High Strength Waste Facility Design Recommendations and Best Practices

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High strength waste (HSW) presents a challenge for any type of onsite wastewater treatment system. This is apparent in restaurant facilities, where the design life of the system is significantly less than a typical residential system. This can also be a factor in other types of businesses that generate HSW. Each facility type will have unique wastewater characteristics as well as unique site and soil conditions for the designer to consider. Therefore, the more information the designer can obtain, the better the proposed design will accommodate certain distinct, potentially problematic conditions. Initial information gathering may include effluent sampling, water meter records, and/or usage patterns. This document provides recommendations on how to address HSW.

Please note that many of the recommendations are in excess of code required minimums. Due to the variability in the creation of HSW, even among similar establishments, many health codes fail to address HSW or address it too broadly. The designer should review the costs and benefits of any additional, recommended design features with the owner. Whereupon the decision for incorporating potentially significant costs initially, to increase reliability and longevity of the wastewater system, will reside with the owner.

HSW has been defined by many agencies and publications and varies accordingly. The State of Georgia regulations define HSW as greater than 200 mg/l Biochemical Oxygen Demand (BOD) or Total Suspended Solids (TSS). However, there may be constituents other than BOD/TSS that would make the waste stream "high strength" including but not limited to pH (too high or too low), fats, oils & grease (FOG), or nitrogen (N). HSW has been loosely defined within the industry as anything greater than residential waste strength.

Recommended HSW Best Practices:

1. **Code Conformance:** At a minimum the design shall conform with state/county rules and regulations. Please note that codes are a minimum design threshold, and the design can incorporate additional features, superseding the code required minimums. For example, it may be good practice to specify additional septic tank capacity, advanced treatment, larger drainfields or alternating/resting drainfields, etc.

2. **Research:** Conduct research to understand the facility type, the wastewater characteristics, and operations within the facility. If it is an existing facility, then visit the facility. Consult with maintenance providers, obtain historical records. This research only takes a small amount of time but may yield valuable information on unique issues that should be accommodated in the design or addressed otherwise.

3. **Obtain Data:** Sampling data could be collected at an existing facility or, if the facility is new, obtain sampling data from similar usage facilities. Some states may have requirements for the number of samples and the sample collection times. Consult with the local permitting authorities about proper procedures. Typical parameters for sampling: BOD, TSS, FOG, N(series), pH, and temperature.

4. **Increased Tank Volume:** Greater retention times can reduce wastewater strength. In many areas of the US and Canada, it is common practice to double the size of the code-required

grease trap. Grease types have changed and dishwasher temperatures have increased, yet codes have not kept pace with the changes. For septic tanks, a minimum of 48-hour retention time is recommended although some codes only require a 24-hour retention time.

5. **Soil Loading Rates:** Please note that the soil loading rates in codes are typically based upon residential strength waste. Soil loading rates can be reduced to account for HSW. Spreading out the effluent over a larger footprint will provide better long-term performance.

6. **Design Based Upon Mass/Organic Loading:** Determine the pounds of BOD per day for the system. Use this information along with organic soil loading rates to determine the size of the system. (The State of North Carolina can be used as a reference.)

7. **Pressure Dosing/Time Dosing:** Pressure and time dosing can spread out the BOD load over a greater area.

8. **Flow Equalization:** For peak flow event facilities, such as a church, party/wedding venue, stadium, or weekend restaurant, designing the system with increased pump tank storage to accommodate flow equalization would allow the dose to be spread out over an extended amount of time at a reduced daily flow rate.

9. **Pretreatment:** Providing advanced treatment can reduce the strength of the effluent. Options include:
    a. **Advanced Treatment Units (ATUs):** numerous ATU types are available. Code approvals of treatment technologies differ. Any code-approved ATU is acceptable. Consult the ATU manufacturer on ATU size and specifications based upon waste strength and flow.
    b. **Remediator:** a simple, low-cost device to reduce wastewater strength. Contact Infiltrator to verify that Remediator is approved in the state/province. The Remediator can pretreat the effluent down to residential levels, thereby allowing the use of residential loading rates. This will protect the drainfield and increase the system lifespan.

