

City of Wheat Ridge Site Drainage Requirements



I. INTRODUCTION

Purpose

The City of Wheat Ridge (“the City”) has specific Site Drainage Requirements that must be followed by proposed developments or re-developments. The City Site Drainage Requirements provide explicit information pertaining to drainage improvements and guidance to development applicants for the civil design documents typically required with Building Permit Applications, Land Use Applications (such as subdivisions of land), and for the Stormwater Management Plan (SWMP).

The City adheres to the Mile High Flood District (MHFD) criteria and the latest editions of its published Drainage Criteria Manuals, Volumes 1, 2 and 3, and calculation spreadsheets. The criteria and design procedures presented in the MHFD Drainage Criteria Manuals are implicitly incorporated into the Site Drainage Requirements by reference herein. The City utilizes the MHFD Four-Step Process found in their *Urban Storm Drainage Criteria Manual Volume 3* during the selection of water quality Best Management Practices (BMPs) for new development or significant redevelopment.

The MHFD Four-Step Process* protects receiving waters from runoff and focuses on

1. Reducing runoff volumes to reduce runoff peaks, volumes, pollutant loads, and employ Low Impact Development practices.
2. Employing BMPs that provide a water quality capture volume (WQCV) used to treat runoff prior to release into drainageways.
3. Stabilizing drainageways to reduce bed and bank erosion.
4. The implementation of long-term source controls.

The City’s Site Drainage Requirements may also include additional requirements not addressed in the MHFD Drainage Criteria Manuals. In some instances, these criteria are more stringent than, and may be in conflict with, the criteria of the MHFD Drainage Criteria Manuals. Wherever conflicts exist among the criteria, the criteria stated in the City Site Drainage Requirements shall apply.

General Criteria

For purposes of the Site Drainage Requirements, any project that proposes changing the patterns or amount of stormwater drainage or the existing amount of impervious area on a property is classified and hereafter referred to as “development”. Developments are divided into two general categories:

1. Single Family/Duplex
2. Subdivision/Multi-Family/Commercial

All new Single Family or Duplex residential developments not associated with a new or recent¹ subdivision and that disturb an area of less than one acre in size, are as a general rule not subject to the stormwater detention and water quality criteria found in the Site Drainage Requirements. Exceptions to this general rule include, but are not limited to, sites equal to or greater than one (1) acre in size, or even individual sites less than one acre in size if they are part of a larger common plan of development that is greater than one (1) acre in size, even if multiple, separate and distinct land development

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

activities may take place at different times and on different schedules. Any developments appearing to be a part of a greater project shall be subject to the Site Drainage Requirements.

The term “recent” as used herein is defined as a subdivision having an approved Final Drainage Report and Plan on file at the City, which the City began requiring for all residential subdivision and commercial development projects in the 1980’s.

The site drainage for new Single Family Residential or Duplex Residential (SFR/Duplex) developments constructed within a recent¹ or new subdivision must either conform to the previously approved civil engineering documents for the subdivision, or a new drainage report and plan shall be prepared by a Colorado licensed Professional Engineer in accordance with current regulations and submitted for review and approval. As the current regulations are in all likelihood more stringent than when the original documents were prepared, the current drainage requirements could be much greater. As all developments are unique, including SFR/Duplex developments, the City reserves the right to enforce any or all of the Site Drainage Requirements in instances where it is deemed necessary to protect adjacent or downstream properties.

All new Single Family or Duplex residential development projects that disturb an area of one acre or more in size are subject to the same requirements as the New Minor Development sub-class of the Subdivision/Multi-Family/Commercial development classification, defined in the Site Drainage Requirements below, and shall submit a Stormwater Management Plan (SWMP) and State CDPS permit prior to the issuance of any Building Permits. All commercial building additions and any SFR/Duplex building additions that increase the site imperviousness by 3000 square feet or more will be treated as Redevelopment under the Site Drainage Requirements.

Subdivision, Multi-Family, and Commercial developments are divided into two classes, New Developments and Redevelopments, and then further divided into sub-classes based upon the magnitude of the development. New Development is divided into the Minor and Major sub-classes, and Redevelopment is divided into the Minor, Moderate, and Major sub-classes. The different Development Categories are outlined in Section II below. The Multi-Family/Commercial sub-classes have specific requirements and are discussed in further detail in Section III.

All Commercial projects, Residential Subdivision, and Multi-Family land development projects whereby an existing site of one (1) acre or more in size is to be completely scraped and reconstructed, or is a vacant lot to be newly constructed upon, will be classified as New Development. Commercial, residential subdivision, and multi-family projects proposed on a site less than one (1) acre in size that contains existing improvements to be removed, the imperviousness of the existing improvements may be deducted from that of the proposed improvements. In this case only the net increase in imperviousness is used to determine the required stormwater facilities. Any land development project that disturbs the existing impervious area on a property and modifies the site layout, but would not ordinarily be construed as being a scrape, will be classified as Redevelopment.

Routine Maintenance of Parking Lots

Parking lot maintenance processes involve milling and/or overlay or seal coating of the existing pavement are considered basic maintenance and are not subject to the Site Drainage Requirements. Parking lot maintenance involving the complete removal and replacement of asphalt or concrete

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

pavement could also be exempt from the Site Drainage Requirements as long as the area of removal is less than one (1) acre in size and all existing grades and drainage patterns remain unchanged within the area of removal.

Projects where buildings or other structures and/or pavement are removed to the point where the sub-grade or underlying soil is exposed, and grades or drainage patterns are even slightly modified from the existing patterns, will fall into the Redevelopment category. The total area of impervious surface to be disturbed by such a project will establish which one of the three categories of Redevelopment the project will fall into, and ultimately determine the drainage requirements for the project.

Please refer to Section VI. *Routine Maintenance of Existing Impervious Areas* for additional information and guidelines regarding routine maintenance activities.

Low Impact Development

The City of Wheat Ridge encourages the use of Low Impact Development (LID) practices for controlling stormwater runoff volume and reducing pollutant loads to receiving waters. Not all sites will be suitable for LID, and site conditions such as soil permeability, depth of the local water table, and existing or proposed grades must be taken into consideration. In some instances, the use of LID may not completely replace the need for conventional stormwater controls. The most common types of LID measures found to be acceptable by the MHFD, such as measures to minimize directly connected impervious areas (MDCIA) or any other methods that slow runoff are generally acceptable to the City of Wheat Ridge.

One method of reducing site runoff that is gaining popularity and that closely imitates undeveloped land, is the use of a sub-surface full infiltration basin as the detention facility. A sub-surface full infiltration basin may be implemented in a variety of ways, such as porous landscape detention (PLD), or placing a basin underneath parking lot stalls, pedestrian walkways and courtyards by using Permeable Interlocking Concrete Pavers (PICP). The basin is basically comprised of a 3" angular gravel-filled basin with PICP placed on top.

While the initial cost of a PICP detention system may be initially higher than the typical above-ground detention facility, this type of low impact design is becoming more and more attractive as both the initial construction methods and post-construction maintenance aspects are proven to be less costly than they once were. By employing a PICP/ infiltration basin design the property owner gains more area for amenities, landscaping, parking, or other items required by the Wheat Ridge Zoning Code that may otherwise have to be reserved for a standard above-ground facility. PICP systems can be ADA-compliant and provide design options such as a variety of color and patterns.

The key elements to success of a PICP system are a high percolation rate and a deep water table. Please note that for a full infiltration system to be approvable there must be a minimum of 3 feet between the high water table line and the bottom of the proposed basin, and the basin must have an average percolation rate of no less than 1 inch/hour. A geotechnical engineer shall be consulted and a subsurface study completed with a minimum of two (2) percolation tests performed at the proposed location and anticipated bottom of the basin prior to completion and submission of a PICP, PLD, or other underground detention design.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

Stormwater Detention

The City of Wheat Ridge prefers and encourages the use of Full Spectrum Detention (two-stage release) designs. The City of Wheat Ridge also accepts the proposals for both above-ground standard extended detention basins (EDBs/multi-stage release) design as well as sub-surface detention systems. For all designs, the MHFD spreadsheets will need to be used and included in the Appendix of the Final Drainage Report. The City follows MHFD criteria for detention volumes with the exception of the full infiltration basin system. For full infiltration systems the MHFD recommends a 12 hour drain time used to calculate the volume for both the water quality capture VOLUME (WQCV) and additional flood storage volume. The City prefers standard volumetric calculations be used to gain an initial volume value and additional volume to account for the void space taken up by the 3" angular rock plus the inclusion of a safety factor. Whether the detention system desired is to be above-ground or underground, an Operations and Maintenance Schedule (O &M) fully describing the maintenance procedures for the system shall be required.

All detention facilities shall lie within a separate, non-buildable tract, commonly referred to as "Tract A" on subdivision plats, and be fully encumbered by a Stormwater Detention/Drainage Easement to the benefit of the City of Wheat Ridge. As every development is unique, water quality-only facilities shall lie within a separate tract or only within an easement depending on the circumstances. This determination will be made on a case-by-case basis and will be provided as early as possible during the development review process.

The following detention facility notes shall be included on the Final Plat, or if no plat is required, on a separate easement document:

"TRACT A IS A NON-BUILDABLE TRACT USED STRICTLY FOR STORMWATER DETENTION AND WATER QUALITY. A STORMWATER DETENTION/DRAINAGE EASEMENT TO THE BENEFIT OF THE CITY OF WHEAT RIDGE OVER THE ENTIRETY OF TRACT A IS HEREBY GRANTED BY THIS PLAT (REFER TO STORMWATER QUALITY NOTE ON THIS PLAT).

STORMWATER DETENTION/DRAINAGE EASEMENT

THE STORMWATER QUALITY AND DETENTION AREA HEREIN SHOWN AS 'TRACT A' SHALL BE CONSTRUCTED AND MAINTAINED BY THE OWNER AND SUBSEQUENT OWNERS, HEIRS, SUCCESSORS AND ASSIGNS. IN THE EVENT THAT SUCH CONSTRUCTION AND MAINTENANCE IS NOT PERFORMED BY SAID OWNER, THE CITY OF WHEAT RIDGE SHALL HAVE THE RIGHT TO ENTER SUCH AREA AND PERFORM NECESSARY WORK, THE COST OF WHICH SAID OWNER, HEIRS, SUCCESSORS, AND ASSIGNS AGREES TO PAY. NO BUILDING OR STRUCTURE SHALL BE CONSTRUCTED IN THE DETENTION AREA AND NO CHANGES OR ALTERATIONS AFFECTING THE HYDRAULIC CHARACTERISTICS OF THE DETENTION AREA WILL BE MADE WITHOUT THE APPROVAL OF THE DIRECTOR OF COMMUNITY DEVELOPMENT."

City Stormwater Detention Requirements:

For **above-ground detention systems**:

1. Gravity outfall is always required.
2. Parking lot detention is allowed but limited to six (6) inches depth.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

3. All above-ground detention facilities shall lie within a separate, non-buildable tract, fully encumbered by a Stormwater Detention/Drainage Easement.

