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# Bay City Flowers Company, Inc.
# Half Moon Bay, California

## Summaries of Documents

## Concerning Geology and Groundwater Hydrology

## In the proximity of

## The Warheit Well and the Bean Hollow Nursery

Prepared for

ENTRIX,INC.
Walnut Creek, California

February, 1999


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# Bay City Flowers Company, Inc.
# Half Moon Bay, California

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# Summaries of Documents Concerning Geology and Groundwater Hydrology In the proximity of The Warheit Well and the Bean Hollow Nursery

**by**

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During the January 11, 1999 public meeting, concern was expressed whether the plan for Pond No. 4 at Bean Hollow Nursery would adversely affect the Warheit Well, which is used for Pescadero's water suppply.

In response to this concern, a review was conducted of the available reports at San Mateo County Department of Health Services, and also various engineering and hydrology reports previously commissioned by Bay City Flowers Co., Inc. In addition, some relevant reports of the US Geological Survey were also reviewed. The following summaries were prepared to facilitate review of the regional hydrogeology by the Water Resources Control Board and other interested parties. Complete copies of the cited documentation are being mailed separately to the State Water Resources Control Board and can be made available to others on request, at cost.

Reference to *Southwest, Two and Three Creeks* occurs in the following text; these are arbitrary names assigned to drainage areas on which the Bean Hollow Nursery is located. (A map showing these drainage areas is given in the *Bean Hollow Road Nursery Preliminary Hydrological Assessment* (Kilmartin, 1998). The Warheit Well is located on the eastern boundary of the "Three Creek" drainage shed.

Comments by this writer on the reports, if any, are indicated in italics. Summary comments and conclusions are presented at the end of the report

**Reference 1:**

***Review of Warheit Water Test Well Near Pescadero San Mateo County, California*, Perry R. Wood, Engineering Geologist, September 13, 1982.**

Well is located on Hill 285 on almost a direct north line from the Bean Hollow Road Nursery, about 1600 ft from its northern property corner. The well location is located on the drainage basin rim line of Three Creek (Kilmartin, 1998). This site is on land owned by the County.

A hardpan was encountered at 4 to 15 feet. Below that conglomerates, sands, and silts in various layers with no significant water flow. A brown dune sand began at 110 feet and continued to 240 feet depth. Ground water was reached at 205 feet depth, i.e., El 80 +/-. The flow increased gradually to a depth of 220 feet and was then constant to 240 feet. Salt-tasting water was not encountered. Difficulty with caving and boiling of sand and water in cavities prevented estimating specific yield.

The report includes a west to east cross section through Butano Creek, the Warheit Well and the Pacific Coast.

Mr. Wood opined that " ...the lens of fresh water probably covers many tens of acres and probably is 30 to 100 feet thick in the project area. If not overly developed by other wells, the fresh-water lens probably will be a source of fresh water for many years".

Samples were taken for chemical analysis by the County but not given in this report.

***Reference 2:***

***Water Quantity and Quality Impact Study - Bean Hollow Housing Project (BHHP), Pescadero, CA* March 3, 1994, ASE- Applied Science and Engineering (ASE), Inc., PO Box 1166 San Carlos, CA 94070 prepared by Frederick A. Yukic, Principal Engineer, for Mid-Peninsula Housing Coalition.**

Housing project proposed for same hilltop where the Warheit Well is located. Will use Warheit water plus water from the Pescadero Community Water System (PCWS) well. The latter is "very near" the former. The project proposes 30 housing units with a population of 182.

With regard to surface hydrology: The presence of ponds, reservoirs and seeps on the soils map " ...suggest that vertical leakage of water through the shallow soils is restricted by underlying low permeability sediments. Seeps usually occur where permeable, water-bearing sediments, underlain by impermeable sediments, intercept the ground surface. Thus the presence of the seeps

suggests that very little is occurring from the ground surface to the deeper sediments at the site."

FBLA (report does not identify this abbreviation) is noted as having studied shallow wells in the adjacent quarry area. They found a spring along Bean Hollow Road and perched groundwater in excavations; from these they concluded that the Pigeon Point formation has low permeability. Following heavy rainfall "the surface materials (terrace and colluvium) were found to be essentially saturated to the ground surface whenever bedrock was within approximately 20 feet of the ground surface".

But they quote a Kennedy Jenks Childon report which suggested the primary source of recharge to the deep aquifer is most likely rapid infiltration of precipitation through the terrace deposits. ASE concluded that the perched groundwater bodies provide a " ...significant component of vertical flow ...into the underlying Pigeon Point formation over the long term. There is not another satisfactory explanation for the presence of groundwater at an elevation above Butano Creek and Arroyo de Los Frijoles. They also thought that the quarry pond might be a source of recharge, but they had no data to substantiate this opinion.

ASE opined that the extent of the aquifer was indicated by the Bay City Flowers Co. well and one across the road from Bay City Flowers. No quantitative data for the latter wells were cited.

