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CDM FEDERAL PROGRAMS CORPORATION
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July 8, 1994

Mr. Keith Kollar
U.S. Environmental Protection Agency
26 Federal Plaza
New York, NY 10278

PROJECT: EPA ARCS Contract 68-W9-0024
Work Assignment 073-2P1D
Tutu Well Field Site

DOC. NO.: 7720-073-EP-BZQZ

SUBJECT: Revised Pathway Exposure Report
Draft Endangerment Assessment
DCN: 7720-073-LR-BZQY

Dear Mr. Kollar:

CDM Federal Programs Corporation (CDM Federal) is pleased to submit the document titled "Revised Pathway Exposure Report Draft Endangerment Assessment" as partial fulfillment of the reporting requirements for work assignment 073, Tutu Well Field Site, St. Thomas, U.S. Virgin Islands.

If you have any questions concerning this submittal, please call me or Sally Odland at (212) 393-9634.

Sincerely,

CDM FEDERAL PROGRAMS CORPORATION

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Document Control (2 copies)

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REVISED PATHWAY EXPOSURE REPORT
DRAFT ENDANGERMENT ASSESSMENT
TUTU WELLS SITE
ST. THOMAS, VIRGIN ISLANDS

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Waste Programs Enforcement
Washington, D.C. 20460

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EPA Region	: II
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TABLE OF CONTENTS

BASELINE HUMAN HEALTH RISK ASSESSMENT

TABLES

FIGURES

1.0 INTRODUCTION

Under the Technical Enforcement Support (TES) V contract, CDM Federal Programs Corporation (CDM Federal) received a work assignment (WA) from the U.S. Environmental Protection Agency (EPA) Region II (Contract No. 68-W9-0002, WA No. C02116) to provide technical oversight for the EPA by conducting an endangerment assessment to characterize site risk as part of a Remedial Investigation/Feasibility Study (RI/FS) at the Tutu Wells site in St. Thomas, Virgin Islands. A work plan for this assignment was submitted to EPA on December 11, 1992.

Task 7 of the work plan requires the preparation and submittal to EPA of a Pathway Exposure Report, specifying the approach which will be used to evaluate the potential human health and environmental impacts associated with the site. The following major issues will be discussed in this report:

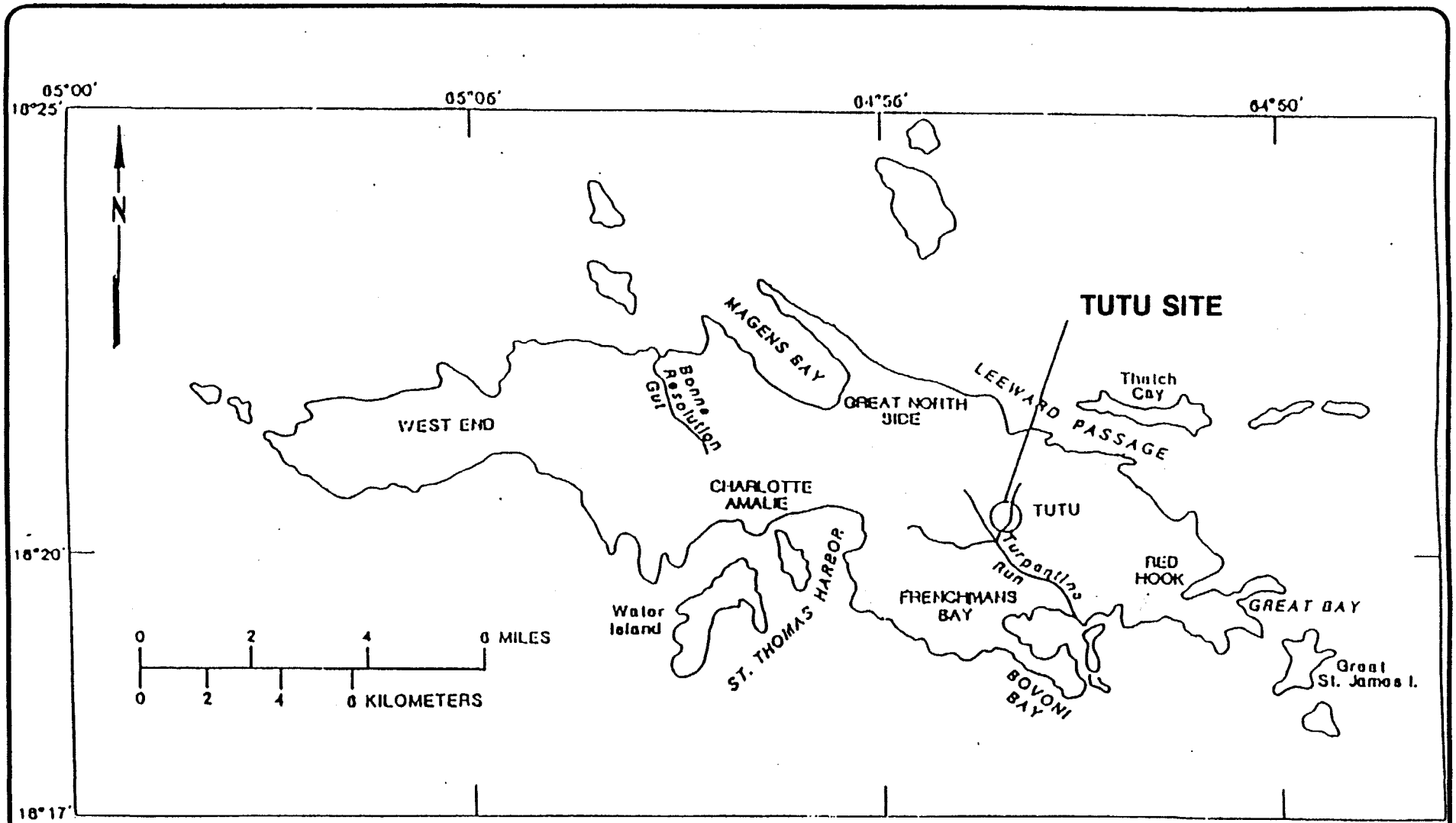
Baseline Human Health Risk Assessment

- Media to be evaluated and treatment of data (quantitative and qualitative)
- Exposure routes (i.e., groundwater ingestion, dermal contact with soils)
- Exposure scenarios (i.e., worker, resident, present/future)
- Dose/response parameters
- Human health risk characterization
- Uncertainties in risk assessment
- Preliminary remediation goals (PRGs)

Ecological Risk Assessment

1.1 Background

The Tutu Wells site is located on the eastern end of St. Thomas at the Anna's Retreat Section (Figure 1). Most of the wells are used for public drinking water supply. On July 16, 1987, the EPA received a request from the Department of Planning and Natural Resources (DPNR) in St. Thomas, for the sampling and analyses of several wells in Tutu, after the DPNR had received a report regarding an odor emanating from the raw well water on a private property located at Anna's Retreat, St. Thomas, Virgin Islands.



GERAGHTY & MILLER, INC.
Environmental Services

SCALE: SHOWN

SITE LOCATION

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 1

Source: Technical Memorandum II - Results of the Field Program - Tutu Service Station Investigation by Geraghty & Miller (May 1993).

On July 21, the EPA and its Technical Assistance Team (TAT) contractor, Roy F. Weston, Inc., mobilized to St. Thomas, to perform sampling on the drinking water wells suspected of being contaminated. These wells were also reported to have a strong, unpleasant odor and were found to be contaminated with hazardous substances and petroleum products coming from two gas stations in the Tutu area.

The EPA and TAT, in coordination with DPNR, initiated sampling of wells in the affected area in July 1987. The test results showed the presence of high concentrations of gasoline and chlorinated organic compounds. Four wells, Eglin, Four Winds, Harthman, and VIHA, were closed down by order of DPNR due to high volatile organic compound (VOC) concentrations.

Several of the wells in this area are major commercial well services used for public drinking water supply; therefore, the incident was classified as major, and the DPNR Commissioner requested the EPA to assume the role of lead agency.

A testing program of wells located outside of the known area of contamination was conducted to evaluate possible alternate water supply sources for those areas.

