TECHNICAL MEMORANDUM NO. 1
SAN MATEO COUNTY MIDCOAST GROUNDWATER STUDY, PHASE II
SAN MATEO COUNTY, CALIFORNIA

April 23, 2004

Kleinfelder, Inc.
1362 Ridder Park Drive
San Jose, California 95131

April 23, 2004
File No.: 26848/RPT

Mr. Terry Burnes
County of San Mateo
Planning Services Department
455 County Government Center
Redwood City, California 94063

SUBJECT: **Technical Memorandum No. 1 for San Mateo County Midcoast Groundwater Study, Phase II, San Mateo County, California**

Dear Mr. Burnes:

Kleinfelder is pleased to present Technical Memorandum No. 1 for the San Mateo County Midcoast Groundwater Study, Phase II. The purpose of the Midcoast Groundwater Phase II Study is to evaluate groundwater conditions and to assess the suitability and long-term and sustainable water supplies within the study area. The potential effects on surrounding wells, and potential cumulative effects on the area aquifers in terms of water quality, and quantity and potential effects on riparian environments will also be evaluated during the coarse of this study.

Our investigation to date has consisted of 1) collecting, assessing, and editing water-well, septic and other databases provided by the County, 2) reviewing readily available hydrogeologic reports conducted by other investigators in the vicinity of the project study area, 3) conducting site reconnaissance, 4) compiling and assessing well logs from the County's files, 5) reviewing groundwater documentation conducted by Balance Hydrologics, Inc. as well as other selected sources, 6) developing a hydrogeologic graphic information system (GIS) database, and 7) preparing this Technical Memorandum that presents our on-going methods, analyzes, and findings.

As we have progressed in our assessment of groundwater in the Midcoast area, however, our original perceived goals of analyzing existing well data has required modification in light of data quality available. The project has been delayed over the past twelve months by several unforeseen factors. More time than was initially anticipated was needed to collect, assess, and edit the County's water-well databases. Most recently, the project was delayed by the understanding that the County's Digital Elevation Model (DEM) for the local study area would be made available for this project. After several month's delay, we were informed that the County's DEM would not be available and we proceeded with incorporating the statewide DEM into the project GIS.

The accompanying Technical Memorandum summarizes the project progress to date. Subsequent Memoranda will summarize steps to the completion of our groundwater study for the Midcoast area. This Memorandum, obviously, describes a project in progress and as such all parts of this document including text, tables, and plates are preliminary and subject to updates and changes as the project proceeds. If you have any questions, please contact the undersigned.

Respectively submitted,

KLEINFELDER, INC.

Michael Clark, C.E.G. 1264, C.Hg. 161
Senior Hydrogeologist

KLEINFELDER 1362 Ridder Park Drive, San Jose, CA 95131-1571 (408) 436-1155 (408) 436-1771 fax

A Memorandum Prepared for:

County of San Mateo
Planning Services Department
455 County Government Center
Redwood City, CA 94063

Attention: Terry Burnes, Planning Director

TECHNICAL MEMORANDUM No. 1
SAN MATEO COUNTY MIDCOAST
GROUNDWATER STUDY, PHASE II
SAN MATEO COUNTY, CALIFORNIA

Kleinfelder Project No.: 26848

April 23, 2004

By:

Michael Clark, C.E.G. 1264, C.Hg. 161
Senior Hydrogeologist
Project Manager

Christopher S. Johnson, R.G., C.Hg. 642
Chief Hydrogeologist
Technical Resource Council

Charles H. Almested, R.G., C.Hg. 397
Senior Hydrogeologist

Peter Dellavalle
GIS Specialist

KLEINFELDER, INC.
1362 Ridder Park Drive
San Jose, California 95131

TECHNICAL MEMORANDUM NO. 1
SAN MATEO COUNTY MIDCOAST GROUNDWATER STUDY, PHASE II
SAN MATEO COUNTY, CALIFORNIA

TABLE OF CONTENTS

1.0 INTRODUCTION **1**

1.1 PURPOSE AND SCOPE OF SERVICES 2
1.1.1 Task 1 Compile / Analyze Existing Data 3
1.1.2 Task 2 Field Investigation 4
1.1.3 Task 3 Hydrogeological Assessment / Modeling 6
1.1.4 Task 4 Project Report 7

1.2 INVESTIGATIVE METHODS 7
1.2.1 Report and Document Review 7
1.2.2 Data Management 8
1.2.3 Geographic Information Systems (GIS) 9

2.0 GEOLOGIC SETTING **11**

2.1 REGIONAL GEOLOGIC SETTING 11
2.1.1 Lithologic Units 12
2.1.2 Structure 12

2.2 MIDCOAST GEOLOGIC SETTING 13
2.2.1 Midcoast Stratigraphy 13

3.0 HYDROGEOLOGY **15**

3.1 HYDROGEOLOGIC SETTING 15

4.0 DESCRIPTION OF THE CONCEPTUAL MODELING **17**

4.1 HYDROGEOLOGIC CONCEPTUAL MODEL 17

4.2 PRELIMINARY EVALUATION OF AVAILABLE DATA AND IDENTIFICATION OF DATA GAPS 20

4.3 DIGITAL ELEVATION MODEL 21

5.0 CONTINUING INVESTIGATION **23**

6.0 LIMITATIONS **25**

7.0 BIBLIOGRAPHY **26**

Plates

Plate 1 - Project Location Map
Plate 2 - Project Area Map
Plate 3 - Balance Hydrologics, Inc. Proposed Groundwater Sub-basins
Plate 4 - Septic Tanks, Midcoast Aquifer Study, North
Plate 5 - Septic Tanks, Midcoast Aquifer Study, South
Plate 6 – Land Use, Midcoast Aquifer Study, North
Plate 7 – Land Use, Midcoast Aquifer Study, South
Plate 8 –Annual Precipitation

Technical Memorandum No. 1
San Mateo County Midcoast Groundwater Study, Phase II
San Mateo County, California

Table Of Contents
(Continued)

Plates, Continued

Plate 9 - Regional Geologic Map
Plate 10 - Vicinity Geologic Map
Plate 11 - Hydrologic Sub-Areas, Midcoast Aquifer Study, North
Plate 12 - Hydrologic Sub-Areas, Midcoast Aquifer Study, South
Plate 13 - Well Locations, Midcoast Aquifer Study, North
Plate 14 - Well Locations, Midcoast Aquifer Study, South
Plate 15 - Calculated Well Elevations, Midcoast Aquifer Study, North
Plate 16 - Calculated Well Elevations, Midcoast Aquifer Study, South
Plate 17 – Calculated Water Elevations, Midcoast Aquifer Study, North
Plate 18 – Calculated Water Elevations, Midcoast Aquifer Study, South

Appendix A

Table A-1 Frequency Distribution of Wells and Well Depths by Sub-Areas
Plate A-1 and A-2 Frequency Distributions by Sub-Areas

Appendix B

Plate B-1 – Geologic Time Scale

Appendix C

Application for Authorization to Use

TECHNICAL MEMORANDUM NO. 1
SAN MATEO COUNTY MIDCOAST GROUNDWATER STUDY, PHASE II
SAN MATEO COUNTY, CALIFORNIA

1.0 INTRODUCTION

The San Mateo Midcoast area is a scenic stretch of California coastline extending along US Highway 1 from north of Half Moon Bay in the south to north of the town of Montara (Project Location Map, Plate 1). The study area encompasses the communities of Montara, Moss Beach, Seal Cove, Princeton, El Granada, and Miramar (Project Area, Plate 2). The land surface rises from the Pacific Ocean along wave-cut terraces, slopes gently upward to the east, then steepens along the granitic slopes of Montara Mountain. Surface topography is interrupted at several places in its assent up slope by tectonic (fault offset) and fluvial (stream erosion) processes.

The lower, flatter portions of the Midcoast area consist predominately of marine terraces deposited during the last oceanic high-water stand during the Sangamon interglacial period of the Pleistocene Age (11,000 to 1.6 million years ago, see Geologic Time Scale, Appendix, Plate A-2). As the ocean has withdrawn from higher elevations during Holocene time (the latest 11,000 years) due in part to tectonic uplift, streams flowing from the highlands of Montara Mountain have eroded narrow valleys into the mountain's granite slopes and into the marine terrace deposits. The alluvium within the valleys and the terrace deposits generally consists of loose, unconsolidated, coarse- and medium-grained sand eroded from the granitic rocks of Montara Mountain. These sediments are the storage reservoirs for most groundwater in the Midcoast area. Generally, groundwater in the Midcoast area is derived from the alluvial and coastal-terrace deposits and weathered granite that are recharged by rain falling on the coastal plains and in the mountains to the east.

The San Mateo County Board of Supervisors has determined that because of the rapid growth within the Midcoast area of the county and the potential limited groundwater source, a comprehensive study of the hydrogeologic conditions of the area along with analysis of future management suggestions should be conducted. The planned study was proposed to be conducted in phases. The Board contracted with Balance Hydrologics, Inc. to conduct the Phase I portion of the Midcoast Groundwater Study. The Phase I study consisted of a literature and data review (Balance, April 2002).

The purpose of Balance's Phase I report was to provide a base-line list and review of publications, reports and other documents pertaining to the hydrogeologic conditions of the Midcoast area. The report gives a summary of regional hydrogeology and conditional aquifer boundaries, generalized groundwater occurrence by sub-basin and a list of data sources and possible data gaps. Using a "broad-reaching watershed approach" Balance separated out four sub-basins in the Midcoast area. Balance designated the sub-basins as 1) Martini Creek south to Dean Creek, which includes Montara Creek; 2) San Vicente south to Denniston Creek, including the airport aquifer; 3) El Granada area; and 4) Arroyo de en Medio south to Frenchmans Creek. These proposed sub-basins are shown on Plate 3, Balance Hydrologics, Inc. Proposed Groundwater Sub-basins.

1.1 PURPOSE AND SCOPE OF SERVICES

The San Mateo County Board of Supervisors has retained Kleinfelder to conduct the Phase II portion of the San Mateo County Midcoast Groundwater Study. The purpose of the Midcoast Groundwater Phase II Study is to evaluate groundwater conditions and to assess the suitability and long-term and sustainable water supplies within the study area. The County has requested this hydrogeologic evaluation of the Midcoast area to assist in long-term basin and watershed planning. It is anticipated that this hydrogeologic study will lead to appropriately controlled and efficient permitting of new water wells in the study area.

Beginning with the sub-basins defined by Balance, we refined the basin boundaries and defined sub-areas within the sub-basins based on consideration of geologic structural and stratigraphic relationships, topography, known or inferred hydraulic characteristics, and watershed boundaries. It is anticipated that the present study will demonstrate that the defined sub-areas will possess distinct hydrogeologic characteristics that will be useful in future groundwater management. In this Technical Memorandum the watershed areas previously defined by Balance Hydrologics will be described as "sub-basins" and will be distinguished from areas established to this point in our study which are referred to herein as "sub-areas." As noted in this report, the sub-areas described do not necessarily follow the margins of watersheds but include other boundaries as well such as lithologic contacts and fault traces. At the conclusion of our hydrogeologic study of the Midcoast area, it is anticipated that a clear and distinct definition of hydrogeologic areas will be presented that will combine the qualities of the sub-basins and sub-areas.

The purpose of this first Technical Memorandum for the Phase II Midcoast Groundwater Study is to review the efforts completed to date in Kleinfelder's project assessment. This and subsequent technical memoranda will be compiled at the end of the Phase II study to provide a hydrogeologic report for the Midcoast area to be used by the County in managing groundwater resources.

The following general scope of work was developed to meet the requests by the County in a meeting on November 7, 2002. The scope of the project has been altered (in conference with the County) based in part on the general condition and quantity of well data provided by the County. The nature of database information as it is accumulated and unforeseen conditions that may have an impact on the approach to the project may give further rise to alterations in the planned scope of services. Any major changes to the general outline of services will be discussed with and approved by the County.

1.1.1 Task 1 Compile / Analyze Existing Data

Review Existing Reports and Data

A hydrogeologic review of existing data will be conducted. A limited search for new published and unpublished data will also be performed in consultation with County staff. The review will include documents related to the underlying and regional hydrogeology, site topography, surface-water bodies and sources, rainfall-runoff data, groundwater recharge, and soils in the contributing watersheds. The review will focus on identifying and filling, as possible, the data gaps and other inadequacies in existing databases and reports including the Phase I investigation.

Groundwater-resource data that will be reviewed will include identification of aquifers and water yielding geologic formations, groundwater basin information (size and storage capacity), location of domestic and other production wells, well yields and water-quality information, groundwater-level and flow information, surface and groundwater interaction information, hydraulic-parameter information, etc.

Update Geographic Information System (GIS)

Kleinfelder will meet with County personnel to review and categorize existing groundwater and related data. GIS databases will be transported to Kleinfelder's GIS. The GIS will be expanded to include the hydrogeologic data compiled in this assessment.

Preliminary Conceptual Model Development

Preliminary conceptual-hydrogeologic models will be developed for the Midcoast area. A conceptual model is generally a pictorial representation of the hydrogeologic flow system in the form of block diagrams, plan maps and cross sections. It is used to describe the relationships between various components of the hydrogeologic flow system. The purpose of building conceptual models is to simplify the field problem and organize the associated field data so the system can be analyzed more readily. In addition, it is the first step in developing more complex models. Simplification is necessary because complete reconstruction of the field system is not feasible. With the conceptual model, significant data gaps will be identified and assessed.

Technical Status Memorandum

This Technical Memorandum No. 1 is submitted to the County to summarize the work performed to date and report on the status of the project. This memorandum provides lists of documents reviewed and status of the GIS work. This document constitutes Technical Memorandum No. 1.

1.1.2 Task 2 Field Investigation

Additional field studies in selected areas will be performed to provide updated geologic mapping of the study area, estimates of aquifer conditions or properties of the terrace-deposit, alluvial, and granitic water-bearing zones, and data on the extent of barriers to groundwater movement posed by clay horizons, faults and/or other geologic features. This work will be performed after consultation with and approval by County staff. Work elements below are those we assume will be performed.

Geologic Mapping

The occurrence, distribution and flow of groundwater in the Midcoast Groundwater Study project area is ultimately controlled by the geology within and in the vicinity of the various watersheds. The movement of water in the subsurface is controlled by geologic conditions including depth and type of alluvial and colluvial deposits, bedrock character and aerial distribution.

Stereo-paired aerial photographs covering the site provided by the County will be reviewed to assess the geomorphic setting, possible evidences of faulting, and other geologic conditions within the project study area. The geologic setting of the project site and surrounding area will be assessed by review of available geologic maps and reports published by the U.S. Geological Survey, the California Geologic Survey, and reports in Kleinfelder's library. Ortho-photo quads and geotechnical consultant's studies made available by the County also will be included, as appropriate, in the study. Field mapping or field "ground truthing" will be conducted to the extent possible to update existing geologic maps. Scale of the final geologic map will be dependent on the base map provided by the County.

Test Wells

Wells will be located in areas where hydrogeologic data may be lacking or where supplemental data are deemed necessary to be representative of site hydrogeologic conditions. Specific selection of aquifer-test wells will be coordinated with County personnel.

Pumping Tests

At present, 72-hour constant rate pumping tests are proposed. It is assumed that the pumped water will be returned either to the ground at distance downstream from the well or to a storm drain and no erosion control will be needed for the discharge. Each pumping well will either be manned during testing or be equipped with transducers and recording data loggers.

Pump Test Analysis

Time-drawdown data from the aquifer pumping tests will be analyzed using published and accepted analytical methods. The methods used will be dependant on aquifer conditions observed (e.g. confined, unconfined or leaky conditions, etc.), test performance data and based on the shapes of drawdown curves.

Technical Memorandum

Technical Memorandum No. 2 will be prepared for submittal to the County to summarize the field work. The report will include a geologic map, well location maps, well logs, well construction details, and the results of pump test analyses.

1.1.3 Task 3 Hydrogeological Assessment / Modeling

Refine Conceptual Models

As the first step in the hydrogeological assessment, the preliminary conceptual models developed under Task 1 will be refined. The models will be refined based on the new information developed in the field investigation phase of work and using any other new information obtained during public workshops and following additional non-published information gathering activities performed during the initial phases of the project.

Hydrogeologic Modeling

Hydrogeologic models will be developed for each sub-basin to assess the groundwater resource. The form (analytical or numerical) and complexity of the models developed will be dependent on the availability of site-specific hydrogeologic data from each sub-basin with which to construct, calibrate and validate the models. The sub-area models will be developed to the extent possible to assess the groundwater flow, water balance, sustainable yield, well interference, and impacts on sensitive areas.

Technical Memorandum

Technical Memorandum No. 3 will be prepared for submittal to the County to summarize the work performed to date and status of the project. The memorandum will provide a description of the models developed, and preliminary information on hydrogeologic balance estimates and sensitive area delineation. Details of the work will be presented in the project report as described in Task 4.

1.1.4 Task 4 Project Report

A draft hydrogeologic report will be prepared for County staff review and comment. The report will be comprehensive in nature, describing and summarizing the work and results of the work performed in Tasks 1 through 3. Kleinfelder will work with the County early in the process to identify necessary project description information required for the hydrogeologic analysis.

Following receipt of comments from County staff, we will revise the report to best address staff comments while retaining independence of professional analysis. Bound report copies and a disk copy of the final report will be provided to the County for duplication and circulation to agencies and to interested individuals and groups. The final report / submittals will include updated GIS databases and modeling spreadsheets to assist future development of management procedures and decision-tree processes.

1.2 INVESTIGATIVE METHODS

The following are descriptions of Kleinfelder's research program that has been used to date to conduct the San Mateo County Midcoast Groundwater Study. These methods and others will be continued in our on-going analysis.

1.2.1 Report and Document Review

Our hydrogeologists reviewed readily available published reports, maps, and other technical documents which are listed in the attached References section. Hydrogeologic research for this assessment included compiling documents which relate to the Midcoast Study Area. Additional documents reviewed include selected internet meteorological and agricultural sources.

Stereo-paired aerial photographs of the site were analyzed for landforms and as an aid in geologic interpretation. Our senior engineering geologist and hydrogeologist have initiated mapping the study area to delineate rock exposures for verification of local geologic conditions. The available data were and will be plotted and assessed to assist in our hydrogeologic interpretations.

1.2.2 Data Management

Kleinfelder received information regarding wells, septic tanks and developed and undeveloped lots (APNs) from the San Mateo County Health Services Agency. The data sets included GIS layers and data tables. The well data came in two sets, a large data set which contained location, ownership and correspondence information and smaller set which contained location and well construction information. The usefulness of the data was initially limited because there was no unique identifier for each and every well. In some cases, information about individual wells was in both data sets but there was no consistent link between the related records. Consequently, Kleinfelder created a new field, WellID, in the largest data set, and then assigned a unique identification number for each well. To find the related records in the smaller data set, Kleinfelder searched for fields common to both data sets and found fields for latitude and longitude that occurred in both sets. Kleinfelder compared the values in both fields of each record of one data set with the values in each record of the other. In all but about 30 records, the combination of latitude and longitude proved to uniquely identify the related records. The remaining 30 records represented cases where two or more wells had the same latitude and longitude. Kleinfelder reviewed the data for each of these groups to determine if duplicate records existed. In cases where duplicates existed, the duplicate was removed from the data set. In cases where there was clearly more than one well which shared the exact same latitude and longitude, Kleinfelder assigned a unique WellID to each and changed the value of latitude of one record by 0.0000001 decimal degree. For all practical purposes, the two wells still plot to the same place on the map but are otherwise treated as unique.

The large data set was also edited to separate out records for wells which do not occur in the study area or within the watersheds above the study area. The data were not actually deleted because the they will be returned to the County and may be useful to later studies.

1.2.3 Geographic Information Systems (GIS)

GIS is a software application that combines the benefits of detailed maps and databases. It allows the organization of data in layers, each containing a set of geographic features and information associated with them. Each layer contains the location and information relating to a single subject such as well locations or geologic formations. The layers used in this study to date include: wells, septic tanks, precipitation, topography, land use, and geology (See Plates 4, 5, 6, 7, 8, 9, and 10). Additional layers will be added as appropriate and based on their availability. Each feature in a layer has a unique place on the map represented by a point, a line or a two-dimensional shape. Information about the feature is stored in associated tables of data. Wells, for example, are shown on the map as points. Information about how the wells are constructed, including total depth, diameter, date drilled, and static water level, is stored in a related data table.

The GIS allows layers to be stacked, like sheets of clear film, over a map. The features of one layer can be used to query or categorize features in another layer. For example, Kleinfelder has mapped hydrogeologic sub-areas based on our inferences and previous studies. We can use these sub-areas to analyze relationships like: how many wells in a given area have a depth greater than 100 feet, how many are within 500 feet of the creek, or, what is the daily water demand in the Montara Heights area?

The value of the GIS is that we can collect and map data about single subjects in the manner most appropriate for that subject. Then, by overlaying features from many layers on a map, we can explore the special relationships between the attributes of different data sets.

Kleinfelder is still collecting and integrating data into GIS layers for use in this project. Additional data sets we are working on include:

- Well data from previous assessments,
- Aquifer test data,
- Water quality data,
- Census data, and others.

The GIS layers obtained to date use a variety of projection systems and many layers have no projection data. Without a common projection system alignment errors can occur. An example of this is the misalignment of the watershed boundaries and topographic contours, which can be seen on Plate 4. As a next step, Kleinfelder will select a projection appropriate to the goals of the study and reproject the data into a single projection.

2.0 GEOLOGIC SETTING

The following descriptions of geologic conditions will be expanded upon as further investigation proceeds. To assist with the definitions of Geologic Time Scale, Plate B-1 is included in Appendix B of this Memorandum.

2.1 REGIONAL GEOLOGIC SETTING

The Midcoast study area lies within the Coast Ranges Geomorphic Province which is a discontinuous series of northwest-southeast trending mountain ranges, ridges, and intervening valleys characterized by complex folding and faulting. The general geologic framework of the Central Coast Area of California is illustrated in studies by Jennings and Strand (1958), and Page (1966) included as the Regional Geologic Map (Plate 9), Brabb, Graymer, and Jones (1998), included as the Vicinity Geologic Map (Plate 10).

