

DETENTION BASIN DESIGN STANDARDS

The following design standards apply when detention basins are proposed. Deviation from these standards requires written approval of the Floodplain Administrator. Additional standards to address specific site conditions may apply. These standards apply to Detention Basins without retention. If retention is proposed within a Detention Basin, design shall follow the standards in Section 5.6.

Requirements for Drainage Report content are provided in Chapter 9, Drainage Report Content, and the required content for Development Plans and Plats is found in Chapter 10, Requirements for Plats, Development Plans. Required content for As-Built is described in Chapter 11, Required Content for As-Built Certification and Plans. Typical details required on plans are provided in Appendix B.

4.1 Detention Basin General Requirements

1. Inspection and maintenance are required for all basins. An inspection and maintenance protocol including frequency of inspection, a checklist of items to be inspected, and recommended maintenance when an inspection identifies a maintenance requirement shall be prepared by an Arizona registrant. The protocol may be included in the project Drainage Report or prepared as a separate document. The protocol shall be reviewed and approved by the Floodplain Administrator prior to approval of the Tentative Plat or Development Plan. The protocol shall be delivered to the entity responsible for inspection and maintenance. An example of a detention basin inspection and maintenance checklist is provided in Appendix C.
2. To allow performance of inspection and maintenance, basins shall be legally and physically accessible.
3. Upon completion of construction of all basins, an as-built certification of the basin shall be prepared by an Arizona registrant and submitted to the Floodplain Administrator. The as-built certification shall be used by the responsible party when performing periodic inspections and when restoring the basin to design specifications, if required.
4. Any modification of a basin, other than routine maintenance, that would affect volume or performance requires a Floodplain Use Permit.
5. When detention basins are to be maintained by a private entity, such as a Homeowners Association, this responsibility shall be described in the association's Covenants, Conditions and Restrictions which shall refer to the inspection and Maintenance protocol and as-built certification.

4.2 Detention Basin General Prohibitions

1. Although the use of stormwater and rainwater harvesting facilities on private residential lots is encouraged, any retention volume on private residential lots shall not be counted towards reducing the required detention volume for the project.
2. Counting rainwater harvesting cistern volume to reduce the required detention volume is prohibited.
3. On-line detention within regulatory floodplains is prohibited without the approval of the Floodplain Administrator.
4. Walls within the basin are not allowed, without the approval of the Floodplain Administrator.

4.3 Detention Basin Location and Collection

4.3.1 Detention Basin Location and Collection Standards

1. Basins shall be located within the project boundary.
2. Basins shall be located to ensure that post-development flow depth, width and velocity approximate pre-developed flow conditions when flow exits the project boundary.
3. To allow maintenance access, a minimum 4-foot setback from basins and appurtenances, including basin outlets (but not including outlet protection) and outer toes of embankments, to the project boundary shall be provided, unless:
 - a. a greater setback is required to comply with Section 4.3.1.2, or
 - b. other adequate access space exists adjacent to the basin, such as right-of-way.

The measurement from the outlet to the property line is illustrated in Figure 4.1.

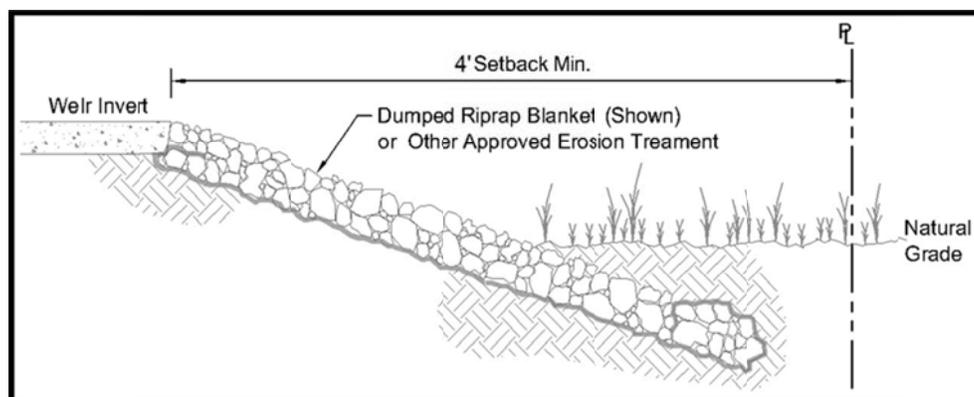


Figure 4.1 Minimum Setback from Property Line

4. In subdivisions, detention basins shall be located in Common Area for Drainage.
5. Basins shall be located to avoid the use of embankments, if possible.
6. When basins are located to accept flows from predominantly natural areas, sediment basins shall be required at the inlet. The configuration and volume of the sediment basin shall be determined by an engineer registered in the State of Arizona.
7. When basins are proposed to be located within a regulatory floodplain or erosion hazard area, it shall be demonstrated that the basin will mitigate local project flows during the 2-, 10- and 100-year storm events. Basins shall be designed to withstand all flood and erosion hazards.

4.3.2 Detention Basin Location and Collection Maintenance Requirements

1. Basins shall be maintained to perform as designed for the life of the project and shall not be converted to a different use without a Floodplain Use Permit.
2. Inlet and outlet locations shall be maintained free of obstructions.

4.3.3 Detention Basin Location and Collection Prohibitions

1. Inlets or outlets which direct flow to a sidewalk or other paved pedestrian pathway shall include a scupper or other conveyance to prevent sidewalk or pathway overtopping by the 10-year design discharge. Inlets or outlets shall not direct flow over a decomposed granite or other erodible pedestrian pathway.
2. Inlets or outlets shall not direct flow through a handicap accessible ramp or handicap parking space.
3. Post-development alterations that affect the function or design of drainage infrastructure are prohibited unless prior approval is obtained from the Floodplain Administrator. Alterations requiring approval include, but are not limited to, alteration of drainage structures, construction of new improvements and post-development site grading which increases or causes flows to bypass the basin.

4.4 Detention Basin Depth and Freeboard

4.4.1 Detention Basin Depth and Freeboard Standards

1. Minimum freeboard shall be 6 inches within basins constructed below natural grade and 12 inches within basins designed with an embankment.

- Freeboard is measured from the 100-year water surface elevation to the lowest top of the basin bank, as shown in Figure 4.2. The freeboard requirement does not apply within weirs or spillways.
- The water depth is measured from the lowest elevation on the basin floor to the top of the 100-year water surface elevation, as shown in Figure 4.2.

