

# Storm Drainage Design Manual

Town of Paradise Valley

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## FOREWORD

# STORMWATER DRAINAGE DESIGN

This design manual provides guidance for complying with specific federal, state, county, and town regulations applicable to floodplain management, water quality, and stormwater management. It presents guidance for preparing drainage reports and grading and drainage plans using the design standards and methodologies adopted by the town of Paradise Valley, the Flood Control District of Maricopa County, the Arizona Department of Water Resources, and the Federal Emergency Management Agency.

## Overview

### 1-1 GENERAL INFORMATION

A. This document, titled the Paradise Valley Storm Drainage Design Manual (SDDM):

1. Administers Chapter 5, Articles 5-10-3 and 5-11-1 through 27, and Chapter 8, Articles 8-1-10 through 11 of the Paradise Valley Town Code.
2. Provides guidance for compliance with federal, state, county and town regulations applicable to floodplain management, water quality and stormwater management.
3. Outlines requirements for preparing drainage reports and grading and drainage plans.

B. This document is intended to guide the design of meaningful flood protection. Such protection can prove challenging, because, among other reasons, much of the natural grade has already been disturbed and existing development may constrain drainage options. In such cases, the Floodplain Administrator may require different or additional flood protections to:

1. Avoid increased danger or damage to persons or property, and
2. Meet the general intent and purposes of related regulation.

## 1-2 GOVERNMENT AUTHORITIES

### A. Federal authorities

1. Federal Emergency Management Agency (FEMA)
2. U.S. Environmental Protection Agency (EPA)
3. The U.S. Army Corps of Engineers (Corps)
4. The U.S. Department of Agriculture (USDA) Natural Resources Conservation Services

### B. State authorities

1. Arizona Department of Water Resources (ADWR)
2. Arizona Department of Environmental Quality (ADEQ)

### C. Local authorities

1. Flood Control District of Maricopa County (FCDMC)
2. Maricopa County Department of Public Health
3. Town of Paradise Valley (PV)

### D. Coordination

Applicants are responsible for coordinating with other interested parties, including utilities, federal, state and local agencies. Other agency permits may be required before applying for Town permits. Applicants should consider time frames associated with obtaining these non-Town permits.

## 1-3 STANDARDS

### A. FEMA 44 CFR

<https://www.law.cornell.edu/cfr/text/44/part-206>

### B. ADWR State Standards

<http://www.azwater.gov/azdwr/SurfaceWater/FloodManagement/StateStandards.htm>

### C. Drainage Design Policies and Standards for Maricopa County

<http://www.maricopa.gov/DocumentCenter/View/2370>

### D. Paradise Valley Storm Drainage Design Ordinance

## 1-4 RESOURCES

### A. Federal

1. National Flood Insurance Act

<https://www.fema.gov/media-library/assets/documents/7277>

2. Flood Insurance Rate Maps (FIRMs)

<https://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping>

3. Clean Water Act (CWA)

<https://www.epa.gov/laws-regulations/summary-clean-water-act>

4. USDA Natural Resources Conservation Services (NRCS) Soil Survey Maps

<https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/>

5. National Oceanic and Atmospheric Administration (NOAA) Precipitation Frequency

<http://www.nws.noaa.gov/oh/hdsc/currentpf.htm>

6. US Environmental Protection Agency, Storm Water Management Model (SWMM)

<https://www.epa.gov/water-research/storm-water-management-model-swmm#description>

7. US Environmental Protection Agency, Low Impact Development (LID)

<https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/urban-runoff-low-impact-development>

B. State

1. Arizona Department of Water Resources (ADWR)

<http://www.azwater.gov/azdwr/>

2. Arizona Department of Environmental Quality (ADEQ) Water Quality

[www.azdeq.gov/environ/water/permits/stormwater.html](http://www.azdeq.gov/environ/water/permits/stormwater.html)

C. Local

1. Paradise Valley Town Code (Particularly Chapters 5, 6 and 8)

<http://paradisevalleyaz.gov/DocumentCenter/Home/Index/30>

2. Paradise Valley Stormwater Management Plan (SWMP)

<http://www.paradisevalleyaz.gov/DocumentCenter/View/5095>

3. Paradise Valley Permits and Handouts

<http://paradisevalleyaz.gov/24/Permits-and-Handouts>

4. Paradise Valley Historical Aerial and Other Maps

<http://paradisevalleyaz.gov/DocumentCenter/Index/16>

5. Paradise Valley Record Request Form

<http://paradisevalleyaz.gov/documentcenter/view/137>

6. Flood Control District of Maricopa County

[www.fcd.maricopa.gov](http://www.fcd.maricopa.gov)

7. Maricopa County Environmental Health Code

<https://www.maricopa.gov/1888/Maricopa-County-Environmental-Health-Cod>

## **1-5 Definitions and Forms**

### **Definitions**

Base Flood: Flooding as the result of a 100-year, 6-hour storm event, or flooding as defined in the Maricopa County Drainage Design Manual.

Building Site Slope: The percent of slope measured at right angles to the natural contours along a line passing through the center of the site and terminating where it crosses the edge of the area of disturbance at each end.

Developer: Individual or business entity that purchases and/or improves real estate for the purposes of subdivision requiring Town approval and/or a Special Use Permit.

Drainage Easement: grants easement right and a right of entry in, over, and across the drainage easement area. Agreement shall be recorded in the Maricopa County Recorder's office.

Drainage Easement Maintenance Agreement: in addition to granting an easement right and a right of entry in, over, and across the Drainage Easement area, specifies maintenance responsibility for the Drainage Easement remains with the property owner. The agreement shall be recorded in the Maricopa County Recorder's office.

Hillside Wash: any creek, stream, wash, arroyo, channel or other body of water having a flow rate equal to or greater than 2 cubic feet per second based on a 100-year storm event or any wash at least two feet deep from the top of the bank and measuring at least five feet wide at the top of the bank.

Minor Wash: A surface watercourse (swale, ditch, etc.) too small to meet the definition of a Natural Wash.

Natural Wash: A natural watercourse at least two feet deep from the top of the bank and measuring at least five feet wide at the top of the bank.

New Development: Any improvements requiring town approval or a Special Use Permit (SUP), including residential and commercial development, churches and other institutions.

Post Development Calculation: A calculation representing the stormwater runoff conditions predicted in the area of disturbance after intended revisions, including impervious and pervious surfaces.

Pre Development Calculation: A calculation representing stormwater runoff conditions in the evaluated area as would have existed prior to any site development. Utilizes slopes, soil types and runoff coefficients consistent with area's predevelopment conditions.

Pre vs. Post Calculation: A calculation representing the change in condition of the evaluated area from its current state.

Habitable Structure: A structure located on a property acceptable for occupancy under current zoning, subject to a Certificate of Occupancy.

First Flush: The volume of stormwater created by the first 0.5 inches of direct runoff from a storm event. Normally, this minimum level of control is met by following the Town's retention requirement.

Single Family Home: A new residence or a remodel of an existing residence that exceeds \$500,000 in construction cost.

Storm Drainage Facilities Agreement (SDFA): An agreement, which shall be recorded with the Maricopa County Recorder prior to Certificate of Occupancy issuance, obliging the land owner and successors to maintain on site storm drainage facilities in perpetuity. On recorded plans, the Engineer shall place the location, size and design volume of all retention basins and conveyances, as well as a statement requiring basins to drain in a maximum of 36 hours.

## FLOODPLAIN MANAGEMENT

### 2-1 GENERAL INFORMATION

- A. The Town's design, construction and documentation requirements for development in Special Flood Hazard Areas (SFHAs) and pending SFHAs are contained in this manual. Unless otherwise approved by the Floodplain Administrator, each project must conform to the Town's requirements as referenced in Article 5-11 of the Paradise Valley Municipal Code.



