Wastewater Collection

(Sewer Alternatives)

Sewer Basics

- **Collection and transport** of wastewater from each home/building to the point where treatment occurs.
- **Wastewater Characterization**
  - Solids
  - Liquids
- **Pipe System**
  - Plastic
  - Ductile iron
  - Concrete/lined

Satellite Wastewater Management

- Also called “*decentralized*” or “*distributed*”

- Undertaken by utilities for a variety of reasons:
  - ✓ Economics
  - ✓ To reuse water locally
  - ✓ To avoid expanding “centralized facilities

- As communities expand, the distances from the new developments to existing wastewater treatment facilities becomes so great as to not be economically feasible

- Sustainable
  - ✓ Cost Effective, good for the public and the environment

Collection System Alternatives

1. Conventional Gravity sewers
2. Septic Tank Effluent Gravity (STEG)
3. Septic Tank Effluent Pump (STEP)
4. Pressure Sewers with Grinder Pumps
5. Vacuum Sewers

Conventional Gravity vs. Pressure Sewers

TABLE 6-1

Comparison of conventional gravity sewers to pressure sewers with septic tanks

Issue	Conventional gravity	Pressure sewers
Infiltration and inflow	Usually encountered	Avoided
Minimum velocities	Required to avoid solids deposition	Not required
Minimum diameter	6–8 in (150–200 mm)	2 in (50 mm)
Downhill slopes	Must be maintained at all times	Not required, follow the topography
Cleaning access to main lines	Access ports regularly spaced	Cleanouts and pigging ports
Trench depth	Minimum depth to 20–30 ft (6–9 m) depending on the slope of the sewer	Maintain minimum depth as with water transmission lines
Pump stations	Needed for low areas where downhill slopes cannot be maintained	Built in to each service or cluster of services
Conflicts with other buried utilities	May require redesign to avoid conflicts	Easily avoided
Ease of construction	Deep and wide trenches go in relatively slowly with traffic disruption	Narrow, shallow trenches go in relatively quickly with minimal traffic disruption

Sewer Alternatives and Characteristics

TABLE 6-2
Relative characteristics of alternative sewer systems*

Sewer type or combination	Ideal topography	Construction cost in rocky, high-groundwater sites	Sulfide potential	Minimum slope or velocity required
Conventional gravity	Downhill	High	Moderate	Yes
STEP	Uphill, undulating	Low	High	No
STEG	Downhill	Moderate	High	No
Grinder pump (GP)	Uphill	Low	Mod.–high	Yes
Vacuum	Flat	Low	Low	Yes
STEG-STEP	Undulating	Low–mod.	High	No
Conventional-GP	Undulating	Mod.–high	Moderate	Yes
Conventional-vacuum	Undulating	Mod.–high	Low–mod.	Yes

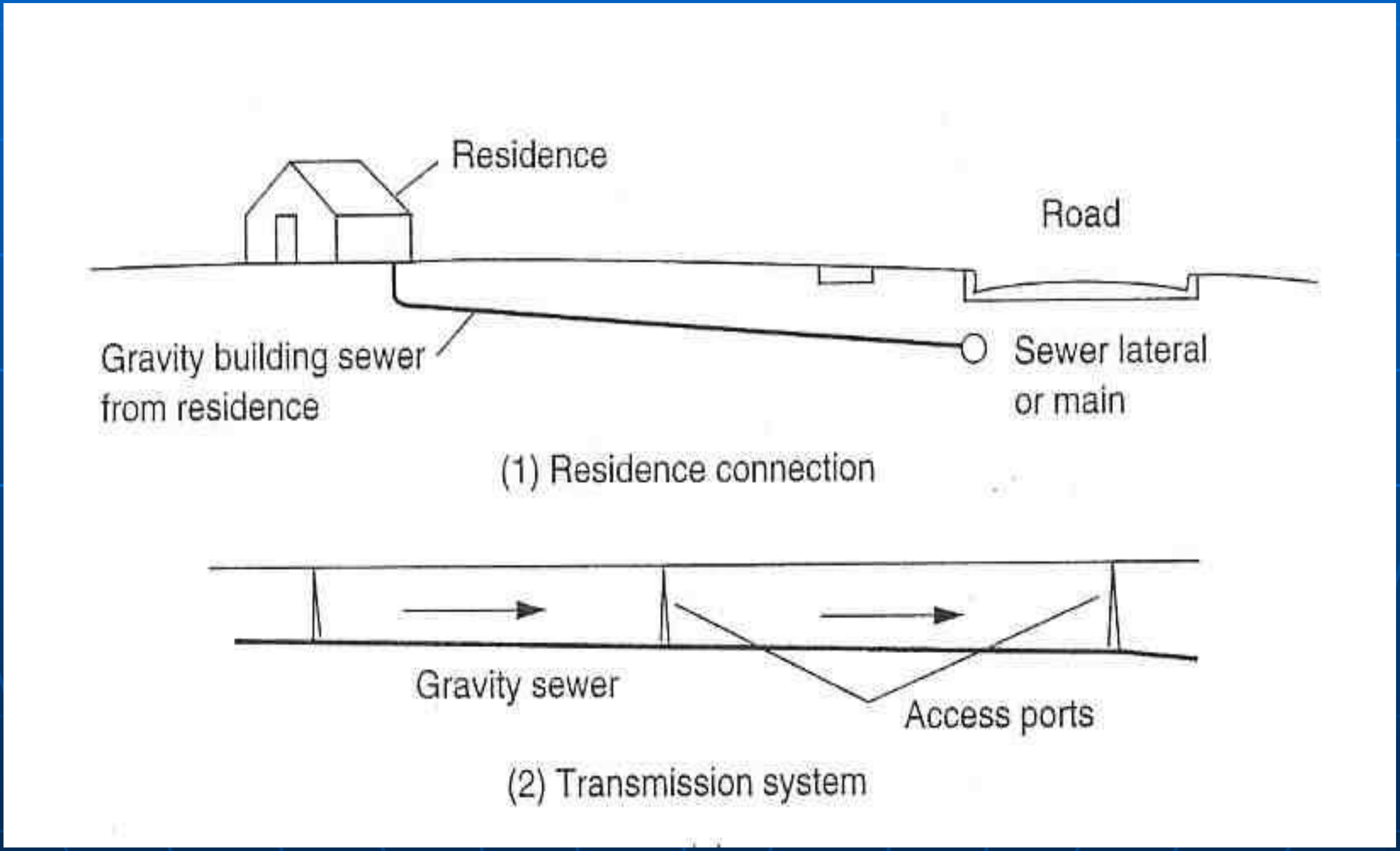
*Adapted from WPCF (1986).

Conventional Gravity Sewer

- Large pipe (8" minimum), manholes spaced 300-500 feet
- Designed to transport solids
- Minimum velocity >2 fps *(to avoid the deposition of solids)* Max velocity = 15 fps
- Infiltration and Inflow (I & I)
- Uniform Slope between manholes

Sewer size	Minimum slope (feet/100 ft)
8-inch	0.40
10-inch	0.28
12-inch	0.22
14-inch	0.17
16-inch	0.14
18-inch	0.12
24-inch	0.08

Conventional Gravity Sewer



Conventional Gravity Sewer

Alignment: 24-inch sewers (or smaller) should be laid with straight alignment between manholes.

