Chapter 11 Outfall Systems

This section presents the methods, criteria and details for analysis and design of outfall systems. Properly designed outfalls are critical to reducing the chance of adverse impacts as the result of concentrated discharges from pipe systems and culverts, both onsite and downstream. Outfall systems include piping, rock splash pads, flow dispersal trenches, gabion or other energy dissipaters.

11.1 Outfall Design Criteria

All outfalls must be provided with an appropriate outlet / energy dissipation structure such as a dispersal trench, gabion outfall, or rock splash pad (see Figure 3 - 35) as specified below and in Table 3 - 21.

No erosion or flooding of downstream properties shall result from discharge from an outfall.

Table 3 - 21: Rock Protection at Outfalls

Discharge Velocity at Design Flow in Feet per Second (fps)	Required Protection (Minimum Dimensions)				
	Type	Thickness	Width	Length	Height
0 – 5	Rock lining(1)	1 foot	Diameter + 6 feet	8 feet *or* 4 x diameter, whichever is greater	Crown + 1 foot
>5 - 10	Riprap(2)	2 feet	Diameter + 6 feet *or* 3 x diameter, whichever is greater	12 feet *or* 4 x diameter, whichever is greater	Crown + 1 foot
>10 - 20	Gabion outfall	As required	As required	As required	Crown + 1 foot
>20	Engineered energy dissipater required				

NOTES:

(1) **Rock lining** shall be quarry spalls with gradation as follows:

- Passing 8-inch square sieve: 100%
- Passing 3-inch square sieve: 40 to 60% maximum
- Passing 3/4-inch square sieve: 0 to 10% maximum

(2) **Riprap** shall be reasonably well graded with gradation as follows:

- Maximum stone size: 24 inches (nominal diameter)
- Median stone size: 16 inches
- Minimum stone size: 4 inches

Riprap sizing is based on outlet channel side slopes of approximately 3:1.

11.1.1 Energy dissipation

- For freshwater outfalls with a design velocity greater than 10 fps, a gabion dissipater or engineered energy dissipater may be required. The gabion outfall detail shown in Figure 3 - 38 is illustrative only. A design engineered to specific site conditions must be developed.
- In marine waters, rock splash pads and gabion structures are not recommended due to corrosion and destruction of the structure, particularly in high energy environments. Diffuser Tee structures, such as that depicted in Figure 3 - 39, are also not generally recommended in or above the intertidal zone. They may be acceptable in low bank or rock shoreline locations. Generally, tightlines trenched to extreme low water or dissipation of the discharge energy above the ordinary high water line are preferred. Outfalls below extreme low water may still need an energy dissipation device (e.g., a tee structure) to prevent erosion in the immediate vicinity of the discharge.
- Engineered energy dissipaters, including stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, are required for outfalls with design velocity greater than 20 fps. These should be designed using published or commonly known techniques found in such references as Hydraulic Design of Energy Dissipaters for Culverts and Channels, published by the Federal Highway Administration of the United States Department of Transportation; Open Channel Flow, by V.T. Chow; Hydraulic Design of Stilling Basins and Energy Dissipaters, EM 25, Bureau of Reclamation (1978); and other publications, such as those prepared by the Soil Conservation Service (now Natural Resource Conservation Service).
- Alternate mechanisms may be allowed with written approval of Environmental Services. Alternate mechanisms shall be designed using sound hydraulic principles with consideration of ease of construction and maintenance.
- Mechanisms that reduce velocity prior to discharge from an outfall are encouraged. Some of these are drop manholes and rapid expansion into pipes of much larger size. Other discharge end features may be used to dissipate the discharge energy. An example of an end feature is the use of a Diffuser Tee with holes in the front half, as shown in Figure 3 - 39.

Stormwater outfalls submerged in a marine environment can be subject to plugging due to biological growth and shifting debris and sediments. Regular maintenance is needed to ensure the outfall continues to function as designed.

