GEOMATRIX

PRELIMINARY REMEDIAL ALTERNATIVES REPORT
5051 Coliseum Way
Oakland, California

Prepared for

Pacific Gas & Electric Company
77 Beale Street
San Francisco, California

October 1996
Project No. 2906

Geomatrix Consultants

100 Pine Street, 10th Floor
San Francisco, CA 94111
(415) 434-9400 • FAX (415) 434-1365

GEOMATRIX

8 October 1996
Project 2906

Ms. Yvonne J. Meeks
Environmental Services
Pacific Gas and Electric Company
77 Beale Street, Room 2439C-B24A
San Francisco, California 94105

Subject: Preliminary Remedial Alternatives Report
5051 Coliseum Way
Oakland, California

Dear Ms. Meeks:

We are herewith providing you 13 copies of the Preliminary Remedial Alternatives Report for the subject site prepared by Geomatrix Consultants, Inc., on behalf of Pacific Gas and Electric Company (PG&E). This report summarizes the range of technically viable remediation options for soil and groundwater at 5051 Coliseum Way and for a portion of PG&E's adjacent Substation J in Oakland, California.

We appreciate the opportunity to provide you with our consulting services. Please contact the undersigned if you have any questions or require further information.

Sincerely,

GEOMATRIX CONSULTANTS, INC.

Sally E. Goodin

Sally E. Goodin, R.G.
Principal Geologist

SEG:mdg
K:\WPDOCS\2906\PRAR-LTR.DOC (WORD)

Enclosure

cc: Earl Hagström, Esq. (2 copies)

GEOMATRIX

PRELIMINARY REMEDIAL ALTERNATIVES REPORT
5051 Coliseum Way
Oakland, California

Prepared for

Pacific Gas & Electric Company
77 Beale Street
San Francisco, California

October 1996
Project No. 2906

Geomatrix Consultants

GEOMATRIX

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF FIGURES

GEOMATRIX

TABLE OF CONTENTS
(Continued)

LIST OF APPENDICES

PRELIMINARY REMEDIAL ALTERNATIVES REPORT
5051 Coliseum Way
Oakland, California

1.0 INTRODUCTION

This Preliminary Remedial Alternatives Report (PRAR) has been prepared for Pacific Gas and Electric Company (PG&E) by Geomatrix Consultants, Inc. (Geomatrix). The purpose of this report is to summarize the range of technically viable remediation options for soil and groundwater at 5051 Coliseum Way, Oakland, California (the site). Descriptions of nine possible alternatives are presented, and costs associated with the implementation of each option are summarized. The incremental costs for remediation of a portion of PG&E's adjacent Substation J are also summarized, should remediation of that property be required.

These remedial options and costs have been developed based on the results of investigations performed by Geomatrix at the 5051 Coliseum Way property (Geomatrix, 1996) and remedial investigations performed by Levine-Fricke Consultants (Levine-Fricke, 1994a and 1994b) at an adjacent property.

1.1 SITE SETTING

The 5051 Coliseum Way site is located in Oakland, California, adjacent to Interstate 880 and approximately 0.5 miles from San Leandro Bay (Figure 1). The surrounding area is industrial. The 5051 Coliseum Way site encompasses approximately 5 acres and is approximately 10 feet above sea level in elevation. Regional groundwater generally flows west towards San Francisco Bay.

The 5051 Coliseum Way site is divided by a cyclone fence; the area north of the fence is open and unpaved and previously was used by PG&E for temporary storage of various construction materials. Two electrical transmission towers are located on this portion of the property. The area south of the fence is paved and used for weekend parking. Along the western perimeter of area south of the fence is paved and used for weekend parking. Along the western perimeter of the 5051 Coliseum Way site there is a tidally influenced stormwater drainage channel. The drainage channel is underground, beneath and north of 50th Avenue. The channel is open and concrete lined along the northwestern perimeter of the site, and an open, unlined channel along the southwestern perimeter of the property prior to entering a culvert under Interstate 880 (Figure 2).

Northwest of the 5051 Coliseum Way site and across the drainage channel is PG&E's Substation J; southwest of the 5051 Coliseum Way site is Interstate 880. Southeast of the 5051 Coliseum Way site there is an additional parking area, a pump station and a small drainage ditch. Coliseum Way runs along the northeastern edge of the site. Northeast of Coliseum Way there are the buildings associated with a former Volvo-GM truck maintenance facility and a mini-storage facility. The former Volvo-GM truck maintenance facility property at 750 - 50th Avenue and 5050 Coliseum Way is the location of a former lithopone manufacturing facility. This property, referred to as the Volvo-GM site, is an environmental site under the jurisdiction of the Alameda County Health Care Services Agency (ACHCSA). Levine-Fricke has performed remedial investigations for the Volvo-GM site. Their work is documented in a Remedial Investigation Report and a Preliminary Remedial Alternatives Evaluation Report (Levine-Fricke, 1994a and b).

1.2 RESULTS OF THE SITE CHARACTERIZATION INVESTIGATION AT THE 5051 COLISEUM WAY PROPERTY

The site characterization performed by Geomatrix included a review of investigations at adjacent properties, a review of historical aerial photographs and documentation, and collection of soil and groundwater data from eight soil borings, seven soil and grab groundwater borings, and eight wells. The location of these borings and wells are presented on Figure 2. The investigations were performed between January and December 1995. Details of these investigations and the associated results are presented in the June 1996 Site Characterization Report (Geomatrix, 1996). The results of the site characterization are summarized below.

1.2.1 Historical Review

The historical review of aerial photographs and documentation, and the Levine-Fricke reports for the Volvo-GM site, indicate that a lithopone manufacturing facility operated at the Volvo-GM site adjacent to the 5051 Coliseum property from approximately 1926 until 1963. The Levine-Fricke (1994a) Remedial Investigation Report indicates that wastes from the facility were disposed of on properties to the south (5200 Coliseum Way) and east (5051 Coliseum Way). Based on testimony and aerial photographs, waste material (black ash sludge) from the baryte plant operation is known to have been disposed of on the 5200 Coliseum Way property. The aerial photographs indicate that material disposed of on the 5200 Coliseum Way property was transported onto the 5051 Coliseum Way property via overflow and/or stormwater runoff.

The aerial photographs also indicate pipe discharge from the vicinity of the zinc sulfate plant of the lithopone manufacturing facility to the northeastern corner of the 5051 Coliseum Way property. Testimony indicates that this discharge is a waste or by-product from the zinc sulfate process. This discharge area, based on the aerial photographs, appears to have extended under the current locations of the stormwater drainage channel and a portion of the transformer banks at PG&E's Substation J. At the time the lithopone manufacturing facility was operating, the stormwater drainage channel was not concrete lined and was located approximately 75 feet north of the present channel location. Between 1966 and 1968, the channel was moved south to its present location and lined. The area north of the channel was graded to be part of Substation J and, subsequently, transformer banks were constructed on that portion of the property. It is not known whether waste materials which may have been present were removed prior to grading and construction.

1.2.2 Site Stratigraphy

Three distinct soil layers were encountered beneath the 5051 Coliseum Way site: an upper fill unit, a waste layer, and native soils (Bay Mud). Geologic cross-sections based on the soil boring logs are presented on Figures 3 through 7.

The upper fill unit was encountered in all soil borings and consists of a brown clayey sand with gravel containing varying amounts of wood, brick, and concrete fragments along with other general debris such as glass and metal fragments. The fill was present from the ground surface to depths ranging from 2 to 20 feet bgs in the borings; typical fill thicknesses were 6 to 10 feet.

A waste layer was encountered beneath the fill in 16 out of 23 borings. The waste layer appears to be limited to the eastern half of the site (east of a former roadway, shown on Figure 2). The observed thickness of the waste layer ranges from 0.5 to 7 feet. The waste layer is thickest at locations along the Coliseum Way property boundary and thins to the west, away from the former lithopone manufacturing site (illustrated on Figures 6, 7, and 8). Field observation of the waste indicates that it varies across the site. In the vicinity of the northern discharge area observed on the aerial photographs (borings B-2, B-3, B-4, and B-8 and monitoring wells MWA-1 and MW-4), the waste is generally a lean clay in composition and very colorful, with colors ranging from white to dusky red to brown to black. In the southeastern portion of the site, under the pavement along the southern boundary of the site (borings B-6, B-11, and BA-5 and monitoring well MW-6), the waste is a black silty clay to clayey silt unit. In between these two areas (borings BA-4 and B-7 and monitoring wells MWA-2 and MWA-3), the waste is more variable in composition and color, ranging from silty clay to sandy gravel to glassy fragments. The color of the waste in this central area is highly variable, ranging from blue black to streaked gray, brown, white, and orange. The colors are typically more similar to the northern discharge area than the southern.

Native materials belonging to the Bay Mud formation were encountered beneath the fill and/or waste layer. Plant fibers were commonly present at the interface of the Bay Mud and fill/waste layers, suggesting that the top of the Bay Mud unit is likely the top of the former tidal marsh. The Bay Mud unit consists predominantly of grayish green lean clay with lenses of sandy clay and clayey sand.

1.2.3 Hydrogeology

Depth to water at the 5051 Coliseum Way site typically ranges from approximately 4 to 10 feet bgs. The waste layer was usually saturated. A potentiometric surface map based on the water level measurements (excluding MW-7 which had not equilibrated) is included on Figure 8. As indicated on Figure 8, groundwater flow at the 5051 Coliseum Way site is generally from east of Coliseum Way (the 5200 and 5050 Coliseum Way properties) towards the tidally influenced stormwater drainage channel. Flow is to the northwest under the northern portion of the property and to the west beneath the rest of the property. Groundwater levels were measured at low and high tide; only one well, MW-4, showed a pronounced response to the tidal fluctuation indicating some communication with the stormwater drainage channel at that location. Shallow groundwater at the site is not currently used for drinking water, and its potential future uses have not been evaluated.

1.2.4 Soil Analytical Results

The analytical data indicate that the fill unit and the native soils at the 5051 Coliseum Way property generally do not contain chemical constituents at elevated concentrations. The waste unit, however, has elevated concentrations of numerous metals. Metals which exceed their total threshold limit concentration [TTLC; California Code of Regulations (CCR) Title 22] in at least one waste sample include arsenic, barium, cadmium, copper, mercury, lead, antimony, and zinc. Table 1 presents maximum metals concentrations (for metals which exceeded the TTLC in any soil sample) for each of the three waste areas identified on the 5051 Coliseum Way property. The table also includes the range of pHs observed in each area.

The waste in the northern portion of the site is dominated by zinc, lead, copper, and cadmium, and has an acidic pH. As described in Section 1.2.2, this waste material is characterized by a clay-like composition and strong colors. The composition, appearance and location of this waste indicate that it is waste and/or by-products from the zinc sulfate process.

The waste in the southern portion of the site is dominated by barium and has a basic pH. As described in Section 1.2.2, this waste material is a silty clay to clayey silt and black in color. The composition, appearance and location of this waste indicate that it is black ash sludge from the baryte process.

The waste in the central portion of the site is more variable in texture than the other two areas; the waste ranges from clay-like material to glassy fragments. The color ranges from blue black to streaked gray, white, and orange. The chemical composition indicates that zinc, lead, and copper dominate and pH ranges from somewhat acidic to somewhat basic. Based on the chemical similarities to the northern area, the strong colors, and generally clayey composition of some of the waste in the central area, it is likely that much of the waste in this area is associated with the zinc sulfate plant wastes. Differences in texture may be related to the filling which occurred after the lithopone manufacturing facility was torn down. Other waste materials in this area may derive from other portions of and/or activities at the lithopone manufacturing facility.

1.2.5 Groundwater Analytical Results

Based on the analytical data, the primary impacts to groundwater at the 5051 Coliseum Way property are effects on pH and elevated concentrations of metals in groundwater. The pH of the groundwater is acidic in the vicinity of the northern disposal area and basic in the vicinity of the southern disposal area; elsewhere the pH of the groundwater is neutral.

Metals which exceed their respective federal and California Maximum Contaminant Levels (MCLs) for drinking water include arsenic, antimony, barium, cadmium, lead, nickel, selenium, and thallium. Although MCLs may not directly apply to shallow groundwater at the site (because shallow groundwater may not be a potential drinking water source), these values are being used for comparative purposes to evaluate impact.

The groundwater analytical data indicate that the distribution of metals in groundwater is typically related to the composition of the waste. Cadmium, lead, nickel, selenium, and zinc concentrations are higher in the vicinity of the northern disposal area. This distribution is the product of the composition of the waste in this area and the low pH of both the waste and the groundwater. Barium is highest in the southern disposal area where barium levels are elevated in the waste. Arsenic concentrations in groundwater are elevated in the northern and central waste areas, which have elevated arsenic in the waste. The data also suggest that elevated concentrations of metals in groundwater may be limited to areas in proximity to the waste material. However, possible impacts to surface water or deeper groundwater have not been evaluated.

1.3 LEVINE-FRICKE REMEDIAL INVESTIGATIONS AT VOLVO-GM SITE

As part of their remedial investigations at the adjacent Volvo-GM site, Levine-Fricke (1994b) performed soil stabilization and soil leachability studies. Their results are summarized below. The metals at the 5051 Coliseum Way site are very similar to those encountered at the Volvo-GM site. The existing Levine-Fricke results have been used to develop cost estimates for soil stabilization at the 5051 Coliseum Way site. Should soil stabilization be adopted as the most appropriate remediation option, a site specific treatability study would be required. Cost have been included in the appropriate remedial estimates to complete such a study.

The purpose of the leachability study completed by Levine-Fricke was to identify the concentrations of total metals in soils below which the ground water would not be expected to be significantly impacted by leaching. The leachability study targeted three metals(zinc, lead, and arsenic) and was carried out on non-acid soils (soils with a pH greater than 6). Results of the leachability study indicate that soils with zinc, lead and arsenic concentrations below their respective TTLCs (5000 mg/kg, 1000 mg/kg, and 500 mg/kg, respectively) would not be expected to leach metals above the soluble threshold limit concentrations (STLC, CCR, Title 22).

The purpose of the stabilization study was to evaluate how zinc, copper, lead, and arsenic might be immobilized using stabilization techniques. Cement dosages of between 10% and 20% were tested and it was found that, although each dosage was effective in reducing leachable copper and zinc to below STLC values, no single cement treatment was effective in reducing both arsenic and lead to below their respective STLCs. Adding ferric chloride to the cement enhanced the effectiveness of the stabilization treatment. Adding 4% ferric chloride to 15% and 20% cement dosages achieved leachable concentrations for zinc, copper, lead, and arsenic below STLC values. Levine-Fricke adopted treatment ratios of 15% Type V cement and 4% ferric chloride in their cost analyses.

The Levine-Fricke results are considered relevant to most of the waste at the 5051 Coliseum Way property based on the similar chemistry of the material at the two properties. However, these results may not be applicable to the black ash sludge, which has elevated barium. Site-specific leachability and treatability studies would need to be performed for the waste at the 5051 Coliseum Way property prior to actual design of a soil stabilization remedial action. In addition, water-quality objectives (not necessarily STLCs) would need to be determined by the RWQCB to serve as the basis for the actual soil stabilization goals.

2.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

2.1 BASIS FOR DEVELOPMENT OF REMEDIAL ALTERNATIVES

For the purpose of developing remedial alternatives for the site and based on the site characterization results, we have identified the waste layer and associated impacted groundwater as the media for which remediation alternatives should be evaluated. The waste layer has been assumed to occur only east of the former roadway at thicknesses similar to those observed in the borings. The waste layer is known to occur under the 5051 Coliseum Way property. Based on the aerial photographs, the waste layer likely extends under the stormwater drainage channel and a portion of PG&E's Substation J unless the material was removed during grading and construction. The identified chemicals of concern (COCs) in the waste include arsenic, barium, cadmium, copper, mercury, lead, antimony, and zinc. These chemicals have been identified as COCs based on their occurrence in the waste layer at concentrations greater than their respective TTLCs. Site-specific levels of concern will need to be negotiated with the appropriate regulatory agencies.

Impacted groundwater occurs in the vicinity of the waste. In addition, discharge of groundwater to the stormwater drainage channel and the small drainage ditch may be occurring. The impacts, if any, of this discharge are unknown. Chemicals of concern identified in the groundwater include arsenic, barium, cadmium, nickel, lead, antimony, selenium, thallium, and zinc. These COCs for groundwater have been identified based on their occurrence at concentrations above the MCLs. It is important to note that MCLs would not be applicable to the site if site groundwater is not a potential drinking water source. Site-specific COCs and levels of concern for groundwater will need to be negotiated with the appropriate regulatory agencies.

In developing remedial alternatives for the site, we have assumed that: 1) discharge, if any, of impacted shallow groundwater to surface water should be minimized; and 2) the waste layer acts as an ongoing source of metals to groundwater which should be minimized. In addition, we have assumed that remediation of deeper groundwater will not be required. Deeper groundwater has not been investigated at the site; if deeper groundwater is impacted, remedial costs would be substantially higher. In our evaluation of remedial alternatives, we also have not considered any remediation that may be necessary off PG&E's property. Prior to the construction of the roadway across the center of the property and prior to the channelization of the stormwater drainage channel, impacted water and sediment may have discharged from the site.

2.2 SELECTION OF REMEDIAL ALTERNATIVES

Nine alternatives to either remediate or contain heavy metals in the soil and groundwater are presented in this document. All alternatives presented are considered to be technically proven and feasible for use at the site, although additional data are needed to develop each alternative fully. It should be noted that the scope of this report is limited to technical matters, and issues regarding regulatory approval, future development and use of the property, and public acceptance of the alternatives have not been evaluated and associated costs have not been included.

The first of the nine alternatives considered involves the implementation of a groundwater monitoring program. No engineering controls are proposed. Option 1 is considered to represent the baseline option with which all other options may be compared.

The implementation of each of the other eight alternatives would enhance the protection of the environment using various engineering controls. Each alternative would improve the isolation of soils containing elevated levels of metals from human contact, and seven of the eight options would limit the further migration of groundwater containing elevated levels of metals off site. The engineering controls include technologies that:

- limit communication between the site and adjacent drainage channels and, ultimately, San Francisco Bay
- contain and treat groundwater on site
- remove metals from the groundwater without containment
- reduce metal migration from the waste to the groundwater

Prior to selection of any of the remedial alternatives, additional hydrogeological evaluation, engineering design and a risk assessment will need to be performed and a feasibility study and remedial action plan approved by the regulatory agency. Costs for these additional studies have been included in our cost estimates.

3.0 REMEDIAL ALTERNATIVES

A range of alternatives has been considered to remediate both soil and ground water containing elevated levels of metals at the site. Except for Option 1, each option involves the implementation of some form of engineering control to limit the further migration of groundwater containing elevated levels of metals off site and/or limit the migration of metals from the waste. The following nine remediation alternatives have been considered:

1. Groundwater monitoring.
2. Groundwater monitoring and cap construction.
3. Repair of the concrete lined drainage channel and groundwater monitoring.
4. Repair of the concrete lined drainage channel, extension of the concrete lining to the unlined portion of the channel and the southern drainage ditch, groundwater monitoring, and cap construction.
5. Groundwater extraction and treatment, groundwater monitoring, and cap construction.
6. Slurry wall construction, groundwater extraction and treatment, groundwater monitoring, and cap construction.
7. Permeable treatment wall construction, groundwater monitoring, and cap construction.
8. Waste stabilization (in-situ with cap construction and ex-situ) and groundwater monitoring.
9. Excavation and removal of soil with elevated levels of metals and groundwater monitoring.

Each of the nine remedial alternatives are described in the following sections.

Summaries of the costs for each alternative are presented in Tables 4 and 5. Costs for 5051 Coliseum Way are summarized in Table 4, and incremental costs of Substation J in addition to costs for 5051 Coliseum Way are summarized in Table 5.

In general, costs have been based on Geomatrix's experience on similar projects and on data presented by Levine-Fricke (1994b). Appropriate increases in cost (5% per annum) were assigned to account for inflation, as necessary. In some instances, cost estimates were obtained from potential subcontractors.

3.2 OPTION 1 – GROUNDWATER MONITORING

Option 1 does not involve the use of any engineering controls but is limited to the implementation of a groundwater monitoring program. This option serves as a baseline for comparison with other options.

The groundwater monitoring program would involve monitoring groundwater elevations and water quality on a quarterly basis for 2 years and semiannually thereafter for a period of at least 28 years. Reports would be produced after each monitoring event, with a summary evaluation report completed after the first two years and thereafter every five years. It is assumed that no additional monitoring wells will be required on the 5051 Coliseum Way property. The location of existing monitoring wells are indicated on Figure 8. It has been assumed that two monitoring wells would be installed on the Substation J property west of the drainage channel, as indicated on Figure 8. The wells on the Substation J property would only be necessary if waste is present under the substation property.

3.3 OPTION 2 – CAP CONSTRUCTION AND GROUNDWATER MONITORING

Option 2 involves the implementation of a groundwater monitoring program and the construction of a cap. The cap would be installed to limit the percolation of rain water through the soils. Existing asphalt on the 5051 Coliseum Way property would be removed prior to cap construction as this is considered to be a more viable option than attempting to repair the heavily damaged surface (see Figure 8). No additional remedial measures would be taken. Costs associated with the groundwater monitoring program would be the same as for Option 1.

3.4 OPTION 3 – REPAIR OF THE CONCRETE LINED DRAINAGE CHANNEL AND GROUNDWATER MONITORING

Groundwater monitoring data (Geomatrix, 1996) suggest that water levels in monitoring well MW-4 are tidally influenced. This indicates that there is some hydraulic connection between the groundwater on the site and the adjacent stormwater drainage channel. In order to reduce the potential for the migration of groundwater containing elevated levels of metals from the site to water in the drainage channel, Option 3 includes the repair of the concrete lining in the channel (see Figure 9). The implementation of this option would involve the diversion of the water in the channel to a point downstream of the lined section. Repairs would be completed as required.

Until a site inspection has been completed, it is not possible to determine how much of the channel is damaged or the extent of the damage. For costing purposes, it has been assumed that 25% of the lining is damaged and will have to be removed and replaced. Costs associated with the groundwater monitoring program would be the same as for Option 1.

3.5 OPTION 4 – REPAIR AND EXTENSION OF CONCRETE LINED DRAINAGE CHANNEL, DITCH EXTENSION, CAP CONSTRUCTION, AND GROUNDWATER MONITORING

Option 4 includes all components of Option 3 with the addition that the lined section of the channel be extended and that the southern drainage ditch be concrete lined. By extending the channel lining and lining the southern drainage ditch, the likelihood of groundwater with elevated levels of metals discharging to surface water would be reduced. Costs are provided for the extension of the channel lining and lining the southern drainage ditch over two different lengths (see Figures 10 and 11). Costs associated with the repair of the concrete lining would be the same as Option 3, the costs for cap construction the same as Option 2, and the costs for groundwater monitoring the same as for Option 1.

