4.21 Recirculating Gravel Filter

Revision: May 18, 2016
Installer registration permit: Complex
Licensed professional engineer required: Yes

4.21.1 Description

A recirculating gravel filter is a bed of filter media in a container that filters and biologically treats septic tank effluent. The filter effluent is returned to the recirculation tank for blending with untreated septic tank effluent and recirculated back to the filter. The treated effluent is distributed to a disposal trench of reduced dimension. The effluent returned from the filter may either return to the recirculation tank or a combination of the equalization tank and recirculating tank depending on effluent treatment requirements. Minimum system components include, but are not limited to, the following:

1. Septic tank
2. Equalization tank (if nitrogen reduction is required)
3. Recirculation tank
4. Low-pressure distribution system
5. Free-access filters
6. Flow splitter
7. Dosing chamber (if drainfield is pressurized)
8. Drainfield

4.21.2 Approval Conditions

1. Nondomestic wastewater must be pretreated to normal domestic wastewater strengths (section 3.2.1, Table 3-1) before discharge to the recirculating gravel filter system.
2. The bottom of the filter must not come within 12 inches of seasonal high ground water.
3. All pressurized distribution components and design elements of the recirculating gravel filter system that are not specified within section 4.21 must be designed and installed according to the guidance for pressure distribution systems in section 4.19.
4. All tanks and the recirculating gravel filter container shall meet the same separation distance requirements as a septic tank.
5. Recirculating gravel filters required to reduce total nitrogen shall meet the additional design requirements in section 4.21.3.4.
6. System must be designed by a PE licensed in Idaho.
7. Recirculating gravel filters that are required to reduce total nitrogen to 27 mg/L shall follow the operation and maintenance requirements outlined in sections 4.8.3 and 4.8.4 effective July 1, 2017.
    a. Operation and maintenance must be performed, as described in section 4.8.3, by a permitted complex installer that maintains a current service provider certification.
    b. All subsurface sewage disposal permits issued for recirculating gravel filters meeting the above requirements shall contain the following statement beginning July 1, 2017: *Annual treatment system equipment servicing and reporting is required per IDAPA*

58.01.03.005.14. Operation and maintenance must be conducted by a complex installer maintaining a current service provider certification.

c. See sections 4.8.5 and 4.8.6 for compliance related information for recirculating gravel filter operation, maintenance, and reporting.

4.21.3 Design Requirements

Minimum design requirements for the recirculating gravel filter components are provided below.

4.21.3.1 Recirculating Tank

1. Minimum recirculating tank volume shall be capable of maintaining two times the daily design flow of the system (Figure 4-27).
2. The recirculating tank may be a modified septic tank or dosing chamber selected from section 5.2 or section 5.3.
   a. Alternatively, the recirculation tank may be designed by the system's design engineer to meet the minimum requirements of this section and IDAPA 58.01.03.007.
   b. Recirculating tank design is exempt from subsections .07, .08, .10, and .11 of IDAPA 58.01.03.007.
3. The recirculating tank shall be accessible from grade and the return line, pump, pump screen, and pump components shall be accessible from these access points.
4. The recirculating filter effluent return point shall be located before the recirculation tank and shall enter at the inlet of the recirculating tank, unless a gravity float valve is used in which case the return point shall be located near the inlet.
5. The recirculating tank shall meet all other minimum design and equipment requirements of section 4.19.3.4.

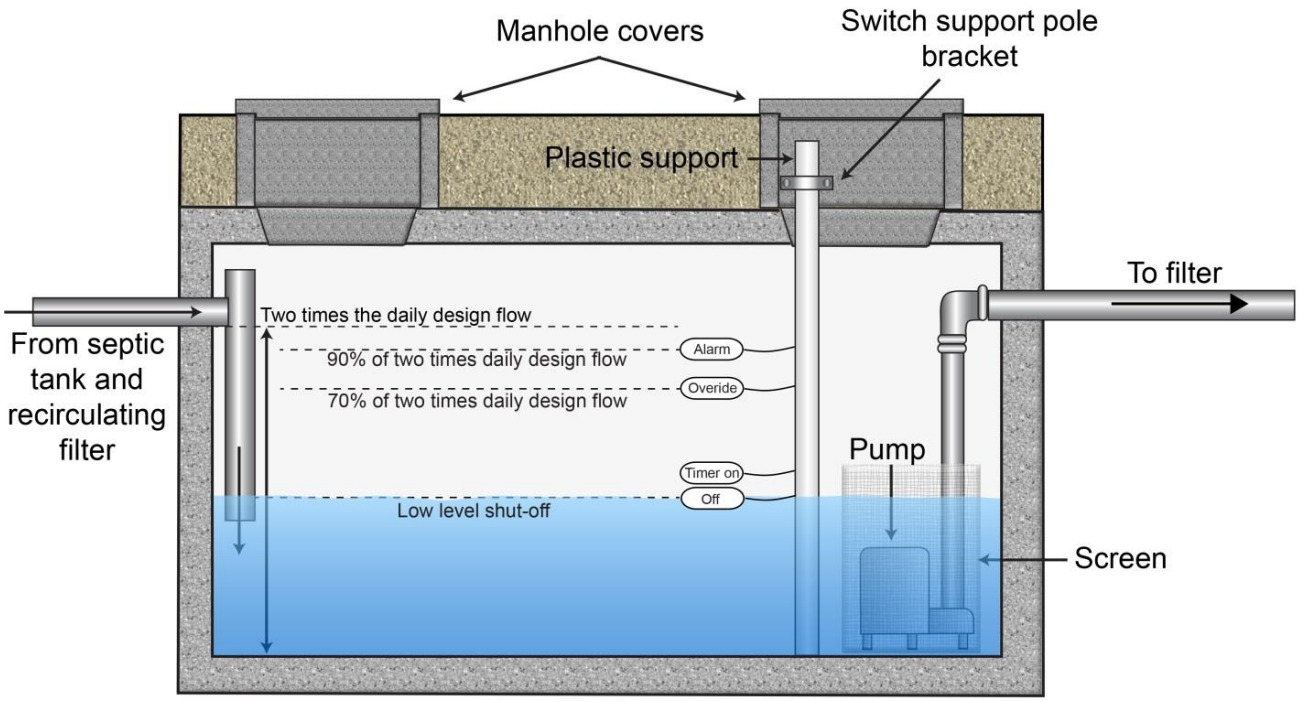

Figure 4-27. Recirculating tank in system design without nitrogen treatment requirements.