The in-stream sample gabion mattress energy dissipater may not be acceptable within the ordinary high water mark of fish-bearing waters or where gabions will be subject to abrasion from upstream channel sediments. A gabion basket located outside the ordinary high water mark should be considered for these applications.

11.1.2 Flow dispersion

- The flow dispersal trenches shown in Figure 3 - 36 and Figure 3 - 37 shall not be used unless both criteria below are met:
  - An outfall is necessary to disperse concentrated flows across uplands where no conveyance system exists and the natural (existing) discharge is unconcentrated; and
  - The 100-year peak discharge rate is less than or equal to 0.5 cfs.
- Flow dispersion may be allowed for discharges greater than 0.5 cfs, providing that adequate design details and calculations for the dispersal trench to demonstrate that discharge will be sheet flow are submitted and approved by Environmental Services. For

dispersion trenches discharging more than 0.5 cfs, additional vegetated flow path may be required.

- For the dispersion trenches shown in Figure 3 - 36 and Figure 3 - 37, a vegetated flowpath of at least 25 feet in length must be maintained between the outlet of the trench and any property line, structure, stream, wetland, or impervious surface. A vegetated flowpath of at least 50 feet in length must be maintained between the outlet of the trench and any steep slope. Sensitive area buffers may count towards flowpath lengths.
- All dispersions systems shall be at least 10 feet from any structure or property line. If necessary, setbacks shall be increased from the minimum 10 feet in order to maintain a 1H:1V side slope for future excavation and maintenance.
- Dispersion systems shall be setback from sensitive areas, steep slopes, slopes 20% or greater, landslide hazard areas, and erosion hazard areas as governed by the Tacoma Municipal Code or as outlined in this manual, whichever is more restrictive.
- For sites with multiple dispersion trenches, a minimum separation of 10 feet is required between flowpaths. Environmental Services may require a larger separation based upon site conditions such as slope, soil type and total contributing area.
- Runoff discharged towards landslide hazard areas must be evaluated by a geotechnical engineer or a licensed geologist, hydrogeologist, or engineering geologist. The discharge point shall not be placed on or above slopes 20% (5H:1V) or greater or above erosion hazard areas without evaluation by a geotechnical engineer or qualified geologist and City approval.

Please refer to the Tacoma Municipal Code for additional requirements. TMC 13.11 Critical Areas Protection Ordinance may contain additional requirements depending upon the project proposal. A Hydraulic Project Approval (Chapter 77.55 RCW), an Army Corps of Engineers permit, and other state and federal approvals may be required for any work within or below the ordinary high water mark.

Other provisions of that RCW or the Hydraulics Code - Chapter 220-110 WAC may also apply.

