle Bennett and Heather Seyfarth, Water Quality Manager, Jennifer Lawson, and Public Services Administrator, Brian Steglitz. Additionally, Council Members from Ward 5, Council Member Briggs and Council Member Cornell, were also in attendance.

The goal of the meeting was to provide the public with opportunities to discuss their issues in the Valley Drive/Evergreen Subdivision and help determine the scope and direction of the study. The meeting was structured to ensure productivity and efficiency while encompassing a stormwater management overview, discussion of the Valley Drive/Evergreen Subdivision drainage history, facilitation of resident inquiries, and establishing realistic expectations for the study's progression.

A timeline of Evergreen's stormwater history was presented to attendees to provide context on previous studies, plans, and implementations, as well as emphasizing the importance of long-term approaches to deliver sustainable stormwater management solutions for the future. This meeting marked a pivotal step in fostering community engagement and inclusivity that is essential for achieving a positive outcome for the Gravel Roads Drainage Management Study. The information presented during the public listening session, as well as the link to the meeting video, can be found in Appendix A.

Drainage Study Webpage

To support ongoing engagement, the City of Ann Arbor developed a dedicated webpage in the City website for the Gravel Roads Drainage Management Study. This web page, as seen in Figure 4, outlined the project scope, timeline, geographical limits, engagement opportunities, interactive

maps of the area, and allowed users the option to subscribe for notifications of project updates. Additionally, the project manager's contact information was provided on the page to facilitate community outreach, as well as the previous, current, and upcoming engagement opportunities. This detailed web page outlined the drainage issues, localized flooding, and standing water affecting numerous subdivisions within the City and explained how this study would benefit the community. The community was able to address their individual drainage concerns and stay updated with the previous meetings and presentations.

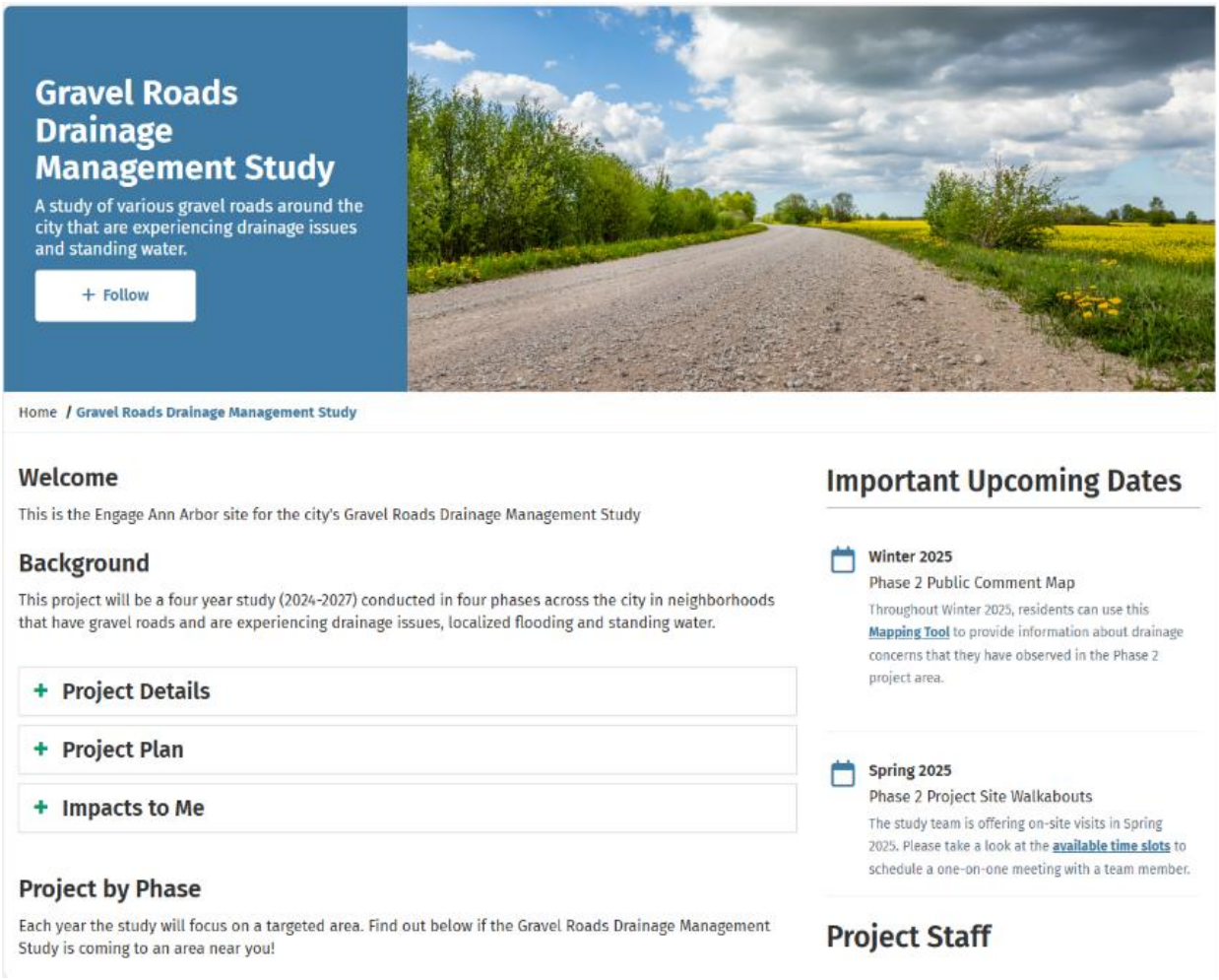


Figure 4: The City of Ann Arbor's web page for the Gravel Roads Drainage Management Study (Gravel Roads Drainage Management Study | Engage Ann Arbor).

Drainage Hub Interactive Map

As part of the public engagement strategy, a public engagement website was created that includes a drainage study hub to allow residents to submit drainage issues seen on their property that could be studied by the project team. The drainage hub interactive map illustrated the existing conditions of the roads with input from residents being prioritized. Clear and comprehensive instructions were provided to use the interactive map, as seen in Figure 5. The interactive map allowed residents to

submit their observations as an image or as text explaining the issue to provide context about the drainage concerns in the area. By submitting an observation, the specific address was added to the study and reviewed by City staff and the study teams. A baseline schedule for the community to see when their area would be studied over the four-phase span of the project was also included within the Drainage Hub, as above in Table 5.

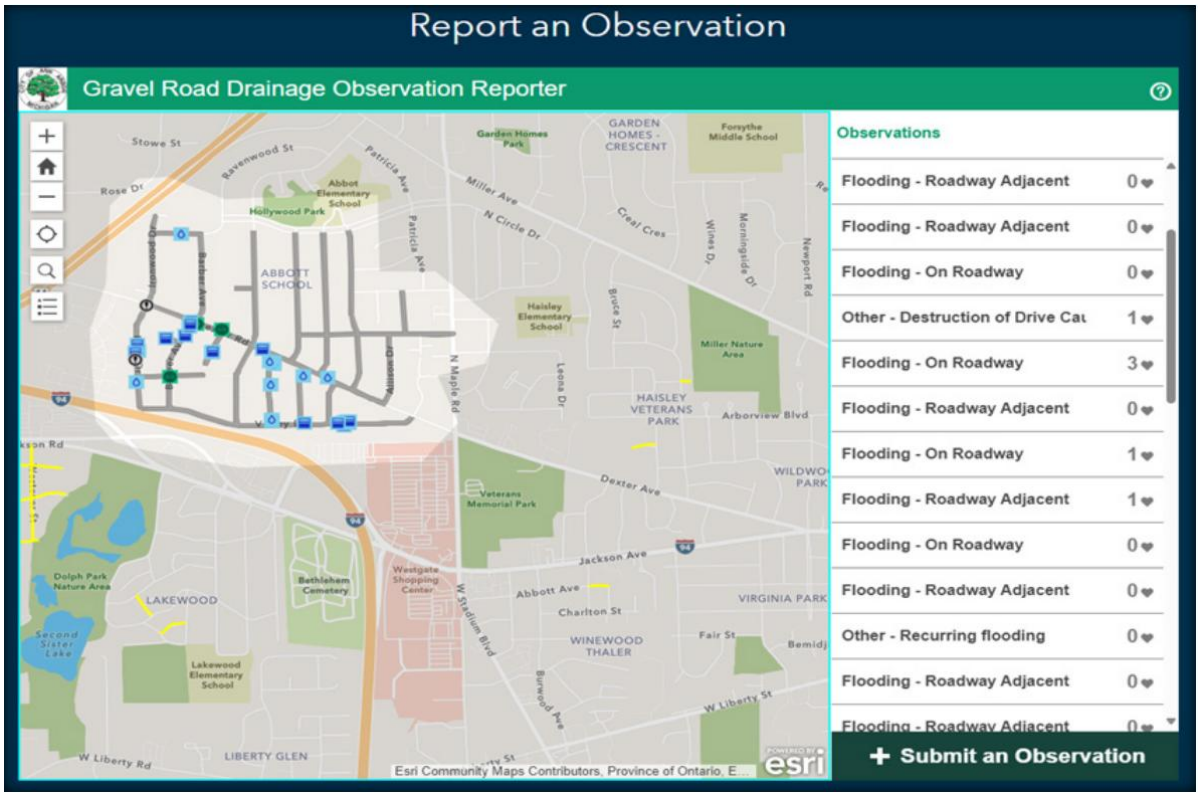


Figure 5: Interactive map window used for observation reporting for the Valley Drive/Evergreen Subdivision (AA Gravel Rd Drain Study Hub).

