STAFF REPORT FOR PLANNING COMMISSION MEETING OF OCTOBER 28, 2020

FILE: ZA-2020-0007 **AGENDA ITEM: E.1**

STAFF CONTACT: Hope Sullivan, Planning Manager

AGENDA TITLE: For Possible Action: Discussion and possible action regarding a recommendation to the Board of Supervisors concerning an ordinance amending the Title 18 Appendix, Development Standards Division 14 (Storm Drainage) to repeal all existing language and replace it with language directing the public to review the Carson City Drainage Manual. (Hope Sullivan, hsullivan@carson.org)

STAFF SUMMARY: Division 14 of the Carson City Development Standards addresses the City's storm drainage design standards. The City's Public Works staff is seeking to update the City's stormwater design standards including incorporating low impact design standards. These updates will require an amendment to Carson City Municipal Code (CCMC) Title 12 and CCMC Title 18 Appendix. In Title 18, the applicant proposes to remove all stormwater drainage design standards and replace it with language referring to the Carson City Drainage Manual. The Planning Commission makes a recommendation to the Board of Supervisors when considering an amendment to CCMC Title 18.

RECOMMENDED MOTION: "I move to recommend to the Board of Supervisors approve the zoning text amendment ZA-2020-0007 as presented."

LEGAL REQUIREMENTS: CCMC 18.02.050 (Review); 18.02.075 (Zoning Map Amendments and Zoning Code Amendments)

DISCUSSION:
Carson City is required to implement and enforce a Stormwater Management Program (SWMP) to reduce the pollutants in its stormwater and discharge through its Municipal Separate Storm Sewer Systems (MS4). It is also required to have development policies and procedures to implement and enforce the operation and maintenance of source control and structural treatment controls for new development and redevelopment within the City. The requirements for the SWMP and a permit to discharge pollutants into the waters of the United States from a MS4 are contained in Section 402 of the Federal Clean Water Act.

Division 14 of the Development Standards addresses the City's Storm Drainage design standards. The City's Public Works Department is seeking to modify the design standards so as to incorporate and promote the use of Low Impact Development practices, as well as to modify the minimum design storm from a 5-year, 24-hour storm to a 10-year, 24-hour storm.

Low Impact Development (LID) is a stormwater management approach to land development and redevelopment that works to manage stormwater close to its source. Design principles are used that minimize disturbance, maintain or create perviousness, and use on-site stormwater treatment techniques. LID practices can be effective in reducing runoff quantity, enhancing groundwater recharge, preserving flood plain storage, and removing pollutants by filtration and biological processes before entering the City's storm drainage system.

In addition to adding LID practices and modifying the storm event, the applicant is also seeking to remove the stormwater standards from the Division 14 of the Development Standards and to place them in a stand-alone manual. Division 14 would still exist, but the text would be limited to a reference to the Carson City Drainage Manual.

The Carson City Development Standards are an appendix to Title 18. As with any amendments to Title 18, the Planning Commission shall conduct a public hearing and, based on the three required findings of fact, make a recommendation to the Board of Supervisors. The Board of Supervisors is authorized to amend Title 18.

Of note, the applicant is also seeking to amend CCMC Title 12. The Planning Commission does not have any responsibility relative to Title 12.

PUBLIC COMMENTS: A notice of public hearing was published in the newspaper on October 10, 2020. As of the writing of this report, there have been no public comments. Any comments that are received after this report is completed will be submitted prior to or at the Planning Commission meeting, depending on their submittal date to the Planning Division.

FINDINGS: Staff recommends the following findings for approval of the Zoning Map Amendment pursuant to the Carson City Municipal Code Section and 18.02.075, Zoning Map Amendments and Zoning Code Amendments.

Zoning Map Amendment Findings

1. **The proposed amendment is in substantial compliance with and supports the goals and policies of the Master Plan.**

   The applicant has advised that amendment to the Development standards is in substantial compliance with and supports the goals and policies of the master plan by providing sustainable and resilient infrastructure which lessons the burden on city's street network and reduces the damage caused by flooding in Carson City. Staff finds that this is consistent with Goal 3.3 of the Master Plan, which is to minimize impacts of potential natural disaster events on the community.

2. **That the proposed amendment will provide for land uses compatible with existing adjacent land uses and will not have detrimental impacts to other properties in the vicinity.**

   The proposed amendment will improve land use compatibility by encouraging standards that address stormwater management closer to the source, as well as modeling for a storm that could happen every ten years instead of a storm that might happen every five years.

3. **That the proposed amendment will not negatively impact existing or planned public services or facilities and will not adversely impact the public health, safety and welfare.**

   The proposed amendment will not negatively impact existing or planned public services. The proposed amendment will encourage standards that address stormwater management closer to the source as well as will utilize modeling for the ten year storm. By providing LID on development and redevelopment sites, there will be reduced infrastructure costs and reduced flooding.

Attachments:

Application
Draft Zoning Text Amendment Ordinance

Proposed Carson City Drainage Manual Section 2.1 Design Storm Events
Proposed Carson City Drainage Manual Section 9.3 Low Impact Design Techniques

Carson City Planning Division
108 E. Proctor Street· Carson City NV 89701
Phone: (775) 887-2180 • E-mail: planning@carson.org

For Office Use Only:

ZONING CODE AMENDMENT

FEE: $3,250.00 + noticing fee

- ☐ Application Form, Written Project Description and Supporting Documentation
- ☐ 5 Completed Application Packets (1 Original + 4 Copies)

Application Reviewed and Received By:

_____

Submittal deadline: Planning Commission application submittal schedule.

Note: Submittals must be of sufficient clarity and detail such that all departments are able to determine if they can support the request. Additional Information may be required.

FILE

APPLICANT
Carson City Public Works

MAILING ADDRESS, CITY STATE, ZIP
3505 Butti Way

PHONE # 283-7370

FAX #

EMAIL ADDRESS
RFellows@carson.org

Requested Amendment to Development Standards: Division 14 or Title ~~13~~ 12.20

As required under the City's MS4 permit, the Storm Water Division 14 will modified to include LID provisions and other needed updates.

Also, a new title 12.20 LID will be created to will compliment the changes in the Storm Water Division

Required Findings: Title 18 of the Carson City Municipal Code (CCMC) requires that the applicant must present evidence justifying the revision to the Code, that the proposed addition/deletion will be consistent with the objectives of the Master Plan and will not be detrimental to the surrounding properties. A statement relative to findings from Page 2 **MUST** be included herewith, or on an attached sheet.

Please remember that the requested code revision will affect **all** of Carson City and not only your parcel of land. Present your statement with that in mind. In addition to the brief description of your project and proposed use, provide additional page(s) to show a more detailed summary of your project and proposal.

These changes are requested to comply with the requirements of the city's MS4 permit.

LID requirements provide water quality for storm water and help reduce flooding.

ACKNOWLEDGMENT OF APPLICANT:

I certify that the foregoing statements are true and correct to the best of my knowledge and belief.

Applicant's signature

8/20/20
Date

SUMMARY: An ordinance implementing low impact development practices in Carson City.

BILL NO. ___

ORDINANCE NO. 2020-____

AN ORDINANCE RELATING TO UTILITIES; AMENDING TITLE 12 (WATER, SEWERAGE, AND DRAINAGE) BY ADDING CHAPTER 12.20 (LOW IMPACT DEVELOPMENT) OF THE CARSON CITY MUNICIPAL CODE TO ESTABLISH VARIOUS PROVISIONS IMPLEMENTING LOW IMPACT DEVELOPMENT PRACTICES, PROVIDING DEFINITIONS, DECLARING THE PURPOSE, STATING THE APPLICABILITY, PROVIDING GENERAL REQUIREMENTS, AND STATING EXEMPTIONS; AMENDING TITLE 18 APPENDIX (DEVELOPMENT STANDARDS), DIVISION 14 (STORM DRAINAGE), BY ADDING THERETO A NEW SECTION 14.05 (CARSON CITY DRAINAGE MANUAL) AND REPEALING THE REMAINING SECTIONS TO STATE THE TECHNICAL STANDARDS FOR LOW IMPACT DEVELOPMENT IN THE CARSON CITY DRAINAGE MANUAL; AND OTHER MATTERS PROPERLY RELATED THERETO.

The Board of Supervisors of Carson City, Nevada, do ordain:

SECTION I:

That Title 12 (WATER, SEWERAGE AND DRAINAGE) is hereby amended by adding thereto a new chapter (**bold, underlined text** is added, ~~[stricken]~~ text is deleted) as follows:

12.20 – LOW IMPACT DEVELOPMENT

SECTION II:

That Title 12 (WATER, SEWERAGE AND DRAINAGE), new Chapter 12.20 (LOW IMPACT DEVELOPMENT) is hereby amended by adding thereto a new section (**bold, underlined text** is added, ~~[stricken]~~ text is deleted) as follows:

12.20.010 Definitions

As used in this chapter, unless the context requires otherwise, the words and terms defined in this section have the meanings ascribed to them as follows:

"Development" means the conversion of previously undeveloped or pervious surfaces to impervious surfaces and managed landscape areas.

