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BAYROCK
RESIDENTIAL

Alameda County Environmental Health Care Services
Local Oversight Program
1131 Harbor Way Parkway, Suite 250
Alameda, California 94502-6577

Date: July 17, 2006

Your Reference: RO2733

Attn. Mr. Barney Chan, REHS

SUBJECT: Corrective Action Plan - Oak Walk Redevelopment Site Emeryville, CA

Dear Mr. Chan:

Enclosed please find a copy of the *Corrective Action Plan - Oak Walk Redevelopment Site, Emeryville California,* which is in two volumes as prepared by our consultants The San Joaquin Company Inc. (SJC). The transmittal includes a compact disk containing an electron edition of the plan.

The plan is a formal documentation of proposed corrective action and associated risk-based environmental assessments that Dr Dai Watkins of SJC and I presented to you when we met in your offices on December 06, 2005.

We plan to start demolition work at the Oak Walk Redevelopment Site in mid-September and implementation of the environmental corrective action plan will start in parallel with that work. Please note that as the developer BayRock Residential, LLC has no responsibility either as discharger or property owner in relation to any of the unauthorized releases of regulated materials that occurred on and off site from the subject property. Our undertaking of environmental corrective action work on the property is strictly voluntary in nature.

With respect to the Corrective Action Plan transmitted herewith I state the following:

"I declare, under penalty of perjury, that the information and recommendations contained in the document transmitted herewith are true and correct to the best of my knowledge"

If you have any technical questions about the plan please call Dr. Watkins at questions, or if I can be of assistance to you in any way, please call me at (510) 336-9118. For administrative questions please call me at (510) 594-8811 Ex. 205.

Sincerely,
BayRock Residential, LLC

Peter Schellinger

Enc: Report: *Corrective Action Plan - Oak Walk Redevelopment Site, Emeryville, California*
(In 2 Volumes with electronic edition on compact disk.)
cc: Dr. Dai Watkins- The San Joaquin Company Inc.

THE SAN JOAQUIN COMPANY INC.
1120 HOLLYWOOD AVENUE, SUITE 3, OAKLAND, CALIFORNIA 94602

CORRECTIVE ACTION PLAN

Oak Walk Redevelopment Site
Emeryville, California

for

BAYROCK
RESIDENTIAL

July 2006

Project No.: 0004.085

VOLUME I of II
Site History and Proposed Corrective Action

TELEPHONE: OAKLAND, CALIFORNIA (510) 336-9118 TRACY, CALIFORNIA (209) 832-2910

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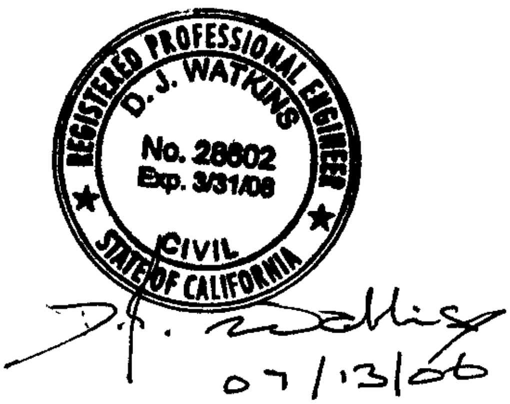
PROFESSIONAL CERTIFICATION AND LIMITATIONS

This corrective action plan was prepared under the direction of the engineer whose seal and signature appear below. The work was performed in accordance with generally accepted standards of engineering practice based on information available to us at the time of its preparation and within the limits of the scope of work directed by the client. No other representation, express or implied, and no warranty or guarantee is included or intended as to professional opinions, recommendations, or field or laboratory data provided.



D. J. Watkins, Ph.D., P.E.
Geotechnical Engineer
The San Joaquin Company Inc.

1.0 INTRODUCTION

This corrective action plan was prepared by The San Joaquin Company Inc. (**SJC**) of Oakland, California for the "Oak Walk Redevelopment Site" in the City of Emeryville, California. The site location is shown on Figure I-1.

Soil and groundwater beneath that property has been affected by the release of fuel hydrocarbons and industrial solvents, the sources of which were underground storage tanks formerly located at several off- and on-site locations. This work plan has been developed in response to regulatory direction issued by Alameda County Environmental Health Care Services (**ACEHCS**) (Alameda County Environmental Health Care Services 2005B). In order to provide oversight of site characterization and remediation of the Oak Walk Site, the ACEHCS assigned the case number RO2733 to the property.

With the exception of a small parcel at the intersection of 40th and Adeline Streets that is owned by the City of Emeryville Redevelopment Agency (**ERDA**), the whole of the Oak Walk Site is currently owned by the Oaks Club, a California Limited Partnership (**Oaks Club**). SJC prepared the work plan for Bay Rock Residential, LLC (**Bay Rock**) of Emeryville, California, who plan to redevelop the site. However, it is important to note that Bay Rock is not a responsible party for any of the chemicals of concern that have been found on the Oak Walk Site or for any of the sites from which those chemicals migrated onto the subject property.

In addition to descriptions of proposed remediation of soil and groundwater and construction of engineered barriers designed to reduce soil and groundwater contamination and eliminate health risks that might otherwise be associated with redevelopment of the site, this plan also includes the design of additional exploratory trenches and an extended array of groundwater-quality monitoring wells that, as also requested by the ACEHCS (Alameda County Environmental Health Care Services 2005B), will provide additional site characterization data that will further delineate the extent of soil and groundwater contamination beneath the site.

This corrective action plan is contained in two volumes. This document is Volume I. It presents a history of the site, a description of its environmental conditions, a description of the elements of the proposed remediation plan that will be implemented at the subject property and the design of post-remediation, soil gas and groundwater-quality monitoring program that will be implemented.

It is intended that both Volumes I and II of this Plan be read as a whole. Accordingly, the corrective action plan presented in this volume should be read in conjunction with the technical data and information presented in Volume II.

1.1 Site Description and History

Figure I-2 is a site plan showing the property with the structures and infrastructure that are currently extant on the site. Plate 1 is an aerial photograph of the subject property and nearby properties taken on April 19, 2003 and photo-enlarged to scale of 1:100.

1.1.1 Site North

As is shown on Figures I-1 and I-2, true north at the Oak Walk Site is slightly to the west of the center line of Adeline Street, which runs along the eastern side of the city block on which the Oak Walk property is located. However, to simplify discussion, in this report we have established a “Site North” that parallels the alignment of San Pablo Avenue, which runs along the western side of the property. Unless otherwise stated, or in cases where true north is shown on drawings, all compass directions referenced in this document should be interpreted in the context of that directional construct.

1.1.2 20th Century History

By the early years of the 20th Century, the Oak Walk Redevelopment Site was fully occupied by residential structures, with some minor commercial buildings that included a restaurant fronting onto San Pablo Avenue. The residential structures were single-family homes on large lots with stables and other auxiliary buildings.

By 1911, the residential sites that were formerly adjacent to the Atchison, Topeka and Santa Fe (**AT&SF**) Railroad line that, at that time, followed a route that approximately coincided with what is today the alignment of 40th Street, had become areas of open land along the southern frontage of the subject Property. The residences in the central and northern portions of the site remain in place. However, in the 1950s, those areas of open land in the southern and western portions of the Property became occupied by commercial buildings. These included a wholesale plumbing supply warehouse, which, over the years, was successively converted to use as an upholstery business and a bakery owned by the San Francisco French Bread Company (**SFFBC**). The SFFBC installed two underground fuel storage tanks: a 10,000-gallon gasoline tank and a 10,000-gallon diesel tank in order to fuel their delivery vehicles. The former locations of those tanks are shown on Figure I-2.

By the 1980s, many of the industrial facilities in western Emeryville had begun to decay and became increasingly idle. In the 1990s, the City of Emeryville through its redevelopment agency, the Emeryville Redevelopment Agency (**ERDA)**, began an ambitious undertaking to clean up and redevelop former industrial areas of the City and other tracts where commercial and residential properties had become rundown. Included in that redevelopment program was construction of a major new thoroughfare formed by extending 40th Street from its previous termination at Adeline Street westward to the frontage of Interstate 80, which passes along the eastern shore of San Francisco Bay, some 0.85 miles to the west of the Oak Walk Site. The highway construction included the extension of 40th Street from Adeline Street to San Pablo Avenue, for which purpose the City of Emeryville procured the land along the alignment of that extension.

Construction of the extension of 40th Street took land that was previously occupied by the Celis Service Station (**Celis**) that had occupied an area that is today beneath 40th Street at its intersection with San Pablo Avenue. It also took a portion of the land previously occupied by the SFFBC. Subsequent to that highway construction, the commercial building at 4070 San Pablo Avenue and its surrounding yard were purchased by the Oaks Club, which uses the building as a carpentry and maintenance shop and has converted the frontage land into a private parking lot. A small area of the Oak Walk Redevelopment Site, located at the corner of Adeline and 40th Streets, is owned by ERDA. Since the time that the extension of 40th Street was constructed, it has been used as the site of an Alameda County Transit (**AC Transit**) restroom facility. These extant features of the Oak Walk Redevelopment Site are also shown on Figure I-2.

Until it was vacated in early 2005, the commercial building at 4086 San Pablo Avenue was, historically, the site of an upholstery business and, later, a specialty hydraulic hose fitting shop that neither dispensed nor used hydraulic oil or similar liquid material. The latter business also occupied the ground floor of the adjacent building at 4090 San Pablo Avenue, which, as previously noted, had historically been a restaurant. The upper floor of the latter building had occasionally been used by the Oaks Club for staff training, but is now vacant.

The other structures on the Oak Walk Site are either single or multi-family residential buildings that, with their garages and outbuildings, were originally constructed, as was noted earlier, during the early years of the 20th Century. None of those structures are compliant with modern building codes and are generally in a very dilapidated condition. They are all currently vacant.

1.2 Proposed Redevelopment

Bay Rock is proposing to redevelop the Oak Walk Site for mixed residential and commercial use. Figure I-3 is an architect’s drawing showing a plan view of the proposed development.

The commercial buildings at 4070, 4086 and 4090 San Pablo Avenue will be demolished, as will the AC Transit restroom facility that is currently located in the southeast corner of the site at the intersection of 40th and Adeline Streets. The existing residences at 1081, 1085, 1087 and 1089 1/2 on 41st Street will also be demolished. The existing residences at 1083 and 1089B will be demolished, but their facades with their trim and other architectural features will be persevered and incorporated into new residential structures that will be located along the 41st street frontage of the site. The residences at 1077 1/2, 1079 and 1089 on 41st Street will be temporarily moved to the southern area of the site to permit geotechnical and environmental corrective action work to be completed. They will then be returned to the location shown on figure I.3 along the 41st street frontage of the site where they will be set on new foundations and completely rehabilitated to comply with current building codes. The three-story residence currently located at 1077 41st Street will be moved to the location shown on Figure I-3 at the intersection of Adeline and 40th Streets, where it will be rehabilitated as a three-story condominium building with a garage on the ground floor.

The new development will include three new structures that are designated Buildings 1, 2, and 3 on Figure I-3. Building 3 will be a four-story residential building, which will be comprised of a total of 45 one-, two- and three-bedroom condominium and townhome units with a 62 car garage that will occupy a portion of the ground-floor. This garage will be accessible from 40th Street as shown on figure I.3. Building 1 will be constructed at the intersection of 40th Street and San Pablo Avenue. Its ground floor will be a large retail space that is anticipated to be occupied by a restaurant. Above that space will be one floor that will incorporate one one-bedroom and one two-bedroom condominium residences. Building 2, which will have 3 stories, will be located at the northwestern corner of the site at the intersection of 41st Street and San Pablo Avenue. The ground floor of that structure will include a retail space, two two-bedroom town homes and one three-bedroom town home. The upper floors of that building will incorporate two one-bedroom condominiums and two two-bedroom condominiums. A new restroom facility for AC Transit will be constructed on the 40th Street frontage of the redeveloped site to the east of Building 3, at the location shown on Figure I-3.

2.0. SITE SETTING

As noted previously, the Oak Walk Site occupies a major part of the city block that is bounded by 41st Street, Adeline Street, 40th Street and San Pablo Avenue. It has a total area of some 79,360 sq. ft. (1.8 acres).

2.1 Topography

As it currently exists, the site has a mean elevation close to 45.5 ft. above the National Vertical Datum (**NVD**). At the scale of the property as a whole, it has a downward slope from east to west (*i.e.*, from Adeline Street to San Pablo Avenue). Along the subject property's southern frontage, 40th Street slopes down toward San Pablo Avenue at a gradient of 1.35%, while along the northern frontage on 41st Street the corresponding slope is only 0.78%. Except for that general slope of the land, the site has no significant relief. Although there are minor changes of elevation (typically less than one foot), these occur where one parcel of land into which the site is currently divided adjoins another.

The whole of the Oak Walk Site is surrounded by public streets except along its eastern boundary, beyond most of which are residential sites that front onto 41st Street and Adeline Street (see Figure I-4).

2.2 Regional Geology

The subject property is situated on the eastern side of San Francisco Bay in the California Coast Ranges section of the Pacific Border physiographic province.

As is typical of sites in the neighborhood, the subject property is underlain by fill that varies in thickness from approximately 3 to 10 feet. Beneath the fill are strata of alluvial fan deposits of the Quaternary-age Temescal Formation that is comprised of inter-fingering lenses of clayey gravel, sandy silty clay and sand-clay-silt mixtures (Radbruch 1957). At the site, this formation is some 20 ft. to 30 ft. thick and lies unconformably over earlier Quaternary continental and marine sands, clays and gravels of the Alameda Formation, the maximum thickness of which has not been fully explored in the region around the subject property, but is known to exceed 1,050 ft.

2.3 Regional Hydrology

Temescal Creek flows in underground culverts along a generally east to west course approximately 0.5 miles to the north of the subject property and discharges into San Francisco Bay, the shore of which is today some 0.85 miles to the west of the site. Prior to circa 1880, after which it was filled to become the site of a housing tract, there was a 30-acre tidal flat that formed an embayment in the shoreline of the Bay at a distance of some 0.6 miles southwest of the Oak Walk Site.

Temescal Creek and the tidal flats of San Francisco Bay dominated the regional hydrology of the area prior to its urbanization in the late 19th Century. However, there were no known streams that existed during the historical period in the vicinity of the Oak Walk Site closer than Temescal Creek. Today, substantially all precipitation running from roofs and paved areas on the site flows to storm water drains that are part of the City of Emeryville's storm water management system. That system drains to San Francisco Bay.

2.4 Regional Hydrogeology

The depth to the groundwater table in the area of the subject property reflects long term weather cycles as well as seasonal variations in local precipitation in the San Francisco Bay Area. Depending upon those factors, the piezometric level of the regional groundwater may be at elevations that vary between approximately 4 and 12 ft. below the ground surface (**BGS**) (The San Joaquin Company Inc. 2005).

In May, 2004, the depth to groundwater measured in wells installed at the Oak Walk Site varied from approximately 4.5 to 10 feet below the existing ground surface. By November of 2004, the water table beneath the site had, on average, risen about 0.4 ft from its May 2004 elevation.

Regionally, the general direction of groundwater flow is west toward San Francisco Bay. However, at any given location the direction of groundwater flow can be substantially different because it is influenced by the local presence of high-permeability facies in the subsurface that were deposited by paleo streambeds and other geomorphologic processes typical of those that influence the depositional environment of alluvial fans.

2.5 Sources of Contamination Affecting the Oak Walk Site

The program of environmental site characterization that has been completed at the Oak Walk Site has shown that soil and groundwater beneath the property is affected by both fuel hydrocarbons and paint thinners (solvents) (The San Joaquin Company Inc. 2005). Those materials were released into the subsurface at three separate locations. Two of the sources, one where paint solvents were released and one where fuel hydrocarbons were released, are located off the Oak Walk Site, while the third, at which a release of fuel hydrocarbons occurred, is today partially outside and partially inside the site boundary. Each of those sources is discussed below.

2.5.1 The Former Dunne and Boysen Paint Sites

These sites are in close proximity to each other and are situated to the east of the Oak Walk Site beyond the adjacent Ennis property and Adeline Street. Their locations are shown on Figure I-4. Paint was manufactured and paint solvents were stored in underground tanks at both of these facilities. In the case of the former Boysen Paint Site, contamination is also known to have been released from a sump on that property. Both are cited in regulatory records as sources of releases of regulated materials to the subsurface. With the currently available information it is not possible to know precisely whether the solvents released at Boysen Paint commingled with solvents released at the

Dunne Paint Site and are a contributor to the plume of paint solvents found to be affecting the subsurface beneath the Oak Walk Site. Therefore, for the purposes of this report, those two release sites will be treated as if they are a single source.

Petroleum hydrocarbons in the gasoline and middle distillate ranges, including compounds in the diesel and mineral spirits range, which can be ascribed to releases of solvents at the Dunne Paint Site and possibly at the Boysen Paint Site, have been detected over essentially the whole area of the Oak Walk Site. There is also clear evidence that those materials are present at high concentrations in soil and groundwater under the Ennis property, which is adjacent to the Oak Walk Site and lies between it and the former paint manufacturing sites.

The ACEHCS has assigned the case number RO72/RO73 to the Dunne Paint Site and the case number RO79 to the Boysen Paint/Oakland One Site.

2.5.2 The Former Celis Alliance Automobile Service Station

The location of the former Celis service station, which is today beneath the 40th Street right-of-way and adjacent to the Oak Walk Site, is also shown on Figure I-4. Large quantities of fuel hydrocarbons were released from underground storage tanks on that site. The releases contaminated soil and groundwater over a wide area that is, today, occupied by the 40th Street right-of-way, a portion of the Andante condominium housing site south of the former Celis Site, and a significant portion of the Oak Walk Site to the north. After the City of Emeryville Redevelopment Agency acquired the Celis Site by eminent domain for the purpose of extending 40th Street west from Adeline Street, a portion of the area of the subsurface affected by the release at that site was remediated by removal of contaminated soil down to, but not deeper than, some 9 ft. BGS and by a limited program of groundwater pumping. Some limited areas beneath the 40th Street right-of way to the east of, and up the hydrogeologic gradient from, the tanks were also partially remediated by excavation and off-site disposal of contaminated soil.

The Celis Site is recorded in California regulatory databases with the identifiers shown below:

> The California State Water Resources Control Board (**SWRCB**) has established the following Global ID for the Celis Site: T0600101794
>
> The California Regional Water Quality Control Board - San Francisco Bay Region (**RWQCB**) has been assigned the following case number to the Celis Site: 01-1938
>
> The ACEHCS Local Oversight Program (**LOP**), which is the lead agency for the site, has assigned the following case number to the Celis Site: RO453/RO567

Releases of fuel hydrocarbons and, to limited extent, motor oil from the Celis Site commingled beneath the Oak Walk Site with the paint solvents released at the Boysen and Dunne Paint Sites to the east.

2.5.3 The Former San Francisco French Bread Site

As was described in Section 1.1.2, the San Francisco French Bread Company (**SFFBC**) formerly occupied a part of the Oak Walk Site that fronts onto 40th Street. The company used the building that remains extant on the site at the address 4070 San Pablo Avenue. SFFBC installed two ten thousand-gallon underground storage tanks at what was then their facility. One tank stored diesel and the other stored gasoline for use in the bread company's fleet of distribution vehicles. The former locations of the tanks are shown on Figures I-2 and I-4.

When the extension of 40th Street between Adeline Street and San Pablo Avenue was constructed by the City of Emeryville, soil was remediated by excavation to a depth of 10 ft. over an approximately 20 ft. by 18 ft. rectangular area at a location coincident with the southern half of the former SFFBC tank pit. However, no further remediation of the SFFBC tank site was performed at that time.

The SFFBC is recorded in California databases with the identifications shown below.

> The SWRCB has established the following Global ID for the SFFBC Site: T0600101186
>
> The RWQCB has been assigned the following case number to the SFFBC Site: 01-1289
>
> The ACEHCS LOP, which is the lead agency for the site, has assigned the following case number to the SFFBC Site: RO171

2.5.4 Oak Walk Site

With the exception of the small area of the former SFFBC property that is included in the Oak Walk Site, there are no known sources of contamination on the subject property. However, in order to provide oversight of the site characterization and remediation of the Oak Walk Site, the ACEHCS has assigned the following case number to the Oak Walk Site: RO2733.

3.0 RESULTS OF SITE CHARACTERIZATION PROGRAM

SJC completed an extensive, multi-phased environmental and geotechnical engineering site characterization program for the Oak Walk Redevelopment Site. The results were previously reported to the ACEHCS (The San Joaquin Company 2005, 2004a,b,c). Additional geotechnical and geochemical information was available from borings drilled by Clayton Group Services (**Clayton**) as part of its investigation of releases of petroleum hydrocarbons that occurred at the previously-described Frank Dunne Paint site (Clayton Group Services 2004). The scope of SJC's site characterization work included excavation of eight exploratory trenches, drilling of two cone penetrometer test holes and a total of 30 exploratory borings, in 21 of which groundwater-quality monitoring wells were constructed (see Figure I-5 for locations).

> **Note**: In addition to the wells installed by SJC, with the permission of the City of Emeryville, a well, designated WCEW-1 that had been installed by Woodward Clyde Consultants (**Woodward-Clyde**) near the corner of San Pablo Avenue and 40th Street (Woodward-Clyde Consultants 1995), was included in the array of wells used to evaluate groundwater quality at the Oak Walk Site.

SJC recovered soil samples from its 30 borings and analyzed them for chemicals of concern; the results of those analyses are presented in Tables I-2 and I-3. Groundwater samples were recovered from the monitoring wells and those were also analyzed for chemicals of concern. The results are compiled in Table I-4. Groundwater contours (see Figure I-6) were constructed from the measurements of depths to groundwater that are recorded in Table I-1. Available geochemical data from wells and borings installed by Clayton are included in Tables I-5 and I-6. Logs of all the trenches, borings and wells drilled for the Oak Walk Site are compiled in Appendix I-A, together with logs of the wells and borings constructed by Clayton that are referenced in this report.

SJC's principal findings derived from the site characterization work are summarized below.

3.1 Site Hydrogeology

As has been described in Section 2.4, the regional direction of groundwater flow at the site is essentially from east to west but, locally, it is greatly influenced by zones and channels of permeable sands and gravels that are present in the subsurface. Areas where channels and zones of high-permeability soils are present extend from east to west across the length of the site. However, such permeable facies are relatively less pronounced along the southern boundary of the site at 40th Street, and, in close proximity to the northern boundary of the site along 41st Street, they are essentially absent.

3.1.1 Groundwater Contours

The presence or absence of permeable facies in the subsurface beneath the Oak Walk Site is reflected in the groundwater contours shown on Figure I-6. The geometry of the piezometric contours is strongly indicative of areas that have zones and channels of relatively permeable soils in a matrix of lower-permeability soils and shows how those zones are flanked to the north and south by strata that are dominated by low-permeability clays and silty clays.

Examination of Figure I-6 shows that, at the scale of the site, the direction of groundwater flow beneath the Oak Walk property on November 8, 2004 was to the west at an average gradient of 0.0094 ft/ft. However, locally, due to the influence of channels of high permeability sands and gravels in the subsurface, which is otherwise dominantly composed of clayey facies, the direction of groundwater flow may be to the northwest, southwest, or in intermediate compass directions at gradients as great as 0.02 ft/ft.

To develop a more detailed understanding of the geology and hydrogeology of the Oak Walk Site, hydrostratigraphic sections and isocore maps of permeable facies were prepared.

<u>3.1.2 Hydrostratigraphic Sections</u>

Information from the logs of the trenches, borings and wells drilled on the site was synthesized to develop hydrostratigraphic sections along the lines A-A’, B-B’, C-C’, D-D’, E-E’, F-F’, G-G’ and H-H’ that are located as shown on Figure I-5. The sections are shown on Figures I-7 through I-14.

The cross sections that are oriented from south to north across the site (*i.e.*, Sections D-D’ through H-H’) extend from 40th Street in the south to 41st Street in the north. The cross sections that are oriented from west to east across the site (*i.e.*, sections A-A’ through C-C’) extend beyond the eastern boundary of the subject property, cross the adjoining Ennis property, and end on Adeline Street to the east. This arrangement permitted the hydrogeologic sections to include information from borings and wells drilled on the Ennis Property and in Adeline, 40th and 41st Streets by Clayton as part of its characterization of the plume of contamination emanating from the former Dunne Paint Site (see Figure I- 4 for location).

The cross sections show the fill material that covers the site and the underlying alluvial sediments, which are divided into four classes: the very low-permeability clays and silty clays; the slightly more permeable sandy clay and clays with some silt, sand or gravel (*i.e.,* soils that are dominantly clayey, but which have small lenses and inclusions of coarser facies); permeable silts, clayey gravels and sands; and highly permeable gravels that are free of silty or clayey fractions. That presentation makes it possible to reduce the details of the stratigraphy to a tractable degree of complexity by distinguishing between the different soil types based on the properties that are of importance to the understanding of the distribution and transport of chemicals of concern in the subsurface. It is not intended to represent the detailed geologic stratigraphy of the complex of inter-bedded and lenticular strata and paleo streambed deposits that are present in the alluvial fan on which the Oak Walk Site is located.

Also shown on the cross sections are the locations from which soil samples were recovered from the borings and monitoring wells that were located on, or close to, the section lines. The concentrations of TPHg, TPH (middle-distillates) and the critical analyte, benzene, that were detected in those samples are noted adjacent to the sampling locations.

The hydrostratigraphic cross sections reveal that beneath the central area of the Oak Walk Site there is a broad band of the subsurface that is hydrogeologically dominated by strata and in-filled channels composed of relatively high-permeability facies. That band of permeable facies runs from San Pablo Avenue to the eastern boundary of the site where it adjoins the Ennis property and appears to continue eastward from there to at least the eastern side of Adeline Street. The permeable strata are well represented on hydrostratigraphic section B-B' (See Figure I-8), which is aligned from west to east though the proximate center of the Oak Walk Site. Sections D-D', E-E', F-F' and G-G' on Figures I-10 through I-13, which are orthogonal to Section B-B', reveal that in several zones of the subsurface in the central area of the site the most permeable soils were deposited in relatively narrow channels.

One of the channels crossing the site from west to east is particularly prominent. It is present in Section D-D' (Figure I-10) in the area between Monitoring Well MW-6 and Boring BE-5, to the north and south of Monitoring Well MWT-6 in Section E-E' (Figure I-11), and on either side of Monitoring Well MWT-7 in Section F-F' (Figure I-12). The highly-permeable gravels and the deeper silts and sands that were intersected by Monitoring Well MWT-14 (see Section G-G' on Figure I-13) typify the materials in that channel.

3.1.3 Net Permeable Facies

To further elucidate the distribution of high-permeability channels in the subsurface beneath the Oak Walk Site, the net permeable facies diagram shown on Figure I-15 was constructed. Diagrams of that type, which are often colloquially referred to as "Net Sand Diagrams" by practitioners of petroleum exploration geology, express, in the form of isocores (*i.e,* lines joining points of equal net thickness of a stratigraphic unit or units of a given classification within a specified interval), the areal distribution of the net thickness of permeable soil facies within an interval. Facies that are defined as "permeable" are selected according to the phenomenon being studied. In this case, it is the migration of groundwater contaminated by petroleum hydrocarbon compounds of less specific gravity than water.

The selection of the interval over which the net permeable facies in each boring in the array is computed is based partially on data from a given interval that is available from the logs of all of the borings in the array and partially on the characteristics of the hydrostratigraphy and the engineering issues being studied. In the case of the Oak Walk Site, where groundwater is affected by petroleum hydrocarbons that are lighter than water, the 15-ft. interval between 5 ft. BGS and 20 ft. BGS was selected.

It is recognized that at sites at which the hydrostratigraphy is complex, construction of a net permeable facies diagram, by necessity, requires application of professional judgment by the engineer who prepares it. When constructing isocores, that individual must consider available geochemical data and hydrogeologic interpretations developed from hydrostratigraphic cross sections in an integrated manner, as well as the simple "net permeable facies" percentages computed by direct examination of the boring logs. However, given those limitations, Figure I-15, on which areas where the net permeable facies in the subsurface exceed 50% in the selected interval are highlighted, provides a good visual image of the areal distribution of permeable zones and channels beneath the site through which contaminants of concern have preferentially migrated across the Oak Walk Site following their release at the paint factory sites to the east of Adeline Street, at the Celis Site beneath 40th Street, and at the former SFFBC site.

The channelization of permeable facies through the center of the Oak Walk Site is prominently reflected in the geometry of the groundwater contours shown on Figure I-6, which was drawn before the hydrostratigraphic sections were developed and was constructed independently using groundwater elevation data alone.

The geometry of groundwater contours also reflects other permeable zones and channels in the interior of the Oak Walk Site that can be well-correlated with the distribution of those features as they are seen in the cross sections. Compared to the hydrogeology of the interior areas of the site, there are relatively few high-permeability zones in the subsurface along the southern and northern boundaries of the site. As can be seen in Sections A-A' and C-C', none of those that are present in those sections exhibit the west to east connectivity that is characteristic of the high-permeability sediments present in the interior of the site.

The relatively permeable soils beneath the center of the Oak Walk Site are not confined to that property alone. They extend westward beneath San Pablo Avenue and eastward beneath the adjoining Ennis property. Although data from boring and monitoring wells in that area is relatively sparse, it is evident that they continue further to the east and are continuous with those of the same complex of sandy and gravelly deposits that have, as is shown on Figure I-4, been found beneath the former Dunne Paint Site at 4050 Adeline Street.

The hydrogeological interpretation described above indicates that the principal route of relatively rapid groundwater flow beneath the Oak Walk Site is in a broad band that is aligned east to west through the central area of the site. However, there is also evidence that there is a second narrow, but very pronounced, channel of paleo streambed deposits present beneath the eastern portion of the Ennis property that crosses the Oak Walk Site in a northeast to southwest direction and continues beneath 40th Street. That paleo channel is shown on Figure I-4. It was originally discovered in 2003 when SJC was remediating the Andante Site to the south of 40th Street (The San Joaquin Company 2003) and it was confirmed to cross 40th Street when its sandy and gravely deposits were again encountered in exploratory Trench 3 (See Figure I-5 for location) during early stages of the site characterization work at the Oak Walk Site (The San Joaquin Company

2004c). Following its discovery on the Andante Site, the streambed deposits were excavated from the channel and a clay plug was installed across the channel where it crossed into the Andante Site at the 40th Street boundary.

The hydrogeologic features described above, including the paleo streambed deposits, are features compatible with the published geology of the region, which is covered by an alluvial fan that includes bands of stream and levee deposits in the neighborhood of the Oak Walk Site (California Regional Water Quality Control Board - San Francisco Bay Region 1999).

3.1.4 Hydraulic Conductivity of Soil

To support the interpretation developed from the hydrostratigraphy of the site that groundwater flow across the property is dominated by the presence of the permeable channels of sandy material revealed in the cross sections described above, SJC recovered samples of silty clay recovered from boring BG-2 (see Figure I-5 for location) at a depth of 6.5 ft. and a second sample of similar material from a depth of 6 ft. in Monitoring Well MW-7. Constant-head permeability tests conducted on those samples found that the soils had hydraulic conductivities of 2.51×10^{-9} cm/sec and 2.95×10^{-8} cm/sec, respectively (The San Joaquin Company Inc. 2005).

Those test results confirm the extremely low permeability of the silty clays beneath the site and confirm SJC's hydrogeological interpretation that the pattern of migration of contaminants in groundwater moving through the subsurface of the site is controlled by the distribution of silts, sands and gravels that were deposited on the site in large lenses, paleo streambed channels and alluvial outwash areas during the Recent geological era.

3.2 Chemicals of Concern in Soil and Groundwater

As can be concluded by an examination of Tables I-2 through I-6 and Figure I-5, soil and groundwater over essentially the whole of the Oak Walk Site is affected by hydrocarbons that are typical of components of a mixture of distilled petroleum products that comprise automotive fuels and industrial solvents. As was discussed in Section 2.5 above, those materials were released at two off-site locations and at a third location that is partially within the site perimeter and partially outside the property boundary. In some areas of the site, the industrial solvents migrating from the former paint manufacturing sites to the east of Adeline Street have co-mingled with the petroleum hydrocarbons that were released from the former Celis service station located just beyond the southwestern boundary of the Oak Walk Site and, to a limited degree, with the fuels released from the SFFBC tanks that were formerly located beneath what is today the boundary line that separates the north side of 40th Street from the Oak Walk Site (see Figure I-4 for locations).

As was detailed in the Oak Walk Site Characterization Report (The San Joaquin Company Inc. 2005), to achieve a tractable understanding of the distribution of contaminants in soil and groundwater beneath the site that resulted from the co-mingling of the petroleum hydrocarbons that originated at those sources, SJC distinguished between petroleum hydrocarbons in the middle-distillate range, which includes diesel fuel and mineral spirits solvent, and petroleum hydrocarbons in the gasoline range. Figures I-16 and I-17 show plots of isocons of concentrations of gasoline-range and middle distillate-range petroleum hydrocarbons, respectively, in groundwater beneath the Oak Walk Site. In addition, Figure I-18 is a plot of isocons of benzene which, due to its carcinogenic properties, is of greatest concern in the context of the environmental condition of the site.

The isocon plots do indicate the areas of the site where the highest concentrations of gasoline- and middle distillate-range petroleum hydrocarbons and benzene are present in groundwater, but due to the extreme spatial variability of the concentrations over small distances, particularly in the case of benzene, the isocons do not effectively reflect the complex distribution of those materials over the Oak Walk Site. However, when the distributions of relative ranges of contaminants in both soil and groundwater are considered in the manner shown on Figure I-19 for gasoline-range hydrocarbons, Figure I-20 for middle distillate-range hydrocarbons, and Figure I-21 for benzene, the relationships between the locations of the sources from which the contaminants were released and the hydrostratigraphy of the site are more clearly illustrated.

Figures I-19 and I-20 show that the subsurface beneath essentially the entire area of the Oak Walk Site is affected by petroleum hydrocarbons. However, Figure I-21 shows that the presence of benzene is limited. Figure I-21 shows that benzene is present in the subsurface in a limited area in the southwestern portion of the site, where soil and groundwater are affected by gasoline released from the former Celis service station. Figure I-22 shows the area of the site that is affected by methyl-tertiary-butyl ether (**MTBE**) in the subsurface soils and groundwater. That figure provides a useful means to distinguish the portions of the site that were affected by the release of gasoline from the Celis Site.

3.2.1 Concentration of Analytes in Excess of the ESLs

To provide a standard process for determining whether analytes of concern detected at a contaminated site will require additional evaluation, the RWQCB and the California Environmental Protection Agency (**Cal/EPA**) have established Environmental Screening Levels (**ESLs**) for many chemicals and for mixtures of chemicals such as gasoline and diesel (California Regional Water Quality Control Board - San Francisco Bay Region 2005, California Environmental Protection Agency January 2005). An assessment designed to determine whether or not chemicals of concern in the subsurface exceed the ESL values is often described as a Tier I Assessment (American Society for Testing and Materials 2002). The concentrations of analytes of concern in soil and groundwater at an affected site are compared to the ESLs, with consideration of the future use of the site. If the concentrations are lower than the applicable ESLs, no further work need be completed before the site is released for the intended use. However, if exceedance occurs, it does not necessarily require active remediation of soil and groundwater, installation of engineered barriers, or enforcement of administrative controls at an affected site. The condition simply means that a formal risk assessment must be made before it can be determined whether or not corrective action measures must be undertaken.

As is discussed below, there are several areas where the applicable ESLs for chemicals of concern in soil or groundwater are exceeded at the Oak Walk Site.

3.2.1.1 Applicable ESLs

Different ESLs have been established for sites where the planned future use of the property is residential compared to commercial or industrial, for sites where soil is affected at shallow depth as opposed to at greater depth, and for sites where groundwater is a source of drinking water as opposed to sites where it is not (California Regional Water Quality Control Board - San Francisco Bay Region 2005).

The RWQCB has found that shallow groundwater in the region of the Oak Walk Site is not a source of drinking water (California Regional Water Quality Control Board - San Francisco Bay Region 1999). In the case of the Oak Walk Site, the planned redevelopment will include both residential and commercial structures. Risk evaluations that distinguish between the areas of the site that will be the locations of commercial as opposed to residential buildings can be made during the development of a corrective action plan, but given the proposed mixed use of the Oak Walk Site, SJC has elected, conservatively, to use only the applicable ESLs that relate to residential use of an affected site. Due to the presence of contaminants in shallow soils on the subject property, the applicable ESLs are those for sites where chemicals of concern affect shallow soils at less than three meters (9 ft.) BGS and the groundwater is not a source of drinking water. To simplify the assessment and to provide for a conservative evaluation, that criterion has been applied even in areas of the site where chemicals of concern are not present at depths shallower than three meters. The applicable ESLs for the analytes of concern at the Oak Walk Site that have been selected based on those considerations are compiled in Table I-7.

The results of analyses of soil and groundwater that indicated the presence of contaminants of concern at concentrations in excess of the applicable ESLs are shown in **bold** in Tables I-2 through I-6. On Figures I-19 through I-22, areas of the site where soil and groundwater are affected by analytes of concern at concentrations in excess of the applicable ESLs are distinguished from areas where the concentrations are lower than the ESLs by the intensity of shading.

3.2.2 Distribution of Middle Distillate-range Petroleum Hydrocarbons

As can be seen on Figure I-17, the areas where the concentrations of middle distillate-range petroleum hydrocarbons are present in soil or groundwater at concentrations in excess of the applicable ESLs are distributed in a wide band that runs from the San Pablo Avenue frontage of the Oak Walk Site eastward to the boundary of the site where it adjoins the Ennis property. That band connects with a similar band that extends northward from the 40th Street frontage of the Oak Walk Site through to the approximate center of the property. That distribution correlates well with the distribution of high-permeability soils, which is shown on the net permeable facies diagram that is presented on Figure I-15.

The highest concentrations of middle distillate-range hydrocarbons were detected in a groundwater sample recovered from Monitoring Well MW-11 that contained mineral spirits at a concentration of 3,500 μg/L. In that same area of the site, where sand-filled channels are present in the subsurface, concentrations of mineral spirits in groundwater in Monitoring Wells MWT-7 and MWT-14 were also elevated at 3,200 μg/L and 1,200 μg/L, respectively. Relatively high concentrations of middle distillate-range hydrocarbons are also present along the southwestern boundary of the site where 3,200 μg/L of mineral sprits were detected in a sample recovered from Monitoring Well MWT-2 and 2,100 μg/L of the same material was detected in groundwater in Monitoring Well MW-2.

3.2.3 Distribution of Gasoline-range Petroleum Hydrocarbons

As is shown on Figure I-18, in the case of gasoline-range petroleum hydrocarbons the concentrations of those analytes in the subsurface exceed the ESL over an area that almost completely covers the site. This is reflective of the commingling of gasoline fuel released at the Celis and SFFBC Sites with the high concentrations of gasoline-range compounds in the paint solvents that migrated down the groundwater gradient from the Dunne and/or Boysen Paint Sites to the east of Adeline Street.

The concentration of gasoline-range hydrocarbons in Monitoring Well MWT-7, at 56,000 μg/L, is the highest detected anywhere on the Oak Walk Site, but it is notable that no BTEX compounds, with the exception of a trace of benzene, were detected in the sample of groundwater recovered from that well. That condition indicates that the source of the gasoline-range hydrocarbons in that area of the site was the release of solvents that appeared at the paint manufacturing facilities to the east of Adeline Street rather than the fuel hydrocarbons that were released along 40th Street. However, high concentrations of gasoline-range hydrocarbons that do include BTEX compounds were detected in Monitoring Wells MW-2, MWT-2 and WCEW-1, at 49,000 μg/L, 28,000 μg/L and 3,700 μg/L, respectively. Those data indicate that groundwater contamination in that area of the site originated, at least in part, from the fuel hydrocarbon releases at the former Celis service station and, to a more limited extent, at the former SFFBC tank site.

3.2.3.1 Distribution of BTEX Compounds

As is shown on Figure I-21, concentrations of benzene in soil or groundwater beneath the site that exceed the applicable ESL are confined to a limited area along the 40th Street frontage of the site. That area extends no more than 55 ft. northward from the Oak Walk Site's frontage with that thoroughfare, but it extends eastward some 210 ft. from San Pablo Avenue. Within that area, the highest concentration of benzene in groundwater was detected in the sample recovered from Monitoring Well MW-2 at a concentration of 7,900 μg/L.

As can be seen by examination of Tables I-2 and I-4, in addition to benzene, each of the three other compounds in the BTEX group (*i.e.*, toluene, ethyl benzene and xylene isomers) is also present in soil and/or groundwater at some locations beneath the site at concentrations that exceed their ESLs. However, such instances are few, and where they occur, they are generally coincident with the presence of benzene in the subsurface media.

3.2.3.2 Distribution of MTBE

As can be seen by examination of Figure I-22 and Tables I-2 and I-4, the concentrations of the gasoline additive MTBE in soil or groundwater beneath the property nowhere exceed its ESL in soil or groundwater.

3.2.4 Distribution of Polynuclear Aromatic Compounds and Other Analytes

Tables I-2 and I-4 also show that there are a few instances where the polynuclear aromatic compounds (**PNA**s), naphthalene and 2-methyl-naphthalene, are present in soil and groundwater beneath the Oak Walk Site. Those PNAs may be components of diesel fuel or of industrial solvents. At the Oak Walk Site, they are at their highest concentrations in groundwater in samples recovered from monitoring wells MW-2 and MWT-2 (see Figure I-5 for locations), which suggests that they are principally associated with diesel released from the former Celis service station site. Some very low concentrations of PNAs were detected in some soil samples from more widely-dispersed locations, but the preponderance of those additional detections was also in areas that are believed to have been affected by fuel hydrocarbons.

4.0 TIER 2 RISK-BASED HEALTH ASSESSMENT

As has been discussed above in Section 3.2, soil and groundwater in some areas of the Oak Walk Redevelopment Site are affected by analytes of concern at concentrations that exceed the applicable ESLs. Under those circumstances, it is necessary to perform a Tier 2 risk-based human health assessment to determine whether any corrective actions are required to permit the site's future use as a mixed commercial and residential development.

In cases where a risk-based human health assessment indicates the need for active correction action measures to be taken at a site, the results of the assessment can also be used as an aid to the design of the elements of the corrective action program.

SJC has completed risk-based human health assessments in compliance with the applicable sections of ASTM Standards E2081-00 and E1739-95/2002 (American Society for Testing and Materials 2000a, 2002) for the Oak Walk Site in its un-remediated condition. In addition, risk assessments were made for other scenarios in which a staged series of corrective actions were modeled. The risk-assessment procedures employed and the geotechnical, geochemical and toxicological parameters selected for the analyses, together with the results of the risk assessment, are presented in detail in Volume II of this work plan. As previously stated, it is intended that Volume I and Volume II be read as a single document. However, for convenience of presentation, the principal elements of the risk assessment procedure and the results of the analyses are summarized below.

4.1 Exposure Pathways

Potentially, both the groundwater and affected soil beneath the Oak Walk Site could release chemicals of concern (**COC**s) by volatilization. The volatized materials could migrate through the underlying soil and be released into outdoor air where they would be dispersed, or into enclosed space within buildings where they might accumulate. If concentrations of COCs in the affected air were excessive, they might adversely affect human receptors occupying the site. The exposure pathways by which receptors might be affected by the COCs are shown diagrammatically on Figure I-23.

Flow paths other than volatilization of COCs into outdoor and indoor air via which human receptors might be affected are absent at the Oak Walk Site. Volatilization to air from affected surficial soils does not occur because none of the surficial soil on the site is affected by COCs. There are no potential points of down-gradient human exposure to affected groundwater that can be attributed to a source of contamination on the Oak Walk property itself and there are no nearby locations where migration of the affected groundwater might produce contaminated discharge to surface waters.

4.2 Receptors

The health risk assessment must consider two types of human receptors that might be affected by COCs in the subsurface beneath the Oak Walk Redevelopment Site. They can be classified according to their potential exposures to COCs on the property: 1) the occupants of the residential units being constructed on the property and 2) persons who will work in the commercial spaces that are included on the ground floors of some of the buildings on the property. In the case of the residents, this class of human receptor can be further subdivided by age into adults, youths and young children. SJC's analytical procedures used for the health risk analyses permitted each of those classes and sub-classes of receptors to be considered.

> **Note:** There is an additional pathway via which construction workers involved in excavation beneath the ground surface during construction of the project might be affected by COCs. However, such exposures will be of very short duration and the types of and concentrations of COCs in the soil are such that workers will not require any clothing or protective equipment beyond that defined by the Level D category (*i.e.*, there will be no need for personal protective equipment (**PPE**) in excess of that required for construction work in any environment).

Because of the total duration of time to which they are exposed to potential health risks associated with an affected site, the risks to residents are usually computed separately from risks to the occupants of commercial buildings whose total exposure to the environmental conditions on the property is more limited. With respect to potential exposure to vapors of concern in indoor air, such distinction is applicable to the Oak Walk Site to the extent that the ground floors of some of the buildings that will be located on the property will be used as commercial space, while ground floors of the majority of the buildings will incorporate residences. However, due to the mixed use of the property, when evaluating health risks due to potential exposures to affected outdoor air, SJC's conceptual models assumed that, regardless of a specific building's use, persons exposed to outdoor air anywhere on the site will be residents and those persons may include young children.

4.3 Acceptable Health Risks

Health risks due to human exposure to detrimental environmental conditions at a site are expressed in two forms: carcinogenic risk factor and toxic hazard quotient. The carcinogenic risk is expressed as the projected increase in the number of persons that become affected by cancer due to extended exposure to the conditions on the subject site compared to the general population not exposed to the site conditions. For example, a carcinogenic risk factor of 1.0×10^{-5} expresses the risk where there would be one additional occurrence of cancer in a population of 100,000 persons exposed to the conditions at the site compared to the number of incidents of cancer found in a reference population of 100,000 persons not exposed to the environmental conditions at the site.

4.3.1 Health Risk Limits for Carcinogens

Although there is a general perception that a risk factor of 1.0×10^{-6} represents an established upper limit of acceptable carcinogenic health risk promulgated in State and Federal regulations, that is not, in fact, the case. The US-EPA has indicated that the appropriate risk limit applicable to a specific site or a specific form of exposure should fall within the range 1.0×10^{-6} to 1.0×10^{-4}. The origin of the 1.0×10^{-6} limit appears to have been a recommended limit for residues of animal drugs found in human food-grade meat set by the United States Food and Drug Administration (**FDA**) (United States Food and Drug Administration 1973). However, that standard was not intended to be a criterion for use in Tier 2 environmental health risk assessments for contaminated sites.

Acceptable limits for risk-based human carcinogenic health risk at contaminated sites have been set by federal, state and local regulatory agencies and by specific legislation. For example, in its Hazardous Waste Management Systems Toxicity Characteristics Revisions, the US-EPA selected a single level of 1.0×10^{-5} based on that Agency's belief that, due to the extremely conservative nature of the exposure scenarios employed in risk-based health risk assessments and the underlying health criteria used, a 1.0×10^{-5} risk level is realistic and appropriate as a practical target limit to protect the health of an exposed population (United States Environmental Protection Agency 1995a). The State of California has defined "no significant risk" as less than one excess case of cancer per 100,000 individuals, which corresponds to target risk of 1.0×10^{-5}. That value has been incorporated into California State Proposition 65 (The Safe Drinking Water and Toxic Enforcement Act of 1986), which requires the Governor of California to publish annually a list of chemicals known to the State to cause cancer or reproductive harm. After extensive input from representatives of a wide range of local interests that included regulatory agencies, consulting engineers, community improvement groups, minority business associations, the Sierra Club and a wide cross-section of its residents, the City of Oakland also set a health risk limit of 1.0×10^{-5} for Tier 2 health risk assessments (Spence and Gomez 1999).

In agreement with the agencies listed above, ASTM also recommends a target carcinogenic health risk of 1.0×10^{-5} for risk-based assessments at petroleum release sites and describes that value as representative of *de minimus* risk (American Society for Testing and Materials 2002, 2004). SJC is firmly of the opinion that the 1.0×10^{-5} limit is applicable to the Oak Walk Site because: a) below that level there is no significant risk to exposure from a known carcinogen; b) given the approximations inherent to Tier 2 health risk computations, health risk targets set lower than 1.0×10^{-5} have no practical mathematical significance other than a representation of what is, in reality, a *zero* health risk; and c) the City of Oakland's election to use a health risk of 1.0×10^{-5} for sites in that city that include geologic, hydrogeologic, climatic and economic and socio-political environments that are essentially identical to those in the City of Emeryville, including those of the Oak Walk Site, properly reflects all of the factors that should be considered when setting a site-specific target risk level. However, the RWQCB, which has jurisdiction of the subject property in Emeryville, uses a target risk of 1.0×10^{-6} when preparing ESLs (California Water-quality Control Board - San Francisco Bay Region

2005). Accordingly, although for the reasons stated above SJC believes that such a target risk is unwarranted and mathematically meaningless, when evaluating the results of the Tier 2 risk assessment for the subject property that are reported herein, SJC compared the carcinogenic risk to that 1.0×10^{-6} target risk level.

4.3.2 Toxic Hazard Limits

For non-carcinogenic health effects the results of most health risk assessments are compared with a toxic hazard quotient of 1.0. This represents the threshold value below which no adverse health effects are experienced by exposed populations and is the ASTM default value for Tier 2 risk assessments. This value is based on the precedents set by the US-EPA (United States Environmental Protection Agency 1989). It was also adopted by the City of Oakland, but with a requirement to address cumulative risk, if necessary (Spence and Gomez 1999). With respect to this measure of health risk, SJC concurs with both the US-EPA and the City of Oakland, and we normally set both the target health risk quotients and the health risk index at 1.0 when evaluating specific sites where the environment has been impaired. The RWQCB, however, in preparing its ESLs for affected soil and groundwater in the San Francisco Bay region, elected to use target quotients at the unusually conservative value of 0.2. That Agency's guidance document provides an option for site-specific adjustment of that value (California Water Quality Control Board - San Francisco Bay Region 2005); however SJC has elected to conform to the RWQCB’s unmodified value and has also adopted the extremely conservative criterion that limits both the target quotients and target index to 0.2 for the purpose of designing corrective action measures for the Oak Walk Redevelopment Site.

4.4 Chemicals of Concern in the Subsurface

As noted previously, the subsurface beneath essentially all of the Oak Walk Redevelopment Site is affected by releases of fuel hydrocarbons and by paint solvents (principally mineral spirits). Each of those materials is a mixture of a large number of organic and other chemicals, some of which are carcinogenic or toxic to humans.

The concentrations of diesel fuel, gasoline and mineral spirits (**TPHd**, **TPHg** and **TPHms**) that have been detected in soil and groundwater have been compiled in Tables I-2 and I-4, respectively, which compilations also include the concentrations of individual components of fuel hydrocarbons and mineral spirits that, due to their carcinogenicity or toxicity, are of particular concern to a risk-based environmental assessment.

Because laboratory analyses that determine the concentrations of individual compounds contained within the mixtures that comprise the various fuel hydrocarbons in industrial compounds are costly to perform, methods have been developed that call for only the quantification of the concentrations of the various categories of petroleum hydrocarbons such at TPHd, TPHg and TPHms. Such “fractional” approaches include that developed by the Total Petroleum Hydrocarbon Criteria Working Group to estimate the concentrations of individual components of petroleum hydrocarbon mixtures based on consideration of the fraction of the whole that each component present in a typical product mixture represents (Gustafson, Tell and Orem 1997). However, those methods cannot account for the complex factors that influence the fate and transport of each individual component of the product as it migrates through the subsurface. Recognizing that limitation, the developers of that methodology concluded that, even for initial site screening, it is not advisable to base health risk assessment related to the presence in the subsurface of chemicals that are known human carcinogens or are highly toxic on simplified estimations. Instead, they call for the actual concentrations benzene (a human carcinogen) and toluene (a human toxin) to be measured in the subsurface. They further specify that following initial screening of a site based on the "fractional" approach, risk assessment should be performed for each known carcinogen found at the site, which may include compounds in addition to benzene. Furthermore, ASTM Standard E1739 (Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites) specifically states that *"…TPH should not be used for "individual constituent" risk assessments because the general measure of TPH provides insufficient information about the amounts of individual components present"* (American Society of Testing and Materials 2002).

In compliance with the requirements of ASTM Standard E1739, the health risk assessments described in this document are based on consideration of the specific human carcinogens and highly toxic petroleum hydrocarbons actually detected in the subsurface beneath the Oak Walk Redevelopment Site.

As is documented in Table I-2, concentrations of the following components of fuel hydrocarbons and industrial solvents were detected in the soil in the subsurface beneath the site. (**Note:** the listing below includes *all* detected COCs in soil, regardless of how small the amount or how infrequently the COC was encountered.)

COCS IN SOIL AT THE OAK WALK SITE

BTEX Compounds and Fuel Oxygenates (EPA Method 8260B)

Benzene	Toluene	Ethylbenzene	Total Xylene Isomers
Methyl tert-butyl ether			

Other Volatile Organic Compounds (EPA Method 8260B)

Acetone	2-Butanone	n-Butylbenzene
sec-Butylbenzene	tert-Butylbenzene	Isopropylbenzene
p-Isopropylbenzene	p-Isopropyltoluene	1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene		

Polynuclear Aromatic Compounds (EPA Method 8270C)

Naphthalene
2-Methylnaphthalene

Total Petroleum Hydrocarbons

Total Petroleum Hydrocarbons (quantified as Diesel)	EPA Method 8015M
Total Petroleum Hydrocarbons (quantified as Mineral Spirits)	EPA Method 8015M
Total Petroleum Hydrocarbons (quantified as Gasoline)	EPA Method 8260B

As is documented in Table I-4, the following COCs were detected in groundwater at the Oak Walk Redevelopment Site.

COCS IN GROUNDWATER AT THE OAK WALK SITE

BTEX Compounds and Fuel Oxygenates (EPA Method 8260B)

Benzene	Toluene	Ethylbenzene
Total Xylene Isomers	Methyl tert-butyl ether	

Other Volatile Organic Compounds (EPA Method 8260B)

n-Butylbenzene	sec-Butylbenzene	tert-Butylbenzene
Isopropylbenzene	p-Isopropylbenzene	1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene		

Polynuclear Aromatic Compounds (EPA Method 8270C)

Naphthalene

Total Petroleum Hydrocarbons

Total Petroleum Hydrocarbons (quantified as Diesel)	EPA Method 8015M
Total Petroleum Hydrocarbons (quantified as Mineral Spirits)	EPA Method 8015M
Total Petroleum Hydrocarbons (quantified as Gasoline)	EPA Method 8260B

4.4.1 Properties of Chemicals of Concern

To perform a risk-based environmental assessment, the complete array of physical, chemical, toxicological and carcinogenic properties for each of the individual chemicals in the lists presented above must be known. However, in the case of n-butylbenzene, sec-butylbenzene, p-isopropylbenzene, n-isopropylbenzene, 1,2,4-trimethylbenzene, and 1,3,5 trimethylbenzene, not all such data is available. To permit the contribution of those chemicals to any potential health risks that might be present at the Oak Walk Site, as discussed in detail in Section 3.4 in Volume II of this work plan, SJC equated the concentrations of those compounds in soil and groundwater to the equivalent concentrations of cumene in the same manner that has been adopted by the United States Environmental Protection Agency (**US-EPA**) and the California Office of Environmental Health Hazard Assessment (**OEHHA**) (United States Environmental Protection Agency 1997, The California Office of Environmental Health Hazard Assessment 2000). Table I-8 shows the applicable chemical, physical, toxicological and carcinogenic properties of the components of chemicals found in the subsurface beneath the Oak Walk Site.

4.5 Building Type Models

The depth to, and thickness of, affected soil beneath the buildings that will be constructed on the Oak Walk Site varies from one location to another, as do the mean depths to the groundwater table and the concentrations of COCs in the affected soil and groundwater in the subsurface. In addition, the residential and commercial units on the site will vary significantly in their principal dimensions and in the occupancies of their ground floors. These parameters are significant variables that must be accounted for when performing health risk analyses. To permit appropriate models to be developed for the health risk assessments, SJC has categorized the residential and commercial units in the development according to a series of "building types." Ground floor units that have common architectural features, floor slab elevations and beneath which the environmental subsurface conditions are similar have been grouped into a single Building Type. The building types and their locations are shown on Figure I-25.

4.5.1 Vulnerable Building Types

As is described in Volume II of this report, the highest potential health risks will be associated with residential and commercial units located over areas of the site that have the highest concentrations of benzene in the subsurface and whose floor slabs are separated from the groundwater by the smallest vertical distances. This approach permits risk-based environmental risk assessments to be performed, as necessary, according to building type rather than redundantly for each ground floor unit. Based on the evaluation of these and other factors, it was concluded that the most vulnerable units on the proposed development are the ground floor residence Type 3A and the commercial space on the ground floor of building Type 1.

As is detailed in Volume II, the principal parameters governing the selection of those building types as the most vulnerable were the relatively high concentration of benzene in the groundwater below Building Type 3A that is illustrated on Figure I-18 and the low elevation of the floor slab of Building Type 1 relative to the elevation of the groundwater table. Key building dimensions that are significant with respect to environmental risk assessments are presented for each of the building types in Table I-9. Key parameters related to the soil column beneath the building types down to the groundwater table are cited in Table I-10.

4.6 Risk Assessment Software

SJC used Version 1.3a RBCA Tool Kit for Chemical Releases software published by Groundwater Services of Houston, Texas (Groundwater Services, Inc. 2000) to compute the potential health risks in most vulnerable buildings at the Oak Walk Project site.

The RBCA Tool Kit software complies with ASTM Standards E2081-00 and E1739-95/2002 (American Society for Testing and Materials 2000a, 2002). The risk-based site evaluation process and the fate and transport modeling methods employed by the software are described in detail in Volume II of this report.

4.7 Results of Risk Assessment Analyses for Existing Site Conditions

Initial risk assessment analyses were made to evaluate health risks associated with constructing the proposed residential and commercial units on the Oak Walk Redevelopment Site if no corrective action measures were taken to improve the environmental condition of the subsurface from its present state. The analyses were performed for both Building Types 3A and 1 that, as noted in Section 4.5.1 above, would be the most susceptible to exposure to elevated potential health risks.

4.7.1 Concentrations of COCs for Unimproved Site Conditions

Tables I-11 and I-12 list the concentrations of COCs in soil and groundwater beneath Building Types 3A and 1 that were used to model the pre-remediation environmental condition of the subsurface (*i.e.*, the condition that would prevail if the buildings were constructed on the site without any corrective action being taken). The cited values were selected based on the measured concentrations of chemicals of concern in the subsurface beneath the locations of those two building types and were selected to be conservative and to represent worst-case conditions.

4.7.2 Other Risk Assessment Modeling Parameters

In addition to the architectural features of Buildings Types 3A and 1 that are documented in Table I-9, the soil column parameters in Table I-10, the concentrations of COCs in soil and groundwater that are cited in Tables I-11 and I-12, respectively, and the chemical, physical, toxicological, carcinogenic properties of the COCs that are cited in Table I-8, there are two other key parameters that influence the health risks to occupants of the residential and commercial ground floor units on the site. These are the hydraulic conductivity of the soil above the water table and the height to which the capillary fringe rises above the water table.

As has been discussed in Section 3.1.4, the surficial soils that cover the Oak Walk Site are highly impermeable clays and silty clays, but locally the surficial soil may be composed of sands. Based on the extensive hydrostratigraphic investigations that have been conducted at the site, it can be concluded that it is highly unlikely that sands are present in the shallow subsurface beneath the Type 3A buildings. However, to ensure abundant conservatism for the purpose of performing a health risk assessment for the Type 3A buildings when the soil is in its unimproved condition, it will be assumed that sands are present beneath the floor slabs. In the case of the Type 1 building there is, in fact, sand present at shallow depth over a significant portion of the plan area of that building so that an assumption that the unimproved soil beneath its floor slab is entirely composed of that material is appropriate for a conservative health risk assessment.

The ASTM default value for vertical hydraulic conductivity of soil is 1.0 x 10^{-2} cm/sec. and the default value for capillary zone thickness is 0.16 ft. (5 cm). Those values are appropriate for sandy soils and were used to model the unimproved conditions of the Oak Walk Site.

Other parameters required to perform the health risk analyses include properties of the soil column (*e.g.*, the porosity and vapor permeability of the soil in the capillary and vadose zones above the groundwater table) and the site and building-specific air parameters affecting the migration of vapors (*e.g.*, the properties of cracks that may develop in the floor slabs and the differential pressure between indoor and outdoor air). In addition, receptor-specific parameters (*e.g.*, the body weight and inhalation rate of human receptors and the duration and frequency of their exposures) are also required. All of those parameters were selected conservatively according to the procedures described in Sections 3.5 through 3.7 of Volume II of this document.

4.7.3 Risks for Building Type 3A under Unimproved Conditions

The results of the health risk analysis for Building Type 3A, based on the assumption that it will be constructed on an unremediated site, are presented in Table I-13. Examination of that Table shows that both the calculated cumulative carcinogenic risk and the toxic hazard index for both outdoor and indoor air exceed the applicable target risk and target index of 1.0 x 10^{-6} and 0.2, respectively, that have been set for the project.

> **Note:** The graphic and numerical data produced as output by the health risk assessment software for the Building 3A for the unimproved site conditions are presented in Appendix II-C of Volume II of this report. The Appendix includes complete documentation of the input parameters used to perform the assessments and the results of the interim and final calculations required to compute both the chemical-specific and pathway-specific toxicological and carcinogenic health risks for Building Type 3A assuming it were to be constructed on the unimproved site.

It is recognized that, as noted previously, the key parameters used for the health risk analysis for Building Type 3A, if constructed on the unimproved site, were assigned extremely conservative values including the assumption that the hydraulic conductivity of the near-surface soil would be characteristic of sand, rather than the clays and silty clays that dominates the shallow soil at the site, so that the actual risk to residents of Building Type 3A would be very much less than the computed values. However, because the results exceed the highly-conservative cumulative carcinogenic and toxic hazard quotients of 1.0 x 10^{-6} and 0.2, respectively, that have been set for this project, corrective action measures will be necessary in the area of the site where that building type is located. Reduction in the potential health risks that can be achieved by implementation of elements of the proposed corrective action program are discussed in Section 4.8 below.

4.7.4 Risks for Building Type 1 under Unimproved Conditions

The results of the health risk analyses for unimproved conditions for Building Type 1 that were abstracted from the complete output generated by the computational software that is included in Appendix II-F of this document are presented in Table I-14. As was the case for Building Type 3A, those results were generated by using the parameters defined in Tables I-9, I-10, I-11 and I-12 and the other modeling parameters developed in Sections 3.5 through 3.7 of Volume II of this document.

As is documented in Table I-14, the cumulative carcinogenic risk and toxic hazard index for indoor air, which is the critical exposure pathway for Building Type 1, assuming that it were to be constructed on the unimproved site, are computed to be 9.6×10^{-7} and 0.092, respectively. Those values are very much lower than the corresponding targets for the Oak Walk Site of 1.0×10^{-6} and 2.0×10^{-1}, respectively. The corresponding results for the outdoor air pathway are 13×10^{-7} and 0.15. Those results indicate that if there were no other engineering considerations controlling the development of the property, no corrective action measures would be required in that area of the site.

4.8 Reduction of Health Risk by Corrective Action Measures

As is noted in Section 4.7.3, the conservatively-computed cumulative carcinogenic risks and toxicity indices for Building Type 3A, if it were to be built on the unimproved site, would be greater than the highly-restrictive cumulative carcinogenic target value and target toxicity risk values of 1.0×10^{-6} and 0.2, respectively, that have been set for this project. Accordingly, SJC considered the reduction in health risks that would be achieved if contaminated soil in the near surface were to be excavated and replaced by low-permeability engineered fill and the additional reductions in risks that would be achieved by remediation of contaminated groundwater.

4.8.1 Risk Reduction Achieved by Excavation and Replacement of Contaminated Soil

The geotechnical engineering requirements for the Oak Walk Project call for soft surficial soils to be excavated from beneath Building Type 3A to a depth of 6 ft and replaced by an impermeable engineered fill compacted to a relative density of 90% (The San Joaquin Company 2004b). The source of the engineered fill will be clean overburden soil excavated from the site during the earth-moving work required to grade the site for development. Because, as is noted in Section 4.7.3, the conservatively-computed cumulative carcinogenic risk and toxicity indices for Building Type 3A, if it were to be built on the unimproved site, would be greater than the highly-restrictive cumulative carcinogenic target value and target toxicity risk values of 1.0×10^{-6} and 0.2, respectively, SJC considered the reduction in health risk that would occur if the contaminated soil to a depth of 6 ft. BGS were to be excavated from beneath Building Type 3A and replaced by low-permeability engineered fill.

Experience obtained when the same soil types that are present on the Oak Walk Redevelopment Site were re-engineered as compacted fill on the neighboring SNK Andante project site (see Figure I-4 for location) showed that they have a hydraulic conductivity of 5.65 x 10^{-7} cm/sec. (The San Joaquin Company 2003). However, when that material is used, due to its very small pore size, high capillary forces can be generated within it. Accordingly, SJC set the height of the capillary fringe at 5 ft. for the condition when buildings on the Oak Walk Site are constructed on the engineered fill. Those values for hydraulic conductivity and height of the capillary fringe were used in the health risk analyses performed for commercial and residential units constructed on the filled ground.

The concentrations of COCs in soil for Building Type 3A in the *post*-remediation condition are, as presented in Table I-10, identical to those for the pre-remediation condition. This is because remediation of soil beneath the Type 3A unit will be limited to a total depth of 6 ft below the existing ground surface, but the soil at a depth of 10 ft BGS is affected by high concentrations of COCs in the area of building type 3A and will not be improved by the remediation measures. Nevertheless, as is cited in Table I-10, the depth from the floor slab of Building Type 3-A to the top of the affected soil will increase from approximately 5.13 ft. to 7.13 ft. That increase in the depth from the floor slab to the top of the affected soil will result in a reduction in risk to occupants of the building. However, the greatest reduction in health risk will be generated by the large decrease in the hydraulic conductivity and air permeability along the pathway by which vapors of COCs migrate upward through the subsurface to the underside of the building slab.

The output from the health risk assessment software for Building Type 3-A, if it were constructed on clean, compacted fill, is presented in Appendix II-D and the results are summarized in Table I-13.

As can be seen by examination of Table I-13, the effect of remediating the soil down to a depth of 6 ft below the existing ground surface in the area around Building Type 3A is to improve the cumulative carcinogenic risk and toxic hazard quotients for both the indoor and outdoor air pathways by more than an order of magnitude. For the indoor air pathways, at a cumulative carcinogenic risk of 3.9 x 10^{-6} and a toxic hazard index of 0.25, health risks continue to exceed the very conservative targets that have been set for this project at 1.0 x 10^{-6} for the cumulative carcinogenic health risk and 0.2 for the toxic hazard index. This result indicates that to meet those targets, additional remedial measures beyond excavation of contaminated soil will be required.

For the case of Building Type 1 following excavation and replacement of soil by low-permeability engineered fill, the characterizing concentrations of COCs in soil will be taken to be those cited in Table I-11. As was the case for Building Type 3A, although affected soil will be removed down to a depth of 7 ft. beneath the existing ground surface in the area of Building 1, that action will not change the maximum detected concentration of benzene in the ground beneath it. Consequently, as is presented in Table I-11, the concentrations of COCs in soil in both the pre- and post-remediation conditions for Building Type 1 will be identical.

As is shown in Table I-14, both the cumulative carcinogenic risk and the toxic hazard quotients for Building Type 1 are lower than those computed for the unimproved site after affected, near-surface soils have been replaced by engineered fill. However, it should be noted that even for the unimproved condition of the site, the hazard quotients for both the indoor and outdoor pathways were very much lower than the target quotients set for this project, so that the mathematical values for both the case of the unimproved and remediated site have no quantitative meaning other than to demonstrate that the occupants of Building Type I will be exposed to no health risks due to the environmental conditions of the Oak Walk Redevelopment Site.

4.8.2 Risk Reduction Achieved by Both Soil and GW Remediation

Finally, a risk assessment analysis was performed for Building Type 3A for conditions when it was assumed that remediation work included not only excavation of affected soil to a depth of 6 ft. beneath the existing ground surface and replacement of that soil with low-permeability engineered fill, but also assumed that contaminated groundwater beneath that area of the site will be extracted so as to reduce local concentrations of COCs in groundwater to 40% of those that prevailed at the time that the site characterization conducted at Oak Walk Redevelopment Site was completed in November 2004. Those remediated groundwater conditions are presented in Table I-12, where they are designated to be the “post-remediation” conditions. The results of the risk analysis conducted for those conditions are presented in Appendix II-E of Volume II of this work plan and they are also summarized in Table I-13.

Table I-13 shows that the additional reduction, beyond that associated with soil replacement, in computed health risk associated with the remediation of groundwater is sufficient to eliminate entirely risks associated with the outdoor pathways in Building Type 3A because the computed cumulative carcinogenic risk of 5.9×10^{-8} and the toxic hazard index of 0.028 for that pathway are now both below their very conservatively-established targets. The toxic hazard index for the outdoor air pathway is also almost an order of magnitude lower than the target toxic hazard index. However, although very low at 2.3×10^{-6}, which would meet the target of 1.0×10^{-5} set by the US-EPA and ASTM, the cumulative carcinogenic risk associated with the indoor air pathway for Building Type 3A remains at greater than the unusually-restrictive target of 1.0×10^{-6} and 0.2, respectively, set for this project. To entirely eliminate those risks, further corrective action measures will have to be implemented. Those measures will consist of installation of membranes that are impermeable to the migration of vapors and gasses of COCs into the residential and commercial buildings on the site, the specifications for which are presented in Section 5.5 of this work plan.

5.0 PROPOSED CORRECTIVE ACTION

To ensure that the environmental condition of the Oak Walk Site will pose no health risk to the occupants of the residences and commercial premises that are planned for the property, the corrective action measures described in this section will be implemented. Those include excavation of contaminated soil and its replacement by clean, low-permeability, engineered fill, reduction of concentrations of COCs in groundwater in the area of the site where benzene concentrations are elevated and installation of impermeable barriers beneath the floor slabs of residential and commercial units. To comply with the geotechnical engineering site-preparation requirements, that low-permeability material will also be placed over the whole area of the property to depths varying from a minimum of 3 ft. to a maximum of 7 ft.

In addition to the measures required to eliminate all potential health risks that might affect the property, corrective measures will also be implemented to reduce the rate of flow of groundwater contaminated by solvents that originated at up-gradient sources and to reduce the concentrations of those petroleum hydrocarbons in the groundwater in the area where their concentrations are elevated.

Administrative controls will also be implemented to ensure that the engineered barriers will be maintained intact and that future use of the property will be consistent with its environmental status.

5.1 Qualified Engineering Supervision of Remediation Program

The engineering program that was implemented at the Oak Walk Site to characterize the environmental condition of the subsurface was unusually intensive in character, but it is well established that precise delineation of contaminated zones in alluvial fans, particularly, as is the case at the Oak Walk Site where they are intersected by paleo streambed deposits, is notoriously difficult when exploration, by default, is generally restricted to drilling of small-diameter borings and installation of groundwater-quality monitoring wells (Salvany, J.M., et al. 2004). In such circumstances, with the application of the well-proved Observational Method, which has been employed for many years in geotechnical engineering practice (Peck 1969), it is possible to reliably remediate such sites economically and effectively if a flexible, holistic approach, rather than a prescriptive paradigm, is taken and the work is directed by a well-experienced engineer. To successfully apply that methodology, it is necessary to refine the specific scope of the remediation program in local areas of the site in response to detailed information regarding the condition of the subsurface as it is exposed in the field by the excavation equipment and by the continuous flow of laboratory data. To ensure that field information will be appropriately interpreted as it develops, all of the corrective action measures implemented at the Oak Walk Site will be conducted under the direct supervision of an experienced, California-registered Geotechnical Engineer.

5.2 Site Preparation

To prepare the Oak Walk Site for redevelopment, as was described previously, all of the commercial structures currently present on the Oak Walk Site will be demolished prior to its redevelopment, together with the existing residences at 1081, 1083, 1085, 1087, 1089 1/2 and 1089B 41st Street. The residences at 1077 1/2, 1079 and 1089 will be temporarily moved off their foundations and parked in the southern area of the site. This will permit their existing foundations to be demolished and new foundations constructed before they are returned to the locations on the 41st street frontage of the site, as shown on Figure I-3, and will be rehabilitated at the locations (although the existing residences at 1093 and 1089B will be demolished, they will be replaced by new buildings with the same architectural features that will also be situated along the 41st street frontage). The three-story residence currently located at 1077 41st Street will be moved to the location shown on Figure I-3 at the intersection of Adeline and 40th Streets, where it will be rehabilitated on a new foundation as a three-story condominium building with a garage on the ground floor.

The demolition and site clearance work will include removal of all vegetation, paving and existing foundation concrete from the site. In preparation for the demolition work, with the approval of the ACEHCS case officer (Alameda County Health Care Services Agency, 2005), the temporary groundwater quality monitoring wells MWT-1 through MWT-14 were closed in October of 2005 under the permit and oversight of the Alameda County Public Works Agency (**ACPWA**).

In addition to the demolition or relocation of the structures on the site and clearance of other infrastructure and vegetation on the property, the geotechnical engineering specifications for the project call for the soft surficial soils to be excavated and, after conditioning, to be reconstituted as engineered fill that will be suitable for the support of the new building foundations. The excavation depth needed to achieve the soil improvement required by the geotechnical specifications depends upon the anticipated soil loading and the local geotechnical properties of the subsurface beneath each area of the site. An excavation depth of 3 ft. below the existing ground surface is required beneath areas of the site occupied by parking lots, landscaping and other open space. The depth required beneath Building 1 in the southwestern corner of the development (see Figure I-25 for location) is 7 ft (The San Joaquin Company Inc. 2004b). Under Building 3, the required depth of excavation is 6 ft. and beneath the remaining structures the geotechnical specifications call for the soil to be improved to a depth of 4 ft.

In some areas of the site the excavation depth required to comply with the geotechnical engineering site preparation requirements will be such that contaminated soil will be encountered in the bottom of the excavations. Where that occurs, according to the procedures described in Section 5.4 below, the contaminated material will be loaded directly into trucks and shipped for off-site disposal at a permitted facility. Except to the extent that it will be required to facilitate removal and disposal of contaminated soil, excavation and other earthwork required to comply with the geotechnical engineering specifications for the project are beyond the scope of this corrective action plan. All general earthmoving work will be the responsibility of the project's general contractor and will be performed under the oversight of the project's geotechnical engineer.

Prior to initiation of demolition work on the site and continuing through completion of the corrective action program, the whole of the Oak Walk Redevelopment Site will be secured by 6-ft. high chain link fencing with access controlled by lockable gates. No persons other than representatives of the owner, the consulting engineers, regulatory agency personnel and employees of the remediation and general construction contractors and subcontractors will be permitted to enter the site until all construction is complete.

5.3 Groundwater Remediation

To reduce contaminant transport across the Oak Walk Site from the paint manufacturing facilities located to the east of Adeline Street (see Figure I-4 for locations), 30 ft. deep grout curtains will be installed near the eastern and western boundaries of the site at the locations shown on Figure I-24. This will eliminate or greatly reduce the influx of mineral spirits and other regulated materials that are being transported through the paleo streambed channels that, as shown on Figure I-15, traverse the northern portion of the Oak Walk Site. A third 30-ft. deep grout curtain will be installed, as is also shown on Figure I-24, near the southeastern corner of the site to intercept groundwater in the previously-identified paleo streambed channel that crosses that area of the site from its boundary with the Ennis Property to the east and extends from there across 40th Street. That paleo channel had continued from there across the Andante Property to the south until it was removed as part of the remediation work performed at that site in 2003 (The San Joaquin Company Inc. 2003)

To reduce the high concentration of gasoline-range hydrocarbons that originated at the former paint manufacturing facilities that, as shown on Figure I-16, are present in the vicinity where Monitoring Well MWT-7 was formerly located, a groundwater extraction pond will be excavated in the area at the location shown on Figure I-24. As is also shown on Figure I-24 a second groundwater extraction pond will be excavated at the southern boundary of the site to remediate groundwater affected by the high concentration of benzene that is shown on Figure I-18.

<u>5.3.1 Barriers to Groundwater Flow</u>

As noted above, three grout curtains will be installed to restrict the flow of contaminated groundwater onto the Oak Walk Site and to reduce the rate at which contaminants are transported off the site to down-gradient locations. The location of a continuous channel of medium to coarse sands that fill a paleo streambed that passes through the Oak Walk Site from east to west is revealed in the cross-sections shown on Figures I-10, I-11 and I-12. As is reflected in the net permeable facies map shown on Figure I-15, the channel enters the site beneath the existing residential structure at 1077 41st Street, continues west and passes under the property boundary on the west side of the parking lot situated at the corner of San Pablo Avenue and 41st Street. The dashed lines to the north and south of that alignment that are shown on Figure I-24 are the estimated southern and northern limits of that sand filled channel as interpreted from the hydrostratigraphic information gathered during the site characterization work conducted at the site.

As is shown on Figure I-4, the second sand-filled paleo channel on the site crosses the southeastern corner of the property and is an extension of the channel originally exposed on the Andante site to the south. It was also exposed in the walls of exploratory Trench 8. That trench was excavated during the preliminary subsurface reconnaissance investigation at the Oak Walk Site in December 2003 (The San Joaquin Company Inc. 2004c). Its log is included in Appendix I-A.

5.3.1.1 Exploratory Trenches

Although the lateral boundaries and alignments of the paleo streambed channels crossing the Oak Walk Site have been defined with a relatively high degree of confidence, to ensure that grout curtains will fully cut off flow through those channels, prior to their installation, additional exploratory trenches will be excavated. The trenches, which will be numbered exploratory Trenches 9, 10 and 11, are shown on Figure I-24.

Each trench will be 2 ft. wide and will be excavated to a minimum depth of 15 ft. The stratigraphy exposed in the walls of the trenches will be logged by a California-licensed geotechnical engineer. The lengths of the trenches will be determined in the field so that they extend no less than 10 ft. beyond the lateral limits of the paleo streambed channels.

Any soil excavated from the exploratory trenches that is affected by petroleum hydrocarbons will be temporarily stockpiled on the site prior to off-site disposal in the manner described in Section 5.4 below.

To extend current understanding of the distribution of COCs in the subsurface of the Oak Walk Site, samples will be recovered from approximate depths of 12 ft. BGS at 25-ft. intervals along the lengths of the exploratory trenches. Samples will be recovered from the trench using the bucket of the excavator and will be prepared and shipped for laboratory analysis in compliance with the protocol specified in Section 5.4.4 below.

Because the trenches will be excavated to depths greater than the depth to the water table, to backfill the trenches it will be necessary to place a portion of the backfill under water. The materials and procedures that will be used for that backfilling will be the same as those described in Section 5.4.5 below.

5.3.1.2 Construction of Grout Curtains

The grout curtains will be constructed along the alignments shown on Figure I-24. They will extend horizontally a minimum of 15 ft. beyond the lateral limits of the paleo streambed channels that they are designed to intercept. The details of the installation procedure will be determined based on on-site field trials of the grout injection procedure. However, for planning purposes, it may be assumed that 2-in. diameter grout injection borings will be drilled to a total depth of 30 ft. with a separation of one foot between each boring.

A neat Type II Portland cement grout, formed by mixing 3 parts of water with one part of cement powder, will be injected under pressure into each of the borings. The grout injection pressure will also be determined by field trials and will vary, depending upon the particle size in the formation into which the grout is being injected. However, the maximum injection pressure will be limited so as to avoid ground heave or hydraulic fracturing of the formation. Given this constraint, it is expected that for the 30 ft. deep grout curtains the maximum injection pressure will be limited to approximately 30 psi.

Any soil excavated from the exploratory trenches that is affected by petroleum hydrocarbons will be temporarily stockpiled on the site prior to off-site disposal in the manner described in Section 5.4 below.

5.3.2 Extraction of Affected Groundwater

To permit extraction of significant volumes of groundwater affected by elevated concentrations of petroleum hydrocarbons, open pits will be excavated well below the groundwater table at two locations on the site. The locations of the pits, which will be designated Groundwater Extraction Ponds 1 and 2, are shown on Figure I-24. Each will be square in plan with side lengths of approximately 40 ft. and will be excavated to a maximum depth of 15 ft. BGS. An excavation of those dimensions will be sufficient to intercept thin layers and lenses of permeable material in the subsurface so that when water is extracted from them it will flow from a significant radial distance around each pond. Extraction of groundwater from large ponds of the type proposed is much more effective than extraction from small-diameter wells, particularly in the complex stratigraphy found in alluvial fan deposits such as those present beneath the Oak Walk Redevelopment Site (Salvany, et al. 2004).

Any soil excavated from a groundwater extraction pond that is affected by petroleum hydrocarbons will be temporarily stockpiled on the site prior to off-site disposal in the manner described in Section 5.4 below. When the pond excavations have reached their full depth, soil samples will be recovered from each corner of their floors using the bucket of the excavator and will be prepared and shipped for laboratory analysis in compliance with the protocol specified in Section 5.4.4 below.

After the ponds have been excavated, they will be left for a minimum of 24 hours to permit the groundwater that will flow into them to come to a quiescent state. During that time, because the petroleum hydrocarbons have specific gravities less than that of water, their concentrations in the groundwater in the extraction ponds will be at a maximum near the surface of the water and will decrease with depth. Research has shown that the concentrations of COCs decrease with depth below the free water surface according to a Gaussian distribution with concentrations falling to very small values at a depth of 10 ft. below the water table (Chiang,., *et. al.* 1989, Robbins and Martin-Hayden 1991).

After the water in the extraction ponds has been allowed to reach quiescence, 20,000 gallons of groundwater will be extracted from each of the ponds and decanted into a transportable, open-top, steel retaining tank. To ensure that the most contaminated water contained in the pit will be evacuated, the dewatering pump's inlet will be elevated so that it is at, or close to, the surface of the water. The rate of pumping will be at all times restricted to approximately match the rate of water inflow into the pond so that the turbulence associated with complete emptying of a pond will not occur. This will permit the groundwater affected by the highest concentrations of COCs to be extracted throughout the process.

When a 20,000-gal. transportable retaining tank has been filled, the water in the tank will be left undisturbed for several days. This will permit fine soil particles to settle to the bottom of the tank so that clear water can be decanted slowly from the top of the tank into a second 20,000 gal. holding tank. This procedure is designed to reduce the volume of water containing more than 2% by weight of solids to a minimum, permitting most of the water to be treated off-site at significantly less cost than will be the case for the tank bottom water, which will be affected by a higher load of suspended solids.

Extracted groundwater held in the second transportable holding tank will be discharged into a vacuum truck and transported to the DeMenno/Kerdoon recycling facility in Compton, California, where the petroleum hydrocarbons will be recycled into beneficial use before the cleaned water is discharged to the municipal sewer under the waste discharge requirements of the Sanitation Districts of Los Angeles County.

When the groundwater extraction is complete, each pond will be backfilled. That procedure will include backfilling of the portion of the ponds that are below the groundwater table. The materials and procedures that will be used for that backfilling will be the same as those described in Section 5.4.2.1 below.

5.4 Excavation and Disposal of Hydrocarbon-affected Soil

As discussed previously, it will be necessary to excavate soil on the site to varying depths up to 7 ft. BGS so that it can be replaced by compacted engineered fill to comply with the geotechnical engineering specifications for the project. In some areas of the site that operation will involve excavation of soil affected by components of petroleum hydrocarbons. Where that is the case, it will be necessary to remove the contaminated material and ship it off-site to a permitted disposal facility. As has been discussed in Section 4.8.1, removal of that contaminated material will also reduce environmental risks that might affect the occupants of commercial and residential structures constructed on the Oak Walk Site.

It is planned to remove contaminated soil from two excavations that will be opened in the southern portion of the property where the soil is affected by components of fuel hydrocarbons at relatively shallow depth beneath the surface. Those areas are shown on Figure I-24 and have been designated Remedial Excavation No. 1 and Remedial Excavation No. 2. Remedial Excavation No. 1 is bounded by San Pablo Avenue on the west and 40th Street on the south. It will be 60 ft. wide, as measured from west to east, 110 ft. long, as measured from south to north and will be 7 ft. deep. Remedial Excavation No. 2 will be located along the 40th Street frontage of the Oak Walk Site and, as shown on Figure I-23, will be 75 ft. wide as measured from south to north, 215 ft. long west to east and 6 ft. deep. The methods that will be employed to open the excavations, remove and dispose of the contaminated soil, recover samples of soil for laboratory analysis from the floors of the excavations and to backfill and restore the site to its existing grade are described below.

5.4.1 Removal of Clean Overburden

The clean overburden that overlies the contaminated soil in the excavation areas will first be removed and stockpiled on the redevelopment site for later use as a source of engineered fill. For planning purposes, based on results of sampling and analysis of soil recovered from borings drilled at the site as part of the site characterization program (The San Joaquin Company Inc. 2005), it is assumed that the excavation will reach a minimum depth of 4 ft. before contaminated soil is encountered. However, the actual depth to contaminated soil may differ and the excavation work will be carefully supervised to ensure that no affected soil is placed in the overburden stockpile.

Prior to initiating the excavation work, straw wattles and other barriers will be installed in the area to control any turbid run-off that might occur if rain falls on the site at the time the excavation work is being performed. The barriers will be set so as to prevent turbid water or loose soil from being carried off the site or into the storm drains located in the adjacent streets.

5.4.2 Excavation and Disposal of Contaminated Soil

For the excavation work to proceed, a permit for excavation of contaminated soil will be obtained from the San Francisco Bay Area Air Quality Management District (**SFBAAQMD**) in compliance with that Agency's Regulation 8, Rule 40.

After the clean overburden is removed, excavation of the hydrocarbon-affected soil will be initiated using a track-mounted excavator.

To provide for stability, the walls of the excavation will be sloped. The slope angle will be such as to ensure safety while the excavation is open and will be selected by the California-registered Geotechnical Engineer in Responsible Charge of the remediation program. The permissible side slope of the excavation will be based on the soil strength characteristics, the total depth of the excavation and the anticipated rate of excavation.

Excavated soil will be discharged directly into end dump semi-trailer trucks unless, due to the scheduling requirements of the trucking operations, it is necessary to stockpile it temporarily in or close to the working excavation before it is loaded into the trucks by a front-end loader. All excavation, stockpiling and loading operations required to remove the affected soil from the site will be conducted in compliance with SFBAAQMD Rule

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Immediately following the loading of each truck, its trailer will be covered by a tarpaulin so that venting of volatile organic compounds will be minimized during transport as is required by SFBAAQMD Rule 40. Before the trucks leave the site, they will be moved to a decontamination pad that will be paved with crushed rock so that their wheels or any other affected equipment can be cleaned of adhered soil or other debris.

The affected soil will be shipped under Special Waste Manifests for disposal to either Allied Waste's Keller Canyon Landfill in Pittsburg, California or to its Forward Landfill in Manteca, California. The specific landfill at which each truckload will be discharged will be determined based on the trucking logistics plan. That plan will be modified dynamically to account for traffic congestion along the heavily-trafficked routes from the Oak Walk Site to the disposal facilities and the requirement to make efficient use of each vehicle to import fill materials to the site as well as to export contaminated materials from it.

5.4.2.1 Excavation Below the Groundwater Table

For the remedial excavations to reach their full design depths it will be necessary to excavate below the water table and to backfill the submerged depth of the excavation in a manner that will comply with the geotechnical engineering requirements of the project. Those requirements are designed to provide adequate bearing capacity for support of foundations and to limit consolidation settlement to an acceptable degree.

To permit excavation below the water table, a technique developed by SJC for remediating sites under similar conditions to those present at the Oak Walk Redevelopment Site will be applied. This technique involves the use of large sieve-sized crushed concrete and crushed or river-run rock containing no fines to stabilize the submerged walls and floors of small areas of the total excavation, known as excavation cells. Within each cell the soil is excavated to the total depth of the excavation but the resulting pit is left open for only the minimum time necessary for the excavation to be accomplished and, where applicable, a soil sample to be recovered from the bottom of the cell. Immediately after any sampling has been completed, crushed, recycled concrete having a sieve size from 4 in. to 6 in. containing no fine material will be discharged into the excavation cell and spread over its floor with the excavator bucket so that it forms a layer of approximately 1.5 ft. in thickness. Directly following placement of the crushed concrete, 3 in. to 1.5 in. sieve-sized crushed or river-run rock with no fines will be tipped into the open cell excavation and spread by the excavator bucket until the surface of the spread rock lies a few inches above the water table.

The next cell to be excavated will overlap the adjacent cell or cells that have been backfilled with crushed concrete and rock. In this way, the contaminated soil present at depths greater than that of the water table can be incrementally removed and replaced by concrete and rock backfill until the whole of the remedial excavation is complete down to the design depth. As the number of rock-filled cells expands, they will form a dry, hard standing surface that will permit the excavator to advance into the central area of the remedial excavation and, where necessary, for a front-end loader to shuttle the excavated soil to the trucks that will transport it off-site. To ensure that the rock is fully compacted, the front-end loader and excavator will be used to level its surface. It will then be thoroughly compacted using a heavy, pad-footed, vibratory compactor. When the rock filling operation is complete, the front-end loader and excavator will be used to level the surface of the rock before it is thoroughly compacted using a heavy vibratory roller.

The technique whereby the excavations beneath the water table are made by opening cells of limited plan area that are quickly backfilled with concrete and rock material not only provides a means whereby contaminated soil beneath the water table can be removed in a controlled manner, but the resulting compacted granular fill has a bearing capacity well in excess of that required to support foundations of the type required for the structures to be constructed on the Oak Walk Site. Rapid backfilling of a cell with the concrete and rock material stabilizes its walls and prevents sloughing or flowing soil from filling the excavation. The large sieve-sized crushed concrete with no fines that is placed at the bottom of a submerged excavation will penetrate into any soft material on the excavation's floor and, together with the crushed or river-run rock, will prevent a layer of soft material developing there. Due to the large size of the voids in the compacted crushed rock, that material will have an extremely high hydraulic conductivity and it will be extremely dense. Consequently, it will not be susceptible to liquefaction during a seismic event.

A primary concern during the excavation of the contaminated soil will be for the safety of the excavation and the stability of the public streets, sidewalks and the underground utilities that run beneath them. These conditions require careful control of the size of the excavation cells and the time that they are permitted to be open before they are backfilled to prevent destabilization of adjacent ground. To establish the size of an excavation cell that can be successfully excavated and backfilled while its walls remain stable, a square test cell, limited to an area no more than 15 ft. on a side, will be opened beneath the groundwater table in each remedial excavation.

The licensed geotechnical engineer in responsible charge of the work will carefully observe the stability of the walls of the test cells as they are excavated and backfilled. If, at that size, the cells are stable, the overlapping cells that will subsequently be excavated will increase incrementally in plan area so that complete excavation of the submerged portions of the remedial excavations can be efficiently excavated while maintaining the stability of the cell walls. This will ensure that the concrete and rock backfill will be properly placed in the cells without being affected by sloughing or flowing soil. Based on our previous experience with this type of geotechnical construction in similar ground conditions and given the relatively shallow depth of the water table and the depths of the remedial excavations (no more than approximately 3 ft.) that will be opened on the Oak Walk Site, we expect that it will be possible to develop cells of considerably greater size than the test cells and that the excavation work will be completed expeditiously.

5.4.3 Closure of Sewer Laterals

Any sewers or other conduits that are encountered during the remedial excavations will be removed from the site and cut off and plugged at the property boundary in compliance with the requirements if the City of Emeryville. Following plugging of the conduits, an impermeable blanket of compacted clay will be placed at the point where the utility trench, in which the sewer or conduit had run, exits the site. That clay will extend a minimum of 2 ft. beneath the bottom of the utility trench upwards to the existing ground surface, will extend a minimum of 5 ft. laterally on either side of the utility trench and for a minimum distance of 5 ft. from the site boundary inward along the former alignment of the sewer or conduit. That clay will cut off any off-site flow of contaminated water that might otherwise migrate through the permeable backfill of a utility trench.

5.4.4 Soil Sampling in Remedial Excavation

As the remedial excavations are extended, sampling locations will be established on the floors of the excavations at the intersections of a grid that will have lines spaced 25 ft. apart in both directions. To obtain samples for analysis, intact blocks of soil will be excavated from the target locations, whether they be on the dry bottom of an excavation or submerged beneath the water surface, and raised to the surface in the excavator bucket. A face of the block of soil in the bucket will be cut with a shovel to expose an undisturbed surface and a clean, 2-in. diameter by 6-in. long brass sampling tube will be driven into the cut soil face until the tube is completely filled with soil.

Following sample recovery, each sample tube will be cleaned externally, its ends covered with Teflon foil and closed with tightly-fitted plastic caps secured with adhesive-less tape. Each sample tube will then be labeled for identification, entered into chain-of-custody control and packed on chemical ice for transport to STL's laboratory in Pleasanton, California within 24 hours.

Each soil sample submitted to the laboratory will be analyzed for the following suite of analytes.

Analyte	Method of Analysis
Total Petroleum Hydrocarbons (quantified as Diesel)	EPA Method 8015M
Total Petroleum Hydrocarbons (quantified as Mineral Spirits)	EPA Method 8015M
Total Petroleum Hydrocarbons (quantified as Gasoline)	EPA Method 8260B
Benzene	EPA Method 8260B

Toluene	EPA Method 8260B
Ethyl benzene	EPA Method 8260B
Total Xylene Isomers	EPA Method 8260B

STL's laboratory is certified by the DHS to perform the soil analyses listed above.

> **Note:** The results of the analysis of the soil samples recovered from the remedial excavations will be summarized in tabular form and will be provided to the ACEHCS case officer as the remediation work progresses.

5.4.5 Completion of Backfilling with Low-permeability Fill

As noted above, when the remedial excavations have been backfilled with crushed concrete and rock to the extent that the rock forms a hard standing a few inches above the groundwater table, the remainder of the excavation will be backfilled by a low permeability, highly compacted engineered fill. The fill material will be taken from the stockpile of clean overburden soil that was removed from the surface of the site in the manner that was described in Section 5.4.1, above.

To assess its properties for use as engineered fill, two representative 5-gal. samples of the clean overburden soil stockpiled on the site will be taken to develop compaction curves for the materials according to procedure D1557-00 published by the American Society for Testing and Materials (**ASTM**) (American Society for Testing and Materials 2000c) and to identify its maximum dry density and its optimum moisture content for use as backfill. Constant head permeameter tests will also be conducted on the material when it is compacted to a relative density of 90% to assess the vertical hydraulic conductivity of the compacted fill. The latter data will be used in a post-remediation risk-based environmental analysis of the site in its as-built condition.

Using a heavy, pad-foot front-end loader will be used to place clean soil recovered from the stockpile over the rock base in the remedial excavation and to spread it in uniform, 6- to 8-in. thick layers, each of which will be compacted using the vibratory compactor to achieve a minimum relative density of 90%. A licensed technician working under the direction of the California-licensed geotechnical engineer will perform density tests on the compacted backfill using a nuclear density gauge, calibrated against the previously-developed compaction curves to measure the relative density of the compacted backfill according to the procedure specified by ASTM Standard D2922 (American Society for Testing and Materials 2001b).

Placement and compaction of clean, impermeable fill in a remedial excavation will continue until its surface is at an elevation equal to that of the current surface elevation of the site.

> **Note**: Final grading of the site, which will include, as necessary, placement of additional compacted, low-permeability fill, will be performed under the terms

of the general construction contract for the redevelopment project and is beyond the scope of this corrective action plan.

5.4.6 Grading Plan

As has been described above, earthwork associated with the proposed remediation program for the Oak Walk Site is limited to excavations that will be backfilled to the existing ground level. The design and implementation of additional grading that will subsequently be required to permit construction of the new buildings and placement of existing residential units on new foundations and to develop their associated infrastructure is beyond the scope of this corrective action plan.

Because in most cases remediation of affected soil in the groundwater involves opening and backfilling excavations so that the original ground surface is restored, formal grading plans are not normally required unless the remediation work itself requires significant re-grading of the surface of the site. However, for this project, submittal of a grading plan for the corrective action work to the City of Emeryville Public Works Department has been required. In response, SJC has prepared the grading plan shown on Figure I-26. The volumes of earth materials to be excavated, temporarily stockpiled, used as backfill and exported from and imported to the site during the remediation program are summarized in Table I-15. It is important to understand that the volumes cited in that Table are approximate. Actual volumes will depend upon the total volume of the soil that will be excavated as directed by the engineer in responsible charge of the remediation program and the depth at which the groundwater is encountered at the time the work is performed. The estimated volumes shown in Table I-15 do not include any materials that may have to be exported from or imported to the site to complete the final grading required for the redevelopment project. A plan for that work will be submitted to the City of Emeryville by the project's civil engineer and will replace the grading plan shown on Figure I-26, which is strictly limited to the approximate grades that will be extant upon completion of the environmental remediation program.

5.5 Engineered Vapor Barriers

To entirely eliminate any risk, however small, that vapors of any COCs might migrate from the subsurface into the residential or commercial spaces constructed on the Oak Walk Redevelopment Site, a gas-tight impermeable membrane that will not break down in the presence of benzene or other hydrocarbons will be installed beneath the ground floor slabs of each of the residential and commercial units that are to be constructed on the site. The placement of the membrane beneath the floor slabs is shown on Figure I-27. Note: the membrane will not be installed under the ground floor slab of the parking garage.

The impermeable membrane that will be installed beneath the floor slabs of the residential and commercial units will be Liquid Boot®, manufactured by LBI Technologies, Inc. of Santa Ana, California (**LBI**) or equivalent material that has been tested according to ASTM Standard D545-95 (2001a) and found to be resistant to deterioration in the presence of components of fuel hydrocarbons including benzene

(American Society for Testing and Materials 2001a). As is shown on Figure I-27, the Liquid Boot® membrane will be sprayed over a geotextile substrate laid over a gravel base until it reaches a minimum thickness of 60 mils. The membrane will also be installed vertically along the interior sides of the building's strip footings and column bases as well as around each utility pipe or other penetration passing through the floor slabs. That technique ensures that the membrane forms a complete seal against ingress of the gaseous and vapor phases of COCs into the building's interior spaces. No penetration of the impermeable membrane will be allowed after the membrane has been installed and cured.

When the membrane has cured, the concrete slab shown on Figure I-27 will be laid down over it.

> **Note:** The slab thickness and reinforcement shown on Figure I-27 are the minimum required by this corrective action plan. Thicker slabs or heavier reinforcement may be installed as required by the structural engineering design of the building.

5.6 Administrative Controls

After the proposed corrective action measures have been completed, but before property ownership of any of the commercial and residential units of the development is transferred to private parties, a deed restriction will be prepared that will place appropriate limits on future uses of the property and ensure the integrity of the impermeable membrane placed beneath the floor slabs of all buildings on the site.

The specific terms of the deed restrictions which will be applicable to each individually-owned residential or commercial unit and to the common area of the property will be prepared in consultation with ACEHCS. It is expected to include the following principal elements:

- No penetrations shall be made through the impermeable barrier installed beneath the floor slabs of each of the residential and commercial units located on the site. In the event of accidental damage to the impermeable membrane or if a future installation of a penetration through that membrane is unavoidable, the affected area of the membrane will be reconstructed so that its ability to completely prevent passage of gasses from the subsurface into the overlying structure is fully restored.

- Future use of the property shall be restricted to commercial or multi-family residential uses. Redevelopment for construction of new single-family homes will be prohibited. However, single-family use of the rehabilitated residential structures that will front onto 41st Street (see Figure I-3) will be permitted, but construction of swimming pools or similar infrastructure requiring excavation in excess of three feet BGS will be prohibited anywhere on the grounds of those properties.

6.0 POST REMEDIATION MONITORING

After backfilling of the remedial excavations on the Oak Walk Site has been completed, a soil gas survey will be conducted. Following construction of the buildings and infrastructure on the site, a total of 10 new groundwater-quality monitoring wells will be installed on the property so that, together with the eight currently-existing wells in 40th and 41st Streets and San Pablo Avenue, they can be used to implement a post-remediation groundwater-quality monitoring program.

6.1 Soil Gas Survey

At sites where soil and groundwater are affected by volatile contaminants, chemicals of concern in the form of gasses and vapors accumulate in the pore space of the soil in the Vadose zone above the capillary fringe that extends upward from the water table. Those gasses and vapors can be a source of vapors that may intrude into the indoor space of buildings constructed over affected areas of such sites.

<u>6.1.1 Computational Estimates of Accumulations of Vapors in Indoor Air</u>

Computational methods are available to assess health risks due to potential accumulation of chemical vapors in buildings due to the presence of contaminants in the subsurface. These methods require calculation of the concentrations of gas that partitions into the pore space in the soil from the contaminated soil particles and groundwater and the concentrations of those gasses that reach the surface through migration of the soil column. However, computed concentrations of chemical vapors in air due to the presence of contaminants in soil and groundwater, such as those derived from the widely-used method developed by Johnson and Ettinger (1991), are subject to a degree of uncertainty. For example, the Johnson-Ettinger model typically *overestimates* the concentrations of COCs in indoor air by a factor varying from 10 to 1,000 (Hartman, 2002).

Because the Johnson-Ettinger model provides highly-conservative results, it is widely used in risk assessment analyses and has been approved by the US-EPA (United States Environmental Protection Agency 1995b). Regulatory agencies that have approved the use of the Johnson-Ettinger model include those of the State of Michigan, whose Environmental Science Board confirmed its suitability for predicting vapor concentrations in the interiors of buildings after subjecting the method to a rigorous evaluation (Fisher *et al* 2001). For health risk assessments for indoor air at the Oak Walk Site, SJC has also adopted the Johnson-Ettinger model.

Computational overestimates of vapor in outdoor air produced by use of the Johnson-Ettinger model are more severe than is the case for indoor air. However, they can be can be conservatively bounded by comparing the results of computations based that model with the results of computations based on a model that assumes that the COCs in the subsurface behave as if they were vaporizing on the surface of the ground. Whichever of those highly conservative computations yields the lowest result is then used for the purpose of risk analysis. SJC adopted that procedure for the environmental risk analyses described herein.

At some (but not at all) sites, more accurate estimates of COC gasses and vapors that might migrate into the interior of buildings can be derived from direct measurement of the concentration of COCs in the pores in the vadose zones of the soil. The gasses and vapors in the soil pores are commonly known as "soil gas." However, for the reasons stated below, assessments based on soil gas measurements at the Oak Walk Site may produce unreliable and non-conservative results.

6.1.2 Limitations on Measurement of Soil Gas

Techniques are available to measure the concentrations of chemicals in soil gas to an acceptable degree of accuracy in gravels, course and fine sands and even in clean silts. However, this is not the case in clay or clayey soils. Reliable measurement of the concentration of chemicals in soil gas requires that the air in the soil pore space be sampled at a minimum depth of 5 ft. BGS. Shallower sampling introduces errors due to the effects of changes in atmospheric pressure on partitioning of the gas between water and air in the interstices of the soil (Peck 1960, California Department of Toxic Substances Control 2004).

The limitations of the methodology will severely affect the applicability of soil gas survey technology at the Oak Walk Site. As has been seen by examination of Table I-1, the groundwater table at the site varies between some 5.5 ft to 11.0 ft. BGS. Over all but a very small percentage of the site, soils down to that depth are clays and silty clays that, as is noted in Section 3.1.4 above, have hydraulic conductivities in the range of 1.0×10^{-8} cm/sec to 1.0×10^{-9} cm/sec. In such highly-impermeable materials, the capillary fringe that rises above the water table is on the order of 5 ft. high (Guymon 1994, Technical Advisory Committee 1996). Furthermore, as is described in Section 4.8.1 above, to comply with the geotechnical engineering requirements for the redevelopment project, surficial soils on the site will be re-engineered to form a compacted layer that will have a hydraulic conductivity of some 6.0×10^{-7} cm/sec. Under those conditions, due to the very shallow depth to the top of the capillary fringe that extends upward from the water table, there will be few, if any, locations on the Oak Walk Site where reliable measurements of the concentrations of COCs in soil gas can be made.

Of even greater concern than the limitations on soil gas testing at the Oak Walk Site that are imposed by the high water table is the dominant presence of clay soils in the subsurface. Clay particles can range downward in size to 10 angstroms with individual particles being separated from each other by even smaller distances that may be on the order of 5 angstroms (Grim 1953 and 1962). In the vadose zone in clays, water is present in the spaces between the clay particles that form the walls of the macropores. That water forms menisci between the clay particles in the walls of the macropores and due to their very small span they develop extremely high tensile strength (Skempton 1961). The mineralogy of clays can also be such that their surfaces have very high negative charge, which causes molecules of COC to be adsorbed onto them. Due to the combined effect of those phenomena, the permeability of the soil matrix to air is very close to zero (Lambe and Whitman 1969, Mitchell 1976).

Because of the physical and chemical forces that dominate the environment of the microscopic interstices in clay soils, the migration of COCs through them is dominated by diffusion rather than convection (Johnson, Cherry, and Pankanow 1989). In such soils very little gas migrates through the walls of the borings from which gas extraction is attempted during a soil gas survey. The result is that vapors that might accumulate in buildings constructed over such clayey strata can be severely *underestimated* if they are computed based on the results of soil gas surveys.

The limitations of measurements of COCs in soil gas are recognized in the guidance standards for implementation of soil gas surveys (American Society for Testing and Materials 2000d). The advisory document issued by the California Department of Toxic Substances Control and the California Regional Water Quality Control Board – Los Angeles Region (2003) specifically *prohibits* soil gas tests to be performed at locations where the bottom 5 ft of a test boring is in clay. At many sites where the water table is at shallow depth, such as is the case at the Oak Walk Redevelopment Site, an option to advance the boring to a depth where the clay is absent, as is suggested in the advisory document, is not available due to the shallow depth of the top of the capillary fringe that is present above the water table.

As is evidenced by the above discussion, SJC is well aware of the severe limitations on the applicability of soil gas measurement technology for estimation of environmental risks to potential accumulation of vapors from COCs in indoor space at sites having geology and hydrogeology of the type that is present at the Oak Walk Site. However, in recent years we have experienced an increase in calls for soil gas surveys to be conducted at contaminated sites without regard for their geology and hydrogeology. We suspect that this trend has been caused by naïve interpretations of the recently-published guidance documents promulgated by various divisions of the CALEPA (*e.g.,* California Department of Toxic Substances Control and California Regional Water Quality Control Board 2003 and California Department of Toxic Substances Control 2004) by persons who are not registered geotechnical engineers or who have not had the benefit of exposure to even an introductory course in soil mechanics.

6.1.3 Proposed Soil Gas Survey

In the professional opinion of the author of this document, for the reasons stated in Section 6.1.2 above, the Oak Walk Site is *not* a candidate for the use of a soil gas survey to assess accurately the potential concentrations of COCs in vapors that might accumulate in the interior space of buildings on the site. In fact, we have great concern that any estimates of the risks associated with such accumulations may be *severely underestimated* if those risks are based on calculations that rely on measurements of the concentrations of COCs in soil gas. However, to meet a requirement set by the City of Emeryville (City of Emeryville 2005), the soil gas survey described in the following paragraphs will be conducted at the Oak Walk Site when the soil and groundwater remediation program has been completed.

The proposed soil gas survey will be conducted following the placement of engineered fill on the site in compliance with the geotechnical engineered specifications for the redevelopment project. That fill will include the material used to restore the remedial excavations. This arrangement will permit the soil gas measurements to be made in the material that will actually be present when the proposed residential structures have been constructed on the property, which conditions will, in the context of contaminant transport, be significantly different from the currently-prevailing conditions.

The soil gas test locations are shown on Figure I-28. Those sites are located at the center of the foot print of representative ground floor residential and commercial units. Selected sites include those beneath future buildings where concentrations of COCs are relatively high in both the soil and groundwater. For example, a soil gas sample will be recovered from beneath the future location of the residential unit (Building Type 3A) located a short distance to the northwest of groundwater-quality monitoring well MW-2 which, as is shown on Figure I-18, is in an area where there are currently-elevated concentrations of benzene in groundwater.

At each soil gas testing location, the test hole will be advanced to a depth of 5 ft. BGS by a drilling rig operated by a contractor holding the requisite C57 license issued by the California State Contractors Licensing Board. If any is present, soil gas will be extracted from the test borings according to the applicable methodologies specified in the advisory document for active soil gas investigation issued by the DTSC and the RWQCB (California Department of Toxic Substances Control 2003, California Regional Water Quality Control Board - San Francisco Bay Region 2005).

Gas samples recovered from the test holes in sealed flasks issued by the laboratory will be stored on chemical ice and transported within 24 hours to STL’s laboratory in Pleasanton, California where they will be analyzed for the suite of volatile organic compounds included in EPA Method 8260. STL’s laboratory is certified by the DHS to perform those analyses.

6.1.4 Supplemental Soil Sampling and Analysis

As has been discussed in section 6.1.2, soil conditions at the Oak Walk Site are poorly suited to reliable measurement of COCs in soil gas. Accordingly, as is required by the DTSC’s guidance document on vapor intrusion into indoor air, soil samples will be recovered from the bottom of each of the borings opened to conduct the soil gas survey (California Department of Toxic Substances Control 2004).

While the borings for the soil gas survey are being drilled, the drilling equipment will be used to recover the soil samples in clean, plastic liners from the bottom of each hole. Following sample recovery, each sample tube will be cleaned externally, its ends covered with Teflon foil and closed with tightly-fitted plastic caps secured with adhesive-less tape. Each sample tube will then be labeled for identification, entered into chain-of-custody control and packed on chemical ice for transport to STL's laboratory in Pleasanton, California within 24 hours. They will be analyzed for the suite of volatile organic compounds included in EPA Method 8260.

The results of the analyses of the soil samples recovered from the soil gas borings will be added to the extensive accumulation of geotechnical data that has already been obtained for the Oak Walk Redevelopment Site. These will be available for post-remediation health risk assessments. These, together with the extended groundwater quality monitoring program described in section 6.2 below will be available.

6.2 Groundwater-quality Monitoring

When those risk assessments are performed, risks related to the possible accumulation of vapors in indoor space will be separately calculated from both the measured concentration of COCs in soil and groundwater and the measured concentration of COCs in soil gas. Any risks that might be present will be quantified based on the methodology that yields the highest estimated concentration of vapors of COCs in indoor or outdoor air.

To supplement the eight currently-existing groundwater-quality monitoring wells on the site (WCEW-1 and MW-2 through MW-8) and to permit groundwater-quality monitoring in the interior of the site in its post-remediated condition, after the proposed buildings are constructed and the paved areas completed a total of 10 new wells will be installed in the locations shown on Figure 1-29. Those well locations have been selected with consideration for the known distribution of analytes of concern in the subsurface, their proximity to residential and commercial buildings where soil and groundwater was affected, and the accessibility of well sites on the redeveloped property.

With the exception of proposed Monitoring Wells MW-16A, MW-16B and MW-16C, all the new monitoring wells will have a total depth of 20 feet. The purpose of the well cluster at location 16 is to assess any significant variations in the concentrations of COCs in groundwater with depth beneath the groundwater table. In a uniform but porous medium, petroleum hydrocarbons with a specific gravity less then 1.0 (*i.e.*, that are lighter then water), the concentrations of COCs are highest at the groundwater table and decline with depth in a Gaussian distribution so that they are reduced by at least an order of magnitude at a depth of no more then 10 ft. below the water table (American Society for Testing and Materials 2004). However, such idealized distributions of concentrations of COCs are rarely seen in the field because the distributions in the subsurface are actually controlled by the details of the microscopic and macroscopic lithology and stratigraphy.

In the case of the Oak Walk Site, the concentrations of COCs are greatest in the groundwater in the zones and channels of permeable soil shown on Figures I-7 through 1-14, through which the fuel hydrocarbons and industrial solvents have migrated from the underground storage tanks where they originated. The interstices of the highly impermeable clays and silty clays which are the dominant facies beneath the Oak Walk

Site contain less mobile groundwater which is less severely affected by COCs. In such environments, to insure that the groundwater that flows into monitoring wells contains a representative concentration of analytes in groundwater, experienced engineers design the wells so that they are continuously screened from a short distance above the groundwater table to the full depth of a monitoring well that is typically some 20 to 25 feet deep. That design provides confidence that the screened interval will include the thin beds of permeable facies through which the most severely-contaminated groundwater flows. However, as a conservative check to determine whether there are any unexpected variations in the concentration of COCs with depth beneath the water table, the cluster of wells MW-16A, -16B and -16C will include a 15-ft. well that will be screened from approximately one foot above the water table to the full depth of the well (16-A), a 20-ft. well that will be screened from 15 ft. to 20 ft. BGS (16-B) and a 25 ft. well that will be screened from 20 to 25 ft. BGS (16-C). The location for this well cluster has been selected to investigate conditions in the area of the site where the concentrations of the BTEX compounds are expected to be the highest in the post-remediated condition of the site.

6.2.1 Well Drilling and Soil Sampling

The monitoring well borings will be advanced using an 8-in., open-stem auger mounted on a drilling rig operated by a drilling contractor holding a C57 license issued by the California Contractors State License Board. The borings will be logged under the direction of a California-licensed geotechnical engineer.

While the borings for the proposed monitoring wells are being drilled, the drilling equipment will be used to recover soil samples in clean, brass tubes from a depth of 5 ft. in each hole - and at 5-ft. intervals thereafter, to the bottom of the boring. However, the engineer may direct additional or alternate samples to be obtained if the conditions revealed by the boring indicate such to be appropriate.

Following sample recovery, each sample tube will be cleaned externally, its ends covered with Teflon foil and closed with tightly-fitted plastic caps secured with adhesive-less tape. Each sample tube will then be labeled for identification, entered into chain-of-custody control and packed on chemical ice for transport to STL's laboratory in Pleasanton, California within 24 hours.

Each soil sample submitted to the laboratory will be analyzed for the following suite of analytes.

Analyte	Method of Analysis
Total Petroleum Hydrocarbons (quantified as Diesel)	EPA Method 8015M
Total Petroleum Hydrocarbons (quantified as Mineral Spirits)	EPA Method 8015M

Total Petroleum Hydrocarbons (quantified as Gasoline)	EPA Method 8260B
Benzene	EPA Method 8260B
Toluene	EPA Method 8260B
Ethyl benzene	EPA Method 8260B
Total Xylene Isomers	EPA Method 8260B

STL's laboratory is certified by the DHS to perform the soil analyses listed above.

6.2.2 Disposal of Drill Cuttings

Drill cuttings from the well borings will be retained in 55-gal., close-topped, steel drums. When full, the drums will be closed and placed in storage in a secure area of the Oak Walk Site until the results of analyses of soil and water samples are available. When the analytical results are obtained, the soil in the drums will be classified and transported for disposal at a land fill that is permitted to receive such materials. Soil affected by components of fuel hydrocarbons will be loaded into a truck and shipped for disposal at a permitted Class II disposal facility in Manteca, California.

6.2.3 Well Design

The groundwater monitoring wells will be constructed using 2-in. diameter PVC casings with 0.02-in. machine-cut screen slots. The casings will be centered in the 8-in diameter well borings. Except in the cases of MW-16A, MW-16B and MW-16C, the screens will extend from approximately 1-ft above the high groundwater elevation to the bottom of the well. In the case of those three wells the screen intervals will be five feet long and located at the bottom of the well. The annular space between the screened interval and the boring wall will be filled with No. 3 Monterey sand, which will serve as a filter. Above that, hydrated bentonite will form the well seal. Each casing will be equipped with a water-tight, lockable casing cap and the well head will be enclosed in a flush-mounted well head housing. These and other details of the well construction are shown on Figure I-30 and I-31.

6.2.4 Well Development

Following construction, the wells will be developed by pumping and surging and by bailing a minimum of 10 well volumes from each. The development water will be staged on-site in 55-gal., closed-top, steel drums.

6.2.5 Survey of Well-head Locations and Elevations

The locations of the new wells will be surveyed by a California-registered land surveyor, their latitudes and longitudes computed and the elevations of both the top of the casing and the wellhead box cover frame of each will be determined relative to the National Vertical Datum (**NAVD**) in compliance with California Bill AB 2886 (Water Code Sections 13195-13198).

6.2.6 Determination of Groundwater Elevations

After a delay of at least one week following development of the newly-installed groundwater-quality monitoring wells, the depth from the top of the casing to the water table will be measured using a conductivity meter in all monitoring wells that will be extant at the site at that time. That data will be used to compute the groundwater table elevations relative to the NAVD. The computed groundwater table elevations will be used to produce a contour map of the groundwater table and to determine the direction and magnitude of the groundwater flow gradient.

6.2.7 Well Purging

After the depths to groundwater are measured, a small-diameter, submersible pump will be used to purge each groundwater-quality monitoring well of stagnant water. The pumped water will be discharged into 5-gal. pails, each of which will, in turn, be discharged into open-topped, 55-gallon drums, which will be stored in a secure area on the Oak Walk property.

During the purging procedure, the temperature, electrical conductivity and pH of the stream of purge water will be monitored by periodically checking those parameters using a multi-function electronic meter. Purging will continue until all three parameters stabilize, *i.e.*, variations between measurements are less than 10%. The array of parametric results for each well will be recorded in field notes.

6.2.8 Groundwater Sampling Procedure

After purging, samples will be recovered from each monitoring well to be sampled using a disposable bailer. Water brought to the surface in the bailers will be decanted via a discharge spigot valve placed in the bottom of the bailer so as to completely fill clean glassware supplied by the laboratory. The sample vials will then be tightly closed, labeled for identification, entered into chain-of-custody control and packed on chemical ice for transport, within 24 hours, to STL's laboratory in Pleasanton, California.

6.2.9 Groundwater Analyses

Each groundwater water sample will be analyzed for the following suite of analytes.

Analyte	Method of Analysis
Total Petroleum Hydrocarbons (quantified as Diesel)	EPA Method 8015M with pre-treatment by EPA Method 3630.
Total Petroleum Hydrocarbons (quantified as Mineral Spirits)	EPA Method 8015M with pre-treatment by EPA Method 3630.
Total Petroleum Hydrocarbons (quantified as Gasoline)	EPA Method 8260B
Benzene	EPA Method 8260B
Toluene	EPA Method 8260B
Ethylbenzene	EPA Method 8260B
Total Xylene Isomers	EPA Method 8260B
tertiary-Butyl alcohol	EPA Method 8260B
Methyl-tertiary butyl ether	EPA Method 8260B
Di-isopropyl ether	EPA Method 8260B
Ethyl tertiary-butyl ether	EPA Method 8260B
Tertiary-amyl methyl ether	EPA Method 8260B

STL's laboratory is certified by the DHS to perform the groundwater analyses listed above.

6.2.10 Disposal of Development and Purge Water

Development and purge water temporarily held in the 55-gallon drums on the Oak Walk Site will be shipped to a permitted recycling facility for disposal, following several rounds of groundwater sampling and analysis, when sufficient quantity has accumulated for that to be done economically.

6.2.11 Quarterly Groundwater Monitoring

Following completion of the initial round of groundwater-quality monitoring conducted after the construction on the Oak Walk Site, a program of quarterly monitoring rounds will be initiated. After one year, the compiled results of the groundwater monitoring program will be reviewed with the ACEHCS Case Officer and the need for additional monitoring, if any, will be evaluated.

7.0 PROJECT SCHEDULE AND ENGINEER'S ESTIMATE

SJC has developed a project schedule and an engineer's estimate for completion of the proposed corrective action at the Oak Walk Redevelopment Site.

7.1 Project Schedule

The project schedule is shown on Figure I-32. It should be noted that the activities shown on that Figure do not include elements of construction work needed for redevelopment of the Oak Walk Site. For example, it is assumed that the exploratory trenching designed to further delineate the geometry of paleo streambeds beneath the site will begin immediately following completion of the preparatory demolition and site clearing. However, other elements of the corrective action plan such as placement of impermeable barriers beneath the buildings to be built on the site will not occur until after their foundations have been constructed. Similarly, installation of groundwater-quality monitoring wells required for the post-remediation groundwater-quality monitoring program cannot be installed until all construction, including paving and landscaping, is complete. Although construction activities that must be completed before some elements of the environmental corrective action plan can be implemented, they are not specifically included in the corrective action project schedule. However, the milestones shown on that schedule do reflect the interaction between the conventional construction and the remediation work.

As is indicated on Figure I-32, it is expected that the remediation of soil and groundwater at the Oak Walk Site will be completed within six weeks of the date that the remediation contractor mobilizes to the site. That mobilization is expected to occur immediately following the demolition of existing buildings on the site. When the remedial excavations have been completed the soil gas survey will be initiated and it is expected to be completed within two weeks. There will then be a hiatus in the corrective action program until it is possible to install the additional groundwater-quality wells at the site. The installation of those wells will follow completion of building and civil engineering construction on the property, which is expected to occur approximately two years following the start of work. The post-remediation groundwater-quality monitoring program is expected to continue for one year.

7.2 Engineer's Estimate

SJC's engineer's estimate for implementation of the corrective action described in this plan is presented in Appendix I-B. The presentation includes a summary that segregates the estimated costs according to the principal subdivisions of the work required to complete the elements of the corrective action plan that will precede occupancy of the redeveloped site and the post-construction groundwater-quality monitoring program.

The total estimated cost for completion of all elements of the corrective action program is $854,000. That estimate is considered to be reasonably conservative based on SJC's experience with remediation projects of similar scope conducted at sites with similar environmental and hydrostratigraphic conditions. However, as is commonly the case for projects involving work in the subsurface beneath a contaminated site, actual costs may be significantly lower or higher depending upon the actual volume of contaminated soil and groundwater removed from the site and the depths to the water table encountered in the remedial excavation at the time the work is performed.

