CHAPTER II - STORM DRAINAGE

201 General

201.1 Use of Chapter II

Chapter II of the City of Reno Public Works Design Manual is intended to be used in conjunction with the Truckee Meadows Regional Drainage Manual (TMRDM). The TMRDM (formerly known as the Washoe County Hydrologic Criteria and Drainage Design Manual) is the primary reference document for hydrologic criteria and drainage design for the City. The topics and criteria covered in Chapter II of the Public Works design manual are intended to:

1. address those topics not included in the TMRDM
2. provide alternate or more restrictive criteria as compared to the TMRDM
3. emphasize specific criteria from the TMRDM

The TMRDM shall be adhered to except for those cases in which alternative or more restrictive criteria are proposed in this chapter, or where directed by the City Engineer.

For the purposes of this chapter the terms "public facilities" and "City owned facilities" shall be interpreted to mean those facilities built by the City as public facilities, those facilities built by private interests and intended for dedication to the City, or those facilities built by any party other than the City which are reasonable candidates for dedication to the City, or for which it can be reasonably anticipated that the City will maintain at any point in the future.

201.2 Triggers for Drainage Report

A drainage report shall be submitted for any of the following:

1. Permit relating to coverage of 10,000 or more sq. ft. of impervious surface within the property.
2. Where development is in a critical drainage area.
3. Grading permit which entails 20,000 sq. ft. or greater.
4. Subdivision Improvement Plans.
5. Where required by the City Engineer.

The drainage report shall be signed and stamped by a Nevada Licensed Civil Engineer in accordance with City standards unless requirement is waived by the City Engineer.

The drainage report shall be based on current zoning or Master Plan whichever produces the greater runoff.

201.3 Relationship to Chapter on Storm Water Quality

This chapter contains criteria primarily directed toward the consideration of conveyance of stormwater flows and related facilities. The design engineer cannot, however, overlook storm water quality considerations and requirements during the design of conveyance facilities, as they are integrally related and will many times control or heavily influence the design of storm water conveyance facilities. The requirements and criteria relating to storm water quality (Chapter X) are intended to work in conjunction with the requirements presented in this chapter, and the requirements of this chapter are not intended to preclude any requirement or criteria of Chapter X.

202 Design Guidelines

202.1 Hydrology

202.1.1 General

NOAA Atlas 14 shall be used for rainfall in the City of Reno (see http://nws.noaa.gov/ohd/hdsc/). See the TMRDM for alternate methodology, where applicable.

The Rational Method may be used in computations for the rate of runoff for urban and small watersheds 100 acres or less. The SCS method, SCS TR-55 "Urban Hydrology for Small Watersheds", HEC-1/HEC-HMS, or the methods outlined in the TMRDM shall be used for larger watersheds.

The Rational Method:

The design flow for the Rational Method is expressed as:

$$Q = CiA,$$

where:

Q = peak rate of runoff, cubic feet per second

C = runoff coefficient

i = average rainfall intensity, inches per hour

A = watershed area, acres

The following Table 201 listing runoff coefficients based depending on future use, shall be used:

TABLE 201 RUNOFF COEFFICIENTS "C"

Land Use Type	Runoff Coefficient "C"
Rural	0.25-0.35
Single Family Residential	0.45-0.60
Multi-Residential	0.60-0.70
Neighborhood Commercial	0.85
Community Commercial	0.85
Tourist Commercial	0.85
Office	0.85
Manufacturing	0.85-0.90
Distribution and Warehousing	0.85-0.90
Public Facility	0.50-0.85
Pavement and Concrete Surfaces	0.90-0.95
Park	0.25
Open Space (0-5% grade - vegetated)	0.20-0.30
Open Space (0-5% grade - no vegetation)	0.30-0.40
Open Space (5-15% grade - vegetated or unvegetated)	0.40-0.50
Open Space (Over 15% grade - sparsely vegetated, rock or clay soils)	0.40-0.60

Weighted values of the runoff coefficient "C" may be required where land use is most accurately described as a mixture of the land uses listed above or where it is a mixture of impervious and pervious areas and not well represented by a single entry in the preceding list.

Sub-areas which include an LID feature will typically require special consideration and weighting of the runoff coefficient "C". See Chapter X for specific guidance on post construction storm water quality design considerations.

Included below for reference is Table 202 from both the TMRDM and the Truckee Meadows Structural Controls Manual.

TABLE 202 ADDITIONAL RUNOFF COEFFICIENTS "C" FOR REFERENCE

Runoff coefficients for the Rational Method from the Washoe County Hydrologic Criteria and Drainage Design Manual (a.k.a., the TMRDM) and the City of Sparks (1998 and 1996, respectively), and as per the Truckee Meadows Structural Controls Design Manual.