"Impervious surface" has the meaning ascribed to it in CCMC 12.17.010.

"Low Impact Development (LID)" means a land development practice, modeled after nature, that improves and enhances water quality by reducing runoff and non-point source pollution through design techniques to mimic the pre-development hydrology of a site and effectively slow, capture, infiltrate, filter, detain, evaporate, and hold runoff onsite. LID includes green infrastructure practices that use or mimic natural processes to infiltrate, evapotranspirate, or reuse stormwater runoff onsite.

"Redevelopment" means the replacement of impervious surfaces on a developed site. All new impervious surfaces added during redevelopment are considered development.

SECTION III:

That Title 12 (WATER, SEWERAGE AND DRAINAGE), new Chapter 12.20 (LOW IMPACT DEVELOPMENT) is hereby amended by adding thereto a new section (**bold, underlined text** is added, ~~[stricken]~~ text is deleted) as follows:

12.20.020 Declaration of purpose

1. The city is committed to stormwater and drainage management programs that protect water quality and water supply by employing watershed-based approaches that balance environmental, social, conservation, and economic considerations.

2. Urbanization has led to increased impervious surface areas resulting in increased water runoff, causing the transport of pollutants to downstream receiving waters.

3. The city seeks to manage rainwater and urban runoff while mitigating the undesirable impacts of development and urbanization.

4. LID development standards are widely recognized as sensible approaches to managing the quantity and quality of stormwater and non-stormwater runoff. Management of stormwater and non-stormwater runoff is accomplished by setting standards and practices that maintain, improve, or restore the natural hydrological contours of the site, reduce runoff, improve water quality, and provide groundwater recharge.

5. LID development standards promote public health, safety, and general welfare, through standards and incentives to:

(a) ensure that both private and public development provide adequate protection for citizens and property;

(b) minimize offsite runoff from properties;

(c) minimize and control erosion and pollution impacts on the natural environment;

(d) minimize maintenance costs for drainage and flood control systems; and

(e) recognize stormwater as a resource.

6. While the City seeks to minimize offsite runoff from properties through the implementation of LID development standards, compliance with this chapter will not ensure that there will be no unauthorized discharge of pollutants into the waters of the United States.

SECTION IV:

That Title 12 (WATER, SEWERAGE AND DRAINAGE), new Chapter 12.20 (LOW IMPACT DEVELOPMENT) is hereby amended by adding thereto a new section (**bold, underlined text** is added, ~~[stricken]~~ text is deleted) as follows:

12.20.030 Applicability

1. Except as otherwise provided in this chapter or the CCMC, the provisions of this chapter apply to all development and redevelopment in the city.

2. The provisions of this chapter do not apply to the primary permitted uses or the accessory permitted uses of parcels of land zoned agricultural. The provisions of this chapter do apply to conditional uses of parcels of land zoned agricultural that require a special use permit.

3. The provisions of this chapter do not apply retroactively to building permit applications submitted to the Carson City Community Development Department before the effective date of this chapter.

SECTION V:

That Title 12 (WATER, SEWERAGE AND DRAINAGE), new Chapter 12.20 (LOW IMPACT DEVELOPMENT) is hereby amended by adding thereto a new section (**bold, underlined text** is added, ~~[stricken]~~ text is deleted) as follows:

12.20.040 General requirements

All development and redevelopment shall comply with the development standards in the provisions of the Carson City Drainage Manual, adopted in Division 14 of Title 18 Appendix of CCMC.

SECTION VI:

That Title 12 (WATER, SEWERAGE AND DRAINAGE), new Chapter 12.20 (LOW IMPACT DEVELOPMENT) is hereby amended by adding thereto a new section (**bold, underlined text** is added, ~~[stricken]~~ text is deleted) as follows:

12.20.050 Exemptions

1. An applicant for a building permit may request an exemption from the LID development standards in the Carson City Drainage Manuel. The city engineer, or his or her designee, may, in the city engineer's discretion, grant an exemption if the LID development standards:

(a) are not suitable for the site;

(b) interfere with existing drainage in such a manner as to cause damage to an adjacent property or a public right-of-way;

(c) present a hazard to a persons or property; or

(d) have a detrimental influence upon the public welfare.

2. An exception granted under this section applies to the specific building permit for which it is granted. An applicant submitting a future building permit application for the same property must comply with the LID development standards unless the building permit application is not for a development or redevelopment, as defined in this chapter, or the applicant obtains another exemption from the city engineer.

SECTION VII:

That Title 18 Appendix (CARSON CITY DEVELOPMENT STANDARDS), Division 14 (STORM DRAINAGE) is hereby amended by adding thereto a new section (**bold, underlined text** is added, ~~[stricken]~~ text is deleted) as follows:

14.05 – Carson City Drainage Manual

The storm drainage development standards are compiled in the Carson City Drainage Manual, as may be amended, which is hereby adopted and incorporated by reference. A copy of the Drainage Manual is available, without charge, from the Carson City Public

Works Department, 3505 Butti Way, Carson City, Nevada 89701, and on the Carson City Internet website at https://carson.org/government/departments-g-z/public-works.

SECTION VIII:

That Title 18 Appendix (CARSON CITY DEVELOPMENT STANDARDS), Division 14 (STORM DRAINAGE), Sections 14.1 (DRAINAGE POLICY INTRODUCTION AND BASIC PRINCIPLES), 14.2 (TECHNICAL CRITERIA), 14.3 (STORM DRAIN SYSTEM), 14.4 (DETENTION), 14.5 (TRASH RACKS), 14.6 (SUBMITTAL AND REVIEW PROCESS), 14.7 (DRAINAGE STUDY INFORMATION PAGE), 14.8 (CONCEPTUAL DRAINAGE STUDY), 14.9 (TECHNICAL DRAINAGE STUDY), and 14.10 (IMPROVEMENT PLANS) are hereby repealed with reservation of the section numbers as follows:

14.1 – ~~[Drainage policy introduction and basic principles.]~~ **Reserved.**

14.2 – ~~[Technical criteria.]~~ **Reserved.**

14.3 – ~~[Storm drain system.]~~ **Reserved.**

14.4 – ~~[Detention.]~~ **Reserved.**

14.5 – ~~[Trash racks.]~~ **Reserved.**

14.6 – ~~[Submittal and review process.]~~ **Reserved.**

14.7 – ~~[Drainage study information page.]~~ **Reserved.**

14.8 – ~~[Conceptual drainage study.]~~ **Reserved.**

14.9 – ~~[Technical drainage study.]~~ **Reserved.**

14.10 – ~~[Improvement plans.]~~ **Reserved.**

SECTION IX:

That no other provisions of the Carson City Municipal Code are affected by this ordinance.

SECTION X:

This ordinance shall be in force and effect:

1. upon adoption and required publication for the purpose of performing any preparatory administrative tasks to carry out the provisions of this ordinance; and

2. from and after the ____ day of _____ 2021.

PROPOSED on _____, 2020

PROPOSED by Supervisor _____

PASSED on _____, 2020

VOTE: AYES: SUPERVISORS: _____

_____

_____

_____

_____

NAYES: SUPERVISORS: _____

_____

ABSENT: SUPERVISORS: _____

_____

_____

BRAD BONKOWSKI
Mayor Pro Tempore / Acting Mayor

ATTEST:

_____

AUBREY ROWLATT
Clerk-Recorder

TEXT OF REPEALED SECTIONS

~~[14.1 - Drainage policy introduction and basic principles.~~

~~Adequate drainage systems shall be provided in order to preserve and promote the general health, welfare, and economic well being of the region. Drainage is a regional feature that affects all of Carson City. Drainage plans shall be consistent with and integrated with the Carson City drainage master plan upon adoption. This characteristic of drainage requires coordination and cooperation from both the public and private sectors.~~

~~Storm water drainage systems are an integral part of the development process. The planning of drainage facilities shall be included in the development process and in preparation of improvement plans.~~

~~Drainage systems require space to accommodate conveyance and storage functions. When the space requirements are considered, the provision for adequate drainage becomes a competing use for space along with other land uses.~~

~~Storm drainage planning for all development shall include the allocation of space for drainage facility construction and maintenance, which may entail the dedication of right-of-way and/or easements. The provision of multi-use facilities such as combining with parks, open space, and recreation needs is strongly encouraged.~~