4.21.3.2 Recirculating Filter

1. The filter container shall be constructed of reinforced concrete or other materials where equivalent function, workmanship, watertightness, and at least a 20-year service life can be documented.
2. The following requirements must be met for flexible membrane liners when used in place of concrete:
   a. Have properties equivalent to or greater than 30-mil PVC.
   b. Have field repair instructions and materials provided to the purchaser of the liner.
   c. Have factory fabricated *boots* for waterproof field bonding of piping to the liner.
   d. Liner must be placed against smooth, regular surfaces free of sharp edges, nails, wire, splinters, or other objects that may puncture the liner. A 4-inch layer of clean sand should provide liner protection.
3. The filter surface area is sized at a maximum of 5 gallons/ft^2/day forward flow (forward flow is equivalent to the daily design flow from the structure).
4. Filter construction media shall meet the specifications in section 3.2.8.1.3 for pea gravel and section 3.2.8.1.1 for drainrock.
5. Minimum filter construction specifications (i.e., media depth, geotextile fabric placement, cover slopes, filter container height, and piping placement) shall meet the dimensions and locations depicted in Figure 4-28.
6. The bottom of the filter may be sloped at least 1% to the underdrain pipe.
7. An underdrain must be located at the bottom of the filter to return filtered effluent to the dosing chamber meeting the following requirements:

a. May be placed directly on the bottom of the filter.
b. Placed level throughout the bottom of the filter.
c. Constructed of slotted drain pipe with 0.25-inch slots, 2.5 inches deep and spaced 4 inches apart located vertically on the pipe, or perforated sewer pipe with holes located at 5 and 7 o'clock.
d. One underdrain should be installed for each filter cell zone.
e. The distal end is vented to the atmosphere, protected with a screen, and located within the filter to allow entry of air flow into the bottom of the filter and access for cleaning and ponding observation.
f. Connected to solid pipe that meets the construction requirements of IDAPA 58.01.03.007.21, extends through the filter, and is sealed so the joint between the filter wall and pipe is watertight.

8. Two observation tubes should be placed in the recirculating filter to monitor for ponding and clogging formation.
   a. The monitoring tubes must be secured and perforated near the bottom.
   b. The monitoring tubes must extend through the recirculating filter cover and have a removable cap.
9. The surface of the recirculating filter must be left open to facilitate oxygenation of the filter. No soil cover shall be placed above the upper layer of drainrock in the recirculating gravel filter. However, the filter must be designed to prevent accidental contact with effluent from the surface. The following minimum requirements must be followed:
   a. Chain-link fence or another acceptable protective barrier (Figure 4-28) shall be placed at the top of the filter container and cover the entire surface of the filter to prevent access, unless fencing is placed around the entire system to prevent access.
   b. Geotextile fabric shall be placed over the access barrier.
   c. Fencing around the recirculating gravel filter is recommended for all central systems.

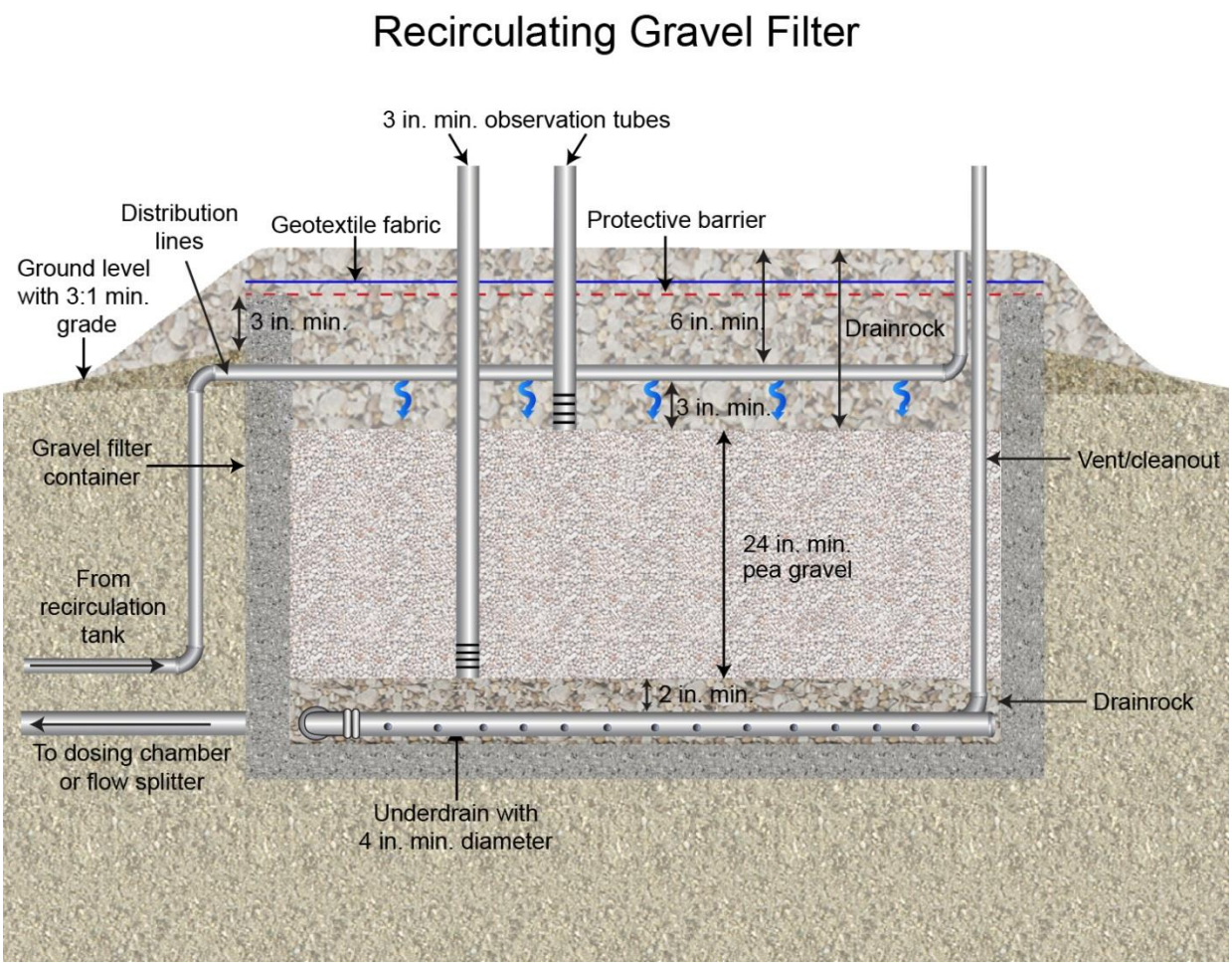

Figure 4-28. Recirculating gravel filter.