Sampling of cisterns served by the contaminated wells was also performed. EPA directed the Emergency Response Cleanup Services contractor (ERCS) to: clean and disinfect the five (5) cisterns that had tested positive for tetrachloroethene (PCE), modify the existing home plumbing, disconnect the contaminated wells, and dispose of the contaminated water. At EPA's direction, ERCS also contracted a local water hauler to deliver uncontaminated drinking water to the cisterns by tank truck. A well sampling program was established by the EPA to monitor the wells at the Tutu Wells site.

EPA issued a Unilateral Administrative Order to Esso Standard Oil Company, Texaco Caribbean, Inc., and O'Henry Cleaners on March 22, 1990, to conduct groundwater monitoring of the drinking water wells in the Tutu aquifer, and to provide water to affected homes until the respondents connected to the water main.

Esso and Texaco entered into a RCRA 7003/9003 Order of Consent with EPA to conduct a Remedial Investigation/Feasibility Study at the Tutu Wells site in February 1992. The site was proposed on the NPL in February 1992. Technical Memorandums I and II, submitted to EPA in April 1992 and May 1993, respectively, present the initial results of the studies of the Esso and Texaco gas stations and of VOC contamination in supply wells at the site. The PRP Technical Committee requested a more complete RI of the site be conducted, and, in December 1993, a Phase II RI work plan was submitted to EPA by Geraghty & Miller, the PRP contractor. Phase II RI field work is currently in progress.

2.0 MEDIA TO BE EVALUATED AND TREATMENT OF DATA

Seven quarterly groundwater sampling reports (Geraghty & Miller-February 1991 through March/April 1993), Technical Memorandum II - Results of the Field Program Tutu Service Station Investigation (Geraghty & Miller-June 1993), CDM Federal's Data Comparison and Evaluation Report for Groundwater and Soil Split Samples at the Tutu Wells site (June 1993), and CDM Federal's September 8 through 15, 1988 and June 5 through 10, 1989 sampling reports serve as the primary sources of site characterization and analytical data for this deliverable and the endangerment assessment. As Geraghty & Miller, the PRP contractor, is currently conducting field sampling activities at the site, additional samples not available at present will be included in the endangerment assessment per the EPA WAM.

The first quarterly sampling report (Geraghty & Miller-September 1990) results are not being included in this report or the endangerment assessment as seven more recent quarterly reports are available.

Monitoring of residential wells at the site has been conducted by Geraghty & Miller since September 1990. Samples collected during the majority of the sampling events were analyzed for Target Compound List (TCL) volatile organic compounds (VOCs) only. However, the fifth and eighth quarterly sampling events also included analyses for TCL semivolatile organic compounds (SVOCs) and Target Analyte List (TAL) inorganics and cyanide. The second quarterly sampling event included, in addition to VOCs, antimony, mercury, selenium, and thallium analyses. As part of Technical Memorandum II, Geraghty & Miller drilled soil borings, conducted downhole geophysical surveys, installed monitoring wells, took water level measurements, conducted two aquifer pump tests, and collected soil and groundwater samples.

2.1 Media to be Evaluated

The environmental media to be quantitatively evaluated in the endangerment assessment include surface soil, subsurface soil, and groundwater. The following is a summary of specific data sets for each media for use in the evaluation of potential human health risks and environmental impacts.

2.1.1 Soil

As part of Technical Memorandum II, seventeen borings, including B-1 through B-13, B-13A, B-14, B-15 and B-16 and eighteen monitoring wells, including MW-1 through MW-10, MW-14, MW-1D, MW-4D, MW-6D, MW-10D, MW-11D, MW-12D, and MW-13D were drilled. Soil samples were collected from June to August 1992 (see Figures 1-3 and 1-4 of Technical Memorandum II-June 1993).

Eight surface soil samples, SS-1 through SS-8, were collected from seven locations in August 1992 (See Figure 1-3 of Technical Memorandum II - June 1993). Surface soil samples SS-1,

SS-2 and SS-8 are considered background samples and were analyzed for TAL metals and cyanide only. Surface soil samples SS-3 through SS-7 (SS-7 is a duplicate sample of SS-6) were analyzed for TCL VOCs, 1,2-dibromomethane, n-propylbenzene, methyl tertiary butyl ether, TCL SVOCs, TAL metals and cyanide, and total petroleum hydrocarbons (TPHs). Samples were collected at intervals ranging from one to seven inches below land surface after removing the top one inch layer of soil and vegetation.

Overall, thirty-nine samples, including four replicates, were collected from thirty-five soil boring and monitoring well locations during the Technical Memorandum II investigation. These samples were analyzed for TCL VOCs, 1,2-dibromomethane, n-propylbenzene, methyl tertiary butyl ether, TCL SVOCs, TAL metals and cyanide, and TPHs.

Soil samples were collected at depth intervals ranging from zero to sixteen feet. Of these, eighteen soil samples were collected at depths ranging from zero to two feet, while twenty-one soil samples were collected at depths ranging from two to twelve feet (with the exception of sample MW-1D which was collected from one to two and one half feet). Of the eighteen soil samples collected from zero to two feet, only six are considered surface soil samples since twelve were collected from beneath paved surfaces. Three of the six surface soil samples (B-14, B-15, and B-16) are considered surface soil samples at present only, since they will likely be paved over in the near future. Based on this expected activity, these samples will be considered subsurface soil samples in the future-use scenario. Surface soil samples collected from zero to two feet below unpaved surfaces, and subsurface soil samples collected from under paved surfaces and from two (and one and one half feet - sample MW-1D) to approximately twelve feet will be used to produce data summary tables and calculate chemical concentration - toxicity screens and exposure point concentrations. Subsurface soil data down to approximately twelve feet will be used in the risk assessment, as this is the zone of soils which may be accessed during any potential excavation activities.

As part of the RI, Geraghty & Miller is currently installing additional monitoring wells at the site from which soil samples will be collected. These soil results will be incorporated into the endangerment assessment per direction of the EPA WAM.

CDM Federal collected hand augered surface soil samples at the Tutu Wells site from September 8 through 15, 1988 and from June 5 through 10, 1989. During the September 1988 sampling event, one surface soil sample (e-01) was collected at O'Henry dry cleaners, two surface soil samples (eR-07s and eR-08s) were collected at the Ramsay motor company, two surface soil samples (eC-09s and eC-10s) were collected at Antilles auto parts, and two surface soil samples (eTT-14 and eTT-15) were collected at Tillett Gardens. Samples were analyzed for various combinations of analytes including TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPHs, and were collected at intervals ranging from zero to twelve inches below land surface. Two samples collected at the Texaco gas station (eT-02s and eT-02sd) were originally identified as surface soil samples, however, based on a recent site visit, the Texaco gas station area was observed to be completely paved. Therefore, these samples will be considered subsurface soil samples in the endangerment assessment.

During the June 1989 sampling event, three surface soil samples (e0-02-01, e0-02-02, and e0-02-03) were collected at O'Henry dry cleaners, three surface soil samples (eL-02-01s, eL-02-02s, and eL-02-03s) were collected behind the Curriculum Center Building, and one surface soil sample (eR-02-02s) was collected at the Ramsay motor company. Samples were analyzed for various analyte combinations including TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPHs, and were collected at intervals ranging from zero to two feet below land surface.

Split samples were collected by CDM Federal in August 1992 for each of eight surface soil samples (SS-1 through SS-8) taken by Geraghty & Miller. In July and August 1992, seven subsurface soil samples were split with Geraghty & Miller including MW-8, MW-6D, MW-9, B-6, B-1, MW-5 and B-12. These samples were analyzed for TCL VOCs, SVOCs, TAL metals and cyanide. Subsurface soil samples were also analyzed for methyl tertiary butyl ether, 1,2-dibromomethane, n-propylbenzene, and TPHs.

2.1.2 Groundwater

Geraghty & Miller has been monitoring approximately twenty-five residential and commercial water supply wells at and in the vicinity of the site since September 1990 and has produced eight quarterly sampling reports including the most recent March/April 1993 sampling event results. The seven most recent sampling reports (reports two through eight) will be utilized in the production of the Tutu Wells site endangerment assessment. In addition to these reports, Geraghty & Miller has produced the Technical Memorandum II Tutu Service Station Investigation report which evaluated fourteen monitoring wells located at the site. O'Henry dry cleaners has independently installed and sampled four monitoring wells for VOCs. These data, according to the EPA WAM, will be validated by EPA so that they can be incorporated into the endangerment assessment. Geraghty & Miller is currently installing and sampling additional monitoring wells at the site. Per the EPA WAM, results from these wells will be incorporated into the endangerment assessment.

