CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

ORDER NO. 91-102

SITE CLEANUP REQUIREMENTS AND RECISION OF ORDER NO. 89-56 FOR:

ADVANCED MICRO DEVICES, RESEARCH GROUP 82-1,
THOMPSON PLACE 2, and B/G MANAGEMENT INCORPORATED

FOR THE PROPERTY AT: 901/902 THOMPSON PLACE
SUNNYVALE
SANTA CLARA COUNTY

The California Regional Water Quality Control Board, San Francisco Bay Region (hereinafter called the Board) finds that:

1. Location and Facility Description This Order presents the results of the Remedial Investigation Report, Feasibility Study (RI/FS), and proposed final remedial action plan for Advanced Micro Devices 901 and 902 Thompson Place (AMD 901/902), Sunnyvale, Santa Clara County.

   This facility is located in an area of low to flat relief about 3 miles south of the southern extension of the San Francisco Bay (see Appendix 1, Figure 1). This is an industrial park setting dominated by low rise industrial buildings common in the electronics industry of Santa Clara County. Mixed commercial and light industrial use is common immediately surrounding the industrial park area. Some residential property lies to the south and west of the study area. The area north of Duane Avenue (see Appendix 1, figure 2) is mostly residential.

   AMD operates a printed circuit manufacturing plant in two large low rise buildings at 901 and 902 Thompson Place (AMD 901;AMD 902), Sunnyvale, Santa Clara County in an area bounded by the Bayshore, Central, and Lawrence Expressways and Fair Oaks Avenue. AMD 901 has been used as a semiconductor manufacturing facility since 1969 to the present. Manufacturing operations at AMD 902 began in 1972 and are still active. The manufacturing process at these two facilities involved the use of solvents for cleaning and degreasing, acids for etching, caustics for acid neutralization and some arsine and chromium in the manufacturing process.

2. Site History Underground acid neutralization systems were in place at each facility. The acid neutralization at AMD 901 operated from 1969 to when it was removed in December 1983. The acid neutralization sump at AMD 902 was operated from approximately 1972 to its removal in September 1984.

   Initial investigation at the AMD 901/902 site began in 1982 with the investigation of leakage from an acid neutralization system near AMD 901. This leakage was investigated and the acid neutralization system was removed during 1983. In 1984 the investigation expanded to include the acid neutralization system at AMD 902. Polluted soils were found near both acid neutralization systems.

The polluted soils were identified as point sources that had resulted in groundwater pollution with volatile organic chemicals (VOCs). Further investigation and interim remedial actions followed the soils investigation.

The original development of the property was begun by Johnson and Mape. The property at 901 Thompson Place was acquired from Johnson and Mape by B/G Management in 1977. The property at 902 Thompson Place was acquired from Johnson and Mape by Mr. and Mrs. Edwin Rosenthal in 1974. Partial interest in the 902 property was sold by Mr. and Mrs. Rosenthal in 1982. The remaining interest was sold in 1984. The purchase of these interests was converted into two undivided 50% interests in the property at 902 Thompson Place for Research Group 82-1 and Thompson Place 2, limited partnerships. These are the current property owners of record for AMD 901/902. AMD has been the sole tenant and operator of the facilities and has assumed responsibility for the cleanup actions at the site.

Pursuant to the South Bay Multi-Site Cooperative Agreement (MSCA) and the South Bay Ground Water Contamination Enforcement Agreement, entered into on May 2, 1985 (as subsequently amended) by the Regional Board, EPA, and DHS, the Regional Board has been acting as the lead regulatory agency. The Regional Board will continue to regulate the discharger's remediation and administer enforcement actions in accordance with CERCLA as amended by SARA.

The site has been included on the National Priorities List (NPL) and has been regulated by Regional Board Orders, as indicated herein:

a.	October 1984	Site proposed for inclusion on the National Priorities List (NPL)
b.	September 1985	Waste Discharge Requirements Adopted
c.	June 1986	Site formally added to the NPL
d.	December 1987	Site Cleanup Requirements Adopted
e.	April 1989	Revised Site Cleanup Requirements Adopted

3. <u>Scope and Role of Operable Unit Within Site Strategy</u> For purposes of these reports and the proposed final remedial action plan the study area has been divided into four Operable Units (OU). These operable units include AMD 901/902, Signetics Main Campus (811 East Arques and neighboring Signetics' facilities), the former TRW Microwave facility (825 Stewart Drive) and an offsite area north of Duane Avenue extending about 500 feet north of the Bayshore Freeway (Highway 101) and the Westinghouse facility south of Duane Avenue (see Appendix 1, Figure 2). The plumes have become commingled in the subsurface and the Offsite OU is necessary to include the extent of the groundwater pollution. These dischargers will be referred to collectively in this Tentative Order as "the Companies".

Proposed final Remedial Investigation and Feasibility Study reports(RI/FS) were submitted on behalf of AMD, TRW, and Signetics (the Companies) in January 1991. Adoption of this Order will approve the joint RI/FS and a final Remedial Action Plan (RAP) that will encompass cleanup at the four Operable Units including AMD, Signetics, TRW Microwave and the offsite area.

The purpose of the interim and final actions at the AMD 901/902 OU is to prevent additional migration of pollutants from soil into groundwater and to control the migration of polluted groundwater from the OU. The intent of actions in this Order is to expedite cleanup of groundwater at this OU and to prevent movement of polluted groundwater from this OU to other OUs and potential vertical downward migration into aquifers that currently serve as drinking water sources.

The Offsite OU is the largest of the operable units. No known or suspected contaminant source areas are present in the Offsite OU. The purpose of remedial actions in the Offsite OU is to cleanup groundwaters to protect the beneficial use of the groundwater and to prevent further migration of contaminated groundwater.

4. Regulatory Status AMD, Inc., Research Group 82-1 and Thompson Place 2, limited partnerships, and B/G Management Inc. are hereinafter referred to as dischargers because of the releases of hazardous wastes that have occurred at this site. Advanced Micro Devices has agreed to assume full responsibility to complete all necessary investigations and remedial action programs related to the subject properties. Research Group 82-1 and Thompson Place 2 are the current owners of the 902 Thompson Place property, and B/G Management Inc. is the current owner of the 901 Thompson Place property. AMD has been the operator at both facilities since the completion of the structures.

All four parties are named as dischargers: AMD on the basis that they were the operators when the leaks occurred, and Research Group 82-1 and Thompson Place 2, and B/G Management Inc. as the current property owners. However, Research Group 82-1 and Thompson Place 2, and B/G Management Inc. have responsibility for plume investigation and cleanup only in the event that AMD fails to comply with the requirements of this Board Order. These four parties are hereinafter referred to as dischargers because of the releases of hazardous wastes that have occurred at its site and are also Responsible Parties under Federal Superfund regulations (CERCLA/SARA). AMD 901/902 is a Superfund site on the National Priorities List (NPL). This Order is intended to outline a proposed plan for the final remedial actions at the AMD OU and Offsite OU as required by CERCLA/SARA.

Separate Orders have been prepared for each onsite operable unit (AMD, Signetics and TRW) with joint tasks for the Offsite Operable Unit. This course has been taken due to the commingling of the groundwater plume in the offsite area. Joint Orders were not pursued because the properties are proposed as separate sites on the National Priorities List. The Companies are encouraged to

submit joint reports when feasible. If joint reports are not coordinated and submitted, each company is still individually responsible for the joint tasks in this Order. EPA is expected to agree with the selected remedy and issue a Record of Decision following adoption by the Board of a final Order approving the RI/FS and a final RAP.

Pursuant to Health and Safety Code Sections 25356.1 (c) and (d), the dischargers are the only identified responsible parties associated with the release of pollutants to the subsurface at this location and have accepted responsibility for the cleanup at the AMD OU. In addition, as described in finding 3 above, AMD has accepted responsibility for jointly remediating groundwater pollution in the Offsite area.

5. Remedial Investigation/Feasibility Study and Proposed Final Cleanup Plan The discharger submitted a Draft Final RI, February 1, 1991 and Draft Final FS Report January 15, 1991. With the inclusion of an addendum to the FS submitted March 19, 1991 these reports satisfy the requirements of Regional Board Order No. 89-56, Site Cleanup Requirements, adopted by the Board April 19, 1989. The FS report includes a detailed screening of alternatives for soil and groundwater remedial actions and a summary of the baseline public health assessment.

   The final RI/FS was submitted in March 1991. The technical information contained in the RI/FS and the Proposed Plan Fact Sheet is consistent with the Health and Safety Code requirements for a final RAP and the National Contingency Plan requirements for a RI/FS. The RI/FS contains an evaluation of the interim remedial actions, an evaluation of final remedial alternatives, proposed remedial standards, and a recommended final RAP.

6. Hydrogeology Stratigraphy in the area surrounding the AMD site is characterized by interbedded and interfingering sands, silts and clays. These sediments were deposited in complex patterns by fluvial-alluvial systems draining the uplands to the south; sediments were deposited as the streams flowed north toward the Bay.

   The nomenclature applied to the water bearing units in the study area is representative of the hydrogeology within the Santa Clara Groundwater Basin. A number of shallow water bearing units are separated from deeper aquifers by a thick persistent aquitard. The shallow units may be subdivided into a variety of zones depending upon depth, lithology and lateral persistence. These zones are frequently labeled as A and B zones. The deeper aquifer is commonly referred to as the C aquifer and the clay layer separating the upper and lower water-bearing zones is commonly referred to as the B-C aquitard. The aquitard has been reported to be between 50 and 100 feet thick in Santa Clara Valley.

   Groundwater from this basin provides up to 50% of the municipal drinking water for the 1.4 million residents of the Santa Clara Valley. In 1989, groundwater accounted for approximately 128,000 of the 315,000 acre feet of drinking water delivered to Santa Clara

Valley Water District customers. This water is produced from the C aquifer.

Within the study area the shallowest water-bearing zone has been identified as the A zone. The deeper water-bearing zone within the study area has been subdivided into five water-bearing units, B1 through B5. The groundwater gradient in all identified water-bearing zones, in static conditions, is to the north toward San Francisco Bay. Local reversal of gradient is observed in the vicinity of groundwater extraction systems.