~~14.1.1 Water Rights. All drainage systems shall be planned and constructed with consideration given to the existing water rights and applicable water laws.~~

~~14.1.2 Reasonable Use of Drainage. Downstream properties shall not be unreasonably burdened with increased flow rates, negative impacts, or unreasonable changes in manner of flow from upstream properties. Drainage problems shall not be transferred from one location to another. However, downstream properties cannot block natural or existing runoff through their site and shall accept runoff from upstream properties.~~

~~"Reasonable use of drainage" is defined for planning purposes, as providing an economic and hydraulically efficient drainage system which is demonstrated not to adversely and unreasonably impact downstream properties within reason. This "reasonable use of drainage" therefore allows development to occur while preserving the rights of adjacent property owners.~~

~~14.1.3 Change in Manner of Flow. Development shall tend to concentrate existing natural sheet flow into point flows at property lines. These point flows are generally associated with outlets from gutter flow, storm drains, and detention facilities. Downstream properties may experience a longer duration of storm flows, and greater flows in general due to a shortened time of concentration. Discharge of point flows on downstream property can cause increased erosion at the discharge point and further downstream. Therefore, downstream facilities shall be evaluated for runoff capacity during the design and review process. Mitigation of these point flows can be accomplished through energy dissipaters or flow spreaders. Point flows shall be discharged to downstream properties at non-erosive velocities and depths of flow.~~

~~14.1.4 Diversion of Drainage. Development can alter the historic or natural drainage paths. When these alterations result in a local on-site drainage system that discharges back into the natural drainage way or wash at or near the historic location, then the alterations (inter-basin transfer) are generally acceptable. However, when flows from the local on-~~

site drainage system do not return to the historic drainage way or wash, then inter-basin transfer may result. These inter-basin transfers are generally not acceptable. Planning and design of drainage systems shall not be based on the premise that storm water can be transferred from one basin to another unless part of an adopted city regional drainage system plan.

The flow of storm runoff shall be maintained within its natural drainage course unless reasonable use is demonstrated otherwise. When storm water is discharged into an existing drainage course, the peak discharge into the water course shall not adversely affect or cause damage to property along the drainage course now or in the future based on existing zoning and the Carson City master plan build-out conditions. Erosional impacts due to concentration of flows and increased flow durations shall be evaluated and mitigated.

14.1.5 Water Quality. Storm drainage improvements shall incorporate water quality and erosion controls in accordance with the Nevada "Handbook of Best Management Practices," this division, and accepted engineering practice. Storm drainage leaving a development may not be of a quality that shall adversely affect downstream uses.

14.1.6 Drainage Improvements. Drainage improvements consist of curb and gutter, inlets and storm drains, culverts, bridges, swales, ditches, channels, detention areas, and other drainage facilities required to convey design storm runoff to the point of discharge. Drainage improvements are further defined as on-site (private) facilities that serve a specific development and are privately owned and maintained or off-site (public) facilities. Public and private drainage facilities shall be constructed in accordance with the requirements of this division.

14.1.7 Floodplain Management. Floodplain management shall provide the guidance, conditions, and restrictions for development in floodplain areas while protecting the public's health, safety, welfare, and property from danger and damage. Development within the Federal Emergency Management Agency (FEMA) designated floodplains shall comply with CCMC, and requirements of the National Flood Insurance Program (NFIP).

14.1.8 Storm Runoff Detention. Detention is considered a viable method to reduce storm runoff from developed properties. Temporarily detaining storm runoff can significantly reduce downstream flood hazards as well as pipe and channel requirements. Storage also provides for sediment and debris collection which reduces maintenance requirements for downstream channels and streams.

Local detention storage for land development, which includes subdividing land, shall be required when the development increases flows and downstream conveyance capacities of the drainage system are not capable of handling non-detained flows, and the developer elects to not upgrade the existing storm drainage system. Onsite detention storage shall be sized to

~~detain sufficient runoff to limit flows from a five (5) year storm (Q5) to their predevelopment condition.~~

~~The capacity of downstream conveyance systems shall be analyzed in accordance with this division and shall be based on runoff from the development as fully improved. Local detention can also be required when designated in flood or drainage master plans to reduce the peak rate in regional facilities.~~

~~Exemptions to the detention policy may be granted by the city for the following:~~

~~1. Developments which discharge directly to a regional flood control facility, provided the facility is completed per the adopted plan and designed for the contributing flows.~~
~~2. Locations where a local detention facility is designed and constructed to serve several developments and the contributing flows.~~
~~3. Downstream facilities are upgraded to accommodate the increased flow.~~
~~4. Where the downstream facilities are adequate to carry up to one hundred (100) year flows.~~

~~All exemptions are subject to approval by the city.~~

~~14.1.9 Lower Watershed Design. In certain circumstances, i.e., close to the drainage system's point of discharge, it may be desirable to not detain storm water runoff. The option to directly discharge shall be at the sole option of the city and after review of a flood route analysis.~~

~~14.1.10 Storm Runoff Retention and Infiltration. Storm runoff retention and infiltration has been used to eliminate the need for constructing outlet structures and for ease of construction. However, problems with retention basins and infiltration facilities include perpetual maintenance requirements, soil expansion, siltation, decreasing infiltration capacity, insect abatement and also poses a hazard to city groundwater resources through possible contamination.~~

~~14.1.11 Drainage Facilities Maintenance. An important part of all storm drainage facilities is the continued maintenance of the facilities to insure they shall function as designed. Maintenance of detention facilities involves removal of debris and sediment. Such tasks are necessary to preclude the facility from becoming unhealthy and to retain the effectiveness of the detention basin. Sediment and debris must also be periodically removed from channels and storm drains. Trashrack and street inlets must be regularly cleared of debris to maintain system capacity. Channel bank erosion, damage to drop structures, crushing of pipe inlets and outlets, and deterioration to the facilities must be repaired to avoid reduced conveyance capability, unsightliness, and ultimate failure.~~

All drainage facilities shall be designed to minimize facility maintenance as well as to provide ease of maintenance and include maintenance access to the drainage facility. The owner of the drainage facilities shall be responsible for mosquito control and the method of control shall comply with Carson City environmental health department.

The property owner or developer shall be responsible for maintenance of all privately owned on-site drainage facilities including, but not limited to, inlets, pipes, channels, and detention basins, unless otherwise required or modified by separate agreement. Shall the property owner or developer fail to adequately maintain said facilities, Carson City shall be given the right to enter said property, upon proper notice, for the purposes of maintenance. All such maintenance costs shall be assessed against the owner(s). A maintenance agreement shall be provided to the city for all projects.

14.1.12 Drainage Easements. Easements shall be provided where necessary for access and maintenance of the storm drain system.]

14.2 Technical criteria.

14.2.1 Design Storm Events. Drainage facilities shall be designed to convey the run off for the twenty-four (24) hour duration storm with a recurrence interval for a minor storm event (five (5) year) and a major storm event (one hundred (100) year).

14.2.1.1 Storm Runoff Determination. Storm runoff (rates and volumes) shall be determined in accordance with the following methods (other methods may be used if approved by development engineering):

Contributing Basin Area (A)	Computation Procedure
A ≤ 100 Acres	Rational formula, SCS TR-55, or HEC-1 SCS Unit Hydrograph or Kinematic Wave)
10 SM.> A ≥ 100 Acres	SCS TR-55 or HEC-1 (SCS Unit Hydrograph or Kinematic Wave)
A > 10 S.M.	HEC-1 (SCS Unit Hydrograph or Kinematic Wave)

14.2.1.2 Rainfall. Rainfall data tables and storm design information shall be derived from the NOAA Atlas, latest edition, or other city approval.

14.2.1.3 Streets. The use of streets to convey runoff, although naturally occurring, interferes with the primary function of the street for transportation purposes. Streets are, however, an

important component in the storm drainage system due to their large storm carrying capacity obtained for little or no drainage costs. In order to balance these two competing street uses, limits on the street carrying capacity are required based on the street classification related to emergency usage during storm and flood events.

The allowable street capacity for different roadway functional classifications shall be determined in accordance with Table 14.1 and Table 14.2. To ensure cleaning velocities at low flows, gutters shall have a minimum slope of four-tenths of one percent (0.40%).

14.2.1.4 Culverts, Bridges, Valley Gutter and Dip Sections. Culverts and bridges shall be installed where natural or manmade drainage channels are crossed by streets. Valley gutters, or "dip sections," shall be permitted on local streets. The amount of channel flow which crosses over the street shall be minimized (not more than 0.5 feet) to protect the street embankment and pavement from erosion damage as well as to protect vehicles and pedestrians from dangerous flow depths and velocities. Bridges and culvert crossings under streets shall be sized for the required design storm capacity in accordance with Table 14.1.

