California Conference
of Directors of
Environmental Health

January 3, 2019

Julie Haas, P.E.
Senior Engineer, Water Resources
California Department of Water Resources
901 P Street, Sacramento CA 95814

Subject: Recommended edits to California Well Standards Bulletins

Dear Ms. Haas,

Please find attached recommendations for edits to the current California Well Standards Bulletins. The California Conference of Directors of Environmental Health (CCDEH) is an association of California Environmental Health Directors. Our association's Well Technical Advisory Committee drafted the recommendations over the last year as part of a collaborative effort of technical experts from local jurisdictions and representatives from the California Ground Water Association (CGA). The attachments also incorporate recommendations prepared by a prior Well Technical Advisory Committee group between July 2010 and August 2013. There are some areas noted that need further technical review, particularly as it relates to the use of Bentonite.

We very much appreciate your partnership and support. Please let us know what more we can do to assist as the revision process progresses. Our group may also forward additional recommendations as the process progresses.

With Best Regards,

Elizabeth A. Pozzebon, DrPH, REHS
Director
County of San Luis Obispo
Environmental Health Services
CCDEH Water and Land Policy Committee Chair

910 K Street, Suite 300 • Sacramento, CA 95814 ph (916) 448-1015 fax (916) 448-7176 www.ccdeh.com

CCDEH Well Technical Advisory Committee Recommended Edits to State Well Bulletin Standards

January 3, 2019

CHAPTER 2

Bulletin Section	Proposed Changes	Comments
Ch II, Part I, Section 1.Definitions (A)		Consideration should be given to include dewatering wells into the Bulletin or they should be redefined. Dewatering wells for temporary construction can extract a significant amount of groundwater (we have experience seeing a typical dewatering job extracting 2 to 12 acre-feet). This can add up to a significant volume of water depending on the number of projects in a basin. In addition, with the adoption of SGMA, this should be revisited since Dewatering Wells can be located in the "first" aquifer of a basin and could impact surface water/groundwater interactions (i.e.,

		Groundwater Dependent Ecosystems).
Ch II, Part I, Section 1.Definitions (B)	Community water supply well: A water well used to supply water domestic purposes in systems subject Ch 7, Part 1, Division 5 of the California Health and Safety Code. Included are wells supplying public water systems classified by the ~~Department of Health Services~~ *Department of Public Health* or its successor as "Noncommunity water systems" and "State small water systems" (California Water Works Standards, Title 22, California Administrative Code). Such wells are variously referred to as "Municipal wells", "City wells", or "Public water supply wells". *Also included are "Transient non-community" wells.*	Delete Department of Health Services and replace with Department of Public Health or its successors and addition of transient non-community wells into definition.
Ch II, Part I, Section 1.Definitions (I)	Exploration Hole (or Boring): An uncased, temporary excavation whose purpose is the determination of hydrologic conditions at a site.	See Section 4 of Ch II, Exclusion. Does a test hole need to be included as a definition if it is excluded from all construction standards? Should they be excluded from construction standards? New definition?
Ch II, Part I, Section 1.Definitions (L)	Enforcing agency: An agency designated by duly authorized local, regional or State government to administer and enforce laws or ordinance pertaining to the construction, alteration, maintenance, and destruction of water wells. The ~~Department of Health Services~~ *California Department of Public Health or its successor* or the local health agency is the enforcing agency for community wells.	Delete Department of Health Services and replace with Department of Public Health or its successors
Ch II, Part I, Section 1.Definitions (M)	*Cathodic protection wells: a cathodic protection well contains devices to minimize electrolytic corrosion of metallic pipelines, tank, and other facilities in contact with the earth.*	Adds cathodic protection well to the definitions (not previously in this Part and section)

Ch II, Part I, Section 1.Definitions (N)	*Geothermal heat exchange wells (GHEW): a geothermal health exchange well or loop well is part of a geothermal heat pump system consisting of a vertical borehole within which is emplaced a heat exchange (loop) tube grouted in place from the bottom of the borehole to the surface.*	Adds geothermal heat exchange well to the definitions (not previously in this Part and section)
Ch II, Part I, Section 1.Definitions (O)	*Monitoring wells: wells constructed for the purpose of observing or monitoring groundwater conditions such as water levels or water quality.*	Adds monitoring wells to the definitions (not previously in this Part and section)
Ch II, Part I, Section 5. Special Standards (B)	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 is subject to the *review and* approval of the enforcing agency.	Add language.
Ch II, Part I, Section 6. Well Drillers	The construction, alteration, or destruction of wells shall be performed by contractors licensed in accordance with the provisions if the Contractors License Law (Chapter 9, Division 3 of the Business and Professions Code) *and Section 13750.5 of the California Water Code* unless exempted by *these acts* ~~that act~~.	Additional language from water code which also requires licensed C-57 contractors.
Ch II, Part II Well Construction	*As a guiding principle it should be remembered that all wells should be designed and constructed to also facilitate their eventual destruction at the end of their useful service life.* Section 8. Well Location with Respect to Pollutants and Contaminants ~~and~~, Structures *and Surface Water*	Adds statement immediately preceding Section 8, Part II: Well Construction. Change in section title to include surface water.
Ch II, Part II Well Construction, Section 8. Well Locations	A. Separation. All water wells shall *conform with local City, County or other local code requirements and* be located an adequate horizontal distance from known or potential sources of pollution and contamination. Such sources include, but are not limited to:	In Protecting Our Water & Environmental Resources v. Stanislaus County currently pending Supreme Court review, the Fifth District Court of Appeal based its decision that the permitting process is discretionary based on one word / standard in the Bulletin,

		namely the word "adequate" under Section 8(A). To the extent that this language could be removed and/or modified, that would be helpful.
Ch II, Part II, Section 8. Well Locations (A)	~~Maximum~~ *Minimum* Horizontal Separation Distance Between Well and Known or Potential Source	Horizontal Separation table should be updated to reflect minimum standards as outlined in the OWTS Policy. Consideration should be given to adding a setback for petroleum products pipeline of 150 ft. Title should be changed from Maximum to Minimum Horizontal Separation Distance. Consideration should be given to adding other potential sources of contamination to this table such as bioretention areas/swales, surface water treatment/filters, hydromodification vaults and the like.
Ch II, Part II, Section 8. Well Locations (B)	*B. Surface Water Depletion Prevention:* *"New water wells located within one mile of a navigable waterway (as defined by the U.S. Army Corp of Engineers according to 33 CFR Part 329),*	Recent judicial actions, most recently a Third District Court of Appeal

	must have their uppermost perforation start below a depth of 150 feet. [Distance and depth criteria are based on criteria established by DWR and USBR for acceptance of wells into the groundwater substitution transfer program (2015, Draft Technical Information for Preparing Water Transfer Proposals).] *Wells are exempt from the above restriction if one of the following apply: [Exemptions based on Stanislaus County's exemptions from CEQA.]* *• The well is intended to extract groundwater for domestic use and will be six inches in nominal diameter or less.* *• The well is designed to replace an existing well, provided the well has no greater capacity than the well it is replacing."*	opinion (filed 8/29/2018), have held that 1) public trust doctrine applies to the extraction of groundwater to the extent that the extraction adversely impacts a river, and 2) SGMA does not abrogate state's public trust duty. The Court also held that the public trust responsibility applies at the state and local levels. As such, it is prudent for the Well Bulletin to address this issue. Simply stated, well permits should not be approved if extraction of groundwater from the well would harm a navigable waterway or another surface water feature protected under the public trust doctrine. A proximity screening threshold such as what has been proposed here may reduce the likelihood of significant surface water depletion

		and does not require site-specific ground-surface water modeling.
Ch II, Part II, Section 9. Sealing the Upper Space (A)		Consideration should be given to increase minimum seal depth to 50 ft consistent with AWWA (A100-15) 4.7.8.2
Ch II, Part II, Section 9. Sealing the Upper Space (A)1	Shallow Groundwater: exceptions to minimum seal depths can be made for shallow wells at the approval of the enforcing agency ~~where the water to be produced is a depth less than 20 feet.~~ In no case shall an annular seal extend to a total depth less than ~~10~~ *20* ft below land surface. The annular seal shall be no less than ~~10~~ *20* ft in length.	Further discussion is needed regarding this matter.
Ch II, Part II, Section 9. Sealing the Upper Space (A)4	Vaults: at the approval of the enforcing agency, 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. *To eliminate the requirement for shoring the vault excavation,* ~~In no case shall~~ *it is recommended that* the top of the annular surface seal be *no* more than ~~4~~ *5* ft below ground surface. The vault shall extend from the top of the annular seal to at least ground surface.	Addition of language regarding shoring and change from 4 to 5 ft for depth of vault. Reference CGA Std Practice 290: Below grade well head discharge for further details on the issue.
Ch II, Part II, Section 9. Sealing the Upper Space (A)4	~~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 placed of vaults.~~ *Vaults and the alternative of pitless adapters should be avoided wherever possible in favor of above ground discharge. However, where project considerations dictate, either may provide a solution for subsurface discharge. The employment of one or the other depends on job and site conditions.*	Replaces previous version of language regarding use of vaults and pitless adapters.

Ch II, Part II, Section 9. Sealing the Upper Space (B)	Grout pipe method (1) Drill the hole large enough to accommodate the grout pipe, at least 4 inches greater in diameter than the diameter of the casing. *(Note: for public supply wells, the Division of Drinking Water, or successor, has adopted a minimum annular space of 3 inches, unless the "Halliburton"cementing method is used. A Borehole 6 inches in diameter greater than the diameter of the casing would then be needed.)*	Adds the "Note" to this section.
Ch II, Part II, Section 9. Sealing the Upper Space (B)		Under Pressure cap method & continuous injection: cement with coarse aggregate is not recommended as sealing material in this revision, in any event, and only "fine" aggregate should be used. For definition of "fine" aggregate refer to ASTM standard C-33-03, Standard specification for concrete aggregates, and CGA standard practice series article 210 "Definitions of sand as used in sand-cement mixtures for annular seals"

Ch II, Part II, Section 9. Sealing the Upper Space (B)	Sealing Conditions (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 be used if it is installed in accordance with Item 3 below and ~~Item 5 (Page 32 of Bulletin 74-81~~) *provision may be made for the gravel pack between the conductor casing and the production casing to extend to the top of the well. In this case an annular or "ring" seal plate shall be placed (welded in the case of steel casing) at the top to prevent contamination by surface drainage* (Figure 3A). The conductor casing should extend to at least 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.	Addition of language regarding provisions for gravel packing under permanent conductor casing.
Ch II, Part II, Section 9. Sealing the Upper Space (B)	~~Temporary conductor casing that must be left in place shall be perforated immediately before sealing operations begin to prevent drilling or well construction operation 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 space or voids between the casing and the 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 enforcing agency.~~ ~~Sealing material must also fill the annular space between the conductor casing and the well casing within the required sealing intervals.~~	Deletion of these paragraphs. These paragraphs should be struck from the "Sealing Materials" section as they are impractical. Once the production casing has been installed and it is found that the "temporary" conductor casing can't be removed, there is no way to perforate it. The conductor casing would have to be pre=perforated before installation.

Ch II, Part II, Section 9. Sealing the Upper Space (B)	Sealing Conditions (3) Wells drilled in soft consolidated formations (extensive clays, sandstones, etc): 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. 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 as shown by Figure 3C. *(Note: refer to previous Section 9.B.1 regarding minimum 3 inch annular space required by Department of Public Health for public supply wells resulting in the "oversized" hole being 6 inches in diameter.)*	Addition of "Note" to this paragraph.
Ch II, Part II, Section 9. Sealing the Upper Space (B)	Sealing Conditions (4) Wells situated in "hard" consolidated formations (crystalline or metamorphic rock). An "oversized" hole shall be drilled to the depth specified in Subsection A of this section 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 solid material. If the well is to be open bottomed (lower section uncased) the casing shall be sealed *in the oversized hole prior to drilling inside the casing and extending the smaller diameter open hole to total depth (Figure 4A)* ~~in the sealing material (see Figure 5A)~~.	Addition of information regarding sealing conditions for open bottomed wells.
Ch II, Part II, Section 9. Sealing the Upper Space (B)	Sealing Conditions (5) Gravel Packed Wells (b) Without Conductor Casing: an oversized hole at least 4 inches greater in diameter than the production casing shall be drilled to the depth specified in Subsection A of this section and the annular space between the casing and the drilled hole filled with sealing material. If the gravel fill pipes are installed through the seal, the annular seal shall be of sufficient thickness to assure that there is a minimum of 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 4C). If a temporary conductor casing is used it shall be removed at the sealing material is placed. *(Note: refer to previous Section 9.B.1 for discussion of minimum annular seal required for public supply wells.)*	Addition of "Note" to this paragraph. Disucssion may be warranted to make minimum annular seal 3 inches for consistency with public supply wells. (and AWWA?)

Ch II, Part II, Section 9. Sealing the Upper Space (B)	Sealing Conditions (8) Wells that penetrate zones containing poo-quality water, pollutants, or contaminants: 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, or contaminants during drilling and well construction operations. Special precautions could include the use of temporary or permanent conductor casing, use of ~~borehole liners,~~ *"Strata sealing-off procedures" described in Section 13* and specialized drilling equipment. The conductor casing is described in item 1 above.	Deletion of "borehole liners" from special precautions and addition of "Strata sealing-off procedures".
Ch II, Part II, Section 9. Sealing the Upper Space (D)	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.	Deletion of concrete from approved sealing material.
Ch II, Part II, Section 9. Sealing the Upper Space (D)2	*Pozzolan (also commonly known as "fly ash") combined with Portland cement contributes "cementitious" properties. Some principal benefits of the use of Type F coal fly ash as a component of cement sealing material include enhanced workability, less water demand, reduced permeability and chloride penetration, greater resistance to sulfate attack, and reduced shrinkage during curing. When a deep annular seal is to be emplaced, pozzolan may be mixed up to A 50/50 ratio with cement. This mixture having lighter unit weight reduces the potential for borehole formation breakdown and the resulting lost circulation of sealing material.*	Further research may be needed to determine if generally available fly ash can meet DWR standards ASTM C494 and ASTM C618 or the latest revisions thereof. Consideration should take into account possible metal contamination from the fly ash.