As part of the second quarterly sampling event in February 1991, twenty-three wells were sampled for TCL VOCs and at least two of the following metals: antimony, mercury, selenium, and thallium. These wells and explanations for those wells not sampled are presented in Table 1.

As part of the third quarterly sampling event in June 1991, fourteen wells were sampled for TCL VOCs only. These wells and explanations for those wells not sampled are presented in Table 2.

As part of the fourth quarterly sampling event in October 1991, fourteen wells were sampled for TCL VOCs only. These wells and explanations for those wells not sampled are presented in Table 3.

TABLE 1

List of Wells and Analytical Parameters for the Second Quarterly Sampling Event February 1991. Tutu Wells Site, St. Thomas, USVI.

Well	Predetermined Analytes
Bryan	VOCs, thallium, mercury
Dede	VOCs, antimony, thallium
Dimitri	VOCs, thallium, mercury
Dench	VOCs, antimony, thallium
Devcon I	VOCs, antimony, thallium
Devcon III	VOCs, antimony, thallium
Eglin I	VOCs, thallium, mercury
Eglin II	VOCs, antimony, thallium
Eglin III	VOCs, antimony, thallium
Four Winds I[a]	VOCs
Four Winds II	VOCs, antimony, thallium
Gassett	VOCs, thallium, mercury
Hartman II	VOCs, antimony, thallium
Hartman III	VOCs, antimony, thallium
Harvey	VOCs, antimony, thallium
LaPlace	VOCs, thallium, mercury
Leonard	VOCs, antimony, thallium
Matthias	VOCs, thallium, mercury
Ramsey	VOCs, thallium, mercury
Rodriguez	VOCs, antimony, thallium
Smith	VOCs, antimony, thallium, selenium
Steele	VOCs, antimony, thallium
Tillett	VOCs, thallium, mercury
VIHA I[b]	VOCs, thallium, mercury
VIHA III	VOCs, antimony, thallium

a Four Winds I not sampled due to inoperable pump.
b VIHA I not sampled due to inoperable pump.

Source: Geraghty & Miller Second Quarterly Sampling Report (February 1991).

TABLE 2

List of Wells and Analytical Parameters for the Third Sampling Event, June 1991, Tutu Wells Site, St. Thomas, U.S. Virgin Islands.

Well	Proposed Analytes
Eglin I	VOCs
Eglin II	VOCs
Eglin III	VOCs
Four Winds I	VOCs
Gassett	VOCs
Hartman II	VOCs
Hartman III	VOCs
Harvey	VOCs
LaPlace	VOCs
Matthias	VOCs
Ramsay	VOCs
Smith	VOCs
Steele	VOCs
Tillett	VOCs

VOCs Volatile organic compounds.
Analysis will be performed using modified USEPA Method 524.2.
Four Winds II and VIHA I were not sampled due to inoperable pumps.

Source: Geraghty & Miller Third Quarterly Sampling Report (June 1991).

TABLE 3

List of Wells and Analytical Parameters for the Fourth Sampling Event, October 1991, Tutu Wells Site, St. Thomas, U.S. Virgin Islands.

Well	Proposed Analytes
Eglin I	TCL VOCs
Eglin II	TCL VOCs
Eglin III	TCL VOCs
Four Winds I	TCL VOCs
Four Winds II	TCL VOCs
Gassett	TCL VOCs
Hartman II	TCL VOCs
Hartman III	TCL VOCs
Harvey	TCL VOCs
LaPlace	TCL VOCs
Matthias	TCL VOCs
Ramsay	TCL VOCs
Smith	TCL VOCs
Steele	TCL VOCs
Tillett	TCL VOCs

VOCs Volatile organic compounds.
Analysis was performed using modified USEPA Method 524.2.
Four Winds II and VIHA I were not sampled due to inoperable pumps.

Source: Geraghty & Miller Fourth Quarterly Sampling Report (October 1991).

As part of the fifth quarterly sampling event in February 1992, eighteen wells were sampled for TCL VOCs and SVOCs, TAL metals, and cyanide. A Water and Power Authority (WAPA) sample was collected from the standpipe at the Virgin Island Housing Authority property. The wells sampled and explanations for those wells not sampled are presented in Table 4.

As part of the sixth quarterly sampling event in May 1992, ten wells were sampled for TCL VOCs only. These wells are presented in Table 5.

As part of the seventh quarterly sampling event in September 1992, thirteen wells were sampled for TCL VOCs only. These wells are presented in Table 6.

As part of the eighth quarterly sampling event in March and April 1993, fifteen wells were sampled for TCL VOCs and SVOCs, TAL metals, and cyanide. A field replicate was collected from the Harvey well and analyzed for the same parameters. These wells and explanations for those wells not sampled are presented in Table 7.

As part of the Technical Memorandum II Tutu Service Station Investigation, Geraghty & Miller installed twelve shallow monitoring wells (MW-1, MW-2, MW-3, MW-4, MW-5, MW-6R, MW-7, MW-8, MW-9, MW-9S, MW-10, and MW-14) and seven deep monitoring wells (MW-1D, MW-4D, MW-6D, MW-10D, MW-11D, MW-12D, and MW-13D).

Groundwater samples were collected from all shallow and deep wells in September and October 1992 and were analyzed for TCL VOCs and SVOCs, metals, cyanide, 1,2-dibromomethane, n-propylbenzene, methyl tertiary butyl ether, and TPHs.

CDM Federal collected split samples in September and October 1992 of five Geraghty & Miller aqueous samples (four groundwater samples and one field blank). The groundwater samples (MW-6R, MW-4, MW-5, and MW-14) were analyzed for TCL VOCs and SVOCs, TAL metals (total and dissolved), cyanide, methyl tertiary butyl ether, 1,2-dibromomethane, n-propylbenzene, and TPHs.

Groundwater results from each of the wells from each sampling round, including split samples, as appropriate, will be used to produce a data summary table and to calculate a chemical concentration-toxicity screen and exposure point concentrations. Upgradient supply wells T3 and T4 (VIHA III and VIHA IV (alternate)) will not be included in the calculation of risk/health effects nor will the cross gradient wells A, C, L, and M (Bryan, Demitri, Leonard, and Lockhart (alternate)) which are impacted by pumping only in the residential area in the immediate vicinity and not by the site. Supply wells B, D, E1, E2, E3 (Dede, Dench, Devcon I, Devcon II (alternate) and Devcon III) are clean wells downgradient of the contaminant plume, and therefore will not be utilized in quantitative calculations in the endangerment assessment. Groundwater data may be segregated as shallow and deep, if appropriate, in the exposure assessment for the evaluation of potential risks/hazards to groundwater.

TABLE 4

List of Sample Locations and Analytical Parameters for the Fifth Sampling Event, February 1992, Tutu Wells Site, St. Thomas, U.S. Virgin Islands.

Sample ID	Proposed Analytes
Dede	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Eglin I	TCL VOCs, TCL BNA, TAL Metals, and Cyanide
Eglin II	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Eglin III	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Four Winds I	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Four Winds II	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Gassett	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Hartman II	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Hartman III	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Harvey	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
LaPlace	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Leonard	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Matthias	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Ramsay	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Rodriguez	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Smith	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Steele	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Tillett	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
VIHA I, VIHA II, or VIHA III (if possible)	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Water and Power Authority (WAPA)	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide

TCL Target compound list.
TAL Target analyte list.
VOCs Volatile organic compounds.
VOC analysis was performed using modified USEPA Method 524.2.
BNAs Base neutral and acid extractable compounds.
VIHA I, VIHA II, and VIHA III were not sampled due to inoperable pumps.
The WAPA sample was collected from the standpipe at the VIHA property located on Route 38 in Tutu.

Source: Geraghty & Miller Fifth Quarterly Sampling Report (February 1992).

TABLE 5

List of Sample Locations and Analytical Parameters for the Sixth Sampling Event, May 1992, Tutu Wells Site, St. Thomas, U.S. Virgin Islands.

Sample ID	Proposed Analytes
Eglin I	TCL VOCs
Eglin II	TCL VOCs
Eglin III	TCL VOCs
Gassett	TCL VOCs
Harvey	TCL VOCs
LaPlace	TCL VOCs
Ramsay	TCL VOCs
Smith	TCL VOCs
Steele	TCL VOCs
Tillett	TCL VOCs

TCL Target compound list.
VOCs Volatile organic compounds.