3.6 OPTION 5 – GROUNDWATER EXTRACTION AND TREATMENT, CAP CONSTRUCTION, AND GROUNDWATER MONITORING

Under Option 5, a cap would be constructed and groundwater would be extracted and treated prior to discharge to the storm-drain system at the site. Implementation of this alternative would reduce the potential for leaching of metals from the soil by limiting surface water infiltration, and reduce migration of groundwater from the site through hydraulic containment. Costs associated with the cap construction and groundwater monitoring would be the same as for Option 2.

3.6.1 Groundwater Extraction

To capture the groundwater and prevent it from migrating off site, a French drain would be installed around that portion of the 5051 Coliseum site east of the former roadway (as indicated on Figure 12). Should remediation of the Substation J portion of the site be required, groundwater extraction wells would be used to capture the water on the north side of the drainage channel. An air-driven displacement pump would be installed at the low point of the drain or in the extraction wells to pump the water to a central treatment system. Capital costs would include installation of the drain/extraction wells and the design and construction of pipelines to convey air to the pump(s) and return water to a central treatment system. Operation costs would include routine maintenance costs incurred over an extended, and as yet undefined, period of time. A 30-year operation period has been assumed for cost estimating purposes.

3.6.2 Groundwater Treatment

Groundwater treatment alternatives were selected based on estimated influent concentrations summarized in Table 2. Three potentially suitable methods of treatment have been evaluated for removal of metals from extracted groundwater. At the feasibility stage of the project, other treatment technologies might also be considered. A groundwater treatability study would be required to provide the basis for a performance guarantee from the selected vendor. The three treatment methods are discussed in the following paragraphs.

Treatment A: Evaporation/Drying Process. This technology consists of a two-stage process. In the first stage, the flow stream passes into a steam heated evaporator where the solids concentration is increased to approximately 50%. The steam for the evaporator is produced in a natural gas-fueled boiler. From the evaporator, the flow stream passes into a natural gas heated spray dryer, where the solids concentration is increased to 97%. The dry solid residue is disposed of as waste (either hazardous or nonhazardous, depending on the metals concentrations). All water is exhausted as vapor.

Treatment B: Precipitation/Membrane Filtration/Ion Exchange Polishing. The first phase in this three phase process consists of an alkaline precipitation process using caustic soda, where metal hydroxides are formed. The product stream from this phase is treated in a membrane filtration unit to increase the solids concentration to approximately 3 to 5%, then filter pressed to separate the precipitated solids. The filter cake is disposed of as waste. In the last stage, effluent water is pumped through an ion exchange polisher to remove additional soluble metals prior to discharge.

Treatment C: Unipure System. UNOCAL Corporation has developed a proprietary precipitation process to remove soluble metals from water. In the Unipure system, ferrous iron is added to the stream to reduce the metals, followed by precipitation of an iron hydroxide floc which mechanically enhances the removal of the metal hydroxides. The precipitated material is removed as waste. The fluids may require an ion exchange polishing step to achieve the low metals concentrations prior to discharge. Due to high concentrations of zinc in the influent water, an alkaline precipitation process (using caustic soda) is recommended for the partial removal of zinc and other metals upstream of the Unipure process.

3.6.3 Disposal of Treated Groundwater

It is anticipated that any treated water would be discharged to the storm-drain system under an NPDES permit. If water could be used on-site for some industrial purpose, then discharge to the local sanitary sewer system might be allowed under the less rigorous industrial treatment standards. For the precipitation treatment options, where a substantial amount of discharge is expected, reuse on site could represent a significant cost saving.

3.7 OPTION 6 – CUT-OFF WALL CONSTRUCTION, GROUNDWATER EXTRACTION AND TREATMENT, CAP CONSTRUCTION, AND GROUNDWATER MONITORING

The major component of Option 6 involves the construction of a cut-off wall around that portion of the site east of the former roadway (see Figure 13). The purpose of the wall would be to contain groundwater with elevated levels of soluble metals on the site, thereby minimizing the off-site flow of groundwater with elevated concentrations of soluble metals. A slurry wall would be installed along three sides of the site with Waterloo Barrier™ sheet piles installed adjacent to the stormwater drainage channel to complete the cut-off wall. The Waterloo Barrier™ was selected adjacent to the channel for ease of construction. This option is not considered practicable for the Substation J site because of its small size.

The slurry wall has been estimated as a 3-feet-wide, 20-feet-deep wall, keyed into the Bay Mud. It has been assumed that the wall would be constructed from a soil-cement-bentonite slurry. Cement, added for strength, increases the cost of the slurry, the shrinkage of the wall and the permeability of the wall. Further analysis, completed at the design stage, may indicate that a soil-bentonite wall would be a more appropriate solution. Along Coliseum Way, it is anticipated that traffic diversions would be required during the construction of this section of the slurry wall.

Along the northern edge of the property, adjacent to the drainage channel, more lateral support would be required than can be provided by a slurry wall. It is proposed that 20 feet deep, Waterloo Barrier™, modified, steel sheet piles would be installed to complete the cut-off wall. The interlocking joints of these sheet piles incorporate a cavity that can be flushed and filled with a low-permeability sealant following installation to form a low-permeability barrier wall. It has been assumed that waste material from the small area at the north of the property, where the treatment plant is located, would be excavated and disposed of off site prior to construction of the treatment facility.

In order to maintain an inward hydraulic gradient towards the center of the site, a groundwater extraction and treatment system would be installed. Approximately five extraction wells are anticipated, as indicated on Figure 13. Costs have been developed based on the use of the Unipure treatment system, chosen for economic reasons based on the cost comparison completed for Option 5.

As an alternative to using extraction wells to maintain an inward hydraulic gradient, the relatively innovative technique of using specially selected trees and plants might be considered. A cost estimate for using this approach has been included in the Option 6 cost summary (see Appendix A). Additional studies would be required if this option were to be pursued further. Costs for these additional studies have been included in the estimate.

It is possible that the PG&E towers and power lines which traverse the northern portion of the site will require removal; no costs have been included for this. Costs associated with the groundwater monitoring program and cap construction would be the same as for Option 2.

3.8 OPTION 7 – PERMEABLE TREATMENT WALL CONSTRUCTION, CAP CONSTRUCTION, AND GROUNDWATER MONITORING

The implementation of Option 7 would involve the construction of a slurry wall/Waterloo Barrier™ containment wall with a permeable treatment wall at some downgradient point within the wall (see Figure 14). The purpose of the containment wall would be to contain and direct groundwater through the permeable treatment wall, which is composed of sand-sized filings of zero-valent iron. The installation of a permeable treatment wall at the site would locally decrease the redox potential significantly, thereby enhancing metals precipitation. The intent of this remediation option is to reduce the level of soluble metals in the groundwater to acceptable levels for discharge to the San Leandro Bay.

As for Option 6, cost estimates for the cutoff wall have been based on a 3 feet wide, 20 feet deep, soil-cement-bentonite slurry wall combined with a 20 feet deep, Waterloo Barrier™, adjacent to the stormwater drainage channel. The proposed permeable treatment wall would be 85 feet long and approximately 6 feet wide. The final configuration/location of the containment wall and permeable treatment wall would probably be revised once the hydrogeological evaluation has been completed and the groundwater chemistry has been evaluated further. It has been assumed that waste material from the small area at the north of the property outside the containment wall would be excavated and disposed of off site.

As for Option 6, it is possible that the PG&E towers and power lines which traverse the northern portion of the site will require removal; these costs have not been included. It has been assumed that costs associated with the groundwater monitoring program and cap construction would be the same as for Option 2. Again, the option is not considered practicable for the Substation J portion of the site.

3.9 OPTION 8 – GROUND STABILIZATION (EX-SITU AND IN-SITU), CAP CONSTRUCTION, AND GROUNDWATER MONITORING

The objective in implementing Option 8 would be to immobilize metals within the soil thereby reducing the potential for metals to leach into the groundwater. It has been assumed that chemical stabilization would be completed using approximately the same treatment ratios of cement and $FeCl_3$ (15% Type V cement and 4% $FeCl_3$) derived by Levine-Fricke from the results of their stabilization study as summarized in Section 1.3 of this report. A site specific treatability study would be required to finalize these ratios. Cost analyses have been completed assuming both ex-situ treatment (Option 8A) and in-situ treatment (Option 8B).

As indicated on Table 3, for the ex-situ treatment option on the 5051 Coliseum Way portion of the site, a total of approximately 68,000 cubic yards (cy) of soil would be excavated. Approximately 35,000 cy of the excavated fill not requiring treatment would be stockpiled on site. The rest of the fill (15,000 cy) and 18,000 cy of waste material (including an estimated 20% over excavation at the interface between the waste and the Bay Mud) would be treated and replaced in the excavation. The stockpiled clean fill would be used to backfill the excavation over the treated material. As a result of treatment, a 50% bulk factor is expected. Excess material would be graded over the site. At Substation J, a total of approximately 3100 cy of soil would be excavated. Approximately 1400 cy of fill would be stockpiled and used to backfill over the treated material; 1700 cy of fill and waste would be treated and replaced in the excavation. No cap would be required for the ex-situ stabilization option.

For the in-situ treatment option it has been assumed that all soil, from the ground surface to the base of the waste material, would be treated. An initial analysis indicates that this would be the most economic approach. An alternative would be to treat the waste material only and inject water into the soil above it. However, precautions would have to be taken to ensure that the waste material was not dispersed into the clean fill above. Implementation of these precautions would be time consuming and expensive and possibly not successful. Because the in-situ stabilization process may bring waste materials up to the ground surface, a cap has been included in the cost estimate. Because of access restrictions, we have assumed that the small area at the north of the 5051 Coliseum Way property (see Figure 16) would be excavated and the soil transported to the main area of the site prior to implementing the in-situ stabilization treatment.

For the 5051 Coliseum Way property, removal of the PG&E towers and power lines which traverse the northern portion of the site would likely be necessary in order to implement either Option 8A or 8B. These costs have not been included. At Substation J, removal of all or portions of the transformer banks would be necessary. Costs for this removal have not been included and could preclude the feasibility of these options at the Substation J site. For both Options 8A and 8B, costs associated with the groundwater monitoring program and cap construction would be the same as for Option 2.

3.10 OPTION 9 – EXCAVATION AND REMOVAL OF SOIL WITH ELEVATED LEVELS OF METALS AND GROUNDWATER MONITORING

Option 9 involves the excavation, and removal from the site, of all soil with elevated levels of metals. By removing this soil from the site, and the source of elevated metals to the ground-water, the potential for future human contact with soil containing elevated levels of metals would be eliminated. However, this option does not include treatment of the groundwater which currently contains elevated levels of metals. Long-term groundwater monitoring would be implemented to monitor the migration, if any, of this groundwater.

As indicated on Table 3, a total volume of 50,000 cy of fill would be excavated from the 5051 Coliseum Way site and 2,000 cy from the Substation J site. The areas of excavation are shown on Figure 17. Approximately 70% of the fill material would be returned to the site as fill and the remaining 30% would be disposed of off site at a Class II landfill. Approximately 18,000 cy of waste would be excavated from the 5051 Coliseum Way site and 1,100 cy from the Substation J site. For excavation purposes, it has been assumed that overexcavation of approximately 20% will occur at the interface between the waste and the Bay Mud. The waste material (including overexcavated material) would be disposed of off site at a Class I landfill. It has been assumed that the waste is a non-RCRA hazardous waste.

Temporary support to the sides of the excavation would be provided along the northern, western and eastern boundaries of the 5051 Coliseum Way site using 20-feet-long soldier piles and wooden lagging. Along the southern edge, the excavation would be sloped and no temporary support would be provided. Following excavation, approximately 33,000 cy of clean fill would be imported and replaced in the excavation at 5051 Coliseum Way and approximately 1700 cy to the Substation J site.

In order to excavate the waste, the PG&E towers and power lines which traverse the northern portion of the site will require removal; these costs have not been included. In addition, all or portions of the transformer banks at Substation J would require removal in order to implement this alternative. These costs have not been included and could be prohibitive. It has been assumed that groundwater monitoring costs will be the same as for Option 1.

4.0 IMPLEMENTATION SCHEDULE

Preliminary schedules for the completion of each of the options considered at the 5051 Coliseum Way site are presented on Figures 18 through 28. Separate schedules for the Substation J site have not been prepared. Any remediation of Substation J is likely to take place in conjunction with the 5051 Coliseum Way remediation, and schedules would be adjusted accordingly. Each schedule includes completion of the following tasks:

- Hydrogeological studies
- Risk assessment
- Preparation of a feasibility report
- Lab treatability study (where required)
- Engineering design
- Preparation of a remedial action plan
- Acquisition of permits and approvals
- Subcontractor procurement
- Implementation of remediation option
- Groundwater monitoring

In the development of these preliminary schedules, no allowance has been made for any delays which may occur in obtaining the appropriate permits or access agreements or for any other delays outside of the control of the consultant.

5.0 REFERENCES

California Regional Water Quality Control Board, San Francisco Bay Region, 1995, Water Quality Control Plan, June 1995 amendments.

Geomatrix, Site Characterization Report, 5051 Coliseum Way, Oakland, California, June 1996.

Levine-Fricke, 1994a, Remedial Investigation Report, 5050 Coliseum Way and 750 - 50th Avenue, Oakland, California, prepared for Volvo-GM Heavy Truck Corporation, dated 19 September 1994.

Levine-Fricke, 1994b, Preliminary Remedial Alternatives Evaluation Report, 5050 Coliseum Way and 750 - 50th Avenue, Oakland, California, prepared for Volvo-GM Heavy Truck Corporation, dated 23 November 1994.

GEOMATRIX

TABLE 1

MAXIMUM CONCENTRATIONS OF METALS IN THREE WASTE AREAS

5051 Coliseum Way
Oakland, California

	Northern Waste Area	Central Waste Area	Southern Waste Area
Arsenic	1500	1200	23
Barium	1900	1900	100,000
Cadmium	2100	180	4.6
Copper	3800	4100	410
Mercury	65	18	2.3
Lead	30,000	42,000	84
Antimony	610	850	2
Zinc	54,000	42,000	2000
pH	4.5 - 6.2	6.1 - 8.2	8.5 - 11.2

TABLE 2

GROUNDWATER ANALYTICAL RESULTS
METALS[1]
5051 Coliseum Way
Oakland, California

Concentrations in micrograms per liter (mg/l)

	MCL[2]	---	0.05	1	0.004	0.005	---	0.05	1	0.002	---	0.1	0.05	0.006	0.01	0.002	---	5
Well Name	**Sample Date**	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Co**	**Cr**	**Cu**	**Hg**	**Mo**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**V**	**Zn**
B-2[3]	1/23/95	<0.005	0.22	0.69	<0.002	0.011	0.16	<0.01	0.12	<0.0002	<0.01	0.33	0.17	<0.02	<4	0.12	0.032	21
B-3[3]	1/23/95	<0.005	0.05	0.03	<0.002	0.006	0.35	<0.01	0.01	<0.0002	<0.01	1.1	<0.04	<0.02	<0.04	<0.05	<0.005	0.72
B-4[3]	1/23/95	<0.005	0.006	1.8	<0.002	0.69	0.052	<0.01	0.02	0.0004	<0.01	1	0.22	<0.02	<4	<0.05	<0.005	540
B-5[3]	1/23/95	<0.005	0.003	0.27	<0.002	0.29	0.053	<0.01	0.04	<0.0002	<0.01	0.07	0.3	<0.02	<4	<0.05	<0.005	40
B-6[3]	1/23/95	<0.005	0.17	200	<0.002	<0.005	<0.005	<0.01	<0.01	<0.0002	0.07	<0.01	<0.04	<0.02	0.006	<0.05	0.076	0.05
B-7[3]	1/23/95	<0.005	0.3	5.8	<0.002	0.022	<0.005	<0.01	0.01	<0.0002	0.02	0.03	0.12	0.02	<4	<0.05	0.012	2.6
B-8[3]	1/23/95	<0.05	0.01	<0.1	<0.02	2	0.14	<0.1	<0.1	<0.0002	<0.1	1.8	<0.4	<0.2	<4	<0.05	<0.05	770
MWA-1	6/2/95	<0.05	<0.02	0.01	<0.02	2.7	<0.05	<0.1	0.57	<0.002	<0.1	0.9	<0.4	<0.2	<0.04	<0.05	<0.05	990
MWA-1[4]	6/2/95	<0.01	<0.005	0.0444	0.00808	4.26	0.0412	<15	0.473	0.000317	0.255	0.917	<0.1	0.0015	<0.005	<0.005	<0.01	1128
MWA-1	12/12/95	<0.05	0.011	<0.1	<0.02	2.8	0.11	<0.1	1	0.0003	<0.1	1.2	0.6	<0.2	0.013	<500	<0.05	1000
MWA-2	6/2/95	<0.005	1.1	0.19	<0.002	0.012	0.012	<0.01	<0.01	<0.0002	0.07	0.21	<0.04	0.04	<4	<0.05	0.012	5.5
MWA-2[4]	6/2/95	<0.01	0.937	0.195	0.00723	0.0263	0.0147	<15	<0.01	0.000302	0.259	0.25	<0.1	0.053	<0.005	<0.005	0.0139	7.25
MWA-2	12/12/95	<0.005	1.2	0.56	<0.002	<0.005	0.009	<0.01	<0.01	<0.0002	0.06	0.19	<0.04	0.06	<4	<0.05	0.032	4.6
MWA-3	6/2/95	<0.005	0.012	0.05	<0.002	0.01	0.006	<0.01	<0.01	<0.0002	<0.01	<0.01	<0.04	<0.02	<4	<0.05	<0.005	2
MWA-3[5]	6/2/95	<0.01	0.0273	0.0779	0.00859	0.0376	0.0133	<15	<0.01	0.000291	0.234	<15	<0.1	0.0014	<0.005	<0.005	<0.01	7.85
MWA-3	12/12/95	<0.005	0.018	0.12	<0.002	0.07	0.04	<0.01	<0.01	<0.0002	<0.01	0.04	<0.04	<0.02	<4	0.05	0.007	26
MW-4	12/11/95	<0.05	0.005	<0.1	<0.02	<0.05	1.2	<0.1	<0.1	<0.0002	<0.1	3	<0.4	<0.2	<0.02	<500	<0.05	430
MW-5	12/11/95	<0.005	0.009	0.21	<0.002	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.01	<0.04	<0.02	<4	<0.05	<0.005	0.02
MW-6	12/11/95	<0.005	<0.002	0.24	<0.002	<0.005	0.009	<0.01	<0.01	<0.0002	0.03	0.03	<0.04	<0.02	<4	<0.05	0.022	0.02
MW-7	12/11/95	<0.005	<0.002	0.1	<0.002	<0.005	0.014	<0.01	0.02	<0.0002	<0.01	0.02	<0.04	<0.02	<4	<0.05	<0.005	0.04
MW-8	12/11/95	<0.005	0.004	1.2	<0.002	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.01	<0.01	<0.04	<0.02	<4	0.05	0.011	0.01

Notes:

1 Metals (silver (Ag), arsenic (As), barium (Ba), beryllium (Ba), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), Mercury (Hg), molybdenum (Mo), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), thallium (Tl), vanadium (V), and zinc (Zn)) analyzed by American Environmental Network of Pleasant Hill, California. Laboratory reports detailing the analyses performed, method detection limits for each constituent, and analytical results are included in Appendix C.

2 MCL = maximum contaminant level based on Federal and California drinking water standards, 1995.

3 Results for B-2 through B-8 are for grab groundwater samples collected from soil borings.

4 Shaded results indicate samples collected by Miller Brooks and analyzed by RJ Lee Group, Inc.

TABLE 3

SOIL QUANTITIES
5051 Coliseum Way
Oakland, California

	Relevant Options	5051 Coliseum Way	Substation J
Area (square feet)	2 through 9	160,000	7,000
Volume of fill (cubic yards)	8A, 8B, 9	50,000	2,000
Volume of fill to Class III landfill or replaced on site if excavated (cubic yards) - 70% of total	8A, 9	35,000	1,400
Volume of fill to Class II landfill if excavated or treated ex-situ (cubic yards) - 30% of total)	8A, 9	15,000	600
Volume of waste (cubic yards)	8B	15,000	900
Estimate of volume of waste excavated (cubic yards) - 120% of total	8A, 9	18,000	1,100

GEOMATRIX

TABLE 4

COST[1] SUMMARY
5051 Coliseum Way
Oakland, California

Option	Description	Total Cost[2] ($)
Option 1	Groundwater monitoring	466,000
Option 2	Groundwater monitoring and cap construction	1, 757,000
Option 3	Channel repair and groundwater monitoring	701,000
Option 4A	Channel repair and extension, ditch extension, cap construction and groundwater monitoring – length of extension = 250 feet	2,700,000
Option 4B	Channel repair and extension, ditch extension, cap construction and groundwater monitoring – length of extension = 900 feet	4,021,000
Option 5A	Groundwater extraction and treatment, groundwater monitoring and cap construction – treatment using evaporation/drying	7,683,000[3]
Option 5B	Groundwater extraction and treatment, groundwater monitoring and cap construction – treatment using membrane filtration	6,514,000[3]
Option 5C	Groundwater extraction and treatment, groundwater monitoring and cap construction – treatment using Unipure system	6,344,000[3]
Option 6	Slurry wall construction, groundwater extraction and treatment, cap construction and groundwater monitoring	7,788,000[4]
Option 7	Iron wall construction, cap construction and groundwater monitoring	3,204,000[4]
Option 8A	Ex-situ stabilization and groundwater monitoring	10,750,000[4]
Option 8B	In-situ stabilization, cap construction and groundwater monitoring	12,866,000[4]
Option 9	Excavation and removal of soil with elevated levels of metals and groundwater monitoring	16,516,600[4,5]

Notes:

1 Cost estimates do not include costs for community acceptance or any remediation which may be required off of the 5051 Coliseum Way property.
2 Cost represents 30-year present value cost.
3 If excavated lithopone waste were a RCRA hazardous material, costs would increase by approximately 5 to 10%
4 Costs do not include cost for possible removal of PG&E power lines and towers.
5 If excavated lithopone waste were a RCRA hazardous material, costs would increase by approximately 35%.

GEOMATRIX

TABLE 5

SUMMARY OF INCREMENTAL COSTS[1]
SUBSTATION J
5051 Coliseum Way
Oakland, California

Option	Description	Total Cost[2] ($)
Options 1 and 3	Groundwater monitoring/channel repair	161,000
Options 2 and 4	Groundwater monitoring and cap construction/channel repair and extension	252,000
Option 5	Groundwater extraction and treatment, groundwater monitoring and cap construction	516,000
Option 8A	Ex-situ stabilization and groundwater monitoring	869,000[3]
Option 8B	In-situ stabilization, cap construction and groundwater monitoring	827,000[3]
Option 9	Excavation and removal of soil with elevated levels of metals and groundwater monitoring	1,039,000[3,4]

Notes:

1 These costs represent the amounts which would be added to the costs for 5051 Coliseum Way in order to remediate Substation J, if necessary.
2 Cost represents 30-year present value cost.
3 Costs do not include cost for removal and replacement or relocation of electrical equipment at Substation J.
4 If excavated lithopone waste were a RCRA hazardous material, costs would increase by approximately 35%.