Geologic structures within the Coast Ranges Province are generally controlled by a major tectonic transform plate boundary defined by the San Andreas fault system. This right-lateral strike-slip fault system extends from the Gulf of California, in Mexico, to Cape Mendocino, off the coast of Humboldt County in northern California and forms a portion of the boundary between two global tectonic plates. In this portion of the Coast Ranges Province, the Pacific plate moves north relative to the North American plate, which is located east of the transform boundary. Deformation along this plate boundary is distributed across a wide fault zone that is referred to as the San Andreas fault system. The general trend (about N30-45W) of the faults within this system is responsible for the strong northwest-southeast structural grain of most geologic and geomorphic features in the Coast Ranges Province.

The large wedge of geologic rock west of the San Andreas fault that generally is underlain by Cretaceous Age (about 140 to 65 million years old) basement of granitic and high-grade metamorphic rock is referred to as the Salinian Block (Regional Geologic Map). This is a tectonic sub-province defined as a northwest trending, elongate slice of the Coast Ranges. The Salinian Block is bounded by the San Andreas fault on the east and on the west by tectonic features off the coast of California, including the Nacimiento fault zone (Page, 1966).

Geologically, the study area has a crystalline basement of Upper Cretaceous granitic rocks. The Midcoast area lies wholly within the Salinian Block.

2.1.1 Lithologic Units

Lithologic associations in San Mateo County have been divided into ten assemblages by Graymer, Jones, and Brabb, 1994. The assemblages are large, fault-bounded blocks that contain unique stratigraphic sequences. The stratigraphic sequence differs from that of neighboring assemblages by containing different rock units, or by different stratigraphic relationship among similar rock units. The current adjacent location of the different assemblages reflects the juxtaposition of different basins or parts of basins by large offsets along the faults that bound the assemblages. In general, in San Mateo County, the Tertiary strata rest with angular unconformity on complexly deformed Mesozoic rock complexes. West of the Pilarcitos fault, the Salinian complex, which is composed of granitic plutonic rocks, and inferred gabbroic plutonic rocks at depth, overlain in places by Cretaceous strata, forms the Mesozoic bedrock. These plutonic rocks are part of a batholith that has been displaced northward by offset on the San Andreas fault system (Brabb, Graymer, Jones, 1998) and is referred to as the La Honda Domain (Sedlock, 1995).

2.1.2 Structure

Faults of San Mateo County are characterized by both strike-slip and dip-slip components of displacement. There are three major fault systems in the County that display large right-lateral offsets, the San Andreas, the Pilarcitos, and the Seal Cove/San Gregorio fault zones. These fault systems trend roughly N30°W and include several fault strands in a broad zone. Offset is distributed on the various faults in the zones, and the locus of fault movement associated with a fault zone has changed through geologic time. The Seal Cove/San Gregorio fault zone, which lies near the base of the terrace adjoining the west side of the airport area, has strands that display Holocene offset and are, therefore, considered by the State of California to be an active fault system.

Pleistocene Age terraces are not observed to be folded, but are tilted and uplifted in several places. Late Pleistocene and Holocene surficial deposits retain most of their original depositional shape, but the Pleistocene alluvium and marine terrace deposits have been uplifted as much as several tens of feet in places throughout the County (Brabb, Graymer, Jones, 1998).

2.2 Midcoast Geologic Setting

2.2.1 Midcoast Stratigraphy

Mapped geologic units and formations within the Midcoast area as described by Brabb, Graymer, Jones (1998) and depicted on the Area Geology Map, Plate 10 are presented below.

Qcl Colluvium (Holocene)--Loose to firm, friable, unsorted sand, silt, clay, gravel, rock debris, and organic material in varying proportions. This material veneers steeper slopes in the County and is deposited by slow downslope movement of soil mixed with weathered rock. Colluvium generally exists as a thin (a few feet thick) veneer on slopes and generally is not considered as a groundwater source.

Qyf Younger (inner) and Qyfo Younger (outer) alluvial fan deposits (Holocene)--Unconsolidated fine- to coarse-grained sand, silt, and gravel, coarser grained at heads of fans and in narrow canyons.

Qhsc Stream channel deposits (Holocene)—Poorly- to well-sorted sand, silt, silty sand, or sandy gravel with minor cobbles. Cobbles are more common in the mountainous valleys. Only those deposits related to major creeks are mapped. In some places these deposits are under shallow water for some or all of the year, as a result of reservoir release and annual variation in rainfall. Potentially, stream channel deposits may store relatively large quantities of water.

Qmt Marine terrace deposits (Pleistocene)--Poorly consolidated and poorly indurated well- to poorly-sorted sand and gravel. Thickness is variable but usually less than 90 feet. Marine terrace deposits in the Midcoast area have historically been a predominate source of groundwater.

Tp Purisima Formation (Pliocene and upper Miocene)--Predominantly gray and greenish-gray to buff fine-grained sandstone, siltstone, and mudstone, but also includes some porcelaneous shale and mudstone, chert, silty mudstone, and volcanic ash. Generally, a moderate to poor source of water.

Tm Monterey Formation (middle Miocene)--Grayish-brown and brownish-black to very pale orange and white, porcelaneous shale with chert, porcelaneous mudstone, impure diatomite, calcareous claystone, and with small amounts of siltstone and sandstone near base. Monterey closely resembles parts of Purisima Formation. Thickness ranges from 360 to 1350 feet at the surface and up to 1800 feet in the subsurface west of the Seal Cove/San Gregorio fault. The porcelaneous and indurated nature of the Purisima and Monterey Formations generally make these rock formations poor sources of water. In addition, groundwater sourced from the Tertiary is generally of lower quality than that from Quaternary units in the Midcoast Area.

Kgr Granitic rocks of Montara Mountain--Very light gray to light brown, medium- to coarsely-crystalline foliated granitic rock, largely quartz diorite with some granite. These rocks are highly fractured and deeply weathered. Foliation is marked by an alignment of dark minerals and dark dioritic inclusions. Tabular bodies of aplite and pegmatite generally parallel foliation. Narrow valleys incised in the granite of Montara Mountain rise from the base level of the Pacific Ocean to nick points within the pluton. Groundwater can be sourced (perhaps unreliably) from near surface weathered granitic rock or front factures and points (secondary porosity) within the granitic pluton.

3.0 HYDROGEOLOGY

3.1 HYDROGEOLOGIC SETTING

For groundwater resource evaluation, geologic formations at the project site can be grouped into the following four units: 1) alluvium in the valley troughs and overlying low-lying terrace deposits, 2) marine-terrace deposits, 3) Tertiary Age Purisima and Monterey Formations, and 4) granitic bedrock.

Where sufficiently thick, Quaternary Age deposits are the better-quality sources of groundwater in the Midcoast area. The Quaternary units are not as lithified or naturally cemented as the older Tertiary and Mesozoic rocks and contain abundant interconnecting pore spaces that act as reservoirs that store and easily give up water to wells.

Because of the fine-grained nature and cementation of the Monterey and Purisima Formations and the intergrown crystalline structure of the Montara granite, little primary porosity and water storage is expected in the unfractured bedrock. Fractured bedrock holds water in its cracks which originated due to folding and faulting of the brittle rock. Water enters the fractured bedrock by means of off-site through-flow and downward percolation of surface water.

Groundwater dynamics of fractured bedrock aquifers are not well understood and it is challenging to solve water-resource problems in bedrock settings. Flow and storage occurs primarily in bedrock fractures, joints, and foliation planes. The matrix porosity and permeability is very low or close to zero, with higher permeability in the fractures (Youcha, and others, 2002).

Many groundwater issues are amplified in fractured-rock aquifers because responses to pumping stresses and contamination can be more rapid than in alluvial aquifers. Significant features of fractured-rock aquifers include: 1) flow of groundwater across a surface-water divide is rarely observed; 2) aquifer parameters like storativity and transmissivity often show erratic variations over small areas; 3) the saturated portion of the mantle of weathered rock or alluvium overlying the fractured rock often makes a significant contribution to the yield obtained from a well; 4) only a modest quantity of groundwater is generally available in any one well; and

5) drawdown in a pumping well is often almost equal to the total saturated thickness of the aquifer.

The volume of water stored in fractured hard rock is generally estimated to be less than two percent of the rock volume (DWR, 1991). This percentage decreases with depth as fractures become narrower and farther apart. The total amount of water in storage in the rock surrounding a hard-rock well is small, so that the groundwater level and the well's yield can decline dramatically in response to pumping or drought. Relevant information regarding the occurrence, movement, quantity, and quality of groundwater in fractured-rock aquifers typically is sparse.

The available volume of water stored in many alluvial soils can amount to 10-15 percent of the volume of the alluvium (DWR, 1991). In areas where alluvium overlying the hard rock is saturated with water, the alluvium provides additional water storage for nearby hard-rock wells. This situation most often occurs in valleys. Half of all hard-rock wells yield ten gallons per minute or less, which is only enough for individual domestic supplies.

Groundwater sourced from fractured bedrock generally is limited by a finite interconnected system of open spaces. The interconnected fractures form a reservoir for water storage and migration. Water may flow freely (even turbulently) from such a reservoir and may be pumped for a limited duration but may not have a sustainable yield.

4.0 DESCRIPTION OF THE CONCEPTUAL MODELING

4.1 HYDROGEOLOGIC CONCEPTUAL MODEL

A hydrogeologic conceptual model generally includes a graphic representation of the hydrogeologic flow system in the form of block diagrams, plan maps and geologic cross-sections. These graphic representations are used to identify and describe the relationships between various components of a hydrogeologic flow system. The purpose of a conceptual model is to simplify the field problem and organize the field data such that the system can be analyzed more readily. Simplification is necessary because complete reconstruction of the field system is not feasible. Development of conceptual models is the first step in developing more complex predictive models. These more complex models generally include mathematical equations to quantify parameters of interest.

For the San Mateo Mid-Coast study, Kleinfelder is using a GIS to develop plan maps for the conceptual model. The process was carried out as follows:

- Published and open-file reports were reviewed to draw from previous work at the site and assess known hydrogeologic relationships and the amount of usable data available.
- The County's well database was acquired and reviewed, culled of references that could not be adequately located or contained no significant data, and sorted for parameters of interest.
- A plan map was prepared using the GIS to delineate the major study areas of interest and their aquifers and contributing watersheds. The map developed by Kleinfelder is consistent with the Midcoast sub-basin boundary outline used by Balance Hydrologics in the Phase I report for the Mid-Coast (Balance Hydrologics, 2002). The major study areas of interest include:
    - Montara / Moss Beach
    - Seal Cove
    - Airport Aquifer

- El Granada
- Miramar and Vicinity

- Each study area was then subdivided to delineate aquifers and each major contributing watershed. In this study, "watershed" is defined as the drainage basin topographically above and contributing to each aquifer of interest in the study areas.
- Significant features were delineated within each of the contributing watersheds that play an important part in the groundwater hydraulics of the area (i.e., they store significant amounts of water). These include the elongate alluvial valleys: including the Wagner Valley alluvium, San Vicente Creek alluvium and the Denniston Creek alluvium.
- Study-area aquifers were delineated based on geology (similar geologic units through which groundwater flows, with similar groundwater behavior, and considering structural features), available well data and topography.
- Further subdivision was made of the study-area aquifers, as appropriate, to consider areas of development or future development.
- The subdivisions were assessed and refined based on the information available and the relative importance of each area. The minimum size of the subdivisions relates to the amount of information available for each unit and/or the importance of each subdivision.

The current working hydrogeologic area map for the Mid-Coast is shown in Plates 11 and 12. The subdivisions include:

Montara / Moss Beach Study Areas

Watersheds:

- Martini Creek,
- Montara Creek,
- Unnamed Martini Creek Area Drainages,
- Dean Creek,
- San Vicente Creek (in Moss Beach)

Watershed aquifer:

- Wagner Valley

Study area - Aquifer:

- Martini Creek Terrace
- Montara Terrace
- Montara Heights
- Portola Estates Area
- Upper Moss Beach
- Moss Beach Terrace

Seal Cove Study Area

Airport Area Study Area

Watersheds:

- San Vicente Creek
- Denniston Creek

Watershed Aquifer

- San Vincent Creek alluvium
- Denniston Creek alluvium

Aquifer:

- Airport Aquifer

El Granada Study Area

Watershed:

- El Granada basins

Aquifer:

- El Granada

Miramar Study Area

Water sheds:

- Arroyo de en Medio
- Frenchmans Creek

Aquifer:

- Miramar and vicinity

The subdivisions listed above and shown on the Plates 11 and 12 are generally consistent study areas developed by Kleinfelder (1988), Kleinfelder (1989), Balance Hydrologics (2002), and California DWR (1999). Lowney-Kaldveer (1974) studied the Denniston Creek area in 1974 adjacent to the airport. In their investigation, they distinguish three sub-areas in the airport aquifer: San Vicente fan area, Denniston Creek fan area and the airport area. These subdivisions were not made in the current study as these fan areas are relatively small, not easily distinguishable and are an integral part of the Airport Aquifer Area. Further subdivision of this area may be made in the future, as necessary, following further assessment of the area.

4.2 Preliminary Evaluation of Available Data and Identification of Data Gaps

As noted above, Kleinfelder reviewed the County's well database to determine what information was available from this source, and assessed the usefulness of the data. Beginning with 1087 well records for the Midoast area, 539 were deemed useable for the purposes of this study (See Section 1.2.2). Records were generally eliminated if the location of the wells could not be determined with any reasonable degree of certainty. After the list was pared down, the wells were plotted using the GIS to observe the distribution of the wells. Plates 13 and 14 show the distribution of the reduced set of wells in the County's database in the Midcoast area. The plot indicates generally good coverage in the areas of interest.

After grouping the well data by each aquifer-study area, the relevant hydraulic data from the County records were tabulated and assessed. Table 1 provides a listing of the numbers of well records in each aquifer-study area and statistics on well depth and depth to water. Frequency distributions were plotted for each aquifer including Montara Terrace, Montara Heights, Upper Moss Beach, Moss Beach Terrace, Airport, El Granada and Miramar. These frequency distribution plots are included in Appendix A.

TABLE 1 – SUMMARY OF WELL RECORDS IN MIDCOAST SUB-AREAS

Sub-Area	Total Number of Well Records[a]	Useable[b] Number of Well Records	Number of Well Logs[c]	Average Well Depth (feet)	Well Depth Range[d] (feet)	Average Depth to Water (feet)	Average Depth to Water Range[d] (feet)	Average DEM Wellhead Elevation (feet)	Average DEM Well Water Elevation (feet)
Martini Creek Terrace	1	0							
Montara Terrace	34	16	0	179	110-275(900)	62	6-155	40	-27
Montara Heights	22	13	2	258	180-350	125	16-328	60	-64
Portola	12	10	2	171	120-265	77	40-210	89	12
Wagner Valley	9	2	1	200	125-275	114	77-150	121	7
Upper Moss Beach	6	3	1	438	303-560	65	22-140	30	-35
Lower Moss Beach Terrace	36	20	1	129	50(19)-230(900)	24	5-30(130)	20	-4
Airport Aquifer	40	14	5	104	40-155	22	6-29	16	-6
Seal Cove	3	0							
San Vicente Creek	1	0							
Denniston Creek	0	0							
El Granada	273	238	156	178	43-460	52	4-320	41	-11
Miramar	32	21	16	82	60-160	24	8-48	19	-5
Watersheds	71	0							
Totals		337	184						

Notes:

a In County master database
b Has identifiable address on location
c As identified in master database
d Outliers in parenthesis
DEM Digital Elevation Model

4.3 DIGITAL ELEVATION MODEL

A USGS digital elevation model (DEM) with 10-meter accuracy was used with the GIS in an attempt to assess the depth to water data in the County's database. This assessment was performed by first estimating with the DEM the wellhead elevation of each of the wells (since little actual elevation data are available for the wells), then calculating the groundwater surface elevations using the depth-to-water data. The resultant groundwater surface elevation data were graphically displayed by plotting color-coded well groundwater surface elevation ranges (e.g. green is –25 to 0 elevation, yellow is 1 to 25 feet elevation etc.). Plates 15 and 16 show a plot of wellhead elevations based on the DEM, and Plates 17 and 18 show the calculated groundwater surface elevations for the El Granada area. The DEM based wellhead plot shows the expected pattern of elevations, however the predicted elevations are significantly off upslope. The water surface elevation plots show significant scatter in the data. Scatter in the generated water surface elevation data was expected as the depth-to-water data from which it was derived were collected at different times of the year, in different years and it is not known whether the measurements were made following periods of pumping, which would tend to lower the elevations. Currently, Kleinfelder is evaluating the DEM to correct the error in estimation problem. The depth-to-water data, although qualitatively interesting, for the reasons stated above may not be deemed reliable enough for detailed assessment.

The County data also contains limited information on pumping rates, availability of boring logs, water quality etc. Where depth-to-water data were available for a well, there generally is pumping rate information available. Collectively these data are used to estimate the specific capacity (gallons per minute / feet of drawdown) of each well. Specific capacity has been used by investigators to derive a rough estimate of an aquifer's transmisivity. The parameter of transmisivity is important in assessing the volumetric rate of groundwater flow to a well, the amount of drawdown at the well during pumping etc. In a few cases, actual long-term pumping test data are available, reported with the well logs or found in Midcoast area reports. The specific-capacity data are useful for generalizing about areas where groundwater production is good and where it is poor. However, given the scatter (the wide range) in the depth to water data, one would expect that the specific-capacity data would have a similar distribution, making prediction based in this data, relatively poor.

At the conclusion of Phase I of the Midcoast Investigation, Balance Hydrologics recommended, in part, several wells for aquifer testing and ongoing monitoring; water-quality sampling and analysis; and stream-flow and rainfall monitoring. Groundwater monitoring along with accurate elevation-survey data will be important in assessing groundwater flow patterns, the magnitude of flow and ultimately the amount of groundwater in storage.

5.0 CONTINUING INVESTIGATION

As we continue the investigation of the Midcoast Groundwater Study, we will refine the understanding of the hydrogeologic conditions and characteristics within the study area. We will continue to interpret well data as well as apply information provided in reports and documents listed in the Phase I report. Filling data gaps will be a necessary part of successfully completing the Midcoast Groundwater Study.

Our investigation to date suggests that although there are a large number of wells in the study area, specific information needed to conduct a rigorous hydrogeologic analysis is not available. The information missing includes long-period pumping-test results in the study areas, and area-wide water elevations. Initially, Kleinfelder proposed to construct several wells for aquifer characteristics testing at selected points in the study area. The number of wells was reduced after discussions with the County (meeting of June 12, 2003) in which it was decided to move a portion of the budget to GIS data management. Now that Kleinfelder has assessed the County's database information, we may be able to apply value engineering to further reduce well construction yet increase the volume and quality of groundwater data. Essentially half of the wells were eliminated from the primary data set in our study to date. Based on this adjustment in data available for analysis, we feel wellhead and water-level surveys at existing wells should be added to the scope of our analysis, so that we can capture some of the wells that "got away."

Our continued study for the field investigation phase of the Midcoast investigation will be to provide updated geologic mapping of selected areas within the study area and estimates of aquifer properties for the terrace-deposit, alluvial, and granitic water-bearing zones, and for exploring the extent of barriers to groundwater movement posed by clay horizons, faults or other major geologic features. To complete this next phase of the investigation, it may be appropriate to discuss conducting static water-level measurements over time and pumping tests at selected existing domestic wells in the area. If sufficient interest from well owners in the study area can be achieved, the data that potentially can be derived by using existing wells for pumping and observation could increase the overall quantity and quality of data that can be used in our analysis. With the number and distribution of existing wells within the Midcoast study area, it may be that more appropriate data may be collected by using these existing wells than can be gathered at restricted locations with a few new pumping-test wells.

6.0 LIMITATIONS

The information in this Memorandum is based on our field observations, review and evaluation of published papers and articles, reports, and maps readily available to us and our knowledge of geologic conditions in the area. It is possible that geologic and hydrogeologic conditions could vary between observation points. The accuracy of the information presented in this Memorandum should not be implied beyond the limitations of the methods described. We have prepared this Memorandum in substantial accordance with the generally accepted hydrogeologic procedures and guidelines as they exist today. No warranty is expressed or implied.

This Memorandum has been prepared for the exclusive use of San Mateo County and its agents for purposes so stated, and within a reasonable time from its issuance. Land use, site and groundwater conditions, both on- and off-site, or other factors may change over time, and additional hydrogeologic investigative work may be required. Any party other than San Mateo County who wishes to use this Memorandum shall notify Kleinfelder of such intended use. Based on the intended use of the Memorandum, Kleinfelder may require that additional work be performed and that an updated Memorandum be issued. Non-compliance with any of these requirements will release Kleinfelder from any liability resulting from the use of this Memorandum by any unauthorized party.

7.0 BIBLIOGRAPHY

Atwater, B.F., 1975, Generalized geologic map of the uplands east of the San Andreas and Pilarcitos faults, South San Francisco Bay Area, California. Stanford University, Thesis (M.S.) - Dept. of Geology, Stanford University, scale 1:62500.

Balance Hydrologics, Inc, 2/1/1999, Wells Logs of the Montara Area, San Mateo County

Balance Hydrologics, Inc, 3/1/1999, Preliminary Feasibility Assessment of Ground Water in the Martini Creek, McNee Ranch and Upper Montara Creek Area, Interim Status Report

Balance Hydrologics, Inc, 4/1/2002, San Mateo County Mid-Coast Aquifers: Literature and Data Review

Brabb, E.E. and Hanna, W.F., 1981, Maps showing aeromagnetic anomalies, faults, earthquake epicenters, and igneous rocks in the southern San Francisco Bay region, California: U.S. Geological Survey, Geophysical Investigations Map GP-932, scale 1:125000.

Brabb, E.E. and Olson, J.A., 1986, Map showing faults and earthquake epicenters in San Mateo County, California: U.S. Geological Survey, Miscellaneous Investigations Series Map I-1257-F, scale 1:62500.