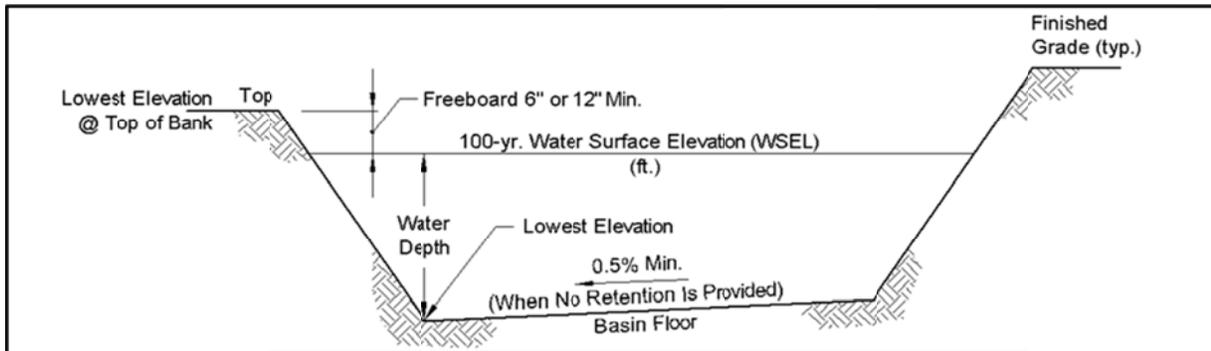


Figure 4.2 Basin Depth and Freeboard Requirements

- Basins shall have a minimum of 1 sediment level measurement device, which can be incorporated into the weir or the side slope, or constructed as a separate stand-alone device. The device(s) shall be located where sediment is likely to accumulate.
- Basins designed for 100-year water depths of greater than 2 feet and with side slopes steeper than 4:1 shall have a security barrier at all locations where side slopes are steeper than 4:1. Security barriers shall meet the requirements found in Section 4.11.

4.4.2 Detention Basin Depth and Freeboard Maintenance Requirements

- The depth of the basin shall be inspected annually to ensure the design volume is maintained.
- Design volume shall be restored when the depth of sediment exceeds 6" anywhere above the elevations shown on the basin as-built certification.
- Slopes shall be maintained to the original design configuration.

4.4.3 Detention Basin Depth Prohibition

- 100-year water depth shall not exceed 6 feet, unless approved by the Floodplain Administrator.

4.5 Storage Time

4.5.1 Storage Time Standards

1. The maximum storage time for a basin that intercepts runoff from a watershed up to 10 acres in size is 12 hours. The storage time is defined as the time required for stormwater to be removed from the basin.
2. The maximum storage time for a basin that intercepts runoff from a watershed greater than 10 acres in size is 24 hours. The storage time is defined as the time required for stormwater to be removed from the basin.

4.5.2 Storage Time Maintenance Requirements

1. Basin bottoms shall be inspected annually and after storm events for evidence of ponding lasting longer than the limits in Section 4.5.1.
2. If an inspection identifies evidence of ponding lasting longer than the limits in Section 4.5.1, the following maintenance shall be performed:
 - a. Areas of ponding shall be graded to drain to the outlet,
 - b. Compacted soil shall be scarified to promote infiltration,
 - c. Basin outlets shall be maintained to function as designed, and
 - d. Obstructions at the outlet shall be removed.

4.6 Basin Floor

4.6.1 Basin Floor Standards

1. The basin floor shall be graded to a minimum slope of 0.5% to provide positive drainage to the basin outlet, when no retention is provided, as illustrated in Figure 4.3.

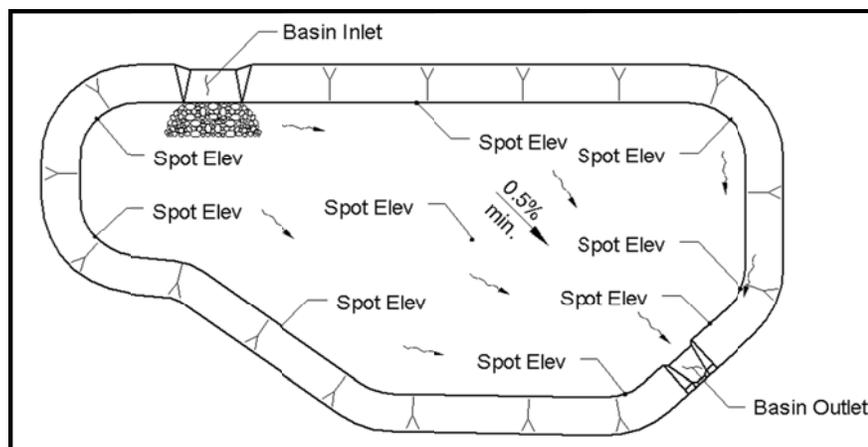


Figure 4.3 Basin Floor Minimum Slope for Positive Drainage

2. The basin floor may be hydroseeded. If hydroseeding is proposed, plant species used in the seed mix shall be selected from the Approved Plant List provided in Appendix B of the Pima County Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines available at:
http://rfcd.pima.gov/wrd/riparian/pdfs/revised_guidelines_jan2010.pdf.
3. Other types of vegetation shall comply with Section 4.17.

4.6.2 Basin Floor Maintenance Requirements

1. The basin floor shall be inspected annually and after storm events to ensure that positive drainage is maintained for basins that do not include retention volume.
2. Maintenance shall be performed when accumulated sediment and debris alter the design slope from the basin inlet to the basin outlet.
3. Invasive non-native plants shall be removed. A list of the invasive non-native plants can be found in Appendix E of the Pima County Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines available at:
http://rfcd.pima.gov/wrd/riparian/pdfs/revised_guidelines_jan2010.pdf.
4. Compacted soil shall be scarified to avoid areas of ponding and promote infiltration.
5. Soil with evidence of oil, grease or other chemicals shall be removed and disposed of properly.
6. Debris and trash shall be removed from the basin at least annually.

4.6.3 Basin Floor Prohibitions

1. Except for paths within multi-use basins, the use of decomposed granite or rock less than 4 inches in diameter on the basin floor is prohibited.
2. Invasive non-native plants on the basin floor are prohibited, except for turf grass in multi-use basins.

4.7 Side Slopes

4.7.1 Side Slope Standards

1. Recommended side slope stabilization is presented in Table 4.1, or as otherwise specified in the geotechnical report.

Table 4.1 Side Slope Stabilization

Side Slope Ratio	Stabilization Method
3H:1V or flatter	Approved Hydroseed Screened rock with minimal fines Dumped Riprap with Filter Fabric
no steeper than 2H:1V	Hand Placed Riprap with Filter Fabric Gabion Mattress
no steeper than 1.5H:1V	Articulated Revetment Units
no steeper than 1H:1V	Grouted Riprap Concrete Lining with Welded Wire Fabric Gabions
steeper than 1H:1V	Retaining Wall

2. The following standards apply to riprap side slope treatments:
 - a. Dumped riprap shall have a D_{50} of at least 6 inches and be placed with a blanket thickness of 2 times the D_{50} .
 - b. Hand placed or dumped riprap shall consist of hard, durable angular stone in erosive environments. In non-erosive environments, non-angular stone is allowed. Gradation shall be provided as described in Table 4.2.

Table 4.2 Dumped or Hand Placed Riprap Gradation

Dumped/Hand Placed Riprap Gradation	
% Passing	Size
100 – 90	2.00 D_{50}
85 - 70	1.50 D_{50}
50 – 30	1.00 D_{50}
15 – 5	0.67 D_{50}
5 - 0	0.33 D_{50}

- c. Unless grouted, rock riprap shall be underlain with filter fabric. The filter fabric shall be woven for a minimum of 2 feet into the upper end of the blanket and wrapped for a minimum of 2 feet around the riprap base of the blanket as illustrated in Figure 4.4.

