**Dry Creek Rancheria**
**Band of Pomo Indians**

Environmental Code

# TITLE 6. WATER WELL STANDARDS ORDINANCE

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## CHAPTER 1. INTRODUCTION

Improperly constructed, altered, maintained, or destroyed wells are a potential pathway for introducing poor quality water, pollutants, and contaminants to good-quality groundwater. The potential for groundwater quality degradation increases as the number of wells and borings in the area increases.

Improperly constructed, altered, maintained, or destroyed wells can facilitate groundwater quality degradation by allowing:

- Pollutants, contaminants, and water to enter a well bore or casing;
- Poor quality surface and subsurface water, pollutants, and contaminants to move between the casing and borehole wall;
- Poor quality groundwater, pollutants, and contaminants to move from one stratum or aquifer to another; and,
- The well bore to be used for illegal waste disposal.

Permanently inactive or "abandoned" wells that have not been properly destroyed pose a serious threat to water quality. They are frequently forgotten and become dilapidated with time, and thus can become conduits for groundwater quality degradation. In addition, humans and animals can fall into wells left open at the surface.

### SECTION 1. Limitation of Standards

In some cases, it may be necessary for the Dry Creek Rancheria Department of Environmental Protection ("DEP") to substitute alternate measures or standards to provide protection equal to that otherwise afforded by DEP standards. Such cases arise from practicalities in applying standards, and from variations in geologic and hydrologic conditions. Because it is impractical to prepare "site-specific" standards covering every conceivable case, provision has been made for deviation from the standards.

Standards in this Ordinance *do not ensure* proper construction or function of any type of well. Proper well design and construction practices require the use of these standards together with accepted industry practices, regulatory requirements, and consideration of site conditions.

*It is the ultimate responsibility of the well owner and/or the owner's technical and/or contractor representative(s) to ensure that a well does not constitute a significant pathway for the movement of poor-quality water, pollutants, or contaminants; does not constitute a public nuisance or hazard; and, adequately performs a desired function. The Department accepts no responsibility for improper design, construction, alteration, maintenance, function, or destruction of individual wells.*

**SECTION 2. Applicability**

Construction standards presented in this Ordinance apply to all water wells, monitoring wells, and cathodic protection wells constructed after the date of this Ordinance. Alteration, maintenance, and destruction standards presented in this supplement apply to all water wells, monitoring wells, cathodic protection wells, and "borings" regardless of their original date of construction.

## CHAPTER 2. STANDARDS

The standards presented in this Chapter are intended to apply to the construction (including major reconstruction) or destruction of water wells throughout the lands of Dry Creek Rancheria ("DCR"). However, under certain circumstances, adequate protection of groundwater quality may require more stringent standards than those presented here; under other circumstances, it may be necessary to substitute other measures which will provide protection equal to that provided by these standards. Such situations arise from practicalities in applying any standards or, in this case, from anomalies in groundwater geology or hydrology. Since it is impractical to prepare standards for every conceivable situation, provision has been made for deviation from the standards as well as for additional ones

**SECTION 1. Definitions**

(A) "Well or Water Wells" means any artificial excavation constructed by any method for the purpose of extracting water from, or injecting water into, the underground. This definition shall not include: (1) oil and gas wells, or geothermal wells, except those wells converted to use as water wells; or (2) wells used for the purpose of (a) dewatering excavations during construction, or (b) stabilizing hillsides or earth embankments.

(B) "Community Water Supply Well" means a water well used to supply water for domestic purposes in systems subject to the Federal Safe Drinking Water Act. Included are wells supplying public water systems classified by the U.S. Environmental Protection Agency ("USEPA") as "Noncommunity water systems" and "State small water systems" (California Waterworks Standards, Title 22, California Administrative Code). Such wells are variously referred to as "Municipal Wells", "City Wells", or "Public Water Supply Wells".

(C) "Individual Domestic Well" means a water well used to supply water for the domestic needs of an individual residence or systems of four (4) or less residential service connections (or "hook-ups" as they are often called).

(D) "Industrial Wells" means water wells used to supply industry on an individual basis (in contrast to supplies provided through community systems).

(E) "Agricultural Wells" means water wells used to supply water only for irrigation or other agricultural purposes, including so-called "stock wells".

(F) "Recharge or Injection Wells" means wells constructed to introduce water into the ground as a means of replenishing groundwater basins, repelling the intrusion of seawater, or disposing of waste water.

(G) "Horizontal Wells" mean water wells drilled horizontally or at an angle with the horizon (as contrasted with the common vertical well). This definition does not apply to horizontal drains or "wells" constructed to remove subsurface water from hillsides, cuts, or fills (such installations are used to prevent or correct conditions that produce landslides).

(H) "Exploration Hole (or Boring)" means an uncased, temporary excavation whose purpose is the determination of hydrologic conditions at a site.

(I) "Test Wells" means wells constructed to obtain information needed for design of other wells. Test wells should not be confused with "exploration holes", which are temporary. Test wells are cased and can be converted to other uses such as groundwater monitoring and, under certain circumstances, to production wells.

(J) "Inactive or Standby Well" means a well not routinely operating, but capable of being made operable with a minimum effort.

(K) "Enforcing Agency" means an agency designated by duly authorized Tribal or Federal government to administer and enforce laws or ordinances pertaining to the construction, alteration, maintenance, and destruction of water wells. The USEPA or the DEP is the enforcing agency for community water supply wells.

(L) "Registered Geologist" means any person or agency in possession of a valid California registration as a geologist.

**SECTION 2. Application to Type of Well**

Except as prescribed in Sections 3 and 4 (following) these standards shall apply to all types of wells described in Section 1 above. Before a change of use is made of a well, compliance shall be made with the requirements for the new use as specified herein.

**SECTION 3. Exemption Due to Unusual Conditions**

If the enforcing agency finds that compliance with any of the requirements prescribed herein is impractical for a particular location because of unusual conditions or if compliance would result in construction of an unsatisfactory well, the enforcing agency may waive compliance and prescribe alternative requirements which are "equal to" these standards in terms of protection obtained.

**SECTION 4. Exclusions**

Springs are excluded from these standards.

**SECTION 5. Special Standards**

(A) In locations where existing geologic or groundwater conditions require standards more restrictive than those described herein, such special additional standards may be prescribed by the enforcing agency.

(B) Special standards are necessary for the construction of recharge or injection wells, horizontal wells, and other unusual types of wells. Design of these wells shall be conducted by a Registered Geologist and is subject to the approval of the enforcing agency.

**SECTION 6. Well Drillers**

The construction, alteration, or destruction of wells shall be performed by contractors licensed in accordance with the provisions of the Contractors License Law (Chapter 9, Division 3, of the Business and Professions Code) unless exempted by that act.

**SECTION 7. Reports**

Reports concerning the construction, alteration, or destruction of water wells shall be filed with the DEP.

**SECTION 8. Well Location With Respect to Pollutants and Contaminants, and Structures**

(A) Separation. All water wells shall be located an adequate horizontal distance from known or potential sources of pollution and contamination. Such sources include, but are not limited to:

(1) Sanitary, industrial, and storm sewers;

(2) Septic tanks and leachfields;

(3) Sewage and industrial waste ponds;

(4) Barnyard and stable areas;

(5) Feedlots;

(6) Solid waste disposal sites;

(7) Above and below ground tanks and pipelines for storage and conveyance of petroleum products or other chemicals; and,

(8) Storage and preparation areas for pesticides, fertilizers, and other chemicals.

Consideration should also be given to adequate separation from sites or areas with known or suspected soil or water pollution or contamination.

The following horizontal separation (see chart below) distances are generally considered adequate where a significant layer of unsaturated, unconsolidated sediment less permeable than sand is encountered between ground surface and groundwater. These distances are based on present knowledge and past experience. Local conditions may require greater separation distances to ensure groundwater quality protection.

| Potential Pollution or Contamination Source | Minimum Horizontal Separation Distance Between Well and Known or Potential Source |
|---|---|
| Any sewer (sanitary, industrial, or storm; main or lateral) | 50 feet |
| Watertight septic tank or subsurface sewage leaching field | 100 feet |

| | |
|---|---|
| Cesspool or seepage pit | 150 feet |
| Animal or fowl enclosure | 100 feet |

If the well is a radial collector well, minimum separation distances shall apply to the furthest extended point of the well.

Many variables are involved in determining the "safe" separation distance between a well and a potential source of pollution or contamination. No set separation distance is adequate and reasonable for all conditions. Determination of the safe separation distance for individual wells requires detailed evaluation of existing and future site conditions.

Where, in the opinion of the DEP adverse conditions exist, the above separation distances shall be increased, or special means of protection, particularly in the construction of the well, shall be provided, such as increasing the length of the annular seal.

Lesser distances than those listed above may be acceptable where physical conditions preclude compliance with the specified minimum separation distances and where special means of protection are provided. Lesser separation distances must be approved by the DEP on a case-by-case basis.

(B) Gradients. Where possible a well shall be located up the groundwater gradient from potential sources of pollution or contamination. Locating wells up gradient from pollutant and contaminant sources can provide an extra measure of protection for a well. However, consideration should be given that the gradient near a well can be reversed by pumping, as shown in Figure 3, or by other influences.

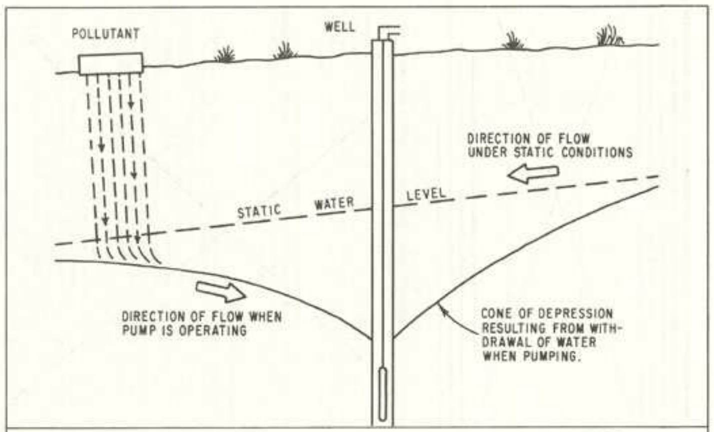


Figure 3. EFFECT OF REVERSAL OF GROUND WATER GRADIENT

(C) Flooding and Drainage. If possible, a well should be located outside areas of flooding. The top of the well casing shall terminate above grade and above known levels of flooding caused by drainage or runoff from surrounding land. This is defined as any area within the flood plain of a 100-year flood.

If compliance with the casing height requirement for community water supply wells and other water wells is not practical, the DEP shall require alternate means of protection.

Surface drainage from areas near the well shall be directed away from the well. If necessary, the area around the well shall be built up so that drainage moves away from the well.

(D) Accessibility. All wells shall be located an adequate distance from buildings and other structures to allow access for well modification, maintenance, repair, and destruction, unless otherwise approved by the DEP.

**SECTION 9. Sealing the Upper Annular Space**

The space between the well casing and the wall of the drilled hole, often referred to as the annular space, shall be effectively sealed to prevent it from being a preferential pathway for movement of poor-quality water, pollutants, or contaminants. In some cases, secondary purposes of an annular seal are to protect casing against corrosion or degradation, ensure the structural integrity of the casing, and stabilize the borehole wall.

(A) Minimum Depth of Annular Surface Seal. The annular surface seal for various types of water wells shall extend from ground surface to the following minimum depths:

| Well Type | Minimum Depth Seal Must Extend Below Ground Surface |
|---|---|
| Community Water Supply | 80 feet |
| Industrial | 50 feet |
| Individual Domestic | 50 feet |
| Agricultural | 20 feet |
| Air-Conditioning | 20 feet |

| | |
|---|---|
| All Other types | 20 feet |

(B)

(1) Shallow groundwater. Exceptions to minimum seal depths can be made for shallow wells at the approval of the DEP, where the water to be produced is at a depth less than 20 feet. In no case shall an annular seal extend to a total depth less than 10 feet below land surface. The annular seal shall be no less than 10 feet in length.

Caution shall be given to locating a well with a 'reduced' annular seal with respect to sources of pollution or contamination. Such precautions include horizontal separation distances greater than those listed in Section 8, above.

(2) Encroachment on known or potential sources of pollution or contamination. When, at the approval of the DEP, a water well is to be located closer to a source of pollution or contamination than allowed by Section 8, above, the annular space shall be sealed from ground surface to the first impervious stratum, if possible. The annular seal for all such wells shall extend to a minimum depth of 50 feet.

(3) Vaults. At the approval of the DEP, the top of an annular surface seal and well casing can be below ground surface where traffic or other conditions require, if the seal and casing extend to a watertight and structurally sound subsurface vault, or equivalent feature. In no case shall the top of the annular surface seal be more than 4 feet below ground

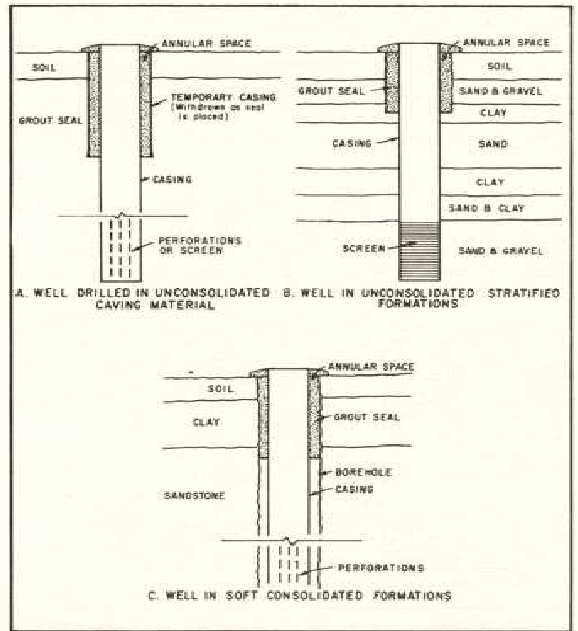


Figure 4. SEALING CONDITIONS FOR UPPER ANNULAR SPACE–UNCONSOLIDATED AND SOFT, CONSOLIDATED FORMATIONS

surface. The vault shall extend from the top of the annular seal to at least ground surface.

The use of subsurface vaults to house the top of water wells below ground surface is rare and is discouraged due to susceptibility to the entrance of surface water, pollutants, and contaminants. Where appropriate, pitless adapters should be used in place of vaults.

(C) Sealing Conditions. The following requirements are to be observed for sealing the annular space:

(1)Wells drilled in unconsolidated, caving material. An 'oversized' hole, at least 4 inches greater in diameter than the outside diameter of the well casing, shall be drilled and a conductor casing temporarily installed to at least the minimum depth of annular seal specified in Subsection (A), above. Permanent conductor casing may be used if it is installed in accordance with (3) and (5) below, and if it extends at least to the depth specified in Subsection (A), above. One purpose of conductor casing is to hold the annular space open during well drilling and during the placement of the well casing and annular seal.

Temporary conductor casing shall be withdrawn as sealing material is placed between the well casing and borehole wall, as shown in Figure 4A, above. Sealing material shall be placed at least within the interval specified in Subsection (A), above. The sealing material shall be kept at a sufficient height above the bottom of the temporary conductor casing as it is withdrawn to prevent caving of the borehole wall.

Temporary conductor casing may be left in place in the borehole after the placement of the annular seal only if it is impossible to remove because of unforeseen conditions and not because of inadequate drilling equipment, or if its removal will seriously jeopardize the integrity of the well and the integrity of subsurface barriers to pollutant or contaminant movement. Temporary conductor casing may be left in place only at the approval of the enforcing agency on a case-by-case basis.

Every effort shall be made to place sealing material between the outside of temporary conductor casing that cannot be removed and the borehole wall to fill any possible gaps or voids between the conductor casing and the borehole wall. At least two (2) inches of sealing material shall be maintained between the conductor casing and well casing. At a minimum, sealing material shall extend through intervals specified in Subsection (A), above.

Sealing material can often be placed between temporary conductor casing that cannot be removed and the borehole wall by means of pressure grouting techniques, as described below. Other means of placing sealing material between the conductor casing and the borehole wall can be used, at the approval of the enforcing agency.

