

**IMMEDIATE RESPONSE ACTION STATUS  
And QUARTERLY LANDFILL MONITORING  
With SUPPORTING DOCUMENTATION  
MA DEP RTN 4-24301**

Town of Eastham Landfill  
255 Old Orchard Road  
Eastham, MA  
BEA09-10104

**MARCH 29, 2013**

# BENNETT ENVIRONMENTAL ASSOCIATES, INC.

LICENSED SITE PROFESSIONALS ♪ ENVIRONMENTAL SCIENTISTS ♪ GEOLOGISTS ♪ ENGINEERS

1573 Main Street - P.O. Box 1743, Brewster, MA 02631 ♪ 508-896-1706 ♪ Fax 508-896-5109 ♪ www.bennett-ea.com

BEA09-10104

March 29, 2013

Millie Garcia-Serrano, Regional Deputy Director  
Bureau of Waste Site Cleanup  
MA Department of Environmental Protection (MA DEP)  
Southeast Regional Offices (SERO)  
20 Riverside Drive - Lakeville, MA 02347

**RE: IMMEDIATE RESPONSE ACTION STATUS REPORT I AND  
QUARTERLY LANDFILL MONITORING REPORT**  
RTN#4-24301 Eastham Landfill  
Old Orchard Road - Eastham, MA

Dear Ms. Garcia-Serrano,

On behalf of the Town of Eastham, BENNETT ENVIRONMENTAL ASSOCIATES, INC. (BEA) has prepared the following Immediate Response Action Status Report (IRAS) with Imminent Hazard Evaluation (IH) and Remedial Monitoring Report (RMR) and Supporting Documentation per the MA DEP "Conditional Approval to Conduct Immediate Response Actions/Interim Deadlines" communications dated January 30, 2013. This document further includes landfill monitoring requirements for the sampling of onsite/offsite monitoring wells and select residences as set forth in the revised Landfill Monitoring Plan (LMP) dated August 14, 2012. This report covers the period from January 12, 2013 through March 22, 2013, following the submittal of the original Immediate Response Action Plan (1/11/13). The Immediate Response Action (IRA) is in response to the MA DEP Notification of 1,4-Dioxane in landfill monitoring well MW-3D, above the applicable RCGW-1 Reportable Concentrations on November 13, 2012 as within 500' of multiple private potable wells. Subsequent testing of downgradient private wells in the following IRA documented the presence of 1,4-Dioxane in private wells as the sole source of drinking water in the Town of Eastham. The compound 1,4-Dioxane is currently an unregulated volatile organic compound (VOC) under the Federal (EPA) and State (MA DEP) drinking water programs with a current Notification and MCP Cleanup standard (GW-1) of 3.0 ug/L and a Drinking Water Guideline (ORSG) of 0.3 ug/L. The EPA has listed 1,4-Dioxane as a Group B2 (probable human) carcinogen.<sup>1</sup>

In this reporting period, some 88 owners of record for downgradient residential properties east of the Eastham Landfill were notified by registered mail to request the voluntary sampling of their private wells for regulated volatile organic compounds (VOC's) including low-level 1,4-Dioxane. Questionnaires were provided to each property owner for additional information on their private wells to fill in gaps in public records and to help document the horizontal and

<sup>1</sup> EPA Integrated Risk Information System (last updated 8/11/2010) <http://www.epa.gov/IRIS/subst/0326.htm>

vertical extent and magnitude of VOC's, particularly 1,4-Dioxane. From February 11<sup>th</sup> to February 25<sup>th</sup>, some 58 responding property owners, representing some 65 residences, the Eastham DPW well and Eastham Elementary School, were tested for regulated VOC's (EPA 524) including low-level 1,4-Dioxane (EPA 522 0.2 ug/L). These sampling protocols were recommended by the MA DEP and approved by the Town of Eastham as commensurate with the current 2012 MA Drinking Water Standards (MMCL) and Guidelines (ORSG). Landfill monitoring wells and offsite monitoring wells were similarly tested.

Analytical results detected 1,4-Dioxane in some thirty-one (31) of the sixty-two (62) samples analyzed [50% +/-], exclusive of the duplicates, and as including estimated values ("J") below the reporting limit of 0.2 ug/L. Of the wells reporting detectable concentrations of 1,4-Dioxane, four (4) reported concentrations above the current GW-1, Method 1 - Risk Characterization Standard for drinking water (3.0 ug/L) and an additional seven (7) [total of 11] above the ORSG Drinking Water Guideline (0.3 ug/L) [18% +/-]. In the Landfill monitoring wells, nine (9) wells were tested for 1,4-Dioxane and five (5) had detectable concentrations [55% +/-], with one (1) reporting a concentration (14.0 ug/L) significantly greater than the current GW-1, Method 1 - Risk Characterization Standard for drinking water (3.0 ug/L) [11% +/-]. In all of the other VOC testing conducted at the Landfill, no other compounds were reported at concentrations exceeding the current Drinking Water Standards (MMCL) or the MA Contingency Plan (MCP) GW-1, Method 1 - Risk Characterization Standards.<sup>2</sup>

Concurrent with the residential private well and monitoring well testing, bottled water was immediately provided to anyone reporting a 1,4-Dioxane concentration of 1.5 ug/L, based on Method 3 - Risk Characterization and as consistent with guidance provided by the MA DEP. Additionally, interim measures for the mitigation of Critical Exposure Pathways (CEPs) to residents was being pursued at those locations with the highest 1,4-Dioxane concentrations (RES-30/RES-35). A replacement well was installed and tested at RES-35 (50 Alston Avenue) and the existing point-of-entry GAC treatment system at RES-30 (325 Schoolhouse Road) was equipped with coconut shell based granular activated carbon (GAC) that had reportedly shown increased capacity for 1,4-Dioxane sorption. At the time of this reporting, both the replacement well and the GAC treatment system have documented the effective elimination or significant reduction of 1,4-Dioxane concentrations at these residences (<0.3 ug/L), although household water use is noted as minimal at these locations. As such, point-of-entry GAC treatment and shallow replacement wells in select locations appears to be an effective temporary measure in the mitigation of potential exposure risks as CEP's to household residents.

This IRASI/LMP represents the findings and interpretation of the additional analytical testing conducted and evaluates the mitigating measures implemented in the review of potential exposure risks. Additionally, the information gained from the broader study of private wells and

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<sup>2</sup> Certain compounds reported have no prescribed drinking water standard or GW-1 standards. In the case of 1,2-dibromo-3-chloropropane (DBCP) and 1,2-dibromoethane (EDB), low level testing of these compounds by EPA method 8011 in the landfill wells, reported these concentrations as below the detection limit wherein the detection limit is lower than the prescribed standards. As such, these compounds are not considered to be contaminants of concern and not normally tested by special low level methods in downgradient private wells.

offsite monitoring wells is used to help define the magnitude, extent and hydrogeologic characteristics of offsite solute transport of impacted groundwater underlying the Eastham Landfill in order to refine the Conceptual Site Model (CSM) as a predictive tool towards future investigations under the Immediate Response Action. Specifically, it is the recommendation of this IRASI to expand the Study Area for residential well testing east of the Landfill, as well as the sampling and laboratory analysis of Public Water Supply wells at commercial businesses west of the Eastham Landfill along Route 6, which have Zone II Wellhead Protection radii that fall within the boundaries of the Landfill property. It is further recommended that point-of-entry GAC treatment systems be installed as a temporary measure for the treatment of domestic water for properties where the concentration of 1,4-Dioxane exceeds the Method 3 - Risk Characterization for either chronic or sub-chronic cancer and non-cancer exposure risks, as well as to provide bottled water to all residences, institutional and commercial establishments where laboratory analysis reports 1,4-Dioxane at or above the recommended 1.5 ug/L threshold. Finally, the multi-level monitoring wells at the MW-22 location should be replaced using membrane interface probe (MIP) or similar technology, to provide real-time water quality data to afford dynamic decision making in the setting of representative wells. This information, combined with the normalized private well production horizons reporting such impacts, will be used to define the horizontal and lateral extent of significant groundwater impacts towards remediation or prioritization of municipal water connections towards a permanent solution.

The sum of the remedial response actions undertaken on behalf of the Town of Eastham, as described and recommended, have been conducted under LSP oversight in a manner consistent with the MCP Response Action Performance Standards (RAPS) pursuant to 310 CMR 40.0191 and the QA/QC policies of BENNETT ENVIRONMENTAL ASSOCIATES, INC. The facts and statements herein are, to the best of our knowledge, a true and accurate representation of the Site activities, remedial response actions and environmental conditions associated with the project. The LSP opinions are based on the available data and regulations in effect at the time of this reporting.

## **BACKGROUND**

The Town of Eastham operated the unlined Eastham Landfill at the current 19 +/- acres parcel of land off Old Orchard Road [Map 8, Parcel 120] from 1937 until its closure in 1997. According to the available records including the Initial Site Assessment and Comprehensive Site Assessment (ISA/CSA) Scope of Work prepared for the Eastham Landfill in 1992, the Site was a burning dump from the late 1930's until the early 1960's. Landfill activities began in the late 1960s with some 9.15 acres used for the burial of municipal solid waste (MSW). An adjacent 4.48 acre "stump dump" was acquired in 1987 from a private owner and operated by the Town. Another half-acre contained the Town's unlined septage lagoon facility which operated in the 1970s and remained active until 1988 when the sludge was excavated and disposed of in the Landfill. According to town personnel interviewed in 1992, no records were kept regarding solid waste generators, solid waste generation rates and composition of the waste stream prior to 1991 when the existing transfer station began operating. By 1992, it appears that the active burial of solid waste landfill was halted.