Changes in pipe size: When a smaller sewer joins a larger one (at a manhole), the invert (bottom) of the larger sewer should be lowered sufficiently to overcome head losses. An approximate method is to place the 0.8 depth point of both sewers at the same elevation.

Sewer Materials: many types, materials and bedding shall prevent damage from external loads, and joints shall prevent leakage

Manholes

* Located at changes in sewer size, direction, or slope

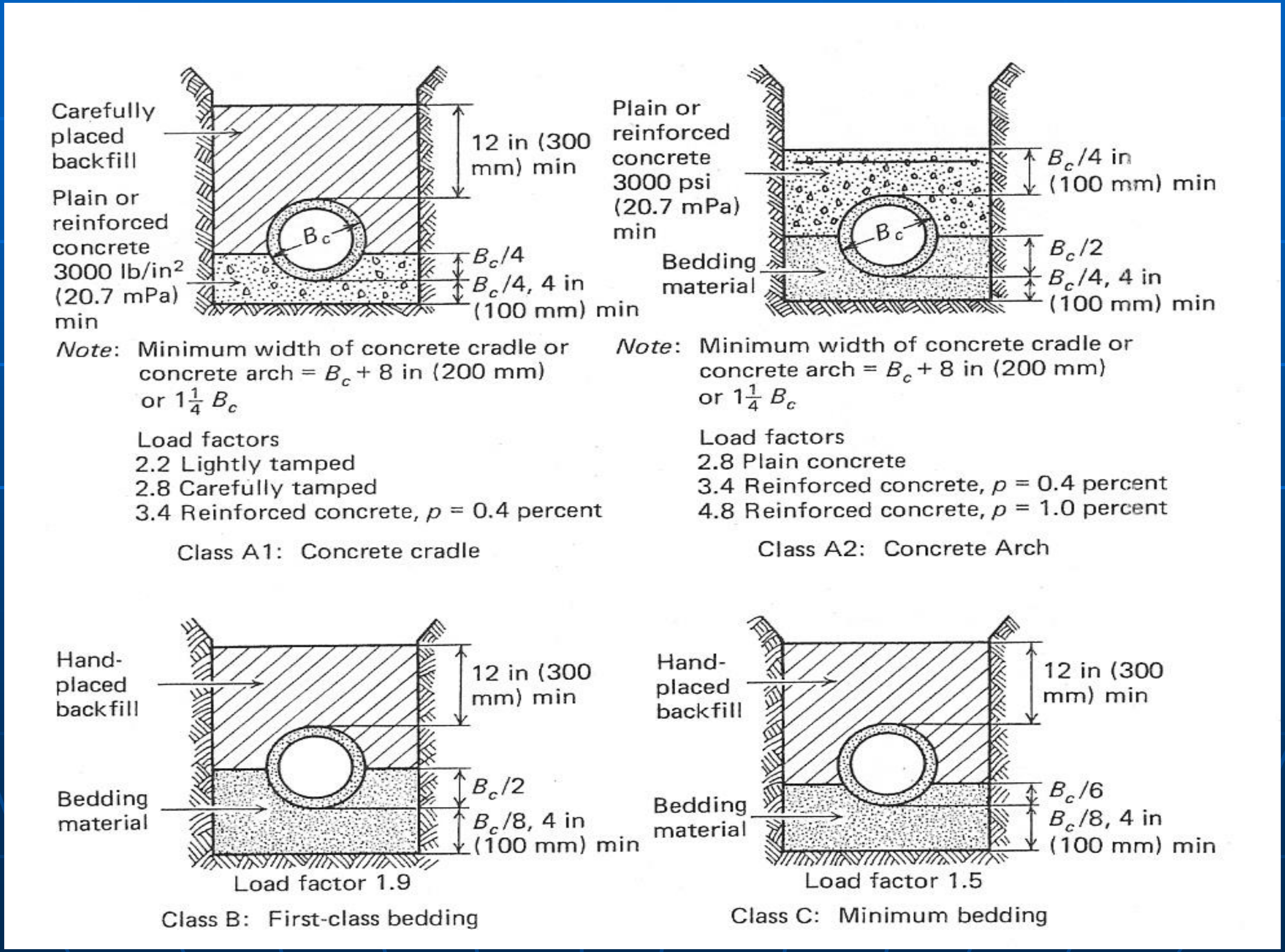
* Or every 300-500 feet

* Provides access for maintenance (cleanout, etc.)

* Problematic because of Infiltration and Inflow (I&I)

Conventional Gravity Sewer

Bedding: specified by an engineer for pipe type and anticipated loads



Conventional Gravity Sewer

Backfill: suitable material, free of debris, stones, etc.

DO NOT DISTURB SEWER ALIGNMENT

Separation from Water Lines:

- 10 feet horizontal
- Water line 18-inches above sewer

Crown Corrosion

$H_2S + H_2O \rightarrow \rightarrow \rightarrow H_2SO_4$

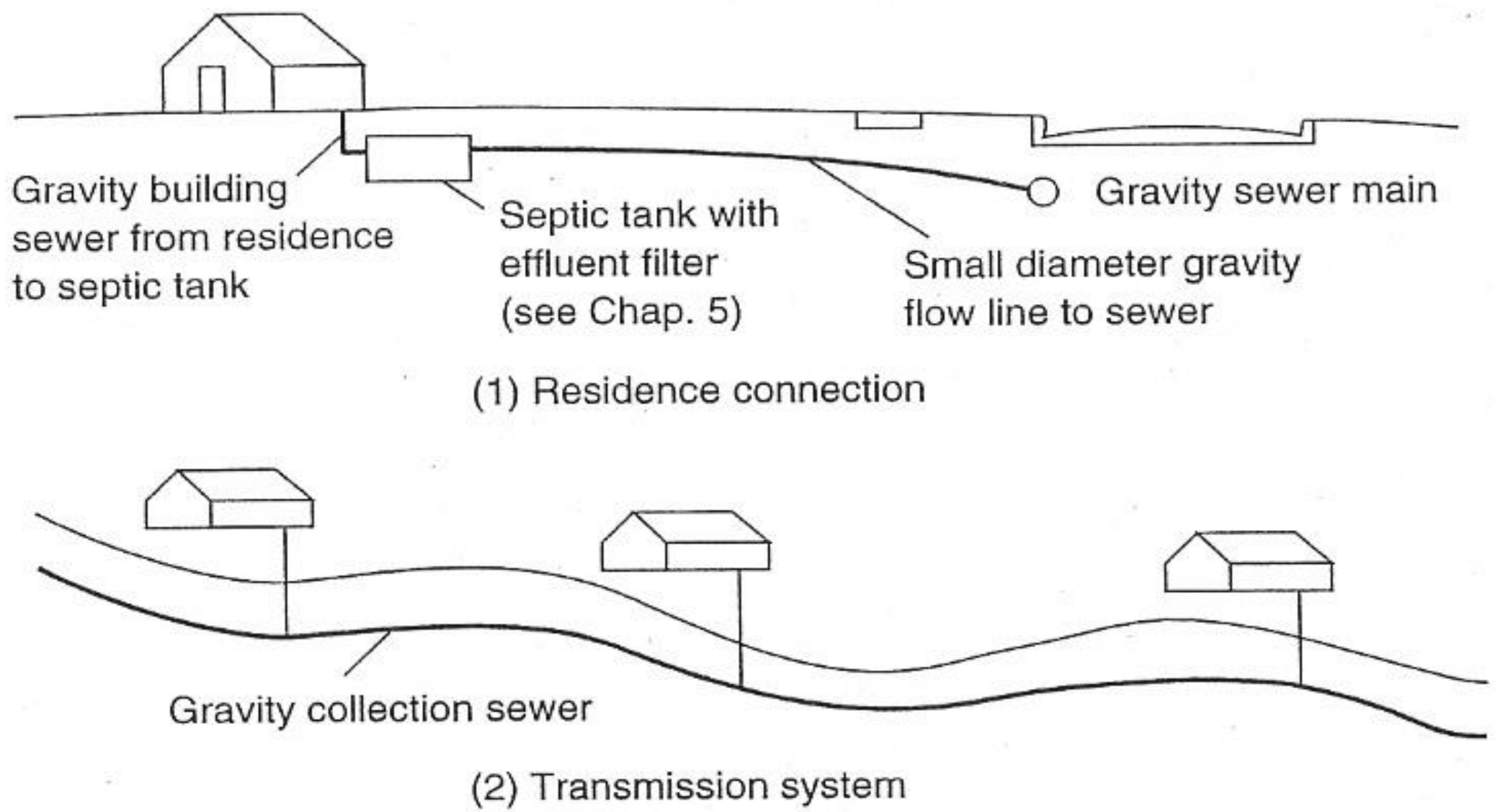
Estimating Flowrate

- **Equivalent Dwelling Unit (EDU)**
  - A residence with a given number of people (say 3.5)
  - Represents the average household flowrate
- **Design Peak Flowrate (DPF)**
  - Flowrate expected in the collection system, assuming a given number of EDUs are discharging at the same time
  - Typical values for systems with >50 EDUs is 0.35 to 0.5 gal/min-EDU
  - Total DPF $Q_{DP} = 0.5\ N$

Septic Tank Effluent Gravity
STEG

- Small diameter plastic pipe
- Conveys effluent from a septic tank
  - *with an effluent filter*
- No solids to transport *(no minimum velocity required)*
- Can be installed at variable (flat) grades
- No manholes
- Air-release valves needed at high points

Septic Tank Effluent Gravity
STEG



(*b*)

STEG Sewer Components

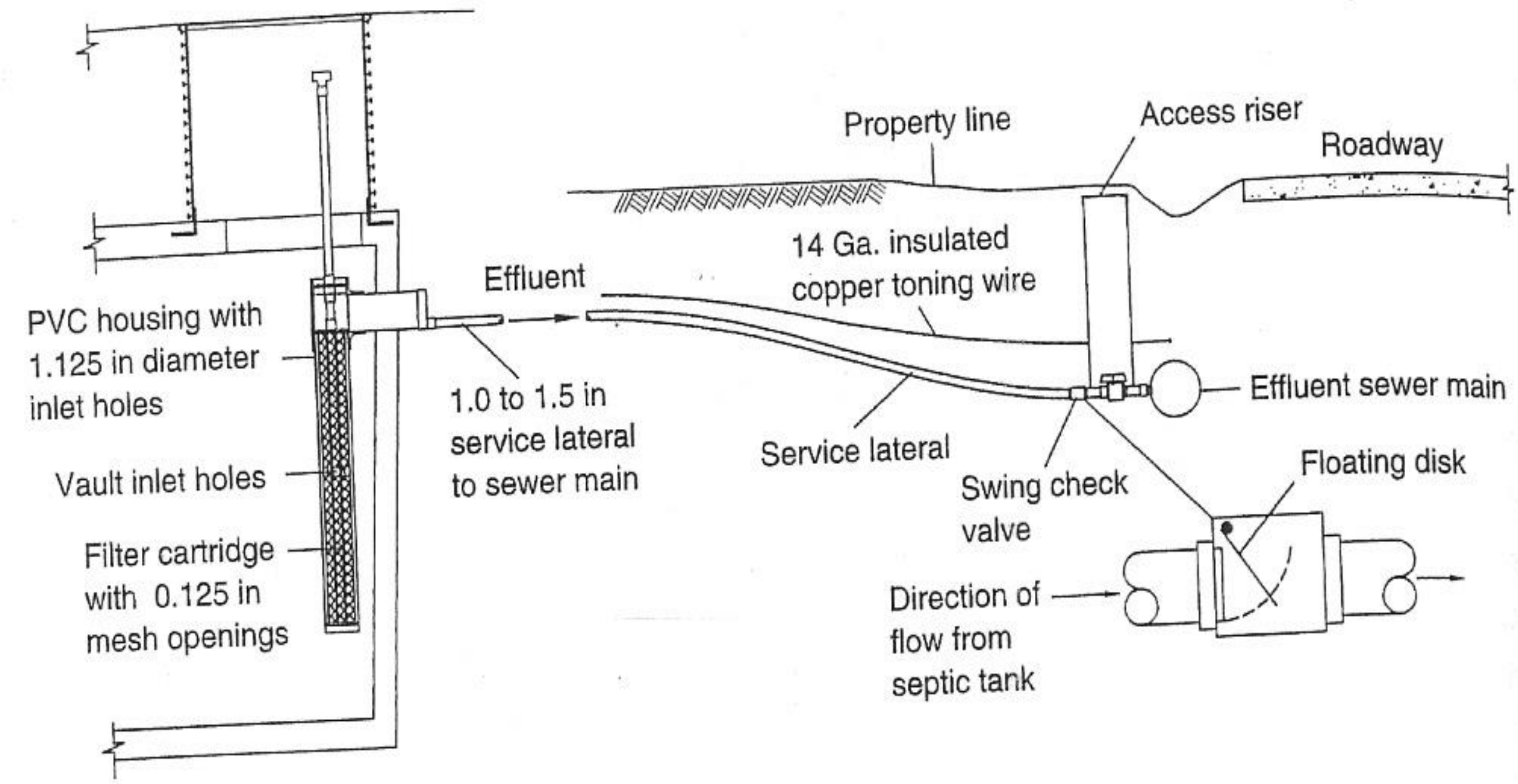


FIGURE 6-4

Schematic of septic tank effluent gravity (STEG) collection system components.