The report contains an annual water budget for the project; a total demand of 15.1 AF/year is projected, and ASE concludes that up to 11 AF/year "may" recharge the aquifer.

The report discusses the potential for reducing infiltration of oil and grease, and for reducing the net withdrawal from the aquifer, assuming recharge from the project area. Hydrocarbon infiltration would be limited to surface layers, where it would biodegrade. Nitrates from leachate fields could be up to 3 ppm at the deep aquifer water-table, according to ASE, diluting to 1 ppm with mixing. (EPA standard 10 mg/l). Nitrogen might be more harmful in the perched watertables; the perched water tables call into question the technical feasibility of using septic systems at the site.

A detailed discussion of the potential for salt-water intrusion is given. This is deemed a likely result if pumping is excessive.

A study by Todd(Winzler & Kelly, 1989) is cited as estimating a total aquifer water volume of 2400 acre-ft, with an annual recharge rate of 25 to 50 acre-ft.

Pescadero-CWS has a projected demand of 50 acre-ft/year. Assuming a volume of 1300 acre-ft Todd derived an aquifer life of 27 years for the Pescadero-CWS use only. The gross demand for the BHHP is 15.1 acre-ft. The BHHP would reduce the aquifer life by another 4 to 8 years.

***Comment:***

*At the public meeting called by WRCB on February 1, 1999 at Pescadero, it was mentioned by an observer that the BHHP project could not obtain bank financing because of inadequate assurances on the water supply.*

*There is some discrepancy in the various Warheit well yield estimates cited by this report. Also, different consultants quoted by the report seemed to have very different concepts on the total volume in the aquifer and the recharge mechanism. No discussion is offered to reconcile these differences.*

*It is noted that the map accompanying this report places the Warheit well within or very near a mapping of Qt, Holocene and Pleistocene terrace deposits, and apparently not directly in the Kpp Pigeon Point Formation mapping. However, a geologic section accompanying the report and attributed to the SCS (1961) shows the Warheit site in a shallow terrace formation overlying the much deeper Pigeon Point Formation. If this interpretation is accurate the Warheit well does penetrate the Pigeon Point formation, however, it is locally much more homogeneous than the complexity displayed by the lithology at the Nursery wells.*

***Reference 3:***

***TEST WELL EVALUATION 75-ACRE PARCEL, BEAN HOLLOW ROAD, SAN MATEO COUNTY, CALIFORNIA, GEOCONSULTANTS, INC., DECEMBER 10, 1991.***

A small spring in the SW portion of the Bay City Flowers Company (BCFC) property was noted, and is used to maintain water in open reservoir at site. A pump for an existing domicile was tested.

Drilled 3 small diameter wells to depths of 350 to 400 feet ; geologic inspector classified sample type every 5 feet; electric well logs; water quality test results.

Possible N-S Fault trace identified, slicing diagonal from near S corner to near N corner; shown on accompanying photomap.

Logs for the three wells variously indicate sand, clayey sand, silty sand, and sandstone in the upper 50 feet. Complex profiles. A clayey siltstone is mapped in all three wells, however its upper surface varies considerably - depths of 120,

180 and 220 feet, and thickness also varies considerably. Water bearing formation is at and below 200 ft depth.

Well No. 1 located in greenhouse area and was drilled to a depth of 430 feet; pump test results: static initial water level at -35 ft, or with a surface elevation of about 287, a WS elevation of 252 ft. After 8 hours pumping at 9.1 gpm the drawdown was 84.8 feet. to WS El 167+/-. Specific capacity 0.11 gpm per foot of drawdown. Maximum yield recommended at 17 gpm.

Well No. 2 located in southern part of property, 430' N of south corner. Drilled to 400 feet. Decided to abandon since indications were little potential.

Well No. 3 located 300' N of Well No. 1 near N edge of greenhouses, and drilled to a depth of 355 feet. Pump test results: static initial water level at -27.6 or based on a ground elevation of about El 283, a WS elevation of 255.4. At an average Q of 4.4 gpm, drawdown was 116.4 feet after 5.2 hours to an elevation of 139 ft. Specific capacity 0.04 gpm per foot of drawdown. Maximum yield recommended at 6 gpm.

The house well was determined to have a maximum recommended yield of 3 gpm.

