

These example calculations of storm detention are based on Chapter 9 detention criteria in Infrastructure Design Manual (IDM), effective March 31, 2021, and related governing documents. Outside of these examples, the IDM shall govern. Note: this information may be subject to change due to proposed changes to the IDM.

SCENARIO 1: PROPOSE TO FULLY DEVELOP A 10-ACRE TRACT

The entire 10-acre site is disturbed with construction activity and 80% of the site has impervious cover when the project is complete.

Calculate required detention rate:

80% impervious area on 10-acre site:

$$0.8 \times 10 \text{ ac} = 8 \text{ ac of impervious area}$$

From detention rate chart, 80% impervious area requires 0.91 ac-ft/ac detention rate:

$$8 \text{ ac} \times 0.91 \text{ ac-ft/ac} = 7.28 \text{ ac-ft of total detention volume required}$$

SCENARIO 2: PHASED DEVELOPMENT OF A 10-ACRE PROJECT

Phase 1: The owner of a 10-acre site chooses to develop only 4 acres in the first phase. The other 6 acres is not disturbed. The impervious cover is 60% of the 4-acre Phase 1 project area. The ultimate 10-acre project has a master plan showing 80% impervious cover.

Calculate required detention rate:

60% impervious area on 4-acre site:

$$0.6 \times 4 \text{ ac} = 2.4 \text{ ac of impervious area}$$

From detention rate chart, 60% impervious area requires 0.81 ac-ft/ac detention rate:

$$2.4 \text{ ac} \times 0.81 \text{ ac-ft/ac} = 1.944 \text{ ac-ft of total detention volume required in Phase 1}$$

Note: proposed master plan will need to be included in the Phase 1 calculations.

Phase 2: The owner chooses to develop the remaining 6 acres of the 10-acre site. The existing 4 acres in Phase 1 is not disturbed. The impervious cover is 93% of the 6-acre Phase 2 project area. The entire 10-acre tract has 80% impervious cover.

Calculate required detention rate:

93% impervious area on 6-acre site:

$$0.93 \times 6 \text{ ac} = 5.6 \text{ ac of impervious area}$$

From detention rate chart, 93% impervious area requires 0.96 ac-ft/ac detention rate:

$$5.6 \text{ ac} \times 0.96 \text{ ac-ft/ac} = 5.376 \text{ ac-ft of total detention volume required in Phase 2}$$

Add Phase 1 and Phase 2 volumes for total volume needed for the 10-acre tract:

$$1.944 \text{ ac-ft} + 5.376 \text{ ac-ft} = 7.32 \text{ ac-ft}$$

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Note: If construction between the start of Phase 1 and the start of Phase 2 is continual and less than a period of 5 years, then the Phase 2 development is not subject to any change in detention rates, provided the master plan was designed using Atlas-14.

If construction is not continual or is greater than 5 years, then Phase 2 is subject to any new detention rates adopted by the City of Houston after Phase 1 approval.

SCENARIO 3: PARKING LOT MAINTENANCE PROJECT

A 2.5-acre site (85% overall impervious cover) with existing building and existing 1-acre *concrete* parking lot needs repair. The parking lot will be completely removed and reconstructed with new *asphalt*. No changes to paving grades, percent impervious cover or drainage patterns are proposed. The only change is in material used for the parking lot.

Calculate required detention rate:

Detention will be required at 0.98 ac-ft/ac for this maintenance project due to the change in pavement material.

Note: if there is no change in pavement material, drainage pattern, and subgrade, then detention is not required.

SCENARIO 4: EXPANSION TO EXISTING SITE WITH NO DETENTION

An existing 5-acre retail center was built 30 years ago and there is currently no detention. Three acres of the 5-acre site will be redeveloped with 90% impervious cover. The remaining 2 acres will remain untouched.

Calculate required detention rate:

90% impervious area on 3-acre site:

$$0.9 \times 3 \text{ ac} = 2.70 \text{ ac of impervious area}$$

From detention rate chart, 90% impervious area requires 0.95 ac-ft/ac detention rate:

$$2.70 \text{ ac} \times 0.95 \text{ ac-ft/ac} = 2.57 \text{ ac-ft of total detention volume required}$$

SCENARIO 5: NEW POOL ON A 14,000 SQ FT RESIDENTIAL LOT

A home built 5 years ago on a 14,000 sq. ft. lot has exactly 65% impervious cover. The owner proposes to put in a new swimming pool. The new pool and deck will add 850 sq. ft. of impervious cover above the 65% impervious cover threshold.