Ch II, Part II, Section 9. Sealing the Upper Space (D)2	~~Dry additives should be mixed with dry cement before adding water to the mixture to~~ *The normal process of cement "batching" will* ensure proper mixing of *the additives*, uniformity of hydration and an effective and homogenous seal. The water demand of additives shall be taken into account when water is added to the mix. *Minimum* times required for sealing material containing Portland cement to set and begin curing before construction operations on a well can be resumed are:....	Deletion of "Dry additives should be mixed with dry cement before adding water to the mixture to" and replace with "The normal process of cement batching will..". Addition of "Minimum" to times required for sealing.
Ch II, Part II, Section 9. Sealing the Upper Space (D)2c	~~Concrete. Concrete us often used for larger 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 pounds of Type I or Type 11 Portland cement per cubic yard of uniform *3/8* inch aggregate.~~ ~~In no case shall the size of the aggregate be more than 115 the radial thickness of the annular seal. Water shall be added to concrete mixes to attain proper consistency for placement setting, and curing.~~	Deletion of section pertaining to concrete as a sealing material.
Ch II, Part II, Section 9. Sealing the Upper Space (D)3	Bentonite: bentonite clay in "gel" *or chip* form has ~~some~~ many of the advantages of cement-based sealing material, *along with additional useful characteristics as a sealing material* ~~a disadvantage is that the clay can sometimes separate from the clay water mixture~~.	Addition of "chip" and language regarding usefulness.

Ch II, Part II, Section 9. Sealing the Upper Space (D)3	Although many types of clay mixtures are available, none has sealing properties comparable to bentonite clay. Bentonite expands significantly in volume when hydrated. Only bentonite clay is an acceptable clay for ~~annual~~ *annular* seals and *it is in two forms:* *High solids sodium bentonite: this type of "sealing grade" grout consists of 20 to 30 percent solids content by weight of sodium bentonite when mixed with water. Pumping in place is necessary for this bentonite to lower the viscosity and generally higher pumping pressures are needed than normally used with cement grout.* *Bentonite chips: these grout products commonly known as "hole plug" or medium or coarse "Enviroplug" are intended to be poured into the well annulus to form a seal. The materials readily absorb water and form a very low permeability and permanent seal. Being denser than water they can be poured through standing water.*	Addition of "high solids sodium bentonite" and "bentonite chips" to section.
Ch II, Part II, Section 9. Sealing the Upper Space (D)3	~~Unamended~~ Bentonite clay seals should not be used where structural strength of the seal is require or where is will be dry. Bentonite seals may have 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, *such as in wells that penetrate formations containing water of high salinity (generally 2,000 ppm TDS or more) such as in coastal areas subjected to seawater intrusion* ~~as can~~ ~~cement-based materials~~.	Addition of language regarding chemical conditions and quantification of TDS to be aware of.
Ch II, Part II, Section 9. Sealing the Upper Space (D)3	Bentonite clay mixtures shall be thoroughly mixed with clean water prior to placement. A sufficient amount of water shall be added to the bentonite to allow proper hydration. Depending on the bentonite sealing mixture used*, 6.3 gallons* of water should be added to about every 1 pound of bentonite. Water added to bentonite for hydration shall be of suitable quality and free of pollutants and contaminants.	Addition of language for 6.3 gal/1 lb ratio of water to bentonite.

Ch II, Part II, Section 9. Sealing the Upper Space (D)3	Bentonite	General discussion of bentonite use as a sealing material in reference to coated "time released" chips and their appropriate usefulness as well as consideration of Nebraska grout study and DWR's memo regarding bentonite slurries.
Ch II, Part II, Section 9. Sealing the Upper Space E	Radial Thickness of Seal: a minimum of 2 inches of sealing material shall be maintained between all casing and the borehole wall, within the interval to be sealed, except where temporary conductor casing cannot be removed, as noted in Subsection B above *or the "strata sealing-off" method is employed in an existing well as described in Section 13.C*....	Addition of language regarding "strata sealing-off" method. Discussion regarding AWWA A100-06's allowance of a 1.5 inch annular seal when using the "Halliburton" or similar method of grouting may be warranted. Refer to Section 9.B.1 for discussion regarding 3 in requirement for public wells.
Ch II, Part II, Section 9. Sealing the Upper Space (F)3	Foundation and transition seals: Water should be added to bentonite at a ratio~~n~~ *of about 6.3 gallons of water for each pound* of bentonite to allow for proper hydration. Water added to bentonite for hydration shall be of suitable quality and free of pollutants and contaminants.	Addition of language for 6.3 gal/1 lb ratio of water to bentonite.
Ch II, Part II, Section 9. Sealing the Upper Space (F)4	Timing and method of placement	Refer to 9.D.3 on bentonite "time release"

		materials relative to this "freefall" issue.
Ch II, Part II, Section 9. Sealing the Upper Space (F)5	Groundwater flow	Refer to CGA Standard practice Article 550 "Management of surface artesian flows during well construction" for further detail.
Ch II, Part II, Section 10. Surface Construction Features		AWWA 4.7.10.3 requires minimum height of casing aboveground to be 24" from finished grade and 24" above the 100-year flood level of record if the well is within a flood zone. It would be beneficial if minimum height of well casing is included in the bulletins.
Ch II, Part II, Section 10. Surface Construction Features (A)5	Bases: 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 watertight 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 enforcing agency.~~	Deletion of language regarding cement seals and the need to pour the slab prior to it setting. This is impractical as seals are placed by drillers and slabs usually done after the fact by others. This was removed as all references to cement as a seal material have been deleted. In addition, the annular

		seal is the primary means of prevention against contamination.
Ch II, Part II, Section 10. Surface Construction Features (A)5		There is a reference to the Vertical Turbine Pump Association in the Bulletin. There appears to be no state standard for well head design with respect to base and pedestal for municipal wells with large vertical turbine motors. New example guidance provided in Figure 6. Does reference need to be deleted or is there a state standard to incorporate?
Ch II, Part II, Section 10. Surface Construction Features (A)5.a	Where the well is to be gravel packed and the pack extends to the surface, a water tight cover shall be installed between the conductor casing and the inner casing (see Section 9.B.5)	Refer to CGA Standard practice Article 290 "Below grade well discharge" for further details.
Ch II, Part II, Section 10. Surface Construction Features (B)	Well Pits and 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 enforcement agency. ~~A substitute device such as a pitless adapter or pitless adapter unit (a variation) should almost always be used in place of a vault of pit.~~	See discussion of the issue Section 9.A.4.

Ch II, Part II, Section 10. Surface Construction Features (B)	~~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 enforcing agency. If bentonite based sealing material is used for the annual seal, the vault should be set into the bentonite before it is fully hydrated.~~	Deletion for reasons as noted in Ch II, Part II, Section 10. Surface Construction Features (A)5
Ch II, Part II, Section 10. Surface Construction Features (B)	~~The sealing material surrounding the 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 the 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.~~	Deletion for reasons as noted in Ch II, Part II, Section 10. Surface Construction Features (A)5
Ch II, Part II, Section 10. Surface Construction Features (B)	The vault cover or lid shall be watertight but shall allow the venting of gases. *However this consideration should not prevent those wells that are "double cased" and are non-vented because they are designed to draw a vacuum to enhance the pumping of water from the aquifer, from being installed in a vault.* 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.	Addition of language for vacuum designed wells.
Ch II, Part II, Section 10. Surface Construction Features (F)	Backflow Prevention	Refer to CGA standard practice series Article 320 "Backflow prevention for agricultural wells" for further details if needed.
Ch II, Part II, Section 11. Disinfection and other Sanitary Requirements	Gravel	Refer to CGA standard practice series Article 225 "Gravel Pack Materials and Handling" for further information.

Ch II, Part II, Section 12. Casing Material and Installation (A)2a	Standard and Line piping: This material shall meet one of the following specifications, *including the latest revision thereof:* …. ~~8. ASTM A211, Standard Specifications for spiral welded steel or iron pipe~~	#8 was withdrawn in 1993 and not replaced.
Ch II, Part II, Section 12. Casing Material and Installation (A)2b	Structural Steel: 5. ASTM A570, *(now A1011/A1011M)* "Standard specification for hot-rolled carbon steel sheet and strip, structural quality"	Change in reference #.
Ch II, Part II, Section 12. Casing Material and Installation (A)3a(2)	Thermoset Plastic: 3. ~~Reinforced plastic mortar and pressure pipe:~~ ASTM D3517-11 "Standard specifications for *Fiberglass (glass-fiber reinforced thermosetting resin) pressure pipe"*	
Ch II, Part II, Section 12. Casing Material and Installation (A)3a(3)	Plastic casing: plastic casing may be ~~may be joined by solvent welding or~~ mechanically joined by threads or other means, *such as "Certa-Lok" coupling*, depending on the type of material and its fabrication. ~~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."~~	Clarification of standards for casing in drinking water supply wells.
Ch II, Part II, Section 13. Sealing-off Strata (C)	*C. The "strata seal off" (liner) method may be employed to seal off fractured intervals containing poor quality water in previously constructed "hard rock" wells that were appropriately sealed and approved in accordance with local regulations. Such wells are not usually cased to their total depth, having a relatively short section of casing installed and sealed through weathered materials into solid rock. At some time after well completion, poor quality water may originate from below the depth of the existing annular seal, and*	This section is taken from Appendix B in Bulletin 74-81, "Sealing the Annular Space" and because of its importance is inserted here. However, that portion of Appendix B

	the "strata seal off" (liner) method may be employed to remedy this occurrence (Figure 9). *In this method, blank and perforated casing 2-inches less in diameter than the production casing should be installed from the surface to the total depth of the well. A packer or "shale-trap" to confine the bottom of the interval to be sealed should be placed at least 10 feet below the contaminated zone (and at least 20 feet from the bottom of the existing production casing), and the top of the sealing material should be at least 1O feet above the contaminated zone. The sealing material can be emplaced in the 1-inch annulus by a small diameter tremie pipe, which is entirely feasible with current grouting materials and equipment.*	dealing with "strata seal-off'' is expanded and included herein as Section 13.C.
Ch II, Part II, Section 14. Well Development		Refer to CGA Standard practice series Article 227 "Well Development" for further reference if needed.
Ch II, Part II, 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~~ *sealing material.*	Deletion of mud and replacement with generic sealing material.
Ch II, Part II, Section 18. Rehabilitation, Repair and Deepening of Wells (A)	7. *brushing and swabbing*; or 8. combination of these	Addition of language
Ch II, Part II, Section 21. Definition of "Abandoned" well	*Pursuant to Section 115700 of the California Health and Safety Code,* ~~A~~ a well is considered "abandoned" or permanently inactive if it has not been used for a period of one year, unless the owner demonstrates intention to use the well again. In accordance with Section ~~24400~~ *115700* of the California Health and Safety Code, the well owner shall properly maintain	Correction of Health and Safety Code sections.

	an inactive well as evidence of intention for future use in such a way that the following requirements are met:…	
Ch II, Part II, Section 23. Requirements for Destroying Wells (A)1	Obstructions. The well shall be cleaned, as needed, *to its total depth if known*, 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. *It should be recognized that despite diligent efforts, such as in trying to extract old pump bowls that have fallen to the bottom of the well, or in attempting to remove collapsed casing, that such efforts may not be successful. The clearing of obstructions should be carried out only to an extent that is reasonably feasible. Demonstrating "proof" of the bottom of the hole may depend on local hydrogeologic conditions and/or requirements of the enforcing agency.*	Additional language regarding possible outcomes to be considered when clearing obstructions.
Ch II, Part II, Section 23. Requirements for Destroying Wells (A)2	*Casing Destruction:* Where necessary, to ensure that sealing materials 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. *Openings in the casing may be made with a gun-perforator per oilfield practice, with an air-percussion perforator, by ripping with a mechanical knife or similar device if casing condition allows, or by explosive devices. PVC casing can be difficult to perforate; in some cases it may be perforated successfully with a "wheel cutter", but more commonly PVC casing must either be "drilled out" or destroyed by use of a detonator cord or shaped charges inserted into the well at selected intervals. After filling the well with neat cement sealing materials, the explosives are detonated, simultaneously opening the casing and driving the sealing material into the annulus and borehole wall. The purpose of any of these operations is to facilitate entry of the sealing material into the annulus and achieve penetration into the native formation or any existing gravel pack to the maximum extent possible.*	Additional details on how to destroy casing appropriately.

Ch II, Part II, Section 23. Requirements for Destroying Wells (B)	~~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, Page 55 of Bulletin 74-81)~~ ~~2.~~*1.* 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 *from the bottom to the top with sealing materials as specified in Section 23.D* 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.~~ *2*. 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 *bentonite chips* ~~concrete~~ *from the bottom of the well to the top.* ~~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	Deletion of section regarding seals in unconsolidated material.

	grained material shall not be used as fill material for creviced or fractured rock formations. 3. Well in Noncreviced, Consolidated Formation. The upper 20 *to 50* feet of a well *(depending on original annular seal depth)* in a noncreviced consolidated formation shall be filled with impervious *sealing* material *as defined in Section 23.D.* The remainder of the well may be filled with *clean fill materials such as sand or gravel as defined in Section 23.D.* ~~clay or other suitable inorganic material.~~	
Ch II, Part II, Section 23. Requirements for Destroying Wells (C)	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 appropriate material (as described in item D of this section) from the bottom of the well up *using a tremie pipe which is kept submerged in the mixture and is periodically raised as the well bore is filled.* 2. Where neat cement grout, *or* 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 aggregates from cementing materials. *If bentonite chips are used, they should be screened to eliminate "fines" and installed slowly to prevent bridging, and the fill depth should be measured frequently to assure proper placement.* 5. In destroying gravel-packed wells, the casing shall be perforated or otherwise punctured opposite the area to be sealed. The ~~sealing material~~ *neat cement* 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 *by whatever method is being used.*	Addition and deletion of language consistent with changes proposed to sealing material and methods.

Ch II, Part II, Section 23. Requirements for Destroying Wells (D)	~~1. Impervious~~ Sealing Materials. No material is completely impervious. However, sealing materials shall have such a low permeability that the volume of water passing through them is of small consequence. *Used drilling muds or cuttings are not acceptable sealing materials.* ~~Suitable impervious materials include neat cement, sand cement grout, concrete, and bentonite clay, all of which are described in Section 9, paragraph D, "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.~~ *Recommended sealing materials include: neat cement, sand- cement, bentonite, or combinations of these materials. In some cases, additives are used to affect viscosity, setting time, and strength. It should be noted that make-up water chemistry may be important in determining the ultimate behavior of the sealing materials during placement and curing. The water quality of the make-up water should be checked before operations begin to ensure that the water is compatible with the sealing materials.* *• Neat cement grout: Neat cement grout generally involves use of a ratio of one 94-pound bag of Portland cement to no more than 6-112 gallons of water (which is equal to a 17-sack cement/water mix as available from a "ready mix" source). A small amount of bentonite (up to 6% by weight) may be added to make the mixture more "fluid" and reduce shrinkage. Special additives may be needed to prevent deterioration of the cement column in areas subjected to seawater intrusion, for example.* *• Sand-cement mixtures: Sand-cement mixtures increase the "bulk" and might be used in such situations as filling a large diameter hand-dug well. The recommended mixture is generally 2 parts sand to 1 part Portland cement by weight and about 7 gallons of water.*	Revised destruction sealing materials section consistent with proposed changes.

