COACHELLA VALLEY WATER DISTRICT
GUIDELINE K-2
BANK (SLOPE) PROTECTION DESIGN GUIDANCE

K.2.1 General Requirements

Section 8.5.3 requires analysis of the potential for bank erosion when modifying existing stormwater facilities or designing new ones. Bank erosion will occur if the imposed velocities or shear stresses on the bank during the 100-Year flood exceed threshold or critical velocities or stresses for the bank materials.

If erosion will occur, CVWD requires that bank protection be designed for the stormwater facility in accordance with this Guideline.

K.2.2 Recommendation of Setback Requirements

At a maximum, CVWD requires a 300 foot setback from the top of slope for any structures where no concrete slope protection exists. This setback considers hydraulic parameters and soil conditions that exist on average throughout the Whitewater River/Coachella Valley Stormwater Channel. In lieu of applying the maximum setback requirement, CVWD has developed the following three options for determining a setback that will provide an opportunity for developers and property owners to justify a reduced setback.

The three options are as follows:

Option 1

Setback is calculated as follows:

$$SB = 1.5 (Q_{100})^{0.5}$$

SB = setback from the top of the channel in feet
Q_{100} = the 100-year discharge for the channel in cfs.

Note: Option 1 is not applicable in areas adjacent to channel curvature unless said curvature is determined to be mild. This determination is at CVWD's discretion.

Option 2

Setback is determined by calculating General Scour, following the Blench procedures as defined in the K-3 Guidelines (which are based on local hydraulics, channel geometry, and soil grain size). The erosion hazard limit will be determined from the depth of maximum scour, located vertically below the point where the 100-year water surface intersects the bank, and projected laterally from the channel at a 6:1 slope to where it intercepts the adjacent ground (see Figure 1).

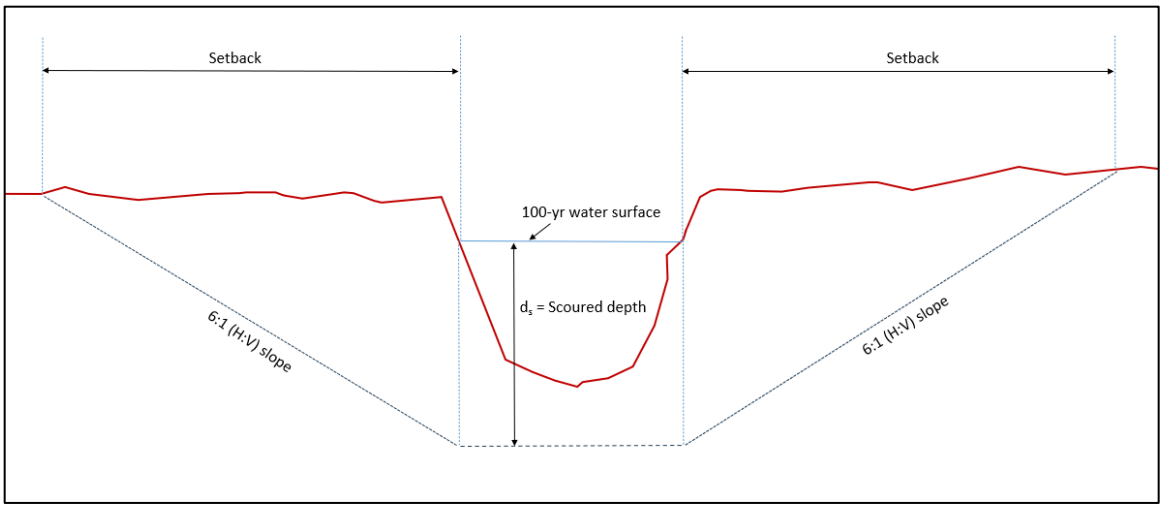


Figure 1. Cross-section view of a stream channel illustrating setback distance determination

The result of the Option 2 approach is that it will provide a variable setback distance that is dependent on local hydraulics, sediment size, and channel geometry and curvature conditions. A first estimate of how this setback allowance would vary along the WWRSC/CVSC is shown in Figure 2. Note that the setback variation shown in this figure is a rough estimate only, with the general scour basis applied assuming hydraulic conditions and channel geometry from CVWD 's HEC-RAS model (with overbank elevations approximated by bank elevations specified in this model), a constant D_{50} for the bed material of 0.2 mm, and a constant Z factor in the Blench equation of 1.25, which is applicable to generally straight reaches. In actual application to a given site, updated topographic and hydraulic information would be used, and the Blench procedures for general scour would be adjusted according to the local grain size and channel curvature conditions.