0 2200 Feet

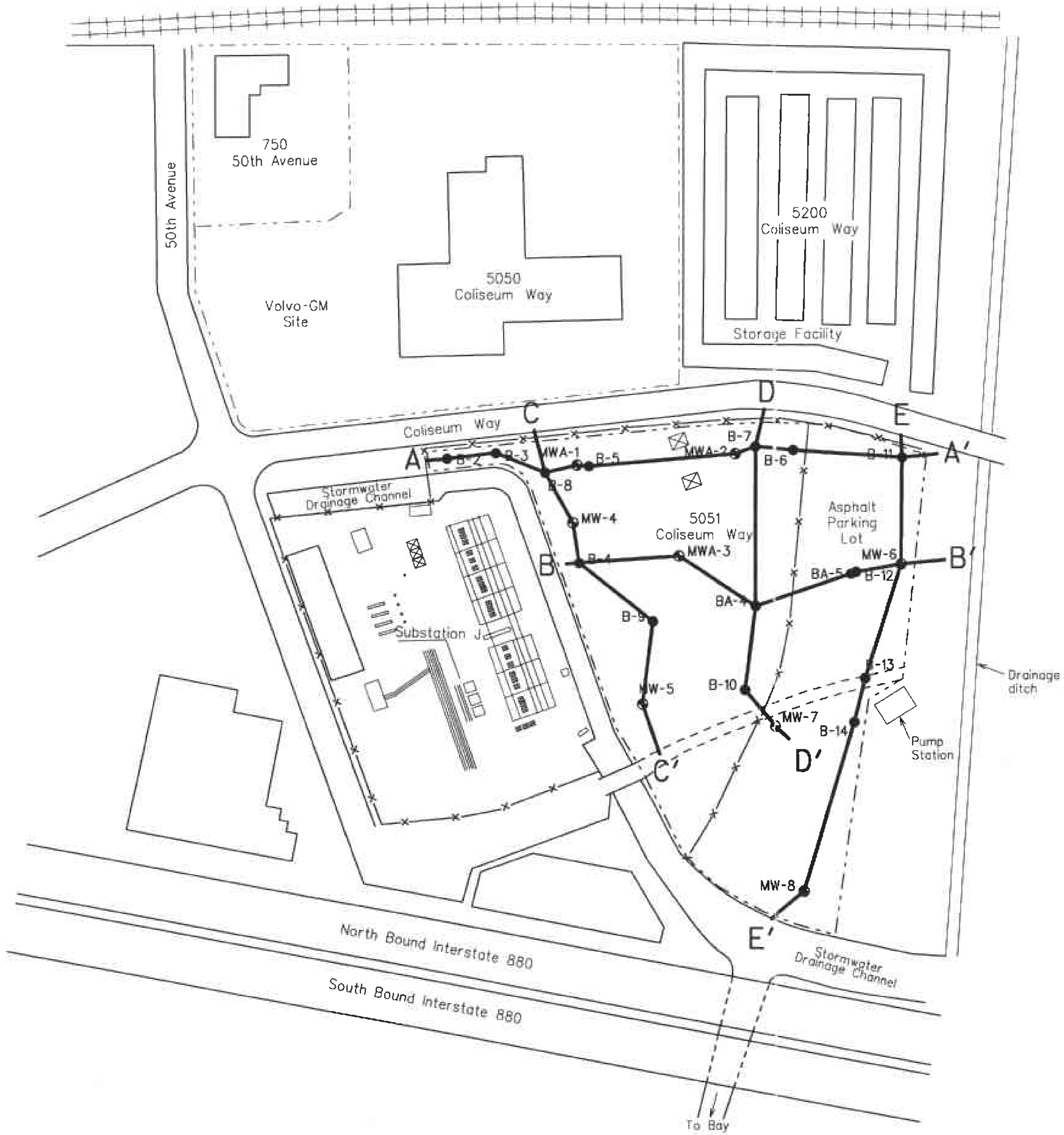
GEOMATRIX

SITE LOCATION MAP
PG&E Oakland Yard
5051 Coliseum Way
Oakland, California

Figure 1

Project No. 2906H

2906H.001



EXPLANATION

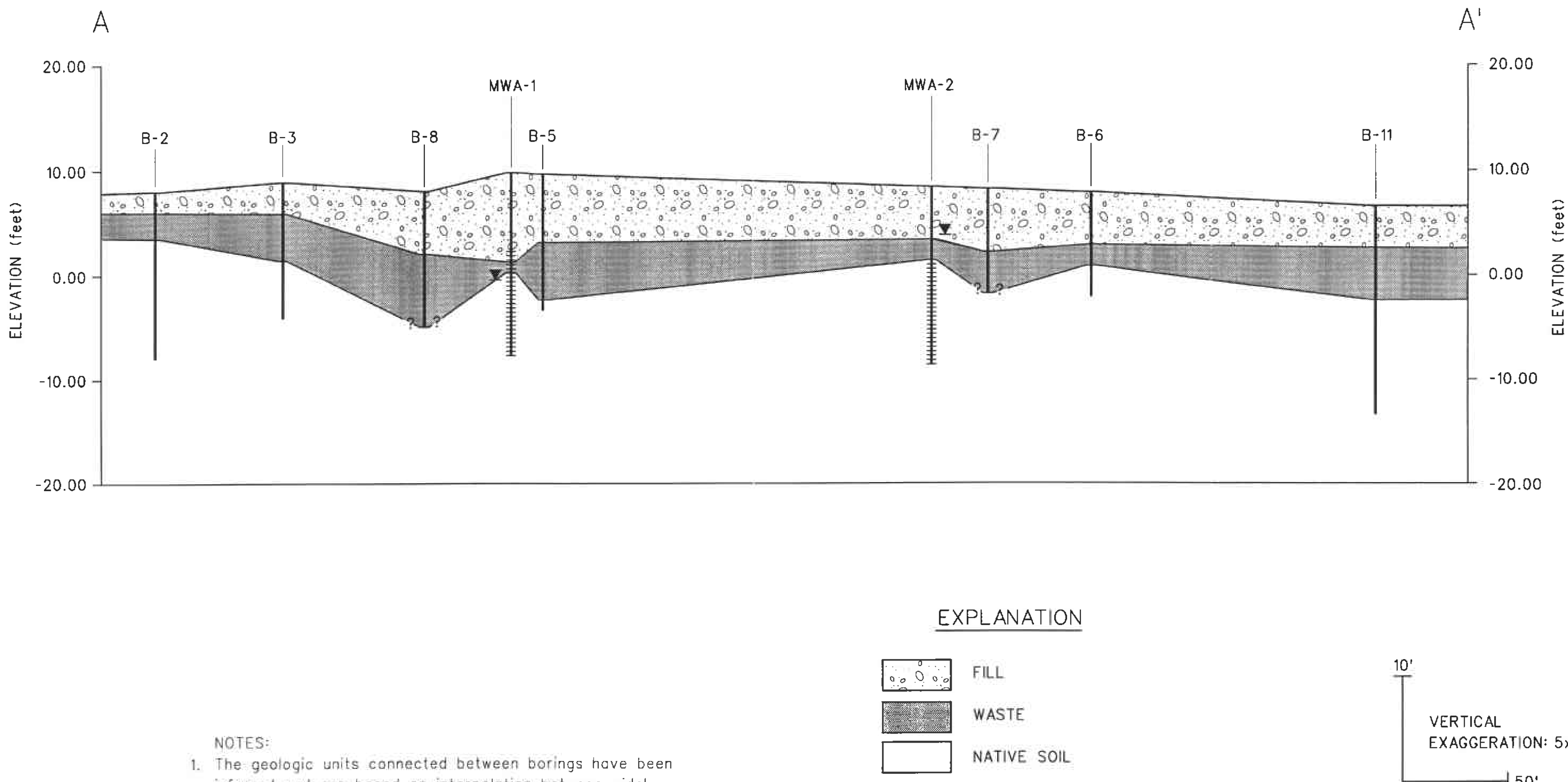
- ● SOIL BORING LOCATION
- MONITORING WELL LOCATION
- ELECTRICAL TOWER
- FORMER ROADWAY
- FENCE
- PROPERTY BOUNDARY
- A A' LOCATION OF GEOLOGIC CROSS SECTION

0 150
SCALE IN FEET

GEOLOGIC CROSS-SECTION,
BORING AND MONITORING WELL LOCATIONS

5051 Coliseum Way
Oakland, California

GEOMATRIX	Project No. 2906	Figure 2



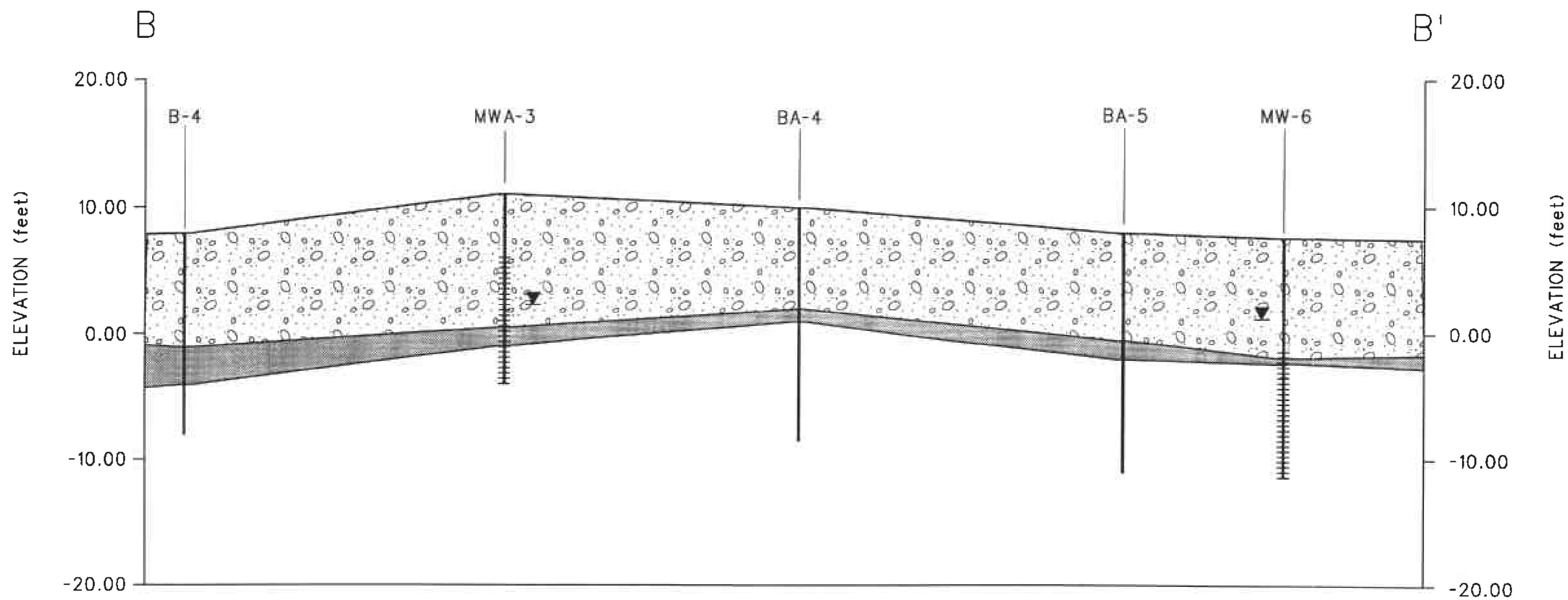
NOTES:

1. The geologic units connected between borings have been inferred and are based on interpolation between widely spaced points. For clarity, solid lines are used to represent contacts between these units, but these are not meant to imply certainty.
2. Cross-Section shown on Figure 2.
3. Elevations are in feet, msl.

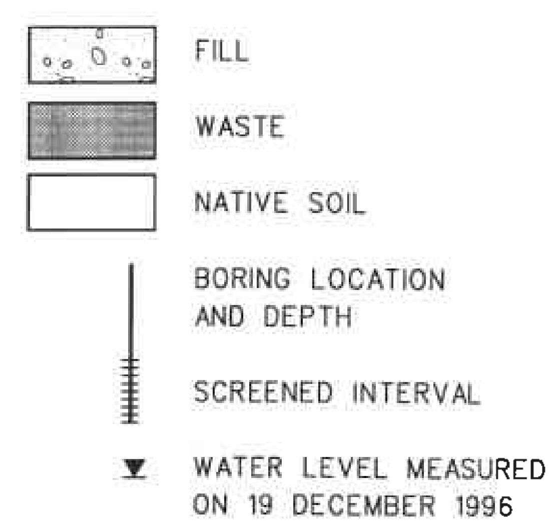
CROSS-SECTION A-A'

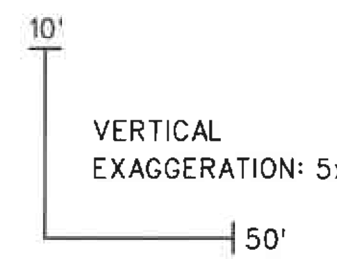
5051 Coliseum Way
Oakland, California

GEOMATRIX	Project No. 2906	Figure 3



EXPLANATION





NOTES:

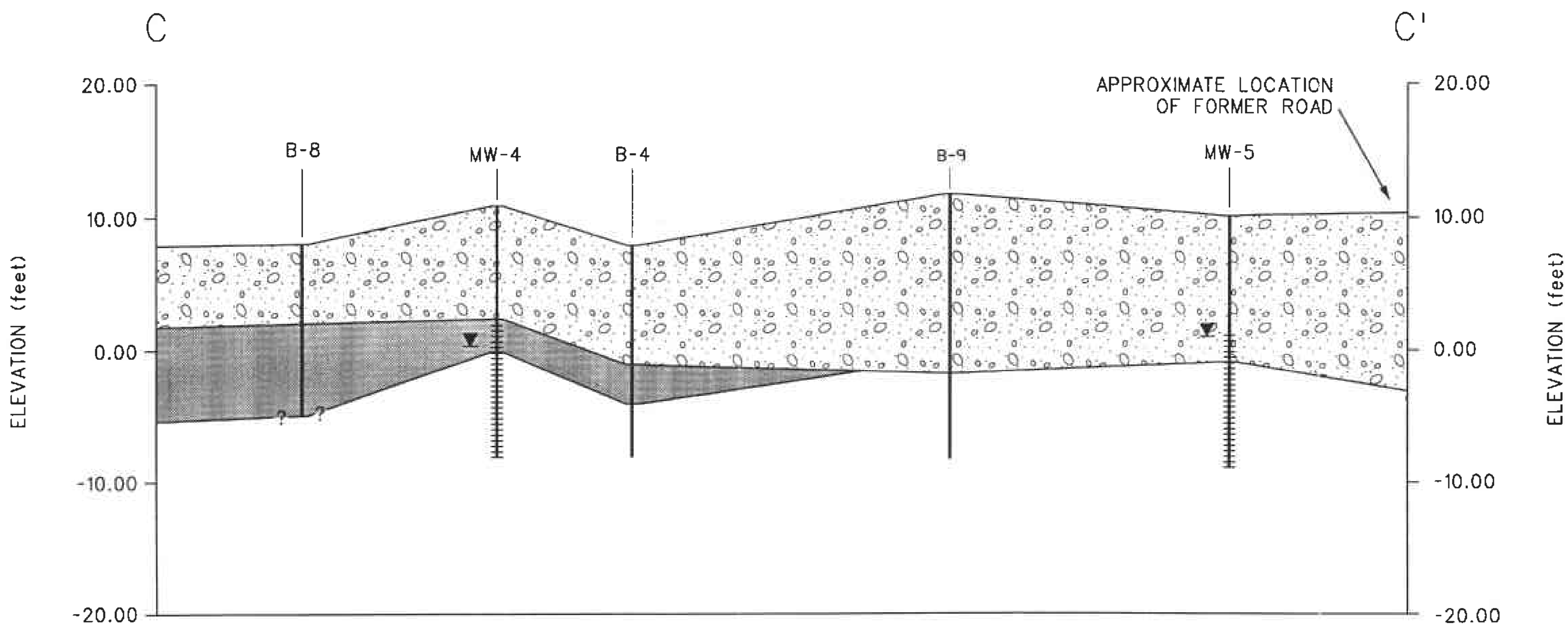
1. The geologic units connected between borings have been inferred and are based on interpolation between widely spaced points. For clarity, solid lines are used to represent contacts between these units, but these are not meant to imply certainty.
2. Cross-Section shown on Figure 2.
3. Elevations are in feet, msl.

CROSS-SECTION B-B'

5051 Coliseum Way
Oakland, California

GEOMATRIX

Project No.	Figure
2906	4



EXPLANATION

- FILL
- WASTE
- NATIVE SOIL
- BORING LOCATION AND DEPTH
- SCREENED INTERVAL
- WATER LEVEL MEASURED ON 19 DECEMBER 1996

10'
VERTICAL EXAGGERATION: 5x
50'

NOTES:

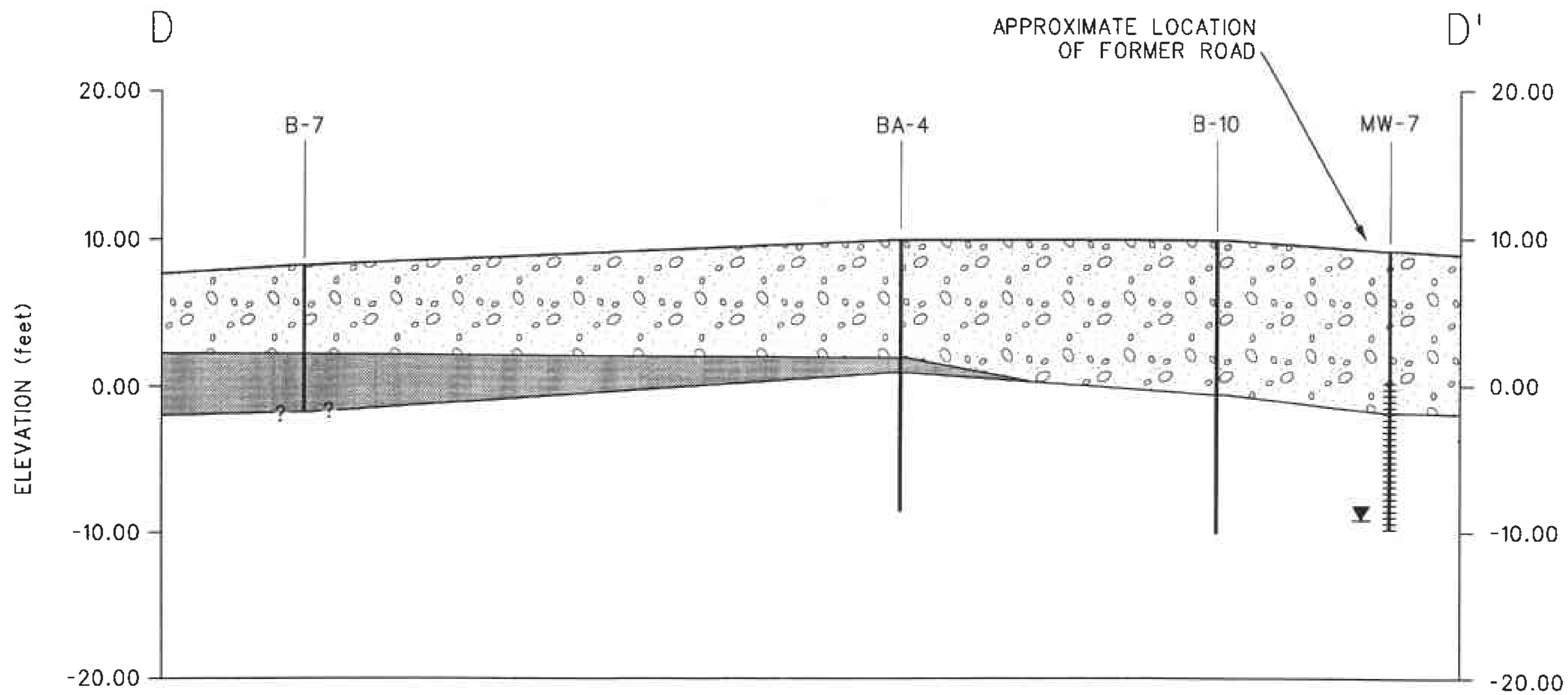
1. The geologic units connected between borings have been inferred and are based on interpolation between widely spaced points. For clarity, solid lines are used to represent contacts between these units, but these are not meant to imply certainty.
2. Cross-Section shown on Figure 2.
3. Elevations are in feet, msl.

CROSS-SECTION C-C'

5051 Coliseum Way
Oakland, California

GEOMATRIX

Project No.	Figure
2906	5



NOTES:

1. The geologic units connected between borings have been inferred and are based on interpolation between widely spaced points. For clarity, solid lines are used to represent contacts between these units, but these are not meant to imply certainty.
2. Cross-Section shown on Figure 2.
3. Elevations are in feet, msl.

