

Chapter 8: Grading

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1.0 Overview

This Chapter provides requirements and guidance on site grading parameters to be incorporated into overall site design and for more specific locations such as single-family lots and detention basins. The requirements set forth in this Chapter shall be adhered to unless there are more stringent parameters set forth in a geotechnical report for the development site.

2.0 Site Grading Design

2.1 Single Family Lot Grading

Single family lot grading design requirements include the following:

- **Positive drainage away from structures:** Grading design must show that there is positive grade away from all structures. More specifically, there must be a minimum grade of five percent (5%) away from a structure within the first five feet (5') (10' preferred), or as specified in the geotechnical report for the site, whichever is greater.
- **Top of foundation elevation:** Grading design must show the top of foundation elevation for a structure and it must be set a minimum of six inches (6") above the highest grade surrounding the structure, or as specified in the geotechnical report for the site, whichever is greater.
- **Maximum slopes:** must be 3:1 (3H:1V) or flatter (4:1 side slopes are recommended). Slopes exceeding the 3:1 maximum will be required to provide an alternative means to take up vertical grade, such as steps or retaining walls.

SINGLE FAMILY LOT GRADING PLAN REQUIREMENTS:

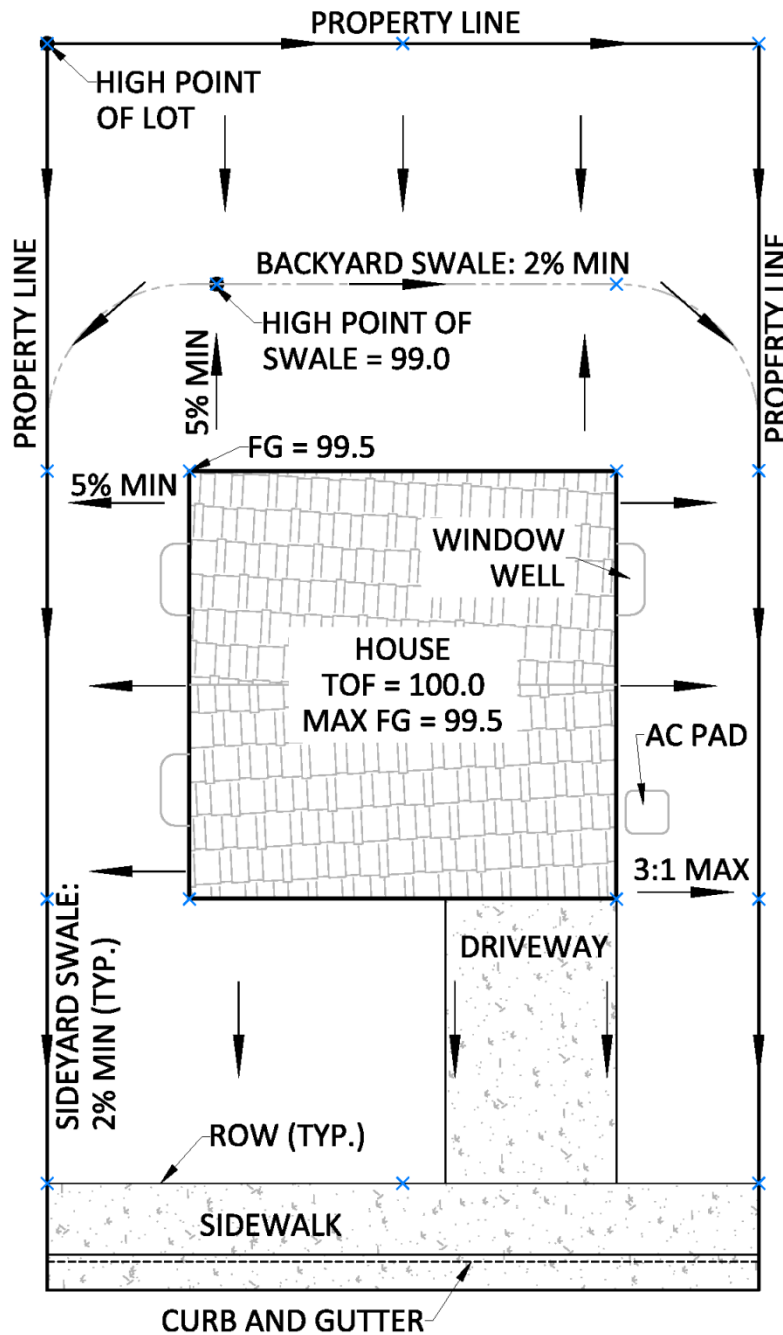
- SHOW POSITIVE DRAINAGE AWAY FROM ALL STRUCTURES THAT MEETS MINIMUM SLOPE REQUIREMENTS
- SHOW TOP OF FOUNDATION AND/OR FINISHED FLOOR ELEVATION FOR ALL STRUCTURES THAT MEET ELEVATION REQUIREMENTS
- SHOW THAT YOU MEET MAXIMUM AND MINIMUM SLOPE REQUIREMENTS
- 3:1 MAXIMUM SLOPES ALLOWED ON SINGLE FAMILY LOTS ONLY
- SHOW SPOT ELEVATIONS AND 1' INTERVAL PROPOSED CONTOURS
- SHOW THAT BACKYARD SWALES DO NOT DRAIN MORE THAN 3 SEPARATE LOTS