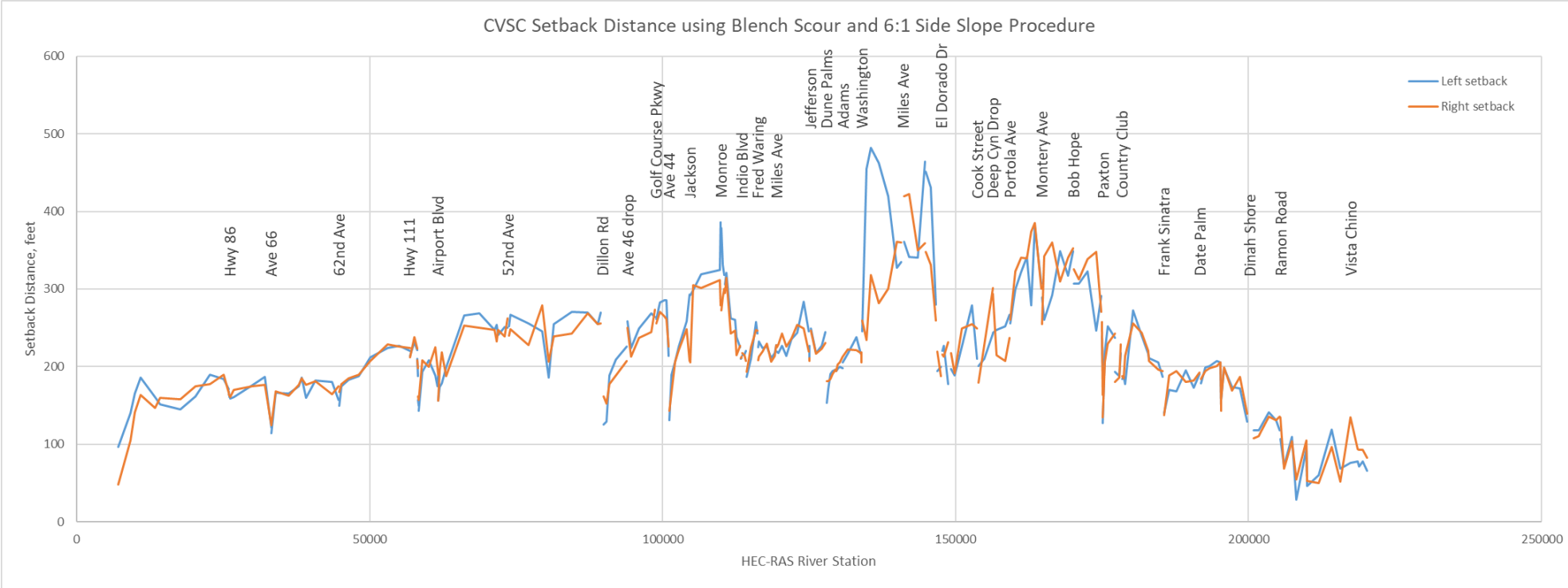


Figure 2. Example (approximate) application of Level II setback procedure to the WWRSC/CVSC

Option 3

Setback is determined based on technical data provided by the applicant related to instances where localized conditions may be present that have the potential to reduce lateral erosion limits. These conditions can include geologic features, off-bank structural measures, or any other conditions that may influence and minimize the potential for lateral erosion along the banks of the channel. Consideration of modifications to the setback based on this effort shall be supported by a detailed geotechnical report and/or other site-based data certified by a licensed professional.

K.2.3 CVWD Bank Protection Design

The recommended bank protection for CVWD stormwater facilities is a concrete revetment that extends from the 100-Year water surface elevation plus freeboard to the Minimum Scour Elevation (refer to Guideline K-3). Minimum freeboard standards are defined in Ordinance 1234.2 and Section 8.5.2, based on channel type.

