Fort Collins Amendments
to the Urban Drainage and Flood Control District Criteria Manual

Fort Collins Amendments to the Urban Drainage and Flood Control District Criteria Manual, adopted by the City Council of the City of Fort Collins, as referenced in Section 26-500 (c) of the Code of the City of Fort Collins, are as follows:

(A) ***Volume 1, Chapter 1*** **- Drainage Policy:**

(1) *Section 1.0* is amended to read as follows:

1.0 Policy

1.1 Drainage Policy

The requirements contained in the Urban Drainage and Flood Control District Criteria Manual (the "Urban Drainage Manual"), as adopted by the City Council of the City of Fort Collins and as modified by these Fort Collins Amendments (together referred to as the "Fort Collins Stormwater Criteria Manual," the "Stormwater Criteria Manual, or "Manual') are the basis for all stormwater management within the city of Fort Collins and are to be used as guidelines in the design and evaluation of all storm drainage facilities.

In general, these requirements address five areas of concern: (1) overall storm drainage planning and management; (2) the interface between urban development and irrigation facilities such as dams, reservoirs and canals; (3) the treatment of historic drainageways and natural channels; (4) the requirements and specifications for engineering design of storm drainage facilities; and (5) the quality and extent of urban stormwater runoff and erosion control.

1.2 Purpose and Scope

(a) The purpose of this Manual is to set forth the technical criteria to be utilized in the analysis and design of drainage systems within the city limits of Fort Collins, Colorado and its Growth Management Area.

(b) Any reference in the Urban Drainage Manual to a city, region or district is to the City of Fort Collins (the "City") or the Fort Collins area or region.

(c) This Manual applies to all land disturbing activities defined as development in the Land Use Code of the City of Fort Collins (the "City Land Use Code") or otherwise regulated by the City, including activities on public or private lands, including but not limited to activities on private land, public rights-of-way, easements dedicated for public use, private roads and to all privately, publicly, and quasi-publicly owned and maintained facilities.

(d) All planned public or private improvements, or any other proposed construction or development activities regulated by the City must include an adequate plan for storm drainage. This plan must be based on an analysis and design in compliance with all the applicable regulations and specifications set forth in this Manual.

(e) Prior to commencement of any construction or development activities subject to the requirements of this Stormwater Criteria Manual, formal approval must be obtained from the Executive Director of the Utilities or his designee.

(f) Should a conflict arise between the Code of the City of Fort Collins (the "City Code"), the City Land Use Code, or other City adopted standards and requirements, including but not limited to these Fort Collins Amendments, and the Urban Drainage Manual, the City Code, City Land Use Code or other City-adopted standards will govern.

(g) References to "standards" or "criteria" refer to those in effect on the date the "Drainage Plans" for a site development or public improvements are approved.

1.3 Regional Master Planning

(a) In recognition that drainage boundaries are non-jurisdictional, the City has developed regional basin-wide "Master Drainage Plans". These Master Drainage Plans establish at a watershed level what public improvements, if any, are needed in each basin and guide or dictate requirements for new developments proposed in each basin.

(b) Where a Master Drainage Plan for a given area of the City is available, proposed drainage systems design and construction must comply with all requirements set forth in that Plan. In areas where a Master Drainage Plan is not available, drainage systems must be planned and constructed in a manner that ensures continuity in flow quantity and quality with existing flow conditions.

(c) Master Drainage Plans must be developed and, or updated in cooperation with Larimer County, the appropriate affected irrigation companies and any other affected governmental agencies within a given basin or basins. Such plans or updates to plans will be adopted only after they have been reviewed by all affected entities, and after, soliciting public input.

(d) Master Drainage Plans are available from the City at the Fort Collins Utilities offices.

1.4 Local Master Planning

(a) Local flood control facilities, as planned by the City or developers, are an integral part of the total drainage system required to preserve and promote the general health, welfare, and economic wellbeing of the area.

(b) Any facility that generates benefits exclusively to a development (or a group of developments sharing a facility) and not designated by the City as a regional facility, is considered a local facility, and as such is to be maintained by its private owner(s).

(c) The City requires the planning and construction of all private local stormwater control and treatment facilities be performed in a manner that ensures that such facilities are compatible with all regional drainage master plans including the City's Master Drainage Plans.

1.5 Storm Runoff Determination

(a) The runoff analysis for a particular area must be based on the proposed land use for that area. Contributing runoff from upstream areas must be based on the existing land use and the topographic characteristics of those areas.

(b) All runoff calculations, requirements and assumptions must be based on the Master Drainage Plan for the area, if one is available.

(c) Natural topographic features are the basis of location for easements and future runoff calculations. In developed and undeveloped areas, average land slopes may be utilized in runoff computations. Wherever existing drainage patterns and slopes are defined, these

must be used. The drainage facilities so designed must be able to handle the design flows with virtually no erosion damage to the system.

(d) The City requires storm runoff to be determined by the use of either the "Rational Method", or the "Stormwater Management Model" (SWMM), within the limitations set forth in this Manual.

1.6 Reasonable Use

The City's management of drainage facilities is guided by the "Reasonable Use" principle. This principle is defined as one that:

(a) Limits the rate of flow from developing properties to those release rates as defined in the City's Master Drainage Plans.

(b) Limits the rate of flow from developing properties to their "2-year pre-development condition flow rate" during the 100-year storm event unless otherwise specified by the relevant Master Drainage Plan.

(c) Allows a larger release rate than is existing at the time of development or redevelopment if it can be demonstrated that downstream facilities at full watershed development, and analyzed in accordance with the applicable Master Drainage Plan(s), can accommodate a larger release rate to a master planned major drainageway.

(d) Causes no increase in downstream runoff rates after development from that under existing conditions unless otherwise specified in the applicable Master Drainage Plan.

(e) Properly and orderly transitions flows from developing properties to their pre-development paths on downstream properties unless the downstream property owners agree to alterations of those changes by granting drainage easements for the new drainage paths.

(f) Maintains flows, to the extent possible, in their natural and historic drainage paths.

In certain instances the transfer of drainage flows from one basin to another is a permissible alternative if it is done in accordance with the approved Master Drainage Plan for that basin and if it causes no undue burden or harm to any downstream property. Basin transfers of drainage flows are subject to City review and may be approved, on a case-by-case basis, subject to a showing of no undue burden or harm satisfactory to the Utilities Executive Director, and a determination by the Utilities Executive Director that the modification of this requirement is appropriate.

1.7 Water Rights

The City recognizes the potential effect of drainage facilities on existing water rights. The City requires that the interrelation between the proposed facilities and water rights be accounted for in planning, reviewing and designing drainage and subdrain systems or facilities.

1.8 Drainage Planning and Required Space

(a) The stormwater drainage system is an integral part of the urbanization process; and requires storm drainage planning for all developments to include the allocation of space for drainage facilities' construction and maintenance which may entail the dedication of right-of-way and, or easements.

(b) Drainage facilities, such as channels, storm sewers, and detention facilities serve conveyance, treatment as well as storage functions for water quantity and quality. When space requirements are considered, the provision for adequate drainage becomes a competing use for space. Therefore, adequate provision must be made in the land use

plan for drainage space requirements. This may entail the dedication of adequate right-of-way or easements, in order to minimize potential conflict with other land uses.

1.9 Use of Streets

The use of streets to convey storm runoff interferes with their primary function as transportation corridors. However, streets are an important component of the storm drainage system due to their large storm runoff carrying capacity obtained for little or no drainage-related costs. In order to balance these two competing street uses, limits on the street carrying capacity are required based on the classification of the street related to emergency usage during flood events.

The City allows the use of streets for drainage within the limitations discussed in the "Streets" section as described in Volume 1, Chapter 6 of this Manual, "Streets, Inlets, Storm Sewers". :

1.10 Nuisance Water

The City's stormwater policies and requirements are primarily intended to address water quantity and quality concerns as they relate to the health, safety and welfare of the general public as well as the protection of the environment. This involves the control of runoff during large rainfall or snow melt events on major public drainage systems that could have flooding potential and the control and improvement of the water quality of runoff that enters the City's receiving waters.

Control of "nuisance" waters such as shallow ponding that occasionally concentrate on flat lawns, landscaped, paved or other such areas is strictly the responsibility of the property owner of the land where ponding occurs. Shallow ponding sometimes occurs in street cross pans or flat sections of curb and gutter. These usually are not a major threat to the health safety and welfare of the public.

The City will make reasonable efforts to minimize the occurrence of such nuisances through its review and inspection authorities, but if such nuisances do occur, the City is not responsible or obligated to correct or require any other party to correct such a problem.

1.11 Retention Ponds and Pumping

1.11.1 Positive Outfall

The City requires that all drainage facilities be designed in a manner that provides a gravity-driven positive outfall into a natural drainageway such as a river or creek, or a component of or a tributary to the public storm drainage infrastructure system. Positive outfall in this context refers to the provision that all sites must be designed to drain with a gravity system to the public infrastructure system or natural drainageway(s).

1.11.2 Retention Ponds

Retention ponds are sometimes necessary to hold water until a permanent outfall is built. The City may approve retention ponds as an interim solution until a permanent outfall is built. If accepted, these ponds must be designed to hold twice the 100-year volume generated by a two-hour storm and be evacuated within seventy-two (72) hours. Permanent retention ponds are not allowed to serve as permanent water quantity or quality control measures for any development within the city of Fort Collins.

1.11.3 Pumps in Detention Ponds

Pumps in detention ponds may be allowed only when approved in writing in advance by the Utilities Executive Director or his designee. A pump shall only be approved when a satisfactory showing is made that the pump is needed as a back-up system to an infiltration pond or as a designed temporary retention pond. Temporary in this context means that a permanent gravity controlled outlet system is planned to be built within the next 5 years. These must be designed and built with a sump pit as well as a back-up pump. The pump must be of sufficient capacity to drain the retention pond in seventy-two (72) hours or less**.**

1.11.4 Sump Pumps

(a) Discharge from foundation drains or sump pumps must comply with all applicable State requirements and those set forth in Section 26-214 of the City Code, which prohibits discharge across the sidewalk or into or upon any street, alley or gutter and of Section 26-498, which prohibits connections to a storm drainage facility to convey flows other than storm drainage flows and uncontaminated groundwater flows.

(b) Discharge from sump pumps must be tied to the City's stormwater system upon approval from the Utilities Executive Director. All tie-in points must be installed at approved locations such as at a manhole or at an inlet. No direct tie-in to a storm drain pipe will be allowed. Sump pump discharge flows can only be released into a stormwater conveyance system (such as pipes, channels or ponds) specifically designed and approved by the City to accept such discharge. Please refer to Section 26-214 of the City Code for further guidance.

1.12 Conveyance or Detention on Private Single Family Lots

In designing drainage systems, the City requires that no undue burden be placed on the owners of single family lots by the placement of large storm drainage conveyance or detention facilities on their property. In order to prevent or minimize such occurrences all storm drainage channels, pipes or detention facilities serving more than three (3) properties must be located within tracts dedicated as drainage easements to the City.

1.13 Lot Grading

(a) The City requires that there be a positive grade away from all structures. More specifically, the City requires that there be a minimum grade of five percent (5%) away from a structure within the first five to ten feet adjacent to single family residences.

(b) Minimum grades required for different types of sheet flow drainage surfaces are as follows:

Grass swales	Two (2) percent

A one percent (1%) longitudinal slope grass swale may be allowed on single family lots when the swale is draining the runoff from only two adjoining properties.

Asphalt	One (1) percent
Concrete	One half (0.5) percent

(c) The top of foundation elevation for a structure must be set a minimum of six (6) inches above the highest grade surrounding the structure.

1.14 Use of Criteria, Amendments, Technical Revisions and Administrative Modifications of Standards

(a) All public or private storm drainage facilities regulated by the City must be planned and designed in accordance with the standards and criteria set forth in this Stormwater Criteria Manual.

(b) The Stormwater Criteria Manual may be periodically revised and amended, either by approval of the City Council of the City or by Technical Revision approved by the Utilities Executive Director in accordance with Section 26-500 of the City Code, as new technology is developed and, as experience in gained in the use of the criteria.

(c) The purpose of this Manual is to promote the health, safety, welfare, and property of the City and citizens through the proper control and treatment of stormwater, (whether above or below surface); and, to ensure uniformity in performance with respect to design and construction of all drainage facilities. Consequently, when the Utilities Executive Director determines that an applicant has made a sufficient showing that an alternate design, analysis or procedure would meet the purposes of a specific requirement of this Manual in a manner and to an extent equal to or better than would compliance with the specific requirement the Utilities Executive Director may authorize a modification of the standard to allow for the use of the alternative design, analysis or procedure, as applicable.

(2) *Section 2.11* is amended to read as follows:

2.11 Historic Drainage and Easements

(a) Whether or not natural drainageways are dedicated, or otherwise formally recognized, these are considered the most appropriate location of stormwater conveyance systems. Historic and natural drainage paths and channels are recognized as easements for storm drainage conveyance.

(b) Even when historic drainage is accomplished by means of sheet flow, it is reasonable to assume that after site development, flows will be channelized and concentrated at a point, and an easement for the concentrated flows still exists to the extent of its historic use for the conveyance of stormwater.

(3) *Section 2.12* is amended to read as follows:

2.12 Off-Site Flows

(a) The only way to maintain truly historic drainage flows is to prohibit all future development. "Reasonable" development is allowed so long as any increase or change in runoff does not injure downstream properties. The Master Drainage Plans, as adopted by City Council, establish the most "reasonable" drainage system for the entire basin. All proposed developments are required to be planned and constructed in conformance with the approved Master Drainage Plan(s).

(b) Downstream properties have an obligation to accept off-site flows from upstream properties. This obligation includes future developed flows provided they are the result of "reasonable" development upstream in compliance with the applicable Master Drainage Plan for the upstream property and do not result in any injury or have an adverse impact on the downstream property.

(c) Drainage easements are needed on the downstream property when the upstream flows entering that property are altered in quality, quantity, or character.

(d) If stormwater is being imported from one basin to another, or if a completely artificial drainage path is being created altering the historical flow patterns (in quality, quantity or character) of an existing channel, a natural easement argument cannot be used to justify directing any additional drainage into an existing drainage channel.

(e) New improvements that affect or have an impact upon existing drainage easements must preserve and maintain those easements.

(4) A new *Section 2.13* is added, to read as follows:

2.13 Watershed Approach to Stormwater Management

(a) The City has initiated a "Watershed Approach" to stormwater management. This program includes three major watershed components and associated objectives:

(i) Land – The objectives of this component is pollution prevention, including public education, regulation, and enforcement. This is accomplished through implementation of the City's Municipal Separate Storm Sewer System (MS4) permit, as described in Section 4.1.7, "Water Quantity and Quality Integration" in this chapter.

(ii) Tributaries – The objectives of this component are stormwater treatment and pollutant load reduction and include the development of design criteria for "Best Management Practices" (BMPs).

(iii) Receiving Waters – The objectives of this component are aimed at stream and habitat protection and restoration and include the creation of buffer zones on creeks and natural drainageways.

(b) The water quality protection regulations as specified in this Manual are primarily directed at the Tributaries component of this approach. This includes BMPs for erosion control during construction and post-construction controls for new development and re-development. These BMPs are intended to be located on-site and therefore address runoff from development or re-development sites or from any public improvements.

(c) Any public or private improvement that has an impact on receiving waters must be constructed in accordance with the criteria specified in this Manual, the City's Master Drainage Plans, the City Land Use Code, and any other applicable State or Federal regulations such as the United States Army Corps of Engineers (USACE) 404 permit requirements.

(d) Runoff generated from any public or private improvement and directed into historic and natural drainageways must be done in a manner that would promote the multi-functional use of these drainageways, protect and restore their natural functions and enhance their aesthetic value.

(e) Natural drainageways, creeks or streams are considered important community assets that contribute to the aesthetic value and the livability of the urban environment. Their function extends beyond that of conveying floodwater, to their use as trails and open space corridors, for water quality protection and enhancement, and to preserve natural vegetation and wildlife habitat to the greatest extent possible.

(f) Public or private improvements located in or near receiving waters, must not adversely affect the natural character of the stream or water course. To that effect, the following provisions must be met:

(i) Pollutant reduction and treatment facilities must be located upstream of streams and natural drainageways.

(ii) Natural drainageways must remain in as near a natural state as practicable.

(iii) Any proposed modification, including any erosion mitigating measures, must be designed and constructed in a manner that protects and enhances the natural character of receiving waters. Such modification must be addressed in the Drainage Report and clearly shown on the associated Drainage Plans

(5) A new *Section 2.14* is added, to read as follows:

2.14 Erosion and Sediment Control

The clearing and stripping of land for development can cause high, localized soil erosion with subsequent deposition and damage to off-site properties and to receiving waters.

The City requires an "Erosion Control Plan", be prepared and implemented for all public improvement projects, private development projects and all redevelopment projects in accordance with the criteria set forth in Volume 3, Chapter 7, "Construction BMPs", of this Manual. The terms "development" and "redevelopment" are as defined in the City Land Use Code.

The purpose of implementing this policy is to minimize the impact of construction to an acceptable level without placing undue burdens on any public or private infrastructure, downstream drainageway(s), or the community in general.

(6) *Section 3.1* is deleted in its entirety.

(7) *Section 3.2* is deleted in its entirety.

(8) *Section 3.3* is deleted in its entirety.

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(9) *Section 4.1.2* is deleted in its entirety

(10) A new *Section 4.1.7* is added, to read as follows:

4.1.7 Water Quantity and Quality Integration

(a) The public's concerns with stormwater are not limited to flooding and public safety. Stormwater runoff can have a significant and lasting impact on the City's receiving waters. This impact is reflected not only in the quality of streams and aquatic ecosystems, but more generally in the quality of life in the community.

(b) Pursuant to federal law and regulations of the U.S. Environmental Protection Agency ("EPA") operators of small Municipal Separate Storm Sewer Systems (MS4s) in urbanized areas are required to obtain permit coverage for their stormwater discharges. In Colorado, the Water Quality Control Division of the Colorado Department of Public Health and Environment has primary enforcement authority over MS4 permits via the Colorado Discharge Permit System. Pursuant to these requirements, as an operator of an MS4 the City is required to implement stormwater management programs, which must include the following program elements:

1. Public Education and Outreach – The city must implement a public education program in an effort to promote behavior change by the public to reduce water

quality impacts associated with pollutants in stormwater runoff and illicit discharges.

2. Public Participation and Involvement – The city must provide a mechanism and process to allow the public to review and provide input on the MS4 Stormwater Management Program.

3. Illicit Discharge Detection and Elimination – The city must implement and enforce a program to detect and eliminate illicit discharges (non-stormwater discharges to the MS4), including procedures for tracing and removing the source and training for municipal staff.

4. Construction Site Runoff Control – The city must develop and implement a program to assure adequate design, implementation, and maintenance of BMPs at construction sites within the MS4 to reduce pollutant discharges and protect water quality.

5. Post-Construction Stormwater Management in new Development and Redevelopment – The city must implement and enforce a program to address stormwater runoff from new development and redevelopment projects that discharge into the MS4. The program must ensure that controls are properly designed, installed, and maintained to prevent or minimize water quality impacts.

6. Pollution Prevention/Good Housekeeping for Municipal Operations – The city must implement an operation and maintenance program to prevent or reduce pollutants in stormwater runoff from municipal operations, including written standard operating procedures for stormwater pollution prevention and training of municipal staff.

(c) Requirements numbered 4 and 5 above are addressed primarily through this Manual, reviewed through the City's development review process, and implemented through the City's Municipal Separate Storm Sewer System ("MS4") construction and post-construction inspection and enforcement program.

(11) *Section 4.3.4* is amended to read as follows:

4.3.4 Maintenance and Maintenance Access

(a) All drainage facilities must be designed to minimize the need for facility maintenance and must provide for ease of maintenance access to all storm drainage facilities in order to ensure the continuous operational function of the system.

(b) Maintenance access for all stormwater control and treatment facilities must be adequate and must be clearly delineated on the Final Plat and on the Final Development Plans for any development. Maintenance responsibility must be clearly described on the Final Plats and on the Final Development Plans.

(c) Stormwater control and treatment facilities must be continually maintained to ensure their long term operational effectiveness. Maintenance of storm drainage facilities includes, but is not limited to the regular performance of the following activities:

(i) Sediment and debris must be periodically removed from channels, storm sewers and stormwater treatment facilities.

(ii) Trash racks and street inlets must be cleared of debris.

(iii) Pipe inlets and outlets must be regularly flushed.

(iv) Channel bank erosion or damage to drop structures must be repaired to avoid reduced conveyance and treatment capability, unsightliness, and ultimate failure.

(d) The owner of the drainage facility is responsible for the maintenance of all components of the drainage system located on their property; including inlets, pipes, culverts, channels, ditches, hydraulic structures, detention basins or other such appurtenances unless modified by the development agreement or as described in City Code Section 26-547.

(e) Should the owner or responsible party fail to adequately maintain said facilities, the City has the right to enter said property for the purpose of maintenance as described in City Code Section 26-22. All such maintenance costs will be assessed to the property owner in accordance with City Code Section 26-28.

. (f) Required minimum widths of drainage easements for common types of drainage facilities are listed in Table-DP-4.

Table – DP-4

Required Maintenance Easements

DRAINAGE FACILITY	MINIMUM EASEMENT WIDTH
Storm Sewer	
(a) Storm Sewer Diameter < 36 inches	
Depth to Invert less than5 feet	20 feet
5 feet < Depth to Invert≤ 10 feet	30 feet
Depth to Invert greater than 10 feet	Minimum of 30 feet or Pipe I.D. + 6 + Depth * 2 (in feet)
(b) Storm Sewer Diameter ≥ 36 inches	
Depth to Invert less than 5 feet	Minimum of 20 feet or Pipe I.D. + 7 + Depth * 2 (in feet)
5 feet < Depth to Invert ≤ 10 feet	Minimum of 30 feet or Pipe I.D. + 7 + Depth * 2 (in feet)
Depth to Invert greater than 10 feet	Pipe I.D. + 7 + Depth*2 (in feet)
Open Channel/Swales	
100-Year Discharge less than 20 cfs	Minimum of 15 feet or Top Width of Channel With Freeboard + 10 feet
20 cfs ≤ 100 year Discharge < 100 cfs	Minimum of 25 feet or Top Width of Channel With Freeboard + 10 feet
100-Year discharge greater than 100 cfs	Minimum of 30 feet or Top Width of Channel With Freeboard + 10 feet
Detention Ponds	As required to contain storage, freeboard, and associated facilities plus adequate maintenance access around perimeter

(g) Smaller drainage easements widths are allowed along residential lot lines (five feet to ten feet on each side), when these are for swales or channels that carry a limited amount of drainage, and drain at the most three residential lots.

(12) A new *Section 4.3.5* is added, to read as follows:

4.3.5 Open Channels

(a) Developments in or near major runoff channels in and near developing areas must be designed to maintain channel stability. Developments in and near major runoff channels must adopt measures to ensure that excessive erosion does not occur under peak flood flow conditions.

(b) Realignment of natural channels in urban areas is not encouraged and may only be permitted if the City approves a design that maintains stream stability and aesthetics, enhances or improves the ecological character of the natural channel and prevents failure and erosion under peak flow conditions.

(c) The City prohibits the use of backyard swales on residential lots where these can be physically avoided. Where these cannot be avoided due to physical or grade constraints, they must be designed in a manner that will minimize the basin area contributing to the backyard swale. Backyard swales must not receive runoff from more than three (3) residences.

(d) Residential lots that include backyard swale(s) are subject to "Certification" as defined in Section 7.1.12.3 of this chapter, "Certifications for Single Family Developments" as well as fencing restrictions that would prohibit the impedance of drainage flows from one residential lot to an adjacent one. Fencing restrictions must be recorded on the development's plat, and the appropriate deed restrictions on that plat must be filed with Larimer County.

(e) The design of all open channels must comply with all the appropriate provisions set forth in Section 4.0, "Open Channel Criteria", Volume 1, Chapter 7 "Major Drainage", of this Manual.

(13) *Section 4.5.4* is amended to read as follows:

4.5.4 Water Quantity Control

(a) Detention storage of stormwater runoff as directed by individual Master Drainage Plans and a hydrologic routing analysis is required. In basins where a Master Drainage Plan has not been approved, the City may require detention storage in accordance with the criteria set forth in this Manual as well as when such storage is deemed necessary to protect irrigation rights or structures or to protect downstream properties. More specific information about detention storage criteria are described in Volume 2, Chapter 10, "Storage" chapter of this Manual.