For all **underground detention systems** (including PLD/PICP designs):

1. The system structural capacity must be **designed to support AASHTO HS20 (fire truck)** loading, as well as the anticipated lifetime AASHTO 18,000 lb. equivalent single axle loads (ESALs).
2. A gravity outfall is required at the invert of all underground detention systems.
3. The minimum pipe size allowed for detention in pipes is eighteen inches (18").
4. There shall be a minimum of three (3) feet clearance between the local high water table and the anticipated bottom of the infiltration basin.
5. The percolation rate shall be no less than 1"/hour.
6. Maintenance access must be provided, at a minimum, at the point of inflow and point of outflow from the system. The accesses shall be such that they would allow human access to inspect the functionality of the system.
7. All pipes or chambers must be vacuum truck accessible through manholes.
8. Underdrain pipes may be required. If required, the underdrain pipe shall be at least four inches (4") in diameter. Underdrain cleanouts are required at all changes in direction. If the minimum underdrain size results in a release rate larger than allowed under these criteria, a restrictor plate in a manhole must be added at the point of outflow.
9. All underground detention facilities shall lie within a separate, non-buildable tract, fully encumbered by a Stormwater Detention Easement. The following note shall be included on the Final Plat, or if no plat is required, on a separate easement exhibit:
"THE STORMWATER QUALITY/DETENTION AREA HEREIN SHOWN AS
"STORMWATER DETENTION EASEMENT" SHALL BE CONSTRUCTED AND
MAINTAINED BY THE OWNER AND SUBSEQUENT OWNERS, HEIRS, SUCCESSORS
AND ASSIGNS. IN THE EVENT THAT SUCH CONSTRUCTION AND MAINTENANCE
IS NOT PERFORMED BY SAID OWNER, THE CITY OF WHEAT RIDGE SHALL HAVE
THE RIGHT TO ENTER SUCH AREA AND PERFORM NECESSARY WORK, THE COST
OF WHICH SAID OWNER, HEIRS, SUCCESSORS, AND ASSIGNS AGREES TO PAY. NO
BUILDING OR STRUCTURE WILL BE CONSTRUCTED IN THE DETENTION AREA
AND NO CHANGES OR ALTERATIONS AFFECTING THE HYDRAULIC
CHARACTERISTICS OF THE DETENTION AREA WILL BE MADE WITHOUT THE
APPROVAL OF THE DIRECTOR OF COMMUNITY DEVELOPMENT."

Volume:

For all development/redevelopment requiring detention, the following volume requirements will apply:

1. **EDB / WQCV:** For all above-ground extended detention basin facilities, full flood attenuation detention incorporating water quality measures, equal to the 100-yr. storm event + 50% of the Water Quality Capture Volume (WQCV) for the entire site is required of all new Major New Multi-Family/Commercial Developments. While for Minor New Multi-Family/Commercial Developments, 100% of the WQCV for only the additional impervious surface (but no flood attenuation) is required. The EDB is designed to release the 5-year and 100-year events at the MHFD limits, and fully drain the WQCV in 40 hours.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

2. **EDB / Full Spectrum:** For above-ground facilities utilizing the Full Spectrum Detention design, a volume equal to the 100-year storm event plus the difference between the urban and pre-developed runoff volume, known as the excess urban runoff volume, or EURV, for the entire site is required of all new Major New Multi-Family/Commercial developments or Major Redevelopments. For Minor New Multi-Family/Commercial Developments or Moderate Redevelopments, the EURV for only the additional impervious surface is required. The Full Spectrum Detention facility is designed to release the 100-year volume at MHFD limits, while fully draining the EURV within 72 hours.
3. **Infiltration Basins (or Sand Filters):** For designs incorporating an Infiltration Basin or Sand Filter (full infiltration) type of design, a volume equal to the 100-year storm event for the entire site is required of all new Major New Multi-Family/Commercial developments or Major Redevelopments. While for Minor New Multi-Family/Commercial Developments, only 100% of the WQCV for the additional impervious surface only is required. The City requires that the elevation of the high water table be at least 3.0' below the proposed bottom of the Infiltration Basin. In addition, all infiltration basins shall incorporate the MHFD Rain Garden growing medium design for pond bottom soil amendment. For a full-infiltration section this is a 6" depth of *BioLite Rain Garden Growing Media* (Golf & Sport Solutions, 970.284.6121) or MHFD approved equivalent.
4. **Underground:** For below-ground detention facilities, including but not limited to underground conduit or infiltration basin designs:
 - a. An underground conduit system incorporating the use of a proprietary water quality (WQ) unit such as a separate hydrodynamic separator upstream of the detention facility, the required volume is for the 100-year storm event only (no WQCV is required). If no WQ unit is used upstream, then 50% WQCV must be included in the total volume.
 - b. For a Permeable Interlocking Concrete Paver (PICP) / Infiltration Basin system, the required 100-year volume from the MHFD FAA Method spreadsheet will not include the WQCV, but a safety factor to mitigate the unknowns associated with the underlying soils, water table, etc. must be added in. Note the following:
 - i. **Void Space:** The overall volume calculations of the basin (BV) must assume a 30% void space from the 3" angular rock comprising the basin structure underneath the PICPs.
 - ii. **Safety factor:** Due to the length of time being unknown that the underlying soils are able to handle the average percolation rate uninterrupted without substantially decreasing the rate or becoming saturated, a 20% safety factor shall be built into the detention volume calculations. The safety factor must be based upon a 20% reduction of the average percolation rate and NOT a 20% increase in overall basin volume.
 - iii. **Average Percolation Rate (APR):** The average percolation rate is obtained by:
 1. Calculating the average rate per hole: Discarding the highest and lowest readings and averaging the remaining readings.
 2. Calculating the Average Percolation Rate: Add the average rate per hole (see 1 above) and divide by the number of test holes to obtain the APR.

Notes:

1. Underlying soils should have no greater than 20 percent clay content.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

2. The minimum allowed percolation rate is 1.00"/hour, with 3"/hour recommended.
3. All percolation tests must commence from the bottom of the proposed infiltration basin elevation to a minimum depth of three (3) feet below the basin bottom, and lie within the proximity of the proposed PICP/Infiltration Basin facility.
4. The high water table must be a minimum of three (3) feet below the infiltration basin bottom elevation.
5. An underdrain may be required. If required, the underdrain pipe shall be slotted pipe at least four inches (4") in diameter, and may be required to be wrapped in filter fabric depending on soil conditions. Underdrain cleanouts are required at all changes in direction. If the minimum underdrain size results in a release rate larger than allowed under these criteria, a restrictor plate in a manhole must be added at the point of outflow.
6. Each PICP/Infiltration Basin system design must include a sufficient number of monitoring wells to ensure long-term functionality by allowing periodic inspections.

Stormwater Detention Release Rates

The release rates for all detention facilities will of course need to be analyzed on an individual project by project basis, but as a general rule the following will apply:

1. EDB: For a standard above-ground EDB the City follows the current MHFD release criteria.
2. For underground detention systems:
 - a. Systems utilizing underground conduit to detain stormwater such as those produced by Rinker or Contech®, the release rates will adhere to the current MHFD release criteria.
 - b. The release rate of a PICP/ Infiltration Basin system is based upon the average percolation rate (PR) and bottom area of the basin (BA):

$$\text{Infiltration Basin Release Rate} = \text{PR} \times \text{BA}$$

Placement of Detention/WQ Facilities and Drainage Conveyances

Detention and Water Quality facilities shall be constructed in the following locations:

- A minimum of ten (10) feet away from any existing or proposed structure.
- A minimum of ten (10) feet away from any external subdivision or property boundary line.

Drainage Conveyances including but not limited to channels, swales, and pipes, shall be constructed as follows:

- The nearest edge of a pipe or channel shall be a minimum of five (5) feet away from any existing or proposed structure or external subdivision or property boundary line.
- The nearest edge of a grass-lined swale shall be a minimum of two (2) feet away from any existing or proposed structure or external subdivision or property boundary line.

Depending on the site conditions or other factors as determined by the Engineering Division and/or the Building Division, additional geotechnical engineering and/or hydrologic analyses and recommendations may be required.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

Developments Adjacent to Major Drainageways

Developments immediately adjacent to a major drainageway may not have to provide full flood attenuation detention volumes, but may instead be required to provide only 100% of the WQCV. Per discussions with the MHFD, developments immediately adjoining or drain directly via conduit to either the Lena Gulch or Clear Creek drainageways will not be required by the City to provide full flood attenuation detention volume if the time of concentration is very short. The time of concentration (T_c) will be considered to be very short if it is 10 minutes or less in duration for any design point within the basin. In an effort to minimize runoff peaks during a major storm event, developments immediately adjoining either of the two above-mentioned major drainageways will be allowed to directly discharge into them during such an event.

SWMPs for Subdivisions

The following excerpt was provided from the State of Colorado, Division of Water Quality to clarify the State's position regarding individual lots and their relationship to the subdivision as a whole, and may be used in determining CDPS Permit and Stormwater Management Plan (SWMP) submittal requirements for proposed subdivisions:

*"A common plan of development or sale" is a site where multiple separate and distinct construction activities may be taking place at different times on different schedules. Examples include: 1) phased projects and projects with multiple filings or lots, even if the separate phases or filings/lots will be constructed under separate contracts or by separate owners (e.g., a project where developed lots are sold to separate builders); 2) a development plan that may be phased over multiple years, but is still under a consistent plan for long-term development; and 3) projects in a contiguous area that may be unrelated but still under the same contract, such as construction of a building extension and a new parking lot at the same facility. If the project is part of a common plan of development or sale, **the disturbed area of the entire plan must be used in determining CDPS permit requirements.***

This means the entire project must be analyzed to determine the contents of the SWMP. For example, even if lots of less than 1 acre in size are developed one at a time, if they belong to a larger (new) subdivision which is more than an acre in size, each lot as it is developed will be viewed by the State of Colorado as a "phase" of the overall subdivision project. These "phases" will need to be referenced in the SWMP by stating the subdivision is to be completed in a single-lot, phased manner, and the SWMP must not only include full and complete descriptions of all of the BMP's needed to complete each phase, but also for the ultimate full build-out of the subdivision.

Irrigation Ditches

Irrigation ditches shall not be used to convey storm runoff unless written permission is obtained from the affected ditch company and/or owner(s) and submitted to the City. Written permission shall be in the form of a signed letter from the ditch company owner(s), board, or representative(s) to the City of Wheat Ridge expressly stating the specific rights being granted.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

II. DEVELOPMENT CATEGORIES

Drainage requirements for SFR/Duplex residential developments are described in Section A below. The threshold criteria for the Multi-Family/Commercial New Development and Redevelopment sub-classes are defined in Section B, and graphically depicted in two flowcharts, Figures 1 and 2.

