Henrico County
Department of
Public Works

Technical Guidance Manual for Floodplain Management

Effective October 1, 2021; Revised: July 14, 2023 & August 9, 2023

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ACKNOWLEDGEMENTS

The contributions of the following graphic designers and technical reviewers in the development of this technical guidance manual are appreciated:

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1. INTRODUCTION AND PURPOSE

1.1. NFIP Participation

The National Flood Insurance Program (NFIP) was created in 1968 and is managed by the Federal Emergency Management Agency (FEMA). The NFIP makes federal flood insurance available to homeowners, renters, and businesses in NFIP participating communities.

Henrico County has participated in the NFIP since February 4, 1981, making NFIP flood insurance coverage available to all county residents, as well as certain federal and state grants, loans, and disaster assistance. As part of this participation, Henrico County is required to adopt and enforce a floodplain ordinance that regulates development in the mapped Special Flood Hazard Area (SFHA), also known as the 100-year floodplain.

These mapped SFHAs make up approximately 15% of the county's land area.

1.2. Purpose of the Floodplain Technical Guidance Manual

This Floodplain Technical Guidance Manual (Manual) supports the Floodplain Ordinance and helps explain the applicability of the Floodplain Ordinance. The Manual also provides guidance for meeting the technical requirements outlined in the Floodplain Ordinance, as well as provides additional detail on the permitting process and submittal requirements. Although anyone may use this Manual, it is intended to be used by individuals proposing development in the county's SFHA.

If there is any discrepancy between this Manual and the Floodplain Ordinance, the Floodplain Ordinance requirements shall take precedent.

1.3. Amendments to the Manual

The Floodplain Administrator may revise this Manual from time to time. Revisions may be based on changes to the Floodplain Ordinance, feedback from users, application form updates, etc. Any changes will be clearly identified in the Manual and shall take effect at the time they are made publicly available on the Henrico County website.

1.4. Applicability

The Floodplain Ordinance and this Manual apply to all lands within the areas designated as SFHA, and some areas adjacent to SFHAs as defined in the Floodplain Ordinance, shown on the county's current Floodplain Maps. The SFHA is the land subject to a one percent or greater chance of flooding in any given year, or the 100-year floodplain.

1.5. Contact Information

Henrico County's Floodplain Management Program is in the Department of Public Works, Design Division. Current contact information for the Floodplain Administrator and program staff is available on the county's website here: https://henrico.us/works/design/design-contacts/.

1.6. Definitions

Below are some definitions from the Floodplain Ordinance that are important for understanding the information in this Manual. Additional definitions are included in Sec. 10-3 of the Floodplain Ordinance.

500-year Floodplain: The land at risk for flooding from a 0.2 percent (500-year) flood in any given year. This area may be identified as a Shaded X Zone or Shaded X5 Zone on the Floodplain Maps.

Accessory or Appurtenant Structure: A structure which is on the same parcel of property as the principal structure and the use of which is incidental to the use of the principal structure. An accessory structure is considered nonresidential for the purposes of [the Floodplain Ordinance] and may include detached garages, sheds, barns, or greenhouses.

Agricultural Structure: A structure that is used exclusively in connection with the production, harvesting, storage, raising, or drying of agricultural commodities and livestock, including aquatic animals or plants associated with aquaculture activities. An agricultural structure does not include any structure used for human habitation.

Base Flood Elevation (BFE): The water surface elevation of the base flood as shown either on (1) the most recent Federal Emergency Management Agency Flood Insurance Rate Map or Flood Insurance Study or (2) the county's most recent Comprehensive Drainage Map, whichever is higher. For areas without mapped base flood elevations, the developer shall use the 100-year flood elevations and floodway information from federal and state sources when available or, if such information is not available, flood elevations derived from sufficiently detailed hydrologic and hydraulic computations by a professional engineer who certifies the correct use of currently accepted technical concepts.

Community Special Flood Hazard Area: Also referred to as the Community SFHA, the land subject to a one percent or greater chance of flooding in any given year, based on 100-acre drainage areas or less, as identified on the county's current Comprehensive Drainage Maps. These areas do not include and are in addition to FEMA Special Flood Hazard Areas.

Conditional Letter of Map Revision (CLOMR): Either (1) a formal review and comment from FEMA stating that a proposed project complies with the minimum NFIP requirements for the project with respect to delineation of FEMA SFHAs or (2) a letter from the county engineer that provides conditional approval of a study, based on as-built conditions, that changes the location of the Community SFHA. A CLOMR does not revise the Floodplain Maps.

County Comprehensive Drainage Map. The most recent map approved by and maintained by the county engineer on the county's GIS designating the 100-year floodplain in the county. The county engineer may amend the County Comprehensive Drainage Map at any time upon review of additional engineering studies of floodplain areas.

Critical Facility: A structure or other improvement that, because of its function, size, service area, or uniqueness, has the potential to result in serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if it is destroyed or damaged or if its functionality is impaired. Critical facilities include health and safety facilities, utilities, government facilities, and hazardous materials facilities.

Development: Any man-made change to improved or unimproved real estate, including buildings or other structures, as well as mining, dredging, filling, grading, paving, excavation or drilling operations, and storage of equipment or materials.

FEMA Special Flood Hazard Area: Also referred to as the FEMA SFHA, the land in the floodplain within a community subject to a one percent or greater chance of flooding in any given year as designated by FEMA. The area may be designated on a Flood Insurance Rate Map as Zones A, AO, AH, A1-30, AE, A99, AR, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, or V1-30, VE, or V.

Flood Damage-Resistant Materials: Any construction materials capable of withstanding direct and prolonged contact with floodwaters without sustaining any damage that requires more than cosmetic repair.

Flood Insurance Rate Map (FIRM): An official map of a community, on which the Federal Insurance Administrator has delineated both the FEMA SFHAs and the risk premium zones applicable to the community. A FIRM that has been made available digitally is called a Digital Flood Insurance Rate Map (DFIRM).

Flood Insurance Study (FIS): An examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations, or an examination, evaluation, and determination of mudslide (i.e., mudflow) and/or flood-related erosion hazards.

Floodplain Administrator: The person appointed to administer, implement, and enforce the provisions of [the Floodplain Ordinance]. This person is also known as the Floodplain and Dam Safety Manager.

Floodplain Maps: The current Flood Insurance Rate Maps and Flood Insurance Study for Henrico County prepared by the Federal Emergency Management Agency, Federal Insurance Administration, effective December 18, 2007, and the current County Comprehensive Drainage Map, effective December 18, 2007, and subsequent revisions or amendments thereto.

Floodway: The channel of a river or other watercourse and the adjacent land areas that must be reserved to discharge the base flood without cumulatively increasing the water surface elevation. The Floodway is part of the SFHA. This may also be referred to as the Regulatory Floodway.

Hydrologic and Hydraulic Engineering Analysis: Analyses performed by a licensed professional engineer in accordance with standard engineering practices to determine the base flood, other frequency floods, flood elevations, floodway information and boundaries, and flood profiles.

Letter of Map Change (LOMC): A Letter of Map Change is (1) an official FEMA letter that amends or revises an effective Flood Insurance Rate Map or Flood Insurance Study or (2) an official county letter that amends or revises the most recent County Comprehensive Drainage Map.

Letter of Map Revision (LOMR): A revision to the Floodplain Maps based on technical data that shows a change or changes to flood zones or flood elevations or floodplain and floodway delineations or planimetric features. This includes (1) a revision approved by FEMA to revise a FEMA SFHA on a Flood Insurance Rate Map or Flood Insurance Study or (2) a revision approved by the county engineer to revise a Community SFHA on the most recent County Comprehensive Drainage Map.

Lowest Floor: The lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement area is not considered a building's lowest floor if such enclosure does not violate the applicable enclosure requirements in Sec. 10-10(c) of [the Floodplain Ordinance].

Mechanical Equipment: Includes electrical, heating, ventilation, plumbing, and air conditioning equipment, and other service facilities.

Non-Residential Building: A building or accessory structure where the primary use is commercial or not for human habitation.

No-Rise Certification: A certification statement signed by a professional engineer licensed to practice in the Commonwealth of Virginia certifying that a proposed project will not increase the base flood elevations in the community.

Residential Building: A non-commercial building designed for habitation by one or more families or a mixed-use building, including any building or portion of a building occupied or designed to be occupied exclusively for residential purposes. The term includes guesthouses, cabins, and sleeping units but does not include a tent, recreational vehicle, hotel or motel, boardinghouse, hospital, or other accommodation used for transient occupancy.

Special Flood Hazard Area (SFHA): Land subject to a one percent or greater chance of flooding in any given year. This area includes both FEMA Special Flood Hazard Areas and Community Special Flood Hazard Areas and may also be referred to as the 100-year floodplain.

Structure: A walled and roofed building that is principally above ground. Walled is considered “two or more outside rigid walls” and roofed is “a fully secured roof.” This may also be referred to as a building.

Substantial Damage: Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

Substantial Improvement: Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the Start of Construction of the improvement. This term includes improvements to structures which have incurred Substantial Damage, regardless of the amount of the actual repair work performed. For the purposes of [the Floodplain Ordinance], the relocation of a residential structure within the SFHA is deemed a substantial improvement. This term does not, however, include any improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum improvements necessary to assure safe living conditions.

Variance: A grant of relief from any requirement of [the Floodplain Ordinance]. Variances may only be granted in compliance with the provisions of Division 5 of [the Floodplain Ordinance].

Water Surface Elevation (WSE): The height of floods of various magnitudes and frequencies in the floodplains of coastal or riverine areas. These heights are shown on maps by reference to the National Geodetic Vertical Datum (NGVD) of 1929 (or other datum, where specified).

2. SPECIAL FLOOD HAZARD AREAS

Henrico County defines the Special Flood Hazard Area (SFHA) as the land subject to a one percent or greater chance of flooding in any given year and may also be referred to as the 100-year floodplain. The SFHA is shown on the county's Floodplain Maps and includes both FEMA Special Flood Hazard Areas and Community Special Flood Hazard Areas. The county Floodplain Maps can be viewed using the Henrico County Flood Zone and Dam Safety Information map on the county's online GIS. Structures, fill, and vegetation that are situated on land that lies below the flood hazard area base flood elevation are considered to be within the SFHA. The SFHA and adjacent areas are regulated by the county's Floodplain Ordinance.

The SFHA in Henrico County has been mapped as either A or AE Zones. All flood zones were modeled in HEC-RAS, so Base Flood Elevations (BFEs) are available for the entire SFHA in Henrico County. The methods used to create these models include approximate, limited detailed, and detailed studies, which vary in both complexity and accuracy. The county has copies of both FEMA and county HEC-RAS models available for property owners and developers, which can be accessed through the county's Flood Model Repository, available on the county's online GIS. Because the county provides all current and archived models, it is important to use the most current and highest detailed models available for any floodplain analysis.

Figure 1: Special Flood Hazard Areas

2.1. Flood Zone Descriptions

A. A Zones

A Zones are modeled using approximate methods. Approximate methods do not typically utilize field survey data and leverage automated procedures for input parameters. These models generally use lower resolution topographic data obtained with remote measurements, like aerial photogrammetry, and obstructions (e.g., culverts) are generally not modeled. Approximate methods provide the lowest accuracy in floodplain modeling. Because detailed hydraulic analyses have not been performed, no BFEs are shown on FEMA FIRMs. However, Water Surface Elevation (WSE) data is available for all A Zones in the county and will be utilized as the best available data for the BFE. The Estimated BFE Excel Template, found in Appendix 12, can be used to help estimate the BFE at a specific location using the cross-sections from the current effective Floodplain Maps.

B. AE Zones (without a floodway designation)

AE Zones can be modeled using limited detailed methods or detailed methods. Limited detailed methods do not utilize field survey data but do generally include field data collection from sketches and photos to show major obstructions like culverts, buildings, and encroachments, as well as better information about site land cover conditions. Detailed methods include field survey data that provide detailed topographic information about a site. Detailed methods provide the highest accuracy in floodplain modeling. BFEs are available for all AE Zones in the county.

C. AE Zones (with a floodway designation)

AE Zones can also be modeled using detailed methods to identify a regulatory floodway. When this is done, an AE Zone is comprised of two parts: the inner portion called the floodway, and the outer portion called the flood fringe. Floodways are critical to floodplain management as they contain the channel of a river or other watercourse, and the adjacent land areas that must be reserved as this area provides the most flood water conveyance.

The NFIP typically identifies the flood fringe as an area designated for development if certain standards are met and restricts development in the floodway unless it can demonstrate it will not increase the BFE. Henrico County requires that all development in all flood zones demonstrate that it will not increase the BFE, so the county does not typically use the “flood fringe” and “floodway” terminology when describing its floodplains.

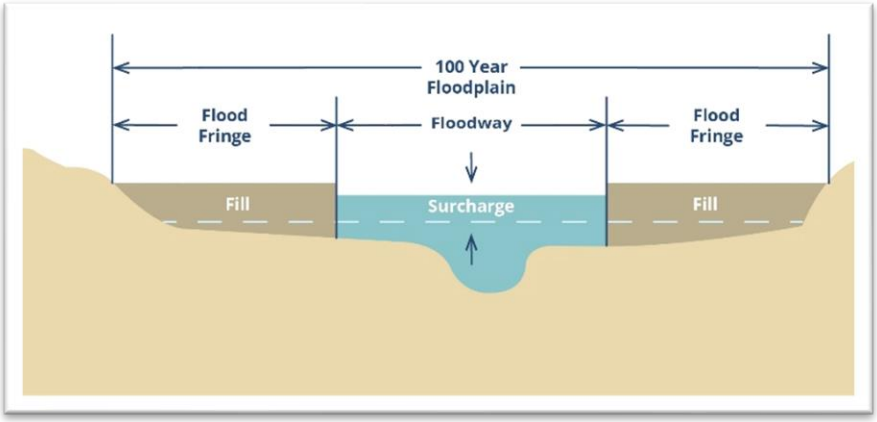

Figure 2: Floodway cross-section

D. Shaded X or X5 Zones (500-year floodplain)

Shaded X Zones or X5 Zones are used to identify the 500-year floodplain, or a moderate risk area. If mapped by FEMA, these areas are identified as Shaded X Zones, and if mapped by Henrico County, these areas are identified as X5 Zones on the Floodplain Maps. This area is not considered part of the SFHA. Although risk is lower in these areas, it is not completely removed. Because of this, some requirements of the Floodplain Ordinance apply to this area, including elevating buildings and protecting critical facilities.

2.2. Establishing SFHA Limits and Elevations

The SFHA limits and Base Flood Elevations (BFEs) are based on the county's Floodplain Maps, which include the current effective FEMA FIRMs and the current effective County Comprehensive Drainage Maps. The Floodplain Administrator shall make interpretations, where needed, as to the exact location of SFHAs, floodplain boundaries, floodway boundaries, and BFEs.

Sec. 10-6 of the Floodplain Ordinance outlines requirements for the use and interpretation of floodplain maps and data.

A. FEMA SFHAs

The Federal government, through FEMA, has mapped the floodplain in many places in Henrico County for drainage areas that are one square mile and larger. FEMA SFHAs are shown on the Henrico County Flood Zone and Dam Safety Information map on the county's online GIS, but the official map viewer for FEMA SFHAs is the National Flood Hazard Layer (NFHL). Additionally, the Flood Insurance Rate Map (FIRM) panels and Flood Insurance Study (FIS) report should also be used for flood hazard data.

1) Preliminary SFHAs

When FEMA conducts a community-wide map update, the revised floodplains will first be released as Preliminary SFHAs. Preliminary data includes the FIRM, FIS, and NFHL GIS data. FEMA released preliminary data in November 2021 for Henrico County. Sec. 10-6(d) of the Floodplain Ordinance requires that preliminary data be used as the best available data if it is more restrictive than the current effective floodplain. The Preliminary SFHAs are shown on the Henrico County Flood Zone and Dam Safety Information map

B. Community SFHAs

FEMA FIRMs only map the SFHA for drainage areas that are one square mile or larger. To account for this lack of data, Henrico County created Community SFHAs to map the additional flood hazard for drainage areas that are between 100-acres and one square mile in size. The Community SFHA begins where FEMA's modeling stops, and they do not overlap. These areas combined make up the regulated SFHA in Henrico County. In general, the FEMA SFHA and Community SFHA are treated the same except in how floodplain map changes are processed. Additional information on floodplain map changes is in Section 5.2 of this Manual.

The Community SFHAs are identified on the county's current Comprehensive Drainage Maps. These are available on the Henrico County Flood Zone and Dam Safety Information map on the county's online GIS. The county does not have paper flood maps or Flood Insurance Study (FIS) booklets for Community SFHAs at this time.

C. Overlapping FEMA and Community SFHAs

In general, FEMA SFHAs and Community SFHAs will not overlap. If FEMA SFHAs are updated and encroach into where Community SFHAs are currently mapped, the Community SFHA will be replaced. However, if a Community SFHA is updated and the model encroaches into a FEMA SFHA, the Community SFHA will not replace the FEMA SFHA. Instead, the model will be submitted through a Letter of Map Revision through FEMA to update the FEMA SFHA portion of the study area, and the remaining Community SFHA will also be updated.

There may be a situation when mapping data overlaps, at least temporarily, such as when a map change is in process. When this occurs, all maps must be compared. The most restrictive flood elevation and flood hazard boundary must be used. Information from all maps must be combined to yield the higher flood elevation, wider floodway limit, and more restrictive flood zone designation.

2.3. Boundary Interpretations

In many cases, boundary interpretations are required to appropriately determine flood stages and their footprint. It is not uncommon for there to be discrepancies in the SFHA floodplain limit when comparing a flood model's reported BFEs to current and surveyed data. These discrepancies can be attributed to several reasons but typically occur due to data resolution/accuracy improvements, natural causes, or manmade alterations. Sediment transport is an example of a natural reason for topographic changes that can account for higher or lower than expected ground surface elevations due to deposition or erosion. Manmade changes can lower or raise expected elevations from examples like trenching or placing fill. As a result of these unaccounted-for changes, it is always important to follow the methods below to ensure that the SFHA is appropriately mapped on site.

