BOUTIN & ALTIERI, P.L.L.C.
Attorneys At Law

Brenda E. Keith

March 1, 2010

Karlee Kenison, P.G.
Department of Environmental Services
Solid Waste Management Division
29 Hazen Drive, P.O. Box 95
Concord, NH 03302-0095

Via E-mail & USPS

Re: Corrective Action Plan Comments
North Country Environmental Services, Inc.'s Landfill
Bethlehem, New Hampshire
NHDES: Site 198704033

Dear Ms. Kenison:

Attached is Aries Engineering's comments on the November 24, 2009 *Corrective Action Plan* prepared by Sanborn, Head & Associates, Inc. We submit this on behalf of the Town of Bethlehem.

Please do not hesitate to contact me if you have any questions.

Sincerely,

Brenda E. Keith

Enc. (Review by Aries Engineering, Inc.)

c. John Regan (via email)
Wayne Wheeler (via email)
Michael Wimsatt (via email)
Bryan Gould (via email)
Mike Guilfoy (via email)
Richard Head (via email)
Clients (via email)
File

One Buttrick Road • P.O. Box 1107 • Londonderry, NH 03053 • 603.432.9566 • 603.432.7419 (fax)
With offices in Meredith, NH and Fairfield, CT
E-mail: Bkeith@boutinlaw.com
Web site: www.boutinlaw.com

ARIES ENGINEERING, INC.
Environmental Engineers and Hydrogeologists
Founded 1987
46 South Main Street | Concord, NH 03301 | Phone: 603-228-3008 | Fax: 603 226-3074 www.aries-engi.com

February 25, 2010
File No. 2002-015

Brenda E. Keith, Esq.
Boutin & Altieri, P.L.L.C.
P.O. Box 1107
Londonderry, NH 03053

Re: Corrective Action Plan Comments
North Country Environmental Services Landfill
Bethlehem, New Hampshire
NHDES: Site 198704033

Dear Brenda:

Aries Engineering, Inc., (Aries) is pleased to provide to the Town of Bethlehem (Town) the following technical comments (comments) on the November 24, 2009, *Corrective Action Plan* (CAP), prepared by Sanborn, Head & Associates, Inc. (SHA) of Concord, New Hampshire concerning the North Country Environmental Services, Inc. (NCES) landfill (site) located in Bethlehem, New Hampshire. In preparing these comments, Aries also reviewed the following pertinent site documents which were prepared between July 2009 and January 2010:

1. August 26, 2009, *July 2009 Water Quality Monitoring Results, Groundwater Management and Release Detection Permit No. GWP-198704033-B-005, North Country Environmental Services, Inc. (NCES) Landfill, Bethlehem, New Hampshire*, prepared by Sanborn, Head & Associates, Inc. (SHA) of Concord, New Hampshire (July 2009 Water Quality Monitoring Results);
2. November 24, 2009, *Corrective Action Plan, North Country Environmental Services Landfill, Bethlehem, New Hampshire*, prepared by SHA (November 2009 Correction Action Plan (CAP);
3. November 5, 2009, *North Country Environmental Services, Leachate Management Improvements Project, GWP-197804033-B-005, DES-SW-SP-03-002 - Report on Final Soil Excavation and Removal & Construction Certification for Repair to Cap Drainage*, prepared by CMA Engineers, Inc. (CMA) of Portsmouth, New Hampshire (November 2009 CMA Final Report & Construction Certification);
4. December 18, 2009, *November 2009 Water Quality Monitoring Results, Groundwater Management and Release Detection Permit No. GWP-198704033-B-005, North Country Environmental Services, Inc. (NCES) Landfill, Bethlehem,*

New Hampshire, prepared by SHA (November 2009 Water Quality Monitoring Results);

5. January 6, 2010, NCES correspondence regarding: *North Country Environmental Services, Inc. Landfill Facility - Bethlehem, NH, Groundwater Permit No. GWP-198704033-B-003 Condition 15, Monthly Bromide Report - December 2009* (December 2009 NCES Monthly Bromide Report); and
6. January 8, 2010, NCES correspondence regarding: *North Country Environmental Services, Inc. Landfill Facility - Bethlehem, NH, Env-SW 806.08(h) Facility Monthly Report - December 2009* (December 2009 NCES Facility Monthly Report).

OBJECTIVES

Aries' CAP comments objectives were to:

1. Provide technical comments on the site CAP and related site documents; and

2. Assess how recent groundwater monitoring data and landfill construction information affects Aries' prior conclusions and recommendations regarding observed site groundwater bromide and volatile organic compound (VOC) concentrations repeatedly detected in groundwater samples collected downgradient of the landfill facility.

Aries provides the following comments.

1. July and November 2009 Water Quality Monitoring Results

Available July and November 2009 site Groundwater Management and Release Detection Permit (GMP) monitoring data indicated similar concentrations of bromide and VOCs observed in the July and November 2009 groundwater samples when compared to groundwater bromide and VOCs concentrations previously detected during prior site sampling events. Based on the July and November 2009 groundwater data, it is Aries' opinion that observed groundwater bromide concentration trends are consistent with a persistent, long-term bromide concentration signature and, therefore, consistent with an on-going bromide source which potentially includes leaks from the landfill liner system, repeated discharges from the site leachate management system, an as yet undetermined release mechanism, or a combination of these leachate release mechanisms.

The November 2009 Water Quality Monitoring Results report justified purging five to ten well volumes (extended-purge regiment) prior to collecting groundwater samples as a means of testing the hypothesis that a greater purge volume than the EPA-approved[1] three to five well volumes would result in groundwater sample concentrations which

[1] Field Sampling Guidance Documents #1220, US U.S.EPA Region 9 Laboratory, Rev. 1, September 2004.

were more representative of actual site groundwater conditions. The November 2009 report indicated that, due to large diameter boreholes and relatively large annular spaces in site monitoring wells, additional purging might be necessary to get a representative groundwater samples. The November 2009 report concluded that the extended-purge regiment did not yield data that differed significantly from data collected using the EPA-approved three-well-volume purging method.

