STATE OF TEXAS X

COUNTY OF BEXAR X **ORDINANCE # 612**

CITY OF CONVERSE X

AN ORDINANCE OF THE CITY OF CONVERSE ESTABLISHED FOR REGULATING PLATTING PROCEDURES FOR PROPERTY WITHIN THE CITY OF CONVERSE, PROVIDING GUIDELINES AND DEVELOPMENT MANAGEMENT FOR THE PURPOSE OF PROMOTING THE HEALTH, SAFETY, MORAL, AND GENERAL WELFARE OF THE COMMUNITY.

Subdivision IV – Storm Drainage **Definitions**

1. **100-Year Floodplain –** Area inundated by a one (1) percent chance flood in any given year as designated on Federal Emergency Management Agency Digital Flood Insurance Rate Maps. The 100-year floodplain is also known as the area of special flood hazard.

2. **Area of Shallow Flooding -** A designated AO, AH, or VO zone on a community's flood insurance rate map (FIRM) with a one (1) percent chance or greater annual chance of flooding to an average depth of one (1) to three (3) feet where a clearly defined channel does not exist, where the path of flooding is unpredictable and where velocity flow may be evident. Such flooding is characterized by ponding or sheet flow.

3. **Area of Special Flood Hazard** - The land in the floodplain within a community subject to a one (1) percent or greater chance of flooding in any given year. This area is also known as the 100-year floodplain. The area is designated as a Federal Emergency Management Agency Zone A, AE, AH, AO on the flood insurance rate maps.

4. **Digital Flood Insurance Rate Map (DFIRM)** - An official map of a community, on which the Federal Emergency Management Agency has delineated both the areas of special flood hazards and the risk premium zones applicable to the community.

5. **Drainage System -** All streets, gutters, inlets, swales, storm sewers, channels, streams, or other pathways, either naturally occurring or manmade, which carry and convey stormwater during rainfall events.

6. **Floodplain -** Any land area susceptible to being inundated by existing conditions water from any source as designated on the FEMA Digital Flood Insurance Rate Map.

7. **Freeboard -** A factor of safety usually expressed in feet above a flood level for purposes of stormwater management. "**Freeboard**" tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed.

8. **Impervious Cover -** Roads, parking areas, buildings, pools, patios, sheds, driveways, local sidewalks, and other impermeable construction covering the natural land surface; this shall include, but not [be] limited to, all streets and pavement within the subdivision. "Percent impervious cover" is calculated as the area of impervious cover within a lot, tract, or parcel or within the total site being developed, divided by the total area within

the perimeter of such lot, tract, parcel or development. Vegetated water quality basins, vegetated swales, other vegetated conveyances for overland drainage, and public sidewalks shall not be calculated as impervious cover.

9. **Multi-**Use Drainage Facility – Any drainage channel, drainage way, or detention facility used in combination with recreation facilities such as horse/bike/hiking trails, walking paths, sports fields, nature preserves, wildlife habitat areas.

10. **New Development** – any man-made improvement to existing natural undisturbed land or existing developed property that will increase the area of impervious surface.

11. **Overland Flow** - Stormwater runoff that is not confined by any natural or manmade channel such as a creek, drainage ditch, storm sewer, or the like. Also known as "sheet flow", this involves the movement of runoff in a thin layer (usually less than one (1) inch in depth) over a wide surface, which begins when water ponded on the surface of the land becomes deep enough to overcome surface retention forces.

12. **PMP** - Probable Maximum Precipitation

13. **Sodded/Sodding** – Hydro-mulch, grass blankets laid in place or planted approved vegetation.

14. **Structure** - A walled and roofed building, including a gas or liquid storage tank, which is principally above ground, as well as a manufactured home.

15. **Ultimate Development** – All land is developed to the maximum extent allowed for the land uses designated within a watershed.

16. **Watershed** - The area drained by a given stream, river, watercourse, or other body of water.

B. Applicability. The provisions of this section shall apply to any capital improvement project, application for subdivision plat, master development plan, or building permit approval except as otherwise provided by this chapter. A storm-water management plan shall be provided as set forth in **section (C)**.

C. Storm Water Management Program

1. System Criteria

   a. All dedicated public storm-water management facilities, or combination of facilities, shall be designed for ultimate development. Facilities shall be designed for a 100-year storm or a 25-year storm plus freeboard (based on Table 9) which ever elevation is higher. .

   b. Detention facilities and streets are exceptions to the frequency criteria cited above. Detention facility outflows will be designed for five (5) year, twenty-five (25) year and one hundred (100) year frequency storms. Refer to **Section H** for specific drainage design criteria for streets.

   c. Three (3) development conditions shall be analyzed for each development.

i. Existing Conditions. This refers to current development conditions in the watershed and on-site. Use as the baseline analysis for determining the impact of development.

ii. Proposed Conditions. This refers to existing conditions with the proposed development added. Use to evaluate the impact of the increased runoff on the downstream structures 2000-feet. Adverse impacts to existing structures shall not be allowed. The evaluation shall determine whether the increased runoff is contained within the downstream storm water facilities.

iii. Ultimate Conditions. This refers to ultimate development conditions within the watershed used to design the drainage facilities.

d. Responsibility to Accept Storm Water. The owner or developer of property to be developed shall be responsible for the conveyance of all storm-water flowing through the property. This responsibility includes the storm-water flowing onto the property by any other developed property as well as the drainage naturally flowing through the property by reason of topography. Future upstream development shall be accounted for by assuming ultimate development when sizing drainage systems as specified in this section.

e. Positive Overflow Pathways

Storm-water management facilities for local drainage systems will be designed to ensure that a positive overflow pathway is provided to the nearest one hundred (100) year conveyance facility. The overflow pathway must be delineated on a plan that shows all existing structures in the vicinity impacted by the overflow pathway.

f. Maintenance

i. Maintenance of dedicated public facilities will be the responsibility of the City. Maintenance of local facilities is the responsibility of the property owner or the community association and must be specified in the maintenance schedule submitted to the City. A maintenance schedule for both publicly owned and privately owned facilities must be approved by the City Manager or designee prior to the approval of construction drawings.

ii. Authorized personnel from the City shall conduct periodic inspections of these local facilities and structures. Any required repairs will be consistent with current construction standards. Maintenance issues identified by the City or State during inspections shall be the responsibility of the current owner. City shall retain the right to enter local detention basin easement to perform required maintenance of local facilities if not properly maintained and charge the property owner for reimbursement and/or place a lien on the property.

g. New Development

New development or redevelopment as allowed by the current zoning shall be required to provide detention of storm water or pay to the City fees established as fee-in-lieu of providing detention. When approved by the City Manager or designee, the fees must be paid before a subdivision plat is recorded or a building permit is released.

(A) Development Type	(B) Minimum Fees
Detached single-family and two-family duplex residential developments	$1,200.00 per participating acre or $750.00 per lot, whichever is less
Residential development other than single-family or two-family	$1,600.00 per participating acre
Nonresidential with less than sixty-five (65) percent impervious cover (e.g. schools, churches, parks)	$2,600.00 per participating acre
Nonresidential with impervious cover of sixty-five (65) percent or greater (e.g. commercial development)	$3,000.00 per participating acre
Building permits with additional impervious cover less than one-tenth of an acre (;lt;0.1 Ac.)	$300.00

Development type refers to the maximum possible development allowed by the current zoning.

Development types for public rights-of-way (with the exception of roadways on the major thoroughfare plan) shall be equivalent to the adjacent development type(s). Where development types are different from one side of the right-of-way to the other, each development type shall be assumed to extend to the centerline of the right-of-way. Roadways on the major thoroughfare plan shall be exempt from payment of Storm Water Management Program (SWMP) fees.