EXPLANATION

- FILL
- WASTE
- NATIVE SOIL
- BORING LOCATION AND DEPTH
- SCREENED INTERVAL
- WATER LEVEL MEASURED ON 19 DECEMBER 1996

10'

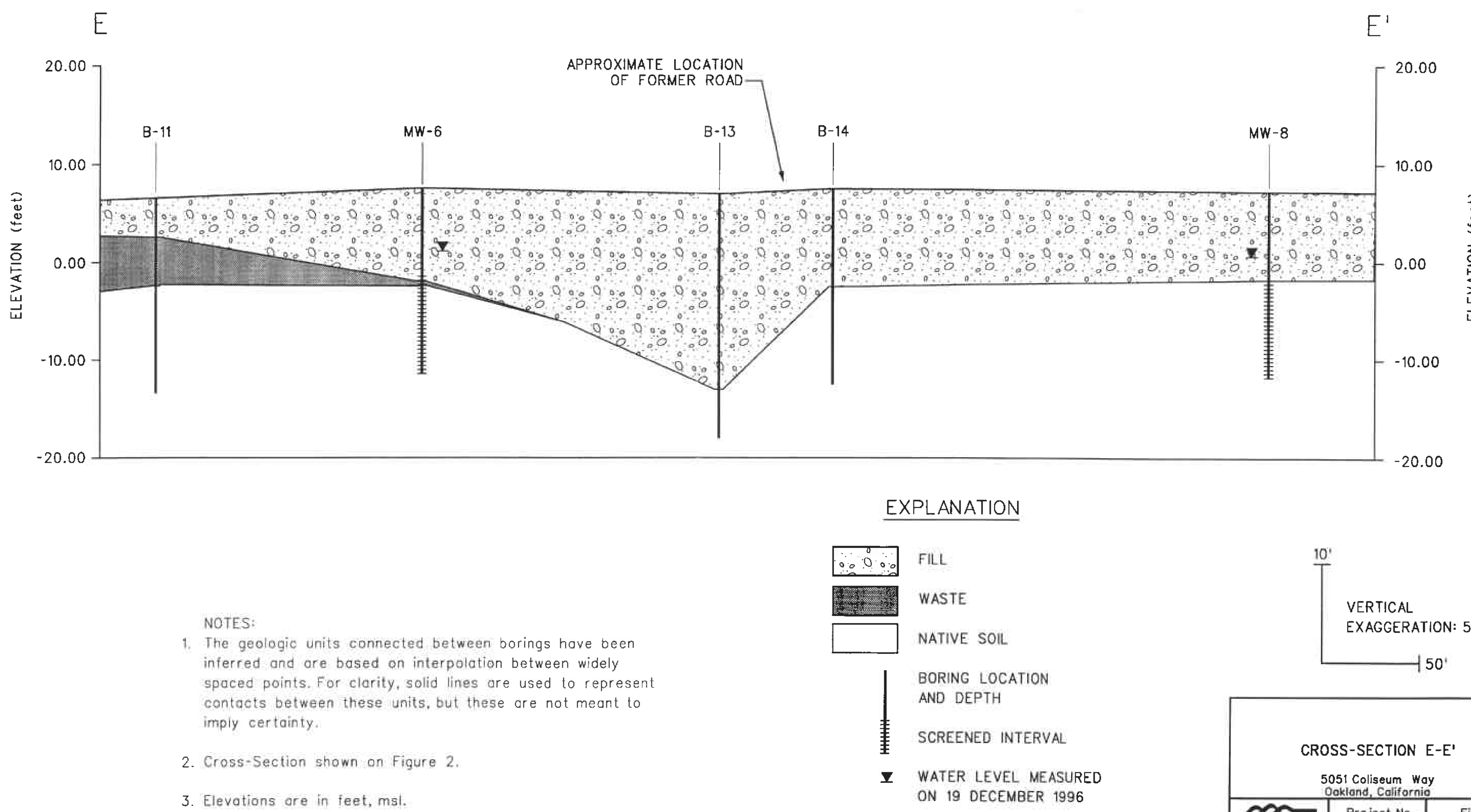
VERTICAL EXAGGERATION: 5x

50'

CROSS-SECTION D-D'

5051 Coliseum Way
Oakland, California

GEOMATRIX	Project No. 2906	Figure 6



NOTES:

1. The geologic units connected between borings have been inferred and are based on interpolation between widely spaced points. For clarity, solid lines are used to represent contacts between these units, but these are not meant to imply certainty.
2. Cross-Section shown on Figure 2.
3. Elevations are in feet, msl.

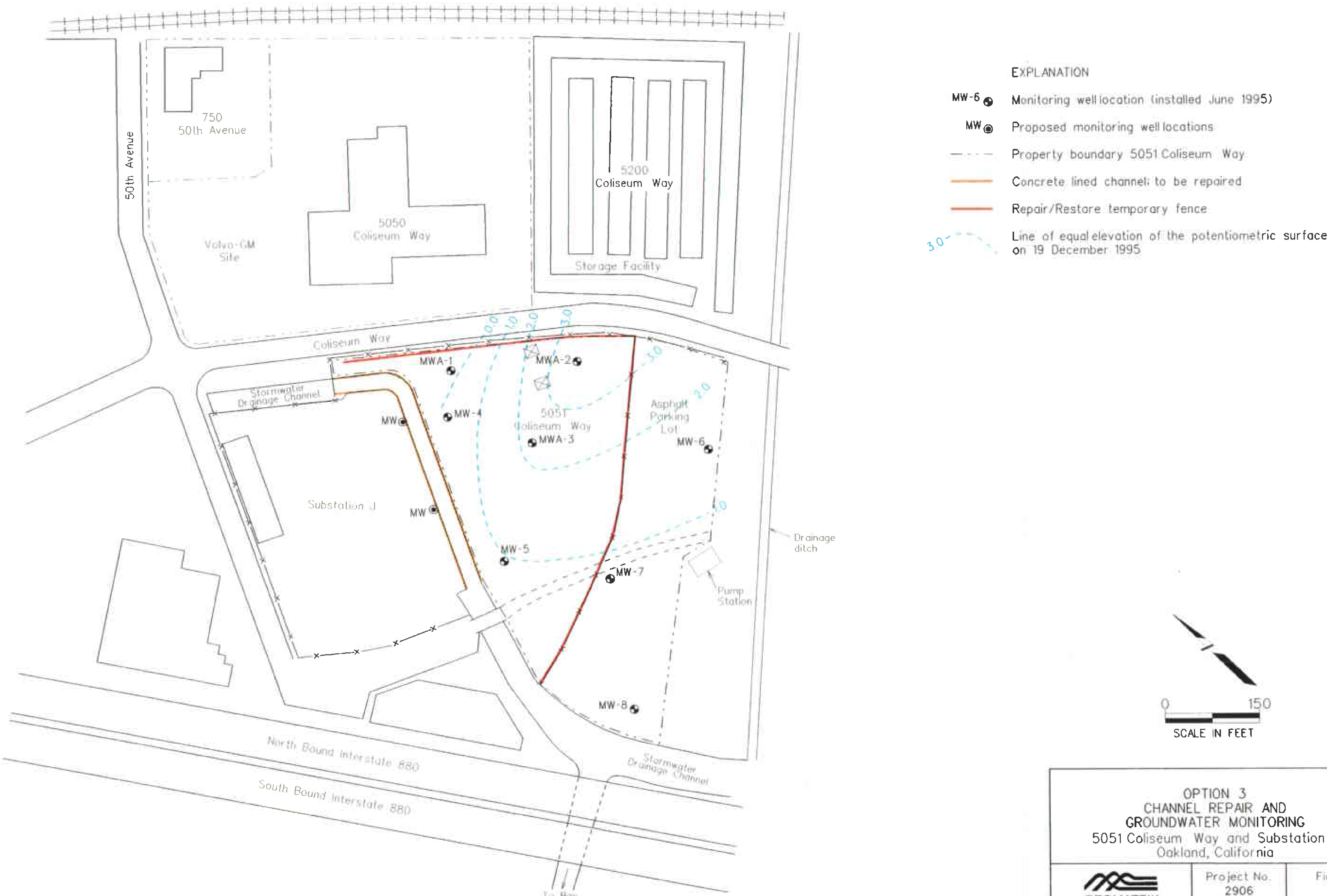
CROSS-SECTION E-E'

5051 Coliseum Way
Oakland, California

GEOMATRIX	Project No. 2906	Figure 7

OPTIONS 1 AND 2
GROUNDWATER MONITORING (OPTION 1)
AND CAP CONSTRUCTION (OPTION 2)
5051 Coliseum Way and Substation J
Oakland, California

GEOMATRIX	Project No. 2906	Figure 8



OPTION 3
CHANNEL REPAIR AND
GROUNDWATER MONITORING
5051 Coliseum Way and Substation J
Oakland, California

GEOMATRIX	Project No. 2906	Figure 9

OPTION 4A
CHANNEL REPAIR AND EXTENSION,
DITCH EXTENSION, CAP CONSTRUCTION
AND GROUNDWATER MONITORING
5051 Coliseum Way and Substation J
Oakland, California

GEOMATRIX	Project No. 2906	Figure 10

OPTION 4B
CHANNEL REPAIR & EXTENSION, DITCH EXTENSION, CAP CONSTRUCTION AND GROUNDWATER MONITORING
5051 Coliseum Way and Substation J
Oakland, California

Project No.	Figure
2906	11

OPTION 5
GROUNDWATER EXTRACTION AND TREATMENT
5051 Coliseum Way and Substation J
Oakland, California

GEOMATRIX	Project No. 2906	Figure 12

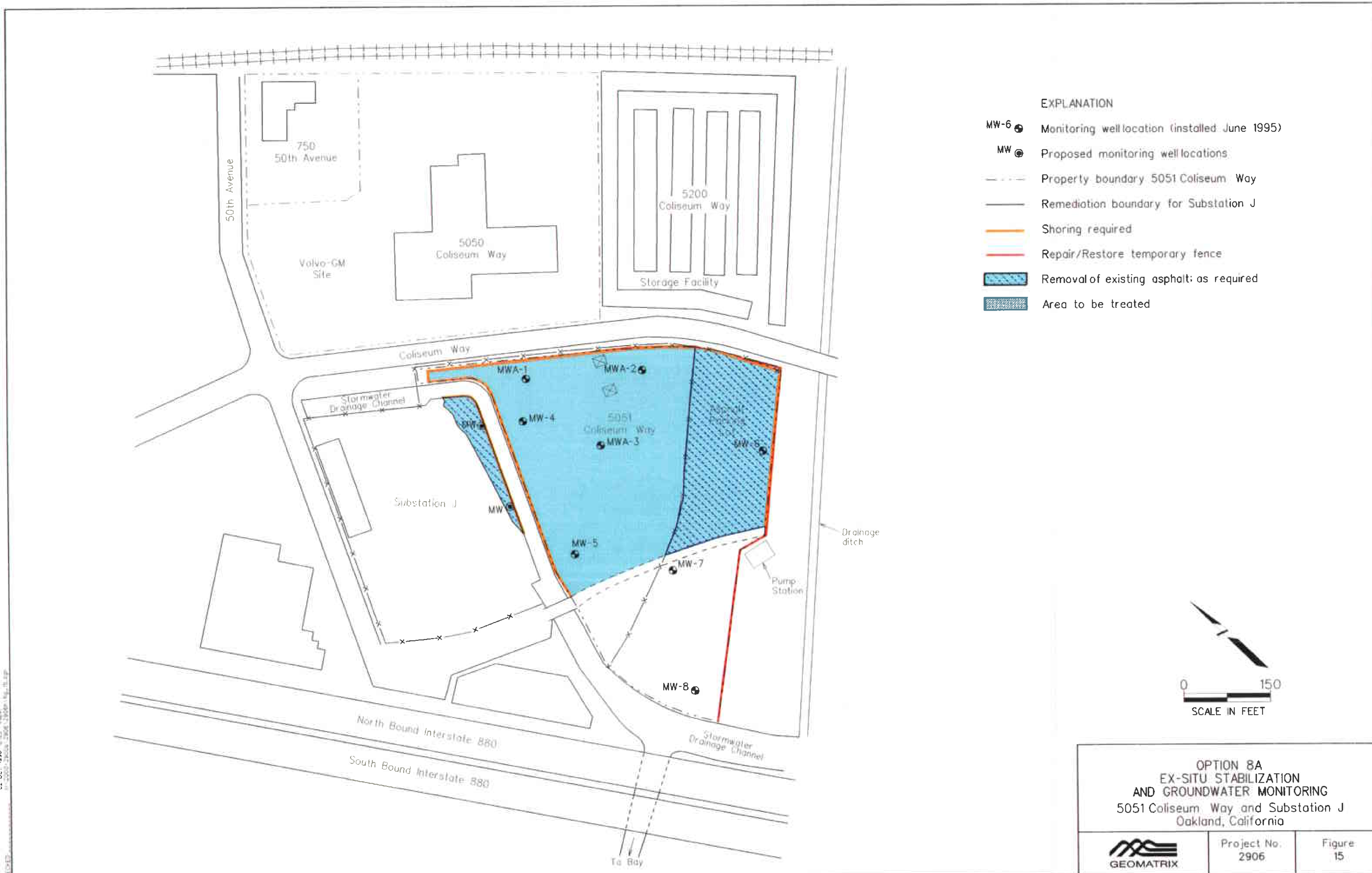
OPTION 6
CUT-OFF WALL, GROUNDWATER EXTRACTION AND TREATMENT, CAP CONSTRUCTION, AND GROUNDWATER MONITORING
5051 Coliseum Way
Oakland, California

GEOMATRIX | Project No. 2906 | Figure 13

OPTION 7
IRON WALL, CAP CONSTRUCTION, AND GROUNDWATER MONITORING

5051 Coliseum Way
Oakland, California

GEOMATRIX	Project No. 2906	Figure 14



OPTION 8A
EX-SITU STABILIZATION
AND GROUNDWATER MONITORING
5051 Coliseum Way and Substation J
Oakland, California

Project No.	Figure
2906	15

OPTION 8B
IN-SITU STABILIZATION,
CAP CONSTRUCTION AND
GROUNDWATER MONITORING
5051 Coliseum Way and Substation J
Oakland, California

GEOMATRIX	Project No. 2906	Figure 16

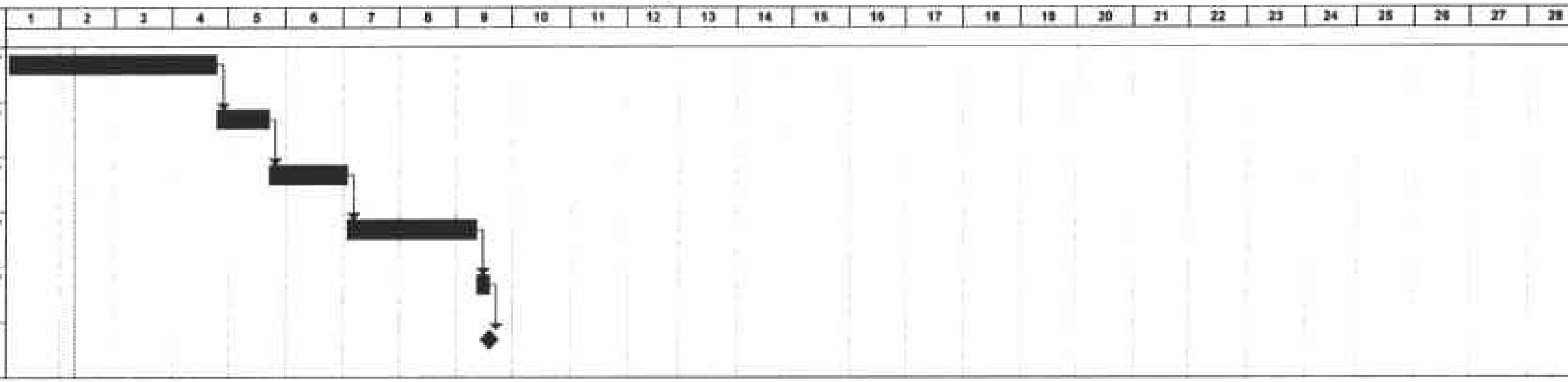
OPTION 9
EXCAVATION AND REMOVAL,
GROUNDWATER MONITORING
5051 Coliseum Way and Substation J
Oakland, California

GEOMATRIX	Project No. 2906	Figure 17

TIME IN MONTHS

IMPLEMENTATION SCHEDULE
OPTION 1 - GROUNDWATER MONITORING ONLY
5051 Coliseum Way

ID	Task Name	Duration
1	HYDROGEOLOGICAL EVALUATION/FEASIBILITY STUDY/RISK ASSESSMENT	10w
2	CLEINT REVIEW AND APPROVAL OF FEASIBILITY STUDY	4w
3	REMEDIAL ACTION PLAN	6w
4	AGENCY REVIEW AND APPROVAL OF REMEDIAL ACTION PLAN/PERMITTING	10w
5	ON-SITE FIELD WORK	1w
6	GROUNDWATER MONITORING (ON-GOING FOR 30 YEARS)	



GEOMATRIX

Project No 2906
PG&E Oakland
Date 4/9/96 5051 COLISEUM WAY

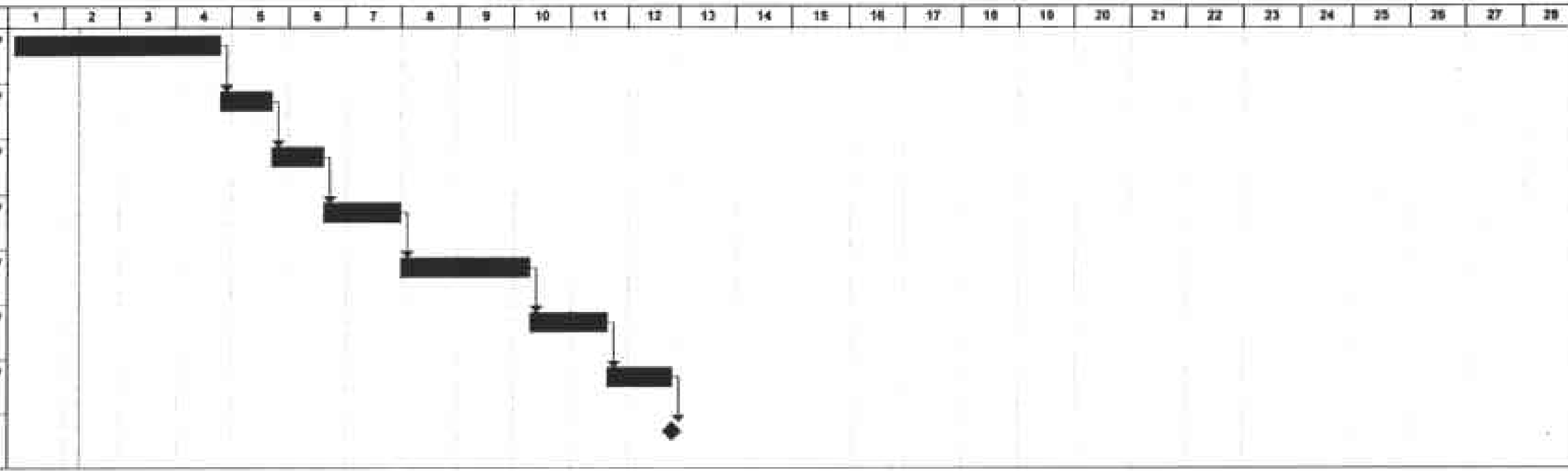
Task	▬	Milestone	◆	Rolled Up Task	▬	Rolled Up Progress	▬
Progress	▬	Summary	▬	Rolled Up Milestone	◇		

Figure 18

TIME IN MONTHS

IMPLEMENTATION SCHEDULE
OPTION 2 - GROUNDWATER MONITORING AND CAP CONSTRUCTION
5051 Coliseum Way

ID	Task Name	Duration
1	HYDROGEOLOGICAL EVALUATION/FEASIBILITY STUDY/RISK ASSESSMENT	10w
2	CLEINT REVIEW AND APPROVAL OF FEASIBILITY STUDY	4w
3	ENGINEERING DESIGN AND SPECIFICATIONS	4w
4	REMEDIAL ACTION PLAN	6w
5	AGENCY REVIEW AND APPROVAL OF REMEDIAL ACTION PLAN/PERMITTING	10w
6	SUBCONTRACTOR PROCUREMENT	6w
7	ON-SITE FIELD WORK/CONSTRUCTION	5w
8	GROUNDWATER MONITORING (ON-GOING FOR 30 YEARS)	



GEOMATRIX

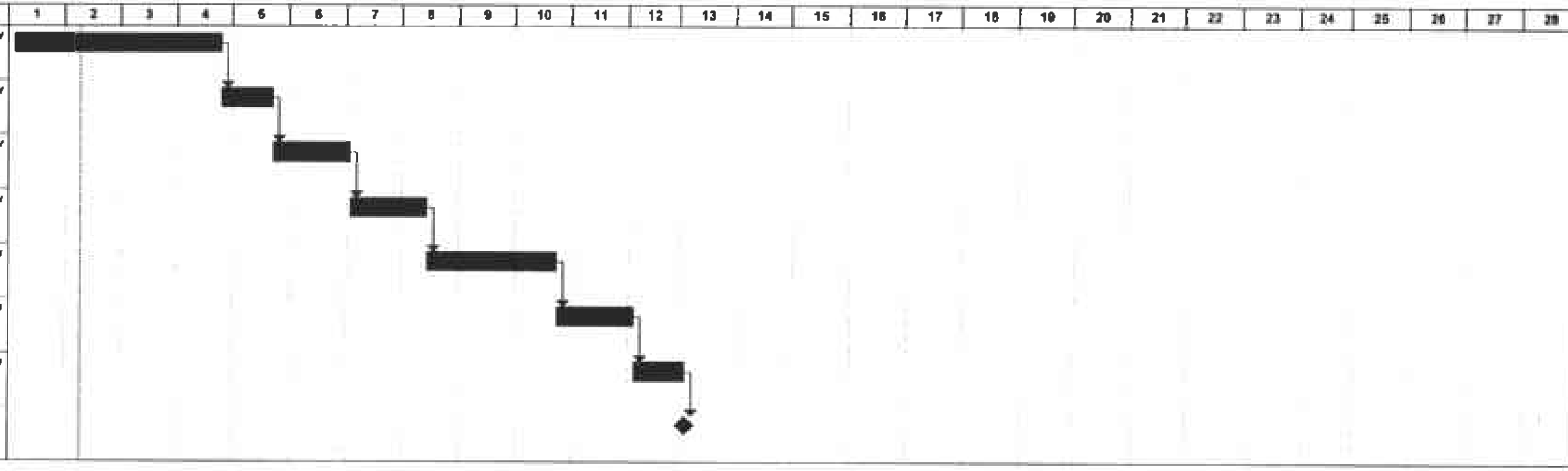
Project No 2906
PG&E Oakland
Date: 4/9/96 5051 COLISEUM WAY

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

TIME IN MONTHS

IMPLEMENTATION SCHEDULE
OPTION 3 - CHANNEL REPAIR AND GROUNDWATER MONITORING
5051 Coliseum Way

ID	Task Name	Duration
1	HYDROGEOLOGICAL EVALUATION/FEASIBILITY STUDY/RISK ASSESSMENT	16w
2	CLEINT REVIEW AND APPROVAL OF FEASIBILITY STUDY	4w
3	ENGINEERING DESIGN AND SPECIFICATIONS	6w
4	REMEDIAL ACTION PLAN	6w
5	AGENCY REVIEW AND APPROVAL OF REMEDIAL ACTION PLAN/PERMITTING	10w
6	SUBCONTRACTOR PROCUREMENT	6w
7	ON-SITE FIELD WORK/CONSTRUCTION	4w
8	GROUNDWATER MONITORING (ON-GOING FOR 30 YEARS)	