2. November 2009 Corrective Action Plan

Aries' comments on the November 2009 CAP follow:

1. The CAP proposed that NCES continue groundwater assessment monitoring in site monitoring wells MW-402U and B-913M until VOCs are not detected and bromide concentrations are at or below 0.1 mg/l in the assessment monitoring samples for two consecutive monthly sampling rounds.

   Aries anticipates that more than one year of site groundwater sampling data will likely be required after all groundwater remedial measures have been completed, to accurately assess whether groundwater sample non-detection of VOCs or bromide accurately reflect long-term concentration trends and remedial action effectiveness. Therefore, Aries recommends one to two years monitoring data be collected from site monitoring wells MW-402U and B-913M after all groundwater remedial measures have been completed, to assess remedial impacts and seasonal variations in site groundwater concentrations before considering changing site groundwater assessment monitoring parameters or frequency.

   Aries also recommends that VOC and bromide monitoring be continued indefinitely in site release detection monitoring wells due to the on-going and continued potential threat of a release from the landfill liner system, leachate management system, and landfill gas (LFG) management system.

2. The CAP provided a non-parametric evaluation of site groundwater VOC and bromide concentration trends in selected monitoring wells using the Mann-Kendall (M-K) Analysis. The CAP M-K analyses used software developed by the U.S. Geological Survey (USGS)[2] to analyze selected date ranges of groundwater bromide and total VOC (TVOC) concentrations in selected well samples. In general, the CAP assessed bromide and TVOC concentration trends for 21 selected data sets of varying date ranges collected from eight site monitoring wells. CAP M-K analyses identified: decreasing concentration trends in 33% of the analyses (7 of 21 analyses); probable decreasing concentration trends in 19% of the analyses (4 of 21); increasing concentration trends in 5% of the analyses (1 of 21) ; and stable or no discernable trend in 43% (9 of 21).

[2] "Computer Program for the Kendall Family of Trend Tests; Helsel, D.R., Mueller, D.K., and Slack, J.R. (2006), USGS Scientific Investigations Report No. 2005-5275.

Using the methodology and software described in the CAP, Aries' reviewed the M-K trend analysis results, with a focus on data from site monitoring wells MW-402U and B-913M, which were considered in the CAP to be key release detection monitoring wells. Aries' M-K trend comments follow:

a. Aries interprets the finding of "stable" or "no trend" to signify groundwater concentrations that are neither increasing nor decreasing with statistical significance, but rather that are more or less constant, with varying degrees of data "scatter". Scatter in observed groundwater TVOC and bromide concentrations may be related to seasonal variations, potential variance in the leachate generation rates or other temporal changes. Stable concentration trend are likely consistent with a continuing TVOC or bromide source.

b. In general, the CAP M-K analyses used selected data sets which started with the "peak" TVOC observance. Aries cautions that such selection of data points in the data set could result in a bias in the trend outcome. For example, selection of a data set which begins with the highest or higher values through time will nominally be interpreted as decreasing through time.

c. The CAP indicated that "all data" were used on nine of 21 M-K analyses. However, review of the reported date ranges for CAP "all data" indicated that the data sets did not include sample data results which were non-detect prior to the data cut-off point used. For example, in the case of B-913M, the CAP indicated that "all data" included samples collected starting in April 2006 through November 2009. Review of the data tables[3] for samples from this well indicated that collection of TVOC and bromide data for this well began in November 2000, with the majority of the unreported data comprised of non-detect concentrations. Aries recommends conducting the M-K analyses using all available data, including non-detect values to reduce the possibility of a biased outcome in data trend analysis.

d. In performing the M-K analyses, the CAP used a value of zero to represent non-detect (ND) results. Aries recommends employing the convention of using a value of one-half of the method detection limit (MDL) to represent non-detect sample results in the M-K analyses. This convention has been recommended by the New Hampshire Department of Environmental Services (Department) for data analyses at other groundwater monitoring sites.

e. The sampling frequency for monitoring wells MW-402U and B-913M increased from three sampling events per year (April, July and November)

[3] November 2009 Corrective Action Plan, Appendix B - Summary of Select Analytical Results - Groundwater.

to monthly sampling events beginning in November 2008. Such a change could influence the outcome of the non-parametric M-K analysis by inadvertently weighting the later time data as the analysis only measured the difference in concentration without consideration of the temporal distrubution of the data.

3. Aries performed an independent M-K analysis of site bromide concentrations observed in groundwater samples collected from site release detection monitoring wells MW-402U and B-913M using the methods described in the CAP. Aries also assessed trends in the Stage III Secondary leachate (S3S) and Stage IV Secondary (S4S) leachate samples collected between approximately 2006 and April 2009[4]. In general, the M-K analysis compared each data point in a data set with all the other data points in the set. A value of 1 was provided for an increasing difference, while a value of -1 was provided for a decreasing difference. The sum of the differences is the Kendall Statistic (S). Large positive numbers indicate a greater occurrence of increasing sample differences and a strongly upward concentration trend. Strong decreasing trends are supported by large negative numbers. The Confidence Factor (CF) indicates the statistical probability of a given trend; a CF of less than 90% indicates no apparent trend at the 90% confidence interval. As discussed in the prior comment, Aries used a value of one-half the MDL for non-detect values in our M-K analyses.

   Aries findings are provided below in Table 1 and discussed further below:

   a. Comparison of M-K analyses of data sets using one-half of the MDL for non-detect values resulted in negligible variations in the M-K test statistics and confidence factors. As such, Aries' and the CAP's M-K analytical methods are general equivalent and comparison of the M-K results can be reasonably made.

   b. M-K analysis of all data points (including initial non-detect results) available for the MW-402U and B-913M data sets indicated strong evidence of increasing bromide concentration trends with CF's of greater than 99%. Viewed from a historical perspective, the calculated increasing trends are to be anticipated as bromide is not considered a native or background groundwater constituent, but rather the result of sodium bromide application at the NCES facility. Thus, through time, groundwater bromide concentrations have likely increased above background. Employing all data provided, Aries' observed increasing bromide concentration trends contrast with the CAP's reported decreasing or stable concentration trends for the same monitoring points as summarized in the following Table 1.

