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AQUIFERS AND HYDROLOGY AT ANCHOR POINT, ALASKA

by

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INTRODUCTION

Anchor Point, Alaska is a rural community located along the western edge of the Kenai Peninsula. Leaking underground fuel storage tanks have caused significant water-supply disruption and local controversy regarding these incidents and consequences. Future problems can be eliminated or minimized through planning and protective measures. The purpose of this report is to define and characterize aquifers in the Anchor Point area. The results of this study will offer valuable hydrologic data to local residents as a tool for potential development of an aquifer and wellhead protection program to ensure quality of local ground-water resources.

The definition of aquifers was performed by the analysis and interpretation of well log and geologic information for the area. Field reconnaissance occurred September 16 through 18, 1992, for the purpose of familiarization with the geologic and hydrologic setting by examining geologic exposures including Cook Inlet beach bluffs, local gravel mining operations, and bluffs along the Anchor River and its forks. Public supply well locations were established for purposes of potential protection.

This report is a companion report of Reger and Petrik (1993).

DATA ACQUISITION

Groundwater site records were assembled using the Alaska Division of Water (DOW) Well Log Tracking System (WELTS) and the U.S. Geological Survey (USGS) Groundwater Site Inventory system (GWSI). Two-hundred four site records were entered into a unique database for project analysis. The status of these records is as follows: domestic-water supply wells, 97; observation wells, 29; test holes, 25; public-water supply wells, 25; dry wells, 8; destroyed wells, 6; unused wells, 6; unused springs, 3; observation wells equipped with a recorder, 2; spring used for domestic-water supply, 1; spring used for public-water supply, 1; and, irrigation-water supply well, 1. Groundwater site records having lithologic descriptions number 169. Geophysical borehole log copies for Anchor Point No. 1 well were obtained from the Alaska Oil and Gas Conservation Commission. Contaminant plume information was obtained from Alaska Department of Environmental Conservation (ADEC) and consultant reports. Public supply wells were located using the ADEC Public Water Supply Inventory (PWSI) database in conjunction with well record data, and interviews with Anchor Point residents and ADEC personnel.

ANALYTICAL METHODS

Of the 204 available groundwater site records, the locations of 186 were plotted on maps (Sheet 1). The 18 well sites not plotted were monitoring wells located in a small area that would cause congestion on final maps. Most data from these sites are redundant but were examined for geologic and hydrologic interpretations.

Approximately one-third of the final number of site records had inadequate locational information prior to this investigation. Well locations were determined using as-built surveys, plat maps, obtaining legal descriptions and property histories from the Kenai Peninsula Borough Assessor's Office, and telephoning or writing well owners. WELTS and GWSI use a method of locating well data called Local Well Numbers. This method is explained in detail in Appendix A (Allely, written commun., 1993). Data plotted on work maps consisted of location, depth, static water level, yield, aquifer type, and indication of available lithologic descriptions, water quality data, or bedrock

encountered. Only location, well status, and reported yield were plotted on the final published map.

A spreadsheet database was developed containing key well characteristics including: well location; depth; yield; aquifer tapped, type, and thickness; topsoil thickness; water-bearing zone thickness; well finish; reported yield; potential yield; well status; water quality data; and, comments. Appendix C is an abbreviated list of these data. Appendix B is an explanation of headings, terms, and abbreviations listed in Appendix C and D. Well depth, static water level, relative geographic location and surficial geology were the best correlative data used to identify aquifers. This database was used extensively for statistical interpretations as well as a quick reference for other data.

Watershed boundaries were drawn by examination of local drainage networks and their divides on 1:25,000 scale USGS topographic maps.

Twenty-six public-water supply well locations were plotted. This includes 2 class A wells, 10 class B wells, and 14 class C wells (Appendix D). All public-water supply wells have ADEC PWSI numbers except 11 class C wells. Class C wells are often not entered into the PWSI because of state and federal funding limitations and the lack of regular water quality monitoring requirements on this class of wells. These data were obtained by collaboration with ADEC personnel (P. Horwath, D. Litchfield, oral commun., 1993).

WELL YIELDS

Of 204 available groundwater site records, 109 had reported yield data. Potential well yield was calculated using well construction information. There were 61 site records with sufficient well construction data and reported drawdown data to accurately estimate potential yield. No attempt was made to estimate potential yield when insufficient data were available. The method used to estimate potential yield in unconfined aquifers was from Driscoll (1986, p. 216-21), using a 90 percent maximum yield scenario. For confined aquifers, a direct ratio relationship method of drawdown to yield was used. This method uses distances from potentiometric surfaces to top of aquifer (available drawdown) in the calculations. The potential yield equals the product of the reported pumping rate and the available drawdown divided by the reported drawdown at the reported pumping rate.

The maximum estimated potential yields for each aquifer are listed in the aquifer yield table (Table 1). This table is an analysis of existing data and an estimate of maximum potential yield. The maximum estimated potential yield for each aquifer was an interpretation based on reported data, projected saturated thicknesses for each aquifer, and estimated hydraulic conductivities based on average aquifer composition (Freeze and Cherry, 1979), and calculated specific capacities.

The maximum estimated potential yield for a well using the alluvial valley aquifer was calculated at 85 gpm but listed as 250 gpm as the potential using an infiltration gallery. Maximum estimated potential yield for the bedrock aquifer was calculated at 25 gpm but was upgraded to 100 gpm based on ground-water information from Waller (1968) indicating potential yields in the area north of Homer. Maximum estimated potential yield for each aquifer was based on the probable maximum thickness of saturated sediments existing that can freely contribute significant amounts of water to a well. This thickness of material can be continuous or a series of thinner zones effectively contributing as one. Both scenarios probably exist in the project area.

Table 1. Summary of reported well yield data and maximum estimated potential aquifer yields.

Aquifer	Number of sources tapping aquifer	Number of wells with reported yields	Reported yield range (gpm)	Median yield (gpm)	Mean yield (gpm)	Maximum estimated potential yield (gpm)
Qal	8	2	8 - 10	9	9.0	250
Qd2	20	11	1.5 - 30	12	13.9	55
Qgl	124	53	0 - 60	8	10.3	70
Qac	16	13	5 - 15	10	9.4	60
Qd1	19	18	0 - 50	8	11.9	75
Tkb	17	14	0 - 20	3	6.3	100
Summary	204	111	0 - 60	8	10.3	250

AQUIFERS

Aquifers in the study area were defined based on analysis and interpretation of well record data and a surficial geology map by Reger and Petrik (1993). Aquifer descriptions in this report follow those presented by Reger and Petrik (1993) but emphasize hydrologic conditions and are supplemented with related data. A detailed discussion of the aquifers is contained in *Description of Map Units* (Sheet 1). Each groundwater site record listed in Appendix C has been assigned an aquifer whether water was actually encountered or not. Aquifer assignments are highly interpretive and are based on relative hole or well depth and location of well site for many site records with incomplete data.