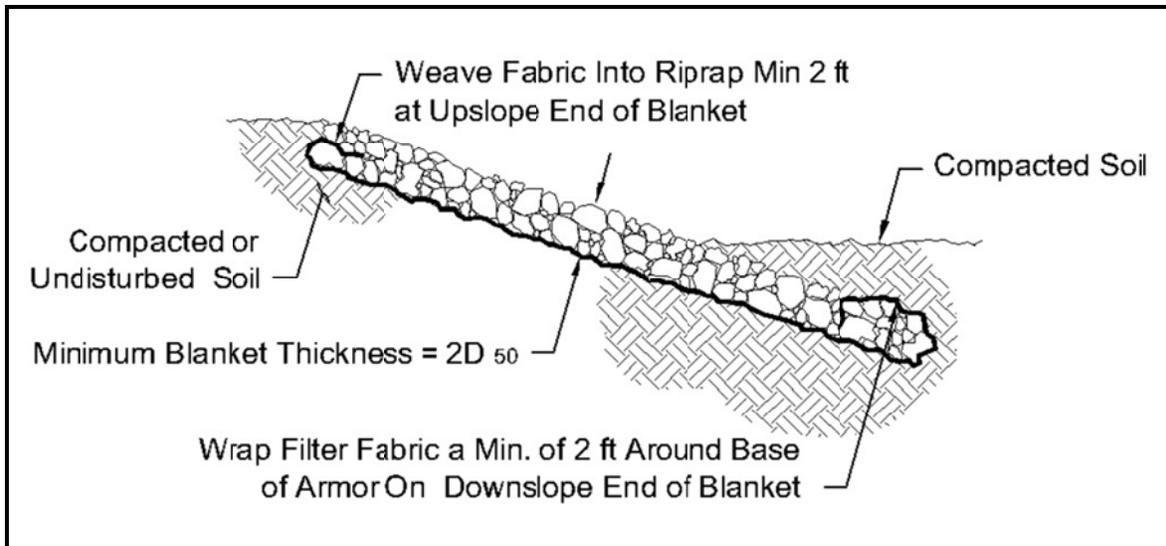


Figure 4.4 Riprap Blanket with Filter Fabric End Treatment

- d. Grouted riprap shall be placed on a grout bed at least 6 inches thick. Stones shall be hard, durable and hand-embedded into the grout bed to a minimum depth of one-half the grout depth.
3. When a retaining wall is proposed as a basin side slope, stability design for the retaining wall shall be provided with the Development Plan or Tentative Plat. A detail, accompanied by a report clearly stating the assumptions about all soil parameters under saturated conditions, shall be provided and sealed by an Arizona registrant.
4. When hydroseed is used as slope treatment the seed mix shall have plant species from the Approved Plant List provided in Appendix B of the Pima County Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines available at http://rfcd.pima.gov/wrd/riparian/pdfs/revised_guidelines_jan2010.pdf.

4.7.2 Side Slope Maintenance Requirements

1. Inspections shall occur annually and after storm events to ensure that slope treatment has not been damaged by settling, vegetation, erosion, or other causes.
2. Should damage be observed, basin side slopes shall be restored to design specifications.
3. When slope treatment is dumped riprap, the treatment shall be repaired when foundation soil is lost or filter fabric is exposed.
4. Filter fabric that has migrated under the dumped rock riprap layer or has tears or holes shall be restored to design specifications.

5. Grouted riprap side slopes shall be restored to design specifications when foundation soil is lost.
6. Retaining walls shall be restored to design specifications when signs of tipping, clogged weep holes or soil subsidence are observed.

4.7.3 Side Slope Prohibitions

1. Free-standing walls are not allowed as a basin side, without prior approval of the Floodplain Administrator.
2. Retaining walls greater than 4 feet measured from the top of the footing are not allowed as a basin side, unless prior approval is obtained from the Floodplain Administrator.
3. Riprap that consists of rock that is not hard and durable is not allowed.
4. Invasive non-native plants located on a basin side slope are not allowed. A list of the invasive non-native plants can be found in Appendix E of the Pima County Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines available at: http://rfcd.pima.gov/wrd/riparian/pdfs/revised_guidelines_jan2010.pdf.

4.8 Inlet Structures

4.8.1 Inlet Structure Standards

1. The capacity of an inlet structure shall be determined by methods provided in:
 - a. *Drainage and Channel Design Standards for Local Drainage for Flood Plain Management within Pima County, Arizona,*
 - b. *The City of Tucson Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona,* or
 - c. Other methods accepted by the Floodplain Administrator.
2. When flow crosses a sidewalk or other paved pedestrian pathway, a scupper or other conveyance to prohibit overtopping of the 10-year design discharge shall be used. Inlets shall not direct flow over a decomposed granite or other erodible pedestrian pathway.
3. When pipes are used as an inlet, the minimum size allowed is 12 inches.
4. Inlets shall have erosion protection with dimensions determined by the methods provided in the:
 - a. *Drainage and Channel Design Standards for Local Drainage for Flood Plain Management within Pima County, Arizona,*

- b. The *City of Tucson Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona*,
 - c. *Federal Highway Administration, Hydraulic Engineer Circular No. 14; HEC-14*, or
 - d. Other methods accepted by the Floodplain Administrator.
5. The erosion protection shall extend below the finished grade of the basin floor and/or side slope to the appropriate design depth. The surface of the erosion protection shall be level with the finished grade.
 6. Unless grouted, rock riprap shall be underlain with filter fabric. The filter fabric shall be woven for a minimum of 2 feet into the upslope end of the blanket and wrapped for a minimum of 2 feet around the riprap base of the blanket on the down-slope end as shown in Figure 4.4.

Photo 4.1 shows a basin inlet in service which does not exhibit degradation of the basin slopes or floor near the inlet, indicating that an adequate riprap transition was provided. The standards in this manual attempt to provide guidance for designs which will remain well-maintained during the project life.

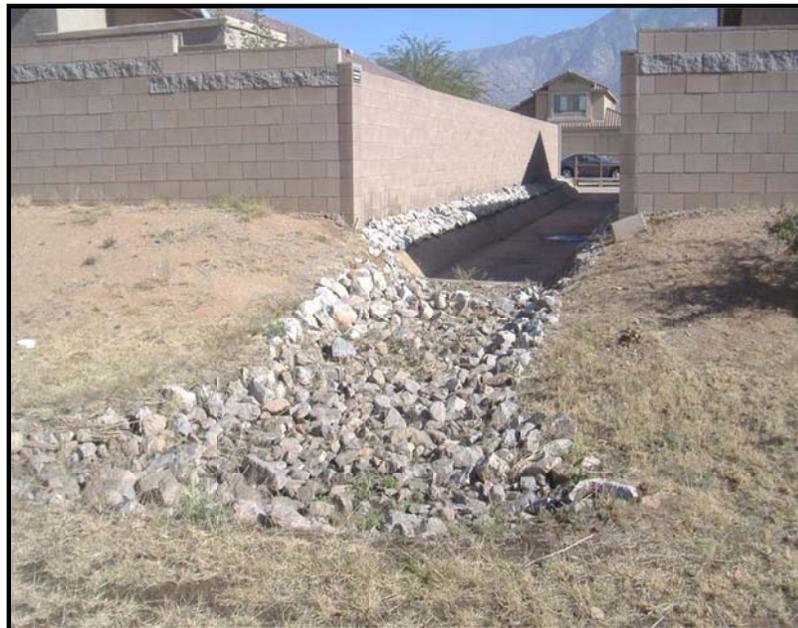


Photo 4.1 Basin Inlet with Riprap Protection

Photo 4.2 illustrates inadequate riprap placement resulting in erosion extending away from the basin inlet erosion protection.



