A – Summary of Past Work to Develop Program

Attachment to Executive Summary for January 18, 2023 Board Discussion – Drainage Infrastructure Management Program

Through the Board's Strategic Plans and past meeting discussions, the Board has directed the Facilities and Environmental Services Department (FES) to develop a drainage infrastructure management program. The following summary provides a background of this initiative, describes current thinking regarding program scope, summarizes work done to quantify the problems and solutions through data development, and recaps past Board discussions.

Background

Unlike most Virginia cities, Albemarle County does not maintain an extensive stormwater conveyance system – despite the County's longstanding Growth Management Policy resulting in densely-developed urban areas. The current drainage network is made up of thousands of interconnected inlets, pipes, manholes, culverts, and channels lying on hundreds of private properties and crossing public roads at hundreds of locations.

The County currently maintains conveyance infrastructure only on properties it owns and within drainage easements that have been *dedicated to public use* (hereafter referred to as public easements). The County has no responsibility for infrastructure outside such public easements, and has only the *right* – but not a legal obligation – to maintain infrastructure within public easements.

Especially in older subdivisions, easements were not consistently dedicated to public use during the land development process. As a result, the presence of dedicated public easements is not well correlated with the degree to which the infrastructure serves the public interest. However, Community Development Department (CDD) staff now ensure that the portions of new drainage infrastructure that serves more than a single property – for instance, sections that convey offsite runoff through a site – are dedicated to public use.

Environmental Services Division (ESD) staff coordinate with other County staff in responding to drainage-related complaints from the public. ESD staff take the lead in investigating and addressing those complaints that are related to infrastructure that is already built or not currently under construction. It has been ESD's practice to repair infrastructure failures – such as sinkholes and badly eroding channels – only when they are located within dedicated public easements. Determining ownership of easements is a time-consuming process, which is currently done on a case-by-case basis when infrastructure on private property needs maintenance or repair.

As the County began considering dedicated funding options to support water resources programs in 2014, two infrastructure failures occurred on private properties outside of dedicated public easements. One failure involved a particularly expensive repair on a single private property in Carrsbrook but

affected much of that neighborhood. The Board at the time decided that the cost to repair these failures shouldn't be borne by a single property owner and directed staff to address the issues using a combination of County and VDOT funding. These situations highlighted the County's lack of a proactive program to maintain community-serving portions of the drainage system. As part of the funding study, drainage infrastructure management was identified as a program gap to be addressed.

Soon thereafter, in its FY17 – 19 Strategic Plan, the Board directed staff as follows:

- "By April 2017, staff will develop technologies and procedures to map stormwater infrastructure not already mapped and commence mapping throughout the County"
- "By January 2018, Board will determine role and responsibility of local government for maintaining infrastructure not already dedicated to public use."

Following the Board's decision to cease consideration of the stormwater utility in 2018, the Board directed staff to continue exploring how to best implement and fund a drainage infrastructure management program. The Board's prioritized FY20 – 22 Strategic Plan included infrastructure planning as one of nine priorities:

The Board continues to include infrastructure management as a strategic priority. One of the six objectives from the Board's adopted FY24 – 28 Strategic Plan is to "Invest in infrastructure and amenities that create connection, opportunity, and well-being" and sub-objective 3.3 is to "Determine the level and extent of services necessary to create a public works department for enhanced maintenance of public rights of way and other infrastructure of public use."

The following section summarizes work that has been completed to build a foundation for a drainage infrastructure management program. This work includes 1) defining program scope, 2) data collection, management, and development, and 3) Board presentations and discussions.

Program Scope

The scope of the drainage infrastructure management program will be dictated by adopted guidelines, which would describe the breadth and details of the program and provide criteria for decision-making. The two primary program guidelines are the *extent of service* (EOS) and *level of service* (LOS). The EOS would define what portions of drainage infrastructure the County will maintain, and the LOS would define what the County would do to maintain these portions.

It should be noted that many localities – even those having existing infrastructure maintenance programs –are struggling with defining clear rules regarding the EOS. Staff could not find definitive existing model guidelines.

