

STANDARD 350 - 2022 - REQUIREMENTS

ONSITE RESIDENTIAL AND COMMERCIAL WATER REUSE SYSTEMS

8 Performance testing and evaluation

The analytical methods listed in Table N-1.2 shall be used for testing. Alternate methods are permissible, provided equivalency is demonstrated by technical review and the review is documented. An equivalent method involves the same measurement technique. Equivalent methods are known to be capable of generating reliable results to equivalent quality requirements. All sample collection methods shall be in accordance with *Standard Methods*⁴ unless otherwise specified.

8.1 Greywater treatment systems with capacities up to 5,678 LPD (1,500 GPD)

This section describes the methods used to evaluate the performance of onsite residential and commercial greywater treatment systems that treat greywater, those that treat laundry water from residential laundry facilities, and those that treat bathing water. Systems shall be classified as Class R (single-family residential), or Class C (multi-family or commercial), in accordance with Section 8.6. The performance classification shall be based upon the evaluation of effluent samples collected over a minimum 6-mo (26-wk [182-d]) testing period. Manufacturers that recommend a service frequency longer than 6-mo (26-wk [182-d]) shall be tested for the full period of the recommended service frequency.

8.1.1 Preparations for testing and evaluation of greywater treatment systems

8.1.1.1 The system shall be assembled, installed, and filled in accordance with the manufacturer's instructions.

8.1.1.2 Some greywater treatment systems provide a means to top off the treated water storage tank with potable water. This assures the user that water will always be available for the intended use. For performance testing, this feature shall be disabled. Some greywater treatment systems require a potable water connection to provide water for a backflush or other function. This feature may be active during performance testing, provided the volume of water used does not exceed 5% of the daily hydraulic capacity and a minimum 90% of the fresh water used in the process goes directly to waste. For example, fresh water could be used to flush the treated water storage tank every 5 d with the flush going to sewer. However, if this process results in more than 10% of the flush water remaining in the treated water storage tank, the feature shall be disabled during performance testing.

8.1.1.3 The manufacturer shall inspect the system for proper installation. If no defects are detected and the system is judged to be structurally sound, it shall be placed into operation in accordance with the manufacturer's start-up procedures. If the manufacturer does not provide a filling procedure, $\frac{2}{3}$ of the system's capacity shall be filled with water meeting the specifications of Section 8.1.2.1, and the remaining $\frac{1}{3}$ shall be filled with greywater meeting the specifications of Sections 8.1.2.1.1, 8.1.2.1.2, or 8.1.2.1.3, as appropriate, based upon manufacturer's decision to test with bathing water, laundry water, or both.

8.1.1.4 The system shall undergo design loading (see Section 8.1.2.2.1) until testing and evaluations are initiated. Sample collection and analysis shall be initiated within 3 wk (21 d) of filling the system and, except as specified in Section 8.6.1.2, shall continue without interruption until the end of the evaluation period.

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8.1.1.5 If the system is to be installed outdoors, and conditions at the testing site preclude installation of the system at its normally prescribed depth, the manufacturer shall be permitted to cover the system with soil to achieve normal installation depth.

8.1.1.6 If the system is to be installed outdoors, performance testing and evaluation of systems shall not be restricted to specific seasons.

8.1.1.7 When possible, electrical or mechanical defects shall be repaired to prevent evaluation delays. All repairs made during the performance testing and evaluation shall be documented in the final report.

8.1.1.8 The system shall be operated in accordance with the manufacturer's instructions. Routine service and maintenance of the system shall not be permitted during the performance testing and evaluation period. Routine refilling or topping off of disinfection device reservoirs, such as tablet or liquid chlorinators or other similar disinfection devices, is permissible once every 30 d and shall be documented in the final report.

It is permissible for the manufacturer to recommend or offer more frequent service and maintenance of the system, but for the purpose of performance testing and evaluation, service and maintenance shall not be performed beyond what is specified in this standard.

8.1.1.9 Prior to initiation of design loading, the air delivery component (if one is utilized) – either air compressor or blower – shall be connected to the system and run for a minimum of 4 h. Air pressure shall be measured by a pressure gauge installed near the exhaust port of the air delivery component and that reading recorded. Then the air compressor or blower component shall be disconnected from the system and the air flow measured at the system pressure and recorded.

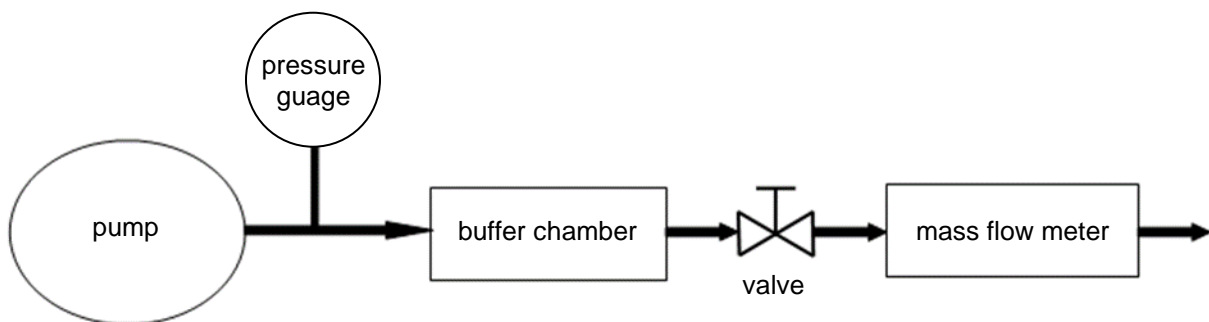


Figure 1

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8.1.2 Testing and evaluation conditions, hydraulic loading, and

schedules 8.1.2.1 Greywater challenge water – Base water supply

A public water supply shall be used as the base water to which individual ingredients are added, as described in Sections 8.1.2.1.1, 8.1.2.1.2, and 8.1.2.1.3. The 30-d average concentration of the base water supply shall meet or be adjusted to meet the following requirements:

| Parameter | Required range |
|------------|--------------------------------|
| hardness | 110 to 220 mg/L |
| alkalinity | > 40 mg/L as CaCO ₃ |