Table 14.1
Design Storm Events for Crossings

Design Storm Criteria	Design Storm Event (see Notes)
1. Local Streets	25-year return period, 24-hour duration
2. Arterial and Collector Streets	100-year return period, 24-hour duration
3. Developments (commercial, industrial, residential)	5-year return period, 24-hour duration

Notes:

1. All development shall provide emergency flow paths for a one hundred (100) year peak storm in accordance with Table 14.2.
2. Refer to section 14.3.1 for additional situations where the drainage system shall be designed for not less than a one hundred (100) year return period, twenty-four (24) hour duration.
3. Refer to section 14.1.8 for additional requirements for projects located within a floodplain.]

[14.3 - Storm drain system.

14.3.1 Introduction. The size of the storm drain system is generally governed by the design storm peak flows as shown in Table 14.2. There are conditions, however, when the storm drain system design shall be governed by the one hundred (100) year return period, twenty-

four (24) hour duration storm flows. Storm drain systems shall be designed for not less than a one hundred (100) year peak storm for the following situations:

1. Locations where street flow is collected in a sump with no allowable overflow capacity.
2. Locations where the desired one hundred (100) year return period, twenty-four (24) hour duration storm flow direction is not reflected by the street flow direction during a one hundred (100) year return period, twenty-four (24) hour duration storm (i.e., flow splits at intersections).

If a storm drain is to be designed to convey one hundred (100) year return period, twenty-four (24) hour duration storm flows, then the inlets to the storm drain shall be designed accordingly.

Table 14.2
Design Storm Street Capacity Limitations

Roadway Functional Classification	Maximum Limits of Street Inundation (See Notes)
1) Arterial	Q5 Storm: Flow contained in R/W. No curb overtopping. A minimum forty-eight foot (48′) wide dry lane centered shall be maintained and in each direction twenty-four feet (24′). Runoff in excess of street capacity shall be piped.
	Q100 Storm: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be 1 foot (1′). A minimum twelve foot (12′) wide dry lane shall be maintained in each direction or twenty-four feet (24′) centered.
2) Collector	Q5 Storm: Flow contained in R/W. No curb overtopping. A minimum eighteen foot (18′) wipe dry lane centered shall be maintained. Runoff in excess of street capacity shall be piped.
	Q100 Storm: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be one foot (1′). A minimum twelve foot (12′) wide dry lane shall be maintained centered.
3) Local or Industrial Street	Q5 Storm: Flow contained in R/W. No curb overtopping. A minimum twelve foot (12′) wide dry lane centered shall be maintained. Runoff in excess of street capacity shall be piped.

	~~Q100 Storm: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be one foot (1′). Street flooded.~~

~~Notes:~~

~~1. Where no curb exists, encroachment onto adjacent property shall be allowed but must contained to not inundate structures.~~
~~2. Other criteria such as the Federal Housing Administration regulations may impose standards more restrictive than cited.~~

~~14.3.2 Design Criteria.~~

~~14.3.2.1 Allowable Storm Drain Capacity.~~

~~The storm drain capacity calculations shall begin at the storm drain outlet and proceed upstream, accounting for all energy losses. The Energy Grade Line (EGL) and Hydraulic Grade Line (HGL) shall be calculated to include all hydraulic losses including friction, expansion, constriction, bend, and junction losses. The available energy at all junctions and transitions shall be checked to determine whether or not the flow in the storm drain shall be pressurized due to backwater effects even if the design flow is less than the full flow capacity of the storm drain.~~

~~If any section of the storm drain is pressurized due to backwater effects, then the storm drain system shall be designed to convey the design storm under surcharged or pressure flow conditions. The storm drain shall be considered surcharged when the depth of flow (HGL) in the storm drain is greater than eighty percent (80%) of full flow depth. The maximum level of surcharging for the capacity analysis shall be limited to maintaining the HGL to one foot (1′) below the final grade above the storm drain at all locations. Special site conditions that warrant additional surcharging shall require locking type manhole covers or grated covers and shall be reviewed on a case-by-case basis by development engineering.~~

~~14.3.2.2 Allowable Storm Drain Velocity. The maximum allowable storm drain velocity is dependent on many factors including the type of pipe, the acceptable wear level during the pipe design life, proposed flow conditions (open channel versus pressure flows), and the type and quality of construction of joints, manholes, and junctions. In consideration of the above factors, the maximum velocity in all storm drains and culverts shall not exceed the erosion resisting capabilities of the conduit and storm drain system, but in no case exceed fifteen feet (15′) per second (fps).~~

All storm drains and culverts, and low flow outlets shall be designed to maintain a minimum velocity of three (3) fps at half or full conduit conditions, but in no case shall the storm drain slope be less than one-fourth percent (¼%).

14.3.2.3 Manning's Roughness Coefficient. All storm drain system hydraulic calculations shall be performed using Manning's formula. A Manning's roughness factor, or "n," shall be as defined by the specific pipe manufacturer provided that the coefficient is within the range of accepted engineering standards.

14.3.2.4 Pipe Size. The minimum pipe size for storm inlet laterals and storm drain mains shall be fifteen inches (15″) in diameter for round pipe, or an equivalent flow area for other pipe shapes.

14.3.2.5 Minimum and Maximum Cover. The required cover over a storm drain pipe is dependent on many factors including the design pipe strength, pipe size, and cover material. For practical purposes, the storm drain shall be protected from potential surface disturbances and displacements. The minimum and maximum cover is dependent upon the design pipe strength.

14.3.2.6 Manhole and Junction Spacing. A manhole, catch basin, or junction box shall be located at all changes in pipe size, direction, elevation and grade for all pipes with a diameter (or rise dimension) of less than forty-eight inches (48″), and at the end of all public storm drain lines (unless the storm drain daylights at the end of the line). Maximum spacing between manholes or junction boxes shall be three hundred fifty feet (350′). For pipes with a diameter (or rise dimension) of forty-eight inches (48″) and greater, the designer shall consult with development engineering for location of manholes and junctions based on hydraulic and maintenance considerations.

14.3.2.7 Horizontal Alignment. The horizontal alignment of storm drains shall be generally straight between manholes and/or junctions. All storm drains shall be placed within the right-of-way dedicated for public streets unless the use of easements is approved by development engineering.

When storm drains are to be installed in existing streets, factors such as curbs, gutters, drainage ditches, sidewalks, traffic conditions, pavement conditions, future street improvement plans, and existing utilities shall be considered by the design engineer when selecting the storm drain location and alignment.

14.3.2.8 Utility Clearances. Storm drains and culverts shall be located to minimize potential contamination and disturbance of water supply and sanitary sewer mains. Additional requirements may be imposed by the local utility companies, or the Nevada Division of Health. Where requirements differ, the more stringent shall apply.

14.3.2.9 Storm Inlet and Catch Basin Types, Locations, and Capacity Factors. Standard storm inlet and catch basin details are included in the standard details. The allowable use of these storm inlet and catch basin types is presented on Table 14.3. Allowable inlet capacity factors for each of the standard inlets and catch basins are also presented on Table 14.3. These capacity factors shall be applied to the theoretical capacity of the inlets and catch basins to account for conditions which decrease the capacity of the standard inlets. These conditions include plugging from debris and sediment, pavement overlaying, variations in design assumptions, and the general deterioration of the inlet and catch basin conditions over time. All catch basins shall have sumps (seventeen inches (17″) minimum, twenty-four inches (24″) maximum).

Catch basins or inlets shall be installed at low points of vertical curves, at all street intersections, and at sufficient intervals to intake the design storm peak flow such that flows shall not interfere with traffic or flood adjoining property in accordance with the requirements of Table 14.2. Catch basins and inlets at street intersections shall be located on the upstream side of the intersection and upstream of crosswalk locations.

When storm drain pipes are connected to a catch basin, inlet, or manhole with concrete/grout, both the inside and outside of the catch basin, manhole, or inlet shall be grouted at the pipe connection.

14.3.3 Materials.

14.3.3.1 Pipe Material and Shape.

The material and shape of the storm drain shall be in accordance with the "Standard Specifications for Public Works Construction." Round, square, or rectangular reinforced concrete pipe (RCP) in accordance with ASTM C-789 or C-850 shall be used for storm drain construction under roadways, driveways and other traffic areas. Reinforced concrete pipe shall be at a minimum Class III, or the appropriate class when design requires a greater pipe support strength. Other pipe materials as approved by the city for storm drain use, with the exception of corrugated metal (permitted for residential driveway culverts), are permitted outside of roadway or traffic areas.

