

CHAPTER 4

STORM DRAINAGE FACILITIES - DESIGN AND CONSTRUCTION

4-1 GENERAL INFORMATION

A. Intent

The guidelines contained in this section are intended to expand upon and supplement information contained in legally adopted Chapters of the Peoria City Code. All designers should familiarize themselves with the provisions of the City of Peoria Flood Control Ordinance, and any code or ordinance, which may have been adopted prior to undertaking projects within the City. In case of conflict between these provisions and those of the Code, the more restrictive shall govern.

B. Requirement for Storm Drainage

All developments within the City shall provide such storm drainage facilities as are necessary to ensure that all improvements, structures and properties, both within the subject development and those located upstream and downstream of the development, shall be protected from the adverse impact of storm water due to the proposed development.

A Stormwater Pollution Prevention Plan shall be required of all development/construction projects unless determined to be non-applicable by the Engineering Director. Each development shall comply, as a minimum, with NPDES notification to the EPA and implementation of SWPPP control measures, as defined and required by the "Best Management Practices" of the Drainage Design Manual for Maricopa County.

C. System Classification

1. The "Minor System" (10-year) shall consist of those collection and/or storm water storage facilities necessary to collect, convey, retain and/or detain storm water runoff from the more frequent rainfalls. The "Minor System" shall be designed to accommodate storms up to and including a "10-year storm" and shall be used only when specifically approved by the Engineering Director.
2. The "Major System" (100-year storm of duration as defined by the Drainage Design Manual for Maricopa County) shall consist of those facilities necessary to convey storm water runoff from storms up to and including a "100-year storm." It consists primarily of the planning and/or analysis of the overall drainage system to insure: that there is always positive drainage from all areas, that the "100-year" flows can safely pass through the project, and that all structures are above the 100-year water elevation in areas where temporary and/or long duration ponding may occur as well as those areas lying within the FEMA floodplain.

D. Drainage Facilities Components

1. Collection System. This portion of the system is intended to collect and convey runoff to storm water storage, trunk line storm drain facilities and/or outfall into natural and man-made drainage *channel* facilities.
2. Storm Water Storage Facilities. Storm water storage facilities are defined as any apparatus, device, manmade construction or method for temporarily storing, suspending storm water runoff and releases by means of basins, channels, swales, wetlands, ponds, lakes, vaults, cisterns, or any other means approved by the Engineering Director. This

portion of the system is intended to retain, detain, store or suspend sufficient volumes of runoff to minimize the adverse impact of new developments upon downstream areas. All developments must provide storm water storage facilities, which consist of one or both of the following as provided below:

- a. "On-Site" facilities, for private property to be maintained by the property owner or owners association are required for any or all of the following types of developments.
 - (1) Apartment complexes
 - (2) Town homes, Condos, Patio Homes and/or locations where a Homeowners Association will maintain the common area and drainage facilities.
 - (3) Large lot Single Family parcels, where the lot is at least one half acre or larger. (Note: this is an option in lieu of "off-site or public facilities").
 - (4) "Hillside lots", as defined by the subdivision regulations, require an individual drainage review regardless of the lot size or the means of storm water storage.
 - (5) Industrial Developments including Subdivisions (Note: this is an option in lieu of "off-site or public facilities").
 - (6) Commercial Developments including Commercial Subdivisions.
 - (7) Any lot being developed, permanently or temporarily, for any purpose, including materials or commodity storage, parking, open space, structures of any kind or temporary use consistent with the Zoning Code.
 - b. "Off-Site" facilities, for projects in a separate tract dedicated, as "Public Drainage Easements", to the City and to be maintained by an association of owners, are required of the following types of development:
 - (1) Single-Family lots (regardless of acreage) that are part of a subdivision.
 - (2) Planned Area Developments (PAD) or other large master planned developments.
 - c. Storm water storage facilities shall be protected from further development by a recorded drainage easement and must be fully improved with landscaping, irrigation systems, lighting and such other aesthetic improvements as may be required by the City. Any basin, which is accepted by the City for maintenance, shall be deemed public property and shall be dedicated to the City in fee simple title. If the City does not accept a basin for maintenance, the developer shall be responsible for establishing some satisfactory means to maintain the area.
3. Open Channels. Channels consist of facilities that collect, store, suspend, convey and discharge accumulated runoff by means respectively described as follows:
- a. *Natural Channels*: Are described as Rivers, washes, arroyos, lakes, wetlands, or other naturally occurring watercourse, with the capacity to accept drainage discharges generated by the development of land. Except as specifically approved by the Engineering Director, it is the City's preference that existing drainage channels be left in an undisturbed and natural state. When this is the case, a drainage easement or right-of-way shall be dedicated over, at a minimum, the 100-year floodway zone of the natural drainage way. Design shall be in accordance with the Drainage Design Manual for Maricopa County, Arizona Department of Water Resources; Delineation of Riverine Floodplains and Floodways in Arizona, State

Standard Attachment SSA 2-96; the State Standard for Detention/Retention, SSA8-99; and the Watercourse Bank Stabilization, SSA 7-98; or the current version of the aforementioned. The developer is required to coordinate compliance with any requirements of the Army Corps of Engineers Section 404 Certification. The developer is required to coordinate all revisions to the FEMA flood insurance rate maps resulting from construction of bank protection.

- b. *Man-made Channel:* When man-made channels are required, the emphasis will be placed on a "natural" appearance and on safety. Grass lining will be allowed, with side slopes 6:1 or flatter, with specific City approval only. Full channel lining will be considered only on a case by case basis.
 - (1) *Maximum Velocities/Erosion Protection:* In general the maximum velocity shall not exceed the scouring velocity of the soil (with natural cover). When the scour velocity is exceeded, additional erosion protection shall be provided. Bank/channel protection may consist of one or more of the following: Concrete or gunite lining, reinforced with 4 inch x 4 inch WWF-12GA.
 - (2) Natural stone grouted riprap 4-inch to 12-inch diameter stones - leave a minimum 1/4 diameter exposed.
 - (3) Natural Stone loose riprap 4-inch to 12-inch diameter stone.
 - (4) Gabion Baskets/Gabion Mattresses.
 - (5) Soil Cement.
 - (6) Design shall be in accordance with the Drainage Design Manual for Maricopa County, Arizona Department of Water Resources; Delineation of Riverine Floodplains and Floodways in Arizona, State Standard Attachment SSA 2-96; the State Standard for Detention/Retention, SSA8-99; and the Watercourse Bank Stabilization, SSA 7-98; or the current version of the aforementioned. The developer is required to coordinate compliance with any requirements of the Army Corps of Engineers Section 404 Certification. The developer is required to coordinate all revisions to the FEMA flood insurance rate maps resulting from construction of bank protection.
4. Conveyance Systems. Conveyance systems are storm drains, channels, washes, rivers and storm water storage facilities designed to provide regional storm drainage protection in accordance with approved Master Drainage Studies and Drainage Master Plans. Conveyance systems shall carry off-site drainage around and/or through the development, and/or the discharge of on-site storm water generated by the development, in accordance with the requirements herein. Streets shall not be considered as a facility for conveyance of off-site flows other than those impacting the development from upstream street right-of-ways.
5. Direct Discharge. If a development has direct and immediate access to a natural watercourse or manmade regional drainage facility which can be demonstrated to receive discharges from the development without adversely affecting other properties nor the intended parameters of the receiving facility or underlying property's use or interests within the watercourse, and the Flood Control District of Maricopa County acknowledges and approves of such discharge, approvals for direct discharge can be considered with the following conditions met:
 - a. The developer will be required to request such intent in writing. The request shall be for only those areas of the development which cannot meet the storm water storage

requirements of Section 4-1.G.3. The developer will be required to obtain any approvals necessary from the agency, property owners and tenants having jurisdiction, ownership or interest over the receiving facilities. The requirements to provide appropriate sediment control in conformance with the NPDES and the City's requirements remain in full force and effect. For remaining areas of the development, storm water storage requirements shall be in accordance with Section 4-1.G.3. The developer will be required to coordinate compliance with any requirements of the Army Corps of Engineers Section 404 Certification, FEMA and the Environmental Protection Agency; Clean Water Act; 401 Certification. Approvals from the Engineering Director and Chief Engineer of the Maricopa County Flood Control District.