A. Single Family/Duplex Residential

1. Developments Disturbing Less Than One Acre
 - a. New Single Family/Duplex residential developments which disturb less than one (1) acre and are not part of a new or recent subdivision are as a general rule not subject to the City Site Drainage Requirements. The typical requirement for Single Family/Duplex developments is a basic Site Plan showing the proposed structure, lot lines, and spot elevations. Drainage improvements are generally not required, however the site does need to be graded and roof drains need to be directed in such a manner as to minimize any potential impacts to adjoining or downstream properties. A Site Plan showing the roof drains must be included with the Building Permit Application.
 - b. New Single Family/Duplex residential developments which disturb less than one (1) acre within a new or recent subdivision will need to have the site grading performed in a manner consistent with the approved civil plans and documents for the subdivision to ensure the site drainage will function per these documents. A Site Plan showing the proposed structure, lot lines, and site grading for the lot will be required with the Building Permit Application. Upon project completion, a **Drainage Certification Letter** from the Engineer-of-Record, the Professional Engineer who prepared the previously approved Final Drainage Report and civil plans, **shall be required prior to issuance of the Certificate of Occupancy (C.O.) for all new subdivisions**. A Drainage Certification Letter from a Colorado licensed Professional Engineer may be required prior to C.O. for recent subdivisions depending on the age of the original documents and the individual circumstances surrounding the project. When required, the Drainage Certification Letter shall state that the site has been graded and the drainage will function in accordance with all approved civil documents for the subdivision.
2. Developments Which Disturb One Acre or More. New Single Family/Duplex residential developments whereby the area of land disturbance is equal to or greater than one acre in size will be treated as a New Minor Multi-Family/Commercial Development under the Site Drainage Requirements. Therefore, a Drainage Letter and Plan, a Grading & Erosion Control Plan (G & EC), and SWMP, must be prepared by a Professional Engineer licensed in the State of Colorado (the Engineer-of-Record) and submitted for review and approval with the Building Permit Application. An approved SWMP will be required prior to the issuance of any Grading or Building Permit Applications. Upon project completion, a **Drainage Certification Letter** from the Engineer-of-Record stating the site has been graded and the drainage will function in accordance with all approved civil documents for the project or subdivision, **shall be required prior to issuance of the C. O.** The Drainage Certification Letter is to be accompanied by As-Built plans with adequate spot elevations to support the statements made in the Letter.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

B. Subdivision/Multi-Family/Commercial

1. New Development

- a. **Minor:** A Development that increases the amount of impervious area of the site by:
 - i. Less than 10,000 square feet, and
 - ii. The overall area of land disturbance is less than one acre in size.
- b. **Major:** A Development that increases the amount of impervious area of the site by:
 - i. 10,000 square feet or more, or
 - ii. The overall area of land disturbance is equal to or greater than one acre in size.

2. Redevelopment

- a. **Minor:** A Redevelopment that:
 - i. Disturbs the existing impervious area of the site by 3,000 square feet or less, **or**
 - ii. Increases the amount of impervious area on the site by 3,000 square feet or less, **and**
 - iii. The overall area of land disturbance is less than one acre in size.
- b. **Moderate:** A Redevelopment that:
 - i. Disturbs the existing impervious area of the site by more than 3,000 but less than 10,000 square feet, **or**
 - ii. Increases the amount of impervious area of the site by more than 3,000 square feet but less than 10,000 square feet, **and**
 - iii. The overall area of land disturbance is less than one acre in size.
- c. **Major:** A Redevelopment that:
 - i. Disturbs the existing impervious area of the site by 10,000 square feet or more, **or**
 - ii. Increases the amount of impervious area of the site by 10,000 square feet or more, **or**
 - iii. The overall area of land disturbance is equal to or greater than one acre in size.

Notes:

- Subdivision, Multi-Family, and Commercial land development projects whereby an existing site of one (1) acre or more in size is to be completely scraped and reconstructed, or is a vacant lot to be newly constructed upon, will be classified as New Development.
- Residential subdivision and multi-family projects proposed on a site one (1) acre or less in size that contains existing improvements, the imperviousness of the existing improvements may be deducted from that of the proposed improvements. In this case only the net increase in imperviousness is used to determine the required stormwater facilities.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

III. REQUIREMENTS – Subdivision/Multi-Family/Commercial

1. New Development

- a. **Minor:** Minor New Developments are not subject to flood attenuation detention, but must address 100% WQCV or 100% EURV for the additional impervious area only. Acceptable designs include but are not limited to:
- i. *Roof runoff controls*, to direct runoff to vegetative swales or buffer areas. They must be sized according to the amount of rooftop runoff received, but are typically 4 to 5 feet square, and 2 to 3 feet deep, with a minimum of 1-foot soil cover over the top to allow for vegetative growth.
 - ii. **Grass Buffer (GB) Strips*. Uniformly graded and densely vegetated areas of turf grass located adjacent to impervious areas. These strips must be a minimum of 10 feet in width.
 - iii. **Porous landscaping detention*. Water quality “detention” may be achieved through the use of, but not limited to, the following:
 - a. *Infiltration trenches* consisting of a long rock-filled trench with no outlet that receives runoff. While the length of these will vary with the size of the site and the amount of calculated runoff and water quality capture volume (WQCV) that is required, they are a minimum of 10 feet in width, 2 to 3 feet in depth, and have a minimum of 1-foot of soil cover over the top to allow for vegetative growth.
 - b. Create *natural storage reservoirs* through the use of depressions with areas containing a bed of permeable soils, and grass-lined swales.
 - iv. **Porous Interlocking Concrete Pavers*. A Porous Interlocking Concrete Paver (PICP) system is an acceptable means of stormwater detention, water quality treatment, and useful for runoff reduction.

Site Drainage Submittals:

- **Drainage Letter and Drainage Plan:** A detailed Drainage Letter, signed and sealed by a Professional Engineer licensed in the State of Colorado, is always required for Minor New Developments. The Letter must state how the additional impervious surfaces will be placed to minimize any negative impacts to adjacent properties, such as the use of roof runoff directors and directing roof drains away from adjoining properties. One hundred percent (100%) of the WQCV for all additional imperviousness is required to be detained on-site for a Minor New Development. The volume must be calculated for the additional imperviousness only, and used to determine the proper Best Management Practices (BMP's) needed to achieve water quality. The Letter must describe how water quality will be achieved through the use of the various methods employed, such as infiltration trenches, grass-lined swales, landscape strips, porous landscaping, or any other standard *water quality BMP. A soils analysis and percolation test data for any proposed infiltration areas shall be included. Please be advised that the minimal acceptable width for WQ landscape areas is 10 feet, and there must

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

be a minimum 2 foot buffer from the edge of the proposed WQ landscape area to the property line. The Drainage Letter must be accompanied by a signed and sealed Drainage Plan showing the existing and proposed site drainage, the percent grades and drainage direction, and all proposed water quality features (including all details necessary to construct).

- **Drainage Certification Letter:** Upon project completion, a Drainage Certification Letter from the Engineer-of-Record stating the site has been graded and the drainage/water quality will function in accordance with all approved civil documents for the project or subdivision, **shall be required prior to issuance of any C. O.** The Drainage Certification Letter is to be accompanied by As-Built plans on the *Current City Datum* with adequate spot elevations to support the statements made in the Letter.

- b. **Major:** Major New Developments shall meet all flood attenuation and water quality requirements for the entire site.

For an above-ground, standard Extended Detention Basin (EDB) design, full flood attenuation and WQCV detention volume equal to 100% of the 100 year event + 50% WQCV is required. A preferred alternative to this type of design is by use of Full Spectrum Detention which utilizes Excess Urban Runoff Volume (EURV) per the Urban Drainage and Flood Control (MHFD) criteria (100-year + EURV). Please refer to Section IV. *Technical Civil Documents* and Section VI. *Final Drainage Report* for the required outline format. Please note that an Operations and Maintenance (O & M) schedule must be established for all types of facilities utilized, and that a Stormwater Maintenance Agreement containing the maintenance schedule shall be submitted for review and approval prior to issuance of the C.O.

Detention may be achieved through the use of, but not limited to, the following:

- i. **Above-ground detention facility.* The above-ground facility is the least expensive and most common form of detention; however they do require the most site area to construct.
- ii. **Porous Interlocking Concrete Pavers.* A Porous Interlocking Concrete Paver (PICP) system utilizing an underground infiltration basin is an acceptable means of stormwater detention, and works well for use in runoff reduction. As stated earlier, this type of design is gaining in popularity due to its simplistic construction and the relative ease of maintenance.
- iii. **Porous Landscape Detention.* Porous landscaped areas are acceptable as a means of detention and for water quality purposes. A detailed maintenance schedule must be established for all porous landscape designs. Initially, this may be more expensive to construct than an above-ground facility, but just as the porous pavement type of design, it allows the land area to be used in other ways such as a lawn area, playground, practice field, etc. Detention may be achieved through the use of, but not limited to, the following:
 - a. *Infiltration trenches* consisting of a long rock-filled trench with no outlet that receives runoff. While the length of these will vary with the size of the site and the amount of calculated runoff and water quality capture volume (WQCV) that is required, they are a minimum of 10 feet in width, 2 to 3 feet

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- in depth, and have a minimum of 1-foot of soil cover over the top to allow for vegetative growth.
- b. *Infiltration Basins* are an acceptable means of detention and for water quality purposes if the underlying soils are fairly permeable and allow for good infiltration, e.g., the soil should be 20% clay or less. The elevation of the local (high) water table must be a minimum of three (3) feet below the bottom of the proposed basin, which is critical to the success of this type of design. All infiltration basins shall incorporate the MHFD Rain Garden growing medium design for pond bottom soil amendment. For a full-infiltration section this is a 6" depth of *BioLite Rain Garden Growing Media* (Golf & Sport Solutions, 970.284.6121) or MHFD approved equivalent.
 - c. Create *natural storage reservoirs* through the use of depressions with areas containing a bed of permeable soils, and grass-lined swales.
 - iv. *Underground detention.* Underground detention using conduit or a vault is also an acceptable means of detention if adequate access for maintenance is provided. The underground system structural capacity must be **designed to support AASHTO HS20 (fire truck)** loading, as well as the anticipated lifetime AASHTO 18,000 lb. equivalent single axle loads (ESALs). A detailed maintenance schedule must be established for all underground designs. Just as in the porous detention designs, the underground detention facility allows the site area to be utilized rather than reserved for an above-ground detention facility. The drawbacks to undergrounding are the same as in all of the alternatives to the above-ground facility, the initial cost and long-term maintenance issues, should be considered.
 - v. **Grass-lined Swales (GS).* A GS can be located to collect overland flows from areas such as parking lots, buildings, residential yards, roadways and grass buffer strips (GBs). They can be made a part of the overall drainage plan to minimize a directly connected impervious area by using them as an alternative to a curb-and-gutter system. The GS is set below adjacent ground level, and runoff enters the swales over grassy banks.
 - vi. **Grass Buffer (GB) Strips.* These must be uniformly graded and should include densely vegetated areas of turf grass located adjacent to impervious areas. GB Strips must be a minimum of 10 feet in width.
 - vii. *Combinations of designs.* Any combination of the above-mentioned designs will be considered provided that volumes, release rates, and water quality have been proven and adequately addressed.