EOS and LOS Scenarios

Staff established the following EOS and LOS categories to place boundaries on and provide a common language for program considerations, facilitate assessment work, and allow for the development of cost estimates.

All EOS scenarios are limited to the Development Areas defined by the Comprehensive Plan. The lowest EOS (1) includes only infrastructure located on County properties and within existing public easements, which is consistent with current practice. The highest EOS (4) essentially includes all infrastructure except that which serves only a single, private property or lies within VDOT rights-of-way. Note that even EOS-4 constitutes only about 25% of all drainage infrastructure – since about 55% of infrastructure lies wholly within a single private property (typically commercial) and about 20% lies within VDOT rights-of-way.

LOS categories reference three categories of repair urgency defined by an engineering consultant: priority 1 in which the risk of failure is imminent, priority 2 in which moderate defects were detected, and priority 3 in which minor defects were detected.

EOS category	**description (each builds on the previous)**
1	within local government and public school properties and public easements
2	category 1 + downstream of public lands
3	category 2 + downstream of VDOT roadways
4	category 3 + concentrated discharges from multiple private properties
LOS category	**description**
low	assessment every 20 years; priority 1 issues are addressed within 20 years
medium	assessment every 20 years; address priority 1 issues within 10 years and priority 2 issues within following 20 years
high	assessment every 10 years; address priority 1 issues within 5 years and priority 2 issues within following 15 years

Priority	Description
priority 1	risk of failure
priority 2	moderate defects
priority 3	minor defects

Each increase in the category of EOS and LOS would result in a greater program scope and higher cost to implement the program. Cost estimates will be discussed in more detail below.

Besides the EOS and LOS, additional program implementation questions will require consideration, including:

- how to treat drainage channels, for which the definition of failure is different than pipes and manholes
- whether services should vary based on zoning or land use (commercial versus residential) or how a residential property is owned or managed (homeowners' association versus an individual)
- the most appropriate legal mechanisms and processes to gain access to private properties to either assess or repair infrastructure
- how to proceed when a property owner is uncooperative or uninterested

- where improvements, and not merely maintenance and repairs, to infrastructure is warranted

Note that the scope and cost of the program will naturally increase over time as additional infrastructure is added to the system through development and discovery. In other words, the EOS will grow even as the EOS *category* remains constant.

Data Collection, Management, and Development

While considering program alternatives, staff has been collecting information about the condition of the existing drainage conveyance system in order to inform cost estimates of program scope alternatives and serve as proof-of-concept for future program elements. This information includes 1) video-assessments of underground infrastructure, 2) visual assessments of drainage channels, and 3) analysis of reported drainage issues. This information is managed in spatial data systems (i.e., GIS) and spreadsheets and made available for review via dashboards.

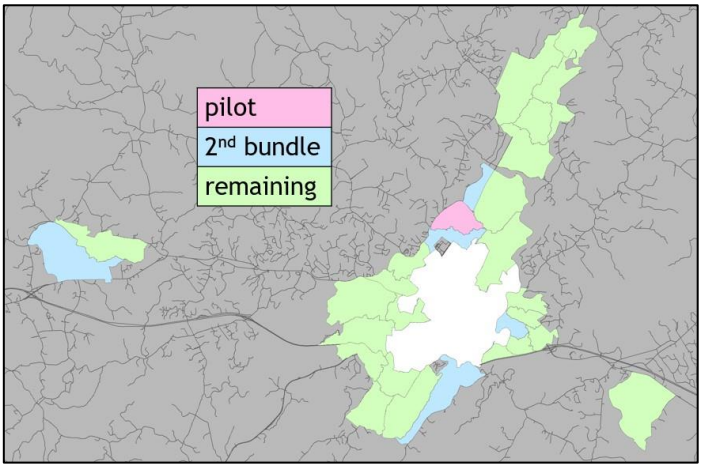
Underground Infrastructure (pipes, culverts, manholes)