WATER QUALITY

Reported water quality data considered for this report included iron, pH, hardness, conductivity, and alkalinity (Table 2). Temperature measurements were also made on approximately one-third of the total number of reported water quality samples. Temperatures were not considered in statistical analyses of water quality data because of the relatively small number of samples with this information. A total of 25 groundwater site records had at least one of these elements of analytical water quality information reported (Table 2). The types of water quality reports include: driller field tests (10), USGS field tests (9), DOW lab results (2), USGS lab results (2), and private test lab results (2). All reported data, except pH, were reduced to fundamental units of milligrams per liter (mg/l). A conversion of 1,000 micrograms per liter = 1 mg/l and 1 mg/l is approximately 1 part per million. In the table, hardness and alkalinity were both reported as mg/l as calcium carbonate ($CaCO_3$).

Driller field tests most commonly tested for pH, iron, and hardness. These tests were assumed to be performed mostly using Hach or similar kits. Hardness values, and occasional alkalinity values, were mostly measured in grains per gallon (gpg). A conversion multiple of 17.12 was used to obtain mg/l whenever gpg was encountered.

Table 2. Summary of reported field water quality data from groundwater site records.

Aquifer	Total Iron (mg/l) Range	n[1]	pH Range	n[1]	Total Hardness (mg/l as $CaCO_3$) Range	n[1]	Specific Conductance (micromhos/cm) Range	n[1]	Total Alkalinity (mg/l as $CaCO_3$) Range	n[1]	Number of wells with reported inorganic water quality samples
Qal	0-3.00	2	6.0	2	42-51	2	270	1	51	1	2
Qac	0.06	1	6.7	1	51	1	-	-	-	-	1
Qd1	0.50	2	6.0	2	34	2	-	-	-	-	2
Qd2	0.06	1	6.3-6.5	2	34-130	3	180-320	2	10	1	3
Qgl	0-22.00	14	6.0-7.0	10	15-86	12	55-240	9	17-46	7	15
Tkb	2.00-3.50	2	6.6-7.0	2	120	1	139	1	52	1	2
Summary of Aquifers	0-22.00	24	6.0-7.0	19	15-130	21	55-320	13	10-52	10	25
Mean	1.91	24	6.5	19	50	21	160	13	33	10	
Median	0.33	24	6.5	19	42	21	139	13	33	10	

[1] n = number of sample occurrences

The USGS field tests generally indicated the use of Hach kits for iron and hardness. Temperature, pH, and conductivity were generally also measured. It has been assumed that meters were used for these values. Additionally, USGS parameters sometimes included alkalinity. However, USGS alkalinity values were generally measured as bicarbonate (HCO_3^-) and were converted to carbonate standard by multiplying by 0.82.

Lab analyses were assumed to be conducted under strict procedural guidelines as outlined by industry standards although in-house variations probably occur. Organic constituents were not a major focus of the scope of this report. Historic benzene plumes in the Anchor Point vicinity have been plotted on Sheet 1 (Rozak (1992) and Texaco (1992)). Lab analyses for organic constituents are available for all class A and B and some class C wells through ADEC area offices. In addition, organic analyses have been performed as part of contamination investigations by ADEC (ADEC, 1988), ENSR Consulting and Engineering (Texaco, 1992), Hart Crowser, Inc. (Hart Crowser, 1989), Ron Rozak, P.E. (Rozak, 1992), and Tauriainen Consulting Engineers (Tauriainen, 1986). Analyses are available as appendices to their respective reports. Access to most of these reports and related data are also available through ADEC or DOW offices.

There were 25 groundwater site records for the entire project area that reported water quality data. Reported water quality records were most frequent for the glaciolacustrine aquifer (15) and the next highest frequency for the kettle moraine aquifer (3). The remaining four aquifers each had only one or two sites with reported water quality data.

Total iron values had a relatively wide range. The glaciolacustrine aquifer displayed the lowest, 0, and highest iron values, 22 mg/l. This measurement was made by the USGS using a Hach kit. The second highest value for iron was 5.5 mg/l. Concentrations of iron less than 0.3 mg/l are desired for domestic uses although most domestic wells exceed this level.

PH values ranged from 6.0-7.0. The secondary maximum contaminant concentration level (SMCL) is 6.5-8.5 (ADEC, 1993). Nine pH values were lower than the SMCL range and none higher. The mean and median pH values, 6.5, equals the lower limit of SMCL. The relatively narrow pH range and equal mean and median values indicates relatively homogeneous groundwater quality conditions.

Total hardness ranged from 15-130 mg/l, with a mean of 50 mg/l and median of 42 mg/l. Waters having total hardness less than 60 mg/l are considered soft, between 60 and 120 mg/l, moderately hard, and 121 to 180 mg/l, hard. Of 21 total hardness values, 17 were soft, 3 moderately hard, and 1 hard.

Specific conductance values ranged from 55-320 micromhos/cm within the project area and generally considered acceptable for domestic use. The mean value is 160 micromhos/cm and median 139 micromhos/cm.

Total alkalinity values ranged from 10-52 mg/l as $CaCO_3$ with a mean and median of 33 mg/l. These values indicate low buffering capacity, rainwater recharge, and relatively uniform water quality.

There is a high correlation between water quality values found in the West Nikiski glacial aquifers (Maurer, 1993) and those in the Anchor Point area. This is not surprising as both areas are part of the Kenai lowlands and were subjected to similar glacial deposits and processes, and underlain by similar bedrock type (Reger and Petrik, 1993).

Water quality samples from the bedrock aquifer had either one or two values for each constituent listed in Table 2. Though statistically insignificant, the values were all above average for the project area. Waller and others, (1968) indicate that water quality is generally softer, lower in iron, and pH values more neutral to slightly alkaline than glacial deposits in the bedrock aquifer just north of Homer. This is not the case observed in the limited number of bedrock aquifer samples reported in the Anchor Point

area. Nonetheless, all parameters of water quality in the bedrock aquifer in the Anchor Point area were good except higher total iron values (2.0 and 3.5 mg/l), which are not unusually high for Alaskan groundwater. The bedrock aquifer exhibited the highest value range for total iron, pH, total hardness, and total alkalinity as compared to the mean and median for the entire project area.

As a consequence of coal water-bearing zones, occasional water discoloration and hydrogen sulfide odor present serious practical and aesthetic limitations for use of the bedrock aquifer. Of 11 bedrock wells seeking potable water, one well record indicates well abandonment due to malodor, discoloration, or sulfide gases due to coal and another well of similar quality was discovered during a telephone inquiry. Some local residents have stigmatized this aquifer as generally bad due to these qualities. Nonetheless, site records show that drillers often bypass first and second water-bearing strata in search of higher quality water which is generally found in conglomerate, sandstone, or shale, respectively.

