

MEMORANDUM

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To: Ms. Brenda Ardrey, CGFM
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From: Todd Thalhamer, P.E.

Date: February 13, 2014

RE: Comments on the Evaluation of Possible Impacts of a Potential Subsurface Smoldering Event on the Record of Decision – Selected Remedy for Operable Unit-1 at the West Lake Landfill – Dated January 14, 2014

I have reviewed the above mentioned report as requested by the Missouri Department of Natural Resources (DNR). This memorandum presents my initial comments and recommendations on the report. All potential issues in relation to a subsurface smoldering event (SSE) have not been examined and I reserve the right to modify my opinions and recommendations if new information, additional data, research, transcripts, or publications become available.

The following preliminary opinions and recommendations are those of Hammer Consulting Services and provided in my capacity as technical expert/advisor to DNR. These preliminary opinions and recommendations are based on my review of the relevant data and the recommendations provided below may or may not be acted upon by DNR. This memorandum to DNR was produced under a contract between the author and DNR. The statements, recommendations, and conclusions contained in this memo report are not necessarily those of DNR or its employees.

Initial Comments

Given the environmental worry and the community's sensitivity associated with the entire West Lake disposal complex, Engineering Management Support, Inc. (EMSI), should be advised to disclose in their report that they have worked for and represented the landfill industry and specifically identify that one of the responsible parties, Republic Services, Inc., has been a client.

While the report considers certain potential impacts to the West Lake disposal complex, both before and after construction of the remedy selected by the United States Environmental Protection Agency (U.S. EPA), the report does not discuss the impacts to the community, businesses, and/or emergency responders from the presence of such a subsurface smoldering event (SSE). The report is limited to a discussion from a remedial action point of view and additional social and economic factors should be considered and included in the evaluation.

At times SSEs can be straightforward to evaluate, monitor, and suppress; however, this disposal complex has accepted a mix of radiological, industrial, commercial, municipal, construction and demolition debris, and other wastes with potentially unknown characteristics that complicate the assessment process to the point that no one can state that an SSE at this complex could be easily abated.

The facts are:

- This disposal complex illegally accepted radiologically-impacted material (RIM).
- The RIM is intermixed with and interspersed within the landfilled refuse, debris and fill materials, and unimpacted soil and quarry spoils in Areas 1 and 2 (See EMSI Report, Figure 1, West Lake Landfill Features, dated May 15, 2013).
- The facility did not maintain adequate records to allow for a ready determination of the types and profiles of the waste streams disposed of in the landfill(s).
- In some portions of Areas 1 and 2, the RIM is at or may be near the surface.

Should an SSE in the West Lake Landfill Operable Unit-1 or other area occur, it will potentially cause complications to the engineering solutions provided for in the Record Of Decision (ROD), potential response actions, and to the livelihoods and quality of life of the surrounding community.

Background Information

The West Lake Landfill Complex is located in Bridgeton, Missouri. The site is listed on the U.S. EPA's Superfund National Priorities List due to the illegal disposal of RIM at the site. The Bridgeton Sanitary Landfill site sits within the West Lake Landfill site and is inactive and no longer accepting waste for disposal.

The West Lake Landfill site has four distinct units:

- Operable Unit 1, Area 1 – Radiologically contaminated wastes
- Operable Unit 1, Area 2 – Mixture of debris
- Bridgeton Sanitary Landfill – Primarily municipal solid waste
- Demolition Landfill

The U.S. EPA oversees the first two units. The Bridgeton Sanitary Landfill, owned by Bridgeton Landfill, LLC, whose parent company is Republic Services, Inc., is overseen by DNR.

Executive Summary

The executive summary states “An SSE does not create conditions that could carry RIM particles or dust off the site.” I disagree with this statement. As discussed later in the report if an SSE surfaces and should the area collapse, the potential exists for creation of a void space, smoke, dust, chemicals and the exposure of RIM to the atmosphere which places at risk the local

community. To what extent and the level of risk associated with the event is dependent upon the type, duration and magnitude of the event. Smoldering events that propagate to the surface either through fissures, vent holes, or areas that have collapsed can transmit RIM via the smoke, water vapor, and/or dust created by such an event. Depending on site conditions, SSEs can create temperatures high enough to ignite non-RIM waste and/or chemical compounds; however the term “explode” should only be used in the context of methane explosions, which have been documented by industry on a number of occasions while excavating SSEs, and not as part of a “dirty bomb” scenario.