The slope of the concrete bank protection, from the 100-year water surface elevation plus freeboard to the design channel bed elevation, is 1.5H:1V. The slope of the cut-off wall, that extends from the channel bed down to the Minimum Scour Elevation, is 1H:1V or 1.5H:1V.

Standard details for the design of the concrete bank protection are included on the sheets at the end of this Guideline. CVWD recommends that proponents utilize these standard details. If the details are modified, CVWD and their consultants will require additional time to review the submission, adding costs to the project.

K.2.4 Modifications to CVWD Bank Protection Design

In some circumstances, such as where high ground water elevations occur, it may be impractical to excavate deep enough to construct the concrete bank protection to meet Minimum Scour Elevations. Where this occurs, CVWD will consider modifications to the standard details, such as excavating to a practical limit and constructing a sheet pile wall to support the concrete protection or excavating to a practical limit and constructing a riprap toe berm that has sufficient volume to launch and protect the slope to the maximum scour depth during a flood. Proponents considering such modifications should contact CVWD to confirm that CVWD will accept such a modification at their project location and discuss design standards, if acceptable.

K.2.5 Alternative Slope Protection Designs

CVWD will consider alternative slope protection designs for some stormwater facilities. The proponent will be required to demonstrate through manufacturer specifications or certifications and analysis of 100-year hydraulic conditions at the project site that the alternative will prevent erosion at the site and meet all CVWD standards for bank protection. The proponent will also be required to submit a maintenance plan and demonstrate that expected levels of maintenance and repair are consistent with typical CVWD bank protection works.

CVWD and their consultants will require additional time to review alternative protection submissions, adding additional costs to the project.

K.2.6 Procedures for Design of CVWD Bank Protection

The following sections provide procedures for design of CVWD bank protection.

Top of Bank Protection

The top elevation of the bank protection is set by the 100-Year Plus standard in Ordinance 1234.2. For incised channels, three (3) feet of freeboard is added to the 100-Year water surface elevation to determine the top elevation; for leveed channels, four (4) feet of freeboard is added. Incised and leveed channels are defined in Section 8.5.2.

For existing facilities, CVWD will provide hydraulic models of stormwater channels, where they are available. The proponent is responsible for calculating 100-Year water surface elevations for project conditions and determining if the facility is incised or leveed. If a hydraulic model is not available, the proponent will develop a hydraulic model that meets the basic standards in Section 8 of the DDM.

For new facilities, the proponent will be responsible for developing a hydraulic model that meets the basic standard in Section 8 of the DDM. New facilities are to be designed as incised channels. Exceptions to this may be considered if the new facilities discharge directly to CVWD owned and operated regional stormwater facilities.

Top of Cut-off Wall Elevation

The slope of the concrete bank protection changes at the bed elevation of the channel to the cut-off wall. For existing channels, the bed elevation is typically defined as the channel design invert elevation. CVWD will provide as-built drawings of their existing facilities that show this elevation.

For existing facilities without as-built drawings or other design information, CVWD recommends adopting the lowest surveyed bed elevation in the project vicinity as the design bed elevation.

For new facilities, the top elevation of the cut-off wall will be the design bed elevation.

Bottom of Cut-off Wall Elevation

The bottom of the cut-off wall will be at or below the Minimum Scour Elevation, as calculated by the procedures in Guideline K-3. Guideline K-3 provides procedures for calculating minimum scour elevations in straight sections, at bends and at structures, such as bridges or grade control structures. The proponent is responsible for selecting the appropriate procedure for their particular situation.

K.2.7 Design Drawing Requirements

The design plan set should indicate the extent of the works and show the keys or tie-ins or other features at the upstream and downstream ends of the project, particularly where the proposed bank protection joins existing works.