[4] Site leachate bromide concentration data obtained from a June 19, 2009 bromide summary table.

Table 1 - Summary of Mann-Kendall Analysis Results - Bromide Concentrations in Monitoring Well MW-402U and B-913M

WELL	TEST By	DATA RANGE TESTED	KENDALL TEST STATISTIC	CONFIDENCE FACTOR (%)	MANN-KENDALL TREND
MW-402U	CAP	From TVOC peak to end of data - ND = 0 (04/05/04 to 11/09/09)	-90	93.91	Probably Decreasing
	Aries	From TVOC peak to end of data - ND = ½ MDL (04/05/04 to 11/09/09)	-90	93.91	Probably Decreasing
	Aries	All data provided - ND = 0 (7/10/95 to 11/09/09)	372	99.75	Increasing
	Aries	All data provided - ND = ½ MDL (7/10/95 to 11/09/09)	357	99.57	Increasing
B-913M	CAP	Test from TVOC peak ND=0 (11/05/07 to 11/09/09)	-106	99.86	Decreasing
	Aries	Test from TVOC peak ND = ½ MDL (11/05/07 to 11/09/09)	-106	99.86	Decreasing
	CAP	All data (4/10/2006 to 11/09/09)	-72	88.40	Stable
	Aries	All data provided - ND = 0 (11/13/00 to 11/09/09)	312	99.96	Increasing
	Aries	All data provided - ND = ½ MDL (11/13/00 to 11/09/09)	312	99.96	Increasing
S3 Sec Leachate	Aries	All data provided - ND = ½ MDL (1/25/01 to 12/1/09)	1809	>99.99	Increasing
	Aries	Sodium Bromide Application Period ND = ½ MDL (1/25/01 to 4/20/05)	403	99.89	Increasing
	Aries	Post-Sodium Bromide Application Period ND = ½ MDL (4/20/05-12/1/09)	-1344	>99.99	Decreasing
S4 Sec Leachate	Aries	All data provided - ND = ½ MDL (12/70/06 to 12/1/09)	-127	73.76	No Trend

c. Application of bromide, the presumed source for the observed site groundwater bromide concentrations, began in approximately 1998 in Stage II and January 2001 in Stage III. Aries understands that sodium bromide was never applied in the municipal solid waste (MSW) landfilled Stage I or Stage IV. Sodium bromide application ceased in Stage II and Stage III in approximately February 2002 and April 2005, respectively. Based on the reported sodium bromide application periods, Aries anticipates that site landfill leachate bromide concentrations should general increase during periods of sodium bromide application, and decrease through time after the end of the application period and as the source mass slowly attenuates. Similar groundwater bromide concentration trends would also likely be observed if the landfill leachate

were consistently released to groundwater from the secondary landfill liner.

To test this hypothesis, Aries assessed available bromide concentrations detected in monthly leachate samples collected from Stage III and Stage IV. Available information indicated that in October 2006, the Stage II leachate system was combined with the Stage IV system. Reported Stage IV leachate bromide concentrations are assumed to be related to Stage II leachate production, as sodium bromide was not applied in Stage IV.

M-K analysis of all available (1/25/01 to 12/1/09) Stage III Secondary leachate system (S3S) samples indicated a strong overall increasing bromide concentration trend. Similarly, using all S3S leachate sample data collected during the Stage III sodium bromide application period (1/25/01 to 4/20/05), Aries' M-K analysis also indicated a strong increasing bromide concentration trend. However, using all S3S leachate sample data collected after the end of the Stage III sodium bromide application (4/20/05-12/1/09), Aries' M-K analysis indicated a strong decreasing bromide concentration trend.

Similar trends were reported in the CAP for groundwater bromide concentrations in monitoring wells MW-402U and B-913M for data ranges that were isolated to the post-bromide application date ranges. However, direct comparison of leachate concentration trends with observed bromide concentration trends in groundwater samples from monitoring wells MW-402U and B-913M is difficult because limited data are available for leachate bromide concentrations from the Stage I landfill leachate system. To better evaluate the potential connection between site landfill leachate and site groundwater VOC and bromide concentrations, Aries recommends assessing whether Stage I primary and secondary leachate samples could be collected and analyzed for bromide, consistent with the current Stage III and Stage IV monitoring requirements.

Based on these findings, Aries agrees with the results of the M-K trend analyses presented in the CAP for the selected data range periods. However, Aries' interpretation of the CAP results differs from those provided in the CAP. Where the CAP concluded that, "Decreasing temporal trends have been established as a consequence of the recent remedial actions completed at the site and natural attenuation," Aries concludes that the reported decreasing groundwater bromide concentration trends are also potentially due to observed decreasing secondary leachate bromide concentrations, which continue to be detected in groundwater downgradient of the site landfill, and the selected data range tested.

Further, the CAP assertion that recent remedial measure conducted in 2009 have resulted in decreasing concentration trends which began one or more years before the remedial measures where conducted, is not fully supported by the available data. To assess for potential concentration trends, monitoring should be assessed after all the remedial measures have been completed.

4. Because the CAP focused on groundwater concentration trends in the key release detection monitoring wells MW-402U and B-913M, Aries made a paired comparison of the Stage I, Phase I (S1/P1) secondary leachate data with the B-913M groundwater data due to the apparent downgradient location of B-913M to landfill S1/P1. Aries used sample concentration data for the pair collected in July 2009[5], with the exception of the S1/P1 secondary bromide concentration data, which was collected in September 2008[6].