(b) Urban development is not permitted immediately downstream of existing or proposed emergency spillways or in areas that may act as spillways for canals, dams, or embankments impounding stormwater.

(c) On-site detention is required for all new development, expansion, and redevelopment. The required minimum detention volume and maximum release rate(s) for the developed condition 100-year recurrence interval storm must be determined in accordance with the

conditions and regulations established in the appropriate Master Drainage Plan(s) for that development and in accordance with the criteria set forth in this Manual.

(d) On-site detention requirements may be deemed met where the Utilities Executive Director determines that an applicant has made a sufficient showing that existing regional conveyance or detention facilities are sized with the capacity to accommodate flows from a fully developed basin and are publicly owned and maintained, provided that any requirements for cost sharing or reimbursement to the City have been met.

(14) *Section 4.5.5* is amended to read as follows:

4.5.5 Water Quality Treatment

(a) Water quality treatment of stormwater runoff is required, at a minimum, for land disturbing activities greater than or equal to one half an acre, including projects less than one half an acre that are part of a larger common plan of development or sale.

(b) On-site water quality detention requirements may be deemed met where the Utilities Executive Director determines that an applicant has made a sufficient showing that existing regional water quality detention facilities are sized with the capacity to accommodate flows from a fully developed basin and are publicly owned and maintained, provided that any requirements for cost sharing or reimbursement to the City have been met.

(c) Water quality control and treatment can be achieved through the use of an array of methods and devices as described in Chapter 4, Volume 3, "Treatment BMPs" of this Manual.

(d) Water quality treatment structures must be built in compliance with all applicable City, State and Federal regulations.

(15) *Section 5.1.1* is amended to read as follows:

5.1.1 Design Criteria

If a proposed development site is located within an area encompassed within a Master Drainage Plan, the criteria specified in the appropriate Master Drainage Plan will hold precedence over the criteria set forth in this Manual in the event these differ or conflict.

(16) *Section 5.1.3* is amended to read as follows:

5.1.3 Use of Criteria

The City will make reasonable efforts to design and build storm drainage improvements and to evaluate the design and construction of non-City drainage improvements, based on the criteria, standards and specifications set forth in this Manual.

(17) *Section 5.2.1* is amended to read as follows:

5.2.1 Design Storm Return Periods

(a) The 2-year drainage system, as a minimum, must be designed to transport the runoff from the 2-year recurrence interval storm event with minimal disruption to the urban environment. The 2-year storm runoff can be conveyed in the curb and gutter area of the street or roadside ditch (subject to street classification and capacity), by a storm sewer, a channel, or other conveyance facility.

(b) The 100-year drainage system, as a minimum, must be designed to convey runoff from the 100-year recurrence interval flood to minimize life hazards and health, damage to structures, and interruption to traffic and services. Runoff from the 100-year storm can be conveyed in the urban street system, channels, storm sewers and other facilities, provided the conveyance is done within acceptable criteria as specified in this Manual.

(c) Storms with recurrence intervals greater than 100-year, must still be considered in the drainage analysis, if only on a qualitative basis.

(d) All new public and private improvements must plan, design, and construct drainage systems that account for the 2-year storm event as well as the 100-year storm.

(e) The 100-year storm event is the standard level of protection in the city of Fort Collins unless otherwise specified by the applicable Master Drainage Plan.

(18) *Section 5.4.1* is deleted in its entirety.

(19) *Section 5.5.1* is amended to read as follows:

5.5.1 Use of Ditches

(a) Stormwater facilities and improvements must be designed to avoid discharge of runoff from urban areas into irrigation facilities except as required by water rights or where such discharge is in conformance with the approved Master Drainage Plan. Where these conditions are present, the responsible party must submit to the Utilities Executive Director and the affected ditch company or other affected parties documentation of the relevant water rights-related constraint or Master Drainage Plan condition. The Utilities Executive Director may approve a modification of this requirement upon a determination that sufficient showing has been made that a discharge into irrigation facilities is acceptable to the affected ditch company and is not expected to result in harm or interfere with the operation of affected stormwater management plans or systems, and that the requirements for a modification have been met. Notwithstanding the foregoing, whenever irrigation ditches cross major drainage channels in developing areas, the responsible party must separate stormwater runoff flows from normal ditch flows.

(b) Whenever development occurs where an irrigation ditch or facility is present, the responsible party must provide adequate right-of-way for ditch maintenance as required by the owners of the ditch or irrigation company.

(c) The City requires the appropriate ditch company's approval wherever public or private improvements cause any of the following:

(i.) Alteration of the existing patterns of drainage into irrigation ditches;

(ii.) Increased flow rates or volumes discharged into the ditch;

(iii.) Changes in the quality of runoff entering the ditch;

(iv.) Change in the historic point of discharge into the ditch;

(v.) Any proposed ditch crossing(s) or relocation(s);

(vi.) Any proposed grading within the ditch right-of-way;

(vii.) Access to the ditch right-of-way during construction activities.

This approval may be in the form of signature on the construction plans or documents. If determined by the Utilities Executive Director to be sufficient, other formal legal agreements may be substituted for an approval signature on the construction plans. The

list above is not exhaustive and represents examples of circumstances when ditch company approval is required. Early contact with affected irrigation companies may be beneficial.

(d) In the rare instance where an irrigation ditch is allowed to serve as the outfall for a stormwater facility the following provisions must be met:

(i) The ditch flow water surface elevation must be determined based on the maximum amount of flow in the ditch.

(ii) The water surface elevation of the ditch must be obtained by combining the maximum irrigation flow in the ditch with the 100-year stormwater flows in the ditch.

(iii) The detention outlet must be designed such that backflow from the ditch into the detention facility is prevented.

(iv) The backwater effects caused by the design of a detention outlet, if any, must be reviewed and approved by both the City and the appropriate ditch company.

(v) The outlet design must consider tailwater effects on the outlet pipe resulting from the combination of the maximum irrigation flow and the 100-year storm discharge within the ditch. The appropriate ditch or irrigation company, is the determining authority in regards to the maximum irrigation flow in the ditch. Written verification of the maximum irrigation flow from the ditch or irrigation company must be submitted with the hydraulic analysis of the ditch water surface elevation.

(vi) The 100-year water surface elevation of the ditch must be determined using the appropriate Master Drainage Plan or if not available, additional studies may be required from the party seeking to discharge into the ditch. For cases where 100-year discharges are not available, upstream restrictions can be considered for determining ditch flows.

(e) If new developments are adjacent to irrigation facilities but no flows are being directed into the ditch or canal, the ditch company must be notified of the proposed development. In such cases, ditch company approval shall be required prior to any approval by the City, unless the Utilities Executive Director determines that the development will result in no impact on or to the ditch company, that there will be no impact on stormwater flows or improvements from the adjacent irrigation facilities, and that the conditions for a modification of this requirement have been met.

(f) The party seeking modifications to existing ditch conditions must to obtain the appropriate ditch company approvals and signatures prior to seeking City approval for such modifications.

(g) When privately owned and maintained irrigation facilities abut private property, it is the responsibility of the private parties involved to develop and implement a policy regarding safety.

(h) In summary, City requirements regarding the use of ditches are as follows:

(i) Drainage analysis must ensure that an irrigation ditch does not intercept the storm runoff from the upstream basin and that the upstream basin is tributary to the basin area downstream of the ditch.

(ii.) Plans for the development must direct the storm runoff into historic and natural drainageways and avoid discharging into an irrigation ditch except as required by water rights.

(iii.) Whenever new development will alter patterns of the storm drainage into irrigation ditches by increasing or decreasing flow rates, volumes, or changing points of concentration, the written consent from the ditch company must be submitted with the development applications. The discharge of runoff into the irrigation ditch will be approved only if such discharge is consistent with an adopted Master Drainage Plan and is in the best interest of the City.

(iv.) Whenever irrigation ditches cross major drainageways within the developing area, the developer is required to design and construct the appropriate structures needed to separate storm runoff from ditch flows subject to the condition noted in item (ii.) above.

(v.) Whenever drainage that is less than the historic amount in quantity and rate drains into an irrigation canal or ditch, such flow is allowed to freely discharge into the irrigation canal or ditch.

(20) *Section 6.0* is amended to read as follows:

6.0 Review Process

(a) As it relates to drainage, all development proposals must be processed and approved through the City's development review process in accordance with the City Land Use Code.

(b) Building Permit Applications, Overall Development Plans (ODPs), Project Development Plans (PDPs), and Final Plans (FPs), and all other development applications submitted to the City under the City Land Use Code, must include storm drainage, floodplain, floodway and erosion control information (in addition to any other information required by applicable City Land Use Code or other related provisions) if the development increases the impervious area in excess of 350 square feet.

(c) An analysis and review of floodplain modifications may be necessary if the development proposes to modify the floodplain or floodway.

(d) In addition to the submittals mentioned above, a site certification must be submitted to the City, as well as individual lot certifications as appropriate.

(21) *Section 6.1* is amended to read as follows:

6.1 Conceptual Review

The Conceptual Review is an opportunity to discuss requirements, standards, and procedures that apply to a development proposal. During the Conceptual Review, major problems as they relate to drainage must be identified so that they can be resolved prior to a formal application being submitted to the City. At that meeting, the applicant must furnish at minimum a sketch showing the location of existing and proposed streets, drainage courses, drainage facilities and any other significant natural features near the proposed development.

(22) *Section 6.2* is amended to read as follows:

6.2 Overall Development Plan (ODP) Submittal Requirements

An ODP is required for any property that is proposed to be developed over time in at least two separate project development plan submittals. The purpose of the ODP is to establish general planning and development control parameters for these multi-phase projects. The required drainage information presented in an ODP submittal does not normally entail a detailed drainage analysis of the project but does require a general presentation of the project's features and effects on drainage. The drainage report for the ODP must review at a conceptual level the feasibility and design characteristics of the proposed development. The drainage report must be written in accordance with the outline contained in Section 6.4 of this chapter listed below and must contain all the applicable information as described in that section.

(23) *Section 6.3* is amended to read as follows:

6.3 Drainage Plan Submittal and Review

All single family residences not in a previously approved subdivision, subdivisions without a drainage plan, new multi-family developments, and commercial developments with an increase in impervious area of 350 square feet or greater must submit Drainage Reports and Plans to be approved by the City.

When an Overall Development Plan (ODP) is required an Overall Drainage Plan may also be required. The detailed information contained in such Drainage Plan must be consistent with the ODP. At a minimum, off-site runoff, conveyance locations, detention ponds, outfall systems, and other drainage facilities must be shown on the Overall Drainage Plan. Applicants are encouraged to prepare a plan with as much detail as possible. Please contact the City Stormwater Department early in the process to determine the detail level needed for that plan.

All 100-year storm floodplain boundaries must be shown on all preliminary and final Drainage Plans and labeled in the NAVD 1988 and NGVD 1929 (unadjusted) vertical datum for FEMA basins. City basin base flood elevations must be reported in NGVD 1929 only.

Review and acceptance by the City of Drainage Plans, studies, and construction drawings are required in order to obtain a final drainage system that is consistent and integrated in analysis, design, and level of protection to the City's Master Drainage Plans.

Due to the dynamic nature of urbanization, the needs of the public will change with time, requiring adjustment of design and construction requirements. Therefore, a time limitation on the approved construction plans shall be as follows: construction of any drainage facility not initiated within a three-year period from time of final plan approval will be re-evaluated and be subject to a renewed approval by the City.

(24) *Section 6.4* is amended to read as follows:

6.4 ODP Drainage Report Contents

Drainage report contents must contain at the minimum the following elements:

I. GENERAL LOCATION AND DESCRIPTION

A. Location

1. City, County, State Highway and local streets within and adjacent to the site, or the area to be served by the drainage improvements.

2. Township, range, section, ¼ section
3. Major drainageways and facilities
4. Names of surrounding developments

B. Description of Property
1. Area in acres
2. Ground cover (type of ground cover and vegetation)
3. Major drainageways
4. Existing major irrigation facilities such as ditches and canals
5. Proposed land use

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description
1. Reference to major drainageway planning studies such as flood hazard delineation report, major drainageway planning reports, and flood insurance rate maps
2. Major basin drainage characteristics, existing and planned land uses within the basin, as defined by the Planning Department
3. Identification of all nearby irrigation facilities within 150-feet of the property boundary, which will influence or be influenced by the local drainage

B. Sub-Basin Description
1. Discussion of historic drainage patterns of the property in question
2. Discussion of offsite drainage flow patterns and impact on development under existing and fully developed basin conditions pursuant to zoning and land use plans adopted by the City.
3. Soils information of the site shall be presented. The discussion on soils shall include rainfall and wind erodibility problems, limiting characteristics, groundwater depths, and suitability of the soils for development. Information shall be presented concerning conceptual plans for controlling wind and rainfall erosion and the effectiveness of establishing vegetation.

III. DRAINAGE FACILITY DESIGN

A. General Concept
1. Discussion of concept and typical drainage patterns
2. Discussion of compliance with offsite runoff considerations
3. Discussion of anticipated and proposed drainage patterns
4. Discussion of the content of tables, charts, figures, plates, or drawings presented in the report
5. Discussion of the need to provide offsite public improvements for conveyance of minor or major flows to the major drainageway.

B. Specific Details (Optional Information)

1. Discussions of drainage problems encountered and solutions at specific design points
2. Discussion of detention storage and outlet design
3. Discussion of maintenance and access aspects of the design
4. Discussion of impacts of concentrating the flow on the downstream properties

IV. REFERENCES

Reference all criteria, master plans, and technical information used in support of the concept.

V. APPENDICES

A. On-site and off-site flow calculations

B. Preliminary sizing of detention ponds, storm sewers, and channels.

(25) *Section 6.5* is amended to read as follows:

6.5 ODP Drawing Contents

(a) General Location Map: All drawings must be 22" x 34" in size. A map in sufficient detail to identify drainage flows entering and leaving the development and general drainage patterns must be provided. The map should show the path of all drainage from the upper end of any offsite basins to the defined major drainageways. The map shall identify any existing and proposed facilities from the property (i.e., development, irrigation ditches, existing detention facilities, culverts, storm sewers) along the flow path to the nearest major drainageway.

(b) Existing and Future Land Use: Existing and proposed vegetation and landscaping must be shown to the extent that it is known at the ODP level. Existing and proposed building footprints, parking lots, sidewalks, and streets shall be submitted. If details of the proposed information are unknown, the zoning as shown on the ODP diagram is acceptable.

(c) Floodplain Information: All 100-year floodplain and floodway boundaries, cross sections, and base flood elevation lines must be shown. Base flood elevations must be reported in NAVD 1988 and NGVD 1929 (unadjusted) vertical datum for all FEMA basins. City basin base flood elevations must be reported in NGVD 1929 only. All floodplain requirements as detailed in Chapter 10 of the City Code shall apply.

(d) Drainage Plan: Map(s) of the proposed development at a scale of 1” = 20’ to 1” = 200’ on a 22" x 34" drawing must be included. The plan must show the following:

1. Existing topographic contours at 2-foot maximum intervals. In terrain where the slope exceeds 15%, the maximum interval is 10 feet. The contours shall extend 50 feet beyond the property lines or further, if necessary, to show the drainage relationship with the adjacent property.
2. All existing drainage facilities.
3. Approximate flooding limits based on available information.
4. Conceptual major drainage facilities including detention basins, storm sewers, streets, culverts, channels, swales, riprap, and hydraulic structures in the detail consistent with the proposed development plan.
5. All watercourses, rivers, wetlands, creeks, irrigation ditches or laterals located within 150 feet of the property.
6. Major drainage boundaries and sub-boundaries.
7. Any offsite feature influencing development.
8. Proposed flow directions and, if available, proposed contours.
9. Legends to define map symbols.
10. All water quality on-site detention facilities required for every new development and redevelopment must be designated on the plans, including notes indicating the approximate surface area and volume of the facilities.

(26) *Section 6.6* is amended to read as follows:

6.6 Project Development Plan (PDP) and Building Permit Submittal Requirements

A PDP is needed after the ODP if the project will be completed in phases, or a PDP is needed after the Conceptual Review if the project will be completed in only one phase. The PDP submittal shall contain a general description of the existing and proposed land uses and layout of the site. All Building Permit Process submittals have the same requirements as the PDP requirements.

All analyses and designs of storm drainage systems within the City limits of Fort Collins must be submitted to the City for review and must obtain the City's written approval before any phase of construction. PDP submittals to the Stormwater Utility must consist of two copies of a Drainage and Erosion Control Report with one set of engineering drawings containing the necessary information.

The information and calculations contained within the Drainage Report and Erosion Control Report must be presented in a neat and orderly fashion to facilitate review.

All reports must be stamped and signed by a Colorado licensed professional engineer and must include, at the minimum:

- a cover letter indicating the date
- the name of the project or subdivision
- a vicinity map
- the name of the engineer(s) designing the site
- a statement of compliance with this Manual.

Detailed engineering drawings must be included in the Drainage Report supporting the information and calculations provided in the report.

All PDP submittals must indicate whether any portion of the development site is located within or is directly adjacent to a FEMA or City designated floodplain. In the event where any portion of the development site meets that condition, then the proposed development plan must comply with all applicable floodplain regulations as specified in Chapter 10 of City Code, "Flood Prevention and Protection".

(27) *Section 6.7* is amended to read as follows:

6.7 PDP Drainage Report

6.7.1 Report Contents

The Report must be formatted in accordance with the following outline and must contain all the applicable information listed below and meet the requirements of Vol. 3, Chapter 7, "Construction BMPs."

I. GENERAL LOCATION AND DESCRIPTION

A. Location

1. Vicinity Map: A map showing the project location within the City. The project area shall be shaded, major arterial streets labeled, the major water courses and water bodies shall be labeled, and the City's drainage basin that the site is located in shall be labeled. The map shall be a minimum size of 6 inches by 6 inches with a scale ranging from 1" = 1000' to 1" = 3000'. The vicinity map shall be located directly after the table of contents of the drainage report.
2. Township, range, section, ¼ section
3. Local streets within and adjacent to the subdivision with ROW width shown.
4. Major drainageways, facilities, and easements within or adjacent to the site.
5. Names of surrounding developments

B. Description of Property

1. Area in acres
2. Ground cover (type of trees, shrubs, vegetation, general soil conditions, topography, and slope)
3. Major drainageways
4. General project description
5. Irrigation facilities
6. Proposed land use

C. Floodplain Submittal Requirements

1. "City of Fort Collins Floodplain Review Checklist for 50% Submittals"

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

1. Reference to major drainageway planning studies such as flood hazard delineation reports, major drainageway planning reports, and flood insurance rate maps

2. Major basin drainage characteristics, existing and planned land uses
3. Identification of all irrigation facilities within the basin, which will influence or be influenced by the local drainage design

B. Sub-Basin Description
1. Discussion of historic and proposed drainage patterns of the property in question
2. Discussion of offsite drainage flow patterns and impact on development under existing and fully developed basin conditions

III. DRAINAGE DESIGN CRITERIA

A. Regulations: Discussion of the optional provisions selected or the deviation from the criteria, if any, and its justification.

B. Discussion on how the Directly Connected Impervious Area (DCIA) is being minimized and or disconnected and discussion on how compliance with the "Four Step Process" is being implemented.

C. Development Criteria Reference and Constraints
1. Discussion of previous drainage studies (i.e., project master plans) for the site in question that influence or are influenced by the drainage design and how the plan will affect drainage design for the site.
2. Discussion of the effects of adjacent drainage studies.
3. Discussion of the drainage impact of site constraints such as streets, utilities, rapid transit, existing structures, and development or site plan.

D. Hydrological Criteria
1. Identify design rainfall
2. Identify runoff calculation method
3. Identify detention discharge and storage calculation method
4. Identify design storm recurrence intervals
5. Discussion and justification of other assumptions or calculation methods used that are not referenced by the criteria.

E. Hydraulic Criteria
1. Identify various capacity references
2. Discussion of other drainage facility design criteria used that are not referenced in the criteria
3. If there are proposed modifications to areas within the 100-year floodplain or floodway, a "Floodplain Modeling Report" must be submitted
4. If there are proposed modifications to a natural drainageway where a 100-year floodplain has not been designated, a "Floodplain Modeling Study" must be submitted

F. Floodplain Regulations Compliance

1. Complete a "City of Fort Collins Floodplain Review Checklist for 50% Submittals" that clearly states the intent to comply with all applicable City of Fort Collins floodplain regulations as specified in Chapter 10 of the City Code.

G. Modifications of Criteria

1. Identify provisions by section number for which a modification is requested
2. Provide justification for each modification requested

IV. DRAINAGE FACILITY DESIGN

A. General Concept

1. Discussion of concept and typical drainage patterns
2. Discussion of compliance with off-site runoff considerations
3. Discussion of the content of tables, charts, figures, plates, or drawings presented in the report
4. Discussion of anticipated and proposed drainage patterns

B. Specific Details

1. Discussion of drainage problems encountered and solutions at specific design points
2. Discussion of detention storage and outlet design
3. A summary table for each detention storage pond on the site to include:
    - Stage-Storage Curve
    - Stage-Discharge Curve
    - Detention Pond Volume Required
    - Detention Pond Volume Provided
    - Water Quality Capture Volume (WQCV)
    - Water Quality Elevation
    - Spillway Elevation
    - Pond Freeboard
    - Outlet(s) size(s)
4. Discussion of maintenance access
5. Discussion of easements and tracts for drainage purposes, including the conditions and limitations for use
6. Discussion of the facilities needed offsite for the conveyance of minor and major flows to the major drainageway

V. CONCLUSIONS

A. Compliance with Standards

1. Compliance with Fort Collins Stormwater Criteria Manual
2. Compliance with the City's Master Drainage Plan(s)
3. Compliance with the City's floodplain regulations

4. Compliance with all State and Federal regulations

B. Drainage Concept
   1. Effectiveness of drainage design to control damage from storm runoff
   2. Influence of proposed development on the Master Drainage Plan recommendation(s)

VI. REFERENCES

Reference all criteria and technical information used

VII. APPENDICES

A. Hydrologic Computations
   1. Land use assumptions regarding adjacent properties
   2. Initial and major storm runoff at specific design points
   3. Historic and fully developed runoff computations at specific design points
   4. Hydrographs at critical design points
   5. Time of concentration and runoff coefficients for each basin

B. Hydraulic Computations
   1. Culvert capacities
   2. Storm sewer capacity. Allowable models include StormCAD, UDSewer, FlowMaster, and Extran. Other models will be accepted on a case by case basis upon prior approval from the City
   3. Street flow calculations for the 2-year and 100-year events regarding street encroachment, theoretical capacity, and allowable gutter flow
   4. Storm inlet capacity including inlet control rating at connection(s) to storm sewer system
   5. Open channel design
   6. Check dam and/or channel drop design
   7. Detention facility design including area/volume capacity, outlet capacity, soil analysis, and ground water table elevations
   8. Downstream/outfall system capacity to the major drainageway system
   9. Design of erosion protection measures for culverts, and storm sewer outlets.

C. Letters of intent to acquire all necessary off-site easements

D. Water quality design calculations

E. Printed copies of input and output files for all computer models used in the analysis and design

F. Digital copies of input and output files for all computer models used in the analysis and design

6.7.2 PDP Engineering Drawings for Drainage Reports

The drawings must contain all the applicable information listed below and meet the requirements of Vol. 3, Chapter 7, "Construction BMPs." All drawings shall be prepared by a Colorado licensed civil engineer and must be on a reproducible medium of one or more sheets with an outer dimension of twenty-four by thirty-four (22x34) inches. Please note that if feasible and legible the Grading Plan and Erosion Control Plan can be combined.

