CITY of PHOENIX

Storm Water Policies and Standards

March 2004

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Notice:

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Acronyms

Term	Description
ACDC	Arizona Canal Diversion Channel
ADEM	Arizona Division of Emergency Management
ADEQ	Arizona Department of Environmental Quality
ADMP	Area Drainage Master Plan
ADMS	Area Drainage Master Study
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
APP	Aquifer Protection Permit
ARS	Arizona Revised Statute
ASTM	American Society for Testing Materials
BFE	Base Flood Elevation
BMP	Best Management Practice
BWCDD	Buckeye Water Conservation Drainage District
CAP	Central Arizona Project
CC&R's	Covenants, Conditions and Restrictions
cfs	cubic feet per second
CIPP	Cast-in-Place Pipe
CLOMA	Conditional Letter of Map Amendment
CLOMR	Conditional Letter of Map Revision
CSP	Corrugated Steel Pipe
COP	City of Phoenix
CRS	Community Rating System
DCM	Design & Construction Mgmt Division (City of Phoenix Street Transportation Dept.)
DSD	Development Services Department (City of Phoenix)
EPA	Environmental Protection Agency
FCDMC	Flood Control District of Maricopa County
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
fps	feet per second
Fr	Froude Number
gpm	gallons per minute
HDPE	High Density Polyethylene

Acronyms

Term	Description
hp	horsepower
HVAC	Heating, Ventilation and Air-conditioning
LOMA	Letter of Map Amendment
LOMR	Letter of Map Revision
MAG	Maricopa Association of Governments
MCDOT	Maricopa County Department of Transportation
MSGP	Multi-Sector General Permit
NFIP	National Flood Insurance Program
NOI	Notice of Intent
NOT	Notice of Termination
NPDES	National Pollutant Discharge Elimination System
npsh	net pump suction head
NRCS	Natural Resource Conservation Service
OEP	Office of Environmental Programs (City of Phoenix)
PMF	Probable Maximum Flood
PMR	Physical Map Revision
PRD	Parks and Recreation Department (City of Phoenix)
RCP	Reinforced Concrete Pipe
RID	Roosevelt Irrigation District
ROW	Right of Way
rpm	revolutions per minute
SCS	Soil Conservation Service
SFHA	Special Flood Hazard Area
SRP	Salt River Project
SWMP	Storm Water Management Plan
SSA	State Standard Attachment
SWPPP	Storm Water Pollution Prevention Plan
TDH	Total Dynamic Head
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDOT	United States Department of Transportation
USGS	United States Geological Survey
WCMP	Watercourse Master Plan

1 INTRODUCTION

1.1 PURPOSE

It is the intent of the City of Phoenix to have a comprehensive storm water management program that protects the health, safety, and welfare of its citizens, their property, and the environment. This document outlines the City's philosophy on planning for storm water facilities, the federal and state regulations pertaining to such facilities, and the City's storm water ordinances, policies, and standards. This document is intended to be used in concert with the *Drainage Design Manuals for Maricopa County (Hydrology, Hydraulics, & Erosion Control)*. The objective of the *Drainage Design Manuals for Maricopa County* is to provide technical guidance for storm drainage facilities in Maricopa County. The Hydrology and Hydraulics Manuals provide a convenient source of analytical and design information that is specifically tailored to the unique hydrologic, environmental, and social character of Maricopa County. Together, these four documents supercede City of Phoenix "Storm Drain Design Manual – Storm Drains With Paving Of Major Streets" (July 1987) and the "Storm Drain Design Manual – Subdivision Drainage Design" (July 1988).

The City of Phoenix reviews and approves drainage reports and plans for construction projects for general conformance with the City's policies and standards. This not withstanding, the City does not assume liability for insufficient design or improper construction. This review and approval does not absolve the owner, developer, design engineer, or contractor of liability for inadequate design or poor construction. The design engineer has the responsibility to design drainage facilities that meet standards of practice for the industry and promote public safety. Compliance with the regulatory elements, policies, and design standards does not imply a guarantee that properties will be free from flooding or flood damage. The City, its officials, or employees assume no liability for information, data, or conclusions prepared by private engineers and makes no warranty expressed or implied in its review/approval of drainage projects.

1.2 BACKGROUND

In 1997, the City of Phoenix Street Transportation Department and Development Services Department embarked on an effort to update and bridge the differences between the 1987 and 1988 Phoenix drainage manuals. In 1998, the City of Phoenix started a collaborative effort with the Flood Control District of Maricopa County to meld their drainage manuals. This final collaboration provides three major benefits. First, various technical aspects of both the City and County's manuals have been updated with advances in the engineering science and further experience with applications unique to Maricopa County. Second, the advances in computer technology provide the opportunity to develop living manuals posted on the internet that also include unique engineering software for the design/evaluation of drainage facilities. Third, the

"uniform policies" identified in the *Drainage Design Manual for Maricopa County* first edition have been removed to allow the City of Phoenix and Maricopa County to have their own individual policies and standards. In this sense, the *Drainage Design Manuals for Maricopa County* serve strictly as technical manuals, relegating Phoenix policies and standards to this *City of Phoenix Storm Water Policies and Standards Manual*. The Flood Control District of Maricopa County will have a similar "Policies and Standards" manual for work that is unique to their agency needs. In this way, other local agencies may easily adopt the County's technical manuals and methodologies, while continuing to exercise their own individual policies and standards that best meet their needs and desires.

The users of these manuals are encouraged to routinely check the web-based version for updates as all addenda will be issued as needed by this means.

1.3 SCOPE

The City of Phoenix Storm Water Policies and Standards Manual, is divided into eight chapters that address the major administrative areas of storm water management. The intent of this manual is to provide regulatory guidance for the design of storm water facilities. Chapter 2, Planning, stresses the City of Phoenix's vision for storm water management while providing guidance for the planning process. The storm water management policies provided in Chapter 3 build upon this vision and are supported by the City's ordinances. Federal, State and other regulatory requirements are outlined in Chapter 4, Regulations. The City of Phoenix ordinances are provided in Chapter 5. The standards, provided in Chapter 6, identify specific criteria for the design of storm water facilities in conformance with the more general policies. Chapter 7 identifies the procedures for modifying Phoenix policies and standards. Finally, Chapter 8 describes the software developed by the City to facilitate drainage submittals and review.

2 PLANNING

2.1 INTRODUCTION

Storm water runoff facilities are an integral part of public infrastructure systems and should be planned as such. The drainage engineer must be included in the formulation of both site-specific and regional drainage plans and all urban planning should be coordinated from the beginning with the drainage engineer. Drainage master plans need to be carefully prepared for all local and regional flood control and flood management projects, and this same general concept should be followed for land development of all sizes. A drainage master plan, in addition to providing a unified drainage plan, should be coordinated with planning for open space and recreation facilities, planning for transportation, and other urban considerations. Drainage planning should not be done after all the other decisions are already made as to the layout of a new subdivision, commercial or industrial area. It is this latter approach which creates drainage problems which are costly to correct.

Good planning ultimately results in lower cost drainage facilities and a better community. Natural drainage ways and street drainage patterns should be coordinated to achieve the policies and design criteria presented in this Manual. The construction and/or long term maintenance costs for drainage and flood control measures are high when planning is poor. The quality of the planning significantly impacts the costs to the developer and City. Furthermore, inadequate planning potentially affects residents and other infrastructure systems in terms of flood damages.

Supplemental or complimentary benefits and uses from drainage facilities should be considered. Both passive and active recreational uses are examples. Any effort made towards increasing local and community-wide benefits is appropriate and is encouraged.

Consideration of multiple uses and multiple benefits in drainage planning and engineering can minimize societal costs and increase benefits to the community. A way to maximize consideration of these multiple uses is by preparing practical drainage master plans so that the overall effort is coordinated with predetermined objectives.

2.2 PLANNING PHILOSOPHY

Planning of drainage facilities should be based upon incorporating natural waterways, artificial channels, storm drains, and other drainage works into the development of a desirable and aesthetic community, rather than attempting to superimpose drainage works on a development after it is laid out. Channels and storm water storage facilities that are designed as a focal point of the community minimize mis-use (e.g. dumping) and encourage proper maintenance.

Urban drainage should be considered on the basis of two design phases. The first is the planning phase where master drainage plans are developed. The second is the final design phase, which encompasses detailed engineering using the first phase as the basis for the final design. The first phase is a more global view, as discussed herein, and results in the conceptualization of an overall drainage solution. The second phase is an extension of the first and it is here that the engineering details for the localized issues get worked out.

The drainage system is the backbone of good urban planning in that a well planned system can reduce or eliminate the need for costly underground storm drains, and it can protect the urban area from extensive property damage and loss of life from flooding. This system is generally designed for the more severe and less frequent storm water runoff, such as the 100-year return period. It generally consists of open channels; however, large storm drains can be used. It must be remembered that the drainage system exists in a community whether or not it is planned and designed, and whether or not development is situated wisely with respect to it. Water will obey the law of gravity and will flow downhill to seek its lowest level whether development and people are in its way or not.

2.3 BENEFITS OF PLANNING

Good drainage planning is a complex process. Basic planning considerations that should be taken up early include planning for the drainage system, developing a grading concept, and planning for the environment. When planning a new subdivision for residential purposes, various drainage concepts should be evaluated before decisions are made as to street location and block layout. It is perhaps at this point of the development process where the greatest impact can be made as to the cost of drainage facilities. When flood hazards are involved, the planner should take these hazards into consideration in land planning to avoid unnecessary complications.

Benefits that can be derived from a good drainage plan include:

1. Reduced street maintenance costs
2. Reduced street construction costs
3. Improved movement of traffic
4. Lower cost open space
5. Lower cost park areas and more recreational opportunities
6. Development of otherwise undevelopable land
7. Opportunities for lower building construction cost
8. Avoidance of flood damage claims and resultant litigation.

9. Avoidance of fines and fees levied for non-compliance with Federal and State regulations, including NPDES Storm Water regulations.

2.4 TYPES OF DRAINAGE PLANS

Drainage plans can be divided into two types, master drainage plans and final drainage plans. Master drainage plans or preliminary drainage plans as they are sometimes referred, deal with the broad assessment of existing drainage conditions and development of conceptual solutions to drainage problems, either existing or induced by a proposed project. Final drainage plans provide engineered solutions and details to support the final design of a project.

Regional Drainage Planning

On a watershed basis, regional master drainage plans, otherwise called Area Drainage Master Study's & Plans (ADMS's & ADMP's), are prepared to identify areas of existing flooding problems and present potential alternative solutions. Solutions typically include an array of storm water conveyance and storage alternatives. These plans are an excellent source for hydrology as sub-basin hydrographs are typically provided for the 6 and 24 hour storms. The ADMP is typically a more detailed study providing more robust flood prevention designs.

A Watercourse Master Plan (WCMP) is similar to an ADMP, except that a WCMP has more of a focus on the management of a particular watercourse and associated flood hazard zones.

Drainage Planning for Land Development

Master drainage plans are also prepared for land development projects. Here, the focus is to identify existing flooding conditions and to develop approaches to prevent the proposed development from exacerbating existing flooding conditions while protecting the proposed development. Master drainage plans for developments are typically required for large parcels of land (80 acres and larger), but the principles remain valid for all parcels regardless of size. The key to master drainage plans for land developments is determining the magnitude of flow entering the property, developing an approach to intercept this flow, identifying a workable means of conveying the flow through the project and discharging the flow to the downstream drainage network (whether natural or man-made) in a manner similar to existing conditions. Master drainage plans for land developments also identify locations for storm water storage facilities to accommodate on-site runoff.

Final Drainage Plans

As identified above, final drainage plans provide engineered solutions and details to support the final design of a project. Here, the hydrology and hydraulics of the selected approach from the master drainage plan is further refined to apply to the chosen drainage solution. The project may be a regional capital improvement project to alleviate existing flooding conditions or improvements associated with land development.

The primary difference between master drainage plans and final drainage plans is that master drainage plans are more conceptual and may assess more than one potential solution. The master drainage plan becomes a building block for the final drainage plan. The final drainage plan addresses details such as depth of flow in roadways and storm sewer geometry that are not generally fully defined at the master drainage plan level. Master drainage plans do not require detailed grading plans in order to develop conceptual drainage solutions whereas final drainage plans are prepared in concert with grading plans.

2.5 INFORMATION FOR DRAINAGE PLANNING

There is a significant amount of existing information available to the hydrologist or drainage engineer that should be considered when undertaking a master drainage plan. The following table highlights some of these.

Item	Source	Description
Flood insurance studies	FEMA	Watershed peak discharges, floodwater levels, flood risk.
Area Drainage Master Plans & Studies (ADMP & ADMS)	FCDMC, Municipalities	Watershed hydrographs and peak discharges, conceptual storage and conveyance solutions.
Watercourse Master Plans (WCMP)	FCDMC, Municipalities	Management of a particular watercourse and its associated flood hazards
Studies & plans from existing flood control projects	FCDMC, USACE, USBR, NRCS	Examples: ACDC, Cave Buttes Dam, CAP dikes, Indian Bend Wash.
Transportation Plans & Studies	ADOT, MCDOT, Municipalities	Corridor studies address existing and proposed drainage conditions. Plans depict drainage improvements.
Land use zoning maps	Municipalities	Provides insight to future runoff characteristics. Zoning may limit type of drainage solution.
Soil maps	NRCS	Identifies runoff characteristics and engineering limitations
Aerial Photography	Municipalities, MCDOT, ADOT private	Identifies watershed and existing land-use characteristics

Item	Source	Description
Topographic mapping	Municipalities, MCDOT, ADOT, USACE, USBR, USGS, private	Used to determine watershed boundaries, slopes, and water-course hydraulic characteristics
ALTA Surveys	Maricopa County Recorder's Office	Land ownership, boundary & utility easements (if available)
Drainage plans from adjacent developments	Municipalities, Developers, Home Owners Assoc.	Depicts existing or proposed conditions for adjacent properties that may affect the site under study
Specific regional and arterial street storm drain reports	FCDMC, Municipalities, ADOT, MCDOT	Provide specific final drainage plans for regional and arterial street storm drain systems

2.6 MASTER DRAINAGE PLANNING PROCESS

Plan Development

The master drainage planning process requires the collection and assimilation of information from most of the sources identified above. Consideration must be given to regulations/permitting, environmental impacts, ordinances, open space, zoning, regional hydrology, flood hazards, safety, and cost. 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.

Waters of The U.S.

Plans that impact waters of the U.S. must be permitted through the Army Corps of Engineers. For many areas under study, jurisdictional waters exist. Therefore, master drainage plans must consider the impacts to jurisdictional waters (See Chapter 4, Regulations). The professional preparing a master drainage plan must have knowledge of the requirements of Section 404 of the Clean Water Act to apply to the planning objective and may need to have the jurisdictional waters delineated early in the master drainage planning process. It is likely that the jurisdictional waters will have a significant impact on the overall drainage plan and on-going maintenance activities.

Ordinances and Policies

All master drainage plans must conform with the City ordinances and with the City of Phoenix Storm Water Policies and Standards. These set the guidelines for all storm water drainage improvement projects, be they public or private.

Linear Open Space

The concept of combined flood control/recreation uses can be applied to drainage corridors. Natural or semi-structural drainage corridors can be developed with landscaping and multi-use trails incorporated into the drainage design to provide recreational opportunities. This concept can be applied to new drainage channels and storm water basins that are utilized for recreation and existing open channels that currently do not provide recreational opportunities. The multi-use trails should be located above the channel banks to minimize storm water runoff erosion, interaction with nuisance flows, and to minimize maintenance requirements.

The City stresses the establishment of natural or semi-structural drainage corridors. Utilizing natural corridors to accommodate storm water is the City of Phoenix preferred approach for several reasons.

1) Watercourses make excellent natural open spaces of high scenic quality due to their associated vegetation, wildlife and landforms.

2) Natural features such as topography and natural processes such as erosion have defined the land along natural watercourses as a storm water runoff corridor for intermittent drainage.

3) Desert adapted vegetation is dependent on natural watercourses for water supply and seed disbursement/germination.

4) Many desert wildlife species are adapted to seek watercourse areas for food and shelter.

5) Impacts to watercourses have environmental consequences such as habitat loss, reduced flood conveyance, loss of a valuable landscape amenity, and reduced ground water recharge.

6) Impacts to watercourses often have decreased property value implications as environmental impacts diminish abutting land value.

7) Designating open space along watercourses is often more cost effective for the developer due to the increased risk of flooding in these corridors.

8) Engineered storm water conveyances should be developed in a linear open space system, if one is existing or planned for the area.

Storm Water Storage

In the planning process, drainage corridors and storm water storage basins should be combined where feasible with open space, parks, and trails to create focal points for the community instead of isolated tracts. These combined uses should be planned and designed to augment City of Phoenix parklands. The benefits of this approach are an enhanced sense of community, increased open space with landscape amenities, and decreased crime.

The City encourages combined use of drainage and recreation facilities on both public and private lands. The desired location for storm water storage basins is adjacent to parks to increase the open space. Given the demand for organized sports such as soccer, football, baseball and softball which require large fields; basins should be used for more than one purpose. These basins should be designed with tiers or gentle slopes to allow for the collection of nuisance water and conveyance around fields to allow for dry field areas under normal conditions. Siting recreational facilities at the very bottom of basins should be avoided. It is recommended that storm water storage basins be non-geometrically designed to provide a more natural and aesthetically pleasing method of addressing runoff and storm water storage.

Design of multi-use basins or basins adjacent to parks should be coordinated with the City Parks and Recreation Department. Design of storm water storage facilities should also be coordinated with the Street Transportation Department to achieve compliance with water quality requirements.

Zoning

Zoning often dictates the nature of watercourse development and open space requirements for land development projects. Rezoning land to address flooding or erosion hazards, either through the use of an overlay or replacement zoning district (such as the flood hazard and erosion management district), or through conditions of zoning approval that limits the use of such land, is intended to provide a natural or limited structural design approach to watercourse management. Generally, this results in ideally situated open space. Even small washes lend themselves to regulation in the same manner as larger watercourses if the identification of the flood hazard and erosion impact is initiated early enough. Where Watercourse Master Plans have been completed, a Flood Hazard and Erosion Management Zoning District (or a district of similar design) may dictate land-use/drainage design options. In other areas, individual rezoning applications or zoning overlay districts (such as the desert maintenance character overlay) may include stipulations or design guidelines that address watercourse treatment and the degree to which the watercourse may be altered or disturbed. Generally, zoning requirements will take precedence over other storm water regulations when they are more restrictive in nature.

Design Hydrology and Hydraulics

At the master plan level, the drainage engineer should concentrate on quantifying off-site flows that may impact the project and determine the means for conveying the flow through the project site. Review of a Flood Control District of Maricopa County (FCDMC) Area Drainage Master Study/Plan that encompasses the project area could provide the design team with valuable information pertaining to the magnitude of storm water affecting the project area. The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) should also be reviewed to establish if regulated floodplains are within the project area. Where existing studies are not available, the drainage engineer should contact the City and FCDMC to see if any new studies are planned or are in progress[1]. "In-progress" information is often available, and if not, staff experience may be extensive.

A reasonable estimate of the design peak discharge is necessary to approximate the channel or drainage structure capacity and size. The improvements presented in a master drainage plan shall not adversely impact adjacent property owners. In other words, flood stage and velocity (when erosive) can not be increased off-site.

For the master drainage plan, on-site hydrology is typically performed to estimate storm water storage requirements[2] and the approximate size and layout of storm drains[3]. Here, drainage divides are often times set consistent with existing topography since the desired grades have yet to be determined. This is a reasonable assumption since earthwork costs become significant to appreciably change direction of slope from the existing direction.

Flood Hazards

Master drainage plans need to focus on more than flood levels derived from open channel hydraulic analysis. Aggradation of channel beds via sedimentation and degradation of channels from erosive processes are threats to the performance of drainage systems that must be considered. In addition, the lateral migration of watercourses threatens public health and welfare unless proper erosion hazard zones are provided. The determination of flood levels on alluvial piedmonts is particularly challenging because of active geomorphic processes. Finally, ponding areas upgradient of elevated roads, railroads, and irrigation canals must be considered during the development of the master drainage plan.

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[1] In areas where older studies exist, the professional should contact the FCDMC to determine if the area is under re-study.

[2] Storm water storage for most land-uses can be approximated on an ac-ft/acre basis. Storm water storage area requirements are often estimated as a percentage of the overall area.

[3] Storm drains are designed during the final design process. The size and alignment for storm drains are often dictated by proposed road configurations and contributing drainage area.

Safety

A basic tenet of any storm water improvement project is the promotion of public safety. Public safety must be a consideration taken throughout the development of a master drainage plan. Excessive storm water depth and/or velocity poses a threat to safety and public health.

Cost

During the development of a master plan, initial capital costs and long term maintenance costs must be considered. Ideally, the least societal costs necessary to provide the required level of protection to the public is the desired goal. Attainment of this goal is fostered by adherence to the City of Phoenix's policies and standards.

2.7 APPROACH TO MASTER DRAINAGE PLANNING

Open Channel Conveyance

The alignment of a drainage system is often set by following the natural watercourse flow line or low flow channel. In these cases, the alignment is a more straightforward matter, and essentially it need only be defined on mapping.

In many areas about to be urbanized, the runoff has been so minimal that well-defined natural channels do not exist. However, low flow channels nearly always exist which provide an excellent basis for location of improved channels. Use of these channels to convey storm water is likely to reduce development costs and minimize drainage problems. In some cases, the wise utilization of natural watercourses in the development of a drainage system will eliminate the need for an underground storm drain system. Where Watercourse Master Plans have been completed, setbacks for erosion hazard zones may have been identified. If setbacks have not been defined as part of the Watercourse Master Plan, then erosion hazard should be approximated following the methodologies identified in the Hydraulics Manual. Detailed lateral migration and long-term erosion analysis would be performed as part of final design in those circumstances.

In many urbanized areas, there is no well-defined watercourse, or the watercourse has been filled and built upon. In this instance, the master plan establishes channel alignment.

The master plan is where major decisions are made as to design velocities, location of structures, means of accommodating conflicting utilities, and the potential alternate uses in the case of an open channel. The choices of channel types available to the design team are numerous, depending only upon good hydraulic practice, environmental design, sociological impact, and basic project requirements. However, from a practical standpoint, the basic choice to be made initially is whether or not the channel is to be lined for higher velocities or if a natural channel already exists and can be effectively utilized with considerations to erosion setbacks and the 100-year flooding limits.

A more natural approach is preferred. The ideal channel is an undisturbed one. The benefits of such a channel are that:

1. Velocities are usually lower; resulting in longer concentration times and lower downstream peak flows.

2. Natural channel and overbank floodplain storage tends to decrease peak flows.

3. Maintenance needs are usually less than artificial channels because it is in dynamic equilibrium with the natural erosion/sedimentation process.

4. The channel provides desirable open space and recreational area adding significant social benefits.

5. The closer an artificial channel character can be made to that of a natural channel, generally the better will be the artificial channel.

For a master plan, the level of analysis necessary to establish artificial channel widths varies. If the artificial channel is for a major watercourse (say design discharge greater than 500 cfs) or a natural channel with varying geometry and slope, a detailed floodplain analysis is likely to be required. This is also dependent upon the existing/proposed land-use and whether encroachments, such as road culvert embankments, affect the flow regime. Otherwise, simple “normal depth flow” calculations may suffice. Watershed master planning typically requires the former level of analysis while the latter is usually adequate for subdivision master planning. Supercritical flow analysis may be warranted depending upon channel slope, channel lining, design discharge and other factors.

Another key component of planning for a channel at the master plan level is the transitioning of flow into and out of a proposed channel. As identified herein, a key City of Phoenix policy requires that proposed facilities do not exacerbate flooding conditions for abutting properties. Thus, any drainage improvement must not increase water levels or result in erosive velocities greater than existing conditions. Interceptor channels may be required to funnel flow into a channel. Similarly, spreading basins or channel expansions may be necessary to transition from an artificial channel to the existing floodplain.

Storage

The master plan is where decisions need to be made on the use of storm water storage facilities and their location. The siting of storage facilities where topography is favorable to the excavation of basins will provide significant benefits including the reduction of peak flows, the settling out of sediment and debris and the likely improvement to the quality of water downstream.

For preliminary sizing of storm water storage facilities, storage per unit area relationship along with a safety factor can be utilized to derive an approximate storm water volume for storage[4]. The storage per unit area is primarily dependent upon the land-use of the proposed project within the contributing drainage area.

For land development projects involving large acreage, establishing contributing drainage area prior to final design can be problematic for the inexperienced. Overlaying the proposed site plan with existing topography allows for the development of a conceptual or preliminary grading plan. Establishing proposed grade breaks consistent with existing drainage divides establishes drainage area. Maintaining existing watershed boundaries during the master planning effort provides an additional benefit in that it minimizes earthwork and storm drainage expenditures pursuant to final design. Undertaking such an approach supports the basis for preliminary storm water storage design and will minimize dramatic revisions for storm water during final design.