A major potential limitation to the bedrock aquifer's utilization is saltwater. Oil and gas exploratory data (McGee, 1977) suggest a freshwater/saltwater interface ranging from approximately 100 to 320 feet (ft) (30.5 to 97.6 m) bls from the western to southeastern edge of the project area, respectively. The gradient of this interface is approximately 33 ft per mile (6.3 m/km). These data are not supported by reported water-well data. The deepest water-bearing strata encountered was 244 ft (74.4 m) bls in a 360 ft (109.8 m) hole (SC5-15-04AACC). No indication of saltwater was indicated on this well log despite other complaints of coal-related water quality problems noted. This well is located in an area McGee estimated the freshwater/saltwater interface to be approximately 140 ft (43.0 m) bls. Discrepancies may be due to the difference in the scale of this (1:25,000) and McGee's study (1:500,000) and topographic variation. A conductivity borehole log from Standard Oil Company of California's oil and gas exploratory Anchor Point No. 1 well (SC5-15-10CCAC2-1), approximately 1.25 miles (2 km) east of the inlet at an approximate elevation of 215 ft (66 m), suggests brackish water encountered approximately 210 ft (64.1 m) bls and turning to saltwater by 275 ft (83.9 m) bls. Owners of a 213 ft (65 m) well drilled adjacent to the Cook Inlet bluff, just north of the mouth of the Anchor River (SC4-15-33DDDC1-4), indicated no saltwater problems, although domestic use was discontinued due to coal-associated water quality problems. Based on these observations, the saltwater/freshwater interface exists, although the gradient calculated from McGee's data is less within the project area.

Two known contaminant plumes in the unconfined aquifer in the Anchor Point area have been plotted on Sheet 1. One plume originates near observation wells SC4-15-34CDCD1-8 to 4-8. The 10 parts per billion (ppb) benzene concentration contour has been plotted for this plume and has an approximate maximum distance of 200 ft (61 m) downgradient (southwest) from its source. Concentrations outside this plume polygon were less than 5 ppb during the sampling period October 28 to November 2, 1991. This was the lowest level contour plotted in the Rozak (1992) study. The plume generally follows the groundwater flow direction which varies from azimuth 215 to 246. These extremes occurred from water level measurements made February 20 and March 30, 1991, respectively (Rozak, 1992). Other water level data analyzed regarding this plume indicated groundwater flow directions intermediate of these values.

A second plume originates in SC5-15-04AABD and has numerous observation wells associated with it. The 5 ppb benzene concentration contour plotted for this plume resulting from groundwater levels measured April 4-7, 1992, indicate an approximate southerly groundwater flow direction. This is the minimum concentration contour plotted for this plume (Texaco, 1992). The plume has a roughly elongate oval shape with approximate maximum dimensions of 230 ft (70 m) wide by 775 ft (236 m) long. Effects of this spill are greater in magnitude and duration than the previously mentioned plume.

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APPENDIX A

Explanation of local well numbers

USGS Local Well Numbers – – How They Work

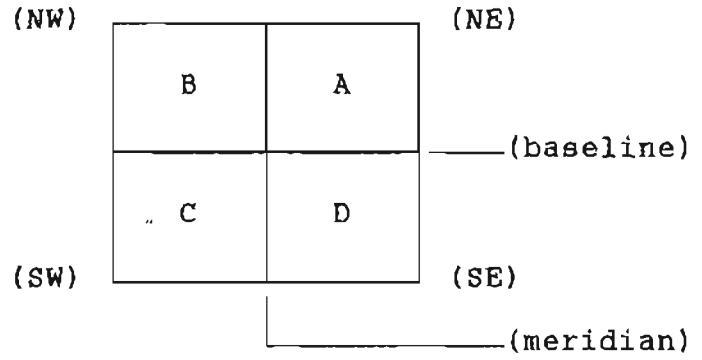
by Roger Allely, DGGS

This is a brief description of how the USGS's local well number scheme is used to identify and locate wells. This system is based on the township-and-section convention of land surveying. Using a reversed variation of aliquot parcel descriptions, sections of land (one square mile) are further partitioned in descending order by four successive levels of quartering down to individual 2.5 acre tracts. Here's how it works:

Given the example local number SB 012 003 29 DBAD 1-016, the first two letters indicate the well's position in reference to a principal baseline and meridian system.

The first letter, S, identifies the well in this example as lying within a township surveyed from the Seward baseline and meridian.

The second letter, B, indicates the well's relative position within one of four quadrants formed by the intersection of the baseline and meridian, lettered alphabetically counter-clockwise from the northeast corner as pictured:

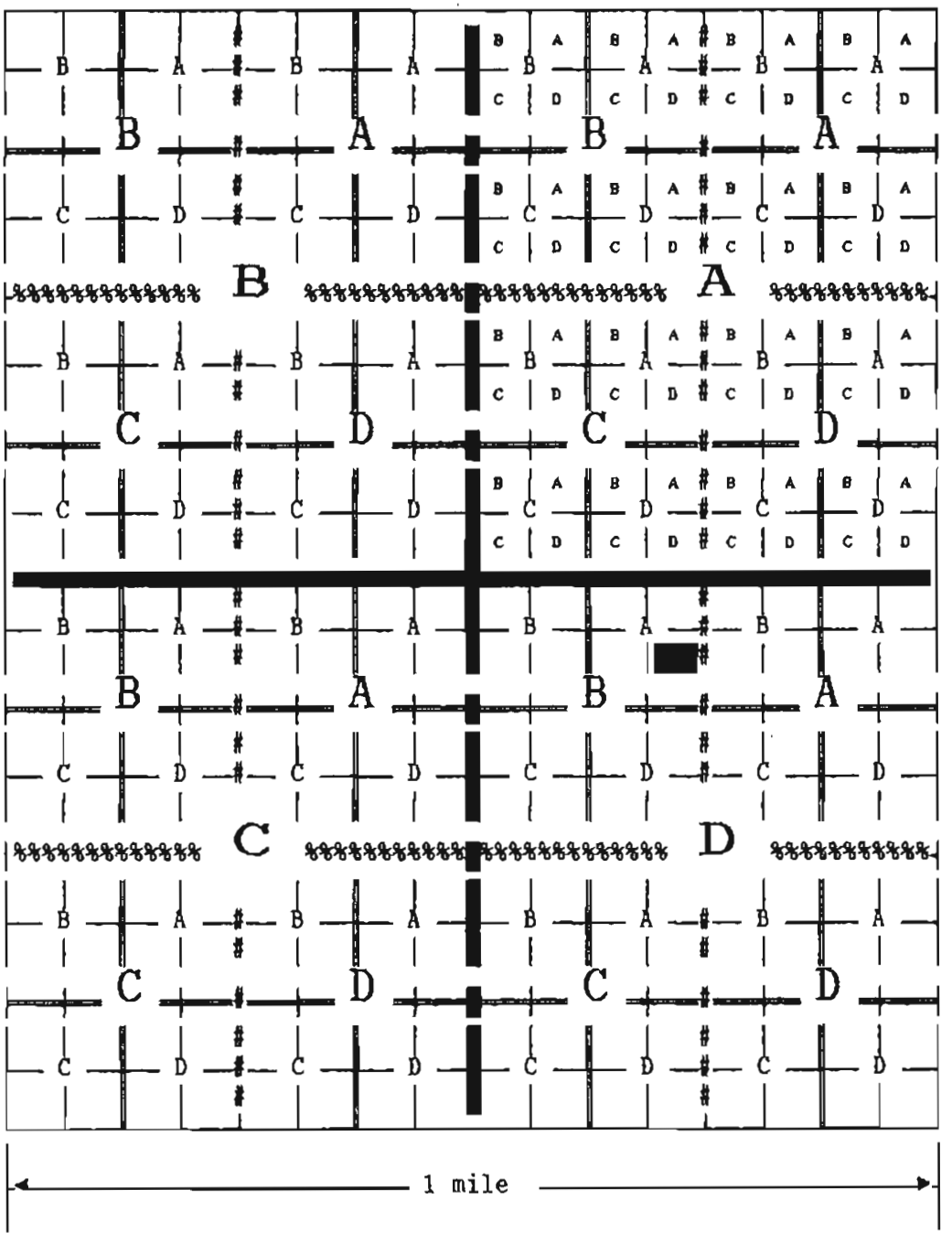


In the local number example, the letter B indicates relative location within the northwest quadrant, i.e. township north, range west. (The letter C would indicate township south, range west.) The first three digits (012) indicate the township in which the well is located, the next three digits the range (003), and the last two digits the section (29). The example well is located in township 12 north, range 3 west, section 29, Seward meridian.

Letters following the section number indicate four further levels of subdivision: the quarter section, quarter-quarter section, ¼¼¼ section, and ¼¼¼¼ section. These proceed in descending order, first specifying a 160-acre quadrant of the 640-acre section; 2ndly, 40 acres of that; 3rdly, 10 acres of that, and finally 2.5 acres at the fourth-order level. The fourth-order quarter delineates a tract of land 330 ft square.

As with baseline and meridian quadrants, each succeeding level of quadrant sets is lettered counter-clockwise from the northeast corner.

Well SB01200329DBAD1-016 is thus located in the SE 160-acre ¼, the NW 40-acre ¼¼, the NE 10-acre ¼¼¼, and the SE 2.5-acre ¼¼¼¼, section 29. The grid below shows the location of 4th quarter DBAD (shaded). For reference, the first-order quarter A (NE 160 acres) shows all four quarter order levels labelled; 1st-order quarters B, C, and D show the ¼, ¼¼, and ¼¼¼ levels.



Map and Sequence Number

The last three digits of the local well number (016) constitute the map number. Within a given section, this refers to the arbitrary order in which wells in random fourth quarters are scheduled into the GWSI data base. In the local number example, this is the sixteenth fourth quarter to contain one or more scheduled wells within section 29.

Immediately preceding the map number is the sequence number (1). The sequence number denotes that this is the first well to be scheduled within this 4th quarter. This may not be the 16th well to be recorded in section 29, as any of the fifteen preceding 4th quarters to have wells scheduled within them may contain more than one well. If four wells were listed within this 4th quarter, the last well would have a sequence and map number of 4-016.

APPENDIX B
Explanation of terms

The following explanations of ambiguous headings and abbreviations in this report are listed in the order in which they appear in Appendix C and D, unless redundant.

Local Well Number — An alphanumeric series used to describe well locations in the WELTS and GWSI databases. Meridian, township, range, section, and first- through fourth-quarter divisions of sections, and map numbers within fourth quarter-sections are the components of this designation. See Appendix A for further explanation. The absence of map numbers indicates that a well record has not been entered into GWSI as of July 1, 1993.

Aquifer — Aquifer map unit as described on Sheet 1 in *Description of Map Units*. All groundwater site records have been assigned an aquifer.

Hole Depth — Total distance drilled, in ft, from land surface in search of water-yielding zones. May or may not be depth of well.

Well Finish — How a well is constructed in order to produce water:

- *Grv. Pac.* — Washed, sorted gravel is deposited at the bottom of a casing
- *O* — Casing is open at the bottom in a water-yielding zone
- *P* — Well casing is perforated
- *P/#* — Same as "P", and "#" indicates the distance the casing is perforated; or the depth range of casing perforations
- *P/# #* — Same as above, and second "#" indicates the size of perforations (in)
- *P #* — Same as "P", and "#" indicates the size of perforations (in)
- *S* — A screened casing is installed at the bottom of a solid casing along a water-yielding zone
- *S/#* — Same as "S", and "#" indicates the screened casing length (ft); or a screened casing is installed between these depths below land surface (ft)
- *S/# #* — Same as above, and second "#" indicates the size of screen openings in the casing (in)
- *S #* — Same as "S", and "#" indicates the size of screen openings (in)

Yield — The reported flow of water pumped from a well.

Maximum Calculated Potential Yield — The optimum amount of water calculated to flow from a well based on reported yield, well construction techniques, static water level, drawdown distance of water level from static level during pumping, and aquifer characteristics.

Confined or Unconfined Aquifer — Indicates whether the aquifer the listed well is penetrating is confined or unconfined.

Well Status — The current state of the well site. See explanation on Sheet 1 for different status.

Comments General remarks pertaining to specific well record including:

- *#* WELTS index number, ranges from 0-22,300. This number generally appears in appendix C and D when groundwater site records are present in the WELTS system but are not yet processed into GWSI as of July 1, 1993.
- *NL* No well record with lithologic log available
- *NP* Well record data and location not plotted on any maps
- *QW* Water quality
- *Lac* Lacustrine (freshwater lake) sediments
- *TD* Total depth of hole

PWSI# Public Water Supply Inventory is a statewide database created by ADEC which contains six digit index numbers assigned to public-water supply wells. All class A, B, and only a select number of class C wells have numbers assigned as determined by the ADEC Drinking Water Program (ADEC, 1993). Not all public-water supply wells are assigned these numbers.

Cl Class of public-water supply well assigned by the ADEC. The choices are A, B, or C as outlined by the ADEC (1993).