Photo 4.2 Basin Inlet with Inadequate Riprap Placement

4.8.2 Inlet Structure Maintenance Requirements

1. Inspections shall occur annually and after storm events to ensure the inlet is free of obstructions and not damaged.
2. Should obstructions or damage be observed, inlets shall be restored to design specifications.

4.8.3 Inlet Structure Prohibitions

1. Inlets shall not direct flow through a handicap accessible ramp or handicap parking space.
2. Water exceeding 12 inches in depth at an inlet located in a vehicular use area is prohibited.

4.9 Outlet Structures

4.9.1 Outlet Structure Standards

1. Outlets shall be designed to ensure that flows exiting the project boundary are compatible with the existing downstream drainage conditions and will not have an adverse impact on surrounding properties.

2. Outlets shall be designed to release flow from the basin at rates that do not exceed the 2-, 10- and 100-year pre-development peak discharge rates as determined by the methods specified in Chapter 3 of this manual. Illustrations of outlet structures indicating that outlets must be designed for 3 design storms are shown in Figures 4.5 and 4.6 and Photo 4.3. The examples are illustrative only and not intended to be proposed or required designs.

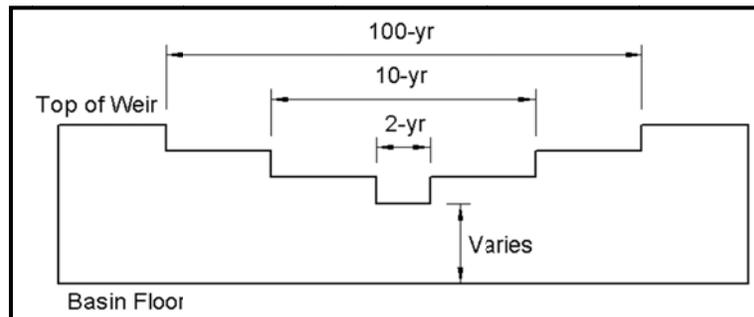
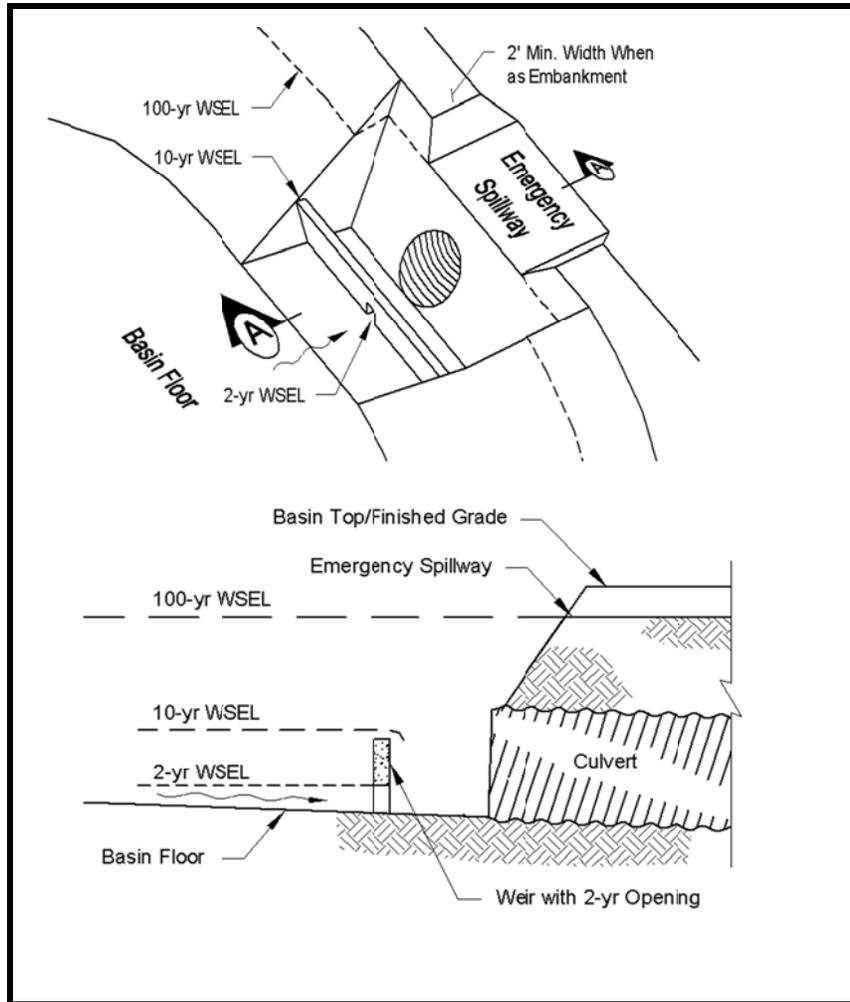


Figure 4.5 Multi-Level Weir Outlet for the 2-, 10-, and 100-year Storm



Cross Section A-A

Figure 4.6 Combination Weir – Culvert Outlet



Photo 4.3 Combination Weir Box

3. The capacity of outlet structures shall be determined using methods provided in:
 - a. *Drainage and Channel Design Standards for Local Drainage for Flood Plain Management within Pima County, Arizona,*
 - b. *The City of Tucson Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona,* or
 - c. Other methods accepted by the Floodplain Administrator.
4. Outlets which direct flow to a sidewalk or other paved pedestrian pathway shall include a scupper or other conveyance to prevent sidewalk or pathway overtopping by the 10-year design discharge. Outlets shall not direct flow over a decomposed granite or other erodible pedestrian pathway.
5. Outlets shall have erosion protection with dimensions determined by the methods provided in:
 - a. *Drainage and Channel Design Standards for Local Drainage for Flood Plain Management within Pima County, Arizona,*
 - b. *Federal Highway Administration, Hydraulic Engineer Circular No. 14; HEC-14,* or
 - c. Other methods accepted by the District.
6. The erosion protection shall be placed beneath the finished grade of the downstream side of the outlet to the appropriate design depth. The surface of the erosion protection shall be level with the finished grade.
7. Unless grouted, rock riprap shall be underlain with filter fabric. The filter fabric shall be woven a minimum of 2 feet into the upslope end of the blanket and wrapped for a minimum of 2 feet around the riprap base of the blanket on the down-slope end as shown in Figure 4.4.