4.21.3.2.1 Recirculating Filter Cells

Depending on the volume of effluent and type of structure using a recirculating gravel filter, the recirculating filter may need to be split into cells that contain dosing zones (Figure 4-29). A filter cell is the total filter area that can be served by a single dosing pump or set of pumps. A filter zone is the area of a cell that can be dosed by a single dosing pump at any one time. Zone sizing depends upon pump size, lateral length, perforation size, and perforation spacing. The minimum filter design requirements for cells, zones, and pumps include the following:

1. Single-family homes: one cell, one zone, and one pump. If more than one cell or zone is used for a single-family home, duplex pumps are not required.
2. Central systems or systems connected to anything other than a single-family home (flows up to 2,500 GPD): one cell, two zones, and one pump per zone.
3. Large soil absorption systems (flows of 2,500 to 5,000 GPD): one cell, three zones, and one pump per zone.
4. Large soil absorption systems (flows over 5,000 GPD): two cells, two zones per cell, and one pump per zone.

5. An alternative to installing one pump per zone is to install duplex pumps connected to sequencing valves that alternate zones for each pressurization cycle. For systems with multiple cells, each cell must have a dedicated set of duplex pumps. Pumps should alternate between each cycle.
6. Filter cells are recommended to be hydraulically isolated from one another and shall be constructed according to the minimum requirements in section 4.21.3.2.
7. Each cell shall be equivalent in surface area and volume and have the same number of zones.
8. Each zone shall have the same number of laterals and perforations.

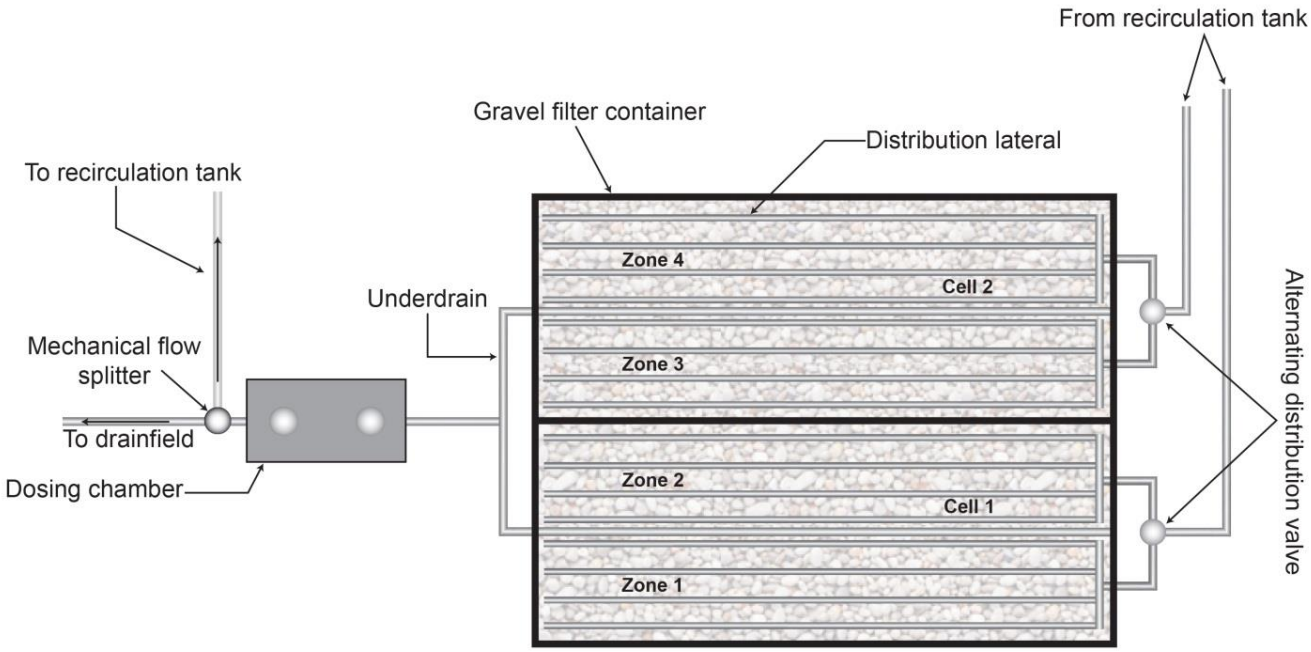

Figure 4-29. Overhead view of a recirculating gravel filter with multiple cells and dosing zones discharging to a dosing chamber and using mechanical flow splitting.

4.21.3.2.2 Recirculating Filter Dosing

1. The minimum recirculation ratio of the filter is 5:1, and the maximum recirculation ratio is 7:1 (the daily flow moves through the filter a minimum of five times or a maximum of seven times before discharge to the drainfield).
2. Timed dosing is required, and the filter dosing cycle should meet the following minimum recommendations:
   a. Pumps are set to dose each zone approximately two times per hour.
   b. Dose volume delivered to the filter surface for each cycle should be 10.4% of the daily flow from the structure (forward flow).
   c. A pump-on override float should be set at a point that equates to 70% of the recirculating tank's volume.
   d. A low-level off float should be placed to ensure that the pump remains fully submerged at all times.

3. The pump controls should meet the following:
    a. Be capable of monitoring low- and high-level events so that timer settings can be adjusted accordingly.
    b. Have event counters and run-time meters to monitor daily flows.

4.21.3.3 Effluent Return

1. Effluent must be returned from the filter to the recirculation tank, which may occur by gravity or under pressure.
2. Gravity return must occur using a float valve (Figure 4-30) within the recirculating tank, and the float valve must (Figure 4-34 and Figure 4-37):
    a. Be located on the inlet side of the recirculating tank.
    b. Allow for continual splitting of filtered effluent when the buoy is fully seated and discharging to the drainfield.
    c. Be capable of returning 83% of the filtered effluent to the recirculation tank when the buoy is fully seated.
3. Other types of gravity flow splitters shall not be used to split recirculation flows.
4. Pressurized return must be done using a dosing chamber that meets the minimum requirements of section 4.19.3.4, and the dosing chamber must (Figure 4-33 and Figure 4-36):
    a. Be located after the recirculating filter.
    b. Use a mechanical flow splitter (Figure 4-31 and Figure 4-32) that is capable of simultaneously returning effluent to the recirculating tank and discharging effluent to the drainfield.
5. Mechanical flow splitters shall:
    c. Be located outside of the dosing chamber and prior to the recirculation tank.
    b. Be capable of returning effluent to the recirculating tank and discharging to the drainfield in a volume ratio equivalent to the designed recirculation ratio (e.g., if a recirculation ratio of 5:1 is used, 83% of the filtered effluent by volume shall be returned to the recirculating tank, and 17% shall be discharged to the drainfield).
6. Discharge of effluent to the drainfield must occur after filtration and flow splitting.

