APPENDIX D. STANDARDS FOR WATER SOURCES

I. LOCATION OF WATER SOURCES

DISTANCE FROM SOURCES OF CONTAMINATION

All ground water sources should be located a safe distance from sources of contamination. In cases where sources are severely limited; however, a ground water aquifer that might become contaminated may be considered for a water supply, if treatment is provided. After a decision has been made to locate a water source in an area, it is necessary to determine the distance the source should be placed from the origin of contamination and the direction of water movement. A determination of a safe distance is based on specific local factors described in the section on "Sanitary Survey."

Because many factors affect the determination of "safe" distances between ground water supplies and sources of pollution, it is impractical to set fixed distances. Where insufficient information is available to determine the "safe" distance, the distance should be the maximum that economics, land ownership, geology and topography will permit. It should be noted that the direction of ground water flow does not always follow the slope of the land surface. Each installation should be inspected by a person with sufficient training and experience to evaluate all of the factors involved.

Since safety of a ground water source depends primarily on considerations of good well construction and geology, these factors should be the guides in determining safe distances for different situations. The following criteria apply only to properly constructed wells, as described in this appendix. There is no safe distance for a poorly constructed well.

When a properly constructed well penetrates an unconsolidated formation, with good filtering properties, and when the aquifer itself is separated from sources of contamination by similar materials, research and experience have demonstrated that 15 meters (50 feet) is an adequate distance separating the two. Lesser distances should be accepted, only after a comprehensive sanitary survey, conducted by qualified State or local health agency officials, has satisfied the officials that such lesser distances are both necessary and safe.

If it is proposed to install a properly constructed well in formations of unknown character, the State or U.S. Geological Survey and the State or local health agency should be consulted.

When wells must be constructed in consolidated formations, extra care should always be taken in the location of the well and in setting "safe" distances, since pollutants have been known to travel great distances in such formations. The owner should request assistance from the State or local health agency.

The following table is offered as a guide in determining distances:

Table 10. Distance of Well from Sources of Contamination	
Formation	**Minimum Acceptable Distance of Well from Sources of Contamination**
Favorable (Unconsolidated)	15 meters (50 feet) – Lesser distances only on health department approval following comprehensive sanitary survey of proposed site and immediate surroundings.
Unknown	15 meters (50 feet) – Only after comprehensive geological survey of the site and its surroundings has established, to the satisfaction of the health agency, that favorable formations do exist.
Poor (Consolidated)	Safe distances can be established only following both the comprehensive geological and comprehensive sanitary surveys. These surveys also permit determining the direction in which a well may be located with respect to sources of contamination. In no case should the acceptable distance be less than 15 meters (50 feet).

EVALUATING CONTAMINATION THREATS TO WELLS

Conditions unfavorable to the control of contamination and that may require specifying *greater* distances between a well and sources of contamination are:

1. **Nature of the Contaminant:** Human and animal excreta and toxic chemical wastes are serious health hazards. Salts, detergents and other substances that dissolve in water can mix with ground water and travel with it. They are not ordinarily removed by natural filtration.

2. **Deeper Disposal:** Cesspools, dry wells, disposal and waste injection wells and deep leaching pits that reach aquifers or reduce the amount of filtering earth materials between the wastes and the aquifer increase the danger of contamination.

3. **Limited Filtration:** When earth materials surrounding the well and overlying the aquifer are too coarse to provide effective filtration, as in limestone, coarse gravel, etc., or when they form a layer too thin, the risk of contamination is increased.

4. **The Aquifer:** When the materials of the aquifer itself are too coarse to provide good filtration, as in limestone, fractured rock, etc., contaminants entering the aquifer through outcrops or excavations may travel great distances. It is especially important in such cases to know the direction of ground water flow and whether there are outcrops of the formation (or excavations reaching it) "upstream" and close enough to be a threat.

5. **Volume of Waste Discharged:** Since greater volumes of wastes discharged and reaching an aquifer can significantly change the slope of the water table and the direction of ground water flow, it is obvious that heavier discharges can increase the threat of contamination.

6. **Contact Surface:** When pits and channels are designed and constructed to increase the rate of absorption, as in septic tank leaching systems, cesspools and leaching pits, more separation from the

water source will be needed than when tight sewer lines or waste pipes are used.

7. **Concentration of Contamination Sources:** The existence of more than one source of contamination, contributing to the general area, increases the total pollution load and, consequently, the danger of contamination.

SANITARY SURVEY

The importance of a sanitary survey of water sources cannot be overemphasized. With a new supply, the sanitary survey should be made in conjunction with the collection of initial engineering data, covering the development of a given source and its capacity to meet existing and future needs. The sanitary survey should include the detection of all health hazards and the assessment of their present and future importance. Persons trained and competent in public health engineering and the epidemiology of waterborne diseases should conduct the sanitary survey. In the case of an existing supply, the sanitary survey should be made at a frequency compatible with the control of the health hazards and the maintenance of a good sanitary quality.

The information furnished by the sanitary survey is essential to complete the interpretation of bacteriological and frequently the chemical data. This information should always accompany the laboratory findings. The following outline covers the essential factors which should be investigated or considered in a sanitary survey. Not all of the items are pertinent to any one supply and, in some cases, items not in the list would be important additions to the survey list.

Ground Water Supplies:

a. Character of local geology and slope of ground surface.

b. Nature of soil and underlying porous strata; whether clay, sand, gravel, rock (especially porous limestone); coarseness of sand or gravel; thickness of water-bearing stratum; depth to water table and location, log and construction details of local wells in use and abandoned.

c. Slope of water table, preferably determined from observational wells or as indicated, presumptively, but not certainly, by the slope of ground surface.

d. Extent of drainage area likely to contribute water to the supply.

e. Nature, distance and direction of local sources of pollution.

f. Possibility of surface-drainage water entering the supply and of wells becoming flooded and methods of protection.

g. Methods used for protecting the supply against pollution by means of sewage treatment, waste disposal and the like.

g. Well construction:

(1) Total depth of well.

(2) Casing: diameter, wall thickness, material and lengths from surface.

(3) Screen or perforations: diameter, material, construction, locations and lengths.

(4) Formation seal: material (cement, sand, bentonite, etc.), depth intervals, annular thickness and method of placement.

i. Protection of well at top: presence of sanitary well seal, casing height above ground floor or flood level, protection of well vent and protection of well from erosion and animals.

j. Pumphouse construction (floors, drains, etc.), capacity of pumps and draw down when pumps are in operation.

k. Availability of an unsafe supply, usable in place of normal supply, hence involving danger to the public health.

l. Disinfection: equipment, supervision, test kits or other types of laboratory control.

Surface Water Supplies:

a. Nature of surface geology: character of soils and rocks.

b. Character of vegetation, forests, cultivated and irrigated land, including salinity, effect on irrigation water, etc.

c. Population and sewered population per square mile of catchment area.

d. Methods of sewage disposal, whether by diversion from watershed or by treatment.

e. Character and efficiency of sewage-treatment works on watershed.

f. Proximity of sources of fecal pollution to intake of water supply.

g. Proximity, sources and character of industrial wastes, oil field brines, acid mine waters, etc.

h. Adequacy of supply as to quantity.

i. For lake or reservoir supplies: wind direction and velocity data, drift of pollution and sunshine data (algae).

j. Character and quality of raw water: coliform organisms (MPN), algae, turbidity, color and objectionable mineral constituents.

k. Nominal period of detention in reservoirs or storage basin.

l. Probable minimum time required for water to flow from sources of pollution to reservoir and through reservoir intake.

m. Shape of reservoir, with reference to possible currents of water, induced by wind or reservoir discharge, from inlet to water-supply intake.

n. Protective measures in connection with the use of watershed to control fishing, boating, landing of airplanes, swimming, wading, ice cutting and permitting animals on marginal shore areas and in or upon the water, etc.

o. Efficiency and constancy of policing.

p. Treatment of water: kind and adequacy of equipment; duplication of parts; effectiveness of treatment; adequacy of supervision and testing; contact period after disinfection and free chlorine residuals carried.

q. Pumping facilities: pumphouse, pump capacity and standby units and storage facilities.

II. CONSTRUCTION

SANITARY CONSTRUCTION OF WELLS

The penetration of a water-bearing formation by a well provides a direct route for possible contamination of the ground water. Although there are different types of wells and well construction, there are basic sanitary aspects that must be considered and followed.

1. The annular space outside the casing shall be filled with a watertight cement grout or puddled clay from a point just below the frost line or deepest level of excavation near the well to as deep as necessary to prevent entry of contaminated water.

2. For artesian aquifers, the casing shall be sealed into the overlying impermeable formations so as to retain the artesian pressure.

3. When a water-bearing formation containing water of poor quality is

penetrated, the formation shall be sealed off to prevent the infiltration of water into the well and aquifer.

4. A sanitary well seal, with an approved vent, shall be installed at the top of the well casing to prevent the entrance of contaminated water or other objectionable material.

Well Casing or Lining: All that part of the suction pipe or drop pipe of any well within 3 meters (10 feet) of and below the ground surface shall be surrounded by a watertight casing pipe extending above the ground, platform or floor surface, as the case maybe, and covered at the top as herein provided. The casing of every well shall terminate above the ground level; the annular space outside the casing shall be filled with a watertight cement grout or clay, with similar sealing properties, from the surface to a minimum of 3 meters (10 feet) below the ground surface. A dug well, in lieu of a casing pipe, may be provided with a substantial watertight lining of concrete, vitrified tile with outer concrete lining, or other suitable material. Such lining shall extend at least 3 meters (10 feet) below the surface and shall extend up to the well platform or pump room floor with a watertight connection. In such case, the platform or floor shall have a suitable sleeve pipe, surrounding the suction pipe or drop pipe, and projecting above as herein provided for a casing pipe.

Well Covers and Seals: Every well shall be provided with an overlapping, tight-fitting cover at the top of the casing or pipe sleeve to prevent contaminated water or other material from entering the well.

The sanitary well seal, in a well exposed to possible flooding, shall be either watertight or elevated at least .6 meters (2 feet) above the highest known flood level. When it is expected that a well seal may become flooded, it shall be watertight and equipped with a vent line, whose opening to the atmosphere, is at least .6 meters (2 feet) above the highest known flood level.

The seal in a well not exposed to possible flooding shall be either watertight (with an approved vent line) or self-draining, with an overlapping and downward flange. If the seal is of the self-draining (non-watertight) type, all openings in the cover should be either watertight or flanged upward and provided with overlapping, downward flanged covers.

Some pump and power units have closed bases that effectively seal the upper terminal of the well casing. When the unit is the open type, or when it is located at the side (some jet- and suction-pump-type installations), it is especially important that a sanitary well seal be used. There are several acceptable designs consisting of an expandable neoprene gasket, compressed between two steel plates. They are easily installed and removed for well servicing. Pump and water well suppliers normally stock sanitary well seals.

If the pump is not installed immediately after well drilling and placement of the casing, the top of the casing should be closed with a metal cap screwed or tack welded into place, or covered with a sanitary well seal.

For large-diameter wells such as dug wells, it would be difficult to provide a sanitary well seal, consequently, a reinforced concrete slab, overlapping the casing and sealed to it with a flexible seal and/or rubber gasket, should be installed. The annular space outside the casing should first be filed with suitable grouting or sealing materials, i.e., cement, clay, or fine sand.

A well slab alone is not an effective sanitary defense, since it can be undermined by burrowing animals and insects, cracked from settlement or frost heave or broken by vehicles and vibrating machinery. The cement grout formation seal is far more effective. It is recognized; however, that there are situations that call for a concrete slab or floor around the well casing to facilitate cleaning and improve appearance. When such a floor is necessary, it shall be placed only after the formation seal and the pitless installation have been inspected.

Well covers and pump platforms shall be elevated above the adjacent finished ground level. Pump room floors shall be constructed of reinforced, watertight concrete and carefully leveled or sloped away from the well, so that surface and waste water cannot stand near the well. The minimum thickness of such a slab or floor shall be 10 centimeters (4 inches). Concrete slabs or floors shall be poured separately from the cement formation seal and when the threat of freezing exists, insulated from it and the well casing by a plastic or mastic coating or sleeve to prevent bonding of the concrete to either.

All water wells shall be readily accessible at the top for inspection, servicing and testing. This requires that any structure over the well be easily removable to provide full, unobstructed access for well servicing equipment. The so-called "buried seal," with the well cover buried under several meter (yards) of earth, is unacceptable because:

1. It discourages periodic inspection and preventive maintenance;
2. It makes severe contamination during pump servicing and well repair more likely;
3. Any well servicing is more expensive; and
4. Excavation to expose the top of the well increases the risk of damage to the well, the cover, the vent and the electrical connections.

Well Pits and Drainage: Because of the pollution hazards involved, the well head, well casing, pump, pumping machinery, valve connected with the suction pump or exposed suction pipe shall not be permitted in any pit, room or space extending below ground level, or in any room or space above the ground, which is walled-in or otherwise enclosed, so that it does not have free drainage by gravity to the surface of the ground. *Provided*, that a dug well properly constructed, lined and covered, as herein prescribed, shall not be construed to be a pit. *Provided further,* that pumping equipment and appurtenances may be located in a residential basement, which is not subject to flooding. *And provided further,* that in the case of existing water supplies which otherwise comply with the applicable requirements of this appendix, pit installations may be accepted, under the following conditions, when permitted by the State water-control authority:

1. Pits shall be of watertight construction, with walls extending at least 15 centimeters (6 inches) above the established ground surface at all points.
2. Pits shall be provided with a watertight, concrete floor, sloping to a drain which discharges to the ground surface at a lower elevation than the pit, and preferably at least 9 meters (30 feet) from it; or if this should be impossible, to a watertight, concrete sump, in the pit, equipped with a sump-pump discharging to the ground surface, preferably at least 9 meters (30 feet) from the pit.
3. Pits shall be provided with a concrete base for pumps or pumping machinery, so that such units shall be located at least 30 centimeters (12 inches) above the floor of the pit.
4. Pits shall be provided with a watertight housing or cover in all cases.
5. If inspection should reveal that these conditions are not being properly maintained, the supply shall be disapproved.