Acreage of participation shall be the entire area of the platted property less any areas specifically designated by restricting easement as being "pervious" and restricted from placement of impervious cover.

SWMP fees shall be paid at either the platting stage or at the building permit stage. Any SWMP fees not previously collected will be due prior to plat recordation or building permit release. Examples of SWMP fees to be paid may include the remaining fee balance when fees were previously paid based on less adverse development types or were paid based solely on impervious cover. The remaining fee balance for the available development area will not be required for building permits with additional impervious cover less than one-tenth of an acre (<0.1 Ac.), however the minimum fee will still be required.

D. Method of Computing Runoff and Conveyance

1. Calculation Methods

a. For drainage areas less than 640 acres, the basis for computing runoff shall be the rational formula or some other method provided it is acceptable to the City Manager or designee. Hydraulic calculations shall be performed by using the U.S. Army Corps of Engineers or HEC-RAS "River Analysis System" computer models. Normal depth channel calculations are permissible for constructed open channels with a uniform geometric cross section where (i) there is no potential for the water surface elevations to be controlled by backwater and (ii) the channel is not in a FEMA floodplain.

b. For drainage areas 640 acres or greater, the basis for computing runoff shall be a unit hydrograph method, preferably the Soil Conservation Service (SCS) Dimensionless Unit graph method as contained in the U.S. Army Corps of Engineers Hydrologic Engineering Center HEC-HMS "Flood Hydrograph Package", which document shall be maintained on file with the City Manager or designee and is hereby incorporated by this reference. For the SCS method, antecedent moisture condition II shall be used in the runoff model. Design rainfall values listed in **Table 21.13.2C** shall be used for hydrograph calculations.

c. Open channel hydraulic calculations shall be performed by using the U.S. Army Corps of engineers HEC-RAS "River Analysis System" computer models, which documents shall be maintained on file with the City Manager or designee and is hereby incorporated by this reference.

d. Certain watersheds have hydrologic and hydraulic models that are available through and maintained by the San Antonio River Authority (SARA). Developments proposed within the limits of these watersheds must have the models updated by the consultant to reflect changes in flow, channel configuration (including alterations to vegetation) and channel structures. The consultants shall use the same computer program or comparable program as approved by the City Manager or designee. The updated models shall be submitted to the City Manager or designee in electronic form on a CD. The updated models will be made available for use and distribution as the latest existing condition models for the watershed.

2. Time of Concentration

a. Overland (sheet) flow, shallow concentrated flow and channel flows are components that need to be considered in the calculation of time of concentration. The following methods are recommended for time of concentration calculation:

b. Overland flow - flow over plane surfaces: Maximum allowable time is twenty (20) minutes. Minimum is five (5) minutes. The overland flow time chart from "Design" **by Elwyn E. Seelye** may be used to calculate overland flow times. Note that the minimum time has been reduced to five (5) minutes.

c. Shallow concentrated flow - overland flow usually becomes shallow concentrated flow after a maximum of 300 feet: Use Manning's equation to

estimate travel time for defined swales, bar ditches and street sections, etc. Figure 3-1 from TR-55 "Urban Hydrology for Small Watersheds", SCS 1986, may be used where a geometric section has not been defined.

d. Channel flow: Use existing computer models where available or Manning's equation if data is not available. Non-floodplain channel velocities for ultimate watershed development should not be less than six (6) fps when estimating time of concentration.

3. Runoff Coefficients

Runoff coefficients (C value) for use in the rational formula shall not be less than the values shown in **TablesD.3A or D.3B**, as appropriate.

Table 1
Runoff Coefficients (C) – Percentage

Character of Area	Slope			
	Up to 1%	Over 1% up to 3%	Over 3% up to 5%	Flow over 5%
Business or commercial areas (90% or more impervious). Existing Pavement / Buildings	95	96	97	97
Densely developed areas (80% to 90%) impervious	85	88	91	95
Closely built residential areas and school sites	75	77	80	84
Undeveloped areas* - Present land is undeveloped and ultimate land use is unknown. C values for use in ultimate development calculations	68	70	72	75
Large lot residential area	55	57	62	64
Undeveloped areas * - Existing conditions See Table 2				
Average residential area	65	67	69	72

* Areas included within parks, green belts or regulatory floodplains shall be considered to remain undeveloped per Table 2.

Table 2
Runoff Coefficients (C) – Percentage

Character of Area	Slope			
	Up to 1%	Over 1% up to 3%	Over 3% up to 5%	Flow over 5%
Cultivated or Range (Grass Cover <50% of Area)	44	47	53	55
Range (Grass Cover 50 – 75% of Area)	37	41	49	53
Forest or Range (Grass Cover >75% of Area	35	39	47	52

4. Rainfall Intensity

Table 3
Rainfall Intensities (inches/hour)

Duration Minutes	Frequency						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
1	6.94	8.00	8.84	9.99	11.09	11.92	13.55

Table 3 Rainfall Intensities (inches/hour)							
Duration Minutes	Frequency						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
2	6.69	7.72	8.53	9.67	10.69	11.53	13.24
3	6.45	7.46	8.24	9.36	10.31	11.15	12.93
4	6.22	7.21	7.95	9.05	9.95	10.79	12.62
5	6.00	6.96	7.68	8.76	9.60	10.44	12.30
6	5.79	6.72	7.42	8.48	9.27	10.10	11.98
7	5.59	6.50	7.17	8.20	8.95	9.78	11.66
8	5.40	6.28	6.93	7.94	8.65	9.47	11.34
9	5.21	6.08	6.70	7.69	8.37	9.17	11.01
10	5.04	5.88	6.48	7.44	8.10	8.88	10.68
11	4.88	5.69	6.27	7.21	7.85	8.61	10.35
12	4.72	5.52	6.08	6.98	7.61	8.35	10.02
13	4.58	5.35	5.89	6.76	7.39	8.10	9.68
14	4.45	5.19	5.72	6.56	7.19	7.86	9.34
15	4.32	5.04	5.56	6.36	7.00	7.64	9.00
16	4.22	4.94	5.46	6.26	6.89	7.53	8.89
17	4.12	4.84	5.36	6.16	6.79	7.42	8.78
18	4.03	4.75	5.27	6.06	6.68	7.31	8.68
19	3.94	4.66	5.17	5.96	6.58	7.20	8.57
20	3.85	4.56	5.08	5.86	6.48	7.09	8.47
21	3.76	4.48	4.99	5.77	6.38	6.99	8.36
22	3.67	4.39	4.90	5.68	6.28	6.88	8.26
23	3.59	4.30	4.82	5.59	6.18	6.78	8.16
24	3.51	4.22	4.73	5.50	6.09	6.68	8.06
25	3.43	4.14	4.65	5.41	6.00	6.58	7.96
26	3.35	4.06	4.57	5.33	5.91	6.49	7.86
27	3.27	3.98	4.49	5.24	5.82	6.39	7.76
28	3.20	3.91	4.41	5.16	5.73	6.30	7.67
29	3.13	3.83	4.33	5.08	5.64	6.21	7.57
30	3.06	3.76	4.26	5.00	5.56	6.12	7.48
31	2.99	3.69	4.19	4.92	5.48	6.03	7.39
32	2.93	3.62	4.12	4.85	5.40	5.95	7.30
33	2.87	3.56	4.05	4.77	5.32	5.86	7.21
34	2.81	3.49	3.98	4.70	5.24	5.78	7.12
35	2.75	3.43	3.92	4.63	5.17	5.70	7.03
36	2.69	3.37	3.86	4.56	5.09	5.62	6.94
37	2.64	3.31	3.80	4.50	5.02	5.54	6.86
38	2.59	3.26	3.74	4.43	4.95	5.47	6.77
39	2.54	3.21	3.68	4.37	4.88	5.40	6.69
40	2.49	3.15	3.62	4.31	4.82	5.32	6.61
41	2.45	3.10	3.57	4.25	4.75	5.25	6.53
42	2.40	3.06	3.52	4.19	4.69	5.19	6.45
43	2.36	3.01	3.47	4.13	4.63	5.12	6.37
44	2.32	2.97	3.42	4.08	4.57	5.05	6.29
45	2.29	2.92	3.37	4.02	4.51	4.99	6.21
46	2.25	2.88	3.33	3.97	4.45	4.93	6.14
47	2.22	2.85	3.29	3.92	4.40	4.87	6.06