	• High solids sodium bentonite: This type of "sealing grade" grout consists of 20 to 30% solids content by weight of sodium bentonite when mixed with water. Pumping in place is necessary for this bentonite to lower the viscosity, and generally higher pumping pressures are needed than normally used with cement grout. Bentonite sealing material will not "gel" properly and should not be used in wells that penetrate formations containing water of higher salinity (generally 2,000 parts per million TDS or greater) such as in coastal areas subjected to seawater intrusion. Also, in such subsurface environments, increasing formation water salinity with time may compromise the sealing properties of bentonite. *• Bentonite chips: These grouts products, commonly known as "Hole Plug" or medium and coarse "Enviroplug" are intended to be poured into the well to form a seal. The materials readily absorb water and form a very low permeability and permanent seal. Being denser than water they can be poured through standing water.* *• Materials for filling: In cases where no sealant is needed to prevent water flow and materials are only needed to fill the well, such as completed in a non-creviced, consolidated formation, coarse sand or gravel may be employed. These materials should be clean and not contaminated, and of a particle size that minimizes the potential for "bridging" during placement.* ~~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.~~	
Ch II, Part II, Section 23. Requirements for Destroying Wells (E)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. *However, it should be noted that old wells that have been "sand pumpers" may have a cavity surrounding the top of the well, and excavation for the "mushroom" cap may be hazardous to the safety of personnel and equipment, as the soil in the annulus around the excavation of the casing may be unstable. Cutting*	Additional detail added to urban area destruction requirements.

	off the casing at a lesser depth than 5 feet may be warranted in such a situation, along with emplacement of sealing material to a minimum depth of 20 feet. With this treatment, the "mushroom" cap is not recommended.	
Ch II, Part II, Section 23. Requirements for Destroying Wells (G)	*G. Disposal of Fluids and Solids: Disposal of fluids and solids resulting from well destruction operations should be accomplished in accordance with applicable local and State regulations relative to "Best Management Practices (BMP) ".*	Addition of section
Ch II, Part II, Section 23. Requirements for Destroying Wells (H)	*H. Records: Records of the materials and well destruction procedures are normally required by enforcing agencies and their requirements should be adhered to. It is always useful to survey the well location using a GPS system so the location of a destroyed well may be recovered if a problem or contamination, for example, should arise in the future. In addition, a method of visual identification such as a marker or ID tag could be placed at the well location (or above it, if top of casing is below ground) and would be useful in recovering the location at a later date.*	Addition of section. For further information, refer to CGA Standard Practice Series Article 299 - "Destruction of Water Wells," and/or references (some of which have been updated) cited therein. Another reference is Section 11 "Permanent Well and Test-Hole Decommissioning" in the April 2011 draft of the National Groundwater Association (NGWA) ANSI/NGWA-01-07 Water Well Construction Standard.

CHAPTER 3 – MONITORING WELLS

Bulletin Section	Proposed Changes	Comments
Chapter 3, Introduction	Groundwater monitoring wells are principally used for observing groundwater levels and flow conditions, obtaining samples for determining groundwater quality, and for evaluating hydraulic properties of water-bearing strata. ~~Monitoring wells are sometimes referred to as observation wells.~~ ***In contrast to water supply wells which are typically designed to obtain water from multiple water-bearing strata, the*** screened or perforated section of a monitoring well usually extends only a short length to obtain water from, or to monitor conditions within, an individual water-bearing unit or zone. ~~Water wells are often designed to obtain water from multiple water bearing strata.~~ Although there are usually differences between the design and function of monitoring wells and water wells, water wells sometimes are used as monitoring wells, and vice versa.	

	The California Legislature amended the California Water Code in 1986 specifically to include requirements for monitoring well standards. Monitoring wells we**re** previously assumed by the Department to be covered by the collective term ‘well” in the law.	
Chapter 3, History of Monitoring Wells	Monitoring wells were first used mainly for water level measurements. The wells were often referred to as piezometers in reference to the "piezometric surface" of groundwater. ~~In recent years the term "piezometric surface" is often replaced by "potentiometric surface".~~ However the term "piezometer" is still sometimes used for monitoring wells installed only for water level measurements. Modern electronic water level measuring and recording devices now allow for small- diameter water-level monitoring wells. Some continuous water-level measurement devices can be used in wells less than 2-inches in inside diameter **or narrower.** Most monitoring wells constructed today are used to assess: • The nature and distribution of pollutants and constituents in ~~groundwater~~ ***in the saturated and vadose zones.*** The nature and. distribution of naturally occurring chemical constituents ***in the saturated and vadose zones;*** • Subsurface hydrologic conditions; The hydraulic properties of strata as they relate to pollutant and contaminant movement; ***and,*** • ***The effectiveness of implemented soil and groundwater mitigation operations*** Some monitoring wells are designed to be multipurpose. Monitoring wells can sometimes be used as "extraction" or "injection" wells for mitigation of pollutants or contamination ***while they are also being monitored. Others can be used to monitor conditions in both the saturated and vadose zones.***	

	Monitoring wells have been constructed in nearly all California counties. ***In some urbanized counties as many as 90 percent of annual well construction and destruction activities are related to monitoring wells.*** ~~The largest concentrations of water quality monitoring wells occur in metropolitan areas of the State. Large numbers of monitoring wells are installed for detetion and assessment of leaks from underground storge tanks.~~	
Chapter 3, Types of Monitoring Wells	For the purpose of these standards, the term "monitoring well" is limited to wells designated to monitor subsurface ***conditions*** in the saturated and vadose zones. ~~existing at or above atmospheric pressure (groundwater) rather than water, water vapor, and/or gasses contained in the unsaturated or vadose zone. Monitoring devices used for the unsaturated zone differ significantly from those used for the saturated (groundwater) zone.~~ As shown in Figure***10*** , three types of monitoring wells ***commonly installed are:*** • ***Single cased*** monitoring wells; • Nested monitoring wells and; • Clustered monitoring wells ***Single cased*** monitoring wells consist of a single casing ~~string~~ within a ***unique*** borehole, as illustrated in Figures ***10*** and ***11. Single cased monitoring wells*** are the most common type of monitoring well constructed in California. ***While single cased monitoring wells typically have only one screened interval to monitor conditions in a single, discrete depth interval, some single cased monitoring wells can contain multiple screened intervals.*** Nested monitoring wells consist of two or more casing***s*** within the same borehole. Normally the screened interval of each casing is designed to obtain groundwater or soil vapor data from ***discrete*** zones.	At some sites, polyethelyene Continuous Multi-Channel Tube (CMT) monitoring wells have been installed, where several (3 to 7) smaller channels are extruded to form the CMT well casings. This allows for multi-level monitoring within one borehole. When their useful life has ended, these installations are extremely difficult to destroy. The small diameter of the multi-casings makes effective pressure grouting difficult, and the materials they are made of do not cut, as they are pliable and "stretch", and are very hard if not impossible to drill out. Accordingly, the Subcommittee recommends that the installation of this type of monitoring well should be discouraged, owing to the difficulty in destroying them once they are no longer needed.

Chapter 3, Types of Monitoring Wells	~~A nested monitoring well can be difficult to construct because of multiple casings within the same borehole. Care is required during construction to ensure water bearing zones for each casing string are hydraulically isolated from one another and the annular seals are effective. Some regulatory agencies may prohibit the use of nested monitoring wells for certain contamination or pollution investigations. Normally this can be due to uncertainties about whether water bearing strata can be isolated and whether the annular seals in a nested well are always effective.~~ ~~Individual casing strings for the various types of monitoring wells discussed above, as sometimes designated to obtain water from more than one aquifer or water bearing unit. These casing strings usually have multiple intervals of openings or screen. Such well casing strings, often referred to as multi-level monitoring wells" can sometimes serve as a potential pathway for the movement of poor quality water, pollutants, and contaminants from one unit to another. Some regulatory agencies prohibit the use of multi-level monitoring wells for certain pollution or contamination investigations out of concerns for water quality protection and data quality requirements.~~	
Chapter 3, Types of Monitoring Wells	***These standards are intended to protect groundwater resources by providing direction on monitoring well construction, modification, and destruction. They are intended to provide the minimum requirements at a statewide level. Other Federal, State, and local regulatory agencies also have developed well construction, modification, and destruction guidance documents that pertain to monitoring wells. These guidance documents may be more conservative than this standard, so as to provide added groundwater protection in their jurisdictions. Jurisdictional entities who have adopted a well ordinance should be consulted prior to initiation of any well construction, modification, or destruction activity. Ultimate responsibility for compliance to local, State, and Federal requirements associated with monitoring wells rests with the well owner.***	
Chapter 3, Part I General	***Once a monitoring well is constructed it permanently alters the subsurface environment. Because this alteration can negatively affect our groundwater resources, special care must be taken in the design and construction of monitoring wells so that their impact is minimized, both while they are being used and after their use has***	

	ended. Monitoring wells should be designed and constructed to minimize or eliminate the negative effects of the inter-aquifer transfer of fluids and surface water introduction, and be designed in a manner that facilitates their later destruction. At no time should a monitoring well be designed and constructed such that it cannot be properly destroyed using existing well destruction techniques.	
Chapter 3, Part I General, Section 4 Exclusions	Exploration holes for determining suitability of on-site sewage disposal that are less than 10 feet in depth are exempt from the reporting and destruction requirements of these standards, ***though these holes should be destroyed such that they do not allow poor quality water to more easily enter the subsurface or act as public nuisances.***	
Chapter 3, Part I, Section 6. Responsible Parties	Pursuant to Section 13750.5 (Division 7, Chapter 10, Article 3) of the California Water Code; construction, alteration, and destruction of monitoring wells shall be performed by contractors licensed in accordance with the California Contractor's License Law (Division 3, Chapter 9, California Business and Professions Code), except where exempted by law. Construction, alteration, and destruction of monitoring wells to monitor hazardous waste facilities, or underground storage tanks, shall be performed under the supervision of California Professional ***Civil*** Engineer, California ***Professional*** Geologist, California Certified Engineering Geologist, or ***Certified Hydrogeologist***.	Added "Civil", "Professional" and "Certified Hydrogeologist" to the list responsible parties.
Chapter 3, Part I, Section 7. Reports	Monitoring well construction, alteration, and destruction reports shall be completed on forms provided the California Department of Water Resources. Other types of forms may be used for submission to the Department with the prior approval of the Department. The completed forms shall be submitted to the Department in accordance with relevant provisions of Sections 13750 through 13754 (Division 7, Chapter 10, Article 3) of the California Water Code. Information concerning completion and submission of well construction, alteration, and destruction reports is contained in the ***document "How to Fill Out a Well Completion Report" issued by the California Department of Water Resources, dated November 1999, updated March 2007*** or its latest revision.	
Chapter 3, Part II, Section 8. Well Location with Respect to Pollutants and	**As a guiding principle it should be remembered that all monitoring wells should be designed and constructed to also facilitate their eventual destruction at the end of their useful service life.**	

Contaminants and Structures		
Chapter 3, Part II, Section 8. Well Location with Respect to Pollutants and Contaminants and Structures	Add table for separation distances.	Consideration should be given to adding other potential sources of contamination to this table such as bioretention areas/swales, surface water treatment/filters, hydromodification vaults and the like.
Chapter 3, Part II, Section 8. Well Location with Respect to Pollutants and Contaminants and Structures (C)	Accessibility: All monitoring wells shall be located an adequate distance from buildings and other structures to allow access for well maintenance, modification, repair, and destruction, unless otherwise approved by the enforcing agency. ***Care shall be taken to maintain this accessibility throughout the life of the well.***	
	Disposal of Wastes When Drilling in Contaminated or Polluted Areas: All materials generated during permitted activities must be safely handled, properly managed, and disposed of according to all applicable Federal, State, and local statutes regulating such. Unless approved by the enforcing agency in no case shall materials/waters generated during permitted construction, destruction, or alteration activities be allowed to enter, or potentially enter, on- or off-site storm drains, dry wells, or waterways, or move off the property where the work is taking place. ~~Drill cuttings and wastewater from monitoring wells or exploration holes in areas of known or suspected contamination or pollution shall be disposed of in accordance with all applicable federal, State, and local requirements. The enforcing agency should be contacted to determine requirements for proper disposal of cuttings and wastewater.~~	
Chapter 3, Part II, Section 9. Sealing the Annular Space ***and Excess Borehole***	General discussion of sealing methods and requirements ***also applicable to*** monitoring wells is contained in Section 9, and Section 13, of the Water Well Standards. Special requirements for monitoring wells include the following:	

	A. Minimum Depth of Annular Seal. Water quality monitoring wells and monitoring wells constructed in areas of known or suspected pollution or contamination. The ~~annurar~~ ***annular*** space…	
Chapter 3, Part II, Section 9. Sealing the Annular Space ***and Excess Borehole***	~~(A)3. Sealing Off Strata: Additional annular sealing material shall be placed below the depth of the upper annular seal, as is needed, to prevent the movement of poor quality water, pollutants, and contaminants through the well to zones of good quality water. Requirements for sealing off zones are in Section 13 of the Water Well Standards.~~	This sealing procedure would not be easily accomplished in practice particularly in a small diameter bore hole, so the Subcommittee recommends this procedure be stricken. Please note that there is not full agreement on this recommendation and should have further review.
Chapter 3, Part II, Section 9. Sealing the Annular Space ***and Excess Borehole*** (B)	B. Shallow Water Level Observation Wells: Water level ***monitoring*** wells less than 15 feet in total depth that are used to assess root zone drainage in agricultural areas are exempt from an annular surface seal requirements, unless otherwise required by the enforcing agency. ***When shallow water level monitoring wells are no longer being used for their intended purpose, they shall be properly destroyed.***	
Chapter 3, Part II, Section 9. Sealing the Annular Space ***and Excess Borehole*** (D)	D. Vaults: At the approval of the enforcing agency, the top of the annular seal and well casing can be below ground surface where traffic or other conditions require. In no case shall the top of the annular seal be more than 4 feet below ground surface. ***All vaults must be secured so that they do not allow unauthorized access to the monitoring well head, and are completely water-tight.***	
Chapter 3, Part II, Section 9. Sealing the Annular Space ***and Excess Borehole*** (E)	***E. Sealing Excess Borehole: any portion of the borehole that extends more than three (3) feet below the bottom of the casing or penetrates a confining layer must be backfilled with 10-sack sand/cement slurry or commercially produced bentonite pellets or chips.***	Note that there may be other materials that will work. This section does need further technical review.
Chapter 3, Part II, Section 9. Sealing the	2. Permanent Conductor Casing. If a permanent conductor casing is to be installed, the borehole diameter shall ~~be at least 4 inches greater~~ ***large enough to allow for the effective placement of approved sealing material by means of a tremie pipe, while maintaining a***	