Environmental Protection

As explained in the Regulations section of this manual, there are numerous federal, state, and municipal regulations that must be adhered to during plan development and implementation. At the federal and state level, 404 (waters of the U.S.) and 401 (water quality) permitting are typically required during the project approval process and may be required for maintenance or other activities proposed in conjunction with the drainage facilities. For the City of Phoenix, the plan must comply with 40 CFR 122, storm water quality. Taking the requirements of these regulations into account during the development of the master drainage plan will streamline the design and implementation process. For example, recognition of the trigger points in 404 permitting will provide guidance in developing mitigation plans (see Chapter 4, Regulations). The City of Phoenix strongly endorses minimizing disturbances to natural watercourses in order to lessen the impacts to jurisdictional waters and wildlife habitat.

2.8 FINAL DESIGN CONSIDERATIONS

With the major drainage system conceptualized, attention to the remainder of the project area can be given relative to localized drainage concerns. For land development projects, maintaining existing watershed boundaries during the master planning effort minimizes earthwork and storm drainage expenditures. Such an approach also supports the basis for preliminary storm water storage design.

[4] By way of example, residential areas with a rational method “C” value of 0.65 require approximately 0.15 ac-ft per acre of development. This translates to roughly 11 percent of the land depending upon side slope/embankment grading and recreational features such as tot lots and ball courts that need to be elevated above nuisance water.

The master drainage plan serves as the framework for final design. A thorough master drainage plan streamlines the final design process. That is not to say that changes will not occur during final design. However, wholesale changes will not occur due to drainage issues.

It is during final design that street drainage is analyzed and catch basins/storm drains are designed. The specifics and supporting analysis for open channels including culverts/bridges and the influences of sedimentation/scour are developed during final design. It is here that storm water storage facility details, including pump stations if appropriate, are enumerated to permit review by the City of Phoenix and subsequent construction. During final design, the design engineer applies the policies and standards of the City of Phoenix to minimize capital cost and long term maintenance of the drainage improvements while accommodating safety concerns. A Storm Water Management Plan is developed and submitted with the final design to the City for approval coincident with submittal of a 404 Permit application to the Army Corps of Engineers.

3 POLICIES

3.1 INTRODUCTION

It is the intent of the City of Phoenix to have a comprehensive storm water management program that protects the health, safety and welfare of its citizens, their property, and the environment. The City's storm water management documents include the following:

- City Code – Chapter 32A, Grading and Drainage
- City Code – Chapter 32b, Floodplains
- City Code – Chapter 32C, Storm Water Quality Protection
- City Code – Chapter 41, Zoning
- City Drainage Policies
- City Drainage Standards
- Drainage Design Manual for Maricopa County, Hydrology
- Drainage Design Manual for Maricopa County, Hydraulics
- Drainage Design Manual for Maricopa County, Erosion Control

The City has adopted floodplain management and storm water drainage policies that set forth guiding principles for storm water management. These drainage policies fall under the following categories:

- Drainage Character
- Hydrology
- Water Quality
- Floodplain Management
- Street Drainage
- Conveyance Facilities
- Storage Facilities
- Maintenance
- Erosion Control
- Permitting

These policies, together with the Phoenix City Codes, the Phoenix Drainage Standards (chapter 6), and the Maricopa County Drainage Design Manuals, define the criteria and procedures to be used for storm water management and drainage design in the City of Phoenix.

Variances from policies and/or standards may be allowed under certain circumstances. For a variance, the design engineer must provide engineering justification and request approval by the management of the reviewing department. Requests must be made in writing. Prior to making such request, the engineer is encouraged to discuss options with City staff for further guidance.

3.2 DRAINAGE CHARACTER

The provision for facilities to convey storm water runoff is a necessary part of land development activity. Proper planning and design of drainage facilities is as important as that for water, wastewater, streets and other infrastructure needs in a growing community. In the natural environment, storm water runoff will determine its own course. Land development may require alteration of the natural alignment of a drainage system. This may result in realigned flow paths, larger peak discharges, greater volume of runoff, higher water surface elevations, increased flow velocities and other drainage modifications which can adversely impact adjacent property owners. As a result:

- Historic drainage patterns shall be maintained, to the extent possible, within practical and economical constraints.

- Drainage improvements shall not adversely change water surface elevations and flow velocities where runoff enters and exits a property being developed, such as the concentration of sheet flows or braided washes.

- The City of Phoenix strongly endorses minimizing disturbances to natural watercourses in order to lessen the impacts to riparian vegetation, wildlife habitat, and jurisdictional areas. Use of elevated roadways adjacent to natural watercourses to facilitate the preservation of watercourses is accepted. A plant salvage plan shall be completed and approved by the reviewing department prior to any grading activities associated with roadway improvements or the issuance of a grading and drainage permit.

- Any facility or structure that will be located within a watercourse, drainageway, or other means of conveying or storing storm water shall be designed and constructed to City Standards.

3.3 HYDROLOGY

Hydrology addresses surface water and the estimation of peak discharges, volumes and time distributions, which result from precipitation. Hydrologic data is fundamental in the design of drainage facilities.

Peak discharges and runoff volumes shall be calculated in accordance with the procedures in the Drainage Design Manuals and for the durations and return frequencies specified in the City Standards.

3.4 WATER QUALITY

No person or entity may cause the discharge of pollutants[1] into a public storm sewer system or facility. Pollutants released to the land surface that subsequently become a constituent of storm water runoff are considered a discharge of pollutants[2]. Soil is considered a pollutant when it is entrained in storm water runoff from construction sites in quantities greater than natural conditions. Erosion control measures for new developments shall be in conformance with the Flood Control District of Maricopa County Erosion Control Manual.

3.5 FLOODPLAIN MANAGEMENT

The City of Phoenix participates in the National Flood Insurance Program (NFIP) which provides flood insurance to its citizens, flood mitigation assistance and emergency assistance to flood victims. The Federal Emergency Management Agency (FEMA) oversees the NFIP. FEMA has regulations pertaining to floodplain management that must be followed in order for the City to continue as a member of the NFIP.

City of Phoenix has local policies to manage floodplains in a uniform and consistent manner. These policies are categorized as being FEMA related and non-FEMA related in nature. The policies strictly adhere to Federal regulations governing floodplains and drainage design.

Where a Watercourse Master Plan has been completed, is in progress, or is slated to be undertaken as identified by the City of Phoenix or the FCDMC, undisturbed watercourses (and their related land uses) shall conform to Erosion Hazard Management Zoning requirements. Conformance with erosion setbacks, if established as part of the Watercourse Master Plan or if expected as part of the Watercourse Master Plan process, shall be required. These setbacks shall be established by studies undertaken by or for the FCDMC or the City of Phoenix.

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[1] As defined in Chapter 32C of the Phoenix City Code.

[2] As of 11/30/01, excludes certain activities such as not-for-profit washing of vehicles, non-agricultural irrigation water discharges, fire hydrant/potable water system flushing, dust control watering, and discharge of residential evaporative cooler/air conditioning condensate. Since the federal regulations pertaining to this matter change periodically, the practitioner should review the City ordinances for revision.

3.5.1 FEMA

FEMA is an independent agency of the federal government, reporting to the President. Since its founding in 1979, FEMA's mission has been clear: To reduce loss of life and property and protect our nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery.

The City of Phoenix's policies pertaining to FEMA regulatory floodways and floodplains are as follows[3]:

- No development shall be allowed in a FEMA regulatory floodway.
- Basements shall not be allowed in Special Flood Hazard Areas for residential structures.
- Non-residential structures are allowed basements below the base flood elevation (BFE) as long as a registered professional engineer certifies all required "floodproofing" for the structure.
- Lowest floor elevation for houses and other buildings located within or adjacent to a Special Flood Hazard Area shall be a minimum of 1 foot above the FEMA regulatory base flood elevation (BFE). Levees, berms, or floodwalls while discouraged, must comply with FEMA standards and be reviewed by the City of Phoenix Street Transportation Department, Floodplain Management Section, prior to approval by the Development Services Department.
- Variances shall not be approved for conditions that do not meet FEMA regulatory standards.
- Any change or proposed improvements within a mapped FEMA floodplain shall be required to follow FEMA submittal procedures.

3.5.2 Non-FEMA

- Lowest floor elevation for houses and other buildings that are not located within or on property abutting a Special Flood Hazard Area shall be elevated above adjacent streets.
- New developments shall not increase runoff onto streets outside of the development.
- Lots shall be graded to drain to the front so as not to affect adjacent property owners. Runoff may drain onto or through adjacent property if a City owned property, dedicated

[3] These policies apply to all floodplains/floodways designated on FEMA Flood Insurance Rate Maps or FEMA Flood Boundary and Floodway Maps.

right-of-way, or privately owned drainage tract is provided and such grading schemes promote undisturbed watercourses.

- In locations where a FEMA regulatory base flood elevation does not exist and the 100-year discharge exceeds 500 cfs, a base flood elevation shall be established using the standards and procedures in the Drainage Design Manuals (Hydrology and Hydraulics) and shall require approval.

- In locations where the 100-year discharge in a wash exceeds 500 cfs and is contained within the existing channel banks, erosion setbacks consistent with the ADWR standard[4] shall be required for all properties developed where watercourses are to be left in an undisturbed state.

- Residential, commercial, and industrial structures are not allowed in Flood Hazard and Erosion Management Districts with the exception of roadway/bridge/utility crossings, applicable drainage improvements reflecting a natural condition, and certain recreational features conforming to the designated zoning.

- Development not covered by a flood hazard and erosion management zoning district should be reviewed for stipulations or design guidelines relating to watercourse design or development that may be a condition of an individual zoning approval or an overlay zoning district.

- Any variances to the City of Phoenix's floodplain policies shall require approval.

3.6 STREET DRAINAGE

The primary purpose of streets is to serve transportation needs. Accommodation of street drainage is provided so that motorists and emergency vehicles have a reasonable level of access and safety during storm events. Storm water flowing within or across a street shall be managed in accordance with the Phoenix Drainage Standards.

- Street design shall not increase runoff onto adjacent properties.

- Streets shall be designed to convey storm water runoff so as to provide motorists and emergency vehicles access and safety during a storm event.

- Streets will be designed to convey storm water in conformance with Phoenix Drainage Standards.

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[4] State Standard for Watercourse System Sediment Balance, Guideline 1, Lateral Migration Setback Allowance for Riverine Floodplains in Arizona, SSA 5-96, Arizona Department of Water Resources, *September 1996.*

- Street flow velocities in excess of those established in the Phoenix Drainage Standards require approval.

- Inverted crown streets shall not be permitted for arterial, collector or parkway streets. Inverted crowns on local streets are discouraged and shall require design review and approval.

- Arterial, collector or parkway streets shall not direct surface runoff onto local streets.

- Culverts or bridges shall be provided for all streets which cross open channels or drainageways in accordance with the Phoenix Drainage Standards.

3.7 CONVEYANCE FACILITIES

Storm water conveyance facilities (drainageways) can be open channels, undisturbed watercourses, ditches and swales, streets, culverts, or storm drains.

- Watercourses shall be reviewed for conveyance capacity and erosion/sedimentation considerations in accordance with the Phoenix Drainage Standards and the Drainage Design Manuals (Hydrology and Hydraulics).

- The designer of drainage facilities shall undertake the appropriate level of erosion/sedimentation analysis commensurate with the risk of undesirable consequences expected to the health, safety, and welfare of the general public from the privately or publicly funded improvement.

- Design water surface elevations shall generally be at or below adjacent natural ground or engineered fill. Conveyance provided above natural ground via levees, berms, or floodwalls shall require approval. The department responsible for plan and design review for new development or capital improvement projects including levees, berms, or floodwalls shall submit the plans to the Street Transportation Department, Floodplain Manager for approval.

- Levees, berms, or floodwalls shall not obstruct side or interior drainage to a channel. Side or interior drainage may not be conveyed by pumping. The use of levees, berms, or floodwalls to accommodate drainage is discouraged.

- Irrigation canals shall not be used as an outfall for storm water runoff.

- For all conveyance facilities, City owned property, dedicated right-of-way, or privately owned drainage tract shall be provided and must accommodate access for maintenance.

- Siphons are not allowed.

- All engineered channels are to be designed to blend with the surrounding landscape. Earthen engineered channels shall blend in plant type and density with the surrounding landscape.

- Flood water conveyance must be provided at all times during construction in such a manner as to not increase flood depths, sedimentation, or erosive velocities above pre-construction levels for the areas adjacent to construction projects.

3.8 STORAGE FACILITIES

Land development can convert natural pervious areas to impervious or otherwise altered surfaces. These activities may cause an increase in runoff volume and/or peak discharge. The temporary storage of storm water runoff can decrease downstream peak discharges and associated impacts to drainage infrastructure.

- All development shall make provisions to retain storm water runoff in accordance with the requirements in the Drainage Standards.

- A Homeowner's Association shall be formed to maintain common storm water storage areas. Storm water storage areas shall be located within platted drainage or open area tracts.

- Storm water storage areas in residential developments shall incorporate multi-use features and be graded with varying side slopes/land features to be aesthetically pleasing while accommodating safety features per the Phoenix Drainage Standards.

- Storm water storage facilities to be maintained by the City shall be designed to City standards. They shall be located in City Right of Way or Drainage Easement and shall be dedicated to the City.

- Storm water storage facilities shall be designed with public health and safety in mind.

- New regional flood control facilities located in previously developed neighborhoods shall have flood control as their primary objective.

- Storage facilities shall be designed to drain in accordance with the requirements in the Phoenix Drainage Standards.

- Depth and side slopes of storm water storage facilities shall be in accordance with the requirements in the Phoenix Drainage Standards.

- All storm water storage facilities shall be designed to drain to appropriate drainage facilities.

- Flows in excess of basin capacity shall be directed to adjacent streets or drainage facilities.

- The discharge of storm water to City owned drainage facilities shall require approval.

- The use of a storm water discharge pump is prohibited without a Temporary Discharge Permit issued by the Street Transportation Department/Storm Water Management Section prior to the discharge. Laboratory analyses may be required by the Storm Water Management Section prior to any discharge of water. All costs associated with the laboratory analyses will be the responsibility of the owner. Other restrictions may also apply such as flow rates and monitoring. If approved, the pump shall be maintained and operated by the owner, including Homeowners Associations.

- On-lot storage shall not be allowed for residential developments except for in-fill areas[5] consistent with the Phoenix Drainage Standards. Rooftop storage is not allowed.

- Storm water storage and conveyance facilities must consider multiple use opportunities. For storm water facilities, a preliminary landscaping plan must be submitted prior to the issuance of a final grading permit. A plant salvage plan must be approved prior to the issuance of any grading permit. Aesthetics as well as functionality must be considered in the design of storm water storage and conveyance facilities.

- Off-site flows may not be routed through a storm water storage facility without City approval.

- All storm water storage facilities, that are not multiple use, are to be designed to blend, in plant type and density, with the surrounding landscape.

- Storm water storage requirements may be waived in cases for in-fill areas or re-development parcels, or where post-development peak discharges are less than pre-development and post-development times of concentrations do not exacerbate downstream conditions. This later exception will only be allowed after City acceptance of comprehensive hydrologic analysis undertaken in conformance with the Flood Control District of Maricopa County Hydrology Manual. NPDES requirements must be met regardless of storm water storage provisions.

- Basins shall incorporate native materials (including native stone and boulders) and be revegetated in such a manner consistent with the engineering intent of the facility and conducive to maintenance activities.

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[5] In-fill areas are considered to be undeveloped individual lots that are not developed as part of the normal build-out of a subdivision. The last phase of a subdivision is not considered to be an in-fill area for these purposes.

3.9 MAINTENANCE

It is essential that maintenance be considered during the planning, design and construction of drainage facilities. Maintenance is provided so that the facilities can function as they were originally designed and constructed, and so that the service life of the facility is maximized. Common maintenance problems associated with drainage facilities include growth of unwanted vegetation, debris accumulation, sedimentation, erosion, scour, soil piping, soil settlement and structural damage. Culverts and bridges are to be designed to avoid impacts to existing sediment transport conditions.

Provision for permanent drainage facility accessibility, including access for maintenance equipment into channels and culverts, is necessary for regularly scheduled maintenance activities.

- All drainage facilities shall be accessible for maintenance equipment.
- All drainage facilities shall be designed and constructed with consideration to the cost of ongoing operation and maintenance.
- All drainage facilities that are to be maintained by the City of Phoenix shall be encompassed within a designated City owned property or right-of-way[6] and clearly shown on the recorded plat. To eliminate ambiguity and term confusion, drainage easements are not accepted as a means to describe public or private ownership.
- All drainage facilities that are to be privately maintained shall be encompassed within a platted drainage tract with said tract clearly identified as private property without public access.
- All drainage facilities owned and/or operated by private entities, including Homeowner's Associations, shall be properly maintained to promote performance of the drainage facilities consistent with the original design intent.
- Homeowner's Associations that own and/or operate drainage facilities shall include statements in its CC&R's clearly identifying that the Homeowners Association is responsible for operation, maintenance and repair of the drainage facilities.
- Drainage features/facilities that are the responsibility of entities other than the City of Phoenix (i.e. Homeowner's Associations, developers, management companies, private owners) may not be altered in form or function that detrimentally impacts the performance of the feature.

[6] A right-of-way encompasses land owned by the public.

- Trash racks at entrances and access barriers at outlets shall be provided for storm water conduits as specified in Chapter 6 (Standards).

- Where required, Section 404 permits shall be obtained prior to the start of maintenance activities.

3.10 EROSION CONTROL DURING CONSTRUCTION

Construction activity disturbs the land surface, thereby exposing native soils to increased rates of erosion by wind and rain. Airborne soil poses detrimental health risks and reduces visibility. Erosion of soil from construction sites by storm water increases the rate of siltation of drainageways, which can exacerbate flooding and increase the cost of on-going maintenance. Appropriate erosion control measures shall be required at construction sites.

- Storm Water Management Plans (SWMP) or Storm Water Pollution Prevention Plans (SWPPP) that incorporate best management practices shall be required of new developments as specified in the Phoenix Drainage Standards. See NPDES Storm Water construction requirements for full details.

- Erosion control shall be in accordance with the Erosion Control Manual of the Flood Control District of Maricopa County.

3.11 PERMITTING

There are a myriad of federal, state, and city permits that may be required prior to the start of construction of a project (see Chapter 4, Regulations). It is not the City's responsibility to ensure that the plans for a proposed project satisfy state and federal permit requirements. This not withstanding:

- The City will not issue a Grading and Drainage Permit until the applicant documents that all of the applicable state and federal permits have been obtained.

- "At risk" grading permits may be obtained upon receipt of documentation that the developer/owner has made proper permit applications to the appropriate state and federal agencies. Section 32A of the City Code identifies conditions that may be attached to grading and drainage permits (Section 32A-10-e-5). Specifically, as it relates to the protection of hillside and desert preservation areas (such as undisturbed watercourses), temporary fencing may be called for to restrict/prevent construction activities within these designated areas. Failure to protect these areas may result in revocation of the grading and drainage permit, payment of cash for the restoration, and/or the calling of a previously mandated surety bond.

4 REGULATIONS

4.1 INTRODUCTION

Engineers responsible for drainage design must conform to all regulations that may affect their project including federal, state and local acts, codes, laws, regulations, ordinances and policies[1]. Although these regulations are constantly changing, the following discussion provides some guidance as to the areas where governmental agencies exercise control over drainage related activities.

4.2 WATER RESOURCE AND CULTURAL RESOURCE AGENCY CONTACT LIST

The list that follows identifies the various agencies one may need to contact to obtain information or file a permit for drainage projects. This list is provided as assistance and for information purposes only. This list may not include all agencies or environmental reviews or permits that are required for a given project. Telephone numbers and addresses are subject to change.

General Information

Environmental Protection Agency (EPA)
www.epa.gov/region09
Public Info. Center:
(415) 744-1500

Arizona Department of Environmental Quality (ADEQ)
www.adeq.state.az.us
(602) 207-2300, Main Number
(602) 207-2254, Ombudsman
(602) 207-2330, Emergency Response Line

Arizona Department of Water Resources
(602) 417-2400

Maricopa County Department of Environmental Services
www.maricopa.gov/ensvc
(602) 506-6970

Floodplain Information

Federal Emergency Management Agency
www.fema.gov
(415) 923-7100 (San Francisco)
(202) 646-4600 (Washington D.C.)

Flood Control District of Maricopa County
www.fcd.maricopa.gov
(602) 506-1501

City of Phoenix
Street Transportation
(602) 262-4960
www.phoenix.gov

City of Phoenix
Street Transportation
Storm Water Management
(602) 495-5326

City of Phoenix
Development Services
(602) 262-6538

City of Phoenix
Fire Department
(602) 262-6771

[1] In addition, there are many computer programs available to help in the design of drainage systems. These programs may use different methods of analysis than those presented in the Drainage Design Manual for Maricopa County. Therefore, the designer of the storm drain system should check with the governing agency before using particular software packages.

Clean Water Act Section 404 Permits

US Army Corps of Engineers
www.usace.army.mil
(602) 640-5385

National Pollutant Discharge Elimination System (NPDES) Permits

EPA (415) 744-1906
ADEQ (602) 207-4665

Aquifer Protection Permits

ADEQ (602) 207-2315

Drywell Permits

ADEQ
(602) 207-4686
(877) 800-3207 - Hotline

Groundwater & other Water Permits

ADEQ (602) 207-4428
ADWR (602) 417-2400

Water Quality Certification 401 Permits

ADEQ (602) 207-4502

State Species of Concern

Arizona Game & Fish Department
Habitat Branch
(602) 789-3605

Native Plant Law

Arizona Dept. of Agriculture
Plants and Cactus Division
(602) 542-7182

Endangered Species Act

U.S. Fish & Wildlife Service
www.southwest.fws.gov
(602) 640-2720

Historic & Prehistoric Sites

State Historic Preservation Office
www.pr.state.az.us
(602) 542-4009

City of Phoenix Historic Preservation Office
(602) 261-8699

City of Phoenix Archeologist Office
Pueblo Grande Museum
602-495-0901

Native American Community Contacts, Maricopa County

Ak Chin Indian Community
(520) 568-2618

Ft. McDowell Mohave - Apache Tribe
(480) 837-5121

Gila River Indian Community
(520) 562-6000

Salt River Pima Maricopa Indian Community
(480) 850-8001

4.3 NATIONAL FLOOD INSURANCE PROGRAM

4.3.1 Permits

Introduction

The National Flood Insurance Act of 1968, as amended in 1973, provides for a federally subsidized National Flood Insurance Program (NFIP) conditioned on active management and regulation of floodplain development by states and local governments. FEMA administers the NFIP as a part of its overall responsibilities in preventing and responding to natural events that damage private and public property and any life-threatening natural event including floods. The NFIP provides flood insurance at affordable rates through Federal subsidy of the insurance offered by licensed insurance agents. This insurance is designed to provide an insurance alternative to

disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

Participation in the NFIP is based on an agreement between local communities and the Federal Government. This agreement states if a community will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction in Special Flood Hazard Areas, the Federal Government will make flood insurance available within the community as a financial protection against flood losses.

Availability of the subsidized flood insurance is contingent upon the development of a floodplain management system by the local municipality. Prevention of floods and resultant property damage is achieved through the delineation of property subject to flood events and the establishment of specific rules concerning development within these designated areas. FEMA publishes Flood Insurance Rate Maps (FIRM's) for certain flood prone areas that delineate different special flood hazard areas.

The City of Phoenix participates in the NFIP and has adopted floodplain regulations and ordinances so that its citizens have access to the subsidized insurance. The role of the community is to enact and implement floodplain regulations required for participation in the NFIP.

Community Rating System

The NFIP Community Rating System (CRS) was implemented in 1990 as a program for recognizing and encouraging community floodplain management activities that exceed the minimum NFIP standards. The National Flood Insurance Reform Act of 1994 codified the Community Rating System in the NFIP. Under the CRS, flood insurance premium rates are adjusted to reflect the reduced flood risk resulting from community activities that meet the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance.

FEMA Special Flood Hazard Areas

Citizens within the City of Phoenix are required to ascertain whether or not their respective property is located in a FEMA special flood hazard area (SFHA) before commencing with any building or land disturbance activity. FEMA special flood hazard maps, FIRM's, are available for review at the City of Phoenix, the Flood Control District of Maricopa County and the Arizona Department of Water Resources. The FIRM's are used to determine if a property is located within a special flood hazard area regulated by FEMA.

Flood Hazard Zones

The flood hazard maps are subdivided into zones that relate to flooding depths. These are defined as follows:

100-year Floodplain: Floodplain resulting from the occurrence of the 100-year rainfall. FEMA sets its jurisdictional limits to the 100-year event, which is cited as the base flood elevation. Jurisdictional limits are defined by horizontal flooding limits using the base flood elevation.

Floodway: That portion of the 100-year floodplain that is required to convey the 100-year flood with a rise in water surface no greater than 1 foot. The allowable rise and the limits of the floodway are predetermined by the governing municipality. The City of Phoenix allows landowners to encroach into the 100-year floodplain equally on both sides in terms of conveyance, except where a Flood Hazard and Erosion Management District has been adopted.