During the investigation at the AMD OU four identifiable, local aquifers have been characterized. The shallowest of these aquifers has been designated the A aquifer and extends from 7 to 20 feet below the ground surface. The next shallowest unit has been designated as the B1 aquifer and generally occurs from 22 to 40 feet below the ground surface. The next unit has been designated as the B2 aquifer and generally occurs between 45 and 65 feet below ground surface. The deepest aquifer investigated at AMD 901/902, the B3, generally occurs from 60 to 80 below ground surface. At the AMD 901/902 OU the B3 is characterized by a single well. The B-C aquitard occurs at depths greater than 100 feet.

7. State Board Resolution 88-63 On March 30, 1989, the Regional Board incorporated the State Board Policy of "Sources of Drinking Water" into the Basin Plan. The policy provides for a Municipal and Domestic Supply designation for all waters of the State with some exceptions. Groundwaters of the State are considered to be suitable or potentially suitable for municipal or domestic supply with the exception of: 1) the total dissolved solids in the groundwater exceed 3000 mg/L, and 2) the water source does not provide sufficient water to supply a single well capable of producing an average, sustained yield of 200 gallons per day. Based on data submitted by AMD, the Board finds that neither of these two exceptions apply to the A and B zones at AMD and Offsite OUs. Thus, the A and B zones are considered to be potential sources of drinking water.

8. Source Investigation Two possible sources of pollution have been identified at the AMD 901/902 OU. These include acid neutralization systems south of the AMD 902 building and north of AMD 901 (see Appendix 1, Figure 3). Soil pollution was the highest near the AMD 901 acid neutralization system. During removal of the system, soil with up to 186,000 µg/kg of trichloroethylene (TCE) was excavated. Due to proximity of the building not all of the polluted soil could be removed from the southern portion of the excavation.

Additional investigation of source area soil was completed in 1988. This investigation confirmed the presence of polluted soil beneath the excavation for the acid neutralization system removed near the AMD 901 building. The maximum concentrations detected in soil include 242,000 µg/l of 1,2-dichlorobenzene (DCB), 35,000 µg/l of tetrachloroethylene (PCE), 80,000 µg/l of TCE, and 72 µg/l of 1,1-dichloroethylene (1,1-DCE). The estimated volume of soil remaining in this area containing levels of total VOCs higher than 1 ppm is 37 cubic yards.

An acid neutralization system was also removed from the vicinity of AMD 902 in 1984. The maximum concentration of soil pollution detected during the investigation of the neutralization system was 1200 μg/kg of TCE, directly beneath the former tank location. No other soil pollution above 100 μg/kg was detected during this removal action. Based on analysis of soil following the excavation and concentrations of pollutants in groundwater in the area of the excavation no additional investigation of the AMD 902 source area was required.

9. Extent of Pollution TCE is the most common pollutant and has been used as an indicator for groundwater pollution at AMD 901/902. Initial levels of groundwater pollution at this site were as high as 100 ppm of TCE with total VOCs as high as 1000 ppm prior to the point source removal in 1983. The highest current levels of groundwater pollution are about 1 ppm TCE for the onsite area. Currently the onsite pollution extends to a depth of up to 65 feet.

   Offsite the pollution extends to a depth of up to 100 feet and extends laterally downgradient for approximately 4000 feet. The offsite downgradient plume has commingled with pollutants derived from point sources at TRW (FEI) Microwave, 825 Stewart, and Signetics 811 Arques facilities. The extent of the lateral migration of groundwater pollution is difficult to assess due to the commingling of the groundwater plumes. The groundwater contamination does not appear to have had an impact on any special ecological environment or endangered populations based upon no current direct use of the groundwater and from measurements of the VOCs coming off the soils.

   Soil contamination is confined to elevations greater than ten feet in depth beneath the AMD 901 structure or surrounding paved areas. The volume of contaminated soil containing greater than 1 ppm of total VOCs is estimated to be 37 cubic yards. Maximum soil contamination levels are greater than 20 ppm. Due to the isolation of the soil and control of the groundwater the soil does not present any known environmental impacts.

10. Baseline Public Health Evaluation A Baseline Public Health Evaluation (BPHE) is conducted at every Superfund site to evaluate the risk posed by the site in its existing condition. The BPHE examines the chemicals present at the site and the possible routes of exposure to humans and animals. Once the potential risk or hazard from the site is established, judgments can be made as to which environmental laws and standards are applicable to the situation and what cleanup goals are appropriate.

    Chemicals of Concern Using very conservative assumptions regarding concentration, distribution, toxicity, and potential routes of exposure, the BPHE (*Clement, 1990*) identified twenty-eight "chemicals of potential concern" for groundwater. This included sixteen organic chemicals and twelve inorganic chemicals. Further evaluation of the groundwater data in the FS has resulted in the reduction of the number of organic chemicals to ten chemicals of concern and the elimination of all the inorganics.

Exposure Scenarios Using similarly conservative assumptions, the BPHE also developed future and current exposure scenarios. For the hypothetical future exposure scenarios, it was assumed that the onsite areas of the site would be developed for residential use and that the groundwater in the A- and B-aquifers would be used for domestic water supply purposes. The potential current exposure scenario considered in the BPHE evaluated inhalation of VOC vapors originating from the offsite groundwater plume.

According to the BPHE, **potential future exposure** routes at the Companies site may include ingestion of groundwater containing the chemicals of potential concern, inhalation of VOC vapors from groundwater during showering or other domestic uses, and inhalation of VOC vapors originating from the groundwater. Based on the absence of known soil "hot-spots", other than those well below ground surface and beneath buildings, direct contact exposure to chemicals of concern was not considered further in the exposure evaluation.

In addition to the above, the BPHE also assumed that the current cleanup actions would be discontinued and cleanup measures would not be implemented at any time in the future. Using these assumptions, the BPHE concluded that the only **average exposure scenario** for which there would be a potential health risk or an increased cancer risk greater than 1 in 10,000 was the hypothetical future domestic use of contaminated shallow groundwater. The most crucial of these assumptions is that cleanup activity in the study area would cease. This implies that current concentrations in groundwater would persist into the future.

The only **current exposure identified** in the BPHE is indoor exposure to vapors migrating from the contaminated groundwater in the offsite area. This pathway was evaluated for two separate populations, residents of the offsite area and children attending the San Miguel school. These cancer risks and health hazard assessments are based on estimates of the indoor air concentrations of the chemicals of concern predicted by mathematical models. The predicted carcinogenic risk for the average case is estimated to be about 4 in 100,000,000 for schoolchildren and about 1 in 10,000 for residents. The model does not predict any toxic effects from this exposure. This is within the risk range that would be allowable under EPA guidance after cleanup.

The **future use scenarios** considered by the BPHE is domestic use of shallow groundwater beneath the site. This would expose residents to contaminated groundwater through ingestion of water and inhalation during domestic use (showering, cooking, etc.). The greatest potential carcinogenic risk related to the average exposure through these pathways is approximately 2 in 1000.

Domestic use is a hypothetical case since shallow groundwater in the A- and B-aquifers is not currently used for water-supply purposes and local ordinances prohibit such practice. Currently, there are no plans to use the A- and B-aquifer groundwater as a drinking water supply. However, it is the intent of the proposed final RAP presented in this Order to protect the beneficial use of

this resource as a potential source of drinking water.

The BPHE assumption that there will be no continued or further cleanup is invalid. Based on the potential risk identified by the BPHE it is appropriate to cleanup the groundwater. The Companies have been cleaning up contaminated groundwater from the site since 1982. It is the intent of this Order and actions taken by the Board and other agencies to assure and require that these efforts will continue.

11. Chemicals Of Concern The BPHE identified chemicals of concern for the study area based on toxicity and frequency of detection for soil and groundwater data. The presence of these chemicals varies between the OUs and subsets of the chemicals of concern have been developed for each OU (see Appendix 2, Table 1). In addition new data on inorganics has been collected since the completion of the BPHE. This data indicates that inorganics are not present in groundwater above naturally occurring levels. Therefore inorganics are no longer considered to be chemicals of concern.

    Chemicals of concern identified in the FS for the AMD OU include 1,1-dichloroethane (1,1-DCA), 1,1-DCE, cis-1,2-dichloroethylene (cis-1,2-DCE), trans-1,2-dichloroethylene (trans-1,2-DCE), TCE, trichloroethane (TCA), PCE, 1,2-DCB, vinyl chloride (VC), and Freon 113. The chemicals of concern identified for the Offsite OU include all of the above except DCB and VC. TCE is the chemical most commonly present and serves as an indicator chemical for the AMD OU and the other OUs within the study area.

    All of these chemicals are potentially toxic at some concentration. VC is a considered to be a known human carcinogen (EPA class A). 1,1-DCA, PCE, and TCE are considered to be potential or probable human carcinogens (EPA class B1 and B2). 1,1-DCE is a possible human carcinogen (EPA class C).

12. Interim Remedial Actions, Onsite Soils Onsite interim remedial actions began in 1983 with the removal of the acid neutralization sump and about 103 cubic yards of soil, at AMD 901. Not all of the polluted soil was removed due to possible structural damage to AMD 901. In 1984, the acid waste neutralization sump and about 114 cubic yards of soil was removed from the vicinity of Building 902. Contaminated soil above the saturated zone is not expected or known in the Offsite OU, therefore no interim remedial actions for soils in the Offsite OU have been proposed or undertaken.

13. Interim Remedial Actions, Onsite Groundwater Remediation of the groundwater began in 1984 with the installation of two dewatering sumps and one extraction well to contain the onsite pollution. One sump extracts water from the shallow (A) aquifer; the other two systems extract water from the B1 aquifer. Three additional extraction wells were installed in 1988 to enhance the containment of the onsite groundwater pollution plume and to begin containment of the groundwater pollution in the B2 aquifer. The extracted groundwater is treated and reused as process water at the AMD 901/902 facility.

14. Interim Remedial Actions, Offsite Groundwater Two offsite groundwater containment extraction systems have been installed. The Duane Avenue Extraction system, consisting of nine extraction wells, is located just south of Duane Avenue, approximately 1200 to 2100 feet downgradient (north) of the AMD, Signetics, and TRW OUs. This extraction system was installed and began operation in 1986. The Duane Avenue system extracts water from the A, B1, B2, B3 and B4 aquifers.