2.0 Site Grading Design

- **Minimum slopes:** one percent (1%) longitudinal grade grass swales may be allowed on single family lots when the swale is draining the runoff from only three (3) adjoining properties. A more typical slope of two percent (2%) is required for swales draining more than three (3) lots.
- **Spot Elevations:** must be included for all locations within the lot that help to illustrate compliance with the drainage and slope requirements stated above. Examples of locations of spot elevations for each different type of lot (type A, B or C) are included in **Figures 2.1-1 through 2.1-3** below.
- **Backyard swales:** The FCU prohibits the use of backyard swales on residential lots where these can be physically avoided. Where these cannot be avoided due to physical or grade constraints, they must be designed in a manner that will minimize the basin area contributing to the backyard swale. As such, backyard swales must not receive runoff from more than three (3) residences. A drainage easement along lot lines will be required in cases where there are three (3) or less residences draining to a common swale. The required minimum width of the easement will be 5 feet (5') on both sides of the lot line, but may be wider as necessary to accommodate the full spread of flow in the easement. In any case where back lot swales are conveying runoff from more than three (3) residential lots, the swale must be placed in a separate legal tract that is owned and maintained by the HOA. In addition, there are fencing restrictions that would prohibit the impedance of drainage flows from one residential lot to an adjacent one. Fencing restrictions must be recorded on the subdivision plat, and the appropriate deed restrictions on that plat must be filed with Larimer County.

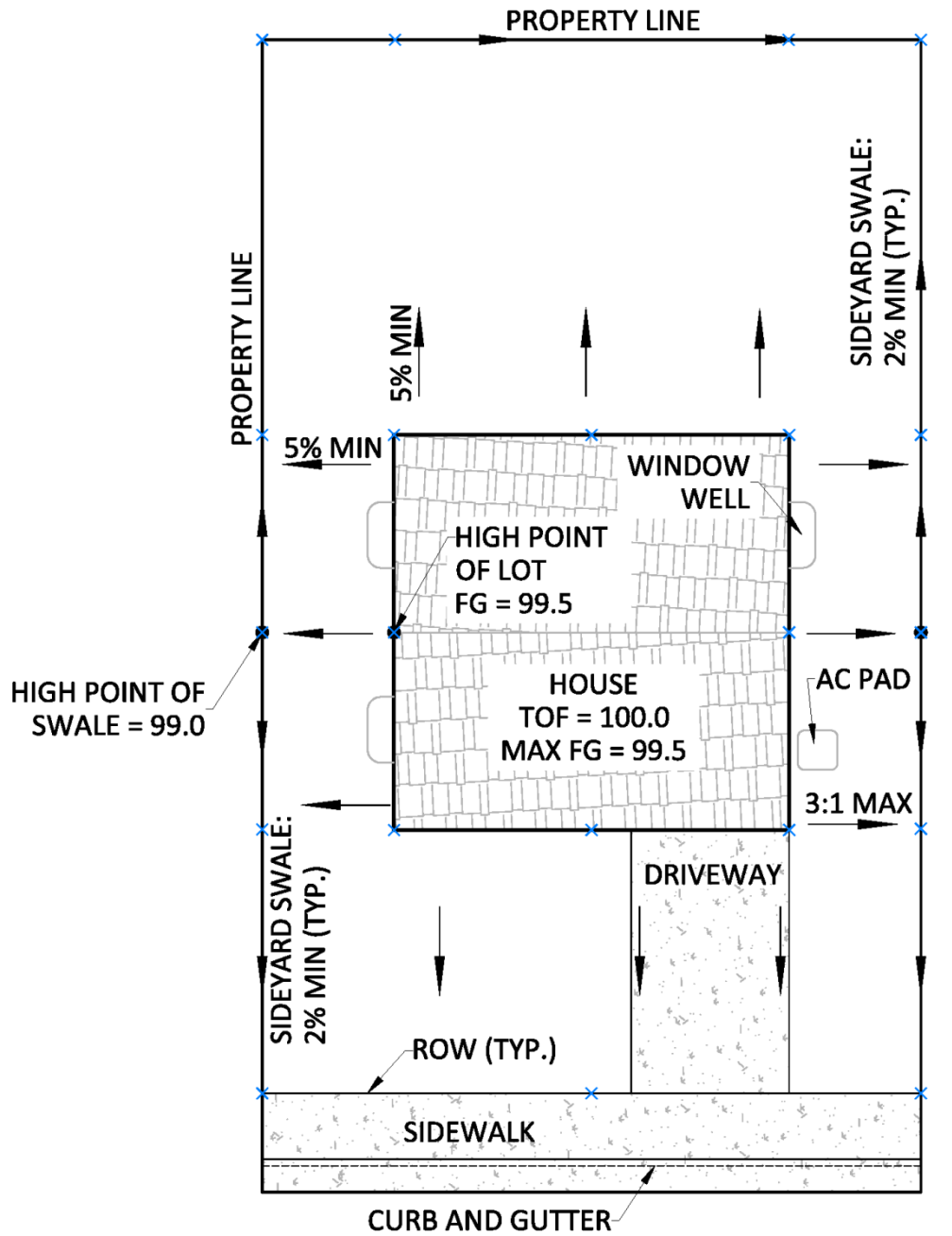
Reference: Residential lots are subject to “Individual Lot Certifications”, as discussed in Chapter 3: During & Post-Construction Requirements, of this Manual.