Water quality tests indicated water suitable for drinking water and agriculture

***Comment:***

*The three wells are located within the "Three Creek" drainage area as described in Kilmartin, 1998. Their center of gravity is about 2500 feet south of the Warheit Well, the water supply for the City of Pescadero.*

*The geology described for the upper layers varies among the three sites - At well #1 the upper 25 feet is described as Clay, sandy (fine), tan; at well #2, the upper 5 feet is described as sand; fine grained, silty, tan; at well # 3 the upper 5 feet are described as clay, orange color with some silt grains. These descriptions are inadequate to ascribe infiltration characteristics, but even a minor amount of clay could reduce permeability and act to limit infiltration to deeper layers.*

*The main water bearing formations appear to be from about 100 feet above sea level to 100 feet below sea level. While this range is not inconsistent with that of the Warheit well, It is noted that the specific capacities of these wells is much lower than for the Warheit Well.*

*The logs indicated sandstones in various layers interbedded with siltstones, sands and silty sands. While the well logs indicate high*

*variability, it is reasonable that the deeper formations in the Pigeon Point syncline may "daylight" on the gentler lower slopes of the hill mass between Lake Lucerne and Pescadero, where they have direct access to recharge from surface infiltration. The gentler slopes on the lower part of the hill mass afford a greater exposed recharge area to infiltration than the near-crest area of the hill mass where the wells are sited.*

*The interbedded siltstones and clayey/silty sands are likely to facilitate formation of some of the springs that have been reported occurring on this hill mass (Reference 2) at lower elevations.*

***Reference 4:***

***SUMMARY REPORT, DRILLING AND WELL COMPLETION PRODUCTION WELLS NO. 4 AND 5 - 75-ACRE PARCEL, BEAN HOLLOW ROAD, SAN MATEO COUNTY, CALIFORNIA*, GEOCONSULTANTS, INC., JULY 29, 1992.**

Well No. 4 is adjacent to Bean Hollow Road at about the mid-point between property boundaries. Well No. 5 is located near the southwest property line, about 500 feet northwest of the existing pond No. 2. No. 4 was drilled to 700 feet, and No. 5 to 800 feet.

Report contains drill log, lithologic log, and caliper log for each well. The lithologic logs showed the extreme variability of the underlying geology in this parcel over comparatively short distances. At both wells the upper 20 to 30 feet are terrace deposits of either clay, sand, or clayey sands. At Well No. 4 there is next about a 60 foot layer of siltstone, followed by about 300 feet of sandstone/siltstone, and then about 350 feet of sandstone.

At Well 5 there is about 360 feet of sandstone below the upper surface material, followed by various layers of sandstone, shale, sand. The two wells are about 900 feet apart. The difference in geologic profiles over this relatively short distance is striking.

The pump test for Well No. 4 began with a static water depth of 24 feet; with a ground elevation of about 281, the static ground water level was El 257. At the end of an interrupted and resumed test, total drawdown was 216 feet. The specific capacity was estimated at 0.13 gpm/ft of drawdown, and the recommended 24-hour sustainable yield was 35 gpm.

The pump test for Well No.5 began with a static water depth of 34.3 feet. The ground elevation at the well site is approximately 245; the static ground water level was therefore at about El 211. During the pumping test for Well No. 5 there was little change in WS El at pump #4, which would tend to indicate the upper layers at the two wells may not be hydraulically connected.

The specific capacity for Well No. 5 was computed at 0.17 gpm/ft, and the recommended maximum yield set by the Consultant was 35-40 gpm on a 24-hour sustained basis.

Water quality was determined to be satisfactory for drinking as well as for agriculture.

The Consultant recommended that if a third well is needed, it should be sunk roughly halve way between No. 4 and No. 5.

***Comment:***

*Well No 4 lies close to if not on the boundary between Two Creek and Three Creek (see Kilmartin, 1998), and Well No. 5 is similarly situated on or near the boundary between Southwest Creek and Two Creek. However, it is doubtful that the surface water direction in the vicinity of the wells has anything to do with the recharge pattern to the deep aquifers which supply these wells.*

*Both of these wells lie to the west of the possible N-S fault trace mapped through the Nursery in Reference 3. The existence of a fault line discontinuity tends to be confirmed by the differences in well geology and yield between wells No. 1 and 3 and No. 4 and 5. It is noted that the Warheit Well in on the east side of the fault line, most likely further isolating it from effects of pumping of these two wells.*

***Reference 5:***

***REPORT, GEOTECHNICAL INVESTIGATIONS, PROPOSED FARM POND, 1000 BEAN HOLLOW ROAD, PESCADERO, CALIFORNIA, FOR BAY CITY FLOWER COMPANY, INC.,* Bay Area Geotechnical Group, Palo Alto, CA, September 27, 1996.**

This report deals with the geotechnical aspects of the proposed pond No. 4 and presents results of borings and piezometers to document soil and groundwater conditions in the upper 25-50 feet of the soil profile in the vicinity of the proposed pond excavation. Test results are also presented for various soil engineering properties, such as PL, LL, wet and dry density, shear strength, permeability, grain-size distribution, etc.

The proposed pond in the southwest corner of the Bay City Flowers property will be almost entirely an excavated pond. Present ground elevation slopes from El 250 southwest to El 240 across the pond site. Excavation will be to El 225, or a depth below existing ground averaging about 20 feet. There will be a small

engineered fill in the western corner of the pond with a maximum height of 6 feet above existing grade.