Drinking water samples collected and reported to the MA DEP in 1987, 1990 and 1991 reported volatile organic compounds (VOCs) impacts to residential wells southeast (downgradient) of the Landfill, as apparently impacted by leachate. In an effort to eliminate further impacts to private wells, the Town proceeded through the ISA/CSA process through its consultant, ATP Environmental, to cap the unlined landfill against the mobilization of contaminants to groundwater as appeared to be the standard of practice shared among local municipalities. The engineering barrier was designed and approved and the area of active solid waste burial was subsequently capped in 1997. In accordance with the Landfill Closure permit conditions, ATP Environmental continued sampling of monitoring wells and private wells in the area of the Landfill.

In March 2004, a Notice of Responsibility (NOR) [RTN 4-18278] was issued to the Town of Eastham for the suspected release of hazardous materials [vinyl chloride (VC)] from the Eastham Landfill to a private drinking water well at a concentration of 2.0 ppb. Bennett & O'Reilly, Inc. was subsequently engaged by the Town as LSP of Record to conduct remedial response activities for the apparent release. On September 22, 2004, in a meeting between various Department heads, Town officials, and the LSP of Record, it was decided that quarterly VOCs analysis as well as inorganics would be conducted on select landfill monitoring wells and private wells as part of the MCP Waste Site Cleanup monitoring protocols and to also satisfy Solid Waste Landfill Monitoring requirements, as concentrated on VC-related impacts.

With the subsequent closure of RTN 4-18278 under a Class A Response Action Outcome in 2009, as based on a preponderance of physical testing over five years, BEA as successor for Bennett & O'Reilly, Inc., prepared a proposed Landfill Monitoring Plan (LMP) for the continuation of Post-Closure monitoring under MA DEP Solid Waste Program outside of the MCP. Such landfill monitoring was conducted and reported on a quarterly basis by BEA from 2009 to 2012.

In August 2012, the Town of Eastham received a revised LMP from the Department. Included in the revised LMP was the requirement for one-time sampling and analysis of 1,4-Dioxane at selected monitoring and private wells. As such, in the first quarterly sampling under the revised LMP in September-December 2012, the low level sampling of 1,4-Dioxane (8260 SIM) was included at the MW-3I and MW-3D monitoring wells. Analytical results reported that 1,4-Dioxane was detected in monitoring well MW-3D at 18 ug/L, above the applicable Reportable Concentration (RCGW-1) of 3 ug/L as was communicated to the Town of Eastham over the Veteran's Day weekend. After communicating this information to the Town of Eastham, Release Notification was made to the Department and additional sampling was conducted at the RES-1 (180 Old Orchard), RES-8 (100 Meetinghouse) and RES-20 (285 Alston) private wells for VOC's inclusive of low level 1,4-Dioxane, as immediately downgradient of the MW-3D monitoring well. Additionally, MW-3D was re-tested in consideration of data validation, repeatability and variation. All such samples were submitted on a 24-hour RUSH basis.

Concentrations of 1,4-Dioxane were reported as 4.3 ug/L in the repeat sampling of the MW-3D landfill monitoring well as confirming the presence of 1,4-Dioxane above the RCGW-1 Reporting Concentration, albeit significantly decreased from the initial testing some 5 weeks earlier. An estimated concentration of 1.7 ug/L was additionally reported in the RES-8 (100 Meetinghouse) drinking water well, as less than the aforementioned RCGW-1 and GW-1, Method 1 - Risk Characterization Standards. No concentrations of 1,4-Dioxane were reported above the reporting limit (2.0 ug/L) or method detection limits (0.75 ug/L) in RES-1 (180 Old Orchard) or RES-20 ((285 Alston) in this confirmatory sampling. The residences sampled were notified of the analytical results and based on the fact that the 100 Meetinghouse Road property reported 1,4-Dioxane at a concentration greater than 50% of the GW-1, Method 1 – Risk Characterization Standard, bottled water was provided to the residents at the duplex for drinking and food preparation as a precautionary measure.

The Department subsequently issued release tracking number (RTN) 4-24301 and authorized additional assessment activities as verbal approvals under the Immediate Response Action (IRA). Supplemental assessment activities included sampling additional private potable wells within 500 feet of the MW-3D well for 1,4-Dioxane, and similar testing of the remaining landfill monitoring wells and residential private wells as consistent with the LMP semi-annual and annual testing requirements. This strategy was approved by the MA DEP and specifically outlined in the Notice of Responsibility (11/28/12) sent to the town as modified for EPA 8260B TCL VOC/SIM testing as falling under CAM/PC protocols to facilitate validation and Representativeness Evaluation and Data Usability Analysis (REDUA). The testing of these additional residential private wells within 500' of the Landfill monitoring well MW-3D, and accelerated semi-annual and annual testing of other residences within the LMP, was conducted under verbal approvals.

This additional work identified the presence of 1,4-Dioxane in the private wells at 325 Schoolhouse Road (RES-30) and 50 Alston Avenue (RES-35) above the 3.0 ug/L GW-1 standard as Critical Exposure Pathways (CEPs), as well as documenting an apparent Condition of Substantial Release Migration for 1,4-Dioxane at a significant distance from the Eastham Landfill. These residents were immediately provided with bottled water as a temporary mitigating measure against ingestion of 1,4-Dioxane, as the primary and most sensitive route of potential exposure. All potential exposures (ingestion, inhalation and dermal contact) were evaluated under Method 3 – Risk Characterization utilizing the MA DEP ShortForms. These findings and recommendations for an expanded sampling program were presented in the Immediate Response Action Plan filed with the Department on January 11, 2013.

#### **ENVIRONMENTAL CONDITIONS [Refer to Appendix A – Site Plan and Reference Maps]**

The Eastham Landfill is located northwest of the intersection of Old Orchard Road and Meetinghouse Road, in the town of Eastham, MA. The property is represented on Eastham Assessor's Map 8, Parcel 120, and contains 18.74 acres of vacant land [Refer to Figure 1]. Access to property along Old Orchard Road is restricted by a locked gate and 6-foot stockade perimeter fence. As such, 1,4-Dioxane containing municipal solid waste (MSW) materials

buried, or other soils impacted by 1,4-Dioxane from the former septage lagoons located on the property, as the likely primary source of 1,4-Dioxane, appears to be isolated at the Eastham Landfill property by the fencing, an engineered barrier and/or at such depths to be considered isolated.

The current estimated Site, as that area where 1,4-Dioxane is present or has come to migrate at significant concentrations ( $>$  RCGW-1) above background concentrations, includes the Eastham Landfill property itself and is now projected within the Study Area to include residential properties to the east of the Eastham Landfill roughly running south to Route 6, east beyond Schoolhouse Road and north to Whidah and Eldia Lanes. The surrounding properties, as well as the entire Study Area, are primarily moderately to highly developed with seasonal and year-round single and two-family residential dwellings. Included in the Study Area is the Eastham Elementary School. It is estimated that there are slightly more than 100 residences in the current 200-acre Study Area, all of which are served by septic systems and private wells as no municipal sewer or municipal water supply is available in the Town of Eastham.

Based on the density of development, it is estimated that there are as many as 200 residences within the expanded Study Area. Additionally, to the west of the Landfill, there are several small transient non-community (TNC) public water supply wells serving restaurants and hotels/motels along Route 6. Several of these TNC public water supply wells have Zone II protective well radii that fall onto the DPW property and capped unlined landfill area.

The surficial geology in the Study Area is characterized as a part of the Eastham Plain Deposit consisting primarily of gravelly sand, which may contain localized gravel, silt, clay, till and boulders. Hydrologic references indicate groundwater exists at 15' NGVD (+/-) as projected within 20-50' of ground surface over the Study Area. Regional groundwater contours indicate a southeasterly flow direction towards Salt Pond and the Salt Pond Bay estuary beyond, with Molls Pond and Ministers Pond in between. Local groundwater flow has been qualified by the gauging of landfill and offsite monitoring wells confirming a southeasterly flow as consistent with regional groundwater contours. The occurrence of 1,4-Dioxane in deep wells ( $>$  100') near the intersection of Schoolhouse Road and Alston Avenue, more easterly of the Landfill, appears to be influenced by clay strata as representing preferential pathways for solute transport for dense non-aqueous phase liquids (DNAPL). Based on Site features and environmental conditions, Molls Pond and Ministers Pond are identified as the primary potential environmental receptors as the closest zero-head boundaries, while residents with private wells on downgradient properties are identified as the primary human receptors in the absence of a municipal water system [Refer to Figure 2].

The Mass GIS, MA DEP Water Supply Protection overlay shows that several Interim Wellhead Protection Area (IWPA) for commercial establishments along Route 6 fall onto the Eastham Landfill property. Furthermore, in the downgradient Study Area, additional IWPA are identified as well as numerous private wells. As such, the entirety of the Site including the unlined capped landfill and Study Area is defined as a Drinking Water Source Area [Refer to Figure 3]. The groundwater that migrates from under the Eastham Landfill is the source of

potable water as no municipal public water supply exists. The ingestion of 1,4-Dioxane in groundwater is the primary exposure route as driving the evaluation of exposure under the GW-1, Method 1 – Risk Characterizations Standards (3.0 ug/L). In addition, the GW-2 and GW-3, Method 1 – Risk Characterization Standards for vapor entry (6,000 ug/L) and significant environmental impacts to resource areas (50,000 ug/L) would be considered. Soil impacts associated with 1,4-Dioxane anticipated at the Landfill are isolated as previously represented and, as such, the S-3/GW-1 (0.2 mg/Kg), S-3/GW-2 (6 mg/Kg) and S-3/GW-3 (500 mg/Kg), Method 1 – Risk Characterization Standards are applicable.