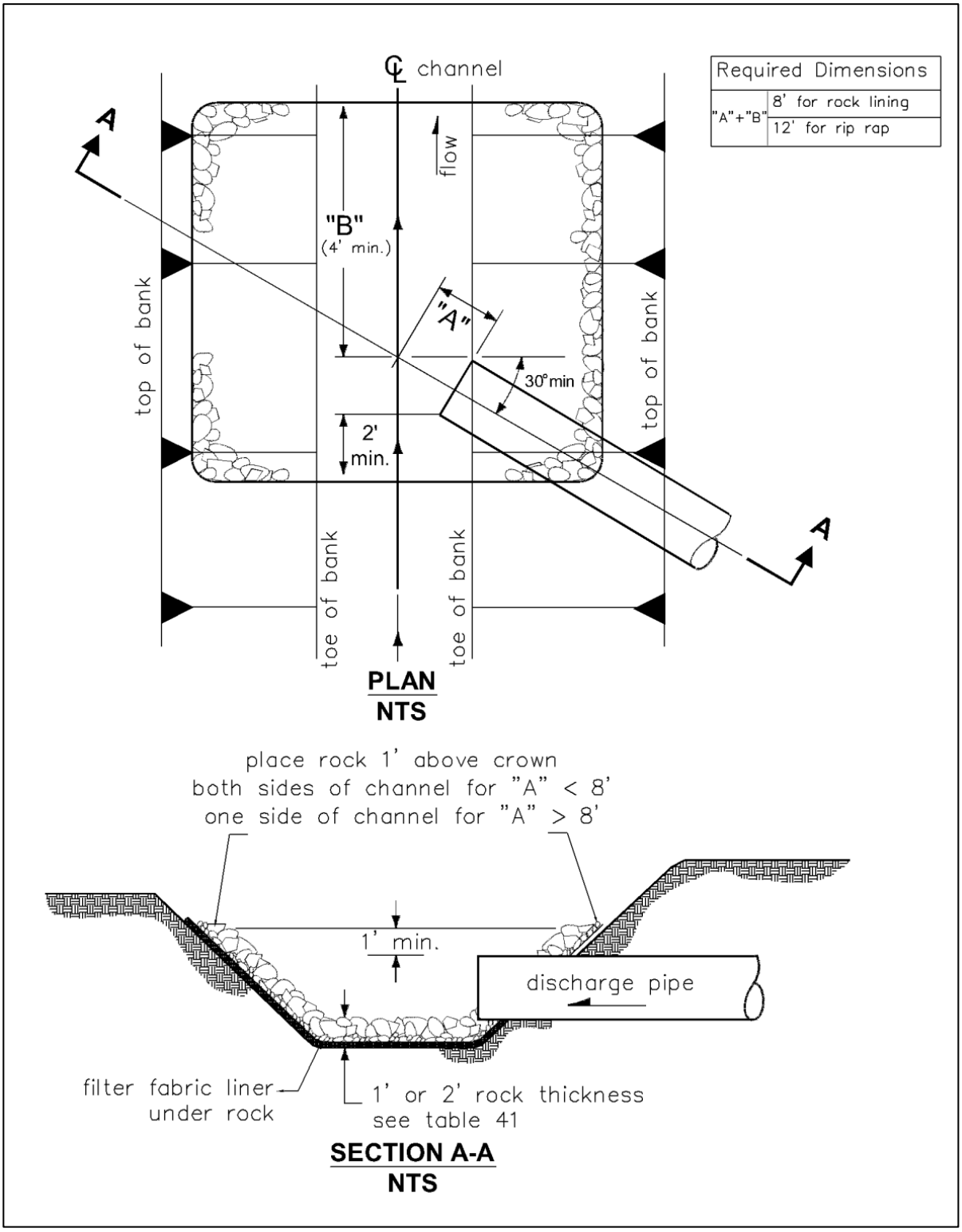

Figure 3 - 35. Pipe/Culvert Outfall Discharge Protection

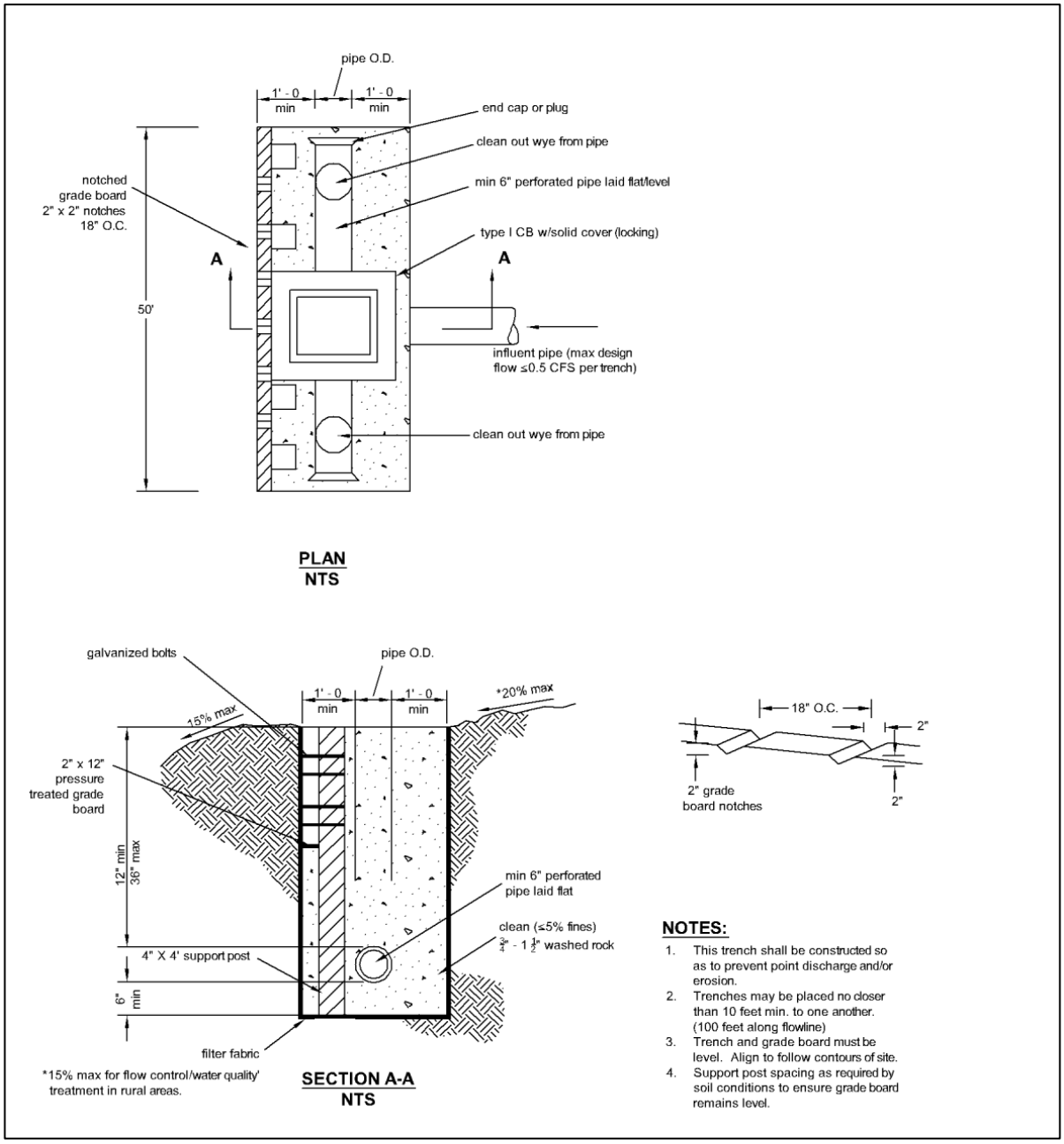

Figure 3 - 36. Flow Dispersal Trench

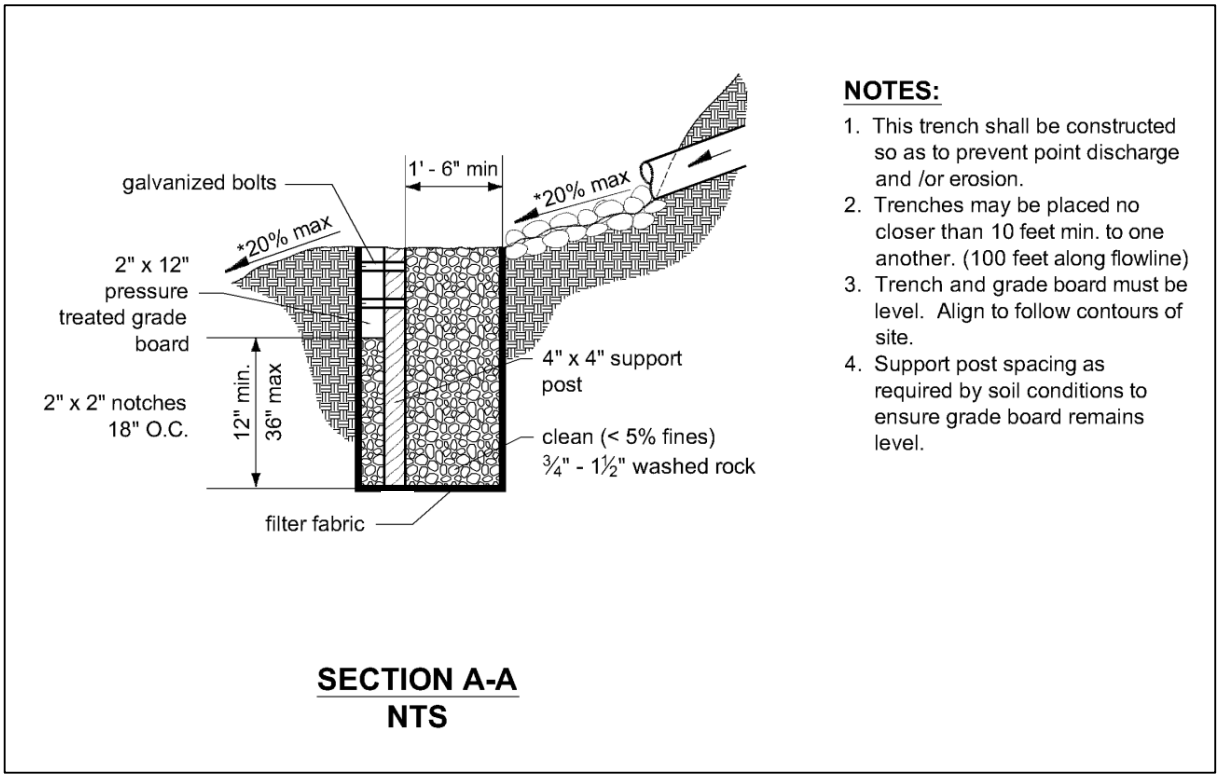

Figure 3 - 37. Alternative Flow Dispersal Trench

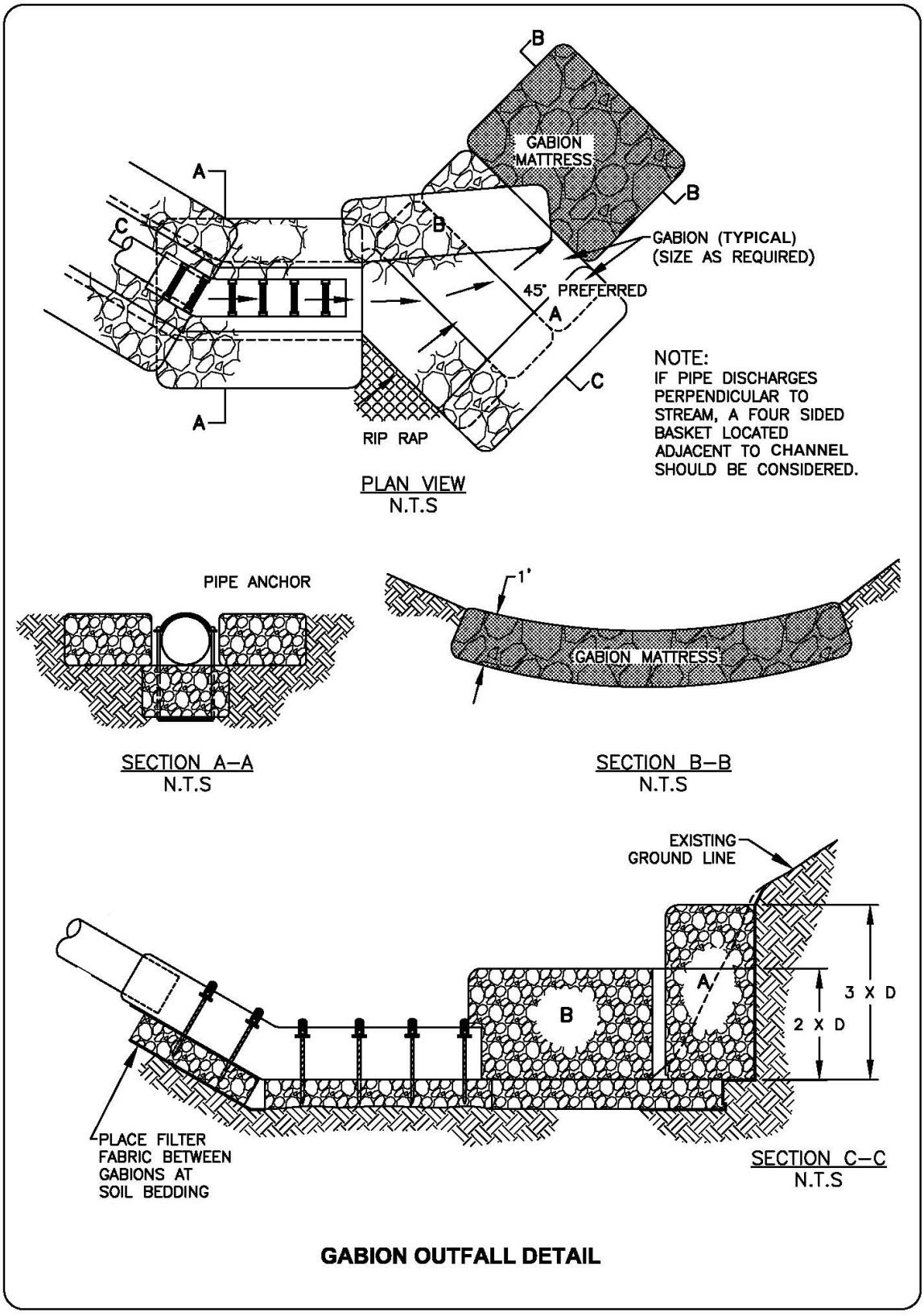

Figure 3 - 38. Gabion Outfall Detail

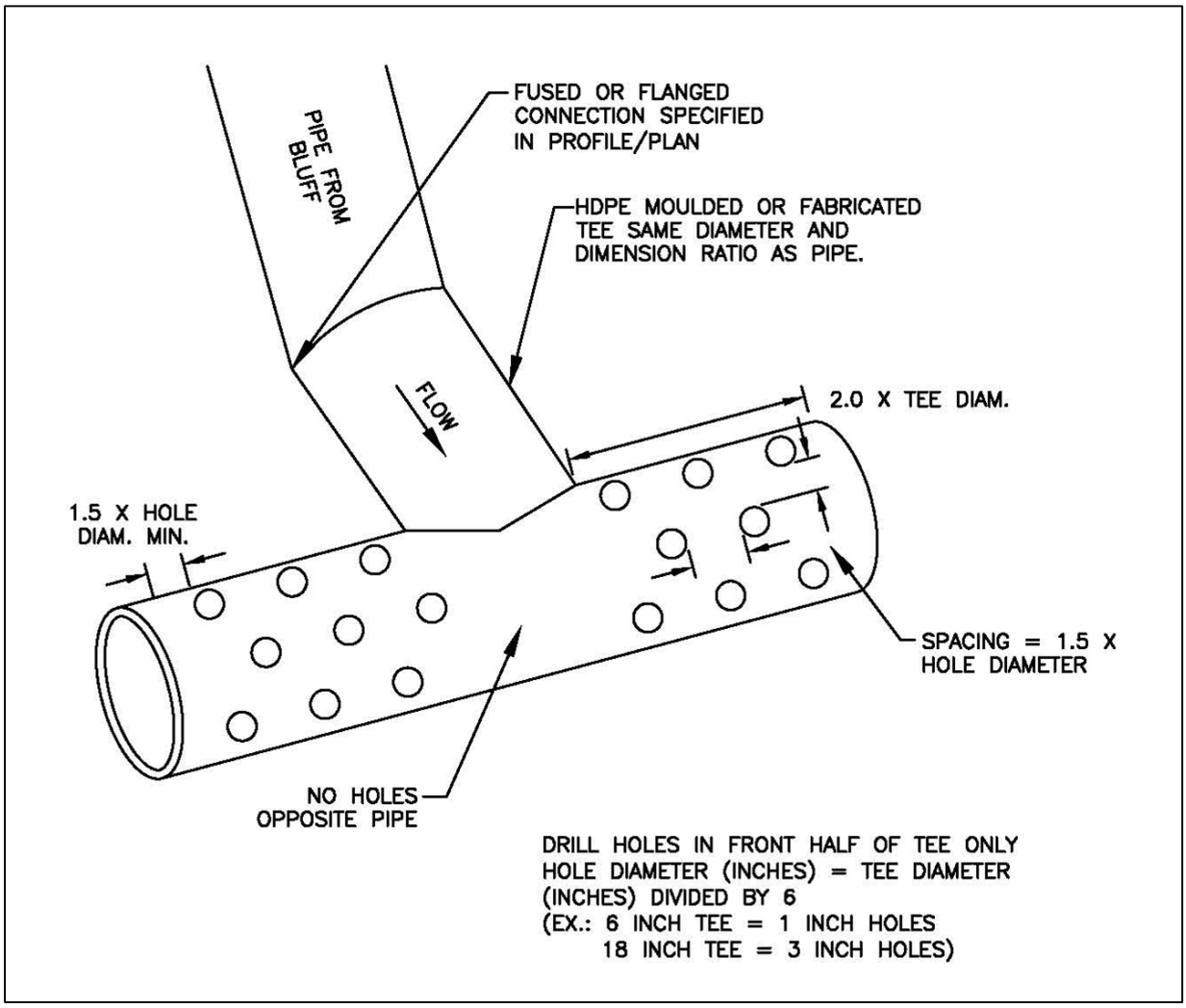

Figure 3 - 39. Diffuser TEE (an example of energy dissipating end feature)

11.2 Tightline Systems