   Aries compared the "chemical signatures" of detected analytes (indicator constituents) in landfill leachate samples with those detected in groundwater samples collected from monitoring wells located hydraulically downgradient of the landfill cell from which the leachate samples were collected. The presumption is that if leachate were to leak from the landfill containment system, similar indicator constituents with similar relative concentrations would be detected in downgradient groundwater samples, albeit at lower concentrations due to attenuation such as dispersion in groundwater. This hypothesis assumed that the selected indicator constituent analytes were conservative and not subject to rapid biodegradation or transformation during transport from the potential leachate release area to the sampled monitoring well.

   Comparison of leachate concentrations with groundwater concentrations is difficult due to limited site data of corresponding leachate/groundwater sample pairs; that is leachate and groundwater quality data collected at approximately the same time and in the relative hydrogeologic proximity.

   For this analysis, Aries compared the following landfill leachate indicator constituents which had at least one detected concentration above the analytical detection limit in the S1/P1 secondary leachate data and B-913M groundwater data. The selected indicator constituents included: 1,4-dioxane (1,4-D); tertiary-butyl alcohol (TBA); tetrahydrofuran (THF); toluene; ethylbenzene; xylenes; bromide; chloride; and total Kjeldahl nitrogen (TKN). For non-detect values, Aries used the convention of one-half of the MDL to represent non-detect sample results in the regression analysis.

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[5] CAP, Table 1 Summary of 2009 Analytical Results - Leachate, and Appendix B, Summary of Selected Analytical Results - Groundwater.

[6] October 13, 2008, NCES correspondence regarding: North Country Environmental Services, Inc. Landfill Facility - Bethlehem, New Hampshire, Response to September 10, 2008 NHDES Comment Letter, Exhibit C - Laboratory Analytical Results, Leachate Sampling.

In general, observed indicator constituent concentrations spanned approximately seven orders of magnitude (ranging from 0.1 micrograms per liter (ug/l), or parts per billion (ppb) to 2,500 milligrams per liter (mg/l), or parts per million (ppm)) and generally fell into two groups of data values at the upper or lower limit of the value range. Testing of the data sets for normality revealed the sampling data sets to be log normally distributed. Therefore, Aries transformed the indicator constituent concentrations to natural log values where, ln(x) = x'.

Linear regression of the transformed leachate indicator constituent concentrations against the groundwater indicator constituent concentrations revealed a high degree of correlation between the S1/P1 secondary leachate data and B-913M groundwater data. As provided in Attachment A.1, linear regression analysis of the transformed data sets indicated a high degree of correlation between observed leachate and groundwater sample concentrations, with a calculated regression coefficient of determination (R^2) of approximately 0.89. An R^2 value of 1.0 indicates perfect correlation and an R^2 value 0.0 indicates no correlation.

Aries also analyzed the correlation between indicator constituents detected in both the leachate and groundwater sample for the July 2009 sample pair, as provided in Attachment A.2. Indicator constituents detected in both samples of sample pair included 1,4-D, THF, bromide, and chloride. Linear regression of the log-transformed detected indicator constituent concentrations revealed a near perfect correlation between the S1/P1 secondary leachate data and B-913M groundwater data, with an R^2 value of 0.99.

Based on the calculated high degree of correlation between the paired leachate and groundwater sample concentrations, Aries concluded that there is substantial evidence that observed B-913M groundwater leachate indicator constituent concentrations are related to upgradient S1/P1 secondary leachate indicator constituent concentrations. To further assess this potential connection, additional groundwater quality and leachate data would have to be collected and analyzed.

Further, due to the detection of bromide in the Stage I, Phase I secondary leachate sample at a concentration of 6.9 mg/l, even though available site information indicated that sodium bromide was never applied in the MSW landfilled in Stage I, Aries recommends that further study be conducted to asses the origin and the fate of the bromide concentrations detected in the Stage 1 Phase 1 secondary leachate samples, and it's apparent relationship and correlation with observed downgradient groundwater bromide concentrations detected in site monitoring well B-913M.

5. The CAP indicated that laboratory analysis of soil samples collected from the leachate underground storage tank (UST) area (former primary and secondary leachate USTs and their associated subsurface piping, and the former leachate

consolidation building and associated concrete pad/load out) "*generally did not detect VOCs*"[7] although stained soils were observed and attributed to leachate spills. Aries concludes that the non-detection of VOCs and bromide in site soils likely rules out the former leachate consolidation building and associated subsurface leachate handling infrastructure (former leachate infrastructure area) as a potential source area for the VOCs detected in the groundwater samples from monitoring well MW-402U.

However, the CAP concluded that, *"The general absence of detected VOCs in these soils is consistent with spills/release(s) of leachate to these soils being the primary source of the VOCs detected in groundwater from MW-402."*

The CAP concluded that spilled leachate contained low VOC concentrations that were generally highly soluble in water. Therefore, the soluble leachate constituents *"would be expected to have dissolved readily in infiltrating precipitation and migrated with groundwater (e.g., similar to chloride), leaving behind the less soluble/less mobile leachate constituents (such as iron and manganese) near the initial spill location."* To confirm this CAP hypothesis, substantial additional testing and analyses would have to be conducted. Additional testing may include soil column tests to evaluate residual soil contaminant concentrations due to the migration of leachate and precipitation through soil. Further, in the absence of soil analytical data, it is difficult to draw conclusions as to the nature of "stained soil", its causative mechanism, and whether the "stained soil" was due to a leachate release.

The CAP hypothesis of the absence of VOCs being consistent with a leachate release does not explain the continuing detection of VOCs and bromide in groundwater samples collected downgradient of the former leachate infrastructure area in site monitoring well MW-402U.