Brabb, E.E. and Pampeyan, E.H., 1983, Geologic map of San Mateo County, California: U.S. Geological Survey, Miscellaneous Investigations Series Map I-1257-A, scale 1:62500.

Brabb, E.E., 1983, Map showing direction and amount of bedding dip of sedimentary rocks in San Mateo County, California: U.S. Geological Survey, Miscellaneous Investigations Series Map I-1257-C, scale 1:62500.

Brabb, E.E., Clark, J.C., and Throckmorton, C.B., 1977, Measured sections of Paleogene rocks from the California coast ranges: U.S. Geological Survey, Open-File Report OF-77-714, scale 1:62500.

Brabb, E.E., Graymer, R.W., and Jones, D.L., 1998, Geology of the onshore part of San Mateo County, California: a digital database: U.S. Geological Survey, Open-File Report OF-98-137, scale 1:62500.

Brabb, E.E., Graymer, R.W., and Jones, D.L., 2000, Geologic Map and Map Database of the Palo Alto 30' X 60' Quadrangle, California

Brabb, E.E., Pampeyan, E.H., and Bonilla, M.G., 1972, Landslide susceptibility in San Mateo County, California: U.S. Geological Survey, Miscellaneous Field Studies Map MF-360, scale 1:62500.

Brabb, E.E., Roberts, S., Cotton, W.R., Kropp, A.L., Wright, R.H. and Zinn, E.N. (2000): Possible Costs Associated with Investigation and Mitigating some Geologic Hazards in

Rural Parts of San Mateo County, California; Geology of the Half Moon Bay Quadrangle, San Mateo County, California; US Geological Survey; derived from the map by Brabb, E.E., Graymer, R.W. and Jones, D.L. (1998); Digital Database by Sebastian Roberts and Suzanne K. Mills; Plot derived from Open-File Report 00-127 Sheet 8 of 22; http://geopubs.wr.usgs.gov/open-file/of00-127/

Brady/LSA, 5/1/2002, Fitzgerald Marine Reserve Master Plan, Geological / Geotechnical Conditions

Buechel, S.W. and Wagner, A.F., 1996, Map showing vegetation in San Mateo County, California: U.S. Geological Survey, Miscellaneous Investigations Series Map I-1257-N, scale 1:62500.

California Division of Mines and Geology, 1976, Official map of Alquist-Priolo Earthquake Fault Hazard Zones, Half Moon Bay Quadrangle: California Division of Mines and Geology, scale 1:24000.

California Division of Mines and Geology, 1982, Revised official map of Alquist-Priolo Earthquake Fault Hazard Zones, Montara Mountain Quadrangle: California Division of Mines and Geology, scale 1:24000.

Coastside County Water District, 2001, 2001 Annual Water Quality Report

Davis, F.F., 1955, Mines and mineral resources of San Mateo County, California: California Division of Mines and Geology, California Journal of Mines and Geology v.51 no.4, p.401-458, scale 1:123500.

Dept of Water Resources, January 1, 1999, Final Draft, Montara Water Supply Study for Montara Sanitary District, San Mateo County, California

Dept of Water Resources, April 1991, Ground Water in Fractured Hard Rock, Water Facts No. 1

DMG Staff, 2000, Digital images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, central coast region: California Division of Mines and Geology, CD 2000-004, scale 1:24000.

Earth Metrics Inc., 12/1/1987, Administrative Draft, Environmental Impact Report for the Proposed Farallon Vista Water Supply Development Project.

Earth Sciences Associates, 8/12/1986, Evaluation of Ground-Water Development Potential in the Half Moon Bay and El Granada Areas

Emily K Youcha, Michael R. Lilly, Larry D. Hinzman, 2002, Geohydrologic Properties of Fractured Bedrock Aquifer Systems: A Review and Application to Ester Dome, Alaska American Water Resources Association, Alaska Section Annual Meeting, April 8-10, 2002, Soldotna, Alaska. Oral.

F. Beach Leighton & Associates, 10/15/1971, Geologic Report of Seal Cove & Moss Beach Area, County of San Mateo

Hedlund, C. (2003): Hydrogeology and Geochemistry of the Northern Groundwater Basin, San Mateo County, California; Master Thesis at San Francisco State University.

Helley, E.J., Lajoie, K.R., Spangle, W.E., Blair, M.L., and William Spangle & Associates, 1979, Flatland deposits of the San Francisco Bay region, California - their geology and engineering properties, and their importance to comprehensive planning: U.S. Geological Survey, Professional Paper 943, scale 1:125000.

Kennedy, G.L, Lajoie, K. R., Blunt, D.J. and Mathieson, S.A. (1982): Half Moon Bay Terrace, California, and the age of its Pleistocene invertebrate faunas, Western Society of Malacologists Annual Report, 14, 2p.

Kleinfelder, 2/6/1989, Administrative Draft, Montara - Moss Beach Water Well EIR, Partial Administrative Draft

Kleinfelder, 3/24/1988, El Granada Ground-Water Investigation

Kleinfelder, 4/1/1988, El Granada Ground-water Investigation Report

Kleinfelder, 6/6/1996, Water Use Assessment, Pigeon Point Inn, San Mateo County, California

Kleinfelder, 8/9/1989, Final Montara-Moss Beach Water Well EIR

Kleinfelder, October 1991, Rural Area Water Use Study, Final Report

Knudsen, K.L., Noller, J.S., Sowers, J.M., and Lettis, W.R., 1997, Quaternary geology and liquefaction susceptibility, San Francisco, California 1:100,000 quadrangle: a digital database: U.S. Geological Survey, Open-File Report OF-97-715, scale 1:100000.

Lajoie, K.R., Helley, E.J., Nichols, D.R., and Burke, D.B., 1974, Geologic map of unconsolidated and moderately consolidated deposits of San Mateo County, California: U.S. Geological Survey, Miscellaneous Field Studies Map MF-575, scale 1:62500.

Larue, D., Steel, R.J (eds), 5/18/1983, Cenozoic Marine Sedimentation, Pacific Margin, SEPM

Leithton & Assoc, 5/26/1905, Official Map, County of San Mateo, State of California

Lowney-Kaldveer Associates, 4/4/1974, Groundwater Investigation, Denniston Creek Vicinity, San Mateo County, California

Luhdorff and Scalmanini / Earth Sciences Assoc, 6/1/1987, Half Moon Bay / Piller Point Marsh Ground-Water Basin Report, Phase I

Luhdorff and Scalmanini / Earth Sciences Assoc, 9/1/1991, Half Moon Bay / Piller Point Marsh Ground-Water Basin Report, Phase II

Luhdorff and Scalmanini, no date, Preliminary Well Profile, for Kingsley Management, El Granada Mobile Home Park, Moss Beach, California, 102 Celurra, APN 134-131-410

Mark, R.K., Newman, E.B., and Brabb, E.E., 1988, Slope map of San Mateo County, California: U.S. Geological Survey, Miscellaneous Investigations Series Map I-1257-J, scale 1:62500.

Moore, D.E. and Byerlee, J., 1989, Active faults, probable active faults and associated fracture zones, San Mateo County, California: U.S. Geological Survey, Open-File Report of 89-347, scale 1:62500.

Napier, Gene, Perkins, J.B., Moreland, Roberta, Mark, Robert, and Brabb, E.E., 1992, Map showing land use and land cover in San Mateo County, California: U.S. Geological Survey, Miscellaneous Investigations Series Map I-1257-L, scale 1:62500.

Nelson, E, no date, Phase II of Lower Pilarcitos Creek Groundwater Investigation, Half Moon Bay, California

Nicole Pullman (San José State paper), 5/20/1987, Initial Study of Ground-Water Assessment of El Granada

Page, Ben M. (1966): Geology of the Coast Ranges of California, in: Bailey, E.H. (1966): Geology of Northern California; California Division of Mines and Geology Bulletin 190; p.255-276.

Pampeyan, E.H., 1981, Geologic map of the Montara Mountain quadrangle, San Mateo County, California: U.S. Geological Survey, Open-File Report OF-81-451, scale 1:12000.

Pampeyan, E.H., 1994, Geologic map of the Montara Mountain and San Mateo 7.5' quadrangles, San Mateo County, California: U.S. Geological Survey, Miscellaneous Investigations Series Map I-2390, scale 1:24000.

San Mateo County, 5/22/2002, Midcoast Groundwater Study Phase 1 Report; Proposed Revisions to County Well Regulations for the Midcoast

San Mateo County, 5/6/2002, Status report of the Board Subcommittee on Wells and Aquifers and Review of Phase I of the Midcoast Aquifer Study

San Mateo County, 7/18/2002, Request for Proposal, Groundwater Basin Geotechnical & Economic Feasibility Study, Lower Pilarcitos Creek Groundwater Basin Project

San Mateo County, 8/24/2002, Report to the Board Subcommittee on Wells and Aquifers on Introduction Ordinance Amending the County Well Ordinance for the Midcoast Area

San Mateo County, Environmental Services Agency, 6/30/1998, Local Coastal Program, Policies

San Mateo County, no date, An Ordinance Amending Chapter 4.68 Wells, San Mateo County Ordinance Code

Sedlock, R. (1995): Tectonic Framework, Origin and Evolution of the San Francisco Bay Region; in: Recent Geologic Studies in the San Francisco Bay Area, volume 76, edited by E.M. Sangines, D.W. Anderson, and A.V. Buising, pp. 1-18, Society of Economic Paleontologists and Mineralogists, Pacific Section; Los Angeles, California.

Terry Burnes, San Mateo Co, 8/15/2002, Request for Proposals (RFP), Midcoast Groundwater Study, Phase 2

Teter, J.S., 7/1/1998, Coastside County Water District, Preliminary Engineering Report, Phase II Water Supply Project

U.S. Geological Survey, 1973, Atlas of urban and regional change, San Francisco Bay region, California: U.S. Geological Survey, Open-File Report OF-73-322, scale 1:62500.

U.S. Geological Survey, 1976, Atlas of urban and regional change, San Francisco Bay region, land use change, 1970-72: U.S. Geological Survey, Open-File Report OF-76-396, scale 1:62500.

U.S. Geological Survey, 1978, Land use and land cover, 1976-77, Montara Mountain [quadrangle], California: U.S. Geological Survey, Open-File Report OF-78-739, scale 1:24000.

Webster, D.A., 1972, Maps showing areas in the San Francisco Bay region where nitrate, boron, and dissolved solids in ground water may influence local or regional development: U.S. Geological Survey, Miscellaneous Field Studies Map MF-432, scale 1:125000.

Base: U.S. G. S. topographic sheet Original in Color

KLEINFELDER

1362 Ridder Park Drive
San Jose, California 95131
Phone: (408) 436-1155 Fax: (408) 436-1771

Project Location Map

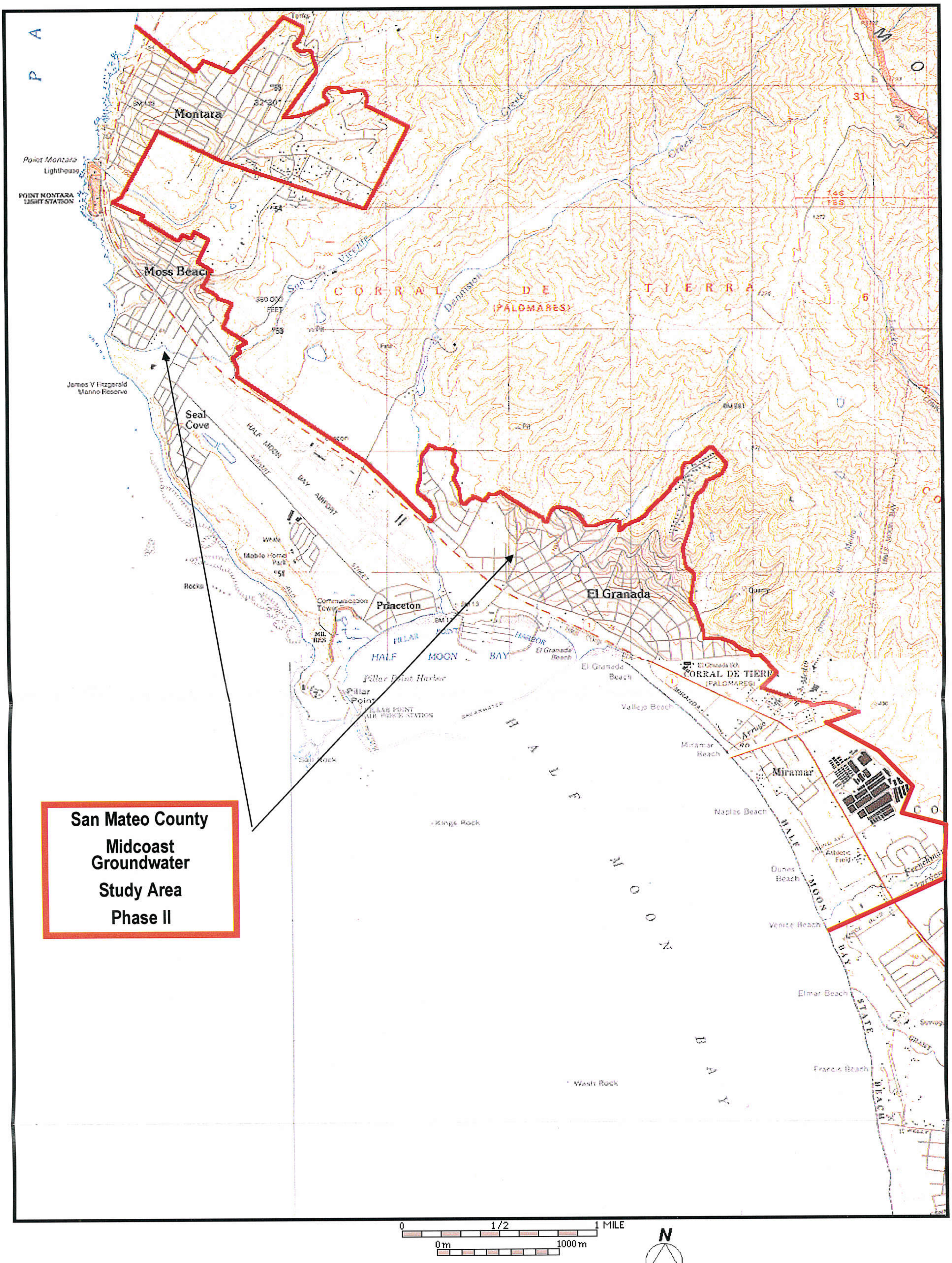
San Mateo County Midcoast Groundwater Study Area Phase II

San Mateo County, California

PLATE 1

Compiled by: P. Holland | Date: 02/22/04 | PROJECT NO. 26848

Library file: L:\2004\library\projects\26848*.ppt



Base Map, Portions of: U.S. Geologic Survey Half Moon Bay, Montara Mountain, San Mateo, and Woodside 7.5-Minute Topographic Quadrangles, San Mateo County, California. Original in Color

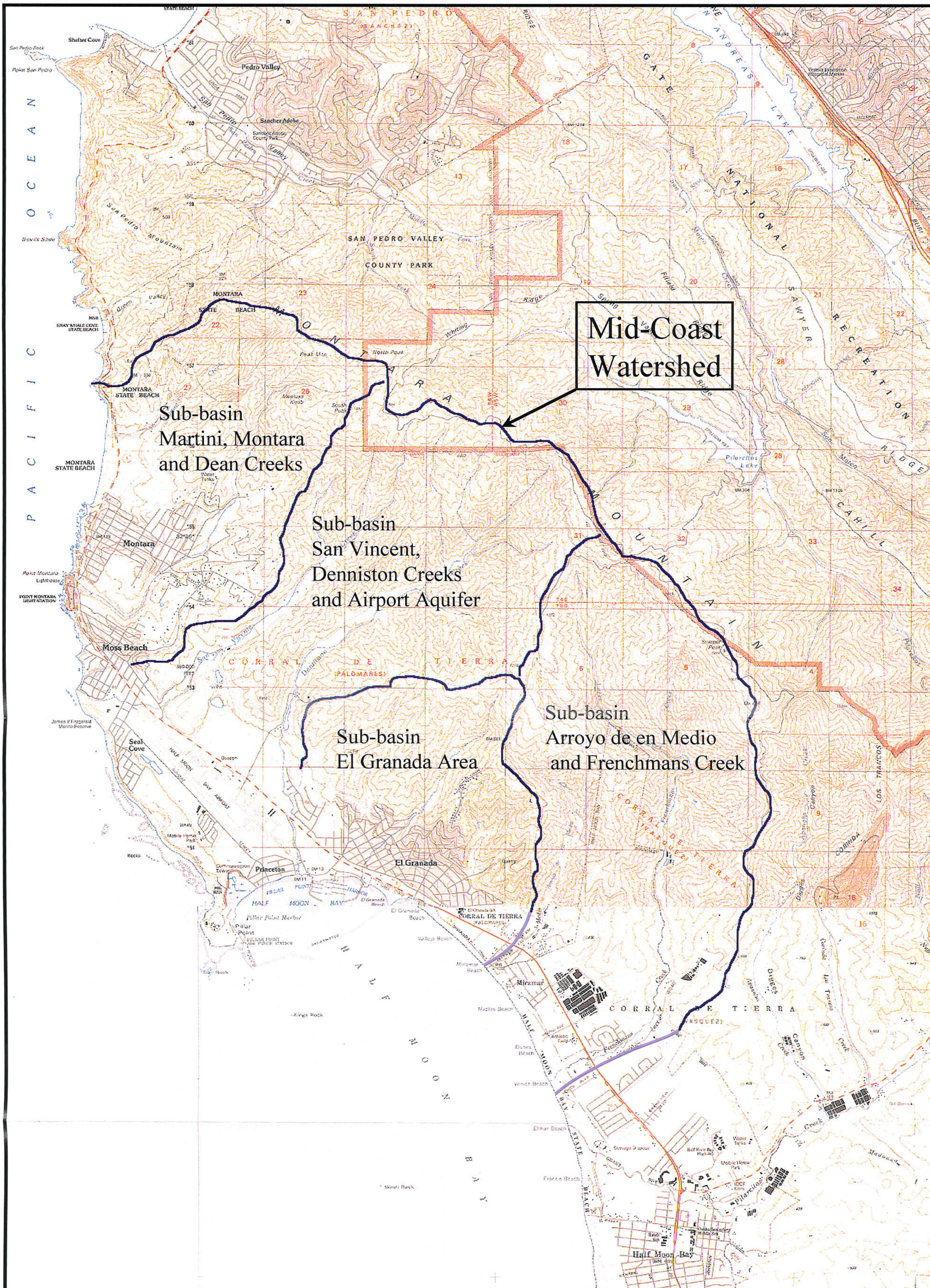
KLEINFELDER
1362 Ridder Park Drive
San Jose, California 95131
Phone: (408) 436-1155 Fax: (408) 436-1771

Compiled by: P. Holland	Date: 02/22/04
Reviewed by: M. Clark	Revision date:

Project Area Map
San Mateo County Midcoast Groundwater Study, Phase II
San Mateo County, California
PROJECT NO. 26848

PLATE 2

Library file: L:\2004\library\projects\26848*.ppt



Original in Color

Base Maps: U.S Geologic Survey, Montara Mountain and Half Moon Bay, 7½ minute quadrangles.

