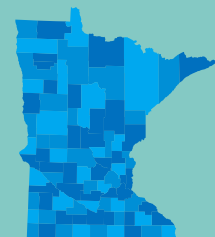


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# Prefill and Water Balance Criteria

Technical criteria for stabilization pond construction.



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# Introduction

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These Water Balance Criteria apply to all stabilization ponds and other basins and structures such as reed beds, constructed wetlands, and filters that are lined with clay or a membrane to prevent leakage. Also included are modifications for aerated ponds.

Ponds constructed after March 16, 1975, are required to meet a 500 gallon per acre per day (gpad) leakage rate, ponds constructed before this date are required to meet a 3,500 gpad leakage rate. Ponds required to meet a 1,500 gpad leakage (500 gpad +/- 1,000 gpad based on a 95% confidence interval after analysis of data), those required to meet a 3,500 gpad have no high or low value, 3,500 gpad is the maximum allowed.

The only method that is acceptable for a new pond is a water balance by the barrel method, which is discussed in these criteria. Other methods of construction quality control, such as electronic leak detection, while useful and encouraged to achieve a quality product, cannot be used as a substitute for the water balance barrel test.

These criteria also apply to existing ponds. However, existing ponds should be isolated, if possible, during the testing period. If this is not practical, contact your Minnesota Pollution Control Agency (MPCA) review engineer to discuss accurate flow monitoring of influent wastewater. Existing cells must run the water balance test for 90 days if the pond cannot be isolated; other alterations to the test to accommodate existing and aerated ponds are noted throughout the criteria.

All parties involved in the project (permittee (owner), engineer, inspector, contractor, testing labs, etc.) must be aware of the procedures, constraints, and expectations related to the requirements for construction, prefill, and the water balance test and the need for MPCA inspections and approvals at the interval discussed below (preliner and prefill inspections). The details of these items and the responsibilities of each party involved should be spelled out in the various contracts listed below:

1. Construction contract between the permittee and contractor (plans and specifications)
2. Engineer's or independent testing laboratory's contract with the permittee
3. Independent soil laboratory's contract with the permittee or consultant

The requirements for the water balance itself should be put into the specifications and in the contract of the party conducting the water balance (engineer or independent testing laboratory). The requirements for soils testing should be included in the independent soil laboratory's contract. Also, all parties, including the synthetic liner manufacturer when a synthetic liner is being used, must be aware of these items. All of the requirements that follow should be included in the plans and specifications.

## Preconstruction meeting

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At the preconstruction meeting, with all of the parties listed above, the specified inspections (prefill and preliner if necessary), quality control testing, and water balance testing should be discussed. The duties, responsible parties, and scheduling of the actions should be made clear to all participants.

# Water balance test plan

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The party responsible for the performance of the water balance test and the data collected is required to develop a water balance test plan that must be submitted and approved by the MPCA at the time of plan and specification submittal. This plan should address the site specific details of the testing procedures, and at a minimum, address the following details:

1. Who will conduct the water balance test (engineer, independent testing laboratory, owner):
  - a. Indicate who will be taking the readings. When possible, one specific individual should be identified to take all field readings. If this is not possible, the data collected in the field shall include the name of the individual who collected specific information. *The Water Balance Field Data Sheet* is attached to this form and can also be found at [www.pca.state.mn.us/index.php/view-document.html?gid=15318](http://www.pca.state.mn.us/index.php/view-document.html?gid=15318) that shows the minimum amount of information that must be collected.
2. Where the prefill water will come from (river, lake, city water, onsite wells, treated effluent, etc.). The use of some water sources may require appropriation permits and time for that permitting process should be factored into the overall schedule.
  - a. If treated effluent is used, it must meet the fecal coliform effluent limit. Discuss other parameters with the MPCA review engineer.
3. The depth of the water the test will be run at:
  - a. A minimum of two feet of water for wastewater stabilization ponds that have 180 days (or 210 days) storage/treatment capacity; with a variable operating depth and seasonally controlled discharges.
  - b. Maximum operating depth shall be used for all other ponds including aerated, anaerobic and equalization/storage ponds
    - i. For water balance tests performed at greater than two feet of water depth, safe access to the barrel sets to take readings must be addressed. This may require the use of boats, docks, additional personnel, and other special items to allow for the safe reading of water levels.
  - c. An estimate of the time necessary to fill the ponds to the required depth as well as seasonal challenges (lack of water in the fall, etc.)
4. Where the barrels will be located and how many will be used (per pond):
  - a. A minimum of three barrel sets shall be used in compliance with Diagram 1. If control structures are used for pond measurements for aerated ponds (Diagram 2), the combination of control structures and barrels used for pond measurements must total three.
5. How the pond water elevation will be measured:
  - a. A permanently mounted scale, in millimeters in the control structure and/or separate perforated barrels for aerated ponds. For scales in a control structure (allowed for aerated ponds) they must be easy to read without entrance into the structure and consistent readings must be taken.
  - b. Describe fixed measuring devices to be used for readings.
  - c. Water level measurements in barrels and control structures will be measured to the nearest millimeter.

- i. In pond level barrels (perforated barrel) readings should be averaged over a time span of at least one minute to account for wave action.
    - ii. If more than one individual will be taking readings, training should be provided to those individuals to ensure consistent data collection methods.
  - d. If transducers are used, the accuracy of the meter must allow for a reading to be taken and recorded to at least the nearest millimeter. To account for water fluctuation in the pond and wave action, the meter must be capable of reading and recording multiple points per second with the average of these points over a period of one minute reported as a single value for one day. The time of day that the water level is recorded should remain consistent from day to day.
6. Where and how rainfall will be measured (it needs to be measured at the pond site, what type of recorder will be used, scale, etc.).
7. How often the barrels will be measured:
  - a. It is strongly recommended to take readings daily or as often as possible.
  - b. At a minimum, they must be taken twice a week and after each rainfall event. If it is unclear to take a reading or not for a given day due to rain, take the reading and record it as a rain day.
8. How often rainfall will be measured:
  - a. A minimum of two times a week and after each rainfall event. If a pond reading is taken, take a rainfall reading.
9. For existing ponds only, location of the groundwater table (i.e., is it near liner elevation or will it be during the course of water balance? How was groundwater elevation determined? Who is responsible for further groundwater elevation readings?) When the groundwater level is determined to be less than 4 feet below the top of the pond seal, the barrel test may not be acceptable to determine seepage. Additional groundwater elevation and assessment will be required including an assessment by a Minnesota licensed/registered professional geologist evaluating:
  - a. Groundwater levels
  - b. Directional flow
  - c. Groundwater quality, up and down gradient of the pond cell including, but not limited to, nitrogen, fecal, chlorides, phosphorus
10. The pad elevations and barrels must be surveyed and elevations recorded prior to the water balance test and after completion to verify they did not move. Readings are not allowed to be adjusted using pad elevation readings.
11. This plan shall be submitted to the MPCA and must be approved prior to the permittee's request for a prefill inspection. This will allow for the resolution of any concerns with the test procedure before the planned start of the water balance test. It is recommended this report be submitted as soon as possible from the start of construction.

# Prefill inspection requirements

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The request for the prefill and preliner inspections should be made as far in advance as possible, but in no case shall the permittee expect the MPCA inspector to be able to schedule the inspection with less than seven days' notice.

## A. For synthetic liners

### 1. Preliner inspection

When the owner's engineer determines that the preparation of the subgrade will be accepted and the engineer will authorize placement of the liner, the MPCA must be notified to allow for the completion of a "preliner" inspection. The notification shall provide sufficient time to allow for scheduling of the inspection (at least seven days). The MPCA will visually inspect the subgrade for the presence of material that could damage the liner and review the results of subgrade compaction test results (See MPCA HDPE and MPCA PVC Liner Guidance: <https://www.pca.state.mn.us/water/engineering-and-technical-information-construction-or-expansion>).