Manholes: Manholes may be provided on dug wells, reservoirs, tanks and other similar features of water supplies. A manhole, if installed, shall be provided with a curb, the top of which extends at least 10 centimeters (4 inches) above the slab and shall be equipped, where necessary for physical protection, with a locked or bolted overlapping watertight cover. The sides of which extend downward at least 5 centimeters (2 inches). The covers shall be kept closed at all times, except when it may be necessary to open the manhole.

Vent Opening: Any reservoir, well, tank or other structure containing water for the dairy water supply may be provided with vents, overflows, or water-level control gauges, which shall be so constructed as to prevent the entrance of birds, insects, dust, rodents or contaminating material of any kind. Openings on vents shall be not less than 46 centimeters (18 inches) above the floor of a pump room, or above the roof or cover of a reservoir. Vent openings on other structures shall be at least 46 cm (18 inches) above the surface on which the vents are located. Vent openings shall be turned down and screened with corrosion-resistant screen of not less than 16 x 20 mesh. Overflow outlets shall discharge above and not less than 6 inches from a roof, roof drain, floor, floor drain or over an open water-supplied fixture. The overflow outlet shall be covered by a corrosion-resistant screen of not less than 16 x 20 mesh and by .6 centimeters (1/4-inch) hardware cloth, or shall terminate in a horizontal angle seat check valve.

DEVELOPMENT OF SPRINGS

There are two general requirements necessary in the development of a spring, used as a source of domestic water.

1. Selection of a spring with adequate capacity to provide the required quantity and quality of water for its intended use throughout the year.
2. Protection of the sanitary quality of the spring. The measures taken to develop a spring must be tailored to its geological conditions and sources.

The features of a spring encasement are the following:

1. An open-bottom, watertight basin intercepting the source which extends to bedrock or a system of collection pipes and a storage tank;
2. A cover that prevents the entrance of surface drainage or debris into the storage tank;
3. Provisions for the cleanout and emptying of the tank contents;
4. Provision for overflow; and
5. A connection to the distribution system or auxiliary supply. (See Figure 12).

A tank is usually constructed in place with reinforced concrete, of such dimensions, as to enclose or intercept as much of the spring as possible. When a spring is located on a hillside, the downhill wall and sides are extended to bedrock or to a depth that will insure maintenance of an adequate water level in the tank. Supplementary cutoff walls, of concrete or impermeable clay, extending laterally from the tank may be used to assist in controlling the water table in the locality of the tank. The lower portion of the uphill wall of the tank can be constructed of stone, brick or other material, so placed that water may move freely into the tank from the formation. Backfill of graded gravel and sand will aid in restricting movement of fine material from the formation toward the tank.

The tank cover shall be cast in place to insure a good fit. Forms should be designed to allow for shrinkage of concrete and expansion of form lumber. The cover shall extend down over the top edge of the tank at least 5 centimeters (2 inches). The tank cover shall be heavy enough so that it cannot be dislodged by children and shall be equipped for locking.

A drain pipe with an exterior valve shall be placed close to the wall of the tank near the bottom. The pipe shall extend horizontally so as to clear the normal ground level at the point of discharge by at least 15 centimeters (6 inches). The discharge end of the pipe shall be screened to prevent the entrance of rodents and insects.

The overflow is usually placed slightly below the maximum water-level elevation and screened. A drain apron of rock shall be provided to prevent soil erosion at the point of overflow discharge.

The supply outlet, from the developed spring, shall be located at least 15 cm (6 inches) above the drain outlet and properly screened. Care shall be taken in casting pipes into the walls of the tank to insure good bond with the concrete and freedom from honeycomb around the pipes.

SANITARY PROTECTION OF SPRINGS

Springs usually become contaminated when barnyards, sewers, septic tanks, cesspools or other sources of pollution are located on higher adjacent land. In limestone formations; however, contaminated material frequently enters the water-bearing channels through sink holes or other large openings and may be carried along with ground water for long distances. Similarly, if material from such sources of contamination finds access to the tubular channels in glacial drift, this water may retain its contamination for long periods of time and for long distances.

The following precautionary measures will help to insure developed spring water of consistently high quality:

1. Provide for the removal of surface drainage from the site. A surface drainage ditch shall be located uphill from the source so as to intercept surface-water runoff and carry it away from the source. Location of the ditch and the points at which the water should be discharged are a matter of judgement. Criteria used should include the topography, the subsurface geology, land ownership and land use.
2. Construct a fence to prevent entry of livestock. Its location should be guided by the considerations mentioned in item 1. The fence shall exclude livestock from the surface-water drainage system at all points uphill from the source.
3. Provide for access to the tank for maintenance, but prevent removal of the cover by a suitable locking device.
4. Monitor the quality of the spring water with periodic checks for contamination. A marked increase in turbidity or flow after a rainstorm is a good indication that surface runoff is reaching the spring.

SURFACE WATER

The selection and use of surface water sources, for individual water supply systems, require consideration of additional factors not usually associated with ground water sources. When small streams, open ponds, lakes or open reservoirs must be used as sources of water supply, the danger of contamination and the consequent spread of enteric diseases, such as typhoid fever and dysentery is increased. As a rule, surface water shall be used only when ground water sources are not available or are inadequate. Clear water is not always safe, and the old saying that running water "purifies itself", to drinking water quality, within a stated distance is false.

The physical and bacteriological contamination of surface water makes it necessary to regard such sources of supply as unsafe for domestic use, unless reliable treatment, including filtration and disinfection, is provided.

The treatment of surface water to insure a constant, safe supply requires diligent attention to operation and maintenance by the owner of the system.

When ground water sources are limited, consideration shall be given to their development for domestic purposes only. Surface water sources can then provide water needed for stock and poultry watering, gardening, fire-fighting and similar purposes. Treatment of surface water used for livestock is not generally considered essential. There is; however, a trend to provide stock and poultry drinking water which is free from bacterial contamination and certain chemical elements.

Where resort must be made to surface water for all uses, a wide variety of sources, including farm ponds, lakes, streams and the roof runoff of buildings may be considered. These sources are regarded, without exception, to be contaminated, and their use cannot be condoned unless an individually tailored treatment process can be used, which will make them safe and satisfactory. Such treatment may include aeration and the use of suitable filtration or precipitation devices to remove suspended matter, in addition to routine full-time disinfection.

The milk producer or milk plant operator, who is considering surface sources of water for milking, milkhouse and milk plant operations shall receive the advance approval of the regulatory agency and shall comply with all applicable requirements of the State water control authority on the construction, protection and treatment of the chosen supply.

NOTE: The U. S. Environmental Protection Agency publishes a *Manual of Individual Water Supply Systems* which is an excellent source of detailed information on the development, construction and operation of individual water systems and also contains a suggested well-drilling code.

III. DISINFECTION OF WATER SOURCES

All newly constructed or newly repaired wells shall be disinfected to counteract contamination introduced during construction or repair. Every well shall be disinfected immediately after construction or repair and flushed prior to bacteriological testing.

An effective and economical method of disinfecting wells and appurtenances is the use of calcium hypochlorite, containing approximately 70 percent available chlorine. This chemical can be purchased in granular form at hardware stores, swimming pool equipment supply outlets or chemical supply houses.

When used in the disinfection of wells, calcium hypochlorite should be added in sufficient amounts to provide a dosage of approximately 50 mg. available chlorine per liter in the well water. This concentration is roughly equivalent to a mixture of 1 gram (.03 ounce) of dry chemical per 13.5 liter (3.56 gallons) of water to be disinfected. A stock solution of disinfectant may be prepared by mixing 30 grams (1 ounce) of high-test hypochlorite with 2 liters (2 quarts) of water. Mixing is facilitated if a small amount of the water is first added to the granular calcium hypochlorite and stirred to a smooth watery paste free of lumps. The stock solution should be stirred thoroughly for 10 to 15 minutes. The inert ingredients should then be allowed to settle. The liquid containing the chlorine should be used and the inert material discarded. Each 1.9 liter (2 quarts) of stock solution will provide a concentration of approximately 50 mg/l when added to 378 liters (100 gallons) of water. The solution should be prepared in a clean utensil. The use of metal containers should be avoided, as they are corroded by strong chlorine solutions. Crockery, glass or rubberlined containers are recommended.

Where small quantities of disinfectant are required and a scale is not available, the material can be measured with a spoon. A heaping tablespoonful of granular calcium hypochlorite weighs approximately 14 grams (1/2 ounce).

When calcium hypochlorite is not available, other sources of available chlorine such as sodium hypochlorite (12-15 percent of volume) can be used. Sodium hypochlorite, which is also commonly available as liquid household bleach with 5.25 percent available chlorine, can be diluted with two parts of water to produce the stock solution. 1.9 liter (2 quarts) of this solution can be used for disinfecting 378 liters (100 gallons) of water.

Stock solutions of chlorine in any form will deteriorate rapidly unless properly stored. Dark glass or plastic bottles with airtight caps are recommended. Bottles containing solution should be kept in a cool place and protected from direct sunlight. If proper storage facilities are not available, the solution should always be prepared fresh, immediately before use.

Complete information concerning the test for residual chlorine is included in the latest edition of *Standard Methods for the Examination of Water and Wastewater,* published by the American Public Health Association.

DUG WELLS

After the casing or lining has been completed, follow the procedure outlined below:

1. Remove all equipment and materials which will not form a permanent part of the completed structure.
2. Using a stiff broom or brush, wash the interior walls of the casing or lining with a strong solution (100 mg/l of chlorine) to insure thorough cleaning and sanitizing.
3. Place the cover over the well and pour the required amount of chlorine solution into the well through the manhole or pipe opening just before inserting the pump cylinder and drop-pipe assembly. The chlorine solution should be distributed over as much of the surface of the water as possible to obtain proper diffusion of the chemical through the water hose or pipeline as the line is being alternately raised and lowered. This method should be followed whenever possible.
4. Wash the exterior surface of the pump cylinder and drop pipe, with the chlorine solution, as the assembly is being lowered into the well.
5. After the pump has been set in position, pump water from the well and through the entire water distribution system to the milkroom until a strong odor of chlorine is noted.
6. Allow the chlorine solution to remain in the well for at least 24 hours.
7. After 24 hours or more have lapsed, flush the well to remove all traces of chlorine.

DRILLED, DRIVEN, AND BORED WELLS

After the casing or lining has been completed, follow the procedure outlined below:

1. Remove all equipment and materials which will not form a permanent part of the completed structure.
2. When the well is being tested for yield, the test pump should be operated until the well water is clear and as free from turbidity as possible.
3. After the testing equipment has been removed, slowly pour the required amount of chlorine solution into the well just before installing the permanent pumping equipment. Diffusion of the chemical with the well water may be facilitated as previously described.
4. Wash the exterior surface of the pump cylinder and drop pipe with chlorine solution as the assembly is being lowered into the well.
5. After the pump has been set in position, operate the pump until water discharge through the entire distribution system to waste has a distinct odor of chlorine. Repeat this procedure a few times, at 1-hour intervals, to insure complete circulation of the chlorine solution through the column of water in the well and the pumping equipment.
6. Allow the chlorine solution to remain in the well for at least 24 hours.
7. After 24 hours or more have elapsed, flush the well to remove all traces of chlorine. The pump should be operated until water discharged to waste is free from the chlorine odor.

In the case of deep wells having a high water level, it may be necessary to resort to special methods of introducing the disinfecting agent into the well so as to insure proper diffusion of chlorine throughout the well. The following method is suggested.

Place the granulated calcium hypochlorite in a short section of pipe capped at both ends. A number of small holes should be drilled through each cap or into the sides of the pipe. One of the caps should be fitted with an eye to facilitate attachment of a suitable cable. The disinfecting agent is distributed when the pipe section is lowered and raised throughout the depth of the water.

WATER-BEARING STRATA

Sometimes a well is encountered that does not respond to the usual methods of disinfection. A well like this has usually been contaminated by water that entered under sufficient head to displace water into the water-bearing formation. The displaced water carries contamination with it. The contamination that has been carried into the water-bearing formation can be eliminated or reduced by forcing chlorine into the formation. Chlorine may be introduced in a number of ways, depending on the construction of the well. In some wells, it is advisable to chlorinate the water and then add a considerable volume of a chlorine solution in order to force the treated water into the formation. When this procedure is followed, all chlorinated water should have a chlorine strength of approximately 50 mg/l. In other wells, such as the drilled well cased with standard weight casing pipe, it is entirely practicable to chlorinate the water, cap the well and apply a head of air. When air is alternately applied and released, a vigorous surging effect is obtained and chlorinated water is forced into the water bearing formation. In this procedure, the chlorine strength of the treated water, in the well, will be reduced by dilution as it mixes with the water in the water-bearing formation. It is; therefore, advisable to double or triple the quantity of chlorine compound to be used so as to have a chlorine strength of 100 to 150 mg/l in the well as the surging process is started. After treating a well in this manner, it is necessary to flush it to remove the excess chlorine.

DISINFECTION OF SPRINGS

Springs and encasements should be disinfected by a procedure similar to that used for dug well. If the water pressure is not sufficient to raise the water to the top of the encasement, it may be possible to shut off the flow and thus keep the disinfectant in the encasement for 24 hours. If the flow cannot be shut off entirely, arrangements should be made to supply disinfectant continuously for as long a period as practicable.

DISINFECTION OF WATER DISTRIBUTION SYSTEMS

These instructions cover the disinfection of water distribution systems and attendant standpipes or tanks. It is always necessary to disinfect a water system before placing it in use under the following conditions:

1. Disinfection of a system which has been in service with raw or polluted water, preparatory to transferring the service to treated water.
2. Disinfection of a new system upon completion and preparatory to placing in operation with treated water or water of satisfactory quality.
3. Disinfection of a system after completion of maintenance and repair operations.