KLEINFELDER
1362 Ridder Park Drive
San Jose, California 95131
Phone: (408) 436-1155 Fax: (408) 436-1771

Balance Hydrologics, Inc. Proposed Groundwater Subbasins

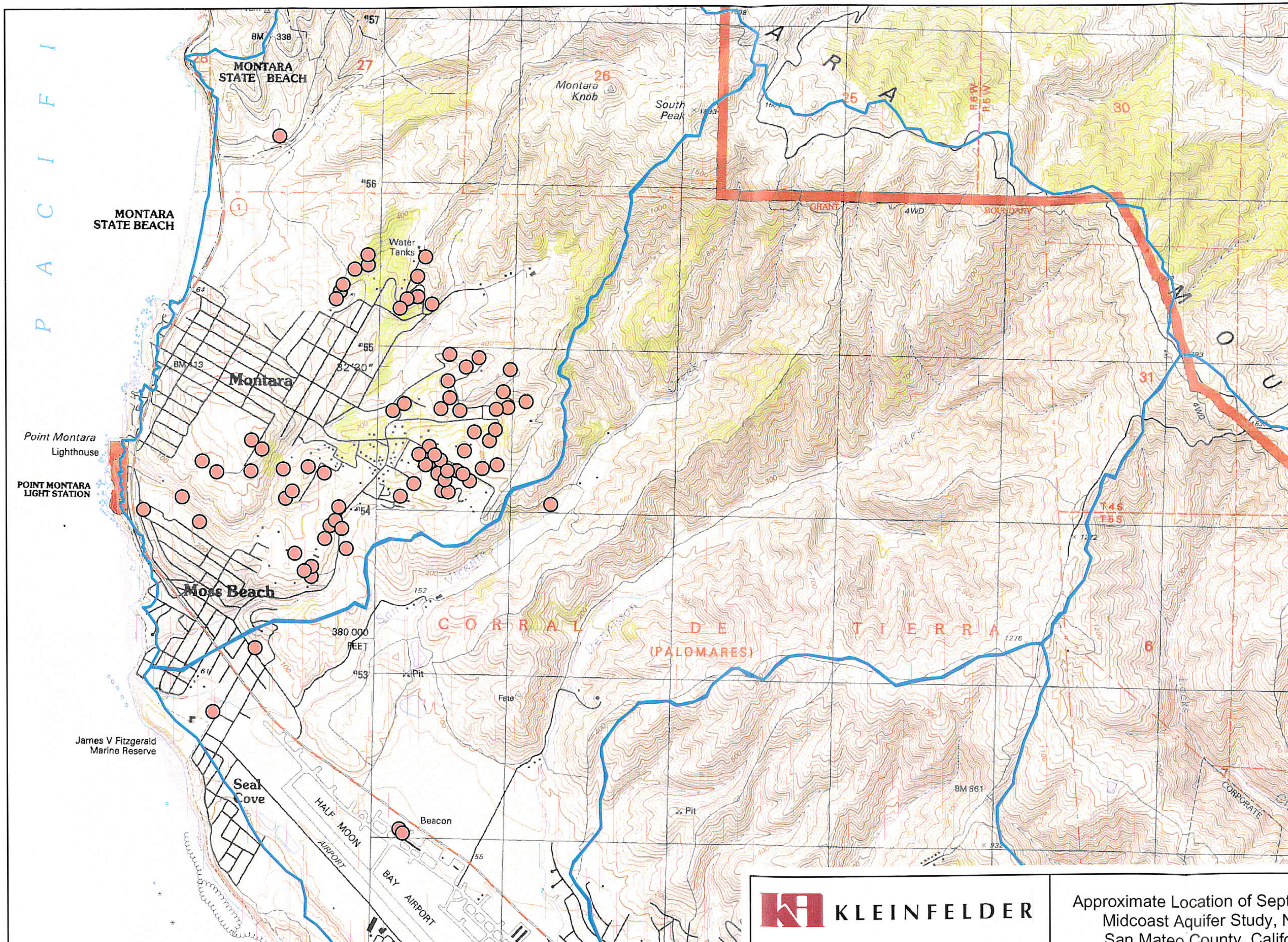
San Mateo County Midcoast Groundwater Study, Phase II

San Mateo County, California

PROJECT NO. 26848

PLATE 3

Compiled by: P. Holland	Date: 02/22/04
Reviewed by: M. Clark	Revision date:



EXPLANATION

- Septic Tanks
- Watershed Boundary

Preliminary Draft

N

1,000 0 1,000 2,000 Feet

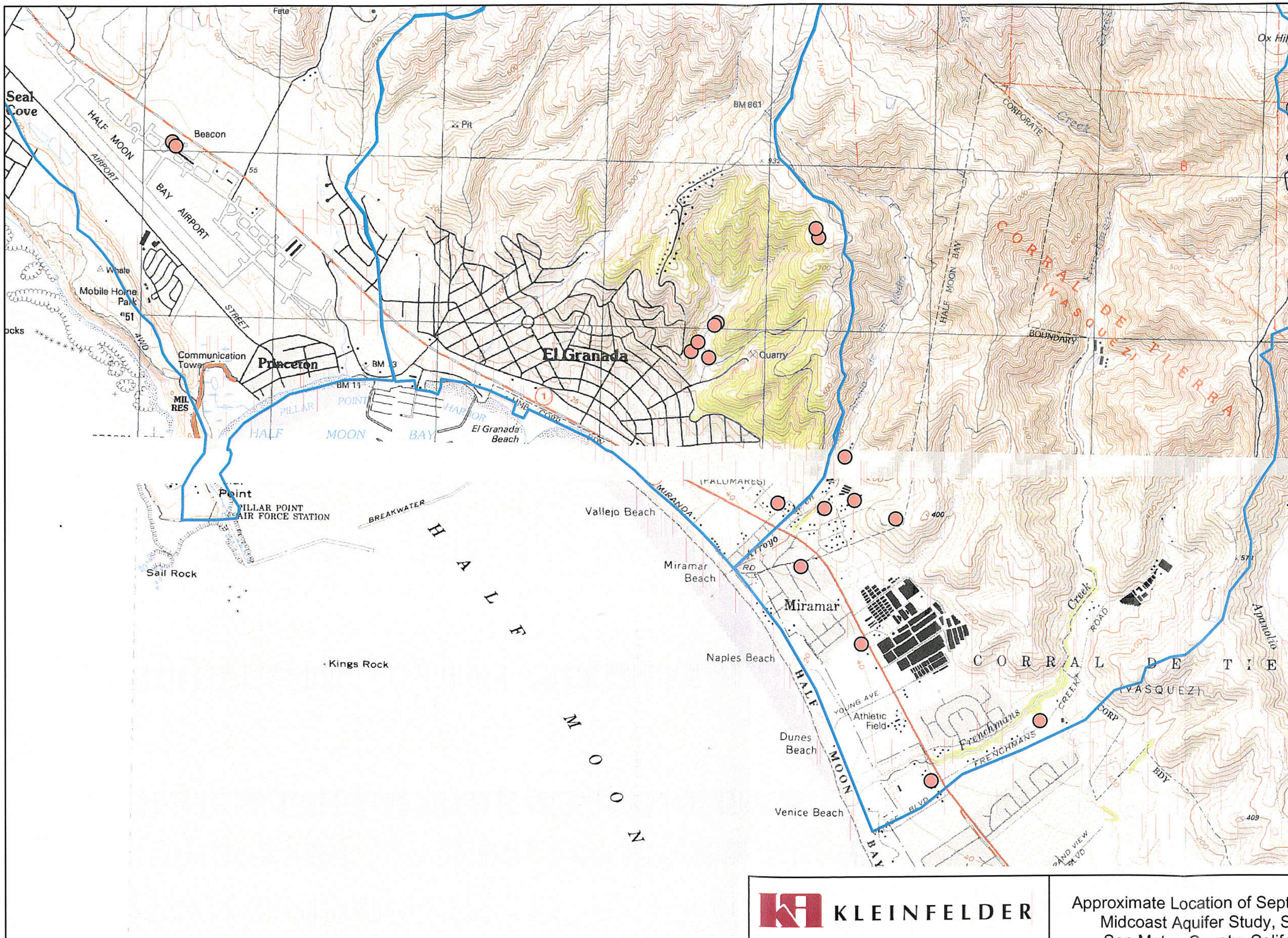
1 inch equals 2,000 feet

KLEINFELDER

Project No. 26848 Date: March 2004

Approximate Location of Septic Tanks
Midcoast Aquifer Study, North
San Mateo County, California

Plate
4



EXPLANATION

- Septic Tanks
- Watershed Boundary

Preliminary Draft

N

1,000 0 1,000 2,000 Feet

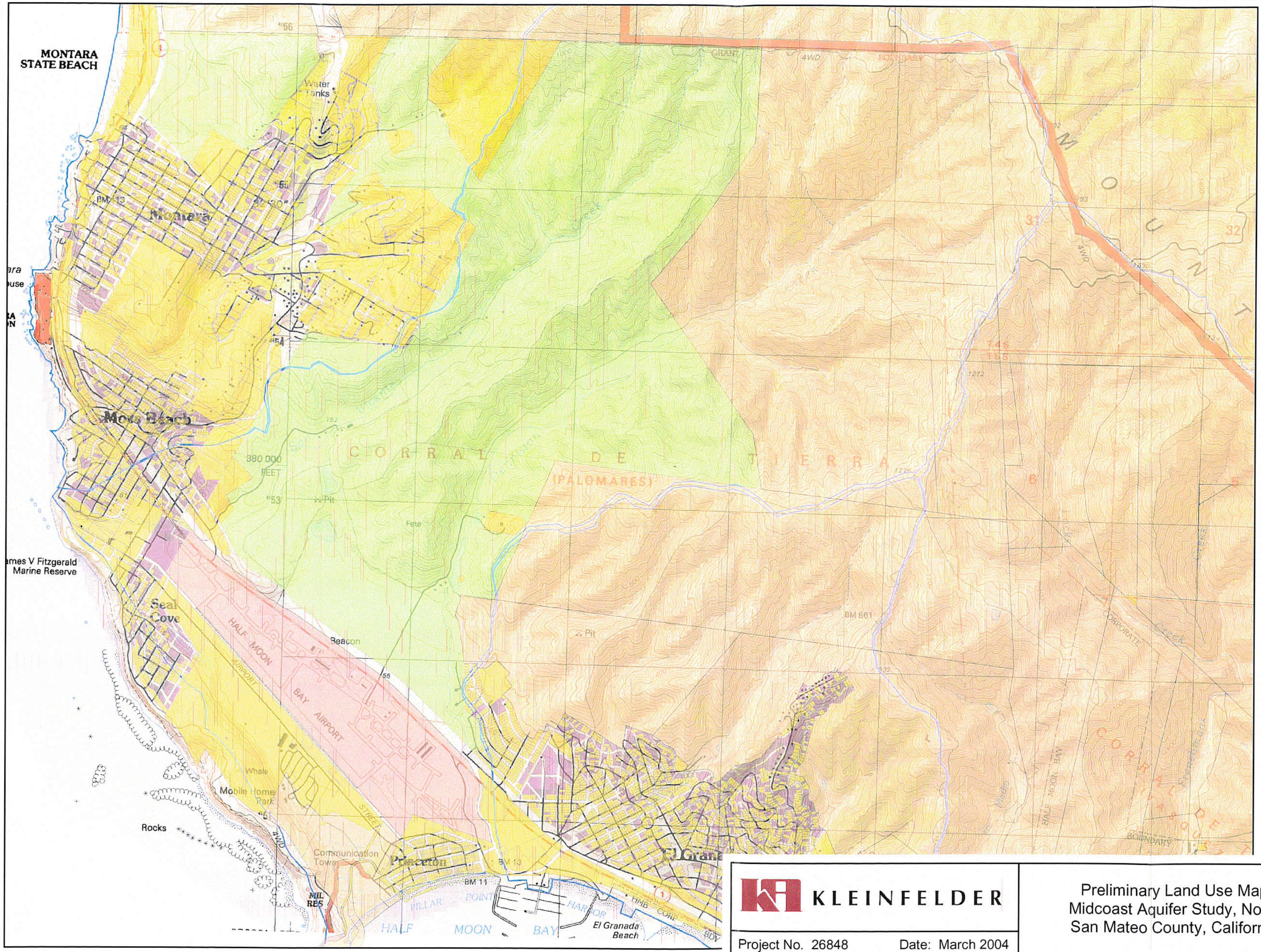
1 inch equals 2,000 feet

KLEINFELDER

Project No. 26848   Date: March 2004

Approximate Location of Septic Tanks
Midcoast Aquifer Study, South
San Mateo County, California

Plate 5



EXPLANATION

watersheds 1

LANDUSE

- Agriculture
- Open Range
- Commercial
- Residential
- Undeveloped

Preliminary Draft

N

1,000 0 1,000 2,000 Feet

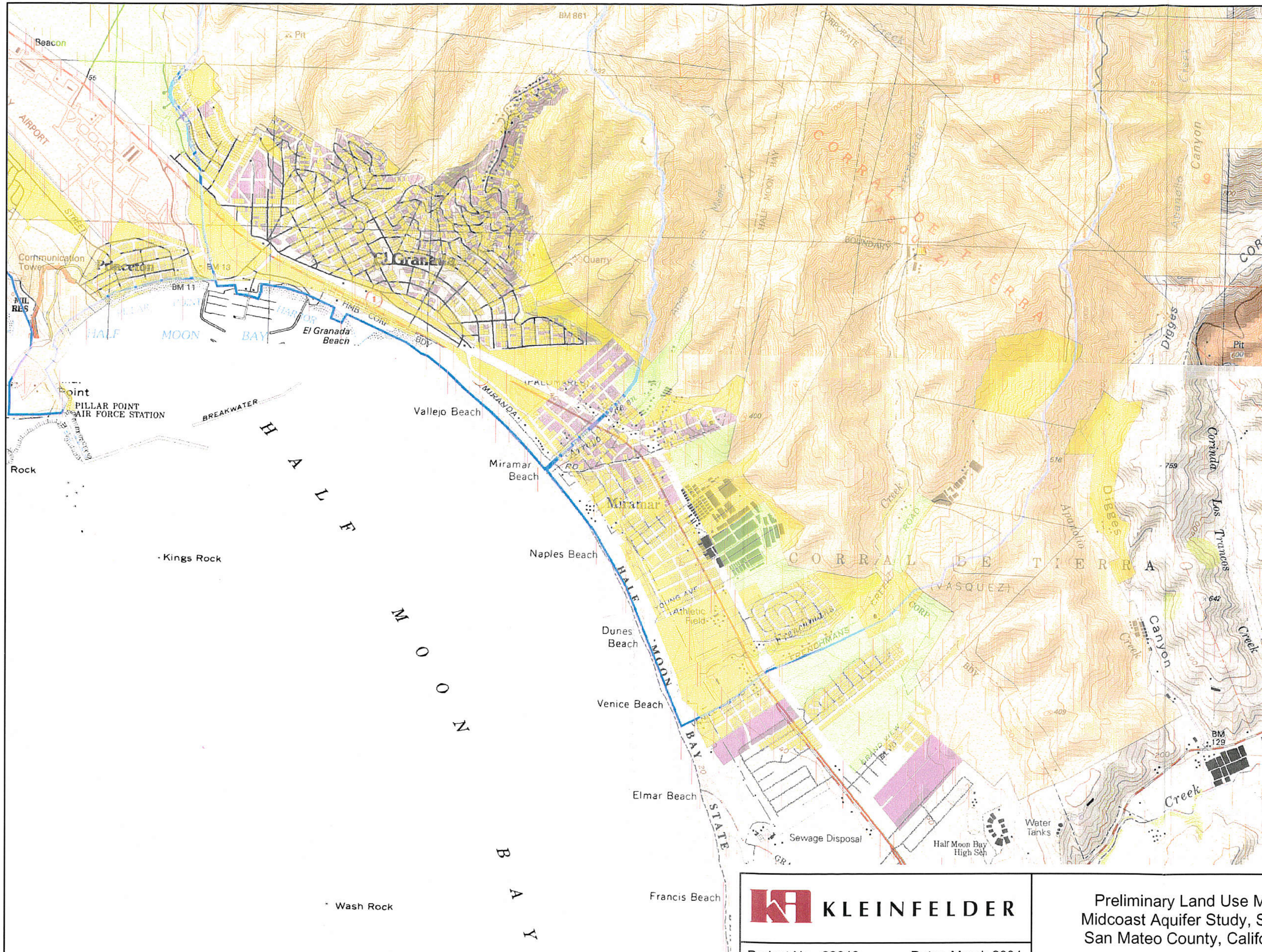
1 inch equals 2,000 feet

KLEINFELDER

Project No. 26848 Date: March 2004

Preliminary Land Use Map
Midcoast Aquifer Study, North
San Mateo County, California

Plate 6



EXPLANATION

LANDUSE

- Agriculture
- Open Range
- Commercial
- Residential
- Undeveloped
- Watershed Boundary

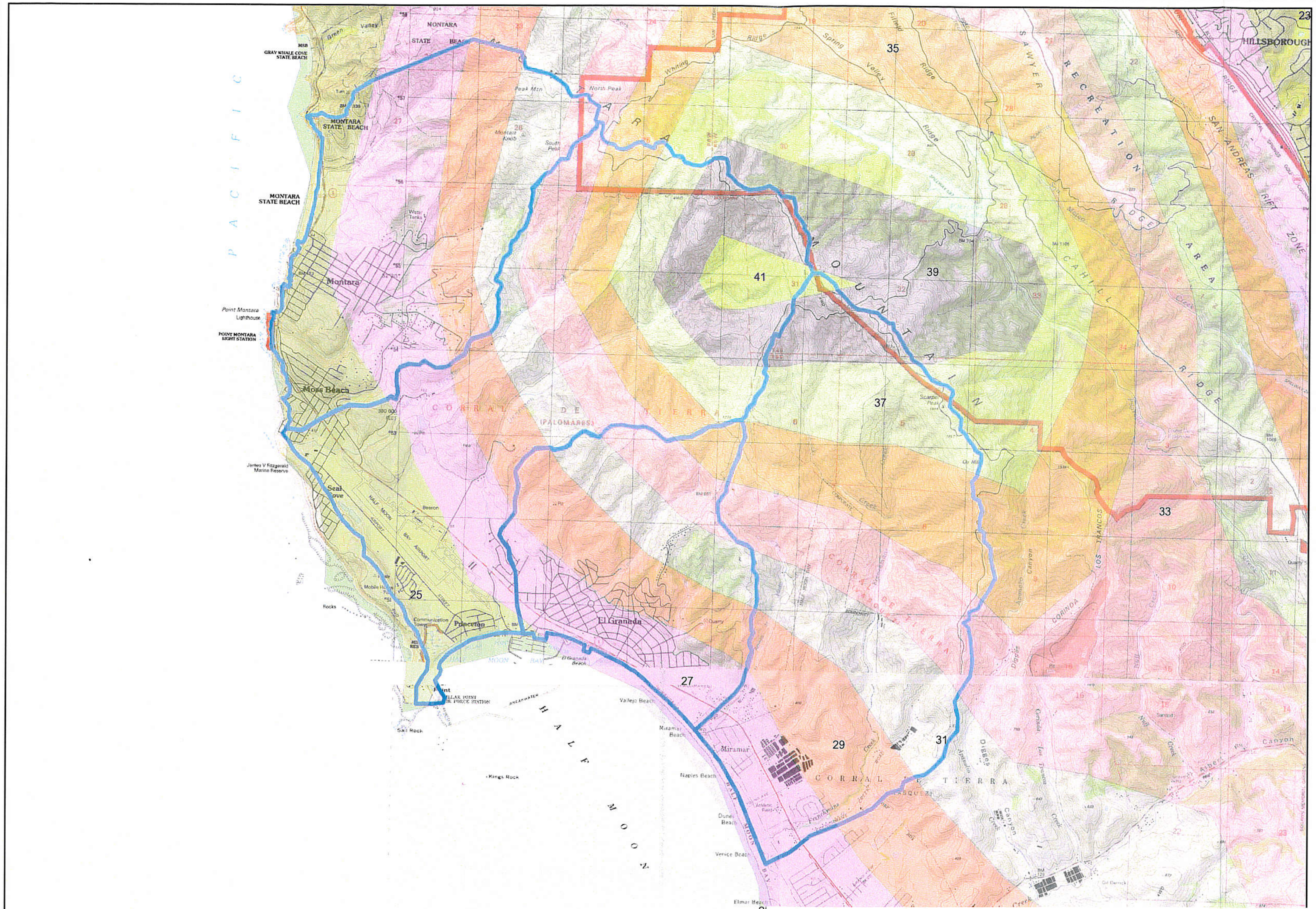
Preliminary Draft

N

1,000 0 1,000 2,000
Feet

1 inch equals 2,000 feet

KLEINFELDER	Preliminary Land Use Map Midcoast Aquifer Study, South San Mateo County, California	Plate 7
Project No. 26848 Date: March 2004		



EXPLANATION

Average Annual Precipitation

- 25 "
- 27 "
- 29 "
- 31 "
- 33 "
- 35 "
- 37 "
- 39 "
- 41 "
- 43 "
- Watershed Boundary

Preliminary Draft

N

2,000 0 2,000 4,000 Feet

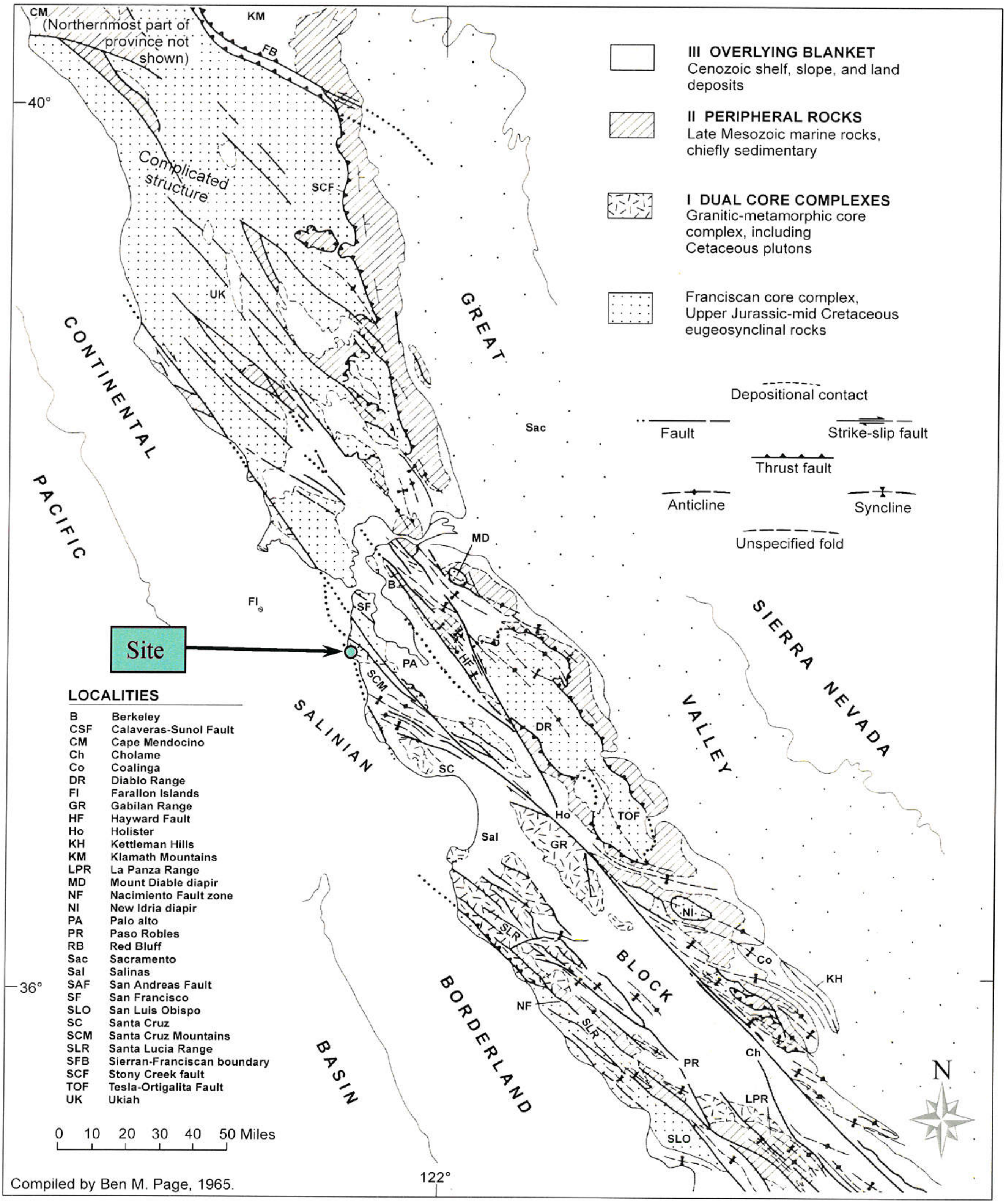
1 inch equals 4,000 feet

KLEINFELDER

Average Annual Precipitation
Midcoast Aquifer Study
San Mateo County, California

Project No. 26848 Date: March 2004

Plate 8



KLEINFELDER
1362 Ridder Park Drive
San Jose, California 95131
Phone: (408) 436-1155 Fax: (408) 436-1771