Table 3 Rainfall Intensities (inches/hour)							
Duration Minutes	Frequency						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
48	2.19	2.81	3.25	3.87	4.34	4.81	5.99
49	2.16	2.78	3.21	3.83	4.29	4.76	5.92
50	2.14	2.74	3.17	3.78	4.24	4.70	5.85
51	2.11	2.71	3.13	3.74	4.19	4.65	5.78
52	2.09	2.69	3.10	3.70	4.15	4.60	5.71
53	2.07	2.66	3.07	3.66	4.10	4.55	5.64
54	2.06	2.63	3.04	3.62	4.06	4.50	5.58
55	2.04	2.61	3.01	3.59	4.02	4.45	5.51
56	2.03	2.59	2.99	3.55	3.98	4.41	5.45
57	2.02	2.57	2.96	3.52	3.94	4.37	5.38
58	2.01	2.56	2.94	3.49	3.91	4.33	5.32
59	2.00	2.54	2.92	3.46	3.8	4.29	5.26
60	2.00	2.53	2.90	3.43	3.84	4.25	5.20
120	1.10	1.54	1.83	2.21	2.50	2.78	3.48
180	0.86	1.19	1.41	1.68	1.88	2.08	2.53
240	0.70	0.97	1.13	1.33	1.50	1.65	1.99
360	0.51	0.71	0.83	0.98	1.09	1.19	1.41
720	0.28	0.39	0.46	0.55	0.61	0.67	0.81
1440	0.165	0.227	0.273	0.324	0.366	0.413	0.513

5. SCS Curve Numbers

The SCS curve numbers adopted for use by the City are shown in **Table 4**. The hydrologic soil groups are listed in the latest version of the United States Natural Resources Conservation Service [formerly the Soil Conservation Service], "Urban Hydrology for Small Watersheds", Technical Release No. 55 (TR 55), which document is hereby incorporated by this reference. Soil types that relate to the hydrologic soil group may be found in the latest version of the United States Natural Resources Conservation Service Soil Surveys for Bexar, Guadalupe and Comal Counties, Texas which documents are hereby incorporated by reference. Soil types may also be based on a Geotechnical Engineering Report.

Table 4 SCS Curve Number by Soil Type		
Hydrologic Soil Group	Description	SCS Curve Number
A	Soils having a low runoff potential due to high infiltration rates. These soils consist primarily of deep, well drained sand and gravels.	25
B	Soils having a moderately low runoff potential due to moderate infiltration rates. These soils consist primarily of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures	55
C	Soils having moderately high runoff potential due to slow infiltration rates. These soils consist primarily of soils in which a layer exists near the surface that impedes the downward	70

	movement of water or soils with moderately fine to fine texture.	
D	Soils having a high runoff potential due to very slow infiltration rates. These soils consist primarily of clays with high swelling potential, soils with permanently high water tables, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious parent material.	77

6. Percent Impervious Cover

The percent impervious cover for typical land use types in the City are presented in **Table 5.**

Table 5
Percent Impervious Cover by Land Use

Land Use Category		Average Percent Impervious Cover
Residential	1/8 Acre Residential Lots, or Garden or Townhouse Apartments.	65 – 85%
	1/4 Acre Residential Lots	38%
	1/3 Acre Residential Lots	30%
	1/2 Acre Residential Lots	25%
	1 Acre Residential Lots or	20%
Industrial		85-95%
Business or Commercial		85 – 95%
Densely Developed (Apartments)		65 – 85%
Streets, Roads, and Parking Areas		98%

7. Design Rainfall

A twenty-four-hour (24 hr) rainfall distribution shall be applied for runoff calculations. Rainfall intensities as adopted for the City are given in **Table 3** and should be used for HEC-HMS input. The lag value for a subarea shall be calculated as 0.6 times the time of concentration.

8. Routing of Runoff

Routing of the runoff hydrograph through the channel from one subarea calculation point to the next in the HEC-HMS shall be computed using one of the following methods:

a. Overbank/channel storage not significant: Use normal depth channel routing.

b. Overbank/channel storage is significant: use the Muskingum method where a hydraulic model is not available. Use Modified Puls storage method where a hydraulic model is available to develop storage/out flow relationship.

c. Kinematic wave method for channel reaches where inflow from overbank runoff or multiple point sources (Example: storm sewer outfalls) is significant and where hydrograph attenuation is insignificant. Channel routing methodologies currently being applied in the existing HEC-HMS model of the watershed shall not be replaced with a different methodology without approval or direction from the City Manager or designee.

9. Manning's Roughness Coefficient Manning's roughness coefficients ("N" values) for use in routing methods or in hydraulic calculations shall be consistent with the values listed in **Table 6.**

Table 6 Manning's Roughness Coefficient	
Channel Description	Manning's "N" Value
Concrete Lined Channel	0.015
Grass Lined Channel With Regular Maintenance	0.035
Grass Lined Channel Without Recent Maintenance	0.050
Vegetated Channel with trees, little or no underbrush	0.055
Natural Channel With Trees, Moderate Underbrush	0.075
Natural Channel With Trees, Dense Underbrush	0.090
Natural Channel With Dense Trees and Dense Underbrush	0.100
Overbank Description	Manning's "N" Value
Pasture	0.035 – 0.055
Trees, Little or No Underbrush, Scattered Structures	0.060 – 0.075
Dense Vegetation, Multiple Fences and Structures	0.075 – 0.090

The "N" value to be used in Manning's Formula shall conform to the following for design purposes:

a. earth channels--0.035

b. concrete lined channels--0.015

c. reinforced concrete pipe--0.013

d. concrete box culverts--0.013

e. corrugated metal pipe:

   i. unpaved ½" corrugated--0.024

ii. unpaved one (1) inch corrugated--0.027

iii. any other "N" value shall be based on generally accepted engineering principles.

E. Drainage Easements/Rights-of-Way

1. Where a subdivision is traversed by a watercourse, drainage-way, natural channel or stream, there shall be provided an easement or right-of-way conforming substantially to the limit of such watercourse, plus additional width as outlined below.

2. Easement or right-of-way requirements are specified in the following subsections of this section for particular storm-water management facilities:

   a. subsection E.3 Natural Watercourses or Floodplains;

   b. subsection H.7.g Concrete Lined Channels;

   c. subsection H.8.c and H.8.d Vegetated Earth Channels;

   d. subsection J.3 Storm Sewers.