- Outfall tightlines may be installed in trenches with standard bedding on slopes up to 20%. In order to minimize disturbance to slopes greater than 20%, it is recommended that tightlines be placed at grade with proper pipe anchorage and support.
- Except as indicated above, tightlines or conveyances that traverse the marine intertidal zone and connect to outfalls must be buried to a depth sufficient to avoid exposure of the line during storm events or future changes in beach elevation. If non-native material is used to bed the tightline, such material shall be covered with at least 3 feet of native bed material or equivalent.
- High density polyethylene pipe (HDPE) tightlines must be designed to address the material limitations, particularly thermal expansion and contraction and pressure design, as specified by the manufacturer.
- Due to the ability of HDPE tightlines to transmit flows of very high energy, special consideration for energy dissipation must be made. Details of a sample gabion mattress

energy dissipater have been provided as Figure 3 - 38. Flows of very high energy will require a specifically engineered energy dissipater structure.

- Tightline systems may be needed to prevent aggravation or creation of a downstream erosion problem.
- Tightline systems shall have appropriate anchoring designed, both along the slope and to provide anchoring for the entire system.

11.3 Habitat Considerations

- New pipe outfalls can provide an opportunity for low-cost fish habitat improvements. For example, an alcove of low-velocity water can be created by constructing the pipe outfall and associated energy dissipater back from the stream edge and digging a channel, over widened to the upstream side, from the outfall to the stream. Overwintering juvenile and migrating adult salmonids may use the alcove as shelter during high flows. Potential habitat improvements should be discussed with the Washington Department of Fish and Wildlife biologist prior to inclusion in design.
- Bank stabilization, bioengineering and habitat features may be required for disturbed areas.
- Outfall structures should be located where they minimize impacts to fish, shellfish, and their habitats.
- The City's Critical Area Preservation Ordinance and other state and federal regulations may regulate activities in these areas.