APPENDIX C

Listing of groundwater site records and selected data sorted by local well numbers

Local Well Number	Aquifer	Hole Depth (feet)	Well Finish	Yield (gpm)	Maximum Calculated Potential Yield (gpm)	Confined (C) or Unconfined (U) Aquifer	Well Status	Comments
SC4-14-28CBDB1-1	Qd1	65	O ?	50		C	DO	Bottom at tertiary ?
SC4-14-30DACC	Tkb	135	O ?	15	24	C	DO	#21997 Tertiary starts at 91'?
SC4-14-30DCCB1-1	Qd1	82	O	5		C	DO	Calls OK, Poor log
SC4-14-31ABCD	Qd1	47	O	15	16.5	C	DO	#20593, Qac < 17, Was ACBA1-2
SC4-14-31BACB1-1	Qac	26	O	6	6.4	U	DO	Qac could be Qal.
SC4-14-31CBBB1-4	Qac	21	O	5	5	U	DO	Qac could be Qal
SC4-14-31CBBC	Qac	30	O	10	12.9	U	DO	#11929 Was CBCB1-3
SC4-15-23BCAA1-1	Qd1	43	O	4	10	U	DO	Qac > 30'
SC4-15-23BCAB1-5	Qd1	55	S/5',010	8	12	U ?	DO	
SC4-15-23BCDC	Qd1	65	S/5',010	8	17	U	DO	#14807 Could be Qac/Qd or all Qd
SC4-15-23BCDD	Qd1	39	O	7	16	U ?	DO	#12556 Driller Hach QW Qd > 11'
SC4-15-23BCDD1-4	Qd1	38	O	8	15.8	U	DO	#12555 Driller Hach QW Qd > 11'
SC4-15-23CAAB1-6	Qd1	100					DO	NL
SC4-15-23CDCA1-2	Qd1	35	Grv.Pac	3	3	C	DO	Aq. thick. ?
SC4-15-23CDCD	Qd1	41	S/5',020	30		U ?	DO	#20592 Was CDDC1-3 Possibly Tkb?
SC4-15-25CDBA1-2	Qac	31	O	10	40	U	DO	
SC4-15-25CDBD1-4	Qac	33	?	13		U	DO	Est. pot. yield = 52 gpm
SC4-15-25DADB	Qd1	93	S/3',010	15	25	C	DO	#21580 Either Lac or Qd >10' Was DACA1-1
SC4-15-25DCAA1-3	Qac	33	?	5		U	DO	Driller Hach QW
SC4-15-25DCBA1-5	Qac	29					DO	NL
SC4-15-25DCBC1-6	Qac	20		10			DO	NL
SC4-15-25DDCD	Qac	30	O	13	13.5	U	DO	#17839
SC4-15-26CDDC1-1	Qac	17					DO	NL
SC4-15-26DCAA1-2	Qd1	44	Dry	0	0		DR	Qd > 20'
SC4-15-27CAAB1-1	Qgl	50	Dry	0	0		DR	
SC4-15-27CAAB2-1	Qgl	50	Dry	0	0		DR	
SC4-15-27CAAB3-1	Qgl	59	O/gr.pk.	2	2	C	DO	Aq. 41-45'
SC4-15-27CAAC	Qgl	105				C	DO	#21581 Sand & water 30-48' Was BDDD1-1
SC4-15-27CADC	Qgl						P	#22119 NL Church of the Nazarene
SC4-15-27CCDB1-3	Qgl	126	O ?	15	15	C	DO	Coarse sands & gravel < 67'< Lac
SC4-15-33DAAA1-1	Qgl	63	S/10',010	2.75		C	DO	Well const. ?
SC4-15-33DDAB1-3	Qgl	55		5			DO	NL
SC4-15-33DDAC1-2	Qgl	63	?	5		C	DO	Qac < 17' .5 gpm 31-33' Driller Hach QW
SC4-15-33DDDC	Qgl	45					DO	#19312 NL
SC4-15-33DDDC	Qgl	87		5			DO	#21950 NL
SC4-15-33DDDC1-4	Tkb	213	O ?	10		C	DO	Qac<24<Lac<Tkb@98'(or 130)
SC4-15-33DDDD1-5	Qgl	30					DO	NL
SC4-15-34ABCA1-1	Qgl	55	S				DO	USGS Hach QW
SC4-15-34CACC1-11	Qgl	60	10' liner	3	4.5	C	DO	Fine Qac < 23'
SC4-15-34CCBD1-9	Qgl	55	O	5	6.4	U	DO	Fine Qac, 11' Aq. but 51<water<53'
SC4-15-34CCBD2-9	Qgl	56	O	10	16	C	DO	Fine Qac < 27'
SC4-15-34CCCD1-13	Qgl	34	O	8	15.2	C	P	Qac < 18' ? Anchor Pt. Clinic

