CITY OF LOVELAND

STORM DRAINAGE CRITERIA

(ADDENDUM TO THE

URBAN STORM DRAINAGE CRITERIA MANUALS

VOLUMES 1, 2 AND 3)

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Date: September 1, 2002

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PREFACE

In 1986 the City of Loveland Master Drainage Plan and Storm Drainage Criteria Manual were completed and adopted. The City of Loveland Storm Drainage Criteria Manual was modeled after the 1969 version of the Urban Storm Drainage Criteria Manual (USDCM) as developed by the Urban Drainage & Flood Control District (UD&FCD) in Denver, Colorado. The 1969 version of the USDCM consisted of Volumes 1 and 2. Many of the local communities outside of the Denver area have since adopted the USDCM as their drainage criteria, even though they were not within the UD&FCD. However, the USDCM was written with the regional concept in mind and provides criteria and design standards for many different conditions within the UD&FCD. Late in the 1990's the UD&FCD began a process to write Volume 3 titled, Best Management Practices, which addresses stormwater quality and erosion control. Upon completion and adoption of Volume 3, the UD&FCD realized that they needed to update Volumes 1 and 2 to bring their criteria manuals current with technology. In July of 2001 the UD&FCD completed and adopted updated Volumes 1 and 2 of their drainage criteria.

The City of Loveland would like to provide engineering professionals working within the Loveland community with the latest tools and information related to the design of storm drainage infrastructure. The new USDCM Volumes 1, 2, and 3 include a CD Rom containing Volumes 1,2,3 and approximately 50 Excel Spreadsheets for consistent calculation purposes. In order to provide engineering professionals with the latest tools and information in storm drainage, and implement the EPA Phase 2 Stormwater Quality Permit requirements, the City of Loveland is adopting the USDCM Volumes 1, 2, and 3 with an Addendum relating to City of Loveland needs. The Addendum makes changes to the USDCM Volumes 1, 2, and 3 in order to enable the criteria to become specific to the Loveland community. The USDCM may be ordered by visiting the UD&FCD web site at www.udfcd.org or by contacting the UD&FCD at 303-455-6277.

AMENDMENTS AND REVISIONS

The USDCM and Addendum have been prepared utilizing state-of-the-art technology and procedures. Due to the dynamic nature of urban storm drainage, amendments and revisions will be required from time to time as experience is gained in the use of the USDCM and Addendum. Amendments and revisions will be posted within the Stormwater Utility link of the City of Loveland web site at www.ci.loveland.co.us/ and on the UD&FCD web site at www.udfcd.org

Users of the USDCM and Addendum are encouraged to submit their comments, criticism, and errors that are found. Comments can be submitted through the Stormwater Utility link of the City of Loveland web page or by mailing written comments to:

Kevin Gingery
City of Loveland
Public Works Department - Stormwater
200 N. Wilson Avenue
Loveland, CO 80537

General Provisions

1.1 Short Title

The USDCM and Addendum together with all future amendments shall be known as the Loveland Storm Drainage Criteria (LSDC).

1.2 Jurisdiction

The LSDC shall apply to all incorporated land within the City of Loveland. Lands within the Urban Growth Area considered for annexation and requiring drainage analysis, shall follow the regulations set forth herein.

1.3 Purpose

Presented in the LSDC are the minimum design and technical criteria for the analysis and design of storm drainage facilities. All new developments, or any other proposed construction submitted for acceptance, shall include adequate storm drainage system analysis and appropriate drainage system design. Such analysis and design shall conform to the criteria set forth herein.

1.4 Enactment Authority

The City of Loveland Municipal Code (CODE) has been adopted pursuant to the authority conferred within Title 31, Article 16 and other applicable sections of CRS 1973 as amended. Title 16 "Subdivision of Land" of the CODE adopts the LSDC by reference.

1.5 Amendment and Revisions

The policies and criteria are basic guidelines which may be amended as new technology is developed and/or experience gained in the use of the LSDC indicate a need for revision. Amendments and revisions will be made through ordinance adoption.

1.6 Enforcement Responsibility

It shall be the duty of the Stormwater Utility Senior Civil Engineer to enforce provisions of the LSDC.

1.7 Interpretation

The Stormwater Utility Senior Civil Engineer is responsible for the interpretation of provisions of the LSDC using the following guidelines:

1. In the interpretation and application, the provisions of the LSDC shall be held as the minimum requirements for promotion of the health, safety, and general welfare of the community.

2. The LSDC is not intended to interfere with, abrogate, or annul any other regulation, statue, or other provision of law.

3. Where any provision of the LSDC impose restrictions different from those imposed by any other provisions of the LSDC or any other regulation, or provision of law, that provision which is more restrictive or imposes higher standards shall govern.

4. The LSDC is not intended to abrogate any easement, covenant, or any other private agreement or restriction, provided that where the provisions of the LSDC are more restrictive or impose higher standards or requirements than such easement, covenant, or other private agreement or restriction, the provisions of these Regulations shall govern.

1.8 Exceptions

The City Council may at its discretion grant exceptions to the regulations of the LSDC in accordance with the provisions of Chapter 16 of the CODE.

Drainage Planning Submittal Requirements

1.1 Review Process

All new developments within the jurisdiction of the LSDC shall submit drainage reports, construction drawings, and as-built information in accordance with the requirements of this section.

1.2 Conceptual Drainage Report

The purpose of the Conceptual Drainage Report is to identify and define conceptual solutions to problems, which may occur on-site and off-site as a result of the development. In addition, those problems that exist on-site prior to development must be addressed during the conceptual phase. All reports shall be typed on 8-1/2" x 11" paper and bound. The drawings shall be bound within the report or included within a pocket attached inside the back cover of the report. The report needs to stand-alone and therefore all important reference material should be copied and included within the report appendix. The report shall include a cover letter presenting the conceptual design for review and shall be prepared by or supervised by an engineer licensed in Colorado. The report shall contain a certification sheet as follows:

"I hereby certify that this report for the conceptual drainage design of (Name of Development) was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Loveland Storm Drainage Criteria for the owners thereof."

_____
Registered Professional Engineer
State of Colorado No. _____
(Affix Seal)

1.2.1 Report Contents

The Conceptual Drainage Report shall be prepared in accordance with the following outline and contain the applicable information listed:

I. General Location and Description
   - A. Location
     1. Township, range, section, ¼ section.
     2. Local streets within and adjacent to the development.
     3. Major open channels and facilities.
     4. Names of surrounding developments.
   - B. Description of Property
     1. Area in acres.
     2. Ground cover.

3. Major open channels.
4. General project description.
5. Irrigation facilities.

II. Drainage Basins and Sub-Basins
   A. Major Basin Description
      1. Reference to City of Loveland Master Drainage Plan.
      2. Major basin drainage characteristics
      3. Identification of all nearby irrigation facilities within 100-feet of the property boundary.
   B. Sub-Basin Description
      1. Historic drainage patterns on the subject property.
      2. Off-site drainage flow patterns and impact on the subject property.

III. Drainage Facility Design
   A. General Concept
      1. Concept and typical drainage patterns.
      2. Compliance with offsite runoff considerations.
      3. Anticipated and proposed drainage patterns.
   B. Specific Details
      1. Drainage problems encountered and solutions at specific locations.
      2. Maintenance access and aspects of the design.

1.2.2 Drawing Contents

A General Location Map shall be provided at a scale of 1" = 2000' or larger in sufficient detail to identify upstream off-site drainage areas flowing into the development and general drainage patterns.

A Drainage Plan of the proposed development shall be provided at a scale from 1" = 100' to 1" = 200' on a 24" x 36" drawing. The plan shall show the following information:

1. Existing contours at 2-feet maximum intervals.
2. Property lines, lot lines, and easements.
3. Streets with names.
4. Existing drainage facilities, structures, irrigation facilities, and sizes.
5. Overall drainage area boundary and sub-area boundaries.
6. Proposed flow directions using arrows.
7. Conceptual location of storm sewers, swales, open channels, culverts, detention ponds, and other appurtenances.
8. Location of all defined 100-year floodplains affecting the property.
9. Any other items so noted within the Drainage Report.

1.3 Preliminary Drainage Report

The purpose of the Preliminary Drainage Report is to identify and define preliminary solutions to problems, which may occur on-site and off-site as a result of the development. In addition, those problems that exist on-site prior to development must be addressed during the preliminary phase. All reports shall be typed on 8-1/2" x 11" paper and bound. The drawings shall be bound within the report or included within a pocket attached inside the back cover of the report. The report needs to stand-alone and therefore all important reference material should be copied and included within the report appendix. The report shall include a cover letter presenting the preliminary design for review and shall be prepared by or supervised by an engineer licensed in Colorado. The report shall contain a certification sheet as follows:

"I hereby certify that this report for the preliminary drainage design of (Name of Development) was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Loveland Storm Drainage Criteria for the owners thereof."

_____
Registered Professional Engineer
State of Colorado No. _____
(Affix Seal)

1.3.1 Report Contents

The Preliminary Drainage Report shall be in accordance with the following outline and contain the applicable information listed:

I. General Location and Description
   - A. Location
     1. Township, range, section, ¼ section.
     2. Local streets within and adjacent to the development.
     3. Major open channels and facilities.
     4. Names of surrounding developments.
   - B. Description of Property
     1. Area in acres.
     2. Ground cover.
     3. Major open channels.
     4. General project description.
     5. Irrigation facilities.

II. Drainage Basins and Sub-Basins
   - A. Major Basin Description
     1. Reference to City of Loveland Master Drainage Plan.
     2. Major basin drainage characteristics.

3. Identification of all nearby irrigation facilities within 100-feet of the property boundary.

B. Sub-Basin Description
   1. Historic drainage patterns on the subject property.
   2. Off-site drainage flow patterns and impacts on the subject development.