B. All Habitable Structures must be designed so as not to flood in a Base Flood (as defined in 5-11-1).

## 2-2 PERMIT REQUIRED

A. Appropriate permits are required before construction or development begins within any SFHA, as mapped on the FIRMs. Applications for permits shall be made on Town forms and submitted to the Floodplain Board, which is defined by Town Code as the Town Council of the Town of Paradise Valley. Application materials may include, but are not limited to, plans drawn to scale showing the nature, location, dimensions and elevation of the area of development, existing or proposed structures, fill, excavation, storage of materials, and drainage facilities. Specifically, the following information is required:

1. Proposed elevation in relation to North American Vertical Datum (NAVD 88) of all structures' lowest floors (including basement).
2. Proposed elevation in relation to NAVD 88 to which any non-residential structure will be protected from flooding.
3. Certification by an Arizona licensed engineer that flood protection methods for any nonresidential structure meet flood protection requirements of the Town, the County and FEMA.
4. Base floor elevation for all development within or contiguous to floodplains.
5. Description of extent to which any watercourse will be altered or relocated as a result of proposed development. See Section 6, Drainage Report and Grading Plans.

## 2-3 SPECIAL FLOOD HAZARD AREAS

A. Portions of the Town fall within Special Flood Hazard Areas (SFHAs), as mapped on the FIRMs. Special Flood Hazard Areas are flood zone designations that begin with an "A" and require particular attention when analyzed and designed for development.

## 2-4 SUBSTANTIAL IMPROVEMENTS AND SUBSTANTIAL DAMAGE IN SFHAS

A. This section applies when a structure within an SFHA is not in compliance with current standards, and:

1. Improvements requiring a building permit are proposed; or
2. Repairs to damage, requiring a building permit, are proposed.

B. If, upon application to the Community Development Department for a building permit, it appears this section is applicable to the project, the applicant shall submit an appropriate Substantial Improvement/Substantial Damage Worksheet (made available by the Town). This Worksheet utilizes FEMA criteria to screen and establish which projects exceed 60% or are less than 40% of the structure's existing market value before improvements or repairs.

C. If it appears the project costs between 40% and 60% of the structure's existing market value, the applicant shall provide an appraisal of the value of the existing structure (excluding land value and other improvements to the property such as a swimming pool or accessory structures, before improvements and/or repairs) and a construction proposal signed by an Arizona licensed contractor.

- D. An applicant may bypass the Substantial Improvement/Substantial Damage Worksheet, or challenge the Worksheet's calculation by providing an appraisal of the value of the existing structure as described in C above and a signed construction proposal from an Arizona licensed contractor.
- E. In case of substantial improvements or repairs to substantially damaged structures (defined as projects costing 50% or more of the value of the existing structure) the entire structure must be brought into compliance with the Town's floodplain management regulations.

For additional information, refer to FEMA's guide to substantial damage and substantial improvements.

<https://www.fema.gov/media-library/assets/documents/18562>

## Stormwater Management

### 3-1 GENERAL INFORMATION

- A. The design standards and methodologies described in the Drainage Design Manual (DDM) for Maricopa County, Arizona, latest edition, include Volume I - Hydrology, Volume II - Hydraulics and Volume III - Erosion. The SDDM prevails in any conflict between the DDM for Maricopa County and the Town's SDDM whenever the latter is more restrictive. The Design Engineer should discuss and resolve any conflict with the appropriate Town staff before submitting reports and plans for review.

B. Analysis of hydrologic and hydraulic hazards within this region must consider impacts to all downstream and upstream areas. Failure to consider these impacts may result in hazardous flow diversions, increases in peak discharge flow rates, and transport equilibrium disruptions. Any of these phenomena can increase flooding and erosion potential to downstream properties and create liability.

1. Design drainage facilities to maintain natural runoff and channel characteristics.
2. Do not adversely impact drainage patterns, including the location and configuration of watershed boundaries, or create new areas of concentrated flow leaving the site.
3. Maintain the stability of natural drainage channels, particularly channel banks, as much as is possible.
4. Do not increase the natural conveyance capacity of existing channel flows.
5. Maintain the natural sedimentation characteristics of existing drainage ways.
6. Do not restrict or obstruct natural habitat conditions or movements with improvements to existing channels.
7. Maintain the natural vegetation density and diversity of existing channels.
8. Preserve the viewshed characteristics of Natural Washes.

#### C. Retention and Detention Basins

1. Design retention and detention basins to blend with the natural contours and undulations of the site and local natural terrain.
2. When designing or platting a new subdivision, locate retention and detention basins in separate tracts, not on individual lots. Exceptions may be made by the Community Development Director and Town Engineer provided the following conditions are met:
  - a. Basins will be maintained by a property owners association or equivalent organization;
  - b. Appropriately sized drainage and maintenance access easements are provided; and
  - c. Basins are accessible from a street.
3. The design depth of water stored in the basin shall not exceed 3 feet.
4. The maximum side slope of the basin shall not exceed 4:1 unless otherwise approved by the Town Engineer.
5. Round and contour the bottom and top edges of the side slopes to achieve a gradual slope transition.
6. Where retaining walls are utilized as part of a basin, use textured and/or dark surface treatments on the portion of the wall that could be inundated to minimize water staining visibility. Guardrails may be required at the top of such walls per the Town's adopted building code.
7. In basins, use only plant materials capable of surviving inundation. Trees and woody shrubs are preferred; avoid succulents and herbaceous shrubs. In areas using natural desert plants, use plants typical to desert riparian areas, such as mesquite, blue palo verde, desert willow, wolfberry, desert hackberry, desert holly, jojoba, beloperone, etc.

8. Basins shall not occupy more than 50 percent of the frontage landscaped area unless specifically approved by the Town Engineer.
9. Landscape installation shall conform to the current version of the Town Landscape Guidelines.
10. Consider natural growth habits to minimize maintenance frequency and intensity.
11. Landscaping should not create public safety hazards through either plant growth habit, structure, or location. Examples of public safety hazards may include but are not limited to impeding views within sight visibility triangles, impeding sidewalks or pathways, and impeding views of regulatory signage along public streets.

#### D. Surface Channels

Site plans should incorporate the following criteria in the placement, design and use of surface drainage facilities:

1. Preserve and protect all natural vegetation in and along washes wherever possible.
2. Landscape all engineered and constructed channels to help manage storm flows and, if located within the Right-of-Way, enhance the channel as a visual amenity for the site and community consistent with the Town's Landscape Guidelines. Concrete and rock surfaces should be kept to a minimum. If such materials are used, they should be formed and applied in a "natural" manner or designed to integrate with onsite buildings.
3. Rocks and boulders used in drainage facilities shall be native local source stone, river run cobble or crushed rock.

## 3-2 STORMWATER STORAGE

#### A. General Requirements

1. To reduce the impact of impervious surfaces created by the development of private property, the Town has adopted several stormwater retention requirements. These requirements help protect neighboring properties and properties downstream of the development site from additional runoff created by roofs, driveways, patios, tennis courts, and other site improvements. In some cases, when properties are located on sloped lots, the town utilizes a sliding scale to lower the amount of retention required for lots with greater slopes. However, in all cases, a minimum retention of the first one half inch of rainfall shall be retained.
2. Stormwater storage facilities are designed primarily as retention facilities. Other stormwater management facilities, such as detention basins, dry wells, pumps and injection wells, will only be allowed following approval by the Town Engineer.

3. All New Development, including single family residential development, shall make provisions to retain the runoff of a 100-year, 2-hour duration storm falling within the boundaries of the development unless (1) the drainage can be conveyed directly to an existing major channel or natural drainageway and (2) the Developer can demonstrate no adverse off-site impacts to the satisfaction of the Town Engineer.
4. Lot-to-lot drainage within a new subdivision is prohibited unless permanent drainage facilities are constructed in dedicated Drainage Easements or tracts are maintained by a homeowners' association (HOA).
5. Developments with HOAs may locate retention facilities in private dedicated drainage tracts. These tracts will be maintained by the homeowners' association.

## B. Stormwater Storage Volume

### 1. Design Volume

- a. For all New Development, the standard formula for determining required stormwater storage runoff volume is shown below.

$$V_r = C(R/12)A$$

$V_r$  = Required storage volume in cubic feet.

$R$  = Precipitation amount = The depth in inches of the 100-year, 2-hour rainfall, from FCDMC Hydrology Manual Figure A.56 at the site.

$A$  = Area (square feet) of disturbance, including:

- (1) Easements, tracts and rights-of-way within the development, plus
- (2) Where the development includes improvements to the rights-of-way on the perimeter of the property, the area of those improvements up to the ROW centerline.

