



## MEMORANDUM

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**TO:** North Central Texas Council of Governments  
iSWM Implementation Subcommittee

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**SUBJECT:** Guidance on Inflow Forebays and Potential Alternatives

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### INTRODUCTION

The North Central Texas Council of Governments (NCTCOG) integrated Stormwater Management (iSWM) subcommittee of the Public Works Council (PWC) prepared the following summary guidance on wet pond inflow forebays for municipalities with support from Halff Associates, Inc. The current iSWM manual includes several options for dry pond outfalls that are not submerged. Outfalls that are submerged within a wet pond present specific challenges. Inflow forebays in ponds provide energy dissipation and water quality benefit to flows entering the basins. The following memo outlines the advantages and disadvantages of different types of forebays and introduces considerations for additional guidance on forebay design and maintenance.

### CURRENT ISWM GUIDANCE ON FOREBAY DESIGN

Forebays are mentioned throughout the current iSWM Site Development Control Manual, including references and design criteria included as part of the controls for Enhanced Swales (Section 3), Dry Detention/Extended Detention (Section 10), Infiltration Trench (Section 20), Stormwater Ponds (Section 22), and Stormwater Wetlands (Section 28). The recommended proposed sizing for forebays is 0.1 inches of runoff per impervious acre of drainage area, and forebays are recommended to be between four and six feet deep. When designing forebays, the iSWM criteria allow for the forebay storage volume to count towards the overall Water Quality Volume requirement. Finally, the manual recommends installing vertical sediment depth markers in forebays to indicate when maintenance is required.

Under the current guidance, a forebay is to be provided at each inlet, unless the inlet provides less than 10% of the total design storm inflow to the pond (iSWM Technical Manual – Site Development Controls, Section 22.5, D.)

Forebays are also an integral part of riprap basins, as noted in the Hydraulics Technical Memorandum. They perform a similar function as those in the Site Development Control Manual, performing to reduce exit velocities from outfalls and collect sediment and debris.



## FOREBAY OPTIONS FOR ALL WATERSHEDS

Two types of commonly used forebays are outlined below with their respective advantages and disadvantages. These forebays are employed typically for concentrated inflows to ponds and may be challenging to design for small applications.

### TIERED FOREBAYS AND MICROPOOLS

A tiered forebay refers to a separate micropool within the basin, which can be elevated above the elevation of the larger ponding pool. This typically includes an above ground overflow channel or weir from the forebay to the pond to handle larger flows. This type of forebay is typically sized by volume of treatment required and can be lined with concrete or be planted with wet footed plants.

#### **Advantages:**

An above ground micropool can provide aesthetic benefit to a site. Some micropools are outfitted with aeration functionality, improving water quality. Micropools concentrate sediment buildup to the forebay, reducing sediment buildup and long-term maintenance in the larger ponding pool. Dissolved nutrients can be removed by planted micropools if plants are harvested and removed periodically.

#### **Disadvantages:**

Tiered micropools require more elevation change than non-tiered examples in order to create the cascading feature, and therefore may be unfeasible on some flat sites. Maintenance is also more difficult with this type of micropool than with a manufactured system due to increased footprint of the sediment capture area. Removing sediment from planted micropools can be especially difficult.

### UNDERWATER FOREBAYS

Underwater forebays are part of the overall footprint of the pond, and there is no above ground separation from the forebay to the larger ponding area. Underwater structures create a sediment forebay which is always hidden underneath the permanent ponding in the pond. This type of forebay is typically sized by volume and can be concrete lined or planted as well.

#### **Advantages:**

In this configuration, the forebay and even the inflow pipe may be hidden from view completely as they are located under the permanent ponding area. Adding one of these forebays as a retrofit may be easier due to the invert of the inlet not necessarily requiring a change.

#### **Disadvantages:**

Maintenance on this type of forebay is more difficult than on most other types. Assessing the need for maintenance is more challenging due to the lack of visibility of sediment. The forebay must be dewatered to perform maintenance, and accessing an underwater structure is more challenging than a dry structure. Additionally, the forebay may contain a large amount of saturated sediment which further increases the maintenance challenge.

#### **Other Considerations:**

When designing underwater forebays, concrete lined and planted varieties each have their merits. Concrete lined forebays provide easier maintenance, and can be cleaned without damaging any plants,



while planted forebays can provide nutrient removal if plants are harvested and removed periodically and may provide a desirable aesthetic to the pond.

## FOREBAY OPTIONS FOR SMALL WATERSHEDS

Existing iSWM guidance on forebays allows for inflows to stormwater ponds to not include a forebay if they contribute less than 10% of the pond's total inflow. Traditional forebay designs may be challenging to implement for these watershed sizes, but there are alternatives to these designs which accomplish the goals of forebays for small inflows. Some recommended alternatives to consider are outlined below, with the advantages and disadvantages outlined for each option.

### MANUFACTURED SYSTEMS

Manufactured systems such as hydrodynamic separators (HDS) and screening systems are potential supplements or replacements for typical wet-pond inflow forebays. Manufactured systems are rated for levels of treatment in some areas of the country by formal testing and approval processes. These systems rate the system for its level of treatment based on design factors such as flow rate and volume. Manufacturers of the systems also provide design guidance.