Zone A: No base flood elevations determined.

Zone AE: Base flood elevations determined.

Zone AH: Flood depths of 1 to 3 feet (usually areas of ponding), base flood elevations determined.

Zone AO: Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain), average depths determined (and velocities determined for alluvial fan floodplains).

Zone X (shaded): Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

Zone X (unshaded): Areas determined to be outside 500-year floodplain.

Application Process

Flood insurance through the NFIP is available for those properties located within the special flood hazard area. The following figures illustrate a generic representation of the permitting process for a single building lot and a larger community tract.

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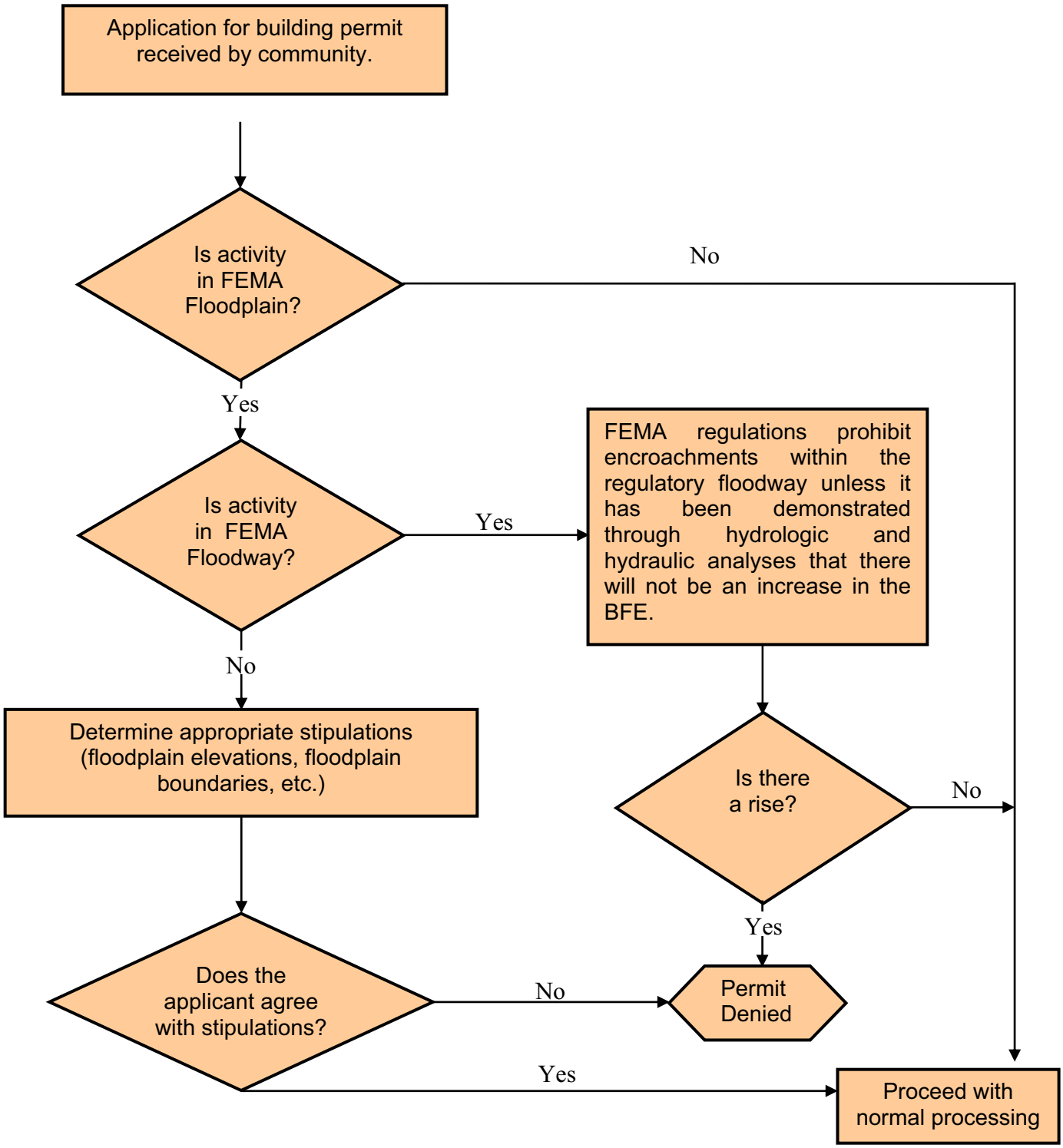
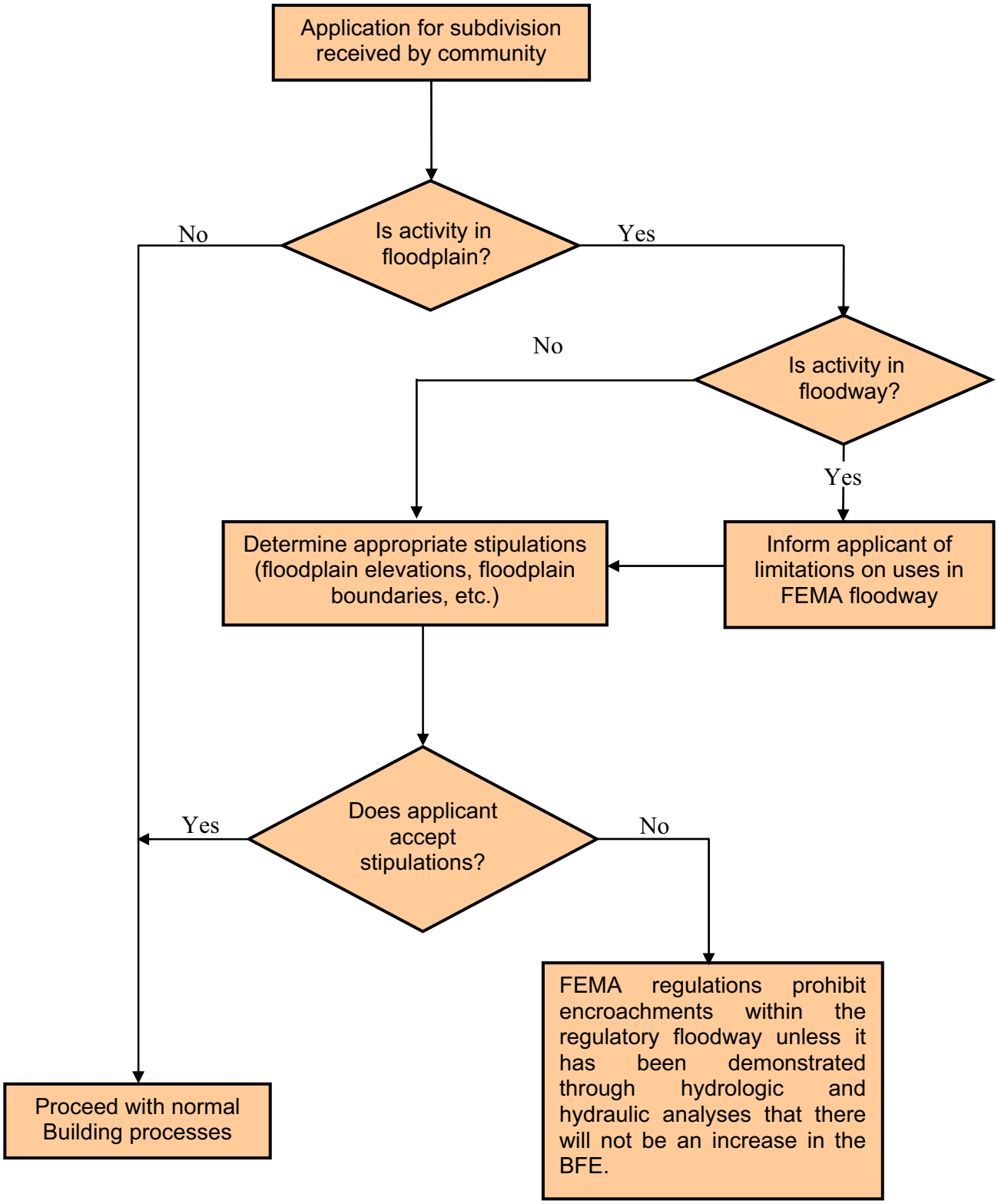
Single Lot Building



Community Development



Approval Actions Taken by FEMA

If a property is determined to be located within a FEMA special flood hazard area after reviewing the appropriate FIRM, there are several approval options available that the landowner must process through FEMA. The landowner must select the permit option that best fits the need of the property and satisfies FEMA requirements. Each permit option requires completion of specific application forms and may require that a registered land surveyor or professional engineer complete the forms. Each permit/application form is identified below by name followed by a brief description of the approval response to be expected from FEMA.

Conditional Letter of Map Amendment (CLOMA) - A letter from FEMA stating that a proposed structure that is not to be elevated by fill would not be inundated by the 100-year flood if built as proposed.

Letter of Map Amendment (LOMA) - A letter from FEMA stating that an existing structure or parcel of land that has not been elevated by fill would not be inundated by the 100-year flood.

Conditional Letter of Map Revision Based on Fill (CLOMR-F) - A letter from FEMA stating that a parcel of land or proposed structure that is to be elevated by fill would not be inundated by the 100-year flood if fill is placed on the parcel as proposed or the structure is built as proposed.

Letter of Map Revision Based on Fill (LOMR-F) - A letter from FEMA stating that an existing structure or parcel of land that has been elevated by fill would not be inundated by the 100-year flood.

Application forms for the four items listed above can be obtained from FEMA by reference MT-1 FEMA FORM 81-87 SERIES. FEMA's contact address is provided at the end of this section.

Conditional Letter of Map Revision (CLOMR)- A letter from FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision.

Letter of Map Revision (LOMR) - A letter from FEMA officially revising the current FIRM to show changes to floodplains, floodways, or flood elevation. Physical changes include watershed development, flood control structures, etc.

Physical Map Revision (PMR) - A reprinted FIRM incorporating changes to floodplains, floodways, or flood elevations. Because of the time and cost involved to change, reprint, and redistribute a FIRM, a PMR is usually processed when a revision reflects increased flood hazards or large-scope changes.

Application forms for the three items listed above can be obtained from FEMA by reference MT-2 FEMA FORM 81-89 SERIES. FEMA's contact address is provided at the end of this section.

Projects receiving a conditional letter must re-apply for a letter of map revision upon completion of construction. The conditional letter allows financing and local approvals of plans and permits for the project to take place. No building permit will be issued until a letter of map revision is issued by FEMA. To initiate FEMA review for a specific activity or location, a letter to FEMA requesting one of the "conditional" letters is sent to FEMA along with supporting data which includes a signed letter from the City of Phoenix indicating its concurrence with the request. Supporting data may be in the form of improved methodology or improved survey data. Improved methodology may be a different technique (model) or adjustments to models used in the effective FIS. Improved survey data include revised as well as new data. Floodway revisions involve any shift in the FEMA-designated floodway boundaries, regardless of whether the shift results in a change in the mapped floodway.

Approval and Denial

Once the review is completed and if the proposed development complies with the local floodplain management ordinance, a letter is issued identifying acceptance. The day the letter is issued is considered to be the date of the "start of construction" provided that actual construction begins within a certain timeframe. Otherwise, the applicant receives a letter identifying deficiencies in the information provided to FEMA.

Construction in Special Flood Hazard Areas

The lowest floor of all residential structures constructed in the Special Flood Hazard Area (SFHA) must be a minimum of one foot above the Base Flood Elevation (BFE)[2]. Building structures located within the SFHA (but not within the Floodway) may be protected from floods up to and including the 100-year flood by placement of fill to elevate the structure above the BFE. See FEMA guidelines for further specifications. Basements of residential structures located in the SFHA must be elevated above the BFE. The NFIP regulations allow nonresidential buildings (commercial structures, garages, warehouses, etc.) the option to floodproof rather than elevate as a means of protection from the base flood. Non-residential structures can be flood proofed to one foot above the BFE instead of being elevated. Modular buildings must have the bottom of the structure raised one (1) foot above the Base Flood Elevation (BFE) regardless of its use. Detached garages, small barns, and storage sheds are some examples of buildings that may not have to be elevated or dry floodproofed if openings are installed to allow floodwaters to enter or exit a structure and meet all other wet floodproofing requirements. Wet floodproofing requires the use of flood-resistant materials below the BFE and elevating items subject to flood damage above the BFE. Floodproofed structures must comply with appropriate sections of the NFIP regulation 60.3. Levees, berms, and floodwalls must meet, and continue to meet, minimum design,

[2] All new construction and substantial improvements of residential structures located within Zones A1-30, AE, and AH shall have the lowest floor, including the basement, elevated at or above the Base Flood Elevation.

operation, and maintenance standards that are consistent with the criteria established by NFIP regulation 60.3.

All new construction and substantial improvements shall be constructed with electrical, HVAC, plumbing, and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding. Mechanical and electrical equipment must be installed one foot above the BFE. Septic tanks within a SHFA must be above the BFE. All other below ground tanks must be anchored against floatation. Above ground tanks are considered structures for floodplain management purposes.

The community must require new and replacement water supply systems within floodprone areas to be designed to minimize or eliminate infiltration of floodwaters into the systems. The location and design of on-site waste disposal systems should be reviewed in order to prevent possible operational failure and potential contamination to the environment during flooding. The system should be protected from flood damage such that it can resume operation after the flood recedes. Manholes should be raised above the 100-year flood level or equipped with seals to prevent leakage. Pump stations should be located to allow access during a flood and designed to not release contamination. Automatic backflow valves should be installed to prevent sewage from backing up into buildings during a flood event.

Under no circumstances can filling or other construction activity be allowed within a floodway that may cause any rise in the water surface elevation above the designated floodway elevation.

An “Elevation Certificate” (FEMA Form 81-31) must be completed for each structure constructed in the SFHA prior to the electrical clearance and final acceptance for that structure. One copy of the “Elevation Certificate” is to be submitted to the General Building Safety Inspector on site and one copy is to be submitted to the City of Phoenix Floodplain Manager. See City Code and Federal Code for a complete list of requirements. Show the limits of the floodplain and Base Flood Elevations on the Site Plan and Grading and Drainage Plan.

Floodplain Requirements for Alluvial Fans

In addition to or in place of the above requirements, the following is required for alluvial fan floodplains. The lowest floor of all residential structures in the SFHA must be elevated one foot above the highest adjacent grade in accordance with the Code of Federal Regulations (CFR) Section 60.3c(7). Non-residential structures may be floodproofed in lieu of elevation. Adequate drainage paths must be provided in accordance with Section 60.3c(11) of the CFR.

Post Construction Review

After the proposed improvements have been constructed, the owner/developer is required to submit as-built/documents of record to FEMA and the City of Phoenix Floodplain Manager along with a request for a letter of map revision or amendment as appropriate.

Fees

Fees will be assessed by FEMA for it's review of proposed and "as-built" projects, as outlined in NFIP regulations 44 CFR Ch. 1, Part 72. In addition, the City of Phoenix levies a fee to help defray its cost for administering floodplain management in conformance with the NFIP.

Additional Information

FEMA publishes numerous documents to aid those within or adjacent to a special flood hazard area that can be located using FEMA's contact address at the end of this section. Documents that are very useful to consult if a property is determined to be within a special flood hazard area are:

1. "National Flood Insurance Program (Regulations for Floodplain Management and Flood Hazard Identification)," Federal Emergency Management Agency, 44 CFR, Part 1 Revised as of October 1, 1999.

2. "Flood Insurance Study Guidelines and Specifications for Study Contractors - FEMA 37," Federal Emergency Management Agency, April 1999.

3. "Technical Bulletin 2-93, Flood-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas in accordance with National Flood Insurance Program," Federal Emergency Management Agency, April, 1993.

4. "Technical Bulletin 3-93, Non-Residential Floodproofing Requirements and Certification for Buildings Located in Special Flood Hazard Areas in accordance with National Flood Insurance Program," Federal Emergency Management Agency, April, 1993.

Non-FEMA Flood Hazard Areas

The State of Arizona has set minimum floodplain management requirements for areas that are not studied and identified by FEMA as a special flood hazard area. The Arizona Department of Water Resources (ADWR) and the Arizona Division of Emergency Management (ADEM) are responsible for floodplain management statewide and for administering the NFIP at the state level. ADWR has developed a series of State Standards to aid in floodplain management for the non-FEMA studied areas of the state. Each State Standard has a companion document called the State Standard Attachment (SSA). The SSA is the technical document that provides the methodology and examples of how to apply it.

The following is a list of State Standards currently available from ADWR. It is the responsibility of each person to obtain the most current version of the State Standard available. ADWR does update existing State Standards periodically and is developing new State Standards where a need exists.

SS 1-97 - Requirement of Flood Study Technical Documentation

SS 2-96 - Requirement for Floodplain and Floodway Delineation in Riverine Environments

SS 3-94 - State Standard for Supercritical Flow

SS 4-95 - State Standard for Identification of and Development within Sheet flow Areas

SS 5-96 - State Standard for Watercourse System Sediment Balance

SS 6-96 - State Standard for Development of Individual Residential Lots within Floodprone Areas

SS 7-98 - State Standard for Watercourse Bank Stabilization

SS 8-99 - State Standard for Retention/Detention

4.3.2 Contact

City of Phoenix
Street Transportation Department
Floodplain Management
200 West Washington
Phoenix, AZ 85003
(602) 262-4960
www.phoenix.gov

State of Arizona
Department of Water Resources
Flood Mitigation Section
500 North 3rd Street
Phoenix, AZ 85004-3903
(602) 417-2400
www.adwr.state.az.us

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009
(602) 506-1501
www.fcd.maricopa.gov

Federal Emergency Management Agency
Region IX
Mitigation Division
Presidio of San Francisco, Building 105
San Francisco, CA 94129-1250
(415) 923-7177
www.fema.gov/

4.4 SECTION 404 PERMIT FOR WATERS OF THE UNITED STATES

The U.S. Army Corps of Engineers (USACE) has been involved in regulating certain activities in the nation's waterways since the 1890's (River and Harbors Act of 1899). Until 1968, the primary thrust of the USACE regulatory program was the protection of navigation. As a result of several new laws and judicial decisions (Clean Water Act of 1968; Marine Protection, Research, and Sanctuaries Act of 1972), the program evolved to one that considers the full public interest by balancing the favorable impacts against the detrimental impacts. Section 404 of the Clean Water Act is to protect the physical, biological, and chemical quality of our nation's water from irresponsible and unregulated discharges of dredged or fill material that could permanently alter or destroy these valuable resources.

Any person, firm, or agency (including federal, state, and local government agencies) planning to work in or place dredged or fill material in Waters of the United States, must first obtain a permit from the USACE. The regulatory area is designated “Waters of the United States” or “jurisdictional waters." Waters of the United States includes essentially all surface waters such as all navigable waters and their tributaries, all interstate waters and their tributaries, all wetlands adjacent to these waters, and all impoundment's of these waters. Here in the Phoenix metropolitan area, ephemeral streams (washes) may be jurisdictional if they exhibit certain characteristics. The width of the wash, presence of hydraulic sorting, and the presence of riparian habitat, are factors, among other things, considered by the USACE. The regulations governing waters of the U.S. (including wetlands) apply to both public and private property.

Determination of the presence and extent (if present) of jurisdictional waters should be undertaken during the early stages of project planning. A jurisdictional delineation establishes the USACE regulatory area. It is highly recommended that the inexperienced seek guidance from the USACE or other environmental professionals.

4.4.1 Permits

Physical work in a watercourse or wetland may require a USACE permit. The program provides for the consideration of all concerns of the public - environmental, social, and economic - in the USACE decision-making process to either issue or deny permits. As part of its responsibility to protect water quality, the USACE Section 404 permit program extends to many areas that were not regulated prior to the Clean Water Act.

Capital improvement projects undertaken on behalf of and paid by the City of Phoenix must coordinate their efforts with their client department[3] and/or the City’s Office of Environmental Programs (OEP) prior to contacting the USACE. Joint ventures between the City and private entities must coordinate with the OEP prior to any inquiries or submittals to the USACE. Privately funded projects that are later to be conveyed to the City may need to certify proper compliance with 404 requirements.

Should a permit be required, there are several options depending on the type of land disturbance activity.

Individual Permits

Individual permits are issued following a full public interest review of an individual application for a USACE permit. A public notice is distributed to all known interested persons. After evaluating all comments and information received, final decision on the application is made.

[3] Consultants should contact their client department to determine the best means of communication.

The permit decision is generally based on the outcome of a public interest balancing process where the benefits of the project are balanced against the detriments. A permit will be granted unless the proposal is found to be contrary to the public interest.

An individual permit requires a 401 Water Quality Certification from the Arizona Department of Environmental Quality.

Application forms for individual permits are available from all USACE regulatory offices.

Nationwide Permits

A nationwide permit (NWP) is a form of general permit that authorizes a category of activities throughout the nation. These permits are valid only if the conditions applicable to the permits are met. If the conditions cannot be met, a regional or individual permit will be required. Please note that the NWP program is proposed to be revised by notice dated August 9, 2001 (see FR Vol. 66, No. 154, August 9, 2001) (see www.usace.army.mil/inet/functions/cw/cecwo/reg). Nationwide permits listed below may be modified to accommodate regional conditions. Contact the USACE office provided at the end of this section to obtain the most current information on the NWP program changes. A list of the more pertinent, presently available, nationwide permits follows. The reader should contact the USACE for a complete listing, permit details, and regional limitations placed upon nationwide permits. Some activities under nationwide permits require notification submittals to the USACE prior to the carrying out of those activities. Notification requirements are described in General Condition 13, 65 FR 52 12818-12899. All nationwide permits must comply with the requirements of the particular nationwide permit, the nationwide permit general conditions, the 401 conditions (for water quality), and, if adopted, the Los Angeles District regional conditions.

NWP 3. Maintenance. The repair, rehabilitation, or replacement of any previously authorized, currently serviceable, structure or fill, or of any currently serviceable structure or fill authorized by 33 CFR 330.3. Discharges of dredged or fill material, including excavation, into all waters of the United States to remove accumulated sediments and debris in the vicinity of, and within, existing structures and the placement of new or additional rip rap to protect the structure.

NWP 6. Survey Activities. Survey activities including core sampling, seismic exploratory operations, plugging of seismic shot holes and other exploratory-type bore holes, soil survey and sampling, and historic resources surveys.

NWP 7. Outfall Structures. Activities related to construction of outfall structures and associated intake structures where the effluent from the outfall is authorized, conditionally authorized, or specifically exempted, or are otherwise in compliance with regulations issued under the National Pollutant Discharge Elimination System program (NPDES) (Section 402 of the Clean Water Act).

NWP 12. Utility Lines. The construction, maintenance, or repair of utility lines, including outfall and intake structures and the associated excavation, backfill, or bedding for the utility lines, in all waters of the United States, provided there is no change in preconstruction contours.

NWP 14. Linear Transportation Crossings. Activities required for the construction, expansion, modification, or improvement of linear transportation crossings (e.g., highways, railways, trail, and airport runways and taxiways) in waters of the United State subject to acreage limitations.

NWP 18. Minor Discharges. Minor discharges of dredged or fill material into all waters of the United States subject to volume or acreage limitations.

NWP 20. Oil Spill Cleanup. Activities required for the containment and cleanup of oil and hazardous substances which are subject to the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Part 300) in accordance with certain state and federal requirements.

NWP 25. Structural Discharges. Discharges of material such as concrete, sand, rock, etc. into tightly sealed forms or cells where the material will be used as a structural member for standard pile supported structures, such as bridges, transmission line footings, and walkways.

NWP 29. Single-Family Housing. Discharges of dredged or fill material into non-tidal waters of the United States, including non-tidal wetlands for the construction or expansion of a single-family home and attendant features (such as a garage, driveway, storage shed, and/or septic field) for an individual permittee.

NWP 31. Maintenance of Existing Flood Control Facilities. Discharges of dredged or fill material for the maintenance of existing flood control facilities, including debris basins, storm water storage basins, and channels. The maintenance is limited to that approved in a maintenance baseline determination made by the District Engineer.

NWP 38. Cleanup of Hazardous and Toxic Waste. Specific activities required to effect the containment, stabilization, or removal of hazardous or toxic waste materials that are performed, ordered, or sponsored by a government agency.

NWP 39. Residential, Commercial, and Institutional Developments. Discharges of dredged or fill material into non-tidal waters of the United States for the construction or expansion of residential, commercial, and institutional building foundations and building pads and attendant features that are necessary for the use and maintenance of the structures.

NWP 40. Agricultural Activities. Discharges of dredged or fill material into non-tidal waters of the United States for the purpose of improving agricultural production and the construction of building pads for farm buildings. Authorized activities include the installation, placement, or construction of drainage tiles, ditches, or levees; mechanized land clearing; land leveling; the reloca-

tion of existing serviceable drainage ditches constructed in waters of the United States; and similar activities.

NWP 41. Reshaping Existing Drainage Ditches. Discharges of dredged or fill material into non-tidal waters of the United States to modify the cross-sectional configuration of currently serviceable drainage ditches constructed in these waters. The reshaping of the ditch cannot increase drainage capacity beyond the original design capacity or expand the area drained by the ditch as originally designed (i.e., the capacity of the ditch must be the same as originally designed and it cannot drain additional wetlands or other waters of the United States).