$C$  = Weighted average runoff coefficient over entire site, per current FCDMC Hydrology Manual tables 3.2 and 3.3

- b. For single family residential lots (non-hillside)

$$V_r = C(R/12)A$$

100% retention amount

- c. For single family hillside lots

$$V_r = C(R/12)A$$



100% of the post dev – pre dev calculated amount

- d. Volume requirement shall be prorated based on Building Site Slope. But, in all cases, First Flush requirements shall be met where required. General guidelines are:

Slopes between 10% and 30% (exclusive) according to the following figure.

<insert table> hillside retention volume requirements

Slopes greater than or equal to 30% require 0% (no retention required); however First Flush is required for all slopes greater than 10%.

The Town Engineer may waive requirement if proved otherwise based on certain criteria, such as adverse impact and soil type.

e. Hillside development.

Hillside Overlay Districts: The Town of Paradise Valley has a Hillside Zoning Ordinance (Article XXII) that outlines specific requirements for development on lots with slopes greater than 10%. The Hillside Building Committee will review all applications for development in these areas.

Purpose and Need: Hillside lots have special stormwater management needs stemming from higher runoff rates and difficulties associated with establishing onsite retention areas. These needs are exacerbated by construction of impervious surfaces that increase runoff intensity and volume during a storm event. These sites are also likely to be more visible from surrounding off-site areas. The purpose of these requirements is to preserve the character of hillsides while accommodating responsible development and protecting people and property from potentially hazardous conditions unique to hillside development.

Storm Drainage on Hillside Lots: The first priority of hillside development is to properly site buildings, structures and use areas to preserve a site's Natural Wash. This can be accomplished by clustering development while preserving connected Natural Washes and linear open spaces that convey and store stormwater. Development regulations for hillside lots are identified in the Town's hillside zoning ordinance.

Development shall minimize changes to existing topography, including Natural Washes. Where excavation and filling are required for approved site improvements, grades and vegetation shall be restored to meet the Town Landscape Design Guidelines. Application of Low Impact Development (LID) approaches, as identified in Section 6, can reduce the amount of impervious surfaces to mimic a site's predevelopment runoff conditions. The Town may consider waivers to on site retention requirements only in such cases where approved LID practices, such as porous pavements, green roofs and/or reduced pavement areas are incorporated within the site.

## 2. First Flush Retention Volume

a. First Flush retention shall be required for all New Developments that provide onsite detention regardless of Building Site Slopes accordance with Sections 3-2.B and 3-2.C.12. Where on-site stormwater detention is employed, the First Flush volume shall be retained on the individual lot or within a common area. All runoff from disturbed areas shall be routed to First Flush retention basin(s), subject to grading plan approval. In no case shall runoff from disturbed areas impact adjoining off-site properties.

b. First Flush retention is also required for all new hillside developments with Building Site Slopes that exceed 30%.

c. The First Flush volume is calculated using the following formula:

$$V_f = CPA$$

$V_f$  = the required First Flush storage volume, in cubic feet;

C= the weighted average runoff coefficient for the disturbed area of the proposed development per the current FCDMC Hydrology Manual (see appendix);

P= required precipitation depth of 0.5 inches, converted to feet; and

A= the disturbed area of the proposed development, in square feet.

- d. Where retention of the First Flush volume is provided, the stormwater storage facilities must be fully evacuated within 36 hours. The maximum allowable infiltration rate shall be 50% of the in-situ tested rate of the as-constructed basin. Testing shall be conducted using double-ring infiltrometer methodology in accordance with FCDMC standards.

### 3. Certified Volume

- a. Before acceptance or before issuance of a Certificate of Occupancy, the Engineer of Record must provide the Town with certified, as-built dimensions of facilities and the actual volume of storage provided.
- b. The actual volume of storage provided must:
- i. Be based on as-built topographic surveys performed by an engineer or surveyor;
  - ii. Reflect permanent, finished landscaping in place;
  - iii. Meet or exceed the required volume;
  - iv. Be constructed to perform as designed; and
  - v. Be certified by an engineer.
- c. The volume of storage provided must equal or exceed the approved design volume before the Town issues a Certificate of Occupancy.
- d. Applicant shall provide the Town a recorded Storm Drainage Facilities Agreement prior to receiving a Certificate of Occupancy – see Appendix.

### C. Storage Facilities Design

1. All on-site stormwater retention areas, other than piped systems, shall be entirely landscaped. Storage facilities shall be located to intercept flows generated for each tributary area within the entire development to the maximum extent practicable.
2. Storage facilities shall be set back at least 5 feet from adjacent properties, rights-of-way (ROW), public utility easements (PUE's) or other utility easements, or as approved by the Town Engineer.
3. Because they interrupt the natural flow of the wash and can create debris and sediment obstructions, in-stream storage facilities are prohibited.
4. Retention/detention facilities should be designed with a positive gravity drain system to a historical outflow whenever possible.
5. Basin side slopes shall not exceed a 4:1 (4 foot horizontal to 1 foot vertical) ratio.
6. The design depth of a facility's stored water shall not exceed 3 feet unless otherwise approved by the Town Engineer.
7. Ultimate outfall of basins must be one (1) foot below adjacent finished floor elevations.

8. Facilities shall have an emergency spillway to safely direct overflow into a recognized watercourse or to the historical outfall of the lot.
9. Above-ground storage facilities contained by an embankment are generally prohibited. If above-ground storage facilities are permitted, they must be designed and constructed according to generally accepted geotechnical and, if necessary, structural-engineering principles. Slope stability, piping, seepage, sliding, overturning and material integrity shall be considered.
10. Except as provided in 11 below, stormwater storage facilities for residential subdivisions shall be located in a tract.
11. Stormwater storage facilities for a residential subdivision may be located on a private lot if the owner:
  - a. Provides a physical demarcation around the stormwater storage facility to avoid interference with its purpose in accordance with an approved Grading Exhibit per Section 8-1
  - b. Constructs and maintains an approved cistern for rainwater harvesting to reduce irrigation water use.
12. Detention basins and related storm drainage facilities shall drain to a recognized watercourse, such as an established wash, or to the lot's historical outfall. Unless otherwise approved by the Town Engineer, stormwater may not be discharged onto a street or alley or into a storm drain.
13. A stormwater storage facility shall not detain or retain standing water longer than thirty-six (36) hours unless the facility is designed and constructed to be a permanent body of water with appropriate health, safety, and water quality measures. Consistent with requirements specified in the DDM for Maricopa County, double-ring infiltrometer testing shall be required (de-rated by 50%) to demonstrate adequate drawdown within 36 hours for all basins. Calculations shall be included on the drainage sheet of any submittal.
14. Drain time should be maximized to ensure facility effectiveness. Drain time should generally range from 12 to 24 hours. Discharge from the detention basin may be regulated with a hinged orifice plate (with a minimum diameter of 6 inches) over the entrance of the outlet pipe if the outlet pipe meets minimum size requirements.
15. Storage facilities shall be designed to allow for regular maintenance activities, such as access for inspection, vegetation and soil management, and removal of sediment, debris and other obstructions.
16. For only non-residential properties requiring a Special Use Permit, surface stormwater storage may occur in a parking lot if the following conditions are met:
  - a. At least the first 50% of the required storage volume is provided in an approved stormwater storage basin or underground storage tank;
  - b. No more than 50% of the required storage volume is provided on the surface;
  - c. The depth of water does not exceed six inches; and
  - d. Interference with pedestrian traffic is minimized.

### 3-3 UNDERGROUND STORMWATER STORAGE POLICY

- A. This policy supplements the Town Code requirements for all stormwater storage. Underground stormwater storage involves the construction of underground tanks, pipes, or vaults that accept stormwater runoff by



means of inlets and storm drain pipes. The Town will only approve underground storage after rigorous analysis of storage system location, specifications, access, operation and maintenance, liability, and signage.

B. Projects qualifying for underground stormwater storage must meet the following criteria:

1. Projects located within a commercial, non-residential or multi-family development with a viable property maintenance organization or other maintenance mechanism to assume continued maintenance of the underground stormwater storage system and protect the public interest.
2. Single family residences with a Storm Drainage Facilities Agreement instead of a Drainage Easement.