Annular Space ***and Excess Borehole*** (F)2	***uniform annular seal radial thickness of at least one (1) inch between the conductor casing and the borehole wall during and after the sealing operation.. Similarly, the*** inner diameter of the permanent conductor casing shall ***be large enough to allow for the effective placement of approved sealing materials by means of a tremie pipe, while maintaining a uniform annular seal radial thickness of at least one (1) inch between the conductor casing and the interior (monitoring casing during and after the sealing operation.***	
Chapter 3, Part II, Section 9. Sealing the Annular Space ***and Excess Borehole (G)***	***G.*** 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 as noted in Section 9 of the Water Well Standards~~. ***The borehole diameter shall be large enough to allow for the effective placement of approved sealing materials by means of a tremie pipe, while maintaining a uniform annular seal thickness of at least one (1) inch between the conductor casing and the borehole wall during and after the sealing operation.*** At least ~~two inches~~ ***one inch*** of sealing material shall also be maintained ***between*** all "casings" in a borehole, within the interval to be sealed unless otherwise approved by the enforcing agency. Additional space shall be provided, where needed, to allow casings to be properly centralized and spaced ad allow the use of a tremie pipe during well construction (if required), especially for deeper wells	There is much discussion "pro and con" relative to retaining the 2-inch traditional annular space versus the 1-inch annular space, but on balance the Subcommittee views the 1-inch annular space as being compatible with current pumping equipment and sealing materials. Note: that this should have further technical review.
Chapter 3, Part II, Section 9. Sealing the Annular Space ***and Excess Borehole (H)***	***H.*** Sealing Materials: Sealing materials ***allowed for sealing the annular space of monitoring wells are Sand/Cement Slurry-Mixed at a ratio of one (1) 94# bag of ASTM Type I or Type II Portland Cement to 188 pounds of clean sand and seven (7) gallons of clean water; commonly known as a "10-Sack Mix:. Up to 6 percent by dry weight of bentonite may be added to the cement. The cement/sand slurry must be fully mixed so that no "lumps" are present and must be free of gravel or foreign material. Special considerations for the use of cement-based sealing materials in monitoring wells are:*** ***1) Additives: Caution should be exercised in the use of special additives for cement-based materials, such as those used for modifying cement setting time, as increased heat of hydration could affect the integrity of PVC casing. Some additives could also interfere with sensitive water quality determinations.***	

Chapter 3, Part II, Section 9. Sealing the Annular Space ***and Excess Borehole (I)***	***1. Cooling Water: Any cooling water introduced into the well to protect PVC casing from heat build-up during setting of cement-based sealing materials shall be of potable quality.*** ***Bentonite Chips or Pellets-Bentonite used for annular seals shall be commercially prepared, granulated, pelletized, or shipped/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 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 below water, up to 30 feet in length is to be sealed. Precaution shall be taken to prevent bridging during the placement of the bentonite seal material. Before placement, chips or pellets should be screened to eliminate "fines".*** ***Unamended bentonite seals should not be used where structural strength of the seal is required or where the seal will dry. Bentonite seals have a tendency to dry, shrink, and crack in arid and semi-arid area 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,***	Note: This should have further technical review as some also feel the bentonite grout mixtures should be prohibited <u>without sand</u>.

	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 enforcing agency. Bentonite based sealing materials should not be used where low soil moisture conditions are present or where large hydraulic pressure gradients (upward or downward vertical gradients) or high groundwater flows are present in the sealed interval.*** Sealing material shall be selected based on ***its*** structural, handling, and sealing properties, and chemical environment into which it ***will be*** placed. Used drilling mud or cuttings from the drilling shall ***never*** be used for any part of ***the*** sealing material. Water used for sealing mixtures should be of ***potable*** drinking water quality, shall be compatible with the type of sealing material used, shall be free of petroleum and petroleum products, and shall be free of suspended matter. Good-quality water is necessary to ensure that sealing materials achieve proper consistency for placement and achieve adequate structural and settling properties.	
Chapter 3, Part II, Section 9. Sealing the Annular Space ***and Excess Borehole (J)***	J. Transition Seal. A bentonite-based transition seal is ***allowed*** in the annular space to separate filler pack and cement-based seal materials. The transition seal ***is intended to*** prevent cement-based sealing materials from infiltrating the filter pack. A short interval of fine-grained sand, usually less than 2 feet in length ***can also be employed for this purpose. Transition seals shall be installed by using a tremie pipe or equivalent. Sealing materials shall not be installed by "free fall" unless the interval to be sealed is less than 30 feet in depth.*** Bentonite can be placed in the well annulus in dry form or as slurry for transition seals. Water should be added to the bentonite transition seal prior to the placement of cement-based sealing materials where the bentonite is dry in the borehole. ***Caution*** should be exercised during the	Note: This section should have additional technical review.

	addition of water to the borehole to prevent displacing the bentonite.	
Chapter 3, Part II, Section 9. Sealing the Annular Space ***and Excess Borehole (K)***	Casing spacers ***and centralizers*** shall be used within the interval(s) to be sealed to ***provide for a uniform radial seal thickness and to*** separate individual well casing strings from one another ***(Figure 11).*** . The centralizers and spacers shall be placed at intervals along the casing to ensure a minimum radial thickness of annular seal and casing separation of ~~2 inches~~ ***1 inch***. ***Centralizers and s***pacers shall be constructed of corrosion-resistant metal, plastic, or other non-degradable material. Wood shall not be used as a centralizer or spacer material. Any metallic component of a ***centralizer or*** spacer used metallic casing shall-consist of the same material as the casing. Metallic ***centralizer or*** spacer components shall meet the same metallurgical specifications and standards as the casing to reduce potential for galvanic corrosion of the casing. The spacing of the casing ***centralizers and*** spacers is normally dictated by casing materials used, the orientation and straightness of the borehole, and the method used to install the casing. Spacers shall not be more than 12 inches in length and shall not be placed closer than 10 feet apart along a casing string within the interval to be sealed, unless otherwise approved by the enforcing agency. Casing spacers ***and centralizers*** shall be designed to allow the proper passage and distribution of sealing material around casing(s) within the interval(s) to be sealed.	
Chapter 3, Part II, Section 10. Surface Construction Features	B. Casing Cap. The top of a monitoring well casing shall be fitted with a cap ***or sanitary seal*** to prevent surface water, pollutants, or contaminants from entering the borehole. Openings or passages for water level measurement, venting, pump power cables, discharge tubing, and other access shall be protected against entry of surface water, pollutants, and contaminants. C. Flooding. ***In areas of potential flooding*** the top of the well casing shall terminate above ground surface and known levels of flooding ***or be "water tight",*** except where site conditions, such as vehicular traffic, will not allow.	

Chapter 3, Part II, Section 10. Surface Construction Features (D)	Where ~~cement based annular sealing materials~~ ***sand-cement slurry sealing material*** is used, the concrete base shall be poured before the annular seal has set, unless otherwise approved by the enforcing agency.	
Chapter 3, Part II, Section 10. Surface Construction Features (E)	E. Vaults. ~~At the approval of the enforcing agency~~ ***T***he top of the well casing may be below ground surface because of traffic or other critical considerations. A structurally-sound watertight vault, or equivalent feature, shall be installed to house the top of a monitoring well that is below ground surface. The vault shall extend from the top of the annular seal to at least ground surface. In no case shall the top of the annular seal be more than 4 feet below ground surface. ~~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 enforcing agency. 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. ~~Bentonite based sealing material may be used between the vault and excavation at the approval of the enforcing agency.~~ Sealing material surrounding the 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 the vault, the sealing material shall be placed in a "continuous" pour. In other words, cement based sealing material shall be placed between the vault and the excavation and contact the cement based annular seal before the annular seal has set.~~	
Chapter 3, Part II, Section 11. Filter Pack	***Section 11. Filter Pack*** ***Monitoring well filter pack material shall consist of non-reactive, smooth, rounded, spherical, granular material of uniform size and known composition. Filter pack material shall not degrade or***	Add entirely new section. Refer to CGA Standard Practice Series Article 225 "Gravel Pack Materials and

	consolidate after placement. The grain size of the filter pack shall be matched to the slot size of the well screen so that any movement of filter pack material into the well will be limited to prevent significant voids in the filter pack that could ultimately destabilize the annular seal. ***Filter pack material shall be obtained from clean sources. Filter pack material should be washed and properly packaged for handling, delivery, and storage particularly if the materials are to be used in monitoring wells constructed for sensitive water quality determinations.*** ***Care should be exercised in the storage of filter pack materials at a drilling site to assure that the material does not come into contact with pollutants or contaminants. Care should also be exercised to prevent the introduction of foreign substances, such as clay or vegetative matter that might interfere with the placement and function of the pack.*** ***Length-Filter Pack: The filter pack of a monitoring well should be designed to best accomplish the monitoring requirements, but should also minimize the possibility of the inter-aquifer transfer of fluids. The filter pack must not extend through or into site-specific or regional barriers to vertical transport of fluids or vapors, or extend more than three (3) feet above or below the screened interval of the well.***	Handling" for further information.
Chapter 3, Part II, Section 12. (I)3	3. Plastic and Steel Casing. Plastic and steel well casing materials are commonly used for monitoring wells. The ***principal*** plastics used for water-quality monitoring wells are thermoplastics and fluorocarbon resins. Standards for thermoplastic well casing are in Section 12 of the Water Well Standards. The ***principal*** thermoplastic material used for water-quality monitoring wells is polyvinyl chloride (PVC).	
Chapter 3, Part II, Section 12. (J)	J. Multiple Screens. Monitoring well casing strings shall not have openings in multiple water-bearing units (multi-level monitoring wells~~) if poor quality water, pollutants, or contaminants in units penetrated by the well could pass through the openings and move to other units penetrated~~	

	~~by the well and degrade groundwater quality~~ unless ~~otherwise~~ approved by the enforcing agency.	
Chapter 3, Part II, Section 12. (K)	K. ***Length of Screened Interval; The length of the perforated or screened casing of a monitoring well should be designed to best accomplish the monitoring requirements. However, to minimize the possibility of inter- aquifer transfer of fluids, the screened interval of the well shall not exceed 25 feet in length, unless approved by the enforcing agency. If multiple screened intervals exist in one well casing, the length of casing from the top of the uppermost screened interval to the bottom of the lowermost screened interval, including "blank" casing shall not exceed 25 feet.***	
Chapter 3, Part II, Section 12. (M)2	~~2.~~ Joining Plastic Casing. Depending on the type of material and its fabrication, plastic casing shall be joined (threaded or otherwise coupled) in a manner that ensures its water tightness. Organic solvent welding cements or glues should not be used~~. For joining plastic casing if glues or cement compounds could interfere with water quality determinations~~	
Chapter 3, Part II, Section 13. Well Development	***All materials generated during well development must be safely handled, properly managed, and disposed of according to all applicable Federal, state, and local statutes regulating such. In no case shall materials/waters generated during well development activities be allowed to enter or potentially enter on- or off-site storm sewers, dry wells, or waterways, or move off the property where the work is taking place.*** ~~Water, sediment, and other waste removed from a monitoring well for "development" operations shall be disposed of in accordance with applicable federal, State, and local requirements. The enforcing agency should be contacted concerning the proper disposal of waste from development operations.~~	
Chapter 3, Part II, Section 16. Purpose of Destruction	***The destruction of a well is the last opportunity to restore the hydrologic conditions that existed prior to the wells construction. If a well is not properly destroyed, it can permanently act as a vertical conduit and allow the degradation of groundwater resources. Improperly destroyed wells can also pose significant threats to public health and safety. It is extremely important to destroy monitoring wells in an effective manner when they are no longer needed.***	

	~~A monitoring well or exploration hole subject to these requirements that is no longer useful, permanently inactive, or "abandoned" must be properly destroyed to ensure the quality of groundwater is protected, and eliminate a possible physical hazard to humans and animals.~~	
Chapter 3, Part II, Section 17. Definition of "Abandoned" Monitoring Well (2)	(2) 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 water tight 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 water tight if the well is inactive for more than five consecutive years. A pump motor, angle drive, or other surface features of a well when in compliance with above provisions shall suffice as a cover.~~	
Chapter 3, Part II, ***Section 19. Requirements for Destroying Monitoring Wells***	***Section 19. Requirements for Destroying Monitoring Wells*** ***Two methods for the destruction of monitoring wells are allowed:*** ***1. Pressure grout: sealing the well casing and annular filter pack by pumping approved sealing materials, under pressure into the well.*** ***2. Drill out: the complete removal of all well casing and annular material (seal and filter pack) followed by backfilling the resultant borehole with approved sealing materials.*** ***Prior to submittal of a well destruction permit, the well must be investigated to determine its identity (State Well No. and/or Local Agency Permit No.) condition, detail of its construction and whether conditions exist that will affect a we/l's destruction (such as debris/materials in the well, or damaged casing). This information must be submitted with the well destruction permit application. An authorized local enforcement agency representative will review the information and well determine which of the above destruction methods is appropriate.*** ***A. Pressure Grout Destruction Requirements***	The entire text from Section 19, Bulletin 74-90 has been replaced by the following in this draft.

	Any of the following criteria will preclude approval of pressure grouting as a destruction method: ***1. The well was constructed with more than 3 feet of annular filter pack materials above or below the screened interval.*** ***2. The well was constructed with an annular seal that either extends less than five (5) feet below grade, or has a radial thickness of less than one (1) inch.*** ***3. The well was constructed with a screened interval of more than 25 feet measured from the top to the bottom of the screened interval or intervals.*** ***4. The well was constructed with "sloughing" of native materials in the annular space, above or below the screened interval or at any interval through the annular seal.*** ***5. The well was constructed without and enforcing agency permit and/or inspection of sanitary seal emplacement.*** ***6. The integrity of the annular seal has been compromised.*** ***7. Obstructions, debris, or other materials currently exist in the well casing.*** ***B. Approved Pressure Grouting Method*** ***The following method must be used for pressure grouting:*** ***1. Before pressurizing, the entire casing must be completely filled with sealing material.*** ***2. The sealing material must be pressurized to a minimum of 25 PSI (pounds per square inch).***	

	3. 25 PSI of pressure must be maintained for at least 5 minutes or until at least an additional 1/3 of the volume of the casing of sealing material (in addition to the material pumped prior to pressurizing) is pumped into the well. ***C. Approved Sealing Material for Pressure Grouting*** ***For a complete discussion of approved sealing materials, refer to Chapter II of the California Well Standards. Because the presence of aggregate in a sealing material would greatly limit the ability of the sealing material to move through the well screen and into the filter pack, only cement grout may be used for pressure grouting. The grout must be mixed at a ratio of one 94 pound sack of ASTM Type I or Type II Portland Cement to 5-6 gallons of clean water, commonly known as a "21-Sack Mix". The grout must be fully mixed so that no "lumps" are present and must be free of gravel or other foreign material. Bentonite should not be added to the cement mix as the resulting increase in viscosity will impede the complete saturation of filter pack with sealing material.*** ***D. Drill-Out Destruction Requirements*** ***Any monitoring well that is not approved for pressure grouting must be completely drilled out (see Pressure Grouting Destruction Requirements, above).*** ***The following method must be used for drill-out well destruction:*** ***1. The entire well casing, annular seal, and filter pack, and any filter pack or "sluff" beneath the casing, must be completely removed to original borehole depth. To accomplish this, the diameter of the drilling apparatus used must be equal to, or greater than, the diameter of the original borehole.*** ***2 The borehole must be completely filled with approved sealing materials.***	Note: the amount of water used may need additional technical review.