GEOMATRIX

Project No 2906
PG&E Oakland
Date: 4/9/98 5051 COLISEUM WAY

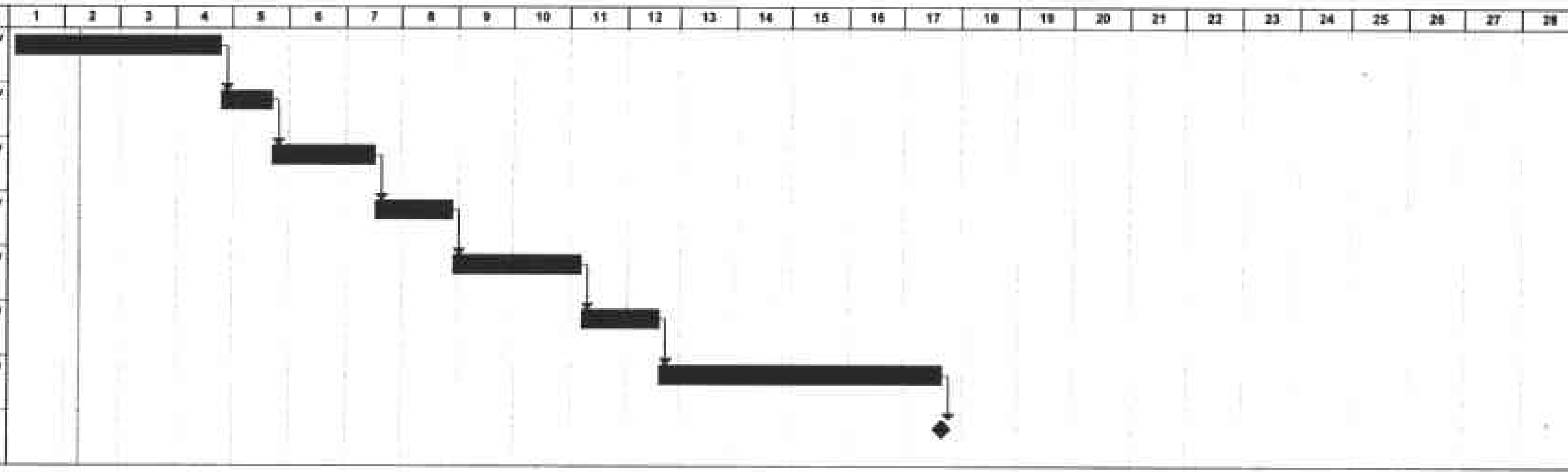
Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

Figure 20

TIME IN MONTHS

IMPLEMENTATION SCHEDULE
OPTION 4B - CHANNEL REPAIR AND EXTENSION (TOWARDS SAN LEANDRO BAY), DITCH EXTENSION,CAP CONSTRUCTION, AND GROUNDWATER MONITORING
5051 Coliseum Way

ID	Task Name	Duration
1	HYDROGEOLOGICAL EVALUATION/FEASIBILITY STUDY/RISK ASSESSMENT	16w
2	CLEINT REVIEW AND APPROVAL OF FEASIBILITY STUDY	4w
3	ENGINEERING DESIGN AND SPECIFICATIONS	8w
4	REMEDIAL ACTION PLAN	6w
5	AGENCY REVIEW AND APPROVAL OF REMEDIAL ACTION PLAN/PERMITTING	10w
6	SUBCONTRACTOR PROCUREMENT	6w
7	ON-SITE FIELD WORK/CONSTRUCTION	22w
8	GROUNDWATER MONITORING (ON-GOING FOR 30 YEARS)	



GEOMATRIX

Project No 2906
PG&E Oakland
Date: 4/9/96 5051 COLISEUM WAY

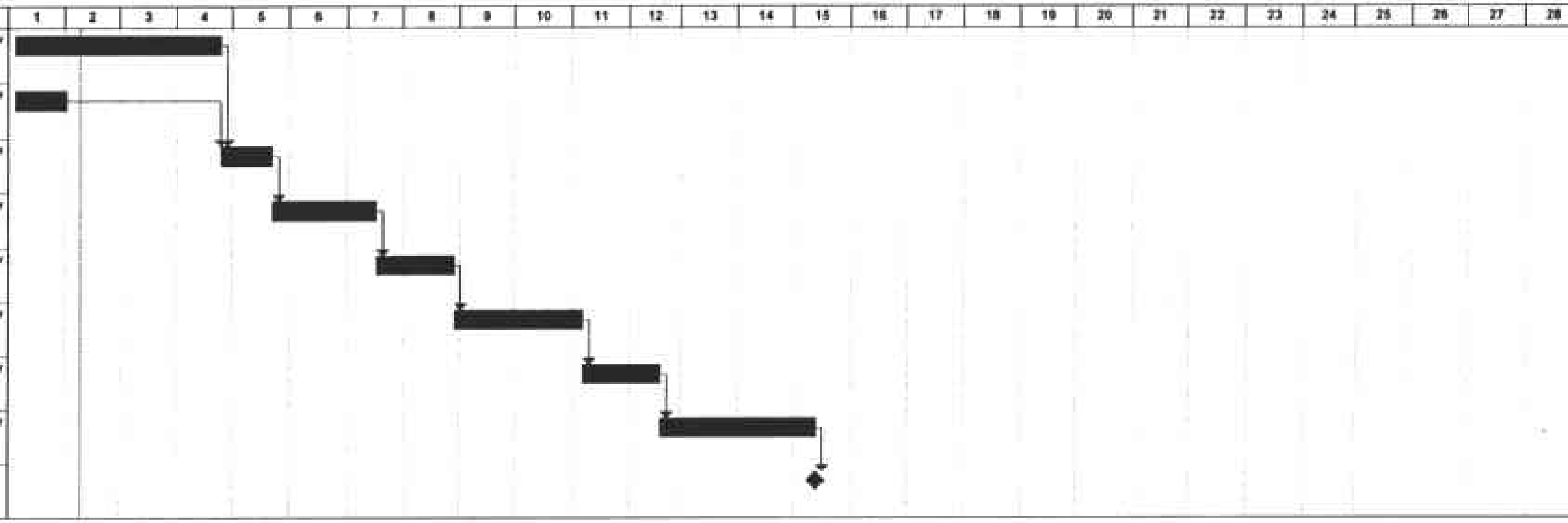
Task | Milestone | Rolled Up Task | Rolled Up Progress
Progress | Summary | Rolled Up Milestone

Figure 22

TIME IN MONTHS

IMPLEMENTATION SCHEDULE
OPTION 5 - GROUNDWATER EXTRACTION AND TREATMENT, CAP CONSTRUCTION, AND GROUNDWATER MONITORING
5051 Coliseum Way

ID	Task Name	Duration
1	HYDROGEOLOGICAL EVALUATION/FEASIBILITY STUDY/RISK ASSESSMENT	16w
2	GROUNDWATER TREATABILITY STUDY	4w
3	CLEINT REVIEW AND APPROVAL OF FEASIBILITY STUDY	4w
4	ENGINEERING DESIGN AND SPECIFICATIONS	8w
5	REMEDIAL ACTION PLAN	6w
6	AGENCY REVIEW AND APPROVAL OF REMEDIAL ACTION PLAN/PERMITTING	10w
7	SUBCONTRACOTR PROCUREMENT	6w
8	ON-SITE FIELD WORK/CONSTRUCTION	12w
9	GROUNDWATER MONITORING (ON-GOING FOR 30 YEARS)	



GEOMATRIX

Project No:2906
PG&E Oakland
Date: 4/9/96 5051 COLISEUM WAY

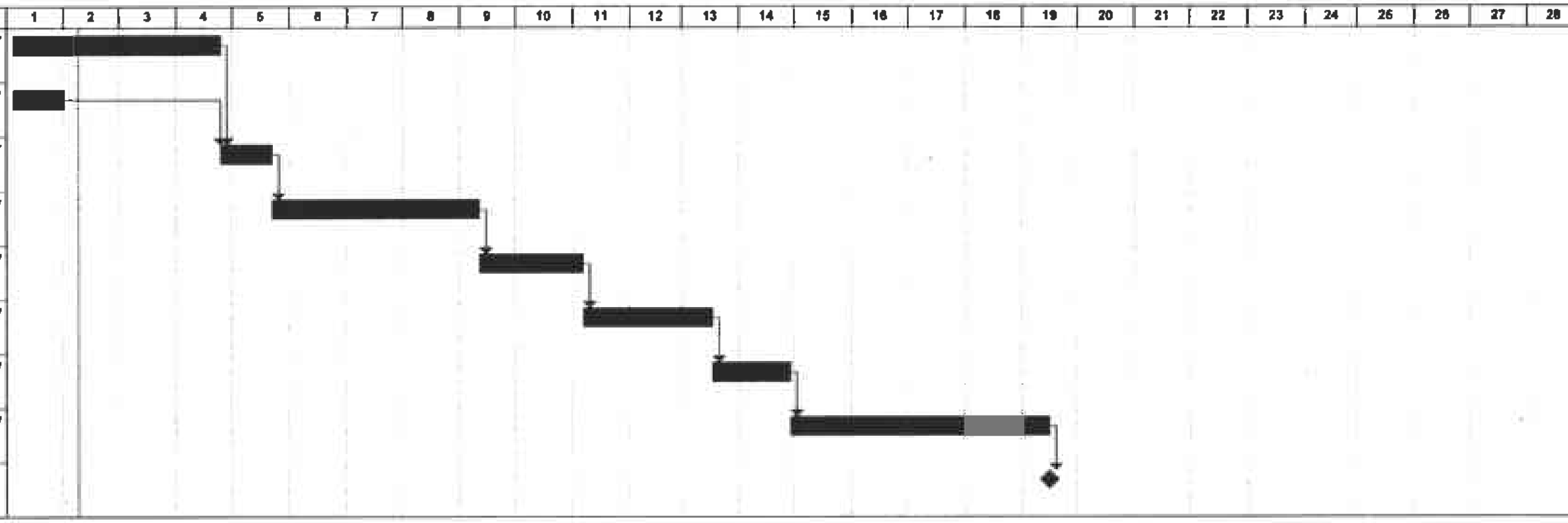
Task	Milestone	Rolled Up Task	Rolled Up Progress
Progress	Summary	Rolled Up Milestone	

Figure 23

TIME IN MONTHS

IMPLEMENTATION SCHEDULE
OPTION 6 - CUT-OFF WALL, GROUNDWATER EXTRACTION AND TREATMENT, CAP CONSTRUCTION, AND GROUNDWATER MONITORING
5051 Coliseum Way

ID	Task Name	Duration
1	HYDROGEOLOGICAL EVALUATION/FEASIBILITY STUDY/RISK ASSESSMENT	16w
2	GROUNDWATER TREATABILITY STUDY	4w
3	CLEINT REVIEW AND APPROVAL OF FEASIBILITY STUDY	4w
4	ENGINEERING DESIGN AND SPECIFICATIONS	16w
5	REMEDIAL ACTION PLAN	8w
6	AGENCY REVIEW AND APPROVAL OF REMEDIAL ACTION PLAN/PERMITTING	10w
7	SUBCONTRACTOR PROCUREMENT	6w
8	ON-SITE FIELD WORK/CONSTRUCTION	20w
9	GROUNDWATER MONITORING (ON-GOING FOR 30 YEARS)	



GEOMATRIX

Project No:2906
PG&E Oakland
Date: 4/9/96 5051 COLISEUM WAY

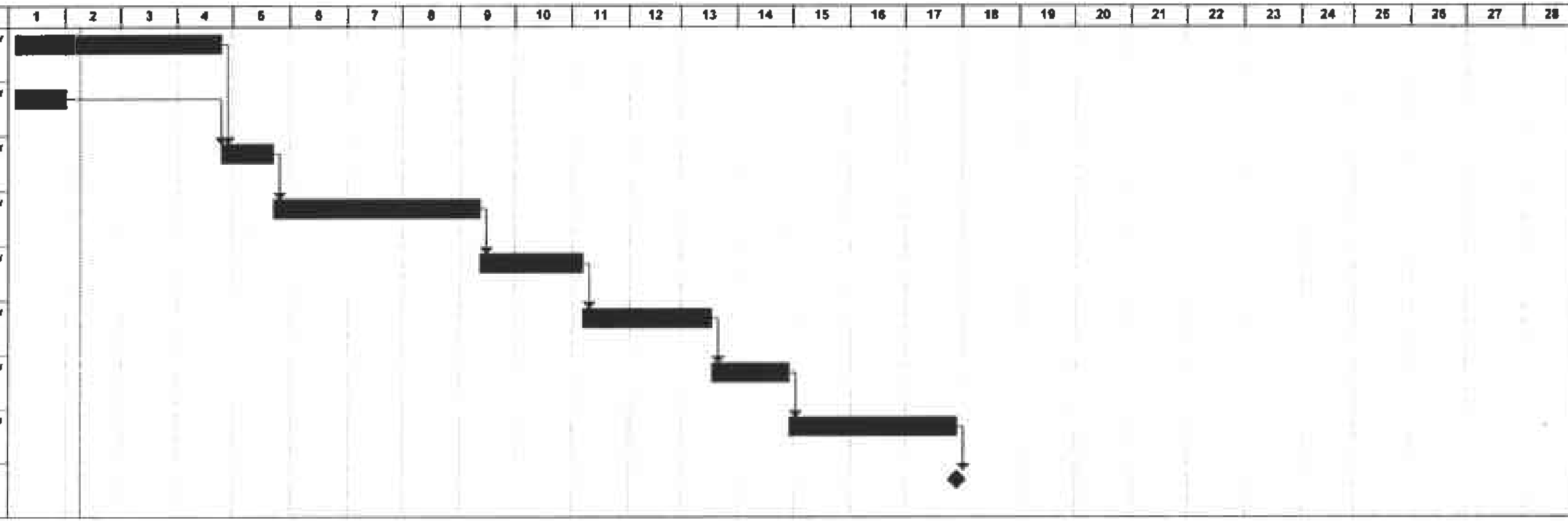
Task | Milestone | Rolled Up Task | Rolled Up Progress
Progress | Summary | Rolled Up Milestone

Figure 24

TIME IN MONTHS

IMPLEMENTATION SCHEDULE
OPTION 7 - IRON WALL, CAP CONSTRUCTION, AND GROUNDWATER MONITORING
5051 Coliseum Way

ID	Task Name	Duration
1	HYDROGEOLOGICAL EVALUATION/FEASIBILITY STUDY/RISK ASSESSMENT	16w
2	LAB TREATABILITY STUDY	4w
3	CLEINT REVIEW AND APPROVAL OF FEASIBILITY STUDY	4w
4	ENGINEERING DESIGN AND SPECIFICATIONS	16w
5	REMEDIAL ACTION PLAN	8w
6	AGENCY REVIEW AND APPROVAL OF REMEDIAL ACTION PLAN/PERMITTING	10w
7	SUBCONTRACTOR PROCUREMENT	6w
8	ON-SITE FIELD WORK/CONSTRUCTION	13w
9	GROUNDWATER MONITORING (ON-GOING FOR 30 YEARS)	



GEOMATRIX

Project No:2906
PG&E Oakland
Date: 4/9/96 5051 COLISEUM WAY

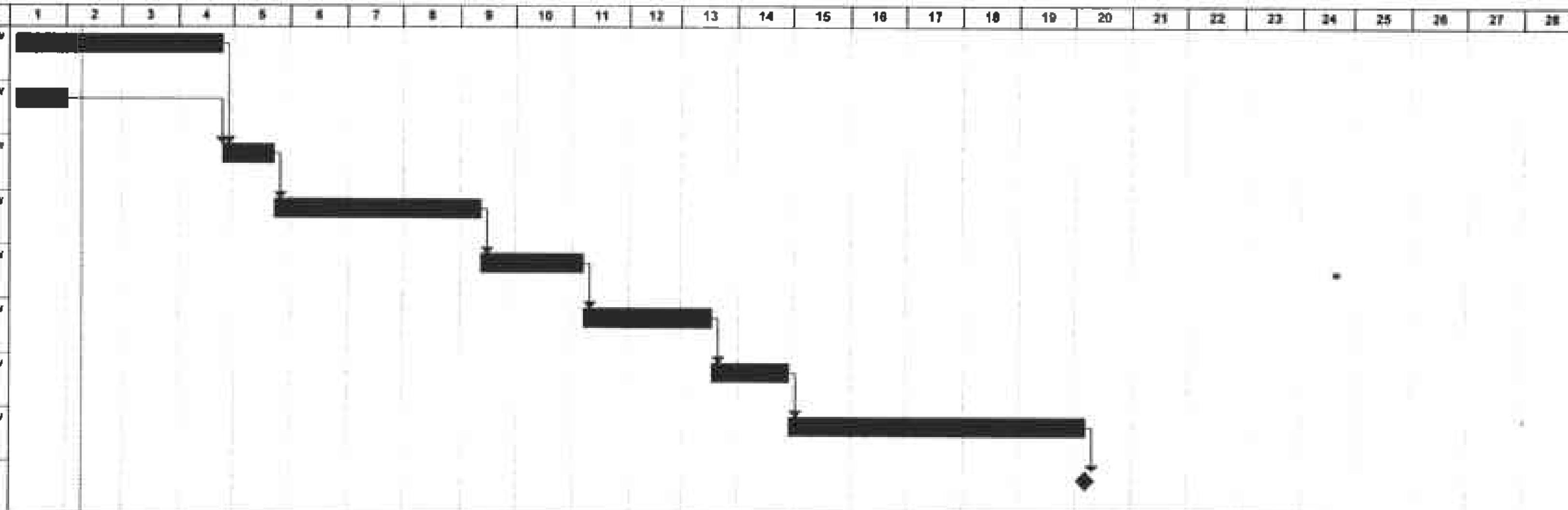
Task | Milestone | Rolled Up Task | Rolled Up Progress
Progress | Summary | Rolled Up Milestone

Figure 25

TIME IN MONTHS

IMPLEMENTATION SCHEDULE
OPTION 8A - EX-SITU STABILIZATION AND GROUNDWATER MONITORING
5051 Coliseum Way

ID	Task Name	Duration
1	HYDROGEOLOGICAL EVALUATION/FEASIBILITY STUDY/RISK ASSESSMENT	16w
2	LAB TREATABILITY STUDY	4w
3	CLEINT REVIEW AND APPROVAL OF FEASIBILITY STUDY	4w
4	ENGINEERING DESIGN AND SPECIFICATIONS	16w
5	REMEDIAL ACTION PLAN	8w
6	AGENCY REVIEW AND APPROVAL OF REMEDIAL ACTION PLAN/PERMITTING	10w
7	SUBCONTRACTOR PROCUREMENT	6w
8	ON-SITE FIELD WORK/CONSTRUCTION	23w
9	GROUNDWATER MONITORING (ON-GOING FOR 30 YEARS)	



GEOMATRIX

Project No:2906
PG&E Oakland
Date: 4/9/96 5051 COLISEUM WAY

Task | Milestone | Rolled Up Task | Rolled Up Progress
Progress | Summary | Rolled Up Milestone

Figure 26

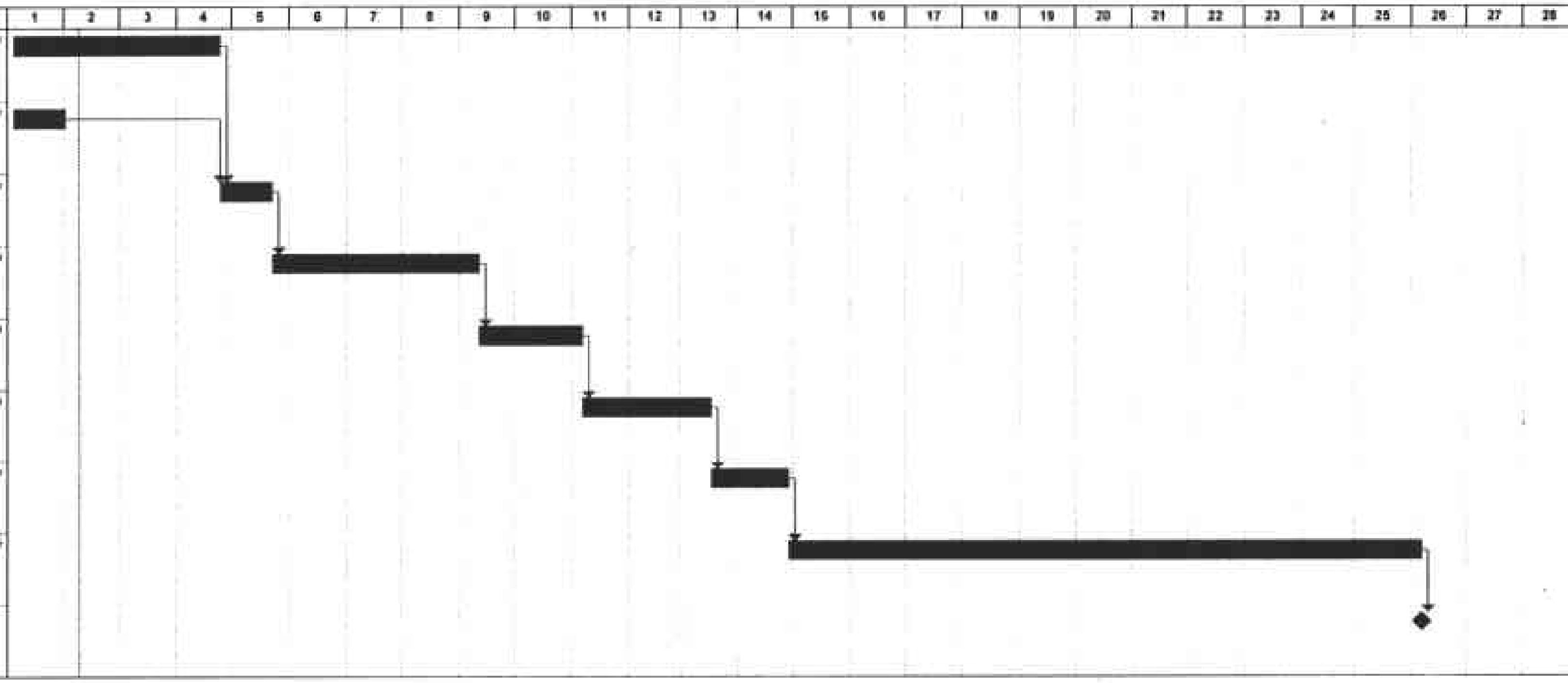
TIME IN MONTHS

IMPLEMENTATION SCHEDULE

OPTION 8B - IN-SITU STABILIZATION, CAP CONSTRUCTION, AND GROUNDWATER MONITORING

5051 Coliseum Way

ID	Task Name	Duration
1	HYDROGEOLOGICAL EVALUATION/FEASIBILITY STUDY/RISK ASSESSMENT	16w
2	LAB TREATABILITY STUDY	4w
3	CLEINT REVIEW AND APPROVAL OF FEASIBILITY STUDY	4w
4	ENGINEERING DESIGN AND SPECIFICATIONS	16w
5	REMEDIAL ACTION PLAN	8w
6	AGENCY REVIEW AND APPROVAL OF REMEDIAL ACTION PLAN/PERMITTING	10w
7	SUBCONTRACTOR PROCUREMENT	6w
8	ON-SITE FIELD WORK/CONSTRUCTION	49w
9	GROUNDWATER MONITORING (ON-GOING FOR 30 YEARS)	