6. Obstructions. Obstructions to drainage are fences, walls, berms, swales, retaining walls, patios, pools, decks, sheds, pens, corrals, water troughs, canals or any other construction that alters, redirects, impedes or suspends drainage from its natural course. Obstructions can occur in landscaping which includes mounding, raised beds, edging, furrowing, gardens, water harvesting, planter boxes, or any other landscape method or construction that alters, redirects, impedes or suspends drainage from its natural course.
7. Ownership and Maintenance Requirements. As part of the initial layout design, the designer must consider and accommodate the future need of vehicular access for maintenance purposes. Preliminary design should minimize long-term maintenance requirements. It is essential that maintenance be considered during the planning, design and construction of drainage facilities. Maintenance is provided so that the facility is maximized. Common maintenance problems associated with drainage facilities includes growth of undesirable vegetation, debris accumulation, sedimentation, erosion, scour, soil piping, soil settlement, structural damage and failing to plan for maintenance access. Culverts and bridges are to be designed to avoid impacts to existing sediment transport conditions.

Culverts and bridge within the City are generally within the public right-of-way for the road. Additional easement or right-of-way, beyond the normal street width may be required to facilitate the construction, operation and/or maintenance of the structure. Design plans for the structure shall include the proposed easement and/or right-of-way limits. Maintenance issues and access shall be considered in the structure design, and appropriate measures should be included to facilitate proper maintenance (i.e. access road if necessary, etc.).

Ramped, vehicular access for maintenance is required at the upstream and downstream ends of all culverts that are not accessible from the roadway. The maintenance access route shall be within public right-of-way or a City approved easement.

A city-owned property, right-of-way, or privately-owned drainage tract or easement shall be provided for the area inundated by backwater from the culverts for the peak 100-year event. The 100-year floodplain limits shall be delineated and shown on the subdivision Final Plat or Map of Dedication.

E. Reports

1. Preliminary Drainage Report. A preliminary drainage report must be submitted at the time of the preliminary plat review, use application or site plan application. The preliminary plat review will not be scheduled without this report. The preliminary drainage report shall delineate the 100-year floodplain and floodway limits for drainage ways that serve areas of more than 1/4 square miles or which generate an estimated flow rate of more than 500 CFS for the 100-year event, per State Standard Attachment SSA 2-96. The preliminary drainage report shall also delineate the FEMA Regulatory Floodplain,

Special Flood Hazard Areas. A preliminary report may be used to present drainage values, impacting or generated by the subject property, to allow a determination by the Engineering Director, for reducing the report requirement to that of "Hydrology Report" (see Section 4-5 of this chapter).

2. *Final Drainage Report.* A final drainage report must be submitted as part of the Civil Plan submittal. Civil Plans review will not be accepted without the report. The final approval of the Civil Improvement Plans will not be considered complete without approval of this report. Approval of the Grading Plan providing drainage facilities does not constitute approval of the Report. An individual grading and drainage plan is required for each lot of a "hillside development area". (See Section 4-5)
3. *To Be Considered Valid.* The Design Engineer shall submit a specific written request for the review of the Preliminary Drainage Report and the Final Drainage/Hydrology Report. To be considered valid, the City must acknowledge the acceptance of this report in writing.

F. Hydrology

1. *Study Requirements.* A hydrology study shall be performed for each development within the City. The study shall define the overall and sub-drainage areas. The basic study format for urban areas lying within areas of "gradual slope" shall also determine appropriate hydrologic data for the following:
 - a. *Off-Project Areas.* The peak flows, times of concentration, and other hydrologic data, for each off-project drainage area tributary to the project shall be computed and submitted in summary form. Data from an approved Area Drainage Master Plan may be provided in lieu of a new study and written approval by the Engineering Director.
 - b. *Project Sub-Basins.* The project shall be divided into sub-basins tributary to appropriate design points. The pertinent hydrologic data shall be computed for each and submitted in summary form.
 - c. *"Appropriate Design Points"* (concentration points) are those points wherein the peak flow rates, or other pertinent data, are needed to determine flow capacity requirements, inflow-outflow relationships, etc. These "points" would include, but not necessarily be limited to, the following: inflow-outflow points of storm water storage facilities; up and/or downstream ends of culverts; intake points for storm drains (i.e. inlets, catch basins, scuppers, etc.); points immediately upstream and downstream of channel junctions and/or street intersections; others as may be necessary to give a complete hydrologic picture and allow a thorough hydraulic evaluation and/or design of the drainage system.
 - d. *Floodplain delineation* of the 100-year floodplain and floodway for drainage ways which serve areas of more than 1/4 square miles or which generate an estimated flow rate of more than 500 CFS for the 100-year event, per State Standard Attachment SSA 2-96 (or current revision). In addition identify and delineate the FEMA Regulatory Floodplain, Special Flood Hazard Areas.
 - e. *Calculation* of the appropriate Time of Concentration (TC).
 - f. *HEC-1* (or approved surface hydrology computer modeling program) using the Drainage Design Manual for Maricopa County, Arizona Volume I, Hydrology.

When site conditions are considered by the Engineering Director to be "rural" in nature and/or influenced by hillside slope runoff, the requirement for a detention style

storm water storage scheme may be necessary. The detention style system Drainage Report format will be required. (See Section 4-5 of this chapter).

2. *Basis of Design*. The basis of design shall be in accordance with the grading, drainage and flood control policies of the City of Peoria, the Flood Control District of Maricopa County and the Department of Homeland Security, Federal Emergency Management Agency (FEMA). The "Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology", as prepared and published by the Flood Control District of Maricopa County shall determine the minimum standards of design for grading, drainage and flood control, or unless otherwise specified herein. As determined by the Engineering Director, a project may be required to use appropriate standards developed by the Arizona Department of Water Resources: "Delineation of Riverine Floodplains and Floodways in Arizona", State Standard Attachment (SSA) 2-96; etc., as made available to the regulatory and design community. In addition standards shall also adhere to the requirements for FEMA Regulated Floodplain, Special Flood Hazard Areas.
3. *Compliance with Master Plans and Studies*. The hydrology shall be in accordance with any approved Area Drainage Master Studies (ADMS), Area Drainage Master Plans (ADMP) Watercourse Master Plans (WCMP) and other Studies, which involve the Agua Fria, New River, Skunk Creek, ACDC or other washes or watercourses as may be relevant.
4. *Compliance with other Regulating Authorities*. The Developer/Engineer shall comply with the Federal Emergency Management Agency (FEMA), U.S. Environmental Protection Agency (EPA) and Army Corps of Engineers (COE) requirements encountered in the pursuit of the hydrology. CLOMR, LOMR, COE 404 and EPA 401 applications and/or permits may be required by these other agencies. The City shall be apprised of agency notifications, applications, reports, and resulting agency decisions by reference and correspondence copy inclusion in the appendix of the project report. (See Section 4-5 of this chapter).
 - a. Conditional Letters of Map Revision (CLOMR's) are required for any proposed encroachment into a regulated floodplain.
 - b. Letters of Map Revision (LOMR's) are required prior to issuing of permits for any grading, structure or any development proposed to encroach into a regulated floodplain.

G. Hydraulics

1. *Basis of Design*. The basis of design shall be the "Drainage Design Manual, Volume II, Hydraulics", as prepared and published by the Flood Control District of Maricopa County. The Design Engineer is responsible for evaluating the specific design conditions to determine the appropriate design criteria in evaluating the hydraulic design and anticipated operation and maintenance conditions. The following provisions shall not relieve the Design Engineer, Consultant, Developer or Owner of the responsibility to apply generally accepted, standard design practices and professional conduct:
 - a. Storm drainage pipes and open channels shall be designed using "Manning's Formula".
 - b. Values of the "n" for "non-typical" materials shall be noted and justified in the report.
 - c. The Step Backwater Method is the preferred method for hydraulic calculations on open channels.

- d. Street capacities shall be computed for each street section and slope.
 - e. Inlet capacity shall be computed for each inlet of the system. Design aids in accordance with the "Drainage Design Manual, for Maricopa County, Volume II, Hydraulics".
 - f. Topography contours and/or grades up to a 500-foot perimeter of the development at a minimum. The Design Engineer shall be responsible to determine whether certain topography and/or drainage features outside of this perimeter, which may affect the hydraulics, shall be considered. These provisions shall be required for review of the Preliminary Drainage Report, when offsite flows are diverted or routed around or through the development.
 - g. HEC-2 or HEC-RAS for step backwater.
2. Calculations Format.
- a. All hydraulic calculations submitted for review shall be submitted in tabular summary form only. Voluminous reports containing numerous pages of routine detailed calculations (computer print-out) may result in a time consuming review and the review of the construction plans may be delayed until these calculations are resubmitted in summary form. (Remember, most hydrologic and hydraulic analyses consist of a repetitious series of standard routine calculations. (Exhibits showing quantifying results from these calculations are required.) Summary forms for hydrologic or hydraulic calculations as published by the City of Phoenix or by the City of Mesa, or as found in various technical publications (such as the ASCE Manual Number 37), are to be used until such time as the City publishes such a form. (See Section 4-5 of this chapter for format requirements of reports containing calculation exhibits.)
 - b. Occasionally, circumstances will warrant or require special solutions, which do not fall within the routine forms and formula, prescribed above. In such cases the design engineer shall use the formulas appropriate for the solution. The report should reference the formulas used and their source. If necessary, a single typical calculation may be shown in detail to clarify the logic of the solution. The balance of similar calculations is to be presented in tabular summary form.
 - c. Summary forms should provide space for each of the critical variables used in the set of calculations. For example, a hydrologic summary table for a study based on the "Rational Method" would include spaces to itemize the variables such as: A, C, CA, $\square CA$, t_c , i, etc., providing the information necessary to check the summary table.
3. Storm Water Storage Facilities.
- a. The design engineer shall determine and present calculations on each storm water storage facility required for their project. The storm water storage volume for the 100-year, two/six hour event, actually achieved shall be provided. Basin volumes, which exceed the contribution from the sub-area(s) it serves, will not be considered as "volume provided".
 - b. All storm water storage facilities are required to provide sufficient volume to retain 100 percent of the 100 year, 2-hour storm for the sub-basin that it serves. The routing of storm drainage for the development shall be through the storm water storage facilities.