8.1.2.1.1 Greywater challenge water – Systems treating bathing source water

Prepare the challenge water according to the following formula:

| Wastewater components ^a | Amount per 100 L |
|--|--|
| body wash with moisturizer | 30 g |
| toothpaste | 3 g |
| deodorant | 2 g |
| shampoo | 19 g |
| conditioner | 21 g |
| lactic acid | 3 g |
| secondary effluent | 2 L |
| raw influent screened to ≤ 1 mm | 1 L |
| bath cleaner | 10 g |
| liquid hand soap | 23 g |
| A2 – Fine Test dust, meeting ISO 12103-1 | 10 g |
| urea | as needed to bring influent TKN within the specified range |
| NaOH | as needed to adjust pH |
| HCl | as needed to adjust pH |
| ^a See Annex I-2 for example products. | |

The amount of individual wastewater components are recommendations. If the required range for the 30-d average concentration of individual parameters are not met using the recommended volumes, then the volume of wastewater components can be adjusted to achieve the required 30-d average concentrations. All necessary adjustments to the ingredient volumes shall be reported in the final report.

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The bathing water delivered to the system shall be as follows:

| Parameter | Required range | Individual sample maximum |
|---|---|---|
| TSS | 50 to 100 mg/L | — |
| BOD ₅ | 100 to 200 mg/L | — |
| temperature | 25 to 35 °C | — |
| pH | 6.0 to 8.5 | — |
| turbidity | 30 to 70 NTU | — |
| total phosphorous – P | 1.0 to 4.0 mg/L | — |
| total Kjeldahl nitrogen – N | 3.0 to 5.0 mg/L | — |
| COD | 200 to 400 mg/L | — |
| total coliforms ^a (30-d geometric mean) | 10 ³ to 10 ⁷ CFU/100 mL or 10 ³ to 10 ⁷ MPN/100 mL | 10 ⁹ CFU/100 mL or 10 ⁹ MPN/100 mL |
| <i>E. coli</i> ⁱ (30-d geometric mean) | 10 ² to 10 ⁶ CFU/100 mL or 10 ² to 10 ⁶ MPN/100 mL | 10 ⁷ CFU/100 mL or 10 ⁷ MPN/100 mL |
| ^a See Section 8.6.1.2. | | |

8.1.2.1.2 Greywater challenge water – Systems treating laundry source water

Prepare the challenge water according to the following formula:

| Wastewater components ^a | Amount/100 L |
|--|--|
| liquid laundry detergent (2x) | 40 mL |
| A2 – fine test dust, meeting ISO 12103-1 | 10 g |
| secondary effluent | 2 L |
| raw influent screened to ≤ 1mm | 1 L |
| liquid laundry fabric softener | 21 mL |
| Na ₂ SO ₄ | 4 g |
| NaHCO ₃ | 2 g |
| Na ₃ PO ₄ | 4 g |
| urea | as needed to bring influent TKN within the specified range |
| NaOH | as needed to adjust pH |
| HCl | as needed to adjust pH |
| ^a See Annex I-2 for example products. | |

The amount of individual wastewater components are recommendations. If the required range for the 30-d average concentration of individual parameters are not met using the recommended volumes, then the volume of wastewater components can be adjusted to achieve the required 30-d average concentrations. All necessary adjustments to the ingredient volumes shall be reported in the final report.

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The laundry water delivered to the system shall be as follows:

| Parameter | Required range | Individual sample maximum |
|---|---|---|
| TSS | 50 to 100 mg/L | — |
| BOD ₅ | 220 to 370 mg/L | — |
| temperature | 25 to 35 °C | — |
| pH | 6.0 to 8.5 | — |
| turbidity | 50 to 90 NTU | — |
| total phosphorous – P | < 2 mg/L | — |
| total Kjeldahl nitrogen – N | 4.0 to 6.0 mg/L | — |
| COD | 300 to 740 mg/L | — |
| total coliforms ^a (30-d geometric mean) | 10 ³ to 10 ⁷ CFU/100 mL or 10 ³ to 10 ⁷ MPN/100 mL | 10 ⁹ CFU/100 mL or 10 ⁹ MPN/100 mL |
| <i>E. coli</i> ^a (30-d geometric mean) | 10 ² to 10 ⁶ CFU/100 mL or 10 ² to 10 ⁶ MPN/100 mL | 10 ⁷ CFU/100 mL or 10 ⁷ MPN/100 mL |
| ^a See Section 8.6.1.2. | | |

8.1.2.1.3 Greywater challenge water: Systems treating bathing and laundry source waters combined

Each 100 L challenge water shall be prepared using 53 L of Section 8.1.2.1.1 and 47 L of Section 8.1.2.1.2. The greywater delivered to the system shall be as follows:

| Parameter | Required range | Individual sample maximum |
|---|---|---|
| TSS | 50 to 160 mg/L | — |
| BOD ₅ | 130 to 210 mg/L | — |
| temperature | 25 to 35 °C | — |
| pH | 6.0 to 8.5 | — |
| turbidity | 30 to 100 NTU | — |
| total phosphorous – P | 1.0 to 3.0 mg/L | — |
| total Kjeldahl nitrogen – N | 3.0 to 5.0 mg/L | — |
| COD | 230 to 420 mg/L | — |
| total coliforms ^a (30-d geometric mean) | 10 ³ to 10 ⁷ CFU/100 mL or 10 ³ to 10 ⁷ MPN/100 mL | 10 ⁹ CFU/100 mL or 10 ⁹ MPN/100 mL |
| <i>E. coli</i> ^a (30-d geometric mean) | 10 ² to 10 ⁶ CFU/100 mL or 10 ² to 10 ⁶ MPN/100 mL | 10 ⁷ CFU/100 mL or 10 ⁷ MPN/100 mL |
| ^a See Section 8.6.1.2. | | |

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8.1.2.2 Hydraulic loading and schedules

During the minimum 6-mo (26-wk [182-d]) testing and evaluation period, the system shall be subjected to periods of design loading, followed by stress loading, and then additional weeks of design loading. Class R and Class C systems claiming service intervals of greater than 6 mo (26 wk [182 d]) shall be loaded beginning in Week 27 at design loading, according to the time frame and percent rated daily hydraulic capacity as shown below, and shall continue dosing such that the test period equals the prescribed service interval.