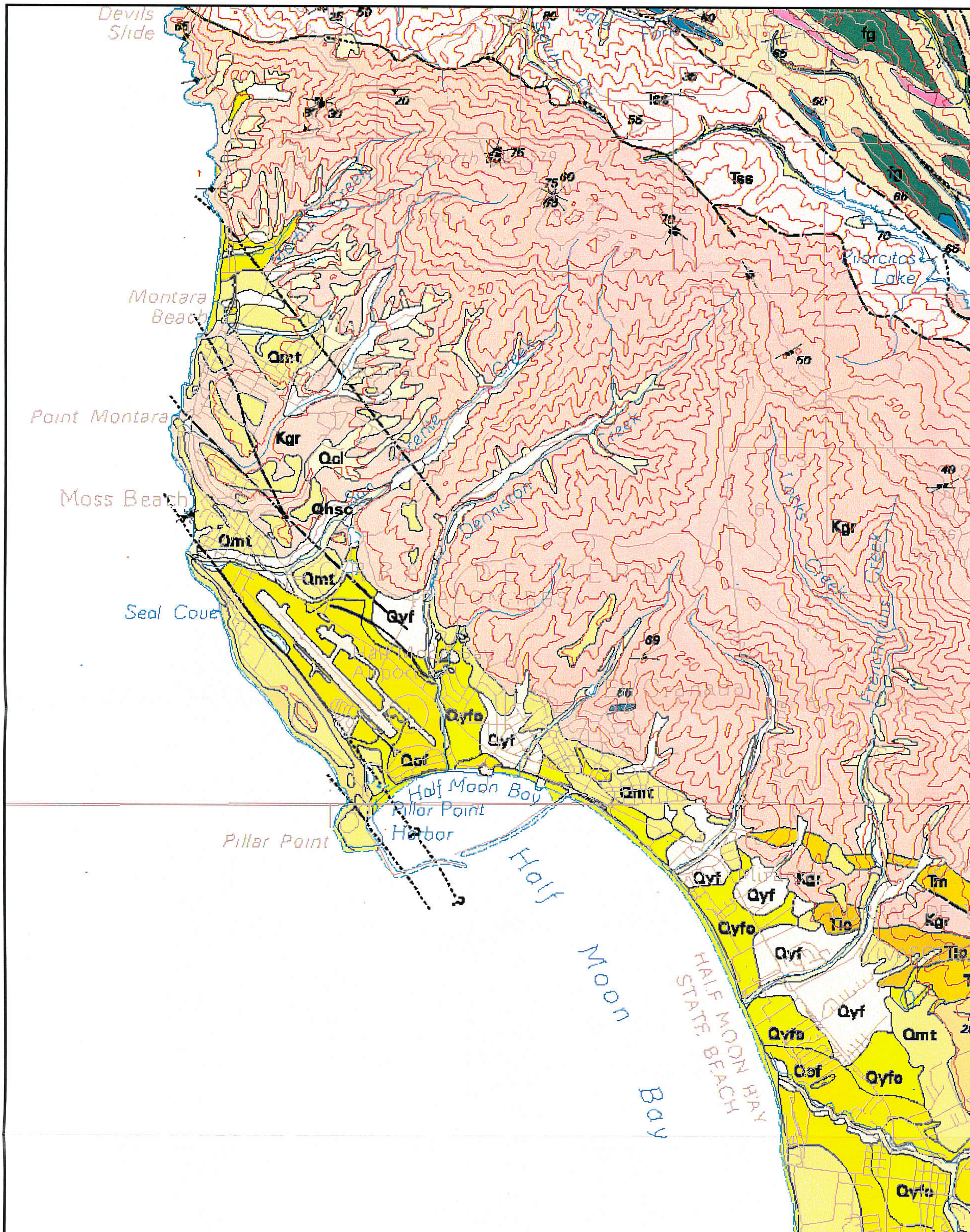
Regional Geologic Map

San Mateo County Midcoast Groundwater Study Area Phase II

San Mateo County, California

PLATE 9

Compiled by: P. Holland | Date: 02/22/04 | PROJECT NO. 26848



Scale (1000 ft.) 0 1 2 3 4 5

N

Base Map, Portion of: Brabb, E.E., Graymer, R.W., and Jones, D.L., 1998, Geology of the onshore part of San Mateo County, California: a digital database: U.S. Geological Survey, Open-File Report OF-98-137, scale 1:62500
Original in Color

Explanation

Qyf	Younger (lower) alluvial fan deposits (Holocene)
Qyfo	Younger (outer) alluvial fan deposits (Holocene)
Qaf	Coarse-grained older alluvial fan deposits (Holocene)
Qmt	Marine terrace deposits (Pleistocene)
Tp	Purisima Formation (Pliocene & upper Miocene)
	Fault, dashed where appx.
25	Strike and dip of beds
Tm	Monterey formation (middle Miocene)
Tlo	Lompico sandstone (middle Miocene)
Tmb	Mindego Basalt and related volcanics
Tw	Whiskey Hill formation (middle and lower Eocene)
Kgr	Montara Mountain granite
KJf	Franciscan formation (Cretaceous, Jurassic)

KLEINFELDER
1362 Ridder Park Drive
San Jose, California 95131
Phone: (408) 436-1155 Fax: (408) 436-1771

Compiled by: P. Holland | Date: 02/22/04
Reviewed by: M. Clark | Revision date:

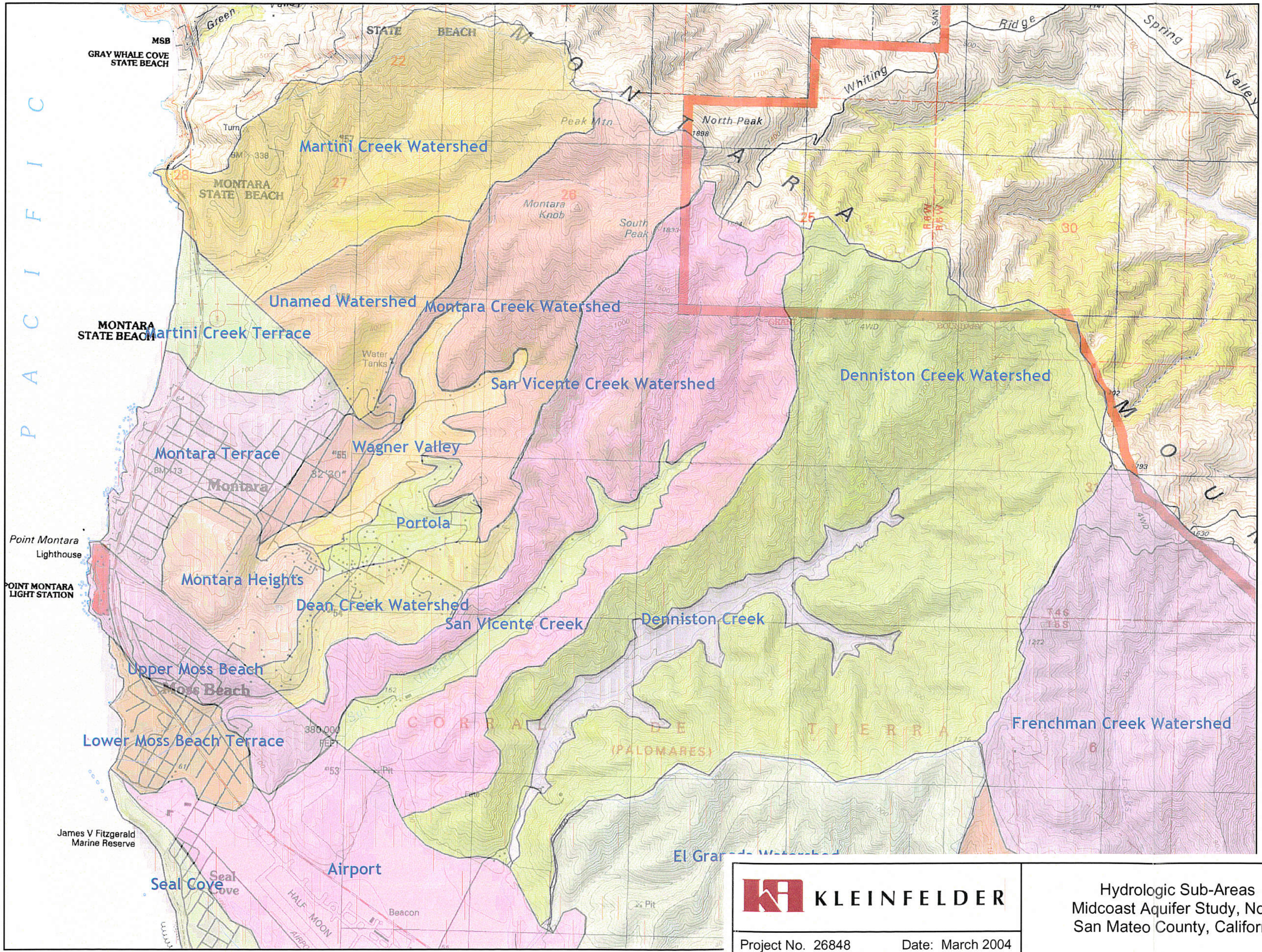
Area Geologic Map

San Mateo County Midcoast Groundwater Study, Phase II

San Mateo County, California

PROJECT NO. 26848

PLATE **10**



EXPLANATION

- Airport
- Arroyo de en Medio Watershed
- Dean Creek Watershed
- Denniston Creek
- Denniston Creek Watershed
- El Granada
- El Granada Watershed
- Frenchman Creek Watershed
- Lower Moss Beach Terrace
- Martini Creek Terrace
- Martini Creek Watershed
- Miramar
- Montara Creek Watershed
- Montara Heights
- Montara Terrace
- Portola
- San Vicente Creek
- San Vicente Creek Watershed
- Seal Cove
- Unamed Watershed
- Upper Moss Beach
- Wagner Valley
- Watershed Boundary

Preliminary Draft

N

1,000 0 1,000 2,000 Feet

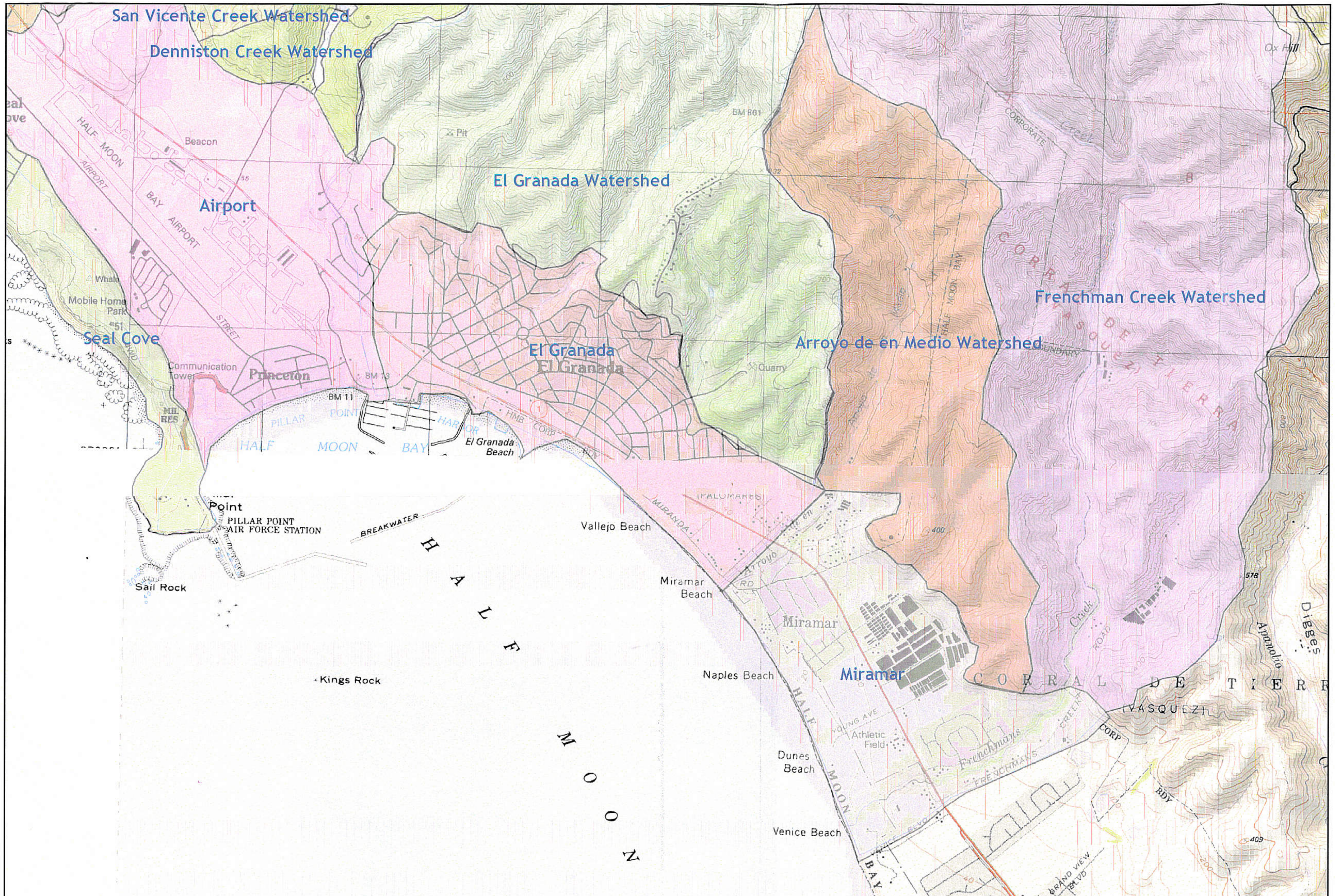
1 inch equals 2,000 feet

KLEINFELDER

Project No. 26848 Date: March 2004

Hydrologic Sub-Areas
Midcoast Aquifer Study, North
San Mateo County, California

Plate 11



EXPLANATION

- Dean Creek Watershed
- Airport
- Arroyo de en Medio Watershed
- Denniston Creek
- Denniston Creek Watershed
- El Granada
- El Granada Watershed
- Frenchman Creek Watershed
- Lower Moss Beach Terrace
- Martini Creek Terrace
- Martini Creek Watershed
- Miramar
- Montara Creek Watershed
- Montara Heights
- Montara Terrace
- Portola
- San Vicente Creek
- San Vicente Creek Watershed
- Seal Cove
- Unamed Watershed
- Upper Moss Beach
- Wagner Valley
- Watershed Boundary

Preliminary Draft

N

1,000 0 1,000 2,000 Feet

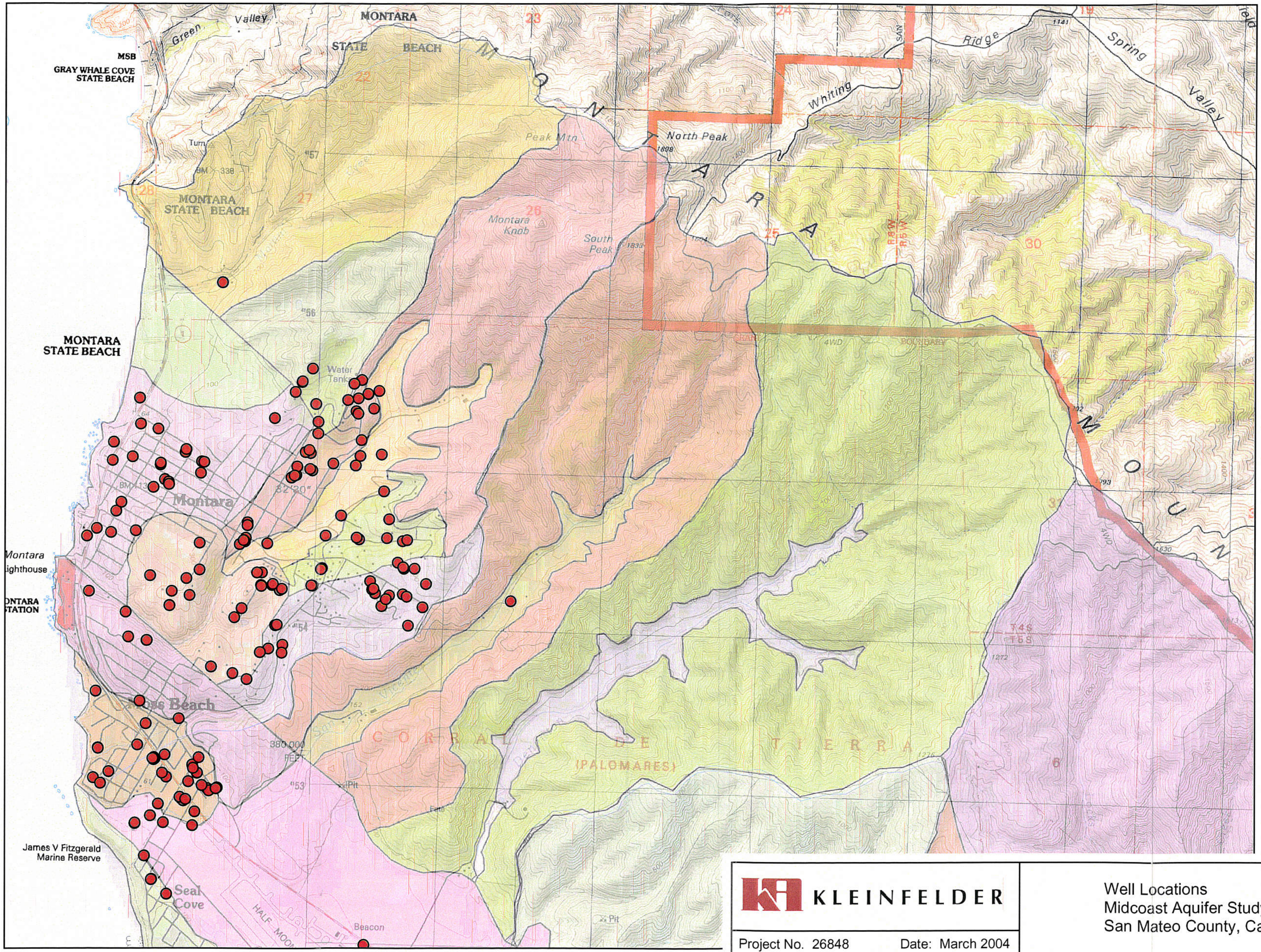
1 inch equals 2,000 feet

KLEINFELDER

Project No. 26848 Date: March 2004

Hydrologic Sub-Areas
Midcoast Aquifer Study, South
San Mateo County, California

Plate
12



EXPLANATION

- Airport
- Arroyo de en Medio Watershed
- Dean Creek Watershed
- Denniston Creek
- Denniston Creek Watershed
- El Granada
- El Granada Watershed
- Frenchman Creek Watershed
- Lower Moss Beach Terrace
- Martini Creek Terrace
- Martini Creek Watershed
- Miramar
- Montara Creek Watershed
- Montara Heights
- Montara Terrace
- Portola
- San Vicente Creek
- San Vicente Creek Watershed
- Seal Cove
- Unamed Watershed
- Upper Moss Beach
- Wagner Valley
- Watershed Boundary
- Well

Preliminary Draft

N

1,000 0 1,000 2,000 Feet

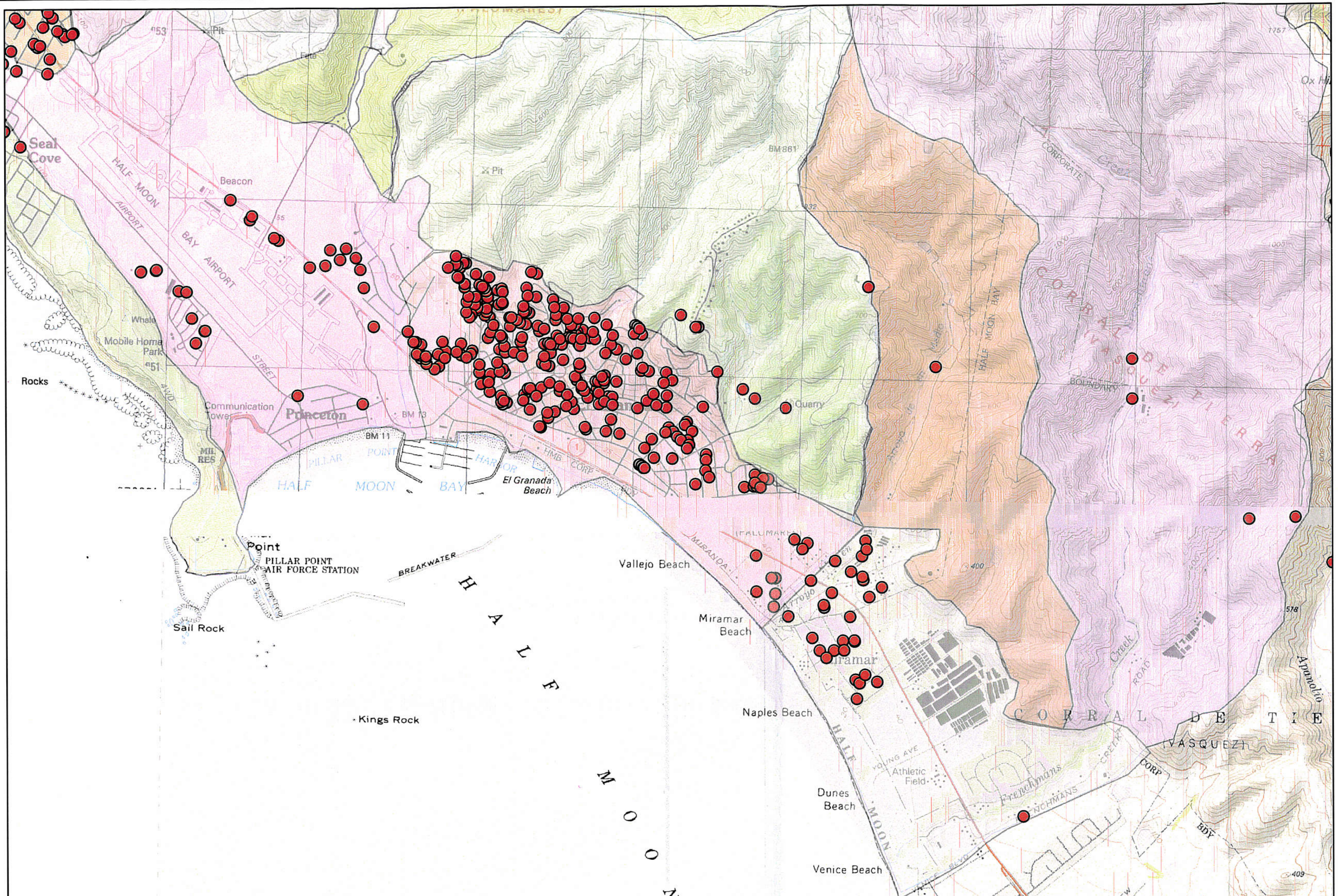
1 inch equals 2,000 feet

KLEINFELDER

Project No. 26848 Date: March 2004

Well Locations
Midcoast Aquifer Study, North
San Mateo County, California

Plate 13



EXPLANATION

- Airport
- Arroyo de en Medio Watershed
- Dean Creek Watershed
- Denniston Creek
- Denniston Creek Watershed
- El Granada
- El Granada Watershed
- Frenchman Creek Watershed
- Lower Moss Beach Terrace
- Martini Creek Terrace
- Martini Creek Watershed
- Miramar
- Montara Creek Watershed
- Montara Heights
- Montara Terrace
- Portola
- San Vicente Creek
- San Vicente Creek Watershed
- Seal Cove
- Unamed Watershed
- Upper Moss Beach
- Wagner Valley
- Watershed Boundary
- ● Well