Detention style storm water storage facilities shall be designed for the volumes and

discharge rates as defined by the Flood Control District of Maricopa County for purposes other than a storm water storage retention function. Design of the facilities shall meet the criteria of the appropriate recommended procedure level defined by the ADWR "State Standard for Stormwater Detention/Retention", SSA8-99 (or current version).

- c. A drainage easement shall be recorded over the tract or parcel containing each storm water storage facility within the project for both "public" and "private" facilities. The drainage easement shall include a 20-foot access easement from a paved surface. For Publically maintained basins, channels and other drainage facilities, the 20-foot access easement shall connect to a public street.
- d. For the complete half right-of-way area of adjacent *streets* and parkways, a storm water storage facility located outside of the right-of-way, is required to provide the equivalent calculated volume required to retain one hundred percent of the 100-year, 2-hour storm for that area. The basin is not required to intercept that right-of-way flow.
- e. Storm Water Storage facilities shall not be located within public rights-of-way, water easements or sewer easements.

4-2 TECHNICAL DESIGN REQUIREMENTS - STORM DRAINS

A. Drainage

1. Street Drainage.

- a. The basis of design for local streets shall be designed to carry the 10-year storm being contained within the pavement section with a maximum depth of 6-inches.
- b. Streets shall be designed to carry the following minimum flows:
 - (1) Major and minor arterial streets to carry a ten-year flow between the curbs and maintain a 12-foot dry lane in each direction; and carry the 100-year flow within the right-of-way with a maximum depth of 6-inches over the crown of the street, for emergency vehicles and evacuation purposes. (Determine the current City Code concerning emergency access.)
 - (2) Collectors and local streets shall be designed to carry 10-year flows between the curbs, the 50- year flows between the property lines, and the 100-year flow within the right-of-way. The grading plans must substantiate the flow containment capability.
 - (3) Underground storm drains are required when the above street capacity or maximum depth is exceeded. Open Channels may only be used as the supplemental drainage conveyance with specific written request to the Engineering Director and written acknowledgment by the City.
 - (4) 7-inch high curb may be used along streets where parking is prohibited.
 - (5) Streets shall have a crowned section with a maximum cross-slope of 3% for drainage. Exceptions may be submitted with specific written request to the Engineering Director and written acknowledgment by the City.
- c. Streets and street rights-of-way shall not be used for channels. Channels must be located outside of the right-of-way. Drainage incidental to the adjacent street may be

located in the right-of-way.

- d. The street right-of-way shall be designed to limit storm water conveyance to carry a maximum 100 cfs. Storm Drains are required per Section 4-2.A.3 when that capacity is exceeded.
- e. In general, dip crossings of open channels shall be avoided. Such designs are subject to special review.
- f. All storm drains and channels shall be constructed in public rights-of-way or dedicated Public Drainage Easements. The minimum width of the right-of-way or easement shall be adequate to allow a minimum continuous 12-foot wide maintenance road, but in no case shall the easement be less than 20-feet wide.
- g. Where access to a new development requires crossing of a channel or wash, a minimum of one access point accessible during a 100-year storm must be provided. (Determine the current City Code concerning emergency access.) Additional 100-year accesses may be required by the City.

2. Commercial/Multifamily access drive aisles

- a. Inverted crown sections are not allowed for drive aisles within commercial/multifamily developments.
- b. Valley gutters are not allowed to run parallel within the drive aisles for commercial/multifamily developments. Valley gutters may cross the drive aisle as necessary to convey flows.

3. Drainage Between Lots.

- a. Routing of drainage ways between lots or buildings is discouraged and exceptions will be allowed only with written request from the developer and written approval of the Engineering Director.
- b. When allowed, the channel shall be designed to convey the 100-year flow without flooding adjacent properties. Depth of flow within drainage easements shall not exceed 12- inches, outside of and excluding the area of the channel structure.
- c. When allowed, the channel shall be constructed in a dedicated drainage right-of-way or easement leading to a positive outfall point. The minimum width of the right-of-way shall be top width of the channel plus 12- feet for a maintenance roadway but in no case less than 20-feet wide. Maintenance access with a legal and accessible connection to a public street, shall be provided to the drainage way.
- d. The ends of the right-of-way or easement shall be treated in such a manner as to prevent non-maintenance vehicular access without diminishing the hydraulic capacity of the channel. Removable bollards, railings or barricades or gates shall be installed.
- e. A minimum of 25% of the up-stream opening shall be assumed to be clogged with debris, when considering design capacity.
- f. Fencing or railing may be required by the Engineering Director if an open channel is used.

- g. Headwalls, wing walls, retaining walls, grates and trash racks are required in the design of channels and storm drains. Refer to Chapter 3, Section 3-2 A.3 for required Safety Railings.
 - h. Depth of flow within drainage easements shall not exceed 12-inches, outside of and excluding the area of the channel structure consistent with the Flood Insurance Rate Map Flood Zone designation for the area in which the project lies.
4. Underground Storm Drains
- a. Underground storm drains shall be provided whenever the capacity of the pavement section or maximum depth is exceeded, per section 4-2.A.1.a. and b., by the design storm event. Additionally, storm drains are required when the flow in the right-of-way exceeds 100 CFS (4-2.A.1.d.).
 - b. Pipes shall be sized using "Manning's Formula". Values of Manning's "n" shall be from appropriate technical literature and shall be referenced.
 - c. Velocities shall range from 3-feet per second to 9-feet per second in order to prevent sedimentation and abrasion damage.
 - d. The minimum pipe size shall be 15-inch ID, storm drain pipe within the right-of-way or easement or any facility maintained by the City. A minimum of 2-feet of cover is required over all storm drain pipes. Calculations shall be provided for special conditions.
 - e. The hydraulic grade line (HGL) for the design storm may be above the pipe, provided that it remains at least one foot below the ground elevation at all manholes, catch basins, inlets, etc., the pipe shall be designed to operate with the calculated head pressure provided the HGL does not compromise the operation of the storm drain system. The HGL shall be provided on the profile portion of the storm drain plan and profile.
 - f. When the pipe changes direction more than 30 degrees there shall be manhole installed with a drop, between match points, of at least 0.1 feet. In no case shall the deflection angle be greater than 90 degrees.
 - g. Tracer Wire shall be installed per MAG Specification 616.4.1. Material shall be per City of Peoria Standard Details PE-101. Termination shall be per Peoria Details PE-551.
 - h. For storm drains with submerged outlets an acceptable means for dewatering or evacuating the underground storm drain facilities is required. This can be accomplished with drywells or a bleed-off into subsequently connected, positively draining, outfall facility. Bubble-up devices are not permitted, even in a temporary condition.
5. Pipe Bedding Requirements.

Pipe and culverts installed in City of Peoria easements and rights-of-way shall be bedded from bottom of excavation to one foot above the pipe with granular bedding material in accordance with the requirements of Section 601.4.6 of MAG Uniform Standard Specifications, or the manufacturers' recommendations, whichever is more restrictive. Bedding compaction densities shall be per MAG Specification Table 601-2. The initial 4" bedding under the pipe is required for pipe having an inside diameter of 12" or larger, and in all cases where rock larger than 1.5" is encountered in the trench bottom, the

requirements of MAG Standard Specification 601.2.5 shall apply. Specially designed and alternate bedding will be approved on a case by case basis.

6. Trench Backfill Requirements.

- a. Minimum trench backfill requirements shall be per MAG Specification 601.4, with compaction densities per MAG Specification Table 601-2. Backfill requirements provided by the Engineer shall apply, when such provisions are more restrictive than MAG Specification.
- b. Within the existing pavement section of public streets, the backfill shall be ½ sack Controlled Low Strength Material (CLSM) per MAG Specification 728.
- c. Use of CLSM. Anyone using Controlled Low Strength Material (CLSM) for backfilling a trench shall protect all water service lines with sand shading to prohibit contact with metallic water line fittings, metallic joint restraint, valves and valve bonnets, copper and bronze fittings.

