

DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION

Interim Final 2/5/99

**RCRA Corrective Action
Environmental Indicator (EI) RCRIS code (CA750)**

Migration of Contaminated Groundwater Under Control

Facility Name: AMT, Inc. (Hypothetical Case Example) DRAFT 1/27/00
Facility Address: 1001 Riverside Dr., Derekwood, BE, USA
Facility EPA ID #: BED000000001

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?
(Note this determination is site-wide and includes all identified contaminated groundwater on- and off-site from releases at the AMT facility, and as is documented in AMT, Inc. Reports 1, 2, and 3)

 X If yes - check here and continue with #2 below.
 If no - re-evaluate existing data, or
 if data are not available skip to #6 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).

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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):

Yes the **groundwater is** known to be “**contaminated**” above appropriately protective “levels” (i.e., applicable promulgated standards, as well as other appropriate standards, guidelines, guidance, or criteria (see footnotes below)).

The table below identifies the contaminants present in groundwater in concentrations greater than their level of concern.

<u>Contaminant</u>	<u>Levels of Concern</u>	<u>Max. Detected</u>	<u>Times above Std</u>	<u>Location</u>
TCA	200 ug/l (1)	1,900 ug/l	10	MW-5A
DCA	70 ug/l (2)	460 ug/l	7	MW-17A
DCE	7 ug/l (3)	120 ug/l	17	MW-12B
Cr+6	100 ug/l (4)	280 ug/l	3	MW-3A
Ba	1,000 ug/l (5)	4,600 ug/l	5	MW-3A

Footnotes (#)

- (1) - State DEP Drinking Water Well Groundwater Protection Criteria
- (2) - State DEP Drinking Water Well Groundwater Protection Criteria
- (3) - State DEP Drinking Water Well Groundwater Protection Criteria
- (4) - Federal Clean Water Act Maximum Concentration Limit (MCL)
- (5) - Federal Clean Water Act Maximum Concentration Limit (MCL)

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).

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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):

Yes, the **migration** of contaminated groundwater **can be expected to have stabilized** (such that contaminated groundwater can be reasonably expected to remain within the (horizontal or vertical) dimensions of the “existing area of groundwater contamination”²) based on the physical evidence and understanding of the environmental conditions discussed below.

Dissolved Phase Contamination:

Horizontal Migration:

The dissolved phase groundwater contamination plume can be reasonably expected to remain within the horizontal dimensions of the “existing area of groundwater contamination”² (identified by the “clean” wells GP-5, GP-7, GP-8, GP-9), based on the following physical evidence and understanding of the environmental setting discussed below:

Evidence Defining Horizontal Dimensions of Contaminant Plume

The concentrations of contaminants in the furthest down gradient on-site (near fence line) monitoring wells (e.g., MW-7A,B, and MW-12A,B) have been slowly decreasing in samples collected over the last four years. The additional GeoProbe investigation (GP-# sample locations) resulted in evidence summarized in the table below showing what is believed to define the front edge of the plume. The concentrations in the furthest down gradient contaminated monitoring wells (e.g., GP-6) are only slightly above the levels of concern and, the concentrations concentration of the contaminants in the each of the four “clean” wells (GP-5, GP-7, GP-8, GP-9) were found to be below the levels of concern.

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.

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Evidence for Stability in Front Edge of Contaminant Plume

While the 16 Qtrs of decreasing concentrations in furthest down gradient on-site wells suggested the front edge of the contaminant plume was likely to be stable, the GeoProbe locations GP-8 and GP-9 were converted to permanent monitoring wells and monitored for two additional quarterly events (for a total of three) and the concentrations were found to remain stable (identical) in each sampling event.

While no duration of monitoring can guarantee the future, it is reasonable to expect that this dissolved phase plume is stable since:

the “clean” wells were monitored over a period (270 days) that should have been sufficient to detect a mobile plume if the contaminants were moving at a rate similar to the groundwater flow (0.35 ft/day x 270 days = 94.5 ft of travel and the front edge of the plume and the “clean” well GP-9 are only 50 ft apart). While it remains possible that the contaminant plume continues to migrate (at a slower (retarded) rate than the groundwater flow) it is reasonable to expect this contaminant plume is stable due to the physical evidence and rationale described above and the additional understanding of the environmental setting described below:

- 1) concentrations in furthest down gradient on-site (fence line) monitoring wells have been decreasing over the last four years.
- 2) age of the release (at least 10 yrs.) and the plume is only 700 ft long (while gw went 1,277 ft (0.35 x 3,650)),
- 3) source (above ground tank) and visibly contaminated near-surface soils were removed 10 yrs ago,
- 4) groundwater extraction wells have been operating in the source area for the last 3 years (and reducing the mass of contamination heading for the toe of the plume),
- 5) we expect a final remedial action for groundwater to take place in the near future (near the down gradient fence line) which will further reduce the amount of groundwater contamination flowing to the toe of the contaminant plume, and
- 6) the less mobile metallic contaminants in the area of the former lagoon are also bound by “clean” wells (see table below).