Preliminary Draft

N

1,000 0 1,000 2,000 Feet

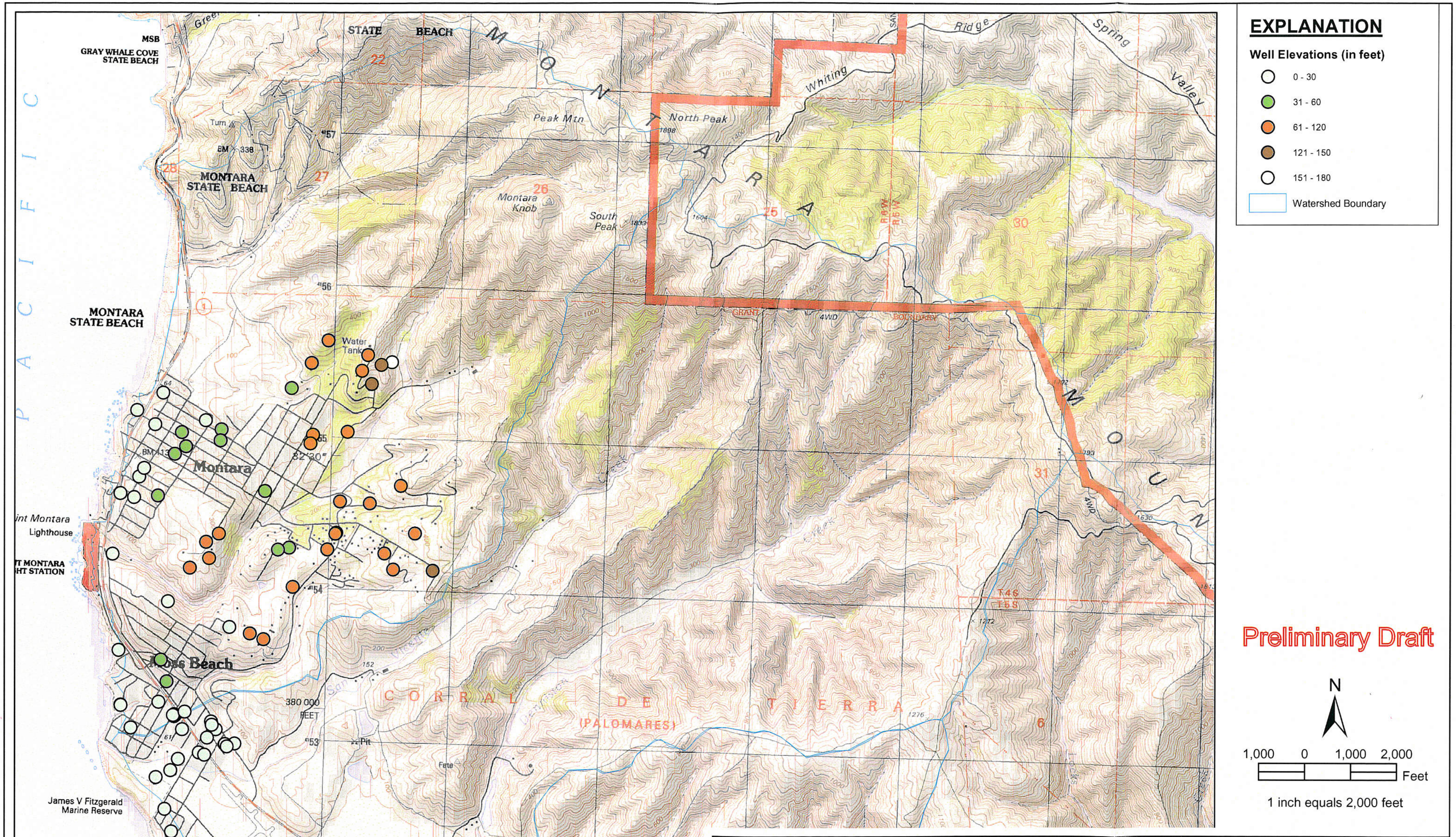
1 inch equals 2,000 feet

KLEINFELDER

Project No. 26848 Date: March 2004

Well Locations
Midcoast Aquifer Study, South
San Mateo County, California

Plate 14

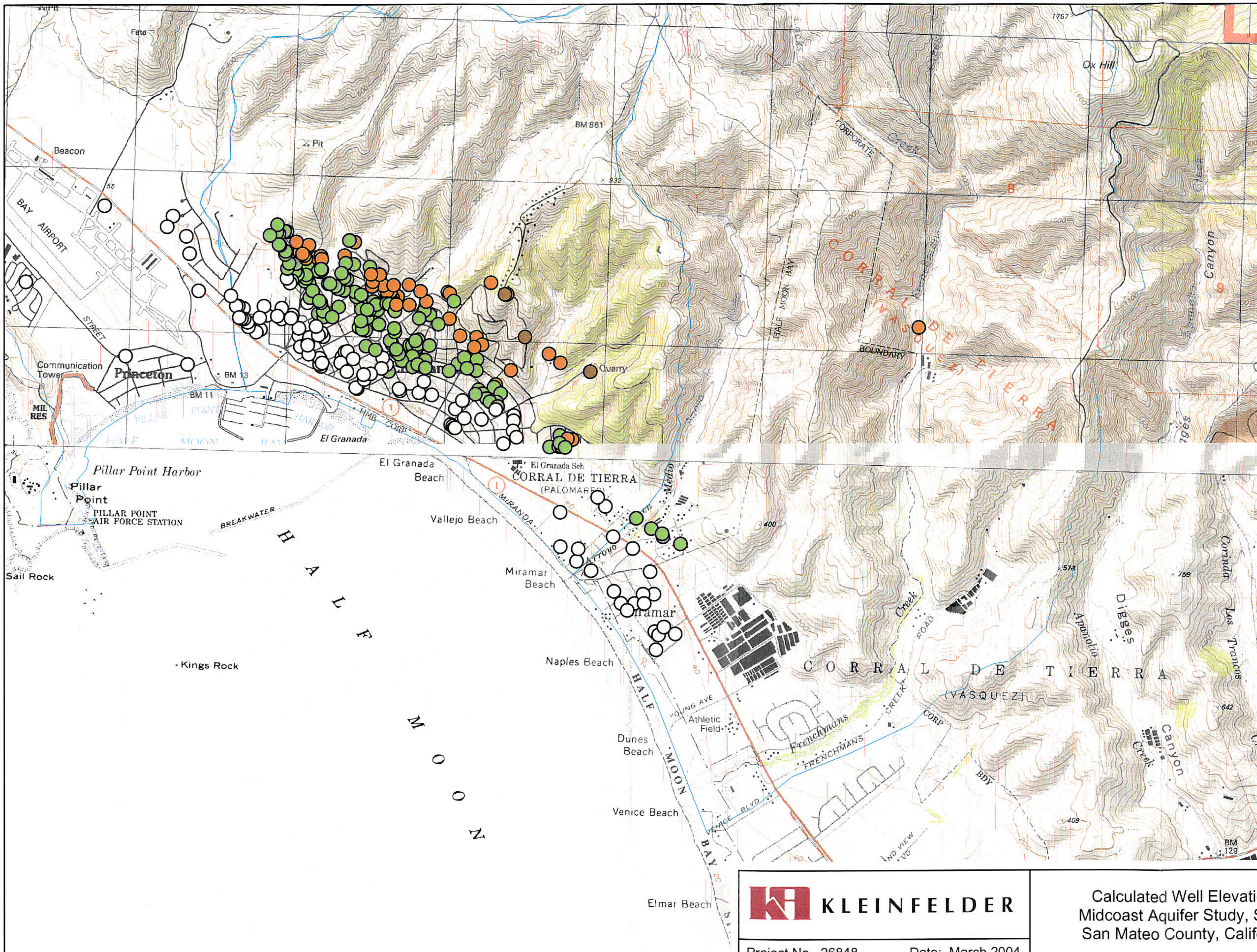


KLEINFELDER

Project No. 26848 Date: March 2004

Calculated Well Elevations
Midcoast Aquifer Study, North
San Mateo County, California

Plate
15



EXPLANATION

Elevation of Wells

- 0 - 30
- 31 - 60
- 61 - 120
- 121 - 150
- 151 - 180
- Watershed Boundary

Preliminary Draft

N

1,000 0 1,000 2,000

Feet

1 inch equals 2,000 feet

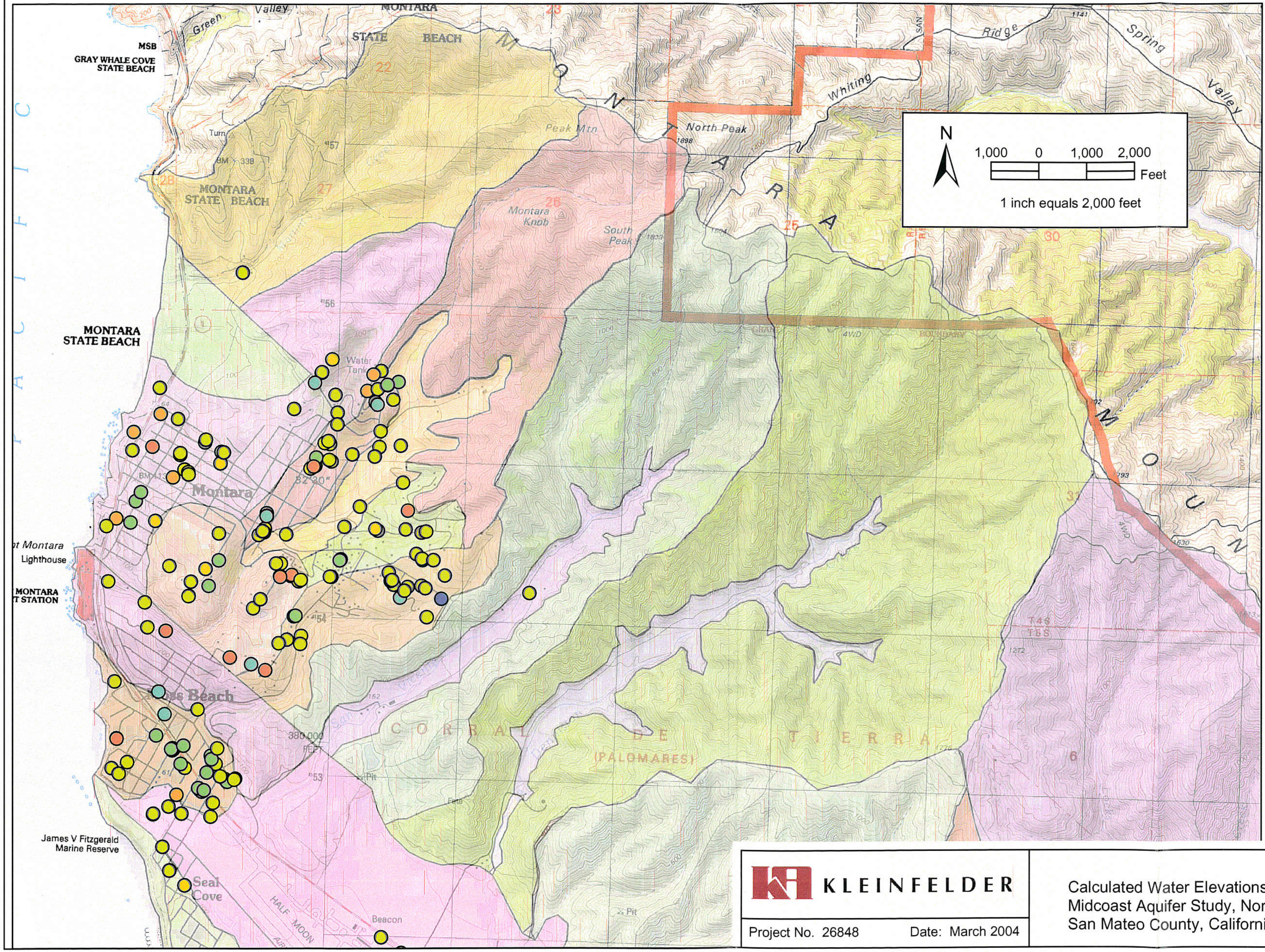
KLEINFELDER

Project No. 26848 Date: March 2004

Calculated Well Elevations
Midcoast Aquifer Study, South
San Mateo County, California

Plate

16



EXPLANATION

Predicted Water Elevations in Wells

- Above 75
- 26 to 75
- 1 to 25
- -24 to 0
- -49 to -25
- -74 to -50
- Below -75

N

1,000 0 1,000 2,000 Feet

1 inch equals 2,000 feet

Hydrologic Sub-Area

SubAreaNam

- Airport
- Arroyo de en Medio Watershed
- Dean Creek Watershed
- Denniston Creek
- Denniston Creek Watershed
- El Granada
- El Granada Watershed
- Frenchman Creek Watershed
- Lower Moss Beach Terrace
- Martini Creek Terrace
- Martini Creek Watershed
- Miramar
- Montara Creek Watershed
- Montara Heights
- Montara Terrace
- Portola
- San Vicente Creek
- San Vicente Creek Watershed
- Seal Cove
- Unamed Watershed
- Upper Moss Beach
- Wagner Valley

Preliminary Draft

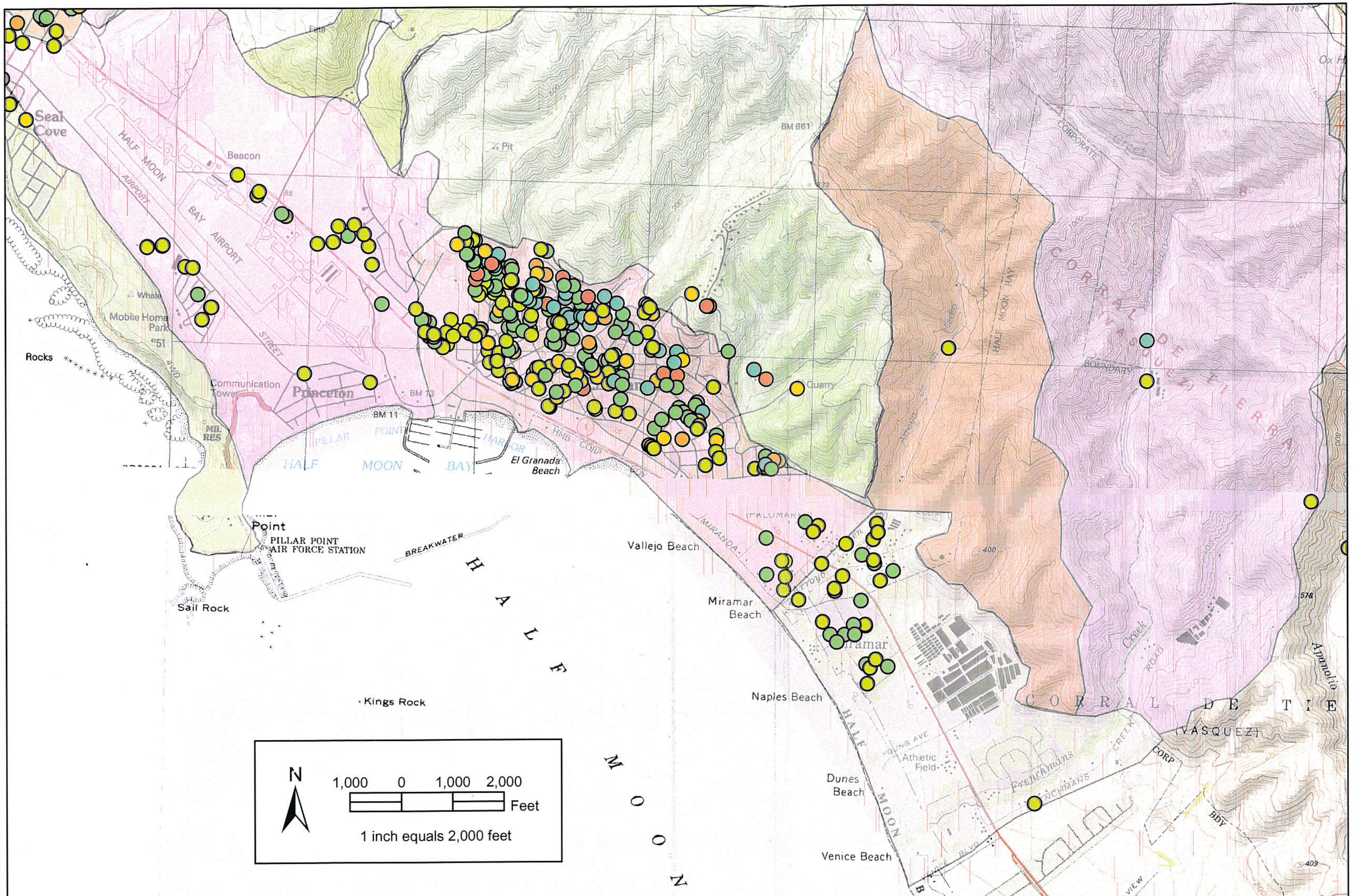
KLEINFELDER

Project No. 26848 Date: March 2004

Calculated Water Elevations in Wells
Midcoast Aquifer Study, North
San Mateo County, California

Plate

17



N

1,000 0 1,000 2,000 Feet

1 inch equals 2,000 feet

EXPLANATION

Predicted Water Elevations in Wells

- Above 75
- 26 to 75
- 1 to 25
- -24 to 0
- -49 to -25
- -74 to -50
- Below -75

Hydrologic Sub-Area

SubAreaNam

- Airport
- Arroyo de en Medio Watershed
- Dean Creek Watershed
- Denniston Creek
- Denniston Creek Watershed
- El Granada
- El Granada Watershed
- Frenchman Creek Watershed
- Lower Moss Beach Terrace
- Martini Creek Terrace
- Martini Creek Watershed
- Miramar
- Montara Creek Watershed
- Montara Heights
- Montara Terrace
- Portola
- San Vicente Creek
- San Vicente Creek Watershed
- Seal Cove
- Unamed Watershed
- Upper Moss Beach
- Wagner Valley

Preliminary Draft

KLEINFELDER

Project No. 26848 Date: March 2004

Calculated Water Elevations in Wells
Midcoast Aquifer Study, South
San Mateo County, California

Plate 18

Appendix A

Frequency Distribution of Wells and Well Depths by Sub-Areas

The following table presents selected data concerning wells in the Midcoast Study Area sorted by Sub-area within the Sub-basins. Following the table below, frequency distribution of well depths and depths to water in wells for four of the Sub-areas are shown graphically on Plate A-1.