B. Materials, Layout and Configuration.

1. Pipes.

- a. See the Materials List for allowable materials, City of Peoria Standard Detail PE-101.
- b. The Design Engineer shall be prepared to justify the pipe class and material specified.

2. Manholes/Junction Boxes, Headwalls.

a. *Materials*

- (1) Manholes: shall be per MAG Standard Details 520, 521, 522 and/or 523
- (2) Junction Boxes and Headwalls are considered Concrete Structures: Concrete Structures shall be per MAG Specifications Part 500. Concrete shall be per MAG Specifications 525. Steel Reinforcement shall be per MAG Standard Specifications 727.
 - (a) Waterproofing shall be in accordance with Chapter 10-3.P of this manual.

b. *Locations* – manholes, catch basins and/or junction boxes are required at all the following:

- (1) Junctions of two or more pipes at the following locations:
 - (a) More than two intersecting pipes
 - (b) Changes in pipe material
 - (c) Changes in pipe sizes
 - (d) Joining of incompatible pipe products of the same nominal dimension.
 - (e) Spacing exceeding requirements per section 4-2.B.2.c.
- (2) Changes in grade
- (3) Changes in alignment
- (4) Changes in pipe sizes
- (5) PC's and PT's, when permitted

c. *Spacing* - The maximum spacing for manholes, catch basins or junction structures

along a storm drain main line shall be:

- (1) 400-feet on lines 15-inch to 36-inch diameter
- (2) 550-feet on lines over 36-inch in diameter

3. Catch Basin, Scuppers, Spillways, Inlets and Outlets.

- a. Catch basins are to be curb opening inlets. Curb opening catch basins shall be constructed per City of Phoenix Detail P-1569.
- b. Drywells, area drains and non-curbed catch basins with grates, within vehicular traffic areas, shall provide a heavy duty H-20 bicycle safe grate.
- c. In addition, construction of all catch basins, scuppers, spillways, inlets and outlets shall include installation of inlet markers per City of Peoria Standard Details PE-559-1 thru 3.
- d. Catch basins and drywells can be used as junction structures provide they meet and achieve the hydraulic requirements of Section 4-2.A.4, and that the pipe sizes do not exceed the recommendations of the inlet or catch basin standards. Connections to drywells must also meet environmental requirements conforming to the NPDES.

4. Tracer Wire.

Tracer wire shall be per City of Peoria Standard Detail PE-101.

4-3 TECHNICAL DESIGN REQUIREMENTS - STORM WATER STORAGE FACILITIES

A. Sizing

1. Basis of Design.

- a. All storm water storage facilities shall be sized to retain 100% of the 100-year, 2-hour storm falling over the entire project site including the total adjacent right(s)-of-way. For the purpose of determining the volume required the project shall be considered to extend to the centerline of all existing and future streets on the exterior boundaries and to include all interior streets and other rights-of-way within the project.
- b. *Freeboard.* There shall be a 1-foot (12-inch) freeboard from the basin overflow water surface elevation to the lowest adjacent building elevation and/or equal to the gutter of the upstream streets. The freeboard for all project building floor elevations shall be a minimum of fourteen inches (14-inch) above the project outfall water surface elevation. The project site outfall elevations must be considered to be lower than an individual on-site basin overflow elevation or the effective depth of the basin is measured to the outfall elevation.

2. *Volume.* The following data shall be provided for each storm water storage facility:

- a. *Volume Required.* The volume required in cubic feet shall be computed using the methods of the "Drainage Design Manual for Maricopa County, Arizona, Volume II Hydraulics" published and sponsored by the Flood Control District of Maricopa County. With few exceptions, the City's developments should be considered urban with respect to percentage of impervious cover.
- b. *Volume Provided.* The volume provided shall be submitted in a table noting the stage-capacity relationships.

3. Storm Water Storage Facilities shall be located such that they can intercept the flows from the entire site. If the basin is located other than at the lowest point of the project, the Design Engineer shall denote on the master drainage map the actual or effective drainage area. If portions of the project cannot drain to the primary basin, additional basins shall be added to retain/detain runoff from these areas. The Engineering Director may make exceptions on a case by case basis.
4. The sub-drainage areas for each basin shall be denoted on the plans and the calculations for each sub-basin storm water storage required shall be provided. Overflow from any sub-basin may be safely routed to another sub-basin, to ultimately be contained in the compilation of storm water storage provided. The storm water storage provided shall contain 100% of the 100-year, 2-hour storm event, as actually routed through the development. Over sizing (having a capacity greater than the possible capture volume) of intermediate basins will not be considered for the provision of storm water storage required beyond the volume of the contributing area.
5. Underground or concealed storm water storage facilities may be considered on a case by case basis. Installation of approved underground facilities shall conform to Section 4-2.A.6 and City of Peoria Standard Detail PE-402.
 - a. The High Water Level (HWL) shall be denoted on the plans for each basin or ponding area. The basin depth (overall average depth) shall be measured from the lowest point to the elevation of the basin overflow. This is not to be considered the water surface elevation of the basin's storm water storage depth (HWL) for the period storm event. The HWL elevation shall be designed to prevent damage of public improvements and minimize damage of site improvements, such as paving, structures, utilities, walls, landscape, signs and light standards.
 - b. The Outfall elevation and each basin Overflow elevation shall be shown on the plans.
 - c. Storm Water Storage facilities located within a drainageway, channelway, or floodway are prohibited.

B. Grading

1. Depths.
 - a. The overall average depth shall not exceed 3-feet without authorization of the City. If granted, the side slopes shall be flattened (See 4-3.B.2.(b)). At the City's option, the basin may be fenced to allow steeper side slopes or greater depths.
 - b. In no case shall the water storage depth exceed 1.0 foot without a positive means (not relying on evaporation) of disposing of accumulated runoff. Soils Investigation Reports and testing in accordance with Section 4-3.B.8.b.(3) must demonstrate that the facility is able to drain the first 1.0 foot of storage in accordance with the City's requirements, otherwise a positive means of disposing accumulated runoff in accordance with these provisions, will be required.
2. Slopes, Side and Bottom.
 - a. The bottom of all basins shall be sloped towards the discharge points. The minimum bottom slope shall be 0.1%.
 - b. Side Slopes.

- (1) Side slopes adjacent to public rights-of-way, or when there is pedestrian type access to that portion of the basin, shall have a side slope of 6:1 or flatter. There shall be at least 2-feet of level ground between the back of the sidewalk and the beginning of the side slope grading.
- (2) When a basin is adjacent to walls, fences, and hedges, etc. (i.e., no or limited pedestrian type access in that area) the side slopes may have slopes up to 4:1 if *adjacent* to public right-of-way or easement and 3:1 if adjacent to private property. There shall be at least two feet of level ground adjacent from any wall or vertical obstruction to the top of the side slope grading.
- (3) Greater water depths will require flatter side slopes and approval of the City. The following depth/side slope criteria shall be used:

<u>Depth (feet)</u>	<u>Side Slope</u>
< 4	4:1
4-6	6:1
6-9	10:1
> 9	14:1

- (4) Retaining walls (i.e., vertical slopes) may be used in areas adjacent to permanent walls, fences, etc., with specific written request to the Engineering Director and written acknowledgment by the City. The horizontal separation of a retaining wall from a building, wall or fence shall be at least equal to the height of the retaining wall but in no case less than 4-feet. There shall be at least 2-feet of level ground adjacent to any building, wall, fence or vertical obstruction to the top of the side slope grading between the retaining wall and such building, wall, fence or vertical obstruction. The grade of the balance of the slope between such retaining wall and a building, wall, fence or vertical obstruction shall not exceed 4:1.
 - (5) Concrete or grouted rip rap slope erosion protection and splash pad, a minimum of 9- inches in thickness, shall be provided when street runoff is collected and conveyed to the basin(s) via a storm drain, scupper, weir or spillway. The width of the slope protection shall be at least the width of the scupper or weir, but have a minimum width of 10-feet. The slope protection shall be channelized to contain the calculated flows and shall terminate at a level concrete splash pad or grouted rip rap within the basin, a minimum of 10-feet beyond the termination of the spillway and 5-foot beyond each side of the spillway. The City may reduce these criteria when flow quantities and velocities may warrant.
 - (6) Side slopes adjacent to public right-of-way or easement where pedestrian access is permitted via sidewalks, trails or paths shall not exceed 6:1.
 - (7) Refer to Chapter 3, Section 3-2 A.3. for required Safety Railings.
3. Basin Access. The following access provisions shall apply to water storage basin and drainage channel construction. Access shall be provided for each storm water storage facilities to be maintained by the City. Provide a driveway entrance, 10-feet of level ground, and a 10:1 ramp, 10-feet (min.) in width. The basin access shall be a minimum of 2-inches compacted decomposed granite over 6-inches of compacted ABC. The ramp shall be concrete, 9-inch in thickness with a surface that provides appropriate traction.
 4. Grading and Landscaping. Storm water storage facilities shall be landscaped in accordance to Article 14-34 of the Peoria Zoning Ordinance. Also see Chapter 8 of this manual. Basins maintained by the City shall incorporate the use of drought tolerant plant material with the ground surfaces being covered with decomposed granite, river rock or

other type of decorative rock. Basins may incorporate the use of other planting including turf. Turf areas shall be kept to a minimum and will be reviewed with respect to promote water conservation. The maximum side slope for turf areas shall be 6:1. The use of turf shall be in compliance with the percent of site area criteria for allowable turf area.

