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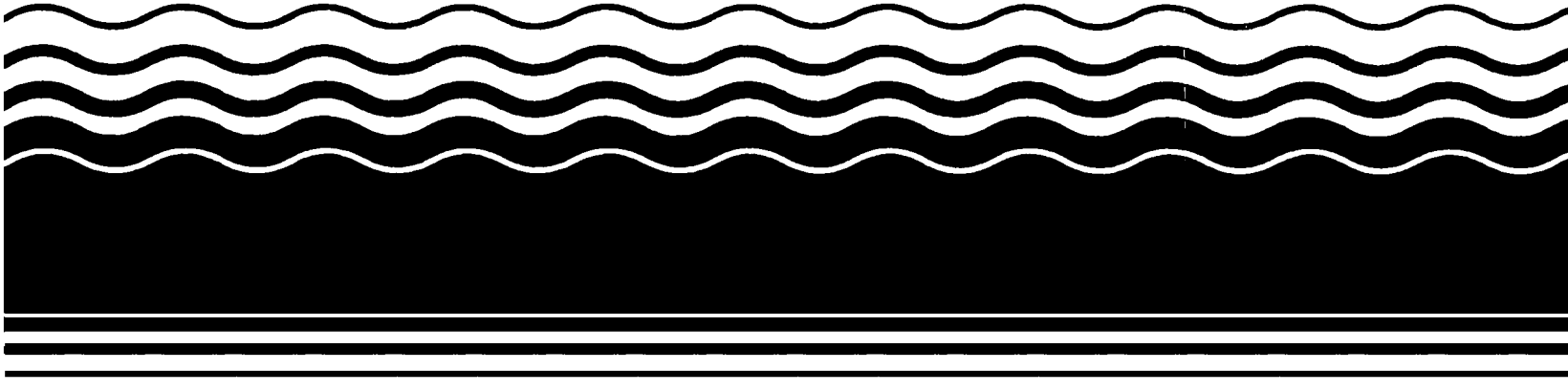
EPA/ROD/R03-92/155
September 1992

EPA

Superfund Record of Decision:

Commodore Semiconductor Group, PA



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15. Supplementary Notes

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16. Abstract (Limit: 200 words)

The 14-acre Commodore Semiconductor Group (CSG) site is a manufacturing facility in Norristown, Montgomery County, Pennsylvania. Land use in the area is residential, commercial, and industrial with a wetland area located within 1 mile from the site. The site overlies a Class IIA aquifer that is used as a source of drinking water. From 1969 to present, the owners, including CGS, used the site to manufacture semiconductor chips. A concrete underground storage tank was installed adjacent to the southeast side of the building to store a waste solution known to contain TCE and other solvents generated from the manufacturing process. The concrete tank was reported to have leaked in 1974. As a result, an unlined steel tank was installed next to the concrete tank. Use of the concrete tank was discontinued. In 1978, a local water supplier detected TCE in two of its wells adjacent to the site. The state identified the CSG site as a possible TCE contaminant source. Subsequently, in 1979, the underground storage tanks were excavated and replaced with a waste solvent collection system. In 1981, CSG also eliminated use of TCE in their manufacturing process. From 1981 to 1984, to address the TCE contamination, CSG pumped and spray irrigated water from a

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Commodore Semiconductor Group, PA
First Remedial Action - Final
Contaminated Medium: gw
Key Contaminants: VOCs (PCE, TCE)

b. Identifiers/Open-Ended Terms

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Commodore Semiconductor Group, PA
First Remedial Action - Final

Abstract (Continued)

public supply well, purchased and installed an air stripper for treating contaminated ground water, implemented a residential sampling program, and installed carbon filter systems at affected residences. In 1984, further state and EPA investigations confirmed contaminants onsite in ground water and drinking water. This ROD addresses the contamination of onsite ground water and drinking water. The primary contaminants of concern affecting the ground water are VOCs, including PCE and TCE.

The selected remedial action for this site includes extending the public water supply lines and connecting affected residences located in areas south of the CSG facility; abandoning contaminated wells; continued maintenance of existing residential carbon units, with disposal or recycling of the spent carbon filters as determined during the remedial design phase; installing additional ground water extraction wells, air strippers, and vapor phase carbon units, to treat the contaminated ground water onsite with discharge to a public water system or reuse by the CSG facility, with overflow discharge offsite to a POTW; sampling ground water and treated water; and implementing institutional controls, including ground water well restrictions. The estimated present worth cost for this remedial action is $5,573,700, which includes an annual O&M cost of $446,500 for years 0-2, and $404,300 for years 3-30.

PERFORMANCE STANDARDS OR GOALS:

Ground water clean-up goals are based on background levels as established by SDWA MCLs or health-based levels, whichever are more stringent. Chemical-specific ground water goals include 1,2 dichlorobenzene 75 ug/l; 1,2-DCA 810 ug/l; tetrachloroethene 5 ug/l; TCA 200 ug/l; trichloroethene 5 ug/l; and vinyl chloride 2 ug/l.

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RECORD OF DECISION
COMMODORE SEMICONDUCTOR GROUP SUPERFUND SITE
DECLARATION

SITE NAME AND LOCATION

Commodore Semiconductor Group Superfund Site
Lower Providence Township, Pennsylvania

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Commodore Semiconductor Group Superfund Site ("the Site"), located in Lower Providence Township, Montgomery County, Pennsylvania. The remedial action was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("CERCLA"), as amended by the Superfund Amendments and Reauthorization Act of 1986 ("SARA") and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"). This decision is based on the Administrative Record for this Site.

The Commonwealth of Pennsylvania has concurred on this remedy.

ASSESSMENT OF THE SITE

Pursuant to duly delegated authority, I hereby determine pursuant to Section 106 of CERCLA, 42 U.S.C. §9606, that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision ("ROD"), may present an imminent and substantial endangerment to the public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy for the Site will restore contaminated groundwater to its beneficial use by cleaning both the shallow and deep aquifers to background levels as established by EPA or to Maximum Contaminant Levels ("MCLs") established under the federal Safe Drinking Water Act ("SDWA"), or to health-based levels identified in the ROD, whichever is lower. The remedy will also protect the public from exposure to contaminated groundwater. The selected remedy as described below is the only planned action for the Site.

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Because this remedy will result in hazardous substances remaining onsite above health-based levels, a review by EPA will be conducted within five years after initiation of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

SEP 29 1992

Edwin B. Erickson
Regional Administrator
Region III

Date

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RECORD OF DECISION

COMMODORE SEMICONDUCTOR GROUP SUPERFUND SITE

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DECISION SUMMARY

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I. SITE NAME, LOCATION AND DESCRIPTION

The Commodore Semiconductor Group ("CSG") Site (the "Site" or the "CSG Site") is located in the Valley Forge Corporate Center ("VFCC") in Lower Providence Township, Montgomery County, Pennsylvania. The CSG facility is located at 950 Rittenhouse Road in Norristown, Pennsylvania. The Site is located approximately one mile north of the Schuylkill River. It is bordered on the northwest by Rittenhouse Road, on the northeast by Van Buren Avenue and on the southeast by Adams Avenue. The General Washington Country Club golf course occupies all the property immediately west of the facility on Rittenhouse Road with the remainder of the surrounding property being occupied by industrial and commercial facilities. The Transcontinental Gas Company ("Transco") Pipeline which includes three natural gas pipes transverses the CSG property. Private residences are located approximately one-half mile from the Site in all directions. (See Figure 1, Location of the CSG Site)

Groundwater is the only source of potable water in the area and residents near the Site are dependent on public or private wells. EPA has classified this aquifer as a Class IIA aquifer, a current source of drinking water.

Regional surface drainage in the vicinity of the Site is toward the Schuykill River via tributary streams. Local surface drainage in the vicinity of the Site is to the south or west, while actual Site runoff is collected and discharged through the VFCC storm water system to Lamb Run, a small tributary of the Schuylkill River. A small portion of the stormwater detention basin at the Site contains tall grasses and cattails and, therefore, is considered a wetland area. No other wetland areas have been identified within one-mile radius of the Site.

There are no known endangered species or critical habitats within the immediate vicinity of the Site.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

On December 31, 1969, the real property at 950 Rittenhouse Road, Norristown, Pennsylvania was transferred from Valley Forge Industrial Park, a Pennsylvania corporation, to Allen-Bradley Company, Inc. ("Allen-Bradley"), a Wisconsin corporation.

The 14-acre CSG facility was originally developed in 1970-71 to meet the specifications of MOS Technology, Inc. ("MOS"), a Delaware corporation, which became the initial lessee of the property. MOS leased the property from Allen-Bradley from November 1, 1970 until March 6, 1976. During that time, MOS was involved in the processing of semiconductor chips. Allen-Bradley

ultimately sold the property to MOS on March 6, 1976.

At the time the CSG property was transferred to MOS by Allen-Bradley, the MOS stock was owned by Commodore Business Machines, Inc. ("Commodore"). Commodore obtained this stock pursuant to a Stock Acquisition Agreement dated November 2, 1976.

Through its acquisition of the MOS stock, Commodore established itself as an owner/operator of the CSG Site. Commodore Semiconductor Group or CSG is not a division of Commodore, but is rather a name used by Commodore to describe its operations at the Norristown facility.

The CSG facility was originally built by Robert E. Lamb, Inc., the developer of the Valley Forge Corporate Center for MOS for manufacturing semiconductor chips. At the time the manufacturing building on site was constructed, a 250-gallon underground concrete storage tank was installed adjacent to the southeast side of the building. The concrete tank was used by MOS to store a waste solution known to contain trichloroethene ("TCE") and other solvents. According to information obtained from Commodore in response to a CERCLA §104(e) information request from the Agency, the concrete tank leaked in 1974. As a result, in 1975, MOS discontinued the use of the concrete tank and installed an unlined steel tank in the ground adjacent to the concrete one.

In 1978, the Audubon Water Company ("AWC"), suppliers of water to the Village of Audubon and Lower Providence Township, detected TCE in two of its wells located near the CSG Site. After some investigation, the Pennsylvania Department of Environmental Resources ("PADER") identified the CSG facility as a possible TCE source. In the fall of 1979, the underground tanks were excavated. Sampling, which was only for TCE and tetrachloroethene ("PCE"), conducted during the excavation revealed high levels of TCE and PCE in the soil directly below the underground storage tanks and in the surrounding groundwater. Commodore replaced the tanks with a waste solvent collection system consisting of a tank within a lined vault. In 1981, Commodore discontinued the use of TCE in its manufacturing process. At the same time, the company installed groundwater monitoring wells and began a sampling program.

Measures to reduce TCE contamination at the Site started in early January 1981. From 1981 to 1983, Commodore pumped and spray irrigated water from Audubon Water Company's public supply well, VFCC-4. Spray irrigation is a practice consisting of spraying contaminated water on a field and allowing volatile organic compounds ("VOCs") to evaporate into the air. Commodore had informal state approval for the spray irrigation system, but did not operate the system under a PADER permit.

In February 1984, Commodore purchased and installed an air stripper on VFCC-4 to be used in the treatment of contaminated groundwater. In 1984, Commodore began a residential sampling program and installed whole-house carbon filter systems on residences with at least 1 part per billion ("ppb") of VOCs detected. A total of 23 residences were supplied with these filters. Commodore also began construction of a 100,000 square foot building expansion with a french drain groundwater collection system under the entire expansion. Construction was completed in 1985. The groundwater from the drain is piped to an air stripper, then discharged to the VFCC stormwater runoff system. As a result of the facility expansion in 1985, the property was regraded, a stormwater detention basin was constructed, and the parking area of the facility was expanded.

In February 1984, EPA performed a Site Inspection ("SI") at the CSG Site. A Preliminary Assessment ("PA") and another SI were subsequently completed on December 5 and 12, 1986, respectively. Sampling results revealed the presence of TCE in nearby residential wells. TCE and TCE-related compounds were also found in the groundwater, surface water, and soil samples taken from the Site. The Site was proposed for inclusion on the National Priorities List ("NPL") in January 1987. The Site scored 42.35 under EPA's Hazard Ranking System and was included on the final NPL on October 4, 1989 (54 Fed. Reg. 41000-41015).

Commodore Business Machines, Inc., ("Commodore"), the current owner/operator of the facility at 950 Rittenhouse Road, has been identified by EPA as a Potentially Responsible Party ("PRP") for contamination at the CSG Site. Commodore conducted a Remedial Investigation/Feasibility Study ("RI/FS") at the Site pursuant to the terms of an Administrative Order By Consent (Docket No. III-88-09-DC) signed by EPA on July 29, 1988. The purpose of the RI/FS was to characterize the type and extent of contamination at the Site, to quantify any existing or potential human health risks, to evaluate potential environmental risks, and to develop alternatives to remediate the contamination. RI/FS Reports were submitted to EPA by Commodore in February 1992 and July 1992.

Allen-Bradley Company, Inc. ("Allen-Bradley") owned the CSG Site during the time hazardous substances were released into the environment. Allen-Bradley has been identified as a PRP for contamination at the CSG Site and was sent a General Notice letter on February 27, 1992.

EPA solicited comment on a draft Feasibility Study for the CSG Site from the Delaware River Basin Commission on March 5, 1992. On July 30, 1992, EPA sent notice of impending remedial design/remedial action ("RD/RA") negotiations to the Department of Interior ("DOI") and the National Oceanic and Atmospheric

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Administration ("NOAA").

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

A Community Relations Plan for the CSG Site was finalized in February 1989. This document lists contacts and interested parties throughout government and the local community. It also establishes communication procedures to ensure timely dissemination of pertinent information. A draft RI/FS report and the Proposed Plan for the CSG Site were released to the public on July 21, 1992, in accordance with Sections 113(k)(2)(B), 117(a), and 121(f)(1) (G) of CERCLA, 42 U.S.C. §§9613(k)(2)(B), 9617(a), and 9621(f)(1)(G). These and other related documents were made available in both the Administrative Record located at the U.S. EPA Region III Offices, 841 Chestnut Building, Philadelphia, Pennsylvania, 19107, and at the Site Repositories, Lower Providence Community Library, 2765 Egypt Road, Audubon, Pennsylvania, 19405, and Montgomery County Planning Commission Courthouse, One Montgomery Plaza, Norristown, Pennsylvania, 19404.

Due to a request for an extension, the comment period was extended to 60 days, closing on September 19, 1992. In addition, a public meeting was held on August 6, 1992 to discuss the results of the RI/FS and the preferred alternative as presented in the Proposed Plan for the Site. Notice of the Proposed Plan and public meeting was published in a major local newspaper of general circulation, The Times Herald, Norristown, Pennsylvania. Additionally, the Proposed Plan and the Notice of the Comment Period Extension were mailed to many residences in the nearby vicinity of the Site.

All significant comments on the Proposed Plan which were received by EPA prior to the end of the public comment period, including those expressed orally at the public meeting, are addressed in the Responsiveness Summary which is attached to this Record of Decision.

IV. SCOPE AND ROLE OF THE ACTION

This Record of Decision ("ROD") mandates remediation of contaminated groundwater and addresses the drinking water sources (public supply wells and residential wells) affected by contamination at the CSG Site. This ROD is the only planned response action for the Site.

EPA has classified the affected aquifer at the CSG Site as a Class IIA aquifer, a current source of drinking water, in accordance with the EPA document "Guidelines for Groundwater Classification" (Final Draft, December 1986). Ingestion of, and contact with, contaminated groundwater poses the primary risk to human health being addressed by this ROD. The concentrations of

contaminants in the groundwater at the Site are above Maximum Contaminant Levels ("MCLs") which are enforceable, health-based drinking water standards established under the Safe Drinking Water Act ("SDWA"), 42 U.S.C. §§300f to 300j-26.

This Class IIA aquifer is located in a Groundwater Protected Area of Southeastern Pennsylvania as designated by the Delaware River Basin Commission. As such it is the intent of the U.S. EPA to beneficially reuse the contaminated groundwater to the maximum extent practicable via a treatment system meeting federal and Commonwealth of Pennsylvania regulations for primary and secondary treatment requirements.

The purpose of the selected response action is to prevent current or future exposure to contaminated groundwater, to protect uncontaminated groundwater for current and future use, and to restore contaminated groundwater to MCLs or to background concentrations, if background for Site-related contaminants is lower than the MCLs. Pumping and treating groundwater is the most expeditious way to reduce the contaminant levels that have been detected.

V. SUMMARY OF SITE CHARACTERISTICS AND EXTENT OF CONTAMINATION

A. SITE CHARACTERISTICS

1. Geology

The Site is underlain by the middle member of the Triassic-age Stockton formation. The Stockton formation is characterized by siltstone, fine-grained and medium-grained sandstone, red shale, very fine-grained red sandstone, and a few beds of coarse-grained sandstone and conglomerate. The strata have a regional dip of five to eighteen degrees to the northwest. Fractures within the bedrock appear to be vertical, and for the most part, evenly distributed.

The unconsolidated overburden deposits consist of predominantly red-brown silt and clay. Overburden thickness ranges from six feet to 22.5 feet. The soil/bedrock interface is gradational. Soil gradually grades into consolidated material where relict bedding is visible, and then into weathered bedrock.

2. Hydrogeology

The Site stratigraphy is complex with many lithologic variations and discontinuous units. This creates complex hydrogeologic conditions. Two units that are not isolated hydraulically were identified beneath the Site: a shallow (perched) water-bearing zone in soil and shallow bedrock and a deeper bedrock unit. The saturated thickness of the shallow zone varies seasonally and is dependent upon precipitation. The

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bedrock water-bearing zone does not appear to respond to precipitation. This is due to the presence of siltsone and shale units that act as semiconfining units by retarding the downward migration of groundwater. Although the water levels in the bedrock water-bearing zone do not appear to respond to precipitation, the shallow zone, which is a low yield zone, provides water to the deeper zone. Water levels in the bedrock water-bearing zone do fluctuate as a result of pumping of nearby water supply wells. The shallow and deep aquifers are not isolated hydraulically and the shallow water provides recharge to the deeper zone.

Groundwater mounding exists in the subsurface soils around the vicinity of the former underground concrete storage tank which were located on Site. The mounding exists as a result of recharge from the porous and permeable material used as fill after the tanks were removed. Groundwater flow in this shallow zone is directed away from the recharge area in all directions. Groundwater in this shallow zone which flows to the south-southeast may also be intercepted by the Transco pipeline. The pipeline is approximately 75 feet from the former underground storage tanks. The permeable fill surrounding the pipeline probably provides a pathway for groundwater flow and migration of contaminants to the southwest.

Groundwater movement through the heterogeneous anisotropic bedrock water-bearing zone occurs through a combination of primary and secondary porosity. Groundwater movement and hence migration of the site-related contaminants is influenced by the pumping of the bedrock public water supply wells: VFCC-2, VFCC-3, VFCC-4, Aud-3, and Aud-5, as well as the gravel bed of the Transco pipeline. The regional groundwater flow is to the southeast; however, groundwater in the vicinity of the Site appears to be moving south-southwest as well.

3. Surface Water

The Site is located in gently rolling terrain in the Schuylkill River Drainage Basin. Regional surface water drainage near the Site is directed to the south toward the Schuylkill River via tributary systems. Since the CSG facility expansion in 1985, roughly 50 percent of the regraded and expanded parking area located on the southern side of the property directs runoff to a man-made detention basin measuring approximately 100 feet by 160 feet by 190 feet. The remainder of runoff is directed to a drainage ditch. The drainage ditch is dry except for periods of heavy or constant rainfall. The drainage ditch empties into the intermittent portion of Lamb Run, a small tributary to the Schuylkill River.

4. Meteorology

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The Site is located in Montgomery County, Pennsylvania. Temperatures in Montgomery County ranged from a mean monthly low of 19 degrees Fahrenheit in January to a mean monthly high of 86 degrees Fahrenheit in July for the years 1981 to 1986. Seasonally, the greatest amount of precipitation occurs in the spring and the least amount occurs during the winter months. Average annual precipitation over the years 1980 to 1990 was slightly less than 44 inches.

5. Natural Resources

The Site and surrounding area ecology consist of an industrial/corporate park with grass-covered lawns, few trees, and some intermittent drainage areas connected to an intermittent stream. Within the industrial park are some open lots with wild grass and shrubs. In addition to the corporate park ecology are residential communities, vacant lots, and a golf course.

Within the corporate park, the vacant lots support the most diverse ecology. This ecology includes birds, rabbits, squirrels, rats and mice in addition to the grasses and shrubs. Though larger animals such as raccoons and deer may possibly wander through, there is not enough vacant area to support a reasonable habitat for larger animals. Areas exterior to the corporate park also would provide minimal habitat and shelter for wildlife beyond the size of a raccoon.

No known threatened or endangered plant or animal species have been identified at the Site. The wildlife that are found are very limited because of the human population and human culture alterations in the Site vicinity. A limited area of wetlands exists in a portion of the stormwater detention basin identified above. Areas do get wet during rainy periods; however, these quickly dry. Most areas of ponding water are manmade and these areas do not contain threatened plant or animal species.

B. NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at the Site was characterized through a soil gas survey; sampling of soils, groundwater monitoring wells, residential drinking water wells, public water supply wells, and golf course irrigation wells; and, sampling of surface water.

1. Soils

Soil gas testing revealed detectable levels in separate, discrete locations of the following four volatile organic compounds ("VOCs"): 1,2-Dichloroethene ("1,2-DCE"), Trichloroethane ("TCA"), Trichloroethene("TCE"), and Tetrachloroethene ("PCE").

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Ten soil samples were taken and analyzed (See Figure 2 for the location of the soil borings). The four borings located within the boundaries of the CSG property were situated near suspected areas of elevated VOC concentrations. These borings were labeled: S-5, which was drilled near the former underground concrete storage tank, and S-6, S-8 and S-10, which were drilled along the trace of the Transco pipeline where elevated soil gas concentrations had been detected.

All ten soil borings were analyzed for the complete target compound list ("TCL"). Soil borings S-5 and S-8 were additionally analyzed for the target analyte list ("TAL"). The following five VOCs were found at detectable levels at the Site: Carbon Tetrachloride, 1,2-Dichloroethene, Trichloroethene, 1,1,2,2- Tetrachloroethane, and 1,2-Dichlorobenzene. The highest detected concentration of any of these compounds was for Trichloroethene at 16 parts per billion ("ppb") from soil boring S-8, at a 1.2 - 1.5 foot depth. For the remaining TCL substances, only 1,2,4-trichlorobenzene, a base neutral extractable compound was detected at a depth of 11 feet.

Several TAL metals were detected in the two TCL/TAL samples including: aluminum, arsenic, barium, beryllium, chromium, copper, iron, lead, magnesium manganese, potassium, silver, vanadium and zinc. The levels detected do not exceed levels which can occur naturally in soils.

Each soil boring was completed as either a vapor probe or a piezometer for the purpose of monitoring conditions in the overburden. Depth-to-water measurements and Organic Vapor Analyzer ("OVA") readings were taken monthly beginning in June 1990 and ending March 1991. See Table 1 for water level measurements and Table 2 for OVA readings.