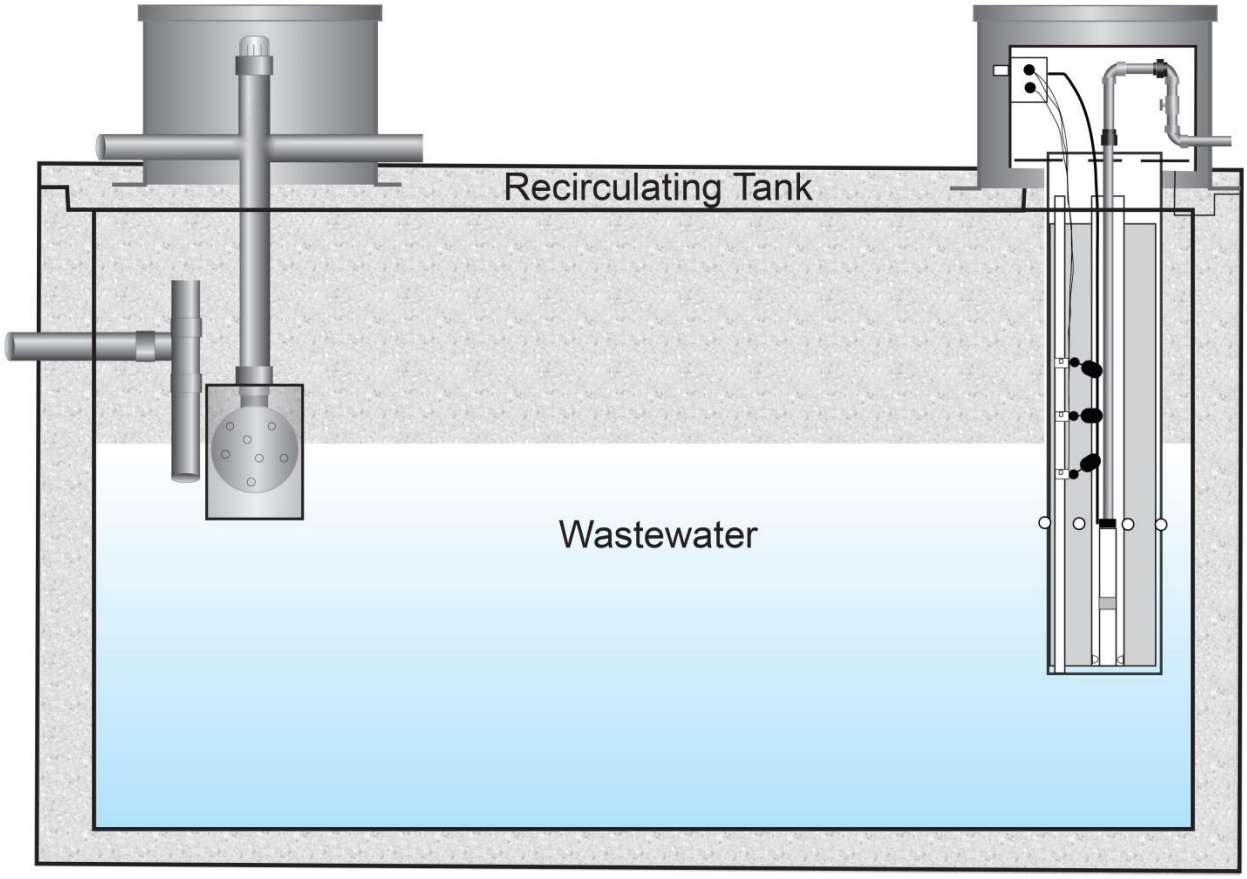

Figure 4-30. Gravity float valve return location within the recirculating tank.

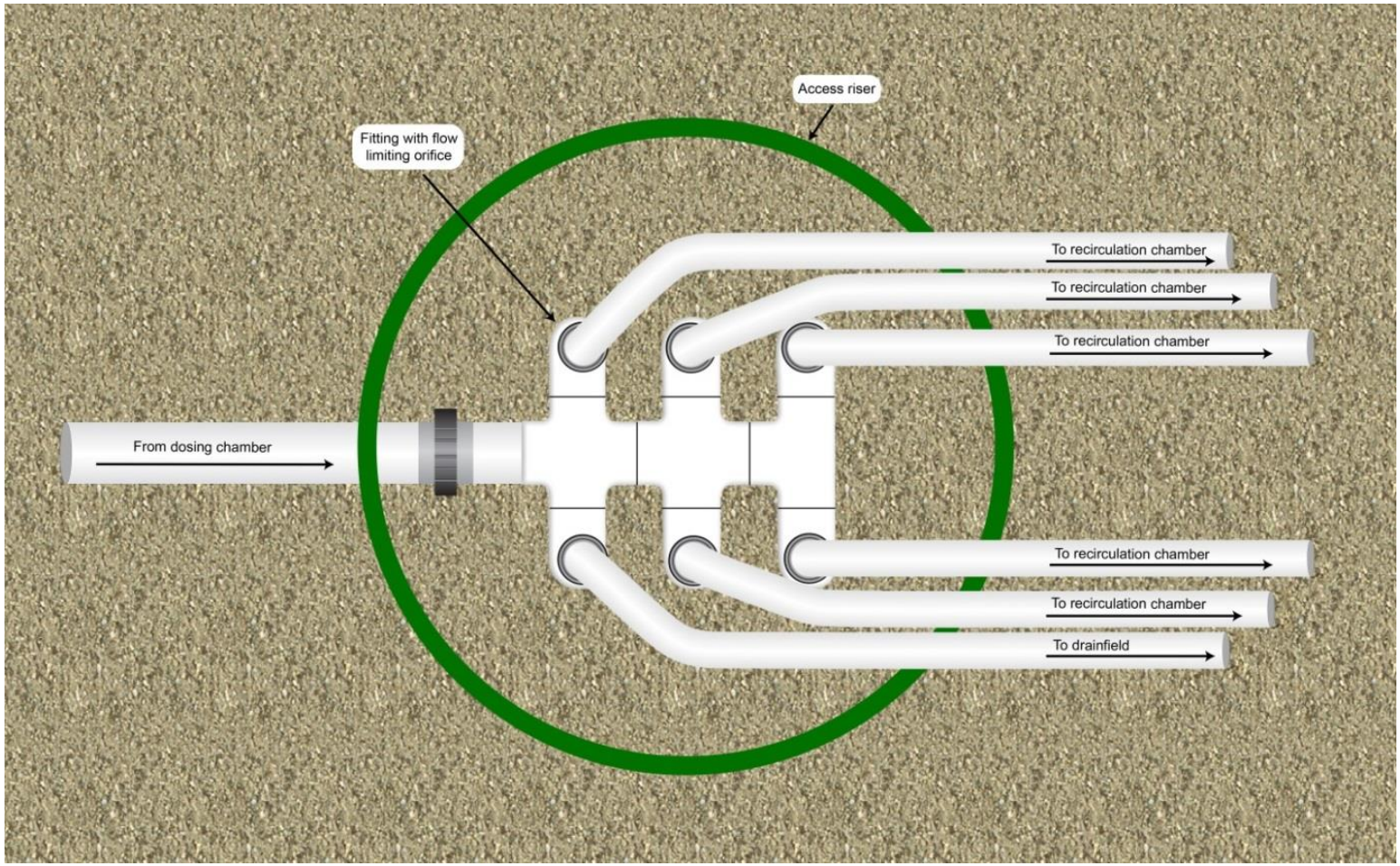

Figure 4-31. Bottom view of a mechanical flow splitter for gravity distribution that delivers wastewater to all transport pipes with each dose.

