UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
1 CONGRESS STREET, SUITE 1100
BOSTON, MASSACHUSETTS 02114-2023

May 31, 2002

Ms. Lauren Levine
United Technologies Corporation
United Technologies Building
Hartford, CT 06101

Re: RCRA Corrective Action
Pratt & Whitney, North Haven facility
EPA ID No. CTD001449511

Dear Ms. Levine:

The United States Environmental Protection Agency (EPA) is pleased to inform you that EPA has determined that the Pratt & Whitney North Haven facility has achieved the federal goal of Stabilization.

EPA New England considers Stabilization as the achievement of the two Environmental Indicators (EI), *Current Human Exposures Under Control* and *Migration of Contaminated Groundwater Under Control*. These EI's were originally set forth in a July 29, 1994 memorandum by then Director of EPA's Office of Solid Waste, Michael Shapiro. This memorandum has been the subject of recent amendments; the most current amendment to the EI's is set forth in a February 5, 1999 Interim Final memorandum under Acting Director of EPA's Office of Solid Waste, Elizabeth Cotsworth.

Stabilization is an interim goal meaning that the environmental conditions at a given site/facility do not pose a current risk to human health. You should be aware, therefore, that any change in facility operations or land use which results in a human health exposure scenario would affect this determination.

Also, because Stabilization is an interim goal, facilities that achieve the goal of Stabilization should be aware that they will be expected to achieve the goal of a final remedy at some point in the future. Facilities should be particularly careful when considering construction activities which could ultimately impact the ability to achieve a final remedy.

Thank you for your continuing commitment to environmental excellence. If you have any questions, please do not hesitate to contact me at (617) 918-1369.

Sincerely,

Ernest R. P. Waterman,
RCRA Corrective Action Section

cc: M. Hoagland EPA
D. Ringquist CT DEP

DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION MIGRATION OF CONTAMINATED GROUNDWATER UNDER CONTROL

Pratt & Whitney
415 Washington Avenue
North Haven, CT

March 2000
Revised:
September 2000
May 2001

Prepared for

PRATT & WHITNEY
400 Main Street
East Hartford, CT 06108

Prepared by

LOUREIRO ENGINEERING ASSOCIATES
100 Northwest Drive
Plainville, CT 06062

LEA Comm. No. 68VF201

Pratt & Whitney
415 Washington Avenue
North Haven, Connecticut

March 2000
Revised:
September 2000
May 2001

PREPARED FOR:

PRATT & WHITNEY
400 Main Street
East Hartford, CT 06108

PREPARED BY:

LEA

Loureiro Engineering Associates, Inc.
100 Northwest Drive
Plainville, Connecticut 06062

Comm. No.68VF201

DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION

Interim Final 2/5/99

Migration of Contaminated Groundwater Under Control

Facility Name:	**Pratt & Whitney, North Haven Facility**
Facility Address:	**415 Washington Avenue**
Facility EPA ID #:	**CTD001449511**

1. Has **all** available relevant/significant information on known and reasonably suspected releases to the groundwater media, subject to RCRA Corrective Action (e.g., from Solid Waste Management Units (SWMU), Regulated Units (RU), and Areas of Concern (AOC)), been **considered** in this EI determination?

 X If yes - check here and continue with #2 below.

____ If no - re-evaluate existing data, or

____ if data are not available, skip to #8 and enter "IN" (more information needed) status code.

BACKGROUND

Definition of Environmental Indicators (for the RCRA Corrective Action)

Environmental Indicators (EI) are measures being used by the RCRA Corrective Action program to go beyond programmatic activity measures (e.g., reports received and approved, etc.) to track changes in the quality of the environment. The two EI developed to-date indicate the quality of the environment in relation to current human exposures to contamination and the migration of contaminated groundwater. An EI for non-human (ecological) receptors is intended to be developed in the future.

Definition of "Migration of Contaminated Groundwater Under Control" EI

A positive "Migration of Contaminated Groundwater Under Control" EI determination ("YE" status code) indicates that the migration of "contaminated" groundwater has stabilized, and that monitoring will be conducted to confirm that contaminated groundwater remains within the original "area of contaminated groundwater" (for all groundwater "contamination" subject to RCRA corrective action at or from the identified facility (i.e., site-wide)).

Relationship of EI to Final Remedies

While Final remedies remain the long-term objective of the RCRA Corrective Action program the EI are near-term objectives which are currently being used as Program measures for the Government Performance and Results Act of 1993, GPRA). The "Migration of Contaminated Groundwater Under Control" EI pertains ONLY to the physical migration (i.e., further spread) of contaminated ground water and contaminants within groundwater (e.g., non-aqueous phase liquids or NAPLs). Achieving this EI does not substitute for achieving other stabilization or final remedy requirements and expectations associated with sources of contamination and the need to restore, wherever practicable, contaminated groundwater to be suitable for its designated current and future uses.

Duration / Applicability of EI Determinations

EI Determinations status codes should remain in RCRIS national database ONLY as long as they remain true (i.e., RCRIS status codes must be changed when the regulatory authorities become aware of contrary information).

2. Is **groundwater** known or reasonably suspected to be **"contaminated"**[1] above appropriately protective "levels" (i.e., applicable promulgated standards, as well as other appropriate standards, guidelines, guidance, or criteria) from releases subject to RCRA Corrective Action, anywhere at, or from, the facility?

__X__ If yes - continue after identifying key contaminants, citing appropriate "levels," and referencing supporting documentation.

____ If no - skip to #8 and enter "YE" status code, after citing appropriate "levels," and referencing supporting documentation to demonstrate that groundwater is not "contaminated."