14.3.3.2 Manholes. Precast manhole tees are not allowed where there is a change in storm drain slope or alignment or where there are intersecting storm drain mains or laterals. Pipes may be directly cast into the manhole base. Gasketed joints, locking type manhole covers, and/or grated manhole covers for pressure flow conditions may be required.

14.3.3.3 Storm Drain Outlet Protection. Storm drain outlets shall be designed to prevent the receiving channel from scour erosion or sediment deposition and shall be constructed with outlet protection for discharges to channels with unlined bottoms in accordance with the following:

Outlet Velocity (fps)	Minimum Outlet Protection
Less than 5	Rip-rap protection
Between 5 and 15	Rip-rap protection or Energy Dissipater
Greater than 15	Energy dissipater

For channels with unlined bottoms, the outlet discharge velocity shall not exceed the maximum allowable channel velocity without an energy dissipation structure. Specifications for the outlet protection shall be submitted with the improvement plans.

14.3.4 Storm Drain Hydraulic Analysis. A hydraulic analysis of all storm drains shall be performed and submitted to development engineering as part of the technical drainage report. Storm drain hydraulic and capacity analysis shall account for changes in flow conditions (open channel versus pressure flow) in the HGL and EGL calculations. Both the HGL and the EGL for the design flow shall be included on storm drain improvement plans as part of the drainage report.

Table 14.3
Allowable Storm Inlet Types and Capacity Factors

Inlet or Catch Basin Type	Permitted Use	Permitted Location Condition	Capacity Factor
Catch Basin Type 1	Private Use Only	Sump	0.65
Catch Basin Type 1A	Street with Curb and Gutter	Continuous Grade Sump	0.70 (Grate), 0.80 (Curb Opening) 0.65
Catch Basin Type 3	Landscaped or Unimproved Areas	Sump	0.50
Catch Basin Type 4	Street with Curb and Gutter	Continuous Grade Sump	0.70 (Grate), 0.80 (Curb Opening) 0.65

Notes:

1. Capacity factor is applied to the theoretical inlet capacity to obtain the allowable inlet capacity to account for factors which reduce actual inlet capacity.

14.3.5 Design Standards for Culverts. Culverts shall be designed and constructed using the following standards. The analysis and design shall consider design flow, culvert size and material, entrance structure layout, outlet structure layout, and erosion protection.

14.3.5.1 Culvert Sizing Criteria.

14.3.5.1.1 Design Frequency. As indicated in section 14.2.1.4 (culverts), all culverts shall be designed to pass the flow from the design storm including an overflow section where permitted.

14.3.5.1.2 Minimum Size. The minimum culvert size shall be eighteen inches (18″) diameter for round pipe or an equivalent flow area for other pipe shapes.

14.3.5.2 Culvert Materials. Culverts shall be RCP in accordance with the standard details under roadways, and other traffic areas. For rural residential driveways CMP is allowed. The use of dip sections rather than culverts are encouraged for rural residential driveway crossings.

14.3.5.3 Outlet Protection. Outlet erosion protection for discharges to channels with unlined bottoms shall be provided as follows:

Outlet Velocity (fps)	Required Outlet Protection
Less than 5	Rip-rap protection
Between 5 and 15	Rip-rap protection or energy dissipater
Greater than 15	Energy dissipater

Specifications for the outlet protection shall be submitted with the improvement plans.

14.3.5.4 Headwater Criteria. The maximum headwater for the design storm for culverts greater than thirty-six inches (36″) diameter or a culvert rise of thirty-six inches (36″) shall be one-and-one-half (1.5) times the culvert height. The maximum headwater for culverts with a height of thirty-six inches (36″) or less shall be five feet (5′) if adjacent properties are not adversely affected.

14.3.5.5 Alignment. Whenever possible, culverts shall be aligned with the natural channel to reduce inlet and outlet transition problems.

~~14.3.5.6 Temporary Crossing. Temporary crossings are defined as dip road sections with a culvert sized to pass nuisance flow, or a culvert system that does not meet criteria presented in this manual. Temporary crossings shall be reviewed on a case by case basis. Consideration shall be given to the following items:~~

~~1. Drainage area contributing to crossing.~~

~~2. Level of roadway traffic.~~

~~3. Vertical and horizontal roadway alignment (sight distance).~~

~~4. Alternate access routes.~~

~~5. Time frame for temporary crossing (time to construction of permanent crossing).~~

~~6. Current and projected development density.~~

~~7. Twenty-five (25) year and one hundred (100) year storm flows.~~

~~14.3.5.7 Multiple Barrel Culverts. Multiple culverts may be used if available fill height limits the size of culvert needed to convey the flood flow.~~

~~14.3.5.8 Inlet and Outlet Configuration. Culverts shall be designed with protection at the inlet and outlet areas. The culvert inlet shall include a headwall with wingwalls or a flared end-section.~~

~~The outlet area shall also include a headwall with wingwalls or a flared end-section. Where outlet velocities exceed the limitation set forth in Section 14.3.5.3 (outlet protection), an energy dissipater shall be required.~~

~~14.3.5.9 Structural Design. All culverts shall be designed to withstand, as a minimum, an H-20 loading in accordance with the design procedures of AASHTO "Standard Specifications for Highway Bridges" and with the pipe manufacturer's recommendations.~~

~~14.3.6 Drainage Channels. When open drainage channels are permitted, the potential for erosion and scour shall be determined, and submitted as part of the drainage report. Recommended mitigation measures to prevent erosion and sediment deposition shall be identified and incorporated into design of the drainage channels. Flow velocities in drainage shall not exceed the maximum permissible flow velocities for the design storm as recommended in the American Society of Civil Engineers (ASCE) Manuals and Reports of Engineering Practice No. 77, "Design and Construction of Urban Storm water Management Systems."~~

~~Side slopes for unlined channels shall be 3:1 (horizontal to vertical) or flatter. Side slopes for lined channels shall be 2:1 (horizontal to vertical) or flatter. The use of rip rap as a channel lining is discouraged due to maintenance requirements.~~

All drainage channels that are not located within public rights-of-way shall be located in easements dedicated to the city or the appropriate entity, and shall be provided with a permanent maintenance access road in accordance with Section 12.11.14 (improved maintenance access) to provide access for maintenance.]

[14.4 – Detention.

14.4.1 Introduction. The main purpose of a detention basin is to temporarily store runoff and reduce peak discharge by allowing flow to be discharged at a controlled rate. This controlled discharge rate shall be determined so that post-development runoff shall not exceed pre-development runoff leaving the site.

Detention facilities shall be designed by and financed by developers or local property owners. The facilities are intended to allow development by protecting a site from existing flooding conditions or to protect downstream property from increased runoff caused by development.

14.4.2 Detention Facilities. Detention facilities shall comply with the following:

1. Impounding of water for storm water control purposes shall comply with regulations of the Nevada state engineer for the construction of dams where pertinent.
2. The potential for use of detention basins for multiple uses must be reviewed with the parks department, and if acceptable to the city, must be designed to accommodate these additional uses.
3. Basins shall be sited within drainage easements.
4. Detention basin outlet capacity shall be based on the downstream channel capacities (existing or build-out conditions) with consideration given to inflows occurring downstream of the detention basin and changes in flow conditions and hydraulics due to the use of the upstream detention basin, and shall not exceed the pre-developed flow rate (up to the design storm) for the affected property (see section 14.1.2.5 (storm runoff detention)).
5. In-channel detention basins shall be required to safely pass the probable maximum flood discharge as a minimum.
6. Detention ponds shall be designed to include provisions for security, public safety, landscaping, and erosion control.
7. Basins shall be drained in not more than forty-eight (48) hours. (Drain time is defined as the time from the end of precipitation until the basin is drained of ninety percent (90%) of design capacity.)
8. Design of all detention basins shall include emergency spillways for one hundred (100) year storms protected against erosive forces.
9. A minimum of one foot (1') of freeboard is required above the emergency spillway design water surface elevation.
10. Basin discharge shall be self-regulating (passive).

11. Generally detention basins shall have side slopes no steeper than 5:1 horizontal to vertical. Access to basins shall be provided by a paved ramp with slope no steeper than 6:1 horizontal to vertical with a minimum width of twelve feet (12').

14.4.6 Flow Restrictor Outlets. The flow restrictor outlet shall be sized to control discharge from a basin as set forth in section 14.1.9 (storm runoff detention). Outfall from a flow restrictor shall be provided by a culvert or pipe conduit. The types of flow restrictors for parking lot detention may be under sidewalk weirs or pipes.

14.4.7 Spillways. All detention facilities shall have the ability to pass flows in excess of the design storm without endangering the structural integrity of the facility or diverting flows from their historic drainage pattern. Impacts to downstream properties shall be considered when siting and designing the spillway(s).