3. Easements for natural watercourses shall be the ultimate 100-hundred year floodplain or the twenty-five-year plus freeboard (see **Table 9** of this section) whichever is greater. In floodplain areas where ongoing maintenance is required or the floodplain will be reserved for use by the public, the drainage easements shall be maintained by a public entity and the property will be dedicated to the City as a multi-use drainage easement. A drivable access way shall be provided in floodplain easements for the length of the easement when regular maintenance of the floodplain is required. Diversion of storm water away from the natural watercourse will not be allowed except within the boundaries of the property controlled by the developer, provided that the diverted water is returned to the watercourse within which it would naturally have been flowing prior to leaving the developer's property. An analysis of the timing of the diverted hydrograph on watersheds greater than twenty (20) acres, as it reenters the receiving watercourse, must be performed to show that the peak flow rate in the receiving watercourse has not been increased as a result of the diversion.

4. An unobstructed access easement connecting the drainage easement with an alley or roadway parallel to or near the easement shall be provided at a minimum spacing of one (1) access right-of-way at approximately one thousand-foot intervals. The access right-of-way shall be a minimum of fifteen (15) feet in width and shall be maintained clear of obstructions that would limit maintenance vehicular access. If the flow line of the designed channel incorporates grade control structures or vehicular bridges that would prevent maintenance equipment from accessing that portion of the channel, additional access points may be required. Channel design, earthen or concrete, shall have ramps in the side slopes near the access points that would allow maintenance equipment to descend to the floor level of the channel. The maximum allowable ramp slope for vehicular access is seven to one (7:1). Access points adjacent to roadways or alleys shall be provided with a post and cable feature with padlock to prevent unauthorized use.

5. Drainage easements crossing lots and property lines are highly discouraged. Where it is determined that this is appropriate, the drainage conveyance structure shall be constructed of concrete, and a statement shall be added to the plat that no fencing or structures that will interfere with adequate drainage flow will be allowed on or across such lines. Fencing may be allowed across drainage easements only in accordance with the following restrictions:

   a. Bottom of fence shall be a minimum of the flow depth, plus freeboard (see **Table 9** of this section) above design flow line of channel or drain.

   b. A hinged gate or fence will not be allowed across public drainage easements.

   c. Fence posts located within the easement must be structurally designed to resist damage from the storm-water flows and impact from debris.

   d. A floodplain development permit will be required to be obtained by the property owner to construct a fence within an easement within the 100-year floodplain.

6. Interceptor drainage easements and channels shall be provided where the drainage area to the back of platted lots exceeds the depth of two (2) average residential lots. Interceptor drains shall be constructed and accepted prior to the issuing of building permits on any lot that would be affected by natural drainage being intercepted.

7. All developments shall provide for adequate drainage outfall at the lower end of the site into an existing street, alley, drainage easements, or right-of-way, or to the centerline of an existing natural drain. Where proposed street, storm sewer, or open channel does not discharge into a natural low or into an existing adequate drainage easement then facilities and drainage easements of adequate width to contain the design discharge shall be constructed and dedicated to the centerline of an existing natural low within the same watershed. However, where the natural low lies within the developer's property, the developer will be required only to plat an easement to the centerline of the natural low, provided that the easement is adequate to accommodate the facilities that will be built in conjunction with the future development of that property. Note- Should allow grade to drain at end of streets for future units where the future streets are of the same ownership.

F. Site Design and Grading

1. All land disturbing or land filling activities or soil storage shall be undertaken in a manner designed to minimize surface runoff, erosion and sedimentation, and to safeguard life, limb, property and the public welfare in accordance with the Texas Pollution Discharge Elimination System (TPDES) General Permit TXR150000, as amended, and the document entitled "Complying with the Edwards Aquifer Rules Technical Guidance on Best Management Practices," by Michael E. Barrett, Ph.D., P.E. Center for Research in Water Resources, Bureau of Engineering Research, University of Texas at Austin, (RG-348, June 1999), which documents are hereby incorporated by this reference.

2. Storm water management shall comply with City Chapter 46 Utilities, Article II Storm Water Management, Section 46-48 and City Ordinance 321. ~~Not needed – Converse does not have Specifications established by the Director of Public Works.~~

3. Projects shall not be considered complete until restoration has been made in accordance with (TPDES) requirements.

4. Where possible, multiple uses of drainage facilities and open space shall be incorporated by the owner or developer of a new subdivision. Alternative uses such as public recreation, horse/bike/hiking trails, walking paths, nature preserves, wildlife habitat areas, etc. are encouraged subject to the approval of the City Manager or designee.

5. A note must be placed on the plat for residential lots, which states that finished floor elevations must be a minimum of eight (8) inches above final adjacent grade. A grading plan shall be prepared and submitted to the City, which indicates typical lot grading for all lots in the subdivision using typical FHA lot grading types (A, B and C). A more detailed grading plan is also acceptable.

G. For projects with an increased impervious area of greater than 0.1 acres, storm-water detention, or SWMP in lieu of detention shall be required for all new developments or redevelopment of individual parcels of property as stated in C.1.g

1. The maximum allowable outflow rate from the detention facility must be restricted to the flow rate from the undeveloped or existing development tract for the five-year, twenty-five-year and one-hundred-year frequency.

   Best management practices shall be used in the design of detention facilities in accordance with this section. The timing of the hydrograph released from the detention facility must be checked against the timing of the flow rate in the first open watercourse to prevent any increase in the peak flow rate in the receiving watercourse. For detention basins constructed in-line on an existing watercourse, the creation of the basin shall not increase flood elevations in the channel upstream of the new development boundaries.

2. On-site detention facilities must be privately owned and shall be maintained by the community association or property owner. A maintenance schedule shall be submitted to the public works department and approved by the City Manager or designee prior to approval of construction plans. The City will have the right to do periodic inspections of privately owned and maintained detention facilities to ensure that the maintenance schedule is being implemented. Detention facilities shall not be allowed to accept flows from public facilities such as City rights-of-way.

3. Multi-use detention facilities are encouraged, but not required (multi-use facilities allows for water quality, satisfy NPDES requirements, enhance around water recharge, provide open space, provide recreation or other amenities, and/or provide habitat) and may be utilized so long as the facility meets the standards set forth in subsection (C.1.a) of this section and does not increase the rate or volume of erosion above that which would result from the use of a facility without multiple uses. The use of multi-use detention facilities to alleviate existing flooding problems, enhance and provide

amenities for older neighborhoods, and support the revitalization of economically depressed areas is encouraged in public and private redevelopment initiatives.

4. Storm-water detention with permanent wet pool or pumped detention systems will not be acceptable methods of storm-water mitigation unless the facility will remain privately owned, operated, and maintained. The City will approve the use of a pumped facility for private use under the following conditions:

   a. A gravity system is not feasible from an engineering and economic standpoint.

   b. At least two (2) pumps are provided each of which is sized to pump the design flow rate.

   c. The selected design outflow rate must not aggravate downstream flooding.

   d. Controls and pumps shall be designed to prevent unauthorized operation and vandalism.

   e. Adequate assurance is provided that the system will be operated and maintained on a continuous basis.

   f. Aeration of permanent wet pool or recirculation for water quality.