2. Surface Water

Groundwater level measurements taken in the overburden piezometers indicate that groundwater at the Site potentially discharges to Lamb Run, a small tributary to the Schuykill River. Five surface water samples were taken from the intermittent stream that parallels Rittenhouse Road, just south of the CSG facility, and were analyzed for VOCs. Sediment samples were not collected because the base of Lamb Run consisted primarily of gravel or bedrock at the sampling locations.

The following three VOCs were detected in the surface water: 1,2 DCE, PCE, and TCE. Figure 3 provides the locations of the samples and a summary of the analytical results. All concentrations were more than 10 times lower than the Fresh Water Acute Water Quality Criteria for aquatic life (25 Pa. Code Section 16.51, Table 1). Of the three compounds detected, only PCE has a chronic limit established by the above cited

regulations (840 ppb). None of the levels detected exceed MCLs established under the SDWA. At the levels detected, natural attenuation will most likely remove the volatile organics.

3. Groundwater

Groundwater was sampled both upgradient and downgradient of the facility. (See Figure 4 for groundwater sampling locations). The results of the groundwater investigations are summarized in Table 3. The highest VOC concentrations detected were in the shallow groundwater near the former underground concrete tank and the unlined steel tank. The VOCs detected in those areas were TCE, TCA, 1,1-DCE, 1,2-DCE, 1,1-DCA, PCE, and chloroform. Vinyl chloride was detected at only three locations in the shallow aquifer: once at 2 ppb in the french drain, once at well MOS-13 at 2.2 ppb, and once at well MOS-15 at 8.1 ppb. Groundwater in the bedrock wells was found to have the same chemicals found in the shallow aquifer.

The concentrations of the contaminants in the deep bedrock aquifer (the drinking water aquifer) were generally lower than those in the shallow aquifer. The exception is vinyl chloride which was detected twice in the deep aquifer at MW-1, at 12 ppb and 14 ppb. The Site-related contaminants detected in the deep bedrock aquifer exceed MCLs. Figure 5 represents the potential areal extent of the Site-related plume and also represents the approximate areal extent where MCLs are exceeded in the bedrock aquifer. Table 4 summarizes the wells with major MCL exceedances.

VI. SUMMARY OF SITE RISKS

This section of the ROD summarizes the results of the baseline risk assessment which was conducted as part of the RI/FS. The risk assessment for the CSG Site characterizes the current and potential threats to human health and the environment based on reasonable maximum exposures to contaminants in the groundwater, soil and subsurface soil, the migration of contaminants to surface water, and exposure to contaminants in the air if no remedial action were taken.

The risk assessment consisted of identification of contaminants of concern, a toxicity assessment, an exposure assessment, and risk characterization. The first task in the risk assessment was the selection of Site-related contaminants for which risks were assessed. In the data evaluation, sampling data were reviewed by medium. The list was based on chemical toxicity characteristics, the occurrence and distribution of the chemical in the medium, potential exposure routes, and contaminant migration characteristics.

A. EXPOSURE ASSESSMENT

Exposure pathways were identified for groundwater, surface water, soils, and air at the Site. The human health risk assessment was conducted only for exposure to groundwater and outdoor air. Exposures to soil and surface water were not evaluated because the concentrations of contaminants detected in these media were low, the duration of the exposure short, and/or the concentrations were below health-based screening criteria. Comparisons of potential chemicals of concern detected in soils and surface waters to risk-based concentrations are listed in Tables 5 and 6, respectively.

Current land use in the vicinity of the Site is residential and industrial park. Future land use in the vicinity of the Site is also expected to be residential and industrial park. The George Washington Country Club golf course ("GWCC") is immediately west of the Site. Though GWCC is currently used for recreation, it is zoned for residential use. Therefore, a probable future use of GWCC is residential use.

Groundwater beneath the Site is classified as a Class IIA aquifer, a current source of drinking water. Contaminants from the Site migrate towards public supply wells and private drinking water wells through the groundwater flow system.

Based on current and potential future land uses at the Site, seven populations were evaluated in the risk assessment:

- Residents who currently obtain water from private wells;
- Residents who currently obtain water from public supply wells;
- Hypothetical future residents of GWCC;
- Current members and recreational users of GWCC;
- Current workers of GWCC;
- Current workers at Valley Forge Corporate Center ("VFCC"); and
- Future workers at VFCC.

These are the populations that are the most probable current and future receptors of contamination from the Site, and represent the populations with maximum potential for exposure to Site-related contaminants. Chemicals of potential concern in the groundwater using the exposure scenarios identified above are listed in Tables 7 through 12.

Use of an exposure scenario based on future residential use is consistent with EPA policy described in "EPA Risk Assessment Guidance for Superfund" (December 1989). This policy requires consideration of hypothetical residential use. In addition, the National Contingency Plan ("NCP"), 40 C.F.R. Part 300, requires that groundwater which is suitable for use as a water supply be protected and restored to its beneficial use.

Potential exposure routes considered for the purpose of evaluating CSG Site risks included: ingestion of contaminated groundwater, inhalation of volatiles from tap water, dermal absorption, and inhalation of volatiles in outdoor air due to the existing air stripping emissions. The potential exposure routes chosen for each of the exposed populations are listed in Table 13.

The next step in the exposure assessment process involved the quantification of the magnitude, frequency, and duration of exposure for the populations and exposure routes selected for evaluation.

The contaminant intake equations and intake parameters were derived from standard literature sources and data from EPA guidance documents. The exposure assumptions used to calculate chemical intakes were selected based on the reasonable maximum exposure ("RME") which is defined as the highest exposure that is reasonably expected to occur at a Site.

The Risk Assessment compiled a list of contaminants of concern from the results of the various sampling activities at the Site. These contaminants of concern were selected based on concentrations at the Site, toxicity, physical/chemical properties that affect transport/movement in air and groundwater, and prevalence/persistence in these media. These contaminants of concern were used in the Risk Assessment to evaluate potential health risks at the Site.

The contaminants of potential concern in the groundwater that were evaluated in the Risk Assessment were VOCs. These chemicals are listed below with their respective maximum contaminant level (MCL) or in the absence of an MCL, a health-based calculation. The contaminants of potential concern were selected for evaluation at a receptor location if they were detected in the groundwater of a well or cluster of wells to which a receptor might potentially be exposed. If a chemical was detected in a grouping of wells to which there might be exposure, the chemical was evaluated for potential risk.

Contaminant of Potential Concern	MCL in parts per billion (ppb)
Bromodichloromethane	100
Chloroform	100
1,2 Dichlorobenzene	75
1,4 Dichlorobenzene	600
1,1 Dichloroethane	810*
1,1 Dichloroethene	7
1,2 Dichloroethene	70
Tetrachloroethene	5
1,1,1 Trichloroethane	200
Trichloroethene	5
Vinyl Chloride	2

*Non-carcinogenic health-based concentration.

B. Toxicity Assessment and Risk Characterization

Projected intakes for each risk scenario and each contaminant were compared to acceptable intake levels for carcinogenic and noncarcinogenic effects. With respect to projected intake levels for noncarcinogenic compounds, a comparison was made to reference doses ("RfDs"). RfDs have been developed by EPA for chronic (lifetime) and/or subchronic (less than lifetime) exposures to chemicals. RfDs define intake levels that are unlikely to cause appreciable risk of deleterious effects. The chronic RfD for a chemical is an estimate of a lifetime daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects. The potential for non-cancer health effects is evaluated by comparing an exposure level over a specified time period with the RfD derived by EPA for a similar exposure period. The ratio of exposure to toxicity is called the hazard quotient. Chronic and Subchronic RfDs for noncarcinogenic health effects are listed in Tables 14 and 15, respectively.

The non-cancer hazard quotient assumes that there is a threshold level of exposure below which it is unlikely for even the most sensitive populations to experience adverse health effects. If the exposure level exceeds that threshold (the hazard quotient exceeds a value greater than 1.0) there may be concern for potential non-cancer effects. If the hazard quotient does not exceed one, there is not a concern for a non-carcinogenic public health threat. The greater the value of the hazard quotient, the greater the level of concern for potential adverse health impacts.

To assess the overall potential for non-cancer effects posed by multiple chemicals, a hazard index ("HI") is derived by adding

the individual hazard quotients for each chemical of concern. This approach assumes additivity of critical effects of multiple chemicals. EPA considers any HI exceeding one to be an unacceptable risk to human health.

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential human carcinogen. The toxicity values that are used in the evaluation of carcinogenic risk are cancer slope factors ("CSFs") that have been developed by EPA. A CSF generally is derived from animal studies of chemical toxicity. The high doses administered to laboratory animals are extrapolated to the low doses generally received by humans in a linear relationship.

The value used in reporting the CSF is the upper 95 percent confidence limit value on the probability of response per unit intake of a contaminant over a lifetime (70 years). The CSF is multiplied by the predicted intake to result in a unitless expression of an individual's likelihood of developing cancer as a result of the defined exposure. An incremental cancer risk of 1 x E-6 (also abbreviated as 1 x 10^{-6}) indicates that the exposed receptor has an additional risk of one in one million of developing cancer. Again, the risks associated with multiple chemicals should be added together. The carcinogenic chemicals addressed in this evaluation and their EPA and International Agency for Research on Cancer ("IARC") carcinogenicity classifications are presented in Table 16. An explanation of the EPA and IARC carcinogenicity classification systems is presented in Table 17. The cancer slopes for the carcinogenic contaminants detected at the CSG Site are listed in Table 18.

The hazard quotients and indices for the residential scenarios are presented in Tables 19 through 24. The hazard quotients and indices for the GWCC member are present in Tables 25 and 26. Hazard quotients and indices for the worker scenarios are presented in Tables 27 through 29.

The lifetime carcinogenic risk and risk distributions by chemical and pathway for each exposure scenario are presented in Tables 30 through 43. The risks and distributions for the residential scenarios are presented in Tables 30 through 35. The carcinogenic risks and risk distributions for the GWCC member are presented in Tables 36 and 37. The carcinogenic risks and distributions for the worker scenarios are presented in Tables 38 through 43.

Table 44 summarizes the total risks from all exposure pathways to contaminants in the groundwater at the CSG Site.

The total lifetime carcinogenic risk for the private residential well scenario is 2.0E-05, with groundwater ingestion

representing the highest risk pathway (61%) and 1,1-DCE the highest risk chemical. The risk from inhalation of outdoor air is 4.5E-09 and accounts for .02 % of the total risk. The hazard indices were less than 1.0, which represents an acceptable risk level.

The risk from exposure to untreated public water (public residential well scenario) is 4.0E-05 with 55% of the total risk attributed to ingestion of groundwater, and 1,1-DCE representing 61% of the total risk. The risk associated with the inhalation of outdoor air is 8.1E-09. The hazard index for the adult receptor was less than 1.0 which represents an acceptable risk level. For the child receptor, the hazard index was 1.2, which represents an unacceptable risk.

The lifetime carcinogenic risk for the hypothetical GWCC future resident is 1.4E-04. As with the other residential scenarios, ingestion of groundwater and exposure to 1,1-DCE represents the majority of the risk. The risk associated with inhalation of outdooor air is 8.7E-07 and is 0.64% of the total risk. The hazard indices were 1.0 or less which represent an acceptable risk level.

The carcinogenic risk posed to the GWCC member is 9.9E-07. Exposure to chloroform through inhalation while showering represents 86% of the total risk. The risk from inhalation of outdoor air is the lowest risk pathway (7.8E-10) and accounts for 0.08% of the total risk. The hazard index was less than 1.0 which represents an acceptable risk level.

The total risk for the GWCC worker is 1.5E-07. Ingestion of water represents 97% of the total risk. Exposure to bromodichloromethene accounts for 47% of the total risk. The hazard index was less than 1.0 which represents an acceptable risk level.

The carcinogenic risks posed to the current and future VFCC workers are 1.0E-05 and 4.9E-05, respectively. Groundwater ingestion accounts for 99% of the risk in the current worker scenario and 64% of the risk to the future worker. Inhalation of outdoor air poses little risk to the VFCC current worker (1.3E-08 and VFCC future worker (6.5E-07). The hazard indices were less than 1.0 which represent an acceptable risk level.

C. ENVIRONMENTAL RISKS

No known threatened or endangered plant or animal species have been identified in the immediate vicinity of the Site. The wildlife that is found is very limited because of the human population and human culture alterations in the Site vicinity. Under current conditions, the compounds detected in surface water (due to discharge from the shallow aquifer) are below the

threshold level for chronic or acute effects to aquatic organisms. Additionally, no risks are anticipated for terrestrial vertebrates that may come into contact with Lamb Run.

D. UNCERTAINTY ANALYSIS

Throughout the risk assessment process, uncertainties associated with evaluation of chemical toxicity and potential exposures arise. For example, uncertainties arise in derivation of toxicity values for reference doses (RfDs) and carcinogenic slope factors (CSFs), estimation of exposure point concentrations, fate and transport modeling, exposure assumptions, and ecological toxicity data.

Risks from exposure to vinyl chloride, a breakdown product of TCE, were evaluated in the uncertainty analysis because vinyl chloride has not been detected in any wells to which there is current exposure but may be found at detectable concentrations in the future. Risks from vinyl chloride were evaluated using a concentration of one-half the required detection limit (1 ppb) in the following two future use scenarios: Future GWCC Residential Well and Future VFCC Worker. The risk would be 1.7E-04 and 5.6-05, respectively.

E. CONCLUSION

Actual or threatened releases of hazardous substances from the CSG Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, and the environment.

VII. DESCRIPTION OF ALTERNATIVES

A feasibility study was conducted to identify and evaluate remedial alternatives for remediation of contaminated groundwater at the CSG Site. Applicable remediation technologies were initially screened in the feasibility study based on effectiveness, implementability, and cost. The alternatives meeting these criteria were then evaluated and compared to nine criteria required by the National Contingency Plan ("NCP"). The NCP requires that a "no action" or "no further action" alternative be evaluated as a point of comparison for other alternatives.

The alternatives evaluated and their present worth costs are described below. It should be noted that all costs and time frames discussed below are estimates. This information will be further refined during the remedial design. The alternatives

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describe final remedial actions for groundwater remediation. The RI/FS Reports dated February 1992 and July 1992 discuss the alternatives evaluated for the Site and provide supporting information leading to the alternative selection by EPA.

ALTERNATIVE 1: No Action

This alternative involves taking no action at the Site to remove, remediate, or contain the contaminated groundwater. Maintenance of the existing whole-house carbon filtration systems on the 23 residential wells would be discontinued and no monitoring of residential wells would be required. The following groundwater monitoring wells on the CSG property would be sampled semi-annually: MOS-15, MOS-14, MOS-13, MOS-11, and the three well cluster at MW-20.

Because this alternative would result in contaminated groundwater remaining on the Site, 5-year site reviews pursuant to Section 121(c) of CERCLA would be required to monitor the effectiveness of this alternative. There are no capital costs for this alternative. This alternative could be implemented immediately.

Compliance with ARARs

Since Alternative 1 does not include groundwater remediation as a component of the remedy, this Alternative would not meet the chemical-specific ARARs relating to groundwater remediation and treatment.

Additionally, Alternative 1 would not comply with the requirements of the Pennsylvania Hazardous Waste Management Regulations, 25 Pa. Code §§264.90-264.100 and in particular, 25 Pa. Code §§ 264.97(i)(j) and 264.100(a)(9), which require contaminated groundwater to be remediated to background levels.

With respect to location-specific ARARs, Alternative 1 would not comply with EPA's Ground Water Protection Strategy policy for a Class IIA aquifer, which is a to be considered ("TBC") standard.

Capital Costs - $00.00
O & M Cost/Year - $26,600
30 Year Present Worth - $299,800

ALTERNATIVE 2: Installation of Private Water Lines and Connection to the Public Water Supply System and Institutional Controls

The general components of this alternative are:

- Connecting affected and potentially affected parties into an extension of the public water supply system;
- Continuing maintenance of carbon filtration systems at residences previously supplied with systems;
- Abandoning of the existing residential wells when parties are connected to the public water supply system;
- Creating a groundwater management zone with restrictions on installation of new wells in areas of contamination which exceed MCLs; and
- Conducting quarterly groundwater monitoring.

The intent of this alternative is to prevent any unacceptable present and future risk associated with exposure to contaminated groundwater. Residences south of the CSG Site on Rittenhouse Road and on Audubon Road between Rittenhouse Road and Thrush Lane would be connected to the public water supply system. Table 46 lists the affected and potentially affected residences.

The existing whole-house carbon filtration systems that have previously been installed in residences would be maintained until connection to the public system is complete. One additional system would be installed in a residence located at 2705 Audubon Road. Maintenance of whole-house carbon filtration systems would also continue for the residences southeast of the Site which are identified as Group 2 in the Feasibility Study.

At the conclusion of the remedy construction or at the Site's first 5-year review, whichever takes place first, this residential area would be re-evaluated to determine whether the maintenance of carbon filters should be continued.

Under Alternative 2, when the affected and potentially affected residences are connected into the public water supply system, the residential wells would be abandoned unless the residential well is selected as a sampling location for long-term groundwater monitoring.

This alternative includes development of a groundwater management zone that encompasses the area of the Site in which the groundwater is contaminated at levels which exceed MCLs, and a surrounding buffer zone. Restrictions on well installations within the contaminated groundwater management zone would be

implemented as institutional controls. The estimated implementation time for installation of additional water lines in the community near the Site is two years.

Because this alternative would result in contaminated groundwater remaining on the Site, 5-year site reviews pursuant to Section 121(c) of CERCLA would be required to monitor the effectiveness of this alternative.

Capital Costs - $125,500
O & M Cost/Year (Years 1-2) - $242,600
O & M Cost/Year (Years 3-30) - $211,800
30 Year Present Worth - $2,564,800

Compliance With ARARs:

Under Alternative 2, the spent whole-house carbon filters would be considered a RCRA hazardous waste if the toxic characteristic leaching procedure ("TCLP") analysis performed on the filters resulted in a VOC concentration greater than 0.5 parts per million ("ppm"). Pennsylvania's Hazardous Waste Management Regulations, 25 Pa. Code Parts 262, 263, and 264 would apply to the disposal of this hazardous waste.

ALTERNATIVE 3: Deep Groundwater Extraction and Treatment and Discharge, and Installation of Private Water Lines and Connection to the Public Water Supply System

This alternative fully incorporates Alternative 2 as described above to provide public health protection.

The additional components of Alternative 3 include extracting contaminated groundwater from the deep bedrock aquifer using wells proposed to be located in close proximity to Aud-3, Aud-5 and VFCC-2, and a well proposed to be located on the CSG property, RW-1; continued use of the french drain system located on the CSG property for passive recovery of contaminated water from the shallow overburden aquifer; and treating the water using air stripping and carbon adsorption.

Treated water from extraction may be provided to the Audubon Water Company for use in the public water supply system or may be utilized by Commodore in its operations and/or discharged to the Publicly Owned Treatment Works ("POTW").

The conceptual design for the location of the extraction wells is illustrated in Figure 6. Groundwater monitoring and 5-year site reviews would be provided to measure the effectiveness of the cleanup.

Under Option A, vapor phase carbon emission control would be

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added to the existing onsite air stripper which currently treats contaminated water from the french drain system located on the CSG property. The contaminated groundwater from well RW-1, a deep recovery well, and the contaminated groundwater from the french drain would then be treated by this air stripper. Groundwater from the deep recovery wells proposed to be located in close proximity to Aud-3 and Aud-5 would be treated by an air stripper with vapor phase carbon. The groundwater extracted from the well proposed to be close in proximity to VFCC-2 would be treated by a separate air stripper with vapor phase carbon.

Under Option B, the existing onsite air stripper would continue to be used for treatment of groundwater from the french drain and an aqueous phase carbon treatment system would be used to treat contaminated groundwater recovered from the deep recovery well, RW-1. Groundwater from the deep wells installed off the CSG property (those wells proposed to be in close proximity to Aud-3, Aud-5, and VFCC-2) would be treated as described in Option A above.

Because this alternative would result in contaminated groundwater remaining on the Site, 5-year site reviews pursuant to Section 121(c) of CERCLA would be required to monitor the effectiveness of this alternative.

For costing purposes the remediation time for this alternative was based on 30 years (the maximum period of performance used by EPA for costing purposes). It is anticipated, however, that this alternative would take more than 30 years.

Implementation time considers the time required to design and construct the alternative. Implementation time for this alternative is estimated to be between two and five years.

Option A Costs:
Capital Costs - $732,730
O & M/Year (Years 1-2) - $288,900
O & M/Year (Years 3-30) - $246,700
30 Year Present Worth - $3,585,300

Option B Costs:
Capital Costs - $985,730
O & M/Year (Years 1-2) - $326,600
O & M/Year (Years 3-30) - $282,500
30 Year Present Worth - $4,244,700

Alternatively, the Audubon Water Company water supply wells Aud-3, Aud-5, and VFCC-2 may be utilized for groundwater extraction. Water extracted from these wells would continue to be treated by their existing air strippers. Vapor phase carbon units would be installed on these existing air strippers to control air emissions. If the Audubon Water Company supply wells

and their existing air strippers can be used for remediation as described above, then the cost for implementing Alternative 3, Option A or Option B, is estimated as follows:

Option A Costs:
Capital Costs - $420,000
O & M/Year (Years 1-2) - $288,900
O & M/Year (Years 3-30) - $246,700
30 Year Present Worth - $3,272,500

Option B Costs:
Capital Costs - $673,000
O & M/Year (Years 1-2) - $326,600
O & M/Year (Years 3 -30) - $285,200
30 Year Present Worth - $3,932,000

Compliance with ARARs:

Under this alternative, the spent whole-house carbon filters would be considered a RCRA hazardous waste if the toxic characteristic leaching procedure ("TCLP") analysis performed on the filters resulted in a VOC concentration greater than 0.5 parts per million ("ppm"). Pennsylvania's Hazardous Waste Management Regulations, 25 Pa. Code Parts 262, 263, and 264 would apply to the disposal of this hazardous waste.

This alternative would comply with the levels for the contaminants of concern identified in Table 45. Also, this alternative would meet the risk-based action levels as referenced in the NCP as acceptable groundwater cleanup criteria. Additionally the Pennsylvania Safe Drinking Water Act (25 Pa. Code Chapter 109) lists secondary maximum contaminant levels as applicable requirements for public drinking water supplies. These requirements would be relevant and appropriate for any water provided to the Audubon Water Company.

This alternative would not comply with the Pennsylvania Hazardous Waste Management Regulations, 25 Pa. Code §§264.90-264.100 and in particular, 25 Pa. Code §§ 264.97(i)(j) and 264.100(a)(9), which require that contaminated groundwater be remediated to background levels since the contaminated shallow aquifer is not actively remediated under Alternative 3. With respect to location-specific ARARs, this alternative would not comply with the EPA's Ground Water Protection Strategy Policy for a Class IIA aquifer, which is a "To Be Considered" ("TBC") standard, since contaminated groundwater from the shallow aquifer will be allowed to migrate vertically to the deep bedrock aquifer which is the drinking water aquifer.