VOC analysis was performed using modified USEPA Method 524.2, Revision 3.0 (USEPA 1989).

Source: Geraghty & Miller Sixth Quarterly Sampling Report (May 1992).

TABLE 6

List of Sample Locations and Analytical Parameters for the Seventh Sampling Event, September 1992, Tutu Wells Site, St. Thomas, U.S. Virgin Islands.

Sample ID	Proposed Analytes
Eglin I	TCL VOCs
Eglin II	TCL VOCs
Eglin III	TCL VOCs
Four Winds I	TCL VOCs
Four Winds II	TCL VOCs
Gassett	TCL VOCs
Harthman II	TCL VOCs
Harvey	TCL VOCs
LaPlace	TCL VOCs
Ramsay	TCL VOCs
Smith	TCL VOCs
Steele	TCL VOCs
Tillett	TCL VOCs

TCL Target compound list.
VOCs Volatile organic compounds.

VOC analysis was performed using modified USEPA Method 524.2, Revision 3.0 (USEPA 1989).

Source: Geraghty & Miller Seventh Quarterly Sampling Report (September 1992).

TABLE 7

List of Sample Locations and Analytical Parameters for the Eighth Sampling Event, March/April 1993, Tutu Wells Site, St. Thomas, U.S. Virgin Islands.

Sample ID	Analytes
Dede	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Dench	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Devcon II	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Eglin I	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Eglin III	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Four Winds I	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Gassett	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Harvey	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Harvey FR	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
LaPlace	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Leonard	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Ramsay	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Rodriguez	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Smith	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Steele	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide
Tillett	TCL VOCs, TCL BNAs, TAL Metals, and Cyanide

TCL Target compound list.
TAL Target analyte list.
VOCs Volatile organic compounds.
BNAs Base neutral and acid extractable compounds.
VOC analysis was performed using Modified USEPA Method 524.2.
The VIHA I, VIHA II, Eglin II, Four Winds II, and Devcon III wells were not sampled due to inoperable pumps.
The Matthias well was not sampled because the property owner did not allow access.
The Harthman II and Harthman III wells were not sampled because of construction activities in the new Tutu Shopping Plaza site.

Source: Geraghty & Miller Eighth Quarterly Sampling Report (March/April 1993).

2.2 Treatment of Data

A summary of detected chemicals in each of the site media will be presented in tabular form in the risk assessment. The table will include, for each detected chemical, the frequency of detection, the range of detected concentrations, the location of the maximum detected concentration, and the range of non-detect concentrations The frequency of detection will be reported as the number of detects divided by the number of analyzed samples. CDM Federal split sample results will be compared to the PRP results. If the results are similar, they will be averaged and this averaged value will be used in the risk assessment calculations. If the results are not similar, the higher value will be used for conservatism in the risk assessment calculations. Each groundwater sample collected from multilevel wells and from multiple sampling rounds will be considered as an individual sample. Blanks, including field, trip, and laboratory, and rejected data (i.e., qualified with "R") will not be included in the frequency tally or range of concentrations. All other data qualifiers will be evaluated for inclusion in the risk assessment.

The maximum concentration of chemicals detected in each of the media and their oral toxicity values (i.e., reference dose and slope factor) will be used in the chemical concentration - toxicity screens. These screens, along with other criteria, will be utilized in the selection of chemicals of potential concern.

3.0 EXPOSURE PATHWAY ANALYSIS

The objective of this section is to present a preliminary analysis of potential exposure pathways to be evaluated in the human health risk assessment. An exposure pathway describes the transport of a chemical from the source of release to the exposed individual. An exposure pathway links the sources, locations, and types of environmental patterns to determine significant pathways of human exposure. As defined in EPA's Risk Assessment Guidance for Superfund (RAGS), an exposure pathway consists of four elements:

- Source and mechanism of chemical release
- Release or transport mechanism
- Point of potential human contact (exposure point)
- Exposure route at the contact point

The potential present and future exposure pathways considered for evaluation in the Tillett Gardens, Curriculum Center Building, Fire Department/Texaco gas station/Antilles auto parts/Ramsay motor company, Esso gas station/Splash and Dash car wash, and O'Henry dry cleaners/Liquor Barn areas of concern at the Tutu Wells site are presented in Table 8. Table 9 presents the exposure variables to be used in the daily intake calculations. An exposure point concentration will be developed for each chemical of potential concern in each medium for use in the calculation of daily intakes. This concentration does not reflect the maximum concentration that could be contacted at any one time, but is considered a reasonable estimate of the concentration likely to be contacted over time as long-term contact with the maximum concentration is not a reasonable assumption.

Due to the uncertainty associated with any estimate of exposure concentration, the 95 percent upper confidence limit (UCL) on the arithmetic mean is used for this variable. If there is a large variability in measured concentrations, the 95 percent UCL may exceed the maximum measured or modeled values in which case the maximum detected or modeled value is used. The formula used to calculate the 95 percent UCL will depend on whether the site data are normally or lognormally distributed.

3.1 Soil

Surficial soil may be contaminated by direct spillage or from surface runoff. Subsurface soil may be contaminated as a result of leaching and downward migration of mobile contaminants. Soil contamination will be evaluated for resident, site worker, and construction worker exposures under present and/or future-use conditions as presented in Table 8. The ingestion, dermal contact, and inhalation routes of exposure have been considered. Justifications for the inclusion

TUTU WELLS SITE
POTENTIAL EXPOSURE PATHWAYS

Matrix	Receptor Population(s)	Exposure Route(s)	Retained for Quantitative Analysis	Justification
PRESENT - USE SCENARIOS:				
Surface Soil				
	Site Residents (Adults and Children) (Tillett Gardens Area)	Ingestion	Yes	Site residents are expected to come into direct contact with surface soil in the vicinity of their home and Tillett Gardens and Art Center. The inhalation of particulates from surface soil is assumed to be negligible, as the areas where samples were collected either consist of hard packed soil or are covered by vegetation.
		Dermal Contact*	Yes	
		Inhalation of Particulates	No	
		Inhalation of VOCs**	Yes	
	Site Workers 1- (Employees of the Curriculum Center Building)	Ingestion	Yes	Site workers may come into direct contact with surface soil during the course of a normal work day (i.e., outdoor work, lunch hour). The inhalation of particulates from surface soil is assumed to be negligible, as the areas where samples were collected consist of either hard packed soil or are covered to a large extent by vegetation.
		Dermal Contact*	Yes	
		Inhalation of Particulates	No	
		Inhalation of VOCs**	Yes	
	2- (Employees of the Fire Dept., Texaco gas station, Antilles auto parts, and Ramsay motor company)	Ingestion	Yes	Site workers may come into direct contact with surface soil during the course of a normal work day (i.e., outdoor work, lunch hour). The inhalation of particulates from surface soil is assumed to be negligible, as the areas where samples were collected consist of either hard packed soil or are covered to a large extent by vegetation.
		Dermal Contact*	Yes	
		Inhalation of Particulates	No	
		Inhalation of VOCs**	Yes	
	3- (Employees of the Esso gas station and the Splash and Dash car wash)	Ingestion	No	Since the Esso gas station and Splash and Dash car wash properties are completely paved, no surface soil is available for contact. Therefore, no surface soil exposure can occur.
		Dermal Contact*	No	
		Inhalation of Particulates	No	
		Inhalation of VOCs	No	
	4- (Employees of O'Henry dry cleaners and Liquor Barn)	Ingestion	Yes	Site workers may come into direct contact with surface soil during the course of a normal work day (i.e., outdoor work, lunch hour). The inhalation of particulates from surface soil is assumed to be negligible, as the area where samples were collected is covered to a large extent by dense vegetation.
		Dermal Contact*	Yes	
		Inhalation of Particulates	No	
		Inhalation of VOCs**	Yes	
	Construction Workers (Site-wide)	Ingestion	No	No construction work is currently in progress in any areas of concern at the site.
		Dermal Contact*	No	
		Inhalation of Particulates	No	
		Inhalation of VOCs	No	