Site Drainage Submittals:

- **Final Drainage Report:** A completed Final Drainage Report and Plan adhering to the outline shown in Section VII below, signed and sealed by a Professional Engineer licensed in the State of Colorado, shall be submitted for review and approval prior to issuance of any Grading or Building Permits. Soils information and percolation test data for any proposed infiltration areas shall be included in the Report.
- **SWMP:** All sites where the area of disturbance is equal to or greater than one acre in size is required to submit a Stormwater Management Plan for review and

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

approval prior to issuance of any Grading/Fill or Building Permits. There are no exceptions to this requirement.

- **Drainage Certification Letter:** Upon project completion, a Drainage Certification Letter from the Engineer-of-Record stating the site has been graded and the drainage will function in accordance with all approved civil documents for the project or subdivision, **shall be required prior to issuance of the C. O.** The Drainage Certification Letter is to be accompanied by As-Built plans on the *Current City Datum* with adequate spot elevations in support of the statements made in the Letter.

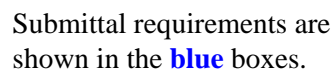
¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

NEW DEVELOPMENT

Site Drainage Requirements



2. Redevelopment

- a. **Minor:** Minor Redevelopments need to address water quality, but are not subject to flood attenuation stormwater detention. Typical features include but are not limited to:
- i. *Roof runoff directors*, used to direct roof runoff. Roof drains must be placed in a manner as to direct the runoff to a vegetative swale, infiltration trench, or buffer area prior to leaving the site.
 - ii. *Landscaped Areas*. Landscaped areas are ideal for use in water quality. The area should be slightly depressed from adjacent pavement to allow runoff to enter.
 - iii. *Buffer Strips*. Landscape buffer areas of a minimal of 6 feet in width are acceptable for quality treatments.
 - iv. *Rock Infiltration trenches*. These consist of a long rock-filled² trench with no outlet that receives runoff. While the length of these will vary with the size of the site and the amount of runoff anticipated, they must be a minimum of 6 feet in width, and 1 to 2 feet in depth.

Site Drainage Submittals:

- **Site Plan:** A Site Plan shall be required showing drainage-related items and how the additional impervious surfaces will be placed. While no formal civil engineering documents are required for Minor Redevelopments, the Site Plan will need to provide sufficient detail for all proposed drainage or water quality items to be properly constructed. Examples of things to show on the Plan are the use of roof runoff directors and directing roof drains away from adjoining properties (show flow direction on Plan) to minimize potential negative impacts, what water quality methods will be employed, such as the use of grass-lined swales, 6 ft.-wide (min.) perimeter buffer strips, landscaped areas, etc. The Site Plan must provide spot elevations, clearly identify all water quality features, and include any details necessary to properly construct.
- **Drainage Letter and Drainage Plan:** A detailed Drainage Letter signed and sealed by a Professional Engineer licensed in the State of Colorado, may be required for Minor Redevelopments. The Letter must state how any additional impervious surfaces will be placed without impacting adjacent properties, such as by using roof runoff directors and directing roof drains away from adjoining properties, thereby minimizing any potential negative impacts to them. While the WQVC is not required to be “detained” on-site for a Minor Redevelopment, it is recommended that the volume be calculated and used to determine the proper Best Management Practices (BMP’s) to achieve water quality. The Letter must describe how water quality will be achieved through the use of the various methods employed. A soils analysis and percolation test data for infiltration areas may be required. Please be advised that the minimal acceptable width for WQ landscape areas is 10 feet. The Drainage Letter must be accompanied by a signed and sealed Drainage Plan showing the existing and proposed site drainage, percent grades and drainage direction, and all water quality features (with any details necessary to construct).

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- **Drainage Certification Letter:** Upon project completion, a Drainage Certification Letter from the Engineer-of-Record stating the site has been completed and the drainage will function in accordance with all approved civil documents for the project or subdivision, **shall be required prior to issuance of the C. O.** The Drainage Certification Letter is to be accompanied by As-Built plans with adequate spot elevations to support the statements made in the Letter.
- b. **Moderate:** Moderate Redevelopments need to address 100% water quality capture volume or 100% EURV for only the additional impervious area, but are not subject to flood attenuation stormwater detention. Typical features include but are not limited to:
- i. *Roof runoff controls*, to direct runoff to vegetative swales or buffer areas. They must be sized according to the amount of rooftop runoff received, but are typically 4 to 5 feet square, and filled with rock² 2 to 3 feet deep, with a minimum of 1-foot soil cover over the top to allow for vegetative growth.
 - ii. *Rock Infiltration trenches*. These consist of a long rock-filled² trench with no outlet that receives runoff. While the length of these will vary with the size of the site and the amount of runoff anticipated, they must be a minimum of 10 feet in width, and 2 to 3 feet deep, and may be used with a permeable fabric placed over the rock and a minimum of 1-foot soil cover over the top to allow for vegetative growth.
 - iii. *Infiltration Basins* are acceptable for water quality purposes if the underlying soils are fairly permeable and allow for good infiltration, e.g., the soil should be 20% clay or less. The elevation of the local (high) water table being a minimum of three (3) feet below the bottom of the proposed basin is also critical to the success of this type of design. All infiltration basins shall incorporate the MHFD Rain Garden growing medium design for pond bottom soil amendment. For a full-infiltration section this is a 6" depth of *BioLite Rain Garden Growing Media* (Golf & Sport Solutions, 970.284.6121) or MHFD approved equivalent.
 - iv. *Natural storage reservoirs* may be created through the use of depressions, areas of permeable soils or rock², and grass-lined swales, while maintaining existing drainage corridors.
 - v. *Proprietary Water Quality Devices*. For proprietary underground BMPs, field collected data shall be provided to demonstrate the anticipated BMP performance will be comparable to surface BMPs such as EDBs, sand filters, etc., by producing effluent quality with a **median TSS concentration of no more than 30mg/L** (TSS-EPA method), as required per MHFD Volume 3 criteria.

Site Drainage Submittals:

- **Drainage Letter and Drainage Plan:** A detailed Drainage Letter signed and sealed by a Professional Engineer licensed in the State of Colorado shall be required stating how the additional impervious surfaces will be placed without impacting adjacent properties, such as by using roof runoff directors and directing roof drains away from adjoining properties to minimize potential negative impacts to them. WQVC is required to be treated on-site for a Moderate Redevelopment; the volume must be calculated and used to determine

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

the proper Best Management Practices (BMP's) needed to achieve water quality. The Letter will need to describe how water quality will be achieved, for example, through the use of infiltration trenches, grass-lined swales, landscape strips, porous interlocking concrete pavers, porous landscaping, or any other standard water quality BMP. A soils analysis and percolation test data for infiltration areas must be included. Please be advised that the minimal acceptable width for water quality landscape areas or perimeter buffers is 10 feet. The Drainage Letter shall be accompanied by a signed and sealed Drainage Plan showing the existing and proposed site drainage, including percent grades and drainage direction, and all water quality features (with details necessary to construct).

- **Drainage Certification Letter:** Upon project completion, a Drainage Certification Letter from the Engineer-of-Record stating the site has been completed and the drainage will function in accordance with all approved civil documents for the project or subdivision, **shall be required prior to issuance of the C. O.** The Drainage Certification Letter is to be accompanied by As-Built plans with adequate spot elevations to support the statements made in the Letter.

- c. **Major:** Major Re-Developments shall meet the full 100-year flood attenuation stormwater detention and water quality volume requirements for the entire site. For an above-ground, standard Extended Detention Basin (EDB) design, full flood attenuation and WQCV detention volume equal to 100% of the 100 year event + 50% WQCV is required. A preferred alternative to this type of design is by use of Full Spectrum Detention which utilizes Excess Urban Runoff Volume (EURV) per the Urban Drainage and Flood Control (MHFD) criteria (100-year + EURV). Please refer to Section IV. *Technical Civil Documents* and Section VI. *Final Drainage Report* for the required outline format. Please note that an Operations and Maintenance (O & M) schedule must be established for all types of facilities utilized, and that a Stormwater Maintenance Agreement containing the maintenance schedule shall be submitted for review and approval prior to issuance of the C.O.

Detention may be achieved through the use of, but not limited to, the following:

- i. **Above-ground detention facility.* The above-ground facility is the least expensive and most common form of detention, although they require the most site area to construct.
- ii. **Porous Pavement.* Porous concrete or asphaltic pavement is acceptable as a means of detention. A detailed maintenance schedule must be established for all porous pavement designs. Initially, this may be more expensive to construct rather than an above-ground facility, but it requires little if no site surface area (area is generally used as a parking lot).
- iii. **Porous Landscape Detention.* Porous landscaped areas are acceptable as a means of detention. A detailed maintenance schedule must be established for all porous landscape designs. Initially, this may be more expensive to construct than an above-ground facility, but just as the porous pavement type of design, it allows the land area to be used in other ways such as a lawn area, playground, practice field, etc. Detention may be achieved through the use of, but not limited to, the following:

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- a. *Infiltration trenches* consisting of a long rock-filled trench with no outlet that receives runoff. While the length of these will vary with the size of the site and the amount of calculated runoff and water quality capture volume (WQCV) that is required, they are a minimum of 10 feet in width, 2 to 3 feet in depth, and have a minimum of 1-foot of soil cover over the top to allow for vegetative growth.
- b. *Infiltration Basins* are an acceptable means of detention and for water quality purposes if the underlying soils are fairly permeable and allow for good infiltration, e.g., the soil should be 20% clay or less. The elevation of the local (high) water table being a minimum of three (3) feet below the bottom of the proposed basin is also critical to the success of this type of design. All infiltration basins shall incorporate the MHFD Rain Garden growing medium design for pond bottom soil amendment. For a full-infiltration section this is a 6" depth of *BioLite Rain Garden Growing Media* (Golf & Sport Solutions, 970.284.6121) or MHFD approved equivalent.
- c. Create *natural storage reservoirs* through the use of depressions with areas containing a bed of permeable soils, and grass-lined swales.
- iv. *Underground detention.* Underground detention using conduit or a vault is also an acceptable means of detention if adequate access for maintenance is provided. The underground system structural capacity must be **designed to support AASHTO HS20 (fire truck)** loading, as well as the anticipated lifetime AASHTO 18,000 lb. equivalent single axle loads (ESALs). A detailed maintenance schedule must be established for all underground designs. Just as in the porous detention designs, the underground detention facility allows the site area to be utilized rather than reserved for an above-ground detention facility. The drawbacks to undergrounding are the same as in all of the alternatives to the above-ground facility, the initial cost and long-term maintenance issues, should be considered.
- v. *Roof runoff controls*, to direct runoff to vegetative swales or buffer areas. They must be sized according to the amount of rooftop runoff received, but are typically 4 to 5 feet square, and filled with rock² 2 to 3 feet deep, with a minimum of 1-foot soil cover over the top to allow for vegetative growth.
- vi. *Rock Infiltration trenches.* These consist of a long rock-filled² trench with no outlet that receives runoff. While the length of these will vary with the size of the site and the amount of runoff anticipated, they must be a minimum of 10 feet in width, and 2 to 3 feet deep, and utilize with a permeable fabric placed over the rock and a minimum of 1-foot soil cover over the top to allow for vegetative growth.
- vii. **Grass-lined Swales (GS).* A GS can be located to collect overland flows from areas such as parking lots, buildings, residential yards, roadways and grass buffer strips (GBs). They can be made a part of the plans to minimize a directly connected impervious area by using them as an alternative to a curb-and-gutter system. A GS is set below adjacent ground level, and runoff enters the swales over grassy banks.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- viii. **Grass Buffer (GB) Strips.* Uniformly graded and densely vegetated areas of turf grass located adjacent to impervious areas. These strips must be a minimum of 10 feet in width.
- ix. *Combinations of designs.* Any combination of the above-mentioned designs will be considered provided that volumes, release rates, and water quality have been adequately addressed.