This alternative would comply with fugitive emissions control requirements established under the Clean Air Act, 42 U.S.C. §§7401 to 7671q, the Pennsylvania Air Quality Regulations,

25 Pa. Code Chapter 127, and EPA OSWER Directive 9355.0-28 regarding control of air emissions from Superfund air strippers at Superfund groundwater sites.

Pumping of groundwater and discharge of treated water would be in compliance with the requirements of the Delaware River Basin Commission (18 C.F.R. Part 430).

Any treated water discharged through a "point source" to "waters of the United States" would comply with the Clean Water Act, 33 U.S.C. §§1251 et seq., the National Pollutant Discharge Elimination System ("NPDES") regulations promulgated thereunder at 40 C.F.R. Parts 122-124, including any state and federal regulations promulgated pursuant to Section 402(p) of the Clean Water Act, 33 U.S.C. §1342(p) ("Municipal and Industrial Stormwater Discharges"), the Pennsylvania NPDES regulations (25 Pa. Code §92.31), and the Pennsylvania Water Quality Standards (25 Pa. Code §§93.1-93.9).

All hazardous wastes generated during implementation of this alternative would be handled, transported, treated, and disposed of in compliance with 25 Pa. Code Chapter 262 Subparts A (relating to hazardous waste determination and identification numbers), B (relating to manifesting requirements for off-site shipments of spent carbon or other hazardous wastes), and C (relating to pretransport requirements; 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264 Subparts B-D, I (in the event that hazardous waste generated as part of the remedy is managed in containers), 25 Pa. Code Chapter 264 Subpart J (in the event that hazardous waste is managed, treated or stored in tanks). 40 C.F.R. Part 264, Subpart AA (relating to air emissions from process vents) and 40 C.F.R. Part 268, Subpart C, Section 268.30 and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste). 40 C.F.R. Part 264, Subpart AA (relating to air emission standards for process vents); 49 C.F.R. Parts 107 and 171-179 (relating to the transportation of hazardous wastes off-site.

This alternative would comply with EPA OSWER Directive 9834.11 and CERCLA §121(d)(3) which prohibit the disposal of Superfund Site waste at a facility not in compliance with §3004 and §3005 of RCRA and all applicable State requirements.

ALTERNATIVE 4: Shallow and Deep Groundwater Extraction, Treatment, and Discharge; Installation of Private Water Lines, and Connection to Public Water Supply System

This alternative fully incorporates all the components of Alternative 2 to provide public health protection. The

additional components of Alternative 4 include extracting both shallow and deep groundwater, and treating the water using air stripping and carbon adsorption.

Treated water from extraction may be provided to the Audubon Water Company for use in the public water supply system or may be utilized by the CSG facility in its operations or discharged to the Publicly Owned Treatment Works ("POTW"). The conceptual design developed for the approximate location of the shallow and deep bedrock extraction wells is illustrated in Figure 7.

The primary objective of the shallow and deep groundwater recovery on the CSG property is to provide a hydraulic control that would minimize migration of VOCs and recover groundwater near the source areas. The supplemental shallow groundwater wells would recover the higher concentration VOCs before they migrated down to the deep aquifer. By extracting from both shallow and deep groundwater on the CSG property, the overall volume of water extracted over the life of remediation should be reduced as well as the overall time required for groundwater remediation. Groundwater monitoring and 5-year site reviews would be provided to measure the effectiveness of the cleanup.

Under Option A, recovered water from the deep groundwater well, RW-1, the french drain and shallow wells: MOS-11, MOS-14, and MOS-15, would be treated by the air stripper which currently treats groundwater from the french drain system. Vapor phase carbon control would be added to this stripper. Groundwater from the deep recovery wells RW-3 and RW-5 proposed to be located in close proximity to Aud-3 and Aud-5 would be treated by an air stripper with vapor phase carbon. The groundwater extracted from well RW-4, proposed to be in close proximity to VFCC-2, would be treated in a separate air stripper with vapor phase carbon.

Under Option B, an aqueous phase carbon treatment system would be used to treat contaminated groundwater recovered from RW-1, the french drain, MOS-11, MOS-14, MOS-15. Groundwater from the deep wells RW-3, RW-5 and RW-4, the deep bedrock wells proposed to be located in close proximity to Aud-3, Aud-5, and VFCC-2, respectively would be treated as described in Option A above.

Because this alternative would result in contaminated groundwater remaining on the Site, 5-year site reviews pursuant to Section 121(c) of CERCLA would be required to monitor the effectiveness of this alternative.

For costing purposes the remediation time for this alternative was based on 30 years (the maximum period of performance used by EPA for costing purposes). It is anticipated, however, that this alternative would take more than 30 years.

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Implementation time considers the time required to design and construct the alternative. Implementation time for this alternative is estimated between two and five years.

Option A Costs:
Capital Costs - $810,930
O & M/Year (Years 1-2) - $300,300
O & M/Year (Years 3-30) - $258,000
30 Year Present Worth - $3,790,900

Option B Costs:
Capital Costs - $1,071,230
O & M/Year (Years 1-2) - $356,100
O & M/Year (Years 3-30) - $313,900
30 Year Present Worth - $4,680,300

Alternatively, the Audubon Water Company water supply wells Aud-3, Aud-5, and VFCC-2 may be utilized for groundwater extraction. Water extracted from these wells would continue to be treated by their existing air strippers. Vapor phase carbon units would be installed on these existing air strippers to control air emissions. If the Audubon Water Company water supply wells and air strippers can be used to implement the remedy, the costs for implementing Alternative 4, Option A or Option B, is estimated as follows.

Option A Costs:
Capital Costs - $498,200
O & M/Year (1-2 years) - $300,300
O & M/Year (3-30 years) - $258,000
30 Year Present Worth - $3,478,200

Option B Costs:
Capital Costs - $758,500
O & M/Year (1-2 years) - $356,100
O & M/Year (3-30 years) - $313,900
30 Year Present Worth - $4,367,600

Compliance with ARARS:

Under this alternative, the spent whole-house carbon filters would be considered a RCRA hazardous waste if the toxic characteristic leaching procedure ("TCLP") analysis performed on the filters resulted in a VOC concentration greater than 0.5 parts per million ("ppm"). Pennsylvania's Hazardous Waste Management Regulations, 25 Pa. Code Parts 262, 263, and 264 would apply to the disposal of this hazardous waste.

This alternative is designed to meet MCLs established under the SDWA for the contaminants of concern identified in Table 45. Also, this alternative would meet the risk-based action levels as

referenced in the NCP as acceptable groundwater cleanup criteria. Additionally the Pennsylvania Safe Drinking Water Act (25 Pa. Code Chapter 109) lists secondary maximum contaminant levels as applicable requirements for public drinking water supplies. These requirements would be relevant and appropriate for any water provided to the Audubon Water Company.

This alternative would comply with the Pennsylvania's Hazardous Waste Management Regulations, 25 Pa. Code §§264.90-264.100 and in particular, 25 Pa. Code §§264.97(i)(j) and 264.100(a)(9) which require that contaminated groundwater be remediated to background levels. With respect to location-specific ARARs, this alternative would comply with the EPA's Ground Water Protection Strategy Policy for a Class IIA aquifer, which is a "To Be Considered" ("TBC") standard.

This alternative would comply with the Pennsylvania's Hazardous Waste Management Regulations, 25 Pa. Code Chapter 264, Subchapter F regarding groundwater monitoring requirements.

This alternative would comply with fugitive emissions control requirements according to the federal Clean Air Act, RCRA (40 C.F.R. Part 264, Subpart AA),the Pennsylvania Air Quality Regulations, 25 Pa. Code Chapter 127, and EPA's OSWER Directive 9355.0-28 regarding the control of air emissions from Superfund air strippers at Superfund groundwater sites.

Pumping of groundwater and discharging of treated water would be in compliance with the requirements of the Delaware River Basin Commission (18 C.F.R. Part 430).

Any treated water discharged through a "point source" to "waters of the United States" would comply with the Clean Water Act, 33 U.S.C. §§1251 et seq., the National Pollutant Discharge Elimination System ("NPDES") regulations promulgated thereunder at 40 C.F.R. Parts 122-124, including any state and federal regulations promulgated pursuant to Section 402(p) of the Clean Water Act, 33 U.S.C. §1342(p) ("Municipal and Industrial Stormwater Discharges"), the Pennsylvania NPDES regulations (25 Pa. Code §92.31, and the Pennsylvania Water Quality Standards (25 Pa. Code §§93.1-93.9).

All hazardous wastes generated during implementation of this alternative would be handled, transported, treated, and disposed of in compliance with 25 Pa. Code Chapter 262 Subparts A (relating to hazardous waste determination and identification numbers), B (relating to manifesting requirements for off-site shipments of spent carbon or other hazardous wastes), and C (relating to pretransport requirements; 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264 Subparts B-D, I (in the

event that hazardous waste generated as part of the remedy is managed in containers), 25 Pa. Code Chapter 264 Subpart J (in the event that hazardous waste is managed, treated or stored in tanks). 40 C.F.R. Part 264, Subpart AA (relating to air emissions from process vents) and 40 C.F.R. Part 268, Subpart C, Section 268.30 and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste). 40 C.F.R. Part 264, Subpart AA (relating to air emission standards for process vents); 49 C.F.R. Parts 107 and 171-179 (relating to the transportation of hazardous wastes off-site.

This alternative would comply with the EPA OSWER Directive 9834.11 and CERCLA §121(d)(3) which prohibit the disposal of Superfund Site waste at a facility not in compliance with §3004 and §3005 of RCRA and all applicable State requirements.

ALTERNATIVE 5: Shallow and Deep Groundwater Extraction, Treatment, Discharge; Installation of Private Water Lines and Connection to Public Water Supply System

This alternative fully incorporates all of the components of Alternative 2 to provide public health protection. The additional components of Alternative 5 include extracting both shallow and deep groundwater, and treating the water using air stripping and carbon adsorption.

Treated water from extraction may be provided to the Audubon Water Company for use in the public water supply system or may be utilized by the CSG facility in its operations or discharged to the Publicly Owned Treatment Works ("POTW"). The conceptual design developed for the approximate location of the shallow and deep bedrock wells is illustrated in Figure 8.

This alternative is similar to Alternative 4 except that deep groundwater recovery is modified such that off-property pumping maximizes capture within the Site plume by changing the location of one of the off-property pumping wells. Instead of utilizing the deep well proposed to be located in close proximity to VFCC-2 as in Alternatives 3 and 4, a new recovery well, RW-2, would be utilized to more effectively recover the contaminated plume. It is assumed that RW-2 would pump at the same rate that VFCC-2 currently pumps. This pumping scenario is expected to recover the highest rate of VOCs while maximizing the use of the local water resources. Groundwater monitoring and 5-year site reviews would be required to measure the effectiveness of the cleanup.

Under Option A, recovered water from the deep groundwater well, RW-1, the french drain, and wells MOS-11, MOS-14, and MOS-15, would be treated by the existing french drain air stripper. Vapor phase carbon control would be added to this stripper.

Groundwater from the deep recovery wells RW-3 and RW-5 proposed to be located in close proximity to Aud-3 and Aud-5 would be treated by an air stripper with vapor phase carbon. The groundwater extracted from the deep bedrock well, RW-2, would be treated in a separate air stripper with vapor phase carbon.

Under Option B, an aqueous phase carbon treatment system would be used to treat contaminated groundwater recovered from RW-1, the french drain, MOS-11, MOS-14, and MOS-15. Groundwater from the deep wells RW-3 and RW-5 (the deep bedrock wells proposed to be located in close proximity to Aud-3 and Aud-5), and RW-2 would be treated as described in Option A above.

Because this alternative would result in contaminated groundwater remaining on the Site, 5-year site reviews pursuant to Section 121(c) of CERCLA would be required to monitor the effectiveness of this alternative.

For costing purposes the remediation time for this alternative was based on 30 years (the maximum period of performance used by EPA for costing purposes). It is anticipated that this alternative would take 25 years.

Implementation time considers the time required to design and construct the alternative. Implementation time for this alternative is estimated between two and five years.

Option A Costs:
Capital Costs - $946,910
O & M/Year (Years 1-2) - $446,500
O & M/Year (Years 3-30) - $404,300
30 Year Present Worth - $5,573,700

Option B Costs:
Capital Costs - $1,203,910
O & M/Year (Years 1-2) - $521,500
O & M/Year (Years 3-30) - $477,400
30 Year Present Worth - $6,657,000

Alternatively, the Audubon Water Company water supply wells Aud-3, Aud-5 may be utilized for groundwater extraction. Water extracted from these wells would continue to be treated by their existing air stripper. Additionally the existing stripper at VFCC-2 may be utilized to treated groundwater extracted from well RW-2. Vapor phase carbon units would be installed on these existing air strippers to control air emissions. If the Audubon Water Company water supply wells and air strippers can be used to

implement the remedy, the cost for implementing Alternative 5, Option A or Option B, is estimated as follows.

Option A Costs:
Capital Costs - $641,500
O & M (0-2 years) - $446,500
O & M (3-30 years) - $404,300
30 Year Present Worth - $5,268,300

Option B Costs:
Capital Costs - $899,400
O & M/Year (0-2 years) - $521,500
O & M/Year (3-30 years) - $477,400
30 Year Present Worth - $6,352,800

Compliance with ARARS:

Under this alternative, the spent whole-house carbon filters would be considered a RCRA hazardous waste if the toxic characteristic leaching procedure ("TCLP") analysis performed on the filters resulted in a VOC concentration greater than 0.5 parts per million ("ppm"). Pennsylvania's Hazardous Waste Management Regulations, 25 Pa. Code Parts 262, 263, and 264 would apply to the disposal of this hazardous waste.

This alternative would comply with the Pennsylvania's Hazardous Waste Management Regulations, 25 Pa. Code §§264.90-264.100 and in particular, 25 Pa. Code §§264.97(i)(j) and 264.100(a)(9) which require that contaminated groundwater be remediated to background levels. With respect to location-specific ARARs, this alternative would comply with the EPA's Ground Water Protection Strategy Policy for a Class II aquifer, which is a "To Be Considered" ("TBC") standard.

This alternative would comply with the Pennsylvania's Hazardous Waste Management Regulations, 25 Pa. Code §264, Subchapter F regarding groundwater monitoring requirements.

This alternative is designed to meet the MCLs established under the SDWA for the contaminants of concern. Also, this alternative would meet the risk-based action levels as referenced in the NCP as acceptable groundwater cleanup criteria. Additionally the Pennsylvania Safe Drinking Water Act (25 Pa. Code, Chapter 109) lists secondary maximum contaminant levels as applicable requirements for public drinking water supplies. These requirements would be relevant and appropriate for any water provided to the Audubon Water Company.

This alternative would comply with fugitive emissions control requirements according to the federal Clean Air Act, RCRA (40 C.F.R. Part 264, Subpart AA), the Pennsylvania Air Quality Regulations, (25 Pa. Code Chapter 127), and EPA's OSWER Directive

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9355.0-28 regarding the control of air emissions from Superfund air strippers at Superfund groundwater sites.

Pumping of groundwater and discharging of treated water would be in compliance with the requirements of the Delaware River Basin Commission (18 C.F.R. Part 430).

Any discharge of treated effluent to the POTW would comply with federal Clean Water Act pretreatment regulations and any State/federal regulations promulgated thereunder. Any discharge of treated effluent to the Audubon Water Company would meet SMCLs established under the Pennsylvania Safe Drinking Water Act, 25 Pa. Code, Chapter 109.

Any treated water discharged through a "point source" to "waters of the United States" would comply with the Clean Water Act, 33 U.S.C. §§1251 et seq., the National Pollutant Discharge Elimination System ("NPDES") regulations promulgated pursuant thereto at 40 C.F.R. Parts 122-124, including any state and federal regulations promulgated pursuant to Section 402(p) of the Clean Water Act, 33 U.S.C. §1342(p) (Municipal and Industrial Stormwater Discharges"), the Pennsylvania NPDES regulations (25 Pa. Code §92.31), and the Pennsylvania Water Quality Standards (25 Pa. Code §§93.1-93.9).

All hazardous wastes generated during implementation of this alternative would be handled, transported, treated, and disposed of in compliance with 25 Pa. Code Chapter 262 Subparts A (relating to hazardous waste determination and identification numbers), B (relating to manifesting requirements for off-site shipments of spent carbon or other hazardous wastes), and C (relating to pretransport requirements; 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264 Subparts B-D, I (in the event that hazardous waste generated as part of the remedy is managed in containers), 25 Pa. Code Chapter 264 Subpart J (in the event that hazardous waste is managed, treated or stored in tanks). 40 C.F.R. Part 264, Subpart AA (relating to air emissions from process vents) and 40 C.F.R. Part 268, Subpart C, Section 268.30 and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste). 40 C.F.R. Part 264, Subpart AA (relating to air emission standards for process vents); 49 C.F.R. Parts 107 and 171-179 (relating to the transportation of hazardous wastes off-site.

This alternative would comply with CERCLA §121(d)(3) which prohibits the disposal of Superfund Site waste at a facility not in compliance with §3004 and §3005 of RCRA and all applicable State requirements.

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Each of the remedial alternatives described above were evaluated using nine criteria. The resulting strengths and weaknesses of the alternatives were then weighed to identify the alternative providing the best balance among the nine criteria. These nine criteria are:

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements ("ARARs")

Primary Balancing Criteria

- Reduction of toxicity, mobility or volume
- Implementability
- Short-term effectiveness
- Long-term effectiveness and permanence
- Cost

Modifying Criteria

- State acceptance
- Community acceptance

A. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

A primary requirement of the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA") is that the selected remedial action be protective of human health and the environment. A remedy is protective if it eliminates, reduces, or controls current and potential risks posed through each exposure pathway to acceptable levels through treatment, engineering controls, or institutional controls.

Alternative 1, the no action alternative, does not include treatment or controls, provides no reduction in risk, and is not protective.

Alternatives 2, 3, 4, and 5 are protective of human health. Risks posed by exposure to contaminated groundwater are addressed by connecting affected and potentially affected parties to the existing public water supply system and by the use of whole-house carbon filter systems until the water lines are installed. Since Alternative 2 does not provide for treatment of contaminated groundwater or prevent migration of contaminants to currently unaffected areas it is not as protective of human health as Alternatives 3, 4 and 5.

Alternatives 3, 4, and 5 include extraction and treatment of

contaminated groundwater. These alternatives would eventually restore contaminated groundwater to background levels or MCLs, whichever is more stringent. By providing connection to the existing public water supply and continuing maintenance of existing carbon filters, human health would be protected from exposure to contaminated groundwater while the groundwater aquifer is being restored. Public and environmental risks from direct contact with, and ingestion of, contaminated groundwater would be mitigated through treatment of the groundwater plume. Alternatives 3, 4, and 5 would achieve a greater degree of overall protection of human health and the environment than Alternatives 1 and 2. Alternatives 4 and 5 would achieve an even greater degree of overall protection of human health and the environment than Alternative 3 because Alternatives 4 and 5 actively remediate the shallow aquifer while Alternative 3 does not.

B. COMPLIANCE WITH ARARS

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and State standards, requirements, criteria, and limitations which are collectively referred to as "ARARs", unless such ARARs are waived under CERCLA Section 121(d)(4). Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or State laws that specifically address hazardous substances found at the site, the remedial action to be implemented at the site, the location of the site, or other circumstances present at the site.

Relevant and appropriate requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or State law which, while not applicable to the hazardous materials found at the site, the remedial action itself, the site location or other circumstances at the site, nevertheless address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the site. ARARs may relate to the substances addressed by the remedial action (chemical-specific), to the location of the site (location-specific), or the manner in which the remedial action is implemented (action-specific).

In addition to applicable or relevant and appropriate requirements, the lead and support agencies may, as appropriate, identify other advisories, criteria, or guidance to be considered for a particular release. The "to be considered" ("TBC") category consists of advisories, criteria, or guidance that were developed by EPA, other federal agencies, or states that may be useful in developing CERCLA remedies.

Since Alternatives 1 and 2 do not include groundwater remediation as a component of their respective remedies, neither alternative would meet the chemical-specific ARARs relating to groundwater remediation and treatment.

Additionally, Alternatives 1, 2, and 3 would not comply with the requirements of the Pennsylvania Hazardous Waste Management Regulations, 25 Pa. Code §§264.90-264.100 and in particular, 25 Pa. Code §§264.97(i)(j) and 264.100(a)(9), which require contaminated groundwater to be remediated to background levels. Alternatives 1 and 2 do not involve any treatment of contaminated groundwater, and Alternative 3 does not comply with these regulations since the shallow aquifer would not be actively remediated.

With respect to location-specific ARARs, Alternatives 1, 2, and 3 would not comply with EPA's Ground Water Protection Strategy Policy for a Class IIA aquifer, which is a TBC standard.

With respect to location-specific ARARs, Alternatives 4 and 5 would comply with the EPA's Ground Water Protection Strategy Policy for a Class IIA aquifer, which is a TBC standard. Alternatives 4 and 5 would protect current and potential sources of drinking water and waters having other beneficial uses.

With respect to location-specific ARARs, Alternatives 3, 4, and 5 would comply with the substantive requirements of the Delaware River Basin Commission (18 C.F.R. Part 430).

Alternatives 4 and 5, which include groundwater remediation, would meet the chemical-specific ARARs (as set forth in Section XI of this ROD) relating to groundwater remediation and treatment. Alternative 3 would only meet all chemical-specific ARARS through natural attenuation of the contaminants because the shallow aquifer would not be actively remediated.

Alternatives 3, 4, and 5 would meet all action-specific ARARs relating to activities performed as part of the remedy, including federal and State air emission requirements, federal Pretreatment Standards for discharges to a POTW, and federal and State treatment, storage, and disposal requirements for any hazardous and solid wastes generated during the groundwater treatment process.

C. REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

This evaluation criteria addresses the degree to which a technology or remedial alternative reduces toxicity, mobility or volume of hazardous substances.

Alternatives 1 and 2 are remedial actions that do not use treatment technologies. Therefore, Alternatives 1 and 2 would

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not reduce the toxicity, mobility, or volume of contaminants in the groundwater plume at the Site. Over time, contaminant levels in the present areas of contamination may decrease gradually through natural attenuation, but the groundwater plume itself may increase in area.

Alternatives 3, 4, and 5 are the only alternatives which involve treatment and which would result in active reduction of VOCs in the contaminated aquifer. Alternative 3, however, would not actively reduce the level of VOCs in the shallow aquifer. A reduction of contaminants in the shallow aquifer, under Alternative 3, would only occur through natural attenuation. Alternatives 4 and 5 would remove contaminants from both the shallow and the deep aquifers which would result in the reduction of toxicity, mobility and volume of Site contaminants in groundwater through treatment. Specifically, a combination of air stripping and carbon adsorption would change the physical, chemical and/or biological characteristics of the contaminants on Site, thereby reducing the toxicity, mobility, and volume of these contaminants.

D. IMPLEMENTABILITY

Implementability refers to the technical and administrative feasibility of a remedy, from design through construction, operation, and maintenance. It also includes coordination of federal, State, and local governments to clean up the Site. All alternatives evaluated are considered implementable and use technologies that have been recommended and used at other Superfund sites. All alternatives require groundwater monitoring and Alternatives 3, 4, and 5 require monitoring of treated groundwater discharge.