C. General Criteria for Underground Stormwater Storage System Design

1. Underground stormwater storage systems must demonstrate protection of public health, safety, and welfare as established by the Town Code and adopted policies.
2. All underground stormwater storage elements must meet or exceed industry standards.
3. Storage systems must not be located under buildings or parking garages.
4. The owner must execute a Storm Drainage Facilities Agreement for single family residential properties.
5. Design must address:
  - a. Water quality protection measures to protect underground and surface water resources that meet applicable water quality standards.
  - b. Vector control within storage system.
  - c. Redundancy in case of storage system failure, with particular attention to potential structure or street flooding, sediment accumulation, or storm events greater than a 100-year, 2-hour event.
  - d. Initial suspended sediment load removal.
  - e. At least a 75-year life of the entire system, including the lining and coating of the underground storage structure.
  - f. Drainage by percolation or gravity. Pumped systems will only be considered if no other reasonable alternative exists.

D. Specific Criteria for Underground Stormwater Storage Design

1. Outfall—underground storage systems must have some sort of outfall, such as gravity drains or pumps.
2. Percolation—provide calculations that demonstrate the existence of pervious sub-soils and substantiate percolation within 36 hours.
3. Pipes—underground storage system pipes must have a smooth interior floor to prevent debris from collecting in the pipe and reducing its effective volume.
4. Installation—excavation, bedding, and backfill procedures and materials must align with MAG standards.
5. Access—a minimum of one access point must be provided for each underground storage system to enable inspections and removal of accumulated sediment and debris. Access must align with MAG standards.

E. Criteria for Operations, Maintenance and Liability

1. Operations and maintenance—generally owner must provide:
  - a. Contractor or maintenance staff with experience in operating, inspecting, and maintaining an underground stormwater storage system.
  - b. An on-site Operations and Maintenance Manual for the system that includes (i) a schedule for inspections and maintenance and (ii) provisions for emergency operations due to power failure, pump failure and clogged inlet/outlet structures.
  - c. A log of inspections and required maintenance services.
2. Inspections and maintenance required—in addition to maintenance required by the Town Code and other applicable requirements, owner shall:
  - a. Inspect system semiannually (preferably before summer and winter rains) after each storm event of 0.5 inch or more.
  - b. Remove accumulated trash and debris from inlet and outlet structures as needed to ensure free flow of stormwater.
  - c. Inspect all other elements of the drainage system (pipes, geotextiles, and stone) and repair/replace elements as needed for the storage system to operate at peak efficiency.
3. Before receiving a Certificate of Occupancy, the owner must install a marker or signs at the access point for each underground storage tank that reads “Notice—Underground Stormwater Storage Tank.” The size, color, and location of the marking must be clearly visible at all times.
4. Liability—the property owner assumes all liability for the design, construction, maintenance and failure of the underground stormwater storage system in perpetuity and holds the Town harmless from any associated liability. Before receiving a Certificate of Occupancy, the owner must record a Storm Drainage Facilities Agreement with the Town in a form satisfactory to the Town Attorney at the Maricopa County Recorder’s Office.

### 3-4 STORMWATER STORAGE WAIVERS

#### A. Waiver of Stormwater Storage Requirements

Note: if a waiver of storage requirements is approved, it does not relieve the landowner or Developer of liability stemming from flood damage.

#### B. Waiver of First Flush

Generally, there is no waiver permitted for stormwater storage volume required to hold runoff from the First Flush. However, in highly unusual circumstances, the owner may provide a smaller basin and/or alternative stormwater controls if they meet the approval of the Town Engineer.

#### C. Waiver Process

To apply for a waiver, the Developer shall complete and submit the following materials with the final drainage report:

1. A Request for Stormwater Storage Waiver in writing to the office of the Town Engineer, and

2. A certified engineering report stamped by a licensed Arizona engineer, along with documentation satisfactory to the Town Engineer that the project qualifies for a waiver and proves no adverse impact to any upstream or downstream property.

The Town Engineer may request additional information and may deny, approve, or approve the waiver with conditions.

Unless the project is designed to provide full storage, the Town Engineer will not accept final improvement plans without a copy of the approved waiver.

## 3-5 STREET DRAINAGE

### A. Access

Generally, street improvements for New Development shall provide access to properties during a Base Flood. To prove access, an engineer must demonstrate at least one structural roadway section with asphalt, concrete or compacted aggregate has a depth of flow no greater than 1 foot during a Base Flood. Refer to Fig. 3a, Street Hydraulic Design Criteria, for inundation limits for specific street sections.

### B. General Design Standards

Streets may carry water from adjacent property and from local areas, but they should not be used as major water carriers in lieu of Natural Washes or man-made channels. The design criteria below imply that water may flow deeper than a normal vertical curb height for a short distance over sidewalk or other back-of-curb areas, but the flow is always confined to the right-of-way or Drainage Easements. For New Developments, Developers should provide catch basins, scuppers, or similar facilities, together with necessary channels, at appropriate locations (particularly street sag areas) to remove water flow in streets and comply with MAG, DDM and the below design criteria.

STREET HYDRAULIC DESIGN CRITERIA			
dmax = maximum depth at any point within the right-of-way			
Drainage Feature	Peak Frequencies		
	10-Year	25/50-Year	100-Year
Street with Curb & Gutter	Contain runoff within street curbs. For collector and arterial streets maintain one 12-foot- wide dry driving lane in each direction.	N/A	Contain runoff below the building's lowest floor. Confine runoff to street rights-of-way or Drainage Easements. dmax = 8 inches.
Street without Curb & Gutter (Dirt Roads, Ribbon Curbs)	Contain longitudinal runoff within roadside channels with water surface elevation below pavement subgrade.	N/A	Contain runoff below the building's lowest floor. Confine runoff to street rights-of-way or Drainage Easements. dmax = 8 inches.
Street without Storm Drain System	Add pipes or roadside channels if runoff from 10-year flood exceeds street capacity, unless waived.	N/A	Add storm drain systems if a Base Flood inundates building's lowest floor. Provide catch basins, scuppers, etc. to remove water so dmax = 8 inches.

Cross Road Culvert or Bridge for Collector & Arterial Streets	N/A	Convey runoff by culvert or bridge under street with no flow overtopping the street for a 50-year flood.	Convey runoff by culvert and flow over the street so dmax = 6 inches.
Cross Road Culvert or Bridge for Collector Streets, and Local Streets	Convey runoff by culvert or under bridge with no flow overtopping the street.	For a 25-year event, convey runoff by culvert or bridge and by flow over the street with so dmax = 6 inches.	dmax = 12 inches.
Any street or watercourse crossing that provides the only access to residential area.	N/A	N/A	Make all lots and structures accessible by at least 1 street with dmax = 12 inches for a Base Flood.
Local Streets with Low Volume Average Daily Trips	N/A		

FIGURE 3a STREET HYDRAULIC DESIGN CRITERIA CHART

### C. Valley Gutters

Valley gutters are permitted on local streets to transport runoff when a storm drain system is not required. Valley gutters are generally not acceptable on collector or arterial streets. In unusual cases, valley gutters may be necessary to convey runoff across a collector or arterial street. In such situations, the valley gutter shall be a minimum of 8 feet wide to lessen impact on traffic. Refer to Figure 3b below.

FIGURE 3b TYPICAL SECTION FOR VALLEY GUTTER

### D. Roadside Swales

Unless waived by Town staff, swales must intercept and safely convey flow to the nearest recognized watercourse within the same watershed. If velocities exceed 5 feet per second, then the Engineer must design the swale to provide erosion and scour protection. Swales are necessary to prevent:

1. Runoff and debris from washing onto the roadway,
2. Erosion of roadway areas adjacent to the edge of pavement or curbing, and
3. Roadway runoff from flowing into front yards, driveways, garages and homes. Refer to Figure 3.c Typical Cross Section for Roadside Swales, on non-raised curb street or straight cross slope.

FIGURE 3c TYPICAL CROSS SECTION FOR ROADSIDE SWALES

#### E. Wet Crossings

1. For wet crossings of road, calculate flow velocity for sediment erosion. Erosion control measures for scour protection must be evaluated and documented.
2. Wet crossings shall be constructed from concrete paving or include continuous ribbon curb per MAG standard details.