5. Storm-water detention facilities shall be located in topographically depressed areas where possible. When necessary, dams may be constructed to detain flows. All proposed dams shall conform to the following items:

   a. All dams over six (6) feet above existing natural ground shall be approved by the Dam Safety Team of the Texas Commission on Environmental Quality (TCEQ) for safety. All other new dams shall be designed in accordance with acceptable design criteria as approved by the City Manager or designee, or his authorized representative.

   b. All hydrology and hydraulic properties of a dam will be reviewed by the Department of Public Works with regard to spillway design, freeboard hydraulics, backwater curves and downstream effects due to the dam site.

   c. The spillway section of any earthen dam with a height greater than six (6) feet shall be large enough to pass a PMP (probable maximum precipitation) flood, as defined by the NRCS, without overtopping the crest of the dam in accordance with TCEQ regulations.

   d. A 100-year frequency flood shall be routed through the proposed dam and all land subject to flooding shall be dedicated as drainage easement or right-of-way. An unobstructed fifteen-foot access easement around the periphery of the flooded area shall be dedicated as drainage easement for facilities that require regular mowing or other ongoing maintenance, at the discretion of the City Manager or designee. An unobstructed fifteen-foot access right-of-way shall be established which connects the drainage easement adjacent to the dam structure to a road or alley.

e. Development below existing dams will take into account the original design conditions of the existing dam. Dam breach analysis checks will be required, dependent upon location of development with respect to dam site.

f. All spillway discharges shall be adequately routed to the centerline of the natural low below the dam site. The adequate routing of spillway discharges pertains to the hydraulic routing of the one hundred (100) year ultimate frequency flood for dedication of drainage easement limits. Probable maximum precipitation (PMP) defined PMP on definition section flood routing or breaches will only be considered for safety considerations (that is, the placement of building and the setting of minimum floor slab elevations below the dams). Any proposed concrete dam structure need not have spillway capable of routing a PMP flood, however, it shall be shown to be structurally capable of withstanding any range of flood conditions with regard to possible failure due to sliding, overturning, and structural integrity, up to and including the PMP flood.

H. Streets

1. Generally

a. Design of streets shall consider public safety and limit potential conflicts between storm-water conveyance, traffic, parking, pedestrian access, ADA requirements, and bicycle traffic.

b. Developments that drain a watershed greater than one hundred (100) acres shall have streets designed to convey within the right-of-way the 25 year storm for ultimate development with a drainage system designed to convey the 100 year storm for ultimate development.

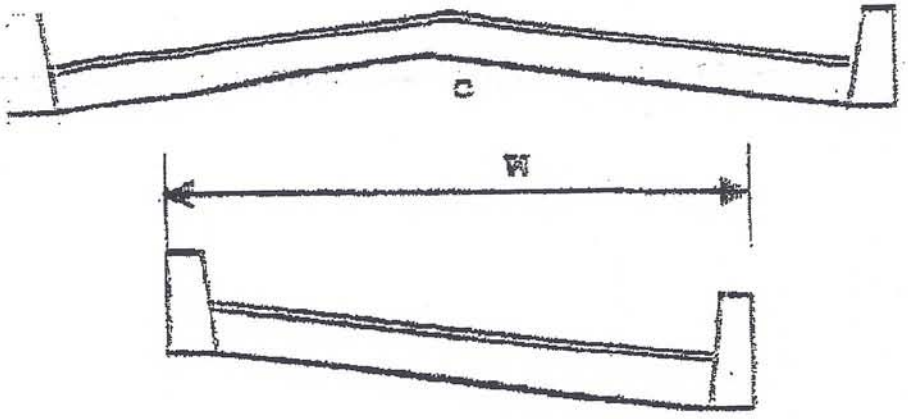

Table 7
Street Velocities and Capacities
Manning's n=0.018

	Minor Street	Collector street	Marginal Residential Access Street	Secondary Street-1 side	Primary Street-1 side
	W-30'	W=42'	W=/26'	W-24'	W-36'

Slope percent	C=4" wp-31.16 a=12.45 r=.40		C=5" wp=43.16 a=15.54 r=.36		C=3" wp-27.16 a=11.83 r=.44		C=6' wp-24.66 a=7.92 r=.32		C=9" wp=28.52 a=8.12 r=.28	
	V f/s	Q cfs	V f/s	Q cfs	V f/s	Q cfs	V f/s	Q cfs	V f/s	Q cfs
0.10	1.42	17.68	1.32	20.51	1.51	17.86	1.22	9.66	1.12	9.09
0.15	1.74	21.66	1.62	25.17	1.85	21.89	150	11.88	1.37	11.12
0.20	2.00	24.90	1.87	29.06	2.13	25.20	1.73	13.70	1.58	12.83
0.25	2.24	27.89	2.09	32.48	2.39	28.27	1.93	15.29	1.77	14.37
0.30	2.46	30.63	2.29	35.59	2.61	30.88	2.12	16.79	1.94	15.75
0.35	2.65	32.99	2.47	38.38	2.82	33.36	2.29	18.14	2.09	16.97
0.40	2.84	35.36	2.64	41.03	3.02	35.73	2.44	19.32	2.24	18.19
0.45	101	37.47	2.80	43.51	3.20	37.86	2.59	20.51	2.37	19.14
0.50	3.17	39.47	2.95	45.84	3.37	39.87	2.73	21.62	2.50	20.30
0.55	3.32	41.33	3.10	48.17	3.54	41.88	2.87	22.73	2.62	2127
0.60	3.47	4120	3/4	50.35	3.70	43.77	2.99	23.68	2.74	22.25
0.65	3.61	44.94	3.37	52.37	3.85	45.55	3.12	24.71	2.86	23.14
0.70	3.75	44.69	3.50	54.39	3.99	47.20	3.23	25.58	2.96	24.04
0.75	3.88	48.31	3.62	56.25	4.13	48.86	135	26.53	3.06	24.85
0.80	4.01	49.92	3.74	58.12	4.27	50.51	3.46	27.40	3.16	25.66
0.85	4.13	51.52	3.85	59.83	4.40	52.05	3.56	28.20	3.26	26.47
0.90	4.25	5191	3.96	61.54	4.53	53.59	3.67	29.07	3.35	27.20
0.95	4.37	54.41	4.07	63.25	4.65	55.01	3.77	29.86	3.44	27.93
1.00	4.48	55.78	4.18	64.96	4.77	56.43	3.86	30.57	3.53	28.66
150	5.49	68.35	5.12	79.56	5.85	69.21	4.73	37.46	4.33	35.16
2.00	6.34	78.93	5.91	9184	6.75	79.85	5.46	43/4	5.00	40.60
150	7.09	88.27	6.61	102.72	7.54	89.20	6.11	48.39	5.59	45.39
3.00	7.76	96.61	7.24	112.51	8/7	97.83	6.69	52.98	6.12	49.69
3.50	8.39	104.46	7.82	121.52	8.93	105.64	7.23	57.26	6.61	53.67
4.00	8.97	111.68	8.36	129.91	9.54	112.86	7.73	61.22	7.07	57.41
4.50	9.51	118.40	8.86	137.68			8.20	64.94	7.50	60.90
5.00	10.0o	124.75	9.34	145.14			8.64	68.43	7.90	64.15
5.50			9.80	152.29			9.06	71.76	8.29	67.31
6.00							9.46	74.92	8.65	70.24
6.50							9.85	78.01	9.01	73.16
7.00									9.35	75.92
7.50									9.68	78.60
8.00									9.99	81.12

c. Streets may be used for storm-water drainage only if the calculated storm-water flow does not exceed the flows outlined in Table 7 or the velocity does not exceed ten feet (10') per second.

d. Where streets are not capable of carrying storm-water, as outlined above, inlets or curb openings discharging to drainage channels or storm sewers shall be provided. Partial flow past the inlet will be allowed when the capacity of all downstream street systems can accommodate the flow.

e. Street width shall not be widened beyond the width as determined by the street classification for drainage purposes.

f. Storm-water conveyance on streets shall be designed to account for the cumulative impact of peak flows and runoff volumes on the system as the storm-water progresses downgrade.

g. Curb cuts for driveways on all streets shall be designed for compatibility with the storm-water conveyance function of streets.

h. Potential flooding problems or conflicts at the connection points where new or modified drainage systems (including streets, storm sewers, etc.) and the existing portions of the downstream street system and storm-water conveyance system shall be identified and resolved either in the design of the new or modified drainage system or in modifications to the existing system.

i. Dwelling units located on the downhill side of a T-intersection with a street or drainage channel discharging onto the intersection shall be sited so as to avoid obstruction of the drainage patterns.