All submissions were recorded and analyzed based on road conditions, locations, and weather. Table 6 outlined the street name, and the type of observations recorded for those locations. For the Valley Drive/Evergreen Subdivision, a total of 39 comments were documented and analyzed. Among the submissions, 12 observations were related to flooding or standing water and 7 were reports in private yards. A total of 21 comments were related to weather conditions, with 16 being related to rainfall and 5 pertaining to snow melt.

Table 6: Display of streets in the Valley Drive/Evergreen Subdivision and the corresponding observation type.

Street Name	Observation Type
Rose Drive	Flooding (5) Standing Water (2)
Dexter Road	Flooding (2) Drainage Structure Failure (2) Standing Water
Kingwood Street	Drainage Structure Failure
Valley Drive	Flooding (9) Standing Water Debris in Roadway
Barber Avenue	Drainage Structure Failure Flooding (3)
Dupont Circle	Flooding
Parkwood Street	Flooding (2)
Glenwood Street	Standing Water (6)
Evergreen Drive	Flooding
Ravenwood Street	Standing Water

One-On-One Discussions

The project engagement team hosted one-on-one meetings to provide residents with the opportunity to meet with project staff. Notification of this opportunity was placed on eight signs throughout the subdivision with QR codes that directed residents to the sign-up page. During these meetings, participants were given the opportunity to explore the designated project areas, allowing them to observe and articulate their concerns regarding maintenance and drainage issues. Specifically, they served as a valuable opportunity for project leaders to actively engage with community members, gather feedback, address any questions or concerns, and foster transparent communication and community engagement. The three days of scheduled one-on-one meetings were conducted on the following dates:

- April 24, 2024, from 3 p.m. to 7 p.m.
- April 26, 2024, from 3 p.m. to 7 p.m.
- April 27, 2024, from 3 p.m. to 7 p.m.

Each one-on-one discussion was approximately 15 minutes long. In total, 18 appointments were scheduled over the three day period, with additional residents without appointments also engaging with staff.

In addition to the one-on-one discussions, virtual office hours were held by John Balint (HRC), project manager. These office hours were held on May 7, 2024, from 12 p.m. to 2 p.m. and May 9, 2024, from 4 p.m. to 6 p.m. Throughout the available time period, no residents signed up or attended the meeting.

On May 21, 2024, the City began to review the data collected by residents during the one-on-one discussions. Throughout the discussion, emphasis was placed on the availability of the digital mapping tool and community members were encouraged to utilize the drainage hub website to upload photos and provide comments regarding any concerns with the phase one study area limits. The data collection period closed for this feature on May 24, 2024.

Open House

The Valley Drive/Evergreen Subdivision phase one study area for the Ann Arbor Gravel Roads Drainage Management Study concluded with an open house on October 16, 2024, at 6 p.m. at Abbot Elementary School. The event was attended by 40 residents of all ages and offered the residents of the area an opportunity to learn about the purpose and progress of the study.

During the open house, an in-depth description of the project and a review of prior public engagement efforts were given to the attendees. The presentation detailed the history of the Gravel Roads in Ann Arbor, as well as providing residents with a basic understanding of the different types and the importance of stormwater management techniques. Additionally, the key findings and plans specific to improving the stormwater management practices for the Valley Drive/Evergreen Subdivision were discussed.

A tabletop 3D model was developed for phase one that showed topography, roads, and existing buildings in the area. A recommendation table was also presented that addressed all potential improvements on the individual, local, regional, and neighborhood-wide scale. To engage the residents during the meeting, a round-robin brainstorming session allowed the attendees to move freely through stations, ask questions, and share feedback directly with the project team. Additionally, residents were invited to participate in a visual feedback exercise by placing green or red stickers on the regional recommendations for the ideas they supported and opposed. The full recommendations table and the results of the exercise can be found in Appendix B and C, respectively.

SECTION 4.0 - DRAINAGE STUDY

4.1 TEAM ROLES

To ensure the successful and timely completion of this project, six specialized teams were established, each focusing on a distinct task. This strategic approach allowed each team to concentrate on their specific tasks, thereby enhancing efficiency and minimizing redundancy in work hours. This structure was additionally designed to prevent capacity issues that could have potentially disrupted the project's budget and schedule. By organizing the teams in this way, we facilitated simultaneous efforts on multiple fronts, enabling them to progress in parallel rather than sequentially, which not only accelerated the overall project timeline but also optimized the use of resources from each firm involved.

TEAM 1 – Administration (HRC)

As the primary contractor, HRC was tasked with overseeing the entire team and met regularly with the City to ensure effective communication. HRC was responsible for producing all reports, coordinating work, and managing the project's scope, budget, and schedule. This included organizing kickoff meetings and conducting regular project update meetings with staff.

TEAM 2 – Survey and Base Drawings (Spicer)

Since Spicer Group is a national leader in surveying and mapping technical services, they used their expertise in mobile LiDAR scanning to produce survey-grade point clouds for all rights of way and produced working drawings of each area. LIDAR scanning allowed for significantly more data to be captured along a right-of-way than with traditional surveying methods. This information was used to identify areas of known drainage concerns as a part of the study. The data was extracted for each study area in the phase it was focused on. With the remaining data still being valuable for future designers, City staff could respond to the issues in between the project and CIP implementation and verify any resident claims from their perspective with real data without sending a crew out for additional survey. The base drawing for each area included a combination of aerial maps, survey data, property lines from the City, existing utilities, known complaints from the City's database, and historic soil boring locations. Additionally, each sheet had space available to add photo documentation and notes from the field investigation, as well as add details, graphics, and notes of a proposed solution. The overall drainage maps were further developed to show tributary areas of each study area so solutions that were not easily shown on street-level plans could be highlighted.

TEAM 3- Modeling, Design Criteria, Climate Resiliency (LimnoTech)

LimnoTech was tasked with creating detailed 2D rain-on-grid models (PC-SWMM) for sub-catchments with drainage challenges related to gravel roads. These models were built on the existing stormwater framework that outlined the local stormwater infrastructure. The 2D model ran for a series of design storms (e.g., 1 through 100-year return period rainfall frequency for multiple durations – 1 through 24 hours) to identify areas of model-predicted flooding. Topography for the 2D model was based on high-resolution LiDAR data that was collected along the roadways. This data was stitched together with USGS high-resolution DEMs for areas where the linear LiDAR data collection did not cover. The resulting model was used to predict flooding depths for the design

storms and identify if the model was detailed enough to predict flooding in areas of inadequate drainage. The performance was then verified with the identified drainage issues seen by City staff and the public.

Specifically, LimnoTech took the lead in conducting comprehensive hydraulic analyses and prepared detailed written reports for the proposed stormwater improvements. These enhancements were designed to tackle critical water quality issues while effectively managing the volume of rainfall during smaller, more frequent storm events. Additionally, the improvements focused on peak flow attenuation during larger storm design events, ensuring that the system could manage increased water flow without overwhelming local infrastructure.