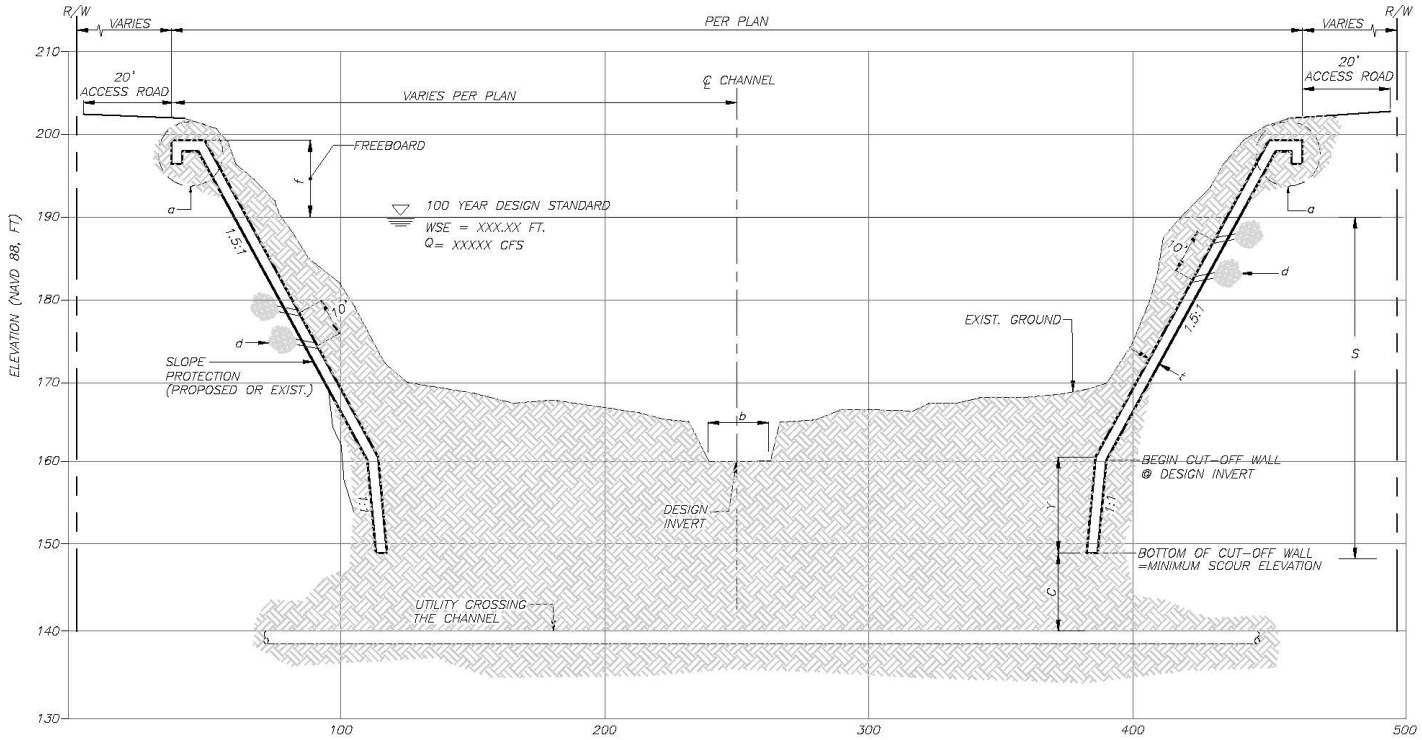
The following specific information is required on the drawings:

- Plan, profile and typical sections of the slope protection works with stationing according to CVWD designations, design water surface elevations, top of bank protection elevations, top of cut-off wall elevations, minimum scour elevations, channel bed elevations, etc. Elevations will refer to the NAVD88 vertical datum.

- Cut-off wall top elevations will be referenced to the design invert.
- Details showing the tie to existing bank protection, if applicable.
- Details of the wrap-around or key-in to the bank at the upstream and downstream ends of the protection, if applicable.
- Details at storm drain outlets through or in the vicinity of the proposed bank protection works, if applicable. Guideline K-4 provides details.
- The location and crown elevation of all utilities within CVWD's right-of-way.
- The CVWD right-of-way boundary.

K.2.8 Submissions

A Hydraulic Design Report (see Guideline K-1) will be submitted with the design drawings.