Alternative 1 which includes groundwater monitoring solely on the CSG property would be the easiest alternative to implement.

Alternative 2 can also be implemented easily, but would require the participation of the Audubon Water Company and State and local governments for the construction of water lines within existing road right-of-ways. The public water supply is regulated under the Safe Drinking Water Act. The Audubon Water Company is in compliance with the Safe Drinking Water Act and operates under a State permit.

Alternatives 3, 4, and 5 would require the participation of the Audubon Water Company and State and local governments for the construction of water lines within existing road right-of-ways. Because Alternatives 3, 4, and 5 involve the extraction and treatment of groundwater, there are more implementation and operation considerations associated with these alternatives. Alternatives 3, 4, and 5 present minimum technical difficulties

in designing and constructing the treatment systems but may require additional groundwater investigations during the design stage.

The components of the air stripping and carbon adsorption systems (Alternatives 3, 4, and 5) are readily implementable using existing technologies. The reliability of these treatment technologies has also been established and demonstrated successfully at other hazardous waste sites. No special materials or equipment would be required to implement Alternatives 3, 4, or 5. Operation and maintenance considerations include cleaning and replacement of wells and well pumps; maintenance of blower units; cleaning of fouled packing; and regeneration of the vapor phase carbon units (Option A) or the liquid phase carbon units (Option B).

E. SHORT-TERM EFFECTIVENESS

Short-term effectiveness addresses the period of time needed to achieve protection of human health and the environment and any adverse impacts that may be posed during the construction and operation period until remediation goals are achieved.

None of the alternatives evaluated involve extensive construction, excavation, or other remedial action measures that would pose any appreciable short-term risks to the community or to workers during construction or implementation. Workers will be required to wear appropriate levels of protection during installation of extraction wells to avoid direct contact with contaminated groundwater. During installation of the treatment systems and other Site activities, precautions mandated by the Occupational Safety and Health Act ("OSHA") for construction activities will be taken. Disposal of any wastes generated during construction and operation will follow proper handling practices and therefore should not have an adverse environmental impact.

EPA's Well-Head Protection Areas ("WHPAs) Model was used to estimate the time frame for aquifer remediation. The WHPA model is a model which models an area through which contaminants are reasonably likely to move toward and reach water wells or wellfields. Based on the model, Alternative 5 should remediate the aquifer in the shortest time frame because the groundwater extracted using Alternative 5 should contain a greater concentration of contaminants. However, a more accurate evaluation of the response of the aquifer to pumping will be undertaken during the remedial design stage.

F. LONG-TERM EFFECTIVENESS AND PERMANENCE

Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and

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the environment over time. This evaluation criterium includes the consideration of residual risk and the adequacy and reliability of controls.

Since no actions would be taken to remediate the contaminated groundwater under Alternative 1, the health risks remaining after implementation of this alternative would be very similar to those posed by the present use of contaminated groundwater. Implementing Alternative 1 would result in more than minimal residual risk from groundwater ingestion, dermal contact, and inhalation under the future use reasonable maximum exposure scenario, since groundwater would not be treated or contained and ARARS would not be attained.

Alternative 2 meets the objective of eliminating the public health risk associated with use of contaminated groundwater, but does not involve the actual treatment or remediation of contaminated groundwater. Therefore, it would not maintain reliable protection of the environment over time.

With respect to environmental risk, the contaminants in the groundwater would continue to migrate over time under Alternatives 1 and 2. Under Alternative 3, contaminants would continue to migrate from the shallow aquifer to the deep aquifer. Therefore Alternatives 1, 2 and 3 would not maintain reliable protection of the environment over time.

Alternatives 4 and 5 would provide the greatest degree of long-term effectiveness and permanence for groundwater protection and remediation and would result in minimal residual risk by attaining ARARs for groundwater.

G. COST

This criterion examines the estimated costs for each remedial alternative. For comparison, capital, annual O&M, and present worth costs are shown in Table 47.

H. STATE ACCEPTANCE

The Pennsylvania Department of Environmental Resources has concurred on EPA's selected remedy, Alternative 5, Option A.

I. COMMUNITY ACCEPTANCE

A public meeting on the Proposed Plan was held on August 6, 1992 in Eagleville, Pennsylvania. Comments received orally at the public meeting and in writing during the public comment period are referenced in the Responsiveness Summary attached to this Record of Decision. Residents who live in Lower Providence Township have not objected to the selected remedy.

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IX. THE SELECTED REMEDY: DESCRIPTION AND PERFORMANCE STANDARD(S) FOR EACH COMPONENT OF THE REMEDY

A. GENERAL DESCRIPTION OF THE SELECTED REMEDY

EPA has selected Alternative 5, Option A, as the selected remedy for the CSG Site. This remedy will restore the groundwater in the area of attainment to background levels or MCLs, whichever is lower, for the contaminants of concern and protect the public from exposure to contaminated groundwater. The area of attainment for the cleanup is the potential extent of the contaminant plume as depicted in Figure 5. Based on current information, this alternative provides the best balance among the alternatives with respect to the nine criteria EPA uses to evaluate each alternative. The selected remedy consists of the following components:

- Construction of public water supply lines and connections to the residences south of the CSG facility on Rittenhouse Road and on Audubon Road between Rittenhouse Road and Thrush Lane.

- Continued maintenance of the whole-house carbon filtration systems previously supplied to residences along Audubon Road near Trooper Road;

- Installation, operation and maintenance of groundwater extraction wells to remove contaminated groundwater from beneath the Site and to prevent contaminants from migrating further;

- Installation, operation, and maintenance of air strippers at the groundwater extraction wells to treat groundwater to the required levels;

- Installation, operation, and maintenance of vapor phase carbon units on air strippers;

- Periodic sampling of groundwater and treated water to ensure that treatment components are effective and that groundwater remediation is progressing towards the cleanup goals; and

- Creation of a groundwater management zone with restrictions on the installation of new wells in areas of contamination which exceed MCLs.

Each component of the selected remedy and its performance standard(s) is described in detail in Section C, below.

B. Strategy if the Selected Remedy is Not Achieved

Based on the information obtained during the RI, and the analysis of the remedial alternatives, EPA and the Commonwealth of Pennsylvania believe that it may be possible to achieve the required groundwater cleanup levels. However, the ability to achieve required cleanup levels at all points throughout the area of attainment or plume of contamination cannot be determined until the extraction system has been implemented, modified as necessary, and plume response monitored over time.

If it is determined by EPA, in consultation with PADER, that on the basis of the system performance data, that certain portions of the aquifer cannot be restored to background levels, or MCLs, whichever is lower, and/or if EPA determines that it is technically impracticable to restore the aquifer, EPA may amend the ROD or issue an Explanation of Significant Differences in accordance with the NCP. In such event, the likely alternative actions will attempt to remediate the groundwater to its beneficial use that would be used as a drinking water source. If the aquifer cannot be restored to its beneficial use, some or all of the following measures involving long-term management could occur, as determined by EPA in consultation with PADER, for an indefinite period of time, as a modification of the existing system:

- long term gradient control may be provided by low level pumping, as a containment measure;

- chemical-specific ARARs may be waived for those portions of the aquifer for which EPA and PADER determine that it is technically impracticable to achieve further contaminant reduction;

- institutional controls may be provided/maintained to restrict access to those portions of the aquifer where contaminants remain above Performance Standards;

- remedial technologies for groundwater restoration may be reevaluated; and

- further sampling and/or monitoring of existing and/or new wells may be ordered.

C. PERFORMANCE STANDARDS

1) Connection to the Public Water Supply

The extension of the Audubon Water Company water supply lines shall be constructed in compliance with local and State requirements. Connections shall be offered and provided to the residences listed in Table 46 and any other residence determined by EPA during the Remedial Design to be affected or potentially

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affected by the plume of contamination. All areas impacted by the construction activities during remedy implementation and operation and maintenance shall be restored to preexisting conditions. When the affected and potentially affected parties are connected into the public water supply system, each residential well shall be abandoned in accordance with all applicable regulations unless the residential well is selected as a sampling location for long-term groundwater monitoring.

2) Maintenance and Disposal of Existing Whole-House Carbon Filtration Systems

Residences south of the Site on Rittenhouse Road and on Audubon Road between Rittenhouse Road and Thrush Lane shall be connected to the public water supply system. The existing whole-house carbon filtration systems that have previously been installed in residences to the south of the CSG property shall be maintained in proper working order until connection to the public system is complete. Such maintenance will ensure that breakthrough of contaminants does not occur. The maintenance shall include regular changing of carbon filters in accordance with the work plan for the Remedial Design and/or at EPA's request. One additional system shall be installed in a residence located at 2705 Audubon Road. Maintenance of whole-house carbon filtration systems shall also continue for the residences southeast of the Site along Audubon Road near Trooper Road, which are identified as Group 2 in the Feasibility Study.

At the conclusion of the remedy construction or at the Site's first 5-year review, whichever takes place first, this residential area shall be reevaluated by EPA and EPA will determine whether the maintenance of whole-house carbon filtration systems will be continued.

The management and ultimate disposition of these spent carbon filters will be determined, subject to EPA approval, during the remedial design. Such management may entail treatment and/or disposal of the carbon filters. In the event these units are a hazardous waste, the following ARARs will apply: 25 Pa. Code Chapter 262, Subparts A (relating to hazardous waste determination and identification numbers), B (relating to manifesting requirements for off-site shipments of spent carbon or other hazardous wastes), and C (relating to pretransport requirements; 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264, Subparts B-D, I (in the event that hazardous waste generated as part of the remedy is managed in containers), 25 Pa. Code Chapter 264, Subpart J (in the event that hazardous waste is managed, treated or stored in tanks). 40 C.F.R. Part 264, Subpart AA (relating to air emissions from process vents) and 40 C.F.R. Part 268, Subpart C, Section 268.30 and Subpart E

(regarding prohibitions on land disposal and prohibitions on storage of hazardous waste). 40 C.F.R. Part 264, Subpart AA (relating to air emission standards for process vents).

3) Groundwater Extraction and Treatment

The selected remedy includes groundwater extraction and treatment which shall be required until such time as EPA in consultation with PADER determine that the Performance Standard (remediation to background levels as established by EPA during the Remedial Design, or MCLs, whichever is lower) for each contaminant of concern, as identified in Table 45, in the groundwater has been achieved throughout the entire areal extent of groundwater contamination. The details of the system are described below:

a) Groundwater Extraction System

The groundwater shall be decontaminated through extraction and treatment of the contaminated groundwater throughout the entire plume of contamination. The extraction shall create capture zones to capture contaminated groundwater throughout the plume. Groundwater shall be extracted using multiple extraction wells, the exact location, groundwater extraction flow rate, and number of which shall be determined during the Remedial Design and shall be approved by EPA in consultation with PADER.

b) Groundwater Cleanup Levels

The well system for extracting groundwater shall be operated until the Performance Standard for each contaminant of concern is met and maintained throughout the entire plume of contamination for a period of 12 consecutive quarters in accordance with Subparagraph (e), infra. The Performance Standard for each contaminant of concern in the groundwater shall be the MCL for that contaminant (the federal ARAR for public drinking water supplies under the Safe Drinking Water Act) or the background concentration of that contaminant (the Pennsylvania ARAR under 25 Pa. Code §§264.90-264.100), whichever is lower. The background concentration for each contaminant of concern shall be established by EPA during the Remedial Design in accordance with the procedures for groundwater monitoring outlined in 25 Pa. Code §264.97. Establishment of background concentrations shall not delay implementation of the remedy. In the event that a contaminant of concern is not detected in samples taken for the establishment of background concentrations, the method detection limits of EPA-approved low level drinking water analytical methods with respect to that contaminant of concern shall constitute the background concentration of the contaminant.

c) Air Stripper and Vapor Phase Carbon Units

The recovered groundwater shall be treated using packed column air stripping units and, where required, vapor phase carbon units. The Performance Standard for the air emissions from the air stripping units shall be the requirements of the RCRA regulations set forth at 40 C.F.R. Part 264, Subpart AA - Air Emission Standards for Process Vents. The total organic emissions from all affected process vents at the Site are required to be below 1.4 kg/hr and 2800 kg/yr under this regulation. Any vinyl chloride air emissions from the groundwater treatment units will comply with Section 112 of the Clean Air Act, 42 U.S.C. §7412, National Emission Standard For Hazardous Air Pollutants (NESHAPs). The relevant and appropriate NESHAP for vinyl chloride is set forth at 40 C.F.R. Part 61, Subpart F. The air emissions will also comply with the Commonwealth of Pennsylvania regulations set forth at 25 Pa. Code, Chapter 127, Subchapter A. Those regulations require that emissions be reduced to the minimum obtainable levels through the use of best available technology, as defined in 25 Pa. Code §121.1.

The management and ultimate disposition of the spent carbon from the vapor phase carbon units will be determined, subject to EPA approval, during the remedial design. Such management may entail treatment and/or disposal of the carbon filters. In the event these units are a hazardous waste, the following ARARS will apply as the Performance Standard: 25 Pa. Code Chapter 262 Subparts A (relating to hazardous waste determination and identification numbers), B (relating to manifesting requirements for off-site shipments of spent carbon or other hazardous wastes), and C (relating to pretransport requirements; 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264, Subparts B-D, I (in the event that hazardous waste generated as part of the remedy is managed in containers), 25 Pa. Code Chapter 264, Subpart J (in the event that hazardous waste is managed, treated or stored in tanks). 40 C.F.R. 268 Subpart C Section 268.30 and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste). 40 C.F.R. Part 264, Subpart AA (relating to air emission standards for process vents).

d) Discharge of Treated Water

The Performance Standard for each contaminant of concern in the effluent water from the air strippers, which may be supplied to the Audubon Water Company Public Water System or may be used by the CSG facility with overflow discharged to the POTW, shall be the MCL for that contaminant as promulgated under the Safe Drinking Water Act, 42 U.S.C. §§300f to 300j-26, and set forth at 40 C.F.R. §141.61(a). In the absence of an MCL, an EPA health-

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based concentration applies. The MCLs for the contaminants of concern are listed in Table 45. The Pennsylvania Safe Drinking Water Act (25 Pa. Code, Chapter 109) lists the secondary maximum contaminant levels ("SMCLs") as applicable requirements for public drinking water supplies. SMCLs are relevant and appropriate for discharge of treated effluent to the Audubon Water Company.

The appropriate analytical method for the contaminants of concern is the "Superfund Analytical methods for Low Concentration Water for Organics Analysis, (June 1991). The exact point of discharge and receiver of treated water shall be determined during the Remedial Design and shall be approved by EPA in consultation with PADER. The discharging of water shall comply with any applicable Clean Water Act and Commonwealth of Pennsylvania ARARs.

e) Periodic Monitoring and System Shutdown

A long-term groundwater monitoring program shall be implemented to evaluate the effectiveness of the groundwater pumping and treatment system throughout the entire plume. Numbers and locations of these monitoring wells shall be approved by EPA during the remedial design, in consultation with the PADER. The wells shall be sampled quarterly for the first three years and semi-annually thereafter until the levels of contaminants of concern in these wells have reached background levels as established by EPA, in consultation with PADER during the Remedial Design, or MCLs whichever is lower. Once these required levels have been reached, the wells shall be sampled for twelve consecutive quarters throughout the entire plume and if contaminants remain at or below these required levels, the operation of the extraction system shall be shut down.

Semi-annual monitoring of the groundwater shall continue for five years after the system is shutdown. If subsequent to an extraction system shutdown, monitoring shows that groundwater concentrations of any contaminant of concern are above background levels or MCLs, whichever is lower, the system shall be restarted and continued until the required levels have once more been attained for twelve consecutive quarters. Semi-annual monitoring shall continue until EPA determines, in consultation with the PADER, that contaminants have reached stable levels. The EPA-approved analytical method will be determined in the Remedial Design. An operation and maintenance plan for the groundwater monitoring system shall be required, and must be approved by EPA in consultation with the PADER.

f) Operation and Maintenance of Extraction and Treatment System

An operation and maintenance plan for the groundwater

extraction and treatment system shall be required. The performance of the groundwater extraction and treatment system shall be carefully monitored on a regular basis and the system may be modified, as warranted by the performance data collected during operation. Samples of treated groundwater shall be collected periodically to ensure that the treatment technologies employed are reducing contaminant levels to required standards. These modifications may include, for example, alternate pumping of extraction wells or the addition or elimination of certain extraction wells.

4) Institutional Controls

Restrictions on the installation of new wells shall be implemented in areas of the Site where MCLs are exceeded.

5) Worker Safety

During all Site work, Occupational Safety and Health Administration ("OSHA") standards set forth at 29 C.F.R. Parts 1910, 1926 and 1904 governing worker safety during hazardous waste operations, shall be complied with.

6) Five-Year Reviews

Five-year reviews shall be conducted after the remedy is implemented to assure that the remedy continues to protect human health and the environment. A 5-Year Review Work Plan shall be required and shall be approved by EPA in consultation with the PADER.

X. STATUTORY DETERMINATIONS

EPA's primary responsibility at Superfund sites is to select remedial actions that are protective of human health and the environment. Section 121 of CERCLA also requires that the selected remedial action comply with ARARs, be cost-effective, and utilize permanent treatment technologies to the maximum extent practicable. The following sections discuss how the selected remedy for the CSG Site meets these statutory requirements.

A. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy will provide adequate protection of human health and the environment by providing public water to affected and potentially affected residences and maintenance of existing whole-house carbon filtration systems, and by extracting and treating the contaminated groundwater to achieve MCLs

established under the SDWA or background levels, whichever is lower.

Implementation of the selected remedy will not pose unacceptable short-term risks or cross-media impacts. The remedial technologies employed in the selected remedy are proven to reduce the concentrations of volatile organic compounds to acceptable levels.

B. COMPLIANCE WITH AND ATTAINMENT OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS ("ARARS")

The selected remedy will comply with all applicable or relevant and appropriate chemical-specific, location-specific, and action-specific ARARs. Those ARARs are:

1. Chemical-Specific ARARs

The selected remedy will be designed to achieve compliance with chemical-specific ARARs related to groundwater and ambient air quality at the Site. The Safe Drinking Water Act specifies MCLs for drinking water at public water supplies. The contaminants of concern for the CSG Site and their respective MCLs which are listed in Table 45 (for 1,1 Dichloroethane a health-based concentration is listed) are relevant and appropriate for this remedial action. These MCLs shall be achieved throughout the entire contaminated groundwater plume. These MCLs, as set forth at 40 C.F.R. §141.61(a), are listed in Table 45.

Pennsylvania regulations set forth at 25 Pa. Code §§ 109.202(1), 109.201(2), 109.203 and 109.503 establish drinking water quality standards at least as stringent as the federal MCLs.

The Commonwealth of Pennsylvania standards specify that all groundwater containing hazardous substances must be remediated to "background" quality as set forth in 25 Pa. Code §§264.90 - 264.100, and in particular, 25 Pa. Code §§264.97(i) and (j), and 264.100(a)(9). The Commonwealth of Pennsylvania also maintains that the requirement to remediate to background is found in other legal authorities. This requirement that all groundwater be remediated to background levels is a relevant and appropriate requirement.

The method(s) by which background levels will be determined are set forth under the description of the selected remedial alternative. These background levels, if more stringent than MCLs, shall be attained as part of this remedial action unless EPA and the PADER determine that attaining such levels is technically impracticable.

Any vinyl chloride emissions from the groundwater treatment system shall comply with Section 112 of the Clean Air Act, 42 U.S.C. Section 7412, National Emission Standards for Hazardous Air Pollutants (NESHAPs). The relevant and appropriate NESHAP for vinyl chloride is set forth at 40 C.F.R. Part 61, Subpart F.

2. Location-Specific ARARs

The substantive requirements of the Delaware River Basin Commission (18 C.F.R. Part 430) are applicable. These regulations establish requirements for the extraction of groundwater within the Delaware River Basin.

3. Action-Specific ARARs

Federal Clean Air Act requirements, 42 U.S.C. §§7401 et seq. are applicable and must be met for the discharge of contaminants to the air. Pennsylvania's Air Pollution Control Act is also applicable, as are Pennsylvania's Air Pollution Control Regulations (25 Pa. Code Chapters 121-142).

The requirements of Subpart AA (Air Emission Standards for Process Vents) of the Federal RCRA regulations set forth at 40 CFR Part 264 are relevant and appropriate and, (depending upon the levels of organics in the extracted groundwater and treatment residuals) may be applicable to the air stripping operations conducted as part of the selected remedy. These regulations require that total organic emissions from the air stripping process vents must be less than 1.4 kg/hr (3 lb/hr) and 2800 kg/yr (3.1 tons/yr).

25 Pa. Code Section 123.31 is applicable to the selected remedial alternative and prohibits malodors detectable beyond the CSG property line.

25 Pa. Code Section 127.12(a)(5) will apply to new point source air emissions that result from implementation of the selected remedial alternative. These Commonwealth of Pennsylvania regulations require that emissions be reduced to the minimum obtainable levels through the use of best available technology ("BAT") as defined in 25 Pa. Code § 121.1.

25 Pa. Code Section 127.11 will apply to the selected remedy alternative. These Commonwealth of Pennsylvania regulations require a plan for approval for most air stripping and soil venting/decontamination projects designed to remove volatile contaminants from soil, water, and other materials regardless of emission rate.

Regulations concerning well drilling as set forth in 25 Pa. Code Chapter 107 are applicable. These regulations are

established pursuant to the Water Well Drillers License Act, 32 P.S.§ 645.1 et seq.

The groundwater collection and treatment operations will constitute treatment of hazardous waste (i.e., the groundwater containing hazardous waste), and will result in the generation of hazardous wastes derived from the treatment of the contaminated groundwater (i.e., spent carbon filters from the air stripping operations and whole-house carbon filtration systems). The remedy will be implemented consistently with the requirements of 25 Pa. Code Chapter 262 Subparts A (relating to hazardous waste determination and identification numbers), B (relating to manifesting requirements for off-site shipments of spent carbon or other hazardous wastes), and C (relating to pretransport requirements; 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264, Subparts B-D, I (in the event that hazardous waste generated as part of the remedy is managed in containers), 25 Pa. Code, Subpart J (in the event that hazardous waste is managed, treated or stored in tanks). 40 C.F.R. Part 264, Subpart AA (relating to air emissions from process vents) and 40 C.F.R. Part 268, Subpart C, Section 268.30 and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste). 40 C.F.R. Part 264, Subpart AA (relating to air emission standards for process vents).

25 Pa. Code Chapter 264, Subchapter F, regarding groundwater monitoring is applicable to the selected remedial alternative.

The discharge of treated effluent to the POTW shall comply with the federal Clean Water Act (33 U.S.C. §§1251 et seq.) pretreatment regulations for existing and new sources of pollution as set forth at 40 C.F.R. Part 403.

