

Section 1200

Detention

1201 INTRODUCTION

The main purpose of a detention basin is to temporarily store runoff and reduce peak discharge by allowing flow to be discharged at a controlled rate. This controlled discharge rate is based on either limited downstream capacity (regional and local facilities) or on a limit on the increase in flows over pre-development conditions (local facilities only). Regional and local detention facilities are more fully discussed below. CCRFCD Policy regarding detention basin design is presented in the "Policy" Section 303.7.

1201.1 Definition of Regional Facilities

Regional detention facilities are those identified in the current flood control master plan of the CCRFCD. Generally, these facilities control flow on major washes, are of major proportion, and are funded in large part by the CCRFCD. The purpose of these facilities is to significantly reduce downstream flows, not to return the flows to pre-development levels.

1201.2 Definition of Local Facilities

Local detention facilities are usually designed by and financed by developers or local property owners or local entities. The facilities are intended to allow development by protecting a site from existing flooding conditions or to protect downstream property from increased runoff caused by development. Two classes of local facilities are defined below.

1201.2.1 Local Minor Facilities

Local minor detention facilities are defined as serving hydrologic basins -smaller than or equal to 20 acres, and are designed to mitigate the impact of increased runoff due to development. The outlet capacity is based on pre-development hydrology and downstream conveyance system capacity and the structures are generally small (0.01 to 1 acre-feet). Detention storage volume may be provided as small landscaped or turfed basins, parking lot storage, roof top storage, or a suitable combination of all three.

1201.2.2 Local Major Facilities

1. Local major detention facilities are defined as serving hydrologic basins greater than 20 acres. These facilities may serve a double function. They are required to reduce existing flooding to allow development and/or control increased runoff caused by the development. These facilities may store significant flood volumes and will generally be funded by the

developer. They may handle both off-site and on-site flows. Due to their considerable size, these basins are designed much the same as regional facilities.

1202 DETENTION/RETENTION DESIGN GUIDELINES AND STANDARDS

Certain guidelines for detention basin design need to be identified in order to properly design facilities. These guidelines cover items such as outlet flows, spillway sizing, and sedimentation. The following sections describe major guidelines governing detention basin designs.

1202.1 Regional Detention

The design of regional detention facilities will be coordinated with the CCRFCD. Also, as mentioned in Section 1206.1, the Nevada State Engineer must review detention basins which require dams having embankments greater than 20 feet in height or impounding over 20 acre-feet of water. Regional detention guidelines include:

1. Regional detention basins are preferred to smaller local detention basins.
2. Off-channel detention basins are preferred.
3. Multi-use (e.g., recreation) can be considered in the design of detention basins.
4. Below-grade detention basins are preferred to above-grade facilities.
5. Basins should be sited on publicly-owned lands whenever possible.

Regional Detention Standards include:

1. Detention basin outlet capacity shall be based on the downstream channel capacities (existing or Master Planned) with consideration given to inflows occurring below the detention basin.
2. All detention basins are required to properly function under all debris and sedimentation conditions.
3. In-channel detention basins typically will be required to safely pass the PMF discharge as a minimum. HMR 49 (1977) shall be used to calculate PMF flows.
4. Detention ponds shall be designed to include provisions for security/public safety.

5. Basins should be drained in not more than 7 days with the preferred standard drain time set at 24 hours. (Drain time is defined as the time from the end of precipitation until the basin is drained of 90 percent of design capacity.)
6. A minimum of 1 foot of freeboard is required above the emergency spillway design water surface elevation. (See **Figure 1201.**)
7. Basins shall be self-regulating (passive).
8. Dams greater than 20 feet in height or impounding more than 20 acre-feet of water must be approved by the State Engineer.
9. Inflows shall be based on ultimate development conditions and Master Planned tributary area.
10. Design of all detention basins shall include emergency spillways.
11. Embankment protection will be considered for each basin.

1202.2 Local Detention

Since the functions of local minor and local major detention facilities are different, the development guidelines for each are described separately below:

1202.2.1 Local Minor Detention

Local minor detention may be required for developments in hydrologic basins of less than 20 acres in size. The need for local minor detention is based on analysis of downstream conveyance (e.g., street or storm sewer system capacity) and/or pre- and post-development hydrology.

Local Minor Detention Guidelines include:

1. Public safety should be paramount in all designs.
2. Accommodation of debris and sedimentation should be considered in all designs.

Local Minor Detention Standards include:

1. Post-development peak discharges must not exceed pre-development discharges if downstream facilities lack adequate capacity to handle the increased flow rates.
2. Basins must drain completely in less than 24 hours.

3. A minimum 1 foot of freeboard is required above the major design storm water surface elevation.

1202.2.2 Local Major Detention

Local major detention (typical storage > 1 .0 acre-feet) may be required in accordance with Section 303.7 or where upstream off-site flows must be intercepted and controlled to protect the development. Design of such basins should be coordinated with the local entity.

Local Major Detention Guidelines include:

1. Off-channel detention basins are preferred.
2. All basins are required to properly function under debris and sedimentation conditions. Adequate access must be provided for the necessary equipment to periodically remove accumulated sediment and debris.
3. Multi-use (e.g., recreation) can be considered for all detention basins.
4. Below-grade detention basins are preferred to above-grade detention basins.