TEAM 4 – Field Investigation (all firms split into teams)

Field investigation was primarily completed by HRC, with support from LimnoTech and Spicer Group. This involved identifying areas of known drainage concern and then proposing and implementing public engagement and communication strategies with the residents of the area in each identified area of study. To begin the phase one study area, duplicate field investigations were conducted to ensure the technology and process worked. This initial investigation was independently performed by HRC and did not involve residents or stakeholders. Performing the first inspection independently allowed field investigators to better understand the drainage issues at hand without the opinions and priorities of stakeholders and property owners. City maintenance staff were also able to meet and discuss their knowledge of each street's issues. For the second investigation, a minimum of 20 individual stakeholders were met onsite to collect anecdotal drainage concerns per study area. The meeting was used to inform the consultant of specific drainage concerns from the stakeholders. The two inspections allowed gaps in information to be filled in, as it was ideal to do fieldwork during or immediately after a rain event, which was not always feasible.

HRC's project team created a GIS tool to perform field investigations, which included photo documentation. The GIS tool allowed data to be collected for each property for both inspections taking place in the phase one study area. The GIS files were cross-referenced with an overlaid base map with icons and reference numbers for each inspection location. Each area was documented from a ground perspective to confirm model, complaint, and staff recollection of issues and search for unmistakable evidence of standing water, washouts, erosion/sedimentation, flow paths, and vegetation markers.

TEAM 5 – Proposed Solutions (all firms)

The proposed solutions were led by HRC with support from LimnoTech and Spicer Group. This included pulling together the survey, base drawings, model outputs (existing, proposed, and resiliency design flows), and the results of the two field investigations to further discuss which of the proposed areas needed to be addressed. The areas of concern were then given options for improvements, and the creation of an overall strategic plan was developed. The proposed solutions were added to the base street and sub watershed level drawings, with written descriptions of each area and supporting information.

Furthermore, Team 5 was tasked with identifying areas where drainage solutions were needed, assessing the area, and proposing opportunities for both green and gray infrastructure to address

surface flooding concerns raised by residents. They evaluated road drainage and determined whether modifications to existing stormwater systems were necessary within the project area. Additionally, they developed strategic plans for each identified study area, encompassing a range of actionable recommendations, and conducted hydraulic analyses while preparing written reports on the proposed stormwater improvements.

Team 6 – Public Engagement (HRC)

HRC oversaw all public engagement and communication with the City's specialists. This involved completing the City's PR Toolkit, refining the stakeholder list, and clarifying the roles and responsibilities between the City and consultants. HRC also developed project materials in collaboration with the City, outlining the process and providing specific information about the study area to be evaluated.

Team 6 explored various outreach methods for property owners in the study area, including the City website, Next Door posts, direct mail, temporary street signs, and other communication strategies. Virtual open house meetings with stakeholders were organized for each study area to introduce the project, outline objectives, address unconsidered areas, discuss timing, and review the drainage study area.

Following Team 4's initial review, HRC conducted street walks with Tier 4 stakeholders, allowing technical staff to engage directly with property owners. After Team 5 completed its tasks, the engagement team hosted virtual Open House meetings for each study area to present findings, proposed solutions, and next steps. To address individual property concerns, virtual Office Hours were held for one-on-one discussions.

Team 6 was specifically tasked with creating and implementing public engagement strategies and facilitating both in-person and virtual meetings for each study area. This included exercises and presentations from the consultants that informed the public about the process and potential impacts, while also gathering feedback on their flooding experiences. Team 6 also worked with City staff to complete the City of Ann Arbor’s Community Engagement Toolkit for at least two hours, developed a stakeholder list for invitations, determined the best outreach methods, and collaborated with the City's Communications staff on project messaging and materials for approval and distribution.

Finally, Team 6 systematically documented public feedback, analyzed the data, and, if needed, presented the results creatively to the public. They prepared public information materials in partnership with the City's communications staff for approval and distribution.

4.2 TECHNICAL DATA – BACKGROUND

Watershed/Drainage Districts and Outlet Points

Watersheds, drainage districts, and outlet points are key concepts in stormwater management as they help define how water flows after a rain event and how best to manage it to prevent flooding, erosion, and water pollution. Each concept plays a vital role in designing and implementing effective stormwater management practices.

A watershed is an area of land where all the water from precipitation or runoff flows to a common outlet, such as a river or lake. This area includes the land surface, streams, rivers, and groundwater that contribute to the flow of water through the outlet point. The accumulation of water and the flow rate downstream are dependent on the size and characteristics of the watershed. By knowing the boundaries of the watershed, engineers can use them to play a significant role in stormwater management. Watersheds can be used for hydrologic modeling so engineers can determine where water is flowing and manage runoff at appropriate points, reduce pollution and protect ecosystems as pollutants can travel within the watershed, and can be used to identify flood-prone areas and design flood control infrastructure to mitigate the impacts of heavy rainfall. Management practices at the watershed scale can lead to designs that address runoff on a larger scale. This allows for water flow to be slowed and treated before reaching outlet points through practices such as detaining water through rainwater harvesting, green infrastructure, or retention/detention basins.

A county drainage district is a designated area that is created to manage the collection, division, and discharge of stormwater. The area is legally established and has a formal structure to oversee the maintenance of drainage infrastructure such as ditches, culverts, or storm sewers. These districts are established to manage runoff in agricultural, urban, or suburban areas and are used to focus on controlling water flow within its boundaries to determine the best-localized stormwater management practice. These practices can range from the construction of storm sewers, drainage districts, or culverts to direct water to outlet points or detention/retention basins. Additionally, drainage districts are significant in stormwater management as they manage flood-prone areas by implementing strategies to protect property and infrastructure, as well as enforcing local stormwater regulations including managing land-use practices and controlling impervious surfaces that may contribute to runoff. They also are responsible for the maintenance and operations of the infrastructures that convey stormwater, as proper maintenance is important for preventing blockages, reducing flooding, and ensuring water flows smoothly to its proper designation.

Outlet points are where water exists in a watershed or drainage system and flows into a larger body of water, such as rivers, streams, lakes, or oceans. The stormwater is discharged after being captured or conveyed with stormwater management practices. Outlet points play a significant role in stormwater management as the location can help determine the capacity and design of stormwater infrastructure as the points cannot manage larger flows which may contribute to further flooding, erosion, and water quality issues if not properly accounted for. Outlet points require regulatory agencies and permitting processes based on the quality and quantity of stormwater discharge into the body of water to ensure they meet certain standards to protect resources. As stormwater carries many pollutants, the location of the outlet is vital in managing water to prevent pollutants from entering important water bodies such as water sources, wetlands, and coastal environments. As outlet points serve as the destination for stormwater systems, they need to be able to manage the volume and water quality being discharged. This means using techniques like stormwater treatment at the point of discharge to help reduce environmental impacts.

Watersheds, drainage districts, and outlet points are fundamental in implementing stormwater management practices as they define water movement through an area and its endpoint. Effective stormwater management requires planning from engineers at the watershed and local levels to ensure proper techniques are used for large-scale hydrological processes and to maintain infrastructure and runoff control within drainage districts. Engineers and planners can design

systems that not only reduce flood risks but also improve water quality and protect natural resources when considering watersheds, drainage districts, and outlet points in their design.

Geotechnical Information

Geotechnical information plays a critical role in stormwater management, especially when implementing green infrastructure such as permeable pavements, rain gardens, bioswales, infiltration basins, and green roofs. These systems rely on specific soil and subsurface conditions that influence how water infiltrates, filters, and drains across a site. Geotechnical data provides key insights into soil texture, permeability, depth, groundwater levels, compaction, and bearing capacity. These factors help assess a site's suitability for infiltration-based solutions and guide system design.

The soil permeability is especially important for stormwater system designs as sandy soils allow water to infiltrate quickly and are ideal for rain gardens, infiltration trenches, and permeable pavements. Conversely, clay or compacted soils inhibit infiltration, making alternatives like detention basins or stormwater ponds more appropriate. High or shallow groundwater tables can also limit how much water can be stored or infiltrated, reducing the effectiveness of systems like infiltration basins and requiring stormwater to be managed through controlled release.

By preforming geotechnical evaluations, engineers can tailor stormwater systems to site-specific conditions and avoid long-term issues like clogging, erosion, or poor drainage. Knowing the characteristic can also implement designs that support climate resiliency. Soils like clay or silt retain moisture longer and help mitigate drought, while sandy soils are better for managing heavy rainfall due to their superior drainage. This knowledge helps inform system performance under changing weather patterns and ensure long-term functionality.

When matched to appropriate soil conditions, green infrastructure offers many benefits for stormwater management. Rain gardens work best in permeable soils that absorb runoff and filter pollutants. Bioswales slow and treat runoff using vegetation and porous soils. Infiltration trenches allow water to percolate through gravel and surrounding soil, while wetlands and stormwater ponds are effective in low-permeability soils where retention and treatment are needed.