NWP 42. Recreational Facilities. Discharges of dredged or fill material into non-tidal waters of the United States, excluding non-tidal wetlands adjacent to tidal waters, for the construction or expansion of recreational facilities.

NWP 43. Storm Water Management. Discharges of dredged or fill material into non-tidal waters of the United States for the construction and maintenance of storm water management facilities, including activities for the excavation of storm water ponds/facilities, detention basins, and retention basins; the installation and maintenance of water control structures, outfall structures and emergency spillways; and the maintenance dredging of existing storm water management ponds/facilities and detention and retention basins.

NWP 44. Mining Activities. Discharges of dredged or fill material into: (i) Isolated waters, streams where the annual average flow is 1 cubic foot per second or less, and non-tidal wetlands adjacent to headwater streams, for aggregate mining and other mining activities subject to certain limitations.

To apply for a nationwide permit, an application form must be completed. This application is available from all USACE regulatory offices.

Regional Permits

Regional permits are issued by the District Engineer for a general category of activities when:

1. The activities are similar in nature and cause minimal environmental impact (both individually and cumulatively), and

2. the regional permit reduces duplication of regulatory control by State and Federal agencies.

Contact the USACE District Regulatory office in your area for information regarding regional permits.

4.4.2 Contact

U.S. Army Corps of Engineers
Los Angeles District
Regulatory Branch
3636 North Central Avenue
Suite 970
Phoenix, AZ 85012-1936
(602) 640-5385
www.spl.usace.army.mil

Arizona Department of Environmental Quality
Reuse and Federal Permits Unit
1110 W. Washington St., 5415B-3
Phoenix, AZ 85007
(602) 771-2300

City of Phoenix
Office of Environmental Programs
200 West Washington
Phoenix, AZ 85003
(602) 534-1775
www.phoenix.gov

4.5 STORM WATER NPDES

Storm water systems are subject to the requirements and permitting process of the National Pollutant Discharge Elimination System (NPDES) which is a U.S. Environmental Protection Agency (EPA) program and is the administrative mechanism chosen for storm water permitting. The EPA issued regulations in 1990 authorizing the creation of an NPDES permitting system for storm water discharges from a large group of industrial activities and construction activities. A NPDES permit is required for any point source discharge of pollutants to Waters of the United States. Because storm water runoff can transport pollutants to either municipal storm sewer systems or to Waters of the United States, permits are required for those discharges. In addition to storm water permits, there are also NPDES permits required for the discharge of processed wastewater and the land application of sludge. The application process for both general permits is similar.

4.5.1 Permits

Currently, the storm water program relies upon three types of permits.

1. Construction General Permit
2. Multi-sector General Permit
3. Individual Permit

Construction General Permit

A Construction General Permit is required for all construction projects that disturb one or more contiguous acres of land. Application for a permit is achieved by the completion and submission of a simple one-page form called a Notice of Intent (NOI) at least 48 hours before breaking ground. The NOI is a promise by the applicant that there will be compliance with the permit con-

ditions. However, before the NOI is submitted a Storm Water Pollution Prevention Plan (SWPPP) must be prepared. The Construction permit contains the requirements EPA considers necessary to produce an acceptable SWPPP. The requirements for an acceptable SWPPP can be found starting on Part IV D, on page 7907, of the permit. There is no requirement to submit the SWPPP to either EPA or ADEQ. However, the SWPPP can be requested by any agency (including the City of Phoenix) and must remain available for review at the project site. The City of Phoenix requires a Storm Water Management Plan (SWMP) to be prepared to its specific format, with two copies for initial submittal and review (See Section 4.9). The components of a SWPPP can be used as part of the City's storm water management plan. Upon approval, a mylar set of plans is required for recordation. Once the SWPPP is approved, and the NOI submitted, there is a waiting period of 48 hours. If the applicant is not informed differently by EPA within the waiting period, the applicant may assume permit coverage has been granted. After the 48-hour waiting period the permittee may implement the SWPPP and begin activities. The NOI must be submitted at least 48 hours before the initiation of any activities. Eventually, EPA will confirm permit coverage with the permittee by a letter containing a general permit number. If the NOI is submitted with missing or incorrect information, EPA will inform the applicant of the inadequacies and request additional information. Permit authorization to discharge storm water is only possible after the submittal of a complete and accurate NOI. After the construction project is complete, and the project's disturbed area is stabilized to at least 70 percent of natural background levels, the permittee must submit within 30 days a Notice of Termination (NOT) to end participation in the construction phase of the NPDES storm water program. Failure to develop specific Best Management Practices (BMP's) or to implement these BMP's identified in the SWPPP or SWMP may subject the Permittee(s) to fines of up to $25,000 per day per violation.

Multi-Sector General Permit

The Multi-Sector General Permit (MSGP) is designed for those industrial activities that are of a non-construction nature. This is one large permit divided into numerous separate sectors. Each sector represents a different type of activity. A facility's sector within the MSGP is dependent upon its Standard Industrial Classification (SIC) code or narrative description. Once the necessity for a permit is determined, a facility will be subject to the requirements of more than one sector if it has operations that can be described by other sectors.

Application for a permit is achieved by the completion of a simple one-page form called a Notice of Intent (NOI) associated with Industrial Activities. The NOI is a promise by the applicant that there will be compliance with the permit conditions. However, before the NOI is submitted a Storm Water Pollution Prevention Plan (SWPPP) must be prepared. The MSGP, within the sectors, contains the requirements EPA considers necessary to produce an acceptable SWPPP. There is no requirement to submit the SWPPP to either EPA or ADEQ, however the City requires that the plan be approved by the Storm Water Management Section of the Street Transportation Department. However, the SWPPP can be requested by any agency and should remain available for review on site. Once the SWPPP is prepared, and the NOI submitted, there is a waiting

period of 48 hours. If the applicant is not informed differently by EPA within the waiting period, the applicant may assume permit coverage has been granted. After the 48-hour waiting period the permittee may implement the SWPPP and begin activities. The NOI must be submitted at least 48 hours before the initiation of industrial activities. Eventually, EPA will confirm permit coverage with the permittee by a letter containing a general permit number. If the NOI is submitted with missing or incorrect information, EPA will inform the applicant of the inadequacies and request additional information. Permit authorization to discharge storm water is only possible after the submittal of a complete and accurate NOI. The permittee submits a Notice of Termination (NOT) associated with Industrial Activities to end participation in the NPDES storm water program. Failure to develop specific Best Management Practices (BMP's) or to implement these BMP's identified in the SWPPP may subject the Permittee(s) to fines of up to $25,000 per day per violation.

Individual Permit

The Individual Permit is a permitting strategy used by those who believe the general permit requirements do not accurately represent the activity at their facility and wish a permit customized to their site. Another major reason an Individual Permit may be necessary is that the Limitations on Coverage section of the general permits does not allow the facility's discharge to be covered within the general permit. For example, if the storm water discharge from the facility adversely affects an endangered species, an Individual Permit would be required. It is the responsibility of every applicant to determine if any of the Limitations on Coverage apply to the facility seeking the permit. To apply for an Individual Permit NPDES Forms 1 and 2F must be submitted to EPA. Failure to develop specific Best Management Practices (BMP's) or to implement these BMP's may subject the Permittee(s) to fines of up to $25,000 per day per violation.

Permit information and forms may be obtained from the agencies listed below.

4.5.2 Contact

Arizona Department of Environmental Quality
1110 W. Washington St., 5415B-3
Phoenix, Arizona 85007
(602) 771-2300
www.adeq.state.az.us

City of Phoenix
Development Services Department
200 West Washington St.
Phoenix, AZ 85003
(602) 262-6551
www.phoenix.gov

City of Phoenix
Street Transportation Department
Storm Water Management Section
200 W. Washington St. 5th Floor
Phoenix, AZ 85003
(602) 495-5326
www.phoenix.gov

4.6 DAMS

Dams in the state, except those owned or operated by an agency or instrumentality of the federal government, are under the jurisdiction of the Arizona Department of Water Resources (ADWR). A dam is any artificial barrier that impounds or diverts water above the natural ground surface. A detention basin or retention basin that impounds storm water above the natural ground surface may be considered as being a dam under the authority of ADWR. The following do not fall under the authority of ADWR.

Any artificial barrier:

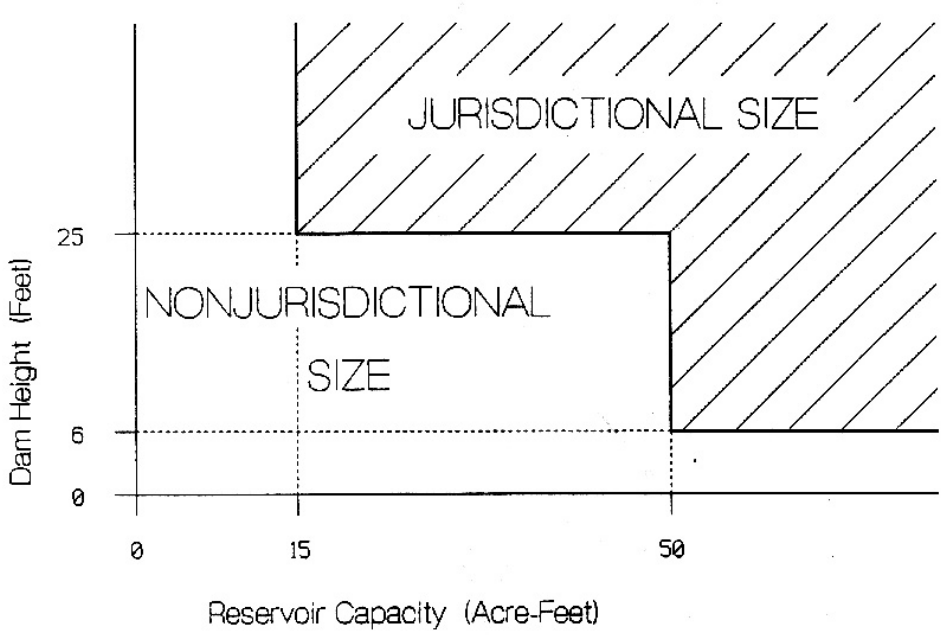
1. Less than 6 feet in height, regardless of storage capacity.

2. Fifteen acre-feet or less of storage capacity, regardless of height.

3. Between 6 and 25 feet in height with a storage capacity less than 50 acre-feet.

Any impoundment or diversion structure that exceeds the criteria above will require a permit from ADWR. Individuals having questions should contact the Dam Safety Section of ADWR.

A JURISDICTIONAL DAM is either 25 or more feet in height or has capacity to store more than 50 acre-feet. If a dam is less than six feet in height, regardless of storage capacity, it is not jurisdictional. If the dam has 15 acre-feet or less of storage capacity, regardless of height, it is not jurisdictional. HEIGHT is the vertical distance from the lowest point on the downstream toe (at natural ground) to the emergency spillway crest. CAPACITY is the maximum storage that can be impounded when there is no discharge of water.



4.6.1 Permits

A permit is required for all new dams or the repair, alteration or removal of an existing dam. Application forms are available from ADWR. An administrative review fee is required by ADWR.

4.6.2 Contact

State of Arizona
Department of Water Resources
Dam Safety Section
500 North 3rd Street
Phoenix, AZ 85004-3903
(602) 417-2400
www.adwr.state.az.us

4.7 DRY WELL REGISTRATION

A person who owns an existing dry well that is or has been used for storm water disposal shall register the dry well with the Arizona Department of Environmental Quality (ADEQ). A dry well is a bored, drilled, or driven shaft or hole whose depth is greater than its width and is designed and constructed specifically for the disposal of storm water. They must be registered by completing a form by ADEQ, and submitting a registration fee for each dry well.

4.7.1 Permits

Dry wells are regulated by Arizona Revised Statute (A.R.S.) § 49-241 and § 49-331 through § 49-336, and Aquifer Protection Permit statutes and rules. Dry wells that drain areas where hazardous substances are used, stored, loaded, or treated are subject to the General Permit or full Aquifer Protection Permit (see Section 4.8). Specific rules regarding dry wells are found in R-18-9-102-A and R18-9-A301. Program guidance documents are available from ADEQ, and should be followed for dry well construction, maintenance, siting, investigation, decommissioning, and closure. Registration is generally not required for dry wells used in conjunction with golf course maintenance, and they are exempted from regulation under the dry well program. However, vadose zone injection wells (including dry wells) that receive storm water mixed with reclaimed wastewater or groundwater from manmade bodies of water associated with golf courses, parks, and residential areas must be registered. In this situation, a general permit issued by statute in lieu of an individual permit, provided that six criteria, including registration, are met (A.R.S. § 49 - 245.02).

Dry well registration and permit information and forms may be obtained from ADEQ at the location provided below.

4.7.2 Contact

Arizona Department of Environmental Quality
1110 W. Washington St., 5415B-3
Phoenix, Arizona 85007
(602) 771-2300
www.adeq.state.az.us

4.8 AQUIFER PROTECTION PERMIT

An individual will need to obtain an Aquifer Protection Permit (APP) if they own or operate a dry well that discharges a pollutant either directly to an aquifer or to the land surface or the vadose zone in such a manner that there is a reasonable probability that a pollutant will reach an aquifer. ADEQ may provide an "APP Determination of Applicability Form" for dry wells in areas where hazardous substances are used, stored, loaded, or treated. Dry wells that are used solely for the disposal of storm water runoff do not require an Aquifer Protection Permit, however, dry well registration is still a requirement.

4.8.1 Permits

The following Aquifer Protection Permits are available:

Individual Permits

Individual permits are issued for a term not to exceed the operational lifetime of the facility. Individual permits take, on average, from 6 months to over 2 years. Processing time is approximately 6 months, however, incomplete applications often result in delays.

Area-Wide Permits

Area-wide permits may be issued in lieu of an individual permit to cover facilities under common ownership in a contiguous geographic area. Discharge reduction in the pollutant management area and the demonstration that aquifer water quality standards will not be violated or further degraded can be evaluated collectively for existing facilities. This type of permit is most applicable to large mining and industrial sites.

General Permits

There are currently 15 different types of general permits. These are issued by rule or statute, and the facility is automatically permitted, provided that certain conditions are adhered to. A separate permit document is not required to operate under these conditions and no fee is required.

Information regarding APP's are available from ADEQ at the locations listed below.

4.8.2 Contact

Arizona Department of Environmental Quality
1110 W. Washington St., 5415B-3
Phoenix, Arizona 85007}
(602) 771-2300
www.adeq.state.az.us

4.9 CITY OF PHOENIX STORM WATER MANAGEMENT

It is the goal of the City of Phoenix to protect, maintain, and enhance the public health, safety and general welfare by establishing requirements and procedures to control the adverse affects of storm water runoff and pollution and associated with land development. This manual sets forth the policies and standards for management of urban drainage and floodplains.

The City of Phoenix Development Services Department administers the approval and permit processes established for grading, drainage and floodplain management

4.9.1 Permits

The City of Phoenix has permit requirements for storm water facilities. Individual permits are available for the following.

1. Drainage Facilities Permit

2. Grading and Drainage Permit

3. Storm Water Management Plan Permit.

Drainage Facilities Permit

A Drainage Facilities Permit is required in order to connect and discharge storm water into the City's storm drain system. New storm drain segments or inlets, low-flow bleed-off lines from detention basins, or storm water discharge pumps are examples of drainage facilities requiring a permit. This permit provides a procedure for the City to track additions to the City’s storm drain system.

Grading and Drainage Permit

A Grading and Drainage Permit is required for development activities that include excavation, fill, drainage swales and channels, drainage structures and pipes, detention/retention areas, and dry wells.

Storm Water Management Plan Permit

A Storm Water Management Plan Permit may be required for proposed construction activities within the City of Phoenix. Storm water management permit information and forms are available at the City of Phoenix at the location below.

As part of the City of Phoenix 'Storm Water Quality Protection' ordinance effective 1992, all commercial and industrial facilities with the potential to pollute storm water must prepare, submit and implement a Storm Water Management Plan (SWMP). Since contractors completing the construction end their involvement by filing a NOT, the Development Services Department will inform the property representative who receives the Certificate of Occupancy of the requirement to submit the SWMP. The owner/operator(s) will submit a Storm Water Management Plan (SWMP) to the City before they begin operations at the facility. Failure to develop specific Best Management Practices (BMP's) or to implement these BMP's located in the SWPPP or SWMP may subject the permittee(s) to fines of up to $2500 per day per violation. A SWPPP may be submitted in lieu of a SWMP. The SWMP will be submitted to the City of Phoenix Storm Water Management Section identified below.

4.9.2 Contact

City of Phoenix
Development Services Department
200 West Washington St.
Phoenix, AZ 85003
(602) 262-6551
www.phoenix.gov

For industrial specifications:

City of Phoenix
Street Transportation Department
Storm Water Management Section
200 W. Washington St. 5th Floor
Phoenix, AZ 85003
(602) 495-5326
www.phoenix.gov

5 ORDINANCES

5.1 UNDER CONSTRUCTION

6 DRAINAGE STANDARDS

6.1 SAFETY AND PROTECTION OF THE NATURAL ENVIRONMENT

Designs for hydraulic structures must address the issue of safety.

1. For engineered portions of channels with actual water depths greater than three feet in the 100-year event; and for shallow, fast-flowing, engineered channels where the product of maximum depth and average velocity exceeds nine ft^2/sec for the 100-year event:

    - Appropriate measures must be designed to keep the public away from these locations.

    - Adequate fencing or railings must be provided along all walls, such as wing walls or training walls (excluding vertical drops in channel bottom.)

2. For channel drop structures, the maximum vertical drop height from invert crest to invert toe for any single step shall be 2.5 feet. A six foot wide (minimum) horizontal apron shall be provided for every 2.5 feet of vertical drop in a "stair step" fashion. Drop structures constructed of concrete or shotcrete shall have a roughened surface to discourage inappropriate recreational use.

3. All concrete, shotcrete, or smooth sided soil cement channels flowing in a subcritical flow regime with design flow depth greater than three feet shall have emergency escape stairsteps formed; alternating every 300 feet from one side of the channel to the other.

4. For storm water storage ponds with a permanent water body in the bottom, the pond edge shall be designed to minimize safety hazards. Water depth should be limited to 1.5 to 2 feet within eight feet of the edge of the water feature, and gradually get deeper as needed.

5. Amenities placed within the inundation area of a storm water facility shall be adequately secured to prevent them from becoming waterborne debris. Methods for securing items shall be shown on the design approval and construction plans.

6. Where accessible, adequate fencing is required along portions of engineered basins or engineered channels greater than three-feet deep where side-slopes are steeper than 4:1.

7. Grates or trash racks (inlet end) and access barriers (outlet end) are required on exposed inlet or outlet ends of all storm drains 18 inches or greater in diameter. Access barriers shall be constructed in accordance with City Detail P1562 and P1563. Trash racks shall be constructed in accordance with MAG Detail 502-1 or 502-2.

8. Area security and pathway lighting shall be placed as needed to provide illumination within multi-use stormwater storage facilities. Lighting shall conform to City of Phoenix Parks and Recreation Department standards.

9. Walkways shall meet the Americans with Disabilities Act (ADA) requirements and be elevated at least one foot above the invert of any low flow channel.

10. All drainage facilities must be readily accessible by emergency or ordinary maintenance vehicles (e.g., pickup truck, loader, backhoe, etc).

    - For engineered channels and storm water storage facilities/basins with geometric depths greater than three feet deep, accessways to the channel or basin; and ramps into the channel or basin shall be required.

    - For natural washes, a minimum 16-feet wide accessible clear-zone area for emergency and ordinary maintenance vehicle access shall be provided.

    - For engineered channels or storm water storage facilities/basins with geometric depths of three feet deep or shallower with a portion of side slope set at 6:1 or flatter along at least one side to allow emergency or ordinary maintenance vehicle access, ramps into the channel or basin are not required.

    - For all other small engineered channels such as swales, roadside drainage ditches, etc., reasonable access for emergency and ordinary maintenance vehicles shall be provided.

    - Access ramps shall be a minimum of 16 feet wide with a longitudinal slope no steeper than 10%. Accessways approaching channels or basins shall be a minimum of 12 feet wide within a clear 16-feet wide tract (included as part of a City owned property, right-of-way, or privately owned drainage tract) such that emergency and ordinary maintenance vehicles can freely maneuver.

    - At a minimum, hard surface paving (such as concrete, soil cement, etc.) shall be required for the portions of access ramps that will be inundated in the 100-year event, and shall be properly "toed-in" to protect the ramp from erosion during storm events.

    - Portions of accessways or ramps may be combined with portions of multi-use trails, subject to approval by the reviewing department(s).

    - To minimize the extent of off-site temporary easements, accessways are not required for temporary collector channels constructed on adjacent developable properties provided that the channels are accessible by ordinary maintenance equipment. Should these temporary collector channels become a permanent component of the drainage system under future developed conditions, then accessways will be required at that time.

- The design engineer may propose other means of providing access for maintenance by ordinary maintenance equipment subject to approval by the appropriate reviewing department(s).

11. The City staff of the reviewing department may require temporary fencing around certain environmentally important areas of a project (such as washes or open desert areas that are to remain undisturbed) to restrict or prevent construction activities within those designated areas. This requirement will be determined on a case-by-case basis.

12. For all construction projects that have the potential to disturb more than one acre of property the developer/contractor must prepare and submit a Storm Water Pollution Prevention Plan (SWPPP) along with a Notice of Intent (NOI) to ADEQ at least 48 hours prior to groundbreaking. Best Management Practices (BMP's) must be included in the SWPPP. Upon completion of the project, the developer/contractor must prepare and submit a Notice of Termination (NOT) to ADEQ. See the Federal Register and the Drainage Design Manual for Maricopa County, Erosion Control for more details on these requirements.

6.2 HYDROLOGY

6.2.1 Rainfall Criteria

Purpose	Criteria
Street Storm Drains	2-year
Storm Water Storage Facilities	100-year, 2-hour rainfall as defined in the Maricopa County Flood Control District Hydrology Manual for stormwater volume.
Analysis for undisturbed drainageways and design of engineered channels, bridges, and culverts.	
Drainage area: 160 acres to 20 square miles	100-year, 6-hour local storm as defined in Maricopa County Flood Control District Hydrology Manual.
Drainage area: 20 to 100 square miles	Either a critically centered 6-hour local storm as defined in Maricopa County Flood Control District Hydrology Manual, or a 24-hour general storm using the SCS Type II distribution for the 100-year event.
Drainage area: 100 to 500 square miles	100-year, 24-hour general storm using the SCS Type II distribution as defined in Maricopa County Flood Control District Hydrology Manual.

6.2.2 Rational Method Criteria

C Coefficients for Use with the Rational Method

Land Use	Return Period	
	2-10 Year	100 Year
Paved Streets, Roads, and Parking Lots	0.95	0.95
Industrial Areas	0.70	0.90
Business/Commercial Areas	0.75	0.90
Lawns, Parks, Cemeteries	0.25	0.30
Graveled Surfaces	0.70	0.85
Agricultural Areas	0.15	0.20
Undeveloped Desert	0.35	0.45
Mountain Terrain (Slopes >10%)	0.70	0.85
Residential Areas		
Single Family Zoning District RE-35	0.45	0.55
Single Family Zoning District R1-18	0.50	0.60
Single Family Zoning District R1-10	0.55	0.65
Single Family Zoning District R1-8	0.60	0.70
Single Family Zoning District R1-6	0.65	0.75
Single/Multi Family Zoning District R-2	0.70	0.80
Single/Multi Family Zoning District R-3	0.70	0.80
Single/Multi Family Zoning District R-3A	0.75	0.85
Single/Multi Family Zoning District R-4	0.75	0.85
Single/Multi Family Zoning District R-5	0.75	0.85

13. The Rational Method shall only be allowed to predict storm water peak flow and run-off volume estimates for design of storm drains, minor channels and retention storm water storage facilities with contributing drainage areas up to 160 acres.

14. The Rational Method shall not be used for channel routing procedures or detention storm water storage facilities. For contributing drainage areas greater than 160 acres, and for

channel routing and detention storm water storage facilities design, the HEC-1 methodology described in the Maricopa County Flood Control District Hydrology Manual shall be used.

15. The run-off coefficients above shall be used with the Rational Method. The Engineer shall assign separate coefficients to streets, residential lots, landscape areas, etc. and may provide an area-weighted coefficient for the watershed in analysis. The Engineer may assign alternate coefficients where appropriate justification and documentation can be provided.