		Runoff Coefficients	
Land Use or Surface Characteristics	**Aver. % Impervious Area**	**5-Year (C_5)**	**100-Year (C_{100})**
Business/Commercial:			
Downtown Areas	85	.82	.85
Neighborhood Areas	70	.65	.80
Residential:			
(Average Lot Size)			
⅛ Acre or Less (Multi-Unit)	65	.60	.78
¼ Acre	38	.50	.65
⅓ Acre	30	.45	.60
½ Acre	25	.40	.55
1 Acre	20	.35	.50
Industrial:	72	.68	.82
Open Space:			
(Lawns, Parks, Golf Courses)	5	.05	.30
Undeveloped Areas:			
Range	0	.20	.50
Forest	0	.05	.30
Streets/Roads:			
Paved	100	.88	.93
Gravel	20	.25	.50
Drives/Walks:	95	.87	.90
Roofs:	90	.85	.87

Notes:

1. Composite runoff coefficients shown for Residential, Industrial, and Business/Commercial Areas assume irrigated grass landscaping for all previous areas. For development with landscaping other than irrigated grass, the designer must develop project specific composite runoff coefficients from the surface characteristics presented in this table.

Intensity-Duration-Frequency curves from NOAA Atlas 14 (at http://hdsc.nws.noaa.gov/hdsc/pfds/sa/nv_pfds.html) shall be used for determining the applicable intensity. The time of concentration is expressed as:

$$t_c = 10 \text{ or } \frac{L}{V \times 60}, \text{ whichever is greater}$$

where:

t_c	=	initial time of concentration at inlet, minutes
L	=	length from uppermost point of watershed inlet, feet
V	=	channel or overland velocity, feet per second

Given the time of concentration at a design point, the time of concentration at the next design point is determined by adding travel time, expressed as:

$$t = \frac{L}{V \times 60}$$

where:

t	=	travel time, minutes
L	=	length of channel or conduit between design points, feet
V	=	channel or conduit velocity, feet per second

Refer to Chapter X for additional hydrologic criteria relating to storm water quality.

202.1.2 Design Storm Frequency

For Streets and Roads see the TMRDM for requirements.

For developed sites, both onsite and offsite flows are to be provided for and channelized to City standards within dedicated easements, streets or public right-of-way to protect structures from flooding for events up to and including the 100-yr return frequency storm. Additionally, onsite and offsite flows for the 5-yr return frequency are to be contained within the storm drain, where less than 60 cfs. See section 2.2.4 for additional criteria for storm drain. A lesser return period may be acceptable for some limited cases such as where minor flows are present or for improvements in built-out areas, and will require prior approval by the City Engineer.

For onsite calculations, runoff from surface drainage of streets and roads shall be computed by the Rational Method.

See Chapter X for additional criteria on design storm frequencies.

See the TMRDM for special criteria relating to the Silver and Swan Lake (a.k.a. Lemmon Lake) basins.

202.2 Hydraulic Design

202.2.1 General

Discharge of stormwater runoff into a major drainage facility or natural water course shall not be allowed to increase the 100-yr historical peak flow in said facility, unless it can be demonstrated that any increase in peak flow will not adversely affect or cause damage to:

1. the facility itself, whether it be a natural or improved conveyance
2. any property along said drainage facility or water course now or in the future, based on existing zoning, master plan and elements thereof.

This shall be demonstrated to the City in the drainage report, and include consideration of runoff volumes, flow velocities, flow depths, timing of peaks, sediment and erosion.

Constructed public drainage facilities with design flows of 60 cubic feet per second or less shall be piped in accordance with City standards. Constructed drainage facilities with flows exceeding 60 cubic feet per second may be open channel conveyances, when approved by the City Engineer.

Drainage shall not be diverted from one major drainage basin to another without prior approval from the City Engineer and documentation demonstrating no adverse impact with consideration given to peak flows, flow duration, volume of flow, sediment, erosion, timing of peak flow or other factors.