Site Drainage Submittals:

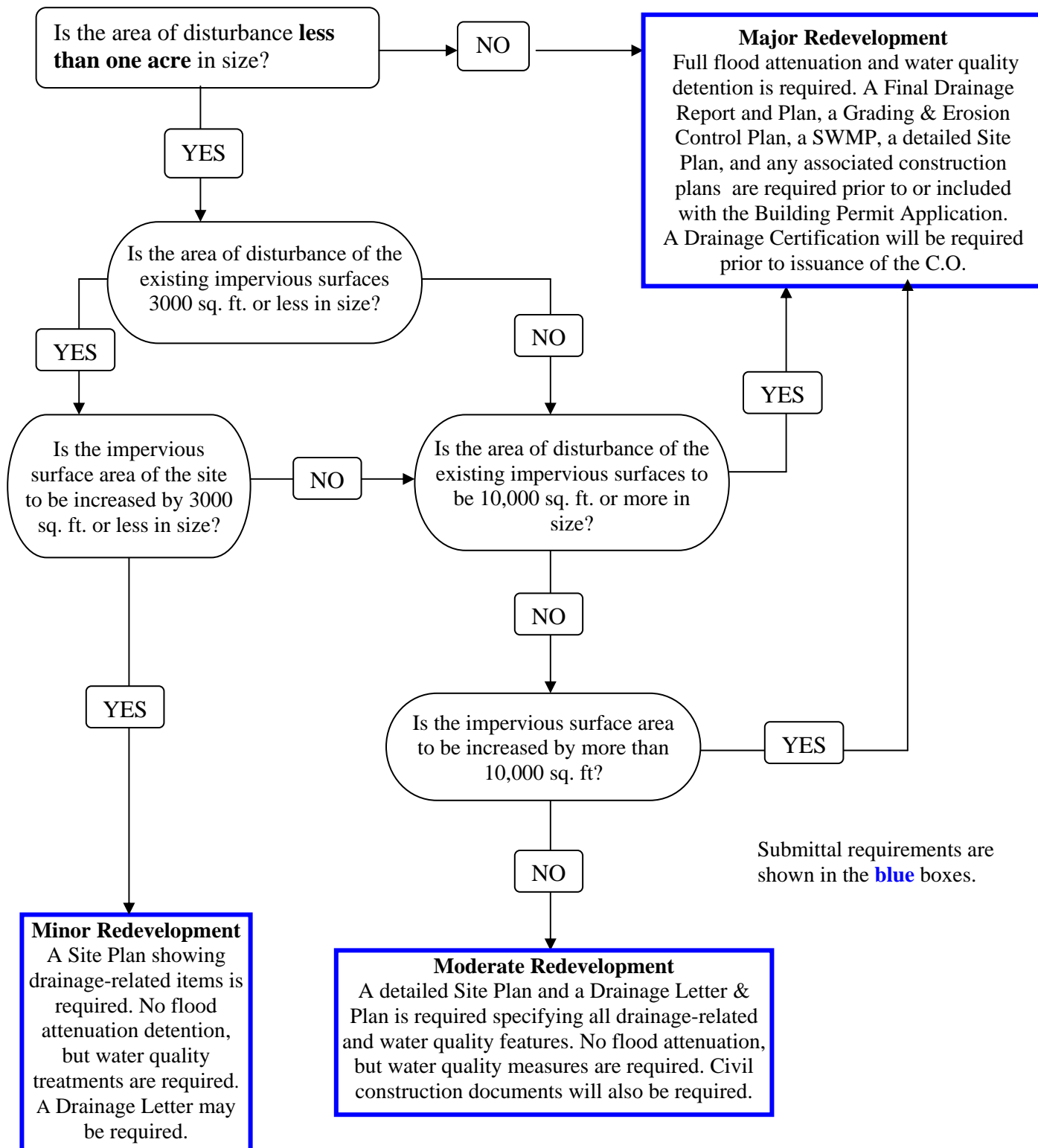
- **Final Drainage Report:** A completed Final Drainage Report and Plan adhering to the outline shown in Section VII below, signed and sealed by a Professional Engineer licensed in the State of Colorado, shall be submitted for review and approval prior to issuance of any Grading or Building Permits. Soils information and percolation test data for any proposed infiltration areas shall be included in the Report.
- **SWMP:** All sites where the area of disturbance is equal to or greater than one acre in size are required to submit a Stormwater Management Plan for review and approval prior to issuance of any Grading/Fill or Building Permits.
- **Drainage Certification Letter:** Upon project completion, a Drainage Certification Letter from the Engineer-of-Record stating the site has been completed and the drainage will function in accordance with all approved civil documents for the project or subdivision, **shall be required prior to issuance of the C. O.** The Drainage Certification Letter is to be accompanied by As-Built plans with adequate spot elevations to support the statements made in the Letter.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

FIGURE 2
REDEVELOPMENT
Sub-Class Threshold Criteria



IV. TECHNICAL CIVIL DOCUMENTS

Submittals

All Developments, requiring a Final Drainage Report shall submit the Report to the City for review and approval with the Land Use or Building Permit Application. This report shall be prepared by a Professional Engineer licensed in the State of Colorado in accordance with the latest editions of the *Urban Drainage and Flood Control District's, Urban Storm Drainage Criteria Manual, Volumes I-III*, and shall incorporate the use of Best Management Practices whenever applicable.

All Final Drainage Reports must be submitted in the format of the attached outline, and contain copies of all MHFD spreadsheets where applicable. The City of Wheat Ridge will not review a Final Drainage Report submitted in any other format. **One hardcopy and one electronic copy in PDF format of the Final Drainage Report and Plan shall be included with each submittal.**

All civil engineering documents including the Final Drainage Report and Plan will be reviewed by Engineering Division staff electronically. Therefore, if the PDF file(s) are not included in the submittal package it will be deemed incomplete and cannot be reviewed by Engineering Division. Subsequent review comments will be redlined on the PDF of the report and on all plans, and a review letter containing summarizing all comments will be created. The comment letter accompanied by all of the redlined PDF documents will then be returned for revision. The resubmittal package **must contain a response letter** indicating previous comments have been addressed. When it has been determined by Engineering Division staff that all previous comments have been adequately addressed and the Final Drainage Report/Plan is acceptable, two signed, wet-stamped hardcopies and one electronically scanned PDF copy of the signed & sealed Final Drainage Report/Plan shall be submitted for approval.

Any subsequent revisions to the approved Final Drainage Report and/or Plan(s) shall be submitted to the City of Wheat Ridge for review and approval by the same process previously defined. The approved Drainage Plan sheet must be included in the final construction plan set for the proposed development.

Building Permit Applications

Prior to the issuance of any Building Permits for a proposed multi-family/commercial or subdivision development, certain technical documents must be submitted for review and approval. Required technical documents shall include, but not limited to, a Final Drainage Report and Plan, Grading Plan, Erosion Control Plan, and if applicable, a Trip Generation Analysis, Traffic Impact Study, Stormwater Management Plan, and engineered construction drawings. These documents shall be in accordance with the current Urban Drainage & Flood Control District and City of Wheat Ridge Site Drainage Requirements criteria as set forth herein.

No Building Permit applications shall be approved until the aforementioned requirements have been met to the satisfaction of the City of Wheat Ridge Engineering Division.

Drainage Certification Letter & As-Built Plans

Upon completion of the drainage improvements, the Engineer-of-Record shall provide to the City of Wheat Ridge a written, signed and sealed Drainage Certification Letter stating that the overall site

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

grading was completed per the approved Grading and Drainage Plans, all drainage facilities were constructed per the approved construction plans and shall function as defined in the approved Final Drainage Report/Plan, and that the site has been accurately surveyed to confirm that the grading and construction of all drainage facilities was completed in accordance with these documents. The Drainage Certification Letter shall be submitted to the City for review and approval, and shall be accompanied with As-Built Plans on the *Current City Datum* for all constructed drainage facilities **prior to issuance of any Certificate of Occupancy**. Three (3) copies of the “As-Built” Plans are to be submitted as follows:

- a. **One (1) hardcopy** is to be signed & sealed on 24” X 36” bond paper, and
- b. **Two (2) electronic files** are to be delivered on DVD/CD-ROM as follows: One (1) file in the **AutoCAD DWG format (with xref attached)** currently acceptable to the Engineering Division, and one (1) file in **PDF format**.

Per Section 26-412 of the Municipal Code of Laws, no Certificate of Occupancy will be issued until the Drainage Certification Letter and As-Built Plans have been received.

V. MAINTENANCE OF POST-CONSTRUCTION BMP’S

All post-construction Best Management Practices (BMP’s) for water quality must be maintained and inspected by the property owner(s) per Section 20-34 of the City of Wheat Ridge Municipal Code of Laws. For all water quality treatment facilities such as above-ground detention facilities with outlet structures, underground detention facilities, porous landscape detention areas, porous pavement, and centrifuge type devices such as a Rinker Stormceptor®, a Stormwater Maintenance Agreement accompanied by an Operations and Maintenance (O & M) Schedule will be required prior to issuance of the Certificate of Occupancy. The O & M Schedule shall be kept current and will be inspected on a regular basis by City staff to ensure compliance with the State and local requirements.

For sites less than one acre in size, grass swales, infiltration trenches, porous landscaping, landscaped buffers and similar types of water quality BMP’s may not need a full blown Operations and Maintenance Plan (O & M Plan) they will still need to be maintained, and will be inspected by the City periodically to ensure their continued functionality. For sites greater than one acre in size, all permanent BMPs must be included in the O & M Plan.