GEOMATRIX

Project No.2906
PG&E Oakland
Date: 4/9/95 5051 COLISEUM WAY

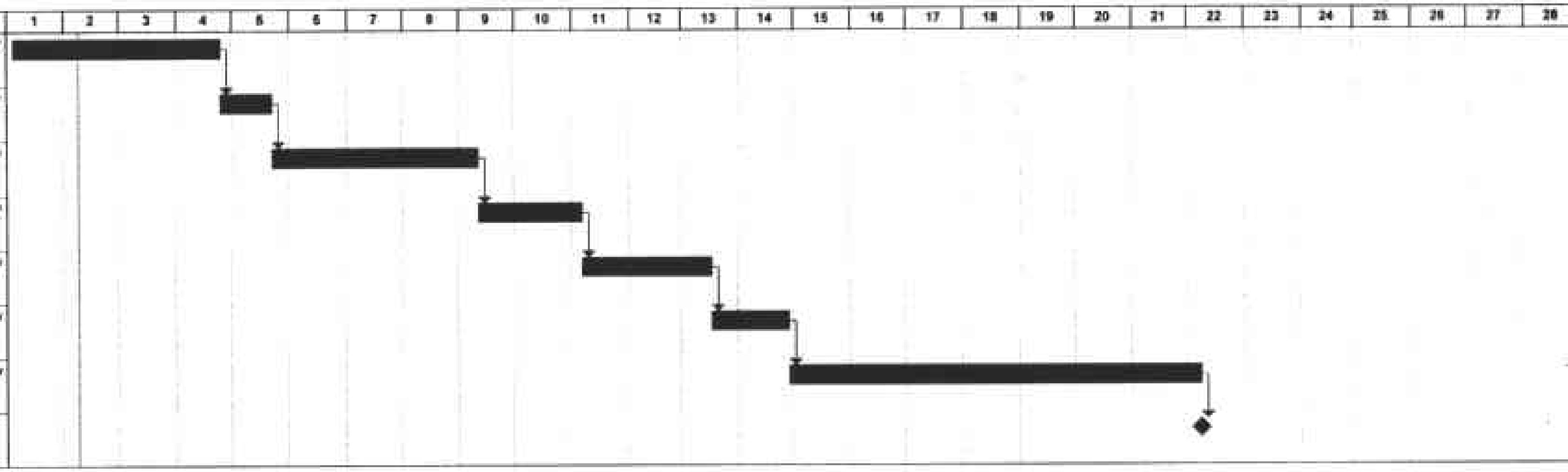
Task | Milestone | Rolled Up Task | Rolled Up Progress
Progress | Summary | Rolled Up Milestone

Figuare 27

TIME IN MONTHS

IMPLEMENTATION SCHEDULE
OPTION 9 - EXCAVATION AND BACKFILL AND GROUNDWATER MONITORING
5051 Coliseum Way

ID	Task Name	Duration
1	HYDROGEOLOGICAL EVALUATION/FEASIBILITY STUDY/RISK ASSESSMENT	16w
2	CLEINT REVIEW AND APPROVAL OF FEASIBILITY STUDY	4w
3	ENGINEERING DESIGN AND SPECIFICATIONS	16w
4	REMEDIAL ACTION PLAN	8w
5	AGENCY REVIEW AND APPROVAL OF REMEDIAL ACTION PLAN/PERMITTING	10w
6	SUBCONTRACTOR PROCUREMENT	6w
7	ON-SITE FIELD WORK/CONSTRUCTION	32w
8	GROUNDWATER MONITORING (ON-GOING FOR 30 YEARS)	



GEOMATRIX

Project No.2906
PG&E Oakland
Date: 4/9/96 5051 COLISEUM WAY

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

Figure 28

OPTION 1
GROUNDWATER MONITORING ONLY - 5051 Coliseum Way

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
hydrogeological evaluation/modeling	200	hour	100	20,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
remedial action plan	280	hour	100	28,000
permitting and regulatory interaction	160	hour	100	16,000
project management (10% of engineering cost)				11,400
contingency (15% of engineering cost)				18,800

Total Engineering Cost: $144,000

II. CONSTRUCTION COSTS
A. SITE PREPARATION

repair/restore permanent site security fence	1250	linear feet	15	18,800
engineer's oversight (includes procurement costs)	20	hour	100	2,000
project management (10% of construction cost)				2,100
contingency (15% of construction cost)				3,400

Total Construction Cost: $26,000

III. ANNUAL O&M COSTS
A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first two years ($6,000/quarter)	8	lump sum	6000	48,000
semiannual monitoring and reporting for next 28 years ($6000/event)	28	lump sum	12000	336,000
5-year evaluation report ($21,000 every 5 years)	6	lump sum	21000	126,000
project management (10% of annual O&M cost)				51,000
contingency (15% of annual O&M costs)				84,200

Total O&M Cost: $645,000
30-Year Present Value O&M Cost: $296,000

ESTIMATED 30-YEAR COST: $466,000

Notes:
1. Based on available data, it is assumed that there are no underground utilities at the site.
2. A net interest rate of 6% was assumed.
3. Groundwater monitoring requirements may be modified during the permitting phase of the project.
4. It is assumed that no additional monitoring wells will be required.

GEOMATRIX

OPTION 2
GROUNDWATER MONITORING AND CAP CONSTRUCTION - 5051 Coliseum Way

I. ENGINEERING COST

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
hydrogeological evaluation/modeling	200	hour	100	20,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
remedial action plan	280	hour	100	28,000
engineering design	80	hour	100	8,000
specifications and drawings	80	hour	100	8,000
permitting and regulatory interaction	160	hour	100	16,000
project management (10% of engineering cost)				13,000
contingency (15% of engineering cost)				21,500

Total Engineering Cost: $165,000

II. CONSTRUCTION COSTS

A. SITE PREPARATION

temporary site security fence	1250	linear feet	2	2,500
engineer's oversight (includes procurement costs)	20	hour	100	2,000

B. CAP CONSTRUCTION

existing asphalt removal (only on south portion of site)	47000	square foot	0.7	32,900
asphalt disposal (@165 pcf, 6-inch thick)	1940	ton	10	19,400
regrade site	160000	square foot	1.3	208,000
1 foot of aggregate base (@ 140 pcf)	11500	ton	20	230,000
6-inch thick asphalt cap (includes mob/demob)	160000	square foot	3	480,000
construction oversight (2 people for 4 weeks)	400	hour	100	40,000

C. MISCELLANEOUS

procurement	100	hour	100	10,000
project management (10% of construction cost)				102,500
contingency (15% of construction cost)				169,100

Total Construction Cost: $1,296,000

III. ANNUAL O&M COSTS

A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($6,000/quarter)	8	lump sum	6000	48,000
semiannual monitoring and reporting for next 28 years ($6000/event)	28	lump sum	12000	336,000
5-year evaluation report ($21,000 every 5 years)	6	lump sum	21000	126,000
project management (10% of annual O&M cost)				51,000
contingency (15% of annual O&M costs)				84,200

Total O&M Cost: $645,200
30-Year Present Value O&M Cost: $296,000

ESTIMATED 30-YEAR COST: $1,757,000

GEOMATRIX

OPTION 2
GROUNDWATER MONITORING AND CAP CONSTRUCTION - 5051 Coliseum Way

Notes:
1. Based on available data, it is assumed that there are no underground utilities at the site.
2. A net interest rate of 6% was assumed.
3. Groundwater monitoring requirements may be modified during the permitting phase of the project.
4. It is assumed that no additional monitoring wells will be required.

GEOMATRIX

OPTION 3
CHANNEL REPAIR AND GROUNDWATER MONITORING - 5051 Coliseum Way

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
hydrogeological evaluation/modeling	200	hour	100	20,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
field inspection of channel lining	50	hour	100	5,000
engineering design	120	hour	100	12,000
specifications and drawings	80	hour	100	8,000
remedial action plan	280	hour	100	28,000
permitting and regulatory interaction	160	hour	100	16,000
project management (10% of engineering cost)				13,900
contingency (15% of engineering cost)				22,900

Total Engineering Cost: $175,800

II. CONSTRUCTION COSTS

A. SITE PREPARATION

install temporary facilities (e.g., trailer, utilities, etc.)	1	lump sum	5000	5,000
operation of temporary facilities	2	month	1500	3,000
temporary site security fence	1250	linear foot	2	2,500
engineer's oversight of site preparation	20	hour	100	2,000

B. CHANNEL REPLACEMENT

water diversion	1	month	4000	4,000
channel repair	140	linear foot	900	126,000
on-site health and safety (20 hours/week)	60	hour	100	6,000
on-site construction management (1.5 people for 3 weeks)	225	hour	100	22,500

C. MISCELLANEOUS

procurement costs	100	hour	100	10,000
project management (10% of construction cost)				18,100
contingency (15% of construction cost)				29,900

Total Construction Cost: $229,000

III. ANNUAL O&M COSTS

A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($6,000/quarter)	8	lump sum	6000	48,000
semiannual monitoring and reporting for next 28 years ($6000/event)	28	lump sum	12000	336,000
5-year evaluation report ($21,000 every 5 years)	6	lump sum	21000	126,000
project management (10% of annual O&M cost)				51,000
contingency (15% of annual O&M costs)				84,200

Total O&M Cost: $645,000
30-Year Present Value O&M Cost: $296,000

ESTIMATED 30-YEAR COST: $701,000

GEOMATRIX

OPTION 3
CHANNEL REPAIR AND GROUNDWATER MONITORING - 5051 Coliseum Way

Notes:
1. Based on available data, it is assumed that there are no underground utilities at the site.
2. A net interest rate of 6% was assumed.
3. It is assumed that approximately 25% of the length of the lined channel will require repair. This number will be revised following the site inspection.
4. The cost of the channel repair is based on a conservative assumption that the channel will be demolished and replaced to repair it. After the field investigation, it may be determined that a less expensive method of repair (e.g., chip concrete and patch or epoxy injection) could be done.
5. For the water diversion cost, it is assumed that the channel is always active.
6. The channel is assumed to be 30 feet wide, 10 feet deep and constructed of 8-inch-thick reinforced concrete.
7. Groundwater monitoring requirements may be modified during the permitting phase of the project.
8. It is assumed no additional monitoring wells will be required.

GEOMATRIX

OPTION 4A
CHANNEL REPAIR AND EXTENSION, DITCH EXTENSION, CAP CONSTRUCTION AND GROUNDWATER MONITORING - 5051 Coliseum Way

I. ENGINEERING COST

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
hydrogeological evaluation/modeling	400	hour	100	40,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
field inspection of channel	80	hour	100	8,000
engineering design	160	hour	100	16,000
specifications and drawings	100	hour	100	10,000
remedial action plan	280	hour	100	28,000
permitting and regulatory interaction	160	hour	100	16,000
project management (10% of engineering cost)				16,800
contingency (15% of engineering cost)				27,700

Total Engineering Cost: $213,000

II. CONSTRUCTION COSTS

A. SITE PREPARATION

Install temporary facilities (e.g., trailer, utilities, etc.)	1	lump sum	5000	5,000
operation of temporary facilities	4	month	1500	6,000
temporary site security fence	1250	linear foot	2	2,500
engineer's oversight of site preparation	20	hour	100	2,000

B. CHANNEL REPAIR AND EXTENSION

repair channel	140	linear foot	900	126,000
excavate soil for channel extension	750	cubic yard	10	7,500
disposal of soil from excavation (as non-RCRA hazardous)	750	cubic yard	300	225,000
install channel lining (includes mob/demob, materials)	250	linear foot	500	125,000
water diversion	3	month	4000	12,000
on-site health and safety (20 hours/week)	160	hour	100	16,000
on-site construction management (1 person for 8 weeks)	400	hour	100	40,000

C. DRAINAGE DITCH EXTENSION

excavate soil from ditch	400	cubic yard	10	4,000
disposal of soil from excavation (as non-hazardous)	400	cubic yard	80	32,000
install channel lining (includes mob/demob, materials)	400	linear foot	200	80,000
water diversion	2	month	2000	4,000
on-site health and safety (20 hours/week)	50	hour	100	5,000
on-site construction management (1 person for 4 weeks)	200	hour	100	20,000

D. CAP CONSTRUCTION

existing asphalt removal (only on south portion of site)	47000	square foot	0.7	32,900
asphalt disposal (@165 pcf, 6-inch-thick)	1940	ton	10	19,400
regrade site	160000	square foot	1.3	208,000
1 foot of aggregate base(@ 140 pcf)	11500	ton	20	230,000
6-inch-thick asphalt cap (includes mob/demob)	160000	square foot	3	480,000
construction management (2 people for 3 weeks)	400	hour	100	40,000

E. MISCELLANEOUS

procurement costs	100	hour	100	10,000
project management (10% of construction cost)				173,200
contingency (15% of construction cost)				285,800

Total Construction Cost: $2,191,000

GEOMATRIX

OPTION 4A
CHANNEL REPAIR AND EXTENSION, DITCH EXTENSION, CAP CONSTRUCTION AND GROUNDWATER MONITORING - 5051 Coliseum Way

III. ANNUAL O&M COSTS

A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($6,000/quarter)	8	lump sum	6000	48,000
semiannual monitoring and reporting for next 28 years ($6000/event)	28	lump sum	12000	336,000
5-year evaluation report ($21,000 every 5 years)	6	lump sum	21000	126,000
project management (10% of annual O&M cost)				51,000
contingency (15% of annual O&M costs)				84,200

Total O&M Cost: **$645,000**
30-Year Present Value O&M Cost: **$296,000**

ESTIMATED 30-YEAR COST: **$2,700,000**

Notes:
1. It is assumed that no additional monitoring wells will be required.
2. It is assumed that approximately 25% of the length of the lined channel will require repair. This number will be revised following the site investigation.
3. Groundwater monitoring requirements may be modified during the permitting phase of the project.
4. The cost of the channel repair is based on a conservative assumption that the channel will be demolished and replaced to repair it. After the field investigation, it may be determined that a less expensive method of repair (e.g., chip concrete and patch or epoxy injection) could be done. Channel extension will match the materials and configuration of the existing channel which is assumed to be 30 feet wide, 10 feet deep and constructed of 8-inch-thick reinforced concrete. Drainage ditch extension is assumed to be 10 feet wide, 5 feet deep and constructed of 8-inch-thick reinforced concrete.
5. It is assumed that 3 cubic yards of soil will be excavated per linear foot of channel extension and 1 cubic yard of soil will be excavated per linear foot of drainage ditch construction.
6. Based on available data, it is assumed that there are no underground utilities at the site.
7. A net interest rate of 6% was assumed.
8. If soil from the drainage ditch excavation requires disposal as hazardous waste, there would be an additional construction cost of $88,000. Analysis of soil will be required at the design stage to determine this.
9. If it is determined that a cap is not required for this option, the estimated 30-year cost would be reduced by approximately $1,000,000.

GEOMATRIX

OPTION 4B
CHANNEL REPAIR AND EXTENSION (TOWARDS SAN LEANDRO BAY), DITCH EXTENSION, CAP CONSTRUCTION AND GROUNDWATER MONITORING - 5051 Coliseum Way

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
hydrogeological evaluation/modeling	400	hour	100	40,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
field inspection of channel	80	hour	100	8,000
engineering design	160	hour	100	16,000
specifications and drawings	100	hour	100	10,000
remedial action plan	280	hour	100	28,000
permitting and regulatory interaction	160	hour	100	16,000
project management (10% of engineering cost)				16,800
contingency (15% of engineering cost)				27,700

Total Engineering Cost: $213,000

II. CONSTRUCTION COSTS

A. SITE PREPARATION

Install temporary facilities (e.g., trailer, utilities, etc.)	1	lump sum	5000	5,000
operation of temporary facilities	4	month	1500	6,000
temporary site security fence	1250	linear foot	2	2,500
engineer's oversight of site preparation	20	hour	100	2,000

B. CHANNEL REPAIR AND EXTENSION

repair channel	140	linear foot	900	126,000
excavate soil for channel extension	2700	cubic yard	10	27,000
disposal of soil from excavation (as non-RCRA hazardous)	2700	cubic yard	300	810,000
install channel lining (includes mob/demob, materials)	900	linear foot	500	450,000
water diversion	4	month	4000	16,000
on-site health and safety (20 hours/week)	240	hour	100	24,000
on-site construction management (1 person for 12 weeks)	600	hour	100	60,000

C. DRAINAGE DITCH EXTENSION

excavate soil from ditch	650	cubic yard	10	6,500
disposal of soil from excavation (as non-hazardous)	650	cubic yard	80	52,000
install channel lining (includes mob/demob, materials)	650	linear foot	200	130,000
water diversion	2	month	2000	4,000
on-site health and safety (20 hours/week)	50	hour	100	5,000
on-site construction management (1 person for 6 weeks)	300	hour	100	30,000

D. CAP CONSTRUCTION

existing asphalt removal (only on south portion of site)	47000	square foot	0.7	32,900
asphalt disposal (@165 pcf, 6-inch-thick)	1940	ton	10	19,400
regrade site	160000	square foot	1.3	208,000
1 foot of aggregate base(@ 140 pcf)	11500	ton	20	230,000
6-inch-thick asphalt cap (includes mob/demob)	160000	square foot	3	480,000
construction management (2 people for 3 weeks)	400	hour	100	40,000

E. MISCELLANEOUS

procurement costs	100	hour	100	10,000
project management (10% of construction cost)				277,600
contingency (15% of construction cost)				458,100

Total Construction Cost: $3,512,000

GEOMATRIX

OPTION 4B
CHANNEL REPAIR AND EXTENSION (TOWARDS SAN LEANDRO BAY), DITCH EXTENSION, CAP CONSTRUCTION AND GROUNDWATER MONITORING - 5051 Coliseum Way

III. ANNUAL O&M COSTS

A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($6,000/quarter)	8	lump sum	6000	48,000
semiannual monitoring and reporting for next 28 years ($6000/event)	28	lump sum	12000	336,000
5-year evaluation report ($21,000 every 5 years)	6	lump sum	21000	126,000
project management (10% of annual O&M cost)				51,000
contingency (15% of annual O&M costs)				84,200

Total O&M Cost: **$645,000**
30-Year Present Value O&M Cost: **$296,000**

ESTIMATED 30-YEAR COST: **$4,021,000**

Notes:
1. It is assumed that no additional monitoring wells will be required.
2. It is assumed that approximately 25% of the length of the lined channel will require repair. This number will be revised following the site investigation.
3. Groundwater monitoring requirements may be modified during the permitting phase of the project.
4. The cost of the channel repair is based on a conservative assumption that the channel will be demolished and replaced to repair it. After the field investigation, it may be determined that a less expensive method of repair (e.g., chip concrete and patch or epoxy injection) could be done. Channel extension will match the materials and configuration of the existing channel which is assumed to be 30 feet wide, 10 feet deep and constructed of 8-inch-thick reinforced concrete. Drainage ditch extension is assumed to be 10 feet wide, 5 feet deep and constructed of 8-inch-thick reinforced concrete.
5. It is assumed that 3 cubic yards of soil will be excavated per linear foot of channel extension and 1 cubic yards of soil will be excavated per linear foot of drainage ditch construction.
6. Based on available data, it is assumed that there are no underground utilities at the site.
7. A net interest rate of 6% was assumed.
8. If soil from the excavations requires disposal as hazardous waste, there would be an additional construction cost of $143,000. Analysis of soil will be required at the design stage to determine this.
9. If it is determined that a cap is not required for this option, the estimated 30-year cost would be reduced by approximately $1,000,000.

GEOMATRIX

OPTION 5A
GROUNDWATER EXTRACTION, TREATMENT (EVAPORATOR/DRYER)
CAP CONSTRUCTION AND GROUNDWATER MONITORING - 5051 Coliseum Way

I. ENGINEERING COST

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
lab treatability study/field pilot study	1	lump sum	8500	8,500
hydrogeological evaluation/modeling	500	hour	100	50,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
engineering design	200	hour	100	20,000
specifications and drawings	120	hour	100	12,000
remedial action plan	280	hour	100	28,000
permitting and regulatory interaction	160	hour	100	16,000
system start-up	1	lump sum	21000	21,000
project management (10% of engineering cost)				20,600
contingency (15% of engineering cost)				33,900

Total Engineering Cost: 260,000

II. CONSTRUCTION COSTS

A. SITE PREPARATION

Install temporary facilities (e.g., trailer, utilities, etc.)	1	lump sum	5000	5,000
operation of temporary facilities	3	month	1500	4,500
install temporary security fence	1250	linear foot	2	2,500
engineer's oversight of site preparation	20	hour	100	2,000

B. REMEDIATION

EXTRACTION TRENCHES

mob/demob, trenching (includes piping, gravel, paving), soil disposal	1	lump sum	100,000	100,000
soil disposal (50% non-hazardous, 50% non-RCRA hazardous)	1125	cubic yard	190	213,750
extraction pump and head equipment	1	each	3,500	3,500
extraction trenching with pipe and backfill	1000	linear foot	75	75,000
on-site health and safety (5 hrs/wk)	10	hour	100	1,000
construction management (1.5 people for 2 weeks)	150	hour	100	15,000

TREATMENT SYSTEM - Evaporator/Dryer

concrete pad	1	lump sum	8,400	8,400
fencing	1	lump sum	15,800	15,800
awning	1	lump sum	15,000	15,000
evaporator	1	lump sum	262,500	262,500
spray dryer	1	lump sum	220,500	220,500
boiler for steam generation (50 bhp)	1	lump sum	52,500	52,500
solids handling equipment dried solids drummed from bag filter	1	lump sum	52,500	52,500
tax and delivery on major equipment			12%	70,600
system piping/supports	1	lump sum	13,000	13,000
equalization tank, secondary and seismic	1	lump sum	3,700	3,700
pressure gauges, valves/ports, flow meter	1	lump sum	5,300	5,300
bag filter for dried solids	1	each	850	850
flow metering system-electronic	1	each	3,200	3,200
transfer pump	2	each	1,600	3,200
natural gas service for boiler	1	lump sum	4,000	4,000
electrical service	1	lump sum	8,000	8,000
field electrical wiring	1	lump sum	5,300	5,300
electrical control panel fabrication	1	lump sum	21,000	21,000
contractor installation	1	lump sum	31,500	31,500
on-site health and safety (5 hrs/wk)	15	hour	100	1,500
construction management (2 people for 3 weeks)	300	hour	100	30,000

GEOMATRIX

OPTION 5A
GROUNDWATER EXTRACTION, TREATMENT (EVAPORATOR/DRYER) CAP CONSTRUCTION AND GROUNDWATER MONITORING - 5051 Coliseum Way

C. CAP CONSTRUCTION

existing asphalt removal (only on south portion of site)	47000	square foot	0.7	32,900
asphalt disposal (@165 pcf, 6-inch-thick)	1940	ton	10	19,400
regrade site	160000	square foot	1.3	208,000
1 foot of aggregate base (@ 140 pcf)	11500	ton	20	230,000
6-inch-thick asphalt cap (includes mob/demob)	160000	square foot	3	480,000
construction management (2 people for 4 weeks)	400	hour	100	40,000

D. MISCELLANEOUS

procurement costs	100	hour	100	10,000
project management (10% of construction cost)				227,100
contingency (15% of construction cost)				340,600

Total Construction Cost: $2,839,000

III. ANNUAL O&M COSTS

(assuming precipitate disposal as a non-RCRA hazardous waste)

steam generation (785,000 btu/hr)	86000	therms	0.55	47,300
scale control chemical (est)	6	drums	1600	9,600
electricity (hp=40hp)	260000	KW-hr	0.12	31,200
natural gas (730,000 btu/hr)	80000	therms	0.55	44,000
solids disposal (300 lbs/day as non-RCRA hazardous)	55	tons	200	11,000
O&M site visits (15 hrs/wk)	52	weeks	1500	78,000
monthly major maintenance visit (8 hours)	12	months	800	9,600
parts and materials	1	lump sum	3700	3,700
laboratory analysis	1	lump sum	11400	11,400
BAAQMD permit renewal fees for boiler combustion source	1	lump sum	500	500
quarterly monitoring and reporting for first 2 years ($6,000/quarter)	1	lump sum	1600	1,600
semiannual monitoring and reporting for next 28 years ($6000/event)	1	lump sum	11200	11,200
5-year evaluation report ($21,000 every 5 years)	1	lump sum	4200	4,200
project management (10% of annual O&M cost)				26,300
contingency (15% of annual O&M costs)				43,400

Annual O&M Cost: $333,000
30-Year Present Value O&M Cost: $4,584,000

ESTIMATED 30-YEAR COST: $7,683,000

Notes:
1. If the precipitate does not require disposal as a non-RCRA hazardous waste, there would be an annual O&M cost saving of $6,600. Analysis of the precipitate will be required to determine this.
2. It is assumed that no additional monitoring wells will be required for this option.
3. Based on the available data, it is assumed that there are no underground utilities at the site.
4. It is assumed that treated groundwater will be discharged to the storm-drain system authorized by an NPDES permit within 20 feet of the treatment system.
5. A performance guarantee from the groundwater treatment vendor is recommended.
6. It is assumed that each vendor will require a treatability study on groundwater from the site prior to issuing a performance guarantee. This information will be used as part of the design data required to complete the full-scale treatment system design.
7. Operation costs include routine maintenance and periodic equipment maintenance.
8. A net interest rate of 6% was assumed.
9. Groundwater monitoring requirements may be modified during the permitting phase of the project.
10. If all soil removed from the excavation trench required disposal as a non-RCRA hazardous waste, there would be an additional cost of approximately $124,000.