Any surface water discharge of treated effluent will comply with the substantive requirements of the Section 402 of the Clean Water Act, 33 U.S.C. §1342, and the National Pollutant Discharge Elimination System ("NPDES") discharge regulations set forth at 40 C.F.R. Parts 122-124, the Pennsylvania NPDES regulations (25 Pa. Code §92.31, and the Pennsylvania Water Quality Standards (25 Pa. Code §§93.1-93.9).

The Pennsylvania Safe Drinking Water Act (25 Pa. Code Chapter 109) lists the secondary maximum contaminant levels ("SMCLs") as applicable requirements for public drinking water supplies. SMCLs are relevant and appropriate for discharge of treated effluent to the Audubon Water Company.

The Occupational Safety and Health Act ("OSHA") regulations codified at 29 C.F.R. Section 1910.170 are applicable for all activities conducted during this remedial action.

25 Pa. Code Sections 261.24 and 273.421 are applicable regulations for the handling of residual and other waste and for the determination of hazardous waste by the Toxic Characteristic Leaching Procedure ("TCLP").

Transportation of any hazardous wastes off-site shall also comply with the Department of Transportation ("DOT") Rules for Hazardous Materials Transport (49 C.F.R. Parts 107 and 171-179).

4. To Be Considered Standards

Pennsylvania's Ground Water Quality Protection Strategy, dated February 1992 is a to be considered standard.

EPA Directive 9355.0-28, which covers emissions from air strippers at Superfund groundwater sites is a to be considered standard.

Pennsylvania Bureau of Air Quality Memorandum, "Air Quality Permitting Criteria for Remediation Projects Involving Air Strippers and Soil Decontamination Units" is a to be considered standard.

EPA's Ground Water Protection Strategy, dated July 1991, is a to be considered standard.

EPA OSWER Directive 9834.11 which prohibits the disposal of Superfund Site waste at a facility not in compliance with §3004 and §3005 of RCRA and all applicable State requirements.

C. COST-EFFECTIVENESS

The selected remedy is cost-effective in providing overall protection in proportion to cost, and meets all other requirements of CERCLA. The NCP, 40 C.F.R. Section 300.430(f)(ii)(D), requires EPA to evaluate cost-effectiveness by comparing all the alternatives which meet the threshold criteria - protection of human health and the environment and compliance with ARARs - against three additional balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility and volume through treatment; and short-term effectiveness. The selected remedy meets these criteria and provides for overall effectiveness in proportion to its cost. The estimated present worth cost for the selected remedy is $5,573,700 if new extraction wells and treatment systems are installed and $5,268,300 if Audubon Water Company wells and air strippers are utilized in lieu of utilizing new extraction wells and strippers as described under Alternative 5A.

ORIGINAL
(Red)

D. UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized while providing the best balance among the other evaluation criteria. Of those alternatives evaluated that are protective of human health and the environment and meet ARARs, the selected remedy provides the best balance of tradeoffs in terms of long-term and short-term effectiveness and permanence, cost, implementability, reduction in toxicity, mobility, or volume through treatment, State and community acceptance, and preference for treatment as a principal element.

Under the selected remedy, treatment of both shallow and deep bedrock groundwater using air stripping (and vapor phase carbon where required) will provide a greater degree of reduction of toxicity, mobility, or volume than the other alternatives evaluated. Alternative 5, Option A will reduce contaminant levels in groundwater and reduce the risks associated with direct contact and ingestion of the groundwater to the maximum extent practicable, as well as provide long-term effectiveness.

E. PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The selected remedy satisfies the statutory preference for treatment as a principal element. Alternative 5, Option A addresses the primary threat of future ingestion and direct contact of contaminated groundwater through treatment using an air stripper.

XI. DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for the Commodore Semiconductor Site was released for public comment in July 1992. The Proposed Plan identified Alternative 5A as the preferred alternative. EPA reviewed all written and oral comments submitted during the comment period. Upon review of these comments, it was determined that no significant changes to the remedy, as it was originally identified in the Proposed Plan were necessary.

EPA has updated the cost estimates for Alternatives 3, 4, and 5 based on the increased capital cost of installing, new wells and air strippers with vapor phase carbon units if the existing Audubon Water Company wells and strippers can not be utilized.

Additionally EPA has updated the cost estimates for Alternatives 3, 4, and 5 if the Audubon Water Company wells and strippers are used based on the increased cost of installing, operating and maintaining vapor phase carbon units on the existing air strippers that may be used to implement the remedy.

ORIGINAL (Red)

APPENDIX A FIGURES

Figure 1
Site Location Map

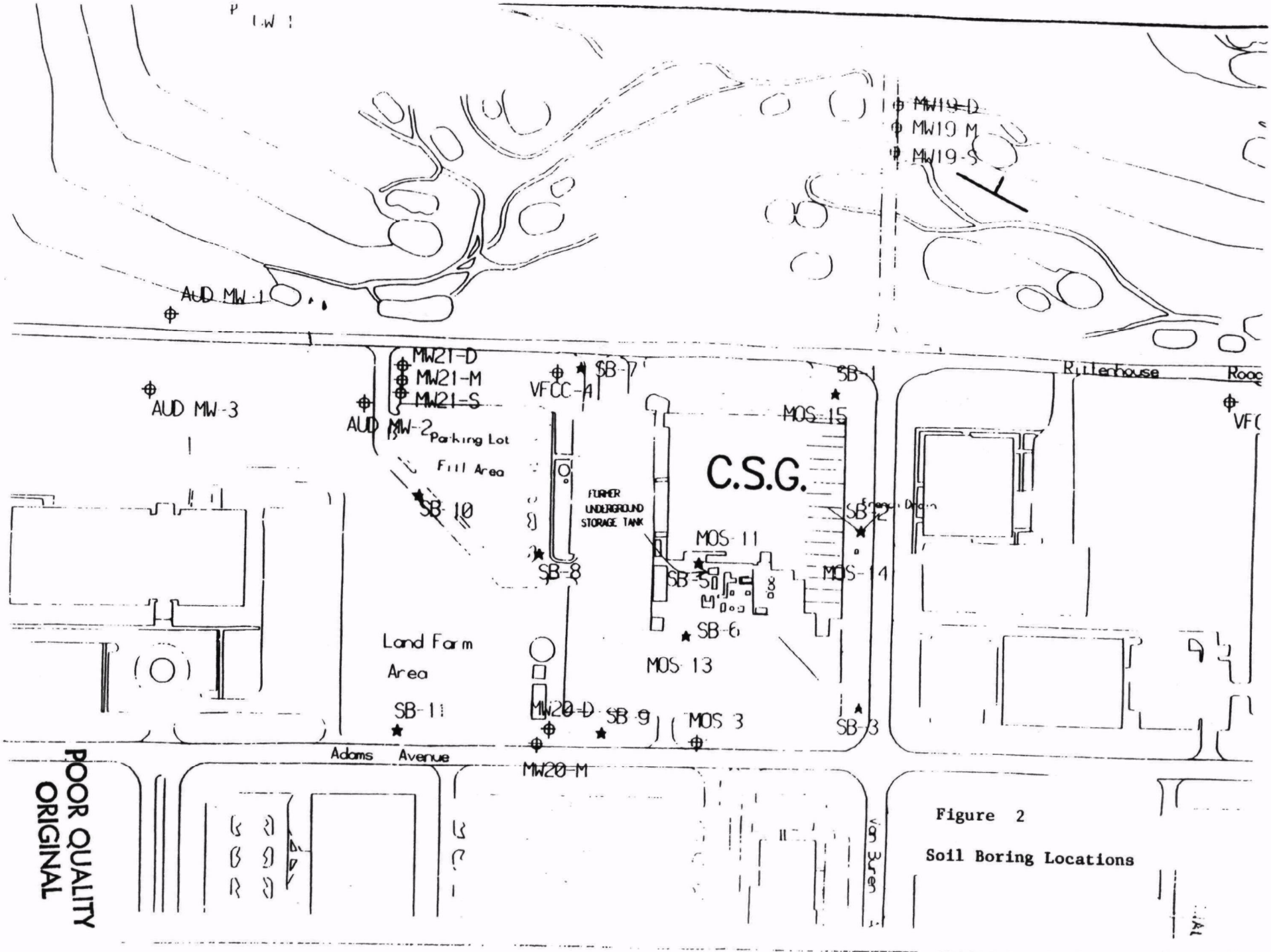


Figure 2

Soil Boring Locations

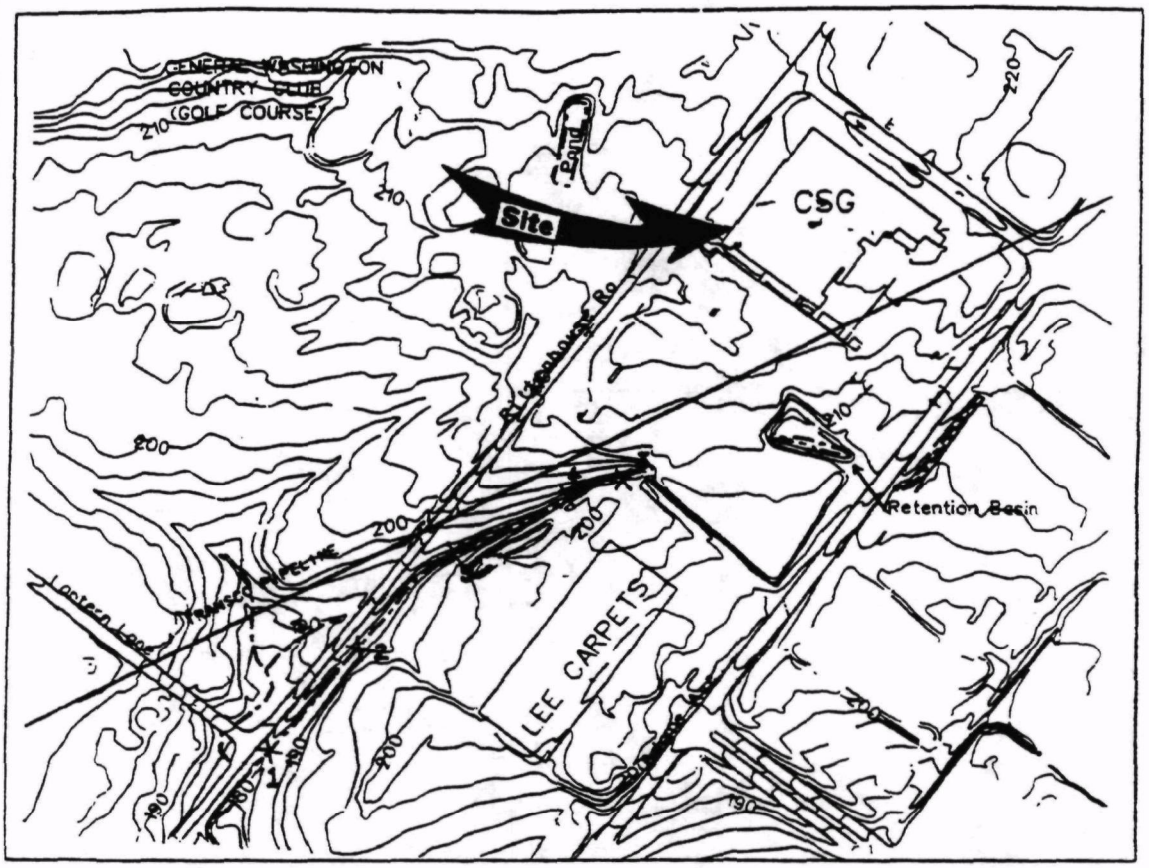


FIGURE 3 · LOCATIONS & RESULTS OF SURFACE WATER SAMPLING

	Analytical Results (in ppb.)		
	1,2-DCE	TCE	PCE
•1	6.7	6.3	1.8
•2	9.3	8.3	2.5
•3	4.5		
•4	3.7		
•5	2.9		

LEGEND

——— 2 ft. Contours

—·—·— Intermittent Stream

0 100 200
FEET

N

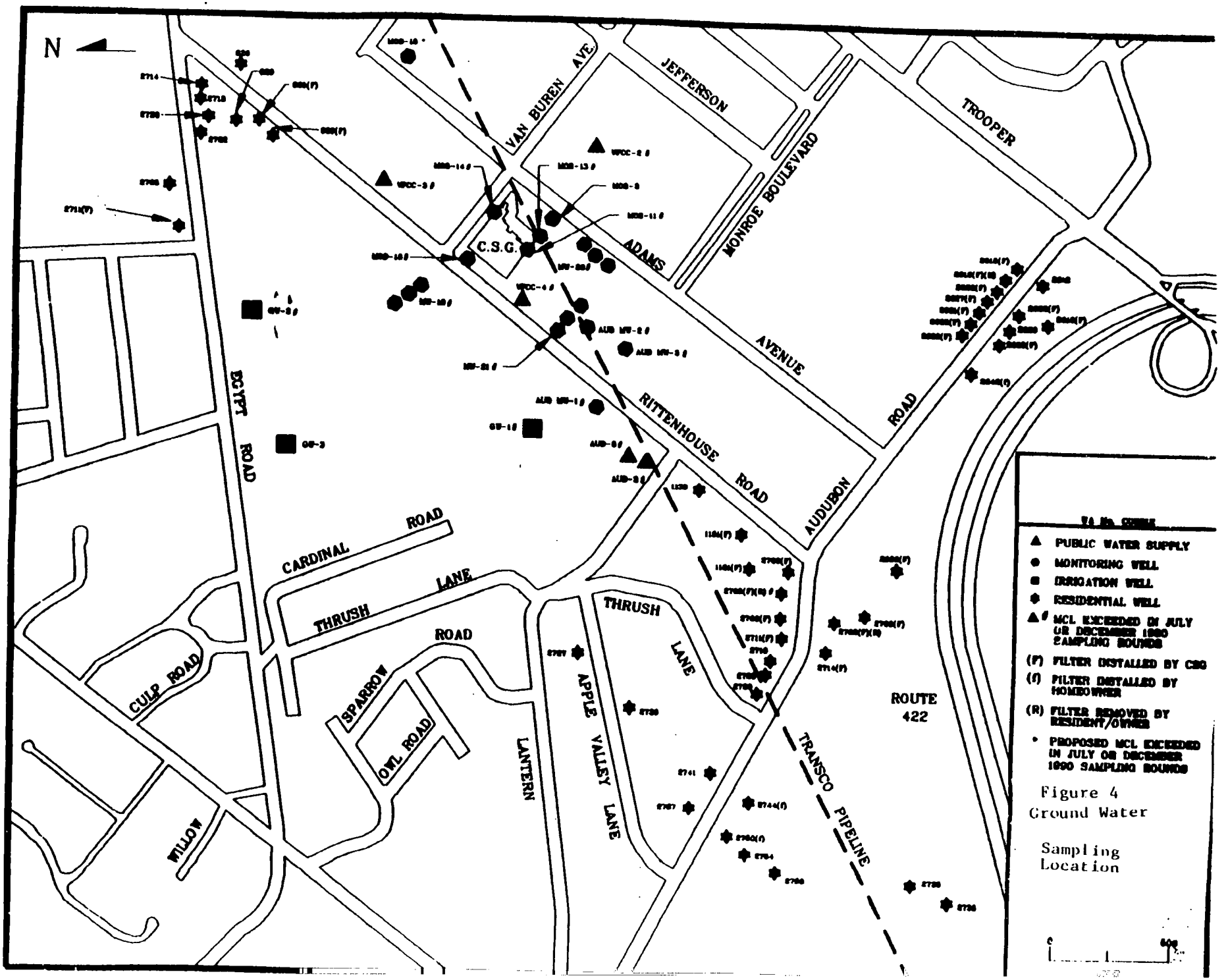
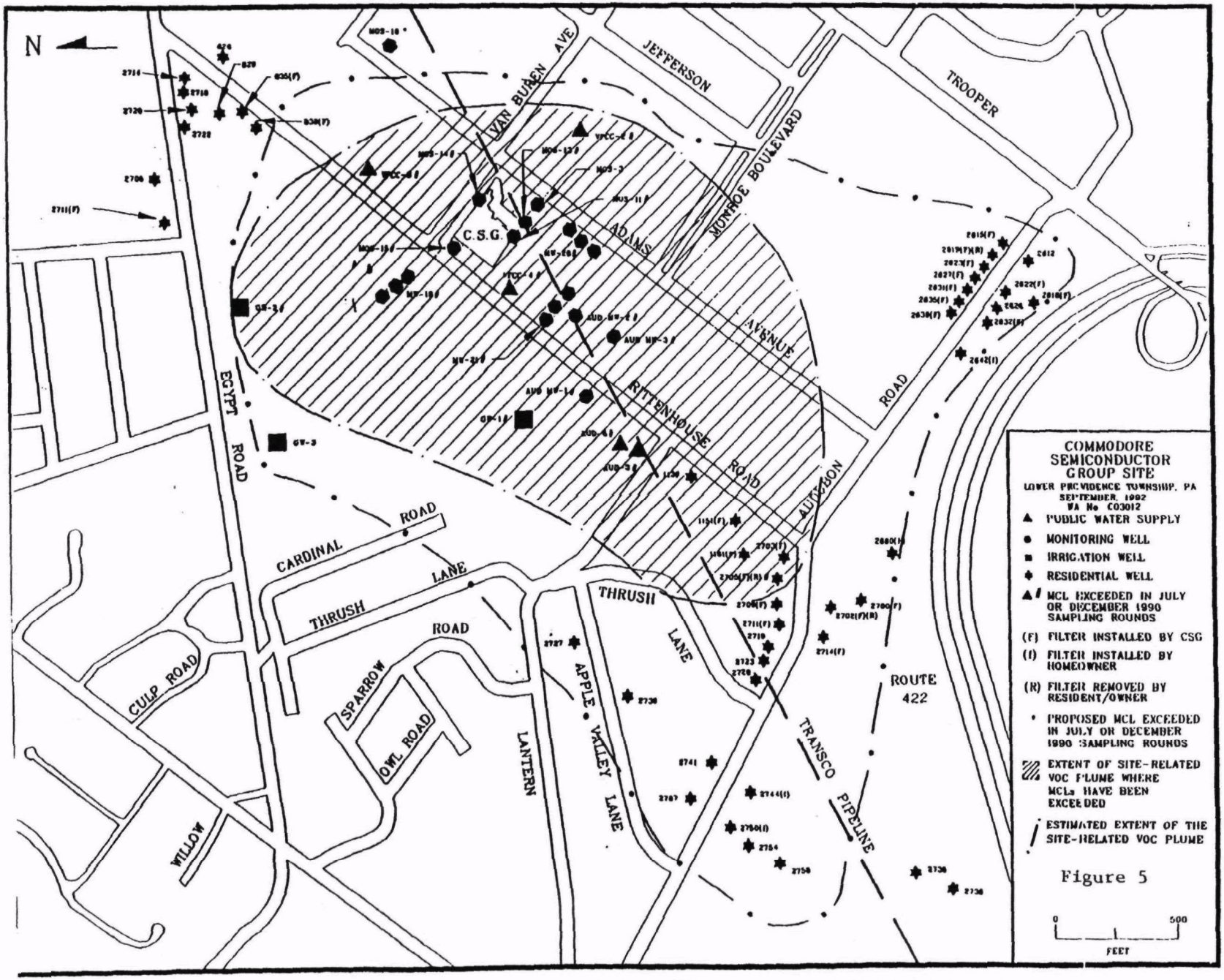


Figure 4
Ground Water

Sampling
Location



Note The estimated site-related VOC Plume as represented is a broad estimation of the two maps included in Figure 4-10 of the RI/FS Report (i.e. this estimation takes into account that the limit of detection of the analytical methods is less than 5 ppb as arbitrarily depicted in Figure 4-10).