Local Major Detention Standards include:

1. Detention basin outlet capacity will be based on either (a) downstream conveyance system capacities with consideration given to inflows below the detention basin or (b) pre- and post-development hydrology.
2. Detention basins shall be drained in not more than 3 days with the preferred drain time set at 24 hours.
3. A minimum of 1 foot of freeboard will be required above emergency spillway design water surface elevation or as required by the State Engineer.
4. Detention basins will be passive.
5. Emergency outlets will be incorporated on all detention basins.

1202.2.3 Local Minor Retention

Local minor retention may be required for containing stormwater in the event downstream conveyance is unavailable or detention is infeasible. The purpose of a retention basin is to temporarily store runoff and allow for infiltration into the underlying soils. Local minor retention basins are defined as serving hydrologic

basins smaller than or equal to 20 acres. Local major retention basins are not recommended.

Local Minor Retention Guidelines include:

1. Public Safety should be paramount in all designs.
2. Flat terrain is the preferred location for a retention basin.
3. The basin shall be below-ground and have dimensions that maximize infiltration.
4. Soil permeability shall be determined in the soil layer with the minimum permeability.
5. Soil shall have a permeability equal to **or** greater than 1-inch per hour.
6. Soil permeability should be determined using percolation or "Perk" tests used to design septic systems or equivalent.
7. The depth of bedrock and/or groundwater shall be a minimum of 5 feet below the design bottom elevation of the basin at all times.
 - a. The basin shall be designed to allow bypassing of the peak runoff in the event the facility clogs. This bypass can be provided by overland relief.
9. Accommodation of debris and sedimentation should be considered in the design.
10. The basin shall be designed to contain the volume of runoff generated by the peak discharge and the volume of sediment accumulated in a three year period.
11. Designs should be based on ultimate development conditions.
12. Erosion protection shall be considered for side slopes and inlet works.
13. Adequate access must be provided for the necessary equipment to periodically remove accumulated sediment and debris.
14. Designs shall include an analysis of groundwater effects of the completed and operating basin on the surrounding groundwater levels, since change in the groundwater could adversely impact neighboring facilities including basements, septic systems and existing wells.
15. Permanent structures such as buildings and roads and other surcharge loads shall be located a safe distance away from the basin.

1203 HYDROLOGIC DESIGN METHODS AND CRITERIA

The hydrologic design of detention facilities is based on the type of facility (regional versus local) and the method used to estimate the runoff (HEC-1 and SCS TR-55 versus Rational Method). If HEC-1 or SCS TR-55 is used, a full hydrograph is available for traditional storage routing (Section 1203.3.1). If the Rational Method is used, a simplified triangular procedure has been developed as described below.

1203.1 Inflow Hydrograph

The determination of required detention storage is based on volume calculations derived from the inflow hydrograph, along with the maximum outlet flow. The inflow hydrograph shall be based on ultimate development conditions.

1203.1.1 HEC-1 Method

The hydrograph for local and regional facilities may be calculated using HEC-1 or SCS TR-55 (Section 600). HEC-1 or SCS TR-55 can calculate a hydrograph for any location in the hydrologic basin. The HEC-1 data input file must be structured so that the proposed detention basin site is a hydrograph routing or hydrograph combining point. For specific model input format, see the HEC-1 User's Manual.

1203.1.2 Modified Rational Method

For the design of local minor detention facilities in hydrographic areas of less than 150 acres, a simple, "triangular" hydrograph will be developed using the Modified Rational Formula Method. The application of the Modified Rational Formula Method is described in Section 604.

The Rational Method is traditionally used solely for peak runoff estimation, but a hydrograph can be constructed using the following assumptions:

- a) Peak Flow Occurs at the t_c ;
- b) Flow Increases Linearly from $Q = 0$ to $Q = Q_{\text{peak}}$ for $T = 0$ to $t = t_c$;
- c) Flow Decreases Linearly from $q = Q_{\text{peak}}$ to $Q = 0$ for $t = t_c$ to $t = 2t_c$.

The resulting hydrograph is triangular in shape and has a volume given by

$$V = 60 (t_c * Q_p) \quad (1201)$$

Where V = Volume in ft^3

t_c = Time of Concentration in Minutes

Q_p = Peak Flow Rate in cfs

1203.2 Detention Basin Design Outflow Limitations

The controlled outlet capacity has direct influence on size of the basin. The outflow limitation can be based on existing undeveloped peak flow from the hydrologic limitations in the capacity of the downstream conveyance on a hydrologic analysis of local conditions.

1203.2.1 Regional Facilities

The allowable release rate for regional facilities in the Master Plan is based on the non-damaging capacity of the downstream conveyance system or on the conveyance capacity of the system as improved by the detention project. The design maximum outlet capacity of a regional facility must be coordinated with the CCRFCD.

1203.2.2 Local Facilities

The outflow limitation for local facilities is stated in Section 303.7. Existing flow conditions will be calculated based on development conditions that exist prior to construction of project. The allowable outlet rate is equal to the existing peak runoff rate.

1203.3 Hydrologic Calculation Methods

After the inflow hydrograph has been calculated (1203.1) and the outflow limits (1203.2) have been established, the storage volume requirement can be estimated. Separate methods for calculating required storage are used depending on the method used to estimate the inflow hydrograph.