NATURAL BOTTOM CHANNEL CROSS SECTION DETAIL

STATION XXXX + XX
NTS

a = REFER TO TOP OF SLOPE PROTECTION DETAIL ON SHEET 2 OF 5

b = BOTTOM WIDTH OF PILOT CHANNEL PER PLAN (WHEN APPLICABLE)

C = CLEARANCE FOR UTILITY CROSSING (USUALLY 2 FEET)

d = WEEP HOLES 3" DIAMETER, REFER TO WEEP HOLE DETAIL ON SHEET 4 OF 5

f = FREEBOARD (3' FOR 100 YEAR FLOOD INCISED CHANNEL) (4' FOR 100 YR. FLOOD LEVEED CHANNEL)

t = SLOPE PROTECTION THICKNESS PER PLAN (6" TYP.)

Y= DEPTH OF CUT-OFF WALL AS DETERMINED BY THE HYDRAULIC ANALYSIS

S = MAXIMUM SCOUR DEPTH FROM HYDRAULIC ANALYSIS

NOTE: CROSS SECTIONS (LOOKING DOWNSTREAM) TO BE SHOWN FOR ALL HYDRAULIC ANALYSIS REPORT AND PLANS WITH CVWD STATIONING

COACHELLA VALLEY WATER DISTRICT

TYPICAL SLOPE PROTECTION DETAILS

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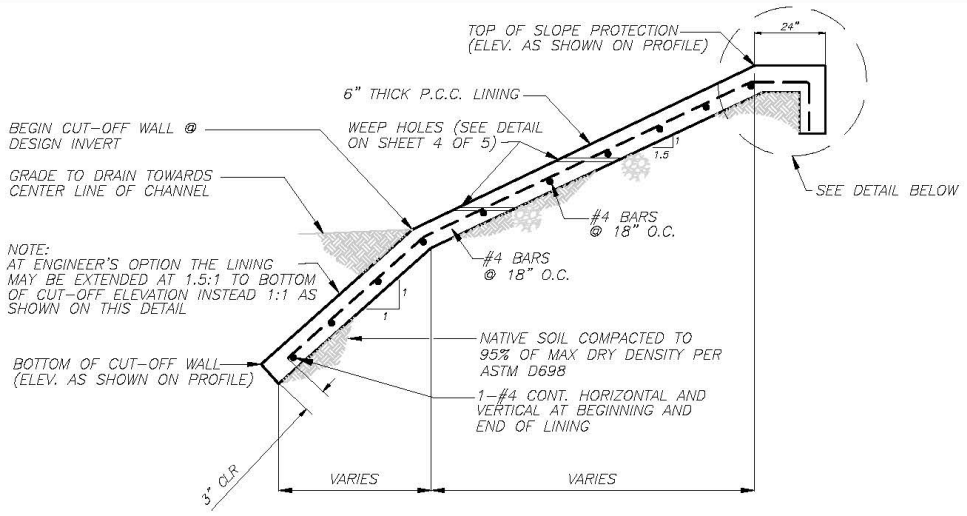
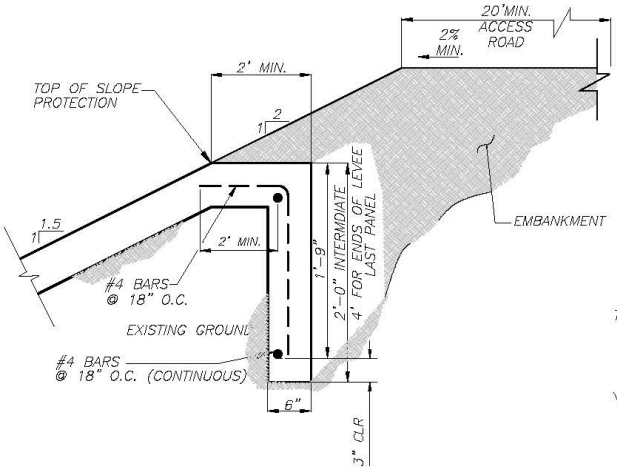


SLOPE PROTECTION DETAIL
NTS

NOTE: 1) CONCRETE CLASS 560-C-3250 OF SUBSECTION 201-1.1.2 OF THE SSPWC (560 lbs/cy PORTLAND CEMENT, GRADE C AGGREGATE GRADATION, MIN. COMPRESSIVE STRENGTH OF 3250 PSI, 4-IN MAX SLUMP). WHEN APPLICABLE HIGHER STANDARDS MAY BE REQUIRED PER APPROVED SOILS REPORT.