16. The minimum time of concentration allowed shall be ten minutes.

17. Hydrology analysis of off-site areas shall be based on existing conditions at time of design drainage analysis.

6.2.3 Hydrologic Design Criteria

Drainage Feature	Peak Frequencies	
	2 Year	100 Year
Street with Curb and Gutter (longitudinal flow…Storm drain systems installed as needed to meet street drainage criteria)	Runoff contained within street curbs. For major collector and arterial streets, one 12-foot dry driving lane in each direction must be maintained in each direction and sump depths shall not exceed 0.4 foot measured upgradient, immediately adjacent to catch basin. Historic drainage divides shall be retained. Flows within existing streets shall follow historic drainage paths.	Runoff to be contained below the finished floor of building. Q_{max} = 100 cfs V_{max} = 10 fps D_{max} roadway = 8 inches
Street without Curb and Gutter (longitudinal flow).	Runoff contained within the roadside channels with the water surface elevation below the road subgrade. Historic drainage divides shall be retained. Flows within existing streets shall follow historic drainage paths.	Same as Street with Curb and Gutter (8 inch depth at edge of pavement).
Cross Road Culvert for Collector and Arterial Streets.	N/A	All runoff to be conveyed by culvert with no roadway overtopping allowed. V_{max} = 15 fps
Cross Road Culvert for Local Streets	N/A	Runoff to be conveyed by culvert with overtopping flow no more than six inches deep. V_{max} = 15 fps $D_{max\ (at\ crown)}$ = 6 inches

Drainage Feature	Peak Frequencies	
	2 Year	**100 Year**
FEMA Floodplain Channel	N/A	100-year peak storm to delineate a floodplain for discharges greater than 500 cfs
Channel to Convey Off-site Flow Through Development.	N/A	100-year peak storm
Lowest floor elevation for buildings within a FEMA Floodplain Area.	N/A	Lowest floor elevation to be a minimum of one foot above the floodplain water surface elevation.
FEMA AO Zones and alluvial fans	N/A	Retained natural watercourses shall contain the 100-year peak storm. Floodproofed freeboard shall be required in these drainageways. Cutoff walls to protect from lateral migration and/or headcutting may be required. Drainage that leaves the development shall be re-distributed in a manner similar to existing conditions. *At a minimum, the lowest floor elevation shall be set above the highest adjacent grade by the designated AO zone depth or 2' if no depth is specified. A registered professional engineer / surveyor shall certify the finish floor elevations comply with the above. The engineer shall certify that the structure foundation will not be inundated as a result of the 100-year storm flows. Levees, berms, or floodwalls while discouraged, must comply with FEMA standards and be submitted to the City Floodplain Manager for approval by the department responsible for plan/ design review.* All finish floors shall be a minimum of 14 inches above the low curb elevation of the residential lot.
Lowest floor not in a FEMA Designated Floodplain.	N/A	See section 6.3
Storm water storage Basin.	N/A	100-year 2-hour storm for determining storm water storage volume.

6.3 STREET DRAINAGE

The conveyance of storm water in a roadway is influenced by the typical roadway cross-section, cross-slope, longitudinal slope and roadway material. The following are standards to be used in the evaluation of roadway conveyance:

1. Finished floor elevations of buildings, shall be a minimum of 0.5 foot above the crown of an adjacent street. As measured perpendicular to the street, no portion of a structure shall have its finish floor less than 0.5 foot above the crown of the adjacent street.

2. Finished floor elevations shall be a minimum of 14 inches above the top of adjacent low curb or outfall and, for all lots except hillside lots, a minimum of six inches above the top of adjacent high curb. In areas of natural topographic or engineered sumps, the finished floor elevations for new construction shall be a minimum of 14 inches above the outfall or 0.5 foot above the maximum 100-year water surface elevation, whichever is greater.

3. Runoff calculations for the sizing of storm drain catch basin inlets and connector pipes shall be based on the Rational formula.

4. A Manning's "n" value of 0.015 shall be used for street flow on paved streets unless special conditions exist.

5. Valley gutters are only allowed on local and minor collector streets. For valley gutters crossing minor collector streets, the valley gutters shall provide mild slope transitions (maximum 5% total algebraic breakover) to provide smooth vehicular ride across them, and shall be at least seven-feet wide.

6. Curb returns should have a minimum slope of 0.01 foot of fall for every one foot of curb radius. For example, a 25 foot radius curb return should have at least 0.25 foot of fall from one end to the other.

7. For arterial and collector streets, the maximum flow depth at the gutter invert for the 2-year event shall be 0.5 feet as measured immediately up gradient of the catch basin or scupper (catch basins are depressed to provide a 5-inch opening to receive flow). Maximum flow depth in gutter sump conditions at catch basins shall be no more than 0.4 feet, beyond which, the storm water must be allowed to "break out" and continue flowing in the original historic path direction.

8. For multi-lane collector streets and all arterial streets, a 12-foot dry lane in each direction must be provided for the 2-year event.

9. For major collector and arterial streets, the maximum distance that drainage may be carried as surface flow in the street is 660 feet before reaching a catch basin or outfall. This requirement may be waived for streets with longitudinal slopes of 2% or greater, or portions of streets with very minimal flow (less than 2 cfs in the 2-year design event).

10. Catch basins on continuous grade are not required to intercept 100% of the 2-year flow.

11. The curb opening for a catch basin shall not be greater than five inches in height. Permissible catch basins are contained in the City of Phoenix Standard Details. The reduction factors, as identified below, shall be applied to the theoretical catch basin capacity to obtain the interception capacity used for design.

Reduction Factors to Apply to Catch Basins

Condition	Inlet Type	Reduction Factor
Sump	Curb Opening	0.80
Sump	Grated[1]	0.50
Sump	Combination	Apply factors separately to grate and curb opening
Continuous Grade	Curb Opening	0.80
Continuous Grade	Grated	0.50
Continuous Grade	Combination	Apply factors separately to grate and curb opening
Shallow Sheet Flow [2]	Slotted Drain	0.75

[1] Grated inlets in sump condition should be avoided whenever possible.

[2] Slotted drains are most effective for shallow sheet flow conditions or sumps. With greater depths and flows, a different type of inlet should be used.

12. Regardless of the calculated "Q", no curb inlet type catch basin shall be smaller than an M-1, L=3' basin constructed in accordance with City of Phoenix Detail P1569-1 or P1569-2.

6.4 STORM DRAINS

Minimum Hydraulic Design Standards

Minimum Velocity	5 fps for 2-Year Q_{design} 3 fps for 0.5 x Q_{design}
Minimum Pipe Size Main Line Catch Basin Connector Pipe	 18 inches 15 inches
Maximum surface flow distance within street to first catch basin or outfall, and maximum distance between catch basins or outfalls	660 feet* *May be waived for major collector or arterial streets with longitudinal slopes of 2% or greater, or with very minimal flow (less than 2 cfs in the 2-year design event).
Maximum Manhole Spacing (D = Storm Drain Diameter)	$D \leq 30$ inches 330 feet $33 \leq D \leq 45$ inches 440 feet $D \geq 48$ inches 600 feet
Maximum design hydraulic grade line (HGL) elevation	Ideally, at the top of main line storm drain pipe, but generally no higher than 1-foot above the top of pipe at the design Q. In certain circumstances, it may be allowed to go higher than this for short reaches of pipe, but in no case should the HGL reach higher than 5-feet below the ground or roadway surface elevation over the pipe.
Minimum catch basin freeboard elevation	12 inches below bottom of curb inlet or 12 inches below top of grate at the design intercept Q for the catch basin.
Minimum Manning's "n" Values Reinforced Concrete Pipe (RCP) Reinforced Concrete Box Culvert (RCBC) Corrugated Metal Pipe-(Concrete-lined) Corrugated Metal Pipe (Unlined) High Density Polyethylene Pipe (HDPE)	 0.013 0.015 0.013 0.024 0.013

The following standards shall be met for the design of storm drains:

1. Storm drain pipes and manholes shall be shown in plan and profile along with existing and proposed grades of the pipeline and ground surface above the pipeline. Catch basin and connector pipe profiles shall also be provided in the design drawings. The pipe size and slope to four significant figures shall be shown. All existing utilities, including water and sani-

tary sewer, crossing the proposed storm drain shall be shown in plan, and in profile at their proper elevation. Proposed new utilities shall be labeled and shown at anticipated locations and standard depths when exact information is not yet known. Clearance with City of Phoenix water and sewer facilities require a minimum of six feet horizontally and one foot vertically. Salt River Project utilities require a minimum of two feet clearance horizontally and one foot vertically. Clearance with other utilities shall be a minimum of one foot both horizontally and vertically.

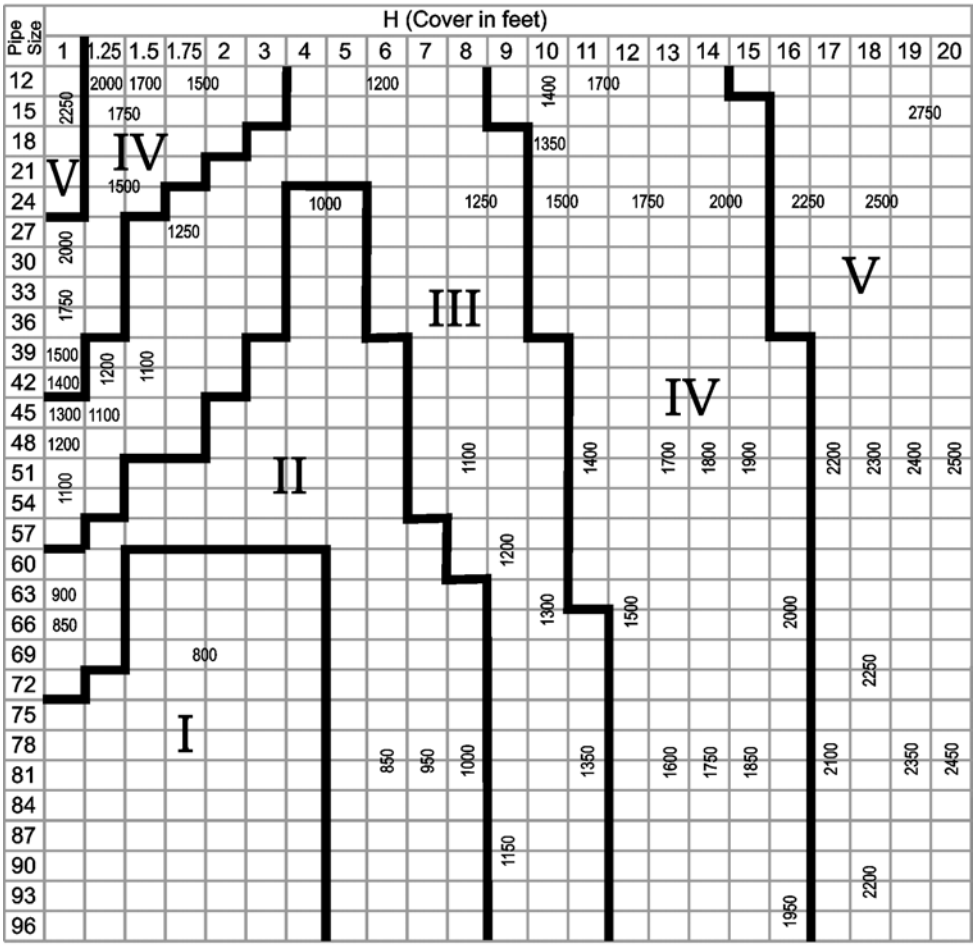
2. The design engineer shall submit hydraulic and energy grade line calculations for all main line storm drain pipes. The information shall be provided in tabular and profile format and shall include: pipe stationing, pipe size, pipe discharge (Q), pipe velocity, pipe material, hydraulic grade line, energy grade line, and finish grade over pipe. See Section 6.12 for construction drawing requirements.

3. Minimum cover of fill over storm drains should be at least five feet, and shall be designed to fall within the allowable ranges identified in the "D" load table. D-Load requirements shall be determined using a 140 pcf earth load. In ordinary soil conditions, positive projected condition shall be used up to ten feet of cover. Trench condition shall be used for deeper trenches in ordinary soil conditions. If the soil information indicates unstable soil, positive projected condition shall be used exclusively in determining D-Load requirements.

4. Manholes are required for all mainline storm drain pipe size changes, vertical grade breaks, horizontal angle deflections great than five (5) degrees, mainline pipe intersections, and periodic locations for access and maintenance. Maximum manhole spacing shall conform to the "Minimum Hydraulic Design Standards" table in this Section on page 6-9.

   Typically, when mainline pipe size changes, the inside top of pipe elevations (pipe crowns) shall be matched. In the event where the downstream pipe is smaller than the upstream (such as when a required 6-inch oversized alternate pipe is attached to RGRCP), then the pipe invert elevations shall be matched.

Required "D" Load For Reinforced Concrete Pipe
Positive Projection Condition
(140 P.C.F. Earth Load)



Structural Notes:

1. Ku = 0.1924
2. For H< 10, P = 1.0, He/Bc = 1.7
3. For H> 10, P = 0.5, He/Bc = 1.4
4. Dead Load Factor = 1.9
5. Safety Factor = 1.0
6. Earth Loading = 140 pcf (Marston's Formula)
7. Live Loading: H-20, S-16 Truck, AASHO Impact

5. Soil boring information is required for all pipe materials. Soil boring logs shall be provided with the design documentation for all storm drains within public right-of-way. Storm drains in excess of 660 feet in length shall have multiple borings at intervals not to exceed 660 feet. Boring depths shall be at least two feet below the proposed pipe invert. If cemented or rock material is encountered during drilling which results in refusal, then sufficient rock cores shall be taken to define the specific limits of rock and to identify the type and extent of refusal to at least two feet below the proposed pipe invert. Borings shall be located in plan and tied to the

same vertical datum as the proposed project. Resistivity and pH testing of the soils shall be required to support pipe design in terms of alternate pipe material selection. If resistivity readings fall below 1500 ohms per cubic centimeter, additional readings shall be made at intervals of not less than 25 feet or more than 100 feet until the limits of the area of low resistance soil are fully defined.

6. Boring log data shall include the following information:

   A. The name of the company that produced the soil report.

   B. The date the test boring was made.

   C. The type of equipment used to drill the hole and take the samples.

   D. The size of the auger used.

   E. A description of caving that occurred during the excavation, if any.

   F. Horizons of each type of soil encountered.

   G. Description of the soil.

   H. Classifications by the Unified Soil Classification System.

   I. Plasticity index.

   J. Percent passing No. 200 sieve.

   K. Water encountered.

   L. Pavement structure (AC thickness, sub-base thickness, if applicable).

   M. Relative moisture content (specify depth taken).

   N. Representative unit weight of native material (specify depth taken)

   O. Laboratory calculated optimum moisture content.

   P. Resistivity and pH readings.

7. Storm drains with flow velocities less than five fps for Q_{Design} or in excess of 15 fps shall require approval.

8. Catch basin connector pipes shall be connected to new mainline storm drain pipes with prefabricated "tees." One catch basin connector pipe may be joined to the mainline at a manhole if the standard required mainline manhole spacing provides a convenient location for it. If there are two directly opposing catch basins to connect to the mainline at a manhole, only one connector pipe may connect to the manhole and the second connector pipe shall connect to the mainline by way of a prefabricated "tee" at least 5-feet downstream of the manhole. Where connector pipes are to be joined to existing mainline storm drains, they shall be

connected by manhole; or in accordance with City of Phoenix Special Detail 621 (future City of Phoenix Standard Detail P1577), which is available from the Street Transportation Department, DCM Division; or in accordance with City of Phoenix Detail P1576 for connections to cast-in-place-pipe; or by way of City of Phoenix Special Detail 274 (future City of Phoenix Standard Detail P1578 and also available from the Street Transportation Department, DCM Division) when a new reinforced concrete connector pipe outside diameter (O.D.) is greater than one-half (1/2) the inside diameter (I.D.) of the existing reinforced concrete pipe main. MAG Detail 524 'Storm Drain Lateral Pipe Connections' shall not be used.

Connection of new mainline pipe to new mainline pipe shall be by manhole or special junction structure depending on size. Connection of new mainline pipe to existing mainline pipe shall be by manhole, special junction structure, or City of Phoenix Special Detail 274 (future City of Phoenix Standard Detail P1578), depending on size and feasibility of manhole or special junction structure installation.

9. To minimize headloss and maintain structural integrity of the mainline pipe, opposing catch basin connector pipes connecting to a mainline storm drain pipe shall be offset a minimum of five feet horizontally as measured from the centerline of each connector pipe

10. To minimize headloss, opposing storm drain laterals greater than 24 inches in diameter shall be joined by a special junction structure designed to minimum HS-20 loading by a registered professional engineer. The junction structure shall be designed to be hydraulically efficient.

11. Pulling joints for mainline storm drain pipe deflection shall be allowed only within manufacturer's tolerances. Specifications for horizontal deflection using this method shall be noted on the construction plans, citing manufacturer's requirements. An angular bend in catch basin connector pipe (horizontal or vertical), up to, and including 22 ½ degrees may be accomplished by using a standard MAG Detail 505 pipe collar. Prefabricated pipe bends shall be required for deflections in catch basin connector pipes greater than 22 ½ degrees. In addition, the maximum angle for a catch basin connector pipe to exit any wall of a catch basin shall be 22 ½ degrees from perpendicular.

12. A City owned property, dedicated right-of-way, or privately owned drainage tract shall be a minimum of 16 feet wide for underground storm drains if not under a designated road right of way.

13. All storm drain designs shall be prepared on the basis of using precast reinforced concrete storm drain pipe (RCP). RCP storm drain mainline, laterals and catch basin connector pipes shall be rubber gasketed.

14. Alternate Pipe Information:

    - Cast in place, unreinforced concrete pipe (CIPP) is not allowed within the curb returns of any major arterial or collector street, or within any other signalized or potentially signalized intersection.

    - The minimum gauge for Corrugated Steel Pipe (CSP) storm drain pipe shall be 14 gage. The specific gage specified shall provide a design life of at least 75 years to first perforation based on soil conditions (see "Minimum Gage Thickness for CSP" chart, p. 6-48).

    - CSP mainline storm drain pipe shall be concrete lined, Type "F" pipe. CSP catch basin connector pipe shall be Type 2, aluminized pipe.

    - Minimum allowable thickness, in inches, for CIPP storm drain pipe is equal to the sum of the inside diameter of the pipe (in feet) plus one inch with the minimum thickness being four inches. For example:
      The thickness required for a 48 inch CIPP is (48/12)+1 = 5 inches.

    - Alternate pipe information is to be presented in table format (see 6.15.2 for table, p. 6-45).

    - For CIPP and CSP mainline storm drain pipes, soil boring and resistivity information shall be provided and shown on the construction drawings in plan view. If the soil cannot stand vertically in the trench, CIPP will not be allowed as an alternate material. If soil resistivity readings are below 1500 ohms per cubic centimeter, CSP will not be allowed.

    - The minimum diameter for CIPP shall be 30 inches. If CIPP or CSP alternate is specified for mainline storm drain pipe, the required inside diameter shall be a minimum of six inches greater than the calculated design diameter for RCP.

    - HDPE may be used for mainline storm drain pipes and catch basin connector pipes 48 inches or smaller, provided Type S pipe is specified with water tight joints meeting or exceeding 10.8 psi (25 column feet of water head) water pressure test criteria as specified in ASTM D-3212.

15. The City Of Phoenix Standard Details, 1500 series, shall be used for storm drain systems. MAG or ADOT standards may be used for applications not covered by the 1500 series.

16. Where storm drain systems discharge into undisturbed or naturalistic drainageways, headwalls shall have aesthetic treatment to blend with the surroundings. The area surrounding the headwall (exclusive of the wash bottom) shall be revegetated and landscaped using boulders and native stone where indigenous. Railings shall be designed compatible with the colors and form of the surrounding area and the development or village theme.

17. Additional standards pertaining to Storm Drains are listed in Section 6.1, Safety.

18. All private irrigation pipe in street right of way shall be rubber gasketed precast reinforced concrete pipe.

6.5 CULVERTS AND BRIDGES

The following standards are to be employed in the design of culverts and bridges:

1. All watercourses meeting 404 permit jurisdictional criteria shall be culverted or bridged.

2. Access by maintenance vehicles to the watercourse bottom shall be provided such that maintenance activities can be undertaken without encumbering traffic flow.

3. A City owned property, right-of-way, or privately owned drainage tract shall be provided for the area inundated by backwater from culverts and bridges for the 100-year event.

4. Culverts for major collector and arterial streets are to be designed to convey, as a minimum, the 100-year peak discharge with no flow crossing over the roadway. Culverts for minor collector and local streets shall be designed to convey the 100-year peak discharge with a maximum 0.5 foot flow depth over the roadway. Dip sections without culvert are not allowed.

5. Concrete headwalls are required on all culvert installations at both ends. All culvert headwalls shall have beveled edges.

6. Culvert headwalls shall have cut-off walls. Cut-off wall depths shall be a minimum of 2.5 feet below the invert for 30 inch diameter pipe and smaller. Cut-off wall depths shall be a minimum of six feet below the invert for pipes with diameters greater than 30 inches up to 84 inches. Minimum cut-off wall depths for pipes greater than 84 inches and for all box culverts shall be per ADOT standards.

7. Where culverts convey flow in undisturbed or naturalistic drainageways, the culvert headwalls shall have aesthetic treatment designed to blend with the surroundings. The area surrounding the headwall (exclusive of the watercourse bottom) shall be revegetated and landscaped using boulders and native stone where indigenous. Railings shall be designed compatible with the colors and form of the surrounding area and the development or village theme.

8. Pipe culverts shall not exceed a maximum length of 80 feet. The maximum diameter shall be 36 inches. The minimum diameter for a culvert is 18 inches. Any culvert longer than 80-feet shall be box culvert.

9. For maintenance purposes, minimum box culvert width shall be four feet and minimum desired height shall be six feet. Maximum desirable length shall be 200 feet. Where roadway profiles are low and design depth of flow is two feet or greater, the allowable clear opening in a six foot high box may be reduced to four feet with the invert of the box set two feet below the natural invert of the adjacent channel. In extremely tight locations, the minimum-height may be reduced to four feet with adequate justification and approval by the appropriate reviewing department(s).

   Where a public or private multi-use path/trail easement/right-of-way is located in a watercourse corridor, and the path/trail is to go under a roadway, the minimum box culvert width shall be ten feet and the minimum height shall be ten feet. Where equestrian access is anticipated, the desired minimum height is 12 feet. Multi-use culverts shall be lighted in accordance with Parks and Recreation Department standards.

10. Ramped, vehicular access for maintenance is required at the upstream and downstream ends of all culverts (See Section 6.1). Ramps shall have lockable bollards or gates and be accessible by mountable curbs from the road.

11. Culverts are to be designed with consideration to the guidelines presented in the Culverts and Bridges, and Sedimentation chapters in the FCDMC Hydraulics Manual. Minimum velocities through the culvert shall promote sediment transport to keep the culvert clear.

12. Outlet velocities shall be kept below 15 feet per second unless special conditions exist. The maximum velocity should be consistent with channel stability requirements at the culvert outlet. Agradation or degradation at culvert crossings must be examined in the design of culverts.

Design Criteria for Culvert Outlets

Outlet Protection	Natural Channel	Artificial Channel
None	Up to 1.3 times existing channel velocity	Up to maximum allowable velocity for channel lining
Riprap or other suitable transition apron	1.3 to 2.5 times existing channel velocity	1.0 to 2.5 times allowable channel lining velocity
Energy Dissipater	Velocities greater than 2.5 times existing channel velocity	Velocities greater than 2.5 times allowable channel lining velocity

13. The size, depth, and lateral extent of riprap shall be designed in conformance to the Culvert and Bridges Chapter of the Drainage Design Manual for Maricopa County, Hydraulics. While the use of grouted riprap is discouraged, riprap may be grouted to minimize vandalism and/or inhibit the growth of nuisance vegetation in order to minimize maintenance. Grouting shall not reduce the required size, depth, or lateral extent of riprap.

14. Bridges shall be designed to have a minimum freeboard of two feet from the design water surface elevation to the low chord elevation for the 100-year event. The structural design of the bridge shall take into account the possibility of debris build up and flows impacting the bridge. As a minimum, hydraulic modeling of bridges shall reflect piers as twice their design width to account for debris. Bridge footings shall be founded below the depth of total scour as defined in the Hydraulics Manual. Where a public or private multi-use trail easement/right-of-way is located in a wash, the minimum span between piers shall be ten feet and the minimum height between low chord and the wash bottom shall be 12 feet.

15. Where bridges convey flow in undisturbed or naturalistic drainageways, bridge designs shall incorporate materials, colors, and forms compatible with the surroundings and the theme of the development or the village. Where it is indigenous, the use of native stone in bank protection is encouraged if it meets the engineering requirements. Wingwalls shall have aesthetic treatment to blend with the surroundings. The area near the bridge (exclusive of the wash bottom) shall be revegetated and landscaped using indigenous boulders and stones where possible.

16. Bridges crossing undisturbed watercourses with designated erosion setbacks shall span across the watercourse from setback to setback. Alternatively, a comprehensive sediment transport analysis that assesses sediment transport in time and space (i.e. dynamic modeling consistent with tier 3 analysis identified in the Drainage Design Manual, Hydraulics) shall be undertaken to support design.

17. For channels carrying supercritical flow, there shall be no reduction in cross sectional area at bridges and culverts; or any obstructions (including bridge piers) in the flow path.