GEOMATRIX

OPTION 5B
GROUNDWATER EXTRACTION, TREATMENT (PRECIPITATION WITH MEMBRANE FILTRATION) CAP CONSTRUCTION AND GROUNDWATER MONITORING - 5051 Coliseum Way

I. ENGINEERING COST

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
lab treatability study/field pilot study	1	lump sum	8500	8,500
hydrogeological evaluation/modeling	500	hour	100	50,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
engineering design	200	hour	100	20,000
specifications and drawings	120	hour	100	12,000
remedial action plan	280	hour	100	28,000
permitting and regulatory interaction	160	hour	100	16,000
system start-up	1	lump sum	21000	21,000
project management (10% of engineering cost)				20,600
contingency (15% of engineering cost)				33,900

Total Engineering Cost: $260,000

II. CONSTRUCTION COSTS

A. SITE PREPARATION

install temporary facilities (e.g., trailer, utilities, etc.)	1	lump sum	5000	5,000
operation of temporary facilities	3	month	1500	4,500
install temporary security fence	1250	linear foot	2	2,500
engineer's oversight of site preparation	20	hour	100	2,000

B. REMEDIATION

EXTRACTION SYSTEM - TRENCH

mob/demob, trenching (includes piping, gravel, paving)	1	lump sum	100,000	100,000
soil disposal (50% non-hazardous, 50% non-RCRA hazardous)	1125	cubic yard	190	213,750
extraction pump and head equipment	1	each	3,500	3,500
extraction trenching with pipe and backfill	1000	linear foot	75	75,000
on-site health and safety (5 hrs/wk)	10	hour	100	1,000
construction management (1.5 people for 2 weeks)	150	hour	100	15,000

TREATMENT SYSTEM - PRECIPITATION WITH MEMBRANE FILTRATION (MEMTEK)

concrete pad	1	lump sum	8,400	8,400
fencing	1	lump sum	15,800	15,800
awning	1	lump sum	15,000	15,000
Memtek treatment system-precipitation/microfiltration/ion exchange	1	lump sum	173,300	173,300
oil/water separator	1	lump sum	10,500	10,500
tax and delivery on major equipment			12%	22,100
system piping / supports	1	lump sum	10,000	10,000
pressure gauges, valves/ports, flow meter	1	lump sum	5,300	5,300
air compressor	1	each	4,000	4,000
flow metering system-electronic	1	each	3,200	3,200
pH monitoring system	1	each	3,200	3,200
discharge piping	20	linear foot	75	1,500
city water service	1	lump sum	3,000	3,000
electrical service	1	lump sum	10,500	10,500
field electrical wiring	1	lump sum	5,300	5,300
electrical control panel fabrication (incl PLC)	1	lump sum	21,000	21,000
contractor installation	1	lump sum	31,500	31,500
on-site health and safety (5 hours/week)	15	hour	100	1,500
construction management (2 people for 3 weeks)	300	hour	100	30,000

GEOMATRIX

OPTION 5B
GROUNDWATER EXTRACTION, TREATMENT (PRECIPITATION WITH MEMBRANE FILTRATION) CAP CONSTRUCTION AND GROUNDWATER MONITORING - 5051 Coliseum Way

C. CAP CONSTRUCTION

existing asphalt removal (only on south portion of site)	47000	square foot	0.7	32,900
asphalt disposal (@165 pcf, 6-inch-thick)	1940	ton	10	19,400
regrade site	160000	square foot	1.3	208,000
1 foot of aggregate base (@ 140 pcf)	11500	ton	20	230,000
6-inch-thick asphalt cap (includes mob/demob)	160000	square foot	3	480,000
construction management (2 people for 4 weeks)	400	hour	100	40,000

D. MISCELLANEOUS

procurement costs	100	hour	100	10,000
project management (10% of construction cost)				181,800
contingency (15% of construction cost)				299,900

Total Construction Cost: $2,299,000

III. ANNUAL O&M COSTS
(assuming precipitate disposal as a non-RCRA hazardous waste)

Memtek operations	2630	1000 gallons	5	13,200
solids disposal (3.3 cf/8 hr as non-RCRA hazardous)	137	tons	200	27,400
NPDES sampling/reporting	1	lump sum	37000	37,000
ion exchange regeneration/replacement	1	lump sum	5000	5,000
O&M site visits (4 hours each)	208	visits	400	83,200
semi-monthly major maintenance visit (8 hours each)	24	visits	800	19,200
parts and materials	1	lump sum	3700	3,700
laboratory analysis	1	lump sum	11400	11,400
NPDES permit renewal fees	1	lump sum	10000	10,000
quarterly monitoring and reporting for first 2 years ($6,000/quarter)	1	lump sum	1600	1,600
semiannual monitoring and reporting for next 28 years ($6000/event)	1	lump sum	11200	11,200
5-year evaluation report ($21,000 every 5 years)	1	lump sum	4200	4,200
project management (10% of annual O&M cost)				22,700
contingency (15% of annual O&M costs)				37,500

Annual Cost: $287,300
30-Year Present Value O&M Cost $3,955,000

ESTIMATED 30-YEAR COST: $6,514,000

Notes:
1. If the precipitate does not require disposal as a hazardous waste, there would be an annual O&M cost saving of $29,000. Analysis of the precipitate will be required to determine this.
2. It is assumed that no additional monitoring wells will be required for this option.
3. Based on available data, it is assumed that there are no underground utilities at the site.
4. It is assumed that treated groundwater will be discharged to the storm-drain system authorized by an NPDES permit within 20 feet of the treatment system.
5. A performance guarantee from the groundwater treatment vendor is recommended.
6. It is assumed that each vendor will require a treatability study on groundwater from the site prior to issuing a performance guarantee. This information will be used as part of the design data required to complete the full-scale treatment system design.
7. Operation costs include routine maintenance and periodic equipment maintenance.
8. A net interest rate of 6% was used.
9. Groundwater monitoring requirements may be modified during the permitting phase of the project.
10. If all soil removed from the excavation trench required disposal as a non-RCRA hazardous waste, there would be an additional cost of approximately $124,000.

GEOMATRIX

OPTION 5C
GROUNDWATER EXTRACTION, TREATMENT (UNOCAL Unipure),
CAP CONSTRUCTION AND GROUNDWATER MONITORING - 5051 Coliseum Way

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
lab treatability study/field pilot study	1	lump sum	8500	8,500
hydrogeological evaluation/modeling	500	hour	100	50,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
engineering design	200	hour	100	20,000
specifications and drawings	120	hour	100	12,000
remedial action plan	280	hour	100	28,000
permitting and regulatory interaction	160	hour	100	16,000
system start-up	1	lump sum	21000	21,000
project management (10% of engineering cost)				20,600
contingency (15% of engineering cost)				33,900

Total Engineering Cost: $260,000

II. CONSTRUCTION COSTS

A. SITE PREPARATION

Install temporary facilities (e.g., trailer, utilities, etc.)	1	lump sum	5000	5,000
operation of temporary facilities	3	month	1500	4,500
install temporary security fence	1250	linear foot	2	2,500
engineer's oversight of site preparation	20	hour	100	2,000

B. REMEDIATION

EXTRACTION SYSTEM - TRENCH

mob/demob, trenching (includes piping, gravel, paving)	1	lump sum	100,000	100,000
soil disposal (50% non-hazardous, 50% non-RCRA hazardous)	1125	cubic yard	190	213,750
gas displacement pump and head equipment	1	each	3,500	3,500
extraction trenching with pipe and backfill	1000	linear foot	75	75,000
on-site health and safety (5 hrs/wk)	10	hour	100	1,000
construction management (1.5 people for 2 weeks)	150	hour	100	15,000

TREATMENT SYSTEM - UNOCAL

concrete pad	1	lump sum	8,400	8,400
fencing	1	lump sum	15,800	15,800
awning	1	lump sum	15,000	15,000
Unipure treatment system:	1	lump sum	90,600	90,600
tax and delivery on major equipment			12%	10,900
system piping/supports	1	lump sum	10,000	10,000
pressure gauges, valves/ports, flow meter	1	lump sum	5,300	5,300
air compressor	1	each	4,000	4,000
flow metering system-electronic	1	each	3,200	3,200
pH monitoring system-electronic	1	each	3,200	3,200
discharge piping	20	linear foot	75	1,500
city water service	1	lump sum	3,000	3,000
electrical service	1	lump sum	10,500	10,500
field electrical wiring	1	lump sum	5,300	5,300
electrical control panel design/fabrication (incl PLC)	1	lump sum	16,000	16,000
contractor installation	1	lump sum	31,500	31,500
on-site health and safety (5 hours/week)	15	hour	100	1,500
construction management (2 people for 3 weeks)	300	hour	100	30,000

GEOMATRIX

OPTION 6
SLURRY WALL, GROUNDWATER EXTRACTION AND TREATMENT, GROUNDWATER MONITORING, AND CAP CONSTRUCTION - 5051 Coliseum Way

I. ENGINEERING COST

	quantity	unit	price ($)	COST ($)
health and safety plan	40	hour	100	4,000
lab treatability/field pilot study	1	lump sum	8500	8,500
hydrogeological evaluation/modeling	200	hour	100	20,000
feasibility study	720	hour	100	72,000
risk assessment	280	hour	100	28,000
engineering design	500	hour	100	50,000
specifications and drawings	300	hour	100	30,000
remedial action plan	320	hour	100	32,000
permitting and regulatory interaction	160	hour	100	16,000
extraction system start-up	1	lump sum	21000	21,000
project management (10% of engineering cost)				28,000
contingency (15% of engineering cost)				46,000

Total Engineering Cost: $356,000

II. CONSTRUCTION COSTS

A. MISCELLANEOUS

procurement costs	100	hour	100	10,000
project management (10% of construction cost)				274,000
contingency (15% of construction cost)				452,000

B. SITE PREPARATION

Install temporary facilities (e.g., trailer, utilities, etc.)	1	lump sum	5000	5,000
operation of temporary facilities	3	month	1500	4,500
repair/restore permanent site security fence	1250	linear foot	20	25,000
level trench area for walls (1600 lf by 20 feet wide)	32000	square foot	1.3	41,600
engineer's oversight of site preparation (1 person for 1 week)	50	hour	100	5,000

C. REMEDIATION

SLURRY WALL

mobilization/demobilization	1	lump sum	100000	100,000
bonds/insurance, general	1	lump sum	125000	125,000
install soil-cement-bentonite slurry wall (1150 lf to 20 feet deep)	23000	square foot	11	253,000
disposal of excess soil spoils (as non-hazardous)	1050	cubic yard	80	84,000
on-site health and safety (20 hr/week)	80	hour	100	8,000
on-site construction management (2.5 people for 4 weeks)	500	hour	100	50,000

WATERLOO BARRIER

install barrier 450 lf to 20 feet deep (includes mob/demob, supplies)	9000	square foot	19.75	177,750
on-site health and safety (20 hrs/week)	80	hour	100	8,000
on-site construction management (2.5 people for 4 weeks)	500	hour	100	50,000

GROUNDWATER EXTRACTION SYSTEM
(UNOCAL Unipure per option 5.3)

extraction system (based on 5 wells)	1	lump sum	122000	122,000
treatment system	1	lump sum	327000	327,000

D. CAP CONSTRUCTION

existing asphalt removal (only on south portion of site)	47000	square foot	0.7	32,900
asphalt disposal (@165 pcf, 6-inch-thick)	1940	ton	10	19,400
regrade site	160000	square foot	1.3	208,000
1 foot of aggregate base (@ 140 pcf)	11500	ton	20	230,000
9-inch-thick asphalt cap (includes mob/demob)	160000	square foot	4	640,000
seal coat	160000	square foot	1.1	176,000
on-site construction management (2 people for 4 weeks)	400	hour	100	40,000

Total Construction Cost: **$3,468,000**

III. ANNUAL O&M COSTS

A. GROUNDWATER TREATMENT AND MONITORING

annual O&M cost for UNOCAL Unipure system	1	lump sum	288000	288,000

Annual O&M Cost: **$288,000**
30-Year Present Value O&M Cost: **$3,964,000**

ESTIMATED 30-YEAR COST: **$7,788,000**

Notes:
1. As an alternative to mechanical groundwater extraction system, groundwater gradient control could be obtained by planting special types of trees. Construction costs would decrease by approximately $78,000 if trees were used.
2. If trees were used for the groundwater gradient control, annual O&M costs could be decreased by approximately $130,000.
3. On-site construction management time is based on a 50-hour week.
4. The groundwater treatment method used for this option was determined by the most inexpensive capital costs and operation and maintenance costs of the 3 alternatives presented in Option 5.
5. A production rate of 1400 square feet per day was assumed for the soil-cement-bentonite slurry wall.
6. It is assumed that the slurry wall is constructed of a soil-cement-bentonite mixture.
7. The cost of the slurry wall installation includes subcontractor's labor, equipment, and materials.
8. In the final engineering, it may be determined that a soil-cement-bentonite wall is not required and a soil-bentonite wall could be installed instead at a savings of $3 to $5 per square foot.
9. It is assumed that the slurry wall and waterloo barrier will be keyed into Bay Mud and have a tip depth of 20 feet below ground surface.
10. PG&E lines may have to be moved to install the slurry wall, or a smaller sized piece of equipment may have to be used in the area of the power lines. Costs are not included to deal with this.
11. It is assumed that the slurry wall is 3 feet wide.
12. It is assumed that 40% of the slurry wall spoils will not go back into the trench and will be disposed of off site.
13. The seal coat on top of the cap will be placed approximately 3 to 5 years after the construction of the cap.
14. Redox testing will be performed during each monitoring period.
15. A net interest rate of 6% was assumed.
16. Groundwater monitoring requirements may be modified during the permitting phase of the project.
17. The cost for the feasibility study is based on the Department of Toxic Substances Control Review and Oversight reviewing the report.
18. Based on available data, it is assumed that there are no underground utilities at the site.

GEOMATRIX

OPTION 8A
EX-SITU STABILIZATION AND GROUNDWATER MONITORING - 5051 Coliseum Way

I. ENGINEERING COST

I. ENGINEERING COST	quantity	unit	price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
lab treatability study/field pilot study	1	lump sum	50000	50,000
hydrogeological evaluation/modeling	400	hour	100	40,000
pre-excavation soil sampling and testing	1	lump sum	100000	100,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
engineering design	500	hour	100	50,000
specifications and drawings	300	hour	100	30,000
remedial action plan	320	hour	100	32,000
permitting and regulatory interaction	160	hour	100	16,000
project management (10% of engineering cost)				36,800
contingency (15% of engineering cost)				60,700

Total Engineering Cost: $466,000

II. CONSTRUCTION COSTS

A. SITE PREPARATION

Install temporary facilities (trailer, utilities, etc.)	1	lump sum	5000	5,000
operation of temporary facilities	7	month	1500	10,500
install temporary site security fence	1250	linear foot	2	2,500
existing asphalt removal (on south portion of site)	4700	square foot	0.7	3,300
asphalt disposal (@165 pcf, 6-inch-thick)	1940	ton	10	19,400
engineer's oversight of site preparation	40	hour	100	4,000

B. REMEDIATION

mobilization and demobilization	1	lump sum	125000	125,000
temporary power	1	lump sum	27000	27,000
temporary sanitary tank	1	lump sum	5800	5,800
shoring - soldier piles (@10-foot intervals, 20 feet deep)	141	each	1000	141,000
shoring - lagging	14050	square foot	30	421,500
dewatering	110	days	1000	110,000
disposal of water (5 gpm for 110 days)	792000	gallon	1	792,000
excavation of non-affected soil	35000	cubic yard	10	350,000
QA/QC testing	68000	cubic yard	3	204,000
excavation of affected soil	33000	cubic yard	12	396,000
treatment of soil and placement in excavation	33000	cubic yard	80	2,640,000
supply reagents (ferric chloride and cement)	33000	cubic yard	42	1,386,000
drain rock (2 feet deep)	11850	cubic yard	35	414,800
filter fabric	160000	square foot	0.32	51,200
backfill and compaction on non-affected soil	35000	cubic yard	6.8	238,000
on-site health and safety (20 hours/week)	440	hour	100	44,000
on-site construction management (4.5 people for 22 weeks)	4950	hour	100	495,000

C. MISCELLANEOUS

procurement costs	100	hour	100	10,000
project management (10% of construction cost)				789,600
contingency (15% of total construction cost)				1,302,800

Total Construction Cost: $9,988,000

III. ANNUAL O&M COSTS

A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($6,000/quarter)	1	lump sum	1600	48,000
semiannual monitoring and reporting for next 28 years ($6,000/event)	1	lump sum	5600	336,000
5-year evaluation report ($21,000 every 5 years)	1	lump sum	4200	126,000
project management (10% of annual O&M cost)				51,000
contingency (15% of annual O&M costs)				84,200

Total O&M Cost: **$645,000**
30-Year Present Value O&M Cost: **$296,000**

ESTIMATED 30-YEAR COST: **$10,750,000**

Notes:

1. Based on available data, it is assumed that there are no underground utilities at the site.
2. It is assumed that no additional monitoring wells are required.
3. The treated soil will have an approximately 50% bulking factor. It is assumed that this soil will be spread, graded, and leveled over the property once the remediation is complete. This may cause significant grade changes.
4. It is assumed that the top layer of unaffected soil will not require fixation; therefore, reagents are not needed.
5. Volumes calculated are in-place volumes.
6. Shoring will be required along the canal, along Coliseum Way, and along the southern property line. It is assumed that the excavation will require lagging to an average of 10 feet below ground surface. Shoring will be driven to a depth of 20 feet bgs.
7. It is assumed that the PG&E power towers and overhead power lines that transverse the site will be removed by others prior to commencing this work. Costs are not included for these removal activities.
8. A net interest rate of 6% was assumed.
9. Groundwater monitoring requirements may be modified during the permitting phase of the project.
10. It is assumed that one soil sample will be collected every 100 cubic yards of non-affected soil and stabilized soil.
11. If the water from dewatering can be disposed to the sanitary sewer, there will be a cost saving of approximately $396,000. Analysis of the water will be required to determine this. In addition, it may be possible to reduce the amount of water required for disposal by using the water in the treatment process.

GEOMATRIX

OPTION 8B
IN-SITU STABILAZATION, CAP CONSTRUCTION, AND GROUNDWATER MONITORING - 5051 Coliseum Way

I. ENGINEERING COST

	quantity	unit	unit price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
lab treatability study/field pilot study	1	lump sum	50000	50,000
hydrogeological evaluation/modeling	400	hour	100	40,000
pre-treatment soil sampling and testing	1	lumpsum	100000	100,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
engineering design	500	hour	100	50,000
specifications and drawings	300	hour	100	30,000
remedial action plan	320	hour	100	32,000
permitting and regulatory interaction	160	hour	100	16,000
project management (10% of engineering cost)				36,800
contingency (15% of engineering cost)				60,700

Total Engineering Cost: $466,000

II. CONSTRUCTION COSTS

A. SITE PREPARATION

Install temporary facilities (trailer, utilities, etc.)	1	lump sum	5000	5,000
operation of temporary facilities	12	month	1500	18,000
install temporary site security fence	1250	linear foot	2	2,500
engineer's oversight of site preparation	20	hour	100	2,000

B. REMEDIATION

mobilization and demobilization	1	lump sum	125000	125,000
temporary power	1	lump sum	27000	27,000
temporary sanitary tank	1	lump sum	5800	5,800
QA/QC testing	65000	cubic yard	3	195,000
in-situ soil treatment	65000	cubic yard	65	4,225,000
ferric chloride reagent (4%)	65000	cubic yard	22	1,430,000
type V Portland cement (15%)	65000	cubic yard	20	1,300,000
shoring - soldier piles (@10-foot intervals, 20 feet deep)	24	each	1000	24,000
shoring - lagging	2400	square foot	30	72,000
excavation of soil and move to treatment area pad	1000	cubic yard	12	12,000
backfill and compaction of treated soil	1000	cubic yard	6.8	6,800
on-site health and safety (20 hours/week)	860	hour	100	86,000
on-site construction management (4 people for 43 weeks)	8600	hour	100	860,000

C. CAP CONSTRUCTION

existing asphalt removal (only on south portion of site)	47000	square foot	0.7	32,900
asphalt disposal (@165 pcf, 6-inch-thick)	1940	ton	10	19,400
regrade site	160000	square foot	1.3	208,000
1 foot of aggregate base (@ 140 pcf)	11500	ton	20	230,000
6-inch-thick asphalt cap (includes mob/demob)	160000	square foot	4	640,000
on-site construction management (2 people for 4 weeks)	400	hour	100	40,000

D. MISCELLANEOUS

procurement costs	100	hour	100	10,000
project management (10% of construction cost)				953,600
contingency (15% of total construction cost)				1,573,500

Total Construction Cost: $12,104,000

GEOMATRIX

III. ANNUAL O&M COSTS

A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($6,000/quarter)	8	lump sum	6000	48,000
semiannual monitoring and reporting for next 28 years ($6,000/event)	28	lump sum	12000	336,000
5-year evaluation report ($21,000 every 5 years)	6	lump sum	21000	126,000
project management (10% of annual O&M cost)				51,000
contingency (15% of annual O&M costs)				84,200

Total O&M Cost: $645,000
30-Year Present Value O&M Cost: $296,000

ESTIMATED 30-YEAR COST: $12,866,000

Notes:
1. Based on available data, it is assumed that there are no underground utilities at the site.
2. It is assumed that no additional monitoring wells are required.
3. The treated soil will have an approximately 50% bulking factor. It is assumed that this soil will be spread, graded and leveled over the property once the remediation is complete. This may cause significant grade changes.
4. The cost estimate is based on soil being treated from ground surface to the treatment depth. At the time of the design, it may be determined that reagents will not be required in the fill layer, and cost could be reduced.
5. Volumes calculated are in-place volumes.
6. Soil will be excavated from the northern corner of the property, and will be moved to the treatment area where it will be treated. The excavation will be backfilled with treated soil.
7. It is assumed that shoring will be required around the area of excavation.
   It is assumed that lagging will be required to an average of 10 feet below ground surface.
   Shoring will be driven to a depth of 20 feet below ground surface.
8. It is assumed that the PG&E power towers and overhead power lines that transit the site will be removed by others prior to commencing this work. Costs are not included for these removal activities.
9. It is assumed that one soil sample will be collected for every 100 cubic yards of soil.
10. A net interest rate of 6% was assumed.
11. Groundwater monitoring requirements may be modified during the permitting phase of the project.