Two aquifers are distinguished in this report. A shallow aquifer that will manifest itself in pond construction 7 to 18 feet below existing ground, and a deep aquifer considerably below the upper aquifer. The deep aquifer referred to in this report is encountered 30-40 feet below the ground surface, immediately above bedrock.

Artesian pressure is cited as pushing piezometric levels to El 250 in the SE corner of the pond site, compared to existing ground elevation in the range of 243. The bottom of the pond in this area will require sufficient cover over the sand aquifer to resist blow-out from artesian pressure, or else drain wells to relieve the pressure.

The report includes a discussion of seismic activity in the area and seismic effects on the pond and its containing soil mass. The cut face slopes on the pond interior are subject to seismic hazards. These are addressed with stability analyses based on a repeatable horizontal ground acceleration of 65% of the maximum credible earthquake peak acceleration, or 0.32 g. The Palo Colorado-San Gregorio Fault is potentially more severe at the site than the San Andreas, with peak acceleration of 0.49 versus 0.21 for the latter

Liquefaction during an earthquake event was considered; however the soils encountered were too dense or contained too much clay to liquefy.

Soil boring logs are presented for nine sites in the vicinity of the proposed pond. The upper 2-4 feet are dark brown silty to clayey fine sand, generally wet, and loose to medium density at the surface. Next below is 5 to 10 feet consisting of a clayey sand that is most and medium dense. The 3rd strata is 4-10 feet in thickness and consists of a slightly silty fine sand to clean sand. The next layer is 11 to 29 feet thick - mostly clayey sand with some sandy clay, generally saturated and medium dense to dense. The bottom layer immediately above bedrock varies 5-16 feet in thickness and consists of a silty sand to a clean sand, with some pea gravel at some locations. Medium dense to dense, under artesian pressure.

Stability analyses are presented for the cut embankment section and also for the fill embankment section. Static factors of safety of 1.7 and 2.7 are obtained, and under earthquake loading 1.1 and 1.3 respectively. BAGG concludes that small portions of the pond excavated face slopes may fail into the pond during a design earthquake, "...but we do not believe that this would result in irreparable damage to the pond or appreciable damage to the surrounding area".

The report details precautions that are necessary during construction for handling the expected artesian pressure with wellpoints to avoid quick conditions, and also details construction control methods which should be followed in embankment construction.

***Comment:***

*The artesian pressures found to exist in the pond area to elevations of 250 above mean sea level could result from infiltrating waters from higher elevations. The nursery lies generally on the western slopes of Hill 340, where infiltrating waters could impose artesian pressures in the lower elevations. Considering that the deep aquifer wells indicated static water levels to 210.7 and 257 in well No. 4 and 5, there might be also be some leakage from the deep aquifers into the near-surface areas. Also, pond No. 1 at a water surface elevation of about El. 278 may exert a significant control on shallow ground water levels downhill in both the Two Creek and Southwest Creek watersheds (Kilmartin, 1998).*

***Reference 6:***

**Akers, J.P., *The Potential for Developing Ground-Water Supplies in the Pescadero Area, San Mateo County, California*, USGS WRI 80-6, 1980.**

Abstract summary: Adequate supplies of ground water for municipal use are generally not available within a 3-mile radius of Pescadero. The required quantity of 100 gpm could be obtained from wells in the alluvium along Pescadero Creek; however, the quality of the water would probably deteriorate with time and might not be suitable for public supply for more than 20 or 30 years. San and Gravel beds in the alluvium near the junction of Honsinger and Pescadero Creeks offer the best potential for developing domestic water supplies.

Alluvial aquifer contamination by septic effluent from individual homes along Pescadero Creek and nitrates from irrigation return flows had made the shallow aquifer a health hazard. This report explored the possibility of new sources.

Discusses "The Mesa", consisting of the Pigeon Point Formation, several hundred feet of conglomerate, sandstone, siltstone, and mudstone, generally with low permeability.

The Mesa is the hill mass which includes the Bean Hollow Nursery and the Warheit Well and also extends south of Lake Lucerne, as shown on the USGS quad sheet. This formation is approximately 8.5 miles long and has a surface manifestation approximately 1 to 1.4 miles in width.

The Mesa is characterized by numerous seeps which give rise to small perennial streams. The seeps indicate a measure of recharge to and groundwater storage in the Pigeon Point Formation. However, most of the seeps are in topographically high areas, suggesting that not much of the recharged water moves very far downward into the Pigeon Point Formation. Most of the water that sustains the seeps is probably from shallow fracture systems or from soil.

The report discussed water supply potential from several sources including "The Mesa" and concluded they were not promising for a supply of 100 gpm. The report recommended drilling test wells near the junction of Pescadero and Honsinger Creek.

***Reference 7:***

**Wagner, D.L., E.J. Bortugno and R.D. McJunkin, *Geologic Map of the San Francisco-San Jose Quadrangle*, California Division of Mines and Geology, 1990.**

This map shows the Pigeon Point formation as being generally the same in plan as The Mesa on the topographic map. Note: this is a set of 5 map sheets.