18. Freeboard for bridges over channels flowing under supercritical conditions shall be the greater of two feet or the velocity head for thalweg velocities.

6.6 OPEN CHANNELS

The following standards shall be employed in all designs of engineered open channels (does not apply to undisturbed drainageways):

1. All engineered channel construction drawings shall contain a plan and profile or detailed grading plan as well as adequate cross sections (to describe geometry) for channels convey-

ing 100-year discharges of 500 cfs or greater. Engineered channels or ditches designed for flows less than 500 cfs may be shown more simply in plan view only, with spot elevations, flow direction arrow, and typical section. The channel plan shall show the horizontal alignment and dimensions as well as the type and extent of the proposed work. For channels greater than 500 cfs or channels designed for supercritical flow, the plan shall also show the following: Q_{100} ; proposed invert and top of bank; estimated water surface profile; energy grade line; hydraulic jump location and length; original ground at channel centerline; all utilities and structure crossings; freeboard; and if necessary, top of proposed embankment fill.

2. All channelization within FEMA mapped floodplains must be designed so that the cumulative effect of all new development does not raise the 100-year water surface (or energy grade line for supercritical flow) more than one foot. In addition, when determining encroachments of fill or other development, the "equal conveyance from both sides of channel" rule shall apply. The one foot rise in water surface may not come from one side of the channel at the expense of the adjacent property owner.

3. Encroachment and/or stabilization on one bank must address increased erosion potential on the opposite bank.

4. Channels shall be designed consistent with the guidelines provided in the Open Channels and Sedimentation Chapters of the Drainage Design Manual for Maricopa County, Hydraulics.

5. Use of concrete lined channels shall generally not be permitted in residential or recreational areas with 100-year design storm discharges of 100 cfs or greater. Concrete-lined channels may be allowed in certain circumstances where public access is limited due to specific site conditions or where adequate treatment by landscape screening, concrete color integration, etc. is provided, with adequate justification and approval by the appropriate reviewing department(s).

6. All concrete and shotcrete lined channels shall have continuous reinforcement extending both longitudinally and transversely. Shotcrete channels shall be designed to the same structural integrity as concrete channels.

7. All sloping and flat concrete, shotcrete, and soil cement finished surfaces shall have roughened surfaces (e.g. embedded rock, grooves from ¼ inch steel tined rakes, etc.) to discourage inappropriate recreational use.

8. The minimum thickness of concrete lining on the invert and ramps shall be eight inches for channels that will have periodic maintenance vehicle traffic.

9. Use of grouted riprap for channel lining is not permitted in any application. Rock embedded into structural concrete linings is acceptable.

10. The minimum thickness of riprap linings shall be the greater of d_{100} or 1.5 times d_{50}. In a well graded stone riprap lining, the recommended maximum stone size is two times the d_{50} and the recommended minimum size is one -third of the d_{50}.

11. All stones composing the riprap shall be angular, with a minimum specific gravity of 2.4, following the standard test ASTM C127.

12. Due to erosion and scour of erodible channels and safety concerns with excessively high velocities, the recommended upper limit of Froude Number (Fr) shall be 2.0. The Froude Number for all types of channel linings shall be $Fr < 0.86$ for subcritical flow regime. For concrete, soil cement, and shotcrete lined channels functioning in supercritical flow regime, the additional range of $1.13 < Fr < 2.0$ is allowed. The design Froude Number shall not fall between 0.86 and 1.13. At locations where there are to be planned hydraulic jumps, concrete, soil cement, and shotcrete lined channels may pass through $0.86 < Fr < 1.13$. No other linings, other than concrete, shotcrete or soil cement or roller compacted concrete may be used in channels that fall in the range of 1.13 to 2.0.

13. Earthen bottom channels with lined side slopes buried below the depth of expected total scour are allowed with supporting engineering justification including sediment transport analysis, scour analysis, soil boring logs, and long term watershed yield analysis to support equilibrium longitudinal slopes. Gabions, soil cement, angular dumped riprap, roller compacted concrete or reinforced structural concrete may be used to line side slopes.

14. Gabions are not allowed on channel bottoms except at grade control, drop structures, or similar hydraulic structures. Gabions shall be backfilled with native material or stones when possible and should be seeded or planted with native vegetation.

15. Maximum channel velocities shall be governed by the following tables:

Maximum Permissible Velocities for Unlined Drainage Channels[1]

Soils Type (Earth, No Vegetation)	Maximum Permissible Velocity [2], ft/s
Fine Sand (noncolloidal)	2.5
Sandy Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (noncolloidal)	5.5
Alluvial Silts (noncolloidal)	3.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5
Shales and Hard Pans	6.0

[1] Adopted from USDOT, FHWA, 1961 and 1983.

[2] For sinuous channels multiply permissible velocity by: 0.95 for slightly sinuous; 0.90 for moderately sinuous; and 0.80 for highly sinuous.

Maximum Permissible Velocities for Channels with Uniform Stand of Various Grass Cover and Well Maintained [1], [2], [3]

Cover	Maximum Permissible Velocity, fps	
	Erosion Resistant Soils	Easily Eroded Soils
Bermuda Grass	6.0	4.5
Desert Salt Grass Vine Mesquite	5.0	4.0
Lehman Lovegrass Big Galleta Purple Threeawn Sand Dropseed	3.5	2.5

[1] Adopted from USDOT, FHWA, 1961 and 1983.

[2] Use velocities over 5 fps only where good covers and proper maintenance can be obtained.

[3] Grass is accepted only if an irrigation system is provided and maintained.

Criteria for Artificial Channels

Type of Channel Lining [1]	Maximum Side Slope, H:V (%)	Maximum Velocity, fps [2]
Structural Concrete [3]	Vertical	15
Soil Cement / Roller Compacted Concrete	2:1 (50%)	7 [4]

[1] The values in this table are for channel sections with the same lining material for bottom and sides. For conditions where the bottoms and sides of the channels are different, the most critical applicable criteria are to be used.

[2] Maximum flow velocity in artificial channels shall be calculated by an appropriate method and shall not exceed the maximum allowable velocity.

[3] Shotcrete is allowed provided it is designed with the same reinforcement as structural concrete.

[4] Higher velocities for soil cement or RCC lined channels/drop structures are acceptable upon submittal of a geotechnical analysis that assesses the suitability of the in-situ materials for soil cement or RCC applications and presents cement mixture specifications for the in-situ soils for the proposed maximum design velocities. The submittal shall be stamped by a PE. Velocities greater than 15 fps are not recommended.

Criteria for Artificial Channels

Type of Channel Lining [1]	Maximum Side Slope, H:V (%)	Maximum Velocity, fps [2]
Angular Rock Riprap	3:1 (33%)	9 [3]
Rock Filled Gabion Baskets	Per manufacturers' specifications	9 [4]
Grass (irrigated & maintained)	5:1 (20%)	2.5 to 6.0
Earth	4:1 (25%)	2.5 to 6.0

[1] The values in this table are for channel sections with the same lining material for bottom and sides. For conditions where the bottoms and sides of the channels are different, the most critical applicable criteria are to be used.

[2] Maximum flow velocity in artificial channels shall be calculated by an appropriate method and shall not exceed the maximum allowable velocity.

[3] Guideline only. Strict limits have not been set because this manual recommends that these channels flow subcritically.

[4] Guideline only. Strict limits have not been set because this manual recommends that these channels flow subcritically.

Note: The criteria listed in this table are boundary values. The designer is responsible for determining adequacy of criteria for each specific application. For design of lining materials, analyses of soil conditions and subsurface drainage may be required.

16. For channels with Froude Numbers less than 0.86, the ratio of the channel radius (at the centerline) to the design width of the water surface shall be greater than 3.0.

17. Required freeboard shall be computed according to the following formula:

$$FB = 0.25\left(Y + \frac{V^2}{2g}\right)$$

where:

FB = freeboard in feet,
Y = depth of flow in feet,
V = velocity of flow in ft/s, and
g = acceleration due to gravity in ft/s^2.

The minimum freeboard value for rigid channels shall be one foot for subcritical and two feet for supercritical flows. The freeboard requirements are to be added to the superelevated water surface elevation at channel bends for both subcritical and supercritical flow conditions (See Drainage Design Manual for Maricopa County, Hydraulics for superelevation analysis). Using a smaller freeboard in specific cases requires approval. Freeboard exceeding the minimum standard is strongly recommended in undeveloped or developing areas. Levees, berms, or floodwalls, although discouraged, must meet FEMA freeboard requirements. In all FEMA jurisdictional floodplains, the greater of the above equation or FEMA's freeboard requirement shall prevail for design freeboards.

18. To reflect sporadic maintenance conditions, additional freeboard is required when water surface elevations exceed top of bank for the design discharge analyzed at a Manning's "n" value 0.05 greater than the design "n" value. The depth added shall only be that depth needed to accommodate the design discharge within the channel banks (i.e. utilizing the conveyance area associated with the freeboard to convey the design discharge at the higher "n" value).

19. A City owned property, dedicated right-of-way, or privately owned drainage tract shall be a minimum of the top width of an appropriately sized open channel plus 16 feet contiguous on one side if maintenance access is not provided within the channel bottom. In no case shall a City owned property, right-of-way, or private drainage tract be less than 20 feet wide without approval. Open channels shall be included within a City owned property, right-of-way, or private drainage tract that must be platted. This does not apply to off-site, adjacent developable property where temporary easements have been obtained for temporary collector channels provided these collector channels are accessible by ordinary maintenance equipment.

20. Roadside ditches and swales that are intended to convey 100-year flows less than 100 cfs shall be no deeper than two feet. The side slopes of roadside ditches should be as mild as

practical and shall be no steeper than 4H:1V. For maintenance purposes, ditches shall be trapezoidal and minimum bottom widths shall be four feet for ditches adjacent and parallel to streets or access roads.

21. Artificial channels that are to be maintained by the City shall not be grass lined except as approved by the City.

22. Landscaping and revegetation, in its mature size and state, must not prevent access by ordinary maintenance equipment (e.g. pick-up truck, loader, backhoe, etc.). The mature vegetation shall comply with the design intent of the channel in terms of conveyance and freeboard.

23. During the course of the Master Planning process, the 100-year runoff will be used to delineate a floodplain for major channels with discharges of more than 500 cfs. The final drainage plan shall show the floodplain delineations for pre-project and post-project conditions. The drainage report shall discuss any disparity in these delineations on adjacent properties.

24. For projects where buildings may be placed within a Special Flood Hazard Area, the following note shall be added to the Final Site Plan/Final Plat and Setback Exhibit.

> *A Federal Emergency Management Agency (FEMA) "Elevation Certificate" must be completed for each structure constructed in a Special Flood Hazard Area (SFHA) prior to an Electrical Clearance for that structure. One copy of the "Elevation Certificate" is to be submitted to the General Building Safety Inspector onsite and one copy is to be submitted to the City of Phoenix Floodplain Manager.*

25. Floodplain analysis of an AO zone is required to verify that all new construction of residential structures have the lowest floor set above the highest adjacent grade by the designated AO zone depth or two feet if no depth is specified. A professional engineer or land surveyor registered in Arizona shall certify the finished floor elevation and shall certify that it will not be inundated as a result of the adjacent 100-year storm flows. Certifications are required to be submitted to the Development Services Department after the pad elevation has been set and prior to the construction of foundations or stem walls. Levees, berms, or floodwalls while discouraged, must comply with FEMA standards and be submitted to the City Floodplain Manager for approval from the department responsible for plan/design review.

26. Additional standards pertaining to open channels are listed in Section 6.1, Safety.

6.7 HYDRAULIC STRUCTURES

The following standards shall be utilized in the design of hydraulic structures:

1. A clogging factor of 50 percent of the rack area shall be used in the hydraulic analysis of all trash racks.

2. At drop structures, a hydraulic jump analysis shall be conducted for a range of flows, since flow characteristics at the drop may vary with discharge. This analysis is to be used to support the design of the structure and erosion control measures.

3. Due to a high failure rate and excessive maintenance costs, drop structures having loose riprap on a sloping face are not permitted.

4. Where hydraulic structures are located within or adjacent to undisturbed or naturalistic drainageways, the structures shall have aesthetic treatment to blend with the surroundings. Trash racks shall have an exterior color to blend with the surrounding native soil.

5. Open channels are recommended in lieu of pipes for conveyance of low flows through drop structures. Pipes, if approved for conveying low flows through drop structures, shall be no smaller than 24 inches in diameter.

6. Additional standards pertaining to hydraulic structures are listed in Section 6.1, Safety.

6.8 STORM WATER STORAGE

The analysis and design of storm water storage facilities shall meet the following standards:

1. All new developments shall make provisions to retain the storm water runoff from a 100-year, 2-hour duration storm falling within its boundaries. This requirement may be waived by the Development Services Director for isolated developments under 1/2 acre in area if there will be no critical drainage problem created by the additional runoff from the proposed development. The finding of no detrimental impact must be documented following the methodologies established in the Maricopa County Drainage Design Manuals, Hydrology and Hydraulics.

2. Stormwater retention is not required for collector and arterial street rights of way. Classification of streets shall be per the Street Transportation Department "Street Classification Map".

3. In the special case when a detention facility is allowed, the requirement to retain the 100-year 2-hour runoff volume may be waived. Post-development peak discharges shall not exceed pre-development peak discharges for the 2-, 10-, and 100-year storm events. In addition, first flush water quality criteria per the EPA requirements must be met.

4. Required retention basin volume shall be obtained by using the following equation:

$$V = C\left(\frac{P}{12}\right)A$$

where:

V = Calculated volume in acre-feet
C = Runoff coefficient (see Section 6.2.2)
P = 100 year, 2 hour rainfall depth in inches
A = Drainage area in acres

5. All developments shall be designed to have a positive outfall to adjacent streets once the on-site storm water storage basins are filled. An additional 25% retention for the design storm event will be required when the storm water storage basin does not outfall to public right of way or public drainage easement.

6. Sedimentation basins as required per Section 6.10 shall be located at the upstream (inlet) end of stormwater storage facilities. All stormwater storage facilities receiving flow from undisturbed watercourses shall incorporate sediment settling basins at the terminus of the undisturbed watercourse(s) as identified in Section 6.10. The sediment settling basins shall be easily accessible by maintenance equipment (such as backhoes and loaders) and shall have a minimum storage capacity as required in Section 6.10.

7. Storm water storage basins shall have a maximum water depth of three feet for the 100-year, 2-hour storm event. Deeper water depths for the design event shall require approval by the reviewing department(s).

   - The required stormwater storage volume shall be provided on private property and not intrude upon the ultimate road right-of-way as shown on the Street Classification Map.

   - The maximum depth of the stormwater storage basin within ten feet of the right-of-way shall be 18 inches; and within 20 feet of the right of way shall be 24 inches. The basin side slope shall not begin closer than two feet from back of sidewalk. If there is no sidewalk, storm water storage shall begin no closer than seven feet from the back of curb.

   - Berms shall not be placed closer than 2-feet from the back of sidewalk or 2-feet from back of curb where sidewalk is detached from curb. Berms shall not be higher than 2-1/2 feet above the top of sidewalk or curb. Berms shall have a minimum top width of 2-feet with an overflow area (emergency spillway) cut into the berm.

   - Side slopes of storm water storage facilities shall be no steeper than 5:1 for irrigated grass areas and 3:1 for landscaped areas. The drainage plans must provide slope stabi-

lization measures for all slopes steeper than 5:1. The slope stabilization measures must be readily maintainable using common maintenance equipment and be designed with consideration to aesthetics. The slope stabilization measures shall be consistent with commonly used engineering practices. Unstabilized decomposed granite is not allowed on slopes steeper than 5:1.

- Where necessary, vertical retaining walls may be utilized for portions of basin sides, subject to public safety requirements (fences, railing, etc.) as needed and described elsewhere in this Manual.

- The designer is encouraged to discuss proposed slopes, landscaping and stabilization measures with the reviewing department staff prior to submittal of plans

8. Storm water storage basin sides, edges, or top of slopes shall be of irregular geometry. Basins shall incorporate native materials (including native stone and boulders) and be revegetated in such a manner consistent with the engineering intent of the facility and conducive to maintenance activities. Storm water storage facilities in excess of 0.5 acre-ft design storage (excluding freeboard) and over 3 feet in depth shall incorporate benches no narrower than ten feet (level bench width) for at least 40 percent of the circumference of the basin. The bench shall be at least two feet higher than the basin bottom.

9. The maximum depth of ponded water within any parking lot location shall be six inches with the deeper portions confined to remote areas of parking lots, whenever possible. The minimum longitudinal slope permitted within parking lot storage facilities is 0.005 ft/ft, unless concrete valley gutters are provided. With concrete valley gutters, a minimum longitudinal slope of 0.002 ft/ft is permitted.

10. All storm water storage basins shall be designed to have positive outfall without ponding in local streets. When a design does utilize ponding in local streets, the storm water storage basin must have 0.5 foot freeboard above the design storm event and the maximum ponding in the local street shall not exceed 0.5 foot before positive outfall. Ponding in major and collector streets is not allowed. These criteria do not take into account off-site flows being routed through the storm water storage basin.

11. The design of all storm water storage facilities shall be such that the stored runoff shall be emptied completely from the facility within 36 hours after the runoff event has ended by either infiltration, controlled bleed-off, dry well or discharge pump to an approved facility. Where bleed-off pipes are to be used as the primary means of draining the storm water storage basin, the calculated outlet diameter shall drain the 100-year (design) storm water storage volume in 36 hours, but not less than 24 hours. The proposed diameter may be rounded up to the nearest standard size made by pipe manufacturers. The minimum allowable pipe size for primary outlet structures is 18 inches in diameter. If the flow capacity of an outlet pipe

must be further reduced, a permanently attached, hinged orifice plate shall be used. Maximum bleedoff rate into a City of Phoenix storm drain system shall be limited to one cfs.

12. Discharges from storm water facilities must be in compliance with 40 CFR 122, the National Pollution Discharge Elimination System (NPDES) and City Code Chapter 32C Storm Water Quality Protection.

13. Field investigations shall include percolation tests to obtain permeability rates for use in the design of the storm water storage facility. Such tests shall be in the receiving layer below the proposed basin

14. Dry wells shall be designed in conformance with ADEQ guidelines. The accepted design disposal rate for a dry well shall not exceed 0.1 cfs per well unless a greater rate can be supported by a detailed, certified soils report. Should the soils report indicate a higher rate, a conservative value of 50 percent of the higher rate (not to exceed 0.5 cfs per well) shall be used to compensate for deterioration over time and for silting and grate obstruction. Dry wells that cease to drain a facility within the 36 hour period shall be replaced/refurbished by the owner with new ones and such a requirement shall be written in the CC&R's for all subdivisions where drywells are used to drain storm water storage facilities. Dry wells are not allowed within City right-of-way. Dry wells, when required, shall be drilled a minimum of ten feet into permeable porous strata or percolation tests will be required after construction. The City inspector must inspect and approve the well before backfill or well pipes are placed within any dry well bore holes. Where dry wells are installed, it shall be the owner's responsibility to clean and maintain each structure to assure that each remains in proper working order. Under no condition shall the regular maintenance schedule be greater than every three years.

15. Emergency spillways of jurisdictional dams (see section 4.6) shall comply with the rules and regulations of ADWR. Emergency spillways for non-jurisdictional dams that are less then six feet in height shall have the capacity to discharge the 100-year inflow flood with no attenuation due to storage routing. Emergency spillways for non-jurisdictional dams that are more than six feet but less than 25 feet in height shall have the capacity to discharge the ½ probable maximum flood (PMF) when routed through the storage basin. The residual freeboard for all non-jurisdictional dams shall be a minimum of one foot. Spillways shall be designed to resist failure due to erosion during the design flood. If spillways result in a diversion of flood flows in either magnitude or direction from its normal and natural course, then down-gradient properties shall be protected from damage caused by spillway release. Dam height is the vertical distance from the lowest point along the downstream slope to the emergency spillway crest or to the top of the dam if no spillway exists. Residual freeboard is the vertical distance between the top of the dam and the design water surface elevation when passing the maximum discharge through the spillway. The probable maximum flood (PMF) is defined by

ADWR as the flood runoff expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The ½ PMF is that flood hydrograph equivalent to ½ the ordinates of the PMF hydrograph.

16. The finish floor elevation of structures must be at least 0.5 foot above the overflow water surface elevation at the crest of the emergency spillway. Finished floor elevations of structures shall be a minimum of one foot above the 100-year water surface of the stormwater storage facility for the 2-hour storm event.

17. The maximum water surface elevation resulting from the storage of the required stormwater storage volume shall be below the elevation of the emergency spillway crest.

18. In areas of natural topographic or engineered sumps, the finished floor elevations for new construction shall be a minimum of 14 inches above the outfall.

19. A preliminary landscaping plan for the storm water storage area must be submitted prior to the issuance of a final grading permit. The landscaping plan must accommodate access by maintenance equipment commonly used by the City of Phoenix such as backhoes and loaders among other equipment.

20. Storm water storage basins are to be privately maintained and located within a designated drainage tract unless sited in conjunction with a City owned and operated park. Privately maintained facilities shall have *"Private Drainage Facility - No City Maintenance"* legibly embedded or stamped in concrete using three inch lettering at a conspicuous place in the vicinity of all entrance and exit points of the drainage facility. The construction plans supporting the drainage design shall clearly call out location, size and text for this signage.

21. Storm water storage facilities sited in conjunction with a park that is to be owned and operated by the City of Phoenix Parks and Recreation Department (PRD) shall have the following additional requirements:

    a) Provide positive drainage out of basin.

    b) Site to be graded in a manner to provide some high ground and/or non-flooding area, with a minimum acreage to be determined by the PRD. Five acres is the minimum size and 15 acres is preferred for a multi-use basin. The amount of area above the 100 year water level is contingent upon the facilities to be provided which are established upon consultation with the PRD.

    c) Provide for street frontage on at least one side.

    d) Sited within a dedicated right-of-way with fee simple title transferred to the City.

    e) Ground cover shall be of similar materials. Mixing materials can create maintenance problems.

f) Street nuisance water should not enter park, or shall be accommodated with an approved low flow channel or other storm drain system

g) Grading, landscaping, and irrigation shall be provided by the Owner or Developer with the PRD approval.

h) Location of site and street access shall be approved by the PRD and the Street Transportation Department.

i) Existing vegetation shall be preserved when possible.

j) The top one foot of soil on the bank and the basin floor shall be free of gravel and rock, suitable for establishing turf.

k) Depths greater than three feet by PRD approval only.

l) Where sediment transport analysis is required (See Section 6.10), sediment settling basins at the upstream end of the basin shall be required.

22. Additional standards pertaining to storm water storage are listed in Section 6.1, Safety.

6.9 PUMP STATIONS

1. Water quality testing and approval from City of Phoenix Storm Water Management Section is required prior to the operation of pump station for every pumping event.

2. Pump capacity shall be sufficient to empty the facility within 36 hours and shall have a maximum output of one cfs, unless otherwise permitted.

3. A six feet wide minimum paved apron shall be provided around the inlet opening.

4. An automatic switch control with vertical float controlled mechanism shall be provided and installed to the manufacturer's recommendations.

5. The pump shall be accessible with the basin completely full of water.

6. The pump inlet shall be protected with 3/4-inch mesh screen for both vertical and horizontal faces.

7. Design/performance redundancy shall be required for all facilities in which failure of the pump station will potentially threaten lives or cause significant property damage.

8. Pump stations shall not discharge into the street right-of-way. Pumped discharges from storm water storage facilities to storm drain systems may be allowed with approval of the City Street Transportation Department. Pump stations used to drain storm water from a storm water retention storage facility shall not be operated during storm events.