III. Drainage Design Criteria
   A. Regulations: Discussion of the optional criteria selected or the deviation from the LSDC if any.
   B. Development Criteria Reference and Constraints
      1. Discussion of previous drainage studies (i.e., project master plans) for the subject property that influence or are influenced by the drainage design and how the plan will affect drainage design for the site.
      2. Discussion of the drainage impact of site constraints such as street, utilities, existing structures, and development or site plan.
   C. 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 criteria or calculation methods used that are not presented in or referenced by the LSDC.
   D. Hydraulic Criteria
      1. Identify various capacity references.
      2. Identify detention outlet type.
      3. Identify check/drop structure criteria used.
      4. Discussion of other drainage facility design criteria used that are presented in the LSDC.

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, 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. Discussion of maintenance access and aspects of the design.

V. Conclusions
   A. Compliance with the LSDC.
   B. Drainage Concept
      1. Effectiveness of drainage design to control damage from storm runoff.
      2. Influence of proposed development on the City of Loveland Master Drainage Plan recommendations.
      3. Approval of affected irrigation company or other property owner to be obtained.

VI. References
   Reference all criteria and technical information used.

VII. Appendices
   A. Hydrology Computations
      1. Land use assumptions regarding adjacent properties.
      2. Initial and major storm runoff computations at specific design points.
      3. Historic and fully developed runoff computations at specific design points.
   B. Hydraulic Computations
      1. Culvert sizing.
      2. Storm sewer sizing.
      3. Street capacity evaluation.
      4. Storm inlet sizing.
      5. Swale sizing.
      6. Open channel sizing.
      7. Check and/or drop structure sizing.
      8. Detention pond area/volume capacity and outlet sizing.

1.3.2 Drawing Contents

A General Location Map shall be provided at a scale of 1" = 2000' or larger in sufficient detail to identify upstream off-site drainage areas flowing into the development and general drainage patterns.

A Drainage Plan of the proposed development shall be provided at a scale from 1" = 100' to 1" = 200' on a 24" x 36" drawing. The plan shall show the following information:

1. Existing and proposed contours at 2-feet maximum intervals.
2. Property lines, lot lines, and easements.
3. Streets with names.

4. Existing drainage facilities, structures, irrigation facilities, and sizes.
5. Overall drainage area boundary and sub-area boundaries.
6. Proposed flow directions using arrows.
7. Proposed storm sewers, swales, open channels, culverts, cross-pans, and other appurtenances, including cross-sections of swales and open channels.
8. Proposed outfall point for runoff from the development area and facilities to convey flows to the final outfall point without damage to downstream properties.
9. Routing and accumulation of flows at various critical points for the minor storm runoff.
10. Routing and accumulation of flows at various critical points for the major storm runoff.
11. Detention storage facilities and outlet works, including proposed 100-year water surface elevations.
12. Location and elevations of all defined 100-year floodplains affecting the property.
13. Location of all existing and proposed utilities.
14. Routing of off-site drainage flows through the development.
15. Minimum lowest opening elevations of residential and commercial buildings above the 100-year water surface in streets, open channels, ditches, swales, or other drainage facilities, as illustrated by the preliminary grading plans.
16. Proposed on-site private and public drainage easements.
17. Proposed off-site private and public drainage easements.

1.4 Final Drainage Report

The purpose of the Final Drainage Report is to update the preliminary design concepts, and to present the design details for the drainage facilities discussed in the Preliminary Drainage Report. Also, any change to the preliminary concept shall be presented.

All reports shall be typed on 8-1/2" x 11" paper and bound. The drawings shall be bound within the report or included within a pocket attached inside the back cover of the report. The report needs to stand-alone and therefore all important reference material should be copied and included within the report appendix. The report shall include a cover letter presenting the final design for review and shall be prepared by or supervised by an engineer licensed in Colorado. The report shall contain a certification sheet as follows:

"I hereby certify that this report for the final drainage design of (Name of Development) was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Loveland Storm Drainage Criteria for the owners thereof."

_____
Registered Professional Engineer
State of Colorado No. _____
(Affix Seal)

The final drainage report shall be prepared in accordance with the outline shown above under Preliminary Drainage Report. The report drawings shall follow the requirements presented above under Preliminary Drainage Report. Final design hydraulic calculations shall be provided for each of the proposed elements of the final drainage design.

1.5 Construction Drawings and Specifications

Where drainage improvements are to be constructed in accordance with the accepted Final Drainage Report, the construction plans (on 24" x 36" mylar) and specifications shall be submitted in conformance with the Final Plat for review and acceptance prior to construction. The plans and specifications for the drainage improvements shall include all drainage components designed within the Final Drainage Report.

The information required for the drawings and specifications shall be in accordance with sound engineering principles, the LSDC and the City requirements for subdivision design. Construction documents shall include geometric, dimensional, structural, foundation, bedding, hydraulic, landscaping, and other details as needed to construct the storm drainage facilities. The accepted Final Drainage Plan shall be included as part of the construction documents for all facilities affected by the drainage plan.

1.6 As-Built Drawings

1.6.1 Recording of Drawings

A. The project record drawings shall be submitted to and accepted by the Public Works Department Inspectors.

B. Each drawing shall be labeled "DRAWINGS OF RECORD" in neat large printed letters.

C. Construction information shall be recorded concurrently with construction progress by the Contractor.

D. Project Record Drawings shall be marked legibly and with an indelible pen.

E. Project Record Drawings shall record actual construction and contain, but not limited to, the following:
   1. Field dimensions, elevations, and details.
   2. Field changes which are made by minor deviations to the design drawings.
   3. Details, which are not on the original Construction Drawings.
   4. Elevations of manhole and inlet inverts in relation to project datum.
   5. Critical hydraulic structure dimensions.
   6. Orifice plate sizes.
   7. Detention pond volumes.
   8. All other critical hydraulic elevations.

1.6.2 Submission

A. The project record drawings shall be submitted to and accepted by the Public Works Department Inspectors with a transmittal letter containing the following:

   1. Date.
   2. Project Title.
   3. Design Engineer's name, address, and telephone number.
   4. Title and number of each Record Document.
   5. The signature of the Design Engineer, and their Professional Engineering stamp.

B. The initial acceptance of the storm drainage improvements will not be made until all city installation requirements are satisfied and the Project Record Drawings are received and accepted by the City.

C. The final drawings of the storm drainage improvements will not be made until the Project Record Drawings are received and accepted by the city.

D. The city requires that the Project Record Drawings first be submitted in blueline form for preliminary acceptance before final mylars are submitted.

Drainage Policy

1.4 Planning

Change …watershed in the Denver region.
To …watershed in the Loveland area.

Change …can be stored in detention and retention reservoirs.
To …can be stored in detention reservoirs.

1.5 Technical Issues

Change …(CUHP), or…
To …(CUHP), HEC-1, or…

Change …of stormwater detention and retention basins…
To …of stormwater detention basins…

Change …the many detention and retention facilities in the Denver region.
To …the many detention facilities in the Loveland area.

Change The various governmental agencies within the Denver region have adopted and need to maintain their floodplain management programs.
To The City of Loveland has adopted and needs to maintain its floodplain management program.

1.6 Flood Insurance

Change …The Denver region should encourage continued participation…
To …The Loveland area continues to participate…

2.1 Drainage is a Regional Phenomenon That Does Not Respect the Boundaries Between Government Jurisdictions or Between Properties

Add: The City of Loveland has entered into an Agreement with Larimer County to cooperate on regional planning for the projected Urban Growth Area. The Policy of the City of Loveland shall be to pursue a jurisdictionally unified drainage effort to assure an integrated plan and to cooperate with other regional and local planning agencies on drainage matters.

3.1.2 Rainfall-Runoff Relationships

Change …of the Denver region.
To …of the Loveland area.

3.1.4 Library

Change …The District should…
To …The City of Loveland should…

Change …of the District's educational…
To …of the City of Loveland's educational…

3.1.5 Runoff Magnitudes

Change …for Denver region…
To …for Loveland area…

3.2 Floodplain Data

Delete "the District's Flood Hazard area Delineation Studies,"

3.2.2 Data Inventory

Change …in a central District depository…
To …in a Stormwater Utility file…

3.2.4 Priority for Data Acquisition

Change The District will…
To The City of Loveland will…

3.3.1 Master Plan

Change …in the District.
To …in Loveland.

4.1 Total Urban System

Change …for most of the watersheds in the Denver region.
To …for the Loveland area.

Change An effort to complete the coverage of master plans for yet unplanned areas of the District should be continued until full coverage is achieved.
To An effort to complete coverage of master plans for yet unplanned areas of the City of Loveland should be continued until full coverage is achieved.

4.1.2 Master Plan

Delete Entire first paragraph of this section.

Change The District has…
To The City of Loveland has…

Add The Policy of the City of Loveland shall be to enforce and implement the adopted Master Drainage Plan for the Urban Growth Area. This Master Drainage Plan may be amended from time to time in the future.

4.1.3 Planning Process Ingredients

Delete "to 10" within item 2.

4.1.6 Water Quality

Change …in the Denver region.
To …in the Loveland area.

4.5 Detention and Retention Storage

Add The Policy of the City of Loveland shall be to require regional and/or on-site detention for all future growth areas as set forth in the adopted Master Drainage Plan. Temporary or interim detention/retention may be required if the downstream facilities have not yet been constructed per the Master Plan. Retention facilities are normally not allowed in the Loveland area, but will be considered by the Stormwater Utility for special circumstances. The Greeley and Loveland Irrigation Company filed on all storm water entering the Company lakes and canals. The filing was done in 1977 and is Case No. W-8665-77. The final decree was entered into on June 5, 1978 and the Company received a 1977 priority for the storm water. Retention facilities shall be sized to contain a volume equal to twice the 100-year storm runoff volume plus one foot of freeboard. Water within a retention facility shall be mechanically removed and disposed of off-site by the property owner within 48 hours after a storm event.

4.5.4 Reliance on Non-Flood-Control Reservoirs

Delete The entire paragraph.

Add Jurisdictional dams are classified by the State Engineer as either low, moderate, or high hazard structures depending on conditions downstream. Dams are classified as high hazard structures when, in the event of failure, there is a potential loss of life. Dams presently rated as low or moderate hazard structures may be changed to high hazard rating if development occurs within the potential path of flooding due to a dam breach. In this case, the reservoir owners would be liable for the cost of upgrading the structure to meet the higher hazard classification.