202.2.2 Site Design/Subdivisions

202.2.2.1 Runoff Increases

Development shall not increase peak runoff from a site for all storm events between the 5-yr and 100-yr return period unless it can be demonstrated that no adverse impacts will occur (including demonstration that any downstream storm drain system has the capacity to handle the 5-yr event). Paths of the 100-yr flows must be considered in the design and must not be diverted or obstructed, and must be evaluated to ensure they will not cause damage to existing facilities or infrastructure (public or private). Mitigation of increases in runoff peaks and volume where

downstream systems do not have the capacity to handle the increase, or where adverse impacts will otherwise occur shall be addressed though:

1. detention of flows
2. upgrading of existing downstream system
3. Low Impact Development
4. on-site retention/infiltration system

202.2.2.2 Flow Paths

Surface drainage from any developed area shall not cross any property line except by way of a natural watercourse, major drainage facility, an approved drainage system within a public storm drain easement, or a permanent surface drainage easement. Historic drainages will require new easements, even if no easement existed before.

Existing surface drainage from adjoining property shall be perpetuated through the development, or other means of disposal provided, acceptable to the City Engineer.

202.2.2.3 Future Connections

Storm drain facilities (and post construction storm water quality treatment controls) shall be extended with a subdivision or development to adjacent undeveloped properties for future extensions in accordance with approved drainage plans (or an approved post construction stormwater management plan), unless otherwise approved by the City Engineer.

202.2.2.4 Curb, Gutter and Swales

Reinforced concrete interceptor swales are to be provided along the top of retaining walls and cut slopes to intercept drainage. Discharge swales and wall drains into approved drainages. When required by the City Engineer, reinforced concrete swales shall be provided to intercept drainage from adjacent property.

All drainage from impermeable surfaces on retail, commercial, industrial or similarly developed sites shall be contained by Portland Cement concrete curb and gutter or longitudinal valley gutter to City standards, except where required for LID features as part of the post construction stormwater quality treatment approach.

Surface drainage swales collecting runoff from the area of 2 or more lots are to be addressed through either a paved swale in accordance with City standards, or an LID feature which addresses drainage concerns, and are to be maintained and perpetuated by the property owners. Paving is not required for common side lot swales serving only 2 adjacent lots.

Easements for rear lot drainage swales shall be established by a note on the official plat substantially as follows:

The rear 5.0 feet of Lots, shall be subject to a permanent private and reciprocal drainage swale easement.

-- When Appropriate Add --

Which easement shall be further reciprocal with all lots the rear lots lines of which abut such easement.

Standard lot line drainage swales are to be designed to carry the waters generated by a 100-yr frequency storm, with a maximum of 6 lots contributing run-off to the swale. Discharge from swales shall be conveyed to a public drainage facility. Should it be necessary to provide for drainage from more than 6 lots and/or to exceed the maximum horizontal or vertical alignment (as shown in standard detail), a modified design capable of conveying the run-off from the 100-yr storm may be submitted for review by the City Engineer.

202.2.2.5 Edge Drains and Landscape Drains

All perforated pipe used for landscape drains that connect to the public system must be enclosed around entire circumference (full envelope) in non-woven Geotextile filter fabric.

Edge drains located in streets, parkways, medians, etc. shall extend at least 12 inches below the street subgrade and consist of either a narrow trench backfilled with Class B or C drain rock or a synthetic edge drain product such as MiraDrain 5000 or approved equal. Drain rock should be separated from native soil backfill by a geotextile, such as Geotex 311 or equal. In non-cohesive soils, the fabric should also be placed on the upslope side, between the native soils and the drain rock/backfill.

See section 202.2.5 for special criteria on connections pertaining to approved drains for the benefit of stormwater quality treatment controls and LID features.

All LOMR related improvements must be completed with the associated portion of the project.

202.2.3 Open Channels

202.2.3.1 Design Frequency

All open channels shall be designed to carry the runoff generated by the 100-yr storm from fully developed conditions within the watershed, based on maximum density and in accordance with current zoning. This includes minor roadside channels/ditches and those found within subdivisions or other developed sites. A lesser return period may be acceptable to the City Engineer for some limited cases such as where minor flows

are present or for improvements in already built-out areas, and will require prior approval. In such cases the impacts of the 100-yr flows shall still be considered, and shall not be exacerbated or likely to cause damage.

202.2.3.2 Manning's n Values

Manning's Formula is to be used in computing capacities of all open channels with the following minimum values for roughness coefficient "n":

Open channels with gunite lining 0.019
Open channels with paved bottom.....0.025
Earth channels (no rock or gravel) 0.030

The n value for other linings shall be determined per approved Engineers Manual based on size and placement of materials. See Truckee Meadows Structural Controls Manual for additional guidance on n values for shallow flow depths or for materials typical of LID features.