This map also shows an interesting cross section across the map which happens to cross the Pigeon Point Formation area. It actually crosses through Bean Hollow Lake, about 5.5 miles SE of the BCFC nursery.

What is interesting in the geologic section are the folds displayed in the strata comprising the Pigeon Point formation. These folds rise to an anticline that crests at about the coast line and then dip steeply down heading inland, forming a large bowl or syncline and then up again along the San Gregario fault line, pushed apparently from below by what are mapped as Cretaceous Volcanics on the west side of the San Gregario Fault Zone. The section indicates approximately 4000 feet of depth in the Pigeon Point formation syncline, before the Cretaceous intrusive is reached.

***Comment:***

> *A possible hypothesis is that the bowl area thus formed between the coast and the fault is the general zone of the deep aquifers being tapped by the Bean Hollow wells. The anticline at the coast protects this bowl from sea-water intrusion with impermeable members of the formation such as siltstones, possibly explaining why high-quality water is being pumped from wells drilled well below sea-level. Also, it appears that the up-turned strata daylight on both sides of the deep syncline zone between the coast and the fault, where they allow a much larger area of infiltration to enter the "bowl" area via the more permeable members of the Pigeon Point*

*Formation. This inflow on both sides of the syncline would tend to force water in the central bowl higher, facilitating artesian pressures such as are exerted in the deep aquifers.*

*Thus virtually the entire Mesa representation of the Pigeon Point formation is reasoned to be supplying infiltrated waters to the deep aquifer layers tapped by the deep BCFC wells. In addition to infiltrated waters, it is likely that the bowl contains cognate waters from long ago. Two man-made reservoirs - Lake Lucerne and Bean Hollow Lake, rest on this formation, and may also contribute to recharge into the formation, as would seepage along the various creeks traversing the area.*

*An assumption of this hypothesis is that the folding shown in the section continues up the coast for 5-7 miles to where the wells are located. This seems reasonable since the controlling San Gregario Fault continues northwest well past the area of interest and it appears to shape the linear structure observed along The Mesa formation.*

> *A professional geologist should evaluate this interpretation, and could perhaps shed additional light verifying the anticlinal and synclinal features shown in the section and the interpretation given here.*

*This hypothesis results in a possible conclusion that the recharge area for the aquifer is approximately the entire surface manifestation of the Pigeon Point Formation, roughly 10-11 square miles; this area affords recharge surface-area to the deep aquifer being tapped by the BCFC wells. The higher parts of The Mesa hill mass reach elevations up to 600 feet about four miles southeast of the Nursery. Exposed upturned sediments in this general area could also contribute to infiltration from the higher elevations, pressurizing the same formations in the syncline all along the hill mass. The higher elevations also received somewhat greater amounts of annual precipitation.*

*Such a large area would tend to indicate that there may be a significant amount of water trapped in the Pigeon Point Formation at depth. However, due to the density of the formations the available space for water storage is limited and permeabilities are low, making transmission to the wells slow. This may account for the large drawdowns displayed in the pump tests and the relatively low specific capacities.*

While the Warheit well does not penetrate below sea level into these formations, and would not be drawing directly from the same strata as the Bean Hollow Nursery wells, it seems reasonable that artesian aquifer

leakage from below could be an additional source of recharge to the Warheit well aquifer.

**Reference 8:**

**Wire, Jeremy C., *"Evaluation of Test Well "Warheit" No. 1, Pescadero, San Mateo County, Ca (Agreement #6700-83-1247),* May 3, 1983.**

12-inch diameter drill hole to depth of 280 feet. 6-inch diameter PVC casing sunk to 247 ft depth. Drill log and electric log provided. Sieve Analysis indicated Clay and Sand to 75 feet depth, and fine to medium sand below that. Some intervals were slightly cemented. TDS above drinking water standards was encountered at 260 feet.

A 24-hour pump test started with static water level at a depth of 169.5 feet. This dropped 6.3 feet in the first 30 minutes and then remained constant for the remaining part of the test. Discharge was a constant 22 gpm. Full recovery was achieved in 110 minutes. Specific capacity 3.4 gpm per foot of drawdown. Considering drawdown and the screen setting a maximum yeld that could be obtained was estimated at 135 gpm.