14.4.8 Sizing Requirements. All detention basins shall have emergency spillways which safely pass, as a minimum, a hydrograph developed by using the one hundred (100) year return period, twenty-four (24) hour duration storm.

14.4.9 Embankment Protection. Embankments shall be protected from structural failure from overtopping. Overtopping can be caused by a larger than design inflow, or from obstruction of the low flow outlet. Embankment protection shall be provided by embankment armoring (i.e. rip-rap), use of slopes of 5:1 (horizontal to vertical) or flatter, or by a design overflow section (i.e., emergency spillway). The invert of the emergency spillway shall be set equal to or above the design storm water surface elevation.

14.4.10 Maintenance Requirements. All detention facilities shall be designed to minimize maintenance and to allow access by equipment and workers to perform maintenance.]

[14.5 Trash racks.

All outlet works, the upper end of all closed conduits, and low flow conduits shall be provided with a trash rack for debris control. The trash rack shall provide a maximum bar spacing not to exceed two-thirds (2/3) of the outlet opening or diameter. The total area of the trash rack shall allow for passage of the design outlet flow with fifty percent (50%) of the trash rack blocked.]

[14.6 Submittal and review process.

The purpose of the submittal and review process is to determine whether or not the drainage plan and improvements for a given project meet Carson City drainage requirements. These requirements include overall facility planning to assure an integrated and coordinated design as well as design standards to assure consistent design and analysis. Drainage study submittal requirements for all land development in Carson City are presented in the following section and summarized in Table 14.6. The submittal requirements are intended to provide the necessary information for each development, and minimize review time. The submittal and review process

does not relieve the design engineer of the responsibility to provide a correct and safe drainage design, nor the developer to properly construct the designed drainage facilities.

By reviewing and approving drainage designs for given developments, Carson City shall not assume liability for improper drainage design, nor guarantee that the final drainage design review shall absolve the developer or designer of future liability for improper design or construction.

Table 14.5
Drainage Study Submittal Requirements

Land Development and/or Land Action Process	Required Drainage Submittals(5)
Parcel Map:	Conceptual Study
Improvement Plans	Technical Study
Subdivision (including planned unit developments):	
Conceptual Plan	Conceptual Study
Tentative Map	Conceptual Study
Improvement Plans	Technical Study
Building Permit	Technical Study
Clearing, Grading, Filling and/or Excavation	Conceptual Study
Other:	
MPR/CLU	Conceptual Study
Special Use Permit	Conceptual Study
Project Review	Technical Study
Development Master Drainage Plans	Technical Study
Transportation Studies	

~~Floodplain Modification Study~~	~~Technical Study~~
~~Conditional Letter of Map Revision,~~	
~~Letter of Map Amendment, Letter of Map Revision, etc.~~	

~~Notes:~~

~~1. A technical drainage study may be required by development engineering in lieu of, or in addition to a conceptual drainage study.~~
~~2. If the city does not perceive a flooding hazard with the proposed development, then the development may be approved subject to review and approval of the drainage study and acceptance of conditions of approval by the owner.~~
~~3. All floodplain modification studies shall be prepared in accordance with FEMA requirements and the CCMC.~~
~~4. Development engineering may waive this requirement.~~
~~5. Carson City reserves the right to request additional information of the developer/design engineer after a drainage study has been submitted.~~

~~Drainage studies shall be submitted for all development where new impervious surface coverage equals or exceeds ten thousand (10,000) square feet, except for single family residences. Additionally, drainage studies may be required by development engineering where a proposal may endanger the life, safety and welfare of the public. Three (3) copies of the required drainage studies and attachments shall be submitted to development engineering for review with the required applications or improvement plans. Additional copies, as necessary, shall be submitted as requested by development engineering. All submitted reports shall be clearly and cleanly reproduced. Copies of charts, tables, nomographs, calculations, or other referenced material shall be legible.~~]

[~~14.7 - Drainage study information page.~~

~~A drainage study information form page shall be included with all drainage study submittals. The drainage study information page shall be used to provide basic information regarding the proposed development to catalog the submittal for filing, distribution, and retrieval purposes.~~

~~The drainage study information page shall be bound at the front of the drainage study. The drainage study information page shall contain the seal and signature of the professional engineer licensed in Nevada who is responsible for the drainage study.~~]

[~~14.8 - Conceptual drainage study.~~

~~A conceptual drainage study is a descriptive report which addresses existing and proposed drainage conditions. The conceptual drainage study documents the existing drainage conditions of the project site and presents the details of the proposed drainage system. Additionally, it includes sufficient data to evaluate storm flows and proposed mitigation.~~

~~The conceptual drainage study shall contain sufficient information in order for development engineering to make a recommendation to the appropriate Carson City hearing body.~~

~~14.8.1 Conceptual Drainage Study Outline. The conceptual drainage study shall contain a brief narrative letter, a calculation appendix (if required), and a drainage plan in accordance with the following outline:~~

~~I. Introduction~~

~~A. Drainage study information page~~
~~B. Project name, type of study, study date~~
~~C. Preparer's name, seal, and signature~~
~~D. Description of project~~
~~E. Existing site conditions~~
~~F. General location map (8 ½" x 11" is suggested)~~

~~II. Existing and Proposed Hydrology~~

~~A. Discuss existing and proposed drainage basin boundaries~~
~~B. Provide design storm and one hundred (100) year return period, twenty-four (24) hour duration storm flow calculations for both on-and off-site flows~~
~~C. Discuss existing drainage problems (if applicable)~~
~~D. Discuss on-site and downstream drainage~~
~~E. Discuss floodplain (if applicable)~~
~~F. Existing irrigation~~
~~G. Tributary exhibit~~

~~III. Proposed Drainage Facilities (on-site and off-site)~~

~~A. Discuss routing of flow in and/or around site, downstream, and location of drainage facilities~~
~~B. Discuss mitigation measures~~
~~C. Discuss floodplain modifications (if applicable)~~
~~D. Provide exhibit~~

~~IV. Conclusions~~

~~A. Compliance with the CCMC and the Carson City development standards~~
~~B. Compliance with FEMA (if applicable)~~

C. Discuss effect of development on off-site flow rates and properties
D. Implementation measures necessary for project completion

V. Exhibits

A. Drainage plan
B. FEMA floodplain map (show on drainage plan also)

VI. Calculations Appendix (if required)

A. Runoff calculations
B. Street and drainage facility capacity calculations (if applicable)
C. Detention calculations (if applicable)

14.8.2 Conceptual Drainage Plan. An 8½" × 11" or larger legible drainage plan which covers the development area shall be submitted and bound with the conceptual drainage study. The plan shall contain as a minimum the following:

1. Locate and label development boundary,
2. Locate and label adjacent streets,
3. Locate and label known one hundred (100) year floodplains,
4. Locate and label existing and/or planned local flood control facilities,
5. Show flow paths,
6. Identify design inflow points and design outflow points and corresponding design storm and one hundred (100) year return period, twenty-four (24) hour duration storm flow rates,
7. Show existing and proposed topography,
8. Show time of concentration path for developed and existing conditions.]

[14.9 Technical drainage study.

The technical drainage study shall discuss, at a detailed level, the existing site hydrologic conditions and the proposed drainage plan to accommodate or modify site drainage conditions in the final development plan for the site. The technical drainage study shall address both on-site and off-site drainage analysis and improvements necessary to mitigate the impact of the proposed development on downstream properties.

14.9.1 Technical Drainage Study Contents. The technical drainage study shall be in accordance with the following outline and contain as a minimum the information listed:

I. Title Page

A. Drainage study information page

B. Project name, type of study, date of preparation, and revisions
C. Preparer's name, seal and signature

II. General Location and Development Description

A. Location of Property

1. Street location and assessor's parcel number(s)
2. City, state highway and local streets within and adjacent to the development
3. Township, range, section, 1/4 section
4. Drainage basin(s) encompassing the development
5. Location of development in relationship to existing drainage facilities
6. Names of surrounding developments
7. General location map (8½" x 11" is suggested)

B. Description of Property

1. Area in acres
2. Existing site conditions (buildings, drainage structures, floodplains, and other site conditions that may impact the project)
3. General site topography, ground cover, and soil maps
4. Existing irrigation facilities such as ditches and canals
5. Adjacent and downstream developments, drainages and infrastructure

C. Project Description

1. Purpose and nature of land disturbing activity; include estimated amount of grading
2. Critical areas on the site which have the potential for serious erosion and/or sedimentation, or other drainage problems

III. Drainage Basin Description

A. Off-Site drainage description

1. Discuss historic drainage patterns (overland flow, channelized flow, points of discharge) for off-site flows which enter the project site
2. Discuss off-site flows which enter the project site
3. Provide map of drainage basins
4. Discuss drainage basin characteristics (topography, area, land use, coverage, soil types, erosion potential, etc.)
5. Identify design storm and one hundred (100) year return period, twenty-four (24) hour duration storm flows for each drainage basin and sub-basin impacting or impacted by the project site

6. Discuss downstream flow paths, rates, and conveyance capacity

B. On-site drainage description

1. Discuss historic on-site drainage patterns and capacity of the property (flow directions through site and at property lines)
2. Discuss historic drainage patterns of upstream runoff
3. Provide map of drainage basins
4. Discuss historic drainage basin characteristics (topography, area, land use, coverage, soil types, erosion potential, etc.)