The Floodplain Administrator may require field survey information for any development to verify adjacent ground elevations from a licensed land surveyor or professional engineer. Where BFE and floodway data have not been identified, including in areas where SFHAs have not been identified, the Floodplain Administrator is authorized to require the applicant to determine the BFE and/or floodway in accordance with accepted hydrologic and hydraulic engineering practices, and the determination must be made by a licensed professional engineer.

A. Newer Topographic Data is Available

The county's current Floodplain Maps (effective 2007) are based on models that derived their elevations using 1998 aerial photogrammetry. As maps are updated, models will utilize available Virginia Geographic Information Network (VGIN) Light Detection and Ranging (LiDAR) data to derive elevations. The county typically strives to update their models so that they reflect the best possible available data. However, due to the staggered release of LiDAR datasets and infrequency of model updates, there could be newer topographic data available that is not reflected in the newest flood models. With newer topographic data typically comes higher resolution and better accuracy, so the newest data should always be used if available.

When new LiDAR data is available, the water surface elevations as reported in the flood models must be maintained and mapped to the newer LiDAR topography. In doing this, it is likely that the limits of the floodplain can change, but the limit that results in the largest floodplain footprint must be used unless a Letter of Map Revision has been approved to officially change the SFHA boundaries.

B. Field Survey is Available

In cases where a project is accompanied by field survey data, this must be incorporated into the SFHA interpretation. Field survey data typically provides higher accuracy data than that of LiDAR and gives more site-specific information that improves flood limit determinations within the survey limits.

When field survey is available, the water surface elevations as reported in the flood models must be maintained and mapped to the field survey topography. In doing this, it is likely that the limits of the floodplain can change, but the limit that results in the largest floodplain footprint must be used.

C. Site Adjacent to a Model Limit of Study

In some instances, a site may be located just beyond of a model's defined limit of study. For these cases, three options are available for adequate establishment of the SFHA boundary. The first option is to utilize existing data available from federal, state, or other sources. Typically, if additional data was available, a Letter of Map Revision (LOMR) would have been processed, so this option may not be common.

Another option is to extend the hydraulic model by adding additional cross-sections and extending the model stream centerline. This process follows similar procedures to those mentioned in Section 5.4.

Finally, the county recognizes that updating models is an intensive process and allows for an alternative method for projects just beyond the study limits, up to 500 feet. This method is consistent with FEMA's Data Extrapolation process outlined in FEMA 265: Management Floodplain Development in Approximate Zone A Areas. It states that if a development occurs within 500 feet upstream of the end of a floodplain model, data extrapolation can be used.

The best approach to determining a development's 100-year floodplain elevation is to measure the distance along the streamline between the development and the last cross-section in the model. Then, indicate the development's distance from the last cross-section on the hydraulic model profile plot. This plot must also include the extension of the BFE to the location of the development while maintaining the slope on the water surface from the last cross-section in the model.

For Community SFHAs, the profile plot must be obtained using the HEC-RAS model, and for FEMA SFHAs, the profile plot can be obtained from the FIS. This method is only applicable to areas that are not affected by downstream hydraulic controls or contain any obstructions. If the SFHA is subject to any of these within the reach between the development and the last cross-section of the model, the county reserves the right to require the model to be updated with a floodplain study.

D. Local Low Spots

If there is a local low spot adjacent to a floodplain, meaning the ground elevation is below the BFE, this area must be carefully considered to determine if it is inside or outside the SFHA. For features that are hydraulically disconnected from the floodplain, local low spots can remain outside of the floodplain; if there is a break in topography or infrastructure providing conveyance to the low spot, this portion must be included in the SFHA. If a low spot is found to be hydraulically connected to the floodplain, the BFE for this area can be determined by linear interpolation between cross-sections. If the local low spot is significant in size, the county may require updates to the hydraulic models using better topographic data or additional cross-sections.

E. Ridgeline or Local High Spots

If a ridge line or local high spot is found within the floodplain and its ground elevation is above the BFE, it is considered in the SFHA until a LOMR has been approved to officially remove the area from the floodplain.

F. Unpermitted Development

In very few cases, topographic discrepancy can be attributed to unpermitted development, such as grading activity, within the SFHA. Unpermitted development in the SFHA is a violation of the Floodplain Ordinance and will be addressed as outlined in Division 6: Enforcement of the Floodplain Ordinance. If this is identified as part of the boundary interpretation, the issue must be rectified before the permitting process can move forward. Any corrections made in this respect do not qualify as compensatory storage to be counted as added flood storage volume as part of a proposed project.

2.4. Mandatory Flood Insurance Purchase Requirements

Flood insurance is made available through the National Flood Insurance Program (NFIP) and may also be available through some private entities. Homeowners and renters insurance policies do not typically cover flood damages. Federal mandatory flood insurance purchase requirements applies in FEMA SFHAs only. Any structure, home, or business with a federally backed mortgage or loan in a FEMA SFHA is required to carry flood insurance. This requirement does not apply to Community SFHAs. However, flood insurance coverage is strongly recommended in these areas and outside of the SFHA. According to FEMA, over 40% of NFIP flood insurance claims were from outside of the FEMA SFHA. Learn more about flood insurance and the NFIP at www.FloodSmart.gov.

3. SPECIFIC DEVELOPMENT STANDARDS

As an NFIP participating community, Henrico County is required to regulate all development in the SFHA. These requirements are found in the Floodplain Ordinance. However, additional requirements in the Zoning Ordinance, Subdivision Ordinance, Building Code, or others may also apply to development in the SFHA.

The information included in this Manual is based on the Floodplain Ordinance only. Applicants must contact the appropriate department or agency for any other requirements that may apply.

3.1. Floodplain Ordinance

The Floodplain Ordinance outlines the regulatory requirements for development in the SFHA and can be found in Chapter 10, Article 1 of the Henrico County Code. The purpose of the Floodplain Ordinance is to promote and protect the health, safety, and general welfare of the citizens of Henrico County and to minimize losses due to flood hazards.

The county's Floodplain Ordinance exceeds the NFIP minimum floodplain management standards to reduce vulnerability to flooding and promote extra preparedness among Henrico County citizens. Because

a property in the SFHA is periodically inundated by floodwaters, a certain volume of floodwater will naturally occupy that property during a flood. This volume of floodwater is known as flood storage and is accounted for in the modeling that creates a floodplain map. However, flood storage on a site can be reduced by new development, which can force floodwater that would have occupied the site onto neighboring upstream and downstream properties, potentially worsening flood conditions on those properties. For this reason, the Floodplain Ordinance includes higher standards that address flood volume.

Additionally, we know that floodwaters do not always follow boundaries on a map. For example, sediment may naturally build up in a stream over time and reduce its carrying capacity, or culverts or bridges may become blocked by debris during a flood event, which could result in flooding that differs from the floodplain map. Flood events greater than the 100-year event could also occur, so these higher standards help reduce the risk of property damage and loss of life from flooding.

Below is a summary of some of the higher standards adopted in the Floodplain Ordinance. The specific requirements are outlined in the Floodplain Ordinance, and some of these are addressed in more detail in this Manual.

- New development may not increase the base flood elevation, and a No-Rise Certificate must be provided
- Compensatory storage may be used to meet the No-Rise requirement
- Fill in the SFHA is prohibited
- New residential buildings are prohibited in the SFHA and within a 15’ setback from the SFHA
- New residential buildings within a 40’ setback from the SFHA or within the 500-year floodplain must be elevated
- Nonresidential buildings may be permitted in the SFHA, but they must be elevated
- Dryland access is required for new roads, driveways, and parking areas to allow for safer access during a flood event
- Critical facilities are prohibited in the SFHA and must be elevated if located in the 500-year floodplain
- Stormwater management facilities are prohibited in the SFHA
- Storage of hazardous materials is prohibited in the SFHA

For Floodplain Ordinance questions, please contact the county’s Floodplain Administrator in the Department of Public Works, Design Division.

3.2. Zoning Ordinance

The Zoning Ordinance applies to the use and development of all lands within the county and can be found in Chapter 24 of the Henrico County Code. The purpose of the Zoning Ordinance is to promote the health, safety, and general welfare of the present and future residents, businesses, and landowners of the county, while also ensuring all development within the county’s jurisdiction is consistent with the goals and policies of the adopted comprehensive plan.

All development in the SFHA must also comply with all applicable requirements in the Zoning Ordinance. Below is a summary of some of the requirements in the Zoning Ordinance that may apply to development in the SFHA:

- The SFHA cannot be used to calculate lot area (Sec. 24-8302.A) or residential density (Sec. 24-8303).

- The C-1 Conservation District may be used to preserve and protect the SFHA (Sec. 24-3203).
- Development within dam break inundation zones must meet certain requirements (Sec. 24-2314). Although dam break inundation zones are not the same as the SFHA, they often overlap.

For Zoning Ordinance questions, please contact the Planning Department.

3.3. Subdivision Ordinance

The Subdivision Ordinance applies to any subdivision of land that is situated wholly or partly within the county and can be found in Chapter 19 of the Henrico County Code. The purpose of the Subdivision Ordinance is to promote the health, safety, and general welfare of the present and future residents, businesses, and landowners of the county and to establish procedures and standards relating to the subdivision of land within the county and to establish standards for access, circulation, streets, and other infrastructure provided as part of subdivisions in order to assure the orderly subdivision of land and its development.

All subdivision of land in the SFHA must also comply with all applicable requirements in the Subdivision Ordinance. Below is a summary of some of the requirements in the Subdivision Ordinance that may apply to development in the SFHA:

- Subdivisions must comply with the Floodplain Ordinance and the limits and elevation of SFHA must be conspicuously noted and labeled on the plat and the construction plans, and a variable width drainage and utilities easement within the SFHA must be granted (Sec. 19-3601, Sec. 19-3502).
- The SFHA is considered a primary conservation area for Cluster Subdivisions (Sec. 19-5303).
- Development within dam break inundation zones must meet certain requirements (Sec. 19-2302). Although dam break inundation zones are not the same as the SFHA, they often overlap.

For Subdivision Ordinance questions, please contact the Planning Department.

3.4. Building Code

The Virginia Uniform Statewide Building Code (USBC) establishes minimum regulations to govern the construction and maintenance of buildings and structures and is adopted and maintained by the Virginia Board of Housing and Community Development. Additional requirements can be found in Chapter 6 of the Henrico County Code.

All buildings or structures in the SFHA must also comply with all applicable requirements in the USBC. Please note that the USBC does not supersede the county's Floodplain Ordinance (USBC, Sec. 102.2), some USBC requirements may not be applicable if the Floodplain Ordinance includes a more restrictive standard. Below is a summary of some of the locations where requirements can be found in the 2018 USBC (effective July 1, 2021) that may apply to buildings or structures in the SFHA:

- The building official may require a permit for activities generally exempt from the building permit requirement if located in the SFHA (Sec. 108.2).
- After placement of the lowest floor and prior to further vertical construction, an elevation certificate must be submitted to the building official (Sec. 113.3.2).
- Moved buildings or structures shall not be occupied or used until flood hazard documentation has been approved by the building official (Sec. 117.2)

- Sections 1603 and 1612 of the Virginia Construction Code.
- Section R322 of the Virginia Residential Code
- Requirements are also located in other books of the USBC collection (e.g., Virginia Existing Building Code, Virginia Mechanical Code, etc.)

For Building Code questions, please contact the Building Inspections Department.

3.5. Other Standards

In addition to the standards listed above, there may be other county or state requirements that apply to development in the SFHA, such as water quality standards.

The Stormwater Management Ordinance applies to certain land disturbing activities and can be found in Chapter 10, Article II of the Henrico County Code. The purpose of the Stormwater Management Ordinance is to promote and protect the health, safety, and general welfare of the citizens of Henrico County and to protect state waters, stream channels, and other natural resources from the potential impacts of development. This ordinance also addresses Chesapeake Bay Preservation Area (CBPA). Additional CBPA requirements can also be found in the Zoning Ordinance, Chapter 24, Division 8 of the Henrico County Code.

Development in the SFHA must also comply with all applicable Stormwater Management and CBPA requirements. The SFHA is considered a CBPA Resource Management Area.

For Stormwater Management or CBPA questions, please contact the Department of Public Works, Environmental Services Division.

4. SPECIFIC DEVELOPMENT ACTIVITIES AND REQUIREMENTS

This section is intended to provide additional guidance on specific development activities and requirements outlined in the Floodplain Ordinance. This **does not** include all types of development, nor does it include all ordinance requirements that apply within the SFHA.

Development activities that are located partially in the SFHA will be treated as if the entire development is in the SFHA and must comply with the ordinance requirements. For example, a nonresidential building that has a small portion of the building located in the SFHA and the rest of the building located outside the SFHA must have the lowest floor of the entire structure elevated.

4.1. Buildings and Structures

New construction and substantial improvements, including manufactured homes, must be built in accordance with the Floodplain Ordinance and the USBC, and anchored to prevent flotation, collapse, or lateral movement of the structure, constructed with materials and utility equipment resistant to flood damage, and constructed with methods and practices that minimize flood damage. Manufactured homes may be considered a Residential or Non-Residential Building depending on their use. For the purposes of

the Floodplain Ordinance and this Manual, mixed use buildings are considered residential.

A. Residential Structures

New or substantially improved residential structures are prohibited in the SFHA and within 15 feet of the SFHA. New or substantially improved residential structures located in the 500-year floodplain or that are closer to the SFHA than 40 feet may be permitted if the lowest floor, including mechanical equipment, is elevated a minimum of one foot above the BFE.

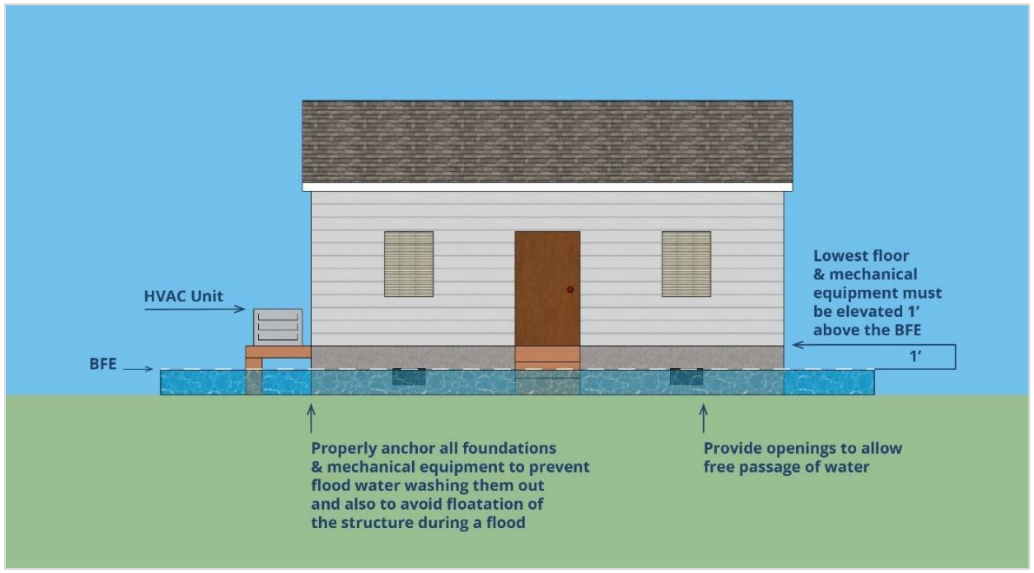

Figure 3: Example elevated residential structure adjacent to the SFHA.

The 15-foot and 40-foot distances are measured from the edge of the floodplain to the structure. These must be measured horizontally showing the shortest distance between the floodplain and nearest structure corner.

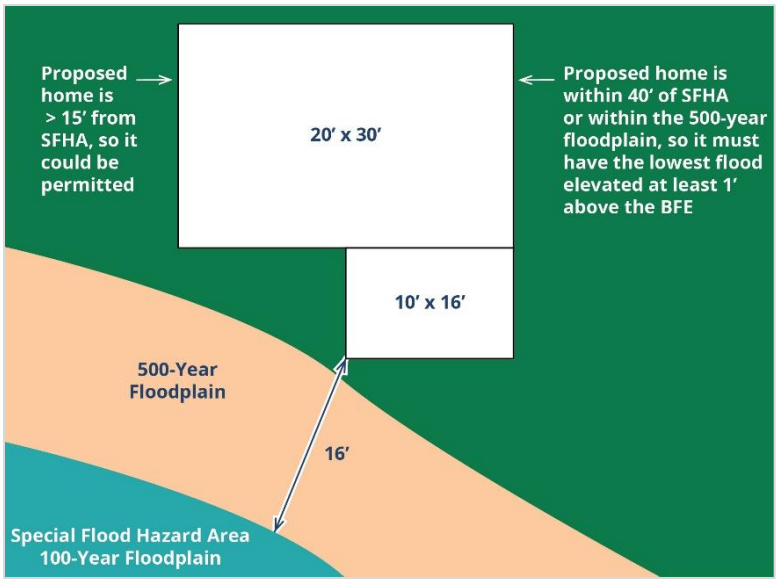

Figure 4: Example site plan with floodplain setback drawn to the nearest structure corner.

B. Nonresidential Structures

New or substantially improved nonresidential structures may be permitted in the SFHA if the lowest floor, including mechanical equipment, is elevated a minimum of two feet above the BFE. New or substantially improved nonresidential structures located in the 500-year floodplain or that are closer to the SFHA than 40 feet may be permitted if the lowest floor, including mechanical equipment, is elevated a minimum of one foot above the BFE of the adjacent SFHA.