1203.3.1 HEC-1 Method

In order to calculate the required storage volume at a particular detention basin site, the following information must be available or prepared:

- a) Inflow hydrograph
- b) Outlet capacity limitation
- c) Proposed outlet discharge versus elevation data for the proposed basin site

- d) Proposal storage versus elevation data for the proposed basin site
- e) Proposed drain time for the proposed basin site

The HEC-1 computer program can be used to determine the required storage volume and outflow limitation based on a reservoir routing procedure. The data described above is added to the existing HEC-1 data set as described in HEC-1 Users Manual. Initial estimates of outlet size are made and the program is run. The output is reviewed and changes are made to the outlet configuration as needed until the desired degree of flood peak attenuation and acceptable drain time is achieved. This method is shown in the example in Section 1208.1.

The storage-routing determination can also be performed manually by the modified Puls method described in Section 609. Using data for the inflow hydrograph, the storage versus elevation data for the proposed site and the outlet limits, the outflow hydrograph from the proposed detention facility can be predicted.

1203.3.2 Rational Method

After the inflow hydrograph (1203.1) and the outflow limitation (1203.2) have been determined, the required storage volume can be calculated. The estimated hydrograph is plotted at a suitable scale. The maximum outflow rate is plotted on the receding limb of the hydrograph. A straight line is constructed from the origin to the outlet limit on the receding limb. The area above this line is the required storage volume. The estimation of required storage volume is shown in the example in Section 1208.2.

1204 HYDRAULIC CALCULATIONS

This section describes the methods to be used to size outlet structures for detention facilities. Although the methods presented are recommended for the hydraulic structures described, alternative hydraulic techniques may be more appropriate depending upon the configuration of the outlet structure.

1204.1 Low Flow Outlets

The low flow outlet (principal spillway) is sized to control discharge from a basin as set forth in Section 1203.2.

In traditional detention basins, outlet control is usually provided by a culvert or large (> 18-inch diameter) pipe conduit. The types of low flow control typically used for parking lot detention are small under-sidewalk weirs or pipes.

1204.1.1 Minimum Conduit Size

To reduce the potential for outlet clogging by debris, minimum conduit sizes have been set for the CCRFCD area. The minimum conduit size for use in detention facilities is 18-inch diameter or equivalent. Orifice plates may be utilized to reduce flows from these minimum pipe sizes.

1204.1.2 Flow Calculations

The capacity of outlets shall be calculated using nomographs in Section 1000. The capacity of a small closed conduit (Section 1000 nomographs are not applicable) is estimated assuming inlet control using the orifice equation shown below:

$$Q = CA (2gh)^{1/2} \quad (1202)$$

Where Q = Discharge in cfs

A = Cross-sectional Area of Conduit in ft²

g = Gravitational Constant (32.2 ft/sec²)

h = Head, in ft, Above Centerline of Orifice Opening

C = Orifice Coefficient (0.65)

The orifice coefficient to be used in all calculations is 0.65, unless deviation is approved by local entity. An example of this calculation is provided in Example 1208.1.

The capacity of a weir can be estimated using the following equations:

1. For Horizontal crested weirs:

$$Q = CLH^{3/2} \quad (1203)$$

Where Q = Flow in cfs

C = Weir Coefficient

L = Horizontal Length of Weir in ft

H = Head, in ft, Above Weir Crest

2. For V-notched weirs:

$$Q = C (8/15) \tan (\theta/2) H^{5/2} \quad (1204)$$

Where Q = Flow in cfs

C = Weir Coefficient

θ = Angle of V-notch in Degrees

H = Head, in ft, Above Weir Crest

For the horizontal sharp crested weirs, the weir coefficient can be taken to be 3.1 while the coefficient for broad crested weirs can be taken to be 3.0. The V-notch weir coefficients are provided in **Figure 1202**.

1204.2 Spillways

Since storm flows may enter a detention facility in excess of the maximum design flow of the outlet works, a safe method of passing these flows must be provided. All detention facilities must have the ability to pass flows in excess of the major design storm without endangering the structural integrity of the facility or diverting flows from their historic drainage pattern.

A detention basin may have more than one spillway, or in the case of local facilities, the complete structure may be designed to act as an overflow section. If a basin has only one spillway, it must be able to pass both the design flow and a larger flow to provide a margin of safety. These larger flows are discussed in Section 1202. If the geometry of the basin site does not allow for a single spillway to serve these two flows, two spillways may be provided. The principal spillway will be designed to handle the major design storm flow. If flows greater than the major design storm flow, the emergency spillway would allow these greater flows to be passed safely. For minor local detention structures, the structure may be designed to be safely overtopped and the structure itself is the emergency spillway.

1204.2.1 Sizing Requirements

All detention basins in the CCRFCD region shall have emergency spillways which safely pass the following peak flow rates:

1. Regional Facilities: The spillway will be required to pass, as a minimum, a hydrograph developed by using twice the adjusted point precipitation of the major storm if approval of the State Engineer's Office is not required (1206.1).

2. Local Major Facilities: The spillway will be required to pass, as a minimum, a hydrograph developed by using twice the adjusted point precipitation of the major storm if approval of the State Engineer's Office is not required (1206.1).
3. Local Minor Facilities: Emergency spillways for local minor facilities shall be designed to pass the major storm.