	E. Approved Sealing Materials for Wells Destroyed by the Drill-Out Method ***For a complete discussion of approved sealing materials, refer to Chapter II of the California Well Standards. The only approved sealing material for filling the borehole following a drill-out is Sand-Cement Slurry, mixed at a ratio of one 94- pound bag of ASTM Type I or Type II Portland Cement to 188 pounds of clean sand and 7 gallons of clean water, commonly known as a "10-sack" mix. Up to 6 percent by dry weight of bentonite may be added to the cement. The sand/cement slurry must be fully mixed so that no "lumps" are present and must be free of gravel or other foreign material.*** ***F. Placement of the Sealing Material Following Drill-Out*** ***Following the drill-out operation and before sealing, all cuttings and other obstructions must be removed from the borehole, Sealing materials should be installled as soon as possible following the drill-out operation. Sealing material shall not be installed without the use of a tremie pipe, unless the interval to be sealed is less than 30 feet deep.*** ***G. Surface Features Following Monitoring Well Destruction*** ***Surface features of the monitoring well, including but not limited to, a vault, stove pipe, or similar protective structure, must be removed during the well destruction operation and any resulting excavation must be backfilled with appropriate material.***	
Chapter 3, Part II, ***Section 19. Requirements for the Destruction of Exploratory Borings***	***Section 20. Requirements for the Destruction of Exploratory Borings*** ***Exploratory borings are constructed for a variety of reasons, including hydrologic, soil and groundwater quality, and geotechnical investigations. Any boring that has had casing or filter pack materials installed into it is considered to be a well for purposes of these standards, and subject to the permitting and construction/destruction requirements applied to wells.***	Add entirely new section.

	All exploratory borings should be destroyed within 24 hours of the completion of testing operations, Where the enforcing agency requires permits for borings that extend deeper than 45 feet below ground surface, all exploratory borings deeper than 15 feet below ground surface, all exploratory borings installed at locations where soil or groundwater contamination is known to be or is potentially present, must be completely backfilled with approved sealing materials following exploratory/testing operations. ***1. Approved Sealing Materials for Exploratory Boring Destruction*** ***For a complete discussion of approved sealing material, refer to Chapter II of the California Well Standards. The only approved sealing material for filling an exploratory boring is Sand/Cement Slurry: Mixed at a ratio of one 94-pound bag of ASTM Type I or Type II Portland Cement to 188 pounds of clean sand and 7 gallons of clean water, commonly known as "10-sack" mix. Up to 6 percent dry weight of bentonite may be added to the cement. The sand/cement slurry must be fully mixed so that no "lumps" are present and must be free of gravel or other foreign material.*** ***2. Placement of the Sealing Materials*** ***Before sealing, all cuttings, debris, and other materials must be removed from the borehole. Sealing materials must not be installed without using a tremie pipe, unless the interval to be sealed is less than 30 feet in depth.***	

CHAPTER 4 - CATHODIC PROTECTION WELLS

Bulletin Section	Proposed Changes	Comments
Chapter 4, Cathodic Protection Wells	Few cathodic protection wells illustrated in Figure 6 have been constructed by: ***1.*** Drilling a 6-12 inch diameter borehole to a desired depth. Cathodic protection wells normally range from 100 to 500 feet in total depth. A few wells have been constructed to depths of 800 feet. ***A surface casing may be required, in some cases, to control caving of near-surface materials during drilling of the borehole, as shown on Figure 14.*** 2. **EDITORIAL NOTE: Industry standard is 10-inch borehole.** 2. Placing a string of anodes in the borehole within a designated interval usually referred to as the "anode interval." *3.* Backfilling the anode interval around the anodes with the electrically conductive material, such as granular coke***, with electrically conductive material extending to the bottom of the annular seal***. **EDITORIAL NOTE: "Granular fill," Item 5 below, is eliminated.** 4. Installing a small-diameter vent pipe that extends from the top of the anode interval to land surface, or above. The purpose of the vent pipe is to release generated gases. Medium to large-diameter pipe or casing used in water wells to maintain the well bore and house pumping equipment is not normally used for cathodic protection wells. ~~5. Backfilling the annulus between the vent pipe and borehole wall with an electrically non-conducive fill material to a specific height above the anode interval. Such fill material usually consists of uniform, small diameter gravel. Its purpose is to provide a permeable medium for migration of gasses and to stabilize the walls of the borehole.~~ ~~In the past, this material was sometimes used to fill the annulus between the vent pipe and the borehole wall from the top of the~~	• Inserted editorial notes as FYI. • Clarified depth requirements of conductive, backfill material • Deleted #5 and then renumbered the subsequent sections. • Corrected (new) #5

	~~anode interval to land surface. These standards require specific interval(s), of the upper annular space of a cathodic protection well be filled with sealing materials instead of gravel; to protect groundwater quality.~~ **<u>EDITORIAL NOTE</u>: Steve McKim noted that California practice is to eliminate use of the granular backfill; conductive material ("coke breeze") contacts the annular seal.** 6. **<u>5.</u>** Sealing the annulus between the vent pipe and the borehole wall, from the top of the ~~non-~~conductive annular fill to land surface, with sealing material. 7. **<u>6.</u>** Installing a permanent cover over the well at ground surface. 8. **<u>7.</u>** Connecting the anode leads to the facility to be protected, possibly through an electrical current source.	
Chapter 4, Cathodic Protection Wells	***Individual designs of cathodic protection wells vary, and if an "unconventional" well design is proposed (particularly a design that does not facilitate eventual destruction of the well such as the "Matcor Deep Well Anode System" or installations involving conductive concrete instead of coke breeze), permission for its installation should be decided on a case by case basis by the enforcing agency.***	
Chapter 4, Cathodic Protection Wells, Corrosion Coordinating Committees	**<u>EDITORIAL NOTE</u>: This section needs to be updated as necessary, if we are to include it.**	Included editorial note as FYI.
Chapter 4, History of Cathodic Protection Wells	Cathodic protection well standards for California were first published in 1973 as DWR Bulletin 74-1, Cathodic Protection Well Standards: State of California. Standards present here replace those contained in Bulletin 74-1***, Bulletin 74-81, and Bulletin 74-90***. ~~Additional discussions on the history of well standards is contained in the "Introduction" section of this supplement (Bulletin 74-90) and Bulletin 7-81, Water Well Standards: State of California.~~	Consolidated/made description less wordy.
Chapter 4, Cathodic Protection Wells, Operation of Standards,	A. <u>Cathodic Protection Well</u>. A cathodic protection well is defined in Section 13711 of the California Water Code as: "… any artificial excavation in excess of 50 feet constructed by any method for the purpose of installing	Editorial note as FYI

Part 1, Section 1. Definitions	equipment or facilities for the protection electrically of metal equipment in contact with the ground, commonly referred to as cathodic protection." **EDITORIAL NOTE: Unless changed in the California Water Code, 50-feet depth will remain in the Standards.**	
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 1, Section 5. Reports	Other types of forms may be used for submission to the Department with prior approval of the Department. The completed forms shall be submitted to the Department in accordance with relevant Sections 13750 through 13754 (Division 7, Chapter 10, Article 3) of the California Water Code. Information concerning completion and submission of well construction, alteration, and destruction reports is contained in ~~Guide to the Preparation of the Water Well Drillers Report, Department of Water Resources, October 1977,~~ **the document "How to Fill Out a Well Completion Report" issued by the California Department of Water Resources, dated November 1999,** or its latest revision.	"Modernized" this section
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 2, Section 6. Well Location with Respect to Pollutants and Contaminants and Structures	A. Separation. Cathodic protection wells shall be located an adequate distance from known or potential sources of pollution or contamination, where site constraints and corrosion control considerations allow. Potential sources of pollution and contamination include those listed in Section 8 of the Water Well Standards. ***If the well is to be located within a known area of contamination, drilling in or near a contaminated site may be subject to additional construction requirements depending on the nature of the site (such as containing multiple alluvial aquifers with confining layers, etc.).***	Acknowledged that certain situations (regarding contamination) may mean additional construction requirements
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 2, Section 7. Sealing the Upper Annular Space	A. Minimum Depth of Annular Seal. 1. Minimum Depth. The annular space shall be filled with appropriate sealing material from ground surface to a depth of at least 20 feet below land surface. The annular space shall be sealed to a depth of at least 50 feet below land surface in congested urban areas, or where a cathodic protection well is within 100 feet of any potential source of pollution or contamination. Additional annular sealing material shall be installed to greater depths where adverse conditions exist that increase the risk of pollution or contamination of groundwater.	• Editorial note as FYI • Removed #2 and fixed subsequent numbering • Updated/created Section(s) D, E, F, and G of (new) #2.

Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 2, Section 7. Sealing the Upper Annular Space (CONTINUED)	**EDITORIAL NOTE: The subcommittee decided to retain the 20-feet sealing depth requirement.** 2. ~~Fill. Any annular space existing between the base of the annular surface seal and the top of the anode and conductive fill interval shall be filled with appropriate fill or sealing material. Fill material should consist of washed granular material such as sand, pea gravel, or sealing material. Fill material shall not be subject to decomposition or consolidation after placement and shall be free of pollutants and contaminants. Fill materials shall not contain drill cuttings or drilling mud. Sealing material is often more practical and economical to use for filling the annular space than granular material.~~ ~~3.~~ ***2.*** Sealing-Off Strata. Additional annular sealing material shall be placed below the minimum depth of the annular surface seal, as needed, to prevent the movement of poor-quality water, pollutants, and contaminants through the well zones of good-quality water. Requirements for sealing off zones are in Section 10, below. D. Sealing Material. Sealing material shall consist of neat cement, ***10.3 sack*** sand-cement ***mix***, ~~concrete,~~ or bentonite clay as discussed in Section 9 of the Water Well standards. ~~Cement-based sealing material shall be used opposite zones of fractured rock used. Concrete shall only be used at the approval of the enforcing agency.~~ Drill cuttings and used drilling mud shall not be used as any part of sealing material. E. ***Transition Seal. A transition seal between the coke breeze and cement-based sealing materials can be utilized but shall not exceed 5 feet in length. The transition seal may be comprised of bentonite granules, pellets, or chips. Bentonite transition seals should be fully hydrated before the emplacement of a cement-based seal (if used) above it.***	
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 2, Section 7. Sealing the Upper	**F.** Placement of Seal. Standards for the placement of annular seals are described in Section 9 and appendix B of the Water Well Standards. ***G. Drilling Depth. Drilling depth should be planned as to avoid artesian conditions (such as penetrating through a confining clay***	

Annular Space (CONTINUED)	***layer). The vent pipe can act as a casing for artesian flow that might be very difficult to shut off. This condition could result in uncontrolled flow that causes waste and may become a public nuisance. If artesian conditions are perceived to be present or encountered, two or more shallow cathodic protection wells should be considered.***	
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 2, Section 9. Casing	Pipe, anode access tubing, and any other tubular materials that pass through the interval to be filled and sealed are all considered casing for the purpose of these standards. Materials used for cathodic protection well casing generally shall meet the requirements for casing materials and their installation in Section 12 of the Water Well Standards. Variance from the standards shall be at the approval of the enforcing agency. It is recommended that practices prescribed by the Nation Association of Corrosion Engineers also be followed in the design and installation of gas vents and electrical conduit. ***A. Characteristics:*** Cathodic protection well ***(vent)*** casing should be at least 2 inches in internal diameter to facilitate eventual well destruction ***and use of smaller diameters, such as 1-inch, should be discouraged for this reason. Slots, rather than holes, should be provided to allow the gases to escape, but at the same time to facilitate the flow of cement through the casing during well destruction operations. Recommended slot size for this purpose is 0.060-inch, and the slotted section should extend from 5 feet below the top of the coke breeze, through the conductive material to the bottom of the well, as shown on the typical construction diagram (Figure 6 – to be revised).*** ***B. Centralizers: Within the depth interval in which the annular seal will be constructed, centering guides or "centralizers" shall be installed around the vent casing or other tubular structures to ensure that a 2-inch radial thickness seal is maintained throughout the annular seal. Centralizers are not required if the well casing is centered in the borehole during annular seal construction by the use of removable tools, such as hollow-stem augers. No fewer than two (2) centralizers shall be installed in the annular seal interval and they shall be installed at a minimum interval of 40-feet throughout the seal interval. Centralizers must be positioned so as to allow the proper***	• Created subsets A & B in order to provide more clarity regarding expected characteristics and use of centralizers

	placement of sealing material, and they shall be composed of metal, plastic, or other non-degradable material. If metallic casing is to be installed, any metallic centralizer components shall be comprised of the same material as the casing, so as to reduce the potential for galvanic corrosion of the casing.	
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 2, Section 10. Conductive Materials	***The conductive material in which the anodes are emplaced is commonly known as "coke breeze" in the industry. Coke breeze commonly consists of either coarse grained materials, designated as equivalent to a 1/8" x 3/8" sand mixture or a "6 x 12" sand gradation, and finer grained materials with the consistency of "silica sand." The coarser mixture is more commonly used in California and is recommended as in combination with the slotted vent pipe recommended above. The coarser gradation will facilitate transfer of the sealing material beyond the vent pipe during well destruction operations.*** **EDITORIAL NOTE: There has been further discussion that the coarser gradation is only suited for "top loading" for shallow well "free-fall" applications, but it cannot be pumped in through a tremie pipe, as the "6 x 12" gradation or "silica sand" mixture can be for deep applications. Ideally the subcommittee would like to see the coarser gradation used to facilitate grout penetration during well destruction, but as a practicality, this objective may not be achievable in all cases.**	Editorial note to explain committee's reasoning behind Section 10's new wording
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 2, Section 11. Sealing-Off Strata	**EDITORIAL NOTE: The subcommittee decided to retain language in paragraphs, Case 1, Case 2, and Case 3, below, but recommended including a diagram (Figure ___) to follow the discussion more easily.** The supplementary seals described in the cases above shall be extended up to and contact the base of the required minimum annular surface seal described in Section 7, above, if they are otherwise required to be within 10 feet of the surface seal. Sealing the entire annulus above the anode interval will often economically fulfill the conditions outlined above ***and is recommended in all cases possible to achieve maximum protection of groundwater quality.***	Editorial note to explain thoughts regarding this section
Chapter 4, Cathodic Protection Wells, Operation of Standards,	**Section 1~~1~~*2*. Repair of Cathodic Protection Wells.**	Corrected numbering from Sections 11 and 12—now sections 12 and 13