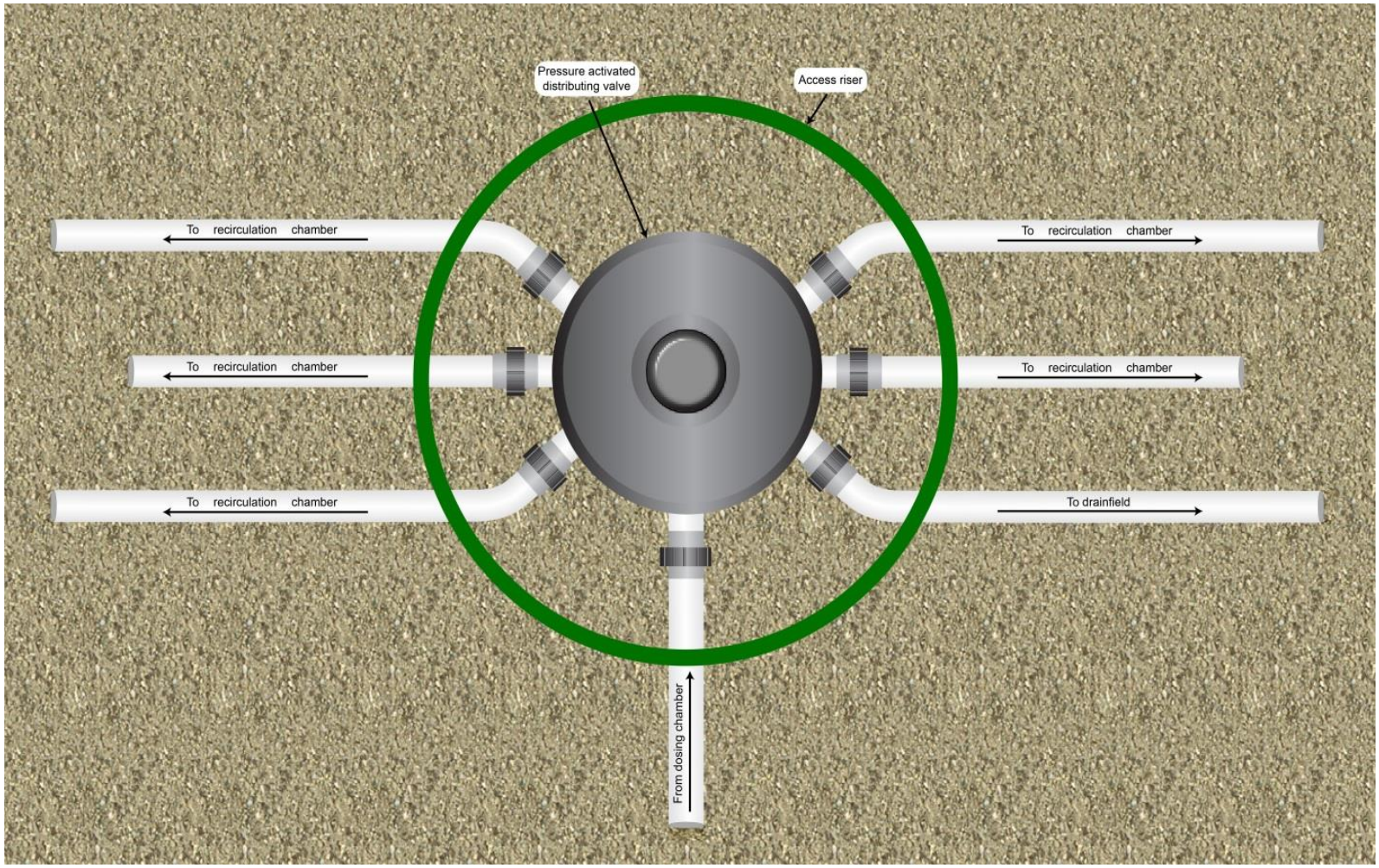

Figure 4-32. Overhead view of a mechanical flow splitter for pressure distribution that only delivers wastewater to one transport pipe with each dose.