> ***Commentary*** *- This well differs in many respects from the Bean Hollow Wells as described by this same consultant earlier in this summary of reports. The Bean Hollow wells are deeper by 100 to 550 feet, have mostly standstone, siltstone, mudstone and conglomerate strata, as opposed to mostly uncemented sand in the Warheit well; and they have specific capacities (gpm per foot of drawdown) an order-of-magnitude lower. These stark differences in physical are sufficient to rule out any significant commonality of geology or water supply. It is apparent that there must be significant changes in lithology between this well and the Bean Hollow wells, even though they are only about a half-mile apart.*

***Reference 9:***

**Draft Letter to Mr. R. George Zinckgraf, Department of Public Works, County of San Mateo, Redwood City, CA, Subject*: "Feasibility of Using the Warheit Well as a Water Supply for Pescadero, CA (K/J/C 875015.00);* undated and unsigned, no report header or letter title; originating author/organization unknown but apparently a Kennedy Jenks Chilton draft report, based on job number in title and text description involving KJC personnel. Document cites a contract with the Department of Public Works date July 1987, and describes tests performed August 11-13, 1987.**

Investigated Warheit Well. Conducted Step-drawdown test and sustained pump test. Draft describes 3-step test with pumping rates of 26.4, 40.3 and 45 gpm

and detail on general test setup. Results only partially presented and conclusions not included. An aquifer specific yield of 0.08 was given.

***Comment***

*It is not known if a final version of this report exists; the final report may have been an intended inclusion in Reference 12 below.*

***Reference 10:***

**Brabb, Earl E., *Preliminary Geologic Map of the onshore part of the Palo Alto 1:100,000 Quadrangle, California*, U.S. Geological Survey Open File Report 93-271, (1993).**

The scale of this preliminary map is 1:62,500 allowing greater detail than the Wagner, et al 1:250,000 map cited previously. It shows greater geologic complexity in the area of concern.

This map shows the Bean Hollow nursery as apparently lying in a Qmt Marine Terrace Deposit (Pleistocene) rather than Kpp Pigeon Point Formation as shown on Wagner, et al. The Qmt formation is stated to be less than 30 m thick. This presumably overlies the Pigeon Point formation as mapped by Wagner, et al.

The Qmt is described as poorly consolidated and poorly indurated well- to poorly-sorted sand, gravel, and minor silt.

The Qmt Marine Terrace is mapped in the general area of the Bean Hollow Nursery, with Kpp Pigeon Point Formation locally to the north and east, along with several isolated representations of Qcl Colluvium.

The draft map is not colored and boundaries between the complex mappings are not clear. The Warheit Well apparently plots within the Pigeon Point mapping. One of the Qcl mappings plots about 0.1 mile SW of the Warheit well, where it could conceivably contribute to the higher specific yield of the Warheit well, as compared to the wells at the Bean Hollow Nursery. (The Qcl Colluvium, described as loose to firm, friable, unsorted sand,silt, clay, gravel, rock debris, and organic material in varying proportions, would ordinarily be expected to be a better aquifer than the Pigeon Point Formation, which contains many strata of low permeability, e.g., siltstones and mudstones).

The Mesa representation south of Lake Lucerne is also represented as Qmt instead of Pigeon Point Formation as mapped by Wagner et al.

The report includes numerous USGS references to special geologic studies of the area at even larger scales.

***Comment***

*Considering the preliminary status of this mapping and its lack of clarity in the area of concern, full acceptance of the mapping should be reserved; however, it appears to indicate that the Warheit Well is situated in a somewhat different geologic setting than the Bean Hollow Nursery.*

*A concern is the conflict between the identity of the local geology in the vicinity of the Bean Hollow Nursery and the Warheit Well, as compared to Wagner, et al. The latter map identified a surface manifestation of the Pigeon Point formation of about 11 square miles extending southeast from Pescadero, whereas Brabb calls this same area as Qmt Marine Terraces. There is no question that the Brabb report was a far more intensive study of the general area of concern than Wagner, et al and that Qmt marine terraces are entirely plausible. However this switch in mapping of this relatively large area seems surprising.*

*There might be some value in reviewing some of the more detailed USGS reports listed in the references to this report to obtain a better understanding of local geology, if there remain unanswered concerns about the Warheit well. However, the reports cited by Brabb are expect to treat only geology, not groundwater per se.*

*Brabb has been studying San Mateo geology since the early 1960s; in Reference 1 above, a 1972 report by Brabb and Pampeyan (not available for this review) is quoted as describing the area in the vicinity of the Warheit well as Pigeon Point Formation (Kpp). This might indicate an inconsistency with the 1993 mapping of Qmt, that can be charged to its preliminary status, or the latter could have been a reclassification based on later findings by Brabb indicating the Marine Terrace formation is the dominant surface strata.*

***Reference 11:***

***Environmental Assessment of Water Supply Alternatives for the Community of Pescadero, California*, Prepared for San Mateo County by Thomas Reid Associates, Palo Alto, CA, October, 1987. This report accompanied the *NOTICE OF DETERMINATION* (of negative impact) by the County of San Mateo, CA, dated October 14, 1987. The report contains 87 pages, references, tables, figures, and text, and a section titled Responses to Comments (including comments).**

**Additionally the Kennedy/Jenks/Chilton Report dated September, 1987, *Report Regarding Feasibility of Using Warheit Well as a Water Supply Source for Pescadero, Ca,* is listed as an appendix, however it was <u>not</u> included in the copy obtained from the County of San Mateo for this review. While not included, it is quoted at several locations in the report.**

This report presents a comprehensive investigation of water supply alternatives for the town of Pescadero. *This summary* will only note matters of interest relative to the Warheit well and its aquifer. The latter was selected among several alternatives as the one with an adequate water supply for Pescadero, with satisfactory water quality, and with the least cost to develop.