6. The CAP concluded that the sources of VOCs and bromide constituents in groundwater were due to: (1) incidental releases and spills of leachate, as previously reported to NHDES: and (2) uncontrolled landfill gas (LFG) emissions. Aries previously noted[8] that groundwater bromide concentrations are not likely the result of uncontrolled LFG contaminating groundwater. The CAP described the observed VOC and bromide concentrations in site leachate and VOCs reported in LFG at other landfills, and hypothesized a connection of these potential VOC sources to observed groundwater concentrations. However, the CAP did not include an analysis that would rule out any other potential VOC sources, such as from a liner release, that could contribute to VOCs observed in site groundwater.

[7] CAP, p. 11
[8] Aries' August 21, 2009, March 2009 to July 2009 Document Review, p. 7.

The CAP used generic data for LFG to support the assertion that LFG is a source of observed groundwater VOCs, but did not provide site-specific LFG VOC data to support the assertion.

Available technical literature[9] reports that LFG impacts to groundwater at landfills are not common. In fact, of the 74 landfills assessed in a 2002 EPA study, groundwater impacts could be attributed to LFG contamination at only one landfill. In making their conclusion, the 2002 EPA study relied on LFG analytical data and soil gas data collected at and downgradient of the landfill boundary. However, the CAP did not include similar data collected at the NCES landfill site. To assess for LFG impacts, the 2002 EPA study analyzed LFG concentrations, conducted a soil gas survey around the landfill perimeter, and conducted additional groundwater and leachate analyses. To establish a LFG connection to groundwater contamination, EPA concluded that the following observations and conditions would be required:

a. LFG was detected in the landfill perimeter soil gas survey;
b. VOCs that were detected in groundwater were also detected in LFG samples;
c. Relatively high concentrations of methane (over 30% on a volumetric basis) were detected in the headspace of monitoring well samples; and
d. Inorganic leachate constituents were not detected in groundwater samples.

Testing the CAP hypothesis of uncontrolled LFG contributing to groundwater contamination would require conducting a similar study to confirm the LFG contamination mechanism and to rule out other potential VOC sources such as leachate releases from the landfill containment system.

If LFG is found to contribute to observed site groundwater VOC contamination, it will be important to control this contaminant source since the current site groundwater release detection system would likely become substantially non-functional since groundwater impacts from uncontrolled LFG releases would interfere with the release detection monitoring for other release mechanisms such as landfill containment releases or leachate spills.

7. The CAP referenced a prior CMA conclusion that, "*The observations of stained soils are consistent with LFG migration out of the cap/anchor trench on the northern edge of Stage I and along this drainage pipe/backfill.*" However, available soil analytical data did not correlate stained soils with leachate soil signatures. In the absence of such data, it is difficult to confidently identify the nature, cause, and impacts of "stained soils".

[9] Bonaparte, R., Daniel, D.E., and Koerner, R.M., December 2002, *Assessment and Recommendations for Improving the Performance of Waste Containment Systems*, United States Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Cincinnati, OH 45268, EPA/600/R-02/099.

8. During the 2009 Stage I Landfill Capping System Repair Project, CMA reported, several *"apparently construction/installation-related holes observed in the cap"*[10]. Aries anticipates that similar cap liner construction/installation defects may be present in other areas of the landfill cap. The presence of observed cap defects also suggests that other landfill construction/installation defects may present in other area of the landfill, including the primary and secondary landfill liners. Further effective monitoring may disclose the need to address other areas of the landfill with potential construction and installation containment defects. The CAP report stated that repair to the cap and anchor trench were reconfigured for approximately 216 feet west of the downchute repair area and that repair was not continued beyond that point due to the presence of subsurface utilities. It is unclear whether additional areas of repair to the landfill cap were needed but not completed due to the obstructions. If such repairs were needed but not performed, additional releases to the groundwater could occur.

9. Based on leachate flow data provided in NCES' December 2009 Facility Monthly Report, observed secondary leachate flows were approximately 2.7% of the reported primary leachate flows. The presence of leachate in the secondary containment system is consistent with potential construction/installation defects in the primary landfill liners. The presence of leachate-related VOCs and bromide in groundwater also suggests that landfill construction/installation defects may also be present in the site landfill secondary liners. Such potential construction/installation defects may only be effectively assessed through continued monitoring using an effective groundwater release detection system. If the groundwater release detection system is compromised by contamination due to uncontrolled LFG releases, and leachate management system spills, it would not likely effectively monitor for such potential containment system defects.

10. As part of the CAP's proposed LFG monitoring program, two soil-vapor probes were proposed in the area directly north of the Stage I Landfill anchor trench (and south of the well MW-402U area) with the soil gas probe screens installed just above the water table. This sampling configuration may not be representative of LFG concentrations in the unsaturated zone, but rather may indicate dissolved-phase groundwater VOCs that may have potentially migrated from beneath the landfill to the proposed sample collection area. Aries recommends that soil gas wells be installed in clusters which are completed at shallow, intermediate and deep intervals above the observed site water table to provide a vertical profile of potential LFG distribution.

11. The CAP concluded that VOCs detected in groundwater samples collected from monitoring wells located in the northeastern portion of the site were related to groundwater impacts from the former site unlined landfill[11]. However, continued detection of a "stable" trend of bromide, a groundwater contaminant not related to

[10] CAP, p. 12.
[11] CAP, p. 18-19.

the former site unlined landfill, in samples collected from site monitoring well B-304UR located in the northeast portion of the site is consistent with an ongoing, contaminant source, and not releases from the former unlined landfill.

12. The CAP indicated the "continued northerly migration" of VOCs, including dichlorodifluoromethane (DCDFM) and 1-1 dichloroethane (1,1-DCA), from the former unlined landfill area, which would suggest a continuing VOC source located beneath the existing lined landfill. However, the CAP also reported that the unlined landfill materials had been removed down to the subsurface soils. If the VOC source is a relict of the former unlined landfill, the source mass would likely be decreasing through time with the transport of VOC contaminant mass in groundwater away from the potential source zone. The resultant VOC signature would likely consist of slowly decreasing VOC contaminant concentrations at a fixed monitoring point through time. Natural attenuation processes could also reduce the observed VOC contaminant concentrations at distance from the source resulting in decreasing contaminant concentrations.