Loading of the systems will be based on the following matrix:

| System design | Design loading ^a weeks | | Stress tests ^a weeks | | | | |
|------------------|-----------------------------------|--------------|---------------------------------|---------------------------|------------------------|------------------------|-----------------------|
| | Before stress | After stress | Wash-day surge | Power / equipment failure | Vacation | Water efficiency | Cleaning solution |
| R – Bathing only | #1 to 16 | #22 to 26 | — | #17 (Mon to Wed) | #18 (Thur) to 19 (Sat) | #21 (Sun to Sat) | — |
| R – Laundry only | #1 to 16 | #25 to 26 | #17 (Fri) to 18 (Thur) | #19 (Fri) to 20 (Sun) | #21 (Mon) to 22 (Wed) | #23 (Thur) to 24 (Wed) | — |
| R – Combined | #1 to 16 | #25 to 26 | #17 (Fri) to 18 (Thur) | #19 (Fri) to 20 (Sun) | #21 (Mon) to 22 (Wed) | #23 (Thur) to 24 (Wed) | — |
| C – Bathing only | #1 to 20 | #24 to 26 | — | #21 (Mon to Wed) | #22 (Thur) to 23 (Sat) | — | — |
| C – Laundry only | #1 to 20 | #24 to 26 | — | #21 (Mon to Wed) | #22 (Thur) to 23 (Sat) | — | — |
| C – Combined | #1 to 17 | none | — | #18 (Thur to Sat) | #20 (Sun) to 21 (Tues) | — | #22 (Wed) to 26 (Fri) |

^a For 6 mo (26 wk [182 d]) test.

^b These are the starting and ending days for each stress. Unlisted days / weeks are design loading between stress tests.

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8.1.2.2.1 Design loading

The system shall be dosed 7 d a week with a greywater volume equivalent to the daily hydraulic input capacity of the system. The following schedule shall be adhered to for dosing Class R systems throughout the 26-wk [182-d] evaluation period and for Class C systems during the first 20 wk (140 d), except in those cases where the stress loading requirements differ (see Section 8.1.2.2.2).

Class R and Class C systems claiming service intervals of greater than 6 mo (26 wk [182 d]) shall be loaded beginning in Week 27 at design loading according to the time frame and percent rated daily hydraulic input capacity as described in the appropriate tables under Sections 8.1.2.2.1.1, 8.1.2.2.1.2, and 8.1.2.2.1.3 below.

When a system sends a portion of the treated or untreated water to sewer, both input and output shall be measured and reported. When a system treats and makes available for reuse 100% of the input volume, only input shall be measured and reported. When a system uses fresh water for a treatment function, such as backflushing to sewer, the volume of fresh water used shall be measured and reported.

8.1.2.2.1.1 Systems treating combined greywater

| Time frame | Percent rated daily hydraulic input capacity |
|-------------------------|--|
| 7:00 a.m. to 10:00 a.m. | approximately 40 |
| 11:00 a.m. to 2:00 p.m. | approximately 35 |
| 6:00 p.m. to 9:00 p.m. | approximately 25 |

Individual doses shall be 10 to 15 gal and be uniformly applied over the dosing periods. For systems with a rated capacity less than 400 GPD, individual doses may be adjusted to less than 10 gal as needed to meet the dosing schedule requirements.

Class C systems shall be dosed 7 d a week according to the following schedule for the final 4.5 wk (31 d):

| Time frame | Percent rated daily hydraulic input capacity |
|-------------------------|--|
| 7:00 a.m. to 5:00 p.m. | approximately 90 |
| 9:00 p.m. to 10:00 p.m. | approximately 10 |

Individual doses shall be 10 to 15 gal and be uniformly applied over the dosing periods. For systems with a rated capacity less than 400 GPD, individual doses may be adjusted to less than 10 gal as needed to meet the dosing schedule requirements.

8.1.2.2.1.2 Systems treating bathing water

| Time frame | Percent rated daily hydraulic input capacity |
|-------------------------|--|
| 7:00 a.m. to 10:00 a.m. | approximately 50 |
| 11:00 a.m. to 2:00 p.m. | approximately 25 |
| 6:00 p.m. to 9:00 p.m. | approximately 25 |

Individual doses shall be 10 to 15 gal and be uniformly applied over the dosing periods. For systems with a rated capacity less than 400 GPD, individual doses may be adjusted to less than 10 gal as needed to meet the dosing schedule requirements.

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8.1.2.2.1.3 Systems treating laundry water

| Time frame | Percent rated daily hydraulic input capacity |
|-------------------------|---|
| 7:00 a.m. to 10:00 a.m. | approximately 100; Thursday, Friday |
| 11:00 a.m. to 2:00 p.m. | approximately 100; Monday, Tuesday, Wednesday |
| 6:00 p.m. to 9:00 p.m. | approximately 100; Saturday, Sunday |

Individual doses shall be 10 to 15 gal and be uniformly applied over the dosing periods. For systems with a rated capacity less than 400 GPD, individual doses may be adjusted to less than 10 gal as needed to meet the dosing schedule requirements.

8.1.2.2.2 Stress loading

Stress loading is designed to evaluate a system's performance under non ideal conditions. Systems shall be sequentially subjected to each stress condition once during the 6-mo (26-wk [182-d]) testing and evaluation period. Each of the stress conditions shall be separated by 1 wk (7 d) of design loading (Section 8.1.2.2.1).