The plan set should include the following sheets:

a) Vicinity Map
b) Drainage Plan
c) Floodplain Plan
d) Grading Plan
e) Erosion Control Plan

The Drainage and Erosion Control Report and associated drawings must include the following information in aggregate:

a) The name of the subdivision or project.
b) The date of preparation, the scale, and symbol designating true north.
c) The boundary lines of the subdivision or project, right-of-way lines of streets, easements and other rights of way, irrigation ditches, detention ponds, watercourses, and lot lines, with accurate bearings and distances.
d) Designations of all streets and other rights of way, including dimensions and names of such streets.
e) The location and dimensions of any easements.
f) All required floodplain information and studies as specified in the City of Fort Collins Floodplain Review Checklist for 50% Development Review Submittals.
g) Existing and proposed contours at two foot intervals. Spot elevations or one foot contours where two foot contours do not show on the property or where needed to depict the grading. Spot elevations may be needed in critical areas, especially adjacent to existing developed property.
h) The location, size, and type of all storm sewers.
i) The location, size, and type of all inlets, cross pans, manholes, and other storm sewer appurtenances.
j) Profile views for all subsurface drainage facilities showing their size, slope, lengths, design storm hydraulic grade lines (2-year and 100-year), cover, details of structures or City Standard details, and relationship with existing utilities.
k) The location, size, and type of all culverts, including box culverts.
l) The location, size, and type of all open channels, including irrigation ditches with profile views where applicable.
m) The location, size, and type of all existing utilities.
n) Cross-sectional views of all open channels, including irrigation ditches, trickle channels, spillway structures, etc. These views must include applicable easement/right-of-way boundaries and water surface elevations such as the 100-year storm depth, 2-year storm depth, major storm freeboard, and operating irrigation level.
o) Capacity, discharge, outlet structure, spillways, permanent pool water level (if any), and 100-year high water level for all detention ponds, including both the

water quality and water quantity elevations. Cross-hatching of the area inundated by the 100-year water surface elevation is recommended.

p) Water surface profiles for all major open channels, or as required.

q) Show the lowest floor elevation (the basement floor elevation or the bottom of the crawl space) and grade at foundation elevations of all buildings. Grading away from the foundation within the first 5 feet adjacent to the building shall be a minimum of 5%. In residential developments, also provide lot corner elevations and any grade break elevations critical to the grading concept. The minimum opening elevations are also required for all lots that are adjacent to a major drainage channel, a detention pond, or a water body, or located in or adjacent to a floodplain.

r) Spot elevations critical to describe drainage features and their function (e.g., inlets, cross pans, spillways, inlets/outlets of manholes, culverts, and storm sewers).

s) Drainage sub-basin boundaries and concentration points for the developed site clearly delineated and labeled.

t) A summary table of site hydrology, including offsite flows entering the site for the 2-year and 100-year design storms, basin numbers, basin areas, runoff coefficients, and onsite flows for the 2-year and 100-year design storms at the concentration points.

u) A summary table for each detention pond on the site to include:

- Stage-Storage Curve
- Stage-Discharge Curve
- Detention pond volume required
- Detention pond volume provided
- Water Quality Capture Volume (WQCV)
- Water Quality Elevation
- Spillway Elevation
- Pond Freeboard
- Outlet(s) size(s)

v) A vicinity map showing the project location within the city. The project area shall be shaded, and major arterial streets labeled. The map shall be a minimum size of 6" x 6", with a scale ranging from 1"=1000' to 1"=3000’.

w) Letters of intent to acquire all necessary offsite easements shall be included with the submittal

x) If SWMM modeling is used, a sub-basin map and a SWMM schematic diagram are required to depict the sub-basins and conveyance elements represented in the model.

y) General notes relating to the design of the drainage features of the development are required on the utility plan cover sheet. (Additional notes are required by other departments, such as Engineering and Water/Wastewater.) The required drainage notes are as follows:

1) All street, sanitary sewer, storm sewer and water construction shall conform to City Standards and Specifications current at date of execution of the Development Agreement pertaining to this development. Any construction occurring three years after the execution of the development agreement shall require re-examination of the plans by the Director who may require that they be made to conform to standards and specifications current at that time.

2) The type, size, location, and number of all known underground utilities are approximate as shown on the drawings. It shall be the responsibility of the contractor to verify the existence and location of all underground utilities along the route of the work. Before commencing new construction, the contractor shall be responsible for locating unknown underground utilities.

3) These plans have been reviewed by the City for concept only. The review does not imply responsibility by the reviewing department, the City Engineer, or the City for accuracy or correctness of the calculations. Furthermore, the review does not imply that the quantities of the items on the plans are the final quantities required. The review shall not be construed in any reason as acceptance of financial responsibility by the City for additional quantities of items shown that may be required during the construction phase.

4) Prior to the commencement of any construction, the contractor must give the City Engineering Department (970-221-6605) and the Erosion Control Inspector (970-221-6700) twenty-four (24) hours advance-notice. Initial erosion control measures must be installed and a site inspection by the Erosion Control Inspector is required before commencing construction activities.

5) Maintenance of onsite drainage facilities shall be the responsibility of the property owners.

6) All recommendations of the final drainage and erosion control study for this development by (Engineering Firm) must be met.

7) Prior to final inspection and acceptance by the City, certification of the drainage facilities by a Colorado registered professional engineer must be submitted to and approved by the City Stormwater Department. (including the applicable note as set forth below)

   For commercial and multi-family developments, certification of all drainage facilities shall be submitted to the City Stormwater Department at least two weeks prior to the release of a certificate of occupancy. Individual lot certification, elevation certification, or floodproofing certification, as specified in the development agreement, must be submitted to the City Stormwater Department at least two weeks prior to the release of a certificate of occupancy for such lot.

   For single family developments, certification of all drainage facilities must be submitted to the City Stormwater Department in accordance with all conditions as prescribed by the development agreement associated with this development. Individual lot certification, elevation certification, or floodproofing certification, as specified in the development agreement, must be submitted to the City Stormwater Department at least one week prior to the release of a certificate of occupancy for such lot.

8) If dewatering is used to install utilities, and discharge will be into the street, gutter, storm sewer, channel, irrigation ditch, or any waters of the State a State Construction Dewatering Industrial Wastewater Discharge Permit is required.

9) All land disturbing activities greater than or equal to one acre must comply with the State of Colorado permitting process for Stormwater

Discharges Associated with Construction Activity. For more information contact the Colorado Department of Public Health and Environment, Water Quality Control Division, at 303-692-3500 or refer to the web site at http://www.cdphe.state.co.us/wq/PermitsUnit/ .

10) Benchmark: City of Fort Collins Vertical Control located at the Elevation = _____feet, City of Fort Collins Datum.

11) If fill or dredged material is discharged into waters of the United States, a USACE 404 permit is required.

12) If construction affects any Colorado Highway, a Colorado Department of Transportation right-of-way permit is required.

(28) A new *Section 6.8* is added, to read as follows**:**

6.8 PDP Erosion Control Report and Plan

An Erosion Control Report and an Erosion Control Plan must be prepared for all land disturbing activity subject to this Manual for areas that are greater than or equal to ten thousand (10,000) square feet in area and less than four to one (4:1) slopes except emergency work or where construction activities are within fifty (50) feet of the outer limits of sensitive areas. This includes but is not limited to floodplains, slopes, riparian corridors, wetlands, lakes, or irrigation ditches. Said report and plan must be prepared in accordance with the specifications set forth in Volume 3, Chapter 7, "Construction BMPs", of this Manual. Land disturbing activity refers to any activity that results in a change in the existing soil cover (both vegetative and non-vegetative) and/or the existing soil topography including but not limited to, clearing, grading, excavation, demolition, installation of new or improved haul roads and access roads, staging areas, stockpiling of fill materials, and borrow areas. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or the original purpose of the facility.

(29) A new *Section 6.9 is* added, to read as follows:

6.9 Final Plan (FP) Submittal Requirements

After the PDP submittal has been approved, the applicant can present the FP submittal to the City. The FP is the site-specific development plan, which describes and establishes the type and intensity of use for a specific development.

The FP submittal shall contain one set of the following:

a) A statement of compliance to the approved PDP.

b) All easements in final form (except City signatures) must be submitted with the FP submittal.

c) Any necessary revisions to the PDP Drainage Report and drawings and to the Erosion Control Report and drawings.

d) Final construction drawings.

e) A statement of compliance with all floodplain requirements specified in chapter 10 of the City Code as well as the completion "City of Fort Collins Floodplain Review Checklist for 100% Development Review Submittals"

Upon approval of the Final Plan, three final Drainage and Erosion Control Reports and one complete set of construction drawings must be sent to the City Stormwater Department. The Engineering Department will require additional copies for other

departments. One copy of the report must include digital copies of the input and output files for all computer models used for the analysis and design. In addition, one copy of the Erosion Control Plan with details must be submitted to the Erosion Control Inspector.

(30) A new *Section 6.10* is added, to read as follows:

6.10 Floodplain Modeling Reports

All guidelines and requirements as specified in Chapter 10 of the City Code must be satisfied. All requirements identified in the document titled "Guidelines for Submitting Floodplain Modeling Reports" must be completed and submitted.

(31) A new *Section 6.11* is added, to read as follows:

6.11 Drainage Certification

All new developments are required to submit for review and approval, an overall site certification of the constructed drainage facilities. The overall site certification must specify the proposed and the as-built conditions of the site's drainage facilities. Any variation from the approved plans must be noted and proven to function properly within the standards in this Manual. Supporting calculations to justify any variation from the approved plans shall be provided, including but not limited to, detention volumes, detention discharge rates, pipe capacities, channel capacities, water surface and lowest opening elevations, and swale capacities.

The City will review the certified record drawing information with the construction drawings. A Certification will only be accepted if:

1. The record drawing information demonstrates that the construction complies with the design intent.
2. The record drawings are certified by both a registered professional land surveyor and a registered professional engineer in the state of Colorado.
3. There is a compliance statement by the professional engineer.
4. Any discrepancies between the original drainage plan and the constructed system need to be discussed and shown to function within the criteria set forth in this Manual. If the construction does not comply with the criteria, the design engineer must redesign the drainage facilities and plan and revise the construction plan mylars to correct the deficiencies.
5. All Floodplain certifications required by the City's Floodplain Administrator must also be included. These may include FEMA Elevation or Floodproofing Certifications and No-Rise Certifications and or other documents as specified in Chapter 10 of the City Code.

6.11.1 Overall Site Certifications

This type of certification is for the overall site drainage facilities shown on the construction plan drawings. The construction plans together with the development agreement identify when and what facilities must be certified and how many building permits and/or Certificates of Occupancy ("Cos") are allowed prior to certifying the facilities. Twenty-five percent of the building permits can be issued prior to acceptance of an overall site certification. In multi-family building projects the overall site certification must be accepted before or at the same time as the release of the first certificate of occupancy in that phase.

6.11.2 Certifications for Commercial and Multi-Family Developments

Individual lot or building certification is required before the release of a Certificate of Occupancy ("CO"). Certification of all drainage facilities must be submitted to the City at least two weeks before the release of a CO.

6.11.3 Certifications for Single Family Developments

Certification of all drainage facilities must be submitted to the City at least one week before the release of additional building permits to those allowed by the development agreement. The development agreement for single-family developments usually allows for the release of 25% of the total building permit. An overall site drainage certificate shall be submitted and approved by the City before the release of any remaining building permits in the development as specified in the development agreement. Individual lot certifications are required prior to the release of a Certificate of Occupancy ("CO") for any lot.

6.11.4 Individual Lot Certifications

Certification may be required for individual lots to ensure lot grading was completed according to the approved grading plan. Lots requiring certification will be specified in the development agreement. A lot certification must show the proposed and the "as-built" conditions of the lot grading, including corner lot elevations, high points, side-lot swales, drainage patterns, and minimum building opening elevations.

It must include separate discussions of the intent of the grading on the previously approved grading plan as well as the final grading being certified. If the final grading matches the approved plan there must be a statement of compliance or if not an explanation of what is different and why. In the latter case, the changes must be justified or explained in order to obtain City approval and the release of the Certificate of Occupancy ("CO").

For properties within floodplains, a flood-proofing or elevation certificate is required for all structures prior to the release of the CO.

(32) A new *Section 6.12* is added, to read as follows:

6.12 Final Close-Out Inspection

A Final Close-Out Inspection is required for all new developments and redevelopments.

This inspection must be scheduled at the conclusion of all construction activities on the site and prior to transferring ownership and maintenance responsibilities of the site to a subsequent entity such as a Home Owners' Association.

The Owner must request the Final Close-Out Inspection from the City. The Final Close-Out Inspection must be scheduled with the City following a minimum two-week advance notice.

At the time of the Close-Out Inspection the Owner must provide to the City contact information for the entity that will be assuming ownership and maintenance responsibilities and a plan for funding and carrying out these responsibilities.

During the Final Close-Out Inspection, the Owner must demonstrate to the satisfaction of the City that:

a) All permanent drainage facilities and BMPs have been constructed in compliance with the approved final plan documents and are functioning as designed.

b) All revegetation measures are complete and all soil surfaces are stable.

c) All drainage facilities and appurtenances have been cleared of any debris and sediment.

d) All temporary BMPs have been removed from the development site.

(33) *Section 7.0* is deleted in its entirety.

(34) *Section 7.1* is deleted in its entirety.

(35) *Section 7.2* is deleted in its entirety.

(36) *Section 7.3* is deleted in its entirety.

(37) *Section 7.4* is deleted in its entirety.

(38) *Table DP-1* is deleted in its entirety.

(39) *Table DP-2* is deleted in its entirety.

(40) *Table DP-3* is deleted in its entirety.

(41) *Table DP-4* "Required Maintenance Easements" is added.

(42) *Figure DP-1* is deleted in its entirety.

(B) ***Volume 1, Chapter 4*** **- Rainfall*:***

(1) *Section 1.0* is deleted in its entirety.

(2) A new *Section 1.1* is added, to read as follows:

1.1 General Design Storms

All drainage system design and construction must take into consideration three separate and distinct drainage problems.

The first is the eightieth (80^{th}) percentile storm event or the rain event for which 80% of all rain events have an equal or smaller depth of rain. This storm event is used to design water quality features. The second is the "Minor" or "Initial Storm", which is the 2-year storm in the city of Fort Collins. This is the storm that has a probability of occurring, on the average, once every two (2) years (or one that has a fifty percent chance probability of exceedance every year). The third is the "Major Storm", which is the 100-year storm in the city of Fort Collins. This is the storm that has a probability of occurring, on the average, once every one hundred (100) years (or one that has a one percent probability of exceedance every year). In some instances the 100-year storm routing of runoff will not be the same as that for the 2-year storm.

(3) A new *Section 1.2* is added, to read as follows:

1.2 Minor (2-Year) Storm Provisions

The objectives of such drainage system planning are to minimize inconvenience, to protect against recurring minor damage and to reduce maintenance costs in order to create an orderly drainage system at a reasonable cost. The 2-year storm drainage system may include such facilities as curb and gutter, storm sewer, open channels, drainageways, ponds, rivers, streams, and detention facilities.

(4) A new Section 1.3 is added, to read as follows:

1.3 Major (100-Year) Storm Provisions

The objectives of the 100-year storm drainage system planning are to eliminate substantial loss of life or property damage. Major drainage systems may include storm sewers, open channels, drainageways, ponds, rivers, streams, and detention facilities. The correlation between the minor and major storm system must be analyzed to ensure that a well coordinated drainage system is designed and constructed.

(5) *Section 2.0* is deleted in its entirety.

(6) *Section 2.1* is deleted in its entirety.

(7) *Section 2.2* is deleted in its entirety.

(8) *Section 3.0* is deleted in its entirety.

(9) *Section 3.1* is deleted in its entirety.

(10) *Section 3.2* is deleted in its entirety.

(11) *Section 4.0* is amended to read as follows:

4.0 Intensity-Duration-Frequency Curves for Rational Method:

The one-hour rainfall Intensity-Duration-Frequency tables for use the Rational Method of runoff analysis are provided in Table RA-7 and in Table RA-8.

Table RA-7 -- City of Fort Collins

Rainfall Intensity-Duration-Frequency Table for Use with the Rational Method

(5 minutes to 30 minutes)

Duration (min)	**2-Year Intensity** (in/hr)	**10-Year Intensity** (in/hr)	**100-Year Intensity** (in/hr)
5	2.85	4.87	9.95
6	2.67	4.56	9.31
7	2.52	4.31	8.8
8	2.4	4.1	8.38
9	2.3	3.93	8.03
10	2.21	3.78	7.72
11	2.13	3.63	7.42
12	2.05	3.5	7.16
13	1.98	3.39	6.92
14	1.92	3.29	6.71
15	1.87	3.19	6.52
16	1.81	3.08	6.3
17	1.75	2.99	6.1
18	1.7	2.9	5.92
19	1.65	2.82	5.75
20	1.61	2.74	5.6
21	1.56	2.67	5.46
22	1.53	2.61	5.32
23	1.49	2.55	5.2
24	1.46	2.49	5.09
25	1.43	2.44	4.98
26	1.4	2.39	4.87
27	1.37	2.34	4.78
28	1.34	2.29	4.69
29	1.32	2.25	4.6
30	1.3	2.21	4.52

Table RA-8 -- City of Fort Collins

Rainfall Intensity-Duration-Frequency Table
for Use with the Rational Method

(31 minutes to 60 minutes)

Duration (min)	**2-Year Intensity** (in/hr)	**10-Year Intensity** (in/hr)	**100-Year Intensity** (in/hr)
31	1.27	2.16	4.42
32	1.24	2.12	4.33
33	1.22	2.08	4.24
34	1.19	2.04	4.16
35	1.17	2.0	4.08
36	1.15	1.96	4.01
37	1.16	1.93	3.93
38	1.11	1.89	3.87
39	1.09	1.86	3.8
40	1.07	1.83	3.74
41	1.05	1.8	3.68
42	1.04	1.77	3.62
43	1.02	1.74	3.56
44	1.01	1.72	3.51
45	0.99	1.69	3.46
46	0.98	1.67	3.41
47	0.96	1.64	3.36
48	0.95	1.62	3.31
49	0.94	1.6	3.27
50	0.92	1.58	3.23
51	0.91	1.56	3.18
52	0.9	1.54	3.14
53	0.89	1.52	3.1
54	0.88	1.5	3.07
55	0.87	1.48	3.03
56	0.86	1.47	2.99
57	0.85	1.45	2.96
58	0.84	1.43	2.92
59	0.83	1.42	2.89
60	0.82	1.4	2.86

(12) A new *Section 4.1* is added, to read as follows:

4.1 Intensity-Duration-Frequency Curves for SWMM:

The hyetograph input option must be selected when creating SWMM input files. Hyetographs for the 2-, 5-, 10-, 25-, 50-, and 100-year City of Fort Collins rainfall events are provided in Table RA-9.

Table RA-9 – City of Fort Collins

Rainfall Intensity-Duration-Frequency Table

for Use with SWMM

Duration (min)	**2-Year Intensity** (in/hr)	**5-Year Intensity** (in/hr)	**10-Year Intensity** (in/hr)	**25-Year Intensity** (in/hr)	**50-Year Intensity** (in/hr)	**100-Year Intensity** (in/hr)
5	0.29	0.40	0.49	0.63	0.79	1.00
10	0.33	0.45	0.56	0.72	0.90	1.14
15	0.38	0.53	0.65	0.84	1.05	1.33
20	0.64	0.89	1.09	1.41	1.77	2.23
25	0.81	1.13	1.39	1.80	2.25	2.84
30	1.57	2.19	2.69	3.48	4.36	5.49
35	2.85	3.97	4.87	6.30	7.90	9.95
40	1.18	1.64	2.02	2.61	3.27	4.12
45	0.71	0.99	1.21	1.57	1.97	2.48
50	0.42	0.58	0.71	0.92	1.16	1.46
55	0.35	0.49	0.60	0.77	0.97	1.22
60	0.30	0.42	0.52	0.67	0.84	1.06
65	0.20	0.28	0.39	0.62	0.79	1.00
70	0.19	0.27	0.37	0.59	0.75	0.95
75	0.18	0.25	0.35	0.56	0.72	0.91
80	0.17	0.24	0.34	0.54	0.69	0.87
85	0.17	0.23	0.32	0.52	0.66	0.84
90	0.16	0.22	0.31	0.50	0.64	0.81
95	0.15	0.21	0.30	0.48	0.62	0.78
100	0.15	0.20	0.29	0.47	0.60	0.75
105	0.14	0.19	0.28	0.45	0.58	0.73
110	0.14	0.19	0.27	0.44	0.56	0.71
115	0.13	0.18	0.26	0.42	0.54	0.69
120	0.13	0.18	0.25	0.41	0.53	0.67

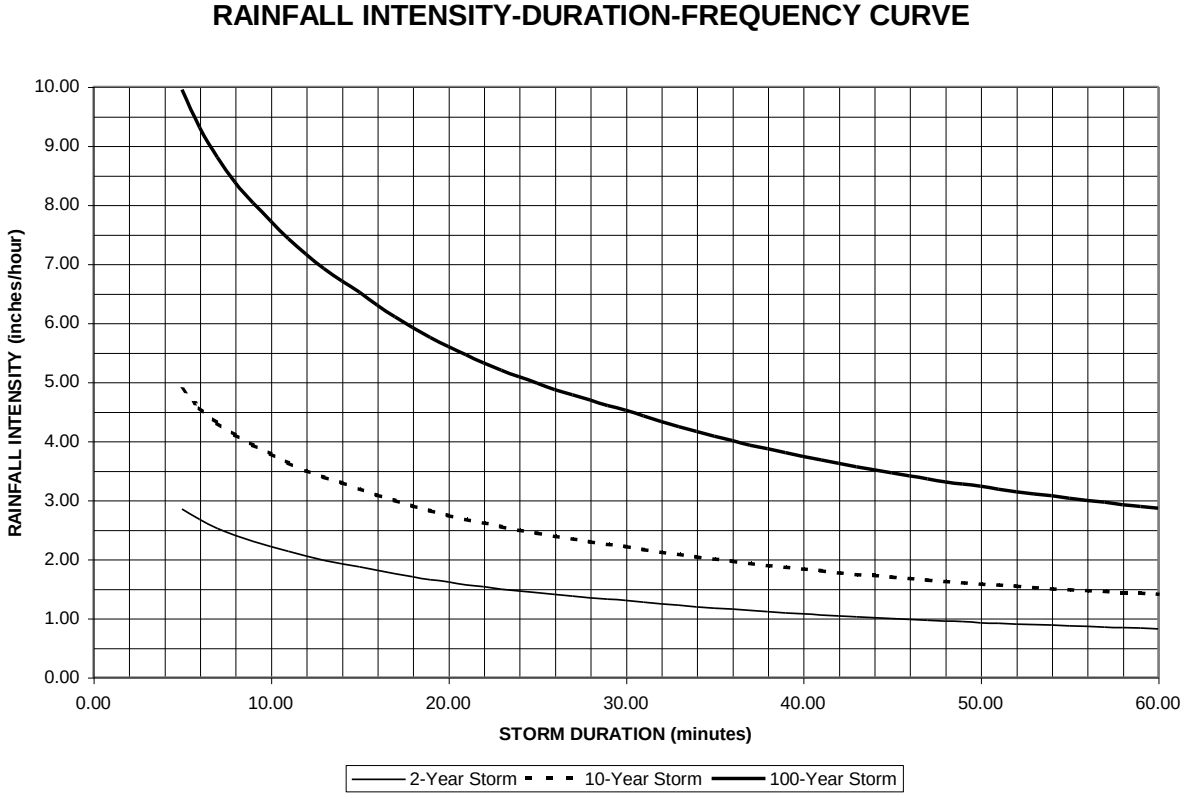

Figure RA-16 City of Fort Collins Rainfall Intensity-Duration-Frequency Curves

(13) *Section 5.0* is deleted in its entirety.

(14) *Section 6.0* is deleted in its entirety.

(15) *Section 7.0* is deleted in its entirety.

(16) *Section 7.1* is deleted in its entirety.

(17) *Section 7.2* is deleted in its entirety.

(18) *Section 7.3* is deleted in its entirety.

(19) *Section 8.0* is deleted in its entirety.

(20) *Table RA-1* is deleted in its entirety.

(21) *Table RA-2* is deleted in its entirety.

(22) *Table RA-3* is deleted in its entirety.

(23) *Table RA-4* is deleted in its entirety.

(24) *Table RA-5* is deleted in its entirety.

(25) *Table RA-6* is deleted in its entirety.

(26) *Table RA-7*—City of Fort Collins Rainfall Intensity-Duration-Frequency Table for use with the Rational Method (5minutes to 30 minutes) is added.

(27) *Table RA-8*—City of Fort Collins Rainfall Intensity-Duration-Frequency Table for use with the Rational Method (31 minutes to 60 minutes) is added.