TABLE A-1

Well ID	Sub Area Nam	TD	Surf Elevation	DTW	Casing Material	Diameter	Seal Depth	Perf Top	Elev_F	W Elev
342	Airport	100	0	25	PVC	5	20	20	14	-11
1194	Airport	100	0	20	PLASTIC	4	20	20	15	-5
1229	Airport	100		27	PVC	6		60	14	-13
1231	Airport	120		29	PVC	5	20		18	-11
1268	Airport	155		6	PVC	6	50	53	10	4
1272	Airport	60		14	STEEL	6	13	40	8	-6
1292	Airport	114	50	10	IRON	12			20	10
1293	Airport	116	49	16	IRON	30			19	3
1347	Airport	90		75	PVC	4	23	25	20	-55
86	Airport			23					22	-1
204	Airport	120		6	PVC	5	48	50	14	8
219	Airport	130	23	18		10		24	17	-1
225	Airport	112	56	23		10			19	-4
1753	Airport	40		12	PVC	5	12	20	8	-4
	n=14	104.4		21.7		8.3	22.9	31.2	15.6	-6.1
		n=13		n=14		n=13	n=9	n=10	n=14	n=14
1	El Granada	350	50	49	PVC	8	30	26	32	-17
2	El Granada	220		80	PVC	5	20	80	50	-30
3	El Granada	400		60	PVC	8	20	120	53	-7
4	El Granada	180		38	PLASTIC	6	50	140	59	21
5	El Granada	305		180	PVC	5	25	65	74	-106
6	El Granada	275		70	PVC	5	35	75	80	10
8	El Granada	75		60	PVC	6	20	20	12	-48
9	El Granada	75		65	PVC	5	20	35	17	-48
11	El Granada	43	0	28		0	21	25	20	-8
13	El Granada	50	0	39		4	21	25	20	-19
16	El Granada	300		100	PVC	5	20	20	15	-85
17	El Granada	300	0	40	PVC	8	20	20	15	-25
18	El Granada	110	0	15	PVC	5	20	30	14	-1
21	El Granada	120	0	20	PVC	5	20	20	14	-6
24	El Granada	120	0	58	PVC	6	20	40	27	-31
25	El Granada	70	0	40	PVC	5	20	20	28	-12

Well ID	Sub Area Nam	TD	Surf Elevation	DTW	Casing Material	Diameter	Seal Depth	Perf Top	Elev_F	W Elev
27	El Granada	180		160	PVC	5	30	90	32	-128
28	El Granada	80		35	PVC	5		30	33	-2
29	El Granada	100		30	PVC	5	20	40	29	-1
30	El Granada	87		38	PVC	5	20	30	33	-5
31	El Granada	135		32	PVC	4	20	20	34	2
32	El Granada	120		57	PVC	5	30	40	29	-28
34	El Granada	85		42	PVC	5	30	30	41	-1
35	El Granada	200		22	PVC	5	30	40	35	13
37	El Granada	160		41	PVC	6	25	41	46	5
295	El Granada	280		45	PVC	5	20	80	41	-4
296	El Granada	195		55	PVC	5	20	40	41	-14
297	El Granada	225		40	PVC	5	20	90	54	14
298	El Granada	305		35	PVC	5	30	120	65	30
299	El Granada	275		225	PVC	5	20	195	92	-133
302	El Granada	300	0	25	PVC	4	20	100	81	56
305	El Granada	166		50	PVC	5	20	80	100	50
307	El Granada	90		50	PVC	6	30	50	45	-5
308	El Granada	90		55	PVC	6	30	70	49	-6
310	El Granada	95		21	PVC	5	20	55	16	-5
311	El Granada	280		175	PVC	5	20	180	40	-135
312	El Granada	280		140	PVC	5	20	120	47	-93
314	El Granada	320		37	PVC	5	30	100	57	20
315	El Granada	150		50	PVC	5	20	130	59	9
316	El Granada	170		100	PVC	5		115	48	-52
317	El Granada	260		37	PVC	5	30		46	9
318	El Granada	180		80	PVC	5	20	160	35	-45
319	El Granada	70		19	PVC	5	20	30	26	7
320	El Granada	195		65	PVC	6	20	39	31	-34
322	El Granada	80		50	PVC	5	20	40	17	-33
323	El Granada	95		50	PVC	5	30	50	23	-27
324	El Granada	85		54	PVC	6	20	35	24	-30
325	El Granada	80	0	22	PLASTIC	6	20	40	23	1
326	El Granada	80		30	PVC	5	40	40	26	-4
327	El Granada	30		21	PVC	8	20	60	18	-3
328	El Granada	83		35	PVC	5	20	40	18	-17
329	El Granada	80		21	PVC	5	20	60	16	-5
331	El Granada	95		30	PVC	5	20	55	15	-15
332	El Granada	100		21	PVC	6	20	40	15	-6
333	El Granada	60		15	PVC	6	20	23	13	-2
335	El Granada	75		1	PVC	6	20	35	14	13
337	El Granada	100		38	PVC	5	20	20	12	-26
338	El Granada	50		15	PVC	5		22	13	-2

Well ID	Sub Area Nam	TD	Surf Elevation	DTW	Casing Material	Diameter	Seal Depth	Perf Top	Elev_F	W Elev
339	El Granada	100		20	PVC	5	20	40	13	-7
340	El Granada	50		10	PVC	5	20	20	13	3
341	El Granada	100		20	PVC	5	20	40	13	-7
344	El Granada	58	0	58	PVC	4	20	58	35	-23
345	El Granada	58		8	PVC	4	20	20	40	32
347	El Granada	95	0	35	PLASTIC	5	20	35	40	5
348	El Granada	360		9	PVC	4	20		42	33
349	El Granada	56		8		8	10	20	32	24
354	El Granada	240		40	PVC	8		120	36	-4
355	El Granada	75		55	PVC	6	20	40	23	-32
356	El Granada	120	0	30	PVC	5	20	20	26	-4
357	El Granada	104		16	PVC	5		41	24	8
362	El Granada	60		25	PVC	5	20	30	32	7
363	El Granada	60		25	PVC	5	20	25	35	10
365	El Granada	74		24	PVC	5	20	40	34	10
369	El Granada	80		35	PVC	5	20	40	16	-19
370	El Granada	90		31	PVC	5	23	30	17	-14
371	El Granada	74		15	PVC	5	20	34	31	16
372	El Granada	100		30	PVC	5	20	30	31	1
373	El Granada	110		12	PVC	5	27	40	33	21
374	El Granada	100		31	PVC	5	20	20	55	24
375	El Granada	160		75	PVC	5	20	80	55	-20
376	El Granada	100		21	PVC	5	20	40	57	36
377	El Granada	140		23	PVC	5	20	80	55	32
378	El Granada	140		98	PVC	5	20	80	61	-37
379	El Granada	188	0	140	PVC	5	25	88	67	-73
383	El Granada	120		38	PVC	5	20	60	50	12
387	El Granada	430		135	PVC	5	100	245	73	-62
388	El Granada	430		135	PVC	5	100	240	67	-68
389	El Granada			9					51	42
390	El Granada	100		29	PVC	5	20	40	51	22
1359	El Granada	100		43	PVC	6	20	40	23	-20
1391	El Granada	120		36	PVC	5		40	23	-13
1392	El Granada	78		3	PVC	5	20	43	22	19
1396	El Granada	63		9	PVC	5			26	17
1397	El Granada	160		60	PVC	5	30	60	19	-41
1400	El Granada	76		6	PVC	6			7	1
1401	El Granada	80		20	PVC	5	20	40	24	4
1413	El Granada	94		6	PVC	5	20	32	13	7
1414	El Granada	60		25	PVC	5	20	30	9	-16
1415	El Granada	80		16	PVC	5	35	90	10	-6
38	El Granada	200		138	PVC	5	30	80	45	-93

Well ID	Sub Area Nam	TD	Surf Elevation	DTW	Casing Material	Diameter	Seal Depth	Perf Top	Elev_F	W Elev
39	El Granada	70		4	PVC	5		20	40	36
40	El Granada	240		7	PVC	5	30	60	42	35
41	El Granada	120		35	PVC	8	20	40	47	12
42	El Granada	260		155	PVC	5	30	100	46	-109
45	El Granada	240		13	PVC	5	20	180	52	39
47	El Granada	220		197	PVC	5	20	120	52	-145
48	El Granada	300		100	PVC	5	20	40	51	-49
50	El Granada	160		80	PVC	5	25		20	-60
51	El Granada	240		23	PVC	5	30	60	30	7
52	El Granada	460		57	PVC	6	25	60	28	-29
53	El Granada	250		65	PVC	6	20	40	43	-22
54	El Granada	140	0	20	PVC	5	20	20	49	29
55	El Granada	120	0	30	PVC	6	20	40	46	16
57	El Granada	475		11		0	0		50	39
59	El Granada	80		34	PVC	5	20	30	16	-18
61	El Granada	72		55	PVC	5		37	17	-38
64	El Granada	150		37	PVC	5	20	50	37	0
65	El Granada	260		90	PVC	5	30	100	41	-49
66	El Granada	305		37		6	20	120	41	4
67	El Granada	260		40	PVC	8	30	120	45	5
68	El Granada	240		30	PVC	5	30	120	42	12
69	El Granada	240		59	PVC	5	30	120	42	-17
70	El Granada	350		100	PVC	5	20	60	33	-67
72	El Granada	280		33	PVC	5		120	49	16
73	El Granada	451		35	PVC	4	20	30	70	35
77	El Granada	300		80	PVC	6	20	60	54	-26
80	El Granada	300		210	PVC	5	20	20	58	-152
82	El Granada	250		8	PVC	5	50	55	75	67
92	El Granada	85		32	PVC	5			15	-17
93	El Granada	80		35	PVC	5	22	40	17	-18
94	El Granada	100		24	PVC	5	20		19	-5
96	El Granada	195		25	PVC	5	20		40	15
98	El Granada	300		26	PVC	5	20	40	53	27
99	El Granada	300		169	PVC	6	20	40	47	-122
100	El Granada	80		70	PVC	5	20	40	17	-53
101	El Granada	170		20	PVC	8	20	170	17	-3
102	El Granada	78		48	PVC	5	20	20	23	-25
103	El Granada	80		38	PVC	6	20	20	24	-14
104	El Granada	95		45	PVC	5	20	24	24	-21
107	El Granada	80		60	PVC	5	20	20	32	-28
108	El Granada	60		22	PVC	6	20	20	42	20
110	El Granada	250	0	40	PVC	5	20	110	55	15

Well ID	Sub Area Nam	TD	Surf Elevation	DTW	Casing Material	Diameter	Seal Depth	Perf Top	Elev_F	W Elev
111	El Granada	395	0	65	PVC	6	32	135	73	8
114	El Granada	190	0	90	PVC	6	20	90	74	-16
115	El Granada	275		37	PVC	5	20	90	68	31
116	El Granada	240		120	PVC	5	20	60	86	-34
118	El Granada	490	0	90	PVC	5	20	100	70	-20
125	El Granada	75		27	PVC	5	20	45	23	-4
126	El Granada	300	0	5	PVC	5	20	60	26	21
136	El Granada	295	0	135	PVC	5	20	130	65	-70
138	El Granada	350	0	225	PVC	5	20	200	64	-161
140	El Granada	275	0	105	PVC	5	20	80	60	-45
143	El Granada	375		120	PVC	5	20	40	124	4
156	El Granada	282		120	PVC	5	30	80	65	-55
157	El Granada	250		50	PVC	5	20	50	72	22
159	El Granada	280		122	PVC	5	30	40	51	-71
160	El Granada	300		60	PVC	6			49	-11
161	El Granada	240		49	PVC	5	20	100	57	8
162	El Granada	440		30	PVC	4	20		48	18
163	El Granada	80		21	PVC	5	20	40	71	50
164	El Granada	70		16	PVC	6	28	30	65	49
165	El Granada	60		50	PVC	5	20	20	61	11
167	El Granada	80		21	PVC	5	20	25	62	41
168	El Granada	68		10	PVC	5	25	38	53	43
169	El Granada	200	0	40	PLASTIC	5	20	40	74	34
170	El Granada	175		45	PVC	5	20	40	70	25
171	El Granada	320		53	PVC	4	25	170	73	20
172	El Granada	300		35	PVC	5	30	40	66	31
173	El Granada	185		33	PVC	4	20	185	69	36
174	El Granada	300		60	PVC	5	20	160	85	25
176	El Granada	205		198	PVC	5	20	65	58	-140
177	El Granada	80		67	PVC	5	20	40	21	-46
180	El Granada	69		12	PVC	6	20	20	25	13
181	El Granada	106		68	PVC		25		33	-35
182	El Granada	111		44	PVC	5		40	32	-12
184	El Granada	300	0	90	PLASTIC	5	50	40	41	-49
185	El Granada	105		23	PVC	5	20	20	43	20
186	El Granada	105	0	40	PLASTIC	5	20	40	49	9
187	El Granada	225	0	56	PVC	5	20	40	43	-13
188	El Granada	300	0	75	PVC	6	20	140	49	-26
193	El Granada	320		281	PVC	5	30	140	60	-221
195	El Granada	160		30	PVC	5	20	25	47	17
199	El Granada	73		55	PVC	8	20	50	63	8
200	El Granada	140		38	PVC	4	20	20	60	22

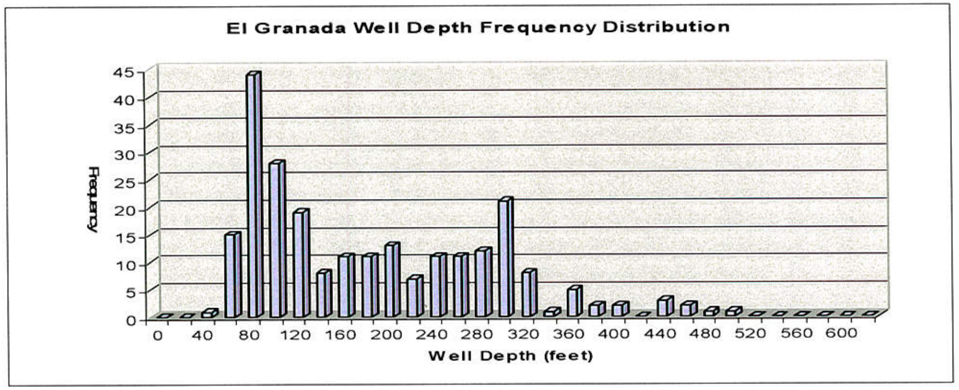
Well ID	Sub Area Nam	TD	Surf Elevation	DTW	Casing Material	Diameter	Seal Depth	Perf Top	Elev_F	W Elev
201	El Granada	170		20	PVC	8	22	80	49	29
205	El Granada	275		18	STEEL	6	20	40	40	22
208	El Granada	178		60	PVC	9	20	40	14	-46
209	El Granada	120		60	PVC	6		60	32	-28
210	El Granada	50		35	PVC	6	50	130	26	-9
211	El Granada	150		22	PVC	9	20	50	28	6
213	El Granada	148		38	PVC		30		31	-7
214	El Granada	220		25	PVC	5	20	60	51	26
215	El Granada	220		35	PVC	10	20	40	52	17
230	El Granada	80	0	40	PVC	5	20	40	21	-19
232	El Granada	180		10	PVC	5	30	180	28	18
234	El Granada	160		24	PVC	5	20	60	47	23
235	El Granada	203		31	PVC	5	30	100	48	17
237	El Granada	305		24	PVC	5	30	30	49	25
239	El Granada	190		40	PVC	6	20	40	43	3
240	El Granada	80		20	PVC	6	20	20	40	20
244	El Granada	95	0	82	PVC	6	20	60	36	-46
245	El Granada	140		32	PVC	6	20	40	37	5
247	El Granada	377		36	PLASTIC	5	20	2	31	-5
248	El Granada	300		40	PLASTIC	5	30	100	27	-13
249	El Granada	248		34			20		25	-9
250	El Granada	170		36	PVC	5			26	-10
251	El Granada	120		41	PVC	5	30	40	24	-17
253	El Granada	115		13	PVC	5	22	80	32	19
254	El Granada	80		23	PVC	5	25	30	32	9
255	El Granada	300		12	PVC	6	20	60	35	23
256	El Granada	140		33	PVC	5	20	40	37	4
257	El Granada	320		60	PVC	5		80	64	4
259	El Granada	80		25	PVC	5	25	40	11	-14
260	El Granada	75		9	PVC	10	20		12	3
263	El Granada	75		9	PVC	5	20	28	12	3
266	El Granada	200		60	PVC	5	25	40	43	-17
267	El Granada	300	0	65	PVC	6	20	280	34	-31
269	El Granada	80	0	58	PVC	5	20	40	33	-25
270	El Granada	80	0	27	PVC	5	25	50	33	6
271	El Granada	200		38	PVC	5	20	40	41	3
272	El Granada	200		100	PVC	5	20	100	45	-55
273	El Granada	50		18	PVC	5	20	30	45	27
274	El Granada	160		70	PVC	5	20	60	43	-27
275	El Granada	80		15	PVC	5	30	40	48	33
276	El Granada	260		50	PVC	5	20	70	42	-8
278	El Granada	120		18	PVC	4	20	120	51	33

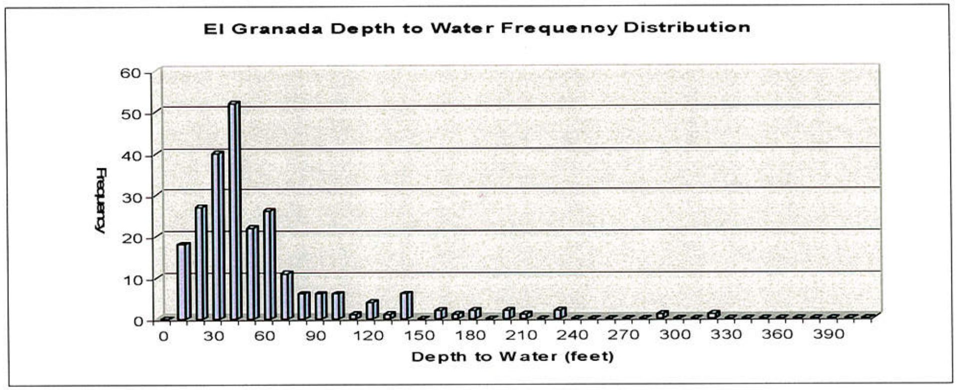
Well ID	Sub Area Nam	TD	Surf Elevation	DTW	Casing Material	Diameter	Seal Depth	Perf Top	Elev_F	W Elev
279	El Granada	140		90	PVC	5	20	80	58	-32
280	El Granada	100		20	PVC	5	20	25	56	36
281	El Granada	263		63	PVC	5	30	63	56	-7
282	El Granada	300		50	PVC	5	20	50	74	24
283	El Granada	220		52	PVC	5	20	50	56	4
284	El Granada	225		45	PVC	5	20	75	67	22
286	El Granada	325		39	PVC	5	30	140	93	54
287	El Granada	250		44	PVC	5	20	25	70	26
289	El Granada	360		320	PVC	8	20	280	70	-250
290	El Granada	262		120	PVC	5	20	120	74	-46
292	El Granada	100		40	PVC	5	20	35	49	9
293	El Granada	300		52	PVC	4	20	100	46	-6
	n=238	177.9		51.9		5.3	23.4	64.3	41.4	-10.6
		n=237		n=238		n=234	n=219	n=221	n=238	n=238
1195	Lower Moss Beach Terrace	200		130	PVC	5	24	25	7	-123
1196	Lower Moss Beach Terrace	200		130	PVC	5	24	25	7	-123
1209	Lower Moss Beach Terrace	19	0	7		0	2	3	21	14
1210	Lower Moss Beach Terrace	19	0	6		0	2	4	21	15
1211	Lower Moss Beach Terrace	19	0	6		0	2	4	21	15
1212	Lower Moss Beach Terrace	19	0	6		0	2	4	21	15
1215	Lower Moss Beach Terrace	150	0	7	PVC	5	30	30	19	12
1220	Lower Moss Beach Terrace	230	0	30	PVC	10	0	35	9	-21
1221	Lower Moss Beach Terrace			5	PVC	6			34	29
1224	Lower Moss Beach Terrace			12	PVC	6			20	8
1233	Lower Moss Beach Terrace		0	11	PVC	6			24	13
1280	Lower Moss Beach Terrace	82		30	PVC	4	20	20	25	-5
1281	Lower Moss Beach Terrace	50		14	PVC	6	20	20	24	10
1282	Lower Moss Beach Terrace	81		10	PVC	5	10	10	24	14
1295	Lower Moss Beach Terrace	900		11					16	5
1298	Lower Moss Beach Terrace			11	PVC	6	20		24	13
1307	Lower Moss Beach Terrace			11	PVC	6			20	9
1320	Lower Moss Beach Terrace			11	PVC	6			22	11
1346	Lower Moss Beach Terrace	140		10	PVC	5	25	30	24	14
1354	Lower Moss Beach Terrace	30		14	PVC	4		20	17	3
	n=20	152.8		23.6		4.5	13.9	17.7	20.0	-3.6
		n=14		n=20		n=19	n=13	n=13	n=20	n=20
		129.2								
		n=9								

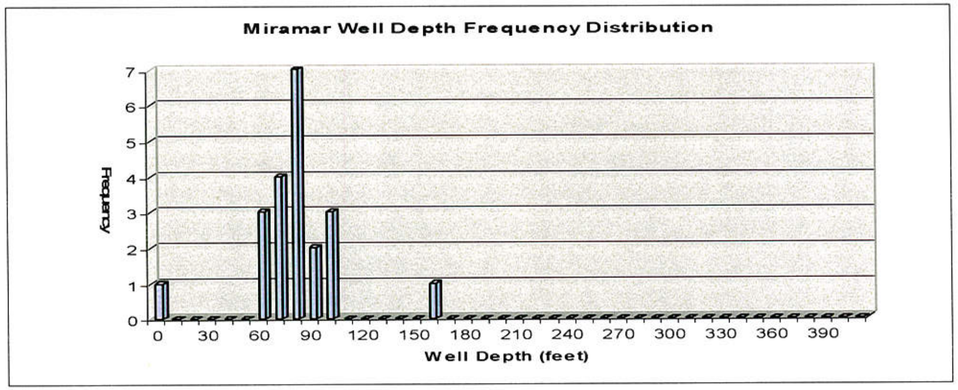
Well ID	Sub Area Nam	TD	Surf Elevation	DTW	Casing Material	Diameter	Seal Depth	Perf Top	Elev_F	W Elev
983	Miramar	90		27	PVC	6	20	40	13	-14
1081	Miramar	0	0	48	PVC	5	25	40	32	-16
1156	Miramar	70		12	PVC	9	30	40	13	1
1158	Miramar	80		20	PVC	5	20	20	9	-11
1356	Miramar	85		32	PVC	5	20	25	23	-9
1367	Miramar	60		10	PVC	5	22	20	14	4
1380	Miramar	100		11	PVC	5	20	20	12	1
1409	Miramar	80		42	PVC	5		40	31	-11
1410	Miramar	160		24	PVC	5	30		32	8
1411	Miramar	80		40	PVC	5	20	40	25	-15
1420	Miramar	70		35	PVC	5	20	20	12	-23
1426	Miramar	60		16	PVC	5			32	16
1427	Miramar	92		44	PVC	5	20	60	31	-13
1442	Miramar	65		20	PVC	5	20	35	12	-8
1444	Miramar	100		30	PVC	5	20	40	13	-17
1447	Miramar	80		10	PVC	5	35	40	13	3
1448	Miramar	80		10	PVC	5	35	40	13	3
1450	Miramar	80		15	PVC	5	24	40	22	7
1453	Miramar	60		34	PVC	5	25	25	18	-16
1457	Miramar	68		8	PVC	5	20	24	17	9
1458	Miramar	75		12	PVC	5	20	30	15	3
	n=21	81.8		23.8		5.2	23.5	33.6	19.1	-4.7
		n=20		n=21		n=21	n=19	n=19	n=21	n=21
1685	Montara Heights	350		328	PVC	9	20	230	49	-279
1692	Montara Heights	300		270	PVC	5	20	240	48	-222
1697	Montara Heights	230		28	PVC	5	20	20	76	48
1299	Montara Heights	235		103	PVC	4	27	170	28	-75
1344	Montara Heights	180	0	150	PVC	0		0	66	-84
1461	Montara Heights	250		90	PVC	4	20	150	50	-40
1509	Montara Heights	280		150	PVC	8	50	200	40	-110
1516	Montara Heights	300		115	PVC	5	25	40	47	-68
1542	Montara Heights	243		88	PVC	6	40	100	93	5
1544	Montara Heights	243		78	PVC	6	40	140	84	6
1547	Montara Heights	220		80	PVC	6	20	80	63	-17
1548	Montara Heights	300		125	PVC	7	20	75	89	-36
1596	Montara Heights	225		16	PVC	4	20	145	52	36
	n=13	258.2		124.7		5.3	26.8	132.5	60.4	-64.3
		n=13		n=13		n=13	n=12	n=12	n=13	n=13

