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Continuing Education Course #051
Considerations In Estimating Tailwater Elevations
For Hydraulic Calculations

1. When designing a project, the Drainage Engineer should typically be concerned with the following:
- ○ a. Drainage of the project site itself
- ○ b. Impact of the project on adjacent upstream properties
- ○ c. Impact of the project on adjacent downstream properties
- ○ d. All of the above

2. Adverse impacts to adjacent parcels on the upstream side of a project normally show up in the form of increased water stages.
- ○ a. True
- ○ b. False

3. Increased discharges to adjacent parcels on the downstream side of a project site are not typically considered as adverse or negative impacts.
- ○ a. True
- ○ b. False

4. Determination of whether adjacent properties are adversely impacted by project site improvements is usually evaluated by regulatory permitting agencies, but should be addressed by the Design Engineer during the design of the project.
- ○ a. True
- ○ b. False

5. Tailwater refers to waters located immediately downstream from a hydraulic structure.
- ○ a. True
- ○ b. False

6. Tailwater elevations are critical to the calculations when "Inlet" control conditions exist.
- ○ a. True
- ○ b. False

7. For "Outlet" control conditions, which of the following factors are considerations in determining how high water gets on the upstream side of a culvert?
- ○ a. Discharge, culvert size, entrance configuration
- ○ b. Barrel characteristics (roughness, area, shape, length, and slope)
- ○ c. Tailwater elevation
- ○ d. All of the Above

8. Culverts in low-lying, flat terrain areas may be under inlet control for low flow conditions, but will typically be under outlet control for design flows and high discharge conditions.

○ a. True
○ b. False

9. An engineer is designing the control structure from a stormwater pond. The control structure is a typical "drop"structure consisting of a modified ditch bottom inlet with a weir and orifice cut into the structure wall and then a section of pipe. The outlet end of the pipe is at a ditch that drains away from the structure. In coming up with a tailwater elevation, the preferred method would be to:
○ a. Conservatively set the tailwater at the downstream crown elevation of the outlet pipe.
○ b. Calculate normal depth in the ditch and use that as the tailwater elevation.
○ c. Use the depth resulting from the equation (dc+D)/2, where dc is the critical depth and D is the pipe diameter
○ d. Evaluate if there are downstream influences in the ditch such as culverts, weirs other structures, etc. and perform backwater calculations to determine the tailwater at the project discharge point, taking into account the increase in discharge due to the additional contributing downstream drainage area, and hydraulic losses associated with the downstream conveyances.

10. Of the following, which typical tailwater condition is least likely to be under "Outlet" control?
○ a. Discharge into a lateral ditch draining away from the hydraulic structure
○ b. Discharge into a ditch running parallel to the roadway
○ c. Discharging into an open body of water
○ d. Discharging in close proximity to a downstream hydraulic structure
○ e. Discharging at a location where ground elevations drop rapidly downstream of the end of the structure
○ f. Discharging in a sumped outlet condition
○ g. Discharging through a "Bubbler Structure"

11. A cross drain culvert, a storm drain system, and a stormwater pond all discharge at the same location. Since they are all discharging at the same point, the same tailwater elevation should be used for the design of each.
○ a. True
○ b. False

12. A storm drain is being designed to discharge into an existing storm drain system. The design engineer has not been provided storm drain tabulations for the existing system. However, drainage maps and construction plans for the existing system are available. The design engineer should:
○ a. Use the drainage maps and plans to recreate storm drain tabulations and calculate the hydraulic gradient at the point of connection.
○ b. Assume the hydraulic gradient for the proposed storm drain system is at the crown of the pipe at the point of connection to the existing system
○ c. Assume the hydraulic gradient to be 1-ft. below the inlet elevation at the point of connection to the existing system
○ d. Conservatively assume the existing hydraulic gradient elevation to be at the existing inlet elevation at the point of connection to the existing system.

13. Which of the following is not a potential consequence of overestimated tailwater elevations (i.e. actual tailwater elevations for design storms are less than predicted)?
○ a. Lower pond stages
○ b. Larger pond sizes
○ c. Smaller pipe sizes
○ d. More fill for project site
○ e. Increased actual discharges to downstream adjacent parcels

14. Culvert cross drains are typically designed for 25-year or 50-year frequencies depending on the importance of the roadway. In addition the Federal Highway Administration (FHWA) requires evaluating these cross drains for the 100-year (base flood) and the greatest (500-year) or overtopping flood event. Is it usually appropriate to use a seasonal high water elevation or permanent stain line on the culvert endwall at the outlet end as a tailwater elevation?

○ a. Yes
○ b. No

15. Which of the following are not considerations in determining whether assumed or calculated tailwater elevations are reasonable?
○ a. Existing physical conditions downstream of structure
○ b. Observed water levels
○ c. Recorded high water levels
○ d. Historical drainage maps with high water elevations
○ e. Results from published studies and models
○ f. None of the above

16. For a tailwater condition which consists of a trapezoidal channel, if the calculated depth exceeds the top of bank elevation for the channel, what would be the appropriate channel section to assume in the FHWA HY-8 Culvert program for determining the tailwater?
○ a. Trapezoidal Channel
○ b. Irregular Channel

17. In the preceding question, which modeled channel configuration would be expected to give the higher tailwater elevation assuming the same range of discharges, same channel bottom slope, same channel side slopes, same roughness coefficient, etc.?
○ a. Trapezoidal Channel
○ b. Irregular Channel

18. Will a higher than anticipated tailwater elevation be expected to cause a higher than anticipated water surface elevation on the upstream side of a hydraulic structure?
○ a. Yes
○ b. No

19. If underdrain systems are unable to lower the groundwater levels because of higher than anticipated tailwater elevations, the base and roadway pavement can be adversely affected.
○ a. True
○ b. False

20. The assumption of a constant tailwater elevation at a project site's discharge point is usually valid in dynamic routing calculations if the project site is being modeled, and the site discharges upstream of the additional conveyances and contributing drainage areas, which are not included in the modeling.
○ a. True
○ b. False

21. Assuming a high tailwater for a "conservative" design can result in underestimating the actual post-developed discharge rate, which can lead to downstream flooding problems.
○ a. True
○ b. False

22. Which of the following is the biggest pitfall in estimating tailwater elevations?
○ a. Ignoring downstream contributing area influences on tailwater
○ b. Not accounting for downstream controls that may influence tailwater
○ c. Failing to adequately document the assumptions made in establishing tailwater elevations
○ d. Assuming a "High" tailwater elevation for "Conservative" design
○ e. Accepting watershed model results Without verification that results are reasonable

23. If the estimated tailwater is too low and the actual tailwater is higher than estimated, which of the following potential problems can result?

- ○ a. Increased potential for project site to flood
- ○ b. Stormwater management system may not function as designed
- ○ c. Adverse impacts to upstream property owners due to increased water stages
- ○ d. All of the above

24. Which of the following should the Design Engineer consider in avoiding pitfalls in determining tailwater elevations?

- ○ a. Identify the correct design frequency to be used for design
- ○ b. Identify physical constraints that could result in higher tailwater conditions
- ○ c. Identify physical conditions that could result in lower tailwater conditions
- ○ d. Makes sure that the physical conditions are hydraulically accounted for in the tailwater calculations
- ○ e. Determine if predicted elevations are reasonable based on field review and available data
- ○ f. Verify that the correct vertical datum is used
- ○ g. Clearly document all assumptions used in determining tailwater
- ○ h. All of the above

25. It is important for the design engineer to know which vertical datum he/she is working with when evaluating calculated or assumed tailwater elevations for reasonableness.

- ○ a. True
- ○ b. False