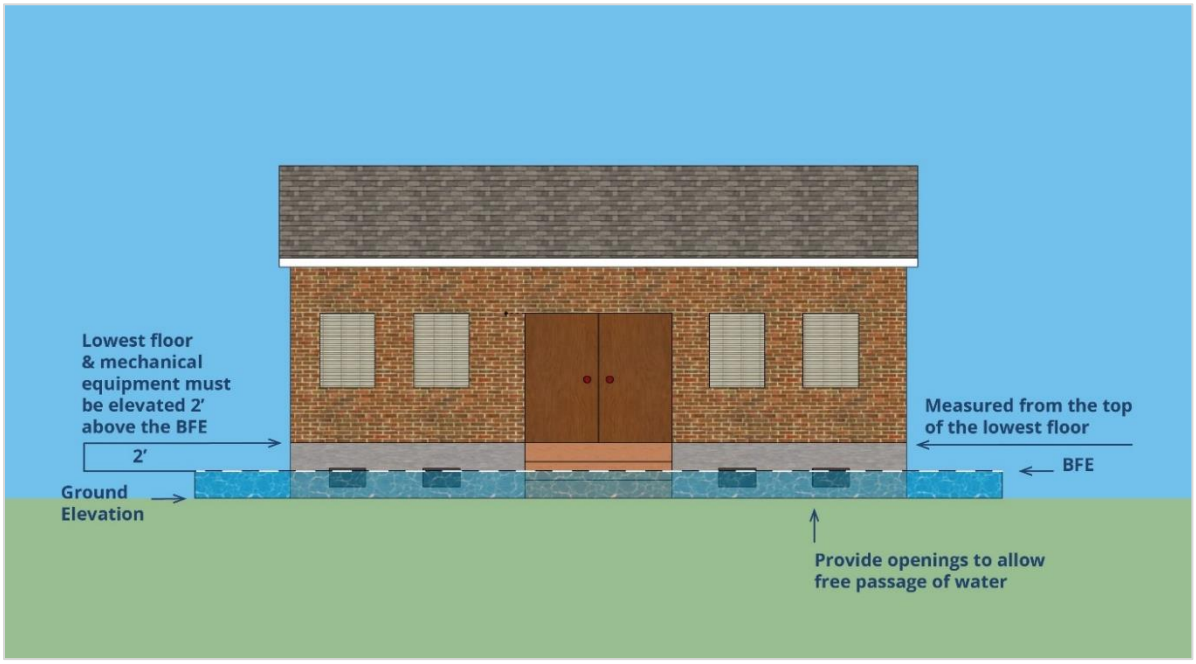

Figure 5: Example elevated nonresidential structure within the SFHA.

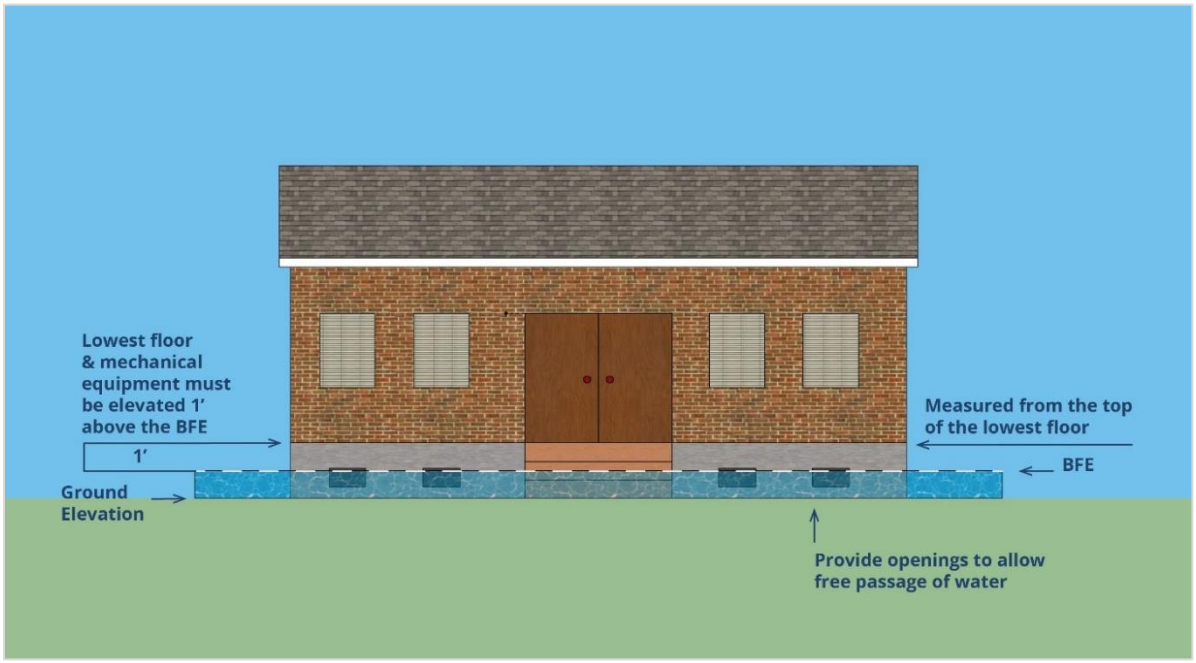

Figure 6: Example elevated nonresidential structure adjacent to the SFHA.

The 40-foot distance must be measured horizontally showing the shortest distance between the floodplain and nearest structure corner.

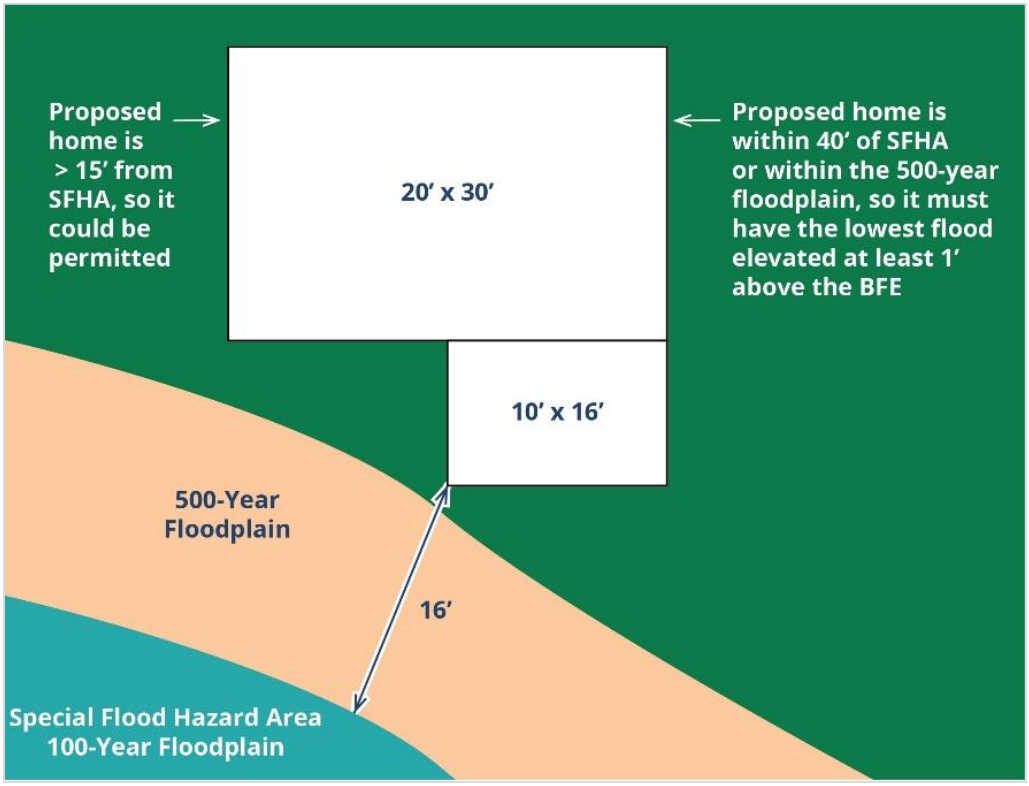

Figure 7: Example site plan with floodplain setback drawn to the nearest structure corner.

1) Accessory Structures

For the purposes of the Floodplain Ordinance and this Manual, accessory structures are considered nonresidential even if their use may be considered residential in nature by other ordinances (e.g., detached garage, backyard shed, greenhouse, etc.). Accessory structures must meet the requirements of nonresidential structures above. However, detached accessory structures used only for parking of vehicles and/or storage may be permitted with the lowest floor below the BFE if the following conditions are met:

- The structure is not larger than 600 square feet - approximately the size of a one-story two-car garage and walls.
- The structure has flood openings that meet the requirements for Enclosures Below the Lowest Floor
- The structure is anchored to resist flotation, collapse, and lateral movement.
- Flood damage-resistant materials are used below the BFE.
- Mechanical, electrical, and utility equipment is elevated or dry-floodproofed to or above the BFE. Dry-floodproofing must be certified by a licensed professional engineer or architect.

2) Agricultural Structures

For the purposes of the Floodplain Ordinance and this Manual, agricultural structures are considered nonresidential and must meet the requirements of nonresidential structures above.

3) Dry Floodproofing

Dry Floodproofing is the combination of measures that results in a structure and its attendant utilities and equipment being watertight with all elements substantially impermeable and with structural components having the capacity to resist flood loads. Dry floodproofing generally includes making the building watertight through sealing openings, installing waterproof doors and windows, or sealing walls with waterproof coatings, impermeable membranes, and/or a supplementary layer of masonry or concrete. Dry floodproofing is appropriate only for certain nonresidential buildings.

New nonresidential structures in the SFHA must have their lowest floor elevated above the BFE and may not use dry floodproofing. However, there may be situations when elevation of a nonresidential structure is not feasible because of the nature of the lot and/or the building use. If this occurs, an Administrative Variance may be issued to allow dry floodproofing.

If an Administrative Variance is approved, all areas of the building components below the BFE plus three feet must be watertight with walls substantially impermeable to the passage of water. Structural components must be used that have the capability of resisting hydrostatic and hydrodynamic loads and the effect of buoyancy; this must be designed and constructed in accordance with the USBC and ASCE 24, as well as be certified by a professional engineer or architect.

A Floodproofing Certificate (Appendix 6) with supporting data and an inspection and operational plan that includes, but is not limited to, installation, exercise, and maintenance of floodproofing measures must be provided. This certification, operational plan, and inspection and maintenance plan shall be prepared by or under the direct supervision of a professional engineer or architect and certified by same.

C. Existing Structures

Although Henrico County has prohibited dwellings in the SFHA since 1989, many were built prior to that prohibition being adopted or prior to being mapped in the SFHA. There are approximately 1,200 existing residential structures and approximately 200 existing nonresidential structures in the SFHA. A structure or use that lawfully existed before the adoption of the Floodplain Ordinance but does not satisfy the current requirements of Floodplain Ordinance may continue.

1) Ordinance Requirements for Existing Structures

The following items are from Sec. 10-13 of the Floodplain Ordinance:

a) An existing structure in the floodway may not be expanded or enlarged if the proposed expansion or enlargement would result in an increase in the BFE.
b) If a modification, alteration, repair, reconstruction, or improvement to a structure in a floodplain would cost less than 50 percent of the market value of the structure, the modification, alteration, repair, reconstruction, or improvement must be designed to minimize flood damage. If such structure does not comply with the current requirements of the Floodplain Ordinance, the modification, alteration, repair, reconstruction, or improvement must not increase the amount of nonconformity.
c) A substantial improvement must meet the requirements of [the Floodplain Ordinance] for new construction, and the entire structure must conform with the current USBC after the substantial improvement is completed. If a substantial improvement will be located in the 500-year floodplain or will be between 15 and 40 feet from the SFHA, the lowest floor of the substantial improvement, including mechanical equipment, must be elevated a minimum of one foot above the BFE.

d) An existing residential structure may not be enlarged if any part of the enlarged structure will be in, or within 15 feet of, the SFHA.
e) A residential structure may be relocated only if the new location of the structure is entirely outside the SFHA, and the new location does not violate the provisions of the Floodplain Ordinance.

2) Substantial Improvements and Substantial Damages

Substantial damages and substantial improvements require that structures be brought into compliance with the current requirements for new construction under both the Floodplain Ordinance and the USBC.

Substantial Improvement is any improvement to a structure where the cost of the improvements is greater than or equal to 50% of the market value of the structure before the start of construction of the improvement. A Substantial Damage is damage to a structure from any origin, not just flooding, where the cost to repair the structure to the pre-damaged value equals or exceeds 50% of the market value of the structure before the damage occurred. By definition, a substantial damage is also considered a substantial improvement. Additional information is available in FEMA's Substantial Improvement/ Substantial Damage Desk Reference.

If existing violations of state or local health, sanitary, or safety codes were identified through the county's code enforcement process before a substantial damage or substantial improvement occurs, the costs to address the violation may not be incorporated into the substantial damage or substantial improvement determination. However, the violation must have been documented in writing and must be the minimum improvements necessary to assure safe living conditions.

The tax assessed value for a structure will be used as the market value for making substantial damage and substantial improvement determinations. However, property owners may choose to have an independent appraisal of the structure done by a professional appraiser for this determination. If an independent appraisal is done, this may be used to update the tax assessment.

The Floodplain Administrator is responsible for making Substantial Improvement or Substantial Damage determinations. As part of this process, FEMA has identified several costs that must be included in this calculation, as well as some costs that may be excluded. When applying for a Floodplain Development Permit for an existing structure, a cost breakdown must be submitted with the permit application so this determination can be made.

FEMA has identified specific items that must be included and excluded from the cost determination for Substantial Damages and Substantial Improvements. Items that must be included in the costs of improvement and the costs to repair are those directly associated with the building. Items that can be excluded are those that are not directly associated with the building. Figure 8 below provides a list of all the items that must be included and excluded from the cost determination. Appendix 13 may be used to track costs as part of a permit application.

COSTS INCLUDED

in SI/SD Determination

- **Materials and labor**, including the estimated value of donated or discounted materials and owner or volunteer labor
- **Site preparation related to the improvement or repair** (e.g., foundation excavation or filling in basements)
- **Demolition and construction debris disposal**
- **Labor and other costs associated with demolishing, moving, or altering building components** to accommodate improvements, additions, and making repairs
- **Costs associated with elevating a structure** when the proposed elevation is lower than the BFE
- **Costs associated with complying with any other regulations or code requirement** that is triggered by the work, including costs to comply with the requirements of the Americans with Disabilities Act (ADA)
- **Construction management and supervision**
- **Contractor's overhead and profit**
- **Sales taxes on materials**
- **Structural elements and exterior finishes**, including: *Foundations (e.g., spread or continuous foundation footings, perimeter walls, chain- walls, pilings, columns, posts, etc.); Monolithic or other types of concrete slabs; Bearing walls, tie beams, trusses; Joists, beams, subflooring, framing, ceilings; Interior non-bearing walls; Exterior finishes (e.g., brick, stucco, siding, painting, and trim); Windows and exterior doors; Roofing, gutters, and downspouts; Hardware; Attached decks and porches.*
- **Interior finish elements**, including: *Floor finishes (e.g., hardwood, ceramic, vinyl, linoleum, stone, and wall-to-wall carpet over subflooring); Bathroom tiling and fixtures; Wall finishes (e.g., drywall, paint, stucco, plaster, paneling, and marble); Built-in cabinets (e.g., kitchen, utility, entertainment, storage, and bathroom); Interior doors; Interior finish carpentry; Built-in bookcases and furniture; Hardware; Insulation.*
- **Utility and service equipment**, including: *Heating, ventilation, and air conditioning (HVAC) equipment; Plumbing fixtures and piping; Electrical wiring, outlets, and switches; Light fixtures and ceiling fans; Security systems; Built-in appliances; Central vacuum systems; Water filtration, conditioning, and recirculation systems.*

COSTS EXCLUDED

in SI/SD Determination

- **Clean-up and trash removal**
- **Costs to temporarily stabilize a building** so that it is safe to enter to evaluate and identify required repairs
- **Costs to obtain or prepare plans and specifications**
- **Land survey costs**
- **Permit fees and inspection fees**
- **Carpeting and recarpeting** installed over finished flooring such as wood or tiling
- **Outside improvements**, including landscaping, irrigation, sidewalks, driveways, fences, yard lights, swimming pools, pool enclosures, and detached accessory structures (e.g., garages, sheds, and gazebos)
- **Costs required for the minimum necessary work to correct existing violations** of health, safety, and sanitary codes
- **Plug-in appliances** such as washing machines, dryers, and stoves

Figure 8: Costs that must be included and excluded in SI/SD determinations

3) Historic Structures

A historic structure may be considered a Residential or Non-Residential Building depending on its use. Historic structure is defined as any structure that is:

1) listed individually in the National Register of Historic Places maintained by the U. S. Department of Interior or preliminarily determined by the U. S. Secretary of the Interior as meeting the requirements for individual listing on the National Register, or
2) certified or preliminarily determined by the U. S. Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district, or
3) individually listed on a state inventory of historic places in states with historic preservation programs which have been approved by the U. S. Secretary of the Interior, or
4) individually listed on a local inventory of historic places in communities with historic preservation programs that have been certified either:
    a. by an approved state program as determined by the U. S. Secretary of the Interior or
    b. directly by the U. S. Secretary of the Interior in states without approved programs.

Henrico County is not currently a Certified Local Government through the Virginia Department of Historic Resources, so (d) is not applicable.

Variances for the repair or rehabilitation of historic structures may be granted upon a determination that the proposed repair or rehabilitation will not preclude the structure's continued designation as a historic structure and the variance is the minimum necessary to preserve the historic character and design of the structure. Documentation from a historic preservationist or the Virginia Department of Historic Resources must be provided that clearly demonstrates meeting the requirements of the Floodplain Ordinance would jeopardize the structure's historic designation.

D. Determining the Lowest Floor

The lowest floor of a structure is measured from the lowest enclosed area (including crawlspace or basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement area may not be considered a building's lowest floor if it meets the requirements below for enclosures below the lowest floor. An Elevation Certificate must be submitted to document the lowest floor elevation. More information on Elevation Certificates is in Section 6.3.D.1.