202.2.3.3 Lining

Lining for drainage channels shall conform to the following requirements:

a. Design velocity of less than 6 fps - Channel lining of non-eroding, long life, low maintenance material as approved by the City Engineer. Side slopes 3:1 maximum unless otherwise approved by the City Engineer. For highly erosive soils, riprap may be required by the City Engineer, even for velocities less than 6 fps.

b. Design velocity 6 to 15 fps - Channel lining of loose rock riprap sized for velocity. Side slopes 2:1 maximum. Other lining types may be allowed as approved.

c. Design velocity greater than 15 fps - Channel lining of concrete or an engineered equivalent.

For criteria on riprap sizing, see the TMRDM.

For riprap lined channels, 1 ft min freeboard is required.

Any connecting or entering channels must be designed with consideration given to the lining or erosion control measures of the primary channel, and shall not cause damage, scour or erosion.

The use of grouted riprap is not allowed. Any exceptions must be approved by the City Engineer, and the installation must still conform to criteria in the TMRDM.

202.2.3.4 Easements and Access

Easements and access are also required along drainage ditches for the entire ditch length for general maintenance, vegetation maintenance and control, herbicide spraying, and Washoe County Vector Control. This includes features intended for post construction stormwater quality management

202.2.4 Storm Drain Systems

202.2.4.1 Design Frequency

Design the storm drain system to convey the five year storm including all downstream improvements and discharge to an existing adequate public storm drain system, major drainage facility or natural watercourse. Where by reason of terrain or other circumstances, the City Engineer determines that piping stormwater runoff is inappropriate or unnecessary, alternative approaches may be approved.

Minimum design velocity shall be 3 feet per second for storm drains and gutter pans to avoid deposition of sediment.

202.2.4.2 Material

Corrugated metal pipe (CMP) is not acceptable for storm drain systems for public improvements. All storm drain piping over 36" in diameter and located within the City right-of-way shall be a minimum of RCP Class III or the appropriate class when design requires a higher pipe support strength. Storm drain piping 36" and less shall be RCP III or solid wall plastic pipe with a minimum stiffness of 46 psi as specified in the Standard Specifications (Orange Book), except for culvert crossings. Individual catch basin leads may be constructed of unreinforced concrete pipe Class III or solid wall plastic pipe with minimum stiffness of 46 psi as specified in the Orange Book.

For open-jointed storm drain pipe placed below the water table, non-woven Geotextile filter fabric wrap shall be used with trench gravels, enclosed around entire circumference (full envelope).

202.2.4.3 Manning's n Values

Manning's formula is to be used in computing capacities of all closed conduits with the following minimum values for roughness coefficient "n":

PVC or ABS	0.013
Concrete Pipe	0.013

Corrugated Metal Pipe (100% paved).....0.015
Corrugated Metal Pipe (paved invert).....0.019
Corrugated Metal (plain).....0.024

202.2.4.4 Minimum Diameter

Minimum pipe diameter for any public storm drain shall be 12 inch except for individual catch basin laterals not exceeding 80 feet in length which may be 10 inch minimum diameter.

202.2.4.5 Discharge to Channel

Where storm drain discharges to a major drainageway, the storm drain shall extend, as a minimum, to the water surface elevation of the 100-yr flood and be riprapped from the outlet of the storm drain to the bottom of the channel in the direction of flow.

202.2.4.6 Headwalls

Headwalls shall be placed on the inlet and outlet of all storm drain systems per applicable standards for culvert headwalls (see 2.2.6) unless due to hydraulic or geometric considerations a concrete end section is more appropriate (i.e., where a storm drain discharges to an open channel).

202.2.4.7 Manholes

Manholes shall be spaced at intervals not greater than 350 feet for pipes 21 inches dia. and smaller and at 600 feet maximum spacing for pipes 24 inches dia. and larger, unless otherwise approved by the City Engineer. Concrete collars shall be placed around all manholes, valves or other appurtenances within any right-of-way or easement. Such collar shall encircle all casting with a minimum width of one foot. Manhole collars shall conform to standard details; all others shall extend to a minimum depth of one foot.

Within storm drain manholes, the difference between the invert elevations of the primary inlet and outlet pipes shall create a minimum fall of one tenth (0.1) of a foot. When smaller secondary inlet pipes are to be added to the manhole, these pipes shall be positioned to optimize flow, where possible, and to prevent adverse flow conditions, as approved by the City Engineer.

202.2.4.8 Catch Basins

Flow through catch basins (i.e., catch basins which tie into each other) shall not be allowed in public systems.

202.2.4.9 Maintenance and Access

Maintenance access roads for storm drain structures (including inlets, outlets and manholes) sufficient for a backhoe to clear debris from trash racks during storm events must be provided.

202.2.4.10 Abandoned Pipe

Storm drain pipe that is abandoned must be solid grouted or removed.