____ If unknown - skip to #8 and enter "IN" status code.

Rationale and Reference(s):

A report entitled *Conceptual Site Models and Screening Levels for Pratt & Whitney's VCAP Connecticut Facilities*, was prepared by Gradient Corporation (Gradient Report). This report was issued on December 19, 1997 and revised on September 18, 1998 and September 15, 1999. A copy of applicable portions of this report, those portions addressing the North Haven facility, has been included in Attachment No. 1. For the North Haven facility, the Gradient Report provides a facility-specific conceptual site model, a description of facility-specific exposure media and exposure pathways, a description of potential receptors, a rationale and approach to screening analytical data generated for exposure media, and screening levels for exposure media. For the North Haven Facility, the Gradient Report identifies the applicable receptors, exposure media and pathways that require screening as follows:

1) Groundskeepers, Samplers, Trespassers and On-site Recreators: surface soil by ingestion and dermal contact (Table 3-10);
2) Maintenance and Indoor Workers, Samplers and On-site Recreators: indoor air inhalation (Table 3-4);
3) Off-site Residents: indoor air by inhalation (Table 3-5);
4) Samplers: surface water, ingestion and dermal contact (Tables 3-6, 3-7 and MCLs (for process water potentially affecting surface water and sediment));
5) Trespassers and Off-site Recreators: surface water, ingestion and dermal contact (Tables 3-6 and 3-7);
6) Samplers, Trespassers and Off-site Recreators: sediment, ingestion and dermal contact (Table 3-10);
7) Maintenance Workers: groundwater by dermal contact (Table 3-8), and;
8) Indoor Workers: groundwater by dermal contact (MCLs for process water only).

This documentation of environmental indicator determination is based on a review of all available relevant/significant data as it applies to these receptors for the identified exposure media and pathways.

The following discussions and resulting conclusions are based on the review and evaluation of available groundwater data for the site. Specifically, the discussions and resulting conclusions are based on the following:

- Groundwater samples collected from groundwater monitoring wells installed at the Pratt & Whitney North Haven facility as part of the Voluntary Corrective Action program (VCAP) groundwater monitoring since December 1998;
- Over 150 different groundwater sampling locations (i.e. monitoring wells, piezometers, etc.) sampled since January 1982;
- Three (3) powerhouse groundwater dewatering wells and the six (6) facility process water wells have been sampled since May 1979; and
- University of Waterloo field studies performed in 1999 and 2000 to evaluate the effect of a sheet-pile cell on dissolved-phase groundwater contamination emanating from the location of an historic release of industrial solvent.

Site plans for the North Haven facility indicating groundwater sampling locations are provided in Attachment No. 2. Each of the site plans depict topographic features for the site. A complete listing of constituents in groundwater for which samples were analyzed is provided in Attachment No. 3. To present a hardcopy table of all sample results, or even a hardcopy table of all detected constituents in groundwater, would be too voluminous to include in this document. The groundwater analytical data set can be submitted electronically under a separate cover.

Site geology has been identified in the course of multiple site investigations. The unconsolidated deposits on the site have been differentiated into three units. The upper most unit consists of brown to red, fine to medium sand with some to trace quantities of gravel and little silt. The intermediate unit is composed of red and brown silt and clay. A lower sand unit is present beneath the silt and clay. A basal till layer was also reported in some soil borings. Geologic cross-sections previously prepared by Fuss & O'Neill, Inc. are provided in Attachment No. 2.

The site hydrogeology has been interpreted from soil borings and on-site monitoring wells as consisting of four distinct zones within the unconsolidated aquifer. These zones are related to the upper sand unit; the silt/clay layer; the lower sand unit; and the northwest corner of the site where the silt/clay layer is absent and the lower and upper sand units combine. The silt/clay layer, where present, acts as a semi-confining layer.

Groundwater flow in the upper aquifer, as interpreted from water levels measured in the on-site monitoring wells, is generally from east to west toward the Quinnipiac River.

There are, however, local inconsistencies due to groundwater withdrawal from the process wells, and the absence of the silt/clay layer in the vicinity of the process wells PW-01N and PW-02D and the presence of the former surface impoundments (located in the central portion of the site). It should be noted, the former surface impoundments currently exist as a pond in the central portion of the site. The pond is a surficial representation of groundwater and is neither fed nor drained by a stream. For example, groundwater contours developed from water table elevations observed during the December 1998 VCAP sampling (see Groundwater Monitoring Data site plan provided in Attachment No. 2) indicate a localized northwest gradient at the northwest corner of the site which may be attributed to these two process wells located in that area. A review of process well usage indicates that only PW–02 and PW–06 have been used for pumping at the facility since January 1998. During this period the majority of process well water usage was from PW-02, but PW-06 was used between June and September 1999. The groundwater contours generated for December 1998 (during a period of pumping from only PW-02) depicting a localized northwest gradient in the vicinity of process well PW-02 appear to support that localized groundwater flow is influenced by the pumping from this well.

Groundwater flow direction observed in the lower sand unit of the aquifer is consistent with regional north-to-south flow toward the Quinnipiac River. However, as noted above, the flow pattern on the Pratt & Whitney site is also influenced by pumping from the process wells.

The groundwater data provided in the attachments have been compared to the numeric screening levels published in the Gradient Report. Specifically, the groundwater data were compared to the numeric screening criteria published in Tables 3-7 and 3-8 of the above referenced report, as well as the MCLs. The groundwater monitoring well network at the site is determined adequate in number and spatial distribution to assess the quality of groundwater that discharges to surface water bodies at the site and the potential for exposure to maintenance and indoor workers.

To address potential exposures to Maintenance Workers while servicing and maintaining facility dewatering pumps, the groundwater data from the three (3) power house groundwater dewatering wells was compared to the numeric screening criteria listed in Table 3-8 of the Gradient Report. The table is titled *Generic P&W Groundwater Screening Levels Based on Dermal Contact, P&W VCAP, Connecticut Facilities.* There were no exceedances of the generic screening criteria for these dewatering wells. Attachment No. 3 includes a database listing of constituents for groundwater collected from the power house groundwater dewatering wells.

To address potential exposures to Indoor Workers from contact with process waters, the groundwater data from the three (3) power house groundwater dewatering wells and the six (6) process water wells was compared to the MCLs. The power house dewatering wells were included in the data set because water from these wells is combined with the facility's process water. Exceedances were identified for: cadmium, manganese, nickel, nitrate (as N), 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,1-dichloroethylene, chloroform, tetrachloroethylene, trichloroethylene and vinyl chloride. See Attachment No. 3 for database listings of constituents analyzed for groundwater collected from the power house groundwater dewatering wells and the facility process water wells, as well as tables of exceedances of the MCLs for these wells.

However, a closer evaluation of the data indicates that use of groundwater as process water is not expected to pose significant risks. The screening results presented in Question No. 2 utilized all available data from the on-site process wells and the power house wells, with some measurements from the late 1970s. However, groundwater concentrations have declined significantly over time at these locations. To account for this declining trend in concentrations, the following data set was used to screen against risk-based criteria developed for Indoor Workers (presented in Attachment No. 1):

Process Wells — Since a comprehensive data base exists for the process wells (designated as "PW" in Table 1 and Table A in Attachment No. 3), the maximum value detected in the last eight monitoring events was used; and

Power House Wells — Since the database for these wells is smaller as compared to the process wells, the maximum recorded value for each chemical at these wells was used.