Pressure grouting shall be accomplished by perforating temporary conductor casing that cannot be removed, in place. The perforations are to provide passages for sealing material to pass through the conductor casing to fill any spaces and voids between the casing and borehole wall. Casing perforations shall be a suitable size and density to allow the passage of sealing materials through the casing and the proper distribution of sealing material in spaces between the casing and borehole wall. At a minimum, the perforations shall extend through the intervals specified in Subsection (A), above, unless otherwise approved by the DEP.

Temporary conductor casing that must be left in place shall be perforated immediately before sealing operations begin to prevent drilling or well construction operations from clogging casing perforations. Once the casing has been adequately perforated, sealing material shall be placed inside the conductor casing and subjected to sufficient pressure to cause the sealing material to pass through the conductor casing perforations and completely fill any spaces or voids between the casing and borehole wall, at least within the intervals specified in Subsection (A), above. Sealing material shall consist of neat cement, or bentonite prepared from powdered bentonite and water, unless otherwise approved by the DEP. Sealing material must also fill the annular space between the conductor casing and the well casing within required sealing intervals.

(2) Wells drilled in unconsolidated material with significant clay layers. An 'oversized' hole, at least 4 inches greater in diameter than the outside diameter of the well casing, shall be drilled to at least the depth specified in Subsection (A), above, and the annular space between the borehole wall and the well casing filled with sealing material in accordance with Subsection (A) above, as shown in Figure 4B, above. If a significant layer of clay or clay-rich deposits of low permeability is encountered within 5 feet of the minimum seal depth prescribed in Subsection (A), above, the annular seal shall be extended at least 5 feet into the clay layer. Thus, the depth of seal could be required to be extended as much as another 10 feet. If the clay layer is less than 5 feet in total thickness, the seal shall extend through its entire thickness.

If caving material is present within the interval specified in Subsection (A), a temporary conductor casing shall be installed to hold the borehole open during well drilling and placement of the casing and annular seal, in accordance with the requirements of (C)(1), above. Permanent conductor casing may be used if it is installed in accordance with (3) and (5), below, and it extends to at least the depth specified in Subsection (A), above.

(3) Wells drilled in soft consolidated formations (extensive clays, sandstones, etc.). An 'oversized' hole, at least 4 inches greater than the outside diameter of the well casing, shall be drilled to at least the depth specified in Subsection (A), above. The space between the well casing and the borehole shall be filled with sealing material to at least the depth specified in Subsection (A), above.

If a permanent conductor casing is to be installed to facilitate the construction of the well, an oversized hole, at least 4 inches greater in diameter than the outside surface of the permanent conductor casing, shall be drilled to the bottom of the conductor casing or to at least the depth specified in Subsection (A), above, and the annular space between the conductor casing and the borehole wall filled with sealing material. In some cases, such as in cable tool drilling, it may be necessary to extend permanent conductor casing beyond the depth of the required depth of the annular surface seal in order to maintain the borehole. Sealing material is not required between conductor casing and the borehole wall other than the depths specified in Subsection (A), above, and Section 13, below.

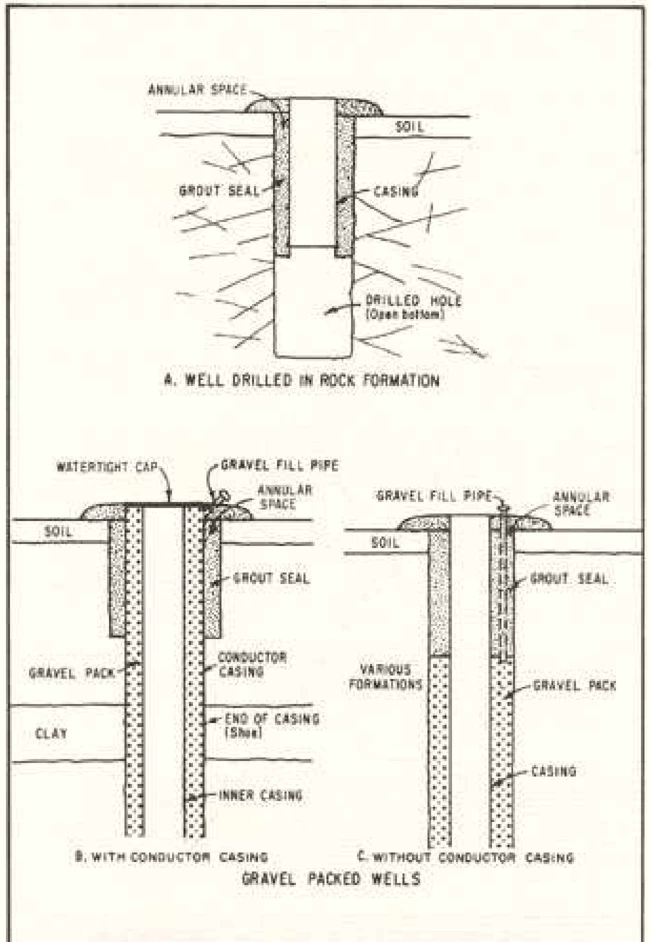

**Figure 5. SEALING CONDITIONS FOR UPPER ANNULAR SPACE- HARD ROCK FORMATIONS AND GRAVEL PACKED WELLS**

(4) <u>Wells situated in "hard" consolidated formations (crystalline or metamorphic rock).</u> An oversized hole shall be drilled to the depth specified in Subsection (A), above, and the annular space filled with sealing material. If there is significant overburden, a conductor casing may be installed to retain it. If the material is heavily fractured, the seal should extend into a solid material. If the well is to be open-bottomed (lower section uncased), the casing shall be seated in the sealing material (see Figure 5A).

(5) <u>Gravel packed wells.</u>

(a) <u>With conductor casing.</u> An oversized hole, at least 4 inches greater than the diameter of the conductor casing, shall be drilled to the depth specified in Subsection (A), above, and the annular space between the conductor casing and drilled hole filled with sealing material. (In this case the gravel pack may extend to the top of the well but to prevent contamination by surface drainage, a welded cover shall be installed over the top in the space between the conductor casing and the production casing, see Figure 5B).

(b) <u>Without conductor casing</u>. An oversized hole at least 4 inches greater in diameter than the production casing, shall be drilled to the depth specified in Subsection (A), above, and the annular space between the casing and drilled hole filled with sealing material. If gravel fill pipes are installed through the seal, the annular seal shall be of sufficient thickness to assure that there is a minimum of two (2) inches between the gravel fill pipe and the wall of the drilled hole. The gravel pack shall terminate at the base of the seal (see Figure 5C). If a temporary conductor casing is used, it shall be removed as the sealing material is placed.

(6) For wells situated in circumstances differing from those described above, the sealing conditions shall be as prescribed by the DEP.

(7) <u>Converted wells.</u> Wells converted from one use to another, particularly those constructed in prior years without annular seals, shall have annular seals installed to the depth required in Subsection (A), above and at the thickness described in Subsection (E). Where it is anticipated that a well will be converted to another use, the DEP may require the installation of a seal to the depth specified for community water supply wells.

(8) <u>Wells that penetrate zones containing poor-quality water, pollutants, or contaminants.</u> If geologic units or fill known or suspected to contain poor-quality water, pollutants, or contaminants are penetrated during drilling, and, the possibility exists that poor-quality water, pollutants, or contaminants could move through the borehole during drilling and well construction operations and significantly degrade groundwater quality in

other units before sealing material can be installed, then precautions shall be taken to seal off or 'isolate' zones containing poor-quality water, pollutants, and contaminants during drilling and well construction operations. Special precautions could include the use of temporary or permanent conductor casing, borehole liners, and specialized drilling equipment. The use of conductor casing is described in (C)(1), above.

(D) Conductor Casing. For community water supply wells, the minimum thickness of steel conductor casing shall be 1/4 inch for single casing or a minimum of No. 10 U. S. Standard Gage for double casing. Steel used for steel casing shall conform to the specifications for steel casing described in Section 12.

(E) Sealing Material. Sealing material shall consist of neat cement, sand cement, concrete, or bentonite. Cuttings from drilling, or drilling mud, shall not be used for any part of the sealing material.

(1) Water. Water used to prepare sealing mixtures should generally be of drinking water quality, shall be compatible with the type of sealing material used, be free of petroleum and petroleum products, and be free of suspended matter. In some cases water considered nonpotable, with a maximum of 2,000 milligrams per liter chloride and 1,500 mg/l sulfate, can be used for cement-based sealing mixtures. The quality of water to be used for sealing mixtures shall be determined where unknown.

(2) Cement. Cement used in sealing mixtures shall meet the requirements of American Society for Testing and Materials C150, Standard Specification for Portland Cement, including the latest revisions thereof. Types of Portland cement available under ASTM C150 for general construction are:

Type I - General purpose. Similar to American Petroleum Institute Class A.

Type II - Moderate resistance to sulfate. Lower heat of hydration than Type I. Similar to API Class B.

Type III - High early strength. Reduced curing time but higher heat of hydration than Type I. Similar to API Class C.

Type IV - Extended setting time. Lower heat of hydration than Types I and III.
Type V - High sulfate resistance.

Special cement setting accelerators and retardants and other additives may be used in some cases. Special field additives for Portland cement mixtures shall meet the requirements of ASTM C494, Standard Specification for Chemical Admixtures for Concrete, and latest revision thereof.

Hydrated lime may be added up to ten percent (10%) of the volume of cement used to make the seal mix more fluid. Bentonite may be added to cement-based mixes, up to six percent (6%) by weight of cement used, to improve fluid characteristics of the sealing mix and reduce the rate of heat generation during setting.

Dry additives should be mixed with dry cement before adding water to the mixture to ensure proper mixing, uniformity of hydration, and an effective and homogeneous seal. The water demand of additives shall be taken into account when water is added to the mix.

Minimum times required for sealing materials containing Portland cement to set and begin curing before construction operations on a well can be resumed are:

(a) Types I and II cement – 24 hours

(b) Type III cement – 12 hours

(c) Type V cement – 6 hours

Type IV cement is seldom used for annular seals because of its extended setting time.

Allowable setting times may be reduced or lengthened by use of accelerators or retardants specifically designed to modify setting time, at the approval of the DEP.

More time shall be required for cement-based seals to cure to allow greater strength when construction or development operations following the placement of the seal may subject casing and sealing materials to significant stress. Subjecting a well to significant stress before a cement-based sealing material has adequately cured can damage the seal and prevent proper bonding of cement-based sealants to casing(s).

If plastic well casing is used, care shall be exercised to control the heat of hydration generated during the setting and curing of cement in an annular seal. Heat can cause plastic casing to weaken and collapse. Heat generation is a special concern if thin-wall plastic well casing is used, if the well casing will be subject to significant net external pressure before the setting of the seal, and/or if the radial thickness of the annular seal is large. Additives that accelerate cement setting also tend to increase the rate of heat generation during setting and, thus, should be used with caution where plastic casing is employed.

The temperature of a setting cement seal can be lowered by circulating water inside the well casing and/or by adding bentonite to the cement mixture, up to six percent (6 %) by weight of cement used.

Cement-based sealing material shall be constituted as follows:

(a) Neat Cement. For Types I or II Portland cement, neat cement shall be mixed at a ratio of one 94-pound sack of Portland cement 5 to 6 gallons of 'clean' water. Additional water may be required where special additives, such as bentonite, or 'accelerators' or 'retardants' are used.

(b) Sand Cement. Sand-cement shall be mixed at a ratio of not more than 188 pounds of sand to one 94-pound sack of Portland cement (2 parts sand to 1 part cement, by weight) and about 7 gallons of clean water, where Type I or Type II Portland cement is used. This is equivalent to a '10.3 sack mix.' Less water shall be used if less sand than 2 parts sand per one part cement by weight is used. Additional water may be required when special additives, such as bentonite, or 'accelerators' or 'retardants' are used.

(c) Concrete. Concrete is often useful for large volume annular seals, such as in large-diameter wells. The proper use of aggregate can decrease the permeability of the annular seal, reduce shrinkage, and reduce the heat of hydration generated by the seal.

Concrete shall consist of Portland cement and aggregate mixed at a ratio of at least six-94 pound sacks of Portland cement per cubic yard of aggregate. A popular concrete mix consists of eight-94 pound sacks of Type I or Type II Portland cement per cubic yard of uniform 3/8-inch aggregate.

In no case shall the size of the aggregate be more than 1/5 the radial thickness of the annular seal. Water shall be added to concrete mixes to attain proper consistency for placement, setting, and curing.

(d) Mixing. Cement-based sealing materials shall be mixed thoroughly to provide uniformity and ensure that no 'lumps' exist.

Ratios of the components of cement-based sealing materials can be varied depending on the type of cement and additives used. Variations must be approved by the enforcing agency.

(3) Bentonite. Bentonite clay in 'gel' form has some of the advantages of cement-based sealing material. A disadvantage is that the clay can sometimes separate from the clay-water mixture.

Although many types of clay mixtures are available, none has sealing properties comparable to bentonite clay. Bentonite expands significantly in volumes when hydrated. Only bentonite clay is an acceptable clay for annular seals.

Unamended bentonite clay seals should not be used where structural strength of the seal is required, or where it will dry. Bentonite seals may have a tendency to dry, shrink, and crack in arid and semi-arid areas of California where subsurface moisture levels can be low. Bentonite clay seals can be adversely affected by subsurface chemical conditions, as can cement-based materials.

Bentonite clay shall not be used as a sealing material if roots from trees and other deep rooted plants might invade and disrupt the seal, and/or damage the well casing. Roots may grow in an interval containing a bentonite seal depending on surrounding soil conditions and vegetation.

Bentonite-based sealing material shall not be used for sealing intervals of fractured rock or sealing intervals of highly unstable, unconsolidated material that could collapse and displace the sealing material, unless otherwise approved by the DEP. Bentonite clay shall not be used as a sealing material where flowing water might erode it.

Bentonite clay products used for sealing material must be specifically prepared for such use. Used drilling mud and/or cuttings from drilling shall not be used in sealing material.

Bentonite used for annular seals shall be commercially prepared, powdered, granulated, pelletized, or chipped/crushed sodium montmorillonite clay. The largest dimension of pellets or chips shall be less than 1/5 the radial thickness of the annular space into which they are placed.

Bentonite clay mixtures shall be thoroughly mixed with clean water prior to placement. A sufficient amount of water shall be added to bentonite to allow proper hydration. Depending on the bentonite sealing mixture used, 1 gallon of water should be added to about every 2 pounds of bentonite. Water added to bentonite for hydration shall be of suitable quality and free of pollutants and contaminants.

Bentonite preparations normally require ½ to 1 hour to adequately hydrate. Actual hydration time is a function of site conditions and the form of bentonite used. Finely divided forms of bentonite generally require less time for hydration, if properly mixed.

Dry bentonite pellets or chips may be placed directly into the annular space below water, where a short section of annular space, up to 10 feet in length, is to be sealed. Care shall be taken to prevent bridging during the placement of bentonite seal material.

(F) Radial Thickness of Seal. A minimum of two inches of sealing material shall be maintained between all casings and the borehole wall, within the interval to be sealed, except where temporary conductor casing cannot be removed, as noted in Subsection B, above. A minimum of two inches of sealing material shall also be maintained between each casing, such as permanent conductor casing, well casing, gravel fill pipes, etc., in a borehole within the interval to be sealed, unless otherwise approved by the enforcing agency. Additional space shall be provided, where needed, for casings to be properly centralized and spaced and allow the use of a tremie pipe during well construction (if required), especially for deeper wells.

(F) Placement of Seal.

(1) Obstructions. All loose cuttings, or other obstructions to sealing shall be removed from the annular space before placement of the annular seal.

(2) Centralizers. Well casing shall be equipped with centering guides or 'centralizers' to ensure the 2-inch minimum radial thickness of the annular seal is at least maintained. Centralizers need not be used in cases where the well casing is centered in the borehole during well construction by use of removable tools, such as hollow-stem augers.