The costs included in the engineer's estimate are for the scope of the corrective action measures presented in this plan. Those costs include the cost of removing and replacing clean overburden that overlies contaminated soil and other ancillary work directly related to the implementation of the corrective action measures. They do not include the cost of the general earthwork otherwise required to prepare the site for redevelopment or any other civil engineering or construction work that would be required if the site were not affected by releases of industrial solvents and hydrocarbons.

8.0 PROJECT SPECIFIC HEALTH AND SAFETY PLAN

All of the work described in this Work Plan will be conducted in compliance with the standard requirements of The San Joaquin Company Inc. *Master Health and Safety Plan* (The San Joaquin Company Inc. 1993), a copy of which is on file at ACEHCS, and the Project Specific Health and Safety Plan included herein as Appendix I-C.

9.0 REPORTS

During the progress of the corrective action work at the Oak Walk Site, the Engineer in Responsible Charge will maintain close communication with the ACEHCS case officer and provide results of analyses of soil and groundwater as they become available.

Following installation of the additional groundwater-monitoring wells described in Section 6.2 of this report, well completion reports, together with attached boring logs, well construction details and groundwater quality data, will be filed with the California Department of Water Resources (**DWR**) and with the ACPWA, as required by Sections 13700 through 13806 of the California Water Code regulatory requirements, Well Completion Reports (Form 188).

When the corrective action program is complete, a Corrective Action Report that will document the corrective action program and provide a record of all observations and laboratory data generated during the progress of the work will be prepared and submitted to the ACEHCS for review. That report will include a post-remediation risk-based environmental analysis of the site in its as-built condition.

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TABLE I - 1

DEPTHS TO GROUNDWATER
AT OAK WALK REDEVELOPMENT SITE

Well No.	Date Measured	Casing Elevation ft. MSL	Groundwater Depth ft.	Groundwater Elevation ft. MSL
WCEW-1		41.73		
	06/02/98		7.24	34.49
	03/13/98		5.92	35.81
	12/05/97		6.00	35.73
	09/26/97		8.06	33.67
	05/19/04		7.88	33.85
	11/08/04		7.13	34.60
MW-2		44.40		
	05/19/04		5.98	38.42
	11/08/04		4.94	39.46
MW-3		45.49		
	05/19/04		5.66	39.83
	11/08/04		5.89	39.60
MW-4		47.31		
	05/19/04		6.19	41.12
	11/08/04		5.81	41.50
MW-5		42.51		
	05/19/04		7.39	35.12
	11/08/04		7.09	35.42
MW-6		43.35		
	05/19/04		7.16	36.19
	11/08/04		6.93	36.42
MW-7		44.75		
	05/19/04		8.40	36.35
	11/08/04		8.10	36.65
MW-8		48.38		
	05/19/04		9.65	38.73
	11/08/04		9.05	39.33
MWT-1		42.98		
	05/19/04		8.43	34.55
	11/08/04		6.82	36.16
MWT-2		45.28		
	05/19/04		7.69	37.59
	11/08/04		7.17	38.11

Well No.	Date Measured	Casing Elevation ft. MSL	Groundwater Depth ft.	Groundwater Elevation ft. MSL
MWT-3		47.64		
	05/19/04		7.64	40.00
	11/08/04		7.66	39.98
MWT-4		44.74		
	05/19/04		8.43	36.31
	11/08/04		7.99	36.75
MWT-5		47.10		
	05/19/04		9.07	38.03
	11/08/04		8.84	38.26
MWT-6		45.21		
	05/19/04		9.05	36.16
	11/08/04		8.73	36.48
MWT-7 [1]		46.61		
	05/19/04		9.90	36.71
	11/08/04	45.69	8.60	37.09
MWT-8		47.23		
	05/19/04		9.65	37.58
	11/08/04		9.31	37.92
MWT-9		45.78		
	05/19/04		8.70	37.08
	11/08/04		8.23	37.55
MWT-10		47.22		
	05/19/04		9.53	37.69
	11/08/04		9.03	38.19
MWT-11		46.63		
	11/08/04		9.71	36.92
MWT-12		47.97		
	11/08/04		10.79	37.18
MWT-13		48.16		
	11/08/04		10.65	37.51
MWT-14		47.85		
	11/08/04		9.63	38.22

Notes:

1) MWT-7 casing truncated by vandals. Elevation resurveyed on 11/10/04

TABLE I - 2

RESULTS OF ANALYSES OF SOIL SAMPLES RECOVERED FROM OAK WALK REDEVELOPMENT SITE FOR ORGANIC CHEMICALS

			Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds													PNAs		
Sample ID	**Date Sampled**	**Depth BGS**	**Mineral Spirits**	**TPHd (diesel)**	**TPHg (gasoline)**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**MTBE**	**Acetone**	**2-Butanone**	**n-Butylbenzene**	**sec-Butylbenzene**	**tert-Butylbenzene**	**Isopropylbenzene**	**p-Isopropylbenzene**	**p-Isopropyltoluene**	**n-Propylbenzene**	**1,2,4-Trimethylbenzene**	**1,3,5-Trimethylbenzene**	**Other VOCs by 8260B**	**Napthalene**	**2-Methylnapthalene**	**15 Other PNAs by 8270C**
		ft.	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	**GC/MS**	mg/Kg	mg/Kg	mg/Kg
Trenches - December 2003																									
T1 - 7.0	12/03/03	7.0	n/a	70	**530** [5]	ND	ND	8.3	4.7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T1 - 8.5	12/03/03	8.5	n/a	90	**1,400** [5]	ND	ND	10	1.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T2 - 6.5	12/03/03	6.5	n/a	ND	3.8 [5]	0.026	ND	0.024	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T2 - 8.5	12/03/03	8.5	n/a	1.5	**300** [5]	**1.1**	3.1	6.4	**27**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T3 - 8.0	12/03/03	8.0	n/a	4.3	6.4	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a
T3 - 9.5	12/03/03	9.5	n/a	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T4 - 10.5	12/03/03	10.5	n/a	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	ND
T5 - 9.0	12/03/03	9	ND	70 [4]	**400**	ND	2.6	6.1	**36**	ND	n/a	n/a	ND	0.6	ND	0.88	ND	ND	3.9	25	7.6	ND	**4.1**	**1.8**	ND
T6 - 8.5	12/02/03	8.5	n/a	70	**3,000** [5]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T7 - 9.0	12/02/03	9.0	n/a	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T8 - 8.5	12/02/03	8.5	n/a	**150**	**820** [5]	ND	ND	ND	ND	ND	n/a	n/a	0.51	0.81	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	ND
Borings and Wells 2004																									
BE-1-5.0	04/02/04	5.0	62 [3]	ND	**540**	ND	ND	5.1	1.6	ND	ND	ND	8.4	3.1	ND	2.7	ND	0.29	13	12	3.8	ND [6]	**18**	**3.2**	ND [9]
BE-1-10.0	04/02/04	10.0	**130** [3]	ND	**3,600**	**13**	**140**	**80**	**430**	ND	ND	ND	3.7	ND	ND	1.4	ND	ND	6.2	32	12	ND	**7.5**	ND	ND
BE-1-13.5	04/02/04	13.5	n/a [2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BE-1-15.0	04/02/04	15.0	ND	ND	7.9	0.096	0.029	0.12	0.6	0.011	ND	ND	0.014	ND	ND	ND	ND	ND	0.027	0.054	0.013	ND	0.12	ND	ND
BE-1-20.0	04/02/04	20.0	ND	ND	2.5	0.027	0.011	0.016	0.033	ND	0.031	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-1-25.0	04/02/04	25.0	ND	ND	ND	ND	0.0053	ND	0.011	0.012	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-2-5.0	04/02/04	5.0	27 [3]	ND	**340**	**1.3**	ND	5.7	**26**	ND	ND	ND	9.1	2.4	ND	2.5	ND	ND	12	37	14	ND	**18**	**1.4**	ND
BE-2-10.0	04/02/04	10.0	24 [3]	ND	**820**	**7.4**	**33.0**	16.0	**87.0**	ND	ND	ND	3.3	ND	ND	1.3	ND	ND	5.7	29	10	ND	**6.8**	**0.31**	ND
BE-2-15.0	04/02/04	15.0	ND	2.5 [8]	5.0	0.052	ND	0.027	ND	0.075	0.14	ND	0.046	0.019	ND	0.0097	ND	ND	0.046	ND	ND	ND	ND	ND	ND
BE-2-20.0	04/02/04	20.0	ND	2.4 [7]	ND	ND	ND	ND	0.0086	0.11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-2-25.0	04/02/04	25.0	ND	ND	ND	0.053	0.051	0.038	0.15	0.018	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0069	ND	ND	ND	ND	ND
BE-3-5.0	04/02/04	5.0	ND	1.1 [8]	ND	ND	ND	ND	ND	ND	0.11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-3-10.0	04/02/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	0.025	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-3-15.0	04/02/04	15.0	ND	1.3 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-3-20.0	04/02/04	20.0	**190**	ND	**1,600** [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

SJC

			Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds													PNAs		
Sample ID	Date Sampled	Depth BGS	Mineral Spirits	TPHd (diesel)	TPHg (gasoline)	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	Acetone	2-Butanone	n-Butylbenzene	sec-Butylbenzene	tert-Butylbenzene	Isopropylbenzene	p-Isopropylbenzene	p-Isopropyltoluene	n-Propylbenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Other VOCs by 8260B	Napthalene	2-Methylnapthalene	15 Other PNAs by 8270C
		ft.	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	GC/MS	mg/Kg	mg/Kg	mg/Kg
BE-4-5.0	04/01/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-4-9.5	04/01/04	9.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-4-14.5	04/01/04	14.5	ND	1.3 [8]	2.8	0.006	ND	0.047	0.024	ND	0.04	ND	0.081	0.027	ND	0.017	0.0099	ND	0.081	0.12	0.005	ND	0.086	ND	ND
BE-4-19.5	04/01/04	19.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-5-5.0	04/01/04	5.0	ND	4.5 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-5-10.0	04/01/04	10.0	14	ND	**340** [5]	ND	ND	ND	ND	ND	ND	ND	0.092	0.046	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-5-14.5	04/01/04	14.5	ND	2.5 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-5-19.5	04/01/04	19.5	ND	12 [7]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BE-6-4.0	04/01/04	4.0	ND	22 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-6-9.5	04/01/04	9.5	ND	**1,200** [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0066	ND	ND
BE-6-15.0	04/01/04	15.0	ND	11 [8]	**130** [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-6-20.0	04/01/04	20.0	ND	4.9 [8]	2.6 [5]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BG-1-5	04/06/04	5.0	ND	ND	1.30	ND	ND	ND	ND	ND	0.046	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	ND
BG-1-10	04/06/04	10.0	35 [3]	ND	**870**	ND	9.0	13	**75**	ND	ND	ND	2.6	ND	ND	1.1	ND	ND	4.4	23	8.1	ND	**4.2**	**3.5**	ND
BG-1-15	04/06/04	15.0	ND	3.7 [8]	**270**	**1.1**	0.99	4.9	**24**	ND	0.065	ND	0.028	ND	ND	ND	ND	ND	0.025	0.160	0.056	ND	0.055	ND	ND
BG-1-20	04/06/04	20.0	ND	ND	ND	0.0062	ND	ND	ND	0.005	0.044	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BG-1-25	04/06/04	25.0	ND	ND	ND	ND	ND	0.0051	0.023	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BG-1-30	04/06/04	30.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a
BG-1-35	04/06/04	35.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BG-2-5.0	04/06/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BG-2-10.5	04/06/04	10.5	47 [3]	ND	**1,200**	ND	ND	16	**80**	ND	ND	ND	6.0	ND	ND	2.4	ND	ND	10	50	17	ND	**8.5**	**3**	ND
BG-2-15.0	04/06/04	15.0	ND	ND	ND	ND	ND	ND	ND	ND	0.028	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BG-2-18.0	04/06/04	18.0	ND	ND	ND	ND	ND	ND	ND	0.020	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BG-2-21.0	04/06/04	21.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BG-2-25.0	04/06/04	25.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BG-2-30.0	04/06/04	30.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BG-2-35.0	04/06/04	35.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-1-4.0	04/02/04	4.0	ND	ND	ND	ND	ND	ND	0.0063	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-1-11.5	04/02/04	11.5	74	ND	**2,400** [5]	ND	ND	ND	ND	ND	ND	ND	ND	0.023	0.022	ND	ND	ND	ND	ND	ND	ND	ND	**1.7**	ND
MWT-1-15.0	04/02/04	15.0	ND	2.8 [8]	ND	ND	ND	ND	ND	ND	ND	ND	0.0051	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-1-20 [11]	04/02/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-2-5.5	04/02/04	5.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-2-10.0	04/02/04	10.0	12 [3]	ND	**440**	ND	ND	2.3	6.8	ND	ND	ND	1.8	0.44	ND	0.500	ND	ND	2.4	10	3.8	ND	**1.2**	**0.93**	ND
MWT-2-15.0	04/02/04	15.0	ND	8.0 [8]	**120**	ND	ND	0.67	1.2	ND	0.099	0.027	0.035	0.0079	ND	0.0055	ND	ND	0.032	0.18	0.047	ND	0.08	0.14	ND
MWT-2-20.0	04/02/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

SJC

			Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds													PNAs		
Sample ID	**Date Sampled**	**Depth BGS** *ft.*	**Mineral Spirits** mg/Kg	**TPHd (diesel)** mg/Kg	**TPHg (gasoline)** mg/Kg	**Benzene** mg/Kg	**Toluene** mg/Kg	**Ethylbenzene** mg/Kg	**Total Xylenes** mg/Kg	**MTBE** mg/Kg	**Acetone** mg/Kg	**2-Butanone** mg/Kg	**n-Butylbenzene** mg/Kg	**sec-Butylbenzene** mg/Kg	**tert-Butylbenzene** mg/Kg	**Isopropylbenzene** mg/Kg	**p-Isopropylbenzene** mg/Kg	**p-Isopropyltoluene** mg/Kg	**n-Propylbenzene** mg/Kg	**1,2,4-Trimethylbenzene** mg/Kg	**1,3,5-Trimethylbenzene** mg/Kg	**Other VOCs by 8260B** **GC/MS**	**Napthalene** mg/Kg	**2-Methylnapthalene** mg/Kg	**15 Other PNAs by 8270C** mg/Kg
MWT-3-5.0	04/02/04	5.0	ND	1.2 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-3-10.0	04/02/04	10.0	ND	7.5 [8]	7.0 [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.026	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-3-15.0	04/02/04	15.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-3-20.0	04/02/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-4-4.0	04/01/04	4.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-4-10.0	04/01/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-4-15.0	04/01/04	15.0	**150**	ND	**120** [5]	ND	ND	ND	ND	ND	ND	ND	0.026	0.015	0.0094	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-4-20.0	04/01/04	20.0	ND	2.4 [8]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-5-5.0	04/02/04	5.0	ND	1.3 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-5-10.0	04/02/04	10.0	ND	1.1 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-5-15.0	04/02/04	15.0	ND	7.0 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-5-20.0	04/02/04	20.0	ND	7.6 [7]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-6-5.0	04/01/04	5.0	ND	2.1 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-6-10.5	04/01/04	10.5	51	ND	**860** [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-6-14.5	04/01/04	14.5	ND	1.4 [8]	9.0 [5]	ND	ND	ND	ND	ND	0.064	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-6-19.5	04/01/04	19.5	ND	8.5 [8]	13.0 [5]	ND	ND	ND	0.09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-7-5.0	04/01/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-7-10.0	04/01/04	10.0	ND	3.5 [8]	4.40 [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-7-15.0	04/01/04	15.0	ND	3.4 [8]	7.20 [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-7-20.0	04/01/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	0.088	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-8-5.5	04/02/04	5.5	ND	1.5 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-8-10.5	04/02/04	10.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-8-15.0	04/02/04	15.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-8-18.0	04/02/04	18.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-9-4.0	04/01/04	4.0	ND	3.3 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-9-9.5	04/01/04	9.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-9-14.5	04/01/04	14.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-9-19.5	04/01/04	19.5	ND	14 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-10-5.0	04/01/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-10-10.0	04/01/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-10-15.0	04/01/04	15.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-10-20	04/01/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-11-5	11/05/04	5.0	ND	1.1 [12]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-11-10	11/05/04	10.0	33 [13]	ND	**170** [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-11-15	11/05/04	15.0	ND	1.4 [12]	27 [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-11-19.5	11/05/04	19.5	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

			Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds													PNAs		
Sample ID	**Date Sampled**	**Depth BGS** *ft.*	**Mineral Spirits** mg/Kg	**TPHd (diesel)** mg/Kg	**TPHg (gasoline)** mg/Kg	**Benzene** mg/Kg	**Toluene** mg/Kg	**Ethylbenzene** mg/Kg	**Total Xylenes** mg/Kg	**MTBE** mg/Kg	**Acetone** mg/Kg	**2-Butanone** mg/Kg	**n-Butylbenzene** mg/Kg	**sec-Butylbenzene** mg/Kg	**tert-Butylbenzene** mg/Kg	**Isopropylbenzene** mg/Kg	**p-Isopropylbenzene** mg/Kg	**p-Isopropyltoluene** mg/Kg	**n-Propylbenzene** mg/Kg	**1,2,4-Trimethylbenzene** mg/Kg	**1,3,5-Trimethylbenzene** mg/Kg	**Other VOCs by 8260B** **GC/MS**	**Napthalene** mg/Kg	**2-Methylnapthalene** mg/Kg	**15 Other PNAs by 8270C** mg/Kg
MWT-12-5	11/05/04	5.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-12-10	11/05/04	10.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-12-15	11/05/04	15.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-12-19.5	11/05/04	19.5	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-13-5	11/05/04	5.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-13-10	11/05/04	10.0	40 [13]	ND	**520 [14]**	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-13-15	11/05/04	15.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-13-19	11/05/04	19.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-14-5	11/05/04	5.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-14-10	11/05/04	10.0	**110 [13]**	ND	**360** [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-14-15	11/05/04	15.0	12 [13]	ND	1.2 [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-14-19.5	11/05/04	19.5	15 [13]	ND	82 [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MW-2-5.0	04/07/04	5.0	29 [3]	ND	**860**	ND	ND	19	**87**	ND	ND	ND	2.9	ND	ND	0.098	ND	ND	4.4	27	9.8	ND	**7.2**	**1.1**	ND
MW-2-10.0	04/07/04	10.0	16 [3]	ND	**530**	ND	2.4	9.2	**47**	ND	ND	ND	2.1	ND	ND	0.77	ND	ND	3.4	21	7.4	ND	**5.0**	0.23	ND
MW-2-15.0	04/07/04	15.0	ND	ND	ND	0.03	ND	0.021	0.029	ND	0.04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0085	ND	ND
MW-2-20.0	04/07/04	20.0	ND	ND	ND	ND	0.0062	ND	0.037	0.12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3-5.0	04/07/04	5.0	Lost	Core																					
MW-3-10.0	04/07/04	10.0	Lost	Core																					
MW-3-14.0	04/07/04	14.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3-20.0	04/07/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4-5.5	4/30/2004	5.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4-10.5	4/30/2004	10.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4-15.5	4/30/2004	15.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4-19.5	4/30/2004	19.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5-6.0	4/30/2004	6.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5-10.0	4/30/2004	10.0	27	ND	**1,000** [5]	ND	ND	0.55	3.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5-15.5	4/30/2004	15.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5-19.5	4/30/2004	19.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-6-5.0	04/07/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-6-10.0	04/07/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-6-15.0	04/07/04	15.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MW-6-20.0	04/07/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7-5.0	04/06/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7-10.0	04/06/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7-15.0	04/06/04	15.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MW-7-20.0	04/06/04	20.0	ND	7.9 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

SJC

			Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds												PNAs		
Sample ID	**Date Sampled**	**Depth BGS**	**Mineral Spirits**	**TPHd (diesel)**	**TPHg (gasoline)**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**MTBE**	**Acetone**	**2-Butanone**	**n-Butylbenzene**	**sec-Butylbenzene**	**tert-Butylbenzene**	**Isopropylbenzene**	**p-Isopropylbenzene**	**p-Isopropyltoluene**	**n-Propylbenzene**	**1,2,4-Trimethylbenzene**	**1,3,5-Trimethylbenzene**	**Other VOCs by 8260B**	**Napthalene**	**2-Methylnapthalene**	**15 Other PNAs by 8270C**
		ft.	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	**GC/MS**	mg/Kg	mg/Kg	mg/Kg
MW-8-5.0	04/07/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-8-10.0	04/07/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-8-15.0	04/06/04	15.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MW-8-20.0	04/06/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

(1) ND = Not Detected above the Method Detection Limit (MDL).
(2) n/a = Not analyzed
(3) The laboratory reports that the detected hydrocarbon does not match its mineral spirits standard.
(4) The laboratory reports that the detected hydrocarbon does not match its Diesel standard.
(5) The laboratory reports that the detected hydrocarbon does not match its standard for gasoline.
(6) Laboratory Method EPA 8260B analyzes for 108 Volatile Organic Compounds. Only those found are listed separately in this table.
(7) The laboratory reports that the compound reported reflects individual or discrete unidentified peaks detected in the diesel range; the pattern does not match a typical fuel standard.
(8) The laboratory reports that the hydrocarbon reported is in the early Diesel range and does not match the laboratory's Diesel standard.
(9) Laboratory Method EPA 8270C analyzes for 17 Polynuclear Aromatics. Only those found are listed separately in this table.
(10) Concentrations in **bold** script exceed the 2005 San Francisco Bay Area RWQCB's Environmental Screening Levels in shallow soils (<3m bgs) where groundwater is not a source of drinking water.
(11) MWT-1-20.0 was also analyzed for 65 Semi-volatile chemicals by GC/MD - EPA8270C. None were detected in the sample.
(12) Quantity of unknown hydrocarbon(s) in sample based on Diesel
(13) Quantity of unknown hydrocarbon(s) in sample based on Mineral Spirits
(14) Quantity of unknown hydrocarbon(s) in sample based on Gasoline

TABLE I - 3

HEAVY METALS IN SOIL SAMPLES RECOVERED FROM SELECTED SOIL BORINGS
OAK WALK REDEVELOPMENT SITE

Sample No.	**Date Sampled**	**Depth BGS** ft.	**Anti-mony** mg/Kg	**Ar-senic** mg/Kg	**Bar-ium** mg/Kg	**Beryl-lium** mg/Kg	**Cad-mium** mg/Kg	**Chro-mium III** mg/Kg	**Chro-mium VI** mg/Kg	**Cobalt** mg/Kg	**Copper** mg/Kg	**Lead** mg/Kg	**Molyb-denum** mg/Kg	**Nickel** mg/Kg	**Sele-nium** mg/Kg	**Silver** mg/Kg	**Thal-lium** mg/Kg	**Vana-dium** mg/Kg	**Zinc** mg/Kg	**Mer-cury** mg/Kg
BE-4-5.5	04/01/04	5.5	ND	2.6	110	ND	ND	27	n/a	2.6	17	4.3	ND	24	ND	ND	ND	22	31	ND
BE-1-13.5	04/02/04	13.5	ND	1.3	110	ND	ND	35	ND	4.9	12	4.1	ND	46	ND	ND	ND	24	28	0.053
BE-3-19.5	04/02/04	19.5	ND	2.1	150	ND	ND	30	n/a	6.9	19	5.4	ND	26	ND	ND	ND	25	32	ND

Notes:

(1) ND = Not Detected above the Method Detection Limit (MDL).
(2) Concentrations in **bold** script exceed the 2005 San Francisco Bay Area RWQCB's Environmental Screening Levels in shallow soil (<3m bgs) and where groundwater is not a source of drinking water

TABLE I - 4

RESULTS OF ANALYSES OF GROUNDWATER SAMPLES RECOVERED FROM TRENCHES AND WELLS
OAK WALK REDEVELOPMENT SITE

		Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds												PNAs		
Sample ID	**Date Sampled**	**TPHd (diesel)** µg/L	**Mineral Spirits** µg/L	**TPHg (gasoline)** µg/L	**Benzene** µg/L	**Toluene** µg/L	**Ethylbenzene** µg/L	**Total Xylenes** µg/L	**MTBE** µg/L	**Acetone** µg/L	**2-Butanone** µg/L	**n-Butylbenzene** µg/L	**sec-Butylbenzene** µg/L	**tert-Butylbenzene** µg/L	**Isopropylbenzene** µg/L	**p-Isopropylbenzene** µg/L	**p-Isopropyltoluene** µg/L	**n-propylbenzene** µg/L	**1,2,4-trimethylbenzene** µg/L	**1,3,5-trimethylbenzene** µg/L	**Naphthalene** µg/L	**2-Methylnapthalene** µg/L	**15 Other PNAs by 8270C** µg/L
Trenches December 2003																							
T3-W	12/03/03	**2300** [3]	n/a	**6300** [5]	ND	ND	31	30	ND	ND	ND	100	47	ND	ND	23	ND	230	320	110	12	n/a	n/a
T7-W	12/02/03	ND	n/a	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a
Wells 2004																							
WCEW-1	5/19/04	ND	**600** [6]	**3700**	**90**	0.66	48	56	170	ND	ND	ND	8.7	ND	12	1.8	ND	31	14	5.6	8.3	ND	ND
MW-2	5/19/04	ND	**2100** [6]	**49000**	**7900**	**2100**	**980**	**8300**	770	ND	ND	100	ND	ND	ND	ND	ND	ND	1600	460	**490**	ND	ND
MW-3	5/19/04	ND	**420** [6]	**1300**	ND	ND	ND	1.1	5.8	ND	ND	14	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND
MW-4	5/19/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5	5/19/04	ND	**330** [6]	**2600** [5]	ND	ND	ND	ND	17	ND	ND	ND	ND	2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-6	5/19/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	5/19/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-8	5/19/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-1	5/19/04	ND	74 [6]	350	ND	ND	ND	ND	ND	ND	ND	8.0	ND	ND	1.0	ND	ND	1.0	ND	ND	ND	ND	ND
MWT-2	5/19/04	ND	**3200** [6]	**28000**	**460**	ND	**1200**	**2700**	66	ND	ND	100	ND	ND	ND	ND	ND	310	1600	490	**340**	ND	ND
MWT-3	5/19/04	ND	**450**	**1000** [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND

		Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds													PNAs		
Sample ID	Date Sampled	TPHd (diesel) µg/L	Mineral Spirits µg/L	TPHg (gasoline) µg/L	Benzene µg/L	Toluene µg/L	Ethylbenzene µg/L	Total Xylenes µg/L	MTBE µg/L	Acetone µg/L	2-Butanone µg/L	n-Butylbenzene µg/L	sec-Butylbenzene µg/L	tert-Butylbenzene µg/L	Isopropylbenzene µg/L	p-Isopropylbenzene µg/L	p-Isopropyltoluene µg/L	n-propylbenzene µg/L	1,2,4-trimethylbenzene µg/L	1,3,5-trimethylbenzene µg/L	Naphthalene µg/L	2-Methylnapthalene µg/L	15 Other PNAs by 8270C µg/L
MWT-4	5/19/04	ND	88 [6]	**540** [5]	ND	ND	ND	ND	ND	ND	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-5	5/19/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-6	5/19/04	ND	**980**	**4200 [5]**	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-7	5/19/04	ND	**3200**	**56000 [5]**	0.78	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-8	5/19/04	ND	**370**	**800 [5]**	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.6	ND	ND	ND	ND	0.70	ND	ND	ND	ND
MWT-9	5/19/04	ND	ND	ND	ND	ND	ND	ND	0.79	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-10	5/19/04	ND	ND	59 [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-11	11/6/04	ND	**3500** [8]	**930** [9]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	ND	ND
MWT-12	11/6/04	ND	**830** [8]	**1400** [9]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	ND	ND
MWT-13	11/6/04	ND	**440 [8]**	**1100** [9]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	ND	ND
MWT-14	11/6/04	ND	**1200** [8]	**4600** [9]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	ND	ND

Notes:

(1) ND = Not Detected above the Method Detection Limit (MDL).
(2) n/a = Not Analyzed.
(3) The laboratory reports that the detected hydrocarbon does not match its diesel standard.
(4) Laboratory Method 8260B looks for 66 Volatile Organic Comppunds. Only those detected are presented on this table.
(5) The laboratory reports that the detected hydrocarbon does not match its gasoline standard.
(6) The laboratory reports that the detected hydrocarbon does not match its mineral spirits standard.
(7) Concentrations in **bold** script exceed the 2005 San Francisco Bay Area RWQCB's Environmental Screening Levels for shallow soils (<3m bgs) and where groundwater is not a source of drinking water.
(8) Quantity of unknown hydrocarbons in sample based on Mineral Spirits
(9) Quantity of unknown hydrocarbons in sample based on gasoline

TABLE I - 5

RESULTS OF ANALYSES OF SOIL SAMPLES FROM GREEN CITY (FORMER DUNNE PAINTS) INVESTIGATION [1]

Sample ID [2]	**Date Sampled**	**Sample Depth** *ft. BGS*	**Mineral Spirits** mg/Kg	**Acetone** mg/Kg	**sec-Butylbenzene** mg/Kg
OB-2	06/30/03	10.5	**160**	**21**	ND
OB-10	06/30/03	10	**430**	ND	ND
B-1-3.5	02/10/05	3.5	ND	na	na
B-1-7.5	02/10/05	7.5	ND	na	na
B-1-11.5	02/10/05	11.5	**180**	na	na
B-2-3.5	02/10/05	3.5	ND	na	na
B-2-7.5	02/10/05	7.5	ND	na	na
B-2-12.5	02/10/05	12.5	9.6	na	na
B-3-3.5	02/10/05	3.5	ND	na	na
B-3-7.5	02/10/05	7.5	ND	na	na
B-3-11.5	02/10/05	11.5	**330**	na	na
B-4-3.5	02/10/05	3.5	ND	na	na
B-4-7.5	02/10/05	7.5	ND	na	na
B-4-11.5	02/10/05	11.5	**1,600**	na	na
B-4-13.5	02/10/05	13.5	**1,400**	na	na
B-5-3.5	02/10/05	3.5	ND	na	na
B-5-7.5	02/10/05	7.5	ND	na	na
B-5-11.5	02/10/05	11.5	**4,900**	na	na
B-5-13.5	02/10/05	13.5	ND	na	na
B-6-3.5	02/10/05	3.5	ND	na	na
B-6-7.5	02/10/05	7.5	ND	na	na
B-6-11.5	02/10/05	11.5	**380**	na	na
B-6-13.5	02/10/05	13.5	**260**	na	na

Notes:

(1) Data from Clayton Group Services 2003 and 2005
(2) Sampling points be found on Figure 4.
(3) Concentrations in **bold** script exceed the 2005 San Francisco Bay Area RWQCB's Environmental Screening Levels (**ESL**s) in shallow soil (<3m bgs) where groundwater is not a source of drinking water.
(4) ND = Not detected
(5) na = not analyzed.

TABLE I - 6

RESULTS OF ANALYSES OF GROUNDWATER SAMPLES FROM GREEN CITY (FORMER DUNNE PAINTS) INVESTIGATIONS [1]

Sample ID [2]	**Date Sampled**	**Mineral Spirits** μg/L	**Tetrachloroethene** μg/L	**Trichloroethene** μg/L
OB-1	06/27/03	ND	ND	ND
OB-2	06/27/03	**12,000**	ND	ND
OB-3	06/27/03	ND	ND	ND
OB-4	06/27/03	ND	ND	ND
OB-5	06/27/03	ND	ND	**9.6**
OB-6	06/27/03	ND	**11**	**15**
OB-7	06/27/03	ND	ND	ND
OB-8	06/27/03	ND	ND	ND
OB-9	06/27/03	ND	ND	ND
OB-10	06/27/03	**5,800**	ND	ND
CW-1	11/12/03	85	*na*	ND
	03/12/04	ND	*na*	ND
CW-2	11/12/03	ND	*na*	ND
	03/12/04	ND	*ns*	ND
CW-3	11/12/03	ND	*na*	**5.1**
	03/12/04	ND	*na*	ND
MW-D1	11/12/03	85	*na*	ND
	03/12/04	**260**	*na*	ND
MW-D2	11/12/03	**1,400**	*na*	ND
	03/12/04	**330**	*na*	ND
B-1-W	02/10/05	**330**	*na*	na
B-2-W	02/10/05	**220**	*na*	na
B-4-W	02/10/05	**1,600**	*na*	na
B-5-W	02/10/05	**7,200**	*na*	na
B-6-W	02/10/05	**47,000**	*na*	na

Notes:

(1) Data from Clayton Group Services 2003 amd 2005

(2) Sampling points can be found on Figure 4 unless they are beyond the coundaries of that Figure.

(3) Concentrations in **bold** script exceed the 2005 San Francisco Bay Area RWQCB's Environmental Screening Levels (**ESL**s) in shallow soil (<3 m bgs) and groundwater is not a source of drinking water.

(4) ND = Not detected

(5) na = not analyzed

TABLE I - 7

RWQCB TIER 1 CONCENTRATION LIMITS (ESLs) FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER

In shallow soils (<3m bgs) at sites where groundwater is ***not*** *a source of drinking water.*

	Limiting Concentrations to Protect Human Health		
	Soil		***Groundwater***
Chemical of Concern	Residential mg/Kg	Commercial mg/Kg	Resid. or Comm. µg/L
Acetone	0.50	0.50	1,500
Aroclor® 1260	0.22	0.74	0.014
Antimony	6.1	40	30
Arsenic	5.5	5.5	36
Barium	750	1,500	1,000
Benzene	0.18	0.38	46
Beryllium	4.0	8.0	2.7
2-Butatone (Metyl Ethyl Ketone)	13	13	14,000
n-Butylbenzene (1-Phenylbutane)	ne	ne	ne
sec-Butylbenzene (Butyl Benzene)	ne	ne	ne
tert-Butylbenzene	ne	ne	ne
Cadmium	1.7	7	1.1
Chromium III	750	750	180
Chromium VI	1.8	1.8	11
Cobalt	40	80	3.0
Copper	230	230	3.1
Ethyl benzene	32	32	290
Lead	150	750	2.5
Mercury	3.7	10	0.012
2-Methylnaphthalene	0.25	0.25	2.1
4-Methylphenol	ne	ne	ne
Methyl Teritary Butyl Ether	2.0	5.6	1,800
Methylene Chloride	0.52	1.5	2,200

Chemical of Concern	Limiting Concentrations to Protect Human Health		
	Soil		***Groundwater***
	Residential mg/Kg	Commercial mg/Kg	Resid. or Comm. µg/L
Molybdenum	40	40	240
Naphthalene	0.46	1.5	24
Nickel	150	150	8.2
Isopropylbenzene (Cumene)	ne	ne	ne
p-Isopropylbenzene	ne	ne	ne
p-Isopropyltoluene (p-Cymene)	ne	ne	ne
n-Propylbenzene (Isocumene)	ne	ne	ne
Selinium	10	10	5.0
Silver	20	40	0.19
Thallium	1.0	13	20
Toluene	9.3	9.3	130
TRPH (Total Recoverable Petroleum Hydrocarbons)	100	500	640
TPHd (Diesel)	100	500	640
TPHms (Mineral Spirits)	100	500	640
TPHg (Gasoline)	100	400	500
1,2,4 Trimethylbenzene	ne	ne	ne
1,3,5 Trimethylbenzene	ne	ne	ne
Vanadium	110	200	19
Xylene Isomers (Total)	11.0	11.0	100
Zinc	600	600	81

Note:

ne = not established in the RWQCB ESL guidance document (California Regional Water Quality Control Board - San Francisco Bay Region 2005).

TABLE I - 8

APPLICABLE CHEMICAL, PHYSICAL, TOXICOLOGIC AND CARCINOGENIC PROPERTIES OF CHEMICALS OF CONCERN

Constituent	Molecular Weight (g/mole) MW	Diffusion Coefficients in air (cm2/s) Dair	Diffusion Coefficients in water (cm2/s) Dwat	Log (Koc) (@ 20 - 25 C) log(L/kg)	Henry's Law Constant (@ 20 - 25 C) (atm-m3) mol	Henry's Law Constant (@ 20 - 25 C) (unitless)	Vapor Pressure (@ 20 - 25 C) (mm Hg)	Solubility (@ 20 - 25 C) (mg/L)
Benzene	78.1	8.80E-02	9.80E-06	1.77	5.55E-03	2.29E-01	9.52E+01	1.75E+03
Toluene	92.4	8.50E-02	9.40E-06	2.13	6.30E-03	2.60E-01	3.00E+01	5.15E+02
Ethylbenzene	106.2	7.50E-02	7.80E-06	2.56	7.88E-03	3.25E-01	1.00E+01	1.69E+02
Xylene (mixed isomers)	106.2	7.20E-02	8.50E-06	2.38	7.03E-03	2.90E-01	7.00E+00	1.98E+02
Methyl t-Butyl ether	88.146	7.92E-02	9.41E-05	1.08	5.77E-04	2.38E-02	2.49E+02	4.80E+04
Acetone	58.08	1.24E-01	1.14E-05	-0.24	2.50E-05	1.03E-03	2.66E+02	1.00E+06
Naphthalene	128.2	5.90E-02	7.50E-06	3.30	4.83E-04	1.99E-02	2.30E-01	3.10E+01
Cumene	120.2	6.50E-02	7.10E-06	0.00	1.46E-02	6.02E-01	2.30E-01	4.98E+01

Continued on next page

TABLE I - 8

(*Continued*)

APPLICABLE CHEMICAL, PHYSICAL, TOXICOLOGIC AND CARCINOGENIC

PROPERTIES OF CHEMICALS OFCHEMICALS OF CONCERN

Constituent	Reference Dose (mg/kg/day)		Ref. Conc. (mg/m3)	Slope Factors 1/(mg/kg/day)		Unit Risk Factor 1/(µg/m3)	EPA Weight of Evidence	Is Constituent Carcino-genic?	Maximum Contamination Level MCL (mg/L)	Time-Weighted Av. Workplace Criteria TWA (mg/m3)
	Oral RfD_oral	Dermal RfD_dermal	Inhalation RfC_inhal	Oral SF_oral	Dermal SF_dermal	Inhalation URF_inhal.				
Benzene	3.00E-03	-	5.95E-03	2.90E-02	2.99E-02	8.29E-06	A	TRUE	5.00E-03	3.25E+00
Toluene	2.00E-01	1.60E-01	4.00E-01	-	-	-	D	FALSE	1.00E+00	1.47E+02
Ethylbenzene	1.00E-01	9.70E-02	1.00E+00	-	-	-	D	FALSE	7.00E-01	4.35E+02
Xylene (mixed isomers)	2.00E+00	1.84E+00	7.00E+00	-	-	-	D	FALSE	1.00E+01	4.34E+02
Methyl t-Butyl ether	1.00E-02	8.00E-03	3.00E+00	-	-	-	-	FALSE	-	6.00E+01
Acetone	1.00E-01	8.30E-02		-	-	-	D	FALSE	-	5.90E+02
Naphthalene	4.00E-01	3.56E-01	1.40E+00	-	-	-	D	FALSE	-	5.00E+01
Cumene	1.00E-01	8.00E-02	4.00E-01	-	-	-	D	FALSE	-	2.45E+02

TABLE I - 9

KEY GROUND FLOOR BUILDING DIMENSIONS

Building Type	**Ground Floor Occupancy**	**Slab** Emeryville Datum *ft.*	**Elevation** NAVD *ft.*	**Length East to West** *ft.*	**Length North to South** *ft.*	**Plan Area** *ft.* ^{2}	**Foundation Perimeter** *ft.*	**Gr. Floor Floor to Ceiling** *ft.*	**Gr. Floor Interior Volume** *ft.* ^{3}	**Ground Floor Volume/Area Ratio**	**Gr. Floor Slab Thickness** *in.*	**Imper-meable Barrier**
1	Commercial	36.70	42.38	55.0	91.0	4,260	331.0	18	76,680	18.0	6	Liquid Boot®
2A	Commercial	37.90	43.58	30.5	34.0	1,022	129.0	18	18,396	18.0	6	Liquid Boot®
2B	Residential	39.75	45.43	23.0	32.5	722	118.3	9	6,498	9.0	6	Liquid Boot®
2C	Residential	40.50	46.18	31.3	30.0	932	126.6	9	8,388	9.0	6	Liquid Boot®
3A	Residential	41.15	46.83	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
3B	Residential	41.60	47.28	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
3C	Residential	40.50	46.18	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
4	Residential	40.35	46.03	26.0	42.8	990	146.3	9	8,910	9.0	6	Liquid Boot®
5	Residential	40.95	46.63	24.5	49.0	923	139.0	9	8,307	9.0	6	Liquid Boot®
6	Residential	41.75	47.43	24.0	48.0	1,132	146.0	9	10,188	9.0	6	Liquid Boot®
7	Residential	41.95	47.63	24.5	49.0	923	139.0	9	8,307	9.0	6	Liquid Boot®
8	Residential	42.25	47.93	24.0	46.0	1,095	140.0	9	9,855	9.0	6	Liquid Boot®
9	Garage	42.09	47.77	62.5	25.0	1,543	175.0	8	12,344	8.0	6	Liquid Boot®

Notes:

(1) For Building Types 4 through 8 slab elevations cited are for basement concrete laid over impermeable membrane.
(2) First floors will be suspended at approximately 2.25 ft higher elevations.

TABLE I - 10

KEY SOIL COLUMN PARAMETERS

Building Type	Use of First Floor	Indoor Exposure Environment Classification	Outdoor Exposure Environment Classification	Depth to Groundwater	Depth to Top of Contam. Soil		Depth to Bottom of Contam. Soil	
					Pre-remediation	Post-remediation	Pre-remediation	Post-remediation
				ft.	*ft.*	*ft.*	*ft.*	*ft.*
1	Commercial	Commercial	Residential	7.64	3.21	6.21	24.21	24.21
3A	Residential	Residential	Residential	7.23	5.13	7.13	26.13	26.13

TABLE I - 11

REPRESENTATIVE CONCENTRATIONS OF CHEMICALS OF CONCERN
IN SOIL BENEATH VULNERABLE BUILDINGS

Chemical of Concern	Building Type 3A Pre-Remediation mg/Kg	Building Type 3A Post-Remediation mg/Kg	Building Type 1 Pre-Remediation mg/Kg	Building Type 1 Post-Remediation mg/Kg
	Concentrations			
Benzene	13	13	1.1	1.1
Toluene	140	140	9.0	9.0
Ethylbenzene	80	80	13.0	13.0
Xylene (mixed isomers)	430	430	75	75
Methyl tertiary-butyl ether	ND	ND	0.005	0.005
Acetone	ND	ND	0.065	0.065
n-Butylbenzene	8.4	8.4	2.6	2.6
sec-Butylbenzene	3.1	3.1	ND	ND
Cumene (isopropylbenzene)	2.7	2.7	1.1	1.1
p-isopropylbenzene	ND	ND	ND	ND
n-propylbenzene	13	13	4.4	4.4
1,2,4-trimethylbenzene	32	32	23.0	23.0
1,3,5-trimethylbenzene	12	12	8.1	8.1
Naphthalene	18	18	4.2	4.2

Note: ND = Not detected above the Method Detection Level (MDL) of the analytical method employed.

TABLE I - 12

REPRESENTATIVE CONCENTRATIONS OF CHEMICALS OF CONCERN
IN GROUNDWATER BENEATH VULNERABLE BUILDINGS

	Building Type 3A		**Building Type 1**	
	Pre-Remediation $\mu g/L$	Post-Remediation $\mu g/L$	Pre-Remediation $\mu g/L$	Post-Remediation $\mu g/L$
Chemical of Concern	**Concentrations**			
Benzene	7,900	3,160	90	90
Toluene	2,100	840	0.66	0.66
Ethylbenzene	980	392	48	48
Xylene (mixed isomers)	8,300	3,320	56	56
Methyl tertiary-butyl ether	770	308	170	170
Acetone	ND	ND	ND	ND
n-Butylbenzene	100	40	ND	ND
sec-Butylbenzene	ND	ND	8.7	8.7
Cumene (isopropylbenzene)	ND	ND	12	12
p-isopropylbenzene	ND	ND	1.8	1.8
n-propylbenzene	ND	ND	31	31
1,2,4-trimethylbenzene	1,600	640	14	14
1,3,5-trimethylbenzene	460	184	5.6	5.6
Naphthalene	490	196	8.3	8.3

Note: ND = Not detected above the Method Detection Level (MDL) of the analytical method employed.

TABLE I - 13

HEALTH RISK ANALYSIS RESULTS FOR BUILDING TYPE 3A

Condition	**Outdoor Exposure Environment Classification**	**Indoor Exposure Environment Classification**	**Cumulative COC Carcinogenic Risk**			**Toxic Hazard Index**		
			Outdoor Air	Indoor Air	Target Risk	Outdoor Air	Indoor Air	Target Index
Unimproved Site	Residential	Residential	2.0×10^{-6}	**9.6×10^{-5}**	*1.0×10^{-6}*	0.620	**4.800**	*0.200*
Improved Soil	Residential	Residential	1.0×10^{-7}	**3.9×10^{-6}**	*1.0×10^{-6}*	0.028	**0.250**	*0.200*
Remediated Site	Residential	Residential	5.9×10^{-8}	**2.3×10^{-6}**	*1.0×10^{-6}*	0.028	**0.130**	*0.200*

Note: Critical Exposure Pathways are in **bold** font.

TABLE I - 14

HEALTH RISK ANALYSIS RESULTS FOR BUILDING TYPE 1

Condition	**Outdoor Exposure Environment Classification**	**Indoor Exposure Environment Classification**	**Cumulative COC Carcinogenic Risk**			**Toxic Hazard Index**		
			Outdoor Air	Indoor Air	Target Risk	Outdoor Air	Indoor Air	Target Index
Unimproved Site	Residential	Commercial	1.3×10^{-7}	**9.6×10^{-7}**	*1.0×10^{-6}*	**0.150**	0.092	*0.200*
Remediated Site	Residential	Residential	3.6×10^{-8}	**2.2×10^{-7}**	*1.0×10^{-6}*	**0.046**	0.022	*0.200*

Note: Critical Exposure Pathways are in **bold** font.

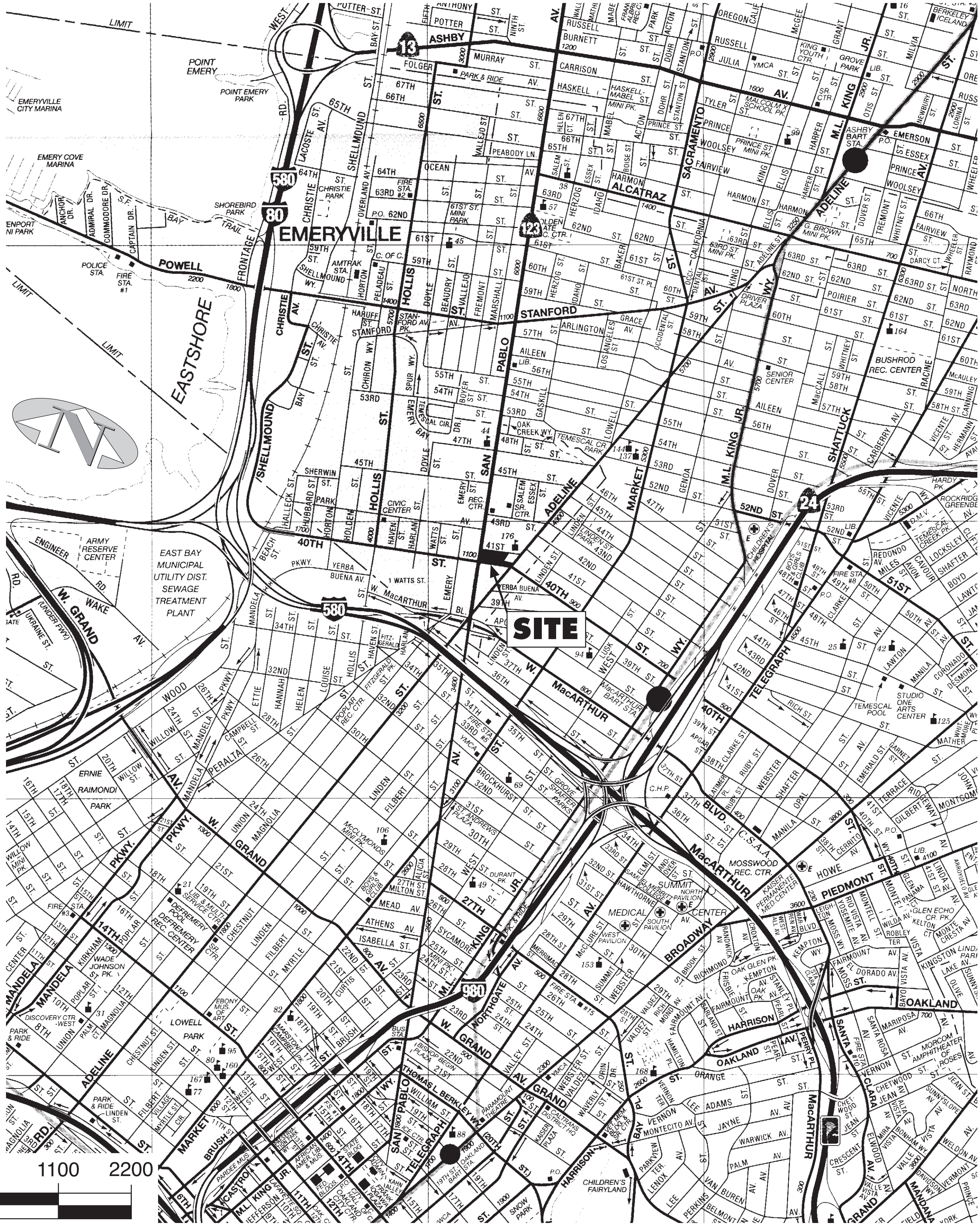
TABLE I - 15

EARTHWORK VOLUMES FOR ENVIRONMENTAL REMEDIATION

Material	**Stockpile on Site** *yd^3*	**Remove from On-site Stockpile** *yd^3*	**Export from Site** *yd^3*	**Import to Site** *yd^3*
Clean Overburden Soil	4,880			
Soil Affected by Petroleum Hydrocarbons			3,554	
Crushed Concrete 6 in. to 4 in. (No fines)				1,414
Crushed Rock 3 in. to 1.5 in. (No fines)				1,530
Clean Soil Compacted to 90% Relative Density (From stockpile)		4,880		
Clean Soil Compacted to 90% Relative Density (Imported)				610
Totals	**4,880**	**4,880**	**3,554**	**3,554**
NET IMPORT =	**3,554**	***yd^3***		
NET EXPORT =	**3,554**	***yd^3***		

Notes:

(1) All yards are measured *in situ*
(2) Actual volume of crushed concrete, crushed rock and imported soil will depend on depth to water table at time remedial excavations are made.
(3) Volumes account for all remedial excavations, groundwater extraction ponds and exploratory trenches



0 1100 2200

SCALE IN FEET

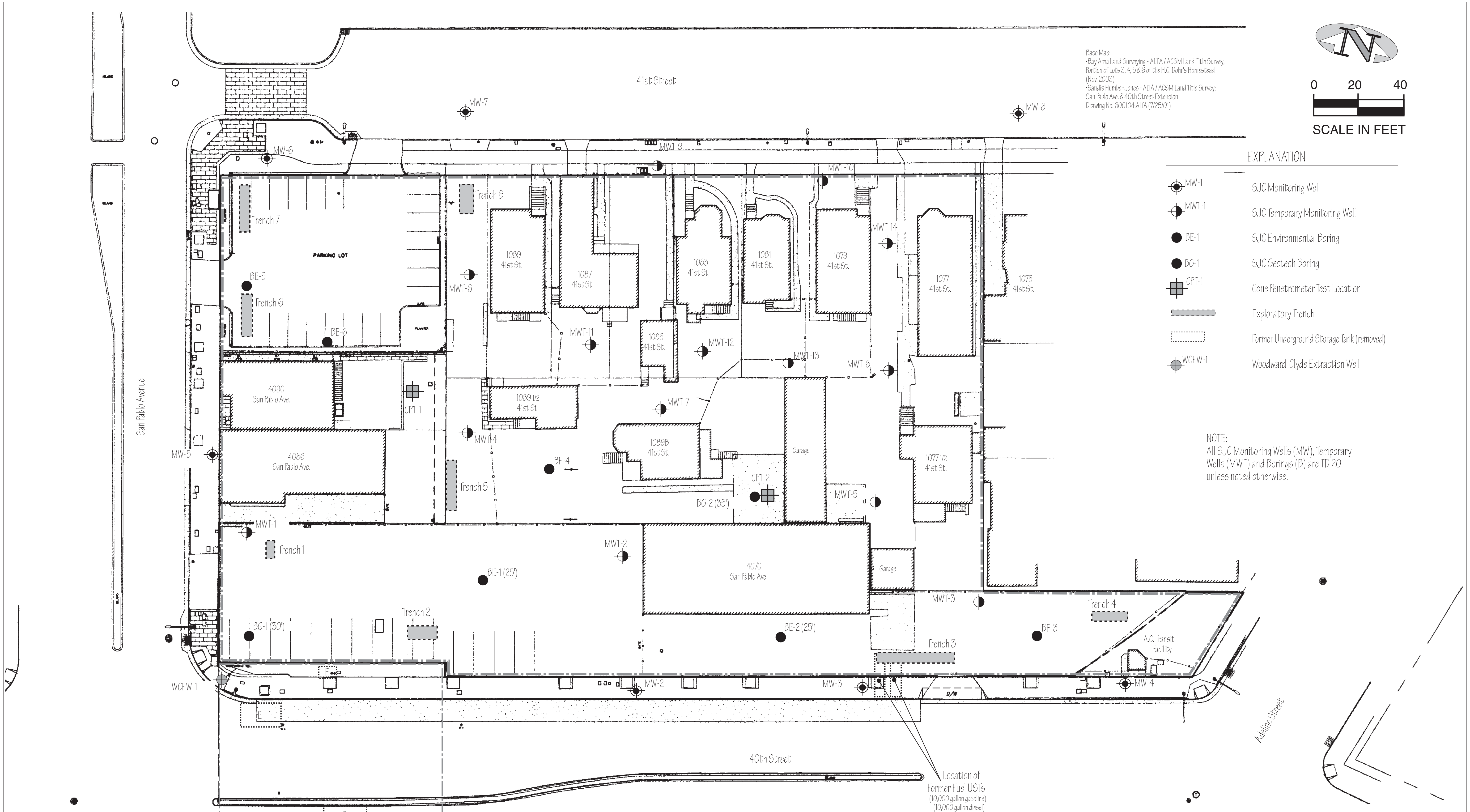
Basemap: AAA; Oakland-Berkeley-Alameda (12/02)

SITE LOCATION

Oak Walk Redevelopment Project

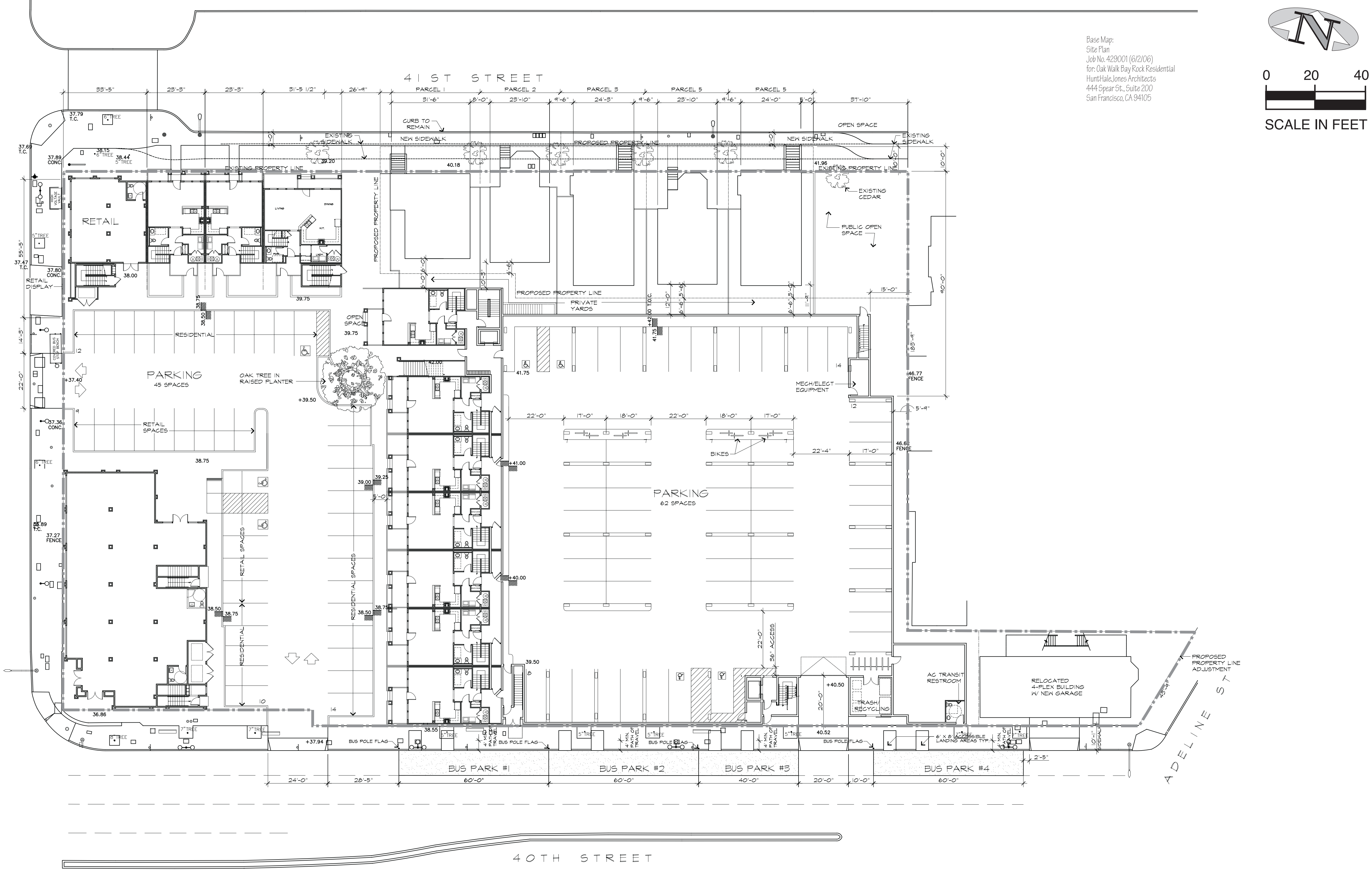
Emeryville, California

FIG I-1	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM Date: 06/10/06



SITE PLAN
Oak Walk Redevelopment Project
Emeryville, California

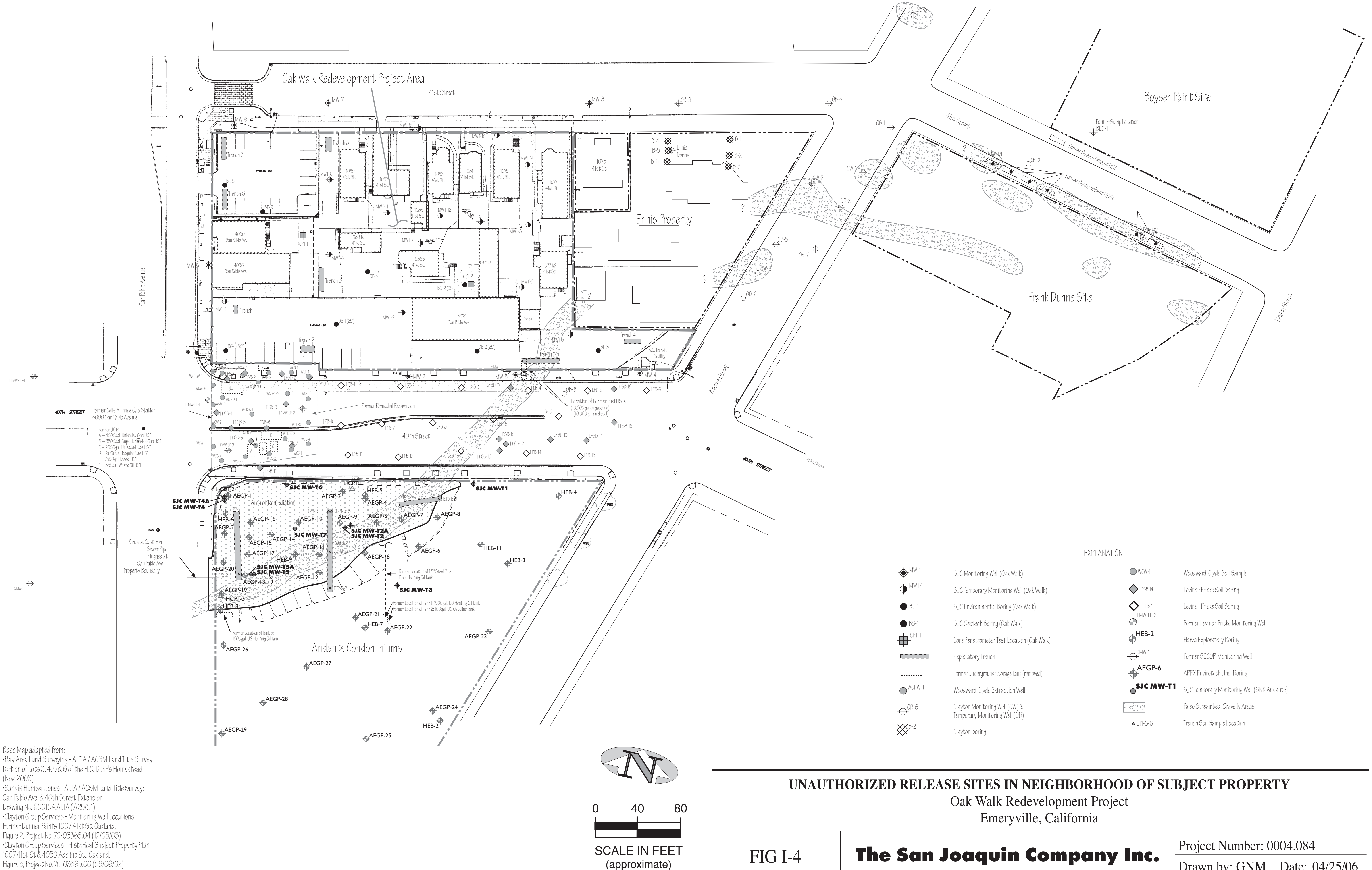
FIG I-2	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM · Date: 06/10/06



PLAN OF PROPOSED REDEVELOPMENT

Oak Walk Redevelopment Project
Emeryville, California

FIG I-3	The San Joaquin Company Inc.	Project Number: 0004.084
		Drawn by: GNM — Date: 06/20/06

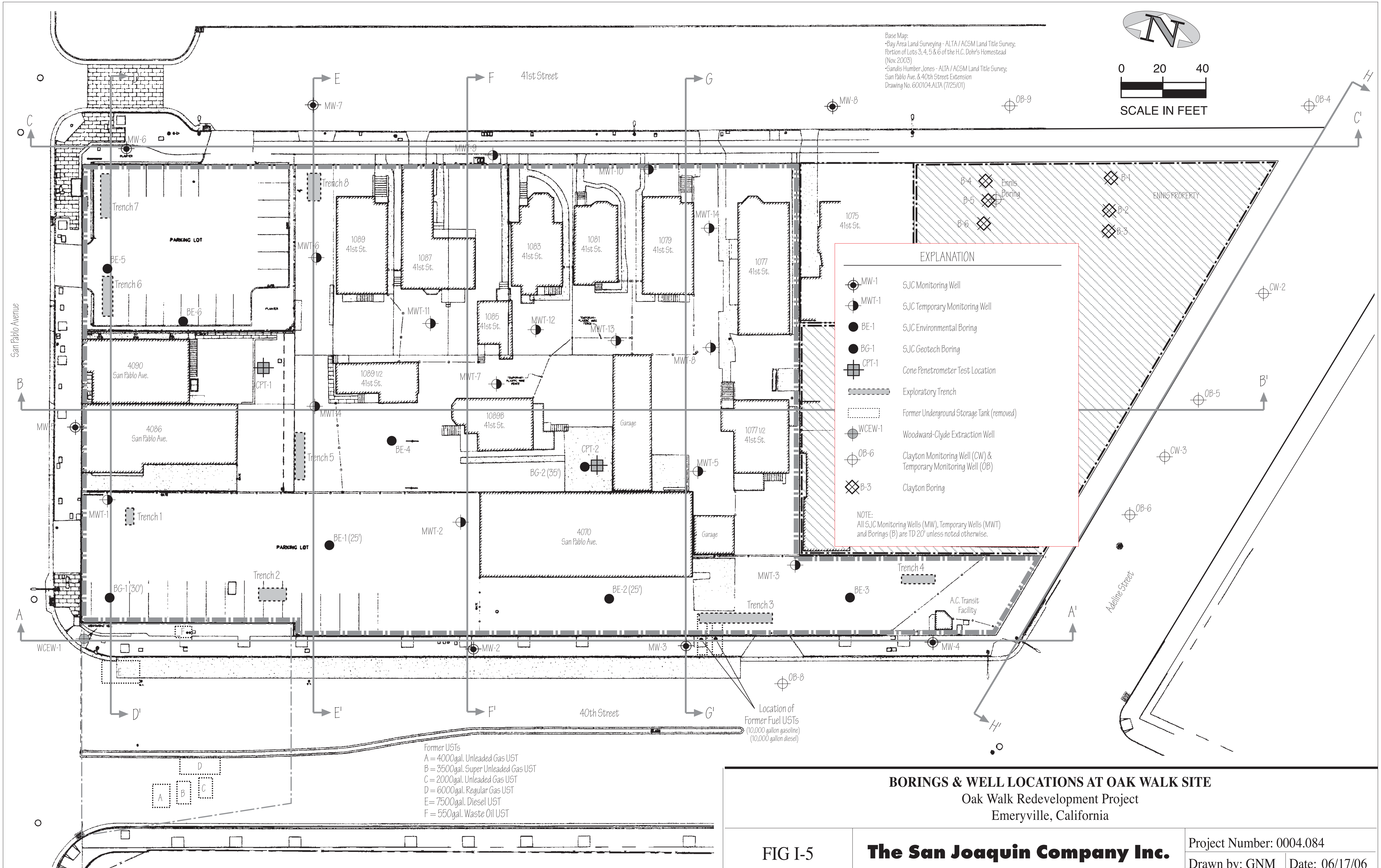


Base Map adapted from:
•Bay Area Land Surveying - ALTA / ACSM Land Title Survey; Portion of Lots 3, 4, 5 & 6 of the H.C. Dohr's Homestead (Nov. 2003)
•Sandis Humber Jones - ALTA / ACSM Land Title Survey; San Pablo Ave. & 40th Street Extension Drawing No. 600104.ALTA (7/25/01)
•Clayton Group Services - Monitoring Well Locations Former Dunner Paints 1007 41st St. Oakland, Figure 2, Project No. 70-03365.04 (12/05/03)
•Clayton Group Services - Historical Subject Property Plan 1007 41st St & 4050 Adeline St., Oakland, Figure 3, Project No. 70-03365.00 (09/06/02)

UNAUTHORIZED RELEASE SITES IN NEIGHBORHOOD OF SUBJECT PROPERTY

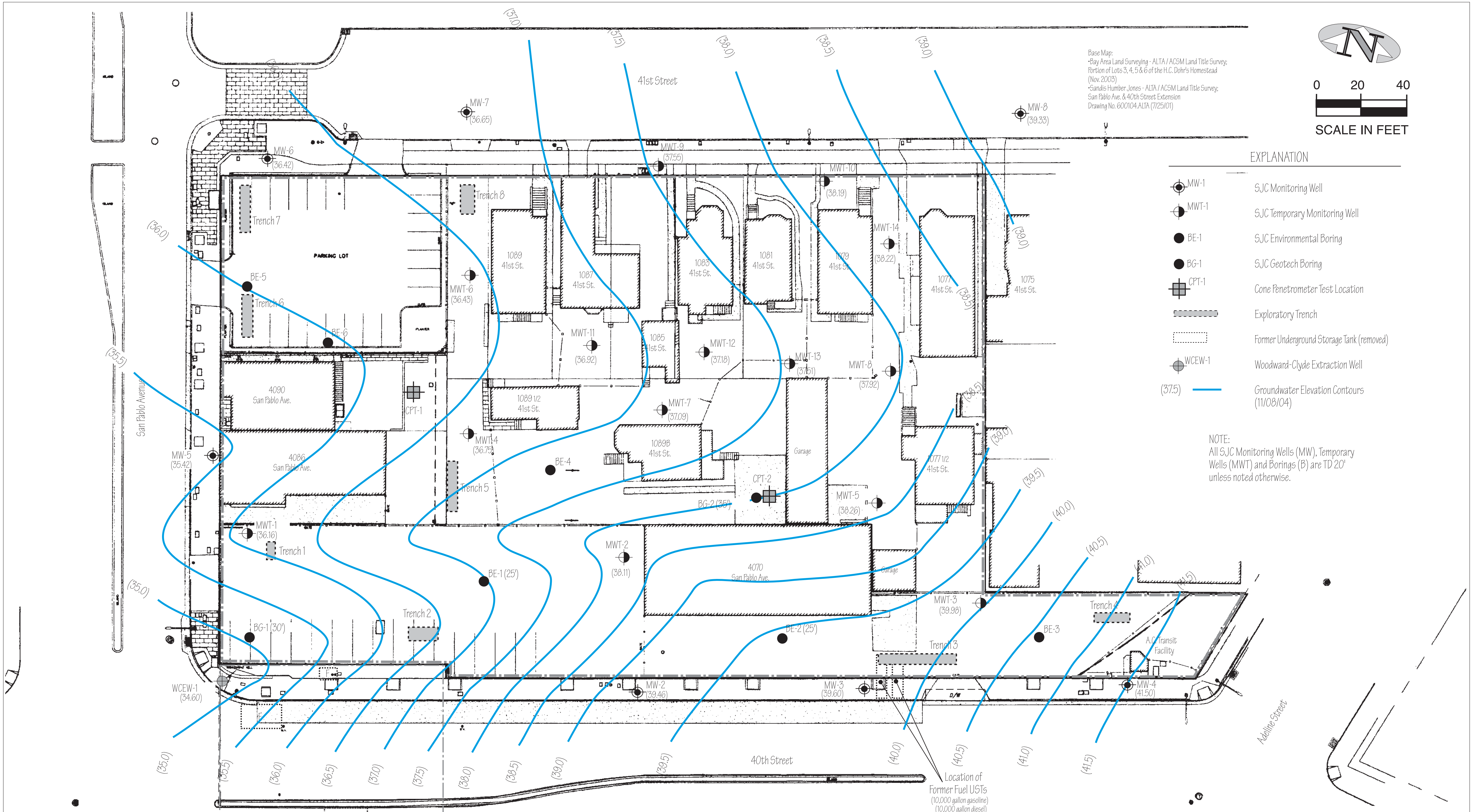
Oak Walk Redevelopment Project
Emeryville, California

FIG I-4	**The San Joaquin Company Inc.**	Project Number: 0004.084 Drawn by: GNM · Date: 04/25/06



BORINGS & WELL LOCATIONS AT OAK WALK SITE
Oak Walk Redevelopment Project
Emeryville, California

FIG I-5	The San Joaquin Company Inc.	Project Number: 0004.084
		Drawn by: GNM · Date: 06/17/06

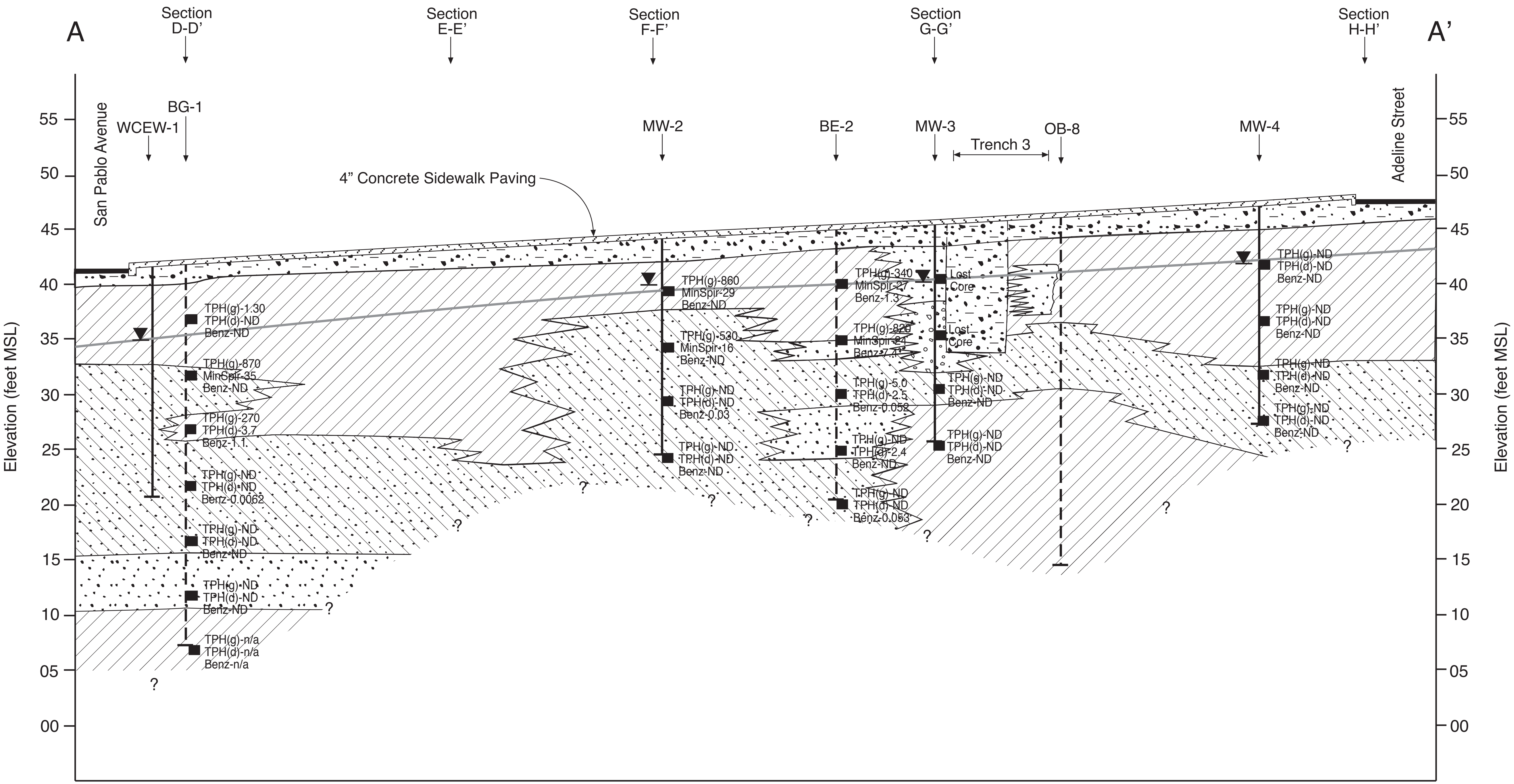


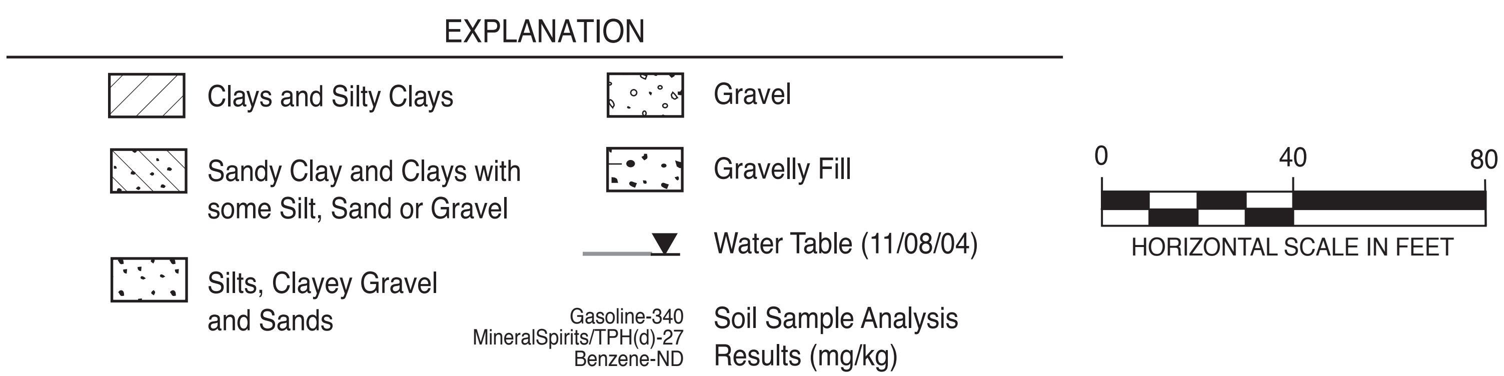
GROUNDWATER CONTOURS (11/08/04)

Oak Walk Redevelopment Project

Emeryville, California

FIG I-6	**The San Joaquin Company Inc.**	Project Number: 0004.084 Drawn by: GNM Date: 04/23/06



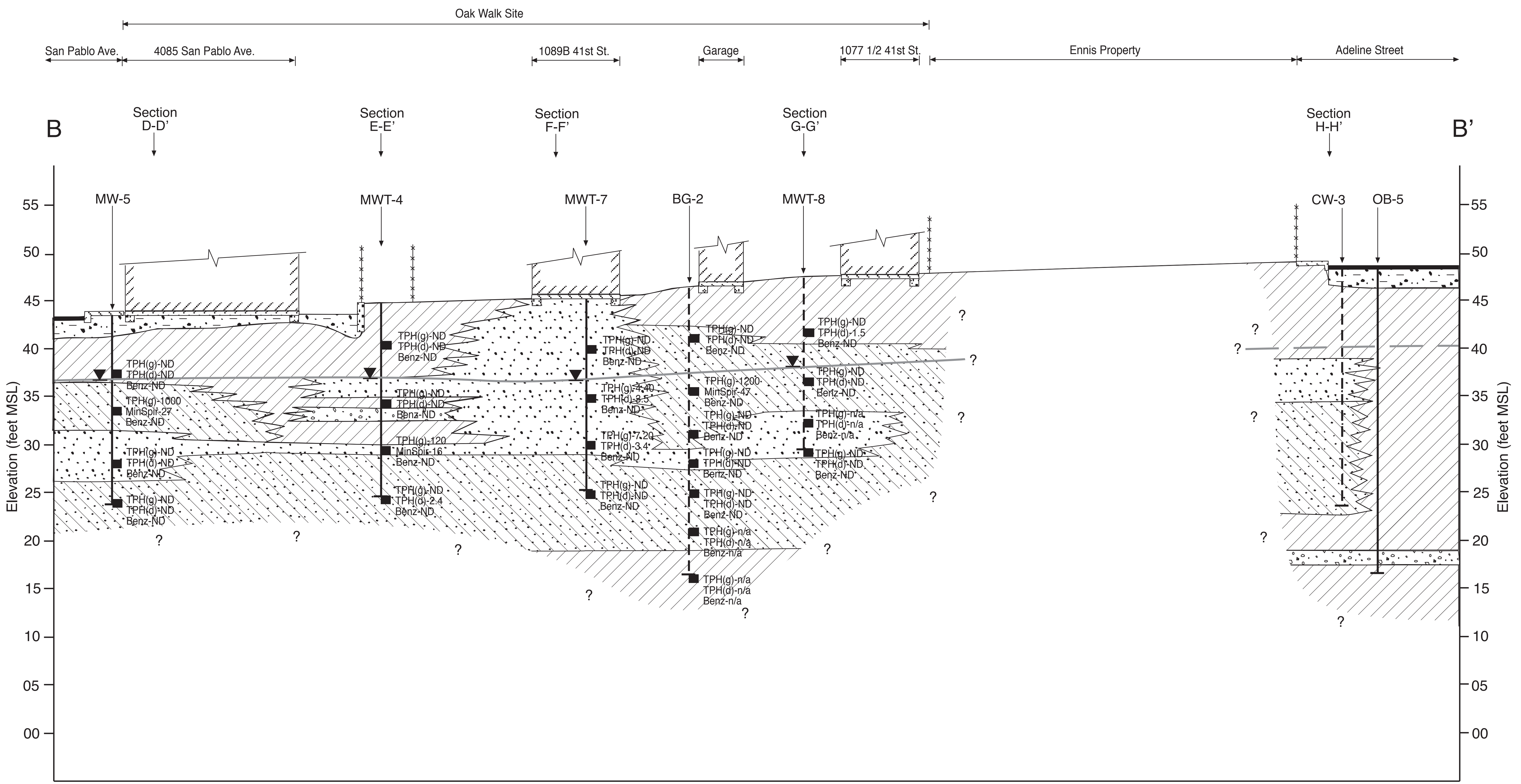


HYDROSTRATIGRAPHIC SECTION A-A'

Oak Walk Redevelopment Project

Emeryville, California

FIG I-7	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM — Date: 10/30/05



EXPLANATION

- Clays and Silty Clays
- Sandy Clay and Clays with some Silt, Sand or Gravel
- Silts, Clayey Gravel and Sands
- Gravel
- Gravelly Fill
- Water Table (11/08/04)
- Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

0 40 80

HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION B-B'

Oak Walk Redevelopment Project

Emeryville, California

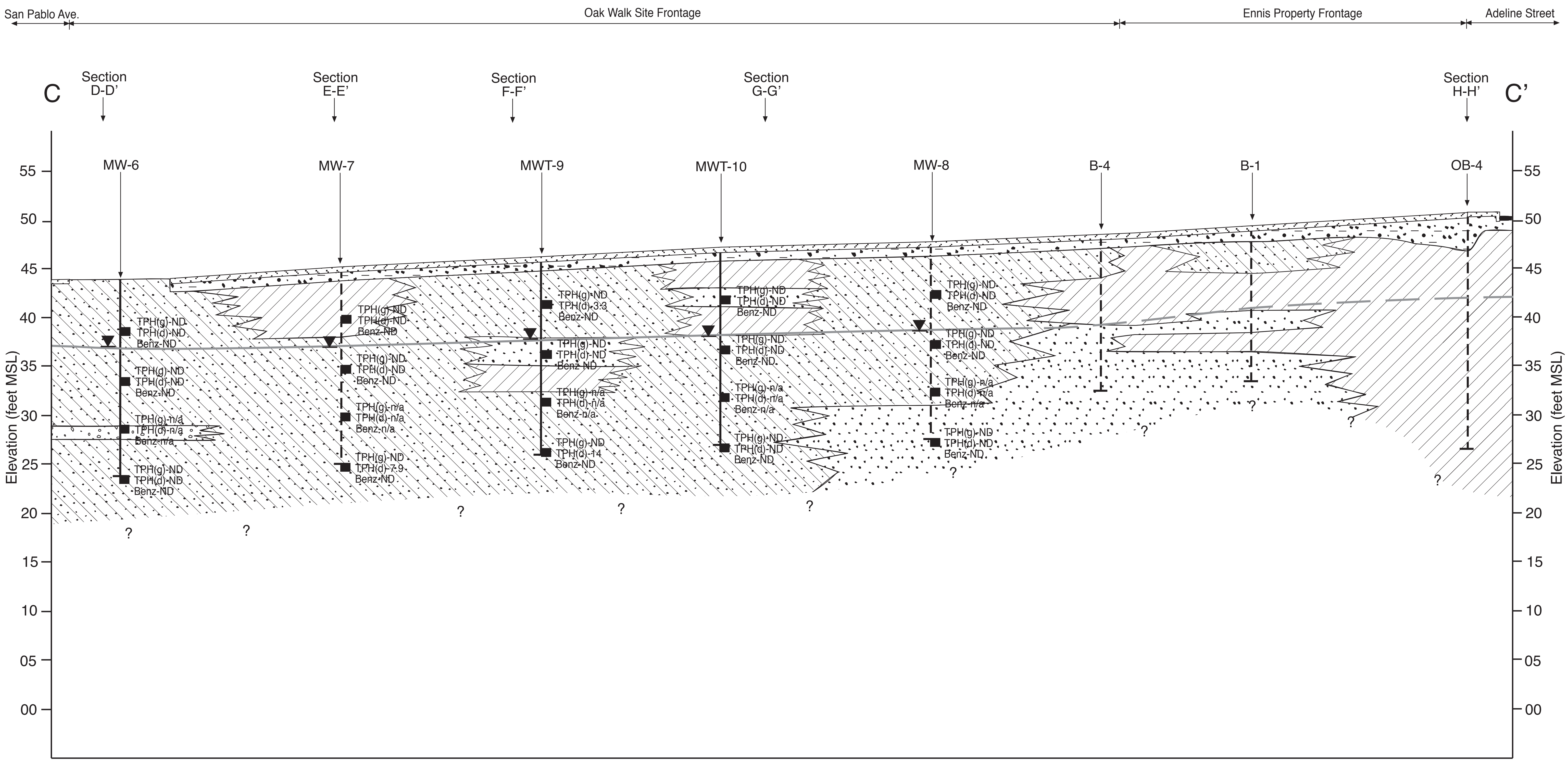
FIG I-8

The San Joaquin Company Inc.

Project Number: 0004.084

Drawn by: GNM

Date: 04/17/06



EXPLANATION

- Clays and Silty Clays
- Sandy Clay and Clays with some Silt, Sand or Gravel
- Silts, Clayey Gravel and Sands
- Gravel
- Gravelly Fill
- Water Table (11/08/04)
- Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

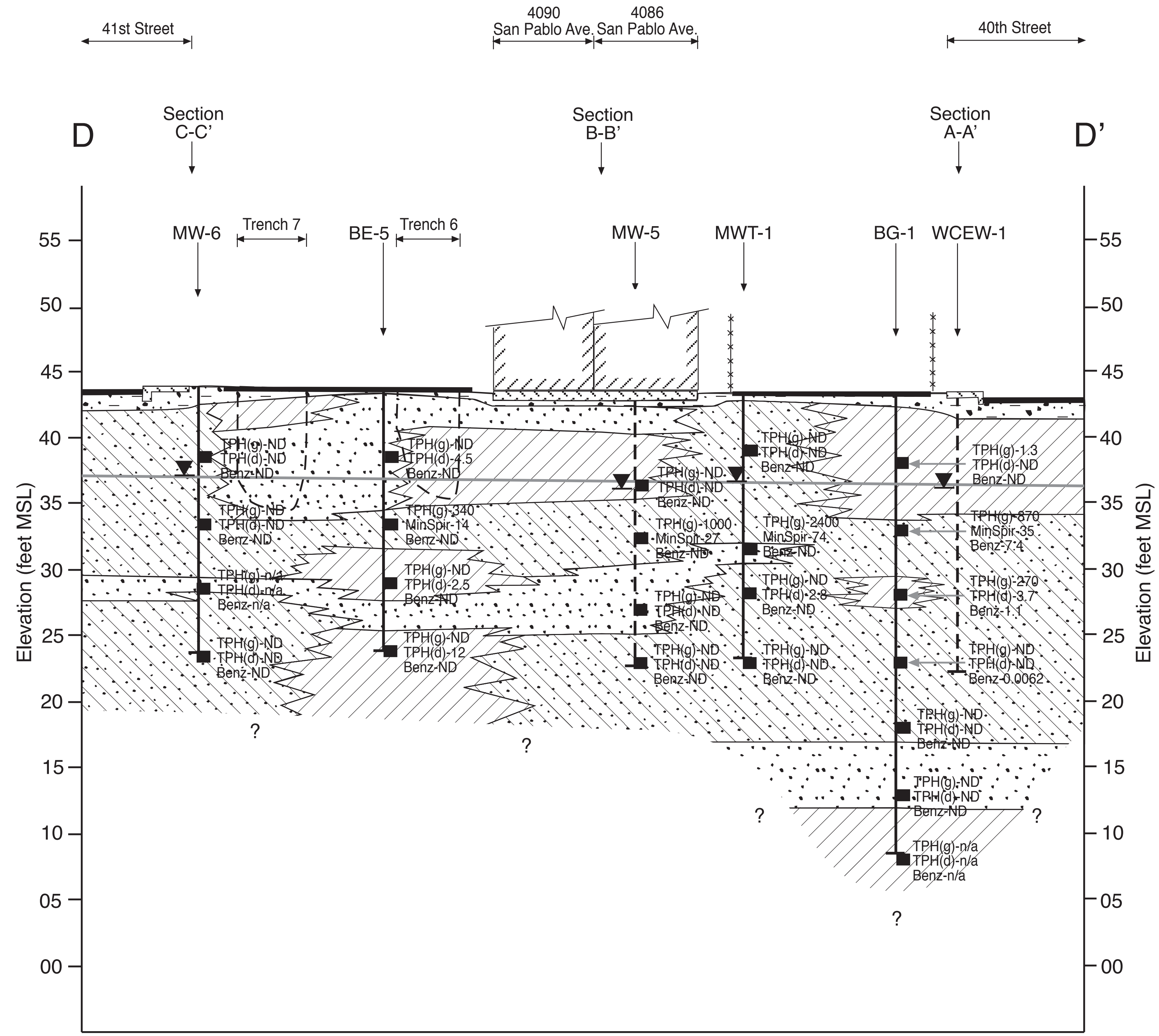
0 40 80
HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION C-C'
Oak Walk Redevelopment Project
Emeryville, California

FIG I-9

The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: GNM
Date: 06/21/06



EXPLANATION

- Clays and Silty Clays
- Sandy Clay and Clays with some Silt, Sand or Gravel
- Silts, Clayey Gravel and Sands
- Gravel
- Gravelly Fill
- Water Table (11/08/04)
- Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

0 40 80

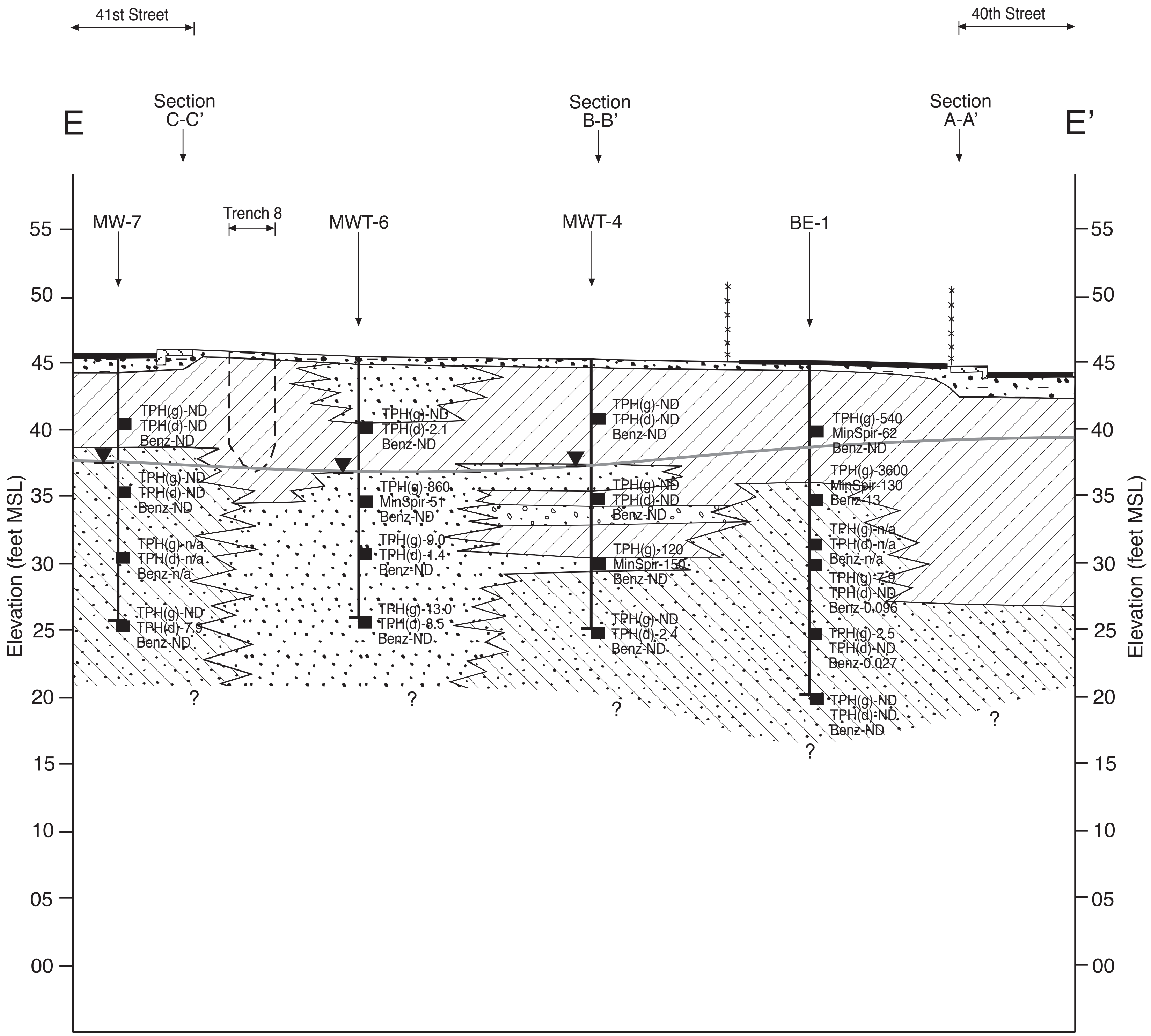
HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION D-D'

Oak Walk Redevelopment Project

Emeryville, California

FIG I-10	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM — Date: 04/25/06



EXPLANATION

Clays and Silty Clays

Sandy Clay and Clays with some Silt, Sand or Gravel

Silts, Clayey Gravel and Sands

Gravel

Gravelly Fill

Water Table (11/08/04)

Gasoline-340
MineralSpirits/TPH(d)-27
Benzene-ND

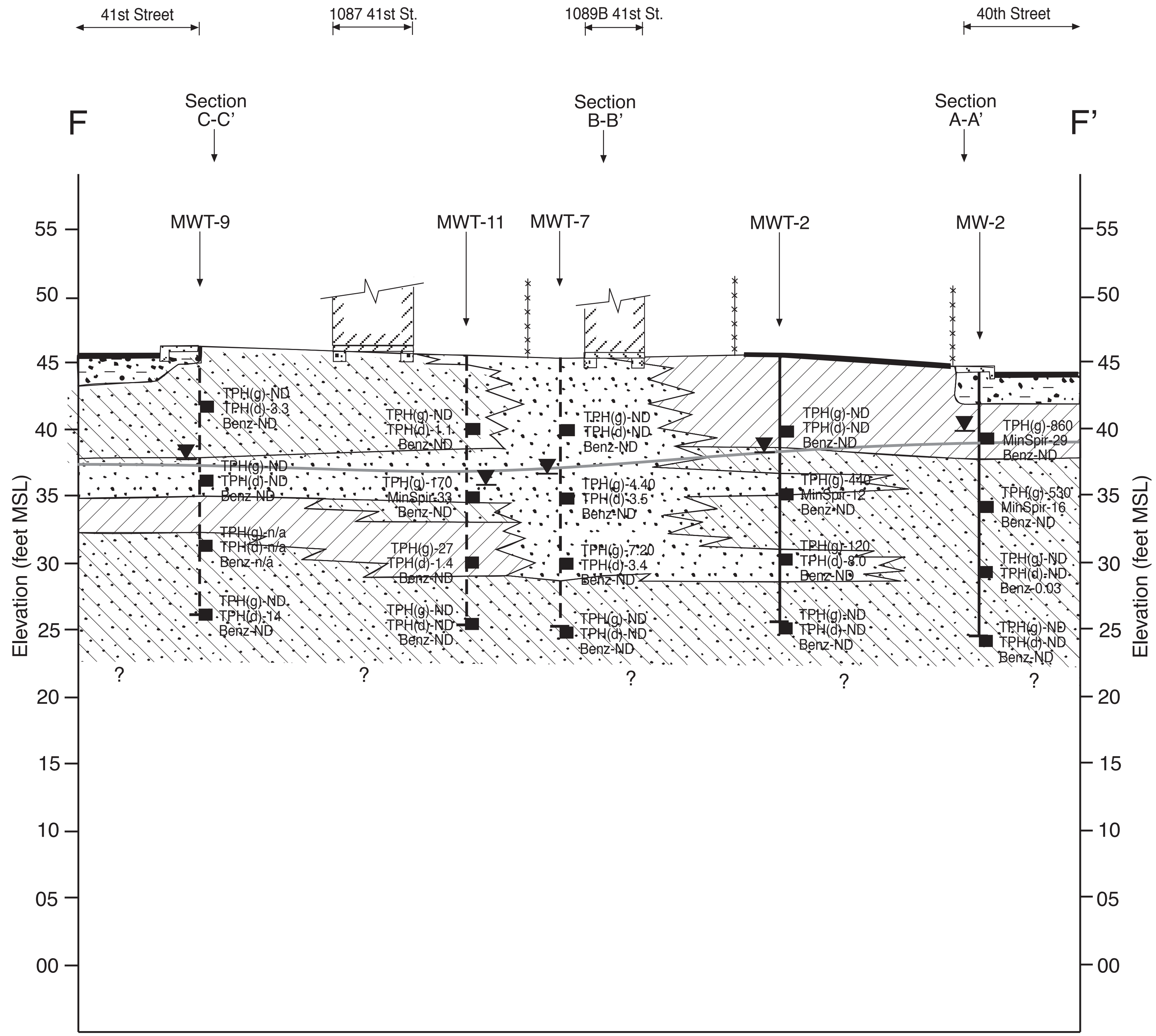
Soil Sample Analysis Results (mg/kg)

0 40 80

HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION E-E'
Oak Walk Redevelopment Project
Emeryville, California

FIG I-11	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM / Date: 04/25/06



EXPLANATION

- Clays and Silty Clays
- Sandy Clay and Clays with some Silt, Sand or Gravel
- Silts, Clayey Gravel and Sands
- Gravel
- Gravelly Fill
- Water Table (11/08/04)
- Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

0 40 80

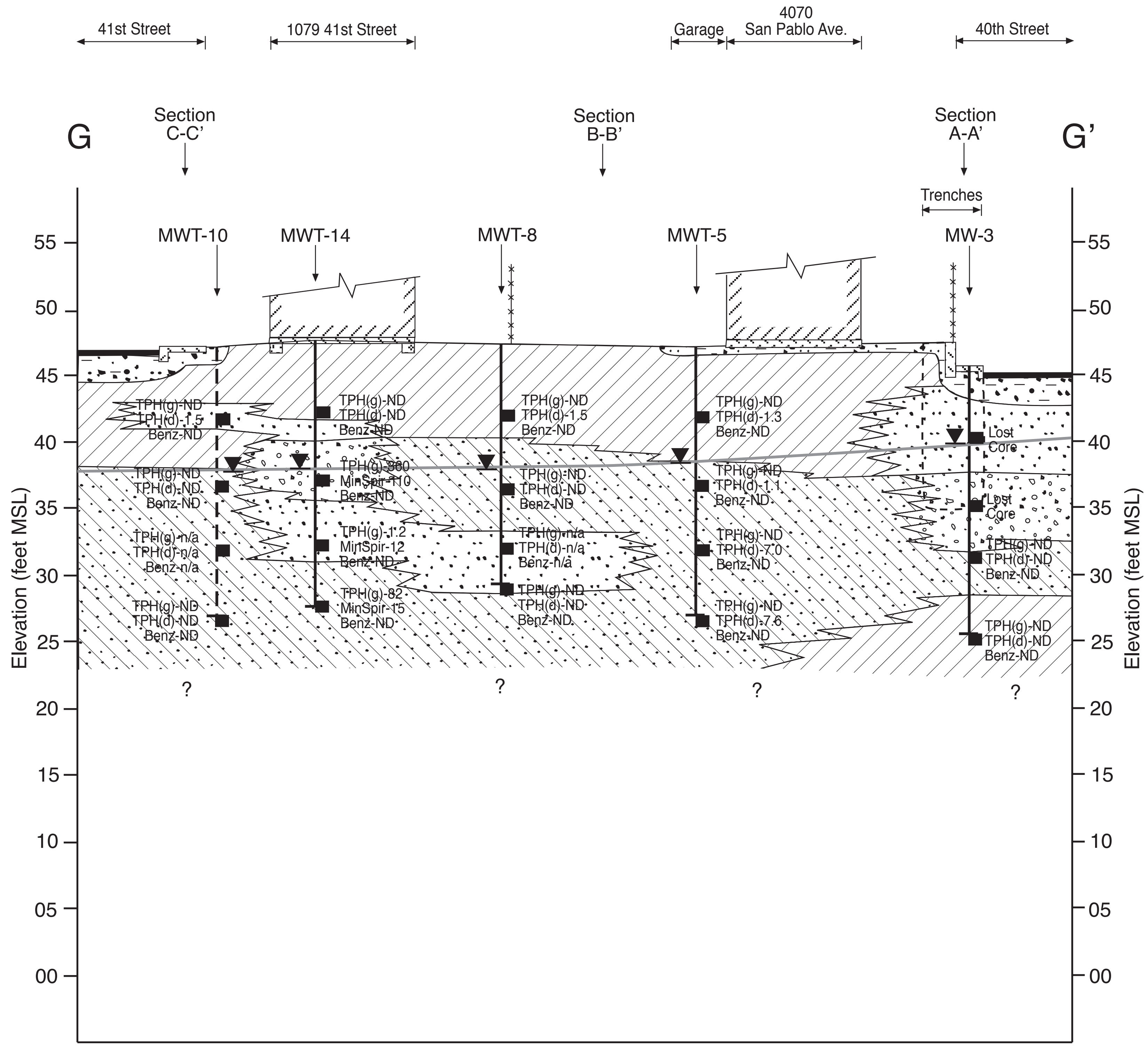
HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION F-F'

Oak Walk Redevelopment Project

Emeryville, California

FIG I-12	The San Joaquin Company Inc.	Project Number: 0004.084	
		Drawn by: GNM	Date: 04/25/06



EXPLANATION

- Clays and Silty Clays
- Sandy Clay and Clays with some Silt, Sand or Gravel
- Silts, Clayey Gravel and Sands
- Gravel
- Gravelly Fill
- Water Table (11/08/04)
- Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

0 40 80

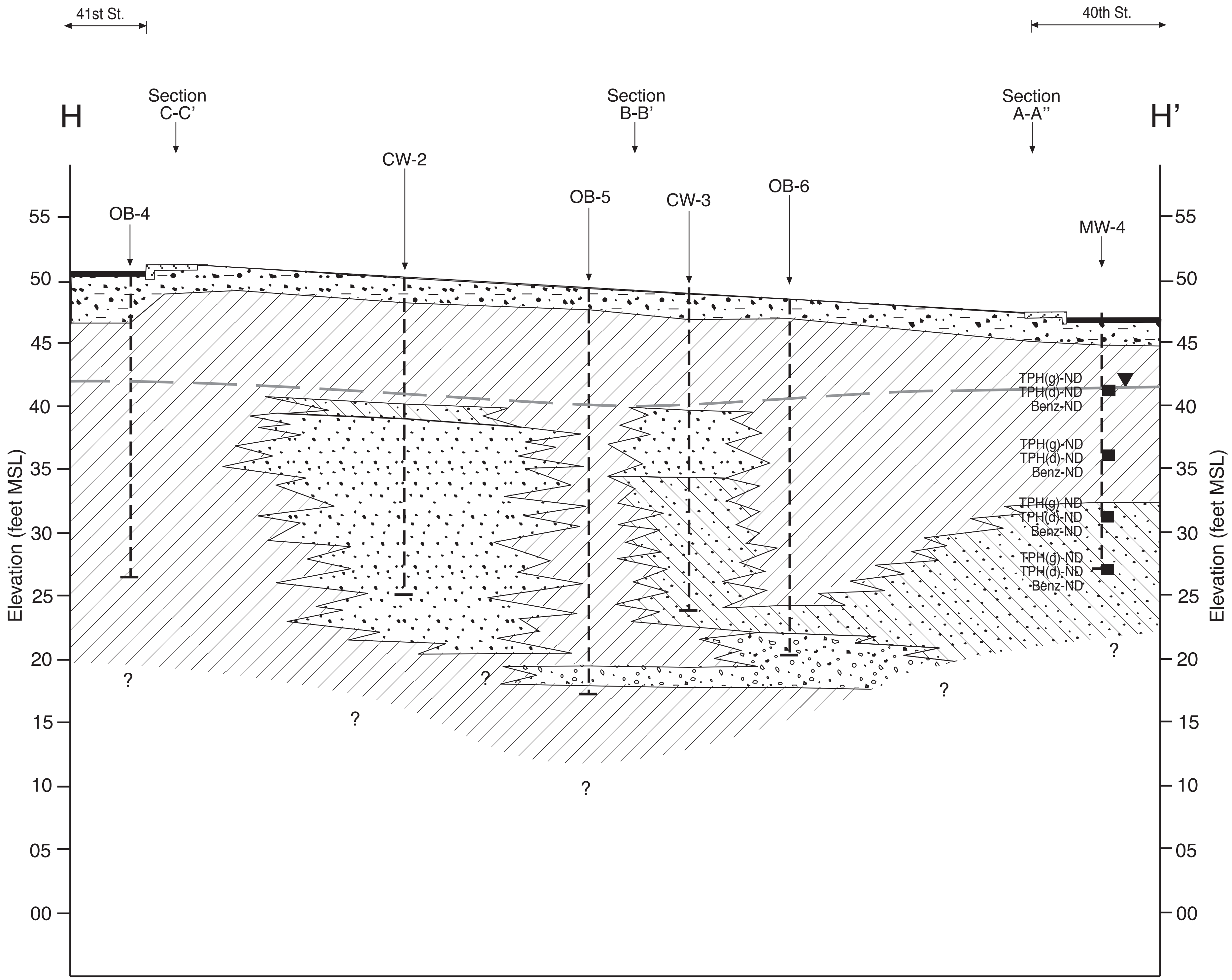
HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION G-G'

Oak Walk Redevelopment Project

Emeryville, California

FIG I-13	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM / Date: 04/25/06



EXPLANATION

Clays and Silty Clays	Gravel
Sandy Clay and Clays with some Silt, Sand or Gravel	Gravelly Fill
Silts, Clayey Gravel and Sands	Water Table (11/08/04)
	Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

0 40 80

HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION H-H'

Oak Walk Redevelopment Project

Emeryville, California

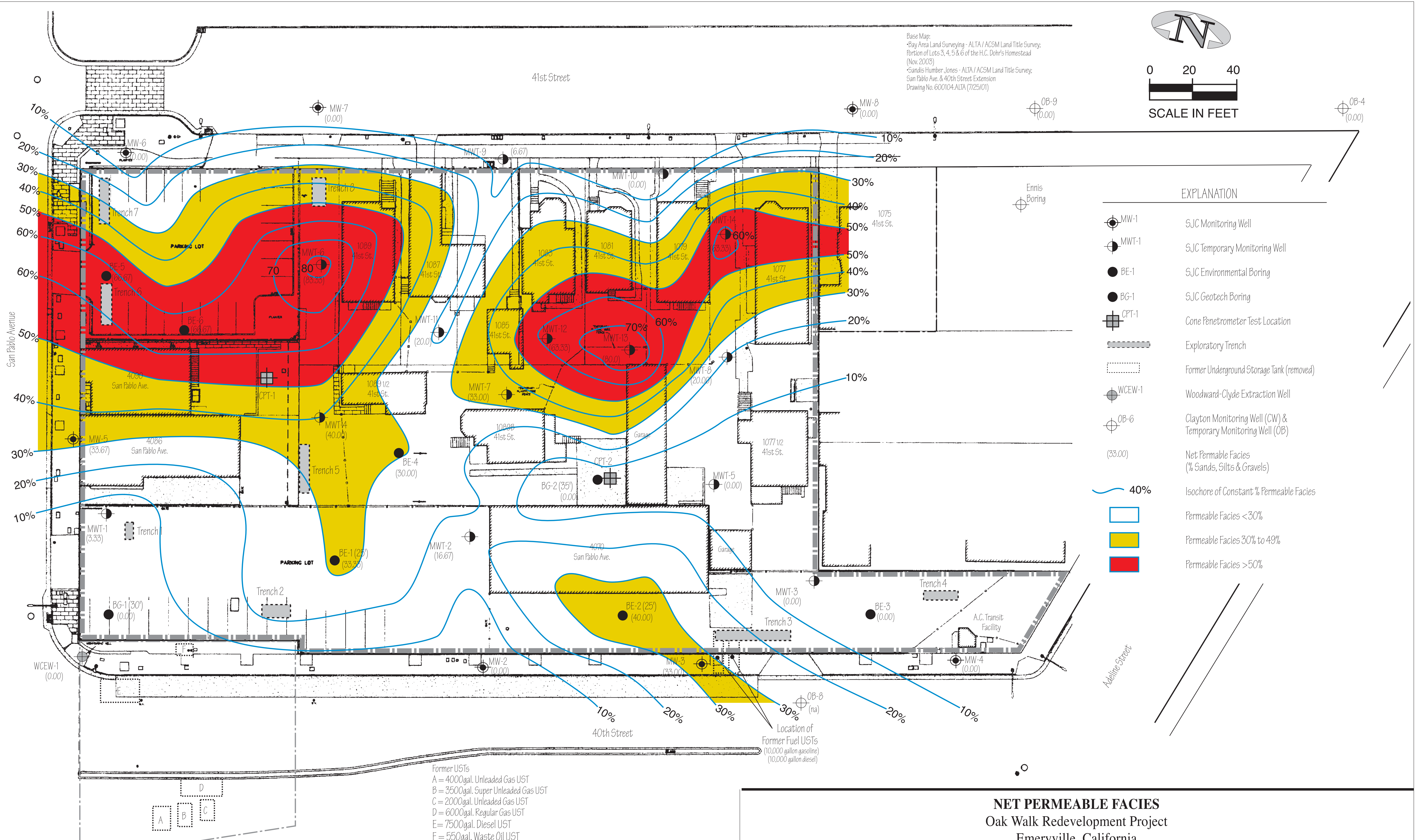
FIG I-14

The San Joaquin Company Inc.