The screening results are presented in the table below[1]:

Chemical	Exposure Concentration (μg/l)	Risk-based Criteria for Indoor Workers (μg/l)
Process Wells		
1,1,2-Trichloroethane	21	906
Trichloroethylene	34	1,936
Tetrachloroethylene	46	18
Nitrate	17,350	4,866,667
Power House Wells		
Trichloroethylene	620	1,936
Tetrachloroethylene	13	18
Nickel	120	657,000
Chloroform	130	8,094
1,1-Dichloroethylene	16	35
Manganese (total)	119	340,667

1 The approach of screening groundwater concentrations against criteria is conservative, *i.e.*, health-protective, because it ignores any loss of VOCs from the well head to the point of use. In addition, the data used in the screening is approximately 4 to 9 years old, and current groundwater concentrations are expected to be even lower due to ongoing groundwater use.

The screening results indicate that concentrations for all chemicals, except tetrachloroethylene (PCE), were less than the risk-based criteria. The maximum PCE concentration at the process wells was approximately 2.5 times the screening level. Since the screening criteria for PCE is based on a cancer risk of 1×10^{-6}, the maximum PCE concentration represents a cancer risk of 2.5×10^{-6}, *i.e.*, within the range of cancer risks (10^{-6} to 10^{-4}) considered acceptable by USEPA. Furthermore, because concentrations for the other chemicals did not exceed the risk-based criteria, the incremental contribution to total risks from these chemicals is expected to be less than 1×10^{-6}, *i.e.*, insignificant. Overall, the total human health risks posed to Indoor Workers as a result of usage of groundwater as process water are not expected to be significant.

To address potential exposures to Samplers from contact with surface water that might be affected by the discharge of facility process waters, the groundwater data from the three (3) power house groundwater dewatering wells and the six (6) process water wells was compared to the MCLs. The power house dewatering wells were included in the data set because water from these wells is combined with the process water. Exceedances of the MCLs were identified for: cadmium, manganese, nickel, nitrate (as N), 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,1-dichloroethylene, chloroform, tetrachloroethylene, trichloroethylene and vinyl chloride.

To address potential impacts to surface water bodies, the groundwater data for the site was compared to the numeric screening criteria listed in Table 3-7 of the Gradient Report. The table is titled *Generic P&W Groundwater Screening Levels (SLs) Based on Surface Water Protection, P&W VCAP, Connecticut Facilities*. A total of 62 wells (three (3) power house wells, six (6) process wells and 53 monitoring wells) had compounds that exceeded the screening criteria in Table 3-7. These compounds include: aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, silver, zinc, cyanide (total), carbon tetrachloride, 1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethylene, cis-1,2-dichloroethylene, tetrachloroethylene, trans-1,2-dichloro-ethylene, trichloroethylene, dichlorodifluoromethane and MTBE. Attachment No. 3 includes a database listing of groundwater constituents exceeding Table 3-7 criteria.

The potential for exposure to Off-site Residents by indoor air impacted by volatile organic compounds in groundwater was indeterminate at the time of the Gradient Report because it was unclear if groundwater contaminant plumes had the potential to impact residential areas. From a review of the available groundwater analytical data, coupled with the fact that groundwater flow at the site is towards the Quinnipiac River, it is concluded that contaminated groundwater at the site does not have the potential to impact abutting residential areas. Groundwater contours developed during the December 1998 VCAP sampling event depicted on the Groundwater Monitoring Data site plan provided in Attachment No. 2 support this conclusion. Further information supporting the conclusion that contaminated groundwater at the site does not have the potential to impact adjoining residential areas is provided in a response to Question 4 below. The information is in the form of a study performed by the University of Waterloo to assess the degree and extent of dissolved-phase groundwater contamination emanating from an historic release of industrial solvent, the majority of which is contained by a sheet-pile cell. The results of the study further support the conclusion that contaminated groundwater flows toward the Quinnipiac River and does not flow in the direction of abutting residential areas.

Footnotes:

[1]"Contamination" and "contaminated" describes media containing contaminants (in any form, NAPL and/or dissolved, vapors, or solids, that are subject to RCRA) in concentrations in excess of appropriate "levels" (appropriate for the protection of the groundwater resource and its beneficial uses).

3. Has the **migration** of contaminated groundwater **stabilized** (such that contaminated groundwater is expected to remain within "existing area of contaminated groundwater"[2] as defined by the monitoring locations designated at the time of this determination)?

__X__ If yes - continue, after presenting or referencing the physical evidence (e.g., groundwater sampling/measurement/migration barrier data) and rationale why contaminated groundwater is expected to remain within the (horizontal or vertical) dimensions of the "existing area of groundwater contamination"[2]).

_____ If no (contaminated groundwater is observed or expected to migrate beyond the designated locations defining the "existing area of groundwater contamination"[2]) - skip to #8 and enter "NO" status code, after providing an explanation.

_____ If unknown - skip to #8 and enter "IN" status code.

Rationale and Reference(s):

At the time of this determination, the groundwater monitoring well network on the site consists of approximately 100 groundwater monitoring well locations. In general, wells with an "S" designation in their location identification designation are constructed such that the screen section intersects the groundwater table. Those wells with a "D" in the location identification designation are typically constructed with screen sections immediately above the bedrock/unconsolidated material interface. Details of well construction for process wells ("PH" and "PW") are unknown.

Historically, over 150 different groundwater sampling locations (i.e. monitoring wells, temporary wells, piezometers, etc.) have been sampled since January 1982. In addition, three (3) power house groundwater dewatering wells and the six (6) facility process water wells have been sampled since May 1979. Site plans for the North Haven facility indicating groundwater sampling locations are provided in Attachment No. 2. A complete listing of constituents in groundwater for which samples were analyzed is provided in Attachment No. 3. To present a table of all sample results, or even a table of all detected constituents in groundwater, would be too voluminous to include in this document. If desired, these tables can be provided upon request.