10. **Outlet Filters:** Septic tank outlet filters can provide a performance enhancement. However, they require routine maintenance more often than the maintenance to the tank itself. Therefore, design with maintenance in mind with access risers. Review the owner’s current maintenance contract (if any) to see if outlet filters would be beneficial. Contact the outlet filter manufacturer to specify the correct filter size and type. If possible, oversize the filter to protect during abusive or high flow events. Install multiple filters. They can be installed in parallel configuration and some manufacturers offer an alarm feature. Some wastewater systems utilize the building roof vent for venting purposes and rely on air flow through the septic tank. When an outlet filter is specified or required, designers should specify a model which will maximize airflow through the filter for these systems.

There is no one solution that will fit all cases. Each site and facility is different. For example: If an RV park with HSW is only in use for 3-4 months per year, it may be good to increase tank sizes to deal with peak flows. Then the drainfield may remain at the minimum code required size with the understanding that the system can rest and recover for many months during the off season.

Drainfield monitoring can also be incorporated. The appropriate solution may incorporate a combination of these recommendations.

The design decisions are ultimately the responsibility of the designer and the owner. All designs and solutions will vary. There may be additional best practices not listed herein. This document is not intended to limit other recommendations. All designs are required to meet the minimum code requirements and should follow engineering best practices. Also please note, these recommendations are independent of product type. The goal is to provide a system that will perform well for the customer, meet the regulatory treatment levels, and protect public health.

Please feel free to contact Infiltrator Water Technologies for design assistance with HSW facilities. We look forward to the opportunity of working with you.

References for High Strength Waste:

From USEPA Onsite Wastewater Treatment Systems Manual

A. Table 4-3, note right column: organic loading rates, lbs BOD/1000 sf-d.

Table 4-3. Suggested hydraulic and organic loading rates for sizing infiltration surfaces

Texture	Structure		Hydraulic loading (gal/ft^2-day)		Organic loading (lb BOD/1000ft^2-day)	
	Shape	Grade	BOD=150	BOD=30	BOD=150	BOD=30
Coarse sand, sand, loamy coarse sand, loamy sand	Single grain	Structureless	0.8	1.6	1.00	0.40
Fine sand, very fine sand, loamy fine sand, loamy very fine sand	Single grain	Structureless	0.4	1.0	0.50	0.25
Coarse sandy loam, sandy loam	Massive	Structureless	0.2	0.6	0.25	0.15
	Platy	Weak	0.2	0.5	0.25	0.13
		Moderate, strong				
	Prismatic, blocky, granular	Weak	0.4	0.7	0.50	0.18
		Moderate, strong	0.6	1.0	0.75	0.25
Fine sandy loam, very fine sandy loam	Massive	Structureless	0.2	0.5	0.25	0.13
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak	0.2	0.6	0.25	0.15
		Moderate, strong	0.4	0.8	0.50	0.20
Loam	Massive	Structureless	0.2	0.5	0.25	0.13
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak	0.4	0.6	0.50	0.15
		Moderate, strong	0.6	0.8	0.75	0.20
Silt loam	Massive	Structureless		0.2	0.00	0.05
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak	0.4	0.6	0.50	0.15
		Moderate, strong	0.6	0.8	0.75	0.20
Sandy clay loam, clay loam, silty clay loam	Massive	Structureless				
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak	0.2	0.3	0.25	0.08
		Moderate, strong	0.4	0.6	0.50	0.15
Sandy clay, clay, silty clay	Massive	Structureless				
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak				
		Moderate, strong	0.2	0.3	0.25	0.08

Source: Adapted from Tyler, 2000.