    A second extraction system consisting of fourteen wells, along Alvarado Avenue, approximately 2700 to 4300 feet downgradient (north) of the AMD, Signetics and TRW OUs, was completed in 1988. Operation of the Alvarado Avenue system began in October 1988. This system extracts water from the A, B1, and B2 aquifers. Data has been collected for the evaluation of both extraction systems and a report evaluating the effectiveness of the systems was submitted on March 10, 1989.

    All extracted groundwater is transferred by a piping system to the AMD 915 DeGuigne facility where the water is treated. About 30 % of the treated water is utilized as process make-up water by the AMD 915 facility and the remainder is released to a storm drain tributary to Calabazas Creek under NPDES Permit Number CA0028797.

15. Vertical Conduit Study A well search for abandoned wells in a 3350 acre area encompassing the study area was completed in December 1986. This includes over one mile in all directions and over three miles in the downgradient direction. The focus of the well search was to identify wells that potentially may form migration pathways to the deeper aquifer. The search identified 177 possible well locations. Of these wells 76 are identified as destroyed. Only two of the wells were within the groundwater contamination plume area. Further investigation indicated that one of these wells was a cathodic protection well maintained by PG&E. This type of well is frequently installed to inhibit rust in underground pipelines. These wells are typically shallow (i.e. pipeline depth) and cased with steel. No additional data was available on the other well and attempts to field check the well location were unsuccessful.

    Two municipal supply wells were identified by the potential conduit study. Well ID number 1845 is a City of Sunnyvale water supply well. This well is over 3000 feet upgradient of the known groundwater contamination plume. Well ID number T6SR1WS29N2 T6SR1WS29 is also upgradient of the groundwater pollution plume and is shown in Santa Clara Valley Water District records as destroyed.

16. Data Quality Development of the Board's final RAP was based on four criteria: 1) data was collected following an approved sampling and analysis plan, 2) random sample splits were collected by Board staff to confirm the validity of data generated by AMD, 3) AMD's data was validated by the Department of Health Services and found to be at least qualitatively acceptable, and 4) there has been reasonable repeatability of the data based on seven years of monitoring. Thus the Board finds that there is sufficient acceptable data to make cleanup decisions.

17. Description of Remedial Alternatives Initially, a large number of cleanup methods (technologies) were screened with respect to their effectiveness, implementability, and order-of-magnitude cost. The methods which passed this initial screening were then combined into cleanup alternatives most applicable to each Operable Unit and evaluated in detail. The detailed analysis included an evaluation based on the nine criteria listed below:

- Overall protection of human health and the environment
- Compliance with ARARs
- Short-term effectiveness
- Long-term effectiveness
- Reduction of toxicity, mobility, or volume
- Implementability
- Cost
- State acceptance
- Community acceptance.

The cleanup alternatives which were so evaluated for AMD and the Offsite OUs are described below. The results of the nine criteria evaluation are presented in Finding 18.

AMD Operable Unit

Cleanup Alternatives for the AMD OU are listed in Appendix 2, Table 2. Residual contaminated soil (approximately 37 cubic yards) is located in the unsaturated zone upgradient of the groundwater extraction and treatment system. Alternative 1 applies to both soil and groundwater. Alternatives 2 through 7 specifically address the soil, and Alternatives 8 through 10 address groundwater.

Alternative 1: No Action - Monitoring The no action alternative includes completely stopping operation of the existing groundwater treatment system which has been operating for the last 6 years. No additional soil remediation would be performed. Groundwater monitoring would continue. Time for the groundwater to achieve compliance with ARARs is unknown with best estimates in the range of hundreds of years. The present worth cost is projected to be $1,500,000.00.

Alternative 2: Soil Flushing In this alternative, water would be percolated through contaminated soil to solubilize VOCs adsorbed to the soil and flush them into the groundwater. Groundwater would then be treated by an activated carbon treatment system. This procedure would reduce the residual concentrations in the soil and increase the soluble concentrations in the groundwater. It is estimated this alternative would take hundreds of years to reduce concentrations of VOCs in soil to the 1 ppm level. The present worth cost of this alternative is estimated to be $2,800,000.00.

Alternative 3: Soil Aeration This alternative consists of excavating the contaminated soil and transporting it to an appropriate treatment area. The soil would be spread out to a predetermined depth, usually 1 to 3 feet, and mechanically mixed on a regular basis. The contaminants would volatilize and be released

to the air. Again, it is estimated this alternative would take hundreds of years to reduce concentrations of VOCs in soil to the 1 ppm level. The present worth cost of this alternative is estimated to be $2,700,000.00.

Alternatives 4 through 6: Vacuum Extraction (VE); VE with Heated Air Assist; VE with Steam Assist These three alternatives involve in situ vacuum extraction whereby VOCs are removed from the soil by mechanically drawing or venting air through the unsaturated soil layer. The soil would be gradually treated as the VOCs are released from the soil particles. Extraction of the VOC-containing vapors could be enhanced by using heated air or steam. VOC-laden air would then be treated with an appropriate treatment system. Again, it is estimated this alternative would take hundreds of years to reduce concentrations of VOCs in soil to the 1 ppm level. The present worth cost of these alternatives ranges from $2,800,000.00 to $3,500,000.00.

Alternative 7: Excavation and Offsite Disposal/Treatment In this alternative, the contaminated soil would be excavated, the building reinforced as needed, and the excavation backfilled. The excavated soil would be treated and/or disposed offsite. The concentrations of VOCs in soil can be reduced to the 1 ppm level during the duration of the excavation. The present worth cost of this alternative is estimated to be $2,700,000.00.

Alternative 8: Extraction - Air Stripping with Carbon Adsorption of the Offgas This alternative comprises the current interim remedial treatment system for the groundwater (extraction wells, air stripper, and carbon adsorption of the offgas). Air stripping as a stand-alone technology is very effective in removing VOCs from groundwater at the AMD Operable Unit. Carbon adsorption of the stripper vapor exhaust provides additional treatment. This alternative is modeled to achieve cleanup standards in 18 years at a present value cost of $2,600,000.00.

Alternative 9: Extraction - Carbon Adsorption Alternative This alternative consists of extraction of groundwater using the current well system. The extracted groundwater could then be passed directly through granular activated carbon for adsorption of VOCs. Use of the air stripper would be discontinued. This alternative would not change the time to achieve ARARs (18 years) however the present value cost would increase to $4,600,000.00.

Alternative 10: Augmented Extraction with Enhanced Treatment This alternative involves installing additional wells on the AMD OU to extract additional groundwater. The groundwater would be treated in the existing air stripper system. An additional carbon adsorption unit would be installed to provide additional capacity to treat the air stripper offgas. The increased number of wells would not result in an increased rate of groundwater extraction, therefore the estimated time to achieve ARARs remains at 18 years. The estimated present value cost of this alternative is $2,800,000.00.

Treated Groundwater Disposal For all three groundwater remediation alternatives (8 through 10), discharge options for treated groundwater include: discharge to a publicly owned treatment works (POTW), discharge to storm drain, and industrial process applications. Currently, AMD uses approximately 50% of the treated groundwater in onsite facility uses. The remaining 50 is discharged to the sanitary sewer.

Offsite Operable Unit

Remedial alternatives for soil were not addressed for the Offsite OU because contaminant sources in soil are limited to the AMD OU. The Alternatives for groundwater are listed in Appendix 2, Table 3.

Alternative 1: No Action The no action alternative involves no further action to treat, contain, or remove any of the contaminated groundwater. To implement this alternative, planned and existing remedial measures would be discontinued. Groundwater monitoring would continue. Time for the groundwater to achieve compliance with ARARs is unknown with best estimates in the range of hundreds of years. The present worth cost is projected to be $1,900,000.00.

Alternative 2: Expanded Extraction, Air Stripping, and Carbon Adsorption: This alternative consists of continued operation of the existing offsite extraction and treatment system. The system currently extracts groundwater from 23 extraction wells. The extracted groundwater is conveyed through an underground piping system to the AMD Building 915 treatment facility; the groundwater is treated by air stripping followed by aqueous carbon adsorption. Currently, about 30% of the treated groundwater is reused at the AMD facility, with the remainder discharged under NPDES permit CA0028797 to the storm drain system. The spent carbon is removed and regenerated offsite as needed, approximately every 1.5 years.

The hydraulic performance evaluation of the extraction system indicated that because of declining water levels, hydraulic capture is not being fully maintained in the A- and B2-aquifers. It is estimated that 5 new A-aquifer extraction wells (or an extraction trench) and 3 new B2-aquifer wells may be needed to maintain adequate capture. Based on results of a simplified model it is estimated that this alternative could meet groundwater ARARs in 36 years. The present worth cost for this alternative is estimated at $4,400,000.00.

Alternative 3: Extraction and Carbon Adsorption This alternative consists of pumping groundwater from the upgraded offsite extraction systems and treatment of the water by carbon adsorption. The treated groundwater would be reused and/or discharged under NPDES permit CA0028797 to the storm drain system. This alternative differs from Alternative 2 in that VOC removal is accomplished by means of a carbon adsorption unit only, rather than by use of a combined air stripping/carbon adsorption system. The estimated time to achieve cleanup is 36 years, the same as Alternative 2. The present worth cost for this alternative is estimated at $10,000,000.00.

18. Evaluation of Final Remedial Alternatives As previously mentioned, the alternatives for each Operable Unit were evaluated using the nine FS criteria. Tables 2 and 3 in Appendix 2 summarize the results of the evaluation using the first seven criteria; evaluation of community and agency acceptance was deferred until after the public comment period.

AMD OU SOIL

Proposed Alternative

Alternative 7, Excavation and Offsite Disposal/Treatment is the recommended cleanup measure for the 37 cubic yards of contaminated soil that remains beneath AMD Building 901. This alternative meets the criterion of protection of human health and the environment, complies with ARARs, is effective in both the long- and short-term, reduces the mobility and volume of the contaminants in the soil by removing them from the site, and is cost-effective.

The alternative is not easily implemented because it will require that operations in the building be temporarily halted, and adequate construction controls (including dust minimization) would be needed. It is, however, the only soil remediation alternative that will comply with Board guidance and ARARs in a reasonable time. The present worth cost of this alternative is estimated to be $2,700,000.00.