8.1.2.2.2.1 Wash-day surge stress

The wash-day surge stress shall consist of combining 1 wk (7 d) of loading into three days; Tuesday, Wednesday, and Thursday. No loading shall be done during Friday of the previous week through Monday. Tuesday shall be dosed with the equivalent of 2 d hydraulic input capacity. Wednesday shall be dosed with the equivalent of 3 d hydraulic input capacity and Thursday shall be dosed with the equivalent of 2 d hydraulic input capacity. All loading shall be done between 10:00 a.m. and 3:00 p.m.

| The week before wash-day – Surge stress | | | | | | |
|---|---------------|---------------------|---------------------|---------------------|---------------|---------------|
| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
| normal dosing | normal dosing | normal dosing | normal dosing | normal dosing | no dosing | no dosing |
| Wash-day – Surge stress | | | | | | |
| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
| no dosing | no dosing | 200% daily capacity | 300% daily capacity | 200% daily capacity | normal dosing | normal dosing |

8.1.2.2.2.2 Power / equipment failure stress

On the day the power / equipment failure stress is initiated power to the system shall be turned off at 9:00 p.m. After the last dosing period of the day, dosing shall be discontinued for 48 h. After 48 h, power shall be restored and the system shall be dosed over a 3-h period with 60% of its daily hydraulic input capacity. For residential systems designed to treat laundry or combined bathing and laundry greywater, the 60% dosing upon resumption of power shall include one wash load (114 L [30 gal]) of the laundry challenge water (described in Section 8.1.2.1.2).

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| | Day 1 | Day 2 | Day 3 |
|----------|--|---------------------|---|
| combined | normal dosing, power off at 9:00 p.m. | no dosing, no power | Power restored at 9 p.m. Dose 60% of daily input capacity between 9 p.m. and midnight, including one wash load |
| bathing | normal dosing, power off at 9:00 p.m. | no dosing, no power | Power restored at 9:00 p.m. Dose 60% of daily input capacity between 9:00 p.m. and midnight. |
| laundry | normal dosing, power off at 9:00 p.m. | no dosing, no power | Power restored at 9:00 p.m. Dose 60% of daily input capacity between 9:00 p.m. and midnight |

8.1.2.2.3 Vacation stress

On the day that the nonloading stress is initiated, a system treating combined greywater shall be dosed at 40% of its daily hydraulic input capacity between 7:00 a.m. and 10:00 a.m. and at 35% between 11:00 a.m. and 2:00 p.m. A system treating bathing water shall be dosed at 50% of its daily hydraulic input capacity between 7:00 a.m. and 10:00 a.m. and at 25% between 11:00 a.m. and 2:00 p.m. A system treating laundry water shall be dosed at 100% of its daily hydraulic input capacity between 7:00 a.m. and 10:00 a.m. Dosing shall be discontinued for eight consecutive days, beginning the day after initiating the stress (power shall continue to be supplied to the system). Between 6:00 p.m. and 9:00 p.m. of the ninth day, the system shall be dosed with 60% of its daily hydraulic input capacity. This shall include three wash loads (each wash load equal to 114 L [30 gal]) of the laundry challenge water (described in Section 8.1.2.1.2) for residential systems designed to treat more than 100 gpd combined greywater. This shall include two wash loads (each wash load equal to 114 L [30 gal]) of the laundry challenge water (described in Section 8.1.2.1.2) for residential systems designed to treat more than 50 GPD combined greywater. This shall include one wash load (each wash load equal to 114 L [30 gal]) of the laundry challenge water (described in Section 8.1.2.1.2) for residential systems designed to treat 50 GPD or less combined greywater.

| | 7:00 a.m. to 10:00 a.m. | 11:00 a.m. to 2:00 pm | Following eight days | Day 9 |
|-----------------------|---------------------------------|--------------------------------|-------------------------|--|
| combined > 100 GPD | 40% of daily input capacity | 35% of daily input capacity | no dosing | 60% from 6:00 p.m. to 9:00 p.m., including three wash loads for residential systems |
| combined > 50 GPD | 40% of daily input capacity | 35% of daily input capacity | no dosing | 60% from 6:00 p.m. to 9:00 p.m., including two wash loads for residential systems |
| combined ≤ 50 GPD | 40% of daily input capacity | 35% of daily input capacity | no dosing | 60% from 6:00 p.m. to 9:00 p.m., including one wash load for residential systems |
| bathing | 50% of daily input capacity | 25% of daily input capacity | no dosing | 60% from 6:00 p.m. to 9:00 p.m. |
| laundry | 100% of daily input capacity | no dosing | no dosing | 60% from 6:00 p.m. to 9:00 p.m. |

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8.1.2.2.4 Water efficiency stress

The water efficiency stress test shall consist of 1 wk (7 d) of loading with challenge water at 1.4 times the normal strength (see Sections 8.1.2.1.1, 8.1.2.1.2, and 8.1.2.1.3 for normal strength challenge water, as applicable), and a 40% reduction in the rated daily hydraulic input capacity of the design loading (see Sections 8.1.2.2.1.1, 8.1.2.2.1.2, and 8.1.2.2.1.3, as applicable).

Individual doses shall be 6 gal to 15 gal. Individual doses shall be uniformly applied over the dosing periods. For systems with a rated capacity less than 400 GPD, individual doses may be adjusted to less than 6 gal as needed to meet the dosing schedule requirements.

8.1.2.2.5 Cleaning chemical stress – Greywater commercial treatment systems

During final 4.5 wk (31 d) of design loading, the system shall be subjected to an additional load of cleaning compounds during the dosing period of 9:00 p.m. to 10:00 p.m. Dosing shall consist of the base water as described in Section 8.1.2.1 in addition to the cleaning compound at the following concentration:

| Cleaning compound | Amount |
|--|--------------|
| trisodium phosphate (TSP) ^a | 750 mL/100 L |
| A2 – fine test dust, meeting ISO 12103-1 | 10 g/100 L |
| ^a See Annex I-2 for example products. | |

8.1.2.3 Dosing volumes

The 30-d average volume of the wastewater delivered to the system shall be within 100% ± 10% of the system's rated hydraulic capacity.