The following items need to be submitted for a preliner inspection:

- a. A copy of the soil test results (density, etc., on both subbase and dikes)
- b. The written results of the pond bottom survey indicating the level is within the proper tolerances

### 2. Prefill inspection

- a. The permittee must submit a letter indicating that they have accepted the work necessary to conduct the prefill and complete the water balance and are requesting MPCA to conduct a prefill inspection.
- b. Included with the above letter, if not previously submitted to the MPCA, must be the following:
  - i. The contractor and liner manufacturer certification that the liner was installed per the plans and specifications.
  - ii. The contractor and liner manufacturers' certification that the cover material was placed per the plans and specifications.
  - iii. The liner manufacturer's certification that the installation was in conformance with all warranty provisions and that no provisions of the warranty have been voided.
  - iv. A copy of all liner test results for seam strength, strength of liner material, mil thickness, etc. If electro-resistivity testing was completed those results must also be submitted.
  - v. A copy of the liner warranty. If the final warranty is not available, a copy of the generic warranty is sufficient; submit the final warranty to the municipality.

## B. For clay seals (no preliner inspection required, only prefill)

### 1. Prefill inspection

At the MPCA prefill inspection, the ponds will be inspected for (at a minimum) the following:

- a. Adequate erosion protection (i.e., proper grass growth, proper riprap material, and placement). See *MPCA Recommended Design Criteria for Stabilization Ponds* for erosion control requirements ([www.pca.state.mn.us/publications/wq-wwtp5-53.pdf](http://www.pca.state.mn.us/publications/wq-wwtp5-53.pdf))
- b. Placement, cover, gradation, and presence of fines in the rip rap.
- c. Proper seal placement (for clay) and cover material (for synthetic).
- d. Proper completion of any other items necessary to approve the prefill or to conduct the water balance (piping placement, gates, controls and erosion protection for the fill system).
- e. Proper barrel set-ups for conducting the water balance test.

## Water balance test

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Upon approval of the prefill inspection, the permittee may begin to fill the structure with water and record the data as directed in the approved water balance plan. All of the information on *The Water Balance Field Data Sheet* should be recorded.

The following items are the general requirements for conducting a water balance:

### A. Recordable data

#### 1. Study period

A least 30 days needs to be planned for completion of the water balance test. It may take longer to collect a sufficient amount of data if there is rainfall or freezing conditions during the test period.

Days with rain or freezing conditions must be excluded from the data analysis. Data sets shall include only one data point per day that does not have precipitation. The time span between the first and last useable reading of the final analyzed **data set** must be at least 14-days. This allows for graphical trends to become apparent and verification of the linear regression assumptions. Water balances must have nine total readings from the data set without freezing. These nine readings must be made up of individual barrel results containing a minimum of five readings per barrel

It is strongly recommended to take readings daily or as often as possible. **Do not** stop collecting data until the MPCA has approved the results. Even if passing results have been submitted or the test has been run for 30-days, you must continue to take readings until the MPCA approves the test or it is determined the pond does not meet requirements and more data is needed. No test may be less than 14 calendar days.

All parties need to be aware that readings cannot be taken during time of freeze up, or if ice occurs in the barrel. After the ice melts, it is possible to resume water balance readings. Although the data does not have to be continuous, the method for combining data sets outlined at the end of Appendix B of the Report on Evaluation of Minnesota Water Balance Test, April 1989 under data preparation, must be followed.



## **2. Inflow to system**

No inflow to the pond, except as allowed in Section A.6., will be allowed until the test has been completed and approved. Any influent, discharge, or transfer of water to the pond occurring during the test period will invalidate the entire water balance test, and subsequently must be redone.

