April 6, 2023

LCRA Highland Lakes Watershed Ordinance Technical Manual – Batch Detention

This bulletin provides technical criteria for the design, implementation, and maintenance of batch detention systems as an alternative BMP to the BMPs found in LCRA Highland Lakes Watershed Ordinance Technical Manual (5th Edition, 2007). Designers will also need to meet relevant criteria found in Sections 2, 4 and 5 of the Technical Manual.

Example Batch Detention System

As an alternative to Technical Manual Section 4.2.1 (8) (iii) (flow spreading device), the water quality outlet (6-inch PVC pipe or appropriately sized pipe) may discharge across the buffer zone to the receiving waterway, creek, or channel. Please see the Technical Manual Bulletins - BMP Details for guidance.

Example Batch Rotary Weir

Batch Detention

Description

A batch detention basin is an extended detention basin modified to operate as a batch reactor by using a smart pond automated controller or approved equal, rather than an orifice. The valve on the batch detention basin outlet is used to hold the required treatment volume for a fixed amount of time before releasing it to the receiving waterway or for further treatment in a secondary BMP. As in an extended detention basin, the batch detention basin is primarily used to remove particulate pollutants and can reduce post-development runoff rates from frequent storm events to their predevelopment levels. Batch detention basins have superior water quality performance compared to traditional extended detention basins; however, **a batch detention basin requires a secondary measure to obtain compliance with the Highland Lakes Watershed Ordinance (HLWO).**

Application

Batch detention basins may be used in small watersheds (no minimum size), since the discharge is regulated by a valve instead of an orifice. In addition, batch detention basins tend to accumulate debris deposits rapidly, making regular maintenance necessary to minimize aesthetic and performance problems. Batch detention basins can readily be combined with flood and erosion control detention facilities to satisfy other regulatory requirements. Secondary treatment is required to meet phosphorus removal requirements.

Design Guidelines

Basin geometry of a batch detention basin is not critical to performance, which allows for flexible basin designs with the ability to accommodate site constraints and incorporate aesthetic appeal. Batch Detention also provides options for integration with rainwater storage for irrigation or toilet flushing. Some constraints other than the existing topography include, but are not limited to, the location of existing and proposed utilities, depth to bedrock, and location and number of existing trees. Batch detention basins do not require a long-flow path to operate effectively.

(1) *Contributing drainage area:* Less than 128 acres is recommended and there is no minimum drainage area.

(2) *Pretreatment:* A sediment forebay is designed to retain the bulk of the sediment entering the facility. This will simplify sediment removal and reduce overall basin maintenance. Refer to the design guidelines for sediment forebays in General Guidelines Item No. 7, where the forebay volume is equal to 25% of the water quality volume to retain the first flush runoff volume. To promote advanced treatment of the first flush volume, the forebay design relies on a rock separator element (berm) and/or gabion within the basin with a height equal to 1 foot below the water level for the water quality volume. Non-woven filter fabric with a 0.15 mm (U.S. Sieve Size 100) opening shall be placed on the rock berm or gabion to ½ the height or 1 foot, whichever is higher, to facilitate maintenance. Rock rip rap should be placed on the downstream side to prevent scouring in the event flow passes over the gabion. The filter fabric should be removed at project closeout or when the contributing drainage area is stabilized, whichever comes first.

(3) *Secondary treatment:* Required after the pond in the form of a vegetative filter strip, an infiltration basin/trench or a bioretention basin.

<u>Up-gradient</u>	
Natural Vegetative Filter Strip	WQV* 0.63
Engineered Vegetative Filter Strip	WQV* 0.32
Vegetative Infiltration Strip	WQV* 0.21
<u>Down-gradient</u>	
Natural Vegetative Filter Strip	WQV* 0.24
Engineered Vegetative Filter Strip	WQV* 0.12
Vegetative Infiltration Strip	WQV* 0.08
Infiltration Basin	WQV* 0.036
Infiltration Trench (Void)	WQV* 0.019
Infiltration Trench (length) + VFS*	WQV* 0.0037 (see below for VFS information)
Bioretention	WQV*0.027

WQV = Required Water Quality Volume as calculated in Chapter 2.3 of the Technical Manual (cubic feet).

An infiltration trench also serves as a flow spreader. Optimal pollutant removal within a limited best management practices (BMP) footprint is provided when the batch detention is used in combination with an infiltration trench and vegetated filter strip.

Section 4.2.7 of the Technical Manual provides guidance on the sizing of vegetative filter strips.