The report asserts that the local geology is the Pigeon Point Formation, however this report was prepared prior to the Brabb mapping (1993) described previously.

In discussion of the Warheit well as a potential water supply source, the report quotes a Kennedy Jenks Chilton report dated August 1987 ... "long term impacts to local groundwater and surface levels can not be quantified at this time; however, the impacts to recharge of the local groundwater flow system will not be significant in comparison with the available regional recharge".

Under impacts of the Warheit Well System, a possibility is noted ..."that extended pumping of the well would drawn down poorer quality shallow groundwater or surface water, or draw up the saline water from the strata below, causing degradation of the quality of the aquifer. The production rate of the well would be controlled to prevent this. "...the formation appears capable of producing 80 gpm or more with an estimated drawdown of approximately 30 feet. Present physical constraints caused by the size of the well casing and the depth to groundwater "appear to limit the production of the Warheit well to approximately 45 to 50 gpm." And, "... the effect of continuous pumping of the Warheit well on the surface waters is expected to be insignificant."

A concern was expressed in the report that pumping could result in depletion of surface waters and thus of recharge to the Pescadero marsh. The source of the well's recharge was not identified. However, a *what-if scenario* was discussed assuming Butano Creek was the source of recharge to the Warheit well aquifer; the report stated that if the flow in Butano Creek dropped to zero, pumping of the well could decrease the aquifer and increase the amount of time required for flows in Butano to return to normal.

This was elaborated in the response section, page 7; the average annual discharge of Butano Creek is 16,010 acre ft. Assuming all of the aquifer demand came from the creek, the water demand for the Pescadero

system would only be 0.4% of this amount. This same page quotes the missing Appendix A (K/J/C report): "...the recharge for the Warheit well aquifer is primarily from precipitation, the groundwater flow is directed toward regional discharge areas including Butano Creek, and long-term pumping of the well would result in only a slight reduction of total recharge to the groundwater flow system."

***Comment:***

*The Butano Creek level was cited in one of the reports as being at about El 40 (The San Mateo County maps indicate El 10 or less east of the Warheit well), whereas the aquifer water bearing formations for the Warheit well had a static level of El 116 feet. Thus it is probable that a ground water flow component is normally directed towards the creek from the sand aquifer used by the well, rather than from the creek, unless barred by an intervening impermeable barrier. On the other hand, upturned permeable strata along the axis of the San Gregario fault, which in this area is generally along the creek, could be receiving creek recharge.*

***Reference 12:***

***Pescadero County Service Distric Water Supply - Water Quality Test Results Laboratory Reports form 8/21/97; 11/27/95; 2/8/96; 12/30/96; and 3/25/97.***

The Department of Health Services, San Mateo County, monitors water quality for all systems supplying drinking water in the County. Mr. Kenneth W. Robinson of that agency provided these data.

Some of the analyses presented regulatory organics and some also included inorganics.

Variation in natural inorganic concentrations can be an indicator of introduction of new sources of recharge with continued aquifer usage. The following table shows complete data sets for two years, followed by an additional sample of nitrate only.

| | TOT | | | | | Alk. | | | | | Spec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | HARD- | | | | | AS | | | | | Cond. |
| | NESS | Ca | Mg | Na | K | Ca | HCO 3 | SO4 | Cl | N03 | umho/ |
| | | | | | | CO3 | | | | | cm |
| 8.13.87 | 120 | 24 | 15 | 63 | 2.8 | 90 | 55 | 10 | 110 | 8.5 | 610 |
| 11.27.95 | 140 | 25 | 19 | 62 | 2.24 | - | 95 | 13 | 120 | 16 | 520 |
| 12.24.96 | - | - | - | - | - | - | - | - | - | 13 | - |

The values in these samples indicate no significant differences over a eight-year period, except that HCO3 and NO3 appear to be on the order of 73 and 88 percent higher, respectively, in the 1995 results. A resampling in 1996 of nitrate only indicated a small decline. In general, these results do not indicate any trend in aquifer water properties.