2. An arterial street is a street so designated on the current **Master Thoroughfare Plan**. One (1) lane in each direction on arterial streets shall remain passable with a flow depth not to exceed 0.30-foot during a twenty five-year storm event. The maximum depth of water in the street section must not exceed seven (7) inches (the height of a standard City curb).

3. A maximum flow depth to the top of curb on a collector street section will be allowed during a twenty-five-year storm event. A collector street is a street with a width of forty-two (42) feet or more and not shown as an arterial street on the current **Master Thoroughfare Plan.**

4. Local Streets. Local streets shall be designed on a basis of a five-year frequency. A twenty-five-year frequency storm must be contained within the street right-of-way.

5. Alleys shall be designed for five-year frequency within the limits of the alley pavement/curbs and twenty-five-year frequency within the right-of way/easement to carry storm-water.

6. All-Weather Crossings

   a. Where streets cross existing or proposed watercourses, all weather crossings shall be required. Culverts or bridges shall be adequate to allow passage of the design storm identified in section C.1.a.

   b. All crossings, culverts and bridges shall be designed for an H-20-44 or HS-20 loading.

   c. Dangerous conditions for existing crossings are defined by the Public Works Department Specifications Manual (**Dangerous Conditions on Crossing during Floods**).

   d. All curb openings shall be required to provide all weather crossing for pedestrians.

l. This section addresses proposed improvements or modifications to drainage channels and watercourses required to convey storm-water runoff from or through the proposed development. Refer to Section C.1.a. for storm frequency design criteria.

1. Except as authorized by City Manager or designee a development plan approved by the Director of Public Works or his/her designee, no person shall place or cause to be placed any obstruction of any kind in any watercourse within the City and its ETJ. The owner of any property within the City, through which any watercourse may pass, shall keep the watercourse free from any obstruction not authorized by a development plan.

2. Channel Modifications

   a. Modifications to existing watercourses or newly created open channels may be designed as earth channels, sod channels or as concrete lined channels. Liners other than sod or concrete which enhance the aesthetics or habitat value of the watercourse and which reduce future maintenance requirements are encouraged. Preliminary planning for the applicability of other channel liners shall be reviewed with the City Manager or his/her representative prior to the submittal of construction plans for approval.

   b. Runoff that results from upstream development and is discharged to an unimproved waterway can cause flood damage to structures adjacent to the waterway. Natural undeveloped waterways do not receive regular maintenance. The downstream unimproved waterway shall be evaluated to verify that all structures adjacent to the waterway are not being impacted. If it is determined that structures are impacted, then the upstream development will be required to reduce the discharge to predevelopment flows. Design of natural waterways shall take into consideration fluvial geomorphologic principals and practices.

3. Design of new channels or alterations to existing channels shall consider future maintenance requirements. A maintenance schedule for any local channel shall be submitted to and approved by the City Manager or designee prior to approval of construction plans. Maintenance requirements of concrete channels consist of de-silting activities, prevention of vegetation establishment in construction joints, and repair of concrete as necessary. Maintenance of earthen channels includes regular observation and repair, as necessary, of erosion, scouring, and removal of silt deposits, as necessary to maintain design parameters. Developers shall be responsible for maintaining newly planted channels until 70% vegetated coverage is achieved for all disturbed areas. This area shall include slopes, floor, and any attendant maintenance easement. New earthen channels shall be planted with drought resistant, low growth, native species grasses, which will allow unobstructed passage of floodwaters. Johnson grass, Giant Tagweed and other invasive species shall not be allowed to promulgate in channels. Suggested species shall include, but not be limited to, common Bermuda, coastal Bermuda, Buffalo grass, Sideoats Grama, Seep Muhly, Little Bluestem, and Indian grass. Mowing frequencies vary with the vegetation growth rates, but is required when the grass exceeds the design roughness coefficient of the channel.

4. Planned multiple-use of a watercourse is allowed (e.g. bike paths or greenbelt). If multiple use of the watercourse is to be incorporated, the applicant shall form a property owners' association that shall assume maintenance responsibility for private amenities. The appropriate government agency will be responsible for maintenance of public amenities. The applicant shall provide overlay easements for public or private use.

5. **Table 8** shall be used to determine maximum permissible channel velocity.

Table 8 Runoff Coefficients (C) – Percentage				
Velocity (fps)	Type of Facility Required	Hydraulic Radius (ft.)	Correction Factor	Maximum Permissible Velocity (fps)
1 to 6 (Maximum Average Velocity = 6 fps)	Vegetated Earthen Channel	0 – 1 1 – 3 3 – 5 5 – 8 8 – 10 Over 10	0.8 0.9 1.05 1.15 1.225 1.25	5 5.5 6.3 6.9 7.35 7.5
6 to 8	Concrete Retards	N/A	N/A	N/A
>8	Concrete Lining or Drop Structures	N/A	N/A	N/A

a. *Channel design shall incorporate the appropriate hydraulic jump to address velocities in the super critical range.*

b. Ensure that the channel will contain the hydraulic jump (sequent depth) throughout the extent of the supercritical profile. An exception to this criterion is where concrete lined lateral channels discharge down the side slopes of channels. These channels may be designed for normal depth plus freeboard provided velocity controls are established at the main channel flow line.

c. Ensure that the energy grade of the channel will not result in upstream flooding at existing or proposed lateral facility connections.

6. Retard spacing shall be computed as follows when using the City standard retard section Table in the Public Works Department Specifications Manual and the following equations: $L = 1.0' \div (S1 - S2)$

Where: L = Distance required between retards in feet.

S1 = Actual slope of channel in ft./ft.

S2 = Slope of proposed channel for maximum permissible velocity established from Table 4, i.e.:

and $S2 = [(NV) \div (1.486R\ 2/3\ )]\ 2$

Where: V = maximum permissible velocity established from Table 8

N = .035R = area/wetted perimeter

7. Concrete Lined Channels

The design of concrete lined channels shall comply with the following general requirements:

a. Freeboard consistent with **Table 9** will be applied to the twenty-five-year design storm for ultimate development

b. From the top of the concrete lining to the top of the channel, a side slope not steeper than three (3) horizontal to one (1) vertical shall be required; nor shall the slope be less than twelve to one (12:1).

c. For normal conditions, the concrete lining shall be a minimum of five inches (5") thick and reinforced with No. 3 round bars at twelve inches (12") on center each way. Where surcharge, nature of ground, height and steepness of slope, etc., becomes critical, design shall be in accordance with latest structural standards. All concrete lining shall develop a minimum compressive strength of not less than three thousand (3,000) pounds per square inch in twenty-eight (28) days. The depth of all toe downs shall be thirty six inches (36") upstream, twenty-four inches (24") downstream, and eighteen inches (18") for side slopes. The City's construction inspector may permit an eighteen inch (18") toe down in rock sub-grade in-lieu of the above toe down requirements. The horizontal dimensions of toe downs shall not be less than six inches (6").

d. Maximum concrete riprap side slopes shall be one and one-half (1 1/2) horizontal to one (1) vertical, unless soil tests made by a geotechnical engineer show that a greater slope, or a special design, will be stable. Where vehicular traffic may travel within a horizontal distance equal to one-half (1/2) the vertical rise of the slope, a two foot (2') surcharge load shall be included in the design.

e. Fencing will be required adjacent to the channel where channel vertical wall heights exceed two feet (2'). Fencing will also be required adjacent to the channel where channel side slopes exceed two to one (2:1) and the channel depth is greater than two feet (2'). The fencing must not cause sight distance obstructions for motorists.

f. Vertical walls will not be permissible for depths greater than two feet (2') unless properly fenced or enclosed. Walls will have a minimum thickness of six inches (6").

g. Easements or rights-of-way for concrete lined channels shall extend a minimum of two feet (2') on both sides of the extreme limits of the channel, and concrete shall be extended the width of the easement. "Extreme limits" of the channel shall mean the side slope intercept with the natural ground or proposed finished ground elevation.

h. A minimum "n" value of roughness coefficient of 0.015 shall be used for concrete surfaces. This "n" value is as used in Manning's formula.