(4) *Basin sizing*: The required BMP volume is calculated by applying a factor of 1.05 to the water quality volume (WQV) calculated per Chapter 2.3 of the Technical Manual. The WQV is increased by a factor of 5% to accommodate for the reduction in the available storage volume due to deposition of solids in the time between full-scale maintenance activities.

$$\text{BMP Volume} = \text{WQV} * 1.05$$

(5) *Basin configuration:* The basin should maintain a longitudinal slope between 0.5 – 2.0% with a lateral slope between 1.0 – 1.5%. A low flow channel can be provided if desired to improve drainage. No specific length to width ratio is required since all the runoff is detained for 24 hours. Maximum water depth for the water quality volume should not exceed 5 feet. Side slopes of the pond should be 3:1 (H:V) or flatter for grass stabilized slopes. Slopes steeper than 3:1 (H:V) must be stabilized with an appropriate slope stabilization practice.

(6) *Basin depth:* The water depth in the basin when full if used for flood detention must be no greater than 8 feet. The water quality volume depth must be no greater than 6 feet.

(7) *Basin outlet:* Basin drawdown is regulated by a single valve operated by an automated actuator. A perforated riser pipe or rotary weir is used to allow water into the outlet. A trash rack or other acceptable means of preventing clogging of outflow pipes or valve is required (see examples below). The outflow structure should be sized to allow for complete drawdown of the water quality volume within 48 hours after the required detention time. Velocity controls are required at the discharge point to prevent erosion and scour since there will be significant hydraulic head when the valve first opens.

Riser/Trash Rack Examples

(8) *Basin soils:* To enhance infiltration and water storage within the basin, topsoil must be placed on the basin floor after the excavated bottom is scarified to a depth of 2 to 3 inches to improve drainage. The topsoil must be 6 to 8 inches deep and composed of a soil mixture of 30-40% sand or granite sand and 60-70% topsoil, by volume. The topsoil must have a clay content less than 20% and be free of

stones, stumps, roots, or other similar objects larger than 1 inch. Caliche or infertile soils may not be used. Topsoil placement may be omitted if existing soils demonstrate an infiltration rate of 0.5 inch per hour. If a gas station or other facility, where hazardous materials are stored or dispensed, is within the pond drainage area, then an impermeable liner should be used below the topsoil. Per Technical Manual 4.2.1 (2) iii, a valve should be installed and/or the timer can be turned off in case runoff from a spill of hazardous material enters the basin. The control for the valve/timer must be always accessible, including when the basin is full.

(9) *Vegetation:* The primary vegetation in the basin should be grass ground cover. Bermuda sod is recommended for quick establishment, however sod grown on heavy clay should be avoided as this may reduce infiltration. Shrubs may be included around the perimeter of the pond and in the pond bottom for screening and to help evapotranspiration and drying between rain events. Muhly grass can be used to aid in spreading flow and concealing the riser pipe and mid-basin gabion. Irrigate as necessary to establish vegetation growth.

(10) *Controller:* The controller consists of a level sensor in the detention basin, a valve (default closed position) and actuator, and the associated control logic. **The system must be able to be monitored remotely using either a camera or system that detects the controller state**. The controller detects water filling the basin from the level sensor and initiates a 24-hour detention time when the water depth exceeds 1.0 inch. At the end of the detention time, the controller opens the valve and drains the basin into the secondary BMP. Subsequent rainfall events that occur prior to the basin draining should cause the valve to remain open and allow the additional stormwater to pass through the basin. Once the basin is drained the controller closes the valve. The drawdown time of the basin should not exceed 48 hours for a single storm event after the 24-hour required detention time. All cables should be protected by conduit and buried to prevent damage during maintenance activities.