2) MINIMUM REBAR COVERAGE = 1.5"

3) ALL REBAR SHALL BE DEFORMED BARS AND CONFORM TO ASTM A-615 GR 60 OR A706 GR 60



SLOPE PROTECTION DETAIL
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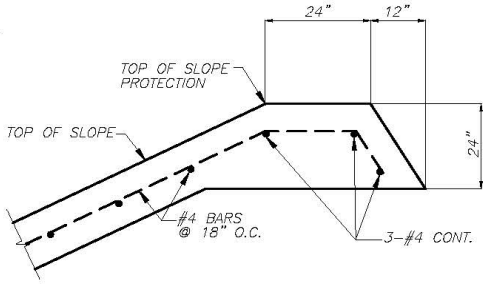

ALTERNATE SLOPE PROTECTION DETAIL
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TYPICAL SLOPE PROTECTION DETAILS

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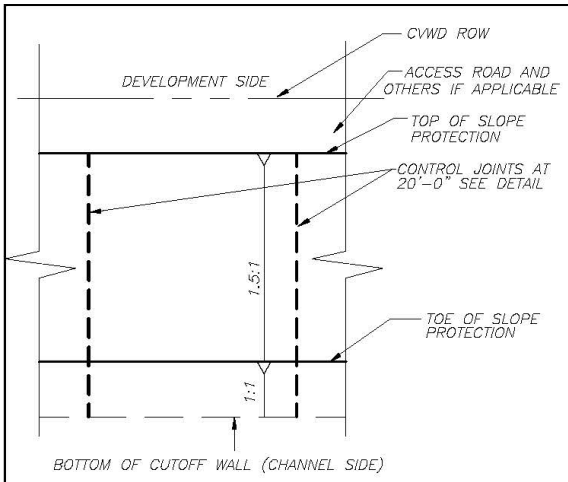
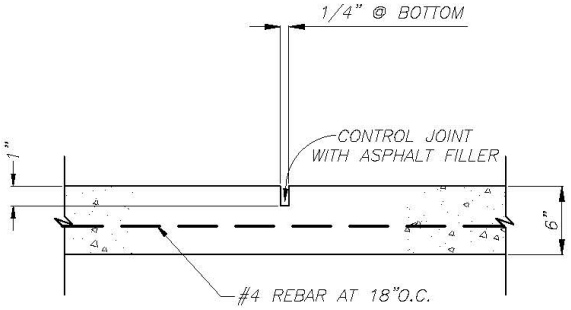


CONTROL JOINT PLAN
NTS



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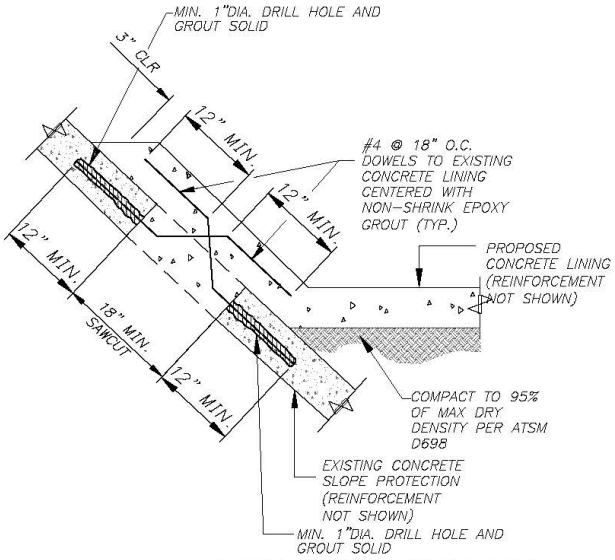

CHANNEL PAVING AT EXISTING SLOPE LINING AND CONSTRUCTION JOINT DETAIL
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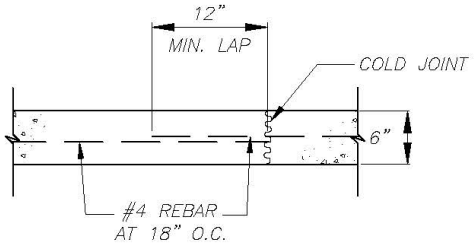