4.9.2 Outlet Structure Maintenance Requirements

1. Inspections shall occur annually and after storm events to ensure the outlet and all components are free of obstructions and not damaged.
2. Should obstructions or damage be observed, outlets shall be restored to design specifications.

4.9.3 Outlet Structure Prohibition

1. Outlets shall not direct flow to a handicap accessible ramp or handicap parking space.

4.10 Embankments

An embankment, for the purposes of this manual, is a side of a detention basin constructed above natural grade. A typical embankment is illustrated in Photo 4.4.



Photo 4.4 Embankment in a Residential Subdivision Basin

4.10.1 Embankment Standards

1. When site constraints prevent a basin from being constructed entirely below grade, an embankment is allowed. Site constraints include topography, existing infrastructure and conflicting code requirements.
2. When an embankment is proposed, the applicant shall include an embankment section in the Drainage Report describing at least the following:
 - a. The physical environment downstream of the embankment, such as natural drainage paths, drainage infrastructure, developed property, and distance to property boundary;
 - b. Expected flow conditions in the event of embankment failure; and
 - c. Possible effects to public safety and property in the event of embankment failure.
3. Embankments shall have a top width of the 100-year ponding depth or 2 feet, whichever is greater.
4. Embankments shall have at least 1 foot of freeboard above the 100-year water surface elevation in the basin.

5. Embankments shall be compacted to at least 95% of Standard Proctor density.
6. A minimum of 6 inches, or depth recommended by an engineer registered in the State of Arizona, of in-situ soil beneath the embankment base shall be excavated prior to embankment construction.
7. When an outlet is placed through an embankment, an anti-seep collar or equal, shall be provided as specified by an Arizona registered engineer.
8. To allow maintenance access, a minimum 4-foot setback from the outer toes of embankments (not including outlet protection) to the project boundary shall be provided, unless:
 - a. a greater setback is required to comply with Section 4.3.1.2, or
 - b. other adequate access space exists adjacent to the basin, such as right-of-way.

Width, spillway and setback measurement are illustrated in Figure 4.7.

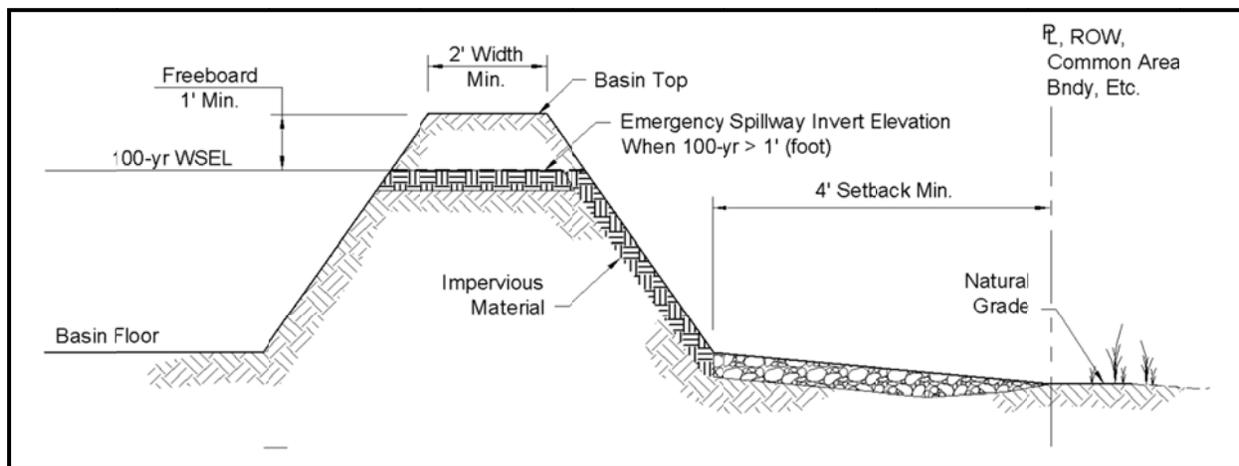


Figure 4.7 Embankment Requirements

9. When embankments are designed to impound greater than 1 foot of water,
 - a. An emergency spillway shall be provided,
 - b. The emergency spillway invert elevation shall be at the 100-year water surface elevation,
 - c. The invert and the downstream side of the emergency spillway, as shown in Figure 4.7, shall be constructed of impervious material,
 - d. The design capacity of the emergency spillway shall be the pre-developed 100-year peak discharge outflow rate. The outlet will not be included in the routing because it is at the 100-year water surface elevation which is the highest water surface elevation used for routing,

- e. The location of the emergency spillway shall not create any adverse impact to surrounding properties.
10. When an embankment is located within an erosion hazard setback or regulatory sheet flood area, an engineering analysis shall be provided to determine erosion protection requirements which will protect the embankment from lateral migration of the watercourse.
11. A covenant which specifies, or Conditions, Covenants and Restrictions (CCR's) which include, inspection and maintenance responsibilities shall be recorded when a basin includes an embankment. An example covenant can be found in Appendix A. The covenant or CCR's shall be reviewed and approved prior to approval of the Development Plan or Final Plat. Properly executed covenants shall be provided to the District for recording prior to approval of the Development Plan or Final Plat.

4.10.2 Embankment Maintenance Requirements

1. Inspections shall be conducted annually and after storm events to ensure the embankment is not damaged due to erosion, piping, sliding, settling or other causes.
2. If damage to an embankment is observed, the embankment shall be restored to the design specifications.

4.10.3 Embankment Prohibition

1. Embankments that are classified as dams pursuant to Arizona Revised Statutes §45-1201 are prohibited.

4.11 Security Barrier

4.11.1 Security Barrier Standards

1. Basins designed for 100-year water depths of more than 2 feet and with side slopes steeper than 4:1 shall have a security barrier at all locations where side slopes are steeper than 4:1.
2. Security barrier shall be a minimum of 42 inches high.
3. The security barrier shall consist of metal, masonry or a combination of the two, meeting the minimum standards in the latest edition of the *City of Tucson/Pima County Standard Details for Public Improvements*.

4. When 100-year water depths exceed 2 feet and pedestrian circulation occurs within 5 feet of the top of a basin, a security barrier shall be constructed. Pedestrian circulation includes ingress/egress to structures, sidewalks, parking or other accessory structures.
5. When vehicle maintenance access is required, a gate or bollards shall be provided at the appropriate location.

4.11.2 Security Barrier Maintenance Requirements

1. Inspections shall be conducted annually to ensure the security barrier and surrounding grade are not damaged to the extent that the security of the basin is compromised.
2. If compromising damage is observed, the security barrier shall be restored to design specifications.

4.11.3 Security Barrier Prohibitions

1. The use of vegetation as a security barrier is prohibited.
2. Security barriers shall not restrict the hydraulic capacity of basin inlet and outlet structures.

4.12 Perimeter Walls

4.12.1 Perimeter Wall Standards

1. When perimeter walls have openings that allow flow to enter into a basin, erosion protection that meets the minimum standards of Section 4.8 shall be provided.
2. When a wall is proposed within 5 feet of the horizontal location of the 100-year water depth, a report from an engineer registered in the State of Arizona shall be provided prior to approval of the Improvement Plan that contains at least the following:
 - a. The appropriate minimum setback from the top of slope, and
 - b. Specific structural design requirements with details.