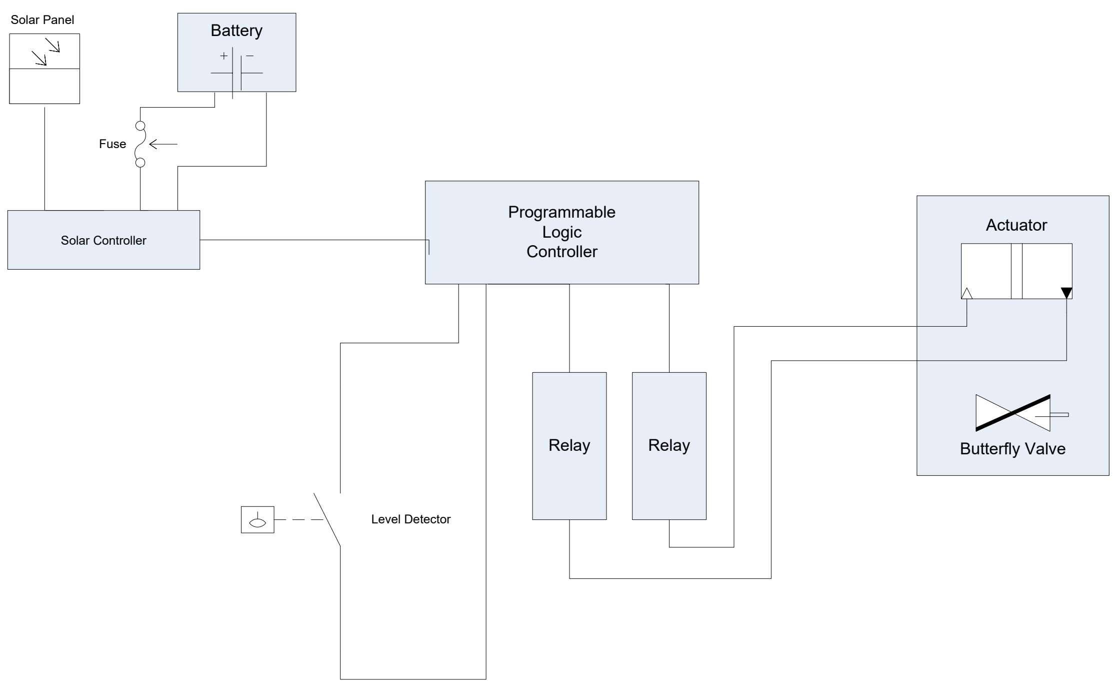
Other information to be submitted in the plan:

- Power – Indicate whether the system is line or solar powered, and the voltage of the controller and actuator. Also describe how the system will respond to a loss of power in the middle of a cycle if backup battery power is not provided.

- Logic controller – Identify the controller model and provide a general overview of cycles. The controller must be programmed to begin draining runoff from the basin 24 hours after the first runoff is sensed. The system should be programmed to have the valve remain open for two hours after the level sensor indicates the basin is empty to allow any remaining shallow water to be discharged. The system should provide the following: a test sequence, a way to deal with low battery/power outages, an on/off/reset switch, manual open/close switches (maintenance/spill), clearly visible external indicator to indicate a cycle is in progress without opening the box, and ability to exercise the valve to prevent seizing. Other features the controller must include:

- Master switch with settings to include valve open, valve closed, and automatic.
- Auto settings switch that includes a water quality mode and test mode.
- Display to easily show cycle time and time remaining.

- Parts enclosure – Provide a general description of the lockable parts enclosure.
- Circuit – Provide a block diagram of site-specific controller circuit, such as the illustrated example found below.



- Nature of event sensing – Identify the type of sensor used to indicate the water level in the basin. Float switches (mercury free) or pressure transducers are appropriate choices. In addition, the sensor must be located on a concrete pad or other location where vegetation and debris will not affect its operation.
- Valve – Identify the model of valve proposed, size, type, pressures, and over-torque sensors. A manual override should be provided. Valve selection is based on designs that are not prone to clogging if trash or debris enters

the outlet pipe. Ball valves are required as butterfly valves are prone to retaining debris. The box/manhole containing the valve and actuator must have a 2-inch diameter drainpipe so that the actuator and valve are not submerged.

- Reliability – The system should operate between 0 to 130ºF and 10 to 90% humidity and for 40,000 hours (4.6 years) or greater.

- Safety precautions – An alarm system to indicate system malfunction should be clearly visible with a sign posted with phone numbers of the owner.

- Power consumption – Total wattage and W-hours of actuator, controller, and relay must be defined.

- Control panel – The control panel must be visible from within the basin so that the float switches can be tested while the control panel showing activation (visible light should turn on) can be easily viewed.

(11) *Hazardous material threat operation* – The basin's outlet valve should normally be closed and will detain a hazardous material spill. However, after a spill occurs, manual controls on the controller or the actuator/valve should be used to prevent the valve from automatically opening prior to removal of the hazardous material.

(12) *Splitter box* – When the pond is designed as an offline facility, a splitter structure should isolate the water quality volume and bypass the remaining flow around the system once the entire water quality volume has been captured. See Section 4.2.1 in the Technical Manual for additional basin outflow criteria. As an alternative to a splitter structure, the basin can include a spillway or outlet device near the pond inflow to convey runoff events more than the water quality design storm.