It is important to note that proposed revisions to the governing MCP regulations under 310 CMR 40.0000 have been advertised, as only recently published and subject to public comment and ratification at some later date expected this year. The proposed change in the GW-1, Method 1 – Risk Characterization Standard for 1,4-Dioxane is 0.3 ug/L as consistent with the current MA Office of Research and Standards Drinking Water Guideline of 0.3 ug/L. Notwithstanding the uncertainty in promulgation of the proposed revisions to the MCP, the Town of Eastham has elected, at the MA DEP's recommendation, to conduct future testing of 1,4-Dioxane under the low level EPA 522 Method so that the reporting limits will be 0.2 ug/L, as less than the current ORSG and proposed GW-1 standards. The potential drawback of the 522 Method is that no MA Laboratory Certification is offered, CAM protocols do not necessarily apply to 500 series Methods and the sensitivity of the analysis with a detection limit of 0.7 ug/L is expected to report background conditions attributed to non-point sources or sanitary wastewater discharge from private septic systems.

Additionally, wherein no Drinking Water Standard (MMCL) has been established for 1,4-Dioxane, under the provisions of 310 CMR 40.0990, Method 3 - Risk Characterization may be considered to evaluate specific Imminent Hazard and Significant Risk. This investigation further utilizes the Method 3 - Risk Characterization MA DEP ShortForms (Version 10-12) as assisted by Peter Woodman, PhD of Risk Management, Inc (RMI). Method 3 - Risk Characterization allows for the review of both chronic and sub-chronic, cancer and non-cancer, ingestion, inhalation and dermal contact exposure risks in sensitive age groups relative to a lifetime of residential exposures.

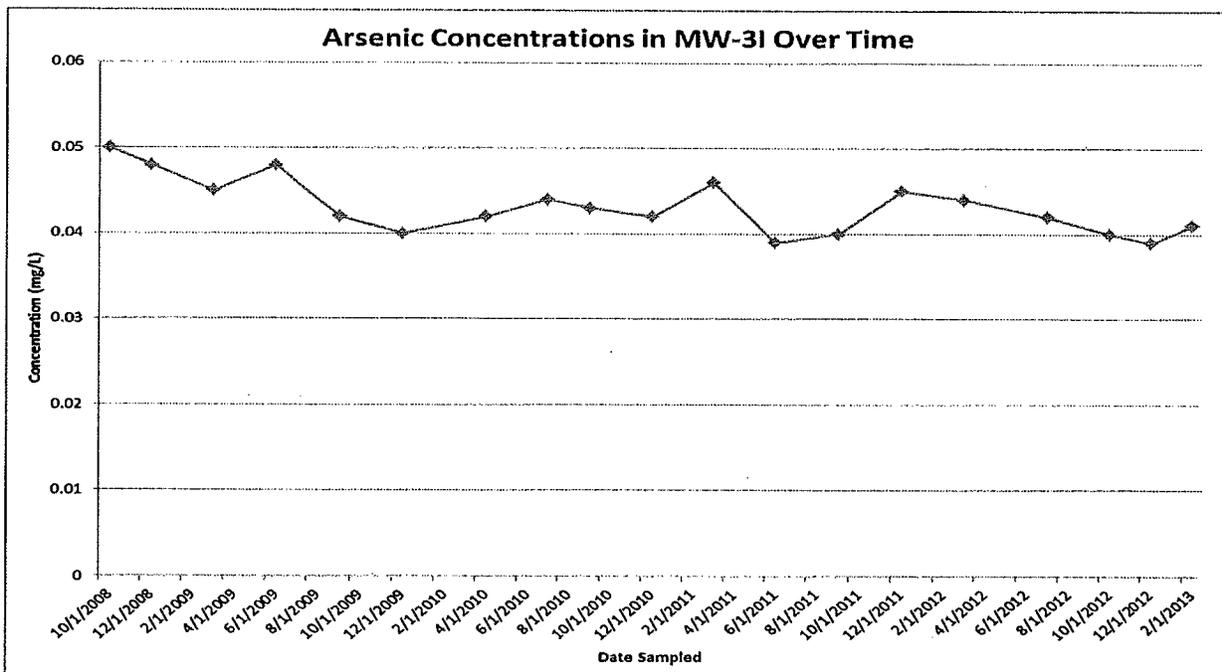
## **ENVIRONMENTAL ASSESSMENT LMP [Refer to Appendix B]**

### Groundwater

Barnstable County Department of Health & the Environment (BCDHE) personnel conducted the March 2013 quarterly sampling of the Eastham Landfill monitoring wells in accordance with the revised LMP on February 14, 2013, as extended to include all multi-level monitoring wells on the downgradient property line (MW-2 S/D, MW-3 S/I/D and MW-4 S/D). Each of the select wells was field screened, purged and sampled for VOCs via Method 8260B as well as inorganics, indicators and low level 1,4-Dioxane as consistent with the provisions of 310 CMR 19.132(1)(h).

Significant concentrations of alkalinity and total dissolved solids (TDS) consistent with historic testing were reported for MW-3D as evidence of landfill solute impacts to groundwater associated with MSW burial at that location. Moderate concentrations of alkalinity and TDS continue to be reported at MW-3I. Moderate concentrations of alkalinity and TDS were also reported in MW-2S, MW-4S and MW-5S. TDS concentrations were noted as consistent with previous testing in these wells.

Monitoring wells MW-3I and 3D both reported arsenic at concentrations in excess of the applicable RCGW-1 Reportable Concentration. It is noted that these exceedances are consistent with historic concentrations reported in MCP deliverables submitted under RTN 4-18278 for the Moll's Pond Study Area, as exempt from certain remedial response provisions under the Adequately Regulated provisions of 310 CMR 40.0110 for Solid Waste facilities, wherein no such downgradient impacts have been documented in the historic sampling and analysis of off-site private wells and monitoring wells under the LMP protocols. Arsenic is typically not mobile in groundwater. Concentrations appear only to be in the deeper portion of the shallow aquifer and localized around the MW-3 landfill monitoring well. The presence of arsenic is often attributed to leaching from chromated copper arsenate (CCA) pressure-treated wood that may be buried as part of the MSW. Arsenic concentrations within the MW-3I and MW-3D monitoring wells has historically decreased over time but remain significantly above the MA Drinking Water Standard (MMCL = 0.01 mg/L) [Refer to Table 1A and 1B]. All other inorganic compounds (metals) prescribed for landfill monitoring wells within the LMP (MW-2S, MW-3I, MW-3D, MW-4S and MW-5S) reported inorganic compounds below the applicable standards [Refer to Table 2].



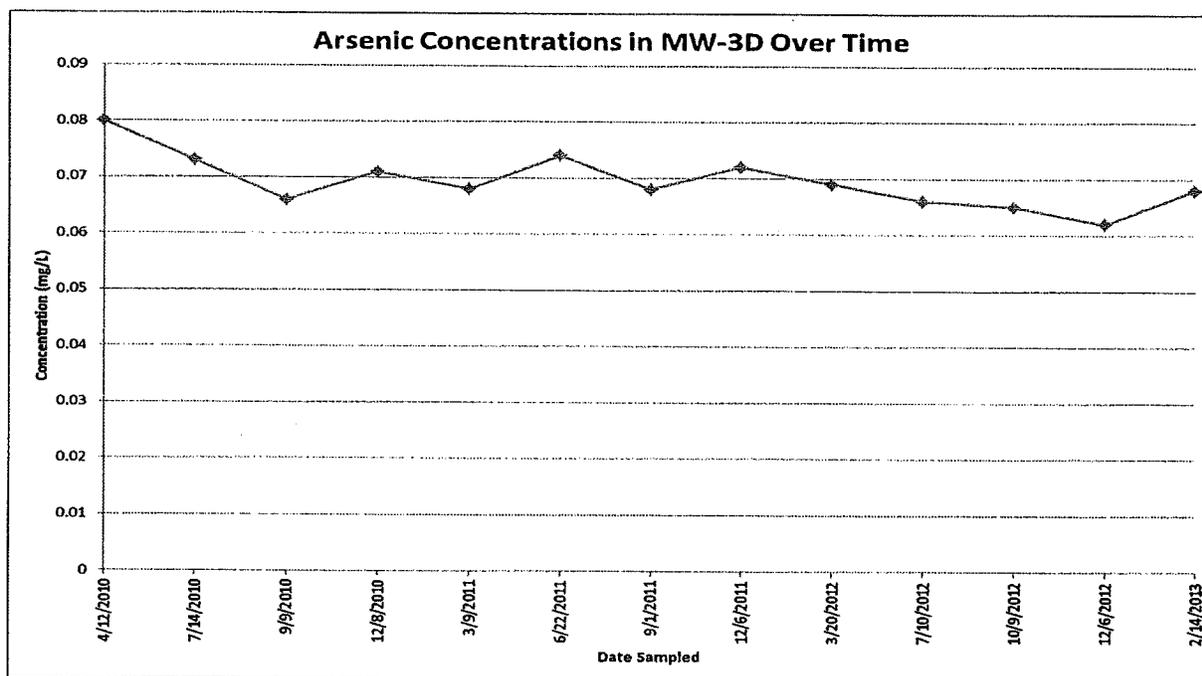


Table 2: Metals Analysis in Landfill Monitoring Wells (mg/L)  
Town of Eastham Landfill - Old Orchard Road, Eastham, MA

