GUIDELINES TO SCREEN FOR DRINKING WATER USAs IN CALIFORNIA

The rule set defined below is based on information published in the USGS Hydrologic Investigations Atlas 730-B (referred to as Segment 1 atlas, USGS, 1995 below). The data set available to us included: 1. surface geology, 2. state defined aquifer names and boundaries, 3. well location. Because no depth or source information existed, wells were classified on the basis of their location and surface geology.

In general the aquifer coverage provided to us was compatible with the aquifers described in the segment 1 atlas. However, the segment 1 atlas describes only the geologic units of primary importance to the aquifer systems whereas the surface geology coverage includes all units present. By classifying wells on the basis of surface geology a situation evolved in which units not described in the atlas needed to be given a Pettyjohn classification. In some cases description of the units could be inferred from the segment 1 atlas on the basis of age, abbreviated lithology from the key of the geologic map, and location within the aquifer. When the aquifer was not included in the segment 1 atlas, well classification was made on the basis of the abbreviated lithologic description alone (example: gb. Mesozoic Gabbroic rock: Class IIb because if water is actually derived from this rock, which is not likely, the aquifer is probably low yield.). In general, rules were written with the units described in the segment 1 atlas in mind. Additional units introduced by the intersection of the GIS coverages could in some cases be classified on the basis of these rules. In other cases the additional units introduced by the intersection of the GIS coverages could not accurately be classified on the basis of a pre-existing rule. When this occurred the general rule was appended with additional statements addressing individual units. The geologic units KJF (Franciscan Complex), TK (Tertiary-Cretaceous coastal belt rocks), and M? (Miocene rocks?) always resulted in a well classification of “unknown” because the unit name was too general to infer lithology from, even when compared to aquifer descriptions within the segment 1 atlas.

1) Classification of all wells should be based on the shallowest sourced interval in the well. However, depth data and source information are currently unavailable

for the pilot test in the state of California. Wells are classified on the basis of location and surface geology alone.

2) Wells that derive water from the surficial (Holocene) sediments in alluvial valleys of river systems throughout the state are Class Ia USAs, because these Holocene sands and gravels are unconsolidated deposits that connect directly with the surficial water table.

3) The Basin and Range aquifers, located primarily in the southeastern part of the state, are, for the most part, unconsolidated sand and gravel sediments of Pliocene to Holocene age. The aquifer sediments were deposited in basins associated with uplifted fault blocks. All wells in these areas that derive water from the basin-fill deposits are Class Ia USAs, if the aquifers are unconfined, because such aquifers are in hydraulic continuity with the water table. As a generalization, the groundwater in these aquifers is unconfined at the margins of the basins, but confined in the central parts of the basins where fine-grained sediments have been deposited over time (usually in playa lakes). Therefore, wells located in the central parts of the basins are Class III or unknown, because the deeper aquifers are overlain by confining units but shallow unconfined aquifers may still exist.

In the absence of data on well depths, a 10 km. zone extending from the basin edge inward defines the limit of Class Ia, USA wells. This 10 km. buffer is based on an estimate of average alluvial fan radii from USGS cross-sections and geological maps (Figs 27 and 36, Segment 1 atlas, USGS, 1995). In Figure 36 it is shown that Quaternary and Tertiary unconsolidated, coarse grained basin-fill deposits (alluvial fans) rarely exceed a length of 10 km in a line perpendicular to the consolidated rocks surrounding them. Wells further than 10 km inward from the basin edge are ranked as unknown, because though it is likely that confined conditions are prevalent at depth, shallow unconfined aquifers may exist.

Exceptions to the buffer rule brought about by the GIS intersection occur when wells source limestones (as well as marine units) or igneous extrusives, of any age. In these cases wells are Class Ib USAs, since porosity is dominantly the result of fracturing or dissolution. Wells within the buffer zone that source undifferentiated schists or igneous intrusives of any age are Class IIb because

these are likely to be low yield aquifers. Wells within Tertiary clastic units are conservatively called Class Ia USAs because they may be unconsolidated Pliocene basin fill or older semi-consolidated fill units. Wells within Miocene clastic deposits are Class Ic, because these units are consolidated according to page B7 of the segment 1 atlas. Lastly, wells within undivided PreCambrian units or pre-Cenozoic metamorphic units are classified as unknown because the title is too general to infer lithology from.