1204.2.2 Flow Calculations

The equation for flow over a spillway is the same as that for flow over a sharp crested weir given in Section 1204.1.2, although the discharge coefficient, C , for broad or ogee-crested weirs is normally used in design. A graph for coefficient estimation for ogee-crested weirs is provided as **Figure 1203**.

1205 DEBRIS AND SEDIMENTATION

The performance and reliability of detention facilities can be reduced by natural and man-made debris. Naturally occurring sedimentation can over a period of time reduce the storage capacity of a detention basin and thereby reduce the degree of flood protection provided. The obstruction of low flow conduits by debris can reduce outlet capacity and cause the premature filling of the detention basin with storm water, again reducing the flood protection provided by the structure. Consequently, adequate care must be exercised in design to provide for protection of the outlet works from debris and for the control and removal of sedimentation in the basin.

1205.1 Trash Racks

All outlet works and low flow conduits shall be provided with a trash rack for debris control. The trash rack shall provide a maximum bar spacing not to exceed two-thirds of the outlet opening or diameter. The total area of the trash rack shall allow for passage of the design flow with 50 percent of the trash rack blocked. Examples of common trash rack designs are provided in **Figure 1204**. Calculations for head losses through a trash rack shall be included in the outlets hydraulic evaluation.

1205.2 Sedimentation

The storage volume of a detention basin can be reduced and/or eliminated by sediment deposition. Depending on the cover and soil conditions in a watershed, detention basin filling may happen slowly over a period of many years or, in extreme cases, during one storm event.

Sedimentation effects may be reduced by the construction of debris basins (Section 1300) upstream of the detention facility or by providing additional storage

capacity in the detention facility for storage of sediment. Section 1300 presents some basic information regarding debris sedimentation, control, facilities.

1206 DESIGN STANDARDS AND CONSIDERATIONS

The following section describes current standards and special considerations for detention design.

1206.1 Dam Safety

All dams which store more than 20 acre-feet of water or have an embankment 20 feet or greater in height must be approved by the State Engineer.

1206.2 Grading Requirements

All detention facilities will be graded to allow for complete drainage by the low flow outlet of the principal spillway. No permanent standing water will be allowed. Minimum grade is 0.5 percent.

1206.3 Depth Limits

The maximum ponding depth for parking lot detention facilities is 18 inches.

1206.4 Trickle Flow and Basin Dewatering

All detention basins shall include provisions for a concrete low flow channel and/or a storm drain to ensure positive dewatering of the basin. Low flow criteria are presented in Section 705.

1206.5 Embankment Protection

Embankments shall be protected from structural failure from overtopping. Overtopping can be caused by a larger than design inflow or from obstruction of the low flow outlet. Embankment protection may be provided by embankment armoring (i.e., riprap) or by a design overflow section (i.e., emergency spillway). The invert of the emergency spillway shall be set equal to or above the major design storm water surface elevation.

1206.6 Maintenance Requirements

All detention facilities will be designed to minimize required maintenance and to allow access by equipment and workers to perform maintenance. Maintenance for facilities on public lands or within dedicated easements will be maintained by the local entity. Regional facilities will be maintained by the local entities and may be eligible for funding by CCRFCD. Facilities on private land will be the responsibility of the owner. The local entity reserves the right to perform required

maintenance on facilities located on private land and charge the owner for the cost of such maintenance.

1206.7 Local Detention Basin Siting Guidelines

Local detention basins should be located as to minimize their impact on the site and to ensure public safety. Basins should not be located adjacent to building because of the potential of saturating foundation materials. To ensure public safety, basins should not be located adjacent to pedestrian walkways. Basins should also be placed to minimize detrimental impact on public facilities (e.g., roadway and sidewalk deterioration).

1207 WATER QUALITY

The quality of urban storm water runoff has come under review in the past decade. The USEPA-funded Nation-Wide Urban Runoff Program was directed toward characterizing the quality of urban runoff. This study identified 24 separate priority pollutants which were found in 10 percent or more of the study areas.

Many pollutants have an affinity for and are transported with sediment particles which can settle out in detention basins, or in flood channels or downstream receiving waters.

1207.1 USEPA Regulations

The USEPA is currently promulgating regulations on storm water runoff quality which may require NPDES permits for storm water discharges. These proposed regulations are still under revision and their full impact is not currently known.

1208 EXAMPLE APPLICATIONS

1208.1 Example: Detention Pond Outlet Sizing

Problem: Size the principal and emergency spillway for a detention pond given the following information:

Inflow hydrograph in **Table 1201 (A)**
Basin Site characteristics in **Table 1201 (B)**
Outflow limitation of 300 cfs (Major Storm)
Emergency spillway design flow = 1,000 cfs

Solution:

Step 1: Size Low Flow Conduit:

$$Q = C_d A (2gh)^{1/2}$$

$$300 \text{ cfs} = 0.65 A (2gh)^{1/2}$$

$$A = 21.8 \text{ ft}^2$$

Diameter = 5.3 ft, Use 72 in RCP

Step 2: Develop depth-outflow data for low flow conduit as presented in **Table 1201 (C)**.

Step 3: Perform storage routing using HEC-1. The input data listing and resulting outflow summary is presented in **Table 1202**.