Due to the difficulty in implementation, the discharger will be given up to two years from the adoption of this Order to complete the removal action. This is proposed because at this time the majority of soil in question is protected from infiltrating water from above by concrete. This soil is also prevented from coming into direct contact with the water table by operation of the AMD 901 groundwater extraction system. This extraction system also controls the migration of contaminated water from the site. This alternative can achieve Board guidance of 1 ppm total VOCs immediately upon completion of the removal action. Land disposal restrictions (LDRs) will serve as an ARAR for offsite disposal. Treatment or treatment technology will be determined by LDRs at the time of removal. However the current treatment technology for removal of the majority of VOCs in soil is incineration, which would result in permanent destruction of the chemicals of concern for AMD 901.

Rejected Alternatives

Alternative 1, the no action alternative would not be protective of human health or the environment. No further consideration will be given to this alternative

Alternative 2, soil flushing would take an excessively long time to reach the proposed cleanup level of 1 ppm for total VOCs. This is exacerbated by the low solubilities of some of the chemicals of concern, particularly DCB. Therefore this alternative is dropped from further consideration.

Alternative 3, soil aeration is not easily implementable due to the physical constraints site structure would place on the excavation. More importantly the treatment would not result in permanent destruction of the contaminants, only transfer to the air. In addition, time to reach the cleanup standard for offsite disposal through this technology is estimated to be hundreds of years. This is a function of the physical properties of some chemicals of concern, notably DCB and PCE, that makes removal from soil difficult.

Alternatives 4 through 6, Vacuum Extraction (VE); VE with Heated Air Assist; VE with Steam Assist are all dependent upon the transfer of chemicals from soil to vapor, as is alternative 3. The advantage is that alternatives 4 through 6 rely on in situ techniques. This eliminates the need for an excavation and the related implementability problem. However, compliance with TBCs is questionable due to the length of time required to reach the soil cleanup criteria of 1 ppm due to the difficulty in removing DCB and PCE from soil under native conditions. Heated air or steam injection may enhance the removal rates, however neither is a proven technology and the same physical limits may still apply.

AMD OU GROUNDWATER

Proposed Alternative

Alternative 8, Extraction and Groundwater Treatment with Existing Air Stripper and Carbon Adsorption of Offgas is the recommended cleanup measure. This system comprises the existing interim cleanup measure and, thus, has demonstrated its effectiveness. It provides protection of human health and the environment by removing the VOCs from the groundwater, complies with ARARs, is effective in both the long- and short-term, reduces the volume and mobility of the contaminants, and is cost-effective. Alternative 9 increases the permanent destruction of contaminants as compared to Alternative 8, however the projected present worth cost is $2,000,000.00 greater. Alternative 10 may also offer increased permanent destruction of contaminants and may additionally reduce toxicity or mobility of contaminants as compared to Alternative 8. The mass of contaminants produced by the air stripper system is low and this would not be a significant difference. Alternative 10 has a projected net worth cost $200 000.00 greater than alternative 8. Alternative 8 is modeled to achieve cleanup standards in 18 years at a present value cost of $2,600,000.00.

In addition to the above components staff proposes the inclusion of institutional constraints in the form of a deed restriction. The purpose of the deed restriction should be to control site access and prevent the installation of water supply wells in the shallow water-bearing zones and to provide a warning for any subsurface construction activities. The deed restriction would be designed to "run with" the property to insure that any potential future site occupants woulld be aware of the past contamination at the site.

Rejected Alternatives

Alternative 9, Extraction and treatment through Carbon Adsorption would result in increased permanent destruction of the chemicals due to the offsite carbon regeneration process. It would not result in increased compliance with ARARs or decreased time to achieve ARARs.

Alternative 10, Augmented Extraction with Enhanced Treatment would increase the number of extraction wells and add additional carbon units to the treatment system for capture and treatment of air stripper offgas. This system would not decrease the time to cleanup since the current system is limited by current water levels in the shallow water-bearing zones. Compliance with ARARs would not be improved. Reduction in toxicity, mobility and volume would be improved through the capture of the air stripper offgas. If the carbon regeneration process for the treatment units on the air stripper offgas relays on destructive techniques the use of permanent solutions would be enhanced.

OFFSITE OPERABLE UNIT

Proposed Alternative

Extraction, air stripping, and carbon adsorption, Alternative 2 is the recommended cleanup measure for the Offsite OU. This alternative provides good protection of human health and the environment, complies with ARARs, is effective in both the long- and short-term, reduces the toxicity, mobility, and volume of VOCs, is currently in operation, and is cost-effective. Upgrading the current extraction/treatment system with additional wells and/or trenches would improve the performance of the system. The current system's performance is in part due to low water levels in the A zone resulting from the drought and groundwater extraction. The actual number, depth, and location of additional extraction wells that will be required to improve system performance will be determined as part of the remedial assessment remedial design (RA/RD) process (see Task 14). Based on results of a simplified model it is estimated that this alternative could meet groundwater ARARs in 36 years. The present worth cost for this alternative is estimated at $4,400,000.00.

Rejected Alternatives

The other alternatives considered for the Offsite OU were the no action, Alternative 1, which would not be protective of human health or the environment, and Alterative 3, groundwater extraction with treatment by carbon adsorption. The no action alternative is included only for comparison and no further consideration will be given to this alternative. The only advantage that treatment by carbon adsorption alone as compared to treatment by an air stripper followed by carbon adsorption is the elimination of the release of offgas and the potential for increased permanent destruction of contaminants after removal. The present worth cost for carbon adsorption treatment alone is estimated at $10,000,000.00, more than twice the estimated cost of air stripping followed by carbon

adsorption.

In summary the proposed final RAP for the AMD and Offsite OUs would include the following components:

1. Continued groundwater and soil flux monitoring,

2. Soil excavation at the AMD 901 source area and offsite disposal,

3. Continued groundwater extraction and treatment with the existing system at AMD 901/902,

4. Modification of the Alvarado and Duane Avenue offsite extraction systems and continued groundwater extraction from these modified systems for the Offsite OU. The modification would focus on improving control of the A zone pollutant plume under the current drought conditions. Treatment would continue with the existing system at AMD 915 with air stripping followed by aqueous phase carbon treatment. The carbon is transfered to a licensed facility where it is regenerated by the use of a rotary kiln and reused at the AMD facility. The treated water is either discharged under NPDES permit or reused onsite, and

5. Implementation of institutional constraints for the AMD 901/902 OU until cleanup standards are achieved.

19. Cleanup Standards The cleanup standards must meet all applicable, relevant, and appropriate requirements (ARARs) and be protective of human health and the environment. There are no ARARs for soil cleanup. However, the chemicals of concern in soil are the same as those in groundwater, predominantly VOCs. The presence of VOCs at high concentrations would present a continued threat to water quality. The Board has proposed a cleanup standard of 1 part per million (ppm) total VOCs for vadose zone soil. As an alternative to this cleanup level the discharger was given the option of providing a technical demonstration that levels of VOCs greater than 1 ppm could remain in place in the soil without partitioning from soil into groundwater at levels above groundwater cleanup standards. The latter has not been demonstrated for this site.

Cleanup standards for groundwater are shown as shaded in Appendix 2, Table 4 of this Order. The standards for nine of the ten chemicals of concern for the AMD and Offsite OUs are the California maximum contaminant levels (MCLs) for drinking water. The exception is 1,2-DCB for which California has not established an MCL. The cleanup standard for 1,2-DCB shall be the proposed Federal MCL. Since groundwater cleanup levels are based on MCLs this will meet all ARARs for groundwater cleanup.

An additional concern that is discussed in the FS is the potential contamination of the air by the treatment systems at the AMD OU and the AMD 915 (offsite treatment) facility. The appropriate standards for this consideration are the regulations of the Bay Area Air Quality Management District (BAAQMD) Regulation 8, Rule 47 which is an ARAR for this facility. The air stripper systems at AMD 901/902 and AMD 915 DeGuigne Drive sites are regulated by the BAAQMD. The

air stripper offgas from the system at AMD 901/902 is treated through vapor phase carbon. The air stripper offgas at AMD 915 (offsite extraction system treatment) is not treated. Air emissions from the AMD 915 facility as a whole, including the air stripper, were required to be evaluated by the BAAQMD under AB 2588. This evaluation ranked the AMD 915 complex as a medium priority. Based on this ranking a health risk assessment for air emissions was not required by the BAAQMD. The air emissions from these units do satisfy the ARAR cited above as regulated and required by the BAAQMD.

20. Risk Associated With Cleanup Standards The selected remedy is protective of human health and the environment -- as required by Section 121 of CERCLA -- in that pollution in groundwater is treated to at least MCLs and falls within EPA's acceptable carcinogenic risk range and noncarcinogenic hazard index. EPA's acceptable carcinogenic risk range for cleanup standards selected for a site is 10^{-4} to 10^{-6} as an acceptable cleanup level. If the noncarcinogenic hazard index is less than one, EPA considers the combined intake of chemicals unlikely to pose a health risk.

At the AMD OU, the carcinogenic risk at the cleanup standards (for all chemicals listed in Appendix 2, Table 4) associated with the potential future use scenario of groundwater ingestion and inhalation of VOCs from groundwater is 6×10^{-6}. In cleaning up TCE to the 5 ppb cleanup standard it is quite likely that the concentrations of other VOCs will be reduced to levels below the 5 ppb range. This estimated risk is based on cleanup to MCLs or the geometric mean concentration of a chemical, if that mean is currently below the cleanup standard established for that chemical. This is an attempt to provide a more realistic estimate of the residual risk after cleanup is achieved.

For the Offsite OU, the carcinogenic risk for the four chemicals of concern identified as carcinogens (1,1-DCA, 1,1-DCE, PCE, and TCE) associated with the potential future use scenario of groundwater ingestion and inhalation of VOCs from groundwater is 4×10^{-5}. This estimate is based on the exposure that would be experienced if all four chemicals were present at the concentration required by the cleanup standards. In addition this risk includes 1,1-DCE which is classified by the EPA as a possible human carcinogen. This classification is currently under review and the California Department of Health Services (DOHS) does not recommend including 1,1-DCE in risk calculations as a carcinogen. If 1,1-DCE is not included in the calculation the estimated residual risk after cleanup associated with the potential future use scenario of groundwater through ingestion and inhalation of VOCs from groundwater in the Offsite OU is 3×10^{-6}.

The noncarcinogenic hazard index associated with the cleanup standards at the AMD OU is 0.80. The noncarcinogenic hazard index associated with the cleanup standards at the Offsite OU is 0.20. The low hazard index at the Offsite OU is a function of the small number of chemicals of concern identified for the Offsite OU.

