

DESIGN GUIDELINES FOR WASTEWATER FACILITIES

MARYLAND DEPARTMENT OF THE ENVIRONMENT
ENGINEERING AND CAPITAL PROJECTS PROGRAM

2013

Purpose:

- Recommended Standards for Wastewater Facilities (as revised) for Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (10-State Standards) will continue to be the main source of guidance for the program's design review and construction permit functions. The 10-State Standards can be downloaded free from <http://www.10statesstandards.com> website, or purchased as a book from the Health Education Services (HES) at <http://www.healthresearch.org/store>.
- These guidelines are intended to serve as addenda to supplement the 10-State Standards.
- The 10-State Standards (as revised) and these guidelines supersede all other design guidelines for wastewater (sewerage facilities) previously issued by the Department.
- The following sections serve as addenda to the mentioned 10-State Standards' chapters and/or sections.
- At the appearance of conflicting information, these guidelines supersede the 10-State Standards as they intended to provide further clarifications specific for MDE.
- Additional requirements beyond these guidelines and the 10-State Standards can be added by the facility's discharge permit and/or consent order or decree issued by MDE.

**ADDENDUM TO CHAPTER 10
ENGINEERING REPORTS AND FACILITY PLANS**

HYDRAULIC CAPACITY

Terminology and Typical Use:

Term	Description	Typical Design Use
Average Daily Flow (Current or Initial)	For existing facility, it's the current average daily flow based on the last three years data. This is done by averaging the daily flow for each year, then averaging the three years. For a proposed facility, it's the project initial flow.	To evaluate and address low flow conditions (minimum flows)
Design Average Flow (Design Capacity)	Average daily flow a facility is designed to successfully process	To develop maximum flowrates and ratios to be used for the design of equipment and unit processes.
Approved/Permitted Design Capacity	A treatment plant design flow approved by the County Water and Sewer Plans and permitted by the discharge permit with certain limits and conditions. It must be greater than or equal to a proposed design flow.	The maximum flow that can be evaluated to become the facility's new design capacity.
Diurnal Flow Pattern	The typical daily flow pattern for domestic wastewater with usually peaks occurring in the morning and evening.	Important in developing process control strategies for managing high flows.
Peak Hour Flow	The largest volume of flow occurring within 1-hour period in the record examined.	Sizing of pumping facilities and conduits, sizing physical treatment units (ie grit chambers, screens, sedimentation tanks). Sizing chlorine or other disinfection contact tanks. Also important in developing process control strategies for managing high flows.
Maximum or Peak Day Flow	The largest volume of flow occurring within a 1-day period in the record examined.	Sizing of equalization tanks Sizing of sludge pumping system Sizing of chemical feed system
Maximum Month Flow	The average daily flows for the month with the highest total flow in the record examined.	Sizing of the bioreactor Sizing of the chemical storage tank

Peaking Factor:

The peaking factor is used to forecast the maximum/peaking flows for the new proposed design capacity. The above average and maximum/peak flows are highly impacted by I/I and wet weather events. Therefore, the preferred method of estimating these values is by using actual data. When available, a record of three years should be examined at an existing facility. New facilities may use data from plants of the similar size.

$$\text{Peaking Factor (PF)} = \frac{\text{current peak flow (hourly, daily, monthly)}}{\text{Current average daily flow}}$$

$$\text{Peak Flow} = \text{PF calculated above} \times \text{Proposed Design Capacity}$$

New facilities may use data from other plants of the similar size and condition (preferred method), or may use the following typical Peaking Factors (PF):

Design Capacity Range	Hourly PF	Daily PF	Monthly PF
0 to 0.25 MGD	4	3	2
0.25 to 16 MGD	$(3.2 \times \text{Design Capacity}^{5/6})$ Design Capacity	75% of Hourly PF	50% of Hourly PF, but not below 1.2
More than 16 MGD	2	1.5	1.2

Proposed Design Capacity:

$$\text{Proposed Design Capacity} = \text{Current Average Daily Flow (0 for new facilities)} + \text{Projected Future Flow}$$