Project Number: 0004.084

Drawn by: GNM

Date: 04/25/06

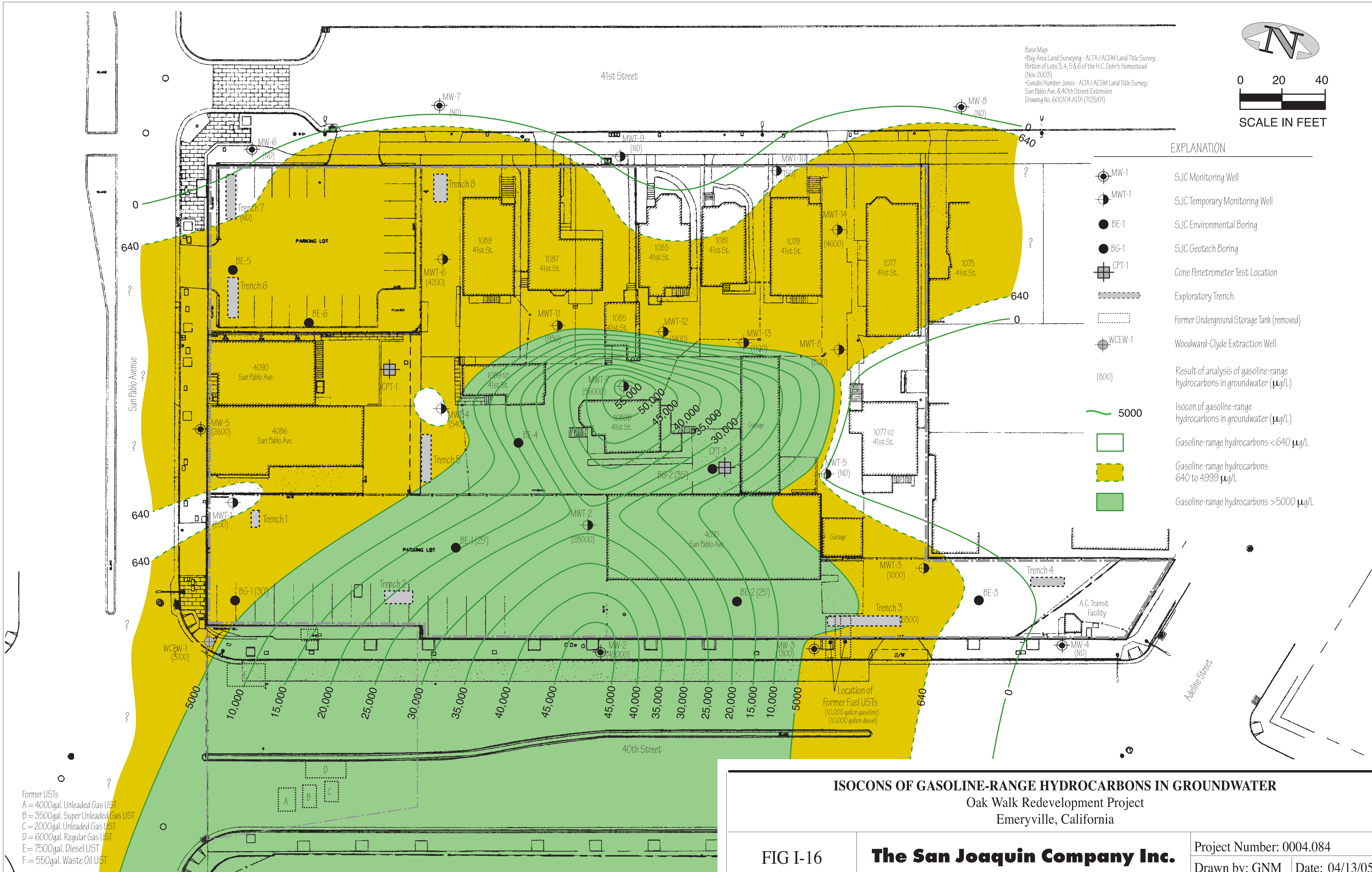


NET PERMEABLE FACIES
Oak Walk Redevelopment Project
Emeryville, California

FIG I-15

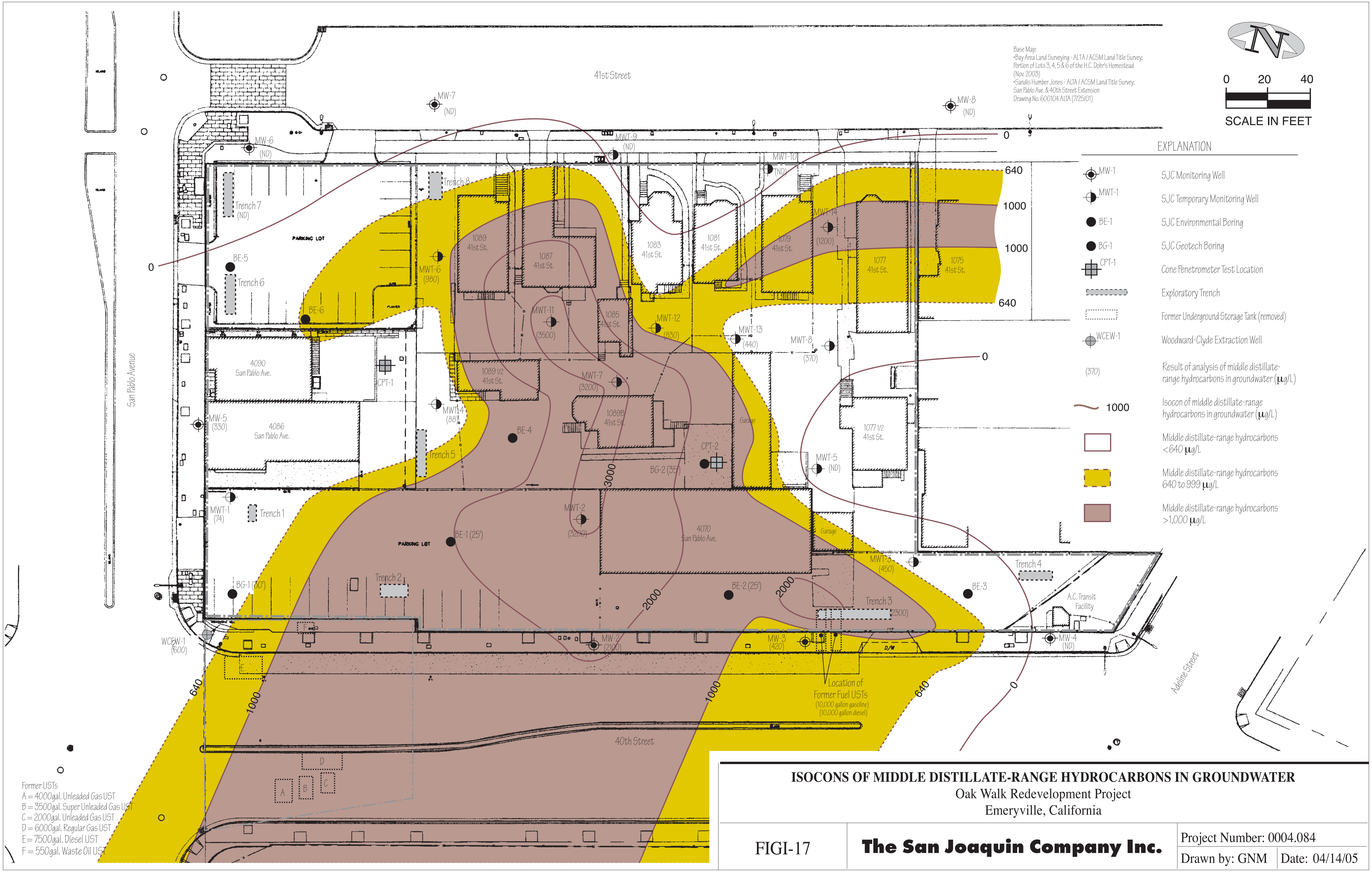
The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: GNM
Date: 04/10/05



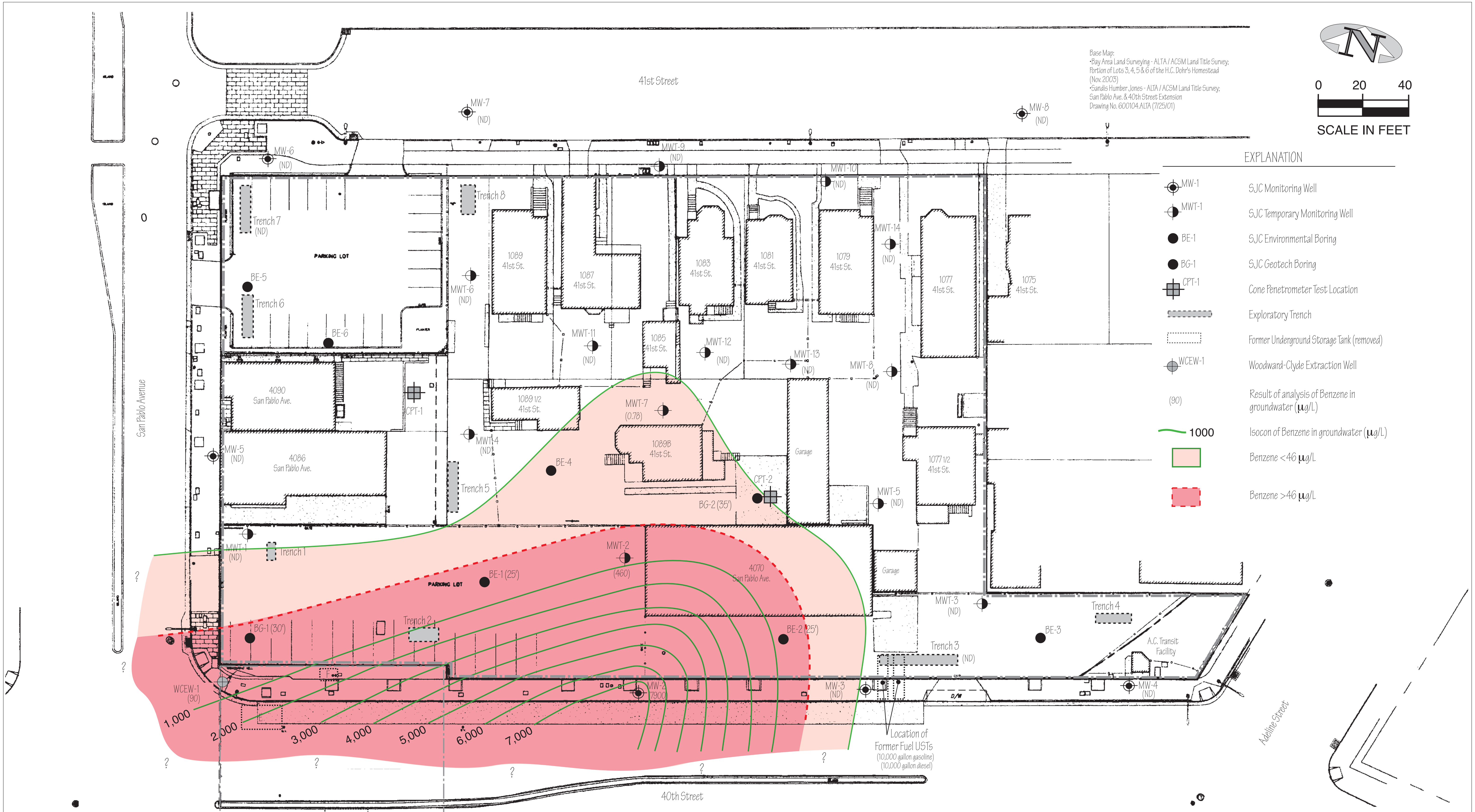
ISOCONS OF GASOLINE-RANGE HYDROCARBONS IN GROUNDWATER
Oak Walk Redevelopment Project
Emeryville, California

FIG I-16	**The San Joaquin Company Inc.**	Project Number: 0004.084 Drawn by: GNM Date: 04/13/05



ISOCONS OF MIDDLE DISTILLATE-RANGE HYDROCARBONS IN GROUNDWATER
Oak Walk Redevelopment Project
Emeryville, California

FIGI-17	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM Date: 04/14/05

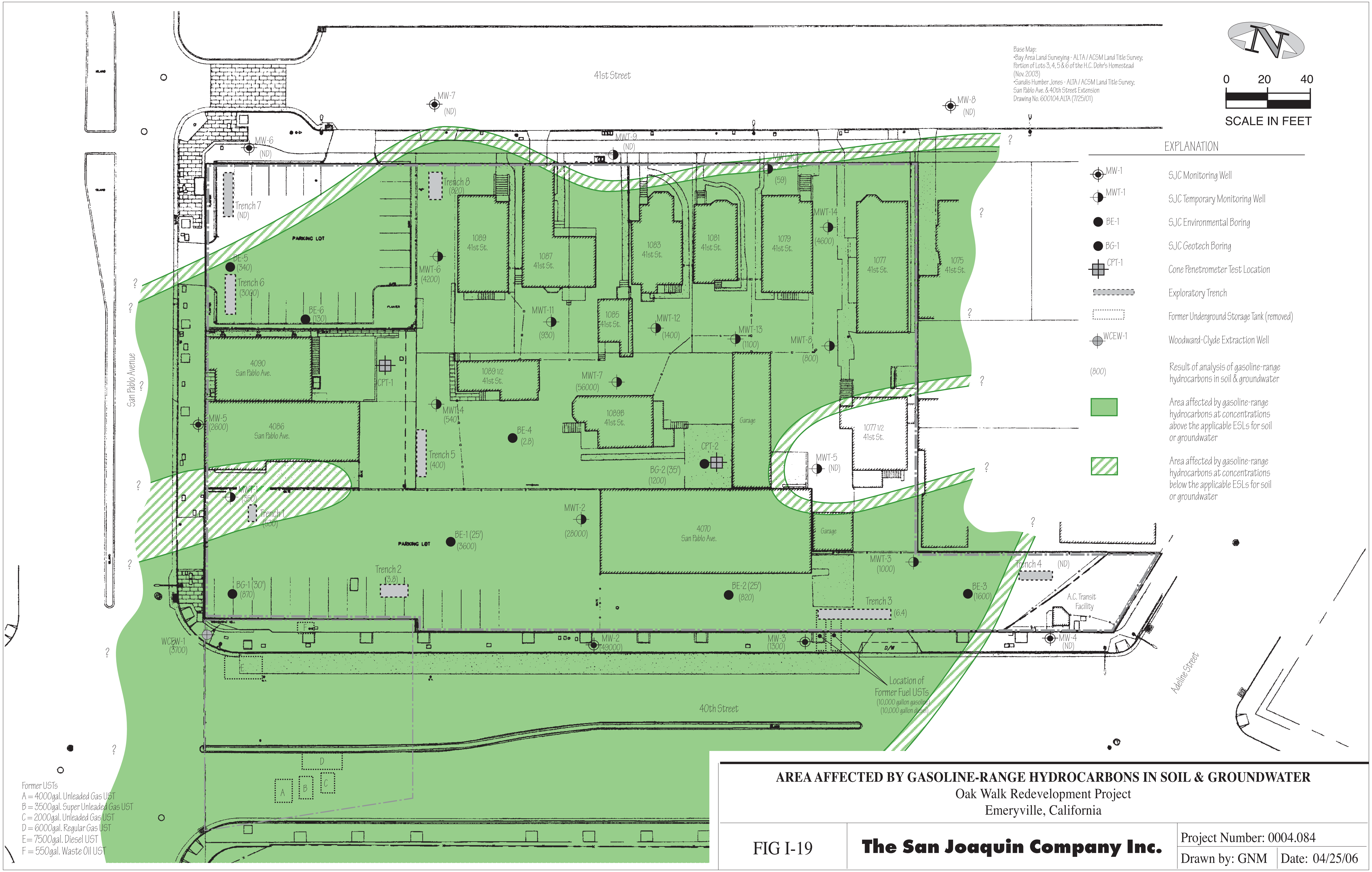


ISOCONS OF BENZENE IN GROUNDWATER
Oak Walk Redevelopment Project
Emeryville, California

FIG I-18

The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: GNM
Date: 05/03/06

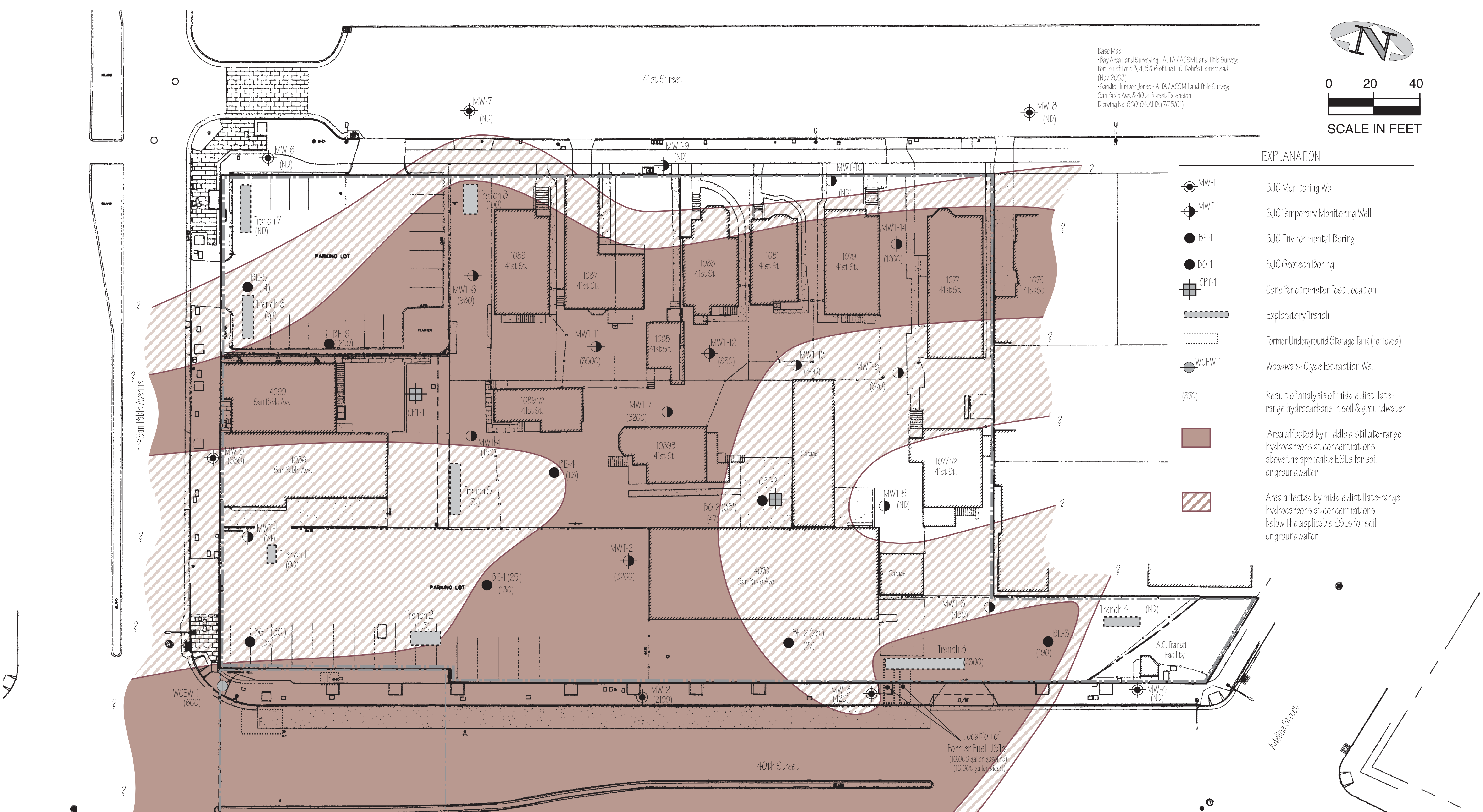


AREA AFFECTED BY GASOLINE-RANGE HYDROCARBONS IN SOIL & GROUNDWATER

Oak Walk Redevelopment Project

Emeryville, California

FIG I-19	The San Joaquin Company Inc.	Project Number: 0004.084
		Drawn by: GNM / Date: 04/25/06



AREA AFFECTED BY MIDDLE DISTILLATE-RANGE HYDROCARBONS IN SOIL & GROUNDWATER

Oak Walk Redevelopment Project

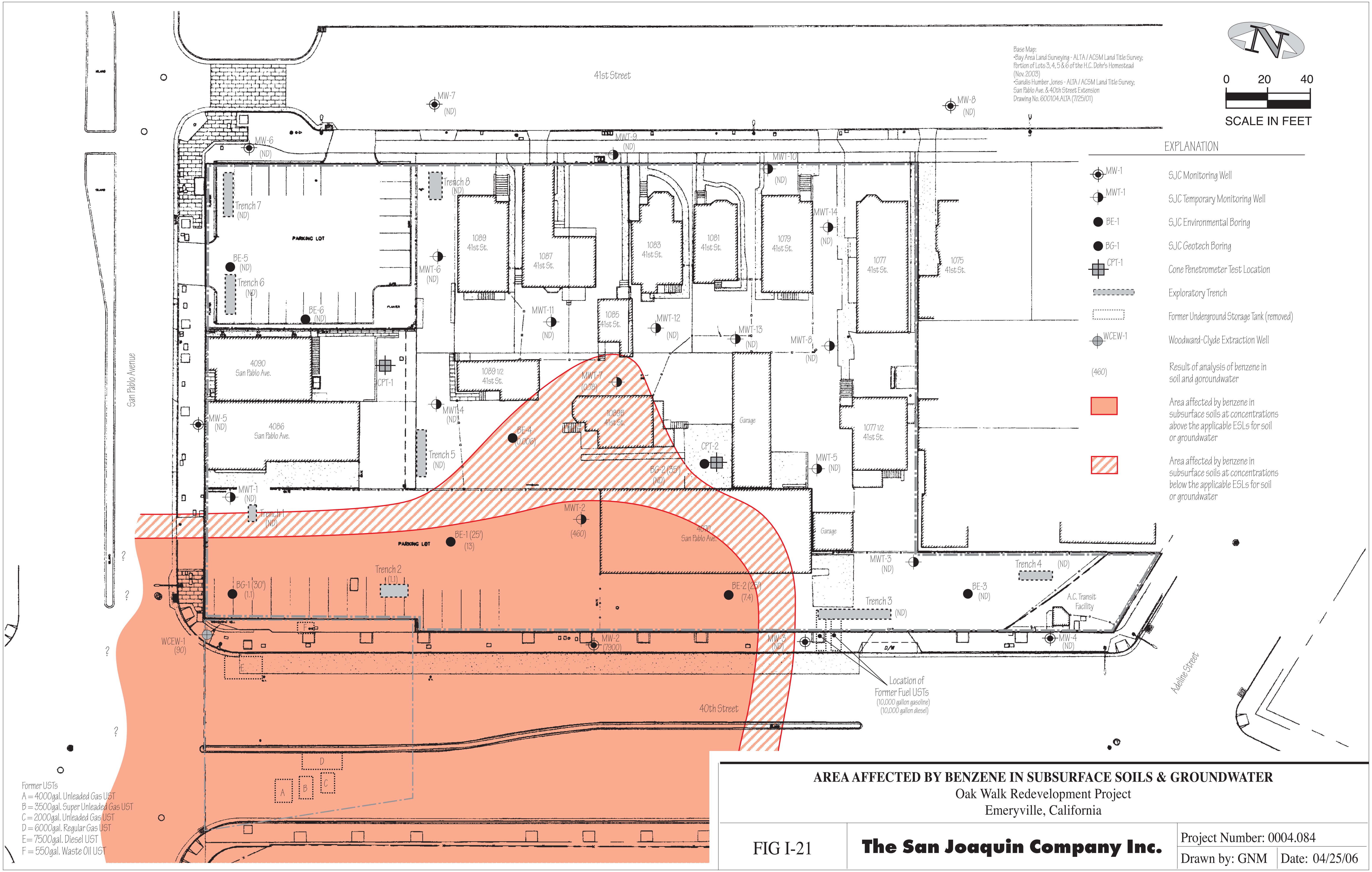
Emeryville, California

FIG I-20

The San Joaquin Company Inc.

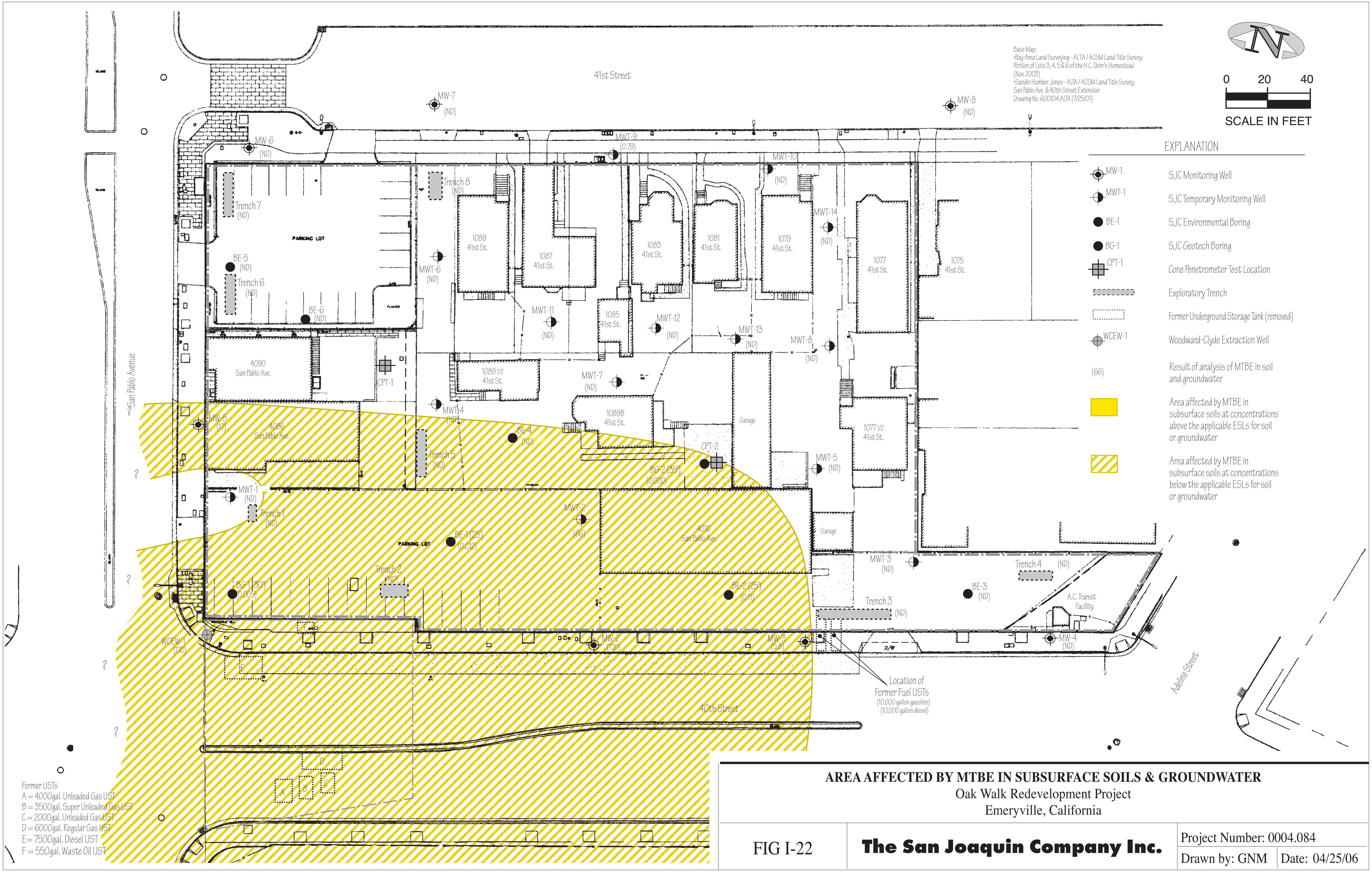
Project Number: 0004.084

Drawn by: GNM | Date: 04/25/06



AREA AFFECTED BY BENZENE IN SUBSURFACE SOILS & GROUNDWATER
Oak Walk Redevelopment Project
Emeryville, California

FIG I-21	**The San Joaquin Company Inc.**	Project Number: 0004.084 Drawn by: GNM Date: 04/25/06

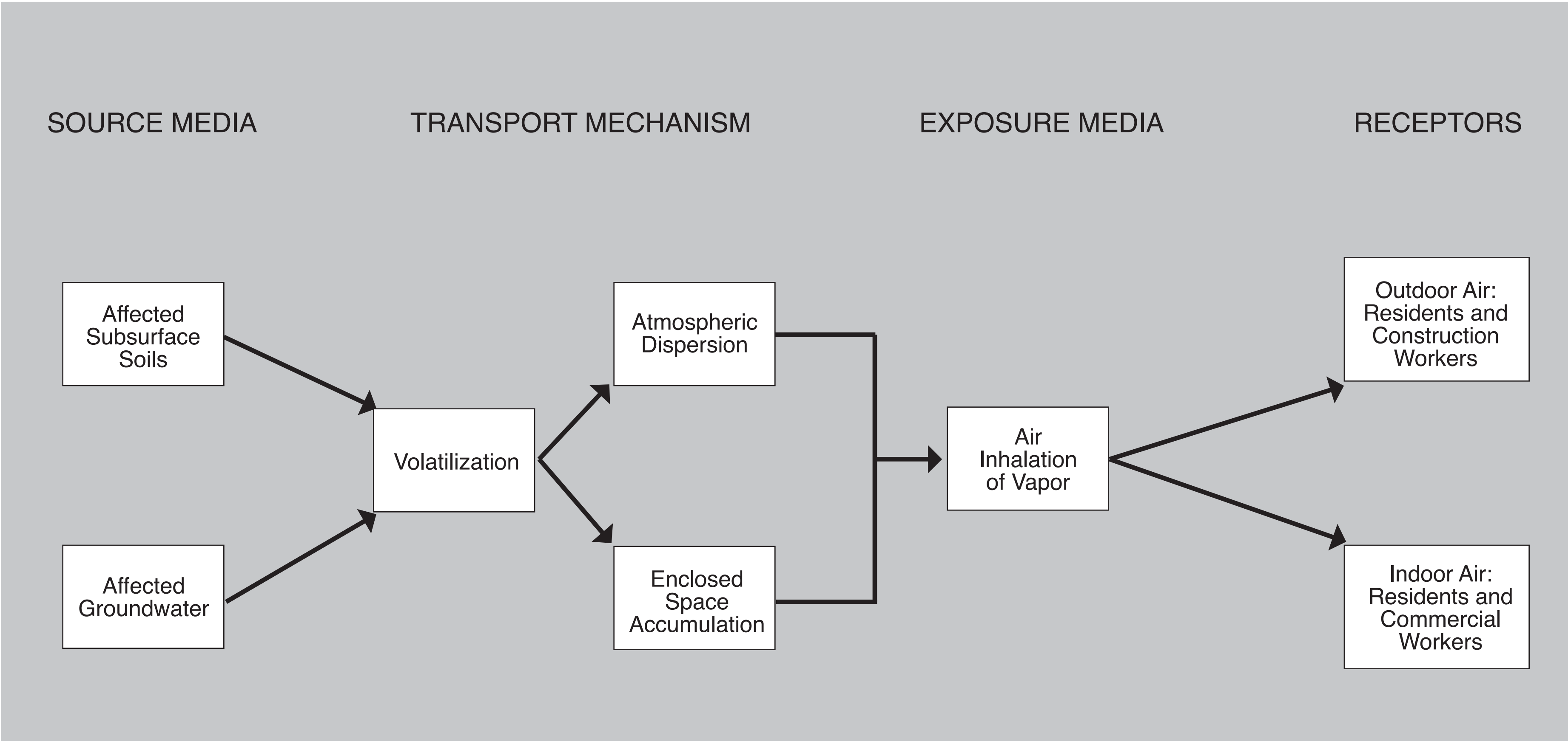


AREA AFFECTED BY MTBE IN SUBSURFACE SOILS & GROUNDWATER

Oak Walk Redevelopment Project

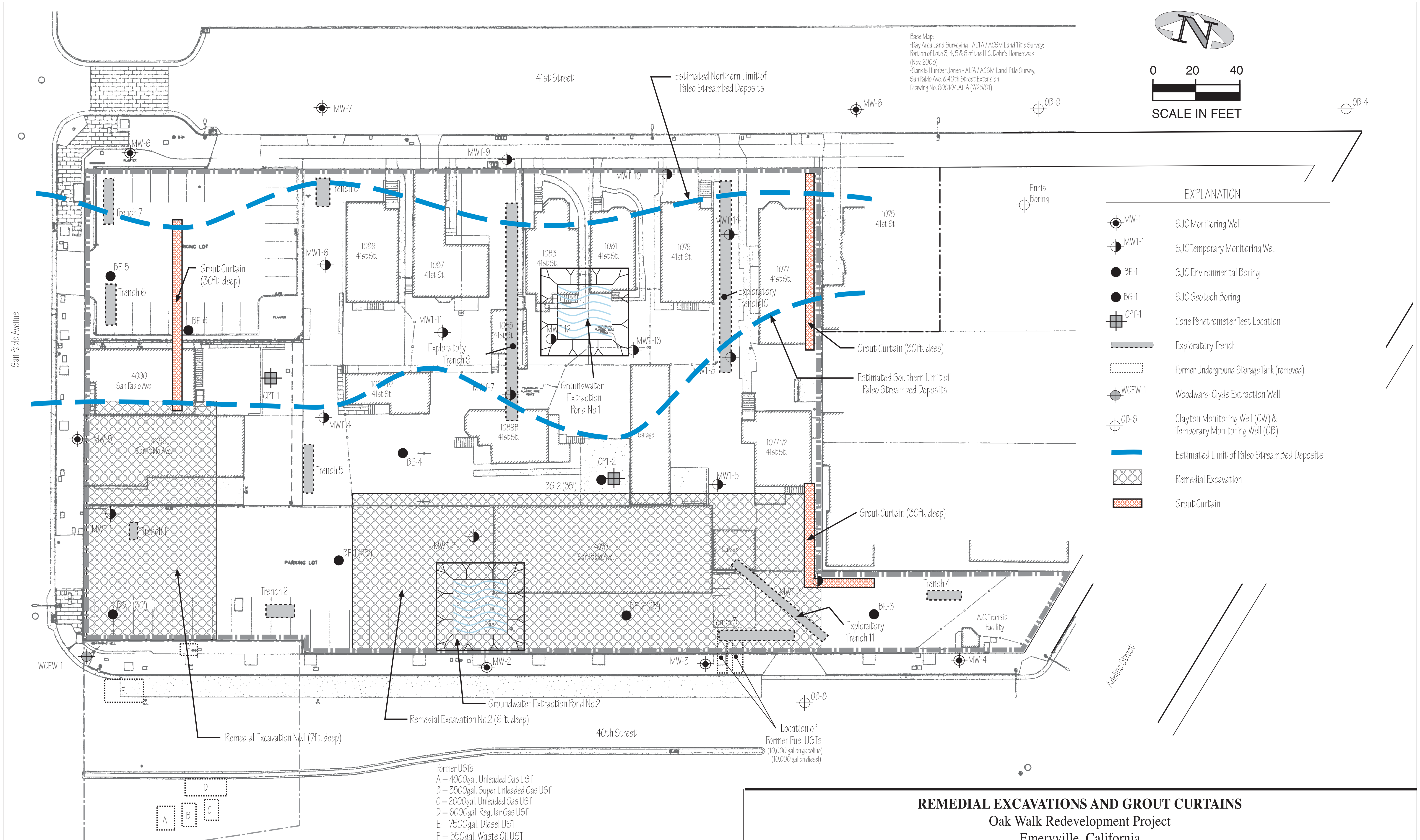
Emeryville, California

FIG I-22	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM Date: 04/25/06



EXPOSURE PATHWAYS FOR HUMAN HEALTH RISK ASSESSMENTS
Oak Walk Redevelopment Project
Emeryville, California

FIG I-23	**The San Joaquin Company Inc.**	Project Number: 0004.084 Drawn by: GNM Date: 06/20/06

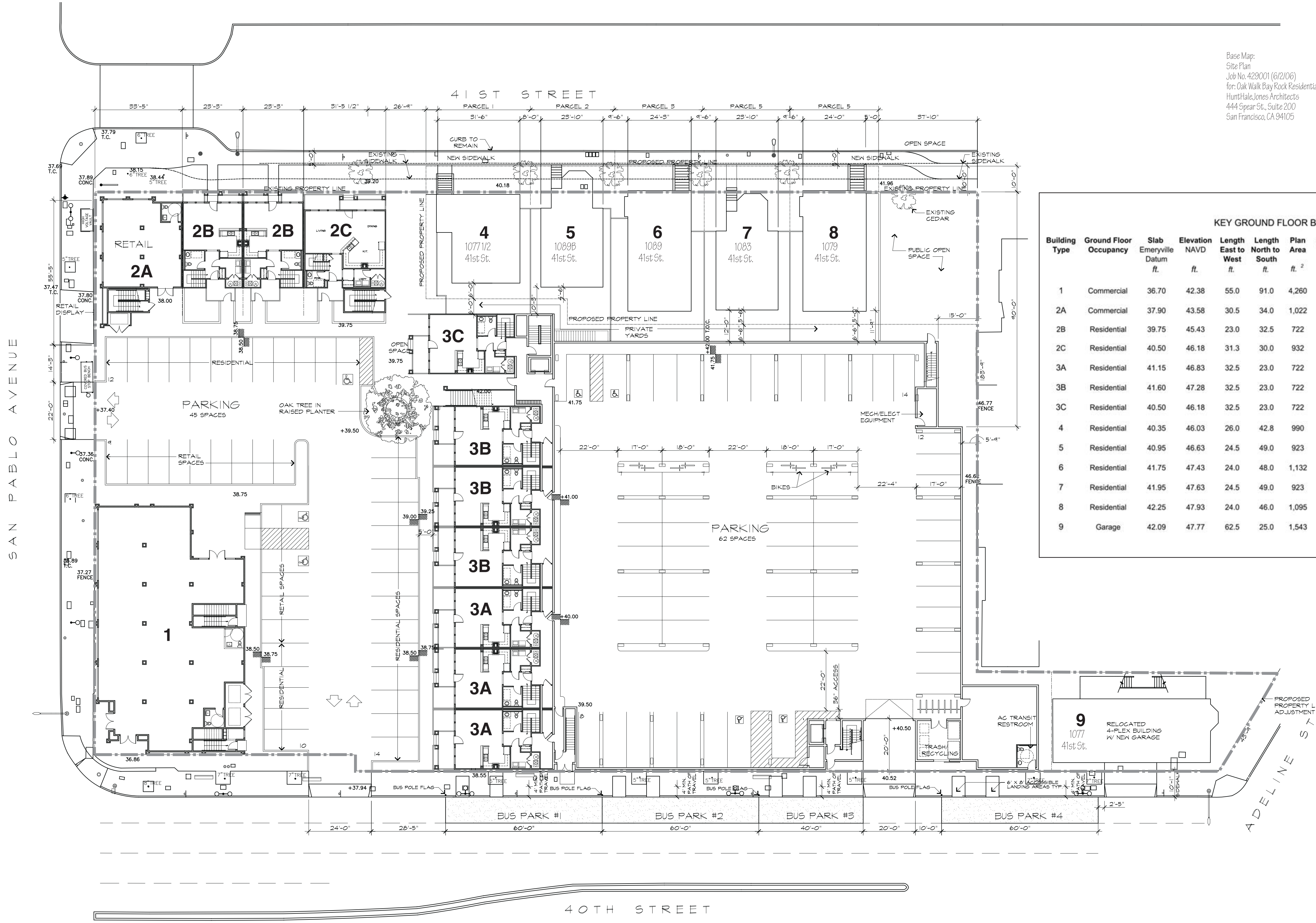


REMEDIAL EXCAVATIONS AND GROUT CURTAINS
Oak Walk Redevelopment Project
Emeryville, California

FIG I-24

The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: GNM
Date: 06/20/06



KEY GROUND FLOOR BUILDING DIMENSIONS

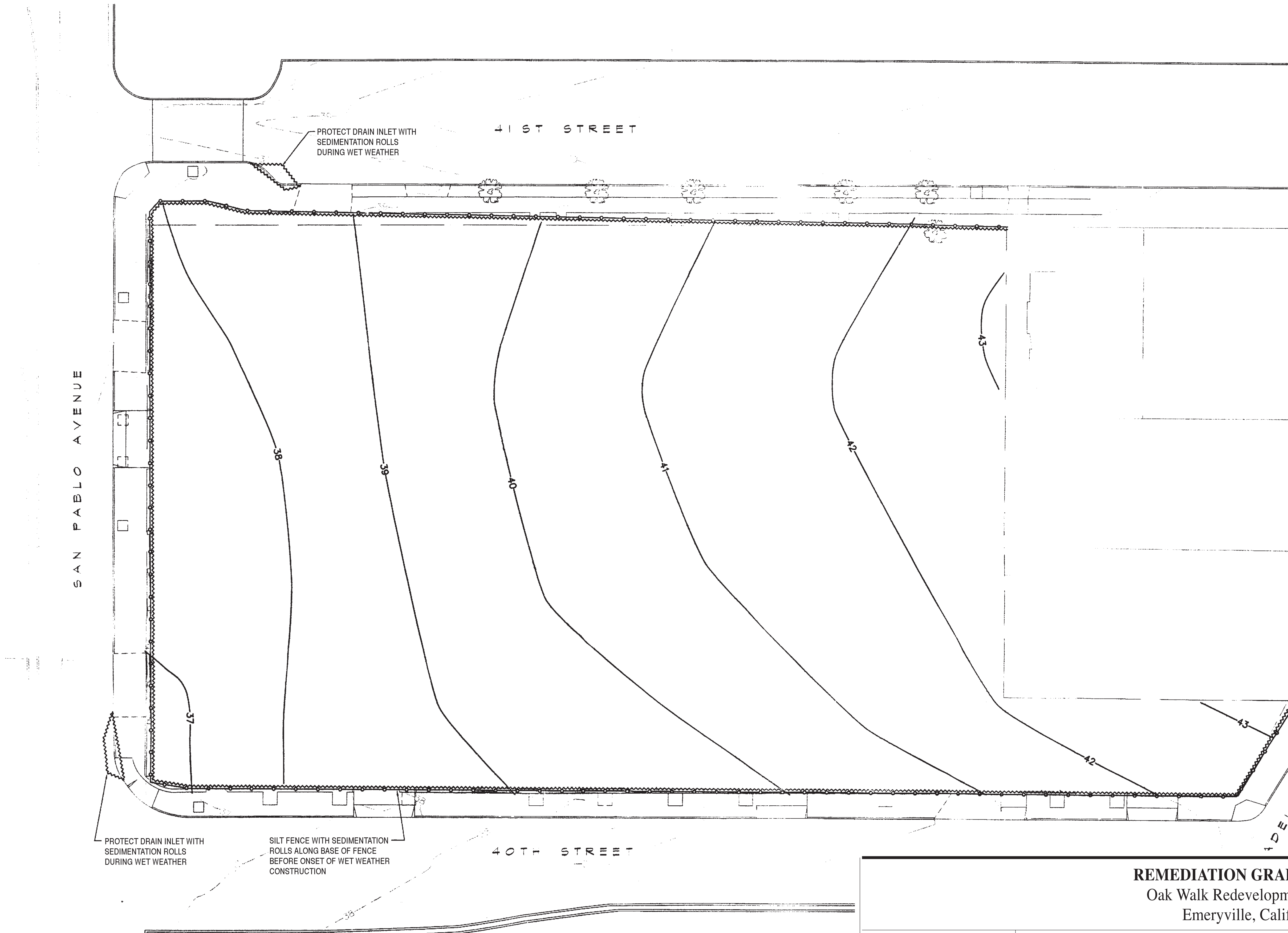
Building Type	Ground Floor Occupancy	Slab Emeryville Datum ft.	Elevation NAVD ft.	Length East to West ft.	Length North to South ft.	Plan Area ft.^{2}	Foundation Perimeter ft.	Gr. Floor Floor to Ceiling ft.	Gr. Floor Interior Volume ft.^{3}	Ground Floor Volume/Area Ratio	Gr. Floor Slab Thickness in.	Impermeable Barrier
1	Commercial	36.70	42.38	55.0	91.0	4,260	331.0	18	76,680	18.0	6	Liquid Boot®
2A	Commercial	37.90	43.58	30.5	34.0	1,022	129.0	18	18,396	18.0	6	Liquid Boot®
2B	Residential	39.75	45.43	23.0	32.5	722	118.3	9	6,498	9.0	6	Liquid Boot®
2C	Residential	40.50	46.18	31.3	30.0	932	126.6	9	8,388	9.0	6	Liquid Boot®
3A	Residential	41.15	46.83	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
3B	Residential	41.60	47.28	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
3C	Residential	40.50	46.18	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
4	Residential	40.35	46.03	26.0	42.8	990	146.3	9	8,910	9.0	6	Liquid Boot®
5	Residential	40.95	46.63	24.5	49.0	923	139.0	9	8,307	9.0	6	Liquid Boot®
6	Residential	41.75	47.43	24.0	48.0	1,132	146.0	9	10,188	9.0	6	Liquid Boot®
7	Residential	41.95	47.63	24.5	49.0	923	139.0	9	8,307	9.0	6	Liquid Boot®
8	Residential	42.25	47.93	24.0	46.0	1,095	140.0	9	9,855	9.0	6	Liquid Boot®
9	Garage	42.09	47.77	62.5	25.0	1,543	175.0	8	12,344	8.0	6	Liquid Boot®

GROUND FLOOR RESIDENTIAL AND COMMERCIAL UNIT TYPES

Oak Walk Redevelopment Project

Emeryville, California

FIG I-25	The San Joaquin Company Inc.	Project Number: 0004.084
		Drawn by: GNM — Date: 06/21/06



0 20 40

SCALE IN FEET

GENERAL NOTES:

1 BENCH MARK: ELEVATIONS ARE BASED ON THE CITY OF EMERYVILLE DATUM.

2. GRADING SHALL BE CONDUCTED IN CONFORMANCE WITH:
   A. THE CITY OF EMERYVILLE PUBLIC WORKS DEPARTMENT. AND IN ACCORDANCE WITH:
   B. THE GEOTECHNICAL INVESTIGATION REPORT FOR THE SITE PREPARED BY THE SAN JOAQUIN COMPANY, DATED AUGUST 2004.

3. THE CONTRACTOR SHALL NOTIFY UNDERGROUND SERVICE ALERT, (800) 642-2444 48 HOURS PRIOR TO ANY EXCAVATION. THE USA AUTHORIZATION NUMBER SHALL BE KEPT AT JOB SITE.

4. SHOULD IT APPEAR THAT THE WORK TO BE DONE, OR ANY MATTER RELATIVE THERETO, IS NOT SUFFICIENTLY DETAILED OR EXPLAINED ON THESE PLANS, THE CONTRACTOR SHALL CONTACT THE SAN JOAQUIN COMPANY INC AT 510-336-9118 FOR SUCH FURTHER EXPLANATIONS AS MAY BE NECESSARY.

5. WORK WITHIN THE CITY RIGHT OF WAY SHALL BE DONE IN ACCORDANCE WITH THE STANDARD PLANS AND SPECIFICATIONS OF THE CITY.

6. ANY SIDEWALK, CURB OR GUTTER DAMAGED DURING THE COURSE OF CONSTRUCTION WILL BE REPLACED IN ACCORDANCE WITH CITY OF EMERYVILLE STANDARDS.

7. MATERIALS FOR SERVICE UTILITIES SHALL CONFORM TO THE STANDARDS OF THE RESPECTIVE LOCAL AGENCIES AND TO THE CURRENT ADDITION OF THE UNIFORM BUILDING CODE.

WET WEATHER GRADING NOTES:

1. IF GRADING IS NOT COMPLETED PRIOR TO THE RAINY SEASON, OCTOBER 15 UNTIL APRIL 15, CONSTRUCT AND MAINTAIN A FIBER ROLL BARRIER, PER A.B.A.G. EROSION AND SEDIMENTATION CONTROL STANDARDS, ALONG THE PROPERTY FRONTAGE.

2. DURING THE RAINY SEASON PROVIDE DROP INLETS AND AREA DRAINS WITH SEDIMENTATION FILTERS OR SILT FENCE PROTECTION.

3. DURING THE RAINY SEASON PROVIDE SHORING, AS DETERMINED NECESSARY BY THE GEOTECHNICAL ENGINEER, TO SUPPORT EXCAVATION WALLS AND SLOPES.

4. DURING THE RAINY SEASON INSPECT, AND IF NECESSARY REPAIR AND CLEAN, WET WEATHER CONTROL MEASURES AFTER EACH SIGNIFICANT STORM EVENT.

BEST MANAGEMENT PRACTICES AND STORMWATER POLLUTION PREVENTION NOTES:

1. ALL WORK SHALL APPLY THE "BEST MANAGEMENT PRACTICES" (BMPs) FOR THE CONSTRUCTION INDUSTRY, INCLUDING BMPs FOR DUST, EROSION, AND SEDIMENTATION ABATEMENT, AS WELL AS ALL SPECIFIC CONSTRUCTION RELATED CONDITIONS OF APPROVAL FOR THIS PROJECT. IN ADDITION, THE CONTRACTOR IS REQUIRED TO BE FAMILIAR WITH, AND IMPLEMENT ALL STORMWATER QUALITY AND POLLUTION CONTROL MEASURES IN ACCORDANCE WITH CODE.

2. PROTECT ADJACENT PROPERTIES FROM ALL STORM WATER OR SILT RUNOFF GENERATED BY ON-SITE CONSTRUCTION ACTIVITIES.

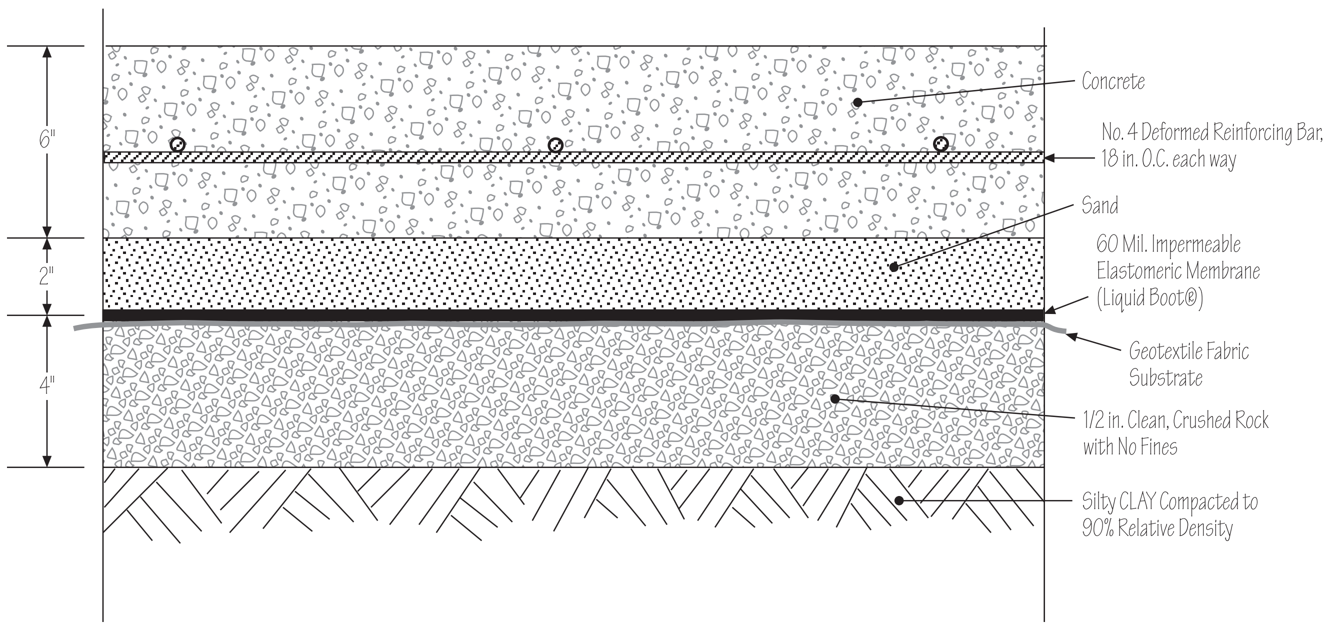
3. GATHER ALL CONSTRUCTION DEBRIS ON A REGULAR BASIS. STORE ALL CONSTRUCTION MATERIALS AND WASTE IN A COVERED AREA, OR UNDER A TARP. SWEEP WHERE POSSIBLE. DO NOT USE WATER TO WASH DOWN AREAS DRAINING TO STORM DRAINS.

4. MINIMIZE CONSTRUCTION ACCESS POINTS TO THE SITE. PROVIDE A CONSTRUCTION ENTRANCE AT EACH ACCESS POINT. REMOVE ALL SILT, GRAVEL, RUBBISH, AND GREEN WASTE FROM THE STREET ADJOINING THE SITE PRIOR TO OCTOBER 1ST. PROVIDE REGULAR MAINTENANCE, WEEKLY OR AFTER STORM EVENTS, TO KEEP ACCESS POINTS CLEAN AND FREE OF DEBRIS. DURING WET WEATHER AVOID DRIVING OFF PAVED AREAS AND TRACKING MUD AND SILT ONTO PAVED AREAS.

5. DUST CONTROL MEASURES:
   1. WATER ALL ACTIVE CONSTRUCTION AREAS NECESSARY TO CONTROL DUST.
   2. COVER STOCKPILES OF DEBRIS, SOILS OR OTHER MATERIAL IF BLOWN BY WIND.
   3. SWEEP ADJACENT PUBLIC RIGHT OF WAY AND STREET DAILY IF VISIBLE SOIL MATERIAL OR DEBRIS IS CARRIED ONTO THESE AREAS.
   4. COVER ALL TRUCKS HAULING SOIL, SAND, AND OTHER LOOSE MATERIALS OR REQUIRE ALL TRUCKS TO MAINTAIN AT LEAST TWO FEET OF FREEBOARD.
   5. ENCLOSE, COVER, WATER TWICE DAILY OR APPLY NON-TOXIC SOIL BINDERS TO EXPOSED STOCKPILES (DIRT, SAND, ETC.).

REMEDIATION GRADING PLAN
Oak Walk Redevelopment Project
Emeryville, California

FIG I-26	**The San Joaquin Company Inc.**	Project Number: 0004.084 Drawn by: GNM / Date: 6/26/06

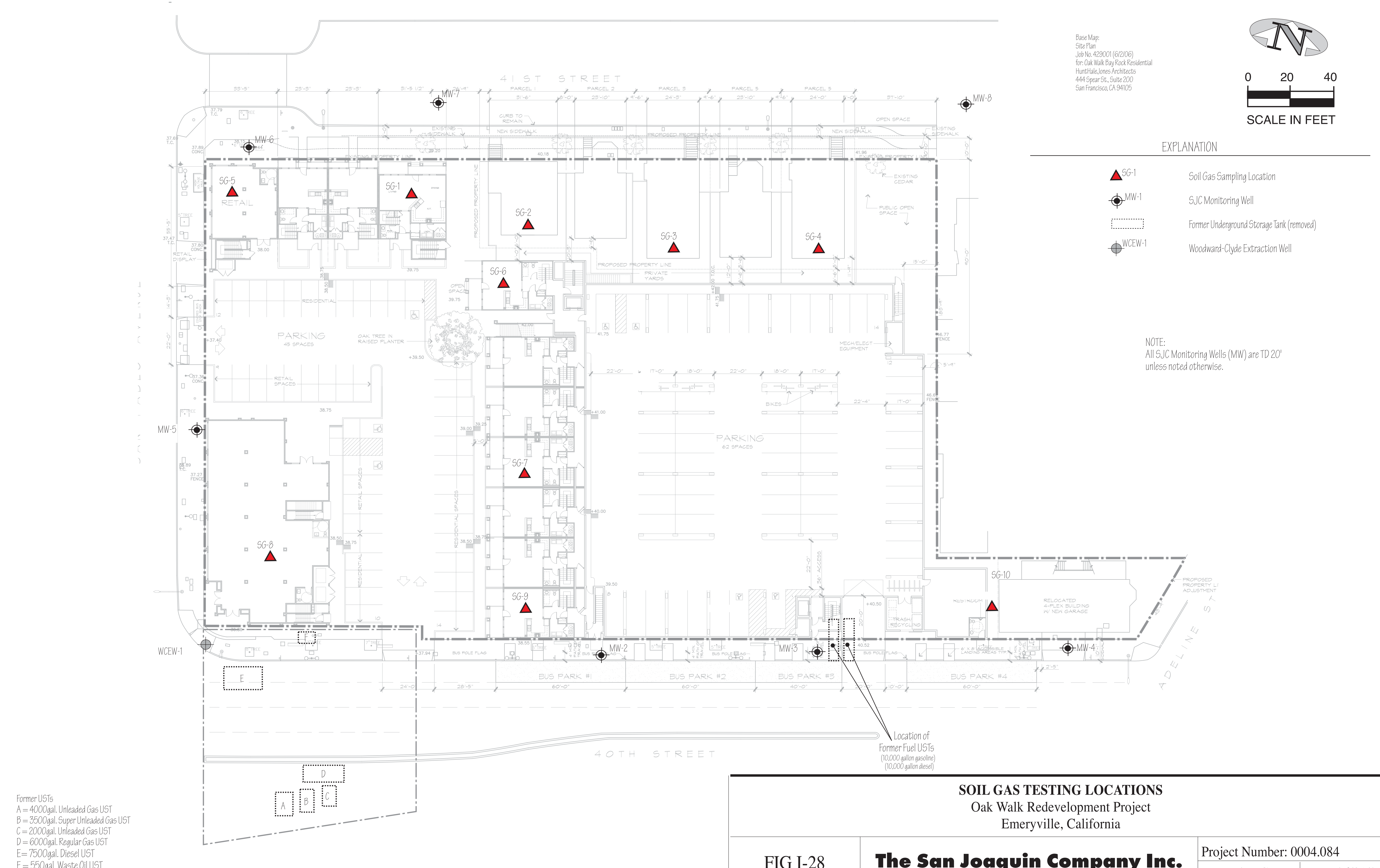


FLOOR SLAB WITH LIQUID BOOT® MEMBRANE

Oak Walk Redevelopment Project

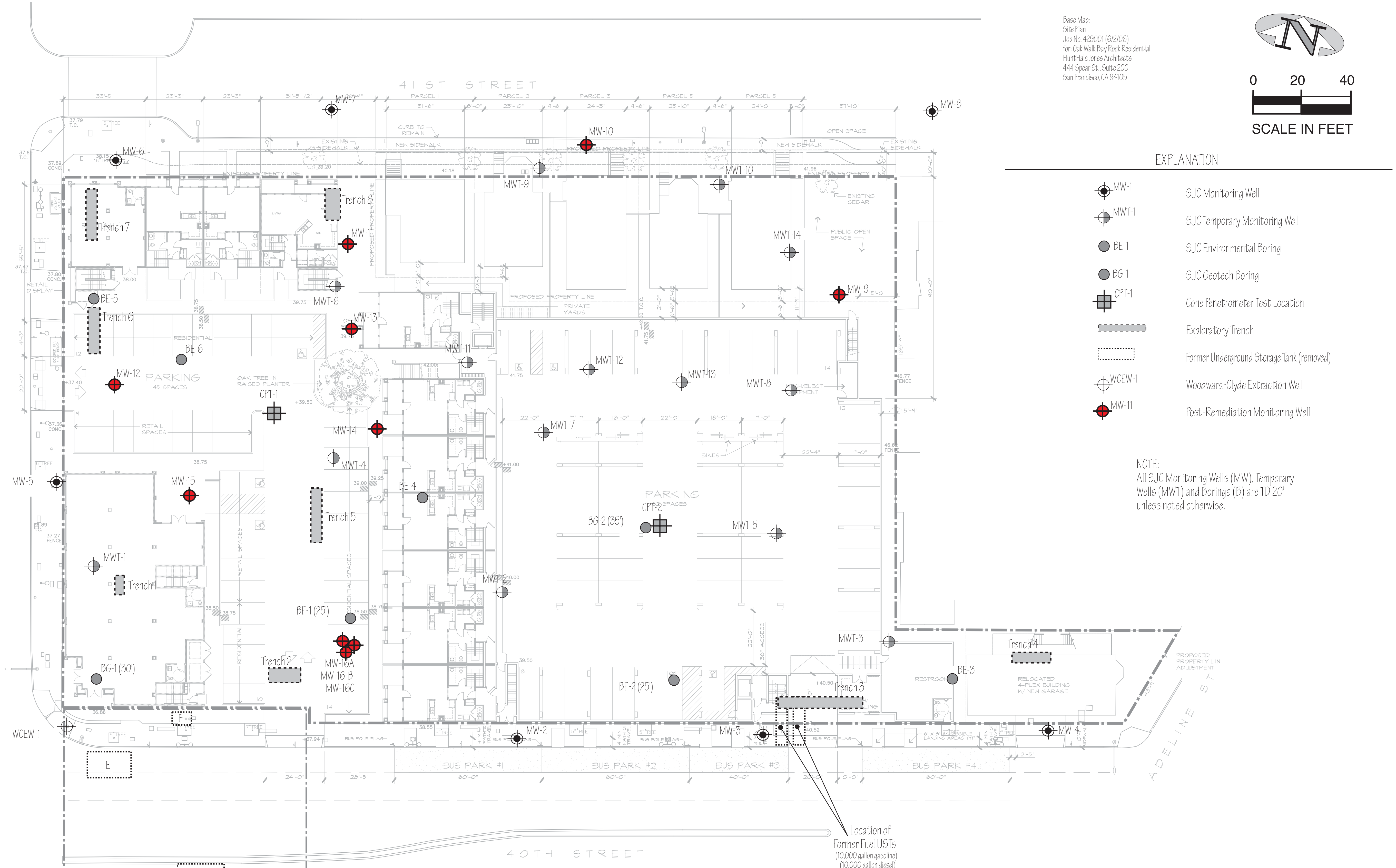
Emeryville, California

FIG I-27	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM	Date: 06/20/06



SOIL GAS TESTING LOCATIONS
Oak Walk Redevelopment Project
Emeryville, California

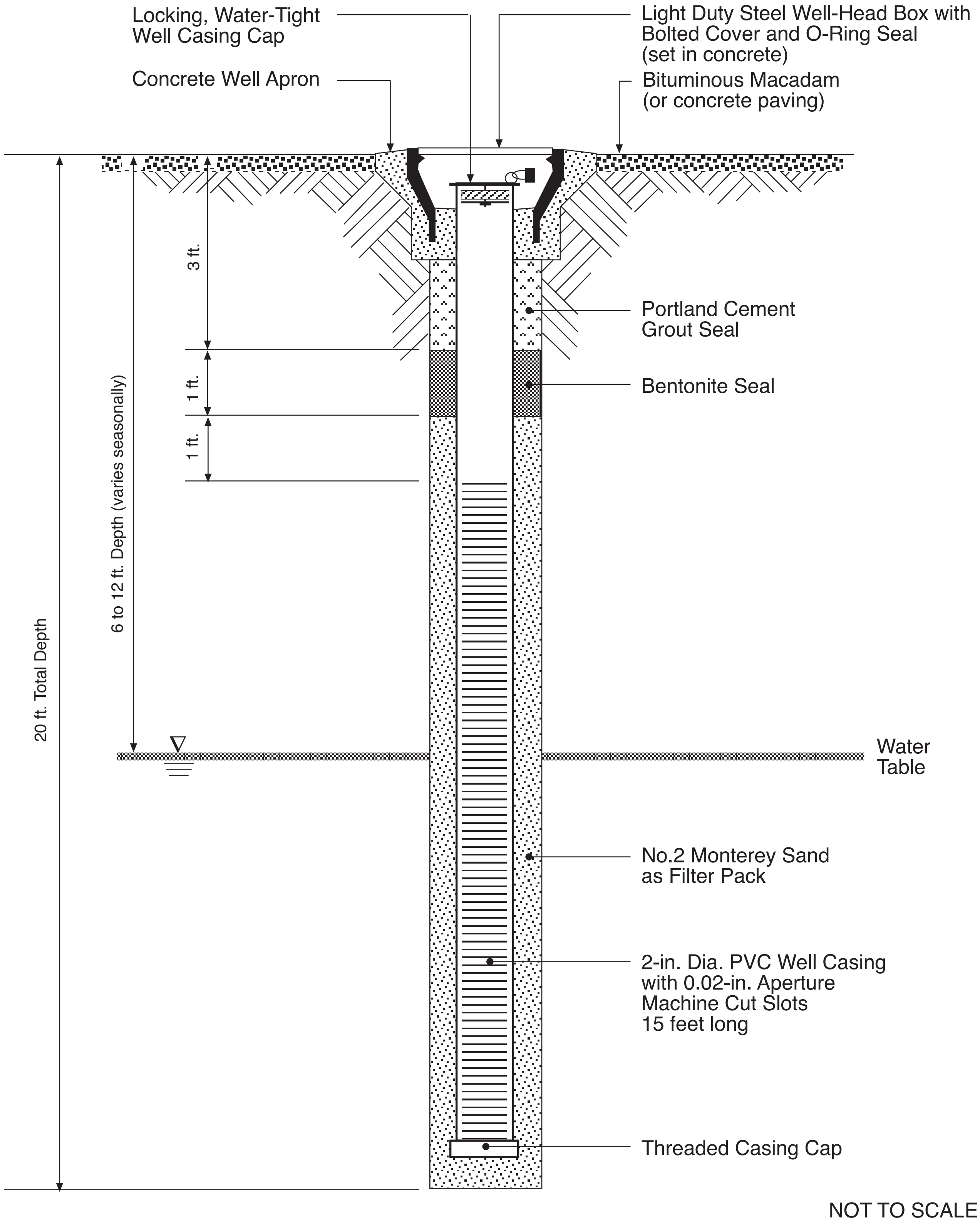
FIG I-28	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM Date: 06/21/06



Former USTs
A = 4000gal. Unleaded Gas UST
B = 3500gal. Super Unleaded Gas UST
C = 2000gal. Unleaded Gas UST
D = 6000gal. Regular Gas UST
E = 7500gal. Diesel UST
F = 550gal. Waste Oil UST

POST-REMEDIATION GROUNDWATER QUALITY MONITORING WELLS
Oak Walk Redevelopment Project
Emeryville, California

FIG I-29	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM Date: 6/21/06

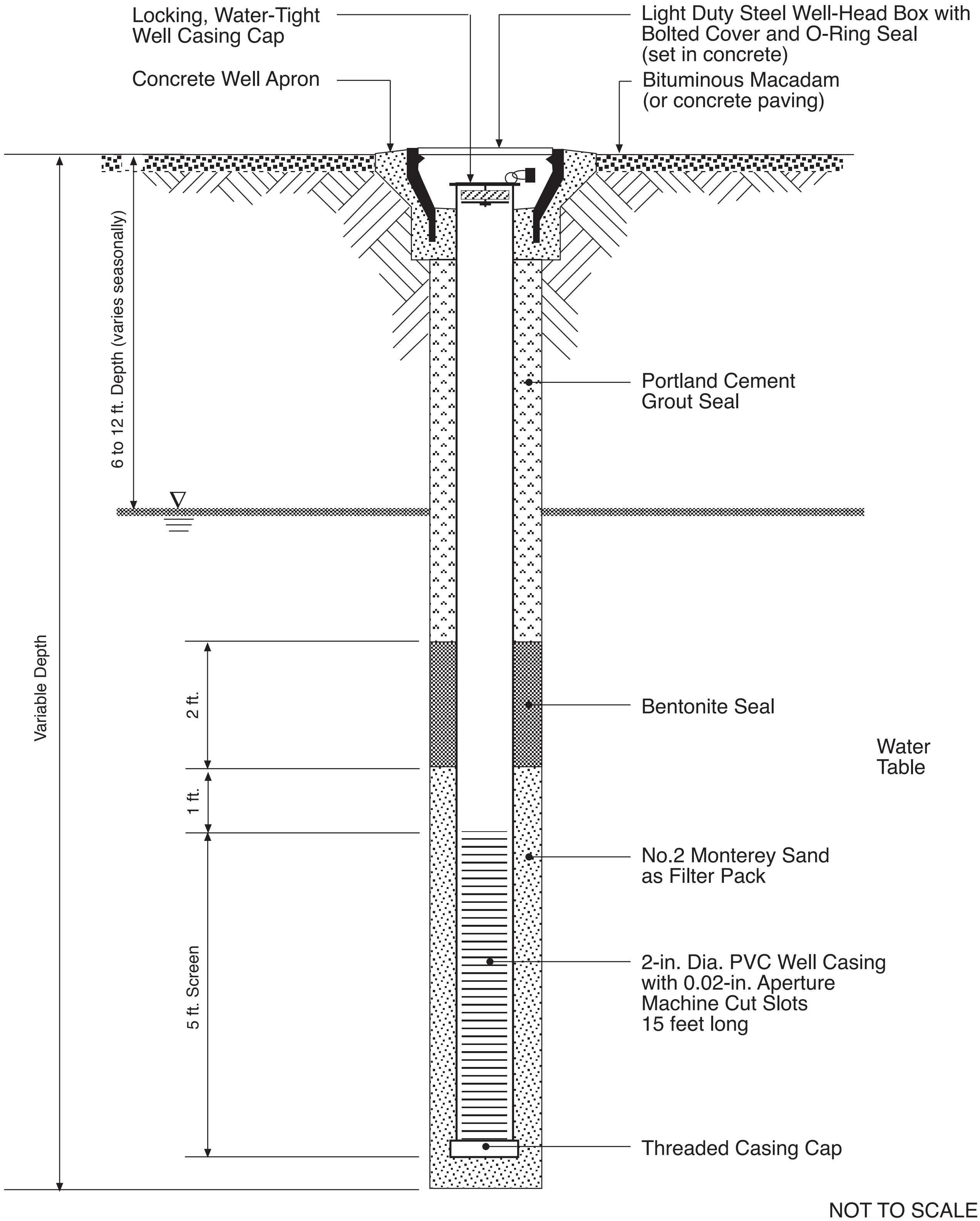


FULLY SCREENED GROUNDWATER QUALITY MONITORING WELL

Oak Walk Redevelpoment Project

Emeryville, California

FIG I-30	**The San Joaquin Company Inc.**	Project Number: 0004.084	
		Drawn by: GNM	Date: 06/21/06

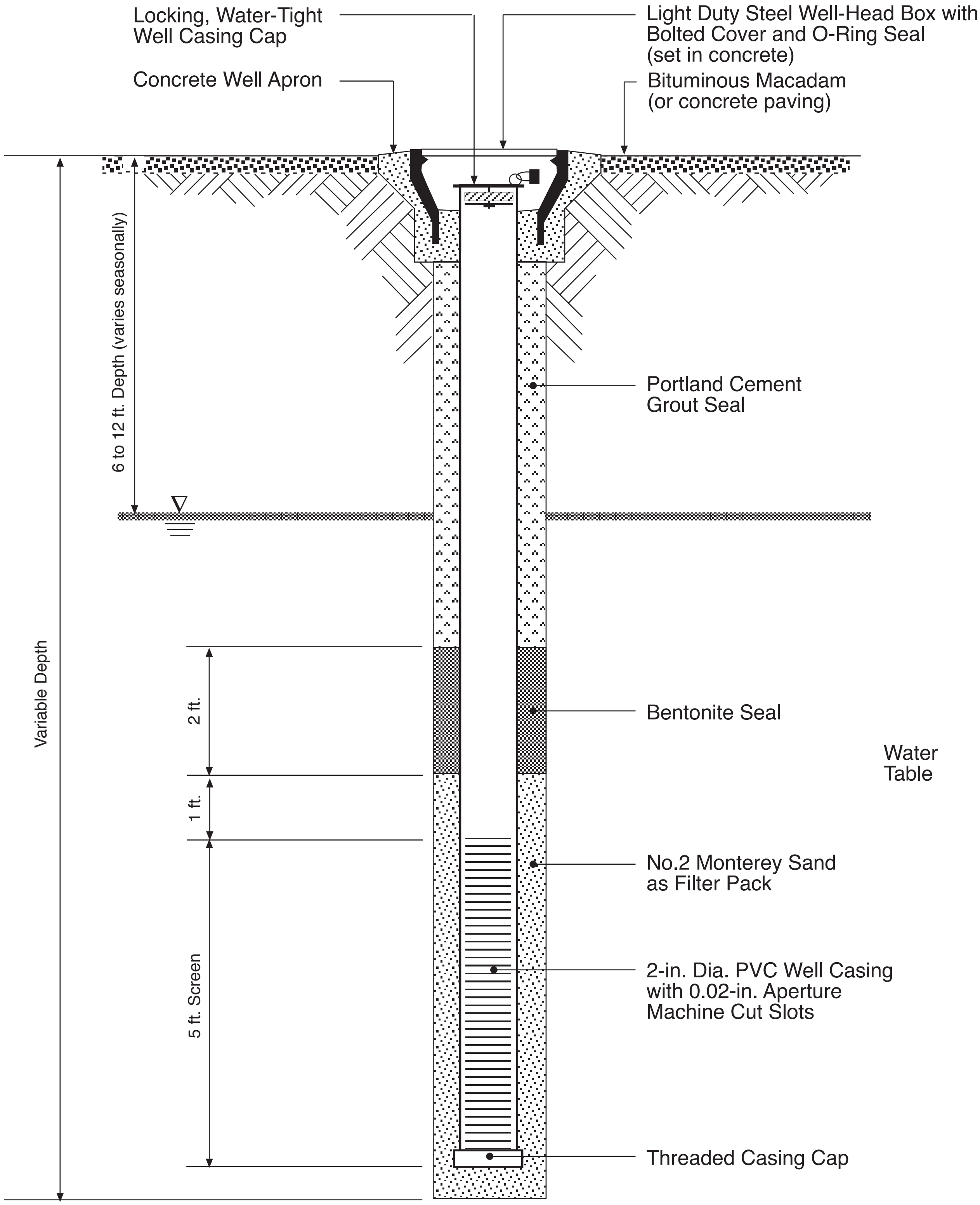


GROUNDWATER QUALITY MONITORING WELL WITH 5-FOOT SCREEN

Oak Walk Redevelpoment Project

Emeryville, California

FIG I-31	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM — Date: 06/28/06



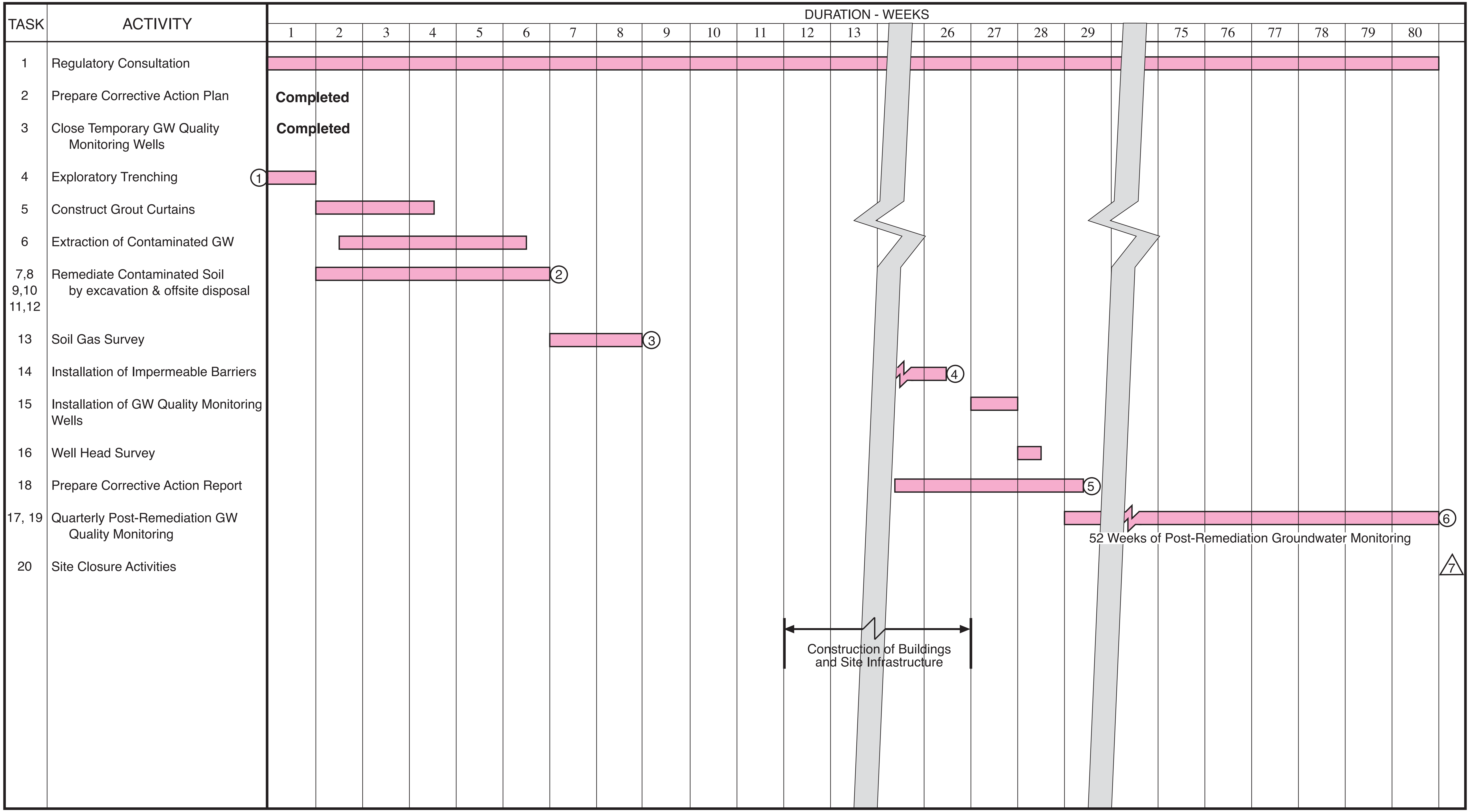
NOT TO SCALE

GROUNDWATER QUALITY MONITORING WELL WITH 5-FOOT SCREEN

Oak Walk Redevelpoment Project

Emeryville, California

FIG I-31	**The San Joaquin Company Inc.**	Project Number: 0004.084	
		Drawn by: GNM	Date: 06/28/06



Principal Milestones:

1 Remediation Contractor Mobilization
2 Soil & Groundwater Remediation Complete
3 Site Released for Construction
4 Impermeable Barrier Complete (3 week period ending in week 26)
5 Deliver Corrective Action Report
6 Complete Post-Remediation Groundwater Quality Monitoring

Corrective Action Schedule
Oak Walk Redevelopment Project
Emeryville, California

FIG. I-32

The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: *DJW* **Date:** 12/15/05

Plate I-1: Aerial Photograph No. AV-8401-3-4, flown 4/19/03. Oak Walk Redevelopment Site is outlined.

APPENDIX I-A

TRENCH AND BORING LOGS

The San Joaquin Company Inc.

Trench Log

Surface Elevation: 43.3 - 43.2 ft.

Trench Length at Surface: 13.0 ft.

Trench Width at Surface: 4.0 ft.

Maximum Depth of Trench: 8.5 ft.

Depth to First Water: n/a ft.

Depth to Water on: Not measured ft.

NOTES:
1. Uniform Soil Classifications are from field observations only. No geotechnical engineering laboratory tests were performed.

2. All Elevations are in feet MSL.

3. Ground surface elevations adjusted to conform to common datum reference as site borings (April 2005).

Trench ID: **Trench 1**

Project: Oak Walk Project

Project No.: 0004.081

Owner: Bay Rock Residential LLC

Location: San Pablo Avenue, Emeryville, California

Date Excavated: 12/03/03

Excavation By: Dietz Irrigation

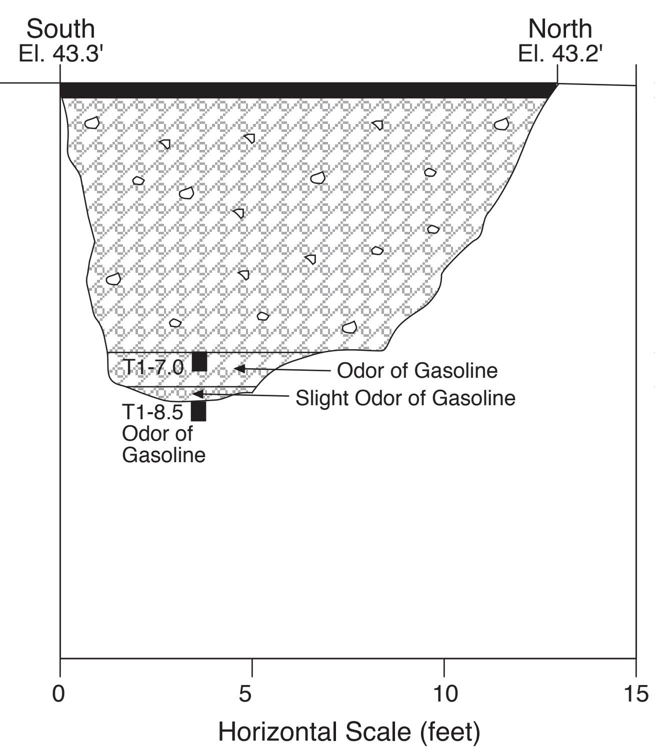
Logged By: D J Watkins

Equipment Operator: H B Dietz

Equipment Used: Case Excavator

Depth (Feet)	Sample	Trench Log / Description
0		Bituminous Macadam 4 in.
2–6		(SC) - Brown / black, Silty CLAY with bricks and other debris (FILL)
7	soil	(SC) - Grey / green with brown stiff Silty CLAY
8	soil	(SC) - Brown, medium soft Silty CLAY

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30



Exploratory Trench 1
Average trench width 4 feet, Trench Length 13 feet

The San Joaquin Company Inc.

Trench Log

Surface Elevation: 44.6 - 45.1 ft.

Trench Length at Surface: 12.5 ft.

Trench Width at Surface: 4.0 ft.

Maximum Depth of Trench: 8.5 ft.

Depth to First Water: n/a ft.

Depth to Water on: Not measured ft.

NOTES:
1. Uniform Soil Classifications are from field observations only. No geotechnical engineering laboratory tests were performed.

2. All Elevations are in feet MSL.

3. Ground surface elevations adjusted to conform to common datum reference as site borings (April 2005).

Trench ID: **Trench 2**

Project: Oak Walk Project

Project No.: 0004.081

Owner: Bay Rock Residential LLC

Location: San Pablo Avenue, Emeryville, California

Date Excavated: 12/03/03

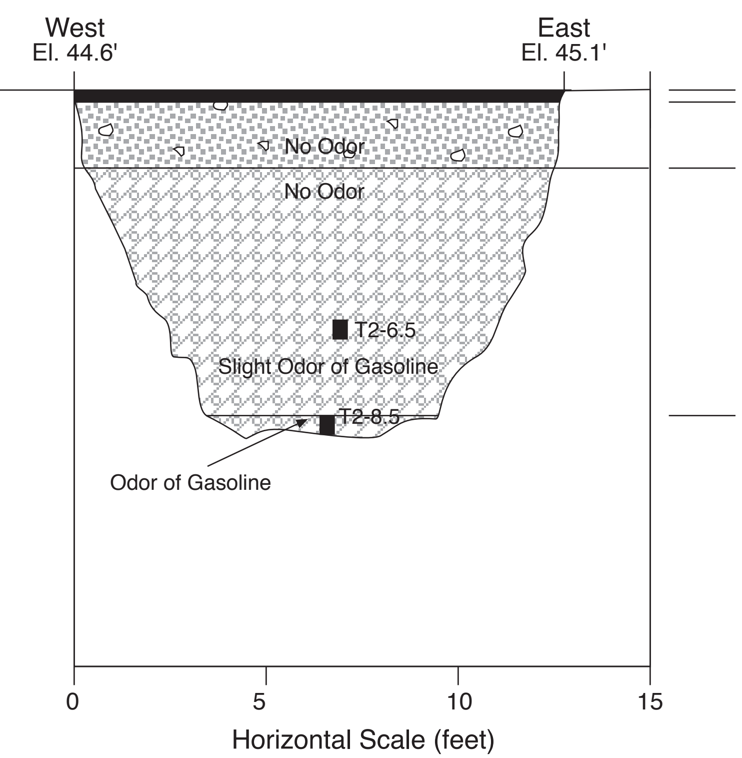
Excavation By: Dietz Irrigation

Logged By: D J Watkins

Equipment Operator: H B Dietz

Equipment Used: Case Excavator

Depth (Feet)	Sample	Trench Log / Description
0		Bituminous Macadam 3 in.
		(SP) - Light brown, Sandy Gravel (FILL)
2		
4		(SC) - Dark gray / black, soft Silty CLAY (FILL)
6	soil	
8	soil	(SC) - Grey / green, medium soft Silty CLAY
10		
12		
14		
16		
18		
20		
22		
24		
26		
28		
30		



Exploratory Trench 2
Average trench width 4 feet, Trench Length 12.5 feet

The San Joaquin Company Inc.

Trench Log

Surface Elevation: 47.2 - 47.7 ft.

Trench Length at Surface: 31.0 ft.

Trench Width at Surface: 4.0 ft.

Maximum Depth of Trench: 9.5 ft.

Depth to First Water: 9.0 ft.

Depth to Water on: Not measured ft.

NOTES:
1. Uniform Soil Classifications are from field observations only. No geotechnical engineering laboratory tests were performed.

2. All Elevations are in feet MSL.

3. Ground surface elevations adjusted to conform to common datum reference as site borings (April 2005).

Trench ID: **Trench 3**

Project: Oak Walk Project

Project No.: 0004.081

Owner: Bay Rock Residential LLC

Location: San Pablo Avenue, Emeryville, California

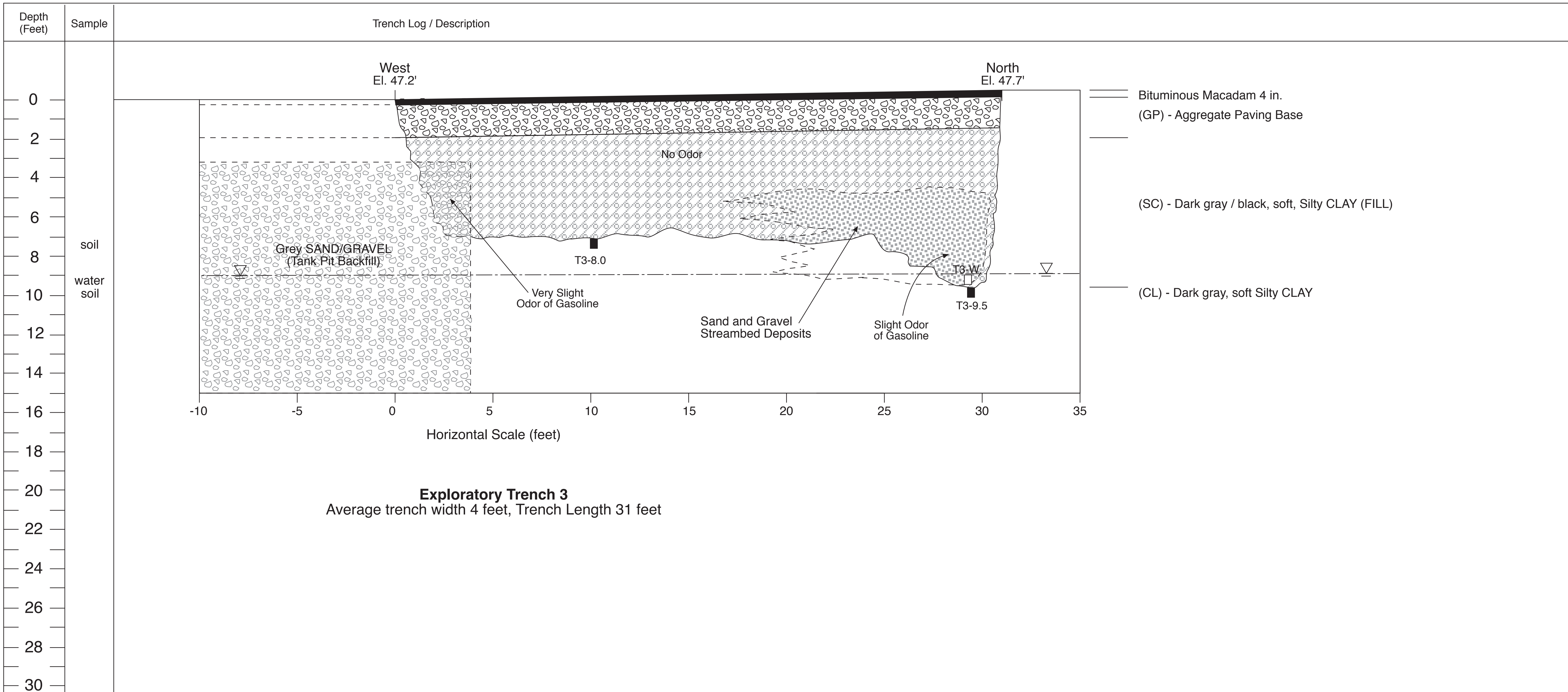
Date Excavated: 12/03/03

Excavation By: Dietz Irrigation

Logged By: D J Watkins

Equipment Operator: H B Dietz

Equipment Used: Case Excavator



Exploratory Trench 3
Average trench width 4 feet, Trench Length 31 feet

The San Joaquin Company Inc. — Trench Log

Surface Elevation: 48.0 - 48.13 ft.

Trench Length at Surface: 14.0 ft.

Trench Width at Surface: 4.0 ft.

Maximum Depth of Trench: 10.5 ft.

Depth to First Water: n/a ft.

Depth to Water on: Not measured ft.

NOTES:
1. Uniform Soil Classifications are from field observations only. No geotechnical engineering laboratory tests were performed.

2. All Elevations are in feet MSL.

3. Ground surface elevations adjusted to conform to common datum reference as site borings (April 2005).

Trench ID: **Trench 4**

Project: Oak Walk Project

Project No.: 0004.081

Owner: Bay Rock Residential LLC

Location: San Pablo Avenue, Emeryville, California

Date Excavated: 12/03/03

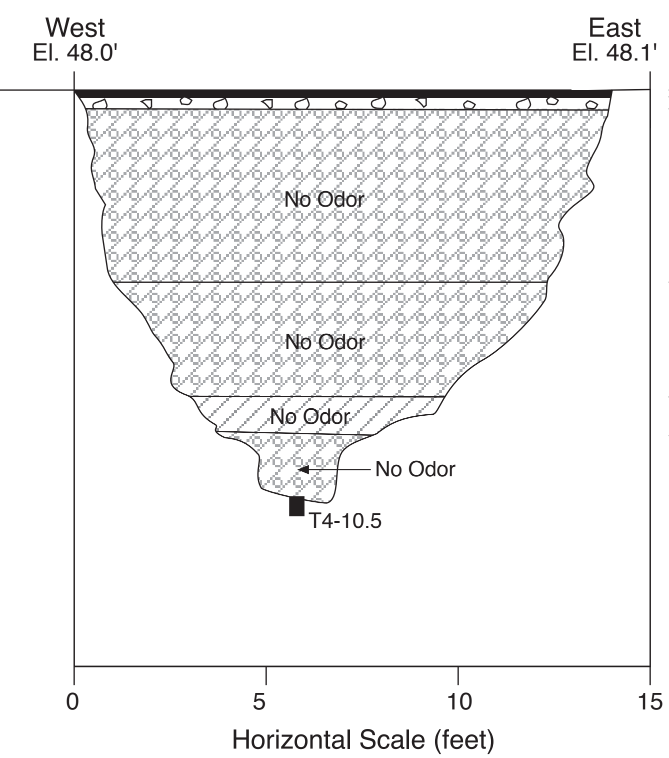
Excavation By: Dietz Irrigation

Logged By: D J Watkins

Equipment Operator: H B Dietz

Equipment Used: Case Excavator

Depth (Feet)	Sample	Trench Log / Description
0		Bituminous Macadam, 2 in. (GP) - Aggregate paving base, 4in.
2		(SC) - Dark gray / black, soft Silty CLAY with some glass (FILL)
4		
6		(SC) - Light brown, medium stiff Silty CLAY
8		(CL) - Gray / green, moderately stiff CLAY
10	soil	(SC) - Light brown, medium stiff Silty CLAY
12		
14		
16		
18		
20		
22		
24		
26		
28		
30		



Exploratory Trench 4
Average trench width 4 feet, Trench Length 14.0 feet

The San Joaquin Company Inc.

Trench Log

Surface Elevation: 45.1 - 45.2 ft.

Trench Length at Surface: 21.0 ft.

Trench Width at Surface: 4.0 ft.

Maximum Depth of Trench: 8.5 ft.

Depth to First Water: n/a ft.

Depth to Water on: Not measured ft.

NOTES:
1. Uniform Soil Classifications are from field observations only. No geotechnical engineering laboratory tests were performed.

2. All Elevations are in feet MSL.

3. Ground surface elevations adjusted to conform to common datum reference as site borings (April 2005).

Trench ID: **Trench 5**

Project: Oak Walk Project

Project No.: 0004.081

Owner: Bay Rock Residential LLC

Location: San Pablo Avenue, Emeryville, California

Date Excavated: 12/02/03

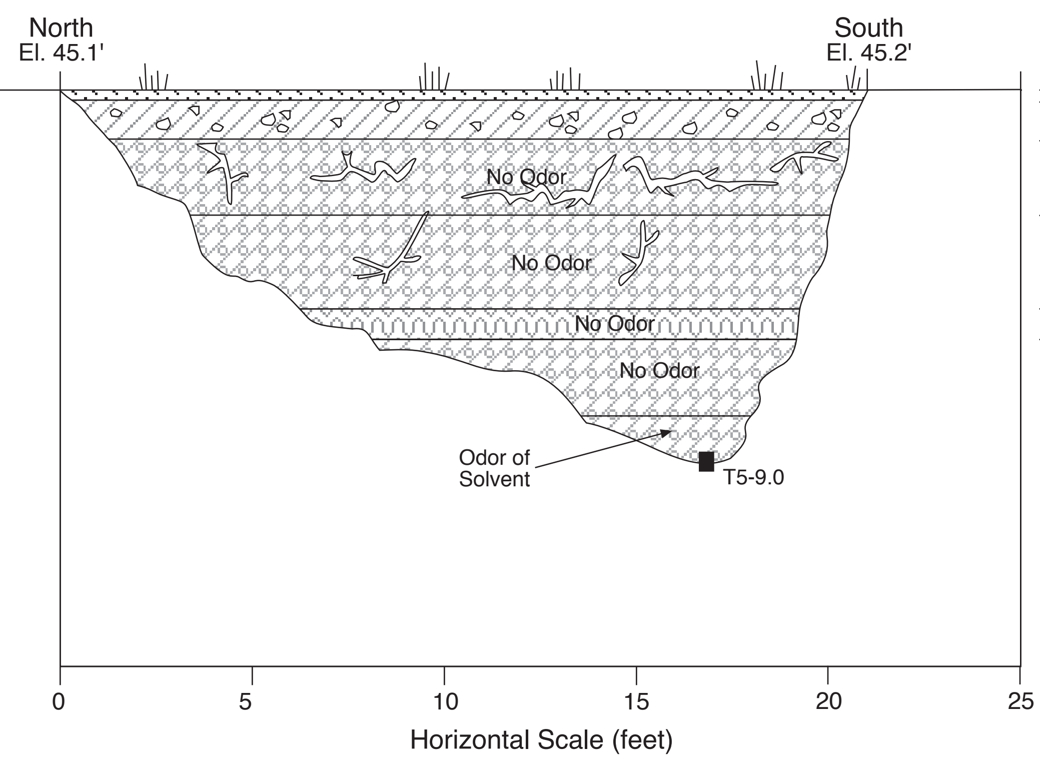
Excavation By: Dietz Irrigation

Logged By: D J Watkins

Equipment Operator: H B Dietz

Equipment Used: Case Excavator

Depth (Feet)	Sample	Trench Log / Description
0		Topsoil under grass, 3 in. / Random FILL
2		(SC) - Brown, soft Silty CLAY with heavy tree roots
4		(SC) - Brown, soft Silty CLAY with tree roots
6		(Pt) - Vegetative Matter with dryrot fungus in Silty CLAY
8		(SC) - Brown, medium stiff Silty CLAY
10	soil	(SC) - Grey/ green, medium stiff Silty CLAY
12		
14		
16		
18		
20		
22		
24		
26		
28		
30		



Exploratory Trench 5
Average trench width 4 feet, Trench Length 21.0 feet

The San Joaquin Company Inc.

Trench Log

Surface Elevation: 44.1 - 43.6 ft.

Trench Length at Surface: 17.25 ft.

Trench Width at Surface: 4.0 ft.

Maximum Depth of Trench: 8.5 ft.

Depth to First Water: n/a ft.

Depth to Water on: Not measured ft.

NOTES:
1. Uniform Soil Classifications are from field observations only. No geotechnical engineering laboratory tests were performed.

2. All Elevations are in feet MSL.

3. Ground surface elevations adjusted to conform to common datum reference as site borings (April 2005).

Trench ID: **Trench 6**

Project: Oak Walk Project

Project No.: 0004.081

Owner: Bay Rock Residential LLC

Location: San Pablo Avenue, Emeryville, California

Date Excavated: 12/02/03

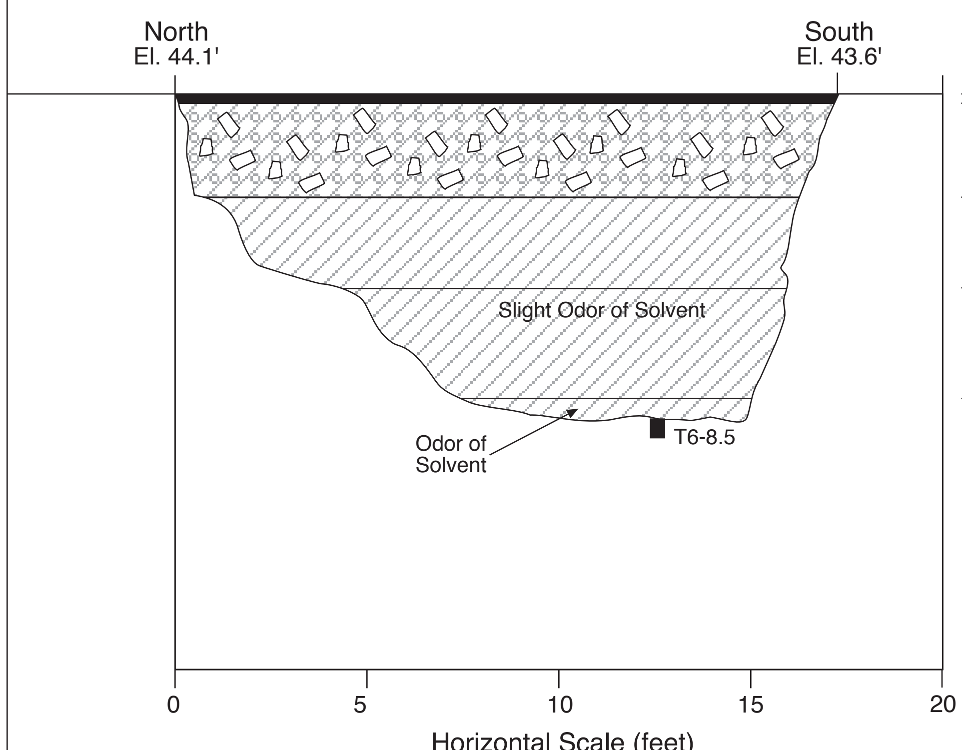
Excavation By: Dietz Irrigation

Logged By: D J Watkins

Equipment Operator: H B Dietz

Equipment Used: Case Excavator

Depth (Feet)	Sample	Trench Log / Description
0 – 30	soil	



Bituminous macadam, 2in.

(SC) - Silty CLAY with bricks (Random FILL)

(CL) - Dark grey / black, medium soft Silty CLAY (FILL)

(CL) - Light brown, medium firm Silty CLAY

(CL) - Grey/ green, medium soft Silty CLAY with some Gravel

Exploratory Trench 6
Average trench width 4 feet, Trench Length 17.25 feet

The San Joaquin Company Inc.

Trench Log

Surface Elevation: 43.9 - 43.8 ft.

Trench Length at Surface: 21.5 ft.

Trench Width at Surface: 4.0 ft.

Maximum Depth of Trench: 9.5 ft.

Depth to First Water: 8.0 ft.

Depth to Water on: Not measured ft.

NOTES:
1. Uniform Soil Classifications are from field observations only. No geotechnical engineering laboratory tests were performed.

2. All Elevations are in feet MSL.

3. Ground surface elevations adjusted to conform to common datum reference as site borings (April 2005).

Trench ID: **Trench 7**

Project: Oak Walk Project

Project No.: 0004.081

Owner: Bay Rock Residential LLC

Location: San Pablo Avenue, Emeryville, California

Date Excavated: 12/02/03

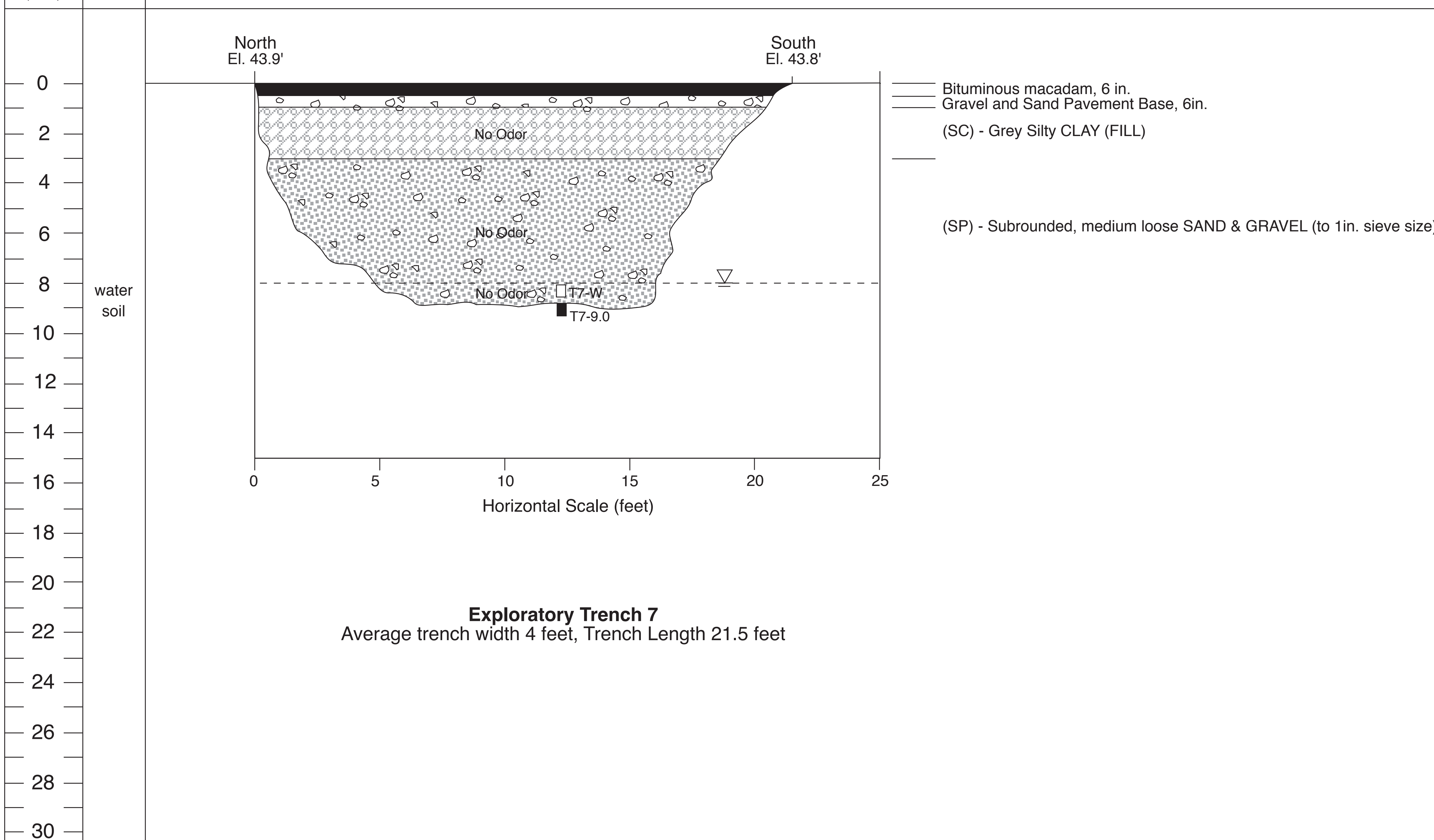
Excavation By: Dietz Irrigation

Logged By: D J Watkins

Equipment Operator: H B Dietz

Equipment Used: Case Excavator

Depth (Feet)	Sample	Trench Log / Description



Exploratory Trench 7
Average trench width 4 feet, Trench Length 21.5 feet

The San Joaquin Company Inc.

Trench Log

Surface Elevation: 45.2 - 45.4 ft.

Trench Length at Surface: 13.5 ft.

Trench Width at Surface: 4.0 ft.

Maximum Depth of Trench: 9.0 ft.

Depth to First Water: n/a ft.

Depth to Water on: Not measured ft.

NOTES:
1. Uniform Soil Classifications are from field observations only. No geotechnical engineering laboratory tests were performed.

2. All Elevations are in feet MSL.

3. Ground surface elevations adjusted to conform to common datum reference as site borings (April 2005).

Trench ID: **Trench 8**

Project: Oak Walk Project

Project No.: 0004.081

Owner: Bay Rock Residential LLC

Location: San Pablo Avenue, Emeryville, California

Date Excavated: 12/02/03

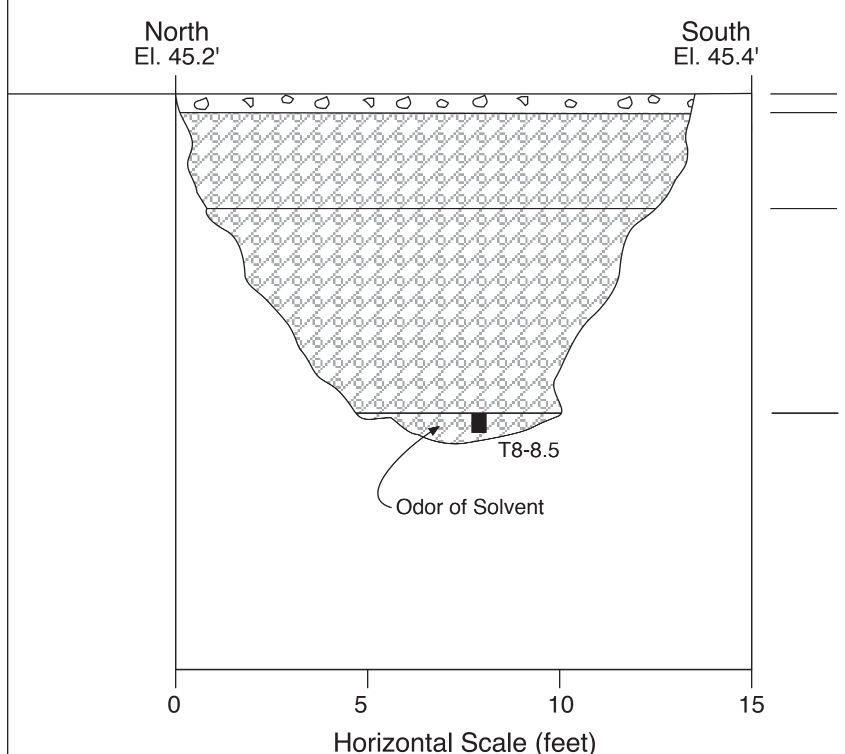
Excavation By: Dietz Irrigation

Logged By: D J Watkins

Equipment Operator: H B Dietz

Equipment Used: Case Excavator

Depth (Feet)	Sample	Trench Log / Description
0		(GP) - Aggregate paving base, 4in.
		(SC) - Dark gray / black, soft Silty CLAY (FILL)
		(SC) - Light brown, soft to slightly firm Silty CLAY
8	soil	(SC) - Gray / green, moderately firm Silty CLAY



Exploratory Trench 8
Average trench width 4 feet, Trench Length 13.5 feet

Project: 40th Street UST, Emeryville, CA	Log of Well EW-1
Project Number: 94114NA	
Location: Northeast corner of San Pablo Ave. and 40th St.	

Date(s) Drilled: 3/24/97	Total Depth Drilled (feet): 21.0	Top of Casing Elevation (feet):	Groundwater Level (feet): First 13.8	Completion 8.8	12 Hours
Logged by: W. Dittman	Checked by:	Diameter of Hole (inches): 10	Diameter of Well (inches): 4	Number of Samples: Disturbed	Undisturbed 4
Drilling Company: Gregg Drilling		Drilling Method: Hollow Stem Auger		Drill Rig Type: Mobile B61	
Sampler Type: 2" cal mod		Drill Bit Size: 10"		Type of Well Casing: 4" PVC Sch. 40	
Screen Perforation: 0.020" Slotted 6-20ft		Type of Sand Pack: #3 Lonestar Sand 5-21ft			
Type of Seals: Neat Cement 1 to 4 ft.; Bentonite Pellets 4 to 5 ft.					
Comments					

Depth, feet	Elevation, feet	SAMPLES: Recovery	Sample	Blows/foot	USCS Classification	MATERIAL DESCRIPTION	HNu (ppm)	REMARKS
0						8" Concrete slab over 1 ft. of clayey fill w/ rubble		Photo Ionization Detector readings in air in parts per million
						CLAY (CH) Stiff; damp; very dark brown (10YR - 2/2); high plasticity		
5		X		16		SILTY CLAY (CL) Medium stiff; damp; very dark gray (10YR - 3/1); med. to high plasticity; color change to dark greenish-grey (10Y - 3/1)		PID = 536 Strong product odor @ 6.5'
		X		20		greenish-gray (10GY - 5/1); trace to some fine gravel to 3/8"; trace coarse sand		PID = 464
10								
15		X		34		yellowish-brown (10YR - 5/4) mottled w/ med. gray; trace fine to coarse sand to 1/4"; patches of reddish sand		PID = 144
20		X		15		SANDY CLAY (CL) Soft; moist to wet; olive gray (5Y - 4/2); low to med. plasticity; fine to coarse sand; trace fine gravel to 3/8"		PID = 11.0
						TD @ 21 FT.		
25								

The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: **MW-2**

Project: Oak Walk

Project No.: 0004.083

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 44.40 ft.

Surface Elevation: 44.70 ft.

Depth to Water: 5.98 ft.

Date Installed: 04/07/04

Total depth of Boring: 20 ft.

Boring Diameter: 8 in.

Well Casing Diameter: 2 in.

Total depth of Well: 20 ft.

Casing Material: PVC

Drilling Company: Gregg Drilling & Testing

Drilling Method: Hollow Stem Auger

Driller: Don Kiersnas

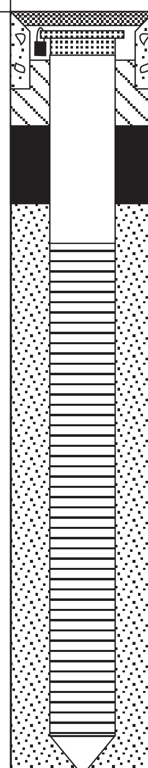
Logged By: Dennis Alexander

Depth (Feet)	Sample (3.0 / 2.5 / 0.75)	Blows/ 6 in.	Graphic Log	Description	Well Construction
0				Concrete Paving Dark brown Silty Sandy GRAVEL (GM), dense, moist (Fill)	Light Duty Well-Head Box (with bolted cover and O-ring seal Set in concrete) Portland Cement Grout
2		Cuttings		Mottled dark gray-brown-dark brown CLAY (CH), very stiff, moist, high plasticity, with trace fine sand Moderate odor of gasoline	
4		9 15 25			Prefabricated Self-expanding Bentonite Seal
6					▼ 05/19/04
8		13 18 21		Mottled blue-gray and orange-brown CLAY (CL), hard, moist, medium plasticity, with little to some fine sands, and a trace of subangular gravel to 1/4" diameter Moderate to strong odor of gasoline	2-in. Dia PVC Well Casing with 0.02-in. Aperture Machine-cut slots
10					No.3 Monterey Sand Filter
12					
14		20 26 32		Mottled brown and blue-gray Sandy CLAY (CL), hard, moist, medium plasticity, with some fine sands, few angular to subrounded gravel to 1/2" diameter Slight odor of gasoline	
16					
18		8 11 15		Mottled orange-brown and blue-gray CLAY (CL), very stiff, moist, medium plasticity, with some very fine sands, trace fine subrounded gravels to 1/4' diameter No odor	▽ Conical PVC casing cap
20				TD Boring @ 20 feet	
22					
24					
26					
28					
30					

The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: **MW-3**	Project: Oak Walk		Project No.: 0004.083
Owner: Bay Rock Residential LLC	Location: Emeryville, California		
Top of Casing Elevation: 45.49 ft.	Surface Elevation: 45.9 ft.		Depth to Water: 5.66 ft.
Date Installed: 04/07/04	Total depth of Boring: 20 ft.		Boring Diameter: 8 in.
Well Casing Diameter: 2 in.	Total depth of Well: 20 ft.		Casing Material: PVC
Drilling Company: Gregg Drilling & Testing	Drilling Method: Hollow Stem Auger		
Driller: Don Kiersnas	Logged By: Dennis Alexander		



Depth (Feet)	Sample (3.0 / 2.5 / 0.75)	Blows/ 6 in.	Description	Well Construction
0			Concrete paving	Light Duty Well-Head Box (with bolted cover and O-ring seal Set in concrete)
0–2			Gray Gravelly SAND (GW), very dense, moist, non-plastic, mostly fine to medium sands, with some angular to rounded gravels to 1 1/2" diameter (AB Fill) No odor	Portland Cement Grout
4				Prefabricated Self-expanding Bentonite Seal
6				▼ 05/19/04 ▽
8			Gray GRAVEL (GP), very dense, wet, non-plastic, mostly poorly graded subangular to rounded gravels to 3" diameter (Drainrock Fill) No odor	2-in. Dia PVC Well Casing with 0.02-in. Aperture Machine-cut slots
11			Gray Sandy GRAVEL (GW), medium dense to dense, wet, non-plastic, mostly well graded gravels to 3/4" diameter (Fill) No odor	No.3 Monterey Sand Filter
14		16 19 17	(Fill/Native interface at 14.25 feet) Yellow-brown CLAY (CL), hard, moist, medium plasticity, with some very fine to fine sands, trace fine subangular to rounded gravel to 1/4" diameter, decreasing gravel with depth No odor	
19–20		12 16 18	No odor	Conical PVC casing cap
20			TD Boring @ 20 feet	
22				
24				
26				
28				
30				

The San Joaquin Company Inc.

Monitoring Well Log

WELL No.:	**MW-4**

Project: Oak Walk

Project No.: 0004.083

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 47.31 ft.

Surface Elevation: 47.5 ft.

Depth to Water: 6.19 ft.

Date Installed: 04/30/04

Total depth of Boring: 20 ft.

Boring Diameter: 8 in.

Well Casing Diameter: 2.0 in.

Total depth of Well: 20 ft.

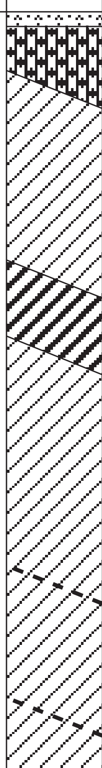
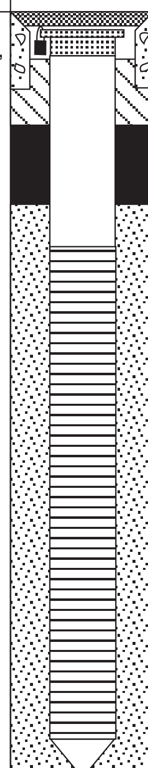
Casing Material: PVC

Drilling Company: Gregg Drilling & Testing

Drilling Method: Hollow Stem Auger

Driller: Bobby Deason

Logged By: Steve Flexser

Depth (Feet)	Sample (2.0 / 1.5 / 0.75)	Blows/ 6 in.	Graphic Log	Description	Well Construction
0				4 inches concrete paving	 Light Duty Well-Head Box (with bolted cover and O-ring seal Set in concrete)
				Dark brown Silty Sandy Clayey GRAVEL (GM), medium dense, moist (Fill)	Portland Cement Grout
2				Dark brown Silty CLAY (CL), soft, moist No odor	
4	MW-4/5.5				Prefabricated Self-expanding Bentonite Seal
6					▼ 05/19/04
8				Brown CLAY (CH), medium stiff, moist No odor	2-in. Dia PVC Well Casing with 0.02-in. Aperture Machine-cut slots
10	MW-4/10.5			Light brown Silty CLAY (CL), stiff, moist, with dark brown and orange mottling No odor	No.3 Monterey Sand Filter
12					
14					
16	MW-4/15.5			Light brown Silty CLAY (CL), stiff, moist, with dark brown and orange mottling, with some sand and gravel No odor	
18	MW-4/19.5			Light brown Silty CLAY (CL), stiff, moist, with little mottling, with some sand No odor	Conical PVC casing cap
20				TD Boring @ 20 feet	
22					
24					
26					
28					
30					

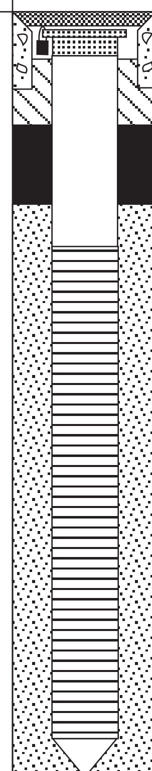
The San Joaquin Company Inc.

Monitoring Well Log

WELL No.:	**MW-5**
Project:	Oak Walk
Project No.:	0004.083
Owner:	Bay Rock Residential LLC
Location:	Emeryville, California
Top of Casing Elevation:	42.51 ft.
Surface Elevation:	42.9 ft.
Depth to Water:	7.39 ft.
Date Installed:	04/30/04
Total depth of Boring:	20 ft.
Boring Diameter:	8 in.
Well Casing Diameter:	2.0 in.
Total depth of Well:	20 ft.
Casing Material:	PVC
Drilling Company:	Gregg Drilling & Testing
Drilling Method:	Hollow Stem Auger
Driller:	Bobby Deason
Logged By:	Steve Flexser

Depth (Feet)	Sample (2.0 / 1.5 / 0.75)	Blows/ 6 in.	Description	Well Construction
0			4 inches concrete	Light Duty Well-Head Box (with bolted cover and O-ring seal Set in concrete)
0–2.5			Dark brown Silty Sandy GRAVEL (GM), medium dense, moist (Fill)	Portland Cement Grout
2.5–7	MW-5/6.0		Dark brown Silty CLAY (CH), soft, moist, with minor gravel No odor	Prefabricated Self-expanding Bentonite Seal
7–12.5	MW-5/11.0		Blue gray CLAY (CL), very stiff, moist to wet, with abundant gravel and sand, with inclusions of orange sandy silt. Moderate odor of gasoline	▼ 05/19/04 2-in. Dia PVC Well Casing with 0.02-in. Aperture Machine-cut slots ▽
12.5–17.5	MW-5/15.5		Dark gray Clayey SILT (ML), medium stiff, wet, with orange mottling, with some gravel No odor	No.3 Monterey Sand Filter
17.5–20	MW-5/19.5		Light brown and gray mottled CLAY (CL), stiff, wet, very sandy, with gravel, with orange silt inclusions No odor	Conical PVC casing cap
20			TD Boring @ 20 feet	

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30



The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: **MW-6**

Project: Oak Walk

Project No.: 0004.083

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 43.35 ft.

Surface Elevation: 43.9 ft.

Depth to Water: 7.16 ft.

Date Installed: 04/07/04

Total depth of Boring: 20 ft.

Boring Diameter: 8 in.

Well Casing Diameter: 2 in.

Total depth of Well: 20 ft.

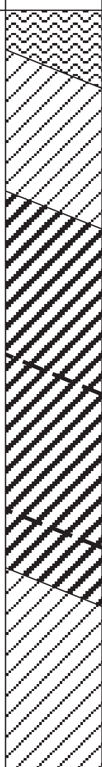
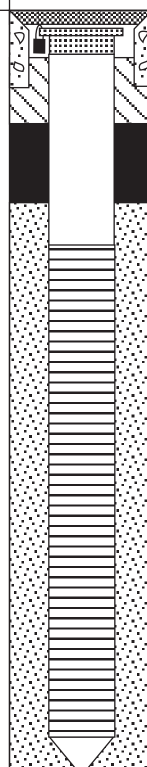
Casing Material: PVC

Drilling Company: Gregg Drilling & Testing

Drilling Method: Hollow Stem Auger

Driller: Don Kiersnas

Logged By: Dennis Alexander

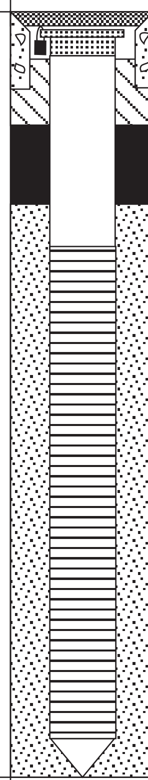
Depth (Feet)	Sample (3.0 / 2.5 / 0.75)	Blows/ 6 in.	Graphic Log	Description	Well Construction
0				Garden Soil (Fill)	 Light Duty Well-Head Box (with bolted cover and O-ring seal Set in concrete)
2				Mottled Gray-brown and orange-brown Sandy CLAY (CL), very stiff, moist, medium plasticity, with some fine sands, little medium to coarse sands, few subangular to rounded gravels to 3/4" diameter No odor	Portland Cement Grout
4	ES	10 11 14			Prefabricated Self-expanding Bentonite Seal
6		5 5 6		Gray-brown CLAY (CH), stiff, moist, high plasticity, trace to some fine sands No odor	▼ 05/19/04
8					2-in. Dia PVC Well Casing with 0.02-in. Aperture Machine-cut slots
10	ES	16 20 27		Light olive brown CLAY (CH), hard, moist, high plasticity, some fine sands, few medium to coarse sands little angular to subrounded gravels to 1/2" diameter No odor	No.3 Monterey Sand Filter
12					
14	ES	16 22 27		Mottled orange-brown and light Gray-dark brown CLAY (CH), hard, moist, high plasticity, with some very fine to fine sands, and gravelly sand lens at 15 feet No odor	
16				Mottled orange-brown and light Gray CLAY (CL), very stiff, moist, medium plasticity, with some fine sands, medium to coarse sands, and subrounded to rounded fine gravels to 1/4" diameter No odor	
18		12 15 18			
20	ES			TD Boring @ 20 feet	Conical PVC casing cap
22					
24					
26					
28					
30					

The San Joaquin Company Inc. Monitoring Well Log

WELL No.: **MW-7**	Project: Oak Walk	Project No.: 0004.083	
Owner: Bay Rock Residential LLC	Location: Emeryville, California		
Top of Casing Elevation: 44.75 ft.	Surface Elevation: 45.2 ft.	Depth to Water: 8.40 ft.	
Date Installed: 04/06/04	Total depth of Boring: 20 ft.	Boring Diameter: 8 in.	
Well Casing Diameter: 2 in.	Total depth of Well: 20 ft.	Casing Material: PVC	
Drilling Company: Gregg Drilling & Testing	Drilling Method: Hollow Stem Auger		
Driller: Don Kiersnas	Logged By: Dennis Alexander		

Sample: 3.0 / 2.5 / 0.75

Depth (Feet)	Blows/ 6 in.	Description	Well Construction
0		5" Bituminous Macadam paving Class II Cal Trans paving base (GW)	Heavy Duty Well-Head Box (with bolted cover and O-ring seal Set in concrete)
2	13 21 25	Dark Gray-brown CLAY (CH), hard, moist, high plasticity, with some fine sand, trace angular gravel to 1/2" diameter. No odor	Portland Cement Grout
4	6 9 13	Dark brown CLAY (CL), very stiff, moist, medium plasticity, little to some fine sands, trace angular to subangular gravel to 1-1/2" diameter No odor	Prefabricated Self-expanding Bentonite Seal
6	9 11 13		2-in. Dia PVC Well Casing with 0.02-in. Aperture Machine-cut slots
8		Mottled olive-brown and orange-brown CLAY (CH), hard, moist, high plasticity, with some fine sands, few medium to coarse sands, trace angular gravels to 1/2" diameter, and small sandy lenses with trace gravel	▼ 05/20/04
10	9 18 28	No odor	No.3 Monterey Sand Filter
12		Mottled orange-brown and light olive brown CLAY (CL), very stiff, moist to wet, medium plasticity, with some fine sands, few medium to coarse sands, and few angular to rounded gravels to 1" diameter	
14	13 21 33	No odor	
16		Decreasing sands and gravels to 18 feet	
18			▽
20	9 11 12	No odor	Conical PVC casing cap
22		TD Boring @ 20 feet	
24			
26			
28			
30			



The San Joaquin Company Inc.

Monitoring Well Log

WELL No.:	**MW-8**

Project: Oak Walk
Project No.: 0004.083

Owner: Bay Rock Residential LLC
Location: Emeryville, California

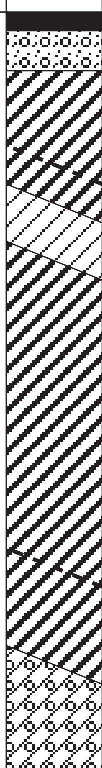
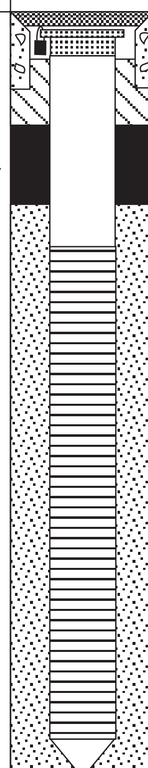
Top of Casing Elevation: 48.38 ft.
Surface Elevation: 48.5 ft.
Depth to Water: 9.65 ft.

Date Installed: 04/07/04
Total depth of Boring: 20 ft.
Boring Diameter: 8 in.

Well Casing Diameter: 2 in.
Total depth of Well: 20 ft.
Casing Material: PVC

Drilling Company: Gregg Drilling & Testing
Drilling Method: Hollow Stem Auger

Driller: Don Kiersnas
Logged By: Dennis Alexander

Depth (Feet)	Sample (3.0 / 2.5 / 0.75)	Blows/ 6 in.	Graphic Log	Description	Well Construction
0				5" Bituminous Macadam 12" Class II CalTrans Paving base (GW)	 Heavy Duty Well-Head Box (with bolted cover and O-ring seal Set in concrete)
2		15 21 24		Dark Gray and dark brown CLAY (CH), very stiff, moist, high plasticity, with some fine sand and medium to coarse sands. No odor	Portland Cement Grout
4		4 5 6		Mottled brown and Gray CLAY (CH), stiff, moist, high plasticity, few to minor fine sands. No odor	Prefabricated Self-expanding Bentonite Seal
6		8 11 15		Mottled Gray and brown CLAY (CL), very stiff, moist, medium plasticity, with some fine sands and trace medium sands. No odor	
8		19 24 36		Mottled light brown and orange-brown CLAY (CH), very stiff, moist, high plasticity, with some very fine to fine sands, few medium to coarse sands, some angular to subrounded gravels to 1/2" diameter No odor	2-in. Dia PVC Well Casing with 0.02-in. Aperture Machine-cut slots ▼ 05/19/04
10					
12					No.3 Monterey Sand Filter
14		13 17 26		Decreasing coarse sands and gravels with depth No odor	
16					
18		14 18 21		Mottled brown, light brown and orange-brown Clayey SAND (SC), dense, moist, low plasticity, fine to medium sands, with minor coarse sands, some angular to rounded gravels to 3/4" diameter. No odor	▽
20				TD Boring @ 20 feet	Conical PVC casing cap
22					
24					
26					
28					
30					

The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: **MWT-1**

Project: Oak Walk

Project No.: 0004.082

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 42.98 ft.

Surface Elevation: 43.32 ft.

Depth to Water: 8.43 ft.

Date Installed: 04/02/04

Total depth of Boring: 20 ft.

Boring Diameter: 2 in.

Well Casing Diameter: 0.75 in.

Total depth of Well: 20 ft.

Casing Material: PVC

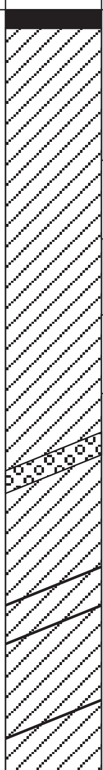
Drilling Company: Gregg Drilling & Testing

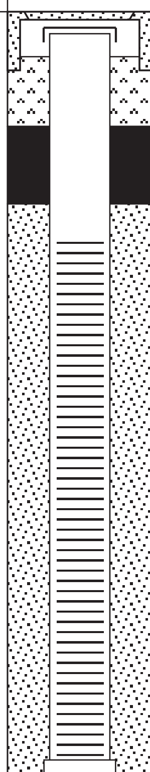
Drilling Method: Push Probe

Driller: Paul Rogers

Logged By: Steve Flexser

Depth (Feet)	Sample (2.5 / 2.0 / 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				3 inches bituminous macadam	Light Duty Steel Well-Head Box (with bolted cover and O-ring seal Set in concrete)
				Dark brown to black CLAY (CL), medium stiff,moist, with some gravel	
2					Portland Cement Grout
4	MWT-1-4.0		No Recovery		Prefabricated Self-expanding Bentonite Seal
6					
8			No Recovery		05/19/04
10					0.75-in. Dia PVC Well Casing with 0.02-in. aperture Machine-cut slots
12	MWT-1-11.5			Dark Gray and brown Gravelly SAND (SW)	
				Light blue Gray CLAY (CL), stiff, wet, with minor gravel Very slight odor of gasoline	No.3 Monterey Sand Filter
14				Dark brown CLAY (CL), soft, wet, with minor gravel No odor	
16	MWT-1-15.5			Gray brown CLAY (CL), stiff, wet, with gravel No odor	
18				Brown CLAY (CL), soft,wet, with minor gravel No odor	
20	MWT-1-20.0				Threaded Casing Cap
				TD Boring @ 20 feet	
22					
24					
26					
28					
30					





The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: **MWT-2**

Project: Oak Walk

Project No.: 0004.082

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 45.28 ft.

Surface Elevation: 45.70 ft.

Depth to Water: 7.69 ft.

Date Installed: 04/02/04

Total depth of Boring: 20 ft.

Boring Diameter: 2 in.

Well Casing Diameter: 0.75 in.

Total depth of Well: 20 ft.

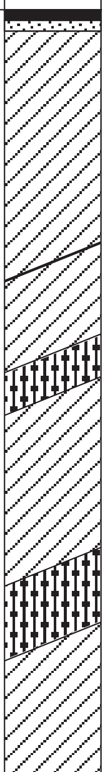
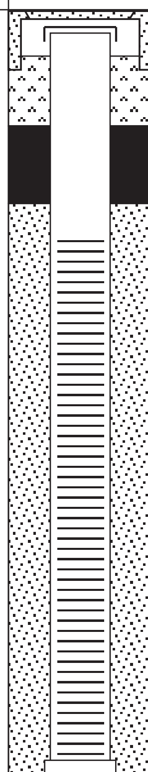
Casing Material: PVC

Drilling Company: Gregg Drilling & Testing

Drilling Method: Push Probe

Driller: Paul Rogers

Logged By: Steve Flexser

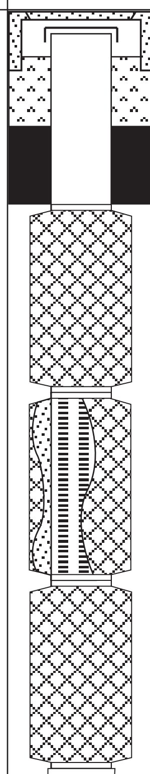
Depth (Feet)	Sample (2.5 / 2.0 / 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				2 inches bituminous macadam 2 inches loose sand Black CLAY (CL), medium stiff, moist No odor	 Light Duty Steel Well-Head Box (with bolted cover and O-ring seal Set in concrete) Portland Cement Grout
4					Prefabricated Self-expanding Bentonite Seal
5.5	MWT-2-5.5			Stiffening No odor	
6				Gray CLAY (CL), medium stiff, with some gravel Slight odor of gasoline Increasing gravel with depth, strong odor of gasoline	
8				Gray Silty SAND (SM), medium dense, moist, with black clayey inclusions, gravel Little or no odor	▼ 05/19/04 0.75-in. Dia PVC Well Casing with 0.02-in. aperture Machine-cut slots
10	MWT-2-10.0			Light blue-Gray CLAY (CL), stiff, moist, with some fine gravel Slight odor Increasing odor of gasoline with depth	
12					No.3 Monterey Sand Filter
14				Brown Silty SAND (SM), medium dense, moist, with inclusions of Gray Clay, yellow fine sand, gravel and shiny black grains or coatings. Moderate odor of gasoline	
15	MWT-2-15.0				
16				Gray brown mottled CLAY (CL),stiff, moist, with sparse sand and gravel Moderate odor of gasoline No odor to very slight odor of gasoline	
20	MWT-2-20.0			TD Boring @ 20 feet	Threaded Casing Cap
22					
24					
26					
28					
30					

The San Joaquin Company Inc.