The results show that a storage volume of 31.4 acre-feet is sufficient to limit the pond outflow to less than 300 cfs (actual outflow = 302 cfs).

Step 4: Size Emergency Spillway

Assume $H = 2.0 \text{ ft}$

For a Broad Crested Weir, $C_d = 3.0$

$$1,000 \text{ cfs} = 3.0 L (2.0)^{1.5}$$

$$L = 117.9$$

Use 120 ft

Step 5: The actual water surface elevation for the emergency spillway design flow is then found by repeating the storage routing procedure for the required emergency spillway design hydrograph.

1208.2 Example: Rational Formula Detention Method

Problem: Determine the required detention volume given the following parameters:

Peak flow from Modified Rational Formula Method is 29 cfs

Time of Concentration is 15.2 min

Outflow is Limited to an Existing Flow Rate of 13 cfs

Solution:

Step 1: Plot triangular hydrograph as described in Section 1203.1.2 (see **Figure 1205**).

Step 2: Plot outflow limitation of 13 cfs on falling limb of hydrograph (Point D on **Figure 1205**).

Step 3: Calculate area under triangle above line A-D (**Figure 1205**)

$$V = 14,592 \text{ ft}^3$$

**INFLOW HYDROGRAPH AND BASIN
CHARACTERISTICS FOR EXAMPLE IN
SECTION 1208.1**

(A) INFLOW HYDROGRAPH

<u>TIME (MINUTES)</u>	<u>RUNOFF (CFS)</u>	<u>TIME (MINUTES)</u>	<u>RUNOFF (CFS)</u>
0	0	130	442
10	21	140	394
20	38	150	346
30	72	160	300
40	105	170	233
50	171	180	163
60	247	190	102
70	336	200	73
80	411	210	57
90	480	220	43
100	499	230	30
110	504	240	24
120	480	250	0

(B) BASIN CHARACTERISTICS

<u>ELEVATION (feet)</u>	<u>SURFACE AREA (acres)</u>
103	0
104	0.34
105	1.54
106	3.38
107	5.26
108	5.86
110	6.46
112	8.26

(C) 72" RCP DISCHARGE RATING

<u>DEPTH</u>	<u>DISCHARGE</u>
0	0
1	20
2	40
3	70
4	110
5	160
7	270
9	350

<i>Revision</i>	<i>Date</i>

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

HEC - 1 RUN FOR EXAMPLE IN SECTION 1208.2

HEC-1 INPUT

PAGE 1

LINE	ID.....	1.....	2.....	3.....	4.....	5.....	6.....	7.....	8.....	9.....	10
1	ID	CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT									
2	ID	SECTION 1208.1 EXAMPLE: DETENTION POND OUTLET SIZING									
3	ID	WRC ENGINEERING, INC. 1/26/90									
4	IT	10	0	0	300						
5	IO	2	0	0							
6	QI	0	21	38	72	105	171	247	336	411	480
7	QI	499	504	480	442	394	346	300	233	163	102
8	QI	73	57	43	30	24	0				
9	KK	A	ROUTED DISCHARGE FROM DETENTION POND								
10	RS	1	STO	0							
11	SA	0	.34	1.54	3.38	5.26	5.86	6.46	8.26		
12	SE	103	104	105	106	107	108	110	112		
13	SQ	0	20	40	70	110	160	270	350		
14	ZZ										

RUNOFF SUMMARY
 FLOW IN CUBIC FEET PER SECOND
 TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	PEAK STORAGE	TIME
				+ (AC-FT)	(HR)
HYDROGRAPH AT				31.	2.67
	A	504.	1.83	PEAK STAGE	TIME
ROUTED TO				+ (FEET)	(HR)
	A	302.	2.67	110.79	2.67