	Date Sampled	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
MCL		0.01	2	0.005	0.1			0.015		0.002	0.05		
SMCL						1.0	0.3		0.05			0.10	5.0
MW-2S	12/6/2012	ND (<0.0030)	0.013	ND (<0.0030)	ND (<0.0030)	ND (<0.0030)	0.68	ND (<0.0030)	0.43	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.060)
MW-2D	12/6/2012	ND (<0.0030)	0.0032	ND (<0.0030)	ND (<0.0030)	ND (<0.0030)	ND (<0.10)	ND (<0.0030)	0.051	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.060)
MW-3S	12/6/2012	ND (<0.0030)	0.030	ND (<0.0030)	ND (<0.0030)	ND (<0.0030)	0.25	ND (<0.0030)	0.28	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.060)
MW-3I	12/6/2011	0.045	0.011	ND (<0.003)	ND (<0.003)	ND (<0.003)	80	ND (<0.003)	1	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.06)
	3/20/2012	0.044	0.011	ND (<0.003)	ND (<0.003)	ND (<0.003)	85	ND (<0.003)	1.4	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.06)
	7/10/2012	0.042	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	88	ND (<0.003)	1.1	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.1)
	10/9/2012	0.040	0.011	ND (<0.003)	ND (<0.003)	ND (<0.003)	85	ND (<0.003)	1.0	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.1)
	12/6/2012	0.039	0.011	ND (<0.003)	ND (<0.003)	ND (<0.003)	72	ND (<0.003)	1.1	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.060)
	2/14/2013	0.041	0.012	ND (<0.003)	ND (<0.003)	ND (<0.003)	69	ND (<0.003)	1.1	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.060)
MW-3D	12/6/2011	0.072	0.1	ND (<0.003)	0.0033	ND (<0.003)	50	ND (<0.003)	1.2	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.06)
	3/20/2012	0.069	0.1	ND (<0.003)	ND (<0.003)	ND (<0.003)	40	ND (<0.003)	1.7	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.06)
	7/10/2012	0.066	0.099	ND (<0.003)	ND (<0.003)	ND (<0.003)	38	ND (<0.003)	1.4	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.1)
	10/9/2012	0.065	0.090	ND (<0.003)	0.0030	ND (<0.003)	39	ND (<0.003)	1.4	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.1)
	12/6/2012	0.062	0.097	ND (<0.003)	ND (<0.003)	ND (<0.003)	40	ND (<0.003)	1.8	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.060)
	2/14/2013	0.068	0.096	ND (<0.003)	0.0059	ND (<0.003)	40	ND (<0.003)	1.7	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.060)
MW-4S	6/24/2010	ND (<0.005)	0.034	ND (<0.0005)	ND (<0.003)	ND (<0.05)	2.3	ND (<0.003)	4.9	ND (<0.00025)	ND (<0.003)	ND (<0.002)	ND (<0.05)
	6/22/2011	ND (<0.0015)	0.03	ND (<0.0015)	ND (<0.0015)	ND (<0.0015)	2.7	ND (<0.0015)	5.2	ND (<0.00025)	ND (<0.0075)	ND (<0.0005)	ND (<0.03)
	7/10/2012	ND (<0.0015)	0.031	ND (<0.0015)	ND (<0.0015)	ND (<0.0015)	2.4	ND (<0.0015)	4.4	ND (<0.00025)	ND (<0.0075)	ND (<0.001)	ND (<0.05)
	12/6/2012	0.0034	0.028	ND (<0.0015)	ND (<0.0015)	ND (<0.0015)	2.4	ND (<0.0015)	5.1	ND (<0.00025)	ND (<0.0075)	ND (<0.001)	ND (<0.05)
MW-4D	12/6/2012	ND (<0.0030)	0.028	ND (<0.0030)	ND (<0.0030)	ND (<0.0030)	ND (<0.10)	ND (<0.0030)	0.16	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.060)
MW-5S	12/6/2012	ND (<0.003)	0.044	ND (<0.003)	ND (<0.003)	ND (<0.003)	5.5	ND (<0.003)	3.8	ND (<0.0005)	ND (<0.015)	ND (<0.002)	ND (<0.060)

Clarification of these provisions, and identification of other potential contaminants of concern (COCs) from historic landfill monitoring, was sought in a meeting with the MA DEP, the Town of Eastham officials and their consultants (Environmental Partners) on February 6, 2013. A formal MA DEP file review was requested by BEA on February 21, 2013 as related to

the Solid Waste records for this purpose. At the time of such request, BEA was advised that the historic records were currently under internal review and that a summary of findings would be forthcoming from the Department in consideration of adjusting analytical protocols either under the MCP or LMP programs. At the time of this filing, no such information was provided or alternative date for file review arranged.

Indicator compounds iron and manganese were also noted as exceeding the MA Drinking Water Secondary Standards (SMCL) standards in MW-3I and MW-3D and total dissolved solids in MW-3D. These Secondary Standards are primarily based on aesthetic quality of the water and not typically health based. The occurrence of elevated iron and manganese is common to some areas of town. In the landfill setting, it is suspected that the reducing environment of the decaying MSW leaches naturally-occurring iron and manganese from the surrounding soils. All other indicator compounds were met for the LMP landfill monitoring wells and analytical protocols prescribed [Refer to Table 3].

Table 3: Inorganic/Indicators Analysis in Landfill Monitoring Wells (mg/L)								
Town of Eastham Landfill - Old Orchard Road, Eastham, MA								
	Date Sampled	COD	Total Cyanide	Nitrate - N	Alkalinity	Chloride	Sulfate	TDS
<b>MCL</b>			0.2	10				
<b>SMCL</b>						250	250	500
MW-2S	12/6/2012	ND (<3.0)	NT	0.45	150	27	40	280
MW-2D	12/6/2012	ND (<3.0)	NT	0.60	23	22	6.7	81
MW-3S	12/6/2012	ND (<3.0)	NT	3.0	16	10	10	61
MW-3I	12/6/2011	ND (<3.0)	ND (<0.01)	ND (<0.01)	180	18	60	290
	3/20/2012	15	ND (<0.01)	0.42	180	19	63	290
	7/10/2012	18	ND (<0.01)	0.19	180	19	66	320
	10/9/2012	ND (<3.0)	ND (<0.01)	ND (<0.01)	180	12	79	270
	12/6/2012	17	NT	0.35	190	10	81	290
	2/14/2013	15	ND (<0.01)	0.14	180	14	70	250
MW-3D	12/6/2011	84	ND (<0.01)	0.53	990	120	65	1800
	3/20/2012	62	ND (<0.01)	1.7	1000	240	68	1500
	7/10/2012	71	ND (<0.01)	0.72	970	100	67	1700
	10/9/2012	5.8	ND (<0.01)	6.2	960	130	70	1600
	12/6/2012	63	NT	1.4	960	91	73	1700
	2/14/2013	70	ND (<0.01)	ND (<0.10)	920	120	68	1600
MW-4S	12/6/2011	ND (<1.5)	ND (<0.005)	0.29	220	27	26	410
	3/20/2012	ND (<1)	ND (<0.005)	0.22	190	34	18	270
	7/10/2012	13	ND (<0.005)	0.18	180	26	20	300
	12/6/2012	14	NT	ND (<0.05)	180	21	22	240
MW-4D	12/6/2012	ND (<3.0)	NT	2.3	16	50	18	140
MW-5S	12/5/2012	8	NT	0.45	200	34	29	320
MW-5D	12/5/2012	ND (<3.0)	NT	2.3	23	77	25	230

Table 4: VOC Analysis in Landfill Monitoring Wells (Detects only) (ug/L)								
Town of Eastham Landfill: Old Orchard Road, Eastham, MA								
	Date Sampled	Vinyl Chloride	Chloroethane	cis-1 2-DCE	Benzene	Chlorobenzene	MTBE	1, 4-Dioxane
RCGW-1		2.0	1,000	70	5	100	70	3
MW-2S	12/6/2012	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<2.5)
	2/14/2013	NT	NT	NT	NT	NT	NT	0.47
MW-2D	12/6/2012	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<2.5)
	2/14/2013	NT	NT	NT	NT	NT	NT	0.14J
MW-3S	12/6/2012	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<2.5)
	2/14/2013	NT	NT	NT	NT	NT	NT	ND (<0.2)
MW-3I	12/6/2011	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<500)
	3/20/2012	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	NA
	7/10/2012	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	NA
	10/9/2012	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<2.5)
	12/6/2012	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<2.5)
	2/14/2013	ND (<0.50)	ND (<0.50)	0.84	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.2)
MW-3D	12/6/2011	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<500)
	3/20/2012	ND (<0.5)	ND (<0.5)	1.5	1.2	1.8	ND (<0.5)	NA
	7/10/2012	ND (<0.5)	ND (<0.5)	1.7	1.4	1.9	1.2	NA
	10/9/2012	0.58	0.58	1.3	1.2	1.9	1.6	18
	12/6/2012	ND (<0.050)	ND (<0.050)	1.2	1.1	1.8	1.1	14
	2/14/2013	ND (<0.050)	ND (<0.050)	1.5	1	1.6	1.2	14/16
MW-4S	12/6/2012	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	0.56	ND (<2.5)
	2/14/2013	NT	NT	NT	NT	NT	NT	1.5
MW-4D	12/6/2012	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<2.5)
	2/14/2013	NT	NT	NT	NT	NT	NT	ND (<0.2)
MW-5S	12/6/2012	ND (<0.50)	ND (<0.50)	0.51	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<2.5)
	2/14/2013	NT	NT	NT	NT	NT	NT	1.2
MW-5D	12/6/2012	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<0.50)	ND (<2.5)
	2/14/2013	NT	NT	NT	NT	NT	NT	ND (<0.2)
MW-8	12/6/2012	ND <0.50	ND <0.50	ND <0.50	ND <0.50	ND <0.50	ND <0.50	ND <2.5
MW-21S	12/6/2012	ND <0.50	0.72	2.1	ND <0.5	ND < 0.50	ND < 0.50	3.7
MW-21D	2/25/2013	ND <0.50	ND < 2.0	ND < 0.1	ND < 1.0	ND < 1.0	0.20J	0.54