202.2.4.11 Laterals

For ease of maintenance, laterals from catch basins must tie into trunk lines at a manhole and may not make a blind connection. See TMRDM for special criteria where trunk lines are greater than or equal to 48 inches. Where blind connections are specifically allowed for storm drain laterals, pipe inverts are to be at spring line or lower, preferably matching invert, and shall be positioned to provide maximum hydraulic efficiency. However, yard drains, landscaping drains, foundation drains and other similar local drain systems common to developed sites must tie directly into trunk line via a blind connection, and are not allowed to connect to manholes or catch basins. This criterion for local drain systems accomplishes the following:

1. discourages private interests from entering the public storm drain system for maintenance
2. promotes orderly placement of drain lines, typically perpendicular to trunk line and front lot lines
3. encourages consolidation of multiple drains from developed site into single conduit before connection to public system, thereby reducing utility clutter

Due to the special nature of LID features, especially in retrofit situations, where it is not feasible or practical to tie into the storm drain main, all City approved drains for the benefit of stormwater quality treatment controls (including edge drains where appropriate) may tie directly to catch basins and manholes with approval of the City Engineer.

202.2.4.12 Cover

Depth of cover on pipes shall be measured from bottom of A.C. to top of bells per the City of Reno Supplemental Standard Drawings.

202.2.5 Streets and Roads (surface drainage)

202.2.5.1 Sump Inlets

Except for where design approach varies due to LID features, catch basins shall be installed at low points of vertical curves, at all major street intersections, and at sufficient intervals to intercept the peak flow for the 5-yr storm runoff such that flows

will not interfere with traffic or flood adjoining property. Alternate design approaches which direct storm water quality flows to into an LID feature must still intercept and divert flows out of street section, and be no less effective or reliable than an appropriately designed catch basin for all events up to the 100 year event.

For all sump inlets in a street section, size the inlet and connecting pipe for the 100-yr event, or provide a paved overland concrete swale within a corresponding drainage easement (where necessary) to convey storm runoff in excess of the inlet or storm drain capacity for flows up to the 100-yr event.

Where practicable locate inlets on grade (not in a sump) and design site to eliminate or minimize the number of inlets in a sump condition.

202.2.5.2 Allowable Spread

In no instance shall the flow of water from the 5-yr storm extend more than halfway into the travel lane adjacent the curb. Streets without parking lanes will require more frequent inlet locations. At intersections, catch basins shall be located behind the curb returns (not on the radius).

202.2.5.3 General

See section 202.2.2 for applicable requirements for edge drains in streets and medians.

Reinforced concrete valley gutters for public improvements may be placed at street intersections only when approved by the City Engineer.

202.2.6 Culverts and Bridges

202.2.6.1 Design Frequency

All culverts shall be designed to convey flows from the 100-yr event, based on fully developed conditions within the upstream watershed. This applies to roadway culverts, approach culverts, and culverts within subdivisions or other developed private sites. A lesser return period may be acceptable to the City Engineer for some limited cases such as where minor flows are present or for improvements in already built-out areas, and will require prior approval by the City Engineer. In such cases the impacts of the 100-yr flows must still be considered, and must not be exacerbated or likely to cause damage.

202.2.6.2 Minimum Size

For public improvements, the minimum culvert size shall be 18 inches in diameter for round pipe or shall have a minimum flow area of 2.2 square feet for other pipe shapes.

202.2.6.3 Material

Corrugated metal pipe (CMP) is not allowed for public improvements. CMP may be approved for retrofit projects to match existing systems with the approval of the City Engineer.

202.2.6.4 Headwalls

Headwalls or concrete end sections are required on all public culverts (this includes residential driveway culverts). All headwalls shall be designed with consideration given to skew angle of flows with respect to the culvert (The Nevada Department of Transportation standard culvert headwalls are acceptable and accommodate various skew angles). The City Engineer may require additional riprap armoring for any headwalls where scour or erosion is a concern, especially due to the angle of attack of any approach channel or ditch. For pipes up to and including 72 inches in diameter: the design, size, and material used shall comply in all cases with City standards. Headwalls for pipes exceeding 72 inches require special design as approved by the City Engineer.

202.2.6.5 Retrofit Criteria

New developments are required to utilize storm drainage in place of roadside ditches. For those areas where retrofit of drainage systems is a factor, driveway culverts for single family residences shall be sized for 100-yr flows, or shall be sized for the equivalent roadside ditch flow area and be a minimum of 12 inches in diameter. Where headwalls are used for residential driveway culverts 18 inches in diameter and smaller, the following factors should be considered:

1. environment which is friendly to the residential user
2. aesthetics
3. protecting the culvert from damage due to anticipated residential wheel traffic
4. protecting the culvert from equipment during removal of sediment and debris
5. hydraulic efficiency

For such culverts, alternate headwall designs (i.e., smaller headwalls) which address these design concerns are acceptable and encouraged.