Local Well Number	Aquifer	Hole Depth (feet)	Well Finish	Yield (gpm)	Maximum Calculated Potential Yield (gpm)	Confined (C) or Unconfined (U) Aquifer	Well Status	Comments
SC4-15-34CCDA1-10	Qgl	37	O	10	22	C	DO	Qac < 23' Coarse sand 32-37'
SC4-15-34CCDB1-14	Qgl	36	O	5	5.3	U	DO	Fine Qac
SC4-15-34CDCD1-8	Qgl	19.5				U	O	Med. Qac Organic QW available
SC4-15-34CDCD2-8	Qgl	18				U	O	Fine Qac Organic QW available
SC4-15-34CDCD3-8	Qgl	19.5				U	O	Med. Qac Organic QW available
SC4-15-34CDCD4-8	Qgl	19.5				U	O	Grades coarse gravel to silt w/depth Organ. QW avail.
SC4-15-34CDDB1-3	Qgl	52		6		C	DO	Seep at 44-45'
SC4-15-34CDDC1-7	Qgl	73	O	40		C	DO	Qac < 12'
SC4-15-34DBDC	Qgl						P	#22122 NL Anchor Point Tesoro, Catherine Lapan
SC4-15-34DBDC1-4	Qgl	57	O	9	9.5	U	P	Qd3 or Qac. Lab inorg. anal. avail.- Mn=.1
SC4-15-34DCAD1-5	Qgl	67	O	10	36	C ?	DO	Sat. > 42'
SC4-15-34DCBA1-12	Qd1	100	O	20	20	C ?	DO	Sat. > 2. 15 gpm 74-77'
SC4-15-34DCCD1-15	Tkb	100		0	0		DR	28>Qd<Lac<Tkb at 65'(or >100'?)
SC4-15-34DCCD2-15	Qgl	25	S/5' .300	16	18.7	C	P	Could be Qac inc. cobbles Alk=2ppm?
SC4-15-34DCDA	Qgl						P	#22125 NL Rozak, Ron.-Clendenen's Corner
SC4-15-34DCDB1-2	Tkb	140	?	12		C	P	18'>Qd<Lac<Tkb at 83'(or 125'?) 25 gpm @ 48'
SC4-15-34DCDB2-2	Tkb	147	?	2	2	C	DO	16'>Qac<Lac<Tkb at 78'(or 108')
SC4-15-34DCDB3-2	Tkb	85	O	0.33		C	P	Good Time Charters 25'>Qac<Lac<Tkb at 73.5'(or > 85'?)
SC4-15-34DCDC1-6	Qgl	66					P	Billie's Video Ambiguous well construction
SC4-15-34DCDD1-16	Qgl	64	O	7	7	U	DE	Qac?
SC4-15-35AADD1-3	Qac	14		10			DO	NL
SC4-15-35ADDA1-2	Qac	34	?	15		U	DO	Fine Qac. Sat. > 10'
SC4-15-35DACC1-1	Tkb	121	O	1	1	C	T	Qd>28' Water at 58' Tkb>78' ? 2-3 gpm 14-28'
SC4-15-35DACC2-1	Qac	30		8			DO	NL
SC4-15-35DADB1-5	Qac	59	P/2'.25X2	12	13	U	DO	Qd > 26'
SC4-15-35DBCD1-4	Qac	23					DO	NL
SC5-14-07DCCD1-1	Qd1	120	P .0625	10	52.6	C	DO	Qd<31'<Lac
SC5-14-18BADC1-2	Qd1	57	S/5' .006	8		C	P	
SC5-14-18CACC	Tkb	112	?	12		C	DO	#21579 Tkb > 99' ? Was ABBD1-1 USGS Hach QW
SC5-14-19CCAA1-2	Qd2	31				C	DO	
SC5-14-19CCDA	Qd2	236	S			C	DO	#13922 Was CCDD1-1 Could still be Qd2
SC5-14-24CDDA1-5	Qd2	27					DO	NL
SC5-15-03ABCC1-1	Qd1	120	O	2.5		C	DO	Qd/Lac
SC5-15-03CBDA1-2	Qgl	65	P/34-37'	4		C ?	DO	Qac < 42'
SC5-15-03DADA1-4	Qd1	63	O	6	6	C	DO	Qac < 24'
SC5-15-03DADB1-3	Qac	37	O	5	5.2	U	DO	
SC5-15-04AAAB1-8	Qgl	78					U	Qac 27-45'? Tkb > 50'?
SC5-15-04AAAB2-8	Qgl	60	?	8	15	C	P	Qac 27-45'? Tkb > 51'? USGS Hach QW
SC5-15-04AAAB3-8	Qgl	50					O	Varies from silt-sand-gravel, mostly fine sand to 45'
SC5-15-04AAAB4-8	Qgl	65		15		C	DO	Qac>41' Sand-C. sand & gravel w/depth. Sand to 64'
SC5-15-04AAAC1-S	Qgl			13			SD	NL USGS lab QW, more inorganics available
SC5-15-04AABA	Qgl						P	#22128 NL Thurmond's Automotive

Local Well Number	Aquifer	Hole Depth (feet)	Well Finish	Yield (gpm)	Maximum Calculated Potential Yield (gpm)	Confined (C) or Unconfined (U) Aquifer	Well Status	Comments
SC5-15-04AABA1-23	Qgl	75	P/55-58'	5	5	C	U	Gravel 38-57' & 60-63'
SC5-15-04AABA2-23	Qgl	54	O	7	8	C	P	Lac edge? Sand to 54'TD Organic QW avail.
SC5-15-04AABA4-23	Qgl	55.5					T	Lac edge? Sand in bottom 1/2 to 55'TD
SC5-15-04AABA5-23	Qgl	55					O	Lac? Gravelly sand > 41'
SC5-15-04AABA6-23	Qgl	55.5					O	Lac, f.alluvium? Silt to grvl w/depth Sand to 55'TD
SC5-15-04AABC	Qgl						P	#22126 NL Baptist Church
SC5-15-04AABC1-22	Qgl	57	O	15		?	P	Finer Qac < 20' Water 46-7' Sand to 57'TD
SC5-15-04AABC2-22	Qgl	51				U	T	NP Lac, f.alluvium? Silt to grvl w/depth Sand to 51'TD
SC5-15-04AABC3-22	Qgl	59.5	S			U	O	NP Lac, f.alluvium? Silt to grvl w/depth Sand to 52'TD
SC5-15-04AABD1-24	Qgl	51.5				U	DR	NP Coarsening from sand to gravel > 35'
SC5-15-04AABD2-24	Qgl	45					T	Silt to sand w/depth. Alluvial? Sand to 45'TD
SC5-15-04AABD3-24	Qgl	55.3					O	Qac > 29' Sand to 54'
SC5-15-04AABD4-24	Qgl	50					T	Mostly sand > 40' to 50'TD
SC5-15-04AABD5-24	Qgl	55					O	Sand, gravel layers > 28' to 55'TD
SC5-15-04AABD6-24	Qgl	51.5					T	
SC5-15-04AABD7-24	Qgl	56				U	O	Mixed silt to gravel to TD Sand to 56'TD
SC5-15-04AABD8-24	Qgl	60.5				U	O	Mixed silt to gravel to TD Sand to 60'TD
SC5-15-04AABD9-24	Qgl	51				U	O	NP Silt to grvl w/depth. Alluvial? Sand to 51'TD
SC5-15-04AABD10-24	Qgl	51	S			U	O	NP Silt to sand & gravel w/depth. Alluvial? Sand to 51'TD
SC5-15-04AABD11-24	Qgl	51				U	O	NP Silt to sand & grvl w/depth. Alluvial? Sand to 51'TD
SC5-15-04AABD12-24	Qgl	56	S			U	O	NP Silt to cobbles w/depth. Alluvial? Sand to 56'TD
SC5-15-04AABD13-24	Qgl	50				U	T	NP Silt to sand & grvl w/depth. Alluvial? Sand to 50'TD
SC5-15-04AABD14-24	Qgl	51				U	T	NP Silt to sand & grvl w/depth. Alluvial? Sand to 51'TD
SC5-15-04AABD15-24	Qgl	51				U	T	NP Silt to sand & grvl w/depth. Alluvial? Sand to 51'TD
SC5-15-04AABD16-24	Qgl	51				U	T	NP Silt to sand & grvl w/depth. Alluvial? Sand to 51'TD
SC5-15-04AABD17-24	Qgl	51				U	T	NP Silt to mixed sand, grvl, & cobbles w/depth. Alluvial? Sand to 50'
SC5-15-04AABD18-24	Qgl	51				U	T	NP Silt to sand & grvl w/depth. Alluvial? Sand to 51'TD
SC5-15-04AABD19-24	Qgl	51				U	T	NP Silt to mixed sand, grvl, & cobbles w/depth. Alluvial? Sand to 51'TD
SC5-15-04AACA	Qgl	60		17		C	DO	#20606 Till Gordon Heddell property Was AADB2-2 Organic QW available
SC5-15-04AACA	Qgl	60		20			DO	#20607 USGS QW, Poor log, formerly AADC1-3 Oranic QW avail.
SC5-15-04AACA	Qgl	61.5	S .020				O	#21642 Qac > 43'? Sand to 53' Organic QW available
SC5-15-04AACB	Qgl	37					DE	Sandy clay 0-23' Was AACC1-6
SC5-15-04AACB1-1	Qgl	62					P	USGS Hach QW Poor log
SC5-15-04AACB2-1	Qgl	55	P/49-52'	5	8	U	P	Mixed sand & gravel to 52', Lac < 55'TD
SC5-15-04AACB3-1	Qgl	49	S .020			U	O	NP Sand > 12' Sand to 47'
SC5-15-04AACB4-1	Qgl	50	S .020			U	O	NP All sand to 44' exc. coarser aquifer 42-9'
SC5-15-04AACC	Qgl	70					DE	#21563 NL USGS lab Was ADBB3-7
SC5-15-04AACC	Qgl	40		13			DE	#21576 NL Was ADBB2-7
SC5-15-04AACC	Tkb	360					DE	#21577 NL Aquifer used at 244' Was ADBB1-7
SC5-15-04AACC2-6	Qgl	36				U	T	Alluvial throughout?
SC5-15-04AACC3-6	Qgl	41					O	Could be Qac < 38'
SC5-15-04AACD	Qgl	41					O	#21630 Alluvium? Sand to 41'