The spacing of centralizers is normally dictated by the casing materials used, the orientation and straightness of the borehole, and the method used to install the casing.

Centralizers shall be metal, plastic, or other non-degradable material. Wood shall not be used as a centralizer material. Centralizers must be positioned to allow the proper placement of sealing material around casing within the interval to be sealed.

Any metallic component of a centralizer used with metallic casing shall consist of the same material as the casing. Metallic centralizer components shall meet the same metallurgical specifications and standards as the metallic casing to reduce the potential for galvanic corrosion of the casing.

(3) Foundation and Transition Seals. A packer or similar retaining device, or a small quantity of sealant that is allowed to set, can be placed at the bottom of the interval to be sealed before final sealing operations begin to form a foundation for the seal.

A transition seal, up to 5 feet in length, consisting of bentonite, is sometimes placed in the annular space to separate filter pack and cement-based sealing materials. The transition seal can prevent cement-based sealing materials from infiltrating the filter pack. A short interval of fine-grained sand, usually less than 2 feet in length, is sometimes placed between the filter pack and the bentonite transition seal to prevent bentonite from entering the filter pack. Also, fine sand is sometimes used in place of bentonite as the transition seal material.

Fine-sized forms of bentonite, such as granules and powder, are usually employed for transition seals if a transition seal is to be placed above the water level in a well boring. Coarse forms of bentonite, such as pellets and chips, are often used where a bentonite transition seal is to be placed below the water level.

Transition seals should be installed by use of a tremie pipe, or equivalent. However, some forms of bentonite may tend to bridge or clog in a tremie pipe.

Bentonite can be placed in dry form or as slurry for use in transition seals. Water should be added to the bentonite transition seal prior to the placement of cement-based sealing materials where bentonite is dry in the borehole. Care should be exercised during the addition of water to the borehole to prevent displacing the bentonite.

Water should be added to bentonite at a ratio of about 1 gallon for every 2 pounds of bentonite to allow for proper hydration. Water added to bentonite for hydration shall be of suitable quality and free of pollutants and contaminants.

Sufficient time should be allowed for bentonite transition seals to properly hydrate before cement-based sealing materials are placed. Normally, ½ to 1 hour is required for proper hydration to occur. Actual time of hydration is a function of site conditions.

The top of the transition seal shall be sounded to ensure that no bridging has occurred during placement.

(4) Timing and Method of Placement. The annular space shall be sealed as soon as practical after completion of drilling or a stage of drilling. In no case shall the annular space be left unsealed longer than 14 days following the installation of casing.

Sealing material shall be placed in one continuous operation from the bottom of the interval to be sealed, to the top of the interval. Where the seal is more than 100 feet in length, the deepest portion of the seal may be installed first and allowed to set or partially set. The deep initial seal shall be no longer than 10 feet in length. The remainder of the seal shall be placed above the initial segment in one continuous operation.

Sealing material shall be placed by methods (such as the use of a tremie pipe or equivalent) that prevent freefall, bridging, or dilution of the sealing material, or separation of sand or aggregate from the sealing material. Annular sealing materials shall not be installed by freefall unless the interval to be sealed is dry and no deeper than 30 feet below ground surface.

(5) Groundwater Flow. Special care shall be used to restrict the flow of groundwater into a well boring while placing material, where subsurface pressure causing the flow of water is significant.

(6) Verification. It shall be verified that the volume of sealing material placed at least equals or exceeds the volume to be sealed.

(7) Pressure. Pressure required for placement of sealing materials shall be maintained long enough for cement-based sealing materials to properly set.

**SECTION 10. Surface Construction Features**

(A) Openings. Openings into the top of the well which are designed to provide access to the well, i.e., for measuring, chlorinating, adding gravel, etc., shall be protected against entrance of surface waters or foreign matter by installation of watertight caps or plugs. Access openings designed to permit the entrance or egress of air or gas (air or casing vents) shall terminate above the ground and above known flood levels and shall be protected against the entrance of foreign material by installation of down-turned and screened "U" bends (see Figures 6 and 7).

All other openings (holes, crevices, cracks, etc.) shall be sealed.

A "sounding tube" taphole with plug, or similar access (see Figure 6) for the introduction of water level measuring devices shall be affixed to the casing of all wells. For wells fitted with a "well cap" the cap shall have a removable plug for this purpose.

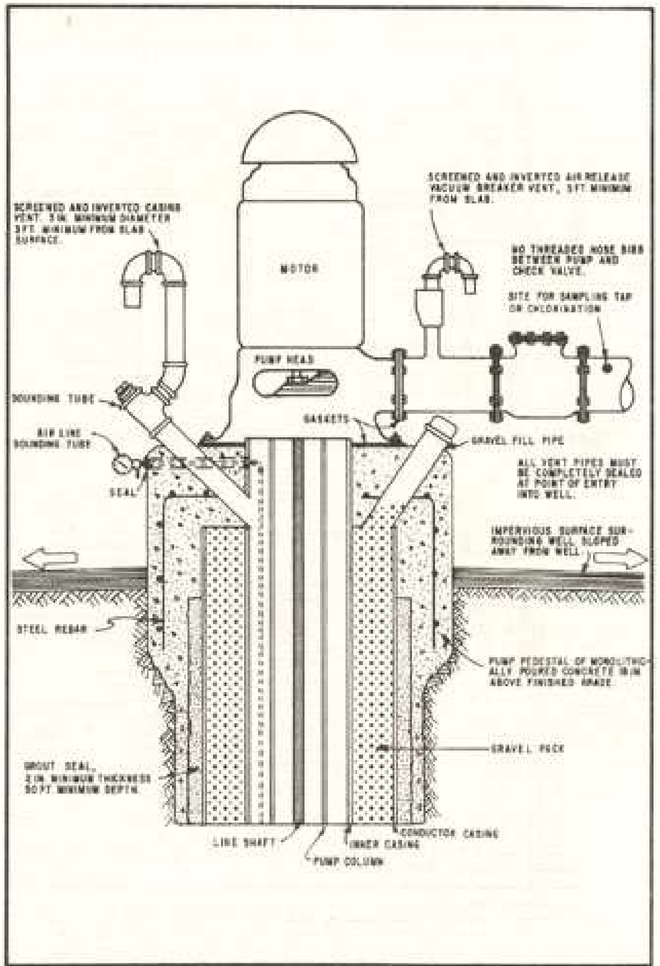


Figure 7. SURFACE CONSTRUCTION FEATURES COMMUNITY WATER SUPPLY WELL

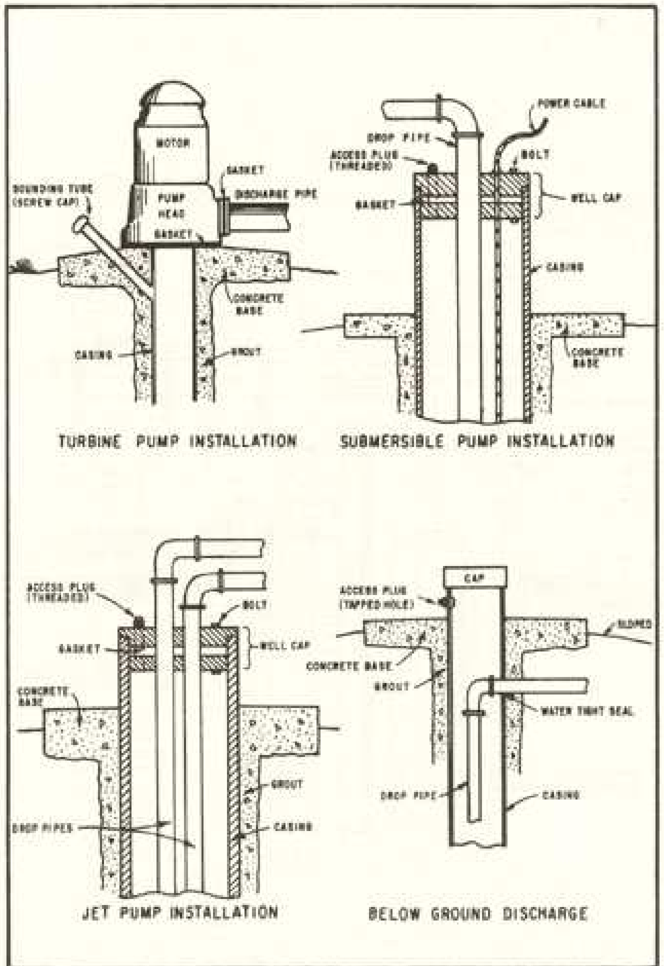


**Figure 6. TYPICAL SURFACE CONSTRUCTION FEATURES**

(1) Where the pump is installed direct over the casing, a watertight seal (gasket) shall be placed between the pump head and the pump base (slab), or a water-tight seal (gasket) shall be placed between the pump base and the rim of the casing, or a "well cap" shall be installed to close the annular opening between the casing and the pump column pipe (see Figure 6 and 7).

(2) Where the pump is offset from the well or where a submersible pump is used, the opening between the well casing and any pipes or cables which enter the well shall be closed by a watertight seal or "well cap".

(3) If the pump is not installed immediately or if there is a prolonged interruption in construction of the well, a watertight cover shall be installed at the top of the casing.

(4) A watertight seal or gasket shall be placed between the pump discharge head and the discharge line; or, in the event of a below-ground discharge, between the discharge pipe and discharge line (see Figures 6 and 7).

(5) Bases. A concrete base or pad, sometimes called a pump block or pump pedestal, shall be constructed at ground surface around the top of the well casing and contact the annular seal, unless the top of the casing is below ground surface, as provided by Subsection (B), below.

The base shall be free of cracks, voids, or other significant defects likely to prevent water tightness. Contacts between the base and the annular seal, and the base and the well casing, must be water tight and must not cause the failure of the annular seal or well casing. Where cement-based annular sealing material is used, the concrete base shall be poured before the annular seal has set, unless otherwise approved by the DEP.

The upper surface of the base shall slope away from the well casing. The base shall extend at least two feet laterally in all directions from the outside of the well boring, unless otherwise approved by the DEP. The base shall be a minimum of 4 inches thick.

A minimum base thickness of 4 inches is normally acceptable for small diameter, single-user domestic wells. The base thickness should be increased for larger wells. Shape and design requirements for well pump bases vary with the size, weight, and type of pumping equipment to be installed, engineering properties of the soil on which the base is to be placed, and local environmental conditions. A large variety of base designs have been used. The Vertical Turbine Pump Association has developed a standard base design for large lineshaft turbine pumps. This design consists of a square, concrete pump base whose design is dependent on bearing weight and site soil characteristics.

Where freezing conditions require the use of a pitless adapter, and the well casing and annular seal do not extend above ground surface or into a pit or vault, a concrete base or pad shall be constructed as a permanent location monument for the covered well. The base shall be 3 feet in length on each side and 4 inches in thickness, unless otherwise approved by the DEP. The base shall have a lift-out section, or equivalent, to allow access to the well. The lift-out shall facilitate inspection and repair of the well.

(6) Where the well is to be gravel packed and the pack extends to the surface, a watertight cover shall be installed between the conductor casing and the inner casing (see also Section (9)(B)(5) and Figure 5).

(B) Well Pits or Vaults. The use of well pits, vaults, or equivalent features to house the top of a well casing below ground surface shall be avoided, if possible, because of their susceptibility to the entrance of poor-quality water, contaminants, and pollutants. Well pits or vaults can only be used if approval is obtained from the DEP. A substitute device, such as a pitless adapter or pitless adapter unit (a variation), should almost always be used in place of a vault or pit.

Pitless adapters and units were developed for use in areas where prolonged freezing occurs, and below ground (frost line) discharges are common. Both the National Sanitation Foundation and Water Systems Council have developed standards for the manufacture and installation of pitless adapters and units. (See Appendix E, Bibliography, Bulletin 74-81.)

If a pit or vault is used it shall be watertight and structurally sound. The vault shall extend from the top of the annular seal to at least ground surface.

The vault shall contact the annular seal in a manner to form a watertight and structurally sound connection. Contacts between the vault and the annular seal, and the vault and the well casing, if any, shall not fail or cause the failure of the well casing or annular seal.

Where cement-based annular seal materials are used, the vault shall be set into or contact the annular seal material before it sets, unless otherwise approved by the DEP. If bentonite-based sealing material is used for the annular seal, the vault should be set into the bentonite before it is fully hydrated.

Cement-based sealing material shall be placed between the outer walls of the vault and the excavation into which it is placed to form a proper, structurally sound foundation for the vault, and to seal the space between the vault and excavation.

The sealing material surrounding a vault shall extend from the top of the annular seal to ground surface unless precluded in areas of freezing. If cement-based sealing material is used for both the annular seal and the space between the excavation and vault, the sealing material shall be emplaced in a 'continuous pour'. In other words, cement-based sealing material shall be placed between the vault and excavation and contact the cement-based annular seal before the annular seal has set.

The vault cover or lid shall be watertight but shall allow the venting of gases. The lid shall be fitted with a security device to prevent unauthorized access. The outside of the lid shall be clearly and permanently labeled 'WATER WELL'. The vault and its lid shall be strong enough to support vehicular traffic where such traffic might occur.

The top of the vault shall be set at, or above, grade so that drainage is away from the vault. The top of the well casing contained within the vault shall be covered in accordance with requirements under Subsection (A), above, so that water, contaminants, and pollutants that may enter the vault will not enter the well casing. The cover shall be provided with a pressure relief or venting device for gases.

(C) Enclosure of Well and Appurtenances. In community water supply wells, the well and pump shall be located in a locked enclosure to exclude access by unauthorized persons.

(D) Pump Blowoff. When there is a blowoff or drain line from the pump discharge, it shall be located above any known flood levels and protected against the possibility of backsiphonage or backpressure. The blowoff or drain line shall not be connected to any sewer or storm drain except when connected through an air gap.

(E) Air Vents. In community water supply wells to minimize the possibility of contamination caused by the creation of a partial vacuum during pumping, a casing vent shall be installed (Figure 7). In addition, to release air trapped in the pump column when the pump is not running, air release vents shall be installed (Figure 7). Air vents are also recommended for other types of wells except those having jet pump installations requiring positive pressure (which cannot have a vent).

(F) Backflow Prevention. All pump discharge pipes not discharging or open to the atmosphere shall be equipped with an automatic device to prevent backflow and/or back siphonage into a well. Specific backflow preventers shall have passed laboratory and field evaluation tests performed by a Federally recognized testing organization. Specific backflow prevention measures are required for drinking water supply wells as prescribed below.

(1) Construction of backflow preventers

(a) Air-gap Separation. An Air-gap separation (AG) shall be at least double the diameter of the supply pipe, measured vertically from the flood rim of the receiving vessel to the supply pipe;

however, in no case shall this separation be less than one inch.

(b) Double Check Valve Assembly. A required double check valve assembly (DC) shall, as a minimum, conform to the AWWA Standard C506-78 (R83) for Double Check Valve Type Backflow Preventive Devices.

(c) Reduced Pressure Principle Backflow Prevention Device. A required reduced pressure principle backflow prevention device (RP) shall, as a minimum, conform to the AWWA Standard C506-78 (R83) for Reduced Pressure Principle Type Backflow Prevention Devices.

(2) Location of Backflow Preventers

(a) Air-gap Separation. An air-gap separation shall be located as close as practical to the user's connection and all piping between the user's connection and the receiving tank shall be entirely visible unless otherwise approved in writing by the water supplier and the health agency.

(b) Double Check Valve Assembly. A double check valve assembly shall be located as close as practical to the user's connection and shall be installed above grade, if possible, and in a manner where it is readily accessible for testing and maintenance.

(c) Reduced Pressure Principle Backflow Prevention Device. A reduced pressure principle backflow prevention device shall be located as close as practical to the user's connection and shall be installed a minimum of twelve inches (12 ") above grade and not more than thirty-six inches (36 ") above grade measured from the bottom of the device and with a minimum of twelve inches (12 ") side clearance.

(3) Type of Backflow Protection Required

*Sewage and Hazardous Substances*

(a) Premises where there are waste water pumping and/or treatment plants and there is no interconnection with the potable water system. This does not include a single-family residence that has a sewage lift pump. An AG is required, but a RP maybe provided in lieu of an AG if approved by the health agency and water supplier.