TUTU WELLS SITE
POTENTIAL EXPOSURE PATHWAYS

Matrix	Receptor Population(s)	Exposure Route(s)	Retained for Quantitative Analysis	Justification
PRESENT - USE SCENARIOS CONT'D:				
Subsurface Soil				
	Site Residents (Adults and Children) (Tillett Gardens Area)	Ingestion	No	No construction work (i.e., excavation activity) is currently in progress in this area of the site.
		Dermal Contact*	No	
		Inhalation of Particulates	No	
		Inhalation of VOCs	No	
	Site Workers 1- (Employees of the Curriculum Center Building)	Ingestion	No	No construction work (i.e., excavation activity) is currently in progress in this area of the site.
		Dermal Contact*	No	
		Inhalation of Particulates	No	
		Inhalation of VOCs	No	
	2- (Employees of the Fire Dept., Texaco gas station, Antilles auto parts, and Ramsay motor company)	Ingestion	No	No construction work (i.e., excavation activity) is currently in progress in this area of the site.
		Dermal Contact*	No	
		Inhalation of Particulates	No	
		Inhalation of VOCs	No	
	3- (Employees of the Esso gas station and the Splash and Dash car wash)	Ingestion	No	No construction work (i.e., excavation activity) is currently in progress in this area of the site.
		Dermal Contact*	No	
		Inhalation of Particulates	No	
		Inhalation of VOCs	No	
	4- (Employees of O'Henry dry cleaners and Liquor Barn)	Ingestion	No	No construction work (i.e., excavation activity) is currently in progress in this area of the site.
		Dermal Contact*	No	
		Inhalation of Particulates	No	
		Inhalation of VOCs	No	
	Construction Workers (Site-wide)	Ingestion	No	No construction work (i.e., excavation activity) is currently in progress in any areas of concern at the site.
		Dermal Contact*	No	
		Inhalation of Particulates	No	
Groundwater				
	Site Residents (Adults and Children)	Ingestion	Yes	Currently, an order against drinking and bathing in groundwater at the site has been issued. However, since evidence of pumping exists at the Ramsay well, residents may be using the groundwater for these purposes in addition to secondary purposes such as clothes washing, lawn watering, etc.
		Dermal Contact (Shower)	Yes	
		Inhalation of VOCs (Shower)	Yes	
	Site Workers (All)	Ingestion	Yes	Currently, an order against drinking and bathing in groundwater at the site has been issued. However, since evidence of pumping exists at the Ramsay well, site workers may be using the groundwater for drinking. Site workers are not expected to shower on-site.
		Dermal Contact (Shower)	No	
		Inhalation of VOCs (Shower)	No	
	Construction Workers (Site-wide)	Ingestion	No	No construction work (i.e., excavation activity) is currently in progress in any areas of concern at the site.
		Dermal Contact (Shower)	No	
		Inhalation of VOCs (Shower)	No	

TAB

TUTU WELLS SITE
POTENTIAL EXPOSURE PATHWAYS

Matrix	Receptor Population(s)	Exposure Route(s)	Retained for Quantitative Analysis	Justification
FUTURE - USE SCENARIOS:				
Surface Soil				
	Residents (Adults and Children) (Tillett Gardens Area)	Ingestion	Yes	Site residents are expected to come into direct contact with surface soil in the vicinity of their home and Tillett Gardens and Art Center. The inhalation of particulates exposure route may be of concern due to the potential for future construction work (i.e., excavation activity) in this area.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	
	Site Workers 1- (Employees of the Curriculum Center Building)	Ingestion	Yes	Site workers may come into direct contact with surface soil during the course of a normal work day (i.e., outdoor work, lunch hour). The inhalation of particulates exposure route may be of concern due to the potential for future construction work (i.e., excavation activity) in this area.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	
	2- (Employees of the Fire Dept., Texaco gas station, Antilles auto parts, and Ramsay motor company)	Ingestion	Yes	Site workers may come into direct contact with surface soil during the course of a normal work day (i.e., outdoor work, lunch hour). The inhalation of particulates exposure route may be of concern due to the potential for future construction work (i.e., excavation activity) in this area.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	
	3- (Employees of the Esso gas station and the Splash and Dash car wash)	Ingestion	No	Since the Esso gas station and Splash and Dash car wash properties are completely paved, no surface soil would be available for contact. Therefore, no surface soil exposure can occur.
		Dermal Contact*	No	
		Inhalation of Particulates	No	
		Inhalation of VOCs	No	
	4- (Employees of O'Henry dry cleaners and Liquor Barn)	Ingestion	Yes	Site workers may come into direct contact with surface soil during the course of a normal work day (i.e., outdoor work, lunch hour). The inhalation of particulates exposure route may be of concern due to the potential for future construction work (i.e., excavation activity) in this area.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	
	Construction Workers (Exposure to be evaluated for the most chemically contaminated area of concern at the site - to be determined)	Ingestion	Yes	The potential exists for future commercial development of the areas of concern at the site. The area of concern selected for evaluation will depend on the chemical concentrations detected, toxicity, and the calculated residential risks.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	

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TUTU WELLS SITE
POTENTIAL EXPOSURE PATHWAYS

Matrix	Receptor Population(s)	Exposure Route(s)	Retained for Quantitative Analysis	Justification
FUTURE - USE SCENARIOS CONT'D:				
Subsurface Soil	Residents (Adults and Children) (Tillett Gardens Area)	Ingestion	No	During potential future construction work (i.e., excavation activity), residents may come into direct contact with exposed subsurface soil. However, they are assumed to ingest a negligible amount of excavated subsurface soil.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	
	1- Site Workers (Employees of the Curriculum Center Building)	Ingestion	No	During potential future construction work (i.e., excavation activity), site workers may come into direct contact with exposed subsurface soil. However, they are assumed to ingest a negligible amount of excavated subsurface soil.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	
	2- (Employees of the Fire Dept., Texaco gas station, Antilles auto parts, and Ramsay motor company)	Ingestion	No	During potential future construction work (i.e., excavation activity), site workers may come into direct contact with exposed subsurface soil. However, they are assumed to ingest a negligible amount of excavated subsurface soil.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	
	3- (Employees of the Esso gas station and the Splash and Dash car wash)	Ingestion	No	During potential future construction work (i.e., excavation activity), site workers may come into direct contact with exposed subsurface soil. However, they are assumed to ingest a negligible amount of excavated subsurface soil.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	
	4- (Employees of O'Henry dry cleaners and Liquor Barn)	Ingestion	No	During potential future construction work (i.e., excavation activity), site workers may come into direct contact with exposed subsurface soil. However, they are assumed to ingest a negligible amount of excavated subsurface soil.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	
	Construction Workers (Exposure to be evaluated for the most chemically contaminated area of concern at the site - to be determined)	Ingestion	Yes	The potential exists for future commercial development of the areas of concern at the site. The inhalation routes of exposure may be of concern based on the fact that construction workers would routinely come into direct contact with soil during invasive activities. The area of concern selected for evaluation will depend on the chemical concentrations detected, toxicity, and the calculated residential risks.
		Dermal Contact*	Yes	
		Inhalation of Particulates	Yes	
		Inhalation of VOCs**	Yes	
Groundwater	Site Residents (Adults and Children)	Ingestion	Yes	Currently, an order against drinking and bathing in groundwater at the site has been issued. However, since evidence of pumping exists at the Ramsay well, residents may continue to use the groundwater in the future for these purposes in addition to secondary purposes such as clothes washing, lawn watering,
		Dermal Contact (Shower)	Yes	
		Inhalation of VOCs(Shower)	Yes	

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TUTU WELLS SITE
POTENTIAL EXPOSURE PATHWAYS

Matrix	Receptor Population(s)	Exposure Route(s)	Retained for Quantitative Analysis	Justification
FUTURE - USE SCENARIOS CONT'D:				
Groundwater				
	Site Workers (All)	Ingestion	Yes	Currently, an order against drinking and bathing in groundwater at the site has been issued. However, since evidence of pumping exists at the Ramsay well, site workers may continue to use the groundwater in the future for drinking. Site workers are not expected to shower on-site.
		Dermal Contact (Shower)	No	
		Inhalation of VOCs (Shower)	No	
	Construction Workers	Ingestion	Yes	Currently, an order against drinking and bathing in groundwater at the site has been issued. However, since evidence of pumping exists at the Ramsay well, construction workers may continue to use the groundwater in the future for drinking. Construction workers are not expected to shower on-site.
		Dermal Contact (Shower)	No	
		Inhalation of VOCs (Shower)	No	

* The dermal contact pathway can only be quantitatively evaluated for PCBs, dioxin, and cadmium as only these chemicals have established dermal absorption factors (PCBs = 6%, dioxin = 3%, and cadmium = 1%). All other chemicals will be qualitatively discussed.