The Policy of the City of Loveland shall be to:

1. Restrict upstream development to areas outside of the jurisdictional dam water surface elevation created by a 100-year storm.
2. Restrict downstream development to areas outside of the jurisdictional dam 100-year floodplain. The jurisdictional dam 100-year floodplain is defined as either:

    a. The 100-year floodplain downstream of the emergency spillway assuming the dam is full to the elevation of the emergency spillway at the beginning of the 100-year storm and the 100-year storm is routed through the dam and out the emergency spillway,
    b. Or the path that the basin's 100-year floodplain would form through the downstream development if the dam were removed by the owner.

4.5.5 Reliance on Embankments

Change …by the District.
To …by the City of Loveland.

5.1 Design Criteria

Change …by the District.
To …by the City of Loveland.

5.1.1 Design Criteria

Change …in the Denver region…
To …in the Loveland area…

Add The City of Loveland Stormwater Utility Senior Civil Engineer may grant Variances from the design criteria of this Manual by his/her acceptance of the Final Drainage Report in which the variance request is well documented.

5.2.1 Design Storm Return Periods

Delete The entire second paragraph.

5.2.2 Initial Storm Provisions

Delete "to 10-" and "depending on local criteria"

5.4 Streets

Change …as summarized in Table DP-1.
To …as summarized in the Streets/Inlets/Storm Sewers chapter of this Manual.

Delete Table DP-1 in its entirety.

Change …summarized in Table DP-2.
To …summarized in the Streets/Inlets/Storm Sewers chapter of this Manual.

Delete Table DP-2 in its entirety.

Change …presented in Table DP-3.
To …presented in the Streets/Inlets/Storm Sewers chapter of this Manual.

Delete Table DP-3 in its entirety.

Change …in the Denver region…
To …in the Loveland area…

5.5 Irrigation Ditches

Add The Policy of the City of Loveland shall be that the use of irrigation ditch company facilities for storm drainage, which companies have agreements with the City of Loveland, shall be as set forth in the agreements and the adopted Master Drainage Plan.

5.5.1 Use of Ditches

Change Landplanners downhill from a ditch should plan…
To Landplanners and engineers downhill from a ditch shall plan...

5.5.3 Conformance With Master Plan

Change …in a District's master plan…
To in the Loveland master plan…

Change …by the District and…
To …by the City of Loveland and…

5.6 Detention and Retention Facilities Maintenance

Change …in the Denver region.
To …in the Loveland area.

6.1 Purpose

Delete "various governmental agencies within the Denver region should initiate floodplain management programs."

6.2 Goals

Change …of Denver region…
To …of Loveland area…

6.3.2 New Development

Add The Policy of the City of Loveland shall be to outsource engineering review of all CLOMR and LOMR submittals received with a development application. The Developers shall reimburse the City of Loveland Stormwater Utility for all outsourced engineering review costs. Upon FEMA approval of a CLOMR or LOMR, payment of all outsourced engineering review costs are due and payable to the City of Loveland Stormwater Utility. Developers are welcome to contract directly with our outsourced

Consultant for the preparation of CLOMR's and LOMR's, if they so desire.

7.1 Adoption of Drainage Master Plans

Change …within the District.
To …within the Loveland area.

7.3 Amendments

Change …by any governmental agency should be reviewed by the District to…
To …by anyone should be reviewed by the City of Loveland to…

Change …The District should continually review the needs of the Denver region in regard…
To …The City of Loveland should continually review the needs of the community in regard...

7.5 Drainage Improvements

Add entire new section as follows:

The City of Loveland Master Drainage Plan sets forth improvements required for existing and future growth areas. The Policy of the City of Loveland regarding the design and construction of improvements within the Master Drainage Plan shall be as set forth below, subject to annual City Council budget and appropriation approval.

1. The City of Loveland shall arrange for the design and construction of improvements as set forth in the adopted Master Drainage Plan for existing and future growth areas.
2. The drainage systems for future development and redevelopment shall be designed and constructed by the Developer.
3. The Developers shall be responsible for design and construction of temporary or interim storm drainage systems required due to the lack of adequate storm drainage facilities downstream of the new development.

Drainage Law

The Drainage Law chapter is hereby deleted in its entirety. No Drainage Law chapter will be provided.

Planning

7.1 Initial Drainage

Change	…by the District to have a return frequency ranging from once in 2 years to once in 10 years.
To	…by the City of Loveland to have a return frequency of once in 2 years.

9.1 Storm Sewers

Change	…storm runoff expected to occur once every two to ten years.
To	…storm runoff expected to occur once every two years.

9.4 System Sizing

Change	The suggested design return periods to be used by local jurisdictions in the Denver region for storm sewer design for all land uses is 2 – to 10 – years.
To	The suggested design return period to be used by the City of Loveland for storm sewer design for all land uses is 2 – years.

Rainfall

Delete	The Rainfall Chapter in its entirety.
Add	The Rainfall Chapter from the March 1986 Loveland Storm Drainage Criteria Manual in its entirety, without change, as included herein.

CITY OF LOVELAND
STORM DRAINAGE CRITERIA MANUAL

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SECTION 500 RAINFALL

501 INTRODUCTION

The data and procedures presented in this section were obtained from the Larimer County Storm Water Management Manual (Reference-18) for the Loveland region of Larimer County (Area II). The data and procedures for other areas of the county can be found in the referenced report.

The methods employed in this section have been adapted from procedures developed by the National Oceanic and Atmospheric Administration and published in Precipitation Frequency Atlas of the Western United States, NOAA Atlas II (Reference-16). These data and procedures presented in the NOAA Atlass II were verified utilizing 34 years of hourly precipitation data for Fort Collins. Utilizing these procedures and data, precipitation frequency curves were developed for the plains area of Larimer County.

502 BASIC DATA

A search of data and methods available for developing precipitation frequency relationships was made in order to determine the best methods and data for Larimer County. A search of published records indicated that there was a limited amount of rainfall data available for Larimer County. Review of established procedures for determining rainfall frequency relationships indicated that the most up-to-date procedures were those published in the NOAA Atlas.

A search of published rainfall data for the State of Colorado revealed that there are seven reporting stations in Larimer County. Table-501 shows the location and number of years of data available from each of these stations. The Fort Collins station is the only rainfall station with long-term hourly precipitation data. These hourly values are needed in order to analyze short-duration storms. Due to this limited amount of available data, other methods of determining precipitation-frequency relationships were employed.

The National Oceanic and Atmospheric Administration published a Precipitation Frequency Atlas of the Western United States in 1973 (mentioned above) of which Volume III contains data for Colorado. This atlas presents charts of precipitation of 6- and 24-hour duration for return periods of 2 to 100 years. The development of the atlas revises Weather Bureau Technical Paper No. 40 developed in 1961. The main emphasis of this revision was to more accurately depict the variation in the precipitation frequency regimes for mountainous regions. The atlas takes into account regional relationships between stations and therefore presents a better regional pattern of precipitation than an analysis of just the stations in Larimer County would produce.

503 FREQUENCY ANALYSIS

The development of the NOAA Atlas utilized two types of rainfall data. The main emphasis was put on utilization of the data from stations which had hourly records. To verify regional relationships, records from daily precipitation

gages were also analyzed. For short-duration storms (less than 24 hours), hourly data were used to develop precipitation-frequency relationships and were verified utilizing data from daily stations. For 24-hour duration storms, all data were analyzed.

To maintain as common a data base as possible, the atlas used 15 years of data for all stations to develop the 2-year precipitation data. Due to the low probability of obtaining a 100-year event within 15 years, data for the 100-year storm events were developed utilizing full lengths of records for stations.

The eastern slope area of Colorado was analyzed utilizing data from 75 rainfall recording stations. To further verify the NOAA Atlas data for Larimer County, a brief analysis was made of the 34 years of data for the Fort Collins station. Table-501 shows the relationships between the 6-hour storms as developed fromt he NOAA Atlas and as developed utilizing only the Fort Collins data. This analysis would indicate that the NOAA Atlas data does accurately predict the rainfall-frequency relationships for the Fort Collins area. A similar analysis of 86 years of Denver data was also made by the Urban Drainage and Flood Control District. The analysis produced approximately the same result as the NOAA Atlas data.

504 RAINFALL ZONES

The County was divided into three major hydrologic areas (as shown in Figure-501), and precipitation-frequency data for each area are different in order to closely match the local precipitation regimes.

The three major areas shown in Figure-501 are described as follows:

Area I: The area near Fort Collins from the east county line on to the first "hogback" on the west and from the watershed divide between the Cache la Poudre and Big Thompson rivers on the south through Township 9 North on the north.

Area II: The area near Loveland from the east county line to the first "hogback" on the west and from the south county line to the watershed divide between the Big Thompson and Cache la Poudre rivers on the north.

Area III: The remainder of the county not in Area I or Area II.

Only the data for Area II are presented herein. The data and procedures for the other areas can be found in Reference-18.

505 CUHP DESIGN STORMS

Rainfall in the Loveland area is influenced by the orographic effects of the Rocky Mountain, the topography of the high plains and the semi-arid climatology of the region. Rainstorms can often have an "upslope" character where easterly flow of moisture settles against the mountains. These types of rainstorms have durations that can exceed 6-hours and produce large amount of total precipitation. However, these storms are rarely intense and seldom result in urban flooding problems.

Very intense rainfall in the Loveland area results from convection storms or frontal stimulated convective storms. These types of storms are often less than 1-hour or 2-hours in duration and can produce brief periods of high rainfall

intensities. These short duration intense rainstorms appear to cause most of the urban flooding problems (reference-1).

Analysis of a 73 year record of rainfall at the Denver rain gage by the Urban Drainage and Flood Control District reveals that an overwhelming majority of the intense rainstorms produce their greatest intensities in the first hour of the storm. In fact, of the 73 most intense storms analyzed, 68 had the most intense period begin and end within the first hour of the storm and 52 had the most intense period begin and end within the first half hour of the storm. The data clearly shows that the leading intensity storms predominate among the "non-upslope" type storms in the Denver Region (Reference-1).