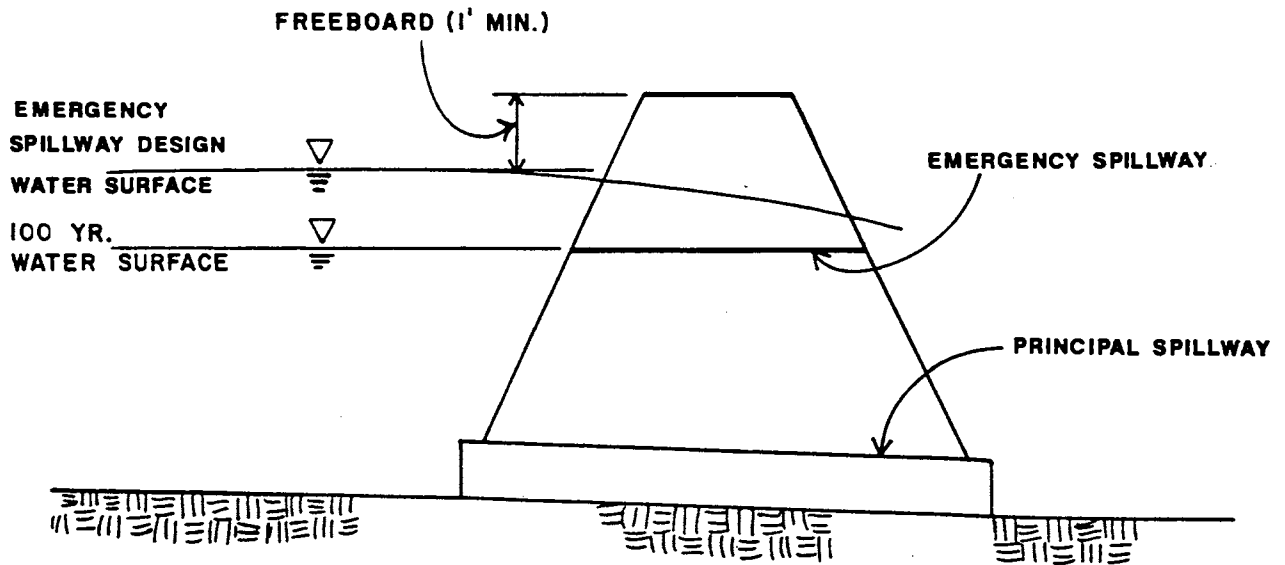
Revision	Date

**WRC
ENGINEERING**

REFERENCE:

TABLE 1202

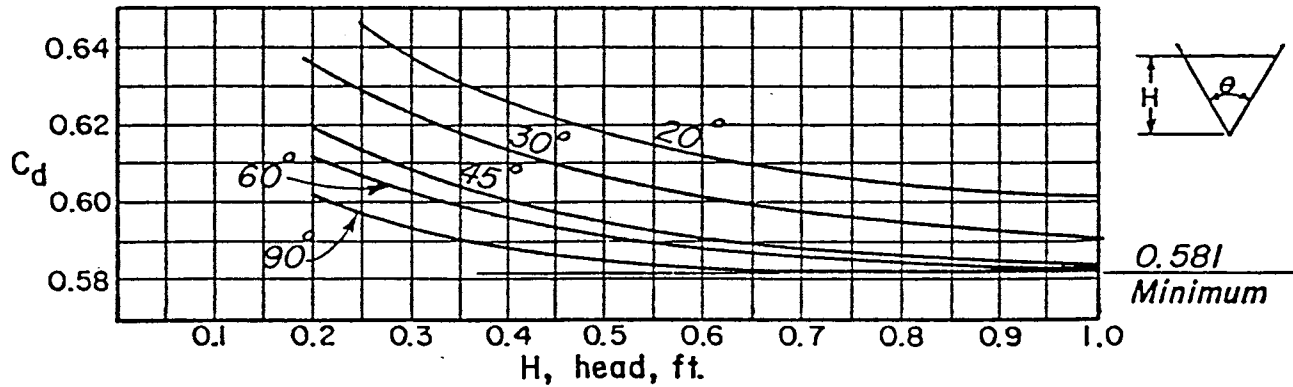
TYPICAL
BASIN GEOMETRY



NOTES: 1. For local minor detention facilities, the required one-foot freeboard shall be above the 100-year water surface elevation.