For the Gravel Roads study, collecting and reviewing geotechnical data, recommendations that may be implemented within the City can be used to determine the most effective, sustainable solutions for each area. This not only ensures proper system performance and easier maintenance but also supports long-term resilience and environmental benefits.

4.3 TECHNICAL DATA

Mobile LiDAR Survey

Team 2 conducted a mobile LiDAR survey along the 13-mile stretch of roads using vehicle-mounted laser ranging technology. This approach captured precise, high-resolution data, creating a detailed 3D model of the road and its surroundings. The mobile mapping system efficiently gathered topographic surveys within the public right-of-way by quickly collecting visible assets. It should be noted that any items that were not visible to the mobile mapping unit, such as backyards and side yards, were not able to be collected with this process. The survey generated an extensive point cloud, which was processed to filter out extraneous data and classify points, enabling the creation of

AutoCAD base maps. In addition to AutoCAD base maps, a 3D viewer was used to view the point cloud for more detailed assessment.

These base maps highlighted essential features such as manholes, utility installations, curbs, guardrails, barriers, drainage ditches, and flow paths. After the base maps were created, a comprehensive analysis of the area's topography, drainage patterns, and low points were conducted. This analysis identified elevation changes and slopes, evaluated existing drainage systems, and located areas susceptible to flooding, aiding engineers in understanding how the system functioned.

The collected data and resulting drawings were crucial for the study's recommendations, providing valuable insights for road maintenance, improvement planning, and environmental management. This information supported informed decision-making and effective project execution.

2D Stormwater Model

The City's stormwater model underwent a comprehensive review to support the base data analysis conducted by Team 3. This review process involved an in-depth examination of the stormwater flows and volumes within the system. The City's stormwater model also served as a foundation for developing detailed 2D rain-on-grid models using PC-SWMM (a specialized stormwater modeling software). This model was initially developed and calibrated by CDM Smith from 2012–2015 and contained most of the City's drainage system, apart from any existing infrastructure near gravel roads.

Following review of the City's stormwater model, Team 3 created a sub model focusing on specific sub catchments within the phase one study area that were currently experiencing drainage issues. By simulating rainfall events in these targeted areas, the 2D models helped identify problem spots, assess the capacity of existing drainage systems, and evaluate potential improvements. This comprehensive approach aided in creating a more resilient and efficient stormwater management system for the City.

While the City's stormwater model was the foundation for the 2D model, Team 3 expanded the drainage system in the sub model by addressing data gaps and incorporating all inlets and catch basins within the study area using GIS data provided by the City. This data identified the locations of pipes and catch basins not included in the existing model. During this process, Team 3 identified numerous ditches and catch basins that were absent from both the existing model and the GIS data. Aerial imagery was used to locate and add several catch basins near Plum Market at North Maple Road and Dexter Avenue, as well as ditches and catch basins along Dexter Road. Missing pipe slopes and elevations were estimated using best professional judgment.

A comprehensive surface elevation model was created by merging high-resolution LiDAR data collected by Team 2 with USGS one meter DEMs. The model extent is defined below and is also shown in Figure 6.

Model Extents:

- North to South: Extends from Highway I-94 to Sequoia Parkway.
- East to West: Spans from N. Maple Road, continuing along Dexter Road until meeting Highway M-14.

- Model area: Approximately 180 acres.

Prior to constructing the computational mesh, the following inputs were prepared: break lines representing road centerlines and obstructions polygon layer of the building footprints. The break lines were created by laying out conduits in an empty PC-SWMM model to represent the road centerlines. These conduits were imported into GIS, where tools were used to place junctions at 15-foot intervals along the conduits. The rim elevations for these junctions were assigned based on the DEMs. The building footprints were extracted from an impervious surface layer in GIS to create the obstructions polygon layer.

The computational mesh for the domain consisted of hexagonal cells with varying resolutions: higher resolution along the roads (15-ft cells), moderate resolution between roads (22-ft cells), and lower resolution in areas far from roads (30-ft cells). This variable resolution approach ensured adequate detail near the gravel roads while optimizing model run times.

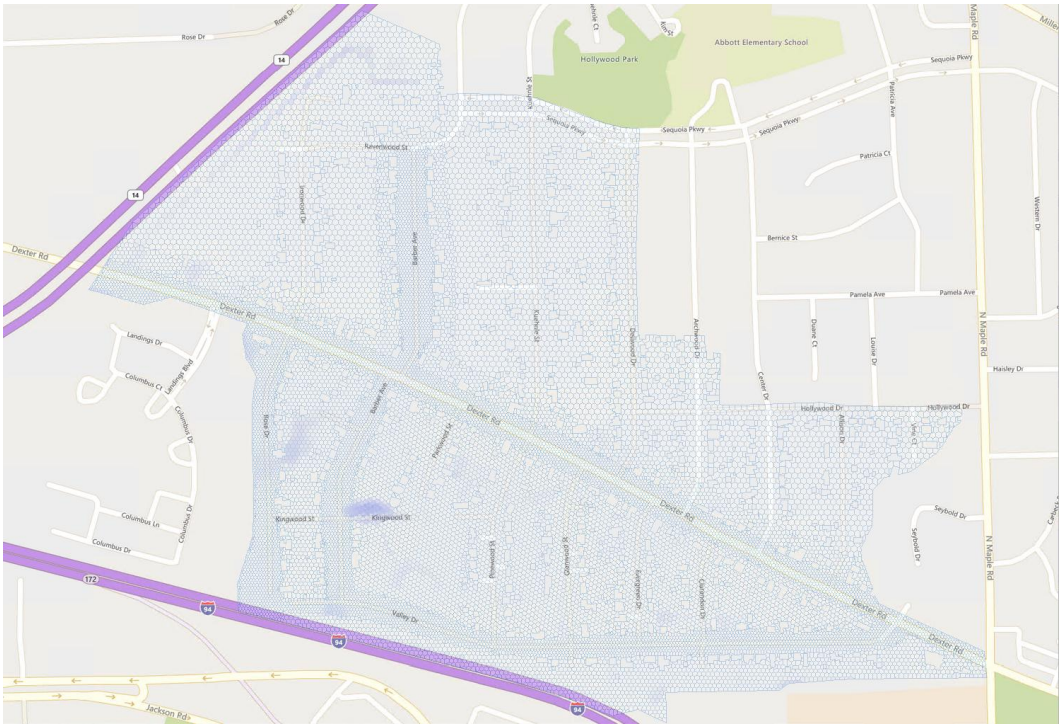


Figure 6: Stormwater Model extents with the 2D cells colored in blue.

The model was run using the City's current design storm requirements for stormwater conveyance (10-year, 12-hour), as well as more extreme events to evaluate the conditions which would cause flooding within the study area. This included changing the hydrology parameterization to simulate rainfall conditions on frozen ground, which had caused many of the most damaging storms in the past based on the resident feedback. The 2D model could be run for a series of unique design storms ranging from 1 to 100-year storms.

The results identified areas vulnerable to flooding, particularly where roadway runoff contributed to rear-yard flooding. The model was then used to develop stormwater improvement concepts to

address roadway drainage issues, capture, and redirect stormwater, and reduce flooding on private properties.

The model was used to assess the effectiveness of the proposed improvements for specific design events. This step was crucial for validating proof of concepts and ensuring that the proposed solutions were viable and effective. Additionally, the model was tested for climate resiliency, examining how well the stormwater system could adapt to changing weather patterns and extreme weather events. This aspect was vital in ensuring that the infrastructure could withstand potential future climate changes.

4.4 NON-TECHNICAL DATA

Project Data Hub

To ensure a full understanding of the drainage issues within the phase one study area, it was vital to use information from residents in the area to gather more information on the issues at hand. As part of the outreach efforts, public input was solicited via Project Data Hub, where residents were encouraged to submit site-specific data related to stormwater drainage concerns. A total of 39 responses were recorded, including photographs and mapped locations indicating where residents had witnessed drainage issues. The study team organized one-on-one walk-arounds with 15 residents who registered for the initiative. During these field visits, 27 specific sites were explored, collecting additional data and insights directly from community members. This firsthand approach not only enriched the data collected but also strengthened relationships between the study team and the residents, fostering a sense of community involvement and shared responsibility in addressing local environmental challenges.