The recommended design storm distribution takes into account the observed "leading intensity" nature of the convection storms. In addition, the temporal distributions were designed to be used with the 1982 version of the CUHP (Section 600), the published NOAA 1-hour precipitation values (Reference-16), and the Horton's infiltration loss equation. They were developed to approximate the recurrence frequency of peak flows and volumes (i.e., 1- through 100-years) that were estimated for the watersheds whose rainfall/runoff data was collected. The procedure for the development of these design storm distributions and the preliminary results were reported at the 1979 International Symposium on Urban Storm Runoff. The recommendations contained in this MANUAL are the result of refinements to the work by the Urban Drainage and Flood Control District.

The recommended design storm distribution was obtained by first computing the incremental rainfall from the total rainfall data in the Larimer County Storm Water Management Manual (see Table-502) for the Loveland area. These incremental values were then rearranged to approximate the recommended distribution by the Urban Drainage and Flood Control District (Reference-1) resulting in the following ranking of values:

DESIGN STORM DISTRIBUTION

	INCREMENTAL PRECIPITATION RANKING					
TIME	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	9	9	9	(lowest)	(lowest)	(lowest)
10	7	7	7	10	10	10
15	4	4	4	8	8	8
20	2	2	2	4	4	4
25	1	1	1	2	2	2
30	3	3	3	1	1	1
35	5	5	5	3	3	3
40	6	6	6	5	5	5
45	8	8	8	6	6	6
50	10	10	10	7	7	7
55	11	11	11	9	9	9
60...	12...	12...	12...	11...	11...	11...

Using the distribution and the total rainfall values in Table-502, the design storms for the Loveland area were developed and are presented in Table-503 for drainage basins less than five square miles.

506 TIME-INTENSITY-FREQUENCY CURVES

The time-intensity-frequency data for the Loveland area was taken directly from the Larimer County Storm Water Management Manual and are presented in Figure-502. The data in this form are used primarily in the Rational Method Runoff Modelling Technique (see Section 600).

LARIMER COUNTY RAINFALL DATA

A) SUMMARY OF RAIN-GAGE STATIONS IN LARIMER COUNTY
(SEE TEXT, SECTION 502)

STATION	LOCATION LATITUDE	LONGITUDE	ELEV.	TYPE	YEARS OF RECORD
Fort Collins	40°35'	105°05'	5004	Recording	97
Fort Collins 9NW	40°40'	105°13'	5220	Recording	4
Waterdale	40°25'	105°12'	5260	Non-recording	83
Estes Park	40°23'	105°31'	7525	Non-recording	67
Red Feather Lake 2SE	40°48'	105°34'	8237	Non-recording	15
Rustic 12 WSW	40°42'	105°48'	8080	Recording	4
Drake	40°26'	105°20'	6170	Recording	4

B) COMPARISON OF HISTORICAL DATA WITH NOAA ATLAS 2 FOR FORT COLLINS
(SEE TEXT, SECTION 503)

RETURN FREQUENCY	34-YR. ANALYSIS 1940-1973 6-HR. PRECIPITATION (IN.)	NOAA ATLAS 2 6-HR. PRECIPITATION (IN.)
2-Yr	1.49	1.43
5-Yr	1.83	1.96
10-Yr.	2.18	2.28
50-Yr	3.04	3.08
100-Yr	3.41	3.45

LOVELAND STORM DRAINAGE CRITERIA MANUAL	TABLE 502

DESIGN TOTAL RAINFALL
AREA II - LOVELAND

2hr-5min Storms

NOTE: All Rainfall Values are in Inches

TIME	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	0.29	0.41	0.49	0.59	0.68	0.77
10	0.45	0.64	0.76	0.92	1.06	1.20
15	0.57	0.81	0.96	1.16	1.34	1.52
20	0.66	0.94	1.12	1.36	1.54	1.78
25	0.73	1.04	1.24	1.50	1.71	1.98
30	0.79	1.12	1.33	1.61	1.86	2.10
35	0.83	1.19	1.41	1.70	2.00	2.30
40	0.87	1.25	1.48	1.78	2.10	2.39
45	0.91	1.30	1.54	1.85	2.18	2.47
50	0.94	1.34	1.60	1.91	2.25	2.54
55	0.97	1.38	1.65	1.97	2.31	2.60
60	1.00	1.41	1.69	2.03	2.36	2.66
65	1.03	1.44	1.73	2.08	2.40	2.71
70	1.06	1.47	1.76	2.12	2.44	2.75
75	1.08	1.50	1.79	2.16	2.48	2.79
80	1.10	1.52	1.81	2.18	2.52	2.82
85	1.11	1.54	1.83	2.22	2.55	2.85
90	1.12	1.55	1.85	2.25	2.58	2.88
95	1.13	1.56	1.87	2.27	2.60	2.91
100	1.14	1.57	1.89	2.29	2.61	2.93
105	1.15	1.58	1.91	2.30	2.62	2.95
110	1.16	1.59	1.92	2.31	2.63	2.97
115	1.17	1.60	1.93	2.32	2.64	2.99
120	1.18	1.61	1.94	2.33	2.65	3.01

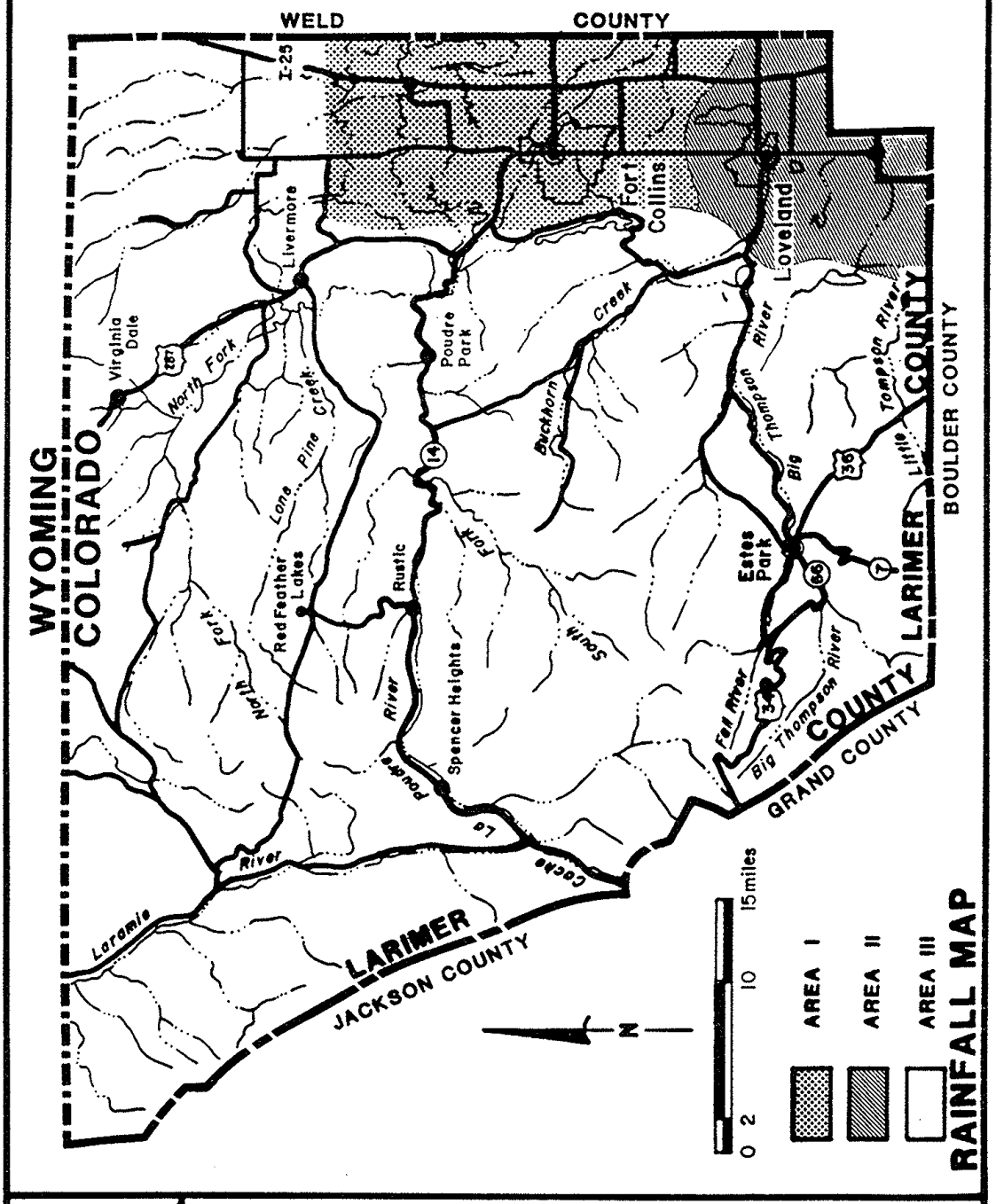
WRC ENG.	REFERENCE: Larimer County Storm Water Management Manual, FEBRUARY 1979