Local Well Number	Aquifer	Hole Depth (feet)	Well Finish	Yield (gpm)	Maximum Calculated Potential Yield (gpm)	Confined (C) or Unconfined (U) Aquifer	Well Status	Comments
SC5-15-04AACD	Qgl	45.5				U	O	#21643 Alluvium? Sand to 44'
SC5-15-04AADB3-2	Qgl	61	S/59-61'	10	20	U	DO	.008 screen Fine Qac Organic QW available
SC5-15-04AADC2-3	Qgl	86	P/34-36'	3	3	U	DO	Sand to 55'< Lac < Tkb at 84'
SC5-15-04AADD1-33	Qgl	52.5	O	4	4	C	DO	Rocks -> Qd or Qac?
SC5-15-04ABAD1-25	Qgl	49					DO	NL
SC5-15-04ABBA1-19	Qgl	35	O	15	21	C	P	VFW Organic QW available
SC5-15-04ABBD1-12	Qgl	43	O			C	O	Qac < 13'
SC5-15-04ABCD1-13	Qgl	11					T	
SC5-15-04ABDC1-27	Qgl	60	S/36-45'	4	4	U	DO	Qac < 48' < Lac < 60'TD .008 Screen
SC5-15-04ABDC2-27	Tkb	380	O			C	P	Lac 36-96'? Tkb > 96'
SC5-15-04ABDD1-26	Qgl	46	S .020	15		U	P	Driller Hach QW Qac to 46'TD Organ. QW avail.
SC5-15-04ABDD2-26	Qgl		P/42-55'	22			IW	Perf.=1/2x1" Poor log
SC5-15-04ABDD3-26	Qgl	72	O				DE	Qac < 48' Gray water
SC5-15-04ACAB1-15	Tkb	160	O	1.5			O	Qac < 14' Tkb at ~ 96'? or >160'
SC5-15-04ACAB2-15	Qgl	11					T	
SC5-15-04ACAB3-15	Qgl	10.5					T	
SC5-15-04ACAC1-16	Qgl	41					O	Qac < 16'
SC5-15-04ACBB1-17	Qgl	11					T	
SC5-15-04ACBB2-17	Qgl	19	S/14-19'	15	24	U	P	.020 screen Alluvium? QW-whole suite
SC5-15-04ACBB3-17	Qgl	21					OR	Qac < 20'
SC5-15-04ACBB4-17	Qgl	11					T	
SC5-15-04ACBB5-17	Qgl	61					OR	Qac < 20' 12'< Water <20'
SC5-15-04ACBB6-17	Qgl	18.5					T	
SC5-15-04ACBC1-18	Qgl	40					T	Qac <16'
SC5-15-04ACDA	Qgl	64	P/30-35'	7	7	C	DO	#20687 Alluvium < 35' < Lac Was ACAD1-20
SC5-15-04ACDD1-4	Qal	14					DO	USGS Hach QW
SC5-15-04ADBA	Qgl	44				U	O	#21641 Alluvium?
SC5-15-04ADBA1-21	Qgl	65	P/34-38'	2		C	U	Qac < 31' Lac > 38'
SC5-15-04ADBB	Qgl	37				U	O	#21645 NP Alluvium?
SC5-15-04ADBB	Qgl	36.5				U	O	#21646 NP Alluvium?
SC5-15-04ADBB4-7	Qgl	44.5	S .012	15		U ?	U	Qac < 28' Screened 31-44'
SC5-15-04ADBB5-7	Qgl	60					U	
SC5-15-04ADBC1-S	Qgl						SU	NL
SC5-15-04BAAB1-9	Qgl	12					DO	NL
SC5-15-04BDAB1-28	Qgl	33		8			DO	NL Qac < 24'
SC5-15-04BDAC1-32	Qgl	35	O	10		C	DO	Lac > 24'
SC5-15-04BDBB1-29	Qgl	50	O	10	10	C	DO	Qd > 29'
SC5-15-04BDCA1-14	Qgl	60	S	0		U	O	Aq. 11-15' Open at bottom - dry
SC5-15-04CAAA1-S	Qgl			25			SU	NL DOW QW CaCO3 alk=23mg/l Hard.=lab calc.
SC5-15-04CADC1-10	Tkb	77	O	4	6	C	P	Tkb > 12'? Artesian
SC5-15-04CBDC1-S	Qgl						SP	#22127 NL Kyllonen spring & watering pt.
SC5-15-04CBDD1-S	Qgl			9			SU	NL DOW QW CaCO3 alk=39mg/l Hard.=lab calc.