202.2.7 Detention/Retention

Detention of 5- to 100-yr storm(s) is required based on limiting conditions downstream, and is many times the primary option for the mitigation of increases to peak runoff due to development.

See Chapter X for additional requirements pertaining to detention and retention

basins. The size of required basins may be reduced through the use of LID features, with appropriate consideration given to effectiveness of LID feature for longer return periods.

Infiltration systems shall require a percolation test as basis of design. The operation and maintenance of such a system is the responsibility of the property owner.

Provide for an emergency spillway which will not cause a direct impact to neighboring sites. The TMRDM provides criteria for the design and sizing of spillways.

Where required, provide a secondary outlet (in addition to the emergency spillway) based on the following criteria:

1. must be a piped system
2. secondary outlet elevation must be above the primary outlet
3. secondary outlet must be sized assuming that primary outlet is completely plugged
4. secondary outlet may tie into the conduit used for the primary outlet; its purpose is to provide an alternate outlet in case the primary outlet is plugged
5. secondary outlet must utilize a trash rack or beehive style grate

202.2.8 Sediment and Stream Stability

See TMRDM.

202.2.9 Additional Hydraulic Structures

Trash racks shall be provided at the upper end of all storm drain as approved by the City Engineer.

Do not place access prevention grate at outlet of drainage structures.

202.3 Major Drainageways

Criteria relating to Major Drainageways are specified in Reno Municipal Code (RMC) 18.12. Major Drainageways may be either natural or improved systems, including both perennial streams and intermittent drainages meeting the applicable criteria. Development of property shall not adversely affect any major drainageway. Natural facilities shall remain in as near a natural state as is practicable with any modification proposed, including any erosion mitigation measures, addressed in the drainage report and drainage plan.

Embankment shall not be placed within the 100-yr floodplain of a major drainage facility. For approved exceptions, the embankment shall be faced with

appropriately sized riprap with freeboard required as for open channels.

The protection of drainage ways in the City of Reno is important to the public health, safety, and welfare and their protection implements the city's mandated policies to preserve major drainage ways as open and recreational space and to save and improve these public resource areas for future generations.

202.4 Easements

Storm runoff generated within the boundaries of a subdivision or development which discharges from a public drain system onto and across private property requires that a permanent easement for access and maintenance be granted the City Engineer from the subdivision or development boundary to the point of discharge into an existing public storm drain system, major drainage facility or natural water course. Improvements to City standards will be required to assure access and proper maintenance within said easement.

Easements with improved vehicular access in accordance with City standards shall be provided to publicly owned storm drain manholes, storm drain inlets and outlets, channels, storm drain ponds and to associated structures not located within an improved street section.

Easements for access to and maintenance of the 100-yr floodplain associated with a major drainage facility or natural water course are to be provided to the City. Improved vehicular access in accordance with City standards shall be provided when determined necessary by the City Engineer.

Consideration shall be given to appropriate maintenance operations and equipment when sizing easements for public improvements and shall be a minimum width of 15 feet. The final easement width shall also consider pipe width, required trench clearance, and excavated trench side slopes (not less than 1:1 horizontal to vertical, from top of pipe), unless approved by the City Engineer.

See Section 202.2.2 for requirements for easement requirements pertaining to site design and subdivisions.

202.5 Access

Where required, access for maintenance of facilities shall consist of a 15 foot easement with a 12’ access road. The required surface treatment of the access road will be based on many considerations, including permeability, anticipated vehicle type and frequency, potential for erosion, slopes of adjacent terrain, priority to City, and anticipated future maintenance requirements, and is to be determined by the City. Where required adjacent a channel, the access road shall be at an elevation higher than the 100-yr water surface elevation in the channel.

For large open channels and those facilities which in the opinion of the City may require emergency vehicle access, a 12' clear lane shall be provided for emergency vehicles at all times.

For channels less than 30 feet in top width, one maintenance access shall be provided as part of the channel improvements. For channels greater than 30 feet in top width, the maintenance road shall be located at the bottom of the channel or on both sides at the channel top. Deviations from this are subject to approval by the City Engineer. Access to the bottom of the channel for maintenance shall be provided at approximately every ¼ mile.

Easements for access shall be dedicated "For Public Use" and shall provide for access by other public entities.