Again, I disagree with the statement contained in the report that “An SSE in the West Lake Area 1 or 2 would create no long-term additional risk to people or the environment.” An SSE in the West Lake Area 1 or 2 has the potential to create both short and long term risks to the community and the environment. In fact the current SSE in the Bridgeton Landfill has the potential to impact OU-1 Radiological, Area 1 and other parts of the waste complex because the North and South Quarry are not isolated from the waste complex. One must consider the social and economic risks/impacts as well as the associated environmental worry resulting from such an SSE. This specific community has been impacted by the ongoing SSE within the Bridgeton Landfill portion of the West Lake Complex which has resulted in noxious odors over an extended period. The community, as a result, is now sensitive to the existence of the RIM and its’ co-disposal with potentially flammable materials and that such materials are located on and/or near the ground’s surface. While I concur that the long term risks from an SSE to some of the engineering components (i.e., soil cover, surface drainage) are minimal, one must examine the other long term issues (e.g., cover systems, gas control systems, slope stability, groundwater, leachate control, odor control, etc.) that have been impacted by similar long-term SSEs. SSEs clearly cause long-term additional risks to people including workers on the landfill property and/or the environment. U.S. EPA is aware of and has access to many case studies including the Kona Landfill in Hawaii which has been smoldering for twenty plus years. These case studies detail the long-term impacts of such events to public health and the environment.

There are likely additional applicable or relevant and appropriate requirements (ARARs) that should be included. It appears the report takes into account only characteristics of a subsurface event and does not carefully consider impacts that would be felt by the surrounding area should such SSE surface. Given the RIM, one should not hope an SSE does not surface; one should plan for the event, design a response, and account for the RIM and other issues such as adequacy of water supply, site access, available response contractors, decontamination, and community safety plans, etc.

Given current circumstances at this specific facility, consideration should be given to an SSE that surfaces or that causes slope stability issues with particular attention given to an area where RIM exists in close proximity to an urban population and a transportation hub, such as an international airport. Local emergency response agencies need to be directly engaged in the planning process and until such time as this occurs, I disagree with the statement that no additional ARARs need to be developed and be readily implementable when an SSE is already known to exist in close proximity to RIM and where no impenetrable barrier exists between the RIM and the existing SSE.

Section 2. Subsurface Heating Events

While the authors understand the complexities of heating events not all subsurface heating events at landfills are smoldering events. Heating events can be from biological factors or other chemical reactions such as aluminum dross or other metal oxide reactions. The key to understanding when a heating event becomes an SSE is determining the presence of carbon monoxide. Carbon monoxide is a by-product of incomplete combustion and is one of the crucial indicators in evaluating whether or not an SSE is occurring.

Section 4. Potential ARARs Relative to an SSE

The authors state no additional ARARs are required. As stated above in Section 1, additional action-specific ARARs may be necessary if an SSE were to develop. Until local emergency response agencies have been consulted, I would recommend revising this section to reflect this possibility.

Section 5.1 Combustion

While the reference is correct, the authors fail to recognize that an SSE may surface and create flame, smoke, vapors, and gaseous emissions. These conditions are dependent upon a number of environmental factors. The referenced section describes the general nature of a smoldering event and not the outcome of such an event. At closed facilities, some with and without gas control systems, the only indication of an SSE is by nearby residents or first responders when they detect smoke, vapor, odors or other odd/abnormal site conditions. One should not generalize that an SSE will not result in the release of radionuclides through flaming combustion. Radionuclides can be released through the presence of water vapor, dust, smoke, and flames in proximity to them.

Additionally, waste temperatures well above 450° F (232° C) have been documented by industry and the regulatory agency from SSEs as they surface. The temperature range as described by Thalhamer, 2013 is purely to describe typical initial stages of a smoldering event and not the maximum observed temperature. This correlation is not correct and should be corrected. If the SSE is not managed properly or detected, an SSE can propagate to the surface. Temperatures can and have reached levels necessary for ignition of paper, gases, and other material. It is also important to note that a smoldering event at a solid waste landfill can and has ignited methane. Methane gas or other flammable gases or liquids exposed to a smoldering object will ignite; however, the correct mixture of gases must be present for ignition to occur.

EMSI also states that methane production decreases significantly when temperatures are elevated above 160° F (71 °C) and appears to incorrectly conclude that methane will not be present and hence a corresponding explosive release of radionuclides will not occur. This statement indicates the authors may not fully understand the complexities of methane generation in landfills. Current landfill gas data from the Bridgeton Landfill indicates a number of gas extraction wells producing methane at explosive levels at temperatures exceeding 160° F (71° C). Additionally, EMSI states that the wastes or waste materials are at least 30 years old or older; however, the 30 year old rule for waste remains a guideline. There are many US solid waste landfills which have had waste in place for over 30 years that are still producing methane

in sufficient quantities (i.e., above explosive levels). Until a gas study is completed in Area 1 and Area 2, it should not be assumed that a methane explosion or release of radionuclides will not occur simply because of the age of the waste or gas temperature. The municipal solid waste landfill within the West Lake complex is experiencing these exact conditions.

The authors should revise this section and recognize the possible transition phases of an SSE and that methane will or may continue to be present at temperatures above 160° F.