#### **Advantages:**

This type of system can provide water quality benefit in a small footprint, with minimal visibility on the surface. HDS units can be placed online such that they provide a single point of maintenance for sediment and trash removal.

#### **Disadvantages:**

HDS units will require access for a vacuum truck in order to provide maintenance and removal of sediment and trash from the system. Manufactured systems may incur a higher initial cost than their on-site construction counterparts. Also, a system that is buried underground does not provide any aesthetic benefit to a site, whereas some aboveground forebay options may be desirable for this purpose.

#### **Examples:**

##### Hydrodynamic Separator (HDS)

Hydrodynamic separators cause the settling of particles by swirling fluids in a vortex which reduces settling time. Some HDS units include a separate up-flow configuration that can further enhance removal. HDS units can be effective at removing Total Suspended Solids (TSS) from stormwater at rates of up to 90% TSS removed.

HDS units can treat other suspended particles as well, including phosphorous, copper, zinc, and lead with high removal rates. Some systems may be outfitted with grease skimmers which allow the removal of up to 99% oils and grease from incoming flow.

##### Screening Systems

Manufactured screening systems can be implemented to remove gross solids from stormwater. They are effective at removing floatables such as leaves and trash. This type of system is typically combined with other treatment types to supplement removal rates. Some systems combine screening with settling chambers so that floatables and suspended particles are removed (Nutrient Separating Baffle Box).



## SUBMERGED CONCRETE BOX FOREBAY (MANSFIELD TX)

The City of Mansfield has proposed a forebay alternative consisting of vertical walls lined with concrete and a concrete lined bottom. This forms a concrete box at the outfall which is sized by volume to store the required micropool treatment volume. This type of forebay functions in a similar way to a tiered forebay.

### **Advantages:**

The proposed structure could provide a small footprint settling basin for sediment, while being less expensive and easier to construct and maintain than a traditional micropool or forebay.

### **Disadvantages:**

The type of system does not provide floatables or trash collection and will not provide water quality benefit for hydrocarbons. Additionally, the treatment levels of this shape of forebay have not been tested or approved. There may also be safety concerns with vertical walls of this depth if the vault does not include ingress or egress access.

## CONSIDERATIONS FOR ADDITIONAL GUIDANCE

Based on the existing iSWM guidance on forebay design and the current understanding of forebay principles, Halff Associates has compiled a list of considerations for additions to the iSWM guidance on forebays. The considerations are broken down by topic and briefly outlined below.

### FOREBAY VOLUME

Existing iSWM guidance indicates that forebays shall be sized to hold the volume equal to 0.1 inches of runoff per impervious acre of contributing watershed. Consider specifying volume of all be equal to 1% of the 100-year storm volume.

### FOREBAY SHAPE

Existing iSWM guidance suggests a recommended depth of 4-6 feet for forebays in stormwater ponds and wetlands. Consider providing a recommended depth for all forebays, regardless of application.

Consider adding minimum side slopes (2:1 if possible) for safety or ingress/egress.

Add guidance about how high the forebay should be relative to pipe diameter.

### FOREBAY DESIGN

Consider requiring non-erosive velocities for the two-year storm event from the forebay to the treatment device.

### WATERSHED SIZE

As mentioned above, existing iSWM guidance provides an exception for inflows to stormwater ponds that contribute less than 10% of the total pond inflow. This exception could lead to a decrease in overall water quality treatment where multiple of these small watershed inflows contribute to a pond. Consider removing this exception or adding stipulation that a percentage of the total inflow must be treated with a forebay, regardless of individual contribution from each inflow. Additionally, consider adding guidance for



the small watershed forebay alternatives outlined above; manufactured systems and the submerged concrete box forebay.

## MANUFACTURED SYSTEMS

Manufactured systems may provide an alternative to traditional forebay designs when site constraints limit construction possibilities, or contributing watersheds are small. Consider adding guidance on the design, construction, and maintenance of manufactured systems such as hydrodynamic separators. If the use of manufactured systems is to be included in iSWM guidance, consider adding information regarding the testing and approval of these systems by the New Jersey Corporation for Advanced Technology (NJCAT) verification process.

## MAINTENANCE GUIDANCE

Maintenance of forebays is important to maintain desired function. Consider adding guidance for maintenance, specifically in the following areas:

- Frequency of inspection of forebays
- Requirement of pond draw down. Draw down is typically best in the month of February, this is easiest for plant purposes and lets the pond refill with spring rains.
- Specific products of depth markers available for sediment in forebays. These products can be seen in commercially available catalogues.
- Pond maintenance may typically fall under the jurisdiction of local HOAs, which may have limited capability to maintain underwater forebays. These HOAs may not have access to boats or GPS units necessary for the maintenance of these forebays.
- Ensure that maintenance access extends to forebays.
- A signed maintenance agreement and report should accompany all Best Management Practices, as required in the iSWM Site Development Control Manual.