Projected Future Flow:

Future flows are projected based on 100 gallons per day per person, or 250 gallons per day per Equivalent Dwelling Unit (EDU). In addition, the following are the flow projections for different establishments:

Table I - Flow Projection Based Upon Gallons Per Person Per Day

Airports (per passenger)	5
Apartments-multiple family (per resident)	60
Bathhouses and swimming pools.....	10
Camps:	
Campground with central comfort stations.....	35
With flush toilets, no showers	25
Day camps (no meals served)	15
Resort camps (night and day) with limited plumbing	50
Luxury camps	100
Cottages and small dwellings with seasonal occupancy.....	50
Country clubs (per resident member).....	100
Country clubs (per non-resident member present).....	25
Dwellings:	
Boarding houses.....	50
additional for non-resident boarders.....	10
Luxury residences and estates	150
Multiple family dwellings (apartments).....	60
Rooming houses.....	40
Single family dwellings.....	75-100
Factories (gallons per person, per shift, exclusive of industrial wastes)	35
Hospitals (per bed space)	350
Hotels with private baths (2 persons per room).....	60
Hotels without private baths.....	50
Institutions other than hospitals (per bed space).....	125
Laundries, self-service (gallons per wash, i.e., per customer)	50
Mobile home parks (per space).....	250
Motels with bath, toilet and kitchen wastes (per bed space)	50
Motels (per bed space)	40
Picnic Parks (toilet wastes only) (per picnicker)	5
Picnic Parks with bathhouses, showers and flush toilets	10
Restaurants (per seat)	25
Restaurants (toilet and kitchen wastes per patron)	10
Restaurants (kitchen wastes per meal served)	3
Restaurants, additional for bars and cocktail lounges.....	2
Schools:	
Boarding	100
Day, without gyms, cafeterias or showers	15
Day, with gyms, cafeterias and showers.....	25
Day, with cafeterias, but without gyms or showers	20
Service Stations (per vehicle served).....	10

Swimming pools and bathhouses	10
Theaters:	
Movie (per auditorium seat)	1
Drive-in (per car space)	5
Travel Trailer Parks without individual water and sewer hook-ups (per space)	50
Travel Trailer Parks with individual water and sewer hook-ups (per space)	100
Workers:	
Construction (at semi-permanent camps).....	50
Day, at schools and offices (per shift).....	15

An alternative method used to project average daily flows generated from commercial establishments, public service buildings, or dwelling units can be figured on the basis of total floor area, number of building units, or service seats multiplied by a statistical factor. Guiding factors are given in Table II.

Table II - Guiding Factors for Flow Projection Related with Commercial Establishments, Public Service Buildings, or Dwelling Units

Office Buildings	Gross Sq. Ft. x 0.09 = gpd
Medical Office Buildings.....	Gross Sq. Ft. x 0.62 = gpd
Warehouses.....	Gross Sq. Ft. x 0.03 = gpd
Retail Stores	Gross Sq. Ft. x 0.05 = gpd
Supermarkets.....	Gross Sq. Ft. x 0.20 = gpd
Drug Stores.....	Gross Sq. Ft. x 0.13 = gpd
Beauty Salons.....	Gross Sq. Ft. x 0.35 = gpd
Barber Shops.....	Gross Sq. Ft. x 0.20 = gpd
Department Store with Lunch Counter.....	Gross Sq. Ft. x 0.08 = gpd
Department Store without Lunch Counter.....	Gross Sq. Ft. x 0.04 = gpd
Banks.....	Gross Sq. Ft. x 0.04 = gpd
Service Stations	Gross Sq. Ft. x 0.18 = gpd
Laundries & Cleaners	Gross Sq. Ft. x 0.31 = gpd
Laundromats.....	Gross Sq. Ft. x 3.68 = gpd
Car Wash without Wastewater Recirculation Equipment.	Gross Sq. Ft. x 4.90 = gpd
Hotels.....	Gross Sq. Ft. x 0.25 = gpd
Motels	Gross Sq. Ft. x 0.23 = gpd
Dry Goods Stores	Gross Sq. Ft. x 0.05 = gpd
Shopping Centers	Gross Sq. Ft. x 0.18 = gpd

Flow projection for country clubs or public parks may be made on the basis of plumbing fixtures. The related statistical flow figures per unit of plumbing fixture are shown in Table III and Table IV.