(b)Premises where hazardous materials are handled in any manner in which the substances may enter the potable water system. This does not include a single-family residence that has a sewage lift pump. An AG is required but a RP may be provided in lieu of an AG if approved by the health agency and water supplier.

(c) Premises where there are irrigation systems into which fertilizers, herbicides, or pesticides are, or can be, injected. RG required.

*Auxiliary Water Supplies*

(a) Premises where there is an unapproved auxiliary water supply, which is interconnected with the public water system. An AP is required. A RP or DC may be provided in lieu of an AG if approved by the health agency and water supplier.

(b) Premises where there is an unapproved auxiliary water supply and there are no interconnections with the public water system. An RP is required a DC may be provided in lieu of a RP I approved by the health agency and the water supplier.

*Recycled water*

(a) Premises where the public water system is used to supplement the recycled water supply, an AG is required.

(b) Premises where recycled water is used, other than as allowed in paragraph (c) below, and there is no interconnection with the potable water system, an RP is required

(c) Residences using recycled water for landscape irrigation as part of an approved dual plumbed use area require the use of a DC. If the water supplier is also the supplier of the recycled water , an alternative backflow protection plan that includes an annual inspection an annual shutdown test of the recycled water and potable water systems.

*Fire Protection Systems*

(a) Premises where the fire system is directly supplied from the public water system and there is and unapproved auxiliary water supply on or to the premises (not interconnected), a DC is required

(b) Premises where the fire system is supplied from the public water system and interconnected with an unapproved auxiliary water supply, an AG is required. A RP may be provided in lieu of an AG if approve by health agency and water supplier.

(c) Premises where the fire system is supplied from the public water system and where either elevated storage tanks or fire pumps which take suction from private reservoirs or tanks are used, a DC is required.

(d) Buildings where the fire system is supplied from the public water system and where recycled water is used in a separate piping system within the same building, a DC is required.

*Dockside watering points and marine facilities*

(a) Pier hydrants for supplying water to vessels for any purpose require an RP.

(b) Premises where there are marine facilities, an RP is required.

*Premises where entry is restricted so that inspections for cross connections cannot be made with sufficient frequency or at sufficiently short notice to insure that they do not exist, and RP is required*

*Premises where there is a repeated history of cross-connections being established or re-established, an RP is required.*

(4) Testing and Maintenance of Backflow Preventors

(a) The water supplier shall assure that adequate maintenance and periodic testing are provided by the water user to ensure their proper operation.

(b) Backflow preventers shall be tested by persons who have demonstrated their competency in testing of these devices to the water supplier or health agency.

(c) Backflow preventers shall be tested at least annually or more frequently if determined to be necessary by the health agency or water supplier. When devices are found to be defective, they shall be repaired or replaced in accordance with the provisions of this Chapter.

(d) Backflow preventers shall be tested immediately after they are installed, relocated or repaired and not placed in service unless they are functioning as required.

(e) The water supplier shall notify the water user when testing of backflow preventers is needed. The notice shall contain the date when the test must be completed.

(f) Reports of testing and maintenance shall be maintained by the water supplier for a minimum of three years.

Irrigation well systems, including those used for landscape irrigation, and other well systems that employ, or which have been modified to employ, chemical feeders or injectors shall be equipped with a backflow prevention device(s) approved by the DEP.

**SECTION 11. Disinfection and Other Sanitary Requirements**

(A) Disinfection. All wells producing water for domestic use (i.e., drinking or food processing) shall be disinfected following construction, repair, or when work is done on the pump, before the well is placed in service.

(B) Gravel. Gravel used in gravel-packed wells shall come from clean sources and should be thoroughly washed before being placed in the well. Gravel purchased from a supplier should be washed at the pit or plant prior to delivery to the well site.

(C) During placement of the gravel in the annular space disinfectants (usually calcium hypochlorite in tablet or granular form) shall be added to the gravel at a uniform rate (two tablets per cubic foot or one pound of the granular form per cubic yard).

(D) Lubricants. Mud and water used as a drilling lubricant shall be free from sewage contamination. Oil and water used for lubrication of the pump and pump bearing shall also be free from contamination.

**SECTION 12. Casing**

(A) Casing Material. Requirements pertaining to well casing are to insure that the casing will perform the functions for which it is designed, i.e., to maintain the hole by preventing its walls from collapsing, to provide a channel for the conveyance of the water, and to provide a measure of protection for the quality of the water pumped.

(1)Well casing shall be strong and tough enough to resist the force imposed on it during installation and those forces which can normally be expected after installation.

(2) Steel is the material most frequently used for well casing, especially in drilled wells. The thickness of steel used for well casing shall be selected in accordance with good design practices applied with due consideration to conditions at the site of the well. There are three principal classifications of steel materials used for water well casing, and all are acceptable for use so long as they meet the following conditions.

(a) Standard and line pipe. This material shall meet one of the following specifications, including the latest revision thereof:

i. API Std. 5L, "Specification for Line Pipe".

ii. API Std. 5LX, "Specification for High-Test Line Pipe".

iii. ASTM A53, "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless".

iv. ASTM A120, "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses".

v. ASTM A134, "Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (sizes NPS 16 and over)".

vi. ASTM A135, "Standard Specification for Electric-Resistance-Welded Steel Pipe".

vii. ASTM A139, "Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (sizes 4 inches and over)".

viii. ASTM A211, "Standard Specification for Spiral-Welded Steel or Iron Pipe".

ix. AWWA C200, "AWWA Standard for Steel Water Pipe 6 Inches and Larger".

(b) Structural Steel. This material shall meet one of the following specifications of the American Society for Testing and Materials, including the latest revision thereof:

i. ASTM A36, "Standard Specification for Structural Steel".

ii. ASTM A242, "Standard Specification for High Strength Low Alloy Structural Steel".

iii. ASTM A283, "Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates of Structural Quality.

iv. ASTM A441, "Tentative Specification for High-Strength Low Alloy Structural Manganese Vanadium Steel".

v. ASTM A570, "Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality".

(c) High strength carbon steel sheets referred by their manufacturers and fabricators as "well casing steel". At present, there are no standard specifications concerning this material. However, the major steel producers market products whose chemical and physical properties are quite similar. Each sheet of material shall contain mill markings which will identify the manufacturer and specify that the material is well casing steel which complies with the chemical and physical properties published by the manufacturer.

(d) Stainless steel casing shall meet the provisions of ASTM A409, "Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service".

(3) Plastic. Two basic types of plastic are commonly used for plastic well casing: thermoplastics and thermosets. Thermoplastics soften with the application of heat and reharden when cooled. Thermoplastics can be reformed repeatedly using heat and sometimes can unexpectedly deform.

Attention should be given to the effect of heat on thermoplastic casing from the setting and curing of cement. Additional discussion on sealing material and heat generation is in Section 9(E), 'Sealing Material'.

Thermoplastics used for well casing include ABS (acrylonitrile butadiene styrene), PVC (polyvinyl chloride), and SR (styrene rubber). PVC is the most frequently used thermoplastic well casing in California. Styrene rubber is seldom used.

Unlike thermoplastics, thermoset plastics cannot be reformed after heating. The molecules of thermoset plastic are 'set' during manufacturing by heat, chemical action, or a combination of both. The thermoset plastic most commonly used for well casing is fiberglass.

(a)Thermoplastics. Thermoplastic well casing shall meet the requirements of ASTM F480. Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80, including the latest revision thereof. (Note: A 'dimension ratio' is the ratio of pipe diameter to pipe wall thickness.)

Pipe made in Schedule 40 and 80 wall thicknesses and pipe designated according to certain pressure classifications are listed in ASTM F480, as well as casing specials referencing the following ASTM specifications:

(i) ABS Pipe. ASTM D1527, Standard Specification for Acrylonitrile- Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80.

(ii) PVC Pipe. ASTM D1785, Standard Specification for (Poly Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

(iii) Pressure-Rated PVC Pipe. ASTM D2241, Standard Specifications for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

Thermoplastic well casing that may be subject to significant impact stress during or after installation shall meet or exceed the requirements for impact resistance classification set forth in Section 6.5 of ASTM F480. Casing that may be subject to significant impact forces includes, but is not limited to; casing that is installed in large diameter, deep boreholes; and casing through which drilling tools pass following installation of the casing in a borehole.

(b) Thermoset Plastics. Thermoset casing material shall meet the following specifications, as applicable, including the latest revisions thereof:

(i) Filament Wound Resin Pipe. ASTM D2996, Standard Specification for Filament Wound Reinforced Thermosetting Resin Pipe.

(ii) Centrifugally Cast Resin Pipe. ASTM D2997, Standard Specification for Centrifugally Cast Reinforced Thermosetting Resin Pipe.

(iii) Reinforced Plastic Mortar Pressure Pipe. ASTM D3517, Standard Specification for Reinforced Plastic Mortar Pressure Pipe.

(iv) Glass Fiber Reinforced Resin Pressure Pipe. AWWA C950, AWWA Standards for Glass-Fiber-Reinforced Thermosetting-Resin Pressure Pipe.

(c) Drinking Water Supply. All plastic casing used for drinking water supply wells, including community supply well and individual domestic wells, shall meet the provisions of National Sanitation Foundation Standard No. 14, Plastic Piping Components and related Materials and any revision thereof. The casing shall be marked or labeled following requirements in NSF Standard No. 14. Standard No. 14 includes the requirements of ASTM F480.

(d) Storage, Handling, and Transportation. Plastic casing shall not be stored in direct sunlight or subjected to freezing temperatures for extended periods of time. Plastic casing shall be stored, handled, and transported in a manner that prevents excessive mechanical stress. Casing shall be protected from sagging and bending, severe impacts and loads, and potentially harmful chemicals.

(e) Large Diameter Wells. Because large diameter plastic casing has not been used extensively at depths exceeding 500 feet, special care shall be exercised with its use in deep wells.

(4) Concrete pipe used for casing should conform to the following specifications, including the latest revision thereof:

(a) ASTM C14, "Standard Specifications for Concrete Sewer, Storm Drain, and Culvert Pipe".

(b) ASTM C76, "Standard Specifications for Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe".

(c) AWWA C300, "AWWA Standard for Reinforced Concrete Pressure Pipe Steel Cylinder Type, for Water and Other Liquids".

(d) AWWA C301, "AWWA Standard for Prestressed Concrete Pressure Pipe Steel, Cylinder Type, for Water and Other Liquids".

(5) Unacceptable Casing Materials. Galvanized sheet metal pipe such as 'downspout' tile pipe, or natural wood shall not be used as well casing.

(6) Other Materials. Materials in addition to those described above may be used as well casing, subject to enforcing agency approval.

(B) Casing Installation. All well casing shall be assembled and installed with sufficient care to prevent damage to casing sections and joints. All casing joints above intervals if perforations or screen shall be watertight. Any perforations shall be below the depths specified in Section 9(A), above.

Casing shall be equipped with centering guides or 'centralizers' to ensure the even radial thickness of the annular seal and filter pack.

(1) Metal Casing. Metallic casing may be joined by welds, threads, or threaded couplings. Welding shall be accomplished in accordance with the standards of the American Welding Society or the most recent revision of the American Society of Mechanical Engineers Boiler Construction Code. Metallic casing shall be equipped with a 'drive shoe' at the lower end if it is driven into place.

(2) Plastic Casing. Plastic casing may be joined by solvent welding or mechanically joined by threads or other means, depending on the type of material and its fabrication. Solvent cement used for solvent welding shall meet specifications for the type of plastic casing used. Solvent cement shall be applied in accordance with solvent and casing manufacturer instructions. Particular attention shall be given to instructions pertaining to required setting time for joints to develop strength.

The following specifications for solvent cements and joints for PVC casing shall be met, including the latest revisions thereof:

(a) *ASTM D2564*, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

(b) *ASTM D2855*, Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

Plastic casing or screen shall not be subjected to excessive stress during installation and shall not be driven into place. Care shall be taken to ensure that plastic casing and joints are not subjected to excessive heat from cement-based sealing material.

A specifically designed adapter shall be used to join plastic casing to metallic casing or screen.

**SECTION 13. Sealing-off Strata**

In areas where a well penetrates more than one aquifer, and one or more of the aquifers contains water that, if allowed to mix in sufficient quantity, will result in a significant deterioration of the quality of water in the other aquifer(s) or the quality of water produced, the strata producing such poor-quality water shall be sealed off to prevent entrance of the water into the well or its migration to other aquifer(s).

(A) Strata producing the undesirable quality water shall be sealed off by placing impervious material opposite the strata and opposite the confining formation(s). (See Figure 8.) The seal shall extend above and below the strata no less than 10 feet even should the confining formation be less than 10 feet in thickness. In the case of "bottom" waters, the seal shall extend 10 feet in the upward direction. The sealing material shall fill the annular space between the casing and the wall of the drilled hole in the interval to be sealed, and the surrounding void spaces which might absorb the sealing material. The sealing material shall be placed from the bottom to the top of the interval to be sealed.

In areas where deep subsidence may occur provision shall be made for maintaining the integrity of the annular seal in the event of subsidence. Such preventive measures may include the installation of a "sleeve" or "slip joint" in the casing, which will allow vertical movement in the casing without its collapse.

(B) Sealing material shall consist of neat cement, cement grout, or bentonite clay (see Section 9(E) for description of the various materials).

(C) Sealing shall be accomplished by a method approved by the enforcing agency.

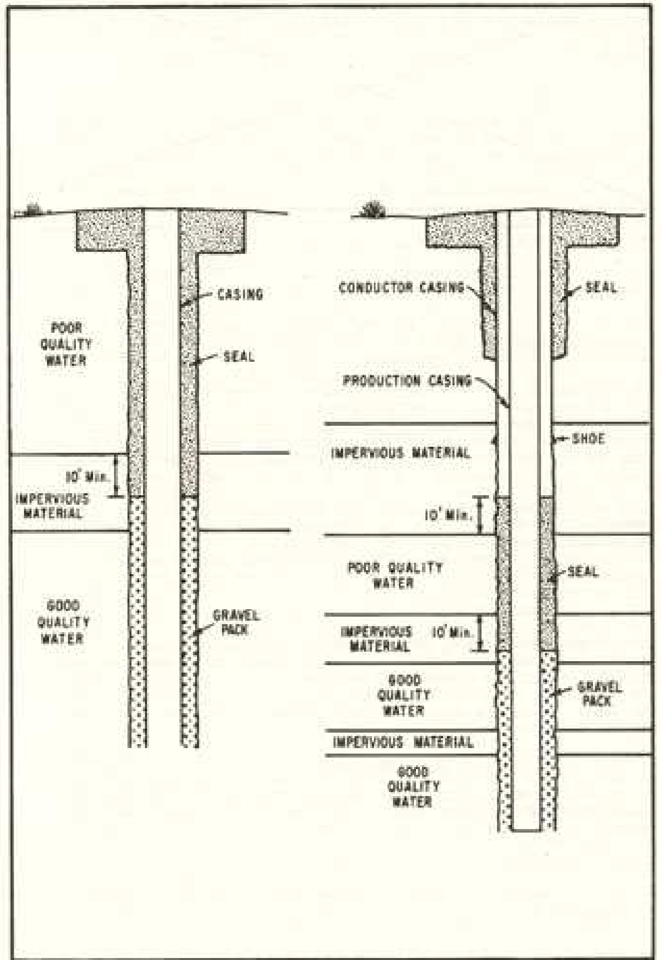


Figure 8. SEALING-OFF STRATA

**SECTION 14. Well Development**

Development, redevelopment, or reconditioning of a well shall be performed with care, by method that will not damage the well structure or destroy natural barriers to the movement of poor quality water, pollutants, and contaminants.
Acceptable well development, redevelopment, or reconditioning methods include:

- Overpumping;
- Surging or swabbing by use of 'plungers';
- Surging with compressed air;
- Backwashing or surging by alternately starting and stopping a pump;
- Jetting with water;
- Introducing specifically-formulated chemicals into a well; and,
- Combinations of the above.