An area of groundwater contamination located at the facility is presently under study by various outside parties, including the University of Waterloo (UW), as part of scientific research into proposed remediation technologies for dense non-aqueous phase liquids (DNAPL). This area, commonly referred to as the "sheet-pile cell" or, alternately, the former "area of concern no. 17" (AOC17), is the site of an historic trichloroethylene

(TCE) release (see location on the site plan provided in Attachment No. 2). The majority of this TCE release is presently contained within the limits of a sheet pile perimeter installed to the depth of a confining silt/clay aquitard located beneath the DNAPL release. The sheet-pile cell was installed in November and December of 1994. In 1999 and 2000 the UW performed field studies to evaluate the effect of the sheet-pile cell on dissolved-phase groundwater contamination emanating from the release area. The results of the study are summarized in the following paragraphs and are provided herein. The results support the conclusion that contaminated groundwater plumes are decreasing with time and will remain within the limits as defined by the monitoring locations designated at the time of this determination. Figures referenced in the following paragraphs have also been provided in Attachment No. 2.

During the performance of the investigation, the UW collected groundwater samples from discrete sampling locations along three transects oriented roughly perpendicular to the groundwater flow direction at the site. Groundwater samples were collected during two events in July and October 1999. At each monitoring location along the transects, groundwater samples were collected at depth-discrete vertical intervals using either multilevel bundle samplers (which are permanent installations, thus allowing temporal sampling) or the Waterloo Profiler (temporary sample locations). Volatile organic compound analyses were typically performed in the field using a portable SRI GC housed in a mobile laboratory.

Transect 1

Included in Attachment No. 2 are plots showing TCE and cis-dichloroethylene (cis-DCE) contours along Transect 1. These figures were compiled from analytical data for groundwater samples collected during the July and October 1999 sampling events. Note that this figures are vertically exaggerated by a factor of 30. TCE was the predominate VOC detected along this transect. The highest TCE concentration observed along this transect was approximately 34,000 μg/l. The highest concentrations are present at the base of the aquifer, consistent with the nature of the upgradient TCE DNAPL source zone. The dissolved-phase VOC plume is over 800 ft wide along this transect.

Transect 2

Included in Attachment No. 2 are plots showing TCE and cis-dichloroethylene contours along Transect 2 in 1999. The highest concentrations occur in the vicinity of where the small stream crosses the Transect, just north of the pond. The highest TCE concentration along the transect was about 3,000 μg/l (roughly an order of magnitude lower than the highest concentration detected along Transect 1). The cis-DCE plume generally overlaps the TCE plume, although the concentrations are generally lower (the maximum cis-DCE concentration was about 150 μg/l). This indicates that some TCE transformation is occurring to cis-DCE. The southern end of the plume was not fully delineated characterized in 1999 and additional multilevel wells were installed in 2000 to delineate the southern end of the plume. Along the transect just downgradient of the pond, a "clean" zone occurs where TCE concentrations were below detection limits, except at the base of the aquifer. It is expected that this is a result of recharge from the pond, with only a portion of the plume passing under the pond. The pond was sampled at a few locations near the upgradient bank in August 2000, and all samples had detectable TCE and cis-DCE, with the highest concentrations in the mg/L range.

Transect 3

Included in Attachment No. 2 are plots showing TCE and cis-DCE contours along Transect 3, located just upgradient of the Quinnipiac River. These figures were compiled from analytical data for groundwater samples collected during the July and October 1999 sampling events. The peak TCE concentration along this transect was less than 50 μg/l (roughly two orders of magnitude lower than the maximum observed concentration along Transect 2). The cis-DCE concentrations along this transect are in a similar range as TCE (i.e. 10's of μg/l).

Dissolved VOC Concentrations vs. Distance

The results of the study performed by UW show a significant drop in peak TCE concentrations, of about 3 orders of magnitude, over the 1200 ft travel distance between the western edge of the facility and the river. UW has concluded that it expects that several attenuation mechanisms are at work, including dispersion, discharge to the pond and streams, diffusion into (and out of) the underlying aquitard, and degradation. It is also expected that the plume is dissipating, as a significant portion of the source zone has been cut-off through the installation of the sheet-pile cell.

Groundwater Flow Direction

As discussed in the response to Question 2 above, a groundwater contour map had been developed for the 1998 VCAP groundwater sampling event. Additionally, the UW generated a groundwater contour map utilizing data collected in September 1999. This map, provided in Attachment No. 2, supports the previous conclusion that groundwater flow at the site is toward the Quinnipiac River and that contaminated groundwater at the site also flows to the Quinnipiac River.

A comparison of the groundwater data from wells sampled recently (i.e. since 1995) does not indicate that contaminated groundwater is migrating to non-impacted areas of the site. (Refer to Question No. 5 for further discussion). Additionally, there are no discernible increasing trends for any of the constituents detected. Based on the investigations performed by UW, coupled with the historic groundwater data for the site, it is concluded that contaminated groundwater exists at the site, the concentrations of dissolved-phase contaminants in groundwater have decreased significantly over time, and the contaminated groundwater has and will continue to dissipate in the direction of groundwater flow at the site (i.e. toward the Quinnipiac River).

The network of groundwater sampling locations is determined to be adequate for the purposes of defining northern, southern, eastern, and the vertical limits of contaminated groundwater at the site. The western limit of contamination at the site is inferred to be the Quinnipiac River. While it is likely that the majority of groundwater within the upper sand unit discharges to the river, it is possible that groundwater within lower portion of the unconsolidated aquifer does not discharge to the Quinnipiac River in the vicinity of the site. Groundwater in the lower zones of the unconsolidated aquifer (beneath the upper sand unit) likely flows from the northeast to southwest and along the predominant flow component of the river (south) within the Quinnipiac River valley. Therefore, it is seen as unlikely that contaminated groundwater from the site extends a significant distance beyond the western banks of the Quinnipiac River. Based on the above discussions, it is concluded that the migration of contaminated groundwater has stabilized (i.e. is expected to remain within the existing area of contaminated groundwater as defined by the monitoring locations designated at the time of this determination).

Footnotes:

[2] "existing area of contaminated groundwater" is an area (with horizontal and vertical dimensions) that has been verifiably demonstrated to contain all relevant groundwater contamination for this determination, and is defined by designated (monitoring) locations proximate to the outer perimeter of "contamination" that can and will be sampled/tested in the future to physically verify that all "contaminated" groundwater remains within this area, and that the further migration of "contaminated" groundwater is not occurring. Reasonable allowances in the proximity of the monitoring locations are permissible to incorporate formal remedy decisions (i.e., including public participation) allowing a limited area for natural attenuation.