Pipe Size and Velocity

TABLE 6-5
Slope of the energy grade line and velocity at specified flows for various pipe sizes*

		2 in†		3 in		4 in		6 in		8 in	
EDUs	Flow, gal/min	Slope, %	Velocity, ft/s	Slope, %	Velocity, ft/s	Slope, %	Velocity, ft/s	Slope, %	Velocity, ft/s	Slope, %	Velocity, ft/s
20	10	0.17	0.88								
30	15	0.36	1.33								
50	25	0.92	2.21	0.14	1.02						
70	35	1.71	3.10	0.26	1.43	0.08	0.86				
100	50	3.32	4.42	0.50	2.04	0.15	1.23				
150	75	7.02	6.63	1.06	3.06	0.31	1.85	0.05	0.85		
200	100			1.81	4.08	0.53	2.46	0.08	1.14		
250	125			2.74	5.09	0.80	3.08	0.12	1.42		
300	150			3.83	6.11	1.13	3.70	0.17	1.71	0.05	1.01
350	175					1.50	4.31	0.23	1.99	0.06	1.17
400	200					1.92	4.93	0.29	2.27	0.08	1.34
500	250					2.90	6.16	0.44	2.84	0.12	1.68
600	300							0.62	3.41	0.17	2.01
700	350							0.82	3.98	0.23	2.35
800	400							1.05	4.55	0.29	2.68
900	450							1.31	5.12	0.36	3.02
1000	500							1.59	5.69	0.44	3.35
1200	600									0.62	4.02
1400	700									0.82	4.69
1600	800									1.05	5.36
1800	900									1.30	6.03
2000	1000									1.58	6.71

*Slope of energy grade line calculated using Hazen-Williams $C = 150$.
† Inside diameters for Class 200 PVC pipe (see Table 6-4) have been used.

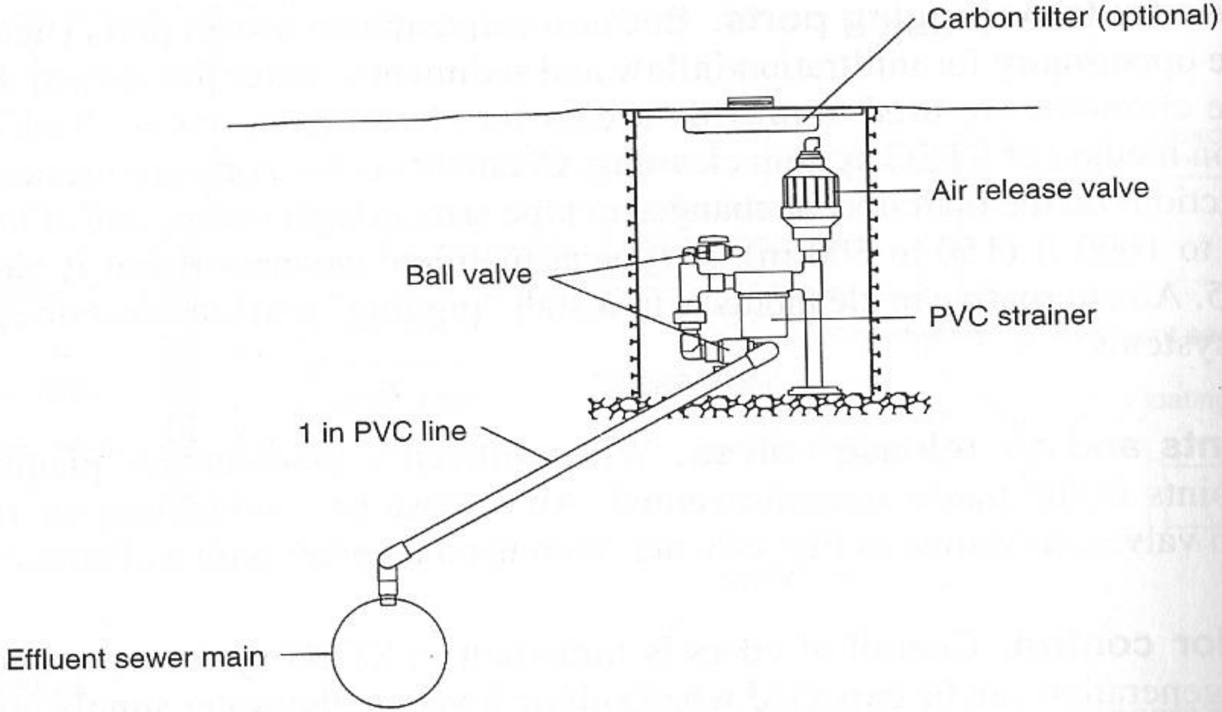


FIGURE 6-6
Typical automatic air release valve detail for STEG system.

TABLE 6-7
Typical design data for STEG sewer wastewater collection systems

Item	Unit	Range	Typical
Service lateral pipeline diameter	in	2.0–4.0	3.0
Collector main pipeline diameter	in	4.0–8.0	6.0
Trench depth*	in	24–36	30
Cleanout intervals†	ft	400–1000	500
Service connection discharge flow rate	gal/min	0.1–1.0	0.4

*Use frost depth in cold climate areas (when insulated or heat-traced piping not used).
† Pigging stations can be farther apart, depending on pipe size variation.