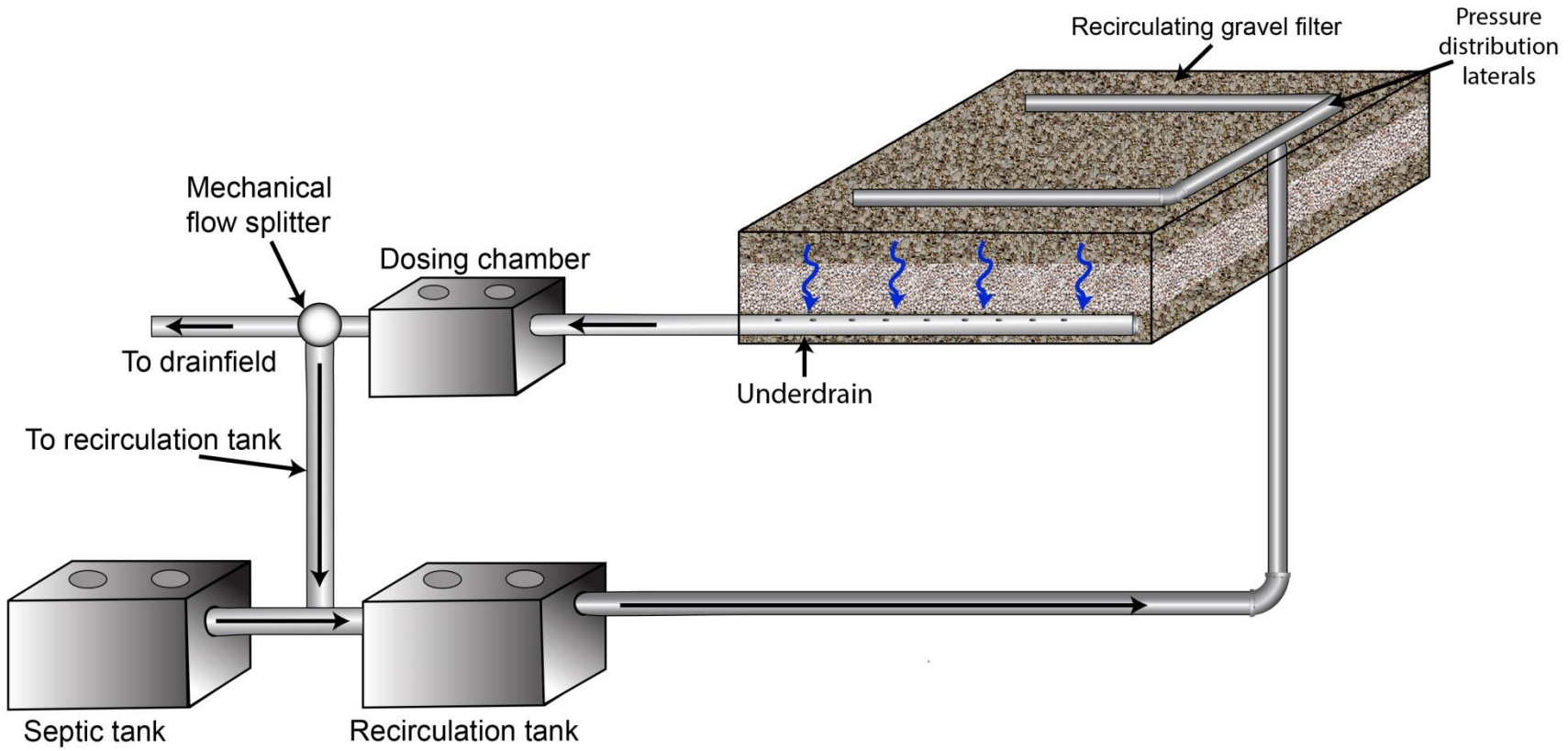

Figure 4-33. Cross section of a recirculating gravel filter system with pressure transport to, and/or within, the drainfield.

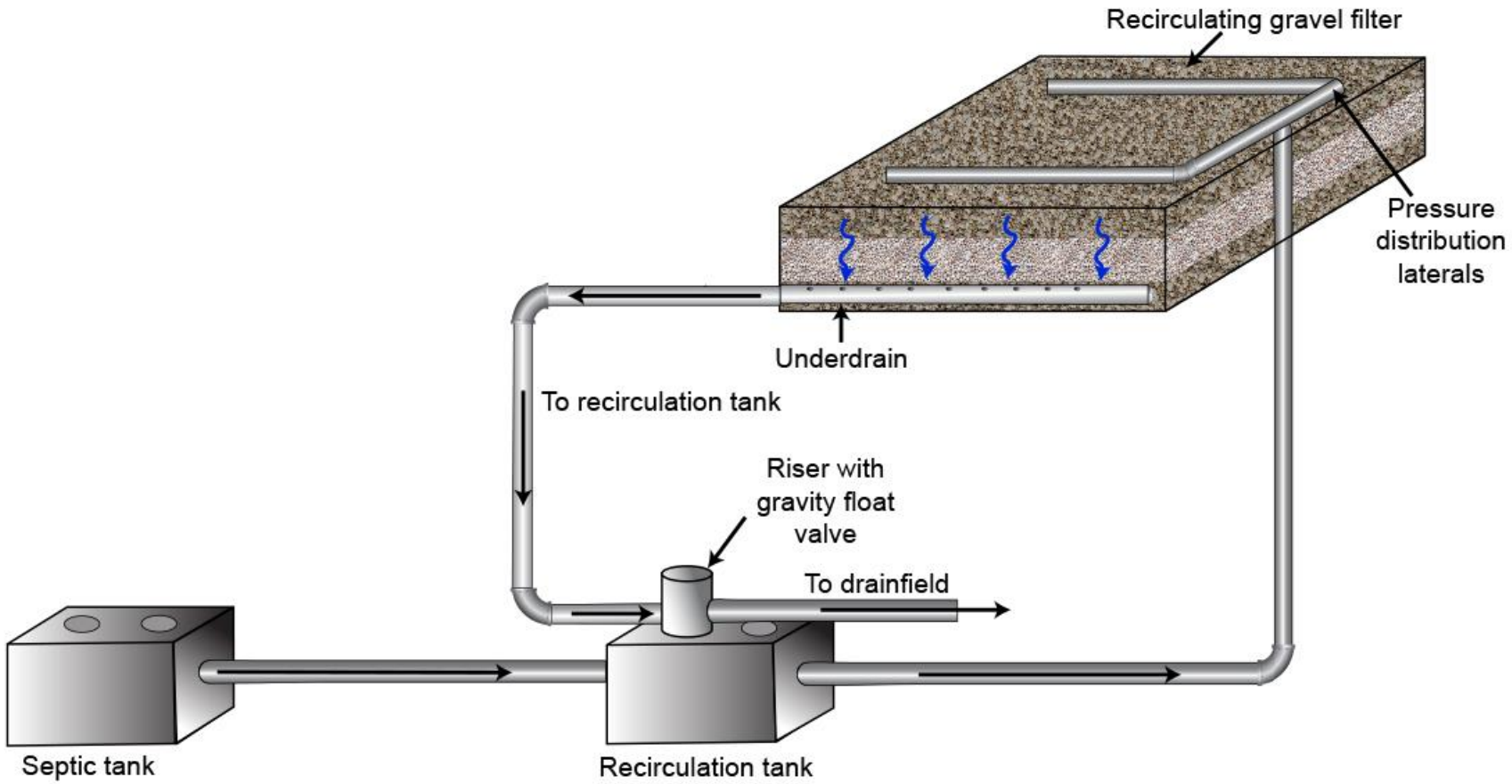

Figure 4-34. Cross section of a recirculating gravel filter system with gravity transport to the drainfield.

4.21.3.4 Additional Design Elements for Recirculating Gravel Filter Systems Required to Reduce Total Nitrogen

4.21.3.4.1 Equalization Tank

1. An equalization tank is required for all recirculating gravel filters treating effluent for total nitrogen.
2. A septic tank sized according to IDAPA 58.01.03.007.07 shall precede the equalization tank.
3. Minimum equalization tank volume shall be capable of maintaining two times the sum of the daily design flow of the system and recirculation volume returned to the equalization tank.
4. The equalization tank may be a modified septic tank or dosing chamber selected from section 5.2 or section 5.3.
   a. Alternatively, the equalization tank may be designed by the system's design engineer to meet the minimum requirements of this section and IDAPA 58.01.03.007.
   b. Equalization tank design is exempt from subsections .07 and .08 of IDAPA 58.01.03.007.
5. The recirculating filter effluent return point shall be located before the equalization tank and shall enter at the inlet of the equalization tank.