VI. ROUTINE MAINTENANCE OF EXISTING IMPERVIOUS AREAS

Commercial properties not undergoing a change of name, use, layout, or site design, may perform routine maintenance on existing impervious areas without triggering the Site Drainage Requirements. Existing impervious area is hereby defined as the impervious area, e.g., pavement, sidewalk, buildings, or any other hard impermeable surface that was in existence when the property was initially developed, or the area shown on the most recent City aerial photography, whichever occurred later.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

Standard maintenance activities taking place on existing impervious areas that do not impact the current drainage functionality or layout of the existing impervious areas will not be classified as redevelopment, and therefore not subject to the Site Drainage Requirements. Standard maintenance activities include seal-coating, slurry seal application, patching, mill and overlay for any size area. Standard maintenance activities also include the complete removal and replacement of an existing mat if each area of removal is less than 3,000 square feet in size (e.g., patchwork), so long as the total area of removal remains under one (1) acre in size. If the total areas of removal and replacement add up to one acre or more in size, refer to items 2 and 4 below.

Please note the following items:

1. Contiguous areas of maintenance activity involving a complete removal and replacement of the pavement area greater than 10,000 square feet in size must submit an Erosion Control Plan prior to the commencement of construction activities. This includes smaller areas of removal and replacement whose aggregate area total 10,000 square feet or more. For example, ten 1,000 square feet areas of removal and replacement will trigger this requirement.
2. A Stormwater Management Plan (SWMP) and Erosion Control Plan is required for maintenance activity involving the disturbance or complete removal and replacement of the pavement area greater than one acre in size. This includes the aggregate total of smaller removal and replacement areas.
3. Any areas of complete removal and replacement of pavement or other impervious surface(s) that will include any re-grading or re-direction of stormwater runoff within those areas of removal shall fall within the Redevelopment category, and be subject to the Site Drainage Requirements.
4. Projects where complete removal and replacement of pavement or other impervious surface(s) will include any re-grading or re-direction of stormwater runoff within those areas, and the total area of disturbance is greater than one (1) acre in size, an Application for Grading Permit (“Permit”) shall be obtained from the Engineering Division (303.235.2846) and all requirements and standards stated in the Permit shall be met prior to commencement of any construction activities.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

VII. FINAL DRAINAGE REPORT

REQUIRED OUTLINE AND INFORMATION

1. TITLE PAGE

- A. Type report (Final, or Flood Hazard).
- B. Project name.
- C. Preparer name, firm, and date.
- D. P.E. seal and signature of preparer.

2. INTRODUCTION

- A. SITE LOCATION
 - 1) City, county, street grid.
 - 2) Adjacent development.
- B. SITE DESCRIPTION
 - 1) Existing topography, ground cover, use, etc.
 - 2) Existing drainage facilities, major channels, Flood hazard zones and studies, irrigation ditches.
- C. PROPOSED PROJECT DESCRIPTION
 - 1) The type, footprint, and use of the primary structure.
 - 2) Overall site, such as parking, landscaping, and public improvements.
- D. FLOOD HAZARD AND DRAINAGE STUDIES RELEVANT TO SITE

3. HISTORIC DRAINAGE SYSTEM (Discuss the following)

- A. MAJOR BASIN
 - 1) Relationship to major basin channel.
 - 2) Major basin drainage characteristics, topography, runoff, use, groundcover, etc.
- B. SUB-BASIN AND SITE DRAINAGE
 - 1) Flow rates for the initial (5-yr) and major (100-yr) storm events.
 - 2) Off-site flows.
 - 3) Include sub-basin names and areas in the discussion.
 - 4) Existing drainage patterns: channelized or overland flow, volumes, historic points of discharge from site.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- 5) Effect of historic flows upon adjacent properties.

PROPOSED (DEVELOPED) DRAINAGE SYSTEM (Discuss the following)

A. CRITERIA

- 1) Area of basin and sub-basins.
- 2) Hydrologic method (Rational or CUHP).
- 3) Design storm frequencies - initial (5-yr) and major (100-yr).

B. RUNOFF

- 1) Developed flow rates and paths.
- 2) Effect of developed flows upon adjacent properties.
- 3) Runoff reduction practices to minimize directly connected impervious areas (MDCIA), i.e., the use of reduced pavement area, PICPs, permeable landscaped areas that will capture runoff, grass buffers, grass-lined swales, etc.

C. DETENTION

Proximity to a major drainageway: If the subject property is immediately adjacent to or drains directly to either Clear Creek or Lena Gulch and if the T_c for any design point within the basin is 10 minutes or less, only the WQCV for the site will be required (no flood attenuation).

1. The following information is required for all standard **Extended Detention Basin**¹ facilities:

- 1) State that the structural BMP to be utilized for water quality is the extended detention basin.
- 2) State the volumes required and provided:
 - A. Water Quality Capture Volume (WQCV).
Please note: If the T_c is very short (≤ 10 min.) for all design points within the basin, and the development lies adjacent to a major drainageway (Lena Gulch or Clear Creek), the WQCV is the only detention volume required. If these 2 conditions cannot be met, all detention volume requirements A, B, and C shall apply.
 - B. 5-yr: The full WQCV + the full 5-yr. detention volume.
 - C. 100-yr: 50% WQCV + the full 100-yr detention volume.
- 3) Water surface elevations: 100-yr, 5-yr, and WQCV.
- 4) Release rates: 100-yr, 5-yr, and WQCV, based upon a 24-hr minimum & 40-hr maximum time to completely drain the pond.
- 5) Discuss the use of a Micro-pool. Please note that micro pools must be a minimum of 2.50' deep and have a minimum surface area of ten (10) square feet per MHFD criteria. Micro-pools may be located inside outlet structures are unnecessary for very small ponds due to small volume (the MHFD recommends using no smaller than a 10 ft² micro-pool area since this would create a mosquito breeding habitat).
- 6) Describe the method(s) of release.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- 7) The use of concrete trickle channel(s) to completely drain the pond.
- 8) State that the pond bottom shall be graded at a minimum of 2% towards the trickle channel(s) to allow the facility to fully drain.
- 9) Excess stormwater passage.
- 10) Emergency overflow location & design.
- 11) Water Quality Outlet Structure and orifice plate design. Minimum orifice openings for EDB orifice plates shall be 0.50”.
- 12) State that the trash rack/orifice plate design shall incorporate the standard Wheat Ridge Well Screen: U.S. Filter Stainless Steel Well-Screen, or approved equivalent, using #93 vee wire with 0.139” openings between the wires.

¹ Per Volume 3 of the Manual, EDB's are not recommended for sites with less than 2 impervious acres; consider a sand filter or rain garden instead.

2. The following information is required for all **Full Spectrum Detention** facilities:

- 1) State that the structural BMP to be utilized for water quality will be a Full Spectrum Detention basin.
- 2) State the volumes required and provided:
 - A. Excess Urban Runoff (EURV).
 - B. 100-yr: 100% EURV + the full 100-yr detention volume.
- 3) Water surface elevations: 100-yr and EURV.
- 4) Release rates: 100-yr and EURV, based upon a 72-hour maximum time to completely drain the EURV from the pond.
- 5) Describe the method(s) of release.
- 6) The use of concrete trickle channel(s) to completely drain the pond.
- 7) State that the pond bottom shall be graded at a minimum of 2% towards the trickle channel(s) to allow the facility to fully drain.
- 8) Excess stormwater passage.
- 9) Emergency overflow location & design.
- 10) Outlet Structure and 100-year restrictor plate design.
- 11) State that the outlet structure design shall incorporate the standard Wheat Ridge Well Screen: U.S. Filter Stainless Steel Well-Screen, or approved equivalent, using #93 vee wire with 0.139” openings between the wires.

3. The following information is required for all **Underground Detention** facilities utilizing conduit with a separate hydrodynamic separator for water quality (BMP):

- 1) Describe the structural BMP to be utilized for water quality. Note: The City highly recommends that the water quality BMP be located upstream of the detention facility for ease of maintenance and to reduce system volume. If the proposed WQ BMP is located downstream of the detention, then 50% WQCV must be included and the number of clean-outs that will be required for the detention facility is going to dramatically increase.
- 2) 100% of the 100-yr detention volume (and WQCV if applicable).
- 3) The 100-year and 5-year release rates.
- 4) Describe the method of release.
- 5) For proprietary underground BMPs, field collected data shall be provided to demonstrate the anticipated BMP performance will be comparable to surface

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

BMPs such as EDBs, sand filters, etc., by producing effluent quality with a **median TSS concentration of no more than 30mg/L** (TSS-EPA method), as required per MHFD Volume 3 criteria.

4. The following information is required for all **Permeable Interlocking Concrete Pavers with Infiltration Basin** designs:

- 1) Discuss the application (i.e., in parking stalls), the type of PICP product to be used (i.e., AquaBric), the proposed pattern (i.e., herringbone), and the use of a concrete perimeter barrier.
- 2) State the square footage and describe the area where the PICPs are proposed.
- 3) State that 100% of the 100-yr detention volume is provided and that no WQCV is required. The 3-inch angular rock used in the basin must be assumed to have 30% voids.
- 4) Discuss the use of a geotextile filter fabric underneath the system to prevent a two-way migration of the basin material with the adjacent soil.
- 5) Discuss the locations of the percolation tests and the average release rate derived from the test results.
- 6) Discuss the release rate safety factor (the 20% decrease in percolation rate) for the infiltration basin.
- 7) Include a statement that monitoring wells will be used to ensure long-term functionality.
- 8) Emergency overflow route (in the event of system failure or inundation).
- 9) Use of an underdrain (if applicable).

5. The following information is required for all proposed **Infiltration Basin** designs:

- 1) State that the structural BMP to be utilized for water quality is the infiltration detention basin.
- 2) State whether the facility is designed for total infiltration or partial infiltration. If the facility uses partial infiltration, an underdrain system shall be incorporated into the design. The specifics of how the underdrain will collect and remove the stormwater that does not infiltrate must be discussed.
- 3) State that 100% of the 100-yr detention volume is provided and that no WQCV is required for the entire site if the proposal is for a new Major New Multi-Family/Commercial development or Major Redevelopment, or if the proposal is for a Minor New Multi-Family/Commercial Development, only 100% of the WQCV for the additional impervious surface is required.
- 4) Discuss the percolation test locations, test methodology, rate per hole, and average percolation rate derived for the infiltration basin (rate must be greater than 1"/hour).
- 5) Discuss the geotechnical information in the area of the proposed Infiltration Basin, such as the Hydrologic Group, percentage of clay/fine material, elevation of the local water table at the time of the test, if the test was done at a time of year when the water table is not at its highest what the anticipated level (or the level used in the design) will be.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

NOTE: The City requires that the elevation of the high water table be at least 3.0' below the proposed bottom of the Infiltration Basin. This information should be contained in the geotechnical engineering report and referenced in the Final Drainage Report.