B. Factors of safety in infiltration surface sizing

Sizing of onsite wastewater systems for single-family homes is typically based on the estimated peak daily flow and the "long term acceptance rate" of the soil for septic tank effluent. In most states, the design flow is based on the number of bedrooms in the house. A daily flow of 150 gallons is commonly assumed for each bedroom. This daily flow per bedroom assumes two people per bedroom that generate 75 gpd each. Bedrooms, rather than current occupancy, are used for the basis of SWIS design because the number of occupants in the house can change. Using this typical estimating procedure, a three-bedroom home would have a design flow of 150 gpd/bedroom x 3 bedrooms or 450 gpd. However, the actual daily average flow could be much less. Based on the 1990 census, the average home is occupied by 2.8 persons. Each person in the United States generates 45 to 70 gpd of domestic wastewater. Assuming these averages, the average daily flow would be 125 to 195 gpd or 28 to 44 percent of the design flow, respectively. Therefore, the design flow includes an implicit factor of safety of 2.3 to 3.6. Of course, this factor of safety varies inversely with the home occupancy and water use. Unfortunately, the factors of safety implicitly built into the flow estimates are seldom recognized. This is particularly true in the case of the design hydraulic loading rates, which were derived from existing SWISs. In most codes, the hydraulic loading rates for sand are about 1.0 to 1.25 gpd/ft2. Because these hydraulic loading rates assume daily flows of 150 gpd per bedroom, they are overestimated by a factor of 2.3 to 3.6. Fortunately, these two assumptions largely cancel each other out in residential applications, but the suggested hydraulic loading rates often are used to size commercial systems and systems for schools and similar facilities, where the ratios between design flows and actual daily flows are closer to 1.0. This situation, combined with a lack of useful information on allowable organic loading rates, has resulted in failures, particularly for larger systems where actual flow approximates design.

C. Loading Comparison

Chapter 4: Treatment Processes and Systems

Comparing hydraulic and organic mass loadings for a restaurant wastewater

Infiltration surface sizing traditionally has been based on the daily hydraulic load determined through experience to be acceptable for the soil characteristics. This approach to sizing fails to account for changes in applied wastewater strength. Since soil clogging has been shown to be dependent on applied wastewater strength, it might be more appropriate to size infiltration surfaces based on organic mass loadings.

To illustrate the impact of the different sizing methods, sizing computations for a restaurant are compared. A septic tank is used for pretreatment prior to application to the SWIS. The SWIS is to be constructed in a sandy loam with a moderate, subangular blocky structure. The suggested hydraulic loading rate for domestic septic tank effluent on this soil is 0.6 gpd/ft² (table 4-3). The restaurant septic tank effluent has the following characteristics:

BOD_5	800 mg/L
TSS	200 mg/L
Average daily flow	600 gpd

Infiltration area based on hydraulic loading:

Area = 600 gpd/0.6 gpd/ft² = 1,000 ft²

Infiltration area based on organic loading:

At the design infiltration rate of 0.6 gpd/ft² recommended for domestic septic tank effluent, the equivalent organic loading is (assuming a septic tank BOD_5 effluent concentration of 150 mg/L)

$$\text{Organic Loading} = 150\ \text{mg/L} \times 0.6\ \text{gpd/ft}^2 \times (8.34\ \text{lb/mg/L} \times 10^{-6}\ \text{gal})$$
$$= 7.5 \times 10^{-4}\ \text{lb BOD}_5/\text{ft}^2\text{-d}$$

Assuming 7.5×10^{-4} lb BOD_5/ft^2-d as the design organic loading rate,

$$\text{Area} = \frac{(800\ \text{mg-BOD}_5/\text{L} \times 600\ \text{gpd} \times 8.34\ \text{lbs/mg/L} \times 10^{-6}\ \text{gal})}{(7.5 \times 10^{-4}\ \text{lb BOD}_5/\text{ft}^2\text{-d})}$$

$$= \frac{4.0\ \text{lb BOD}_5/\text{d}}{(7.5 \times 10^{-4}\ \text{lb BOD}_5/\text{ft}^2\text{-d})} = 5337\ \text{ft}^2\ \text{(a 540\% increase)}$$