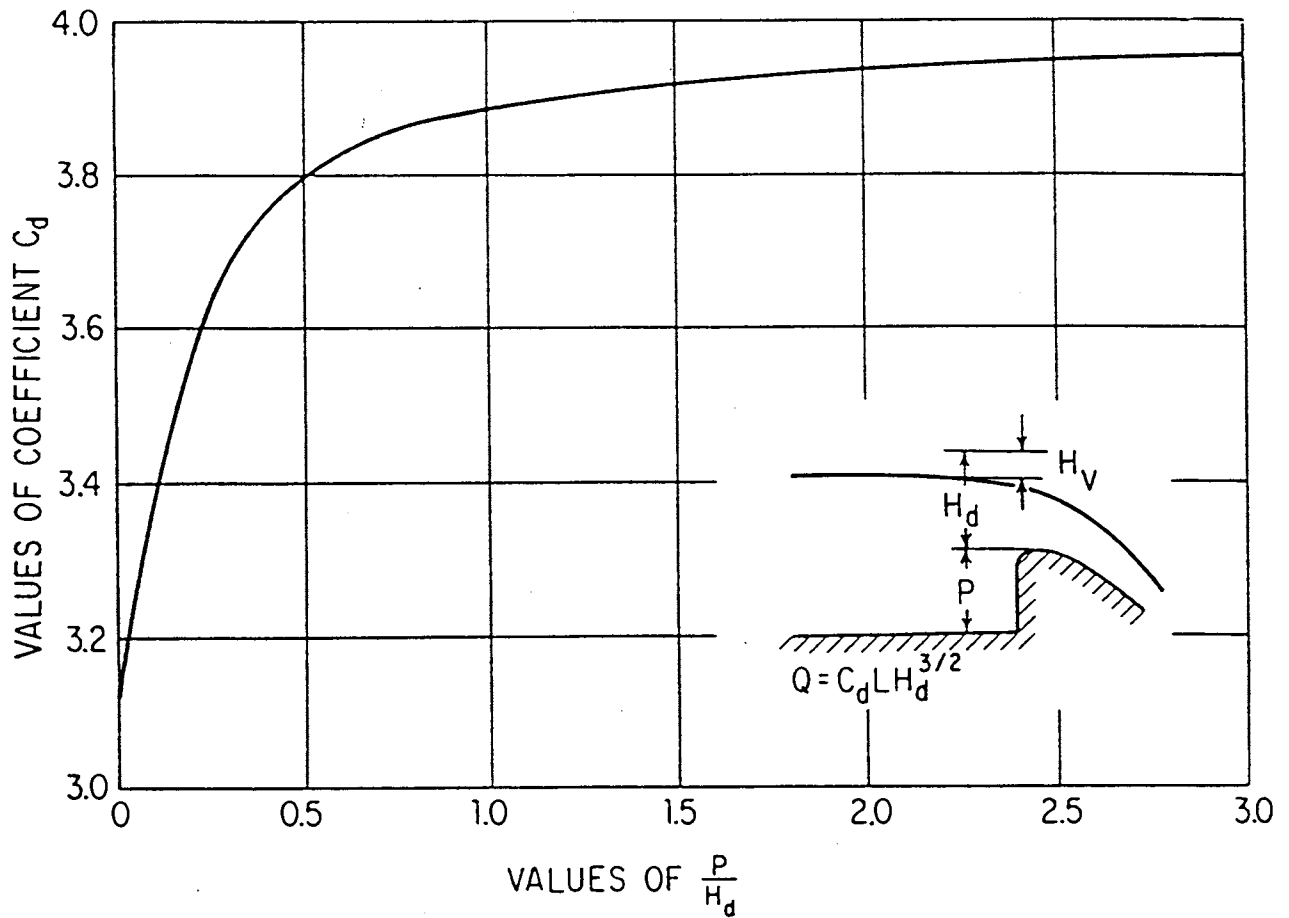
Revision	Date

V-NOTCH WEIR COEFFICIENTS



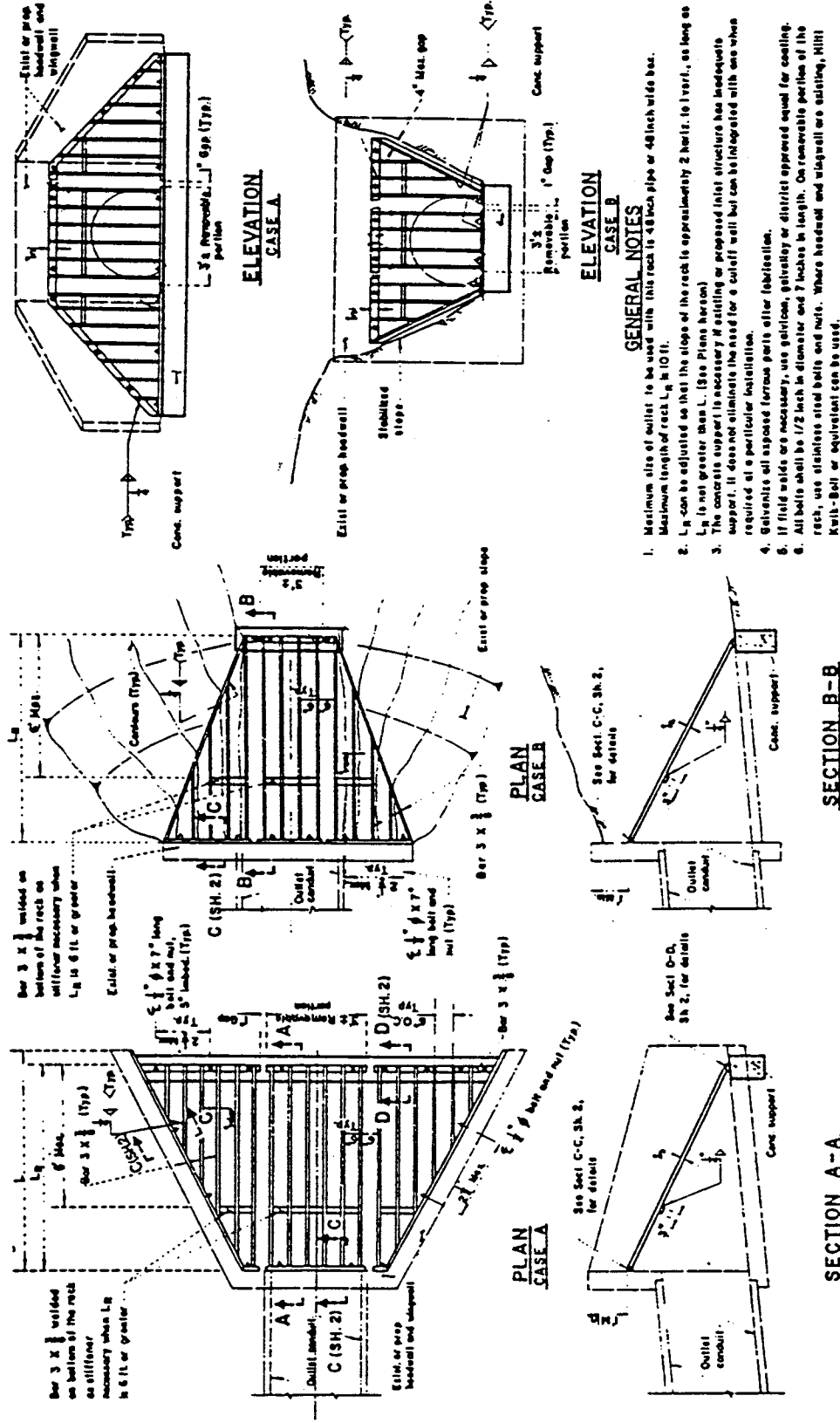
Revision	Date

OGEE-CRESTED WEIR COEFFICIENTS



Revision	Date

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL



- GENERAL NOTES**
1. Maximum size of outlet to be used with this rack is 48 inch pipe or 48 inch wide box.
 2. L_g can be adjusted so that the slope of the rack is approximately 2 horiz. to 1 vert., as long as L_g is not greater than L . (See Plans herein)
 3. The concrete support is necessary if existing or proposed inlet structure has inadequate support. It does not eliminate the need for a cutoff wall but can be integrated with one when required at a particular installation.