GEOMATRIX

OPTION 9
EXCAVATION AND REMOVAL, GROUNDWATER MONITORING - 5051 Coliseum Way

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
health and safety plan	1	lump sum	2000	2,000
hydrogeological evaluation/modeling	400	hour	100	40,000
pre-excavation soil sampling and testing	1	lump sum	100000	100,000
feasibility study	280	hour	100	28,000
risk assessment	200	hour	100	20,000
engineering design	500	hour	100	50,000
specifications and drawings	300	hour	100	30,000
remedial action plan	520	hour	100	52,000
permitting and regulatory interaction	160	hour	100	16,000
project management (10% of engineering cost)				33,800
contingency (15% of engineering cost)				55,800

Total Engineering Cost: $427,600

II. CONSTRUCTION COSTS

A. SITE PREPARATION

Install temporary facilities (trailer, utilities, etc.)	1	lump sum	5000	5,000
operation of temporary facilities	9	month	1500	13,500
install temporary site security fence	1250	linear foot	2	2,500
existing asphalt removal (on south portion of site)	4700	square foot	0.7	3,300
asphalt disposal (@165 pcf, 6-inch-thick)	1940	ton	10	19,400
engineer's oversight of site preparation	40	hour	100	4,000

B. REMEDIATION

mobilization and demobilization	1	lump sum	21000	21,000
shoring - soldier piles (@10-foot intervals, 20 feet deep)	141	each	1000	141,000
shoring - lagging	14050	square foot	30	421,500
dewatering	210	days	1000	210,000
disposal of water (5 gpm for 210 days)	2E+06	gallon	1	1,512,000
QA/QC testing of non-affected soil	50000	cubic yard	3	150,000
QA/QC testing of completed excavation	160000	square foot	0.1	16,000
excavation of fill	50000	cubic yard	10	500,000
excavation of affected soil	18000	cubic yard	12	216,000
soil transport and disposal of affected soil to Class II facility (1.5 tons/cy)	22500	ton	75	1,687,500
soil transport and disposal of affected soil to Class I facility (1.5 tons/cy)	27000	ton	200	5,400,000
import fill (affected and non-affected volume removed less drain rock)	31725	ton	13	412,400
drain rock (2 feet)	11850	cubic yard	35	414,800
filter fabric	160000	square foot	0.32	51,200
backfill and compaction of non-affected fill material (soil)	35000	cubic yard	6.8	238,000
backfill and compaction of imported material (soil and drain rock)	33000	cubic yard	6.8	224,400
on-site health and safety (20 hours/week)	600	hour	100	60,000
on-site construction management (5 people for 30 weeks)	7500	hour	100	750,000

C. MISCELLANEOUS

procurement costs	100	hour	100	10,000
project management (10% of construction cost)				1,248,400
contingency (15% of total construction cost)				2,059,800

Total Construction Cost: $15,792,000

GEOMATRIX

III. ANNUAL O&M COSTS

A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($6,000/quarter)	8	lump sum	6000	48,000
semiannual monitoring and reporting for next 28 years ($6,000/event)	28	lump sum	12000	336,000
5-year evaluation report ($21,000 every 5 years)	6	lump sum	21000	126,000
project management (10% of annual O&M cost)				51,000
contingency (15% of annual O&M costs)				84,200

Total O&M Cost: **$645,000**
30-Year Present Value O&M Co **$296,000**

ESTIMATED 30-YEAR COST: **$16,516,000**

Notes:
1. Based on available data, it is assumed that there are no underground utilities at the site.
2. It is assumed that no additional monitoring wells are required.
3. It is assumed that approximately 500 cubic yards of soil can be excavated per day.
4. Volumes calculated are in-place volumes.
5. Shoring will be required along the canal, along Coliseum Way, and along the southern property line. It is assumed that the excavation will require lagging to an average of 10 feet bgs. Shoring will be driven to a depth of 20 feet bgs.
6. It is assumed that the PG&E power towers and overhead power lines that transit the site will be removed by others prior to commencing this work. Costs are not included for these removal activities.
7. It is assumed that one soil sample will be collected every 100 cubic yards of non-affected soil and one soil sample will be collected every 2500 square feet upon completion of the excavation to verify cleanup levels have been attained.
8. A net interest rate of 6% was assumed.
9. Groundwater monitoring requirements may be modified during the permitting phase of the project.
10. If the water from dewatering can be disposed to the sanitary sewer, there will be a cost saving of approximately $1,000,000. Analysis of the water will be required to determine this. In addition, it is possible to reduce the amount of water required for disposal by using the water in the treatment process.

GEOMATRIX

OPTION 1
GROUNDWATER MONITORING ONLY - Substation J
Incremental Cost Above 5051 Coliseum Way Costs

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
investigation (includes subcontractor costs)	1	lump sum	35000	35,000
project management (10% of engineering cost)				3,500
contingency (15% of engineering cost)				5,800

Total Engineering Cost: $44,000

II. CONSTRUCTION COSTS

install 2 groundwater monitoring wells	2	each	3200	6,400
project management (10% of construction cost)				600
contingency (15% of construction cost)				1,100

Total Construction Cost: $8,000

III. ANNUAL O&M COSTS
A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($2,000/quarter)	8	lump sum	2000	16,000
semiannual monitoring and reporting for next 28 years ($2000/event)	28	lump sum	4000	112,000
5-year evaluation report ($10,000 every 5 years)	6	lump sum	10000	60,000
project management (10% of annual O&M cost)				18,800
contingency (15% of annual O&M costs)				31,000

Total O&M Cost: $238,000
30-Year Present Value O&M Cost: $109,000

ESTIMATED 30-YEAR COST: $161,000

Notes:
1. Based on available data, it is assumed that there are no underground utilities at the site.
2. A net interest rate of 6% was assumed.
3. Groundwater monitoring requirements may be modified during the permitting phase of the project.

GEOMATRIX

OPTION 2
GROUNDWATER MONITORING AND CAP CONSTRUCTION - Substation J
Incremental Cost Above 5051 Coliseum Way Costs

I. ENGINEERING COST

	quantit	unit	unit price ($)	COST ($)
investigation (includes subcontractor costs)	1	lump sum	35000	35,000
engineering design	20	hour	100	2,000
specifications and drawings	20	hour	100	2,000
project management (10% of engineering cost)				3,900
contingency (15% of engineering cost)				6,400

Total Engineering Cost: $49,000

II. CONSTRUCTION COSTS

A. INSTALLATION OF MONITORING WELLS

install 2 groundwater monitoring wells	2	lump sum	3200	6,400

B. CAP CONSTRUCTION

existing asphalt removal	7000	square foot	0.7	4,900
asphalt disposal (@165 pcf, 6-inch-thick)	300	ton	10	3,000
regrade site	7000	square foot	1.3	9,100
1 foot of aggregate base (@ 140 pcf)	500	ton	20	10,000
6-inch-thick asphalt cap (includes mob/demob)	7000	square foot	3	21,000
construction management (2 people for 2 weeks)	200	hour	100	20,000

C. MISCELLANEOUS

project management (10% of construction cost)				7,400
contingency (15% of construction cost)				12,300

Total Construction Cost: $94,000

III. ANNUAL O&M COSTS

A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($2,000/quarter)	8	lump sum	2000	16,000
semiannual monitoring and reporting for next 28 years ($2,000/event)	28	lump sum	4000	112,000
5-year evaluation report ($10,000 every 5 years)	6	lump sum	10000	60,000
project management (10% of annual O&M cost)				18,800
contingency (15% of annual O&M costs)				31,000

Total O&M Cost: $238,000
30-Year Present Value O&M Cost: $109,000

ESTIMATED 30-YEAR COST: $252,000

Notes:
1. Based on available data, it is assumed that there are no underground utilities at the site.
2. A net interest rate of 6% was assumed.
3. Groundwater monitoring requirements may be modified during the permitting phase of the project.

GEOMATRIX

OPTIONS 5A, 5B & 5C
GROUNDWATER EXTRACTION, TREATMENT (ALL METHODS) AND CAP CONSTRUCTION - Substation J

Incremental Cost Over 5051 Coliseum Way Costs

I. ENGINEERING COST

	quantity	unit	unit price ($)	COST ($)
investigation (includes subcontractor costs)	1	lump sum	35000	35,000
engineering design	100	hour	100	10,000
specifications and drawings	80	hour	100	8,000
project management (10% of engineering cost)				5,300
contingency (15% of engineering cost)				8,700

Total Engineering Cost: $67,000

II. CONSTRUCTION COSTS

A. INSTALLATION OF MONITORING WELLS

install 2 groundwater monitoring wells	2	each	3200	6,400

B. REMEDIATION - EXTRACTION WELLS

extraction well installation (inc. mob/demob costs)	12	each	5,250	63,000
well pump and well head equipment	12	each	2,650	31,800
extraction trenching with pipe	450	linear foot	75	33,800
air compressor	1	lump sum	7,900	7,900
construction management (2.5 people for 2 weeks)	525	hour	100	52,500

C. CAP CONSTRUCTION

existing asphalt removal	7000	square foot	0.7	4,900
asphalt disposal (@165 pcf, 6-inch-thick)	300	ton	10	3,000
regrade site	7000	square foot	1.3	9,100
1 foot of aggregate base (@ 140 pcf)	500	ton	20	10,000
6-inch-thick asphalt cap (includes mob/demob)	7000	square foot	3	21,000
construction management (2 people for 2 weeks)	200	hour	100	20,000

D. MISCELLANEOUS

procurement costs	50	hour	100	5,000
project management (10% of construction cost)				26,800
contingency (15% of construction cost)				44,300

Total Construction Cost: $340,000

III. ANNUAL O&M COSTS

quarterly monitoring and reporting for first 2 years ($2,000/quarter)	8	lump sum	2000	16,000
semiannual monitoring and reporting for 28 years ($2,000/event)	28	lump sum	4000	112,000
5-year evaluation report ($10,000 every 5 years)	6	lump sum	10000	60,000
project management (10% of annual O&M cost)				18,800
contingency (15% of annual O&M costs)				31,000

Total O&M Cost: $238,000
30-Year Present Value O&M Cost: $109,000

ESTIMATED 30-YEAR COST: $516,000

OPTIONS 5A, 5B & 5C
GROUNDWATER EXTRACTION, TREATMENT (ALL METHODS)
AND CAP CONSTRUCTION - Substation J

Notes:
1. It is assumed that all wells have their own pump and well head equipment. Due to the close proximity of the wells to each other, it may be determined during the design phase that several of the wells can be manifolded together requiring fewer well pumps and less well head equipment would be required.
2. It is assumed that two monitoring wells will be required.
3. Based on the available data, it is assumed that there are no underground utilities at the site.
4. The groundwater extraction system capital costs include costs for installing 12 extraction wells and for the design and construction of pipelines to convey water to a central treatment system.
5. A net interest rate of 6% was assumed.
6. Groundwater monitoring requirements may be modified during the permitting phase of the project.

GEOMATRIX

OPTION 8A
EX-SITU SOIL STABILIZATION AND GROUNDWATER MONITORING - Substation J
Incremental Cost Over 5051 Coliseum Way Costs

I. ENGINEERING COST

	quantity	unit	unit price ($)	COST ($)
investigation (includes subcontractor costs)	1	lump sum	35000	35,000
project management (10% of engineering cost)				3,500
contingency (15% of engineering cost)				5,800

Total Engineering Cost: $44,000

II. CONSTRUCTION COSTS
A. INSTALLATION OF MONITORING WELLS

install 2 groundwater monitoring wells	2	each	3200	6,400

B. REMEDIATION

shoring - soldier piles (@10-foot intervals, 20 feet deep)	31	each	1000	31,000
shoring - lagging	3100	square foot	30	93,000
dewatering	14	days	1000	14,000
disposal of water (5 gpm for 14 days)	100800	gallon	1	100,800
excavation of non-affected soil	1400	cubic yard	10	14,000
QA/QC testing	3080	cubic yards	3	9,200
excavation of affected soil	1680	cubic yard	12	20,200
treatment of soil and placement in excavation	1680	cubic yard	80	134,400
supply reagents (ferric chloride and cement)	1680	cubic yard	42	70,600
drain rock (2 feet deep)	520	cubic yard	35	18,200
filter fabric	7000	square foot	0.32	2,200
backfill and compaction on non-affected soil	1400	cubic yard	6.8	9,500
on-site health and safety (20 hours/week)	40	hour	100	4,000
on-site construction management (4.5 people for 2 weeks)	450	hour	100	45,000

C. MISCELLANEOUS

project management (10% of construction cost)				57,300
contingency (15% of total construction cost)				85,900

Total Construction Cost: $716,000

III. ANNUAL O&M COSTS
A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($2,000/quarter)	8	lump sum	2000	16,000
semiannual monitoring and reporting for next 28 years ($2000/event)	28	lump sum	4000	112,000
5-year evaluation report ($10,000 every 5 years)	6	lump sum	10000	60,000
project management (10% of annual O&M cost)				18,800
contingency (15% of annual O&M costs)				31,000

Total O&M Cost: $238,000
30-Year Present Value O&M Cos $109,000

ESTIMATED 30-YEAR COST: $869,000

Notes:
1. Based on available data, it is assumed that there are no underground utilities at the site.
2. It is assumed that no additional monitoring wells are required.
3. The treated soil will have an approximately 50% bulking factor. It is assumed that this soil will be spread, graded, and leveled over the property once the remediation is complete. This may cause significant grade changes.
4. Volumes calculated are in-place volumes.
5. Shoring will be required along the canal. It is assumed that the excavation will require lagging to an average of 10 feet below ground surface. Shoring will be driven to a depth of 20 feet bgs.

GEOMATRIX

OPTION 8A
EX-SITU SOIL STABILIZATION AND GROUNDWATER MONITORING - Substation J

6. It is assumed that the PG&E structures at the site will be removed by others prior to commencing this work. Costs are not included for these removal activities.
7. A net interest rate of 6% was assumed.
8. Groundwater monitoring requirements may be modified during the permitting phase of the project.
9. It is assumed that one soil sample will be collected every 100 cubic yards of treated and untreated soil.
10. If the water from dewatering can be disposed to the sanitary sewer, there will be a cost saving of approximately $50,000. Analysis of the water will be required to determine this. In addition, it may be possible to reduce the amount of water required for disposal by using the water in the treatment process.

GEOMATRIX

OPTION 8B
IN-SITU SOIL STABILIZATION, CAP CONSTRUCTION AND GROUNDWATER MONITORING - Substation J

Incremental Cost Over 5051 Coliseum Way Costs

I. ENGINEERING COST

	quantity	unit	unit price ($)	COST ($)
investigation (includes subcontractor costs)	1	lump sum	35000	35,000
project management (10% of engineering cost)				3,500
contingency (15% of engineering cost)				5,800

Total Engineering Cost: $44,000

II. CONSTRUCTION COSTS

A. INSTALLATION OF MONITORING WELLS

install 2 groundwater monitoring wells	2	each	3200	6,400

B. REMEDIATION

QA/QC testing	2900	cubic yard	3	8,700
in situ soil treatment	2900	cubic yard	65	188,500
ferric chloride reagent (4%)	2900	cubic yard	22	63,800
type V Portland cement (15%)	2900	cubic yard	20	58,000
on-site health and safety (20 hours/week)	860	hour	100	86,000
on-site construction management (4 people for 3 weeks)	600	hour	100	60,000

C. CAP CONSTRUCTION

existing asphalt removal	7000	square foot	0.7	4,900
asphalt disposal (@165 pcf, 6-inch-thick)	300	ton	10	3,000
regrade site	7000	square foot	1.3	9,100
1 foot of aggregate base (@ 140 pcf)	500	ton	20	10,000
6-inch-thick asphalt cap (includes mob/demob)	7000	square foot	3	21,000
construction management (2 people for 2 weeks)	200	hour	100	20,000

D. MISCELLANEOUS

project management (10% of construction cost)				53,900
contingency (15% of total construction cost)				80,900

Total Construction Cost: $674,000

III. ANNUAL O&M COSTS

A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($2,000/quarter)	8	lump sum	2000	16,000
semiannual monitoring and reporting for next 28 years ($2000/event)	28	lump sum	4000	112,000
5-year evaluation report ($10,000 every 5 years)	6	lump sum	10000	60,000
project management (10% of annual O&M cost)				18,800
contingency (15% of annual O&M costs)				31,000

Total Annual O&M Cost: $238,000
30-Year Present Value O&M Cost: $109,000

ESTIMATED 30-YEAR COST: $827,000

Notes:
1. Based on available data, it is assumed that there are no underground utilities at the site.
2. It is assumed that no additional monitoring wells are required.
3. The treated soil will have an approximately 50% bulking factor. It is assumed that this soil will be spread, graded, and leveled over the property once the remediation is complete. This may cause significant grade changes.
4. Volumes calculated are in-place volumes.

GEOMATRIX

OPTION 8B
IN-SITU SOIL STABILIZATION, CAP CONSTRUCTION AND GROUNDWATER MONITORING - Substation J

5. It is assumed that the PG&E structures on the site will be removed by others prior to commencing this work. Costs are not included for these removal activities.
6. A net interest rate of 6% was assumed.
7. Groundwater monitoring requirements may be modified during the permitting phase of the project.
8. It is assumed that one soil sample will be collected every 100 cubic yards of treated and untreated soil.

GEOMATRIX

OPTION 9
EXCAVATION AND REMOVAL, BACKFILL WITH IMPORTED MATERIAL AND GROUNDWATER MONITORING - Substation J

I. ENGINEERING COST	quantity	unit	unit price ($)	COST ($)
investigation (includes subcontractor costs)	1	lump sum	35000	35,000
project management (10% of engineering cost)				3,500
contingency (15% of engineering cost)				5,800

Total Engineering Cost: $44,000

II. CONSTRUCTION COSTS

A. INSTALLATION OF MONITORING WELLS

install 2 groundwater monitoring wells	2	each	3200	6,400

B. REMEDIATION

shoring - soldier piles (@10-foot intervals, 20 feet deep)	31	each	1000	31,000
shoring - lagging	3100	square foot	30	93,000
dewatering	21	days	1000	21,000
disposal of water (5 gpm for 21 days)	151200	gallon	1	151,200
QA/QC testing of non-affected soil	2000	cubic yard	3	6,000
QA/QC testing of completed excavation	7000	square foot	0.1	700
excavation of fill	2000	cubic yard	10	20,000
excavation of affected soil	1080	cubic yard	12	13,000
soil transport and disposal of affected soil to Class II facility (1.5 tons/cy)	900	ton	75	67,500
soil transport and disposal of affected soil to Class I facility (1.5 tons/cy)	1620	ton	200	324,000
import fill (affected and non-affected volume removed less drain rock)	1740	ton	13	22,600
drain rock (2 feet)	520	cubic yard	35	18,200
filter fabric	7000	square foot	0.32	2,200
backfill and compaction of non-affected fill material (soil)	1400	cubic yard	6.8	9,500
backfill and compaction of imported material (soil and drain rock)	1680	cubic yard	6.8	11,400
on-site health and safety (20 hours/week)	60	hour	100	6,000
on-site construction management (5.5 people for 3 weeks)	825	hour	100	82,500

C. MISCELLANEOUS

project management (10% of construction cost)				88,000
contingency (15% of total construction cost)				145,200

Total Construction Cost 886,000

III. ANNUAL O&M COSTS

A. GROUNDWATER MONITORING

quarterly monitoring and reporting for first 2 years ($2,000/quarter)	8	lump sum	2000	16,000
semiannual monitoring and reporting for next 28 years ($2000/event)	28	lump sum	4000	112,000
5-year evaluation report ($10,000 every 5 years)	6	lump sum	10000	60,000
project management (10% of annual O&M cost)				18,800
contingency (15% of annual O&M costs)				31,000

Total Annual O&M Cost: $238,000
30-Year Present Value O&M Cost: $109,000

ESTIMATED 30-YEAR COST: $1,039,000

Notes:
1. Based on available data, it is assumed that there are no underground utilities at the site.
2. It is assumed that approximately 200 cubic yards of soil can be excavated per day.
3. Volumes calculated are in-place volumes.
4. Shoring will be required along the canal. It is assumed that the excavation will require lagging to an average of 10 feet bgs. Shoring will be driven to a depth of 20 feet bgs.
5. It is assumed that the PG&E structures on the site will be removed by others prior to commencing this work. Costs are not included for these removal activities.
6. It is assumed that one soil sample will be collected every 100 cubic yards of non-affected soil and one soil sample will be collected every 2500 square feet upon completion of the excavation to verify cleanup levels have been attained.

GEOMATRIX

OPTION 9
EXCAVATION AND REMOVAL, BACKFILL WITH IMPORTED MATERIAL AND GROUNDWATER MONITORING - Substation J

7. A net interest rate of 6% was assumed.
8. Groundwater monitoring requirements may be modified during the permitting phase of the project.
9. If the water from dewatering can be disposed to the sanitary sewer, there will be a cost saving of approximately $75,000. Analysis of the water will be required to determine this. In addition, it may be possible to reduce the amount of water required for disposal by using the water in the treatment process.