4.21.3.4.2 Effluent Return

1. Effluent shall be returned from the recirculating gravel filter in a ratio of 20% to the equalization tank and 80% to the recirculation tank (Figure 4-35).
2. Effluent return from the filter to the equalization tank and recirculation tank may be done by gravity or under pressure.
3. The design engineer must specify how the return ratio will be met with the system design, and document the return flow in the system design calculations.

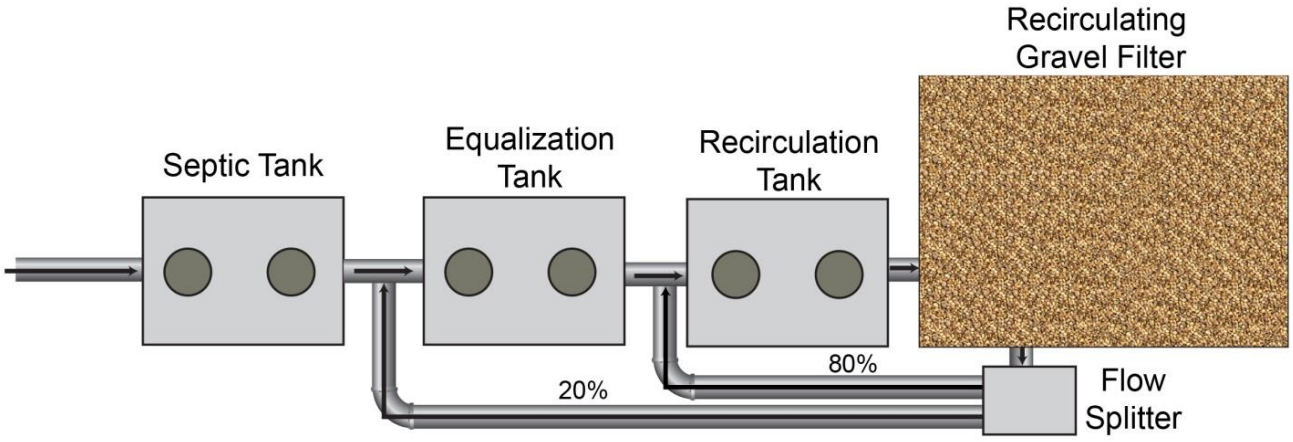

Figure 4-35. Effluent return locations and ratios from the recirculating gravel filter and flow splitter for systems treating total nitrogen.

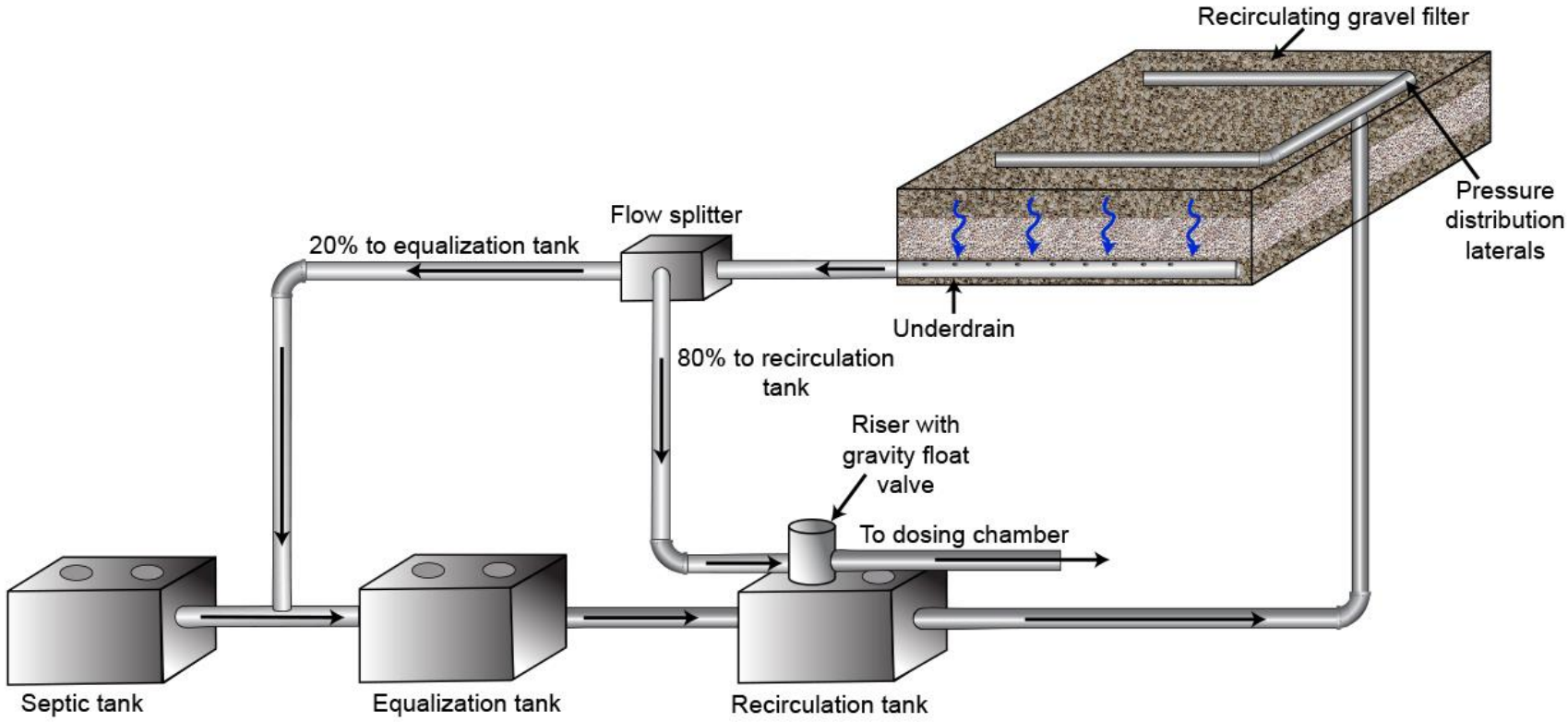

Figure 4-36. Cross section of a nitrogen-reducing recirculating gravel filter system with pressure transport to, and/or within the drainfield.