4) The Central Valley aquifer is primarily river-deposited sand and gravel deposits. This aquifer occurs in the Sacramento Valley, Sacramento-San Joaquin Delta region, San Joaquin Valley, and Tulare Basin. Inasmuch as "in most parts of the valley, fine-grained materials compose 50 percent or more of the aquifer system" (USGS, 1995), the potential for confinement is considerable, particularly with depth. It seems probable that most of the wells in the Central Valley are Class III, because of confinement by silt and clay layers, as a result of the long history of groundwater depletion (and lowering of water source levels to depths greater than 350 feet) in the valley; however, one cannot be certain of this.

In the absence of depth data and in light of the significant trend of fine-grained floodplain deposits within the center of the valley (Fig. 72, Segment 1 atlas, USGS, 1995) an approach similar to that in rule 3 is used. A 10 km. zone extending from the basin edge inward defines the limit of Class Ia, USA wells. Wells at a distance greater than 10 km. from the edge of the basin are unknown because despite the higher probability of confining units, shallow unconfined aquifers may still exist.

Several exceptions to the general rule above arise as a result of the GIS map intersection. Wells may derive water from Tertiary non-marine units. These units are found only in a small area in the southeastern portion of the Central Valley Aquifer and little is known about them, therefore they are classified as unknown. If wells source Eocene marine sediments, the hydrogeologic character of which is described on page B16 of the segment 1 atlas as "consolidated and of minimum permeability", they are Class IIb. Additional exceptions to the buffer zone include wells that source volcanics and/or pyroclastic flows, which result in Class Ib, and wells that source igneous intrusives (in this case ultramafic and gabbroic rocks) or pre-Cenozoic metamorphic rocks, which result in Class IIb.

Volcanics and pyroclastics produce primarily from fracture porosity, and intrusive and metamorphic rocks are most likely low yield if sourced at all.

5) Wells within the Coastal Basin Aquifer system but NOT within one of the separately identified coastal basins (Eureka, North San Francisco Bay area valleys, Santa Clara Valley, Salinas Valley Basin, and the Los Angeles-Orange County aquifer system) are classified based on the GIS intersection of surface geology with the aquifer coverage. Wells within marine rocks of Tertiary to Paleozoic age are conservatively categorized as Class Ic USAs. Undoubtedly limestones and confining shales exist within these units, however, the limited data set prohibits identification. Wells within volcanic rocks are Class Ib USAs, regardless of the aquifer's age, since these aquifers contain fracture porosity. The Miocene, Oligocene, and undifferentiated Tertiary nonmarine and nonvolcanic rocks (the spatial distribution of which is known from the geology coverage provided) are conservatively classified as Class Ic, because these are most likely consolidated clastics, which may or may not be under confining conditions. This classification is supported by the use of the Salinas valley aquifer as a model. Figure 119 in the segment 1 atlas shows that units older than the Pleistocene are treated as semi-consolidated in the Salinas Valley and it seems reasonable that this would apply elsewhere. Wells sourcing undifferentiated schists, PreCambrian igneous, Mesozoic granites, Tertiary intrusive, undivided granitic and metamorphic rocks are Class IIb, because they are most likely low yield aquifers, with little in the way of porosity. Finally, wells within Quaternary and Quaternary-Pliocene aged aquifers are Class Ia, USAs, because they source unconsolidated alluvium.

6) Wells located in the Eureka Area Basins (Fig. 104; Segment 1 Atlas, USGS, 1995) probably derive water from Pliocene and younger unconsolidated deposits of alluvial and eolian origin. Wells in this area that derive water from shallow depths (probably majority of wells) have unconfined aquifers and are, hence, Class Ia USAs. There are exceptions, where "water in deeper parts of the aquifer in the Eel River Valley, near Humboldt Bay in the Eureka Plain, and in the Mad River Valley, between Eureka and Arcata, is under confined or partially confined conditions" (Segment 1 Atlas, USGS, 1995). Wells that derive water from aquifers in those areas are Class III.

In the absence of well depths most wells are conservatively treated as Class Ia, USAs. There were few exceptions resulting from the GIS intersection. Any wells deriving water from Pliocene Marine units are Class Ic for the same reason as in Rule 5 above.