Table 9 Drainage Freeboard for Concrete Lined and Earth Channels for Twenty-Five Year Storm	
Design Depth of Flow	Required Freeboard
0 to 5 feet	0.5 foot
5 to 10 feet	10% of design depth
10 feet and over	1.0 foot

8. Vegetated Earth Channels

a. Freeboard consistent with Table 9 will be applied to the twenty five (25) year design for ultimate development.

b. The side slope shall not be steeper than three (3) horizontal to one (1) vertical.

c. Easements or rights-of-way for improved earth channels shall conform to the requirements stated in subsection (d) of this section and shall extend a minimum of two feet (2') on one (1) side and fifteen feet (15') for an access road on the opposite side of the extreme limits of the channels when such channels do not parallel and adjoin an alley or roadway. When such channels do parallel and adjoin an alley or roadway, the easement or right-of-way shall extend a minimum of two feet (2') on both sides of the extreme limits of the channel. Where utilities are installed in the access road of the drainage right-of-way, the right-of-way shall extend two feet (2') on one (1) side and seventeen feet (17') on the opposite side of the design limits of the channel. These seventeen feet (17') are to provide an access way along the channel with a maximum cross slope of one inch (1") per foot toward the channel. Where designed channel bottoms exceed one hundred feet (100') in width, the fifteen foot (15') extra width shall be provided on both sides of the channel.

d. Interceptor drainage easements shall extend a minimum of two (2) feet on both sides of the extreme limits of the channel. Refer to **Table 5**. Improved earthen channels will be vegetated by seeding or sodding. Seventy percent (70%) of the channel surface area must have established vegetation before the City will accept the channel for maintenance.

9. Freeboard

Allowance for extra freeboard shall be made when the centerline radius of the channel is less than three (3) times the bottom width. Where sharp bends or high velocities are involved, the applicant shall use the following formula for computing the extra freeboard:

$d2 - d1 = V\,2\,(T + B) \div 2gR$

Where: d1 = depth of flow at the inside of the bend in feet.

d2 = depth of flow at the outside of the bend in feet.

B = bottom width of the channel in feet.

V = the average approach velocity in the channel in feet per second.

T = width of flow at the water surface in feet.

g = 32.2 feet/second squared.

R = the center line radius of the turn or bend in feet.

a. The quantity d2 – d1 divided by two (2) shall be added to the normal depth of flow before adding the required freeboard in calculating required right-of-way widths.

b. Where sharp turns are used without curved sections, the depth required shall be large enough to provide for all head losses. Allowance shall be made for any backwater head that may result.

c. For normal design conditions no extra freeboard is required. An accepted rule of thumb to follow is this: Centerline radius of channel should be at least three (3) times the bottom width.

J. Storm Sewers

1. For all ordinary conditions, storm sewers shall be designed on the assumption that they will flow full under the design discharge; however, whenever the system is placed under a pressure head, or there are constrictions, turns, submerged or inadequate outfall, etc., the hydraulic and energy grade lines shall be computed and plotted in profile all the construction plans. In all cases adequate outfalls shall be provided and the system adequately designed.

2. No storm sewers shall be less than twenty-four inches (24") in diameter.

3. Minimum easement widths for storm sewers will be the greater of fifteen feet (15') or six feet (6') on both sides of the extreme limits of the storm sewer width (e.g. the easement width for a three (3) barrel ten-foot wide box culvert with six inch (6") walls would be (3 x 10')+(4 x 0.5')+(2 x 6') = 44').

All storm sewer pipes shall be reinforced concrete pipe (RCP). Alternative pipe material may be approved by City Manager or designee.

K. Inlets and Openings

1. Drop Curb Openings - Sidewalk Does Not Abut Opening

Where drop curb openings are used to take storm-water off the streets and into drains, the length of the curb opening can be calculated from the weir formula using the coefficient of 3.087 in the following formula:

$L = Q \div Ch\ 3/2$

Where: L = the length of drop curb opening required in feet.

Q = amount of flow in CFS based on twenty-five-year design frequency.

C = 3.087. h = head of weir in feet.

Gutter line depressions will be permitted where such depressions will not hamper the flow of traffic. For amount of curb exposure, conform to City inlet standards.

2. Curb or Drop Inlets

Where drop inlets are used, the City standard inlets with adequate reinforcing steel may be used. All other types or designs shall be subject to the approval of the City Manager or designee. The following formulas for inlet capacity are based on drop inlets in sag points. Inlet capacities on grades will be considered less, the amount of which depends on street grades, deflections, cross slopes, depressions, etc.

3. Grate Inlets

The flow of water through grate openings may be treated as the flow of water through a rectangular orifice. The following formula may be used for determining grate capacity:

$Q = CA (2gh) 1/2$

Where: Q = discharge in cubic feet per second.

C = orifice coefficient of discharge (taken as 0.70).

g = acceleration due to gravity (32.2 ft./sec.2).

h = head on the grate in feet.

A = net area of the openings in the grate in square feet.

This formula gives the theoretical capacity of the grate inlet. Since grate inlets are subject to considerable clogging, capacity of the grate inlet will be taken as one-half (1/2) on the value given by this formula.

4. Curb Opening Inlets

The capacity of curb opening inlets will depend on whether or not the opening is running partially full or submerged. If the depth of flow at the curb opening inlet is such as to cause a partially full opening, a weir effect will develop and the following formula will apply:

$Q = CwL(h) 3/2$

Where: Q = the discharge of capacity in cubic feet per second.

Cw = the weir coefficient of discharge (3.087).

L = the length of curb opening in feet.

h = the head or depth of water at the opening in feet.

If the depth of flow at the curb opening is such as to fully submerge the opening, the orifice effect will develop and the formula used shall be identical to that given under

grate inlets with the exception that the head (h) on the curb opening orifice shall be taken as the depth from the top of the water surface to the center of orifice or opening; one hundred percent (100%) efficiency will be allowed for curb opening inlets.

L. Storm Water Management Plan

1. Procedure

a. Number of Copies

The applicant shall provide two (2) blue-line or black-line copies of the plat together with six (6) copies of full size construction drawings and one (1) copy of eleven by seventeen (11"x17") construction drawings.

b. Format

Construction plans shall be submitted on sheets of a size not to exceed twenty-four by thirty-six (24"x36"). A plan which cannot be drawn in its entirety on a single sheet shall be drawn with appropriate match lines on two (2) or more sheets.

c. Contents

To standardize the review process and minimize the time for approval by the City during review of the plat and construction drawings for a subdivision, a complete submittal regarding the analysis of existing drainage conditions and the design of modifications or new drainage facilities is necessary. The owner of the property to be developed is required by the City Manager or designee to provide, at the owner's expense and as a condition of construction plan approval, a storm-water management report for the total development area to be ultimately constructed. The storm-water management report shall contain all of the necessary support data, methodologies used in calculations, and conclusions. A checklist is below that will be used by the City reviewer as a guide during the evaluation of all storm-water management reports submitted to the City. The purpose of the checklist is to expedite the review process for both the engineer and the City, and to aid the engineer in the preparation of reports for the City's review. The storm-water management report shall be submitted to the City Manager or his/her designee prior to approval of any construction plans.