Calculate required detention rate:

Convert 100% impervious area on 850 sq. ft. to acres:

$$850 \text{ sq. ft.} \div 43,560 \text{ sq. ft./ac} = 0.0195 \text{ ac of impervious area}$$

Since this is an existing single-family residential lot that is less than 15,000 sq. ft., the maximum required detention rate is 0.75 ac-ft/ac:

STORM DETENTION EXAMPLES

$0.0195 \text{ ac} \times 0.75 \text{ ac-ft/ac} = 0.0146 \text{ ac-ft}$ of new detention will be required

Convert to gallons:

$0.0146 \text{ ac-ft} \times 43,560 \text{ sq. ft./ac.} = 634 \text{ cu. ft.}$ of volume required

$634 \text{ cu. ft.} \times 7.48 \text{ gal./cu. ft.} = 4,757 \text{ gallons}$

SCENARIO 6: NEW POOL ON AN 8,000 SQ. FT. RESIDENTIAL LOT

A home built 5 years ago on an 8,000 sq. ft. lot has 60% impervious cover (4,800 sq. ft.). The owner proposes to put in a new swimming pool. The new pool and deck will add 850 sq. ft. of impervious cover.

Detention is not required up to 65% impervious cover (up to 5,200 sq. ft.). The first 400 sq. ft. of swimming pool area requires no detention. The remaining 450 sq. ft. of swimming pool puts the project above the 65% threshold and therefore requires detention.

Calculate required detention rate:

Convert 100% impervious cover on 450 sq. ft. to acres:

$450 \text{ sq. ft.} \div 43,560 \text{ sq. ft./ac} = 0.0103 \text{ ac}$ of impervious area

Since this is an existing SFR lot less than 15,000 sq. ft., the maximum required detention rate is 0.75 ac-ft/ac:

$0.0103 \text{ ac} \times 0.75 \text{ ac-ft/ac} = 0.0077 \text{ ac-ft}$ of new detention will be required

Convert to gallons:

$0.0077 \text{ ac-ft} \times 43,560 \text{ sq. ft.} = 335 \text{ cu. ft.}$ of volume required

$335 \text{ cu. ft.} \times 7.48 \text{ gal./cu. ft.} = 2,510 \text{ gallons}$

SCENARIO 7: A FEW HOMES REMAINING TO BE BUILT ON A 19-ACRE SINGLE-FAMILY RESIDENTIAL DEVELOPMENT

A single detention pond serving the entire 19-acre development was built 10 years ago in compliance with City of Houston's detention regulations at that time ($19 \text{ ac} \times 0.65 \times 0.5 \text{ ac-ft/ac} = 6.1 \text{ ac-ft}$ of detention). The full detention pond was built (no phased expansion of the pond).

Out of 75 planned lots, 65 lots have been built and 10 lots remain undeveloped. All remaining lots are greater than 15,000 sq. ft. and have 65% impervious cover. Combined, these lots cover a 2-acre area within the overall 19-acre boundary. To obtain a building permit and start construction on the remaining lots, the developer must show there is sufficient volume in the detention pond to meet the new COH detention rates for the 2-acre disturbed area.

Calculate required detention rate:

65% impervious cover on 2-acre site:

$0.65 \times 2 \text{ ac} = 1.3 \text{ ac}$ of impervious area.

From detention rate chart, 65% impervious area requires 0.83 ac-ft/ac detention rate:

$1.3 \text{ ac} \times 0.83 \text{ ac-ft/ac} = 1.1 \text{ ac-ft}$ of total detention volume required

STORM DETENTION EXAMPLES

Some detention for the 2-acre site to be developed is already provided by the existing detention pond:

$$2 \text{ ac} \times 0.65 \times 0.5 \text{ ac-ft/ac} = 0.65 \text{ ac-ft of existing volume}$$

Calculate the difference between required and existing detention:

1.1 ac-ft - 0.65 ac-ft = 0.45 ac-ft of volume must be added as a part of new construction or must be shown to exist and be effective (i.e., unused freeboard in the existing pond, or other means).

SCENARIO 8: 25-ACRE TRACT INSIDE THE COH LIMITS THAT DRAINS DIRECTLY AND ENTIRELY TO A HCFCD CHANNEL

The 25-acre tract will have 85% impervious cover and is all being developed at the same time.