5.2 Increase in Subsurface Temperature

Again the temperature of 480° F (249° C) is not the maximum observed temperatures of an SSE. Landfill temperatures from heating events have been observed over 1,000° F (537° C). The Bridgeton Sanitary Landfill experienced an SSE in the North Quarry beginning in 1992 with temperatures reported as exceeding 800° F (SCS Engineers, 1994). Should an SSE cause slope stability issues ultimately resulting in a failure of an engineered component, radionuclides could be released by any or a combination of the following: water vapor, dust, smoke, and flames.

6.1 Direct Combustion

While EMSI claims that direct combustion of the selected capping system would not be affected by a smoldering or flaming fire, the capping system can be impacted by differential settlement from an SSE or heating event and result in aerial deposition of RIM. EMSI should also consider impacts from direct combustion from the North Quarry since OIU-1 are not isolated from the current SSE at the Bridgeton Landfill.

7. Conclusion

SSEs at this facility are not theoretical and monitoring protocols and contingency plans should be in place, maintained and readily available for implementation until the site no longer poses a risk. SSEs can cause slope stability issues and could result in the release of radionuclides through water vapor, dust, smoke, and/or flames. The characteristics of SSEs are variable and have the potential to result in the combustion, melting, and/or altering of the stability of the RIM and until such time as Area 1 and 2 are clearly defined by their boundary conditions and waste composition, and isolated from the Bridgeton Landfill one should not eliminate the possibility of an SSE impacting the site workers, first responders, the community, and/or the environment.

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From: Todd Thalhamer, P.E.

Date: April 14, 2014

RE: Addendum to the February 14, 2014 Comments on the Evaluation of Possible Impacts of a Potential Subsurface Smoldering Event on the Record of Decision – Selected Remedy for Operable Unit-1 at the West Lake Landfill – Dated January 14, 2014

Following my recent on-site visit to the Bridgeton Sanitary landfill on April 2-3, 2014 and having viewed the area where on March 21, 2014, a vegetation fire occurred at the south edge of the Bridgeton Sanitary Landfill's soil borrow area, a number of new issues related to impacts from a surface fire must be considered with regard to the Engineering Management Support, Inc. (EMSI) Report. During my preliminary assessment, I followed the outline of the EMSI Report and did not fully examine and report on the current site conditions and the issues that need to be evaluated and acted upon should a vegetation fire occur within the West Lake Landfill Complex in St. Louis, Missouri. At a minimum, the US EPA consultant needs to amend the report to include potential impacts to the Operable Units from a surface fire and the potential for such a fire to result in a subsurface smoldering event.

While these conditions were not evaluated nor discussed in the EMSI Report and were possibly not identified in the original scope of work, US EPA's consultant should examine the current site conditions (i.e., presence of brush and other vegetation within the Operable Units 1 and 2; characterization of waste including type and nature of chemicals and chemical compounds present in the waste mass and potential for reactions) and discuss the impacts from a wildland fire occurring within fenced areas of the West Lake Landfill Complex or from land adjacent to the complex.

My understanding is that the waste materials within Operable Unit 1, Area 1 and Area 2 in addition to the radiologically impacted materials (RIM) have previously been stated as a combination of construction and demolition waste as well as some level of industrial and municipal solid waste, but to my knowledge these waste materials have never been adequately characterized to determine potential chemical reactions from the impacts of a surface fire which would include reactions to water or fire suppression products.

To further complicate this scenario, US EPA recently stated that RIM is known to exist outside the originally defined waste containment areas. US EPA's consultant needs to amend the report to consider whether a vegetation fire, not directly related to an SSE, has the potential to start within the Operable Areas shown in Figure 1 below or move into the Operable Areas from adjacent properties and should then evaluate and consider, at a minimum, the following questions:

- Has US EPA examined for any radiological uptake in the vegetation that has been allowed to grow within the Operable Units?
- How has US EPA accounted for storm water and erosion control issues in the past? And how would US EPA manage the storm water and erosion control once a fire has removed the vegetative cover from the Operable Units?
- Should the local fire agency even respond to a vegetation fire within the Operable Units? Or does this responsibility fall to US EPA personnel?
- If it is safe for the local fire agency to enter the radiological areas to extinguish a surface fire? What level of protection is needed for personnel to enter these areas?
- Should the vegetation just be allowed to burn off?
- What actions should be taken by the emergency management agencies and first responders to protect the first responders and the surrounding community from such a wildfire (i.e., resulting smoke plume and blowing materials, such as ash)?
- Is it possible for a vegetation fire (surface fire) to start a subsurface smoldering event within the Operable Units?
- What control methods have been implemented to prevent this from occurring? Should the heavy brush within the Operable Units be removed? Is the current cover in the Operable Units sufficient to prevent a surface fire from impacting the unclassified waste?

Lastly, with the recent slope movement at Bridgeton and slope failures at other landfills with smoldering events, the EMSI report should include a discussion of potential impacts from a slope failure or significant slope movement from a smoldering event.



Figure 1. Significant Vegetation Fire Risks at the West Lake Landfill Complex. St. Louis, Missouri. (Source Google Earth, 8/6/2012)