4.12.2 Perimeter Wall Maintenance Requirements

1. Inspections shall occur annually to ensure the perimeter wall and/or erosion at wall openings are not adversely impacting the basin.
2. If adverse impacts are identified, the basin and/or wall shall be restored to the design specifications.

4.12.3 Perimeter Wall Prohibitions

1. Perimeter walls shall not block maintenance access.
2. Perimeter walls shall not restrict the hydraulic capacity of inlet or outlet structures.

Perimeter walls are not allowed on embankments.

4.13 Underground Storage

4.13.1 Underground Storage Standards

1. Where underground storage is proposed, failure or blockage of the system shall not pose a hazard to public safety or property. Design considerations include underground storage location and emergency flow conveyance.
2. All stormwater collected during a storm event shall be removed within the disposal time specified in Section 4.5.
3. Underground storage shall have inlets and outlets which meet the design standards found in Sections 4.8, 4.9 and 4.16.
4. Underground storage systems shall provide 1.5 times the required 100-year detention volume.
5. To provide for safe discharge of flow when the volume of an underground storage system is exceeded, an overflow outlet shall be provided which discharges to a drainage path which can convey flow away from structures, electrical equipment, pedestrian pathways, handicap-accessible ramps, hazardous materials, and other areas where stormwater is likely to create damage to health, welfare or property.
6. A recorded covenant which specifies inspection and maintenance responsibilities is required for an underground storage system. An example covenant can be found in Appendix A. The covenant shall be recorded prior to approval of the Development Plan or Final Plat, and the Sequence No. shall be provided on the Development Plan or Plat adjacent to the underground storage location on the plan view.
7. Prior to approval of the Tentative Plat or Development Plan, a report from an engineer registered in the State of Arizona shall be provided that contains at least the following:
 - a. Appropriate building setbacks from the underground storage system related to structural integrity,
 - b. Certification that the load bearing capacity of the soils underlying the underground storage structure is adequate and the soil complex is appropriate bed material,

- c. Structural design details, and
- d. Other design recommendations if appropriate.

4.13.2 Underground Storage Maintenance Requirements

1. Inspections shall occur annually and after storm events to ensure the underground storage system is not damaged and is functioning as designed. Sufficient access for inspection shall be provided.
2. When an inspection reveals any of the following, the underground storage system shall be restored to design specifications:
 - a. Seepage, settlement, cracking, signs of improper joint alignment or displacement of joints,
 - b. Sediment accumulation, and
 - c. Damage to or malfunction of pumps, valves, sumps, piping, manifolds or appurtenances.

4.14 Setbacks

4.14.1 Setback Standards

1. For maintenance access, a minimum 4-foot setback from basins and appurtenances, including basin outlets, outer toes of embankments, to the project boundary or to the limit of other access space shall be provided.
2. Because soil bearing capacity within a potential zone of saturation may be reduced, structures shall be setback at least 15 feet from a basin, unless an appropriate alternative setback is justified by an engineer registered in the State of Arizona prior to approval of the Tentative Plat or Development Plan.
3. When a wall is proposed within 5 feet of the horizontal location of the 100-year water surface elevation, a report from an engineer registered in the State of Arizona shall be provided prior to approval of the Improvement Plan that contains at least the following:
 - a. The appropriate setback, and
 - b. Specific structural design requirements with details.

4.14.2 Setback Prohibition

1. Structures, walls, or other obstructions are prohibited within maintenance access setbacks.

4.15 Elevation Requirements

1. Any electrical equipment, excluding submersible pumps, within the basin shall be elevated 1 foot above the 100-year water surface elevation of the basin, unless an engineer registered in the State of Arizona certifies that the electrical equipment when inundated does not pose any hazard to public health or safety.

4.15.1 Elevation Maintenance Requirements

1. Electrical equipment shall be inspected annually and maintained to ensure the 1-foot elevation above the 100-year water surface has not been reduced.

4.16 Maintenance Access

4.16.1 Maintenance Access Standards

1. Maintenance access is required for all basins, and the access must be shown on the plans and described in the project drainage report.
2. In order to provide maintenance access, a minimum 4-foot setback from basins and appurtenances, outer toes of embankments, to the project boundary or to the limit of other access space, such as right-of-way, shall be provided. An example of a setback from a property line is shown in Figure 4.1.

4.16.2 Maintenance Access Maintenance Requirements

1. Inspections shall be conducted annually and after storm events to ensure access to the basin is not compromised.

4.16.3 Maintenance Access Prohibition

1. Obstruction of maintenance access or a maintenance access ramp is prohibited.

4.17 Landscaping Other Than Riparian Habitat Mitigation

4.17.1 Landscaping Standards

1. Vegetation may be planted on a basin floor or on a basin side slope that is 3:1 or flatter except in areas within a 20-foot radius of the basin inlet, outlet or maintenance access ramp. Plants on the perimeter of a basin shall not obstruct drainage entering or exiting the basin.
2. Plants which can withstand inundation shall be selected.
3. Plants shall be spaced to allow access for maintenance.

4. Trees located adjacent to a required security barrier shall be placed an appropriate distance from the barrier to assure that the tree at maturity does not reduce the structural integrity of the security barrier.
5. Hydroseeding is allowed on the basin floor and 3:1 or flatter side slopes. Plant species used in the seed mix shall be selected from the Approved Plant List provided in Appendix B of the Pima County Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines available at:
<http://rfcd.pima.gov/wrd/riparian/guidelines/pdfs/onsite-guidelines.pdf>.

4.17.2 Landscaping Maintenance Requirements

1. Inspections shall occur annually and after storm events to ensure that landscaping has not impacted basin function.
2. If damage is observed, the basin shall be restored to design specifications.
3. Invasive non-native plants shall be removed. A list of the invasive non-native plants can be found in Appendix E of the Pima County Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines available at:
<http://rfcd.pima.gov/wrd/riparian/guidelines/pdfs/onsite-guidelines.pdf>.
4. Any vegetation or debris within the 20-foot radius described in Section 4.18.1. shall be removed.

4.17.3 Landscaping Prohibitions

1. Any vegetation within the 20-foot radius described in Section 4.18.1 is prohibited.
2. Landscaping shall not be located within maintenance access ramps.
3. The use of decomposed granite or rock less than 4 inches in diameter on the basin floor is prohibited, except paths within multi-use basins.
4. Invasive non-native plants located within a basin are not allowed, except turf grass within multi-use basins.

4.18 Pumps

4.18.1 Pump Standards

1. The use of a pump may be allowed if site constraints prevent the basin from having positive drainage. Site constraints may include topography, existing infrastructure and

conflicting code requirements. Approval to use a pump shall be obtained from the Floodplain Administrator prior to the first submittal of the Tentative Plat or Development Plan.