4. Does "contaminated" groundwater **discharge** into **surface water** bodies?

 __X__ If yes - continue after identifying potentially affected surface water bodies.

 ____ If no - skip to #7 (and enter a "YE" status code in #8, if #7 = yes) after providing an explanation and/or referencing documentation supporting that groundwater "contamination" does not enter surface water bodies.

 _____ If unknown - skip to #8 and enter "IN" status code.

Rationale and Reference(s):

Groundwater at the site discharges to the Quinnipiac River, its unnamed, intermittent tributaries, and the location of the former surface impoundments (located in the central portion of the site – refer to UW investigation results in Attachment No. 2). It should be noted, the former surface impoundments currently exist as a pond in the central portion of the site. The pond is a surficial representation of groundwater and is neither fed nor drained by a stream.

As discussed in Question 1 above, the unconsolidated aquifer at the site has been described as consisting of four distinct zones. These zones are the upper sand unit; the silt/clay layer; the lower sand unit; and the northwest corner of the site where the lower and upper sand units combine. The groundwater at the site that is most likely to discharge directly to the Quinnipiac River and its unnamed intermittent tributaries is that groundwater within the upper sand unit.

As discussed in Question 3 above, it is seen as unlikely that contaminated groundwater from the site extends a significant distance beyond the western banks of the Quinnipiac River. As a conservative measure, a review of mapping available from the Connecticut Department of Environmental Protection was performed to assess the presence of community or public drinking water supply wells west of the Quinnipiac River in proximity to the site. The review indicated that no such wells are located in the vicinity of the site west of the Quinnipiac River.

As noted under Question No. 3, the "sheet-pile cell" is the site of an historic trichloroethylene (TCE) release (see site plan provided in Attachment No. 2). The great majority of the TCE release is presently contained within the limits of a sheet pile perimeter. An area of residual DNAPL located to the northeast of the sheet-pile cell is known to exist. This area of residual DNAPL will continue to act as a source of dissolved-phase groundwater contamination for some time into the future. However, as indicated in the response to Question 3 above, several attenuation mechanisms are affecting the plume, including dispersion, discharge to the pond and streams, , and degradation. Furthermore, it is expected that the overall plume is dissipating, as a significant portion of the source zone has been cut-off through the installation of the sheet-pile cell. The sheet-pile cell was installed to the depth of a confining silt/clay aquitard located beneath the DNAPL release. Transport by gravity and diffusion are not seen as significant due to the historic nature of the release, the time that has passed since the release occurred, and the myriad of data collected outside of the limits of the sheet-pile cell that do not indicate the presence of free-flowing DNAPL.

Ongoing study of the cell, from locations both within and outside the limits of the cell, indicate that the vast majority of the TCE release has been effectively contained by the cell and is no longer contributing as a primary source of contamination of the shallow-zone aquifer. However, as noted in the response to Question 3 above, dissolved-phase TCE and associated by-products are still prevalent in the upper sand unit of the unconsolidated aquifer as a result of migration, dispersion and advection that occurred prior to the installation of the sheet-pile cell. This unit discharges to the Quinnipiac River, its unnamed tributaries, and an onsite stagnant pond. For this reason, the significance of any potential impact this groundwater may have on surface water will be further evaluated.

5. Is the **discharge** of "contaminated" groundwater into surface water likely to be **"insignificant"** (i.e., the maximum concentration[3] of each contaminant discharging into surface water is less than 10 times their appropriate groundwater "level," and there are no other conditions (e.g., the nature, and number, of discharging contaminants, or environmental setting), which significantly increase the potential for unacceptable impacts to surface water, sediments, or eco-systems at these concentrations)?

_X_ If yes - skip to #7 (and enter "YE" status code in #8 if #7 = yes), after documenting: 1) the maximum known or reasonably suspected concentration[3] of key contaminants discharged above their groundwater "level," the value of the appropriate "level(s)," and if there is evidence that the concentrations are increasing; and 2) provide a statement of professional judgment/explanation (or reference documentation) supporting that the discharge of groundwater contaminants into the surface water is not anticipated to have unacceptable impacts to the receiving surface water, sediments, or eco-system.

_____ If no - (the discharge of "contaminated" groundwater into surface water is potentially significant) - continue after documenting: 1) the maximum known or reasonably suspected concentration[3] of each contaminant discharged above its groundwater "level," the value of the appropriate "level(s)," and if there is evidence that the concentrations are increasing; and 2) for any contaminants discharging into surface water in concentrations[3] greater than 100 times their appropriate groundwater "levels," the estimated total amount (mass in kg/yr) of each of these contaminants that are being discharged (loaded) into the surface water body (at the time of the determination), and identify if there is evidence that the amount of discharging contaminants is increasing.

_____ If unknown - enter "IN" status code in #8.

Rationale and Reference(s):

As discussed under Question No. 2, exceedances of the MCLs were identified at the three (3) power house groundwater dewatering wells and the six (6) process water wells. The comparison with the MCLs was conducted to address potential exposures to Indoor Workers from contact with process waters. Evaluation of data with respect to discharge to a surface water indicates that use of groundwater as process water is not expected to pose significant risks to surface water. The screening results presented in Question No. 2 utilized all available data from the on-site process wells and the power house wells, with some measurements from the late 1970s.

Groundwater concentrations have declined significantly over time at the process water wells. Graphs of concentration versus time at each process water well are provided in Attachment No. 3 to illustrate the declining trend(s) for contaminants identified to exceed the MCLs. To account for this declining trend in concentrations, the following data set was used to screen against risk-based criteria developed for samplers (presented in Attachment No. 1), the only receptor likely to be exposed to process water being discharged to surface waters:

Process Wells	Since a comprehensive data base exists for the process wells (designated as "PW" in Table 1 and Table A in Attachment No. 3), the maximum value detected in the last eight monitoring events was used; and
Power House Wells	Since the data base for these wells is smaller as compared to the process wells, the maximum recorded value for each chemical at these wells was used.