Impact of a 40% water use reduction on infiltration area sizing

Based on hydraulic loading,

$$\text{Area} = \frac{(1 - 0.4) \times 600\ \text{gpd}}{0.6\ \text{gpd/ft}^2} = 600\ \text{ft}^2$$

Based on organic loading (note the concentration of BOD_5 increases with water conservation but the mass of BOD_5 discharged does not change),

$$\text{Area} = \frac{(800\ \text{mg-BOD}_5/\text{L} \times 600\ \text{gpd}) \times (8.34\ \text{lb/mg/L} \times 10^{-6}\ \text{gal})}{[(1 - 0.4) \times 600\ \text{gpd}] \times (7.5 \times 10^{-4}\ \text{lb BOD}_5/\text{ft}^2\text{-d})}$$

$$= \frac{4.0\ \text{lb BOD}_5/\text{d}}{(7.5 \times 10^{-4}\ \text{lb BOD}_5/\text{ft}^2\text{-d})} = 5337\ \text{ft}^2\ \text{(an 890\% increase)}$$

From the State of Louisiana:

Louisiana Administrative Code
Title 51, Part XIII
Chapter 15. Sewage Loading Criteria
1501. General Requirements

Place	Loading	Daily Average Flow Gallons per Day	Daily Average BOD_5 Pounds per Day	Design Basis
Apartments		250	0.425	one bedroom
		300	0.52	two bedroom
		400	0.68	three bedroom
Assembly	Note (b)	2	0.0034	per seat
Bowling Alleys (no food service)	Note (b)	75	0.13	per lane
Churches	Note (b)	5	0.0088	per sanctuary seat
Churches (with permitted kitchens)	Note (c)	10	0.017	per sanctuary seat
Country Clubs		50	0.085	per member
Dance Halls	Note (b)	2	0.0034	per person
Drive-In Theaters		5	0.0085	per car space
Factories (no showers)		20	0.051	per employee
Factories (with showers)		35	0.06	per employee

Place	Loading	Daily Average Flow Gallons per Day	Daily Average BOD_5 Pounds per Day	Design Basis
Food Service Operations				
Ordinary Restaurant (not 24 hour)		35	0.12	per seat
24-hour Restaurant		50	0.17	per seat
Banquet Rooms		5	0.017	per seat
Restaurant Along Freeway		100	0.33	per seat
Curb Service (drive-in)		50	0.17	per car space
Bar, Cocktail Lounges, Taverns				
(no food service or very little food service)		25	0.084	per seat
(with regular food service)		35	0.12	per seat
Video Poker Machine		100	0.20	per machine
Fast Food Restaurants		40	0.13	per seat

Place	Loading	Daily Average Flow Gallons per Day	Daily Average BOD_5 Pounds per Day	Design Basis
Hotel/Motel Food Service		45	0.17	per room
Homes/ Mobile Homes in Subdivisions		400	0.68	per dwelling
Individual Homes/Mobile Homes (where individual sewage technology is utilized. For each additional bedroom add 100 gpd)		250	0.425	one bedroom
		300	0.51	two bedrooms
		400	0.68	three bedrooms

Hospitals (no resident personnel)	Note (c)	200	0.51	per bed
Institutions (residents)	Note (c)	100	0.25	per person
Municipalities		100	0.17	per person

Place	Loading	Daily Average Flow Gallons per Day	Daily Average BOD_5 Pounds per Day	Design Basis
Mobile Home Parks				
up to 5 trailer spaces		400	0.68	per mobile home space
6 trailer spaces or more		300	0.51	per mobile home space
Motels	Note (b)	100	0.12	per unit
Nursing and Rest Homes	Note (c)	100	0.25	per patient
		100	0.17	per resident employee
Office Buildings		20	0.051	per employee
Recreational Vehicle Dumping Stations				Consult OPH
Recreational Vehicle Parks and Camps		125	0.21	per trailer or tent space
Retail Store		20	0.034	per employee
Schools• • Elementary	Note (c)	15	0.038	per pupil
Schools• High and Junior High	Note (c)	20	0.051	per pupil