The entire system, including tank or standpipe, should be thoroughly flushed with water to remove any sediment which may have collected during operation with raw water. Following flushing, the system should be filled with a disinfecting solution of calcium hypochlorite and treated water. This solution is prepared by adding 550 grams (1.2 pounds) of high-test 70 percent calcium hypochlorite to each 3,785 liters (1,000 gallons) of water. A mixture of this kind provides a solution having not less than 100 mg/1 of available chlorine.

The disinfectant should be retained in the system, tank or standpipe, if included, for not less than 24 hours, then examined for residual chlorine and drained out. If no residual chlorine is found present, the process should be repeated. The system is next flushed with treated water and put into operation.

IV. CONTINUOUS WATER DISINFECTION

Water supplies which are otherwise deemed satisfactory, but which prove unable to meet the bacteriological standards prescribed herein, shall be subjected to continuous disinfection. The individual character of the supply shall be investigated and a treatment program developed which shall produce a safe supply as determined by bacteriological testing.

For numerous reasons, including economy, effectiveness, stability, ease of use and availability, chlorine is by far the most popular chemical agent employed for the disinfection of water supplies. This does not preclude the use of other chemicals or procedures demonstrated to be safe and effective. The amount necessary to provide adequate protection varies with the supply and the amount of organic and other oxidizable material which it contains. Proper disinfection can only be assured when a residual concentration of chlorine remains, for bactericidal activity, after the demands of these other substances are met.

In general, these factors exert the most important influences on the bactericidal efficiency of chlorine:

1. Free chlorine residual; the higher the residual, the more effective the disinfection and the faster the disinfection rate.

2. Contact time between the organism and the disinfectant; the longer the time, the more effective the disinfection.

3. Temperature of the water in which contact is made; the lower the temperature, the less effective the disinfection.

4. The pH of the water in which contact is made; the higher the pH, the less effective disinfection.

For example, when a high pH and low temperature combination is encountered in a water, either the concentration of chlorine or the contact time must be increased. Likewise, chlorine residual will need to be increased if sufficient contact time is not available in the distribution system before the water reaches the first user.

SUPERCHLORINATION--DECHLORINATION

Superchlorination: The technique of superchlorination involves the use of an excessive amount of chlorine to destroy quickly the harmful organisms which may be present in the water. If an excessive amount of chlorine is used, a free chlorine residual will be present. When the quantity of chlorine is increased, disinfection is faster and the amount of contact time required to insure safe water is decreased.

Dechlorination: The dechlorination process may be described as the partial or complete reduction of any chlorine present in the water. When dechlorination is provided in conjunction with proper superchlorination, the water will be both properly disinfected and acceptable to the consumer for domestic or culinary uses.

Dechlorination can be accomplished in individual water systems by the use of activated carbon (dechlorinating) filters. Chemical dechlorination by reducing agents such as sulphur dioxide or sodium thiosulfate can be used for batch dechlorination. Sodium thiosulfate is also used to dechlorinate water samples prior to submission for bacteriological examination.

DISINFECTION EQUIPMENT

Hypochlorinators are the most commonly employed equipment for the chemical elimination of bacteriological contamination. They operate by pumping or injecting a chlorine solution into the water. When properly maintained, hypochlorinators provide a reliable method for applying chlorine to disinfect water.

Types of hypochlorinators include positive displacement feeders, aspirator feeders, suction feeders and tablet hypochlorinators.

This equipment can be readily adapted to meet the needs of other systems of treatment, which require the regulated discharge of a solution into the supply.

Positive Displacement Feeders: A common type of positive displacement hypochlorinator is one which uses a piston or diaphragm pump to inject the solution. This type of equipment, which is adjustable during operation, can be designed to give reliable and accurate feed rates. When electricity is available, the stopping and starting of the hypochlorinator can be synchronized with the pumping unit. A hypochlorinator of this kind can be used with any water system. However, it is especially desirable in systems where water pressure is low and fluctuating.

Aspirator Feeders: The aspirator feeder operates on a simple hydraulic principle that employs the use of the vacuum created when water flows either through a venturi tube or perpendicular to a nozzle. The vacuum created, draws the chlorine solution from a container into the chlorinator unit where it is mixed with water passing through the unit and the solution is then injected into the water system. In most cases, the water inlet line to the chlorinator is connected to receive water from the discharge side of the water pump, with the chlorine solution being injected back into the suction side of the same pump. The chlorinator operates only when the pump is operating. Solution flow rate is regulated by means of a control valve; pressure variations are known to cause changes in the feed rate.

Suction Feeders: One type of suction feeder consists of a single line that runs from the chlorine solution container, through the chlorinator unit and connects to the suction side of the pump. The chlorine solution is pulled from the container by suction created by the operating water pump.

Another type of suction feeder operates on the siphon principle, with the chlorine solution being introduced directly into the well. This type also consists of a single line, but the line terminates in the well below the water surface instead of the influent side of the water pump. When the pump is operating, the chlorinator is activated so that a valve is opened and the chlorine solution is passed into the well.

Tablet Chlorinator--These hypo-chlorinators inject water into a bed of concentrated calcium hypochlorite tablets. The result is metered into the pump suction line.

V. WATER RECLAIMED FROM THE CONDENSING OF MILK AND MILK PRODUCTS

Condensing water from milk evaporators and water reclaimed from milk and milk products may be reused in a milk processing plant. Acceptable uses of this water fall into three general categories:

1. Reclaimed water which may be used for all potable water purposes including the production of culinary steam.
2. Reclaimed water which may be used for limited purposes including the production of culinary steam.
3. Use of reclaimed water not meeting the requirements of this section.

Reclaimed water to be used for potable water purposes, including the production of culinary steam, shall meet the following requirements:

1. Water shall comply with the bacteriological standards of Appendix G, and, in addition, shall not exceed a total plate count of 500 per milliliter.
2. Samples shall be collected daily for two weeks following initial approval of the installation and semi-annually thereafter. *Provided*, that daily tests shall be conducted for one week following any repairs or alteration to the system.
3. The organic content shall be less than 12 mg/l as measured by the chemical oxygen demand or permanganate-consumed test; or a standard turbidity of less than 5 units.
4. Automatic fail safe monitoring devices shall be used to monitor and automatically divert (to the sewer) any water which exceeds the standard.
5. The water shall be of satisfactory organoleptic quality and shall

have no off-flavors, odors or slime formations.

6. The water shall be sampled and tested organoleptically at weekly intervals.

7. Approved chemicals, such as chlorine, with a suitable detention period, may be used to suppress the development of bacterial growth and prevent the development of tastes and odors.

8. The addition of chemicals shall be by an automatic proportioning device, prior to the water entering the storage tank, to assure satisfactory quality water in the storage tank at all times.

9. When chemicals are added, a daily testing program for such added chemicals shall be in effect and such chemicals shall not add substances that will prove deleterious to the use of the water or contribute to product contamination.

10. The storage vessel shall be properly constructed of such material that it will not contaminate the water and can be satisfactorily cleaned.

11. The distribution system, within a plant, for such reclaimed water shall be a separate system with no cross-connections to a municipal or private water system.

12. All physical, chemical and microbiological tests shall be conducted in accordance with the latest edition of *Standard Methods for the Examination of Water and Wastewater.*

Reclaimed water may be used for limited purposes including:

1. Production of culinary steam.

2. Pre-rinsing of the product surfaces where pre-rinses will not be used in food products.

3. Cleaning solution make-up water. Provided that for these uses items #3-11 of this section are satisfied and:

a. There is no carry-over of water from one day to the next, and any water collected is used promptly; or

The temperature of all water in the storage and distribution system is maintained at 63°C (145°F) or higher by automatic means; or

The water is treated with a suitable, approved chemical to suppress bacterial propagation by means of an automatic proportioning device, prior to the water entering the storage tank; and that,

b. Distribution lines and hose stations are clearly identified as "limited use reclaimed water"; and

c. Water handling practices and guidelines are clearly described and prominently displayed at appropriate locations within the plant; and

d. These water lines are not permanently connected to product vessels, without a break to the atmosphere and sufficient automatic controls, to prevent the inadvertent addition of this water to product streams.

Recovered water not meeting the requirements of this section may be used as boiler feedwater for boilers, not used for generating culinary steam, or in a thick, double walled, enclosed heat exchanger.

VI. WATER RECLAIMED FROM HEAT EXCHANGER PROCESSES

Potable water utilized for heat exchange purposes in plate or other type heat exchangers or compressors on Grade "A" dairy farms may be salvaged for the milking operation if the following criteria are met:

1. The water shall be stored in a storage vessel properly constructed of such material that it will not contaminate the water and be designed to protect the water supply from possible contamination.

2. The storage vessel shall be equipped with a drain and access point to allow for cleaning.

3. No cross-connection shall exist between this supply and any unsafe or questionable water supply or any other source of pollution.

4. There are no submerged inlets through which this supply may be contaminated.

5. The water shall be of satisfactory organoleptic quality and shall have no off flavors or odors.

6. The water shall comply with the bacteriological standards of Appendix G.

7. Samples shall be collected and analyzed prior to initial approval and semi-annually thereafter.

8. Approved chemicals, such as chlorine, with a suitable retention period, may be used to suppress the development of bacterial growth and prevent the development of tastes and odors.

9. When chemicals are added, a monitoring program for such added chemicals shall be in effect and such chemicals shall not add substances that will prove deleterious to the use of the water or contribute to product contamination.

10. If the water is to be used for the sanitizing of teats or equipment (backflush systems), approved sanitizers, such as iodine may be added by an automatic proportioning device located downstream from the storage vessel but prior to its end-use application.

NOTE:--The following figures 8-23 are taken from *The Manual of Individual Water Supply Systems*, Environmental Protection Agency publication number EPA-430-9-73-003.

VII. DRAWINGS OF CONSTRUCTION DETAILS FOR WATER SOURCES

Following are drawings showing the details of several types of water sources:

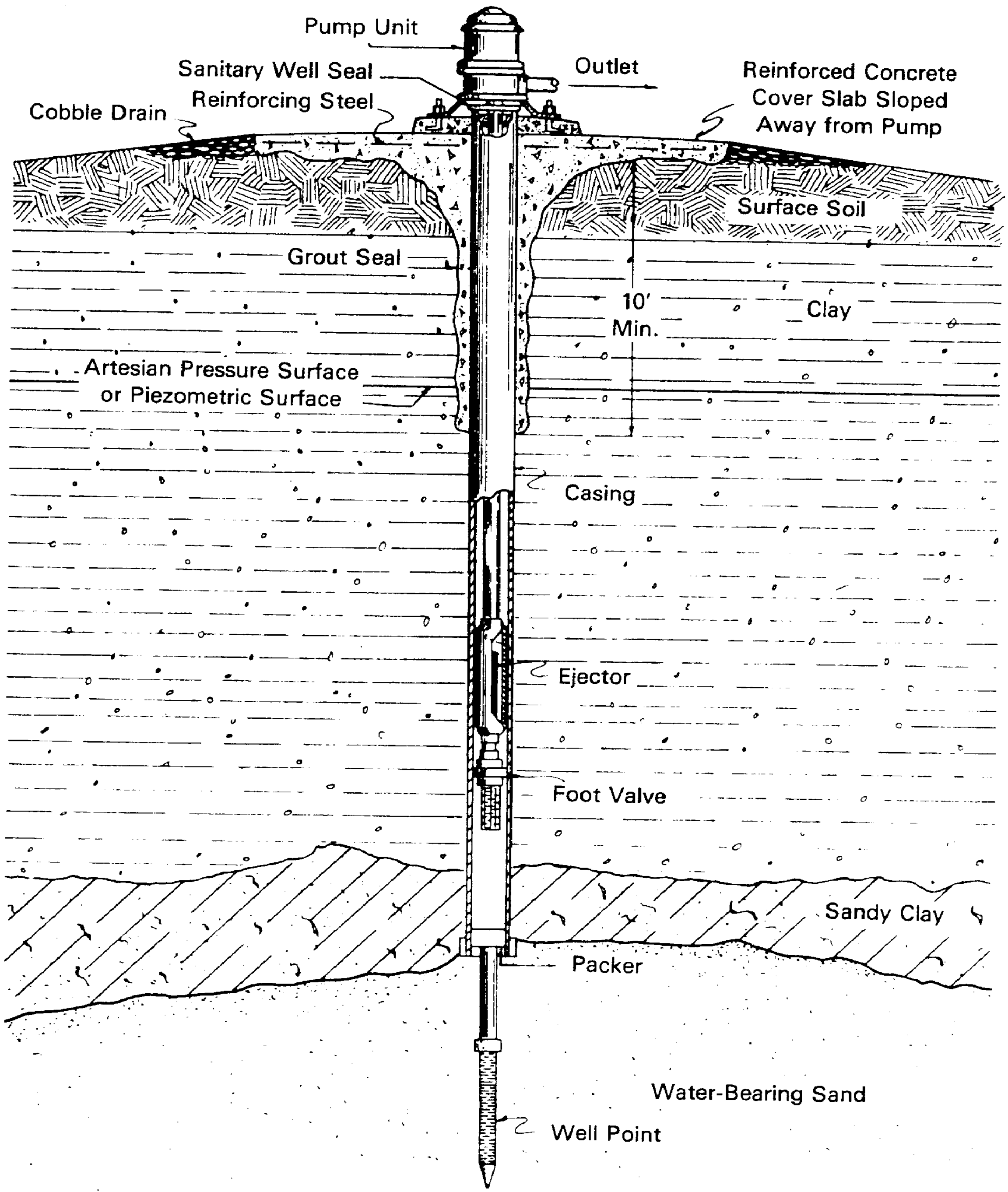

Figure 8. Bored Well with Driven Well Point

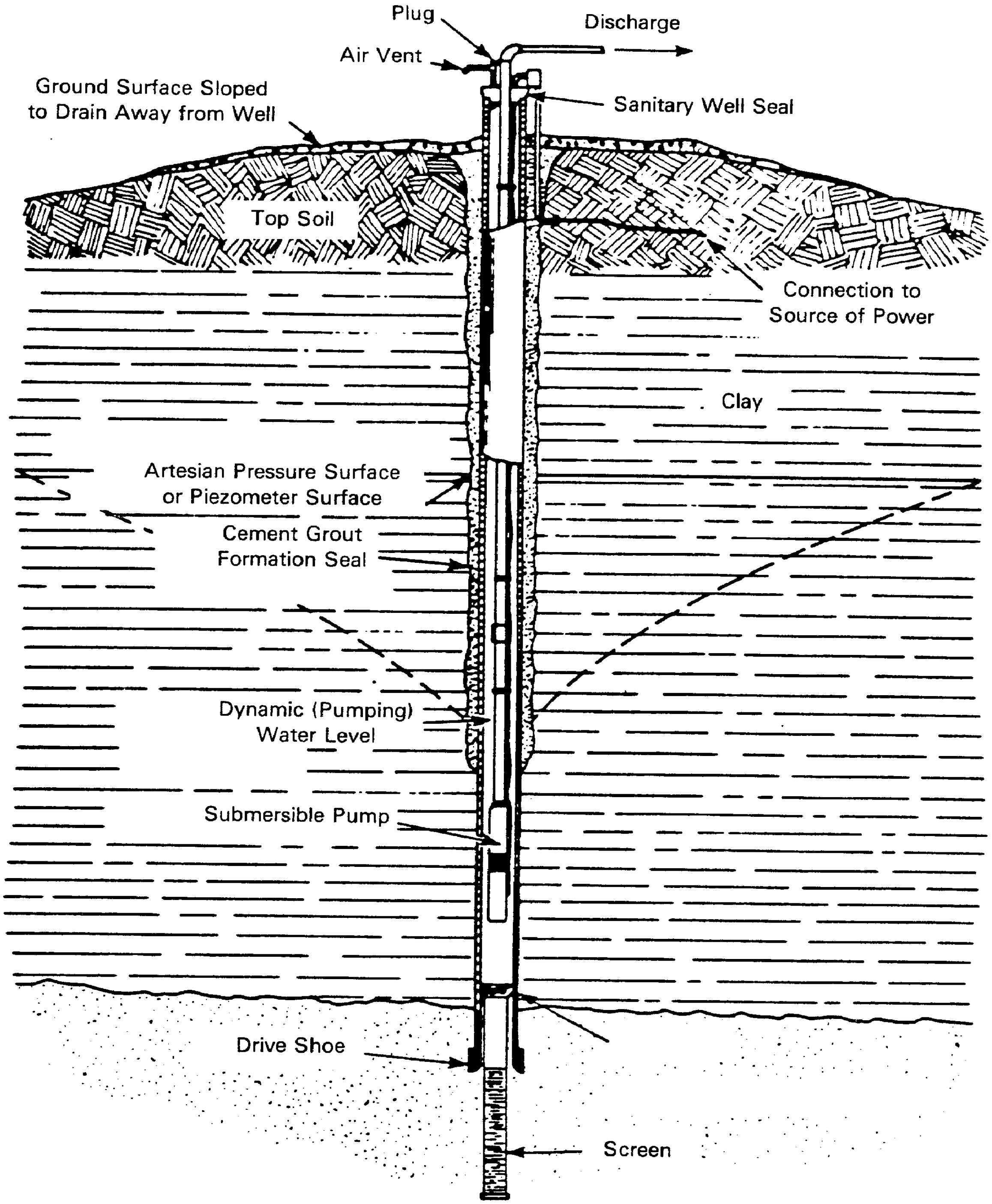

Figure 9. Drilled Well with Submersible Pump

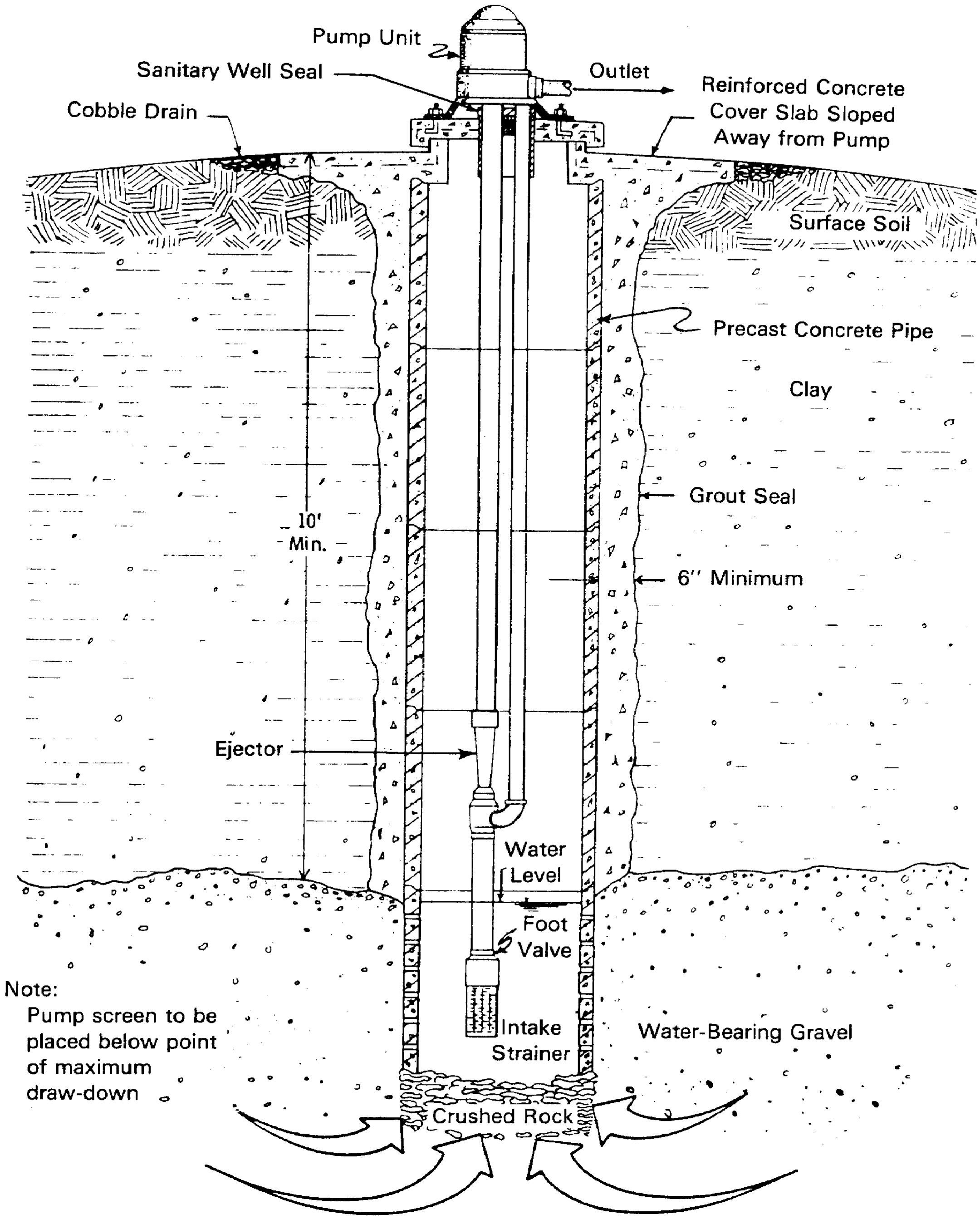

Figure 10. Dug Well with Two-Pipe Jet Pump Installation

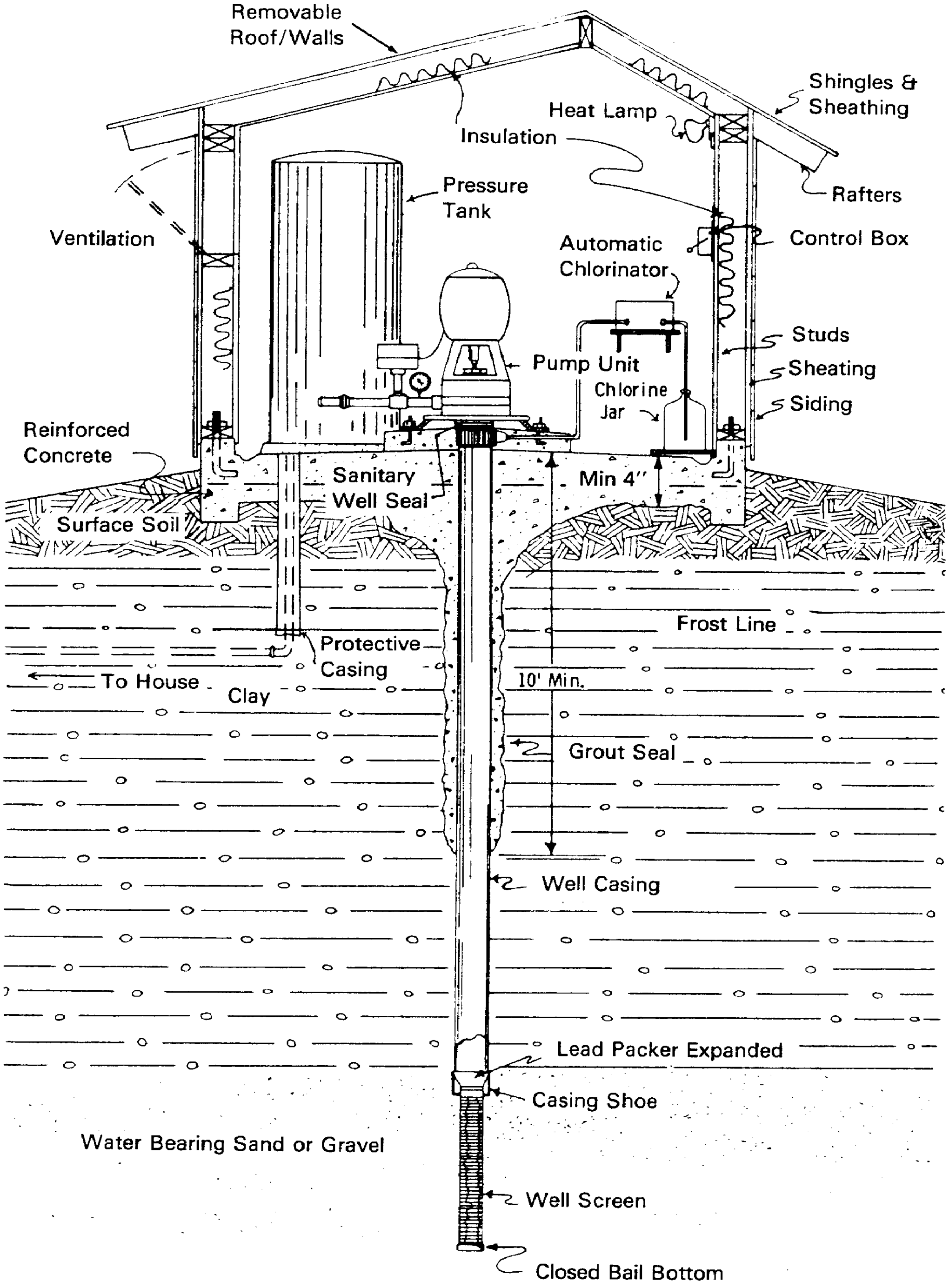

Figure 11. Pumphouse

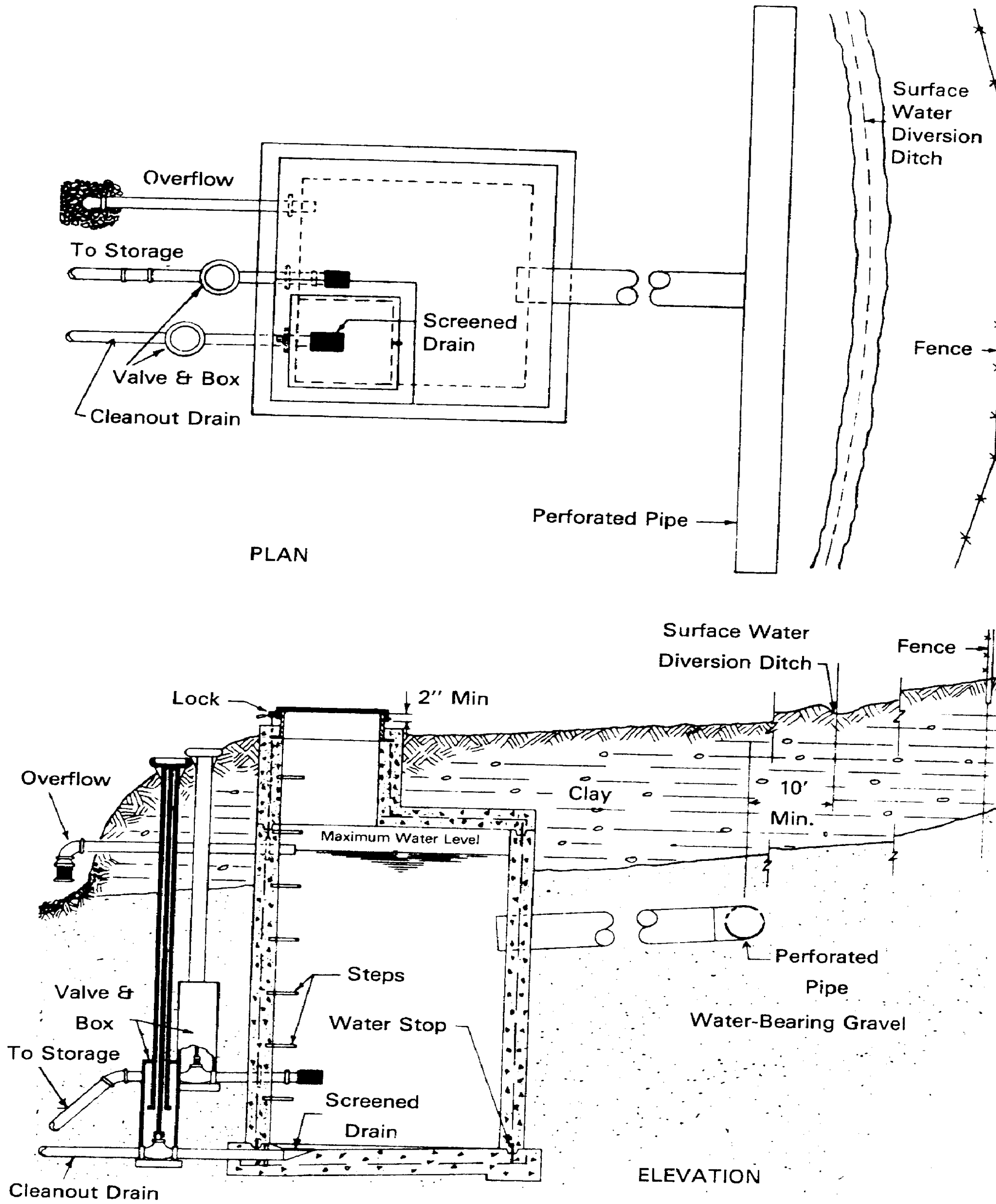

Figure 12. Spring Protection