The screening results are presented in the table below[2]:

Chemical	Exposure Concentration (μg/l)	Risk-based Criteria for Samplers (μg/l)
Process Wells		
1,1,2-Trichloroethane	21	628
Trichloroethylene	34	1,574
Tetrachloroethylene	46	16
Nitrate	17,350	4,267,223
Power House Wells		
Trichloroethylene	620	1,574
Tetrachloroethylene	13	16
Nickel	120	381,133
Chloroform	130	5,676
1,1-Dichloroethylene	16	29
Manganese (total)	119	301,857

The screening results indicate that concentrations for all chemicals, except tetrachloroethylene (PCE), were less than the risk-based criteria. The maximum PCE concentration at the process wells was approximately 2.5 times the screening level. Since the screening criteria for PCE is based on a cancer risk of $1x10^{-6}$, the maximum PCE concentration represents a cancer risk of $2.5x10^{-6}$, *i.e.*, within the range of cancer risks (10^{-6} to 10^{-4}) considered acceptable by USEPA. Furthermore, because concentrations for the other chemicals did not exceed the risk-based criteria, the incremental contribution to

2 The approach of screening groundwater concentrations against criteria is conservative, *i.e.*, health-protective, because it ignores any loss of VOCs from the well head to the point of discharge and mixing with surface water. In addition, the data used in the screening is approximately 4 to 9 years old, and current groundwater concentrations are expected to be even lower due to ongoing groundwater use.

total risks from these chemicals is expected to be less than $1x10^{-6}$, *i.e.*, insignificant. Overall, the total human health risks posed to Samplers as a result of potential exposure to surface water or sediment that might be impacted by process water are not expected to be significant.

As discussed under Question No. 2, exceedances of the groundwater screening levels based on surface water protection (Table 3-7) were identified in a total of 62 wells (three (3) power house wells, six (6) process wells and 53 monitoring wells). However, groundwater from the majority of the wells with exceedances (43 of the total of 62) does not discharge directly to a surface water. Nineteen wells (listed below) have been identified for the purpose of evaluating exceedances of the Table 3-7 criteria as they best represent groundwater that may discharge to surface water and are a subset of wells on the site for which groundwater samples have been frequently collected. It should be noted, other wells may exist on site that would result in the collection of groundwater samples that are representative of a discharge to surface water. However, these other wells have not been included in the list below as groundwater samples have not been collected from those locations for several years. The wells presented below are the closest, upgradient wells to the surface water bodies at the site for which data are available that is representative of current conditions at the site. This well network is adequate to assess groundwater quality that is representative of that which may discharge to a surface water on the site.

MW-02-S1	MW-09-S1	MW-34-S1
MW-03-S1	MW-10-S1	MW-54-S1
MW-04-S1	MW-11-S1	MW-56-S1
MW-05-S1	MW-12-S1	MW-57-S1
MW-06-S1	MW-21-S1	PW-06D
MW-07-S1	MW-30-S1	
MW-08-S1	MW-33-S1	

Compounds in groundwater at these wells that exceed the Table 3-7 criteria include: arsenic, cadmium, copper, iron, lead, manganese, silver, zinc, 1,1-dichloroethane, 1,1-dichloroethylene, cis-1,2-dichloroethylene, tetrachloroethylene, trans-1,2-dichloroethylene, trichloroethylene and dichlorodifluoromethane.

However, historic groundwater data at these wells is not considered to be relevant or significant for the purpose of evaluating current potential impacts to surface water quality (and potential resultant human exposures) due to the time that has passed since the collection and analysis of these samples. Graphs of concentration versus time for the majority of the wells listed above are provided in Attachment No. 3 to graphically illustrate trend(s) for contaminants identified to exceed Table 3-7 criteria. Note that graphs were not prepared for certain wells (MW-10-S1, MW-11-S1, MW-12-S1, MW-

21-S1, MW-33-S1, MW-34-S1, MW-56-S1 and MW-57-S1) because, for the contaminants identified to exceed Table 3-7 criteria, there were only one or two data points and a graph would not present any discernable trend(s).

From a review of the graphs in Attachment No. 3, it is evident that individual contaminant concentrations have either shown a marked decrease over time or individual contaminant concentrations fluctuate within a finite range. Furthermore, the results of the study performed by UW show a significant drop in peak TCE concentrations, of about 3 orders of magnitude, over the 1200 ft travel distance between the western edge of the facility and the Quinnipiac River. UW has concluded that it expects that several attenuation mechanisms are at work, including dispersion, discharge to the pond and streams, diffusion into (and out of) the underlying aquitard, and degradation. It is also expected that the plume is dissipating, as a significant portion of the source zone has been cut-off through the installation of the sheet-pile cell. Given that a significant groundwater quality database exists for the Site (i.e. numerous wells monitored over a long time period) and the observed concentration time trends, it is concluded that groundwater concentrations are not increasing over time. Therefore, groundwater concentrations recorded after September 1, 1995, approximately one year after the sheet-pile source control was implemented, at the previously identified nineteen monitoring wells (located near surface water bodies) were compared to Table 3-7 criteria.

Comparison indicated exceedances of Table 3-7 criteria for the following compounds at these wells: arsenic, manganese, zinc, cis-1,2-dichloroethylene and trichloroethylene. These exceedances occurred at only five of the wells (MW-02-S1, MW-03-S1, MW-04-S1, MW-30-S1 and MW-54-S1). Attachment No. 3 includes a database listing of detected constituents for groundwater that exceeds these criteria.

The generic criteria listed in the Gradient Report and used to identify exceedances for groundwater discharging to a surface water were developed based on readily available published criteria. The readily available published criteria cited are protective of both human and ecological exposure. However, other applicable screening criteria with respect to evaluation of human exposures exist. Specifically, in evaluating the significance of direct human exposures to a surface water, in consideration of the effects of groundwater discharges to the surface water, comparison of MCL multiplied by a default dilution attenuation factor of 10 is considered an applicable screening criterion. The use of a default dilution attenuation factor of 10 is considered appropriate in the evaluation of the data from locations MW-02-S1, MW-03-S1, MW-04-S1, and MW-54-S1 as the northern most onsite unnamed tributaries to the Quinnipiac River receive dry weather discharges from onsite processes (discharges from X and Y drain – refer to Site Plan in Attachment No. 2.). The cumulative dry weather flows from X and Y drain are in the range of 100,000 gallons per day. The dry weather discharges likely exceed the flow of groundwater to these unnamed tributaries by far more than a factor of 10. The use of a default dilution attenuation factor of 10 in evaluating discharges of groundwater to the Quinnipiac River is a conservative approach consistent with the approach utilized in the calculation of the surface water protection criteria in the Connecticut Remediation Standard Regulation. The applicable screening criteria for evaluation of direct human exposures to surface water in consideration of the effects of groundwater discharge to the surface water are as follows:

• Arsenic	0.05 mg/l x 10	=	0.5 mg/l
• Manganese	0.05 mg/l x 10	=	0.5 mg/l
• Zinc	5 mg/l x 10	=	50 mg/l
• cis-1,2-DCE	70 µg/l x 10	=	700 µg/l
• TCE	5 ug/l x 10	=	50 ug/l

After comparing the maxima to the MCLs multiplied by a default dilution attenuation factor of 10, there remain only the exceedance for cis-1,2-dichloroethylene and trichloroethylene at only two of the wells (MW-02-S1 and MW-54-S1).