Table III - Flow Projection for Country Clubs

	Gallons Per Day Per Fixture
Showers.....	500
Baths.....	300
Lavatories	100
Toilets	150
Urinals.....	100
Sinks	50

**Table IV - Flow Projection for Public Parks
(During hours when park is open)**

	Gallons Per Day Per Fixture
Flush toilets	35
Urinals	10
Showers	100
Faucets	15

**ORGANIC CAPACITY
(For Wastewater Treatment Plant)**

For existing facilities, 3-year data, if available should be evaluated, and average concentration is calculated in the treatment plant influent, primary effluent, and secondary effluent. For new wastewater treatment plant typical values are used.

Average Organic/Mass Loading (Lbs/Day)
 = Design Capacity (MGD) X Average Concentration (mg/l) X 8.34 (Conversion Factor)

Sustained Mass Loading (Lbs/Day)
 = Average Mass Loading X PF (hourly, daily, monthly depending on the unit process being sized)

Computer Simulations:

Computer simulations have become more common in recent years, especially in the design of Biological and Enhanced Nutrient Removal processes. Simulators use mathematical models to allow designers to study kinetic- as well as time-based solutions while determining the total mass balances of many constituents.

**ADDENDUM TO CHAPTER 40
WASTEWATER PUMPING STATION**

EMERGENCY OPERATION

Additional Measures for Facilities Located within Certain Critical Water Uses:

Per Section 47.3 of Chapter 40 of the Recommended 10-State Standards (under Emergency Operation), the Maryland Department of Environment (MDE) hereby establishes the following supplemental design guidelines for wastewater pumping stations that can have a potential overflow that may affect public water supplies and other critical water uses identified by MDE. These supplemental guidelines apply to any existing station where pumping capacity is being increased to accommodate increased flows due to growth, and for proposed new pumping stations (not for the purpose of functional replacement); AND fall under at least one of the following categories:

1. Existing or new within 3 miles of a shellfish water
2. Existing or new within 3 miles of a bathing beach water
3. Existing or new within 3 miles of public water supply (“P” designation surface water)
4. Existing pumping stations within 3 miles of bacteria impaired water and has one or more overflow event(s) over the past 3 years that is/are attributable to a power outage, mechanical failure or human error

A. Case I

The wastewater pumping station is missing one of the four essential items: a telemetering alarm system, a standby pump unit, a stationary auxiliary power source, or a pump-around connection.

- MDE may allow a 24-hour emergency wastewater storage capacity as a substitute for the missing essential item.

B. Case II

The wastewater pumping station provides all four essential items:

1. A telemetering alarm system
2. A standby pump unit (internal)
3. A stationary auxiliary power source connected to a separate power feed substation or stationary generator
4. A pump-around connection coupling facility

AND

- (a) For Pumping Capacity (Q_p) \leq 150 gallons per minute (gpm), or serving Equivalent Dwelling Units (EDU) \leq 200, no additional measure is required.
- (b) For Pumping Capacity (Q_p) $>$ 150 gallons per minute (gpm), or serving Equivalent Dwelling Units (EDU) $>$ 200, one of the following items must be provided in addition to the four essential items listed above:

Option 1: A third power source must be provided by a separate feed line to a new power substation, by providing a new stationary generator, or by a stationary independently-powered pumping unit(s) with adequate capacity to maintain proper operation.

Option 2: An additional 2-hour wastewater storage capacity shall be provided for emergency need, based on the newly projected design average daily flow.

Emergency Wastewater Storage:

For existing wastewater pumping station, MDE may approve a wastewater emergency storage capacity with a detention time less than 2 hours, provided that all of the following circumstances are substantive and evidenced:

- (1) Options 1 and 2 above are also not feasible;
- (2) There is no physical means to provide the required storage capacity due to site restriction at the premise of the pumping station;
- (3) The pumping station has had excellent operation records without Overflow of wastewaters at the premise of the station in the past five years; and
- (4) An emergency plan ensuring that the maximum response time will be less than one hour to remedy the malfunction of the pumping station.