C. Floodplain Information

1. Identify all FEMA regulated floodplains which impact the subject site. Locate same on drainage plan
2. Note lowest floor and other pertinent elevation(s)
3. Floodplain/floodway calculations where pertinent

D. Previous Drainage Studies

1. Identify previous drainage studies for the site, and provide a copy if required by Carson City
2. Identify previous drainage studies or previously approved projects which affect the site, and provide copies of the studies if required by Carson City

IV. Proposed Drainage Facilities

A. General Description

1. Discuss criteria and methodology
2. Discuss proposed on-site drainage system plan and layout
3. Discuss proposed off-site drainage system plan

B. Compliance with Regulations and Adopted Plans

1. Discuss compliance with FEMA floodplain regulations and CCMC, and all proposed modifications to or verifications of the FEMA regulated floodplain through the subject site
2. Discuss compliance with previously approved drainage studies for the subject site
3. Identify individually all requests for variances from the requirements of the drainage criteria

C. Hydrologic Criteria

1. Discuss design rainfall computations
2. Discuss design runoff computations
3. Discuss peak flow rates from off-site areas and facilities
4. Discuss off-site limiting conditions and constraints (see section 14.1.3 (increase in rate of flow))
5. Provide schematic of pre- and post-development time of concentration paths and calculations

D. Facility Design Calculation

1. Discuss design calculations for the on-site drainage system (design storm and one hundred (100) year storm flows)

   a. Street and ditch flow calculations
   b. Storm drains, inlets, and ditch flow calculations
   c. Channel and culvert flow calculations
   d. Other hydraulic structure flow calculations (trash rack, grates, etc.)
   e. Detention storage and outlet design calculations and flows
   f. Provide detail of control structure device
   g. Erosion and sediment deposition and mitigation measures during construction
   h. Permanent stabilization description of how site shall be stabilized after construction is complete

2. Discuss design calculations for the off-site drainage system that is accepting post-development runoff, and impacts from same

   a. Street flow calculations
   b. Storm drain, inlets, and ditch flow calculations, including velocities
   c. Channel and culvert flow calculations
   d. Other hydraulic structure flow calculations
   e. Alluvial fan analysis and calculations (when required)

3. Discuss floodplain/floodway calculations as related to FEMA requirements and compliance with CCMC
4. Discuss maintenance access and potential maintenance requirements, and maintenance responsibilities
5. Discuss easement requirements for the proposed drainage facilities
6. Discuss phasing of all drainage facilities
7. Energy and hydraulic grade lines

V. Conclusions

A. Compliance with drainage laws
B. Compliance with the CCMC
C. Compliance with FEMA requirements
D. Compliance with development standards
E. Effectiveness of proposed drainage facilities to control storm runoff
F. Impact of proposed development on off-site property and facilities
G. Mitigation of impacts and implementation schedule

VI. Appendices as Required by Report.

14.9.2 Technical Drainage Study Plan. A detailed drainage plan(s) for the subject site shall be submitted with the technical drainage study. The plan(s) shall be on a 24" x 36" drawing at an appropriate scale (a scale of 1" = 20' to 1" = 200' is recommended). The following information shall be shown on this drawing, except that the off-site drainage basin boundaries may be shown at an appropriate legible scale on an exhibit:

1. Property lines and streets (roads) including right-of-way widths within one hundred feet (100') of the development.
2. Street names, grades and widths.
3. Existing contours and proposed elevations sufficient to analyze drainage patterns extending a minimum of one hundred feet (100') past property lines of the project limits. If required by development engineering, more extensive off-site topography shall be required.
4. Existing drainage facilities and structures, including ditches, storm drains, channels, street flow direction, and culverts. All pertinent information such as material, size, shape, slope, and location shall also be included.
5. Limits of existing floodplains based on flood insurance rate maps (FIRM), and best available information. Provide tie to FEMA datum if all or a portion of the site is within a FEMA regulated floodplain, and base flood elevation information when available. Establish base flood elevations if not determined on FIRMs.
6. Proposed on-site drainage basin boundaries. Include off-site drainage basins if same runoff enters project.
7. Proposed future on-site and off-site flow directions and paths for design storm and one hundred (100) year storm flows at pertinent locations.
8. Proposed street and ditch flow paths and slopes. Trace peak flows leaving project site to nearest drainage facility; identify capacity and improvements, if needed.
9. Proposed storm drain locations, type, size, capacities, depth of flow, and slope. Include inlet types, sizes and locations, and manhole locations. Correlate to drainage calculations.
10. Proposed channel alignment with typical cross section. Provide street cross sections showing design storm and one hundred (100) year return period, twenty-four (24) hour duration storm depth of flow.
11. Proposed culvert locations, type, size, and slope.

12. Miscellaneous proposed drainage facilities (i.e., hydraulic structures, etc.).
13. Easement widths and boundaries (existing and proposed).
14. Ditch and channel sections with lining, if required.
15. Construction details including control structure and identify construction materials.
16. Legend for all symbols used on drawing.
17. Scale, bar scale, north arrow, date bench mark, title block, professional engineers signature, seal.
18. Energy grade lines (EGL's) and hydraulic grade lines (HGL's) for storm drain and channel storm runoff.
19. Show emergency flow paths for one hundred (100) year peak storm.]

[14.10 - Improvement plans.

Where drainage improvements are to be constructed, the improvement plans (on 24″ × 36″ sheets) and specifications shall be submitted to development engineering. Approval of the final improvement plans by development engineering shall be obtained prior to issuing construction permits, building permits, or grading permits. Plans for the drainage improvements shall include the following as a minimum:

1. Storm drains, inlets, outlets and manholes with stationing, elevations, dimensions, type and horizontal control indicated.
2. Culverts, end sections, and inlet/outlet protection with dimensions, type, elevations, and horizontal control indicated.
3. Channels, ditches, and swales (including side/rear yard swales)with lengths, widths, cross-sections, grades and erosion control (i.e., rip-rap, concrete, grout) indicated.
4. Checks, channel drops, erosion control facilities and measures.
5. Detention pond grading, low flow channels, outlets, landscaping, fencing, and maintenance access.
6. Other drainage related structures and facilities (including underdrains and sump pump lines).
7. Maintenance access considerations.
8. Drainage easements and right-of-way with horizontal distance to improvements.
9. Plan and profile sheets showing all improvements.
10. Details for drainage structures, facilities, and improvements, including detention basin outlet control structures.
11. Erosion and sedimentation control plan.

The information required for the plans shall be in accordance with sound engineering principles, this manual, the Standard Details, and the "Standards Specifications for Public Works Construction." Construction documents shall include geometric, dimensional, structural, foundation, bedding, hydraulic, landscaping, specifications, and other details as needed to construct the drainage improvements. Improvement plans shall be signed and sealed by a

~~professional engineer licensed in Nevada and be in accordance with the approved drainage report/drawings.~~]

The City may grant exemptions to the detention policy for the following:

1. Developments which discharge directly to a regional flood control facility, provided the facility is completed per the adopted plan and designed for the contributing flows.

2. Locations where a local detention facility is designed and constructed to serve several developments and the contributing flows.

3. Downstream facilities are upgraded to accommodate the increased flow.

4. Where the downstream facilities are adequate to carry up to one hundred (100) year flows.

All exemptions are subject to approval by the City.

1.10 Lower Watershed Design

In certain circumstances, i.e., close to the drainage system's point of discharge, it may be desirable not to detain stormwater runoff. The option to directly discharge shall be at the sole option of the City and after review of a flood route analysis. Water quality treatment will be required even if the stormwater runoff is directly discharged.

1.11 Storm Runoff Retention and Infiltration

Storm runoff retention and infiltration have been used to eliminate the need for constructing outlet structures and for ease of construction. However, problems with retention basins and infiltration facilities receiving runoff from pollution generating surfaces include perpetual maintenance requirements, soil expansion, siltation, decreasing infiltration capacity, and insect abatement. Retention basins and infiltration facilities receiving runoff from pollution generating surfaces also pose a hazard to City groundwater resources through possible contamination. The use of infiltration facilities is encouraged for runoff from non-pollution generating surfaces such as roofs. Percolation tests shall be conducted to verify that on-site soils are adequate for infiltration. Retention basins used to mitigate the increase of runoff from development must meet the requirements of detention basins and are only allowed on a case by case basis.