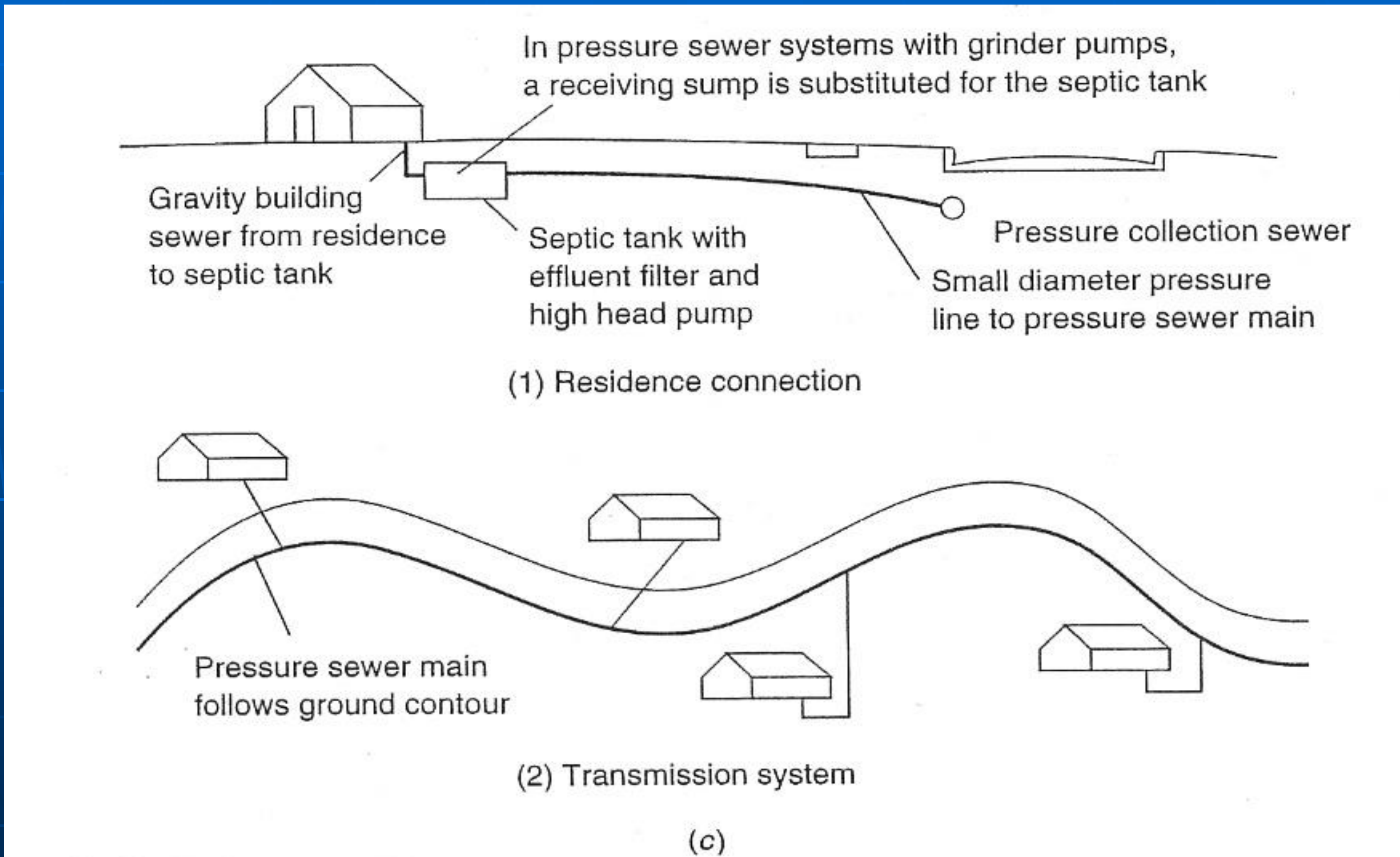
Septic Tank Effluent Pump
STEP

- High-head turbine pump used to pump screened septic tank effluent into a pressurized collection system.
- Small diameter, plastic pipe (2-inch)
- No Solids transport *(no minimum velocities required)*
- Installed shallow
- Can follow terrain
- Air-release valves incorporated

STEP Components

- Building sewer (from house to septic tank)
- Septic Tank (or interceptor tank)
- Vaults/pump basins (effluent filter and pump)
- Pumps (submersible, high-head, turbine)
- Service lateral (1.25-inch typical)
- Check Valves (at pump outlet and at edge of property)

Septic Tank Effluent Pump
STEP



STEP System Design Data

TABLE 6-9

Typical design data for STEP pressure sewer wastewater collection systems

Item	Unit	Range	Typical
Service lateral pipeline diameter	in	1.25–2.0	1.5
Collector main pipeline diameter	in	4.0–8.0	6.0
Trench depth*	in	24–36	30
Cleanout intervals	ft	400–1000	500
Pump discharge flow rate	gal/min	6–9	7

*Use frost depth in cold climate areas (when insulated or heat-traced piping not used).