### 3-6 CHANNEL CONVEYANCE

#### A. Channel Design

##### 1. Visual Character:

To maintain high quality and low water use landscapes that reflect the natural character valued by Town residents, drainageways, wash corridors and other storm drainage facilities will be protected and managed to maintain natural grades and native soils and plantings and provide visual and physical continuity consistent with the Town's Landscape Guidelines and the Design and Maintenance Guidelines found in Appendix 3-A.

##### 2. Natural Wash Corridors:

The Town's policy is to encourage the protection of Natural Wash corridors and discourage constructed and piped stormwater conveyances whenever possible. If a Natural Wash must be disturbed in order to construct a Habitable Structure, it shall be designed in such a way to mimic a natural channel, utilizing natural and native materials to recreate a functional, aesthetic and ecologically sound conveyance. A wash can be piped when necessary to provide a driveway for site access.

Three tiers have been established to define the types of wash modifications permitted in the Town:

Tier 1 (Modification to a Minor Wash): Washes included in this category:

- Are less than 2 feet deep and 5 feet wide as measured at the top of bank;
- Have an existing 100-year, 6-hour peak flow rate of less than 50 cfs, and;
- Do not reside in an existing Drainage Easement.

Allowable wash modifications in Tier 1 with Town Engineer approval include:

- Modify the wash, or;

- Relocate the wash, and/or;
- Enclose the wash.

Tier 2 (Modification to a Natural Wash): Washes included in this category:

- Meet or exceed the definition of a Minor Wash, and/or;
- Have an existing 100-year, 6-hour peak flow rate equal to or exceeding 50 cfs, and;
- Impact more than 25% of the site's buildable area

Allowable wash modifications in Tier 2 with Town Engineer approval include:

- Relocate the wash, and/or;
- Enclose the wash.

Tier 3 (Protection of a Natural Wash): Washes included in this category:

- Meet or exceed the definition of a Minor Wash, and/or;
- Have an existing 100-year, 6-hour peak flow rate equal to or exceeding 50 cfs, and;
- Impact less than 25% of the buildable area of the site.

A Tier 3 modification requires the Developer to maintain the wash in its natural condition or restore it in its original location or as close to its original condition as practicable considering the principals outlined in Appendix 2-A (Low Impact Development Guidelines).

In all cases, wash modifications must maintain the locations of inflow onto the property and outfall from the property and have no adverse impacts on other property owners as documented in a drainage report signed and sealed by a professional engineer.

In all cases, except for Tier 1 modifications that modify a Minor Wash, an easement for protection and access shall be dedicated to the Town. For single family residential properties, a recorded SFDA shall also be required. Washes that are located on properties designated as Hillside and meet the definition of a Hillside Wash, shall not be diverted, relocated or moved from its present position to another location, however, a Hillside Wash may be bridged by a structure so long as the structure does not impede the flow of the Hillside Wash in accordance with hillside regulations.

### 3. Natural Wash Preservation

Town rights-of-way and easements along Natural Wash corridors shall be maintained to preserve the natural environment and landscape features. Natural Wash corridors shall include a landscape buffer area of at least 5 feet on each side, perpendicular to the top of the bank, and designed to protect the wash's functional and ecological integrity.

### 4. Maintenance:

Regular (annual) inspections are required by the property owner to determine the condition of drainageways, including erosion, sedimentation, dead or unhealthy vegetation, potential for blockage and maintenance needs. Dead or dying plants shall be replaced immediately. Vegetation shall be pruned regularly to remove dead limbs and overgrowth.

## 5. Modified Channel:

When constructed or reconstructed channels are elected or required, emphasis will be placed on both safety and a "natural" appearance. Native landscaping is encouraged for lining and protection, with side slopes 4:1 or flatter, as approved by the Town Engineer. Channel lining and erosion control systems will be considered on a case-by-case basis, but in all cases must mimic predevelopment conditions.

Design shall be in accordance with the Drainage Design Manual for Maricopa County, Arizona. The permittee is required to coordinate compliance with any requirements of the Army Corps of Engineers Section 404 Certification. The permittee is required to coordinate all revisions to the FEMA flood insurance rate maps resulting from construction of bank protection.

Channel sections shall be designed so the final finish grade is the surface of any channel lining for erosion protection. Channel capacity shall be designed for increased capacity to accommodate any reduction occurring from landscaping, vegetation and/or sediment accumulation, as shown in Fig. 3d Channel Lining Design Capacity.

## FIGURE 3f CHANNEL LINING DESIGN CAPACITY

## 6. Maximum Velocities/Erosion Protection:

In general, maximum velocity shall not exceed the scouring velocity of the soil (with natural cover). When the scour velocity is exceeded, additional erosion protection shall be provided. Bank/channel protection may consist of one or more of the following:

- b. Natural stone grouted riprap 6-inch to 12-inch diameter stones—leave a minimum 1/4 diameter exposed.
- c. Natural Stone loose riprap 6-inch to 12-inch diameter stone.
- d. Gabion Baskets/Gabion Mattresses.
- e. Soil Cement.

## 7. Aesthetic Standards:

All designed channels shall blend with the surrounding landscape, including contoured site grading for earthen channels and matching plant types and density.

## 8. Landscaping:

Utilize Sonoran Desert indigenous plant material wherever appropriate in landscaping associated with construction and maintenance of public property and easements for stormwater conveyance. Town

Landscape Guidelines can be found at:

<http://www.paradisevalleyaz.gov/DocumentCenter/Home/View/37>

#### 9. Obstructions:

Do not obstruct drainage conveyance by changing site grading or constructing fences, walls, berms, swales, retaining walls, patios, pools, decks, sheds, pens, corrals, water troughs, canals or any other construction that alters, redirects, impedes or suspends drainage from its natural course. Landscaping obstructions, including mounding, raised beds, edging, furrowing, gardens, water harvesting, planter boxes, and other landscape construction that alters, redirects, impedes or suspends drainage from its natural course, are prohibited without prior approval from the Town Engineer.

#### 10. Operation and Maintenance Requirements:

As part of an approved design, the Owner must consider and accommodate potential future needs for vehicular access to stormwater facilities for maintenance purposes. Maintenance must be considered during the planning, design and construction of drainage facilities. Design should minimize long-term maintenance requirements so that maintenance can be provided on a regular basis to maintain system capacity. Regular maintenance includes reducing growth of undesirable vegetation, removal of debris and sediment accumulation, and repair/restoration of erosion, scour, soil settlement, and structure damage.

#### 11. Pools and Spas

Pools and spas shall not be drained or backwashed into a street, storm drain or Natural Wash. The Town's two sanitary sewer providers, (City of Scottsdale and Phoenix) currently allow the disposal of pool or spa water into their collection systems. If discharging into a sanitary sewer, pool or spa water shall enter the sewer on private property by appropriate means, such as via a sanitary clean-out. Other examples of appropriate locations to backwash a pool or spa may include onsite retention basin(s) with adequate volume or an approved septic tank hauling service.

### 3-7 STORM DRAIN PIPES, CULVERTS AND BRIDGES

- A. The Town's culverts and bridges are generally within the public right-of-way for the road. Additional easement or right-of-way, beyond the normal street width may be required to facilitate a structure's construction, operation and/or maintenance. Design plans for the structure shall include the proposed easement and/or right-of-way limits. Maintenance issues and access shall be considered in the structure design, and appropriate measures should be included to facilitate proper maintenance (i.e. access road if necessary, etc.).
- B. The minimum pipe size of culverts and storm drain laterals in the public right of way shall be 18 inches in diameter, and 12 inches in diameter on private property. Where debris may be expected, follow the FCDMC requirements to prevent clogging.
- C. Culverts and storm drain laterals on private property should be sized to manage a 100-year runoff event but shall be no less than 12 inches in diameter. Culverts that do not have 100-year peak flow capacity must be designed to adequately convey the balance of runoff by channel or other means to the appropriate watercourse or storage basin.