- 6) Discuss the soil amendment for the pond bottom: All infiltration basins shall incorporate the MHFD Rain Garden growing medium design for pond bottom soil amendment. For a full-infiltration section this is a 6" depth of *BioLite Rain Garden Growing Media* (Golf & Sport Solutions, 970.284.6121) or MHFD approved equivalent.
- 7) Emergency overflow location & design.

D. STREETS

- 1) Depth and velocity of flow for initial and major storms.
- 2) Curb overtopping (not allowed for the Minor Storm, cannot exceed 12" for the Major Storm*).
- 3) Street Spread (discuss spread and depth*).
- 4) Storm drainage systems.

E. OPEN CHANNEL FLOW

- 1) Type of channel lining.
- 2) Maximum depth and velocity.

F. STORM SEWERS AND CULVERTS

- 1) Type, size, class, and % grades of storm sewer pipe. Include a statement that the current design adheres to the City's minimum standard of 18" RCP within the public Right-of-Way.
- 2) Hydraulic characteristics; subcritical or supercritical. If the flow is supercritical discuss any hydraulic jump, scouring, or other adverse conditions and their associated remedies.

4. **CONCLUSIONS**

A. DISCUSS IMPACT OF IMPROVEMENT

- 1) Benefits - Does the improvement reduce existing drainage problems?
- 2) Solutions to mitigate any adverse impact.

B. STATE COMPLIANCE WITH APPLICABLE CRITERIA

- 1) Detention ponds.
- 2) Depth and velocity of street flows.
- 3) Channel flow depth and velocity.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- C. FLOOD HAZRD: Do Areas In Flood Hazard Zone Meet Flood Plain Section of the Wheat Ridge Zoning Ordinance? (Special use permit may be required).

5. **APPENDICES**

A. HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1) Runoff (Historic)

- a. Historic off-site + site for as many design points as required
- 1) Separate time of concentration (T_c) for each design point (Rational Method).
 - 2) Runoff coefficients and percent impervious values (reference Tables RO-3 and RO-5 of the Runoff Chapter*).
 - 3) Existing drainage facilities carrying flows must include flow for entire tributary area for each design point.
 - 4) Irrigation ditch flows.

2) Runoff (Developed)

The City **recommends** using the current version of the MHFD *Peak Runoff Prediction by the Rational Method* spreadsheet to perform the runoff calculations.

- a. Off-site + site for as many design points as required
- 1) Separate time of concentration (T_c) for each design point (Rational Method).
 - 2) Runoff coefficients and percent impervious values (reference Tables RO-3 and RO-5 of the Runoff Chapter*).
 - 3) Existing drainage facilities carrying flows must include flow for entire tributary area for each design point.
 - 4) Irrigation ditch flows.

3) Detention

The City **REQUIRES** the use of the current version of the MHFD *Detention Basin Volume Estimating Workbook* spreadsheet for stormwater facilities requiring flood attenuation detention, WQCV, or EURV. Include a copy of all spreadsheets used in the Appendix.

The following information must be included for all standard **Extended Detention Basin** facilities:

- a. Storage volume provided for the 100-yr event: 50% WQCV + the full 100-yr detention volume. Include calculations for:
- 1) The 5-yr: The full WQCV + the full 5-yr. detention volume.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- 2) Water Quality Capture Volume.
- b. Release rates for the 5-yr and 100-yr storm events, and also for the WQCV (based upon a minimum drain time of 24 hrs, & a maximum time of 40 hrs to completely drain the pond).
- c. ** Detention Pond Outlet Structures
 - 1) Outlet structure design. Include all the dimensions and grate information necessary to construct. The design shall provide for the detention pond to completely drain within 40 hours.
 - 2) Use appropriate outlet discharge calculations - include offsite flows & consider head at entrance.
 - 3) Provide excess capacity for grates.
 - 4) WQ orifice plate & trash rack designs.
 - 5) Compute outlet velocity and provide energy dissipater if velocity exceeds maximum permissible channel velocity.
 - 6) Check excess storm water passage effects.
 - 7) The trash rack/orifice plate design shall incorporate the use of a U.S. Filter Stainless Steel Well-Screen (or approved equivalent) using #93 vee wire with 0.139" openings between the wire.
- d.** Size outlet structures for parking areas.
- e.** Depths of ponding anticipated for parking areas, and the durations of storage for each storm event.

The following information is required for all **Full Spectrum Detention** facilities:

- a. Include calculations for:
 - 1) Excess Urban Runoff Volume (EURV).
 - 2) Storage volume provided for the 100-yr event: The full 100-yr detention volume + EURV.
- b. Include release rate calculations for:
 - 1) The 100-yr storm event.
 - 2) The EURV, based upon a maximum drain time of 72 hours to completely drain the EURV from the pond.
- c. ** Detention Pond Outlet Structures
 - 1) Outlet structure design. Include all the dimensions and grate information necessary to construct. The design shall provide for the detention pond to completely drain within 72 hours.
 - 2) Use appropriate outlet discharge calculations - include offsite flows & consider head at entrance.
 - 3) Provide excess capacity for grates.
 - 4) 100-year restrictor plate & trash rack designs.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- 5) Compute outlet velocity and provide energy dissipater if velocity exceeds maximum permissible channel velocity.
- 6) Check excess storm water passage effects.
- 7) The trash rack/orifice plate design shall incorporate the use of a U.S. Filter Stainless Steel Well-Screen (or approved equivalent) using #93 vee wire with 0.139" openings between the wire.
- f. ** Size outlet structures for parking areas.
- g. ** Depths of ponding anticipated for parking areas, and the durations of storage for each storm event.

The following is required for all **Underground Detention** facilities utilizing a proprietary vault or conduit system:

- It must be demonstrated that the underground system structural capacity has been **designed to support AASHTO HS20 (fire truck)** loading, as well as the anticipated lifetime AASHTO 18,000 lb. equivalent single axle loads (ESALs).
 - a. Include calculations for the following:
 - 1) Storage volume provided for the 100-yr event. If a hydrodynamic separator is used upstream of the detention facility to provide water quality treatment, only the 100-yr detention volume is required (no WQCV required).
 - 2) If water quality is to be achieved within the underground conduit detention facility (which is discouraged due to maintenance concerns):
 - A. 50% WQCV + the full 100-yr detention volume must be provided. Also note that additional access points shall be provided to ensure proper maintenance of such a facility.
 - B. Outlet structure design. Include all the dimensions and information necessary to construct. The design shall provide for the detention pond to completely drain within 40 hours.
 - C. WQ orifice plate design.

The following is required for all **Underground Detention** facilities utilizing a Permeable Interlocking Concrete Paver (PICP) design:

- a. Include calculations/information for the following:
 - 1) Storage volume provided for the 100-yr event. Only the 100-yr detention volume is required (no WQCV required). The 3-inch angular rock used in the basin must be assumed to have 30% voids.
 - 2) The geotextile filter fabric to be employed underneath the system (to prevent a two-way migration of the basin material with the adjacent soil).
 - 3) Percolation test results:
 - A. Include a to-scale map showing the locations of the percolation test holes.
 - B. The percolation test results at each location.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- 4) The calculations used to derive average release rate from all percolation test results.
- 5) Discuss the release rate safety factor (the 20% decrease in percolation rate) for the infiltration basin.
- 6) Emergency overflow design (in the event of system failure or inundation).
- 7) Underdrain design (required for partial infiltration systems only):
 - A. Control orifice design to drain the WQCV in 12 hours or more (orifice diameter to be sized using MHFD Equation B-3 in Volume 3 of the Manual).
 - B. Underdrain spacing to be a maximum of 20 feet on center.
 - C. The use and proposed thickness of CDOT Class C filter material used for underdrain bedding (NOTE: A minimum of 6" thickness is required per MHFD criteria).
 - D. Cleanout locations or spacing.
- 8) The square footage where the PICPs are proposed
- 9) Include the type of PICP product to be used (i.e., AquaBric), the proposed pattern (i.e., herringbone), and describe the concrete perimeter barrier to be used. A product brochure may be used for this information.

The following is required for all proposed **Infiltration Basin** designs:

- a. Include calculations/information for the following:
 - 1) Storage volume provided for the 100-yr event (no WQCV needs to be included - the structural BMP to be utilized for water quality is the infiltration detention basin).
 - 2) The percolation test locations, test methodology, rate per hole, and average percolation rate derived for the infiltration basin (rate must be greater than 1"/hour).
 - 3) Provide the applicable geotechnical information in the area of the proposed Infiltration Basin, such as the Hydrologic Group, percentage of clay/fine material, elevation of the local water table at the time of the test and depth below pond bottom, if the test was done at a time of year when the water table is not at its highest what the anticipated level, and the level used in the design.
NOTE: The City requires that the elevation of the high water table be at least 3.0' below the proposed bottom of the Infiltration Basin. This information should be contained in the geotechnical engineering report and referenced in the Final Drainage Report.
 - 4) Underdrain design (required for partial infiltration systems only):
 - A. Control orifice design to drain the WQCV in 12 hours or more (orifice diameter to be sized using MHFD Equation B-3 in Volume 3 of the *Manual*).
 - B. Underdrain spacing to be a maximum of 20 feet on center.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- C. The use and proposed thickness of CDOT Class C filter material used for underdrain bedding (NOTE: A minimum of 6" thickness is required per MHFD criteria).
 - D. Cleanout locations or spacing.
 - 5) Specify the soil amendment for the pond bottom: All infiltration basins shall incorporate the MHFD Rain Garden growing medium design for pond bottom soil amendment. For a full-infiltration section the accepted medium is the MHFD recommended minimum 6" depth of *BioLite Rain Garden Growing Media* (Golf & Sport Solutions, 970.284.6121), or other MHFD approved equivalent.
 - 6) Emergency overflow location & design.
- 4) Streets
 - a. ** Compute depths and velocity of flow, for initial & major storm.
 - b. ** Inlet capacities and depths at inlet.
 - c. ** Meet street standards in Table 6-1 & 6-2* of the Streets chapter.
- 5) Open Channel Flow
 - a. Roughness-coefficient.
 - b. Trickle channel.
 - c. Depth and velocity for initial and major storms.
 - d. Channel protection
 - e. Minimum freeboard
 - f. ** Pipe profile(s), including hydraulic grade line(s).
- 6) ** Hydraulic Structures-pipes, culverts, inlets
(Provide MHFD spreadsheets as applicable for the following)
 - a. Culvert capacity using standard nomographs of the Inlets & Culverts Chapter.
 - b. Storm sewer capacity at each design section.
 - c. Inlet capacity.
 - d. Flow depth or headwater depth at inlet.
 - e. Drop Structures.
 - f. Weirs.
 - g. Streets, gutters, and cross-pans.
 - h. Minimum and maximum velocities.
 - i. Energy dissipaters.
 - j. Hydraulic grade lines.
 - k. Define any areas of supercritical flow. Any proposed supercritical flows through conduit shall require a complete hydraulic jump analysis with associated remedies.