202.6 Irrigation or Water Supply Ditches

Irrigation flows and public storm drain flows shall be conveyed by separate systems, unless specifically approved by ditch companies. All plans adjacent to or containing an irrigation or water supply ditch shall require the signature of the ditch company on the face of the plans.

No public storm drainage runoff shall be allowed to flow or discharge into any irrigation or water supply ditch. Private storm drainage runoff shall be allowed to flow or discharge into an irrigation or water supply ditch only with the approval of the ditch or utility company. Where allowed, discharge of private storm drain flows into an irrigation or water supply ditch are not to be a contributing factor insofar as increasing the peak flow or total volume of water for a 24-hour, 5-yr frequency storm in said facility above existing conditions.

All approved stormwater discharges to a natural waterway, irrigation ditch or water supply ditch must show that source controls have been applied to the maximum extent practicable. See chapter on Post Construction Stormwater Quality Management for additional requirements.

Where irrigation or water supply ditches are located within or adjacent to a subdivision/development, improvements and access as required for the operation and maintenance of the ditch shall be provided to the ditch company's approval. Any improvements within the ditch company's easements are subject to the ditch company's approval.

Any irrigation or water supply ditch adjacent to residential units is to be fenced with 54" fencing, approved by the City Engineer, to safeguard the general public [RMC 18.12.604].

202.7 Flood Hazard Areas

Development within areas shown on the Flood Insurance Rate Map (FIRM) shall comply with Chapter 18.12 of the Reno Municipal Code (RMC). The RMC regulates development in which any portion of a structure or facility is within a FEMA regulated Flood Hazard Area. If a structure or facility lies within two or more Flood Hazard Areas, the most restrictive shall apply. Flood Zone regulations shall also apply to any portion of a parcel within a FEMA regulated Flood Hazard Area for which grading or other improvements are proposed.

Construction shall meet building requirements for the Truckee River Flood Plain Storage Zone 1: Critical Flood Pool per RMC 18.12.605.

202.8 Safety

When the flows, velocity, or side slope as determined by the Drainage Report indicate a potential safety issue, fencing shall be provided.

202.9 Other Agencies

Any work which requires fill be placed within the "waters of the State of Nevada" shall require a permit from the State Department of Environmental Protection prior to beginning construction. The City of Reno shall receive a copy of the State permit prior to issuance of a City permit.

Prior to issuance of any City permit for any facility encroaching on state right-of-way, and for disposal of any drainage onto state right-of-way, the approved NDOT encroachment permit shall be furnished to the City.

203 Submittal Requirements

203.1 Drainage Report

The following standards apply to the Drainage Report (public and private). The report is required to identify problems and present solutions with engineering documentation. Where appropriate, tabularized data on maps is preferred to lengthy written descriptions.

1. Title Page:

    a. Project name.

    b. Preparer's name, firm, date.

c. Professional engineer's seal of preparer and signature.

2. Introduction:

a. Site location:

(1) Street location, assessor's parcel number(s), and section reference.

(2) Adjacent developments.

b. Site description:

(1) Topography, ground cover, etc.

(2) Existing drainage facilities, major drainage facilities, flood hazard areas, irrigation ditches, other site conditions that must be considered.

c. Proposed project description.

d. Other previous studies relevant to site.

3. Historic drainage system (discuss the following):

a. Major basins and offsite contributions:

(1) Relationship to major drainage facilities.

(2) Major basin drainage characteristics (topography, runoff, cover, use, erosion, etc.).

b. Sub-basin and site drainage (1 and 2 may be tabulated on map):

(1) Minor (5-yr) and major (100-yr) storm flows for each sub-basin affecting the site.

(2) Existing drainage patterns: channelized or overland flow, point of discharge, etc.

(3) Effect of historic flows on adjacent properties.

4. Proposed (developed) drainage system (discuss each of the following):

a. Criteria:

(1) Size of major basins, tributary sub-basins, and other offsite contributions.

(2) Hydrologic method to be used for analysis (Rational, SCS, etc.).

(3) Design storm intensities (minor 5-yr, major 100-yr) or as required by the City Engineer.

b. Runoff and other contributions:

(1) Historic storm flow rates and paths.

(2) Developed storm flow rates and paths for minor and major storms.

(3) Contributions added from open joined system.

(4) Demonstrate that flows are routed to a public system with adequate capacity.

c. Piping:

(1) Demonstrate the capacity of the storm drain system, including all downstream improvements.

(2) Verify storm flows from inlets to ultimate outlets of the drainage system.

d. Detention system including

(1) Volume required and provided for zero increase in peak flows.