Also note, additional monitoring will be conducted to continuously verify the accuracy of this determination (see response to Ques.7). For further description of the evidence considered see AMT, Inc. Groundwater Stabilization Report.

<u>Contaminant</u>	<u>Level of Concern</u>	<u>Down Gradient Wells</u>	<u>“Clean” Wells</u>
TC A	200 ug/l	GP-6 = 210 ug/l	GP-9 = 150 ug/l
DCA	70 ug/l	GP-6 = 80 ug/l	GP-9 = 50 ug/l
DCE	7 ug/l	GP-6 = 8 ug/l	GP-9 = ND (<5)
Cr ⁺⁶	100 ug/l	MW-3A = 280 ug/l	MW-22A, & -18A = ND
Ba	1,000 ug/l	MW-3A=4,600;-2A=2,600	MW-22A, & -18A = ND

Vertical Migration:

Although the monitoring data is somewhat limited, the significant reductions in contaminant concentrations in the bedrock aquifer near the source area (MW-11C) and at the overburden-bedrock interface (in MW-5B) beneath the source area suggests little spreading of contamination into the bedrock aquifer in the upland areas where the highest hydraulic gradient is present. The upward hydraulic flow gradient of groundwater in the lower (downhill) of the plume is believed to limit downward vertical migration of contamination in the bedrock aquifer (although the conditions in wells MW-7 A & B appear anomalous).

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Free Product (Non-Aqueous Phase Liquid, NAPL) Contamination:

It is important to consider the mobility of groundwater contamination in the NAPL phase to ensure that this form of groundwater contamination (NAPL): 1) also remains within the boundaries of the dissolved phase contamination discussed above, and 2) does not migrate such that it causes further migration of the front edge of the dissolved phase plume.

Probability of NAPL

A Dense Non-Aqueous Phase Liquid (DNAPL, 1,1,1- Trichloroethane, TCA) was known to have been used in the Above Ground Tank (and associated piping) believed to have been the source of the plume of volatile organic contaminated groundwater. Thus, DNAPL was believed to have been released to the environment, and residual amounts of NAPL in unsaturated soils were observed during the site investigation (and largely removed during tank closure).

Horizontal & Vertical Migration

Throughout the investigation observations were made trying to identify the presence and extent of mobile NAPL contamination. While some residual amounts of NAPL were observed in surface soils and in borehole cuttings from wells (up to 25 ft b.g.s. in MW-5A and MW-5B) immediately beneath the source area, no evidence of mobile NAPL was found during the investigations. NAPL contamination is believed to be limited to residual contamination and (based on the discussion below) is not expected to be mobile such that it could expand the “existing area of contaminated groundwater” as defined above (by the dissolved phase contamination).

The evidence collected is deemed to be sufficient for this determination based on the following understandings. If a sufficient amount NAPL was released such that the NAPL was able to continuously exceed the residual saturation limits of the media encountered the DNAPL would be expected to migrate vertically downward under gravitational forces until it encountered a sufficiently less permeable media, such as the bedrock at the overburden-bedrock interface. Again, assuming sufficient NAPL was released, such that the NAPL would continue to be mobile (continually exceeding residual saturation limits of the media) the DNAPL would then likely travel in the down-dip direction along the NAPL-impermeable surface, such as the overburden-bedrock interface (until the amount of NAPL released was consumed by the media as residual saturation, or still-mobile NAPL ponded in a depression).

No evidence of free flowing (mobile) NAPL was found in any of the boreholes during well construction or sampling events, and while there are conditions that can prevent the observations of NAPL despite its presence, when this evidence is combined with the observations of relatively low maximum dissolved phase concentrations (far below 1% of the aqueous phase solubility limit (4,500 mg/l for 1,1,2- TCA, as per App. VIII web site)), it was concluded that the NAPL present at this site is largely immobile.

Evidence from the monitoring well samples at this site suggests that the DNAPL did not migrate completely through the overburden materials and reach the overburden-bedrock interface in the source area (possibly due to insufficient volume of NAPL release, or due to impermeable zones within the overburden) since the concentrations observed in the deeper well MW-5 which is screened at the interface directly beneath the source area had much lower concentrations (44 ppb) than the shallower MW-5A (1,900 ppb) of TCA. Similarly, in the (approx. 100 ft) further down gradient wells MW-11A and 11B the deeper well (which is screened at the bedrock interface, where we might expect DNAPL to be present) the concentration of TCA in the dissolved phase sample results were less than one-half the concentration in the shallower well MW-11A. Thus, in summary, observations made during the construction and sampling of over 20 groundwater monitoring wells and nine GeoProbe samples did not provide evidence of mobile NAPL threatening the further migration of groundwater contamination at this site.