For many years – and for purposes other than a drainage infrastructure management program – staff has been inputting in GIS the location of and some attribute data associated with underground infrastructure. The length of infrastructure currently mapped totals approximately 245 miles. A clip of this data is depicted in the image on the right, which includes stormwater management facilities, drainage channels, and natural streams. Staff continues to input infrastructure into this system. As new infrastructure is built, staff inputs the data from construction drawings. In addition, as staff becomes aware of existing infrastructure, staff typically uses a field data collection tool (iPad and ESRI Collector application). Note that staff strives to map *all* discovered infrastructure, even that not considered for public maintenance under any EOS scenario (for instance, infrastructure serving a single commercial property, lying within VDOT right-of-way, or located in the rural area).

Video Assessments

To better understand the condition of underground infrastructure and the cost implications of maintenance and repairs, staff video-assessed this infrastructure within selected watersheds generally meeting the most comprehensive EOS scenario under consideration (EOS-4, as described above). Approximately 16 miles (85,600 linear feet) of infrastructure was assessed in two bundles: the first in late-2018 and the second in mid-through late-2019. The assessed infrastructure represents about 29% of the approximately 39.2 miles of all EOS-4 infrastructure estimated in the County's urban areas.

The video contractors flagged issues (identified by location, description, and severity) and a specialized engineering consultant further refined this information to include estimated maintenance and repair costs and recommended timelines for addressing each issue. Staff received the results of the analysis for the second, and larger, bundle in April 2020.



Comparison of Two Assessments

The first assessment bundle included a single (pilot) watershed located within the 29/West Rio loop (see image depicting the location). The second bundle included five discrete watersheds located throughout the County's urban areas.

The results of the two bundles are summarized in the table below.

Priority	1st bundle				2nd bundle			
	length* (ft)	count	%	repair cost	length* (ft)	count	%	repair cost
1 – imminent failure	2,994	48	17%	$458,057	2,705	21	5%	$675,049
2 – moderate defects	4,946	59	21%	$1,248,852	7,816	79	20%	$1,157,913
3 – minor defects	6,659	81	29%	$1,588,779	13,380	129	33%	$2,489,675
4 – no issues	8,422	87	32%	-	11,032	160	41%	-
TOTAL	**23,021**	**275**	**100%**	**$3,295,688**	**34,933**	**389**	**100%**	**$4,322,638**
average cost (2020) per linear foot	**$143**				**$124**			
	$131 (both bundles, weighted)							

* represents the total of the lengths of pipe sections having at least one issue of a given priority

Though the overall condition of the infrastructure in the two bundles is comparable, the infrastructure in the second bundle is in better condition overall than that of the pilot watershed – possibly because the second bundle includes newer development than what typically lies in the pilot watershed. The second bundle had a smaller portion of issues identified as Priority 1 – although the total estimated cost to repair the Priority 1 issues in the second bundle is larger. The second bundle had a larger percentage of less serious (Priority 3) issues and pipe sections having no issues. The average cost *per linear foot* of infrastructure to address all identified issues is $143 for the first bundle and $124 for the second bundle. This equates to an average cost of $131 per linear foot (in 2019) to address all found issues in underground drainage infrastructure.

Cost Estimates for Program Scenarios

In preparation for a July 2019 Board presentation, the repair cost data from the first bundle in the above table was used to develop long-term program costs for combinations of EOS and LOS (the data from the second bundle was not yet available). The programs were presumed to include 1) recurring infrastructure assessments and 2) ongoing infrastructure repairs – both stretched out along varying timeframes defined by the LOS. Average annual program costs per linear foot of infrastructure were calculated for each LOS and summarized in the table on the right.