(13) *Erosion protection at the outfall* – For online basins, special consideration should be given to the facility's outfall location. Flared pipe end sections that discharge at or near the stream invert are preferred. The channel immediately below the pond outfall should be modified to conform to natural dimensions and lined with large stone riprap placed over filter cloth. A stilling basin may be required to reduce flow velocities from the primary spillway to non-erosive velocities.

(14) *Safety considerations* – See Section 4.2.1 of the Technical Manual.

Maintenance

Batch detention basins will have more maintenance requirements than most BMPs since they include mechanical and electrical components. For this reason, LCRA strongly recommends the facility owner/operator to enter into long-term maintenance contract and incorporate remote sensing. The following BMP-specific criteria supplement the Permanent BMP Maintenance Guidelines found in Chapter 5 of the Technical Manual.

Inspections – Inspections should take place a minimum of four times per year. Two inspections should take place during wet weather to determine if the basin is meeting the target detention time of 24 hours and a drawdown time of no more than 48 hours. If the facility is designed with continuous remote monitoring, then that data can be used in lieu of an inspection during a weather event. The remaining inspections should occur between storms so that manual operation of the valve and controller can be verified. The level sensor in the basin should be inspected and any debris or sediment in the area should be removed. The outlet structure and the trash screen should be inspected for signs of clogging. Debris and sediment should be removed from the orifice and outlet(s). Debris obstructing the valve should be removed. During each inspection, erosion areas inside and downstream of the BMP should be identified and repaired or revegetated immediately. Inspection reports must be provided to LCRA on a six-month basis and include two inspections with one being a joint inspection with LCRA staff.

Mowing – The basin, basin side slopes and embankment must be mowed to prevent woody growth and control weeds. A mulching mower should be used, or the grass clippings should be caught and removed. Mowing should take place at least twice a year, or more frequently if vegetation exceeds 18 inches in height. More frequent mowing to maintain aesthetic appeal may be necessary in landscaped areas.

Litter and debris removal – Litter and debris removal should take place at least twice a year, as part of the periodic mowing operations and inspections. Debris and litter should be removed from the surface of the basin. Particular attention should be paid to floatable debris around the outlet structure. The outlet should be checked for possible clogging or obstructions and any debris removed.

Erosion control – The basin side slopes, and embankment may periodically suffer from slumping and erosion. Corrective action, such as regrading and revegetation, may be necessary. Correction of erosion control should take place whenever required based on the periodic inspections.

Nuisance control – Standing water or soggy conditions may occur in the basin. Some standing water may occur after a storm event since the valve may close with 2 to 3 inches of water in the basin. Some flow into the basin also may occur between storms due to spring flow and residential water use that enters the storm sewer system. Twice a year, the facility should be evaluated in terms of nuisance control (insects, weeds, odors, algae, etc.).

Structural repairs and replacement – With each inspection, any damage to structural elements of the facility (pipes, concrete drainage structures, retaining walls, etc.) should be identified and repaired immediately. Examples of this type of repair include patching of cracked concrete, sealing of voids, and removal of vegetation from cracks and joints.

The various inlet/outlet structures in a basin will eventually deteriorate and must be replaced.

Sediment removal – A properly designed batch detention basin will accumulate quantities of sediment over time. The accumulated sediment can detract from the appearance of the facility and reduce the pollutant removal performance of the facility. The sediment tends to accumulate near the outlet structure and can interfere with the level sensor operation. Sediment must be removed from the basin at least every three years, when sediment depth exceeds 6 inches, when the sediment interferes with the level sensor or when the basin does not drain within 48 hours.

Logic controller – The logic controller must be evaluated as part of the four inspections each year. Verify that the external indicators (active, cycle in progress) are operating properly by turning the controller off and on, and by initiating a cycle by triggering the level sensor in the basin. The valve must be manually opened and closed using the open/close switch to verify valve operation and to assist in inspecting the valve for debris. The solar panel must be inspected and any dust or debris on the panel must be removed, and the battery replaced annually. The controller and all other circuitry and wiring must be inspected for signs of corrosion, damage from insects, water leaks, or other damage. At the end of the inspection, the controller must be reset.