7) The primary producing aquifers in the North San Francisco Bay Area Valleys (Figs. 107 and 108; Segment 1 Atlas, USGS, 1995) are unconfined at shallow depths and confined at greater depths (no numbers given in atlas). Shallow wells that derive water from alluvial deposits are Class Ia USAs, because the aquifers are in hydraulic continuity with the water table. All wells covered by more that 50 feet of fine-grained (clay and silt) alluvium and those that derive water from non-alluvial systems are Class III. Non-alluvial sources with less than 50 ft. of cover are Class Id USAs.

However, in the absence of depth data, most wells are conservatively treated as Class Ia USAs. There are some exceptions to this as a result of the GIS intersection. Any wells within the limits of the aquifer system that source rocks of the "Franciscan Melange or schist" are Class IIb, low yield bedrock aquifers. These rocks are meta-sediments and therefore are most likely highly consolidated aquifers with low overall yields, if water is derived from them at all. In addition any wells within volcanics of any age or Pliocene marine deposits (limestones with or without shales and sandstones) are Class Ib USAs, because the porosity of these aquifers derived from fracturing and dissolution. Lastly any wells within upper Cretaceous marine units are Class IIb, because these units are described as "consolidated… .with little permeability" on page B22 of the segment 1 atlas.

8) Conditions in the Santa Clara Valley are similar to those described in Rule 6. Any wells shallower than 150-200 feet are Class Ia USAs, because the aquifers are in hydraulic continuity with the surficial water table. Any wells deeper than 150-200 feet derive water from aquifers that are confined by overlying fine-grained sediments, thus they are mostly Class III. Some wells near the margin of the valley may be Class Ia USAs, because of the presence of relatively thick alluvial fan and river channel deposits in those areas. Most wells between San Jose and the San Francisco Bay are Class III, because of the abundance of fine-grained sediments in that area (except for wells <150-200 feet deep).

However in the absence of depth information, any wells sourcing Tertiary age non-volcanic units are Class III because of the probability of confining units above them. Wells deriving water from Quaternary units are Class Ia USAs. Any wells sourcing volcanics of any age are Class Ib, USAs, because volcanics will produce primarily from fracture porosity.

9) The aquifers in the Salinas Valley basin are almost entirely unconsolidated continental deposits of Miocene to Holocene age. However, the aquifers are distinctly different in the upper and lower parts of the basin. Because the Salinas Valley basin was not separated into upper and lower halves in the ARC-View coverage supplied to us, surface geology was used to approximate this division.

In the upper ground water basin (Fig. 118; Segment 1 Atlas, USGS, 1995), the degree of confinement within the aquifer varies widely. Deeper wells are generally confined while shallow wells may be under water table conditions. Because of this, wells could be classed as Ia, III, or unknown. With the data provided it is unfortunately most accurate to label wells within this aquifer as unknown. Most wells located within the Quaternary-Pliocene nonmarine surface geology unit are within the upper ground water basin, and therefore they are classified as unknown.

In the lower ground water basin (Fig. 118; Segment 1 Atlas, USGS, 1995), however, most of the wells tap unconfined aquifers and they are Class Ia USAs, because of their aquifer's connection with the surficial water table. Wells in Quaternary alluvium are for the most part within the lower ground water basin and are classified as Class Ia USAs.

In both the upper and lower ground water basins any wells sourcing granitic rocks of any age are Class IIb since porosity is most likely low within these aquifers.

10) The Los Angeles-Orange County coastal plain aquifer system (Fig. 125; segment 1 atlas, USGS, 1995) consists of eleven different sand and gravel deposits that range from late Pliocene to Holocene in age. Throughout much of the basin, a layer of clay that ranges from 1-180 feet thick is at or near the surface. Therefore, most of the wells are either: a) Class III, where the clay layer is >50 feet thick; or b) Class Id, where the clay layer is <50 feet thick (if the

aquifer is shallow enough so that it is not overlain by a confining layer at depth). Class III wells probably predominate in the basin. An exception to this rule occurs near the Santa Monica and San Pedro Bay shorelines, where the surface clay layer is missing. Wells in those areas are most probably Class Ia USAs, if the aquifers are shallow, because the aquifers are in hydraulic continuity with the surficial water table.