(28) *Table RA-9*—City of Fort Collins Rainfall Intensity-Duration-Frequency Table for use with SWMM is added.

(29) *Figure RA-1* is deleted in its entirety.

(30) *Figure RA-2* is deleted in its entirety.

(31) *Figure RA-3* is deleted in its entirety.

(32) *Figure RA-4* is deleted in its entirety.

(33) *Figure RA-5* is deleted in its entirety.

(34) *Figure RA-6* is deleted in its entirety.

(35) *Figure RA-7* is deleted in its entirety.

(36) *Figure RA-8* is deleted in its entirety.

(37) *Figure RA-9* is deleted in its entirety.

(38) *Figure RA-10* is deleted in its entirety.

(39) *Figure RA-11* is deleted in its entirety.

(40) *Figure RA-12* is deleted in its entirety.

(41) *Figure RA-13* is deleted in its entirety.

(42) *Figure RA-14* is deleted in its entirety.

(43) *Figure RA-15* is deleted in its entirety.

(44) *Figure RA-16* is added

Figure RA-16—City of Fort Collins Rainfall Intensity-Duration-Frequency Curves.

(C) ***Volume 1, Chapter 5*** **- Runoff:**

(1) *Section 1.0* is deleted in its entirety.

(2) A new *Section 1.1* is added, to read as follows:

1.1 Runoff Methodologies

(a) There are two runoff determination methodologies that are approved by the City, the Rational Method and the Stormwater Management Model (SWMM). The City is the determining authority with respect to the appropriate methodology to use under different circumstances. Early contact with the City is encouraged for the timely determination of the appropriate runoff methodology to use.

(b) The Rational Method may only be used to determine the runoff from drainage basins that are less than ninety (90) acres in size. The Stormwater Management Model (SWMM) must be used to model drainage basin areas of ninety (90) acres or more.

(c) All runoff calculations made in the design of both 2-year and 100-year drainage systems must be included with the Storm Drainage Report and all storm drainage facilities designed must be shown on Storm Drainage Plans.

(3) A new *Section 2.8* is added, to read as follows:

2.8 Rational Method Runoff Coefficients

(a) The runoff coefficients to be used in the Rational Method can be determined based on either zoning classifications or the types of surfaces on the drainage area. Zoning classifications may be used to estimate flow rates and volumes for an Overall Drainage Plan (ODP) submittal, if the types of surfaces are not known. Table RO-10 lists the runoff coefficients for common types of zoning classifications in the city of Fort Collins.

(b) For a Project Plan or Final Plan submittal, runoff coefficients based on the proposed land surface types must be used. Since the actual runoff coefficients may be different from those specified in Table RO-10, Table RO-11 lists coefficients for the different types of land surfaces. The runoff coefficient used for design must be based on the actual conditions of the proposed site.

Table RO-10

Rational Method Minor Storm Runoff Coefficients for Zoning Classifications

Description of Area or Zoning	Coefficient
R-F	0.3
U-E	0.3
L-M-In	0.55
R-L, N-C-L	0.6
M-M-N, N-C-M	0.65
N-C-B	0.7
Business:	
C-C-N, C-C-R, C-N, N-C, C-S	0.95
R-D-R, C-C, C-L	0.95
D, C	0.95
H-C	0.95
C-S	0.95
Industrial:	
E	0.85
I	0.95
Undeveloped:	
R-C, T	0.2
P-O-L	0.25

For guidance regarding zoning districts and classifications of such districts please refer to Article Four of the City Land Use Code, as amended.

Table RO-11

Rational Method Runoff Coefficients for Composite Analysis

Character of Surface	Runoff Coefficient
Streets, Parking Lots, Drives:	
Asphalt	0.95
Concrete	0.95
Gravel	0.5
Roofs	0.95
Recycled Asphalt	0.8
Lawns, Sandy Soil:	
Flat <2%	0.1
Average 2 to 7%	0.15
Steep >7%	0.2
Lawns, Heavy Soil:	
Flat <2%	0.2
Average 2 to 7%	0.25
Steep >7%	0.35

(4) A new *Section 2.9* is added, to read as follows:

2.9 Composite Runoff Coefficient

Drainage sub-basins are frequently composed of land that has multiple surfaces or zoning classifications. In such cases a composite runoff coefficient must be calculated for any given drainage sub-basin.

The composite runoff coefficient is obtained using the following formula:

$$C = \frac{\sum_{i=1}^{n} (C_i * A_i)}{A_t} \qquad \text{(RO-8)}$$

Where: C = Composite Runoff Coefficient
C_i = Runoff Coefficient for Specific Area (A_i)
A_i = Area of Surface with Runoff Coefficient of C_i, acres or feet^2
n = Number of different surfaces to be considered
A_t = Total Area over which C is applicable, acres or feet^2

(5) A new *Section 2.10* is added, to read as follows:

2.10 Runoff Coefficient Adjustment for Infrequent Storms

The runoff coefficients provided in tables RO-10 and RO-11 are appropriate for use with the 2-year storm event. For storms with higher intensities, an adjustment of the runoff coefficient is required due to the lessening amount of infiltration, depression retention, evapo-transpiration and other losses that have a proportionally smaller effect on storm runoff. This adjustment is applied to the composite runoff coefficient.

These frequency adjustment factors are found in Table RO-12.

Table RO-12

Rational Method Runoff Coefficients for Composite Analysis

Storm Return Period (years)	Frequency Factor C_f
2 to 10	1.00
11 to 25	1.10
26 to 50	1.20
51 to 100	1.25

Note: The product of C times C_f cannot exceed the value of 1, in the cases where it does a value of 1 must be used

(6) *Section 3.1* is deleted in its entirety.

(7) *Section 3.2* is deleted in its entirety.

(8) *Section 3.3* is deleted in its entirety.

(9) A new *Section 4.3* is added, to read as follows:

4.3 Computer Modeling Practices

(a) For circumstances requiring computer modeling, the design storm hydrographs must be determined using the Stormwater Management Model (SWMM). Basin and conveyance element parameters must be computed based on the physical characteristics of the site.

(b) Refer to the SWMM Users' Manual for appropriate modeling methodology, practices and development. The Users' Manual can be found on the Environmental Protection Agency (EPA) website (http://www.epa.gov/ednnrmrl/models/swmm/index.htm).

(c) It is the responsibility of the design engineer to verify that all of the models used in the design meet all current City criteria and regulations.

4.3.1 Surface Storage, Resistance Factors, and Infiltration

Table RO-13 provides values for surface storage for pervious and impervious surfaces and the infiltration rates to be used with SWMM. Table RO-13 also lists the appropriate infiltration decay rate, zero detention depth and resistance factors, or Manning's "n" values, for pervious and impervious surfaces to be used for SWMM modeling in the city of Fort Collins.

Table RO-13

SWMM Input Parameters

Depth of Storage on Impervious Areas	0.1 inches
Depth of Storage on Pervious Areas	0.3 inches
Maximum Infiltration Rate	0.51 inches/hour
Minimum Infiltration Rate	0.50 inches/hour
Decay Rate	0.0018 inches/sec
Zero Detention Depth	1%
Manning's n Value for Pervious Surfaces	0.025
Manning's n Value for Impervious Surfaces	0.016

4.3.2 Pervious-Impervious Area

Table RO-14 should be used to determine preliminary percentages of impervious land cover for a given land-use or zoning. The final design must be based on the actual physical design conditions of the site.

Table RO-14

Percent Imperviousness Relationship to Land Use*

LAND USE OR ZONING	**PERCENT IMPERVIOUS (%)**
Business:	
T	20
CCN, CCR, CN	70
E, RDR, CC, LC	80
C, NC, I, D, HC, CS	90
Residential:	
RF,UE	30
RL, NCL	45
LMN,NCM	50
MMN, NCB	70
Open Space:	
Open Space and Parks (POL)	10
Open Space along foothills ridge (POL,RF)	20
RC	20

*For updated zoning designations and definitions, please refer to Article Four of the City Land Use Code, as amended

4.3.3 Conveyance Element Methodology

Embedded conveyance elements must begin at the midpoint of the sub-basin in order to appropriately represent the basin based on its actual physical characteristics.

4.3.4 Basin Width

Basin width must be calculated as the area of the basin divided by the length of the basin. The basin length is defined as the length of the concentrated flow.

4.3.5 Dynamic Flow Analysis

Conditions may arise where a steady flow hydraulic analysis may not provide sufficient information on the operation of drainage facilities. This is especially of concern when analyzing detention ponds inter-connected by culverts or storm sewers and where release rates and pond volumes may be affected. In such cases, if the Utilities Executive Director determines that additional analysis is required for an adequate evaluation of proposed drainage facilities, an unsteady flow hydraulic analysis using hydrographs generated from SWMM and the EXTRAN block of SWMM may be required.

(10) *Section 5.0* is deleted in its entirety.

(11) *Section 5.1* is deleted in its entirety.

(12) *APPENDIX A* is deleted in its entirety.

(13) *Table RO-1* is deleted in its entirety.

(14) *Table RO-6* is deleted in its entirety.

(15) *Table RO-7* is deleted in its entirety.

(16) *Table RO-8* is deleted in its entirety.

(17) *Table RO-9* is deleted in its entirety.

(18) *Table RO-A1* is deleted in its entirety.

(19) *Table RO-10* Rational Method Minor Storm Runoff Coefficients for Zoning Classifications is added.

(20) A new *Table RO-11* Rational Method Runoff Coefficients for Composite Analysis is added.

(21) A new *Table RO-12* Rational Method Frequency Adjustment Factors is added.

(22) A new *Table RO-13* SWMM Input Parameters is added.

(23) A new *Table RO-14* Land Use Versus percent Imperviousness is added.

(24) *Figure RO-9* is deleted in its entirety.

(25) *Figure RO-10* is deleted in its entirety.

(26) *Figure RO-A1* is deleted in its entirety.

(27) *Figure RO-A2* is deleted in its entirety.

(28) *Figure RO-A3* is deleted in its entirety.

(29) *Figure RO-A4* is deleted in its entirety.

(30) *Figure RO-A5* is deleted in its entirety.

(31) *Figure RO-A6* is deleted in its entirety.

(32) *Figure RO-A7* is deleted in its entirety.

(33) *Figure RO-A8* is deleted in its entirety.

(34) *Figure RO-A9* is deleted in its entirety.

(35) *Figure RO-A11* is deleted in its entirety.

***(D) Volume1, Chapter 6* - Streets/Inlets/Storm Sewers:**

(1) *Section 2.2* is amended to read as follows:

2.2 Design Requirements

(a) The Minor (or Initial) Storm is designated as the 2-year storm. The Major Storm is designated as the 100-year storm.

(b) The encroachment of gutter flow on the street for the 2-year storm runoff must not exceed the criteria set forth in Table ST-2. A storm drainage system must begin where the encroachment reaches the limits found in this table.

Table ST-2

Pavement Encroachment Standards for the Minor (i.e., 2-Year) Storm

Street Classification	Maximum Encroachment* **
Local (includes places, courts, and alleys)	No curb-topping. Flow may spread to crown of street.
Collector and Arterial (Without Median)	No curb-topping. Maximum six (6) inch flow depth at the gutter. Flow spread must leave at least a six (6) foot wide clear travel lane on the one-half street section
Arterial (with Median)	No curb-topping. Maximum six (6) inch flow depth at the gutter. Flow spread must leave at least a twelve (12) feet wide clear travel lane in each direction

*Where no curbing exists, encroachment must not extend over property lines.
** These criteria apply only to City streets where no floodplain has been designated. For areas with designated floodplains, please refer to Chapter 10 of the City Code for further guidance.

(c) Standards for the Major Storm and cross-street flows are also required. The Major Storm needs to be assessed to determine the potential for flooding and public safety. Cross-street flows also need to be regulated for traffic flow and public safety reasons. The City has established street inundation standards during the Major Storm event and allowable cross-street flow standards for the Minor (2-year) Storm and the Major (100-year) Storm.

(d) Table ST-3 sets forth the allowable street encroachment for the 100-year storm runoff.

Table ST-3

Street Inundation Standards for the Major (i.e., 100-Year) Storm

Street Classification	Maximum Encroachment **
Local, Collector and Arterial (without Median)	The depth of water at the street crown shall not exceed six (6) inches to allow operation of emergency vehicles, the depth of water over the gutter flow line shall not exceed twelve (12) inches, and the flow must be contained within the right-of-way or easements paralleling the right-of-way. The most restrictive of the three criteria shall govern.
Arterial (with Median)	The depth of water must not exceed the bottom of the gutter at the median to allow operation of emergency vehicles, the depth of water over the gutter flow line shall not exceed twelve (12) inches, and the flow must be contained within the right-of-way or easements paralleling the right-of-way. The most restrictive of the three criteria shall govern.

** These criteria apply only to City streets where no floodplain has been designated. For areas with designated floodplains, please refer to Chapter 10 of the City Code for further guidance.

(e) Table ST-4 sets forth the allowable cross-street flow for the Minor (2-Year) and the Major (100-Year) Storm events.

Table ST-4

Allowable Cross-Street Flow

Street Classification	Minor (2-Year) Storm Flow	Major (100-Year) Storm Flow
Local	Six (6) inches of depth in cross pan.	Eighteen (18) inches of depth above gutter flow line.
Collector	Where cross pans are allowed, depth of flow should not exceed six (6) inches in cross pan	Twelve (12) inches of depth above gutter flow line.
Arterial	None.	No cross flow. Maximum depth at upstream gutter on road edge of twelve (12) inches.

(f) Once an allowable spread (pavement encroachment) has been established for the Minor Storm, the placement of inlets can be determined. The inlets will remove some or all of the excess stormwater and thus reduce the spread. The placement of inlets is covered in Section 3.0 of this chapter. It should be noted that proper drainage design utilizes the full allowable capacity of the street gutter in order to limit the cost of inlets and storm sewers.

(g) Another important design consideration is the frequency of occurrence of the Minor Storm. In other words, the design engineer must factor into his design how often the spread of stormwater will reach or exceed the maximum encroachment limit. This is addressed by assigning a frequency (or recurrence interval) for the Minor Storm for

various street classifications. The selection of a design frequency is based on many factors including street function, traffic load and vehicle speed. In the city of Fort Collins, the Minor Storm recurrence interval is the 2-year storm for all street classifications.

(h) For street sump locations, provisions must be included to carry the 100-year runoff in a pipe or an overflow channel to an acceptable outfall while the maximum water surface depth criteria as designated in Table ST-2 and in Table ST-3 are not violated.

(i) An access and maintenance easement for the overflow drainage facility must be provided if that facility is not contained within the public right-of-way.

(j) Two additional design considerations of importance in street drainage are gutter (channel) shape and street slope. Most urban streets contain curb and gutter sections. Various types exist including spill shapes, catch shapes, curb heads, and roll gutters. The shape is chosen for functional, economic, or aesthetic reasons and does not dramatically affect the hydraulic capacity. Swales are common along some urban and semi-urban streets, and roadside ditches are common along rural streets. Their shapes are important in determining hydraulic capacity and are covered in the next chapter.

(2) *Table ST-2* Pavement Encroachment Standards for the Minor (i.e., 2-Year) Storm is amended

(3) *Table ST-3* Street Inundation Standards for the Major (i.e., 100-Year) Storm is amended

(4) *Table ST-4* Allowable Cross-Street Flow is amended

(5) A new *Section 3.5* is added, to read follows:

3.5 Inlet Design and Construction Standards

(a) Storm inlets must be designed and installed where sump (low-spot) conditions exist or when allowable street capacities are exceeded. The outlet pipe of the storm inlet must be sized on the basis of the theoretical capacity of the inlet, with a minimum diameter of fifteen (15) inches, or a minimum dimension of twelve (12) inches if elliptical or arch pipe is used.

(b) All curb openings must be installed with the opening at least two (2) inches below the flow line elevation. The minimum transition length allowed is five (5) feet

(c) Any curb opening greater than six (6) inches in height must have a metal bar welded horizontally across the inlet for public safety purposes such that no opening height is greater than six (6) inches.

(d) All inlet covers must be stenciled or stamped with the following designation: NO DUMPING - DRAINS TO POUDRE RIVER

(6) A new *Section 4.5* is added, to read as follows:

4.5 Storm Sewer System Construction Standards

Construction of all stormwater facilities must be built in accordance the approved Water Utilities Development Construction Standards or the Water Utilities Capital Construction Standards as appropriate.

(E) *Volume 1, Chapter 7*- Major Drainage:

(1) Section 3.2.8 is amended to read as follows:

3.2.8 Open Channel Design

The minimum design criteria requirements listed below must be satisfied.

3.2.8.1 Natural Channels (Open Floodplain Design)

For development sites located out of the 100-year floodplain, the following open channel requirements must be met:

1. If the total flow of the channel and floodplain is confined to an incised channel and erosion can be expected to endanger adjacent structures, 100-year check structures are required to control erosion and degradation of the channel area. See Volume 2, Chapter 8, "Hydraulic Structures", of this Manual for more information. In addition, sufficient right-of-way must be reserved to install the equivalent of a trapezoidal grass-lined channel that satisfies the velocity criteria specified in Table MD-2. Extra width must be reserved where drop structures are needed, in which locations a twenty (20) foot-wide maintenance access bench must be provided along one side of the channel.

2. If the floodplain is wide and the low-flow channel represents a small portion of the floodplain area, low-flow check structures are usually required, unless it can be demonstrated that the channel will remain stable as the watershed urbanizes.

3. Consult the applicable City's Master Drainage Plan document for guidance on the design event and stable stream or waterway longitudinal slope.

4. For either of the above cases, a maintenance access trail must be provided. It should be designed according to the guidelines for grass-lined channels in Section 3.2.8.3, below.

3.2.8.2 Open Floodway Design (Natural Channel with Floodplain Encroachment)

Although floodplain preservation is preferable, when the development involves preserving the floodway while filling and building on the fringe area, the open channel design must meet the all the requirements in listed Section 3.2.8.1 of this chapter, as well as the following requirements listed below for fill.

The fill slopes must be adequately protected against erosion with:

1. Fill slopes of four to one (4H:1V) or flatter that are vegetated in accordance with the criteria listed in the "Revegetation" chapter of this Manual (Volume 2, Chapter 12).

2. Fill slopes must be protected by rock (not broken concrete or asphalt) riprap meeting City criteria with up to two and a half to one (2.5H:1V) slopes.\

3. Retaining walls must not be not taller than three and a half (3.5) feet, with adequate foundation protection.

3.2.8.3 Grass-Lined Channel Design

The design for a grass-lined channel must meet the following criteria:

1. Side slopes must be four to one (4H:1V) or flatter.

2. Continuous maintenance access, such as with a trail, must be provided. The stabilized trail surface must be at least eight (8) feet wide with a clear width of twelve (12) feet. It must be located above the minor (2-year) event water surface elevation, but never less than two (2) feet (three feet for streams with perennial flow) above that elevation. Trail profiles need to be shown for all critical facilities such as roadway crossings, stream crossings and drop structures. All access trails shall connect to public streets. Maintenance trails need not be paved, but must be of all-weather construction such as aggregate base course, crusher fines, recycled concrete course or Aggregate Turf Reinforced Grass Pavement (RGP) described in Volume 3 of this Manual and capable of sustaining loads associated with large maintenance equipment. Paved trails are encouraged to allow for recreational use of the trails. When paved, pavement should be five (5) inches minimum thickness of concrete (not asphalt). Maximum longitudinal slope for maintenance-only trails is ten percent (10%), but less than five percent (5%) when used as multi-purpose recreational trails to meet the requirements of the *Americans with Disabilities Act*. The Utilities Executive Director may accept adjacent public local streets or parking lots as maintenance access in lieu of a trail, if he or she determines that a modification of this requirement is appropriate.

3. A low-flow or trickle channel is desirable. See Section 4.1.5 of this chapter for criteria.

4. Wetland bottom and bioengineered channels are acceptable when designed according to City wetland bottom channel criteria in Section 4.2 of this chapter.

5. The channel bottom minimum cross slope for dry bottom channels shall be one percent (1%).

6. Tributary inflow points shall be protected all the way to the low-flow channel or trickle channel to prevent erosion. Inflow facilities to wetland bottom channels shall have their inverts at least two (2) feet above the channel bottom to allow for the deposition of sediment and shall be protected with energy dissipaters.

7. All roadway crossings of wetland bottom channels shall incorporate a minimum of a stabilized two (2) foot drop from the outlet to the bottom of the downstream channel in order to preserve hydraulic capacity as sediment deposition occurs over time in the channel.

8. All drop structures must be designed in accordance with the “Hydraulic Structures” chapter of this Manual. Underdrain and storm sewer outlets located below the stilling basin’s end-sills are not acceptable. Construction plans must utilize City standard details.

9. Storm sewer outlets must be designed in accordance with the criteria in Sections 5.0, 6.0, and 7.0 of this chapter. Alternatively, conduit outlet structures, including low tailwater riprap basins design described in Section 3.0 of the “Hydraulic Structures” chapter of this Manual must be used when appropriate.

10. Grouted boulder rundowns and similar features must be designed in accordance with Section 7.0 of the "Hydraulic Structures" chapter of this Manual.

11. Grass seeding specifications provided by the City (see the "Revegetation" chapter of this Manual) are recommended unless irrigated blue grass is used. The City will not maintain irrigated blue grass..

(2) Section 3.3.3 is amended to read as follows:

3.3.3 Environmental Permitting Issues

Environmental permitting, in particular wetland permitting, must be considered in selection of the type of major drainage channel. To assist with the selection of type of channel or drainageway improvements to be used, a flow chart is presented in Figure MD-4. The flow chart contains a series of questions to be considered in light of the requirements in this Manual and the requirements of the Clean Water Act, Section 404 (dredge and fill in jurisdictional wetlands and "Waters of the United States").

Following along with the chart, the first step is to determine whether channelization is needed or desired. In many cases, a well-established natural drainageway and its associated floodplain can be preserved and protected from erosion damage. Therefore, before deciding to channelize, assess whether the value of reclaimed lands will justify the cost of channelization and whether a new channel will provide greater community and environmental benefits than the existing drainageway.

If the decision is to neither channelize nor re-channelize an existing drainageway, investigate the stability of the natural drainageway and its banks, design measures to stabilize the longitudinal grade and banks, if needed, and obtain any necessary, Section 404 permits and other approvals for these improvements.

If the decision is to channelize, then determine whether the existing natural drainageway has a perennial flow, evidence of wetland vegetation, or is a well-established ephemeral channel. This will often require the assistance of a biologist with wetland training. If any of these conditions exist, then the project is likely to be subject to individual or nationwide Section 404 permitting requirements. Regardless, it is suggested that the designer check with the local United States Army Corps of Engineers (USACE) office early to determine which permit will be needed. Keep in mind that it is the responsibility of the proponent to comply with all applicable Federal and State laws and regulations. Approvals by the City do not supersede or waive compliance with these laws.

(3) Section 3.3.4 is amended to read as follows:

3.3.4 Maintenance

(a) All major drainage channels in urban areas will require maintenance to ensure that they are capable of conveying their design flow, such as the 100-year flow (as well as more frequently occurring flows) and to ensure that channels do not become a public nuisance and eyesore. Routine maintenance (i.e., mowing for weed control or annual or seasonal clean-outs), unscheduled maintenance (i.e., inspection and clean-out after large events) and restorative maintenance after some years of operation should be expected.

(b) Native tall grasses may require mowing three to six times a year or on a less frequent schedule, depending on the type of channel and setting. Mowing cuts down the presence of standing dead grasses and places them on the ground where decomposition can take

place. Often mowing of dry-land native grasses during the growing season may not be necessary, except for weed control.

(c) A maintenance access platform with a minimum passage width of twelve (12) feet shall be provided along the entire length of all major drainageways except at drop structures, where a twenty (20) foot maintenance platform is needed

(d) When public or private drainage channels and associated facilities abut private property, it is the responsibility of the parties involved, whether they are public or private, to develop and implement a policy regarding fencing and safety.

(4) Section 4.1.1.5 is amended to read as follows:

4.1.1.5 Design Discharge Freeboard

All open channels shall be designed with a freeboard. Freeboard for major channels (defined as those with capacity in excess of one hundred (100) cfs) must be a minimum of one foot of extra depth. Freeboard for minor channels (defined as those carrying less than one hundred (100) cfs design flow) must be designed to handle a minimum of an additional 33 percent of runoff, over and above the 100-year design flow.