Hydraulic fracturing (hydrofracturing) is sometimes an acceptable well development and redevelopment method when properly performed. Good quality water shall be used in hydrofracturing. The water shall be disinfected prior to introduction into a well. Material used as 'propping' agents shall be free of pollutants and contaminants, shall be compatible with the use of a well, and shall be thoroughly washed and disinfected prior to placement in a well.

Development, redevelopment, or reconditioning by use of specially designed explosive charges is in some cases, another acceptable development method. Explosives shall be used with special care to prevent damage to the well structure and to any natural barriers to the movement of poor-quality water, pollutants, and contaminants. Explosives shall only be used by properly- trained personnel.

Wells subjected to chemicals or explosives during development, redevelopment, or reconditioning operations shall be thoroughly pumped to remove such agents and residues immediately after the completion of operations. Chemicals, water, and other wastes removed from the well shall be disposed of in accordance with applicable local, State, and federal requirements. The DEP should be contacted regarding the proper disposal of waste.

**SECTION 15. Water Quality Sampling**

The requirements to be followed with respect to water quality sampling are:

(A) Community Water Supply Wells and Certain Industrial Wells. The water from all community water supply wells and industrial wells which provide water for use in food processing shall be sampled immediately following development and disinfection, and appropriate analysis made. Rules and regulations governing the constituents to be tested, type of testing, etc, for community water supply systems are regulated and enforced by EPA through the Public Water System Supervision (PWWS) program. Currently regulated contaminants, potential health effects, and sources of contaminants can be found in the USEPA National Primary Drinking Water Standards, which lists the legally enforceable standards that apply to public water systems as well as National Secondary Drinking Water Regulations, the non-enforceable guidelines regulating contaminants that may cause cosmetic or aesthetic effects in drinking water. Water analysis shall be performed by a laboratory certified by an accredited laboratory. The laboratory should be able to provide a valid Environmental laboratory Accreditation program (ELAP) or National laboratory accreditation program (NLAP) number. A copy of the laboratory analysis shall be forwarded to the DEP and EPA. Approval of the EPA must be obtained before the well is put into use.

Except where there is free discharge from the pump (that is, there is no direct connection to the water delivery system such as to a sump), a sample tap (see Figure 7) shall be provided on the discharge line so that water representative of the water in the well may be drawn for laboratory analysis. The tap shall be located so as to prevent back siphonage to the pump discharge when the pump is shut off (e.g., on the system side of the check valve).

(B) Other Types of Wells. To determine the quality of water produced by a new well it should be sampled immediately following construction and development. Appropriate analyses shall be made based upon the intended uses of the water.

**SECTION 16. Special Provisions for Large Diameter Shallow Wells**

(A) Use as Community Water Supply Wells. Because shallow groundwaters are often of poor quality and because they are easily contaminated, the use of bored or dug wells, or wells less than 50 feet deep, to provide community water supplies shall be avoided (unless there is no other feasible means for obtaining water). When used for this purpose, these wells shall be located at least 2,000 feet from any underground sewage disposal facility.

(B) Bored Wells. All bored wells shall be cased with concrete pipe or steel casing whose joints are water-tight from 6 inches above the ground surface to the depths specified in Section 9(A). Except where corrugated steel pipe is used as casing, the minimum thickness of the surrounding concrete seal shall be 3 inches. Where corrugated steel pipe is employed, the joints are not watertight and a thicker annular seal (no less than 6 inches) shall be installed.

(C) Dug Wells. All dug wells shall be "curbed" with a watertight curbing extending from above the ground surface to the depths specified in Section 9(A). The curbing shall be of concrete poured-in-place or of casing (either precast concrete pipe or steel) surrounded on the outside by concrete.

If the curbing is to be made of concrete, poured-in-place, it shall not be less than 6 inches thick. If precast concrete pipe or steel casing is used as part of the curbing, the space between the wall of the hole and the casing shall be filled with concrete to the depths specified in Section 9(A). The minimum thickness of the surrounding concrete shall be 3 inches.

(D) Casing Material. Either steel (including corrugated steel pipe) or concrete may be used for casing bored or dug wells. Corrugated aluminum pipe is not recommended for use as casing.

(1) Steel used in the manufacture of casing for bored and dug wells should conform to the specifications for casing material described in Section 12. Minimum thickness of steel casing for bored and dug wells shall be:

| Diameter (inches) | U.S. Standard Gage or Plate Thickness |
|---|---|
| 18 | 8 gage |
| 24 | 1/4 inch |
| 30 | 1/4 inch |
| 36 | 1/4 inch |
| 42 | 1/4 inch |
| 48 | 1/4 inch |

(2) Corrugated steel pipe used as casing shall meet the specifications (including the latest revision) of ASTM A444, "Standard Specification for Steel Sheet, Zinc Coated (Galvanized) by the HOT-DIP Process for Culverts and Under- drains". The minimum thickness of sheet used shall be 0.109 inch.

(3) Concrete casing can consist of either poured-in-place concrete or precast concrete pipe. Poured-in-place concrete should be sufficiently strong to withstand the earth and water pressures imposed on it during, as well as after, construction. It should be properly reinforced with steel to furnish tensile strength and to resist cracking, and it should be free from honeycombing or other defects likely to impair the ability of the concrete structure to remain watertight. Aggregate small enough to place without "bridging" should be used. Poured-in-place concrete shall be "Class A" (6 sacks of Portland cement per cubic yard) or "Class B" (5 sacks per cubic yard).

Precast concrete pipe is usually composed of concrete rings from 1 to 6 feet in diameter and approximately 3 to 8 feet long. To serve satisfactorily as casing, these rings should be free of blemishes that would impair their strength or serviceability. Concrete pipe shall conform to the specifications listed in Section 12(A)(4).

(E) Covers. All bored and dug wells shall be provided with a structurally sound, watertight, cover made of concrete or steel.

**SECTION 17. Special Provisions for Driven Wells ("Well Points")**

(A) If the well is to be used as an individual domestic well, an oversize hole with a diameter at least 3 inches greater than the diameter of the pipe shall be constructed to a depth of 6 feet and the annular space around the pipe shall be filled with neat cement, cement grout, or bentonite mud.

(B) The minimum wall thickness of steel drive pipe shall not be less than 0.140 inch.

(C) Well points made of thermoplastic materials should not be driven but jetted or washed into place.

**SECTION 18. Rehabilitation, Repair, and Deepening of Wells**

(A) Rehabilitation is the treatment of a well by chemical or mechanical means (or both) to recover lost production caused by incrustation or clogging of screens or the formation immediately adjacent to the well. The following methods used for rehabilitating a well when done with care are acceptable: (1) introduction of chemicals designed for this purpose, (2) surging by use of compressed air, (3) backwashing or surging by alternately starting or stopping the pump, (4) jetting with water, (5) sonic cleaning, (6) vibratory explosives, and (7) combinations of these. Methods which produce an explosion (in addition to the use of vibratory explosives mentioned above) are also acceptable provided, however, they are used with great care, particularly where aquifers are separated by distinct barriers to the movement of groundwater.

In those cases where chemicals or explosives have been used, the well shall be pumped until all traces of them have been removed.

(B) In the repair of wells, material used for casing shall meet the requirements of Section 12 "Casing" of these provisions. In addition, the requirements of Section 11, Subsection A "Disinfection" and, when applicable, Section 13 "Sealing-off Strata" shall be followed.

(C) Where wells are to be deepened, the requirements of Section 11, Section 12, Section 13, Section 14, and Section 15 of these standards shall be followed.

**SECTION 19. Temporary Cover**

Whenever there is an interruption in work on the well such as overnight shutdown, during inclement weather, or waiting periods required for the setting up of sealing materials, for tests, for installation of the pump, etc., the well opening shall be closed with a cover to prevent the introduction of undesirable material into the well and to insure the public safety. The cover shall be held in place or "weighted-down" in such a manner that it cannot be removed except with the aid of equipment or through the use of tools.

During prolonged interruptions (i.e., one week or more), a semipermanent cover shall be installed. For wells cased with steel, a steel cover, tack- welded to the top of the casing, is adequate.

**SECTION 20. Purpose of Destruction**

A well that is no longer useful (including exploration and test holes) must be destroyed in order to: (1) Assure that the groundwater supply is protected and preserved for further use; and (2) Eliminate the potential physical hazard.

**SECTION 21. Definition of "Abandoned" Well**

A well is considered 'abandoned' or permanently inactive if it has not been used for one year, unless the owner demonstrates intention to use the well again. The well owner shall properly maintain an inactive well as evidence of intention for future use in such a way that the following requirements are met:

(A) The well shall not allow impairment of the quality of water within the well and groundwater encountered by the well.

(B) The top of the well or well casing shall be provided with a cover, that is secured by a lock or by other means to prevent its removal without the use of equipment or tools, to prevent unauthorized access, to prevent a safety hazard to humans and animals, and to prevent illegal disposal of wastes in the well. The cover shall be watertight where the top of the well casing or other surface openings to the well are below ground level, such as in a vault or below known levels of flooding. The cover shall be watertight if the well is inactive for more than five consecutive years. A pump or motor, angle drive, or other surface feature of a well, when in compliance with the above provisions, shall suffice as a cover.

(C) The well shall be marked so as to be easily visible and located, and labeled so as to be easily identified as a well.

(D) The area surrounding the well shall be kept clear of brush, debris, and waste materials.

If a pump has been temporarily removed for repair or replacement, the well shall not be considered 'abandoned' if the above conditions are met. The well shall be adequately covered to prevent injury to people and animals and to prevent the entrance of foreign material, surface water, pollutants, or contaminants into the well during the pump repair period.

**SECTION 22. General Requirement**

All "abandoned" wells and exploration or test holes shall be destroyed. The objective of destruction is to restore as nearly as possible those subsurface conditions which existed before the well was constructed taking into account also changes, if any, which have occurred since the time of construction. (For example, an aquifer which may have produced good quality water at one time but which now produces water of inferior quality, such as a coastal aquifer that has been invaded by seawater.)

Destruction of a well shall consist of the complete filling of the well in accordance with the procedures described in Section 23 (following).

**SECTION 23. Requirements for Destroying Wells**

(A) Preliminary Work. Before the well is destroyed, it shall be investigated to determine its condition, details of construction, and whether there are obstructions that will interfere with the process of filling and sealing. This may include the use of downhole television and photography for visual inspection of the well.

(1) Obstructions. The well shall be cleaned, as needed, so that all undesirable materials, including obstructions to filling and sealing, debris, oil from oil-lubricated pumps, or pollutants and contaminants that could interfere with well destruction are removed for disposal.

The enforcing DEP shall be notified as soon as possible if pollutants and contaminants are known or suspected to be in a well to be destroyed. Well destruction operations may then proceed only at the approval of the DEP.

The DEP should be contacted to determine requirements for proper disposal of materials removed from a well to be destroyed.

(2) Where necessary, to ensure that sealing material fills not only the well casing but also any annular space or nearby voids within the zone(s) to be sealed, the casing should be perforated or otherwise punctured.

(3) In some wells, it may be necessary or desirable to remove a part of the casing. However, in many instances this can be done only as the well is filled. For dug wells, as much of the lining as possible (or safe) should be removed prior to filling.

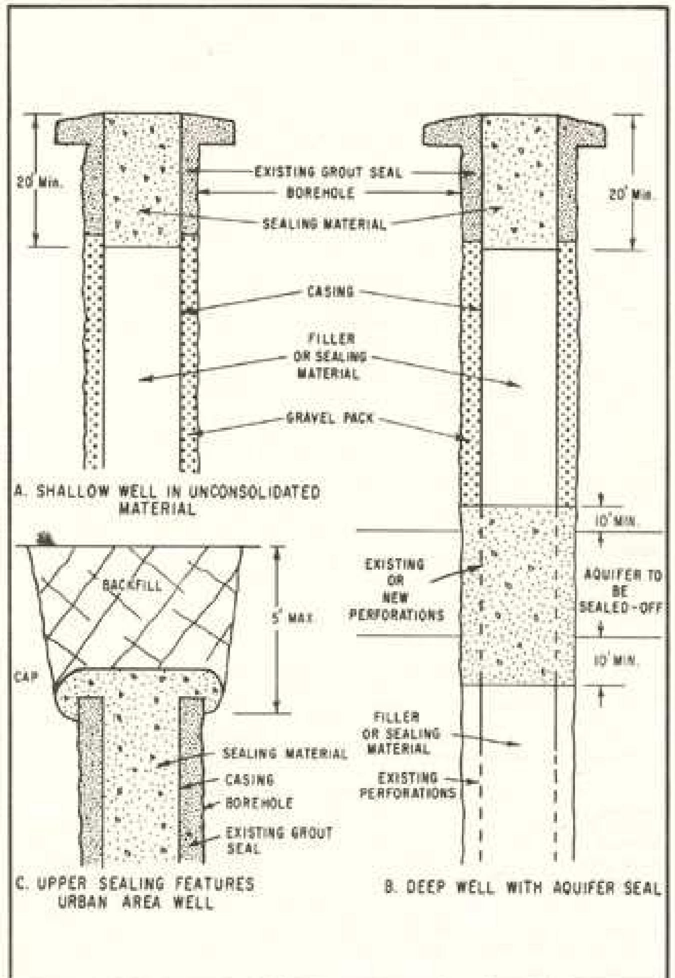


Figure 9. PROPERLY DESTROYED WELLS

(B) Filling and Sealing Conditions. Following are requirements to be observed when certain conditions are encountered:

(1) Wells situated in unconsolidated material in an unconfined groundwater zone. In all cases the upper 20 feet of the well shall be sealed with suitable sealing material and the remainder of the well shall be filled with suitable fill, or sealing material. (See Figure 9A, of Bulletin 74- 81.)

(2) Well penetrating several aquifers or formations. In all cases the upper 20 feet of the well shall be sealed with impervious material.

In areas where the interchange of water between aquifers will result in a significant deterioration of the quality of water in one or more aquifers, or will result in a loss of artesian pressure, the well shall be filled and sealed so as to prevent such interchange. Sand or other suitable inorganic material may be placed opposite the producing aquifers and other formations where impervious sealing material is not required. To prevent the vertical movement of water from the producing formation, impervious material must be placed opposite confining formations above and below the producing formations for a distance of 10 feet or more. The formation producing the deleterious water shall be sealed by placing impervious material opposite the formation, and opposite the confining formations for a sufficient vertical distance (but no less than 10 feet) in both directions, or in the case of "bottom" waters, in the upward direction. (See Figure 9B.)

In locations where interchange is in no way detrimental, suitable inorganic material may be placed opposite the formations penetrated. When the boundaries of the various formations are unknown, alternate layers of impervious and pervious material shall be placed in the well.

(3) Well penetrating creviced or fractured rock. If creviced or fractured rock formations are encountered just below the surface, the portions of the well opposite this formation shall be sealed with neat cement, sand-cement grout, or concrete. If these formations extend to considerable depth, alternate layers of coarse stone and cement grout or concrete may be used to fill the well. Fine grained material shall not be used as fill material for creviced or fractured rock formations.

(4) Well in noncreviced, consolidated formation. The upper 20 feet of a well in a noncreviced, consolidated formation shall be filled with impervious material. The remainder of the well may be filled with clay or other suitable inorganic material.

(5) Well penetrating specific aquifers, local conditions. Under certain local conditions, the enforcing agency may require that specific aquifers or formations be sealed off during destruction of the well.

(A)Placement of Material. The following requirements shall be observed in placing fill or sealing material in wells to be destroyed:

(1) The well shall be filled with the appropriate material (as described in Subsection (D) of this section) from the bottom of the well up.

(2) Where neat cement grout, sand-cement grout, or concrete is used, it shall be poured in one continuous operation.

(3) Sealing material shall be placed in the interval or intervals to be sealed by methods that prevent free fall, dilution, and/or separation of aggregate from cementing materials.

(4) Where the head (pressure) producing flow is great, special care and methods must be used to restrict the flow while placing the sealing material. In such cases, the casing must be perforated opposite the area to be sealed and the sealing material forced out under pressure into the surrounding formation.