## **3. Total rainfall**

Rainfall measurement must be taken from a reliable rain gauge installed at the pond site. The gradation shall be 0.01 inches. The minimum required rain gauge will have a 4-inch diameter outer cylinder with an inner receiver. Capacity of the overflow cylinder and inner receiver shall be 11 inches. It is advised that rainfall measurements and test readings be taken after each rainfall event to provide as many dry daily recordings as possible. One day should be allowed prior to recording the pond level after a storm event due to slow percolation of dike runoff into the pond. As a reminder, the National Pollutant Discharge Elimination System permit for a continuous or controlled discharge requires rainfall measurements daily, so a rainfall gauge in a permanent spot owned by the permittee would be useful.

## **4. Discharger/transfer from pond cells**

In order to provide the highest degree of accuracy for the water balance test, no discharges should be made from the cells during the test period. All gate valves, etc., should be verified to be water tight (no leaks) before beginning the test. If any discharges do occur during the test period, it may be necessary to conduct the water balance again.

## **5. Pond water and depth measurements**

The water level of each cell should be recorded to the nearest millimeter. The measurements should be made from a permanently mounted scale within the perforated barrels located by each evaporation barrel (manhole structures may be used for aerated ponds and existing cells). The measuring device for both the barrels (and the control structure) should be situated such that the zero end of the scale of the measuring device is down in the barrel or structure and the high end of the scale is up. If this is not done, the signs in the following calculations will not work out properly. The measurement devices shall be a metric ruler in one millimeter gradations. The measurement recording should be an average of two readings taken over at least one minute to check for fluctuation of the pond. Floats or transducers may be allowed to record depth measurements.

If transducers are used, the accuracy of the meter must allow for a reading to be taken and recorded to at least the nearest millimeter. To account for water fluctuation in the pond and wave action, the meter must be capable of reading and recording multiple points per second with the average of these points over a period of one minute reported as a single value for one day. The time of day that the water level is recorded should remain consistent from day to day.

## **6. Barrel method (rainfall and evaporation)**

A large (approximately 55-gallon) barrel measuring 35 inches high plus or minus 2 inches and having a diameter of 22.5 inches across plus or minus 1 inch, shall be used to determine rainfall and evaporation in a pond cell. The barrel will be free of defects and must be leak proof. Also, the barrels will be coated with a minimum 3-4 mil of dry film thickness of white high solids epoxy paint (no oil or grease film).

Evaporation barrels must have a surrounding baffle to avoid possible splash-over. The baffle shall be 20 gauge metal welded to the top of the barrel at a 45 degree angle as shown in Diagram 2. The welds shall not perforate the barrel exterior and shall be 2 inches in length spaced 8 inches center to center. The spacing is to allow the rainfall on the baffle to pass down the exterior of the barrel without upsetting the true rainfall occurrence in the barrel itself.

At least three sets of barrels must be strategically located within each pond cell. Barrels shall be placed as shown in Diagrams 1 and 2. The top of the barrel (not the baffle) should extend at least 12 inches and no more than 15 inches above the prefill water level in the pond at the start of the test.

If the pond water level falls more than 6 inches during the period of the test, consideration shall be given to stopping the test, filling the pond back to the initial point, and restarting the test. Weather projections, length of time remaining in the test, and time constraints are factors to be considered when refilling is an issue. The purpose of refilling is to provide as stable a hydraulic head on the liner as possible while maintaining a limited factor of variation due to the barrel's metal exposure and its impact on evaporation.

If the barrel water level differs greater than 6 inches from the pond water level, the reading will be recorded then water in the barrel shall be brought back to the pond water level and recorded again for adjustment.

A measuring device shall be fixed to the inside of the barrel to facilitate accurate water depth measurement to the nearest millimeter. The measuring device shall preferably be a metal metric ruler in one millimeter gradations. The device and method of fixing it to the barrel should not impair the rainfall into or evaporation from the barrel.