The creation of the website to gather information from property owners made it easily accessible for residents to submit their concerns about their property. This allowed for areas of concern to be visualized on the map, providing a representation of hotspots where issues were prevalent. With the data being in one location, the City and study teams were able to evaluate the data and provide recommendations on an individual, local, regional, and neighborhood-wide scale. Additionally, an ArcGIS map was developed to interview residents. The integration of the base-map tool served as an approach to gathering detailed feedback from residents in the form of a survey and questionnaire form to collect information on stormwater drainage issues.

Story Map

Once all the data had been collected and thoroughly evaluated, a story map was developed in ArcGIS. This interactive tool provided the City and property owners with comprehensive information on the project and presented the engineer's recommendations for addressing drainage issues. The story highlighted problem areas and transformed technical findings into engaging, accessible narratives. By integrating maps and recommendations into a single platform, it helped stakeholders — property owners, City officials, and the broader community — better understand the context and challenges related to drainage. This approach fostered transparency, promoted public awareness, and encouraged community involvement in infrastructure improvements and stormwater management efforts. Presenting the data in a storytelling format helped build a stronger connection between residents and the decision-making process.

Other Projects Planned Within The Study Area

Within the phase one study area, another City project is currently underway to enhance pedestrian infrastructure. This project involves new sidewalks being installed along the missing gaps between Seybold Drive and Ironwood Drive/Rose Drive at Dexter Road. Approximately 3,500 feet of new sidewalk will be installed within the public right-of-way on one side of Dexter Road. Construction is expected to begin in the summer of 2026, with final plans and exact construction locations still to be determined.



Figure 7: Drainage issues example located at 305 Glenwood Street.

SECTION 5.0 - ANALYSIS

In the Valley Drive/Evergreen Subdivision (phase one study area), residents have reported concerns related to standing water on their properties and roads, which contributed to difficult driving conditions and localized flooding in yards and in some cases, basements. The severity of these drainage problems varied based on the specific drainage district in which residents reside, indicating the need for tailored recommendations at both individual and community levels. For a visual representation of the drainage districts and affected flood zones, refer to Figure 8.

In the Rose drainage area, multiple residents reported ongoing issues, particularly due to low points in the right-of-way that may contribute to flooding in yards. At 460 Parkwood Street, residents experienced persistent standing water at the base of their driveway, linked to a low point in the roadway; it would be recommended to install stormwater pipes extending along Dexter Road to connect to the Dexter ditch. Meanwhile, at 486 Barber Avenue, property owners have reported flooding in the basement and garage, with potential improvements including the reclamation of right-of-way drainage and the extension of stormwater pipes from the northern culverts to City drywells. Additional private property improvements are also needed at 420 Rose, with residents noting that heavy rainfall caused water to accumulate on the west side of Rose Street and subsequently drain into their property. Similarly, at 453 Dupont Circle, pooling was noted, potentially due to flow patterns from Barber Avenue converging at the base of the circle.

The Kingwood drainage district received several reports, including four properties and one general area where water accumulation occurred. Key issues included low points in roadways, inadequate regrading of ditches, and poor landscaping practices affecting water flow patterns. For instance, flooding occurred at 400 Barber Avenue due to surrounding low points. At 2840 Dexter Road, recent regrading efforts in August 2023 may have resulted in the ditch being dug too low, preventing efficient water drainage, and causing an accumulation of standing water. Maintenance, including clearing the north-side ditch on Dexter Road, was recommended. At 466 Evergreen Street, water tends to accumulate near the driveway and sidewalk, and the addition of a catch basin connected to the stormwater system may improve drainage. Additionally, 415 Pinewood Street experienced drainage from Pinewood Street flowing into their rear yard. Finally, 421 Parkwood Street reported driveway erosion caused by improper landscape work from a neighbor's retaining wall, which would need to be addressed by the property owner to properly direct stormwater to the road.

In the Glenwood district, two properties—400 Clarendon Drive and 2675 Valley Drive — reported instances of standing water. Both properties experienced pooling, and a comprehensive approach, such as regarding the entirety of Valley Drive and installing curb and gutters, may be considered to effectively mitigate these problems.

Additional drainage concerns were documented at six properties located outside designated drainage districts. At 2750 Valley Drive, a buried culvert may require maintenance to alleviate pooling. At 305 Glenwood Street the resident reported the edge of the road was not properly draining to the catch basin and could benefit from the adjustment of the grading to the structure from roadway to the curb inlet. Property owners at 315 Barber Avenue may need to consider onsite regrading, as the layout currently does not direct water to the existing catch basin. At 3261 Ravenwood Avenue, a low point at the northeast corner contributed to rear yard accumulation; replacing the existing culvert

may improve drainage. Maintenance on the catch basin at 2651 Hollywood Drive was also recommended, with a video inspection and an increase in maintenance frequency due to stormwater influx from neighboring properties. Lastly, at 785 Kuehnle Avenue, the owner of the property should contact the County Health Department regarding an abandoned well that is causing water discharge onto the property.

This comprehensive assessment highlighted potential opportunities for targeted interventions to address drainage issues reported by residents based on the specific drainage issues encountered across various districts and sub watersheds.

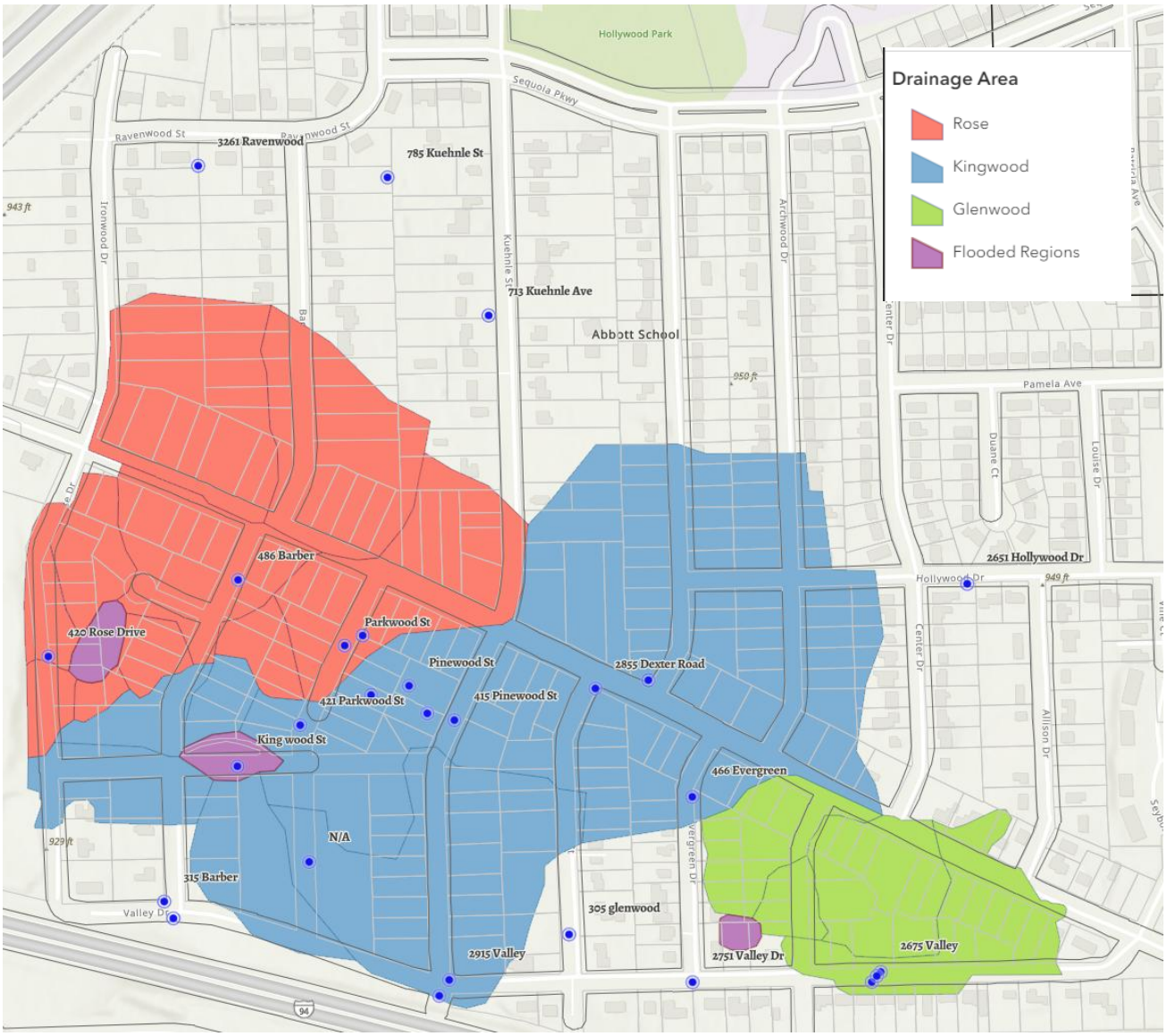


Figure 8: Drainage districts within the phase one study area.