(5) In destroying gravel-packed wells, the casing shall be perforated or otherwise punctured opposite the area to be sealed. The sealing material shall then be placed within the casing, completely filling the portion adjacent to the area to be sealed and then forced out under pressure into the gravel envelope.

(6)When pressure is applied to force sealing material into the annular space, the pressure shall be maintained for a length of time sufficient for the cementing mixture to set.

(7) To assure that the well is filled and there has been no jamming or "bridging" of the material, verification shall be made that the volume of material placed in the well installation at least equals the volume of the empty hole.

(D) Materials. Requirements for sealing and fill materials are as follows:

(1) Impervious Sealing Materials. No material is completely impervious. However, sealing materials shall have such low permeability that the volume of water passing through them is of small consequence.

Suitable impervious materials include neat cement, sand-cement grout, concrete, and bentonite clay, all of which are described in Section 9, Subsection (E), "Sealing Material" of these standards; and well-proportioned mixes of silts, sands, and clays (or cement), and native soils that have a coefficient of permeability of less than 10 feet per year. Used drilling muds are not acceptable.

(2) Filler Material. Many materials are suitable for use as a filler in destroying wells. These include clay, silt, sand, gravel, crushed stone, native soils, mixtures of the aforementioned types, and those described in the preceding paragraph. Material containing organic matter shall not be used.

(E) Additional Requirements for Wells in Urban Areas. In incorporated areas or unincorporated areas developed for multiple habitation, to make further use of the well site, the following additional requirements must be met (see Figure 9C):

(1) A hole shall be excavated around the well casing to a depth of 5 feet below the ground surface and the well casing removed to the bottom of the excavation.

(2) The sealing material used for the upper portion of the well shall be allowed to spill over into the excavation to form a cap.

(3) After the well has been properly filled, including sufficient time for sealing material in the excavation to set, the excavation shall be filled with native soil.

(F) Temporary Cover. During periods when no work is being done on the well, such as overnight or while waiting for sealing material to set, the well and surrounding excavation, if any, shall be covered. The cover shall be sufficiently strong and well enough anchored to prevent the introduction of foreign material into the well and to protect the public from a potentially hazardous situation.

## CHAPTER 3. ENFORCEMENT PROGRAM AND ADMINISTRATIVE PROCEDURES

### SECTION 1. Enforcement Program

(A) Enforcement Policy: It is the policy of the Department of Environmental Protection to encourage informal, practical, result-orient resolution of alleged violations and actions needed to prevent damage to Rancheria resource or harm to the health, safety, or welfare of the Rancheria population. It is also the policy of the Department Environmental Protection, consistent with the principles of due process, to provide effective procedures for enforcement.

(B) Enforcement Agency: The Department of Environmental Protection shall be responsible for enforcing the provisions of this Code. Specifically, the Tribal Department of Environmental Protection shall conduct investigations when a complaint is received by the Tribal Water Quality Control Officer, or where the Tribal Water Quality Control Officer or other Tribal department believes that a violation of this Ordinance has occurred.

(C) Enforcement Activities: Where a written and verified complaint shall be filed with the Tribal Water Quality Control Officer and reviewed by the Department of Environmental Protection alleging that, or where the Tribal-Water Quality Control Officer shall have cause to believe that, any person is violating any condition of this code, the Department of Environmental Protection shall cause a prompt investigation to be made.

(D) Notice of Violation; Cease and Desist Order: If the Department of Environmental Protection finds after an investigation pursuant to Section © of this Ordinance that a violation of any regulation or permit condition exists, the Department of Environmental Protection shall promptly notify both the alleged violator and the Board of Directors in writing.

In the case of an apparent violation of this Ordinance, the Department of Environmental Protection is authorized to issue a Notice of Violation to the person(s) apparently responsible for the violation, and, if the apparent violation occurred on property owned by a person other than the alleged violator, a Notice of Violation shall also be issued to the landowner.

In the case of a continuing violation or a threatened violation, the Department of Environmental Protection is authorized to issue a Cease and Desist Order to prevent the violation from continuing or occurring.

Failure to comply with a Cease and Desist Order shall constitute a violation of this Ordinance. Both a Notice of Violation and Cease and Desist Order may be issued for a single incident. A Notice of Violation will include a Summons to appear before the Board of Directors at an enforcement hearing at a specified time and date, and shall advise the alleged violator that failure to appear may result in the imposition of civil penalties.

If a Cease and Desist Order is issued without an accompanying Notice of Violation, the Order will inform the recipient that failure to comply with the Order will constitute a violation of this Ordinance which will result in the issuance of a Notice of Violation and may result in the imposition of civil penalties.

(E) Informal Conferences: The Department of Environmental Protection shall afford the landowner or his or her representative reasonable opportunities to discuss proposed enforcement actions at an informal conference prior to taking further enforcement action, unless the Department of Environmental Protection determines that there may be either imminent environmental damage to a Rancheria resource or adverse impact upon the health, safety, and welfare of the Rancheria population. Informal conferences may be used at any stage in the enforcement proceedings, except that the Department of Environmental Protection may refuse to conduct information conferences with respect to any matter then pending before the Board of Directors.

(F) Reports Required: The Department of Environmental Protection shall keep written notes of the date and place of the conference, the persons in attendance, the subject matter discussed and any decisions reached with respect to further enforcement action.

(G) Enforcement Hearings: If the landowner and the Department of Environmental Protection are unable to resolve the matter via an informal conference, the Board of Directors is authorized to conduct adjudicatory hearings to determine if a violation of this Ordinance has occurred. In such a hearing the Director of Environmental Protection, in cooperation with the Tribal Water Quality Control Officer, shall present the case to the Board of Directors to establish that the person(s) charged has (have) committed a violation of this Ordinance. Any person so charged shall be entitled, as his or her own expense, to be represented by an attorney or other representative.

(1) Burden of Proof. The Department of Environmental Protection shall have the burden of proving that a violation of this Ordinance has occurred and that a person charged was responsible for the violation. The Board of Directors shall rule that a violation of this Ordinance has occurred if it finds that the charges are supported by substantial evidence and that a preponderance of the credible evidence supports a finding that a violation has occurred.

(2) Enforcement Orders. Within thirty (30) days after the date of any enforcement hearing, the Board of Directors shall issue a written decision. If the Board determines that a violation has occurred and that the person(s) charged was (were) responsible for the violation, the Board’s decision shall include an Enforcement Order.

(H) Civil Penalties and Corrective Action: An Enforcement Order shall direct any person(s) found to have committed a violation of this Ordinance to take whatever corrective action the Board of Directors deems appropriate under the circumstances. An Enforcement Order may impose civil penalties in accordance with a schedule of civil penalties prescribed in the Board's rules. Alternatively, an Enforcement Order may impose civil penalties in the event that a person found to have committed a violation of this Ordinance does not take corrective action in accordance with the Order within a prescribed time frame. If a person who has been found to have committed a violation does not take corrective action within the prescribed time frame, an appropriate department or agency of the Tribal government may take the necessary corrective action, in which case, the amount of any civil penalty shall be increased by twice the amount of the cost incurred by the Tribal department or agency in taking the corrective action.

(1) Emergency Orders. Notwithstanding any other provision of this Ordinance, if the Board of Directors determines that noncompliance with this Ordinance is presenting an imminent and substantial threat to the public health, welfare or environment and determines, in consultation with the Tribe's attorneys, that it is not practicable to assure prompt protection of the public health, welfare or environment of an administrative or judicial enforcement action under this Part, the Board may issue such orders as may be necessary to protect the public health welfare or environment. Any such order shall be effective immediately upon issuance and shall remain in effect for a period not to exceed sixty (60) days.

(2) Revocation of Permit. Failure of any person to comply with any Enforcement Orders will result in an immediate revocation of his or her permit. In order to obtain a reinstatement of such permit, the person(s) against whom the Enforcement Order was issued must first demonstrate compliance with the Order and pay all outstanding penalties and then petition for reinstatement of the permit with the Department of Environmental Protection.

(I) Judicial Enforcement: The Tribal Court shall have jurisdiction of all cases and controversies arising under this Ordinance.

(1) The Department of Environmental Protection may request the Board of Director’s to authorize the Department of Environmental Protection to file an action in Tribal Court pursuant to this Ordinance for a temporary restraining order, a preliminary injunction, a permanent injunction or any other relief provided by law, including the assessment and recovery of civil penalties and clean up and

administrative costs associated with the enforcement of this Ordinance (except that any suit against the Tribe or a tribal department or agency shall be for injunctive relief only and not for penalties or other money damages), in any of the following instances:

(a) Whenever a person has violated, or is in violation of, any provision of this Ordinance, including but not limited to a regulation, permit or order issued pursuant to this Ordinance;

(b) Whenever a person submits false information under this Ordinance or regulations promulgated under this Ordinance; or

(c) Whenever a person is creating an imminent and substantial endangerment to the public health, welfare, environment or cultural resources of the Tribe, in which case the Board of Directors shall request the Department of Environmental Protection to pursue injunctive relief but not the assessment of penalties, unless the endangerment is caused by a violation, as specified in paragraphs (1) and (2) above.

(2) Any person who violates this Ordinance shall be liable for all costs associated with judicial enforcement of this Ordinance, including, but not limited to, court costs.

(J) Special Provisions for Tribal Departments and Agencies: In any case in which the Board of Directors or any Tribal agency or department is alleged to have violated the terms and conditions of a discharge permit, or to have conducted discharge activities without a permit, the Chairperson of the Board of Directors shall bring the matter to the attention of the Board of Directors who shall consider taking action to ensure compliance with this Ordinance. If the matter cannot be resolved informally, the Board of Directors shall conduct an enforcement hearing for the purpose of making factual determinations and issuing a decision recommending a course of corrective action if necessary.

**SECTION 2. Appeals**

(A) Judicial Review**:** Any person, who is aggrieved by the issuance or denial of a discharge permit without respect to whether that person, corporation, or other entity is a party to such permit application, or who is the subject of an Enforcement Order, may file an appeal with the Tribal Court. The Court is authorized to hear such appeal.

**SECTION 3. Other Provisions**

(A) Severability**:** If any provision of this Ordinance, or the application thereof, is held invalid, the remainder of this Ordinance, or applications of such provisions, shall not be affected.

(B) Sovereign Immunity Preserved**:** Nothing in this Ordinance is intended to, nor should be interpreted as a waiver of the Tribe's sovereign immunity from unconsented lawsuit, or as authorization for a claim for monetary damages from the Tribe.

APPENDIX A

## DEFINITION OF TERMS

The following terms are defines as used in this report:

Abandoned Well – A well whose use has been permanently discontinued or which is in such a state of disrepair that no water can be produced. Because abandonment is a state that also involves intent on the part of the well owner, a definition that prescribes a set of conditions and a time limit for use in applying standards appears in Section 21 of Chapter 2, "Standards", of this report.

Active Well – An operating water well.

Annular Space – The space between two well casings or between the casing and the wall of the drilled hole.

Aquifer – A geologic formation, group of formations or part of a formation that is water bearing and which transmits water in sufficient quantity to supply springs and pumping wells.

Artesian Well – A well which obtains its water from a confined aquifer. The water level in an artesian well stands some distance above the top of the aquifer it taps. Where the pressure is sufficient to force the water level above the surface of the ground, the well is termed a flowing artesian well.

Bailer – A long narrow bucket with a valve in the bottom used to remove cuttings or fluids from a well.

Bentonite – A highly plastic colloidal clay composed largely of montmorillonite used as a drilling fluid additive or as a sealant.

Casing – A tubular retaining structure which is installed in the well bore to maintain the well opening.

Clay – A fine-grained geologic material (grain size less than 0.004 mm in diameter) which has very low permeability.

Conductor Casing – A tubular retaining structure installed in the upper portion of a well between the wall of the drilled hole and the inner well casing.

Cone of Depression – A depression in the water table or piezometric surface of a groundwater body that is in the shape of an inverted cone and develops around a well which is being pumped. It defines the area of influence of the pumping well.

Confined Groundwater – Groundwater under pressure whose upper surface is the bottom of an impermeable bed or a bed of distinctly lower permeability than the material in which the confined water occurs. Confined groundwater moves under the control of the difference in head between the intake and discharge areas of the water body.

Connate Water – Water entrapped in the interstices of a sedimentary rock at the time it was deposited. These waters may be fresh, brackish, or saline in character. Usually applies only to water found in geologically older formations.

Consolidated Material - A geological material whose particles are stratified, cemented, or firmly packed together; usually occurs at depth, e.g. sandstone.

Contamination –an impairment of the quality of the waters of the tribe by waste to a degree which creates a hazard to the public health through poisoning or through the spread of disease. 'Contamination' shall include any equivalent effect resulting from the disposal of waste, whether or not waters of the state are affected."

Destroyed Well – A well that has been properly filled so that it cannot produce water nor act as a vertical conduit for the movement of groundwater.

Deterioration – An impairment of water quality.

Drilled Well – A well for which the hole is excavated by mechanical means such as the rotary or cable tool methods.

Driller's Mud – A fluid composed of water and clay used in the drilling (primarily rotary) operation. The mud serves to remove cuttings from the hole, to clean and cool the bit, to reduce friction between the drill stem and the sides of the hole, and to plaster the sides of the hole. Such fluids range from relatively clear water to carefully prepared mixtures of special purpose compounds.

Drive Shoe - A forged steel collar with a cutting edge fastened onto the bottom of the casing to shear off irregularities in the hole as the casing advances, and to protect the lower edge of the casing as it is driven.

Gravel Packed Well – A well in which filter material (sand, gravel, etc.) is placed in the annular space between the casing and the borehole to increase the effective diameter of the well, and to prevent fine-grained material from entering the well during pumping.

Groundwater – That part of the subsurface water which is in the zone of saturation.

Groundwater Basin – A groundwater basin consists of an area underlain by permeable materials which are capable of storing or furnishing a significant water supply; the basin includes both the surface area and the permeable materials beneath it.

Grout – A fluid mixture of cement and water of a consistency that can be forced through a pipe and placed as required. Various additives, such as sand, bentonite, and hydrated lime, are used to meet certain requirements. For example, sand is added when considerable volume of grout is needed.

Impairment – A change in quality of water which makes it less suitable for beneficial use.

Impermeable – That property of a geologic material that renders it incapable of allowing water to move through it perceptibly under the pressure differences ordinarily found in subsurface water.

Impervious Strata – A geologic unit which will not transmit water in sufficient quantity to furnish an appreciable supply to wells or springs.

Inactive Well – A well not routinely operated but capable of being made an operating well with a minimum of effort.

Packer – A device used to plug or seal a well at a specific point; frequently used as retainers to keep grout in position until it “sets”.

Perforations – Openings in a well casing to allow the entrance of groundwater into the well. Perforations may be made either before or after installations of the casing.

Permeability – The capacity of a geologic material for transmitting a fluid. The degree of permeability depends upon the size and shape of the openings and the extent of the interconnections.

Pollution – an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects: (1) such waters for beneficial uses, or (2) facilities which serve such beneficial uses. ‘Pollution’ may include ‘contamination’.”

Quality of Water or Water Quality – ‘Quality of the water’ or ‘quality of the waters’ refers to chemical, physical, biological, bacteriological, radiological, and other properties and characteristics of water which affect its use.”

Screen or Well Screen – A factory-perforated casing used in a well that maximizes the entry of water from the producing zone and minimizes the entrance of sand.

Tremie – A tubular device or pipe used to place grout in the annular space. Originally designed for placing concrete under water, the discharge end of the tube is kept submerged in the freshly deposited grout so as not to break the seal while filling the annular space.

Unconfined (free) Groundwater – Groundwater that has a free water table, i.e., water not confined under pressure beneath relatively impermeable rocks.

Unconsolidated Material – A sediment that is loosely arranged or unstratified, or whose particles are not cemented together occurring either at the surface or at depth.

Waste – ‘Waste’ includes sewage and any/all other waste substances, liquid, solid, gaseous, or radioactive, associated with human habitation, or of human or animal origin, or from any producing, manufacturing, or processing operation of whatever nature, including such waste placed within containers of whatever nature prior to, and for purposes of, disposal.”