Monitoring Well Log

WELL No.:	**MWT-3**
Project:	Oak Walk
Project No.:	0004.082
Owner:	Bay Rock Residential LLC
Location:	Emeryville, California
Top of Casing Elevation:	47.64 ft.
Surface Elevation:	47.93 ft.
Depth to Water:	7.64 ft.
Date Installed:	04/02/04
Total depth of Boring:	20 ft.
Boring Diameter:	2 in.
Well Casing Diameter:	0.75 in.
Total depth of Well:	20 ft.
Casing Material:	PVC
Drilling Company:	Gregg Drilling & Testing
Drilling Method:	Push Probe
Driller:	Paul Rogers
Logged By:	Steve Flexser

Depth (Feet)	Sample (2.5 / 2.0 / 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				2 inches bituminous macadam	Light Duty Steel Well-Head Box (with bolted cover and O-ring seal Set in concrete)
				Dark brown to black Silty CLAY (CL), soft, moist, with fine red fractures, minor sand and gravel No odor	Portland Cement Grout
2					
4					Prefabricated Self-expanding Bentonite Seal
	MWT-3-5.0			Light brown Silty CLAY (CL), soft, moist, with decreasing fractures, minor sand and gravel No odor	
6					
				Dark brown Silty CLAY (CL), medium stiff, moist, with decreasing fractures, minor sand and gravel No odor	▼ 05/19/04
8					
				Gray Silty CLAY (CL), medium stiff, moist, with decreasing fractures, minor sand and gravel No odor	
10	MWT-3-10.0				
				Blue-Gray Silty CLAY (CL), medium stiff Very slight odor of petroleum hydrocarbons	
12					0.75 PVC Well Casing with 0.01in. aperture Machine-cut slots in Prefabricated Sand and Wire Mesh Filter
				Brown Gravelly CLAY (CL), medium stiff, moist, with angular gravel and orange fine sand Moderate odor of petroleum hydrocarbons	
14				Brown-Gray mottled, with black staining, decreasing gravel No odor	
	MWT-3-15.0				
16					
18					
20	MWT-3-20.0				Threaded Casing Cap
				TD Boring @ 20 feet	
22					
24					
26					
28					
30					



The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: MWT-4

Project: Oak Walk

Project No.: 0004.082

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 44.74 ft.

Surface Elevation: 45.15 ft.

Depth to Water: 8.43 ft.

Date Installed: 04/01/04

Total depth of Boring: 20 ft.

Boring Diameter: 2 in.

Well Casing Diameter: 0.75 in.

Total depth of Well: 20 ft.

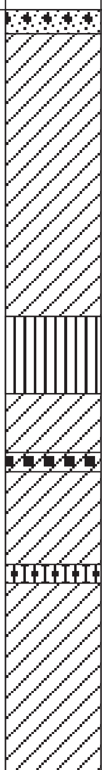
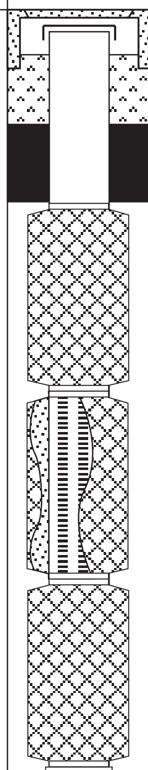
Casing Material: PVC

Drilling Company: Gregg Drilling & Testing

Drilling Method: Push Probe

Driller: Paul Rogers

Logged By: Steve Flexser

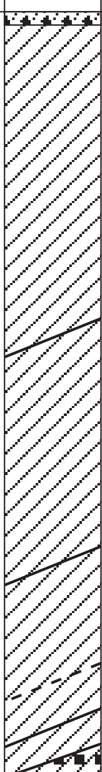
Depth (Feet)	Sample (2.5 / 2.0 / 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				4 inches GRAVEL (GP) road base	 Light Duty Steel Well-Head Box (with bolted cover and O-ring seal Set in concrete)
				Dark brown to black CLAY (CL), medium stiff, moist, with fine white and red cracks, some gravel No odor	Portland Cement Grout
2					
4	MWT-4-4.0				Prefabricated Self-expanding Bentonite Seal
6					
8				Dark brown SILT (ML), stiff, moist, with fine sand	▼ 05/19/04
10	MWT-4-10.0			Gray green Silty CLAY (CL), stiff, moist No odor	
12				Clayey GRAVEL (GC)	0.75 PVC Well Casing with 0.01in. aperture Machine-cut slots in Prefabricated Sand and Wire Mesh Filter
				Gray green Silty CLAY (CL), stiff, moist No odor	
14				Slight solvent odor	
	MWT-4-15.0			Gray Clayey SAND (SM)	
16				Gray and brown mottled CLAY (CL), stiff, moist, with orange sandy silty inclusions of gravel, and yellow sand Slight odor of petroleum hydrocarbons	
18					
				No odor	
20	MWT-4-20.0				Threaded Casing Cap
				TD Boring @ 20 feet	
22					
24					
26					
28					
30					

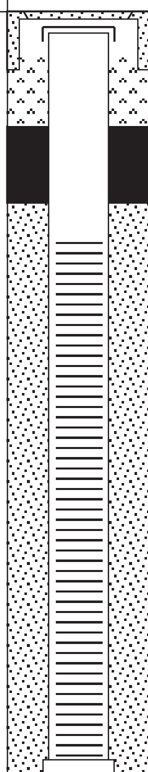
The San Joaquin Company Inc.

Monitoring Well Log

WELL No.:	**MWT-5**
Project:	Oak Walk
Project No.:	0004.082
Owner:	Bay Rock Residential LLC
Location:	Emeryville, California
Top of Casing Elevation:	47.10 ft.
Surface Elevation:	47.32 ft.
Depth to Water:	9.07 ft.
Date Installed:	04/02/04
Total depth of Boring:	20 ft.
Boring Diameter:	2 in.
Well Casing Diameter:	0.75 in.
Total depth of Well:	20 ft.
Casing Material:	PVC
Drilling Company:	Gregg Drilling & Testing
Drilling Method:	Push Probe
Driller:	Paul Rogers
Logged By:	Steve Flexser

Depth (Feet)	Sample (2.5 | 2.0 | 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				2 inches GRAVEL (GP) road base	Light Duty Steel Well-Head Box (with bolted cover and O-ring seal Set in concrete)
1				Dark brown to black Silty CLAY (CL), medium stiff, moist No odor	
2					Portland Cement Grout
4					Prefabricated Self-expanding Bentonite Seal
5	MWT-5-5.0			Stiffening with depth	
7					0.75-in. Dia PVC Well Casing with 0.02-in. aperture Machine-cut slots
8				Light brown CLAY (CL), stiff, moist, with gravel and orange silt inclusions No odor	
9					▼ 05/19/04
10	MWT-5-10.0				
11					No.3 Monterey Sand Filter
14				Gray and brown mottled CLAY (CL), stiff, moist, with minor gravel, root marks, interbedded gray sand and black clay No odor	
15	MWT-5-15.0				
17				Soft, wet, with fine gravel No odor	
18				Brown CLAY (CL), soft, wet, decreasing gravel. No odor	
19.5				Gravelly CLAY (GC)	Threaded Casing Cap
20	MWT-5-20.0				
20.5				TD Boring @ 20 feet	





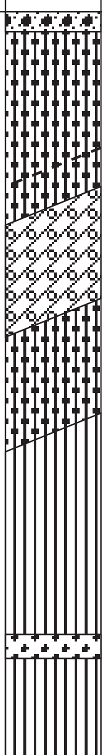
The San Joaquin Company Inc.

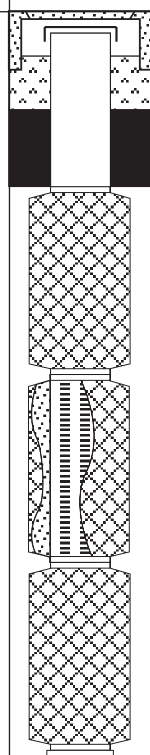
Monitoring Well Log

WELL No.: **MWT-6**	Project: Oak Walk	Project No.: 0004.082
Owner: Bay Rock Residential LLC	Location: Emeryville, California	
Top of Casing Elevation: 45.16 ft.	Surface Elevation: 45.41 ft.	Depth to Water: 9.05 ft.
Date Installed: 04/01/04	Total depth of Boring: 19.5 ft.	Boring Diameter: 2 in.
Well Casing Diameter: 0.75 in.	Total depth of Well: 19.5 ft.	Casing Material: PVC
Drilling Company: Gregg Drilling & Testing	Drilling Method: Push Probe	
Driller: Paul Rogers	Logged By: Steve Flexser	

Depth (Feet)	Sample (2.5 | 2.0 | 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				4 inches Gravel (GP) road base	Light Duty Steel Well-Head Box (with bolted cover and O-ring seal Set in concrete)
				Brown Silty SAND (SM), medium dense, moist, with fine gravel	Portland Cement Grout
4				Black, increasing silt, moist. No odor	Prefabricated Self-expanding Bentonite Seal
5	MWT-6-5.0			Gray CLAY (CL), medium stiff, moist, with brown silty mottling, roots, minor gravel No odor	
8				Brown Silty SAND (SM), medium dense, moist, with Gray clayey mottling, with chert gravel	▼ 05/19/04
10.5	MWT-6-10.5			Gray Clayey SILT (ML), medium stiff, moist, with gravel Slight odor of solvent	0.75 PVC Well Casing with 0.01in. aperture Machine-cut slots in Prefabricated Sand and Wire Mesh Filter
14.5	MWT-6-14.5			Increasing sand and moisture	
16				Light brown Fine SAND (SP), loose, wet, with some angular gravel Dark brown Gravelly Sandy SILT (ML), medium stiff, wet No odor	
19.5	MWT-6-19.5				Threaded Casing Cap
20				Push probe refusal at 19.5 feet TD Boring @ 19.5 feet	

Depth scale (feet): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30





The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: **MWT-7**

Project: Oak Walk

Project No.: 0004.082

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 46.61 ft.

Surface Elevation: 45.43 ft.

Depth to Water: 9.90 ft.

Date Installed: 04/01/04

Total depth of Boring: 20 ft.

Boring Diameter: 2 in.

Well Casing Diameter: 0.75 in.

Total depth of Well: 20 ft.

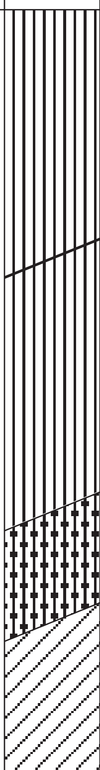
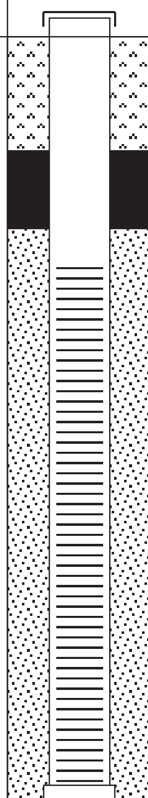
Casing Material: PVC

Drilling Company: Gregg Drilling & Testing

Drilling Method: Push Probe

Driller: Paul Rogers

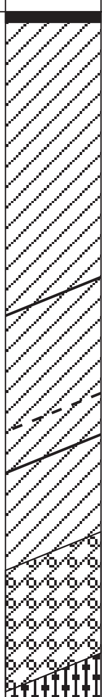
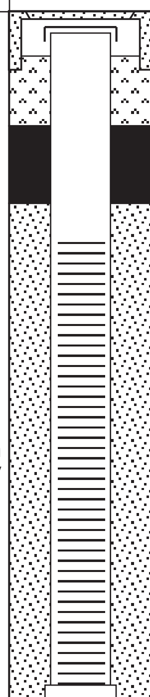
Logged By: Steve Flexser

Depth (Feet)	Sample (2.5 | 2.0 | 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				Very dark brown Clayey SILT (ML), medium stiff, moist No odor	 Casing protrudes above ground level. Grouted to surface Portland Cement Grout
4	MWT-7-5.0				Prefabricated Self-expanding Bentonite Seal
6				Brown and Gray SILT (ML), medium stiff, moist, inclusions of fine gravel and brown sand No odor	
8	MWT-7-10.0				0.75-in. Dia PVC Well Casing with 0.02-in. aperture Machine-cut slots
10					▼ 05/19/04
12					No.3 Monterey Sand Filter
14	MWT-7-15.0			Brown and Gray Silty Gravelly SAND (SM), medium dense, wet No odor	
16					▽
18	MWT-7-20.0			Brown Gravelly CLAY (CL), stiff, wet No odor	
20					Threaded Casing Cap
20				TD Boring @ 20 feet	
24				Note: Casing trucated by vandals. Elevation resurveyed on 11/10/04 Top of Casing El. 45.69 feet	
26					
28					
30					

The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: **MWT-8**		Project: Oak Walk		Project No.: 0004.082	
Owner: Bay Rock Residential LLC		Location: Emeryville, California			
Top of Casing Elevation: 47.23 ft.		Surface Elevation: 47.43 ft.		Depth to Water: 9.65 ft.	
Date Installed: 04/02/04		Total depth of Boring: 18 ft.		Boring Diameter: 2 in.	
Well Casing Diameter: 0.75 in.		Total depth of Well: 18 ft.		Casing Material: PVC	
Drilling Company: Gregg Drilling & Testing		Drilling Method: Push Probe			
Driller: Paul Rogers		Logged By: Steve Flexser			

Depth (Feet)	Sample (2.5 / 2.0 / 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				1 inch Gravel (GP) paving	 Light Duty Steel Well-Head Box (with bolted cover and O-ring seal Set in concrete)
				Dark brown to black Silty CLAY (CL), medium stiff, moist, with fine gravel No odor	
2					Portland Cement Grout
4	MWT-8-5.5				Prefabricated Self-expanding Bentonite Seal
6					
8				Brown Silty CLAY (CL), medium stiff, moist, with abundant roots, minor gravel No odor	0.75-in. Dia PVC Well Casing with 0.02-in. aperture Machine-cut slots
10	MWT-8-10.5			Light brown, increasing gravel with depth	▼ 05/19/04
12				Gray Silty CLAY (CL), medium stiff, moist, with increasing coarse chert gravel and orange sandy inclusions	▽
14	MWT-8-15.0			Dark Gray Clayey SAND (SC), dense, moist, with abundant gravel and orange silty pods No odor	No.3 Monterey Sand Filter
16				Light brown Silty SAND (SM), dense, wet, with fine gravel No odor	
18	MWT-8-18.0			Push probe refusal at 18 feet TD Boring @ 18 feet	Threaded Casing Cap
20					
22					
24					
26					
28					
30					

The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: **MWT-9**

Project: Oak Walk

Project No.: 0004.082

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 45.78 ft.

Surface Elevation: 46.14 ft.

Depth to Water: 8.70 ft.

Date Installed: 04/01/04

Total depth of Boring: 20 ft.

Boring Diameter: 2 in.

Well Casing Diameter: 0.75 in.

Total depth of Well: 20 ft.

Casing Material: PVC

Drilling Company: Gregg Drilling & Testing

Drilling Method: Push Probe

Driller: Paul Rogers

Logged By: Steve Flexser

Depth (Feet)	Sample (2.5 / 2.0 / 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				Dark brown CLAY (CL), stiff, moist, with minor gravel, and thin sandy-gravelly intervals No odor	Light Duty Steel Well-Head Box (with bolted cover and O-ring seal Set in concrete)
2					Portland Cement Grout
4	MWT-9-4.0			No Recovery	Prefabricated Self-expanding Bentonite Seal
6				Light brown mottling	
8				Brown Silty SAND (SM), medium dense, moist No odor	▼ 05/19/04
10	MWT-9-9.5			Light brown CLAY (CL), very stiff, moist, with gray mottling around roots No odor	0.75-in. Dia PVC Well Casing with 0.02-in. aperture Machine-cut slots
12					No.3 Monterey Sand Filter
14	MWT-9-14.5			CLAY (CL), very stiff, moist, with coarse sand and gravel No odor	
16					
18					
20	MWT-9-19.5			CLAY (CL), very stiff, moist, with coarse sand and gravel No odor	Threaded Casing Cap
22				TD Boring @ 20 feet	
24					
26					
28					
30					

The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: MWT-10

Project: Oak Walk

Project No.: 0004.082

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 47.22 ft.

Surface Elevation: 47.38 ft.

Depth to Water: 9.53 ft.

Date Installed: 04/01/04

Total depth of Boring: 20 ft.

Boring Diameter: 2 in.

Well Casing Diameter: 0.75 in.

Total depth of Well: 20 ft.

Casing Material: PVC

Drilling Company: Gregg Drilling & Testing

Drilling Method: Push Probe

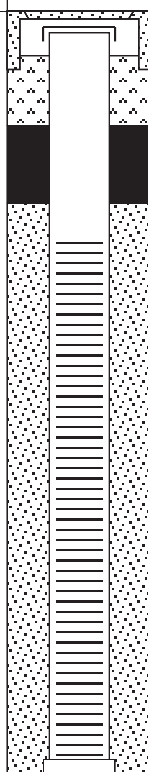
Driller: Paul Rogers

Logged By: Steve Flexser

Depth (Feet)	Sample (2.5 / 2.0 / 0.75)	Blows/ Foot	Graphic Log	Description
0				Dark brown CLAY (CL), stiff, moist, with minor gravel (fill) No odor
4	MWT-10-5.0			Dark brown Silty SAND (SM), medium dense, moist, with bottle glass (fill) No odor
6				Brown CLAY (CL), very stiff, moist, with orange silty inclusions No odor
8				Light brown CLAY (CL), very stiff, moist, abundant chert and black gravel No odor
10	MWT-10-10.0			Decreasing gravel with depth
14				Dark brown CLAY (CL), very stiff, moist, with thin intervals of sandy gravelly clay No odor
15	MWT-10-15.0			
17				Color lightens with depth
20	MWT-10-20.0			TD Boring @ 20 feet

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Well Construction



The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: MWT-11

Project: Oak Walk

Project No.: 0004.082

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 46.63 ft.

Surface Elevation: 45.50 ft.

Depth to Water: 9.71 ft.

Date Installed: 11/05/04

Total depth of Boring: 20.0 ft.

Boring Diameter: 2 in.

Well Casing Diameter: 0.75 in.

Total depth of Well: 20.0 ft.

Casing Material: PVC

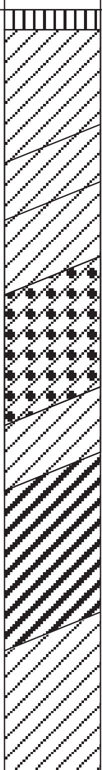
Drilling Company: Gregg Drilling & Testing

Drilling Method: Push Probe

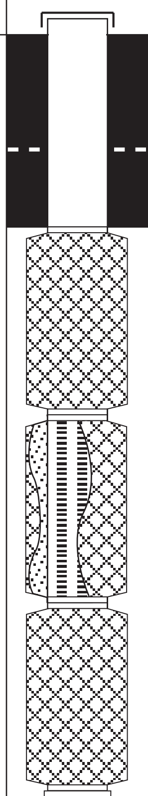
Driller: Jeramy Ness

Logged By: Dennis Alexander

Graphic Log:



Well Construction:



Depth (Feet)	Sample (2.5 / 2.0 / 0.75)	Blows/ Foot	Description	Well Construction
0			Dark brown Sandy SILT (ML), very soft, moist, low plasticity. No odor	Casing protrudes above ground level
			Dark gray brown CLAY (CL), stiff, moist, high plasticity, with some fine sand, trace medium to coarse sand. No odor	Bentonite Pellet Seal
2				
			Light gray and orange-brown mottled Gravelly CLAY (CL), very stiff, moist, medium plasticity, with some fine sand and angular to subrounded gravel to 3/4" dia. No odor	
4	MWT-11-5.0			Prefabricated Self-expanding Bentonite Seal
			Yellow-brown Gravelly CLAY (CL), very stiff, moist, medium plasticity, with increasing sand and gravel with depth. No odor	
6				
			Light gray to gray Clayey GRAVEL (GC), medium dense, moist, low plasticity, with little fine sand, poorly graded angular to rounded gravel to 1 in. dia.	
8				
			Odor of petroleum hydrocarbons	
10	MWT-11-10.5		Gray Sandy CLAY (CL), stiff, moist, low to medium plasticity, with some fine sands, trace gravel to 1/2 in. dia. No odor	▼ 11/08/04
				0.75 PVC Well Casing with 0.01in. aperture Machine-cut slots in Prefabricated Sand and Wire Mesh Filter
12			Olive brown and orange-brown mottled CLAY (CH), stiff to very stiff, moist, high plasticity, with little fine sand, trace medium to coarse sand No odor	
14	MWT-11-14.5			
16			Odor of petroleum hydrocarbons	
			Yellow brown, orange brown and dark brown mottled CLAY (CL), medium stiff to stiff, moist to wet, with little to some fine sand, trace angular to rounded gravel to 1/2 in. dia.	
18				
	MWT-11-19.5			Threaded Casing Cap
20			TD Boring @ 20 feet	
22				
24				
26				
28				
30				

The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: **MWT-12**

Project: Oak Walk

Project No.: 0004.082

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 47.97 ft.

Surface Elevation: 46.10 ft.

Depth to Water: 10.79 ft.

Date Installed: 11/05/04

Total depth of Boring: 20 ft.

Boring Diameter: 2 in.

Well Casing Diameter: 0.75 in.

Total depth of Well: 20 ft.

Casing Material: PVC

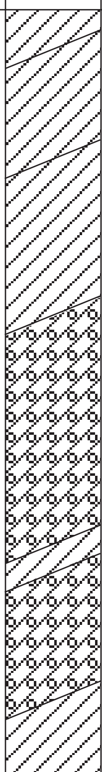
Drilling Company: Gregg Drilling & Testing

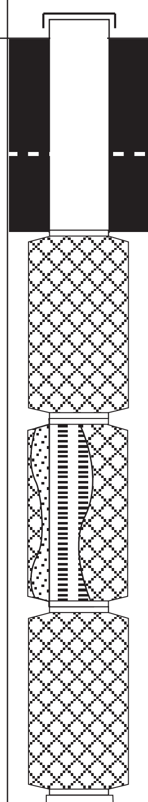
Drilling Method: Push Probe

Driller: Jeramy Ness

Logged By: Dennis Alexander

Depth (Feet)	Sample (2.5 / 2.0 / 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				Dark brown Silty CLAY (CL), soft, moist, medium plasticity, with little fine sand. No odor	Casing protrudes above ground level
2				Dark brown CLAY (CL), stiff to very stiff, moist, high plasticity, with little fine sand, few medium to dense sands No odor	Bentonite Pellet Seal
4	MWT-12-5.0			Gray and orange-brown mottled CLAY (CL), very stiff to hard, moist, medium plasticity, with some fine sands, trace medium to coarse sands No odor	Prefabricated Self-expanding Bentonite Seal
6					0.75 PVC Well Casing with 0.01in. aperture Machine-cut slots in Prefabricated Sand and Wire Mesh Filter
8				Yellow brown to gray Clayey SAND (SC), medium dense, moist to wet, fine to medium sands, with some angular to subrounded gravels to 3/4 in. dia. Slight odor of petroleum hydrocarbons	
10	MWT-12-10.0				▼ 11/08/04
12					
14	MWT-12-15.0			Sandy CLAY (CL) Yellow brown Clayey SAND (SC), medium dense to dense, moist, fine to medium sands, with some angular to subrounded gravels to 1/2 in. dia. Slight odor of petroleum hydrocarbons	
16					
18				Olive-brown, orange-brown, brown mottled CLAY (CL), very stiff, moist, medium plasticity, with little fine sand, few angular to subrounded gravel to 1/2 in. dia. No odor	
20	MWT-12-20.0			TD Boring @ 20 feet	Threaded Casing Cap
22					
24					
26					
28					
30					





The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: MWT-13

Project: Oak Walk

Project No.: 0004.082

Owner: Bay Rock Residential LLC

Location: Emeryville, California

Top of Casing Elevation: 48.16 ft.

Surface Elevation: 46.30 ft.

Depth to Water: 10.65 ft.

Date Installed: 11/05/04

Total depth of Boring: 20 ft.

Boring Diameter: 2 in.

Well Casing Diameter: 0.75 in.

Total depth of Well: 20 ft.

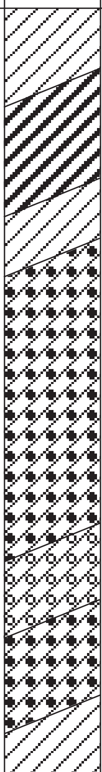
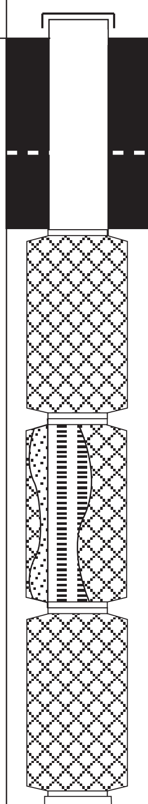
Casing Material: PVC

Drilling Company: Gregg Drilling & Testing

Drilling Method: Push Probe

Driller: Jeramy Ness

Logged By: Dennis Alexander

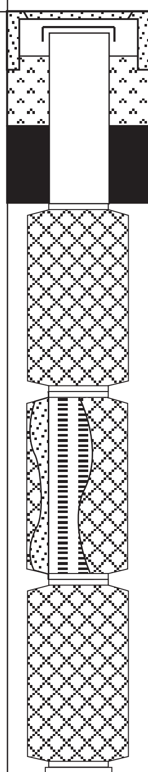
Depth (Feet)	Sample (2.5 | 2.0 | 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				Dark brown Silty CLAY (CL), soft to medium soft, moist, medium plasticity, little fine sand No odor	 Casing protrudes above ground level
2				Dark brown CLAY (CH), stiff to very stiff, moist, high plasticity, with few to little fine sand, decreasing plasticity with depth No odor	Bentonite Pellet Seal
4	MWT-13-5.0			Gray and orange-brown mottled CLAY (CL), very stiff, moist, medium plasticity, with little to some fine sands No odor	Prefabricated Self-expanding Bentonite Seal
6					
8				Yellow-brown to gray Clayey GRAVEL (GC), medium dense to dense, moist, low plasticity, with some fine sand, poorly graded angular to subrounded gravel to 1 in. dia. Slight odor of petroleum hydrocarbons	0.75 PVC Well Casing with 0.01in. aperture Machine-cut slots in Prefabricated Sand and Wire Mesh Filter
10	MWT-13-10.0				▼ 11/08/04
12					
14	MWT-13-15.0			Gray to yellow brown Clayey SAND (SC), medium dense, wet, fine sands No odor	
16				Yellow-brown Clayey GRAVEL (GC), medium dense, wet, with some fine sands, poorly graded angular gravels to 1 in. dia. No odor	
18				Olive-brown, orange-brown mottled CLAY (CL), stiff, moist, medium plasticity, with little fine sand, trace angular to subrounded gravel to 1/2 in. dia. No odor	
20	MWT-13-20.0			TD Boring @ 20 feet	Threaded Casing Cap
22					
24					
26					
28					
30					

The San Joaquin Company Inc.

Monitoring Well Log

WELL No.: **MWT-14**		Project: Oak Walk		Project No.: 0004.082	
Owner: Bay Rock Residential LLC		Location: Emeryville, California			
Top of Casing Elevation: 47.85 ft.		Surface Elevation: 47.80 ft.		Depth to Water: 9.63 ft.	
Date Installed: 11/05/04		Total depth of Boring: 20.0 ft.		Boring Diameter: 2 in.	
Well Casing Diameter: 0.75 in.		Total depth of Well: 20.0 ft.		Casing Material: PVC	
Drilling Company: Gregg Drilling & Testing		Drilling Method: Push Probe			
Driller: Jeramy Ness		Logged By: Dennis Alexander			

Depth (Feet)	Sample (2.5 | 2.0 | 0.75)	Blows/ Foot	Graphic Log	Description	Well Construction
0				Dark brown Silty CLAY (CL), soft to stiff, moist, medium plasticity, with few to little sands, trace gravel to 1/2 in. dia. No odor	Light Duty Steel Well-Head Box (with bolted cover and O-ring seal Set in concrete) Portland Cement Grout
2					
4	MWT-14-5.0			Dark gray brown CLAY (CH), stiff to very stiff, moist, high plasticity, with few fine sands, trace gravel to 1/2 in. dia., increasing sands with depth No odor	Prefabricated Self-expanding Bentonite Seal
6					
8				Gray and orange-brown mottled Clayey GRAVEL (GC), medium dense to dense, moist, with some fine sand, poorly graded angular to subrounded gravel to 3/4 in. dia., few small lenses of clayey sand with gravel Slight Odor of petroleum hydrocarbons	
10	MWT-14-10.5				▼ 11/08/04
12				Gray Clayey SAND (SC), medium dense to dense, moist to wet, sands fine to medium, with some angular to subrounded gravel to 1 in. dia. No odor	0.75 PVC Well Casing with 0.01in. aperture Machine-cut slots in Prefabricated Sand and Wire Mesh Filter
14	MWT-14-14.5				
16				Olive brown and orange-brown mottled CLAY (CL), stiff, moist, medium plasticity, with little to some very fine sand, trace fine subangular to subrounded gravel to 1/2 in. dia, increasing sands and angular to subrounded gravels with depth No odor	
18	MWT-14-19.5				Threaded Casing Cap
20				TD Boring @ 20 feet	
22					
24					
26					
28					
30					



The San Joaquin Company, Inc.

Boring Log

BORING No.: **BG-1**		Project: Oak Walk	Project No.: 0004.083
		Location: Emeryville, California	
Date Drilled: 04/06/04		Surface Elevation: 43.3 ft.	Boring Diameter: 8 in.
Drilling Method: Hollow Stem Auger		Groundwater Depth: 18 ft.	Hammer Weight: 140 lbs.
Logged By: Dennis Alexander		Total depth of Boring: 35.0 ft.	Hammer Drop: 30 in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 / 2.5 / 2.0	Blows/ 6 In.	Water Content (%)	Dry Density (PCF)	Other Lab Data	Description
0						3 inches Bituminous macadam Dark brown Silty Sandy GRAVEL (GM), dense, moist (fill)
1						Dark Gray-brown CLAY (CH), very stiff, moist, high plasticity, with few very fine to fine sands No odor
3	3.0	7 9 15	31.8	87.1		
4.5	2.5	6 9 11				Mottled Gray and brown CLAY (CH), very stiff, moist, with trace medium to coarse sands, and fine sands No odor
9	3.0	11 17 26	22.3	102.9	uc = 1.75ksf	Light Gray and brown CLAY (CH), very stiff, moist, hight plasticity, with few fine sands, some angular to subrounded medium to coarse sands and gravels to 3/4" diameter, trace shells Moderate gasoline odor
14	3.0	10 19 25	19.7	108.4	uc = 2.42ksf	Mottled yellow-brown and light blue Gray CLAY (CH), hard, moist, high plasticity, with vein of very fine to fine sands, trace of medium to coarse sands Slight gasoline odor
16						Gray-brown Sandy CLAY (CL), very stiff, moist, medium plasticity, with some fine sands, trace medium to coarse sands No odor
18						▽
19	3.0	10 13 16	23.8	101.7	<200 = 66.2% LL = 42% PI = 24%	
20						

The San Joaquin Company, Inc.

Boring Log

BORING No.: **BG-1**		Project: Oak Walk	Project No.: 0004.083
		Location: Emeryville, California	
Date Drilled: 04/06/04		Surface Elevation: 43.3 ft.	Boring Diameter: 8 in.
Drilling Method: Hollow Stem Auger		Groundwater Depth: 18 ft.	Hammer Weight: 140 lbs.
Logged By: Dennis Alexander		Total depth of Boring: 35.0 ft.	Hammer Drop: 30 in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 | 2.5 | 2.0	Blows/ 6 In.	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
20							Gray-brown Sandy CLAY (CL), very stiff, moist, medium plasticity, with some fine sands, trace medium to coarse sand No odor
21							
22							
23							Increasing sands and gravels to 23.5 feet
24	3.0	17 27 36	20.6	106.0	uc = 4.05ksf		Mottled yellow-brown and light Gray CLAY (CL), hard, moist, medium plasticity, with little to some fine sands, small lenses of angular to round gravels to 3/4" diameter No odor
25							
26							
27							Yellow-brown Clayey SILT (ML), hard, moist, low to medium plasticity, with little to some very fine sands No odor
28							
29	3.0	17 24 36	23.1	104.4			Yellow-brown Gravelly SAND (SW), dense, wet, non-plastic, well graded, with some subangular to rounded gravels to 1" diameter No odor
30							
31							
32							Yellow-brown CLAY (CL), very stiff, moist, medium plasticity, with little very fine to fine sands No odor
33							
34	3.0	11 13 15	29.6	94.5			
35							TD Boring at 35 feet
36							
37							
38							
39							
40							

The San Joaquin Company, Inc.

Boring Log

BORING No.: **BG-2**	Project: Oak Walk	Project No.: 0004.083
	Location: Emeryville, California	
Date Drilled: 04/06/04	Surface Elevation: 46.5 ft.	Boring Diameter: 8 in.
Drilling Method: Hollow Stem Auger	Groundwater Depth: 14.5 ft.	Hammer Weight: 140 lbs.
Logged By: Dennis Alexander	Total depth of Boring: 30.0 ft.	Hammer Drop: 30 in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 / 2.5 / 2.0	Blows/ 6 In.	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
0							6 inches concrete
0.5							Dark Gray brown Silty CLAY (CL), very stiff, moist, medium plasticity, with little fine sands, trace fine gravel to 1/2" diameter No odor
3	3.0	4 10 16	25.4	97.5			
4							Dark brown CLAY (CH), very stiff, moist, high plasticity, with little fine sands, few medium to coarse sands, trace angular to subrounded gravels to 3/4" diameter No odor
5	2.5	8 11 12					
6	3.0	9 22 28	18.7 25.7	109.0 97.7	uc = 1.23ksf perm = 2.51 E-9cm/sec		Dark brown CLAY (CH), hard, moist, high plasticity, with little fine sands, few medium to coarse sands, trace angular to subrounded gravels to 3/4" diameter No odor
8			21.0	96.5	Shelby 26" Consol.		Gray Lean Sandy CLAY (CL), very stiff, moist, medium plasticity, with some fine sands, little medium to coarse sands, few fine gravels to 1/2" diameter Gasoline odor
11	2.5	14 19 25					Mottled light gray and brown Sandy CLAY (CL), hard, moist, medium plasticity, with some fine sands, increasing subangular gravels to few up to 1" diameter Gasoline odor
12			20.7	99.4	Shelby 15" Consol.		
13							Mottled brown and gray Sandy CLAY (CL), hard, moist, medium plasticity, increasing sands with depth No odor
14.5							▽
15	2.5	14 15 21					Mottled brown and gray Sandy CLAY (CL), hard, moist, medium plasticity, with some fine sands, few medium to coarse sands, some fine angular to rounded gravels to 1/2" diameter No odor
17							Yellow-brown with light gray streaks CLAYEY SAND (SC), medium dense, moist, medium plasticity, with little subangular to rounded gravels to 3/4" diameter No odor
18	3.0	7 8 9	24.1	101.2	<200 = 34.8% LL = 34% PI = 17%		Lens of (CH) at 18.5-19.5'
19							
20							

The San Joaquin Company, Inc.

Boring Log

BORING No.: **BG-2**

Project: Oak Walk

Project No.: 0004.083

Location: Emeryville, California

Date Drilled: 04/06/04

Surface Elevation: 46.5 ft.

Boring Diameter: 8 in.

Drilling Method: Hollow Stem Auger

Groundwater Depth: 18 ft.

Hammer Weight: 140 lbs.

Logged By: Dennis Alexander

Total depth of Boring: 30.0 ft.

Hammer Drop: 30 in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 | 2.5 | 2.0	Blows/ Foot	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
20							Interbedded lenses of yellow-brown CLAY (CH) and CLAY (CL), hard, moist, medium to high plasticity, with few to some fine sands, trace medium to coarse sand, trace to few angular to subrounded gravel up to 1/2" diameter No odor
21		8 13 17					
22							
23							
24		17 20 33	26.3	98.3			
25							
26							
27							
28							Yellow-brown CLAY (CH), hard, moist, high plasticity, with few very fine to fine sands No odor
29		10 17 26	24.4	100.7			
30							TD Boring at 30 feet
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

The San Joaquin Company, Inc.

Boring Log

BORING No.: **BE-1**

Project: Oak Walk

Project No.: 0004.082

Location: Emeryville, California

Date Drilled: 04/02/04

Surface Elevation: 44.9 ft.

Boring Diameter: 2 in.

Drilling Method: Push Probe

Groundwater Depth: n.a. ft.

Hammer Weight: n.a. lbs.

Logged By: Steve Flexser

Total depth of Boring: 25.0 ft.

Hammer Drop: n.a. in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 / 2.5 / 2.0	Blows/ Foot	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
0							3 inches bituminous macadam Black CLAY (CL), medium stiff, moist, with little gravel No odor
1							
2							
3							
4							Dark Gray-brown Silty SAND (SM), loose, dry No odor
5	BE-1-5.0						Black CLAY (CL), medium stiff, moist, with little gravel very slight odor of fuel hydrocarbons
6							
7							
8							Strong odor of fuel hydrocarbons
9							Black CLAY (CL), medium stiff, moist, with interbedded layers of Gray-green fine sand, gravel and weathered chert No odor
10	BE-1-10.0						
11							
12							
13							
14							Gray and light brown Gravelly CLAY (CL), very stiff, moist, with coarse gravel and inclusions of red sand Very slight fuel odor
15	BE-1-15.0						
16							
17							
18							
19							
20	BE-1-20.0						

The San Joaquin Company, Inc.

Boring Log

BORING No.: **BE-1**

Project: Oak Walk

Project No.: 0004.083

Location: Emeryville, California

Date Drilled: 04/02/04

Surface Elevation: 44.9 ft.

Boring Diameter: 2 in.

Drilling Method: Push Probe

Groundwater Depth: n.a. ft.

Hammer Weight: n.a. lbs.

Logged By: Steve Flexser

Total depth of Boring: 25.0 ft.

Hammer Drop: n.a. in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 / 2.5 / 2.0	Blows/ Foot	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
20							Gray and light brown Gravelly CLAY (CL), very stiff, moist, with coarse gravel and inclusions of red sand. With increasing gravel and sand with depth No odor
21							
22							
23							
24	BE-1-25.0						No odor
25							TD Boring at 25 feet
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

The San Joaquin Company, Inc.

Boring Log

BORING No.:	**BE-2**
Project:	Oak Walk
Project No.:	0004.082
Location:	Emeryville, California
Date Drilled:	04/02/04
Surface Elevation:	46.6 ft.
Boring Diameter:	2 in.
Drilling Method:	Push Probe
Groundwater Depth:	n.a. ft.
Hammer Weight:	n.a. lbs.
Logged By:	Steve Flexser
Total depth of Boring:	25.0 ft.
Hammer Drop:	n.a. in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 | 2.5 | 2.0	Blows/ Foot	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
0							3 inches bituminous macadam Black CLAY (CL), medium stiff, moist, with thin interbedded layers of coarse brown Sand and fine Gravel Very slight odor of fuel hydrocarbons
1							
2							
3							
4							Moderate odor of fuel hydrocarbons
5	BE-2-5.0						
6							
7							
8							
9							
10	BE-2-10.0						
11							Gray and orange Clayey SAND (SC), loose, wet
12							Gray and light brown CLAY (CL), soft, wet, with fine subrounded gravel Moderate odor of fuel hydrocarbons
13							
14							
15	BE-2-15.0						Gray-green CLAY (CL), medium stiff, wet, with interbedded layers of orange and black clay Slight odor of fuel hydrocarbons
16							Gray-green CLAY (CL), stiff, wet, with abundant gravel Slight odor of fuel hydrocarbons Silty SAND (SM), medium dense, wet, with interbedded layers of clay and multi-colored gravel Slight odor of fuel hydrocarbons
17							
18							
19							Moderate odor of fuel hydrocarbons
20	BE-2-20.0						

The San Joaquin Company, Inc.

Boring Log

BORING No.: **BE-2**

Project: Oak Walk

Project No.: 0004.083

Location: Emeryville, California

Date Drilled: 04/02/04

Surface Elevation: 46.6 ft.

Boring Diameter: 2 in.

Drilling Method: Push Probe

Groundwater Depth: n.a. ft.

Hammer Weight: n.a. lbs.

Logged By: Steve Flexser

Total depth of Boring: 25.0 ft.

Hammer Drop: n.a. in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 / 2.5 / 2.0	Blows/ Foot	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
20							
21							Light brown CLAY (CL), medium stiff, wet, with sandy inclusions Very slight odor of fuel hydrocarbons
22							
23							
24	BE-2-25.0						Light brown CLAY (CL), soft, wet, with rounded gravel, minor sand, and some black vitreous inclusions No Odor
25							
26							TD Boring at 25 feet
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

The San Joaquin Company, Inc.

Boring Log

BORING No.:	**BE-3**

Project: Oak Walk

Project No.: 0004.082

Location: Emeryville, California

Date Drilled: 04/02/04

Surface Elevation: 48.5 ft.

Boring Diameter: 2 in.

Drilling Method: Push Probe

Groundwater Depth: n.a. ft.

Hammer Weight: n.a. lbs.

Logged By: Steve Flexser

Total depth of Boring: 20.0 ft.

Hammer Drop: n.a. in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 | 2.5 | 2.0	Blows/ Foot	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
0							2 inches bituminous macadam Black CLAY (CL), medium stiff, moist, with few inclusions or root marks No odor
1							
2							
3							
4							Gray CLAY (CL), medium stiff, moist No odor
5	BE-3-5.0						Gray CLAY (CL), stiff, moist, increasing stiffness with depth No odor
6							
7							
8							
9							Very slight odor of fuel hydrocarbons
10	BE-3-10.0						Gray and brown mottled CLAY (CL), stiff, moist No odor
11							Moderate odor of fuel hydrocarbons
12							
13							Slight odor of fuel hydrocarbons
14							Brown Silty SAND (SM), loose, wet, with some gravel No odor
15	BE-3-15.0						
16	BE-3-16.0						Brown Silty SAND (SM), loose, wet, increasing gravel with depth
17					No Sample Recovered		
18							Dark gray to black CLAY (CH), stiff, wet Strong odor of fuel hydrocarbons
19	BE-3-19.5						
20	BE-3-20.0						Gray CLAY (CH), stiff, wet, with coarse sand and gravel Moderate odor of fuel hydrocarbons

TD Boring @ 20 feet

The San Joaquin Company, Inc.

Boring Log

BORING No.:	**BE-4**
Project:	Oak Walk
Project No.:	0004.082
Location:	Emeryville, California
Date Drilled:	04/01/04
Surface Elevation:	44.6 ft.
Boring Diameter:	2 in.
Drilling Method:	Push Probe
Groundwater Depth:	n.a. ft.
Hammer Weight:	n.a. lbs.
Logged By:	Steve Flexser
Total depth of Boring:	20.0 ft.
Hammer Drop:	n.a. in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 | 2.5 | 2.0	Blows/ Foot	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
0							Very dark brown Sandy Clayey SILT (ML), medium stiff, moist No odor
4.5–5.5	BE-4-5.0; BE-4-5.5						
7.5							Light brown CLAY (CL), very stiff, moist, with fine gravel No odor
9–9.5	BE-4-9.5						
9.75							Grey green CLAY (CL), stiff, moist, with orange silty inclusions Slight odor of solvent
10–12					No Sample Recovered		
14–14.5	BE-4-14.5						
15.5							Grey green CLAY (CL), stiff, moist, with some sand and white gravel, increase in sand and white gravel with depth Slight odor of solvent
18.5							Brown CLAY (CL), stiff, moist, with some sand and white gravel No odor
19–19.5	BE-4-19.5						
20							TD Boring @ 20 feet

The San Joaquin Company, Inc.

Boring Log

BORING No.: BE-5

Project: Oak Walk

Project No.: 0004.082

Location: Emeryville, California

Date Drilled: 04/01/04

Surface Elevation: 43.8 ft.

Boring Diameter: 2 in.

Drilling Method: Push Probe

Groundwater Depth: 12 ft.

Hammer Weight: n.a. lbs.

Logged By: Steve Flexser

Total depth of Boring: 20.0 ft.

Hammer Drop: n.a. in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 / 2.5 / 2.0	Blows/ Foot	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
0							3 inches bituminous macadam Dark brown to black Clayey SILT (ML), medium stiff, moist, with red root markings No odor
1							
2							
3							
4							Brown Silty SAND (SM), medium dense, moist, with yellow and red sand inclusions No odor
5	BE-5-5.0						
6							
7							
8							
9							
10	BE-5-10.5						Gray CLAY (CL), medium stiff, moist, with thin sandy intervals and some gravel No odor
11							
12							▽
13							Light brown CLAY (CH), stiff, moist Slight odor of fuel hydrocarbons
14	BE-5-14.5						No odor
15							
16							
17							Brown Clayey SAND(SC), medium dense, wet, with gravel No odor
18							
19							Brown CLAY (CL) No odor
20	BE-5-20.0						TD Boring @ 20 feet

The San Joaquin Company, Inc.

Boring Log

BORING No.: BE-6

Project: Oak Walk

Project No.: 0004.082

Location: Emeryville, California

Date Drilled: 04/01/04

Surface Elevation: 43.9 ft.

Boring Diameter: 2 in.

Drilling Method: Push Probe

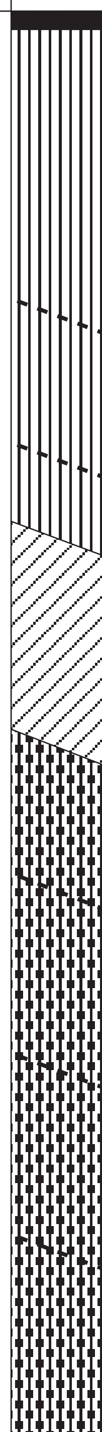
Groundwater Depth: 12 ft.

Hammer Weight: n.a. lbs.

Logged By: Steve Flexser

Total depth of Boring: 20.0 ft.

Hammer Drop: n.a. in.

Depth (Feet)	Sampler Outside Dia. (in.) 3.0 | 2.5 | 2.0	Blows/ Foot	Water Content (%)	Dry Density (PCF)	Other Lab Data	Graphic Log	Description
0							3 inches bituminous macadam Dark brown to black Sandy SILT (ML), medium stiff, moist No odor
1							
2							
3							
4	BE-6-4.0						
5							Dark brown to black Sandy SILT (ML), medium stiff, moist, with some sand, increasing sand with depth Very slight solvent odor
6							
7							Brown and gray mottled Sandy SILT (ML), medium stiff, moist, with orange root marks Very slight solvent odor
8							Black to dark brown CLAY (CL), stiff, moist Very slight solvent odor
9							
10	BE-6-10.0						
11							Brown Silty SAND (SM), medium dense, moist, with some angular weathered chert gravel, and roots Very slight solvent odor to no odor
12							▽
13							Black Silty SAND (SM), medium dense, moist, decreasing gravel with depth No odor
14							
15	BE-6-15.5						Gray Silty SAND (SM), medium dense, moist No odor
16							
17							
18							Gray and brown Silty SAND (SM), medium dense, moist No odor
19							
20	BE-6-20.0						

TD Boring @ 20 feet

Clayton
GROUP SERVICES

LOG OF BORING OB-9

Green City Lofts LLC
Subsurface Investigation
1007 41st Street
Emeryville, California

Clayton Project No.: 70-03365.03

Date Started	: 08/27/03	Driller	: Gregg
Date Completed	: 08/27/03	Logged by	: Matt Reimer
Hole Diameter	: 2-inch		
Drilling Method	: Geoprobe		
Sampling Method	: Macrocore		

Depth in FEET	Samples	OVA (ppm)	Water Levels	GRAPHIC	DESCRIPTION
0					Asphalt and baserock
					CLAY (CL) dark brown, stiff, dry
5					
	☐	0.0			
					Color change to olive brown, stiff, dry, trace large angular gravel (volcanics)
10	☐	0.0			
					SILTY CLAY (CL) brown, medium stiff, moist, trace angular gravel
15	☐	0.0			
	☐	0.0	▽		
20					
	☐	0.0			
					Total Depth of Boring = 24 feet
25					

Notes:
Borehole was initiated with hand auger to 4 feet bgs.
Static water level at 18 feet.
Grab groundwater sample taken at 11:20.
Borehole abandoned with neat cement grout.

Clayton GROUP SERVICES

LOG OF BORING OB-8

Green City Lofts LLC
Subsurface Investigation
1007 41st Street
Emeryville, California

Clayton Project No.: 70-03365.03

Date Started	: 06/27/03	Driller	: Gregg
Date Completed	: 06/27/03	Logged by	: Matt Reimer
Hole Diameter	: 2-inch		
Drilling Method	: Geoprobe		
Sampling Method	: Macrocore		

Depth in FEET	Samples	OVA (ppm)	Water Levels	GRAPHIC	DESCRIPTION
0					Asphalt and baserock
					CLAY (CL) black, stiff, dry, trace gravel
5					
	▭	0.0			
			▽		
10					SILTY CLAY (CL) brownish olive, medium stiff, dry to moist, trace gravel
	▭	0.0			
15	▭	0.0			
					CLAY (CL) brown, soft, moist, trace gravel
	▭	0.0			
20					
					Increasing stiffness
	▭	0.0			
25					Trace organics
	▭	0.0			
30					
					Total Depth of Boring = 32 feet
35					

Notes:
Borehole was initiated with hand auger to 4 feet bgs.
Static water level at 9.0 feet.
Grab groundwater sample taken at 14:50.
Borehole abandoned with neat cement grout.

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Clayton GROUP SERVICES

LOG OF BORING OB-6

Green City Lofts LLC
Subsurface Investigation
1007 41st Street
Emeryville, California

Clayton Project No.: 70-03365.03

Date Started	: 06/27/03
Date Completed	: 06/27/03
Hole Diameter	: 2-inch
Drilling Method	: Geoprobe
Sampling Method	: Macrocore
Driller	: Gregg
Logged by	: Matt Reimer

Depth in FEET	Samples	OVA (ppm)	Water Levels	GRAPHIC	DESCRIPTION
0					Asphalt and baserock
					CLAY (CL) black, stiff, dry
	▭	0.0			CLAY (CL) olive, stiff, moist
10					Color change to brown, trace gravel
	▭	0.0			
					SILTY CLAY (CL) brown, medium stiff, moist, trace angular gravel
15	▭	0.0			
	▭	0.0			
	▭	0.0			CLAY (CL) olive gray, very stiff, moist
			∇		SANDY CLAY (CL) brown, soft, very moist
					CLAYEY GRAVEL (GC) brown, stiff, saturated

Total Depth of Boring = 28 feet

Notes:
Borehole was initiated with hand auger to 4 feet bgs.
Static water level at 24 feet. Grab groundwater sample taken at 15:40 p.m.
Borehole abandoned with neat cement grout.

Clayton GROUP SERVICES

LOG OF BORING OB-5

Green City Lofts LLC
Subsurface Investigation
1007 41st Street
Emeryville, California

Clayton Project No.: 70-03365.03

Date Started	: 06/27/03	Driller	: Gregg
Date Completed	: 06/27/03	Logged by	: Matt Reimer
Hole Diameter	: 2-inch		
Drilling Method	: Geoprobe		
Sampling Method	: Macrocore		

Depth in FEET	Samples	OVA (ppm)	Water Levels	DESCRIPTION
0				Asphalt and basarock
				CLAY (CL) brown/olive, soft, moist
5				
				CLAY (CL) olive gray, stiff, moist, trace gravel, organic matter-plant fibers, hydrocarbon odor
	▭	0.0		
10	▭	74		
	▭	5.0		
15				
				SILTY CLAY (CL) brown, medium stiff, moist
				CLAY (CL) brown/olive, stiff, moist, trace angular gravel
20				
				Very stiff at 23 feet
				SILTY CLAY (CL) brown, soft, moist, trace gravel
25				
			▽	
30				CLAYEY GRAVEL (GC) brown, loose, saturated
				SILTY CLAY (CL) brown, stiff, moist
				Total Depth of Boring = 32 feet
35				

Notes:
Borehole was initiated with hand auger to 4 feet bgs.
Static water level at 28 feet. Grab groundwater sample taken at 15:10 p.m.
Borehole abandoned with neat cement grout.

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Clayton GROUP SERVICES

LOG OF BORING OB-4

Green City Lofts LLC
Subsurface Investigation
1007 41st Street
Emeryville, California

Clayton Project No.: 70-03365.03

Date Started	: 06/27/03	Driller	: Gregg
Date Completed	: 06/27/03	Logged by	: Matt Reimer
Hole Diameter	: 2-inch		
Drilling Method	: Geoprobe		
Sampling Method	: Macrocore		

Depth in FEET	Samples	OVA (ppm)	Water Levels	GRAPHIC	DESCRIPTION
0					Asphalt and baserock
5					CLAY (CL) black, very stiff, dry, trace gravel
	☐	0.0			50 % recovery
					Color change to olive brown, stiff, moist, trace organics
	☐	0.0			
10					
	☐	0.0	▽		
15					SILTY CLAY (CL) brown, soft, moist
	☐	0.0			
20					
	☐	0.0			Increased moisture content
25					Total Depth of Boring = 24 feet

Notes:
Borehole was initiated with hand auger to 4 feet bgs.
Grab groundwater sample taken at 10:50.
Borehole abandoned with neat cement grout.

Clayton GROUP SERVICES

LOG OF BORING OB-3

Green City Lofts LLC
Subsurface Investigation
1007 41st Street
Emeryville, California

Clayton Project No.: 70-03365.03

Date Started	: 06/27/03	Driller	: Gregg
Date Completed	: 06/27/03	Logged by	: Matt Reimer
Hole Diameter	: 2-inch		
Drilling Method	: Geoprobe		
Sampling Method	: Macrocore		

Depth in FEET	Samples	OVA (ppm)	Water Levels	GRAPHIC	DESCRIPTION
0					Asphalt and baseock
					CLAY (CL) brown, stiff, dry
5					
	☐	0.0			Color change to yellowish orange, moist, trace gravels, trace organics
10	☐	0.0			
					SILTY CLAY (CL) brownish olive, stiff, moist, trace organics
15	☐	0.0			
			▽		CLAY (CL) brown, medium stiff, moist, trace organics
	☐	0.0			SILTY GRAVELLY SAND (SM) brownish orange, loose, saturated
20					SILTY CLAY (CL) brown, moist, trace gravel
	☐	0.0			CLAYEY SILT (ML) brown, large angular gravel, moist
25					Total Depth of Boring = 24 feet

Notes:
Borehole was initiated with hand auger to 4 feet bgs.
Static water level at 16.7 feet. Grab groundwater sample taken at 8:50 a.m.
Borehole abandoned with neat cement grout.

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Clayton GROUP SERVICES

LOG OF BORING CW-2

Former Dunne Paint Facility
1007 41st Street
Oakland, California

Clayton Project No.: 70-03365.05

Date Started	: 10/30/03	Driller	: Clear Heart Drilling
Date Completed	: 10/30/03	Logged by	: Mike Krzeminski
Hole Diameter	: 8-inch	Surveyor	: V. Chavez
Drilling Method	: Hollow Stem Auger	Top of Casing	: ft, msl
Sampling Method	: Cal Modified Split Spoon		

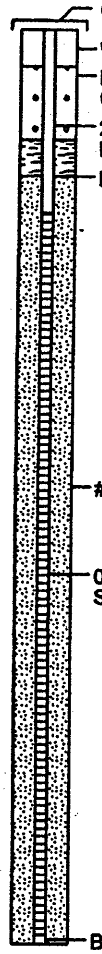
Depth in FEET | Samples | Blow Count | OVM (mg/kg) | USCS | GRAPHIC | DESCRIPTION

Blow Count	OVM (mg/kg)
7, 10, 15	0.3
6, 9, 13	0.3
8, 19, 20	445
7, 13, 17	762
8, 10, 15	
9, 16, 19	25.1
8, 15, 17	0.9
13, 17, 20	0.3

USCS	DESCRIPTION
	Asphalt and Baserock
CL	Silty Clay trace gravel (CL) (5,0,40,55), dark brown, very stiff, fine subangular gravel, dry, rootlets.
CL	Gravelly Clay trace sand (CL) (30,10,10,50), greenish gray, stiff, coarse gravel, moist, hydrocarbon odor present.
GW/SW	Gravelly Sand (GW/SW) (50,50,0,0), light brown, medium dense, coarse gravel, medium sands, saturated, no odor.
GW	Sandy Gravel (GW) (60,40,0,0) light brown, medium dense, coarse gravel, medium sands, saturated.

Total Depth of Boring = 25 feet

Well: CW-2
Elev.:



Notes:

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Clayton GROUP SERVICES

LOG OF BORING CW-3

Former Dunne Paint Facility
1007 41st Street
Oakland, California

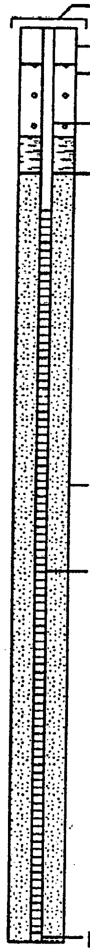
Clayton Project No.: 70-03365.05

Date Started	: 10/30/03	Driller	: Clear Heart Drilling
Date Completed	: 10/30/03	Logged by	: Mike Krzeminski
Hole Diameter	: 8-inch	Surveyor	: V. Chavez
Drilling Method	: Hollow Stem Auger	Top of Casing	: ft, msl
Sampling Method	: Cal Modified Split Spoon		

Depth in FEET	Samples	Blow Count	OVM (mg/kg)	USCS	GRAPHIC	DESCRIPTION
0						Asphalt and Baserock
				CL		Silty Clay (CL) (0,0,30,70), dark brown, stiff, dry, rootlets.
5	X	11 18 22	0.3			
				CL		Gravelly Clay with trace sand (CL) (30,10,0,60), light brown, medium stiff, fine angular gravel, moist.
10	X	10 15 17	0.3			
				GW/SW		Silty Clay trace gravel (CL) (10,0,30,60), light brown, medium stiff, fine angular gravel, saturated.
15	X	9 12 18	0.3			
20	X	9 14 18	0.3			
25						

Total Depth of Boring = 25 feet

Well: CW-3
Elev.:



Notes:

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Clayton GROUP SERVICES

LOG OF SOIL BORING

Project No.: 70-03365.04
Client: GCL
Location: Oakland/Emeryville
Logged By: P. McLaughlin

BORING NO. **B-1**

Start Date: 2/10/2005 | Start Time: 0800 | Elevation: N/A
Finish Date: 2/10/2005 | Finish Time: 0850 | Boring Dia.: 2"

Driller: ECA | Drill Method: Direct Push
Hammer Weight: N/A | Drop: N/A

Borehole Completion Data: Borehole Grouted

SAMPLE INTERVAL	SAMPLE RECOVERY (in)	SAMPLE ID.	PID READING (ppm)	TIME	DEPTH (ft)	USCS	DESCRIPTION
				0800	0–1	ML	CLAYEY SILT dark brown, damp, soft, low plastic, trace fine gravel up to 1/2" dia., organic debris/rootlets
	45	3.5	0.0	0810	1–5	ML	CLAYEY SILT light brown, damp, soft, low plastic, trace fine gravel up to 1/2" dia., organic debris/rootlets
	48	7.5	0.0	0820	5–8.7	CL	SILTY CLAY dark brown, damp, medium stiff, medium plastic, organic debris/rootlets groundwater depth 8.4 feet, 1635, 2/10/2005
					8.7–11	SC	CLAYEY SAND mottled gray and orange-brown, damp, loose, fine sand, no petrol odor
	48	11.5	10 75 148	0835	11–13	CL	SANDY CLAY grayish green, moist, soft, low plastic, 30% fine to coarse sand, petrol odor becomes wet at 11.25'
			17		13–14.7	SM	SILTY SAND light yellow brown, wet, medium dense, fine sand, no petrol odor groundwater depth 15.0 feet, 0900, 2/10/2005
	46	15.5	1.8 0.0	0850	14.7–16	SW	GRAVELLY SAND light brown, wet, medium dense, fine to coarse sand, 25% fine to coarse gravel up to 3/4" dia., some clay
					16		EOB @ 16 feet bgs.

Clayton GROUP SERVICES

LOG OF SOIL BORING

Project No.: 70-03365.04 Client: GCL Location: Oakland/Emeryville Logged By: P. McLaughlin		BORING NO. B-2
Start Date: 2/10/2005 Finish Date: 2/10/2005	Start Time: 0930 Finish Time: 1040	Elevation: N/A Boring Dia.: 2"
Driller: ECA Hammer Weight: N/A	Drill Method: Direct Push Drop: N/A	
Borehole Completion Data: Borehole Grouted		

SAMPLE INTERVAL	SAMPLE RECOVERY (in)	SAMPLE ID.	PID READING (ppm)	TIME	DEPTH (ft)	USCS	DESCRIPTION
				0930	0–1.2	ML	CLAYEY SILT dark brown, damp, soft, low plastic, trace fine gravel up to 1/2" dia., organic debris/rootlets
	36	3.5	0.0	0945	1.2–5	ML	SANDY SILT light brown, moist, soft, low plastic, 30% fine sand
	47	7.5	0.0	1000	5–8.2	CL	SILTY CLAY dark brown, damp, medium stiff, medium plastic, organic debris/rootlets groundwater depth 8.2 feet, 1633, 2/10/2005
					8.2–11	ML	CLAYEY SILT tan, moist, medium stiff, medium plastic, organic debris/rootlets
	48		0.0	1015	11–12.5	SM	SILTY SAND greenish gray, moist, medium dense, fine sand, organic debris/rootlets, no petrol odor groundwater depth 12.0 feet, 1050, 2/10/2005
		12.5	58 9.8	1040	12.5–14	SW	GRAVELLY SAND greenish gray, moist, medium dense, fine to coarse sand, 25% fine gravel up to 3/4" dia., organic debris/rootlets, petrol odor becomes wet at 14.0 feet
	42	15.5	1.8 0.0 0.0	1040	14–16	SW	GRAVELLY SAND light orangish brown-light brown, wet, medium dense, fine to coarse sand, 40% fine gravel up to 3/4" dia., no petrol odor
					16–19		EOB @ 16 feet bgs.

Clayton GROUP SERVICES

LOG OF SOIL BORING

Project No.: 70-03365.04		BORING NO.
Client: GCL		B-3
Location: Oakland/Emeryville		
Logged By: P. McLaughlin		
Start Date: 2/10/2005	Start Time: 1140	Elevation: N/A
Finish Date: 2/10/2005	Finish Time: 1230	Boring Dia.: 2"/1"
Driller: ECA	Drill Method: Direct Push	
Hammer Weight: N/A	Drop: N/A	
Borehole Completion Data: Borehole Grouted		

SAMPLE INTERVAL	SAMPLE RECOVERY (in)	SAMPLE ID.	PID READING (ppm)	TIME	DEPTH (ft)	USCS	DESCRIPTION
				1140	0	ML	CLAYEY SILT dark brown, damp, soft, low plastic, trace fine gravel up to 3/4" dia., organic debris/rootlets
					1.25	SM	SILTY SAND light brown, moist, loose, fine sand, organic debris/rootlets
					2.5	ML	CLAYEY SILT moist, soft, low plastic, organic debris/rootlets
	48	3.5	0.0	1150	4		
					5	CL	SILTY CLAY dark brown, moist, medium stiff, medium plastic, organic debris/roots
	48	7.5	0.0	1200	8		groundwater depth 8.2 feet, 1630, 2/10/2005 becomes light brown
					9	ML	CLAYEY SILT tan, moist, stiff, low plastic, trace fine gravel up to 1/2" dia., no petrol odor increased gravel content up to 12%
			0.0		11	SM	SILTY SAND WITH GRAVEL grayish green, moist, loose, fine sand, 10% fine gravel up to 3/4" dia., petrol odor 11.5 to 12.5 feet
	48	11.5	155	1215	11.5		groundwater depth 11.5 feet, 1240, 2/10/2005
			251				
			18				
			3		13.5		becomes wet at 13.5 feet
	24	13.5	0.9	1230	14		becomes light brown at 13.75 feet
					14		EOB @ 14 feet bgs. 2" dia. borehole to 12 feet bgs, 1" dia. to 14 feet bgs.

Clayton GROUP SERVICES

LOG OF SOIL BORING

Project No.: 70-03365.04	BORING NO.
Client: GCL	B-4
Location: Oakland/Emeryville	
Logged By: P. McLaughlin	

Start Date: 2/10/2005	Start Time: 1500	Elevation: N/A
Finish Date: 2/10/2005	Finish Time: 1540	Boring Dia.: 2"/1"
Driller: ECA	Drill Method: Direct Push	
Hammer Weight: N/A	Drop: N/A	

Borehole Completion Data: Borehole Grouted

SAMPLE INTERVAL	SAMPLE RECOVERY (in)	SAMPLE ID.	PID READING (ppm)	TIME	DEPTH (ft)	USCS	DESCRIPTION
				1500	0–3	ML	CLAYEY SILT dark brown, damp, soft, low plastic, some fine gravel up to 3/4" dia.
	42	3.5	0.0	1510	3–5	ML	SANDY SILT light brown, damp, soft, non-plastic, 30% fine sand, organic debris/rootlets
	40	7.5	0.0	1520	5–9	CL	SILTY CLAY dark brown, damp, stiff, medium plastic, organic debris/rootlets, no petrol odor becomes light brown, trace fine gravel up to 1/2" dia.
			0.0		9–11	SM	SILTY SAND WITH GRAVEL mottled gray brown and orange brown, moist, loose, fine sand, 30% fine to coarse gravel, up to 1" dia., petrol odor
	48	11.5	452	1530	11–15	SM	SILTY SAND grayish green, moist, loose, fine sand, petrol odor 11.25 to 13.5 feet
			94				
	24	13.5	2.6	1535			no petrol odor 13.5 to 16.0 feet groundwater depth 15.0 feet, 1550, 2/10/2005 becomes wet at 15.0 feet
	22		2.4	1540	15–16	SM	SILTY SAND light brown-orange brown, wet, loose, fine sand, no petrol odor
					16–20		EOB @ 16 feet bgs. 2" dia. borehole to 12 feet bgs, 1" dia. to 16 feet bgs.

Clayton GROUP SERVICES

LOG OF SOIL BORING

Project No.: 70-03365.04		BORING NO. B-5
Client: GCL		
Location: Oakland/Emeryville		
Logged By: P. McLaughlin		
Start Date: 2/10/2005	Start Time: 1410	Elevation: N/A
Finish Date: 2/10/2005	Finish Time: 1450	Boring Dia.: 2"/1"
Driller: ECA	Drill Method: Direct Push	
Hammer Weight: N/A	Drop: N/A	
Borehole Completion Data: Borehole Grouted		

SAMPLE INTERVAL	SAMPLE RECOVERY (in)	SAMPLE ID.	PID READING (ppm)	TIME
0-4 ft				1410
	48	3.5	0.0	1425
4-8 ft	48	7.5	0.0	1435
8-12 ft			21.3	
	48	11.5	848	1445
12-14 ft			307	
	24	13.5	4.5	1450

DEPTH (ft)	USCS	DESCRIPTION
0-1.25	ML	CLAYEY SILT dark brown, damp, soft, low plastic, trace fine gravel up to 1/2" dia., organic debris/rootlets
1.25-5	ML	SANDY SILT light brown, moist, soft, non-plastic, 30% fine sand, organic debris/rootlets
5-8.25	CL	SILTY CLAY dark brown, moist, medium stiff, medium plastic, organic debris/rootlets
8.25-9.5	ML	CLAYEY SILT light brown, moist, soft, low plastic, trace fine gravel up to 1/2" dia. groundwater depth 9.5 feet, 1450, 2/10/2005
9.5-10.5	SM	SILTY SAND WITH GRAVEL mottled gray brown and orange brown, moist, medium dense, fine to coarse sand, 25% fine gravel up to 3/4" dia., no petrol odor
10.5-14	SM	SILTY SAND WITH GRAVEL greenish gray, moist, loose, fine sand, 15% fine gravel up to 3/4" dia., petrol odor 10.5 to 13.5 feet no petrol odor from 13.5-14.0 feet

EOB @ 14 feet bgs.

2" dia. borehole to 12 feet bgs, 1" dia. to 14 feet bgs.

light petroleum sheen on collected grab groundwater samples.

Clayton Group Services	Project No.: 70-03365.04 Client: GCL Location: Oakland/Emeryville Logged By: P. McLaughlin	BORING NO. B-6
LOG OF SOIL BORING	Start Date: 2/10/2005 Start Time: 1255 Elevation: N/A Finish Date: 2/10/2005 Finish Time: 1325 Boring Dia.: 2"/1"	
	Driller: ECA Drill Method: Direct Push Hammer Weight: N/A Drop: N/A	
	Borehole Completion Data: Borehole Grouted	

SAMPLE RECOVERY (in)	SAMPLE ID.	PID READING (ppm)	TIME	DEPTH (ft)	USCS	DESCRIPTION
			1255	0–2	ML	CLAYEY SILT dark brown, damp, soft, low plastic, trace fine gravel up to 1/2" dia., organic debris/rootlets
47	3.5	0.0	1305	2–7	SM	SILTY SAND light brown, moist, loose, fine sand, organic debris/rootlets becomes wet at 6.0 feet (perched groundwater)
29	7.5	1.4	1310	7–10.5	CL	SILTY CLAY dark brown, moist, stiff, medium plastic, organic debris/rootlets groundwater depth 9.0 feet, 1335, 2/10/2005
		0.2 36		10.5–11.75	CL	SILTY CLAY tan, moist, medium stiff, medium plastic, trace fine gravel up to 1/2" dia., no petrol odor
30	11.5	213	1315			
24	13.5	311	1320	11.75–15.25	ML	CLAYEY SILT WITH GRAVEL greenish gray, moist, medium stiff, non-plastic, 15% fine gravel up to 1/2" dia., petrol odor 11.0 to 15.25 feet becomes wet at 15.25 feet
14		334	1325	15.25–16	ML	CLAYEY SILT dark brown, wet, very soft, medium plastic, petrol odor from 15.25 to 16.0 feet

EOB @ 16 feet bgs.

2" dia. borehole to 12 feet bgs, 1" dia. to 16 feet bgs.

APPENDIX I-B

ENGINEER'S ESTIMATES

OAK WALK REDEVELOPMENT PROJECT

ENGINEER'S ESTIMATE FOR CORRECTIVE ACTION

Summary of Estimated Costs

Task	Total Estimated Cost $
Task 1 - Regulatory Fees, Consultations and Interface	7,100
Task 2 - Corrective Action Plan	18,800
Task 3 - Close Temporary Groundwater-quality Monitoring Wells	10,000
Task 4 - Exploratory Trenching	9,650
Task 5 - Construct Grout Curtains	73,200
Task 6 - Extraction of Contaminated Groundwater	60,200
Task 7 - Excavate and Stockpile Clean Overburden	27,100
Task 8 - Excavate and Dispose Contaminated Soil	218,500
Task 9 - Engineering Oversight and Confirmation Sampling in Remedial Excavation	24,600
Task 10 - Backfill Below-water Excavations with No Fines Concrete and Rock	165,000
Task 11 - Place Clean Stockpiled Soil in Remedial Excavation as Engineered Backfill	46,700
Task 12 - Import and Compact Low-permeabily Soil in Remedial Excavation to Complete Site Restoration	12,700
Task 13 - Soil Gas Survey	11,500
Task 14 - Impermeable Barrier Beneath Occupied Structures	71,200
Task 15 - Post-remediation Installation of Groundwater-quality Monitoring Wells	26,000
Task 16 - Well Head Survey	3,550
Task 17 - First Post-remediation Groundwater-quality Evaluation	6,800
Task 18 - Prepare Corrective Action Report	12,300
Task 19 - Quarterly Post-Remediation Groundwater-quality Monitoring.	32,000
Task 20 - Site Closure Activities	15,650
Task 21 - Preparation of Deed Restriction	1,100
TOTAL ESTIMATED COST	**$853,650**

OAK WALK REDEVELOPMENT PROJECT

ENGINEER'S ESTIMATE FOR CORRECTIVE ACTION

Estimate Breakdown by Task

Task 1 - Regulatory Fees, Consultations and Interface

Scope: Prepare for and attend meetings with regulatory agency staff, prepare documents in response to regulatory agency requests and pay regulatory agency oversight fees.

Item	No.	Units	Unit Rate	Extension
			$	$
Senior Engineer	16	Hours	95.00	1,520.00
Technician	4	Hours	45.00	180.00
Word Processor	3	Hours	35.00	105.00
Draftsperson	4	Hours	45.00	180.00
Field Vehicle	2	Day	35.00	70.00
Miscellaneous Expenses	1	Lot	50.00	50.00
10% of Engineer's Direct Costs	1	Lot	5.00	5.00
Regulatory Oversight Fee	1	Lot	5000.00	5,000.00
Subtotal Task 1 - Regulatory Consultations and Interface				**$7,110.00**

Task 2 - Corrective Action Plan

Scope: Prepare Corrective Action Plan, including pre-remediation risk-based health assessment and submit to regulatory agencies

Item	No.	Units	Unit Rate	Extension
			$	$
Senior Engineer	24	Hours	95.00	2,280.00
Engineer	100	Hours	80.00	8,000.00
Technician	60	Hours	45.00	2,700.00
Draftsperson	85	Hours	45.00	3,825.00
Word Processor	20	Hours	35.00	700.00
RBCA Analysis Software Fee	1	No.	70.00	70.00
Report Reproduction	1	Lot	1000.00	1,000.00
Miscellaneous Expenses	1	Lot	120.00	120.00
10% of Engineer's Direct Costs	1	Lot	112.00	112.00
Subtotal Task 2 - Corrective Action Plan				**$18,807.00**

Task 3 - Close Temporary Groundwater-quality Monitoring Wells

Scope: Close 14 20 ft. deep groundwater-quality monitoring wells under permit and oversight of Alameda County Public Works Agency. Prepare and submit Well Closure Reports to California Department of Water Resources and Alameda County Public Works Agency

Item	No.	Units	Unit Rate	Extension
			$	$
Engineer	10.00	Hrs.	80.00	800.00
Junior Technician	14.00	Hrs.	40.00	560.00
Field Vehicle	1	Day	35.00	35.00
Alameda County Public Works Agency Perm Well Closure Permit Fee	14	No	300.00	4,200.00
Drilling Contractor's Mobilization	1	Days	300.00	300.00
Pressure Grout 3/4 in.Dia. 20 ft deep Well C	14	No	220.00	3,080.00
Miscellaneous Expenses	1	Lot	250.00	250.00
10% of Engineer's Direct Costs	1	Lot	758.00	758.00
Subtotal Task 3 - Close Temporary Groundwater-quality Mor				**$9,983.00**

Task 4 - Exploratory Trenching

Scope: Open exploratory trenches to improve definition of alignment of sand and gravel filled paleo stream beds. Develop geological logs of trenches. **Note:** Costs of contarctors mobilization is included in contaminated soil and backfilling trench included in Tasks 8, 10 ,11 and 12.

Item	No.	Units	Unit Rate	Extension
			$	$
Excavator (Operated)	3	Day	1,180.00	3,540.00
Technician (Contractor)	24	Hrs.	45.00	1,080.00
Engineer	24	Hrs.	80.00	1,920.00
Draftsperson	12	Hrs.	45.00	540.00
Field Vehicle	2	Day	35.00	70.00
Disposable Bailer	6	No.	6.73	40.38
Field Sampling Kit	2	Day	10.00	20.00
Electrical Sample Cooler	2	Day	2.00	4.00
TPH (d) and TPH (ms) in Water	6	No.	70.00	420.00
TPH (g), BTEX, Fuel Oxyg., DCA and EDB I	6	No.	110.00	660.00
TPH (d) and TPH (ms) in Soil	9	No.	70.00	630.00
TPH (g) and BTEX in Soil	9	No.	65.00	585.00
Electronic Geotracker Data File	2	No.	25.00	50.00
Miscellaneous Expenses	1	Lot	25.00	25.00
10% of Engineer's Direct Costs	1	Lot	36.50	36.50
Subtotal Task 4 - Exploratory Trenching				**$9,620.88**

Task 5 - Construct Grout Curtains

Scope: Construct grout curtains to cut off flow through paleo stream beds. Grout curtains 30 ft deep by 3 ft. wide.

Item	No.	Units	Unit Rate	Extension
			$	$
Engineer	32	Hrs.	80.00	2,560.00
Field Vehicle	3	Day	35.00	105.00
Grout Curtain Wall 30 ft Deep 3 ft Wide Portald Cement Type II grout	220	Lin. Ft.	320.00	70,400.00
Miscellaneous Expenses	1	Lot	100.00	100.00
10% of Engineer's Direct Costs	1	Lot	10.00	10.00
Subtotal Task 5 - Construct Grout Curtains				**$73,175.00**

Task 6 - Extraction of Contaminated Groundwater

Scope: Open groundwater extraction ponds, pump contaminated water into vacuum trucks by skimming from water surface. Ship contaminated water to permitted facility for treatment. **Note:** Costs of excavation and backfilling of ponds are included in Tasks 7, 8, 10, 11 and 12.

Item	No.	Units	Unit Rate	Extension
			$	$
Technician (Contractor)	8	Hrs.	45.00	360.00
Engineer	8	Hrs.	80.00	640.00
Field Vehicle	3	Day	35.00	105.00
Mobiloze/Demobilize 20,000 Gallon Transpc	6	Lot	270.00	1,620.00
20,000 Gallon Transportable Tank	3	Per Montl	900.00	2,700.00
Trash Pump	1	Per Montl	1,000.00	1,000.00
Flexible Hose (100 ft) and Fittings	1	Per Month	400.00	400.00
Disposal of Contaminated Groundwater with No Suspeded Solids	34,000	Gallon	0.85	28,900.00
Disposal of Contaminated Groundwater with 2% suspeded Solids	6,000	Gallon	3.50	21,000.00
Vaccum Truck (Operated)	40	Hr	85.00	3,400.00
Miscellaneous Expenses	1	Lot	25.00	25.00
10% of Engineer's Direct Costs	1	Lot	2.50	2.50
Subtotal Task 6 - Extraction of Contaminated Water				**$60,152.50**

Task 7 - Excavate and Stockpile Clean Overburden

Scope: Excavate clean overburden soil from area where contaminated soil is to be removed and stockpile on site for reuse, including field engineering oversight.

Item	No.	Units	Unit Rate	Extension
			$	$
Engineer	32	Hrs.	80	2,560.00
Field Vehicle	6	Day	35.00	210.00
Excavate and Stockpile Clean Soil	4,880	cu yds	5.00	24,400.00
Subtotal Task 7 - Excavate and Stockpile Clean Overburden				**$27,170.00**

Task 8 - Excavate and Dispose Contaminated Soil

Scope: Excavate contaminated soil, ship off-site and dipose at a permitted facility. Cut off and cap sewer lines at property boundary and place clay to seal sewer trench backfill. **Note:** Engineering oversight is included in Task 9 below.

Item	No.	Units	Unit Rate	Extension
			$	$
Contractors Mobilization/Demobilization	1	Lot	3,600.00	3,600.00
Install Rock Washdown Pad	1	Lot	3,600.00	3,600.00
Straw Runoff Control Wattles	500	Lin Ft.	1.00	500.00
Excavate and Load Contaminated Soil	3,554	cu yds	4.00	14,216.00
Truck Contaminated Soil to Disposal Facility	5,700	ton	17.00	96,900.00
Disposal Fee (including taxes)	5,700	ton	16.78	95,646.00
Cut off cap and seal sewer lines.	8	No.	500.00	4,000.00
Subtotal Task 8 - Excavate and Dispose Contaminated Soil				**$218,462.00**

Task 9 - Engineering Oversight and Confirmation Sampling in Remedial Excavation

Scope: Engineering oversight of remedial excavation and sampling of soil in floor of remedial excavation. Laboratory analysis of samples. Reduce, tabulate and analyze laboratory data.

Item	No.	Units	Unit Rate	Extension
			$	$
Engineer	48	Hrs.	80	3,840.00
Junior Technician	120	Hrs.	40	4,800.00
Field Vehicle	13	Day	35.00	455.00
Engineering Level	13	Day	27.50	357.50
Levelling Staff	13	Day	5.00	65.00
Environmental Sampling Kit	13	Day	10.00	130.00

Electric Sample Cooler	13	Day	2.00	26.00
TPH (d) + Mineral Spirits in Soil (Accelerated	20	No.	140.00	2,800.00
TPH (g) plus BTEX in Soil (Accelerated TAT	20	No.	130.00	2,600.00
TPH (d) + Mineral Spirits in Soil	55	No.	70.00	3,850.00
TPH (g) plus BTEX in Soil	55	No.	65.00	3,575.00
Geotracker File Fee	20	No.	25.00	500.00
Miscellaneous Expenses	1	Lot	250.00	250.00
10% of Engineer's Direct Costs	1	Lot	1,357.50	1,357.50
Subtotal Task 9 - Confirmation Sampling in Remedial Excava				**$24,606.00**

Task 10 - Backfill Below-water Excavations with No Fines Concrete and Rock

Scope: Procure and import 6-in.to 3-in., sieve-size, no-fines crushed rock, place in excavations and compact with vibratory roller.

Item	No.	Units	Unit Rate $	Extension $
Engineer	16	Hrs.	80	1,280.00
Field Vehicle	5	Day	35.00	175.00
Broken Concrete 4 in to 6 in no fines (delivei	2300	tons	13.00	29,900.00
Rock 2 in. to 4 in No Fines (Deliverd)	4040	tons	30.00	121,200.00
Place Concrete and Rock in Excavations and Compact.	2500	cu. yds	5.00	12,500.00
Subtotal Task 10 - Backfill Below-water Excavations with Ro				**$165,055.00**

Task 11 - Place Clean Stockpiled Soil in Remedial Excavation as Engineered Backfill

Scope: Remove claen soil from stockpile, place in remedial excavations and compact as enginered fill to 95% relative density. **Note:** Soil measure is compacted cubic yards in situ.

Item	No.	Units	Unit Rate $	Extension $
Engineer	16	Hrs.	80	1,280.00
Field Inspector (Nuclear gauge included)	30	Hrs.	75	2,250.00
Word Processor	4	Hrs.	30	120.00
Field Vehicle	5	Day	35.00	175.00
Compaction Curve	3	No	200.00	600.00
Constant Head Permeability Test	2	No	300.00	600.00
Remove Soil from Stockpile and place in excavations (bulk yards)	4,880	cu. yds	4.00	19,520.00
Compact Soil to 95 % relative compaction. (in situ yards)	4,880	cu. yds	4.50	21,960.00
Miscellaneous Expenses	1	Lot	50.00	50.00
10% of Engineer's Direct Costs	1	Lot	125.00	125.00
Subtotal Task 11 - Place Clean Stockpiled Soil in Remedial E				**$46,680.00**

Task 12 - Import and Compact Low-permeabily Soil in Remedial Excavation to Complete Site Restoration

Scope: Procure and import claen low-permeability soil suitable for use as engineered fill and place and compact fill material in remedial excavations

Item	No.	Units	Unit Rate	Extension
			$	$
Engineer	8	Hrs.	80	640.00
Field Inspector (Nuclear gauge included)	16	Hrs.	75	1,200.00
Word Processor	4	Hrs.	30	120.00
Field Vehicle	4	Day	35.00	140.00
Compaction Curve	2	No	200.00	400.00
Constant Head Permeability Test	2	No	300.00	600.00
Imported Soil (delivered)	610.00	cu. yds	8.00	4,880.00
Compact Soil to 95 % relative compaction.	610.00	cu. yds	7.50	4,575.00
Miscellaneous Expenses	1	Lot	50.00	50.00
10% of Engineer's Direct Costs	1	Lot	105.00	105.00
Subtotal Task 12 - Import and Place Claen Imported Soil in R				**$12,710.00**

Task 13 - Soil Gas Survey

Scope: Obtain soil gas samples from 10 locations, analyses samples and reduce and tabulate data.

Item	No.	Units	Unit Rate	Extension
			$	$
Engineer	20.0	Hrs.	80	1,600.00
Technician	4.0	Hours	45.00	180.00
Field Vehicle	2	Day	35.00	70.00
Drill at Soil Gas Sampling Location	10	No.	270.00	2,700.00
Gas Cylinder	20	No.	50.00	1,000.00
Gas Regulator	20	No.	75.00	1,500.00
Gas Analyses (15 EPA 8260 Organic Volatile Compounds)	20	No.	175.00	3,500.00
Miscellaneous Expenses	1	Lot	50.00	50.00
10% of Engineer's Direct Costs	1	Lot	875.00	875.00
Subtotal Task 13 - Soil Gas Survey				**$11,475.00**

Task 14 - Impermeable Barrier Beneath Occupied Structures

Scope: Install Liquid Boot, or equivalent, impermeable benzene-resistant barrier beneath floor slabs of s

Item	No.	Units	Unit Rate	Extension
			$	$
Engineer	20	Hrs.	80	1,600.00
Field Vehicle	10	Day	35.00	350.00
Contactor's Mobilization	3	Lot	500.00	1,500.00
Impermeable Barrier (installed)	21,000	Sq. ft .	3.20	67,200.00
Miscellaneous Expenses	1	Lot	500.00	500.00
10% of Engineer's Direct Costs	1	Lot	50.00	50.00
Subtotal Task 14 - Impermeable Barrier Benath Occupied Str				**$71,200.00**

Task 15 - Post-remediation Installation of Groundwater-quality Monitoring Wells

Scope: Install 2 in diameter groundwater-quality monitoring wells log borings and sample and analyse soil at 5 ft intervals prepare well logs.

Item	No.	Units	Unit Rate	Extension
			$	$
Engineer	20	Hrs.	80	1,600.00
Technician	8	Hours	45.00	360.00
Draftsperson	24	Hours	45.00	1,080.00
Field Vehicle	2	Day	35.00	70.00
Drilling Contractor's Mobilization	2	Lot	500.00	1,000.00
Asphalt/Concrete Sawing for Well Vault	7	No.	50.00	350.00
Drill for and Install 15 ft. Deep 2.0 in. Dia. W	1	No.	600.00	600.00
Drill for and Install 20 ft. Deep 2.0 in. Dia. W	8	No.	760.00	6,080.00
Drill for and Install 25 ft. Deep 2.0 in. Dia. W	1	No.	850.00	850.00
Heavy Duty Well Head Vault (installed in pav (2 in. dia. Well)	7	No	125.00	875.00
TPH (d) + Mineral Spirits in Soil	40	No.	70.00	2,800.00
TPH (g) plus BTEX in Soil	40	No.	65.00	2,600.00
Geotracker Data Fee	3	No.	25.00	75.00
Develop 15 ft. Deep 2.0 in. Dia. Well	1	No	175.00	175.00
Develop 20 ft. Deep 2.0 in. Dia. Well	5	No	200.00	1,000.00
Develop 25 ft. Deep 2.0 in. Dia. Well	7	No	225.00	1,575.00
55 Gallon Drums	10	No	50.00	500.00
Dispose of Drill Cuttings	5	ton	50.00	250.00
Dispose of Development Water	600	gal.	3.50	2,100.00
10% of Engineer's Direct Costs	1	Lot	2,083.00	2,083.00
Subtotal Task 15 - Soil Borings and Monitoring Well Installat				**$26,023.00**

Task 16 - Well Head Survey

Scope: Survey of latitide, longitude and elevation of groundwater-quality monitoring wells to comply with State Water Resources Control Board regulations.

Item	No.	Units	Unit Rate	Extension
			$	$
Assistant Engineer	2	Hours	75.00	150.00
Field Vehicle	1	Day	35.00	35.00
California Licensed LS and Party	1	Lot	3000.00	3,000.00
Misc. Exp	1	Lot	50.00	50.00
10% of Engineer's Direct Costs	1	Lot	305.00	305.00
Subtotal Task 16 - Well Head Survey				**3,540.00**

Task 17 - First Post-remediation Groundwater-quality Evaluation

Scope: Sample ground water in 18 monitoring wells, analyse samples and reduce and tabulate analytical results.

Item	No.	Units	Unit Rate	Extension
			$	$
Assistant Engineer	16	Hours	7.00	112.00
Field Technician	16	Hours	45.00	720.00
Technician	8	Hours	45.00	360.00
Field Vehicle	2	Day	35.00	70.00
Groundwater Depth Meter	1	Day	25.00	25.00
Submersible pump	2	Day	25.00	50.00
pH/Temp./Conductivity Meter	2	Day	50.00	100.00
Disposable Bailer	15	No.	6.73	100.95
Electrical Sample Cooler	2	Day	2.00	4.00
TPH (d) amd TPH (ms) in Water	15	No.	90.00	1,350.00
TPH (g), BTEX, Fuel Oxyg., EDB and EDC I	15	No.	150.00	2,250.00
Electronic Geotracker Data File	2	No.	3.00	6.00
Monitoring Report Reproduction	6	No.	20.00	120.00
Disposal of Purge Water	300	gal.	3.00	900.00
Misc. Expenses	1	No.	150.00	150.00
10% of Engineer's Direct Costs	1	Lot	488.10	488.10
Subtotal Task 17 - First Post-remediation Groundwater-quali				**6,806.05**

Task 18 - Prepare Corrective Action Report

Scope: Prepare Corrrective Action Report, including post-remediation risk-based health assessment and submit to regulatory agencies.

Item	No.	Units	Unit Rate $	Extension $
Senior Engineer	16	Hours	95.00	1,520.00
Engineer	80	Hours	80.00	6,400.00
Technician	32	Hours	45.00	1,440.00
Draftsperson	26	Hours	45.00	1,170.00
Word Processor	15	Hours	35.00	525.00
RBCA Analysis Software Fee	1	No.	70.00	70.00
Report Repoduction	1	Lot	1000.00	1,000.00
Miscellaneous Expenses	1	Lot	50.00	50.00
10% of Engineer's Direct Costs	1	Lot	105.00	105.00
Subtotal Task 18 - Corrective Action Report				**$12,280.00**

Task 19 - Quarterly Post-Remediation Groundwater-quality Monitoring.

Scope: Conduct three quarterly groundwater-quality monitoring round and report results in letter reports to regulatory agency.

Item	No.	Units	Unit Rate $	Extension $
Round of groundwater-quality monitoring for 18 groundwater-quality Monitoring wells (See Task 17 for sampling and analysis cost breakdown)	4	No	6,806.05	27,224.18
Engineer	18	Hours	80.00	1,440.00
Technician	15	Hours	45.00	675.00
Draftsperson	21	Hours	45.00	945.00
Word Processor	15	Hours	35.00	525.00
Report Repoduction	1	Lot	1000.00	1,000.00
Miscellaneous Expenses	1	Lot	50.00	50.00
10% of Engineer's Direct Costs	1	Lot	105.00	105.00
Task 19 - Quarterly Post-Remediation Groundwater-qu				**$31,964.18**

Task 20 - Site Closure Activities

Scope: Close 18 20-ft. deep groundwater-quality monitoring wells under permit and oversight of Alameda County Public Works Agency. Prepare and submit Well Closure Reports to California Department of Water Resources and Alameda County Public Works Agency.

Item	No.	Units	Unit Rate	Extension
			$	$
Engineer	24	Hrs.	80.00	1,920.00
Technician	16	Hrs.	40.00	640.00
Junior Technician	24	Hrs.	40.00	960.00
Draftsperson	6	Hrs.	45.00	270.00
Field Vehicle	2	Day	35.00	70.00
Alameda County Public Works Agency Perm Well Closure Permit Fee	18	No	300.00	5,400.00
Drilling Contractor's Mobilization	2	Days	300.00	600.00
Pressure Grout 2 in.Dia. 20 ft deep Well Cas	18	No	260.00	4,680.00
Miscellaneous Expenses	1	Lot	50.00	50.00
10% of Engineer's Direct Costs	1	Lot	1,068.00	1,068.00
Subtotal Task 20 - Site Closure Activities				**$15,658.00**

Task 21 - Preparation of Deed Restriction

Scope: Negotiate terms of deed restriction with ACEHCS and incorprate into deeds for individual commercial and residential units

Item	No.	Units	Unit Rate	Extension
			$	$
Legal Fees	1	Lot	1,100.00	1,100.00
Subtotal Task 21 - Preparation of Deed Restriction				**$1,100.00**

TOTAL FOR CORRECTIVE ACTION **$853,577.61**

APPENDIX I-C

SITE-SPECIFIC HEALTH AND SAFETY PLAN

THE SAN JOAQUIN COMPANY INC.
1120 HOLLYWOOD AVENUE, SUITE 3, OAKLAND, CALIFORNIA 94602

PROJECT-SPECIFIC HEALTH AND SAFETY PLAN

for

Remediation of the Oak Walk Redevelopment Site
Emeryville, California

Prepared for:

BAYROCK RESIDENTIAL

July 2006

Project No. 0004.085

TELEPHONE: OAKLAND, CALIFORNIA (510) 336-9118 TRACY, CALIFORNIA (209) 832-2910

PROJECT-SPECIFIC HEALTH AND SAFETY PLAN

Project Name: Remediation of the Oak Walk Redevelopment Site

Project No.: 0004.085

Client: Bay Rock Residential, LLC

Project Manager: H. B. Dietz , REA II
The San Joaquin Company Inc.

Project Location: 40th Street and San Pablo Avenue, Emeryville, California.

Project Description:

Implementation of environmental corrective actions preparatory to the construction of a mixed use commercial and residential development on the subject property, the subsurface of which is affected by fuel hydrocarbons and industrial solvents. The site location and the location of the closest hospital with full-service emergency treatment facilities are shown on Figure 1. Figure 2 is a site plan that shows the area of the site that is to be remediated.

The scope of work includes: excavation of exploratory trenches to extend understanding of the hydrostratigraphy of the site; installation of grout curtains to control groundwater flow; and excavation of groundwater recovery ponds to permit pumping of contaminated groundwater into holding tanks prior to offsite disposal; opening of remedial excavations to remove affected soil from the subsurface and loading and transport of that soil to offsite disposal facilities; restoration of the remedial excavations by backfilling with crushed concrete, rock, and compacted engineered fill; implementation of a soil-gas survey installation of impermeable membranes beneath floor slabs of residential and commercial buildings; installation of groundwater quality monitoring wells; and conduct of an extended groundwater quality monitoring program.

Figure 2 is a site plan that shows the locations of existing structures on the site and the locations of the grout curtains that will be constructed and the excavations that will be made to implement the corrective action program.

All elements of the corrective action program will be performed in accordance with the *Corrective Action Plan for Oak Walk Redevelopment Site, Emeryville, California*, to which this site-specific health and safety plan is an Appendix. This health and safety plan includes by reference The San Joaquin Company's *Master Health and Safety Plan*, a copy of which is on file at Alameda County Environment Health Care Services (**ACEHCS**).

Remediation Contactor

The remediation work will be performed by Dietz Irrigation of Tracy, California, which holds a Class A Contractor's License with Hazardous Waste Endorsement issued by the California State Contractors Licensing Board.

Engineer of Record

The Engineer of Record for the project is D. J. Watkins Ph.D., P.E., REA II of The San Joaquin Company Inc. of Tracy and Oakland, California.

Known Hazards

The principal hazards expected to be encountered on this project are those common to construction work involving excavation using heavy equipment and installation of groundwater monitoring wells using drilling equipment. Underground utilities that presently serve the existing buildings on the site will be disconnected prior to initiation of the work, but if any remain unidentified prior to the initiation of the remediation work they may pose a hazard to personal engaged in work in the underground. Low to moderate concentrations of components of fuel hydrocarbons and industrial solvents (principally mineral spirits) will be encountered in soil and groundwater beneath the site and will be present in excavated soil.

Construction Hazards

Typical hazards associated with excavation, well-drilling and use of heavy equipment are suffocation or crushing trauma by sidewall failure of unsupported excavations, crushing injuries due to being overrun by machinery, pinching injuries of the extremities, entanglement of extremities and clothing in moving parts, drilling rigs or heavy machinery, exposure to noise from machinery, tripping hazards, and strains due to lifting heavy objects.

Chemical Hazards

Soil and groundwater in the subsurface beneath the subject property is known to be contaminated by low to moderate concentrations of components of gasoline, diesel and industrial solvents which are predominantly mineral spirits. These mixtures of hydrocarbon compounds contain components that are known human carcinogens. They also contain compounds that may injure human respiratory, hepatic, renal and central nervous system functions. If there is exposure to high concentrations of the components' vapors for long periods, dermal and eye injuries can also be sustained, especially if contact is made with the compounds in liquid form or with waste materials that are highly saturated with these materials.

Based on currently available information the highest concentration of mineral spirits in soil beneath the site is 190 mg/Kg, the highest concentration of diesel-range compounds is 1,200 mg/Kg, and the highest concentration of gasoline-range compounds is 36,000 mg/Kg. The gasoline includes the component benzene which is a known human carcinogen at a maximum concentration of 13 mg/Kg. Components of gasoline that are known to be toxic to humans include ethyl benzene, toluene and xylene isomers. Those compounds have been detected in soil beneath the Oak Walk Site at the following maximum concentration: ethyl benzene has a maximum concentration of 80 mg/Kg; toluene has a maximum concentration of 140 mg/Kg; and xylene isomers have a maximum concentration of 430 mg/Kg. The maximum concentrations of those chemicals of concern that have been detected in groundwater at the site are: Mineral Spirits, 3500 μg/L; diesel-range compounds, 2300 μg/L; gasoline-range compounds, 56,000 μg/L; benzene, 7099 μg/L; ethyl benzene, 1200 μg/L; toluene, 2100 μg/L; and xylene isomers, 8300 μg/L.

Specific Health and Safety Requirements

The work required for this project is not known to involve special hazards beyond those covered by the standard requirements of The San Joaquin Company Inc.'s (**SJC**) *Master Health and Safety Plan*, which is incorporated herein by reference. All work will be conducted in compliance with the applicable policies, safety rules and safe working practices set out in that Master Plan. However, for emphasis, the following specific requirements are cited.

<u>Site Access Control</u>

A chain link fence, 6 ft. in height, with lockable gates, shall secure the work site at all times until the project is completed.

No personnel, other than workers directly engaged in the remediation work or authorized representatives of the project engineers, the property owners or concerned regulatory agencies, shall be permitted to enter the property while the work is in progress. All visitors shall comply with the applicable requirements of SJC's *Master Health and Safety Plan.*

<u>Safety in and Around Excavations</u>

It is intended that this project be completed without need for personnel to enter any excavation except when it is less than 5 five feet deep. Under no circumstances shall personnel be permitted to enter any excavation that is deeper than five feet, as measured at any side wall, unless the excavation has been shored in compliance with California Occupations Safety and Health Administration (**Cal-OSHA**) regulations or one or more of the following have been implemented and the project engineer in responsible charge of the work has approved the methods used.

1) All walls of the excavation have been sloped back at an angle approved by the engineer in responsible charge of the work.

2) The side walls of the excavation are supported by an engineered shoring system designed for the specific site and geotechnical conditions has been approved by the project engineer.

3) Personnel entering the excavation are protected by a steel trench-box that has been specifically designed and manufactured for that purpose and attached to an excavator or other earth-moving equipment.

4) No excavated soil, spoil or other material shall be stockpiled within five feet of the edge of any excavation. Except when being worked, all excavations deeper than one and one half feet shall be isolated by barricades connected by yellow caution tape.

<u>Protective Clothing and Equipment</u>

Based on the hazards known to be present, personal protective equipment requirements for this project correspond to Level D as that level of protection is defined in the San Joaquin Company's *Master Health and Safety Plan*.

The following clothing and protective equipment will be used by personnel engaged in the work.

- A hard hat compliant with the American National Standards Institute (**ANSI**) specifications for class C type I or type II.

- Steel-toed boots.

- Safety glasses when performing any operation in which a hazard to the eyes exists (*e.g.* welding, cutting, burning, sandblasting, drilling, grinding or hammering).

- Strong, non-slip gloves.
  (Note: Gloves need not be worn when no identified risk to the hands exists, or when wearing gloves could cause a greater risk.)

- Lightweight cotton or cotton and synthetic fiber work shirt and pants.
  (Note: Neckties, scarves or any loose clothing that could become caught in machinery will not be permitted.)

<u>Upgrade of Protective Clothing and Equipment</u>

If during the progress of the work, the presence of any contaminant is found in the subsurface or detected in the air of a type or concentration that would require, or is suspected to require, a higher level of personal protection than is specified above, all work will be halted, all personnel withdrawn and the site shall be secured until the requisite level of protection has been determined in accordance with The San Joaquin Company's *Master Health and Safety Plan.* Similarly, if any other adverse condition on the site becomes evident, the protection level will be upgraded so as to provide conservatively designed health protection for all persons engaged in the work.

Sanitary Facilities

Portable toilet facilities will be provided on the site that will include facilities for hand washing.

Emergency Services

The telephone numbers of services and persons to call in case of emergency are listed below. Use the following address when calling for emergency services.

Job Site: Oak Walk Redevelopment Site on the east side of San Pablo Avenue between 40th and 41st street, Emeryville, Alameda County, California

Telephone locations:

1. Dietz Irrigation's on-site cellular telephone. Tel. No. (209) 482-7769
2. The San Joaquin Company's on-site cellular telephone. Tel. No. (510) 520-6367
3. At any of several businesses across San Pablo Avenue from the site.

Emergency Telephone Numbers

Fire:	911
Paramedic: (Ambulance)	911
Police:	911
Hospital	(510) 869-6600

Hospital:

Summit Medical Center
350 Hawthorne St.
Oakland, CA
Note: Emergency Room Entrance is on 34th Street
(See Figure I for location)

Emergency:	(510) 869-6600
Non Emergency:	(510) 655-4000

Utility Services:

Pacific Gas & Electric:	(800) 743-5000
East Bay Municipal Utility District: (Municipal Water Supply and Sewers)	(510) 835-3000
City of Emeryville Sewer System (Emergency Number and After Hours)	(510) 596-3700

City of Emeryville:

Public Works Department/City Engineer:	(510) 596-4332
Fire Department:	(510) 596-3753
Police Department:	(510) 596-3700

The San Joaquin Company Inc. (Project Engineers)**:**

Oakland Office: (510) 336-9118

Engineer of Record: Dai Watkins, Ph.D., P.E.

Direct Line:	(510) 336-1772
Cell Phone:	(510) 520-6367
Fax:	(510) 336-9119

Dietz Irrigation (Remediation Contractor):

Tracy Office: (209) 832-2910

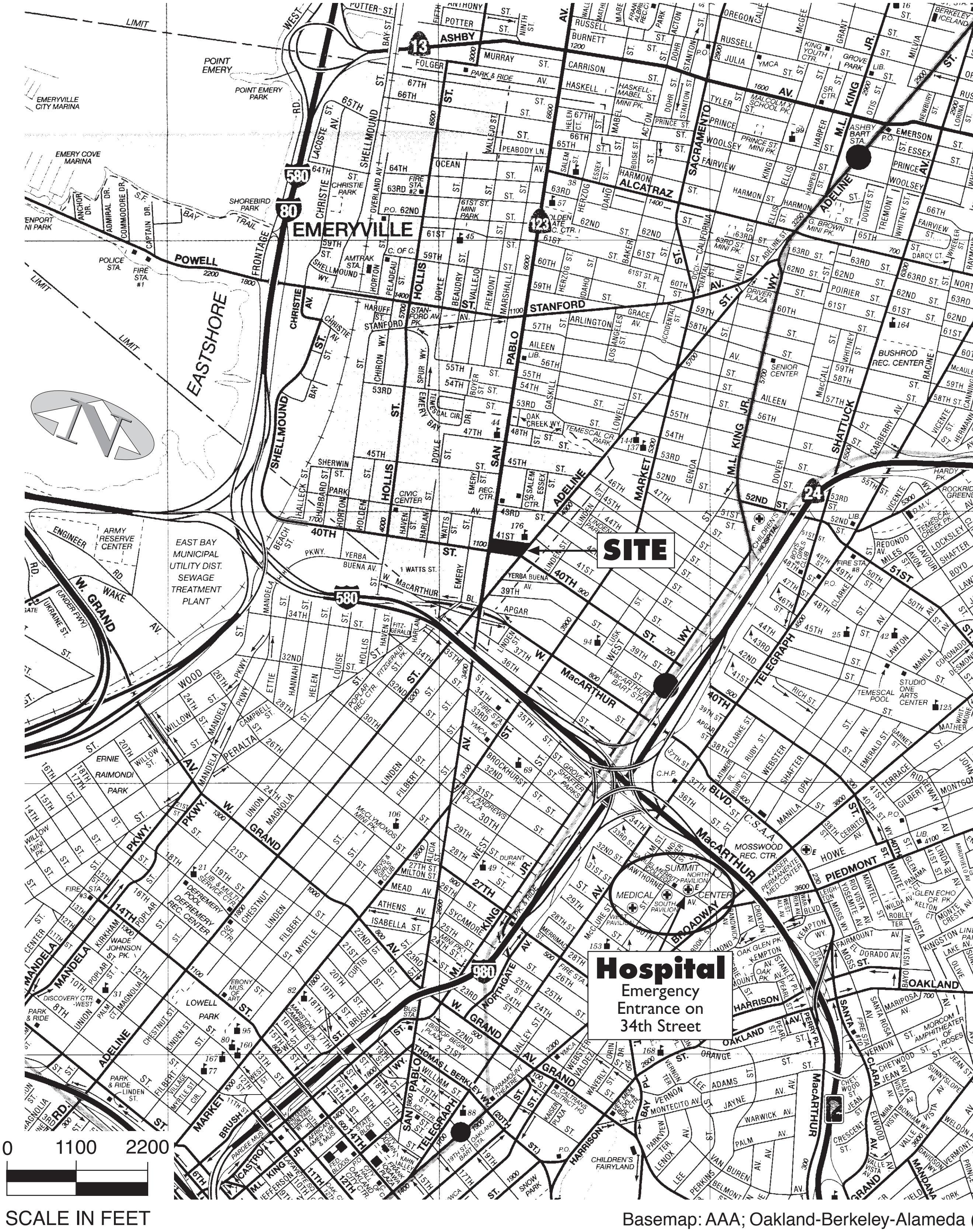
Superintendent: Bernie Dietz, REA II

Direct Line:	(209) 832-2910
Cell Phone:	(209) 482-7769
Fax:	(209) 833-1288

Alameda County Environmental Health Care Services

Case Officer: Barney Chan, REHS

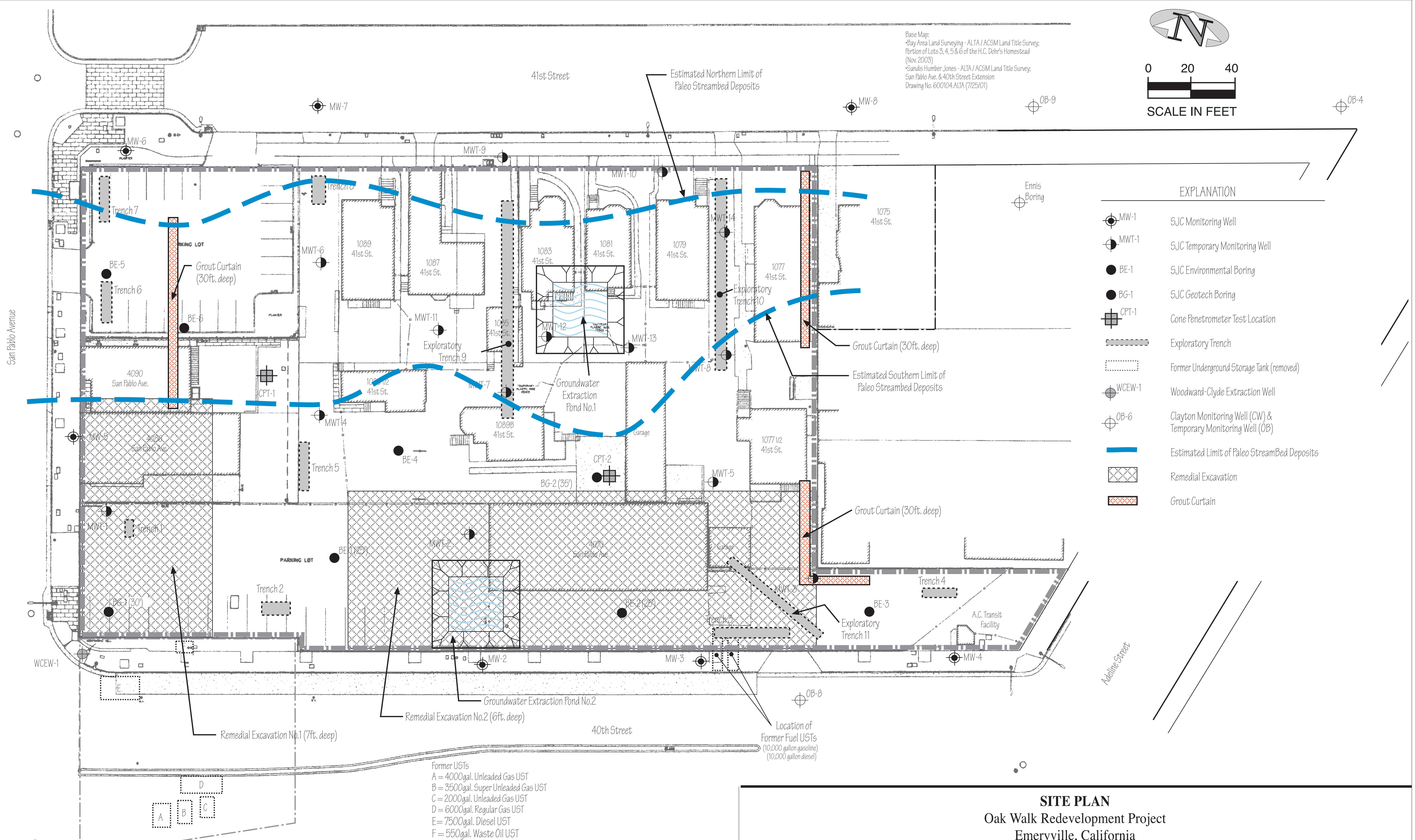
Direct Line: (510) 567-6765



Basemap: AAA; Oakland-Berkeley-Alameda (12/02)

SITE LOCATION
Oak Walk Redevelopment Project
Emeryville, California

FIG 1	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM — Date: 06/26/06



SITE PLAN
Oak Walk Redevelopment Project
Emeryville, California

FIG 2	The San Joaquin Company Inc.	Project Number: 0004.084 Drawn by: GNM Date: 06/20/06

THE SAN JOAQUIN COMPANY INC.
1120 HOLLYWOOD AVENUE, SUITE 3, OAKLAND, CALIFORNIA 94602

CORRECTIVE ACTION PLAN

Oak Walk Redevelopment Site
Emeryville, California

for

BAYROCK RESIDENTIAL

July 2006

Project No.: 0004.085

VOLUME II of II
Pre-remediation Tier II Health Risk Assessment

TELEPHONE: OAKLAND, CALIFORNIA (510) 336-9118 TRACY, CALIFORNIA (209) 832-2910

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VOLUME II - PRE-REMEDIATION TIER 2 HEALTH RISK ASSESSMENT

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FIGURES

APPENDICES

1.0 INTRODUCTION

This document is Volume II of the *Corrective Action Plan - Oak Walk Redevelopment Project, Emeryville, California,* which consists of two volumes. This volume presents the Pre-remediation Tier 2 Health Risk Assessment for the subject property performed by The San Joaquin Company Inc. (**SJC**) in compliance with the requirements of the American Society for Testing and Materials (**ASTM**) Standard E1739-95, Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (American Society for Testing and Materials 2002).

It is intended that both Volumes I and II of this Corrective Action Plan be read as a whole. Accordingly, the pre-remediation health risk assessment presented in this volume should be read in conjunction with the technical data and information presented in Volume I. However, to comply with the requirements of ASTM Standard E-1739095, this volume includes sections that address site description and history, site ownership and use, anticipated future use, and other material specified for inclusion by that Standard as well as a technical presentation of the risk assessment procedure employed and the results of that assessment.

1.1 Site Description and History

The location of the subject property is shown on Figure II-1. Figure II-2 is a site plan showing the property with the structures and infrastructure that are currently extant on the site. Figure II-3 is the architect's drawing showing a plan view of the ground floor elevations of the development that is planned for the property.

1.1.1 Site North

As is shown on Figures II-1 and II-2, true north at the Oak Walk Site is slightly to the west of the center line of Adeline Street, which runs along the eastern side of the city block on which the Oak Walk property is located. However, to simplify discussion, in this report we have established a "Site North" that parallels the alignment of San Pablo Avenue, which runs along the western side of the property. Unless otherwise stated, or in cases where true north is shown on drawings, all compass directions referenced in this document should be interpreted in the context of that directional construct.

1.1.2 20th Century History

By the early years of the 20th Century the Oak Walk Redevelopment Site was fully occupied by residential structures with some minor commercial buildings that included a restaurant fronting onto San Pablo Avenue. The residential structures were single-family homes on large lots with stables and other auxiliary buildings.

By 1911, the residential sites that were formerly adjacent to the Atchison, Topeka and Santa Fe (**AT&SF**) Railroad line that, at that time, followed a route that approximately coincided with what is today the alignment of 40th Street had become areas of open land along the southern frontage of the subject Property. While the residences in the central and northern portions of the site remained in place, by the 1950s those areas of open land in the southern and western portions of the Property were occupied by commercial buildings. These included a wholesale plumbing supply warehouse, which, over the years, was successively converted to use as an upholstery business and a bakery owned by the San Francisco French Bread Company (**SFFBC**). The SFFBC installed two underground fuel storage tanks: a 10,000-gallon gasoline tank and a 10,000-gallon diesel tank in order to fuel their delivery vehicles. The former locations of those tanks, as well as the tank sites at what was a service station site at 4000 San Pablo Avenue (**Celis**), adjacent to the southwest corner of the subject Property, are shown on Figure II-2.

By the 1980s, many of the industrial facilities in western Emeryville had begun to decay and increasingly became idle. In the 1990s, the City of Emeryville through its redevelopment agency, the Emeryville Redevelopment Agency (**ERDA)**, began an ambitious undertaking to clean up and redevelop former industrial areas of the City and other tracts where commercial and residential properties had become rundown. Included in that redevelopment program was construction of a major new thoroughfare formed by extending 40th Street from its previous termination at Adeline Street westward to the frontage of Interstate 80, which passes along the eastern shore of San Francisco Bay, some 0.85 miles to the west of the Oak Walk Site. The highway construction included the extension of 40th Street from Adeline Street to San Pablo Avenue, for which purpose the City of Emeryville procured the land along the alignment of that extension.

Construction of the extension of 40th Street took land that was previously occupied by the Celis service station that had occupied an area that is today beneath 40th Street at its intersection with San Pablo Avenue. It also took a portion of the land previously occupied by the SFFBC. Subsequent to that highway construction, the commercial building at 4070 San Pablo Avenue and its surrounding yard were purchased by the Oaks Club, which used the building as a carpentry and maintenance shop and has converted the frontage land into a private parking lot. A small area of the Oak Walk Redevelopment Site, located at the corner of Adeline and 40th Street, is owned by ERDA. Since the time that the extension of 40th Street was constructed, it has been used as the site of an Alameda County Transit (**AC Transit**) restroom facility. These extant features of the Oak Walk Redevelopment Site are shown on Figure II-2.

Until it was vacated in early 2005, the commercial building at 4086 San Pablo Avenue was, historically, the site of an upholstery business and, later, a specialty hydraulic hose fitting shop that neither dispensed nor used hydraulic oil or similar liquid material. The latter business also occupied the ground floor of the adjacent building at 4090 San Pablo Avenue, which, as noted previously, had historically been a restaurant. The upper floor of the latter building was occasionally used by the Oaks Club for staff training.

The other structures on the Oak Walk Site are either single or multi-family residential buildings that, with their garages and outbuildings, were originally constructed during the early years of the 20th Century. None of those structures are compliant with modern building codes and are generally in a very dilapidated condition. They are all currently vacant.

1.1.3 Site Hydrogeology

As has been described in Volume I of this document, the stratigraphy of the subsurface beneath the Oak Walk Site is composed of recent sedimentary deposits which are dominated by impermeable clays and silty clays. However, some sandy and silty deposits are interspersed within those facies and paleo-stream bed deposits form high-permeability channels in the subsurface. The channels are clearly delineated in the hydrostratigraphic sections shown on Figures II-5 through II-12 that were developed from the logs of the borings drilled at the locations shown on Figure II-4. These borings were installed as part of the site characterization program conducted on the site in 2003 and 2004. The presence of the channels is also reflected in the groundwater contours shown on Figure II-13 (The San Joaquin Company Inc., 2005).

Over most of the area of the site to a depth of least some 5 to 8 ft., the surficial soils that cover the site are highly impermeable. However, in a few localized areas, except for the presence of a covering of humus and vegetative matter, the permeable facies would be exposed on the ground surface. The locations where this occurs can be seen in the hydrostratigraphic sections with the most prominent being that in the vicinity of Monitoring Well MWT-7 (see Figure II-4 for location), which is readily identifiable by examination of Sections B-B' and F-F' on Figures II-6 and II-10, respectively.

1.2 Site Ownership and Use

With the exception of the small parcel at the intersection of 40th and Adeline Streets that is the site of an AC Transit drivers' restroom (See Figure II-2), the whole of the Oak Walk Site is currently owned by the Oaks Club, a California Limited Partnership (**Oaks Club**), which entity acquired individual parcels of the property over a period of many years. The site of the driver's restroom is owned by ERDA.

The Oak Walk Redevelopment Site is currently occupied by vacant residences of considerable age, three vacant commercial buildings, the AC Transit restroom building built in the 1990s, and parking lots.

1.3 Anticipated Future Use

Bay Rock is planning to redevelop the Oak Walk Site for mixed residential and commercial use. Figure II-3 is an architect's drawing showing a plan view of the proposed construction that is currently being considered for the property. It is anticipated that the proposed redevelopment will be extant on the site for at least the next 30 years. Future uses of the site beyond that time will depend upon City of Emeryville planning policy and any changes in zoning ordinances. However, given the urban setting of the site, it can be anticipated that any future changes in use of the site will be limited to multi-family and/or commercial development.

1.4 Chemicals of Concern in the Subsurface

As was detailed in SJC's Environmental Site Characterization report on the subject property, (The San Joaquin Company Inc. 2005), almost the entire area of the subsurface beneath the Oak Walk Site is affected by chemicals of concern (**COCs**), the sources of which were releases from on- and off-site underground storage tanks. The various tanks had contained fuel hydrocarbons and other petroleum hydrocarbons (dominantly mineral spirits) that were used in paint manufacturing.

The COCs were identified in samples of soil and groundwater recovered from trenches, an array of monitoring wells, and geotechnical and environmental borings drilled on the site. Figure II-4 is a site plan that shows the locations of those wells and borings. Figures II-5 through II-12 are hydrostratigraphic sections drawn through the section lines shown on Figure II-4. Figure II-13 presents groundwater contours derived from depth to groundwater measurements made in the monitoring wells on November 8, 2004.

The depths to groundwater in the wells and water table elevations derived therefrom are presented in Table II-1. The results of the analyses of samples of soil and groundwater recovered from the trenches, wells and borings for organic analytes on the Oak Walk Site are compiled in Tables II-2 and II-3. The results of analyses for heavy metals are presented in Table II-4.

The area of the site affected by gasoline-range hydrocarbons in either soil or groundwater is shown on Figure II-14. The area of the site affected by middle-distillate hydrocarbons (principally diesel fuel and mineral spirits) is shown on Figure II-15. The areas of the site affected by benzene and MTBE components of gasoline fuel are shown on Figures II-16 and II-17, respectively.

Figures II-18, II-19 and II-20 show Isocons (i.e., lines joining points of equal concentration) of gasoline-range hydrocarbons, middle-distillate-range hydrocarbons, and the human carcinogen benzene, respectively, in groundwater.

The COCs in the subsurface beneath the Oak Walk Site and their relationship to the Health Risk Assessment are discussed in more detail in Sections 3.1 and 3.2.

1.5 Sources of Chemicals of Concern

As detailed in Volume I of this report, there are three sources of COC affecting the Oak Walk Site. Their locations are shown on Figure II-21. The industrial solvents (mineral spirits) affecting the site were released at either one or both of the former sites of paint manufacturing facilities, the former Frank Dunne and Boysen Paint sites. As is shown on Figure II-21, those sites are located to the east of the Oak Walk Site, beyond the adjoining Ennis Property and across Adeline Street. The sources of the COCs at those sites were leaking underground storage tanks, and, on the Boysen Paint site, a drainage sump.

The COCs of primary concern to this pre-remediation health risk assessment are the benzene, toluene, ethylbenzene and xylene components of gasoline that were released from underground gasoline storage tanks that were formerly located at the Celis Alliance Service Station (**Celis**), the location of which is, today, beneath 40th Street where it intersects with the eastern side of San Pablo Avenue. To a lesser degree, a contribution to the commingled plume of gasoline fuels in the subsurface beneath the site originated at an underground storage tank (one of a pair - the other having stored diesel) that had been installed by the San Francisco French Bread Company (**SFFBC**) at a location which is today partially beneath the subject property and partially beneath 40th Street. The locations of the Celis and SFFBC tanks are also shown on Figure II-21, and in greater detail on Figure II-2. Releases of diesel fuel from tanks that had been located at the Celis site also contributed to the commingled plume of COCs affecting the Oak Walk Site.

1.6 Tiered Health Risk Screening and Assessment Process

Risk-based environmental assessments address the potential for constituent transport from affected media in the source zone to a point of contact with a human or ecological receptor via one or more exposure pathways that may be present under given circumstances. For the present risk assessment, we are concerned with human receptors. For most sites where remediation is required, the primary exposure pathways of concern to human health are: 1) ingestion of contaminated groundwater; 2) release of contaminants from affected soil to groundwater; 3) ingestion of contaminated soil; 4) direct dermal contact with contaminated soil; and 5) inhalation of vapors released from affected soil and/or groundwater.