(5) *Table MD-2* is adopted with the following modification:

The minimum riprap Manning's-n value used to check for stability is 0.07.

(6) *Table MD-3* is adopted with the following modification:

All references to "District Maintenance Eligibility" shall be deleted.

(7) *Table MD-4* is adopted with the following modification:

All references to "District Maintenance Eligibility" shall be deleted.

(8) *Section 4.3.6* is deleted in its entirety.

(9) *Table MD-6* is adopted with the following modification:

All references to "District Maintenance Eligibility" shall be deleted.

(10) *Table MD-7* is adopted with the following modification:

All references to Type VL and Type L riprap designations shall be deleted.

(11) *Table MD-10* is adopted with the following modification:

All references to Type VL and Type L riprap designations shall be deleted.

(12) *Table MD-12* is adopted with the following modification:

All references to Type VL and Type L riprap designations shall be deleted.

(13) A new section 4.4.4.3 is added, to read as follows:

4.4.4.3 Riprap Specifications and Applicability

(a) Riprap applications must be designed by a professional engineer familiar with the design of stormwater conveyance systems and structures.

(b) The minimum mean particle size (intermediate dimension) by weight for riprap, commonly known as the $D_{50,}$ is twelve (12) inches.

(c) All riprap must be angular in shape and clean; no round shaped rocks are allowed.

(d) Riprap coloring must be specified to blend with the existing soil and environment where it will be placed in a manner that will present the smallest amount of visual contrast.

(e) Riprap shall only be used when other methods of protection or stabilization are not appropriate or possible. Riprap alternates with the exception of gabions are recommended whenever practical. Manufactured channel lining or revetment treatments such as Turf Reinforcement Mats (TRMs), erosion control matting, geotextiles, Articulating Concrete Blocks (ACBs), partially-grouted riprap, and other flexible linings are encouraged in lieu of standard riprap applications. These alternates will be considered by the City on a case-by-case basis in order to determine the most appropriate material that should be specified under particular conditions and for different applications.

(14) *Table MD-13* is adopted with the following modification:
All references to "District Maintenance Eligibility" shall be deleted.

(15) *Section 10.0* is adopted with the following modification:
All references to "Rosgen, D., 1996, "Applied River Morphology" shall be deleted.

(F) ***Volume 2, Chapter 8*** **- Hydraulic Structures:**

(1) *Section 2.4.4* is deleted in its entirety.

(2) *Section 2.8.3* is deleted in its entirety.

(3) *Section 3.4.3.2* is adopted with the following modifications:

a. Equation (HS-17) is amended to read as follows:

$T = 2D_{50}$ (HS-17)

And:

b. All references to Type L riprap shall be deleted from *Table HS*-9

(4) *Section 4.1.2* is deleted in its entirety.

(5) *Section 8.1* is amended to read as follows:

8.1 General

Maintenance of hydraulic structures includes removing debris, excessive vegetation and excessive sediment. Replacing or realigning erosion protection, stones, repairing grout and concrete, and replacing warning signs are items of maintenance that must be performed regularly under normal conditions. Other maintenance activities that can be reasonably expected for specific structures must also be performed on a regular basis.

(6) *Table HS-6* is deleted in its entirety.

(7) *Table HS-9* is adopted with the following modification:

All references to Type L riprap shall be deleted

(8) *Figure HS-9* is deleted in its entirety.

(9) *Figure HS-10* is deleted in its entirety.

(G) *Volume 2, Chapter 9* - Culverts:

(1) *Section 3.5.3* is amended to read as follows:

3.5.3 Culvert Diameter

(a) The diameter of pipe that will meet the headwater requirements must be determined after the invert elevations have been assumed, using the design computation forms (e.g., Figure CU-8), the capacity charts (e.g., Figure CU-7), and the nomographs.

(b) To help prevent plugging of small diameter pipes, the minimum allowable culvert diameter is fifteen (15) inches for round pipe. The minimum inside dimension will be no less than twelve (12) inches for elliptical and arch pipe. .

(2) *Section 3.5.5* is amended to read as follows:

3.5.5 Culvert Materials

All culvert design and construction must comply with the same material and construction requirements as those specified in Volume 1, Chapter 6, Section 4.5, "Storm Sewer System Construction Standards", of this Manual and with the approved City Water Utilities Standard Construction Specifications.

(3) *Section 8.3* is amended to read as follows:

8.3 Grate Specifications

(a) Where a structure presents a safety hazard such as when a siphon, a significant drop in elevation adjacent to a sidewalk or road, a long pipe with one or more manholes, or at pipes near playgrounds, parks and residential areas, a grate may be required. For most culverts through embankments and crossing streets, grates will not be required. The grate open area must be at least four times the open area of the pipe.

(b) When called for, grates must meet the following requirements:

1. Grating must be constructed of smooth steel bars with a minimum diameter of five eighth of an inch. Reinforcing bars shall not be used.
2. Welded connections must be a quarter inch thick at the minimum.
3. Spacing between bars must normally be five (5) inch unless site conditions are prohibitive.
4. All exposed steel must be galvanized in accordance with AASHTO M 111.
5. Welded joints must be galvanized with a rust preventive paint.
6. Grates must be secured to the headwall or end section by removable devices such as bolts or hinges to allow maintenance access, prevent vandalism, and prohibit entrance by children.
7. Locks for hinged grates will be provided by the City.
8. Trash racks must be set at angles that are no steeper than three to one (3:1 H:V).

(4) *Photograph CU-6* is deleted in its entirety

(H) *Volume 2, Chapter 10* - Storage:

(1) *Section 3.1.1* is amended to read as follows:

3.1.1 Use of Simplified On-Site Detention Sizing Procedures

(a) There are two methodologies approved by the City for sizing detention storage basins, the Rational Formula-based Federal Aviation Administration (FAA) procedure and the Stormwater Management Model (SWMM). The City is the determining authority regarding the appropriate methodology to use under different circumstances. Early contact with the City is encouraged for the timely determination of the appropriate detention storage sizing methodology.

(b) In general, the Rational Formula-based FAA procedure may only be used in the design of detention storage facilities with tributary areas that are less than five (5) acres in size. The Stormwater Management Model (SWMM) must be used to model and size stormwater detention storage facilities with tributary areas of twenty (20) acres or more. Preliminary sizing of detention storage volume may be performed for site planning purposes using the Rational Formula-based FAA procedure in conjunction with a twenty (20) percent upward adjustment to account for the larger resulting storage volume that would be obtained from SWMM modeling.

(c) For tributary areas between five and twenty (20) acres in size, either SWMM or the Rational Formula-based FAA procedure may be used to calculate detention storage volume. However, if the Rational Formula-based FAA procedure is chosen as the preferred method, the resulting storage volume must be increased by a factor of twenty (20) percent to better match the result that would be obtained from SWMM modeling.

(2) *Section 3.1.2* is amended to read as follows:

3.1.2 Detention Pond Hydrograph Sizing Procedure

(a) Whenever the area limits described above in Section 3.1.1 are exceeded (for tributary catchments larger than twenty acres for the FAA Procedure) the City requires the use of hydrograph flood routing procedures (e.g., using SWMM reservoir routing calculations). In addition, if there are upstream detention facilities in the watershed that catch and route runoff for portions of the upstream tributary area, hydrograph routing methods must be employed.

(b) If off-site tributary areas contribute runoff to an on-site detention storage facility, the total tributary area at existing development rate must be accounted for in the design of the storage facility by routing the flows generated by that off-site area around the proposed storage facility or, by fully accounting for these flows in the design of the spillway system for that storage facility.

(3) *Section 3.1.3* is amended to read as follows:

3.1.3 Water Quality Capture Volume in Sizing Detention Storage

When detention storage volume is sized for a site that also incorporates a water quality capture volume (WQCV) defined in Volume 3 of this Manual, the 100-year volume required for quantity detention must be added to the entire WQCV. The WQCV must also be added in its entirety to the required 5- or 10-year volume.

(4) *Section 3.2.1* is deleted in its entirety.

(5) *Section 3.2.2* is deleted in its entirety.

(6) *Section 3.2.3* is amended to read as follows:

3.2.3 Rational Formula-Based Modified FAA Procedure

The Rational Formula-based Federal Aviation Administration (FAA) (1966) detention sizing method (sometimes referred to as the "FAA Procedure"), as modified by Guo (1999a), provides a reasonable estimate of storage volume requirements for on-site detention facilities. This method provides sizing for one level of peak control only and not for multi-stage control facilities.

The input required for this Rational Formula-based FAA volume calculation procedure includes:

A = area of the catchment tributary to the storage facility (acres)

C = runoff coefficient

Q_{po} = allowable maximum release rate from the detention facility

T_c = time of concentration for the tributary catchment (minutes) (see the Runoff chapter)

P_i = 2-hour design rainfall depth (inches) at the site taken from the Rainfall chapter for the relevant return frequency storms

The calculations are best set up in a tabular (spreadsheet) form with each 5-minute increment in duration being entered in rows and the following variables being entered, or calculated, in each column:

1. Storm Duration Time, T (minutes), up to 180 minutes.
2. Rainfall Intensity, I (inches per hour).
3. Inflow volume, Vi (cubic feet), calculated as the cumulative volume at the given storm duration using the equation:

$$Vi = CIA\,(60T) \qquad \text{(SO-6)}$$

4. Outflow adjustment factor m (Guo 1999a):

$$m = 1/2\,(1 + T_c/T) \qquad 0.5 \le m \le 1 \text{ and } T \ge Tc \qquad \text{(SO-7)}$$

5. Calculated average outflow rate, Q_{av} (cfs), over the duration T:

$$Q_{av\,v} = m\,Q_{po} \qquad \text{(SO-8)}$$

6. Calculated outflow volume, V_o, (cubic feet), during the given duration and the adjustment factor at that duration calculated using the equation:

$$V_o = Q_{av}\,(60\,T) \qquad \text{(SO-9)}$$

7. Required storage volume, Vs (cubic feet), calculated using the equation:

$$Vs = V_i - V_o \qquad \text{(SO-10)}$$

The value of *Vs* increases with time, reaches a maximum value, and then starts to decrease. The maximum value of *Vs* is the required storage volume for the detention facility. Sample calculations using this procedure are presented in Design Example 6.2. The modified *FAA Worksheet* of the UD-Detention Spreadsheet performs these calculations.

(7) *Section 3.2.4* is deleted in its entirety.

(8) *Section 3.2.5* is deleted in its entirety.

(9) *Section 3.2.6* is deleted in its entirety.

(10) *Section 3.2.7* is deleted in its entirety.

(11) *Section 3.3.3* is amended to read as follows:

3.3.3 Spillway Sizing and Design

(a) The overflow spillway of a storage facility must be designed to pass flows in excess of the design flow of the outlet works. When the storage facility falls under the jurisdiction of the Colorado State Engineer's Office (SEO), the spillway's design storm is prescribed by the SEO. If the storage facility is not a jurisdictional structure, the size of the spillway design storm must be based upon analysis of the risk and consequences of a facility failure. Generally, embankments should be fortified against and/or have spillways that, at a minimum, are capable of conveying the total not-routed peak 100-year storm discharge from a fully developed total tributary catchment, including all off-site areas, if any. However, detailed analysis, of downstream hazards must be performed and may indicate that the embankment protection and, or spillway design needs to be sized for events much larger than the 100-year design storm.

(b) The detention pond spillway crest must be set at the 100-year water surface elevation in the pond and the spillway shall be designed such that any spills shall be no more than six (6) inches in depth at the crest during the 100-year storm. The detention pond top of embankment shall be set at all points a minimum of one foot above the spillway crest elevation.

(c) Emergency spillways must be protected from catastrophic erosion failure through the use of bank protection procedures downhill from the spillway to the toe of slope. The slope protection for spillway embankments shall be designed in accordance with all the specifications set forth in Volume 1, Chapter 7, Major Drainage, Section 4.4.4.3, "Riprap Specifications and Applicability", of this Manual.

(d) A concrete cutoff wall eight inches in thickness, three feet deep, extending five feet into the embankment beyond the spillway opening is required on private detention ponds larger than one acre-foot in volume and are also required on all publicly-owned regional detention ponds larger than that size. The emergency spillway crest elevation must be tied back to the top of the pond embankment at a maximum slope of four to one.

(12) *Section 3.3.4* is amended to read as follows:

3.3.4 Retention Facilities

(a) A retention facility (a basin with a zero release rate or a very slow release rate) is used on a temporary basis when there is no available formal downstream drainageway, or one that is grossly inadequate. When designing a retention facility, the hydrologic basis of design is difficult to describe because of the stochastic nature of rainfall events. Thus,

sizing for a given set of assumptions does not ensure that another scenario produced by nature (e.g., a series of small storms that add up to large volumes over a week or two) will not overwhelm the intended design. For this reason, retention basins are not permissible as a permanent solution for drainage problems. When used, they can become a major nuisance due to problems that may include mosquito breeding, safety concerns, odors, etc.

(b) When temporary use of a retention basin is proposed as a solution, the City requires that it be sized to capture, at a minimum, the runoff equal to two times the two hour, 100-year storm plus one foot of freeboard. The facility must be situated and designed so that when it overtops, no human-occupied or critical structures (e.g., electrical vaults, homes, etc.) will be flooded, and no catastrophic failure at the facility (e.g., loss of dam embankment) will occur. It is also required that retention facilities be as shallow as possible to encourage infiltration and other losses of the captured urban runoff. When a trickle outflow can be accepted downstream or a small conduit can be built, it shall be provided and sized in accordance with the locally approved release rates, and be preferably capable of emptying the full volume in seventy-two (72) hours or less.

(c) All retention ponds must be built with a pump back-up system and with a concrete hard surface at the bottom of the pond that is capable of evacuating the full volume in seventy-two (72) hours or less.

(d) All retention ponds must be built and operated in accordance with all applicable State and Federal laws and must respect all established water rights.

(13) *Section 3.4* is amended to read as follows:

3.4 Reservoir Routing of Storm Hydrographs for Sizing of Storage Volumes

The reservoir routing procedure for the sizing of detention storage volumes is more complex and time consuming than the use the FAA procedure. Its use requires the designer to develop an inflow hydrograph for the facility. This is generally accomplished using SWMM computer models as described in the RUNOFF chapter of this Manual. The hydrograph routing sizing method is an iterative procedure that follows the steps detailed below (Guo 1999b).

1. Select Location: The detention facility's location must be based upon criteria developed for the specific project. Regional storage facilities are normally placed where they provide the greatest overall benefit. Multi-use objectives (e.g. use of the detention facility as a park or for open space, preserving or providing wetlands and/or wildlife habitat, or others uses and community needs) influence the location, geometry, and nature of these facilities.

2. Determine Hydrology: Determine the inflow hydrograph to the storage basin and the allowable peak discharge from the basin for the design storm events. The hydrograph may be available in City's published Master Drainage Plans or other basin-wide studies. The allowable peak discharge is limited by the local criteria or by the requirements spelled out in the City-approved Master Drainage Plan.

3. Initial Storage Volume Sizing: It is recommended that the initial size of the detention storage volume be estimated using the modified FAA method described in Section 3.2.3 or the hydrograph volumetric method detailed in Section 3.4.1.

4. Initial Shaping of the Facility: The initial shape of the facility must be based upon site constraints and other goals for its use discussed under item 1, above. This initial shaping is needed to develop a stage-storage-discharge relationship for the facility. The design spreadsheets of this Manual are useful for initial sizing.

5. Outlet Works Preliminary Design: The initial design of the outlet works entails balancing the initial geometry of the facility against the allowable release rates and available volumes for each stage of hydrologic control. This step requires the sizing of outlet elements such as a perforated plate for controlling the releases of the WQCV, orifices, weirs, outlet pipe, spillways, etc.

6. Preliminary Design: A preliminary design of the overall detention storage facility must be completed using the results of steps 3, 4 and 5, above. The preliminary design phase is an iterative procedure where the size and shape of the basin and the outlet works are checked using a reservoir routing procedure and then modified as needed to meet the design goals. The modified design is then checked again using the reservoir routing and further modified if needed. Though termed "preliminary design," the storage volume and nature and sizes of the outlet works are essentially in final form after completing this stage of the design. They may be modified, if necessary, during the final design phase.

7. Final Design: The final design phase of the storage facility is completed after the hydraulic design has been finalized. This phase includes structural design of the outlet structure, embankment design, site grading, a vegetation plan, accounting for public safety, spillway sizing and assessment of dam safety issues, etc.

(14) *Section 4.3* is amended to read as follows:

4.3 Geometry of Storage Facilities

(a) The geometry of a storage facility depends on specific site conditions such as adjoining land uses, topography, geology, preserving or creating wildlife habitat, volume requirements, etc. Several key features must be incorporated in all storage facilities located within the City (see Figure SO-6). These include:

i. Four to one (4H : 1V) or flatter side slopes of all banks.
ii. Low-flow or trickle-flow channel unless a permanent pool takes its place or the pond is designed to handle low flows through infiltration.
iii. Forebay.
iv. Pond bottom sloped at least one percent to drain toward the low-flow or trickle-flow channel or the outlet.
v. Emergency spillway or fortification of the embankment to prevent catastrophic failure when overtopped, spillway shall be designed to safely convey the 100-year overtopping discharge for the entire area tributary to the storage facility.
vi. The micro pool surface elevation must be set at an elevation equal to the invert of the pond which results in the value of D_{MP} being set at 0 ($D_{MP} = 0$) as shown in Figure SO-6 of this Manual.

(b) For safety as well as maintenance considerations, the maximum allowable ponding depth of water in a detention storage facility during the 100-year, 2-hour storm event is ten (10) feet.

(c) Detention storage facilities must be located at least twenty (20) feet away from an irrigation canal or ditch. Whenever a detention pond parallels a canal no more than twenty percent (20%) of the detention pond perimeter can be parallel to the irrigation canal.

(d) In ponds that contain a littoral zone, the littoral zone should be very flat (i.e. 40H:1V or flatter) with the depth ranging from six (6) inches near the shore and extending to no more than twelve (12) inches at the furthest point from the shore.

(e) For more detailed guidance regarding pond shaping and geometry please refer to the document titled "Detention Pond Landscape Standards and Guidelines" dated November 2009 included as an addendum to this Manual.

(15) *Section 4.8* is amended to read as follows:

4.8 Trash Racks

Trash racks must be of sufficient size such that they do not interfere with the hydraulic capacity of the outlet. See Figure SO-7 for minimum trash rack sizes. Trash racks must be designed in accordance with the specifications set forth in Volume 2, Chapter 9, Culverts, Section 8.3, "Grate Specifications" and with the City's Water Utilities Development Construction Standards.

(16) *Section 4.9* is amended to read as follows:

4.9 Landscaping

Detention storage facilities must be landscaped to provide a water quality benefit as well as an aesthetically pleasing amenity. Landscaping should be accomplished with native vegetation whenever possible to reduce the amount of irrigation required after establishment**.** All detention ponds must be designed and constructed in accordance with the "Detention Pond Landscaping Standards and Guidelines" dated November 2009 included as an addendum to this Manual.

(17) *Section 4.10* is amended to read as follows:

4.10 Operation and Maintenance

The performance and reliability of detention storage facilities can be reduced by natural and man-made debris, as well as natural and man-induced sedimentation. These can, over a period of time, reduce the storage capacity of a detention basin and thereby reduce the degree of flood protection provided. The obstruction of outflow conduits by debris and sediment can reduce outlet capacity and cause the premature filling of the detention basin with stormwater, again reducing the flood protection provided by the structure. Consequently, adequate care must be exercised in design to provide for protection of the outlet works from debris and for the control and regular removal of sedimentation in the basin.

Maintenance requirements during design include the following:

1. Use of flat side slopes along the banks and the installation of landscaping (thick, thorny shrubs) that will discourage entry along the periphery near the outlets and steeper embankment sections are advisable. Use of a safety railing at vertical or steeper than four to one structural faces is required to promote public safety. If the impoundment is situated at a lower grade than, and adjacent to a highway, installation of a guardrail is in order. Providing features to discourage public access to the inlet and outlet areas of the facility must be considered.
2. The facility must be accessible to maintenance equipment for removal of silt and debris and for repair of damages that may occur over time. Easements and/or rights-of-way are required to allow access to the impoundment by the owner or agency responsible for maintenance.

3. Bank slopes, bank protection needs, and vegetation types are important design elements for site aesthetics and maintainability.
4. Permanent ponds must have provisions for complete drainage for sediment removal or other maintenance. The frequency of sediment removal will vary among facilities, depending on the original volume set aside for sediment, the rate of accumulation, rate of growth of vegetation, drainage area erosion control measures, and the desired aesthetic appearance of the pond.
5. For facilities designed for multipurpose use, especially those intended for active recreation, the play area might need special consideration during design to minimize the frequency and periods of inundation and wet conditions. It may be advisable to provide an underground tile drainage system if active recreation is contemplated.
6. Adequate dissolved oxygen supply in ponds (to minimize odors and other nuisances) can be maintained by artificial aeration. Use of fertilizer and EPA approved pesticides and herbicides adjacent to the permanent pool pond and within the detention basin must comply with all State and Federal regulations.
7. Secondary uses that would be incompatible with sediment deposits should not be planned unless a high level of maintenance will be provided.
8. French drains or the equivalent are almost impossible to maintain, and should be used with discretion where sediment loads are apt to be high.
9. Underground tanks or conduits designed for detention should be sized and designed to permit pumping or multiple entrance points to remove accumulated sediment and trash.
10. All detention facilities should be designed with sufficient depth to allow accumulation of sediment for several years prior to its removal.
11. Permanent pools should be of sufficient depth to discourage excessive aquatic vegetation on the bottom of the basin, unless specifically provided for water quality purposes.
12. Often designers use trash racks and/or fences to minimize hazards. These may become trap debris, impede flows, hinder maintenance, and, consequently, fail to prevent access to the outlet. On the other hand, desirable conditions can be achieved through careful design and positioning of the structure, as well as through landscaping that will discourage access (e.g., positioning the outlet away from the embankment when the permanent pool is present, etc.). Creative designs, integrated with innovative landscaping, can be safe and can also enhance the appearance of the outlet and pond. Such designs often are less expensive initially.
13. To reduce maintenance and avoid operational problems, outlet structures should be designed with no moving parts (i.e., use only pipes, orifices, and weirs). Manually and/or electrically operated gates should be avoided. To reduce maintenance, outlets should be designed with openings as large as possible, compatible with the depth-discharge relationships desired and with water quality, safety, and aesthetic objectives in mind. One way of doing this is to use a larger outlet pipe and to construct orifice(s) in the headwall to reduce outflow rates. Outlets should be robustly designed to lessen the chances of damage from debris or vandalism. Avoid the use of thin steel plates as sharp-crested weirs to help prevent potential accidents, especially with children. Trash/safety racks must protect all outlets.
14. Clean out all forebays and sediment traps on a regular basis or when routine inspection shows them to be a quarter to half full.

15. For all landscaped storage facilities the minimum amount of biodegradable, nontoxic fertilizers and herbicides needed shall be used to maintain the facility. All landscape debris must be collected and disposed of off-site.
16. All detention facilities must be designed to minimize required maintenance and to allow access by equipment and workers to perform maintenance. The City will generally maintain regional facilities and facilities on public lands. Maintenance responsibility for facilities located on private land shall be the responsibility of the property owner.
17. The entire detention basin including all appurtenances necessary for the operation and maintenance of the detention facility and the area within the required freeboard for the detention storage must be within a dedicated drainage easement.
18. All detention ponds with a water ponding depth of over four (4) feet must have a water depth gauge. The depth gauge must be referenced to the deepest point in the pond. The numbers on the gauge shall be visible from the detention pond access point or the nearest street.

See Volume 3 of this Manual for additional requirements regarding operation and maintenance of water quality-related facilities, some of which also apply to detention facilities designed to meet other objectives.

(18) *Section 4.11* is amended to read as follows:

4.11 Access

(a) An all-weather stable maintenance access must be provided to the bottom of detention ponds. The surface of this maintenance access shall constitute a solid driving surface of gravel, rock, concrete, or gravel-stabilized turf and should allow maintenance access to the inflow forebay, and the outlet works areas. Maximum grades for equipment access shall be no steeper than ten percent. For ponds less than one acre-foot in volume, access may be allowed from an adjacent drivable surface that is not within the detention pond area as long as equipment can safely reach and maintain all of the facility's features and appurtenances.