TWO-HOUR DESIGN STORM FOR BASINS LESS THAN 5 SQUARE MILES

TIME (MIN)	INCREMENTAL RAINFALL DEPTH 2-YR (IN)	5-YR (IN)	10-YR (IN)	25-YR (IN)	50-YR (IN)	100-YR (IN)
5	0.04	0.05	0.06	0.01	0.01	0.02
10	0.04	0.07	0.08	0.06	0.07	0.07
15	0.09	0.13	0.16	0.08	0.10	0.09
20	0.16	0.23	0.27	0.20	0.20	0.26
25	0.29	0.41	0.49	0.33	0.38	0.43
30	0.12	0.17	0.20	0.59	0.68	0.77
35	0.07	0.10	0.12	0.24	0.28	0.32
40	0.06	0.08	0.09	0.14	0.17	0.20
45	0.04	0.06	0.07	0.11	0.15	0.18
50	0.03	0.04	0.06	0.09	0.14	0.14
55	0.03	0.04	0.05	0.07	0.08	0.08
60	0.03	0.03	0.04	0.06	0.06	0.06
65	0.03	0.03	0.04	0.06	0.05	0.06
70	0.03	0.03	0.03	0.05	0.04	0.05
75	0.02	0.03	0.03	0.04	0.04	0.04
80	0.02	0.02	0.02	0.04	0.04	0.04
85	0.01	0.02	0.02	0.03	0.04	0.03
90	0.01	0.01	0.02	0.03	0.03	0.03
95	0.01	0.01	0.02	0.03	0.03	0.03
100	0.01	0.01	0.02	0.02	0.02	0.03
105	0.01	0.01	0.02	0.02	0.01	0.02
110	0.01	0.01	0.01	0.01	0.01	0.02
115	0.01	0.01	0.01	0.01	0.01	0.02
120	0.01	0.01	0.01	0.01	0.01	0.02
TOTAL	1.18	1.61	1.94	2.33	2.65	3.01

WRC ENG. | REFERENCE:

LOVELAND STORM DRAINAGE CRITERIA MANUAL	FIGURE 501

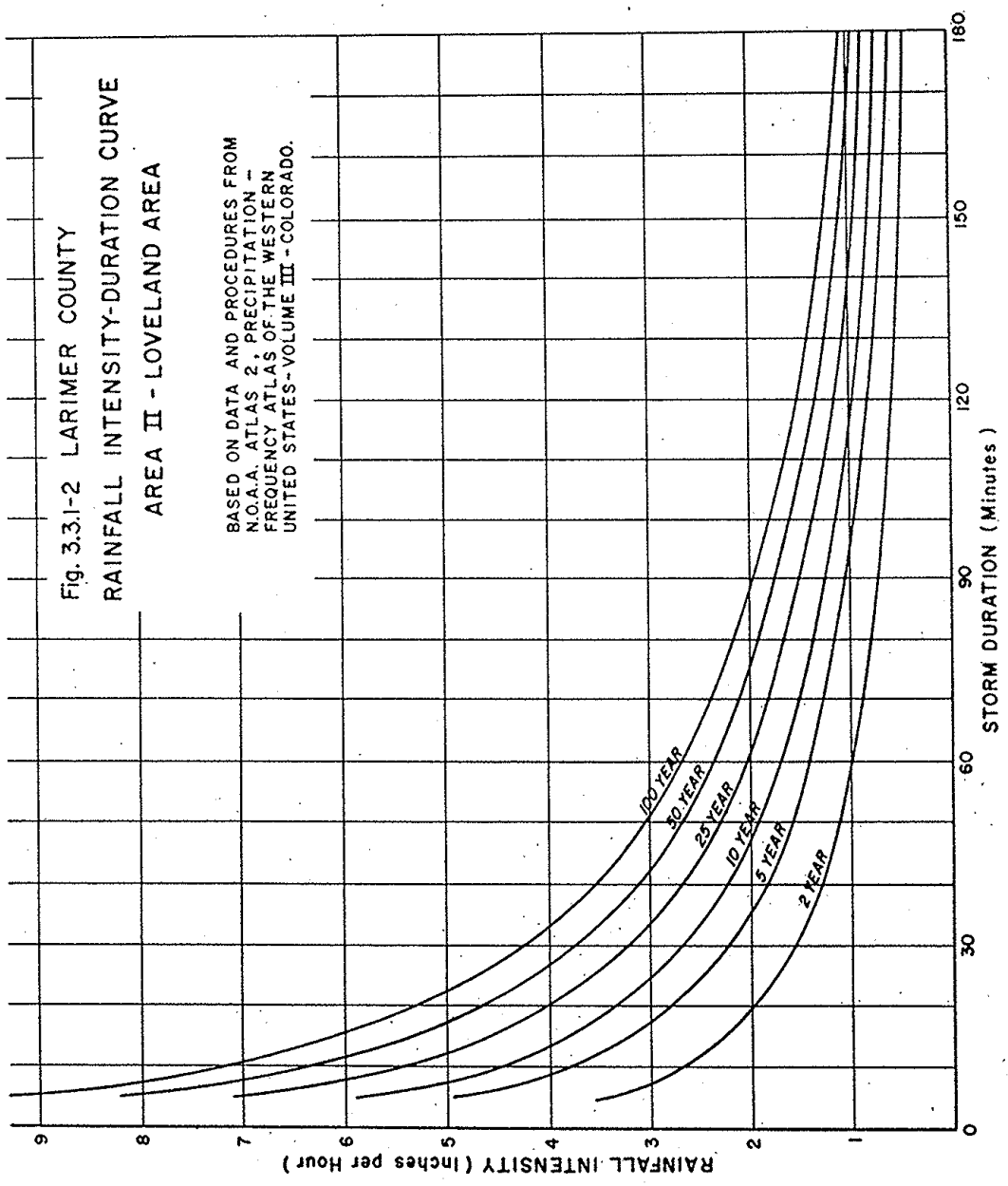


WRC ENG.	REFERENCE:

-508-

LOVELAND STORM DRAINAGE CRITERIA MANUAL	FIGURE 502

RAINFALL INTENSITY - DURATION CURVE



WRC ENG.	REFERENCE:

Runoff

3.3.1 Rainfall

Change section as follows:

From	…this Manual.
To	…the March 1986 Loveland Storm Drainage Criteria Manual.
Add	See Table 502 within the Rainfall Chapter for 1-hour rainfall depths. See Table 503 within the Rainfall Chapter for detailed hyetograph distributions.

5.1 Published Hydrologic Information

Change	The word "District"
To	The words "City of Loveland" throughout the paragraph.
Change	…for the majority of the major…
To	…for the major…
Change	…library.
To	…Stormwater Utility office.

Streets/Inlets/Storm Sewers

1.3 Components of Urban Stormwater Collection and Conveyance Systems

Change	…within the District are…
To	…within the City of Loveland are…

2.2 Design Considerations

Change	…,the District has…
To	…,the City of Loveland has…
Change	These standards were given in the POLICY Chapter and are repeated in Table ST-2 for convenience.
To	These standards are provided in Table ST-2A.
Delete	Table ST-2
Change	The District has…
To	The City of Loveland has…
Change	These standards were given in the POLICY Chapter and are repeated in Table ST-3 and Table ST-4 for convenience.
To	These standards are provided in Table ST-2A.
Delete	Table ST-3 and Table ST-4
Add	Table ST-2A

(see next page)

TABLE ST-2A
ALLOWABLE STREET FLOW DEPTHS

TRAFFIC CLASSIFICATION	**DRAINAGE CLASSIFICATION**	**ALLOWABLE FLOW DEPTH**	
		MINOR STORM (FEET)	**MAJOR STORM (FEET)**
Local	A	0.46	0.67
Residential Collector	B	0.47	0.67
Commercial Collector	B	0.50	0.75
Minor Arterial	C	0.50	0.78
Major Arterial	C	0.50	0.75

Notes: Allowable flow depth is measured vertically from the gutter flowline at the curb face.

2.3.1 Curb and Gutter

Change …allowable spread defined in Table ST-2.
To …allowable depth defined in the POLICY Chapter.

Change …allowable depth defined Table ST-2.
To …allowable depth defined in the POLICY Chapter.

Change …road inundation criteria in Table ST-3.
To …road depth criteria in the POLICY Chapter.

2.3.1.1 Gutters with Uniform Cross Slopes (ie., Where Gutter Cross Slope = Street Cross Slope).

Change …based on Table ST-2.
To …based on the POLICY Chapter.

2.3.1.3 Allowable Gutter Hydraulic Capacity

Change There are two sets of reduction factors developed for Denver metropolitan areas (GUO 2000b).

To There are two sets of reduction factors developed for Denver metropolitan areas (GUO 2000b) and they shall also be utilized for the Loveland area.

2.3.2 Swale Sections (V-Shaped with the Same or Different Side Slopes)

Delete The flow depth and spread limitations of Tables ST-2 and ST-4 are also valid for swales and roadside ditches.

2.4.1 Purpose and Objectives

Change Table ST-3 lists…
To The POLICY Chapter lists…

3.1 Inlet Functions, Types and Appropriate Applications

Add The standard inlets permitted for use in City of Loveland streets are:

INLET TYPE	**PERMITTED USE**
Curb Opening Inlet Type R	All street types with 6" Vertical curb
Grated Inlet Type C	All streets with a roadside Ditch
Grated Inlet Type 13	Alleys or private drives With a valley gutter
Combination Inlet Type 13	All street types with 6" Vertical curb

3.3.6 Inlet Clogging

Add To account for effects which decrease the capacity of the various types of inlets, such as debris plugging, pavement overlaying and variations in design assumptions, the theoretical capacity calculated for the inlets is reduced by the factors presented below for the standard inlets permitted for use in the City of Loveland streets.

ALLOWABLE INLET CAPACITY

CONDITION	INLET TYPE	PERCENT OF THEORETICAL CAPACITY ALLOWED
Sump or Continuous Grade	CDOT Type R 5' length	88
	10' length	92
	15' length	95
Continuous Grade	Combination Type 13	66
Sump	Grated Type C	50
	Grated Type 13	50
Sump	Combination Type 13	65

3.4.2 Design Considerations

Delete Table ST-2 lists pavement encroachment standards for minor storms in the Denver metropolitan area.

4.2 Design Process, Considerations, and Constraints

Change Pipe sizes smaller than 15 inches are not recommended for storm sewers.

To The minimum size storm sewer pipe within a Public Right-of-Way or Public Drainage Easement shall be 18 inches in diameter. Refer to the "City of Loveland Development Standards and Specifications Governing the Construction of Public Improvements", latest edition, for allowable storm sewer pipe materials.