Figure 2.1-1: Type "A" Lot Typical Grading Plan



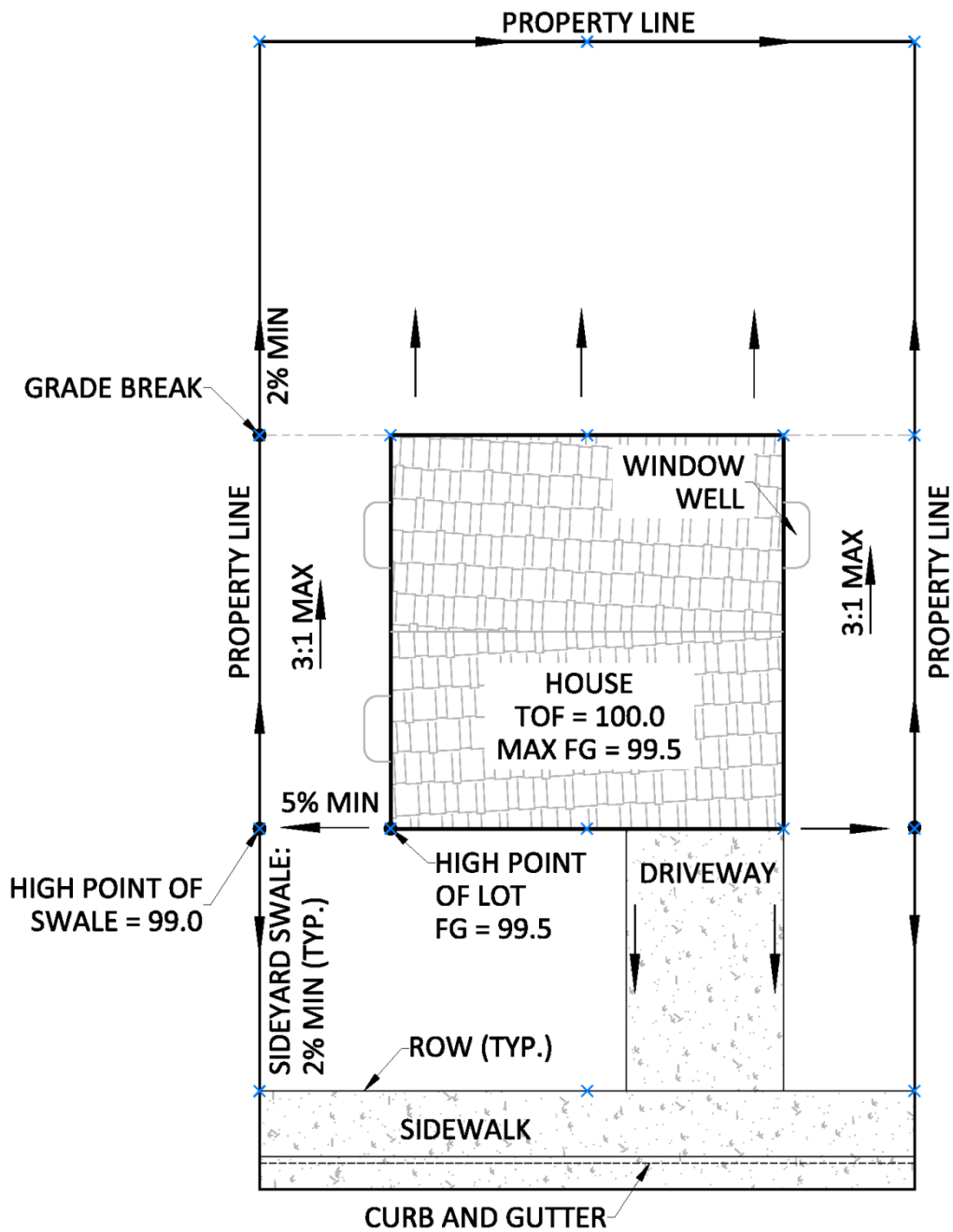
1. SIDEYARD SWALE MINIMUM SLOPE OF 1% ALLOWED FOR 3 OR LESS ADJOINING PROPERTIES
2. HIGH POINT OF BACKYARD SWALE TO BE A MINIMUM OF 12" BELOW THE TOF
3. SPOT ELEVATIONS TO BE PROVIDED ALONG PROPERTY LINES AT 25' INTERVALS AND AT ALL LOCATIONS INDICATED WITH THE SYMBOL X