- D. In special cases, if a culvert invert is placed below the Natural Wash flow line, the design capacity of the culvert shall be reduced by the cross-sectional area below grade level as approved by Town Engineer.
- E. Manholes or junction structures are required at all horizontal and vertical changes in culvert alignment, pipe junctions, and changes in pipe diameter.
  - 1. The hydraulic grade line in storm drains shall be no higher than six inches below the gutter line in a 10-year storm event.
  - 2. Minimum Drainage Easement widths shall be calculated using the following formula:  
$$\text{Width} = \text{pipe outside diameter} + 2 \text{ feet} + 2 \times \text{depth to invert}$$
- F. Storm drain inlets and outlets shall be designed to meet adopted Town Building Code and MAG standards. Structures shall be buried or otherwise blended with the surrounding grade and employ colors and textures that match or complement adjacent structures as approved by the Town.
- D. Headwalls shall extend a maximum of 18 inches above top of pipe, with the top of wall not to exceed four (4) inches above finished grade of surrounding areas. Slope to top of headwall shall not exceed a maximum 4:1. Where vertical drop is greater than 30 inches, install guardrail meeting Town and MAG standards if required by the Town's building codes. Headwalls shall be constructed of poured-in-place concrete. Concrete walls shall be finished with integral color and form liner as approved by the Town Engineer.
- H. Fence and Wall Openings, Trash Racks and Railings shall be designed in accordance with adopted Town Building Code and MAG standards. Steel fabrications shall consist of evenly spaced slats 8 inches on center max., smooth coved welds, primed and painted to match adjacent structures as approved by the Town. Grates are only required on private lots and shall be cleaned and maintained by the property owner. Chicken wire or similar screens are not permitted due to their tendency to clog and block flow.
- I. Culverts and bridges are to be designed to avoid impact on existing sediment transport conditions.

## Erosion Hazard management

## 4-1 GENERAL INFORMATION

- A. The Town uses, as a minimum, the design standards and methodologies described in the ADWR Erosion Hazard Guidelines and FCDMC Hydraulics Manual. These apply to:
1. Structures that could fail or incur significant damage as a result of erosion.
  2. Proposed structures that, if built, could result in adverse impacts to adjacent properties.
  3. Watercourses that do not have identified erosion hazard zones.
  4. Watercourses within existing or proposed land divisions.
  5. Watercourses identified by the Town as significant potential flood hazards.
  6. Watercourses with drainage areas equal to or greater than 30 acres or a 100-year, 6-hour peak discharge estimate of more than 50 CFS, as estimated using the procedures in the FCDMC Hydrology and Hydraulics volumes.
- B. Erosion hazard areas (setback areas) consistent with ADWR SS5-96 may be required for all properties under development where watercourses will be left in an undisturbed state. The Town may require further analysis (ADWR Level II or III) under certain geomorphic conditions when staff is concerned that erosion limits may exceed Level I analysis estimates. The Town may also require a slope stability analysis.

## 5-1 CONSTRUCTION GENERAL PERMITS

- A. The Arizona Department of Environmental Quality (ADEQ) administers the Construction General Permit under the Clean Water Act (CWA). The Town requires evidence that the development will comply with the ADEQ Construction General Permit, when applicable, before issuing development permits.
- B. Stormwater runoff from construction sites can include pollutants such as phosphorous, nitrogen, pesticides, petroleum derivatives, construction chemicals, solid wastes and sediments that adversely affect water quality. Compliance with the Construction General Permit will help prevent these pollutants from entering washes, lakes, other surface waters, and the Town's storm drain system.

## 5-2 HOW TO OBTAIN STATE AND TOWN APPROVAL

- A. When applicable, the operator of a construction site is responsible for applying for appropriate ADEQ permits. The operator may be the owner, Developer, general contractor or individual contractor responsible for operational control. When this responsibility is shared, all operators must apply for ADEQ approval. ADEQ requires a Notice of Intent (NOI) and Stormwater Pollution Prevention Plan (SWPPP). The Town requires submittal of the SWPPP for review prior to ADEQ submittal.
- B. After ADEQ approval, the operator must include 2 copies of the approved NOI and SWPPP with improvement plan submittal to the Town.
- C. The Town requires a SWPPP for all projects that create a land disturbance that may result in potential construction runoff onto neighboring properties, Town rights-of-way, or washes (including demolitions).

## 5-3 OPERATIONAL REQUIREMENTS

- A. The operators must retain a copy of the SWPPP on site for the duration of site clearing, grading, and construction. In addition to ADEQ enforcement, the Town will enforce stormwater management requirements through inspections, responses to complaints, and other means.
- B. Once construction is completed, as defined in the Construction General Permit, operators must submit a Notice of Termination (NOT) to ADEQ and the Town.

## 5-4 SECTION 404 PERMITS

- A. The Town requires all New Developments to comply with Section 404 of the CWA.
- B. The US Army Corps of Engineers (Corps) and EPA jointly administer Section 404 of the CWA. The CWA regulates the discharge of dredged or fill material into washes, rivers, streams, lakes, certain man-made canals and other waters of the United States, including wetlands.

Examples of activities that potentially regulated under this program include:

1. Stream crossings;
2. Dam construction and flow regulation;
3. Water diversion for canals, irrigation systems and stock tanks;

4. Stream bed modification and stabilization; and

5. Building subdivisions, master planned communities, nonresidential structures, highways and airports.

C. Projects determined by the Corps to have a minimal environmental impact require compliance with nationwide permits in a streamlined process. Projects with potentially significant impacts may require individual permits and public notice.

D. Projects cannot jeopardize the continued existence of a threatened or endangered species or its critical habitat. Developers should consult with the Corps or the US Fish and Wildlife Service for guidance concerning threatened and endangered species in the Town.

## 5-5 SECTION 401 CERTIFICATION

A. Before the Corps can issue a Section 404 permit, Section 401 of the CWA requires ADEQ to certify (possibly with additional conditions) that the draft permit complies with effluent limits, state water quality standards, and appropriate requirements of state law. No discharge of dredged or fill material is permitted if:

1. A practicable alternative less damaging to the aquatic environment exists, or
2. The nation's waters will be significantly degraded.

B. ADEQ may grant, deny, or waive water quality certification for both individual and nationwide Section 404 permits.

## 5-6 COMPLIANCE REQUIREMENTS

A. The Town will not issue any development permit where Corps action is required but not yet taken. An applicant must comply with the requirements of Sections 401 and 404 of the CWA, as applicable, prior to commencing construction.

B. Wastewater disposal systems shall comply with Arizona Revised Statutes and ADEQ requirements.

## Drainage Reports and Plans

### 6-1 ACTIVITIES REQUIRING A DRAINAGE REPORT AND GRADING PLANS

A. An applicant may be required to submit a Drainage Report and Grading Plans when submitting any of the following applications. The specific nature of the plans and reports, and the requirements for submittal, are to be determined by Town staff during the pre-application process.

1. Re-zoning
2. Special Use Permit
3. Development or Redevelopment Plan
4. Preliminary and/or Final Subdivision Plat
5. Hillside Building Committee
6. Board of Adjustment
7. Final Plat, lot splits, lot line adjustment, lot combination and/or improvement plans
8. Right-of-way Permit
9. Building Permit with a grading component
10. Grading Permit
11. Demolition Permits
12. Modification or release of a dedicated drainage or retention easement

