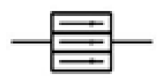
3.3.2.3 Temporary Instream Diversion



INSTREAM DIVERSION

Source: TDOT

Definition and Purpose

Instream diversions use temporary dikes to redirect stream baseflow, allowing for construction activities such as multi-barrel box culverts, bridges, bank stabilization, structural repairs, and intake or outfall installations. This method typically channels water into an existing or newly built barrel, keeping other construction areas dry. By isolating the work zone from the active flow of water, instream diversions help minimize sediment transport and protect water quality.

Appropriate Applications

Instream diversions are practical solutions for projects requiring instream work, particularly when constructing multiple barrel structures. When properly phased, they can also accommodate projects where roadway traffic must be maintained during construction (TDOT). Where applicable, an instream diversion may be more cost-effective than a temporary diversion channel or a temporary diversion culvert.

Limitations and Maintenance

Instream diversions are designed to convey low flow conditions as opposed to a design event like temporary channels or culverts. As a result, they are more susceptible to overtopping during rainfall. When selecting a diversion method, evaluate both the duration of construction and the potential impacts of flooding within the work area. Dewatering practices used for the diversion will need to be maintained to function as intended (Section 4.4.12.2).

Installing instream diversions in jurisdictional waters requires additional permits, such as an ARAP, and therefore, both the conditions of the CGP and ARAP must be followed. A Section 404 permit from USACE may also be required, and if the proposed instream diversion is to be completed in a TVA reservoir, a TVA 26a permit may also be necessary. Consider the criteria and conditions of the necessary permits during the planning stages of the project and EPSC plans.

Planning and Design Considerations

Effective instream diversions require careful sequencing to ensure both regulatory compliance and functional efficiency. The symbol and detail can be shown in the plan set with generalized sequencing notes. These notes not only assist TDEC reviewers in verifying compliance with the CGP but also establish a foundation for more detailed sequencing notes once a contractor is selected. After a contractor is hired, refine and update these notes, as necessary, on the plan sheets to reflect the specific construction approach. Ultimately, the permittee bears responsibility for ensuring that all permit conditions are met before approving the work.

To ensure effective flow management, set the diversion elevation at least one foot above the baseflow elevation within the reduced channel width of the stream (TDOT). Though not required in the state of Tennessee, some states implement side slope limitations of the diversion to 2H:1V (ALSWCC, 2022; GSWCC, 2016). For projects requiring uninterrupted roadway access during construction, the engineer may need to extend the overall length of the box structure to accommodate traffic considerations.

To assess whether the instream diversion can adequately accommodate baseflow under various channel configurations, the following methodology is recommended (TDOT):

1. *Estimate flow characteristics*: Determine the typical width and depth of flow within a representative section of the stream under normal conditions. This can be achieved using field measurements, aerial imagery, or site topographical data.
2. *Calculate cross-sectional flow area*: If the channel is rectangular, multiply the estimated flow depth by the stream width to compute the total cross-sectional flow area. For other channel configurations, refer to Table 2-A.
3. *Determine diverted flow depth*: Identify the width of flow through the diversion channel and divide the original cross-sectional area by this new width to estimate the depth of flow in the diverted section, if rectangular. For other geometries, refer to Table 2-A.

4. *Verify wetted perimeter*: Compute and compare the wetted perimeter of both the natural stream cross-section and the diverted section (Table 2-A). If the diverted section exhibits a greater wetted perimeter, it indicates excessive channel narrowing. In such cases, adjust the design to provide a wider flow width to prevent excessive flow constriction.
5. *Establish final diversion height*: Set the final elevation of the diversion at least one foot above the newly determined diverted flow depth to ensure adequate containment.

Hydraulic computations for each channel shape are governed by channel geometries (Table 2-A), the Continuity Equation (Eqn 7), and Manning's Equation (Eqns 6 and 8). However, tools can be used to reduce computation time, ensure accurate computations, and/or for less typical cross sectional shapes (Fang, 2007; Mejia & Ponce; Perez et al. 2015) as specified in Section 2.1.2.

Where possible, design the sinuosity of the diverted section to mimic the natural flow path of the stream to minimize hydrologic disruption, such that the diversion length is greater than or equal to the length of the diverted stream portion (ALSWCC, 2022). If excavation is required to achieve the necessary flow dimensions, consider alternative diversion methods rather than expanding the existing stream channel, as widening may introduce unnecessary environmental impacts.

A variety of materials can be employed in constructing instream diversions, with polyethylene sheeting (minimum six mil thickness) commonly incorporated to enhance effectiveness. For instance, integrating polyethylene sheeting within a sandbag berm or draping it over jersey barriers can help maintain flow separation and prevent seepage into the work area.

Conduct dewatering using a pump system once the instream diversion is in place and has successfully isolated the work area from the active flow. Effluent from this operation must be properly managed by directing it through a sediment filter bag (refer to Section 4.4.12.6) or a designated dewatering structure (refer to Section 4.4.12.2) to prevent sediment discharge and maintain water quality standards.

Example Application

-Example courtesy of TDOT-

Given:

An existing slab bridge on vertical abutments with a span of 20 feet is to be replaced by a box bridge with three 12-foot spans. A temporary run around will be used to maintain traffic so that the structure can be replaced without traffic. The designer has determined that an instream diversion may be used at this site.

Determine:

The height for the instream diversion.

Solution:

Step 1- Assume a phasing plan: Although it is the responsibility of the contractor to devise a phasing plan, the designer will need to make an educated guess of the plan in order to estimate lengths for each section of the instream diversions.

Based on the bridge layout plan, it appears that the channel will be shifted somewhat to the west in order to accommodate the increased width of the proposed structure. Thus, it is assumed that the phase 1 instream diversion will extend from the west bank of the channel to the west side of the existing structure. This will maintain flows through the existing structure while allowing the western most barrel of the proposed structure to be built. In phase 2, flows would be diverted into the new barrel of the proposed structure by extending instream diversions from the east bank of the channel to the east side of the new barrel. This will allow the demolition of the existing structure and the construction of the two remaining barrels.

Step 2- Determine heights of the instream diversions: Aerial photography of the site is examined in order to estimate the average water surface width of the stream in the project area. This is found to be 25 feet. In this same area, the project survey data indicated that the flow line of the stream is about 1.2 feet below the elevation at the edge of the water. Thus, the cross-sectional flow area (A) and wetted perimeter (P) of the normal flow are computed following Table 2-A:

$$A = 25 \times 1.2 = 30 \text{ ft}^2$$

$$P = 25 + 2 \times 1.2 = 27.4 \text{ ft}$$

In phase 1, the width of flow in the diverted section will be 20 feet. Since the cross-sectional area of the flow in the diverted section is assumed to be equal to the natural cross-sectional flow area, the depth in the diverted section (d_d) is estimated as:

$$d_d = 30 / 20 = 1.5 \text{ ft}$$

Based on this depth, the wetted perimeter of the flow in the diverted section is computed following Table 2-A:

$$P = 20 + 2 \times 1.5 = 23 \text{ ft}$$

Since the wetted perimeter in the diverted section is less than in the natural section, the flow width will be adequate. Thus, the required minimum height of the instream diversion will be 2.5 feet.

In phase 2, the width of the diverted section will be reduced to 12 feet. Using the same process as described above, the depth in the diverted section is found to be 2.5 feet, and the wetted perimeter is found to be 17 feet. Again, the wetter perimeter in the diverted section is found to be less than that in the natural section, and the height of the instream diversion will be 3.5 feet.

References

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