2. If a pump is proposed, the detention system shall provide an emergency spillway directed to a local watercourse that does not cause an adverse impact to the watercourse or neighboring properties and one of the following:
 - a. Additional basin volume to contain the entire volume of the 100-year post-developed hydrograph from the drainage area contributing to the basin, or
 - b. A back-up pump with an emergency power source. If an emergency back-up generator is proposed, the generator shall be elevated 1 foot above the 100-year water surface considering total pump failure or shall be waterproofed.
3. Service equipment (excluding components whose design requires submersion) shall be set at an elevation 1 foot above the unattenuated 100-year water surface elevation, considering total failure of the pump system.
4. Outlets shall be designed to meet the requirements found in Section 4.9.
5. Pumps shall be in an accessible location for routine maintenance and emergency service.
6. Basins with a pump shall meet the storage time standards found in Section 4.5.
7. The pump's discharge rate shall not exceed the pre-developed conditions 2-year peak discharge rate.
8. The collection system shall discharge into a separate sump that screens the water before entering the pump sump. The sump location and dimensions shall be shown on the plan set.
9. A clogging factor of 2.0 shall be used for the trash rack/screen design.
10. The pump shall be designed to pass 3-inch solids.
11. A pump shall be provided with an automatic control switch with a vertical float mechanism as well as a manual control.
12. A potable water supply with hose bibs shall be provided to aid in removal of silt and trash.
13. Each pump shall have an alarm system for high water and low water alarm with, at minimum, the following:
 - a. A light that provides a visual alert,

- b. The name and phone number of a responsible party clearly displayed on the pump housing and alarm system,
 - c. Housing that is vandal proof and weather resistant, and
 - d. Other Floodplain Administrator recommendations as appropriate.
14. A recorded covenant which specifies inspection and maintenance responsibilities is required when a pump is used as a method of stormwater disposal. An example covenant can be found in Appendix A. The covenant shall be recorded prior to approval of the Development Plan or Final Plat, and the Sequence No. shall be provided on the Development Plan or Plat adjacent to the pump location on the plan view.
15. The project's Drainage Report shall provide the following information:
- a. Emergency back-up plan,
 - b. Drainage exhibit showing drainage flow under clogged conditions,
 - c. Maintenance Plan with at minimum the following:
 - i. Maintenance schedule,
 - ii. Type of maintenance activities,
 - iii. Exhibit showing the location of the pump, alarm systems and other equipment, and
 - iv. Copy of the covenant.
16. A pump system analysis shall be submitted for Floodplain Administrator review and approval with the Tentative Plat or Development Plan. The analysis shall include:
- a. Site Data
 - i. Contributing drainage area(s),
 - ii. Location of outfall,
 - iii. Capacity of outfall, and
 - iv. Inflow hydrograph(s).
 - b. Pump System Components
 - i. Specifications for the model and type of pump(s) proposed including pump curves (single pump and parallel operation). Overloading the pump anywhere on the pump curve is not permitted,
 - ii. Location and specifications for intakes and catch basins,
 - iii. Controls and alarm system,
 - iv. Debris handling,
 - v. Location of potable water supply, and
 - vi. Location and design of emergency overflow.
 - c. Hydrologic/Hydraulic Analysis
 - i. Headloss calculations for the entire system, including maximum and minimum Total Dynamic Head (TDH) and flow rate,
 - ii. Net positive suction head (NPSH) and pump level settings for on, off and alarm positions, and
 - iii. Inflow and outflow hydrographs and accumulated inflow and outflow curves (mass flow curves). The use of HEC-HMS is not appropriate for the

design of pump systems. A real-time procedure which routes the design inflow hydrograph using pump on and off elevations and actual pump performance curves must be used.

4.18.2 Pump Maintenance Requirements

1. Inspections shall be conducted annually, after storm events and after the alarm system is activated to ensure the pump is not damaged and is functioning as designed.
2. Prior to the summer and winter rainy seasons, the pump, back-up system and alarm system shall be operated to ensure the system is functioning as designed.
3. If damage/malfunction is observed, the system shall be restored to design specifications.
4. Trash and debris shall be removed from the pump system and properly disposed.
5. The site layout shall consider adequate access for maintenance vehicles and removal of equipment for repair.

4.19 Dry Wells

4.19.1 Dry Well Standards

1. When site constraints justify use of a dry well or dry wells to dispose of detention volume, approval to include a dry well or dry wells in basin design shall be obtained from the Floodplain Administrator prior to the first submittal of the Tentative Plat or Development Plan. When requesting the approval, the engineer must submit field investigation results and a preliminary site plan.
 - a. The field investigations shall include:
 - i. Logs for soil borings to the anticipated depth of the dry well,
 - ii. Determination of depth to groundwater in the proposed locations of dry wells, and
 - iii. A percolation testing report by an Arizona registered engineer. The percolation testing report shall include the testing methods and results.
 - b. The preliminary site plan shall include at minimum:
 - i. The location of the proposed dry well(s) and test well(s),
 - ii. The location of the proposed structure(s) with the building footprint,
 - iii. Parking lot layout including pedestrian circulation, and
 - iv. The general drainage scheme.

Where dry wells are proposed as the sole method of outflow, the basin shall be designed to retain the total of the 100-year storm.

2. Where a dry well is proposed, failure of the system shall not pose a hazard to public safety or property.
3. Dry wells shall be registered with the Arizona Department of Environmental Quality (ADEQ) and designed, operated, and maintained in conformance with the most current ADEQ guidelines.
4. To obtain percolation rates to use in the design of the dry well(s) a percolation test shall be performed to determine a stabilized infiltration rate.
5. Test results shall be de-rated, using Equation 4.1, based on the in-situ soil conditions. De-rating is required to compensate for deterioration of the percolation capacity over time and to provide a factor of safety for silting and grate obstruction

$$\text{Equation 4.1} \quad P_d = \frac{P_r}{D_r}$$

Where:

- P_d = the design percolation rate in inches/hour,
 P_r = the measured stabilized percolation rate in inches/hour, and
 D_r = the de-rating factor.

- a. The following de-rating factors shall be used:
 - i. A de-rating factor of 2 for coarse-grained soils (cobbles, gravels and sands),
 - ii. A de-rating factor of 3 for fine grained soils (silts and loams), and
 - iii. A de-rating factor of 5 for clay soils.
 - b. The design disposal rate for a dry well, after application of the de-rating factor, should not be less than 0.1 cfs per well nor more than 0.5 cfs. Upon approval of performance, adjusted as presented above, a test well may then be used as one of the functioning dry wells for the project.
 - c. Drywells not performing to the original design standards shall be refurbished or replaced by the owner or a representative.
6. Dry wells shall be located into a permeable porous stratum to provide a minimum distance of 10 feet between the water table or an impermeable layer and the base of the injection screen and shall be a minimum distance of 100 feet from any water supply well.
 7. When dry wells are proposed, the basin floor shall be sloped to the dry wells at a minimum of 0.5% to assure that all wells are utilized for lower water levels.