ECTION 6.0 – CONCLUSION

While individual, local, regional and neighborhood management practices all provide the advantages of targeted, efficient solutions for specific problem areas, it is essential to recognize the limitations and potential disadvantages of each of the approaches. A comprehensive and balanced approach to stormwater management is essential to effectively address flooding issues in the Valley Drive/Evergreen Subdivisions. By implementing a strategy that integrates both local and community-wide efforts, a resilient and sustainable stormwater management system that effectively mitigates flooding and enhances overall infrastructure functionality can be created.

This project has considered residents' individual experience with stormwater challenges in their area and offers a range of recommendations intended to alleviate concerns. While not all recommendations made for the phase one study area may be implemented immediately, they are now officially recorded with the City and are available for future consideration as funding and resources become available. The documentation of these issues ensures informed planning and resource allocation to address critical drainage concerns in a strategic and effective manner.

Recommendations for stormwater concerns that have been brought to light within this study have been categorized into four different categories based on scale, location, and residents effected, as outlined in Section 5 and detailed in the recommendation table in Appendix B. Individual-scale solutions, such as culvert maintenance and bioswales, provide quick and cost-effective relief but may not comprehensively resolve larger drainage challenges. Local-scale interventions, such as intersection improvements and ditch reclamation, enhance stormwater flow in key areas but still require coordination to avoid unintended downstream impacts. Regional-scale upgrades, including expanding stormwater infrastructure and installing detention basins, offer long-term benefits by improving drainage capacity across broader areas, but they come with higher upfront costs and longer construction timelines. Finally, neighborhood-wide solutions, such as paving roads and adding curbs, gutters, and stormwater pipes, provide the most extensive flood mitigation but also require significant funding, environmental considerations, and community support.

By using a balanced approach that involves combining immediate maintenance effort, targeting local and regional solutions, and long-term infrastructure investments, stormwater concerns can be effectively addressed. While this report outlines potential strategies, it is important to note that inclusion in this document does not guarantee implementation. Recommendations will be further evaluated in the context of available funding, technical feasibility, and community priorities. This approach supports the City's ongoing efforts to responsibly manage flooding risks while making the most effective use of financial and environmental resources, contributing to a more resilient stormwater system for the community.

APPENDIX A – FALL 2022 MEETING VIDEO AND PRESENTATION

The link to the recorded virtual meeting conducted on November 30, 2022, as well as the presentation slides, can be found below:

https://youtu.be/ulfmSBrejvg?si=LaSiml25a-0uSYRV

STORMWATER MANAGEMENT DISCUSSION

Evergreen Park Neighborhood
aka Valley Drive Neighborhood
aka Scioto Hills Neighborhood

November 30, 2022

Demographic Poll



Technology

Computer

- Select **Raise Hand**
  - You will be identified by the name provided when you entered the meeting
  - Select **Lower Hand** if needed

Q&A:
Type your question
Check **Send Anonymously** if you do not want your name to be publicly visible with your Question
Click **Send**



Phone

- Select *9 to raise your hand
- You will be identified by the last 3 digits of your phone number



Meeting Norms

Please remember the importance of rights and the dignity of others. With that, we ask that you:

- Commit to learning and avoid speculation
- Critique ideas, not people.
- Be thoughtful about your language so this can be a respectful forum for all participants
- Inappropriate written and/or verbal comment or language will result in the attendee being removed from the meeting.

Introductions

- Brian Steglitz, Public Services Area Administrator
- Jennifer Lawson, Water Quality Manager
- Michelle Bennett, Community Engagement Specialist
- Heather Seyfarth, Community Engagement Specialist

- Ward 5 Council Member Briggs
- Ward 5 Council Member Cornell

Agenda

1. Why We Are Here Today
2. Stormwater Management Overview
3. Evergreen Neighborhood Drainage History
4. Comments from Attendees

Why Are We Here Today?

At the request of CM Briggs, this neighborhood meeting was scheduled to:

- Provide information about the City's stormwater management program
- Give residents an opportunity to ask questions about stormwater management
- Set realistic expectations for next steps

The City plans, designs, constructs, and maintains a system to manage stormwater, sediment, and flood mitigation programs and projects to protect water quality and reduce negative impacts on people, property, and infrastructure.

What is Stormwater Management?

How We Plan For and Manage Stormwater

The City maintains a network of "grey" and "green" infrastructure, and public Rights-of-Way (roads) to provide stormwater storage and conveyance during and after a rainfall event. Stormwater infrastructure examples include:

Gray Infrastructure

- Pipes
- Catch Basins
- Underground Storage
- Pervious Pavement

Green Infrastructure

Natural
- Creeks
- Streams
- Street Trees

Built
- Detention Ponds
- Rain Gardens
- Infiltration Basins
- Bio-swales

Public Right of Way

- Roads
- Ditches
- Curb Drains

Examples



Design Criteria & Managing Expectations

Storm drains are not designed to pass all storms... there will always be a bigger storm

- Since the 1980's storm pipes constructed to pass the 10-year storm event* (10% annual chance storm)
- Older storm pipes were designed to pass the 5-year storm event (20% annual chance storm)
- Surcharge (overflow) into streets & low-lying areas can be expected during major storm events
- Negative impacts on downstream properties and neighborhoods



*The definition of what a 10 year storm event looks like has changed over the years due to climate change.



Stormwater Assets

The City's Stormwater assets are only part of a larger stormwater infrastructure network.



Creeksheds (drainage areas)



Unpaved Roads

- 12.5 miles of unpaved roads maintained by the city
- Additional miles of unpaved roads maintained by the County or maintained privately



Study Area

The unpaved roads in Evergreen Neighborhood represent almost a third (29%) of the City-maintained unpaved streets.



Creekshed Boundaries

Evergreen Stormwater History

Late 1960s

- Drainage issues are first brought to the attention of the City.

1970s

- Design of a stormwater system initiated by City Council, outlining drainage into First Sister Lake as the "most viable route."
- City Council directed the design work to halt when this plan received opposition from the Sister Lakes Association.

1980s

- Much of the land in this area had not yet been annexed into the City of Ann Arbor, so consideration of the installation of a full (grey) stormwater system was not viable, due to high unrecoverable costs.
- Temporary solutions were put forward in an attempt to address specific residents' complaints, although it was not clear from City records what those temporary solutions consisted of.

Nov 1992

- A Consultant is hired by the City to perform a drainage outlet study in the area.

Evergreen Stormwater History (cont'd)

Oct 1993

- The drainage outlet study for the area is completed, with three options for creating a storm outlet from the neighborhood.
- The recommended option would create two sub-drainage areas by constructing of two detention basins, utilize the existing 24" outlet for the west portion of the area, and construct a new outlet for the east portion of the area.

Fall 1996

- Public meetings are held with residents to share the possible solutions. Feedback about the viability and desirability of such solutions is obtained from the public meetings and from a mailed survey.
- **Survey responses received expressed an overwhelming desire to discontinue pursuit of the installation of a standard storm sewer**, citing a variety of reasons, including:
- The majority of people are **not experiencing** a significant issue with flooding.
- The expense of the alternatives.
- Some residents perceived that the problem did not exist at all or could be solved on a case-by-case basis (putting the responsibility on the residents experiencing the issues)

Sept 1996

- **A petition was also received from approximately 190 residents in or near the Evergreen / Scioto Hills Subdivision outlining the desire of these residents that the stormwater project should not be pursued.**
- *"We the undersigned residents of the Evergreen/Scioto Hills Subdivision, are* ***opposed to the storm sewer alternatives****"*
- *"We do not want storm water discharged into the Sister Lakes, we do not want detention ponds in our neighborhood, we do not want storm sewers installed and we do not want our dirt roads paved.* ***We prefer that our neighborhood be left as it is.***"

Oct 1996

- Based on feedback from the public meetings and surveys, the City requested information about regulations for the use of dry wells to manage stormwater from the MDEQ.
- MDEQ expressed concern about the use of dry wells for managing the stormwater in the area, due to increasing regulations to prevent groundwater contamination.