9. Pump discharges shall conform to the requirements of the Clean Water Act.

6.10 SEDIMENTATION

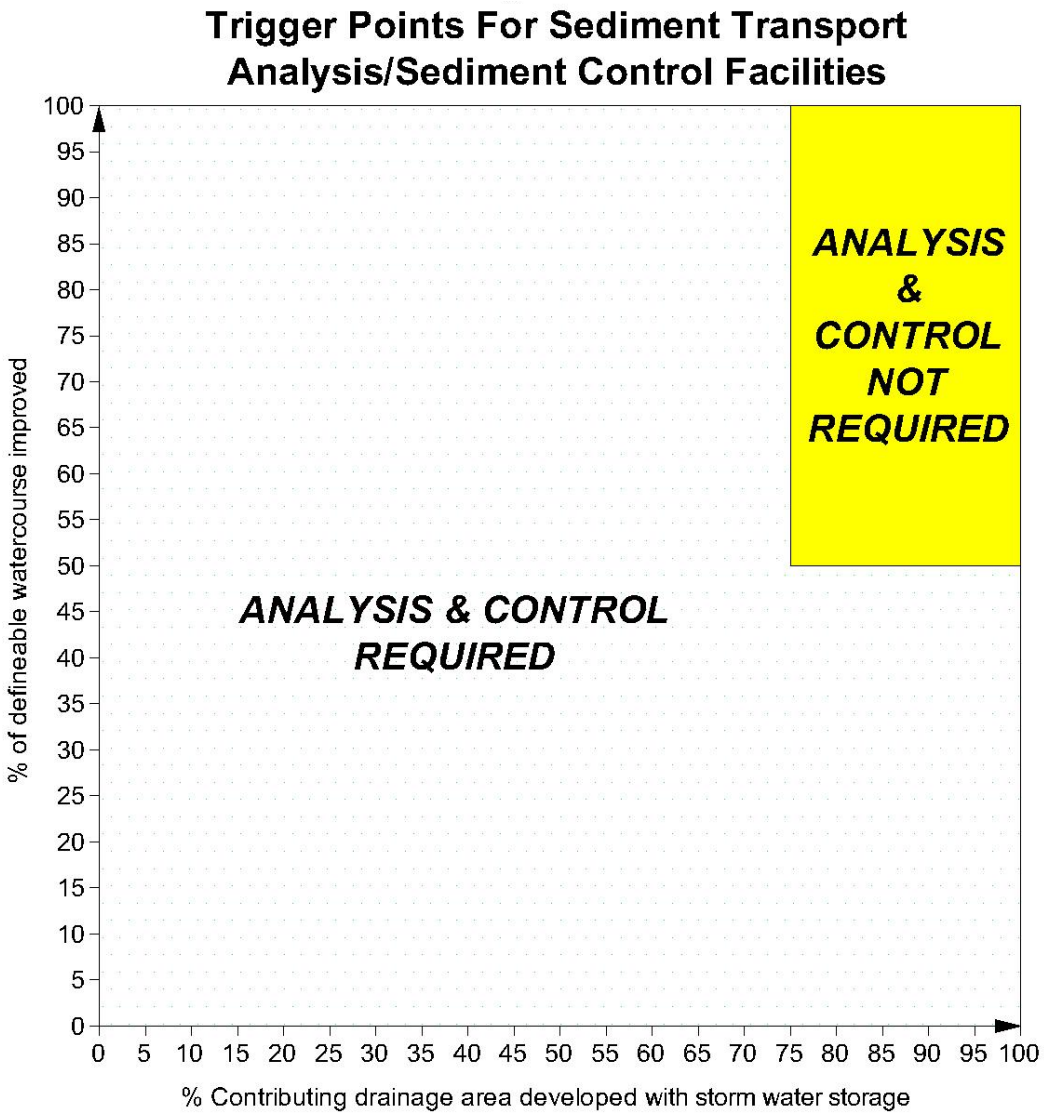
Recognizing that sedimentation and sediment transport is either supply or transport control (see the Maricopa County Drainage Design Manual, Hydraulics) and that storm water runoff may produce sedimentation or erosion, the following standards shall be applied.

1. To support the design for engineered drainage features with less than 50% of the definable watercourse exhibiting engineered improvements or with contributing[1] drainage areas less than 75% developed, the following sediment transport analysis shall be undertaken consistent with the methodologies identified in the Drainage Design Manual for Maricopa County, Hydraulics, Chapter 10, Sedimentation:

100-Year Design Discharge	Sediment Transport Analysis
200 to 500 cfs	Qualitative
501 to 2000 cfs	Qualitative and Quantitative
greater than 2000 cfs	Qualitative, Quantitative, & Dynamic Modeling

2. Where sediment transport analysis is required, sedimentation basins/structures shall be designed and constructed as an integral part of storm water storage and/or conveyance facilities unless a sediment transport analysis of the system demonstrates that sediment is conveyed through the system during frequent events including the 2-year storm event. A definable watercourse is considered to be one that has a three foot wide bottom and exhibits gradation in sediment size due to variations in flow velocity along the watercourse.

[1] For land development projects, the area considered is the "off-site" drainage area.



3. Sedimentation basins/structures shall be designed to hold a minimum of two years of watershed sediment yield using an annual sediment yield of 0.25 ac-ft/sq. mi./year or the site-specific sediment yield based upon in-situ geomorphic analysis meeting or exceeding those identified in the sedimentation chapter of the Drainage Design Manual for Maricopa County, Hydraulics. Sediment basins/structures shall be designed with minimum 8:1 side slopes and 16-foot wide access ways on opposing sides. Sediment basins/structures shall be designed to slow the passage of runoff but not prevent the passage of runoff. Sediment check structures shall have low flow outlets with inverts set equal to the invert of the drainageway and shall be no higher than 18 inches. All outlets shall be designed to protect from scour per the Drainage Design Manual for Maricopa County, Hydraulics.

6.11 HYDROLOGY REPORTS

1. Report Organization

Hydrology reports shall be organized to include the following appropriate sections (as a minimum) in the order given:

TABLE OF CONTENTS

1.0 Storm Drain Checklist
2.0 Introduction
3.0 Location
4.0 Site Description and Proposed Development
5.0 FEMA Floodplain Classification
6.0 Off-site Drainage
    6.1 Background
    6.2 Proposed Offsite Flow Management
7.0 On-site Drainage
8.0 Retention Requirements
9.0 Finished Floor Elevations
10.0 References

FIGURES

Figure 1 Area Location Map
Figure 2 Aerial Photo Map
Figure 3 FIRM Map
Figure 4 Off-site Drainage Map
Figure 5 On-site Drainage Map

APPENDICES

Appendix A Offsite Drainage
Appendix B Peak Flow Calculations
Appendix C Street Capacities & Storm Drain Analysis
Appendix D Retention Requirements

2. Storm Drain Checklist

Each report will contain the following checklist, completed as appropriate for the proposed project.

NO.		STATUS	ITEM
1.			A complete drainage report, sealed by a Civil Engineer licensed to practice in Arizona containing the following:
	a.		A drainage area map at an appropriate scale.
	b.		Each sub-basin area delineated in different colors and labeled with an alpha-numeric character on the Drainage Area Map.
	c.		Directional drainage arrows on all streets, parking lots, paved areas, and vacant land.
	d.		Zoning shown on each parcel.
	e.		Catch basins shown (existing catch basins shown with dashed lines).
	f.		Each catch basin number corresponding to the number of the sub-basin area which contributes to it.
	g.		Catch basins numbered, beginning with number 1 as the first catch basin contributing to the storm drain at the upstream end. The next catch basin contributing shall be number 2, etc.
	h.		The same catch basin number is used throughout the project – on the drainage area map, in the design report, on the Storm Drain Design Summary Sheet, and on the plans
	i.		Minimum catch basin freeboard provided per “Minimum Hydraulic Design Standards” table in Section 6.4 of the Manual.
	j.		Completed Storm Drain Design Summary sheet is included in Drainage Report.
2.			Conformance with previous drainage studies checked and differences discussed.
3.			Storm Drain Quantity Summary sheet is included in plans.
4.			Storm Drain Design Summary sheet is included in plans.
5.			Hydraulic & Energy Grade Line Profile sheet included in Drainage Report and in plans.
	a.		Maximum design HGL meets requirements specified in “Minimum Hydraulic Design Standards” table in Section 6.4 of the Manual.
6.			Design complies with pipe flow velocity standards shown in “Minimum Hydraulic Design Standards” table in Section 6.4 of the Manual.
7.			Dry lane requirements are met.

NO.	STATUS	ITEM
8.	_____	Appropriate drainage runoff was assumed:
a.	_____	No contributing runoff was assumed for properties with existing 100-year on-site retention, or properties with plans for 100-year on-site retention which have been reviewed and approved by the City.
b.	_____	Existing condition land-use runoff coefficients were used where contributory land is vacant or developed prior to storm water storage requirements.
9.	_____	All underground utilities identified in plan & profile.
10.	_____	Utility potholes requested (as needed) for capital improvement projects.
11.	_____	Water, sewer, and natural gas service taps shown in plan & profile.
12.	_____	All sanitary sewer manhole rim and invert elevations shown on plans.
13.	_____	Existing top of water valve nut elevations noted on storm drain plans.
14.	_____	Storm drain and catch basin connector pipe conflicts with other utilities identified.
15.	_____	SRP, RID, and private irrigation facilities checked for conflicts.
16.	_____	Waterline thrust block conflicts shown.
17.	_____	Pipe supports for sanitary sewer lines above main storm drain per MAG Detail 403, are called out.
18.	_____	Any existing Portland Cement concrete pavement underlay shown.
19.	_____	Existing topography and buildings shown at least 30 feet beyond street R.O.W.
20.	_____	Intersecting side street elevations at least 100 feet beyond curb returns noted on plans.
21.	_____	Potential ponding behind sidewalks checked and resolved.
22.	_____	Driveway/catch basin conflicts checked and resolved.
23.	_____	Finish floor elevations checked relative to 100-Year water surface elevations (6 inches), top of curb elevations (14 inches low curb, 6 inches high curb), street crown elevations (6 inches), and sump outfall elevations (6 inches) as appropriate.
24.	_____	One typical full-street cross-section with storm drain and all other underground utilities drawn at 1” = 10’ H & V scale on each storm drain profile sheet. The section should be taken at a specific station location on that sheet, and that station location shall be noted on the cross-section.
25.	_____	Main line storm drain plans shall be 1 inch = 20 feet horizontal and 1 inch=2 feet vertical (unless otherwise approved).

NO.	STATUS	ITEM
26.		Scales for connector pipe/catch basin profiles shall be 1 inch = 5 feet horizontal and 1 inch=5 feet vertical (unless otherwise approved).
27.		Mainline storm drain has minimum 5-foot cover (unless otherwise approved).
28.		Maximum distance that surface drainage is carried in a collector/arterial is 660 feet before reaching a catch basin
29.		Maximum manhole spacing meets requirements specified in "Minimum Hydraulic Design Standards" table in Section 6.4 of the Manual.
30.		At mainline storm drain pipe size changes, inside top of pipe (crown) elevations are matched, unless otherwise approved.
31.		Soil boring(s) extending at least 2 feet below proposed storm drain have been taken and shown on the plans.
32.		Soil boring logs and information including pH & resistivity shown on plans. Alternate pipe materials selected are appropriate for soil conditions.
33.		Existing and proposed ground elevation shown for all mainline and connector pipe profiles.
34.		Storm Drain Key Map is included.
35.		Completed Alternate Pipe Material sheet is included.
	a.	D-loads for RGRCP calculated and shown.
	b.	Existing soil conditions suitable for CIPP or concrete-lined CSP alternate mainline pipe materials.
	c.	For CIPP and CSP mainline storm drain pipe, Alternate Pipe Chart shows required oversized pipe diameter (over precast concrete pipe size).
	d.	Alternate Pipe Chart shows CIPP no smaller than 30 inches in diameter.
	e.	The calculated pipe wall thickness for CIPP is based on the required oversized pipe diameter.
	f.	Maximum allowable pipe size for HDPE pipe is 48-inches in diameter.
36.		Checked and specified Ductile Iron Pipe replacements for all existing ACP waterline crossings above new storm drain mainline pipe per COP Supplement to MAG, Section 601.2.10.

3. Analysis of existing and proposed storm drains/street capacities shall be summarized and shown on the Storm Drain Design Summary sheet in the plans and in the hydrology/hydraulic report. Downloadable AutoCAD files are available on the City of Phoenix website (www.phoenix.gov/STREETS/index.html).

4. Hydrology/Hydraulic reports shall include, but not be limited to, the following items:

    - Professional engineer seal, signed and dated.

    - A drainage map that shows the Q's at points of concentration and clearly identifies the existing drainage system. Minimum scale shall be 1 inch equals 500 feet (1 inch=200 feet for submittals to Street Transportation Department). Where drainage areas are large or otherwise inappropriate, other scales may be approved.

    - Detailed street hydraulic analysis and storm drain analysis (where required).

    - Calculations for the proposed stormwater storage facilities showing storage volume required and storage volume provided. If more than one facility is proposed, calculations must be separated for each area and each tributary area referenced to its respective storm water storage facility. Analysis confirming basin dry up within 36 hours of the end of the design precipitation event is required.

    - If adjacent land drains into or is diverted around the development, adjacent contributory drainage area must be shown and quantified. Size of the adjacent drainage area and slope of the land information shall be shown.

    - A line drawing of the proposed drainage system in plan view showing design flow and capacity.

    - Sufficient information to determine the path of the water entering and leaving the project property under pre-development and post-development conditions. Sufficient information to show that proposed conditions do not pond water on adjacent properties or discharge at erosive velocities above pre-project conditions.

    - Average slope and typical cross sections of all streets.

    - FEMA floodplains in and adjacent to the project area as an exhibit or figure.

    - Summary of previously prepared drainage reports pertinent to the subject area.

6.12 GENERAL CONSTRUCTION DRAWING REQUIREMENTS

1. Information to determine drainage patterns.

2. Information to determine that an adjacent property drainage pattern will not be adversely affected.

3. A plot of hydraulic and energy grade lines profiles for storm drain pipe 18 inch or larger shall be provided. The profiles shall be submitted in summary form in plan and profile at a reduced

scale, intended to highlight the general alignment and hydraulic connectivity of the system herein referred to as the Hydraulic & Energy Grade Line Profile Sheet(s). This information is to be provided with the design data sheet(s) from the hydrology/hydraulics report.

The following data shall also be included with the hydraulic/energy grade lines profiles:

A. The finished street elevation over the storm drain pipe.

B. The pipe profile and size shown.

C. The design peak discharge (cfs) in the storm drain pipe segments.

D. The velocity (fps) in the storm drain pipe segments.

E. Appropriate stationing.

4. Profiles of catch basins and connector pipes shall be provided. These profiles shall show gutter elevation, top of curb elevation, catch basin type, "V" depth (minimum depth is four feet), size and cross-section, connector pipe invert at the catch basin and at the inlet to the main line storm drain (as well as any grade breaks), connector pipe size and slope in ft/ft, and the location and size of existing and proposed utilities along the profile and in the vicinity of the catch basin. Each catch basin profile shall be labeled by road centerline station or main storm drain stationing if different. Connector pipe/catch basin profiles shall have horizontal and vertical scales of 1 inch=5 feet.

5. On the storm drain plan sheets, the engineer shall show the rim and invert elevations at all existing sanitary sewer manholes.

6. The engineer shall identify valve nut elevations for all water valves on the project. The valve nut elevations shall be called out in plan view next to the water valve.

7. In plan and profile, existing and proposed underground utilities shall be labeled according to size and type. Corresponding alphanumeric labels shall be shown for each utility and depicted in the legend. If the utility is an underground conduit, give all the details such as number of ducts and whether or not the conduit is encased in concrete. Any known utilities to be constructed prior to the project shall be shown and so indicated. Conflicts between existing utilities and proposed construction are to be identified. Utilities that are abandoned or to be abandoned shall be indicated as well as those designated to be relocated or removed. The engineer shall contact the appropriate utility if any questions arise about types or locations of underground facilities. Existing and proposed underground tanks shall also be shown.

8. The minimum vertical clearance between a proposed storm drain and all existing utilities shall be one foot unless otherwise required by the given utility.

9. Below ground utilities shall be dimensioned from the road center or monument line.

10. Above ground utilities such as power poles, light poles, guys and anchors, irrigation structures, utility pedestals, transformers, switching cabinets, gas regulators, waterline back-flow prevention units, etc. shall be called out including size and pad elevation, shown in plan, and stationed relative to the adjacent road monument line or centerline from the street side face of the utility (e.g. 12+33 R 32').

11. When below ground appurtenances (utilities, monuments, tanks, valve boxes etc.) depicted on As-Built or "Record" drawings can not be field located, they shall be shown and labeled as "not found".

12. The following items shall be shown on storm drain plan and profile sheets:

    A. New storm drain pipe

    B. Manholes/Junction structures

    C. Catch basins

    D. Connector pipe

    E. Pipe collars

    F. Prefabricated pipe fittings

    G. Other drainage appurtenances (headwalls, trashracks, drop inlets, hand rails, pipe supports, etc.).

13. Where new street paving work joins existing side streets, pavement crown and gutter elevations shall be shown in plan view for a minimum of 100 feet beyond the curb return on the side street. Where new street paving work joins an existing street linearly, existing pavement crown and gutter elevation shall be a minimum of 300 feet beyond the new work to ensure proper drainage and smooth ride for vehicular traffic.

14. All storm drain plans shall have the following format:

    A. Storm drain designs shall be depicted on single plan/profile sheets.

    B. Main line storm drain plans shall be 1 inch = 20 feet horizontal and 1 inch=2 feet vertical, unless otherwise approved.

    C. Scales for connector pipe/catch basin profiles shall be 1 inch = 5 feet horizontal and 1 inch=5 feet vertical, unless otherwise approved.

D. One typical full-street cross-section with storm drain and all other underground utilities drawn at 1" = 10' H & V scale on each storm drain profile sheet. The section should be taken at a specific station location on that sheet, and that station location shall be noted on the cross-section

E. Profile slopes shall be shown in feet per foot dimensions to four significant figures.

F. Grade breaks shall be stationed with elevations shown. Station and elevations shall also be shown at sheet matchlines and at the beginning/end of the storm drain.

G. Centerline stationing shall be shown on plan and profile. Stationing shall run from the low point, or outfall, and increase toward the high point or inflow. Where the storm drain is being installed in conjunction with a paving project (i.e. depicted on corresponding paving plans), the stationing shall be correlated with the paving project stationing.

H. All plans shall use standard City of Phoenix symbols.

I. Final plan sheets shall be 24 inch x 36 inch, ink on mylar.

J. Letter size on full size drawings shall be 14 point minimum.

K. Title blocks shall be located in the lower right-hand corner of the plans and shall include the title "Storm Drain Plan".

L. Storm drain diameters shall be shown in plan and profile without reference to material type.

M. For City capital improvement projects, all plans shall be prepared using AutoCAD. The specific version shall be identified on a specific contract basis.

6.13 SUBMITTALS TO DEVELOPMENT SERVICES DEPARTMENT

1. All grading and drainage submittals shall be accompanied by a transmittal letter and the Grading and Drainage Plan Checklist (in addition to the Storm Drain Checklist identified in 6.11). The transmittal letter shall include the project name, Development Services Department (DSD) project number, engineers name, materials submitted, and purpose of submittal. All plans shall have the DSD project numbers and quarter section number placed in the lower right-hand corner of the plans. An approved preliminary site plan shall be submitted. In addition, a Storm Water Pollution Prevention Plan and Checklist will be required per NPDES criteria if applicable. All checklists shall be obtained from DSD.

2. Approved hydrology reports and grading and drainage plans must precede recordation of instruments of dedication when such data is necessary to determine required rights-of way, City owned properties, facilities for drainage, or finish floor elevations. A permit for off-site construction cannot be issued prior to the grading and drainage permit.

3. All submittals must be logged in with the Central Login Counter and shall be accompanied by a letter of transmittal. The project name, Engineer's Name, project numbers, material submitted and purpose of submittal (i.e. preliminary review, review of calculations, revision approval, etc) shall be given on the letter. Grading and Drainage Plan Review Fees are authorized by Ordinance and payment is required at time of login.

4. In addition to Section 6.12, plans submitted to DSD shall include:

   A. Information to determine drainage outfalls. All drainage outfalls shall be shown on plan and profile, extending until a definite day light condition is established. All temporary outfalls shall be shown in plan and profile, and clearly called out.

   B. Topographic information showing 2-foot contours (or similar detail) within 100-feet of the project property must be provided.

6.14 SUBMITTALS TO STREET TRANSPORTATION DEPARTMENT

1. A drainage report (per Section 6.11), drainage plans, and a completed storm drain checklist must be submitted for review and approval on all capital improvement projects submitted to the City of Phoenix Street Transportation Department.

2. The sheet sequence for all storm drain plans shall be as follows:

   A. Sheet 1 - Cover Sheet

   B. Sheet 2 - Legend & Notes

   C. Sheet 3 - Storm Drain Key Map

   D. Sheet 4 - Storm Drain Quantity Summary sheet

   E. Sheet 5 - Hydraulic & Energy Grade Line Profile Sheet(s)

   F. Sheet 6 - Storm Drain Design Summary Sheet

   G. Sheet 7 - Soil Boring Log Information Sheet

   H. Sheets 8 & up - Storm Drain Plan/Profile Sheets

   I. Catch Basin and Connector Pipe Profile Sheets

J. Alternate Pipe Chart

K. Special Detail Sheets

3. All plans shall include the following Items:

A. Elevation datum and benchmarks (City datum required, plans shall be tied to two benchmarks minimum).

B. Engineer's seal, signed and dated.

C. Existing contours or spot elevations with drainage arrows to indicate drainage pattern.

D. Topography and all man-made features (including buildings, canopies, asphalt aprons, and overhangs) within all permanent and temporary rights of way, easements and 30 feet beyond these boundaries shall be shown.

E. The diameter and types of all trees and cacti must be shown. Limits of shrubs and ground cover shall be shown.

F. The finish floor elevations of all buildings and the elevation of the lowest level of underground parking structures or basements adjacent to the project shall be shown in profile view with corresponding offset dimensions.

G. The location of all utilities. The Consultant shall request potholes in writing to the City for any utility deemed as a possible conflict with proposed work. Specific horizontal and vertical locations will be provided at these pothole locations. Pothole requests on waterlines 12 inches in diameter or less, and sanitary sewer mains will generally not be approved. Water lines that may conflict with construction shall be called out for realignment. Sewer line elevations shall be interpolated from nearby manhole invert elevations. The written request shall accompany plans showing the locations of requested potholes. The City will make arrangements to have potholes excavated. Potholed utility information shall be shown on profiles/cross-sections at the elevation determined in the field, with the elevation called-out, and shall be noted "potholed elevation".

H. All existing underground Portland cement concrete pavements (if such slabs are suspected and no As-Built drawings can be found to verify their existence, the Consultant shall notify the City and seek guidance regarding the necessity for core borings).

I. Construction note indicating that the contractor is responsible for locating and confirming depths of all underground utilities within the project area.

J. Construction note for proposed dry wells indicating that dry wells are to be inspected by the City prior to backfilling and installation of pipes.

K. Construction note indicating that storm water conveyance allowing for the discharge to historic pathways are to be provided during all phases of construction.

4. Pay Items:

A. For City of Phoenix capital improvement paving/stormdrain projects, the following items shall be shown in the right-hand column of the PAVING plan sheets as pay items:

- Catch basins
- Connector pipe

On these plans, the mainline storm drain and prefabricated tees shall be screened back. A note shall be added to the "Roadway Summary" sheet of the paving plans indicating that mainline storm drain pipe and catch basin pipe quantities are listed on the Alternate Pipe Chart. The Alternate Pipe Chart shall be included with the Storm Drain Plans. The Roadway Summary sheet shall include quantities for the catch basins.

B. For City of Phoenix capital improvement projects, the following items shall be shown in the right-hand column of the STORM DRAIN plans as pay items:

- New storm drain pipe (main line)
- Manholes/junction structures
- Pipe collars when 24 inch or over in diameter
- Prefabricated catch basin connector pipe stub-outs (tees)
- Other major drainage appurtenances (e.g. headwalls, splitters, access barriers/trash racks, etc).

On these plans, the catch basin connector pipes and catch basins shall be screened back.

5. Alternate Pipe Chart shall be as shown on Table 6.15.2 on page 6-45.

6. Storm Drain Design Summary sheet shall be as shown on Table 6.15.1 on page 6-44.

7. Alternate Pipe Chart and Storm Drain Design Summary sheet are downloadable AutoCAD files available on the City of Phoenix website (www.phoenix.gov/STREETS/index.html).

6.15 SUPPLEMENTAL TABLES AND CHARTS

6.15.1 Storm Drain Design Summary Sheet

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL	AS BUILT
9	ARIZ				

CONSULTING ENGINEER

DES | DR: | CK: | DATE:

PHOENIX STREETS–MARICOPA CO.

STREET TRANSPORTATION STORM DRAIN DESIGN SUMMARY SHEET

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV. BY	CKD. BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV. BY	CKD. BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV. BY	CKD. BY	DATE

STORM DRAINAGE DESIGN DATA PAVING PROJECT M - P - LOCATION

AREA NO. / INLET NO.	INLET STA.	AREA – ACRES: TOTAL AREA ACRES	AREA – ACRES: C FACTOR	AREA – ACRES: IMPROV. AREA CA	INFILTRATION in. / hr. f_c	FOR CONCENTRATION TIME: STREET SLOPE ft. / ft.	FOR CONCENTRATION TIME: MAX. DIST.	T_C MIN.	INLET I	RUNOFF TO INLET: Q = C.I.A.	AVERAGE UPSTREAM GUTTER SLOPE ft. / ft.	CROSS SLOPE AT INLET ft. / ft.	FLOWBY TO THIS CATCH BASIN	FLOW BY + RUNOFF (Q)	DEPTH OF WATER UPSTREAM GUTTER	WIDTH OF WATER IN STREET	GUTTER VELOCITY	DEPTH OF SUMP IF A SUMP	INLET TYPE	Q ACCEPTED BY C.B.	FLOWBY	TO INLET NO.	T_{C2} MAIN STORM DRAIN: TOTAL AREA IMPER.	T_{C2} MAIN STORM DRAIN: T_C (MIN.)	MAIN STORM DRAIN: I	MAIN STORM DRAIN: Q_2	SLOPE MAIN STORM DRAIN ft. / ft.	SIZE MAIN STORM DRAIN	VELOCITY MAIN STORM DRAIN f.p.s.	LENGTH MAIN STORM DRAIN	$\triangle T_{C2}$ MIN.	ELEVATION: CROWN INLET	ELEVATION: CROWN OUTLET	HYDRAULIC GRADE LINE: S_f ft. / ft.	HYDRAULIC GRADE LINE: H_L ft.	HYDRAULIC GRADE LINE: ELEVATION INLET	HYDRAULIC GRADE LINE: ELEVATION OUTLET	HEAD BETWEEN 0.5' BELOW LIP GUTTER TO H.G. MAIN	LENGTH CONN. PIPE	DIA. CONN. PIPE	DEPTH CATCH BASIN

PER CITY OF PHOENIX ORDINANCE G-4396, THESE PLANS ARE FOR OFFICIAL USE ONLY AND MAY NOT BE SHARED WITH OTHERS EXCEPT AS REQUIRED TO FULFILL THE OBLIGATIONS OF YOUR CONTRACT WITH THE CITY OF PHOENIX.