(2) Release rates and method of release.

(3) Passage of storms exceeding the 5-yr up to the 100-yr.

(4) Engineer to provide detailed description of downstream constraints (or none) and design calculations on how to mitigate the problem.

(5) Need for detention shall be clearly identified in the preliminary or schematic report and the necessary detention area shall be identified on preliminary plans.

e. Streets (This information may be shown on the plans.):

(1) Depth and velocity of flow for major and minor storms. Demonstrate that a 12’ clear lane exists for emergency vehicles at all times.

(2) Drainage system.

f. Open channel flow (This information may be shown on the plans.):

(1) Type.

(2) Depth and velocity.

(3) Freeboard.

(4) HEC-RAS analysis when required by the City Engineer.

g. Storm drains and culverts (Show all data on plans.):

5. Areas within flood hazard zone when applicable:

a. Impacts.

b. Protection.

c. Compliance with Federal Emergency Management Administration (FEMA) requirements, RMC 18.12 "Flood Hazard Areas", and critical flood zones. Show existing and proposed CLOMR and LOMR information, and show status of submittal and review process.

6. Conclusions - Discuss impact of improvements:

a. Benefits.

b. Adverse affects with solutions for mitigation of impacts.

7. Appendices:

a. Hydrologic and hydraulic computations:

(1) List and explain basic assumptions and input factors used:

(a) Tabularized and/or discussed as necessary.

(b) Indicate any sensitivity analysis performed.

(c) Include source tables and references for parameters, such as soils groups, SCS curve numbers, C values, n values, etc.

(2) Historic runoff:

(a) Off-site.

(b) On-site.

(3) Developed runoff:

(a) Off-site.

(b) On-site.

(4) Detention for up to the 100-yr storm.

(5) Hydraulic computations:

(a) Hydraulic grade line (HGL) minor storm.

(b) Hydraulic grade line (HGL) major storm.

(c) Inlet/outlet calculations.

(6) Rip-rap sizing.

b. Drainage plan:

(1) Site drainage plan:

(a) Show the existing and proposed contours at least 100 feet beyond property line.

(b) The site drainage plan may be at the same scale as the grading plan but must meet legibility requirements for scanned documents. Show all sub-drainage areas per catch basin or channel and tabulate existing and proposed drainage showing length, assumed velocity and time of concentration on various runs of grass, gutters, etc., cumulative time of concentration, average rainfall intensity, area, runoff coefficient (weighted if necessary), and peak flows for 5- and 100-yr storms.

(c) All inlets and manholes shall be labeled to correspond to tabular numbering system used in drainage report. Pipe sizes, grades, velocities, peak flows and hydraulic grade lines shall be shown for all parts of the system in a tabular form on the plans.

(d) Both location plan (overall drainage) and subdrainage plan shall be signed and sealed by a Nevada Registered Civil Engineer and shall be included in the construction plans for the subdivision/development.

(e) On grading plans show peak flows for 5- and 100-yr storms at inlets and other sub-basin points of concentration, at discharge points and in channels. Show peak flows entering and leaving the site; trace path leaving site to nearest major drainage facility without adverse impact to downstream owners.

(f) On plan and profile sheets, show peak flows for 5- and 100-yr storms at all inlets and in pipes as per above, and in pipes show slope, velocity, and capacity, and hydraulic grade line if surcharged.

(3) Bench marks - To be shown on plans with description and elevation.

(4) Existing and proposed property lines.

(5) Existing and proposed drainage easements.

(6) Street names, grades, widths and rights-of-way or easements.

(7) Routing and accumulative flows at the upstream and downstream ends of the site and at various critical points on-site for both minor and major runoff. Inflow and outflow for both storms for all sub basins.

(8) Street cross sections showing 100-yr flood levels. Show 12' emergency vehicle clear lane.

(9) Existing and proposed major drainage facilities.

(10) Open channel flow in major channels shall be provided with the following information on plans:

(a) Channel and hydraulic grade line (HGL) profiles.

(b) Cross sections and required rights-of-way at 100 foot intervals.

(c) Location and size of all existing and proposed structures.

(d) Channel section and lining details.

(e) Freeboard for 100-yr flows.

(f) Channel capacity and storm flows, 5- and 100-yr flows and velocities.

(11) Storm sewers (show on plans):

(a) Hydraulic grade line (HGL) profiles.

(b) Location and size of all existing and proposed structures.

(c) Proposed materials.

(d) Pertinent elevations and slopes.

(e) Pipe capacity and 5- and 100-yr flows and velocities.