4.4.1 Flow Equations and Storm Sewer Sizing

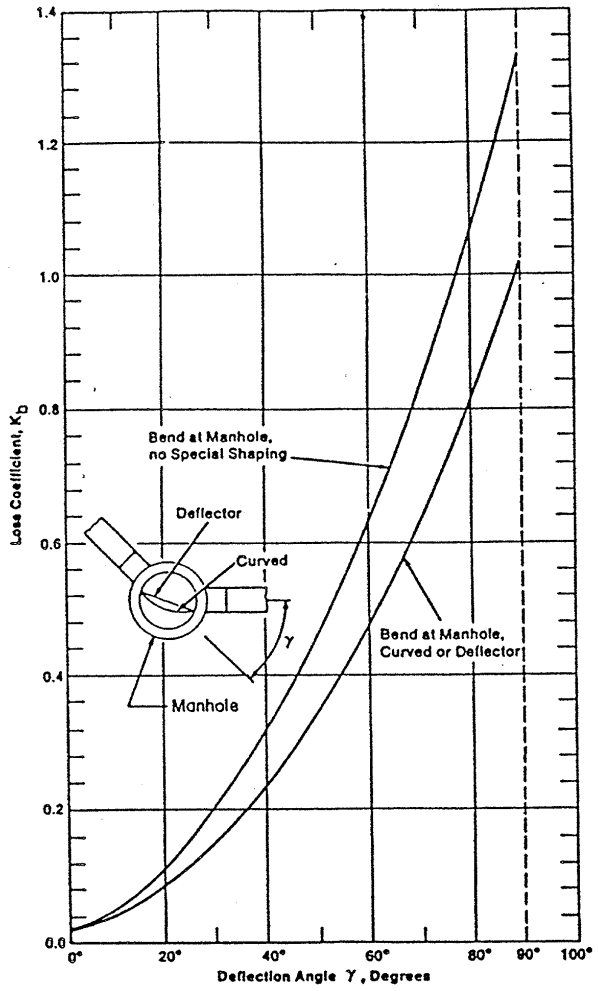
Add The Manning's roughness coefficient "n" for all storm sewer pipe capacity calculations shall be 0.013 regardless of pipe material (ie. Concrete, PVC, or HDPE).

4.4.2 Head Losses

Add Storm sewer energy loss coefficient tables, manhole and junction loss coefficient tables, and an example illustration are included on the following five pages and herein referenced as Figures 1-5.

STORM SEWER ENERGY LOSS COEFFICIENT

(BENDS AT MANHOLES)



NOTE: Head loss applied at outlet of manhole.

Reference: Linsley and Franzini
"Water Resource Engineering, McGraw-Hill, 1964

FIGURE 1

STORM SEWER ENERGY LOSS COEFFICIENT

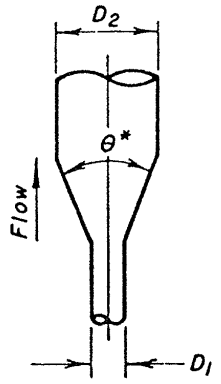
(EXPANSION, CONTRACTION)

REFERENCE: Linsley and Franzini, "Water Resources Engineering", McGraw-Hill, 1964

(a) Expansion (K_e)

θ*	$\frac{D_2}{D_1} = 3$	$\frac{D_2}{D_1} = 1.5$
10	0.17	0.17
20	0.40	0.40
45	0.86	1.06
60	1.02	1.21
90	1.06	1.14
120	1.04	1.07
180	1.00	1.00

*The angle θ is the angle in degrees between the sides of the tapering section.



(b) Pipe Entrance from Reservoir

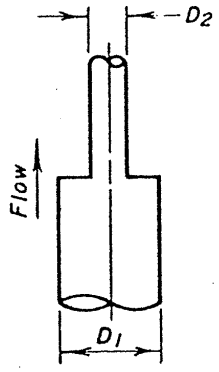
Bell-mouth $H_L = 0.04 \frac{V2}{2g}$

Square-edge $H_L = 0.5 \frac{V2}{2g}$

Groove and U/S For Concrete Pipe $H_L = 0.2 \frac{V^2}{2g}$

(c) Contractions (K_c)

$\frac{D_2}{D_1}$	K_c
0.1	0.5
0.4	0.4
0.6	0.3
0.8	0.1
1.0	0



EQUATIONS:

$$H_L = K_e \left(\frac{V_1^2}{2g}\right)\left[1-\left(\frac{A_1}{A_2}\right)\right]^2$$

$$H_L = K_c \left(\frac{V_2^2}{2g}\right)\left[1-\left(\frac{A_2}{A_1}\right)^2\right]^2$$

FIGURE 2

STORM SEWER ENERGY LOSS COEFFICIENT

(BENDS)

$$H_L = K_j(V^2/2g)$$

REFERENCE:

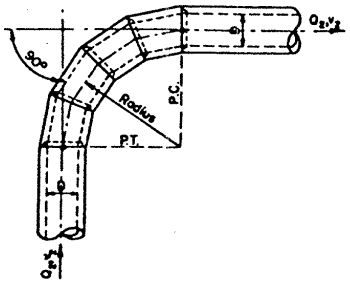
APWA Special Report No. 49, 1981

CASE I
CONDUIT ON 90° CURVES*

NOTE: Head loss applied at P.C. for length

RADIUS	K_b
1 X D	0.50
(2 to 8) X D	0.25
(8 to 20) X D	0.04
>20 X D	0

* When curves other than 90° are used, apply the following factors to 90° curves
60° curve 85%
45° curve 70%
22-1/2° curve 40%



CASE II
BENDS WHERE RADIUS IS
EQUAL TO DIAMETER OF PIPE

NOTE: Head loss applied at begining of bend

θ°BEND	K_b
90	0.50
60	0.43
45	0.35
22-1/2	0.20

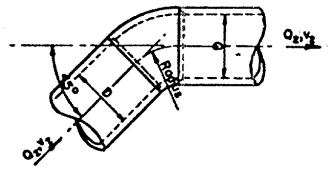
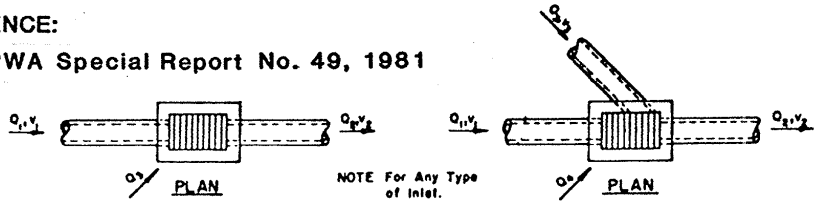


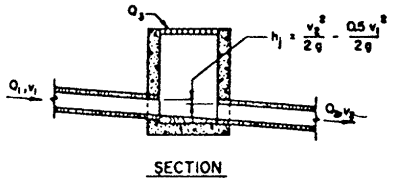
FIGURE 3

MANHOLE AND JUNCTION LOSSES

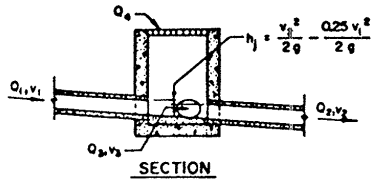
REFERENCE:

APWA Special Report No. 49, 1981

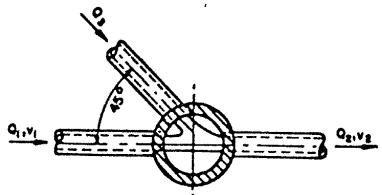


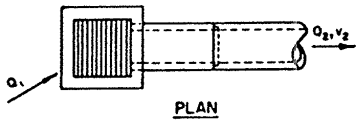


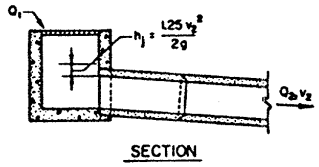
CASE I
INLET ON MAIN LINE



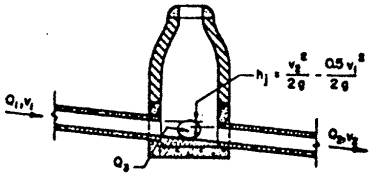
CASE II
INLET ON MAIN LINE
WITH BRANCH LATERAL







CASE IV
INLET OR MANHOLE AT
BEGINNING OF LINE



CASE III
MANHOLE ON MAIN LINE
WITH 45° BRANCH LATERAL

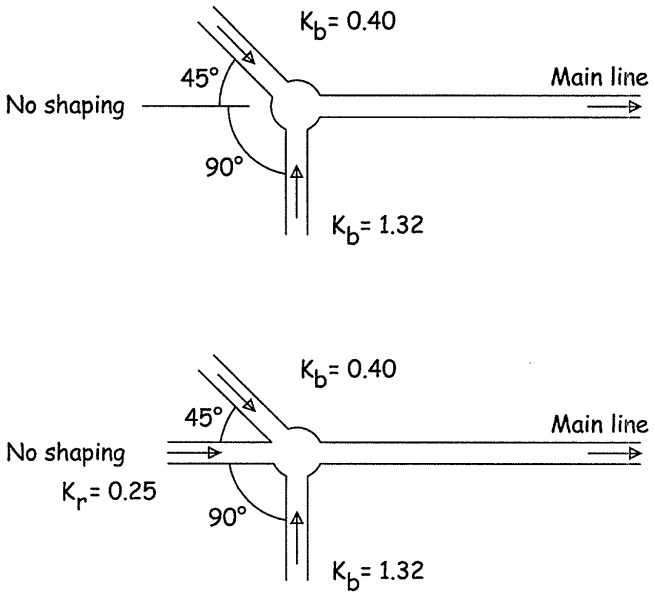
EQUATION:

$$H_L = \left(\frac{V_2^2}{2g}\right) - K_j\left(\frac{V_1^2}{2g}\right)$$

CASE NO.	K_j
I	0.50
II	0.25
IV	1.25

CASE III	
θ°	K_j
22-1/2	0.75
45	0.50
60	0.35
90	0.25
No Lateral	0.50

FIGURE 4



at θ = 45°, K_r^1 = 0.50

at θ = 90°, K_r^2 = 0.25

$K_r = \min(K_r^1, K_r^2) = 0.25$

Manhole Sewer

Example Illustration

FIGURE 5

4.5 Hydraulic and Energy Grade Line Calculations

Add The hydraulic grade line and energy grade line shall be calculated for each storm sewer system and included in the Final Drainage Report. Each storm sewer system shall be profiled on the Final Construction Drawings and shall include the design flow hydraulic grade line. The energy grade line for the design flow shall be 6 inches below the final finished elevation of the manhole rims and inlet flowlines.