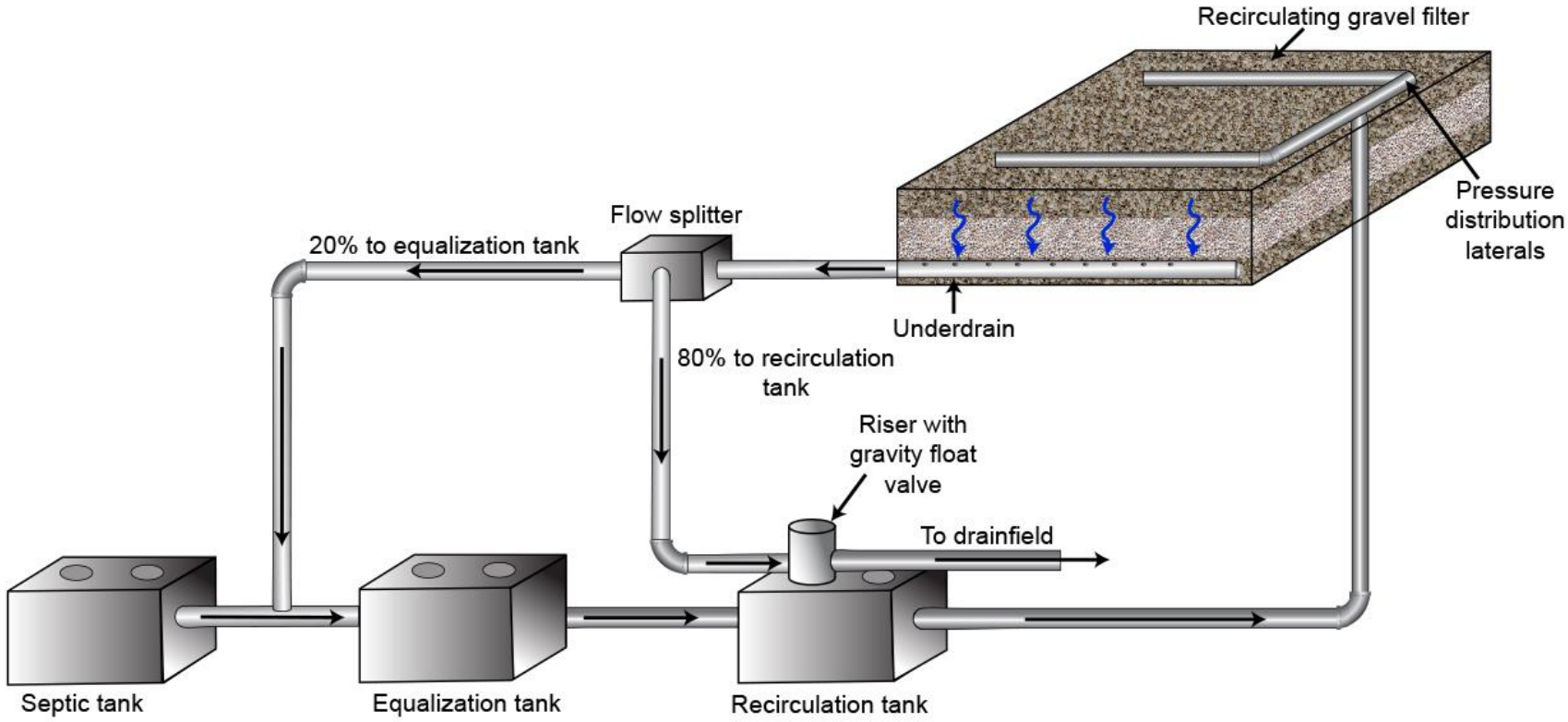

Figure 4-37. Cross section of a nitrogen-reducing recirculating gravel filter system with gravity transport to the drainfield.

4.21.4 Filter Construction

1. All materials must be structurally sound, durable, and capable of withstanding normal installation and operation stresses.
2. Components that may be subject to excessive wear must be readily accessible for repair or replacement.
3. All filter containers must be placed over a stable level base.
4. Geotextile filter fabric shall be placed only over the top of the filter and must not be used in-between the filter construction media and underdrain aggregate.
5. Access to the filter surface must be provided to facilitate maintenance.

4.21.5 Drainfield Trenches

1. Distances shown in Table 4-20 must be maintained between the trench bottom and limiting layer.
2. Pressure distribution, when used, shall meet the following design considerations:
   a. If a pressure distribution system is designed within the drainfield, it must be designed according to section 4.19.
   b. If the pressurized line from the mechanical flow splitter breaks to gravity before the drainfield, it must be done according to section 4.19.3.6.
   c. The recirculation tank and recirculating filter may not be used as the dosing chamber for the drainfield or for flow-splitting purposes.
3. The minimum area, in square feet of bottom trench surface, shall be calculated from the maximum daily flow of effluent divided by the hydraulic application rate for the applicable soil design subgroup listed in Table 4-21.

Table 4-20. Recirculating gravel filter vertical separation to limiting layers (feet).

Limiting Layer	Flow < 2,500 GPD	Flow ≥ 2,500 GPD
	All Soil Types	All Soil Types
Impermeable layer	2	4
Fractured rock or very porous layer	1	2
Normal high ground water	1	2
Seasonal high ground water	1	2

Note: gallons per day (GPD)

Table 4-21. Secondary biological treatment system hydraulic application rates.

Soil Design Subgroup	Application Rate (gallons/square foot/day)
A-1	1.7
A-2a	1.2
A-2b	1.0
B-1	0.8
B-2	0.6
C-1	0.4
C-2	0.3

4.21.6 Inspection

1. A preconstruction meeting between the health district, responsible charge engineer, and installer should occur before commencing any construction activities.
2. The health district should inspect all system components before backfilling and inspect the filter container construction before filling with drainrock and filter construction media.
3. The responsible charge engineer shall conduct as many inspections as needed to verify system and component compliance with the engineered plans.
4. The responsible charge engineer shall provide the health district with a written statement that the system was constructed and functions in compliance with the approved plans and specifications. Additionally, the responsible charge engineer shall provide as-built plans to the health district if any construction deviations occur from the permitted construction plans (IDAPA 58.01.03.005.15).

4.21.7 Operation and Maintenance

1. The recirculating gravel filter design engineer shall provide a copy of the system's operation, maintenance, and monitoring procedures to the health district as part of the permit application and before subsurface sewage disposal permit issuance (IDAPA 58.01.03.005.04.k).
2. Minimum operation, maintenance, and monitoring requirements should follow each system component manufacturer's recommendations.
3. Instructions on how to trouble shoot the pump control panel should be included to allow adjustment to pump cycle timing if the low-level off or high-level alarm switch is frequently tripped in order to maintain the minimum 5:1 recirculation ratio.
4. Operation and maintenance directions should be included describing replacement of the filter construction media and informing the system owner that a permit must be obtained from the health district for this activity.
5. Maintenance of the septic tank should be included in the O&M manual.
6. All pressure distribution system components should be maintained as described in section 4.19.5.

7. Check for ponding at the filter construction media/underdrain aggregate interface through the observation tube in the recirculating filter.
8. Clean the surface of the filter regularly to remove leaves and other organic matter that may accumulate in the aggregate or rock cover.
9. Regularly check the recirculating gravel filter for surface odors. Odors should not be present and indicate that something is wrong. Odors are likely evidence that the dissolved oxygen in the filter is being depleted and that BOD and ammonia removal are being impacted.