The perimeter of basins and channels shall incorporate a means of preventing erosion caused by uncontrolled drainage reaching and damaging side slopes. To prevent rills, head-cutting and other adverse erosion a berm, swale or combination of these features shall be incorporated to guide accumulated side flows safely into the basin or channel thru spillways, hard surfaces or armored faces of the side slopes.

5. Storm Water Storage in Parking Lots.

- a. Storm water storage in parking lots of multi-family developments is not allowed. All storm water storage of such developments shall be in landscaped areas.
- b. Storm Water Storage runoff in parking lots of industrial/commercial developments is allowed subject to the following guidelines:
 - (1) No more than 25% of the volume required may be retained/detained in parking lots. The balance shall be provided in landscaped areas. The tributary areas to each "basin" shall be noted on the master drainage map.
 - (2) Parking spaces shall provide one dry access with no point of the space to exceed 0.67 feet deep, nor 0.25 feet at the midpoint. If paved areas of the parking lot are designed to store water at a depth greater than 0.67 feet, the developer shall post conspicuous warning signs in these areas advising that flooding may occur and vehicles may be subject to inundation.
 - (3) A continuous vehicle access lane shall be provided throughout the development, and it shall be free of ponded water from the storm water storage areas. This access lane should typically coincide with a fire lane and be of a 20-foot minimum width.
 - (4) ADA accessible parking and loading spaces shall be free from ponding.

6. Outfall.

- a. Each project shall be designed such that the "ultimate" outfall for all drainage is a public street, storm drain, drainage channel or natural watercourse. The outfall shall be accessible without draining over private property. Design engineers must evaluate cases where project outfall conditions occur and take necessary actions to prevent flooding or damage to properties located downstream of the outfall. When the prescribed method of storm water management is a detention scheme, the engineer must insure that the "post development flow" does not exceed flow that would result had no development taken place. Additionally, all project site finished floors must be a minimum of fourteen inches (14-inches) above the outfall water surface elevation.
- b. If such an outfall does not exist, the project must provide conveyance to an outfall.
- c. Overflow/Conveyance
 - (1) Upon written request, off-project flows, which historically flowed through the project, may be routed through the storm water storage facilities. The applicant

shall provide specific written request submitted to the Engineering Director and receive written acknowledgment of approval by the City.

- (2) Runoff volumes in excess of those required to be retained/detained (currently the 100-year, 2-hour storm) may be routed through the outfall, although they must be routed via the storm water storage facilities.

7. Location/Conflicts with Existing Utilities.

- a. Storm water storage facilities shall not encroach into existing easements for private utilities without written approval of the encroachment from all utilities that have interest in the easement.
- b. Storm water storage facilities shall not encroach into public rights-of-way or into public easements. If necessary the developer shall relocate conflicting utilities into a new dedicated easement.
- c. The top of the storm water storage facilities (i.e., freeboard elevation) shall be at least four horizontal feet from any building.
- d. Storm water storage facilities shall not be located within 20-feet of an active septic system or within 100-feet of active water well or within any landfill, known or otherwise.
- e. A minimum 4-foot of cover (from the bottom of the basin to the top of the pipe) shall be maintained over water, private sewer and storm drain lines. Additional protection may be required for water lines in conflict with a basin, specifically concrete encasements per MAG Standard Detail 404. Public Utilities are to avoid locations within the area of basin facilities.
- f. Manholes adjacent to storm water storage facilities shall be provided a level area a minimum of 12-feet in diameter from the center of the manhole, and a 12-foot, level vehicular maintenance access way to the manhole from a public vehicular easement or right-of-way. The access way shall be structured and surfaced to be capable of support for maintenance vehicles. The manhole shall be watertight and have a water tight manhole lid.

8. Disposal/Discharge.

- a. All storm water storage facilities shall have a positive method of disposing of retained or detained runoff waters. 100% of the 100-year, 2-hour storm being retained/detained shall be disposed of within 36-hours. Public streets are not considered to be an acceptable outlet for disposal of retained or detained runoff. However, streets are considered an acceptable outlet for basin overflow or project outfall.
- b. Acceptable methods of disposal of accumulated storm water runoff are:
 - (1) A bleed-off discharge to an existing storm drain or drainage channel of sufficient capacity to convey the anticipated flows from the tributary drainage area after the storm subsides.
 - (2) The maximum bleed-off discharge rate shall be 1 cfs. This rate can be achieved by the addition of a 6-inch diameter hole in a plate mounted on the discharge structure. Use a 15-inch minimum diameter discharge pipe within the public right-of-way or public easement. Use a 12-inch minimum diameter discharge

pipe for other locations.

- (3) Drywells (percolation wells) are considered an acceptable method of disposing of the retained runoff when there is no other reasonably accessible discharge method, subject to the following:
 - (a) Bleed-off meeting conditions described in 4-3.B.8.b.1 cannot be met.
 - (b) Drywells shall penetrate a minimum of 10-feet into permeable soil, defined as mostly cobbles and gravel with no material passing a no. 40 sieve.
 - (c) An actual well test shall be performed, and the resultant design disposal rate shall not exceed 50% of the rate determined by the test, in order to compensate for deterioration of percolation rates over time. Only one test will be required if all Drywells in the area have similar soil boring logs. Copies of any percolation tests must be submitted to the City.
 - (d) Percolation tests shall conform to ASTM D3385-94 or D5093-90.
 - (e) The minimum number of wells per storm water storage facility shall be computed, and noted in the drainage report.
 - (f) Drywell drilling log(s) and a copy of the completed Arizona Department of Environmental Quality Drywell registration(s) will be required before project can be accepted.
 - (g) All Drywells are to be equipped with a secured grate to prevent unauthorized removal.
 - (4) Runoff generated from washing vehicles and equipment shall conform to "Arizona Department of Environmental Quality – NOI supplement for Type 3.03 General Aquifer Protection Permit for Vehicles and Equipment Washes" (A.A.C R18-9-D303).
 - (5) Drywells that drain areas at motor fuel dispensing facilities where motor fuels are stored or loaded, shall conform to "Arizona Department of Environmental Quality – NOI supplement for type 2.04 General Permit. Protection Permit for Vehicles and Equipment Washes" (A.A.C R18-9-D303) and Arizona Administrative Code R18-9-C301. In addition, the design of the system shall be fully automated (human intervention not required) and shall not depend on a power source.
 - (6) Drywells that drain areas where hazardous substances are used, stored, loaded or treated, shall conform to "Arizona Department of Environmental Quality – NOI supplement for Type 2.01 General Permit and Arizona Administrative Code R18-9-C301. In addition, the design of the system shall be fully automated (human intervention not required) and shall not depend on a power source.
9. Nuisance Water. Each basin, particularly those used as a park or play area, shall be graded such that there is one or more "sump" areas wherein runoff from the more "frequent" storms and nuisance runoff may be retained/detained without flooding the balance of the basin. Positive methods of disposal shall be provided for each sump in accordance with these provisions.
10. Obstructions. Obstructions per section 4-1.D.6 require special engineering considerations to assure that drainage is not altered, redirected, impeded nor suspended from its natural course.

A drainage analysis will be required to determine the necessary number of drainage openings required in the drainage obstruction. This analysis will be dependent upon the location, size and operation and maintenance constraints of drainage openings working as a system for the drainage.

Consideration shall be given to the structural integrity of the drainage obstruction and its ability to withstand the hydrostatic forces, velocities, accumulation of debris, contamination and other forces of drainage, including anchoring and foundations for the obstruction. The ability for the obstruction to breakaway or breach, in a means that does not alter drainage, may be considered when designing any drainage obstruction. Such breakaway or breach mechanism shall not result in the drainage obstruction causing damage: by becoming a projectile, creating a wave, becoming buoyant, contaminating the flow or becoming debris in the flow and creating a further hazard.