    However, increasing DCDFM concentration trends, as observed in the B-921M data set suggest increasing source mass loading, which would not be consistent with a historic source, or slowly attenuating source. It is Aries' opinion that increasing DCDFM trends observed in samples collected from site monitoring well B-921M would not be consistent with the continued northerly groundwater VOC contaminant flow from the area of the former unlined landfill. Rather, Aries anticipates that increasing or neutral VOC concentration trends would likely indicate potential continuing groundwater contaminant sources which may include continued releases from the site landfill containment system or other site release mechanism.

    The CAP concluded that the general detection of groundwater DCDFM concentrations in the northeast monitoring wells (B-920M, B-921U, B-921M, B-919U, and the replacement well couplet B-304UR and B-304DR), "result from the historical presence of DCDFM in groundwater"[12] and the "generally northerly migration of DCDFM with groundwater flow from the area of the former unlined landfill and wells B-101, MW-804, and MW-805." A review of available Department OneStop online database files for the site revealed the that the analyte DCDFM was not tested for in site groundwater samples, including the former unlined landfill area and northeast area monitoring wells, until the November 1997 groundwater sampling round[13], or approximately four years following completion of the removal of solid waste from the former unlined landfill in October 1993[14] and following start-up of the lined landfill operation. Therefore, a clear connection between "historic" pre-lined landfill groundwater conditions and current downgradient groundwater conditions cannot be confidently made.

[12] CAP, p.18.
[13] 2008 Summary Water Quality Monitoring, North Country Environmental Services (NCES) Landfill, Bethlehem, New Hampshire, September 2008, prepared by SHA.
[14] October 7, 1993, Consumat Sanco Inc. correspondence to the Department.

13. The CAP included groundwater quality data summary for only eight of the approximate 29 site GMP monitoring wells. Aries notes that some of the highest bromide and TKN concentrations have been observed in the monitoring well couplet B-103S/D, which is located hydraulically downgradient from the Stage II landfill area. Aries notes that these wells are also not depicted on the CAP report Water Table Contour Plan (July 2009). Aries recommends that assessment of groundwater VOC, bromide, TKN, and other landfill leachate indicator constituents be conducted downgradient of the Stage II landfill area, including an assessment of off-site groundwater quality located northeast of site monitoring well couplets B-102 and B-103 based on the reported July 2009 northeast groundwater flow direction depicted on the CAP water table contour plan.

3. November 2009 CMA Final Report & Construction Certification

The November 2009 CMA Final Report & Construction Certification report described work conducted during August and September 2009 at the NCES landfill including the following: additional soil excavation and removal, removal of the existing drainage culvert, repairs to the cap system drainage, and construction of a geomembrane-lined swale.

During the excavation work, stained soils were reported in the vicinity of the Stage I anchor trench. Laboratory analysis of seven soil samples collected from the stained soils did not detect VOC or bromide above their respective lower analytical detection limits, while chloride was detected in only one samples at a 6.5 milligrams per kilogram (mg/kg) and slightly above the lower analytical detection limit of 6.3 mg/kg.

CMA reported that Stage I waste filling grades "made it difficult" to tie the cap to the liner system anchor trench.

During the Stage I cap repair work, CMA identified a hole in the cap geomembrane along the Stage I downchute and damage to the primary liner outside the anchor trench. CMA observed apparent leachate seeps running out from underneath the capping system into a stormwater swale that discharges to the site Detention Pond No. 3. VOCs, including tert-butyl alcohol (TBA), tetrahydrofuran (THF) and benzene, toluene, ethylbenzene and xylenes (BTEX) compounds were detected in the landfill liner seep samples at concentrations consistent with reported leachate concentrations. The discovery of existing holes and defects in the site landfill capping system and primary liner system suggest that the other holes and defects are likely probable. CMA indicated that additional areas of the liner systems may also require repair but were not repaired due to the presence of subsurface infrastructure obstructions. It is not clear why the CAP did not acknowledge this apparent leachate release to site soil north of the landfill, as a potential source of leachate observed in site groundwater samples. Instead, the CAP generally attributed groundwater quality impacts to uncontrolled LFG releases and incidental leachate spills.

CONCLUSIONS

Based on our review of the CAP report and available site groundwater and leachate monitoring data, following is a general summary of Aries' conclusions discussed in more detail in this report:

1. Groundwater bromide and VOC concentration trends observed during 2009 are consistent with an on-going source or sources of bromide and VOCs released to groundwater. Potential bromide and VOC release sources include leaks from the landfill liner system, discharges from the site leachate management system, an as yet undetermined release mechanism, or a combination of these leachate release mechanisms. It will be important to identify the release mechanism (or mechanisms) to develop and implement an appropriate remedial action plan, and monitor its effectiveness.

2. Decreasing groundwater bromide concentration trends are likely due in part to attenuating secondary leachate bromide concentrations.

3. Regression analysis of paired leachate and groundwater sample leachate indicator constituent concentrations indicated that observed B-913M groundwater concentrations may be related to upgradient S1/P1 secondary leachate concentrations.

4. Available soil and groundwater data collected during CMA's 2008 and 2009 Leachate Management Improvements Project, as well as during SHA's 2006 soil assessment work, did not clearly indicate the source or sources of the observed site groundwater bromide and VOC concentrations repeatedly detected in the groundwater samples collected downgradient of the landfill facility.

5. Available information indicated that landfill containment construction/installation defects have been observed in the north part of the landfill. Such defects may also be present in other landfill areas, and would only likely be detected by an effective release detection system.

6. The CAP provided opinions and hypotheses regarding groundwater contaminant sources. However, site remedial work is not yet complete and site data have not yet demonstrated that landfill remedial actions have identified and effectively addressed all potential groundwater contaminant sources. The effectiveness of landfill remedial action will only become apparent as additional monitoring data are collected and analyzed. Monitoring data would have to be collected over a one to two year period after landfill remedial actions are completed, before remedial effectiveness conclusions can be confidently drawn.