STEP System Interceptor Tank

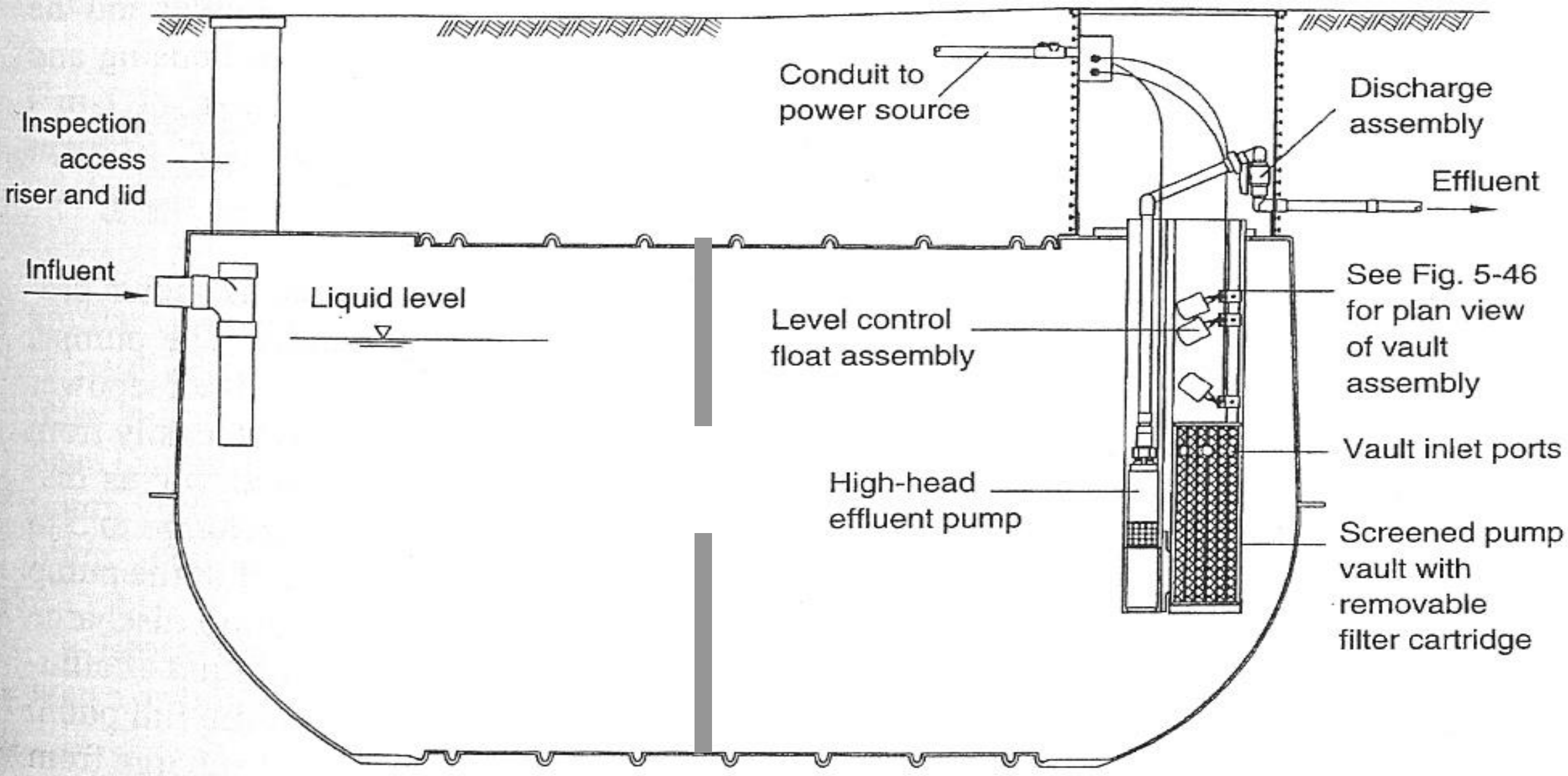


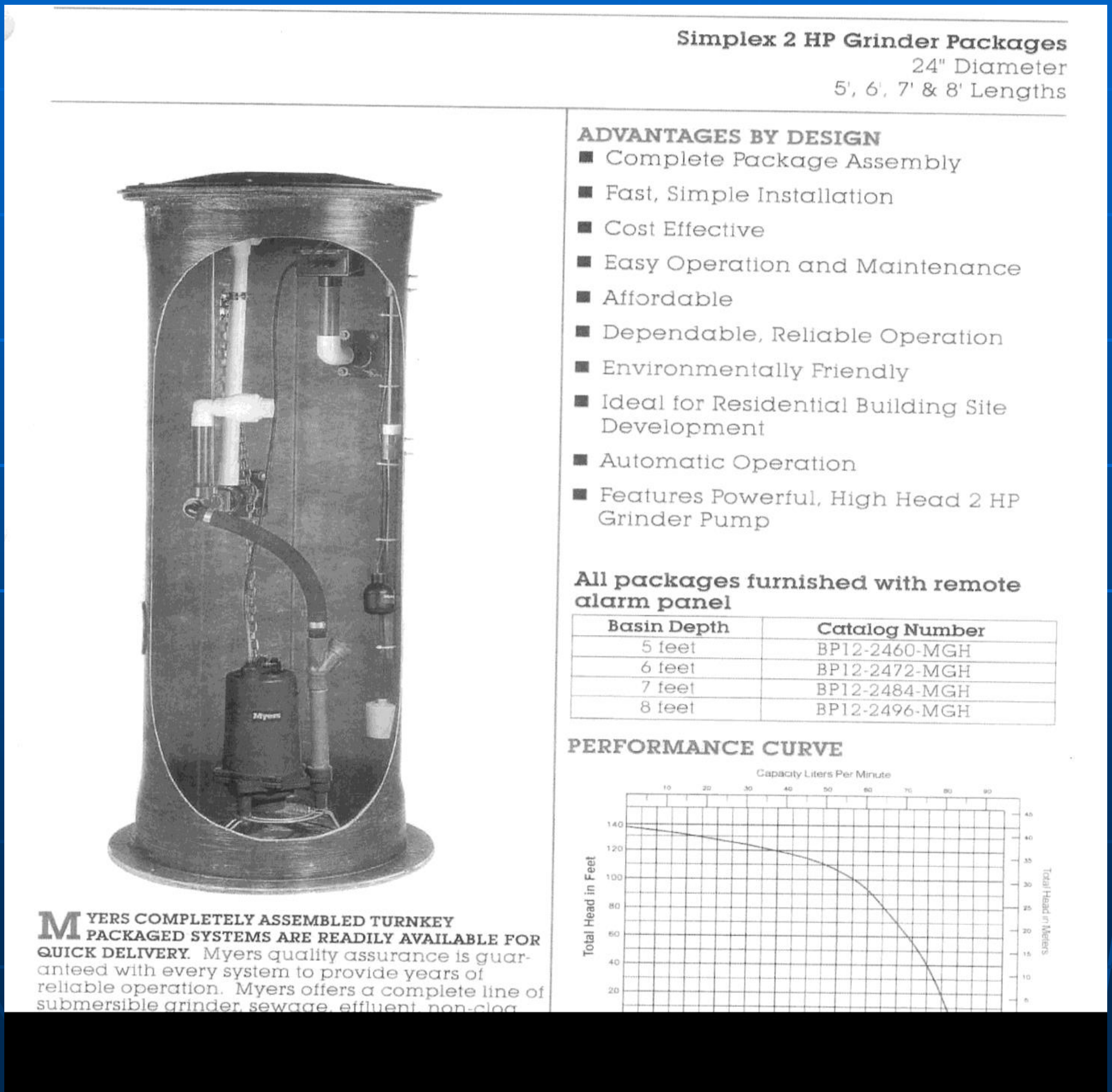
FIGURE 6-7
Schematic of septic tank effluent pump (STEP) collection system onsite components (adapted from Orenco Systems, Inc.) Connection to mainline sewer is as shown in Fig. 6-4.

Pressure Sewer with Grinder Pumps

- Discharge pump with chopper blades in a small pump basin
- Small diameter, pressure line, installed shallow
- Solids and greases are transported
- Relatively simple installation
- Somewhat higher O&M
- No I&I

Pressure Sewer

Grinder Pump basin



Simplex 2 HP Grinder Packages
24" Diameter
5', 6', 7' & 8' Lengths

ADVANTAGES BY DESIGN

- Complete Package Assembly
- Fast, Simple Installation
- Cost Effective
- Easy Operation and Maintenance
- Affordable
- Dependable, Reliable Operation
- Environmentally Friendly
- Ideal for Residential Building Site Development
- Automatic Operation
- Features Powerful, High Head 2 HP Grinder Pump

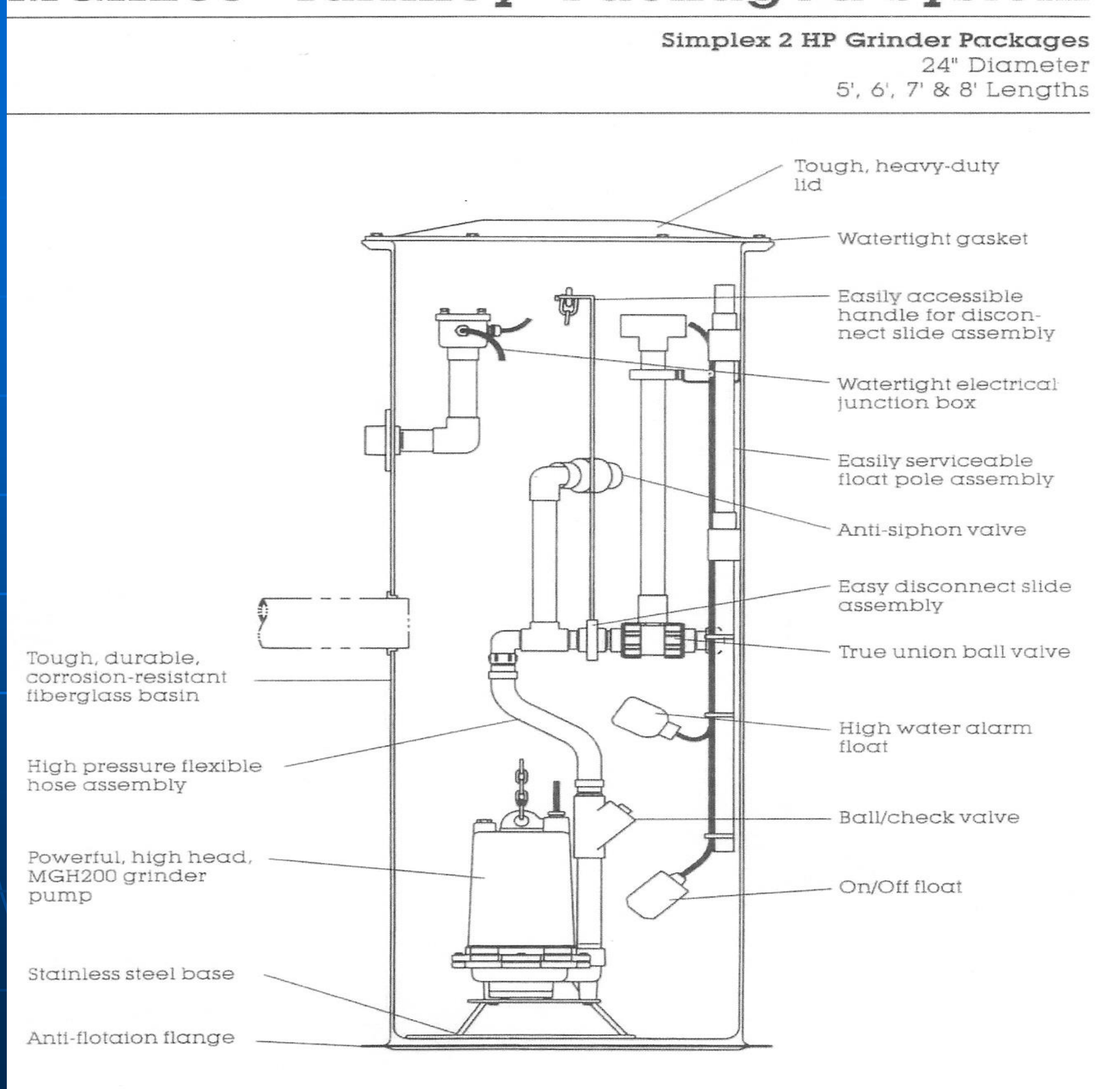
All packages furnished with remote alarm panel