d. Report

The storm-water management plan shall include two (2) copies of a written report that includes the following information, as applicable:

i. a vicinity map of the site and affected reach of the outfall channel;

ii. a detailed map of the area and the outfall channel with all pertinent physiographic information;

iii. a watershed map showing the existing and proposed drainage area boundary along with all sub area delineations and all areas of existing and proposed development;

iv. discharge calculations specifying methodology and key assumptions used including a table of discharges at key locations;

v. hydraulic calculations specifying methodology used, assumptions and values of the design parameters;

vi. profiles of the affected channels, including water surface elevations for the specified design frequencies, all existing and proposed bridge, culvert and pipeline crossings, the location of all tributary and drainage confluences, and the location of all hydraulic structures;

vii. detention basin design calculations, including those used for design of the control structure;

viii. right-of-way and easement requirements, and a subdivision plat showing locations of all rights-of-way and easements;

ix. a soils report which addresses erosion and slope stability of new or altered channels and detention facilities;

x. a computer diskette of all existing and proposed condition HEC-HMS and HEC-RAS models used in analysis; and;

xi. a checklist for the submittal package is included as section 2 below. A checklist for the preparation of a HEC-RAS model is included as section L.2.C below.

2. Subdivision Drainage Checklist

a. _____U.S.G.S. Quadrangle map showing overall drainage areas, runoff coefficients, time of concentration, intensity and Qs.

b. _____Subdivision Master Drainage Plan with overall interior drainage area of subdivision showing drainage area, time of concentration runoff coefficients, intensities, and Qs for the street and alley flows and also channel and underground system design.

c. _____Subdivision plat showing interior drainage areas, time of concentration, runoff coefficients, and intensities, Qs for street and alley flows and also channel and underground system design.

d. Drainage Calculations Required For:

i. _____Open channel design

ii. _____Underground systems

iii. _____Box culverts

iv. _____Pipe culverts

v. _____Hydraulic jump

vi. _____Hydraulic grade lines of pipes

vii. _____Energy Grade Lines of Pipes

viii. _____Super elevation in channel bends

ix.

x. _____Backwater curves with cross sections

xi. _____Draw down curves with cross sections

xii. _____Energy dissipaters

xiii. _____Retard spacing

xiv.

xv.

xvi. _____1) Inlets on grades _____(2) Inlets in sump

xvii. _____Drop curb openings

xviii. _____Sidewalk culverts

xix. _____AR2/3 calculations with cross sections

xx. _____Weir formulas structures

xxi. _____Orifice formulas

xxii. _____Grade to drain channels

xxiii. _____Upstream pickup and flared section

xxiv. _____Downstream backwater control and flare to match downstream condition

xxv. _____Show required free board

xxvi. _____Mannings "N" values

xxvii. _____Velocities

xxviii. _____Easement width

xxix. _____Show access road on each earthen channel

xxx. _____Runoff coefficient

xxxi. _____Time of concentration

xxxii. _____ Qs

xxxiii. _____Street Qs for 5 yr.(30' street) and 25 yr. (greater than 44' street) frequency showing street capacities are correct based on Table 8-

e. _____Subdivision Plat showing all interior drainage easements, outfall drainage easements, U.S.G.S. contour map and all other necessary drainage information

i. Show outfall drainage easements to the centerline of existing natural low

ii. Show finished fill contours

iii. Show interceptor drainage easements

f. _____Typical Details Required on Plans for:

i. _____Box culvert with headwalls or wing walls

ii. _____Pipe culverts with headwalls or wing walls

iii. _____Culvert headwalls shown with proper safety measures

iv. _____Drop curb openings

v. _____1) Inlets on grade _____(2) Inlets on sump

vi. _____Drop structures

vii. _____Retards

viii. _____Sidewalks over drains

ix. _____Guard post installations

x. _____Guard rail on structures

xi. _____Header curb

xii. _____Energy dissipaters

xiii. _____Junction boxes

xiv. _____Concrete lined channels with free board

xv. _____Earth sodded channels with free board

xvi. _____Other concrete structures:

xvii. _____Grade to drain sections

xviii. _____Transition sections

xix. _____Fencing for vertical wall channels greater than 2' deep

xx. _____Other: _____

xxi. _____Side slope

xxii. _____Note: Adjacent lots shall be graded to provide access and drainage to adjacent street and drainage systems.

g. _____Complete Street Plans and Profiles

h. _____Complete Drainage Plan and Profile Including the Following Requirements:

i. _____Proposed flow-line slopes with grades and elevations shown every 50' in profile

ii. _____Proposed top of channel profile

iii. _____Existing ground right and left profile at property line

iv. _____Finished fill profiles

v. _____Locations and size of culverts

vi. _____Drop structures

vii. _____Retards

viii. _____Grade to drain profiles

ix. _____Flow-line elevations at every 50' station and at each structure and change in grade

x. _____Junction boxes

xi. _____Channel plan views

xii. _____Channel sections

xiii. _____Pipes with hydraulic grade lines on profile

xiv. _____Cross sections of existing natural channels or lows which are not to be improved, but left in natural state and dedicated to high water

xv. _____Angles, bearings, distances, etc., for structures, channels, etc.

xvi. _____Lot grading layout drains

xvii. _____Culvert structural details

i. _____Unit and Storm Hydrographs For Major Streams (Over 100 acres)

j. _____Drainage Easements to the Centerline of Natural Low

k. _____Cost Estimate

l. _____Engineer's Signature and Seal

m. _____Other

3. HEC-RAS Submittal Check-list

Floodplain submittal checklist supersedes this attachment for projects in the FEMA Floodplain.

Project _____ Engineer _____ Stream _____ Date _____

The purpose of this checklist is to aid the engineer in the preparation of HEC-RAS studies and reports and to expedite the **City of Converse** review procedure.

4. Submission Package

a. _____Signed, sealed, and dated by a engineer certified to practice in the State of Texas

b. _____Signed checklist

c. _____CD with all input files

d. _____Copy of condensed printouts

5. Narrative

a. _____Table of Contents

b. _____Abstract or executive summary

c. _____Introduction

d. _____ Project description and history

e. _____Location

f. _____Scope and objective of analysis

g. _____Previous and related studies that may affect this analysis

h. _____Methodology

i. _____Sources of discharges

j. _____Bridge routines

k. _____Base or effective models (mention source)

l. _____Revised-base model

m. _____Proposed model

n. _____Summary, conclusions, and recommendations

o. _____Water surface elevation impacts

6. Tables

a. _____Water surface comparison table at each cross section

b. _____Floodway table

c. _____Cross section numbering table (if stationing changes)

d. _____Exhibits

e. _____Vicinity map

f. _____Plan view of project reach

g. _____Water surface profiles for design storm

h. _____Channel cross sections showing limits of drainage easements and property lines

i. _____Bridge cross sections

j. _____Plan view of bridge

k. _____Photographs (if available)

7. Appendices

a. _____Pertinent correspondence (meeting notes, etc.)

b. _____Survey and/or Certified "As-Built" information for all revisions to base model

c. _____Sample calculations

8. Name of submitter_____ Date_____

Certification. The Storm Water Management Report must include a letter signed and sealed by a professional engineer with text descriptions, exhibits, calculations and models.

This Ordinance Supersedes Article IV, Section 23 of Ordinance 612 dates May 20, 2008.

PASSED AND APPROVED, this 5th day of February, 2013.

Al Suarez, Mayor

Attest:

Jackie Gaines, City Secretary

CITY OF CONVERSE TEXAS