Major Drainage

3.2.7 Summary of Preliminary Design Guidance

Add to Table MD-2 the following:

Grass lined open channels conveying ≤ 50 cfs may reduce the minimum 1.0 foot freeboard requirement to the freeboard required to conveying 1.33 times the 100-year design flow. The reduced freeboard may only occur if a 1.0-foot minimum freeboard is not physically or reasonably possible and a variance request is submitted.

3.2.8 Maintenance Eligibility

Delete Delete this section in its entirety.

3.3.4 Maintenance

Change A maintenance access road with a minimum passage width of 12 feet shall be provided along the entire length of all major drainageways. The local government may require the road to be surfaced with 6 inches of Class 2 roadbase or a 5-inch-thick concrete slab.

To The City of Loveland and the design engineer shall work together to provide access to all major drainageways as determined appropriate at the time of preliminary and final design.

Add The City of Loveland encourages volunteers to assist the City in performing routine maintenance of all the drainage ways within the municipal borders through an Adoption program and will assist these groups in a variety of ways.

3.5 Choice of Channel Lining

Change Manufactured channel linings such as gabions, interlocked concrete blocks, synthetic linings, etc., are not recommended for new developments.

To Manufactured channel linings such as gabions, interlocked concrete blocks, synthetic linings, etc., are not recommended for new developments, but will be considered on a case-by-case basis by the City of Loveland.

4.1.5 Trickle and Low-Flow Channels

Add Underdrain pipes shall not be used as trickle channels within the City of Loveland.

4.1.7 Water Surface Profile

Change Water surface profiles should be computed for all channels, typically for the 10-year and 100-year events.
To Water surface profiles shall be computed for all open channels conveying > 50 cfs within the City of Loveland.

Add Hydraulic grade lines shall be shown on the Final Construction Drawing profiles of open channels conveying > 50 cfs within the City of Loveland. It is not necessary to show energy grade lines on Final Construction Drawing profiles, but encouraged. The energy grade line for the design flow shall be at or below the final finished top of channel bank elevation.

4.1.8 Maintenance

Change A stable maintenance access road with a minimum passage width of 12 feet shall be provided along the entire length of all major drainageways. The local government may require the road to be surfaced with 6 inches of Class 2 roadbase or a 5-inch-thick concrete slab.
To The City of Loveland and the design engineer shall work together to provide access to all major drainageways as determined appropriate at the time of preliminary and final design.

4.2.2 Design Procedure

Change Water surface profiles must be computed, typically for the 10-and 100-year events.
To Water surface profiles shall be computed for all open channels conveying > 50 cfs within the City of Loveland.

Add Hydraulic grade lines shall be shown on the final drawing profiles of open channels conveying > 50 cfs within the City of Loveland. It is not necessary to show energy grade lines on final drawing profiles, but encouraged.

4.2.3 Life Expectancy and Maintenance

Change A maintenance access road with a minimum passage width of 12 feet shall be provided along the entire length of all major

drainageways. The Local government may require the road to be surfaced with 6 inches of Class 2 roadbase or a 5-inch-thick concrete slab.

To The City of Loveland and the design engineer shall work together to provide access to all major drainageways as determined appropriate at the time of preliminary and final design.

4.3 Concrete-Lined Channels

Change Vegetated channels are normally preferable in the Denver region…
To Vegetated channels are normally preferable in the Loveland area…

Change In the Denver region, all channels carrying supercritical flow…
To In the Loveland area, all channels carrying supercritical flow…

4.3.6 Maintenance

Change A maintenance access road with a minimum passage width of 12 feet shall be provided along the entire length of all major drainageways. The local government may require the road to be surfaced with 6 inches of Class 2 roadbase or a 5-inch-thick concrete slab.

To The City of Loveland and the design engineer shall work together to provide access to all major drainageways as determined appropriate at the time of preliminary and final design.

4.4.1.3 Wire-Enclosed Rock (Gabions)

Change For these reasons, the District discourages…
To For these reasons, the City of Loveland discourages…

4.4.7 Maintenance

Change A maintenance access road with a minimum passage width of 12 feet shall be provided along the entire length of all major drainageways. The local government may require the road to be surfaced with 6 inches of Class 2 roadbase or a 5-inch-thick concrete slab.

To The City of Loveland and the design engineer shall work together to provide access to all major drainageways as determined appropriate at the time of preliminary and final design.

4.5 Bioengineered Channels

Change The District…District's policies…
To The City of Loveland…City of Loveland's policies…

4.5.3 Bioengineering Resources

Change		…within the District.
To		…within the City of Loveland.

4.5.4 Characteristics of Bioengineered Channels

Change	1.	…of the Denver area,…
To	1.	…of the City of Loveland area,…
Change	2.	…, most bioengineered channels require…
To	2.	…, bioengineered channels may require…
Add		The City of Loveland is open to review and accept alternate bioengineering methods that provide protection to toe of bank slopes (i.e. jacks and lunkers, etc.).

4.5.5 Advantages of Bioengineered Channels

Change		…in metropolitan Denver, but…
To		…in northern Colorado, but…
Change	6.	…that may…
To	6.	…that will…
Add	8.	Are less costly to maintain.

4.5.6 Technical Constraints

Change		The following constraints are associated with bioengineered channels:
To		The following constraints may be associated with bioengineered channels:
Change	2.	…that characterize Denver can be…
To	2.	…that characterize the City of Loveland can be…
Change	3.	…within the District is to…
To	3.	…within the City of Loveland is to…
Delete		The sixth bullet item: Large trees…due to decomposition.
Delete		A portion of the last bullet item: Invasion by other…is in operation.

4.6 Natural Channels

Change Natural waterways in the Denver region are…
To Natural waterways in the Loveland area are…

Change In the Denver area,…
To In the Loveland area,…

Change 2. …with the District's and local floodplain regulations…
To 2. …with the City of Loveland's floodplain regulations…

7.0 PROTECTION DOWNSTREAM OF CULVERTS

Change …within the District.
To …within the City of Loveland.

Hydraulic Structures

4.1.2 Bridge Opening Freeboard

Add The bridge low chord elevation shall be a minimum of 1-foot above the 100-year water course energy grade line.

Culverts

1.1.2 Headwater

Delete The headwater elevation for the design discharge should be consistent with the freeboard and overtopping criteria in the POLICY chapter of this Manual (Tables DP1 through DP-3).

Add The maximum culvert headwater to diameter ratios are:

STORM FREQUENCY	HEADWATER TO DIAMETER
10-Year	HW/D $\leq$ 1.0
100-Year	HW/D $\leq$ 1.5

The minimum culvert capacities are:

DRAINAGE CLASSIFICATION	MINIMUM CAPACITY (RECURRENCE INTERVAL)
Local	10-Year
Residential Collector & Commercial Collector	10-Year
Minor Arterial & Major Arterial	100-Year

When the flow in a roadside ditch exceeds the capacity of the culvert and overtops the cross street, the flow over the street crown shall not exceed the limits established within Table ST-2A in the Streets/Inlets/Storm Sewers chapter.

2.1.1 Energy and Hydraulic Grade Lines

Add The hydraulic grade line and energy grade line shall be determined for each culvert system and included in the Final Drainage Report. Each culvert system shall be profiled on the Final Construction Drawings and shall include the design flow hydraulic grade line.

3.5.3 Culvert Diameter

Add Culverts smaller than 18 inches in diameter may only be used to convey roadside ditches under driveways where basin location, site grading, and roadside ditch depths do not make an 18 inch

diameter culvert practical. A variance shall be requested for use of culverts smaller than 18 inches in diameter.

Delete — Since the pipe roughness influences the culvert diameter, both concrete and corrugated metal pipe should be considered in design, if both will satisfy the headwater requirements.

Add — Refer to the "City of Loveland Development Standards and Specifications Governing the Construction of Public Improvements", latest edition, for allowable culvert pipe materials.

Add — The Manning's roughness coefficient "n" for all culvert pipe sizing calculations shall be 0.013 regardless of pipe material (Concrete, PVC, or HDPE).

4.1 Projecting Inlets

Add — At a minimum, a culvert entrance and outlet shall include a flared end section.

8.0 TRASH/SAFETY RACKS

Change — The District strongly…
To — The City of Loveland strongly…

8.1 Collapsible Gratings

Change — The District does not…
To — The City of Loveland does not…

Storage

2.0 APPLICATION OF DIFFERENT TYPES OF STORAGE

Add 6. Above ground parking lot detention ponds may be utilized when land area for a grassed lined detention pond is not available. To prevent damage to and floatation of automobiles, parking lot detention ponds shall not exceed 12 inches in depth at any point. Parking lot detention ponds shall be signed as such to inform the general public about the potential for flooding. A parking lot detention pond shall not encroach into a public street.

3.1.2 Use of Regional (i.e., Hydrograph Routing) Detention Sizing Procedure

Change …the District recommends…
To …the City of Loveland recommends…

3.1.3 Water Quality Capture Volume in Sizing Detention Storage

Add Within the City of Loveland, the water quality capture volume shall be considered a portion of the total 100-year detention pond volume.

3.2.1 Maximum Allowable Unit Release Rates for On-Site Facilities

Change …in a District-approved…
To …in a City of Loveland-approved…

3.2.2 Empirical Equations for the Sizing of On-Site Detention Storage Volumes

Change …for areas within the District.
To …for areas within the City of Loveland.

Change If the District has…
To If the City of Loveland has…

3.2.4 Multi-Level Control

Change The District recommends…
To The City of Loveland recommends…

Delete the 5 - or

3.3 Design Storms for Sizing Storage Volumes

Add The 10-year and 100-year storms shall be the design storms for all detention pond designs within the City of Loveland.