All dosing days, except those with dosing requirements less than or greater than the daily hydraulic capacity shall be included in the 30-d average calculation

8.1.2.4 Color, odor, foam, and oily film assessments

During the 6-mo (26-wk [182-d]) testing and evaluation, a total of three effluent samples shall be assessed for color, odor, foam, and oily film. The assessments shall be conducted on effluent composite samples selected randomly during the first phase of design loading, the period of stress loading, and the second phase of design loading.

8.2 Residential wastewater treatment systems with capacities up to 5,678 LPD (1,500 GPD)

This section describes the methods used to evaluate the performance of residential wastewater treatment systems. Systems shall be classified as Class R (residential), in accordance with Section 8.6.2. The performance classification shall be based upon the evaluation of effluent samples collected from the system over a 6-mo (26-wk [182-d]) period.

8.2.1 Preparations for testing and evaluation

8.2.1.1 The system shall be assembled, installed, and filled in accordance with the manufacturer's instructions.

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8.2.1.2 The manufacturer shall inspect the system for proper installation. If no defects are detected and the system is judged to be structurally sound, it shall be placed into operation in accordance with the manufacturer's start-up procedures. If the manufacturer does not provide a filling procedure, $\frac{2}{3}$ of the system's capacity shall be filled with water and the remaining $\frac{1}{3}$ shall be filled with residential wastewater.

8.2.1.3 The system shall undergo design loading (see Section 8.2.2.2.1) until testing and evaluations are initiated. Sample collection and analysis shall be initiated within 3 wk (21 d) of filling the system and, except as specified in Section 8.6.1.2, shall continue without interruption until the end of the evaluation period.

8.2.1.4 If conditions at the testing site preclude installation of the system at its normally prescribed depth, the manufacturer shall be permitted to cover the system with soil to achieve normal installation depth.

8.2.1.5 Performance testing and evaluation of systems shall not be restricted to specific seasons.

8.2.1.6 When possible, electrical or mechanical defects shall be repaired to prevent evaluation delays. All repairs made during the performance testing and evaluation shall be documented in the final report.

8.2.1.7 The system shall be operated in accordance with the manufacturer's instructions. Routine service and maintenance of the system shall not be permitted during the performance testing and evaluation period.

It is permissible for the manufacturer to recommend or offer more frequent service and maintenance of the system, but for the purpose of performance testing and evaluation, service and maintenance shall not be performed beyond what is specified in this standard.

8.2.1.8 Prior to initiation of design loading, the air delivery component (if one is utilized) – either air compressor or blower – shall be connected to the system and run for a minimum of 4 h. Air pressure shall be measured by a pressure gauge installed near the exhaust port of the air delivery component and that reading recorded. Then the air compressor or blower component shall be disconnected from the system and the air flow measured at the system pressure and recorded.

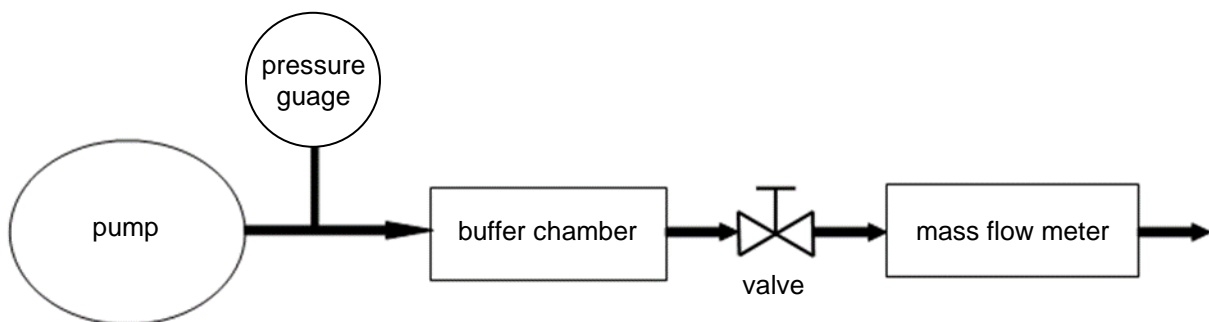


Figure 2

8.2.2 Testing and evaluation conditions, hydraulic loading, and schedules

8.2.2.1 Influent wastewater characteristics

The 30-d average BOD₅ concentration of the wastewater delivered to the system shall be between 100 mg/L and 300 mg/L.

The 30-d average TSS concentration of the wastewater delivered to the system shall be between 100 mg/L and 350 mg/L.

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8.2.2.2 Hydraulic loading and schedules

The performance of the system shall be evaluated for 6 mo (26 wk [182 d]). During the testing and evaluation period, the system shall be subjected to 4 mo (16 wk [112 d]) of design loading, followed by 7.5 wk (52 d) of stress loading, and then an additional 2.5 wk (18 d) of design loading.

8.2.2.2.1 Design loading

The system shall be dosed 7 d/wk with wastewater volume equivalent to the daily hydraulic capacity of the system. The following schedule shall be adhered to for dosing:

| Time frame | Percent daily hydraulic capacity (%) |
|-------------------------|--------------------------------------|
| 6:00 a.m. to 9:00 a.m. | approximately 35 |
| 11:00 a.m. to 2:00 p.m. | approximately 25 |
| 5:00 p.m. to 8:00 p.m. | approximately 40 |

The individual dosage shall be no more than 10 gal per dose, unless the dosage system is based on a continuous flow, and be uniformly applied over the dosing periods.

8.2.2.2.2 Stress loading

Stress loading sequences shall begin in Week 17 \pm 1 wk of the testing and will be completed in the order listed in the following sections. Each stress sequence shall be separated by 7 d of design loading, as described in Section 8.2.2.2.1.

8.2.2.2.2.1 Wash-day stress

The wash-day stress shall consist of three wash-days in a 5-d period. Each wash-day shall be separated by a 24-h period. During a wash-day, the system shall be loaded at times and capacities similar to those delivered during design loading (see Section 8.2.2.2.1), however during the first two dosing periods per day, the design loading shall include three wash loads (three wash cycles and six rinse cycles).