APPENDIX B.

## SUGGESTED METHODS FOR SEALING THE ANNULAR SPACE AND FOR SEALING-OFF STRATA

### Sealing the Annular Space

The annular space is the space between the well casing and wall of the drilled hole created during construction. This space must be adequately sealed to prevent the entrance of surface drainage or poor quality subsurface water, which may contaminate or pollute the well. This seal will also protect the casing against corrosion and possible structural failure.

A number of acceptable sealing methods are presented in this appendix. Other methods may be suggested by individual well drillers on the basis of their experience and availability of equipment. An acceptable method should provide for the complete filling of the sealing interval with the appropriate sealing material to the specified depth.

**General**

Prior to sealing, the annular space should be flushed to remove any loose formation material or drilling mud that might obstruct the operation. The use of centralizers – devices which are affixed to the casing at regular intervals to prevent it from touching the wall of the hole, thereby keeping the casing centered in the borehole – are recommended. This assures that the seal is not less than the desired minimum thickness. It is particularly significant for large diameter wells where the casing exceeds 10 inches in diameter.

The use of the tremie or grout pipe for the introduction of the sealing material into the annular space is preferred. Where a tremie or grout pipe is used, the minimum annular space should be 2 inches and the minimum tremie size should be a nominal 1-1/2 inches in diameter.

Gravity installation without a grout pipe or tremie should not be attempted when the sealing interval contains water or cannot be visually inspected (with the aid of a mirror or light). Where sealing material is to be introduced under water or the interval cannot be observed from the surface, methods involving "positive" placement (by a tremie or grout pipe, pumping or other application of pressure) must be used.

The sealing material must always be introduced at the bottom of the interval to be sealed. This prevents "bridging" (jamming) or segregation (separation of large aggregate from the mixture in sand-cement or concrete grouts) of the sealing material and eliminates gaps.

Sealing should be accomplished in one continuous operation. Where the sealing interval will exceed 100 feet in length, consideration must be given to the collapse strength of the casing. Further, because of the weight of such extensive seals, consideration must also be given to the installation of stronger retaining devices and to staging the placement of the seal (as, for example, the installation of a short segment of rapid- setting sealant in advance of the main body of sealing material; the former becomes a foundation to support the extensive seal).

**Sealing Methods**

The following methods can be used to seal the upper portion of the annular space. Except for the first, these methods are illustrated on Figure 10. The first method is frequently used where short seals, under 20 feet deep, are placed in dry material.

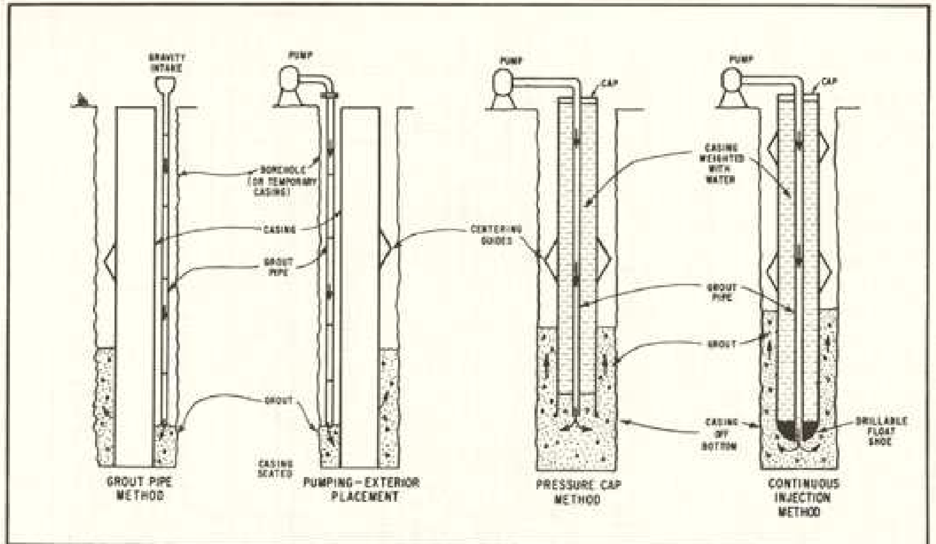


Figure 10. METHODS FOR SEALING THE ANNULAR SPACE

Gravity Installation (Without Tremie). In this method sealing material is poured into the annular space without the use of a tremie or grout pipe. It cannot be used where the annular space contains water and is limited to intervals less than 30 feet deep. When used, visual observation (with the aid of a mirror or light) should be made during placement of the seal.

Grout Pipe Method. In this method, the seal is placed in the annular space by gravity through a grout pipe (or tremie) suspended in the annular space (see Figure 10).

(A) Drill the hole large enough to accommodate the grout pipe (at least 4 inches, greater in diameter than the diameter of the casing).

(B) In caving formations, install a conductor casing.

(C) Provide a packer or grout retainer in the annular space below the interval to be sealed.

(D) Extend the grout pipe down the annular space between the casing and the wall or conductor to near the bottom of the interval to be sealed just above the retainer.

(E) Add grout in one continuous operation, beginning at the bottom of the interval to be sealed. The bottom end of the grout pipe should remain submerged in the sealing material during the entire time it is being placed. The grout pipe is gradually withdrawn as the sealing material is placed. Where a conductor casing is used to hold back caving material, it may be withdrawn as the sealing material is placed.

Pumping-Exterior Placement. For this method the same procedure as described for the Grout Pipe Method (above) is followed except that the material is placed by pumping instead of by gravity flow. The grout pipe must always be full of sealing material and its bottom end must remain submerged in the sealing material until the interval has been filled.

Pressure Cap Method. In the pressure cap method, the grouting is done with the hole drilled about 2 feet below the bottom of the conductor casing and the remainder of the well drilled after the grout is in place and set. The grout is placed through a grout pipe set inside the conductor casing.

(A) The casing is suspended about 2 feet above the bottom of the drilled hole and filled with water.

(B) A pressure cap is placed over the conductor casing and grout pipe extended through the cap and casing to the bottom of the hole.

(C) The grout is forced through the pipe, up into the annular space around the outside of the conductor casing, to the ground surface.

(D) When the grout has set, the pressure cap and the plug formed during grouting are removed and drilling of the rest of the well is continued.

Because there is the possibility that coarse aggregate will “jam” the grout pipe, concrete cannot be used as a sealant when this method is used.

Continuous Injection. This method, called the Normal Displacement Method in the oil industry (which developed it), involves pumping grout through a tube or pipe centered in the casing via a “float shoe” fitted at the bottom of the casing. The gout is forced up into the annular space to the ground surface as is the case with the pressure cap method (above). The tube is detached and flushed. The float shoe, which has a back pressure valve, is drilled out. Because there is the possibility that coarse aggregate will “jam” the grout pipe, concrete cannot be used with this method.

**Sealing-off Strata**

When the hole for a well is drilled, a strata may be found that produces water of undesirable quality. To prevent the movement of this water into other strata and to maintain the quality of the water to be produced by the well, such strata must be sealed-off. Also, where a highly porous non-water producing strata is encountered, it too must be sealed-off to prevent the loss of water or hydraulic pressure from the well.

The following methods can be used in sealing-off strata or zones (see Figure 11). In addition, several of the methods described for sealing the upper annular space can also be used.

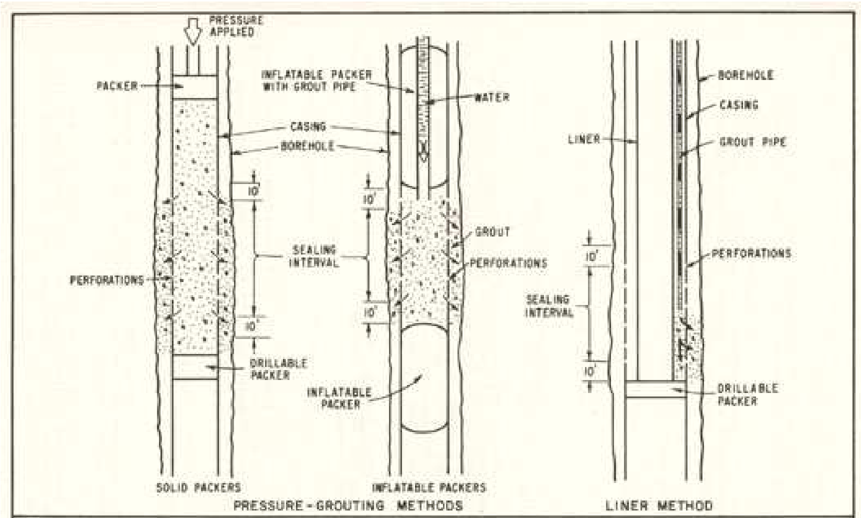


**Figure 11. METHODS FOR SEALING-OFF STRATA**

Pressure-Grouting Method. This method can be employed where a substantial annular space exists between the well casing and the wall of the drilled hole.

(A) Perforate the casing opposite the interval to be sealed.

(B) Place a packer or other sealing device in the casing below the bottom of the perforated interval.

(C) Use a dump bailer or grout pipe to place grout in the casing opposite the interval to be sealed. Sufficient grout shall be placed to fill the annular space and extend out into the strata to be sealed-off.

(D) Place a packer or other sealing device in the casing above the perforations.

(E) Apply pressure to the top packer to force the grout through the perforations into the interval to be sealed.

(F) Maintain pressure until the material has set.

(G)Drill out the packers and other material remaining in the well.

Frequently, an assembly consisting of inflatable (balloon) packers and grout pipe is used. The packers are placed to enclose the interval to be sealed, they are inflated and the grout pumped down the hose (which passes through the upper packer) into the interval to be sealed. Water is then pumped into the interval, squeezing the grout through the perforations. When the grout is sufficiently hardened, the packers are deflated and removed.

Liner Method. Where the annular space between the casing and the wall of the drilled hole is minimal, the liner method can be employed.

(A) Perforate the casing opposite the interval to be sealed.

(B) Place a smaller diameter metal liner, about 2 inches less in diameter, inside the casing opposite the perforated interval to be sealed, and extend it at least 10 feet above and below the perforated interval.

(C) Provide a grout retaining seal at the bottom of the annular space between the liner and the well casing.

(D) Extend the grout pipe into the opening between the liner and casing, and fill the annular space with grout in one continuous operation.

(E) The bottom end of the grout pipe should remain submerged in the sealing material during the entire time it is being placed. The grout pipe is gradually withdrawn as the sealing material is placed.

**SUGGESTED PROCEDURES FOR DISINFECTED WELLS**

Disinfection of all wells is recommended to eliminate pathogenic organisms as well as organisms that can grow in wells and thereby cause clogging and effect the quality of water produced. Disinfection of the well is the final act of well construction or repair before it is placed in service. Wells should also be disinfected following repair or replacement of the pump and/or well maintenance. The procedures described in this appendix are recommended for disinfecting wells; however, other methods may be used provided it can be demonstrated that they will yield comparable results. For new wells, disinfection should take place following development (this will assure that the well is purged of drilling mud, dirt, and other debris that reduces the effectiveness of the disinfection), testing for yield, and installation of the pump. When there is a delay in pump installation, interim or partial disinfection should be undertaken.

Disinfection involves seven steps:

(A)A chlorine solution containing at least 50 mg/l (or parts per million) available chlorine, is added to the well. Table 6 lists quantities of various chloride compounds required to dose 100 feet of water-filled casing at 50 mg/l for diameters ranging from 2 to 24 inches. For wells that have been repaired or when a pump has been repaired or replaced and, bringing the well back into service quickly is desired, the solution should contain at least 100 mg/l available chlorine. To obtain this concentration, double the amounts shown in Table 6.

(B)The pump column or drop pipe shall be washed with the chlorine solution as it is lowered into the well.

(C)After it has been placed into position, the pump shall be turned on and off several times (i.e., “surged”) so as to thoroughly mix the disinfectant with the water in the well. Pump until the water discharged has the odor of chlorine. Repeat this procedure several times at one-hour intervals.

(D)The well shall be allowed to stand without pumping for 24 hours.

(E)The water shall then be pumped to waste until the presence of chlorine is no longer detectable. The absence of chlorine is best determined by testing for available chlorine residual using a test kit designed for this purpose.

Disposal of the waste should be away from trees, shrubs, or lawns and into storm sewers, drainage ditches, etc. Note that heavily chlorinated water should not be wasted into the plumbing system of homes that utilize individual sewage disposal systems (septic tanks). Such strong disinfectants could neutralize the bacteria needed to stabilize the sewage and also could damage the soil adsorption system.

(F)A bacteriological sample shall be taken and submitted to a laboratory for examination (see Appendix D).

(G)If the laboratory analysis shows the water is not free of bacterial contamination, the disinfection procedure should be repeated. Depending on the level of contamination, it may be necessary to use a higher concentration chlorine solution (several times that shown in Table 6). The water should then be retested. If repeated attempts to disinfect the well are unsuccessful, a detailed investigation to determine the cause of the contamination should be undertaken.

Where small individual domestic wells to be treated are of unknown depth or volume, at least one pound (0.45 kilograms) of calcium hypochlorite (70 percent available chlorine) or two gallons (7.5 litres) of household bleach (sodium hypochlorite), such as Clorox or Purex, may be used in lieu of the chemicals shown in Table 6.

**TABLE 6**
**CHLORINE COMPOUND REQIRES TO DOSE 100 FEET OF WATER-FILLED CASING AT 50 MILLIGRAMS PER LITER[1]**

| Diameter of Casing (Inches) | Chlorine Compounds | | |
|---|---|---|---|
| | (70%) Calcium Hypochlorite[2] (Dry Weight)[3] | (25%) Chloride of Lime (Dry Weight)[3] | (5.25%) Sodium Hypochlorite[4] (Liquid Measure) |
| 2 | 1/4 oz (7 g) | 1/2 oz (14 g) | 2 oz (59 mL) |
| 4 | 1 oz (28 g) | 2 oz (57 g) | 9 oz (266 mL) |
| 6 | 2 oz (57 g) | 4 oz (113 g) | 20 oz (0.6 L) |
| 8 | 3 oz (85 g) | 7 oz (0.2 kg) | 2-1/8 pts (1.0 L) |
| 10 | 4 oz (113 g) | 11 oz (0.3 kg) | 3-1/2 pts (1.7 L) |
| 12 | 6 oz (0.2 kg) | 1 lb (0.45 kg) | 5 pts (2.4 L) |
| 16 | 10 oz (0.3 kg) | 2 lb (0.9 kg) | 1 gal (3.8 L) |
| 20 | 1 lb (0.45 kg) | 3 lb (1.4 kg) | 1-2/3 gal (6.3 L) |
| 24 | 1-1/2 lb (0.7 kg) | 4 lb (1.8 kg) | 2-1/3 gal (8.8 L) |

1. Some authorities recommend a minimum concentration of 100 mg/L. To obtain this concentration, double the amounts shown.
2. HTH, Perchloron, Pittchlor, etc.
3. Where dry chlorine is used, it should be mixed with water to form a chlorine solution prior to placing it into the well. Note that dry chlorine should *always* be added to water, not vice versa. Further, the chemical should be added slowly. These precautions are necessary to lessen the possibility of a violent chemical reaction.
4. Household bleaches such as Chlorox, Purex, etc.

APPENDIX C.

## COLLECTION OF WATER QUALITY SAMPLES

Water from all new wells should be sampled in order to determine the quality of the water that is being produced. The type of analysis that will be made is dependent on the expected use of the water. For example, individual domestic wells should be sampled for determination of bacterial quality and chemical quality. The water from agricultural wells is generally examined only for the presence of specific chemicals unless there is the likelihood that there will be incidental domestic use of the water, in which case the bacterial quality ought to be determined too.

Recommendations regarding the types of analyses to be performed for the various uses of water will be found in numerous references on water quality and groundwater; however, it is best to consult with local agencies such as county farm advisors, health departments or water service agencies (irrigation or water districts).