REVISED OCT. 5, 1992

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

DR DATE: | DES DATE: | CK DATE: | SHEET NO. | TOTAL SHEETS | AS BUILT

SCALE: HORIZONTAL VERTICAL

6.15.2 Storm Drain Alternate Pipe Table

PHOENIX STREETS–MARICOPA CO.

STORM DRAIN
ALTERNATE PIPE MATERIAL

F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL	AS BUILT
9	ARIZ				

CONSULTING ENGINEER

DES | DR: | CK: | DATE:

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV. BY	LOAD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV. BY	LOAD BY	DATE

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV. BY	LOAD BY	DATE

MAIN LINE PIPE

STATION		QUANTITY	PIPE DIAMETER			DEPTH TO TOP OF PIPE		MAX TRENCH WIDTH AT TOP OF PIPE	REINFORCED CONCRETE PIPE **	CAST–IN–PLACE CONCRETE PIPE ****	CORRUGATED STEEL PIPES	
FROM	TO	L.F.	R.C.P. (I.D.) IN.	HDPE *** (I.D.) IN.	CIPP & C.S.P. (I.D.) IN.	MIN. (FT.)	MAX. (FT.)	R.C.P.,C.S.P., & HDPE *** FT.	MIN. D–LOAD (TO PRODUCE 0.01" CRACK)	MINIMUM WALL THICKNESS IN.	$2\frac{2}{3}$" x 1" CORR. TYPE "F"* MIN. GAGE	3" x 1" CORR. TYPE "F"* MIN. GAGE

CONNECTOR PIPE

LOCATION	QUANTITY	DEPTH TO TOP OF PIPE		PIPE DIA.	R.C.P. **	C.S.P.
STATION (LT. or RT.)	L.F.	MIN. (FT.)	MAX (FT.)	R.C.P.,C.S.P., & HDPE *** (I.D.) IN.	MIN. D–LOAD (TO PRODUCE 0.01" CRACK)	$2\frac{2}{3}$" x 1" CORR. ALUMINIZED TYPE "2" MIN. GAGE

GENERAL NOTES:

1. ONLY PIPE MATERIALS SPECIFIED ON THIS SHEET ARE ACCEPTABLE FOR THIS PROJECT.
2. WHERE MAXIMUM TRENCH WIDTH IS NOTED AS "UNRESTRICTED", PIPE STRENGTHS ARE SPECIFIED FOR A POSITIVE PROJECTING OR EMBANKMENT LOADING CONDITION. TRENCH WIDTH RESTRICTIONS FOR THE CAST–IN–PLACE CONCRETE PIPE OPERATION, SHALL COMPLY WITH SECTION 620.
3. CITY POLICY REQUIRES THAT CAST–IN–PLACE PIPE AND CORRUGATED STEEL PIPE MAINLINES BE UPSIZED A MINIMUM OF 6–INCHES GREATER DIAMETER THAN THE SPECIFIED REINFORCED CONCRETE PIPE DIAMETER. IF EITHER OF THESE OPTIONS ARE USED, THE CONTRACTOR SHALL BE RESPONSIBLE FOR RESOLVING ANY UTILITY CONFLICTS ASSOCIATED WITH THE INCREASED PIPE DIAMETER.
4. WHERE A CONNECTION TO AN EXISTING STORM DRAIN SYSTEM IS REQUIRED AND CAST–IN–PLACE OR CORRUGATED STEEL PIPE MAINLINE IS USED, THE PIPE INVERTS SHALL BE MATCHED AT THE POINT OF CONNECTION.
5. A MINIMUM OF 14 GAUGE IS REQUIRED FOR ALL CSP BY CITY OF PHOENIX TO OBTAIN DESIGN LIFE REQUIREMENTS OF 75 YEARS TO FIRST PERFORATION.
6. WHERE NEW MAINLINE STORM DRAIN CONNECTION TO EXISTING MAINLINE SYSTEM IS REQUIRED, AND THE NEW MAINLINE IS LARGER THAN THE EXISTING, (SUCH AS NEW 6" OVERSIZED CIPP OR CSP CONNECTING TO EXISTING RGRCP), PIPE INVERTS SHALL BE MATCHED. IN ALL OTHER CASES, INSIDE TOP OF PIPE (CROWN) ELEVATIONS SHALL BE MATCHED.

* TYPE "F" – COATED AND CONCRETE LINED CSP CITY OF PHOENIX SUPPLEMENT TO MARICOPA ASSOCIATION OF GOVERNMENTS UNIFORM STANDARD SPECIFICATIONS.

** RUBBER GASKETED PIPE REQUIRED FOR ALL REINFORCED CONCRETE PIPE

*** HIGH DENSITY POLYETHYLENE (HDPE), TYPE "S" WITH WATERTIGHT JOINTS PER AASHTO 252, AASHTO M294, MAG AND CITY SUPPLEMENTS TO MAG. JOINTS SHALL MEET ASTM D–3212 WATERTIGHT REQUIREMENT (10.8 psi). MAXIMUM DIAMETER ALLOWED = 48–INCH.

**** THE MINIMUM DIAMETER FOR CIPP IS 30 INCHES

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STORM DRAIN
ALTERNATE PIPE TABLE

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

DR	DES	CK	SHEET NO.	TOTAL SHEETS	AS BUILT
DATE:	DATE:	DATE:			
SCALE:	HORIZONTAL VERTICAL				

6.15.3 Special Storm Drain Details

PHOENIX STREETS–MARICOPA CO.

SPECIAL STORM DRAIN DETAILS

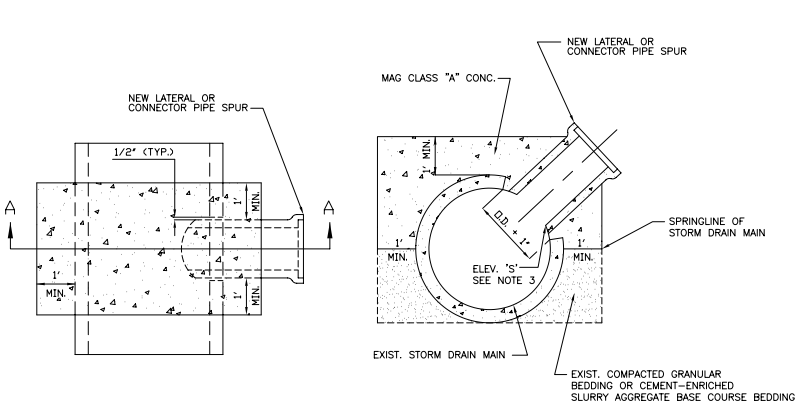
F.H.W.A. REGION	STATE	PROJ. NO.	NO.	TOTAL	AS BUILT
9	ARIZ				

CONSULTING ENGINEER

DES | DR: | CK: | DATE:

REVISION BY CITY OF PHOENIX

NO.	DESCRIPTION	REV. BY	CKD BY	DATE



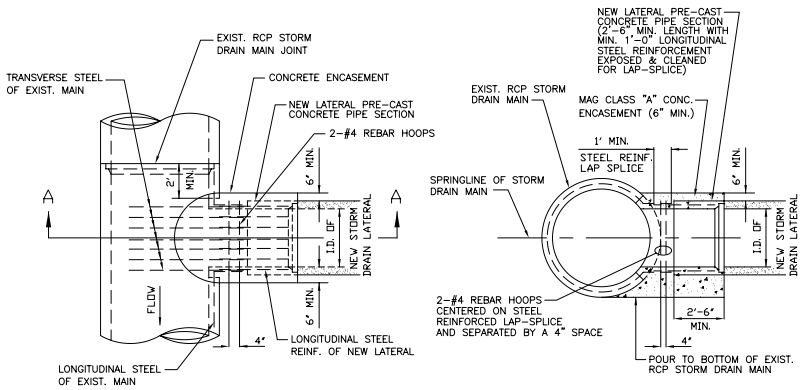
PLAN VIEW SECTION A–A

NOTES:

1. THIS DETAIL SHALL BE USED FOR CONNECTING NEW SMALL STORM DRAIN LATERALS OR CATCH BASIN CONNECTOR PIPES TO EXISTING STORM DRAIN MAINS.
2. THIS DETAIL SHALL ONLY BE USED WHEN OUTSIDE DIAMETER OF NEW LATERAL OR CONNECTOR PIPE SPUR IS LESS THAN OR EQUAL TO THE INSIDE DIAMETER OF THE EXISTING STORM DRAIN MAIN.
3. THE CONNECTOR PIPE SPUR LINE SHALL BE CONSTRUCTED RADIAL TO THE MAIN, UNLESS OTHERWISE SHOWN BY ELEVATION 'S' AS SHOWN ON PLANS.
4. THE LENGTH OF THE SPUR STUB SHALL BE A MINIMUM OF 18" TO ALLOW FULL, CLEAN PIPE CONNECTION TO THE SPUR JOINT.
5. CONCRETE SHALL BE MAG CLASS "A".

SPECIAL DETAIL 621
(FUTURE P–1577)

CONNECTION OF NEW SMALL STORM DRAIN LATERAL OR CATCH BASIN CONNECTOR PIPE TO EXISTING STORM DRAIN MAIN



PLAN VIEW SECTION A–A

NOTES:

1. THIS DETAIL SHALL BE USED FOR CONNECTING NEW LARGE RCP STORM DRAIN LATERALS OR CATCH BASIN CONNECTOR PIPES TO EXISTING RCP STORM DRAIN MAINS.
2. THIS DETAIL SHALL ONLY BE USED WHEN OUTSIDE DIAMETER OF NEW RCP STORM DRAIN LATERAL OR CONNECTOR PIPE IS GREATER THAN THE INSIDE DIAMETER OF THE EXISTING STORM DRAIN MAIN, AND NO OTHER TYPE CONNECTION (SUCH AS A MANHOLE OR SPECIAL JUNCTION STRUCTURE) IS FEASIBLE OR DESIRABLE.
3. THE EXISTING STORM DRAIN MAIN SHALL BE EXPOSED AT THE PROPOSED LOCATION OF NEW CONNECTION. IF NECESSARY, THE LOCATION MAY BE MOVED DOWN STREAM SUCH THAT THE OUTSIDE OF THE NEW OPENING WILL BE A MINIMUM OF 2' FROM THE NEAREST JOINT IN THE EXISTING PIPE MAIN.
4. A CIRCULAR OPENING IN THE EXISTING MAINLINE PIPE SHALL BE CUT TO MATCH THE INSIDE DIAMETER OF THE NEW LATERAL, NORMAL TO THE PIPE SURFACE, WITHOUT DAMAGING STEEL. THE EXPOSED STEEL IN THE CIRCULAR OPENING OF THE EXISTING MAIN SHALL BE CUT TO PROVIDE RELATIVELY EQUAL-LENGTH REINFORCING STUBS AND BENT TO A HORIZONTAL POSITION IN PREPARATION FOR CONNECTION.
5. THE LONGITUDINAL STEEL ON THE END OF THE NEW STORM DRAIN LATERAL STUB SHALL BE PREPARED TO EXPOSE A MINIMUM 1'-0" OF CLEAN STEEL REINFORCEMENT FOR LAP-SPLICING AROUND THE PERIPHERY OF THE NEW STUB. THE EXPOSED STEEL OF THE EXISTING MAIN AND THE NEW STUB SHALL BE LAP-SPLICED A MINIMUM OF 1'-0" AND REINFORCE-TIED WITH 2-#4 REBAR HOOPS.
6. THE NEW STUB AND JOINT SHALL THEN BE ENCASED WITH A MINIMUM OF 6" OF MAG CLASS 'A' CONCRETE. THE ENCASEMENT SHALL EXTEND THE ENTIRE LENGTH OF THE STUB (MIN. 2'-6"). THE SPLICE-JOINT AREA BETWEEN THE PIPES SHALL BE NEATLY FORMED INSIDE TO CREATE A CLEAN, FORMED JOINT.

SPECIAL DETAIL 274
(FUTURE P–1578)

CONNECTION OF NEW LARGE RCP STORM DRAIN LATERAL OR CATCH BASIN CONNECTOR PIPE TO EXISTING RCP STORM DRAIN MAIN

SPECIAL STORM DRAIN DETAILS

CITY OF PHOENIX, ARIZONA
STREET TRANSPORTATION DEPARTMENT

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DR: DATE:	DES: DATE:	CK: DATE:	SHEET NO.	TOTAL SHEETS	AS BUILT
SCALE:	HORIZONTAL VERTICAL				

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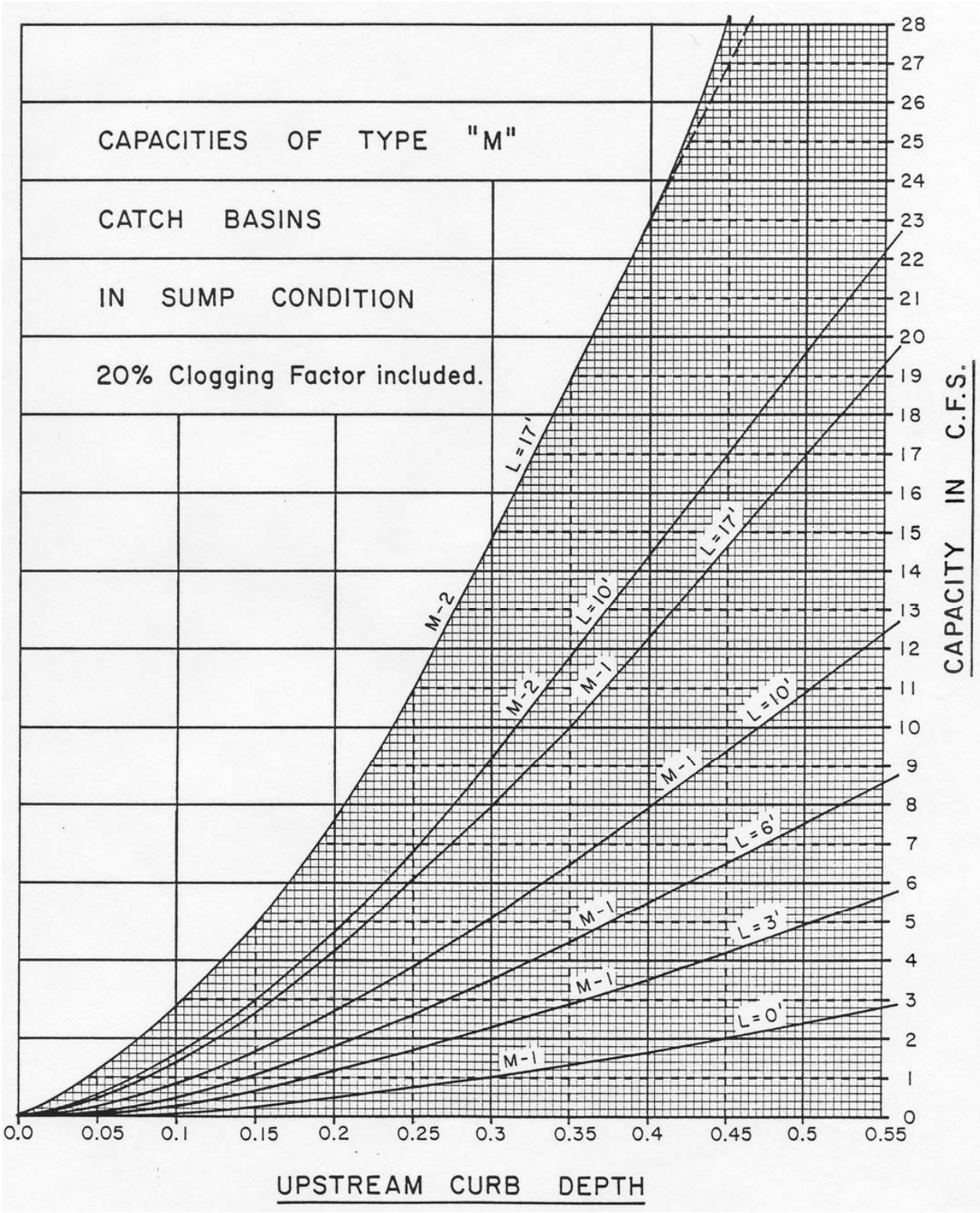
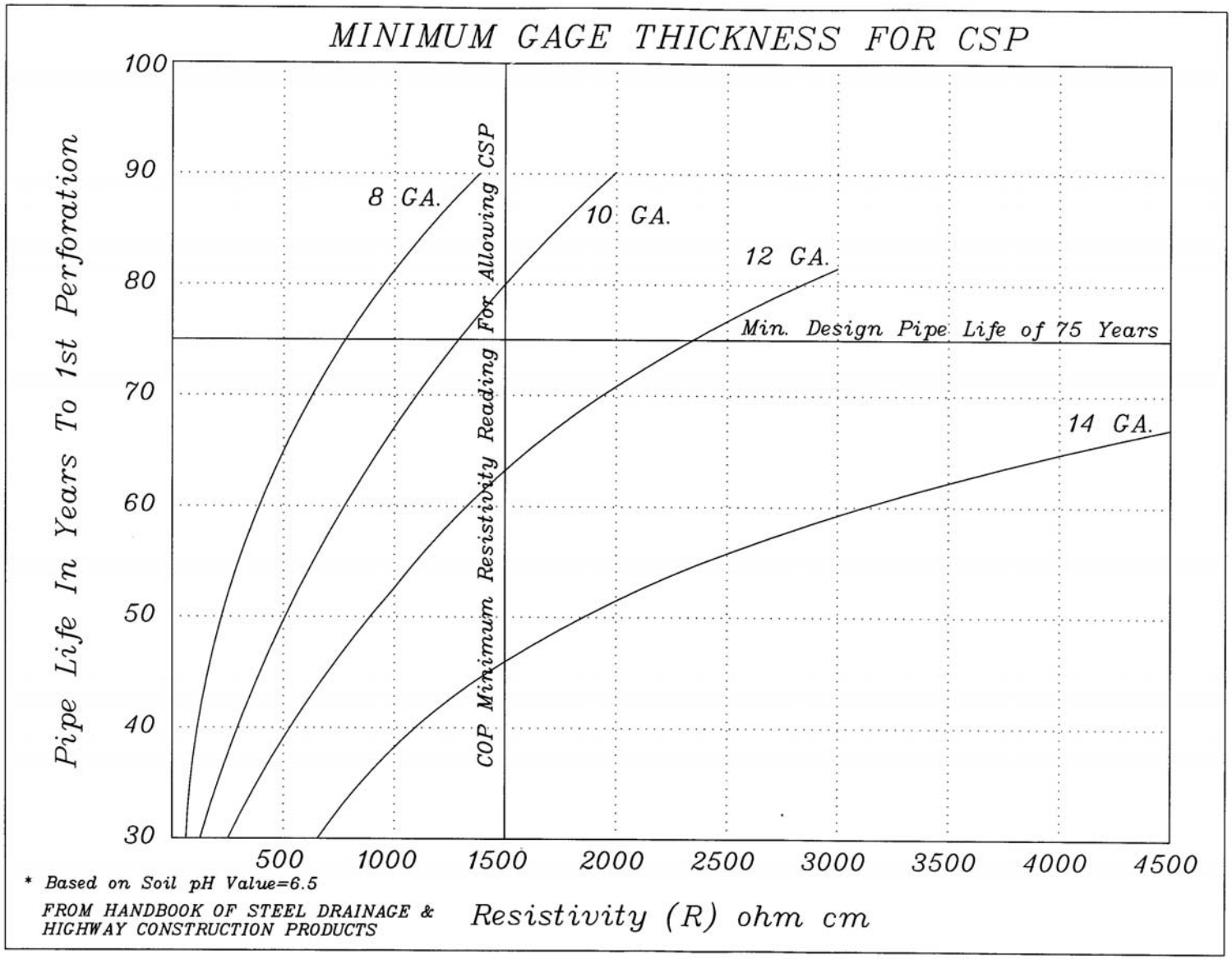
6.15.4 Flow Capacity of "M" Type Catch Basins in Sump Condition Chart



6.15.5 Gage Thickness for CMP Storm Drain Pipe Based on Resistivity Measurements Chart

(75 year lifespan minimum)



7 POLICY AND STANDARD REVISION PROCESS

The City of Phoenix utilizes a multi-disciplinary, multi-departmental committee to review and adopt proposed changes to policies and standards. This committee is made up of multi-disciplined professionals in order to best reflect the multitude of societal resources influenced by storm water runoff. A representative from Development Services Department, Floodplain Management, Parks and Recreation Department, Street Transportation Department, Planning Department, and Environmental Programs will serve on this committee to represent the concerns of their respective departments/programs.

Those seeking changes to policies or standards shall make a formal request submittal to the committee chair (currently the Chief Design Engineer, Zone A, Street Transportation Department, Design and Construction Management Division, 1034 E. Madison Street, Phoenix, Arizona 85034). The request shall state the present policy/standard, identify the proposed change(s), and provide comprehensive justification for the change. The committee shall convene as needed, and at least once a year to review requested changes. An amendment application form is available in this manual. Six copies of the completed application and supporting documents shall be delivered to the committee chair in the Street Transportation Department (as described above). Upon review and certification of a complete submittal, a date will be assigned at which time the committee will review the requested amendment.

Once every year, the committee will convene to review the entire City of Phoenix Storm Water Policies and Standards Manual to discuss and update as needed.

The Street Transportation Department keeps a current list of the representatives from each of the departments/programs referenced above who are assigned to serve on this committee.

Changes to policies or standards are posted on the City's web site, www.phoenix.gov/STREETS/index.html. The web site contains two documents relating to this matter. First, the City's policies, regulations, ordinances, and standards for storm water are posted as a living document. On another web page, changes to these topics are noted and dated for easy referral. Outdated versions of these topics are archived, but available for use as needed. In addition, convenient links to the Flood Control District of Maricopa County Hydrology, Hydraulic and Erosion Control Manuals are provided on this website.

Requested Changes to City of Phoenix Storm Water Policies and Standards Submit 6 copies of each request Submit a separate form for each request			
Date			
Name			
Company			
Phone		Fax	
Email			
Subject			
Chapter/Section/Item No.			
Problem or Concern			
Requested Modification			

Attach additional sheets if necessary

Sheet ____ of ____

8 SOFTWARE

8.1 INTRODUCTION

The City has developed Drainage Design Management System software (Phoenix-DDMS) to facilitate drainage submittals, review and archival. The software has been written in conformance with the procedures developed in the Hydrology and Hydraulics manuals. Data may be hand entered or imported from data developed in a Geographic Information System (GIS) or other environment.

Phoenix-DDMS is a relational database that can manage multiple projects from one single location. Features include pull-down menus, user-friendly screens and editing tools to facilitate data entry. Phoenix-DDMS includes tables for data entry and editing. The tables are related based on a key ID that is established when starting a new project. Model runs are automated from data extracted from the various tables in the database. Modules in Phoenix-DDMS include file management, hydrology, hydraulics and submittals.

8.2 FILE MANAGEMENT

File management is used to establish new projects, default parameters and project paths and to import, export, backup and copy project data. Projects can be automatically “Backed Up” to a self-contained zip file that contains all the information for the project. It is intended that this file be included with submittals to facilitate review and archival.

8.3 HYDROLOGY

The hydrology module currently supports the Rational Method. The module establishes rainfall, land use and sub basin data used for analysis and includes a Rational Method Model Network to facilitate the development of the model. Land use defaults are imported from City of Phoenix default tables and are maintained with the project.

8.4 HYDRAULICS

The hydraulics module includes conveyance facilities, connector pipes, street drainage and storm drains. The module also includes data for natural cross sections, roadway cross-sections and drainage inlets. Roadway cross-sections and inlets defaults are imported from City of Phoenix default tables and are maintained with the project.

8.5 SUBMITTALS

The submittals module establishes the data for the City's Storm Drain Design Summary and provides an export tool to facilitate placing this data on a plan sheet. The data is extracted automatically from calculations developed for the project in accordance with a Design Summary Order established by the user.

All projects in the City of Phoenix which utilize the Rational Method to develop a storm drain system, whether public or private, shall be submitted using this standard submittal module.