(b) When detention storage facilities abut private property, it is the responsibility of the parties involved to develop and implement a policy regarding fencing and safety.

(19) A new *Section 4.14* is added, to read as follows:

4.14 Trickle Channels in Storage Facilities

(a) Measures must be taken to control standing water and to control nuisance flows. Detention basin bottoms are recommended to have a minimum cross slope (measured perpendicular to the trickle channel) of two percent for grassed surfaces and one percent for pavement surfaces where possible. For cross slopes less than these please refer to the detailed guidance provided regarding the appropriateness of the use of trickle channels in the addendum to this Manual titled "Detention Pond Landscape Standards and Guidelines" dated November 2009.

(b) Whenever trickle channels are called for these must be designed to carry approximately one percent of the 100-year design flow with a minimum longitudinal slope of half a percent.

(20) A new *Section 4.15* is added, to read as follows:

4.15 Detention Ponds in Parking Areas

(a) The maximum permissible detention pond depth within parking areas is twelve (12) inches.

(b) For commercial properties an exception may be granted by the Utilities Executive Director or his designee for ponding depths of up to eighteen (18) inches, if the percentage of spaces with ponding depths of greater than twelve (12) inches is less than twenty-five percent (25%) of the total parking spaces provided.

(c) In all circumstances, one foot of freeboard must be provided between the high water elevation and the minimum opening elevations of adjacent buildings.

(d) If a water quality detention is included in a parking lot detention pond, the water quality portion of the total detention volume must be located in vegetated areas not on pavement.

(21) A new *Section 4.16* added, to read as follows:

4.16 Underground Detention

4.16.1 Policy

The use of structural underground detention is generally discouraged, except when satisfying the criteria set forth in 4.16.2. Underground structural BMPs should not be considered for detention storage when surface-based systems are practicable. The responsible party must demonstrate that surface-based detention or other BMPs have been thoroughly evaluated and found to be infeasible before an underground system is proposed. If an underground detention system is proposed, a property owner must seek approval of such a system by the Utilities Executive Director, who may approve such a system upon a determination that the requirements of 4.16.2 are satisfied and that no adverse impacts are expected to result from the proposed system.

4.16.2 Underground Detention Criteria.

The purpose of this subsection is to set forth technical criteria to be utilized for the use of underground stormwater detention as a structural BMP to meet water quality and/or stormwater runoff detention requirements.

(a) All systems.

Any proposed underground stormwater detention system, including gravel reservoirs in porous interlocking concrete pavement (PICP) systems and chambers or pipes, shall satisfy the following design and operating criteria:

1. The system owner shall provide to the City a Standard Operating Procedures (SOPs) Manual detailing the operation and maintenance of the proposed system. The SOPs Manual must comply with approved and updated operational and maintenance procedures maintained by the City for different types of underground detention systems. The SOPs Manual must be submitted to and approved in written form by the Utilities Executive Director, in accordance with the associated Development Agreement, prior to system approval and operation. A final copy of the approved SOPs Manual must be maintained on-site by the party responsible for facility maintenance. Annual reports must be prepared and submitted to the City detailing the results of the maintenance program (i.e. inspection dates, inspection frequency, volume loss due to sedimentation, corrective actions taken, etc.);

2. Runoff must flow through a pre-treatment facility before it enters the underground detention system;

3. A gravity outfall is required at the invert, i.e. lowest point, of the underground detention system;

4. An observation well is required at the downstream end with a perforated stand pipe, as well as a redundant overflow inlet located in a sump condition. The redundant inlet must be designed with pre-sedimentation control at the upstream end of the inlet;

5. The water table level must be documented to be at least one foot (1') below reservoir bottom during the high groundwater period of the calendar year;

6. Where underdrain drainage systems are needed, due to underlying soil conditions, the underdrain pipe diameter shall be at least eight inches (8"). Underdrain cleanouts are required at all changes in direction or elevation locations. If the minimum underdrain size (8") results in a release rate larger than allowed under this Manual, a restrictor plate must be added at the point of outflow;

7. Potential lateral movement of detained storage water outside the limits of the detention storage reservoir must be controlled, accounted and designed for in a manner that ensures the structural integrity of adjacent structures and infrastructure;

8. Infiltration testing must be performed during installation of open bottom/infiltrating systems, after excavation is complete and before rock placement in reservoir. These results must be submitted to the City and approval obtained before commencement of construction activities on the underground detention facility(ies). If the underground detention reservoir is intended to allow for infiltration, the bottom of the reservoir must be protected during construction to minimize compaction;

9. Annual visual inspection is required for all underground detention systems. Documentation verifying inspection and performance must be provided to the City within four (4) weeks after completion of annual inspection. These inspection reports must be filed and available at the City of Fort Collins Utilities office.

10. The underground detention system owner must execute a deed restriction on the affected real property, incorporating the SOPs and penalties specified for lack of performance. SOPs must be included in the site's Development Agreement, as well as in the deed restriction, subject to review by the City Attorney's Office. The deed restriction must provide for the continued, long term operation and maintenance of the underground detention facility by subsequent owners of the affected property.

11. If the City deems that the underground detention system is not being maintained in accordance with the SOPs specified in the deed restriction, and the system owner has been given written notice and at least ten (10) days to cure and has not done so, the City shall have the right of entry to the property in order to maintain the system. The City may then charge the owner the time and material costs incurred by the City to take corrective action and maintain the system, in addition to any administrative costs incurred by the City.

(b) Detention reservoirs located in gravel void spaces of PICP systems.

In addition to the criteria set forth in 4.16.2 (a), the following additional criteria apply to any Porous Interlocking Concrete Pavement (PICP) system with a gravel layer void space:

1. The maximum water quantity detention volume allowed in the subsurface void space is the greater of 0.2 acre-feet or 20% of the total water quantity and water quality detention required. The maximum total detention storage volume to be accounted for in the void space of gravel reservoirs shall be less than 1.0 acre-foot. Additional storage volume is allowed in chambers or pipes or a combination of all the system methods;

2. The material specified in the reservoir storage layer must comply with ASTM Number 2 specifications for rock aggregate, or an alternate approved in writing by the Utilities Executive Director. A 30% ratio for available storage volume in the reservoir layer must be used in volume calculations in order to account for potential sedimentation;

3. A minimum 13,500 pound-force vibratory plate compactor with a compaction indicator and/or a minimum 10-ton vibratory roller must be used to compact the system;

4. A PICP parking lot surface must be designed with a minimum 0.5% slope. All systems must be designed to account for volume detained based on the physical site characteristics and the ability of the system to intercept that volume; and

5. Maintenance vacuuming must be performed in accordance with the approved SOPs for the system. Any infiltration test on the system must be done in accordance with ASTM C1781. Surface infiltration testing locations must be indicated on a site map provided to the City pursuant to Section 4.16. If testing shows an average infiltration rate in excess of one hundred inches per hour (100”/hr.), vacuuming may occur at six month intervals. In no instance shall a system be vacuumed less than once each calendar year.

(c) Detention storage in chambers or pipes.

In addition to the criteria set forth in 4.16.2 (a), the following additional criteria apply to any storage system using underground chambers and/or pipes:

1. All chambers or pipes must be placed with a minimum slope of 0.2%;

2. Maintenance access must be provided at point of inflow and point of outflow into the system. The access must be such that it would allow human access to inspect the functioning of the storage;

3. All pipes or chambers must be vacuum truck accessible through manholes;

4. An underdrain system is recommended for open bottom chambers if the soil underlying the storage reservoir does not consist of either Type A or Type B soils;

5. The minimum pipe size allowed for detention in pipes is fifteen inches (15”);

6. The structural system capacity must be designed to support AASHTO HS20 (fire truck) loading, as well as anticipated lifetime AASHTO 18,000 lb. equivalent single axle loads (ESALs); and

7. The system must be inspected at least once every five (5) years using remote video technology. A written record of this inspection must be submitted to the Utilities Executive Director. he use of underground detention is generally discouraged. Underground BMPs should not be considered for detention storage when surface-based systems are practicable**.** For most areas of new urban development or significant redevelopment, it is feasible and desirable to provide the required storage on the surface. The responsible party must demonstrate that surface-based detention or other BMPs have been thoroughly evaluated and found to be infeasible before an underground system is proposed. In the event where an underground storage system is proposed, a written

request for approval of such a system must be submitted by the Owner describing the system in detailing. The Utilities Executive Director may approve such a system upon a determination that the requirements of this provision have been met and that no adverse impacts are expected to result from the proposed system. For any underground detention, runoff must flow through a pre-treatment facility before it enters the underground detention facility. A standard operating procedures manual must be submitted and approved by the City for all underground facilities. A final copy of the approved standard operating procedures manual must be provided to City and must be maintained on-site by the entity responsible for the facility maintenance. Annual reports must also be prepared and submitted to the City discussing the results of the maintenance program (i.e. inspection dates, inspection frequency, volume loss due to sedimentation, corrective actions taken, etc.).

(22) A new *Section 4.17* is added, to read as follows:

4.17 Rooftop Detention

The use of rooftop detention is prohibited.

(23) A new *Section 4.18* is added, to read as follows:

4.18 On-Stream Storage Facilities

The use of on-stream detention is strongly discouraged. Off-stream detention is the preferred detention storage method in the City. On-stream detention locates the detention facility on a drainageway that collects runoff from the upstream watershed and flows through the proposed development site. The on-stream facility will treat runoff from the proposed development site and runoff generated further upstream from off-site areas. An off-stream storage facility collects and treats runoff from the proposed development site before entering the drainageway. Off-site flow is conveyed by the drainageway through the proposed development site without treatment.

(24) A new *Section 4.19* is added, to read as follows:

4.19 Spill Control for Gas Stations and Vehicle Maintenance Facilities

Spill control structures are required for all new and redeveloping gas stations and vehicle maintenance facilities. In addition to emergency spill response procedures, such as the use of absorbent booms, structural spill controls must be used to protect creeks and tributaries from petroleum products and other pollutants that are stored and handled at gas stations and vehicle maintenance facilities. The spill control structure must have a minimum capacity of 150 gallons.

(25) *Section 5.0* is deleted in its entirety.

(26) *Section 6.1* is deleted in its entirety.

(27) *Table SO-1* is deleted in its entirety.

(28) *Figure SO-8* is deleted in its entirety.

(I) ***Volume 2, Chapter 12*** **- Revegetation:**

(1) A new *Section 3.1.1* is added, to read as follows:

3.1.1 Cattail Plantings

Cattail plantings are generally not recommended for use as wetland plantings in the city of Fort Collins. These may be allowed as part of an overall wetlands mitigation plan, when they are part of a more diversified ecological system upon review and approval by the City.

(2) *Section 3.3* is amended to read as follows:

3.3 Seeding and Planting

(a) Seed mixtures must be sown at the proper time of year specified for the mixture.

(b) Recommended seeding rates specified as "pounds pure live seed per acre" (lbs PLS/acre) should be used.

(c) Seed should be drill seeded, whenever possible.

(d) Broadcast seeding or hydro-seeding may be substituted on slopes steeper than 3(H):1(V) or on other areas not practical to drill seed.

(e) Seeding rates must be doubled for broadcast seeding or increased by 50% if using a Brillion drill or hydro-seeding.

(f) Broadcast seed must be lightly hand raked into the soil.

(g) Seed depth must be ⅓ to ½ inch for most mixtures.

(h) All seeded areas must be mulched, and the mulch should be adequately crimped and or tackified.

(i) If hydro-seeding is conducted, mulching must be conducted as a separate, second operation.

(j) All containerized nursery stock must be kept in a live and healthy condition prior to installation.

(k) Containerized trees and shrubs must be installed according to the planting details provided in Section 4.4 of this chapter.

(l) Live stakes, poles and willow bundles must be installed when dormant (late winter and early spring) according to the planting details in Section 4.7.

(m) Beaver protection must be provided for trees and shrubs for species known to be attractive to beavers if beavers are known to be in the area (see Figure RV-6).

(3) *Section 3.4* is amended to read as follows:

3.4 Maintenance

(a) Sites must be routinely inspected following planting to implement follow-up measures to increase success. Immediate attention to a problem (e.g., weed infestation, failure of seed to germinate) can prevent total failure later.

(b) Areas that have been planted or seeded must be monitored at least one spring and one fall season to ensure that physical evidence growth has been adequately established. Physical evidence of growth shall include no more than 6 inches of bare spots and a minimum of seventy percent of vegetative cover over the entire seeded or planted area. If these minimums are not attained after one fall and one spring season, planted areas shall be re-seeded appropriately as soon as practical.

(c) Access to and grazing on recently re-vegetated areas should be limited with temporary fencing and signage while plants are becoming established (normally the first year).

(d) Weed infestations should be managed using appropriate physical, chemical, or biological methods as soon as possible. See Vol. 2, Ch. 12, Sec. 6.0, "References" for more detail on weed management options.)

(e) Stakes and guy wires for trees should be maintained and dead or damaged growth should be pruned.

(f) Beaver protection cages should be used around tree plantings.

(g) Mulch should be maintained by adding additional mulch and redistributing mulch, as necessary.

(h) Areas of excessive erosion should be repaired and stabilized.

(i) Planted trees and shrubs should be watered monthly or as needed from April through September until established.

(4) *Section 4.2* is amended to read as follows:

4.2 Soil Amendments

Soil amendments must comply with all requirements set forth in sections 12-130, 12-131 and 12-132 of the City Code as well as Section 3.8.21 of the City Land Use Code or other related provisions.

When soil is amended the following provisions must be complied with:

(a) The soil in such areas must be thoroughly loosened to a depth of not less than eight (8) inches.

(b) Soil amendments must be thoroughly incorporated into the soil of such areas to a depth of at least six (6) inches by tilling, disking or other suitable method, at a rate of at least three (3) cubic yards of soil amendment per one thousand (1,000) square feet of area to be planted, unless at least four (4) inches of loose top soil has been placed on the area after completion of construction activity on top of not less than four (4) inches of loosened sub grade soils.

(5) *Section 4.5* is amended to read as follows:

4.5 Mulching

All planted areas must be mulched within twenty-four (24) hours after planting. Mulch conserves water and reduces erosion. The most common type of mulch used is hay or grass that is crimped into the soil to hold it. However, crimping may not be practical on slopes steeper than three to one (3H: 1V).

The following guidelines must be followed when mulching:

(a) Only weed-free and seed-free straw mulch may be used (grass hay often contains weedy exotic species). Mulch should be applied at two (2) tons per acre and adequately secured by crimping, tackifier, netting, or blankets.

(b) Crimping is appropriate on slopes of three to one (3H : 1V) or flatter and must be done so as to tuck mulch fibers into the soil three to four inches deep.

(c) Tackifier or netting and blankets anchored with staples must be used on slopes steeper than three to one (3H : 1V)

(d) Hydraulic mulching may also be used on steep slopes or where access is limited. In these circumstances, wood cellulose fibers mixed with water at two thousands (2,000) to two thousands five hundred (2500) pounds per acre and organic tackifier at one hundred (100) pounds per acre to four hundred (400) pounds per acre, depending on slope, must be applied with a hydraulic mulcher.

(e) Wood chip mulch must be applied to planted trees and shrubs, as shown in Figures RV-2 and RV-3.

Additional details on mulching can be found in Volume 3 of this Manual.

(6) *Table RV-1* is adopted with the following modification:

All references to wildflowers are deleted.

(7) *Table RV-2* is adopted with the following modification:

All references to wildflowers are deleted.

(8) *Table RV-3* is adopted with the following modification:

All references to wildflowers are deleted.

(9) *Table RV-4* is adopted with the following modification:

All references to wildflowers are deleted.

(10) *Table RV-5* is adopted with the following modification:

All references to wildflowers are deleted.

(11) *Table RV-6* is adopted with the following modification:

All references to wildflowers are deleted.

(12) *Table RV-7* is deleted in its entirety.

(13) A new *Section 5.1* is added, to read as follows:

5.1 Land Disturbing Activity and Security

(a) No land disturbing activity subject to this Stormwater Criteria Manual is permitted to commence until an Erosion Control Plan has been approved by the City and the responsible party has provided security designated to ensure the rehabilitation of the disturbed land. Land disturbing activity refers to any activity that results in a change in the existing soil cover (both vegetative and non-vegetative) and/or the existing soil topography including but not limited to, clearing, grading, excavation, demolition, installation of new or improved haul roads and access roads, staging

areas, stockpiling of fill materials, and borrow areas. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility. A performance bond, irrevocable letter of credit, or cash escrow, acceptable to the Utilities Executive Director, and naming the City as the protected party, is required. Such performance bond, irrevocable letter of credit, or cash escrow shall further guarantee the continued maintenance and replacement of any installed erosion control measures shown on the approved plan.

(b) The amount of the security must be based on one and one-half times the estimate of the cost to install the approved measures, or one and one-half times the cost to re-vegetate the disturbed land to dry land grasses based upon unit cost determined by the City's Annual Revegetation and Stabilization Bid, whichever is greater. In no instance, will the amount of security be less than one thousand five hundred dollars ($1,500) for residential development or three thousand dollars ($3,000) for commercial development.

(c) If the requirements of an approved Erosion Control Plan are not be complied with, the City may apply such portion of the security deposit(s) as may be necessary to pay all costs incurred by the City in undertaking the administration, construction, and, or the installation of the erosion control measures required by any plan and these criteria. In addition, the City shall have the option to pursue any other legal remedy available to it under any development agreement or as it deems necessary in order to ensure that the required erosion control measures are implemented.

(d) In the event that the City exercises its rights under the security or pursues any other legal remedy, the City is not thereafter obligated to routinely administer the construction of the measures shown on the Erosion Control or SWMP Plan. However, the City reserves the right to enter upon the land and take whatever actions are necessary to stabilize and re-vegetate all disturbed areas, or to have the plan constructed and to make repairs as necessary.

(e) Upon acceptance by the City of the initial installation of all erosion control and sediment transport measures, the security may, at the request of the owner, be reduced to twenty-five percent (25%) of the original amount. This remaining amount will be retained by the City until erosion control and sediment transport measures on the project are no longer necessary (when all permanent erosion control measures are complete and/or all required re-vegetation measures installed and established through two growing seasons). If the City determines after completion of the Close-Out Inspection as defined in *Section 6.12, Volume 1, Chapter 1*, that the responsible party has met all of the applicable requirements and the security will be released.

(14) A new *Section 5.2* is added, to read as follows:

5.2 Warranty

(a) The responsible party must warrant that the measures shown on the approved Erosion Control Plan are properly constructed, installed, and are free from defective materials and/or workmanship, with said warranty to continue for the terms set forth below.

(b) The responsible party must warrant and maintain all vegetative measures for two growing seasons after installation or until seventy percent (70%) vegetative cover has been established. Any acceptance of installed measures shall not be construed to relieve the responsible party of the duty to warrant and maintain the installed vegetative measures as aforesaid.

(J) *Volume 3, Chapter 2* - BMP Selection:

(1) *Section 1.1* is amended to read as follows:

1.1 Physical Site Characteristics

The first step in BMP selection is identification of physical characteristics of a site including topography, soils, contributing drainage area, groundwater, base flows, wetlands, existing drainageways, and development conditions in the tributary watershed (e.g., construction activity). A fundamental concept of Low Impact Development ("LID") is preservation and protection of site features including wetlands, drainageways, soils that are conducive to infiltration, tree canopy, etc., that provide water quality and other benefits. LID stormwater treatment systems are also designed to take advantage of these natural resources. For example, if a portion of a site is known to have soils with high permeability, this area may be well-suited for rain gardens or permeable pavement. Areas of existing wetlands, which would be difficult to develop from a Section 404 permitting perspective, could be considered for polishing of runoff following BMP treatment, providing additional water quality treatment for the site, while at the same time enhancing the existing wetlands with additional water supply in the form of treated runoff. Some physical site characteristics that provide opportunities for BMPs or constrain BMP selection include:

(a) Soils**:** Soils with good permeability, most typically associated with Hydrologic Soil Groups ("HSGs") A and B provide opportunities for infiltration of runoff and are well-suited for infiltration-based BMPs such as rain gardens, permeable pavement systems, sand filter, grass swales, and buffers, often without the need for an underdrain system. Even when soil permeability is low, these types of BMPs may be feasible if soils are amended to increase permeability or if an underdrain system is used. In some cases, however, soils restrict the use of infiltration based BMPs. When soils with moderate to high swell potential are present, infiltration should be avoided to minimize damage to adjacent structures due to water-induced swelling. In some cases, infiltration based designs can still be used if an impermeable liner and underdrain system are included in the design; however, when the risk of damage to adjacent infrastructure is high, infiltration based BMPs may not be appropriate. In all cases, consult with a geotechnical engineer when designing infiltration BMPs near structures. Consultation with a geotechnical engineer is necessary for evaluating the suitability of soils for different BMP types and establishing minimum distances between infiltration BMPs and structures.

(b) Watershed Size: The contributing drainage area is an important consideration both on the site level and at the regional level. On the site level, there is a practical minimum size for certain BMPs, largely related to the ability to drain the WQCV over the required drain time. For example, it is technically possible to size the WQCV for an extended detention basin for a half-acre site; however, designing a functional outlet to release the WQCV over a 40-hour drain time is practically impossible due to the very small orifices that would be required. For this size watershed, a filtering BMP, such as a rain garden, would be more appropriate. At the other end of the spectrum, there must be a limit on the maximum drainage area for a regional facility to assure adequate treatment of rainfall events that may produce runoff from only a portion of the area draining to the BMP. If the overall drainage area is too large, events that produce runoff from only a portion of the contributing area will pass through the BMP outlet (sized for the full drainage area) without adequate residence time in the BMP. As a practical limit, the maximum drainage area contributing to a water quality facility should be no larger than one square mile. For treatment facilities serving tributary areas that are larger than one (1) acre in size, an extended water quality detention basin is the preferred and recommended water quality treatment device.

(c) Groundwater: Shallow groundwater on a site presents challenges for BMPs that rely on infiltration and for BMPs that are intended to be dry between storm events. Shallow groundwater may limit the ability to infiltrate runoff or result in unwanted groundwater storage in areas intended for storage of the WQCV (e.g., porous sub-base of a permeable pavement system or in the bottom of an otherwise dry facility such as an extended detention basin). Conversely, for some types of BMPs such as wetland channels or constructed wetland basins, groundwater can be beneficial by providing saturation of the root zone and/or a source of baseflow. Groundwater quality protection is an issue that should be considered for infiltration-based BMPs. Infiltration BMPs may not be appropriate for land uses that involve storage or use of materials that have the potential to contaminate groundwater underlying a site (i.e., "hot spot" runoff from fueling stations, materials storage areas, etc.). If groundwater or soil contamination exists on a site and it will not be remediated or removed as a part of construction, separation from the groundwater must be provided. As an example, it may be necessary to use a durable liner to prevent infiltration into contaminated areas.

(d) Base Flows: Base flows are necessary for the success of some BMPs such as constructed wetlands ponds, retention ponds and wetland channels. Without base flows, these BMPs will become dry and unable to support wetland vegetation. For these BMPs, a hydrologic budget should be evaluated. Generally, water rights are also required for these types of BMPs in Colorado. Constructed wetland ponds are allowed provided adequate documentation is submitted to establish the presence of a sufficient and sustained flow of water to support the proposed vegetation in the planned constructed wetlands. Hydrologic documentation must be supplied to the City during the initial planning phase. The City must also receive adequate documentation to establish that the responsible party has secured the required water rights to sustain the proposed constructed wetlands ponds. The City is the final determining authority regarding whether the amount of water flow is deemed sufficient to support the wetlands. For some BMPs such as sand filters, base flows are not desirable since they may lead to bio-fouling and failure. If base flows are present, care should be taken to treat the runoff with an appropriate type of BMP that can better handle such conditions.

(e) Watershed Development Activities (or otherwise erosive conditions): When development in the watershed is phased or when erosive conditions such as steep slopes, sparse vegetation, and sandy soils exist in the watershed, a treatment train approach may be appropriate. BMPs that utilize filtration should follow other measures to collect sediment loads (e.g., a forebay). For phased developments, these measures must be in place until the watershed is completely stabilized. When naturally erosive conditions exist in the watershed, these measures should be permanent. The designer should consider existing, interim and future conditions to select the most appropriate BMPs.