** The inhalation of VOCs pathway will be evaluated for retention in or elimination from the risk assessment based on the results of the chemical concentration-toxicity screens performed for site soils in the various areas of concern and the chemicals of potential concern selected. The results of the screens and the chemicals of potential concern selected for further evaluation will be discussed with the USEPA Risk Assessment Specialist before the pathway is retained for or eliminated from quantitative analysis.

TUTU WELLS SITE
VARIABLES USED FOR CHRONIC AND SUBCHRONIC DAILY INTAKE CALCULATIONS

Matrices and Receptor Populations	Exposure Route	CONCENTRATIONS CW (mg/l)	CA/SSC (mg/m3)	CS (mg/kg)	VF (m3/kg)	CONTACT PARAMETERS SA (cm2)	PC (cm/hr)	IR (1) (variable)	RF (unitless)	AF (mg/cm2)	ABS (unitless)	FI (unitless)	TIME VARIABLES ET (hr/day)	EF (day/yr)	ED (yrs)	AT (2) (years)	CF (3) (variable)	BW (kg)
Surface Soil																		
Residents (Tillett Gardens Area)																		
Adults	Ingestion	-	-	RI Data	-	-	-	100 mg/day	-	-	-	1	-	350	24	70(24)	1E-6 kg/mg	70
Children (0-6 years)	Ingestion	-	-	RI Data	-	-	-	200 mg/day	-	-	-	1	-	350	6	70(6)	1E-6 kg/mg	15
Adults	Dermal Contact	-	-	RI Data	-	5065	-	-	-	1	(5)	-	-	350 events/yr	24	70(24)	1E-6 kg/mg	70
Children (0-6 years)	Dermal Contact	-	-	RI Data	-	1270	-	-	-	1	(5)	-	-	350 events/yr	6	70(6)	1E-6 kg/mg	15
Adults	Inhalation of Particulates	-	0.070	RI Data	-	-	-	0.83 m3/hr	0.75	-	-	-	18	350	24	70(24)	1E-6 kg/mg	70
Children (0-6 years)	Inhalation of Particulates	-	0.070	RI Data	-	-	-	0.83 m3/hr	0.75	-	-	-	18	350	6	70(6)	1E-6 kg/mg	15
Adults	Inhalation of VOCs	-	-	RI Data	(4)	-	-	0.83 m3/hr	-	-	-	-	18	350	24	70(24)	-	70
Children (0-6 years)	Inhalation of VOCs	-	-	RI Data	(4)	-	-	0.83 m3/hr	-	-	-	-	18	350	6	70(6)	-	15
Site Workers																		
Adults	Ingestion	-	-	RI Data	-	-	-	50 mg/day	-	-	-	1	-	250	25	70(25)	1E-6 kg/mg	70
	Dermal Contact	-	-	RI Data	-	1940	-	-	-	1	(5)	-	-	250 events/yr	25	70(25)	1E-6 kg/mg	70
	Inhalation of Particulates	-	0.070	RI Data	-	-	-	0.83 m3/hr	0.75	-	-	-	8	250	25	70(25)	1E-6 kg/mg	70
	Inhalation of VOCs	-	-	RI Data	(4)	-	-	0.83 m3/hr	-	-	-	-	8	250	25	70(25)	-	70
Construction Workers	Ingestion	-	-	RI Data	-	-	-	480 mg/day	-	-	-	1	-	225	1	70(1)	1E-6 kg/mg	70
Adults	Dermal Contact	-	-	RI Data	-	6125	-	-	-	1	(5)	-	-	225 events/yr	1	70(1)	1E-6 kg/mg	70
	Inhalation of Particulates	-	0.070	RI Data	-	-	-	0.83 m3/hr	0.75	-	-	-	8	225	1	70(1)	1E-6 kg/mg	70
	Inhalation of VOCs	-	-	RI Data	(4)	-	-	0.83 m3/hr	-	-	-	-	8	225	1	70(1)	-	70
Subsurface Soil																		
Residents (Tillett Gardens Area)																		
Adults	Dermal Contact	-	-	RI Data	-	5065	-	-	-	1	(5)	-	-	91 events/yr	1	70(1)	1E-6 kg/mg	70
Children (0-6 years)	Dermal Contact	-	-	RI Data	-	1270	-	-	-	1	(5)	-	-	91 events/yr	1	70(1)	1E-6 kg/mg	15
Adults	Inhalation of Particulates	-	0.070	RI Data	-	-	-	0.83 m3/hr	0.75	-	-	-	18	91	1	70(1)	1E-6 kg/mg	70
Children (0-6 years)	Inhalation of Particulates	-	0.070	RI Data	-	-	-	0.83 m3/hr	0.75	-	-	-	18	91	1	70(1)	1E-6 kg/mg	15
Adults	Inhalation of VOCs	-	-	RI Data	(4)	-	-	0.83 m3/hr	-	-	-	-	18	91	1	70(1)	-	70
Children (0-6 years)	Inhalation of VOCs	-	-	RI Data	(4)	-	-	0.83 m3/hr	-	-	-	-	18	91	1	70(1)	-	15
Site Workers																		
Adults	Dermal Contact	-	-	RI Data	-	1940	-	-	-	1	(5)	-	-	65 events/yr	1	70(1)	1E-6 kg/mg	70
	Inhalation of Particulates	-	0.070	RI Data	-	-	-	0.83 m3/hr	0.75	-	-	-	8	65	1	70(1)	1E-6 kg/mg	70
	Inhalation of VOCs	-	-	RI Data	(4)	-	-	0.83 m3/hr	-	-	-	-	8	65	1	70(1)	-	70
Construction Workers	Ingestion	-	-	RI Data	-	-	-	480 mg/day	-	-	-	1	-	65	1	70(1)	1E-6 kg/mg	70
Adults	Dermal Contact	-	-	RI Data	-	6125	-	-	-	1	(5)	-	-	65 events/yr	1	70(1)	1E-6 kg/mg	70
	Inhalation of Particulates	-	0.070	RI Data	-	-	-	0.83 m3/hr	0.75	-	-	-	8	65	1	70(1)	1E-6 kg/mg	70
	Inhalation of VOCs	-	-	RI Data	(4)	-	-	0.83 m3/hr	-	-	-	-	8	65	1	70(1)	-	70

TABLE (cont'd.)

TUTU WELLS SITE
VARIABLES USED FOR CHRONIC AND SUBCHRONIC DAILY INTAKE CALCULATIONS

		CONCENTRATIONS			CONTACT PARAMETERS							TIME VARIABLES					
Matrices and Receptor Populations	Exposure Route	CW (mg/l)	CA/SSC (mg/m3)	CS (mg/kg)	SA (cm2)	PC (cm/hr)	IR (1) (variable)	RF (unitless)	AF (mg/cm2)	ABS (unitless)	FI (unitless)	ET (hr/day)	EF (day/yr)	ED (yrs)	AT (2) (years)	CF (3) (variable)	BW (kg)
Groundwater																	
Site Residents																	
Adults	Ingestion	RI Data	-	-	-	-	2 l/day	-	-	-	-	-	350	30	70(30)	-	70
Children (0-6 years)	Ingestion	RI Data	-	-	-	-	2 l/day	-	-	-	-	-	350	6	70(6)	-	15
Adults	Dermal Contact (Shower)	RI Data	-	-	18150	(7)	-	-	-	-	-	0.2	350	30	70(30)	1E-3 l/cm3	70
Children (0-6 years)	Dermal Contact (Shower)	RI Data	-	-	5400	(7)	-	-	-	-	-	0.2	350	6	70(6)	1E-3 l/cm3	15
Adults	Inhalation(Shower)	-	(6)	-	-	-	0.6 m3/hr	-	-	-	-	0.2	350	30	70(30)	-	70
Children (0-6 years)	Inhalation(Shower)	-	(6)	-	-	-	0.6 m3/hr	-	-	-	-	0.2	350	6	70(6)	-	15
Site Workers																	
Adults	Ingestion	RI Data	-	-	-	-	1 l/day	-	-	-	-	-	250	25	70(25)	-	70
Construction Workers				-													
Adults	Ingestion	RI Data	-	-	-	-	1 l/day	-	-	-	-	-	225	1	70(1)	-	70

NOTES:

(1) Ingestion or inhalation rate
(2) 70 years for carcinogens, 30 years for noncarcinogens for adult residents, 25 years for noncarcinogens for site workers, 6 years for noncarcinogens for children and 1 year for all subchronic exposures (multiplied by 365 days).
(3) Conversion Factor
(4) The soil-to-air volatilization factor (VF) will be calculated individually for chemicals of potential concern as appropriate.
(5) Soil and sediment dermal contact absorption factors: 6% = PCBs, and 1% = cadmium.
(6) This value was modeled from RI Data.
(7) This value is the default value for water when no chemical-specific values were available in USEPA (1992d).