The method and assumptions used to obtain the carcinogenic risk and

the hazard index associated with the cleanup standards are contained in the BPHE and FS. A number of assumptions have been made in the derivation of these values, many of which are intentional overestimates of exposure and/or toxicity. The actual incidence of cancer is likely to be lower than these estimates and may even be zero. The cleanup standards for the site are protective of human health, have a carcinogenic risk that falls within a range of 10^{-6} to 10^{-4}, and a hazard index of less than one.

21. Uncertainty in Achieving Cleanup Standards The goal of this remedial action is to restore groundwater to its beneficial uses. Based on information obtained during the RI and on a careful analysis of all remedial alternatives, the Board believes that the selected remedy will achieve this goal. However, studies suggest that groundwater extraction and treatment will not be, in all cases, completely successful in reducing contaminants to health-based levels in the aquifer zones. The Board recognizes that operation of the selected extraction and treatment system may demonstrate the technical impracticability of reaching health-based groundwater quality standards using this approach. If it becomes apparent, during implementation or operation of the system, that contaminant levels have ceased to decline and are remaining constant at levels higher than the remediation goal, that goal and the remedy may be reevaluated.

The selected remedy will include groundwater extraction for a period of up to 18 years at the AMD OU and up to 36 years in the Offsite OU, during which the system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation.

Modifications may include:

a) discontinuing operation of extraction wells in areas where cleanup standards have been attained;

b) alternating pumping at wells to eliminate stagnation points; and

c) pulse pumping to allow aquifer equilibration and encourage adsorbed contaminants to partition into groundwater.

The projected times to achieve cleanup included in this Order are developed in the FS. These times are derived from a simple groundwater model and are intended to provide a basis of comparison for the screening of alternatives. It is probable that these models provide an underestimate of the time required to achieve the cleanup standards proposed in this Order.

22. Future Changes to Cleanup Levels If new information indicates cleanup standards cannot be attained or can reasonably be surpassed, the Regional Board will decide if further final cleanup actions beyond those completed shall be implemented at this site. If changes to the cleanup standards or amended cleanup standards

are proposed, due to the claimed technical infeasibility of attaining the standards, adopted by this Order, a new Order will be submitted to the Board for consideration and to EPA Region IX for their review and selection concurrence. If changes in health criteria, administrative requirements, site conditions, or remediation efficiency occur, the discharger will submit an evaluation of the effects of these changes on cleanup levels as specified under Provisions C.4.j. and C.4.r.

The Regional Board will not require the discharger to undertake additional remedial actions with respect to the matters previously described herein unless: (1) conditions on the site, previously unknown to the Regional Board, are discovered after adoption of this Order, or (2) new information is received by the Regional Board, in whole or in part after the date of this Order, and these previously unknown conditions or this new information indicates that the remedial actions required in this Order may not be protective of public health and the environment. The Regional Board will also consider technical practicality, cost effectiveness, State Board Resolution No. 68-16 and other factors evaluated by the Regional Board in issuing this Order in determining whether such additional remedial actions are appropriate and necessary.

23. Community Involvement An aggressive Community Relations program has been ongoing for all Santa Clara Valley Superfund sites, including AMD. The Board published a notice in the San Jose Mercury News on March 13,20, and 27, 1991, announcing the proposed final cleanup plan and opportunity for public comment at the Board Hearing of March 20, 1991 in Oakland, and announcing the opportunity for public comment at an evening public meeting held at the Westinghouse Auditorium, Britton at East Duane Avenue, in the City of Sunnyvale on Thursday March 28, 1991. Public comment was received during an extended 60 day period (at community request) from March 20 through May 20, 1991.

Fact Sheets were mailed to interested residents, local government officials, and media representatives. Fact Sheet 1, mailed in december 1989, summarized the pollution problem, the results of investigations to date, and the interim remedial actions. Fact Sheet 2, mailed in March 1991, described the cleanup alternatives evaluated, explained the proposed final RAP, announced opportunities for public comment at the Board Hearing of March 20, 1991 in Oakland and the Public Meeting of March 28, 1991 in Sunnyvale and described the availability of further information at the Information Repository at the City of Sunnyvale Library and the Regional Board offices. Written comments received from the community meeting of March 28, 1991, and at an informal meeting held on May 7, 1991 are reviewed in the Responsiveness Summary included as Appendix C.

24. State Board Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality Waters in California" On October 28, 1968, the State Water Resources Control Board adopted Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality Waters in California". This policy calls for maintaining the existing high quality of State waters unless it is demonstrated

that any change would be consistent with the maximum public benefit and not unreasonably affect beneficial uses. The original discharge of waste to the groundwater at these sites was in violation of this policy; therefore, the groundwater quality needs to be restored to its original quality to the extent reasonable. For the purpose of establishing cleanup objectives, the shallow groundwater at the site is designated a potential source of drinking water (see finding 7).

The FS evaluated groundwater cleanup to background or non-detect levels. Cleanup to non-detect levels would increase estimated groundwater cleanup times by between 33% and 50% and add significantly to cost. In addition, cleanup of groundwater to below the MCL for the chemicals of concern may not be achievable due to the technical difficulties in restoring aquifers by the removal of low concentrations of any VOC. This is due to the slow desorption of VOCs adsorbed to the inner pore spaces of soil particles which make up the aquifer material and VOCs adsorbed to clays and organic matter in the aquitard. Cleanup to MCL levels would protect the primary beneficial use of the groundwater as a potential source of drinking water. For these reasons, MCLs were accepted as concentrations that meet the intent of Resolution No. 68-16.

The proposed remedial water quality standards meet current applicable health criteria and restore the quality of the groundwater to the extent reasonable given technical and economic constraints. These constraints include the high additional incremental costs for removal of small amounts of additional chemicals and the need to minimize the removal of groundwater due to the drought to achieve acceptable remedial standards.

25. Groundwater Conservation AMD has considered the feasibility of reclamation, reuse, or discharge to a publicly owned treatment works (POTW) of extracted groundwater from AMD 901/902, as specified in Board Resolution No. 88-160. Onsite industrial accounts for approximately 50% reuse of the water after treatment. The remaining 50% of the treated water is discharged to the sanitary sewer.

The extracted groundwater from the offsite system is piped to AMD 915 for treatment. Reuse at the AMD 915 facility, which includes water from an onsite remedial groundwater extraction system, currently is at about 50% of the total volume. It is anticipated that this will reach 80% during 1991 with an eventual goal of 100% reuse.

26. Basin Plan The Board adopted a revised Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) on December 17, 1986. The Basin Plan contains water quality objectives and beneficial uses for South San Francisco Bay and contiguous surface and ground waters.

27. Beneficial Use The existing and potential beneficial uses of the groundwater underlying and adjacent to the facility include:

a. Industrial process water supply

b. Industrial service water supply
c. Municipal and Domestic water supply
d. Agricultural water supply

28. The discharger has caused or permitted, and threatens to cause or permit waste to be discharged or deposited where it is or probably will be discharged to waters of the State and creates or threatens to create a condition of pollution or nuisance.

29. This action is an order to enforce the laws and regulations administered by the Board. This action is categorically exempt from the provisions of the CEQA pursuant to Section 15321 of the Resources Agency Guidelines.

30. Onsite and offsite interim containment and cleanup measures need to be continued to alleviate the threat to the environment posed by the continued migration of pollutants and to provide a substantive technical basis for designing and evaluating the effectiveness of final cleanup alternatives.

31. The Board has notified the discharger and interested agencies and persons of its intent under California Water Code Section 13304 to prescribe Site Cleanup Requirements for the discharge and has provided them with the opportunity for a public hearing and an opportunity to submit their written views and recommendations.

32. The Board, in a public meeting on June 19, 1991, heard and considered all comments pertaining to the discharge.

IT IS HEREBY ORDERED, pursuant to Section 13304 of the California Water Code, that the discharger, their agents and assigns or successors, shall cleanup and abate the effects described in the above findings as follows:

A. **PROHIBITIONS**

1. The discharge of wastes or hazardous materials in a manner which will degrade water quality or adversely affect the beneficial uses of the waters of the State is prohibited.

2. Further significant migration of pollutants through subsurface transport to waters of the State is prohibited.

3. Activities associated with the subsurface investigation and cleanup which will cause significant adverse migration of pollutants are prohibited.

B. **SPECIFICATIONS**

1. The storage, handling, treatment or disposal of soil or groundwater containing pollutants shall not create a nuisance as defined in Section 13050(m) of the California Water Code.

2. The discharger shall conduct monitoring activities as outlined in the amended field sample and analysis plan, approved by the Executive Officer, to define the current local hydrogeologic

conditions, and the lateral and vertical extent of soil and groundwater pollution. Should monitoring results show evidence of pollutant migration, additional characterization of pollutant extent may be required. Within sixty (60) days of the Executive Officer's determination and actual notice to Research Group 82-1, Thompson Place 2, and B/G Management Inc. that AMD, Inc. has failed to comply with this paragraph, Research Group 82-1, Thompson Place 2, and B/G Management Inc. as landowners, shall comply with this specification.

3. Pursuant to Water Code Section 13304(c), the dischargers are hereby notified that the Board is entitled to and may seek reimbursement for all reasonable staff oversight costs incurred relating to cleanup of waste on this site, abating the effects thereof, or taking other remedial action.

C. **PROVISIONS**

1. The discharger shall submit to the Board acceptable monitoring program reports containing results of work performed according to a program as described in the October 1897 sampling plan, amended 1989, or as further amended and approved by the Executive Officer.

2. All wells in the AMD and Offsite operable units shall be used to determine if cleanup standards have been met.

3. Final cleanup standards for all onsite and offsite wells shall be not greater than the levels as provided in Finding 19 and as shown in Table 4 of Appendix 2.

4. The discharger shall comply with the Prohibitions and Specifications above, in accordance with the following time schedule and tasks:

TASK/COMPLETION DATE

AMD OPERABLE UNIT

a. TASK 1: PROPOSED CONSTRAINTS: Submit a technical report acceptable to the Executive Officer documenting procedures to be implemented by the dischargers, including a deed restriction prohibiting the use of the upper aquifer groundwater as a source of drinking water, and for controlling onsite activities that could endanger the public health or the environment due to exposure to VOCs. Constraints shall remain in effect until groundwater cleanup standards have been achieved and pollutant levels have stabilized in onsite aquifers.