Emergency wastewater storage capacity defined as detention time is determined by the following:

$$\text{Total Wastewater Storage Time} + \text{Wastewater Traveling Time} = 2 \text{ Hours}$$

- (1) The traveling time of land overflow wastewaters will be calculated at 1 foot per second (fps).
- (2) In water, the traveling time overflow wastewater will be calculated at 2 feet per seconds (fps).
- (3) The wastewater storage time will be calculated by dividing the total storage capacity with the design average daily flow (Q_a).

Where, Q_a = average daily flow, in gpm
 Q_p = pumping capacity, in gpm

If $Q_p = 0$ to 694 gpm \rightarrow $Q_a = 0.25 \times Q_p$
If $Q_p = 695$ to 22,384 gpm \rightarrow $Q_a = 0.0668 \times Q_p^{1.2}$
If $Q_p > 22,384$ gpm \rightarrow $Q_a = 0.5 \times Q_p$

- (4) The total storage capacity includes:
 - the available excess storage in the wet well above the elevation of high water alarm to the elevation where the first sewer service connection is made or the sewer system's lowest ground elevation,
 - the available storage in the wastewater collection system up to where the first sewer service connection is made or the sewer system's lowest ground elevation , and
 - the storage basin provided, if necessary.

**ADDENDUM TO CHAPTER 50
WASTEWATER TREATMENT FACILITIES**

ESSENTIAL FACILITIES

Special Requirements for Facilities Discharge to Shellfish Harvesting Waters:

Per COMAR 26.08.04.04.C (2) (c), these facilities shall incorporate a bypass control system, including a minimum 24-hour emergency holding facility,

- The facility shall provide for biocide residual control.
- The 24-hour emergency holding facility must be sized based on the plant design capacity.
- Retention or holding time of other unit processes used for other purposes cannot be counted toward this 24-hour emergency storage.
- Section 93.4 shall be used for pond construction details.
- Minimum freeboard shall be 3 feet. For small ponds of 5 acres or less, 2 feet may be acceptable.

ADDED CHAPTER 110
SUPPLEMENTAL DESIGN GUIDELINES FOR DRIP DISPERSAL OF TREATED
WASTEWATER

Scope:

Drip dispersal is a method used to distribute treated wastewater over an area of land at root zone depth for final polishing, reuse, and/or recharge of groundwater. The proposed dispersal system shall be capable of uniformly distributing the wastewater effluent over the required area of application.

Applicability:

These guidelines are applicable to the design of large on-site dispersal systems, land application systems or any other treatment systems receiving discharge and construction permits from the Maryland Department of the Environment (Department).

The Department's discharge permit must be issued and its limitations set before a construction permit can be reviewed and issued.

As for any construction permitted facility, the drip system design plans submitted to the Department for construction permit shall be signed and sealed by a Professional Engineer licensed in the State of Maryland. The system design engineer shall follow these guidelines and incorporate necessary manufacturing product specifications into the design document to ensure satisfactory performance of the drip dispersal system.

Pre-Treatment:

Wastewater effluent dispersed through this method must be treated to meet the water quality standards within the issued discharge permit limitations. The treatment process will be reviewed and approved for construction in accordance with the Department's Design Guidelines and the Recommended 10-State Standards.

Nitrogen removal capability by the vegetation planted at a drip irrigation field or other means is determined by the discharge permitting process and is accounted for in the set discharge permit limitations. The vegetation planted on the drip dispersal field shall provide a comparable nitrogen uptake rate as used in the Nitrogen Balance Calculation for achieving a zero nitrogen percolate concentration during the growing season.

Wastewater Effluent Dosing and Equalization Tank:

The treated wastewater effluent shall be discharged to the drip disposal system through a dosing tank that has sufficient volume to provide flow equalization. Storage requirements within the treatment and dispersal system shall be at least one full day-storage located between the treatment and dispersal systems.