Other Abbreviations:

CW = Contaminant concentration in water
CA = Contaminant concentration in air
CS = Contaminant concentration in soil
SA = Skin surface area available for dermal contact
RF = Respirable fraction of particulates
AF = Soil-to-skin adherence factor
SSC = Suspended soil concentration
FI = Fraction ingested from contaminant source
ET - Exposure Time
EF = Exposure Frequency
ED = Exposure Duration
BW = Body Weight
AT = Averaging Time

or exclusion of scenarios from quantitative evaluation have been presented.

Surface soil may currently be contacted by site residents in the Tillett Gardens area and by site workers in the Curriculum Center Building area, Fire Department/Texaco gas station/Antilles auto parts/Ramsay motor company, and the O'Henry dry cleaners area. Surface soil may be contacted in the future by residents, site workers, and/or construction workers. The potential exists for further residential and/or commercial/industrial development of the site in the future. Based on this information, the possibility of exposure to potential future residents, site workers, and/or construction workers have been considered for the ingestion, dermal contact, and inhalation routes. Justifications for the inclusion or exclusion of scenarios from quantitative evaluation have been presented.

Subsurface soil could be contacted in the future (Table 8) by residents, site workers, and/or construction workers. Subsurface soil data collected at depths between two to twelve feet will be used to determine exposure point concentrations since typical excavation activities would not exceed this depth. The potential exists for further residential and commercial/industrial development of the site. Based on this information, the possibility of exposure to potential future residents, site workers, and/or construction workers has been considered for the ingestion, dermal contact, and inhalation routes. Justifications for the inclusion or exclusion of scenarios from quantitative evaluation have been presented.

Per EPA Region II CERCLA guidance, only cadmium, PCBs, and dioxin may be quantitatively evaluated for the dermal contact pathway for the soil matrix.

The inhalation of VOCs pathway will be retained as part of or eliminated from the risk assessent based on the results of the soil chemical concentration-toxicity screens and the selected chemicals of potential concern. The USEPA Risk Assessment Specialist will be consulted before any inhalation of VOCs pathway is eliminated from further consideration.

3.2 Groundwater

Groundwater obtained from wells at the site is currently restricted to secondary uses such as clothes washing and lawn watering. An order against drinking the groundwater at the site has been issued and an alternate source of water has been provided to residents and businesses (i.e., water is brought in by truck). Although an institutional control on groundwater has been put into place, it cannot guarantee that residents or businesses are not using and will not use the groundwater since the wells are not abandoned. Evidence exists which shows that pumping has occurred recently at the Ramsay well. Therefore, it is reasonable to assume that human receptors are using the site groundwater at present and may continue to use it in the future for secondary purposes (clothes washing and lawn watering) and potentially for primary purposes (drinking and bathing). Based on this, the possibility of exposure to current residents and site workers via the ingestion, dermal contact, and inhalation routes and future residents, site workers and construction workers via the ingestion, dermal contact, and inhalation routes have been considered for quantiative evaluation. Justifications for the inclusion or exclusion of scenarios from quantiative evaluation have been presented.

4.0 DOSE/RESPONSE PARAMETERS

In the toxicity assessment portion of the risk assessment, the relationship between the potential level of exposure (dose) and the likelihood and/or severity of adverse effects (response) will be evaluated. As part of this evaluation, available toxicity values or dose/response parameters for the chemicals detected at the site will be compiled. These dose/response parameters will be used in the chemical concentration-toxicity screens and integrated with chemical intake levels derived in exposure assessment to characterize the level of potential risks and health effects.

Dose/response parameters have been developed by EPA for the evaluation of both noncarcinogenic and carcinogenic effects of exposure to humans. The oral and inhalation reference doses (RfDs) are the toxicity values used to evaluate noncarcinogenic effects resulting from exposure. The oral and inhalation slope factors (SFs) are used to evaluate potential carcinogenic effects. Oral RfDs and inhalation reference concentrations (RfCs), as well as SFs derived for oral and inhalation exposures, are available through EPA's on-line Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables (HEAST) Annual FY-1993 and Supplement Numbers 1. When a value is not available through these sources, the Superfund Health Technical Support Center will be consulted.

4.1 Noncarcinogenic Effects

4.1.1 Definition and Derivation of Reference Doses

Toxicity values are available depending on the exposure route (oral or inhalation), the critical effect, and the length of exposure (subchronic or chronic) to be evaluated. Chronic and subchronic oral and inhalation RfDs may be used to evaluate noncarcinogenic effects. A chronic RfD is defined as an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of harmful effects during a lifetime. Chronic RfDs are specifically developed to be protective of long-term exposure to a chemical, and are defined as exposure periods exceeding seven years (approximately ten percent of a human lifetime of 70 years). Subchronic RfDs are used to characterize potential noncarcinogenic effects associated with shorter-term exposure periods between two weeks and seven years.

RfDs are derived by EPA based on the concept of a threshold. For many noncarcinogenic effects, protective mechanisms may exist which must be overcome before an adverse effects is manifested. A range of exposure levels may be tolerated by an organism before an adverse effect occurs. In the development of the RfDs, human epidemiological and clinical studies, and experimental animal studies are reviewed to identify the upper-bound of the tolerance range (i.e., maximum subthreshold level) which is protective of sensitive individuals in the population. The no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) is generally used to describe this level and is the basis for the derivation of the RfD. Uncertainty

and modifying factors are then applied to the NOAEL, depending on the quality and the applicability of the available animal or human toxicity study, as the final step in the derivation of the RfD. The resultant oral RfD is expressed in terms of unit concentration of a compound (mg) per unit body weight (kg) per unit time (day) or mg/kg/day.

Inhalation RfCs, expressed in mg/m^3, are derived by interim methods adopted by EPA in 1988. These methods differ slightly from those used for the derivation of RfDs because of (1) dynamics of the respiratory system and its diversity across species, and (2) differences in physicochemical properties of contaminants, such as size and shape of a particle. The RfC value is reported as a concentration in air (mg/m^3), although it may be converted to a corresponding inhaled dose (mg/kg/day) by dividing by 70 kg body weight and multiplying by 20 m^3/day inhalation rate.

4.1.2 RfDs for Detected Chemical Contaminants

Chronic and subchronic oral and inhalation RfDs and the uncertainty factors associated with them will be presented in the risk assessment for all chemicals detected at the site having such established values.

Only a limited number of inhalation RfDs are available. Those chemicals of potential concern having available RfD values will be evaluated via the inhalation route of exposure. Otherwise, they can only be qualitatively addressed.

4.2 Carcinogenic Effects

4.2.1 Definition and Derivation of Slope Factors

The carcinogenic slope factor and the accompanying weight-of-evidence classification are used to evaluate potential human carcinogenic risks associated with exposures. The hypothesized mechanism of carcinogenesis is based on the concept of nonthreshold effects (i.e., there is essentially no level of exposure to a chemical that does not pose some probability of generating a carcinogenic response).

In defining the potential carcinogenicity of a chemical contaminant to humans, EPA (CERCLA) first evaluates the sufficiency of evidence of carcinogenicity from available data. The evidence is characterized separately for human and animal studies as sufficient, limited, adequate, no data, or evidence of no effect. The characterizations of these two sets of data are evaluated in combination and the chemical is assigned a "weight-of-evidence" classification. EPA has five groups of classification which are as follows:

A	-	Human Carcinogen.
B1	-	Probable Human Carcinogen. Limited human data are available.
B2	-	Probable Human Carcinogen. Sufficient evidence of carcinogenicity in animals and inadequate or no evidence in humans.