The above approach was not applied to the evaluation of data from MW-30-S1 as this well is located along a reach of an unnamed tributary that does not receive dry weather process water discharges. However, the single exceedance for arsenic noted in groundwater collected from location MW-30-S1 during May 1999 is based on data from an unfiltered groundwater sample. The analytical data for the unfiltered sample indicates a concentration of 0.0053 mg/l, slightly above the Table 3-7 criteria of 0.004 mg/l. The groundwater sample collected from this location during the same sampling event that was filtered prior to analysis resulted in the detection of arsenic at a concentration of 0.0012 mg/l, well below the screening criteria. As a result, it is concluded that the concentration in arsenic detected in groundwater that exceeded the Table 3-7 criteria results from sediment or other colloidal material within the sample and the filtered groundwater sample is most representative of groundwater that discharges to surface water. As the filtered sample analytical results do not exceed the Table 3-7 criteria, it is concluded that no exceedance of the Table 3-7 criteria exists for this location.

As a means to assess a worst case impact to surface water as a result of groundwater discharging to surface water, an evaluation was performed based on the assumption that all groundwater passing MW-02-S1 were to enter the surface water as a point source discharge over a period of time for which relevant data were available. To perform the evaluation, the 95% UCL of the mean of the dataset for MW-02-S1 was calculated to obtain a biased-high, but statistically valid concentration of cis-1,2-dichloroethylene in well MW-02-S1. The 95% UCL of the mean of the log-normally distributed data set for cis-1,2-dichloroethylene for groundwater at MW-02-S1 since September 1, 1995 is 666 µg/l. This is below the applicable screening level of 700 µg/l. As a result, the concentration of cis-1,2-dichloroethylene present detected in MW-02-S1 is determined to be insignificant.

Similarly, the 95% UCL of the mean of the log-normally distributed data set for cis-1,2-dichloroethylene for groundwater at MW-54-S1 since September 1, 1995 is 404 μg/l which is below the applicable screening level of 700 μg/l.

The 95% UCL of the mean of the data sets for trichloroethylene at MW-02-S1 and MW-54-S1 each exceed the 10 x the MCL screening level. However, other applicable screening criteria with respect to evaluation of human exposures exist. Risk-based screening criteria, protective of human health, were developed for evaluation of direct human exposures to surface water in consideration of the effects of groundwater discharging to the surface water based on site-specific exposure assumptions by Gradient Corporation. These criteria are provided in Attachment No. 1 and the strictest limit for trichloroethylene is 15,740 μg/l. Comparison of the maxima at wells MW-02-S1 and MW-54-S1 for groundwater since September 1, 1995 with this criterion does not indicate an exceedance.

In addition to evaluating trends in groundwater discharging to surface water at the wells identified above, historic VOC concentrations in groundwater were also evaluated on a site-wide basis. Drawings prepared by Fuss & O'Neill, Inc. depicting total VOCs detected in groundwater (1993 and 1994) are provided in Attachment No. 2. Graphs of detected VOCs concentrations versus time (since January 1992) for wells MW-31-S1, MW-45-S1, MW-46-S1, MW-48-S1, MW-52-S1 and MW-53-S1 are provided in Attachment No. 3. These wells were selected to graphically illustrate the declining trend(s) for VOCs identified in the Fuss & O'Neill drawings for wells down-gradient of the sheet-pile cell (see location on the site plan provided in Attachment No. 2). The sheet-pile cell was installed in November and December of 1994 to contain an historic TCE release. The sheet pile cell was installed to the depth of a confining silt/clay aquitard. The graphs for these wells downgradient of the sheet-pile cell illustrate the expected decline in VOCs in groundwater from those depicted in the Fuss & O'Neill drawings from 1993 and 1994 (before the cell was installed).

Of all the compounds detected in groundwater at concentrations above the generic P&W screening levels, arsenic and cadmium are considered potentially bioaccumulative compounds. Arsenic was detected in 21 of 229 (9.2 percent) of groundwater samples collected at the site for which it was analyzed. Arsenic was observed in groundwater samples from wells distributed throughout the facility site. No identifiable trend or areas of concentrated detections or arsenic were observed in the data set. P&W generic groundwater screening levels for arsenic were exceeded in only 5 of the 229 (2.2 percent) groundwater samples. Cadmium was detected in 68 of 652 (10.4 percent) of groundwater samples collected at the site for which it was analyzed. As with arsenic above, cadmium was observed in groundwater samples from wells distributed throughout the facility site. No identifiable trend or areas of concentrated detections of cadmium were observed in the data set. P&W generic groundwater screening levels for cadmium were exceeded in only 15 of the 652 (2.3 percent) groundwater samples. Due to the infrequent detection of these compounds in groundwater at the site, coupled with the spatial distribution of the locations from which compounds were detected potential bioaccumulative affects are not considered relevant in the evaluation of the data.

Footnotes:

[3] As measured in groundwater prior to entry to the groundwater-surface water/sediment interaction (e.g., hyporheic) zone.

6. Can the **discharge** of "contaminated" groundwater into surface water be shown to be "**currently acceptable**" (i.e., not cause impacts to surface water, sediments or eco-systems that should not be allowed to continue until a final remedy decision can be made and implemented[4])?