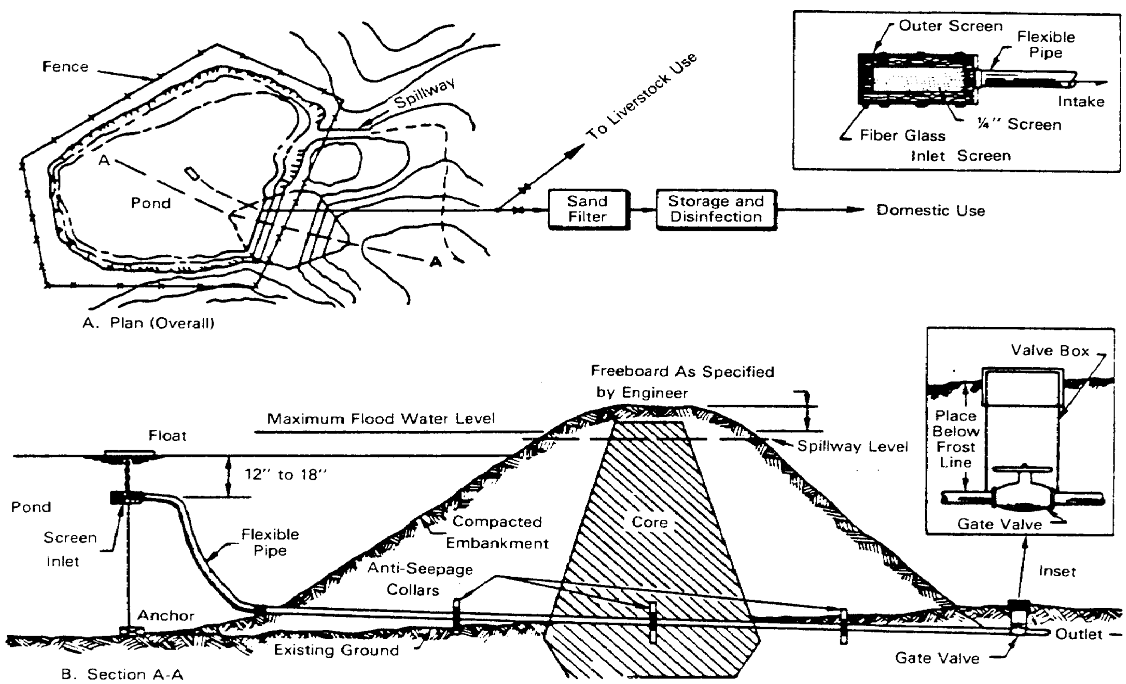

Figure 13. Pond

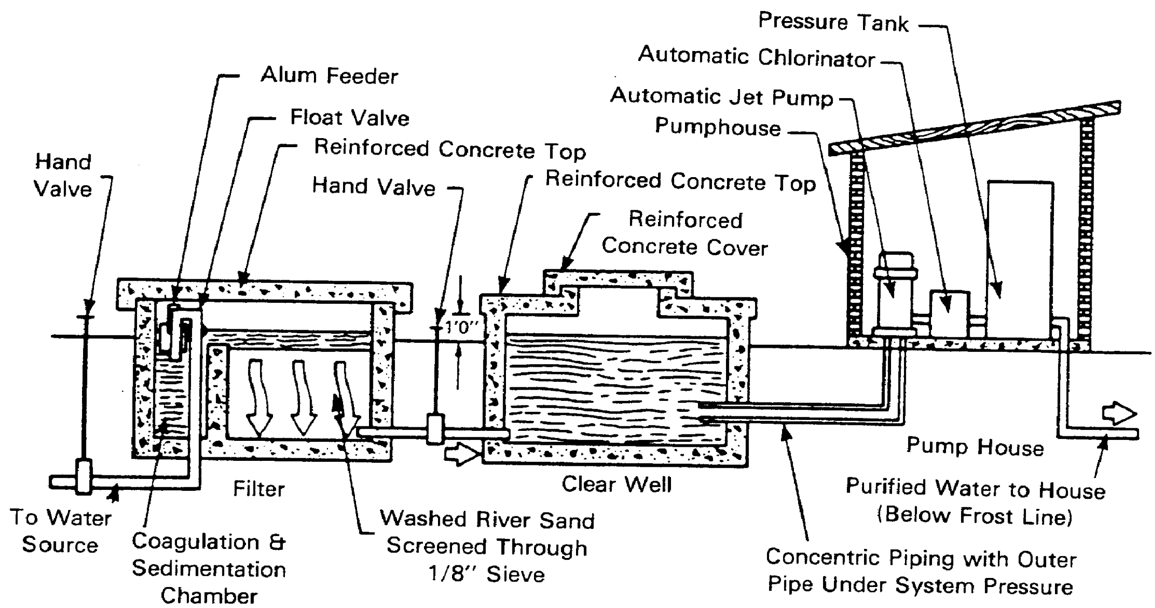

Figure 14. Schematic Diagram of a Pond Water-Treatment System

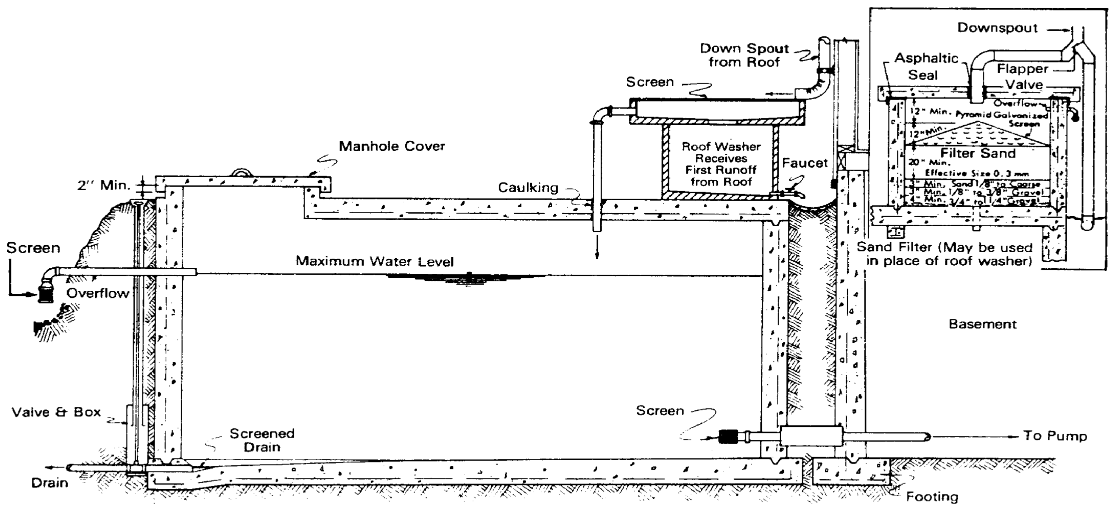

Figure 15. Cistern

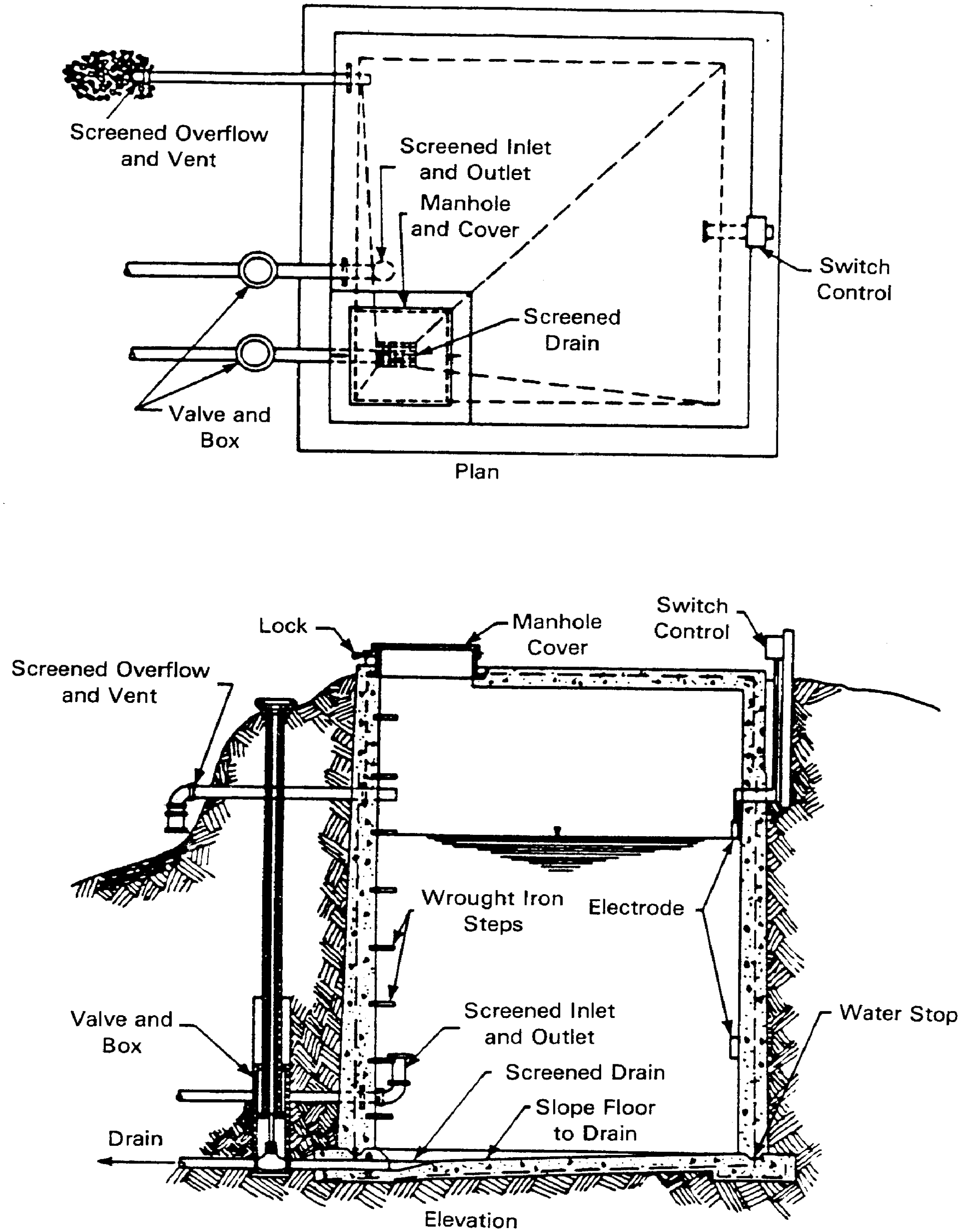

Figure 16. Typical Concrete Reservoir

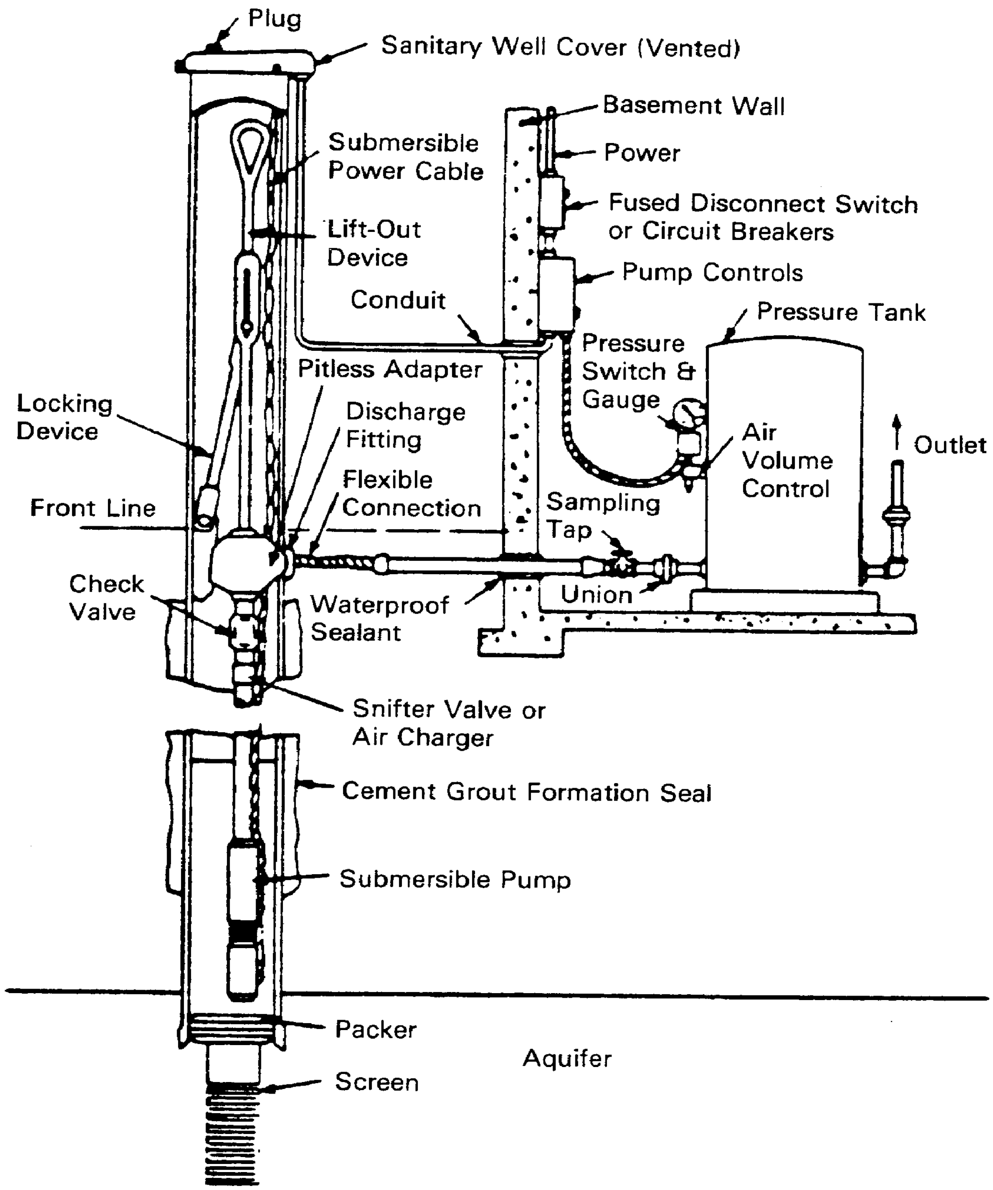

Figure 17. Pitless Adapter with Submersible Pump Installation for Basement Storage