Place	Loading	Daily Average Flow Gallons per Day	Daily Average BOD_5 Pounds per Day	Design Basis
Retail Fuel Stations (Located on major highways, etc., and whose primary function is to provide fuel and service to motor vehicles)	Note (d)	250	0.43	per individual vehicle fueling point (up to the first four)
		125	0.21	for each additional individual vehicle fueling point
Shopping Centers (no food service or laundries		0.2	0.00034	per square foot of floor space
Swimming Pool (including employees)		10	0.017	per swimmer
Showers		20	0.04	per shower

Place	Loading	Daily Average Flow Gallons per Day	Daily Average BOD_5 Pounds per Day	Design Basis
Vacation Cottages		50	0.12	per person
Youth and Recreation Camps	Note (c)	50	0.12	per person
Washing Machines		400	1.34	per machine

1. Note (a) If loading criteria other than presented here are used, they should be justified.
2. Note (b) Food Service waste not included.
3. Note (c) Food Service waste included but without garbage grinders.
4. Note (d) Vehicle fueling points are an arrangement of gasoline or diesel fuel pumps to serve automobiles or other vehicles. For thepurposes of these guidelines, a vehicle fueling point is one that serves a vehicle at one time. Food service waste not included.

Note: Design calculations for sewage treatment facilities must be made based on both hydraulic loading(s) and organic loading(s). Final design of facility to be used upon the larger capacity (size) required by these calculations.

From the State of Maine:

10-144

CHAPTER 241

Division of Environmental Health
Maine Center for Disease Control & Prevention Department of Health and Human Services
STATE OF MAINE

SUBSURFACE WASTEWATER DISPOSAL RULES

H. ADJUSTMENTS FOR EFFLUENT QUALITY

1. Facilities other than residential, using water records to determine design flows, must also complywith Sections 4(G) and 4(H). (The Minimum Lot Size Law may also apply).

2. Factor: Adjustment for restaurant and commercial/institutional food preparation waste: Disposal areas for restaurants must be increased by 80 percent (multiplied by 1.8) to accommodate the additional organic loading typical of such facilities. This multiplying factor may be decreased byusing the following criteria:
   (a) If the septic tank capacity is equal to, or greater than, 200 percent of the design flow - deduct0.2.

   (b) If multiple compartment tanks or tanks in series are used - deduct 0.1.

   (c) If the facility uses an external grease interceptor meeting the requirements of Section 6L -deduct 0.1.

   (d) If the treatment tank(s) use an approved effluent filter - deduct 0.1.

   (e) The designer may add the total deductions and subtract them from 1.8. The disposal area mustbe increased by the resulting factor.

3. Disposal field sizing: The size of the disposal field must be adjusted utilizing the factors listed in Table 4B when the wastewater entering a disposal field has a combined 5-day biochemical oxygendemand (BOD5) and total suspended solid (TSS) concentration not equal to 240 milligrams per liter.

   (a) Values less than 240 mg/L: The constructed size of a stone disposal field may be reduced by use of the appropriate factor from Table 4B. The constructed size of a proprietary device disposal field may be reduced by use of the appropriate factor from Table 4B, provided a reduction is allowed by the manufacturer. If an adjustment factor resulting in a reduction in thedisposal area of more than 50 percent is utilized, the HHE-200 Form submitted for permitting must delineate a disposal area without the use of any adjustment factor.

(b) Values greater than 240 and less than or equal to 2,000 mg/L: The size of a disposal field mustbe increased by use of the appropriate factor from Table 4B.

(c) Values greater than 2,000 mg/L: Subsurface wastewater disposal areas designed to handle wastes with a combined BOD5 and TSS greater than 2,000 mg/L are beyond the scope of these rules and may require licensing by the Department of Environmental Protection as specifiedin Section 1(D)(2) of these rules.