Note The site related MCL exceedance plume as represented is a broad estimation of where MCLs for various VOCs have been met or exceeded. This plume is based on analytical well sampling data collected during the June 1990 and December 1990

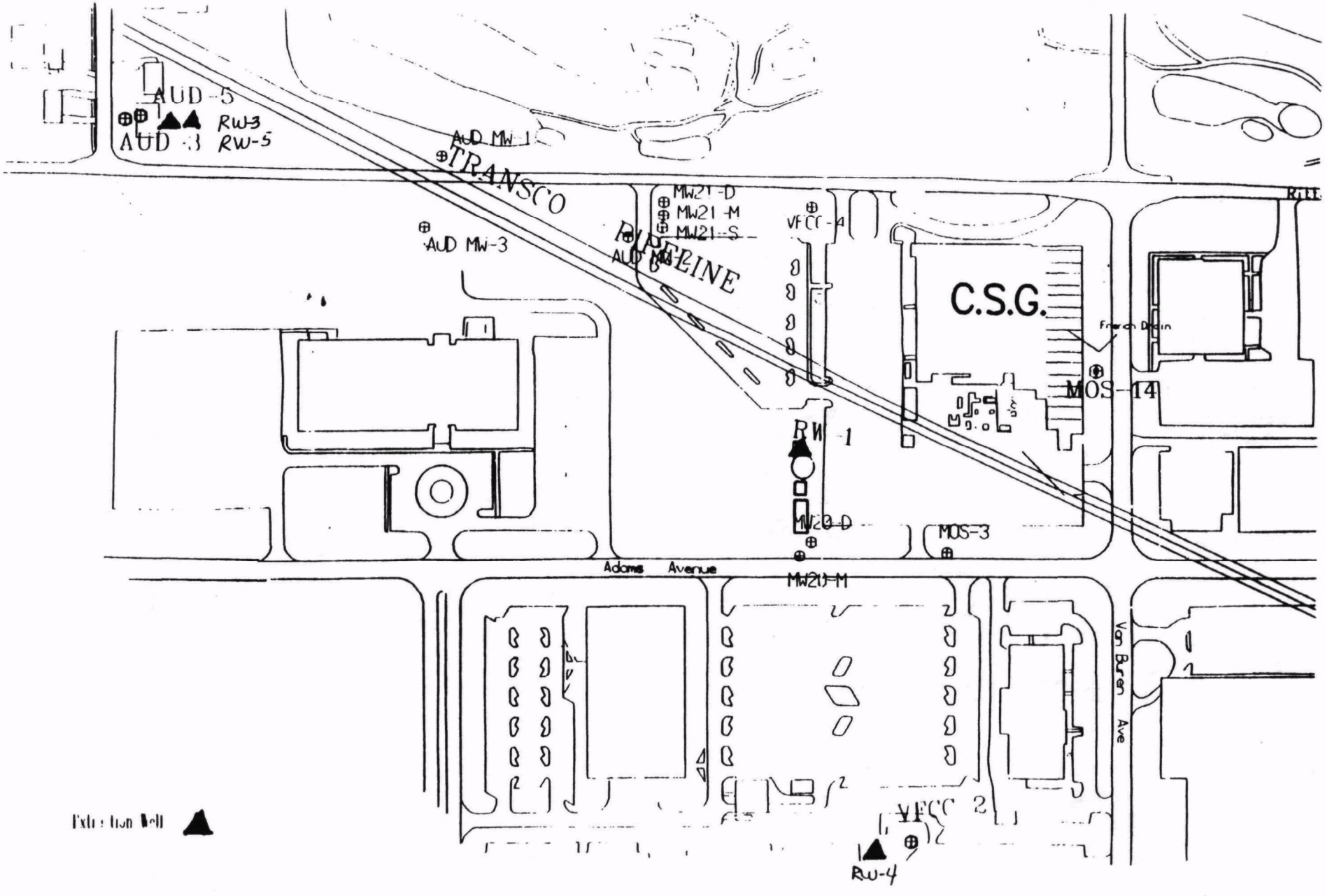

AUD-5
RW-3
AUD-3
RW-5
AUD MW-1
TRANSCO
MW21-D
MW21-M
MW21-S
VFCC-4
AUD MW-3
AUD MW-2
PIPELINE
C.S.G.
Front Drain
MOS-14
RW-1
MW20-D
MOS-3
Adams Avenue
MW21-M
Van Buren Ave
VFCC 2
RW-4
Extraction Well

Figure 6

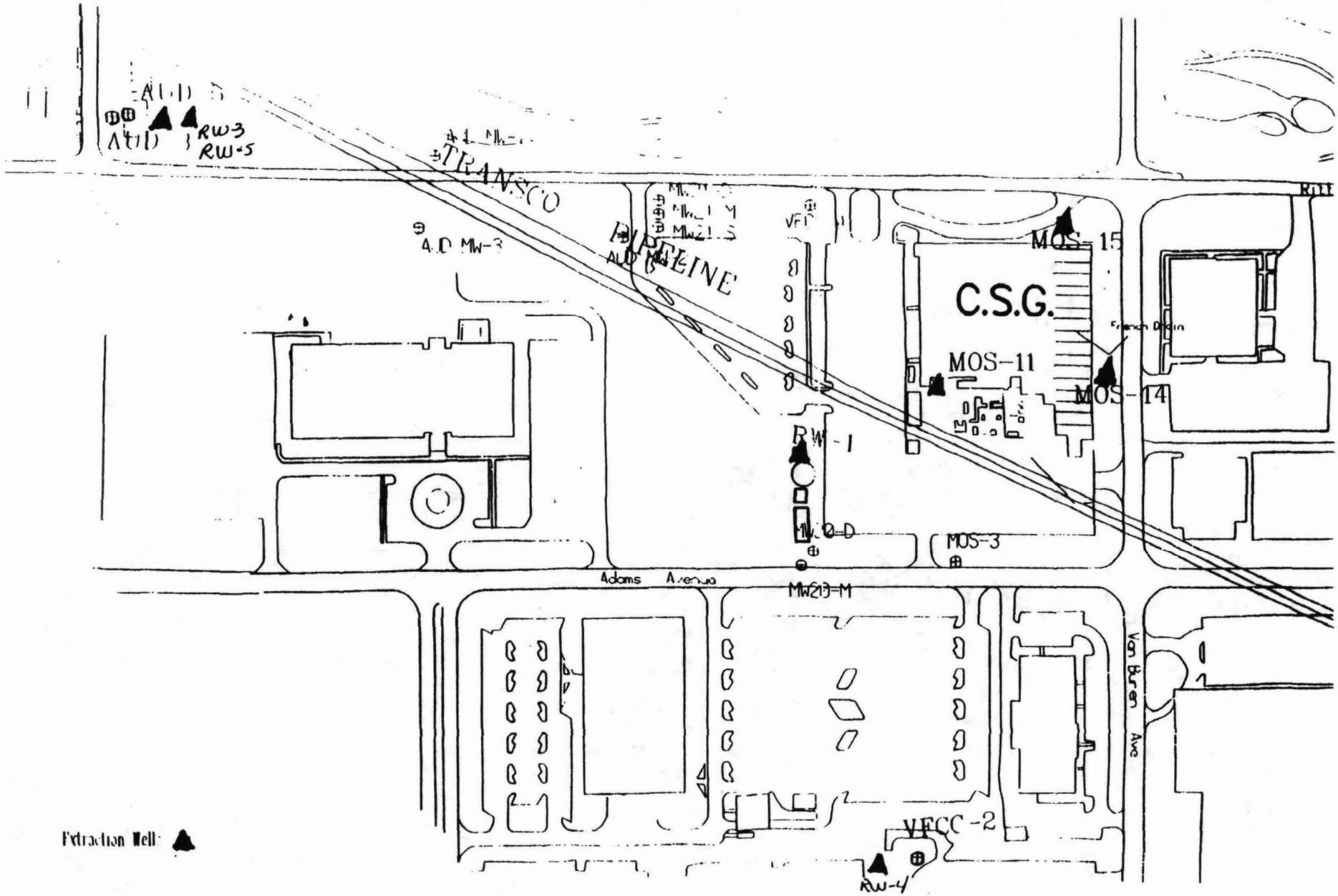


Figure 7

GROUNDWATER EXTRACTION/COLLECTION SYSTEM FOR ALTERNATIVE 4

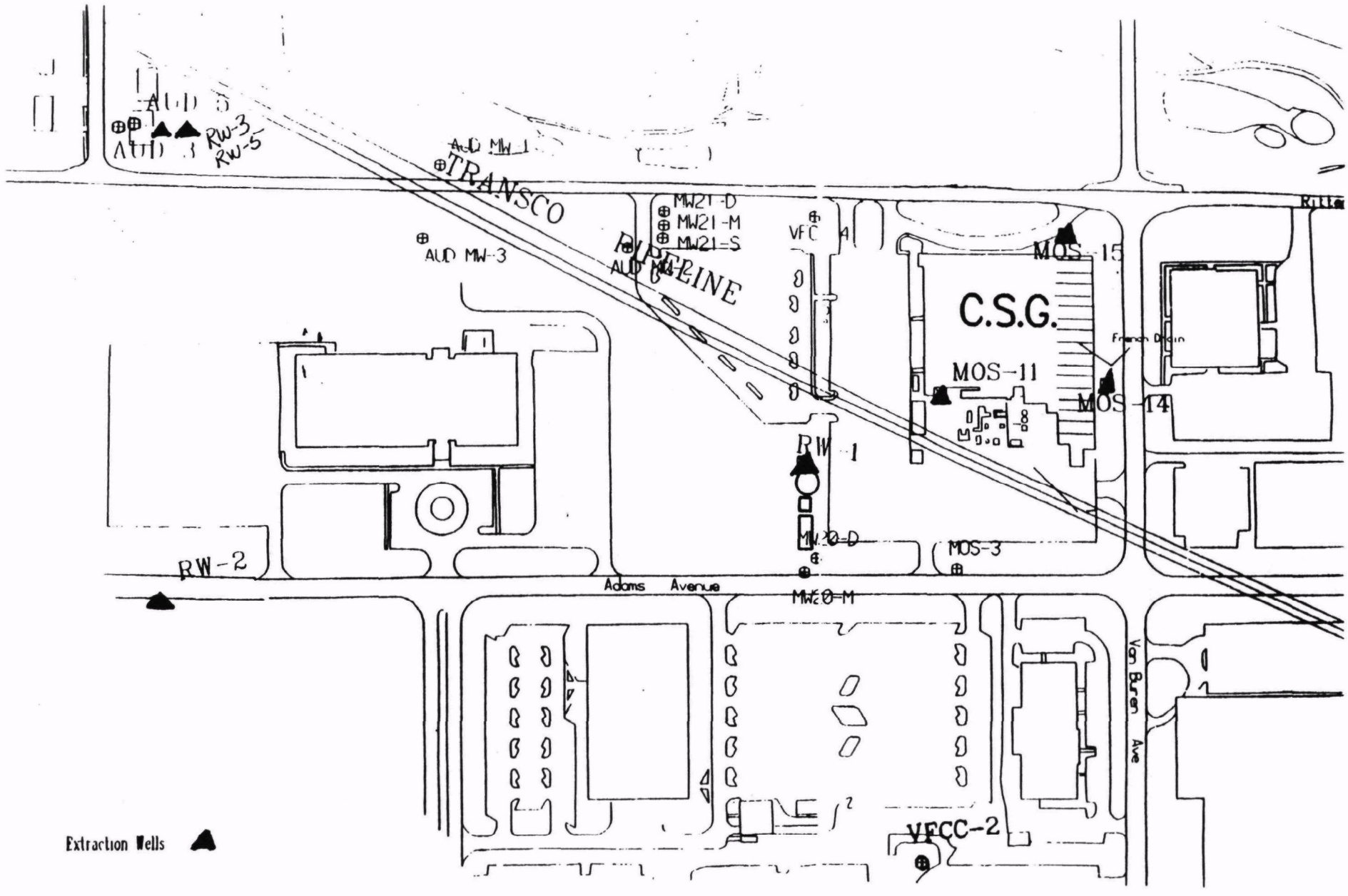


Figure 8

GROUNDWATER EXTRACTION/COLLECTION SYSTEM FOR ALTERNATIVE 5

APPENDIX B TABLES

Table 1

Depth to Water Measurements and Saturated Thickness of the Overburden CSG Site, 1990

DATE	Well I.D. El (BGS) TD	SB-1 217.05 15.00	SB-2 219.42 20.90	SB-3 217.06 9.80	SB-5 215.77 11.50	SB-6 215.17 9.90	SB-7 211.98 11.40	SB-8 212.86 11.40	SB-9 208.20 22.70	SB-10 210.05 7.00	SB-11 202.86 6.10	MW-19S* 226.70 21.00	MW-21S 211.44 11.00
30-Mar-90	DTW	14.25	19.35	dry	8.67	dry	10.02	dry	20.15	NA	dry	NI	dry
	GW ELEV	202.80	200.07	--	207.10	--	201.96	--	188.05	--	--		--
	Sat. Thick	0.75	1.55	--	2.83	--	1.38	--	2.55	--	--		--
05-Jun-90	DTW	11.64	19.30	dry	8.75	dry	9.78	dry	20.23	NA	dry	NI	dry
	GW ELEV	205.41	200.12	--	207.02	--	202.20	--	187.97	--	--		--
	Sat. Thick	3.36	1.60	--	2.75	--	1.62	--	2.47	--	--		--
21-Jun-90	DTW	9.96	18.98	dry	8.06	dry	9.14	dry	19.98	NA	dry	NI	dry
	GW ELEV	207.09	200.44	--	207.71	--	202.84	--	188.22	--	--		--
	Sat. Thick	5.04	1.92	--	3.44	--	2.26	--	2.72	--	--		--
10-Jul-90	DTW	11.75	19.31	dry	5.87	dry	9.79	11.30	dry	NA	dry	NI	dry
	GW ELEV	205.30	200.11	--	209.90	--	202.19	201.56	--	--	--		--
	Sat. Thick	3.25	1.59	--	5.63	--	1.61	0.10	--	--	--		--
24-Jul-90	DTW	12.55	19.51	dry	5.57	dry	9.41	--	20.47	NA	dry	NI	dry
	GW ELEV	204.50	199.91	--	210.20	--	202.57	--	187.73	--	--		--
	Sat. Thick	2.45	1.39	--	5.93	--	1.99	--	2.23	--	--		--
16-Aug-90	DTW	14.40	19.62	dry	6.20	dry	10.45	dry	22.20	dry	dry	NI	dry
	GW ELEV	202.65	199.80	--	209.57	--	201.53	--	186.00	--	--		--
	Sat. Thick	0.60	1.28	--	5.30	--	0.95	--	0.50	--	--		--
29-Aug-90	DTW	dry	19.94	dry	5.81	dry	10.56	dry	22.13	dry	dry	NI	dry
	GW ELEV	--	199.48	--	209.96	--	201.42	--	186.07	--	--		--
	Sat. Thick	--	0.96	--	5.69	--	0.84	--	0.57	--	--		--
10-Sep-90	DTW	14.80	20.10	dry	6.10	dry	10.80	dry	22.50	dry	dry	NI	dry
	GW ELEV	202.25	199.32	--	209.67	--	201.18	--	185.70	--	--		--
	Sat. Thick	0.20	0.80	--	5.40	--	0.60	--	0.20	--	--		--
28-Sep-90	DTW	dry	20.00	dry	8.80	dry	10.80	dry	dry	dry	dry	NI	dry
	GW ELEV	--	199.42	--	206.97	--	201.18	--	--	--	--		--
	Sat. Thick	--	0.90	--	2.70	--	0.60	--	--	--	--		--
26-Oct-90	DTW	dry	20.00	dry	8.75	dry	11.05	dry	dry	dry	dry	NI	dry
	GW ELEV	--	199.42	--	207.02	--	200.93	--	--	--	--		--
	Sat. Thick	--	0.90	--	2.75	--	0.35	--	--	--	--		--
08-Nov-90	DTW	dry	20.17	dry	8.33	dry	10.02	dry	dry	dry	dry	NI	dry
	GW ELEV	--	199.25	--	207.44	--	201.96	--	--	--	--		--
	Sat. Thick	--	0.73	--	3.17	--	1.38	--	--	--	--		--
13-Dec-90	DTW	dry	19.87	dry	8.47	dry	9.92	dry	20.78	dry	5.20	NI	dry
	GW ELEV	--	199.55	--	207.30	--	202.06	--	187.42	--	197.66		--
	Sat. Thick	--	1.03	--	3.03	--	1.48	--	1.92	--	0.90		--
31-Jan-91	DTW	13.82	18.90	dry	8.90	dry	9.22	dry	20.47	dry	dry	14.49	dry
	GW ELEV	203.23	200.52	--	206.87	--	202.76	--	187.73	--	--	212.21	
	Sat. Thick	1.18	2.00	--	2.60	--	2.18	--	2.23	--	--	6.51	
22-Feb-91	DTW	13.40	19.20	dry	8.80	dry	Note	dry	20.40	5.20	dry	15.60	dry
	GW ELEV	203.65	200.22	--	206.97	--	--	--	187.80	204.85	--	211.10	--
	Sat. Thick	1.60	1.70	--	2.70	--	--	--	2.30	1.80	--	5.40	--
01-Apr-91	DTW	11.88	18.48	dry	5.53	dry	8.21	dry	20.04	dry	dry	12.14	9.89
	GW ELEV	205.17	200.99	--	210.24	--	203.77	--	188.16	--	--	214.56	201.55
	Sat. Thick	3.12	2.47	--	5.97	--	3.19	--	2.66	--	--	8.86	1.11

* MW-19S was completed in December 1990
TD is at top of bedrock
DTW - Depth to Water
GWEL - Groundwater Elevation
Sat. Thick - Saturated Thickness.
Note - Surface runoff ran into well.
NI - Not installed at this date

Table 2

OVA Readings
CSG Site, 1990–91

	Date								
	6/21/90	7/10/90	8/16/90	8/29/90	9/28/90	10/26/90	11/8/90	1/31/91	3/21/91
Sampling point									
SB–1	2.1	NA	BKG	BKG	2.6	BKG	3.0	BKG	BKG
SB–2	60.0	NA	20.0	11.0	8	BKG	20.0	BKG	9.8
SB–3	BKG	NA	BKG	BKG	BKG	BKG	BKG	NA	BKG
SB–5	30.0	20.0	10.0	4.0	8	BKG	9.5	10.0	NA
SB–6	NA	>1000	>100	2.0	4	BKG	2.0	5.6	BKG
SB–7	0.4	NA	BKG	BKG	10.2	BKG	1.1	BKG	NA
SB–8	300.0	10.0	>100	100.0	>100	NA	52.0	100.0	15
SB–9	BKG	15.0	>100	50.0	4	30.0	110.0	>10.0	150
SB–10	5.0	NA	NA	>1000	BKG	NA	>1000	40	4
SB–11	BKG	NA	BKG	BKG	BKG	BKG	BKG	BKG	NA
MOS–3	NA	NA	NA	BKG	BKG	NA	1.2	2.0	BKG
MOS–11	20.0	NA	BKG	BKG	BKG	BKG	BKG	BKG	NA
MOS–13	NA	60.0	20.0	8.0	NA	50.0	60.0	90.0	>600
MOS–14	2.8	NA	BKG	BKG	BKG	BKG	1.2	BKG	NA
MOS–15	1.8	NA	BKG	BKG	BKG	70.0	56.0	2.4	75
MOS–18	BKG	NA	BKG	BKG	BKG	BKG	BKG	BKG	BKG
MW–19S	NA	NA	NA	NA	NA	NA	NA	BKG	BKG
MW–19M	NA	NA	NA	NA	NA	NA	NA	BKG	BKG
MW–19D	NA	NA	NA	NA	NA	NA	NA	0.4	BKG
MW–20M	BKG	BKG	BKG	BKG	NA	BKG	BKG	BKG	BKG
MW–20D	BKG	BKG	BKG	BKG	NA	BKG	BKG	1.5	BKG
MW–21S	1.0	1.3	>100	BKG	BKG	NA	1.0	BKG	2.5
MW–21M	BKG	BKG	BKG	BKG	NA	NA	0.4	>120	NA
MW–21D	BKG	BKG	20.0	0.0	18	NA	1.0	2.9	BKG
AUD MW–1	0.6	NA	NA	BKG	NA	NA	BKG	BKG	NA
AUD MW–2	BKG	BKG	2.0	BKG	NA	NA	BKG	BKG	5
AUD MW–3	NA	3.2	NA	BKG	NA	NA	BKG	1.5	15
AUD 3	20.0	NA	NA	NA	NA	NA	NA	NA	NA
AUD 5	10.0	NA	NA	NA	NA	NA	NA	NA	NA
VFCC–2	BKG	NA	NA	NA	NA	NA	NA	NA	NA
VFCC–3	40.0	NA	NA	NA	NA	NA	NA	NA	NA
VFCC–4	2.0	NA	NA	BKG	NA	BKG	BKG	NA	5

Readings in parts per million (ppm).
Background values ranged from .4 to .7 ppm in the ambient air before opening the well or soil boring.
Values have been compensated for background.
NA – Not available.

COMMODORE SEMICONDUCTOR GROUP SITE
LOWER PROVIDENCE TOWNSHIP, PENNSYLVANIA
SUMMARY OF GROUNDWATER ANALYSES, 1989-1990 (5 TOTAL SAMPLING ROUNDS INCLUDED)

COMPOUND	AVERAGE DETECTED CONCENTRATION	MAXIMUM DETECTED CONCENTRATION	NUMBER OF DETECTIONS	NUMBER OF NON-DETECTIONS
PRIMARY CONTAMINANTS OF CONCERN				
VINYL CHLORIDE	13.96	24	10	192
1,1-DICHLOROETHENE	15.51	122	58	144
1,1-DICHLOROETHANE	3.34	12	58	144
1,2-DICHLOROETHENE	338.48	4100	82	120
CHLOROFORM	6.88	24	58	144
1,2-DICHLOROETHANE	25.07	110	10	192
1,1,1-TRICHLOROETHANE	13.55	99	117	85
BROMODICHLOROETHANE	2.42	4.6	3	199
TRICHLOROETHENE	148.52	1800	110	92
TETRACHLOROETHENE	23.36	280	47	155
1,2-DICHLOROBENZENE	288.14	1400	16	186
1,4-DICHLOROBENZENE	12.1	17	4	198
OTHER CONTAMINANTS				
TRICHLOROFLUOROMETHANE	2.50	4.4	6	196
BROMOFORM	4.7	4.7	1	201
1,1,2,2-TETRACHLOROETHANE	1.2	1.4	2	200
CHLOROBENZENE	1.1	1.1	1	201
1,3-DICHLOROBENZENE	2.6	2.6	1	201
ETHYLBENZENE	108.36	300	5	168
TOLUENE	2.35	4.2	4	169
XYLENE	273.44	620	5	168

All results are listed in micrograms per liter (µg/L) or parts per billion (ppb).

NA = Not analyzed during sampling round.
ND = Not detected above method limit of detection.
J = Compound present below the method limit of detection
B = Compound present in laboratory blank

ORIGINAL (Red)

COMMODORE SEMICONDUCTOR GROUP SITE
LOWER PROVIDENCE TOWNSHIP, PENNSYLVANIA
WELLS WITH MAJOR MAXIMUM CONTAMINANT LEVEL (MCL) AND PROPOSED MCL (PMCL) EXCEEDANCE
1990 SAMPLING EVENTS (ONLY VALIDATED DATA INCLUDED)

WELL NO.	DATE	CONTAMINANTS EXCEEDING MCL				CONTAMINANTS EXCEEDING PMCL		
		TCE (MCL = 5 ppb)	1,1-DCE (MCL = 7 ppb)	1,2-DCA (MCL = 5 ppb)	Vinyl Chloride (MCL = 2 ppb)	1,2-DCE (PMCL = 70 ppb/cis 100 ppb/trans)	PCE (PMCL = 5 ppb)	1,2-DCB (PMCL = 600 ppb)
2705 Audubon	08/03/90	5.7 ppb	-	-	-	-	-	-
MOS - 11	07/24/90	390 ppb	14 ppb	-	-	280 ppb	30 ppb	-
	12/31/90	250 ppb	8 ppb	-	-	130 ppb	27 ppb	-
MOS - 13	07/23/90	27 ppb	-	-	-	-	35 ppb	-
	12/20/90	540 ppb	-	-	2.2 ppb	1900 ppb	74 ppb	-
MOS - 14	07/25/90	120 ppb	-	-	-	4100 ppb	-	1400 ppb
	12/17/90	60 ppb	-	-	-	2500 ppb	-	760 ppb
MOS - 15	07/26/90	580 ppb	43 ppb	-	-	570 ppb	-	-
	12/18/90	860 ppb	120 ppb	-	8.1 ppb	510 ppb	-	-
MOS - 18	07/23/90	-	-	-	-	-	5.2 ppb	-
	12/20/90	-	-	-	-	-	-	-
MW - 19S	01/31/91	27 ppb	-	-	-	-	-	-
MW - 19D	07/10/90	24 / 18 ppb	-	-	-	-	-	-
MW - 20D	07/26/90	13 ppb	-	-	-	-	-	-
	12/18/90	17 ppb	-	-	-	-	-	-
MW - 21D	07/26/90	340 ppb	17 ppb	-	-	220 ppb	14 ppb	-
	12/18/90	540 / 480 ppb	25 / 25 ppb	-	-	220 / 200 ppb	21 / 21 ppb	-
MW - 1	07/25/90	130 / 160 ppb	-	-	11 / 12 ppb	2000 / 2000 ppb	31 / 31 ppb	-
	12/20/90	490 ppb	-	-	14 ppb	2200 ppb	57 ppb	-
MW - 2	07/24/90	340 ppb	16 ppb	-	-	160 ppb	17 ppb	-
	12/20/90	640 ppb	39 ppb	-	-	220 ppb	18 ppb	-

U.S. ENVIRONMENTAL PROTECTION AGENCY
SOURCE: 1992 RI/FS Report, Appendix E

Prepared by Dynamac Corporation
MCLEXC.TBl
Page 1 of 2

COMMODORE SEMICONDUCTOR GROUP SITE (Continued)

WELL NO.	DATE	CONTAMINANTS EXCEEDING MCL				CONTAMINANTS EXCEEDING PMCL		
		TCE (MCL = 5 ppb)	1,1-DCE (MCL = 7 ppb)	1,2-DCA (MCL = 5 ppb)	Vinyl Chloride (MCL = 2 ppb)	1,2-DCE (PMCL = 70 ppb/cis 100 ppb/trans)	PCE (PMCL = 5 ppb)	1,2-DCB (PMCL = 600 ppb)
MW - 3	07/25/90	28 ppb	-	-	-	-	-	-
	12/21/90	79 ppb	-	-	-	210 ppb	19 ppb	-
VFCC - 2	07/25/90	7.4 ppb	-	-	-	-	-	-
VFCC - 3	07/27/90	24 ppb	-	-	-	-	-	-
	12/19/90	26 / 32 ppb	-	-	-	-	-	-
VFCC - 4	07/27/90	150 ppb	-	-	-	-	5.0 ppb	-
	12/19/90	290 ppb	8.7 ppb	-	-	130 ppb	11 ppb	-
AUD - 3	07/27/90	16 ppb	-	-	-	-	-	-
AUD - 5	07/27/90	15 ppb	-	-	-	-	-	-
	12/19/90	32 ppb	-	-	-	-	-	-
GW - 1	07/23/90	57 ppb	-	-	-	-	-	-
GW - 2	08/03/90	31 ppb	9.2 ppb	-	-	-	-	-
French Drain	08/03/90	740 ppb	16 ppb	-	2.2 ppb	1500 ppb	-	-
	12/20/90	650 ppb	13 ppb	-	-	1300 ppb	-	-

NOTES:

TCE	=	Trichloroethylene (Trichloroethene)
1,1-DCE	=	1,1-Dichloroethylene (1,1-Dichloroethene)
1,2-DCA	=	1,2-Dichloroethane
1,2-DCE	=	1,2-Dichloroethylene (1,2-Dichloroethene)
PCE	=	Tetrachloroethylene (Tetrachloroethene)
1,2-DCB	=	1,2-Dichlorobenzene
# / # ppb	=	duplicate sample analyses results
-	=	contaminant was not detected at, or above the MCL or PMCL

Table 4 cont'd

Table 5

Comparison of Compounds of Potential Concern in Soil to Risk-Based Concentrations

	Maximum Detected Concentration (mg/kg)	Risk-Based Concentration (mg/kg)
Organics		
Carbon Tetrachloride	0.0078	11.3
1,2-Dichlorobenzene	0.011	92,000
1,2-Dichloroethene	0.005	20,400
Tetrachlorethane	0.0059	35
1,2,4-Trichlorobenzene	0.04	1,340
Trichloroethene	0.016	163
Inorganics		
Aluminum	9,110	2,960,000
Arsenic	2[a]	1.02
Barium	75.1	72,000
Beryllium	1.2[a]	0.42
Chromium	8.3	5,100[b]
Copper	8	38,000
Iron	11,900	--[d]
Lead	3.3	143[c]
Magnesium	1,020	--[d]
Manganese	518	5,100
Potassium	958	--[d]
Silver	3	3,070
Vanadium	17.7	7,200
Zinc	9.7	204,000

[a]Exceeds risk-based concentration.
[b]Based on Cr VI, which is lower than Cr III.
[c]Based on lead as carcinogen, which is lower than noncarcinogenic endpoint.
[d]No number listed.