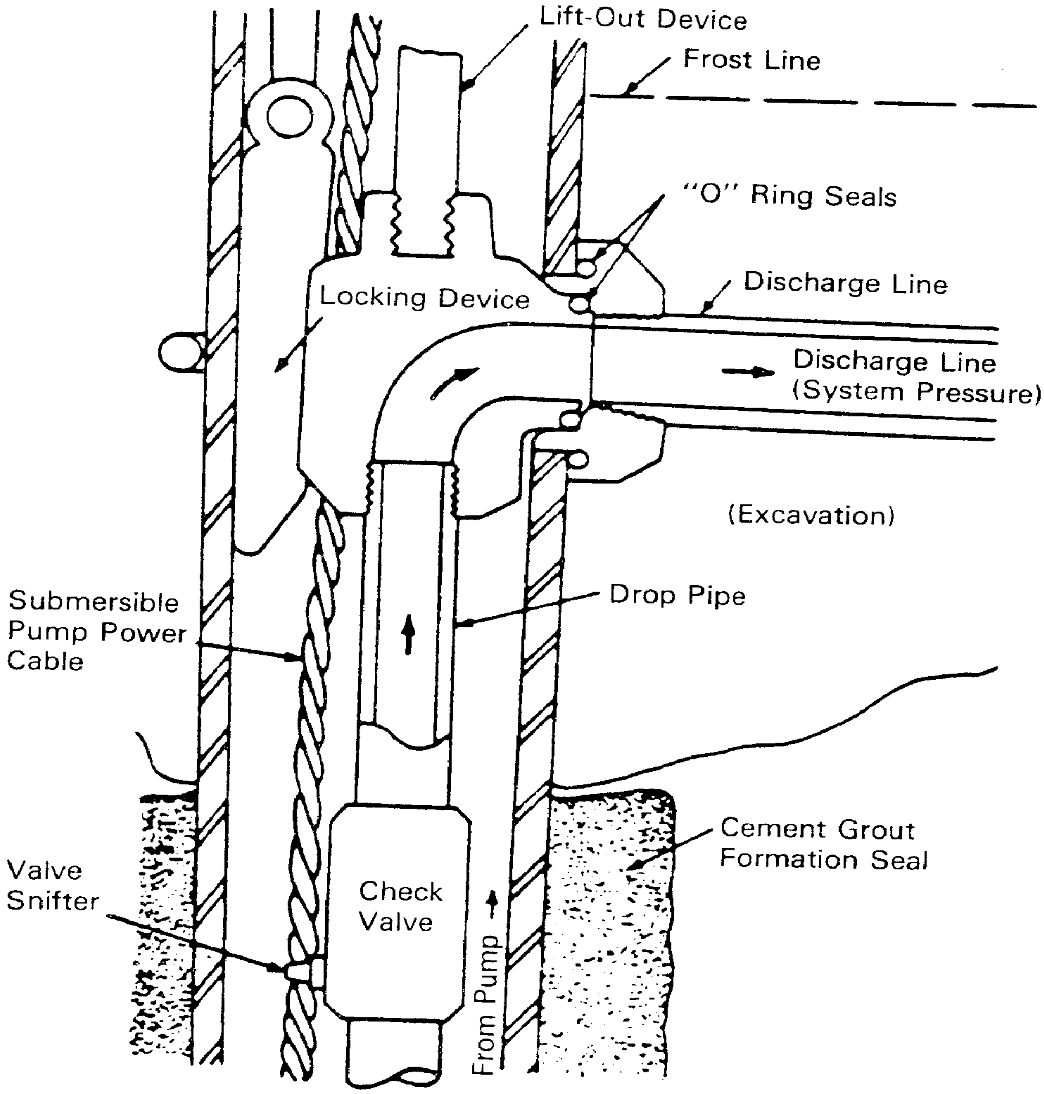

Figure 18. Clamp-on Pitless Adapter with Concentric External Piping for "Shallow Well" Pump Installation

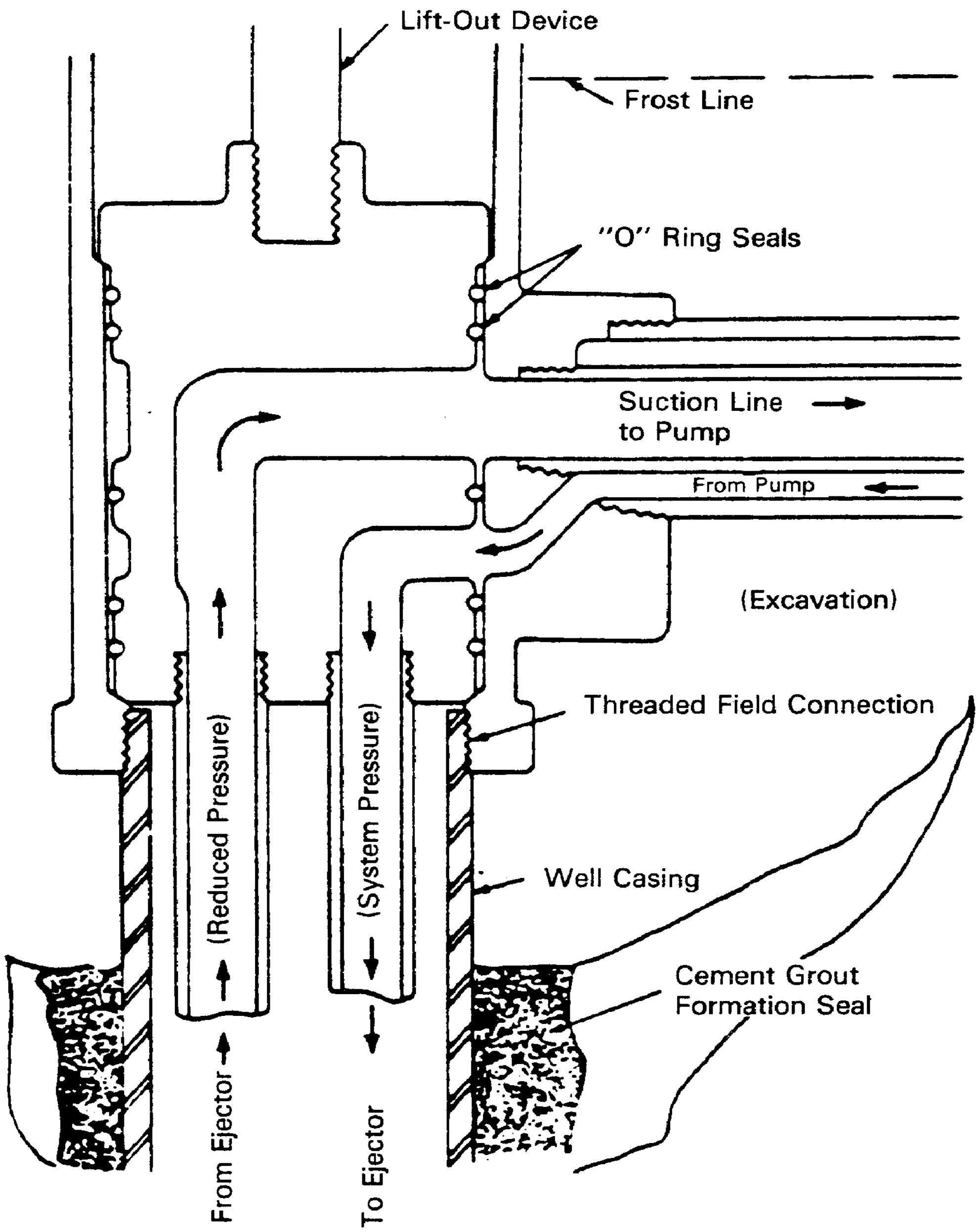

Figure 19. Pitless Unit with Concentric External Piping for Jet Pump Installation

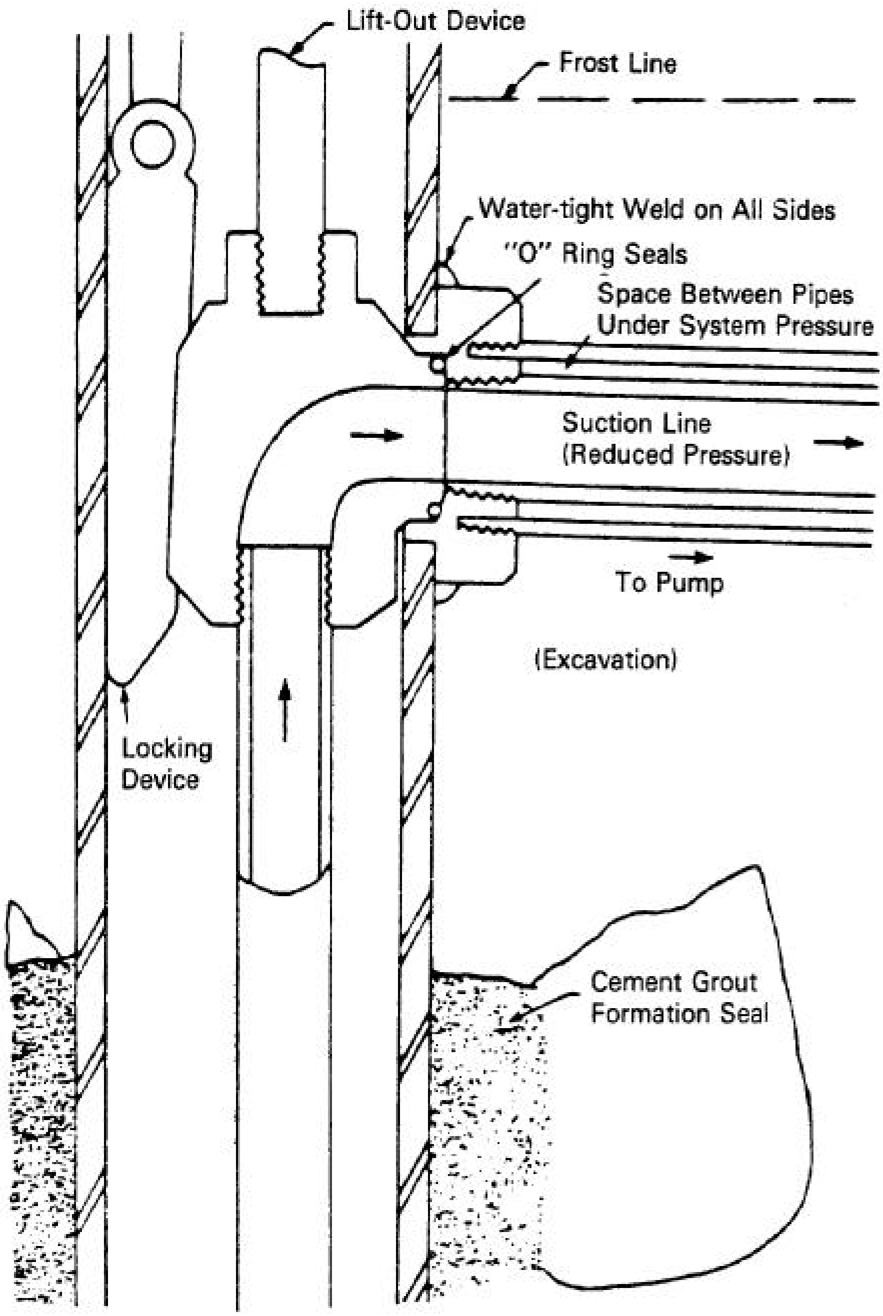

Figure 20. Weld-on Pitless Adapter with Concentric External Piping for "Shallow Well" Pump Installation