In summary, because there is no depth data and no way to delineate clays based on the surface geology coverage (the basin is dominantly covered by Quaternary alluvium) wells in this basin are conservatively classified as Class Ia USAs, if they are within Quaternary or Quaternary-Paleocene deposits. Wells are Class III if they lie within Miocene or Pliocene marine deposits because a shallow clay unit creates confining conditions.

Based on the GIS intersection, a small number of wells may source granitic rocks of Mesozoic age. These wells are conservatively classed as Class IIb, because any porosity within the unit is likely to be minor.

11) Data on the Northern California basin-fill aquifers are scarce, but there appears to be two primary aquifers: a) Quaternary age alluvial fan and alluvial deposits; and b) fractured and porous pre-Cenozoic volcanic rocks. Any wells that derive water from the Quaternary age alluvial fan and alluvial deposits are Class Ia, USAs. This classification is justified by using the Butte Valley as a model (Fig. 133; Segment 1 Atlas, USGS, 1995). It appears that any well in an area that has either alluvial fan or alluvial deposits at the surface (and derives water from those deposits) are Class Ia USAs, because the aquifer is in hydraulic continuity with the surficial water table. Any wells deriving water from the outcrop of volcanic rocks of any age are Class Ib USAs. Wells deriving water from the subcrop of the volcanics where overlain by fine-grained lake deposits < 50 ft. thick are Class Id. Wells that derive water from the volcanic rocks where covered by > 50 ft. of fine-grained lake deposits are Class III. However, because it is not possible to determine thickness of cover using the data available, all wells sourcing volcanics are treated as Class Ib, USAs.

In some exceptional cases introduced by the GIS intersection, wells may source a minor aquifer consisting of marine rocks of Paleozoic or Mesozoic age. These wells are conservatively classified as Class Ib USAs, because they are likely to

include limestones and metasediments, which are characterized by porosity derived from dissolution and fracture respectively. Wells sourcing the nonmarine sediments of Oligocene age are currently classified as unknown. It is likely that they are confined by overlying Pleistocene and Holocene sediments, but no specific information about units of Oligocene age within the Northern California basin-fill aquifer is available. Lastly, wells that are within meta volcanics, metamorphics, or ultramafic units of any age are Class IIb, because the permeability of such an aquifer is likely to be quite low.

12) Wells located in the Northern California Volcanic-aquifer outcrop belt and deriving water from those rocks are either:

a) Class Ib USAs where the aquifer is not covered by lake deposits, because these volcanic rocks have high permeability due to abundant fractures and porous zones.

b) Class III where the aquifer is overlain by fine-grained lake deposits >50 feet thick, because the lake beds are a confining unit; or

c) Class Id where the aquifer is overlain by fine-grained lake deposits <50 feet thick.

Wells sourcing Tertiary pyroclastics are Class Ib USAs, because the pyroclastics are in this case highly permeable (Segment 1 Atlas, USGS, 1995). Wells deriving water from nonmarine rocks of Oligocene age are classified as Class III because of the high probability of confining units within and above the aquifer. Lastly, any wells sourcing ultramafic rocks are Class IIb, because production from this type of aquifer is limited.

The limits of the Northern California Volcanic-aquifer were not included in the Arc-view coverage provided to us. However, the limits of the aquifer are approximated to a fare degree of accuracy by the extent of Quaternary and Tertiary volcanic and pyroclastic deposits.

13.) A minor aquifer system not described in the USGS segment 1 atlas was included in the Arc-view aquifer coverage provided to us. The distribution of

the unknown aquifer system generally corresponds to small Quaternary alluvial and glacial deposits within the Sierra Nevada mountain range (based on our surface geology coverage and topographic maps). Wells within these Quaternary alluvium and glacial deposits are Class Ia USAs. In some cases Mesozoic granites are included in within the limits of the aquifer. Wells sourcing these rocks are Class IIb, because any porosity present would most likely be low. In other cases some wells may be located within undivided limestones, Paleozoic marine deposits or volcanics of Mesozoic, Tertiary, or Quaternary age (including Tertiary pyroclastic flows) in which case they are conservatively classified as Class Ib USAs. Because the minor aquifer is not described in the USGS segment 1 atlas, classification of the lithologies and the wells within its limits should be verified with a local geologist.