 4. Galvanize all exposed ferrous parts after fabrication.
 5. If field welds are necessary, use galvanized steel or district approved equal for coating.
 6. All bolts will be 1/2 inch in diameter and 7 inches in length. On removable portion of the rack, use stainless steel bolts and nuts. Where headwall and wingwall are existing, Hilti Kwik-Bolt or equivalent can be used.

EXAMPLE TRASH RACK

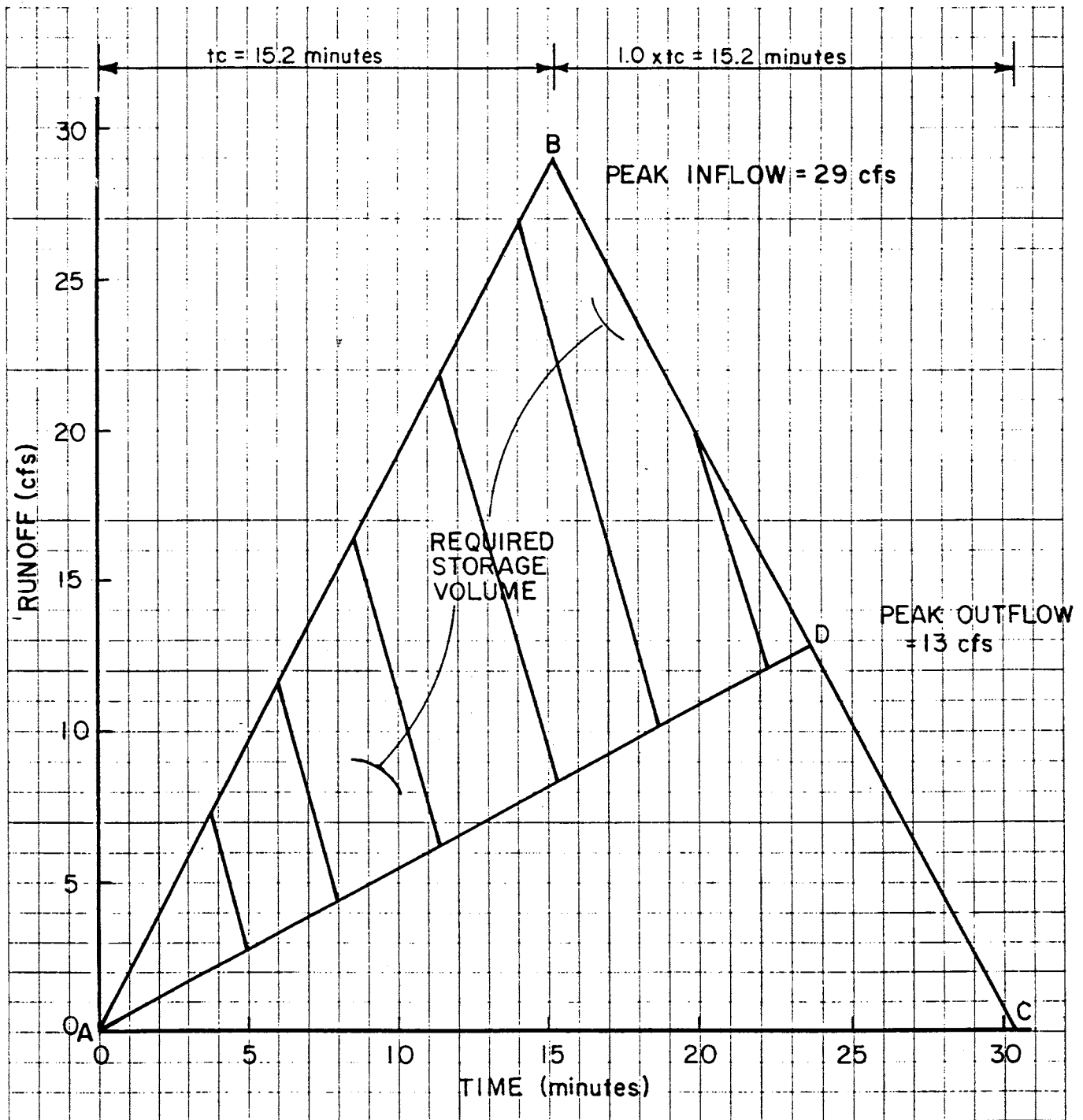
Revision	Date

**WRC
ENGINEERING**

REFERENCE: L.A. County Flood Control District, Design Manual - Hydraulic, 1982.

FIGURE 1204

HYDROGRAPH FOR EXAMPLE IN SECTION 1208.2



Revision	Date