(2) *Section 1.9* is amended to read as follows:

1.9 Integration with Flood Control

In addition to water quality, most projects will require detention for flood control, whether on-site, or in a sub-regional or regional facility. In many cases, it is efficient to combine facilities since the land requirements for a combined facility are lower than those for two separate facilities. Wherever possible, it is recommended WQCV facilities be incorporated into flood control detention facilities
The City requires the following approach be followed, as applicable:

(a) Water Quality: The full WQCV is to be provided according to the design procedures documented in this Manual for water quality facilities.

(b) Minor Storm: The full WQCV, plus the full minor storm detention volume, is to be provided for facilities designed for flows associated with minor storm events.

(c) 100-Year Storm: The full WQCV plus the full 100-year storm event volume must be provided for volumes obtained using the FAA Method or any hydrograph routing methods including SWMM for facilities designed for flows associated with 100-year storm events. When the analysis is done using hydrograph routing methods, each level of control needs to be accounted for and the resultant 100-year flood control volume in addition to the full WQCV should be used in final design.

Finally, designers should also be aware that water quality BMPs, especially those that promote infiltration, could result in volume reductions for flood storage. These volume reductions are most pronounced for frequently occurring events, but even in the major event, some reduction in detention storage volume can be achieved if volume-reduction BMPs are widely used on a site. Additional discussion on volume reduction benefits, including a methodology for quantifying their effects on detention storage volumes, is provided in Volume 3, Chapter 3 of this Manual, "Calculating the WQCV and Volume Reduction".

1.9.1 Sedimentation BMPs

Combination outlets are relatively straightforward for most BMPs in this Manual. For BMPs that utilize sedimentation (e.g. EDBs, constructed wetland ponds, and retention ponds) see BMP Fact Sheet T-12. This Fact Sheet shows examples and details for combined quality and quantity outlet structures.

1.9.2 Infiltration/Filtration BMPs

For other types of BMPs (e.g. rain gardens, sand filters, permeable pavement systems, and other BMPs utilizing processes other than sedimentation), design of a combination outlet structure generally consists of multiple orifices to provide controlled release of WQCV as well as the minor and major storm event. Incorporation of full spectrum detention into these structures requires reservoir routing. The *UD-Detention* worksheet available at www.udfcd.org can be used for this design. When incorporating flood control into permeable pavement systems, the design can be simplified when a near 0% slope on the pavement surface can be achieved. The flatter the pavement the fewer structures required. This includes lateral barriers as well as outlet controls since each pavement cell typically requires its own outlet structure. When incorporating flood control into a rain garden, the flood control volume can be placed on top of or downstream of the rain garden. Locating the flood control volume downstream can reduce the total depth of the rain garden, which will result in a more attractive BMP, and also benefit the vegetation in the flood control area because inundation and associated sedimentation will be less frequent, limited to events exceeding the WQCV.

(3) *Section 1.10* is amended to read as follows:

1.10 Land Use, Compatibility with Surroundings, and Safety

Stormwater quality areas can add interest and diversity to a site, serving a multitude of purposes in addition to providing water quality functions. Gardens, plazas, rooftops, and even parking lots can become amenities and provide visual interest while performing stormwater quality functions and reinforcing urban design goals for the neighborhood and community. The integration of BMPs and associated landforms, walls, landscape, and materials can reflect the standards and patterns of a neighborhood and help to create lively, safe, and pedestrian-oriented districts. The quality and appearance of stormwater quality facilities should reflect the surrounding land use type, the immediate context, and the proximity of the site to important civic spaces. Aesthetics will be a more critical factor in highly visible urban commercial and office areas than at a heavy industrial site. The standard of design and construction should maintain and enhance property values without compromising function. Public access to BMPs should be considered from a safety perspective. The highest priority of the City is to protect public health, safety, and welfare of the citizens of Fort Collins. Stormwater quality facilities must be designed and maintained in a manner that does not pose health or safety hazards to the public. As an example, steeply sloped and/or walled ponds should be avoided. Where this is not possible, emergency egress, lighting and other safety considerations should be incorporated. Facilities should be designed to reduce the likelihood and extent of shallow standing water that can result in mosquito breeding, which can be a nuisance and a public health concern (e.g., West Nile virus). The potential for nuisances, odors and prolonged soggy conditions should be evaluated for BMPs, especially in areas with high pedestrian traffic or visibility.

(K) *Volume 3, Chapter-3* - Calculating the WQCV and Volume Reduction:

(1) *Section 1.0* is amended to read as follows:

1.0 Introduction

This chapter presents the hydrologic basis and calculations for the Water Quality Capture Volume ("WQCV") and discusses the benefits of attenuating this volume. This chapter also describes various methods for quantifying volume reduction when using LID practices. Use of these methods should begin during the planning phase for preliminary sizing and development of the site layout. The calculations and procedures in this chapter allow the engineer to determine effective impervious area, calculate the WQCV, and more accurately quantify potential volume reduction benefits of BMPs.

(2) *Section 2.4* is deleted in its entirety.

(3) A new *Section 3.1* is added, to read as follows:

3.1 Low Impact Development (LID) Criteria

Once the WQCV has been calculated in accordance with the specifications of Section 3.0 of this chapter the total WQCV must be treated by one or more of the methods outlined in Volume 3, Chapter 4, *Treatment BMPs*. In addition, the requirements set forth below in this section, referred to as Low Impact Development (LID) Criteria must be met. For the purposes of this section, the LID methods and techniques described in Volume 3, Chapter 1, Section 4.1, *Runoff Reduction Practices,* together with any methods or techniques determined by the Executive Director to be functionally equivalent, shall be considered *LID techniques*.

The LID Criteria are as follows:

(a) No less than seventy five (75%) of any newly developed or redeveloped area and any modification on a previously developed area for which a Development Construction Permit is required under City codes and regulations must be treated using one or a combination of LID techniques.~~;~~ or

(b) No less than fifty (50%) of any newly developed or redeveloped area and any modification on a previously developed area for which a Development Construction Permit is required under City codes and regulations must be treated using one or a combination of LID techniques when a permeable pavement area covering at least twenty five (25%) of the newly added drivable surface area of any development is constructed as one of the components of the LID treatment techniques used on that site.

(c) If, in the judgment of the Utilities Executive Director, one or more requirements of this Section cannot be met due to site engineering constraints, then a design alternative will be allowed, provided that the design results in equal or better stormwater quality than would compliance with the otherwise applicable requirement.

(4) *Section 4.2* is amended to read as follows:

4.2 Watershed-Level Volume Reduction Method

For a given value of total imperviousness, and depending on overall site imperviousness and typical development patterns there are two levels of LID implementation:

(a) Level 1: The primary intent is to direct the runoff from impervious surfaces to flow over grass-covered areas and/or permeable pavement, and to provide sufficient travel time to facilitate the removal of suspended solids before runoff leaves the site, enters a curb and gutter system, or enters another stormwater collection system. Thus, at Level 1, to the extent practical, impervious surfaces are designed to drain over grass buffer strips or other pervious surfaces before reaching a stormwater conveyance system.

(b) Level 2: As an enhancement to Level 1, Level 2 replaces solid street curb and gutter systems with no curb or slotted curbing, low-velocity grass-lined swales and pervious street shoulders, including pervious rock-lined swales. Conveyance systems and storm sewer inlets will still be needed to collect runoff at downstream intersections and crossings where stormwater flow rates exceed the capacity of the swales. Small culverts will be needed at street crossings and at individual driveways until inlets are provided to convey the flow to storm sewer. The primary difference between Levels 1 and 2 is that for Level 2, a pervious conveyance system (i.e., swales) is provided rather than storm sewer. Disconnection of roof drains and other lot-level impervious areas is essentially the same for both Levels 1 and 2.

Figure 3-7 and Figure 3-8 can be used to estimate effective imperviousness for Level 1 and Level 2. Because rainfall intensity varies with return interval, the effective imperviousness also varies, as demonstrated by the separate curves for the 2-, 10- and 100-year return intervals (see Figure 3-7 and Figure 3-8). The effective imperviousness determined from Figure 3-7 and Figure 3-8 can be used as input for calculation of the WQCV, as the basis for looking up runoff coefficients based on imperviousness in the Runoff chapter in Volume 1. Figure 3-7 and Figure 3-8 are intended for use at the planning level when specifics of the development patterns are not yet well established.

It is notable that the reductions in effective imperviousness shown in Figure 3-7 and Figure 3-8 are relatively modest, ranging from little to no benefit for large events up to approximately 12% for Level 2 for a total imperviousness of roughly 50% (reduced to about 38% for the 2-year event). When site-specific disconnected areas, receiving pervious areas, flow paths, and other design details are available, the site-level methods in Section 4.3 can be used to better quantify volume reduction, and results will typically show greater reductions in effective imperviousness for aggressive LID implementation. Even so, it is unlikely that conveyance-based BMPs alone will provide adequate pollutant removal and volume reduction for most project sites, and a storage-based BMP (i.e., WQCV) will also be required.

(5) *Section 4.3.1* is amended to read as follows:

4.3.1 SWMM Modeling Using Cascading Planes

Because of complexities of modeling LID and other BMPs using SWMM, the cascading planes alternative for site-level volume reduction analysis is recommended only for experienced users. The following guidance for conveyance- and storage-based modeling must be followed:

(a) Each sub-watershed should be conceptualized as shown in Figure 3-6. Two approaches can be used in SWMM to achieve this:

- Create two SWMM sub-catchments for each sub-watershed, one with UIA 100% routed to RPA and the other with DCIA and SPA independently routed to the outlet, or
- Use a single SWMM sub-catchment to represent the sub-watershed and use the SWMM internal routing option to differentiate between DCIA and UIA. This option should only be used when a large portion of the pervious area on a site is RPA and there is very little SPA since the internal routing does not have the ability to differentiate between SPA and RPA (i.e., the UIA is routed to the entire pervious area, potentially overestimating infiltration losses).

(b) Once the sub-watershed is set up to represent UIA, DCIA, RPA and SPA in SWMM, the rainfall distribution should be directly input to SWMM.

(c) Parameters for infiltration, depression storage and other input parameters must be selected in accordance with the guidance in the Runoff Chapter,Volume 1 - Chapter 5, of this Manual.

(d) For storage-based BMPs, there are two options for representing the WQCV:

i. The pervious area depression storage value for the RPA can be increased to represent the WQCV. This approach is generally applicable to storage-based BMPs that promote infiltration such as rain gardens, permeable pavement systems with storage or sand filters. This adjustment should not be used when a storage-based BMP has a well-defined outlet and a stage-storage-discharge relationship that can be entered into SWMM.

ii. The WQCV can be modeled as a storage unit with an outlet in SWMM. This option is preferred for storage-based BMPs with well defined stage-storage-discharge relationships such as extended detention basins.

These guidelines are applicable for EPA SWMM Version 5.0.018 and earlier versions going back to EPA SWMM Version 5.0. EPA is currently developing a version of EPA SWMM with enhanced LID modeling capabilities. This Manual will be updated as newer SWMM modeling capabilities are developed and adopted.

(6) *Section 4.4* is deleted in its entirety.

(L) ***Volume 3, Chapter 4*- Treatment BMPs:**

(1) *Fact Sheet T-5* is adopted with the following modification:

All references to "Excess Urban Runoff Volume or (EURV)" and "Full Spectrum Detention" are deleted.

(2) *Figure EDB-3* is adopted with the following modification:

"Micropool" Depth = 0

(3) *Table EDB-4* is adopted with the following modification:

All references to "Micropools" are deleted.

(4) *Fact Sheet T-7* is adopted with the following modification:

All references to "Retention Pond" are replaced with the term "Wet Pond".

(5) *Fact Sheet T-11* is amended to read in its entirety as follows:

Description

Underground stormwater BMPs include proprietary and non-proprietary devices installed below ground that provide stormwater quality treatment via sedimentation, screening, filtration, hydrodynamic separation, and other physical and chemical processes. Conceptually, underground BMPs can be categorized based on their fundamental treatment approach and dominant unit processes. Some underground BMPs combine multiple unit processes to act as a treatment train.
Historically, underground stormwater quality treatment devices have not been recommended based on City policies and criteria. This is due to several factors including problems with unmaintained or poorly maintained devices, remobilization by wash-out (scour) of accumulated pollutants during larger events, lack of performance data for underground devices in the region, and other issues discussed in this Fact Sheet. While underground flood-control detention is still discouraged, this section provides criteria for determining when the use of underground BMPs may be considered for water quality. When surface BMPs are found to be infeasible, underground BMPs may be the only available strategy for satisfying regulatory water quality requirements, especially in highly built-up urban areas where water quality measures must be implemented as a part of a retrofit to meet regulatory requirements.

Underground BMPs should not be considered for standalone treatment when surface-based BMPs are practicable. For most areas of new urban development or significant redevelopment, it is feasible and desirable to provide the required WQCV on the surface. It is incumbent on the design engineer to demonstrate that surface-based BMPs such as permeable pavements, rain gardens, extended detention basins and others have been thoroughly evaluated and found to be infeasible before an underground system is proposed. Surface-based BMPs provide numerous environmental benefits including infiltration, evapotranspiration, groundwater recharge, aquatic habitat, mitigation of "heat island effect", and other benefits associated with vegetation for those that are planted. Additionally surface-based BMPs are much easier to monitor and maintain.

Site Selection

The most common sites for underground BMPs are "ultra urban" environments with significant space constraints. These could include downtown lot-line-to-lot-line development projects, transportation corridors, or small (less than 0.5 acre) redevelopment sites in urban areas. Important site features that must be considered include the following:

Depth to Groundwater: Due to the potentially large displacement caused by an underground vault, if there is seasonally high groundwater, buoyancy can be a problem. Vaults can be sealed to prevent infiltration of groundwater into the underground system and these systems can be anchored to resist uplift. If seasonally high groundwater is expected near the bottom of an underground system, the engineer should evaluate the potential for infiltration of groundwater and uplift forces and adjust the design accordingly.

Proximity to Public Spaces: As material accumulates in an underground system, there is potential for anoxic conditions and associated odor problems.

Gravity versus Pumped Discharge: The ability to drain to the receiving storm drainage system via gravity is an important consideration. In the city of Fort Collins a gravity outfall system is required for all underground BMPs.

Access: Equipment must be able to access all portions of the underground BMP, typically at multiple locations, to perform maintenance. As the size of the underground system increases, so must the number of access points.

Traffic Loading: Due to space constraints, in some situations, underground BMPs may be located in a right-of-way or other location where there may be traffic loadings. Many underground BMPs are or can be constructed for HS-20 traffic loading. Take additional measures when necessary to ensure that the BMP is designed for the anticipated loading.

Potential for Flooding of Adjacent Structures or Property: For underground BMPs, it is important that the hydraulic grade line be analyzed to evaluate the potential for backwater in the storm sewer system. In addition, some types of underground BMPs, such as catch basin inserts, have the potential to clog and cause flooding if not frequently maintained.

Designing for Maintenance

All underground BMPs must be sized so that routine maintenance is not required more than once per year. The only exception to this is inlet inserts which may need to be cleaned as frequently as following each runoff producing event. **Because underground BMPs are generally less visible and more difficult to access than surface-based BMPs, regular maintenance and early detection of performance issues can be a challenge.**
When developing a design for an underground BMP, the engineer should ensure that all portions of the underground facility can be accessed with maintenance equipment. For multi-chambered systems, access should be provided to each chamber, and openings should be of sufficient size to accommodate the equipment recommended by the manufacturer or designer for maintenance.

Underground BMPs are generally considered confined spaces and OSHA confined space training typically will be required if a person must enter the underground BMP to perform maintenance. In all cases, a maintenance plan should be developed at the time that the underground BMP is designed. The maintenance plan should specify, at a minimum, quarterly inspections with maintenance performed as needed based on inspections. The required inspection frequency may be reduced to biannually if, after two or more years, the quarterly regimen demonstrates that this will provide adequate maintenance. Owners of underground BMPs must provide written inspection and maintenance documentation to the City to ensure that required inspection and maintenance activities are taking place. All maintenance records must be kept on file by the owner and must be provided to the City promptly upon request. Owner must demonstrate that maintenance activities are occurring on an annual basis or on other frequencies as specifically required.

Design Procedure and Criteria

Two primary options are available for underground BMPs:
1. Underground BMPs Based on a Surface BMP design: BMPs that satisfy the requirements for capture and slow release of the WQCV and that are based on and designed in substantial conformance with the criteria for surface-based BMPs described in this Manual.

2. Underground Proprietary BMPs: Proprietary BMPs that satisfy the requirements for capture and slow release of the WQCV. The owner needs to demonstrate that the BMP will at a minimum treat the design storms flow rates and volumes as stated in this Manual as well as the slow release of the WQCV and provide a level of treatment for targeted pollutants that is comparable to that of the surface-based BMPs provided in this Manual.

1. Underground BMPs Based on a Surface BMP Design

This class of underground BMP includes sand filter basins and retention facilities designed for below grade installation. The design must provide the WQCV and empty it over a time period of 12 hours or more. Not all of the surface-based BMPs that provide the WQCV can be adapted for underground use. For example, the vegetative components of a constructed wetland pond render it unsuitable for underground use. Underground extended detention basins are also problematic due to historical problems with remobilization of collected sediment. The most commonly used underground BMP to date in the City is the underground sand filter.
In addition to the criteria for an above ground sand filter, underground sand filters should meet the following criteria:

a) A pretreatment chamber for removal of coarse sediments with a volume equivalent to 0.10 times the WQCV should be provided. The pretreatment chamber must be separated from the underground BMP sand filter chamber by baffles, and serves as the sediment forebay to reduce the frequency of maintenance required in sand filter. Also consider incorporating a vertical baffle to trap oil and grease. This can be easily incorporated into the forebay and should be included where oil and grease are target constituents. Absorbent mats or booms could also be used for this purpose.

b) For flows in excess of the water quality design event, a diversion must be sized so that excess flows bypass the sand filter chamber and the sand filter is not surcharged (in terms of depth or hydraulic grade line) beyond the WQCV maximum elevation.

c) Maintenance access must be provided to each chamber. Access must be sufficient to allow complete removal and replacement of the filter material. Allow for at least 6 feet of headroom (from the surface of the filter) to facilitate maintenance. All areas need to be designed to facilitate human access.

2. Underground Proprietary BMPs

In some situations, the use of an underground manufactured or proprietary BMP may be the only practicable solution due to site or engineering constraints. In such cases the use of a proprietary BMP may be appropriate. There are numerous proprietary BMPs with wide variability in performance, design flow rates, unit processes, and volume of storage provided (if any). Sizing methodologies for proprietary devices vary from device to device—some are flow based, some are volume based, some consider surface/filter hydraulic loading, etc. As a result, this Manual does not seek to provide a one-size-fits-all sizing methodology for proprietary BMPs. Instead, this Manual provides criteria for determining what type of proprietary BMP should be used and whether a specific proprietary BMP is acceptable for use.

Once it has been determined that use of this BMP category is warranted due to site or engineering constraints, the proprietary BMP must meet the following requirements:

a) Technology Verification: The proprietary BMP must be verified for use by a nationally recognized technology verification program.
For the two main categories of proprietary BMPs, these programs are:

For hydrodynamic separators:

The New Jersey Corporation for Advanced Technology (NJCAT) Technology Verification Program (http://www.njcat.org/verification/protocol.cfm) Tier II (Field Testing) verification is required.

For filters or other technologies receiving standalone treatment designation:

The NJCAT Tier II (Field Testing) verification or completion and approval by the Washington State Department of Ecology (2002) TAPE protocol and General Use Level Designation for TSS are required. Reference: Guidance for Evaluating Emerging Stormwater Treatment Technologies, Technology Assessment Protocol – Ecology (TAPE), October 2002 (Revised June 2004), Publication Number 02-10-037. (http://www.ecy.wa.gov/biblio/0210037.html).

Verification by both programs is preferred. If the specific design flow rates for the filters differ, then the most conservative flow rate should be used since sediment loads within the Fort Collins region tend to be fine.

To receive an approval for use by the City, the manufacturer must also provide final verification statements for the technology in consideration.

b) Performance Standards:

Once accepted for use, the sizing of the BMP must be done in accordance with the verification and also achieve the treatment level required by the City. In general, the proprietary BMP approved for standalone treatment should be capable, on an annual basis, of producing an effluent quality with a median TSS concentration of no more than thirty (30) mg/L, Event Mean Concentration (EMC), for the WQCV within a twelve (12)

hour drawdown time for influent TSS concentrations of one hundred forty (140) mg/l or less. This level of treatment is comparable to the long-term effluent median concentrations from the International Stormwater BMP Database for surface-based BMPs. For influent TSS concentrations of one hundred forty (140) mg/l or more an eighty (80) percent load removal rate by the proprietary BMP is required.

Depending on long-term median effluent concentrations and whether or not the BMP provides the required WQCV, a proprietary underground BMP will fall into one of three categories:

1. Not recommended: This category is for underground BMPs that have not demonstrated the ability to capture the required WQCV or meet the performance expectation of thirty (30) mg/l TSS effluent for influent TSS concentrations that are less than one forty (140) mg/l or an eighty (80) percent removal rate for influent TSS concentrations of one forty (140) mg/l or more. Even for underground BMPs that meet these conditions, these are not recommended if they are deemed by the City to be too difficult and, or too expensive to maintain compared to a surface BMP alternative. The City is the final determining authority regarding whether these are considered too difficult or too expensive to maintain over the long term.

2. Pretreatment: This category is for underground BMPs that generally provide little, if any, surcharge storage WQCV. BMPs in this category may be useful as an initial step in a treatment train approach to water quality. A BMP meeting these criteria could be used in conjunction with a downstream BMP that provides slow release of the WQCV. For pretreatment applications, verification programs remain the same however since the volume storage and fine fraction of the TSS are addressed through separate unit processes, the primary design criteria are that the BMP be sized to meet the peak hydraulic flow association with the entire treatment train.
To avoid washout, the peak treatment flow will be the same as verified by NJCAT associated with the eighty (80) percent removal rate of the NJCAT PSD. Flows in excess of the water quality design event Flows in excess of the water quality design event need to be bypassed to avoid re-suspension and washout of accumulated sediments.

3. Standalone: This category is for underground BMPs that demonstrate the ability to meet the performance expectation of thirty (30) mg/l TSS EMC effluent for influent concentrations that are less than one hundred forty (140) mg/l or an eighty (80) percent removal rate for influent TSS concentrations of one hundred forty (140) mg/l or more. "Standalone" devices must be designed to provide for the release of the WQCV in no less than twelve (12) hours. Furthermore, this category of BMP can only be used where it is determined that surface BMPs are not feasible.
In some situations such as in highly urbanized areas with existing infrastructure, right of way issues, achieving this level of treatment for the entire WQCV using a twelve (12) hour drawdown period may not be practicable. In such cases the design of the proprietary BMP must be done to the Maximum Extent Practicable (MEP).

The MEP design approach for underground manufactured BMPs will only be allowed when this is the only practicable alternative available to achieve any level of water quality treatment. In such cases, the design engineer must present sufficient information to:

- Gain acceptance of a specific proprietary BMP, using the verifications described above
- Demonstrate that due to site and engineering constraints that this approach is the most viable solution
- Demonstrate that the technology is sized and designed in accordance with the applicable verification
- Show that the MEP approach was used to approach to the maximum extent practicable the treatment levels and volumetric goals required above.

See Figure UG-1 for typical underground BMPs that may fall into each category. The City does not maintain a list of specific devices that fall into each of these categories. It is the responsibility of the designer to identify the appropriate category for the BMP based on whether the required treatment level can be provided in the underground BMP. The City, reserves the right to prohibit altogether the use of underground BMPs, proprietary or not. In addition, the City may require the presentation of the proprietary underground BMPs' performance and maintenance records, in locations where they have been previously installed, and more particularly in areas with climatic conditions similar to the Colorado Front Range area. Additionally, the City may require agreements that run in perpetuity attached to the property served by the BMPs, assuring that they will be inspected and maintained by the owner as required by the City (or recommended by the manufacturer).
Finally, a standard operating procedures manual must be submitted and approved by the City for all underground facilities. A final copy of the approved Standard Operating Procedures manual must be provided to the City and must be maintained on-site by the entity responsible for the facility maintenance. Annual reports must be prepared and submitted to the City discussing the frequency and results of the maintenance program.