Part 2, Sections 12 and 13	Materials used for repairing cathodic protection wells shall meet the requirements of Section 9, above. **<u>Section 1~~2~~*3*. Temporary Cover.</u>** The well or borehole opening and any associated excavations shall be covered at the surface to prevent the entry of foreign material, water, pollutants, and contaminants, and to ensure public safety whenever work is interrupted by such events as overnight shutdown, poor weather and required waiting periods to allow setting of sealing materials and the performance tests. The cover shall be held in place or weighted down in such a manner that it cannot be removed except by equipment or tools.	
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 3, Section 14. Definition of "Abandoned" Cathodic Protection Well	2. 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 waste 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 motor, angle drive, or other surface feature of a well, when in compliance with above provisions shall suffice as a cover.~~	Deleted last sentence of #2
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 3, Section 15. General Requirements	General requirements for well destructions as contained in Section 23 of the Water Well Standards. Special considerations for cathodic protection wells are as follows: A. <u>Preliminary Work</u>. A cathodic protection well shall be investigated before it is destroyed to determine its condition; details of its construction and whether conditions exist that will interfere with filling and sealing. ***Grouting through the vent pipe is the preferred method for destruction. "Drilling out" or other possible alternative methods are to be reviewed and approved by the enforcing agency prior to implementation.*** The ~~well~~ ***vent pipe*** shall be sounded immediately before it is destroyed to make sure that no obstructions exist that will interfere with filling and sealing. The ~~well~~ ***vent pipe*** shall be cleaned before destruction, as needed, to ensure that all undesirable materials, including obstructions to	Clarified language

	filling and sealing, debris, and pollutants and contaminants that could interfere with well destruction are removed for disposal. The enforcing agency 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 enforcing agency. The enforcing agency should be contacted to determine requirements for proper disposal of materials removed from a well to be destroyed. B. Filling and Sealing Conditions. The following minimum requirements shall be followed when various conditions are encountered: 1. Wells that only penetrate unconsolidated material and a single "zone" of groundwater. At a minimum the upper 20 feet of the well casing and the annulus between the well casing and borehole wall (if not already sealed) shall be completely sealed with suitable material. Sealing material shall extend to a minimum depth of 50 feet below land surface if the well to be destroyed is located in an urban area, or is within 100 feet of any potential source of pollution or contamination. Additional sealing material may be needed if adverse conditions exist. ~~The remainder of the well below the minimum surface seal shall be filled with suitable granular fill material, such as clean sand or pea gravel, or with sealing material.~~ 2. Wells that penetrate several water-bearing strata. The upper portion of the well casing and annular space shall be filled with sealing material as described in Item 1, above. Strata encountered below the surface seal that contain poor-quality water, pollutants, or contaminants that could mix with and degrade water in other strata penetrated by the well, shall be effectively isolated by sealing the well bore and annulus within intervals specified in Section 10, above. The remainder of the well shall be filled with ~~suitable granular fill or~~ sealing material. 3. Wells penetrating fractured rock. Sealing material shall be installed as outlined in Items 1 and 2, above. Cement-based sealing material shall be used opposite fractured rock. The remainder if the well shall be filled with ~~fill or~~ sealing material, as appropriate. 4. Wells in nonfractured consolidated strata. Sealing material shall be installed as outlined in Items 1 and 2, above. The remainder of the well shall be filled with ~~fill or~~ sealing material, as appropriate.	
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 3, Section 15. General Requirements (CONTINUED)		

Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 3, Section 15. General Requirements	C. Placement of Material. The placement of sealing materials for cathodic protection well destruction is generally described in Section 23 and Appendix B of the Water Well Standards. The following additional requirements shall be observed in destroying cathodic protection wells. Casing, cables, anodes, granular backfill, conductive backfill, and sealing material shall be removed as needed, by redrilling, if necessary, to the point needed to allow proper placement of sealing materials within required sealing intervals. Removal of some or all well materials will likely be required for cathodic protection wells that were not constructed in accordance with these standards, or standards adopted by the Southern California Cathodic Protection Committee in December 1969 **(update this reference?)**.	Highlighted reference is older (from '69) and may need an update
Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 3, Section 15. General Requirements	The following requirements shall be observed in placing fill and sealing material in cathodic protection wells to be destroyed. … 2. Timing of Placement. Sealing material shall be placed in one continuous operation (or "pour") from the bottom to top of the well unless conditions in the well dictate that sealing operations be conducted in a staged manner and prior approval is obtained from the enforcing agency. ***Following placement, the sealing material must be pressurized to a minimum of 25 psi (pounds per square inch), and pressure must be maintained for at least 5 minutes or until at least an additional 1/3 of the casing volume if sealing material is pumped into the well.*** ... ~~4. Sealing Pressure. Pressure required for placement of cement-based sealing material shall be maintained long enough for the cement-based sealing material to set.~~ ~~5.~~ **4.** Verification. Verification shall be made that the volume of sealing and fill material placed in a well during destruction operations equals or exceeds the volume to be filled and sealed. This is to help determined that the well has been properly destroyed and that no jamming or bridging of the fill or sealing material has occurred.	• Updated sealing requirements, consolidating 2 and 4. • #5 renumbered as #4

Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 3, Section 15. General Requirements Chapter 4, Cathodic Protection Wells, Operation of Standards, Part 3, Section 15. General Requirements (CONTINUED)	D. Sealing Materials. Materials used for sealing cathodic protection wells for destruction shall have low permeabilities so that the volume of water and possible pollutants and contaminants passing through them will be of minimal consequence. Sealing material shall be compatible with the chemical environment into which it is placed and shall have mechanical properties compatible with present and future site uses. Suitable sealing materials include neat cement, ~~sand cement, concrete,~~ and bentonite, as described in Section 9 of the Water Well Standards. ~~Sealing materials used for isolating zones of fractured rock shall be cement-based, as described in Subsection B, above.~~ Drilling mud or drill cuttings shall not be used as any part of a sealing material for well destruction. ~~Concrete may be used as a sealing material at the approval of the enforcing agency.~~ E. ~~Fill Material. Many fill materials are suitable for destruction of cathodic protection wells. These include clean, washed sand or gravel or sealing material. Fill material shall be free of pollutants and contaminants and shall not be subject to decomposition or consolidations after placement. Fill material shall not contain drilling mud or cuttings.~~ ~~F.~~ Additional Requirements for Destruction of Cathodic Protection Wells in Urban Areas. The following additional requirements shall be met at each well site in urban areas, unless otherwise approved by the enforcing agency: 1. The upper surface of the sealing material shall end at a depth of 5 feet below ground surface; and 2. If the casing was not extracted during destruction and sealing operations, a hole shall be excavated around the well casing to a depth of 5 feet below ground surface after sealing operations have been completed and sealing materials have adequately set and cured. The exposed casing shall then be removed by cutting the casing at the bottom of the excavation. The excavation shall then be backfilled with clean, native soil or other suitable material.	• Deleted language • Consolidated lettering system • Re-numbered as needed

	F. ~~G.~~ Temporary Cover. The well borehole…	

CHAPTER 5 – GEOTHERMAL HEAT EXCHANGE WELLS

Bulletin Section	Proposed Changes	Comments
Chapter 5, Part I. Standards, Geothermal Heat Exchange Well Locations	Geothermal Heat Exchange Well Locations – Geothermal heat exchange wells that are sealed their entire length may be installed closer to a contaminant or pollutant sources or structures that the distances specified for water wells in ~~DWR Bulletin 74-90~~ ***these Standards*** and subsequent revisions. Iron markers, trace tapes, or wire shall be installed ~~at~~ ***above*** each well ***and its connecting header (or main) pipe*** to facilitate locating the buried wells. ***Wells should be located an adequate distance from buildings and other permanent structures to allow access for well modification, repair, and destruction.***	Changed DWR Bulletin 74-90 to "these Standards"—more generic language
Chapter 5, Part I. Standards, Exclusions	~~The geothermal heat exchange well standards prescribed in Bulletin 74-90 do not apply to shallow construction systems as defined in Bulletin 74-90~~ ~~**herein**~~. ~~The enforcing agency may prescribe additional regulations when the fluid is circulated in a loop in a shallow system. To prevent groundwater contamination, the enforcing agency shall prescribe additional regulations for the destruction of shallow geothermal heat exchange systems.~~	Removed reference(s) to Bulletin 74-90.
Chapter 5, Part I. Section 1. Definitions	Geothermal Heat Exchange Well. ***A geothermal heat exchange well is defined in the California Water Code (Section 13713) as*** ~~A~~ any uncased artificial excavation by any method ~~for the purpose of using~~ ***that uses*** the heat exchange capacity of the earth for heating and cooling ~~and~~ in which ***excavation*** the ambient ground temperature is 86° Fahrenheit (30° Celsius) or less and which ***excavation*** uses a closed loop fluid system to prevent the discharge or escape of ~~the~~ ***its*** fluid into ~~the~~ surrounding aquifers or ***other*** geologic formations. Geothermal heat	

	exchange wells ~~are also known as~~ ***include*** ground source heat pump wells. ~~Such wells or boreholes are not intended to produce water or steam.~~ ~~B. Types of Systems. Geothermal heat exchange systems may use a number of different combinations of circulating fluids, construction methods, and heat sources. These are commonly classified as follows:~~ ~~1. Circulating Fluid Systems. This refers to the type of piping system used to circulate heat exchange fluids.~~ ~~a. Closed Looped System. This type of system features continuous piping systems which prevent the circulating fluid from coming in contact with the aquifers or geologic formations. The fluid is repeatedly recirculated. The fluid is commonly water, but may be some other approved fluid.~~ ~~b. Open Loop System. An open loop system results when the circulating fluid is discharged from the piping system after the heat exchange. The most common open loop system consists of ground water pumped from a well and then injected back into the same well or through a second well. Open loop systems, if approved by the Regional Water Quality Control Board or by the enforcing agency, shall conform to Water Well Standards prescribed in DWR Bulletin 74-90 and subsequent revisions.~~ ~~2. Construction Method Systems. This refers to the type of construction and the depth to which the excavation(s) penetrate the ground. Based upon their normal orientation with the surface, a shallow construction system is sometimes called a "horizontal system," while a well construction system us often described as a "vertical system" or a "vertical borehole system."~~ ~~a. Shallow Construction System. This type of system is defined as any heat exchange system having an excavation those bottom does not exceed a depth of 20 feet from ground surface. The standards prescribed in Parts II and III do not apply to shallow construction systems as defined above. The enforcing agency may prescribe additional regulations for a shallow construction system.~~	

	~~b. Well Construction System. This type of system is defined as any heat exchange system in which the bottom of the excavation exceeds 20 feet from ground surface.~~ ~~3. Heat Exchange Systems. This refers to the heating or cooling source for a geothermal heat exchange system.~~ ~~a. Ground Source Heat Exchange System. This system results from the placement of the closed loop circulating pipes directly into the ground and backfilling the excavation around the circulating pipes with grout or other impervious material. Ground source hear exchange systems shall be constructed as either vertical borehole or shallow systems. Such systems shall be approved by the enforcing agency prior to construction.~~ ~~b. Groundwater Source Heat Exchange System.~~ ~~(1) Closed Loop. A geothermal heat exchange system a standing column of groundwater within a water well as the heat source. The fluid is circulated through a closed loop submerged in the groundwater. The standing groundwater in the well is the heat exchange medium. The water well shall conform to water well standards prescribed in DWR Bulletin 74-90 and subsequent revisions.~~ ~~(2) Open Loop. These systems shall be approved by the enforcing agency and the Regional Water Quality Control Board prior to construction. The water well shall conform to standards prescribed in DWR Bulletin 74-90 and subsequent revisions. Open loop groundwater geothermal heat exchange systems should be considered in aquifers where high quality groundwater is plentiful and in which water wells can provide adequate water flow.~~ ~~(a) Standing column well system. A geothermal heat exchange system using standing column of groundwater within a water well as the heat source. Groundwater is extracted from the bottom of the well and umped directly to the heat exchanger. After circulating through the heat exchanger, the water is pumped back into the top of the column. There shall be sufficient groundwater present to maintain the standing column of water.~~	

	~~(b) Open loop 2 well system. Groundwater is extracted from one well and pumped through the heating/cooling system and back into the ground through a second well, the recharge well.~~ ***Geothermal heat exchange wells may be further defined by the type of piping system used to circulate heat exchange fluids (i.e., open loop vs. closed loop), by the method of construction (i.e., horizontal trench vs. horizontal directional drilling vs. vertical borehole), and by heating or cooling source for the system (i.e., ground vs. groundwater). Examples of various types of systems are shown in Figures 15 and 16. Figure 17 shows a cross-section of a typical closed loop geothermal heat exchange well.*** ***Note: Open loop systems (e.g., groundwater extracted from a well, used for heat transfer, and then injected back into the same well or into a second well or into surface water) must be approved by the Enforcing Agency (for well permits) and the Regional Water Quality Control Board (for discharge permits). Any water well used in either an open loop system or a closed loop system must conform to the Water Well Standards prescribed in DWR Bulletin 74-81 and subsequent revisions.*** ***C. Exclusions: It is not intended that surface water systems, shallow closed loop systems less than 10 feet deep, or closed loop systems installed within the foundation system of a structure be subject to these standards.*** ***EDITORIAL NOTE: The Subcommittee reduced the depth of trench from 20 feet to 10 feet in view of the condition that some counties allow sanitary well seals as shallow as 20 feet. Wells with such shallow seals could potentially become contaminated if a 20-foot deep trench is nearby.***	
Chapter 5, Part I. Section 2. Application to type of well		This section should address the directives set forth in CA Water Code, Division 7, Chapter 10, Article 4, Section 13800.5