A statement or report regarding the proper maintenance for the obstruction, its drainage openings and any attached devices shall be required. An engineering analysis and site plan determining the following criteria related to drainage obstructions shall be provided:

For Drainage Openings the following criteria should be addressed.

- a. Number of drainage openings.
- b. Location of drainage openings.
 - (1) Base of drainage obstruction. No greater than 6" above the upstream side of the drainage obstruction.
 - (2) Spacing along drainage obstruction. No more than 8 foot horizontal spacing
- c. Size of draining openings. Individually and in the aggregate.
- d. Maintenance of drainage openings. Provide a means to address the maintenance to prevent clogging, deterioration, damage, or loss of drainage opening efficiency. Repairs shall be recommended, and made promptly.
- e. Access prevention for drainage openings. Assure that any screening, access or rodent barriers operate with a breakaway or swing away mechanism that is automatic and is not reliant upon manual operation.

For Drainage Obstructions the following criteria should be addressed.

- a. Resistance to flow, impoundment, saturation, debris and contamination. The composition of materials used which become the drainage obstruction shall be made of materials that can resist and withstand hydrostatic forces, velocity, debris, saturation and contamination without reducing the integrity of the drainage obstruction in order to prevent catastrophic failure.
- b. Anchoring. A means of fixing, tethering, attaching with proper foundations to prevent drainage obstructions from dislodging, becoming buoyant, becoming debris in the flow, redirecting, impeding or suspending of flow, contaminating of flow and causing damage to property, homes, structures or other drainage obstructions is required.
- c. Breakaway features. Drainage Obstructions may incorporate breakaway mechanisms that allow unimpeded drainage during a flow event. These features must operate automatically and not require human operation or intervention to be activated. Breakaway features shall not alter the drainage pattern. A means of preventing the Breakaway features from becoming a further hazard shall be incorporated and be in accordance with the Anchoring provisions herein.
- d. Maintenance of Drainage Obstructions. Provide a plan to address maintenance of drainage obstructions to prevent deterioration, damage, or loss of drainage obstruction integrity. Repairs shall be recommended, and made promptly.

4-4 CONSTRUCTION DETAILS

All construction shall be per MAG Standard Details and Specifications subject to City of Peoria modifications.

4-5 POLICIES, PROCEDURES, AND FORMATS FOR DRAINAGE REPORTS, HYDROLOGY REPORTS, AND DRAINAGE STATEMENTS

The purpose of this chapter is to present criteria for submittals of drainage reports, hydrology reports, and drainage statements to the City of Peoria, including the necessary information that should be included as part of such submittals. The basic purpose for preparing and submitting any of these studies is to adequately determine the finished floor elevations (FFE or FFs) of proposed improvements. In addition to this purpose, a hydrology study should specifically identify existing runoff patterns and floodplain areas, identify existing flood hazards, and determine the effect of proposed construction upon existing flows and water-surface elevations. In addition, drainage reports should specify storm water storage requirements, as well as identify required drainage improvements and structures.

Before preparing a drainage report, hydrology report, or drainage statement, the consulting engineer is strongly encouraged, to discuss the proposed drainage design with the Floodplain Engineer, or his designated representative, and obtain specific hydrologic, hydraulic, and design requirements for developing the subject parcel. Additional planning information can also be obtained as a result of this meeting, including City drainage policies found in documents with limited distribution, such as the Area Comprehensive Plan, Basin-Management Plans, Neighborhood Plans, and Specific Plans.

A. Reports

1. *Drainage Report.* A drainage report is a report that is required for any site greater than one acre in size or for any site subject to storm water storage requirements. The drainage report shall contain all elements of a hydrology report, as well as descriptive data of the appropriate components for the required storm water storage facility design. In addition, a drainage report shall be required for any site where extensive structural improvements for mitigating drainage impacts are required.
2. *Hydrology Report.* A hydrology report is a report required for developments which are not subject to storm water storage requirements, nor which require extensive structural improvements for handling drainage; but which are impacted by flows from significant watercourses and/or affected by 100-year flows of 500 cfs, or more. The objective of a hydrology report is to establish finished-floor elevations, which assure that all structures are free from flooding during a regulatory flood. Additional objectives of a hydrology report are to establish the size and configuration of flow-through wall openings and other minor drainage features; and, if required by the Engineering Director, to develop a grading plan which demonstrates adequate site drainage with no resulting impact to upstream or downstream properties.
3. *Drainage Statement.* A drainage statement is a brief description of drainage conditions applicable for a site which is not affected by 100-year flows of 500 cfs, or more, and is neither subject to storm water storage requirements nor impacted by flows from a significant watercourse. The objective is to demonstrate adequate site drainage retention according to the methods established by the Drainage Design Manual for Maricopa County, and to establish finished-floor elevations, which assure that all structures are free from flooding during a 100-year flood.

B. Conditions Requiring a Report or Data Submittal

The review and approval of drainage reports, hydrology reports, and drainage statements by staff in the Floodplain Section of the Engineering Director's Office are typically in response to reports and statements submitted in order to satisfy one of the following: (1) a requirement of rezoning; (2) a specific requirement for approval of a subdivision plat or a development plan; (3) approval of a disclosure statement prepared in conjunction with a condominium conversion; (4) the request for a floodplain, building, or grading permit for a parcel located within either a regulatory floodplain, an erosion/building-setback zone, or an identified flood-

hazard area; or (5) application for a Letter of Map Amendment (LOMA) or a Letter of Map Revision (LOMR) from the Federal Emergency Management Agency (FEMA).

The complexities of drainage reports, hydrology reports, and drainage statements depend upon many factors, such as development size, severity of existing drainage problems, extent of drainage improvements needed to satisfy Floodplain Regulations and development standards, and the need to provide storm water storage facilities. A brief description of the amount of drainage information that will be required for various development settings is provided below.

C. Report Content and Format

1. *Drainage Reports and Hydrology Reports.* Whenever a drainage report or a hydrology report is required, its presentation and format should be as brief and as succinct as possible. Unless otherwise noted herein, they should contain the following engineering information, at a minimum, presented in approximately the specified format indicated below:

a. Cover Sheet

- (1) Submittal number (i.e., first submittal, second submittal, first addendum, etc.).
- (2) Name and address of the parcel, project, or development for which the report is being submitted; the Proposed Zoning of the development (i.e. R1-36); the Planning Case Number (e.g.: PR01-00, et. al.); the approximate location of the project site relative to Township, Range, and Section; and the Floodplain FIRM Map Panel Number.
- (3) Name, address, and telephone number of the client for whom the report was prepared.
- (4) Name, address and telephone number of the engineering firm responsible for the report.
- (5) Submittal date.
- (6) Seal and signature of the Arizona Registered Professional Civil Engineer responsible for preparation of the report.
- (7) Table of Contents. All report pages shall be numbered sequentially, including any appendices.

b. Introduction

- (1) Site Location and Project Description
 - (a) When writing the report introduction, very briefly describe the general location of the parcel relative to nearby streets, drainageways, and washes.
 - (b) Submit a site-location map, at a minimum scale of three inches equal to one mile, which shows the geographical relationship of the project to nearby properties, streets, and watercourses.
 - (c) Provide a legal description of the specific parcel or parcels in question (if the description is lengthy, the information may be placed in an Appendix).

- (d) Briefly describe the type, and approximate size, of the project to be constructed. It must be clear to the reviewer, for storm water storage considerations, whether or not the parcel (or parcels) being developed is greater than, or less than, one standard acre (i.e., 43,560 square feet) in size. Any lot subdivided from a parcel greater than or equal to one standard acre in size on or after August 26, 1998 (Ord. No. 98-95) is subject to stormwater (storage) requirements, regardless of lot size. A drainage report will be required under such conditions.
- (e) In order for the reviewer to understand whether or not additional information will be forthcoming, identify those drainageways and roadways for which improvement plans will be prepared.

2. Purpose and Objectives for Submitting a Drainage Report or Hydrology Report.

- a. Give the purpose for submitting the report (i.e., Tentative Plat/ Development Plan approval, Building Permit application, Floodplain Use Permit application, condition of rezoning, etc.).
- b. Briefly enumerate the report objectives.

3. Known Development Requirements.

- a. Repeat, for the benefit of the reviewer, those drainage and land-use policies given in the Area Comprehensive Plan, Basin Management Plans, Neighborhood Plans, or Specific Plans that apply to the project site, or its immediate vicinity. Specify how these policies have been satisfactorily addressed during the design of the development. (NOTE: For many projects, this information may not be required. Consult the Engineering Director's office.)
- b. As may be appropriate, list any rezoning requirements that relate to drainage and grading, and describe how these specific requirements have been satisfied.
- c. Summarize the preliminary requirements given by the Engineering Director's staff during any Pre-Submittal Conference. Include a dated copy of the Pre-Submittal Conference Summary, if required, as prepared by the Developer or the Consulting Engineer.