LOS	annual cost per linear foot (in 2019)
high	$4.04
med	$2.51
low	$0.95

These costs were then multiplied by the estimated amount of infrastructure in each of the EOS categories to calculate the estimated annual program costs for each combination, resulting in the following cost matrix (presented to the Board on July 17, 2019):

Estimated annual program cost (in 2019)		**extent of service (EOS)**			
		1	2	3	4
level of service (LOS)	high	$331,000	$436,000	$789,000	$835,000
	medium	$205,000	$270,000	$489,000	$518,000
	low	$78,000	$102,000	$185,000	$196,000

As expected, incorporating the additional data (second bundle) from the consultant into the cost spreadsheet results in slightly lower estimated annual program costs per linear foot of infrastructure. In the case of the medium level of service, the cost decreases from $2.51 to $1.89 per foot per year – a 25% drop. Conversely, the costs of materials, equipment, and crews have increased by approximately 25% in the past several years. Therefore, the estimated annual program costs summarized in the table above should be considered reasonable, although prices continue to escalate.

Prioritization of Identified Issues

This section describes work that was done to explore how the most critical issues could be addressed within a given budget – such as an annual appropriation.

The engineering consultant's priority classifications were used as the basis of a more comprehensive prioritization of repairs using the following formula:

Prioritization score = [2S+R+3B] x C, where

- S = size of pipe, normalized between 0 and 1 [larger pipe size = larger number]
- R = distance to road, categorized between 0 and 1 [smaller distance = larger number]
- B = distance to building, categorized between 0 and 1 [smaller distance = larger number]
- C = condition score per consultant evaluation categorized between 0 and 1 [more critical issue = larger number]

Staff essentially took the consultant's condition score – which reflects the severity of the issue and urgency of repair – and incorporated a factor representing the "consequence of failure." For instance, the failure of larger size of pipe (S) will have a greater consequence, as will a failure located closer to roadways (R) and buildings (B).

The repairs can be prioritized and ranked with and without factoring in the estimated repair cost. Cost-based prioritization scores are calculated by dividing raw prioritization scores by the cost. Staff created the spreadsheet to order the repairs based on either set of prioritization scores and automatically summarize the number of projects that could be addressed within a given budget. As one would anticipate, incorporating the cost into the prioritization process would give more weight to smaller, yet cost-effective projects, allowing more – but lower cost – projects to be addressed within a specified budget. For instance, a $300,000 budget would support the nine highest priority projects in the

spreadsheet, if cost weren't factored in. However, the same budget could support over ninety of the highest priority projects, if cost *were* factored in.

The total costs of repairing all identified issues – both within the areas already assessed and extrapolated to all urban areas – are summarized in the following table:

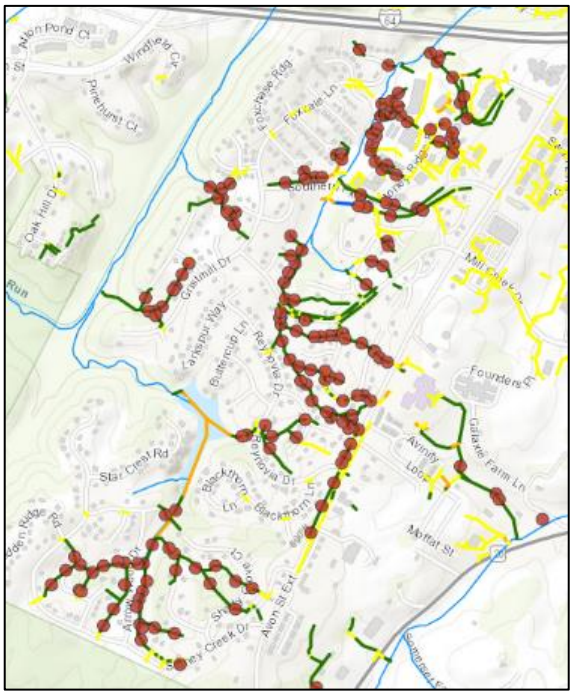
	assessed infrastructure only (29% of all urban areas)			extrapolated to *all urban areas*		
Priority	1	2	3	1	2	3
total cost to repair all issues	$1.1M	$2.3M	$4.0M	$3.6M	$8.0M	$13.9M

* considering issues identified under most inclusive (EOS-4) scenario

Channel Assessments

Channels are an important component of drainage infrastructure, as they are interconnected with underground infrastructure – in turn conveying runoff into underground infrastructure and receiving runoff from underground infrastructure. Channels can be designed and built as part of land development or might have existed as small, natural drainage ways and now carry runoff from built environments. If channels are not adequate for the runoff they convey, they may become eroded, incised (cutting deeper into the ground), or blocked with sediment and debris. They may even migrate laterally to a new course.