Figure 2.1-2: Type "B" Lot Typical Grading Plan



1. SIDEYARD SWALE MINIMUM SLOPE OF 1% ALLOWED FOR 3 OR LESS ADJOINING PROPERTIES
2. HIGH POINT OF SIDEYARD SWALE TO BE A MINIMUM OF 12" BELOW THE TOF
3. SPOT ELEVATIONS TO BE PROVIDED ALONG PROPERTY LINES AT 25' INTERVALS AND AT ALL LOCATIONS INDICATED WITH THE SYMBOL X

Figure 2.1-3: Type "G" and "W" Lot Typical Grading Plan



1. SIDEYARD SWALE MINIMUM SLOPE OF 1% ALLOWED FOR 3 OR LESS ADJOINING PROPERTIES
2. HIGH POINT OF SIDEYARD SWALE TO BE A MINIMUM OF 12" BELOW THE TOF
3. 5% MINIMUM SLOPE AWAY FROM STRUCTURE FOR A MINIMUM OF 5'
4. SPOT ELEVATIONS TO BE PROVIDED ALONG PROPERTY LINES AT 25' INTERVALS AND AT ALL LOCATIONS INDICATED WITH THE SYMBOL X

2.2 Surface Grading

Minimum grades required for different types of sheet flow drainage surfaces are as follows:

Table 2.2-1: Minimum Grades for Surfaces

Sheet Flow Minimum Grade Requirements	Surface Treatment
0.50%	Concrete
2.00%	Asphalt
2.00%	Vegetated

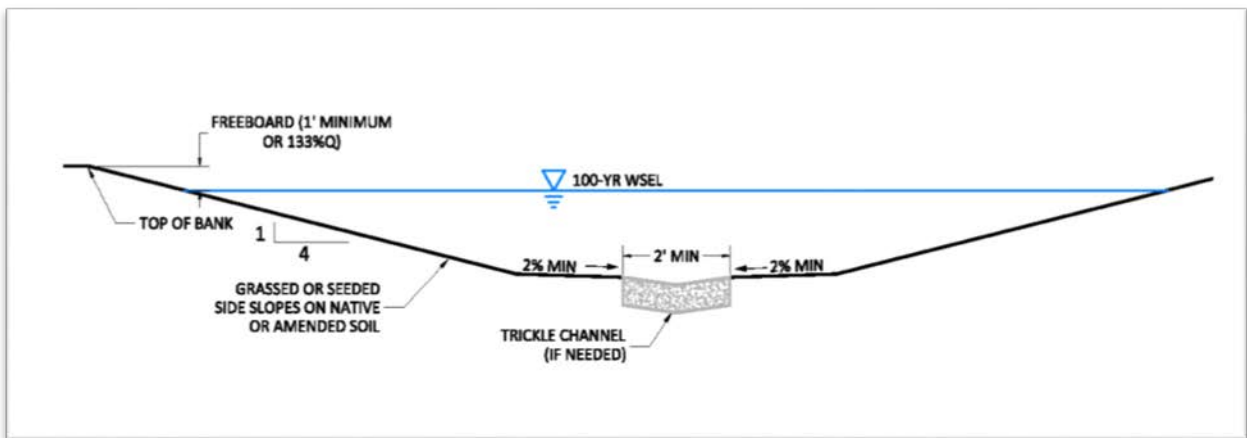
- Slopes throughout the site must be no steeper than 4:1 (4H:1V)
- Areas with steep slopes will be required to provide an alternative means to take up vertical grade, such as steps or retaining walls so as to avoid creating slopes steeper than 4:1

2.3 Channel/Swale Grading

As an alternative to storm drains, it is often desirable to create small surface channels or swales to convey runoff from small drainage areas. This section provides guidance for the design of grass and hard surface bottomed swales.

A typical channel/swale cross-section is provided in **Figure 2.3-1** below.