The barrel must be on a 4-inch concrete pad (not required for aeration ponds or existing cells) for firm footing with the bottom of the barrel shimmed for level. For aerated ponds and existing ponds, another means of securing the barrels may be needed and shall be specified in the work plan. The top of the barrel should remain level throughout the test. **The elevation of the support pad and barrel must be surveyed and recorded before and after the test to confirm that no settling has occurred.**

If possible, every newly constructed cell should run the water balance at the same time. Factors such as precipitation or wind combined with low relative humidity can alter test results significantly.

Operating the tests during the same period will provide a check for the localized conditions at each cell. Also, results may be improved by contacting the MPCA to find other ponds operating the water balance in the area or if time is available avoiding operation of the test during dry hot periods and extremely humid/wet months.

## **7. Applications during ice over**

To use periods of ice formation on the water in the barrels, a reading before and after the presence of ice is required. No permanent ice formation is allowable as readings may not be taken from the barrel when ice is present. The length of days the ice is present may be recorded and used due to the conservative error this would introduce. However, the total test minimum number of nine readings must be obtained, with individual barrel readings being a minimum of five.

# Water balance data analysis

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While data is being collected, it is recommended that it be analyzed at the same time to evaluate the results. The permittee is responsible for analyzing the data to determine compliance with the allowable seepage standard and submitting the results of the analysis to the MPCA. The letter should state whether the permittee has accepted all work completed to date on the project, and that they are requesting approval to allow wastewater into the pond.

The transmittal letter should indicate who performed the least squares analysis, if the length of the test was shortened, whether the test was performed with ice occurring in any of the barrels, or if two non-rainfall event periods were combined. Measurements, observations and a diagram of the actual pond layout designating the barrels numbers and placement shall also be submitted. For the least squares analysis, the transmittal letter should identify which sets of barrels indicate passing and the respective correlation numbers of the least squares test.

## 1. Seepage calculation for the Barrel Method

The test results must provide three items: (1) the mean seepage rate in gpad, (2) the confidence interval for the mean seepage rate also in gpad and (3) the correlation coefficients for the least squares analysis (factors from zero to one with zero being no correlation and one being perfect correlation to a linear relationship). A passing test will have high correlation approximately 0.8 or better with a combined mean seepage rate and confidence interval of 1,500 gpad.

In order to statistically evaluate whether the 500 gpad mean seepage rate plus or minus the 1,000 gpad confidence interval has been met, all raw data collected (barrel levels, pond levels, rainfall and runoff measurements, etc.) must be evaluated independently and combined. The data from each barrel shall be analyzed individually, and in combination with the other barrels (1 and 2; 1 and 3; 2 and 3; and 1, 2, and 3 together.) All calculations and assumptions used to evaluate the raw data should be included in the submittal. If the 500 gpad +/- 1,000 gpad requirements have not been met, a recommendation should accompany the water balance analysis detailing one of the following:

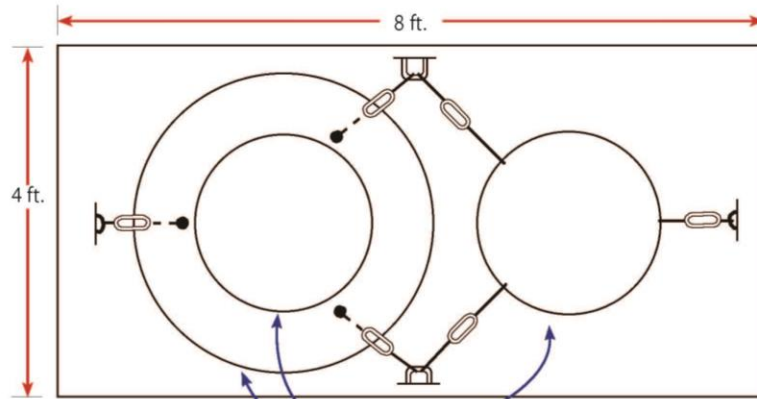
- a. The water balance(s) will be redone.
- b. Identify the problem or possible source of the problem. An option for determining a leak is electro resistivity testing (ASTM D6747-04).
- c. The corrective actions that will be taken to resolve the problem.