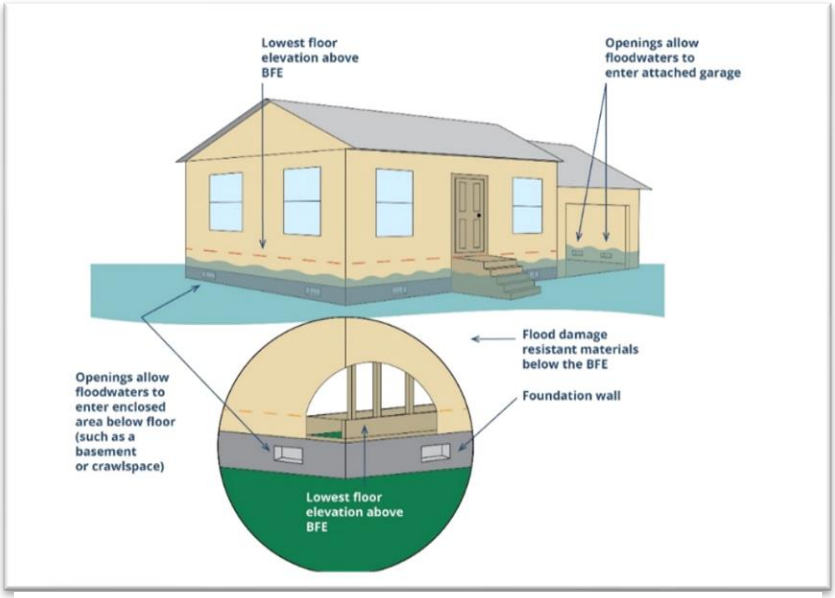

Figure 9: Example lowest floor of a structure within or adjacent to the SFHA

E. Enclosures Below the Lowest Floor

Enclosed areas below the lowest floor in new or substantially improved structures must be designed to allow flood water to automatically enter and exit the space by installing flood openings. This is also referred to as wet floodproofing. Enclosures must meet the following requirements to not be treated as the lowest floor:

- not be designed or used for human habitation,
- be used solely for parking of vehicles, building access, or limited storage of maintenance equipment for the premises. Access to the enclosed area shall be the minimum necessary to allow for parking of vehicles (garage door) or limited storage of maintenance equipment (standard exterior door), or entry to the living area (stairway or elevator),
- be constructed entirely of flood damage-resistant materials,
- include measures to automatically equalize hydrostatic flood forces on walls by allowing for the entry and exit of floodwaters. To meet this requirement, flood openings must meet the following minimum design criteria:
    - there must be a minimum of two openings on different sides of each enclosed area subject to flooding.
    - the total net area of all openings must be at least one square inch for each square foot of enclosed area subject to flooding or be certified by a professional engineer or architect.
    - there must be openings to allow floodwaters to automatically enter and exit each enclosed area if a building has more than one enclosed area.
    - the bottom of all required openings shall be no higher than one foot above the adjacent grade.
    - openings may be equipped with screens, louvers, or other opening coverings or devices that permit the automatic flow of floodwaters in both directions without manual operation or human intervention.

Existing structures with enclosures below the lowest floor that do not meet the requirements listed above may have high flood insurance premiums if the bottom of the enclosure is below the BFE. Property owners of these structures may wish to renovate the existing enclosure to incorporate flood openings to reduce their flood insurance premiums. In some situations, this could result in hundreds or even thousands of dollars in flood insurance premium savings.

4.2. Critical Facilities

A Critical Facility is a structure or other improvement that, because of its function, size, service area, or uniqueness, has the potential to result in serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if it is destroyed or damaged or if its functionality is impaired. Critical facilities include health and safety facilities, utilities, government facilities, and hazardous materials facilities.

New or substantially improved critical facilities may not be located in the SFHA. Critical facilities located in the 500-year floodplain may be permitted, but buildings or structures must have their lowest floor elevated to the BFE plus two feet, or the 500-year flood elevation plus one foot, whichever is greater.

If a Critical Facility must be located in the SFHA, a variance by the County Engineer may be possible.

A. Example

A sewer pump station would be considered a critical facility and could not be located in the SFHA. However, underground sewer lines that connect structures to the pump station would not be considered a critical facility and could be located in the SFHA if all applicable requirements have been met.

4.3. Roads, Bridges, and Culverts

New roads, bridges, and culverts in the SFHA must be modeled to determine their impacts and ensure they meet the ordinance requirements. The HEC-RAS Manuals should be consulted for additional details on how to accurately model these in a flood study. If a new road, bridge, or culvert is proposed, the applicant will need to work closely with the county to determine all applicable design standards.

A. Dryland Access

New roads, driveways, and parking areas located in the SFHA must be designed and constructed so that they will not be overtopped by more than six inches of water during the 100-year flood. A hydrologic and hydraulic analysis may be necessary to demonstrate this, but this may also be demonstrated through a grading plan that shows the top of the road, driveway, or parking area is no more than six inches below the BFE. All applicable requirements in the Henrico County Design Manual must be met for new roads, driveways, and parking areas. It is important to consider all requirements to determine that the most restrictive criteria are met, and all applicable requirements are satisfied.

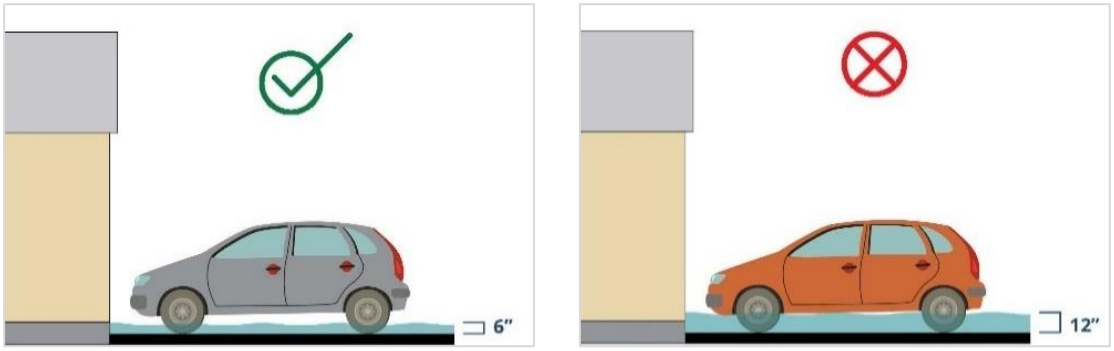

Figure 10: Example new driveway designs that do and do not meet the dryland access requirement.

4.4. Other Development

A. Fill in the Floodplain

Fill is a deposit of materials placed by artificial means in the SFHA. Fill may not be placed in the SFHA, including the placement of fill to remove a lot from the SFHA in order to construct a building or structure.

An Administrative Variance may be approved for minor filling in the SFHA necessary to protect or restore natural floodplain functions or to stabilize stream banks to protect public roads and utilities.

B. Environmental Protection and Restoration Projects

Natural floodplains help reduce flood risk by slowing down runoff and storing flood water. Natural floodplains can add value to the community through socioeconomic and environmental benefits, such as improving water quality, groundwater recharge, fish and wildlife habitat, and recreational opportunities. Development and vegetation removal can degrade natural floodplains causing issues like erosion or

sedimentation, so environmental protection and restoration projects may be implemented to restore these areas. These types of projects are encouraged in the SFHA.

1) Example

Stream restorations are a common project implemented in Henrico County to restore natural floodplains. These projects achieve stability by raising the stream bed to reconnect with the floodplain while also providing additional flow capacity. As a result, it is common to have fill material in the channel. Usually, fill within the SFHA is prohibited; however, minor filling that is necessary to protect or restore natural floodplain functions, such as stream restoration projects, may be allowed with an Administrative Variance.

C. Stormwater Management Facilities

New stormwater management facilities designed specifically to address stormwater quantity may not be constructed in the SFHA, as they can restrict or remove floodplain storage. This does not include facilities designed to exclusively address water quality. The Virginia Stormwater BMP Clearinghouse provides guidance and design specifications for 15 different practices. For Floodplain Management purposes, some of these practices are not considered a "stormwater management facility" and as such could be permitted in the SFHA. Although some practices may be allowed in the SFHA, some practices may be discouraged due to potential maintenance concerns caused by regular flooding. Table 1 below outlines each practice, whether it is considered a stormwater management facility for floodplain purposes, if it is allowed in the SFHA, as well as additional comments that may be relevant.

Table 1 - Stormwater Management Facilities in the SFHA

Practice Description	Stormwater Management Facility (for Floodplain Management Purposes Only)	Allowed in SFHA?
Sheet Flow	Yes	No
Bioretention	Yes	No
Dry Swales	Yes	No
Extended Detention	Yes	No
Soil Compost Amendment	No	Yes, but discouraged
Infiltration Practices	No	Yes, but discouraged
Rooftop Disconnect	No	Yes
Grass Channel	No	Yes
Vegetative Roof	No	Yes
Rainwater Harvesting	No	Yes
Permeable Pavement	No	Yes
Wet Swales	No	Yes
Filtering Practices	No	Yes
Constructed Wetlands	No	Yes
Wet Ponds	No	Yes

All practices listed above that are allowed in the SFHA must comply with all applicable requirements in the Floodplain Ordinance (e.g., No-Rise, no fill, etc.). Stormwater Management Facilities may be allowed in the SFHA if a variance is granted. For practices using sheet flow, the conserved open space area or vegetive filter strip can be within the SFHA, but the actual outfall structure (level spreader, pipe, etc.) cannot be in the SFHA. For soil compost amendments and infiltration practices, flooding could impact maintenance requirements and must be carefully considered in the service life of the BMP.

If locating a stormwater management facility outside of the SFHA is not feasible, a variance may be possible. An Administrative Variance may be issued to allow the stormwater management facility to be in the SFHA. For new facilities that receive this variance, they must meet the No-Rise requirement, no fill requirement, and provide engineering data shows that the proposed stormwater management facility will operate effectively for its intended purpose during a 10-year flood event or the required design storm for the project, whichever is greater, and will have structure stability during a 100-year flood event. If the requirements of the Administrative Variance cannot be met, a County Engineer Variance may be requested. A variance may only be approved if all applicable variance requirements have been met.

1) Meeting the No-Rise Requirement

- If retrofitting an existing stormwater management facility within the SFHA, the hydraulic function for the 100-year must either be maintained or provide smaller outflows.
- For new stormwater management facilities that discharge directly into the SFHA, the 100-year flows should be attenuated to the site's existing condition's peak. An alternative to providing attenuation for the 100-year flows is to conduct a Peak Offset Analysis.
- For new stormwater management facilities located entirely in the SFHA (variance approval required), a hydrologic and hydraulic analysis is required. For new stormwater management facilities located partially in the SFHA (variance approval required), a hydrologic and hydraulic analysis may be required. Compensatory storage may also be required for these facilities.
- See Sec. 5.1 for more information on the No-Rise Certification.

2) Example

A pond in the SFHA that was not designed to hold stormwater could be retrofitted to improve water quality; the pond may collect stormwater because water naturally flows into it, but the pond is not designed specifically for that purpose. However, a detention basin designed specifically to hold stormwater runoff would not be allowed in the SFHA because it is designed specifically to manage stormwater quantity, it would be considered a stormwater management facility.

D. Decks and Porches

A deck, porch, or similar feature added to a new or existing structure is a floodplain obstruction and must be evaluated to determine its impacts. Adding a deck to an existing structure is considered enlarging that structure, and all requirements for existing structures would apply. If an attached deck is located in or adjacent to the SFHA, the deck must comply with the requirements for that type of structure (e.g., top of deck elevated above the BFE, constructed entirely of flood damage-resistant materials, meet enclosure requirements, if applicable, etc.). For Floodplain Management purposes, a deck is considered attached to a structure if it is directly connected to the structure (e.g., bracket connection, roof with attached supports, electrical connection, etc.) or if it is located within one foot of the structure.

A No-Rise Certificate (No Impact Statement) may be used for decks that do not have enclosures or have enclosures with less than 50% obstruction.

E. Fences

Fences may be permitted in the SFHA depending on the type and location of the fence. The type of fence will determine whether the fence will qualify as a minor project or a floodplain obstruction. Fences considered minor do not require a hydraulic study and can be permitted under a General Permit. Fences considered a floodplain obstruction will require a hydraulic study and can only be permitted under an Individual Permit.

Table 2 below outlines the fence types that may be permitted in the SFHA. Case by case reviews may be conducted by the Floodplain Administrator for fence types not listed below, including collapsible or breakaway fencing and fences requiring post spacing shorter than the typical 6-8 foot. Fences installed around swimming pools must be approved under an Individual Permit, and a building permit may also be required.

Table 2 - Fence Types and Requirements in the SFHA

Fence Type	Hydraulic Study Required?	Hydraulic Analysis Modeling Requirements	Permit Type Required
Open wire, welded wire, chain link, pipe, or wood rail fencing (field fence, post and rail)			
	No	N/A	General Permit
Wood, metal, or vinyl picket fencing with equivalent board width and spacing (roughly 50% obstruction) AND fence line is parallel to direction of flow and in a location that should have minimal impact to the flow.			
	No	N/A	General Permit
Wood, metal, or vinyl picket fencing with equivalent board width and spacing (roughly 50% obstruction) AND fence line is designed in a way that has potential to block the direction of flow.			
	Yes	Model fencing using increased Manning's friction.	Individual Permit
Wood, metal, or vinyl fencing with narrow spacing (greater than 50% obstruction).			
	Yes	Model fence as an obstruction.	Individual Permit
Wood, metal, or vinyl solid board fencing (privacy fencing).			
	Yes	Model fence as an obstruction.	Individual Permit
Any fence type installed around a swimming pool.			
	Determined by applicable fence type above.		Individual Permit

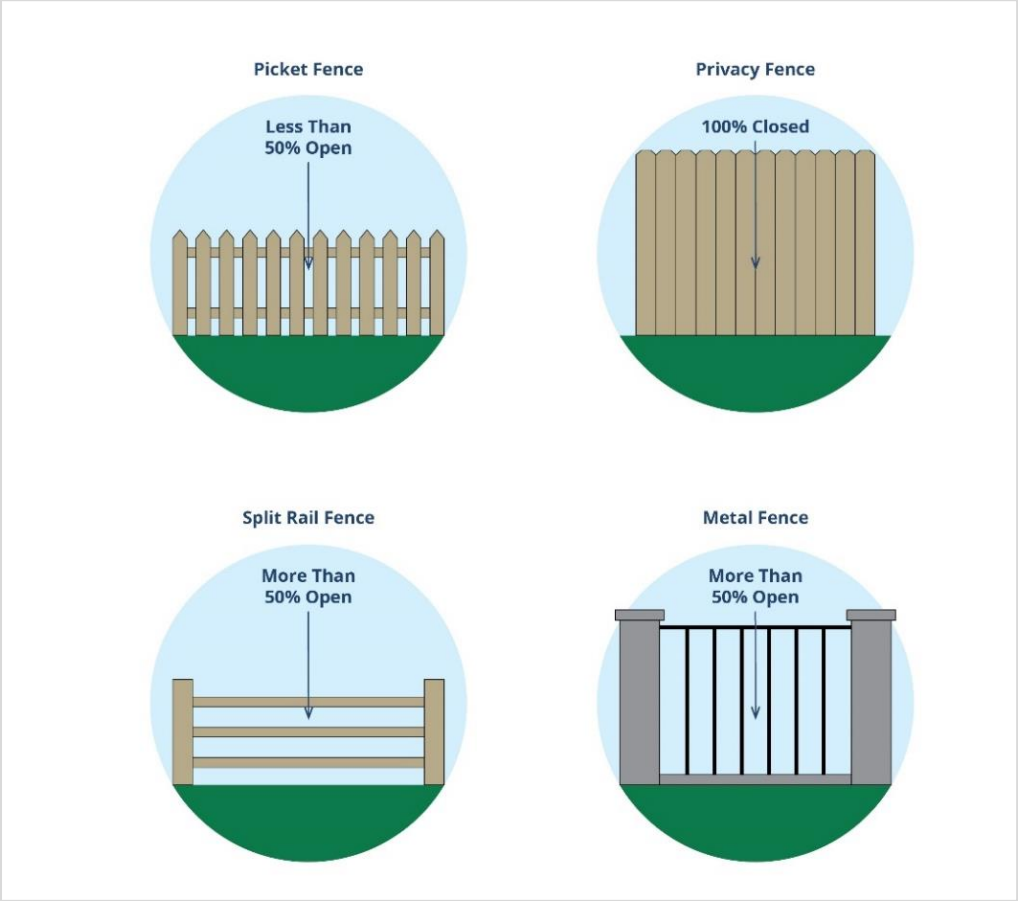

Figure 11: Example fences with and without proper openings.

F. Utility Systems

Additional information on protection utilities is available in FEMA P-348: Protecting Building Utility Systems from Flood Damage.

- Mechanical equipment shall be designed and/or located to prevent water from entering or accumulating within its components during conditions of flooding. Mechanical equipment associated with a building must be elevated to the same requirement as the building's lowest floor.
- New and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the system.
- New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of flood waters into the system and discharges from the system into flood waters.
- On-site waste disposal systems shall be located and constructed to avoid their impairment or contamination during flooding.

G. Maintenance Activities

Some maintenance activities have been approved under a General Permit. Those activities are listed below. All other maintenance activities must be evaluated for floodplain impacts. Activities listed below that are located in a Floodway must be evaluated for floodplain impacts.

- Road maintenance involving painting, repaving, or patching an existing road, driveway, or parking area. This may also include repairs to existing guardrails/barriers. This may not involve replacement with larger or additional above ground infrastructure.
- General maintenance work to existing culverts, bridges, or dams such as repairs to concrete or other materials, cleaning out debris or sediment, or something similar. This may not involve replacement with larger or additional above ground infrastructure.
- Drainage ditch maintenance involving mowing, cleaning out debris or sediment from existing drainage ditches.
- Poles for signs, overhead utilities, billboards, and alike that are no larger than 2 feet in diameter and are not located within the stream channel.
- Underground utilities or repairs to existing underground utilities that do not permanently alter the topography.

H. Temporary Development

1) Temporary Structures

Temporary structures may be permitted in the SFHA if the requirements of Sec. 10-10(k) of the Floodplain Ordinance have been met, which are outlined below.