In the reporting period, as consistent with the analytical protocols prescribed, quarterly testing of MW-3I and MW-3D for VOC's by Method 8260 was accompanied by low level 1,4-Dioxane testing by Method 522. Method 522 was also used to re-test landfill monitoring wells MW-2S/D, MW-3S, MW-4S/D and MW-5S/D in the reporting period. Additionally, because the Method 8260 does not report ethylene dibromide (EDB) and 1,2 dibromo-3-chloropropane (DBCP) concentrations within prescribed MA Drinking Water Standard (MMCL), all of these monitoring wells were also tested by EPA Method 8011 for low-level concentrations, so as to investigate these compounds as potential COC's. 1,4-Dioxane was reported in MW-3D (14 ug/L) above the RCGW-1 Standard, confirming the presence and persistence of this compound in this landfill monitoring well. Concentrations of 1,4-Dioxane were reported as Non-Detect (ND)

(< 0.2 ug/L) in the MW-3S, MW-3I, MW-5D locations. Low level concentrations of 1,4-Dioxane were reported in the MW-2S (0.47 ug/L), MW-2D (0.14J ug/L), MW-4S (1.5 ug/L) and MW-5S (1.2 ug/L) locations. All monitoring wells reported concentrations of EDB and DBCP as non-detect wherein the detection limit is less than the MMCL concentration. As such, these compounds are not considered COC's and therefore, the low-level testing of EDB/DBCP was not included in the testing of private wells.

The VOC analysis of MW-3I and MW-3D in the reporting period reported low-level concentrations of several compounds including MTBE, cis-1,2-DCE, benzene and chlorobenzene, all significantly below applicable MMCL and GW-1, Method 1 – Risk Characterization standards. These VOC results are consistent with prescribed historic LMP testing of the Landfill monitoring wells wherein various low level VOC's are reported but at concentrations significantly lower than the MMCL, RCGW-1 and GW-1, Method 1 – Risk Characterization Standards. As such, the most recent LMP testing indicates that 1,4-Dioxane at a concentration of > 3.0 ug/L is isolated in the deeper portion of the upper aquifer (EL -36 +/- NGVD) in the vicinity of MW-3 only. The low-level 1,4-Dioxane testing conducted in this period, in anticipation of MCP revisions, does however indicate that other concentrations of 1,4-Dioxane are present sporadically in other landfill monitoring wells. The current 0.3 ug/L ORSG guideline and published revised GW-1 standard is exceeded at the MW-2S, MW-4S and MW-5S landfill monitoring wells [Refer to Table 4].

#### Landfill Soil Gas Monitoring

No monitoring of gaseous emissions was made at the Eastham Landfill during this reporting period as provided in the previous quarter. This monitoring is required on a semi-annual (6 month basis).

#### Drinking Water – LMP Residences

BEA personnel performed additional sampling of the private potable wells and downgradient monitoring wells in the reporting period. RES-1 (180 Old Orchard), RES-8 (100 Meetinghouse) and RES-20 (285 Alston) were sampled under the LMP Protocols for VOC's (524/522) and arsenic. As previously discussed, arsenic concentrations in these private wells were Non-Detect (ND < 0.003 mg/L) and have consistently been reported significantly below the MMCL MA Drinking Water Standard (0.01 mg/L). Additionally, VOC testing, exclusive of low-level 1,4-Dioxane, reported all compounds as Non-Detect. In all cases, excluding EDB/DBCP as non-targets, the concentrations and detection limits reported are significantly less than the MA Drinking Water (MMCL) and GW-1 standards.

Low level 1,4-Dioxane testing of LMP RES wells in the period reported detectable concentrations in RES-1 (180 Old Orchard - 0.045J ug/L), RES-8 (100 Meetinghouse - 1.6 ug/L), RES-18 (265 Alston Ave - 0.055J), RES-20 (285 Alston Ave - 0.33 to 0.37 ug/L) and RES-34 (11 Eldia - 2.9 ug/L). All such concentrations are below the current GW-1, Method 1 – Risk

Characterization Standard (excluding 11 Eldia duplicate as pending in reporting period). RES-8 (100 Meetinghouse), RES-20 (285 Alston) and RES-34 (11 Eldia Lane) report concentrations greater than the 0.3 ug/L ORSG Drinking Water Guideline, and RES-8 (100 Meetinghouse) and RES-34 (11 Eldia) reported concentrations of 1,4-Dioxane greater than the 1.5 ug/L action level, and as such are being provided with bottled water for potable drinking water use.

Additionally, RES-2 (290 Old Orchard), RES-3 (210 Old Orchard), RES-4 (165 Meetinghouse), RES-9 (130A Old Orchard), RES-16 (280 Alston), RES-30 (325 Schoolhouse), RES-31 (30 Knowles), RES-33 (170 Meetinghouse), RES-35 (50 Alston) and RES-36 (25 Knowles) were sampled for low-level 1,4-Dioxane under the EPA 522 Method. The majority of these wells had previously been testing under the prescribed LMP semi-annual and annual protocols. Analytical results reported 1,4-Dioxane as Non-Detect (<0.2 ug/L) in the RES-2 (290 Old Orchard), RES-3 (210 Old Orchard), RES-9 (130A Old Orchard), RES-16 (280 Alston), RES-33 (170 Meetinghouse) private wells, as well as the DPW non-potable well. Detectable levels of 1,4-Dioxane were reported in RES-4 (165 Meetinghouse - 0.75 ug/L), RES-30 (325 Schoolhouse Road - 9.7 to 10 ug/L), RES-31 (30 Knowles - 6.4 to 6.9 ug/L), RES-35 (50 Alston - 5.0 to 5.1 ug/L) and RES-36 (25 Knowles - 2.9 to 3.1). With the exception of RES-4 (165 Meetinghouse Road), all such concentrations are greater than the current GW-1, Method 1 – Risk Characterization Standards, and all are greater than the 0.3 ug/L ORSG Drinking Water Guideline. Again, with the exception of RES-4, these residences are being provided with bottled water for potable drinking water use. In the case of RES-30, a point-of-entry granular activated carbon (GAC) water treatment system has been provided. Additionally, RES-35 has been provided with a replacement well. In both cases, initial testing of the treated water and the water from the replacement well indicates that 1,4-Dioxane concentrations are below the most stringent 0.3 ug/L standard. Additional analytical results are pending and bottled water use continues.

Additional information on the magnitude and extent of 1,4-Dioxane impacts to groundwater outside the boundaries of the Eastham Landfill, impacts to private water supplies, and the evaluation of potential exposures to these residents is the primary focus of the Immediate Response Action under RTN 4-24301. The findings of such investigation are detailed in the following section of the report.

#### **IMMEDIATE RESPONSE ACTION STATUS REPORT I [Refer to Appendix C]**

No soil testing has yet been conducted as part of the IRA, but the source of 1,4-Dioxane impacts to groundwater are assumed to be associated with the leaching of buried solid waste (MSW) underlying the engineered barrier at the Eastham Landfill or former septage lagoons north of the buried MSW. The compound 1,4-Dioxane was first manufactured by Dow Chemical in the 1950's. The most recent research indicates that 1,4-Dioxane is a stabilizer historically used in the synthesis of the solvent 1,1,1-Trichloroethane (1,1,1-TCA CAS 71-55-6) wherein in urbanized areas, TCA is most commonly associated with manufacturing (vapor degreaser, printing and polishing compositions: cellulose acetate, benzyl and ethyl cellulose and in the waxes, oils and resins). However, other sources of 1,4-Dioxane reported include septic additives,

flame retardant materials, medical diagnostic testing products (scintillation counting – Bray’s solution), brake cleaners, antifreeze, paints, coatings and news print (inks). Additionally, as a stabilizer, 1,4-Dioxane is still used in commercially available products such as cosmetics, deodorants and detergents<sup>3</sup>. These non-manufacturing based products are to be expected in the SMW buried at the Eastham Landfill and potentially in the septage that was hauled into the former septage lagoons at the property. It is also likely found in domestic wastewater currently being generated from onsite septic systems throughout the Study Area, as accounting for some low-level background concentrations as apparent from recent testing outside the Study Area and known landfill impacts.

### Evaluation of Drinking Water Impacts – Critical Exposure Pathways to Residents

In accordance with the Immediate Response Action Plan and MA DEP approvals, an expanded area of private well and offsite monitoring well testing was conducted. The samples collected were tested using the EPA 524 and EPA 522 methods for detection of 1,4-Dioxane at concentrations below the 0.3 ug/L ORSG and newly-proposed GW-1, Method 1 standards. Some 88 owners of record for residential properties downgradient of the Eastham Landfill within the then defined Study Area, were notified by registered mail to request the voluntary sampling of their private wells for regulated volatile organic compounds (VOC’s) including low-level 1,4-Dioxane. Questionnaires were provided to each property owner for additional information on the their private wells to fill in gaps in public records and to help document the horizontal and vertical extent and magnitude of VOC’s, particularly 1,4-Dioxane.