Figure 2.3-1. Typical Channel/Swale Detail



- Side slopes must not exceed 4:1 (4H:1V)
- Channels/swales must be designed with freeboard:

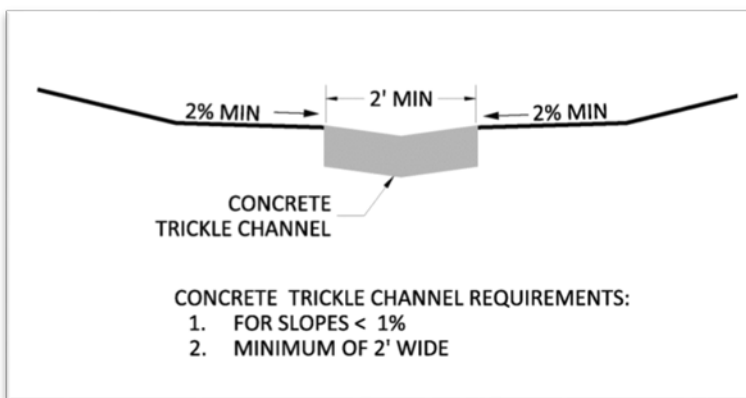
2.0 Site Grading Design

- For channels with > 100 cfs, one foot (1') of freeboard must be provided
- For channels conveying < 100 cfs, the depth of the channel must be able to convey an additional 33% of the 100-year storm flow.
- Maintenance access along the length of the channel must be provided.
- A low-flow or concrete trickle channel is desirable. When concrete trickle channels are utilized for the low flows the following requirements are:
 - Concrete trickle channels must be longitudinally sloped at a minimum of a half percent (0.50%) grade. Slopes toward or perpendicular to the concrete trickle channel must be a minimum of two percent (2%) grade. The use of concrete trickle channels should be avoided in areas with well-draining soils as they reduce infiltration and promote evaporation.
 - Soft pan trickle channels may be utilized when the minimum two percent (2%) grade cannot be achieved; however, the minimum grade allowed for soft pan trickle channels is one percent (1%).
 - Vegetated swales must be graded at a minimum of two percent (2%).

Table 2.3-1. Minimum Grades for Channels/Swales

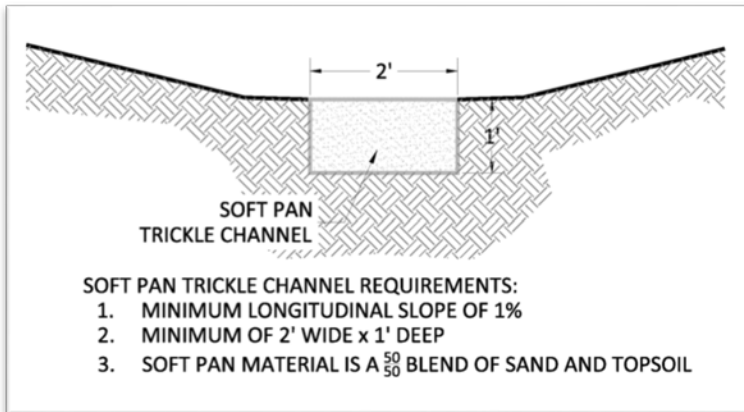
Channels/Swales Minimum Grade Requirements	Surface Treatment
< 1.00%	Concrete trickle channel required
1.00% - 2.00%	Soft pan trickle channel allowed, concrete not required
>2.00%	Vegetation allowed, concrete not required

Figure 2.3-2. Typical Concrete Trickle Channel Detail



3.0 Detention Basin Grading Design

Figure 2.3-3. Typical Soft Pan Trickle Channel Detail



3.0 Detention Basin Grading Design

3.1 Geometry of Stormwater Detention Facilities

Stormwater facilities have a reputation for being functional site features without natural qualities. The basic design parameters for a detention basin design are capacity or volume and rate of discharge. These parameters combined with economic factors typically result in designs that maximize the amount of stormwater detention within the smallest possible area.

These parameters are typically accomplished by the creation of geometric basins with calculated volume and outflow rates, connected to site and local utilities through standard gray concrete structures. The typical detention basin is functional as a facility, yet, provides little or no aesthetic or habitat benefits. In many cases detention basins of this kind detract from the overall project image or appeal and adversely affect surrounding properties.

The geometry of a stormwater detention facility depends on specific site conditions such as adjoining land uses, topography, geology, preserving or creating wildlife habitat, and volume requirements. Several key features must be incorporated in all detention facilities located within Fort Collins:

- Embankments and side slopes are to vary and undulate, with maximum side slopes of four feet horizontal to one foot vertical (4:1) and stabilized. Non-varying slopes and slopes exceeding 4:1 in detention basin areas will not be accepted.