_____ If yes - continue after either: 1) identifying the Final Remedy decision incorporating these conditions, or other site-specific criteria (developed for the protection of the site's surface water, sediments, and eco-systems), and referencing supporting documentation demonstrating that these criteria are not exceeded by the discharging groundwater; OR
2) providing or referencing an interim-assessment,[5] appropriate to the potential for impact, that shows the discharge of groundwater contaminants into the surface water is (in the opinion of a trained specialists, including ecologist) adequately protective of receiving surface water, sediments, and eco-systems, until such time when a full assessment and final remedy decision can be made. Factors which should be considered in the interim-assessment (where appropriate to help identify the impact associated with discharging groundwater) include: surface water body size, flow, use/classification/habitats and contaminant loading limits, other sources of surface water/sediment contamination, surface water and sediment sample results and comparisons to available and appropriate surface water and sediment "levels," as well as any other factors, such as effects on ecological receptors (e.g., via bio-assays/benthic surveys or site-specific ecological Risk Assessments), that the overseeing regulatory agency would deem appropriate for making the EI determination.

_____ If no - (the discharge of "contaminated" groundwater can not be shown to be "**currently acceptable**") - skip to #8 and enter "NO" status code, after documenting the currently unacceptable impacts to the surface water body, sediments, and/or eco-systems.

_____ If unknown - skip to 8 and enter "IN" status code.

Rationale and Reference(s):
____
____
____
____
____
____
____
____

Footnotes:

[4] Note, because areas of inflowing groundwater can be critical habitats (e.g., nurseries or thermal refugia) for many species, appropriate specialist (e.g., ecologist) should be included in management decisions that could eliminate these areas by significantly altering or reversing groundwater flow pathways near surface water bodies.

[5] The understanding of the impacts of contaminated groundwater discharges into surface water bodies is a rapidly developing field and reviewers are encouraged to look to the latest guidance for the appropriate methods and scale of demonstration to be reasonably certain that discharges are not causing currently unacceptable impacts to the surface waters, sediments or eco-systems.

7. Will groundwater **monitoring** / measurement data (and surface water/sediment/ecological data, as necessary) be collected in the future to verify that contaminated groundwater has remained within the horizontal (or vertical, as necessary) dimensions of the "existing area of contaminated groundwater?"

_____ If yes - continue after providing or citing documentation for planned activities or future sampling/measurement events. Specifically identify the well/measurement locations which will be tested in the future to verify the expectation (identified in #3) that groundwater contamination will not be migrating horizontally (or vertically, as necessary) beyond the "existing area of groundwater contamination."

__X__ If no - enter "NO"* status code in #8.

_____ If unknown - enter "IN" status code in #8.

Rationale and Reference(s):

*Exceedances of P&W generic screening criteria were noted in groundwater. However, as noted in Question No. 5 above, the generic P&W screening criteria were based on readily available published criteria that are protective of both ecological and human receptors. The evaluations presented in Question No. 5 above are appropriate in assessing the significance of human exposure to a surface water in consideration of the effects of groundwater discharges to the surface water. Based on these comparisons, it is determined that the concentrations observed in groundwater at the site represent insignificant risks with respect to human exposure via surface water.

Furthermore, groundwater monitoring at the facility indicated that existing groundwater contamination does not exhibit any discernible increasing trend for any of the constituents detected. Based upon this, it is concluded detected constituents in groundwater will remain within the existing area(s) of contaminated groundwater as defined by the monitoring locations currently present at the site. Likewise, the groundwater contamination located within the limits of the sheet-pile cell will remain contained in that area of the site.

It is concluded that groundwater monitoring at the P&W North Haven facility is not warranted because: 1) a significant groundwater quality database exists for the site; and 2) concentrations have either declined or fluctuated within a finite range. Furthermore, even if the current highest levels of groundwater contamination detected at the site were to migrate to surface water, no adverse impact would result. Consequently, it is concluded that migration of contaminated groundwater is under control, and Question No. 8 has been answered accordingly ("YE") to document this conclusion.

8. Check the appropriate RCRIS status codes for the Migration of Contaminated Groundwater Under Control EI (event code CA750), and obtain Supervisor (or appropriate Manager) signature and date on the EI determination below (attach appropriate supporting documentation as well as a map of the facility).

__X__ YE - Yes, "Migration of Contaminated Groundwater Under Control" has been verified. Based on a review of the information contained in this EI determination, it has been determined that the "Migration of Contaminated Groundwater" is "Under Control" at the Pratt & Whitney North Haven facility, EPA ID #CT001449511, located at 415 Washington Avenue, North Haven, Connecticut. Specifically, this determination indicates that the migration of "contaminated" groundwater is under control, and that monitoring will be conducted to confirm that contaminated groundwater remains within the "existing area of contaminated groundwater" This determination will be re-evaluated when the Agency becomes aware of significant changes at the facility.

_____ NO - Unacceptable migration of contaminated groundwater is observed or expected.

_____ IN - More information is needed to make a determination.

Completed by (signature) [signature] Date 5-29-2002
(print) Ernest Waterman
(title) Geologist

Supervisor (signature) [signature] Date 5/29/02
(print) Matthew R. Hoagland
(title) Section Chief
(EPA Region or State) Reg I

Locations where References may be found:

EPA Region I
One Congress St. Suite 1100 Mail code HBT
Boston, MA 02114

Contact telephone and e-mail numbers

(name) Ernest Waterman
(phone #) 617-918-1369
(e-mail) waterman.ernest@epa.gov

LIST OF ATTACHMENTS

Attachment No. 1 COPIES OF APPLICABLE SECTIONS, *CONCEPTUAL SITE MODELS AND SCREENING LEVELS FOR PRATT & WHITNEY'S VCAP CONNECTICUT FACILITIES*, GRADIENT CORPORATION, DECEMBER 19, 1997, REVISED SEPTEMBER 18, 1998, AND SEPTEMBER 15, 1999, AND OTHER APPLICABLE CRITERIA AND RATIONALE DEVELOPED BY GRADIENT CORPORATION

Attachment No. 2 SITE PLANS, GEOLOGIC CROSS-SECTIONS AND GROUNDWATER CONTOURS (DECEMBER 1998) DISTRIBUTION OF VOCS IN GROUNDWATER, AND UW INVESTIGATION RESULTS

Attachment No. 3 SUMMARY OF GROUNDWATER ANALYTICAL DATA AND CONSTITUENTS DETECTED IN GROUNDWATER AND GRAPHS OF CONCENTRATIONS VERSUS TIME AT CERTAIN WELLS