CHAPTER 6
WASTEWATER COLLECTION SYSTEM ALTERNATIVES

In a comparison to IWSs involving on-lot treatment and disposal, a centralized treatment facility that serves a whole community or a decentralized cluster treatment system that serves discrete neighborhoods necessitate the installation of street sewers to collect and convey wastewater to an offsite location for treatment and disposal. This chapter describes alternative collection systems applicable to small communities.

A prime factor in evaluating the cost-effectiveness of a wastewater collection system is the terrain and subterranean characteristics of the area. In rolling terrain, conventional gravity sewers are more costly to install because they must be buried deep in the ground. Further, excavation costs are higher in areas with shallow groundwater due to dewatering activities, and in areas where hard pan rock exists.

The use of collector sewers at the large 5-acre and adjoining 1-acre agricultural parcels of Kapoho Farm Lots is not deemed practical and cost-effective. Low population density and high ground elevation make it practical to dispose septic tank effluent in a drain field situated in a soil mantle zone well above the groundwater table. The evaluation of alternative collection sewers will therefore focus on the coastal subdivision lots comprising Kapoho Beach Lots and Vacationland Estates.

6.1 CONVENTIONAL GRAVITY SEWER SYSTEM

Gravity sewers serving communities similar in size and density to Kapoho Beach Lots and Vacationland Estates typically consist of jointed pipe laid in a trench in a fall line that induces a motive force to attain a self-scour flow velocity of two feet per second or more. Typically, 4-inch diameter laterals transport sewage from household plumbing fixtures to a sewer lateral and collector main in the road. At junctures where collector mains intersect, manholes are installed for maintenance purposes. The collector mains flow to larger trunk sewers that transport wastewater to a central treatment plant.

Sewer depth becomes pronounced in long pipe runs, necessitating the use of pump stations at deep junctures to lift sewage to shallower depths to avoid deep excavations downstream. A conceptual layout of a gravity sewer system for a centralized wastewater treatment facility that serves both Kapoho Beach Lots and Vacationland Estates is depicted on Figure 6-1. A conceptual layout of a gravity sewer system for two separate wastewater treatment facilities, one wastewater treatment plant servicing Kapoho Beach Lots and another serving Vacationland Estates, is illustrated on Figure 6-2. The wastewater treatment plants are conceptually located within a flood zone and a tsunami evacuation area. This is permissible by DOH and it is recommended that safeguards be built into the design to address flooding and storm-induced waves.
Conventional gravity sewers will be extremely expensive to construct due to the depth of cuts required in lava strata and the presence of groundwater during excavation.

Kapoho Beach Lots and Vacationland Estates would require 6- and 8-inch diameter sewers and 10- and 12-inch diameter trunk sewers for the entire development of 406 residential lots. The advantages and disadvantages of gravity sewers are listed in Table 6-1. Gravity sewer design calculations are supplied in Appendix B.

6.2 SEPTIC TANK EFFLUENT PUMP

In a septic tank effluent pump (STEP) system (Figure 6-3), a small submersible pump (1/4 to 2 horsepower) is installed in the final compartment of a septic tank. Three mercury float switches are used to control the pump cycles. In some instances, the STEP does not use a filter cartridge or screen to capture particulate matter and retain troublesome solids that can obstruct a small diameter sewer main. Instead, a grinder pump is used to macerate large solids and waste debris, making a filter unnecessary. Electrical wiring extends from the pump vault to an electrical control panel that can be mounted on a pedestal next to the septic tank or on a nearby wall.

A modified STEP would only have an effluent pump of fractional horsepower size and a pressure line to convey wastewater in an effluent sewer to a central site for treatment and disposal or to lift treated septic tank effluent to drain (leach) fields in an onsite individual treatment and disposal system.

Because sludge and scum are retained in the septic tank, a STEP system requires regular pump out in the same fashion as a septic tank system. If these concentrated solids are not removed, sewers may clog and upset the biological process at the treatment plant.