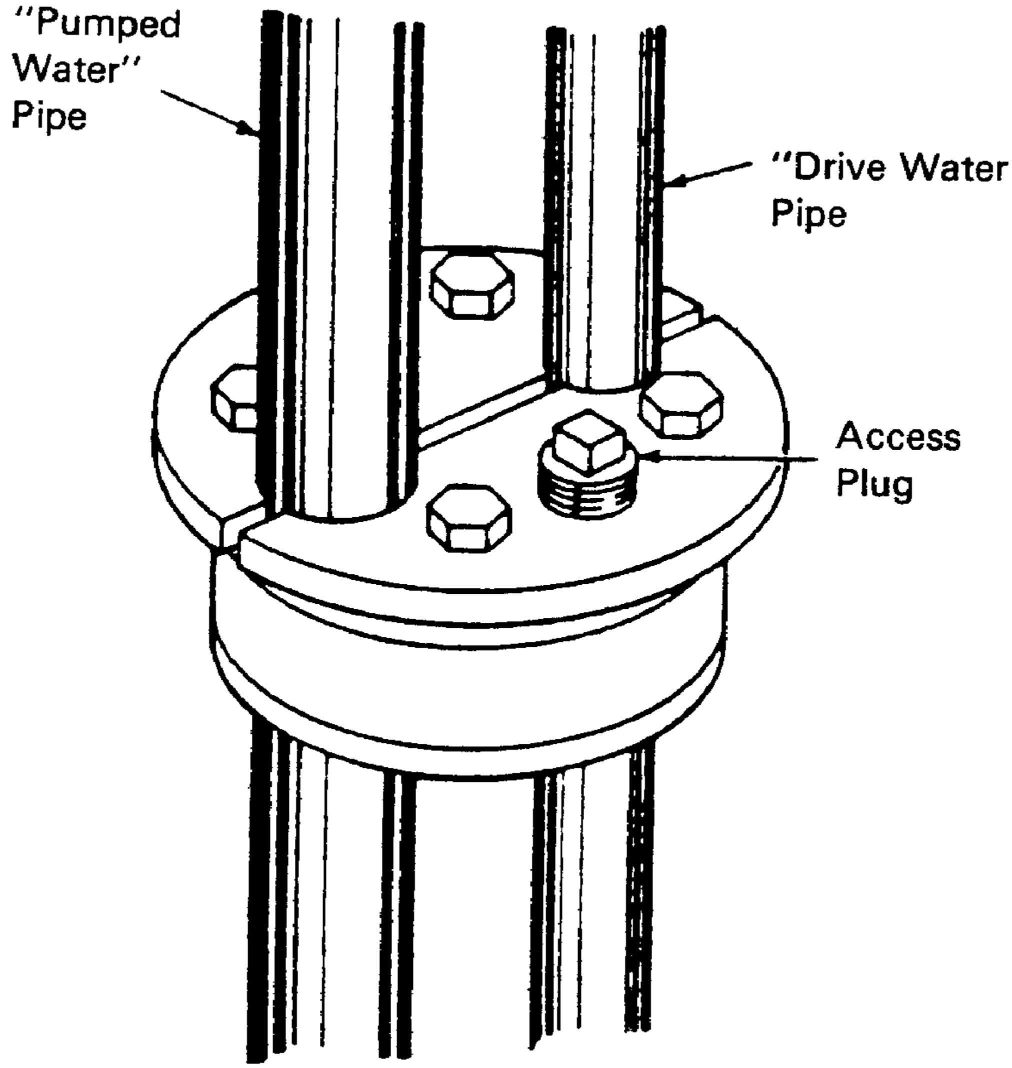

Figure 21. Well Seal for Jet Pump Installation

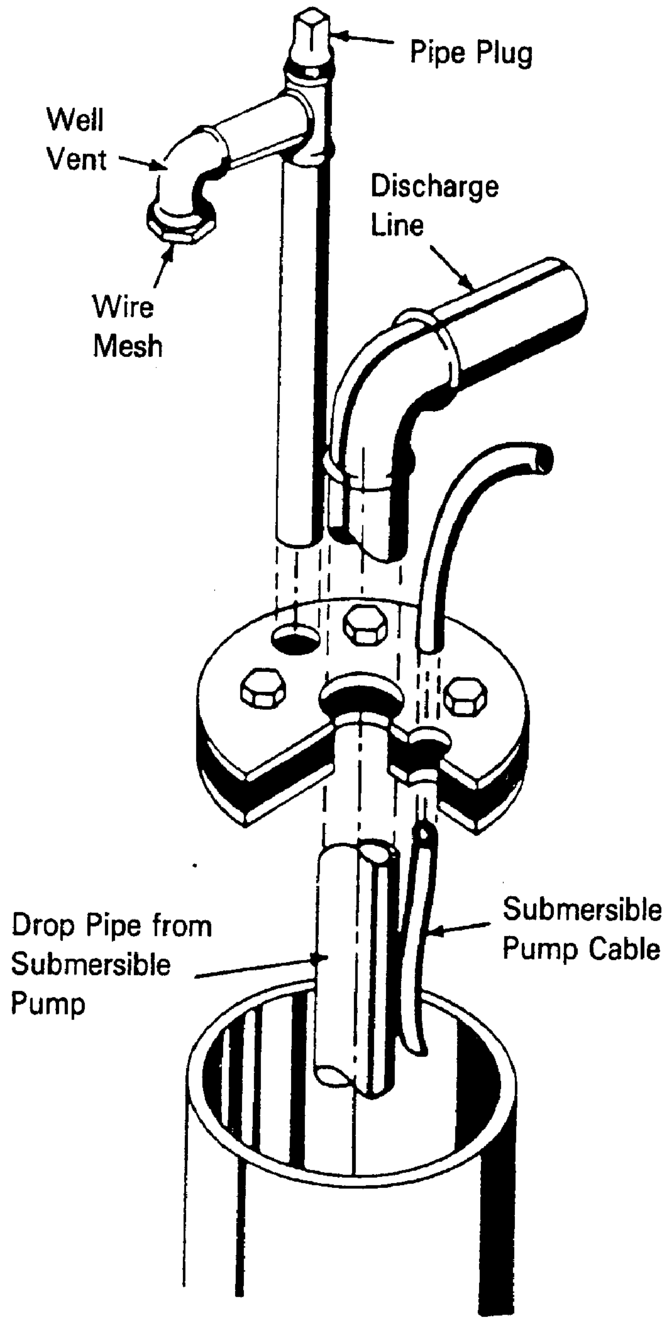

Figure 22. Well Seal for Submersible Pump Installation

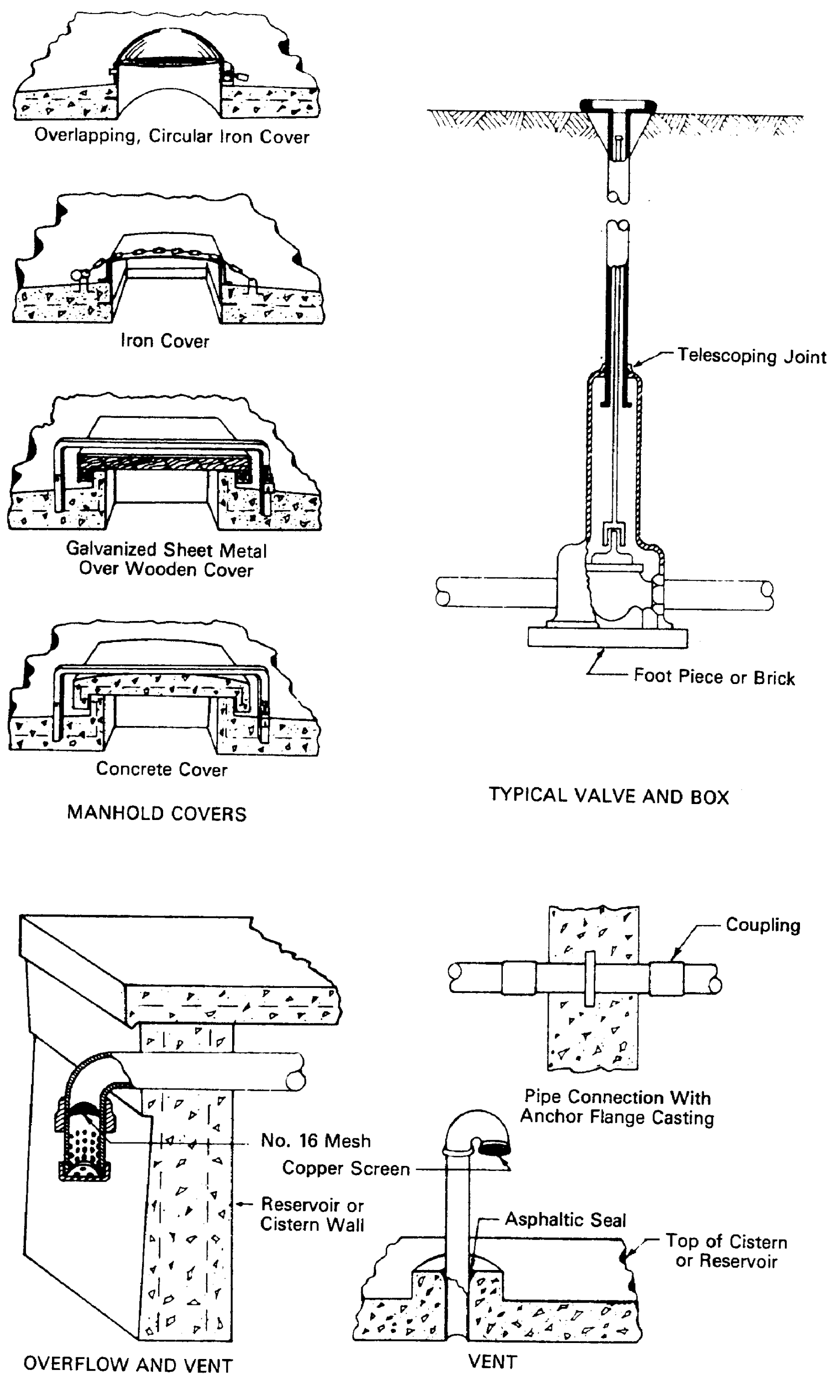

Figure 23. Typical Valve and Box, Manhole Covers, and Piping Installation

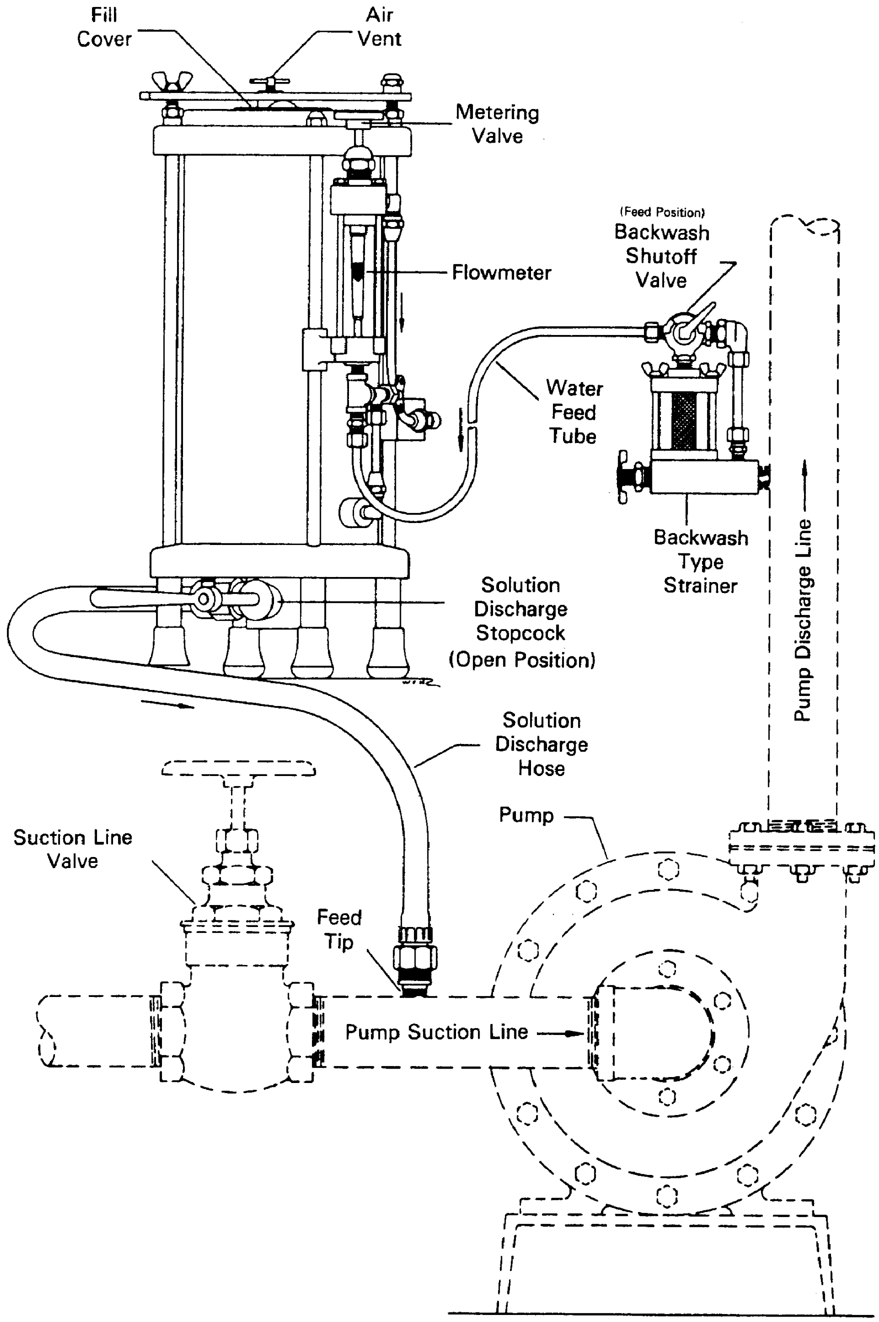

Figure 24. Suction Feeder

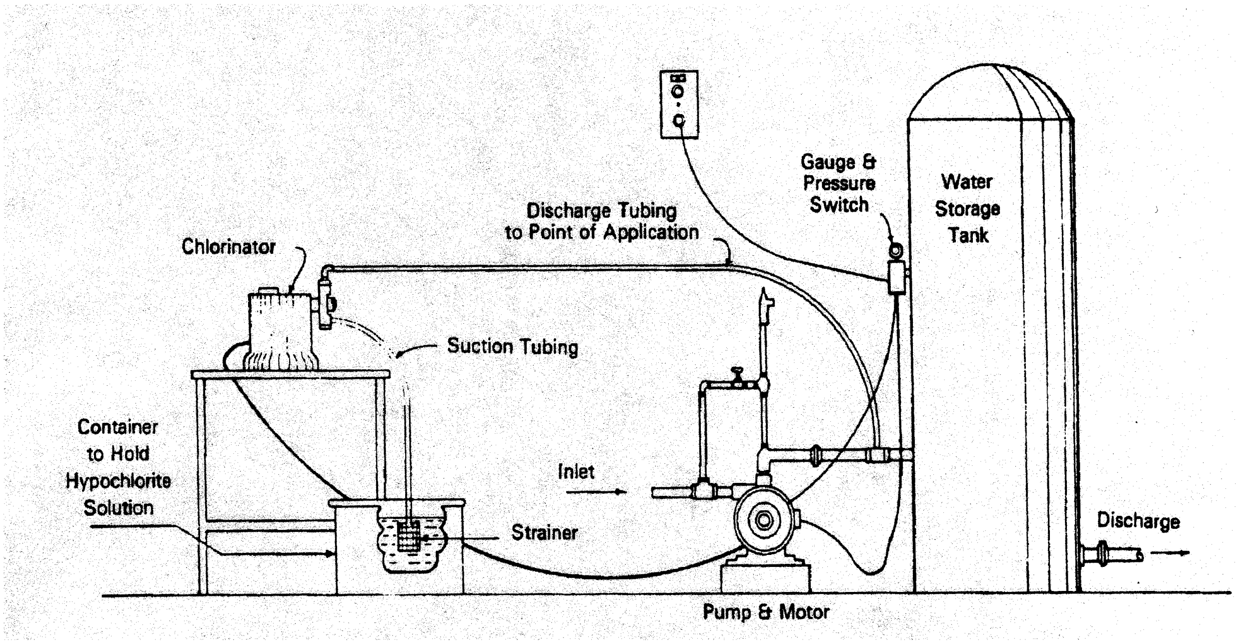

Figure 25. Positive Displacement Chlorinator

APPENDIX E. EXAMPLES OF 3-OUT-OF-5 COMPLIANCE ENFORCEMENT PROCEDURES

The following tables provide several useful examples in the application of the enforcement system described in Section 6. While the illustrations given, relate only to pasteurized milk bacterial counts and somatic cell counts of raw milk, the method is applied, in like fashion, to the enforcement of established standards for cooling temperature, coliform limits, etc. Pasteurized milk which shows a positive phosphatase reaction and milk in which the presence of drug residue, pesticides and other adulterants is found, shall be dealt with as indicated in Sections 6 and 2, respectively.

Table 11. Example of 3-out-of-5 Compliance Enforcement Procedures for Pasteurized Milk

Date	Bacterial count per ml.	Enforcement action as applied to a standard of 20,000/ml.
1/05/99	6,000	No action required
1/28/99	11,000	No action required
2/11/99	12,000	No action required
3/15/99	22,000	No action required
3/25/99	23,000	Written notice to plant, 2 of last 4 counts exceed the standard. (This notice shall be in effect as long as 2 of the last 4 consecutive samples exceed the standard). Additional sample required within 21 days.
4/02/99	9,000	No action required
4/19/99	51,000	Suspend permit or required withdrawal of product in violation, since 3 of last 5 counts exceed required standard.
4/23/99		Issue temporary permit after plant inspection. Begin accelerated sampling schedule.
4/25/99	11,000	Resume sampling; no action required
4/29/99	3,000	No action required
5/4/99	22,000	No action required
5/9/99	5,000	Permit fully reinstated

Table 12. Example of 3-out-of-5 Compliance Enforcement Procedures for Raw Milk Abnormal Milk Tests

Date	Confirmed Somatic Cell Counts per ml.	Enforcement action as applied to a standard of 750,000 per ml.
7/10/01	500,000	No action required
8/15/01	600,000	No action required
10/1/01	800,000	Violative; No action required
11/7/01	900,000	Violative; Written notice to producer, 2 of last 4 counts exceed standard
11/14/01	1,200,000	Violative; Suspend permit. Issue temporary permit after sampling indicates the milk supply is within the limits prescribed in Section 7; Begin accelerated sampling schedule.
11/28/01	700,000	Issue temporary permit
12/7/01	700,000	No action required
12/11/01	550,000	Permit fully reinstated

APPENDIX F. SANITIZATION

METHODS OF SANITIZATION

CHEMICAL

Certain chemical compounds are effective for the sanitization of milk utensils, containers and equipment. These are contained in 21 CFR 178.1010 and shall be used in accordance with label directions.

STEAM

When steam is used, each group of assembled piping shall be treated separately by inserting the steam hose into the inlet and maintaining steam flow from the outlet for at least 5 minutes after the temperature of the drainage at the outlet has reached 94^{o}C (200^{o}F). (The period of exposure required here is longer than that required for individual cans, because of the heat lost through the large surface exposed to the air.) Covers must be in place during treatment.

HOT WATER

Hot water may be used by pumping it through the inlet, if the temperature at the outlet end of the assembly is maintained to at least 77^{o}C (170^{o}F) for at least 5 minutes.

APPENDIX G. CHEMICAL AND BACTERIOLOGICAL TESTS

I. PRIVATE WATER SUPPLIES AND RECIRCULATED WATER--BACTERIOLOGICAL.

Reference: Items 8r, 19r, 7p and 17p.

Application: To private water supplies, used by dairy farms, milk plants, receiving stations, transfer stations and wash stations, and to recirculated cooling water, used in milk plants and dairy farms.

Frequency: Initially, and after repair, modification or disinfection of the private water supplies of dairy farms, milk plants, receiving/transfer stations and wash stations, and thereafter; semiannually for all milk plant, receiving/transfer stations and wash stations water supplies and at least every 3 years on dairy farms. Recirculated cooling water in milk plants and dairy farms shall be tested semiannually.

Criteria: A MPN (Most Probable Number of coliform organisms) of less than 1.1 per 100 ml, when ten replicate tubes containing 10 ml, or when five replicate tubes containing 20 ml, are tested using the multiple tube fermentation technique, or less than 1 per 100 ml by the membrane filter technique, or less than 1.1 per 100 ml when using an mmo-mug technique. (The MMO-MUG technique is not acceptable for recirculated cooling water). 100 ± 2.5 ml water will be used for this analysis. Any sample producing a bacteriological result of TNTC—Too Numerous To Count—(greater than 200 total bacteriological colonies per 100 ml by the membrane filter technique) or confluent growth by the multiple tube fermentation (Most Probable Number – MPN technique, without coliform present, shall have a subsequent heterotrophic plate count of less that 500 colonies per ml in order to be deemed satisfactory. Findings shall be reported as present or less than 1 per 100 ml (absent) for coliform organisms.

Apparatus, Method, and Procedure: Tests performed shall conform with the current edition of *Standard Methods for the Examination of Water and Wastewater* or with FDA approved, EPA promulgated methods for the examination of water and waste water.

Corrective Action: When the laboratory report on the sample is unsatisfactory, the water supply in question shall again be physically inspected and necessary corrections made until subsequent samples are bacteriologically satisfactory.

II. PASTEURIZATION EFFICIENCY-FIELD PHOSPHATASE TEST

Reference: Section 6.

Frequency: When any laboratory phosphatase test is positive, or any doubt arises as to the adequacy of pasteurization due to noncompliance with equipment, or standards of Item 16p.

Criteria: Less than 1 microgram per milliliter by Scharer Rapid Method (or equivalent by other means). See *Standard Methods for the Examination of Dairy Products*.

Apparatus: Field phosphatase test kit (obtainable from Applied Research Institute, 40 Brighton Ave., Perth Amboy, NJ 08861), standards, extra test tubes, stoppers or other approved phosphatase equipment.

Methods: The test is based on the detection of the phosphatase enzyme, a constituent that is inactivated by pasteurization at 63° C (145° F) for 30 minutes or 72° C (161° F) for 15 seconds. When pasteurization is faulty, some phosphatase remains and is detected through its action on phosphoricphenyl esters, releasing phenol, which is measured quantitatively by the addition of dibromo-or dichloroquinonechlorimide to form an indophenol blue color.

Procedure: See *Standard Methods for the Examination of Dairy Products* for details on phosphatase tests.

Corrective Action: Whenever a phosphatase test is positive, the cause shall be determined. Where the cause is improper pasteurization, it shall be corrected and any milk or milk products involved shall not be offered for sale.