Calculate required detention rate:

Per Section 9.2.01.H.3.f. (page 9-29), for areas greater than 20 acres, use the greater of the Harris County Flood Control District (HCFCD) rate of 0.65 ac-ft/ac for the entire tract; or the City of Houston (COH) rate of 0.75 ac-ft/ac for the disturbed area of the tract resulting in impervious cover.

$$\text{HCFCD rate: } 0.65 \text{ ac-ft/ac} \times 25 \text{ ac} = 16.25 \text{ ac-ft}$$

$$\text{COH rate: } 0.85 \times 25 \text{ ac} \times 0.75 \text{ ac-ft/ac} = 15.9375 \text{ ac-ft}$$

The HCFCD criteria governs.

SCENARIO 9: 25-ACRE TRACT INSIDE THE COH LIMITS THAT DRAINS DIRECTLY AND ENTIRELY TO A COH STORM SEWER

A 25-acre tract will have 85% impervious cover and is all being developed at the same time.

Calculate required detention rate:

Per Section 9.2.01.H.3.f. (page 9-29), for areas greater than 20 acres, use the greater of the Harris County Flood Control District (HCFCD) rate of 0.65 ac-ft/ac for the entire tract; or the City of Houston (COH) rate of 0.75 ac-ft/ac for the disturbed area of the tract resulting in impervious cover.

$$\text{HCFCD rate: } 0.65 \text{ ac-ft/ac} \times 25 \text{ ac} = 16.25 \text{ ac-ft}$$

$$\text{COH rate: } 0.85 \times 25 \text{ ac} \times 0.75 \text{ ac-ft/ac} = 15.9375 \text{ ac-ft}$$

The HCFCD criteria governs.

SCENARIO 10: 19-ACRE TRACT INSIDE THE COH LIMITS THAT DRAINS DIRECTLY AND ENTIRELY TO A HCFCD CHANNEL

A 19-acre tract will have 85% impervious cover and is all being developed at the same time.

Calculate required detention rate:

85% impervious cover on 19-acre tract:

$$0.85 \times 19 \text{ ac} = 16.15 \text{ ac of impervious area}$$

STORM DETENTION EXAMPLES

From detention rate chart, 85% impervious area requires 0.93 ac-ft/ac detention rate:

$$16.15 \text{ ac} \times 0.93 \text{ ac-ft/ac} = 15.02 \text{ ac-ft of detention volume required}$$

SCENARIO 11: PARKING LOT MAINTENANCE (ASPHALT)

A commercial asphalt parking lot needs repair. No adjustments to drainage will occur. The owner would like to strip the asphalt down to the subgrade, compact and seal the existing subgrade. The civil engineer's plans call for all top of pavement elevations to match existing, including matching at any existing gutter pans. All inlet elevations will remain as existing. No adjustments are being made to drainage areas or time of concentration to the inlets. The engineer's plans are following the geotechnical engineer's report recommendations to make sure to follow their level of compaction. There are no re-routes of underground piping or any increases in pipe diameter.

Required action:

If detention is required, it will be considered a case-by-case basis.

SCENARIO 12: MODIFYING AN EXISTING DETENTION BASIN

A 2-acre grassed detention basin serves a 12-acre tract of a phased development. The entire basin along with a 6-acre first phase was designed and constructed 8 years ago using a detention rate of 0.50 ac-ft/ac of impervious cover for the anticipated 90% impervious coverage of the entire 12-acre tract. The 6-acre first phase portion was developed with 90% impervious cover.

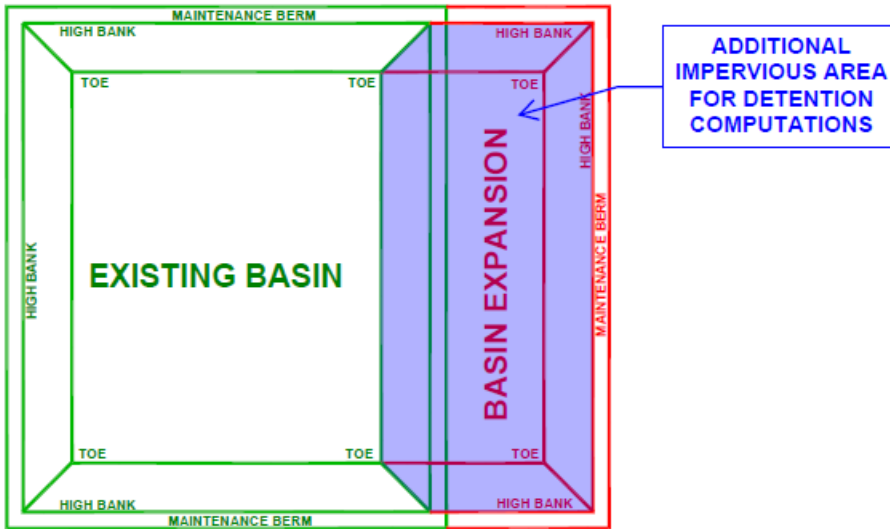
The developer now wishes to develop the 4-acre second phase at 90% impervious cover. Additional detention will be provided by expanding the existing detention basin further into the 4-acre parcel. This expansion will disturb the existing grassed side slope of the detention basin with the detention rate of 0.95 ac-ft/ac.