Manholes are not required in a small diameter pressure pipe system. Instead, cleanout pipe fittings can be used to access the transmission system for maintenance.
Table 6-1

COLLECTION SYSTEM FOR COMMUNITY TREATMENT
GRAVITY SEWERS

WASTEWATER TECHNOLOGY SHEET

Description
- Wastewater is collected and transported by gravity through a network of underground pipes. A wastewater pump station is required to convey wastewater collected from low lying areas to the treatment facility.
- Onsite upgrades include installation of a sewer lateral from the house to the main sewer. The existing individual treatment unit would be demolished.
- Offsite upgrades include installation of sewer mains and construction of wastewater pump station(s) and force mains(s) and a centralized wastewater treatment and disposal facility.

Advantages
- Reliable operation relying on gravity, not pressure
- Nominal cost to maintain gravity sewers compared to pressure sewers and pump stations
- Gravity sewers consume no power; any need for wastewater pump stations will require power supply
- Eliminates pumping and cleaning of septic tank or cesspool

Disadvantages
- High construction cost when sewers are laid in groundwater (the case in residential areas near the coastline)
- Requires construction, operation and maintenance of wastewater pump stations to lift sewage to shallower depths (multiple stations may be required)
- Safeguards against power outages are required to prevent sewage overflows; i.e., emergency backup and warning systems
- Pipe “fall” needed to attain adequate flow and self-cleansing velocities
- Excavations deepen the longer the sewer line traverses
- Manholes add substantial cost
- Damage consequential to deeply laid sewers require deep excavation and trench dewatering for repair

Gravity sewer joints are not leak-tight and allow external water to infiltrate, thereby increasing cost to treat and dispose this extraneous water

Applicability To Study Area
- Kapoho’s flat terrain, high ground water table and underlying lava rock make gravity sewers very costly to install. In addition, wastewater pump stations are required to convey wastewater from the low lying areas to the treatment facility.
- The on-lot portion of the sewer lateral would typically be 4- and 6-inch diameter pipe. Sewer mains in roadways would range from 8 to 12 inches in diameter.
Septic tank effluent pump systems are ideally suited for onsite wastewater pumping applications for single family residential units. Small diameter STEP collection systems have been used in varying degrees for centralized treatment and disposal.

In long-term operation, effluent pumps may become clogged or jammed, particularly during prolonged periods of inactivity where corrosion can bind the pump impeller. These pumps, however, are generally relatively reliable. Typically, the time between unscheduled service calls may be from four to six years if routine maintenance is performed on the equipment and valves are exercised to prevent seizing from idleness. The pros and cons of STEP systems are summarized in Table 6-2.

6.3 LOW PRESSURE SEWER SYSTEM (GRINDER PUMP)

Where implementation of conventional gravity sewers is impractical, uneconomical, or otherwise infeasible, low pressure sewers (LPS) may emerge as a viable collection system. Unlike the STEP system, a septic tank is not required since sewage is conveyed entirely from the household to a treatment facility without pretreatment.

A pressure sewer is a small diameter pipeline, usually of plastic or polyethylene material, shallowly buried, and laid in a manner following the surface terrain. In rolling ground such as Kapoho Beach Lots, LPS are particularly viable. Since basalt or other hard pan geology and shallow groundwater make excavation difficult, LPS becomes even more attractive. Low pressure sewer diameters range from 1-1/2 to 4 inches, where the smaller diameter lines join at main junctures. The piping network can extend for many thousands of feet at a total dynamic pumping head of over 125 feet. Each home uses a small pump in an underground vault to discharge sewage to the main. One example is a grinder pump (GP), which converts sewage to a non-
Table 6-2

COLLECTION SYSTEM FOR COMMUNITY TREATMENT
LOW PRESSURE SEWERS, SEPTIC TANK EFFLUENT PUMP SEWERS

WASTEWATER TECHNOLOGY SHEET

Description
- Wastewater flows into a conventional septic tank to capture heavy solids and floating material. The liquid effluent flows through to a pumping chamber and is pumped to the treatment system.
- Onsite upgrades include installation of a pumping chamber, pump(s), electrical/control panel, and force (pressure) main.
- Offsite upgrades include installation of a pressurized pipe system in streets to the treatment facility.
- Existing septic tank removes settleable and floatable solids.