Construction Considerations

Improper installation will cause poor performance of proprietary underground BMPs. This problem has been noted not only by manufacturers, but also by a number of Colorado municipalities who have observed that the "as built" BMPs often vary significantly from the design. Most underground BMPs already face challenges due to limited vertical fall and because of head losses, so they may be sensitive to slight changes in elevation. In addition, many of the proprietary underground BMPs require assembly of special baffling or patented inserts that may not be familiar to contractors.
For these reasons, it is important to discuss the installation of the underground BMP with the manufacturer prior to selecting a contractor so that the installation requirements are clearly understood. Construction observation by the design engineer, and, if possible, a manufacturer's representative is essential for proper installation. At a minimum, the installation must be inspected by the manufacturer's representative once completed. Any deficiencies of the installation identified by the manufacturer's representative inspection must be immediately corrected.

(6) *Table UG-1* is deleted.

(7) *Fact Sheet T-12* is adopted with the following modification:

All references to "Micropools", "EURV"and "Full Spectrum Detention" are deleted.

(8) *Table OS*-4 is adopted with the following modification:

All references to *Figure OS-2* and *Figure OS-7* are deleted

(9) *Figure OS-2* is deleted in its entirety.

(10) *Figure OS-3* is adopted with the following modification:

All references to "Permanent Water Surface Elevation (WSE)" are deleted.

(11) *Figure OS-4* is adopted with the following modification:

Add Note: Lowest opening must be set at the invert of the pond.

(12) *Figure OS-5* is adopted with the following modification:

All references to "Micropools" are deleted.

(13) *Figure OS-6* is adopted with the following modification:

All references to "Micropools" are deleted.

(14) *Figure OS-7* is deleted in its entirety.

(15) *Figure OS-8* is adopted with the following modification:

All references to "Micropools" are deleted.

(16) *Figure OS-9* is added.

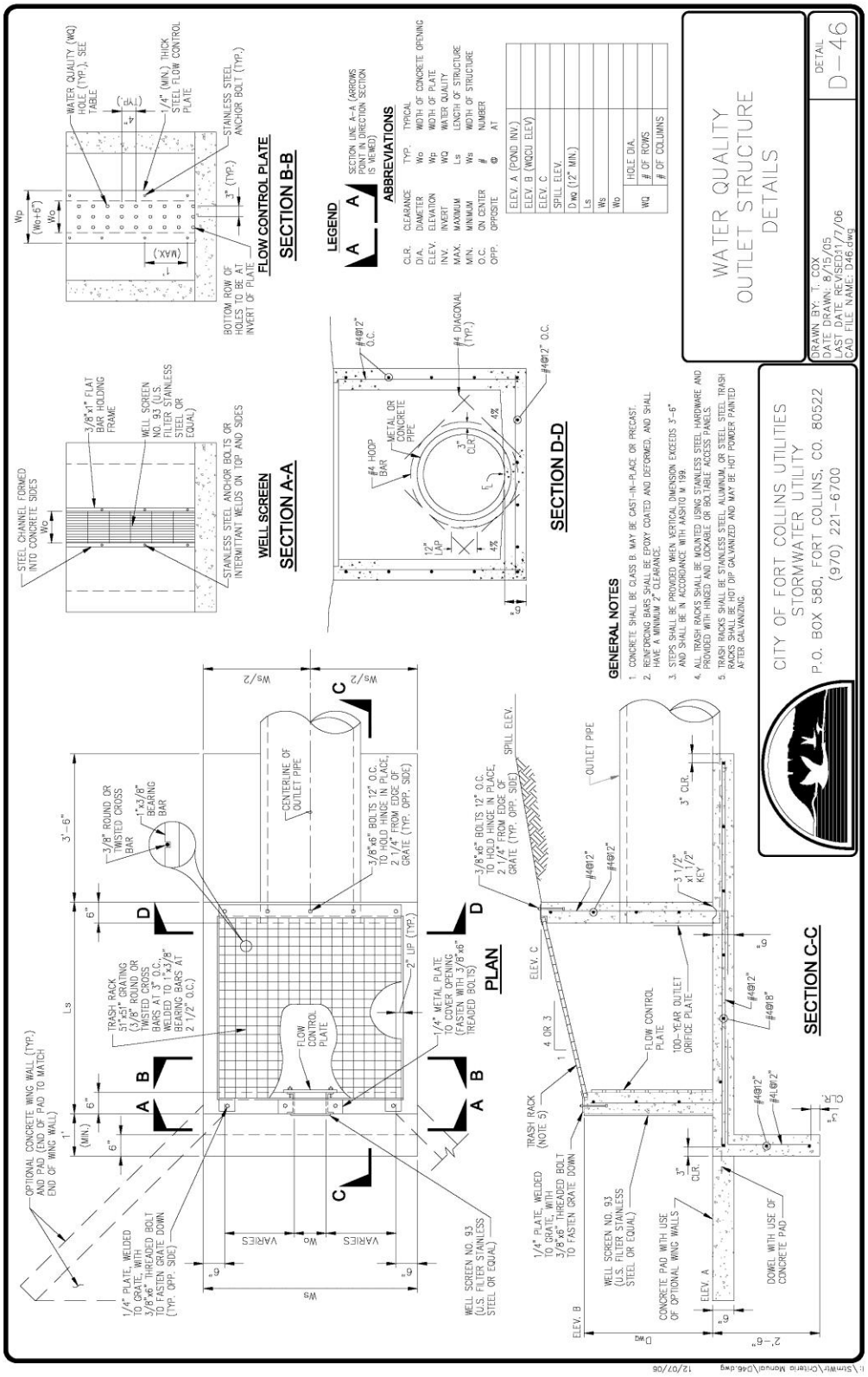

Figure OS-9, City of Fort Collins Water Quality Outlet Structure Details

(M) *Volume 3, Chapter 5* - Source Control BMPs:

(1) *Section 1.0* is deleted in its entirety.

(2) *Section 2.0* is amended to read as follows:

2.0 Structural Source Control BMPs

Site operations and potential pollution source control needs should be considered early in the planning and design process. This will reduce the load of pollutants into stormwater and may also facilitate site operations and reduce maintenance requirements for on-site treatment BMPs. A discussion must be provided specifying the permanent structural source control BMP that is used in relation to the planned use of the project.

Representative questions that must be considered prior to finalizing the site layout include:

1. What materials are stored on-site?

2. How are these materials handled and moved through the site?

3. What on-site operations take place that could potentially cause materials to enter the storm sewer system?

4. Where and how might these materials enter the storm sewer?

5. How can storage and handling areas and drainage facilities be designed to reduce pollutant loading? Is it feasible to cover these areas?

6. When a spill occurs, how and where will it be controlled and contained? Are structural spill containment measures needed?

(3) *Section 3.0* is deleted in its entirety.

(4) *Section 4.0* is deleted in its entirety.

(5) *Section 5.0* is deleted in its entirety.

(6) Source Control BMP Fact Sheets are deleted in their entirety.

(7) *Table 5.1* is deleted in its entirety.

(8) *Table 5.2* is deleted in its entirety.

(9) *Table 5.3* is deleted in its entirety.

(N) *Volume3, Chapter 6* - BMP Maintenance:

(1) *Section 2.0* is adopted with the following modification:

All references to "UDFCD maintenance" are deleted.

(2) *Section 7.7* is amended to read as follows:

7.7 Sediment Removal from the Forebay, Trickle Channel and the BMP Bottom

Remove sediment from the forebay and trickle channel annually. If portions of the watershed are not developed or if roadway or landscaping projects are taking place in the watershed, the required frequency of sediment removal in the forebay may be as often as after each storm event. The forebay should be maintained in such a way that it does not provide a significant source of re-suspended sediment in the stormwater runoff. Ensure that the sediment is disposed of properly and not placed elsewhere in the basin.

Potential accumulation of sediment in the area directly upstream of the outlet structure at the bottom of the BMP must be checked for on a regular basis as well as after every significant storm event. Removal of accumulated sediment or debris must be done immediately when such sediment or debris blocks any portion of the outlet structure and must be done at least on a monthly basis between the months April and September as well as during any rainy period.

(O) *Volume 3, Chapter 7* - Construction BMPs:

(1) A new *Section 1.1* is added, to read as follows:

1.1 Purpose and Scope

The Stormwater Criteria Manual provides the minimum design and technical criteria for the design and analysis of drainage and erosion control plans. The erosion-related requirements of this Manual are intended to reduce erosion to an acceptable level, emphasizing the control of erosion and sediment transport from the surface of disturbed land by water. Channel erosion control for temporary channels (diversions, gullies) and major channel stabilization are addressed as erosion control matters in this Manual. The requirements of Volume 3, Chapter 7, as amended, apply to all land disturbing activities covered by this Manual, except for the following:

(1) Emergency work; and

(2) Single Family Residential lots less than ten thousand (10,000) square feet in area and less than four to one slopes except when construction activities are within 50 feet of the outer limits of sensitive areas including floodplains, slopes, riparian corridors, lakes, irrigation ditches, or other features subject to natural areas buffer requirements under the City Land Use Code

(2) A new *Section 1.2* is added, to read as follows:

1.2 Review and Acceptance

The City will review all erosion control submittals for general compliance with this Manual. An acceptance by the City does not relieve the owner, engineer, or designer from responsibility of ensuring that calculations, plans, and specifications are in general compliance with the criteria.

(4) A new *Section 1.3* is added, to read as follows:

1.3 Policy, Standards and Submittal Requirements

1.3.1 Policy

Erosion and sedimentation are natural processes, the intensity of which is increased by land disturbing activities. Clearing and stripping of land can cause localized increased erosion rates with subsequent deposition of sediments and damage to adjacent downstream and leeward properties. Erosion can reduce or destroy the aesthetic and practical values of neighboring properties, streams and lakes.

The City is committed to the enhancement and protection of existing development, streams, lakes, wetlands and rivers that may be impacted by sediment laden runoff resulting from land-change activities.

Therefore, it is the policy of the City to encourage maintenance of the natural balance between sediment supply and transport.

It is also the City's policy to encourage water erosion control by leaving land undisturbed as long as possible (by project phasing) and using temporary and permanent erosion control Best Management Practices (BMPs).

1.3.2 Elements of an Erosion Control Plan

Erosion control plans must consist of the elements noted below. For developments subject to the subdivision review process, these must be submitted with the final drainage reports. All reports must be typed on 8-1/2" x 11" paper and bound. Drawings, figures, plates, and tables must be bound with the report. The report must include a cover letter presenting the plan for review and must be prepared by or supervised by and engineer licensed in Colorado.

Information used for the Erosion Control Plan must be consistent with the Drainage Report and the grading and drainage plans.

For City projects, the Erosion Control Plan must be submitted and reviewed through the Construction Coordination process, or through the specific department's review process.

1.3.3 PDP Erosion Control Report and Drawings Submittal Requirements

Erosion Control Report and Plans are required at time of PDP Submittal.

The Erosion Control Report must contain or comply with the following:

a. A written analysis of the area proposed for construction in reference to developed conditions, rainfall erodibility, and proposed rainfall erosion and sediment control methods. Control of rainfall erosion and sediment transport shall be analyzed in a manner that clearly demonstrates an understanding of how temporary and permanent mitigation methods will be used, including a discussion of the timing of construction phases and the sequential installation of all erosion and sediment control Best Management Practices (BMPs) proposed in the plan.

b. Stormwater Management Controls:
Include a description of all stormwater management controls that will be implemented as part of the construction activity to control pollutants in stormwater discharges. The appropriateness and priorities of stormwater management controls should reflect the potential pollutant sources identified at the facility. The description of stormwater management controls should address the following components, at a minimum:

i.) Identify SWMP Administrator: Identify a specific individual(s), position, or title that is responsible for developing, implementing, maintaining, and revising the SWMP. This designated individual(s) should address all aspects of the facility's SWMP.

ii) Identification of Potential Pollutant Sources: Identify and describe sources that may contribute pollutants to runoff, and provide means of control through BMP selection and implementation. At a minimum, evaluate each of the following potential sources of pollution:

1. All disturbed and stored soils;

2. Vehicle tracking of sediments;

3. Management of contaminated soils;

4. Loading and unloading operations;

5. Outdoor storage activities (building materials, fertilizers, chemicals, etc.);

6. Vehicle and equipment maintenance and fueling;

7. Significant dust or particulate generating processes;

8. Routine maintenance activities involving fertilizers, pesticides, detergents, fuels, solvents, oils, etc;

9. On-site waste management practices (waste piles, liquid wastes, dumpsters, etc.);

10. Concrete truck/equipment washing, including the concrete truck chute and associated fixtures and equipment;

11. Dedicated asphalt and concrete batch plants;

12. Non-industrial waste sources such as worker trash and portable toilets; and

13. Other areas or procedures where potential spills can occur.

c. For the establishment of dryland vegetation, the discussion must include soil types, seed mix, soil amendments, and mulches.

d. Detailed sequence of construction activities must be submitted as part of the erosion and sediment control plan. The plan identifies the sequence for all the major construction and erosion and sediment control activities, including overlot grading, soil and aggregate stockpiling, construction of permanent drainage facilities, and maintenance activities. The construction sequence will be used as a basis for inspection of construction sites for compliance with the erosion and sediment control plan.

The sequencing plan must clearly indicate the timing, extent and location where temporary BMP measures are installed and/or removed, depending on the type of construction activities undertaken, e.g. site grading, utilities installation, paving, flatwork, or vertical construction.

The construction sequence must include at least the following:

1. Installation of temporary erosion and sediment control measures
2. Sequence of all land disturbing activity
3. Drainage facility construction
4. Sediment basins, temporary channel stabilization
5. Seeding
6. Mulching
7. Required maintenance activities (e.g. expected frequency of sediment pond cleaning, after-storm checks of all BMPs, etc.)

e. Erosion control security calculations.

The Erosion Control Drawing must contain or comply with the following:

The Erosion Control Drawing must use same base used for drainage study. The erosion and sediment control plan may be combined with the grading plan, providing all the required information can be shown, and the combined plan is not so cluttered with

information that all the elements cannot be readily seen and deciphered. All drawings must be twenty-two by thirty-four (22x34) inches in size. A General Location Map shall be provided in sufficient detail to identify drainage flow entering and leaving the development and general drainage patterns. The map should be at a scale of 1" = 1000' to 1" = 8000' and show the path of all drainage from the upper end of any off-site basins to major drainageways. The map must identify any major construction (i.e., development, irrigation ditches, existing detention facilities, culverts, storm sewers) along the entire path of drainage. Basins and divides are to be identified and topographic contours are to be included. The Erosion Control Plan drawings of the proposed development or redevelopment must have a scale of 1" = 20' to 1" = 200' on 22" x 34" drawings.

a. Standard and job-specific construction details of erosion and sediment control measures, and standard and job specific erosion and sediment control notes.

b. List vegetative specifications from this Manual if standard vegetation is to be used. Include alternate specifications and justification if they are to be used.

c. List structural specifications from this Manual if standards are to be used. Include other specifications and justifications if they are to be used.

d. A construction detail for all proposed construction BMPs.

e. The following standard erosion and sediment control notes:

1) The City Stormwater Department erosion control inspector must be notified at least 24 hours prior to any construction on this site.

2) All required BMPs shall be installed **prior** to any land disturbing activity (stockpiling, stripping, grading, etc). All of required erosion control measures must be installed at the appropriate time in the construction sequence as indicated in the approved project schedule, construction plans, and erosion control report.

3) Pre-disturbance vegetation shall be protected and retained wherever possible. Removal or disturbance of existing vegetation shall be limited to the area required for immediate construction operations, and for the shortest practical period of time.

4) All soils exposed during land disturbing activity (stripping, grading, utility installations, stockpiling, filling, etc.) shall be kept in a roughened condition by ripping or disking along land contours until mulch, vegetation, or other permanent erosion control is installed. No soils in areas outside project street rights of way shall remain exposed by land disturbing activity for more than thirty (30) days before required temporary or permanent erosion control (e.g. seed/mulch, landscaping, etc.) is installed, unless otherwise approved by the Stormwater Department.

5) The property must be watered and maintained **at all times** during construction activities so as to prevent wind-caused erosion. All land disturbing activities shall be immediately discontinued when fugitive dust impacts adjacent properties, as determined by the City Engineering Department.

6) All temporary (structural) erosion control measures must be inspected and repaired or reconstructed as necessary after each runoff event and every 14 days in order to assure continued performance of their intended function. All retained sediments, particularly those on paved roadway surfaces, shall be removed and disposed of in a manner and location so as not to cause their release into any drainageway.

7) No soil stockpile shall exceed ten (10) feet in height. All soil stockpiles shall be protected from sediment transport by surface roughening, watering, and perimeter silt fencing. Any soil stockpile remaining after 30 days shall be seeded and mulched.

8) City Ordinance prohibits the tracking, dropping, or depositing of soils or any other material onto city streets by or from any vehicle. Any inadvertent deposited material shall be cleaned immediately by the contractor.

9) Additional notes can (should) be added to reflect the erosion/sediment control plan of the individual development.

(4) A new *Section 1.4* is added, to read as follows:

1.4 Security for Erosion Control

No land disturbing activity subject to this Stormwater Criteria Manual can begin until an Erosion Control Plan has been approved and the Owner has submitted proof of security to ensure rehabilitation of the disturbed land. A performance bond, irrevocable letter of credit, or cash escrow, acceptable to the Utilities Executive Director, and naming the City as the protected party, is required. Such performance bond, irrevocable letter of credit, or cash escrow shall further guarantee the continued maintenance and replacement of any installed erosion control measures shown on the approved plan.

The amount of the security is based on one and one-half times the cost to revegetate the disturbed land to dryland grasses (soil preparation, seed, and mulch) based upon unit cost determined by the City Stormwater Department's Annual Revegetation and Stabilization Bid. In no instance, shall the amount of security be less than one thousand five hundred dollars ($1,500) for residential and three thousand dollars ($3,000) for commercial projects

Should the Owner be out of compliance with provisions of the approved Erosion Control Plan, the City may exercise its rights under the security provided. In the event that the City exercises such rights, it is not the City's intention to routinely administer the construction of the measures shown on the erosion control plans, however, the City reserves the right to enter upon the land and take whatever actions are necessary to stabilize and revegetate all disturbed areas, or to have the plan constructed and make repairs as necessary.

The erosion control security will normally be retained by the City until the project has been completed and there is no further possibility of erosion or sediment transport from the site. This includes the time for two full growing seasons for the establishment of grasses on any revegetated areas. At that time, the security will be released. However, if a part or phase of the site has been completed (including any revegetated areas which are established but have not yet reached the two growing season warranty limit), and if it can be determined by the City that there is no further erosion or sediment transport risk from that part or phase as it relates to the entire project, then the portion of the erosion control security that would apply to that part or phase can be released, whether or not the entire project has been completed. Any partial release of the erosion control security must be requested by the responsible party.

(5) A new *Section 1.5* is added, to read as follows:

1.5 Warranty

The Owner must warrant that the measures shown on the approved erosion and sediment control plan are properly constructed, installed, and are free from defective materials and/or workmanship, with said warranty to continue for the terms set forth below.

The Owner shall warrant and maintain all structural measures for such period of time as construction on the site continues and/or said measures are necessary to protect against erosion and sediment transport. The Owner must warrant and maintain all vegetative measures for two growing seasons after installation. Any acceptance of installed measures shall not be construed to relieve the Owner of the duty to warrant and maintain as aforesaid.

(6) A new *Section 1.6* is added, to read as follows:

1.6 Enforcement

No land disturbing activity subject to this Stormwater Criteria Manual can begin on any project unless it is associated with an approved Erosion Control Plan, a signed Development Agreement, and a submitted erosion control security. All erosion control measures must be installed when they are necessary as indicated by the approved Erosion Control Plan and Report, and maintained in accordance with these Criteria. In order to ensure that all required measures have been correctly installed and are in proper order and repair, no building permit will be issued on any project until an inspection of the site and its required erosion control measures has been made and deemed acceptable by the City.

If, at any time during construction activities, the Owner fails to adhere to the approved Erosion Control Plan and Report, the construction phase sequence, or any of the erosion control criteria, the City may employ any or all of the following:

- Stop all or any part of the work on the project.
- Withhold building permits.
- Withhold certificates of occupancy.
- Exercise the City's rights under the security provided
- Issue summons and or fines.

(7) *Section 2.4* is added, to read as follows:

2.4 Fundamental Erosion Control Principles

The intent of erosion control design is to protect adjacent properties and downstream properties from the detrimental effects of land disturbing activity. Water erosion is always directional, i.e., always down-slope. This directional nature of water erosion can be used to design resistance to sediment movement near the downstream edge of the disturbed property. The erosion control design may govern slope placement so that sediment-laden runoff is not directly tributary to an adjacent property. The slope may need to be built to accommodate a temporary diversion channel, which keeps water on the disturbed parcel.

Control measures are necessary for each phase of development (each phase of a development must have a "stand alone" erosion control plan), and it is understood that initial grading and construction will require certain control measures, which will change or be replaced as development progresses. Temporary control measures such as silt fences or diversion structures may be used during the initial grading and construction phase and later either removed completely or replaced with grass or permanent sediment basins.

Erosion control measures can be arranged to perform in sequence so that sediment reduction caused by one measure releases less sediment to the next. In this manner, series resistance to sediment movement can be built into a project so that stormwater released to adjacent properties or streams is carrying the allowable amount of sediment. The resistance to released sediments can be designed to minimize costs and minimize interference with on-site construction activities.

The construction and maintenance of erosion control measures is critical to ensure proper performance. Erosion Control Plans must include construction details and maintenance guidelines.

(8) *Section 3.0* is deleted in its entirety

(9) *Section 3.1* is deleted in its entirety

(10) *Section 3.2.1* is amended to read as follows:

3.2.1 Inspection Frequency

Documented inspections are required on a biweekly basis and within twenty four (24) hours of a storm event, with some limited, temporary exceptions for inactive sites. The City recommends spot-checking BMPs every workday. This is typically reasonable to achieve and can help to ensure that the BMPs remain in good working condition. For example, vehicle tracking of sediment onto the roadway is a common problem that often requires maintenance more frequently than weekly. Curb socks, inlet protection and silt fence are other BMPs that are prone to damage and displacement, also benefiting from more frequent inspections.

When the site or portions of the site are awaiting final stabilization (e.g., vegetative cover), where construction is essentially complete, the recommended frequency of inspection is at least once every week. Be sure that this change is documented and in accordance with relevant permit requirements prior to reducing the inspection schedule.

When snow cover exists over the entire site for an extended period, inspections are not always feasible. Document this condition, including date of snowfall and date of melting

conditions, and be aware of and prepare for areas where melting conditions may pose a risk of surface erosion.
Inspections of disturbed sites must be done by the responsible party, at the minimum, on a bi-weekly basis. Records of inspections including date and time of inspection, corrective action(s) taken and future planned maintenance activities must be kept at the construction site by the responsible party and submitted to the Erosion Control Inspector upon request.

(11) *Section 4.2* is amended to read as follows:

4.2 Sediment Control Measures

Sediment control measures limit transport of sediment off-site to downstream properties and receiving waters. Sediment controls are the second line of defense, capturing soil that has been eroded. Sediment control generally rely on treatment processes that either provide filtration through a permeable media or that slow runoff to allow the settling of suspended particles. A third treatment process that is used in some parts of the country includes advanced treatment systems employing chemical addition (flocculent) to promote coagulation and settling of sediment particles. The City does not recommend the use of chemical treatment as the improper application of chemicals can be more detrimental than simply removing the sediment.

"Sediment Control" (SC) BMPs Fact Sheets in this chapter are:

- SC-1 Silt Fence (SF)
- SC-2 Sediment Control Log (SCL)
- SC-4 Brush Barrier (BB)
- SC-5 Rock Sock (RS)
- SC-6 Inlet Protection (IP) (*multiple types*)
- SC-7 Sediment Basin (SB)
- SC-8 Sediment Trap (ST)
- SC-9 Vegetated Buffers (VB)
- SC-10 Chemical Treatment (CT) (*also known as Advanced Treatment Systems [ATS])*

No Fact Sheet is included for "SC-3 Straw Bale Barriers" (SBB) as these are prohibited from use as a post-construction sediment control measure in the City.

(12) *Fact Sheet SC-3* is deleted in its entirety.

(13) *Figure SBB-1* is deleted.