Risk assessments are commonly performed using a tiered procedure. At the Tier 1 stage, available information regarding COCs in the subsurface is compared to risk limits developed from generic parameters related to the properties of the COCs, the geotechnical and geochemical properties of the subsurface, the use of the affected site, and the characteristics of the receptors that may be present. Tiered risk assessments are used to screen sites affected by COCs to determine whether the contamination present may be at concentrations sufficient to pose a significant health risk. At the Tier 1 stage, the data regarding geotechnical and geochemical properties of the subsurface may be limited to qualitative data such as the type and thickness of soils, the general groundwater regime, the expected future use of the site, and simple assumptions about the geometry and materials of construction of structures that may be built there. In general terms, if the site is modeled using this type of information and limited data regarding subsurface conditions, the maximum concentrations of one or more COCs that can be present in the affected natural media without risk of a significant deleterious health effect can be assessed without resorting to a more detailed risk analysis process. These limiting concentrations are known as Risk-based Screening Levels (**RBSL**s) (American Society for Testing and Materials 2002).

RBSLs are promulgated by a variety of regulatory agencies that use several alternate nomenclatures. For example, the California Regional Water Quality Control Board- San Francisco Bay Region (**RWQCB**) has set Environmental Screening Levels (**ESL**s) for sites under its jurisdiction in the San Francisco Bay Area (Regional Water Quality Control Board - San Francisco Bay Region 2005). Following the precedent set by the RWQCB, in January 2005 the California Environmental Protection Agency (**Cal/EPA**) promulgated its own compendium of RBSLs which are called California Human Health Screening Levels

(**CHHSL**s) for some chemicals of concern (State of California Environmental Protection Agency January 2005). Based on those agencies' jurisdictions, the applicable RBSLs for an environmental risk analysis for the Oak Walk Site are either the CHHSLs or ESLs, whichever are the more conservative for a given COC.

If the concentrations of COCs at a subject site are less than the applicable RBSLs, the screening process normally permits the site to be used for defined purposes without further evaluation. This is permissible because highly-conservative parametric assumptions and limiting exposures are always assumed when performing a Tier 1 assessment. A finding that a given site has concentrations of COCs present that exceed the RBSLs does not mean that any specified use of the site would be prohibited. Such a finding does, however, indicate that additional, more detailed analysis based on quantitative site-specific data should be performed to determine whether the site could be used for a specified purpose without undue risk to ecological or human health. Such detailed analyses are known as Tier 2 assessments and can be used to assess the maximum permissible concentrations of COCs in natural media at the site. These limiting concentrations are known as Site-specific Target Levels (**SSTL**s) because they are based on site-specific rather than more generalized assessment parameters.

The Tier 2 risk assessment procedure can be used to evaluate the scope of remedial action programs required to render a site free of significant ecological or human health risk as well as to assess the magnitude of any risks that may remain after remediation is complete. The former use of the Tier 2 risk assessment procedure (*i.e.*, to aid the design of a corrective action program at the Oak Walk Site) is the purpose of the assessment presented in this document.

In some cases, it may be necessary or cost-effective to advance the risk assessment process to a third stage. However, Tier 3 risk assessments are not usually performed unless unusually-detailed databases related to the site-specific conditions and the characteristics of the receptors and their exposures are available or it is necessary to assess the beneficial effect of installation of complex systems of engineered barriers to isolate receptors from the sources of COCs. In the case of the Oak Walk Site, it is not anticipated that a Tier 3 risk assessment will be required. However, when post-remediation data from confirmation sampling and the as-built configuration of the structures that will be erected on the site are available, a second, *post*-remediation, Tier 2 health risk assessment will be performed prior to releasing the site for residential occupancy.

1.6.1 Tier 1 Site-screening Values for Concentrations of COCs in Soil and Groundwater

As noted above, the RWQCB and Cal/EPA, which have jurisdiction over the Oak Walk Redevelopment Site, have published RBSLs for a large number of COCs affecting soil and groundwater for a variety of geological and hydrogeological site conditions that are typical of those commonly found in the San Francisco Bay Region. Those RBSLs, which include levels for residential and commercial and industrial land use, provide useful guidance for site screening at the Tier 1 risk assessment level.

The RWQCB's and Cal/EPA's RBSLs are based on the most restrictive of a number of criteria that include COC concentration limits designed to protect groundwater from contaminants leaching from affected soils, eco-toxicity criteria, ceiling values to prevent odors and similar nuisances, criteria to protect aquatic life, limits to protect the quality of surface waters, as well as concentration limits on soil and groundwater that are set to protect human health. To develop final limiting RBSLs, the human health risk limits are further subdivided into direct and indirect exposures to the COCs, as well as the effects of inhalation of their vapors or gasses in indoor or outdoor air. With respect to limiting values for concentrations of COCs in indoor air, for the purpose of establishing RBSLs, the RWQCB and Cal/EPA made highly-conservative default assumptions about the values of parameters required to perform the risk assessment calculations. In general, those assumptions, as well as others related to the properties of geological media and the carcinogenic and toxic properties of the COCs, are similar to those that appear in ASTM guidance documents (American Society for Testing and Materials 2002). However, for specific risk assessment parameters, the RWQCB elected to use alternate values derived from consideration of California law and regulatory practice, local experience, and the geotechnical, demographic and urban characteristics, and the industrial history that are typical of the San Francisco Bay region.

The RWQCB guidance document for RBSLs used for site-screening in the San Francisco Bay region includes separate sets of tables of limiting COC concentrations for application to sites where groundwater is or is not a current or potential drinking water source. In each case, sites are further subdivided into those at which the depth to the top of affected soil is greater or less than 3 meters BGS. Guidance is also provided regarding the choice of limiting COC concentrations for sites underlain by predominately fine-grained soils as well as those underlain by predominately coarse-grained soils.

As is discussed in Section 3.1 and 3.2 of this Tier 2 assessment, for the purpose of performing a health risk assessment of the Oak Walk Project site, the COCs to be considered are benzene, toluene, ethyl benzene, xylene isomers (the **BTEX** compounds), methyl tertiary butyl ether (**MTBE**), acetone, 2-butanone, n-butylbenzene, sec-butylbenzene, tert-butylbenzene, isopropylbenzene, p-isopropylbenzene, p-isopropyltoluene, n-propylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, naphthalene, 2-methylnaphthalene, and, in a qualitative sense, total petroleum hydrocarbons quantified as diesel (**TPHd**), total petroleum hydrocarbons quantified as mineral spirits (**TPHms**) and total petroleum hydrocarbons quantified as gasoline (**TPHg**), the latter three of which are each mixtures of more than 200 organic compounds.

Groundwater beneath the Oak Walk Project site is not a source of drinking water (California Regional Water Quality Control Board - San Francisco Bay Region 1999). With respect to the depth below the ground surface of the first occurrence of soil affected by COCs, that depth varies across the area of the site in which affected soil exists. However, to provide for a conservative tier 1 assessment, SJC elected to use limiting COC concentrations used by the RWQCB to derive RBSLs for sites at which the depth to affected soil is less than 3 meters BGS. Similarly, although the surficial soil covering the site are, with limited exception, highly impermeable clays and silty clays, SJC elected to compare the pre-remedial concentrations of COCs in the subsurface to the guidance values published by the RWQCB for sites underlain by fine-grained soils.

Pathways related to direct ingestion of or exposure to affected soil or groundwater will not be present at the Oak Walk Project site. As is discussed in Section 2.1 of this report, the exposure pathways of concern to human health risk on the subject site are those related to inhalation of indoor and outdoor air affected by vaporization of COCs from affected soil and water present beneath the ground surface. For the purpose of making a Tier 1 screening of the potential human health risk due to mixed residential and commercial use of the property, the critical COC concentration limits are those related to the indoor environment. Due to dispersion by winds and volumetric mixing, exposure to COC vapors in outdoor air imposes less restrictive limits than is the case for indoor spaces where vapors might accumulate.

1.6.2 Comparison of COC Concentrations with Tier 1 Screening Values

Limiting concentrations for the relevant COCs in soil and groundwater based on parameters selected by the RWQCB and the Cal/EPA for derivation of RBSLs related to human health risks at sites where groundwater is not a source of drinking water, the depth to affected soil is less than 3 meters and the soils underlying the site are predominately fine-grained are presented in Table II-5. Those values can be compared to the concentrations of the COCs in soil and groundwater currently beneath the Oak Walk Project site that are presented in Tables II-2 through II-4, in which concentrations that exceed the relevant residential Tier 1 limits are in **bold** script.

As can be seen from the instances cited in Tables II-2 and II-3, there are a sufficient number of samples that contain concentrations of COCs in excess of the Tier 1 limits to justify a Tier 2 analysis in order to assess adequately the environmental risks at the Oak Walk Site.

2.0 SITE CONCEPTUAL MODEL AND EXPOSURE PATHWAYS

To perform a health risk assessment for site-specific conditions, it is necessary to identify the pathways along which COCs potentially might travel and, if such migration occurs, by what mechanism they may affect a human receptor. These site-specific pathways must then be modeled and their characteristics defined so that the effects of those COCs on the receptors that they may reach can be assessed.

The applicable characteristics of the receptors must also be included in the model so that their sensitivity to the COCs can be properly considered. In addition, different durations and frequencies of exposure to a COC occur on different sites, depending upon the land use, which may be commercial, industrial, recreational, parkland, or residential. In other cases, uses may be mixed and it may be necessary to consider exposures separately due to differing occupancies and use of various areas within a large site.

In the case of the Oak Walk Redevelopment Project, there will be a mixture of commercial and residential uses of the buildings that are proposed for the site. The ground floors of some buildings will be used exclusively for commercial purposes, while higher floors will be occupied by residential units. In one building, a garage as well as residences will occupy the ground floor while the upper stories will be entirely residential.

Due to the varying uses of the different buildings on the site, the different types and concentrations of COCs in the subsurface beneath them and the differing depths from their floor slabs to the groundwater table, SJC determined that it was necessary to develop building-type-specific models for analyses of the potential health risks that might be present in various locations on the property. However, regardless of the use of a building, because the site as a whole will have mixed commercial and residential use, all exterior space on the site was assumed to be used by persons residing in the buildings. The selection of exposure pathways, receptors and construction parameters used in the building-specific models are discussed in Sections 2.1 through Section 2.3 below.

2.1 Exposure Pathways

In its pre-remediation condition, there are two sources of COCs at the Oak Walk Project site: 1) groundwater, and 2) affected subsurface soil beneath the site. Potentially, both the groundwater and affected subsurface soil could release COCs by volatilization. The volatized materials could be released into outdoor air where they would be dispersed, or into enclosed space within buildings where they might accumulate. This affected air could serve as an exposure medium that might adversely affect human receptors. These exposure pathways are shown diagrammatically on Figure II-23. (**Note**: There is an additional pathway that may affect construction workers involved in excavation beneath the ground surface during construction of the project. However, such exposures will be of very short duration and the types of and concentrations of COCs in the soil are such that such work will fall into the Level D category, *i.e.*, there will be no need for personal protective equipment [PPE] in excess of that required for construction work in any environment.)

Flow paths other than volatilization of COCs into outdoor and indoor air could also have been considered in the site model but they are not of concern to the health risk assessment described herein. For example, flow paths related to lateral contaminant transport are not considered because the Oak Walk property itself is not a significant source of the contamination affecting its subsurface. Soil and groundwater beneath the site has been principally affected by fuel hydrocarbons flowing into it from the former Celi's Service Station property to the south and from other off-site locations on the former sites of the paint manufacturing plants to the east across Adeline Street. (See Figure II-21 for locations.) Although there will be some degree of cyclical contamination of groundwater beneath the subject property as groundwater rises and falls seasonally through the affected soils, there are no potential points of down-gradient exposure that can be attributed to a primary source of contamination on the Oak Walk property itself. Volatilization to air from affected surficial soils is not included in the models because none of the surficial soil on the site is affected by COCs.

2.2 Receptors

The health risk assessment must consider three types of human receptors that might be affected by COCs remaining in the subsurface beneath the Oak Walk Redevelopment Project site. They can be classified according to their potential exposures to COCs on the property: 1) the occupants of the residential units being constructed on the property; 2) persons who will work in the commercial spaces that are included on the ground floors of some of the buildings on the property; and 3) construction workers engaged in building the structures. In the case of the residents, this class of human receptor can be further subdivided by age into adults, youths and young children. SJC's conceptual models used in the health risk analyses permit each of those classes and sub-classes of receptors to be considered.

A total of nine buildings, which are numbered for identification as Buildings 1 through 9, will be erected or renovated and relocated on the project site. See Figure II-24 for locations. All buildings will include residential units, but in the case of Building Types 1 and 2A, the ground floor of each will be devoted to commercial use. Because of that mixed use, when evaluating health risks due to potential exposures to affected outdoor air, SJC's conceptual models assume that, regardless of a building's use, persons exposed to outdoor air anywhere on the site may include young children. However, where the first floor of a building is dedicated to commercial use, only adult exposures are considered in the models for those buildings; similarly, all construction workers are also assumed to be adults. As is discussed in Sections 3.7.4 and 3.7.5 below, the difference in the duration and frequency of residents', commercial workers' and construction workers' exposure to outdoor or indoor air is also reflected in the models.

2.3 Building-Type Models

As is further discussed in Section 3.3, the depth to, and thickness of, affected soil beneath the buildings that will be constructed on the Oak Walk Site varies from one location to another, as do the mean depths to the groundwater table and the concentrations of COCs in the affected soil and groundwater in the subsurface. In addition, the buildings on the project site vary significantly in their principal dimensions and in the occupancies of their ground floors. Accordingly, SJC has established a set of "building types" to characterize the various types of residential and commercial units on the ground floor of the development. The building types and their locations are shown on Figure II-24. The key building dimensions that are significant with respect to environmental risk assessments are presented in Table II-6. This approach permits environmental risk assessments to be performed, as necessary, according to building type rather than redundantly for each ground floor unit. Table II-6 includes the occupancies, length east to west and north to south of the building-type perimeters, their plan areas, their perimeter lengths and their ground floor to ceiling heights and the ground floor slab thicknesses. It also cites the ground floor volume to area ratios (*i.e.*, the ratio of the volume of each ground floor unit types divided by its ground floor area). In addition, for reference purposes it cites each unit's ground floor slab elevation relative to the City of Emeryville's datum, which will be used by the contractor for building construction purposes, as well as the slab elevations relative to the National Vertical Datum (**NAVD**), which is used throughout this document, as is required for compliance with California regulations.

2.3.1 Vulnerable Building Types

By considering the fundamental toxicology and transport parameters of the range of COCs that were detected in the subsurface, it can be established *a priori* that the highest risks will be associated with buildings that are located over areas of the site that have the highest concentrations of benzene, whose floor slabs are separated from the groundwater by the smallest vertical distances, and which have the smallest interior volumes. Based on consideration of these factors, it can be concluded that the most vulnerable units on the proposed development are the ground floor residences of Type 3A and the commercial space on the ground floor of building Type 1. As can be seen by examination of Figures II-16, II-20 and II-24, the Type 3A units are located in an area of the site that has the highest concentration of benzene in soil and/or groundwater recorded anywhere on the property and, compared to other units, such as Type 3B in the same area, the Type 3A units have a floor slab elevation that is the lowest of that group and thus are situated the closest to the groundwater (see Table II-6). As is also shown in Table II-6, the Type 3A units also have the smallest interior volume of the different types that will be constructed on the site.

Although the first floor of the structure in the southwest corner of the site, which has been designated Building Type 1, will have a commercial use so that its occupants will have a reduced exposure to vapors that may accumulate in its interior and it is located in an area of the site where benzene concentrations are lower than those around the Type 3A unit, due to the low elevation of its floor slab at 42.28 ft. NAVD, its interior may be susceptible to accumulation of vapors of COC. Accordingly, it merits specific analysis as part of the health risk assessments made for the purpose of the corrective action design at the Oak Walk Redevelopment Site.

2.4 Risk Assessment Software

SJC used Version 1.3a RBCA Tool Kit for Chemical Releases software published by Groundwater Services of Houston, Texas (Groundwater Services, Inc. 2000) to perform the computations necessary to compute the potential health risks at the Oak Walk Project site. The risk-based site evaluation process simulated by the software is described in detail in Appendix II-A. Appendix II-B describes the fate and transport modeling methods that are employed in the software, including features that permit selection or de-selection of specific COC transport pathways or to select alternate equations used to simulate specific COC transport mechanisms.

2.4.1 Use of Johnson-Ettinger Model for Air Volatilization Computations

The RBCA Tool Kit for Chemical Releases software includes three methods for computation of air volatilization factors. The air volatilization factor is the predicted ambient air concentration, which may be either indoor or outdoor, divided by the source media concentration (*i.e.,* the concentration in soil or groundwater). For indoor air, the user may elect to use the Johnson-Ettinger model (Johnson and Ettinger 1991) for volatilization for either soil or groundwater, or may specify indoor air volatilization factors computed from other models and input them directly into the software. The equations used for the Johnson-Ettinger model computation for volatilization factors to indoor air from subsurface soil and groundwater are presented as equations CM-4 and CM-6, respectively, on Figure B.2 in Appendix II-B.

Although the Johnson-Ettinger model may overestimate the concentration of COCs in indoor air by a factor varying from 10 to 1,000 (Hartman, 2002), it is widely used in risk assessment analyses and has been approved by the United States Environmental Protection Agency (**USEPA**) (United States Environmental Protection Agency 1995b). Regulatory agencies that have approved the use of the Johnson-Ettinger model include those of the State of Michigan whose Environmental Science Board confirmed its suitability for predicting vapor concentrations in the interiors of buildings after subjecting the method to a rigorous evaluation (Fisher *et al* 2001). Because of its established conservatism and wide regulatory acceptance, SJC elected to use the Johnson-Ettinger model for computing volatilization factors for indoor air.

For outdoor air volatilization factors, users of the RBCA Tool Kit for Chemical Releases software can elect to specify those factors derived by use of one or more alternate simulations. These include direct input to the software from any model or procedure of the user's choice or they can either: a) make use of the Johnson-Ettinger model to predict volatilization from groundwater (see Equation CM-5 on Figure B.2 in Appendix II-B) but employ the ASTM's suggested model, which is shown in mathematical form in Equation CM-1 on Figure B.2 in Appendix II-B for surface soil volatilization (American Society for Testing and Materials 2000b) from both subsurface and surficial soils; or b) use the

Johnson-Ettinger model to predict volatilization from groundwater and apply the volatilization factor computed by either the Johnson-Ettinger model for soils beneath the surface (Equation CM-3 on Figure B.2 in Appendix II-B) or the volatilization factor computed using the ASTM model for surficial soils (Equation CM-5 on Figure B.2 in Appendix II-B), whichever is greater.

Because the ASTM model for volatilization from surficial soils provides a conservative upper-bound limit value on the volatilization factor that otherwise might be erroneously computed by using the Johnson-Ettinger model for volatilization from affected subsurface soil, SJC selected the software option that uses the greater of the values computed by the ASTM model or the Johnson-Ettinger model to assess health risks related to the potential presence of COCs in outdoor air.

3.0 RISK ASSESSMENT PARAMETERS

The ASTM Standard Guide for Risk-Based Corrective Action E2081-00 (American Society for Testing and Materials 2000a) includes suggested values for each of the parameters required for a health risk calculation. If these "default" values were used to compute health risks at a site, it would only be necessary to specify the COCs and their concentrations in soil and groundwater. However, although many of the values cited in the E2081-00 document can be appropriately applied to conditions at actual sites, ASTM did not intend for the values presented in the guidance standard to be universally applied without regard to site-specific conditions. Accordingly, SJC chose risk assessment parameters for the Oak Walk Redevelopment Site based on measured site-specific conditions and made extremely-conservative assumptions designed to ensure that the health risks assessment would yield potentially carcinogenic risk and toxic hazard values highly protective of the health of the project's inhabitants. In many cases, the parameter values selected were considerably more conservative than those suggested for initial screening purposes in the ASTM guidance document. For convenience of reference, the parameter values cited in the ASTM E2081-00 Standard will be referred to as the ASTM "default" values.

For the exposure pathways that must be considered at the subject property, the model input parameters can be categorized into those concerning the following elements of a health risk assessment model:

1. Chemicals of concern in soil
2. Chemicals of concern in groundwater
3. Chemical-specific parameters
4. Site-specific soil transport parameters
5. Site- and building-specific air parameters
6. Receptor-specific parameters
7. Acceptable health risks

The site-specific data and the parametric assumptions made by SJC for the purpose of performing the Health Risk Assessment for the Oak Walk Site are discussed below.

Note:

The software used to perform the risk calculations is capable of analyzing risks associated with many exposure pathways that are inapplicable to conditions at the subject property. Accordingly, the following discussion is limited to a description of the input parameters of relevance to the site conceptual model discussed in Section 2.0 above.

3.1 Chemicals of Concern in Soil

The subsurface beneath essentially all of the subject property is affected by releases of fuel hydrocarbons and by paint solvents (principally mineral spirits). Each of those materials is a mixture of a large number of organic chemicals. Mineral spirits, diesel and gasoline are each composed of hundreds of individual chemicals. Some of those chemicals are carcinogenic and others are toxic to humans, but the large majority is not known to cause adverse health effects to persons exposed to them.

At sites where the subsurface has been affected by a discharge of petroleum hydrocarbons it is standard practice to quantify the petroleum hydrocarbons present in soil according to one or more classifications of those materials. The classifications are made by consideration of the number of carbon units in the molecular chains of the components of a given petroleum product such as gasoline, diesel, jet fuel, paint thinners, or bunker oil. That practice was followed at the Oak Walk Project site where, as is shown in Tables II-2 and II-3, petroleum compounds detected in soil and groundwater having molecular lengths typical of those found in gasoline, diesel fuel and mineral spirits were separately quantified as TPHg, TPHd and TPHms, respectively. However, evaluation of environmental risks, especially health risks, due to the effects of fuel hydrocarbons based on quantification of such gross classifications of ranges of petroleum hydrocarbons in affected media does *not* provide sufficient information about the concentration of individual carcinogenic or toxic chemicals that are actually present in the affected subsurface media to permit health risks to be reliably computed. They can, however, be useful in cases were there is significant concern about environmental nuisances (as opposed to health risks) such as odors.

Because large scale sampling and analysis of specific chemicals of concern is very costly, efforts have been made to develop RBSLs for petroleum hydrocarbons based on the concept of dividing the multitude of chemicals in petroleum products into a manageably small number of “fractions” with each fraction being composed of a group of petroleum hydrocarbons having similar physical-chemical properties. That approach is more refined than a system based on the broader classification that discriminates between a few carbon-chain length groups (or product types) that was described above. Such “fractional” approaches include that developed by the Total Petroleum Hydrocarbon Criteria Working Group that divided petroleum hydrocarbons into thirteen fractions (Gustafson, Tell and Orem 1997). However, because the developers of the methodology recognized that it is not advisable to base health risk assessment on the presence of chemicals in the subsurface that are known human carcinogens or are highly toxic on the average properties of a number of chemicals in a fraction of a petroleum product, they specifically segregated benzene (a human carcinogen) and toluene (a human toxin) into two separate fractions of which benzene and toluene were the sole chemical members. They further specified that, following initial screening of a site based on the “fractional” approach, risk assessments should be performed for each known carcinogen found at the site. Furthermore, ASTM Standard E1739 specifically states that *"…TPH should not be used for 'individual constituent' risk assessments because the general measure of TPH provides insufficient information about the* *amounts of individual components present"* (American Society of Testing and Materials 2002).

In compliance with the requirements of ASTM Standard E1739, the health risk assessments described in this document are based on consideration of the specific human carcinogens and highly toxic petroleum hydrocarbons actually detected in the subsurface beneath the Oak Walk Redevelopment Site.

As part of the earliest stage of site investigation of the Oak Walk Site that was conducted in December 2003, SJC analyzed soil samples for petroleum hydrocarbons, the BTEX compounds, volatile and semi-volatile organic compounds and Polynuclear Aromatic Compounds (**PNA**s) in order to establish the range of COCs that were present on the site (The San Joaquin Company Inc. 2004). Later, to obtain an appropriately-inclusive inventory of chemicals of concern in soil during the major phases of the site investigation in the Spring and Fall of 2004, SJC analyzed samples recovered from 29 environmental and geotechnical engineering borings for the same suite of analytes (The San Joaquin Company Inc. 2005). As is documented in Table II-2, concentrations of the following components of petroleum hydrocarbons were detected in soil beneath the site. (**Note:** the listing below includes *all* detected components of petroleum hydrocarbons in soil, regardless of how small the amount or how infrequently the COC was encountered.)

COCS IN SOIL AT THE OAK WALK SITE

BTEX Compounds and Fuel Oxygenates (EPA Method 8260B)

Benzene	Toluene	Ethylbenzene	Total Xylene Isomers
Methyl tert-butyl ether			

Other Volatile Organic Compounds (EPA Method 8260B)

Acetone	2-Butanone	n-Butylbenzene
sec-Butylbenzene	tert-Butylbenzene	Isopropylbenzene
p-Isopropylbenzene	p-Isopropyltoluene	1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene		

Polynuclear Aromatic Compounds (EPA Method 8270C)

Naphthalene
2-Methylnaphthalene

Total Petroleum Hydrocarbons

Total Petroleum Hydrocarbons (quantified as Diesel)	EPA Method 8015M
Total Petroleum Hydrocarbons	EPA Method 8015M

(quantified as Mineral Spirits)	
Total Petroleum Hydrocarbons (quantified as Gasoline)	EPA Method 8260B

3.2 Chemicals of Concern in Groundwater

For the same reasons that were described in Section 3.1 above for soil, SJC's site characterization program included analyses of groundwater for TPHd, TPHms and TPHd. SJC analyzed groundwater samples for each of the 67 chemicals included in EPA Method 8260B for analysis of volatile organic compounds (**VOC**s), all 17 chemicals included in EPA Method for analysis of Polynuclear Aromatic Compounds (PNAs) and, in addition, SJC made separate analyses for the BTEX compounds and the fuel oxygenate MTBE. As is documented in Table II-3, by using those procedures, the detectible concentrations of the following COCs were detected in groundwater beneath the site. (**Note:** the listing below includes *all* detected COCs in groundwater, regardless of how low or infrequently detected.)

COCs IN GROUNDWATER AT THE OAK WALK SITE

BTEX Compounds and Fuel Oxygenates (EPA Method 8260B)

Benzene	Toluene	Ethylbenzene
Total Xylene Isomers	Methyl tert-butyl ether	

Other Volatile Organic Compounds (EPA Method 8260B)

n-Butylbenzene	sec-Butylbenzene	tert-Butylbenzene
Isopropylbenzene	p-Isopropylbenzene	1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene		

Polynuclear Aromatic Compounds (EPA Method 8270C)

Naphthalene

Total Petroleum Hydrocarbons

Total Petroleum Hydrocarbons (quantified as Diesel)	EPA Method 8015M
Total Petroleum Hydrocarbons (quantified as Mineral Spirits)	EPA Method 8015M
Total Petroleum Hydrocarbons (quantified as Gasoline)	EPA Method 8260B

3.3 Representative Concentrations of Chemicals of Concern in Soil and Groundwater

The RBCA Tool Kit for Chemical Releases software permits the concentrations of COCs in soil and groundwater beneath a site to be specified at more than one location. This enables representative concentrations to be used in the risk assessment analyses performed for sites where there is significant variability in the concentrations from location to location within the subsurface. The software provides several options for computing a representative concentration for a COC in either soil or groundwater from a suite of location-specific concentrations. These options include computation of a mean, a maximum, or an upper confidence limit value.

As can be seen by an examination of Tables II-2 and II-3 and Figures II-14 to II-17, such variability of COCs is present beneath the Oak Walk Site. However, for the purposes of the present health risk analyses, which are intended to assist design of corrective action measures for the site, a more conservative approach will be taken. The highest concentrations of COCs in soil and groundwater beneath the most vulnerable individual residential and commercial buildings on the site will be used to assess the risk associated with the presence of COCs in the subsurface beneath them.

3.3.1 Concentrations of COCs in Groundwater Used in Risk Assessment Computations

Two groundwater conditions were considered for the purpose of assessing environmental risks for the Types 3A and 1 buildings. For the first condition it was assumed that no remediation of groundwater would be performed. For the second, the groundwater remediation measures described in Volume I of this document were taken into account.

For the pre-remediation condition it was assumed that the concentrations of COCs in water would be equal to those detected in the sample of groundwater recovered from the groundwater-quality well having the highest concentration of benzene that was located either beneath or in close proximity to the building type being considered.

As can be deduced from an examination of Figure II-20 and Table II-3, in the case of Building Type 3A, the COC concentrations to be considered are those in Monitoring Well MW-2, from which the groundwater sample contained benzene at a concentration of 7,900 μg/L. That and the concentrations of the other COCs in groundwater used for the risk assessment for the Type 3A building are presented in Table II-8.

For Building Type 1, the highest concentration of benzene was detected in Monitoring Well WCEW-1, at a concentration of 90 μg/L. That data and the associated concentrations of the other COCs in groundwater that will be used for the pre-remediation risk assessment for that building type are also compiled in Table II-8.

Also presented in Table II-8 are the concentrations of COCs in groundwater assumed to be present beneath Building Types 3A and 1 in their post-remediated condition. In the case of Building Type 1, the post-remediation concentrations are the same as those in the pre-remediation condition. That is because the corrective action measures described in Section 5.3 of Volume I of this document do not include groundwater remediation in the area of the site occupied by Building 1. However, in the case of Building Type 3A, the post-remediation concentrations of COCs in groundwater have been assumed to be 40% of those present in the pre-remediated condition. This reflects the expected result of the groundwater remediation activity described in Volume I that will be conducted in the area adjacent to Monitoring Well MW-2.

3.3.2 Concentrations of COCs in Soil Used in Risk Assessment Computations

The representative concentrations of the COCs in soil used in the risk assessments for building Types 3A and 1 were derived in a manner similar to that used for groundwater, except that the COC concentrations used were those associated with the conditions found in soil samples from borings drilled in, or proximate to, the areas of the site where those building types will be constructed.

In the case of Building Type 3A, the highest concentrations of benzene in soil were detected in a sample recovered from Boring BE-1 at a depth of 10 ft (see Figure II-4). BGS. That sample contained 13 mg/Kg of benzene. That result and the concentrations of the other COCs in soil that were used to perform the health risk calculations for Building Type 3A in the pre-remediation condition are compiled in Table II-9. The concentrations of COCs in soil for Building Type 3A in the post-remediation condition are also presented in Table II-9, but they are identical to those for the pre-remediation condition. This is because remediation of soil beneath the Type 3A units will be limited to a total depth of 6 ft. BGS so that soil at a depth of 10 ft BGS, from which depth the soil sample used to conservatively characterize the concentration of COCs in soil was recovered, will not be improved by the remediation measures.

In the case of Building Type 1, the characterizing concentrations of COCs in soil will be taken to be those detected in boring BG-1 in a sample recovered from a depth of 15.0 ft. BGS. As was the case for Building Type 3A, although affected soil will be removed down to a depth of 7 ft. beneath Building 1, soil remediation in the area of the latter building will not change the maximum detected concentration of benzene in the ground beneath it. Consequently, as is presented in Table II-9, the concentrations of COCs in soil in both the pre- and post-remediation conditions for Building Type 1 will be identical.

3.4 Chemical-specific Parameters

The physical, chemical, toxicological and carcinogenic properties of benzene, toluene, ethyl benzene, xylene isomers, MTBE, acetone, cumene (isopropylbenzene) and naphthalene, which are COCs of concern to a risk assessment for Building Types 3A and 1 at the Oak Walk Site, are presented in Table II-10. In each case the suite of parameters was taken from the library of chemical databases provided in the modeling software by its developer, Groundwater Services, Inc. (2000). All COC parameter values used in the software were obtained from sources in the standard chemical and risk assessment literature.

A complete array of physical, chemical, toxicological and carcinogenic properties for the remaining COCs - n-butylbenzene, sec-butylbenzene, p-isopropylbenzene, n-isopropylbenzene, 1,2.4-trimethylbenzene, and 1,3,5 trimethylbenzene are not available. However, n-butylbenzene and sec-butylbenzene are alkylbenzenes that both have the chemical formula $C_{10}H_{14}$ and are structural isomers of butylbenzene. Butylbenzenes are also structurally similar and closely related to the alkylbenzene cumene (ispropylbenze C_9H_{12}), for which there is established toxicological data. Recognizing these similarities, and in the absence of data for the butylbenzenes themselves, the USEPA recommends that the properties of butylbenzenes should, for the purpose of making health risk assessments, be based on the properties and toxicology of cumene (United States Environmental Protection Agency 1997a). The California Office of Environmental Health Hazard Assessment (**OEHHA**) applied the same methodology whereby the toxicological data for cumene was used to develop notification and action levels for sec-butylbenzene and tert-butylbenzene in drinking water (California Office of Environmental Health Hazard Assessment 2000). Following the lead taken by those Federal and State regulatory agencies, SJC will account for the risks related to the presence of n-butylbenzene, and sec-butylbenzene in soil and groundwater beneath the site by adding their concentrations to the concentrations of isopropylbenzene, for which a completed set of physical, chemical, toxicological and carcinogenic properties is available.

To deal with the lack of complete sets of chemical-specific risk assessment parameters for p-isopropylbenzene, n-isopropylbenzene, 1,2.4-trimethylbenzene, and 1,3,5 trimethylbenzene, SJC also adopted a procedure that was employed by the USEPA and the OEHHA to assess health risks associated with the butylbenzene isomers. Cumene, p-isopropylbenzene, n-isopropylbenzene, 1,2.4-trimethylbenzene, and 1,3,5 trimethylbenzene are homologues, all of which have the chemical formula C_9H_{12} and are all members of the same group of structural isomers. Accordingly, they are even more closely related than is the case for cumene (C_9H_{12}) and the butylbenzenes ($C_{10}H_{14}$). Thus, given the absence of other information, it is reasonable to model the properties of each of these structural isomers as being similar to the properties of cumene and to account for their risks by adding their concentrations in soil and groundwater to yield an equivalent concentration of cumene.

In summary, established chemical-specific physical, chemical, toxicological and carcinogenic properties of the COCs benzene, toluene, ethyl benzene, xylene isomers, MTBE, acetone, cumene (isopropylbenzene) and naphthalene were used to assess heath risks in outdoor air and in the vulnerable building types that are proposed for the Oak Walk Site. Following the precedents set by the USEPA and the OEHHA, the risks associated with the COCs n-butylbenzene, sec-butylbenzene, p-isopropylbenzene, n-isopropylbenzene, 1,2.4-trimethylbenzene, and 1,3,5 trimethylbenzene were accounted for by adding their concentrations to that of the closely-related COC cumene (isopropylbenzene).

Note:

The chemical data for the COCs that are included in the output documentation generated by the software also cite additional properties of the chemicals beyond those presented in Table II-10, but those relate to exposure pathways not present on the Oak Walk property.

3.5 Site-specific Soil Transport Parameters

Because the proposed remediation program will remove existing contaminated soil from some areas of the site and replace it with clean engineered fill, in order to evaluate the scope of corrective action measures needed to render the site safe for residential development it is necessary to consider two sets of soil transport parameters for the soil: 1) Those applicable to the site in its unimproved condition and 2) Those applicable to the site in the condition after contaminated soil has been removed to the depth called for by the remediation design and replaced by clean engineered fill. For the purposes of this report the soil in its present in-situ condition will be designated as the “unimproved" condition. The state of the soil after the remedial excavations have been completed and backfilled with clean engineered fill will be designated as the “improved” condition.

The relevant soil transport properties for both the unimproved and improved condition are discussed below.

3.5.1 Soil Column Properties

As has been discussed in Section 1.1.3 the surficial soils that cover the Oak Walk Site are highly impermeable clays and silty clays but, locally, the surficial soil may be composed of sands. Based on the extensive hydrosratigraphic investigations that have been conducted at the site, it can be concluded that it is highly unlikely that sands are present in the shallow subsurface beneath the Type 3A buildings. However, to ensure abundant conservatism for the purpose of performing a health risk assessment for the Type 3A buildings when the soil is in its unimproved condition, it will be assumed that sands are present beneath the floor slabs. In the case of the Type 1 building there is, in fact, sand present at shallow depth over a significant portion of the plan area of that building so that an assumption that the unimproved soil beneath its floor slab is entirely composed of that material is appropriate for a conservative health risk assessment.

When soil beneath the structures that will be constructed on the site has been improved by excavation of specified depths of contaminated material and by backfilling the excavations with engineered fill, the soil column properties will be changed significantly from its unimproved condition. The engineered fill will be composed of the clean silty clay materials that will have been removed from the surface of the site and held in stockpile. When compacted to a 90% relative density, as is proposed for the remediation design, that material has a very low permeability and it will control the migration of COCs to the surface. Accordingly, the properties of the engineered fill will be used to characterize the soil column in risk assessments made to assess the improved condition of the site.

Based on the considerations discussed above, the following condition-specific soil column characteristics and soil properties were used.

3.5.1.1 Hydraulic Conductivity

The ASTM default value for vertical hydraulic conductivity of soil is 1.0×10^{-2} cm/sec, which is typical of a sand or silty sand. This default conductivity is therefore appropriate for performing the risk assessments for the Oak Walk Site when the soil is in its unimproved condition.

When the soil is improved by backfilling the remedial excavations with compacted silty clay, the ASTM default hydraulic conductivity will clearly be invalid. SJC has developed an appropriate hydraulic conductivity for the improved soil column based on the empirical data described below.

To obtain reliable site-specific values for vertical conductivity of the in-situ silty clay soils present, SJC obtained, as part of the site characterization program conducted at the site, direct laboratory measurements of the hydraulic conductivity of two representative samples of soil from the Oak Walk Site. The vertical permeability of one of those samples when measured in a constant head permeameter was found to be 2.51×10^{-9} cm/sec and the permeability of the other was measured at 2.95×10^{-8} cm/sec (The San Joaquin Company Inc. 2005).

Although the permeability test showed that the silty clays that cover almost the entire area of the Oak Walk Site are essentially impermeable, it would not be conservative to use the permeabilities measured by tests conducted on the samples of in-situ material in the risk assessment calculations. This is because it is generally not possible to achieve such low permeabilities in compacted fill. For proper conservatism, the actual permeability of the compacted material should be used. Fortunately, the necessary data is already available.

As part of the corrective action program conducted at the Andante redevelopment site, which is located immediately to the south and across 40th Street from the Oak Walk Site, the permeability of the same silty clay soil as will be used to backfill the Oak Walk remedial excavations was measured for SJC by the Fugro West, Inc. laboratory in Oakland, California (The San Joaquin Company Inc. 2003). In each case, a constant head permeameter was used to measure the hydraulic conductivity of the soil after it had been compacted to 90% relative density, according to procedure D1557-00 published by the ASTM (American Society for Testing and Materials 2000c). The measured hydraulic conductivities of the compacted fill was 5.65×10^{-7} cm/sec, the value of which is appropriate for use in risk assessments made for the Oak Walk Site after the soil conditions have been improved.

In summary the following hydraulic conductivities will be used to calculate the condition-specific heath risks for the vulnerable buildings on the Oak Walk Site:

Hydraulic Conductivity of Unimproved Soil (Silty Sand): 1.0×10^{-2} cm/sec.

Hydraulic Conductivity of Improved Soil (Compacted Silty Clay): 5.65×10^{-7} cm/sec.

3.5.1.2 Dry Bulk Density

The ASTM default value for dry bulk density is 1.7 Kg/L, which will be used in the risk assessment for conditions when the soil is unimproved. The dry bulk density of the backfill material used at the Andante Site, when it was compacted to a relative density of 90%, was 100.3 lb/ft^3. Because the backfill at the Oak Walk Site will be derived from the same type of soil, it is estimated that that material will also have a dry bulk density of 100.3 lb/ft^3. In Standard International Units, that density is expressed as 1.61 Kg/L.

3.5.1.3 Volumetric Water Content

The ASTM default values for volumetric water content of soil are 12.0% for the vadose zone and 34.2% for the capillary fringe, which numbers are typical for fine to medium sand. These values will be used in the risk assessment model for the unimproved condition of the soil at the Oak Walk Site.

The water content of the fill material at the Andante Site, when compacted to 90%, was measured at 18.7% by weight, which is equivalent to a volumetric moisture content of 22.75% (The San Joaquin Company Inc. 2003). Because the same material will be used at the Oak Walk Site, those values are used to support the health risk assessment for the improved condition of the site.

3.5.1.4 Total Porosity

Total porosity is defined as the ratio between the volume of voids in soil to the total volume. The ASTM default value for porosity is 0.38, which is appropriate for medium to coarse sands, but slightly high for the type of fine to medium sands that underlie the Oak Walk Site. SJC used a total porosity of 0.35 in the health risk assessments that included those materials. That value is consistent with the value used for Merritt Sand by the City of Oakland's Technical Advisory Committee (Technical Advisory Committee, Oakland Urban Land Development Program 1996).

For the improved conditions, SJC used the value 0.5, which is conservative and at the upper range of total porosity of the compacted silty clay material that will cover the Oak Walk Site after remediation is complete.

3.5.1.5 Volumetric Air Content

The volumetric air content of a soil is defined as the ratio of the volume of air in the sample to the total volume of the sample. At full saturation, such as occurs in the capillary zone, the theoretical volumetric air content of that soil would be zero and water would completely fill all of the void space. Conversely, when the soil is completely dry, the pores in the soil would contain only air and the volumetric air content would be equal to the total porosity of the sample. At intermediate moisture contents, such as occurs in the vadose zone, the volumetric air content of that soil is equal to the difference between its volumetric water content and the total porosity.

The procedures used to set the volumetric air content parameters in the vadose and capillary zones for the purpose of this health risk assessment are discussed below.

3.5.1.5.1 Vadose Zone

As was noted in Section 3.5.1.3, the volumetric water content of the unimproved soil in the vadose zone is estimated to be 12.00% and the total porosity of that soil is assumed to be 0.35. Thus,

Volumetric Air Content in the Vadose Zone in the Unimproved Soil	=	0.3500 - 0.1200
	=	23%

In the vadose zone that will develop in the compacted fill that it is proposed to be placed on the site, the unsaturated volumetric water content of the soil is, as is noted in Section 3.5.1.3, estimated to be 22.75%, but when the same soil is fully saturated, its moisture content will be 34.2%, so that,

Volumetric Air Content in the Vadose Zone in the Improved Soil	=	0.5000 - 0.2275
	=	27.25%

3.5.1.5.2 Capillary Fringe

In a situation where the soil is formed from fine to medium sands only moderate capillary pressures are generated. In such materials, in the capillary fringe above the water table, all pore space would theoretically be completely full of water and its volumetric air content theoretically would be zero. However, to provide for a thoroughly conservative risk assessment, we assumed that a small amount of air would actually be present in the capillary fringe, and assigned a volumetric air content of 0.025 to that zone for the unimproved soil and 0.010 for the improved soil. Those selections are based on the available literature that addresses air entrainment in the capillary zone (Connor, *et. al.*, 1997). Thus, for the purpose of the health risk analyses, the

Volumetric Air Content in Capillary Fringe of Unimproved Soil	=	2.5%
Volumetric Air Content in Capillary Fringe of Improved Soil	=	1.0%

Note:

Because it was assumed that soil in the capillary fringe contained some air, it was necessary to adjust the volumetric water content in that zone. The adjusted capillary zone volumetric water content, M_v, is computed as follows.

M_v Capillary Fringe = Porosity (*n*) - Volumetric air content of capillary fringe

so that,

M_v Capillary Fringe Unimproved Soil	=	0.35 -0.025
which equals	=	0.325
M_v Capillary Fringe (Unimproved Soil)	=	32.5%
and		
M_v Capillary Fringe Improved Soil	=	0.50 -0.01
which equals	=	0.49
and therefore		
M_v Capillary Fringe (Improved Soil)	=	49%

3.5.1.6 Vapor Permeability

Due to the formation of water menisci at the locations where soil particles touch, the gas or vapor permeability of a partially-saturated soil is extremely low. In practice this parameter is difficult to measure, even in a laboratory. The ASTM default value is 9.8×10^{-4} cm/sec (1.1×10^{-11} ft^2), which is appropriate for sand. That value will be used to characterize the vapor permeability of the soil in its unimproved condition at the Oak Walk Site. However, based on the available literature, an appropriate value for the compacted silty clays that will be present beneath the proposed structures on the site when the remediation is complete would be 9.8×10^{-9} cm/sec (1.1×10^{-16} ft^2) (Connor, *et. al.*, 1997). Accordingly, the latter value is used for the health risk assessments made for the Oak Walk Site in its remediated condition.

3.5.1.7 Capillary Zone Thickness

The ASTM default for capillary zone thickness is 0.16 ft. (5 cm). That value is appropriate for sandy soils and will be used to model the unimproved conditions of the Oak Walk Site. However, it is grossly inadequate for the compacted silty clays that will actually form the shallow soils on the site after it has been remediated. To provide an appropriately conservative value for the capillary zone thickness in the improved soil, SJC assumed a capillary thickness of 5.0 ft. That value is compatible with data available in the standard literature (Guymon 1994, Technical Advisory Committee 1996).

3.5.1.8 Partitioning Parameters

The values used in the health risk analyses for the fraction of organic carbons and pH in the soil beneath the site that affect phase partitioning of the COCs in the affected soil zone are described below.

3.5.1.8.1 Fraction Organic Carbon

The ASTM default value for the fraction of organic carbon in soil is 0.01. The fraction of organic carbon in soils has a major effect on the ability of chemicals to sorb to soil particles. However, even if no organic carbon is present, the out of balance electromagnetic molecular forces on the surface of very fine soil particles such as those that form clay can cause chemicals to adsorb onto. When soil has an organic content, as is the case in the silty organic clays at the Oak Walk Project site, adsorption increases rapidly with increasing organic carbon content. Thus, while the ASTM default value of 0.01 may be appropriate for a sand formation containing a small fraction of organic materials and will be used in the health risk assessment of the unimproved site where it is conservatively assumed that sand might be present under the buildings, it significantly under-represents the chemical adsorption onto clayey soils, which, in addition to their electromagnetic adsorption capacity, frequently contain significant fractions of organic carbons. Accordingly, for analyses of conditions after the surficial soil has been improved by placement of compacted silty clays, SJC used an organic carbon fraction of 0.02 for the health risk analysis reported herein. That value is actually conservative for silty clays, but is compatible with reported values for local soils on the eastern shores of San Francisco Bay (Spence and Gomez 1999a).

3.5.1.8.2 Soil/Water pH

The ASTM default value for the pH of the soil and groundwater is 6.8, which, given the temporal variations that frequently occur in that parameter, is an appropriate value for most soils and groundwater and thus was used when making the health risk analyses reported herein.

3.5.2 Soil Source Zone Characteristics

Following is a discussion of the hyrdogeological and spatial characteristics of the zone of affected soil that serves as a source for COCs that might migrate into the indoor and outdoor air at the subject site.

3.5.2.1 Hydrogeology

The site-specific values for the hydrogeologic characteristics required as input for the health risk analyses are discussed below.

3.5.2.1.1 Depth to Water-bearing Unit

The depth to the water-bearing unit (*i.e*., the depth to the phreatic surface) is an important parameter that affects the concentrations of COCs in indoor and outdoor air above a contaminated subsurface. If the groundwater is shallow, the potential concentrations of airborne COCs are higher compared to a situation where groundwater is deeper in the same formation affected by the same concentrations of COCs. At many locations, the depth to the first water-bearing unit may differ significantly from season to season. However, the modeling procedure used to compute the concentrations of COCs in indoor and outdoor air can accept only a single input parameter for the depth to groundwater. Thus, to avoid excessively conservative or unacceptably non-conservative results from a health risk assessment, it is important to use a conservative, but reasonably representative value for depth to groundwater in the model.

In the case of the Oak Walk Redevelopment Site, SJC elected to use the mean depth to groundwater beneath a building as the representative value for this parameter. That choice is conservative because groundwater elevations beneath the site vary seasonally in response to rainfall in the local area and in the Berkeley and Oakland hills to the east. If precipitation occurred throughout the year, the mean depth to groundwater beneath the site would, in fact, be an accurate representation of the mean hydrogeologic condition because the model would reflect a situation in which groundwater elevation would be between the mean and the highest elevation for the driest half of the year and between the mean and the lowest elevation for the other half of the year. However, in the Oakland-Emeryville area, precipitation does not occur throughout the year. In fact, on average, more than 82% of the rainfall occurs between the months of November and March (Kozlowski 2003). Thus, groundwater elevations are usually above their mean range during that period, but significantly lower during the remaining seven months of the reporting year (April 1 - October 30). Therefore, use of the mean groundwater elevation to compute the depth to groundwater for the purpose of the health risk analyses is conservative because, in actuality, groundwater is at lower elevations than the mean for more than half of the year.

Groundwater elevational data is available for the Oak Walk Site and adjacent property from measurements made in the groundwater-quality monitoring wells installed by SJC during its site characterization work. Those data are presented in Table II-1 and the well locations are shown on Figure II-4.

As was discussed in Section 2.3.1, in order to perform conservative health risk assessments for the Oak Walk Site, the risks associated with the use of Building Types 3A and 1 will be evaluated. Groundwater conditions under Building Types 3A and 1 can be represented by the conditions in Monitoring Wells MW-2 and WCEW-1, respectively.

Examination of Table II-1 shows that the highest groundwater elevation in WCEW-1 was 35.81 ft, which occurred in March 1998, and the lowest elevation was 33.67 ft., which occurred in September 1997. Thus, the mean groundwater elevation within that range in Monitoring Well WCEW-1 is 34.74 NAVD, which is 0.14 ft. higher than the elevation of the groundwater in MCEW-1 computed from the measurement made in that well in November 2004. Groundwater depth measurements extending over a period of years are not available for conditions in Monitoring Well MW-2. However, a reasonable estimate of the mean seasonal groundwater elevation in that well can be made by adding 0.14 ft. to the elevation of 39.46 ft. that was computed for the groundwater in that well in November 2004 to yield a mean groundwater elevation in that well of 39.60 ft. NAVD.

Each of the buildings that will be constructed on the subject property has a ground floor slab, the surface of which will be set at a pre-determined elevation. Accordingly, the depth to groundwater beneath each building can be computed by subtracting the representative mean groundwater elevation beneath that building from its ground floor slab surface elevation. The ground floor slab elevations relative to the National Vertical Datum for Building Type 3A and 1 are shown in Table II-6.

Accordingly, the following values for depth to water bearing unit were used in this Health Risk Assessment.

Building Type	**Floor Slab Elevation** *ft. NAVD*	**Mean Groundwater Elevation** *ft. NAVD*	**Mean Depth to Water-bearing Unit** *ft. NAVD*
3A	46.83	39.60	7.23
1	42.38	34.74	7.64

Note:

In the health risk modeling process, the depth of the unsaturated soil zone (*i.e.*, the soil column thickness) is computed by subtracting the capillary zone thickness from the depth to groundwater. In the health risk assessment software, depth to groundwater is also described as "depth to water-bearing unit." The values used in the health risk assessments for depth to groundwater and to the top and bottom of contaminated soil are shown in Table II-7.

3.5.2.2 Geometry of the Affected Soil Zone

The site-specific values for the affected soil zone characteristics required as input for the health risk analyses are discussed below.

3.5.2.2.1 Depths to Top and Bottom of Affected Soils

By examination of Table II-2, it can be seen that the concentrations of analytes of concern in soil beneath the Oak Walk Site are generally very low at a depth of 20 ft. BGS. Accordingly, for the purpose of this Health Risk Assessment, SJC elected to assume that the depth to the bottom of affected soil at the site is 25 ft. BGS. With respect to the depth to the top of the affected soil, two conditions have to be considered - those that prevail at the present time and those that will prevail after the proposed Corrective Action Program has been completed. Examination of Table II-2 shows that there are low concentrations of some analytes of concern in the soil at depths as shallow as 5 ft. BGS. Those occurrences are relatively few in number; significant concentrations of analytes of concern in soil generally are not present until a depth of 10 ft. BGS is reached. However, to ensure a conservative analysis of the health risks present on the site, SJC assumed that the depth to the top of the zone of affected soil in the present condition of the site is as shallow as 4 ft. BGS. As is shown on Figure II-22, the proposed remediation program calls for affected soil to be excavated from the area beneath the Type 3A Building to a depth of 6 ft. BGS and from beneath the Type 1 Building to a depth of 7 ft. BGS.

The mean elevation of the existing ground surface is reflected by the surveyed elevations of the ground surface at the locations of the borings drilled for the site characterization program (The San Joaquin Company Inc. 2005). The elevation of the ground surface at monitoring well MWT-2, which is 45.70 ft. NAVD, is representative of that in the area where building type 3A will be located (see Figure II-4). The elevations of the ground surface at boring BG-1 and monitoring wells MWT-1 and MW-5 are 43.33 ft. NAVD, 43.32 ft. NAVD, and 42.86 ft. NAVD, respectively. The mean of those three elevations is 43.17 ft. NAVD and will be used to characterize the elevation of the ground surface where building Type 1 will be constructed.

The health risk analysis requires definition of the depth from the top of the basement slab in a building to the top and bottom of the zone of affected soil. Depending upon the project grading plan, that depth may be greater or smaller than the depth of those markers below the existing ground surface of the site. At the Oak Walk Site either condition may prevail. In the case of building Type 3A, for which the floor slab elevation will be 46.83 ft. NAVD, that elevation will be higher than the existing ground surface by 1.13 ft. Conversely, in the case of building Type 1, for which the floor slab elevation will be 42.38 ft. NAVD, the excavation will be required to place the floor slab and its surface will be at an elevation 0.79 ft. lower than the existing ground surface elevation of that area.

Based on the elevational data discussed above, the following parameters were used in the risk assessment analyses:

Building Type	**Depth to Bottom of Affected Soils** *ft.*	**Depth to Top of Affected Soils**	
		Unimproved Condition *ft.*	**Improved Condition** *ft.*
3A	26.13	5.13	7.13
1	24.21	3.21	6.21

Note:

If affected soil is located below the water table, COCs cannot be released from it by the process of vaporization. Such soil may contribute dissolved COCs to groundwater, which itself may cause those materials to migrate along available pathways and affect receptors on the ground surface, within buildings or at other locations, but that scenario does not directly affect computations of health risk due to vaporization of COCs from soil. It is, therefore, erroneous to assume that COCs vaporize from submerged soil when computing health risks at a site.

Although details of the concentrations of COCs in both soil and groundwater were included in the input to the RBCA Tool Kit for Chemical Releases software used to perform the health risk calculations, care was taken to adapt the computational models to account correctly for the lack of vaporization of those chemicals from submerged soils. For the purpose of the health risk analyses for the site in its unimproved condition the depth to the top of the affected soil was inputted into the analytical software, but the bottom of the affected soil zone was assumed to be at the depth of the water table. The effect of this procedure is to cause the software to compute a thickness of the zone of soil affected by the COCs to be that which is above the groundwater table, so that, in the risk computation process, no account is taken of chemical vapors that otherwise might be computed as emitting from the submerged soil.

3.5.2.2.2 Affected Soil Area

As was discussed in Section 2.3 above, because several of the key parameters, such as depth to groundwater, depth to top and bottom of affected soil, and the occupancy of the first-floor units is building-specific at the Oak Walk Project site, separate health risk analyses were made for Building Types 3A and 1, the interiors of which may potentially be exposed to higher concentrations of COC vapors than other buildings built on the site. Accordingly, in making the analyses, the plan areas of the ground floor levels of Buildings 3A and 1 were used to represent the affected soil area in each case. Those building plan areas are listed in Table II-6.

3.5.2.2.3 Length of Affected Soil Parallel to Assumed Wind Direction

Wind directions in the San Francisco Bay area vary considerably both seasonally and daily depending upon the regional weather patterns and relative temperatures in the Central Valley of California and along the Pacific Coast. Although the prevailing wind direction, based on statistical analysis of weather records, is generally stated to be from the northwest, for the purpose of the health risk analyses and to ensure an appropriate degree of conservatism, SJC assumed that the wind would at all times blow in the direction parallel to the longest dimension of the area of the site that is affected by the chemicals of greatest concern (*i.e.,* the BTEX compounds). Further, although a separate risk analysis assessment was made for Building Types 3A and 1, for the purpose of evaluating the potential effect of the COCs on outdoor air in the vicinity of each building type, it was conservatively assumed that the whole of the area of site where the subsurface is affected by benzene contributes to the condition of the local air. Accordingly, based on an examination of Figure II-16, the longest dimension (*i.e.,* west to east) of that area was estimated to be 270 ft. and, in the other dimension (*i.e.,* south to north), was estimated to be 60 ft.

3.6 Site- and Building-specific Air Parameters

For the flow paths considered in the health risk assessment for the Oak Walk Redevelopment Project site, the following site-specific air parameters were used.

3.6.1 Outdoor Air Pathways

For the pathways of concern to the present health risk assessment, the outdoor air pathway parameters of concern are the outdoor air mixing zone height and the ambient air velocity in the mixing zone.

3.6.1.1 Air Mixing Zone Height

The ASTM default outdoor air mixing zone height is 6.56 ft. (200 cm), which reflects the breathing area of an average person. SJC used this value in the health risk analyses reported herein.

3.6.1.2 Ambient Air Velocity in Mixing Zone

The wind speed in the outdoor air mixing zone affects the concentrations of COCs in outdoor air because it has a major influence on the dispersion of those chemicals. The ASTM default value for the wind speed (*i.e.*, the ambient air velocity) in the outdoor mixing zone is 7.38 ft/sec (225 cm/sec). Actual wind speed data is available from an anemometer located at the East Bay Municipal Utility Districts' sewage treatment plant in Oakland, approximately 0.9 miles west-southwest of the subject property. The mean annual wind speed for that site is 10.56 ft/sec (322 cm/sec) (San Francisco Bay Area Air Quality Management District 1997). SJC used that value in the health risk analyses reported herein.

3.6.2 Indoor Air Pathway: Building Parameters

The parameters related to indoor air pathways for Building Types 3A and 1 at the Oak Walk Project are discussed below.

3.6.2.1 Foundation Areas and Perimeters

The foundation areas and perimeters for each building are shown in Table II-6.

3.6.2.2 Building Volume/Area Ratio

The building volume/area ratio expresses the volume of the indoor space in a building as a ratio of the total volume indoor space to its floor area. In the case of the Oak Walk Project buildings, that ratio is equal to the floor-to-ceiling heights of the ground floors of the applicable commercial or residential units. The floor-to-ceiling heights and associated volume/area ratios for each building are shown in Table II-6.

3.6.2.3 Building Air Exchange Rate

The building air exchange rate quantifies how much outdoor air is exchanged with indoor air in buildings. In residences not equipped with air conditioning systems, that value is affected in large measure by natural ventilation that occurs through windows and the opening and closing of exterior doors.

The ASTM default for residential units is 0.5 air changes per hour (**ACH**), which is equivalent to 0.00014 volumes per second. However, that value does not consider the local climate. In hot climates, residents will leave doors and windows open for long periods during the day, thus providing natural ventilation that is significantly above the continental mean. Conversely, in colder regions, or where winters are more inclement and extended, residences will remain relatively closed up, with associated lowering of air exchange rates for much of the year.

Emeryville, which is located on the eastern shore of San Francisco Bay, has a very temperate climate with only minor seasonal variations in average temperature. In fact, Lawrence Berkeley National Laboratory's Environmental Energy Technologies Division considers a value of 2.0 ACH to be reasonable for residences in California generally (Spence and Gomez 1999a). SCJ used that value, which is equivalent to 0.00057 volume exchanges per second, for analyses of health risks for residential units on the Oak Walk Site.

Air exchange rates in occupied commercial buildings are usually considerably higher than those in residential buildings. This is frequently due to mechanical ventilation systems and other equipment installed to control the work environment. The ASTM air exchange rate default for commercial buildings is 0.83 ACH (0.00023 exchanges per second). However, when the outside temperature is between 60° F and 70° F, Pacific Gas & Electric Company's (**PG&E**) Energy Center in San Francisco, California, recommends that buildings should be ventilated with 100% fresh air because that method is more efficient than use of artificially-cooled or processed air.

Given the climate on the eastern shore of San Francisco Bay and the heating, ventilating and air conditioning (**HVAC**) engineering considerations noted above, Spence and Gomez used an air exchange rate of 5.0 ACH (0.0014 exchanges per second) when analyzing health risks for a general class of commercial buildings in the region (Spence and Gomez 1999a). SJC also adopted that exchange rate for commercial space at the Oak Walk Project site. Although that value is higher than the ASTM default, it is considered appropriately conservative when making health risk assessments for the commercial units. It is particularly conservative in the case of Building Type 1, which, when the development is complete, is expected to feature a restaurant on the ground floor. Compliance with building codes and adherence to good HVAC engineering practices require such facilities to be equipped with extensive exhaust systems that operate at capacities that must be greater than specified minimums and that exhaust large volumes of air from the interior to the exterior of the facility, thus promoting frequent exchanges of the total volume of air within the restaurant.

3.6.2.4 Foundation Thickness and Depth to Bottom of Foundation Slab

The ground floors of the buildings to be constructed on the Oak Walk Site will be underlain by a 6-in. thick concrete slab reinforced with No. 4 (0.5-in. diameter) deformed bars at 18 in. on center in both directions. Even when the blocking effect of the impermeable membranes laid beneath them are discounted, in the context of making the health risk evaluation the slabs will provide significant barriers to migration of vapors of COCs into the interior spaces of the buildings. Therefore, their thickness and the degree to which they may become cracked are critical parameters that must be considered when computing the concentrations of gasses or vapors of COCs that might accumulate inside the buildings. To reflect the design of the buildings' foundation and floor slab system, a value of 6 in. (0.50 ft.) was used for both the "foundation thickness" and "depth to bottom of foundation slab" parameters that must be inputted to the risk assessment software.

3.6.2.5 Foundation Crack Fraction

The ASTM default for the areal fraction of cracks in a building foundation or floor slab is 0.01, *i.e.*, 1.0%. However, most practitioners consider this value to be unreasonably high, particularly for modern floor slab construction such as that at the Oak Walk Project where, as is noted in Section 3.6.2.4 above, the floor slabs will be heavily reinforced. SJC assumed that the actual areal fraction of cracks that might develop in the floor slabs in the buildings on the subject property would be 0.001, *i.e.*, 0.1%. That value is supported by data from buildings constructed in California that has been reported by the American Society of Heating, Refrigerating and Air Conditioning Engineering (American Society of Heating, Refrigerating and Air Conditioning Engineering 1981).

3.6.2.6 Volumetric Water and Air Content of Cracks

The more air present in foundation or basement-wall cracks, the more easily a volatilized chemical can infiltrate a building. However, it is unreasonable to assume that cracks in a floor slab would remain free of dirt or water throughout the life of the building. Even if the slab surface remained exposed, the cracks would gradually begin to fill with dirt after they formed. In reality, the slab surfaces in the Oak Walk Project buildings will be covered with tile, carpeting and other flooring materials which will themselves serve to obstruct the flow of air through the cracks regardless of when they are formed. In all cases, these floor coverings will be laid on adhesives and other sealants that are likely to fill completely cracks that are formed during and shortly after the building construction period.

Moisture can also infiltrate cracks and be trapped there under capillary tension, particularly in fine or hairline cracks such as those that might form in the heavily reinforced slabs of the Oak Walk Project buildings. The ASTM default values for the volumetric water content and the volumetric air content of cracks are 0.12 (12%) and 0.26 (26%), respectively. For the reasons stated above, those proportions reflect highly-conservative assumptions about free air in the cracks that might permit convective air flow from the subsurface into the interior of the buildings. Therefore, SJC has elected to use those values as the input required for the health risk analyses reported herein.

3.6.2.7 Indoor/Outdoor Differential Pressure and Convective Air Flow through Cracks

The assumed differential pressure between indoor air and outdoor air is an important parameter controlling convective air flow through cracks in floor slabs and through openings in a building's skin. The rate of convective air flow, in turn, influences the concentrations of vapors of COCs that may accumulate in the interior air. If there is no differential pressure between the interior of a building and the outdoors, there is no convective air flow through foundation slabs. These latter conditions are set as the ASTM defaults for health risk analyses. However, in SJC's opinion, the assumption is non-conservative, particularly with respect to commercial buildings, because those structures frequently have interior air pressures that are less than ambient outdoor pressures. Low interior air pressures are particularly common in restaurants such as the one that is planned for the first floor of Building Type 1 on the Oak Walk Project site because building code requirements and good Heating Ventilating and Conditioning (**HVAC**) engineering practices require enhanced exhaust system flow rates in the vicinity of cooking ranges and other heat- and fume-generating equipment. Negative pressures can occur in commercial buildings and may also be present in residential units, although conditions in restaurants usually represent the upper range of differential pressures that develop between indoor and outdoor air.

Empirical values of relative interior to exterior differential air pressures, including the maximum measured in buildings subject to low interior pressure, have been measured in the field (DiPersio and Fitzgerald 1995, Bonnefous, *et. al.* 1992). These measurements include those published by Nazaroff, who concluded that, with respect to infiltration of vapors of COCs, differential pressure can be as great as 0.01 psi (Nazaroff, *et. al*. 1987). For consistent conservatism in the health risk analyses for the potentially-affected structures on the subject property SJC used that pressure differential which would generate significant convective upward air flow through any cracks that may develop in the floor slabs. That value was used for both commercial and residential units, even though it is recognized that it is extremely conservative when applied to the residential units.

3.7 Receptor-specific Parameters

A health risk analysis must include consideration of the characteristics of the potential "receptors" (*i.e*., in the case of a human health risk assessment, the exposed humans) of COCs that might migrate from the affected zones of subsurface soil and groundwater. Because both carcinogenic and toxic effects of exposure to COCs are, in most cases, cumulative with time and more acutely affect persons having a low body weight, such as children, the frequency and total duration of exposure to a chemical or combination of COCs, and the weight of the person exposed must be considered carefully.

3.7.1 Exposure and Averaging Times

The ASTM guidance documents assume, as a default, that the length of time used to normalize statistically the intake of a carcinogen is 70 years for residential, commercial and construction environments. That default is also the standard upon which the USEPA's carcinogenic and toxicity data are based. SJC's model assumes the same length of time for statistical normalization.

For the purpose of making the health risk assessments, SJC assumes that the concentrations of carcinogens remain constant over the average exposure time, which is very conservatively assumed to be 30 years for persons in residential environments and 25 years for commercial workers. This is a very conservative assumption because concentrations of carcinogens in soil and groundwater will actually decrease over time under the action of natural attenuation processes.

The ASTM default for the averaging times for non-carcinogenic health effects are also 30 years for residential and 25 years for commercial or industrial environments, which are also highly conservative. SJC's model adopts those values, but sets the averaging time for non-carcinogenic effects for construction workers to be one year, which better matches actual construction working conditions on the subject site than does the ASTM default value of 25 years.

3.7.2 Body Weight

Although body weight is known to be an important variable influencing the effects of carcinogens and toxic chemicals on human health, the ASTM default for body weight is set at 70 Kg (154 lbs), which is, in the United States, the approximate mean weight of individuals between the ages of 6 and 75 years (United States Environmental Protection Agency 1989a). However, the USEPA also cites the mean body weight of children between the ages of 0 and 6 years as 15 Kg (33 lbs) (United States Environmental Protection Agency 1996, 1993a, 1991b). For the purposes of evaluating health risks related to the ingestion of soil and water or when related to swimming in affected surface waters, it is SJC's practice to consider different ingestion rates during the first 6 years of a person's life as differentiated from the remainder of that life. In addition, to take advantage of available health risk data regarding dermal exposure to affected soil or surface water, it is SJC's practice to also consider the mean body weight of youths between the ages of 0 and 16 years, for which we use 35 Kg (77 lbs), which value has been statistically established by the USEPA (United States Environmental Protection Agency 1992a).

> **Note**:
>
> Although the body weights of receptors of different ages appear in the output of the health risk analyses presented in Appendices II-C through II-F (*i.e.,* they are used in relation to parameters for which "Age Adjustments" are made), they are cited there only for reasons of formality because there is no exposure to affected soil on the Oak Walk Project site. Following remediation, any such material that remains on the site will be buried at

considerable depth below the surface. Similarly, exposure to contaminated surface water, which, if present, would call for modeling of different ingestion rates and skin surface areas for persons of different ages, is not an issue that needs to be addressed for either on-site or off-site locations in the Tier 2 analyses for the subject property because no surface water is present on the subject property.

3.7.3 Inhalation Rate

The RBCA Tool Kit for Chemical Releases software used to perform the health risk calculations does not contain equations that use age, body weight or inhalation rate in the context of potential exposure pathways that might lead to inhalation of COCs. This is because the calculations made in the software are based on reference *concentrations* as opposed to reference *doses* for non-carcinogens, and *unit risk* factors as opposed to *slope* factors for carcinogens (Groundwater Services, Inc. 2003). See Page A-12 in Appendix II-A for the applicable equations.

A reference *concentration* (**R*f*C**) is an estimate of a maximum continuous inhalation exposure of a human population (including sensitive subgroups such as young children) to a toxic non-carcinogen below which there would be no significant risk of deleterious effects over the average lifetime of the population. A *unit risk* factor (**URF**) is the upper-bound excess lifetime cancer occurrence in a population of 1,000,000 due to continuous inhalation exposure to a carcinogen at a concentration of 1.0 $\mu g/m^3$ in air. Both R*f*C and URF values are independent of inhalation rate or body weight.

Although the equations used in the RBCA Tool Kit for Chemical Releases software make no assumptions with regard to inhalation rate, it would be possible to scale the exposure duration or exposure frequency values (see Sections 3.7.4 and 3.7.5 below) used for the analysis of any given site model to account for varying inhalation rates. However, SJC did not do this because: a) the reference concentrations and unit risk factors that are used for each COC in our calculations are based on lifetime studies of human populations that already account for varying body weight and inhalation rates with age; and b) it would not be conservative to scale either the exposure duration or exposure frequency values. For example, if it was decided to reflect a 10 m^3 /day inhalation rate, which is typical of a young child, instead of a 20 m^3 /day inhalation rate that might be proposed for a physically active commercial worker (United States Environmental Protection Agency 1996, 1997), then the default exposure duration of 350 days per year would be reduced to 350 x 10/20 = 175 days/year which would not yield such conservative results for health risks as would be the case when the unmodified ASTM default value of 350 days/year is used.

3.7.4 Exposure Duration

Exposure duration is the number of years over which an individual is assumed to be exposed to a COC. The ASTM default value for exposure durations is 30 years for residential sites and 25 years for commercial and industrial sites. SJC's model also uses those values for adults potentially exposed to COCs in commercial environments. However, when considering residents of the Oak Walk Project site, depending upon the exposure pathway being evaluated, SJC divided the total 30-year exposure duration into two parts based on the age of the human receptor. Depending upon the availability of data in the published literature, that division occurred at the age of 6 years or at the age of 16 years. Where age adjustments related to young children between the ages of 0 and 6 years were applied, an exposure duration of 6 years was used to that period of a person's life. Similarly, in cases where age adjustments were made for persons between the ages of 0 and 16 years, an exposure duration of 16 years was used for that period of life. In either of those situations, the years spent as a child or young person were subtracted from the total 30-year exposure duration that would have been used if no age weighting had been applied. For the remaining 24 or 14 years of the exposure duration, as applicable, a person was assumed to be at an adult weight. To account for the total effects of a 30-year exposure duration, the time periods over which the exposed person was assumed to have different body weights due to their age were added together.

The ASTM default exposure durations are highly conservative and are the same as the values proposed by the USEPA, which values are based on analysis of 1983 United States Census Bureau data (United States Environmental Protection Agency 1989a). SJC's consideration of age weighting adds significantly to that conservatism.

The degree of conservatism applied to the health risk assessments by SJC's use of age weighting adjustments to the ASTM default values for exposure durations can be gauged by considering the following characteristics of the Census Bureau data used by the USEPA when deriving its assumptions for exposure durations. Emeryville is an urban area and the USEPA exposure durations include statistical data from rural areas where population mobility tends to be significantly lower than in the urban communities on the eastern shore of San Francisco Bay. These factors have been studied by Israeli and Nelson (1992), who report that in the United States, 95% of all urban households stay in one residence for no more than 21.7 years while, regardless of their rural or metropolitan environment, 95% of western households move from one residence to another every 17.1 years. With respect to commercial and industrial land use scenarios, the United States Bureau of Labor Statistics reports that 50% of workers move from one job to another every four years (United States Bureau of Labor Statistics 1988).

In the case of construction workers SJC modeled the exposure duration to be one year, which is again highly conservative, because over the duration of the construction program at the Oak Walk Project site individual workers will spend less than a typical maximum of three months on the site due to the changing trade skills required. Similarly, a one-year exposure for construction work on any future maintenance or reconstruction work at the site is also highly conservative.

3.7.5 Exposure Frequencies

Exposure frequency is the number of days per year that a person is assumed to be exposed to a COC. The ASTM default residential and commercial exposure frequencies, which are based on guidance from the US-EPA, are 350 days per year and 250 days per year, respectively. Because of the limited duration over which construction workers might be exposed to COCs in the subsurface, the frequency of exposure of those workers is set at 180 days per year (United States Environmental Protection Agency 1996). SJC used the same exposure frequencies when computing health risks at the Oak Walk Project site. ASTM also has a separate default value for swimming-event frequency for residential land use, which is set at 12 events per year, but consideration of such events is not applicable to the Oak Walk Project site where no surface waters are present.

The general residential exposure frequency of 350 days per year applies to both indoor and outdoor exposure to inhaled vapors of COCs. In both applications, that frequency is extremely conservative because, with the exception of 15 days per year when it is assumed that a resident would be on vacation, the frequency implies that a person would spend 24 hours of each day at home. In the case of indoor exposure, it takes no consideration of time spent away from home such as, in actuality, is required to meet work schedules, perform errands and participate in such events as weekend trips. Conversely, for the outdoor exposure scenario, the default residential exposure frequency is based on the assumption that a resident at the subject property would spend 24 hours per day on the site and that all of that time would be spent outdoors. That assumption is clearly highly conservative.

The ASTM default exposure frequency of 250 days per year for commercial workers, which was also adopted by SJC for the health risk assessments reported herein, is based on a five-day work week for 50 weeks of the year. This value is conservative because it does not provide for national holidays or additional time off work that typically amounts to 10 - 20 days per year.

3.7.6 Other Receptor-specific Parameters

For reasons of formality, the presentation of the output from the health risk analyses that are compiled in Appendices II-C through II-G include receptor-specific parameters for pathways such as those related to ingestion of surface waters and consumption of fish caught in such waters that are not present on the Oak Walk Site. The values cited in the appendices for such parameters, although they are not actually used in the computations made for the subject site, are all either ASTM default values or highly-conservative numbers derived from reliable sources.

3.8 Acceptable Health Risks

Health risks are expressed in two forms: carcinogenic risk factor and toxic hazard quotient. The carcinogenic risk is expressed as the projected increase in the number of persons that become affected by cancer due to extended exposure to the conditions on the subject site compared to the general population not exposed to the site conditions. For example, a carcinogenic risk factor of 1.0×10^{-6} expresses the risk where there would be one additional occurrence of cancer in a population of one million persons exposed to the conditions at the site compared to the number of incidents of cancer found in a reference population of one million persons not exposed to the environmental conditions at the site.

The toxic hazard quotient is a measure of the severity of exposure for a period of time to a given COC that can be tolerated by a person exposed to that chemical by any pathway (*e.g.*, inhalation of contaminated air, ingestion of contaminated soil, or dermal contact with contaminated soil) or combination of pathways without suffering any toxicological symptoms due to that exposure. It is expressed as a ratio between the level of exposure to a given COC compared to an established reference dose below which no adverse health effects are experienced even when exposure is prolonged. A closely related parameter is the "toxicity hazard index" which is the sum of the toxic hazard quotients of two or more COCs at a given site due to the exposure of a particular receptor. A toxicity hazard index of 1.0 reflects the maximum tolerable limit to which a person can be exposed without suffering negative health effects. A toxic hazard index of less than 1.0 reflects the degree to which the anticipated exposure is less than that required to induce negative health effects. As the toxic hazard index rises above 1.0, its value reflects the severity of the toxicity of the environment to which a receptor is exposed.

On a given site, persons may be exposed to risks due to the presence of more than one carcinogenic and/or toxic chemical and the exposures may be via more than one pathway. Accordingly, to assess health risk properly, it is necessary to consider the cumulative effect on health due to the presence of all of the COCs present and if multiple pathways between the source and the receptor are present their cumulative effects must also be considered. For the health risk assessments presented herein, SJC computed the cumulative risks of all COCs present due to their migration via all applicable pathways.

3.8.1 Classification of Carcinogens

Carcinogens are classified by the USEPA according to a system that is based on the weight of available evidence that they are, or are suspected to be, human carcinogens. Carcinogens are classified according to alphabetic nomenclature that is based on the weight of available evidence that a given chemical is, or is suspected to be, a human carcinogen. Chemicals known to be potent human carcinogens are classified as "A" carcinogens, while non-carcinogenic chemicals are given the classification "D." At the Oak Walk Project site, only one known human carcinogen - benzene - has been detected in the subsurface. Benzene is a Class A carcinogen. The other COCs at the Oak Walk Project site (see Sections 3.1 and 3.2) are toxic materials, but are not known to be carcinogenic; thus, they fall into the "D" classification.

3.8.2 Health Risk Limits of Carcinogens

Although there is a general perception that a risk factor of 1.0×10^{-6} represents an established upper limit of acceptable carcinogenic health risk promulgated in State and Federal regulations, that is *not*, in fact, the case. The USEPA has indicated that the appropriate risk limit applicable to a specific exposure or a specific form of exposure should fall within the range 1.0×10^{-6} to 1.0×10^{-4}. The origin of the 1.0×10^{-6} limit appears to have been a recommended risk-based limit for residues of animal drugs found in human food-grade meat (United States Food and Drug Administration [**FDA**] 1973). That target risk level represents, essentially, a zero risk (Malander 2002).

As the inherently conservative nature of risk assessment calculations has been recognized and as risk-based evaluation of environmentally compromised sites and other potential human exposures have been more widely used in regulatory decision-making, other, less stringent, risk level guidelines have been legislated or adopted. For example, in its Hazardous Waste Management Systems Toxicity Characteristics Revisions, the USEPA selected a single level of 1.0×10^{-5} based on that Agency's belief that, due to the extremely conservative nature of the exposure scenarios employed in risk-based health risk assessments and the underlying health criteria used, a 1.0×10^{-5} risk level is realistic and appropriate as a practical target limit to protect the health of an exposed population (United States Environmental Protection Agency 1995a).

California State Proposition 65 (The Safe Drinking Water and Toxic Enforcement Act of 1986) enforcement is also based on a limiting target risk of 1.0×10^{-5}. Proposition 65 requires the governor of California to publish annually a list of chemicals known to the State to cause cancer or reproductive toxicity. All businesses that might expose individuals to a listed chemical must post a clear warning of such risk on the business premises, unless there is "no significant risk" posed by the chemical in question. The State of California has defined "no significant risk" as less than one excess case of cancer per one-hundred thousand individuals, which corresponds to target risk of 1.0×10^{-5}.

Target carcinogenic risk limits are not values that are derived from the health risk assessment calculation or from the carcinogenic or toxicological properties of any given chemical or combination of chemicals. In fact, as is evidenced by the discussion above, any selected health risk limit is, in fact, an arbitrary value that represents the perspective of a given regulatory agency, a local community, or an interest group about what constitutes an acceptable risk to human health in the context of its social, political and economic milieu. For example, the City of Oakland had preliminarily established a risk limit of 1.0×10^{-6} to develop Tier 1 risk-based assessment guidelines, but after extensive input from representatives of a wide range of local interests that included regulatory agencies, consulting engineers, community improvement groups, minority business associations, the Sierra Club and a wide cross-section of Oakland residents, that city set a health risk limit of 1.0×10^{-5} for Tier 2 health risk assessments (Spence and Gomez 1999b).

ASTM recommends a target carcinogenic health risk of 1.0×10^{-5} for risk-based assessments at petroleum release sites and describes that value as representative of *de minimus* risk (American Society for Testing and Materials 2002). SJC is firmly of the opinion that the 1.0×10^{-5} limit is applicable to the Oak Walk Site because: a) below that level there is, as had been stated by the State of California in the context of Proposition 65, as well as by other regulatory bodies, no significant risk to exposure from a known carcinogen; b) given the approximations inherent to Tier 2 health risk computations, health risk targets set lower than 1.0×10^{-5} have no practical mathematical significance other than as a representation of what is, in reality, a *zero* health risk; and c) the City of Oakland's election to use a health risk of 1.0×10^{-5} for sites in that city that include geologic, hydrogeologic, climatic and economic and socio-political environments that are essentially identical to those in the City of Emeryville, including those of the Oak Walk Project site, properly reflects all of the factors that should be considered when setting a site-specific target risk level. However, the RWQCB, which has jurisdiction of the subject property in Emeryville, uses a target risk of 1.0×10^{-6} when preparing ESLs (California Water-quality Control Board - San Francisco Bay Region 2005). Accordingly, although for the reasons stated above SJC believes that such a target risk is unwarranted and mathematically meaningless, when evaluating the results of the Tier 2 risk assessment for the subject property that are reported herein SJC compared the carcinogenic risk to that 1.0×10^{-6} target risk level.

3.8.3 Toxic Hazard Limits

For non-carcinogenic health effects, the results of most health risk assessments are compared with a toxic hazard quotient of 1.0, which represents the threshold value below which no adverse health effects are experienced by exposed populations and is the ASTM default value for Tier 2 risk assessments. This value is based on the precedents set by the USEPA in its Risk Assessment Guidance for Superfund (**RAGS**) (United States Environmental Protection Agency 1989b). It was also adopted by the City of Oakland, but with a requirement to address cumulative risk, if necessary (*i.e.*, to consider the toxic hazard *index*), when it developed its guidelines for Tier 2 health risk assessments (Spence and Gomez 1999b). With respect to this measure of health risk, SJC concurs with both the USEPA and the City of Oakland and we normally set both the target health risk quotients and the health risk index at 1.0 when evaluating specific sites where the environment has been impaired. The RWQCB, however, in preparing its ESLs for affected soil and groundwater in the San Francisco Bay region, elected to use target quotients at the unusually conservative value of 0.2. That Agency's guidance document provides an option for site-specific adjustment of that value (California Water Quality Control Board - San Francisco Bay Region 2005); however SJC has elected to conform to the RWQCB’s unmodified value and has also adopted the extremely conservative criterion that limits both the target quotients and target index to 0.2.

4.0 RESULTS OF HEALTH RISK ASSESSMENTS

As was discussed in Section 2.3.1, the potential health risks associated with Building Types 3A and 1, which will be constructed on the Oak Walk Project Site, were selected for analysis due to their locations in areas of the site that are affected by relatively high concentrations of COCs in soil and groundwater. Their locations are shown on Figure II-24.

The RBCA Toolkit for Chemical Releases software, described in Section 2.4, was used to compute the potential health risks associated with Building Types 3A and 1 if they were to be built on an unremediated site. In addition, the potential health risks were computed for several additional conditions that would prevail after various elements of the proposed corrective action program had been implemented so that the reduction in health risks associated with each element of the total corrective action plan described in Volume I of this report to be evaluated. That procedure assisted the design process for the corrective action program so that its required elements could be determined.

4.1 Building Type 3A

The location of Building Type 3A is shown on Figure II-24. Due to the relatively low elevation of its floor slab and the relatively high concentrations of COCs in soil and ground water beneath the area of the site on which they will be constructed, that building type is more vulnerable to potential environmental risks than other residential units planned for the site.

4.1.1 RBCA Results for Unimproved Conditions

An initial health risk analysis was performed for Building Type 3A based on the assumption that its floor slab would be constructed at the planned elevation of 46.83 ft. NAVD (see Table II-6) without any remedial action being taken to improve the environmental condition of the underlying soil and groundwater. The results are presented in Appendix II-C and apply to the conservatively-developed, building-specific models and the highly-conservative parameters for the COC transport pathways that were developed in Section 3.0. The key building-specific modeling parameters for Building Type 3A used in the risk assessment are presented in Tables II-6 and II-7 and the concentrations of COCs in soil and groundwater used in the health risk analyses are presented in Tables II-8 and II-9, respectively. The applicable chemical, physical, toxicological and carcinogenic properties of the COCs in soil and groundwater included in the health risk assessment are presented in Table II-10.

The graphic and numerical data produced as output by the health risk assessment software that is presented in Appendix II-C includes complete documentation of the input parameters used to perform the assessments and the results of the interim and final calculations required to compute both the chemical-specific and pathway-specific toxicological and carcinogenic health risks associated with exposure pathways associated with both outdoor air in the area of the site surrounding Building Type 3A and the exposure to indoor air in that building type. Exposure pathways related to contact with soil, groundwater or surface water are not applicable to a risk assessment of the Oak Walk Site because residents will not be exposed to those risk pathways.

> **Note:**
>
> The exposure pathway flow chart included in the computer output presented in Appendix II-C represents affected surficial soils as being a source media for COCs. However, in actuality, that is not the case at the Oak Walk Project Site. All affected soils are buried at depth beneath the ground surface. The presence of affected surficial soils as a source medium in the diagram generated by the software is an artifact of the computer code. It appears on a flowchart whenever the user elects to use the option whereby vaporization from subsurface soil to outdoor air is computed by both the Johnson-Ettinger method and the ASTM method for surface soils, so that the results of the ASTM calculation can be set as an upper limit, which might otherwise be exceeded due to the limitations of the Johnson-Ettinger computational method (See Section 2.4.1 above). The source media and COC migration pathways actually present on the Oak Walk Project site are correctly represented on Figure II-23.

The results of the health risk analysis for Building Type 3A, based on the assumption that it will be constructed on an unremediated site, are presented in Table II-11. Examination of that Table shows that both the calculated cumulative carcinogenic risk and the toxic hazard index for both outdoor and indoor air exceed the applicable target risk and target index of 1×10^{-6} and 0.2, respectively. It is important to recognize that those results are based on the worst-case assumptions regarding the risk modeling parameters that were developed in Sections 2.0 and 3.0 of this document. As expected, the highest risks are associated with exposure of residents to indoor air. The computed carcinogenic risk of 9.6×10^{-5} and the computed toxic hazard index of 4.8 for that pathway demonstrate that the area of the site in the vicinity of Building Type 3A needs to be remediated to reduce human health risks to acceptable levels.

4.1.2 RBCA Results for Conditions Following Soil Remediation

The next health risk assessment performed for Building Type 3A was based on the assumption that soil remediation work in the area of that building type will have removed affected soil down to a depth of 7.0 ft. below the existing ground surface and that soil will have been replaced by the low-permeability compacted fill described in Section 3.5.1 above. The key building parameters and concentrations of COCs in soil and groundwater beneath Building Type 3A for those conditions are also presented in Tables II-6, II-7, II-8 and II-9. The output from the health risk assessment software for that site condition is presented in Appendix II-D and the results are summarized in Table II-11.

As can be seen by examination of Table II-11, the effect of excavating the soil down to a depth of 7 ft. below the existing ground surface in the area around Building Type 3A and replacing it by clean, low-permeability engineered fill is to reduce the carcinogenic risk and toxic hazard index for both the indoor and outdoor air pathways by more than an order of magnitude so that the cumulative carcinogenic risk is 3.9×10^{-6} and the toxic hazard index is 0.250 for the improved soil condition. While both those values are lower than the standards set by the USEPA and the State of California for definition of *de minimus* health risks at 1.0 x 10^{-5} for the cumulative carcinogenic risk and 1.0 for the toxic hazard index, respectively, they exceed the very conservative targets 1.0 x 10^{-6} and 0.250, respectively, that have been set for this project. This result indicates that to meet those targets, additional remedial measures beyond excavation of contaminated soil and its replacement with clean, low-permeability engineered fill will be required.

Note:

To avoid redundancy, selected elements of the health risk assessment output that are common to the analyses of all building types on the site have not been presented in Appendix II-D and the cumulative health risk and hazard index result has been limited to a presentation of a summary of the results for the cumulative affects of all the COCs considered. Similar editing has been applied to the health risk assessment results presented in Appendices II-E through II-G.

4.1.3 RBCA Results for Conditions Following Both Soil and Groundwater Remediation

Finally, a risk assessment analysis was performed for Building Type 3A for conditions when remediation work included not only excavation of affected soil to a depth of 7 ft. beneath the existing ground surface and replacement of that soil with low-permeability engineered fill, but also assumed that the remediation of groundwater in the area that is described in Section 5.3.2 of Volume I of this work plan will have reduced local concentrations of COCs in groundwater to 40% of those that prevailed at the time that the site characterization conducted at Oak Walk Redevelopment Site was completed in November 2004 (The San Joaquin Company Inc., 2005). Those remediated groundwater conditions are stated in Table II-8, where they are designated to be the "Post-remediation" conditions. The results of the risk analysis conducted for those conditions are presented in Appendix II-E and they are also summarized in Table II-11.

Table II-11 shows that the reduction in computed health risk associated with the remediation of groundwater is commensurate with the reduction of the concentration of COCs in that medium in the subsurface. The cumulative carcinogenic risk and the toxic hazard index of 5.9 x 10^{-8} and 0.028, respectively, associated with the outdoor air pathway are now both below their very conservatively-established targets. However, while very low at 2.3 x 10^{-6} and 0.130, and well below the limits of 1 x 10^{-5} and 1.000 set by the USEPA and the State of California, respectively, the cumulative carcinogenic risk and toxic hazard index associated with the indoor air pathway remain at values greater than the highly conservative target risk and target index values set by this project. Corrective action measures to eliminate those insignificant remaining risks for the case of building Type 3A are discussed in Section 5.0 below.

4.1.4 Interpretation of Cumulative Carcinogenic Risk and Toxic Hazard Index

When considering the numerical values of the cumulative carcinogenic risks and toxic hazard indices presented in Table II-11 that were computed for building Type 3A, it is important to note that target cumulative carcinogenic risks and target toxic hazard indices are arbitrarily set. As was noted in Section 3.8.2, the USEPA (United States Environmental Protection Agency 1995a), the State of California (See The Safe Drinking Water and Toxic Enforcement Act of 1986), and the ASTM (American Society for Testing and Materials 2002) are in agreement that when cumulative carcinogenic risks and toxic hazard indices fall below 1.0×10^{-5} and 1.0, respectively, there is no significant health risk present on the site. Lower values simply mean that there are, for practical purposes, zero human health risk present. Although the mathematical formulation used for the health risk analyses are capable of producing cumulative carcinogenic risk and toxic hazard index values smaller than those numbers, it is not meaningful to compare one with the other except to the extent that some may be smaller and others larger than the "no significant risk" criteria. When interpreted in that light it is clear that the risk assessment analysis results presented in II-11 show that there would be no significant health risks to the occupants of building Type 3A on the Oak Walk Redevelopment Site if replacement of contaminated soil by clean low permeability engineered fill was the only corrective action taken in the area of the site where those buildings will be located.

Although mathematically smaller values for the cumulative carcinogenic risk and toxic hazard index are computed when corrective action measures are taken to remediate groundwater as well as to remediate soil in the surface beneath building Type 3A, comparison of those lesser values has, for the reasons stated above, no meaning. The results for either scope of corrective action simply indicate that the residents would be exposed to no meaningful health risks.

4.2 Building Type 1

The location of Building Type 1 is shown on Figure II-24.

4.2.1 RBCA Results for Unimproved Conditions

An initial health risk analysis was performed for Building Type 1 based on the assumption that its floor slab would be constructed at the planned elevation of 42.38 ft. NAVD without any remedial action being taken to improve the environmental condition of the underlying soil and groundwater. The results are presented in Appendix II-F and apply to the conservatively-developed, building-specific models and the highly-conservative parameters for the COC transport pathways that were developed in Section 3.0. The key building-specific modeling parameters for Building Type 1 used in the risk assessment are presented in Table II-6 and the concentrations of COCs in groundwater and soil used in the health risk analyses are presented in Tables II-8 and II-9, respectively. The applicable chemical, physical, toxicological and carcinogenic properties of the COCs in soil and groundwater included in the health risk assessment are presented in Table II-10.

The results of the health risk analysis for Building Type 1, based on the assumption that it will be constructed on an unremediated site are presented in Table II-12. Examination of that Table shows that for that condition, the calculated cumulative carcinogenic risk and the toxic hazard index for both outdoor and indoor air are well below the very conservative target risk and target index of $1x10^{-6}$ and 0.2, respectively, that have been set for this project.

4.2.2 RBCA Results for Conditions Following Soil Remediation

As noted above, the cumulative carcinogenic risk and toxic hazard index for Building Type 1 if it were to be built in its proposed location would, as is shown is Table II-12, be very much smaller than the very conservative targets set by this project without any remedial work being conducted at that area of the site. However, geotechnical engineering considerations will require the soft soil beneath that building to be excavated to a depth of 7 ft. below the existing ground surface and replaced by the clean, low-permeability engineered fill described in Section 3.5 above. The result of that work will be to increase the distance between the top of the floor slab of the building and the soil that is affected by the COCs that will be left in the subsurface. However, as is noted in Table II-9, in the model used to compute the health risks the concentrations of COCs in soil, for the purpose of the risk assessment calculations for the site in the remediated condition, were not reduced because the highest concentrations in that medium were detected at depths greater than 7 ft. below the existing ground surface.

In the case of the concentrations of COCs in groundwater, the post-remediated condition was also assumed to be the same as the pre-remediated condition because no direct remediation is proposed for groundwater in that area of the Oak Walk Redevelopment Site. That latter assumption is also very conservative because removal of a large volume of affected soil by the excavations required to comply with the geotechnical engineering requirement will significantly reduce the availability of COCs to desorb into the groundwater from the soil mass. Over time, that process of desorbtion, which is followed by dispersion of the COCs, will cause the concentrations of COCs in groundwater to fall.

The results of the post remediation health risk assessments for Building Type 1 are included in Table II-12. As would be expected, given that it was assumed that the concentrations of COCs in soil and ground water remained unchanged compared to the analysis where it was assumed that the site conditions were unimproved, the results for the remediated site, while substantially better than those for the unimproved site, have values within the same order of magnitude as those previously computed. As was discussed in Section 4.1.4 above, a mathematical comparison of the results of the health risk results computed for the remediated, compared to the unimproved, site is meaningless because each set of results indicates that workers in Building Type 1 would be exposed to “no significant risk.”

5.0 IMPERMEABLE BARRIERS

As is described in Section 4.0 above, the only pathway for contaminant transport present on the Oak Walk Site that might lead to a cumulative carcinogenic risk or total hazard index higher than the very conservatively-set targets of 1.0×10^{-6} and 0.200, respectively, is the indoor air pathway for Building Type 3A, the analyses from which yield values of 5.9×10^{-8} and 0.130. In practice, it is highly unlikely that the concentrations of COCs in that air will reach the concentrations indicated by the health risk analyses. That is due to the extreme conservatism of the modeling parameters selected and the fact that concentrations of COCs in both soil and groundwater will be reduced from those present in November 2004 and will continue to decline under the action of natural attenuation.

To eliminate any risk, however slight, associated with the quality of indoor air in Building Type 3A, a gas-proof, benzene resistant membrane will be applied beneath the whole area of the floor slabs of those residential units. The installation of the membrane is shown on Figure II-25. The specified membrane is Liquid Boot®, manufactured by LBI Technologies, Inc. of Santa Ana, California (**LBI**) or equivalent material that has been tested according to ASTM Standard D542-95 and found to be resistant to deterioration in the presence of components of fuel hydrocarbons including benzene (American Society for Testing and Materials 2001). The Liquid Boot® membrane will be sprayed over a geotextile substrate laid over a gravel base until it reaches a minimum thickness of 60 mils. The membrane will also be installed vertically along the sides of the buildings' exterior strip footings, column bases and around each utility pipe or other penetration passing through the floor slabs. This technique ensures that the membrane forms a complete seal against ingress of gaseous and vapor phases of COCs into the building's interior spaces. No penetration of the impermeable membrane will be allowed after the membrane has been installed and cured.

Although such application is unnecessary to achieve the conservatively-set cumulative carcinogenic risk and total hazard index values for any commercial or residential unit in the proposed Oak Walk Redevelopment other than for Building Type 3A, the Liquid Boot® membrane will be applied beneath the floor slabs of all residential and commercial units to be constructed on the site. In addition, Liquid Boot® membrane will be installed beneath a concrete slab laid on the floor of the crawl spaces in each of the existing residential structures that will be restored and re-sited along 41st Street and at the intersection of 40th and Adeline Streets. This extremely conservative approach thus will provide all inhabitants of the development with a high degree of confidence in the environmental condition of the site.

Note:

Installation of the impermeable barriers beneath the residential and commercial buildings will entirely eliminate any health risks associated with potential accumulations of COCs in indoor air and would render the health risk analyses described in Section 3.0 for conditions associated with that pathway to be redundant. Despite this, SJC performed those health risk analyses as an aid to design of the necessary corrective action measures and to demonstrate their conservatism.

6.0 SUMMARY OF HEALTH RISK ASSESSMENT

In summary, the health risk assessments conducted for the Oak Walk Redevelopment Site have demonstrated that after the site has been remediated by excavation of soil to meet the geotechnical requirements, and replacement of that affected soil by clean, engineered fill and after concentrations of COCs in groundwater have been locally reduced, neither occupants of the residential units nor workers in the commercial units planned for the mixed-use development will be exposed to any health risk in excess of those set by the target cumulative carcinogenic risk and target toxicity index used by the ASTM, the USEPA and the State of California's Proposition 65 (*i.e.,* 1.0 x 10^{-5} and 1.0, respectively). However, without additional corrective action measures the unusually-conservative target values set for this project (*i.e.*, 1.0 x 10^{-6} for cumulative carcinogenic risk and 0.2 for the toxic hazard index) would be locally exceeded in the case of the indoor air in Building Type 3A. At the location of those residential units, which is shown on Figure II-24, groundwater is locally affected by relatively high concentrations of COCs and the cumulative carcinogenic risk computed for the indoor air pathway is 2.3 x 10^{-6} and the toxic hazard index is 0.130.

When evaluating the health risk analyses results presented above it is important to consider the conservatism used in selecting the modeling parameters used in the analyses and the unusually restrictive target cumulative carcinogenic risk and target toxic hazard index set for the project. As described in Section 3.0, many of the key parameters that were used as input to the risk assessment analyses, such as the height above the water table to which the capillary fringe will rise, were set at much more conservative values than the defaults recommended in ASTM Standard E1739-95 (2002) that applies to risk-based corrective action designs for petroleum release sites. Furthermore, the risk assessment analyses were made without consideration for natural attenuation of the concentrations of COCs in the subsurface which, because the sources of those chemicals have been removed, will cause the concentrations of un-remediated COCs in the soil and groundwater beneath the Oak Walk Site to fall steadily with time.

To entirely eliminate any risk, however theoretical, due to the environmental quality of indoor air in Building Type 3A, 60 mils of Liquid Boot®, a membrane that is impermeable to both gas and water even when exposed to benzene and other components of fuel hydrocarbons, will be installed beneath the floor slab of that Building Type. In addition, Liquid Boot® membrane will be installed beneath a concrete slab laid on the floor of the crawl spaces in each of the existing residential structures that will be restored and re-sited along 41st Street and at the intersection of 40th and Adeline Streets. This extremely conservative approach will provide all inhabitants of the development with a high degree of confidence in the environmental condition of the site.

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TABLE II-1

DEPTHS TO GROUNDWATER
AT OAK WALK REDEVELOPMENT SITE

Well No.	Date Measured	Casing Elevation ft. MSL	Groundwater Depth ft.	Groundwater Elevation ft. MSL
WCEW-1		41.73		
	06/02/98		7.24	34.49
	03/13/98		5.92	35.81
	12/05/97		6.00	35.73
	09/26/97		8.06	33.67
	05/19/04		7.88	33.85
	11/08/04		7.13	34.60
MW-2		44.40		
	05/19/04		5.98	38.42
	11/08/04		4.94	39.46
MW-3		45.49		
	05/19/04		5.66	39.83
	11/08/04		5.89	39.60
MW-4		47.31		
	05/19/04		6.19	41.12
	11/08/04		5.81	41.50
MW-5		42.51		
	05/19/04		7.39	35.12
	11/08/04		7.09	35.42
MW-6		43.35		
	05/19/04		7.16	36.19
	11/08/04		6.93	36.42
MW-7		44.75		
	05/19/04		8.40	36.35
	11/08/04		8.10	36.65
MW-8		48.38		
	05/19/04		9.65	38.73
	11/08/04		9.05	39.33
MWT-1		42.98		
	05/19/04		8.43	34.55
	11/08/04		6.82	36.16
MWT-2		45.28		
	05/19/04		7.69	37.59
	11/08/04		7.17	38.11

Well No.	Date Measured	Casing Elevation ft. MSL	Groundwater Depth ft.	Groundwater Elevation ft. MSL
MWT-3		47.64		
	05/19/04		7.64	40.00
	11/08/04		7.66	39.98
MWT-4		44.74		
	05/19/04		8.43	36.31
	11/08/04		7.99	36.75
MWT-5		47.10		
	05/19/04		9.07	38.03
	11/08/04		8.84	38.26
MWT-6		45.21		
	05/19/04		9.05	36.16
	11/08/04		8.73	36.48
MWT-7 [1]		46.61		
	05/19/04		9.90	36.71
	11/08/04	45.69	8.60	37.09
MWT-8		47.23		
	05/19/04		9.65	37.58
	11/08/04		9.31	37.92
MWT-9		45.78		
	05/19/04		8.70	37.08
	11/08/04		8.23	37.55
MWT-10		47.22		
	05/19/04		9.53	37.69
	11/08/04		9.03	38.19
MWT-11		46.63		
	11/08/04		9.71	36.92
MWT-12		47.97		
	11/08/04		10.79	37.18
MWT-13		48.16		
	11/08/04		10.65	37.51
MWT-14		47.85		
	11/08/04		9.63	38.22

Notes:

1) MWT-7 casing truncated by vandals. Elevation resurveyed on 11/10/04

TABLE II-2

RESULTS OF ANALYSES OF SOIL SAMPLES FOR PETROLUEM HYDROCARBONS RECOVERED FROM OAK WALK REDEVELOPMENT SITE

			Petroleum Hydrocarbons			**BTEX Compounds**				**Volatile Organic Compounds**													**PNAs**		
Sample ID	**Date Sampled**	**Depth BGS**	**Mineral Spirits**	**TPHd (diesel)**	**TPHg (gasoline)**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**MTBE**	**Acetone**	**2-Butanone**	**n-Butylbenzene**	**sec-Butylbenzene**	**tert-Butylbenzene**	**Isopropylbenzene**	**p-Isopropylbenzene**	**p-Isopropyltoluene**	**n-Propylbenzene**	**1,2,4-Trimethylbenzene**	**1,3,5-Trimethylbenzene**	**Other VOCs by 8260B**	**Napthalene**	**2-Methylnapthalene**	**15 Other PNAs by 8270C**
		ft.	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	**GC/MS**	mg/Kg	mg/Kg	mg/Kg
Trenches - December 2003																									
T1 - 7.0	12/03/03	7.0	n/a	70	**530** [5]	ND	ND	8.3	4.7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T1 - 8.5	12/03/03	8.5	n/a	90	**1,400** [5]	ND	ND	10	1.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T2 - 6.5	12/03/03	6.5	n/a	ND	3.8 [5]	0.026	ND	0.024	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T2 - 8.5	12/03/03	8.5	n/a	1.5	**300** [5]	**1.1**	3.1	6.4	**27**	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T3 - 8.0	12/03/03	8.0	n/a	4.3	6.4	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	n/a	n/a
T3 - 9.5	12/03/03	9.5	n/a	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T4 - 10.5	12/03/03	10.5	n/a	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	ND
T5 - 9.0	12/03/03	9	ND	70 [4]	**400**	ND	2.6	6.1	**36**	ND	n/a	n/a	ND	0.6	ND	0.88	ND	ND	3.9	25	7.6	ND	**4.1**	**1.8**	ND
T6 - 8.5	12/02/03	8.5	n/a	70	**3,000** [5]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T7 - 9.0	12/02/03	9.0	n/a	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T8 - 8.5	12/02/03	8.5	n/a	**150**	**820** [5]	ND	ND	ND	ND	ND	n/a	n/a	0.51	0.81	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	ND
Borings and Wells 2004																									
BE-1-5.0	04/02/04	5.0	62 [3]	ND	**540**	ND	ND	5.1	1.6	ND	ND	ND	8.4	3.1	ND	2.7	ND	0.29	13	12	3.8	ND [6]	**18**	**3.2**	ND [9]
BE-1-10.0	04/02/04	10.0	**130** [3]	ND	**3,600**	**13**	**140**	**80**	**430**	ND	ND	ND	3.7	ND	ND	1.4	ND	ND	6.2	32	12	ND	**7.5**	ND	ND
BE-1-13.5	04/02/04	13.5	n/a [2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BE-1-15.0	04/02/04	15.0	ND	ND	7.9	0.096	0.029	0.12	0.6	0.011	ND	ND	0.014	ND	ND	ND	ND	ND	0.027	0.054	0.013	ND	0.12	ND	ND
BE-1-20.0	04/02/04	20.0	ND	ND	2.5	0.027	0.011	0.016	0.033	ND	0.031	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-1-25.0	04/02/04	25.0	ND	ND	ND	ND	0.0053	ND	0.011	0.012	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-2-5.0	04/02/04	5.0	27 [3]	ND	**340**	**1.3**	ND	5.7	**26**	ND	ND	ND	9.1	2.4	ND	2.5	ND	ND	12	37	14	ND	**18**	**1.4**	ND
BE-2-10.0	04/02/04	10.0	24 [3]	ND	**820**	**7.4**	**33.0**	16.0	**87.0**	ND	ND	ND	3.3	ND	ND	1.3	ND	ND	5.7	29	10	ND	**6.8**	**0.31**	ND
BE-2-15.0	04/02/04	15.0	ND	2.5 [8]	5.0	0.052	ND	0.027	ND	0.075	0.14	ND	0.046	0.019	ND	0.0097	ND	ND	0.046	ND	ND	ND	ND	ND	ND
BE-2-20.0	04/02/04	20.0	ND	2.4 [7]	ND	ND	ND	ND	0.0086	0.11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-2-25.0	04/02/04	25.0	ND	ND	ND	0.053	0.051	0.038	0.15	0.018	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0069	ND	ND	ND	ND	ND
BE-3-5.0	04/02/04	5.0	ND	1.1 [8]	ND	ND	ND	ND	ND	ND	0.11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-3-10.0	04/02/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	0.025	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-3-15.0	04/02/04	15.0	ND	1.3 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-3-20.0	04/02/04	20.0	**190**	ND	**1,600** [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

			Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds													PNAs		
Sample ID	**Date Sampled**	**Depth BGS**	**Mineral Spirits**	**TPHd (diesel)**	**TPHg (gasoline)**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**MTBE**	**Acetone**	**2-Butanone**	**n-Butylbenzene**	**sec-Butylbenzene**	**tert-Butylbenzene**	**Isopropylbenzene**	**p-Isopropylbenzene**	**p-Isopropyltoluene**	**n-Propylbenzene**	**1,2,4-Trimethylbenzene**	**1,3,5-Trimethylbenzene**	**Other VOCs by 8260B**	**Napthalene**	**2-Methylnapthalene**	**15 Other PNAs by 8270C**
		ft.	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	**GC/MS**	mg/Kg	mg/Kg	mg/Kg
BE-4-5.0	04/01/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-4-9.5	04/01/04	9.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-4-14.5	04/01/04	14.5	ND	1.3 [8]	2.8	0.006	ND	0.047	0.024	ND	0.04	ND	0.081	0.027	ND	0.017	0.0099	ND	0.081	0.12	0.005	ND	0.086	ND	ND
BE-4-19.5	04/01/04	19.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-5-5.0	04/01/04	5.0	ND	4.5 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-5-10.0	04/01/04	10.0	14	ND	**340** [5]	ND	ND	ND	ND	ND	ND	ND	0.092	0.046	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-5-14.5	04/01/04	14.5	ND	2.5 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-5-19.5	04/01/04	19.5	ND	12 [7]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BE-6-4.0	04/01/04	4.0	ND	22 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-6-9.5	04/01/04	9.5	ND	**1,200** [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0066	ND	ND
BE-6-15.0	04/01/04	15.0	ND	11 [8]	**130** [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BE-6-20.0	04/01/04	20.0	ND	4.9 [8]	2.6 [5]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BG-1-5	04/06/04	5.0	ND	ND	1.30	ND	ND	ND	ND	ND	0.046	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	ND
BG-1-10	04/06/04	10.0	35 [3]	ND	**870**	ND	9.0	13	**75**	ND	ND	ND	2.6	ND	ND	1.1	ND	ND	4.4	23	8.1	ND	**4.2**	**3.5**	ND
BG-1-15	04/06/04	15.0	ND	3.7 [8]	**270**	**1.1**	0.99	4.9	**24**	ND	0.065	ND	0.028	ND	ND	ND	ND	ND	0.025	0.160	0.056	ND	0.055	ND	ND
BG-1-20	04/06/04	20.0	ND	ND	ND	0.0062	ND	ND	ND	0.005	0.044	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BG-1-25	04/06/04	25.0	ND	ND	ND	ND	ND	0.0051	0.023	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BG-1-30	04/06/04	30.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a
BG-1-35	04/06/04	35.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BG-2-5.0	04/06/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BG-2-10.5	04/06/04	10.5	47 [3]	ND	**1,200**	ND	ND	16	**80**	ND	ND	ND	6.0	ND	ND	2.4	ND	ND	10	50	17	ND	**8.5**	**3**	ND
BG-2-15.0	04/06/04	15.0	ND	ND	ND	ND	ND	ND	ND	ND	0.028	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BG-2-18.0	04/06/04	18.0	ND	ND	ND	ND	ND	ND	ND	0.020	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BG-2-21.0	04/06/04	21.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BG-2-25.0	04/06/04	25.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BG-2-30.0	04/06/04	30.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BG-2-35.0	04/06/04	35.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-1-4.0	04/02/04	4.0	ND	ND	ND	ND	ND	ND	0.0063	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-1-11.5	04/02/04	11.5	74	ND	**2,400** [5]	ND	ND	ND	ND	ND	ND	ND	ND	0.023	0.022	ND	ND	ND	ND	ND	ND	ND	ND	**1.7**	ND
MWT-1-15.0	04/02/04	15.0	ND	2.8 [8]	ND	ND	ND	ND	ND	ND	ND	ND	0.0051	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-1-20 [11]	04/02/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-2-5.5	04/02/04	5.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-2-10.0	04/02/04	10.0	12 [3]	ND	**440**	ND	ND	2.3	6.8	ND	ND	ND	1.8	0.44	ND	0.500	ND	ND	2.4	10	3.8	ND	**1.2**	**0.93**	ND
MWT-2-15.0	04/02/04	15.0	ND	8.0 [8]	**120**	ND	ND	0.67	1.2	ND	0.099	0.027	0.035	0.0079	ND	0.0055	ND	ND	0.032	0.18	0.047	ND	0.08	0.14	ND
MWT-2-20.0	04/02/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

			Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds													PNAs		
Sample ID	**Date Sampled**	**Depth BGS** *ft.*	**Mineral Spirits** mg/Kg	**TPHd (diesel)** mg/Kg	**TPHg (gasoline)** mg/Kg	**Benzene** mg/Kg	**Toluene** mg/Kg	**Ethylbenzene** mg/Kg	**Total Xylenes** mg/Kg	**MTBE** mg/Kg	**Acetone** mg/Kg	**2-Butanone** mg/Kg	**n-Butylbenzene** mg/Kg	**sec-Butylbenzene** mg/Kg	**tert-Butylbenzene** mg/Kg	**Isopropylbenzene** mg/Kg	**p-Isopropylbenzene** mg/Kg	**p-Isopropyltoluene** mg/Kg	**n-Propylbenzene** mg/Kg	**1,2,4-Trimethylbenzene** mg/Kg	**1,3,5-Trimethylbenzene** mg/Kg	**Other VOCs by 8260B** **GC/MS**	**Napthalene** mg/Kg	**2-Methylnapthalene** mg/Kg	**15 Other PNAs by 8270C** mg/Kg
MWT-3-5.0	04/02/04	5.0	ND	1.2 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-3-10.0	04/02/04	10.0	ND	7.5 [8]	7.0 [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.026	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-3-15.0	04/02/04	15.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-3-20.0	04/02/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-4-4.0	04/01/04	4.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-4-10.0	04/01/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-4-15.0	04/01/04	15.0	**150**	ND	**120** [5]	ND	ND	ND	ND	ND	ND	ND	0.026	0.015	0.0094	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-4-20.0	04/01/04	20.0	ND	2.4 [8]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-5-5.0	04/02/04	5.0	ND	1.3 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-5-10.0	04/02/04	10.0	ND	1.1 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-5-15.0	04/02/04	15.0	ND	7.0 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-5-20.0	04/02/04	20.0	ND	7.6 [7]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-6-5.0	04/01/04	5.0	ND	2.1 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-6-10.5	04/01/04	10.5	51	ND	**860 [5]**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-6-14.5	04/01/04	14.5	ND	1.4 [8]	9.0 [5]	ND	ND	ND	ND	ND	0.064	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-6-19.5	04/01/04	19.5	ND	8.5 [8]	13.0 [5]	ND	ND	ND	0.09	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-7-5.0	04/01/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-7-10.0	04/01/04	10.0	ND	3.5 [8]	4.40 [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-7-15.0	04/01/04	15.0	ND	3.4 [8]	7.20 [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-7-20.0	04/01/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	0.088	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-8-5.5	04/02/04	5.5	ND	1.5 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-8-10.5	04/02/04	10.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-8-15.0	04/02/04	15.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-8-18.0	04/02/04	18.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-9-4.0	04/01/04	4.0	ND	3.3 [7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-9-9.5	04/01/04	9.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-9-14.5	04/01/04	14.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-9-19.5	04/01/04	19.5	ND	14 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-10-5.0	04/01/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-10-10.0	04/01/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-10-15.0	04/01/04	15.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-10-20	04/01/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-11-5	11/05/04	5.0	ND	1.1 [12]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-11-10	11/05/04	10.0	33 [13]	ND	**170** [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-11-15	11/05/04	15.0	ND	1.4 [12]	27 [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-11-19.5	11/05/04	19.5	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

			Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds													PNAs		
Sample ID	**Date Sampled**	**Depth BGS** ft.	**Mineral Spirits** mg/Kg	**TPHd (diesel)** mg/Kg	**TPHg (gasoline)** mg/Kg	**Benzene** mg/Kg	**Toluene** mg/Kg	**Ethylbenzene** mg/Kg	**Total Xylenes** mg/Kg	**MTBE** mg/Kg	**Acetone** mg/Kg	**2-Butanone** mg/Kg	**n-Butylbenzene** mg/Kg	**sec-Butylbenzene** mg/Kg	**tert-Butylbenzene** mg/Kg	**Isopropylbenzene** mg/Kg	**p-Isopropylbenzene** mg/Kg	**p-Isopropyltoluene** mg/Kg	**n-Propylbenzene** mg/Kg	**1,2,4-Trimethylbenzene** mg/Kg	**1,3,5-Trimethylbenzene** mg/Kg	**Other VOCs by 8260B** GC/MS	**Napthalene** mg/Kg	**2-Methylnapthalene** mg/Kg	**15 Other PNAs by 8270C** mg/Kg
MWT-12-5	11/05/04	5.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-12-10	11/05/04	10.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-12-15	11/05/04	15.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-12-19.5	11/05/04	19.5	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-13-5	11/05/04	5.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-13-10	11/05/04	10.0	40 [13]	ND	**520** [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-13-15	11/05/04	15.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-13-19	11/05/04	19.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-14-5	11/05/04	5.0	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-14-10	11/05/04	10.0	**110** [13]	ND	**360** [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-14-15	11/05/04	15.0	12 [13]	ND	1.2 [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MWT-14-19.5	11/05/04	19.5	15 [13]	ND	82 [14]	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MW-2-5.0	04/07/04	5.0	29 [3]	ND	**860**	ND	ND	19	**87**	ND	ND	ND	2.9	ND	ND	0.098	ND	ND	4.4	27	9.8	ND	**7.2**	**1.1**	ND
MW-2-10.0	04/07/04	10.0	16 [3]	ND	**530**	ND	2.4	9.2	**47**	ND	ND	ND	2.1	ND	ND	0.77	ND	ND	3.4	21	7.4	ND	**5.0**	0.23	ND
MW-2-15.0	04/07/04	15.0	ND	ND	ND	0.03	ND	0.021	0.029	ND	0.04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0085	ND	ND
MW-2-20.0	04/07/04	20.0	ND	ND	ND	ND	0.0062	ND	0.037	0.12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3-5.0	04/07/04	5.0	Lost	Core																					
MW-3-10.0	04/07/04	10.0	Lost	Core																					
MW-3-14.0	04/07/04	14.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-3-20.0	04/07/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4-5.5	4/30/2004	5.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4-10.5	4/30/2004	10.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4-15.5	4/30/2004	15.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-4-19.5	4/30/2004	19.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5-6.0	4/30/2004	6.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5-10.0	4/30/2004	10.0	27	ND	**1,000** [5]	ND	ND	0.55	3.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5-15.5	4/30/2004	15.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5-19.5	4/30/2004	19.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-6-5.0	04/07/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-6-10.0	04/07/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-6-15.0	04/07/04	15.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MW-6-20.0	04/07/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7-5.0	04/06/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7-10.0	04/06/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7-15.0	04/06/04	15.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MW-7-20.0	04/06/04	20.0	ND	7.9 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

			Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds													PNAs		
Sample ID	**Date Sampled**	**Depth BGS**	**Mineral Spirits**	**TPHd (diesel)**	**TPHg (gasoline)**	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylenes**	**MTBE**	**Acetone**	**2-Butanone**	**n-Butylbenzene**	**sec-Butylbenzene**	**tert-Butylbenzene**	**Isopropylbenzene**	**p-Isopropylbenzene**	**p-Isopropyltoluene**	**n-Propylbenzene**	**1,2,4-Trimethylbenzene**	**1,3,5-Trimethylbenzene**	**Other VOCs by 8260B**	**Napthalene**	**2-Methylnapthalene**	**15 Other PNAs by 8270C**
		ft.	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	**GC/MS**	mg/Kg	mg/Kg	mg/Kg
MW-8-5.0	04/07/04	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-8-10.0	04/07/04	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-8-15.0	04/06/04	15.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MW-8-20.0	04/06/04	20.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

(1) ND = Not Detected above the Method Detection Limit (MDL).
(2) n/a = Not analyzed
(3) The laboratory reports that the detected hydrocarbon does not match its mineral spirits standard.
(4) The laboratory reports that the detected hydrocarbon does not match its Diesel standard.
(5) The laboratory reports that the detected hydrocarbon does not match its standard for gasoline.
(6) Laboratory Method EPA 8260B analyzes for 108 Volatile Organic Compounds. Only those found are listed separately in this table.
(7) The laboratory reports that the compound reported reflects individual or discrete unidentified peaks detected in the diesel range; the pattern does not match a typical fuel standard.
(8) The laboratory reports that the hydrocarbon reported is in the early Diesel range and does not match the laboratory's Diesel standard.
(9) Laboratory Method EPA 8270C analyzes for 17 Polynuclear Aromatics. Only those found are listed separately in this table.
(10) Concentrations in **bold** script exceed the 2005 San Francisco Bay Area RWQCB's Environmental Screening Levels in shallow soils (<3m bgs) where groundwater is not a source of drinking water.
(11) MWT-1-20.0 was also analyzed for 65 Semi-volatile chemicals by GC/MD - EPA8270C. None were detected in the sample.
(12) Quantity of unknown hydrocarbon(s) in sample based on Diesel
(13) Quantity of unknown hydrocarbon(s) in sample based on Mineral Spirits
(14) Quantity of unknown hydrocarbon(s) in sample based on Gasoline

TABLE II-3

RESULTS OF ANALYSES OF GROUNDWATER SAMPLES FOR PETROLEUM HYDROCARBONS RECOVERED FROM TRENCHES AND WELLS
OAK WALK REDEVELOPMENT SITE

		Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds												PNAs		
Sample ID	**Date Sampled**	**TPHd (diesel)** µg/L	**Mineral Spirits** µg/L	**TPHg (gasoline)** µg/L	**Benzene** µg/L	**Toluene** µg/L	**Ethylbenzene** µg/L	**Total Xylenes** µg/L	**MTBE** µg/L	**Acetone** µg/L	**2-Butanone** µg/L	**n-Butylbenzene** µg/L	**sec-Butylbenzene** µg/L	**tert-Butylbenzene** µg/L	**Isopropylbenzene** µg/L	**p-Isopropylbenzene** µg/L	**p-Isopropyltoluene** µg/L	**n-propylbenzene** µg/L	**1,2,4-trimethylbenzene** µg/L	**1,3,5-trimethylbenzene** µg/L	**Naphthalene** µg/L	**2-Methylnapthalene** µg/L	**15 Other PNAs by 8270C** µg/L
Trenches December 2003																							
T3-W	12/03/03	**2300** [3]	n/a	**6300** [5]	ND	ND	31	30	ND	ND	ND	100	47	ND	ND	23	ND	230	320	110	12	n/a	n/a
T7-W	12/02/03	ND	n/a	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	n/a	n/a	n/a
Wells 2004																							
WCEW-1	5/19/04	ND	**600** [6]	**3700**	**90**	0.66	48	56	170	ND	ND	ND	8.7	ND	12	1.8	ND	31	14	5.6	8.3	ND	ND
MW-2	5/19/04	ND	**2100** [6]	**49000**	**7900**	**2100**	**980**	**8300**	770	ND	ND	100	ND	ND	ND	ND	ND	ND	1600	460	**490**	ND	ND
MW-3	5/19/04	ND	**420** [6]	**1300**	ND	ND	ND	1.1	5.8	ND	ND	14	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND
MW-4	5/19/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-5	5/19/04	ND	**330** [6]	**2600** [5]	ND	ND	ND	ND	17	ND	ND	ND	ND	2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-6	5/19/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-7	5/19/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-8	5/19/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-1	5/19/04	ND	74 [6]	350	ND	ND	ND	ND	ND	ND	ND	8.0	ND	ND	1.0	ND	ND	1.0	ND	ND	ND	ND	ND
MWT-2	5/19/04	ND	**3200** [6]	**28000**	**460**	ND	**1200**	**2700**	66	ND	ND	100	ND	ND	ND	ND	ND	310	1600	490	**340**	ND	ND
MWT-3	5/19/04	ND	**450**	**1000** [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND

SJC

Sample ID	Date Sampled	Petroleum Hydrocarbons			BTEX Compounds				Volatile Organic Compounds													PNAs		
		TPHd (diesel) µg/L	Mineral Spirits µg/L	TPHg (gasoline) µg/L	Benzene µg/L	Toluene µg/L	Ethylbenzene µg/L	Total Xylenes µg/L	MTBE µg/L	Acetone µg/L	2-Butanone µg/L	n-Butylbenzene µg/L	sec-Butylbenzene µg/L	tert-Butylbenzene µg/L	Isopropylbenzene µg/L	p-Isopropylbenzene µg/L	p-Isopropyltoluene µg/L	n-pro--pylbenzene µg/L	1,2,4-trimethylbenzene µg/L	1,3,5-tri methylbenzene µg/L	Naphthalene µg/L	2-Methylnapthalene µg/L	15 Other PNAs by 8270C µg/L
MWT-4	5/19/04	ND	88 [6]	**540** [5]	ND	ND	ND	ND	ND	ND	ND	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-5	5/19/04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-6	5/19/04	ND	**980**	**4200** [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-7	5/19/04	ND	**3200**	**56000** [5]	0.78	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-8	5/19/04	ND	**370**	**800** [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.6	ND	ND	ND	ND	0.70	ND	ND	ND	ND
MWT-9	5/19/04	ND	ND	ND	ND	ND	ND	ND	0.79	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-10	5/19/04	ND	ND	59 [5]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MWT-11	11/6/04	ND	**3500** [8]	**930** [9]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	ND	ND
MWT-12	11/6/04	ND	**830** [8]	**1400** [9]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	ND	ND
MWT-13	11/6/04	ND	**440** [8]	**1100** [9]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	ND	ND
MWT-14	11/6/04	ND	**1200** [8]	**4600** [9]	ND	ND	ND	ND	ND	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ND	ND	ND

Notes:

(1) ND = Not Detected above the Method Detection Limit (MDL).
(2) n/a = Not Analyzed.
(3) The laboratory reports that the detected hydrocarbon does not match its diesel standard.
(4) Laboratory Method 8260B looks for 66 Volatile Organic Comppunds. Only those detected are presented on this table.
(5) The laboratory reports that the detected hydrocarbon does not match its gasoline standard.
(6) The laboratory reports that the detected hydrocarbon does not match its mineral spirits standard.
(7) Concentrations in **bold** script exceed the 2005 San Francisco Bay Area RWQCB's Environmental Screening Levels for shallow soils (<3m bgs) and where groundwater is not a source of drinking water.
(8) Quantity of unknown hydrocarbons in sample based on Mineral Spirits
(9) Quantity of unknown hydrocarbons in sample based on gasoline

TABLE II-4

HEAVY METALS IN SOIL SAMPLES RECOVERED FROM SELECTED SOIL BORINGS
OAK WALK REDEVELOPMENT SITE

Sample No.	**Date Sampled**	**Depth BGS** ft.	**Anti-mony** mg/Kg	**Ar-senic** mg/Kg	**Bar-ium** mg/Kg	**Beryl-lium** mg/Kg	**Cad-mium** mg/Kg	**Chro-mium III** mg/Kg	**Chro-mium VI** mg/Kg	**Cobalt** mg/Kg	**Copper** mg/Kg	**Lead** mg/Kg	**Molyb-denum** mg/Kg	**Nickel** mg/Kg	**Sele-nium** mg/Kg	**Silver** mg/Kg	**Thal-lium** mg/Kg	**Vana-dium** mg/Kg	**Zinc** mg/Kg	**Mer-cury** mg/Kg
BE-4-5.5	04/01/04	5.5	ND	2.6	110	ND	ND	27	n/a	2.6	17	4.3	ND	24	ND	ND	ND	22	31	ND
BE-1-13.5	04/02/04	13.5	ND	1.3	110	ND	ND	35	ND	4.9	12	4.1	ND	46	ND	ND	ND	24	28	0.053
BE-3-19.5	04/02/04	19.5	ND	2.1	150	ND	ND	30	n/a	6.9	19	5.4	ND	26	ND	ND	ND	25	32	ND

Notes:

(1) ND = Not Detected above the Method Detection Limit (MDL).
(2) Concentrations in **bold** script exceed the 2005 San Francisco Bay Area RWQCB's Environmental Screening Levels in shallow soil (<3m bgs) and where groundwater is not a source of drinking water

TABLE II-5

RWQCB TIER 1 CONCENTRATION LIMITS (ESLs)
FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER

*In shallow soils (<3m bgs) at sites where groundwater is **not** a source of drinking water.*

Chemical of Concern	**Limiting Concentrations to Protect Human Health** *Soil* Residential mg/Kg	*Soil* Commercial mg/Kg	*Groundwater* Resid. or Comm. µg/L
Acetone	0.50	0.50	1,500
Aroclor® 1260	0.22	0.74	0.014
Antimony	6.1	40	30
Arsenic	5.5	5.5	36
Barium	750	1,500	1,000
Benzene	0.18	0.38	46
Beryllium	4.0	8.0	2.7
2-Butatone (Metyl Ethyl Ketone)	13	13	14,000
n-Butylbenzene (1-Phenylbutane)	ne	ne	ne
sec-Butylbenzene (Butyl Benzene)	ne	ne	ne
tert-Butylbenzene	ne	ne	ne
Cadmium	1.7	7	1.1
Chromium III	750	750	180
Chromium VI	1.8	1.8	11
Cobalt	40	80	3.0
Copper	230	230	3.1
Ethyl benzene	32	32	290
Lead	150	750	2.5
Mercury	3.7	10	0.012
2-Methylnaphthalene	0.25	0.25	2.1
4-Methylphenol	ne	ne	ne
Methyl Teritary Butyl Ether	2.0	5.6	1,800
Methylene Chloride	0.52	1.5	2,200
Molybdenum	40	40	240
Naphthalene	0.46	1.5	24

Chemical of Concern	**Limiting Concentrations to Protect Human Health**		
	Soil		***Groundwater***
	Residential mg/Kg	Commercial mg/Kg	Resid. or Comm. µg/L
Nickel	150	150	8.2
Isopropylbenzene (Cumene)	ne	ne	ne
p-Isopropylbenzene	ne	ne	ne
p-Isopropyltoluene (p-Cymene)	ne	ne	ne
n-Propylbenzene (Isocumene)	ne	ne	ne
Selinium	10	10	5.0
Silver	20	40	0.19
Thallium	1.0	13	20
Toluene	9.3	9.3	130
TRPH (Total Recoverable Petroleum Hydrocarbons)	100	500	640
TPHd (Diesel)	100	500	640
TPHms (Mineral Spirits)	100	500	640
TPHg (Gasoline)	100	400	500
1,2,4 Trimethylbenzene	ne	ne	ne
1,3,5 Trimethylbenzene	ne	ne	ne
Vanadium	110	200	19
Xylene Isomers (Total)	11.0	11.0	100
Zinc	600	600	81

Note: ne = not established in the RWQCB ESL guidance document (California Regional Water Quality Control Board - San Francisco Bay Region 2005).