Chapter 5, Part II. General, Section 2. Application to Type of Well	These standards shall apply to all geothermal exchange wells using a closed loop circulating fluid ground source heat exchange system. In all geothermal heat exchange wells that use a groundwater source heat exchange system with either an open or closed loop, well construction and destruction shall confirm to the water well standards prescribed in ~~DWR Bulletin 74-90~~ **herein** and subsequent revisions.	Removed reference(s) to Bulletin 74-90.
Chapter 5, Part II. General, Section 4. Borehole Diameter of Geothermal Heat Exchange Wells	***Diameter of borehole. The smaller the diameter of the borehole is, the greater the thermal exchange efficiency is. It may be necessary to drill a variable borehole diameter to allow proper construction to the design depth. The system designer shall consider the impact of borehole diameter on heat transfer as well as the diameter of the loop piping and the need to install a properly sized tremie pipe for successful grouting of the borehole.*** ***Loop piping shall be equipped with centralizers across the "minimum annular seal depth interval prescribed by the Enforcing Agency (usually 20 to 50 feet below ground surface) in order to isolate the loop materials from each other and from the borehole wall to provide a competent seal. Centralizers must be positioned to allow the proper placement of sealing material around the loop materials.*** ***EDITORIAL NOTE: The Subcommittee recognizes that there will likely be some resistance to the use of centralizers, as they will complicate seal placement. The centralizer requirement through the traditional "minimum annular seal depth" for wells is an alternative to a 2-inch minimum annular seal requirement.*** ***The borehole diameter of a geothermal heat exchange well shall be sufficient to allow placement of a ~~1 1/4~~ minimum 1 inch diameter tremie pipe, in addition to the loop pipes, to emplace material in the borehole that surrounds the loop pipes. It may be necessary to use a larger diameter tremie pipe in deeper holes to ensure proper placement of the sealing material ~~and filler material~~.*** ***EDITORIAL NOTE: IGSHPA Standards specify a minimum 1-inch diameter tremie pipe, but the slightly larger 1-1/4-inch diameter pipe, where it can be used, facilitates ease of grout placement.***	

	Such material includes the sealing material and any thermal conductive material that is placed in the borehole in lieu of sealing material to enhance heat exchange. Both sealing material and thermal conductive material shall fill the hole and surround all loop pipes. The diameter of the tremie pipe shall be adequate to ensure proper placement of the sealing material, and thermal conductive material, ~~and filler material~~. Gravity installation or free-fall of sealing material or fill material without the use of a tremie pipe is not permitted. A grout pump shall be required for placing sealing material through a tremie pipe. ~~Any clean fill between seals shall be chlorinated.~~ ***EDITORIAL NOTE: The use of any type of "fill" material should not be permitted.***	
Chapter 5, Part II. General, Section 5. Sealing Geothermal Heat Exchange Wells	Depth of Seal. The sealing of a geothermal heat exchange well shall be completed immediately after the well is drilled to avoid cave in of the uncased borehole. Full-length sealing material placed by tremie pipe is required to prevent surface contamination or to prevent contaminated water from one aquifer from mixing with waters of another aquifer. ~~The enforcing agency may 'Naive for full length sealing in vertical borehole systems provided the agency prescribes alternative sealing methods that meet the minimum standards of this Section and Section 7.~~ ***EDITORIAL NOTE: This sentence is deleted, as it refers to material discussed later in Section 7, "Non Fully Sealed Geothermal Heat Exchange Wells," which is also deleted.*** B. Sealing Materials. The following sealing materials are approved for use in geothermal heat exchange wells: 1. Bentonite Slurry. The seal shall consist of high solids sodium bentonite slurry made from bentonite grout or an 8 mesh granulated bentonite polymer slurry meeting NSF Standard ~~61~~ ***60*** (National Sanitation Foundation) with a minimum of ~~twenty~~ ***fifty*** percent (~~2~~***5***0%) by weight solids ~~(9.4 pounds per gallon grout weight)~~ mixed according to the manufacturer's specifications. Drilling mud or cuttings shall not be used as sealing materials. Water used in preparing bentonite slurry shall meet the standards in Section 9.0.1 of the Water Well Standards. Bentonite slurry shall be emplaced using a	

	tremie pipe from the bottom of the geothermal heat exchange well to the top of the borehole, excluding the excavation for the header assembly. The tremie pipe may be left in place provided it is completely filled with the high solids bentonite slurry. ~~It is recommended that high solids bentonite slurry be used in all geothermal heat exchange wells.~~ 2. Other Grout. Other types of grout, ***such as thermally enhanced grouts with pre-mixed quantities of silica sand***, may be used as ***noted herein*** ~~if approved by Bulletin 74-~~90 and in subsequent revisions or ~~is~~ ***if they are*** considered a BAT and ~~has~~ ***if they have been*** approved by industry organizations in accordance with Section 3, above ***with the approval of the Enforcing Agency. These grouts shall also have a minimum of fifty percent (50%) by weight solids and they shall be mixed according to the manufacturer's specifications.*** ~~3. Cement is not permitted as a sealing material because of the expansion of the polyethylene loop pipe caused by the heat of hydration if the cement, and subsequent contraction of the pipe after cooling. Such expansion and contraction does not provide an effective seal.~~ C. Placement of Sealing Material. Before placing the sealing material, all loose cuttings or other obstructions shall be removed from the borehole. Sealing material shall be placed in a continuous operation from the bottom of the geothermal heat exchange well to the top of the borehole, excluding the excavation for the head assembly. The sealing material shall be emplaced by pressure pumping through a ~~1 1/4 inch or larger~~ ***minimum 1-inch diameter*** tremie pipe. The pump shall be such that it can adequately complete the pumping to the total depth of the borehole. The discharge end of the tremie pipe shall be continuously submerged in the sealing material until the zone to be sealed or filled is completed. The sealing material shall fill the hole and surround all heat exchange loop pipe. ***The contractor shall verify to the Enforcing Agency that the volume of sealing material placed into each borehole equals or exceeds the volume to be sealed.***	

Chapter 5, Part II. General, Section 6. Construction Materials	A. <u>Casing.</u> Temporary casing may be used to install geothermal heat exchange wells. Such casing shall be removed upon completion of the well. If a permanent casing must be used, the casing material and installation methods and sealing shall comply with the applicable provisions for casing materials, installation, and sealing as specified for water wells ~~in DWR Bulletin 74-90~~ ***<u>herein</u>*** and subsequent revisions.	Removed reference(s) to Bulletin 74-90.
Chapter 5, Part II. General, Section 6. Construction Materials	B. Heat Exchange Loop Material 1. Type of Material. In a geothermal heat exchange well, the material used to make up the heat exchange loop must meet industry standards for this application as specified by the International Ground Source Heat Pump Association (IGSHPA). PVC (polyvinyl chloride) ***and metal*** pipe shall not be used as loop materials in geothermal heat exchange wells. Generally, closed loop materials are composed of high density polyethylene pipe ***(HDPE).*** Other materials that conform to IGSHPA standards, ***such as cross-linked polyethylene (PEX)***, may be used in geothermal heat exchange wells. 3. Installation. Heat exchange loop materials shall be installed and sealed immediately upon completion of drilling ~~of each~~ ***and loop installation, unless otherwise authorized by the enforcing agency, in each*** geothermal heat exchange well borehole. ***Use of a steel "sinker" bar, or temporary attachment of a steel tremie pipe to the "u-bend" to facilitate insertion to the full depth of the borehole and to ensure straightness of the loop pipes to the extent possible, is recommended.*** 4. ~~Metal Pipe and Fittings. If metal pipe or fittings are to be installed underground, cathodic protection shall be provided. Such a cathodic protection system shall be maintained in operating condition~~. ***Pressure Testing. All loops shall be pressure tested prior to installation.*** ***EDITORIAL NOTE: In installations, designers may specify, and contractors may use, such devices as "clips" to separate the loop pipes so they don't touch each other. However, the pipes may contact portions of he borehole wall, and while the resulting contact may enhance heat transfer, this may result in poor sealing from a groundwater protection perspective. Accordingly, the use of "clips" or similar devices should be discouraged, and if they are used, they***	

should be placed below the minimum sealing depth discussed in Section 4.a.

C. Loop Fluids. Fluids contained in the loop as the heat exchange medium in geothermal heat exchange wells shall have low toxicity, ~~as defined below~~, and shall be biodegradable. Such fluids as typically water, or water plus a freeze protection additive. ~~Pure water should be used whenever possible.~~ Any water used in the fluid shall be from a potable source.

Commonly used and acceptable freeze protection additives include propylene glycol and ethanol. ***All loop fluids or additives other than potable water shall be approved by the Enforcing Agency and shall meet BAT standards and be approved by industry organizations in accordance with Section 3, above.***

~~The loop fluid, including water and any additives, shall have an LD50 humans of greater than 25,000 mg/kg of body weight. LD50 is the dose that will be lethal to 50% of the population who ingest the fluid in 1 hour.~~

~~Undiluted freeze protection additives shall have an LD50 for humans of greater than 5,000 mg/kg of body weight. If the LD50 for humans is known for a specific additive, that LD50 shall be used when calculating the toxicity of the loop fluid. In the absence of human toxicity data, the estimated LD50 shall be based on the toxicity data of the most sensitive species, using uncertainty factors as appropriate and in accordance with standard practices in toxicology.~~

D. Final Testing. ~~If pressure testing with water or air to 150 percent above the manufacturer's heat pump operating specifications~~ ***Following the first test performed after loop installation and grouting as discussed in Section 6.B.4, before the connecting or header trench is backfilled1 loops shall be pressure tested a second time at 100 psi*** for a period of 30 minutes ~~shows that any~~ ***with no observed leaks or pressure loss greater than 3 psi. If any*** geothermal heat exchange fluid leaks, the leaking loop shall be repaired or replaced. If the loop ***experiences pressure loss*** and cannot be repaired, the loop shall be

	replaced. If the loop cannot be repaired or replaced, the loop and borehole shall be destroyed in accordance with Part 111. ***E. Identification. To facilitate identification and location of a multi-well installation, it should be marked with a buried conductive or inductive trace tape or iron marker that can be remotely sensed by a metal detector. The depth of this indicator should not exceed half the depth to the horizontal loop piping or header. A trace tape may be labeled with a cautionary warning. A contact telephone number in case of accidental damage by excavation activity is also recommended.*** ***EDITORIAL NOTE: The Subcommittee recommends the deletion of Section 7 (below) in its entirety. There is enough risk to groundwater quality in a multi- aquifer environment in the construction and sealing of "fully sealed" geothermal heat exchange wells. In practice, detailed hydrogeological investigations to warrant this type of construction are generally not accomplished. Also, as a practical matter, a contractor in production mode is not going to take the time to accomplish the sealing called for in Section 7.D, and such construction would be very difficult to confirm or "inspect" to see that it was performed satisfactorily.*** ***In the event that this section is retained, the subcommittee recommends the adoption of IGSHPA Standards pertaining to conditions where full seal requirements might be waived: (1) where the entire borehole is within a single non-flowing aquifer; (2) where the entire borehole is dry and the seasonal high depth to water is well below the borehole depth; and (3) where the entire borehole is homogeneous, low-permeability, low water-yield rock. If one of these conditions is asserted, the contractor shall provide a technical evaluation and/or pilot hole data logged and certified by a California licensed Professional Geologist or Geotechnical Engineer to support that assertion.***	

Chapter 5, Part II. General, Section 7. Minimum Requirements for Non-Fully Sealed Geothermal Heat Exchange Systems	~~Section 7. Minimum Requirements for Non-Fully Sealed Geothermal Heat Exchange Systems.~~ ~~A. Hydrology and Groundwater Quality. Construction of non-fully sealed geothermal heat exchange wells shall require knowledge about the site hydrology and groundwater quality sufficient to ensure that construction of non-fully sealed wells does not degrade groundwater quality. If such knowledge about the site is not available, only fully sealed geothermal heat exchange wells shall be permitted.~~ ~~B. Borehole Size Requirements. See Section 4, above~~ ~~C. Minimum Depth of Seals. If the borehole is not sealed throughout the entire length, the minimum depth of the surface annual seal shall be the same as specified for domestic wells in DWR Bulletin 74-90 and subsequent revisions.~~ ~~D. Sealing Between Aquifers. If full length sealing is not done and the geothermal heat exchange well penetrates more than one aquifer and one or more of the aquifers contains water that, if allowed to mix in sufficient quantity, may result in a significant deterioration of the quality of the water in the other aquifer(s), the strata producing such poor quality water shall be sealed off to prevent mixing of this water with the other aquifers. The seal shall extend no less than ten feet (1O') above and ten feet (1O') below the strata to be sealed off, even if the strata to be sealed off is less than 10 feet in thickness. If the stratum to be sealed is at the bottom of the well, the seal needs to extend only in the upv1ard direction. The sealing material shall fill the borehole and any void spaces in the interval to be sealed. The seal shall be placed by 1% inch tremie pipe and adequately pumped from the bottom to top of the interval to be sealed. Gravity installation or free fall of sealing materials without the use of a tremie pipe is not permitted.~~ ~~E. Fill Material. Any fill materials used in non-fully sealed wells shall meet the standards of Bulletin 74-90 and subsequent revisions and shall have appropriate thermal characteristics for the intended heat exchange purpose. Such fill material shall be emplaced by means of a tremie pipe. Gravity installation or free fall of fill materials without the use of a tremie~~	

	~~pipe is not permitted. Any clean fill placed between seals shall be chlorinated.~~ ~~F. Placement of Fill. Fill material shall be emplaced by the use of a 1 ½ inch tremie pipe. The tremie pipe shall be lowered to the bottom of the zone to be filled, and raised slowly as the material is introduced. All fill shall be emplaced in one continuous operation upv.'ard from the bottom of the borehole. When using the tremie pipe method to install fill material, the bottom of the tremie shall be maintained as close as possible to, but not inside of, the emplaced fill.~~ ~~Gravity installation or free fall of fill material without the use of a tremie pipe is not permitted.~~ ~~G. Sealing Material. Sealing materials shall meet the standards prescribed in Section 5.8~~	
Chapter 5, Part III. General, Section ***7.*** Destroying a Closed Loop, Groundwater Source Heat Exchange System	A. To destroy a geothermal heat exchange well using a closed loop, ground source heat exchange system, the following procedures shall be completed: 1. Fluid Removal. All fluid in the heat exchange loop shall be displaced ***by flushing*** and disposed of properly ***in accordance with applicable regulatory requirements, with particular respect to loop fluids containing anti-freeze or other additives.*** 3. Sealing the Loop in the Borehole. The remaining loop shall be completely filled with high solids bentonite slurry as specified in Section 5.8.1. The slurry shall be allowed to spill into the excavation to provide a cap at least one foot (1') thick above the loop pipe. The remainder of the excavation shall be filled with compacted earth ***that may be followed by a layer*** of ~~or~~ pavement ***as applicable***.	
Chapter 5, Part III. General, Section ***8***. Destroying an Open Loop or Closed Loop, Groundwater Source Heat Exchange System	Destruction of an open loop or closed loop groundwater source heat exchange system shall be completed in conformance with destruction standards for water wells in ~~DWR Bulletin 74-90~~ ***contained herein*** and subsequent revisions.	Removed reference(s) to Bulletin 74-90.