* * * * *

***Overall Comments:***

*The above studies show that there are significant differences in the aquifer properties, geology, and vertical location of the aquifer(s) supplying the Warheit Well versus those supplying the Bean Hollow Nursery Wells.*

*Different aquifer properties are suggested by specific drawdowns of 3.2 gpm/ft of drawdown in the Warheit Well versus less than 0.2 gpm/ft of drawdown in all of the Bean Hollow Wells. While the Bean Hollow wells with 5" casing are smaller than the 12-inch diameter of the Warheit wells, the effect of a doubling in diameter on the specific capacity is of the order of 7 to 11 percent (Cambell & Lehr, 1973, p. 224, under idealized conditions). The difference between the Bean Hollow Wells and the Warheit well is of the order of 1600 percent. A difference of this scale cannot be attributed to the difference in well diameters; clearly different aquifers are involved.*

*Aquifer geology is extremely complex in the Bean Hollow Nursery wells, including sandstones, siltstones, mudstones, conglomerates, sand and clayey sand. All of these materials were generally cemented. In contrast, the Warheit well aquifer was largely sand, and largely uncemented sand, affording higher permeabilities.*

*The Bean Hollow Nursery Wells fall in two depth classes - 300 to 400 feet and 700 to 800 feet. It is believed that both sets of wells tap water from a synclinal bowl of Pigeon Point Formation strata that is under pressure by waters infiltrating from the lower slopes of the Mesa formation locally, and possibly from the broader formation manifestations south of Lake Lucerne. See comment discussion re the Wagner et al map above. The shallower set of wells has very low yields; this set is near to the northeast nursery property line, which is closest to the Warheit Well.*

*The following table compares the four Nursery wells with the Warheit well (Note than Nursery well No. 2 was abandoned as a dry well and is not included).*

| Comparison of Bean Hollow Nursery and Warheit Well Aquifer Data | | | | | | |
|---|---|---|---|---|---|---|
| | Elevations based on Mean Sea Level<br>Depths are from wellhead (estimated) | | | | | |
| | Bean Hollow Nursery Well Number | | | | Warheit |
| **Well No.** | **1** | **3** | **4** | **5** | **1** |
| Ground Elevation | 287 | 283 | 281 | 245 | 280 |
| Drilled to depth of | 360 | 355 | 700 | 805 | 280 |
| Elevation bottom of hole | -73 | -72 | -419 | -560 | 0 |
| Static Water Level | | | | | |
| Depth | 35 | 27.3 | 24 | 34.3 | 169.5 |
| Elevation | 252 | 255.7 | 257 | 210.7 | 110.5 |
| Specific Yield gpm/ft drawdown | 0.11 | 0.04 | 0.13 | 0.17 | 3.4 |
| Water bearing formations | | | | | |
| depth to top | 200 | 100 | 250 | 240 | 80 |
| depth to bottom | 360 | 340 | 635 | 800 | 280 |
| elevation top | 87 | 183 | 31 | 5 | 200 |
| elevation bottom | -73 | -57 | -354 | -555 | 0 |
| Well screen upper and lower limits* set at | | | | | |
| top depth | 200 | 90 | 228 | 260 | 210 |
| bottom depth | 340 | 340 | 628 | 780 | 250 |
| top elevation | 87 | 193 | 53 | -15 | 70 |
| bottom elevation | -53 | -57 | -347 | -535 | 30 |
| * in some wells screens did not cover entire range indicated. | | | | | |
| Recommended well capacity gpm | 17 | 6 | 35 | 35 to 40 | 135 |

*The order-of-magnitude difference in the specific yields of the Nursery wells and the Warheit Well is a good indicator that a different aquifer or aquifers serve the Nursery; this is corroborated by the large differences in well lithology noted in the discussion of references, and the generally deeper water-bearing formations; in the case of the higher-yield deep well set, the water bearing formations are much deeper than the Warheit aquifer.*

*The recharge area of the Pigeon Point Formation for the Bean Hollow wells is suggested to range in elevation from roughly 10-20 feet above sea level on the coast side, and from creek levels of about 10 feet on the east side of the Mesa hill mass, up to the level where seeps have been noted on the upper levels of the hill mass; as noted above in the commentary on Wagner, et al, this formation is mapped to have an areal extent of about 10-11 square miles which is potential recharge area. It is suggested that some of the less permeable members of the Pigeon Point Formation may force the infiltrating waters from above to the surface as the seeps that commonly occur. Another hypothesis might be that the seeps could be occurring at the discontinuity between the Pigeon Point Formation and overlying marine terraces, as indicated by Brabb; mapping is not detailed enough to check this hypothesis. In any event, these seeps continue downhill and may eventually join streams or re-enter upturned more permeable Pigeon Point Formation strata which daylight at lower elevations, and which are associated with the anticlinal fold geometry cresting along the coast line, as displayed in the geologic section given in Wagner et al.*

***The writer's conclusion from this material is that the four nursery wells have little if any chance of significantly affecting the yield of the Warheit well. All evidence indicates the Warheit well is drawing from different aquifer strata in the Pigeon Point Formation than the much deeper wells at Bean Hollow Nursery.***

***References cited:***

Cambell, Micheal D. and Jay H. Lehr, *Water Well Technology, National Water Well Association, Mc Graw Hill, NY, 1973.*

Kilmartin, Ronald F., *Bean Hollow Road Nursery – Preliminary Hydrological Assessment*, Bay City Flower Company, (prepared for ENTRIX, Inc.), Consulting Engineer, Pleasant Hill, CA, 1998.