4. Previous Studies. Identify all known drainage studies for the subject parcel, and for adjacent parcels that share drainageways and/or storm runoff. Mention previous submittals of the subject report, if any; and reference earlier staff correspondence, as appropriate.

5. Long-term Maintenance Responsibility. Specify the name, address, and telephone number of the person(s), firm(s), agency or agencies responsible for the ownership, operation, scheduled and unscheduled maintenance, and liability of drainage improvements (i.e., roads, parking areas, washes, drainage ways, storm water storage facilities, common areas, etc.) described in the drainage report. List other documents where these responsibilities are documented (i.e., CC&R's, Final Plats, Development Plans, etc.).

6. Required Permits. Submit a comprehensive list of permits which either have been or will shortly be obtained from those governmental agencies when approval is required by Federal or State Law, including, but not necessarily limited to: a US Army Corps of Engineers administered Section 404 (of the Clean Water Act) Permit; a Section 401 Certification; an EPA National Pollution Discharge Elimination System (NPDES) Permit;

etc. Provide document copies of the appropriate permits/applications for permits, correspondence to and from the regulatory agencies regarding the need for such permits, and assurance to the City that the Owner/Developer is in compliance with all necessary permit procedures from all such regulatory agencies. Note that, according to current Floodplain Regulations, it is the City's responsibility to make sure that the owner/developer obtains all necessary permits prior to granting final approval of the project construction.

D. Hydrology

1. Offsite Drainage.

- a. In order to help staff locate the development relative to future drainage improvements, give the name of the Major or Minor Wash, or the Regional Watercourse into which the project site drains.
- b. Describe the size, location, and hydrologic characteristics of upstream and adjoining watersheds that may potentially affect the site.
- c. Provide either a topographic map at a scale of one inch equal to 200-feet, or larger, or (preferably) a photo-topo which shows:
 - (1) The parcel boundaries, major streets, drainageways, and nearby storm-drain systems (if they are considered in the analyses);
 - (2) Boundaries of the offsite watersheds affecting the site;
 - (3) Principal points of drainage concentration; and,
 - (4) Flowlines and grade breaks used to compute basin lengths and average watercourse slopes.

Note that U.S. Geological Survey 7.5-minute or 15-minute Topographic Quadrangle Maps, as well as City of Drainage Base Maps, are generally not acceptable for delineating offsite and onsite watershed boundaries, but may be used to show large drainage basins, if the actual basin boundaries are determined from larger-scale maps. The larger-scale maps should also be included within the report.

- d. Identify and describe both the existing natural and/or man-made impacts and the proposed major developments to be located within the contributing watershed, which may impact the subject development, relative to flooding and erosion or sedimentation.
- e. Identify and describe, as appropriate, the effects that nearby impending City/County drainageway and/or roadway-improvement projects may have on site drainage or site design. Also, specify the time frame within which these improvements are planned.
- f. Submit Hydrologic Data Sheets for each significant onsite point of drainage concentration. If they are different, calculations are to be presented for both pre-development and post-development conditions. If there are many sheets, put them in an Appendix, and summarize the watershed characteristics and flood peaks in a table placed, within the text of the report. Indicate, as appropriate, whether the flood-peak estimates are for existing or future watershed conditions, or both.

2. Onsite Drainage.

- a. Describe the size, location, and hydrologic characteristics of the onsite watersheds.
- b. Unless an alternative size has been approved by the Engineering Director's staff, show onsite drainage conditions on topo maps having a minimum scale of one inch equal to 40-feet with one-foot contour intervals, as stipulated in Chapter 10 of this Guideline. A Grading Plan, Tentative Plat, or Site Plan may be modified for this purpose. Show on this map:
 - (1) Watershed boundaries;
 - (2) All points of drainage concentration, and;
 - (3) Flowlines and grade breaks used to compute basin lengths and average watercourse slopes.
- c. Submit Hydrologic Data Sheets for each point of drainage concentration. Calculations are to be presented for both pre-development and post-development conditions. If there are numerous sheets that are difficult to organize comprehensively, place them in an Appendix, and summarize the watershed characteristics and flood peaks in a table exhibited within the text of the report. Indicate whether the flood-peak estimates are for existing or future watershed conditions, or both.

E. Floodplain Analyses and Results

It is intended that the particular section of a drainage report or a hydrology report that addresses Floodplain Analyses be reserved for describing the existing and future floodplains affecting the proposed development. Either normal-depth computations or backwater computations should be used to describe the existing (pre-development) and the future (post-development) flow depths, widths, and velocities.

The format of this chapter will vary, depending upon the complexity of the prevalent drainage patterns. Therefore, the consulting engineer may exercise his or her own judgment in writing this portion of the report. However, the analyses and results must be clearly presented and organized; the calculations and design elements should be clearly cross-referenced to other appropriate sections of the report.

The following list contains the major technical items that must be included, or considered:

1. Describe the hydraulic analyses used to evaluate floodplains and floodways located in, and adjacent to, the proposed development. This description shall include a brief discussion of the theory and/or the numerical/computer model(s) used for the study, the source of input data, and any simplifying assumptions made.
2. Describe the results of the hydraulic analyses in terms of site design.
3. The following items should be shown by appropriate symbols and labels on the Site Plan, Custom Lot Developments, Minor Land Divisions, Preliminary and Final Plat, or Development Plan, if located on or within at least 200-feet of the subject development:
 - (a) All 100-year floodplain limits and areas of sheet flooding resulting from 100-year flood peaks of 100 cfs or greater shall be clearly shown and labeled, and shall also include spot water-surface elevations.
 - (b) Those areas subject to flooding from flows less than 100 cfs shall also be identified and labeled with flow arrows.

- (c) Each significant concentration point, along with its 100-year peak discharge and contributing drainage area, shall be labeled.
 - (d) All applicable floodplain and floodway limits and erosion/building setback lines shall be shown in a surveyable manner on the Final Plat. All boundaries of Federal Emergency Management Agency, (FEMA) Special Flood Hazard Areas shall be indicated and labeled with the applicable Flood Zone designation on all Site Plans, Custom Lot Developments, Minor Land Divisions, Final Plats and Preliminary Plats.
 - (e) Any Regulatory Flood Plain or Special Flood Hazard Areas shall be clearly indicated labeled as "Regulatory Flood Plain".
 - (f) All floodways shall be labeled in one of the following ways: "To be left natural," "To be channelized," "Public (or Private) Flowage Easement," "Public (or Private) Drainage Easement," or "Public (or Private) Right-Of-Way". Prior approval from the Engineering Director shall be required for the dedication of any Public Easement or Right-of-Way.
 - (g) 100-year floodplain limits, which are entirely contained within a street section or constructed drainageway, shall be labeled as such on the plan/plat, or a general note shall be included on the plan/plat that states the same.
4. The Hydraulic Calculation Sheets used in conjunction with the delineation of offsite and onsite flood plains, as well as those used for evaluating flow depths, velocities and flow durations, should be presented in a clearly understandable manner. Note that if computer input/output is submitted it must be well documented and described.
 5. All hydraulic cross sections are to be clearly identified on a map of suitable scale so that they may be easily cross-referenced to the Hydraulic Calculation Sheets used by the consulting engineer. The cross sections are to be plotted to scale, and accompanied by pertinent hydraulic information, such as the ground profile, design discharge and return period, computed water-surface elevation and depth of flow, channel and overbank velocities, effective and ineffective flow areas, Manning's roughness coefficients, wetted perimeter, energy slope and/or ground slope, Froude number, and critical depth.
 6. The calculations used to assess the hydraulic effects that existing and future structures may have upon the floodplain and floodway should be presented and be clearly described. Encroachment analyses shall be provided whenever significant development is planned within FEMA-recognized floodplains/floodways, major washes, or other washes or floodplains, as designated or determined by the Engineering Director.
 7. The floodplain analyses presented in the report being submitted should be compared with those presented in previous reports for the same geographical area. Special emphasis should be given to comparing the current results with those given in Flood Insurance Studies and Flood Insurance Rate Maps, Basin-Management Studies, and studies accompanying drainage or roadway improvement plans. Unless a FEMA Letter of Map Revision (LOMR) is to be requested, the floodplain delineation shall coincide with the FIRM limits.
 8. For developments proposing changes to an established Special Flood Hazard Area (SFHA), including SFHAs determined per the ADWR State Standard 2-96, a FEMA Conditional Letter of Map Revision is required to demonstrate the proposed impact upon the floodplain, complete with plans to address the proposed impact upon the floodplain. Development Plan approvals will be suspended until acknowledgement by FEMA is received by Peoria's Floodplain Administrator,

9. FEMA Elevation Certificates are required for any structures, lots or developments proposed to be impacted by the Special Flood Hazard Area.