Calculate required additional detention rate:

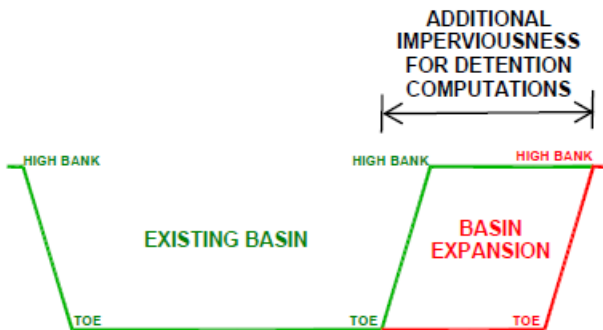
$$0.90 \times 4 \text{ ac} \times (0.95 \text{ ac-ft/ac} - 0.50 \text{ ac-ft/ac}) = 1.62 \text{ ac-ft of additional detention is required}$$

Note: Detention for the existing detention basin and sided slopes was accounted for with the 2-acre detention basin. Any disturbance or expansion outside the original basin footprint will require additional detention at the new rate.

DETENTION SCENARIO #12 EXHIBIT



**DETENTION BASIN EXPANSION
PLAN VIEW**



**DETENTION BASIN EXPANSION
PROFILE VIEW**

STORM DETENTION EXAMPLES

SCENARIO 13: SMALL TRACT AS PART OF A LARGER MASTER PLANNED DEVELOPMENT

A developer is proposing to develop an in-fill 5-acre tract with 85% impervious cover. The 5-acre tract is part of a large 150-acre master-planned development with master-planned detention and drainage. The public drainage and detention infrastructure were constructed 20 years ago. The rate of detention in the master-planned detention basin was 0.50 ac-ft/ac of tract area. Therefore, the total volume of detention allocated to the site in the public detention basin is 2.5 ac-ft or 108,900 cu. ft. ($5 \text{ ac} \times 0.50 \text{ ac-ft/ac} \times 43,560 \text{ sq. ft./ac} = 108,900 \text{ cu. ft.}$).

The 5-acre tract is not a stand-alone tract drainage-wise and is part of a master-planned detention and drainage development with an overall area greater than 20 acres.

Calculate required detention rate:

Per Section 9.2.01.H.3.f. (page 9-29), for areas greater than 20 acres, use the greater of the Harris County Flood Control District (HCFCD) rate of 0.65 ac-ft/ac for the entire tract; or the City of Houston (COH) rate of 0.75 ac-ft/ac for the disturbed area of the tract resulting in impervious cover:

$$\text{HCFCD rate: } 5 \text{ ac} \times 0.65 \text{ ac-ft/ac} = 3.25 \text{ ac-ft of volume required}$$

$$\text{COH rate: } 0.85 \times 5 \text{ ac} \times 0.75 \text{ ac-ft/ac} = 3.19 \text{ ac-ft of volume required}$$

Therefore, HCFCD criteria governs.

Calculate the required detention volume:

$$3.25 \text{ ac-ft} \times 43,560 \text{ sq. ft./ac} = 141,570 \text{ cu. ft.}$$

Calculate the difference between required and existing detention:

$$141,570 \text{ cu. ft.} - 108,900 \text{ cu. ft.} = 32,670 \text{ cu. ft. of additional detention.}$$

SCENARIO 14: PHASED DEVELOPMENT ON A LARGE COMMERCIAL TRACT

A 200-acre commercial development outfalls to a Harris County Flood Control District (HCFCD) channel. A drainage report was created for the entire 200-acres using ATLAS 14 rainfall. The drainage report was approved by HCFCD and the City of Houston prior to the changes to Chapter 9 at a rate of 0.68 ac-ft/ac.

An ultimate detention basin (footprint/area) was master planned for a 136 ac-ft detention basin to serve the entire 200-acre site ($200 \text{ ac} \times 0.68 \text{ ac-ft/ac}$). Phases of this 200-acre development are being permitted and developed continuously, and in less than a period of 5 years.

Required action:

Each phase of development will be required to detain their pro-rata share of 0.68 ac-ft/ac within the ultimate detention basin footprint.