8.2.2.2.2.2 Working parent-stress

For five consecutive days, the system shall be subjected to a working-parent stress. During this stress, the system shall be dosed with 40% of its daily hydraulic capacity between 6:00 a.m. and 9:00 a.m. Between 5:00 p.m. and 8:00 p.m., the system shall be dosed with the remaining 60% of its daily hydraulic capacity, which shall include one wash load (one wash cycle and two rinse cycles).

8.2.2.2.2.3 Power / equipment failure stress

On the day the power / equipment failure stress is initiated power to the system shall be turned off at 9:00 p.m. After the last dosing period of the day, dosing shall be discontinued for 48 h. After 48 h, power shall be restored and the system shall be dosed over a 3-h period with 60% of its daily hydraulic capacity, which shall include one wash load (one wash cycle and two rinse cycles).

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| Day 1 | Day 2 | Day 3 |
|--|---------------------|---|
| normal dosing, power off at 9:00 p.m. | no dosing, no power | Power restored at 9:00 p.m. Dose 60% of daily capacity between 9:00 p.m. and midnight, including one wash load |

8.2.2.2.4 Vacation stress

On the day that the vacation stress is initiated, the system shall be dosed at 35% of its daily hydraulic capacity between 6:00 a.m. and 9:00 a.m. and at 25% between 11:00 a.m. and 2:00 p.m. Dosing shall then be discontinued for eight consecutive days, beginning the day after initiating the stress (power shall continue to be supplied to the system). Between 5:00 p.m. and 8:00 p.m. on Day 9, the system shall be dosed with 60% of its daily hydraulic capacity, which shall include three wash loads (three wash cycles and six rinse cycles).

| 6:00 a.m. to 9:00 a.m. | 11:00 a.m. to 2:00 p.m. | Following eight days | Day 9 |
|------------------------|-------------------------|----------------------|--|
| 35% of daily capacity | 25% of daily capacity | no dosing | 60% from 5:00 p.m. to 8:00 p.m., including three wash loads |

8.2.2.3 Dosing volumes

The 30-d average volume of the wastewater delivered to the system shall be within 100% ± 10% of the system's rated hydraulic capacity.

All dosing days, except those with dosing requirements less than the daily hydraulic capacity shall be included in the 30-d average calculation

8.2.2.4 Color, odor, foam, and oily film assessments

During the 6-mo (26-wk [182-d]) testing and evaluation, a total of three effluent samples shall be assessed for color, odor, foam, and oil film. The assessment shall be conducted on effluent composite samples selected randomly during the first phase of design loading (Weeks 1 to 16), the period of stress loading (Weeks 17 to 23.5), and the second phase of design loading (Weeks 23.5 to 26).

8.3 Commercial treatment systems with combined wastewater flows and commercial laundry water of any capacity, and greywater capacities exceeding 5,678 LPD (1,500 GPD)

Commercial treatment systems that treat combined commercial facility wastewater and commercial facility laundry water of any capacity, and those that treat greywater with capacities exceeding 5,678 LPD (1,500 GPD) shall be tested and evaluated in accordance with Annex N-1. These systems shall be performance tested and evaluated at the location of the reuse system installation, using the wastewater generated onsite from the commercial facility serving the treatment system.

8.4 Sample collection

The following requirements apply to all reuse systems evaluated in accordance with Sections 8.1, 8.2, and 8.3.

For systems with storage of treated reuse water, samples shall be collected from the outlet of the storage component. For those systems without storage of treated reuse water, samples shall be collected from the outlet of the final treatment component.

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8.4.1 Sample frequency

8.4.1.1 Greywater

Influent samples shall be collected two times per week, except for the following (which shall be collected one time per week): total phosphorous, COD, and total coliform. Influent hardness and alkalinity samples shall be collected every two weeks on the same day as influent samples. Effluent samples shall be collected three times per week during design loading periods and three times during each stress recovery period (the week following completion of each of the stress simulations described in Section 8.1.2.2.2). Influent samples shall be collected on the same day as effluent samples during each stress recovery period. Effluent samples shall be collected two times per week during all stress events, except power / equipment failure stress and vacation stress where no samples shall be collected. Color, odor, oily film and foam on the effluent once every 2 mo (8 wk [56 d]) for a total of three samples over the course of the test.

8.4.1.2 Residential wastewater

Influent residential wastewater samples shall be collected three times per week, except for the following (which shall be collected one time per week): total phosphorous, COD, and total coliforms. Effluent samples shall be collected three times per week during design loading periods and three times during each stress recovery period. Influent samples shall be collected on the same day as effluent samples during each stress recovery period. Effluent samples shall be collected two times per week during all stress events, except power / equipment failure stress and vacation stress where no samples shall be collected. Color, odor, oily film and foam on the effluent once every 2 mo (8 wk [56 d]) for a total of three samples over the course of the test.

8.4.2 All sample collection methods shall be in accordance with *Standard Methods*⁴ unless otherwise specified.

8.4.3 Influent and effluent wastewater samples shall be collected in accordance with the table below. Influent samples shall be obtained during periods of system dosing, and effluent samples shall be obtained during periods of system discharge. Effluent samples shall be representative of all treated effluent discharged from the system, as sampled from a central point of collection of all treated effluent. 24-h composite samples shall be flow-proportional. The location of the grab sample shall be appropriate to provide a sample that is representative of the influent or effluent. Systems containing storage of treated greywater shall be sampled at the outlet of the storage container. Grab samples shall be collected during the morning or noon dosing period for gravity flow systems and during a time of discharge for systems that are pump discharged.