## 6-2 TYPES OF DRAINAGE REPORTS AND GRADING PLANS

- A. Sequential levels of drainage reports and grading plans exist, as development proposals range from broad and conceptual to project specific and detailed, as well as requirements for master-planned development proposals. Drainage reports and grading plans address stormwater flows and drainage issues that affect a proposed development and adjacent and nearby sites; and drainage solutions, in accordance with applicable ordinances and standards, to mitigate adverse effects resulting from the proposed development. Each drainage report and grading plan shall describe how the proposed development will manage stormwater runoff, the details of infrastructure to be constructed, the sequence of infrastructure installation, and any project phasing. Drainage reports and grading plans for single-family residences may vary from the sequence below, subject to town staff approval.
1. Conceptual Drainage Reports and Grading Plan. With re-zoning, Special Use Permits, and Conceptual Hillside Submittals, the applicant shall submit a Conceptual Drainage Report and Grading Plan that identifies basic drainage conditions applicable to the site and possible stormwater management solutions that relate to the site's proposed development and unique conditions. In many cases, the Conceptual Drainage Report and Grading Plan will be included in a Development Plan (DP). The Conceptual Drainage Report and Grading Plan shall show how the site's drainage systems will relate to and extend existing drainage systems serving adjacent and nearby properties. The Conceptual Drainage Report and Grading Plan shall establish key elements for consideration in any future drainage reports and grading plans for the site, including applicable FEMA floodplain designations.
  2. Preliminary Drainage Report and Grading Plan. With preliminary plat, subdivision, Master Plan and Hillside Building Committee or Board of Adjustment applications, the applicant shall submit a Preliminary Drainage Report and Grading Plan. While a Preliminary Drainage Report and Plan will not contain sufficient detail or accuracy to function as an improvement plan, the Preliminary Drainage Report and Grading Plan must provide detailed design concepts, specifications for proposed drainage facilities, and management plans for operating and maintaining drainage facilities. The Preliminary Drainage Report and Grading Plan presents the justification for final improvement plans and lowest floor elevations; the plan for connecting the proposed development to existing and planned drainage facilities on and adjacent to the site; pre- and post-project topography; and stormwater runoff calculations (including off-site drainage that enters the site). The Preliminary Drainage Report and Grading Plan shall also demonstrate consistency with any applicable Conceptual Drainage Report and Grading Plan and stipulations associated with approval.
  3. Final Drainage Report and Grading Plans. Along with improvements plans for final plats, construction plans for public infrastructure, the modification of a drainage or retention easement, and construction plans for on-site development, the applicant shall submit a Final Drainage Report and Grading Plan. A Final Drainage Report and Grading Plan is intended for construction and therefore must be fully detailed; compliant with Town of Paradise Valley design standards and applicable regional, State and Federal statutes; and consistent with previously approved Preliminary Drainage Reports and Grading Plans and stipulations, if any.
  4. Master Drainage Reports and Grading Plans. For multi-phased and complex development proposals, the Town may require the applicant to submit a Master Drainage Report and Grading Plan after a rezoning and intermediate/major special use permit amendment approval. A Master Drainage Report and Grading Plan provides the basis for constructing major common drainage improvements that serve an individual phase or property within the proposed development, the entire proposed development, or a portion of the regional drainage requirements. A Master Drainage Report and Grading Plan also

establishes drainage improvement requirements necessary for each development phase. A Master Drainage Report and Grading Plan shall be submitted before or with the site's first Preliminary Plat or Development Review case.

## 6-3 STANDARDS

- A. All drainage reports and grading plans should be prepared in conformance to FCDMC standards and this chapter's requirements. Hydrology calculations may be performed using Drainage Design Management System (available at no cost through the FCDMC), HEC-1, HEC-HMS or the Rational Method. Hydraulic calculations may be performed using HEC-RAS. However, the Town encourages sound, innovative design and the use of new techniques where special conditions or needs exist. With prior Town staff approval, alternate methods, models and procedures may be used in conjunction with appropriate supporting documentation.
- B. Development shall not increase peak discharge rates above the historic peak discharge rates for 10-year and 100-year storm events.
- C. Proposed grading shall be at least 0.5% to allow for positive drainage.
- D. At a minimum, drainage reports should meet the following standards:
  - 1. Reflect Town, County, State and federal requirements
  - 2. Use the best and most current data available
  - 3. Provide a clear narrative of the methods used, parameters selected in the analysis, and conclusions drawn
  - 4. Be technically and legally defensible
  - 5. Be well-organized and concise
  - 6. Provide safe, reasonable and reliable results
  - 7. Provide results consistent with adjacent jurisdictions
- E. All drainage reports and grading plans shall conform to Town of Paradise Valley codes and standards and shall be stamped and sealed by a licensed engineer in the State of Arizona.

## 6-4 LIMITATIONS

The Town does not guarantee the reliability of specific hydrologic methods, techniques and/or parameter values. The engineer is expected to validate the reasonableness of estimated values and design the plan to keep the development and the Town relatively safe from flooding. The owner must submit the completed Warning and Disclaimer of Liability Form, as available from the Town Engineer, with each grading and drainage plan.

## 6-5 GRADING AND DRAINAGE PLANS—METHODOLOGY AND CALCULATIONS

- A. There are two methods to determine peak discharge:

1. The Rational Method (generally used for watersheds less than 160 acres that are regularly shaped and uniformly contoured). The methodology is provided in the FCDMC Hydrology Manual.
2. A rainfall runoff model using the Corps' HEC-1 or HEC-HMS Flood Hydrograph Package (generally used for watersheds larger than 160 acres, irregular in shape and contour, or if routing of flows is necessary).

#### B. Watershed Conditions

Watersheds are subject to change. Grading and drainage plans shall consider all watershed conditions that may result in the greatest peak discharge rate, to:

1. Identify and determine the property's current inflows and outflows,
2. Size drainage facilities, and
3. Determine lowest appropriate building floor elevations.

#### C. The Rational Method

1. Precipitation. Precipitation input is rainfall intensity, "I," and can be obtained directly from NOAA 14 at [http://hdsc.nws.noaa.gov/hdsc/pfds/sa/az\\_pfds.html](http://hdsc.nws.noaa.gov/hdsc/pfds/sa/az_pfds.html).
2. Time of Concentration. Time of concentration "Tc" is the total time of travel from the most hydraulically remote part of the watershed to the concentration point of interest. The calculation of "Tc" must follow FCDMC Hydrology Manual procedures.
3. Runoff Coefficients. Use Runoff Coefficients for Use with Rational Method, as detailed in the Maricopa County Hydrology Manual, pages 3-5/3-6, to obtain the runoff coefficients or "C" values. Applying weighted average values calculated for the specific site is acceptable.

#### D. HEC-1 or HEC-HMS Model

1. Minimum submittals.
  - a. A printout of the input data
  - b. A schematic (routing) diagram of the stream network
  - c. The runoff summary output table, including drainage basin name, area, 100-year and 10-year flow values
  - d. Electronic input file(s) on CD or DVD
  - e. Supporting documentation and source material for parameter selection
  - f. A narrative detailing the impact of adjustments to modeling parameters made to address warnings and error messages
2. Precipitation. Determine precipitation values for modeling using the FCDMC Hydrology Manual, specifically PD and JD records for point rainfall and area reduction factors. Capital Projects shall use the ADOT manual and methodology when specified. Precipitation values are to be obtained from the isopluvial maps for the specific frequency addressed, see the FCDMC Hydrology Manual at <http://www.maricopa.gov/DocumentCenter/View/2370>



3. Infiltration. Determine infiltration or soil losses using Green and Ampt (G&A) procedures per FCDMC Hydrology Manual. Use the most recent, applicable USDA NRCS soil survey maps of the project area to determine the hydrologic soil group or surface soil texture for the G&A procedures.
4. Hydrograph Generation. Generate small basin or sub watershed hydrographs using the Clark unit hydrograph procedure or S-graph method as described in the FCDMC Hydrology Manual.
5. Time of Concentration ("Tc"). Use the estimated time of travel from the most hydraulically remote part of the watershed to the concentration point. The FCDMC Hydrology Manual is recommended for obtaining Tc.
6. Channel Routing. Use the Normal Depth (Modified Puls), eight-point routing procedure, as described in the FCDMC Hydrology Manual for channel routing.
7. Existing and Proposed Discharge Analysis. Use the following analysis procedures when necessary to compare existing and proposed discharge (runoff) conditions. Reflect full development conditions by:
  - a. Increasing the percentage of impervious surfaces on the LG card to show the amount of impervious surface that will exist following full development.
  - b. Recalculating the time of concentration (Tc) based on the proposed drainage system after full development.
  - c. Subdividing, as necessary, the existing condition model to create concentration points that match the sub-watershed areas above each proposed storage facility after full development.
  - d. Modeling each proposed storage facility as it will physically exist after full development, with appropriate routing and combining operations through each facility and through the entire watershed. Modeling storage capacity provided, as one hypothetical facility at the outlet with all upstream storage arbitrarily combined in the facility is not acceptable.
  - e. Analyzing the 10-year and 100-year frequency events, at a minimum.
  - f. Comparing discharge values for existing and full development at concentration points immediately downstream from each proposed storage facility and other critical locations, such as road crossings and points where flows exit the development.