### Bacterial Sampling

For individual domestic wells, technical advice regarding the collection of bacteriological samples may be obtained from the local health departments or from the laboratories that will examine the sample. If no technical assistance is available, the following procedure will suffice: A sterile sample bottle, preferably one provided by the laboratory, must be used. It is extremely important that nothing except the water to be analyzed come in contact with the inside of the bottle or the cap; the water must not be allowed to flow over an object or over the hands and into the bottle while it is being filled. If the water is collected from a sample tap, turn on the tap and allow the water to flow for 2 or 3 minutes before collecting the sample. Do not rinse the sample bottle. The sample should be delivered to the laboratory as soon as possible and in no case more than 30 hours after its collection. During delivery, the sample should be kept as cool as possible (but not frozen).

### Chemical Sampling

Generally, a routine mineral analyses (determination of the concentrations of the common minerals such as calcium, sodium, chloride, sulfate, etc.) plus analyses for selected minor elements will suffice, particularly where there is no prior knowledge of the chemical quality of the water in the area where the well is located. Where quality conditions in the surrounding area are known, a more selective analysis may be made. For specified uses it may also be desirable to make analysis for concentrations of certain constituents (such as iron and manganese in the case of domestic water or boron in irrigation water). Organic chemicals are not routinely determined. Information or advice on chemical quality conditions may be obtained from local agencies such as the county farm advisors, health departments, etc.

The sample should be collected after the well has been pumped long enough to remove standing water and development and disinfectant chemicals, and to ensure that water from the producing formation(s) has entered the well. The water sample should be collected in a chemically clean container, preferably one obtained from the laboratory that will perform the analysis. The container should be rinsed several times with the water to be sampled prior to collecting the sample. The laboratory performing the analysis should issue instructions regarding the quantity of sample required and whether or not preservatives are needed. However, one-half gallon (1.9 litres) is usually sufficient for a routine mineral analysis; one gallon (3.8 litres) when analyses for minor elements (i.e., iron, manganese, etc.) is also required. Sample quantities for organic chemicals vary according to the type of analysis, and range from very small amounts up to several gallons (litres). In addition, where organic chemicals are to be determined, special sampling procedures and equipment may be required. This is particularly true for volatile organic compounds.

In all cases the temperature of the water should be determined immediately upon collection of the sample.

## APPENDIX D.

## BIBLIOGRAPHY


1. Ahrens, Thomas P. "Well Design Criteria. Part 2". Water Well Journal. November 1957.
2. Ahrens, Thomas P. "Corrosion in Water Wells". Water Well Journal. March and April 1966.
3. Ahrens, Thomas P. "Basic Considerations of Well Design". Water Well Journal. April, May, June and August 1970. (Four parts)
4. American Association for Vocational Instructional Materials. "Planning for an Individual Water System". 1973.
5. American Society of Agricultural Engineers. "Designing and Constructing Water Wells for Irrigation". Tentative Recommendation: ASAE R 283 (T). December 1964.
6. American Water Works Association. "Standard Specifications for Deep Wells". AWWA A-100-66. 1967.
7. American Water Works Association. "Groundwater". AWWA Manual No. M21. 1973.
8. American Water Works Association. "Standard for Vertical Turbine Pumps – Line Shaft and Submersible Types". AWWA E-101-77. June 1977.
9. American Water Works Association. "PVC Pipe – Design and Installation". AWWA Manual No. M23. 1980.
10. Anderson, K. "Water Well Handbook". Missouri Water Well Drillers Association. 1963.
11. Associated Drilling Contractors of the State of California. "Recommended Standards for Preparation of Water Well Construction Specifications". September 17, 1960.
12. Brantly, J. E. "Rotary Drilling Handbook". Palmer Publications. Fifth Edition. 1952.
13. California Department of Public Health, Bureau of Sanitary Engineering. "Occurrence of Nitrate in Groundwater Supplies in Southern California". February 1963.
14. California Department of Public Works, Division of Water Resources. "Groundwater Basins in California". Water Quality Investigations Report No. 3. November 1952.
15. California Department of Public Works, Division of Water Resources. "Abstract of Laws and recommendations Concerning Water Well Construction and Sealing in the United States". Water Quality Investigations Report No. 9. April 1955.
16. California Department of Transportation. "Standard Specifications". January 1981.
17. California Department of Water Resources. "Water Quality and Water Quality Problems, Ventura County". Bulletin 75. February 1959.
18. California Department of Water Resources. "Intrusion of Salt Water Into Groundwater Basins of Southern Alameda County". Bulletin 81. December 1960.
19. California Department of Water Resources. "Investigation of Nitrates in Groundwater, Grover City, San Luis Obispo County". April 1962.
20. California Department of Water Resources. "Water Well Standards: State of California". Bulletin No. 74. February 1968.
21. California Department of Water Resources. "Cathodic Protection Well Standards: State of California". Bulletin No. 74-1. March 1973.
22. California Department of Water Resources. "California's Groundwater". Bulletin No. 118. September 1975.
23. California Department of Water Resources. "Sea-Water Intrusion in California". Inventory of Coastal Groundwater Basins. Bulletin No. 63-5. October 1975.
24. California Department of Water Resources. "Guide to the Preparation of the Water Well Drillers Report". October 1977.
25. California Department of Water Resources. "WATER WELLS and What You Should Know About Them". October 1977.
26. California Department of Water Resources. "The 1976-1977 California Drought – A Review". May 1978.
27. California Department of Water Resources. "Groundwater Basins in California". A Report to the Legislature in Response to Water Code Section 12924. Bulletin 118-80. January 1980.
28. California Department of Water Resources. San Joaquin District. "Investigation of Groundwater Contamination by Dibromochloropropane in the Dinuba Area". Memorandum Report. August 1980.
29. California Legislature, Assembly Interim Committee on Water. "State and Local Responsibilities for Water Resources". Assembly Interim Committee Reports 1965-67. Volume 26, No. 17. December 1966.
30. California State Water Pollution Control Board. "Final report on Field Investigation and Research on Wastewater Reclamation and Utilization in Relation to Underground Water Pollution". Publication No. 6. 1953.
31. California State Water pollution Control Board. "Report on the Investigation of Travel of Pollution". Publication No. 11. 1954.
32. California State Water Pollution Control Board. "Effect of Refuse Dumps on Groundwater Quality". Publication No. 24. 1961.
33. California State Water Quality Control Board. "Water Quality Criteria". By McKee, J. and Wolf, H. W. Second Edition. Publication No. 3-A 1963.
34. Campbell, Michael D. and Lehr, Jay H. "Water Well Technology". McGraw- Hill Book Company, Inc. 1973.
35. Clark, N. L. and LuChang, S. "Enteric Viruses in Water". American Water Works Association Journal. Volume 51. October 1959.
36. Crocker, S. "Piping Handbook". Fourth Edition. McGraw-Hill Book Company, Inc. 1945.

37. Davis, Stanley N. and DeWiest, Roger J. M. “Hydrogeology”. John Wiley and Sons, Inc. 1966.
38. Driscoll, Fletcher G., Hanson, David T. and Page, Lyn. “Well-Efficiency Project Yields Energy-Saving Data”. The Johnson Drillers Journal, March- April, May-June, and September-October, 1980, and First Quarter, 1981. (Four parts)
39. Gordon, R. W. “Water Well Drilling with Cable Tools”. Bucyrus-Erie Company. 1958.
40. Ham, Herbert H. “Water Wells and Groundwater Contamination”. Bulletin of the Association of Engineering Geologists. Volume VIII, No. 1. 1971.
41. Helweg, Otto J., Scalmanini, Joseph C. and Scott, Verne H. “Energy and Efficiency in Wells and Pumps”. Presented to the Twelfth Biennial Conference on Groundwater sponsored by the University of California, Water Resources Center and the California Department of Water Resources, at Sacramento, California, September 20-21, 1979. California Water Resources Center, University of California, Davis. Report No. 45. November 1979.
42. Idaho Department of Water Resources. “Minimum Well Construction Standards”. Rules and regulations. June 1975.
43. International Association of Plumbing and Mechanical Officials. “Uniform Plumbing Code”. 1976 Edition. 1976.
44. Johnson Division, Universal Oil Products Company, Inc. “Groundwater and Wells”. 1966.
45. Kurt, Carl E. and Warman, James C. “Engineering Performance of Thermoplastic Water Well Casings”. WRRI Bulletin 44. Water Resources Research Institute, Auburn University. July 1980.
46. Lenain, A. F. “The Impact of Nitrates on Water Use”. Presented to the California Section Meeting, American Water Works Association, Los Angeles, California. October 27, 1966.
47. Library of Congress, Congressional Research Service. “Resource Losses from Surface Water, Groundwater, and Atmospheric Contamination: A Catalog”. A report prepared for the Committee on Environment and Public Works, U. S. Senate, 96th Congress, Serial No. 96-9. March 1980.
48. Lieber, M., et al. “Cadmium and Hexavalent Chromium in Nassau County Groundwater”. Journal of the American Water Works Association. Volume 56. June 1964.
49. Luhdorff, Jr., Eugene E. “Protecting Groundwater Quality – Some Problems and Solutions”. Presented at the Ninth Biennial Conference on Groundwater sponsored by the University of California, Water Resources Center and the California Department of Water Resources at Goleta, California, September 13-14, 1973. Water Resources Center, University of California, Davis. Report No. 26. December 1973.
50. Minnesota Board of Health. “The Water Well Construction Code and Amendments to Regulations Relating to the Licensing of Water Well Contractors”. Adopted April 11, 1974.
51. Moore, Preston L. “Drilling Practices Manual”. The Petroleum Publishing Company. 1974.
52. Moss, Jr., R. “Evaluation of Materials for Water Well Casings and Screens”. Paper presented before the National Association of Corrosion Engineers, Western Region Meeting, San Francisco, California. October 1, 1966.
53. National Sanitation Foundation. “Standard No. 14 for Plastic Piping System Components and Related Materials”. As revised November 1978.
54. National Water Well Association. “Water Well Drillers Beginning Training Manual”. 1971.
55. National Water Well Association and The Plastic Pipe Institute “Manual on the Selection and Installation of Thermoplastic Water Well Casing”. October 1, 1980.
56. Oregon Drilling Association, Incorporated. “Manual of Water Well Construction Practices for the State of Oregon”. Second Edition. 1968.
57. Oregon Water Resources Department. “Rules and Regulations Prescribing General Standards for the Construction and Maintenance of Water Wells in Oregon”. Effective January 1, 1979. Published jointly with Oregon Department of Human Resources, Health Division and Oregon Department of Commerce, Building Codes Division.
58. Rossum, John R. “Control of Sand in Water Systems”. Journal American Water Works Association. Volume 46, No. 2. February 1954.
59. Schrock, B. J. “Thermosetting Resin Pipe”. Presented at the American Society of Civil Engineers Fall Convention, San Francisco, California. October 17-21, 1977. Preprint No. 3088.
60. Schwalen, H. C. “The Stovepipe or California Method of Well Drilling as Practised in Arizona”. University of Arizona, College of Agriculture. Bulletin No. 112. November 1, 1925.
61. Speedstar Division, Koehring Company. “Well Drilling Manual”. (Updated)
62. Spiridonoff, S. V. “Design and Use of Radial Collector Wells”, Journal American Water Works Association. Volume 56. June 1964.
63. State of Nevada, Department of Conservation and Natural Resources, Division of Water Resources. “Rules and Regulations for Drilling Wells and Other Related Material”. Undated.
64. Stead, F. M. “A Discussion of Factors Limiting the Bacterial Pollution of Underground Waters by Sewage”. Report on the California State Assembly Interim Fact-Finding Committee on Water Pollution. 1949.
65. Todd, D. K. “Groundwater Hydrology”. John Wiley and Sons, Inc. 1959.
66. Tolman, C. F. “Groundwater”. McGraw-Hill Book Company, Inc. 1939.
67. U. S. Bureau of Reclamation. “Groundwater Manual”. First Edition. 1977.

68. U. S. Department of Commerce, Environmental Science Services Administration. “CLIMATES OF THE STATES – Climate of California”. Climatography of the United States No. 60-4. Revised June 1970.
69. U. S. Department of Housing and Urban Development. “Minimum Property Standards for One and Two Family Dwellings”. 1973 Edition with Revisions for 1974, 1975 and 1976.
70. U. S. Departments of the Army and the Air Force. “Wells”. Technical Manual TM5-297 and Air Force Manual 85-23. August 1, 1957.
71. U. S. Environmental Protection Agency, Office of Air and Water Programs. “Groundwater Pollution from Subsurface Excavations”. 1973. EPA 430/9-73- 012.
72. U. S. Environmental Protection Agency, Office of Research and Development. “Subsurface Biological Activity in Relation to Groundwater Pollution”. September 1973. EPA 660/2-73-014.
73. U. S. Environmental Protection Agency, Office of Water Programs, Water Supply Division. “Manual of Individual Water Supply Systems”. Revised 1974. EPA 430/9-74-007.
74. U. S. Environmental Protection Agency, Office of Water Supply. “Manual of Water Well Construction Practices”. 1976. EPA 570/9-75-001.
75. U. S. Environmental Protection Agency, Office of Water Supply. “National Interim Primary Drinking Water Regulations”. 1976. EPA 570/9-76- 003.
76. U. S. Environmental Protection Agency, Office of Research and Development. “Impact of Abandoned Wells on Groundwater”. August 1977. EPA 600/3-77-095.
77. U. S. Geological Survey. “Study and Interpretation of the Chemical Characteristics of Natural Water”. Water Supply Paper 1473. 1959.
78. U. S. Geological Survey. “A Primer on Groundwater”. 1963.
79. U. S. Geological Survey. “Reverse Circulation Drilling, an Improved Tool for Production Wells and Exploratory Holes”. Open File Report. May 1963.
80. U. S. Geological Survey. “A Primer on Water Quality”. 1965.
81. U. S. Geological Survey. “Regional Trends in Water Well Drilling in the United States”. Circular 533. 1966.
82. U. S. Geological Survey. “Evaluation and Control of Corrosion and Encrustation in Tube Wells of the Indus Plains, West Pakistan”. Water Supply Paper 1608-L. 1969.
83. U. S. Public Health Service. “Groundwater Contamination”. Proceedings of the 1061 Symposium. Technical Report W61-5. 1961.
84. U. S. Public Health Service. “Recommended State Legislation and Regulations - Urban Water Supply and Sewerage Systems Act and Regulations - Water Well Construction and Pump Installation Act and Regulations - Individual Sewerage Disposal Systems Act and Regulations. July 1965.
85. United States Senate, Eighty-ninth Congress, Committee on Interior and Insular Affairs. “Mineral and Water Resources of California – Part II, Water Resources; Section I; Water Resources Appraisal”. Report of the U. S. Department of the Interior, Geological Survey, in collaboration with the California Department of Water Resources. 1966.
86. University of California. “Irrigation Wells and Well Drilling”. Agricultural Experiment Station, College of Agriculture. Circular 404. May 1951.
87. University of California. “Proceedings – Symposium on Agricultural Waste Waters, Davis, California, April 6-8, 1966”. Water Resources Center Report No. 10.
88. University of California. “Water Wells and Pumps: Their Design, Construction, Operation and Maintenance”. Division of Agricultural Sciences. Bulletin 1889. May 1978.
89. Vertical Turbine Pump Association. “Turbine Pump Facts”. 1962.
90. Walker, T. R. “Groundwater Contamination in the Rocky Mountain Arsenal Area, Denver, Colorado”. The Geological Society of America. Bulletin 72, Volume 3. March 1961.
91. Washington Department of Ecology. “Minimum Standards for Construction and Maintenance of Water Wells”. Chapter 173-160 Washington Administrative Code. January 10, 1979.
92. Water Systems Council. “Water Systems Handbook”. Sixth Edition. 1977.
93. Water Systems Council. “What you need to know about WELLS & WATER SYSTEMS”. 1975.
94. Water Well Journal. “Water Well Drilling Methods”. Reprint of seven papers presented at the 1957 National Water Well Exposition.
95. Weibel, S. R., et al. “Waterborne-Disease Outbreaks, 1946-60”. Journal of the American Water Works Association. Volume 56. August 1964.