TABLE 4B
ADJUSTMENT FACTOR FOR WASTEWATER STRENGTHSDIFFERENT FROM TYPICAL DOMESTIC WASTEWATER

Strength of wastewater entering the disposal field (BOD5 plus TSS)	Adjustment factor (AF)
30 or less milligrams/liter	0.5
52	0.6
82	0.7
122	0.8
175	0.9
240	1.0
320	1.1
420	1.2
530	1.3
660	1.4
810	1.5
985	1.6
1180	1.7
1400	1.8
1645	1.9
2000	2.0

4. Application: The applicant must submit a proposal that is prepared, signed, and sealed by a Maine Professional Engineer or Site Evaluator. The proposal must include at least the following:

(a) Description: A description of the project and all factors that are involved in the design;

(b) Wastewater quality data: The data must include BOD5 and TSS test results from a 24-hour composite sample obtained through flow-proportional composite sampling techniques where feasible. The Department may waive flow-proportional composite sampling when the designer demonstrates that flow-proportional sampling is not practical. In such cases, samples may be obtained through time-proportional composite sampling techniques or through a minimum of four (4) grab samples when the designer demonstrates that this will provide a representative sample of the effluentbeing discharged. Composite samples, and grab samples if used, must be collected in conformance with the *Standard Methods for the Examination of Water and Wastewater*, 21st edition, 2005. The Department maintains a copy of these standards for copy or review. If data from a similar facility are used, there must be at least two such facilities sampled. The reports for all samples must be submitted from a certifiedlaboratory. The rate of flow of wastewater at the time of sampling must also be determined and reported;

(c) Analysis: The 90th percentile value of all samples collected must be used to select anadjustment factor from Table 4B.

5. State approval: An adjustment factor may not be used unless the proposal has been approved inwriting by the Department and the owner has agreed to all conditions (if any) included in the letter of approval.

   (a) State review: The application must be reviewed for compliance with these Rules, good engineering practice, use of the best acceptable technologies, and protection ofthe public welfare.

   (b) Acceptable technology: The use of additional pretreatment to lower the expected wastewater strength must be reviewed by the Department. Approval will require theadoption of an acceptable program for operation, inspection and maintenance appropriate for the proposed technology.

6. Hydraulic loading rate: The hydraulic loading rate noted in Table 4D must be adjusted byusing Equation 4A.

Equation 4A

AHLR = AF x HLR where: **AHLR** is the adjusted hydraulic loading rate. **AF** is the adjustment factor for wastewater strength entering the disposal field, taken from Table 4B, if applicable.**HLR** is the hydraulic loading rate, in square feet per gallon per day, for the applicable soil profile from Table 4D

Other References on High Strength Wastewater, the designer can research other papers on the topic, theseare only a few:

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- Benefield, Laura A., 2002, *Wastewater Quality/Strength/Content*, Washington State Department of Health, Rule Development Committee Research Report (Draft)
- Crites, Tchobanoglous, 1998. *Small and Decentralized Wastewater ManagementSystems*, The McGraw-Hill Companies, Inc.
- National Small Flows Clearinghouse, 2003, *High Strength Flows – Not your average Wastewater*, Pipeline, Summer 2003, Vol. 14, No. 3
- Gross, M.A. 2005 *Wastewater Characterization Text*. In (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.
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- Siegrist, R. L.; Anderson, D. L.; Converse, J. C. (1985) Commercial Wastewater Onsite Treatment andDisposal. Proceedings of the Fourth National Symposium on Individual and Small Community Sewage Systems, New Orleans, Louisiana, December 10-11, 1984; American Society of Agricultural Engineers:St. Joseph, Michigan.
- Stuth, W. L.; Garrison, C. (1995) An Introduction to High Strength Commercial Waste. Stuth Co, Inc.and Aqua Test, Inc. Project: Seattle, Washington