COLD JOINT
NTS

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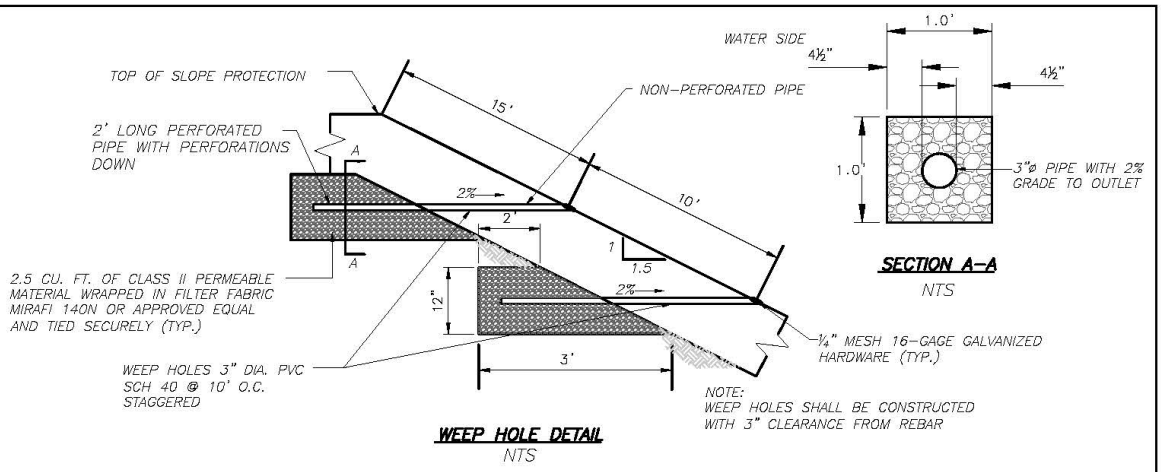

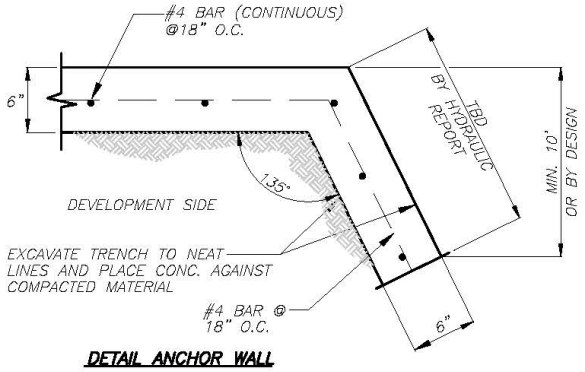

DETAIL ANCHOR WALL
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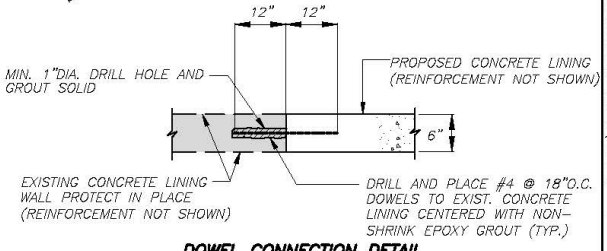

DOWEL CONNECTION DETAIL FOR SLOPE PROTECTION
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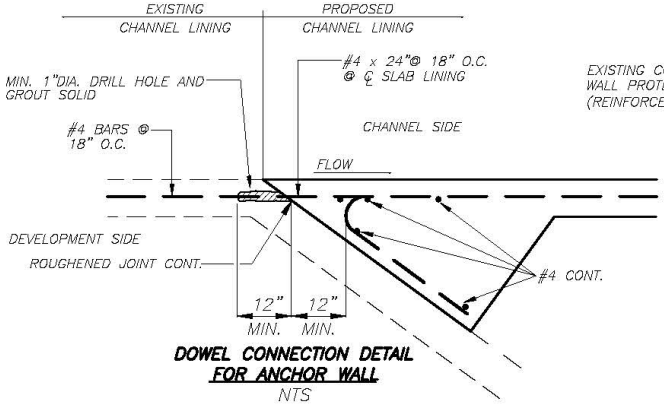