F. Hydraulic Improvements and Hydraulic Structures (Drainage Report Only)

It is intended that the particular chapter of a drainage report which addresses Hydraulic Improvements and Hydraulic Structures be reserved for describing the design of any drainage improvements which are needed in order to satisfy either the wishes of the owner/developer or governmental regulations and standards, whether Local, State, or Federal.

The format of this chapter of the drainage report will vary, depending upon the complexity of the prevalent drainage patterns. Therefore, the consulting engineer may exercise his or her own judgment in writing this portion of the report, subject to specific requirements imposed by the City Floodplain Engineer.

The following list contains the major technical items that shall be included, or considered:

1. Provide a general description of the proposed drainage design for the entire project. Indicate which portions will be constructed in phases, in conjunction with other major structures.
2. Describe and present Hydraulic Calculation Sheets for each of the hydraulic systems used to collect offsite flow. Examples of these kinds of systems include collector channels, existing drainageways, and flow-through openings in perimeter screen walls. Demonstrate that the collector systems to be employed do not unnecessarily obstruct offsite flows. Encroachment analyses shall be provided, as needed.
3. Describe and present detailed and easily understandable Hydraulic Calculation Sheets for each of the stormwater conveyance systems to be constructed as part of the overall project. These systems include, but are not necessarily limited to, lined and unlined channels, drainage swales, streets and alleys, storm drains, and roadway culverts.
4. If any of the proposed drainage structures and roadways are to be dedicated to the City for ownership and operation/maintenance, Improvement Plans, prepared to City Standards, must be submitted for approval prior to the issuance of a Grading Permit or a Building Permit. When applicable, place a note on the Final Plat, Development Plan, Site Plan, and Grading Plan that indicate the conditions of dedication.
5. If computer input/output data are submitted in conjunction with hydraulic computation sheets, they must be well documented and explained.
6. Describe and present Hydraulic Calculation Sheets for each of the hydraulic systems used to return the flow to either its natural or existing location and magnitude along the downstream property line.
7. If flows are to be concentrated or ponded on the upstream or downstream side of the subject property, either a recorded drainage easement or written permission must be obtained from the appropriate property owner(s) prior to issuance of Grading Permits or Building Permits. When this condition applies, place a note on the Development Plan, Final Plat, Site Plan, and Grading Plan, as appropriate, which indicates the same. If drainage improvements are proposed for offsite areas, written approval from the offsite property owner(s) will be required.

G. Storm Water Storage Facilities

1. Storm water storage Location and Description.
 - a. Provide calculations needed to demonstrate that storm water storage can be provided in accordance with criteria given in the Maricopa Standards (i.e., the "Drainage Design Manual for Maricopa County" Vol. II). Provide calculations for the required volume of storm water storage for the 100-year, 2- hour storm per the FCD Standards.
 - b. Give a general description of the proposed storm water storage scheme for the entire project. Indicate which basins and appurtenant drainage structures will be constructed in proposed phases.
 - c. Submit a detailed site plan which clearly shows the dimensions and locations of all proposed storm water storage systems, including:
 - (1) The locations, sizes, and types of inflow and outflow structures to be employed.

Include dimensions and elevations of critical portions of those structures

- (2) The location and size of access and maintenance access ramps and roadways
 - (3) Boundaries of Common Areas and Private Drainage Easements which cover the basin, inlet and outlet structures, inflow and outflow drainage channels, and maintenance routes
 - (4) Clearly marked dimensions of all building and/or erosion setback zones (i.e., additional space provided for structural safety considerations). Show the dimensions or distances between building structures and any proposed basins or drainage ways
 - (5) Maximum water-surface elevations, and the limits of ponding
 - (6) Identified locations and types of all security barriers to be installed around the basins, as appropriate
- d. Provide details and discussions of how the proposed storm water storage scheme will comply with landscaping and grading guidelines required by the City's Development Standards.
2. Retention Basin Design per Section 4-3 of this Chapter.
 3. Detention Basin Design Report Requirements Additional to Section 4-3.
 - a. Provide and describe Reservoir-Routing Calculation Sheets for each basin for the 2-year, 10-year, and 100-year design floods, at a minimum. The Reservoir-Routing Calculation Sheets shall, at a minimum, consist of a working-table for each basin, and a routing-table for each flow event. Note that the City may reserve final approval of basin design until its acceptance of the project's drainage control grading.
 - b. Provide and describe any other Hydraulic Calculation Sheets prepared while evaluating stage-storage and stage-discharge relationships, or any other pertinent data used in the basin analysis and design.
 - c. Submit plotted inflow and outflow hydrographs (preferably superimposed). Include any lag-time calculations.
 4. Basin and Drainageway Maintenance.
 - a. A detailed Drainage way and Storm Water Storage Facility Maintenance Checklist and Schedule shall be provided by an Arizona Registered Professional Civil Engineer, which will be followed by anyone performing scheduled and unscheduled maintenance on behalf of the owner(s). Each of the privately owned drainage structures and storm water storage facilities to be regularly inspected shall be identified. The identification shall reference specific portions of construction documents of the approved final design. Note the minimum frequency of inspection and indicate the expected range of acceptable performance (i.e., sedimentation levels, scour hole dimensions, etc.). If private drainageways or other water-conveyance structures are proposed, but storm water storage facilities are not, a maintenance checklist and schedule shall still be prepared as part of the drainage report. In these cases, the engineer may exercise his or her own judgment as to the location within the report where he or she wishes to place the discussion of maintenance.

b. As part of the checklist, state that the annual inspection report shall contain the following summaries:

- (1) A statement saying that either no maintenance work is needed at that time, or a list of repairs and work to be done to correct deficiencies, to avoid potential problems, and/or to restore the aesthetics. Also state that this work shall be followed by a Letter of Certification from an Arizona Registered Professional Civil Engineer verifying that the recommended work has been satisfactorily completed. The Engineer shall notify the Engineering Director, in writing, should safety-related maintenance not be completed within a reasonable period of time.
- (2) A statement either indicating that watershed conditions have not changed since the previous inspection report, or stating that specific changes have occurred which alter or eliminate some of the design features thereby affecting the level of service of the drainage and storm water storage systems. In addition, the Engineering Director is to be immediately notified, in writing, if watershed conditions have changed to the extent that drainage and storm water storage systems no longer satisfy the requirements of the County Floodplain Regulations.

H. Summary and Conclusions

1. Provide a brief summary of the important analyses and conclusions presented in the report.
2. Certify that the proposed drainage plan, once properly constructed, will adhere to applicable Local, State, and Federal Floodplain Regulations.

I. References

Alphabetically list all of the sources of information and design procedures used in developing the drainage analysis and design.

J. Appendices

Place Hydrologic, Hydraulic, and Reservoir-Routing Calculation Sheets, and other relevant documents, in one or more referenced appendices. Number the pages.

K. Drainage Statement

A drainage statement may be submitted in lieu of a drainage report or hydrology report. Because site conditions vary considerably within the area, each drainage statement may be different in content and format. The Arizona Registered Professional Civil Engineer preparing the report may exercise his or her own judgment in presenting the technical information for review. In all cases, the drainage statement must be clearly written, sealed, and signed by the Engineer; and may contain the following information concerning the proposed project:

1. A brief description of the type and size of the proposed development, including a legal description of the parcel or parcels being developed;
2. A brief description of the amount of runoff expected on, or near, the site;
3. A 200-scale aerial photo-topo, or other acceptable map, showing the subject parcel, the contributing drainage areas and their principal points of drainage concentration, and any other pertinent information related to the site design;
4. Hydrologic Calculation Sheets concentration for each principal point of drainage;

5. The appropriate Hydraulic Calculation Sheets used in designing the proposed method of drainage disposal;
6. A 40-scale Site Plan, for review and approval;
7. Where significant changes to hydraulic structures, storm water storage facilities, grades, FFEs, or other development conditions occur on the grading plan submitted for the purpose of a grading permit, a drainage-report addendum, justifying the proposed changes, must be included with the plan.

L. Quality of Submittals

The Arizona Registered Professional Civil Engineer shall be held solely responsible for the correctness and adequacy of all data, drawings, calculations, and reports submitted to the City Of Peoria for review and approval. In addition, the Engineer shall comply with all Local, State, and Federal Floodplain Regulations in the design of the development.

Staff in the Engineering Director's Floodplain Compliance Section will review the technical submittals for completeness and general compliance with all applicable Floodplain Regulations and Drainage Standards. Approval by the City does not necessarily imply that the design is appropriate, or that the development is in strict compliance with all applicable regulations and standards. Review and approval of drainage submittals shall not create liability on the part of the City or its employees for any flood damages that may result from reliance upon any administrative decision made by the City or its employees.