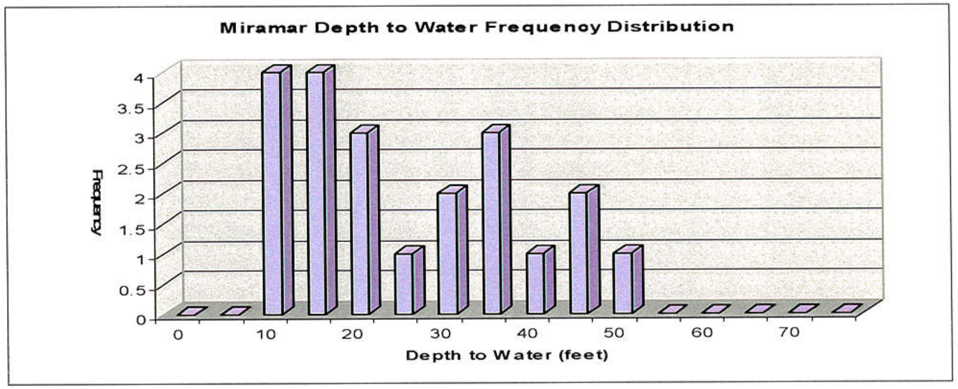
Well ID	Sub Area Nam	TD	Surf Elevation	DTW	Casing Material	Diameter	Seal Depth	Perf Top	Elev_F	W Elev
1644	Montara Terrace	100		6	PVC	5	26	35	27	21
1645	Montara Terrace	100	148	21	PVC	5	22	35	30	9
1699	Montara Terrace	240	0	85	PVC	8	20	70	6	-79
1727	Montara Terrace	275		65	PVC	4		25	91	26
1465	Montara Terrace	200		26	PVC	8	20	120	27	1
1469	Montara Terrace	236		68	PVC	4	20	20	0	-68
1479	Montara Terrace	110	0	70	PVC	4	20	50	5	-65
1485	Montara Terrace	0	0	65	PVC	5	75	0	20	-45
1486	Montara Terrace	180		16	PVC	5	63	80	31	15
1494	Montara Terrace	0	0	78		0	27	0	33	-45
1495	Montara Terrace	100		68	PVC	5	0	40	31	-37
1569	Montara Terrace	200	0	67	PVC	4	20	0	0	-67
1593	Montara Terrace	180	0	47	PVC	0	20	0	67	20
1605	Montara Terrace	200		61	PVC	5	22	100	48	-13
1623	Montara Terrace	200		155	PVC	13	20	100	71	-84
1642	Montara Terrace	900		101	PVC	5	26	60	79	-22
	n=16	230.1		62.4		5.7	28.6	61.3	40.4	-27.1
		n=14		n=16		n=14	n=14	n=12	n=14	n=16
		178.5								
		n=13								
1729	Portola	150	0	60	PVC	4		20	71	11
1732	Portola	120		42	PVC	5	21	50	62	20
1733	Portola	120		44	PVC	5	30	50	63	19
1737	Portola	260		82	PVC	5	30	40	86	4
1265	Portola	175		92	PVC	6	20	55	67	-25
1522	Portola	168		90	PVC	5	20	51	107	17
1526	Portola	140		45	STEEL	6	13	40	129	84
1552	Portola	150		40	PVC	4	12	40	115	75
1568	Portola	265		210	PVC	5	30	90	87	-123
1608	Portola	160		65	PVC	5	20	120	107	42
	n=10	170.8		77		5	21.8	55.6	89.4	12.4
		n=10		n=10		n=10	n=9	n=10	n=10	n=10
1708	Upper Moss Beach Terrace	303		140	PLASTIC	4	20	60	25	-115
1277	Upper Moss Beach Terrace	560		22	PVC	4	20	60	53	31
1475	Upper Moss Beach Terrace	450		34	PVC	4	30	50	13	-21
	n=3	437.7		65.3		4.0	23.3	56.7	30.3	-35.0
		n=3		n=3		n=3	n=3	n=3	n=3	n=3

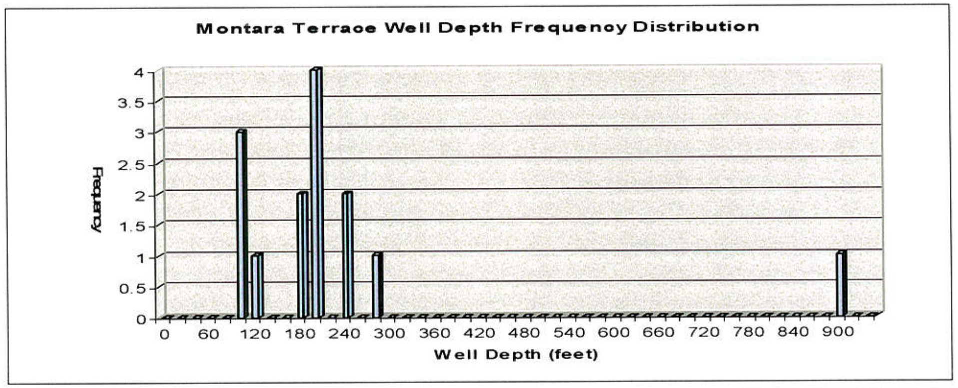
Well ID	Sub Area Nam	TD	Surf Elevation	DTW	Casing Material	Diameter	Seal Depth	Perf Top	Elev_F	W Elev
1720	Wagner Valley	275	0	150	PVC	4	0	155	169	19
1731	Wagner Valley	125		77	PVC	5	20	70	72	-5
	n=2	200		113.5		4.5	10	112.5	120.5	7
		n=2		n=2		n=2	n=2	n=2	n=2	n=2

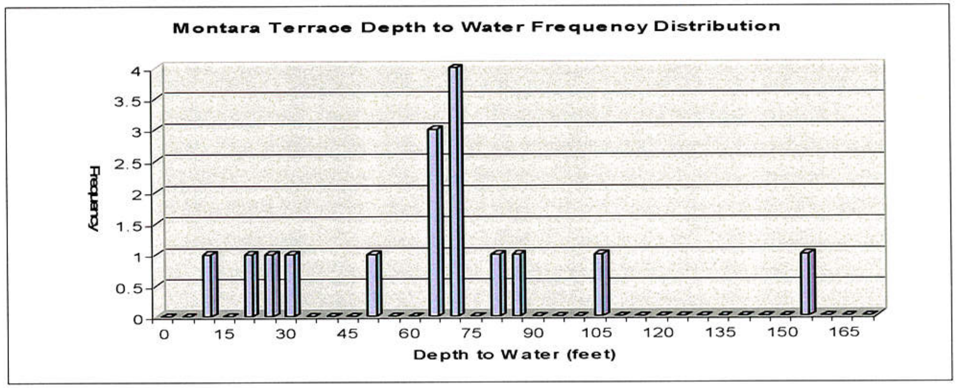












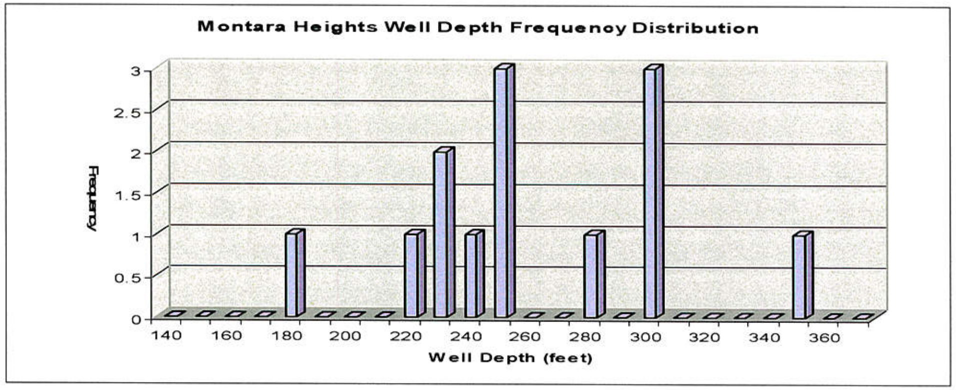
KLEINFELDER
1362 Ridder Park Drive
San Jose, California 95131
Phone: (408) 436-1155 Fax: (408) 436-1771

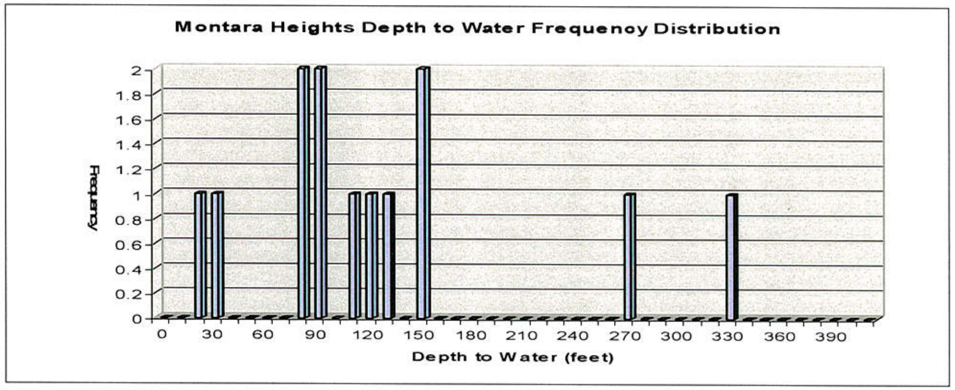
Frequency Distributions by Sub-Areas
San Mateo County Midcoast Groundwater
Study Area Phase II
San Mateo County, California

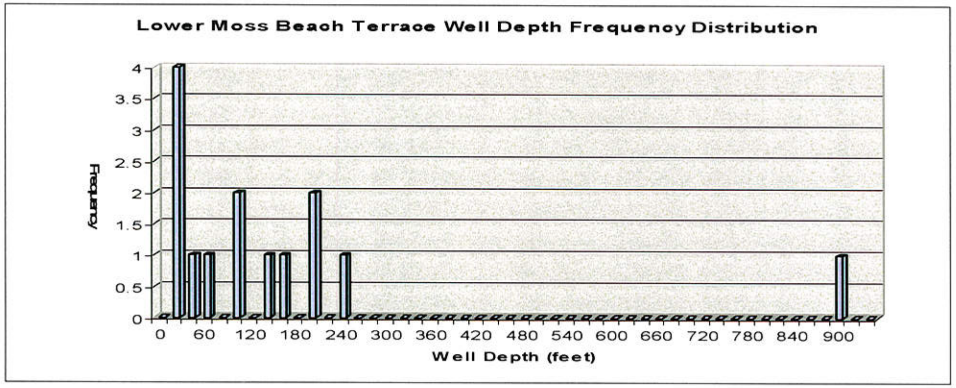
PLATE
A-1

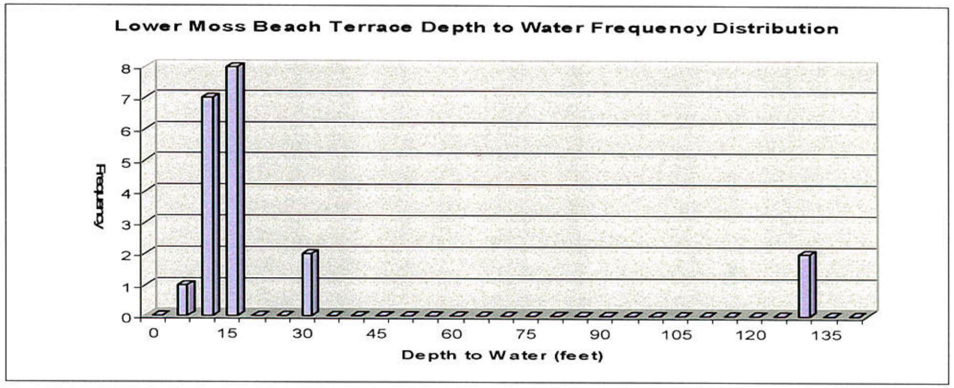
Compiled by: P. Holland | Date: 02/22/04 | PROJECT NO. 26848

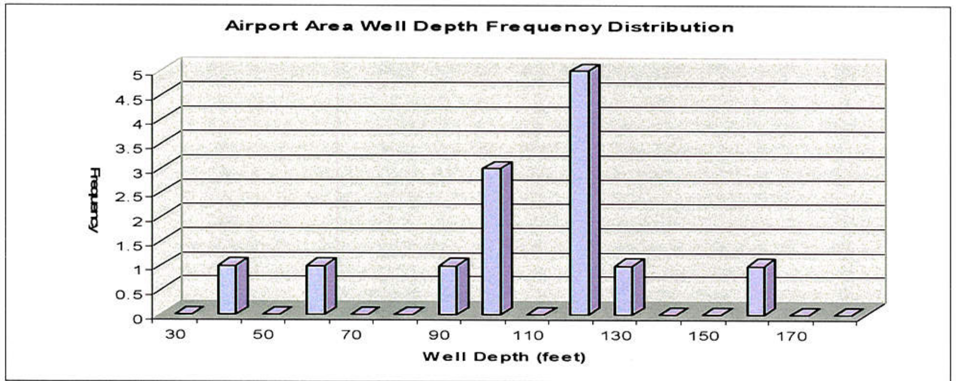
Library file: L:\2004\library\projects\26848*.ppt

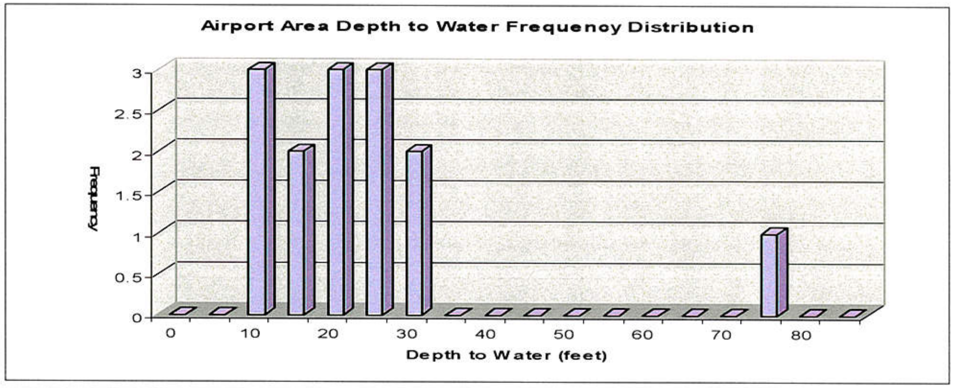












KLEINFELDER
1362 Ridder Park Drive
San Jose, California 95131
Phone: (408) 436-1155 Fax: (408) 436-1771

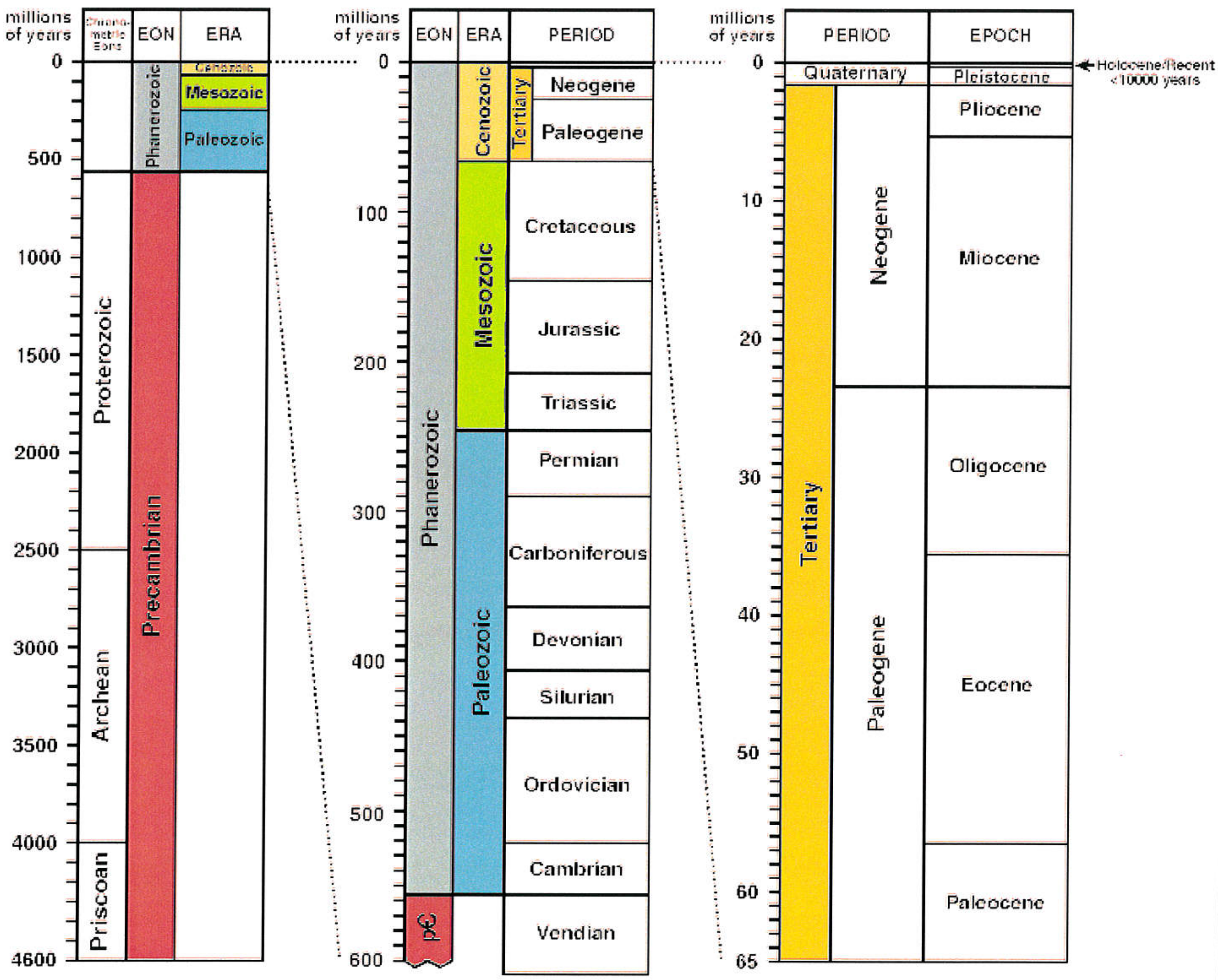
Frequency Distributions by Sub-Areas
San Mateo County Midcoast Groundwater Study Area Phase II
San Mateo County, California

PLATE A-2

Compiled by: P. Holland | Date: 02/22/04 | PROJECT NO. 26848

Library file: L:\2004\library\projects\26848*.ppt

Appendix B
Geologic Time Scale



Source: http://www.geo.ucalgary.ca/~macrae/timescale/time_scale.gif

KLEINFELDER
1362 Ridder Park Drive
San Jose, California 95131
Phone: (408) 436-1155 Fax: (408) 436-1771

Geologic Time Scale

San Mateo County Midcoast Groundwater Study Area Phase II

San Mateo County, California

PLATE

B-1

Compiled by: P. Holland | Date: 02/22/04 | PROJECT NO. 26848

APPLICATION FOR AUTHORIZATION TO USE

Technical Memorandum No. 1
San Mateo County
Midcoast Groundwater Study, Phase Ii
26848
April 23, 2004

Kleinfelder, Inc.
1362 Ridder Park Drive
San Jose, California 95131
408-436-1155 (Telephone)
408-436-1771 (Fax)

To whom it may concern:

Applicant understands and agrees that the Hydrogeologic Investigation for the subject site is a copyrighted document, that Kleinfelder, Inc. is the copyright owner and that unauthorized use or copying of the Report for the subject site is strictly prohibited without the express written permission of Kleinfelder, Inc. Applicant understands that Kleinfelder, Inc. may withhold such permission at its sole discretion, or grant permission upon such terms and conditions, as it deems acceptable.

Applicant agrees to accept the contractual terms and conditions between Kleinfelder, Inc. and the County of San Mateo originally negotiated for preparation of this Hydrogeologic Investigation. Use of this Report without permission releases Kleinfelder, Inc. from any liability that may arise from use of this report.

To be Completed by Applicant

____
(Company Name)

____
(Address)

____
(City, State, Zip)

______________________________ *(Telephone)*　　______________________________ *(Fax)*

By: ______________________________

Title: ______________________________

Date: ______________________________

For Use Only by Kleinfelder, Inc.

_______ Approved for re-use with an additional fee of $ __________

_______ Disapproved, report need to be updated

By: ______________________________
(Kleinfelder, Inc. Project Manager)

Date:

26848 (SJO4R194) mc