RECOMMENDATIONS

Based on our review of the above-reference documents, following is a general summary of Aries' recommendations discussed in more detail in this report:

1. Continued groundwater monitoring should be conducted for the presence of bromide and VOCs to assess whether the source (or sources) of observed groundwater bromide and VOC concentrations are the result of leakage from the landfill liner, releases from the leachate management system, an as yet undetermined release mechanism, or a combination of these leachate release mechanisms. Groundwater monitoring should be conducted on a minimum triannual basis for site GMP and release detection monitoring wells. Aries recommends one to two years monitoring of data be collected following completion of landfill remedial measures to assess seasonal variations in site groundwater concentrations and the effectiveness of landfill remedial measures. Landfill remedial measure effectiveness assessment should be based on attaining, and maintaining groundwater quality at natural background conditions.

2. If possible, Stage I leachate should be sampled for bromide in addition to VOCs and other current monitoring parameters to assess the correlation of landfill leachate to observed groundwater impacts.

3. VOC and bromide monitoring should continue in site release detection monitoring wells due to the potential threat of a release from the landfill liner system. After sufficient release detection system data have been collected, remedial measures are complete, and VOC and bromide concentrations have returned to background, it will be feasible to assess appropriate continued groundwater monitoring requirements.

4. The convention of a value of one-half of the method detection limit (MDL) should be considered for use to represent non-detect groundwater sample results in future groundwater trend analyses.

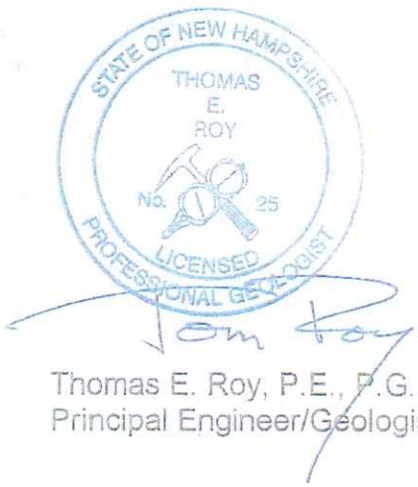
5. LFG analytical data and soil gas data should be collected at and downgradient of the landfill boundary. Soil gas wells should be installed in clusters which are completed at shallow, intermediate and deep intervals above the observed site water table to provide a vertical profile of potential LFG distribution. Sample headspace should be tested for methane, and samples tested for LFG constituents should also be analyzed for inorganic leachate constituents. Depending on the LFG survey results, additional LFG management efforts may be required.

Aries' conclusions and recommendations are similar to our April 29, 2009 and August 21, 2009 site submittal reviews and were not substantially changed by this analysis.

If you have any additional comments or questions, please do not hesitate to contact me at 603-228-0008.

Sincerely,
Aries Engineering, Inc.

George C. Holt, P.G.
Senior Hydrogeologist



Thomas E. Roy, P.E., P.G.
Principal Engineer/Geologist

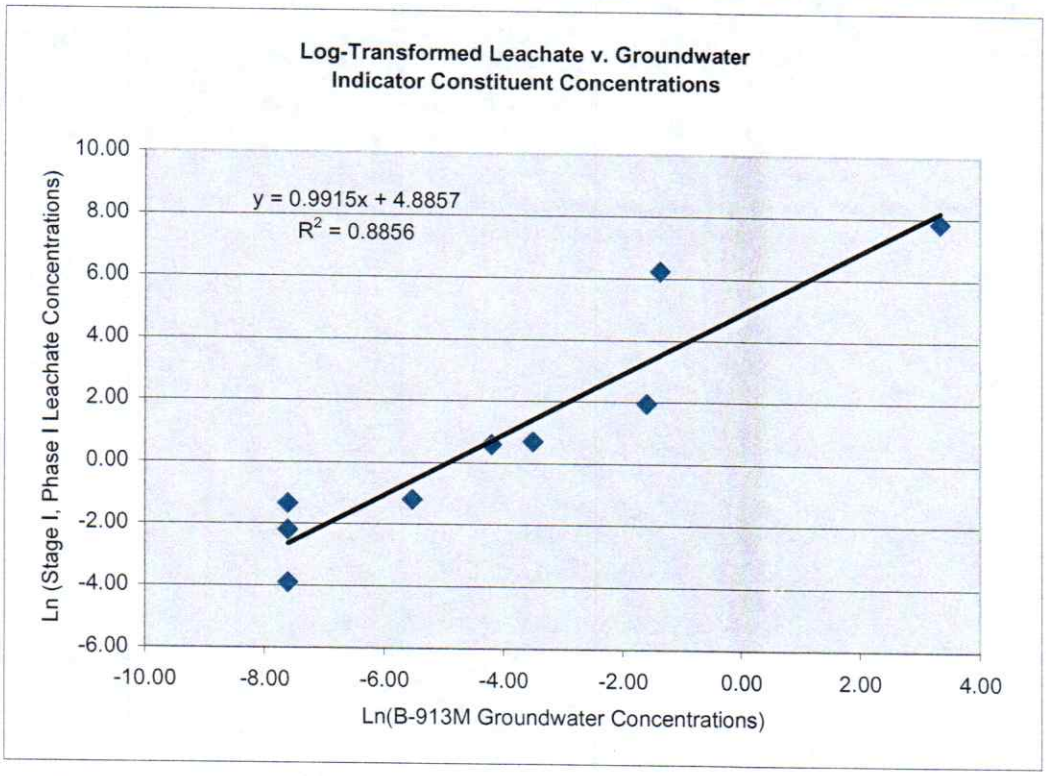
Attachments: A.1; A. 2

GCH:kd

ATTACHMENT A.1
Corrective Action Plan Comments
North Country Environmental Services Landfill
Bethlehem, New Hampshire
NHDES: Site 198704033