The Wastewater Effluent Dosing and Equalization Tank will be reviewed and approved for construction in accordance with the Department's Design Guidelines and the Recommended 10-State Standards.

Drip System Dosing Pump and Filter:

The system is to be designed with the pumps, filters, and dispersal area to accommodate the following conditions:

1. Filter flushing
2. Zone dosing
3. Tubing network flushing

Dosing pump selected for the dispersal system shall be capable of delivering the design hydraulic flow. At least one standby pump must be provided and available for service at all times.

The filters shall be included as part of the drip dispersal system and meet the manufacturer's specifications as approved by the design engineer.

Wastewater Effluent Loading Rate:

The wastewater effluent loading rate will be determined and provided by the issued discharge permit and shall not exceed an annual average loading rate of two inches per week.

$$2 \text{ inch per week} = 0.18 \text{ gal/ft}^2/\text{day}$$

Dispersal Area Sizing:

The size of the required dispersal area is determined by the daily design flow (gpd) and the loading rate stipulated in the issued discharge permit.

Zone Layout:

Dispersal Zone, as defined by NOWRA, is the smallest unit of a drip dispersal system, consisting of a supply manifold, return manifold, drip laterals, and associated appurtenances, which can be loaded independently of all other parts of the dispersal system.

Zone width across contour is typically from 50 to 300 feet. Zone width is delineated by the following factors:

1. Site and soil evaluation.
2. Available distance down slope
3. Maximum linear feet of drip tubing as provided by the manufacturer

Drip Tubing (Dripper line) Runs and Laterals:

A length of dripper line across the contour is defined as a “run.” The tubing is to be installed on contour.

Typical Run Length = 50’ to 300’

Lateral is a dripper line consisting of a run or series of runs extending from the supply manifold to the return manifold of a single dispersal zone. Lateral length is dependent on head loss, and the drip system design (i.e. dosing pump and filter).

Typical Dripper line Depth = 6 to 12 inches

Percent Run Time:

Each manufacturer offers different models with various dispersal dosing capacities. The selected model must be capable to accommodate the peak day flow within the desired Percent Run Time of less than 50%.

$$\text{Percent Run Time} = \frac{\text{Peak Day Flow (gpd)}}{\text{Dispersal Dosing Capacity (gpm) X 1440}} \times 100\%$$

Dripper line Spacing:

Typical manufacturer recommendations call for drip tubing to be spaced 1 foot to 3 feet on center (2’ o.c. is the most common).

Zone Dosing:

- A pressure regulator is required to maintain adequate residual pressure during dosing.
- The control system must allow for variable loading rate and/or dosing time at the individual zones.
- Individual zones shall be designed to be easily taken in and out of service for maintenance or repair.

Zone Forward Field Flushing:

Each drip zone must automatically undergo a periodic forward field flushing usually every 25 cycles or 15 days, whichever occurs first. Other flushing frequencies can be considered if recommended by the manufacturer. Control system must allow for adjustable flushing frequency.

A minimum velocity of 2 ft/sec should be used in the zone flushing.

A minimum velocity of 1 ft/sec is acceptable if the drip tubing is manufactured with antimicrobial inner lining to inhibit adhesion of biological growth on the inside walls of the tube and emitters.

Flush Residuals Required Treatment:

All filter flush and tubing network forward flush residuals are to return to the head of the pre-treatment system, or be treated by an acceptable side-treatment system before returning to the dosing station.

Air Release Valve:

An air release valve shall be provided for each zone at the highest elevation of the zone.

Minimum Required Horizontal Separation:

The following are the minimum horizontal separation distances required between the Drip Dispersal Area and other land features or components. Any exception may be considered by the Department using the Department’s Design Guidelines and the Recommended 10-State Standards.

Land Feature or Component	Minimum Required Horizontal Separation Distances (in feet)
A flowing body of water	50
Well or suction line	100
Water service line	50
Occupied building	50
Property line	50
In-ground Swimming Pool	50