All applicants must submit a plan for removal of the structure in the event of a flood-related severe weather notification (hurricane, tropical storm, flood, flash flood, etc.) which includes the following information:

- certification that the requirements of Sec. 10-9(a) and Sec. 10-9(b) [of the Floodplain Ordinance] have been met;
- a specified time period for the temporary use. The time period may not exceed three months and is renewable for up to one year;
- the name, address, and phone number of the individual responsible for the removal of the structure;
- the amount of time prior to the event when the structure will be removed;
- a copy of a contract with a trucking company to ensure the availability of removal equipment when needed or evidence of removal equipment on the property if a trucking company will not be used. In either case, the owner must provide a written designation of a location outside the SFHA to which the structure will be removed.

2) Temporary Encroachments

Temporary encroachments may be permitted in the SFHA if the requirements of Sec. 10-10(l) of the Floodplain Ordinance have been met, which are outlined below.

Temporary encroachments include sediment control devices, temporary stream crossings, haul roads and construction entrances, storage of equipment, and soil stockpiling. The following conditions must be met to qualify for the exemption:

- The proposed temporary encroachment shall not be in place more than three months and is renewable for up to one year with written approval from the Floodplain Administrator. Temporary sediment control devices may be kept in place longer than one year if required by the appropriate regulatory agency, and,
- Supporting documentation, including a hydrologic and hydraulic analysis (if required by the

Floodplain Administrator) must be submitted by a licensed professional engineer indicating that the proposed project will not impact any existing buildings or overtop any roadway surfaces.

Temporary encroachments may be exempt from the No-Rise requirements of Sec. 10-9(a) and the no fill requirements of Sec. 10-9(b). In general, the No-Rise requirement must be met for all temporary development. However, temporary activities that qualify as minor development under the General Permit in Section 6.1.A.1 may not be required to provide additional documentation. Minor fill may be allowed only if the fill will be removed at the end of the temporary project and returned to the pre-development condition. Documentation, such as engineered plans and field survey, comparing the pre-development and post-development conditions will be required to confirm this has been met. Close coordination with the Floodplain Administrator will be necessary for any temporary encroachment prior to permit approval.

I. State Projects and State-Owned Property

In accordance with § 10.1-603 of the Code of Virginia, all state agencies and departments undertaking development in a floodplain must adhere to local floodplain regulations or receive formal approval through the Department of Conservation and Recreation. Chapter 777 of the 2023 Acts of Assembly states that DCR, in cooperation with others, must establish state standards for development in the floodplain no later than September 30, 3023.

For state projects with development impacting the floodplain in Henrico County, an Individual Floodplain Development Permit application must be submitting following the process in Sec. 6.2.B.

5. Modeling Procedures

The following section outlines the procedures for completing an engineering analysis of floodplain impacts. It includes two main paths to conducting an analysis: (1) verification of no adverse impacts to a floodplain and (2) verification of known adverse impacts and the subsequent map and model updates. At the end of the section are detailed descriptions of all the expected deliverables that are needed to facilitate county review for approval.

All available HEC-RAS models for the county's SFHAs are available online through the county's Flood Model Repository (Repository). The Repository is designed to be a tool developers and engineers can use to easily identify the correct models for an analysis by identifying its location in a county-wide map. Typical application is to provide a nearby address of the site, and users can select the nearby receiving stream to download .ZIP files of all nearby flood models. Additional resources and training on how to effectively use the Repository can be found on the county's Floodplain Management webpage here.

5.1. No-Rise Certification

This section includes the best practices and county preferred methods for addressing the No-Rise requirement for development in the SFHA.

The objective of a No-Rise Certification is to confirm that a project's impacts do not cause adverse impacts to the floodplain or increase the BFE. If a project does not meet the criteria of a minor project under a General Permit, an engineering investigation must be conducted. A No-Rise Certification must be prepared by a Professional Engineer licensed in the Commonwealth of Virginia, and it must be supported

by technical data. There are three distinct types of technical data that may support a No-Rise Certificate: a No Impact Statement, providing Compensatory Storage, or a Flood Study.

A No-Rise has been achieved when it has been shown that there is a 0.00 difference in the corrected effective water surface elevation and the proposed conditions water surface elevation. If this value is 0.004 or less, it may be rounded down to 0.00, which is considered a No-Rise. If this value is 0.005 or greater, it must be rounded up to 0.01, which is not considered a No-Rise.

For No-Rise Certificate submittal requirements, see Sec. 6.3.G.

A. No Impact Statement

The No Impact Statement is a short narrative document for projects too small to warrant a detailed flood study that outlines logical and common-sense engineering calculations and approaches. Examples of these types of projects include at grade improvements like driveway, sidewalk, entryways, and parking area installation/replacement. Projects may include deck replacement/installation, if they are elevated above the BFE. Examples of calculations may include but not limited to single section analysis, volumetric calculations, land cover/land use breakdown, and time of concentration calculations.

1) General Engineering Analysis

For some projects, such as at grade improvements or deck replacement/installation, a general engineering analysis may be done to document that the project will not increase the BFE. For projects like at grade improvements, technical data must be provided to support the No Impact Statement including but not limited to existing and proposed topographic surveys that demonstrates there will not be a grade change.

For projects that involve replacement work, such as deck replacements to repair damaged materials, documentation must be provided that demonstrates the replacement is in-kind and will not result in a change, including but not limited to construction drawings showing existing and proposed conditions (location, dimensions, elevations, materials, etc.).

2) Peak Offset Analysis (Stormwater Discharge)

For new stormwater management facilities adjacent to the SFHA that discharge directly into the SFHA, the 100-year flows should be attenuated to the site's existing condition's peak. An alternative to providing attenuation for the 100-year flows is to conduct a hydrologic analysis for the receiving channel and facility to determine if coincident peaks are occurring. The study must show there is no impact to the mapped floodplain due to increased flows by showing that the facility hydrograph does not overlap the receiving channel hydrograph in a way that results in an increased peak. The analysis must show that the rising limb of the floodplain's peak is not impacted by the falling limb of the proposed discharge's peak.

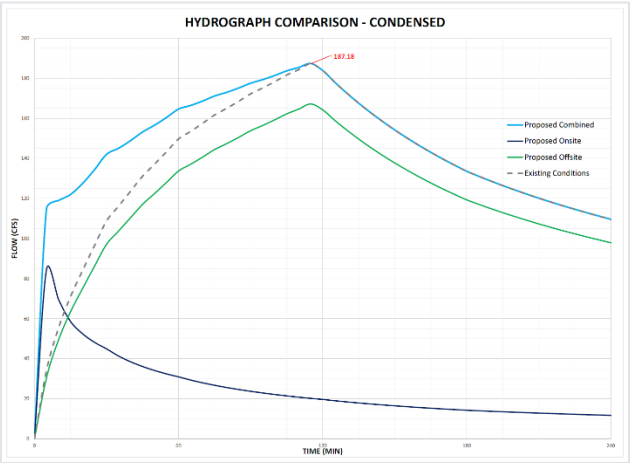

Figure 12: Example hydrograph demonstrating a No-Rise using the Peak Offset method. The gray dashed line represents the floodplain, and the dark blue solid line represents the proposed discharge.

3) Conveyance Shadow

Locations of projects within the conveyance shadow of other structures are also covered as part of this section. If the project is located immediately upstream and downstream perpendicular to an existing flow obstruction, this project can be considered within the conveyance shadow. The reasoning behind this is that flood water is already flowing around the larger obstruction, so the addition of a new structure will not change existing flood flow. Determining the limits of the conveyance shadow is illustrated in the figure below. The proposed project footprint must be entirely contained within the conveyance shadow area for this determination to be accepted by the county. The conveyance shadow is defined by extending lines at 45 degrees from each structure edge using the flood flow direction as the axis. Documentation must be provided that demonstrates the proposed project is located in the conveyance shadow, such as the example in Figure 13 below.

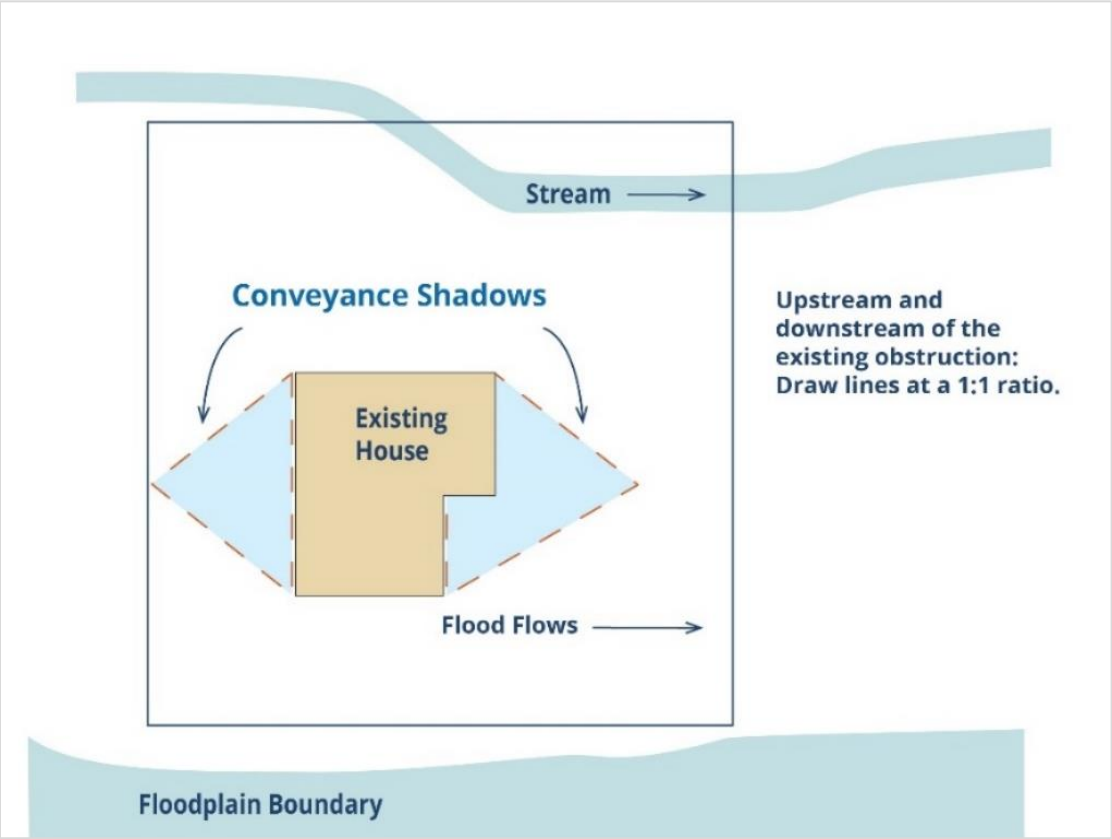

Figure** 13**: Example of a conveyance shadow around a structure in the SFHA.

B. Compensatory Storage

When significant topographical and geometrical changes to the floodplain are part of a project, the designer is allowed to provide compensatory storage to ensure that the flood storage and conveyance of the site is maintained. Removing any unpermitted development, such as fill or structures, does not constitute adequate compensation. Removing unlawful development as compensation for additional proposed flood storage volume displacement does not address the original, illegal loss of flood storage volume. As a result, such compensation cannot be credited toward the new development.

Compensatory storage must be designed in a way that floodwaters are allowed to freely enter and exit

the area without restriction. A few examples of features that create restrictions include embankments, depressed topography, stormwater basins, etc.

Compensatory storage should be located onsite and adjacent to or opposite the areas of new floodplain development. If such placement is not feasible, analysis must show that the proposed location is a hydraulically equivalent site and will not result in an adverse impact to adjacent properties or development. Compensatory storage located on a hydraulically equivalent site provides additional flood conveyance area, so that flood elevations are not increased. All excavations should be constructed to drain freely to the adjacent watercourse and not pond water in the area as flood levels recede. No area below the waterline of a pond or other body of water can be credited as a compensating storage. An alternatives analysis may be required to identify a location for compensatory storage that minimizes the impact to other resources (i.e., riparian buffers, wetlands, fisheries habitat, etc.). Additionally, test pits may be required to demonstrate that the proposed compensatory storage will not intercept the seasonal high groundwater table.

During wetter months, typically January through April, the groundwater table is at its highest elevation. If a compensation area were situated below the elevation of the seasonal high groundwater table, groundwater would enter the compensatory storage areas during the wet times of year, and consequently, those areas would not be available for the storage of floodwaters because they would already be occupied by groundwater. This negates the required functionality of the compensatory storage area and is therefore not permitted.

The compensatory storage area is required to be hydrologically connected to the SFHA. If it is situated below the normal water surface elevation, the compensatory storage area would immediately fill with water during floods and therefore would not be available to store floodwaters from either the 10-year or 100-year flood hazard events.

There are three methods accepted by the county for demonstrating compliance with the compensatory storage requirements. The methods include the Average End Area Method, GRID method, and TIN method. The TIN method provides the most accurate cut and fill volume estimates but is the most computationally intensive. If this method is used, surface files must be provided to the county in the most current CAD format for review.

Proposed development in the SFHA that requires compensatory storage must be compensated with excavation of at least one times the volume of the displaced storage volume (1:1 compensatory storage ratio requirement).

Any compensatory storage calculations or modeling must, at a minimum, be based upon at least one-foot contours that have been field surveyed. All proposed development and compensatory storage must be clearly identified on the site plans. A comparison of storage volumes impacted at all elevations up to the BFE (100-year flood event) must be summarized to quantify the impacts from the development. This information is best presented as a summary table within the engineering report.

All compensatory calculations must show that cut fill volumes are balanced at one-foot elevation increments up to the BFE. This is required as it prevents events smaller than the 100-year from experiencing water surface elevation increases. Without this requirement, compensatory storage can be graded in a way where the majority of the cut volume is found in the higher elevations, causing smaller event's water surface elevations to be increased and push the problem offsite. Due to certain types of projects and site constraints, balancing cut and fill volumes at one-foot intervals may not be possible. In

these instances, this requirement can be waived but must be closely coordinated with the county Floodplain Administrator. If this occurs, additional analysis may be required for smaller rainfall events.

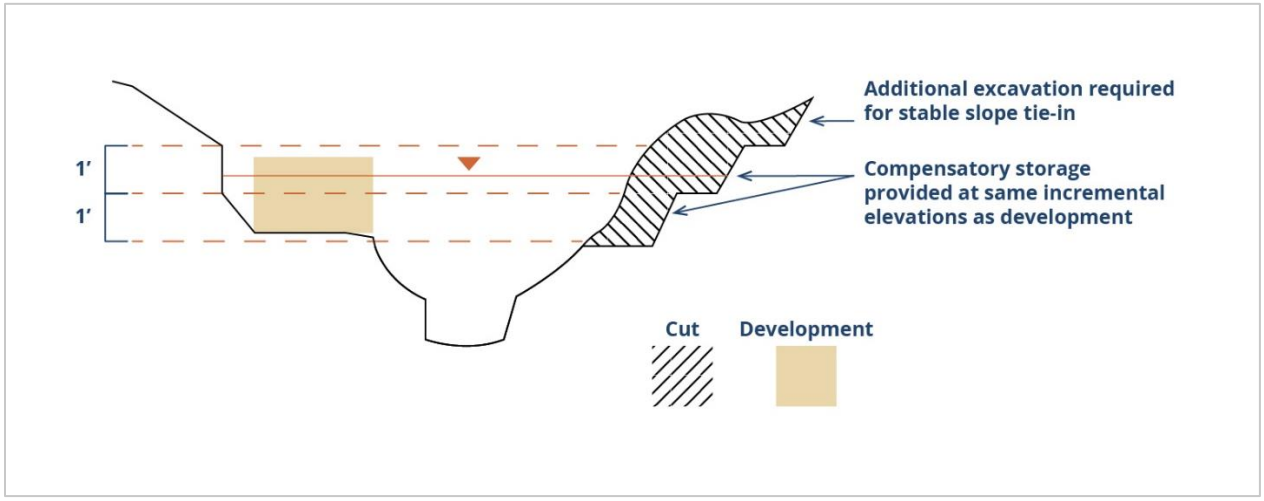

Figure** 14**: Compensatory storage example for a development in the SFHA, such as buildings

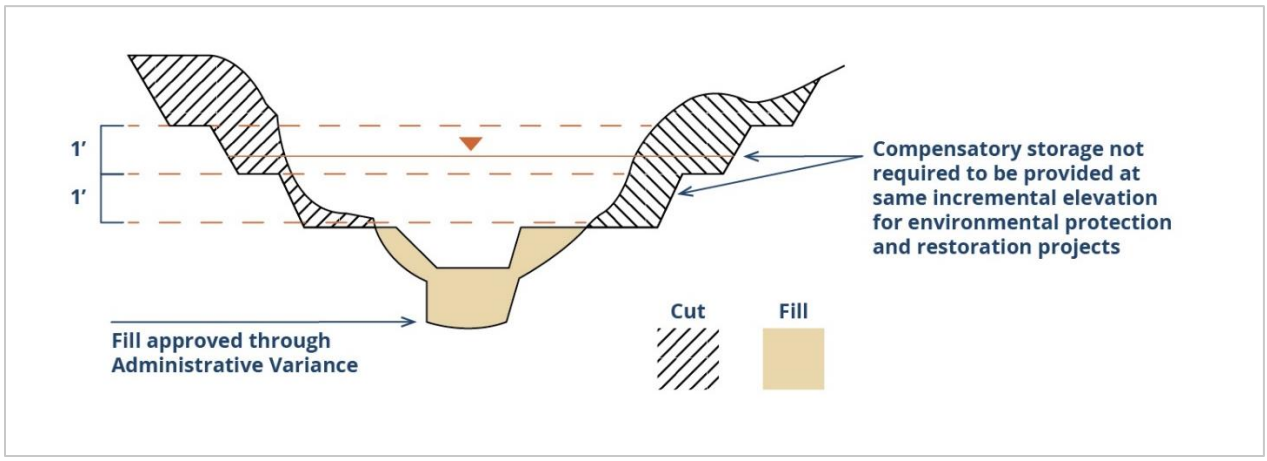

Figure 15: Compensatory storage example with fill in the SFHA, such as a stream restoration

Topographic data derived from field survey including digital elevations models (DEM), triangulated irregular networks (TIN), digital terrain models (DTM), and contours may be used to compare existing and proposed ground surface elevations. This data can be used in computer programs including Geographical Information Systems (GIS) and Computer Aided Design (CAD) to calculate volumes. One method in a GIS would be to overlay a polygon of the SFHA with elevation contours, then split the polygon feature into elevation intervals by tracing the contours. The area of these new polygons can then be multiplied by the depth to BFE to calculate flood storage volume. The depth to BFE should be calculated as the BFE minus the average elevation between two contours. This approach is appropriate for use on most sites, including those with more complex terrain or hydraulic conditions.