C - Possible Human Carcinogen.
D - Not Classifiable as to human carcinogenicity.
E - Evidence of noncarcinogenicity for humans.

For Group A, B1, and B2 carcinogens, EPA typically derives a carcinogenic slope factor. Slope factors for Class C carcinogens are derived on a case-by-case basis. The slope factor defines quantitatively the relationship between dose and response as the plausible upper-bound estimate of the probability of a response (i.e., development of cancer) per unit intake of a potential carcinogen over a lifetime.

The slope factor is derived by EPA by selecting the most appropriate data set, extrapolating to lower doses, determining equivalent human doses for the appropriate route of exposure (ingestion or inhalation), and application of uncertainty factors. The resultant slope factor is expressed in terms of risk per unit concentration of the compound (mg) per unit body weight (kg) per unit time (day) or $(mg/kg/day)^{-1}$.

4.2.2 Slope Factors for Detected Chemical Contaminants

Oral and inhalation slope factors and weight-of-evidence classifications for potentially carcinogenic chemicals detected at the Tutu Wells site will be presented in the risk assessment for all chemicals detected at the site having such established values.

For certain carcinogenic PAHs, interim toxicity equivalency factors (TEFs) will be used in conjunction with the benzo(a)pyrene slope factor since benzo(a)pyrene is the only carcinogenic PAH having established slope factors (oral and inhalation).

5.0 RISK CHARACTERIZATION

In this section of the risk assessment, toxicity and exposure assessments will be integrated into quantitative and qualitative expressions of carcinogenic risk and noncarcinogenic hazards. The estimate of risk and hazard will be expressed numerically in spreadsheets contained in an appendix.

Carcinogenic risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. Per RAGS guidance, the slope factor converts estimated daily intakes averaged over a lifetime of exposure directly to incremental risk of an individual developing cancer. This carcinogenic risk estimate is generally an upper-bound value since the slope factor is often an upper 95th percentile confidence limit of the probability of response based on experimental animal data used in the multistage model.

The potential for noncarcinogenic effects will be evaluated by comparing an exposure level over a specified time period with a reference dose/concentration derived for a similar exposure period. This ratio of exposure to toxicity is referred to as a hazard quotient. This hazard quotient assumes that there is a level of exposure below which it is unlikely even for sensitive populations to experience adverse health effects. If the hazard quotient exceeds one, there may be concern for potential noncancer effects, however, this value should not be interpreted as a probability. Generally, the greater the hazard quotient above unity, the greater the level of concern.

In general, EPA recommends a target value or a risk range (i.e., hazard index = 1 or risk = 10^{-4} to 10^{-6}) as threshold values for potential human health impacts. The results presented in the spreadsheet calculations will be compared to these target values and discussed. These values aid in determining the objectives of the baseline risk assessment which include determining whether additional response action is necessary at the site, by providing a basis for determining residual chemical levels that are adequately protective of human health, by providing a basis for comparing potential health impacts of various remedial alternatives, and to help support selection of the no-action remedial alternative, where appropriate.

Carcinogenic risks and noncarcinogenic hazard indices will be combined across pathways as appropriate. Applicable or relevant and appropriate requirements (ARARs) will be presented for the appropriate chemicals and will be compared to groundwater concentrations detected at and around the site, as appropriate.

6.0 UNCERTAINTIES IN RISK ASSESSMENT

In any risk assessment, estimates of potential carcinogenic risk and noncarcinogenic health effects have numerous associated uncertainties. The primary areas of uncertainty and limitations will be qualitatively discussed. In addition, central tendency calculations will be performed as a quantitative measure of uncertainty, where appropriate.

7.0 PRELIMINARY REMEDIATION GOALS (PRGs)

Chemical-specific PRGs are concentration goals for individual chemicals for specific medium and land use combinations at CERCLA sites. PRGs will be developed based on the risk assessment (i.e., risk-based PRGs). Site-specific parameters will be used in place of default values, where appropriate, to reflect site conditions. Such risk-based PRGs are only initial guidelines and do not establish that cleanup to these goals is warranted.

8.0 SUMMARY OF THE BASELINE RISK ASSESSMENT

A summary section will be presented to briefly discuss the results of the baseline human health risk assessment.

ECOLOGICAL RISK ASSESSMENT

An ecological assessment will also be completed by CDM Federal for the Tutu Wells site. This ecological assessment will be performed to characterize the impacts or potential impacts of chemical contaminants on ecological receptors at the site and adjacent areas. The objective of the ecological assessment is to identify the probability and types of adverse effects that may result from the presence of chemical contaminants.

The ecological assessment will be prepared in accordance with the following EPA guidance documents:

- Framework for Ecological Risk Assessment (EPA/630/R-92-001, February 1992);
- Eco Update (Publication 9345.0-05I, Volume I, Numbers 2 and 4, 1991 and 1992);
- Ecological Assessment of Hazardous Waste Sites: Field and Laboratory Reference (EPA/600/3-89/013, March 1989); and,
- Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (EPA/540/1-89/001, March 1989).

As described in the above EPA guidance, the key components to the ecological assessment will be included and are as follows:

- Problem Formulation (Hazard Identification)
- Exposure Assessment
- Toxicity Assessment (Ecological Effects Assessment)
- Risk Characterization
- Uncertainties and Limitations

1) Problem Formulation

The problem formulation section will define the objectives and scope of the ecological assessment. Description of site history, environmental setting, nature and extent of contamination, and habitat characterization will be included.

If necessary, a selection of chemical contaminants of concern will be performed to identify dominant site ecological risks. The selection process will involve for each detected chemical:

- Evaluation of detection frequency;
- Comparison to background concentrations;
- Comparison to applicable and relevant and appropriate requirements (ARARs) and/or media quality guidelines;
- Evaluation of physical/chemical properties; and,
- Consideration of potential toxicity.

Site-related indicator species will be chosen as ecological representatives of the trophic levels and habitats on and surrounding the site. Selection will be based on an integration of the types and distribution of contaminants of concern, habitats, range and feeding habits of potential ecological receptors, and relationships between the observed/expected species in the area of concern. Other considerations include species that may have beneficial uses to humans and species that are Trustee or regulatory concerns.

For this qualitative or semi-qualitative ecological assessment, assessment endpoints will be benchmark toxicity values from the literature. Where appropriate, risks to receptors will be evaluated using ambient media quality criteria and similar guidance.

2) Exposure Assessment

The exposure assessment will discuss the magnitude and type of actual or potential exposures of ecological receptors to site contamination. Exposure pathways and scenarios will be presented.

Tutu Wells site chemicals have been detected in the groundwater, surface soil, and subsurface soil. These environmental media will be evaluated in terms of potential exposure pathways. However, it is anticipated that groundwater does not present an exposure pathway since ecological receptors are likely to contact chemicals associated with the groundwater only when groundwater discharges to surface water. Likewise, ecological receptor contact with subsurface soil below approximately two feet is not expected, thus, subsurface soil data at greater than two feet will not be considered.

A simplified food web will be presented as part of the exposure assessment section. The food web will include ecological receptor groups expected to come into contact with site contaminants and their trophic relationships.

3) Toxicity Assessment

The toxicity assessment will link potential contaminant exposure point concentrations to adverse effects in selected ecologicial receptors. The goal of the toxicity assessment is to allow for the determination of toxic effects of the Tutu Wells site chemicals of potential concern on selected receptors. Ecological toxicity data will be gathered primarily from the following literature and data bases:

- EPA's ambient water quality criteria documents,
- Aquatic Information Retrieval Database (AQUIRE), and,
- Hazardous Substances Data Bank (HSDB).

The open literature will be also consulted, as necessary, for further toxicological information.

Additionally, site-related ecological effects information will be discussed in the toxicity assessment.

4) Risk Characterization

Risk characterization will evaluate the evidence linking site contaminants with adverse ecological effects. Risk characterization will integrate the exposure assessment with the toxicity assessments. Characterization of risks to site ecological receptors will be determined on the basis of comparison of ecotoxicological values from the literature with site-surveyed contaminant levels. Risks to ecological receptors indicated by site-specific ecotoxicological information will also be discussed.

5) Uncertainties and Limitations

In the process of developing a risk assessment, it is necessary to make assumptions. Assumptions carry with them associated uncertainties which must be identified so that risk estimates can be put into perspective. Uncertainties and limitations associated with the ecological assessment will be discussed.