In the period from February 11th to February 25th, some 58 responding property owners, representing some 65 residences, the Eastham DPW non-potable well and Eastham Elementary School, were tested for regulated VOC’s (EPA 524) including low level 1,4-Dioxane (EPA 522 < 0.2 ug/L). Some of this testing included the resampling of identified RESs private wells within the prescribed LMP, as previously discussed. This work was prioritized on the efficiency of efforts to gain additional information of human CEP exposures to residences, and secondarily to map the extent and magnitude of groundwater impacts as a predictive model to frame future work under the IRA. Offsite monitoring wells were similarly tested (MW-21S/D and MW-8) as part of this evaluation. In the period, MW-22 S/D at the intersection of Schoolhouse Road and Surrey Lane was found to have been damaged beyond further use as filled with sand or otherwise blocked. This well had been a critical sentinel well under RTN 4-18278, and as such, additional multi-level monitoring wells are proposed herein as part of future investigations.

Analytical results reported 1,4-Dioxane above the detection limit in some thirty-one (31) of the sixty-two (62) samples analyzed [50% +/-] exclusive of the duplicates. Of the private wells reporting detectable concentrations of 1,4-Dioxane, four (4) reported concentrations above the current GW-1, Method1 - Risk Characterization Standard for drinking water (3.0 ug/L) and an additional seven (7), totaling 11, above the ORSG Drinking Water Guideline and proposed

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<sup>3</sup> Midwest GeoSciences Group “1,4-Dioxane: Contaminants of Concern Webinar Series” (Thomas K.G. Mohr) March 19, 2013 and March 21, 2013.

new GW-1 standard of 0.3 ug/L [18% +/-]. Other VOC testing by Method 524 reported concentrations of the analyzed regulated compounds (excluding EDB and DBCP as non-target analytes with low level detection limits) as Non-Detect or at low-level concentrations. Review of the analytical results indicates that the reporting limits, or concentrations reported, are significantly less than the MMCL, GW-1 or RCGW-1 standards. All analytical results with tabulated spreadsheets showing concentrations reported relative to the applicable standards are presented in Appendix E of this report. In cases where the concentrations of 1,4-Dioxane were reported at 1.5 ug/L or greater, the property owner or resident was immediately contacted and provided with bottled water.

In the offsite monitoring well testing during the period, MW-8 (Alston @ Meetinghouse) and MW-21S/MW-21D (Alston @ Molls Pond), all reported detectable concentrations of 1,4-Dioxane by the low level EPA 552 analysis. Monitoring well MW-8 reported a 1,4-Dioxane concentration of 0.33 ug/L, MW-21S 3.7 ug/L and MW-21D 0.54 ug/L. Each of these concentrations is above the ORSG standard, and MW-21S is above the current GW-1 standard. Other VOC testing of these monitoring wells by Method 8260 reported concentrations of the analyzed regulated compounds (excluding EDB and DBCP as non-target analytes with low level detection limits) as Non-Detect or at low-level concentrations. Review of the analytical results indicates that the reporting limits, or concentrations reported, are significantly less than the MMCL, GW-1 or RCGW-1 standards.

Additional information regarding exposure risk, CEP evaluation and mitigating measures is presented in the following sections of this report. All analytical data was communicated to the property owners or residents under the BWSC-123 Transmittal Forms as presented in Appendix C of this report and the field work is further documented in the Field Inspection Reports in Appendix B of this report.

#### Data Usability

The EPA Method 524/522 series drinking water analytical methods employed for the sampling of residential wells over the reporting period are not required to meet CAM requirements and are not reported as such. However, BEA did review and validate the data relative to the QA/QC protocols employed by the laboratory (Test America) and ran trip blanks and duplicates as consistent with CAM requirements. Where deficiencies were noted, the resulting directional bias was considered in the interpretation of data. Duplicate analysis matched wells with the original data in laboratory data produced by the same laboratory. In the comparison of low-level 1,4-Dioxane testing between the 8260 SIM/8270 and 522 methods, a minor disparity was noted between the Alpha Analytical and Test America laboratory findings. Of particular note is at the RES-30 replacement well, wherein Alpha initially reported 1,4-Dioxane concentrations as Non-Detect (<0.15) and Test America subsequently reported concentrations between 0.20 ug/L and 0.23 ug/L. Additionally, the BCHED sampling of RES-34 by the 8260 SIM in December 2012 reported 1,4-Dioxane as Non-Detect at a reporting limit of < 2.5 ug/L. Retesting of this same well by the 522 Method reported a 1,4-Dioxane concentration of

2.9 ug/L. At such low detection limits and analytical sensitivity, such discrepancies have greater significance and the estimated (J) low-level reporting of 1,4-Dioxane below the reporting limits is suspect and may represent background conditions attributed to anthropogenic sources such as onsite wastewater discharge.

In regards to the Trip Blanks under the EPA Method 524 VOC testing, some low-level concentrations of acetone and other compounds were reported at trace concentrations significantly below the applicable standards. Acetone may be used in the cleaning of laboratory equipment. Regardless, the concentrations reported had no significance in the review of the analytical data or in the evaluation of exposure risks. As such, the data is considered to be technically justified and sufficiently representative and usable for the purposes intended herein.

#### Evaluation of Critical Exposure Pathways and Risk Characterization

The following section is based on developing data and is not intended, nor represented to be a comprehensive evaluation of all potential exposure risk to human and environmental receptors as is especially evident due to anticipated revisions in the governing regulations and pending response from the Department and/or access to public records to establish any additional COCs that may need to be further investigated. Notwithstanding, the available analytical data for the residential private wells is prioritized and evaluated herein as the only source of drinking water in the Town of Eastham, wherein ingestion of 1,4-Dioxane in drinking water at the Site appears to drive the vast majority of the potential exposure risks.

As such, the available private well data was reviewed relative to all reported concentrations of VOC's as a Critical Exposure Pathway. In accordance with the MCP, exposure risks may be evaluated under the Method 1, Method 2 or Method 3 techniques. Wherein risk characterization is based on the extrapolation of toxic effects of certain chemicals from animal studies, risk is typically represented as a statistical probability of "Significant Risk" (1:100,000).

The Method 1 approach is the most conservative and may be considered as making "worst case" assumptions. Method 2 allows for inclusion of site-specific information relative to exposure considerations using the Method 1 published standards. Method 3 uses toxicological data and site-specific exposures to calculate the specific cancer and non-cancer risks for chronic and sub chronic exposures for the contaminants of concern, inclusive of all detectable compounds. The MA DEP Office of Research and Standards (ORS) have developed Method 3 ShortForms for this approach. In addition, BEA has engaged Peter W. Woodman, PhD of Risk Management Inc. (RMI) in Acton, MA, on behalf of the Town of Eastham, as an expert to review analytical data under Method 3 for the evaluation of Imminent Hazard and Significant Risk under the current provisions of the MCP.

The numerical values listed under Method 1 are useful in determining if there is a basis of "Significant Risk" for additional investigation. Evaluation of the available analytical data from private wells downgradient of the Eastham Landfill indicates that concentrations of 1,4-Dioxane

currently exceed the GW-1, Method 1 – Risk Characterization Standards in the four (4) residential wells at RES-30 (325 Schoolhouse), RES-31 (30 Knowles), RES-35 (50 Alston Ave) and RES-36 (25 Knowles) with concentrations ranging from 3.1 to 10 ug/L. Under the current GW-1, Method 1 – Risk Characterization concentration of 3.0 ug/L, significant risk associated with 1,4-Dioxane concentrations in these wells is categorically indicated by this data. The draft revisions to the MCP recently published and currently under the public comment period set the proposed GW-1, Method 1 - Risk Characterization Standard for 1,4-Dioxane at 0.3 ug/L. Under the proposed revised GW-1 standard, there are a total of eleven (11) private wells where this proposed standard is exceeded as would indicate a Significant Risk. In no case did 1,4-Dioxane concentrations exceed the Method 1 GW-2 or GW-3 standards as indicators of potential vapor entry to occupied residential dwellings or significant impacts to environmental receptors. Additionally, in no case did reported concentrations for other VOC's exceed the most stringent GW-1, Method 1 – Risk Characterization Standards.

For further evaluation and qualification of Significant Risk and Imminent Hazard associated with 1,4-Dioxane, Method 3 – Risk Characterization was conducted by RMI utilizing the most recent version of the MA DEP ShortForms (Version 10-12) as having been updated to include the most recent toxicological data for 1,4-Dioxane under the proposed revisions to the MCP [Refer to Appendix F]. Analytical data, with the highest concentrations of 1,4-Dioxane (inclusive of other VOC's) were forwarded to RMI for the most recent testing of RES-30 (325 Schoolhouse) (10 ug/L), RES-31 (30 Knowles) (6.4 ug/L), and RES-36 (25 Knowles) (2.9 ug/L). Additionally, lower level concentrations of 1,4-Dioxane in the replacement well at RES-35 (50 Alston Ave) (0.23 ug/L), 255 Alston Ave (1.9 ug/L) and 45 Starlight (1.1 ug/L) were additionally evaluated to further qualify the action level for the provision of bottled water which had been set at 1.5 ug/L.

RMI's use of the MA DEP ShortForms, inclusive of all reported VOC's, showed that there was no Imminent Hazard threshold exceeded at any of the residences and that "Significant Risk" is indicated for long term ingestion exposures only at the RES-30 (325 Schoolhouse) and RES-31 (30 Knowles) locations. The ShortForms values for other inhalation and dermal contact exposures was significantly less than the cancer (ELCR  $1 \times 10^{-5}$ ) and non-cancer risk (HI 1.0) thresholds for Significant Risk. It is noteworthy that Method 3 - Risk Characterization indicated that concentrations of 1,4-Dioxane in private wells up to 3.1 ug/L at RES-36 (25 Knowles) did not exceed the ELCR and HI values for Significant Risk. As such, the technical basis for the provision of bottled water at residence locations wherein 1,4-Dioxane exceeds 1.5 ug/L further substantiates the technical basis and rationale for bottle water use as a mitigating measure against "Significant Risk" associated with the ingestion of groundwater impacted with 1,4-Dioxane. The Method 3 ShortForm for RES-36 is presented below.