Table 6

Comparison of Compounds of Potential Concern in Surface Water to Risk-Based Concentrations

	Maximum Detected Concentration (µg/l)	Risk-Based Concentration (µg/l)
Organics		
trans-1,2-Dichloroethene	9.3	89
Tetrachloroethane	2.5*	1.36
Trichloroethene	8.3*	0.64

*Exceeds risk-based concentration.

Table 7

Compounds of Potential Concern in Residential Wells

Organics	Frequency of Detection	Concentration Range (µg/l)	Arithmetic Mean (µg/l)	Standard Deviation (µg/l)	Upper 95% Concentration (µg/l)*
Chloroform	29/52	1.1-22	3.49	5.16	4.94
1,2-Dichlorobenzene	1/52	1.4*	0.51	0.08	0.53
1,4-Dichlorobenzene	1/52	17*	0.74	1.37	1.12
1,1-Dichloroethane	7/52	0.47-2.6	0.71	0.48	0.84
1,1-Dichloroethene	4/52	0.87-1.3	0.53	0.10	0.56
1,2-Dichloroethene	15/52	0.82-8.1	1.18	1.61	1.64
Methylene chloride	4/52	6.4-8.3	2.42	1.35	2.80
Tetrachloroethene	4/52	0.32-1.3	0.49	0.11	0.52
1,1,1-Trichloroethane	27/52	0.91-7.8	1.85	1.73	2.34
Trichloroethene	18/52	0.29-5.7	0.96	1.10	1.27
Trichlorofluoromethane	1/52	2.4*	1.02	0.12	1.05

*Detected only once. Concentration represents only detected value.

Table 7 cont'd

(continued)

IARC Categorization of Carcinogens (IARC, 1987)

Group 1	-	Human carcinogen (sufficient evidence of carcinogenicity in humans).
Group 2A	-	Probable human carcinogen (limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals).
Group 2B	-	Possible human carcinogen (limited evidence of carcinogenicity in humans and insufficient evidence of carcinogenicity in experimental animals; insufficient evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals; or insufficient evidence of carcinogenicity in humans and limited evidence of carcinogenicity in experimental animals, with supporting evidence from other relevant data).
Group 3	-	Not classifiable (substances in this category do not fall into any other category).
Group 4	-	Probably not carcinogenic to humans.

Table 8

Compounds of Potential Concern in Residential Public Supply Wells

Organics	Frequency of Detection	Concentration Range (µg/l)	Arithmetic Mean (µg/l)	Standard Deviation (µg/l)	Upper 95% Concentration (µg/l)
1,1-Dichloroethane	3/3	2.6-2.8	2.13	0.67	5.12
1,1-Dichloroethene	3/3	1.6-1.9	1.73	0.04	1.91
1,2-Dichloroethene	3/3	17-21	19	0	19
1,1,1-Trichloroethane	3/3	1.8-2.9	2.60	0.42	4.48
Trichloroethene	3/3	15-32	19.75	5.30	43.41

Table 9

ORIGINAL (Red)

Compounds of Potential Concern in Corporate Park Supply Wells

Organics	Frequency of Detection	Concentration Range (µg/l)	Arithmetic Mean (µg/l)	Standard Deviation (µg/l)	Upper 95% Concentration (µg/l)
Chloroform	1/3	1.8*	1.15	0.92	5.23
1,1-Dichloroethane	2/3	1.5-3.2	1.43	1.31	7.28
1,1-Dichloroethene	3/3	1.6-4.25	2.74	1.61	9.93
1,2-Dichloroethene	3/3	1.05-6.7	4.09	3.69	20.56
Tetrachloroethene	2/3	2.1	1.30	1.13	6.35
1,1,1-Trichloroethane	3/3	1.9-11	6.40	6.36	37.80
Trichloroethene	3/3	7.4-29	16.95	13.51	77.27

*Only detected value.

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Table 10

Compounds of Potential Concern in GWCC Water Supply Well

Organics	Frequency of Detection	Concentration Range (µg/l)	Arithmetic Mean (µg/l)	Standard Deviation (µg/l)	Upper 95% Concentration (µg/l)
Bromodichloromethane	1/2	0.16[a]	0.33	0.24	-[b]
Chloroform	1/2	3.3[a]	1.90	1.98	-
Trichloroethene	1/2	0.16[a]	0.33	0.24	-

[a]Detected only once. Concentration represents only detected value.
[b]Sample size is too small to calculate.

Table 11

Compounds of Potential Concern in GWCC Irrigation and Monitoring Wells

Organics	Frequency of Detection	Concentration Range (µg/l)	Arithmetic Mean (µg/l)	Standard Deviation (µg/l)	Upper 95% Concentration (µg/l)
Bis(2-ethylhexyl)phthalate	1/1	4[a]	4	-[b]	-[b]
1,1-Dichloroethane	2/4	1.6-3.1	1.6	0.83	2.57
1,1-Dichloroethene	3/4	4.1-9.2	4.63	3.15	8.38
1,2-Dichloroethene	2/4	6.4-65	17.88	31.44	54.87
Dimethylphthalate	1/1	5[a]	5	-[b]	-[b]
Di-n-Butylphthalate	1/1	4.5[a]	4.5	-[b]	-[b]
Tetrachloroethene	2/4	1.6-2.1	1.54	0.92	2.62
Toluene	1/4	4.5[a]	1.5	1.15	2.86
1,1,1-Trichloroethane	3/4	5-25	10.73	10.07	22.57
Trichloroethene	3/4	4.8-57	25.85	23.87	53.94
Pesticides/PCBs					
Not detected	0/1	-	-	-	-

[a]Detected only once. Concentration represents only detected value.
[b]Sample size too small to calculate.

ORIGINAL (Red)

Table 12

Compounds of Potential Concern in VFCC-4 and the Deep Monitoring Wells

Organics	Frequency of Detection	Concentration Range (µg/l)	Arithmetic Mean (µg/l)	Standard Deviation (µg/l)	Upper 95% Concentration (µg/l)
Chloroform	1/12	2.2[a]	1.35	1.26	2.39
1,1-Dichloroethane	6/12	1.9-12	4.44	3.88	7.63
1,2-Dichloroethane	1/12	2.8[a]	1.40	1.27	2.44
1,1-Dichloroethene	10/12	1.4-39	11.37	10.86	20.30
1,2-Dichloroethene	12/12	1.3-280	101.5	91.65	176.89
Methylene chloride	2/12	20-23	5.25	5.06	9.41
Tetrachloroethene	12/12	3.8-30	14.54	8.59	21.61
1,1,1-Trichloroethane	12/12	1.3-51	18.99	17.85	33.67
Trichloroethene	12/12	13-640	253.92	193.79	413.33
Inorganics					
Barium	1/1	415[a]	-	-	-
Calcium	1/1	55,500[a]	-	-	-
Magnesium	1/1	21,600[a]	-	-	-
Sodium	1/1	16,500[a]	-	-	-
Pesticides/PCBs					
Not detected	-	-	-	-	

[a]Detected only once. Concentration represents only detected value.

ORIGINAL (Red)

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Table 13

Human Exposure Scenarios -- Potential Exposure Routes

	Exposure Scenarios						
Exposure Routes	Resident-Private Well Scenario	Resident-Public Well Scenario	GWCC Future Resident Scenario	GWCC Member Scenario	GWCC Worker Scenario	VFCC Worker-Current Use Scenario	VFCC Worker-Future Use Scenario
Drinking water ingestion	X	X	X	X	X	X	X
Inhalation while showering	X	X	X	X			X
Dermal contact while showering	X	X	X	X			X
Inhalation of outdoor air	X	X	X	X	X	X	X
Incidental water ingestion while swimming	X	X	X	X			
Dermal absorption while swimming	X	X	X	X			

Table 14

ORIGINAL (Red)

Reference Doses for Noncarcinogenic Effects (mg/kg-day)

Compound	Chronic Inhalation RfD	Source or Basis	Chronic Oral RfD	Source or Basis	Dermal RfD[b]
Bromodichloromethane	2.00E-02	EPA, 1991b[a]	2.00E-02	EPA, 1991a	1.80E-02
Chloroform	1.00E-02	Oral RfD	1.00E-02	EPA, 1991a	9.00E-03
1,2-Dichlorobenzene	4.00E-02	EPA, 1991b	9.00E-02	EPA, 1991a	NE
1,1-Dichloroethane	1.00E-01	EPA, 1991b	1.00E-01	EPA, 1991a	9.00E-02
1,1-Dichloroethene	9.00E-03	Oral RfD	9.00E-03	EPA, 1991a	8.10E-02
1,2-Dichloroethene	1.00E-02	Oral RfD	1.00E-02[c]	EPA, 1991a	1.80E-02
Tetrachloroethene	1.00E-02		1.00E-02	EPA, 1991a	9.00E-03
1,1,1-Trichloroethane	3.00E-01	EPA, 1991b	9.00E-02	EPA, 1991a	8.10E-02
Trichloroethene	7.40E-03	Oral RfD	7.40E-03	EPA, 1987	6.66E-03
Vinyl chloride	3.71E-03	See text	1.30E-03	See text	1.17E-03

[a] Oral Rfd was used since neither an inhalation RfD nor an OEL were available.
[b] Derived from oral RfD (see Subsection 6.5.3).
[c] Lower of the two RfDs available for cis and trans isomers of 1,2-dichloroethene.
ACGIH-TLV = American Conference of Governmental Industrial Hygienists - Time Weighted Average.
NE = No exposure through this route.

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Table 15

Subchronic Reference Doses for Noncarcinogenic Effects (mg/kg-day)

Compound	Subchronic Inhalation RfD	Source or Basis	Subchronic Oral RfD	Source or Basis	Subchronic Dermal RfD[a]
Bromodichloromethene	2.00E-02	EPA, 1991b	2.00E-02	EPA, 1991a	1.80E-02
Chloroform	1.00E-02	Oral RfD	1.00E-02	EPA, 1991a	9.00E-03
1,2-Dichlorobenzene	4.00E-01	EPA, 1991b	NE	--	NE
1,1-Dichloroethane	1.00E+00	EPA, 1991b	NE	--	NE
1,1-Dichloroethene	9.00E-03	Oral RfD	NE	EPA, 1991a	NE
1,2-Dichloroethene	1.00E-01[b]	Oral RfD	NE	EPA, 1991a	NE
Tetrachloroethene	1.00E-01	Oral RfD	NE	EPA, 1991a	NE
1,1,1-Trichloroethane	3.00E+00	EPA, 1991b	NE	--	NE
Trichloroethene	7.40E-03	Oral RfD	7.40E-03	EPA, 1987	6.66E-03
Vinyl chloride	3.71E-03	See text	NE	--	NE

[a] Subchronic dermal RfDs were calculated from the oral RfDs as described in Subsection 6.5.4.
NE = No exposure through this route.
[b] Lower of the two RfDs available for cis and trans isomers of 1,2-dichloroethene.

ORIGINAL (Red)

EPA and IARC Categorizations of the Carcinogenic Pollutants

Pollutant	EPA[a] Carcinogenicity Category	IARC[b] Carcinogenicity Category
Bromodichloromethane	B2	2B
Chloroform	B2	2B
1,1-Dichloroethane	C	NC
1,2-Dichloroethane	B2	2B
1,1-Dichloroethene	C	NC
Methylene chloride	B2	2B
Tetrachloroethene	B2	2B
Trichloroethene	B2	3
Vinyl chloride	A	1

[a]EPA, 1991a.
[b]IARC, 1987.
NC = Not classified.

Table 17

EPA and IARC Categorizations of Carcinogens Based on Human and Animal Evidence

EPA Categorization of Carcinogens (EPA, 1986)					
	Animal Evidence				
	Sufficient	Limited	Inadequate	No Data	No Evidence
Human Evidence					
Sufficient	A	A	A	A	A
Limited	B1	B1	B1	B1	B1
Inadequate	B2	C	D	D	D
No data	B2	C	D	D	E
No evidence	B2	C	D	D	E

Key:

Group A - Human carcinogen (sufficient evidence from epidemiological studies).

Group B1 - Probable human carcinogen (at least limited evidence of carcinogenicity to humans).

Group B2 - Probable human carcinogen (a combination of sufficient evidence in animals and inadequate data in humans).

Group C - Possible human carcinogen (limited evidence in animals in the absence of human data).

Group D - Not classified (inadequate animal and human data).

Group E - No evidence for carcinogenicity (no evidence for carcinogenicity in at least two adequate animal tests in different species, or in both epidemiological and animal studies).

ORIGINAL (Red)

IARC Categorization of Carcinogens (IARC, 1987)

Group 1	-	Human carcinogen (sufficient evidence of carcinogenicity in humans).
Group 2A	-	Probable human carcinogen (limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals).
Group 2B	-	Possible human carcinogen (limited evidence of carcinogenicity in humans and insufficient evidence of carcinogenicity in experimental animals; insufficient evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals; or insufficient evidence of carcinogenicity in humans and limited evidence of carcinogenicity in experimental animals, with supporting evidence from other relevant data).
Group 3	-	Not classifiable (substances in this category do not fall into any other category).
Group 4	-	Probably not carcinogenic to humans.

Cancer Slope Factors
(mg/kg-day)$^{-1}$

Compound	Inhalation Slope Factor	Source or Basis	Oral Slope Factor	Source or Basis	Dermal Slope Factor[c]
Bromodichloromethane	1.30E-01[a]	EPA, 1991a	1.30E-01	EPA, 1991a	1.44E-01
Chloroform	8.10E-02	EPA, 1991a	6.10E-03	EPA, 1991a	6.78E-03
1,1-Dichloroethane	NFA	--	NFA	--	NFA
1,1-Dichloroethene	1.75E-01[b]	EPA, 1991a	6.00E-01	EPA, 1991a	6.67E-01
Tetrachloroethene	1.80E-03	EPA, 1991a	5.10E-02	EPA, 1991a	NE
Trichloroethene	1.70E-02	EPA, 1991a	1.10E-02	EPA, 1991a	1.22E-02
Vinyl chloride	2.94E-01[b]	EPA, 1991a	1.90E+00	EPA, 1991a	2.11E+00

[a] Oral slope factor used because no inhalation slope factor is available.
[b] Converted from inhalation concentration to CSF assuming breathing rate of 20 m^3/day and body weight of 70 kg.
[c] Dermal slope factors were calculated from oral slope factors as described in Subsection 6.5.5.
NFA = No slope factor available.
NE = No exposure through this route.

ORIGINAL (Red)

Table 19

Private Residential Well Scenario
Child Hazard Quotients and Indices
Chronic Exposure

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
Bromodichloromethane	NA	NA	NA	8.8E-09	NA	NA	8.8E-09
Chloroform	6.4E-03	1.1E-02	1.7E-04	1.3E-06	1.4E-04	4.6E-04	1.8E-02
1,2-Dichlorobenzene	NA	NA	NA	4.7E-09	NA	NA	4.7E-09
1,1-Dichloroethane	NA	NA	NA	7.9E-07	NA	NA	7.9E-07
1,1-Dichloroethene	9.2E-03	1.6E-02	2.0E-04	8.8E-06	2.1E-04	5.5E-04	2.6E-02
1,2-Dichloroethene	4.5E-02	7.6E-02	5.6E-05	8.1E-05	1.0E-03	1.5E-04	1.2E-01
Tetrachloroethene	NA	NA	NA	7.0E-05	NA	NA	7.0E-05
1,1,1-Trichloroethane	NA	NA	NA	4.1E-07	NA	NA	4.1E-07
Trichloroethene	3.7E-02	6.3E-02	1.7E-03	2.3E-05	8.3E-04	4.5E-03	1.1E-01
Vinyl chloride	NA	NA	NA	5.1E-08	NA	NA	5.1E-08
TOTAL	9.8E-02	1.7E-01	2.1E-03	1.9E-04	2.2E-03	5.6E-03	2.7E-01

NA = Compound not detected in the medium.

ORIGINAL (Red)

Table 20

Private Residential Well Scenario
Adult Hazard Quotients and Indices
Chronic Exposure

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
Bromodichloromethane	NA	NA	NA	3.8E-09	NA	NA	3.8E-09
Chloroform	2.7E-03	2.3E-03	9.2E-05	5.7E-07	3.1E-05	2.5E-04	5.4E-03
1,2-Dichlorobenzene	NA	NA	NA	2.0E-09	NA	NA	2.0E-09
1,1-Dichloroethane	NA	NA	NA	3.4E-07	NA	NA	3.4E-07
1,1-Dichloroethene	4.0E-03	3.4E-03	1.1E-04	3.8E-06	4.4E-05	3.0E-04	7.8E-03
1,2-Dichloroethene	1.9E-02	1.6E-02	3.0E-05	3.5E-05	2.1E-04	8.1E-05	3.6E-02
Tetrachloroethene	NA	NA	NA	3.0E-05	NA	NA	3.0E-05
1,1,1-Trichloroethane	NA	NA	NA	1.8E-07	NA	NA	1.8E-07
Trichloroethene	1.6E-02	1.4E-02	9.0E-04	1.0E-05	1.8E-04	2.4E-03	3.3E-02
Vinyl chloride	NA	NA	NA	2.2E-08	NA	NA	2.2E-08
TOTAL	4.2E-02	3.6E-02	1.1E-03	8.0E-05	4.7E-04	3.0E-03	8.2E-02

NA = Compound not detected in the medium.

ORIGINAL (2-4)

Table 21

Public Residential Well Scenario
Child Hazard Quotients and Indices
Chronic Exposure

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
Bromodichloromethane	NA	NA	NA	1.5E-08	NA	NA	1.5E-08
Chloroform	NA	NA	NA	5.4E-06	NA	NA	5.4E-06
1,2-Dichlorobenzene	NA	NA	NA	8.2E-09	NA	NA	8.2E-09
1,1-Dichloroethane	1.0E-03	3.1E-03	3.7E-05	6.7E-07	4.0E-05	9.9E-05	5.0E-03
1,1-Dichloroethene	1.3E-02	2.3E-02	3.0E-04	1.3E-05	3.0E-04	8.0E-04	3.8E-02
1,2-Dichloroethene	1.3E-01	2.3E-01	1.7E-04	8.3E-05	3.0E-03	4.5E-04	3.7E-01
Tetrachloroethene	NA	NA	NA	5.0E-05	NA	NA	5.0E-05
1,1,1-Trichloroethane	2.1E-03	1.1E-03	1.1E-04	6.3E-07	4.6E-05	2.8E-04	3.5E-03
Trichloroethene	2.8E-01	4.7E-01	1.2E-02	7.1E-05	6.2E-03	3.3E-02	8.0E-01
Vinyl chloride	NA	NA	NA	8.9E-08	NA	NA	8.9E-08
TOTAL	4.3E-01	7.3E-01	1.3E-02	2.2E-04	9.5E-03	3.5E-02	1.2E+00

NA = Compound not detected in the medium.

Table 22

Public Residential Well Scenario
Adult Hazard Quotients and Indices
Chronic Exposure

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
Bromodichloromethane	NA	NA	NA	6.6E-09	NA	NA	6.6E-09
Chloroform	NA	NA	NA	2.3E-06	NA	NA	2.3E-06
1,2-Dichlorobenzene	NA	NA	NA	3.5E-09	NA	NA	3.5E-09
1,1-Dichloroethane	7.7E-04	6.6E-04	2.0E-05	2.9E-07	8.5E-06	5.3E-05	1.5E-03
1,1-Dichloroethene	5.8E-03	4.9E-03	1.6E-04	5.5E-06	6.4E-05	4.3E-04	1.1E-02
1,2-Dichloroethene	5.8E-02	4.9E-02	9.1E-05	3.6E-05	6.4E-04	2.4E-04	1.1E-01
Tetrachloroethene	NA	NA	NA	2.1E-05	NA	NA	2.1E-05
1,1,1-Trichloroethane	8.8E-04	2.3E-04	5.7E-05	2.7E-07	9.8E-06	1.5E-04	1.3E-03
Trichloroethene	1.2E-01	1.0E-01	6.7E-03	3.0E-05	1.3E-03	1.8E-02	2.5E-01
Vinyl chloride	NA	NA	NA	3.8E-08	NA	NA	3.8E-08
TOTAL	1.8E-01	1.6E-01	7.0E-03	9.6E-05	2.0E-03	1.9E-02	3.7E-01

NA = Compound not detected in the medium.