DOWEL CONNECTION DETAIL FOR ANCHOR WALL
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TYPICAL SLOPE PROTECTION DETAILS

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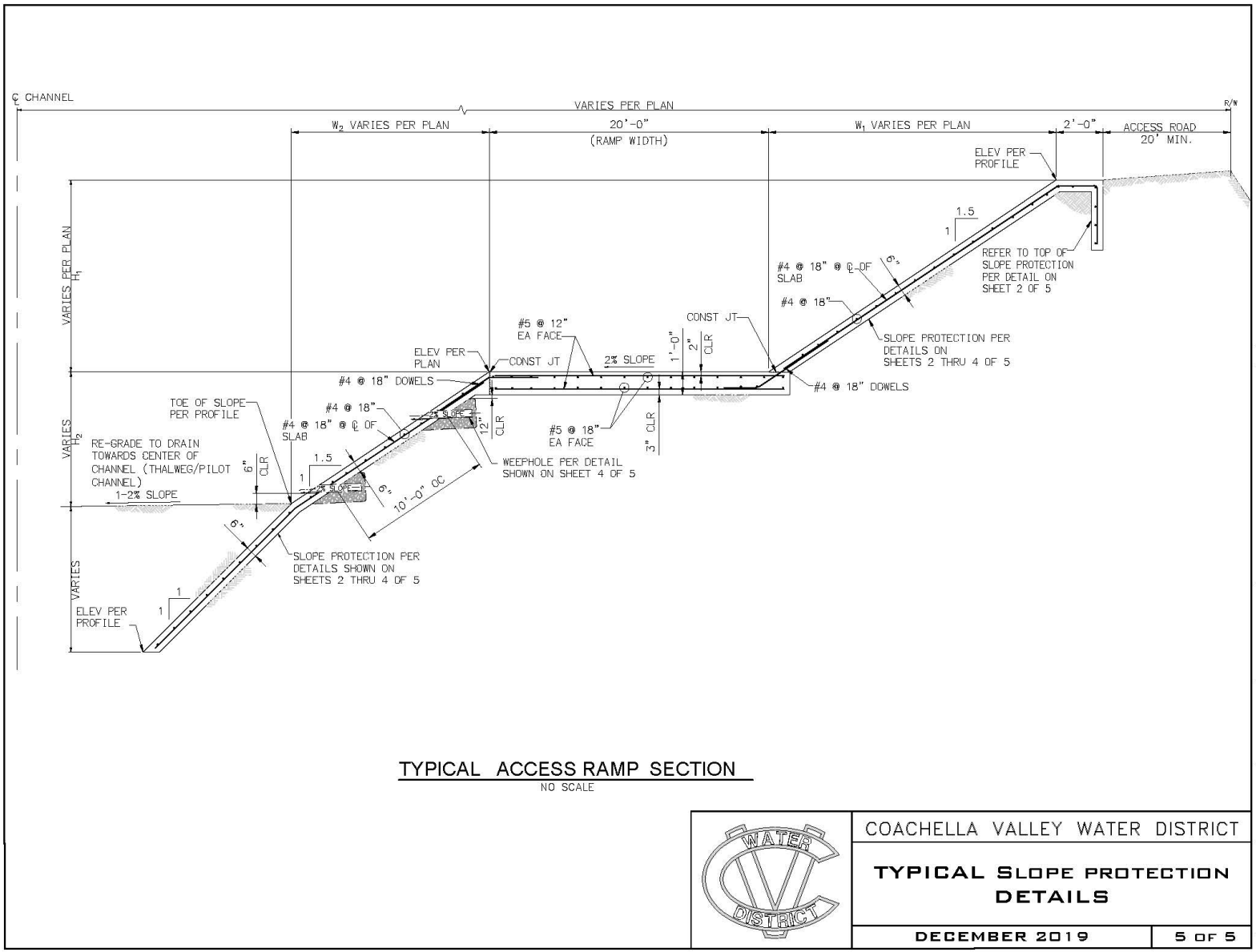

TYPICAL ACCESS RAMP SECTION

NO SCALE

COACHELLA VALLEY WATER DISTRICT	
TYPICAL SLOPE PROTECTION DETAILS	
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