1.12 Drainage Facilities Maintenance

An important part of all storm drainage facilities is the continued maintenance of the facilities to ensure they function as designed. Maintenance of detention facilities involves the removal of debris and sediment. Such tasks are necessary to preclude the facility from becoming unhealthy and to retain the effectiveness of the detention basin. Sediment and debris must also be periodically removed from channels and storm drains. Trash rack and street inlets must be regularly cleared of debris to maintain system capacity. Channel bank erosion, damage to drop structures, crushing of pipe inlets and outlets, and deterioration to the facilities must be repaired to avoid reduced conveyance capability, unsightliness, and ultimate failure.

All drainage facilities shall be designed to minimize facility maintenance as well as to provide ease of maintenance and include maintenance access to the drainage facility. The owner of the drainage facilities shall be responsible for mosquito control, and the method of control shall comply with the Carson City Environmental Health Department.

The property owner or developer shall be responsible for the maintenance of all privately owned on-site drainage facilities, including but not limited to, inlets, pipes, channels, and detention basins unless otherwise required or modified by a separate agreement. An operation and maintenance schedule shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operations shall be identified. Prior to issuance of any permit for any regulated activity covered under this section, the City shall require the applicant and owner to execute an inspection and maintenance agreement binding on all subsequent owners of land served by the private storm drainage system. If the property owner or developer fails to maintain said facilities adequately, Carson City shall

When open drainage channels are permitted, the potential for erosion and scour shall be determined and submitted as part of the drainage report. Recommended mitigation measures to prevent erosion and sediment deposition shall be identified and incorporated into the design of the drainage channels. Flow velocities in drainage shall not exceed the maximum permissible flow velocities for the design storm as recommended in the American Society of Civil Engineers (ASCE) Manuals and Reports of Engineering Practice No. 77, "Design and Construction of Urban Stormwater Management Systems."

Side slopes of unlined channels shall be 3:1 (horizontal to vertical) or flatter. Side slopes for lined channels shall be 2:1 (horizontal to vertical) or flatter. The use of rip rap as a channel lining is discouraged due to maintenance requirements.

All drainage channels that are not located within public rights-of-way shall be located in easements or lands dedicated to the City or the appropriate entity, and shall be provided with a permanent maintenance access road in accordance with Division 12.11.14 (Improved Maintenance Access) to provide access for maintenance.

9. Stormwater Runoff Reduction BMPs

9.1 Introduction

The principal of runoff reduction starts by recognizing that developing or redeveloping land within a watershed inherently increases the imperviousness of the areas and, therefore, the volume and rate of runoff and the associated pollutant load.

Best management practices (BMPs) for reducing runoff include passive systems such as minimization of directly connected impervious areas and low impact development techniques and structural controls such as detention or infiltration facilities.

The main purpose of a detention BMPs is to temporarily store runoff and reduce peak discharge by allowing flow to be discharged at a controlled rate. This controlled discharge rate shall be determined so that post-development runoff shall not exceed pre-development runoff leaving the site and that the appropriate LID feature is being used. The controlled release of storm drainage minimizes impact on downstream properties and also minimizes the potential for downstream erosion that may occur as a result of increased flow velocity. There are three primary types of detention facilities: detention ponds, tanks, and vaults.

9.2 Minimize Directly Connected Impervious Areas (DCIA)

Impervious areas directly connected to the storm drain system are the greatest contributor to non-point source pollution. The first effort in site planning and design for stormwater quality protection is to minimize the directly connected impervious area (DCIA), as shown in Table 5.

Any impervious surface that drains into a catch basin, area drain, or other conveyance structure is a DCIA. As stormwater runoff flows across parking lots, roadways, and paved areas, the oils, sediments, metals, and other pollutants are collected and concentrated. If this runoff is collected by a drainage system and carried directly along impervious gutters or in closed underground pipes, it has no opportunity for filtering by plant material or infiltration into the soil. It also increases in speed and volume, which may cause higher peak flows downstream and may require a larger capacity storm drain system, increasing flood and erosion potential.

Minimizing directly connected impervious areas can be achieved in two ways:

1. Limiting overall impervious land coverage
2. Directing runoff from impervious areas to pervious areas for infiltration, retention/detention, or filtration.

9.3 Low-Impact Development Techniques

The low-impact development (LID) approach combines a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality. The primary goal of LID methods is to mimic the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, and detain runoff. The use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. Since every aspect of site development affects the hydrologic response of the site, LID control techniques focus mainly on site hydrology. Specific LID controls can reduce runoff by integrating stormwater control throughout the site in many small, discrete units. LID controls are distributed in a small portion of each lot, near the source of impact, and may eliminate the need for a centralized BMP facility such as a stormwater management pond.

The Regional Water Planning Commission for the Truckee Meadows has developed the Truckee Meadows Structural Controls Design and Low Impact Development Manual, which may be used as a reference. Information on LID control techniques can also be found in the publication "Low-Impact Development Design Strategies, An Integrated Design Approach, 2000", Prince George's County, Maryland, Department of Environmental Resources, Programs and Planning Division and at the Low Impact Development Center website http://www.lowimpactdevelopment.org.

LID control techniques include the following broad categories of stormwater control:

1. Zero Discharge Areas
2. Self-Treatment Areas
3. Runoff Reduction Areas

Site planning strategies and techniques provide the means to achieve stormwater management goals and objectives; facilitate the development of site plans that are adapted to natural topographic constraints; maintain lot yield; maintain site hydrologic functions; and provide for aesthetically pleasing, and perhaps, less expensive stormwater management controls.

Table 5 presents a list of site design and landscaping techniques and indicates whether they are applicable for use in Zero Discharge Areas, Self-Treating Areas, and Runoff Reduction Areas. Several techniques may be implemented within the same design philosophy. Some techniques may be used to implement more than one design philosophy. Where feasible, combinations of multiple techniques may be incorporated into new development and redevelopment projects to minimize the amount of treatment required.

Table 5 – Site Design and Landscaping Techniques
(From: California Stormwater BMP Handbook, New Development and Redevelopment)

Site Design and Landscape Techniques	Design Criteria		Design Philosophy		
	Volume-Based Design	Flow-Based Design	Zero Discharge	Self-Treating	Runoff Reduction
Permeable Pavements					
Pervious concrete	X				X
Pervious asphalt	X				X
Turf block	X			X	X
Un-grouted natural stone	X				X
Un-grouted concrete unit pavers	X				X
Unit pavers on sand	X				X
Crushed aggregate	X				X
Cobbles	X				X
Wood mulch	X				X
Streets					
Urban curb/swale system	X	X			X
Rural swale system	X	X			X

Dual drainage systems	X	X			X
Concave median	X	X	X		X
Pervious island	X	X			X
Parking Lots					
Hybrid surface parking lot	X				X
Pervious parking grove	X				X
Pervious overflow parking	X			X	X
Driveways					
Not directly connected impervious driveway		X			X
Paving only under wheels	X			X	X
Flared driveways	X				X
Buildings					
Dry-well	X		X		X
Cistern	X	X	X		X
Foundation planting	X	X			X
Pop-up drainage emitters		X			
Landscape					
Grass/vegetated swales	X	X		X	X
Extended detention (dry) ponds	X		X	X	X
Wet ponds	X		X	X	X
Bio-retention areas	X		X	X	X

9.3.1 Zero Discharge Areas

A zero discharge area is an area within a development project that is designed to infiltrate, retain, or detain the volume of runoff requiring treatment from that area. Site design techniques available for designing areas that produce no treatment-required runoff include:

1. Retention/Detention Ponds
2. Wet Ponds
3. Infiltration Areas
4. Large Fountains
5. Retention Rooftops
6. Green Roofs (roofs that incorporate vegetation) and blue roofs (roofs that incorporate detention or retention of rain).

Infiltration areas, ponds, fountains, and green/blue roofs can provide “dual-use” functionality as stormwater retention measures and development amenities. Detention ponds and infiltration areas can double as playing fields or parks. Wet ponds and infiltration areas can serve dual roles when meeting landscaping requirements.

9.3.2 Self-Treatment Areas

Self-treatment areas are developed areas that provide “self-treatment” of runoff if properly designed and drained. Self-treating site design techniques include:

1. Conserved Natural Spaces
2. Large Landscaped Areas (including parks and lawns)
3. Grass/Vegetated Swales
4. Turf Block Paving Areas