3.3.2 Drainage and Flood Control

Change Thus, whenever a District-approved…
To Thus, whenever a City of Loveland-approved…

3.3.3 Spillway Sizing

Add Each detention pond shall contain an emergency spillway capable of conveying the peak 100-year storm discharge draining into the detention pond. The invert of the emergency spillway shall be set equal to or above the 100-year water surface elevation. The depth of flow out the emergency spillway shall be $\leq$ 6 inches.

3.3.4 Retention Facilities

Change …problem, the District recommends…
To …problem, the City of Loveland recommends…

3.4 Reservoir Routing of Storm Hydrographs for Sizing of Storage Volumes

Change 2. Determine Hydrology: The hydrograph may be available in published district outfall system planning or a major drainageway master plan report.

To 2. Determine Hydrology: The hydrograph may be available in the published City of Loveland Master Drainage Plan or Updates.

Change …out in a District-approved…
To …out in a City of Loveland-approved…

3.4.1 Initial Sizing

Change 3…from a District Master Plan,…
To 3…from a City of Loveland Master Plan,…

3.4.2 Initial Shaping

Change The District does…
To The City of Loveland does…

Change …the District encourages…
To …the City of Loveland encourages…

4.0 FINAL DESIGN CONSIDERATIONS

Change The District urges…
To The City of Loveland urges…

4.3 Geometry of Storage Facilities

Change …within the District…
To …within the City of Loveland…

Delete or fortification of the embankment to prevent catastrophic failure when overtopped.

4.4 Embankments and Cut Slopes

Change 2. Freeboard – The elevation of the top of the embankment shall be a minimum of 1 foot above the water surface elevation when the emergency spillway is conveying the maximum design or emergency flow.

To 2. Freeboard – The elevation of the top of the embankment shall be a minimum of 1 foot above the 100-year water surface elevation in the detention pond.

Add 5. Emergency Spillway Downstream Protection – From the emergency spillway downhill to the embankment toe of slope, buried riprap shall be placed and covered with 6 inches of topsoil in order to protect the emergency spillway slot from catastrophic erosion failure. The riprap shall be sized at the time of final engineering design.

6. Concrete Cutoff Wall – A concrete cutoff wall, 8 inches thick, 3 foot deep, extending 5 feet into the embankment beyond the emergency spillway opening, is encouraged on all private detention ponds and required on all public regional detention ponds. A concrete cutoff wall will permanently define the emergency spillway opening. The emergency spillway elevation shall be tied back into the top of embankment using a maximum slope of 4:1.

4.7 Outlet Works

Add The outlet pipe of a regional detention pond shall contain a minimum of two (2) concrete cutoff walls embedded a minimum of 18" into undisturbed earthen soil. The cutoff walls shall be 8 inches thick. The outlet pipe bedding material shall consist of native earthen soil and not granular bedding material to at least the first downstream manhole or daylight point.

4.11 Access

Add Drivable access applies only to Regional Detention facilities within the City of Loveland. Each regional detention pond will be considered on a case-by-case basis at the time of final design.

5.0 CRITERIA FOR DISTRICT MAINTENANCE ELIGIBILITY

Add Regional Master Planned detention ponds, designed and constructed by or on behalf of the City of Loveland, shall be owned and maintained by the City of Loveland Stormwater Utility. All other detention ponds shall be considered privately owned and privately maintained.

Flood Proofing

1.2.1 Classification of Flood Proofing

Change	In the Denver metropolitan area,
To	In the Loveland area,

4.1.1 Determine Flood Hazards

Change	…is available from the District and local officials.
To	…is available from the City of Loveland and Larimer County officials.

4.1.3 Contact Local Officials

Change	The District and local officials have…
To	The City of Loveland and Larimer County officials have…

Change	District or community officials can…
To	The City of Loveland and Larimer County officials can…

Revegetation

1.0 INTRODUCTION

Change …within the Urban Drainage and Flood Control District (District).
To …within the City of Loveland.

Change …in the District virtually…
To …in the City of Loveland…

4.2 Soil Amendments

Change …within the District, amendments…
To …within the City of Loveland, amendments…

Change …work in the District.
To …work in the City of Loveland.

4.3 Recommended Seed Mixes

Change …within the District are…
To …within the City of Loveland are…

DESIGN EXAMPLE SECTION

Add The City of Loveland does not have better values to use for the C1, C2, and C3 coefficients within the "Detention Volume by Modified FAA Method" spreadsheet. Please use the Denver area values.

Stormwater Quality Management

No changes to the Stormwater Quality Management chapter are currently proposed.

New Development Planning

1.2 Four-Step Process

Within Step 3:

Change	The Urban Drainage and Flood Control District does not…
To	The City of Loveland does not…

1.5.4 Guidance for Selecting and locating WQCV Facilities

Change	…by local jurisdictions and the District.
To	…by the City of Loveland.

1.5.5 Incorporating WQCV into Stormwater Quantity Detention Basins

Add	The City of Loveland requires that no more than the 100-year detention volume is provided for a given site and the WQCV be incorporated within the 100-year volume.

Structural BMP's

6.4 Design Considerations

Change …are approved in advance by the District.
To …are accepted in advance by the City of Loveland.

9.0 Retention Pond (RP) – Sedimentation Facility

Add Retention facilities are normally not allowed in the Loveland area, but will be considered by the Stormwater Utility for special circumstances. The Greeley and Loveland Irrigation Company filed on all storm water entering the Company lakes and canals. The filing was done in 1977 and is Case No. W-8665-77. The final decree was entered into on June 5, 1978 and the Company received a 1977 priority for the storm water. Retention facilities shall be sized to contain a volume equal to twice the 100-year storm runoff volume plus one foot of freeboard. Water within a retention facility shall be mechanically removed and disposed of off-site by the property owner within 48 hours after a storm event.

Typical Structural BMP Details

Typical Outlet Structure General Notes
Note #8

Change	…from the perimeter of the pond is required for…
To	…from the perimeter of the pond is optional for…

Figure 1

Delete	Figure 1 in its entirety.

Figure 2

Delete	Overtopping Spillway Option.
Change	Outlet Pipe = 120% of 100-YR Capacity within the Drop Box Outlet Option
To	Outlet Pipe = 100% of 100-YR Capacity within the Drop Box Outlet Option

Figure 2-a

Delete	Overtopping Spillway Option.
Change	Outlet Pipe = 120% of 100-YR Capacity within the Drop Box Outlet Option
To	Outlet Pipe = 100% of 100-YR Capacity within the Drop Box Outlet Option

Maintenance Recommendations

No changes to the Stormwater Quality Maintenance Recommendations chapter are currently proposed.

Industrial and Commercial Best Management Practices

5.0 Structural Controls

Table IC-1

Delete Retention Pond

Nonstructural Best Management Practices

No changes to the Stormwater Quality Nonstructural Best Management Practices chapter are currently proposed.

Construction Best Management Practices

1.1 General

Change …and submitted to the local jurisdiction to obtain a construction or site grading permit.
To …and submitted to the City of Loveland to obtain a grading permit or a building permit.

1.3 Erosion and Sediment Control Plan

Change …must be submitted to the appropriate local government for review and approval.
To …must be submitted to the City of Loveland for review and acceptance.

Add The written narrative report can be a subsection within the drainage report.

1.3.1 Narrative Report

Change Item 16 as follows:
…in the (insert name of local jurisdiction) file for this project. The plan appears to fulfill the Urban Drainage and Flood Control District's technical criteria and the criteria for erosion control and requirements of (insert name of local jurisdiction).
To …in the City of Loveland file for this project. The plan appears to fulfill the City of Loveland criteria for erosion control.

1.3.2 Site Plan

Change Item "m" as follows:
…placed in the (insert name of local jurisdiction) file for…
To …placed in the City of Loveland file for…

1.3.3 Approval of Erosion and Sediment Control Plan

Delete The entire paragraph.

Add An Erosion and Sediment Control Plan must be accepted prior to issuance of a grading permit or a building permit. The final Erosion and Sediment Control Plan must be consistent with the Drainage Report.

1.3.4 Exemptions and Variances

Change	…may be provided by a city or county.
To	…may be provided by the City of Loveland.
Change	Item "1b" as follows: …or other structures on plots zoned R1-R3 of less than five (5) acres in size…
To	…or other structures less than one (1) acre in size…
Change	Item 1.d as follows: …less than five (5) acres…
To	…less than one (1) acre…
Change	Item 1.d as follows: …locally-approved Erosion…
To	…locally-accepted Erosion…
Change	Item 1.h as follows: …local jurisdiction…
To	…City of Loveland…
Delete	Item 2 in its entirety
Add	Item 2 as follows: The City of Loveland Stormwater Utility Senior Civil Engineer may grant variances from the criteria of the Construction Best Management Practices chapter by his/her acceptance of the Final Drainage Report in which the variance request is well documented.

2.2 Summary of Criteria

- Revegetation

Change	…opinion of the city or county of jurisdiction, is…
To	…opinion of the City of Loveland, is…

- Disposition of Temporary Measures

Change	…or as authorized by the city or county of local jurisdiction.
To	…or as authorized by the City of Loveland.

2.4.2 Stormwater Quality Plans

Delete	Where local regulations have not been developed,

3.3.2 Temporary Revegetation

Change …suitable for the Denver metropolitan area…
To …suitable for the City of Loveland area…

4.1 Vehicle Tracking

Change …deemed necessary by the city or county of jurisdiction,
To …deemed necessary by the City of Loveland,

4.3.3 Sediment Basins

Change …in the Denver region shall be…
To …in the Loveland area shall be…

5.1 Working Within or Crossing a Waterway

Change 2. …The city or county of jurisdiction should…
To 2. …The City of Loveland should…

5.3 Outlet Protection

Change …temporary total retention of the runoff form a 24-hour, 100-year storm may be provided. Written approval by the local city or county must be obtained for total retention of stormwater.
To …temporary total retention of the runoff may be considered upon acceptance from the City of Loveland.