1) Average End Area Method

The average end area method is a common approach to estimating earthwork volumes. In this method,

the areas at each end of a cross-section are averaged over the length between them. The results are volumetric estimations of proposed fill or compensatory storage in each cross-section.

The volume between two cross-sections is computed by the formula:

$$Vol = \frac{(A_1 + A_2) * L}{2}$$

where, A_1 represents the fill (or compensatory storage) area of the first cross-section, A_2 represents the fill (or compensatory storage) area of the second cross-section, *L* represents the length between the two cross-sections, and *Vol* is the fill (or compensatory storage) volume between the two sections.

Fill and compensatory storage should be accounted separately for each 1-foot interval and for each pair of cross-sections. The volumes between cross-sections are then tabulated and summed to obtain total estimated fill and compensatory storage volumes. This method is suitable for either level or sloped BFEs across a site. Table 3 below provides an example of a cross-section providing an approvable approach to compensatory storage.

Table 3 - Example volumetric calculations using average end area method

Parameter	Elevation	Width	Length	Cross Section 1		Cross Section 2		Volume
				Distance	Area	Distance	Area	
Unit	ft	ft	ft	ft	ft^2	ft	ft^2	ft^3
Calculation	-	-	-	-	(W*D1)	-	W*D2	A1+A2*(L/2)
Segment								
A	566-567.3	1.3	100	42	54.6	57	74.1	6,435
B	565-566	1	100	39	39	52	52	4,450
C	564-565	1	100	37	37	47	47	4,200
D	563-564	1	100	35	35	45	35	3,500
E	562-563	1	100	34	34	41	41	3,750
							Total Fill (ft^3):	**22,435**
							Total Fill (yd^3):	**831**

An as-built survey showing compensatory storage should be provided to verify final storage volumes and to facilitate the prevention of future encroachment. Site conditions should meet the approved design volumes. Future development within compensatory storage areas shall be prohibited in all cases. This may be achieved through permit conditions and/or deed restrictions.

2) Grid Method

Under the Grid Method, a grid is superimposed over a grading plan, effectively dividing the site into a series of cells. The spot elevations of all cell corners are averaged and designated at the centroid of the cell, and the average elevation is subtracted from each of the 1-foot intervals up to the base flood elevation. Each of these measured depths is then multiplied by the area of the cell to determine the volume of the floodwaters in that cell. The process is repeated for each cell in the grid. Then, the volumes of each cell are summed to determine the total volume of the flood storage on the project site.

Care must be taken in selecting an appropriate cell size as sizes too small results in excessive computations

and sizes too large result in poor average depths that make the approximations much less accurate. It is recommended to adjust cell sizes near very steep topographic changes to better approximate average depths.

3) TIN Method

The TIN Method provides the highest-level accuracy volume calculations by leveraging CAD software to compute cut and fill volumes. The accuracy of the Average End Area Method and the Grid Method is a function of how many cross-sections or cells are utilized and as a result, these methods can be labor intensive. In the TIN Method, the flood storage volume of a site, or a portion thereof, is calculated by comparing an existing and proposed surface generated using a large number of points and connected triangles. If TIN surface files are to be provided to the county, the preferred format is AutoCAD. However, other formats can be used as long as adequate reporting is provided.

C. Flood Study

For some development projects, it may be necessary to provide a flood study to demonstrate No-Rise. Generally, this is the county's preferred method as any changes are permanently documented within the hydraulic models so that future developments have access to the models with the most current topography and structures. The methods in this approach should follow the same procedures as outlined in Sections 5.2, 5.3, and 5.4. The main distinction between a flood study for No-Rise and for map changes is that for No-Rise studies, the numeric and visual depictions of water surface in the reports and cross-sections for the existing and proposed conditions should be identical.

For full studies that incorporate a compensatory storage component, selecting the appropriate locations and number of additional cross-sections must be consistent with practices outlined in Section 5.4.B. Reporting and submittal documents must also be consistent with flood study methods as the revisions to the floodplain geometrics must be adopted into the county's regulatory models for studies and/or developments for future projects.

5.2. Map Changes

Some development projects require map changes that involve updating floodplain limits and the associated hydraulic models. A Letter of Map Change (LOMC) may be issued by FEMA for FEMA SFHAs or by the county engineer for Community SFHAs. The process is similar for each, but map updates for the county generally require less documentation and as a result, have a less rigorous submittal process than FEMA map changes. The two types are outlined further in the following sections.

As part of the map change process, Henrico County requires that any water surface elevation (WSE) grids and depth grids, if available, be updated for the study area. This applies to both FEMA SFHAs and Community SFHAs. Current WSE grid and depth grid data for FEMA SFHAs is available through the FEMA Map Service Center. When updating a WSE or depth grid, the resolution must be equivalent or better than what is provided in the existing dataset. To request this data for Community SFHAs, please contact the county's Floodplain Administrator. If there is no existing WSE or depth grid data, the WSE or depth grid as provided as part of a map change must use cells no larger than 10x10 feet.

A. FEMA Letter of Map Changes

FEMA provides an online portal for Letter of Map Amendment (LOMA) and Letter of Map Revision (LOMR) submittals. Alternatively, FEMA provides a means to submit map change reviews by standard mail with

the use of paper forms: MT-EZ, MT-1, and MT-2. For projects that propose a significant change in the floodplain elevations and geometrics, submittals will be broken into two parts, a Conditional Letter of Map Revision (CLOMR) prior to development, followed by a LOMR after development. Additional information on FEMA LOMCs is available the FEMA website here.

As part of the FEMA LOMC process, some projects may require a Community Acknowledgement Form (also known as Form 3). In these cases, the applicant must submit a copy of the Community Acknowledgement Form, with the complete LOMC application that will be submitted to FEMA, to the county Floodplain Administrator for review. The Floodplain Administrator will only sign the Community Acknowledgement Form if the project complies with the Floodplain Ordinance.

B. County Letters of Map Change

For map changes within a Community SFHA, applicants must submit documentation and modeling outlined in Section 5.2 and Section 6.3.J. This documentation and modeling must be supervised and submitted by a Professional Engineer licensed in Virginia. A flood study report, HEC-RAS model, and export files, as outlined in Section 5 and Section 6.3.H must be submitted digitally to the Floodplain Administrator.

C. Property Owner Notifications

Some LOMRs require notification letters be mailed to all impacted property owners. Property owner notifications and associated postage fees are the responsibility of the applicant. Applicants must submit the draft notification letter (in Microsoft Word format) and an address list of impacted properties (in Microsoft Excel format) to the Floodplain Administrator for review. Once final versions of the letter and address list have been approved, the applicant must mail out by first class mail, at a minimum, to property owners.

5.3. Hydrology

A. Using Established Flow Rates

Flow rates for all study reaches have already been established from previously adopted and published studies for all SFHAs. Explanations for how to determine flow rates are provided below along with a discussion of how to utilize incomplete published data sets.

When already established flow rates are to be used, it is strongly recommended to provide a verification of the established flow rates in order to identify any potential changes that may have occurred since those flows were established. Land use changes or significant drainage projects are two examples of occurrences that could significantly impact flow rates in the model. A simple statement indicating that established flow rates are being used must be included in the study report.

A delineation does not typically compute peak flow rates at every point along a watercourse. Instead, peak flow rates are computed at only a few locations. Often a site will be located along a reach of a watercourse in between two such locations. In these instances, the flow rate established in the model should be used for that reach of the watercourse, and it is not necessary to interpolate between the two locations because interpolation may not accurately reflect how flow in the watercourse changes.

B. Updating Flow Rates

Updating model flow rates may be required for a variety of reasons. Some of the more common reasons are significant changes to the watershed and missing storm event data. The HEC-RAS models typically contain all appropriate storm events including the 10-, 50-, 100- and 500-year events. However, there may be cases where certain models only contain the 100-year event. In these cases, the missing storm events must be included in the updated model. Some projects may require the determination of events smaller than 10-year events for design purposes, but these are not required as part of an analysis for floodplain impacts.

The county generally does not prefer attenuation to be included as part of a hydrologic analysis. Due to the scale of watersheds being regulated and the inability to verify that Best Management Practices (BMPs) are maintained and functioning correctly, the county prefers this conservative approach. At the watershed level, storage factors should not be utilized to establish flow rates. For smaller, offline BMPs, attenuation should not be considered. In some instances, large impoundment structures, like dams, may be found along the floodplain watercourse. In these cases, considerable attenuation occurs and can be considered with close coordination with the county.

To fill out missing storm events, engineers must first establish a baseline model that generally replicates the available established flow rates. This is easiest to achieve by replicating the methods and parameters that can be obtained from the hydrologic analysis reports provided by the county. In some instances, these reports may not be available. The engineer will need to approximate the methods and parameters used and calibrate these terms until a reasonable output is consistent with established flows. For an SCS Curve number method calibration, this can include adjustment of Curve Number or Time of Concentration numbers. Once an appropriate model is created, it can be used to generate flows for the missing storm events. This hydrologic model, and an explanation of its development, must be included for review as part of the engineering report submitted to the county.

Forecasting land use should generally not be included as part of developing watershed hydrology for existing conditions. Hydrology should be based on readily available data. It is important to note that there can be a significant difference between the results of different hydrologic models. This may require the engineer to establish multiple peak flow values for the existing and proposed conditions, as no one method is all encompassing. When updates to hydrology are done by changing the methodology, all assumptions and rational for this change must be documented in the engineering report. When comparing existing to proposed conditions, the methodologies in both scenarios must be consistent. For example, existing conditions flow values derived from the Regression Equation cannot be compared to proposed condition flow values derived using Rational Equation.

1) Required Storm Events

- **10-year event**: provides additional detail, and storm sewer and drainage projects are designed for this event; also required as part of a compensatory storage analysis as outlined in Section 5.1.B
- **50-year event**: utilized for stormwater management design; also required as part of a compensatory storage analysis as outlined in Section 5.1.B
- **100-year event**: utilized for floodplain management, and determines the regulatory SFHAs
- **500-year event**: utilized for floodplain management, particularly in providing a more stringent requirements for critical infrastructure and structure elevations

C. Preferred Hydrologic Methods

1) USGS Regression Equations

All flood models in Henrico County that became effective in 2007, including the models for the FEMA SFHAs and Community SFHAs, utilized USGS Regression Equation to establish flows. Regression equations are best suited for large watersheds where changes are not expected in the hydrologic conditions that existed at the time stream flow measurements were conducted. Because urbanization of watersheds alters the hydrologic conditions over time, the Regression Equation is not suited to forecast peak flow rates due to significant land use changes; however, the county does not allow forecasting land use in establishing hydrology.

With the Regression Equation, designers can estimate peak flow rates for each of the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storms in ungauged and non-tidal watercourses. However, the county does not currently recommend the sole use of the Regression Equation for flood hazard calculations on smaller watersheds. Designers should include the SCS Curve Number Method as it provides a more rigorous calculation of peak flow rates and calculates an entire hydrograph, which is essential for analysis when offsite flooding impacts become a concern.

USGS provides literature to compute Regression Equation peak flow estimates based on a location's physiographic region. Another option is StreamStats, which is a web-based program with a map user interface that facilitates delineating drainage areas and computing hydrology using the Regression Equation. StreamStats does this through the use of GIS analytical tools.

2) SCS Curve Number Method

The Soil Conservation Service (SCS) Curve Number Method is the preferred procedure for smaller watersheds to be submitted for review, as described in the USDA Natural Resources Conservation Service (NRCS) publication Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds. The methodology described in TR-55 is derived from the NRCS's Technical Release 20 (TR-20). TR-55 describes procedures to calculate storm runoff volumes, peak discharge rates, and hydrographs required for flood analyses and delineations. It uses a hypothetical design storm and an empirical nonlinear runoff equation to compute runoff volumes and a dimensionless unit hydrograph to convert those volumes into runoff hydrographs. This method is recommended for drainage areas no greater than 25 square miles (16,000 acres). For larger drainage areas, the SCS curve number method tends to over predict flows, so the USGS regression equations are more appropriate.

It is important to note that several different software packages provide TR-55 calculations; however, it's best to reference FEMA's approved hydrologic models list because some software, like WinTR-55, have discontinued support or have not been reviewed by FEMA for accuracy and are not accepted. A complete description of the NRCS methodology can be found in the NRCS National Engineering Handbook, "Part 630-Hydrology". A detailed discussion of TR-55 is also available from the NRCS. Refer to these resources for more detailed information concerning the basis of the SCS Curve Number Method.

3) Other Methods

As mentioned in the previous section, there are a number of hydrologic methods and models that can be used to estimate peak flow values. The county approved methods are consistent with those approved by FEMA, which can be found on the FEMA website here. FEMA also provides a list of previously approved software that is no longer accepted, which can be found on the FEMA website here. Consult with the

Floodplain Administrator in advance for any questions about hydrologic methods and modeling.

5.4. Hydraulics

A. Approved data sets and data collection procedures

1) Topographic Data

The most important data product in any hydraulic study is a detailed topographic dataset. At the time of this manual, the Virginia Geographic Information Network (VGIN) provides the highest resolution, readily available topographic data. These products use Light Detection and Ranging (LiDAR) technology and are provided to the user in two formats: Digital Elevation Models (DEM) and Point Clouds. The DEMs are preprocessed derived products created by VGIN that are provided as an easy-to-use topographic product. The Point Clouds are QAQC data comprised of raw elevation point data. Point clouds provide the engineer with more flexibility and information; however, care must be taken as deriving land surface product in a usable format becomes more error prone due to the many preprocessing steps needed. LiDAR data can be downloaded from the VGIN website here.

2) Web Soil Survey

The USDA NRCS Web Soil Survey is a valuable resource for determining watershed soil characteristics. This tool provides detailed information about soils including permeability, erosivity, and hydrological soil group (HSG) classifications that can help aid in the identification of frequently wet areas. This data also helps to identify a watershed's susceptibility to increased runoff due to poor infiltration and lack of flood storage potential.

3) Land Use/Land Cover Product

VGIN also provides a Land Use/Land Cover dataset derived through use of spectral imagery. This data provides detailed maps that delineate different land use/land cover types that include forested, impervious, open, water, etc. This dataset also utilizes locally derived impervious areas which improves accuracy on hardscape features like building edges and edge of pavement. Land Use/Land Cover products can be found on the VGIN website here.

4) Aerial Photography

A review of historic aerial photography is critical and can help understanding the origin of a water feature. Google Earth is one software that can be used to view historic imagery to identify natural and manmade features as well as previous land cover characteristics. Historical imagery is only available for Google Earth Pro (desktop and not the web-based) version, which can be downloaded from Google here. It is important to consider the date when reviewing historical images, as the season can have a bearing on some of the input parameters required in the hydrologic and hydraulic models.

5) Field Survey

The datasets mentioned above provide a great level of detail for cursory and offsite analysis, including watersheds. For onsite considerations, it is always best to conduct on-site visits and data acquisition to verify or adjust assumptions made during the initial data gathering phase. Types of information critical to accurate floodplain analysis can include, but are not limited to, vegetative cover for channel and overbank, field survey level topography, bridge/culvert information, and identification of any unexpected obstructions.

When considering vegetative cover, it is always good to denote the density and condition of the vegetation found on site and the time of year. Full summer growth conditions are generally preferred assumptions in hydraulic models.

New field surveys must meet or exceed the National Map Accuracy Standards for the scale of 1 inch to 50 feet. The horizontal accuracy of survey points and measurements shall not be less than 1.5 feet and the vertical accuracy shall be no less than 0.5 feet. A minimum of three permanent markers (property corners, etc.) shall be referenced as part of the field survey. The field survey points shall consist of coordinates in the Virginia State Plane Coordinate System according to the parameters defined in the county's Geodetic Control Network. The surveys are to be supervised by a land surveyor licensed in Virginia, sealed, signed, and submitted on paper as well as in a digital format, such as AutoCAD or ArcMap. The detailed field survey shall be used to develop cross-section locations and layouts. The location and spacing of the field survey data shall ensure that the data used in hydraulic modeling is representative of the geometry of the stream between and around the cross-section locations.

B. Best Practices

1) Study Reach

To establish flood elevations along a watercourse using HEC-RAS, the limits of the study area must first be defined. Flood studies must typically extend at a minimum of 500-feet upstream and downstream of the project limits. By extending the study area to 500-feet offsite or more, the effects of any inaccuracies in starting water surface elevation are dampened by the time the standard step calculation is made on the site. Should the applicant believe that a shorter reach is sufficient, a consultation with the county is strongly recommended prior to submitting an application.

In many situations, study reaches longer than 500-feet offsite will be required. For example, a structure located more than 500-feet downstream of the site may cause backwater that impacts flood elevations at the project site. In this case, the study reach must be extended in the downstream direction to analyze the impact of those conditions. Another example is a bridge or culvert replacement that causes decreases in upstream water surface elevations. In this case, the HEC-RAS model must be extended upstream to where the existing and proposed flood profiles converge for every flood event analyzed to accurately determine impacts. Please note that the study reach must be at least 500 feet upstream, even if the existing and proposed flood profiles converge less than 500 feet from the site for every flood event analyzed.

When determining the study reach, it is recommended that all major structures within 1-mile of the site be considered for determining possible upstream and downstream influences and impacts from the project. Published floodplain elevations and supporting data can be used to help determine if the study reach needs to be extended, and consultation with the county to confirm assumptions may be beneficial in those cases.