TABLE II-6

KEY GROUND FLOOR BUILDING DIMENSIONS

Building Type	**Ground Floor Occupancy**	**Slab** Emeryville Datum *ft.*	**Elevation** NAVD *ft.*	**Length East to West** *ft.*	**Length North to South** *ft.*	**Plan Area** *ft.²*	**Foundation Perimeter** *ft.*	**Gr. Floor Floor to Ceiling** *ft.*	**Gr. Floor Interior Volume** *ft.³*	**Ground Floor Volume/Area Ratio**	**Gr. Floor Slab Thickness** *in.*	**Imper-meable Barrier**
1	Commercial	36.70	42.38	55.0	91.0	4,260	331.0	18	76,680	18.0	6	Liquid Boot®
2A	Commercial	37.90	43.58	30.5	34.0	1,022	129.0	18	18,396	18.0	6	Liquid Boot®
2B	Residential	39.75	45.43	23.0	32.5	722	118.3	9	6,498	9.0	6	Liquid Boot®
2C	Residential	40.50	46.18	31.3	30.0	932	126.6	9	8,388	9.0	6	Liquid Boot®
3A	Residential	41.15	46.83	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
3B	Residential	41.60	47.28	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
3C	Residential	40.50	46.18	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
4	Residential	40.35	46.03	26.0	42.8	990	146.3	9	8,910	9.0	6	Liquid Boot®
5	Residential	40.95	46.63	24.5	49.0	923	139.0	9	8,307	9.0	6	Liquid Boot®
6	Residential	41.75	47.43	24.0	48.0	1,132	146.0	9	10,188	9.0	6	Liquid Boot®
7	Residential	41.95	47.63	24.5	49.0	923	139.0	9	8,307	9.0	6	Liquid Boot®
8	Residential	42.25	47.93	24.0	46.0	1,095	140.0	9	9,855	9.0	6	Liquid Boot®
9	Garage	42.09	47.77	62.5	25.0	1,543	175.0	8	12,344	8.0	6	Liquid Boot®

Notes:

(1) For Building Types 4 through 8 slab elevations cited are for basement concrete laid over impermeable membrane.
(2) First floors will be suspended at approximately 2.25 ft higher elevations.

TABLE II -7

KEY SOIL COLUMN PARAMETERS

Building Type	Use of First Floor	Indoor Exposure Environment Classification	Outdoor Exposure Environment Classification	Depth to Groundwater *ft.*	Depth to Top of Contam. Soil		Depth to Bottom of Contam. Soil	
					Pre-remediation *ft.*	Post-remediation *ft.*	Pre-remediation *ft.*	Post-remediation *ft.*
1	Commercial	Commercial	Residential	7.64	3.21	6.21	24.21	24.21
3A	Residential	Residential	Residential	7.23	5.13	7.13	26.13	26.13

TABLE II -8

REPRESENTATIVE CONCENTRATIONS OF CHEMICALS OF CONCERN
IN GROUNDWATER BENEATH VULNERABLE BUILDINGS

Chemical of Concern	**Building Type 3A** Pre-Remediation µg/L	**Building Type 3A** Post-Remediation µg/L	**Building Type 1** Pre-Remediation µg/L	**Building Type 1** Post-Remediation µg/L
	Concentrations			
Benzene	7,900	3,160	90	90
Toluene	2,100	840	0.66	0.66
Ethylbenzene	980	392	48	48
Xylene (mixed isomers)	8,300	3,320	56	56
Methyl tertiary-butyl ether	770	308	170	170
Acetone	ND	ND	ND	ND
n-Butylbenzene	100	40	ND	ND
sec-Butylbenzene	ND	ND	8.7	8.7
Cumene (isopropylbenzene)	ND	ND	12	12
p-isopropylbenzene	ND	ND	1.8	1.8
n-propylbenzene	ND	ND	31	31
1,2,4-trimethylbenzene	1,600	640	14	14
1,3,5-trimethylbenzene	460	184	5.6	5.6
Naphthalene	490	196	8.3	8.3

Note: ND = Not detected above the Method Detection Level (MDL) of the analytical method employed.

TABLE II - 9

REPRESENTATIVE CONCENTRATIONS OF CHEMICALS OF CONCERN
IN SOIL BENEATH VULNERABLE BUILDINGS

	Building Type 3A		**Building Type 1**	
	Pre-Remediation *mg/Kg*	Post-Remediation *mg/Kg*	Pre-Remediation *mg/Kg*	Post-Remediation *mg/Kg*
Chemical of Concern	**C o n c e n t r a t I o n s**			
Benzene	13	13	1.1	1.1
Toluene	140	140	9.0	9.0
Ethylbenzene	80	80	13.0	13.0
Xylene (mixed isomers)	430	430	75	75
Methyl tertiary-butyl ether	ND	ND	0.005	0.005
Acetone	ND	ND	0.065	0.065
n-Butylbenzene	8.4	8.4	2.6	2.6
sec-Butylbenzene	3.1	3.1	ND	ND
Cumene (isopropylbenzene)	2.7	2.7	1.1	1.1
p-isopropylbenzene	ND	ND	ND	ND
n-propylbenzene	13	13	4.4	4.4
1,2,4-trimethylbenzene	32	32	23.0	23.0
1,3,5-trimethylbenzene	12	12	8.1	8.1
Naphthalene	18	18	4.2	4.2

Note: ND = Not detected above the Method Detection Level (MDL) of the analytical method employed.

TABLE II-10

APPLICABLE CHEMICAL, PHYSICAL, TOXICOLOGIC AND CARCINOGENIC PROPERTIES OF CHEMICALS OF CONCERN

Constituent	Molecular Weight (g/mole) MW	Diffusion Coefficients in air (cm2/s) Dair	Diffusion Coefficients in water (cm2/s) Dwat	Log (Koc) (@ 20 - 25 C) log(L/kg)	Henry's Law Constant (@ 20 - 25 C) (atm-m3) mol	Henry's Law Constant (@ 20 - 25 C) (unitless)	Vapor Pressure (@ 20 - 25 C) (mm Hg)	Solubility (@ 20 - 25 C) (mg/L)
Benzene	78.1	8.80E-02	9.80E-06	1.77	5.55E-03	2.29E-01	9.52E+01	1.75E+03
Toluene	92.4	8.50E-02	9.40E-06	2.13	6.30E-03	2.60E-01	3.00E+01	5.15E+02
Ethylbenzene	106.2	7.50E-02	7.80E-06	2.56	7.88E-03	3.25E-01	1.00E+01	1.69E+02
Xylene (mixed isomers)	106.2	7.20E-02	8.50E-06	2.38	7.03E-03	2.90E-01	7.00E+00	1.98E+02
Methyl t-Butyl ether	88.146	7.92E-02	9.41E-05	1.08	5.77E-04	2.38E-02	2.49E+02	4.80E+04
Acetone	58.08	1.24E-01	1.14E-05	-0.24	2.50E-05	1.03E-03	2.66E+02	1.00E+06
Naphthalene	128.2	5.90E-02	7.50E-06	3.30	4.83E-04	1.99E-02	2.30E-01	3.10E+01
Cumene	120.2	6.50E-02	7.10E-06	0.00	1.46E-02	6.02E-01	2.30E-01	4.98E+01

Continued on next page

TABLE II-10

(*Continued)*

APPLICABLE CHEMICAL, PHYSICAL, TOXICOLOGIC AND CARCINOGENIC

PROPERTIES OF CHEMICALS OFCHEMICALS OF CONCERN

Constituent	Reference Dose (mg/kg/day)		Ref. Conc. (mg/m3)	Slope Factors 1/(mg/kg/day)		Unit Risk Factor 1/(µg/m3)	EPA Weight of Evidence	Is Constituent Carcino-genic?	Maximum Contamination Level MCL (mg/L)	Time-Weighted Av. Workplace Criteria TWA (mg/m3)
	Oral RfD_oral	Dermal RfD_dermal	Inhalation RfC_inhal	Oral SF_oral	Dermal SF_dermal	Inhalation URF_inhal.				
Benzene	3.00E-03	-	5.95E-03	2.90E-02	2.99E-02	8.29E-06	A	TRUE	5.00E-03	3.25E+00
Toluene	2.00E-01	1.60E-01	4.00E-01	-	-	-	D	FALSE	1.00E+00	1.47E+02
Ethylbenzene	1.00E-01	9.70E-02	1.00E+00	-	-	-	D	FALSE	7.00E-01	4.35E+02
Xylene (mixed isomers)	2.00E+00	1.84E+00	7.00E+00	-	-	-	D	FALSE	1.00E+01	4.34E+02
Methyl t-Butyl ether	1.00E-02	8.00E-03	3.00E+00	-	-	-	-	FALSE	-	6.00E+01
Acetone	1.00E-01	8.30E-02		-	-	-	D	FALSE	-	5.90E+02
Naphthalene	4.00E-01	3.56E-01	1.40E+00	-	-	-	D	FALSE	-	5.00E+01
Cumene	1.00E-01	8.00E-02	4.00E-01	-	-	-	D	FALSE	-	2.45E+02

TABLE II - 11

HEALTH RISK ANALYSIS RESULTS FOR BUILDING TYPE 3A

Condition	**Outdoor Exposure Environment Classification**	**Indoor Exposure Environment Classification**	**Cumulative COC Carcinogenic Risk**			**Toxic Hazard Index**		
			Outdoor Air	Indoor Air	Target Risk	Outdoor Air	Indoor Air	Target Index
Unimproved Site	Residential	Residential	2.0×10^{-6}	**9.6×10^{-5}**	*1.0×10^{-6}*	0.620	**4.800**	*0.200*
Improved Soil	Residential	Residential	1.0×10^{-7}	**3.9×10^{-6}**	*1.0×10^{-6}*	0.028	**0.250**	*0.200*
Remediated Site	Residential	Residential	5.9×10^{-8}	**2.3×10^{-6}**	*1.0×10^{-6}*	0.028	**0.130**	*0.200*

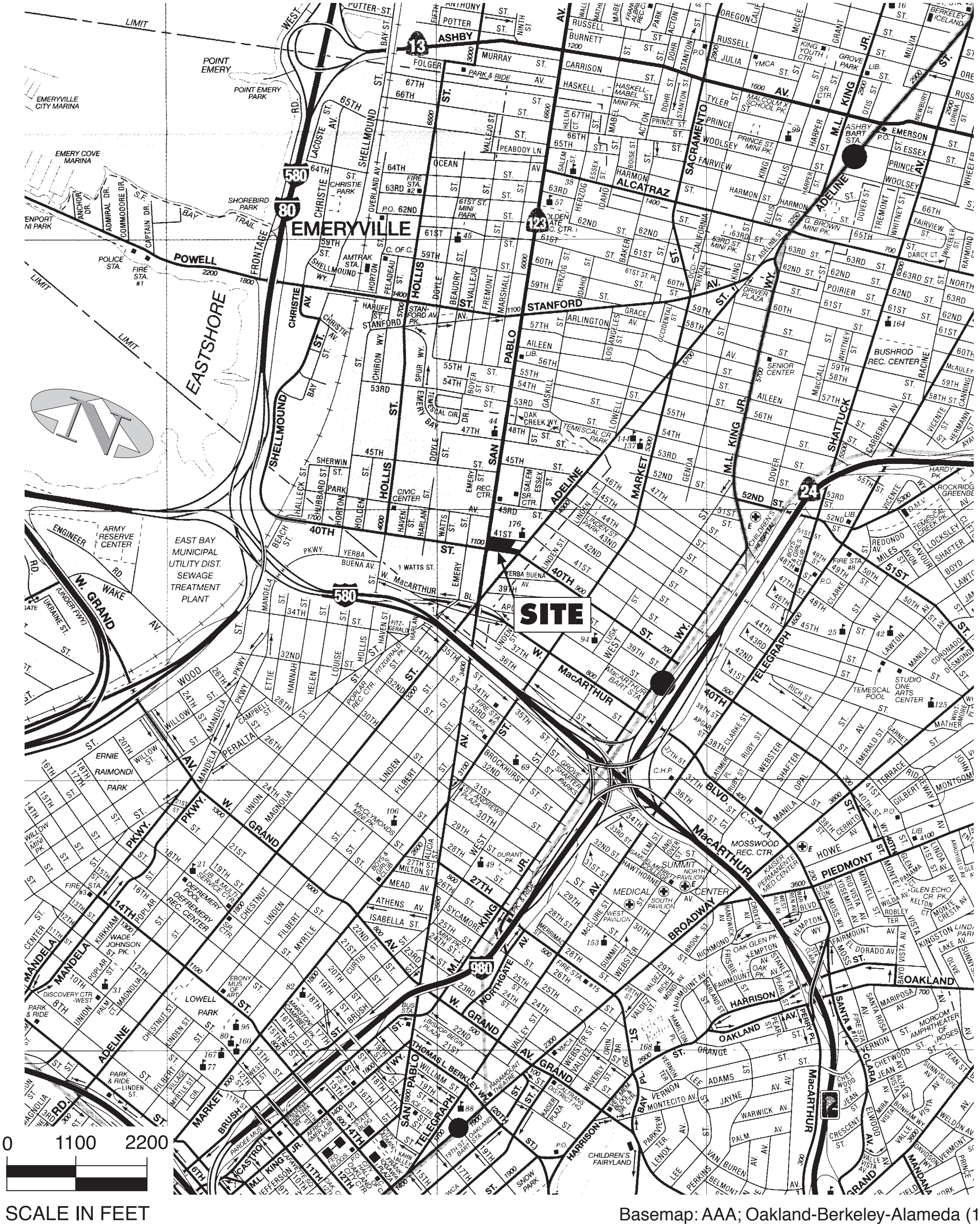
Note: Critical Exposure Pathways are in **bold** font.

TABLE II - 12

HEALTH RISK ANALYSIS RESULTS FOR BUILDING TYPE 1

Condition	**Outdoor Exposure Environment Classification**	**Indoor Exposure Environment Classification**	**Cumulative COC Carcinogenic Risk**			**Toxic Hazard Index**		
			Outdoor Air	Indoor Air	Target Risk	Outdoor Air	Indoor Air	Target Index
Unimproved Site	Residential	Commercial	1.3×10^{-7}	**9.6×10^{-7}**	*1.0×10^{-6}*	**0.150**	0.092	*0.200*
Remediated Site	Residential	Residential	3.6×10^{-8}	**2.2×10^{-7}**	*1.0×10^{-6}*	**0.046**	0.022	*0.200*

Note: Critical Exposure Pathways are in **bold** font.



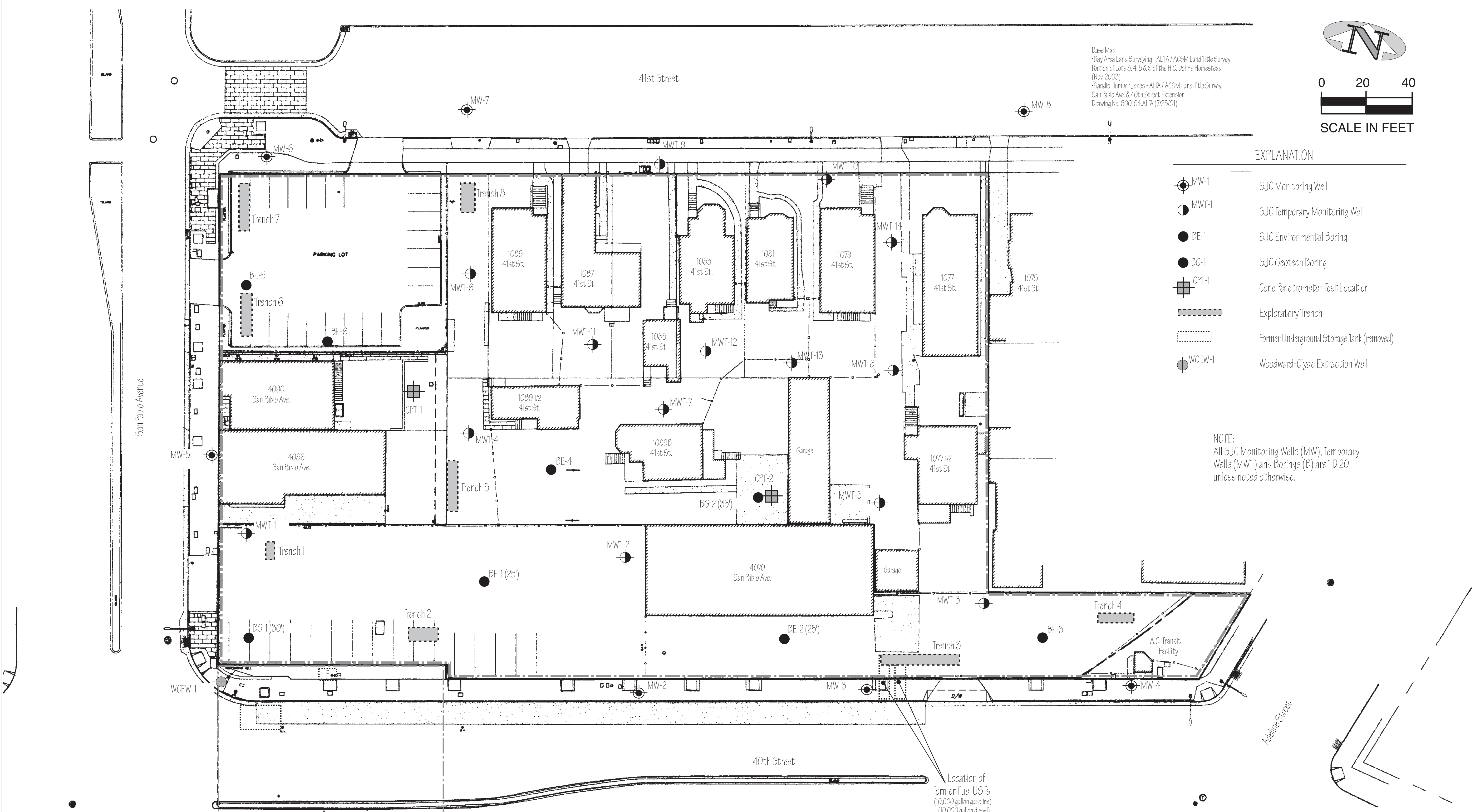
Basemap: AAA; Oakland-Berkeley-Alameda (12/02)

SITE LOCATION

Oak Walk Redevelopment Project

Emeryville, California

FIG II-1	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM / Date: 06/10/06

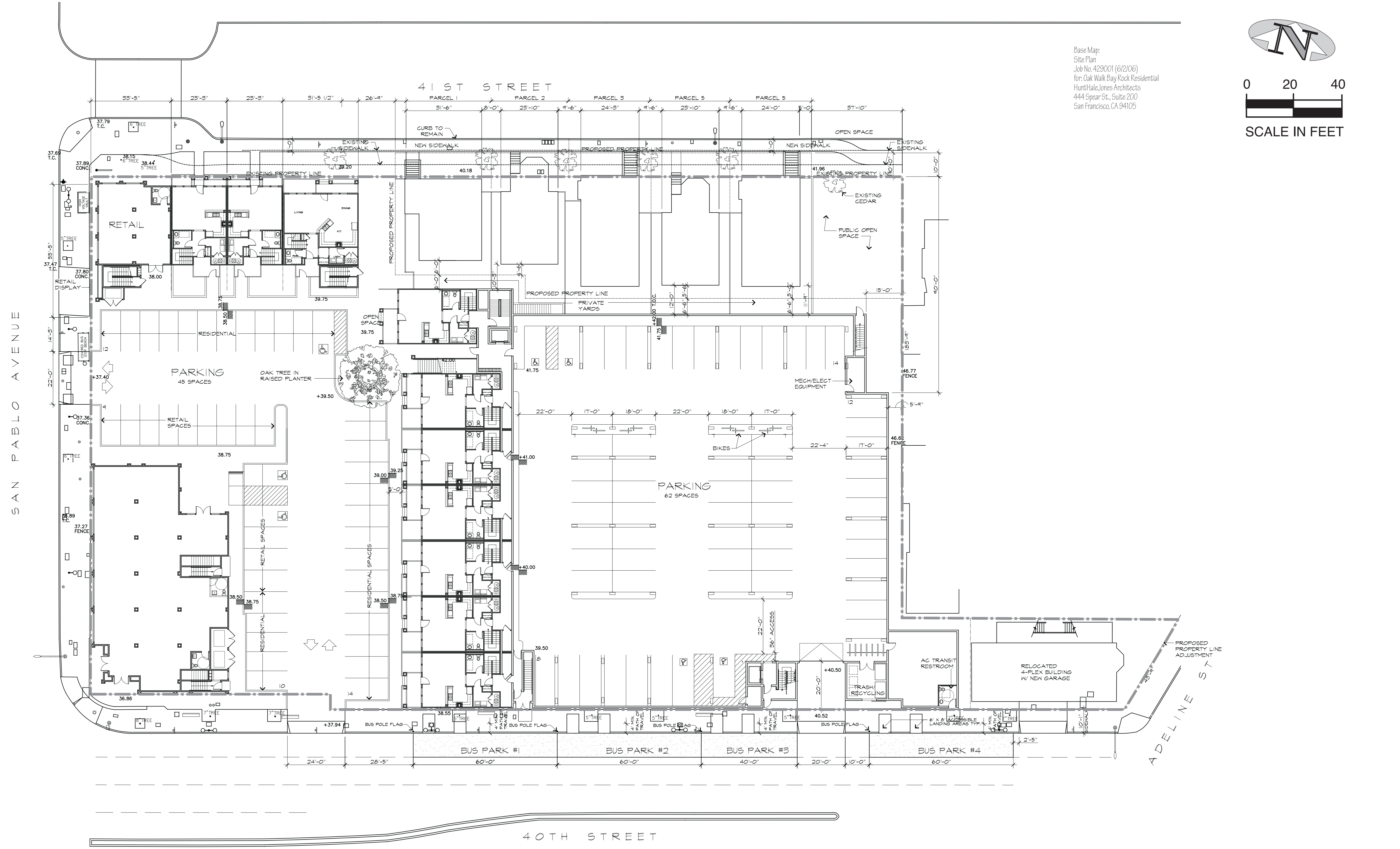


SITE PLAN
Oak Walk Redevelopment Project
Emeryville, California

FIG II-2

The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: GNM
Date: 06/10/06



PLAN OF PROPOSED REDEVELOPMENT

Oak Walk Redevelopment Project

Emeryville, California

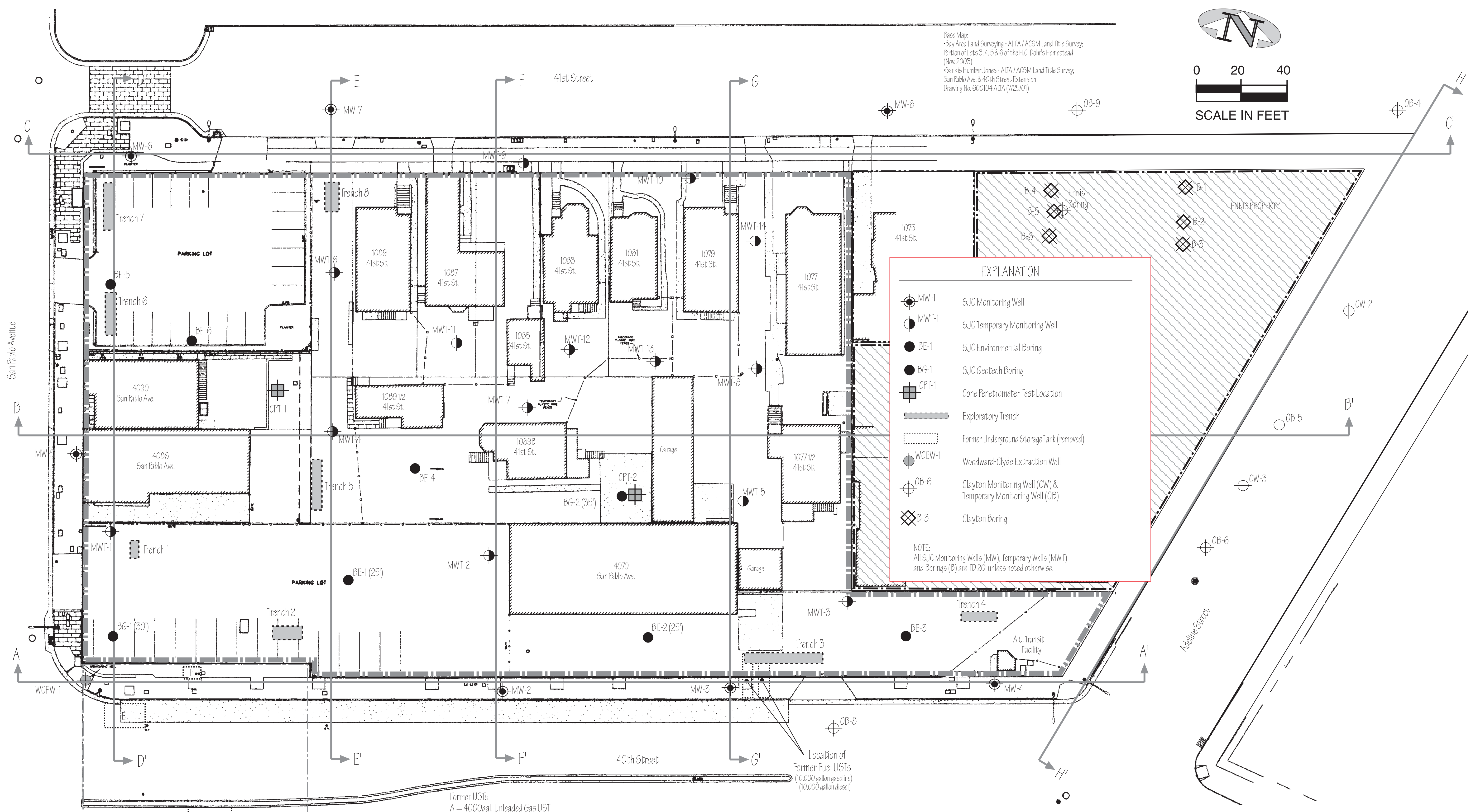
FIG II-3

The San Joaquin Company Inc.

Project Number: 0004.084

Drawn by: GNM

Date: 06/20/06

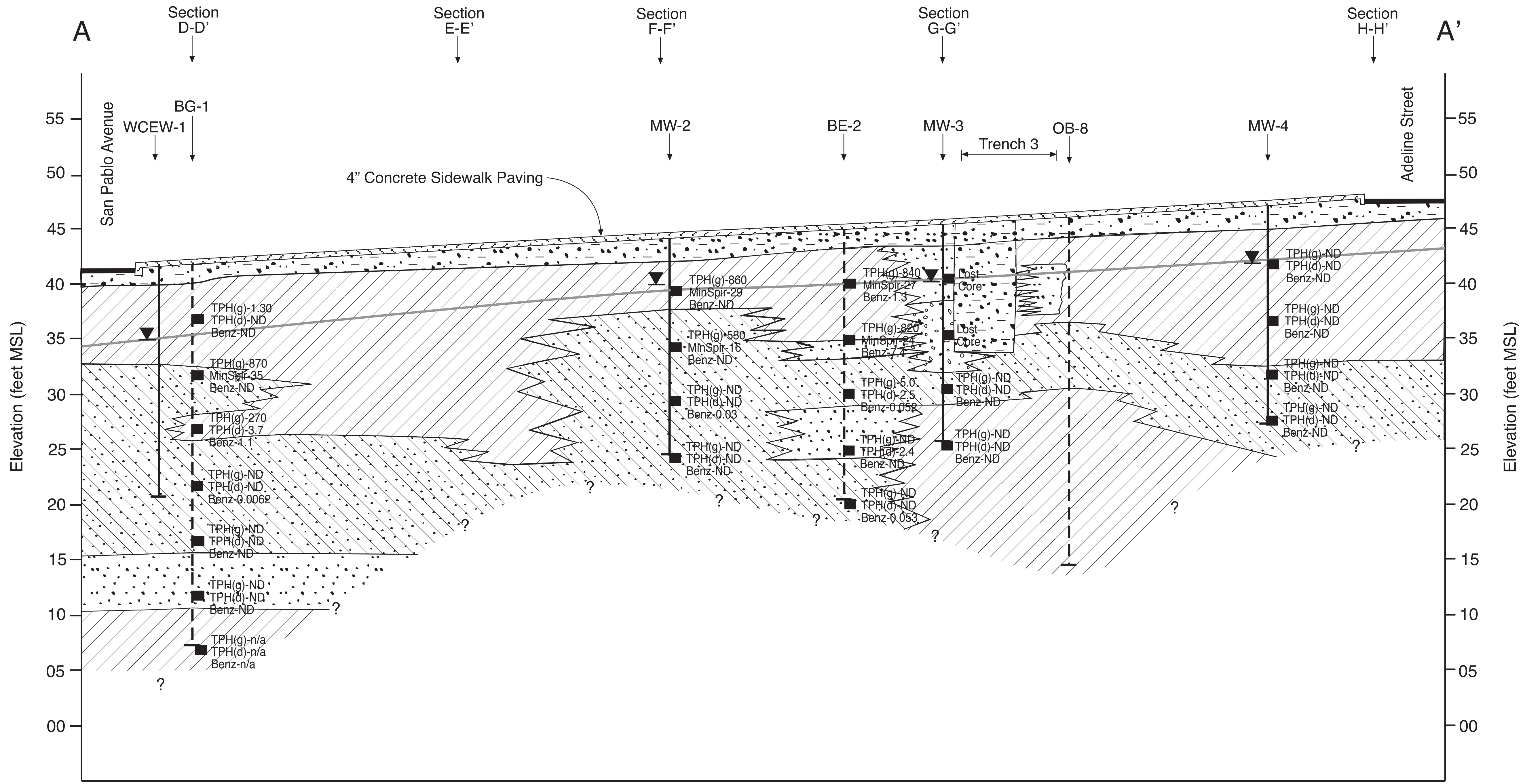


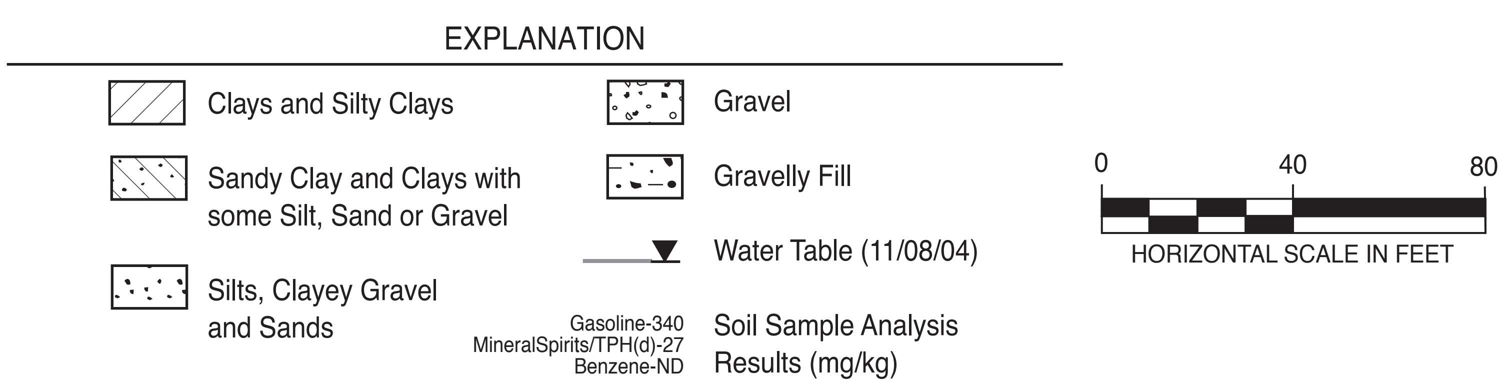
BORINGS & WELL LOCATIONS AT OAK WALK SITE

Oak Walk Redevelopment Project

Emeryville, California

FIG II-4	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM Date: 06/17/06



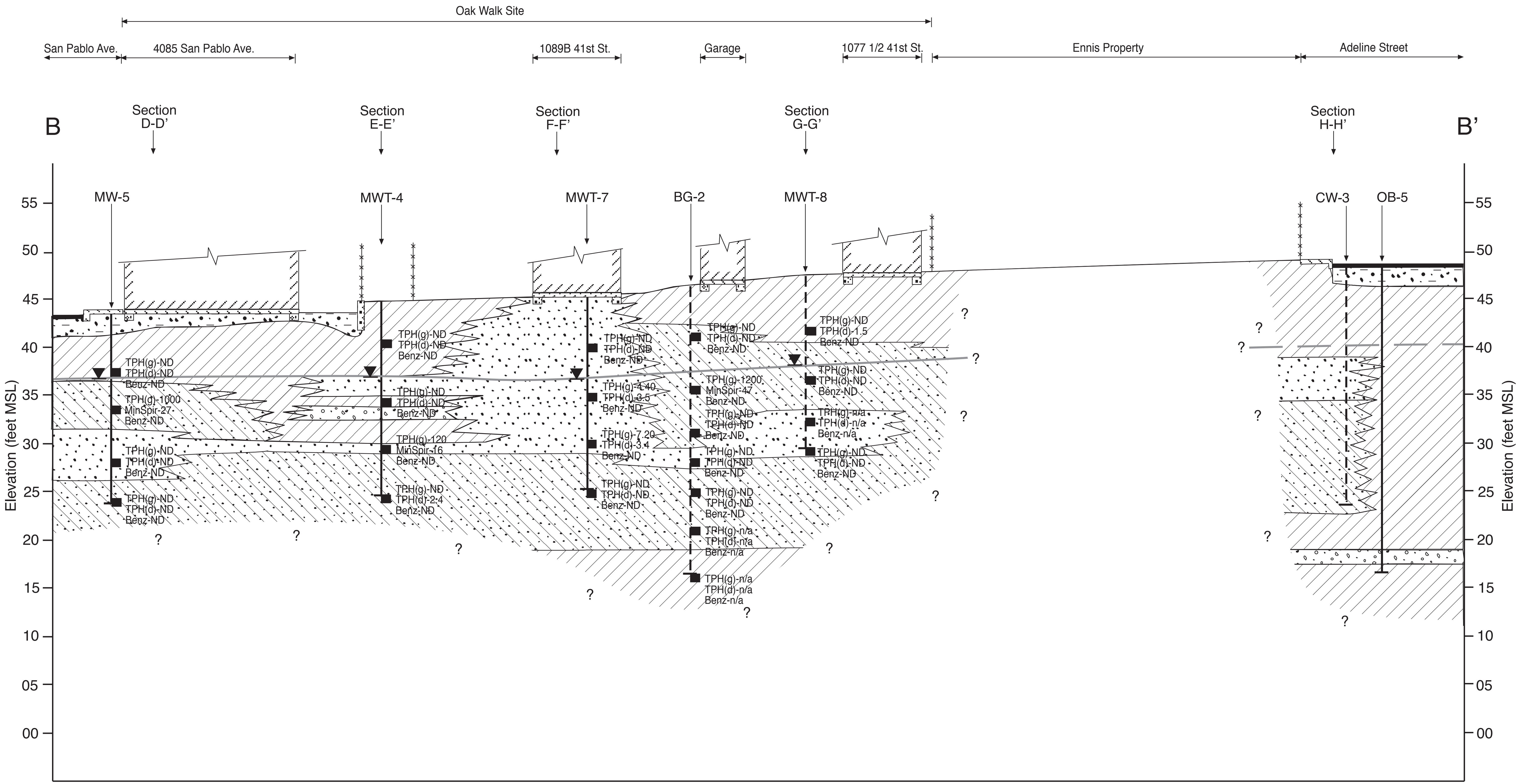


HYDROSTRATIGRAPHIC SECTION A-A'

Oak Walk Redevelopment Project

Emeryville, California

FIG II-5	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM — Date: 10/30/05



EXPLANATION

- Clays and Silty Clays
- Sandy Clay and Clays with some Silt, Sand or Gravel
- Silts, Clayey Gravel and Sands
- Gravel
- Gravelly Fill
- Water Table (11/08/04)
- Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

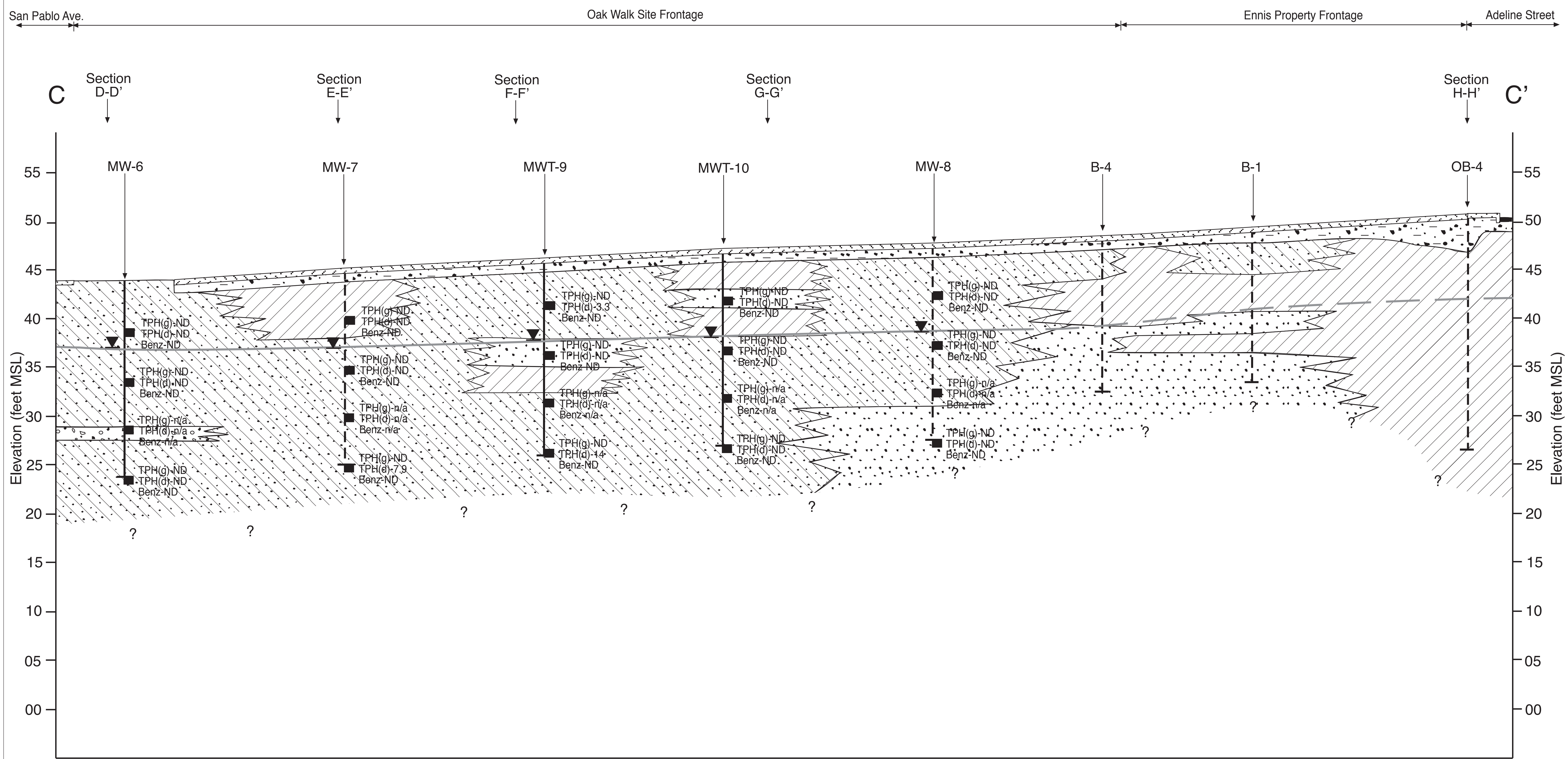
0 40 80
HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION B-B'
Oak Walk Redevelopment Project
Emeryville, California

FIG II-6

The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: GNM
Date: 04/17/06



EXPLANATION

- Clays and Silty Clays
- Sandy Clay and Clays with some Silt, Sand or Gravel
- Silts, Clayey Gravel and Sands
- Gravel
- Gravelly Fill
- Water Table (11/08/04)
- Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

0 40 80

HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION C-C'

Oak Walk Redevelopment Project

Emeryville, California

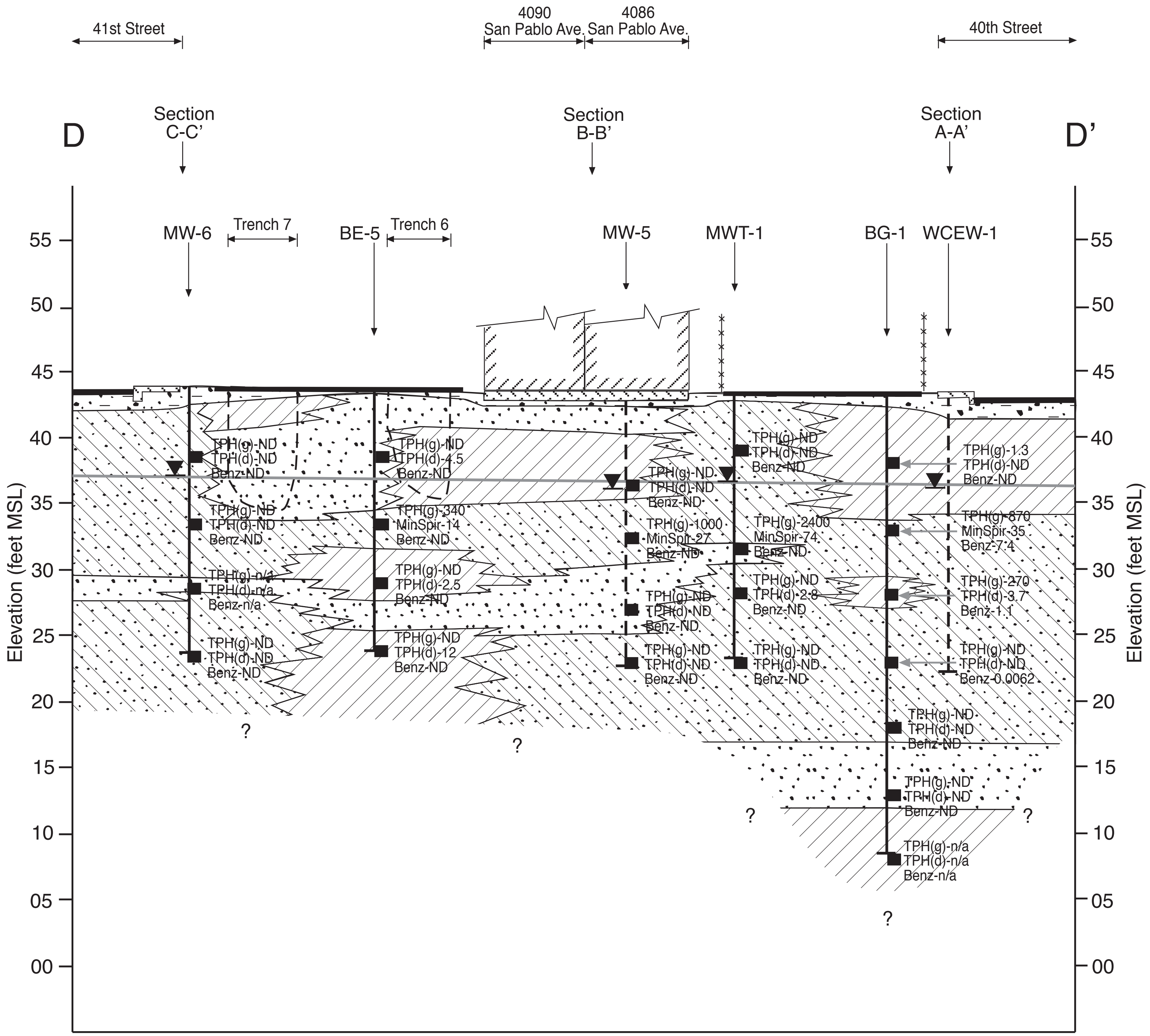
FIG II-7

The San Joaquin Company Inc.

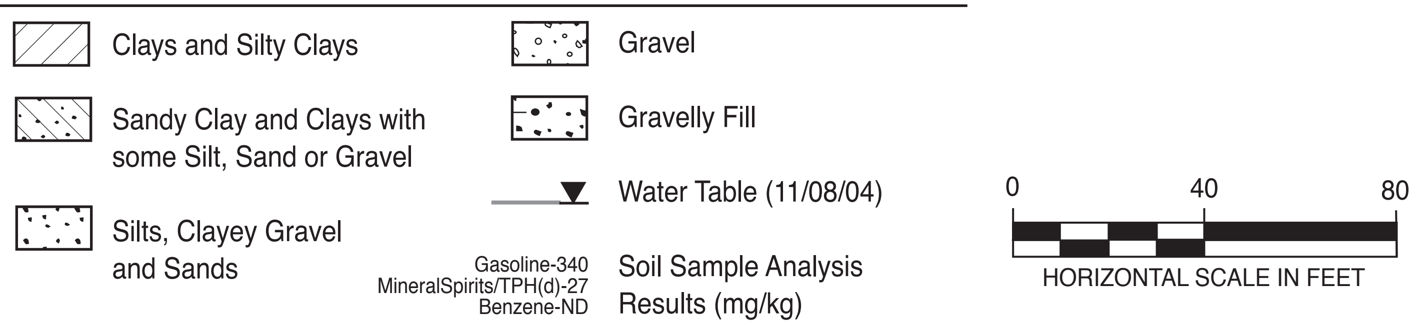
Project Number: 0004.084

Drawn by: GNM

Date: 06/21/06



EXPLANATION

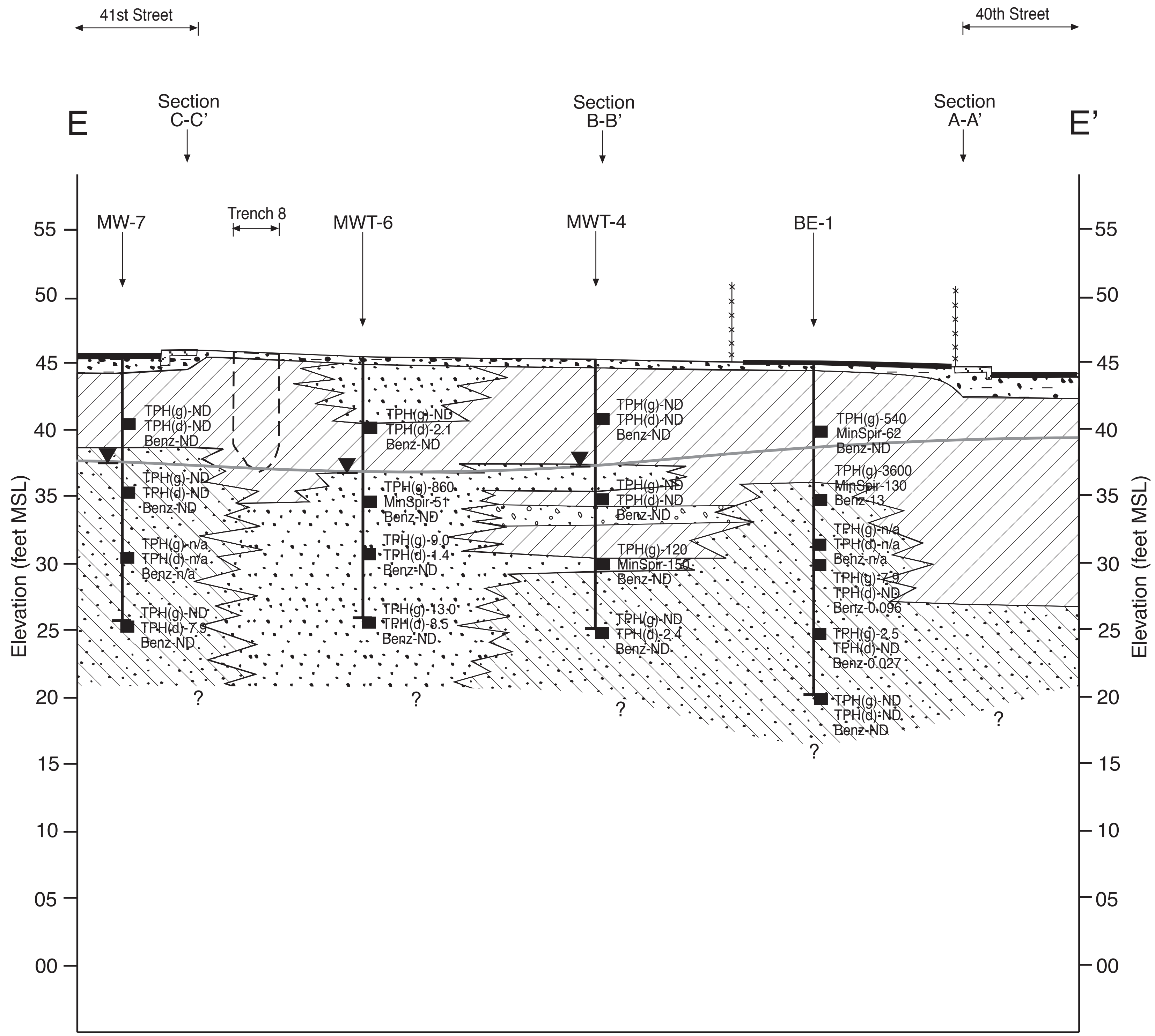


HYDROSTRATIGRAPHIC SECTION D-D'

Oak Walk Redevelopment Project

Emeryville, California

FIG II-8	**The San Joaquin Company Inc.**	Project Number: 0004.084	
		Drawn by: GNM	Date: 04/25/06



EXPLANATION

Clays and Silty Clays

Sandy Clay and Clays with some Silt, Sand or Gravel

Silts, Clayey Gravel and Sands

Gravel

Gravelly Fill

Water Table (11/08/04)

Gasoline-340
MineralSpirits/TPH(d)-27
Benzene-ND

Soil Sample Analysis Results (mg/kg)

0 40 80

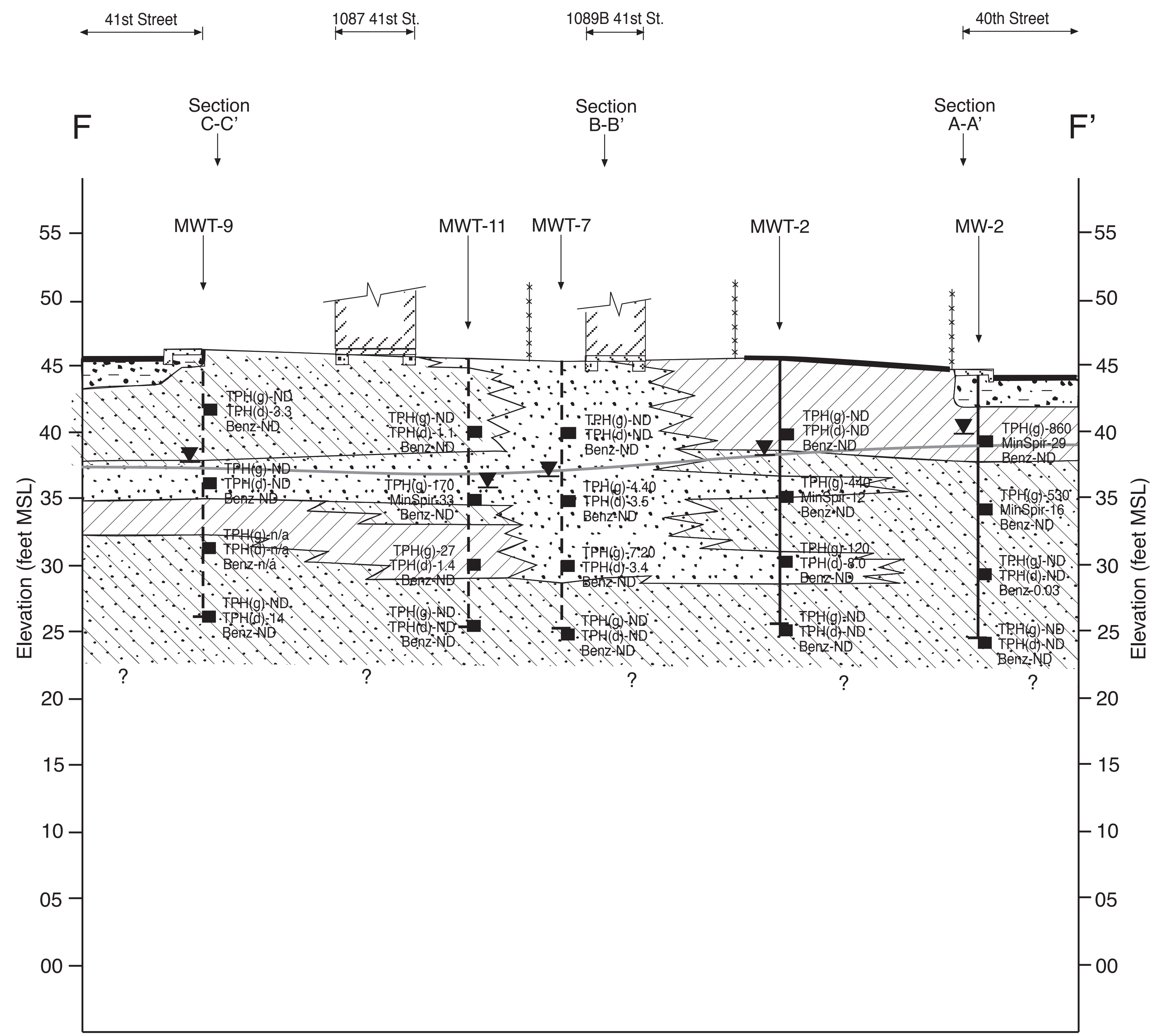
HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION E-E'
Oak Walk Redevelopment Project
Emeryville, California

FIG II-9

The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: GNM
Date: 04/25/06



EXPLANATION

- Clays and Silty Clays
- Sandy Clay and Clays with some Silt, Sand or Gravel
- Silts, Clayey Gravel and Sands
- Gravel
- Gravelly Fill
- Water Table (11/08/04)
- Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

0 40 80

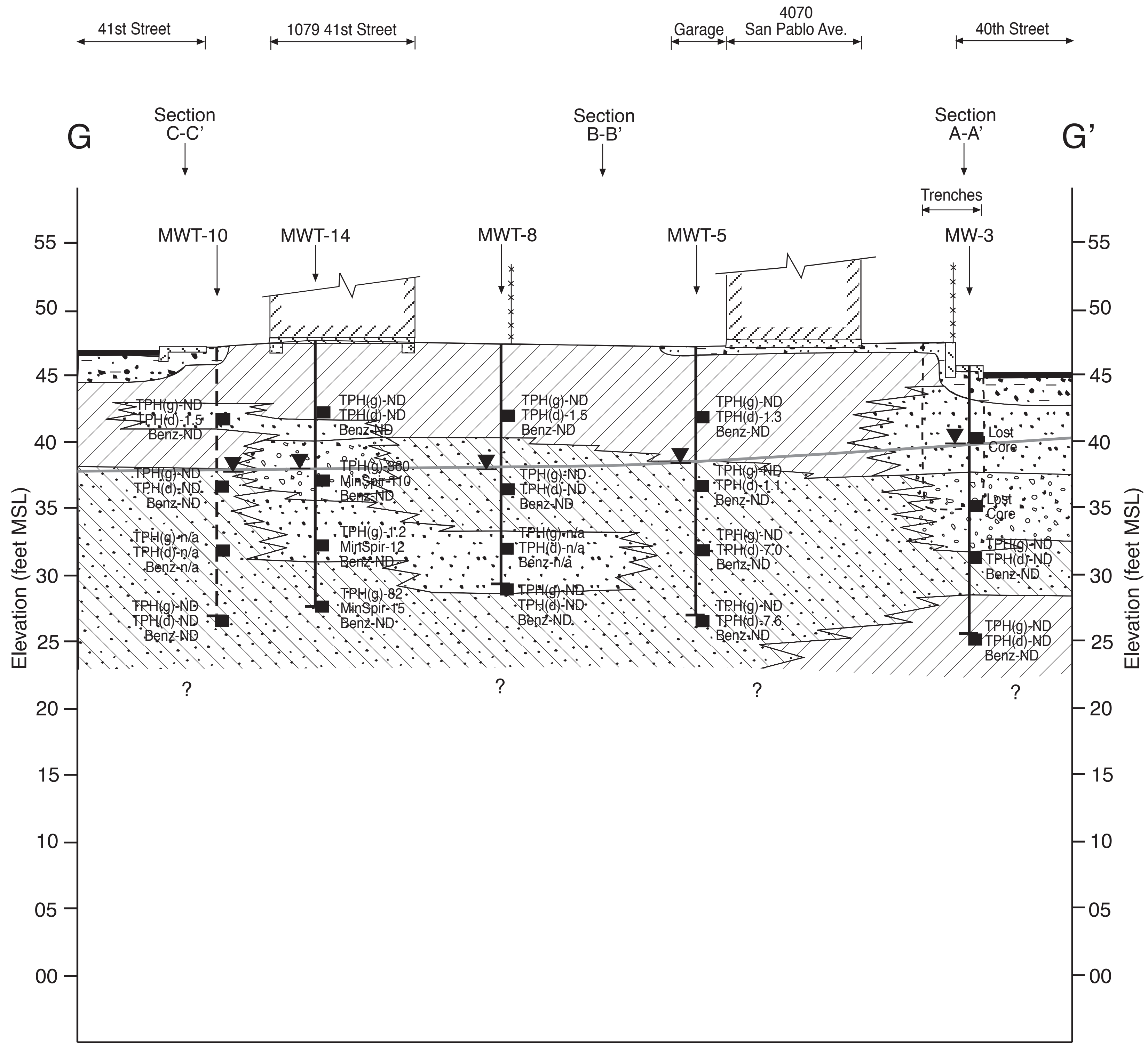
HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION F-F'

Oak Walk Redevelopment Project

Emeryville, California

FIG II-10	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM — Date: 04/25/06



EXPLANATION

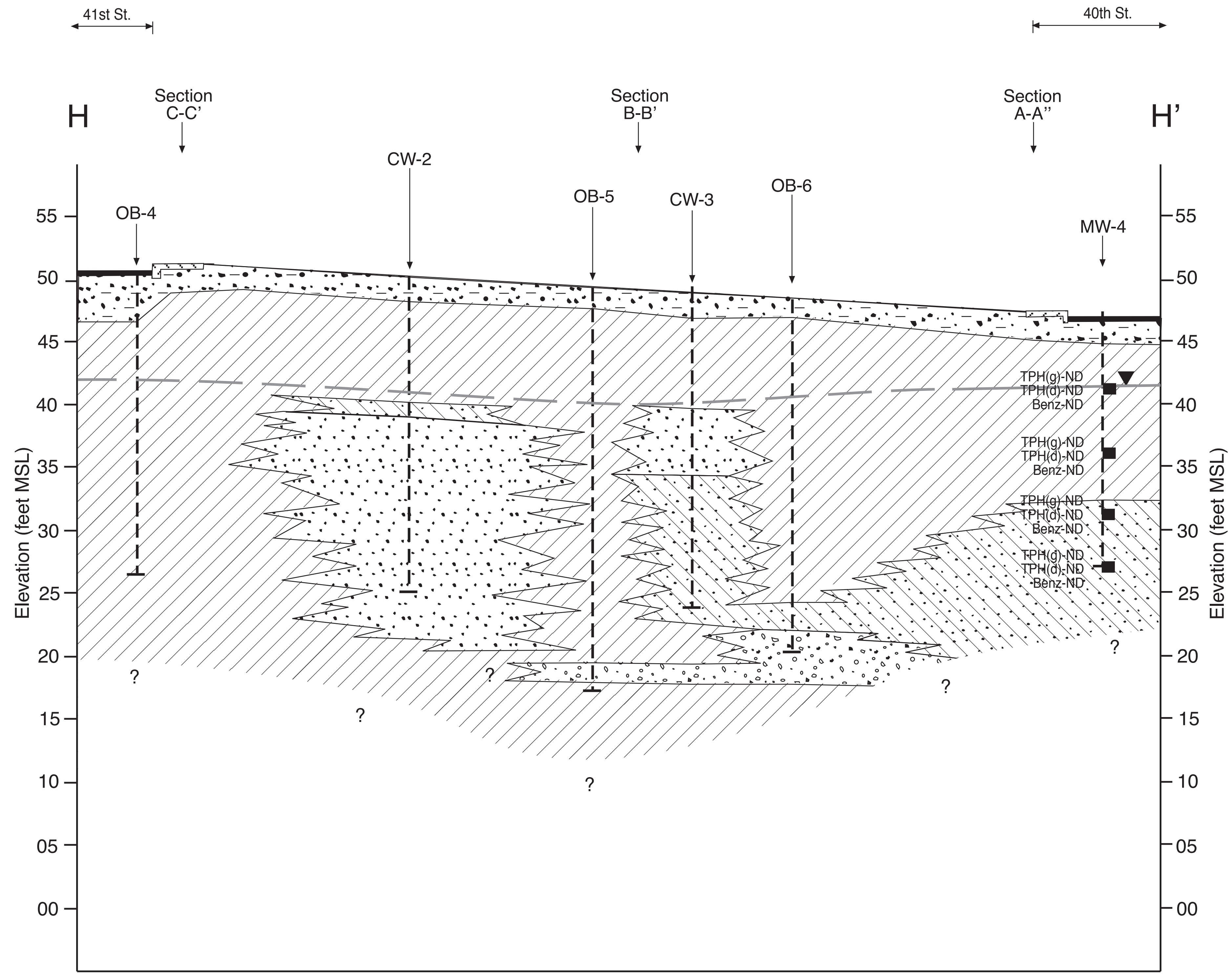
- Clays and Silty Clays
- Sandy Clay and Clays with some Silt, Sand or Gravel
- Silts, Clayey Gravel and Sands
- Gravel
- Gravelly Fill
- Water Table (11/08/04)
- Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

0 40 80

HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION G-G'
Oak Walk Redevelopment Project
Emeryville, California

FIG II-11	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM — Date: 04/25/06



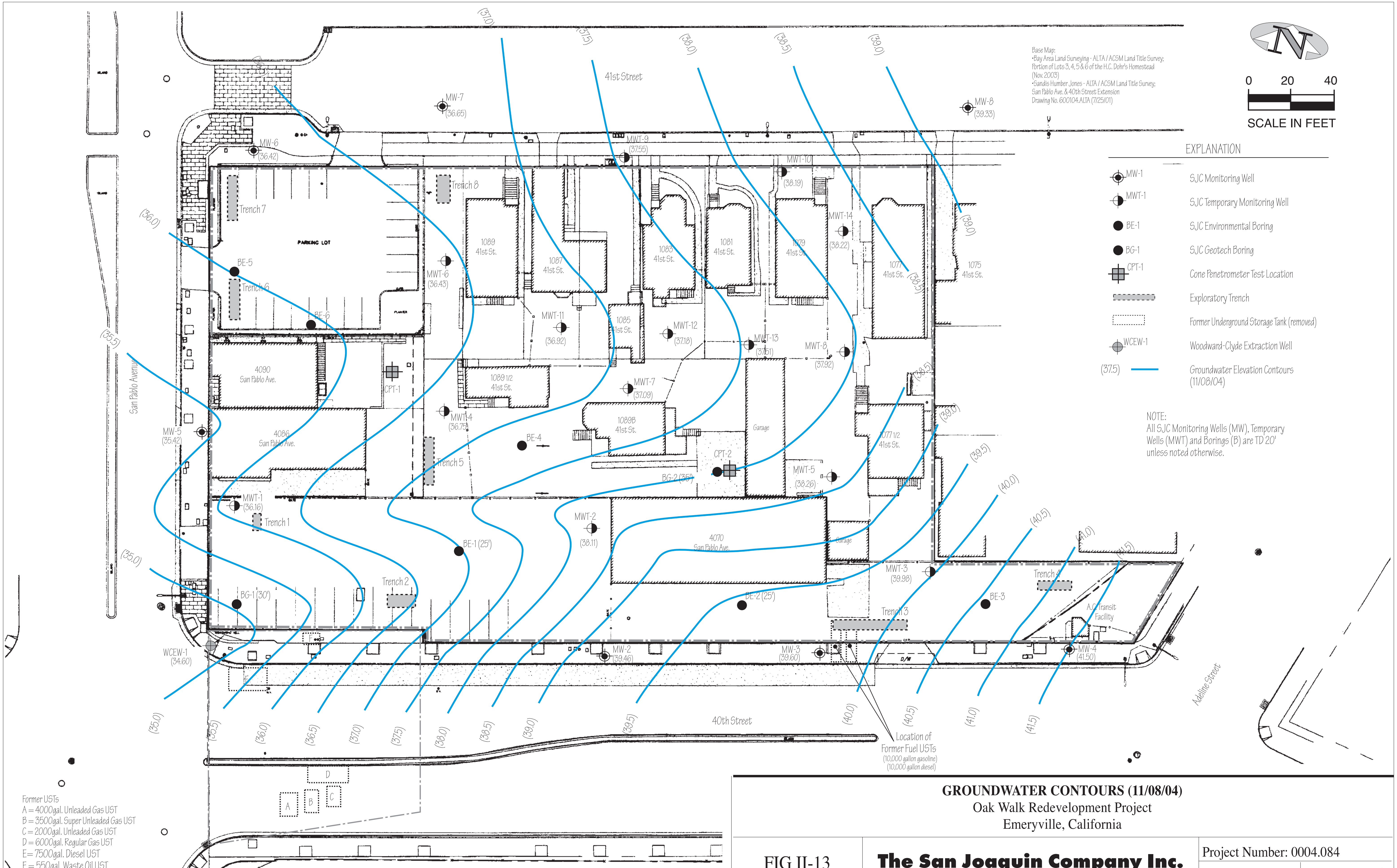
EXPLANATION

- Clays and Silty Clays
- Sandy Clay and Clays with some Silt, Sand or Gravel
- Silts, Clayey Gravel and Sands
- Gravel
- Gravelly Fill
- Water Table (11/08/04)
- Gasoline-340 MineralSpirits/TPH(d)-27 Benzene-ND — Soil Sample Analysis Results (mg/kg)

0 40 80
HORIZONTAL SCALE IN FEET

HYDROSTRATIGRAPHIC SECTION H-H'
Oak Walk Redevelopment Project
Emeryville, California

FIG II-12	The San Joaquin Company Inc.	Project Number: 0004.084	
		Drawn by: GNM	Date: 04/25/06

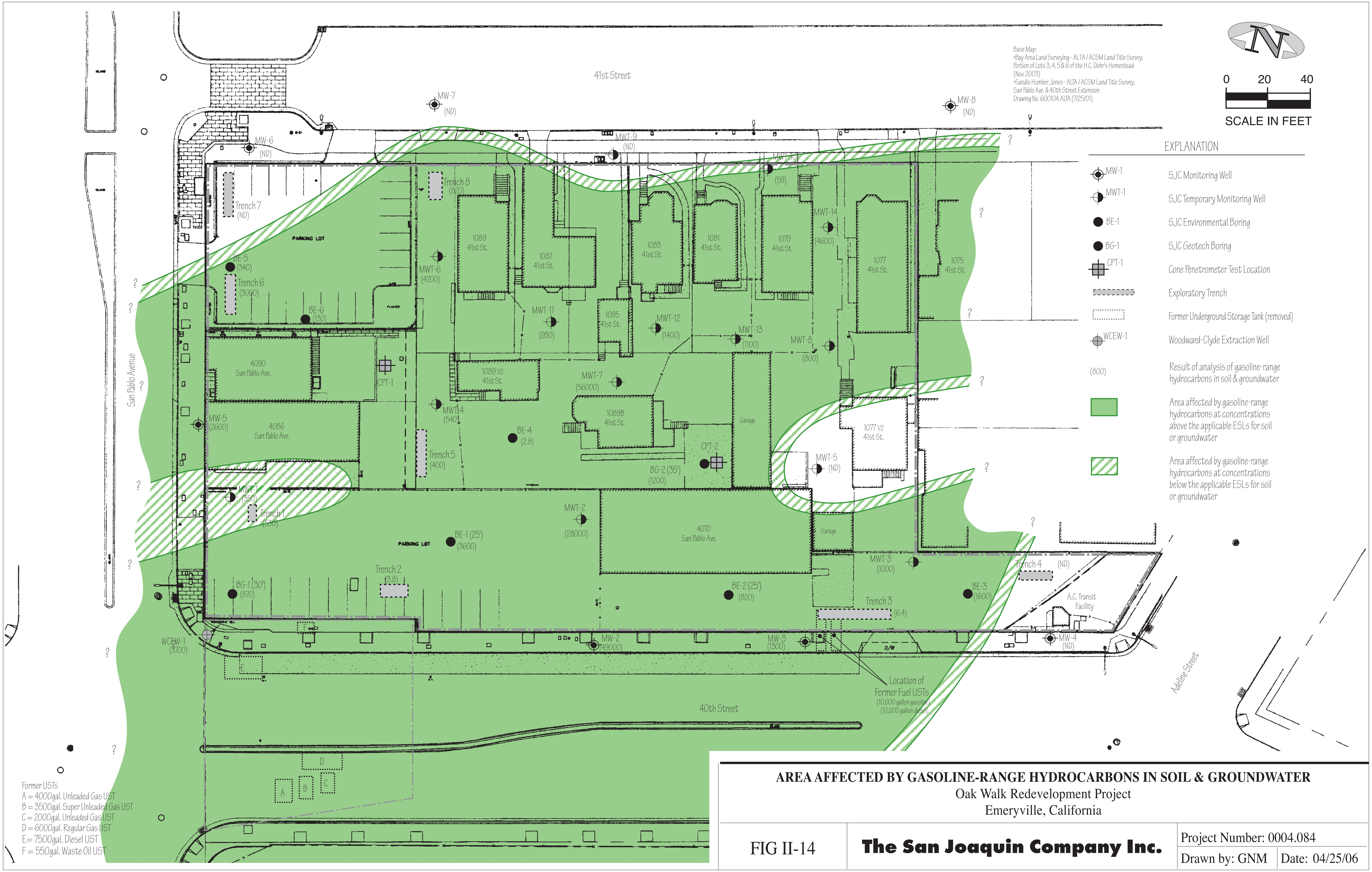


GROUNDWATER CONTOURS (11/08/04)
Oak Walk Redevelopment Project
Emeryville, California

FIG II-13

The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: GNM
Date: 04/23/06

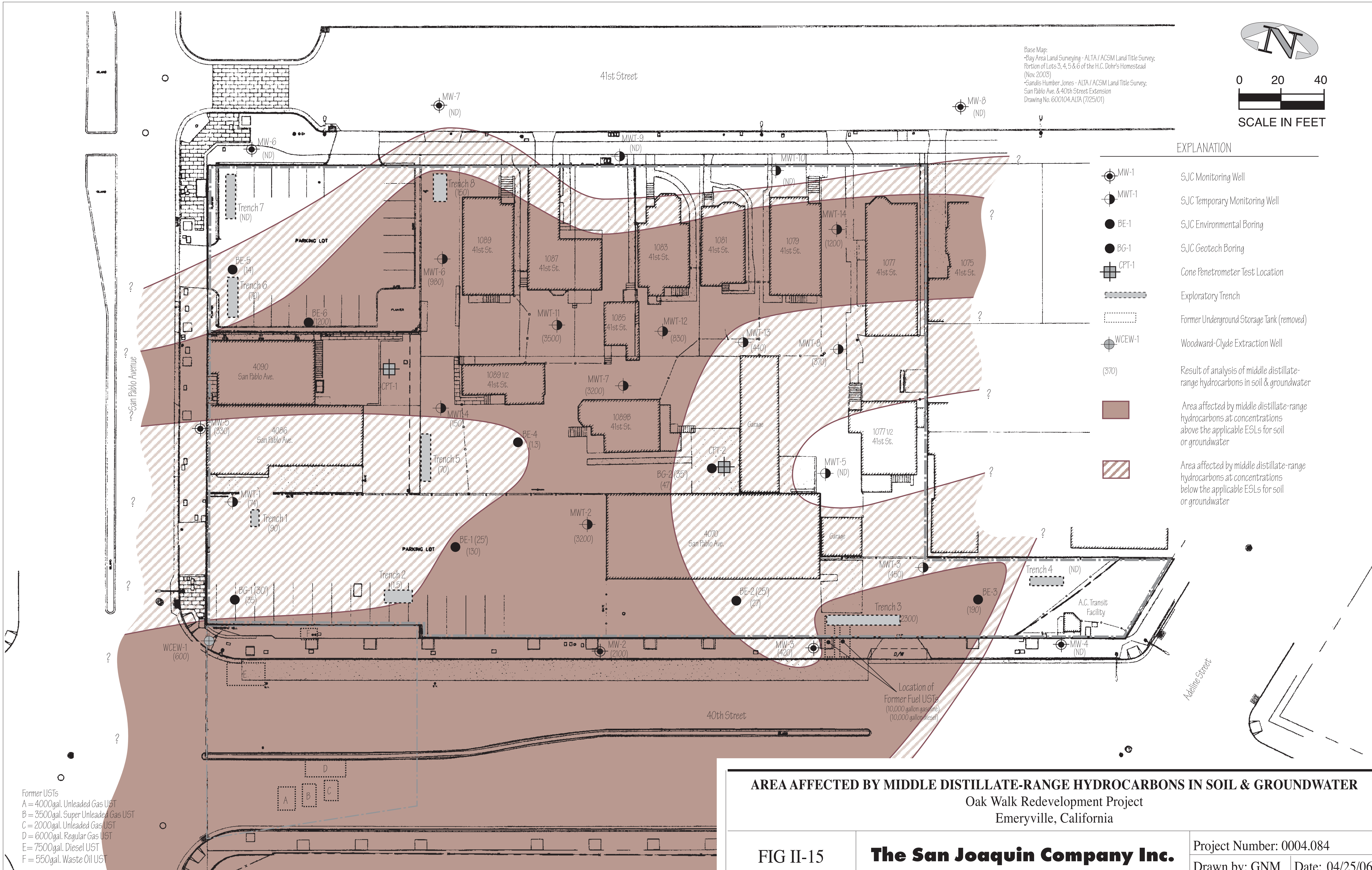


AREA AFFECTED BY GASOLINE-RANGE HYDROCARBONS IN SOIL & GROUNDWATER

Oak Walk Redevelopment Project

Emeryville, California

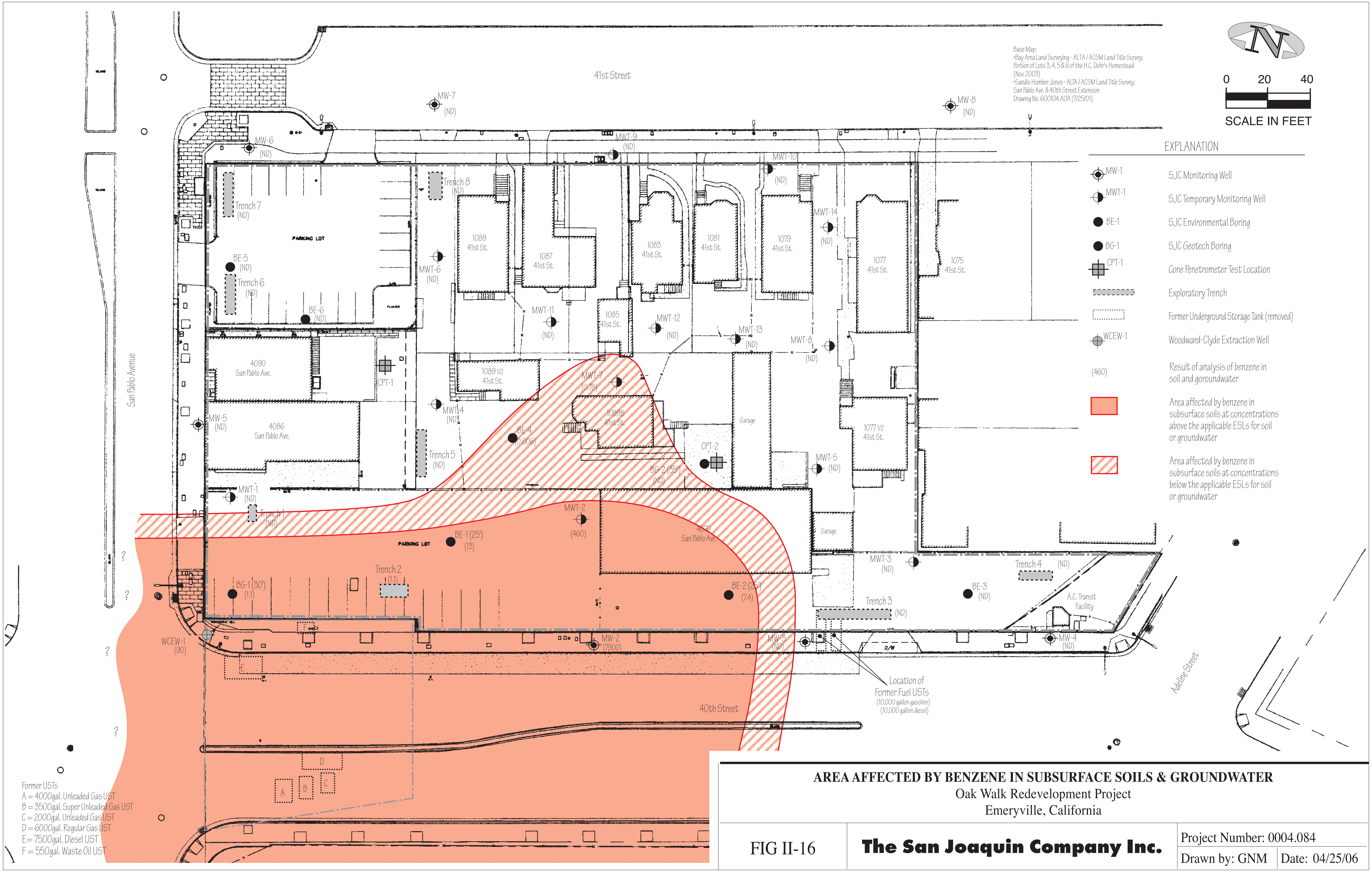
FIG II-14	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM / Date: 04/25/06



AREA AFFECTED BY MIDDLE DISTILLATE-RANGE HYDROCARBONS IN SOIL & GROUNDWATER

Oak Walk Redevelopment Project
Emeryville, California

FIG II-15	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM — Date: 04/25/06

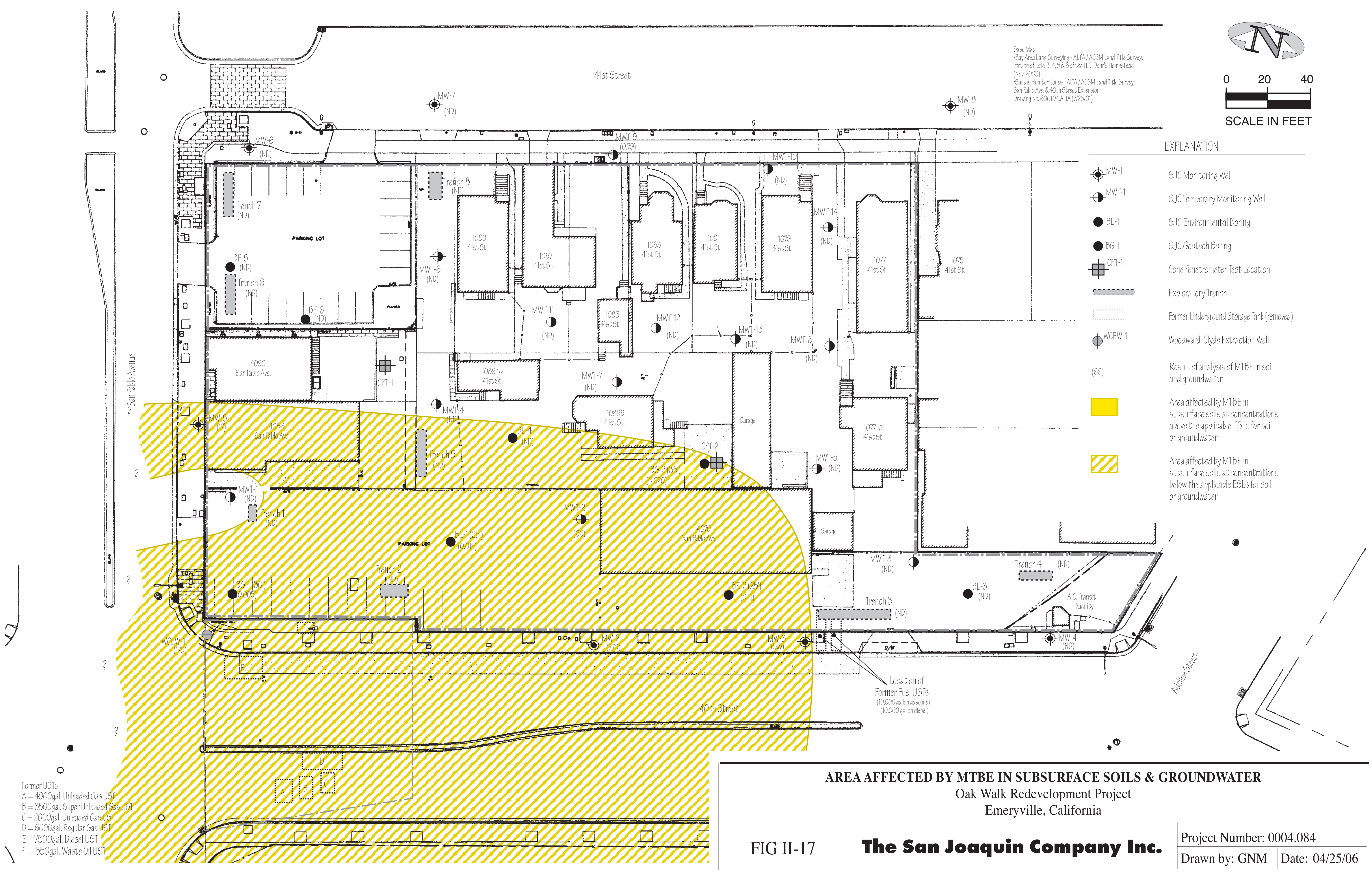


AREA AFFECTED BY BENZENE IN SUBSURFACE SOILS & GROUNDWATER

Oak Walk Redevelopment Project

Emeryville, California

FIG II-16	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM Date: 04/25/06

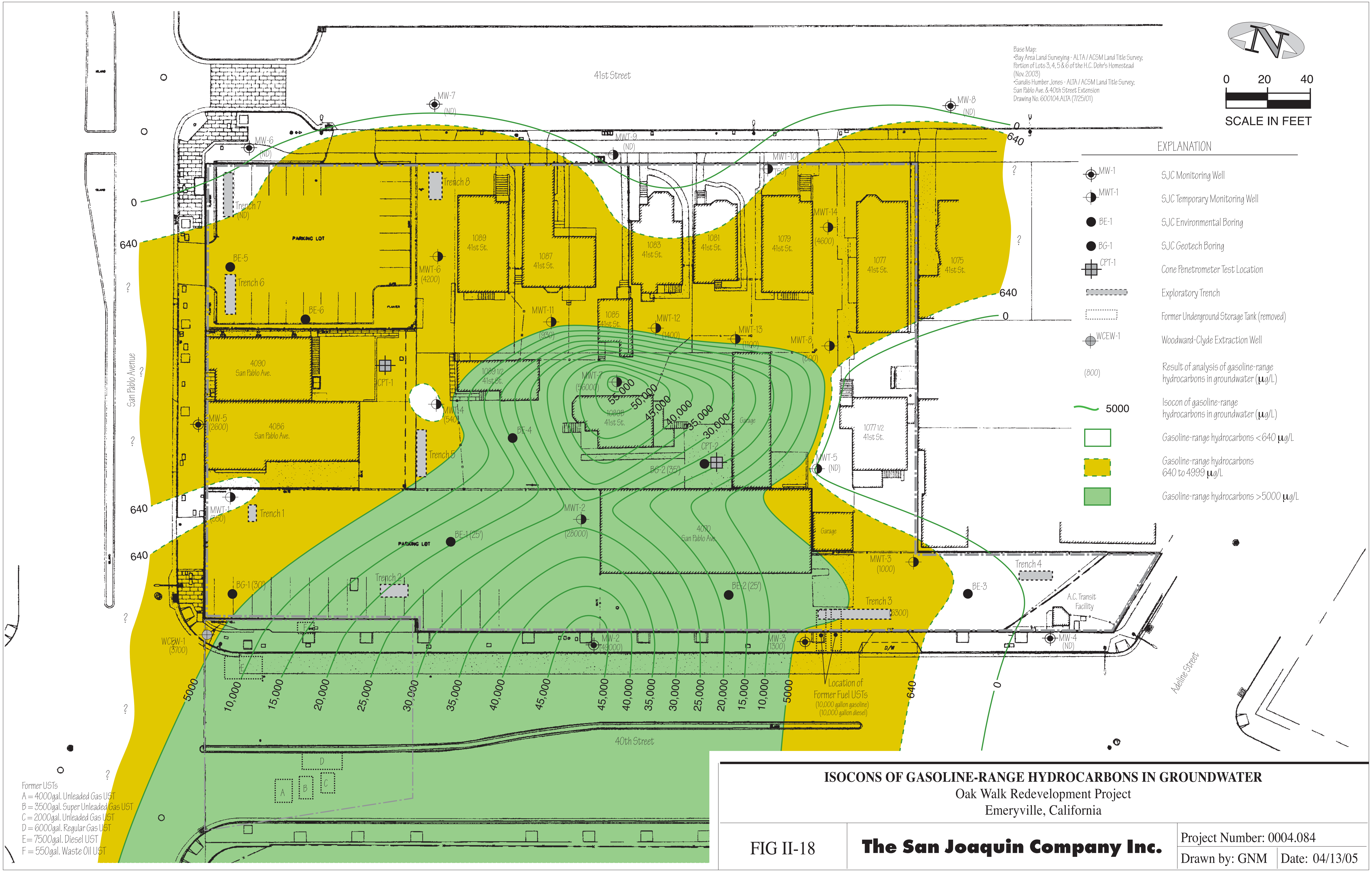


AREA AFFECTED BY MTBE IN SUBSURFACE SOILS & GROUNDWATER

Oak Walk Redevelopment Project

Emeryville, California

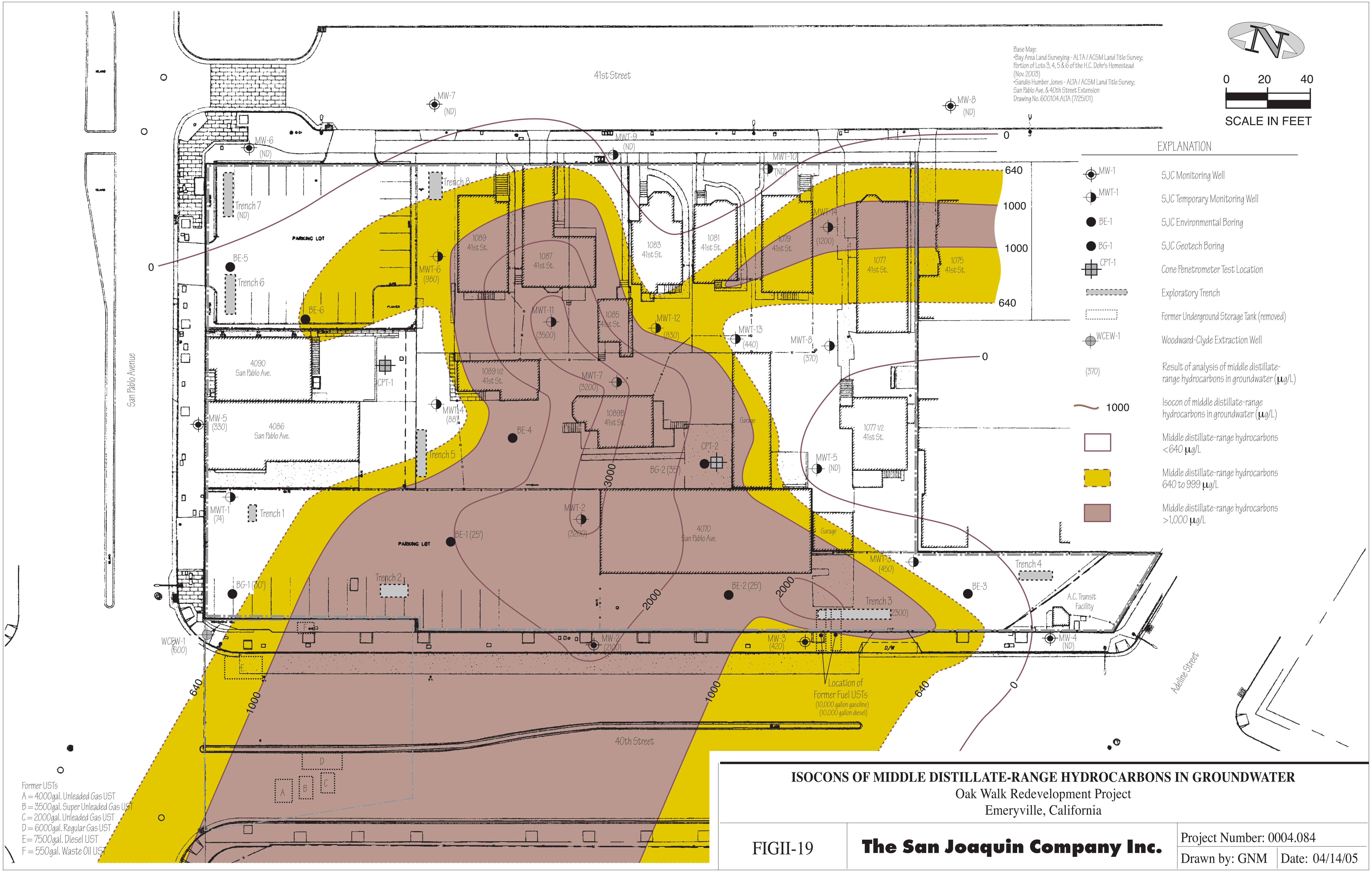
FIG II-17	**The San Joaquin Company Inc.**	Project Number: 0004.084 Drawn by: GNM Date: 04/25/06



ISOCONS OF GASOLINE-RANGE HYDROCARBONS IN GROUNDWATER

Oak Walk Redevelopment Project
Emeryville, California

FIG II-18	The San Joaquin Company Inc.	Project Number: 0004.084
		Drawn by: GNM · Date: 04/13/05



ISOCONS OF MIDDLE DISTILLATE-RANGE HYDROCARBONS IN GROUNDWATER

Oak Walk Redevelopment Project
Emeryville, California

FIGII-19	**The San Joaquin Company Inc.**	Project Number: 0004.084
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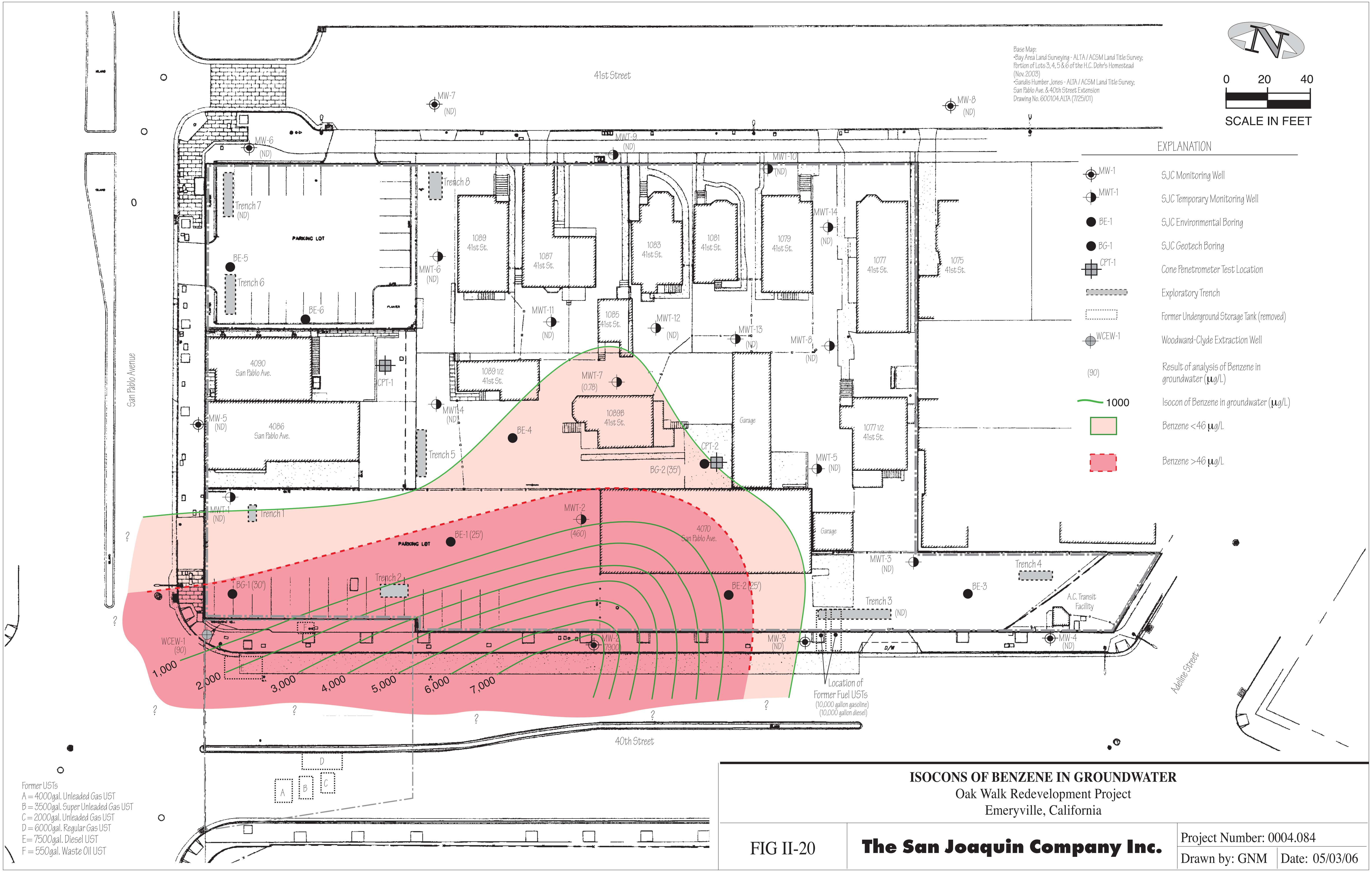
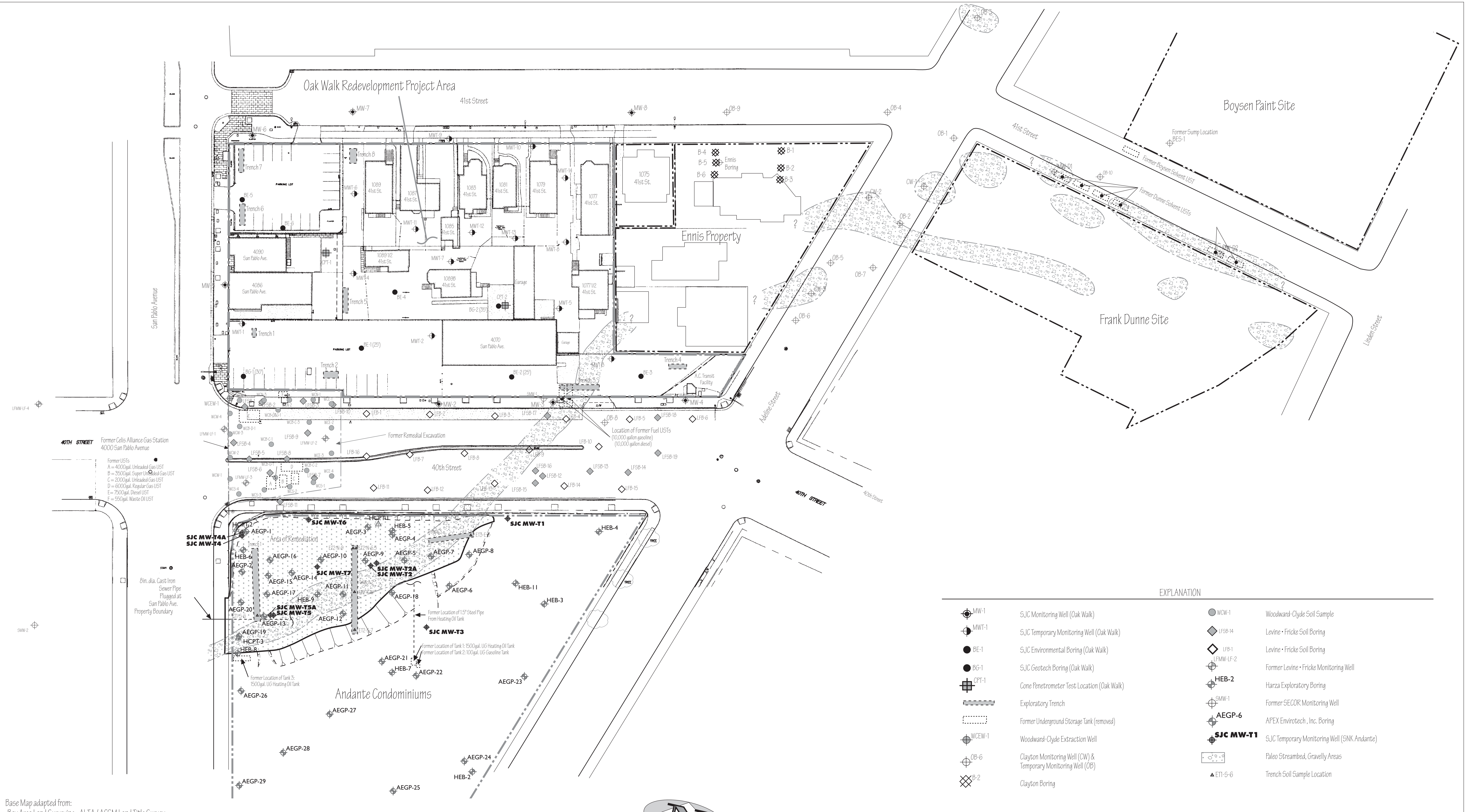


ISOCONS OF BENZENE IN GROUNDWATER
Oak Walk Redevelopment Project
Emeryville, California

FIG II-20

The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: GNM
Date: 05/03/06



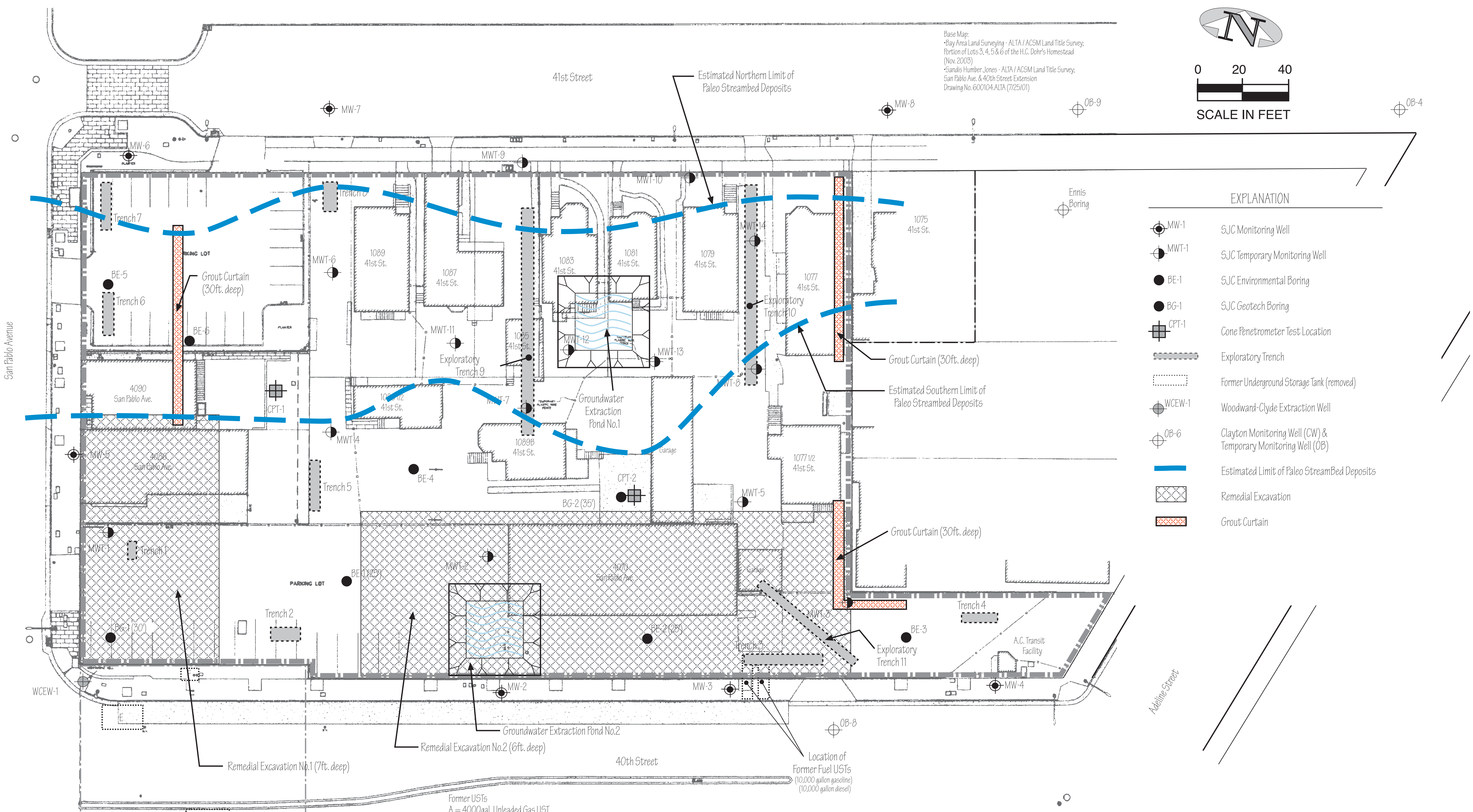
Base Map adapted from:
•Bay Area Land Surveying - ALTA / ACSM Land Title Survey; Portion of Lots 3, 4, 5 & 6 of the H.C. Dohr's Homestead (Nov. 2003)
•Sandis Humber Jones - ALTA / ACSM Land Title Survey; San Pablo Ave. & 40th Street Extension Drawing No. 600104.ALTA (7/25/01)
•Clayton Group Services - Monitoring Well Locations Former Dunner Paints 1007 41st St. Oakland, Figure 2, Project No. 70-03365.04 (12/05/03)
•Clayton Group Services - Historical Subject Property Plan 1007 41st St & 4050 Adeline St., Oakland, Figure 3, Project No. 70-03365.00 (09/06/02)

UNAUTHORIZED RELEASE SITES IN NEIGHBORHOOD OF SUBJECT PROPERTY

Oak Walk Redevelopment Project

Emeryville, California

FIG II-21	**The San Joaquin Company Inc.**	Project Number: 0004.084
		Drawn by: GNM — Date: 04/25/06

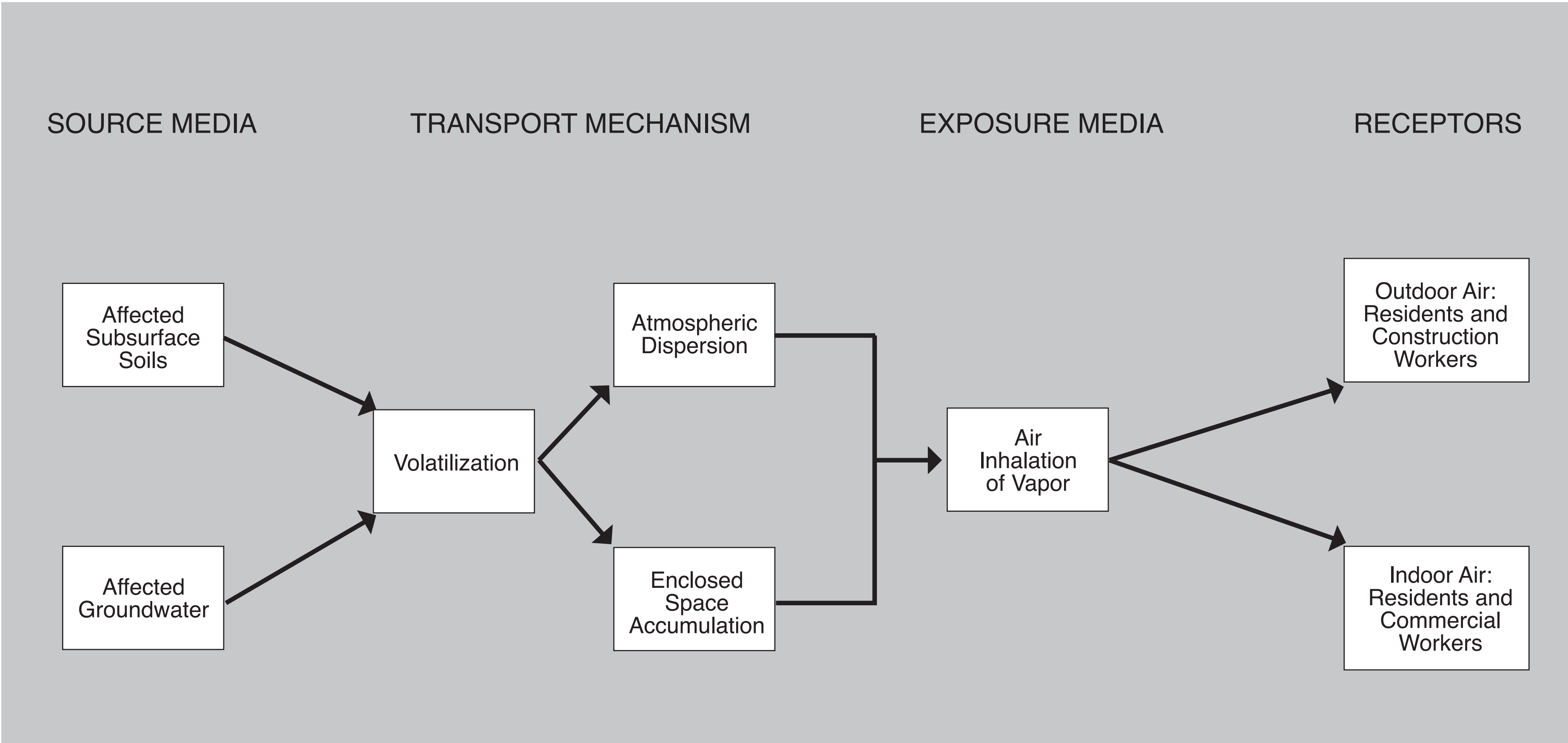


REMEDIAL EXCAVATIONS AND GROUT CURTAINS

Oak Walk Redevelopment Project

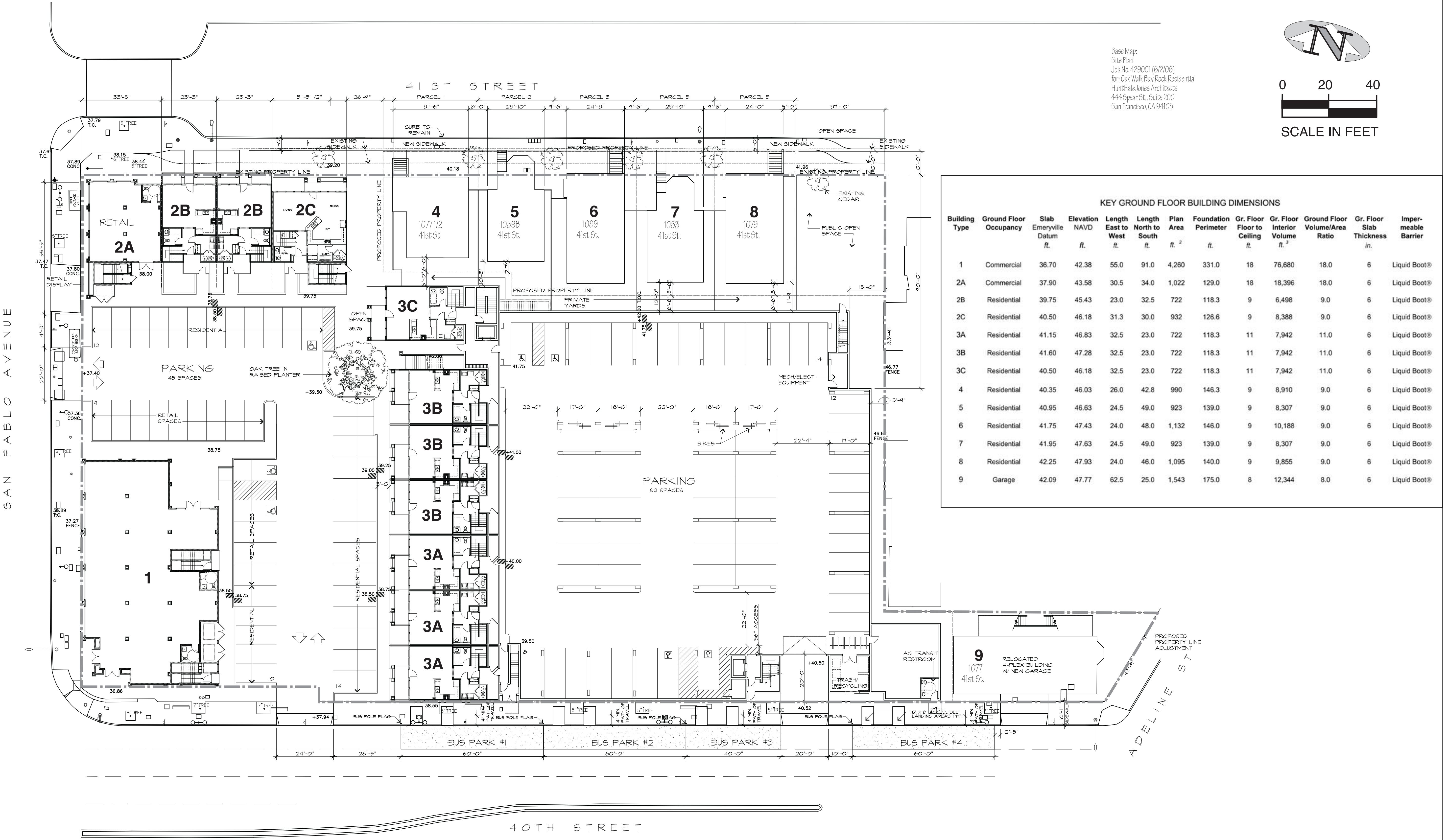
Emeryville, California

FIG II-22	The San Joaquin Company Inc.	Project Number: 0004.084 Drawn by: GNM Date: 06/20/06



EXPOSURE PATHWAYS FOR HUMAN HEALTH RISK ASSESSMENTS
Oak Walk Redevelopment Project
Emeryville, California

FIG II-23	**The San Joaquin Company Inc.**	Project Number: 0004.084 Drawn by: GNM Date: 06/20/06



KEY GROUND FLOOR BUILDING DIMENSIONS

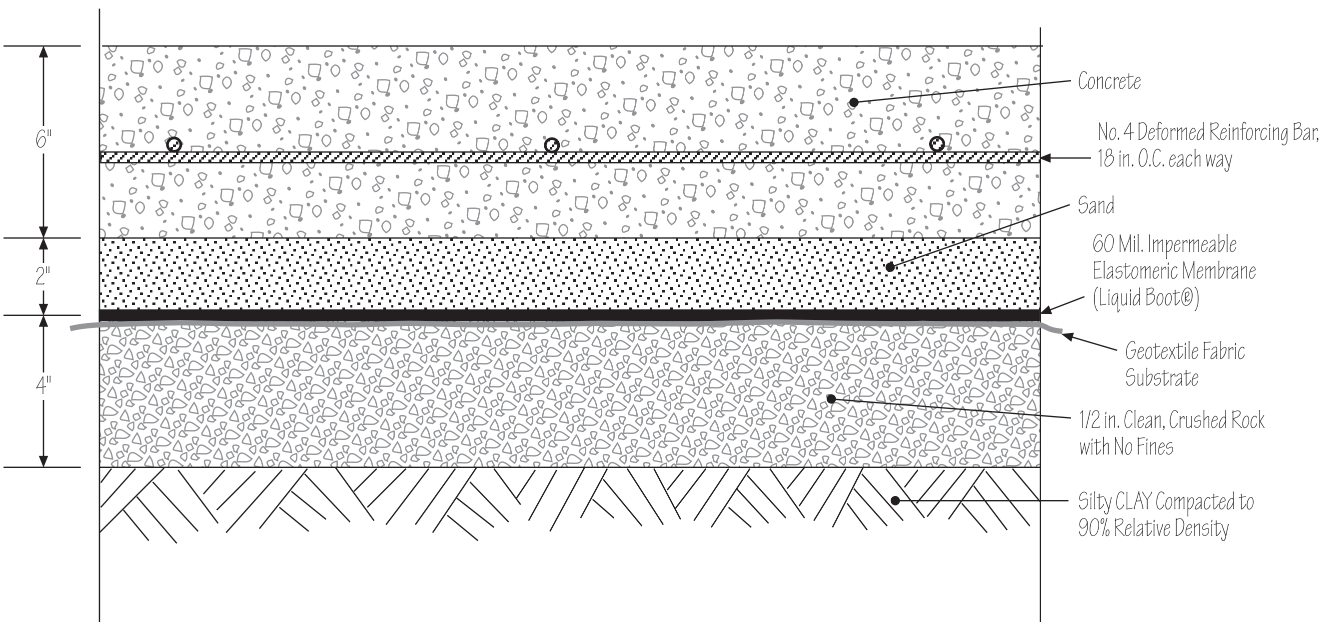
Building Type	Ground Floor Occupancy	Slab Emeryville Datum ft.	Elevation NAVD ft.	Length East to West ft.	Length North to South ft.	Plan Area ft. 2	Foundation Perimeter ft.	Gr. Floor Floor to Ceiling ft.	Gr. Floor Interior Volume ft. 3	Ground Floor Volume/Area Ratio	Gr. Floor Slab Thickness in.	Impermeable Barrier
1	Commercial	36.70	42.38	55.0	91.0	4,260	331.0	18	76,680	18.0	6	Liquid Boot®
2A	Commercial	37.90	43.58	30.5	34.0	1,022	129.0	18	18,396	18.0	6	Liquid Boot®
2B	Residential	39.75	45.43	23.0	32.5	722	118.3	9	6,498	9.0	6	Liquid Boot®
2C	Residential	40.50	46.18	31.3	30.0	932	126.6	9	8,388	9.0	6	Liquid Boot®
3A	Residential	41.15	46.83	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
3B	Residential	41.60	47.28	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
3C	Residential	40.50	46.18	32.5	23.0	722	118.3	11	7,942	11.0	6	Liquid Boot®
4	Residential	40.35	46.03	26.0	42.8	990	146.3	9	8,910	9.0	6	Liquid Boot®
5	Residential	40.95	46.63	24.5	49.0	923	139.0	9	8,307	9.0	6	Liquid Boot®
6	Residential	41.75	47.43	24.0	48.0	1,132	146.0	9	10,188	9.0	6	Liquid Boot®
7	Residential	41.95	47.63	24.5	49.0	923	139.0	9	8,307	9.0	6	Liquid Boot®
8	Residential	42.25	47.93	24.0	46.0	1,095	140.0	9	9,855	9.0	6	Liquid Boot®
9	Garage	42.09	47.77	62.5	25.0	1,543	175.0	8	12,344	8.0	6	Liquid Boot®

GROUND FLOOR RESIDENTIAL AND COMMERCIAL UNIT TYPES
Oak Walk Redevelopment Project
Emeryville, California

FIG II-24

The San Joaquin Company Inc.