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| Parameter | Sample type | Sample location | |
|----------------------------------|---------------------------|-----------------|------------------|
| | | Raw influent | Treated effluent |
| BOD ₅ | 24-h composite | X | — |
| CBOD ₅ | 24-h composite | — | X |
| total suspended solids | 24-h composite | X | X |
| pH | grab | X | X |
| temperature (°C) | grab | X | — |
| <i>E. coli</i> | grab | X | X |
| turbidity | 24-h composite | X | X |
| disinfectant ¹ | grab or 24-h composite | — | X |
| TKN | 24-h composite | X | — |
| NO ₂ /NO ₃ | 24-h composite | X | — |
| total phosphorous | 24-h composite | X | — |
| COD | 24-h composite | X | — |
| total coliforms | grab | X | — |
| alkalinity | grab or 24-h composite | X | — |
| hardness | grab or 24-h composite | X | — |

If the treatment system introduces a disinfectant, the disinfectant shall be measured in the effluent sample. The sample type shall be 24-h composite except when the disinfectant is not stable for 24 h, in which case grab samples shall be collected.

When preparing a batch of synthetic greywater to dose a greywater system, hardness and alkalinity adjustment may be completed and measured before addition of other ingredients as the other ingredients have a negligible impact on these parameters. When taking this approach, hardness and alkalinity are measured from grab samples. Hardness and alkalinity are measured from the 24-h composite sample for other influent preparation methods.

NOTE — Manufacturers may request additional sampling during testing dependent on end use of the effluent.

8.5 Analyses (applicable to all reuse systems evaluated in accordance with Sections 8.1, 8.2, and 8.3)

8.5.1 Color, odor, oil film, and foam

8.5.1.1 General

Three composite effluent samples shall be tested during the 6-mo (26-wk [182-d]) evaluation period, as described in Sections 8.1.2.4 and 8.2.2.4.

8.5.1.2 Color

The apparent color of the undiluted effluent samples shall be determined with the visual comparison method described in Method 2120 B of *Standard Methods*.⁴

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8.5.1.3 Odor

The odor of undiluted effluent sample shall be determined by a panel consisting of at least five evaluators tested in accordance with Method 2150 B of *Standard Methods*.⁴

8.5.1.4 Oily film and foam

Diluted effluent sample aliquots shall be visually evaluated for the presence of an oily film or foaming. The effluent composite samples shall be diluted 1:1,000 with deionized water.

8.5.1.5 Energy consumption

Total energy consumption of the system shall be measured throughout the test using a kilowatt meter. Consumption shall be reported.

8.5.2 Pressure and flow

Air pressure shall be measured using a gauge with accuracy of 2% or better. Airflow shall be measured using a flow meter with accuracy of 10% or better.

8.6 Criteria (applicable to all reuse systems evaluated in accordance with Sections 8.1, 8.2, and 8.3)

8.6.1 General

8.6.1.1 If conditions during the testing and evaluation period result in system upset, improper sampling, improper dosing, or influent characteristics outside of the specified ranges, an assessment shall be conducted to determine the extent to which these conditions adversely affected the performance of the system. Based on this assessment, it is acceptable to exclude specific data points from the averages of effluent measurements. Rationale for all data exclusions shall be documented in the final report.

8.6.1.2 When the 30-d average or geometric mean concentration of one or more individual influent parameters are less than the required minimum value, individual data days may be excluded to bring the 30-d period within range. When influent data is excluded from the averages, all influent and effluent data from that day shall also be excluded. All data exclusions shall be noted in the final report.

8.6.1.3 In the event that a catastrophic site problem not described in this standard including, but not limited to, influent characteristics (including influent total coliform or *E.coli* results exceeding the single sample maximum values during testing under Section 8.1), malfunctions of test apparatus, and acts of nature, jeopardizes the validity of the performance testing and evaluation, manufacturers shall be given the choice to:

- perform maintenance on the system, reinitiate system start-up procedures, and restart the performance testing and evaluation; or
- with no routine maintenance performed, have the system brought back to preexisting conditions and resume testing within 3 wk (21 d) after the site problem has been identified and corrected. Data collected during the system recovery period shall be excluded from averages of effluent measurements.

Preexisting conditions shall be defined as the point when the results of three consecutive data days are within 15% of the previous 30-d average(s).

8.6.1.4 During the design loading sequence, a minimum of $\frac{2}{3}$ of the total scheduled data days shall be necessary for the test to be considered valid. When the minimum number of data days is not met, additional sampling days shall be added to the normal required test period until the $\frac{2}{3}$ minimum is met. When adding

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additional sample days is not enough or not possible, the test shall be extended until the $\frac{2}{3}$ minimum has been met.

8.6.1.5 During the stress loading sequence (Sections 8.1.2.2.2 and 8.2.2.2.2), a minimum of $\frac{2}{3}$ of the total scheduled data days and from at least one of the scheduled data days during any single stress recovery shall be necessary for the test to be considered valid. When the minimum number of data days is not met during stress loading and recovery, individual stress events (including stress recovery) shall be repeated until these minimum requirements have been met. When selecting which stress events to repeat, the event with the fewest number of valid data days shall be selected first, followed by the events with the next fewest number of valid data days until minimum requirements for number of valid samples have been met.

8.6.1.6 Water reuse treatment systems shall produce treated effluent that is a minimum of 60% of the volume of the input water. The input water includes all residential wastewater, greywater, and fresh water used by the process.

8.6.1.7 A 30-d average or 30-d geo mean average discharge value shall consist of a minimum of 50% of the regularly scheduled sampling days per month. If a 30-d period contains less than the required number of data days, it is permissible to transfer sufficient data days from the preceding 30-d period to constitute a 30-d average or 30-d geo mean discharge value. If there are not sufficient data days available in the preceding 30-d period, it is permissible for the transfer of data days to take place from the following 30-d period to constitute a 30-d average or 30-d geo mean discharge value. No data day shall be included in more than one 30-d average or 30-d geo mean discharge value.

8.6.1.8 When a sample result is less than the detection limit, the detection limit shall be used as the value for the purpose of calculating the 30-d average or 30-d geo mean. When all of the sample results in a 30-d period are less than the detection limit, the 30-d average or 30-d geo mean shall be reported as less than the detection limit.

8.6.1.9 When a system does not discharge at least 50% of its rated daily hydraulic capacity for five consecutive days, the system is in malfunction. An assessment shall be conducted to determine the root cause for the discharge failure. Manufacturers shall be given the choice to follow one of the options in Section 8.6.1.3.