2) Cross-Section Placement

Once the study reach is defined, a hydraulic analysis requires that field-surveyed cross-sections be obtained. These cross-sections will represent the watercourse and its floodplains associated with various flood events, the flood hazard area, and the floodway. In general, cross-sections must be placed where there are:

- Significant geometric changes in the channel or floodplain

- Changes in channel slope
- Changes in Manning's roughness in the channel or floodplain
- Changes in flow rate
- Bridges, culverts, or other water control structures

By convention, HEC-RAS cross-sections are taken looking in the downstream direction, not the upstream direction. However, engineering judgment and HEC-RAS modeling experience must be used in determining how cross-sections should be oriented, the number and location of the cross- sections, and the amount of space between each cross-section.

Cross-sections should span the entire flood hazard area. However, in cases where the flood hazard area is significantly wider than the channel itself, such that obtaining field-surveyed cross-sections is not feasible, the field-surveyed cross-sections may be supplemented with other data sources, such as LiDAR data.

Caution should be used whenever using information other than field surveyed data. For example, in cases where LiDAR data is used, elevations below a normal water elevation of a perennial stream will not be included in the LiDAR data set because LiDAR cannot penetrate water to collect bathymetric data. Similarly, it is unknown what precipitation events may have occurred during the time the data was measured. In any situations where field surveyed data is not used, the applicant may want to contact the county to avoid unnecessary delays in the permitting process. A good measure to verify LiDAR accuracy is to provide a limited analysis comparing existing HEC-RAS cross-sections and LiDAR derived cross-sections to field survey data along the same cross-section alignment. If the cross-sections all show good agreement, it can be easier to determine that the LiDAR is of sufficient accuracy.

Cross-sections must encompass the entirety of the 100-year floodplain at minimum. If there are cases where a cross-section does not extend far enough, HEC-RAS will assume a vertical wall at the cross-section edge, resulting in higher water surface elevations than is expected.

Cross-sections must always be taken perpendicular to the direction of flow when near the channel and perpendicular to contours as it moves up through the topography. As a result, cross-sections can appear as faceted curves or angled lines in order for both criteria to be met due to the randomness of natural topography. Cross-sections must not intersect because each cross-section represents flow at a separate location in the floodplain and flood hazard area.

A floodplain work map should be developed to show the study reach and each one of the cross-sections used in the model overlaid on topographic data that will be used to delineate the floodplain.

3) Boundary Conditions

Generally, hydraulic models use normal depth as a water surface elevation for the downstream boundary condition. Because it is unlikely that peaks will be coincident, using a known starting water surface elevation associated with a downstream, larger watercourse may not be appropriate in some situations, even if that larger watercourse is located in the study area of the floodplain in question. Using a starting water surface elevation based on a known peak from the downstream watercourse can mask the hydraulic impact of the proposed bridge or culvert. In situations like this, engineering judgement is crucial, and it is best to consult with the county if there is any concern in selecting starting water surface elevations. In some cases, a mixed or supercritical flow regime is also required, and the upstream boundary condition in this case is typically supercritical depth for the starting water surface elevation upstream. Consult with

the county if there are questions about a hydraulic model for mixed or supercritical flow in a flood study.

4) Polygon Edge Smoothing and Removing Holes

Because HEC-RAS's terrain data is a raster format, the creation and display of output layers can have a pixelated or angular edge in appearance. There are several methods that can be used to smooth these edges to the floodplain limits, ranging from manual edits to CAD/GIS smoothing tools. The county accepts any approach if the following items are considered:

- The smoothed floodplain limit does not deviate from the unsmoothed limit at the cross-sections in the hydraulic model
- The resulting smoothing process follows the outer most edges and the unsmoothed shape is fully contained in the smoothed shape's footprint
- There are no significant deviations from the model output unless consulted with the county
- The starting terrain file has adequate initial resolution
- Holes within the boundary can be remove creating a contiguous shape and significant sized holes are documented in the engineering report

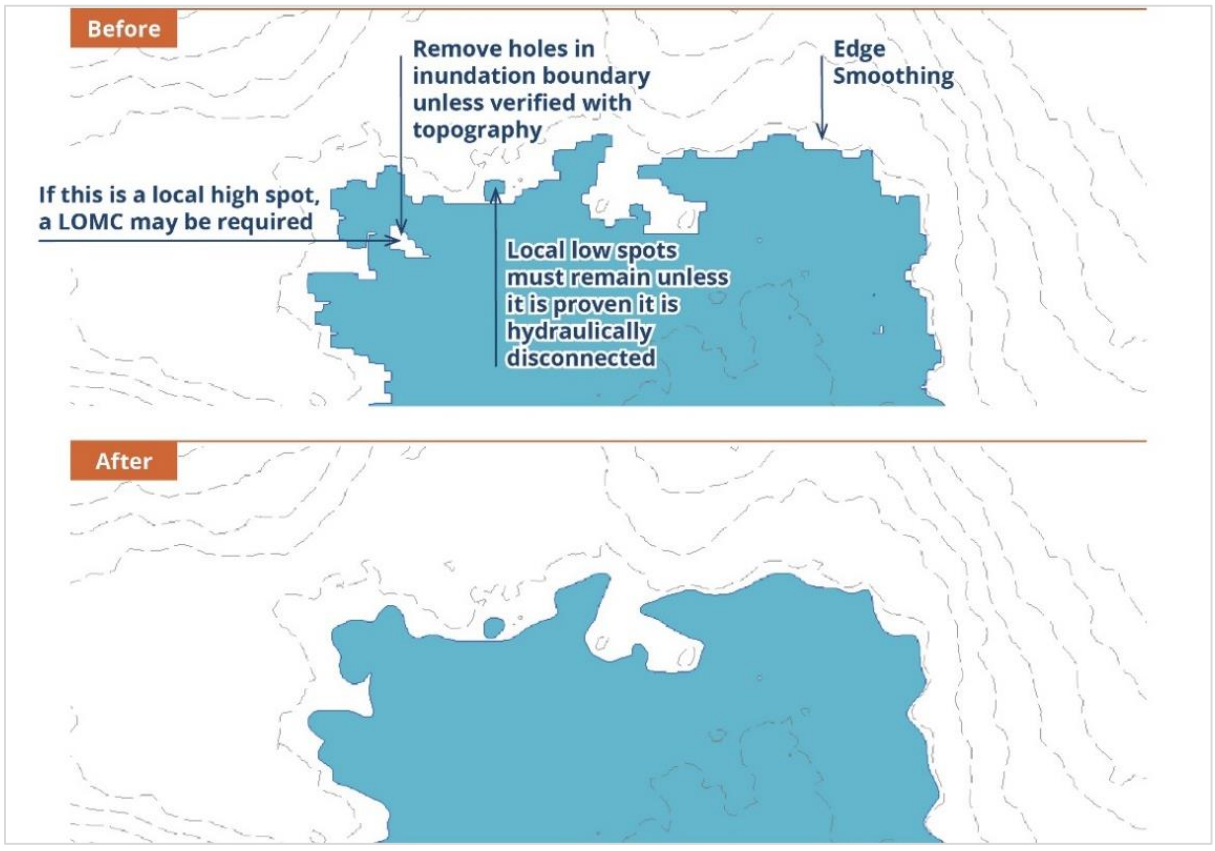

Figure 16: Example of polygon smoothing and removing holes when mapping the floodplain.

C. Floodway Determination

Because the county prohibits placement of fill and structures for the entire floodplain, determining a floodway is only required for floodplains that already have a delineated floodway. In all cases, these floodways are established using FEMA Zone AE hydraulic models. The computation of the floodway uses

the same standard step backwater analysis as the 100-year flood but includes the encroachment function built into HEC-RAS's Run options. Typically, floodway limits are calculated assuming equal conveyance reduction on both sides of the watercourse with a maximum rise in the 100-year water surface elevation of 1.0 foot at any cross-sections. Five different methods for computing the floodway are available and additional information on these methods are available in the HEC-RAS User's Manual. Floodway analysis should almost always use Method 4 to determine the encroachment stations and then provided to the county using Method 1. If another method is deemed appropriate by the engineer, the floodway delineation should be done in close coordination with the county.

D. Approved Software

Once the desired flow rates are calculated along a watercourse, a hydraulic analysis to determine flood elevations at the site in question is required. A hydraulic analysis is also necessary to determine the difference in flood elevations between existing and proposed conditions. Such projects may include the construction or reconstruction of bridges or culverts, channel modifications, and other projects that would alter the hydraulic capacity of the channel or floodway.

As was the case for flow rates, the regulatory flood elevation may be determined from published data, such as county delineations or FEMA mapping. Alternatively, calculations may be performed via the following methodologies:

1) HEC-RAS

The most common hydraulic analysis received by the county for the purposes of a floodplain permit is the standard step backwater analysis as executed through HEC-RAS, which is available for download through the U.S. Army Corps of Engineers. This program was developed by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, to calculate water surface elevations in natural and manmade channels under subcritical, supercritical, and mixed flow conditions. It allows for consideration of the effects of tailwater, changes in channel and overbank shape, slope, and roughness, and hydraulic structures, such as bridges, culverts, weirs, embankments, and dams.

The accuracy of a HEC-RAS model will reflect not only the accuracy of the input data but also the level of effort devoted to the development of the model. Both the input and output data must be reviewed by the county to ensure that the results returned by the model are reasonable.

Therefore, the county recommends full understanding of the assumptions, data requirements, capabilities, methodologies, and limitations of both the software and the hydraulic theory behind the software prior to using HEC-RAS. Such information, including the HEC-RAS User's Manual, should be well understood by the user. In addition, discussions of some of the data collection considerations and important input variables are provided below.

It is important to note that most HEC-RAS-based hydraulic analyses that are accepted by the county rely on steady flow computations. The use of unsteady flow models for the purposes of establishing flood hazard areas is not typically recommended because these models include storage areas that serve to attenuate peak flow rates, the sustained existence of which is uncertain as mentioned in Section 5.3. An unsteady flow analysis will only be accepted to establish the BFE after an applicant demonstrates to the county that it is the most appropriate modeling approach and received county approval. However, unsteady flow analyses may be accepted for bridge and culvert replacement projects because the primary hydraulic concern is the relative impact of a proposed structure, as opposed to the absolute flood elevation. For bridge or culvert replacements, analysis of existing storage areas becomes crucial, in part

because any loss of storage associated with a more hydraulically efficient proposed structure must be accounted for accurately in the design so that existing structures downstream of the existing bridge or culvert do not inadvertently become subject to additional flooding because of the replacement structure.

2) Alternative Software

For nearly all applications related to SFHA mapping and analysis, 1D modeling is the county's preferred approach. Because most of the floodplains in Henrico County have uni-directional flow with well-defined channel and overbanks, 1D modeling is the most appropriate approach. Every floodplain in Henrico County is modeled using HEC-RAS 1D procedure at this time, and any analysis using this same approach will be easier to conduct and review. Due to the complexity of 2D models, modeling efforts and review become much more intensive without providing much additional benefit to the model accuracy for the purposes of a floodplain delineation.

The county does acknowledge that there may be a case where 2D would provide a more accurate model, such as the case described above for unsteady flow modeling. In selecting an appropriate software, the county recommends using HEC-RAS's 2D procedures as a first choice and if need be, FEMA provides a list of acceptable software packages available on the FEMA website here. Any 2D analysis will require close coordination with the county and may require additional deliverables not covered in this manual.

6. Permit Requirements

As part of the county's participation in the NFIP, the county's Floodplain Ordinance must regulate all development in the Special Flood Hazard Area (SFHA), and all development must be permitted. Additionally, the county's Floodplain Ordinance regulates some types of development adjacent to the SFHA.

For the purpose of floodplain management, "development" is defined as any man-made change to improved or unimproved real estate, including buildings or other structures, as well as mining, dredging, filling, grading, paving, excavation or drilling operations, and storage of equipment or materials. This definition is very broad and means that very minor activities like typical landscaping, such as adding mulch to flowerbeds, installing a mailbox, or even painting a structure are considered "development" that must be permitted. In order to ease the burden on country residents, while also maintaining compliance with the NFIP, some minor development activities may be permitted through a General Permit. However, all other activities must receive an individual Floodplain Development Permit.

The Specific Development Activities and Requirements section of this Manual includes additional information on Buildings and Structures, Critical Facilities, Roads, Bridges, and Culverts, and Other Development such as environmental protection and restoration projects, stormwater management facilities, and fences.

The specific type of permit necessary for a given activity depends on the size, scope, location, and/or nature of the activity. Section 6.1 describes authorizations and permits, including an explanation of each type of authorization and permit available under the rules.

A floodplain permit application (Appendix 1) is required to be submitted for most permits, authorizations, and verifications. Additional information on the permitting process and submission requirements is

included in Section 6.2 and Section 6.3. Information is also available on the county's Floodplain Management website, and applicants may also reach out to the Floodplain Administrator with questions.

The permit requirements outlined in this Manual are based on the Floodplain Ordinance only. Other permit requirements through the Planning Department, Building Inspections, Public Works, or others may apply.

6.1. Types of Floodplain Development Permits

A. General Permit

A General Permit (Appendix 11) may be used to allow development in or adjacent to the SFHA that will inherently not increase the base flood elevation (BFE) or would result in no technically measurable increase to the BFE. Below is a list of development activities that are considered compliant with the Floodplain Ordinance requirements and are allowed under a General Permit. An Individual Permit form is not required to be submitted for the activities listed below. Unless specified below, the development activities listed under the General Permit may occur without contacting the Floodplain Administrator. All other development activities **must** apply for an Individual Permit.

Development that is considered compliant under a General Permit requires county review if located in a floodway or when improvements, taken together, may exceed 40% of the assessed value of the improved structure, not including the land.

1) Applicability

The following activities are considered minor and are approved under a General Permit.

- Interior or exterior renovations, with a value less than $10,000, to a structure if the renovations do not constitute an enlargement or structurally alter the building. This includes:
  - Finishes (flooring, paint, wallpaper, etc.).
  - Cabinetry/trim.
  - Replacement windows, doors, plumbing fixtures, electrical fixtures, roofing, siding, or mechanical appliances not fueled by gas or oil.
- Mailboxes.
- Swing sets/Play equipment.
- General farming that does not involve earthwork that permanently alters the topography.
- Gardening that does not involve earthwork that results in permanently altered topography.
- Lawns and lawn maintenance activities.
- Routine maintenance of easement and utility corridors.
- Landscaping that involves "soft scaping" such as plantings, landscaping beds, or mulching. This does not include "hardscaping" that permanently alters the topography such as retaining walls, terraces, or pools.
- New or replacement, non-solid fences that meet the requirements in Section 4.4.E.
- Road maintenance involving pavement marking, repaving, patching, or similar work to an existing road, driveway, parking area, sidewalk, bike path, etc. This may also include repairs to existing guardrails/barriers or traffic control devices such as signs. This may not involve replacement with larger or new above ground infrastructure.
- Path or trail maintenance involving painting, repaving, patching, or similar work to an existing path or trail. This may also include repairs to existing guardrails/barriers. This may not involve replacement with larger or new above ground infrastructure.

- General maintenance work to existing culverts, bridges, dams, or stormwater management facilities such as repairs to concrete or other materials, cleaning out debris or sediment, or something similar. This may not involve replacement with larger or new above ground infrastructure.
- Drainage ditch maintenance involving mowing, cleaning out debris or sediment from existing drainage ditches.
- Poles for signs, overhead utilities, billboards, and alike that are no larger than 2 feet in diameter and are not located within the stream channel.
- Underground utilities or repairs to existing underground utilities that do not permanently alter the topography.

B. Individual Permit

An Individual Floodplain Development Permit is required for all development in the SFHA that does not meet the requirements of the General Permit, as well as certain types of development adjacent to the SFHA. For construction activities approved through the Plan Review process, such as Plans of Development and Subdivision Plats, the construction plans will serve as the Individual Floodplain Development Permit application for the proposed development. However, buildings proposed with Plan Review submittals will not be approved as part of the construction plans and must submit an Individual Floodplain Development Permit for approval.

1) Applicability

In addition to all development in the SFHA, an Individual Permit is also required for:

- New or substantially improved structures within 40’ of the SFHA or within the 500-year floodplain
- Critical facilities within the 500-year floodplain
- Stormwater management facilities outside of the SFHA that discharge directly into the SFHA

2) Permit-Specific Conditions

The following conditions apply to all Floodplain Development Permits:

- The permit applies to the parcel(s) of land listed on the application;
- The permit does not change the Floodplain Maps;
- The permit is for compliance with the Floodplain Ordinance only, and other permit approvals may be required before construction may begin;
- No work may begin in the SFHA or adjacent areas until the permit has been issued;
- The development may not be used or occupied until it has been approved by the Floodplain Administrator for compliance with the Floodplain Ordinance;
- By submitting the permit application, the applicant gives consent to the Henrico County Floodplain Administrator or his/her representative to make reasonable inspections required to verify compliance with the Floodplain Ordinance; and
- The permit may be revoked, and a stop work order may be issued if any false information is provided in the permit application.

Project-specific conditions may apply to any activity authorized under an Individual Permit. These are conditions that the county may include to ensure full compliance with the Floodplain Ordinance. For example, some types of development are required to submit documentation after the permit has been issued, such as Elevation Certificates to verify the lowest floor elevation for new structures. Submittal of

an Elevation Certificate after the lowest floor has been constructed and when final construction is complete may be a permit condition, so everyone involved in the project understands this requirement.

C. Emergency Authorization

In some cases, development must be conducted immediately to protect the environment and/or public health, safety, or welfare, and the applicant does not have time to first submit an application for an Individual Permit. In such cases, the applicant may request an Emergency Authorization. If the Floodplain Administrator issues an Emergency Authorization, the applicant must still apply for an Individual Permit and ensure that all development complies with the Floodplain Ordinance after the Emergency Authorization is granted.

6.2. Permitting Process

A. Pre-Application Meeting

A pre-application meeting may be requested with the Floodplain Administrator to discuss the proposed development, ordinance requirements, and the application procedures that will apply to that project. While pre-application meetings are not mandatory, they are recommended for large and/or complicated projects. Discussions or guidance offered by the Floodplain Administrator during a pre-application meeting do not constitute a commitment to approve or deny an application.