Basin Depth	Catalog Number
5 feet	BP12-2460-MGH
6 feet	BP12-2472-MGH
7 feet	BP12-2484-MGH
8 feet	BP12-2496-MGH

PERFORMANCE CURVE

MYERS COMPLETELY ASSEMBLED TURNKEY PACKAGED SYSTEMS ARE READILY AVAILABLE FOR QUICK DELIVERY. Myers quality assurance is guaranteed with every system to provide years of reliable operation. Myers offers a complete line of submersible grinder, sewage, effluent, non-clog

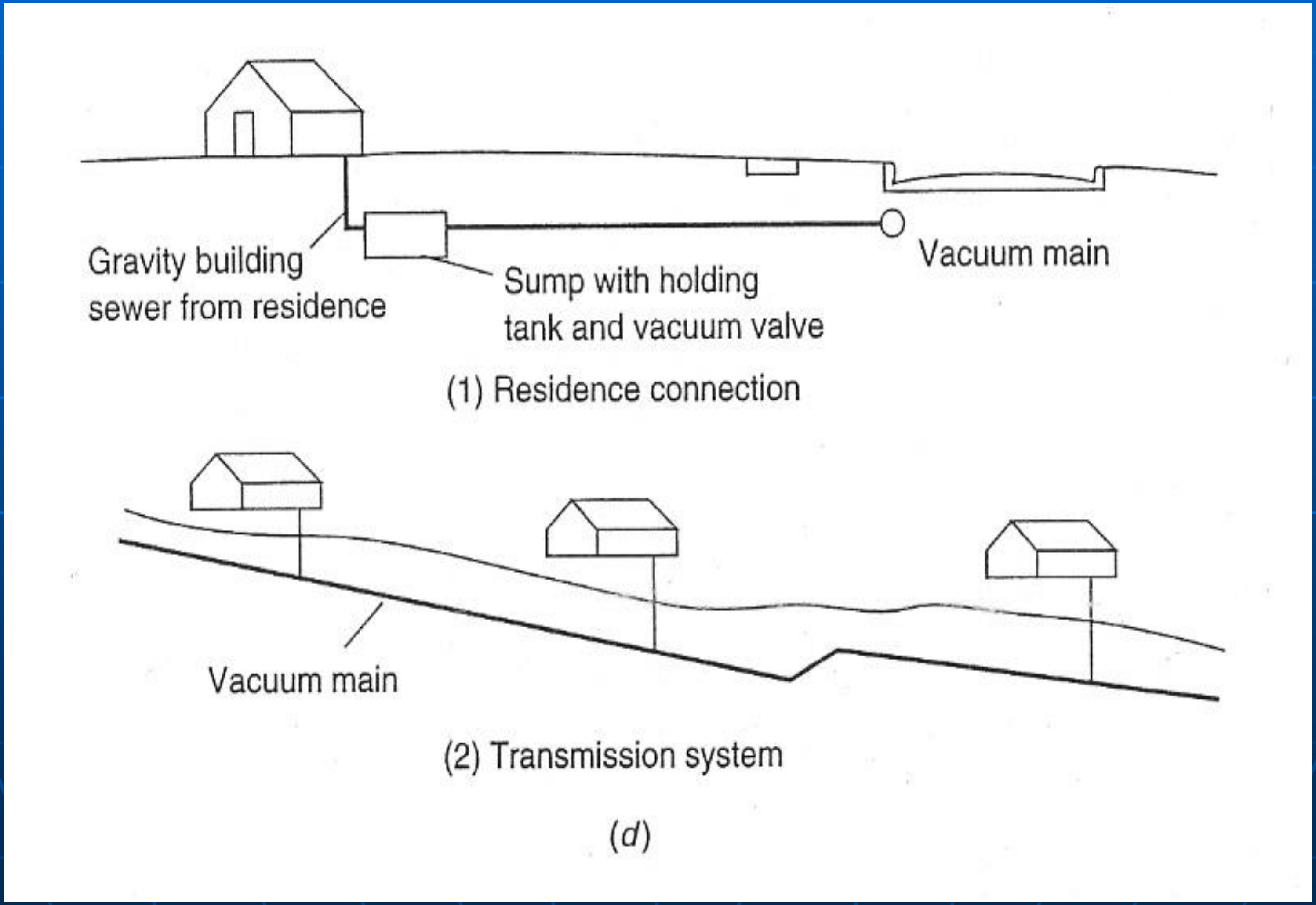
Grinder Pump Basin



Vacuum Sewer

- Central vacuum source maintains a vacuum on a small diameter sewer
- Pulls wastewater to a central location
- Ideal application:
  - Flat terrain
  - High water table
  - 70-100 connections to be economical