III. PHOSPHATASE REACTIVATION IN HTST PASTEURIZED PRODUCTS

The presence of an appreciable quantity of phosphatase in milk and cream after heat treatment has been traditionally regarded as evidence of inadequate pasteurization. However, with the advent of modern high-temperature, short-time (HTST) methods, evidence has been accumulating that under certain conditions, the relationship between inadequate pasteurization and the presence of phosphatase does not hold.

A number of investigators who have studied HTST pasteurizing methods have concluded that while a negative test can be obtained immediately after pasteurization, the same sample may yield a positive test after a short period of storage, particularly if the product is not continuously or adequately refrigerated.

This phenomenon has come to be known as reactivation.

Reactivation may occur in HTST pasteurized products, after storage, at temperatures as low as 10° C (50° F), although 34° C (93° F) is optimum. Products of high fat content generally produce relatively more reactivable phosphatase.

Reactivation is greatest in products pasteurized at about 110° C (230° F) but may occur in products pasteurized at much higher temperatures and as low as 73° C (163° F).

It has been noted that an increase in holding time during pasteurization will reduce reactivation.

The addition of magnesium chloride to HTST processed milk or cream, after pasteurization but before storage, accelerates reactivation. The difference in activity between an adequately pasteurized sample, stored with and without magnesium, and an inadequately pasteurized sample, stored with and without magnesium, forms the basis of a test for differentiating reactivated from residual (inadequately pasteurized) phosphatase.

IV. DETECTION OF PESTICIDES IN MILK

Any regulatory agency which has adopted this *Ordinance* should operate under a control program which will insure that milk supplies are free from pesticide contamination, in conformance with Section 2.

Pesticide compounds gain access to milk by various routes. Insecticide contamination may result from any of the following:

1. Application to the lactating animals;

2. Inhalation of toxic vapors, by the animals, following application of insecticides to their environment;

3. Ingestion of residues in feed and water; and

4. Accidental contamination of milk, feed and utensils. Herbicide contamination may result from residues on the lactating animals feed and in their water supply and/or rodenticides may be present in milk as a result of accidental contamination.

At the present time, chlorinated hydrocarbon pesticides are the chief concern. While there are other pest control compounds which are more toxic than the chlorinated hydrocarbons, many of the agents in this latter group tend to accumulate in the body fat of both lactating animals and human beings, and are secreted in the milk of contaminated lactating animals. The accumulation of these toxic agents in persons continually consuming contaminated milk may reach hazardous concentrations.

Recent advances in residue analysis have resulted in a radical decrease in the use of paper chromatographic screening procedures for milk, because of its rather limited sensitivity. Regulatory agencies can now routinely detect residues as low as 0.01 ppm of many of the chlorinated organic pesticides. Satisfactory screening procedures should, therefore, attain this level of sensitivity which usually necessitates the use of gas chromatography or thin layer chromatography.

General screening procedures of the latter two types are described and discussed in Volume 1 of the *Pesticide Analytical Manual* published by the Food and Drug Administration.

The need for closer scrutiny of milk supplies for pesticide residues has stimulated considerable research in detection technology. The regulatory agency entering upon a surveillance program should carefully check the available equipment in relation to its adaptability to the indicated need.

While a schedule of testing comparable to that for microorganisms (four tests of individual producers milk during any consecutive 6 months) would be desirable, broad spectrum procedures are too time consuming to render such a schedule feasible. As a more practical approach, the following procedure is suggested:

1. Test one load of milk from each tank truck route, every 6 months, by a broad spectrum method and trace positive samples; or

2. Test each producer's milk four times every 6 months for the most common chlorinated hydrocarbon pesticides, by available instrumental methodology.

NOTE: The above testing disciplines may be applied conveniently to can milk supplies. Where plan 1. is used, samples of commingled milk from known sources are drawn from receiving station storage tanks. Sampling for plan 2. may be done directly from the weigh tank.

V. DETECTION OF DRUG RESIDUES IN MILK

The problem of drug residues in milk is associated with their use in the treatment of mastitis and other diseases. Failure to withhold milk from the market for a sufficient length of time after treatment may result in the presence of drug residues in milk. Such milk is undesirable for two reasons; first, it comes from an unhealthy lactating animal, and second, it is adulterated.

The allergenic properties of certain drugs in common use make their presence in milk potentially hazardous to consumers. Also, substantial losses of byproducts may be sustained by the milk industry each year because of the inhibitory effects of drug residues on the culturing process. Drug residues should be tested for using tests provided in Section 6. These tests are specified in informational memoranda from the FDA. (See M-a-85, M-a-86, and the 2400 form for each specific test method.)

Note: *Bacillus stearothermopilus* disk assay analysis performed to fulfill the provisions of Section 7 of the PMO must be capable of detecting at least 4 of 6 beta lactam drugs at or below FDA reference levels. A zone equal to or greater than 16mm will be considered positive when the *Bacillus stearothermophilus* disk assay is used. See the most recent FDA 2400 procedure form(s) for details related to this analysis.

VI. ANALYSIS OF MILK AND MILK PRODUCTS FOR VITAMIN A AND D_3 CONTENT

Reference.—Section 6.

Frequency.—Annually for each product type, or when any doubt arises as to the adequacy of vitamin fortification (see Appendix O).

Methods.—Vitamin testing shall be performed using test methods acceptable to the FDA and other official methodologies which give statistically equivalent results to the FDA methods.

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Campbell, J.E. and McFarren, E.F., *Collaborative Test for Reactivated and Residual Phosphatase in Dairy Products*. Journal of the Association of Official Agricultural Chemists, 44:3 August 1961.

Schafer, M.L., Bush, K.A. and Campbell, J.E., *Rapid Screening Method for DDT in Milk With Gas Chromatography*, Journal of Dairy Science, 43:1025(1963).

Official Methods of Analysis of the Association of Official Analytical Chemists, 12th ed., 1975.

Pesticide Analytical Manual of the Food and Drug Administration, available from the Association of Official Analytical Chemists, Box 540, Benjamin Franklin Station, Washington, DC 20044.