Advantages
- Less costly to construct than conventional gravity sewers.
- Shallow trenches and small diameter piping avoid trench dewatering and minimize excavation.
- Septic tank provides preliminary treatment and reduces waste load to downstream treatment system.

Disadvantages
- Increased energy cost for electricity to operate the pump.
- Pumping system requires periodic inspection and maintenance (6-month intervals)
- Septic tank must be checked for sludge and scum buildup and pumped and cleaned as needed (2- to 5-year intervals)
- Power outages may result in overflows if there is no emergency power backup system.
- Not cost effective for homes currently served by cesspools as low pressure sewer requires installation of a septic tank.

Applicability To Study Area
- STEP systems can be a reliable and cost-effective wastewater collection and conveyance alternative.
- STEP systems require routine service by a commercial contractor. Treatment provided by the septic tank will reduce the risk of pump clogging and the waste load to the downstream treatment facility.
- The pumping chamber for a typical Kapoho Beach Lots and Vacationland Estates subdivision home would be roughly 3 feet in diameter and 5 feet deep. The pump would discharge through a 1-1/4 inch plastic pipe force main.
clogging slurry in the manner of a garbage disposal (Figure 6-4). Grinder pumps for individual residences are usually 2 horsepower in size, but 1 horsepower units are also used. On-lot grinder pumps induce low pressure conveyance. When several houses are served as a cluster by a single pumping unit, the GP may use 3- to 5-horsepower pumps. A check valve on the house lot service line prevents backflow, which is insured with a redundant check valve at the pumping unit.

The features of LPS for centralized systems are summarized in Table 6-3.

![A Typical Overview of Pressure Sewer Installation](image)

**Figure 6-4** Grinder Pump and Low Pressure Sewer Discharge Line
### Table 6-3

**COLLECTION SYSTEM FOR COMMUNITY TREATMENT**  
**LOW PRESSURE SEWERS, GRINDER PUMP (GP)**

#### WASTEWATER TECHNOLOGY SHEET

**Description**
- Wastewater flows by gravity from the house to an on-lot pumping chamber. A grinder pump shreds the solids and pumps the wastewater slurry to the treatment system.
- Onsite upgrades include installation of a pumping chamber, pump(s), electrical/control panel, and force main.
- Offsite upgrades include installation of a pressurized pipe system to the treatment facility.

**Advantages**
- Unlike conventional gravity sewers, no leakage occurs into the sewer (infiltration/inflow) which must be additionally treated.
- Ideal for service areas having high groundwater table since it is a water-tight system (no leakage or infiltration).
- Can retrofit existing septic tanks with grinder pumps.
- Existing septic tank can be used as a storage vault during an emergency.
- Eliminates pumping and cleaning of septic tank or cesspool.
- Practical and cost-effective where gravity sewers are expensive to install due to terrain or hard-pan restrictions.

**Disadvantages**
- Increased energy cost for electricity to operate the pump.
- Power outages may result in overflows if there is no emergency power backup system.
- Untreated wastewater is delivered to the treatment system.
- Pumping system requires periodic inspection and maintenance (6 month intervals).

**Applicability To Study Area**
- Low pressure sewer systems can be a reliable and cost-effective wastewater collection and conveyance alternative. Low pressure sewer systems are cost effective where flat terrain, high ground water and underlying lava rock do not favor gravity sewers. Mechanical components throughout the service area require centralized maintenance.
- The pumping chamber for a typical Kapoho Beach Lots and Vacationland Estates home would be roughly 3 feet in diameter and 5 feet deep. The pump would discharge through a 1-1/2-inch plastic force main.
Refer to Figure 6-5 for a conceptual layout of a low pressure sewer system employing a centralized wastewater treatment facility to serve Kapoho Beach Lots and Vacationland Estates. A low pressure sewer system that separately serves the two subdivisions is illustrated on Figure 6-6. Details of the flows and line sizes are included in Appendix C.