Vacuum Sewer



Vacuum Sewer Components

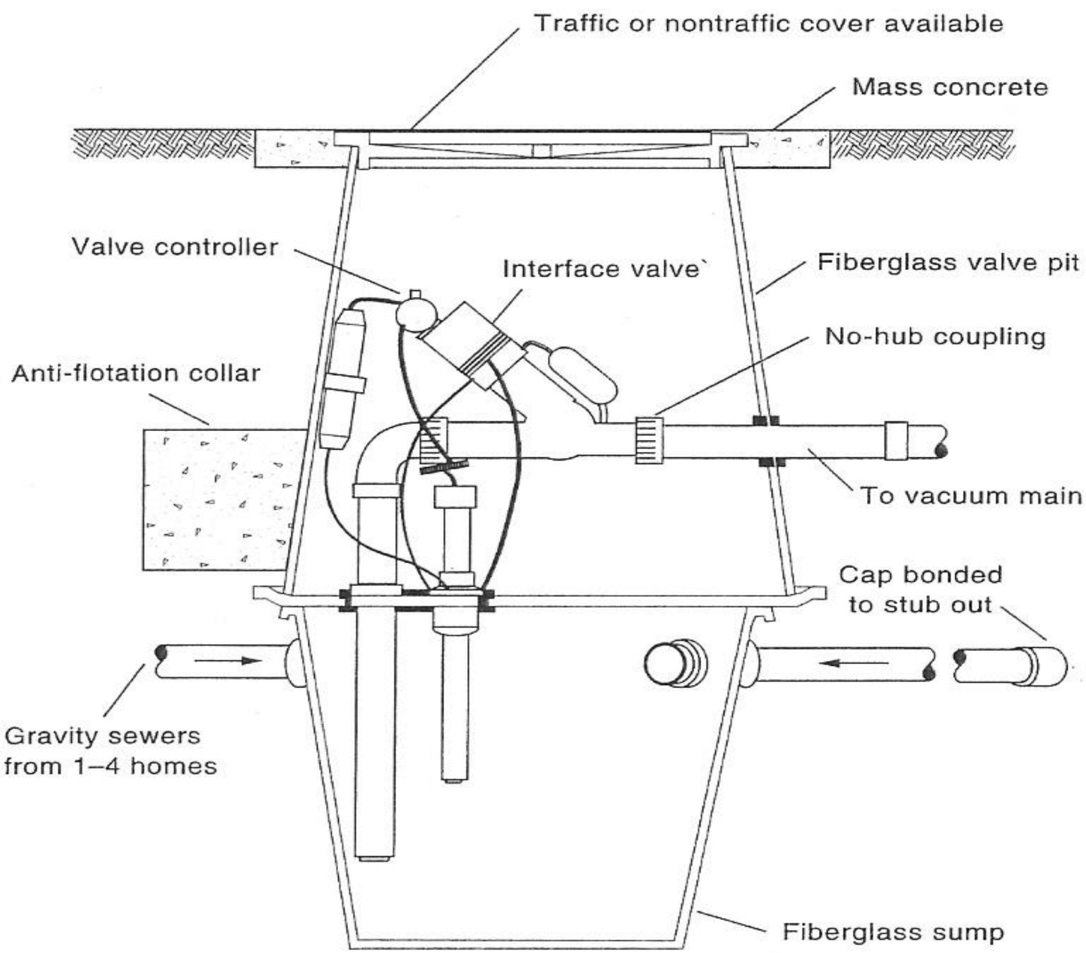


FIGURE 6-15
Typical components of vacuum collection system sump and valve pit (from AIRVAC).

Vacuum Station

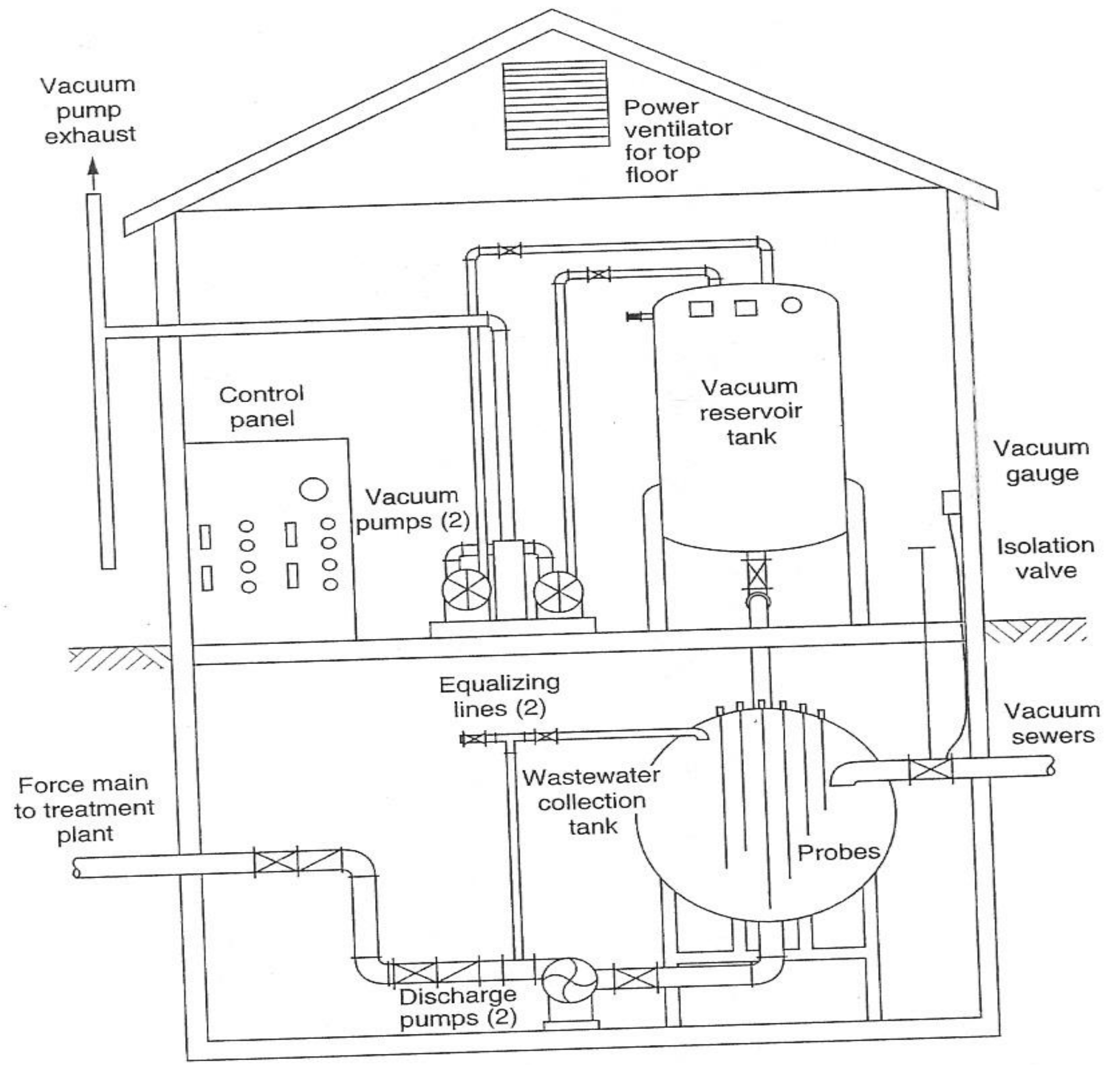


FIGURE 6-16
Typical vacuum station for vacuum collection system (from AIRVAC).