COMPLETION DATE: July 28, 1991

b. TASK 2: CONSTRAINTS IMPLEMENTED: Submit a technical report acceptable to the Executive Officer documenting that the proposed and approved constraints have been implemented.

COMPLETION DATE: 60 days after Board staff approval of Task 1.

c. UPDATING ADMINISTRATIVE RECORD:

1) TASK 3: PROPOSED UPDATE: Submit a technical report acceptable to the Executive Officer containing an updated index for the Administrative Record for the period November 1, 1990 through September 30, 1991.

COMPLETION DATE: October 15, 1991

2) TASK 4: UPDATE ADMINISTRATIVE RECORD: Submit a technical report acceptable to the Executive Officer containing the updated Administrative Record documents for the period November 1, 1990 through September 30, 1991.

COMPLETION DATE: December 1, 1991

d. TASK 5: SOIL REMEDIATION: Submit a technical report acceptable to the Executive Officer describing the soil excavation at AMD 901 including a proposed implementation schedule, name, permit number, and location for offsite soil disposal. This report shall also including limits on soil disposal for chemicals of concern.

COMPLETION DATE: May 31, 1992

e. TASK 6: REVISED SAMPLING AND ANALYSIS PLAN: Submit a technical report acceptable to the Executive Officer containing a proposed Sampling and Analysis Plan, as described in CERCLA/SARA guidance. This plan should include a schedule for groundwater sampling following the soil removal at AMD 901. This report shall also include a proposal for verification sampling for the soil removal action. This report shall also contain a second schedule for sampling and analysis that will follow the attainment of soil cleanup standards. This plan should also include analysis by appropriate EPA series 8000 analysis techniques.

COMPLETION DATE: May 31, 1992

f. TASK 7: COMPLETION OF ONSITE SOIL REMEDIATION: Document in the appropriate quarterly report the completion of the necessary tasks identified in the technical report submitted for Task 3 Provision C.4.a including the results of chemical analyses of appropriate samples from the excavation.

COMPLETION DATE: Due date for quarterly status report for the quarter in which operation of the soil removal and disposal is

completed but not later than May 31, 1993.

g. TASK 8: ONSITE WELL PUMPING CURTAILMENT CRITERIA AND PROPOSAL:Submit a technical report acceptable to the Executive Officer containing a proposal for curtailing pumping from onsite groundwater extraction well(s) and trench(s) and the criteria used to justify such curtailment. This report shall include data to show that cleanup standards for all VOCs have been achieved and have stabilized or are stabilizing, and that the potential for pollutant levels rising above cleanup standards is minimal. This report shall also include an evaluation of the potential for pollutants to migrate downwards to the C aquifer at this location. If the discharger claims that it is not technically feasible to achieve cleanup standards, the report shall evaluate the alternate standards that can be achieved. Cessation of pumping will require the concurrence of the Regional Board and EPA, should either party not concur, continued pumping will be required.

COMPLETION DATE: 90 days prior to proposed implementation of onsite groundwater extraction curtailment

h. TASK 9: IMPLEMENTATION OF ONSITE CURTAILMENT: Submit a technical report acceptable to the Executive Officer documenting completion of the necessary tasks identified in the technical report submitted for Task 8.

COMPLETION DATE; 30 days after the Regional Board approves onsite curtailment

i. TASK 10: FIVE-YEAR STATUS REPORT AND EFFECTIVENESS EVALUATION: Submit a technical report acceptable to the Executive Officer containing the results of any additional investigation including the soil remediation study; an evaluation of the effectiveness of installed final cleanup measures and cleanup costs; additional recommended measures to achieve final cleanup objectives and standards, if necessary; a comparison of previous expected costs with the costs incurred and projected costs necessary to achieve cleanup objectives and standards; and the tasks and time schedule necessary to implement any additional final cleanup measures.

This report shall also describe the reuse of extracted groundwater, evaluate and document the cleanup of polluted groundwater, and evaluate and document the removal and/or cleanup of polluted soil. If safe drinking water levels, through the removal of the chemicals for which this Order specifies cleanup standards, have not been achieved onsite and are not expected to be achieved through continued groundwater extraction and/or soil remediation, this report shall also contain an evaluation

addressing whether it is technically feasible to achieve drinking-water quality onsite, and if so, a proposal for procedures to do so.

COMPLETION DATE: June 19, 1996

j. TASK 11: EVALUATION OF NEW HEALTH CRITERIA: Submit a technical report acceptable to the Executive Officer which contains an evaluation of how the final plan and cleanup standards would be affected, if the concentrations as listed in Provision C.3., Table 4 change as a result of changes in source-document conclusions or promulgation of drinking water standards, maximum contaminant levels or action levels.

COMPLETION DATE: 60 days after request made by the Executive Officer

OFFSITE OPERABLE UNIT

k. TASK 12: SOIL FLUX MONITORING WORKPLAN: Submit a technical report acceptable to the Executive Officer proposing sample locations and a sample schedule for long-term soil flux monitoring of chemicals of concern in the offsite area. The plan shall include sampling and analysis by EPA approved methodology. The schedule shall include seasonal (wet season/dry season) monitoring at locations as proposed and approved, with sampling to commence no later than September 15, 1991.

COMPLETION DATE: August 15, 1991

l. TASK 13: SOIL FLUX MONITORING: Submit a technical report acceptable to the Executive Officer including the results of the monitoring as proposed under Task 12 above. The report shall include results of analysis by EPA approved methodology, appropriately scaled maps, and evaluation of the results of the monitoring including comprehensive tabulations of all data collected and an episodic comparative evaluation of the health risk to residents of the offsite area. This report shall be submitted within forty-five (45) days of the completion of each scheduled sampling event as proposed and approved under Task 12. Following the fourth sample event from commencement of sampling (two years hence), the discharger may propose modification to the number of samples collected, sampling frequency or termination of the sampling program.

COMPLETION DATE: October 30, 1991 and every six months thereafter

m. TASK 14: MODIFICATION TO OFFSITE GROUNDWATER EXTRACTION SYSTEM: Submit a technical report acceptable to the Executive Officer proposing modifications to the offsite groundwater extraction system. This report shall include an evaluation of additional groundwater extraction, especially in the A zone to control migration of pollutants in the A zone. This evaluation may include locations and numbers of additional extraction wells or trenches and mechanical modifications to existing wells to improve system efficiency. Any proposed changes shall include an evaluation of increased groundwater extraction on the treatment system, water reuse, and water conservation. This report shall also include number and proposed location of any additional monitor wells required to improve system monitoring, especially to monitor migration north of the Bayshore Freeway.

COMPLETION DATE: September 15, 1991

n. TASK 15: IMPLEMENTATION OF MODIFICATION TO OFFSITE GROUNDWATER EXTRACTION SYSTEM: Submit a technical report acceptable to the Executive Officer documenting the completion of modifications to the offsite groundwater extraction system. This report shall include well logs and locations for any new wells installed, specifications for modifications to pumps or pump placements, appropriately scaled location maps, and engineering drawings of systems modified as approved under Task 14 above.

COMPLETION DATE: September 15, 1992

o. TASK 16: OFFSITE WELL PUMPING CURTAILMENT CRITERIA AND PROPOSAL: Submit a technical report acceptable to the Executive Officer containing a proposal for curtailing pumping from offsite groundwater extraction well(s) and trench(s) and the criteria used to justify such curtailment. This report shall include data to show that cleanup standards for all VOCs have been achieved and have stabilized or are stabilizing, and that the potential for pollutant levels rising above cleanup standards is minimal. This report shall also include an evaluation of the potential for pollutants to migrate downwards to the C aquifer at this location. If the discharger claims that it is not technically feasible to achieve cleanup standards, the report shall evaluate the alternate standards that can be achieved. Cessation of pumping will require the concurrence of the Regional Board and EPA, should either party not concur, continued pumping will be required.

COMPLETION DATE: 90 days prior to proposed implementation of onsite groundwater extraction curtailment

p. TASK 17: IMPLEMENTATION OF OFFSITE CURTAILMENT: Submit a technical report acceptable to the Executive Officer documenting completion of the necessary tasks identified in the technical report submitted for Task 16. Cessation of pumping will require the concurrence of the Regional Board and EPA, should either party not concur, continued pumping will be required.

COMPLETION DATE; 30 days after the Regional Board approves onsite curtailment

q. TASK 18: FIVE-YEAR STATUS REPORT AND EFFECTIVENESS EVALUATION: Submit a technical report acceptable to the Executive Officer containing the results of any additional investigation including the soil remediation study; an evaluation of the effectiveness of installed final cleanup measures and cleanup costs; additional recommended measures to achieve final cleanup objectives and standards, if necessary; a comparison of previous expected costs with the costs incurred and projected costs necessary to achieve cleanup objectives and standards; and the tasks and time schedule necessary to implement any additional final cleanup measures.

This report shall also describe the reuse of extracted groundwater, evaluate and document the cleanup of polluted groundwater, and evaluate and document the removal and/or cleanup of polluted soil. If safe drinking water levels, through the removal of the chemicals for which this Order specifies cleanup standards, have not been achieved onsite and are not expected to be achieved through continued groundwater extraction and/or soil remediation, this report shall also contain an evaluation addressing whether it is technically feasible to achieve drinking-water quality onsite, and if so, a proposal for procedures to do so.

COMPLETION DATE: June 19, 1996

r. TASK 19: EVALUATION OF NEW HEALTH CRITERIA: Submit a technical report acceptable to the Executive Officer which contains an evaluation of how the final plan and cleanup standards for the Offsite OU would be affected, if the concentrations as listed in Provision C.3., Table 4 change as a result of changes in source-document conclusions or promulgation of drinking water standards, maximum contaminant level goals, maximum contaminant levels or action levels.

COMPLETION DATE: 60 days after request made by the Executive Officer

3. All Technical reports submitted must be acceptable to the Executive Officer. The submittal of technical reports evaluating interim and final remedial measures shall include a projection of the cost, effectiveness, benefits, and impact

on public health and the environment.

4. The remedial investigation and feasibility study shall consider the guidance provided by Subpart F of the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Part 300); Section 25356.1 (c) of the California Health and Safety Code; CERCLA guidance documents with reference to Remedial Investigation, Feasibility Studies, and Removal Actions; and the State Water Resources Control Board's Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California".