Table 23

GWCC Future Resident Scenario
Child Hazard Quotients and Indices
Chronic Exposure

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
Chloroform	NA	NA	NA	9.0E-04	NA	NA	9.0E-04
1,1-Dichloroethane	NA	NA	NA	1.8E-05	NA	NA	1.8E-05
1,1-Dichloroethene	6.5E-02	1.1E-01	1.5E-03	1.1E-03	1.5E-03	3.9E-03	1.8E-01
1,2-Dichloroethene	NA	NA	NA	4.7E-03	NA	NA	4.7E-03
Tetrachloroethene	NA	NA	NA	2.8E-04	NA	NA	2.8E-04
1,1,1-Trichloroethane	1.8E-02	9.1E-03	9.1E-04	5.0E-05	4.0E-04	2.4E-03	3.1E-02
Trichloroethene	2.7E-01	4.6E-01	1.2E-02	1.0E-02	6.0E-03	3.2E-02	7.9E-01
TOTAL	3.5E-01	5.8E-01	1.4E-02	1.7E-02	7.8E-03	3.8E-02	1.0E+00

NA = Compound not detected in the medium.

Table 24

GWCC Future Resident Scenario
Adult Hazard Quotients and Indices
Chronic Exposure

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
Chloroform	NA	NA	NA	3.9E-04	NA	NA	3.9E-04
1,1-Dichloroethane	NA	NA	NA	7.8E-06	NA	NA	7.8E-06
1,1-Dichloroethene	2.8E-02	2.4E-02	7.8E-04	4.7E-04	3.1E-04	2.1E-03	5.6E-02
1,2-Dichloroethene	NA	NA	NA	2.0E-03	NA	NA	2.0E-03
Tetrachloroethene	NA	NA	NA	1.2E-04	NA	NA	1.2E-04
1,1,1-Trichloroethane	7.6E-03	1.9E-03	4.9E-04	2.2E-05	8.5E-05	1.3E-03	1.1E-02
Trichloroethene	1.1E-01	9.8E-02	6.5E-03	4.3E-03	1.3E-03	1.7E-02	2.4E-01
TOTAL	1.5E-01	1.2E-01	7.8E-03	7.3E-03	1.7E-03	2.1E-02	3.1E-01

NA = Compound not detected in the medium.

Table 25

GWCC Member Scenario
Child Hazard Quotients and Indices
Subchronic Exposure

PARAMETERS	DRINKING WATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	OUTDOOR AIR INHALATION	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
Bromodichloromethane	4.4E-05	1.5E-04	2.4E-06	1.0E-09	1.1E-05	3.7E-05	2.4E-04
Chloroform	1.8E-03	6.2E-03	9.6E-05	5.0E-07	4.7E-04	1.5E-03	1.0E-02
1,2-Dichlorobenzene	NA	NA	NA	5.5E-11	NA	NA	5.5E-11
1,1-Dichloroethane	NA	NA	NA	6.2E-09	NA	NA	6.2E-09
1,1-Dichloroethene	NA	NA	NA	1.3E-06	NA	NA	1.3E-06
1,2-Dichloroethene	NA	NA	NA	6.8E-07	NA	NA	6.8E-07
Tetrachloroethene	NA	NA	NA	4.2E-07	NA	NA	4.2E-07
1,1,1-Trichloroethane	NA	NA	NA	6.5E-09	NA	NA	6.5E-09
Trichloroethene	1.2E-04	4.0E-04	1.1E-05	7.0E-06	3.1E-05	1.7E-04	7.4E-04
Vinyl chloride	NA	NA	NA	6.0E-09	NA	NA	6.0E-09
TOTAL	2.0E-03	6.7E-03	1.1E-04	9.9E-06	5.1E-04	1.7E-03	1.1E-02

NA = Compound not detected in the medium.

Table 26

GWCC Member Scenario
Adult Hazard Quotients and Indices
Subchronic Exposure

PARAMETERS	DRINKING WATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	OUTDOOR AIR INHALATION	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	HAZARD INDEX
Bromodichloromethane	1.9E-05	3.2E-05	1.3E-06	4.4E-10	2.4E-06	2.0E-05	7.5E-05
Chloroform	7.7E-04	1.3E-03	5.2E-05	2.1E-07	1.0E-04	8.1E-06	3.1E-03
1,2-Dichlorobenzene	NA	NA	NA	2.4E-11	NA	NA	2.4E-11
1,1-Dichloroethane	NA	NA	NA	2.7E-09	NA	NA	2.7E-09
1,1-Dichloroethene	NA	NA	NA	5.4E-07	NA	NA	5.4E-07
1,2-Dichloroethene	NA	NA	NA	2.9E-07	NA	NA	2.9E-07
Tetrachloroethene	NA	NA	NA	1.8E-07	NA	NA	1.8E-07
1,1,1-Trichloroethane	NA	NA	NA	2.8E-09	NA	NA	2.8E-09
Trichloroethene	5.1E-05	8.7E-05	5.7E-06	3.0E-06	6.6E-06	9.0E-05	2.4E-04
Vinyl chloride	NA	NA	NA	2.6E-09	NA	NA	2.6E-09
TOTAL	8.4E-04	1.4E-03	5.9E-05	4.2E-06	1.1E-04	9.2E-04	3.4E-03

NA = Compound not detected in the medium.

Table 27

GWCC Worker Scenario
Adult Hazard Quotients and Indices
Chronic Exposure

PARAMETERS	GROUNDWATER INGESTION	INHALATION OF OUTDOOR AIR	HAZARD INDEX
Bromodichloromethane	7.8E-05	3.7E-09	7.8E-05
Chloroform	3.2E-03	1.8E-06	3.2E-03
1,2-Dichlorobenzene	NA	2.0E-09	2.0E-09
1,1-Dichloroethane	NA	2.2E-07	2.2E-07
1,1-Dichloroethene	NA	4.5E-06	4.5E-06
1,2-Dichloroethene	NA	2.4E-05	2.4E-05
Tetrachloroethene	NA	1.5E-05	1.5E-05
1,1,1-Trichloroethane	NA	2.3E-07	2.3E-07
Trichloroethene	2.1E-04	2.5E-05	2.4E-04
Vinyl chloride	NA	2.1E-08	2.1E-08
TOTAL	3.5E-03	7.1E-05	3.6E-03

NA = Compound not detected in the medium.

ORIGINAL (Red)

Table 28

VFCC Current Worker Scenario
Adult Hazard Quotients and Indices
Chronic Exposure

PARAMETERS	GROUNDWATER INGESTION	INHALATION OF OUTDOOR AIR	HAZARD INDEX
Bromodichloromethane	NA	3.0E-08	3.0E-08
Chloroform	1.8E-03	5.8E-06	1.8E-03
1,2-Dichlorobenzene	NA	1.6E-08	1.6E-08
1,1-Dichloroethane	3.1E-04	5.4E-07	3.1E-04
1,1-Dichloroethene	4.6E-03	1.2E-05	4.6E-03
1,2-Dichloroethene	6.6E-03	9.0E-05	6.6E-03
Tetrachloroethene	2.1E-03	4.0E-05	2.1E-03
1,1,1-Trichloroethane	1.2E-03	5.6E-07	1.2E-03
Trichloroethene	3.8E-02	8.7E-05	3.8E-02
Vinyl chloride	NA	1.7E-07	1.7E-07
TOTAL	5.5E-02	2.4E-04	5.5E-02

NA = Compound not detected in the medium.

ORIGINAL
Red

Table 29

VFCC Future Worker Scenario
Adult Hazard Quotients and Indices
Chronic Exposure

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	HAZARD INDEX
Chloroform	1.8E-03	1.2E-03	4.7E-05	6.3E-06	3.0E-03
1,1-Dichloroethane	3.2E-04	2.2E-04	6.7E-06	2.9E-05	5.8E-04
1,1-Dichloroethene	9.5E-03	6.5E-03	2.1E-04	1.4E-04	1.6E-02
1,2-Dichloroethene	1.3E-01	8.7E-02	1.6E-04	4.1E-03	2.2E-01
Tetrachloroethene	1.1E-02	7.4E-03	6.2E-04	3.9E-04	1.9E-02
1,1,1-Trichloroethane	1.4E-03	2.9E-04	7.3E-05	1.5E-05	1.8E-03
Trichloroethene	3.8E-01	2.6E-01	1.7E-02	1.3E-02	6.8E-01
TOTAL	5.3E-01	3.6E-01	1.8E-02	1.7E-02	9.3E-01

NA = Compound not detected in the medium.

ORIGINAL (Red)

Table 30

Private Residential Well Scenario
Lifetime Carcinogenic Risk

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
Bromodichloromethane	NA	NA	NA	5.3E-12	NA	NA	5.3E-12
Chloroform	9.1E-08	1.4E-06	2.8E-09	2.5E-10	1.4E-09	7.5E-09	1.5E-06
1,1-Dichloroethene	1.2E-05	4.0E-06	3.0E-07	3.2E-09	1.8E-07	8.0E-07	1.7E-05
Tetrachloroethene	NA	NA	NA	2.9E-10	NA	NA	2.9E-10
Trichloroethene	7.0E-07	1.3E-06	3.7E-08	6.9E-10	1.1E-08	9.8E-08	2.1E-06
Vinyl chloride	NA	NA	NA	1.3E-11	NA	NA	1.3E-11
TOTAL	1.2E-05	6.6E-06	3.4E-07	4.5E-09	1.9E-07	9.1E-07	2.0E-05

NA = Compound not detected in the medium.

ORIGINAL
RED

Table 31

Private Residential Well Scenario
Lifetime Carcinogenic Risk Distribution

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL
Bromodichloromethane	NA	NA	NA	0.00	NA	NA	0.00
Chloroform	0.44	6.88	0.01	0.00	0.01	0.04	7.38
1,1-Dichloroethene	56.67	19.32	1.47	0.02	0.86	3.92	82.26
Tetrachloroethene	NA	NA	NA	0.00	NA	NA	0.00
Trichloroethene	3.44	6.21	0.18	0.00	0.05	0.48	10.36
Vinyl chloride	NA	NA	NA	0.00	NA	NA	0.00
TOTAL	60.55	32.40	1.66	0.02	0.92	4.44	100.00

NA = Compound not detected in the medium.

ORIGINAL (RED)

Table 32

Public Residential Well Scenario
Lifetime Carcinogenic Risk

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
Bromodichloromethane	NA	NA	NA	9.3E-12	NA	NA	9.3E-12
Chloroform	NA	NA	NA	1.0E-09	NA	NA	1.0E-09
1,1-Dichloroethene	1.7E-05	5.8E-06	4.4E-07	4.7E-09	2.6E-07	1.2E-06	2.5E-05
Tetrachloroethene	NA	NA	NA	2.1E-10	NA	NA	2.1E-10
Trichloroethene	5.2E-06	9.5E-06	2.7E-07	2.1E-09	8.0E-08	7.3E-07	1.6E-05
Vinyl chloride	NA	NA	NA	2.3E-11	NA	NA	2.3E-11
TOTAL	2.2E-05	1.5E-05	7.1E-07	8.1E-09	3.4E-07	1.9E-06	4.0E-05

NA = Compound not detected in the medium.

Table 33

Public Residential Well Scenario
Lifetime Carcinogenic Risk Distribution

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL
Bromodichloromethane	NA	NA	NA	0.00	NA	NA	0.00
Chloroform	NA	NA	NA	0.00	NA	NA	0.00
1,1-Dichloroethene	41.98	14.31	1.09	0.01	0.64	2.90	60.93
Tetrachloroethene	NA	NA	NA	0.00	NA	NA	0.00
Trichloroethene	12.96	23.41	0.68	0.01	0.20	1.81	39.06
Vinyl chloride	NA	NA	NA	0.00	NA	NA	0.00
TOTAL	54.94	37.72	1.76	0.02	0.84	4.71	100.00

NA = Compound not detected in the medium.

Table 34

ORIGINAL (Red)

GWCC Future Resident Scenario
Lifetime Carcinogenic Risk

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
Chloroform	NA	NA	NA	1.7E-07	NA	NA	1.7E-07
1,1-Dichloroethene	8.2E-05	2.8E-05	2.1E-06	4.0E-07	1.3E-06	5.7E-06	1.2E-04
Tetrachloroethene	NA	NA	NA	1.2E-09	NA	NA	1.2E-09
Trichloroethene	5.1E-06	9.2E-06	2.6E-07	2.9E-07	7.7E-08	7.1E-07	1.6E-05
TOTAL	8.7E-05	3.7E-05	2.4E-06	8.7E-07	1.3E-06	6.4E-06	1.4E-04

NA = Compound not detected in the medium.

ORIGINAL (Red)

Table 35

GWCC Future Resident Scenario
Lifetime Carcinogenic Risk Distribution

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL
Chloroform	NA	NA	NA	0.13	NA	NA	0.13
1,1-Dichloroethene	60.68	20.68	1.57	0.30	0.93	4.20	88.36
Tetrachloroethene	NA	NA	NA	0.00	NA	NA	0.00
Trichloroethene	3.75	6.77	0.20	0.22	0.06	0.52	11.51
TOTAL	64.43	27.45	1.77	0.64	0.98	4.72	100.00

NA = Compound not detected in the medium.

Table 36

GWCC Member Scenario
Lifetime Carcinogenic Risk

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL RISK
Bromodichloromethane	2.7E-08	6.2E-08	1.7E-09	6.2E-13	4.7E-09	2.6E-08	1.2E-07
Chloroform	2.6E-08	8.0E-07	1.6E-09	9.4E-11	4.6E-09	2.5E-08	8.5E-07
1,1-Dichloroethene	NA	NA	NA	4.6E-10	NA	NA	4.6E-10
Tetrachloroethene	NA	NA	NA	1.7E-11	NA	NA	1.7E-11
Trichloroethene	2.2E-09	8.1E-09	2.3E-10	2.1E-10	4.0E-10	3.7E-09	1.5E-08
Vinyl chloride	NA	NA	NA	1.5E-12	NA	NA	1.5E-12
TOTAL	5.4E-08	8.7E-07	3.5E-09	7.8E-10	9.7E-09	5.5E-08	9.9E-07

NA = Compound not detected in the medium.

ORIGINAL (Red)

Table 37

GWCC Member Scenario
Lifetime Carcinogenic Risk Distribution

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	INGESTION WHILE SWIMMING	SWIMMING DERMAL ABSORPTION	TOTAL
Bromodichloromethane	2.68	6.26	0.17	0.00	0.48	2.66	12.25
Chloroform	2.59	80.47	0.16	0.01	0.46	2.51	86.20
1,1-Dichloroethene	NA	NA	NA	0.05	NA	NA	0.05
Tetrachloroethene	NA	NA	NA	0.00	NA	NA	0.00
Trichloroethene	0.23	0.82	0.02	0.02	0.04	0.37	1.50
Vinyl chloride	NA	NA	NA	0.00	NA	NA	0.00
TOTAL	5.50	87.55	0.36	0.08	0.98	5.54	100.00

NA = Compound not detected in the medium.

Table 38

GWCC Worker Scenario
Lifetime Carcinogenic Risk

PARAMETERS	GROUNDWATER INGESTION	INHALATION OF OUTDOOR AIR	TOTAL RISK
Bromodichloromethane	7.3E-08	3.4E-12	7.3E-08
Chloroform	7.0E-08	5.2E-10	7.1E-08
1,1-Dichloroethene	NA	2.5E-09	2.5E-09
Tetrachloroethene	NA	9.5E-11	9.5E-11
Trichloroethene	6.2E-09	1.1E-09	7.3E-09
Vinyl chloride	NA	8.3E-12	8.3E-12
TOTAL	1.5E-07	4.3E-09	1.5E-07

NA = Compound not detected in the medium.

ORIGINAL (Red)

Table 39

GWCC Worker Scenario
Lifetime Carcinogenic Risk Distribution

PARAMETERS	GROUNDWATER INGESTION	INHALATION OF OUTDOOR AIR	TOTAL
Bromodichloromethane	47.37	0.00	47.37
Chloroform	45.84	0.34	46.18
1,1-Dichloroethene	NA	1.64	1.64
Tetrachloroethene	NA	0.06	0.06
Trichloroethene	4.01	0.73	4.74
Vinyl chloride	NA	0.01	0.01
TOTAL	97.22	2.78	100.00

NA = Compound not detected in the medium.

Table 40

VFCC Current Worker Scenario
Lifetime Carcinogenic Risk

PARAMETERS	GROUNDWATER INGESTION	INHALATION OF OUTDOOR AIR	TOTAL RISK
Bromodichloromethane	NA	2.0E-11	2.0E-11
Chloroform	3.6E-08	1.7E-09	4.0E-08
1,1-Dichloroethene	8.9E-06	6.8E-09	8.9E-06
Tetrachloroethene	3.7E-07	2.6E-10	3.7E-07
Trichloroethene	1.1E-06	3.9E-09	1.1E-06
Vinyl chloride	NA	6.8E-11	6.8E-11
TOTAL	1.0E-05	1.3E-08	1.0E-05

NA = Compound not detected in the medium.

Table 41

VFCC Current Worker Scenario
Lifetime Carcinogenic Risk Distribution

PARAMETERS	GROUNDWATER INGESTION	INHALATION OF OUTDOOR AIR	TOTAL
Bromodichloromethane	NA	0.00	0.00
Chloroform	0.37	0.02	0.38
1,1-Dichloroethene	85.26	0.07	85.33
Tetrachloroethene	3.58	0.00	3.58
Trichloroethene	10.67	0.04	10.70
Vinyl chloride	NA	0.00	0.00
TOTAL	99.88	0.12	100.00

NA = Compound not detected in the medium.

Table 42

VFCC Future Worker Scenario
Lifetime Carcinogenic Risk

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	TOTAL RISK
Chloroform	3.8E-08	3.5E-07	1.0E-09	1.8E-09	3.9E-07
1,1-Dichloroethene	1.8E-05	3.6E-06	4.1E-07	7.6E-08	2.2E-05
Tetrachloroethene	2.0E-06	4.7E-08	1.1E-07	2.5E-09	2.1E-06
Trichloroethene	1.1E-05	1.2E-05	5.0E-07	5.7E-07	2.4E-05
TOTAL	3.1E-05	1.6E-05	1.0E-06	6.5E-07	4.9E-05

NA = Compound not detected in the medium.

Table 43

VFCC Future Worker Scenario
Lifetime Carcinogenic Risk Distribution

PARAMETERS	GROUNDWATER INGESTION	INHALATION WHILE SHOWERING	DERMAL WHILE SHOWERING	INHALATION OF OUTDOOR AIR	TOTAL
Chloroform	0.08	0.71	0.00	0.00	0.80
1,1-Dichloroethene	37.33	7.44	0.84	0.16	45.76
Tetrachloroethene	4.01	0.10	0.23	0.01	4.34
Trichloroethene	22.81	24.09	1.03	1.17	49.10
TOTAL	64.23	32.33	2.10	1.33	100.00

NA = Compound not detected in the medium.

TABLE 44

Summary of Human Health Risk Results

ORIG... (Red

Scenario	Child non-cancer total chronic HI	Adult non-cancer total chronic HI	Adult & Child cancer total lifetime risk
Private Residential Well	0.27	0.082	2.0E-5
Public Residential Well	1.2	0.37	4.0E-5
GWCC Future Resident	1.0	0.31	1.4E-4
GWCC Member	-	-	9.9E-7
GWCC Worker	-	0.0036	1.5E-7
VFCC Current Worker	-	0.055	1.0E-5
VFCC Future Worker	-	0.93	4.9E-5

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filed

Table 45

Contaminant of Concern	MCL in parts per billion (ppb)
Bromodichloromethane	100
Chloroform	100
1,2 Dichlorobenzene	75
1,4 Dichlorobenzene	600
1,1 Dichloroethane	810*
1,2 Dichloroethane	5
1,1 Dichloroethene	7
1,2 Dichloroethene	70
Tetrachloroethene	5
1,1,1 Trichloroethane	200
Trichloroethene	5
Vinyl Chloride	2

* Non-carcinogenic health-based concentration

TABLE 46

Affected And Potentially Affected Residences To Be Connected To The Public Water Supply System

Residence
1139 Rittenhouse Road
1151 Rittenhouse Road
1161 Rittenhouse Road
2660 Audubon Road
2703 Audubon Road
2705 Audubon Road
2709 Audubon Road
2711 Audubon Road
2714 Audubon Road
2719 Audubon road
2723 Audubon Road
2729 Audubon Road

Table 47

COMMODORE SEMICONDUCTOR GROUP SITE
LOWER PROVIDENCE TOWNSHIP, PENNSYLVANIA
SUMMARY OF ALTERNATIVE COSTS FOR REMEDIAL IMPLEMENTATION

ALTERNATIVE	CAPITAL COST	O&M COST (30 years)	NET PRESENT WORTH
COSTS UTILIZING THE INSTALLATION OF NEW WELLS AND STRIPPERS[1]			
ALTERNATIVE 1	NONE	26,640	299,800
ALTERNATIVE 2	125,500	211,800	2,564,800
ALTERNATIVE 3 (OPTION A)	732,730	246,700	3,585,300
ALTERNATIVE 3 (OPTION B)	985,730	282,500	4,244,700
ALTERNATIVE 4 (OPTION A)	810,930	258,00	3,790,900
ALTERNATIVE 4 (OPTION B)	1,071,230	313,900	4,680,300
ALTERNATIVE 5 (OPTION A)	946,910	404,300	5,573,700
ALTERNATIVE 5 (OPTION B)	1,203,910	477,400	6,657,000
COSTS UTILIZING THE EXISTING WATER SUPPLY COMPANY WELLS AND STRIPPERS ADJUSTED TO REFLECT THE COSTS FOR INSTALLATION OF VAPOR PHASE CARBON UNITS[2]			
ALTERNATIVE 1	NONE	26,640	299,900
ALTERNATIVE 2	125,500	211,800	2,564,900
ALTERNATIVE 3 (OPTION A)	420,000	246,700	3,272,500
ALTERNATIVE 3 (OPTION B)	673,000	285,200	3,932,000
ALTERNATIVE 4 (OPTION A)	498,200	258,000	3,478,200
ALTERNATIVE 4 (OPTION B)	758,500	313,900	4,367,600
ALTERNATIVE 5 (OPTION A)	641,500	404,300	5,268,300
ALTERNATIVE 5 (OPTION B)	899,400	477,400	6,352,800

[1] The costs reported for installing new wells and strippers were obtained from the *September 21, 1992, Feasibility Study Cost Evaluation Report*, as prepared by Dynamac Corporation.

[2] The costs reported for using the existing wells and strippers were taken from the *July 1992, RI/FS Report*, as prepared by WESTON, and have been adjusted to account for the installation of Vapor Phase Carbon Units

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