B. Application Submittal

1) Individual Permit and Variance Submittals

Applications for Individual Permits and Floodplain Variances must be submitted through the Department of Public Works. Applications may be submitted in-person or via email. If submitted in person, applications must be dropped off at the Department of Public Works' Reception Desk on the 3rd floor of the Henrico County Administration Annex Building, located at 4305 East Parham Road. If submitted via email, applications must be sent to dpw@henrico.us.

Although Henrico County is transitioning to online permit submittals through Build Henrico, the Floodplain Development Permit and Floodplain Variances are not part of the initial phase. **Until the Floodplain Development Permit and Floodplain Variances are integrated into the Build Henrico system, applications must be submitted directly to the Department of Public Works for review; any documents submitted through the Build Henrico platform will not be accepted.** When these applications have been officially added to the Build Henrico system, this Manual will be updated to reflect the new submittal process.

2) Plan Review Submittals

Plan of Development (POD) and Subdivision (SUB) applications must be submitted through the Planning Department. For other plan review applications, such as Clearing, Grading, and Grubbing plans, that are not submitted through the Planning Department must be submitted through the approved process through the Department of Public Works or another department, if applicable.

C. Permit Expiration

If an Individual Permit is approved, the permit will be issued and sent to the applicant. The permit is invalid if no work is commenced within 180 days of issuance and expires two years from date of issuance.

D. Inspections

The Floodplain Administrator, or designee, is authorized to conduct inspections and conduct other investigations to determine whether the property and the use thereof conforms to the requirements of the Floodplain Ordinance. Inspections will comply with constitutional search and seizure requirements.

A final inspection may be required for all development to confirm compliance with the Floodplain Ordinance. Additional inspections may be required for certain types of development, such as structures. For example, a lowest floor inspection is required for all new buildings before vertical construction may continue. As part of the permit application process, the applicant provides consent to the Floodplain Administrator, or designee, to make these required inspections to verify compliance.

E. Variances

A variance is a grant of relief from any requirement of the Floodplain Ordinance. Variances are typically reserved for situations when meeting the ordinance requirements would effectively prohibit or unreasonably restrict the use of the subject property. Variances may also be issued for a functionally dependent use or repair or rehabilitation of a historic structure. There are two types of variances for floodplain development: a County Engineer Variance and an Administrative Variance. The sections below provide a summary of the variance criteria; however, Division 5 of the Floodplain Ordinance should be consulted to determine all applicable requirements.

1) Minimum Criteria

No variance shall be granted unless the following minimum requirements are met:

- a showing of good and sufficient cause;
- a determination that failure to grant the variance would result in exceptional hardship to the applicant;
- a determination that such variance will not create or result in:
  - unacceptable or prohibited increases in flood heights;
  - additional threats to public safety;
  - extraordinary public expense;
  - nuisances;
  - fraud or victimization of the public; or
  - conflicts with other existing laws or ordinances;
- the granting of the variance will not be detrimental to other property in the vicinity;
- the circumstances giving rise to the variance application are not of a general or recurring nature;
- the need for the variance arises from the physical character of the property or from the use or development of adjacent property and not from the personal or financial situation of the applicant: and,
- the variance shall be the minimum necessary to provide relief.

2) County Engineer Variance

County Engineer Variances are approved by the County Engineer. An application (Appendix 3) must be submitted to the Floodplain Administrator to request this variance. The Floodplain Administrator will review the application and make a recommendation to the County Engineer, who will then approve or deny the variance request based on the ordinance requirements.

Additional Criteria

In addition to the minimum criteria listed above, the county engineer must also consider the following additional factors when granting a variance:

- the danger to life and property due to increased flood heights or velocities caused by encroachments.
- the risk of injury to others if materials are swept onto other lands or transported in floods.
- the water supply and sanitation system proposed for the development and their ability to prevent disease, contamination, and unsanitary conditions.
- the susceptibility of the proposed facility to flood damage and the effect of such damage on individual owners.
- the importance to the community of the services that will be provided by the proposed facility.
- the availability of alternative locations for the proposed use that are not subject to flooding.
- the compatibility of the proposed use with existing reasonably anticipated development.
- the compatibility of the proposed use with the comprehensive plan and county floodplain management program.
- vehicular access to the property during floods.
- the expected heights, velocity, duration, rate of rise, and sediment transport of foreseeable flood waters on the property.
- any other factors particularly relevant to the purposes of [the Floodplain Ordinance].

3) Administrative Variance

Administrative Variances are approved by the Floodplain Administrator and are limited to certain activities. An application (Appendix 2) must be submitted to the Floodplain Administrator to request this variance. The Floodplain Administrator will review the application and approve or deny the request based on the ordinance requirements.

Eligible Activities

- minor filling in the SFHA necessary to protect or restore natural floodplain functions, such as stream restoration projects or stabilization of stream banks to protect public roads or utilities
- dry-floodproofing of nonresidential structures in lieu of requiring higher elevation of the structure
- rebuilding of a residential structure within the SFHA or setback area that has been substantially damaged by some cause other than flooding if there is no site outside of the SFHA or setback area for relocation of the structure
- locating stormwater management facilities in the SFHA if a location outside of the SFHA is not feasible

6.3. Permit Application Submission Requirements

In addition to the Individual Permit application form, there are several documents that must be submitted for review to confirm compliance with the Floodplain Ordinance. Below is a summary of the documentation that must be submitted with a permit application. Please note that some of these items may only be applicable for certain types of development.

Some of the documentation required for Floodplain Development Permits may be similar to requirements for other permit applications, such as providing a site plan. In these situations, one site plan could be used

to satisfy multiple permit applications if all applicable requirements have been included, or separate site plans could be prepared for each application. However, a separate copy of that site plan must be provided with each permit application type. Additionally, an Elevation Certificate for new buildings will be required for Floodplain Development Permits and Building Permits. Separate Elevation Certificates should not be created for each application because the information will be the same, but a copy of the Elevation Certificate should be included with both applications.

A. State and Federal Permits

State and federal permits may be required for some types of development, such as compliance with Endangered Species Act requirements or permits through the U.S. Army Corps of Engineers or the Virginia Department of Environmental Quality for working within Waters of the United States. If required, all applicable state and federal permits must be submitted prior to the Floodplain Development Permit being approved. Permit numbers for other locally required permits (e.g., building permit) must also be provided.

B. Project Cost Breakdowns

Any development proposed to an existing structure must provide a detailed cost breakdown to determine substantial improvement/substantial damage implications. This cost breakdown must include all required costs listed here at a minimum. An Excel spreadsheet template, found in Appendix 13, may be used to document this cost breakdown as part of the Floodplain Development Permit application.

C. Site Plan

A site plan must be provided for all proposed development in and adjacent to the SFHA. The site plan must show the SFHA including floodway (if available), 500-year floodplain (if available), setback distances from the floodplain to the building(s) (if applicable), footprint of proposed development, scale bar, north arrow, property information (e.g., address, GPIN), existing land use/land cover, and topography data matching what was used in the floodplain analysis.

D. Construction Documents for Buildings

For all new buildings, construction drawings that show the plans for the building, including foundation type, enclosures, flood openings, floor locations and elevations, flood resistance materials, etc. must be provided.

1) Elevation Certificates

For all buildings, an Elevation Certificate must be submitted. New buildings are required to submit three Elevation Certificates:

- one with the permit application indicating the proposed lowest floor based on drawings,
- one after the lowest floor has been constructed, which must be approved before vertical construction may continue, and
- one after final construction has been completed prior to the Certificate of Occupancy being issued.

On July 7, 2023, FEMA released the 2022 Edition of the Elevation Certificate (FF-206-FY-22-152 (formerly 086-0-33); Expiration Date: 06/30/2026). This is the current Elevation Certificate form and must be used for all Elevation Certificates that are signed and dated as of November 1, 2023, or later. Additional information is available in FEMA's August 9, 2023 Memo.

The current Elevation Certificate can be found in Appendix 4, and tips for completing an Elevation Certificate can be found in Appendix 5.

NOTE: If you get a "Please Wait" error when trying to download the Elevation Certificate form, it is due to some incompatibility issues with Adobe PDFs and the alternative PDF viewer used by certain browsers. To view the document, download the file to your computer and open it using your system viewer. You may need to install the free Adobe Reader to view the document if you use a different PDF viewer and still experience issues.

2) Floodproofing Certificates

For buildings that will be dry-floodproofed (variance approval required), a Floodproofing Certificate must be submitted. On July 7, 2023, FEMA released the 2022 Edition of the Floodproofing Certificate (FEMA Form FF-206-FY-22-153 (formerly 086-0-34); Expiration Date: 06/30/2026). This is the current Floodproofing Certificate form and must be used for all Floodproofing Certificates that are signed and dated as of July 7, 2023, or later.

A copy of the current Floodproofing Certificate can be found in Appendix 6.

E. Flood Damage-Resistant Materials Documentation

Certain types of development are required to use flood damage-resistant materials. If this is required, documentation from the manufacturer must be provided that clearly indicates the materials are flood resistant. Alternatively, materials listed in FEMA's Technical Bulletin 2: Flood Damage-Resistant Materials Requirements may be used.

F. Anchoring Documentation

Certain types of development are required to be anchored to prevent flotation and lateral movement. If this is required, documentation from a professional engineer must be provided that clearly demonstrates the development will be anchored to meet this requirement.

G. No-Rise Certification

For all development in the SFHA, a No-Rise Certificate is required. The No-Rise Certificate must be signed and sealed by a professional engineer licensed in Virginia. The No-Rise Certificate must be supported by technical data, as outlined in the No-Rise Analysis section. A No-Rise Certificate template can be found in Appendix 7.

A complete No-Rise Review submittal package includes:

- Latest plan set (.pdf)
- Signed and sealed No-Rise Certificate (.pdf)
- Signed and sealed Narrative Report (.pdf)
- Associated technical data (e.g.: HEC-RAS model, hydrologic models (HydroCAD, PondPack, etc.), compensatory storage volumetric calculations, pre-/post-topographic surveys, etc.).
- Response to Comments, when applicable (.xlsx)

Submittal Process

For No-Rise Certificates that are submitted with an Individual Floodplain Development Permit, the

certificate and technical data must be submitted as an attachment to the permit application form following the process in Section 6.2.B.2 above.

For No-Rise Certificates that are submitted with a Plan Review application, submittals must follow the process outlined below.

- The No-Rise Certificate and supporting technical documentation must be submitted electronically in one complete package to the designated DPW Review Engineer and Planner, if applicable.
- Files must be emailed using "NO-RISE REVIEW: (insert project name)" in the subject line and files attached in a compressed folder (.zip).

No-Rise Certificates submitted outside of this process may not be reviewed. The No-Rise Certificate review will occur outside of the typical plan review comment period, but in general, comments should be returned to the applicant within 10 business days.

H. Engineering Report

The Engineering Report is a concise statement of the study including the general location, purpose, objectives, a brief history, any observations or engineering judgments, and property documentation. The report must show all relevant calculations associated with the proposed development. This may include compensatory storage and displacement calculations, structural stability calculations for dry floodproofing techniques, and/or calculations that determine the number and size of proposed flood openings. The report must also contain one copy of the flood study if within a FEMA floodplain and all flood zone determinations. All hydrologic and hydraulic analyses shall be signed and sealed by a Professional Engineer licensed in the Commonwealth of Virginia, and all topographic maps, grading plans, and construction drawings shall be signed and sealed by a licensed professional.

Hydrology should be based on prior studies by FEMA or the county; however, if revisions are needed, computations must include the following:

- Narrative description outlining the necessity for the revision and hydrology methods used.
- Maps showing the delineated watershed area and watershed characteristics used in the peak discharge estimates such as land use, soil types, flow path, and watershed response times.
- Hardcopy results for the hydrologic computations for the estimated peak discharge for all storm events contained in the FIS study or county provided peak discharges
- Digital copies of the computer models used to generate the revised estimated peak discharge values
- ESRI compatible shapefiles for the watershed and any sub-watersheds

Hydraulic calculations must be provided in a HEC-RAS report that includes the following:

- The Duplicate Effective Model including hydraulic analyses which duplicate the hydraulic analyses contained in the Flood Insurance Study or county models with a comparison to published peak stages or elevations for the study reach.
- The Corrected Effective Model (Existing Conditions Model) including hydraulic analyses updating the Duplicate Effective Model with existing floodplain conditions observed in the field at the time of study, including but not limited to, updated field survey information, channel geometry, culvert/bridge locations and dimensions, Manning's "n" values, etc.
    - A written description of all changes from the Duplicate Effective Model must be included.

- Any modifications made to cross-sections must be noted with a revision date in the Description field within the Cross-Section Data editor and Culvert/Bridge Data editor.

- The Proposed Conditions Model including hydraulic analyses incorporating the proposed improvements for the project including, but not limited to, proposed changes to topography, channel geometry, culvert/bridge locations and dimensions, Manning's "n" values, etc.
  - A written description of all changes from the Corrected Effective Model must be included.
  - Any modifications and proposed changes must be noted with a revision date in the Description field within the Cross-Section Data editor and Culvert/Bridge Data editor.
- A standard profile summary table for the entire model reach should be submitted that is formatted to show the differences between each model's water surface elevation at each cross-section for each flood event analyzed.
- All HEC-RAS cross-sections for the entire model reach with both the Corrected Effective Model and Proposed Conditions Model ground surfaces with any applicable obstructions or impedances.
  - The Duplicate Effective Model cross-sections do not need the be provided. However, the changes made to the cross-sections for establishing the Corrected Effective Model must be documented within the report; an appendix may be needed to show the specific cross-sectional comparison in HEC-RAS between the two models to illustrate the changes.
- A digital copy of the HEC-RAS model used to perform the hydraulic computations including all storm events and geometries used.
  - Site photos for Manning's n determinations must be included in the HEC-RAS Model by attaching pictures to cross-sections using the Picture Viewer function within HEC-RAS. Full summer growth conditions are preferred in the photos.
  - Name of lead hydraulic engineer or modeler, company name, and date of modeling report should be included in the comments for the model and preliminary models or alternative models should be deleted from what is submitted to the county for review
- If a project requires a map change, the Map Change Procedures in this manual must be followed. In addition, shapefiles of the new floodplain delineations and floodways (if applicable) must be submitted in an ESRI compatible format for all map changes.

For any analysis comprised of compensatory storage that is not done as part of a flood study, the following is required:

- Cross-sections at least every 25 feet throughout and bounding the limits of the limits of disturbance showing the existing and proposed surfaces or elevation spots consistent with the Grid and Tin surface locations as mentioned in Section 5.1.B.
- Cut and fill volume calculations as reported by CAD software or calculations and an outline of the method used
- A narrative describing required versus provided compensatory storage volumes for each flood stage calculated.

A Compensatory Storage Plan template can be found in Appendix 9, and Flood Study Report template can be found in Appendix 10.

I. Engineering Drawings

For any hydraulic analysis, field surveyed cross-sections must be submitted on signed and sealed engineering drawings with a title block and a true scale. A cross-section location plan showing topography, extent, and orientation of each cross-section is also required and must meet the following:

- Existing and proposed topography of a suitable scale and contour interval
- Effective FEMA SFHA (including floodway) boundary lines for all available storm events
- Effective Community SFHA (including floodway) boundary lines for all available storm events
- Proposed SFHA lines for all available storm events
- Stream centerline, thalweg, and reach name along full extent of the project
- Cross-sections labeled with river station from HEC-RAS models on the drawing showing the proposed improvements.
- Depth raster showing water surface elevations along the project extent.
- Label the cross-sections with the respective water surface elevations as reported from the HEC-RAS model.
- Planimetric features and labels such as roads, buildings, ponds, etc.
- Reference to NAVD 88 as the vertical datum with appropriate benchmark
- Basic property location information (when applicable) such as street address, legal description, parcel identification number
- Limits of development activity (limits of disturbance) including compensatory storage
- Channel modification projects must include detail drawings showing accessory structures such as rock cross vanes, J-hooks, energy dissipaters, channel linings, etc.

For bridges and culverts, the following additional drawings that show:

- Dimensions of both the existing and proposed bridge(s) or culvert(s), including length, the presence of any headwall or wingwalls, the orientation of any wingwalls, the number of spans, width of each span, low chord elevation(s), high chord elevation(s), the dimensions of any parapets, foundations, and watercourse invert elevations.
- Structural detail drawings showing the shape, material, beveling or rounding of inlets, countersinking of culverts, wing wall skew, etc.
- Drawings showing the upstream and downstream structure or channel inverts, overtopping elevations, and stream elevations
- Slope stabilization measures including riprap in the vicinity of the structure

For buildings or structures:

- The proposed footprint, including the footprint of any impacts as a result of the construction.
  - Note that it is not sufficient to show a maximum footprint of a conceptual design. Without a detailed design, the county cannot verify that the proposed development meets applicable standards. Substituting notes on a plan in lieu of a design cannot be accepted as notes do not enable a review for compliance.
- Proposed topography or grading, and erosion control measures.
- The proposed lowest floor elevation for each part of the building. An Elevation Certificate must also be submitted based on building drawings.
- The elevation and proposed use of all enclosed areas below the lowest floor elevation. This information must also be included on the Elevation Certificate.
- Where wet floodproofing is proposed (enclosures below the lowest floor and accessory structures only), the size, location, and number of proposed flood openings must be shown. A detail of the openings must also be provided on the plans. The detail must be drawn to scale and must show the elevation of the proposed flood openings in relation to the adjacent grade.
- The elevation and extent of any proposed driveways, access roads, parking areas, and/or accessory structures and access routes.

- Where dry floodproofing is proposed, the plan view must show every location where dry floodproofing techniques (flood barriers, etc.) are proposed. A detail must also be provided for each dry floodproofing technique, and it must show the elevation to which the technique is proposed in relation to the lowest floor elevation and the BFE. Dry floodproofing is only allowed if a variance has been granted; structures must be dry floodproofed to three feet above the BFE.

J. Map Change Submittals

When a map change is required for a project, the procedures outlined in the Map Changes section above must be followed, and the flood study requirements must be met.