Local Well Number	Aquifer	Hole Depth (feet)	Well Finish	Yield (gpm)	Maximum Calculated Potential Yield (gpm)	Confined (C) or Unconfined (U) Aquifer	Well Status	Comments
SC5-15-04CDAC1-11	Qgl	51		6	7.2	C	DO	2 gpm 41-42'
SC5-15-04CDDA1-31	Qgl	46	O	10		C	DO	
SC5-15-04DBAC1-35	Tkb	140		0			DR	Tkb at 18' next choices 75 or 108'
SC5-15-04DBDB1-34	Qgl						P	NL
SC5-15-04DCAA1-5	Qgl	60					U	Qac < 18'
SC5-15-04DCAA2-5	Qgl	70		60			DO	NL USGS Hach QW CaCO3 Alk=17.16 mg/l
SC5-15-04DCBB	Qgl	40	O	5	6	C	DO	#13788 Alluvium?
SC5-15-05DABD	Qal	31	P/20-25'	8	8	U	P	#14805 Driller Hach QW Was DAAC Alk=3ppm ?
SC5-15-05DADC1-3	Qal	37	O ?	10	10	U	DO	
SC5-15-05DCAD1-1	Qal	19	Crib			U	DO	Qal ?
SC5-15-05DDCD1-2	Qgl	46	O	3	5.4	C ?	DO	Sand to 46'TD
SC5-15-09AADC1-3	Qd2	88	O	10	24	C	DO	
SC5-15-09ADCD1-4	Qd2	29					DO	NL
SC5-15-09CBDC1-2	Qd2	76	O	16	62.4	C	DO	Qac ?
SC5-15-09DACA1-1	Qd2	90				C ?	DO	USGS Hach QW Poor log
SC5-15-10CCAC2-1	Tkb	14,705					T	NL Oil well
SC5-15-10CCBD	Qd2	100	P/9'				DO	#21570 NL Was CCAC1-1
SC5-15-10CDAB1-3	Qd2	33	O	3	5.1	C	DO	Qac < 16'?
SC5-15-10DCCB1-2	Qd2	23					DO	USGS Hach QW CaCO3 Alk=9.59 mg/l
SC5-15-12DDCA1-1	Qd1	68		15		C	DO	Lac NL
SC5-15-13ABCD1-1	Tkb	22		0			DR	Dry Tkb > 16'
SC5-15-13BADA1-4	Qal	4					T	Qal,Qd ?
SC5-15-13BADA2-4	Qal	8					T	Qal,Qd ?
SC5-15-13BADB1-5	Qal	7					T	Qal,Qd ?
SC5-15-13BADD1-3	Tkb	51		20		C	DO	Tkb > 28'? Driller Hach QW
SC5-15-13DACA1-2	Tkb	71	O	10	480	C	P	Tkb > 15'
SC5-15-14BDCB1-1	Qd2	81		30		C	DO	NL
SC5-15-14BDCB2-1	Qd2	108	O	3.5	4.9	C	DO	
SC5-15-14DCDC1-2	Qd2	45		30			DO	NL USGS
SC5-15-15ABAC1-1	Qd2	104		25		C	DO	Incomplete log
SC5-15-15ABDA1-2	Qd2	75					DO	NL
SC5-15-15BABA1-3	Qd2	82	O	12		C	DO	
SC5-15-24BCDA1-1	Qd2	119	O	15	28.6	C	DO	
SC5-15-24DCBA1-3	Qd2	81		7		C	DO	Driller Hach QW
SC5-15-24DCDB1-2	Qd2	20		1.5			DO	NL
SC5-15-24DDDB1-4	Qd2	23.5					DO	NL

APPENDIX D

Listing of public-water supply wells and related information sorted by local well number

Local Well Number	Aquifer	Owner	Business Name	PWSI#	Cl	Comments
SC4-15-27CADC	Qgl	Church of the Nazarene	Church of the Nazarene & Parsonage	245074	B	#22119 NL
SC4-15-34CCCD1-1	Qgl	McAnelly, George & Mary	Anchor Point Clinic		C	No PWSI#
SC4-15-34DBDC	Qgl	Lapan, Catherine	Anchor Point Tesoro		C	#22122 NL No PWSI# Granross Grove Sud., L7
SC4-15-34DBDC1-4	Qgl	Cluchey, David & Terry A.	Terry Ann's Restaurant	243501	B	
SC4-15-34DCCD2-1	Qgl	Kenai Peninsula Borough	Anchor Point Fire Station	247995	C	
SC4-15-34DCDA	Qgl	Rozak, Ronald T.	Clendenen's Corner	240668	B	#22125 NL (The Homestead)
SC4-15-34DCDB1-2	Tkb	Church of Christ	Church of Christ	245391	B	
SC4-15-34DCDB3-2	Tkb	Cundiff, Jeff	Good Time Charters		C	No PWSI#
SC4-15-34DCDC1-6	Qgl	Swisher, Billie	Billie's Video		C	No PWSI#
SC5-14-16BADC1-2	Qdt	World Christian Broadcast Corp.	KNLS Int'l Shortwave Radio Station		C	No PWSI#
SC5-15-04AAAB2-8	Qgl	Craig, Robert W.	Anchor Point Garage		C	No PWSI#
SC5-15-04AABA	Qgl	Thurmond, William & Rochelle	Thurmond's Automotive		C	#22128 NL No PWSI#
SC5-15-04AABA2-2	Qgl	Symens, John & Rebecca	Old U.S. Post Office Building & Mall		C	No PWSI# S.J. Chapman Add., L8
SC5-15-04AABC	Qgl	Baptist MID Mission	Anch. Pt. Baptist Church & Parsonage	245448	B	#22126 NL 65' deep?
SC5-15-04AABC1-2	Qgl	Neff, Richard & Myra	Roadhouse Inn Deli & Laundromat	241698	B	
SC5-15-04AACB1-1	Qgl	Neff, Richard & Myra	Roadhouse Inn Deli & Laundromat	241698	B	
SC5-15-04AACB2-1	Qgl	Anchor Point Community Club	Anchor Point Community Center		C	No PWSI#
SC5-15-04ABBA1-1	Qgl	Anch. Pt. Veterans of Foreign Wars	Anchor Point V.F.W. Post #10221	245498	B	
SC5-15-04ABDC2-2	Qgl	AK. Dist. Council Assembly of God	Lighthouse Assembly of God Church	245375	C	
SC5-15-04ABDD1-2	Qgl	Kenai Peninsula Borough	Chapman Elementary School	240537	A	46' well, 15 gpm
SC5-15-04ACBB2-1	Qgl	Anchor Point Safe Water Corp.	Anchor Point Watering Point	247490	A	
SC5-15-04CADC1-1	Tkb	Kukuchka, George	Silver King Tackle Shop		C	No PWSI#
SC5-15-04CBDC	Qgl	Kyllonen Enterprises, Inc.	Kyllonen Enterprises, Inc.		C	#22127 NL No PWSI# Spring watering point
SC5-15-04DBDB1-3	Qgl	Harrington, Stanley	Anchor Angler	244248	B	86' well, 10 gpm
SC5-15-05DABD	Qal	Kyllonen Enterprises, Inc.	Kyllonen's R.V. Park	244523	C	#14805 N. side Anch. Pt. Rd. Beach lot 2
SC5-15-13DACA1-2	Qgl	ADNR / Division of Parks	Anchor River Campground	240579	B	