5. If the discharger is delayed, interrupted or prevented from meeting one or more of the completion dates specified in this Order, the discharger shall notify the Executive Officer prior to the deadline for the completion date.

6. Technical reports summarizing the status of compliance with the Prohibitions, Specifications, and Provisions of this Order and progress toward completion of tasks as identified in the workplan as revised, shall be submitted on a quarterly basis, according to the schedule below, commencing with the report for the third quarter 1991, due October 31, 1991.

Quarter	1st quarter	2nd Quarter	3rd Quarter	4th Quarter
Period	Jan-March	April-June	July-Sept	Oct-Dec
Due Date	April 30	July 31	October 31	January 31

The quarterly reports shall include;

a. a summary of work completed since the previous quarterly report,
b. appropriately scaled and labeled maps showing the location of all monitoring wells, extraction wells, and existing structures,
c. updated water table and piezometric surface maps for all affected water bearing zones, and isoconcentration maps for key pollutants in all affected water bearing zones, <u>shall be included at a minimum in the reports for the second and fourth quarters</u>, or in the event of significant changes,
d. a summary tabulation of all well construction data, groundwater levels and chemical analysis results for site monitor wells as specified in the revised sampling plan,
e. a summary tabulation of volume of extracted groundwater and chemical analysis for all site groundwater extraction wells,
f. an estimate of volume or mass of contaminants removed by each remedial system in the quarter and a cumulative tabulation of the total volume or mass of contaminants removed, (total and #/day)
g. identification of potential problems which will cause or threaten to cause noncompliance with this Order and what actions are being taken or planned to prevent these obstacles from resulting in noncompliance with this

Order, and

h. in the event of noncompliance with the Provisions and Specifications of this Order, the report shall include written justification for noncompliance and proposed actions to achieve compliance.

7. All hydrogeological plans, specifications, reports, and documents shall be signed by or stamped with the seal of a registered geologist, engineering geologist or professional engineer.

8. All samples shall be analyzed by State certified laboratories or laboratories accepted by the Board using approved EPA methods for the type of analysis to be performed. All laboratories shall maintain Quality Assurance/Quality Control records for Board review.

9. The discharger shall maintain in good working order, and operate, as efficiently as possible, any facility or control system installed to achieve compliance with the requirements of this Order.

10. Copies of all correspondence, reports, and documents pertaining to compliance with the Prohibitions, Specifications, and Provisions of this Order, shall be provided to the following agencies:

    a. Santa Clara Valley Water District
    b. Santa Clara County Health Department
    c. City of Sunnyvale
    d. State Department of Health Services/TSCD
    e. U. S. EPA Region IX

    The Executive Officer may additionally require copies of correspondence, reports and documents pertaining to compliance with the Prohibitions, Specifications, and Provisions of this Order to be provided to a local repository for public use.

11. The discharger shall permit the Board or its authorized representative, in accordance with Section 13267(c) of the California Water Code:

    a. Entry upon premises in which any pollution sources exist, or may potentially exist, or in which any required records are kept, which are relevant to this Order.

    b. Access to copy any records required to be kept under the terms and conditions of this Order.

    c. Inspection of any monitoring equipment or methodology implemented in response to this Order.

    d. Sampling of any groundwater or soil which is accessible, or may become accessible, as part of any investigation or remedial action program undertaken by the discharger.

12. The discharger shall file a report on any changes in site occupancy and ownership associated with the facility described in this Order.

13. If any hazardous substance is discharged to any waters of the state, or discharged and deposited where it is, or probably will be discharged to any waters of the state, the discharger shall report such discharge to this Regional Board, at (415) 464-1255 on weekdays during office hours from 8 a.m. to 5 p.m., and to the Office of Emergency Services at (800) 852-7550 during non-business hours. A written report shall be filed with the Regional Board within five (5) working days and shall contain information relative to: the nature of waste or pollutant, quantity involved, duration of incident, cause of spill, Spill Prevention, Control, and Countermeasure Plan (SPCC) in effect, if any, estimated size of affected area, nature of effect, corrective measures that have been taken or planned, and a schedule of these activities, and persons/-agencies notified.

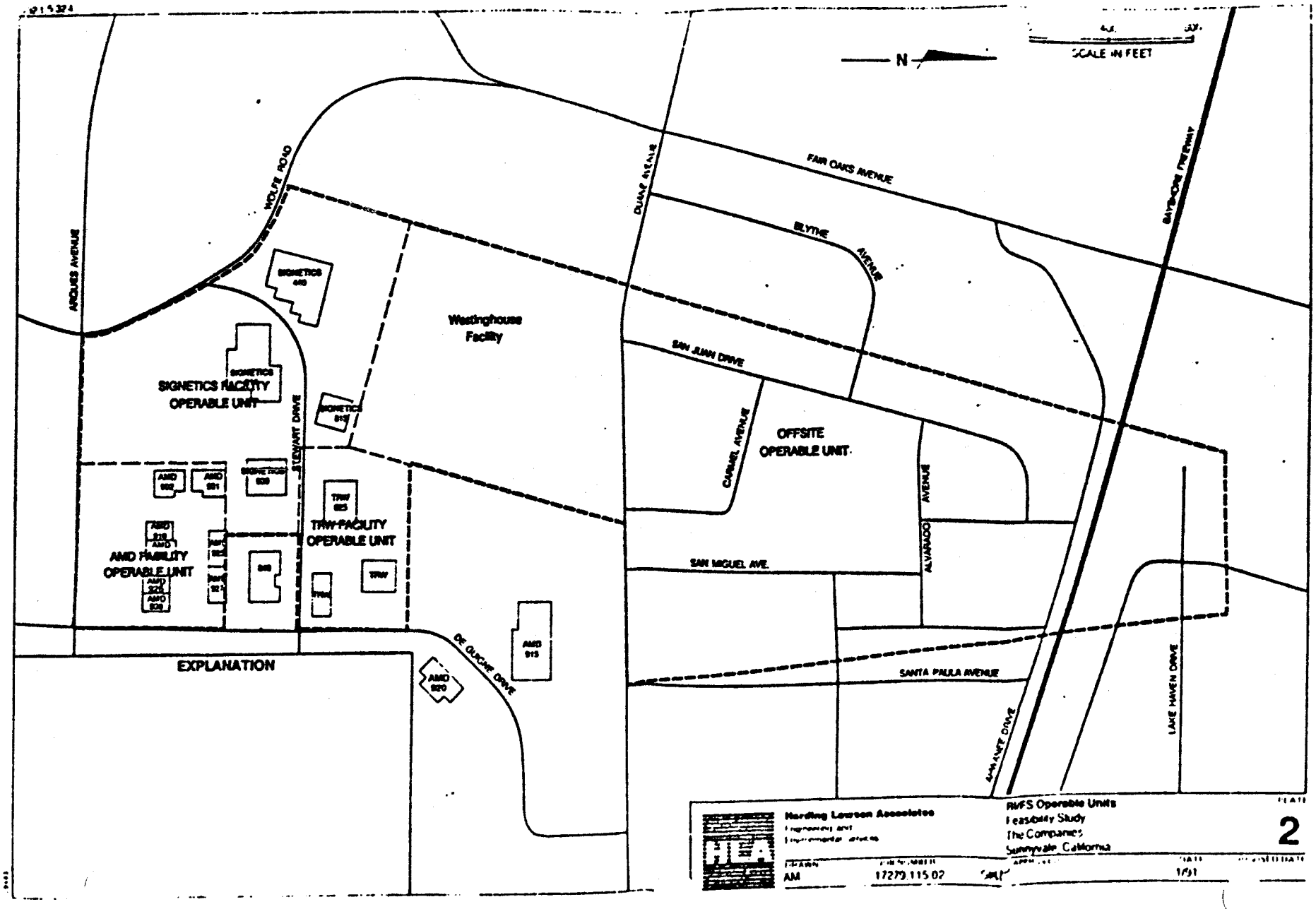
14. The Board will review this Order periodically and may revise the requirements when necessary.

I, Steven R. Ritchie Executive Officer, do hereby certify that the foregoing is a full, true and correct copy of an Order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on June 19, 1991.