Example BMP Design – Single Family Subdivision Project

Project: 50-acre single family subdivision in the Highland Lakes Ordinance jurisdiction

Topography: Slopes vary from 2 to 5% within the 50-acre tract

Soils: Brackett and Tarrant soils as commonly found in the region

This example will look at one 25-acre drainage area within the residential development.

Batch Detention basin example

Step 1 – Define creek buffer zones beginning at creeks with 5 acres of drainage area.

Step 2 - Determine potential compliance with alternate standards. Total impervious cover is 45% and project greater than 3 acres in area. Project cannot comply with alternate standards.

Step 3 - Design project to comply with Performance Standards found in the Ordinance.

a) *Pre-development Planning Meeting*. Planner prepares conceptual plan for development outside the buffer zone, designing with drainage in mind by utilizing topography and slopes to minimize cut and fill for development construction. In addition, minimal land clearing is proposed, thus, construction sediment can be more effectively managed. A pre-development planning meeting is conducted with LCRA staff to review proposed development project and water quality management approaches. Recommendations are provided and the subdivision plan is slightly modified to promote more sheet flow and natural drainage conveyance.

b) *Construction Phase Erosion and Sediment Control* design will be detailed and minimize the concentration of flow. In areas of concentrated flow, sediment basins or other stabilization methods will be used to prevent scour and sediment discharge. Construction phasing will be defined and coordinated with construction limits. The proper sediment controls such as silt fence and rock berms will be selected based upon upstream contributing drainage area. Once areas are disturbed, revegetation will occur as soon as possible through broadcast seeding, hydromulch, compost/seed distribution, and soil protection blankets when necessary. The goal of the erosion sediment control design is to minimize land clearing to reduce erosion potential, then stabilize with vegetation in a rapid manner.

c) *Water Quality Volume (WQV)/Design* computations for the structural basin to manage pollutants and channel erosion. Design volume computed using Equations 2.9 and 2.10.

Drainage Area = 25 acres

Impervious cover = 45%

Runoff volume = 0.83 inches from Eq. 2-9

WQV = (0.83 inches) * (25 acres) * (43560/12) = 75,322 cubic feet (Eq. 2-10)

Designer selects the use of a batch detention basin to minimize the area of the basin. To account for potential sedimentation within the biofiltration basin, the water quality volume must be increased by 5%. Basin located adjacent to buffer zone.

BMP Volume = WQV * 1.05 = 79,089 cubic feet.

Average Basin Depth = 4 feet

Total Basin Area is approximately 0.0.45 acres (145 feet by 145 feet)

A batch detention basin has a removal efficiency of about 90% for total suspended sediment and 50% for total phosphorus. Additional treatment is necessary. A soil evaluation with LCRA staff near the proposed basin site revealed soil conditions for stormwater infiltration, so a vegetated filter strip must be implemented.

Using Table 2-9 Sizing Requirements for Vegetated Filter Strips (VFS) in Series with a sand filter (equivalent performance to batch detention), the following is computed:

Up-gradient of batch detention basin, engineered vegetated filter strip area = 79,089 x 0.32 = 0.58 acres

Down-gradient of batch detention basin, engineered vegetated filter strip area = 79,089 x 0.15 = 0.27 acres

Downgradient of batch detention basin, bioretention volume = 79,089 x 0.027 = 2135 cubic feet. The designer selects a one-foot ponding depth for the bioretention basin.

At this point, the designer prepares the design of the batch detention basin and downstream engineered vegetated filter strip, which will have a total area of 0.87 acres. The area of a batch system with a bioretention basin is 0.65 acres

d) *Water Quality Education*. To minimize pollution at the source, LCRA staff will visit the neighborhood association at least once per year to provide programs and materials on proper lawn care and chemical disposal. Also, each new resident will receive a packet of information concerning lawn maintenance, car care, and other housekeeping tips to minimize the introduction of chemicals into the watershed.

e) *Maintenance Permit*. Since this project constructed a batch detention basin, the owner/operator of the facility is strongly encouraged to enter into a long-term maintenance agreement with LCRA to ensure proper and timely facility maintenance. Due to additional complexity of the batch valve and controller, the designer includes specifications providing for remote monitoring to provide proper and timely facility maintenance. The Maintenance Permit will specify the timing of trash collection, vegetation mowing, vegetation removal, sediment removal, and inspect other hydraulic functions for proper basin and trench operation. LCRA will inspect at least one time each year, if not more frequently, and provide reports to the owner/operator. If the owner does not respond to maintenance requests, LCRA has enforcement authority to ensure BMP system maintenance.