<b>Resident - Drinking Water: Table RW-1</b> <b>Exposure Point Concentration (EPC) and Risk</b> <b>Based on Resident Ages 1-31 (Cancer) and 1-8 (Noncancer)</b> 26 Knowles Street. Highest Detected Values Used. **Do not insert or delete any rows** Click on empty cell below and select CHM using arrow.									
Chemical Name	EPC (ug/L)	ELCR (Cancer)	HI (Noncancer)	ELCR (Cancer)	HI (Noncancer)	ELCR (Cancer)	HI (Noncancer)	HI (Noncancer)	HI (Noncancer)
HEXANE, 1,6-	3.1E+00	5.2E-05	1.7E-05	1.8E-07	5.9E-05	6.1E-05	1.6E-05	5.6E-04	6.7E-05
DICHLOROETHYLENE, CIS-1,2-	2.0E+00					7.6E-02	7.3E-03	3.6E-01	4.4E-01

ShortForm Version 10-12  
Vlookup Version v1012  
ELCR (all chemicals) = 6E-06  
HI (all chemicals) = 4E-01

MassDEP ORS  
Contact: Lydia Thompson  
Lydia.Thompson@state.ma.us  
617-558-1165

1 of 1

Sheet: EPCs

The tabulated VOC results inclusive of low-level 1,4-Dioxane, as presented against the MCP Method 1 – Risk Characterization and MA Drinking Water standards, are included as attached to the analytical results in Appendix E. The Method 3 ShortForms prepared and reviewed by RMI are presented in Appendix F.

Temporary Mitigating Measures [Refer to Appendix D]

As noted above, the most conservative Method 1 – Risk Characterization Standard indicates Significant Risk associated with the ingestion 1,4-Dioxane at a concentration currently above 3.0 ug/L, proposed to be decreased to 0.3 ug/L, as effecting eleven (11) properties, which consist of twelve (12) residences, or approximately 18% of those properties sampled. More specific evaluation of the data under Method 3 indicates that ingestion exposure for “Significant Risk” in private wells is driven by a 1,4-Dioxane concentration between 2.9 ug/L and < 6.4 ug/L as dependent on accessory compounds present. As such, the provision of bottled water for food preparation and consumption for concentrations 1,4-Dioxane of 1.5 ug/L is an effective short-term measure to mitigate against Significant Risk. Notwithstanding, any exposure to 1,4-Dioxane above background concentrations is a Critical Exposure Pathway and an increased exposure to residents. As such, additional mitigating measures have been undertaken as a precaution against uncertainties in future testing and regulatory environment. At the time of this reporting, a replacement well has been installed and tested at RES-35 (50 Alston Ave) and a point-of-entry granular activated carbon treatment system has been operated, maintained and

monitored at the RES-30 (325 Schoolhouse) location as an active remedial system being piloted for further use considerations as has been framed and clarified with the Department under verbal and written approvals.

As per the review of technical literature on the treatment of 1,4-Dioxane for potable water applications, oxidation/UV and sorption technologies have been used in large municipal applications but in the consideration of a residential application, the handling and use of such oxidants in private homes have severe health, practical operation and maintenance, and cost limitations. RES-30 is currently equipped with a granulated activated carbon (GAC) filtration system for the removal of VOCs at the point-of-entry as remnant to RTN 4-18278 and prior investigation of vinyl chloride impacts originating from the Eastham Landfill. The testing of this GAC treatment system in early January 2013, reported a 55-65% sorption capacity for 1,4-Dioxane as was consistent with the published literature. In the review of the technical literature, a relatively obscure paper<sup>4</sup> was found that indicated that coconut shell-based GAC showed additional treatment capacity for 1,4-Dioxane. As such on February 22, 2013, with the permission of the homeowner, BEA assisted Carbon Filtration Systems from Johnston, Rhode Island with the changeover to coconut shell-based GAC. Details for the treatment system are presented in Appendix D with laboratory testing results in Appendix F and RMR reporting in BSWC-105 Appendix C.

In subsequent testing of the RES-30 GAC treatment system, 1,4-Dioxane has consistently been reported as Non-Detect (< 0.20 ug/L) [2/25/13, 3/8/13, and 3/14/13]. Albeit that water use at the property is minimal, such testing is undertaken subsequent to the flushing of the water contained within the filtration vessels as demonstrating treatment capacity to reduce 1,4-Dioxane concentrations from 10 ug/L to < 0.2 ug/L as below the most restrictive 0.3 ug/L ORSG standard. Per requirements within the MCP, the operation, maintenance and monitoring of this active remedial system and RMR reporting will continue.

In the period from January 17-18, 2013, a shallow replacement well was drilled at the RES-35 (50 Alston Ave) property by Desmond Well Drilling of Brewster, MA (Registration # 877) to replace the deeper private well impacted with 1,4-Dioxane that had reported a concentration of 5 ug/L +/- . The replacement well was completed at 80' below grade in sand, as significantly shallower than the existing well that had reportedly been set at -167', below a substantial thickness of clay. The well was originally tested for VOCs and basic bacteriological and wet chemistry in accordance with the Eastham Board of Heath requirements, inclusive of low-level 1,4-Dioxane. These initial test results reported 1,4-Dioxane as Non-Detect (<0.15 ug/L) with coliform absent and suitable wet chemistry. However, VOC testing reported high concentrations of PVC solvent-related compounds (acetone, MEK, THF) as indicating that the well had not been property developed. As such, the well was redeveloped and re-tested on January 29, 2013. These results, inclusive of drinking water metals, reported that the previously reported compounds had been effectively removed by the redevelopment of the well. All

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<sup>4</sup> Michael Curry (2009) "1,4-Dioxane Removal From Groundwater Using Point of Entry Water Treatment Techniques" Thesis Department of Civil Engineering University of New Hampshire

concentrations of metals and VOC's met drinking water standards although elevated manganese was acknowledged as intended to be treated by the existing water softener for the existing well that also had elevated manganese.

With authorizations from both the Eastham Board of Health and owner, the old well was abandoned and the replacement well was connected to the dwelling to demonstrate treatment capacity of the existing water softener to remove manganese. Such authorization was conditioned upon the continued use of bottled water and additional testing of the replacement well. Such capacity was subsequently demonstrated and additional testing of low level 1,4-Dioxane has reported concentrations at 0.23 ug/L (3/4/13) and 0.20 ug/L (3/14/13). All replacement well testing has indicated concentrations of 1,4-Dioxane have been reduced in the replacement well to concentrations below the most restrictive ORSG guideline of 0.3 ug/L. The use of this well is subject to the granting of a Board of Health variance for sideline setback to the roadway layout as scheduled to be heard on March 28, 2013. The monthly sampling of the replacement well for regulated VOC's and low level 1,4-Dioxane will continued over the next reporting period with continued bottled water provided.

Notwithstanding, the use of private well replacement and/or point-of-entry treatment systems are temporary solutions that are costly and labor intensive with inherent uncertainties. Comparatively, groundwater resource management under a municipal water supply system is strongly recommended and advocated by BEA and the Town of Eastham toward a permanent solution and the protection of public health, safety and welfare.

#### Nature and Extent of Groundwater Impacts [Refer to Site Plan – Appendix A]

No reported VOC concentrations other than 1,4-Dioxane has exceeded the Method 1 - Risk Characterization Standards as part of this IRA and as documented in the landfill monitoring dating back to 2008, as substantiated by a preponderance of physical data. As such, the nature and extent of groundwater impacts is limited herein to the evaluation of 1,4-Dioxane under the revised LMP and following IRA. 1,4-Dioxane is highly soluble and tends to travel at a higher velocity and greater lateral and horizontal extent relative to other types of dissolved phase compounds (BTEX/CVOC's). It is denser than water and tends to travel to greater depths within the aquifer away from the source and is also persistent with little attenuation or natural breakdown.

Board of Health records for all private wells in the Study Area were reviewed to determine estimated elevation of the well production horizons to evaluate the occurrence of 1,4-Dioxane in the aquifer downgradient of the landfill. Regional groundwater contours show that the elevation of groundwater in the Study Area is approximately 14' NGVD [Refer to Figure 2 – Appendix A]. As such, the static water level in each well was used as the common benchmark elevation for such estimates [(depth to water + EL 14) – total depth of well = production horizon]. Based on the limited analytical data and private well completion records and homeowner information, it is apparent that closest to the Eastham Landfill property, 1,4-Dioxane

tends to be in the shallow aquifer (EL 0 to -60) and travels in a direction consistent with the southeasterly groundwater flow. Further east, the groundwater impact appears to travel to greater depths in a more easterly direction. The cause of the change in flow direction relative to computed groundwater flow in the upper unconfined aquifer is attributed to significant clay strata reported in boring logs for monitoring and private well installations and as based on local driller knowledge.

In the vicinity of Schoolhouse Road at the intersections of Alston Avenue and Knowles Street, a cluster of elevated concentrations of 1,4-Dioxane is reported in deep private wells and monitoring wells MW-21 S/D. These wells are typically 150-200' in depth and set in production horizons below EL -100. As such, it is predicted that any shallow well east of Molls Pond that is less than 100' deep [ $>$  EL -50] will not be significantly impacted by 1,4-Dioxane. It is also predicted that any 1,4-Dioxane impacts to groundwater extend east of Schoolhouse Road at depths more than 100' below sea level as approaching the saltwater interface.