Evergreen Stormwater History (cont'd)

Oct 1997

- City Council passes resolution directing the City Administrator to put aside the proposed solutions *and* work with property owners to pursue individual solutions to the drainage problems.

Summer/Fall 1999

- Plans were developed to create an additional stormwater outlet from the Evergreen Subdivision.
- The project installed storm sewer along Glenwood Street to Valley Drive and then east to Evergreen Drive. The system then exited the neighborhood to the south, to a detention pond constructed on the Maple Village site. Construction of this project was completed in November of 1999.

2008-2009

- City crews improved ditching and installed several dry wells in an attempt to promote infiltration.

2018

- City Administrator requests analysis from staff recommending further improvements to address remaining localized drainage issues.
- Memo acknowledges that while additional outlet was created in 1999, the gravel roads and neighborhood topography do not optimally convey stormwater to the outlets. Certain areas of the neighborhood will continue to experience localized drainage issues.
- Also acknowledged that solutions involving installation of new infrastructure and paved roads to resolve these drainage concerns have received substantial opposition in the past.

What We Have Heard

Since 2016, the City has received more than 400 calls or complaints from this neighborhood related to road conditions or drainage issues on private property and/or the public right of way.

















What Can You Expect From Us?

Staff intends to request funds for a new drainage study for this neighborhood during the upcoming budget cycle. If approved, funding would be available as soon as July 2023.

- Identify areas of known concern
- Identify areas for recommended solutions
- Some solutions may include paving of the gravel roads

We Want to Hear From You

- What are the questions you want answered in the study?

What do you want to know from us....

- Stormwater Management?
- Drainage Studies?
- Green Infrastructure?

Closing Comments from Council Members

Check for updates and more information to come here:
www.a2gov.org/drainagestudies

ANN ARBOR
WATER

APPENDIX B – RECOMMENDATION TABLE

Table 7: Individual scale issues and recommendations.

Individual			
Location	**Issues**	**Recommendation**	**Estimated Cost**
2840 Dexter	Ditch along Dexter was re-graded in August 2023 - dug too low. Now water sits in ditch before it accumulates enough to flow out.	Clean out Ditch on the north side of Dexter Road.	Maintenance
		Regrade Dellwood ditch to allow for better drainage.	$20,000
2855 Dexter	Drainage off Dexter pools in resident's driveway and side yard and holds standing water. Glenwood is the main concern. Sometimes from neighbors. Will usually soak up within an hour. The cross tube under Dexter is unclear if it's still functioning. Used to flow in 2009. Most times bypassing ditch.	Regrade side yard to direct drainage into outfall.	Property Owner Responsibility
400 Clarendon 2682 Valley	Water from Dexter and Valley roads holds standing water in front and side yards.	See Local recommendation	N/A
2675 Valley 2678 Valley 2681 Valley	Standing water in the driveway and front yard during rain events.	See Local recommendation	N/A
2750 Valley	Drainage from Valley pools in the low point in the right of way in front of this property. Unable to take advantage of existing culvert since it is buried.	Maintain existing culvert.	Maintenance
305 Glenwood	Edge of road not draining to catch basin in greenbelt.	Fix grading to structure from roadway to curb inlet.	$13,000
466 Evergreen	It appears to be an intermediate low point in road. Stormwater collects at foot of property owner's driveway and sidewalk (and foot of south neighbor's driveway). Dry well/pump access in right of way in front of house.	Add a catch basin to connect low point with stormwater pipe.	$113,000
		Add a bioswale (with underdrain) next to the sidewalk.	$20,000
415 Pinewood	Drainage from Pinewood flows to the rear yard from the south.	See Neighborhood-wide recommendation	N/A
465 Pinewood	Water drains across the property from Pinewood to the west. Ends up in neighboring properties (444 Parkwood & 465 Pinewood). The resident has a trench set up next to the driveway to divert this to the rear yard.	See Neighborhood-wide recommendation	N/A
444 Parkwood	Yard and basement flooding due to Pinewood drainage.	See Neighborhood-wide recommendation	N/A

Table 7: Individual scale issues and recommendations (continued).

Individual			
Location	**Issues**	**Recommendation**	**Estimated Cost**
421 Parkwood	Reports that neighbor's landscape work (neighbor to south) is causing her gravel driveway to regularly erode. Construction of a stone retaining wall is causing upstream water to concentrate at a poor location, causing her to lose driveway gravel.	Regrade southern property to direct stormwater to road.	Property Owner Responsibility
		Install a catch basin and connect to Dexter stormwater pipe.	$100,000
460 Parkwood	Low point in road where water collects. Resident states that the bottom of their driveway holds standing water.	Run stormwater pipe up Dexter and connect to Dexter ditch.	$110,000
		Grade greenbelt to direct water into catch basins.	Maintenance
400 Barber	Standing water at low points from surrounding areas.	See Regional recommendation.	N/A
404 Barber			
486 Barber	Basement and garage flooding.	Reclaim right of way for drainage and extend stormwater pipe from the north culvert to City dry wells.	$35,000
475 Barber	Water flows from Dexter and then south down Barber causing standing water.	See Regional recommendation.	N/A
453 Dupont Cir.	Water flows from Barber and creates a large pool of water at the bottom of Dupont Circle.	See Regional recommendation.	N/A
420 Rose	During severe rain events, stormwater will accumulate on the west side of Rose, overtop the road, and then drain into the property.	See Local recommendation.	N/A
315 Barber	Property is not graded to convey water to the existing catch basin in the right-of-way.	Private property owners could explore on-site regrading.	Property Owner Responsibility
3261 Ravenwood	The property owner reports that stormwater accumulates in the east rear/side yard during storm events. Eventually it spills north toward Ravenwood. The portion of Ravenwood at northeast corner of property appears to be low point.	Repair or replace culvert.	$10,000
		Catch basin in the side yard on the south side; connect to stormwater pipe.	$110,000
		Look at the downstream path to check for problems.	Maintenance
2651 Hollywood	Storm water from neighbors to the south and east drain into east side of property.	Catch basins would need video inspection to increase frequency of maintenance.	Maintenance
		Dry well - Actually a storm catch basin.	$35,000
785 Kuehnle	Abandoned well in the southwest corner of property discharges water and causing standing water.	Property owner to contact the County Health Department to discuss well abandonment.	Property Owner Responsibility
713 Kuehnle		Not in public right of way or caused by public right of way.	

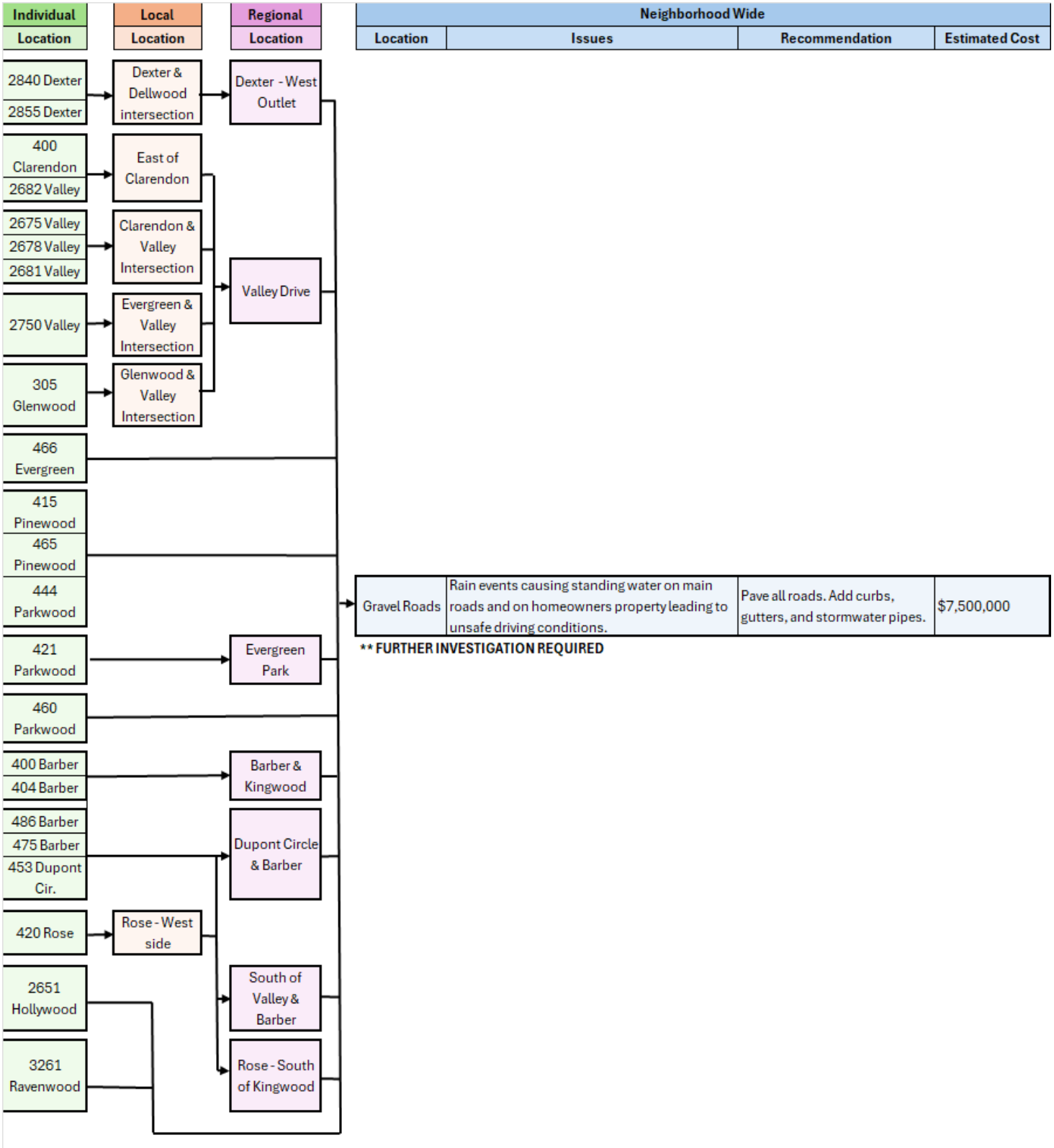
Table 8: Local scale issues and recommendations.