3.0 Detention Basin Grading Design

- Detention basin embankments shall be designed to withstand the 100-year and larger storm. Poorly compacted native soils shall be excavated and replaced. Embankment soils shall be compacted to at least ninety-five percent (95%) maximum density (Modified Proctor) or as specified in the geotechnical report for the site.
- Detention basin bottoms shall have a minimum cross-slope (measured perpendicular to the trickle channel) of two percent (2%) for vegetated surfaces
- Inflow points shall enter the detention basin at or near the toe of the basin to prevent erosion along the basin embankments. If providing an inflow point at the toe of the basin is not feasible, then erosion protection must be provided from the inflow all the way to the toe of the basin.
- Detention basin bottom must be a minimum of twenty four inches (24”) above the groundwater elevation. (Groundwater elevation data must be determined from piezometer data taken during high groundwater months.)
- For safety as well as maintenance considerations, the maximum allowable ponding depth of water in a detention basin during the 100-year storm is ten feet (10’). All detention basins with a water ponding depth of over four feet (4’) must have a water depth gauge. The depth gauge must be referenced to the deepest point in the basin. The numbers on the gauge shall be visible from the detention basin access point or the nearest street.
- Detention basins must be located a minimum of twenty feet (20’) away from an irrigation ditch or other facility, or more if specified by the owner of the irrigation canal and protected from seepage from the irrigation canal.
- An access route into the detention basin must be provided for ingress and egress of maintenance equipment for silt and debris removal as well as repairs. The width, longitudinal slope and surface material of the access route will depend on the type and size of the detention basin but will need to be included in the design and clearly delineated on

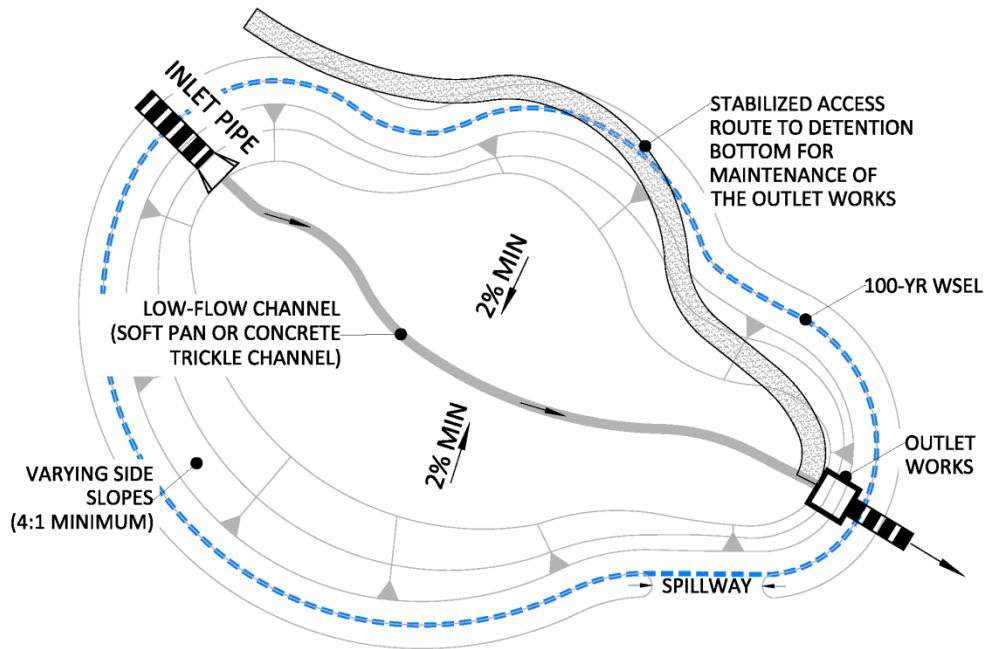
DETENTION BASIN LAYOUT REQUIREMENTS:

- MAXIMUM SIDE SLOPES 4:1
- SHOW UNDULATING SIDE SLOPES BETWEEN 10:1 AND 4:1
- MAXIMUM DEPTH OF 10’
- MINIMUM BOTTOM SLOPE OF 2%
- MINIMUM FREEBOARD OF 12” ABOVE 100-YR WSEL
- MAXIMUM SPILL DEPTH OF 6” AT EMERGENCY SPILLWAY
- INFLOW POINTS TO ENTER AT THE TOE OF THE BASIN
- BASIN BOTTOM MUST BE AT LEAST 24” ABOVE GROUNDWATER ELEVATION
- ACCESS ROUTE FOR MAINTENANCE MUST BE PROVIDED

3.0 Detention Basin Grading Design

the plans. (For basins less than one acre-foot in volume, access may be allowed from an adjacent drivable surface that is not within the detention basin area, as long as equipment can safely reach and maintain all of the facilities and appurtenances.)

Figure 3.1-1. Typical Detention Basin



Reference: For more detailed guidance regarding detention basin aesthetics, refer to the [Landscape Design Standards and Guidelines for Stormwater and Detention Facilities in Appendix B](#).

3.2 Retaining Walls and Safety Railings

The inclusion of retaining walls within detention basins are becoming more commonplace because they add visual character and may aid in providing added volume for small detention areas. However, retaining wall systems can add to maintenance requirements for detention basins as well as cause concerns for safety of maintenance personnel and others that may utilize the area.