Project Number: 0004.084
Drawn by: GNM
Date: 06/21/06



FLOOR SLAB WITH LIQUID BOOT® MEMBRANE

Oak Walk Redevelopment Project

Emeryville, California

FIG II-25	**The San Joaquin Company Inc.**	Project Number: 0004.084	
		Drawn by: GNM	Date: 06/20/06

APPENDIX II-A

Risk-based Site Evaluation Process

Source: Groundwater Services, Inc.

Overview of Risk Management Steps

Effective risk management at chemical release sites involves: i) identification of applicable risk factors on a site-specific basis; and ii) development and implementation of appropriate protective measures in the timeframe necessary to prevent unsafe conditions. Key elements of the risk-based site evaluation process include:

- ***Exposure Pathway Screening:*** Identify potential mechanisms for exposure of human or ecological receptors on a site-specific basis.
- ***Risk-Based Cleanup Objectives:*** For each complete exposure pathway, evaluate potential for exposure in excess of safe limits based on tiered evaluation of soil and groundwater cleanup limits.
- ***Remedy Selection:*** Develop risk-based exposure control strategy based on the nature and timing of the potential impact.
- ***Compliance Monitoring:*** If needed, conduct final compliance monitoring to confirm satisfactory remedy completion prior to formal case closure.

Further discussion of these process steps and relevant risk-based modeling tools is provided below.

Exposure Pathway Screening

The risk-based evaluation addresses the potential for constituent transport from the affected media source zone to a point of contact with a human or ecological receptor via various *exposure pathways*. For most remediation sites, the primary exposure pathways of human health concern are i) groundwater ingestion, ii) soil-to-groundwater release, and iii) soil ingestion, vapor inhalation, and dermal contact. Additional exposure pathways may apply based on site conditions and land use (e.g., surface water impacts, ecological exposures). To pose a risk, three components of each exposure pathway must be present: an affected source medium, a mechanism for constituent transport, and a receptor. In practical terms, exposure pathways may therefore be screened from further consideration based on the presence and mobility of the constituents of concern and the proximity of receptors to the source zone. For example, for an affected groundwater plume in a stable or diminishing condition, no potential exists for impacts on water supply wells located outside the current plume area.

Pathways determined to be potentially complete should be retained for site-specific evaluation. However, if the preliminary screening analysis shows no complete exposure pathways, no further evaluation is required.

- ***Applicable Data Evaluation Tools:*** The RBCA Tool Kit is organized to facilitate pathway screening via the "Exposure Pathway Identification" input screen. The user identifies affected source media and actual and/or potential receptors from among a matrix of possible options. Based on these selections, the complete exposure pathways may be viewed on the Exposure Flowchart output screen. In addition, ASTM standard E-1943, "Standard Guide for Remediation by Natural Attenuation (RNA)," outlines practical data evaluation methods for analysis of groundwater plume stability, including historical data plots, estimation of bulk attenuation rates, and modeling methods. The *GSI Natural Attenuation Tool Kit* developed for use with the ASTM RNA Standard, is also available from GSI (*http://www.gsi.net.com*).

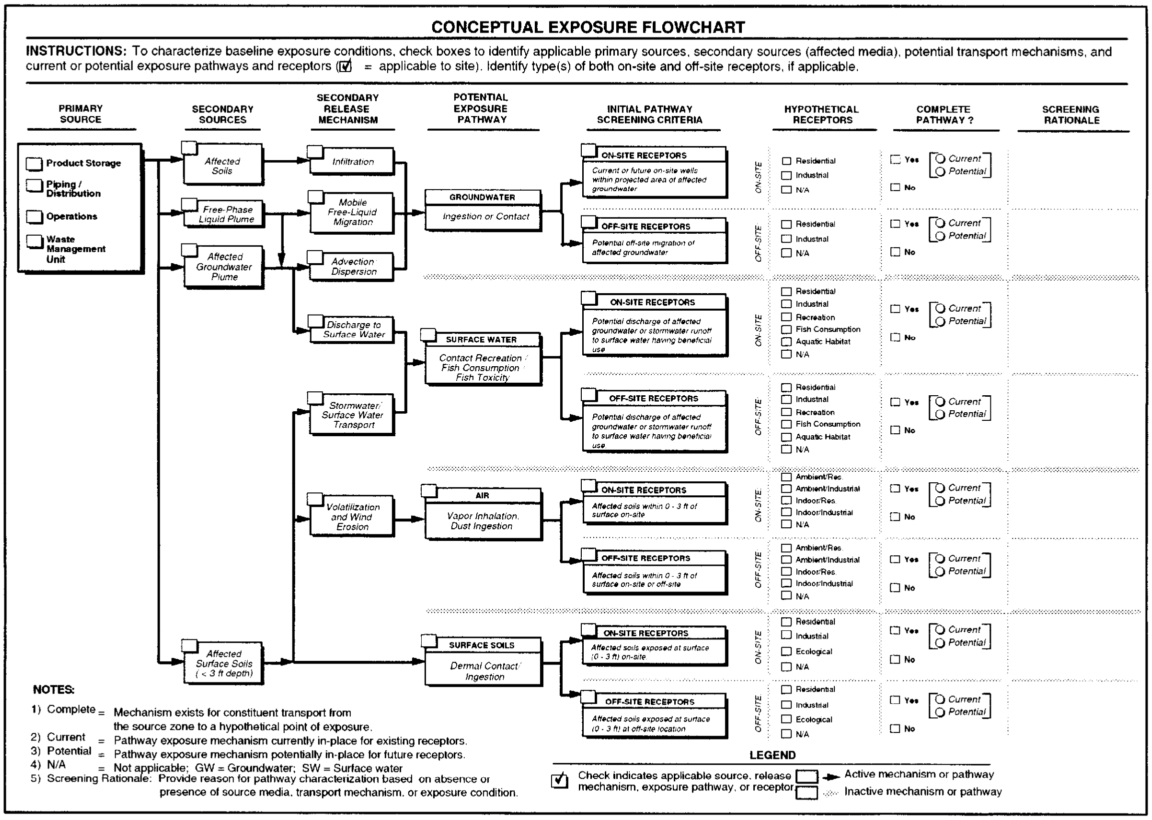


FIGURE A.1. CONCEPTUAL EXPOSURE FLOWCHART

Risk-Based Cleanup Objectives

The RBCA process employs a tiered approach to derivation of risk-based soil and groundwater cleanup goals, with each tier serving to refine the risk analysis based upon additional site data and more sophisticated fate and transport modeling methods. For example, Tiers 1 and 2 of the site evaluation process are amenable to use of simple analytical models to estimate risk-based concentration limits, while more complex and costly numerical modeling methods are reserved for Tier 3 evaluations. In each case, risk-based concentration limits are derived for relevant exposure pathways, receptors, and constituents of concern (COCs) and compared to measured source media concentrations. Source media exceeding these target levels will require either further investigation or remedial action in the timeframe necessary to control exposure. Summary information regarding principal calculation steps is provided below.

i) ***Media-Specific Cleanup Standards:*** For a given exposure pathway and COC, the risk-based standard represents a concentration in the affected source medium (soil or groundwater) that is protective of a human or ecological receptor located at a relevant point of exposure (POE). For example, for the human health soil-to-air exposure pathway, the cleanup standard is the mean concentration in the affected surface soil zone that will prevent unsafe human exposures via soil vapor or particulate release to air. The ASTM RBCA Standard and other regulatory programs distinguish between two types of risk-based cleanup standards: i) the Risk-Based Screening Level (RBSL), a *generic* target level utilized under Tier 1, and ii) a Site-Specific Target Level (SSTL), a *site-specific* target level utilized under Tier 2 or Tier 3. Under the RBCA process, Tier 1 RBSLs are based on an assumed exposure in immediate proximity to the source. If source media COC concentrations exceed Tier 1 RBSLs, the relevant exposure pathways and COCs may be further evaluated under Tier 2 or Tier 3 to calculate SSTLs, which would address actual site-specific exposure conditions , and where the POE may be located at some distance away from the source. For each complete exposure pathway, cleanup standards for the source medium can be back-calculated from safe exposure levels at the POE using the following general expressions:

Tier I: $RBSL = RBEL \times NAF_{CM}$

Tier 2: $SSTL = RBSL \times NAF_{LT}$

where

RBEL = Risk-based *exposure* limit for direct intake of exposure medium (e.g. air concentration limit for inhalation).

NAF_{CM} = Natural attenuation factor defining natural reduction in constituent concentrations during cross-media (CM) transport (e.g., soil to air volatilization).

NAF_{LT} = Natural attenuation factor defining natural reduction in constituent concentrations during lateral transport (LT) (e.g., via dispersion during lateral migration in air).

RBSL or SSTL values must be developed for each complete exposure pathway and COC. For exposure pathways with multiple POEs (e.g., ambient vapor inhalation by on-site worker and by off-site resident), separate SSTLs must be developed for each POE using the appropriate RBEL value. In general, the RBEL value does not vary among Tiers 1, 2, and 3. Rather, the cleanup standard value is refined at each successive tier by improving the NAF estimations, based upon more complete site information and more sophisticated data evaluation and/or modeling methods. Determination of applicable RBEL and NAF values is addressed below.

ii) ***Risk-Based Exposure Limits:*** The RBEL represents the constituent concentration exposed to the receptor that does not exceed target risk limits, based on applicable regulatory criteria. The RBEL applies at the POE, i.e., the likely point of constituent intake or contact by a human or ecological receptor. For each complete exposure pathway and COC, the applicable RBEL must be matched to each relevant POE based on the type of exposure medium (air, water, soil) and the type of receptor (resident, commercial/industrial worker, etc.). For certain exposure media, human health-based exposure limits are specified under applicable regulations, such as Maximum Contaminant Levels (MCLs) for drinking water ingestion or Permissible Exposure Limits (PELs) for industrial air exposure. In the absence of such standards, human health RBELs can be derived for each constituent and exposure medium (air, water, soil) using the following general expressions:

Carcinogens: $$RBEL = \frac{TR}{E \cdot SF}$$

Non-carcinogens: $$RBEL = \frac{THQ \cdot RfD}{E}$$

where

E = effective exposure rate for specified pathway, based on applicable exposure factors (e.g., daily intake rate in mg/day per kg body weight),

TR = target risk limit for carcinogenic effects of individual constituents (dimensionless),

SF = slope factor for carcinogenic effects of COC $(mg/kg\text{-}day)^{-1}$,

THQ = target hazard quotient for non-carcinogenic effects of individual constituents (dimensionless), and

RfD = reference dose for non-carcinogenic effect of COC (mg/kg-day).

Applicable target risk limits (TR, THQ) for health protection can be matched to levels specified by the environmental regulatory authority. Toxicological parameters for each COC can be determined from published references, such as the U.S. EPA Integrated Risk Information System (IRIS). Exposure rates correspond to the chronic rate of contact or intake of the affected exposure medium (air, water, soil) by the receptor under anticipated land use conditions. As a conservative measure, these rates can be estimated based on standard exposure factors published by the regulatory authority or other source (e.g., American Industrial Health Council) for the anticipated land use at the site (e.g., residential, commercial, etc.).

Quantitative measures for derivation of RBELs for ecological receptors are not well defined. However, if the pathway screening evaluation indicates a reasonable potential for ecological exposure (e.g., surface water/aquatic species), applicable RBELs may be based on published standards or ecological screening criteria (e.g., surface water quality standard for aquatic life protection, ecological screening limits for terrestrial species, etc.). The U.S. EPA and various state agencies maintain databases of ecological screening levels for various types of receptors. However, given the highly conservative nature of these concentration limits, use of these values as ecological RBELs is appropriate only for preliminary screening-level analyses.

iii) ***Applicable Exposure Factors:*** For each complete pathway, *exposure factors* must be defined characterizing the potential duration, frequency, and rate of contact of the receptor with affected media at the POE. Depending upon the degree of conservatism desired, exposure activities can be characterized on the basis of either i) *most likely exposure* (MLE) factors, representing average exposure rates, or ii) *reasonable maximum exposure* (RME) factors, corresponding to the highest rate of exposure that could reasonably be expected to occur (i.e., upper 95% value). Standard RME and MLE exposure factors for various exposure pathways, under both residential and non-residential land use scenarios, are listed on Table A.1.

To select appropriate exposure factors, the user must first define the type of receptor anticipated under current and future land use (i.e., residential vs. commercial/industrial) and then evaluate the applicability of the standard factors to site-specific conditions. The likelihood that such exposure will occur and the degree of conservatism desired should be considered in selecting among MLE and RME values. A Tier 2 evaluation may use both MLE and RME values, in order to estimate the potential range of risks associated with exposure to the site. Modification of these standard values may be justified under certain conditions (e.g., frequency of dermal contact with soils in cold weather climates). For detailed information regarding derivation and application of these exposure factors, see U.S. EPA (1997; 1992a; 1991) and American Industrial Health Council (1994).

iv) ***Natural Attenuation Factor:*** For each complete exposure pathway, the NAF represents the cumulative effect of various partitioning, dilution, and attenuation factors acting to reduce constituent concentrations during transport from source to receptor (see Figure A.2). These NAF components may involve both cross-media transfer factors (NAF_{CM}, such as soil-to-air volatilization or soil-to-groundwater leaching) and lateral transport factors (NAF_{LT}, such as air dispersion or groundwater advection-dispersion; see Appendix B). For exposure pathways with multiple POEs, separate NAF_{LT} values must be derived for each POE location (e.g., ambient vapor inhalation by on-site worker and off-site resident; or groundwater ingestion at both hypothetical and actual wells). For a given site and exposure pathway, the NAF value may vary among evaluation of Tiers 1, 2, and 3, based on use of improved site data and evaluation methods.

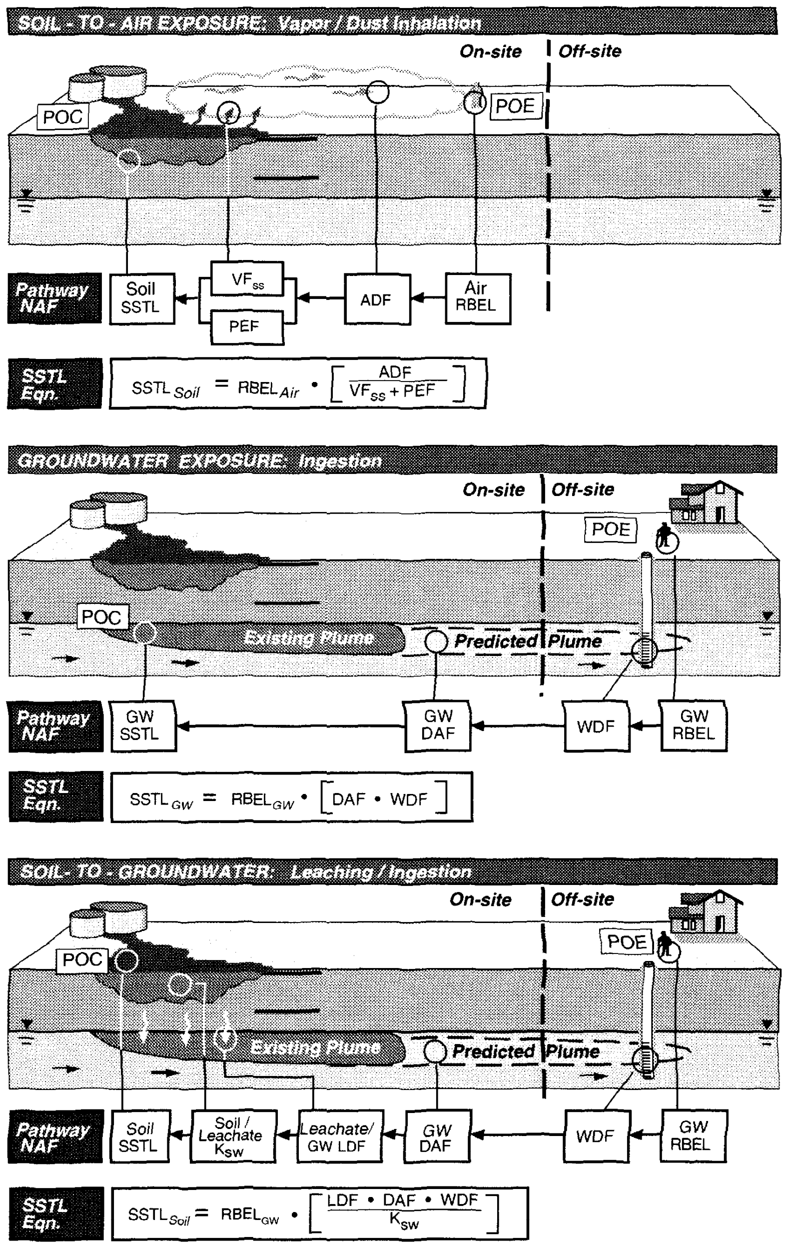
For each complete exposure pathway and COC, the applicable NAF values can be derived based on either: i) the actual measured concentration ratio between the source medium and the POE or

TABLE A.1 STANDARD EXPOSURE FACTORS FOR TIER 1 AND TIER 2 EVALUATIONS

EXPOSURE PATHWAY		Contact Rate (CR)	Exposure Frequency (EF)	Exposure Duration (ED)	Body Weight (BW)	Surface Contact Area (SA)	Soil Adherence Factor (AF)	Dermal Adsorption Factor (DA)	EXPOSURE RATE (E) Equation	Value for Carcinogens	Value for Non-carcinogens
RESIDENTIAL LAND USE											
Ingestion of potable water	MLE:	1.4 L/day	350 days/yr	8 years	70 kg	—	—	—	$\frac{CR \cdot EF \cdot ED}{BW \cdot AT}$	0.0022 L/kg-day	0.019 L/kg-day
	RME:	2 L/day	350 days/yr	30 years	70 kg	—	—	—		0.0012 L/kg-day	0.027 L/kg-day
Ingestion of soil and dust	MLE:	25 mg/day	350 days/yr	8 years	70 kg	—	—	—	$\frac{CR \cdot EF \cdot ED}{BW \cdot AT}$	0.039 mg/kg-day	0.34 mg/kg-day
	RME:	100 mg/day	350 days/yr	30 years	70 kg	—	—	—		0.59 mg/kg-day	1.4 mg/kg-day
Inhalation of volatiles	MLE:	—	350 days/yr	8 years	—	—	—	—	$\frac{EF \cdot ED}{AT}$	40 days/yr	350 days/yr
	RME:	—	350 days/yr	30 years	—	—	—	—		150 days/yr	350 days/yr
Dermal contact with soils	MLE:	—	40 days/yr	9 years	70 kg	5000 cm^2	0.2 mg/cm^2-day	Organics: 0.04* Metals: 0.001*	$\frac{EF \cdot ED \cdot SA \cdot AF \cdot DA}{BW \cdot AT}$	0.008 mg/kg-day**	0.063 mg/kg-day**
	RME:	—	350 days/yr	30 years	70 kg	5800 cm^2	1.0 mg/cm^2-day	Organics: 0.04* Metals: 0.001*		1.4 mg/kg-day**	3.2 mg/kg-day**
COMMERCIAL / INDUSTRIAL LAND USE											
Ingestion of potable water	MLE:	1 L/day	250 days/yr	4 years	70 kg	—	—	—	$\frac{CR \cdot EF \cdot ED}{BW \cdot AT}$	0.00056 L/kg-day	0.0098 L/kg-day
	RME:	1 L/day	250 days/yr	25 years	70 kg	—	—	—		0.0035 L/kg-day	0.0098 L/kg-day
Ingestion of soil and dust	MLE:	50 mg/day	250 days/yr	4 years	70 kg	—	—	—	$\frac{CR \cdot EF \cdot ED}{BW \cdot AT}$	0.028 mg/kg-day	0.49 mg/kg-day
	RME:	50 mg/day	250 days/yr	25 years	70 kg	—	—	—		0.17 mg/kg-day	0.49 mg/kg-day
Inhalation of volatiles	MLE:	—	250 days/yr	4 years	—	—	—	—	$\frac{EF \cdot ED}{AT}$	14 days/yr	250 days/yr
	RME:	—	250 days/yr	25 years	—	—	—	—		89 days/yr	250 days/yr
Dermal contact with soils	MLE:	—	40 days/yr	4 years	70 kg	5000 cm^2	0.2 mg/cm^2-day	Organics: 0.04* Metals: 0.001*	$\frac{EF \cdot ED \cdot SA \cdot AF \cdot DA}{BW \cdot AT}$	0.0036 mg/kg-day**	0.063 mg/kg-day**
	RME:	—	250 days/yr	25 years	70 kg	5800 cm^2	1.0 mg/cm^2-day	Organics: 0.04* Metals: 0.001*		1.4 mg/kg-day**	2.3 mg/kg-day**

NOTES:
1) Exposure factors shown above are matched to published U.S. EPA guidelines, when available (U.S. EPA, 1997, 1992a, 1991a). If no EPA value available, other peer-reviewed reference applied (American Industrial Health Council, 1994).
2) MLE = Most Likely Exposure; corresponding to mean exposure rate for exposed population (American Industrial Health Council, 1994; U.S. EPA, 1992a).
3) RME = Reasonable Maximum Exposure; corresponding to upper 95% exposure rate for exposed population (American Industrial Health Council, 1994; U.S. EPA, 1997, 1992a, 1991a).
4) AT = Averaging Time. For carcinogens, AT = 70 yrs x 365 days/yr. For non-carcinogens, AT = ED x 365 days/yr.
5) * = Default value. Use chemical-specific data if available. Values shown represent mid- to upper-range values per U.S. EPA, 1992b; Howard et al., 1991.
6) ** = Calculations of dermal contact with soils or sediments are based on organic default values. Contact rates for soil ingestion and dermal contact shown above are based upon adult receptor.

ii) fate-and-transport modeling analyses predicting this concentration ratio. For purpose of simplicity and accuracy, direct field measurements represent the preferred method of NAF estimation, whenever feasible. However, due to temporal variability and sampling difficulties, some of these factors can prove difficult to quantify via direct field measurements (e.g., soil volatilization or leaching factors). In this case, modeling analyses, based on appropriate site-specific data and conservative assumptions, provide a convenient method of estimation. NAF_{LT} for groundwater may be referred to as a groundwater dilution attenuation factor (DAF). DAFs are amenable to direct measurement via wells spaced along the centerline of the plume. In all cases, time-series groundwater monitoring data should be evaluated to establish the stability condition of the affected groundwater plume. Stable or diminishing plumes pose no risk to downgradient receptors located outside the plume area (i.e., DAF = infinite). Consequently, groundwater modeling analyses are necessary only for plumes for which available data either are insufficient to establish the stability condition or indicate an expanding plume.



NOTES:

SSTL	=	Site-Specific Target Level; i.e., allowable COC concentration in source medium.
RBEL	=	Risk-Based Exposure Limit, i.e., allowable COC concentration in exposure medium at point of exposure.
COC	=	Constituent of Concern
GW	=	Groundwater
POC	=	Point of Compliance
POE	=	Point of Exposure

Natural Attenuation Factors:

NAF	=	Natural Attenuation Factor.
VF_{ss}	=	Volatilization Factor for surface soils (mg/m^3 - air) / (mg/kg-soil).
PEF	=	Particulate Emission Factor for surface soils (g/cm^2 - s).
ADF	=	Air Dispersion Factor (mg/m^3 - air at POC) / (mg/m^3 - air at POE).
DAF	=	Groundwater Dilution-Attenuation Factor (mg/L - GW at POC) / (mg/L - GW at POE).
WDF	=	Well Dilution Factor (mg/L - well discharge) / (mg/L - plume edge).
LDF	=	Leachate - Groundwater Dilution Factor (cm^3/yr - GW) / (cm^3/yr - Leachate).
K_{sw}	=	Soil - Water Partition Factor (mg/L-water) / (mg/kg-soil).

FIGURE A.2. BACK-CALCULATION OF SSTL VALUES FOR SOIL AND GROUNDWATER *vi)* **Risk Reduction Requirements:** The SSTL represents an action level for affected media in the source zone. Source media containing COC concentrations in excess of applicable SSTLs will require further assessment or remediation to control exposure via the relevant exposure pathway(s). If the SSTLs were estimated on the basis of limited site-specific data or highly conservative assumptions, the appropriate response may be further site assessment and re-evaluation of appropriate target levels. For those pathways for which the results of the site-specific evaluation are reliable, appropriate remedies and exposure control measures must be selected and implemented, as discussed in Remedy Selection below.

- ***Applicable Data Evaluation Tools:*** Derivation of SSTL values involves calculation of NAF values for each complete exposure pathway and relevant constituents of concern. Analytical models which can be used for estimation of steady-state NAF values for various air, soil, and groundwater exposure pathways under Tiers 1 and 2 are incorporated in the RBCA Tool Kit. As noted above, it is advisable to evaluate SSTLs for both *actual* and *potential* POE locations in order to support remedy selection. In addition to steady-state models, the Transient Domenico Worksheet can be used to provide important information regarding the timing and duration of potential groundwater impacts.

Remedy Selection

For each exposure pathway determined to pose a health/environmental concern, a cost-effective remedy must be selected and implemented to achieve necessary risk reduction in the appropriate timeframe. This step of the site evaluation process involves development of an overall *exposure control strategy* and selection of optimal remediation technologies to implement this strategy.

The goal of risk-based site management is to minimize risk by preventing exposure to harmful levels of site constituents. Risk reduction can be achieved by addressing any component of the exposure pathway: i) removing or treating the source, ii) interrupting contaminant transport mechanisms, or iii) controlling activities at the point of exposure. The remedial action plan may consist of one or more exposure control strategies, including:

i) ***Removal/Treatment Action*:** Removal or treatment of affected source media (i.e., affected soils, groundwater, etc.) to reduce COC concentrations to levels less than or equal to applicable SSTLs (e.g., via excavation, soil venting, pump-and-treat, etc.).

ii) ***Containment Measures*:** Long-term engineering controls to prevent migration of harmful concentrations of COCs from the source to the POE (e.g., surface cover/capping, barrier walls, soil stabilization, hydraulic containment, etc.).

iii) ***Natural Attenuation Monitoring*:** Periodic sampling and analysis to confirm stabilization or reduction of affected media concentrations via natural attenuation processes.

iv) ***Institutional Controls*:** Legal or administrative measures to control the nature and frequency of human activity at the POE (e.g., deed notice, alternative water supply, etc.).

The appropriate exposure control strategy for a given site will depend on the nature of the risk reduction requirements. For example, as shown on Figure A.4, engineered remedies (such as removal/ treatment or containment strategies) are appropriate for response to current or anticipated impacts on actual receptors. If risk reduction is required only for protection of potential future receptors (e.g., hypothetical water well users), groundwater remediation by natural attenuation may be employed to confirm plume stabilization or reduction. No response action is required if constituent concentrations do not exceed SSTL values for either actual or potential receptors. The estimated *time to impact* determined in the risk-based site evaluation is also a key consideration in the remedy selection process. For example, if source media concentrations presently exceed an applicable SSTL value but the corresponding RBEL is not likely to be exceeded at the POE for an extended time period, additional time may be available for re-evaluation of potential exposure conditions based on site-specific monitoring program.

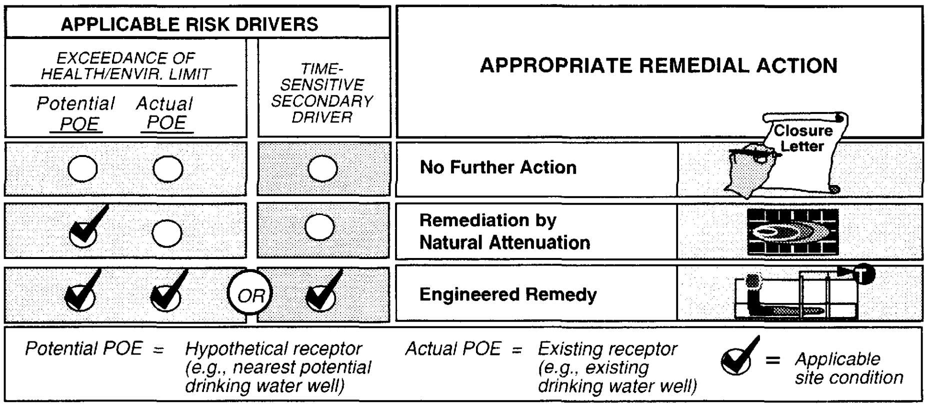


FIGURE A.4. POTENTIAL RISK-BASED REMEDY SELECTION CRITERIA

Compliance Monitoring Program Design

Under many regulatory programs, a final compliance monitoring period is required to confirm satisfactory completion of the remedy. Compliance monitoring (or *verification sampling*) typically involves sampling of one or more locations on an established schedule to identify either i) an exceedance of an applicable concentration limit or ii) a change of condition (e.g., change of land use, failure of engineering control) that might invalidate the basis for the remedy selection. If, upon completion of the monitoring period, compliance with applicable concentration limits is demonstrated, no further action is required.

- ***Applicable Data Evaluation Tools***: To confirm compliance with applicable cleanup standards, compliance monitoring *action levels* for the groundwater exposure pathway can be derived using the same models used for SSTL calculation. Under this approach, groundwater compliance monitoring locations are selected between the source location (point of compliance) and the point of exposure (POE). By adjusting the distance variable on Transient Domenico Worksheet in the RBCA Tool Kit, the NAF value can be calculated for constituent transport from each monitoring point to the POE. The action level can be calculated as the arithmetic product of the NAF times the applicable RBEL for each constituent. If action levels are exceeded during the compliance monitoring period, further evaluation may be required to ensure adequate protection of downgradient receptors.

Model Selection Guidelines

Under the risk-based site evaluation process outlined above, fate-and-transport models are used to derive SSTL values based on estimation of the pathway-specific natural attenuation factor (NAF). Whenever feasible, direct field measurements represent the preferred method of NAF estimation. However, if the exposure pathway is not amenable to direct NAF measurement (e.g., volatilization factors, leachate factors, etc.) or if time-series analyses show the contaminant zone to be expanding over time, modeling analyses, based on appropriate site-specific data and conservative assumptions, can provide a convenient method of estimating future exposure levels.

The "best" model for a given site will be the simplest model providing a reliable and reasonably conservative prediction of potential exposure. Under the ASTM RBCA process, relatively simple analytical modeling tools are applied under Tiers 1 and 2, followed by more sophisticated modeling methods, if warranted, under Tier 3. The choice between simple and complex modeling methods should be dictated by the adequacy of the site database and the relative degree of error likely to be introduced by the model itself. In addition, the cost of upgrading to a more complex Tier 3 site evaluation must be warranted by the potential reduction in site remediation costs or the complex nature of the anticipated exposure condition. General guidelines for application of various types of fate-and-transport models under Tiers 1,2, and 3 are summarized below.

Model Dimensions: For each of the exposure pathways addressed in the RBCA standard, fate-and-transport models are available to estimate NAF values based on either a one-, two-, or three-dimensional analysis of contaminant transport. In reality, all contaminant transport occurs in three dimensions; however, one-dimensional (1-D) or two-dimensional (2-D) modeling tools may be employed for purpose of conservatism and simplicity. One-dimensional models, which ignore lateral and vertical dispersion effects, may significantly overestimate exposure levels and underestimate the pathway NAF. For this purpose, 2-D fate-and-transport models are commonly employed for Tier 1 and Tier 2 analyses, as presented in Appendix X3 of the ASTM RBCA Standard (*PS 104, 1998a*)and included in the RBCA Tool Kit. Three-dimensional transport models may provide a more accurate and less conservative NAF estimate under a Tier 3 evaluation, but must be supported by three-dimensional characterization of key transport parameters (e.g., hydraulic conductivity, etc.). While three-dimensional models are not included in the RBCA Tool Kit, NAF values calculated by these models may be entered directly into the software in order to calculate baseline risks and cleanup standards.

Steady-State vs. Transient Analyses: Steady-state fate-and-transport models, which assume a constant source concentration and constant flow conditions over time, provide a conservative (lowerbound) NAF estimate corresponding to maximum chronic exposure conditions. In reality, following termination of the release, source concentrations in soil and groundwater are likely to diminish over time, resulting in time-variable exposure concentrations at the POE. For purpose of simplicity and conservatism, steady-state, constant-source models, providing a lowerbound NAF value, are commonly employed under Tiers 1 and 2. However, to support risk management decisions, these constant-source models can be run in a transient mode to predict the *time to impact*, i.e., the time required for the exposure concentration to exceed the RBEL at the POE. Under Tier 3, fully transient models, simulating both time-variable source concentrations and transport phenomena, can be used to characterize both the timing and *duration* of the RBEL exceedance. Again, these more sophisticated Tier 3 analyses should be based on sufficient site-specific data to support reliable modeling results.

Probabilistic vs. Deterministic Models: Under Tiers 1 and 2, exposure concentrations and NAF values are characterized on the basis of *deterministic* models which provide a unique output value for each unique set of input values. Uncertainty in the modeling analysis is addressed by means of a *sensitivity study*, i.e., by varying key input values to evaluate their potential impact on the model output. Under Tier 3, *probabilistic* modeling may be employed as a more sophisticated approach to management of model uncertainty. In probabilistic modeling, for each key input parameter, the user provides a probability distribution corresponding to the range and type of distribution observed for the parameter at the site. The model then completes the fate-and-transport calculation for the full range of these input values, effectively conducting multiple random model sensitivity studies. The model result is not a unique value but a probability distribution defining the possible range of results (e.g., exposure concentration, NAF value) for the specified site conditions. The probabilistic analysis provides the user with relatively sophisticated information regarding possible exposure conditions (e.g., for a given SSTL value, what is the probability that the RBEL will be exceeded at any future time?) However, to support reliable results, this Tier 3 modeling method will typically require significant additional site characterization data relative to Tier 1 or Tier 2 deterministic analyses.

RBCA Tool Kit for Chemical Releases

The RBCA Tool Kit has been developed expressly for use with the Tier 1 and Tier 2 site evaluation procedures outlined in the ASTM RBCA Standard (PS 104, 1998a).Based upon site-specific data supplied by the user, the RBCA Tool Kit combines fate-and-transport modeling and risk characterization functions to compute: exposure concentrations, average daily intake, baseline risk levels, and risk-based media cleanup standards

Key features of the RBCA Tool Kit relevant to SSTL calculations and risk-based remedy selection are outlined below.

MODEL CALCULATION FUNCTIONS

Using a system of ten analytical models linked to internal libraries of standard exposure factors and chemical/toxicological data for over 90 compounds, the RBCA Tool Kit can calculate either baseline risk levels or cleanup standards for each complete exposure pathway identified by the user. Key calculation steps are as follows:

***Exposure Concentrations*:** Based on representative concentrations of constituents of concern (COCs) present in the affected source media, maximum steady-state concentrations likely to occur at the point of exposure (POE) are calculated using the steady-state analytical fate-and-transport models identified in Appendix X3 of ASTM PS 104. To perform these calculations, the system evaluates cross-media partitioning (e.g., volatilization from soil to air) and lateral transport from the source to the POE (e.g., contaminant transport via air or groundwater flow). The source media and optional exposure pathways included in the software are as follows:

SOURCE MEDIA	EXPOSURE PATHWAYS
Surface Soils	Inhalation of Vapor and Particulates
	Dermal Contact with Soil
	Ingestion of Soil and Dust
	Leaching to Groundwater
Subsurface Soils	Inhalation of Vapor
	Leaching to Groundwater
Groundwater	Ingestion of Potable Water
	Inhalation of Vapor
	Discharge to Surface Water
	- Ingestion/Dermal Contact via Swimming
	- Ingestion via Fish Consumption
	- Aquatic Life Protection

***Average Daily Intake*:** Based upon the exposure factors selected by the user, the average daily chemical intake for each receptor along each selected pathway is calculated in accordance with EPA guidelines (see Connor et al., 1997). These values are used in baseline risk calculations for each complete pathway.

***Baseline Risk Characterization*:** Human health risks associated with exposure to COCs are calculated by the software on the basis of average daily intake rates and the corresponding toxicological parameters for carcinogenic and non-carcinogenic effects. For each complete pathway, the system output provides both individual and additive constituent results for carcinogens and non-carcinogens.

Media Cleanup Values: The RBCA Tool Kit has the ability to i) compare the site data to Tier 1 Risk-Based Screening Levels (RBSLs), computed using the default parameter values as listed in ASTM PS 104, or ii) calculate Tier 2 Site-Specific Target Levels (SSTLs) based on user-supplied site information. For each source medium (i.e., affected soil and groundwater), the software reports target concentrations for all complete pathways and identifies the applicable (i.e., minimum) value for source remediation. The equations used by the RBCA Tool Kit to calculate RBSLs and SSTLs are presented in Table A.2.

TABLE A.2 RBSL AND SSTL EQUATIONS USED IN THE RBCA TOOL KIT

GROUNDWATER EXPOSURE PATHWAY	
Groundwater Ingestion	
Carcinogens: $RBSL_{GW} = \frac{TR \cdot BW \cdot AT_C}{SFo \cdot EF \cdot ED \cdot IR_w}$ Non-Carcinogens: $RBSL_{GW} = \frac{THQ \cdot RfDo \cdot BW \cdot AT_n}{EF \cdot ED \cdot IR_w}$	$SSTL_{GW} = RBSL_{GW} \cdot DAF$
Soil Leaching to Groundwater → Groundwater Ingestion	
Carcinogens: $RBSL_S = \frac{TR \cdot BW \cdot AT_C}{SFo \cdot EF \cdot ED \cdot IR_w \cdot LF}$ Non-Carc.: $RBSL_S = \frac{THQ \cdot RfDo \cdot BW \cdot AT_n}{EF \cdot ED \cdot IR_w \cdot LF}$	$SSTL_S = RBSL_S \cdot DAF$
SOIL EXPOSURE PATHWAY	
Surface Soil Ingestion, Inhalation, and Dermal Contact	
Carcinogens: $RBSL_{SS} = \frac{TR \cdot BW \cdot AT_C}{EF \cdot ED \cdot \left[(SFo \cdot IR_s) + \left(URF \cdot 1000 \cdot BW \cdot (VF_{ss} + VF_p)\right) + (SFd \cdot SA \cdot M \cdot RAF_d)\right]}$ Non-Carc.: $RBSL_{SS} = \frac{THQ \cdot BW \cdot AT_n}{EF \cdot ED \cdot \left[\left(\frac{IR_s}{RfDo}\right) + \left(\frac{BW \cdot (VF_{ss} + VF_p)}{RfC}\right) + \left(\frac{SA \cdot M \cdot RAF_d}{RfDd}\right)\right]}$	$SSTL_{SS} = RBSL_{SS}$ *(No lateral transport; receptor at source.)*
OUTDOOR AIR EXPOSURE PATHWAY	
Subsurface Soil Volatilization to Ambient Air	
Carcinogens: $RBSL_S = \frac{TR \cdot AT_C}{EF \cdot ED \cdot URF \cdot 1000 \cdot VF_{samb}}$ Non-Carcinogens: $RBSL_S = \frac{THQ \cdot RfC \cdot AT_n}{EF \cdot ED \cdot VF_{samb}}$	$SSTL_S = RBSL_S \cdot ADF$
Groundwater Volatilization to Ambient Air	
Carcinogens: $RBSL_{GW} = \frac{TR \cdot AT_C}{EF \cdot ED \cdot URF \cdot 1000 \cdot VF_{wamb}}$ Non-Carcinogens: $RBSL_{GW} = \frac{THQ \cdot RfC \cdot AT_n}{EF \cdot ED \cdot VF_{wamb}}$	$SSTL_{GW} = RBSL_{GW} \cdot ADF$

Continued

TABLE A.2 RBSL AND SSTL EQUATIONS USED IN THE RBCA TOOL KIT **Continued**

INDOOR AIR EXPOSURE PATHWAY

Subsurface Soil Volatilization to Enclosed Space

Carcinogens: $$RBSL_S = \frac{TR \cdot AT_C}{EF \cdot ED \cdot URF \cdot 1000 \cdot VF_{sesp}}$$

Non-Carcinogens: $$RBSL_S = \frac{THQ \cdot RfC \cdot AT_n}{EF \cdot ED \cdot VF_{sesp}}$$

$SSTL_{GW} = RBSL_{GW}$

(No lateral transport; receptor at source.)

Groundwater Volatilization to Enclosed Space

Carcinogens: $$RBSL_{GW} = \frac{TR \cdot AT_C}{EF \cdot ED \cdot URF \cdot 1000 \cdot VF_{wesp}}$$

Non-Carcinogens: $$RBSL_{GW} = \frac{THQ \cdot RfC \cdot AT_n}{EF \cdot ED \cdot VF_{wesp}}$$

$SSTL_{GW} = RBSL_{GW}$

(No lateral transport; receptor at source.)

SURFACE WATER EXPOSURE PATHWAY

Groundwater Discharge to Surface Water → Swimming and Fish Consumption

RBSL not applicable.

(Receptor located away from source.)

Carcinogens: $$SSTL_{GW} = \frac{TR \cdot BW \cdot AT_C \cdot DAF \cdot DF_{gw-sw}}{ED \cdot \left[(SFo \cdot EV \cdot ET \cdot IR_{sw}) + (SFd \cdot EV \cdot SA_{sw} \cdot Z) + (SFo \cdot IR_{fish} \cdot FI_{fish} \cdot BCF)\right]}$$

Non-Carc.: $$SSTL_{GW} = \frac{THQ \cdot BW \cdot AT_n \cdot DAF \cdot DF_{gw-sw}}{ED \cdot \left[\left(\frac{EV \cdot ET \cdot IR_{sw}}{RfDo}\right) + \left(\frac{EV \cdot SA_{sw} \cdot Z}{RfDd}\right) + \left(\frac{IR_{fish} \cdot FI_{fish} \cdot BCF}{RfDo}\right)\right]}$$

Soil Leaching to Groundwater → Groundwater Discharge to Surface Water → Swimming and Fish Consumption

RBSL not applicable.

(Receptor located away from source.)

Carcinogens: $$SSTL_S = \frac{TR \cdot BW \cdot AT_C \cdot DAF \cdot DF_{gw-sw}}{ED \cdot \left[(SFo \cdot EV \cdot ET \cdot IR_{sw}) + (SFd \cdot EV \cdot SA_{sw} \cdot Z) + (SFo \cdot IR_{fish} \cdot FI_{fish} \cdot BCF)\right] \cdot LF}$$

Non-Carc.: $$SSTL_S = \frac{THQ \cdot BW \cdot AT_n \cdot DAF \cdot DF_{gw-sw}}{ED \cdot \left[\left(\frac{EV \cdot ET \cdot IR_{sw}}{RfDo}\right) + \left(\frac{EV \cdot SA_{sw} \cdot Z}{RfDd}\right) + \left(\frac{IR_{fish} \cdot FI_{fish} \cdot BCF}{RfDo}\right)\right] \cdot LF}$$

Groundwater Discharge to Surface Water → Aquatic Life Protection

RBSL not applicable.

(Receptor located away from source.)

Carcinogens: $$SSTL_{GW} = AQL \cdot DAF \cdot DF_{gw-sw}$$

Non-Carcinogens: $$SSTL_{GW} = AQL \cdot DAF \cdot DF_{gw-sw}$$

Soil Leaching to Groundwater → Groundwater Discharge to Surface Water → Aquatic Life Protection

RBSL not applicable.

(Receptor located away from source.)

Carcinogens: $$SSTL_S = \frac{AQL \cdot DAF \cdot DF_{gw-sw}}{LF}$$

Non-Carcinogens: $$SSTL_S = \frac{AQL \cdot DAF \cdot DF_{gw-sw}}{LF}$$

Continued

TABLE A.2 RBSL AND SSTL EQUATIONS USED IN THE RBCA TOOL KIT ***Continued***

PARAMETER DEFINITIONS

ADF	Lateral air dispersion factor (unitless)	RfC	Reference concentration (mg/m^3)
AQL	Aquatic protection criteria (mg/L)	RfDd	Chronic dermal reference dose (mg/kg/d)
AT_c	Averaging time - carcinogens (yr)	RfDo	Chronic oral reference dose (mg/kg/d)
AT_n	Averaging time - non-carcinogens (yr)	SA	Skin surface area for soil dermal contact (cm^2)
BCF	Bioconcentration factor (mg/kg-fish)/(mg/L-wat)	SA_{sw}	Skin surface area for swimming dermal contact (cm^2)
BW	Body weight (kg)	SFd	Dermal slope factor (mg/kg/d)$^{-1}$
DAF	Lateral groundwater dilution-attenuation factor (unitless)	SFo	Oral slope factor (mg/kg/d)$^{-1}$
$DF_{gw\text{-}sw}$	Groundwater to surface water dilution factor (unitless)	$SSTL_{GW}$	Site-specific target level for groundwater (mg/L)
ED	Exposure duration (yr)	$SSTL_s$	Site-specific target level for soil (mg/kg)
EF	Exposure frequency (d/yr)	$SSTL_{ss}$	Site-specific target level for surface soil (mg/kg)
ET	Exposure time (hr/event)	THQ	Target hazard quotient
EV	Event frequency (events/yr)	TR	Target risk
FI_{fish}	Fraction of ingested fish from affected surface water (unitless)	URF	Unit risk factor (µg/m^3)$^{-1}$
IR_{fish}	Rate of fish consumption (kg/yr)	VF_p	Particulate emission factor (mg/m^3-air)/(mg/kg-soil)
IR_s	Soil ingestion rate (kg/d)	VF_{samb}	Subsurface soil to ambient air volatilization factor (mg/m^3-air)/(mg/kg-soil)
IR_{sw}	Water ingestion rate while swimming (L/hr)	VF_{sesp}	Subsurface soil to enclosed space volatilization factor (mg/m^3-air)/(mg/kg-soil)
IR_w	Water ingestion rate (L/d)	VF_{ss}	Surface soil to ambint air volatilization factor (mg/m^3-air)/(mg/kg-soil)
LF	Soil-to-GW leaching factor (mg/L-wat)/(mg/kg-soil)	VF_{wamb}	GW to ambient air volatilization factor (mg/m^3-air)/(mg/L-wat)
M	Soil-to-skin adherence factor (mg/cm^2/d)	VF_{wesp}	GW to enclosed space volatilization factor (mg/m^3-air)/(mg/L-wat)
RAF_d	Relative absorption factor for soil dermal contact (unitless)	Z	Water to skin dermal absorption factor (cm/event)
$RBSL_{GW}$	Risk-based screening level for groundwater (mg/L)		
$RBSL_S$	Risk-based screening level for soil (mg/kg)		
$RBSL_{SS}$	Risk-based screening level for surface soil (mg/kg)		

RISK-BASED DECISION SUPPORT FEATURES

The RBCA Tool Kit includes several features designed to support key steps of the risk-based site evaluation process, including the following:

Step-by-Step Evaluation Process: From the Main Screen of the graphical user interface, the user is guided through all the necessary steps for completing the Tier 1 or Tier 2 evaluation process. On subsequent screens the interface leads the user through exposure pathway identification, model selection, site-specific parameter input, and output review. All output screens may be printed in a report-quality format.

Analysis of Actual and Potential POEs: Multiple off-site exposure points are allowed for the groundwater and outdoor air pathways. This enables the user to evaluate risks at both actual (e.g. an actual nearby well) and potential (e.g., a hypothetical well at the property boundary) POEs. Whether site risks affect an actual or potential POE adds a qualitative dimension to the risk calculations which may be an important factor in remedy selection at some sites.

Transient Groundwater Modeling Analyses: An optional Transient Domenico Worksheet is provided to allow the user to estimate the time required for site constituents to impact off-site groundwater POEs. Groundwater risk levels and cleanup standards calculated by the software are based on steady-state concentrations. However, the time to reach steady-state concentrations at off-site POEs may be very long for some constituents. Thus, the time required to exceed a concentration limit at a POE may be an important factor in remedy selection as near-term impacts may require a significantly different response than longer-term impacts (e.g., an engineered response vs. natural attenuation).

Summary

The RBCA Tool Kit for Chemical Releases provides a system of simple analytical fate-and-transport models that can be used for comprehensive risk-based evaluation of potential soil, air, groundwater, and surface water exposure pathways. However, as with all predictive modeling efforts, reliable results require proper characterization of site-specific input parameters. In all cases, model predictions must be shown to be consistent with the actual constituent distributions observed at the site. Use of the Tier 1 and Tier 2 calculation methods outlined in the ASTM RBCA Standard (PS 104, 1998) and incorporated in the RBCA Tool Kit can significantly reduce the time and effort required for evaluation of risk reduction requirements and selection of appropriate exposure control methods. However, proper scientific and/or engineering expertise is required both for characterization of input parameters and assessment of model results.

APPENDIX II-B

Fate and Transport Modeling Methods

Source: Groundwater Services, Inc.

The RBCA Tool Kit contains a series of fate and transport models for predicting COC concentrations at points of exposure (POEs) located downwind or downgradient of source areas for air or groundwater exposure pathways, respectively. Under Tiers 1 and 2, relatively simple analytical models are to be employed for these calculations. The RBCA Tool Kit is consistent with Appendix X3 of ASTM PS-104, although selected algorithms and default parameters have been updated to reflect advances in evaluation methods.

The idealized schematic shown on Figure B.1 illustrates the steps included in the RBCA Tool Kit for predicting transport of contaminants from the source zone to the POE for air and groundwater exposure pathways. Each element in Figure B.1 represents a step-specific attenuation factor, corresponding to either a cross-media transfer factor (CM) or a lateral transport factor (LT). The effective NAF value for each COC on each pathway is then calculated as the arithmetic product of the various attenuation factors occurring along the flow path from source to receptor. These steady-state NAF values are then used for calculation of baseline risks and back-calculation of Site-Specific Target Levels (SSTLs). Please note that fate and transport modeling is *not* required for direct exposure pathways, such as soil ingestion or dermal contact, where the source and exposure concentrations are equal (i.e., NAF = 1). Analytical models used for conservative estimation of each transport factor are described below.

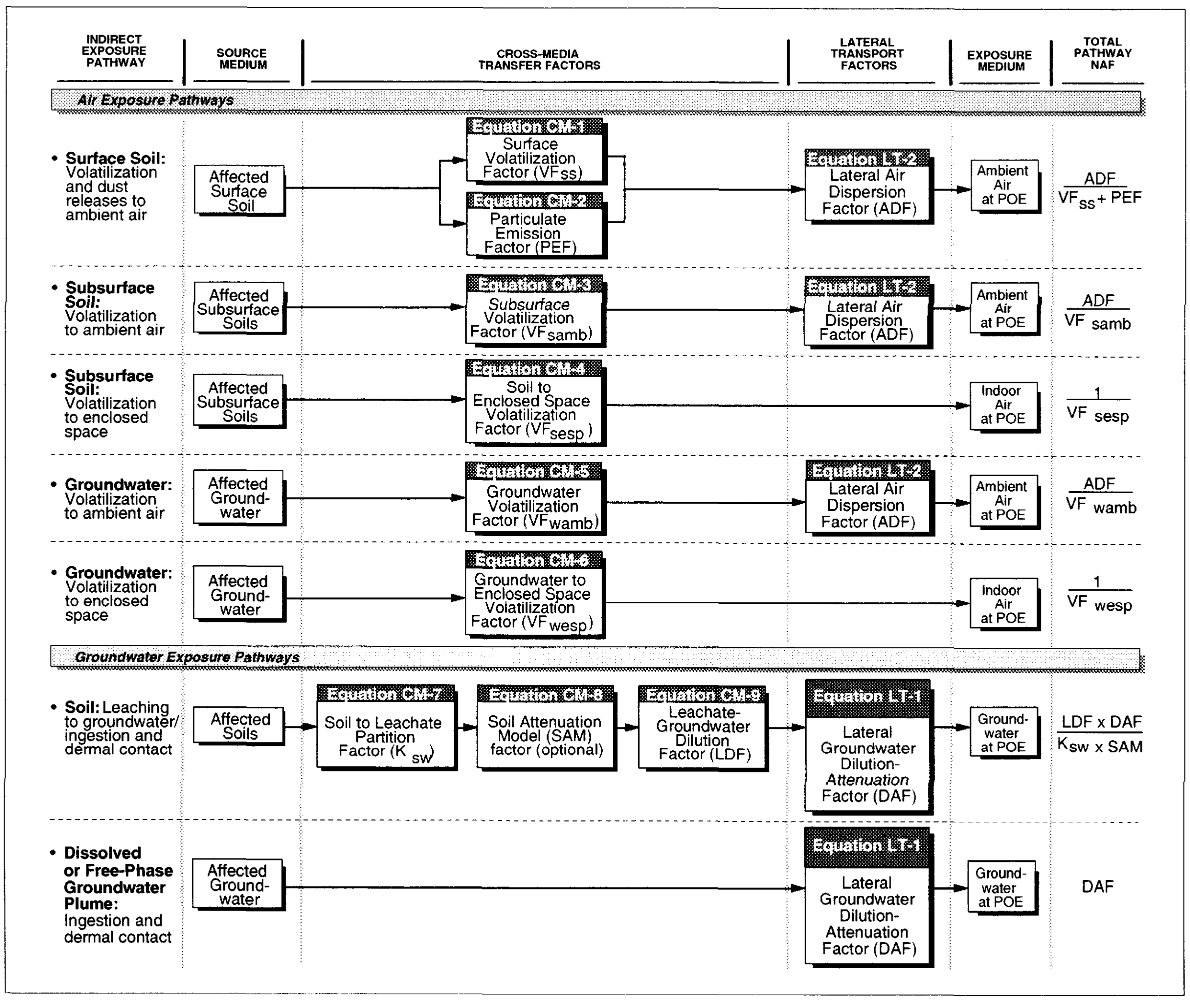


FIGURE B.1. NAF CALCULATION SCHEMATIC FOR INDIRECT EXPOSURE PATHWAYS

Cross-Media Transfer Factors

Exposure pathways involving transport of COCs from one medium to another (e.g., soil-to-air, soil-to-groundwater) require estimation of the corresponding cross-media transfer factor. Various analytical expressions are available for estimating soil-to-air *volatilization factors* as a function of site soil characteristics and the physical/chemical properties of volatile organic COCs. *Leaching factors* for organic and inorganic constituent releases from soil to groundwater can similarly be estimated as a function of COC characteristics, soil conditions, and annual rainfall infiltration. Cross-media transfer equations incorporated in the RBCA Tool Kit are presented in Figure B.2. Detailed discussion of each of these cross-media factors is provided below.

- ***VF_{SS}*: Surface Soil Volatilization Factor (Equation CM-1)**

  The surface volatilization factor is the steady-state ratio of the predicted concentration of an organic constituent in the ambient air breathing zone to the source concentration in the surface soil. The surface volatilization factor incorporates two cross-media transfer elements: i) organic vapor flux from the surface soil mass to ground surface and ii) mixing of soil vapors in the ambient air breathing zone directly over the affected surface soil. For each site, the applicable VF_{SS} value corresponds to the lesser result of two calculation methods (termed CM-1a and CM-1b on Figure B.2). Equation CM-1a typically controls for low-volatility compounds, as it assumes there is an infinite source of chemical in the surface soils and uses a volatilization rate based primarily on chemical properties. Equation CM-1b, which typically controls for volatile organic compounds (VOCs), is based on a mass balance approach. In this equation, a finite amount of chemical is assumed to be present in the surface soil (based on the representative COC concentration), volatilizing at a constant rate over the duration of the exposure period (e.g., 25-30 years). Both expressions account for the dilution of chemicals in ambient air above the source zone due to mixing with ambient air moving across the site. A simple box model is used for this dilution calculation, based on the following adjustable default assumptions: 2-meter mixing zone height and 225 cm/sec (5 mph) lateral wind speed. The length of the mixing zone is set equal to the lateral dimension of the exposed affected surface soil area parallel to the assumed wind direction.

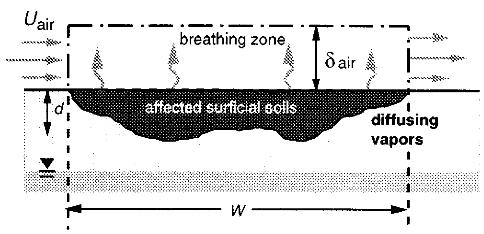
  Key assumptions used in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: VF_{SS}	EFFECT ON CLEANUP STANDARD
• **Uniform COC Concentrations**: Constituent levels uniformly distributed in soil and constant over exposure period.	-----
• **No COC Decay**: No biodegradation or other loss mechanism in soil or vapor phase.	⇩
• **Finite Source Term**: Source term mass adjusted for constant volatilization over exposure period.	-----

- ***PEF*: Soil Particulate Emission Factor (Equation CM-2)**

  The Particulate Emission Factor (PEF) is the steady-state ratio of the predicted concentration of chemicals in particulates in the ambient air breathing zone to the source concentration of chemical in the surface soil. The factor incorporates two cross-media transfer elements: i) the release rate of soil particulates (dust) from ground surface and ii) mixing of these particulates in the ambient air breathing zone directly over the affected surface soil. The particulate release rate is commonly matched to a conservative default value of 6.9×10^{-14} g/cm^2-sec (approximately 0.2 lbs/acre-year), unless a more appropriate site-specific estimate is available. (If the site is paved, the particulate release rate and resultant PEF value for the covered soil area will be zero.) Particulates are assumed to be diluted by lateral air flow directly over the source zone. For this purpose, a simple box model is employed, based on the following adjustable default assumptions: 2-meter mixing zone height and 225 cm/sec (5 mph) lateral wind speed. The length of the mixing zone is matched to the lateral dimension of the exposed affected surface soil area parallel to the assumed wind direction.

Equation CM-1: Surface Soil Volatilization Factor (VFss)



CM-1a:

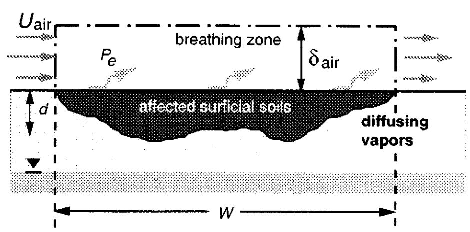
$$VF_{ss}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{2W\rho_s}{U_{air}\delta_{air}}\sqrt{\frac{D_s^{eff}H}{\pi\tau(\theta_{ws}+k_s\rho_s+H\theta_{as})}}\times10^3$$

or CM-1b:

$$VF_{ss}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{W\rho_s d}{U_{air}\delta_{air}\tau}\times10^3$$

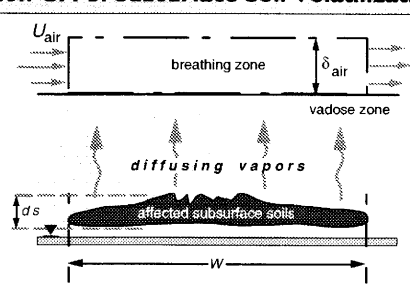
whichever is less

Equation CM-2: Soil Particulate Emission Factor (PEF)



$$PEF\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{P_eW}{U_{air}\delta_{air}}\times10^3$$

Equation CM-3: Subsurface Soil Volatilization Factor (VFsamb)



CM-3a:

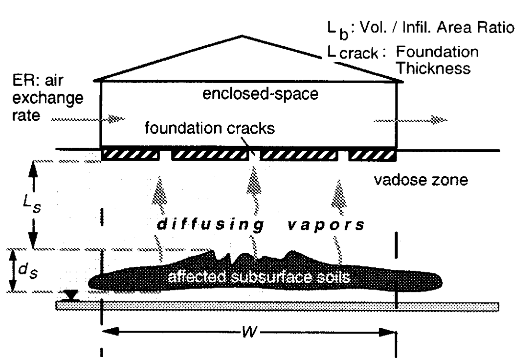
$$VF_{samb}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{H\rho_s}{[\theta_{ws}+k_s\rho_s+H\theta_{as}]\left[1+\frac{U_{air}\delta_{air}L_s}{D_s^{eff}W}\right]}\times10^3$$

or CM-3b:

$$VF_{samb}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{W\rho_s d_s}{U_{air}\delta_{air}\tau}\times10^3$$

whichever is less

Equation CM-4: Subsurface Soil to Enclosed Space Volatilization Factor (VFsesp)



CM-4a:

For $Q_s=0$:

$$VF_{sesp}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{\frac{H\rho_s}{[\theta_{ws}+k_s\rho_s+H\theta_{as}]}\left[\frac{D_s^{eff}/L_s}{ER\,L_B}\right]}{1+\left[\frac{D_s^{eff}/L_s}{ER\,L_B}\right]+\left[\frac{D_s^{eff}/L_s}{(D_{crack}^{eff}/L_{crack})\cdot\eta}\right]}\text{x}10^3$$

For $Q_s>0$:

$$VF_{sesp}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{\frac{H\rho_s}{[\theta_{ws}+k_s\rho_s+H\theta_{as}]}\left[\frac{D_s^{eff}/L_s}{ER\,L_B}\right]e^{\xi}}{e^{\xi}+\left[\frac{D_s^{eff}/L_s}{ER\,L_B}\right]+\left[\frac{D_s^{eff}/L_s}{(Q_s/A_b)}\right]\left[e^{\xi}-1\right]}\text{x}10^3$$

or CM-4b:

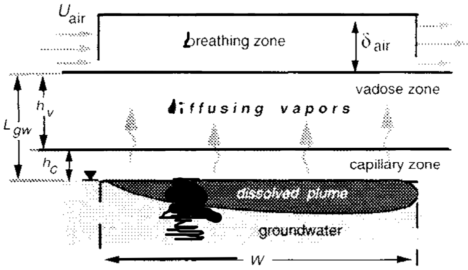
$$VF_{sesp}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{\rho_s d_s}{L_B ER\tau}\text{x}\times10^3$$

whichever is less

FIGURE B.2. CROSS-MEDIA TRANSFER FACTORS IN THE RBCA TOOL KIT ***Continued***

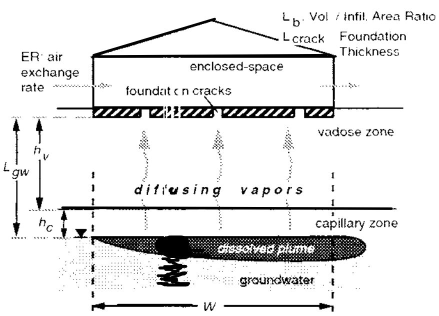
Continued

Equation CM-5: Groundwater Volatilization Factor (VFwamb)



$$VF_{wamb}\left[\frac{(mg/m^3-air)}{(mg/L-H_2O)}\right]=\frac{H}{1+\left[\dfrac{U_{air}\,\delta_{air}\,L_{GW}}{D_{ws}^{eff}\,W}\right]}\times 10^3$$

Equation CM-6: Groundwater to Enclosed Space Volatilization Factor (VFwesp)



For $Q_s = 0$:

$$VF_{wesp}\left[\frac{(mg/m^3-air)}{(mg/L-H_2O)}\right]=\frac{H\left[\dfrac{D_{ws}^{eff}/L_{GW}}{ER\,L_B}\right]}{1+\left[\dfrac{D_{ws}^{eff}/L_{GW}}{ER\,L_B}\right]+\left[\dfrac{D_{ws}^{eff}/L_{GW}}{\left(D_{crack}^{eff}/L_{crack}\right)\cdot\eta}\right]}\times 10^3$$

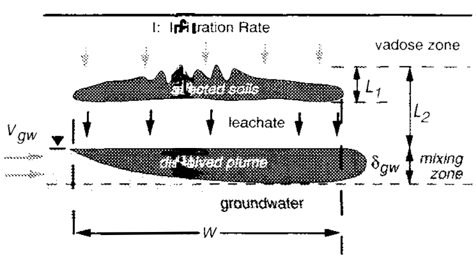
For $Q_s > 0$:

$$VF_{wesp}\left[\frac{(mg/m^3-air)}{(mg/L-H_2O)}\right]=\frac{H\left[\dfrac{D_{ws}^{eff}/L_{GW}}{ER\,L_B}\right]e^{\xi}}{e^{\xi}+\left[\dfrac{D_{ws}^{eff}/L_{GW}}{ER\,L_B}\right]+\left[\dfrac{D_{ws}^{eff}/L_{GW}}{Q_s/A_b}\right]\left[e^{\xi}-1\right]}\times 10^3$$

Equation CM-7: Soil Leachate Partition Factor(Ksw)

Equation CM-8: Optional Soil Attenuation Model (SAM) Factor

Equation CM-9: Leachate-Groundwater Dilution Factor (LDF)



CM-7: $$K_{sw}\left[\frac{(mg/L-H_2O)}{(mg/kg-soil)}\right]=\frac{\rho_s}{\theta_{ws}+k_s\rho_s+H\theta_{as}}$$

CM-8: $$SAM\,[dimensionless]=\frac{L_1}{L_2}$$

CM-9: $$LDF\,[dimensionless]=1+\frac{V_{gw}\delta_{gw}}{I\cdot W}$$

Effective Diffusion Coefficients

Effective diffusivity in vadose zone soils:

$$D_s^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{as}^{3.33}}{\theta_T^2}+\left[\frac{D^{wat}}{H}\right]\left[\frac{\theta_{ws}^{3.33}}{\theta_T^2}\right]$$

Effective diffusivity through foundation cracks:

$$D_{crack}^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{acrack}^{3.33}}{\theta_T^2}+\left[\frac{D^{wat}}{H}\right]\left[\frac{\theta_{wcrack}^{3.33}}{\theta_T^2}\right]$$

Effective diffusivity above the water table:

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right]=(h_c+h_v)\left[\frac{h_c}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right]^{-1}$$

Effective diffusivity in the capillary zone:

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{acap}^{3.33}}{\theta_T^2}+\left[\frac{D^{wat}}{H}\right]\left[\frac{\theta_{wcap}^{3.33}}{\theta_T^2}\right]$$

Convective Air Flow Through Foundation Cracks

$$\xi=\frac{Q_s/A_b}{\left(D_{crack}^{eff}/L_{crack}\right)\cdot\eta}$$

$$Q_s=\frac{2\pi\,\Delta p\,k_v\,X_{crack}}{\mu_{air}\ln\left[\dfrac{2\,Z_{crack}\,X_{crack}}{A_b\,\eta}\right]}$$

FIGURE B.2. CROSS-MEDIA TRANSFER FACTORS IN THE RBCA TOOL KIT ***Continued***

Continued

Definitions for Cross-Media Transfer Equations	
A_b	Area of building foundation (cm^2)
d	Lower depth of surficial soil zone (cm)
d_s	Thickness of affected subsurface soils
D^{air}	Diffusion coefficient in air (cm^2/s)
D^{wat}	Diffusion coefficient in water (cm^2/s)
ER	Enclosed-space air exchange rate (l/s)
f_{oc}	Fraction of organic carbon in soil (g-C/g-soil)
H	Henry's law constant (cm^3-H_2O)/(cm^3-air)
h_c	Thickness of capillary fringe (cm)
h_v	Thickness of vadose zone (cm)
I	Infiltration rate of water through soil (cm/year)
k_{oc}	Carbon-water sorption coefficient (g-H_2O/g-C)
k_s	Soil-water sorption coefficient = foc . koc (g-H_2O/g-soil)
L_B	Enclosed space volume/infiltration area ratio (cm)
L_{crack}	Enclosed space foundation or wall thickness (cm)
L_{GW}	Depth to groundwater = $h_{cap} + h_v$ (cm)
L_s	Depth to subsurface soil sources (cm)
L_1	Thickness of affected soils (cm)
L_2	Distance from top of affected soils to top of water-bearing unit = $L_{GW} - L_S$ (cm)
P_e	Particulate emission rate (g/cm^2-s)
U_{air}	Wind speed above ground surface in ambient mixing zone (cm/s)
V_{gw}	Groundwater Darcy velocity (cm/s)
W	Width of source area parallel to wind, or groundwater flow direction (cm)
X_{crack}	Enclosed space foundation perimeter (cm)
Z_{crack}	Depth to base of enclosed space foundation (cm)
δ_{air}	Ambient air mixing zone height (cm)
δ_{gw}	Groundwater mixing zone thickness (cm)
η	Areal fraction of cracks in foundations/walls (cm^2-cracks/cm^2-total area)
θ_{acap}	Volumetric air content in capillary fringe soils (cm^3-air/cm^3-soil)
θ_{acrack}	Volumetric air content in foundation/wall cracks (cm^3-air/cm^3 total volume)
θ_{as}	Volumetric air content in vadose zone soils (cm^3-air/cm^3-soil)
θ_T	Total soil porosity (cm^3-pore-space/ cm^3-soil)
θ_{wcap}	Volumetric water content in capillary fringe soils (cm^3-H_2O/cm^3-soil)
θ_{wcrack}	Volumetric water content in foundation/wall cracks (cm^3-H_2O)/cm^3 total volume)
θ_{ws}	Volumetric water content in vadose zone soils (cm^3-H_2O/cm^3-soil)
ρ_s	Soil bulk density (g-soil/cm^3-soil)
τ	Averaging time for vapor flux (s)

FIGURE B.2. CROSS-MEDIA TRANSFER FACTORS IN THE RBCA TOOL KIT

Key assumptions incorporated in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: PEF	**EFFECT ON CLEANUP STANDARD**
• **Uniform COC Concentrations**: Constituent levels uniformly distributed in soil and constant over exposure period.	-----
• **No COC Decay**: No biodegradation or other loss mechanism in soil or vapor phase.	⇩
• **Default Emission Rate**: Conservative particulate emission rate.	⇩

- ***VF_{samb}. Subsurface Soil Volatilization Factor (Equation CM-3)***

  The subsurface soil volatilization factor is comparable to the surface volatilization equation, except that the algorithm has been adjusted to account for vapor flux from greater soil depths. The volatilization factor accounts for two cross-media transfer elements: i) organic vapor flux from the subsurface affected soil mass to ground surface and ii) mixing of soil vapors in the ambient air breathing zone directly over the affected soil zone. As with the surface soil volatilization factor, VF_{SS}, the applicable subsurface soil volatilization factor, VF_{samb}, corresponds to the lesser result of two calculation methods (termed CM-3a and CM-3b on Figure B.2). Equation CM-3a, which corresponds to the expression given in Appendix X3 of ASTM PS-104, assumes a constant source mass in the subsurface and can severely overpredict the soil vapor flux rate. To correct for this problem, Equation CM-3b, which accounts for a mass balance of the volatilized source mass over the exposure period (similar to Equation CM-1b) has been incorporated in the RBCA Tool Kit. With either equation (CM-3a or CM 3-b), dilution of soil vapors in the ambient air breathing zone is estimated using the same box model described for Equation CM-1.

Key assumptions incorporated in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: VF_{samb}	EFFECT ON CLEANUP STANDARD
• **Uniform COC Concentrations**: Constituent levels uniformly distributed in soil and constant over exposure period.	-----
• **No COC Decay**: No biodegradation or other loss mechanism in soil or vapor phase.	⇩
• **Finite Source Term**: Source term mass adjusted for constant volatilization over exposure period.	-----

- ***VF_{sesp}. Subsurface Soil-to-Enclosed-Space Volatilization Factor (Equation CM-4)***

  This factor is the steady-state ratio of the predicted concentration of a chemical constituent in indoor air to the concentration in underlying subsurface soils. Again, two expressions are evaluated: i) Equation CM-4a, which assumes an infinite source mass and is of the same form as Equation CM-3a with a term added to represent diffusion through cracks in the foundation of the building, and ii) Equation CM-4b which accounts for a finite source mass volatilizing at a constant rate over the exposure period. The applicable VF_{sesp} value corresponds to the lesser of these two expressions. The soil-to-enclosed-space volatilization factor incorporates two cross-media transfer elements: i) organic vapor flux from the underlying soil mass through the building floor and ii) mixing of soil vapors with indoor air. Tier 1 default assumptions in the software include: i) a 1% open crack space in the foundation allowing vapors to diffuse into the building and ii) a building air exchange rate of 20 exchanges per day (commercial) or 12 exchanges per day (residential). When used with these default values, the expression yields very conservative results and can represent the controlling pathway for SSTL calculations for many sites. In such case, users are advised to conduct direct air or soil vapor measurements prior to proceeding with remedial measures for this pathway.

  Key assumptions used in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: VF_{sesp}	EFFECT ON CLEANUP STANDARD
• **Uniform COC Concentrations**: Constituent levels uniformly distributed in soil and constant over exposure period.	-----
• **No COC Decay**: No biodegradation or other loss mechanism in soil or vapor phase.	⇩
• **Finite Source Term**: Source term mass adjusted for constant volatilization over exposure period.	-----
• **Default Building Parameters**: Conservative default values for foundation crack area and air exchange rate.	⇩

- ***VF_{wamb}: Groundwater Volatilization Factor (Equation CM-5)***

  The groundwater volatilization factor is the steady-state ratio of the predicted concentration of a chemical constituent in ambient air to the source concentration in underlying affected groundwater. Vapor flux rates from groundwater to soil vapor and thence from soil vapor to ground surface are generally lower than those associated with direct volatilization from affected soils. Consequently, this groundwater-to-ambient-air volatilization factor is typically not significant in comparison to soil volatilization factors (i.e., Equations CM-1 or CM-3). This factor accounts for i) steady-state partitioning of dissolved organic constituents from groundwater to the soil vapor phase, ii) soil vapor flux rates to ground surface, and iii) mixing of soil vapors in the ambient air breathing zone directly over the plume. Dilution of vapors in the breathing zone is estimated using a box model, as described for Equation CM-1 above.

Key assumptions incorporated in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: VF_{wamb}	EFFECT ON CLEANUP STANDARD
• **Vapor Equilibrium**: Soil vapor concentrations reach immediate equilibrium with groundwater source.	⇩
• **No COC Decay**: No biodegradation or other loss mechanism in groundwater or vapor phase.	⇩
• **Infinite Source**: COC mass in source term constant over time.	⇩

- ***VF_{wesp}: Groundwater to Enclosed Space Volatilization Factor (Equation CM-6)***

  This factor is the steady-state ratio of the predicted concentration of a chemical constituent in indoor air to the source concentration in the underlying affected groundwater. The algorithm is equivalent to Equation CM-5, modified to address vapor diffusion through a building floor and enclosed space accumulation. Tier 1 default values are the same as those specified for Equation CM-4 and, as noted previously, can provide a relatively conservative (upper-range) estimate of indoor vapor concentrations. If this pathway produces the controlling (minimum) RBSL or SSTL value for a given site, the user is advised to conduct direct air or soil vapor measurements to evaluate the actual need for remedial measures.

  Key assumptions used in this model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: VF_{wesp}	EFFECT ON CLEANUP STANDARD
• **Vapor Equilibrium**: Soil vapor concentrations reach immediate equilibrium with groundwater source.	⇩
• **No COC Decay**: No biodegradation or other loss mechanism in groundwater or vapor phase.	⇩
• **Infinite Source**: COC mass in source term constant over time.	⇩
• **Default Building Factors**: Conservative default values for foundation crack area and air exchange rate.	⇩

- ***K_{sw}: Soil Leachate Partition Factor (Equation CM-7)***

  The soil leachate partition factor is the steady-state ratio between the concentration of an organic constituent in soil pore water and the source concentration on the affected soil mass. This factor is used to represent the release of soil constituents to leachate percolating through the affected soil zone.

  Key assumptions used in this equation and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: K_{SW}	EFFECT ON CLEANUP STANDARD
• **Leachate Equilibrium**: Leachate concentrations reach immediate equilibrium with affected soil source.	⇩
• **No COC Decay**: No biodegradation or other loss mechanism in soil or leachate.	⇩
• **Infinite Source**: COC mass in soil constant over time.	⇩

- ***SAM: Optional Soil Attenuation Model (SAM) factor (Equation CM-8)***
  An optional factor based on the Soil Attenuation Model (see Connor *et al.*, 1997) may be applied to incorporate depth effects by accounting for the sorption of constituents from the leachate onto clean soils underlying the affected soil zone. The presence of clean intervening soils reduces constituent concentrations ultimately delivered to the underlying groundwater. In deeper groundwater systems, wherein a significant thickness of unaffected soils underlies the affected soil zone, neglecting the sorptive capacity of the intervening soils can prove overly conservative. Note that SAM corresponds to movement of *dissolved* constituents through porous media and does not apply to cases involving downward migration of mobile NAPL materials.

  Key assumptions used in this equation and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: SAM	EFFECT ON CLEANUP STANDARD
• **No COC Decay**: No biodegradation or other loss mechanism in soil or leachate.	⇩
• **Infinite Source**: COC mass in soil constant over time.	⇩

- ***LDF: Leachate-Groundwater Dilution Factor (Equation CM-9)***
  The LDF factor accounts for dilution of chemical constituents as leachate from the overlying affected soil zone mixes with groundwater in the underlying water-bearing unit. As indicated on Figure B.1, the leachate dilution factor (LDF) divided by the soil-leachate partition factor (K_{sw}) represents the steady-state ratio between the concentration of a constituent in the groundwater zone and the source concentration in the overlying affected soil. To estimate the leachate dilution factor, a simple box model is used to estimate dilution within a mixing zone in the water-bearing unit directly beneath the affected soil mass (see Equation CM-9, Figure B.2). The leachate volume entering the water-bearing unit is represented by the deep infiltration term, I, which typically falls in the range of 0.5% - 5% of annual site precipitation. For the Tier 1 RBSL calculation, a conservative default infiltration value of 30 cm/year is used, consistent with the example provided in ASTM PS-104, Appendix X3. For many sites, this default value (equivalent to an annual rainfall rate of over 200 in/year) may significantly overestimate actual leachate rates.

  Key assumptions used in this equation and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: LDF	EFFECT ON CLEANUP STANDARD
• **Rainfall Infiltration**: Deep percolation through affected soil assumed to reach water-bearing unit regardless of soil thickness or permeability.	⇩
• **No COC Decay**: No biodegradation or other loss in mechanism groundwater zone.	⇩
• **Default Dilution Parameters**: Conservative default value for infiltration rate.	⇩

Lateral Transport Factors

During lateral transport within air or groundwater, COC concentrations in the flow stream will be diminished due to mixing and attenuation effects (see Figure B.1). Site-specific attenuation factors characterizing COC mass dilution or loss during lateral transport can be estimated using the air dispersion and groundwater transport models provided in the RBCA Tool Kit. Equations for the steady-state analytical transport models incorporated in the RBCA Tool Kit are shown on Figure B.3. The user must provide information regarding COC properties and transport parameters (flow velocities, dispersion coefficients, retardation factors, decay factors, etc.), as required for the selected contaminant transport model. Calculation procedures for lateral air dispersion and groundwater dilution-attenuation factors are described below.

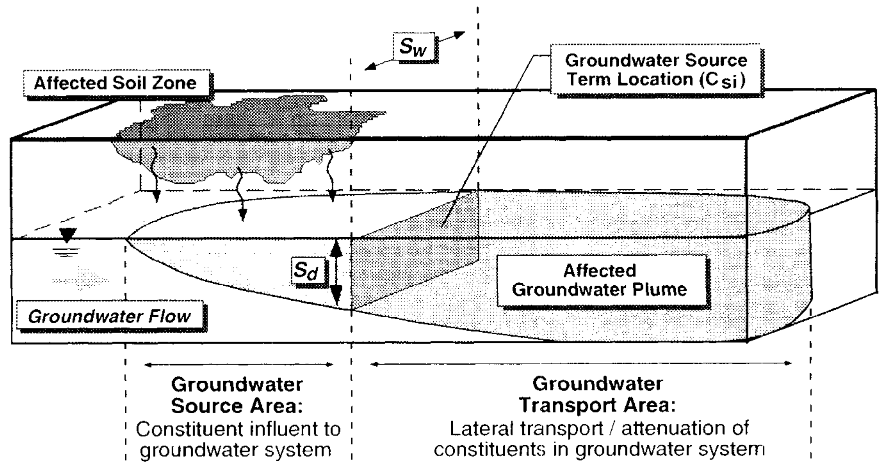
- ***DAF: Lateral Groundwater Dilution Attenuation Factor (Equation LT-1)***
  To account for attenuation of affected groundwater concentrations between the source and POE, the Domenico analytical solute transport model has been incorporated into the RBCA Tool Kit. This model uses a partially or completely penetrating vertical plane source, perpendicular to groundwater flow, to simulate the release of constituents from the mixing zone to the migrating groundwater (see Figure B.3). Within the groundwater flow regime, the model accounts for the effects of advection, dispersion, sorption, and biodegradation. Given a representative source zone concentration for each COC, the model can predict steady-state plume concentrations at any point (x, y, z) in the downgradient flow system. In the RBCA Tool Kit, the model is set to predict centerline plume concentrations at any downgradient distance x, based on 1-D advective flow and 3-D dispersion. The receptor well is assumed to be located on the plume centerline, directly downgradient of the source zone at a location specified by the user. Source concentrations and critical flow parameters must be provided by the user. Guidelines for selection of key input parameters are outlined below.

  i) Groundwater Source Term. The Domenico model represents the groundwater source term as a vertical plane source, perpendicular to groundwater flow, releasing dissolved constituents into groundwater passing through the plane. In the RBCA Tool Kit, the source plane dimensions are matched to the source width and thickness specified by the user. The user should provide source dimensions equivalent to the measured thickness and transverse width of the groundwater plume at the source point (area of maximum plume concentration). The source is assumed to be constant, with source zone concentrations set equal to the representative COC concentrations supplied by the user. Representative source concentrations must be provided for each COC. These values should correspond to the maximum COC concentrations measured at the plume "core" unless sufficient data are available to describe a representative maximum based on statistical estimates. If non-aqueous phase liquids (NAPLs) are present, maximum COC solubility limits in groundwater can be corrected for mixture effects by using Raoult's Law. For this purpose, the user must provide data regarding the mole fractions of principal NAPL constituents.

  ii) Flow and Mixing Parameters. The degree of contaminant mixing predicted by the model will be a function of the dispersion coefficients, hydraulic conductivity, hydraulic flow gradient, and effective soil porosity specified by the user. Hydraulic conductivity and flow gradient should be matched directly to site measurements. In many cases, the effective soil porosity of the water-bearing unit can be reasonably estimated based on soil type using published references. Typical default values are provided in the software. Selection of dispersion coefficients can prove problematic, given the impracticability of direct site measurements. Two dispersivity relationships are incorporated in the RBCA Tool Kit: i) the method employed in ASTM E-1739 (1995) and ii) the Xu and Eckstien (1995) dispersivity model. These relationships allow the user to estimate dispersion coefficients based on the distance from the source to the receptor.

  iii) Retardation Factors. The rate of plume migration can be reduced due to constituent sorption to the solid matrix of the water-bearing unit. The user is referred to standard hydrogeologic texts regarding calculation of retardation factors for both inorganic and organic plume constituents. The RBCA Tool Kit calculates a retardation factor for each COC using information on the organic-carbon partition coefficient (k_{OC}) of the constituent and the fraction organic carbon (f_{OC}) of the soil matrix. Sorption can significantly affect the NAF calculation if first-order decay conditions are assumed to apply. However, the retardation factor will not affect model results under steady-state conditions.

  iv) First-Order Decay Parameters. Under steady-state conditions, hydrolysis and biodegradation represent the principal mechanisms of organic contaminant mass reduction during groundwater plume transport within the subsurface. Many groundwater transport models account for these attenuation phenomena by means of a first-order decay function within the advection-dispersion equation. In the RBCA Tool Kit, the user may elect to use a version of the Domenico solute transport model incorporating first-order decay (see Equation LT-1a on Figure B.3). Considerable care must be exercised in the selection of a first-order decay coefficient for each COC in order to



SELECTION OF GROUNDWATER MODEL INPUT PARAMETERS

For use of Domenico groundwater solute transport model, select source term location, dimensions, and concentration as follows:

1) Groundwater Source Term Location

The source term corresponds to a vertical source plane, normal to the direction of groundwater flow, located at the downgradient limit of the area serving as the principal source of constituent release to groundwater (e.g., affected unsaturated zone soils, NAPL plume, spill area, etc.). If the point of maximum plume concentration is significantly displaced from the initial suspected point of release, this plume "core" should be used as the source point for the groundwater ingestion pathway. However, the downgradient edge of the affected soil zone should be retained as the source location for the soil-to-groundwater leaching pathway. Distances to downgradient points of exposure (POEs) should then be measured from the applicable source location along the principal direction of groundwater flow.

2) Groundwater Source Term Width, S_w

The width of the source term should be matched to the following dimensions:

i) for groundwater ingestion, the measured groundwater plume width, (as defined by RBSL), perpendicular to the principal direction of groundwater flow at the designated source term location.

ii) for soil-to-groundwater impacts, the maximum width of the affected soil zone (as defined by RBSL), perpendicular to the principal groundwater flow direction.

3) Groundwater Source Term Thickness, S_d

The thickness of the source term should be determined by one of the following methods:

i) measure the vertical extent of the affected groundwater plume at the designated source term location, based on depth-specific groundwater sampling and testing; or

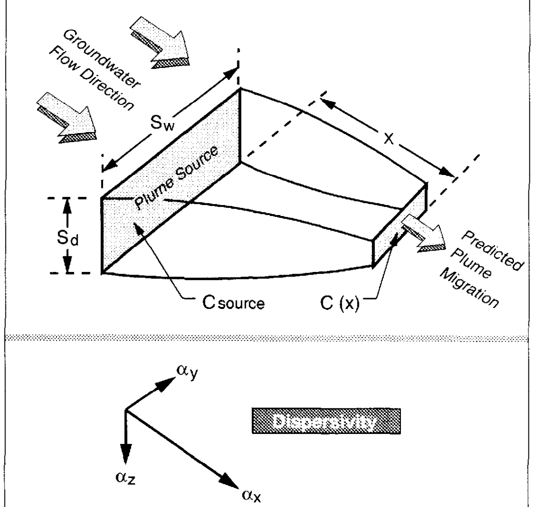
ii) for unconfined water-bearing unit, estimate mixing zone depth at the source location based on the observed magnitude of water table fluctuation.

4) Groundwater Source Term Concentration, C_{si}

To calculate baseline risk levels, the user must also provide a groundwater source concentration C_{si} for each constituent of concern (COC). The vertical plane source acts as a constant source term, applying these input concentrations to all groundwater flowing through the source location. For input to the Domenico model, the source concentration of each COC may be matched to the average concentration (i.e., either mean or 95% UCL) measured across the plume width at the source location.

FIGURE B.3. DEFINITION OF DOMENICO MODEL SOURCE TERM

Equation LT- l: Lateral Groundwater Dilution Attenuation Factor



LT-1a: Solute Transport with First-Order Decay:

$$\frac{C(x)_i}{Csi} = \exp\left(\frac{x}{2\alpha_x}\left[1-\sqrt{1+\frac{4\lambda_i \alpha_x R_i}{v}}\right]\right) erf\left(\frac{S_w}{4\sqrt{\alpha_y x}}\right) erf\left(\frac{S_d}{2\sqrt{\alpha_z x}}\right)$$

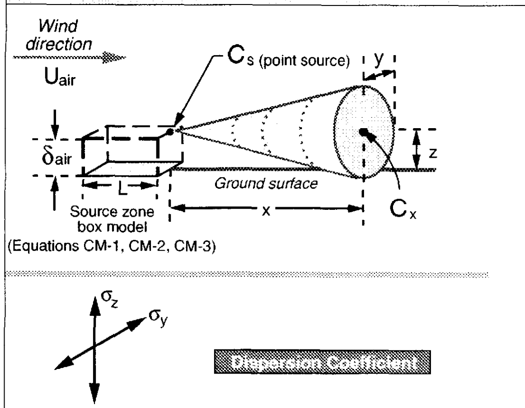
where: $v = \dfrac{K \cdot i}{\theta_e}$

LT-1b: Solute Transport with Biodegradation by Electron-Acceptor Superposition Method:

$$C(x)_i = \left[(C_{si} + BC_i) erf\left(\frac{S_w}{4\sqrt{\alpha_y x}}\right) erf\left(\frac{S_d}{2\sqrt{\alpha_z x}}\right)\right] - BC_i$$

where: $BC_i = BC_T \times \dfrac{C_{si}}{\sum C_{si}}$ *and* $BC_T = \Sigma \dfrac{C(ea)_n}{UF_n}$

Equation LT-2: Lateral Air Dispersion Factor



$$\frac{C(x)_i}{Csi} = \left(\frac{Q}{2\pi U_{air} \sigma_y \sigma_z}\right) \exp\left(-\frac{y^2}{2\sigma_y^2}\right)\left(\exp\left(-\frac{(z-\delta_{air})^2}{2\sigma_z^2}\right) + \exp\left(-\frac{(z+\delta_{air})^2}{2\sigma_z^2}\right)\right)$$

where: $Q = \dfrac{U_{air}(\delta_{air})(A)}{L}$

Definitions for Lateral Transport Equations

$C(x)_i$	Concentration of constituent *i* at distance x downstream of source (mg/L) or (mg/m^3)
C_{si}	Concentration of constituent *i* in Source Zone (mg/L) or (mg/m^3)
BC_i	Biodegradation capacity available for constituent *i*
BC_T	Total biodegradation capacity of all electron acceptors in groundwater
$C(ea)_n$	Concentration of electron acceptor *n* in groundwater
UF_n	Utilization factor for electron acceptor *n* (i.e., mass ratio of electron acceptor to hydrocarbon consumed in biodegradation reaction)
x	Distance downgradient of source (cm)
α_x	Longitudinal groundwater dispersivity (cm)
α_y	Transverse groundwater dispersivity (cm)
α_z	Vertical groundwater dispersivity (cm)
θ_e	Effective soil porosity
λ_i	First-order degradation rate (day^{-1}) for constituent *i*
v	Groundwater seepage velocity (cm/day)
K	Hydraulic conductivity (cm/day)
R_i	Constituent retardation factor
i	Hydraulic gradient (cm/cm)
S_w	Source width (cm)
S_d	Source depth (cm)
δ_{air}	Ambient air mixing zone height (cm)
Q	Air volumetric flow rate through mixing zone (cm^3/s)
U_{air}	Wind Speed (cm/sec)
σ_y	Transverse air dispersion coefficient (cm)
σ_z	Vertical air dispersion coefficient (cm)
y	Lateral distance from source zone (cm)
z	*Height of breathing zone (assumed equal to δ_{air}) (cm)*
A	Cross-sectional area of air emissions source (cm^2)
L	Length of air emissions source parallel to wind direction (cm)

FIGURE B.4. LATERAL TRANSPORT EQUATIONS IN THE RBCA TOOL KIT avoid significantly over-predicting or under-predicting actual biodecay rates. An optional method for preliminary selection of decay coefficients is as follows:

Literature Values: Various published references are available regarding decay half-life values for hydrolysis and biodegradation. The chemical/toxicological database in the RBCA Tool Kit includes minimum published decay rate coefficients (representing maximum decay half-lives) for each chemical, and the user may select to use these or enter other values. These first-order decay coefficients are provided for informational purposes and may used for preliminary analyses. Note, however, that the use of minimum published decay rates will not necessarily ensure conservative modeling results (i.e., predict worst-case exposure concentrations and more stringent cleanup standards).

v) Electron-Limited Biodegradation Rates. As an alternative to a first-order decay function, the user may select a groundwater contaminant transport model incorporating a direct simulation of in-situ biodegradation processes. To account for stoichiometric constraints, such models commonly simulate solute transport of both organic and electron acceptors with an instantaneous reaction assumption. Given proper characterization of background concentrations of key electron acceptors, source zone COC concentrations, and groundwater flow parameters, these models can generally be relied upon to estimate biodegradation effects on organic plume concentrations at the POE, without the difficulty associated with selection of a site-specific, first-order decay rate. Note, however, that this method is not valid for modeling the sequential degradation of chlorinated compounds.

For this purpose, the RBCA Tool Kit includes a version of the Domenico solute transport model incorporating an electron acceptor superposition algorithm (see Equation LT-1b on Figure B.4), as employed in the BIOSCREEN model (Newell et al., 1996). Based on the biodegradation capacity of electron acceptors present in the groundwater system, this algorithm will correct the non-decayed groundwater plume concentrations predicted by the Domenico model for the effects of organic constituent biodegradation. This calculation procedure is illustrated in Figure B.5 and discussed in further detail below.

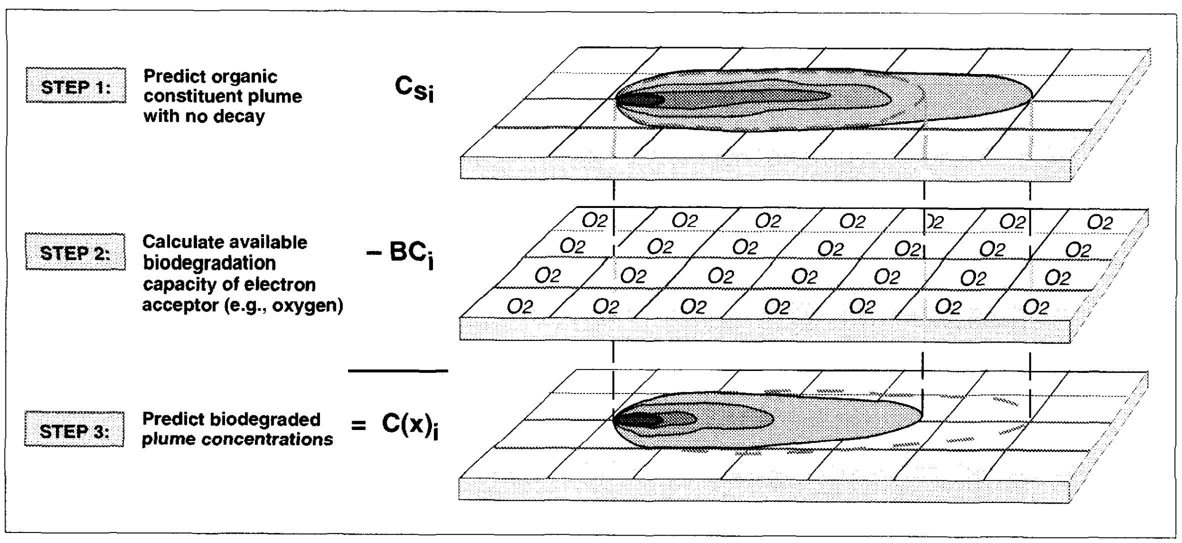


FIGURE B.5. ELECTRON ACCEPTOR SUPERPOSITION METHOD

Based on the stoichiometric equation for the biodegradation reaction, a *utilization factor,* representing the ratio of electron acceptor mass to hydrocarbon mass consumed during biodegradation, can be defined for each electron acceptor. Utilization factors for the principal electron acceptors relating to the degradation of BTEX present in shallow groundwater systems, as reported in the research literature, are summarized on Table B.1.

TABLE B.1 UTILIZATION FACTORS FOR SELECTED ELECTRON ACCEPTORS

ELECTRON ACCEPTOR	UTILIZATION FACTOR (gm/gm)
Oxygen	3.14
Nitrate	4.9
Ferrous Iron (for Ferric Iron)	21.8
Sulfate	4.6
Methane (for Carbon Dioxide)	0.78

Note: "Electron Acceptor" refers to actual electron acceptor or surrogate by-products. Utilization Factor represents the mass ratio of electron acceptor to BTEX quantity consumed (gm/gm) in biodegradation reaction within groundwater. The values listed in this table are for BTEX compounds only. Care should be exercised in selecting appropriate utilization factors for other non-chlorinated hydrocarbons.

Given these values, the potential BTEX mass removal or biodegradation capacity (BC_n) of a given electron acceptor *n* can then be estimated as the concentration of that electron acceptor ($C(ea)_n$) in the groundwater divided by its utilization factor (UF_n). The total biodegradation capacity of the groundwater mass mixing with the BTEX plume is the sum of the individual capacities for each of the principal electron acceptors (i.e., $BC_T = \Sigma\ BC_n$ for n = oxygen, nitrate, iron, sulfate, etc.). Note that, in this process, *electron acceptors* are defined as three easily measured electron acceptors (dissolved oxygen, nitrate, and sulfate) and surrogate by-products for two other difficult-to-quantify electron acceptors (ferrous iron instead of ferric iron and methane instead of carbon dioxide). The concentrations of the actual electron acceptors are measured in background wells, while the concentration of the by-products are measured in the source zone. For this calculation, using the background concentration of each electron acceptor (oxygen, nitrate, sulfate) from outside the plume will provide an upperbound estimate of BC_T. For a lowerbound estimate, the calculation may be based upon the difference in the electron acceptor concentrations (oxygen, nitrate, sulfate) measured inside and outside the plume area (i.e., $C(ea)_n$*-outside* minus $C(ea)_n$*-inside*), thereby accounting for non-utilization of a portion of the electron acceptor mass.

The total biodegradation capacity of the groundwater mass must be distributed among the various organic constituents present in the dissolved contaminant plume. Compared to the rate of plume transport, biodegradation reactions occur relatively instantaneously upon mixing of a readily degradable organic plume (e.g., monoaromatic hydrocarbons) with the background electron acceptor mass. Given the relatively uniform rate of biodecay of the organic compounds typically present in petroleum hydrocarbon products, the portion of the total biodegradation capacity available for removal of each constituent *i* (BC_i) can be estimated based on the mass percentage of each constituent in the plume (i.e., $BC_i = BC_T \cdot Cs_i/Cs_i$, where Cs_i = source concentration of constituent *i*). This assumption will prove reasonable for mixtures of all-readily degradable compounds, due to the relatively uniform biokinetic rates within these groups. However, within mixed degradable and non-degradable constituent plumes (e.g., benzene with dichloroethane), the readily degradable compounds will actually consume a disproportionate share of the biodegradation capacity.

If the user elects to use the electron acceptor superposition option, the RBCA Tool Kit will i) estimate the total biodegradation capacity (BC_T) of the groundwater mass based on the electron acceptor concentrations provided by the user, ii) allocate an available biodegradation capacity (BC_i) to each of the various dissolved organic constituents based on the concentration data provided by the user, and iii) correct the steady-state plume concentrations predicted by the Domenico solute transport model for the effects of biodegradation using Equation LT-1b (see Figure B.4).

Key assumptions used in the groundwater solute transport model and their effect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: LATERAL GROUNDWATER DAF	EFFECT ON CLEANUP STANDARD
• **Infinite Source**: Groundwater source term constant over time with no depletion.	⇩
• **Vertical Dispersion**: Assumes one-directional (downward) vertical dispersion.	⇩
• **Infinite Aquifer Thickness**: Neglects boundary effects on vertical dispersion.	⇧
• **Dispersion Coefficient**: Fixed proportions assumed among longitudinal, transverse, and vertical dispersion coefficients.	-----
• **Receptor Location**: Downgradient receptor well assumed to be on plume centerline.	⇩
• **Biodegradation Rate**: First-order of decay rate may be specified by user per site data.	⇧

- ***ADF: Lateral Air Dispersion Factor (Equation LT-2)***
  The RBCA Tool Kit includes a 3-dimensional Gaussian dispersion model to account for transport of air-borne contaminants from the source area to a downwind POE (see Equation LT-2 on Figure B.4). The model incorporates two conservative assumptions: i) a source zone height equivalent to the breathing zone and ii) a receptor located directly downwind of the source at all times. As indicated on Figure B.1, an effective pathway NAF value is calculated as the steady-state ratio between the ambient organic vapor or particulate concentration at the downwind POE and the source concentration in the on-site affected soil zone. The model requires input data for the affected soil zone dimensions and concentrations, wind speed, and horizontal and vertical air dispersion coefficients to compute the resulting COC concentrations in ambient air at the POE. Guidelines for estimating key input parameters are provided below:

  i) Air Source Term: In the RBCA Tool Kit, the source term for the air dispersion model is matched to the ambient air vapor concentrations determined in accordance with the soil-to-air cross-media transfer equations CM-1, CM-2, and CM-3 shown on Figure B.2. Specifically, the source concentration for off-site vapor transport is equivalent to the vapor concentration exiting the box model for the surface soil and subsurface soil volatilization algorithms (see Figure B.2). The model assumes the source zone to be a point source (located in the center of the affected soil area) with the same mass flux as the entire affected soil zone. The off-site receptor is assumed to be located directly downwind of the source point for the full duration of the exposure period. To define the source term, the user must provide the same soil information as required for the volatilization factors (i.e., affected soil zone concentrations, dimensions, etc.).

  Please note that for receptors located directly over or adjacent to the affected soil zone (i.e., inside the "mixing zone" for Equations CM-1, CM-2, or CM-3), the Gaussian dispersion model is not needed and can be shut off by entering a value of zero for the distance from the source to the off-site receptor in the RBCA Tool Kit.

  ii) Wind Speed: Wind speed should be matched to the average annual wind speed through the mixing zone. The model assumes the wind direction to be in a straight line from the source to the specified POE at all times for the full duration of the exposure period. In the RBCA Tool Kit, a default wind speed value of 225 cm/sec (~ 5 mph) is assumed unless the user enters a site-specific value.

  iii) Air Dispersion Coefficients: Estimating dispersion coefficients requires knowledge of the atmospheric stability class and the distance between the source and POE. Stability is an indicator of atmospheric turbulence and, at any one time, depends upon i) static stability (the change of temperature with height), ii) thermal turbulence (caused by ground heating), and iii) mechanical turbulence (a function of wind speed and roughness). The Pasquill-Gifford system for stability classification is summarized on Figure B.6. Corresponding horizontal and vertical dispersion coefficients for each class are provided on Figure B.7. Stability Class A, which represents extremely unstable air with a high potential for mixing, occurs under low wind conditions and high levels of incoming solar radiation. At the other extreme, Stability Classes E and F represent stable atmospheric conditions, with a lower potential for mixing, and occur with higher wind speeds and greater cloud cover (see DeVaull et al., 1994).

The stability class for a given site can vary with rapidly changing weather conditions. Long-term weather patterns can be characterized on the basis of STAR summaries, comprised of joint frequency distributions of stability class, wind direction, and wind speed, which are available from the National Climatic Data Center in Asheville, North Carolina. Comprehensive atmospheric dispersion models, such as the Industrial Source Complex Long-Term (ISCLT) model, can directly incorporate STAR data to predict constituent dispersion in any direction from the source area. However, due to the complexity and expense of this modeling effort, use of models such as the ISCLT would normally correspond to a Tier 3 evaluation under the RBCA process.

To facilitate a Tier 2 evaluation of downwind receptor impacts, the RBCA Tool Kit employs a simple Gaussian dispersion model to predict maximum exposure concentrations at the POE under steady-state conditions, incorporating the conservative receptor assumptions noted above. A reasonable estimate of downwind COC concentrations can be obtained by assuming a wind turbulence consistent with Stability Class C for the full exposure period. For most locations, Stability Class C (slightly unstable) is representative of average annual conditions over time and can be used to estimate typical dispersion coefficients. Note that, even when these average dispersion coefficients are employed, the exposure concentrations predicted by the RBCA Tool Kit model are likely to be conservative, given that the POE is assumed to be located directly downwind of the source zone at all times during the exposure period.

Key assumptions incorporated in this model and their affect on the SSTL calculation are as follows:

KEY ASSUMPTIONS: LATERAL AIR DISPERSION FACTOR	EFFECT ON CLEANUP STANDARD
• **Source Term**: Vapor source concentration based on steady-state, soil-to-air cross-media equations.	⇩
• **Default Stability Class**: Default dispersion coefficients matched to Class C stability classification (slightly unstable).	-----
• **Receptor Location**: Receptor assumed to be located directly downwind of source zone at all times during exposure period.	⇩

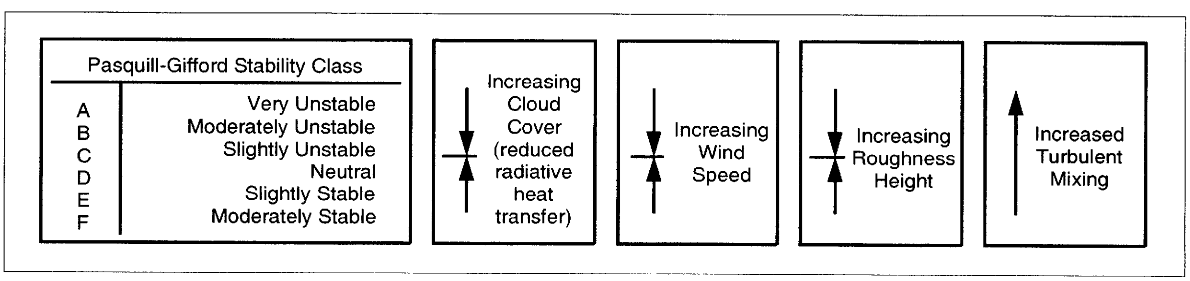


FIGURE B.6. STABILITY CLASSIFICATION FOR AIR TRANSPORT MODELING
SOURCE: DEVAULL ET AL, 1994

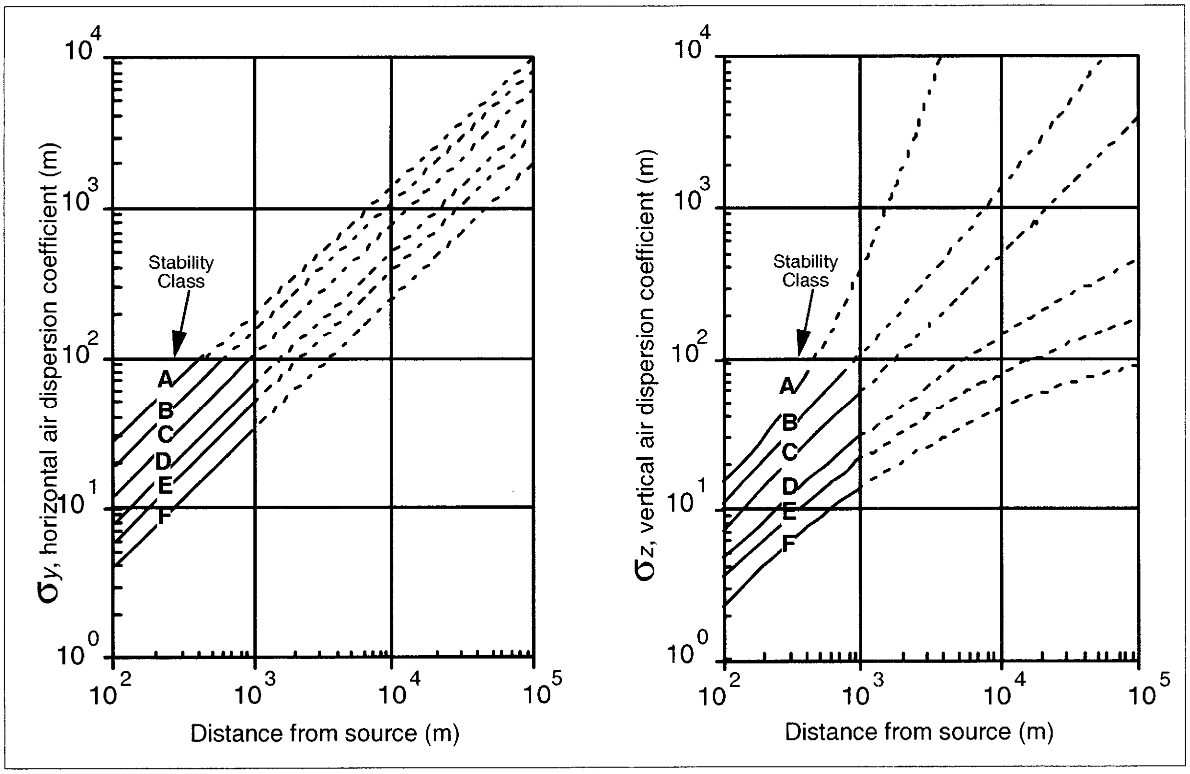


FIGURE B.7. DISPERSION COEFFICIENTS FOR AIR STABILITY CLASSIFICATIONS
SOURCE: EPA, 1988

APPENDIX II-C

Health Risk Assessment for Building Type 3A (Unimproved Site)

Main Screen

RBCA Tool Kit for Chemical Releases
Version 1.3b © 2000

1. Project Information

Site Name:	Oak Walk - Type 3A (Unimproved Site)
Location:	Emeryville
Compl. By:	Dai Watkins
Date:	8-Jul-06
Job ID:	Project No. 0004.085

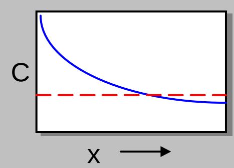
2. Which Type of RBCA Analysis?

?

Tier 1

Generic Values
On-Site
Exposure

Tier 2



Site-Specific Values
On- or Off-Site Exposure

3. Calculation Options

?

Affects which input data are required

- [x] ***Baseline Risks (Forward mode)***
- [ ] ***RBCA Cleanup Standards (Backward mode)***

4. RBCA Evaluation Process

Prepare Input Data

Data Complete? (■= yes, ■= no)

- **Exposure Pathways**
- **Constituents of Concern (COCs)**
- **Transport Models**
- **Soil Parameters**
- **GW Parameters**
- **Air Parameters**

Review Output

- **Exposure Flowchart**
- **COC Chem. Parameters**
- **Input Data Summary**
- **User-Spec. COC Data...**
- **Transient Domenico Analysis...**
- **Baseline Risks...**
- **Cleanup Standards...**

5. Commands and Options

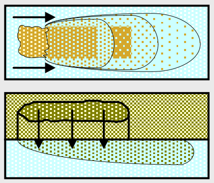
New Site	**Load Data...**	**Save Data As...**	**Quit**
Print Sheet	**Set Units**	Custom Chem. Data...	***Help***

Exposure Pathway Identification

Site Name: Oak Walk - Type 3A (Unimproved Site)
Location: Emeryville
Compl. By: Dai Watkins
Job ID: Project No. 0004.085 Date: 8-Jul-06

1. Groundwater Exposure

?



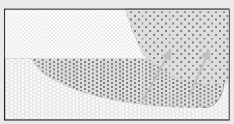
Groundwater Ingestion/ Surface Water Impact

Receptor	None	None	None
Type:	On-site	Off-site1	Off-site2

Source Media: Distance to GW receptors

	On-site	Off-site1	Off-site2	
☐ Affected Groundwater	0	0	0	(ft)
☐ Affected Soils Leaching to Groundwater	0	0	0	(ft)

GW Discharge to Surface Water Exposure



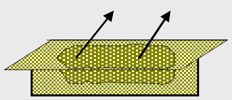
☐ Swimming
☐ Fish Consumption
☐ Aquatic Life Protection

Enter ALP Criteria

2. Surface Soil Exposure

Direct Ingestion and Dermal Contact

?



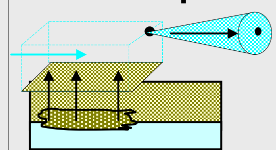
Receptor	None	No off-site receptors
Type:	On-site	

Construction Worker ☐

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation

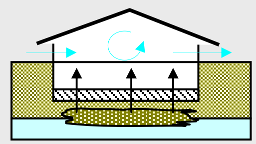
?



Receptor	Res.	None	None	
Type:	On-site	Off-site1	Off-site2	
	0	0	0	(ft)

Construction worker ☑

☑ Affected Soils--Volatilization to Ambient Outdoor Air
☑ Affected Groundwater--Volatilization to Ambient Outdoor Air
☐ Affected Surface Soils--Particulates to Ambient Outdoor Air



Volatilization to Indoor Air Inhalation

Receptor	Res.	No off-site receptors
Type:	On-site	

☑ Affected Soils--Volatilization to Enclosed Space
☑ Affected Groundwater--Volatilization to Enclosed Space

4. Commands and Options

Main Screen | Print Sheet | Set Units | *Help*

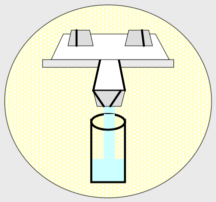
Exposure Factors & Target Risks | Exposure Flowchart

Exposure Factors and Target Risk Limits

Site Name: Oak Walk - Type 3A (Unimproved Site)
Location: Emeryville
Compl. By: Dai Watkins
Job ID: Project No. 0004.085 Date: 8-Jul-06

1. Exposure Parameters

	Age Adjustment?	Residential: Adult	Residential: (Age 0-6)	Residential: (Age 0-16)	Commercial: Chronic	Commercial: Construc.
Averaging time, carcinogens (yr)		70				
Averaging time, non-carcinogens (yr)		30			25	1
Body weight (kg)		70	15	35	70	
Exposure duration (yr)		30	6	16	25	1
Exposure frequency (days/yr)		350			250	180
Dermal exposure frequency (days/yr)		350			250	
Skin surface area, soil contact (cm^2)	☐	5800		2023	5800	5800
Soil dermal adherence factor ($mg/cm^2/day$)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☐	100	200		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☐	0.05	0.5			
Skin surface area, swimming (cm^2)	☐	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				



2. Risk Goal Calculation Options

- ○ Individual Constitiuent Risk Goals Only
- ● Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcins.)	1.0E-6	1.0E-6
Target Risk (Class C carcinogens)	1.0E-6	
Target Hazard Quotient	2.0E-1	
Target Hazard Index		2.0E-1

4. Commands and Options

Return to Exposure Pathways

Use Default Values

Print Sheet

Help

Site Name: Oak Walk - Type 3A (Unimproved Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

Apply Raoult's Law ?

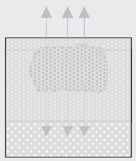
Selected COCs	*Representative COC Concentration*				
COC Select: Add/Insert, Delete. Sort List: Top, Bottom, MoveUp, MoveDown ?	Groundwater Source Zone		Soil Source Zone		Mole Fraction in Source Material
	Calculate	Enter Site Data	Calculate	Enter Site Data	
	(mg/L)	note	*(mg/kg)*	note	*(-)*
Benzene	7.9E+0		1.30E+1		
Toluene	2.1E+0		1.40E+2		
Ethylbenzene	9.8E-1		8.00E+1		
Xylene (mixed isomers)	8.3E+0		4.30E+2		
Methyl t-Butyl ether	7.7E-1		0.00E+0		
Naphthalene	4.9E-1		1.80E+1		
Cumene	2.2E+0		7.12E+1		

Transport Modeling Options

Site Name: Oak Walk - Type 3A (Unimproved Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

1. Vertical Transport, Surface Soil Column

Outdoor Air Volatilization Factors ?



- ○ Surface soil volatilization model only
- ◉ Combination surface soil/Johnson & Ettinger models
  - Thickness of surface soil zone 7.23 *(ft)*
- ○ User-specified VF from other model [Enter VF Values]

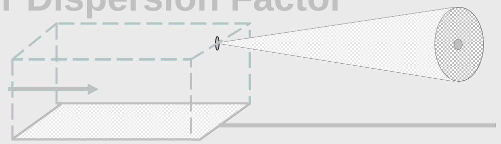
Indoor Air Volatilization Factors ?

- ◉ Johnson & Ettinger model
- ○ User-specified VF from other model [Enter VF Values]

Soil-to-Groundwater Leaching Factor ?

- ○ ASTM Model
  - ☐ Apply Soil Attenuation Model (SAM)
  - ☐ Allow first-order biodecay [Enter Decay Rates]
- ○ User-specified LF from other model [Enter LF Values]

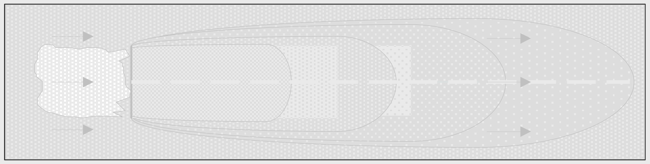
2. Lateral Air Dispersion Factor



?

	Off-site 1	Off-site 2	
○ 3-D Gaussian dispersion model			
○ User-Specified ADF	1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor



Calculate DAF using Domenico Model ?

- ○ Domenico equation with dispersion only (no biodegradation)
- ○ Domenico equation first-order decay [Enter Decay Rates]
- ○ Modified Domenico equation using electron acceptor superposition [Enter Site Data]
  - [Enter Directly] Biodegradation Capacity NC *(mg/L)*

— or —

User-Specified DAF Values

- ○ DAF values from other model or site data [Enter DAF Values]

4. Commands and Options

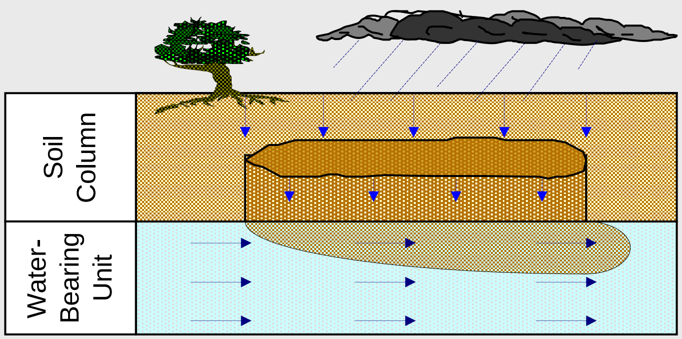
[Main Screen] [Print Sheet] [*Help*]

Site-Specific Soil Parameters

Site Name: Oak Walk - Type 3A (Unimproved Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

1. Soil Source Zone Characteristics ?

Hydrogeology	General Case	Construction	
Depth to water-bearing unit	7.23		(ft)
Capillary zone thickness	0.16		(ft)
Soil column thickness	7.07		(ft)
Affected Soil Zone			
Depth to top of affected soils	5.13		(ft)
Depth to base of affected soils	7.23		(ft)
Affected soil area	16200	16200	(ft^2)
Length of affected soil parallel to assumed wind direction	270	270	(ft)
Length of affected soil parallel to assumed GW flow direction	0		(ft)



2. Surface Soil Column

		Vadose Zone	Capillary Fringe	
Predominant USCS Soil Type				?
or	Calculate	or		
Total porosity		0.35		(-)
Volumetric water content		0.12	0.325	(-)
Volumetric air content		0.23	0.025	(-)
Dry bulk density		1.7		(kg/L)
Vertical hydraulic conductivity		1.0E-2		(cm/s)
Vapor permeability		1.1E-11		(ft^2)
Capillary zone thickness		1.6E-1		(ft)
Net Rainfall Infiltration				
Net infiltration estimate		30		(mm/yr)
or	Calculate	or		
Average annual precipitation		0		(mm/yr)
Partitioning Parameters				
Fraction organic carbon		0.01		(-)
Soil/water pH		6.8		(-)

3. Commands and Options

Main Screen

Set Units

Use Default Values

Print Sheet

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Site-Specific Air Parameters

Site Name: Oak Walk - Type 3A (Unimproved Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

1. Outdoor Air Pathway

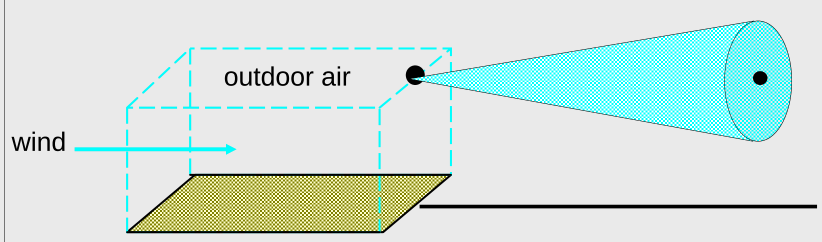
?

Dispersion in Air

	Off-site 1	Off-site 2	
Distance to offsite air receptor	0	0	(ft)
or Enter Directly		*or*	
Horizontal dispersivity	0.00	0.00	(ft)
Vertical dispersivity	0.00	0.00	(ft)

Air Source Zone

Air mixing zone height	6.56	(ft)
Ambient air velocity in mixing zone	10.56	(ft/s)
Areal particulate emission flux	6.9E-14	(g/cm^2/s)



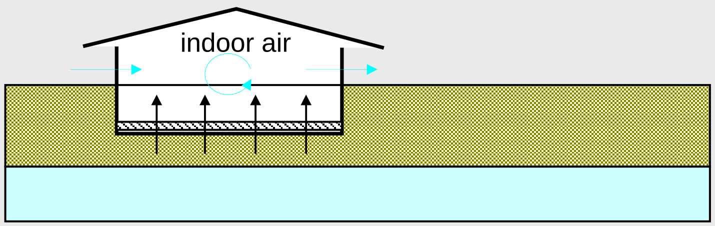
2. Indoor Air Pathway

?