8. Multiple drywells shall be spaced a minimum of 100 feet apart.
9. A dry well shall be located a minimum of 20 feet from the basin inlet.
10. If landscaping is proposed on the basin floor, the dry well inlet shall be raised 3 inches above the basin bottom elevation.
11. The dry well location shall be in an accessible location for routine maintenance and inspection and shall be protected from damage by vehicles.
12. The design of a dry well shall include provisions for trapping sediment within a settling chamber.
13. The system shall use a floating absorbent blanket or pillow to enhance the removal of petroleum-based organics floating on the water, and a hydrophobic petrochemical absorbent with a minimum capacity of 100 ounces per chamber shall be provided.
14. During site development, 1 dry well per basin shall be tested. All dry wells shall be securely covered with filter cloth or other material to prevent silt infiltration during construction. Prior to Release of Assurances for plats and prior to Certificate of Occupancy for development plans, dry wells shall be re-tested if a dry well has been compromised during construction. If the re-test indicates reduced dry well performance, the dry well shall be restored to design specifications prior to Release of Assurances for plats or prior to Certificate of Occupancy for development plans.
15. Landscaping shall be installed a minimum of 4 feet from the perimeter of the bolted ring and grate.
16. The words "Stormwater Only" shall be stamped in raised letters on the drywell grate.
17. A recorded covenant which specifies inspection and maintenance responsibilities is required when a dry well is used as a method of stormwater disposal. An example covenant can be found in Appendix A. The covenant shall be recorded prior to approval of the Development Plan or Final Plat, and the Sequence No. shall be provided on the Development Plan or Plat adjacent to the dry well location on the plan view.
18. A typical drywell installation is shown in Figure 4.8.

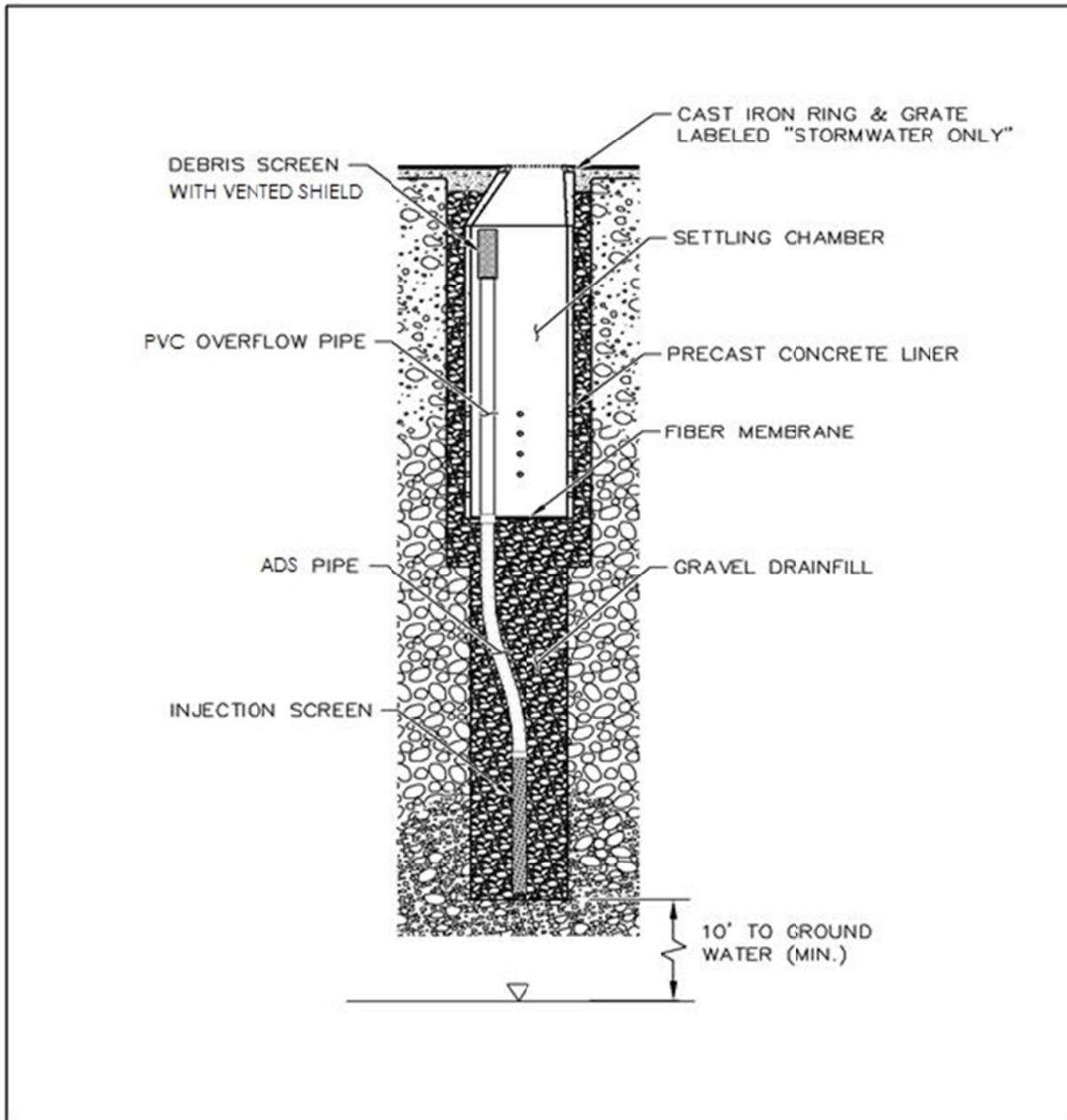


Figure 4.8 Typical Dry Well Installation

19. The project's Drainage Report shall provide the following information:
 - a. Plan for emergency stormwater disposal in the event the drywell(s) cease(s) to function,
 - b. Maintenance Plan with at minimum the following:
 - i. Maintenance schedule,
 - ii. Type of maintenance activities,
 - iii. Exhibit showing the location(s) of the drywell(s),

- Contact information of the driller or authorized maintenance professional,
and
iv. A copy of the covenant.

4.19.2 Dry Well Maintenance Requirements

1. Inspections shall be conducted annually and after storm events to ensure the dry well and settling chamber are functioning as designed.
2. If an inspection identifies that the dry well is not infiltrating within the storage limits outlined in Section 4.5.1, or other damage or maintenance requirements are identified, the maintenance shall be performed to restore the dry well(s) to design specifications.
3. Accumulated debris, weeds and trash shall be removed from the surface.
4. Sediment shall be removed from the settling chamber when approximately 50% of the original volume of the chamber is filled.
5. All sediment removed from a settling chamber shall be disposed of at an authorized sanitary landfill.
6. Maintenance requirements shall be provided in the restrictive covenants for subdivisions where dry wells are used.

4.19.3 Dry Well Prohibitions

1. Disposal methods using infiltration shall not be permitted for stormwater runoff which carries significant concentrations of sediment. This includes stormwater runoff flowing through sand bed channels, as well as stormwater runoff emanating from a predominantly natural watershed.
2. Dry wells are prohibited for industrial developments and other areas where hazardous waterborne pollutants may enter a dry well.
3. In multi-use basins, dry well inlets shall not pose a hazard to pedestrian safety.
4. Landscaping shall not impair dry well function.