Individual Location	Local Location	Issues	Recommendation	Estimated Cost
2840 Dexter 2855 Dexter	Dexter & Dellwood intersection	Water sitting in ditch causing front yards to hold standing water due to inadequate drainage.	Clean out culverts/ditches. Video and clean downstream pipes as necessary. Grade to ensure positive drainage away from the road into ditch, which drains into Glenwood stormwater pipe .	Maintenance $15,000
400 Clarendon 2682 Valley	East of Clarendon	Valley drains water in yards causing solid ice in winter months and algae growing on roads in summer months.	Revise grading and/or provide detention/retention to minimize or eliminate standing water.	See Regional Recommendation
2675 Valley 2678 Valley 2681 Valley	Clarendon & Valley Intersection	Standing water in driveway when it rains. Neighbors state road used to be below the driveways but has been built up over the years.	Regrade the local roadway to eliminate intermediate low point. Lower the roadway surface elevation. Reclaim right of way for ditches and connecting culverts.	$ 135,000.00 $ 185,000.00 $ 54,000.00
2750 Valley	Evergreen & Valley Intersection	Water flowing from west of Valley and pools in neighboring yards at this intersection due to its relatively low elevation. The storm drain at the edge of the intersection is blocked.	Add curbs to keep water on the road and out of yards. Maintain storm structures.	$ 26,000.00 Maintenance
305 Glenwood	Glenwood & Valley Intersection	Water flows down Valley from the west. This is not the lowest intersection in the vicinity, but properties still see roadway drainage in front yards.	Upgrade intersection with curb and gutter to keep stormwater on road. Add a catch basin to allow water to enter system sooner.	$ 28,000.00 $ 54,000.00
420 Rose	Rose - West side	During storm events, water from Dupont Circle flows into the backyards of houses causing excessive standing water.	Revise grading and/or provide detention/retention to minimize or eliminate standing water.	Further Investigation Required

Table 9: Regional scale issue and recommendations.

Individual Location	Local Location	Regional Location	Issues	Recommendation	Estimated Cost
2840 Dexter 2855 Dexter	Dexter & Dellwood intersection	Dexter - West Outlet	City is adding sidewalk along the right of way of Dexter. This presents an opportunity to add drainage improvements while the area is already disturbed.	Add stormwater pipe up Dexter to the highway and enlarge the existing stormwater pipe to handle the increased flow.	$600,000
400 Clarendon 2682 Valley	East of Clarendon	Valley Drive	Road is higher than surrounding driveways and properties, but the general vicinity is a low point.	Regrade (lower) all of Valley to eliminate standing water. Add curb and gutter.	$1,500,000
2675 Valley 2678 Valley 2681 Valley	Clarendon & Valley Intersection				
2750 Valley	Evergreen & Valley Intersection				
305 Glenwood	Glenwood & Valley Intersection				
421 Parkwood		Evergreen Park	Existing pathways appear to divide drainage issue area. Looks like there's potential to drain half of standing water in park area to the northwest, and the other half to the east.	Install detention basins and/or other best management practices to handle local standing water in east of park.	Further Investigation Required
400 Barber 404 Barber		Barber & Kingwood	Drainage flows to a natural low spot on these parcels from the surrounding area and Evergreen Park.	Revise grading and/or provide detention/retention to minimize or standing water.	Further Investigation Required
486 Barber 475 Barber 453 Dupont Cir.		Dupont Circle & Barber	Water flows west down Dexter Ave. and then south down Barber. It then flows across Barber heading down Dupont Circle, standing water found in two yards in the neighborhood.	Extend the stormwater pipe through Barber and the Cul-de-sac to the outlet south of Valley.	$410,000
420 Rose	Rose - West side	South of Valley & Barber	The land to the south of this intersection is underutilized and would benefit from the addition of stormwater storage. The highway ditch to the south could accept water from the neighborhood to alleviate standing water issues in the southwest.	Add detention basins and storm infrastructure to route water from neighborhood and outlet under I-94.	Further Investigation Required
		Rose - South of Kingswood	Even with normal rains, the part of Rose Drive between the dead end and Kingwood gathers up water and it stays for days, even weeks.	Run a stormwater pipe to the south from Kingswood intersection to discharge near I-94.	$250,000

Table 10: Neighborhood-wide scale issues and recommendations.



APPENDIX C – REGIONAL SCALE RECOMMENDATIONS FEEDBACK

Table 11: Regional and neighborhood-wide scale recommendation feedback from residents.

Regional				Public Input (Collected 10/16 at Open House)	
Location	Issues	Recommendation	Estimated Cost	Support	Do Not Support
Dexter - West Outlet	City is adding sidewalk along the right of way of Dexter. This presents an opportunity to add drainage improvements while the area is already disturbed.	Add stormwater pipe up Dexter to the highway and enlarge the existing stormwater pipe to handle the increased flow.	$600,000	16	1
Valley Drive	Road is higher than surrounding driveways and properties, but the general vicinity is a low point.	Regrade (lower) all of Valley to eliminate standing water. Add curb and gutter.	$1,500,000	14	0
Evergreen Park	Existing pathways appear to divide drainage issue area. Looks like there's potential to drain half of standing water in park area to the northwest, and the other half to the east.	Install detention basins and/or other best management practices to handle local standing water in east of park.	Further Investigation Required	6	3
Barber & Kingwood	Drainage flows to a natural low spot on these parcels from the surrounding area and Evergreen Park.	Revise grading and/or provide detention/retention to minimize or standing water.	Further Investigation Required	2	1
Dupont Circle & Barber	Water flows west down Dexter Ave. and then south down Barber. It then flows across Barber heading down Dupont Circle, standing water found in two yards in the neighborhood.	Extend the stormwater pipe through Barber and the Cul-de-sac to the outlet south of Valley.	$410,000	4	0
South of Valley & Barber	The land to the south of this intersection is underutilized and would benefit from the addition of stormwater storage. The highway ditch to the south could accept water from the neighborhood to alleviate standing water issues in the southwest.	Add detention basins and storm infrastructure to route water from neighborhood and outlet under I-94.	Further Investigation Required	1	0
Rose - South of Kingwood	Even with normal rains, the part of Rose Drive between the dead end and Kingwood gathers up water and it stays for days, even weeks.	Run a stormwater pipe to the south from Kingwood intersection to discharge near I-94.	$250,000	2	1
Gravel Roads	Rain events causing standing water on main roads and on homeowners property leading to unsafe driving conditions.	Pave all roads. Add curbs, gutters, and stormwater pipes.	$7,500,000	3	3

APPENDIX D – TOPO MAPS



Figure 9: Spicer LiDAR and contour data for Valley Drive/Evergreen Subdivision.



Figure 10: DEM contours for Valley Drive/Evergreen Subdivision.