#### E. Calculation of Runoff Volumes

1. Standard Formula for Runoff Volumes. The standard formula for determining the required stormwater storage runoff volume is presented in Section 3.2 above.
2. HEC-1 and HEC-HMS Computer Modeling. HEC-1 and HEC-HMS modeling may be used for storage basin design, routing and analysis. Use modified Puls level pool routing option in HEC-1 for hydrograph routing through storage basins and lakes. For permanent lakes, assume no available storage below the normal water surface elevation.

#### F. Methods for Estimating Water Surface Elevations and Inundation Limits

The Engineer may use any standard method for determining water surface elevations. The Town prefers the U.S. Army Corps of Engineers' HEC-RAS for determinations of inundation limits. If the applicant uses the U.S. Army Corps of Engineers' HEC-RAS Computer Models, minimum required submittals for HEC-RAS are:

1. A printout and CD or DVD of the input and output data.

2. A plan of the contributing stream network and sub-basins with cross section locations and stationing, including flow obstructions, ineffective flow areas modeled and other appropriate parameters at a scale sufficient to support the modeling. Overlay the cross sections on the topographic work map.
3. A detailed output summary table, including flow rates, velocities, water surface elevations, bank stations, n-values, ineffective flow stations, flow obstruction stations and other relevant parameters.
4. Cross section profiles.
5. Supporting documentation and source material for parameter selection.
6. A narrative to validate warning and error messages with details of the impact of adjustments to the modeling parameters on the output, if the Town staff allows warning or error messages.

## 6-6 GRADING AND DRAINAGE PLANS—ADDITIONAL REQUIREMENTS BY PLAN TYPE

Depending on the type of plan or development, the following requirements are in addition to the above requirements. Some requirements may apply to other plan types depending on the nature of the project and improvements.

### A. Special Use Permits

The plan must show:

1. The location, orientation and outline of refuse enclosures, including approach slabs
2. Details of driveways conforming to Town standard details, plus existing gutter grades at tie in, longitudinal slopes, the location of grade breaks, sidewalk ramps, curb return radii, existing curb and asphalt removal and asphalt replacement
3. Horizontal control for proposed buildings, drive aisles, parking space dimensions and any other substantial improvements
4. All drainage features such as catch basins, curbs and gutters, pipes, headwalls, basins, and drywells, along with flow arrows and appropriate elevations for each feature
5. High and low points for driveway paving, with elevations
6. Building setback lines
7. Traffic and parking striping
8. Access to underground parking areas

### B. Residential Subdivisions

The plan must illustrate:

1. Lot numbers
2. Tract names and street names from the final plat
3. Street, tract and rights-of-way widths, and street centerlines from paving plans
4. All drainage features, including catch basins, curbs and gutters, pipes, headwalls, basins, and drywells, along with flow arrows and appropriate feature elevations

5. Street longitudinal and cross slopes
6. 10-year and 100-year peak discharge rates at curb cuts and catch basins
7. Flow paths for small washes or swales through lots in custom residential subdivisions
8. High and low points within streets, with elevations
9. Building setback lines
10. Top of curb elevations at lot line intersections with tract or rights-of-way lines

C. Requirements for single-family development can be found at the Paradise Valley Document Center on the Town's website: <http://www.paradisevalleyaz.gov/DocumentCenter/Home/View/10>.

# Drainage Easements and Recorded Agreements

## 7-1 GENERAL INFORMATION

### A. Drainage Easement Requirements

Sections 5-10-7 and 6-3-8 of the Town Code require that Drainage Easements and Storm Drainage Maintenance Agreements are required for:

1. Watercourses having historical banks and a bed at least two (2) feet deep and five (5) feet wide through which waters flow on a recurrent basis.
2. Watercourses, including drainage and stormwater storage facilities for new subdivisions and developments requiring a Special Use Permit.

Related forms are available on the Town's website.

### B. Extent of Drainage Easement Dedication

A Drainage Easement shall be dedicated to the Town to address the limits of stormwater inundation from a Base Flood for watercourses described above and drainage and stormwater storage facilities. Drainage Easement dedications shall encompass all physical structures and sufficient area to access and maintain facilities, including a setback from the property line where required.

Refer to Section 5-10-7 Paragraph C of the Town Code for easement requirements. The Storm Drainage Maintenance Agreement and (non-easement) Storm Drainage Facilities Agreement forms are included in the Appendix.

### C. Maintaining a Drainage Easement or Facility

1. Unless otherwise indicated on the document dedicating the Drainage Easement or in a recorded agreement, the property owner is responsible for maintaining the Drainage Easement.
2. In addition to requirements for maintaining a Drainage Easement in the Storm Drain Design Ordinance, the owner shall:
  - a. Inspect drainage facilities semiannually (preferably before summer and winter rains) and after each storm event of 1/2 inch or more.
  - b. Remove accumulated trash and debris from inlet and outlet structures as needed to permit the free flow of stormwater.
  - c. Inspect all other elements of the drainage system (pipes, geotextiles, and stone) and repair/replace elements as needed to enable the storage system to operate at peak efficiency.

### D. Releasing a Drainage Easement or Agreement

1. A Drainage Easement or agreement may be released only if the applicant documents one of the following circumstances:
  - a. Upstream flows have been physically cut off or diminished;
  - b. More detailed or accurate topographic mapping and/or aerial photography show the original dedication is incorrectly located; or
  - c. The original hydrology is outdated or found to be in error.
2. The Town staff may determine that retaining the easement is in best interest of the Town and may elect to not grant the release. The Town staff may impose reasonable conditions before releasing a Drainage Easement. Once all conditions have been satisfied, as determined by the Town Council, the Town Council may grant the release.

# Grading Permits

## 8-1 GENERAL INFORMATION

- A. For projects other than single-family development, if a pre-submittal meeting is required a review of the Conceptual Site Plan must be completed by Town staff before applying for a grading permit.
- B. Before a grading permit is issued:
1. All substantial grading and drainage issues associated with a project must be resolved to the satisfaction of the Town Engineer.
  2. The Town Council must approve the project's final plat (or other entitlement if applicable). This requirement may be waived by the Town Engineer at the Applicant's own risk.
  3. The owner must complete a Native Plant Preservation Plan. The Native Plant Preservation Plan shall be included with improvement plans submitted for the preliminary grading permit.
  4. If applicable, the owner must obtain a Haul Permit.
  5. If applicable, the owner must obtain a Stormwater Storage Waiver.
  6. The completed No Conflict signature box must be placed on the cover sheet, signed and dated. All applicable No Conflict letters must be submitted.
  7. Where required by ADEQ, the owner must provide a copy of the approved AZPDES Notice of Intent (NOI) and SWPPP.
  8. A SWPPP is required per Section 5 of this document.
  9. When applicable, the owner must provide a completed Section 404 Certification Form and a copy of a permit from the US Army Corps of Engineers.
  10. The owner must submit 2 full size sets of grading plans (24 inches x 36 inches) and a PDF version.
  11. The owner must meet any other project specific requirements to issue a final Grading Permit.
- C. A Grading Permit may only be issued upon approval by Town staff.

## 8-2 STOCKPILE PLANS

- A. Upon Town staff approval, an applicant may temporarily store on-site excess soil from construction operations. To receive approval, the applicant must submit:
1. A letter signed by the applicant documenting the duration of the stockpile and methods used to control dust.
  2. A plan prepared in conformance with grading and drainage plan requirements documenting the stockpile location.
    - a. The stockpile may not be located on or within any easements, rights-of-way or watercourses.
    - b. The plan must provide at least one cross-section through the stockpile that labels the side slopes and the maximum height of the stockpile and demonstrates the total volume of the stockpile.

- c. The plan must illustrate and label all proposed open space areas.
  - d. The plan must manage drainage runoff from the stockpile and upstream watersheds via consideration of stockpile location, stockpile design and grading, and/or temporary stormwater storage.
3. A Native Plant Preservation Plan for the area to be used for the stockpile. The Native Plant Preservation Plan shall be included on the stockpile plan.