Additional work for the verification of private well depths for those wells tested, surveyed elevations and expanded private well testing in the former Study Area of those seasonal dwellings and/or by residents responding after the initial deadline (21 properties) is prioritized over the next reporting period. Concurrently, the research and testing of private wells within the expanded Study Area will be conducted with the notification of all property owners as previously conducted for the testing of additional private wells. Additionally, installation and testing of supplemental multi-level monitoring wells is anticipated to fully qualify the extent and magnitude of significant 1,4-Dioxane impact to groundwater.

The following section of this report specifies those proposed IRA activities recommended over the next 90 day reporting period. This information will help refine the Conceptual Site Model, further define the Site and be used to mitigate identified exposure risks. Within this filing is a specific written request to extend the next interim deadline for IRA Status Report submittal to July 1, 2013 to allow for a full 90 days to complete this work.

## **PROPOSED IMMEDIATE RESPONSE ACTIONS – IRASII**

### Temporary Mitigating Measures

Bottled water must continue to be provided to all residents where the concentration of 1,4-Dioxane is reported above 1.5 ug/L, as an interim measure. It is recommended that any such private well be tested on a quarterly basis for VOC's inclusive of low-level 1,4-Dioxane by Method 524/522 beyond that prescribed in the LMP. In those residences where the concentration of 1,4-Dioxane is reported above 3.0 ug/L in the private well, it is recommended that monthly testing for VOC's inclusive of low level 1,4-Dioxane by Method 524/522 be conducted beyond that prescribed in the LMP. At residences wherein 1,4-Dioxane has been documented in monthly sampling for two consecutive months as confirmed to be greater than 3.0 ug/L, it is recommended that a point-of-entry GAC treatment system be installed and operated, maintained

and monitored per the remedial monitoring requirements for monthly reporting in accordance with the provisions of 310 CMR 40.0027. As an alternative, replacement wells may be considered east of Molls Pond to depths not exceeding 100' as subject to extensive sampling requirements and demonstration of potability. This alternative is less attractive at this time pending further investigation of the extent and magnitude of 1,4-Dioxane, understanding of background conditions, and additional testing of the replacement well at RES-35 (50 Alston Ave). The use of replacement wells should not be considered as a viable option in other locations in the Study Area at this time.

Again, we reiterate the strong recommendation and advocacy of municipal water service in the areas of groundwater impacts towards final solution and resolve of public health, safety and welfare issues framed under the MA DEP MCP and LMP programs.

#### Private Well/Small Commercial PWS Sampling

As noted, there are some remaining seasonal properties that have not been tested under the prescribed LMP testing requirements as the dwellings have been winterized, water drained and well shut off. In the next reporting period, prescribed quarterly and unfulfilled semi-annual and annual sampling requirements under the LMP will be completed. In addition, the private wells for the twenty-one responding property owners within the former Study Area will be tested for regulated VOCs inclusive of low-level 1,4-Dioxane, by Methods 524/522. Depths of critical wells will be investigated to confirm the elevation of production horizons to further map the occurrence/absence of 1,4-Dioxane towards defining the extent and magnitude of groundwater impacts.

The Town of Eastham will conduct a registered mailing to all residents within the expanded Study Area (Site) to solicit and encourage residents to allow for the sampling of their private wells for regulated VOC's and low level 1,4-Dioxane within the expanded Study Area using the format and questionnaire already established. The expanded Study Area runs on the east side of the Eastham Landfill northerly by Glacier Hills Road and southeasterly along Whidah Lane across Meetinghouse Road to Silah Circle and easterly down Candlewood Drive some 750' and then turning south to Redberry and turning westerly across Schoolhouse Road and continuing through Ministers Pond to the intersection of Route 6 and Schoolhouse Road to the southwest corner of the Eastham Landfill property. In addition, the commercial businesses along Route 6 that have PWS IWHPA/Zone II Wellhead Protection areas that fall onto the Eastham Landfill property will be contacted by registered mail and asked to have their wells tested for low level 1,4-Dioxane and to provide copies of the most recent VOC testing and Sanitary Survey's under the PWS requirements. The number of residents participating in the program will be dictated by response to this mailing. It is anticipated that at least an additional 60 wells will be tested in May 2013 as a result of such solicitation.

Test borings for subsurface investigation of hydrogeologic conditions and aquifer characterization to provide for multi-level aquifer testing to further define and qualify the extent

and magnitude of 1,4-Dioxane impacts will be required per MCP requirements. Geo-Probe drilling methods that allow for real-time monitoring of VOC concentrations in groundwater at various depths (Membrane Interface Probe (MIP) or onsite gas chromatography) show great promise in making dynamic decisions on the location and depth of well construction as cost and time efficient in these types of investigations. The location of these proposed drilling locations for sentinel well considerations is shown on the Site Plan in Appendix A as along Eldia at Whidah, Selah Circle at Schoolhouse, some 750' east of Schoolhouse at Cestaro, Surrey and Redberry. However, based on indications that the 1,4-Dioxane impacts are diving and present at depths greater than 150' below grade and through a substantial thickness of clay, the cost, feasibility and benefit of such work needs to be investigated. Over the next reporting period, all BOH records for well completion reports as far east as Nauset Road will be reviewed to identify any deep wells further east than the expanded Study Area for targeted sampling. Additionally, contractors providing these types of drilling services will be contacted to provide estimated costs and technical feasibility to conduct this work at such depths and local geologic conditions towards the future implementation of a drilling and monitoring well construction program to supplement work already conducted.

## CONCLUSIONS AND RECOMMENDATIONS

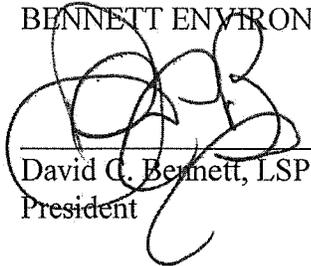
Analytical results reported 1,4-Dioxane above the detection limit in some thirty-one (31) of the sixty-two (62) samples analyzed [50% +/-] exclusive of the duplicates. Of the private wells reporting detectable concentrations of 1,4-Dioxane, four (4) reported concentrations above the current GW-1, Method1 - Risk Characterization Standard for drinking water (3.0 ug/L) and an additional seven (7), totaling 11, above the ORSG Drinking Water Guideline and proposed new GW-1 standard of 0.3 ug/L [18% +/-]. Bottled water is now being provided by the Town of Eastham to nine (9) of the residences as a temporary measure to mitigate against potential significant exposures. Whole household treatment systems are proposed for those with the highest concentrations as now estimated as being up to 5-10% of the estimated properties within the newly defined Study Area.

These trends are expected to continue with the expanded testing. The use of private well replacement and the use of point-of-entry treatment systems is a temporary solution as costly and labor intensive with inherent uncertainties as compared to groundwater resource management under a municipal water supply system, which is strongly recommended and advocated towards the final solution and resolve of public health, safety and welfare issues. An Article for the funding to construct a municipal public water supply distribution system as would be connected to Public Water Supply wells already approved for such use, is being presented at the 2013 Spring Town Meeting and is the third time in the past eight years such an article has been presented. Such a managed groundwater resource is needed to eliminate identified and anticipated future Critical Exposure Pathways to the residents and commercial businesses as associated with 1,4-Dioxane and any future emerging contaminants or associated COCs that may be further identified in the area of the unlined capped Eastham Landfill.

It must be recognized that environmental investigations are inherently limited in the sense that conclusions are drawn and recommendations developed from limited information obtained under the context of the regulations and standard of practice at the time of reporting. The passage of time may result in revisions to regulations, published Policy Guidance and change in the LSP community standards of practice. This report does not warrant against future changes in regulations, policy or standards of practice as may differ from and/or conflict with the current regulations, policies or standards of practice.

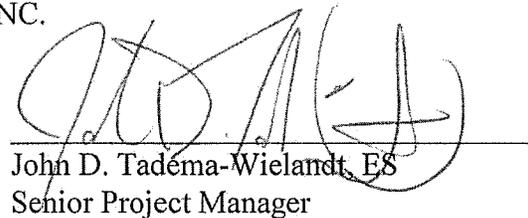
The findings of this investigation, as represented herein, set forth the rationale and technical justifications for the LSP opinions offered, as established by the certifications made on the attached Transmittal Forms. The LSP opinions are based on the available data and regulations in effect at the time of this reporting and based on reliance upon experts. Should you have any questions regarding the project or require additional information, please contact me at your earliest convenience.

Sincerely,  
BENNETT ENVIRONMENTAL ASSOCIATES, INC.



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David C. Bennett, LSP  
President



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John D. Tadema-Wielandt, ES  
Senior Project Manager

Encl. Supporting Documentation [Appendices A-G]

Cc: Sheila Vanderhoef - Eastham Town Administrator (full hard and electronic copy)  
Jane Crowley, Agent – Eastham Health Department\*  
Chief Glenn Olson – Eastham Fire Department\*  
Steve and Lisa Colley, Property Owners\*  
Chris and Deanna Ross, Property Owners\*  
Jeff Carlson, Property Owner\*  
John Cunningham, Property Owner\*  
Peter and Mary Martinelli, Property Owners\*  
Paul and Nancy Underhill, Property Owners\*  
Donna Holway, Property Owner\*

\* Narrative, Title Page and Site Plan provided under public notice distribution requirements pursuant to paperwork reduction policy. Legal Notice being published as consistent with the provisions of 310 CMR 401406 to notify all parties within the Disposal Site. Full copies of reports (electronic or paper) provided on written request.