The design of any retaining wall system within a detention basin shall be reviewed with FCU early in the design process as the extent and location of retaining walls would need to be reviewed for maintenance, access and safety requirements. For any retaining wall, or multiple walls acting in series, that are

3.0 Detention Basin Grading Design

NOTE ABOUT RETAINING WALLS AND RAILINGS:

RETAINING WALL AND/OR RAILING SYSTEMS WILL NEED TO BE REVIEWED BY FCU IN CONJUNCTION WITH THE BUILDING AND ZONING DEPARTMENTS FOR COMPLIANCE WITH CURRENT BUILDING CODES AND THE LAND USE CODE.

collectively taller than forty eight inches (48") (as measured from the base of the foundation footing to the top of the top wall) will need to be reviewed in conjunction with building code and Land Use Code requirements for height or geometry restrictions.

Use of a safety railing at vertical or steeper than 4:1 structural faces may be required to promote public safety. If the facility is situated at a grade lower than and adjacent to a highway or arterial roadway, installation of a

guardrail will likely be required. Providing features to discourage public access to the inlet and outlet areas of the facility must be considered. Railing requirements will be reviewed on a case-by-case basis and will need to be reviewed in conjunction with the Land Use Code for requirements.

3.3 Trickle Channels

When trickle channels are utilized for the low flows in a detention basin, these are the following requirements:

- Concrete trickle channels must be sloped at a minimum of a half percent (0.50%) grade. Slopes toward or perpendicular to the trickle channel must be a minimum of two percent (2%) grade. Embedded cobbles for a more natural aesthetic are encouraged. (The use of concrete trickle channels should be avoided in areas with well-draining soils as they reduce infiltration and promote evaporation.)
- Soft pan trickle channels may be utilized when the minimum two percent (2%) slope cannot be achieved; however, the minimum slope allowed for soft pan trickle channels is one percent (1%). See **Figure 2.3-3**.
- Vegetated swales must be sloped at a minimum of two percent (2%) to the outlet structure.
- Horizontal alignment shall complement the topographic character of the detention basin and be non-linear.

3.4 Freeboard

Freeboard is the vertical distance above a referenced water surface to a specific elevation associated with constructed infrastructure, typically the lowest elevation of a building site adjacent or nearby. In

3.0 Detention Basin Grading Design

the case of stormwater detention basins, the referenced water surface elevation is the developed condition 100-year water surface elevation. Freeboard requirements are:

- Twelve inches (12") of freeboard is to be provided within the detention basin, measured vertically from the 100-year water surface elevation to the top of the basin, or measured from the emergency spillway elevation (if it is higher than the 100-year water surface elevation) to the top of the basin.
- In all circumstances, twelve inches (12") of freeboard must be provided between the 100-year water surface elevation and the minimum opening elevations of adjacent buildings.

3.5 Spillway

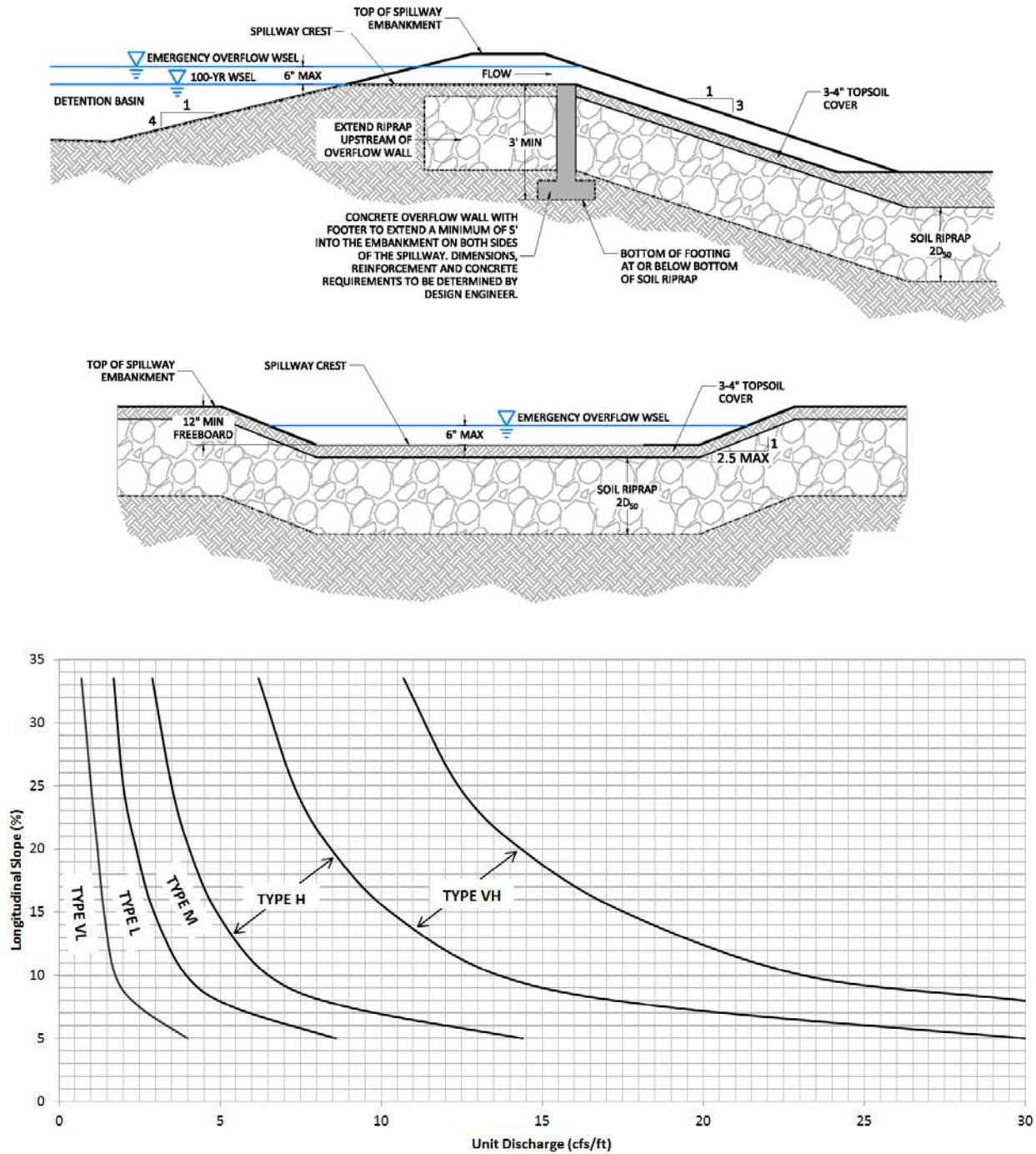
In general, emergency spillways for detention basins are required to include the following parameters:

- The spillway crest must be set at or above the 100-year water surface elevation in the detention basin.
- Emergency overflow depth shall be no more than six inches (6") at the crest during the 100-year storm.
- The detention basin top of embankment shall be a minimum of twelve inches (12") above the spillway crest elevation.
- Erosion protection including the use of buried riprap or other permanent erosion control protection devices required on the downstream side of the embankment from the crest of the spillway to the toe of slope.
- Concrete overflow wall may be required along the length of the spillway at the discretion of FCU. Specific design requirements that may include footing design, reinforcement and concrete mix requirements are to be provided in a construction detail by the Design Engineer. The general design parameters are shown in **Figure 3.5-1** below.
- Provide overflow routing to adequate conveyance system.

In cases where a detention basin is situated adjacent to a roadway, the roadway itself may be considered a stabilized embankment.

3.0 Detention Basin Grading Design

Figure 3.5-1. Spillway Detail and Rock Sizing Chart



4.0 Landscaping

Excerpts from the “City of Fort Collins Landscape Design Standards and Guidelines for Stormwater and Detention Facilities”, dated November 2009, found in Appendix B of this Manual should be referenced for planting design and techniques, irrigation, habitat value and maintenance standards for integration into the overall site and stormwater design. Landscape designs must meet Land Use Code requirements but must also incorporate the principles discussed in the landscape standards for detention facilities document as well as include proper seed mixes for erosion control and vegetation establishment, as provided in Chapter 4: Construction Control Measures.

[Reference](#): Designers are encouraged to review the [Nature in the City Design Strategic Plan](#) as well as the [Landscape Design Standards and Guidelines for Stormwater and Detention Facilities](#) found in Appendix B.

5.0 Drainage Easements

Drainage easements dedicated to the City are required for certain stormwater facilities for the purposes of allowing access to the facilities by the owner, maintenance agency and for City inspection and other purposes.

Drainage easements are required to be provided for:

- **Open channels or swales** on private property that convey offsite runoff or a combination of offsite runoff and runoff generated onsite. The offsite runoff does not have to be from a public right-of-way. The easement shall include the entire width of the channel from top of bank to top of bank and including area adjacent to one or both of top of banks to allow for a ten foot (10') wide maintenance vehicle access, or a minimum of 20' total width, whichever is greater. The easement shall be along the entire length of the channel.
- **Detention basins**, public or privately owned and maintained. The easement shall include the entire area encompassing the basin itself, side slopes into the basin, the entirety of the 100-year water surface elevation and freeboard, all appurtenances necessary for the outfall, operation and maintenance of the facility which may also include additional width beyond the top of bank of the basin to allow for maintenance vehicle access.
- Volume-based **water quality basins**, including volume-based **LID systems**, including any outfall facilities.

Drainage easements do **not** need to be provided for:

- Open channels or swales that are on private property that only convey runoff that is generated on that property

- Non-volume-based water quality basins, including LID systems that are not designed for a specific volume (i.e. permeable pavers without detention, linear bioretention)