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**Table 8.1
Summary of effluent criteria for individual classifications**

| Measure | Class R | | Class C | |
|--|----------------|-----------------------|----------------|-----------------------|
| | Test average | Single sample maximum | Test average | Single sample maximum |
| CBOD ₅ (mg/L) | 10 | 25 | 10 | 25 |
| TSS (mg/L) | 10 | 30 | 10 | 30 |
| turbidity (NTU) | 5 | 10 | 2 | 5 |
| <i>E. coli</i> ^a (MPN/100 mL) | 14 | 240 | 2.2 | 200 |
| pH (SU) | 6.0 to 9.0 | NA | 6.0 to 9.0 | NA |
| storage vessel disinfection (mg/L) ^b | ≥ 0.5 to ≤ 2.5 | NA | ≥ 0.5 to ≤ 2.5 | NA |
| color | MR | NA | MR | NA |
| odor | MR | NA | MR | NA |
| oily film and foam | nondetectable | nondetectable | nondetectable | nondetectable |
| energy consumption | MR | NA | MR | NA |

NOTE — NA: Not applicable. MR: Measured and reported only; there is no criteria requirement for these values.
^a Calculated as geometric mean.
^b If chlorine disinfection is used with a storage vessel, see Section 8.6.2.6 or 8.6.3.6.

8.6.2 Class R systems (single family residential dwelling)

The following criteria shall be met in order for a system to be classified as a residential reuse water treatment system for restricted indoor and unrestricted outdoor use, such as toilet, urinal flushing and surface and subsurface irrigation.

8.6.2.1 CBOD₅

The average CBOD₅ of all effluent samples shall not exceed 10 mg/L. No single sample shall exceed 25 mg/L.

8.6.2.2 TSS

The average TSS of all effluent samples shall not exceed 10 mg/L. No single sample shall exceed 30 mg/L.

8.6.2.3 Turbidity

The average turbidity of all effluent samples shall not exceed 5 NTU. No single sample shall exceed 10 NTU.

8.6.2.4 *E. coli*

The geometric mean of all *E. coli* effluent samples shall not exceed 14 MPN/100 mL. No single sample shall exceed 240 MPN/100 mL.

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8.6.2.5 pH

The pH of individual effluent samples shall be within the range of 6.0 to 9.0 SU.

8.6.2.6 Storage vessel disinfection for restricted water reuse

Systems containing storage of treated restricted reuse water shall provide adequate disinfection. In the case of chlorine, the average total residual chlorine concentration of all effluent samples shall be ≥ 0.5 mg/L and ≤ 2.5 mg/L. Other disinfection procedures shall provide adequate disinfection to prevent microorganism growth in the treated reuse water storage while avoiding degradation of plumbing components and fixtures exposed to the treated reuse water.

8.6.2.7 Color

The color rating of each of the three diluted composite effluent samples shall be reported. There are no criteria that these values shall meet.

8.6.2.8 Odor

The odor rating of each of the three undiluted composite effluent samples shall be reported. There are no criteria that these values shall meet.

8.6.2.9 Oily film and foam

Oily films and foaming shall not be visually detected in any of the diluted composite effluent samples.

8.6.2.10 Energy consumption

The total energy consumption of the system measured throughout the test shall be reported as kWh/unit of water treated. There are no criteria that this value shall meet.

8.6.3 Class C systems (multi family residential units and commercial facilities)

The following criteria shall be met in order for a system to be classified as multi-family and commercial facility water treatment system for restricted indoor and unrestricted outdoor use, such as toilet, urinal flushing and surface and subsurface irrigation.

8.6.3.1 CBOD₅

The average CBOD₅ of all effluent samples shall not exceed 10 mg/L. No single sample shall exceed 25 mg/L.

8.6.3.2 TSS

The average TSS of all effluent samples shall not exceed 10 mg/L. No single sample shall exceed 30 mg/L.

8.6.3.3 Turbidity

The average turbidity of all effluent samples shall not exceed 2 NTU. No single sample shall exceed 5 NTU.

8.6.3.4 *E. coli*

The geometric mean of all *E. coli* effluent samples shall not exceed 2.2 MPN/100 mL. No single sample shall exceed 200 MPN/100 mL.

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8.6.3.5 pH

The pH of individual effluent samples shall be within the range of 6.0 to 9.0 SU.

8.6.3.6 Storage vessel disinfection for restricted water reuse

Systems containing storage of treated restricted reuse water shall provide adequate disinfection. In the case of chlorine, the average total residual chlorine concentration of all effluent samples shall be ≥ 0.5 mg/L and ≤ 2.5 mg/L. Other disinfection procedures shall provide adequate disinfection to prevent microorganism growth in the treated reuse water storage while avoiding degradation of plumbing components and fixtures exposed to the treated reuse water.

8.6.3.7 Color

The color rating of each of the three diluted composite effluent samples shall be reported. There are no criteria that these values shall meet.

8.6.3.8 Odor

The odor rating of each of the three undiluted composite effluent samples shall be reported. There are no criteria that these values shall meet.

8.6.3.9 Oily film and foam

Oily films and foaming shall not be visually detected in any of the diluted composite effluent samples.

8.6.3.10 Energy consumption

The total energy consumption of the system measured throughout the test shall be reported as kWh per unit of water treated. There are no criteria that this value shall meet.

8.6.4 Air pressure and flow

There are no criteria for aerator pressure or flow. Pressure and flow are measured for the purpose of qualifying alternate aerators following the test.

9 Final report

A final report shall be prepared that presents the following:

- all data collected in accordance with the testing and evaluations specified within this standard;
- any adjustments made to the alkalinity of the influent wastewater;
- copy of the current edition of the Owner's Manual;
- process description and detailed dimensioned drawings of the tested system; and
- rationale for exclusion of data.

A supplemental report shall be prepared for any system(s) approved under the performance classification in Section 1.4, including process description(s) and dimensional drawing(s).