B. DRAINAGE PLANS (include both Historic and developed Drainage Plans)

1) Site Location Map

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

** Not required for a Preliminary Report.

- a. Vicinity Map.
 - b. Major drainage basin.
 - c. Sub-basin boundaries, acreage, and runoff coefficients.
 - d. Floodway and floodplain areas.
 - e. Site location.
- 2) Site (Developed) Drainage Plan - Show the following:
- a. Existing and proposed 1' contours based on the Current City Datum. Existing and proposed contours are to extend a minimum of 50' beyond the property line.
 - b. Outlet structure & well-screen/trash rack details (if applicable).
 - c. The location and dimensions of the proposed detention or water quality facility.
 - d. To-scale cross-sections across all property lines not adjacent to a public roadway for all detention facilities that lie in close proximity or require grading in close proximity to a property boundary. The number, location, and lengths of the cross-sections, as well as the information contained therein, shall be sufficient to accurately convey the intent of the proposed drainage design. The cross-sections should include any measures utilized to protect adjoining properties from potential negative impact (e.g., bank stabilization, drainage structures, walls, etc.).
 - e. Location elevation of benchmarks used. All benchmarks shall be on the *Current City Datum*.
 - f. Existing and proposed property lines.
 - g. Existing and proposed drainage and detention easements.
 - h. Street names and grades.

¹ A recent subdivision has an approved Drainage Report/Plan on file.

* Reference the MHFD Criteria

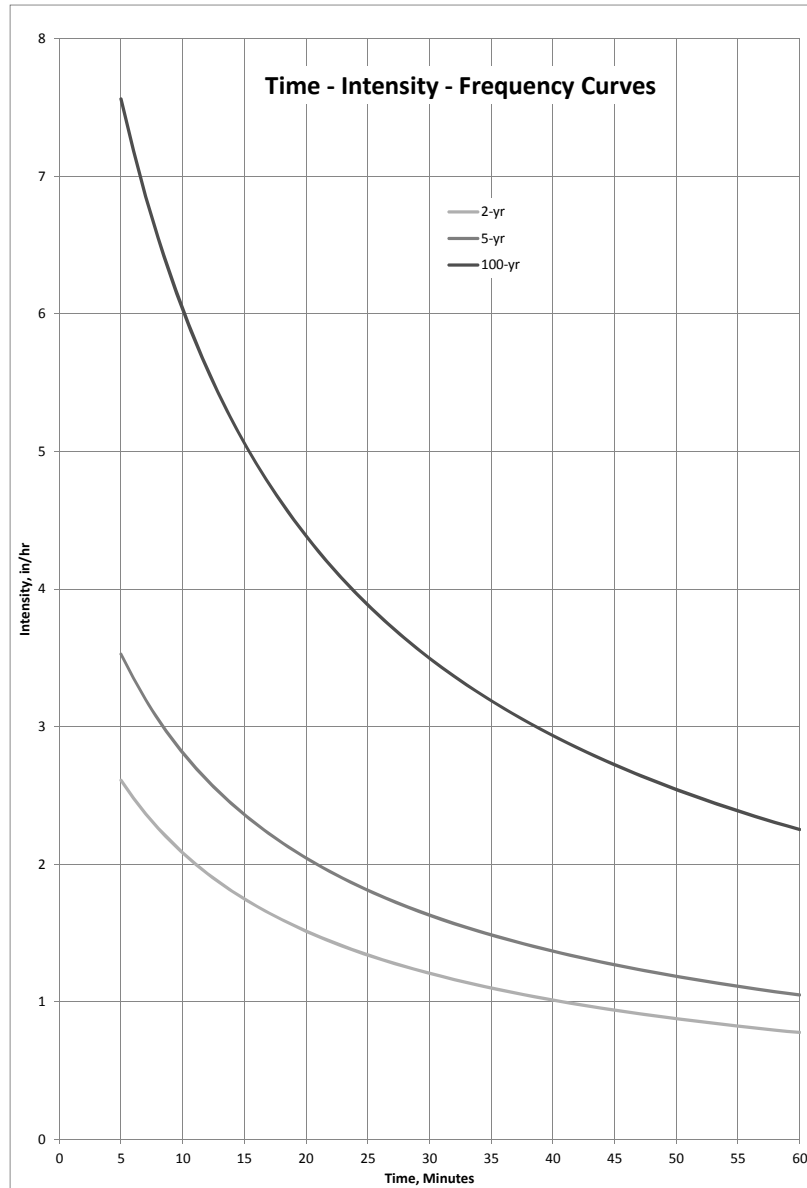
** Not required for a Preliminary Report.

11/14/2016

City of Wheat Ridge Time-Intensity-Frequency Curves

Design Storm	Rainfall, inches (Based upon NOAA Atlas 14)
2-yr	0.77
5-yr	1.04
100-yr	2.23

Time, minutes	Intensity, in/hr		
	2-yr	5-yr	100-yr
0			
1			
2			
3			
4			
5	2.6	3.5	7.6
6	2.5	3.4	7.2
7	2.4	3.2	6.9
8	2.3	3.1	6.6
9	2.2	2.9	6.3
10	2.1	2.8	6.0
11	2.0	2.7	5.8
12	1.9	2.6	5.6
13	1.9	2.5	5.4
14	1.8	2.4	5.2
15	1.7	2.4	5.1
16	1.7	2.3	4.9
17	1.6	2.2	4.8
18	1.6	2.2	4.6
19	1.6	2.1	4.5
20	1.5	2.0	4.4
21	1.5	2.0	4.3
22	1.4	1.9	4.2
23	1.4	1.9	4.1
24	1.4	1.9	4.0
25	1.3	1.8	3.9
26	1.3	1.8	3.8
27	1.3	1.7	3.7
28	1.3	1.7	3.6
29	1.2	1.7	3.6
30	1.2	1.6	3.5
31	1.2	1.6	3.4
32	1.2	1.6	3.4
33	1.1	1.5	3.3
34	1.1	1.5	3.2
35	1.1	1.5	3.2
36	1.1	1.5	3.1
37	1.1	1.4	3.1
38	1.0	1.4	3.0
39	1.0	1.4	3.0
40	1.0	1.4	2.9
41	1.0	1.3	2.9
42	1.0	1.3	2.8
43	1.0	1.3	2.8
44	1.0	1.3	2.8
45	0.9	1.3	2.7
46	0.9	1.3	2.7
47	0.9	1.2	2.6
48	0.9	1.2	2.6
49	0.9	1.2	2.6
50	0.9	1.2	2.5
51	0.9	1.2	2.5
52	0.9	1.2	2.5
53	0.8	1.1	2.4
54	0.8	1.1	2.4
55	0.8	1.1	2.4
56	0.8	1.1	2.4
57	0.8	1.1	2.3
58	0.8	1.1	2.3
59	0.8	1.1	2.3
60	0.8	1.1	2.3



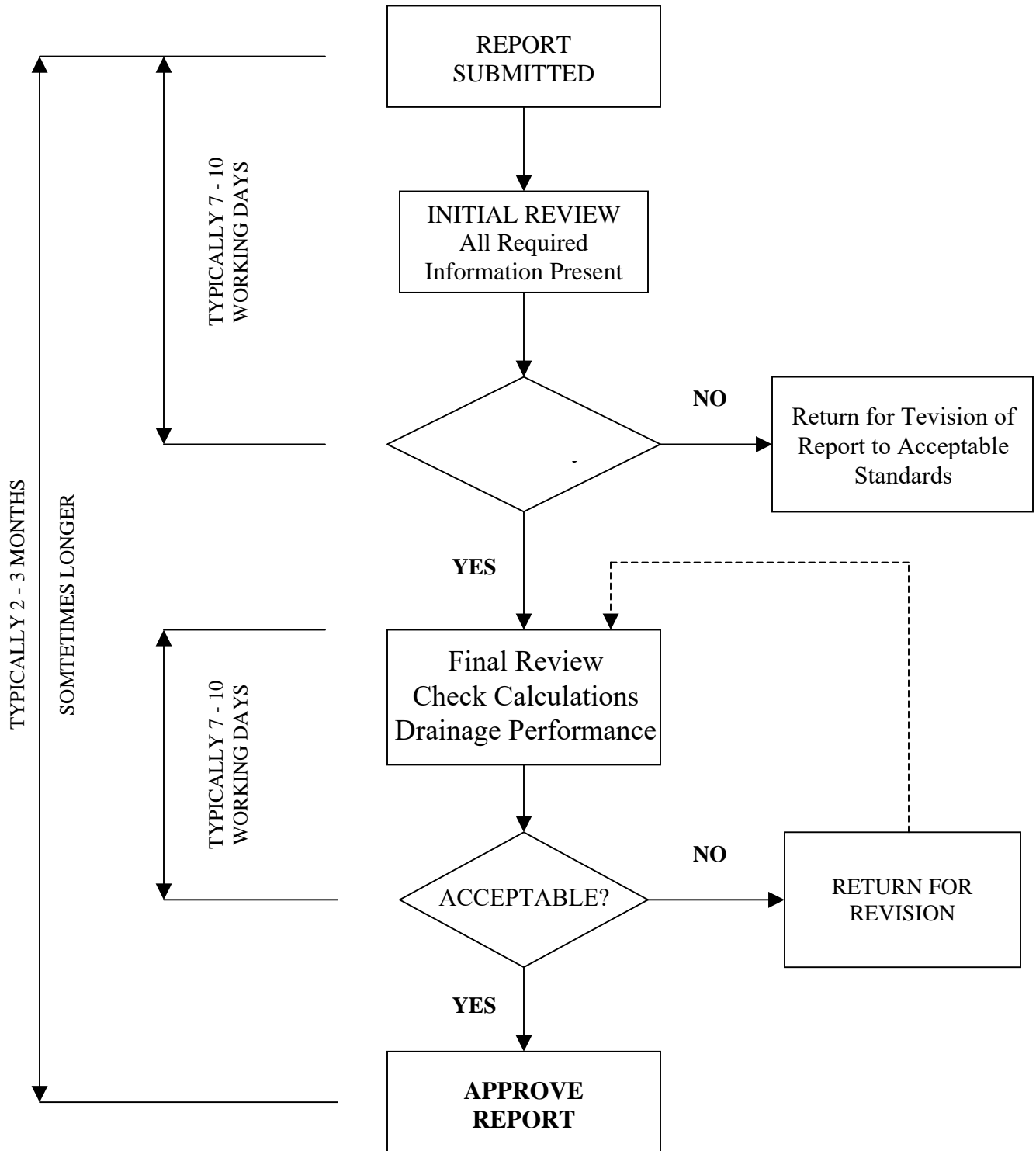


Figure 1 – Final Drainage Report Review Process