To get a sense of the condition of channels within the Development Areas, ESD staff has begun conducting assessments in selected areas using a staff-developed app. The image on the right depicts the locations (red circles) of recent assessments completed in the Mill Creek and Reynovia neighborhoods. The app allows staff to use tablets or smart phones in the field to take photos and record channel conditions at locations representing a uniform channel reach. This data is then processed to derive general statistics regarding the condition of Albemarle's urban channels and to systematically identify channels in the worst condition that could benefit from maintenance and repairs.



The scale of issues with drainage channels is much less significant than with underground infrastructure. Though many drainage channels within the urban areas of the County are incised or eroded, the vast majority do not pose a threat to buildings, roads, utilities, or other improvements – notwithstanding their contributions to pollutant loads in local waters.

However, in a few documented cases, channels conveying runoff from developed watershed have deteriorated to the point of causing impacts on multiple properties. One such case in the Mill Creek neighborhood is pictured above. A particularly intense storm displaced riprap and caused eroded, incised, and unstable area. If not addressed in a comprehensive manner, inadequate channels would likely worsen over time and, perhaps, increase the risk of property damage due to extensive erosion or flood.

Analysis of Reported Drainage Issues

Since 2005, ESD staff has responded to inquiries from residents and business owners related to various issues, including drainage. Staff has used several iterations of data management systems to track pertinent information, including date, caller information, location, type of issue, description, and staff response. The data is currently managed in a geodatabase and allows for easy field data collection, desktop editing, and exploration via a dashboard.

An analysis of drainage complaint data from the past four year (2019 – 2022) indicates that a significant, but not overwhelming, number of community issues would be considered under the envisioned drainage infrastructure management program. Out of 145 complaints in the database related to offsite runoff, localized flooding, failed conveyances, or channel erosion, staff identified 13 cases in which the County took past corrective action due to the issue lying within a public easement. Staff identified an additional 25 cases in which the County would likely act under a proposed program as part of the EOS-4 category described above.

Board Presentations and Discussions

The Board has been receiving information about the development of a drainage infrastructure maintenance program – initially as part of a broader discussion related a stormwater utility – since mid-2017. These discussions are summarized below.

date	purpose	points made	Board feedback
7/5/2017	**introduction** to development of infrastructure program (as part of utility discussion)	- mapped 200 miles of infrastructure - policy considerations - intro to EOS scenarios	focused on utility

12/6/2017	**update** on infrastructure program (as part of utility discussion)	- mapped 225 miles of infrastructure - plausible EOS scenario may include ~68 miles of infrastructure - introduced prelim. costs per mile - estimated reasonable program to cost ~$1.3M/year	focused on utility
4/11/2018	**closing discussion** on stormwater utility	- summary of program and costs - recommendations of committee - review of fee proposal	support WR program through general fund; no utility
12/5/2018	**update** on video assessment work and review of EOS policies	- lessons learned from work within pilot watershed - findings (i.e., % having problems) - understanding EOS; locality examples - will return to Board with LOS/EOS policy options	none
7/17/2019	update on data gathering; seek **Board feedback** on program scope alternatives (EOS/LOS cost matrix, shown above)	- use of appropriations - mapped 242 miles of infrastructure - results of engineering analysis - EOS examples and amount of resulting infrastructure - LOS categories - EOS/LOS cost matrix - other program factors	no Board consensus, but most leaned towards **highest EOS** and **middle LOS** scenarios; recognized need for sustained funding; preferred program be restricted to urban area

At its July 17, 2019 meeting, the Board recognized the need for a program at some scale and expressed broad support for the highest EOS (EOS-4) and medium LOS. Support for EOS-4 reflected the Board's concern that implementing the program at a lower EOS would still likely result in property owners arguing that the County should address EOS-4 failures … and, of course, only after the failures already happened.