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Overall Statement on Migration of Groundwater Contamination

The expectation of no further (horizontal or vertical) migration of (dissolved and NAPL phase) groundwater contamination is also based on knowledge that the primary sources of contamination have been addressed through interim (tank and contaminated near-surface soil removal, and installation of a groundwater extraction system) and soon-to-be implemented final remedial actions (see Interim and proposed Final Action Reports) that should significantly reduce the concentration and amount of contaminants in groundwater heading for the front of the contaminant plume (where natural attenuation processes of degradation, dilution, and absorption are likely to be operating in equilibrium with the current amount and flow rate of contamination).

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

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):

It is not reasonable to expect that groundwater contaminated above levels of concern discharge into surface water at this site since the contaminant plume has been shown to terminate several hundred feet up gradient of the nearest surface water (in the marina and wetlands area, see Figure 7 in AMT Report 3). Additionally, direct sampling of the surface water body in the marina did not detect groundwater contaminants (see AMT Report)

Workshop Case Example - Variation A

For educational purposes only (does not apply to actual case example) - Let’s assume 1,000 ppm of DCE (and not other contaminants) was found in wells 20A and 21A immediately adjacent to the surface water body (i.e., if we had these conditions we would answer Yes to this question and go on to question #5).

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5. Is the **discharge** of “contaminated” groundwater into surface water likely to be “**insignificant**” (i.e., the maximum concentration³ 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)?

_____ If yes - skip to #7 (and enter “YE” status code in #8 if #7 = yes), after documenting: 1) the maximum known or reasonably suspected concentration³ 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 judgement/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 concentration³ 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 concentrations³ 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):

For the Workshop Case Example there would be no need to address this question. However, if we look at:

Variation A of the Workshop Case Example -

We would answer “No” it is not insignificant since the concentration of contaminants in wells adjacent to the surface water body (1,000 mg/l) was (far) greater than our general rule-of-thumb 10 times factor above the aquifer levels of concern (of 7 ug/l for DCE, in fact it was 10,000 times above the aquifer standard).

Then as per the response criteria above for a “No” response where the discharging groundwater was more than 100 times the aquifer standard we would report the “the estimated total amount (mass in kg/yr) of each of these contaminants that are being discharged (loaded) into the surface water body” which was determined to be 0.4 kg of DCE per year (based on $Q=kIA \times \text{conc.}$ (Where $k=0.4 \text{ m/d}$, $I=0.001$, $A=3000\text{m}^2$, $\text{conc.}= 1,000 \text{ mg/l}$)).

We would also document that there is no evidence that the concentrations or discharge rate to be increasing, since earlier sampling also showed 1,000 mg/l. We would then move on the next question to determine if this loading could be considered “currently acceptable.”

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

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Question 5 cont.

Variation B

If the concentration of DCE in wells adjacent to the surface water was 35 ug/l we would?

Perhaps recognize that the concentrations are less than 10 times the appropriate aquifer “levels” and we could choose to use the 10X rule of thumb to determine that this discharge, of this contaminant, at this site, and under these site conditions would not be likely to significantly impact the surface water body. Then we could respond with a “yes” because the **discharge** of “contaminated” groundwater into surface water is likely to be “**insignificant**” and then provide the response documentation criteria for a “yes” answer, and skip to number 7.

Variation C

If we had these same conditions and the receiving surface water body was an extremely small creek with high ecologic value and rare or endangered species (somewhat sensitive to DCE) we would?

Probably answer “no” the discharge is not likely to be **insignificant** and should be considered more closely in the next question.

Variation D

If we had these same relative concentrations (5X levels) and environmental setting conditions as in Variation B above but that the contaminant was mercury (say the aquifer std is 2 ug/l and we have 10 ug/l discharging) we would?

Perhaps recognize that the specific characteristics of this contaminant (a non-degradable and bioaccumulative constituent) could indeed have a significant impact on the surface water, sediment, and ecosystem quality so that we would carry this case forward for more in-depth analysis in the next question.

Variation E

IF we had Light Non-Aqueous Phase Liquids (LNAPL) free product discharging into surface water body (for example with a visible thickness or sheen) we would?

Probably have a hard time calling this an example of migration “under control,” or defending this condition as a measure of success, and we would probably want to carry this forward to be explored further in the next question.

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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 implemented⁴)?

_____ 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):

Variation A

Variation C

Variation D

Variation E

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.

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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.”

If no - enter “NO” status code in #8.

If unknown - enter “IN” status code in #8.

Rationale and Reference(s):

On-going monitoring will be conducted in locations in GP/MW-8, GP/MW-9, and near the location of GP5, as well as in MW-18A, MW-22A, and the Smith home well as is planned on a quarterly frequency in submittals by the AMT facility in their Groundwater Monitoring Plan. These data will be reviewed by the Department upon receipt to ensure that this determination remains accurate.