MEMORANDUM

To: Amy Rutledge, R.E.H.S., Chair, WWTAC

From: The Ad-hoc Bulletin 74 Revision Review Committee (Jeremy C. Wire, Geoconsultants, Inc. and CGA representative to WWTAC, David Landino, Sr., Landino Drilling Co., and Mike Duffy, P.G., Santa Clara Valley Water District)

Subject: Final comments on "Recommended Edits to Bulletin 74 State Well Standards", CCDEH - WWTAC Document dated January 3, 2019

Date: April 30, 2019; Revised 5/22/19 (responses to Items #78-80 and #83-84)

Note that our comments, beginning with Chapter II are keyed to the left-hand column entitled "Bulletin Section", beginning with Item # 1, and respond to those items marked in green denoted "Clarification Requested".

CHAPTER II

4: No comment.

10: Try to avoid too many sections of telescoping casings in well design.

18: The term "Haliburton" cementing method should be reserved for a cementing process that involves filling a blank steel casing (such as a conductor casing) with cement followed by placing a snug- fitting plug on top. With a pressure sealing cap in place on top of the casing, water is introduced under pressure, forcing the plug down to the bottom of the casing in turn forcing the cement mixture up the annulus between the borehole wall and the casing. When cement appears at the surface, or when the plug reaches bottom, noted by a rise in pressure, the cementing operation is considered complete. No grout pipe is needed in this method.

Other "Sealing Methods and Conditions" are shown on Figure 2 of Version 4 and include the Pressure Cap method and the Continuous Injection method, as described in detail on Page 13 of the draft.

In our opinion, it is not the role for CCDEH to recommend one cementing method over another. All are acceptable methods used by California well drilling contractors and the method used depends on sealing requirements for a specific project that may be dictated by local subsurface geologic conditions.

19: See above comment. The pressure cap is a plate usually bolted to a flange at the top of the casing and serves to hold the grout pipe in suspension from the top of the casing, when used with the Pressure Cap method or the Continuous Injection method. The pressure cap also retains any overflow of grout material and/or

water if there should be an abnormal pressure build-up; normal pressure developed is usually very low in actual practice.

Coarse aggregate is not recommended mainly for two reasons: It may result in blocking of the tremie or grout pipe necessitating removal of pipe to remove blockage during cementing operations resulting in a time delay and perhaps a "cold joint" in the cement column before additional cement is placed. In addition, coarse and heavier aggregate particles tend to segregate during pumping, causing an uneven mix gradation.

21 The Bulletin 74 revision Subcommittee did not particularly consider an outright "ban" on temporary casing but thought its use should be discouraged because of possible difficulty removing it, as noted in the "Comments" column. The Subcommittee also left in place language from previous Bulletins that "Temporary conductor casing may be left in place only at the approval of the enforcing agency on a case-by-case basis." (Version 4. P. 14, 3rd paragraph).

24 In Section E. "Radial Thickness of Seal", p. 23 of Version 4, reference is made to Section 9.B.1 concerning the 3-inch minimum annular seal thickness for Public Supply Wells requirement versus the traditional 2-inch annular space minimum, and on p. 25 of the draft, in the Editorial Note mention is made that AWWA Standard allows minimum1.5 inch for annular sealing space if "Haliburton" or similar method of grouting is used (see Item #18 comment, Pressure Cap and Continuous Injection methods would fit the definition of "similar").

#25 Although there are several sealing methods advanced for sealing-off contaminated or salt water bearing intervals in well construction as noted in Bulletin 74 revisions, including Version 4, there is little information on prevention of contaminating fresh-water aquifers during the test drilling process *per se.* for example, before well construction begins The main method recommended for prevention is permanent conductor casing. One of the most pertinent paragraphs addressing this issue is from the Alameda County Water District Well Standards, Edition of April 2011, Section 3.2.6.1, Page 12 and reads as follows:

> "Geologic units known to contain poor-quality water, pollutants, or contaminants require precautions (i.e., conductor casing) to isolate zones containing poor-quality water, pollutants, or contaminants during drilling and well construction operations. The precaution is necessary so that poor quality water, pollutants, or contaminants do not move through the borehole during drilling, and well construction operations, thereby significantly degrading groundwater quality in other units before sealing material can be installed. The District may consider substitutions to a conductor casing on a case-by-case basis, provided the proposed substitution is acceptable to the District and equal to or exceeds these Standards in performance and level of protection"

Perhaps the best way to deal with this issue where a test or pilot hole for a well is to be drilled in a known contaminated area is for the local enforcing agency and the well drilling contractor to cooperate in devising a mitigating plan prior to drilling operations.

28: The “normal batching process” refers to operations at a ready-mix batch plant where dry ingredients such as pozzolan are added to the dry cement in suitable quantity, and then water added both at the plant, and more water added at the job site following transport, if necessary. When a relatively small quantity of cement is being mixed on-site, as a practical consideration an additive such as bentonite is in a bag in dry condition, and has to be thoroughly mixed with the cement in a paddle mixer to assure a fluid homogeneous mixture before being pumped into the annular space. On-site, there is no practical way to mix the bentonite and cement in a dry condition in proper proportions.

42: Additional details are found in CGA Standard Practice Article 290 concerning vaults and pitless adapters. Recommendations are made concerning location and diameter of drainage pipe for vaults, and provision for marking location of casing if pitless adapters are employed by marking the location by a concrete monument, or a locatable subsurface marker. In addition, the Article recommends watertight seal where discharge piping exits the casing wall and around electrical conduit that also exits casing wall.

46: Vacuum designed wells, sometimes called “double-cased”, or “casing path” wells are described in “Handbook of Ground Water Development”, by the Roscoe Moss Company, 1990 edition, p. 119 – 121.

52: Solvent cements contain chemical constituents that could degrade in time, providing potential long-term contamination. However, the use of “Certa-Lok” or similar couplings provides a more robust joint that is not prone to failure Drillers don’t have to wait for cement to set or insert screws to assure that casing won’t come apart during installation. If necessary, the joint can be taken apart if removing casing sections from the borehole is necessary for some reason before the gravel pack is placed. Threaded flush-joint casing is used in smaller diameter wells such as monitoring wells. Based on advantages of “Certa-Lok” or similar couplings solvent cementing of PVC casing has probably been discontinued by most contractors as a practical matter for any type of well.

53: Tremie pipes can be as small as 1/2-inch diameter in normal use. Since the original Bulletin 74 and subsequent revisions were made, grouting equipment has improved greatly. A 3/4 -inch diameter PVC tremie pipe can be used to place sealing material to depths of about 200 feet, and a minimum 1-inch diameter steel tremie pipe is suitable to a depth of 1000 feet. As the hole becomes much larger in diameter, the diameter of the tremie pipe should increase proportionally. The condition of the fluid in the hole should be relatively thin prior to the cementing operation.

.

56: Section 18-C responds to this question: “Where wells are to be deepened, the requirements of Sections 11, 12, 13, 14, and 15 shall be followed”.

62: The last paragraph of the revision “Materials for Filling” section does seem contradictory. This situation might occur when a borehole is drilled in solid granitic rock with no apparent fractures and is “dry” with no ground water found. In some areas of California such as the Sierra Nevada. Such boreholes are commonly filled with pea gravel, with 20 feet of cement “plug” to the surface and this treatment is (or was) apparently allowed by local enforcement agencies. Committee favored use of “impervious” materials listed to fill the borehole from bottom to top, but received negative “feedback” from some reviewers, based on conditions that holes could be very deep (1000 feet), difficulty of getting bentonite or cement to remote locations, etc.

Make-up water is water supplied from a source such as an existing well, or city water, for example, added to the dry cement mixture to make it fluid and the proper consistency for the intended use. Also applies to water used to mix bentonite-based mud fluid for direct rotary drilling.

63: “Sand pumpers” describes wells where collapsed or damaged screen sections allow quantities of sand to be discharged to the surface, being pumped along with the water. The loss of sand over time results in a cavity around the casing that eventually may come close to the surface, with no evidence of its existence, reducing the thickness of the cover over the cavity, and this condition can be extremely hazardous. There are reports from drillers that pump servicing rigs during well abandonment operations have fallen into such cavities, and even overturned, fortunately with no loss of life. Depth of excavation to a maximum depth of 5 feet is in compliance of provisions of California Health and Safety Code. Deeper excavations need stabilization by such methods as shoring before workers should enter. The reference to the minimum depth of 20 feet for sealing material relates to the condition that where hazardous cavity conditions exist, that casing can be cut off at a lesser depth than 5 feet. Then, the sealing material should be brought up from bottom of well to at least a minimum depth of 20 feet for proper well destruction.

CHAPTER III

MONITORING WELLS

69 Not sure why this paragraph on p. 55 of Version 4 was deleted..........probably should be retained as it explains in some detail types of monitoring wells shown on Figure 10.

75` When the Subcommittee was active, at the time some installations used a bundle of casings of varying lengths that were fused together in one solid plastic block. Don’t know whether this type of construction is still being used, but it was very difficult to destroy, was difficult to drill out, as it was difficult to get a pilot bit started with this type of construction. Could be destroyed by blasting, however (see Item # 101)

#79 A description of "Sealing the Excess Borehole" is on page 62, Version 4, paragraph E: "any portion of the borehole that extends more than three (3) feet below the bottom of the casing or penetrates a confining layer must be backfilled with 10-sack sand/cement slurry or commercially produced bentonite pellets or chips".

80 Advances in grouting technology mitigate difficulty in dealing with small annular spaces, so this concern is now probably not valid. See response to Item #53. As noted in Item #101 ahead on blasting, any small diameter well that grout can be introduced into can be destroyed, so for example a monitoring well with an annular space of 1-inch could also be successfully sealed with a 3/4 inch diameter tremie pipe..

83 Possibly neat cement might be a suitable sealing material for the "excess borehole" in some instances. However, sand/cement slurry overall is probably the best choice, particularly in a case where artesian flow might be anticipated from a deeper strata and more "weight" is needed, or where bottom-hole conditions such as water having elevated salinity or contaminants may require sealing such as by a sulfate-resistant cement mixture.

84 Reviewing notes from our Subcommittee meeting of February 6, 2013 revealed much discussion about the 1-inch annular space vs. 2-inch annular space, as applied both to permanent conductor casing and monitoring well annular space that in general is also applicable to Item #85. This discussion resulted in Editorial Note on page 64 of Version 4. The "consensus" of the Subcommittee members was that 1-inch annular space would be compatible with (then) current sealing materials and pumping equipment. However, there was no anecdotal evidence or reports from the field discussed to provide support for this conclusion. In the case of the Santa Clara Valley Water District, their solution to this issue (Reference: *Draft Standards for the Construction, Destruction, and Maintenance of Wells and Other Deep Excavations in Santa Clara County, January 2010*) is as follows:

> "The District will allow the construction of a non-conforming seal (less than 2 inches in radial thickness) provided that (1) this non-conforming seal does not extend through or into site specific or regional barriers to vertical transport of fluids or vapors, and (2) when the length of the non-conforming seal is added to the length of the filter pack, the total length does not exceed 25 feet in length. If a well is constructed in this manner, the filter pack must not extend more than 1 foot above or below the screened interval. In no case shall the annular space be less than 1 inch in radial thickness at any depth interval being sealed".

91: There may be occasions when the actual monitoring well construction is completed by one contractor, and the well head construction and appurtenances done by another at a different time. Pouring the seal and then constructing the concrete base with a steel protective casing and locking cap are two separate operations in this instance. It is not practical when drilling rig is still being used in developing a larger diameter well after installing the seal. The rig needs to move off the location to allow access for continuing surface operations such as

constructing a vault or pad around the well head, otherwise it would just be in the way.

96 The 25-foot screened interval, is recommended to minimize screen lengths in monitoring wells to mitigate inter-aquifer transfer of fluids. This concept originated from draft *"Standards for the Construction, Destruction and Maintenance of Wells and Other Deep Excavations in Santa Clara County" dated January 2010*, as previously referenced in Item #84 . If there are other ideas on this subject, they certainly should be considered, but Subcommittee agreed that in practice that 25 feet was a valid number.

100: Agree with comment. Retain all stricken language ending up to the sentence starting "The cover shall be water tight if the well is.....etc. The next sentence relating to right angle drive should be deleted also, ...this apparently crept in from somewhere in Chapter II.

#101: 1) The blasting method is suitable for destroying monitoring wells, and a well casing having any small diameter that grout can be introduced into is a suitable candidate for this process. Even sparging wells of 1/4-inch diameter have been destroyed by blasting (refer to CGA latest draft "Explosive Perforation Standard" that accompanies this Memorandum for further information). 2) A packer is needed at the top of the casing to maintain the 25 PSI for pressure grouting as described in Section 18 B. 3) PVC casing in a monitoring well (or any well for that matter) is inherently very difficult to perforate, it will just deform. Recommend either "drill out" or use blasting for destruction in old well if suspected that seal with age has been compromised.

#102: Refer to Nebraska Grout Task Force Study. Sand-cement slurry had the best relative performance as a sealing material over others. .

CHAPTER IV

CATHODIC PROTECTION WELLS

#110: The concept here was to eliminate the term "concrete" that is meant to be used as a structural material. By definition, concrete contains aggregate of various sizes, and therefore is not suitable for applications where a tremie pipe is to be used, for example. Sand-cement slurry is preferable sealing material, and in a fractured rock environment, additives can be used to accelerate set-time to avoid lost circulation of sealing material in such a hydrogeologic environment.

#111: Traditional construction of vent pipe (at least at the time of Subcommittee deliberations) employed only slots or a few holes to allow venting. To facilitate destruction by introducing neat cement, for example, into the vent pipe, we recommended using some screen sections next to the anodes, as shown on Figure 14 of Version 4. Slot size of .060 was considered large enough to allow grout movement into conductive material (coke breeze) in the borehole for effective destruction. As for centralizer spacing, the flexible nature of relatively small diameter vent pipe (compared to well casing) calls for attention to spacing to maintain suitable annular space in construction, A minimum of two spacers in the annular seal area with a minimum interval of 40 feet is not excessive for this purpose, particularly in a 10-inch diameter borehole that apparently the industry standard.

112: As determined from Subcommittee meeting notes, the commonly used coarse conductive material (coke breeze) having gradation of 1/8-inch by 3/8 inch will work in a 2-inch annular space as noted in the "Clarification Requested" column. A common practice is to use a gravel chute and "free-fall" the conductive materials into the annular space to whatever depth is required to reach the bottom of the lowest anode. The presence of ground water may influence the effective depth of "free-fall of these materials.

118: See section on pressure grouting requirements, Monitoring Wells, Section 18, B, p. 77 in Version 4

#119: The "fractured rock" sentence can be reinstated. A sand-slurry mix can be used for this purpose. See Item # 110 discussion.

****