2/25/2010

Location Date	ST1,PH1 [y] 7/15/2009	B-913M [x] 7/30/2009	ST1,PH1 [ln(y)] 7/15/2009	B-913M [ln(x)] 7/30/2009
Contaminant of Concern (mg/l)				
1,4-dioxane (1,4-D)	0.300	0.004	-1.20	-5.52
Tert-butyl Alcohol (TBA)	1.800	0.015	0.59	-4.20
Tetrahydorfuran (THF)	2.000	0.030	0.69	-3.51
Toluene	0.020	0.0005	-3.91	-7.60
Ethylbenzene	0.110	0.0005	-2.21	-7.60
Xylenes	0.260	0.0005	-1.35	-7.60
Bromide	6.9	0.2	1.93	-1.61
Chloride	2,500	28	7.82	3.33
Total Kjeldahl Nitrogen	500	0.25	6.21	-1.39



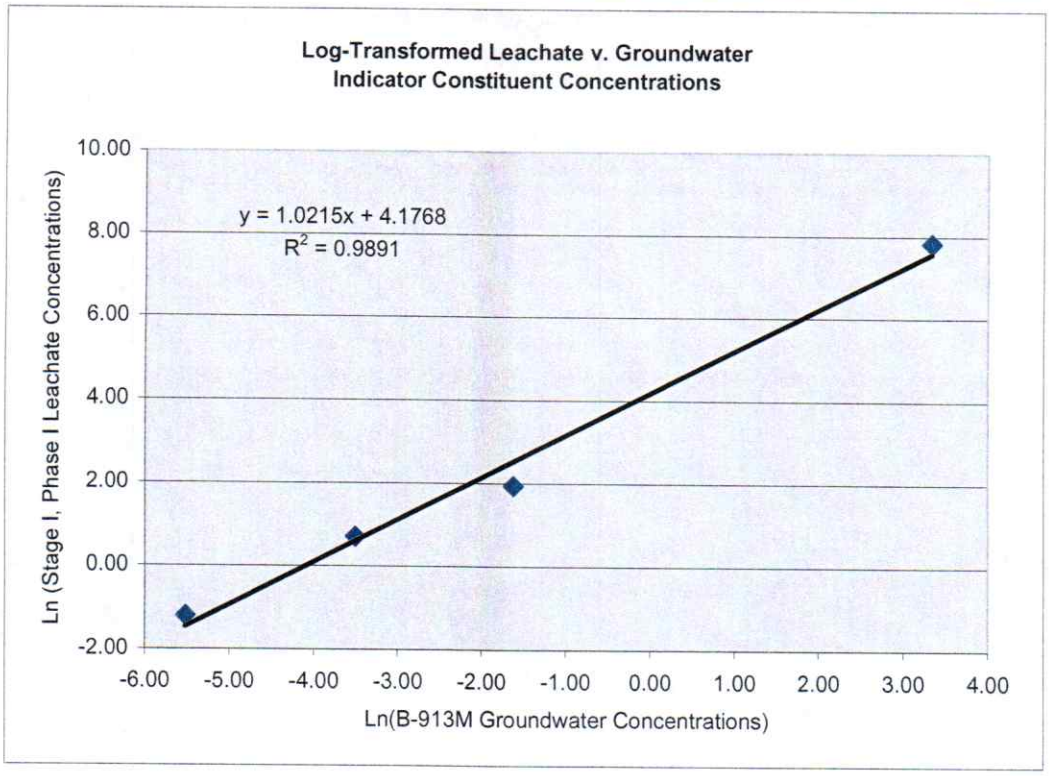
Notes:

1. Shading indicates parameter not detected. Reported value equal to one-half the analytical method detection limit (MDL).
2. All Stage I, Phase I (S1/P1) leachate sample data, except bromide concentration, obtained from SHA's November 2009 Corrective Action Plan, Table 1 Summary of 2009 Analytical Results - Leachate.
3. S1/P1 leachate bromide sample data collected on 9/11/09 and reported in: October 13, 2009, NCES correspondence regarding: North Country Environmental Services, Inc. Landfill Facility - Bethlehem, New Hampshire, Response to September 10, 2008 NHDES Comment Letter, Exhibit C - Laboratory Analytical Results, Leachate Sampling.
4. Groundwater sample B-913M data obtained from SHA's November 2009 Corrective Action Plan, Appendix B Summary of Selected Analytical Results - Groundwater.
5. Aries selected analyte pairs with at least one detected concentration.

ATTACHMENT A.2
Corrective Action Plan Comments
North Country Environmental Services Landfill
Bethlehem, New Hampshire
NHDES: Site 198704033

2/25/2010

Location Date	ST1,PH1 [y] 7/15/2009	B-913M [x] 7/30/2009	ST1,PH1 [ln(y)] 7/15/2009	B-913M [ln(x)] 7/30/2009
Contaminant of Concern (mg/l)				
1,4-dioxane (1,4-D)	0.300	0.004	-1.20	-5.52
Tetrahydorfuran (THF)	2.000	0.030	0.69	-3.51
Bromide	6.9	0.2	1.93	-1.61
Chloride	2,500	28	7.82	3.33



Notes:

1. All Stage I, Phase I (S1/P1) leachate sample data, except bromide concentration, obtained from SHA's November 2009 Corrective Action Plan, Table 1 Summary of 2009 Analytical Results - Leachate.
2. S1/P1 leachate bromide sample data collected on 9/11/09 and reported in: October 13, 2009, NCES correspondence regarding: North Country Environmental Services, Inc. Landfill Facility - Bethlehem, New Hampshire, Response to September 10, 2008 NHDES Comment Letter, Exhibit C - Laboratory Analytical Results, Leachate Sampling.
3. Groundwater sample B-913M data obtained from SHA's November 2009 Corrective Action Plan, Appendix B Summary of Selected Analytical Results - Groundwater.
4. Aries selected analyte pairs with at least one detected concentration.