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

**TABLE 6-2**

Relative characteristics of alternative sewer systems*

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

*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

<table>
<thead>
<tr>
<th>Sewer size</th>
<th>Minimum slope (feet/100 ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-inch</td>
<td>0.40</td>
</tr>
<tr>
<td>10-inch</td>
<td>0.28</td>
</tr>
<tr>
<td>12-inch</td>
<td>0.22</td>
</tr>
<tr>
<td>14-inch</td>
<td>0.17</td>
</tr>
<tr>
<td>16-inch</td>
<td>0.14</td>
</tr>
<tr>
<td>18-inch</td>
<td>0.12</td>
</tr>
<tr>
<td>24-inch</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Conventional Gravity Sewer

1. Residence connection
2. Transmission system

- Residence
- Gravity building sewer from residence
- Road
- Sewer lateral or main
- Gravity sewer
- Access ports
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

- **Carefully placed backfill**
- **Plain or reinforced concrete**
  - Minimum width of concrete cradle or concrete arch = $B_c + 8$ in (200 mm)
  - or $\frac{1}{2}B_c$
  - Load factors
    - 2.2 Lightly tamped
    - 2.8 Carefully tamped
    - 3.4 Reinforced concrete, $\rho = 0.4$ percent

  - **Class A1:** Concrete cradle

- **Plain or reinforced concrete**
  - Minimum width of concrete cradle or concrete arch = $B_c + 8$ in (200 mm)
  - or $\frac{1}{2}B_c$
  - Load factors
    - 2.8 Plain concrete
    - 3.4 Reinforced concrete, $\rho = 0.4$ percent
    - 4.8 Reinforced concrete, $\rho = 1.0$ percent

  - **Class A2:** Concrete Arch

- **Hand-placed backfill**
  - **Bedding material**
  - **Load factor 1.9**

  - **Class B:** First-class bedding

- **Hand-placed backfill**
  - **Bedding material**
  - **Load factor 1.5**

  - **Class C:** Minimum bedding
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

\[ \text{H}_2\text{S} + \text{H}_2\text{O} \rightarrow \rightarrow \rightarrow \text{H}_2\text{SO}_4 \]
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

Gravity building sewer from residence to septic tank

Septic tank with effluent filter (see Chap. 5)

Small diameter gravity flow line to sewer

Gravity sewer main

(1) Residence connection

Gravity collection sewer

(2) Transmission system

(b)
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

<table>
<thead>
<tr>
<th>EDUs</th>
<th>Flow, gal/min</th>
<th>2 in</th>
<th>3 in</th>
<th>4 in</th>
<th>6 in</th>
<th>8 in</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Slope, %</td>
<td>Velocity, ft/s</td>
<td>Slope, %</td>
<td>Velocity, ft/s</td>
<td>Slope, %</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
<td>0.17</td>
<td>0.88</td>
<td>0.14</td>
<td>1.02</td>
<td>0.08</td>
</tr>
<tr>
<td>30</td>
<td>15</td>
<td>0.36</td>
<td>1.33</td>
<td>0.26</td>
<td>1.43</td>
<td>0.15</td>
</tr>
<tr>
<td>50</td>
<td>25</td>
<td>0.92</td>
<td>2.21</td>
<td>0.53</td>
<td>2.46</td>
<td>0.08</td>
</tr>
<tr>
<td>70</td>
<td>35</td>
<td>1.71</td>
<td>3.10</td>
<td>0.80</td>
<td>3.08</td>
<td>0.12</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td>3.32</td>
<td>4.42</td>
<td>1.13</td>
<td>3.70</td>
<td>0.17</td>
</tr>
<tr>
<td>150</td>
<td>75</td>
<td>7.02</td>
<td>6.63</td>
<td>1.50</td>
<td>4.31</td>
<td>0.23</td>
</tr>
<tr>
<td>200</td>
<td>100</td>
<td></td>
<td></td>
<td>1.92</td>
<td>4.93</td>
<td>0.29</td>
</tr>
<tr>
<td>250</td>
<td>125</td>
<td></td>
<td></td>
<td>2.90</td>
<td>6.16</td>
<td>0.44</td>
</tr>
<tr>
<td>300</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.62</td>
</tr>
<tr>
<td>350</td>
<td>175</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.82</td>
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<tr>
<td>400</td>
<td>200</td>
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<td></td>
<td></td>
<td></td>
<td>1.05</td>
</tr>
<tr>
<td>500</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.31</td>
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<tr>
<td>600</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.59</td>
</tr>
<tr>
<td>700</td>
<td>350</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>450</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>500</td>
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<td></td>
<td></td>
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<tr>
<td>1200</td>
<td>600</td>
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<tr>
<td>1400</td>
<td>700</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1600</td>
<td>800</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1800</td>
<td>900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Slope of energy grade line calculated using Hazen-Williams C = 150.

1 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

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

*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

In pressure sewer systems with grinder pumps, a receiving sump is substituted for the septic tank.

Gravity building sewer from residence to septic tank

Septic tank with effluent filter and high head pump

Pressure collection sewer
Small diameter pressure line to pressure sewer main

(1) Residence connection

Pressure sewer main follows ground contour

(2) Transmission system
## TABLE 6-9
Typical design data for STEP pressure sewer wastewater collection systems

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

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

<table>
<thead>
<tr>
<th>Basin Depth</th>
<th>Catalog Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 feet</td>
<td>BP12-2460-MGH</td>
</tr>
<tr>
<td>6 feet</td>
<td>BP12-2472-MGH</td>
</tr>
<tr>
<td>7 feet</td>
<td>BP12-2484-MGH</td>
</tr>
<tr>
<td>8 feet</td>
<td>BP12-2496-MGH</td>
</tr>
</tbody>
</table>

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 pumps.
Grinder Pump Basin

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

- Tough, heavy-duty lid
- Watertight gasket
- Easily accessible handle for disconnect slide assembly
- Watertight electrical junction box
- Easily serviceable float pole assembly
- Anti-siphon valve
- Easy disconnect slide assembly
- True union ball valve
- High water alarm float
- Ball/check valve
- On/Off float
- Stainless steel base
- Anti-flotation flange
- Powerful, high head, MGH200 grinder pump
- High pressure flexible hose assembly
- Tough, durable, corrosion-resistant fiberglass 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

(1) Residence connection

(2) Transmission system
Vacuum Sewer Components

Traffic or nontraffic cover available
Mass concrete

Valve controller
Interface valve
Fiberglass valve pit
No-hub coupling
To vacuum main
Cap bonded to stub out

Anti-flotation collar
Gravity sewers from 1–4 homes

Fiberglass sump

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).

Vacuum pump exhaust
Power ventilator for top floor
Control panel
Vacuum pumps (2)
Vacuum reservoir tank
Vacuum gauge
Isolation valve
Vacuum sewers
Force main to treatment plant
Equalizing lines (2)
Wastewater collection tank
Probes
Discharge pumps (2)