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Water balance analysis and data evaluation must be according to Chapter 7 and Appendix B of the *Report on Evaluation of Minnesota Water Balance Test (Emnwbtt), April 1989* respectively. <https://www.pca.state.mn.us/sites/default/files/wq-wwtp5-61e.pdf>

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Diagram1: Pond water depth measurement



20 gauge metal: 55 gallon metal barrel, leak proof, 3-4 mil dry film thickness, white, high solid epoxy paint.

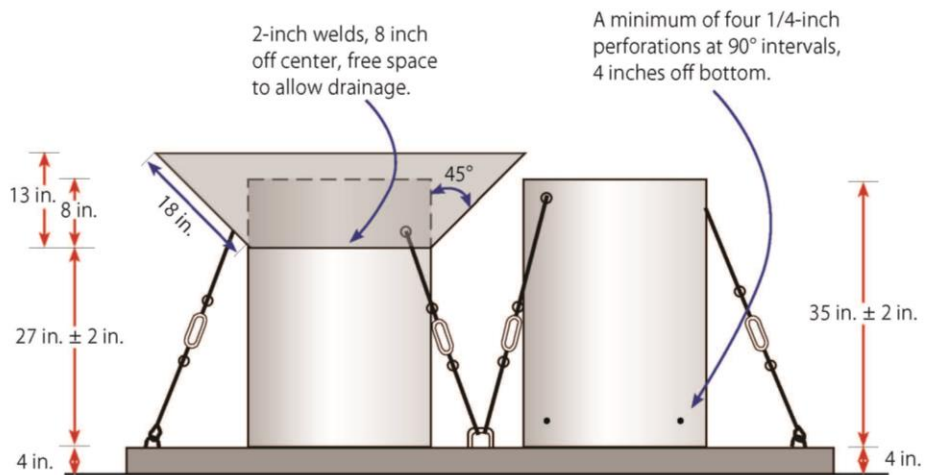
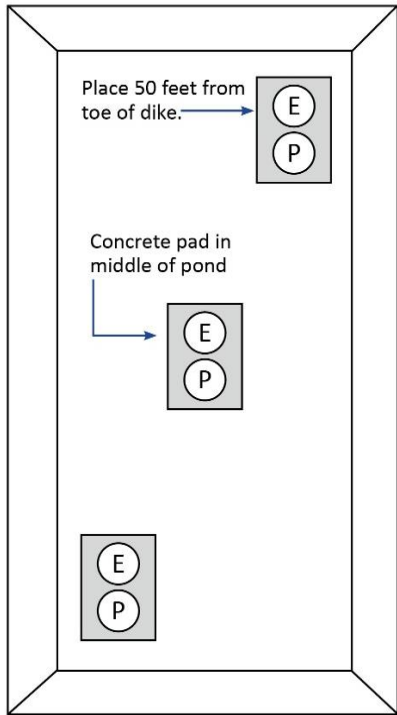


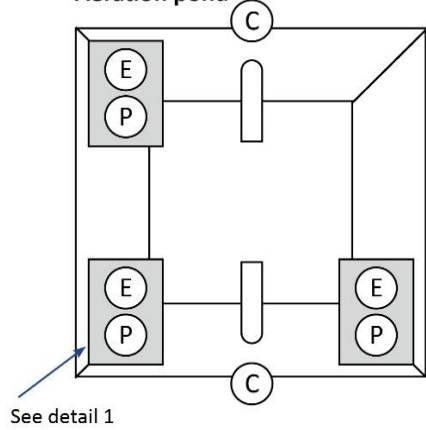
Diagram 2: New construction pond system

**Stabilization pond**



E = Evaporation barrel  
 P = Perforated barrel  
 C = Control structure

**Aeration pond**



Pond Level measurements may be recorded from a control structure in place of a perforated barrel. Three (3) pairs of evaporation/pond or control structure sets are required. A combination of the Pond/Control structure sets as shown can be used.