Building Parameters

	Residential	Commercial	
Building volume/area ratio	11	11	(ft)
Foundation area	722	722	(ft^2)
Foundation perimeter	118.3	118.3	(ft)
Building air exchange rate	5.7E-4	5.7E-4	(1/s)
Depth to bottom of foundation slab	0.5	0.5	(ft)
Convective air flow through cracks	6.1E-3	6.1E-3	(ft^3/s)

Foundation thickness	0.5	(ft)
Foundation crack fraction	0.001	(-)
Volumetric water content of cracks	0.12	(-)
Volumetric air content of cracks	0.26	(-)
Indoor/Outdoor differential pressure	0.01	(psi)



3. Commands and Options

Main Screen
Set Units
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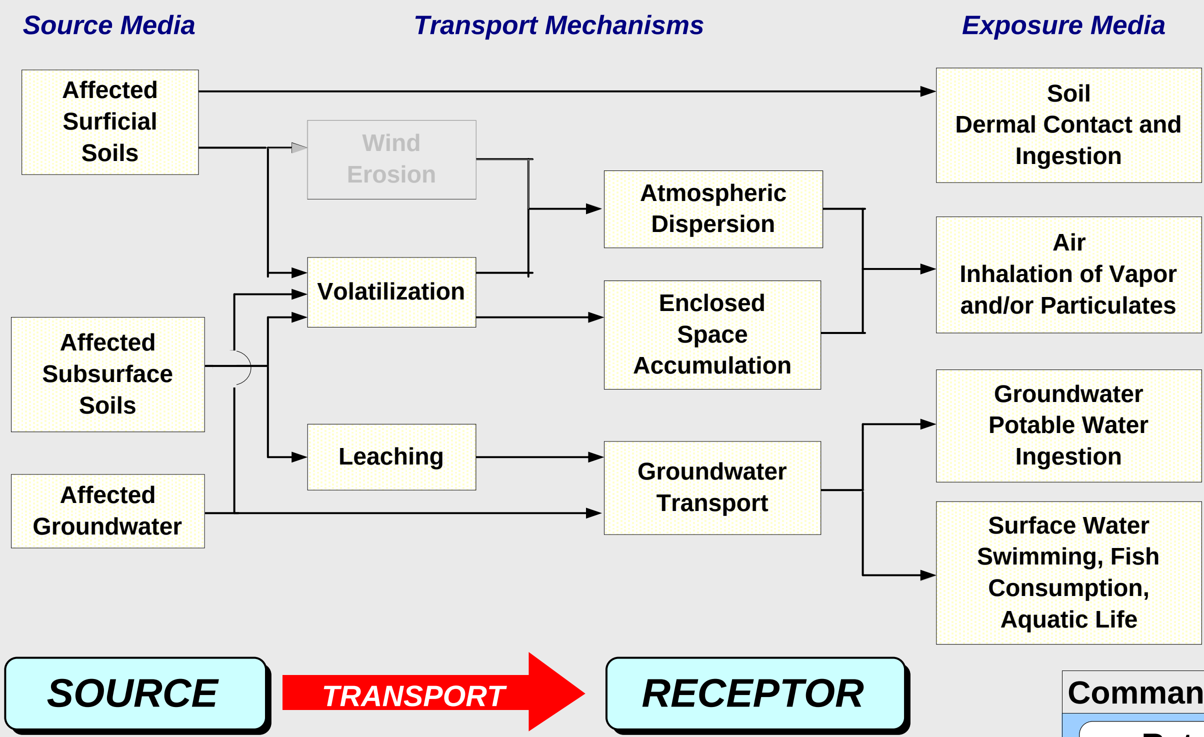
Exposure Pathway Flowchart

Site Name: Oak Walk - Type 3A (Unimproved Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins



Receptors

	On-site	Off-site1	Off-site2
	None	*NA*	*NA*
Outdoor Air: *Res./Constr.*	*None*	*None*	*None*
Indoor Air: *Residential*	*NA*	*NA*	*NA*
	None	*None*	*None*
	NA	*NA*	*NA*

Commands and Options

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CHEMICAL DATA FOR SELECTED COCs

Physical Property Data

Constituent	CAS Number	type	Molecular Weight (g/mole) MW	ref	Diffusion Coefficients in air (cm2/s) Dair	ref	Diffusion Coefficients in water (cm2/s) Dwat	ref	log (Koc) or log(Kd) (@ 20 - 25 C) log(L/kg)	partition	ref	Henry's Law Constant (@ 20 - 25 C) (atm-m3) mol	Henry's Law Constant (@ 20 - 25 C) (unitless)	ref	Vapor Pressure (@ 20 - 25 C) (mm Hg)	ref	Solubility (@ 20 - 25 C) (mg/L)	ref	acid pKa	base pKb	ref
Benzene	71-43-2	A	78.1	PS	8.80E-02	PS	9.80E-06	PS	1.77	Koc	PS	5.55E-03	2.29E-01	PS	9.52E+01	PS	1.75E+03	PS	-	-	-
Toluene	108-88-3	A	92.4	5	8.50E-02	A	9.40E-06	A	2.13	Koc	A	6.30E-03	2.60E-01	A	3.00E+01	4	5.15E+02	29	-	-	-
Ethylbenzene	100-41-4	A	106.2	PS	7.50E-02	PS	7.80E-06	PS	2.56	Koc	PS	7.88E-03	3.25E-01	PS	1.00E+01	PS	1.69E+02	PS	-	-	-
Xylene (mixed isomers)	1330-20-7	A	106.2	5	7.20E-02	A	8.50E-06	A	2.38	Koc	A	7.03E-03	2.90E-01	A	7.00E+00	4	1.98E+02	5	-	-	-
Methyl t-Butyl ether	1634-04-4	O	88.146	5	7.92E-02	6	9.41E-05	7	1.08	Koc	A	5.77E-04	2.38E-02	-	2.49E+02	-	4.80E+04	A	-	-	-
Naphthalene	91-20-3	PAH	128.2	PS	5.90E-02	PS	7.50E-06	PS	3.30	Koc	PS	4.83E-04	1.99E-02	PS	2.30E-01	PS	3.10E+01	PS	-	-	-
Cumene	98-82-8	A	120.2	4	6.50E-02	4	7.10E-06	4	0.00	Koc	4	1.46E-02	6.02E-01	4	4.60E+00	4	4.98E+01	4	-	-	-

Site Name: Oak Walk - Type 3A (Unimproved Site)
Completed By: Dai Watkins
Job ID: Project No. 0004.085

Site Location: Emeryville
Date Completed: 8-Jul-06

CHEMICAL DATA FOR SELECTED COCs

Toxicity Data

Constituent	Reference Dose (mg/kg/day) Oral RfD_oral	ref	Reference Dose (mg/kg/day) Dermal RfD_dermal	ref	Reference Conc. (mg/m3) Inhalation RfC_inhal	ref	Slope Factors 1/(mg/kg/day) Oral SF_oral	ref	Slope Factors 1/(mg/kg/day) Dermal SF_dermal	ref	Unit Risk Factor 1/(µg/m3) Inhalation URF_inhal	ref	EPA Weight of Evidence	Is Constituent Carcinogenic ?
Benzene	3.00E-03	R	-	-	5.95E-03	R	2.90E-02	PS	2.99E-02	TX	8.29E-06	PS	A	TRUE
Toluene	2.00E-01	A,R	1.60E-01	TX	4.00E-01	A,R	-	-	-	-	-	-	D	FALSE
Ethylbenzene	1.00E-01	PS	9.70E-02	TX	1.00E+00	PS	-	-	-	-	-	-	D	FALSE
Xylene (mixed isomers)	2.00E+00	A,R	1.84E+00	TX	7.00E+00	A	-	-	-	-	-	-	D	FALSE
Methyl t-Butyl ether	1.00E-02	31	8.00E-03	TX	3.00E+00	R	-	-	-	-	-	-	-	FALSE
Naphthalene	4.00E-01	PS	3.56E-01	TX	1.40E+00	PS	-	-	-	-	-	-	D	FALSE
Cumene	1.00E-01	R	8.00E-02	TX	4.00E-01	R	-	-	-	-	-	-	D	FALSE

Site Name: Oak Walk - Type 3A

Site Location: Emeryville

Miscellaneous Chemical Data

Constituent	Maximum Contaminant Level MCL (mg/L)	ref	Time-Weighted Average Workplace Criteria TWA (mg/m3)	ref	Aquatic Life Prot. Criteria AQL (mg/L)	ref	Biocon-centration Factor (L-wat/kg-fish)
Benzene	5.00E-03	52 FR 25690	3.25E+00	PS	-	-	12.6
Toluene	1.00E+00	56 FR 3526 (30 Jan 91)	1.47E+02	ACGIH	-	-	70
Ethylbenzene	7.00E-01	56 FR 3526 (30 Jan 91)	4.35E+02	PS	-	-	1
Xylene (mixed isomers)	1.00E+01	56 FR 3526 (30 Jan 91)	4.34E+02	ACGIH	-	-	1
Methyl t-Butyl ether	-	-	6.00E+01	NIOSH	-	-	1
Naphthalene	-	-	5.00E+01	PS	-	-	430
Cumene	-	-	2.45E+02	OSHA	-	-	1

Site Name: Oak Walk - Type 3A

Site Location: Emeryville

CHEMICAL DATA FOR SELECTED COCs

Miscellaneous Chemical Data

Constituent	Dermal Relative Absorp. Factor (unitless)	Water Dermal Permeability Data: Dermal Permeability Coeff. (cm/hr)	Lag time for Dermal Exposure (hr)	Critical Exposure Time (hr)	Relative Contr of Derm Perm Coeff (unitless)	Water/Skin Derm Adsorp Factor (cm/event)	ref	Detection Limits: Groundwater (mg/L)	ref	Soil (mg/kg)	ref	Half Life (First-Order Decay) (days): Saturated	Unsaturated	ref
Benzene	0.5	0.021	0.26	0.63	0.013	7.3E-2	D	0.002	S	0.005	S	720	720	H
Toluene	0.5	0.045	0.32	0.77	0.054	1.6E-1	D	0.002	S	0.005	S	28	28	H
Ethylbenzene	0.5	0.074	0.39	1.3	0.14	2.7E-1	D	0.002	S	0.005	S	228	228	H
Xylene (mixed isomers)	0.5	0.08	0.39	1.4	0.16	2.9E-1	D	0.005	S	0.005	S	360	360	H
Methyl t-Butyl ether	0.5	-	-	-	-	-	-	-	-	-	-	360	180	H
Naphthalene	0.05	0.069	0.53	2.2	0.2	2.7E-1	D	0.01	32	0.01	32	258	258	H
Cumene	0.5	-	-	-	-	-	-	-	-	-	-	16	16	H

Site Name: Oak Walk - Type 3A

Site Location: Emeryville

RBCA SITE ASSESSMENT

Input Parameter Summary

Site Name: Oak Walk - Type 3A (Unimproved Site) Completed By: Dai Watkins Job ID: Project No. 0004.085
Site Location: Emeryville Date Completed: 8-Jul-06

Exposure Parameters		Residential			Commercial/Industrial	
		Adult	(1-6yrs)	(1-16 yrs)	Chronic	Construc.
AT_c	Averaging time for carcinogens (yr)	70				
AT_n	Averaging time for non-carcinogens (yr)	30			25	1
BW	Body weight (kg)	70	15	35	70	
ED	Exposure duration (yr)	30	6	16	25	1
τ	Averaging time for vapor flux (yr)	30			25	1
EF	Exposure frequency (days/yr)	350			250	180
EF_D	Exposure frequency for dermal exposure	350			250	
IR_w	Ingestion rate of water (L/day)	2			1	
IR_s	Ingestion rate of soil (mg/day)	100	200		50	100
SA	Skin surface area (dermal) (cm^2)	5800		2023	5800	5800
M	Soil to skin adherence factor	1				
ET_{swim}	Swimming exposure time (hr/event)	3				
EV_{swim}	Swimming event frequency (events/yr)	12	12	12		
IR_{swim}	Water ingestion while swimming (L/hr)	0.05	0.5			
SA_{swim}	Skin surface area for swimming (cm^2)	23000		8100		
IR_{fish}	Ingestion rate of fish (kg/yr)	0.025				
FI_{fish}	Contaminated fish fraction (unitless)	1				

Complete Exposure Pathways and Receptors	On-site	Off-site 1	Off-site 2
Groundwater:			
Groundwater Ingestion	None	None	None
Soil Leaching to Groundwater Ingestion	None	None	None
Applicable Surface Water Exposure Routes:			
Swimming			NA
Fish Consumption			NA
Aquatic Life Protection			NA
Soil:			
Direct Ingestion and Dermal Contact	None		
Outdoor Air:			
Particulates from Surface Soils	None	None	None
Volatilization from Soils	Res./Constr.	None	None
Volatilization from Groundwater	Residential	None	None
Indoor Air:			
Volatilization from Subsurface Soils	Residential	NA	NA
Volatilization from Groundwater	Residential	NA	NA

Receptor Distance from Source Media	On-site	Off-site 1	Off-site 2	(Units)
Groundwater receptor	NA	NA	NA	(ft)
Soil leaching to groundwater receptor	NA	NA	NA	(ft)
Outdoor air inhalation receptor	0	NA	NA	(ft)

Target Health Risk Values		Individual	Cumulative
TR_{ab}	Target Risk (class A&B carcinogens)	1.0E-6	1.0E-6
TR_c	Target Risk (class C carcinogens)	1.0E-6	
THQ	Target Hazard Quotient (non-carcinogenic risk)	2.0E-1	2.0E-1

Modeling Options	
RBCA tier	Tier 2
Outdoor air volatilization model	Surface & subsurface models
Indoor air volatilization model	Johnson & Ettinger model
Soil leaching model	NA
Use soil attenuation model (SAM) for leachate?	NA
Air dilution factor	NA
Groundwater dilution-attenuation factor	NA

NOTE: NA = Not applicable

Surface Parameters		General	Construction	(Units)
A	Source zone area	1.6E+4	1.6E+4	(ft^2)
W	Length of source-zone area parallel to wind	2.7E+2	2.7E+2	(ft)
W_{gw}	Length of source-zone area parallel to GW flow	NA		(ft)
U_{air}	Ambient air velocity in mixing zone	1.1E+1		(ft/s)
δ_{air}	Air mixing zone height	6.6E+0		(ft)
P_a	Areal particulate emission rate	NA		(g/cm^2/s)
L_{ss}	Thickness of affected surface soils	7.2E+0		(ft)

Surface Soil Column Parameters		Value			(Units)
h_{cap}	Capillary zone thickness	1.6E-1			(ft)
h_v	Vadose zone thickness	7.1E+0			(ft)
ρ_s	Soil bulk density	1.7E+0			(g/cm^3)
f_{oc}	Fraction organic carbon	1.0E-2			(-)
θ_T	Soil total porosity	3.5E-1			(-)
K_{vs}	Vertical hydraulic conductivity	1.0E-2			(cm/s)
k_v	Vapor permeability	1.1E-11			(ft^2)
L_{gw}	Depth to groundwater	7.2E+0			(ft)
L_s	Depth to top of affected soils	5.1E+0			(ft)
L_{base}	Depth to base of affected soils	7.2E+0			(ft)
L_{subs}	Thickness of affected soils	2.1E+0			(ft)
pH	Soil/groundwater pH	6.8E+0			(-)
		capillary	vadose	foundation	
θ_w	Volumetric water content	0.325	0.12	0.12	(-)
θ_a	Volumetric air content	0.025	0.23	0.26	(-)

Building Parameters		Residential	Commercial	(Units)
L_b	Building volume/area ratio	1.10E+1	NA	(ft)
A_b	Foundation area	7.22E+2	NA	(ft^2)
X_{crk}	Foundation perimeter	1.18E+2	NA	(ft)
ER	Building air exchange rate	5.70E-4	NA	(1/s)
L_{crk}	Foundation thickness	5.00E-1	NA	(ft)
Z_{crk}	Depth to bottom of foundation slab	5.00E-1	NA	(ft)
η	Foundation crack fraction	1.00E-3	NA	(-)
dP	Indoor/outdoor differential pressure	1.00E-2	NA	(psi)
Q_s	Convective air flow through slab	6.11E-3	NA	(ft^3/s)

Groundwater Parameters		Value	(Units)
δ_{gw}	Groundwater mixing zone depth	NA	(ft)
I_f	Net groundwater infiltration rate	NA	(mm/yr)
U_{gw}	Groundwater Darcy velocity	NA	(cm/s)
V_{gw}	Groundwater seepage velocity	NA	(cm/s)
K_s	Saturated hydraulic conductivity	NA	(cm/s)
i	Groundwater gradient	NA	(-)
S_w	Width of groundwater source zone	NA	(ft)
S_d	Depth of groundwater source zone	NA	(ft)
θ_{eff}	Effective porosity in water-bearing unit	NA	(-)
$f_{oc\text{-}sat}$	Fraction organic carbon in water-bearing unit	NA	(-)
pH_{sat}	Groundwater pH	NA	(-)
	Biodegradation considered?	NA	

Transport Parameters		Off-site 1	Off-site 2	Off-site 1	Off-site 2	(Units)
Lateral Groundwater Transport		Groundwater Ingestion		Soil Leaching to GW		
α_x	Longitudinal dispersivity	NA	NA	NA	NA	(ft)
α_y	Transverse dispersivity	NA	NA	NA	NA	(ft)
α_z	Vertical dispersivity	NA	NA	NA	NA	(ft)
Lateral Outdoor Air Transport		Soil to Outdoor Air Inhal.		GW to Outdoor Air Inhal.		
σ_y	Transverse dispersion coefficient	NA	NA	NA	NA	(ft)
σ_z	Vertical dispersion coefficient	NA	NA	NA	NA	(ft)
ADF	Air dispersion factor	NA	NA	NA	NA	(-)

Surface Water Parameters		Off-site 2	(Units)
Q_{sw}	Surface water flowrate	NA	(ft^3/s)
W_{pl}	Width of GW plume at SW discharge	NA	(ft)
δ_{pl}	Thickness of GW plume at SW discharge	NA	(ft)
DF_{sw}	Groundwater-to-surface water dilution factor	NA	(-)

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

SURFACE SOILS (5.1 - 7.2 ft):

VAPOR INHALATION

	1) Source Medium	2) NAF Value (m^3/kg) Receptor				3) Exposure Medium Outdoor Air: POE Conc. (mg/m^3) (1) / (2)			
	Soil Conc. (mg/kg)	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern		Residential	Construction Worker	None	None	Residential	Construction Worker	None	None
Benzene	1.3E+1	6.8E+4	2.3E+3			1.9E-4	5.7E-3		
Toluene	1.4E+2	6.8E+4	2.3E+3			2.1E-3	6.2E-2		
Ethylbenzene	8.0E+1	6.8E+4	2.3E+3			1.2E-3	3.5E-2		
Xylene (mixed isomers)	4.3E+2	6.8E+4	2.3E+3			6.3E-3	1.9E-1		
Methyl t-Butyl ether	0.0E+0	6.8E+4	2.3E+3			0.0E+0	0.0E+0		
Naphthalene	1.8E+1	8.6E+4	1.6E+4			2.1E-4	1.1E-3		
Cumene	7.1E+1	6.8E+4	2.3E+3			1.0E-3	3.1E-2		

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins

Date Completed: 8-Jul-06
Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

SURFACE SOILS (5.1 - 7.2 ft):

VAPOR INHALATION (cont'd)

	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)				5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)			
	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern	Residential	Construction Worker	None	None	Residential	Construction Worker	None	None
Benzene	4.1E-1	7.0E-3			7.9E-5	4.0E-5		
Toluene	9.6E-1	4.9E-1			2.0E-3	3.0E-2		
Ethylbenzene	9.6E-1	4.9E-1			1.1E-3	1.7E-2		
Xylene (mixed isomers)	9.6E-1	4.9E-1			6.1E-3	9.4E-2		
Methyl t-Butyl ether	9.6E-1	4.9E-1			0.0E+0	0.0E+0		
Naphthalene	9.6E-1	4.9E-1			2.0E-4	5.6E-4		
Cumene	9.6E-1	4.9E-1			1.0E-3	1.5E-2		

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr)

Site Name: Oak Walk - Type 3A (Unimproved Site) Date Completed: 8-Jul-06

Site Location: Emeryville Job ID: Project No. 0004.085

Completed By: Dai Watkins

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ☐ **(CHECKED IF PATHWAY IS ACTIVE)**

SUBSURFACE SOILS (7.2 - 7.2 ft):

VAPOR INHALATION

	1) Source Medium	2) NAF Value (m^3/kg) Receptor			3) Exposure Medium Outdoor Air: POE Conc. (mg/m^3) (1) / (2)		
Constituents of Concern	Soil Conc. (mg/kg)	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	1.3E+1						
Toluene	1.4E+2						
Ethylbenzene	8.0E+1						
Xylene (mixed isomers)	4.3E+2						
Methyl t-Butyl ether	0.0E+0						
Naphthalene	1.8E+1						
Cumene	7.1E+1						

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins

Date Completed: 8-Jul-06
Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

SUBSURFACE SOILS (7.2 - 7.2 ft):

VAPOR INHALATION (cont'd)

	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)			5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)		
Constituents of Concern	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene						
Toluene						
Ethylbenzene						
Xylene (mixed isomers)						
Methyl t-Butyl ether						
Naphthalene						
Cumene						

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr)

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins

Date Completed: 8-Jul-06
Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

GROUNDWATER: VAPOR INHALATION

Exposure Concentration

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/L) Receptor			3) Exposure Medium Outdoor Air: POE Conc. (mg/m^3) (1) / (2)		
	Groundwater Conc. (mg/L)	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	7.9E+0	1.8E+4			4.5E-4		
Toluene	2.1E+0	1.8E+4			1.2E-4		
Ethylbenzene	9.8E-1	1.9E+4			5.2E-5		
Xylene (mixed isomers)	8.3E+0	1.9E+4			4.3E-4		
Methyl t-Butyl ether	7.7E-1	1.9E+4			4.1E-5		
Naphthalene	4.9E-1	5.5E+4			8.9E-6		
Cumene	2.2E+0	1.6E+4			1.4E-4		

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins

Date Completed: 8-Jul-06
Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

GROUNDWATER: VAPOR INHALATION (cont'd)

Constituents of Concern	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)			5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)		
	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) Residential	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Benzene	4.1E-1			1.8E-4		
Toluene	9.6E-1			1.1E-4		
Ethylbenzene	9.6E-1			5.0E-5		
Xylene (mixed isomers)	9.6E-1			4.2E-4		
Methyl t-Butyl ether	9.6E-1			3.9E-5		
Naphthalene	9.6E-1			8.5E-6		
Cumene	9.6E-1			1.3E-4		

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr)

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins

Date Completed: 8-Jul-06
Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS

TOTAL PATHWAY EXPOSURE (mg/m^3)

(Sum average expsosure concentrations from soil and groundwater routes.)

	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern	Residential	Construction Worker	None	None
Benzene	2.6E-4	4.0E-5		
Toluene	2.1E-3	3.0E-2		
Ethylbenzene	1.2E-3	1.7E-2		
Xylene (mixed isomers)	6.5E-3	9.4E-2		
Methyl t-Butyl ether	3.9E-5	0.0E+0		
Naphthalene	2.1E-4	5.6E-4		
Cumene	1.1E-3	1.5E-2		

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins

Date Completed: 8-Jul-06
Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

CARCINOGENIC RISK

Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Exposure (mg/m^3)				(3) Inhalation Unit Risk Factor (µg/m^3)^-1	(4) Individual COC Risk (2) x (3) x 1000			
		On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)		On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
		Residential	Construction Worker	None	None		Residential	Construction Worker	None	None
Benzene	A	2.6E-4	4.0E-5			8.3E-6	2.2E-6	3.3E-7		
Toluene	D									
Ethylbenzene	D									
Xylene (mixed isomers)	D									
Methyl t-Butyl ether	-									
Naphthalene	D									
Cumene	D									
						Total Pathway Carcinogenic Risk =	**2.2E-6**	**3.3E-7**		

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville

Completed By: Dai Watkins
Date Completed: 8-Jul-06

Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 PATHWAY RISK CALCULATION

OUTDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

TOXIC EFFECTS

	(5) Total Toxicant Exposure (mg/m^3)				(6) Inhalation Reference Conc. (mg/m^3)	(7) Individual COC Hazard Quotient (5) / (6)			
	On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)		On-site (0 ft)		Off-site 1 (0 ft)	Off-site 2 (0 ft)
Constituents of Concern	Residential	Construction Worker	None	None		Residential	Construction Worker	None	None
Benzene	6.1E-4	2.8E-3			6.0E-3	1.0E-1	4.8E-1		
Toluene	2.1E-3	3.0E-2			4.0E-1	5.2E-3	7.6E-2		
Ethylbenzene	1.2E-3	1.7E-2			1.0E+0	1.2E-3	1.7E-2		
Xylene (mixed isomers)	6.5E-3	9.4E-2			7.0E+0	9.3E-4	1.3E-2		
Methyl t-Butyl ether	3.9E-5	0.0E+0			3.0E+0	1.3E-5	0.0E+0		
Naphthalene	2.1E-4	5.6E-4			1.4E+0	1.5E-4	4.0E-4		
Cumene	1.1E-3	1.5E-2			4.0E-1	2.8E-3	3.9E-2		

Total Pathway Hazard Index =	**1.1E-1**	**6.2E-1**		

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville

Completed By: Dai Watkins
Date Completed: 8-Jul-06

Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

SOILS (5.1 - 7.2 ft): VAPOR INTRUSION INTO ON-SITE BUILDINGS

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/kg) Receptor	3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2)	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)	5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)
	Soil Conc. (mg/kg)	Residential	Residential	Residential	Residential
Benzene	1.3E+1	1.7E+3	7.8E-3	4.1E-1	3.2E-3
Toluene	1.4E+2	1.7E+3	8.4E-2	9.6E-1	8.1E-2
Ethylbenzene	8.0E+1	1.7E+3	4.8E-2	9.6E-1	4.6E-2
Xylene (mixed isomers)	4.3E+2	NA		9.6E-1	
Methyl t-Butyl ether	0.0E+0	1.7E+3	0.0E+0	9.6E-1	0.0E+0
Naphthalene	1.8E+1	NA		9.6E-1	
Cumene	7.1E+1	NA		9.6E-1	

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr) NAF = Natural attenuation factor POE = Point of exposure

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins

Date Completed: 8-Jul-06
Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAY IS ACTIVE)**

GROUNDWATER: VAPOR INTRUSION INTO ON-SITE BUILDINGS

Exposure Concentration

Constituents of Concern	1) Source Medium	2) NAF Value (m^3/L) Receptor	3) Exposure Medium Indoor Air: POE Conc. (mg/m^3) (1) / (2)	4) Exposure Multiplier (EFxED)/(ATx365) (unitless)	5) Average Inhalation Exposure Concentration (mg/m^3) (3) X (4)
	Groundwater Conc. (mg/L)	Residential	Residential	Residential	Residential
Benzene	7.9E+0	3.9E+2	2.0E-2	4.1E-1	8.4E-3
Toluene	2.1E+0	3.8E+2	5.5E-3	9.6E-1	5.2E-3
Ethylbenzene	9.8E-1	4.1E+2	2.4E-3	9.6E-1	2.3E-3
Xylene (mixed isomers)	8.3E+0	NA		9.6E-1	
Methyl t-Butyl ether	7.7E-1	4.4E+2	1.8E-3	9.6E-1	1.7E-3
Naphthalene	4.9E-1	NA		9.6E-1	
Cumene	2.2E+0	NA		9.6E-1	

NOTE: AT = Averaging time (days) EF = Exposure frequency (days/yr) ED = Exposure duration (yr) NAF = Natural attenuation factor POE = Point of exposure

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins

Date Completed: 8-Jul-06
Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

INDOOR AIR EXPOSURE PATHWAYS

Constituents of Concern	TOTAL PATHWAY EXPOSURE (mg/m^3) *(Sum average expsosure concentrations from soil and groundwater routes.)* Residential
Benzene	1.2E-2
Toluene	8.6E-2
Ethylbenzene	4.8E-2
Xylene (mixed isomers)	
Methyl t-Butyl ether	1.7E-3
Naphthalene	
Cumene	

Site Name: Oak Walk - Type 3A (Unimproved Site Date Completed: 8-Jul-06
Site Location: Emeryville Job ID: Project No. 0004.085
Completed By: Dai Watkins

RBCA SITE ASSESSMENT

TIER 2 PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

		CARCINOGENIC RISK		
Constituents of Concern	(1) EPA Carcinogenic Classification	(2) Total Carcinogenic Exposure (mg/m^3) Residential	(3) Inhalation Unit Risk Factor (µg/m^3)^-1	(4) Individual COC Risk (2) x (3) x 1000 Residential
Benzene	A	1.2E-2	8.3E-6	9.6E-5
Toluene	D			
Ethylbenzene	D			
Xylene (mixed isomers)	D			
Methyl t-Butyl ether	-			
Naphthalene	D			
Cumene	D			

Total Pathway Carcinogenic Risk = **9.6E-5**

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins

Date Completed: 8-Jul-06
Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT

TIER 2 PATHWAY RISK CALCULATION

INDOOR AIR EXPOSURE PATHWAYS ■ **(CHECKED IF PATHWAYS ARE ACTIVE)**

	TOXIC EFFECTS		
	(5) Total Toxicant Exposure (mg/m^3)	(6) Inhalation Reference Concentration (mg/m^3)	(7) Individual COC Hazard Quotient (5) / (6)
Constituents of Concern	Residential		Residential
Benzene	2.7E-2	6.0E-3	4.5E+0
Toluene	8.6E-2	4.0E-1	2.2E-1
Ethylbenzene	4.8E-2	1.0E+0	4.8E-2
Xylene (mixed isomers)		7.0E+0	
Methyl t-Butyl ether	1.7E-3	3.0E+0	5.6E-4
Naphthalene		1.4E+0	
Cumene		4.0E-1	

Total Pathway Hazard Index = **4.8E+0**

Site Name: Oak Walk - Type 3A (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins

Date Completed: 8-Jul-06
Job ID: Project No. 0004.085

RBCA SITE ASSESSMENT — Baseline Risk Summary-All Pathways

Site Name: Oak Walk - Type 3A (Unimproved Site)
Completed By: Dai Watkins
Site Location: Emeryville
Date Completed: 8-Jul-06

TIER 2 BASELINE RISK SUMMARY TABLE

	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk	Hazard Quotient		Hazard Index		Toxicity
EXPOSURE PATHWAY	Maximum Value	Target Risk	Total Value	Target Risk	Limit(s) Exceeded?	Maximum Value	Applicable Limit	Total Value	Applicable Limit	Limit(s) Exceeded?
OUTDOOR AIR EXPOSURE PATHWAYS										
Complete:	2.2E-6	1.0E-6	2.2E-6	1.0E-6	■	4.8E-1	2.0E-1	6.2E-1	2.0E-1	■
INDOOR AIR EXPOSURE PATHWAYS										
Complete:	9.6E-5	1.0E-6	9.6E-5	1.0E-6	■	4.5E+0	2.0E-1	4.8E+0	2.0E-1	■
SOIL EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	□	NA	NA	NA	NA	□
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	□	NA	NA	NA	NA	□
SURFACE WATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	□	NA	NA	NA	NA	□

CRITICAL EXPOSURE PATHWAY (Maximum Values From Complete Pathways)										
	9.6E-5	***1.0E-6***	***9.6E-5***	***1.0E-6***	■	***4.5E+0***	***2.0E-1***	***4.8E+0***	***2.0E-1***	■
	Indoor Air		***Indoor Air***			***Indoor Air***		***Indoor Air***		

APPENDIX II-D

Health Risk Assessment for Building Type 3A (Soil Remediation Only)

Main Screen

RBCA Tool Kit for Chemical Releases
Version 1.3b © 2000

1. Project Information

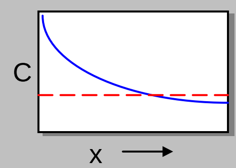
Site Name: Oak Walk - Type 3A (Soil Remediation Only)
Location: Emeryville
Compl. By: Dai Watkins
Date: 8-Jul-06 Job ID: Project No. 0004.085

2. Which Type of RBCA Analysis? ?

○ **Tier 1**

Generic Values
On-Site
Exposure

◉ **Tier 2**



Site-Specific Values
On- or Off-Site Exposure

3. Calculation Options ?

Affects which input data are required

☑ ***Baseline Risks (Forward mode)***
☐ ***RBCA Cleanup Standards (Backward mode)***

4. RBCA Evaluation Process

Prepare Input Data
Data Complete? (■= yes, ■= no)

- **Exposure Pathways**
- **Constituents of Concern (COCs)**
- **Transport Models**
- **Soil Parameters**
- **GW Parameters**
- **Air Parameters**

Review Output

- **Exposure Flowchart**
- **COC Chem. Parameters**
- **Input Data Summary**
- **User-Spec. COC Data...**
- **Transient Domenico Analysis...**
- **Baseline Risks...**
- **Cleanup Standards...**

5. Commands and Options

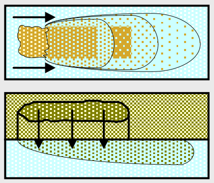
New Site	**Load Data...**	**Save Data As...**	**Quit**
Print Sheet	**Set Units**	Custom Chem. Data...	***Help***

Exposure Pathway Identification

Site Name: Oak Walk - Type 3A (Soil Remediation Only)
Location: Emeryville
Compl. By: Dai Watkins
Job ID: Project No. 0004.085 Date: 8-Jul-06

1. Groundwater Exposure

?



Groundwater Ingestion/ Surface Water Impact

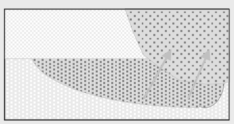
Receptor	None	None	None
Type:	On-site	Off-site1	Off-site2

Source Media:

Distance to GW receptors

☐ Affected Groundwater	0	0	0	*(ft)*
	On-site	Off-site1	Off-site2	
☐ Affected Soils Leaching to Groundwater	0	0	0	*(ft)*

GW Discharge to Surface Water Exposure



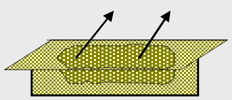
- ☐ Swimming
- ☐ Fish Consumption
- ☐ Aquatic Life Protection

Enter ALP Criteria

2. Surface Soil Exposure

Direct Ingestion and Dermal Contact

?



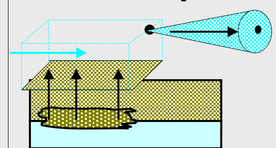
Receptor	None	No off-site receptors
Type:	On-site	

Construction Worker ☐

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation

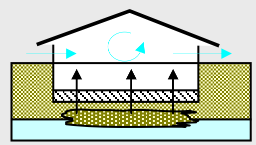
?



Receptor	Res.	None	None	
Type:	On-site	Off-site1	Off-site2	
	0	0	0	*(ft)*

Construction worker ☑

- ☑ Affected Soils--Volatilization to Ambient Outdoor Air
- ☑ Affected Groundwater--Volatilization to Ambient Outdoor Air
- ☐ Affected Surface Soils--Particulates to Ambient Outdoor Air



Volatilization to Indoor Air Inhalation

Receptor	Res.	No off-site receptors
Type:	On-site	

- ☑ Affected Soils--Volatilization to Enclosed Space
- ☑ Affected Groundwater--Volatilization to Enclosed Space

4. Commands and Options

Main Screen | **Print Sheet** | **Set Units** | ***Help***

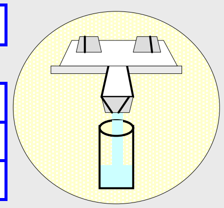
Exposure Factors & Target Risks | Exposure Flowchart

Exposure Factors and Target Risk Limits

Site Name: Oak Walk - Type 3A (Soil Remediation Only)
Location: Emeryville
Compl. By: Dai Watkins
Job ID: Project No. 0004.085 Date: 8-Jul-06

1. Exposure Parameters

	Age Adjustment?	Residential: Adult	Residential: (Age 0-6)	Residential: (Age 0-16)	Commercial: Chronic	Commercial: Construc.
Averaging time, carcinogens (yr)		70				
Averaging time, non-carcinogens (yr)		30			25	1
Body weight (kg)		70	15	35	70	
Exposure duration (yr)		30	6	16	25	1
Exposure frequency (days/yr)		350			250	180
Dermal exposure frequency (days/yr)		350			250	
Skin surface area, soil contact (cm^2)	☐	5800		2023	5800	5800
Soil dermal adherence factor ($mg/cm^2/day$)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☐	100	200		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☐	0.05	0.5			
Skin surface area, swimming (cm^2)	☐	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				



2. Risk Goal Calculation Options

- ○ Individual Constitiuent Risk Goals Only
- ◉ Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcins.)	1.0E-6	1.0E-6
Target Risk (Class C carcinogens)	1.0E-6	
Target Hazard Quotient	2.0E-1	
Target Hazard Index		2.0E-1

4. Commands and Options

Return to Exposure Pathways

Use Default Values

Print Sheet

Help

Site Name: Oak Walk - Type 3A (Soil Remediation C Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

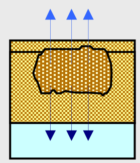
Apply Raoult's Law ?

Selected COCs	*Representative COC Concentration* ?				Mole Fraction in Source Material
COC Select: Add/Insert Delete *Sort List:* ? Top Bottom MoveUp MoveDown	**Groundwater Source Zone**		**Soil Source Zone**		
	Calculate	Enter Site Data	Calculate	Enter Site Data	
	(mg/L)	note	*(mg/kg)*	note	*(-)*
Benzene	7.9E+0		1.3E+1		
Toluene	2.1E+0		1.4E+2		
Ethylbenzene	9.8E-1		8.0E+1		
Xylene (mixed isomers)	8.3E+0		4.3E+2		
Methyl t-Butyl ether	7.7E-1		0.0E+0		
Naphthalene	4.9E-1		1.8E+1		
Cumene	2.2E+2		7.1E+1		

Transport Modeling Options

Site Name: Oak Walk - Type 3A (Soil Remediation Only) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

1. Vertical Transport, Surface Soil Column



Outdoor Air Volatilization Factors ?

○ Surface soil volatilization model only
◉ Combination surface soil/Johnson & Ettinger models
Thickness of surface soil zone 7.23 *(ft)*
○ User-specified VF from other model [Enter VF Values]

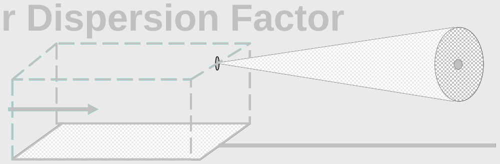
Indoor Air Volatilization Factors ?

◉ Johnson & Ettinger model
○ User-specified VF from other model [Enter VF Values]

Soil-to-Groundwater Leaching Factor

○ ASTM Model ?
☐ Apply Soil Attenuation Model (SAM)
☐ Allow first-order biodecay [Enter Decay Rates]
○ User-specified LF from other model [Enter LF Values]

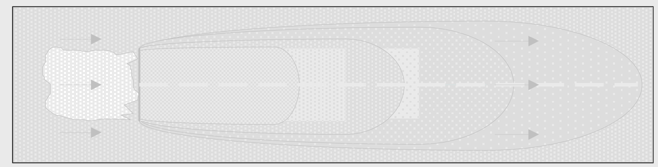
2. Lateral Air Dispersion Factor



?

	Off-site 1	Off-site 2	
○ 3-D Gaussian dispersion model			
○ User-Specified ADF	1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor



Calculate DAF using Domenico Model ?

○ Domenico equation with dispersion only (no biodegradation)
○ Domenico equation first-order decay [Enter Decay Rates]
○ Modified Domenico equation using electron acceptor superposition [Enter Site Data]
[Enter Directly] Biodegradation Capacity NC *(mg/L)*

— or —

User-Specified DAF Values

○ DAF values from other model or site data [Enter DAF Values]

4. Commands and Options

[Main Screen] [Print Sheet] [***Help***]

Site-Specific Soil Parameters

Site Name: Oak Walk - Type 3A (Soil Remediation Only) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

1. Soil Source Zone Characteristics

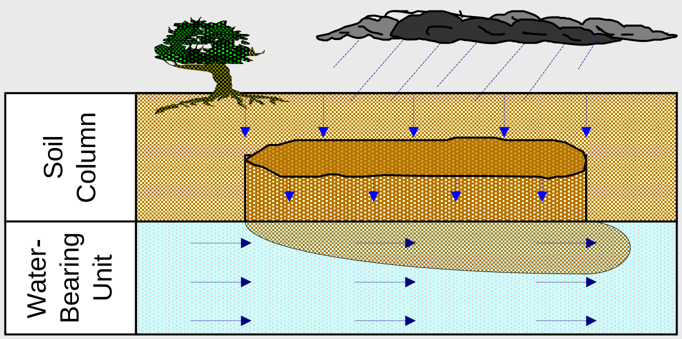
?

Hydrogeology

	General Case	Construction	
Depth to water-bearing unit	7.23		(ft)
Capillary zone thickness	5		(ft)
Soil column thickness	2.23		(ft)

Affected Soil Zone

	General Case	Construction	
Depth to top of affected soils	7.13		(ft)
Depth to base of affected soils	7.23		(ft)
Affected soil area	16200	16200	(ft^2)
Length of affected soil parallel to assumed wind direction	270	270	(ft)
Length of affected soil parallel to assumed GW flow direction	0		(ft)



2. Surface Soil Column

Predominant USCS Soil Type ults ?

or Calculate ↓ or

	Vadose Zone	Capillary Fringe	
Total porosity	0.5		(-)
Volumetric water content	0.2275	0.49	(-)
Volumetric air content	0.2725	0.01	(-)
Dry bulk density	1.61		(kg/L)
Vertical hydraulic conductivity	5.7E-7		(cm/s)
Vapor permeability	1.1E-16		(ft^2)
Capillary zone thickness	5.0E+0		(ft)

Net Rainfall Infiltration

Net infiltration estimate		(mm/yr)
or NA	↑ or	
Average annual precipitation	0	(mm/yr)

Partitioning Parameters

Fraction organic carbon	0.02	(-)
Soil/water pH	6.8	(-)

3. Commands and Options

Main Screen | Use Default Values | Print Sheet
Set Units | Help

Site-Specific Groundwater Parameters

Site Name: Oak Walk - Type 3A (Soil Remediation Only) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

1. Water-Bearing Unit ?

Hydrogeology

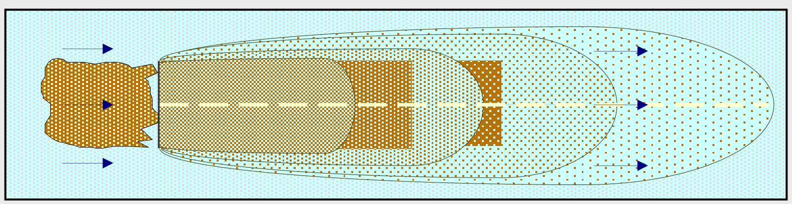
Groundwater Darcy velocity		(cm/s)
Groundwater seepage velocity		(cm/s)
or NA	or	
Hydraulic conductivity		(cm/s)
Hydraulic gradient		(-)
Effective porosity		(-)

Sorption

Fraction organic carbon--saturated zone	0	(-)
Groundwater pH	0	(-)

2. Groundwater Source Zone ?

Groundwater plume width at source	240	(ft)
Plume (mixing zone) thickness at source		(ft)
or NA	or	
Saturated thickness		(ft)
Length of source zone		(ft)



3. Groundwater Dispersion ?

Model:

	GW Ingestion Off-site 1	GW Ingestion Off-site 2	Soil Leaching to GW Off-site 1	Soil Leaching to GW Off-site 2	
Distance to GW receptors	0	0	0	0	(ft)
or NA		or		or	
Longitudinal dispersivity					(ft)
Transverse dispersivity					(ft)
Vertical dispersivity					(ft)

4. Groundwater Discharge to Surface Water ?

	Off-site 2	
Distance to GW/SW disharge point	NA	(ft)
Plume width at GW/SW discharge	0	(ft)
Plume thickness at GW/SW discharge	0	(ft)
Surface water flowrate at GW/SW discharge	0.0E+0	(ft^3/s)

5. Commands and Options

Main Screen | Use Default Values | Print Sheet
Set Units | Help

Site-Specific Air Parameters

Site Name: Oak Walk - Type 3A (Soil Re[illegible] No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

1. Outdoor Air Pathway

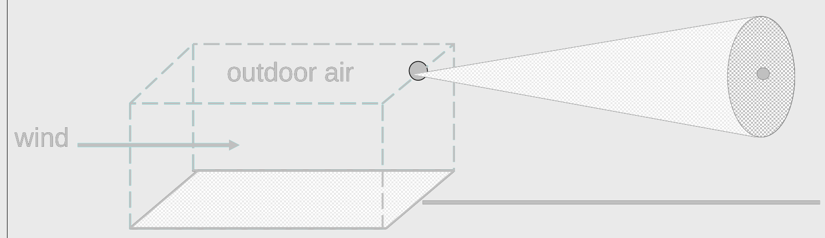
?

Dispersion in Air

	Off-site 1	Off-site 2	
Distance to offsite air receptor			*(ft)*
or NA	↓	*or* ↓	
Horizontal dispersivity			*(ft)*
Vertical dispersivity			*(ft)*

Air Source Zone

Air mixing zone height	6.56	*(ft)*
Ambient air velocity in mixing zone	10.56	*(ft/s)*
Areal particulate emission flux	6.9E-14	*(g/cm^2/s)*

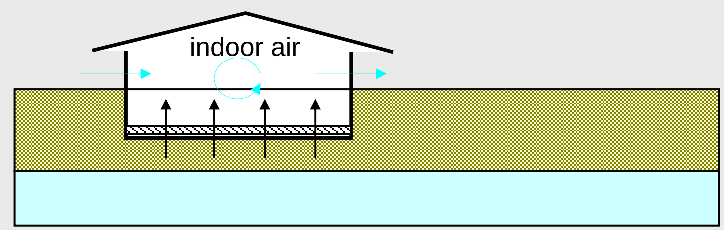


2. Indoor Air Pathway

?

Building Parameters

	Residential	Commercial	
Building volume/area ratio	11	9	*(ft)*
Foundation area	722	722	*(ft^2)*
Foundation perimeter	118.3	118.3	*(ft)*
Building air exchange rate	5.7E-4	5.7E-4	*(1/s)*
Depth to bottom of foundation slab	0.5	0.5	*(ft)*
Convective air flow through cracks	6.1E-8	6.1E-8	*(ft^3/s)*
Foundation thickness	0.5		*(ft)*
Foundation crack fraction	0.001		*(-)*
Volumetric water content of cracks	0.12		*(-)*
Volumetric air content of cracks	0.26		*(-)*
Indoor/Outdoor differential pressure	0.01		*(psi)*



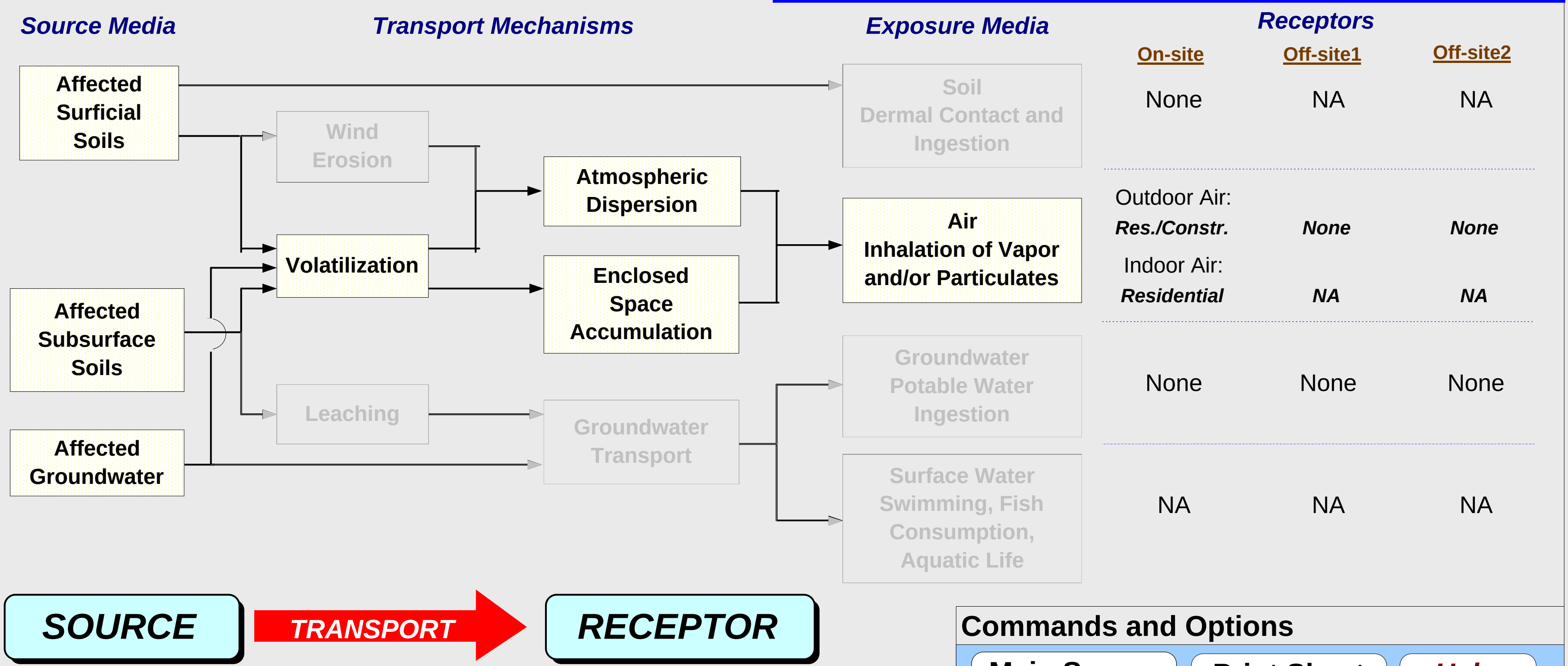
3. Commands and Options

Main Screen | Use Default Values | **Print Sheet**

Set Units | ***Help***

Exposure Pathway Flowchart

Site Name: Oak Walk - Type 3A (Soil Remediation Only) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins



Commands and Options

Main Screen | Print Sheet | Help

RBCA SITE ASSESSMENT | **Baseline Risk Summary-All Pathways**

Site Name: Oak Walk - Type 3A (Soil Remediation Only) Completed By: Dai Watkins
Site Location: Emeryville Date Completed: 8-Jul-06

TIER 2 BASELINE RISK SUMMARY TABLE

	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk	Hazard Quotient		Hazard Index		Toxicity
EXPOSURE PATHWAY	Maximum Value	Target Risk	Total Value	Target Risk	Limit(s) Exceeded?	Maximum Value	Applicable Limit	Total Value	Applicable Limit	Limit(s) Exceeded?
OUTDOOR AIR EXPOSURE PATHWAYS										
Complete:	1.0E-7	1.0E-6	1.0E-7	1.0E-6	□	2.1E-2	2.0E-1	2.8E-2	2.0E-1	□
INDOOR AIR EXPOSURE PATHWAYS										
Complete:	3.9E-6	1.0E-6	3.9E-6	1.0E-6	■	1.9E-1	2.0E-1	2.5E-1	2.0E-1	■
SOIL EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	□	NA	NA	NA	NA	□
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	□	NA	NA	NA	NA	□
SURFACE WATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	□	NA	NA	NA	NA	□

CRITICAL EXPOSURE PATHWAY (Maximum Values From Complete Pathways)										
	3.9E-6	***1.0E-6***	***3.9E-6***	***1.0E-6***	■	***1.9E-1***	***2.0E-1***	***2.5E-1***	***2.0E-1***	■
	Indoor Air		***Indoor Air***			***Indoor Air***		***Indoor Air***		

APPENDIX II-E

Health Risk Assessment Building 3A (Remediated Site)

Main Screen

RBCA Tool Kit for Chemical Releases
Version 1.3b © 2000

1. Project Information

Site Name:	Oak Walk - Type 3A (Remediated Site)
Location:	Emeryville
Compl. By:	Dai Watkins
Date:	8-Jul-06
Job ID:	Project No. 0004.085

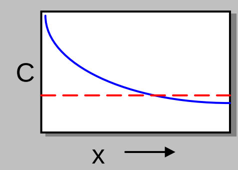
2. Which Type of RBCA Analysis?

?

○ **Tier 1**

Generic Values
On-Site
Exposure

◉ **Tier 2**



Site-Specific Values
On- or Off-Site Exposure

3. Calculation Options

?

Affects which input data are required

- ☑ ***Baseline Risks (Forward mode)***
- ☐ ***RBCA Cleanup Standards (Backward mode)***

4. RBCA Evaluation Process

Prepare Input Data

Data Complete? (■= yes, ■= no)

- **Exposure Pathways**
- **Constituents of Concern (COCs)**
- **Transport Models**
- **Soil Parameters**
- **GW Parameters**
- **Air Parameters**

Review Output

- **Exposure Flowchart**
- **COC Chem. Parameters**
- **Input Data Summary**
- **User-Spec. COC Data...**
- **Transient Domenico Analysis...**
- **Baseline Risks...**
- **Cleanup Standards...**

5. Commands and Options

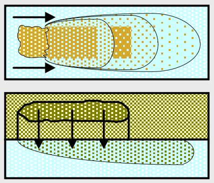
New Site	**Load Data...**	**Save Data As...**	**Quit**
Print Sheet	**Set Units**	Custom Chem. Data...	***Help***

Exposure Pathway Identification

Site Name: Oak Walk - Type 3A (Remediated Site)
Location: Emeryville
Compl. By: Dai Watkins
Job ID: Project No. 0004.085 Date: 8-Jul-06

1. Groundwater Exposure

?



Groundwater Ingestion/ Surface Water Impact

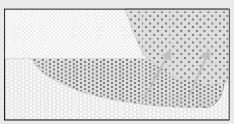
Receptor	None	None	None
Type:	On-site	Off-site1	Off-site2

Source Media:

Distance to GW receptors

☐ Affected Groundwater	0	0	0	*(ft)*
	On-site	Off-site1	Off-site2	
☐ Affected Soils Leaching to Groundwater	0	0	0	*(ft)*

GW Discharge to Surface Water Exposure



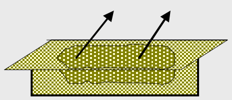
- ☐ Swimming
- ☐ Fish Consumption
- ☐ Aquatic Life Protection

Enter ALP Criteria

2. Surface Soil Exposure

Direct Ingestion and Dermal Contact

?



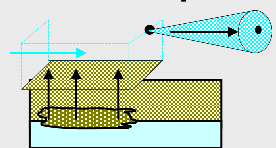
Receptor	None	No off-site receptors
Type:	On-site	

Construction Worker ☐

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation

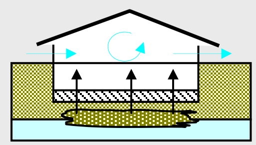
?



Receptor	Res.	None	None	
Type:	On-site	Off-site1	Off-site2	
	0	0	0	*(ft)*

Construction worker ☑

- ☑ Affected Soils--Volatilization to Ambient Outdoor Air
- ☑ Affected Groundwater--Volatilization to Ambient Outdoor Air
- ☐ Affected Surface Soils--Particulates to Ambient Outdoor Air



Volatilization to Indoor Air Inhalation

Receptor	Res.	No off-site receptors
Type:	On-site	

- ☑ Affected Soils--Volatilization to Enclosed Space
- ☑ Affected Groundwater--Volatilization to Enclosed Space

4. Commands and Options

Main Screen | Print Sheet | Set Units | *Help*

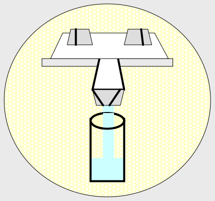
Exposure Factors & Target Risks | Exposure Flowchart

Exposure Factors and Target Risk Limits

Site Name: Oak Walk - Type 3A (Remediated Site)	
Location: Emeryville	
Compl. By: Dai Watkins	
Job ID: Project No. 0004.085	Date: 8-Jul-06

1. Exposure Parameters

	Age Adjustment?	Residential Adult	Residential (Age 0-6)	Residential (Age 0-16)	Commercial Chronic	Commercial Construc.
Averaging time, carcinogens (yr)		70				
Averaging time, non-carcinogens (yr)		30			25	1
Body weight (kg)		70	15	35	70	
Exposure duration (yr)		30	6	16	25	1
Exposure frequency (days/yr)		350			250	180
Dermal exposure frequency (days/yr)		350			250	
Skin surface area, soil contact (cm^2)	☐	5800		2023	5800	5800
Soil dermal adherence factor ($mg/cm^2/day$)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☐	100	200		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☐	0.05	0.5			
Skin surface area, swimming (cm^2)	☐	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				



2. Risk Goal Calculation Options

○ Individual Constitiuent Risk Goals Only

◉ Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcins.)	1.0E-6	1.0E-6
Target Risk (Class C carcinogens)	1.0E-6	
Target Hazard Quotient	2.0E-1	
Target Hazard Index		2.0E-1

4. Commands and Options

Return to Exposure Pathways

Use Default Values

Print Sheet

Help

Site Name: Oak Walk - Type 3A (Remediated Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

Apply Raoult's Law ?

Selected COCs

COC Select: Add/Insert | Delete

Sort List: ? Top | MoveUp | Bottom | MoveDown

Representative COC Concentration ?

Selected COCs	Groundwater Source Zone (mg/L)	note	Soil Source Zone (mg/kg)	note	Mole Fraction in Source Material (-)
Benzene	3.2E+0		1.3E+1		
Toluene	8.4E-1		1.4E+2		
Ethylbenzene	3.9E-1		8.0E+1		
Xylene (mixed isomers)	3.3E+0		4.3E+2		
Methyl t-Butyl ether	3.1E-1		0.0E+0		
Naphthalene	2.0E-1		1.8E+1		
Cumene	8.6E-1		7.1E+1		

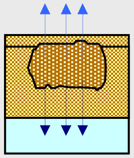
Groundwater Source Zone: Calculate | Enter Site Data

Soil Source Zone: Calculate | Enter Site Data

Transport Modeling Options

Site Name: Oak Walk - Type 3A (Remediated Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

1. Vertical Transport, Surface Soil Column



Outdoor Air Volatilization Factors ?

- ○ Surface soil volatilization model only
- ◉ Combination surface soil/Johnson & Ettinger models
  - Thickness of surface soil zone 7.23 *(ft)*
- ○ User-specified VF from other model [Enter VF Values]

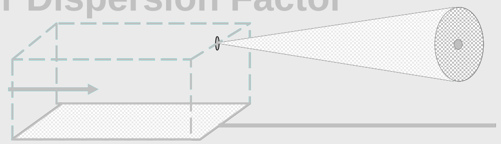
Indoor Air Volatilization Factors ?

- ◉ Johnson & Ettinger model
- ○ User-specified VF from other model [Enter VF Values]

Soil-to-Groundwater Leaching Factor ?

- ○ ASTM Model
  - ☐ Apply Soil Attenuation Model (SAM)
  - ☐ Allow first-order biodecay [Enter Decay Rates]
- ○ User-specified LF from other model [Enter LF Values]

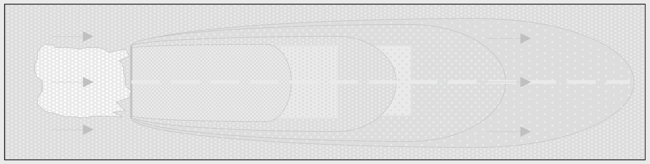
2. Lateral Air Dispersion Factor



?

	Off-site 1	Off-site 2	
○ 3-D Gaussian dispersion model			
○ User-Specified ADF	1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor



Calculate DAF using Domenico Model ?

- ○ Domenico equation with dispersion only (no biodegradation)
- ○ Domenico equation first-order decay [Enter Decay Rates]
- ○ Modified Domenico equation using electron acceptor superposition [Enter Site Data]
  - [Enter Directly] Biodegradation Capacity NC *(mg/L)*

— or —

User-Specified DAF Values

- ○ DAF values from other model or site data [Enter DAF Values]

4. Commands and Options

[Main Screen] [Print Sheet] [***Help***]

Site-Specific Soil Parameters

Site Name: Oak Walk - Type 3A (Remediated Site)	Job ID: Project No. 0004.085
Location: Emeryville	Date: 8-Jul-06
Compl. By: Dai Watkins	

1. Soil Source Zone Characteristics

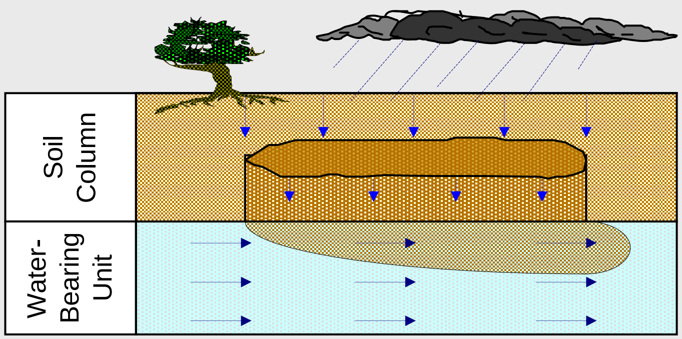
?

Hydrogeology

	General Case	Construction	
Depth to water-bearing unit	7.23		(ft)
Capillary zone thickness	5		(ft)
Soil column thickness	2.23		(ft)

Affected Soil Zone

	General Case	Construction	
Depth to top of affected soils	7.13		(ft)
Depth to base of affected soils	7.23		(ft)
Affected soil area	16200	16200	(ft^2)
Length of affected soil parallel to assumed wind direction	270	270	(ft)
Length of affected soil parallel to assumed GW flow direction			(ft)



2. Surface Soil Column

Predominant USCS Soil Type

?

or Calculate

	Vadose Zone	Capillary Fringe	
Total porosity	0.5		(-)
Volumetric water content	0.2275	0.49	(-)
Volumetric air content	0.2725	0.01	(-)
Dry bulk density	1.61		(kg/L)
Vertical hydraulic conductivity	5.7E-7		(cm/s)
Vapor permeability	1.1E-16		(ft^2)
Capillary zone thickness	5.0E+0		(ft)

Net Rainfall Infiltration

Net infiltration estimate		(mm/yr)
or NA	or	
Average annual precipitation		(mm/yr)

Partitioning Parameters

Fraction organic carbon	0.02	(-)
Soil/water pH	6.8	(-)

3. Commands and Options

Main Screen

Set Units

Use Default Values

Print Sheet

Help

Site-Specific Groundwater Parameters

Site Name: Oak Walk - Type 3A (Remediated Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

1. Water-Bearing Unit ?

Hydrogeology

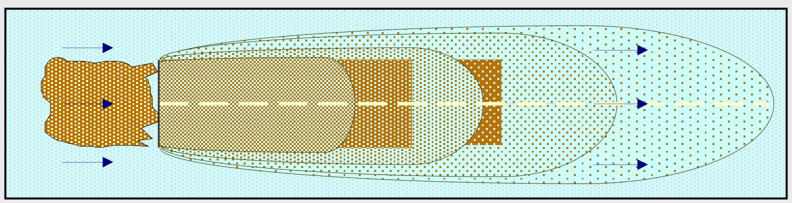
Groundwater Darcy velocity	0.0E+0	*(cm/s)*
Groundwater seepage velocity	#DIV/0!	*(cm/s)*
or Enter Directly	*or*	
Hydraulic conductivity	0.0E+0	*(cm/s)*
Hydraulic gradient	0.0E+0	*(-)*
Effective porosity	0.00	*(-)*

Sorption

Fraction organic carbon--saturated zone	0	*(-)*
Groundwater pH	0.00	*(-)*

2. Groundwater Source Zone ?

Groundwater plume width at source	240	*(ft)*
Plume (mixing zone) thickness at source	0	*(ft)*
or Calculate	*or*	
Saturated thickness	0	*(ft)*
Length of source zone		*(ft)*



3. Groundwater Dispersion ?

Model:

	GW Ingestion Off-site 1	GW Ingestion Off-site 2	Soil Leaching to GW Off-site 1	Soil Leaching to GW Off-site 2	
Distance to GW receptors	0	0	0	0	*(ft)*
or Enter Directly	*or*		*or*		
Longitudinal dispersivity	0	0	0	0	*(ft)*
Transverse dispersivity	0	0	0	0	*(ft)*
Vertical dispersivity	0	0	0	0	*(ft)*

4. Groundwater Discharge to Surface Water ?

	Off-site 2	
Distance to GW/SW disharge point	NA	*(ft)*
Plume width at GW/SW discharge	0	*(ft)*
Plume thickness at GW/SW discharge	0	*(ft)*
Surface water flowrate at GW/SW discharge	0.0E+0	*(ft^3/s)*

5. Commands and Options

Main Screen | Use Default Values | **Print Sheet**

Set Units | ***Help***

Site-Specific Air Parameters

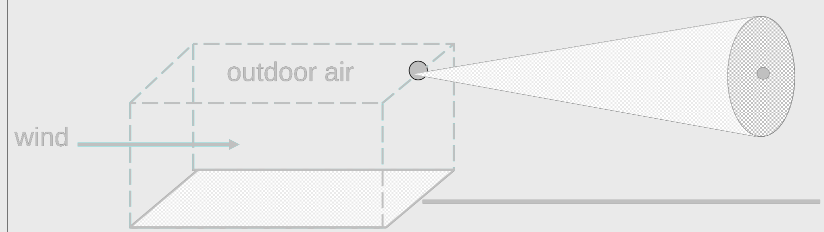
Site Name: Oak Walk - Type 3A (Remediated Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

1. Outdoor Air Pathway

?

Dispersion in Air

	Off-site 1	Off-site 2	
Distance to offsite air receptor			(ft)
or NA	↓	or ↓	
Horizontal dispersivity			(ft)
Vertical dispersivity			(ft)

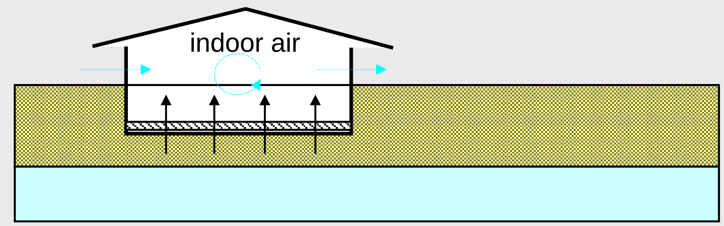


Air Source Zone

Air mixing zone height	6.56	(ft)
Ambient air velocity in mixing zone	10.56	(ft/s)
Areal particulate emission flux	6.9E-14	(g/cm^2/s)

2. Indoor Air Pathway

?



Building Parameters

	Residential	Commercial	
Building volume/area ratio	11	11	(ft)
Foundation area	722	722	(ft^2)
Foundation perimeter	118.3	118.3	(ft)
Building air exchange rate	5.7E-4	5.7E-4	(1/s)
Depth to bottom of foundation slab	0.5	0.5	(ft)
Convective air flow through cracks	6.1E-8	6.1E-8	(ft^3/s)

Foundation thickness	0.5	(ft)
Foundation crack fraction	0.001	(-)
Volumetric water content of cracks	0.12	(-)
Volumetric air content of cracks	0.26	(-)
Indoor/Outdoor differential pressure	0.01	(psi)

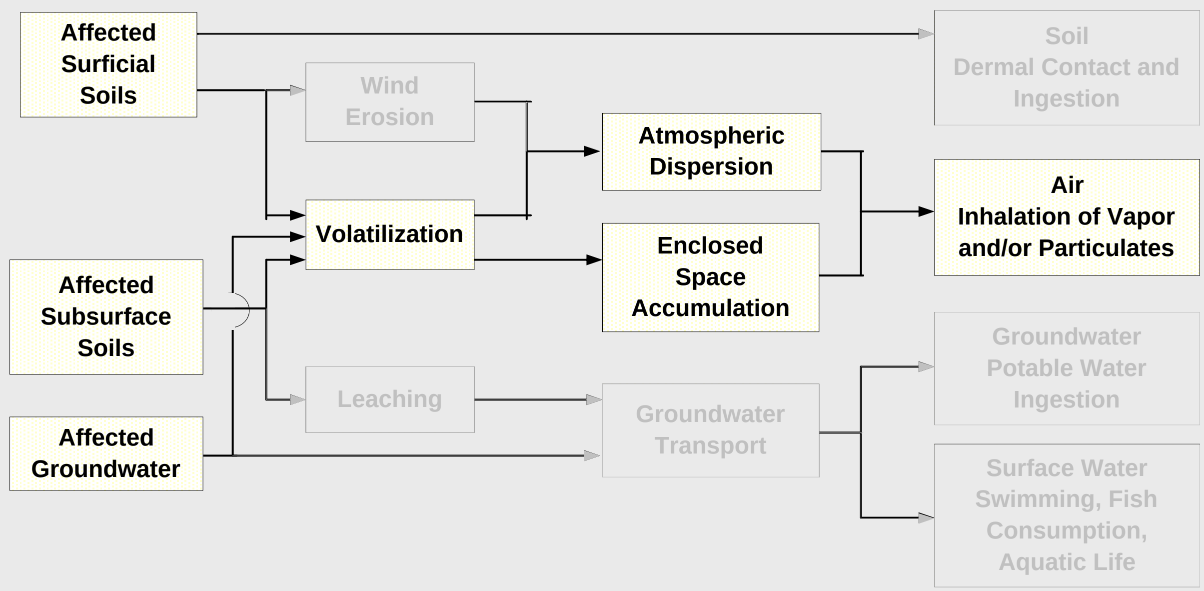
3. Commands and Options

Main Screen | Use Default Values | Print Sheet
Set Units | Help

Exposure Pathway Flowchart

Site Name: Oak Walk - Type 3A (Remediated Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 8-Jul-06
Compl. By: Dai Watkins

Source Media *Transport Mechanisms* *Exposure Media*



Receptors

On-site	Off-site1	Off-site2
None	NA	NA
Outdoor Air:		
Res./Constr.	***None***	***None***
Indoor Air:		
Residential	***NA***	***NA***
None	None	None
NA	NA	NA

SOURCE ***TRANSPORT*** ***RECEPTOR***

Commands and Options

Main Screen **Print Sheet** ***Help***

RBCA SITE ASSESSMENT | **Baseline Risk Summary-All Pathways**

Site Name: Oak Walk - Type 3A (Remediated Site) | Completed By: Dai Watkins
Site Location: Emeryville | Date Completed: 8-Jul-06

TIER 2 BASELINE RISK SUMMARY TABLE

	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk	Hazard Quotient		Hazard Index		Toxicity
EXPOSURE PATHWAY	Maximum Value	Target Risk	Total Value	Target Risk	Limit(s) Exceeded?	Maximum Value	Applicable Limit	Total Value	Applicable Limit	Limit(s) Exceeded?
OUTDOOR AIR EXPOSURE PATHWAYS										
Complete:	5.9E-8	1.0E-6	5.9E-8	1.0E-6	☐	2.1E-2	2.0E-1	2.8E-2	2.0E-1	☐
INDOOR AIR EXPOSURE PATHWAYS										
Complete:	2.3E-6	1.0E-6	2.3E-6	1.0E-6	■	1.1E-1	2.0E-1	1.3E-1	2.0E-1	☐
SOIL EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
SURFACE WATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐

CRITICAL EXPOSURE PATHWAY (Maximum Values From Complete Pathways)										
	2.3E-6	***1.0E-6***	***2.3E-6***	***1.0E-6***	■	***1.1E-1***	***2.0E-1***	***1.3E-1***	***2.0E-1***	☐
	Indoor Air		***Indoor Air***			***Indoor Air***		***Indoor Air***		

APPENDIX II-F

Health Risk Assessment for Building Type 1 (Unimproved Site)

Main Screen

RBCA Tool Kit for Chemical Releases
Version 1.3b © 2000

1. Project Information

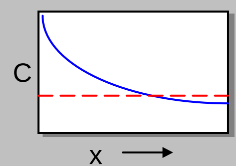
Site Name: Oak Walk - Bld. Type 1 (Unimproved Site)
Location: Emeryville
Compl. By: Dai Watkins
Date: 9-Jul-06 Job ID: Project No. 0004.085

2. Which Type of RBCA Analysis? ?

Tier 1

Generic Values
On-Site
Exposure

Tier 2



Site-Specific Values
On- or Off-Site Exposure

3. Calculation Options ?

Affects which input data are required

- [x] ***Baseline Risks (Forward mode)***
- [ ] ***RBCA Cleanup Standards (Backward mode)***

4. RBCA Evaluation Process

Prepare Input Data

Data Complete? (■= yes, ■= no)

- **Exposure Pathways**
- **Constituents of Concern (COCs)**
- **Transport Models**
- **Soil Parameters**
- **GW Parameters**
- **Air Parameters**

Review Output

- **Exposure Flowchart**
- **COC Chem. Parameters**
- **Input Data Summary**
- **User-Spec. COC Data...**
- **Transient Domenico Analysis...**
- **Baseline Risks...**
- **Cleanup Standards...**

5. Commands and Options

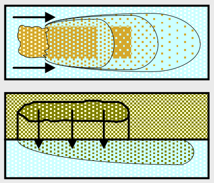
New Site	**Load Data...**	**Save Data As...**	**Quit**
Print Sheet	**Set Units**	Custom Chem. Data...	***Help***

Exposure Pathway Identification

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site)
Location: Emeryville
Compl. By: Dai Watkins
Job ID: Project No. 0004.085 Date: 9-Jul-06

1. Groundwater Exposure

?



Groundwater Ingestion/ Surface Water Impact

Receptor: None

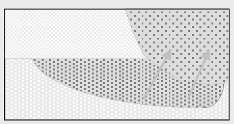
Type: On-site | Off-site1 | Off-site2

Source Media:

Distance to GW receptors

		On-site	Off-site1	Off-site2	
☐	Affected Groundwater	0			(ft)
☐	Affected Soils Leaching to Groundwater	0			(ft)

GW Discharge to Surface Water Exposure



☐ Swimming

☐ Fish Consumption

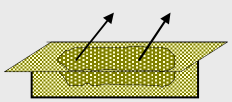
☐ Aquatic Life Protection

Enter ALP Criteria

2. Surface Soil Exposure

Direct Ingestion and Dermal Contact

?



Receptor: None

Type: On-site

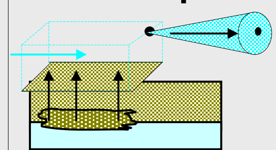
No off-site receptors

Construction Worker ☐

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation

?



Receptor: Res.

Type: On-site | Off-site1 | Off-site2

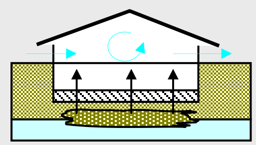
0 (ft)

Construction worker ☑

☑ Affected Soils--Volatilization to Ambient Outdoor Air

☑ Affected Groundwater--Volatilization to Ambient Outdoor Air

☐ Affected Surface Soils--Particulates to Ambient Outdoor Air



Volatilization to Indoor Air Inhalation

Receptor: Com.

Type: On-site

No off-site receptors

☑ Affected Soils--Volatilization to Enclosed Space

☑ Affected Groundwater--Volatilization to Enclosed Space

4. Commands and Options

Main Screen | Print Sheet | Set Units | *Help*

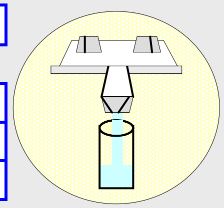
Exposure Factors & Target Risks | Exposure Flowchart

Exposure Factors and Target Risk Limits

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site)	
Location: Emeryville	
Compl. By: Dai Watkins	
Job ID: Project No. 0004.085	Date: 9-Jul-06

1. Exposure Parameters

	Age Adjustment?	Residential Adult	Residential (Age 0-6)	Residential (Age 0-16)	Commercial Chronic	Commercial Construc.
Averaging time, carcinogens (yr)		70				
Averaging time, non-carcinogens (yr)		30			25	1
Body weight (kg)		70	15	35	70	
Exposure duration (yr)		30	6	16	25	1
Exposure frequency (days/yr)		350			250	180
Dermal exposure frequency (days/yr)		350			250	
Skin surface area, soil contact (cm^2)	☐	5800		2023	5800	5800
Soil dermal adherence factor ($mg/cm^2/day$)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☐	100	200		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☐	0.05	0.5			
Skin surface area, swimming (cm^2)	☐	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				



2. Risk Goal Calculation Options

- ○ Individual Constitiuent Risk Goals Only
- ◉ Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcins.)	1.0E-6	1.0E-6
Target Risk (Class C carcinogens)	1.0E-6	
Target Hazard Quotient	2.0E-1	
Target Hazard Index		2.0E-1

4. Commands and Options

Return to Exposure Pathways

Use Default Values

Print Sheet

Help

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 9-Jul-06
Compl. By: Dai Watkins

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

☐ Apply Raoult's Law ?

Selected COCs

COC Select: Add/Insert | Delete

Sort List: ? Top | Bottom | MoveUp | MoveDown

Representative COC Concentration ?

Groundwater Source Zone: Calculate | Enter Site Data

Soil Source Zone: Calculate | Enter Site Data

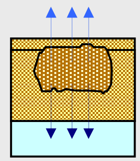
Mole Fraction in Source Material

Selected COCs	Groundwater Source Zone (mg/L)	note	Soil Source Zone (mg/kg)	note	Mole Fraction in Source Material (-)
Benzene	9.0E-2		1.1E+0		
Toluene	6.6E-4		9.0E+0		
Ethylbenzene	4.8E-2		1.3E+1		
Xylene (mixed isomers)	5.6E-2		7.5E+1		
Methyl t-Butyl ether	1.7E-1		5.0E-3		
Naphthalene	8.3E-3		4.2E+0		
Acetone	0.0E+0		6.5E-2		
Cumene	7.3E-2		3.9E+1		

Transport Modeling Options

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 9-Jul-06
Compl. By: Dai Watkins

1. Vertical Transport, Surface Soil Column



Outdoor Air Volatilization Factors ?

- ○ Surface soil volatilization model only
- ◉ Combination surface soil/Johnson & Ettinger models
  - Thickness of surface soil zone 7.64 *(ft)*
- ○ User-specified VF from other model [Enter VF Values]

Indoor Air Volatilization Factors ?

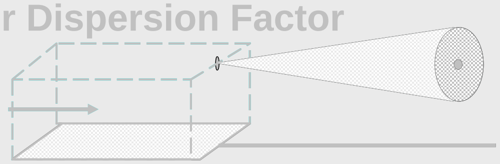
- ◉ Johnson & Ettinger model
- ○ User-specified VF from other model [Enter VF Values]

Soil-to-Groundwater Leaching Factor ?

- ○ ASTM Model
  - ☐ Apply Soil Attenuation Model (SAM)
  - ☐ Allow first-order biodecay [Enter Decay Rates]
- ○ User-specified LF from other model [Enter LF Values]

2. Lateral Air Dispersion Factor

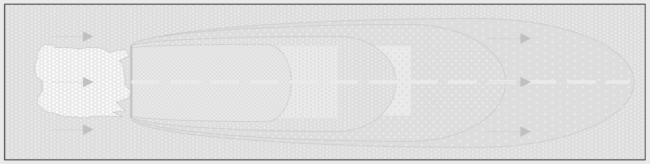
wind



?

	Off-site 1	Off-site 2	
○ 3-D Gaussian dispersion model			
○ User-Specified ADF	1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor



Calculate DAF using Domenico Model ?

- ○ Domenico equation with dispersion only (no biodegradation)
- ○ Domenico equation first-order decay [Enter Decay Rates]
- ○ Modified Domenico equation using electron acceptor superposition [Enter Site Data]
  - [Enter Directly] Biodegradation Capacity NC *(mg/L)*

— or —

User-Specified DAF Values

- ○ DAF values from other model or site data [Enter DAF Values]

4. Commands and Options

Main Screen | **Print Sheet** | ***Help***

Site-Specific Soil Parameters

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 9-Jul-06
Compl. By: Dai Watkins

1. Soil Source Zone Characteristics

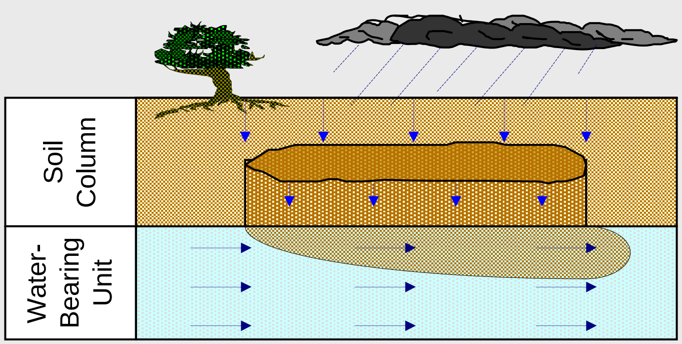
?

Hydrogeology

	General Case	Construction	
Depth to water-bearing unit	7.64		(ft)
Capillary zone thickness	0.16		(ft)
Soil column thickness	7.48		(ft)

Affected Soil Zone

	General Case	Construction	
Depth to top of affected soils	3.21		(ft)
Depth to base of affected soils	7.64		(ft)
Affected soil area	16200	16200	(ft^2)
Length of affected soil parallel to assumed wind direction	270	270	(ft)
Length of affected soil parallel to assumed GW flow direction			(ft)



2. Surface Soil Column

?

		Vadose Zone	Capillary Fringe	
Predominant USCS Soil Type				
or	Calculate	or		
Total porosity		0.35		(-)
Volumetric water content		0.12	0.325	(-)
Volumetric air content		0.23	0.025	(-)
Dry bulk density		1.7		(kg/L)
Vertical hydraulic conductivity		1.0E-2		(cm/s)
Vapor permeability		1.1E-11		(ft^2)
Capillary zone thickness		1.6E-1		(ft)

Net Rainfall Infiltration

Net infiltration estimate			(mm/yr)
or	NA	or	
Average annual precipitation			(mm/yr)

Partitioning Parameters

Fraction organic carbon	0.01	(-)
Soil/water pH	6.8	(-)

3. Commands and Options

Main Screen

Set Units

Use Default Values

Print Sheet

Help

Site-Specific Groundwater Parameters

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 9-Jul-06
Compl. By: Dai Watkins

1. Water-Bearing Unit

?

Hydrogeology

Groundwater Darcy velocity		(cm/s)
Groundwater seepage velocity		(cm/s)
or NA		or
Hydraulic conductivity		(cm/s)
Hydraulic gradient		(-)
Effective porosity		(-)

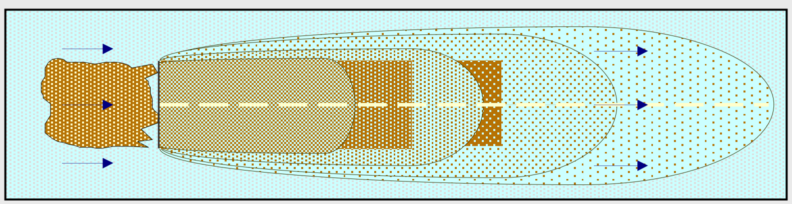
Sorption

Fraction organic carbon--saturated zone		(-)
Groundwater pH		(-)

2. Groundwater Source Zone

?

Groundwater plume width at source	240	(ft)
Plume (mixing zone) thickness at source		(ft)
or NA		or
Saturated thickness		(ft)
Length of source zone		(ft)



3. Groundwater Dispersion

?

Model:

	GW Ingestion Off-site 1	GW Ingestion Off-site 2	Soil Leaching to GW Off-site 1	Soil Leaching to GW Off-site 2	
Distance to GW receptors	0	0	0	0	(ft)
or NA		or		or	
Longitudinal dispersivity					(ft)
Transverse dispersivity					(ft)
Vertical dispersivity					(ft)

4. Groundwater Discharge to Surface Water

?

	Off-site 2	
Distance to GW/SW disharge point	NA	(ft)
Plume width at GW/SW discharge	0	(ft)
Plume thickness at GW/SW discharge	0	(ft)
Surface water flowrate at GW/SW discharge	0.0E+0	(ft^3/s)

5. Commands and Options

Main Screen

Set Units

Use Default Values

Print Sheet

Help

Site-Specific Air Parameters

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site) Project No. 0004.085
Location: Emeryville Date: 9-Jul-06
Compl. By: Dai Watkins

1. Outdoor Air Pathway

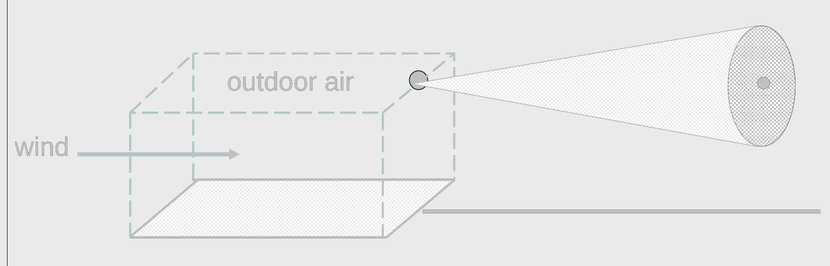
?

Dispersion in Air

	Off-site 1	Off-site 2	
Distance to offsite air receptor			(ft)
or NA	↓	or ↓	
Horizontal dispersivity			(ft)
Vertical dispersivity			(ft)

Air Source Zone

Air mixing zone height	6.56	(ft)
Ambient air velocity in mixing zone	10.56	(ft/s)
Areal particulate emission flux	6.9E-14	(g/cm^2/s)



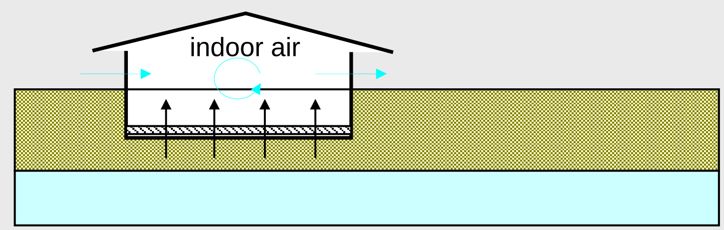
2. Indoor Air Pathway

?

Building Parameters

	Residential	Commercial	
Building volume/area ratio	18	18	(ft)
Foundation area	4260	4260	(ft^2)
Foundation perimeter	331	331	(ft)
Building air exchange rate	5.7E-4	1.4E-3	(1/s)
Depth to bottom of foundation slab	0.5	0.5	(ft)
Convective air flow through cracks	2.0E-2	2.0E-2	(ft^3/s)

Foundation thickness	0.5	(ft)
Foundation crack fraction	0.001	(-)
Volumetric water content of cracks	0.12	(-)
Volumetric air content of cracks	0.26	(-)
Indoor/Outdoor differential pressure	0.01	(psi)



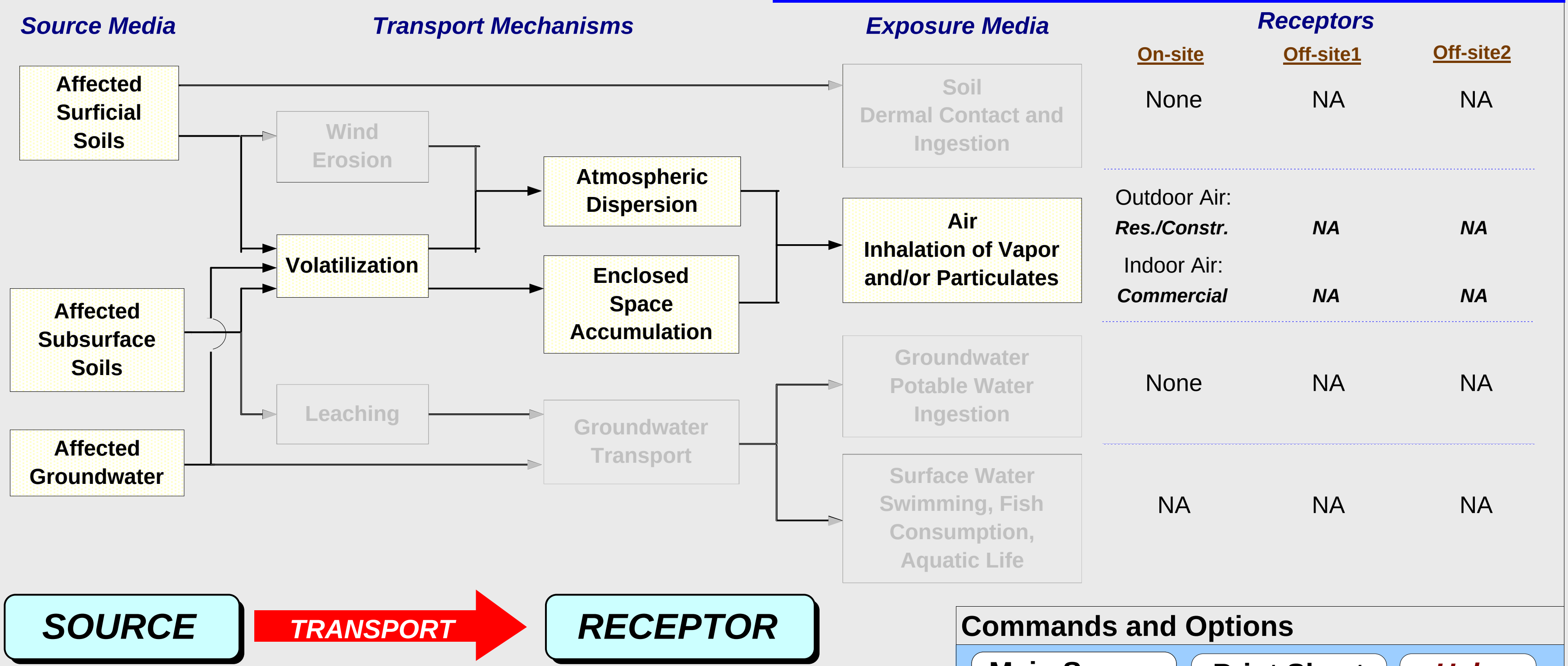
3. Commands and Options

Main Screen | Use Default Values | Print Sheet

Set Units | Help

Exposure Pathway Flowchart

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 9-Jul-06
Compl. By: Dai Watkins



Commands and Options

Main Screen | Print Sheet | Help

CHEMICAL DATA FOR SELECTED COCs

Physical Property Data

Constituent	CAS Number	type	Molecular Weight (g/mole) MW	ref	Diffusion Coefficients in air (cm2/s) Dair	ref	Diffusion Coefficients in water (cm2/s) Dwat	ref	log (Koc) or log(Kd) (@ 20 - 25 C) log(L/kg)	partition	ref	Henry's Law Constant (@ 20 - 25 C) (atm-m3) mol	Henry's Law Constant (unitless)	ref	Vapor Pressure (@ 20 - 25 C) (mm Hg)	ref	Solubility (@ 20 - 25 C) (mg/L)	ref	acid pKa	base pKb	ref
Benzene	71-43-2	A	78.1	PS	8.80E-02	PS	9.80E-06	PS	1.77	Koc	PS	5.55E-03	2.29E-01	PS	9.52E+01	PS	1.75E+03	PS	-	-	-
Toluene	108-88-3	A	92.4	5	8.50E-02	A	9.40E-06	A	2.13	Koc	A	6.30E-03	2.60E-01	A	3.00E+01	4	5.15E+02	29	-	-	-
Ethylbenzene	100-41-4	A	106.2	PS	7.50E-02	PS	7.80E-06	PS	2.56	Koc	PS	7.88E-03	3.25E-01	PS	1.00E+01	PS	1.69E+02	PS	-	-	-
Xylene (mixed isomers)	1330-20-7	A	106.2	5	7.20E-02	A	8.50E-06	A	2.38	Koc	A	7.03E-03	2.90E-01	A	7.00E+00	4	1.98E+02	5	-	-	-
Methyl t-Butyl ether	1634-04-4	O	88.146	5	7.92E-02	6	9.41E-05	7	1.08	Koc	A	5.77E-04	2.38E-02	-	2.49E+02	-	4.80E+04	A	-	-	-
Naphthalene	91-20-3	PAH	128.2	PS	5.90E-02	PS	7.50E-06	PS	3.30	Koc	PS	4.83E-04	1.99E-02	PS	2.30E-01	PS	3.10E+01	PS	-	-	-
Acetone	67-64-1	O	58.08	4	1.24E-01	4	1.14E-05	4	-0.24	Koc	4	2.50E-05	1.03E-03	4	2.66E+02	4	1.00E+06	10	-	-	-
Cumene	98-82-8	A	120.2	4	6.50E-02	4	7.10E-06	4	0.00	Koc	4	1.46E-02	6.02E-01	4	4.60E+00	4	4.98E+01	4	-	-	-

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site)
Site Location: Emeryville

Completed By: Dai Watkins
Date Completed: 9-Jul-06

Job ID: Project No. 0004.085

CHEMICAL DATA FOR SELECTED COCs

Toxicity Data

Constituent	Reference Dose (mg/kg/day) Oral RfD_oral	ref	(mg/kg/day) Dermal RfD_dermal	ref	Reference Conc. (mg/m3) Inhalation RfC_inhal	ref	Slope Factors 1/(mg/kg/day) Oral SF_oral	ref	1/(mg/kg/day) Dermal SF_dermal	ref	Unit Risk Factor 1/(µg/m3) Inhalation URF_inhal	ref	EPA Weight of Evidence	Is Constituent Carcinogenic ?
Benzene	3.00E-03	R	-	-	5.95E-03	R	2.90E-02	PS	2.99E-02	TX	8.29E-06	PS	A	TRUE
Toluene	2.00E-01	A,R	1.60E-01	TX	4.00E-01	A,R	-	-	-	-	-	-	D	FALSE
Ethylbenzene	1.00E-01	PS	9.70E-02	TX	1.00E+00	PS	-	-	-	-	-	-	D	FALSE
Xylene (mixed isomers)	2.00E+00	A,R	1.84E+00	TX	7.00E+00	A	-	-	-	-	-	-	D	FALSE
Methyl t-Butyl ether	1.00E-02	31	8.00E-03	TX	3.00E+00	R	-	-	-	-	-	-	-	FALSE
Naphthalene	4.00E-01	PS	3.56E-01	TX	1.40E+00	PS	-	-	-	-	-	-	D	FALSE
Acetone	1.00E-01	PS	8.30E-02	TX	-	-	-	-	-	-	-	-	D	FALSE
Cumene	1.00E-01	R	8.00E-02	TX	4.00E-01	R	-	-	-	-	-	-	D	FALSE

Site Name: Oak Walk - Bld. Typ

Site Location: Emeryville

Miscellaneous Chemical Data

Constituent	Maximum Contaminant Level MCL (mg/L)	ref	Time-Weighted Average Workplace Criteria TWA (mg/m3)	ref	Aquatic Life Prot. Criteria AQL (mg/L)	ref	Biocon-centration Factor (L-wat/kg-fish)
Benzene	5.00E-03	52 FR 25690	3.25E+00	PS	-	-	12.6
Toluene	1.00E+00	56 FR 3526 (30 Jan 91)	1.47E+02	ACGIH	-	-	70
Ethylbenzene	7.00E-01	56 FR 3526 (30 Jan 91)	4.35E+02	PS	-	-	1
Xylene (mixed isomers)	1.00E+01	56 FR 3526 (30 Jan 91)	4.34E+02	ACGIH	-	-	1
Methyl t-Butyl ether	-	-	6.00E+01	NIOSH	-	-	1
Naphthalene	-	-	5.00E+01	PS	-	-	430
Acetone	-	-	5.90E+02	NIOSH	-	-	1
Cumene	-	-	2.45E+02	OSHA	-	-	1

Site Name: Oak Walk - Bld. Typ
Site Location: Emeryville

CHEMICAL DATA FOR SELECTED COCs

Miscellaneous Chemical Data

Constituent	Dermal Relative Absorp. Factor (unitless)	Water Dermal Permeability Data: Dermal Permeability Coeff. (cm/hr)	Lag time for Dermal Exposure (hr)	Critical Exposure Time (hr)	Relative Contr of Derm Perm Coeff (unitless)	Water/Skin Derm Adsorp Factor (cm/event)	ref	Detection Limits: Groundwater (mg/L)	ref	Soil (mg/kg)	ref	Half Life (First-Order Decay) (days): Saturated	Unsaturated	ref
Benzene	0.5	0.021	0.26	0.63	0.013	7.3E-2	D	0.002	S	0.005	S	720	720	H
Toluene	0.5	0.045	0.32	0.77	0.054	1.6E-1	D	0.002	S	0.005	S	28	28	H
Ethylbenzene	0.5	0.074	0.39	1.3	0.14	2.7E-1	D	0.002	S	0.005	S	228	228	H
Xylene (mixed isomers)	0.5	0.08	0.39	1.4	0.16	2.9E-1	D	0.005	S	0.005	S	360	360	H
Methyl t-Butyl ether	0.5	-	-	-	-	-	-	-	-	-	-	360	180	H
Naphthalene	0.05	0.069	0.53	2.2	0.2	2.7E-1	D	0.01	32	0.01	32	258	258	H
Acetone	0.5	-	-	-	-	-	-	0.1	S	0.1	S	14	14	H
Cumene	0.5	-	-	-	-	-	-	-	-	-	-	16	16	H

Site Name: Oak Walk - Bld. Typ

Site Location: Emeryville

RBCA SITE ASSESSMENT

Input Parameter Summary

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site)
Site Location: Emeryville
Completed By: Dai Watkins
Date Completed: 9-Jul-06
Job ID: Project No. 0004.085

Exposure Parameters		Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Construc.
AT_c	Averaging time for carcinogens (yr)	70				
AT_n	Averaging time for non-carcinogens (yr)	30			25	1
BW	Body weight (kg)	70	15	35	70	
ED	Exposure duration (yr)	30	6	16	25	1
τ	Averaging time for vapor flux (yr)	30			25	1
EF	Exposure frequency (days/yr)	350			250	180
EF_D	Exposure frequency for dermal exposure	350			250	
IR_w	Ingestion rate of water (L/day)	2			1	
IR_s	Ingestion rate of soil (mg/day)	100	200		50	100
SA	Skin surface area (dermal) (cm^2)	5800		2023	5800	5800
M	Soil to skin adherence factor	1				
ET_{swim}	Swimming exposure time (hr/event)	3				
EV_{swim}	Swimming event frequency (events/yr)	12	12	12		
IR_{swim}	Water ingestion while swimming (L/hr)	0.05	0.5			
SA_{swim}	Skin surface area for swimming (cm^2)	23000		8100		
IR_{fish}	Ingestion rate of fish (kg/yr)	0.025				
FI_{fish}	Contaminated fish fraction (unitless)	1				

Complete Exposure Pathways and Receptors	On-site	Off-site 1	Off-site 2
Groundwater:			
Groundwater Ingestion	None	NA	NA
Soil Leaching to Groundwater Ingestion	None	NA	NA
Applicable Surface Water Exposure Routes:			
Swimming			NA
Fish Consumption			NA
Aquatic Life Protection			NA
Soil:			
Direct Ingestion and Dermal Contact	None		
Outdoor Air:			
Particulates from Surface Soils	None	NA	NA
Volatilization from Soils	Res./Constr.	NA	NA
Volatilization from Groundwater	Residential	NA	NA
Indoor Air:			
Volatilization from Subsurface Soils	Commercial	NA	NA
Volatilization from Groundwater	Commercial	NA	NA

Receptor Distance from Source Media	On-site	Off-site 1	Off-site 2	(Units)
Groundwater receptor	NA	NA	NA	(ft)
Soil leaching to groundwater receptor	NA	NA	NA	(ft)
Outdoor air inhalation receptor	0	NA	NA	(ft)

Target Health Risk Values		Individual	Cumulative
TR_{ab}	Target Risk (class A&B carcinogens)	1.0E-6	1.0E-6
TR_c	Target Risk (class C carcinogens)	1.0E-6	
THQ	Target Hazard Quotient (non-carcinogenic risk)	2.0E-1	2.0E-1

Modeling Options	
RBCA tier	Tier 1
Outdoor air volatilization model	Surface & subsurface models
Indoor air volatilization model	Johnson & Ettinger model
Soil leaching model	NA
Use soil attenuation model (SAM) for leachate?	NA
Air dilution factor	NA
Groundwater dilution-attenuation factor	NA

NOTE: NA = Not applicable

Surface Parameters		General	Construction	(Units)
A	Source zone area	1.6E+4	1.6E+4	(ft^2)
W	Length of source-zone area parallel to wind	2.7E+2	2.7E+2	(ft)
W_{gw}	Length of source-zone area parallel to GW flow	NA		(ft)
U_{air}	Ambient air velocity in mixing zone	1.1E+1		(ft/s)
δ_{air}	Air mixing zone height	6.6E+0		(ft)
P_a	Areal particulate emission rate	NA		(g/cm^2/s)
L_{ss}	Thickness of affected surface soils	7.6E+0		(ft)

Surface Soil Column Parameters		Value			(Units)
h_{cap}	Capillary zone thickness	1.6E-1			(ft)
h_v	Vadose zone thickness	7.5E+0			(ft)
ρ_s	Soil bulk density	1.7E+0			(g/cm^3)
f_{oc}	Fraction organic carbon	1.0E-2			(-)
θ_T	Soil total porosity	3.5E-1			(-)
K_{vs}	Vertical hydraulic conductivity	1.0E-2			(cm/s)
k_v	Vapor permeability	1.1E-11			(ft^2)
L_{gw}	Depth to groundwater	7.6E+0			(ft)
L_s	Depth to top of affected soils	3.2E+0			(ft)
L_{base}	Depth to base of affected soils	7.6E+0			(ft)
L_{subs}	Thickness of affected soils	4.4E+0			(ft)
pH	Soil/groundwater pH	6.8E+0			(-)
		capillary	vadose	foundation	
θ_w	Volumetric water content	0.325	0.12	0.12	(-)
θ_a	Volumetric air content	0.025	0.23	0.26	(-)

Building Parameters		Residential	Commercial	(Units)
L_b	Building volume/area ratio	NA	1.80E+1	(ft)
A_b	Foundation area	NA	4.26E+3	(ft^2)
X_{crk}	Foundation perimeter	NA	3.31E+2	(ft)
ER	Building air exchange rate	NA	1.40E-3	(1/s)
L_{crk}	Foundation thickness	NA	5.00E-1	(ft)
Z_{crk}	Depth to bottom of foundation slab	NA	5.00E-1	(ft)
η	Foundation crack fraction	NA	1.00E-3	(-)
dP	Indoor/outdoor differential pressure	NA	1.00E-2	(psi)
Q_s	Convective air flow through slab	NA	2.00E-2	(ft^3/s)

Groundwater Parameters		Value	(Units)
δ_{gw}	Groundwater mixing zone depth	NA	(ft)
I_f	Net groundwater infiltration rate	NA	(mm/yr)
U_{gw}	Groundwater Darcy velocity	NA	(cm/s)
V_{gw}	Groundwater seepage velocity	NA	(cm/s)
K_s	Saturated hydraulic conductivity	NA	(cm/s)
i	Groundwater gradient	NA	(-)
S_w	Width of groundwater source zone	NA	(ft)
S_d	Depth of groundwater source zone	NA	(ft)
θ_{eff}	Effective porosity in water-bearing unit	NA	(-)
$f_{oc\text{-}sat}$	Fraction organic carbon in water-bearing unit	NA	(-)
pH_{sat}	Groundwater pH	NA	(-)
	Biodegradation considered?	NA	

Transport Parameters		Off-site 1	Off-site 2	Off-site 1	Off-site 2	(Units)
Lateral Groundwater Transport		Groundwater Ingestion		Soil Leaching to GW		
α_x	Longitudinal dispersivity	NA	NA	NA	NA	(ft)
α_y	Transverse dispersivity	NA	NA	NA	NA	(ft)
α_z	Vertical dispersivity	NA	NA	NA	NA	(ft)
Lateral Outdoor Air Transport		Soil to Outdoor Air Inhal.		GW to Outdoor Air Inhal.		
σ_y	Transverse dispersion coefficient	NA	NA	NA	NA	(ft)
σ_z	Vertical dispersion coefficient	NA	NA	NA	NA	(ft)
ADF	Air dispersion factor	NA	NA	NA	NA	(-)

Surface Water Parameters		Off-site 2	(Units)
Q_{sw}	Surface water flowrate	NA	(ft^3/s)
W_{pl}	Width of GW plume at SW discharge	NA	(ft)
δ_{pl}	Thickness of GW plume at SW discharge	NA	(ft)
DF_{sw}	Groundwater-to-surface water dilution factor	NA	(-)

RBCA SITE ASSESSMENT | **Baseline Risk Summary-All Pathways**

Site Name: Oak Walk - Bld. Type 1 (Unimproved Site) Completed By: Dai Watkins
Site Location: Emeryville Date Completed: 9-Jul-06

TIER 1 BASELINE RISK SUMMARY TABLE

EXPOSURE PATHWAY	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk Limit(s) Exceeded?	Hazard Quotient		Hazard Index		Toxicity Limit(s) Exceeded?
	Maximum Value	Target Risk	Total Value	Target Risk		Maximum Value	Applicable Limit	Total Value	Applicable Limit	
OUTDOOR AIR EXPOSURE PATHWAYS										
Complete:	1.3E-7	1.0E-6	1.3E-7	1.0E-6	☐	8.5E-2	2.0E-1	1.5E-1	2.0E-1	☐
INDOOR AIR EXPOSURE PATHWAYS										
Complete:	9.6E-7	1.0E-6	9.6E-7	1.0E-6	☐	5.5E-2	2.0E-1	9.2E-2	2.0E-1	☐
SOIL EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
SURFACE WATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐

CRITICAL EXPOSURE PATHWAY (Maximum Values From Complete Pathways)										
	9.6E-7	***1.0E-6***	***9.6E-7***	***1.0E-6***	☐	***8.5E-2***	***2.0E-1***	***1.5E-1***	***2.0E-1***	☐
	Indoor Air		***Indoor Air***			***Outdoor Air***		***Outdoor Air***		

APPENDIX II-G

Health Risk Assessment for Building Type 1 (Remediated Site)

Main Screen

RBCA Tool Kit for Chemical Releases
Version 1.3b © 2000

1. Project Information

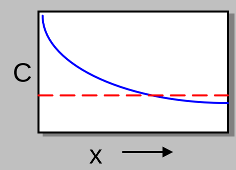
Site Name: Oak Walk - Bld. Type 1 (Remediated Site)
Location: Emeryville
Compl. By: Dai Watkins
Date: 9-Jul-06 Job ID: Project No. 0004.085

2. Which Type of RBCA Analysis? ?

Tier 1

Generic Values
On-Site
Exposure

Tier 2



Site-Specific Values
On- or Off-Site Exposure

3. Calculation Options ?

Affects which input data are required

☑ ***Baseline Risks (Forward mode)***
☐ ***RBCA Cleanup Standards (Backward mode)***

4. RBCA Evaluation Process

Prepare Input Data
Data Complete? (■= yes, ■= no)

- **Exposure Pathways**
- **Constituents of Concern (COCs)**
- **Transport Models**
- **Soil Parameters**
- **GW Parameters**
- **Air Parameters**

Review Output

- **Exposure Flowchart**
- **COC Chem. Parameters**
- **Input Data Summary**
- **User-Spec. COC Data...**
- **Transient Domenico Analysis...**
- **Baseline Risks...**
- **Cleanup Standards...**

5. Commands and Options

New Site	**Load Data...**	**Save Data As...**	**Quit**
Print Sheet	**Set Units**	Custom Chem. Data...	***Help***

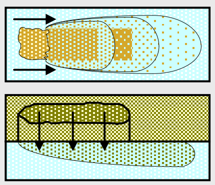
RBCA Tool Kit for Chemical Releases, Version 1.0

Exposure Pathway Identification

Site Name: Oak Walk - Bld. Type 1 (Remediated Site)
Location: Emeryville
Compl. By: Dai Watkins
Job ID: Project No. 0004.085 Date: 9-Jul-06

1. Groundwater Exposure

?



Groundwater Ingestion/ Surface Water Impact

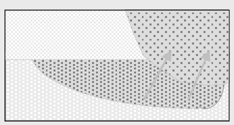
Receptor	None		
Type:	On-site	Off-site1	Off-site2

Source Media:

Distance to GW receptors

☐ Affected Groundwater	0			*(ft)*
	On-site	Off-site1	Off-site2	
☐ Affected Soils Leaching to Groundwater	0			*(ft)*

GW Discharge to Surface Water Exposure



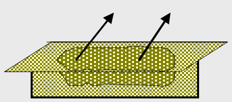
☐ Swimming
☐ Fish Consumption
☐ Aquatic Life Protection

Enter ALP Criteria

2. Surface Soil Exposure

Direct Ingestion and Dermal Contact

?



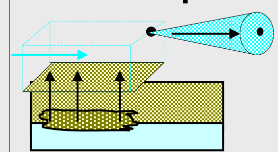
Receptor	None	No off-site receptors
Type:	On-site	

Construction Worker ☐

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation

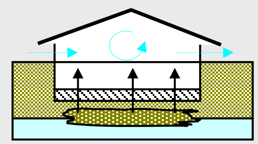
?



Receptor	Res.			
Type:	On-site	Off-site1	Off-site2	
	0			*(ft)*

Construction worker ☑

☑ Affected Soils--Volatilization to Ambient Outdoor Air
☑ Affected Groundwater--Volatilization to Ambient Outdoor Air
☐ Affected Surface Soils--Particulates to Ambient Outdoor Air



Volatilization to Indoor Air Inhalation

Receptor	Com.	No off-site receptors
Type:	On-site	

☑ Affected Soils--Volatilization to Enclosed Space
☑ Affected Groundwater--Volatilization to Enclosed Space

4. Commands and Options

Main Screen | Print Sheet | Set Units | ***Help***

Exposure Factors & Target Risks | Exposure Flowchart

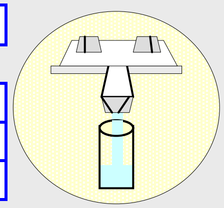
RBCA Tool Kit for Chemical Releases, Version 1.0

Exposure Factors and Target Risk Limits

Site Name: Oak Walk - Bld. Type 1 (Remediated Site)	
Location: Emeryville	
Compl. By: Dai Watkins	
Job ID: Project No. 0004.085	Date: 9-Jul-06

1. Exposure Parameters

	Age Adjustment?	Residential: Adult	Residential: (Age 0-6)	Residential: (Age 0-16)	Commercial: Chronic	Commercial: Construc.
Averaging time, carcinogens (yr)		70				
Averaging time, non-carcinogens (yr)		30			25	1
Body weight (kg)		70	15	35	70	
Exposure duration (yr)		30	6	16	25	1
Exposure frequency (days/yr)		350			250	180
Dermal exposure frequency (days/yr)		350			250	
Skin surface area, soil contact (cm^2)	☐	5800		2023	5800	5800
Soil dermal adherence factor ($mg/cm^2/day$)		1				
Water ingestion rate (L/day)		2			1	
Soil ingestion rate (mg/day)	☐	100	200		50	100
Swimming exposure time (hr/event)		3				
Swimming event frequency (events/yr)		12	12	12		
Swimming water ingestion rate (L/hr)	☐	0.05	0.5			
Skin surface area, swimming (cm^2)	☐	23000		8100		
Fish consumption rate (kg/day)		0.025				
Contaminated fish fraction (unitless)		1				



2. Risk Goal Calculation Options

- ○ Individual Constitiuent Risk Goals Only
- ◉ Individual and Cumulative Risk Goals

3. Target Health Risk Limits

	Individual	Cumulative
Target Risk (Class A/B carcins.)	1.0E-6	1.0E-6
Target Risk (Class C carcinogens)	1.0E-6	
Target Hazard Quotient	2.0E-1	
Target Hazard Index		2.0E-1

4. Commands and Options

Return to Exposure Pathways

Use Default Values

Print Sheet

Help

Site Name: Oak Walk - Bld. Type 1 (Remediated Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 9-Jul-06
Compl. By: Dai Watkins

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

Apply Raoult's Law ?

Selected COCs

COC Select: Add/Insert | Delete

Sort List: ? Top | Bottom | MoveUp | MoveDown

Representative COC Concentration ?

Selected COCs	Groundwater Source Zone (mg/L)	note	Soil Source Zone (mg/kg)	note	Mole Fraction in Source Material (-)
Benzene	9.0E-2		1.1E+0		
Toluene	6.6E-4		9.0E+0		
Ethylbenzene	4.8E-2		1.3E+1		
Xylene (mixed isomers)	5.6E-2		7.5E+1		
Methyl t-Butyl ether	1.7E-1		5.0E-3		
Naphthalene	8.3E-3		4.2E+0		
Acetone	0.0E+0		6.5E-2		
Cumene	7.3E-2		3.9E+1		

Groundwater Source Zone: Calculate | Enter Site Data

Soil Source Zone: Calculate | Enter Site Data

Site-Specific Soil Parameters

Site Name: Oak Walk - Bld. Type 1 (Remediated Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 9-Jul-06
Compl. By: Dai Watkins

1. Soil Source Zone Characteristics

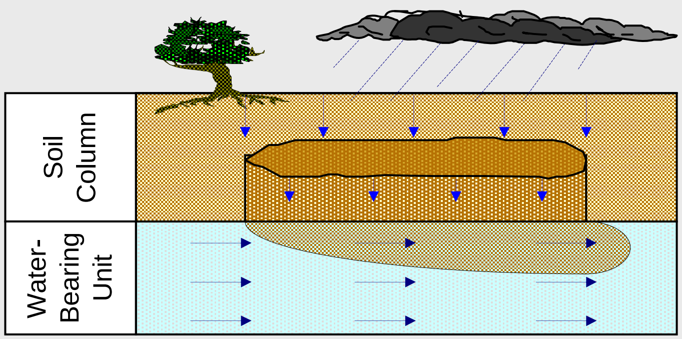
?

Hydrogeology

	General Case	Construction	
Depth to water-bearing unit	7.64		(ft)
Capillary zone thickness	5		(ft)
Soil column thickness	2.64		(ft)

Affected Soil Zone

Depth to top of affected soils	6.21		(ft)
Depth to base of affected soils	7.64		(ft)
Affected soil area	16200	16200	(ft^2)
Length of affected soil parallel to assumed wind direction	270	270	(ft)
Length of affected soil parallel to assumed GW flow direction	0		(ft)



2. Surface Soil Column

?

		Vadose Zone	Capillary Fringe	
Predominant USCS Soil Type				
or	Calculate	*or*		
Total porosity		0.5		(-)
Volumetric water content		0.2275	0.49	(-)
Volumetric air content		0.2725	0.01	(-)
Dry bulk density		1.61		(kg/L)
Vertical hydraulic conductivity		5.7E-7		(cm/s)
Vapor permeability		1.1E-16		(ft^2)
Capillary zone thickness		5.0E+0		(ft)

Net Rainfall Infiltration

Net infiltration estimate		30	(mm/yr)
or	Calculate	*or*	
Average annual precipitation		0	(mm/yr)

Partitioning Parameters

Fraction organic carbon	0.02	(-)
Soil/water pH	6.8	(-)

3. Commands and Options

Main Screen

Set Units

Use Default Values

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Site-Specific Air Parameters

Site Name: Oak Walk - Bld. Type 1 (Remediated Site)	Job ID: Project No. 0004.085
Location: Emeryville	Date: 9-Jul-06
Compl. By: Dai Watkins	

1. Outdoor Air Pathway

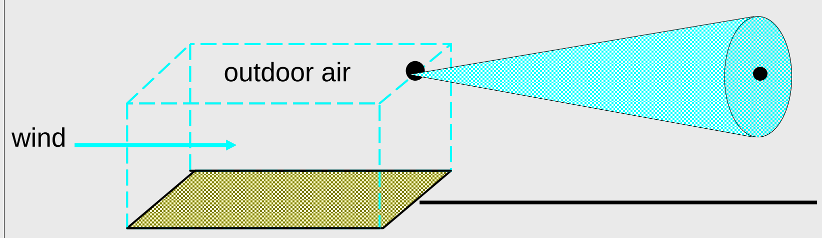
?

Dispersion in Air

	Off-site 1	Off-site 2	
Distance to offsite air receptor	0	0	(ft)
or Enter Directly	↓	*or* ↓	
Horizontal dispersivity	0.00	0.00	(ft)
Vertical dispersivity	0.00	0.00	(ft)

Air Source Zone

Air mixing zone height	6.56	(ft)
Ambient air velocity in mixing zone	10.56	(ft/s)
Areal particulate emission flux	6.9E-14	(g/cm^2/s)



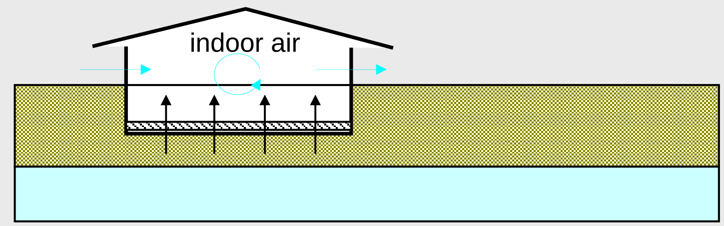
2. Indoor Air Pathway

?

Building Parameters

	Residential	Commercial	
Building volume/area ratio	18	18	(ft)
Foundation area	4260	4260	(ft^2)
Foundation perimeter	331	331	(ft)
Building air exchange rate	5.7E-4	1.4E-3	(1/s)
Depth to bottom of foundation slab	0.5	0.5	(ft)
Convective air flow through cracks	2.0E-7	2.0E-7	(ft^3/s)

Foundation thickness	0.5	(ft)
Foundation crack fraction	0.001	(-)
Volumetric water content of cracks	0.12	(-)
Volumetric air content of cracks	0.26	(-)
Indoor/Outdoor differential pressure	0.01	(psi)



3. Commands and Options

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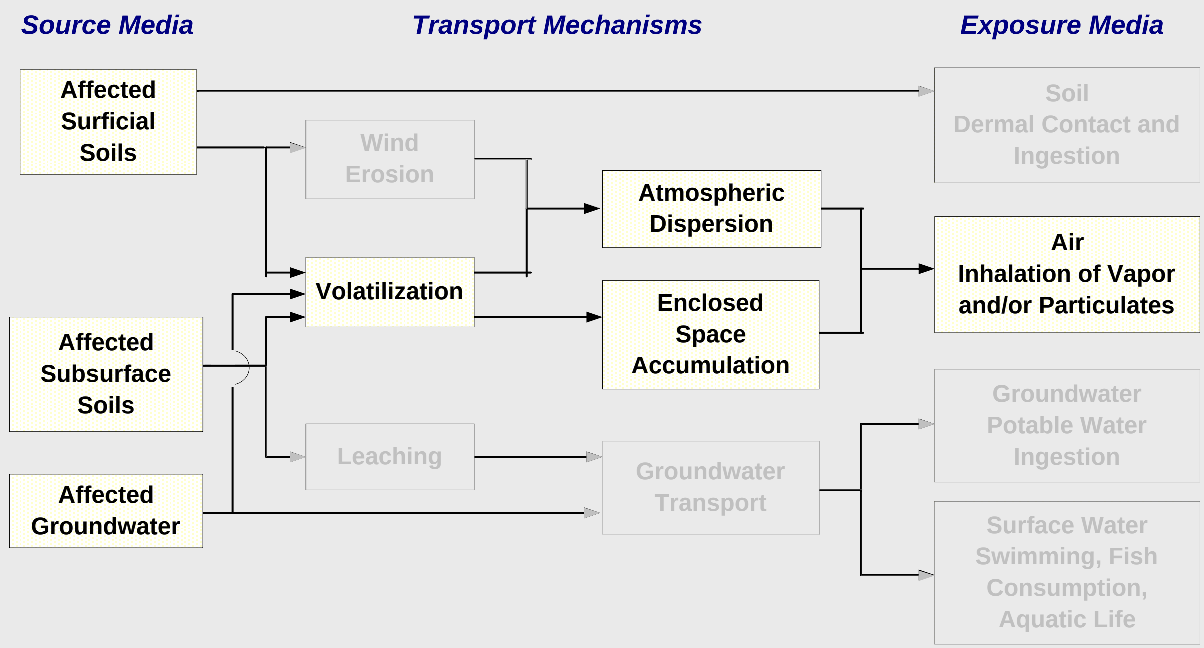
Exposure Pathway Flowchart

Site Name: Oak Walk - Bld. Type 1 (Remediated Site) Job ID: Project No. 0004.085
Location: Emeryville Date: 9-Jul-06
Compl. By: Dai Watkins



Receptors

Exposure Media	On-site	Off-site1	Off-site2
Soil Dermal Contact and Ingestion	None	NA	NA
Air — Outdoor Air: ***Res./Constr.***		***NA***	***NA***
Air — Indoor Air: ***Commercial***		***NA***	***NA***
Groundwater Potable Water Ingestion	None	NA	NA
Surface Water Swimming, Fish Consumption, Aquatic Life	NA	NA	NA

Commands and Options

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RBCA SITE ASSESSMENT	Baseline Risk Summary-All Pathways

Site Name: Oak Walk - Bld. Type 1 (Remediated Site) Completed By: Dai Watkins
Site Location: Emeryville Date Completed: 9-Jul-06

TIER 1 BASELINE RISK SUMMARY TABLE

	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk	Hazard Quotient		Hazard Index		Toxicity
EXPOSURE PATHWAY	**Maximum Value**	**Target Risk**	**Total Value**	**Target Risk**	**Limit(s) Exceeded?**	**Maximum Value**	**Applicable Limit**	**Total Value**	**Applicable Limit**	**Limit(s) Exceeded?**
OUTDOOR AIR EXPOSURE PATHWAYS										
Complete:	3.6E-8	1.0E-6	3.6E-8	1.0E-6	☐	2.6E-2	2.0E-1	4.6E-2	2.0E-1	☐
INDOOR AIR EXPOSURE PATHWAYS										
Complete:	2.2E-7	1.0E-6	2.2E-7	1.0E-6	☐	1.3E-2	2.0E-1	2.2E-2	2.0E-1	☐
SOIL EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
SURFACE WATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐

CRITICAL EXPOSURE PATHWAY (Maximum Values From Complete Pathways)										
	2.2E-7	***1.0E-6***	***2.2E-7***	***1.0E-6***	☐	***2.6E-2***	***2.0E-1***	***4.6E-2***	***2.0E-1***	☐
	Indoor Air		***Indoor Air***			***Outdoor Air***		***Outdoor Air***		