Steven R. Ritchie
Executive Officer

Attachments: Appendix 1: Figures 1 - 3
Appendix 2: Tables 1 - 4

APPENDIX 1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SCALE IN FEET
ARQUES AVENUE
WOLFE ROAD
DUANE AVENUE
FAIR OAKS AVENUE
BAYSHORE FREEWAY
BLYTHE AVENUE
SAN JUAN DRIVE
Westinghouse Facility
SIGNETICS FACILITY OPERABLE UNIT
STEWART DRIVE
CARMEL AVENUE
OFFSITE OPERABLE UNIT
ALVARADO AVENUE
TRW FACILITY OPERABLE UNIT
AMD FACILITY OPERABLE UNIT
SAN MIGUEL AVE.
DE GUIGNE DRIVE
SANTA PAULA AVENUE
ARKANET DRIVE
LAKE HAVEN DRIVE
EXPLANATION
Harding Lawson Associates
RI/FS Operable Units
Feasibility Study
The Companies
Sunnyvale, California
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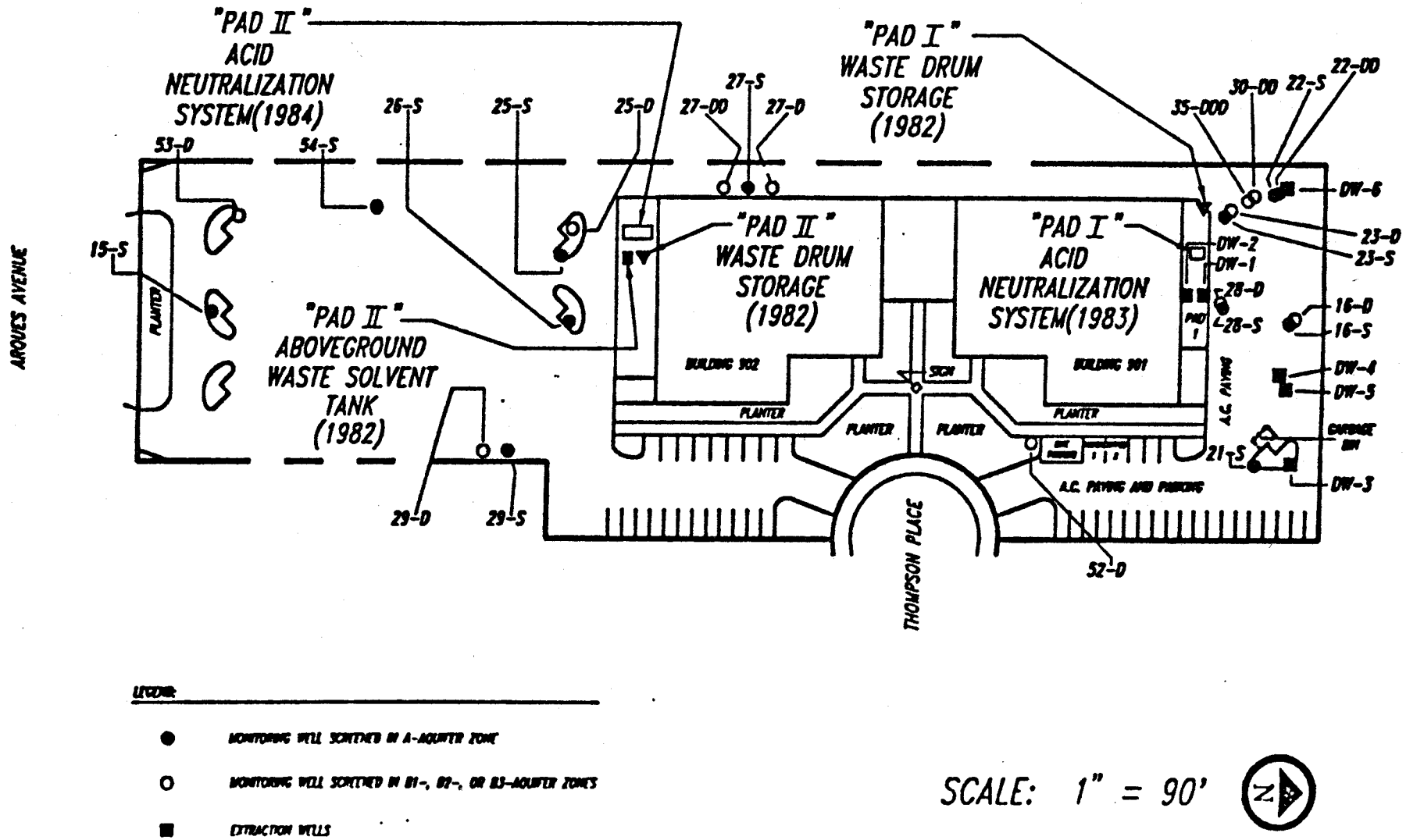
HISTORICAL WASTE STORAGE LOCATIONS AND REMOVAL DATES

AMD Building 901/902



ENGINEERING-SCIENCE

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FIGURE 3

APPENDIX 2

Table 1. Chemicals of Concern In Groundwater

Compound	EPA CARCINOGEN CLASS[a]	APPLICABLE OPERABLE UNITS
1,2- Dichlorobenzene	D	AMD, TRW
1,1-Dichloroethane	B2	ALL
1,1-Dichloroethylene	C	ALL
cis-1,2-Dichloroethylene	D	ALL
trans-1,2-Dichloroethylene	D	ALL
Freon 113	NA	ALL
Tetrachloroethylene	B2	AMD, TRW, Offsite
1,1,1-Trichloroethane	D	ALL
Trichloroethylene	B2	ALL
Vinyl Chloride	A	AMD, TRW, Signetics

(a) EPA Carcinogenicity weight of evidence:

A = known human carcinogen

B1 = probable human carcinogen, limited evidence of carcinogenicity from human studies, but for which there is sufficient evidence of carcinogenicity from animal studies

B2 = probable human carcinogen, inadequate evidence of carcinogenicity from human studies, but for which there is sufficient evidence of carcinogenicity from animal studies

C = possible human carcinogen, limited evidence of carcinogenicity from animal studies

D = not classified as to human carcinogenicity, inadequate human and animal evidence of carcinogenicity or for which no data are available

E = evidence of non-carcinogenicity in humans, no evidence of carcinogenicity in adequate human or animal studies

Table 2 – Evaluation of Remedial Action Alternatives for the AMD Operable Unit

Soil Remedial Alternative	Protection of Human Health and Environment (1)	Compliance with ARARs	Long-term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-term Effectiveness (2)	Implementability	Cost (Present Value) (3)
1 No Action/ Monitoring	Not protective	Not for hundreds of years	Not effective	No reduction of T, M, V	No increased exposure risk	Implementable	$1.5 million
2 Soil Flushing	Protective	Not for hundreds of years	Not effective	Long-term reduction of V	No increased exposure risk	Not implementable	$2.8 million
3 Soil Aeration	Protective	Not for hundreds of years	Not effective	Long-term reduction of V, M	Increased exposure to soil during excavation and treatment	Not easily implemented	$2.7 million
4 Vacuum Extraction (VE)	Protective	Not for hundreds of years	Not effective	Long-term reduction of V, M	Increased exposure during construction	Implementable	$2.8 million
5 VE with Heated Air Assist	Protective	Not for hundreds of years	Effective (4)	Long-term reduction of V, M	Increased exposure during construction	Implementable	$2.9 million
6 VE with Steam Assist	Protective	Not for hundreds of years	Effective (4)	Long-term reduction of V, M	Increased exposure during construction	Implementable	$3.5 million
7 Excavation and Offsite Treatment/ Disposal	Protective	Yes	Effective	Long-term reduction of V, M	Increased exposure during excavation and construction	Not easily implemented	$2.7 million

Table 2 – Evaluation of Remedial Action Alternatives for the AMD Operable Unit (continued)

Groundwater Remedial Alternative	Protection of Human Health and Environment (1)	Compliance with ARARs	Long-term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-term Effectiveness (2)	Implementability	Cost (Present Value) (3)
1 No Action/ Monitoring	Not protective	Not for hundreds of years	Not effective	No reduction of T, M, V	No increased exposure risk	Implementable	$1.5 million
8 Air Stripping with Carbon Adsorption of the OffGas (5)	Protective CR = 4E-5 HI = 0.8	Yes	Effective	Long-term reduction of V, M	No increased exposure risk GCT,A = 18/25 years GCT,B = 9/12 years	Implementable	$2.6/$3.1 million
9 Carbon Adsorption	Not protective	Yes	Not effective	Long-term reduction of V, M	No increased exposure risk	Implementable	$4.6/$5.4 million
10 Augmented Extraction and Treatment	Protective CR = 4E-5 HI = 0.8	Yes	Effective	Long-term reduction of V, M	No increased exposure risk GCT,A = 18/25 years GCT,B = 9/12 years	Implementable	$2.8/$3.4 million

Note: The preferred alternatives are shaded.

(1) CR = Carcinogenic risk for domestic use of groundwater from combined A/B-aquifers; calculations include 1,1-dichloroethene and are for the average scenario.
HI = Hazard Index (see text).

(2) GCT,A = Groundwater cleanup times for the A-aquifer; years to clean up to remedial goals and to background.
GCT,B = Groundwater cleanup times for the B-aquifer; years to clean up to remedial goals and to background.

(3) Costs given for cleanup to groundwater remedial goals (first cost) and to background (second cost).

(4) These alternatives are not effective in attaining soil cleanup criteria, but are likely to remediate soil so that it is not a source for groundwater contamination.

(5) Existing treatment system consists of air stripping of extracted groundwater, followed by carbon treatment of the offgas.

Table 3 – Evaluation of Remedial Action Alternatives for the Offsite Operable Unit

Alternative	Protection of Human Health and Environment (1)	Compliance with ARARs	Long-term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-term Effectiveness (2)	Implementability	Cost (Present Value) (3)
1 No Action	Not protective	Not for hundreds of years	Not effective	No reduction of T, M, V	Not effective	Implementable	$1.9 million
2 Expanded extraction; use of current treatment system (4)	Protective CR = 4E-6 HI = 0.2	Yes	Effective	Reduction of T, M, V	Effective GCT,A = 21/30 years GCT,B = 36/53 years	Implementable	$4.4/$4.9 million
3 Expanded extraction; treatment by carbon adsorption only	Protective CR = 4E-6 HI = 0.2	Yes	Effective	Reduction of T, M, V	Effective GCT,A = 21/30 years GCT,B = 36/53 years	Implementable	$10/$11 million

Note: The preferred alternative is shaded.

(1) CR = Carcinogenic risk for domestic use of groundwater from combined A/B-aquifers; calculations include 1,1-dichloroethene and are for the average scenario.

(2) GCT,A = Groundwater cleanup times for the A-aquifer; years to clean up to remedial goals and to background.
GCT,B = Groundwater cleanup times for the B-aquifer; years to clean up to remedial goals and to background.

(3) Costs given for cleanup to remedial goals (first cost) and to background (second cost).

(4) Existing treatment system consists of air stripping of extracted groundwater, followed by carbon treatment of the water.

TABLE 4
Cleanup Standards for the Chemicals of Concern In Groundwater

ADVANCED MICRO DEVICES 901/902 THOMPSON PLACE
Sunnyvale, California

COMPOUND	FEDERAL MCLG[a]	FEDERAL MCL[b]	CALIFORNIA MCL	APPLICABLE OPERABLE UNITS
1,2- Dichlorobenzene	(600)	(600)	NA	AMD, TRW
1,1-Dichloroethane[c]	NA	NA	5	ALL
1,1-Dichloroethene[d]	7	7	6	ALL
cis-1,2-Dichloroethene	(70)	(70)	6	ALL
trans-1,2-Dichloro-ethene	(100)	(100)	10	ALL
Freon 113	NA	NA	1,200	ALL
Tetrachloroethene[c]	(0)	(5)	5	AMD, TRW, OFFSITE
1,1,1-Trichloroethane	200	200	200	ALL
Trichloroethene[c]	0	5	5	ALL
Vinyl Chloride[c]	0	2	0.5	AMD, TRW, Signetics

(a) MCLG = maximum contaminant level goal. Concentrations in micrograms per liter.
(b) MCL = maximum contaminant level. Concentrations in micrograms per liter.
(c) Potential or probable human carcinogen.
(d) Possible human carcinogen.
NA = Not available.
( ) Criteria in parentheses are proposed standards