UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 7
11201 Renner Boulevard
Lenexa, Kansas 66219

AUG 26 2014

ADVANCE COPY VIA ELECTRONIC MAIL

Jessie Merrigan
Lathrop & Gage, LLP
2345 Grand Boulevard, Suite 2200
Kansas City, Missouri 64108-2618

Re: Isolation Barrier Alternatives Assessment Report
West Lake Landfill Superfund Site

Dear Ms. Merrigan:

Please find enclosed the Isolation Barrier Alternatives Assessment Report for the West Lake Landfill Site (August 25, 2014) (Report) prepared by the U.S. Army Corps of Engineers (USACE). The U.S. Environmental Protection Agency requested USACE to prepare this report in support of our efforts to further evaluate the proposed design and construction of an Isolation Barrier at the West Lake Landfill Superfund Site. As detailed in this report, USACE has performed an analysis of various assessment factors, as well as identification and comparison of advantages and disadvantages related to the three proposed alignments.

As previously identified by various interested parties, evaluation of potential bird strike hazards to aircraft utilizing the Lambert Airport is important to consider as the EPA takes steps towards reaching a final decision regarding the construction of the Isolation Barrier. To that end, the EPA requests that the Responsible Parties use the Report as a basis to further develop more detailed plans for the Isolation Barrier, specifically including bird mitigation plans, for each of the three proposed alignment alternatives. The EPA understands that it may be necessary for the parties to develop a design for each alignment in order to prepare this deliverable. The EPA requests that this plan be submitted to the EPA within 45 calendar days of the date of this letter. To meet this deadline, we propose a conference call during the week of September 8, 2014, to discuss the technical scope of this effort. Please contact me, or David Hoefer at 913-551-7503, to confirm dates that you are available for a conference call.

The EPA appreciates your prompt attention to this request. If you have any questions regarding this letter, please do not hesitate to call me at 913-551-7826 or contact me via email at stoy.alyse@epa.gov.

Sincerely,

Alyse Stoy
Deputy Regional Counsel for Enforcement

U.S. Army Corps of
Engineers

ISOLATION BARRIER ALIGNMENT ALTERNATIVES ASSESSMENT

WEST LAKE LANDFILL BRIDGETON, MISSOURI

FOR

**Environmental Protection Agency Region 7
Superfund Program**

DATE: 25 August 2014

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Isolation Barrier Alignment Alternatives Assessment
West Lake Landfill, Bridgeton, Missouri

1. Summary

The U.S. Environmental Protection Agency (EPA) requested the United States Army Corps of Engineers (USACE) evaluate information conveyed by the Responsible Parties (RPs) during discussions between USACE, the RPs, EPA Superfund personnel (EPA), and EPA's Office of Research and Development (ORD) regarding proposed locations and alignments of an Isolation Barrier (IB) at West Lake Landfill in Bridgeton, Missouri. The purpose for constructing an IB is to prevent a subsurface smoldering event (SSE) in the adjacent Bridgeton Sanitary Landfill from coming into contact with radiologically impacted materials (RIM) located in Operable Unit 1 (OU1) Area 1 of the West Lake Landfill. This assessment focuses on the proposed alignments, the feasibility of constructing the IB, the comparative advantages and disadvantages of the proposed alignments, and the associated risks. Because USACE has not been provided with design drawings, calculations, or lab analyses from recent sampling events, this evaluation is qualitative in nature. As additional information becomes available, this assessment may change.

Key points of the assessment are summarized below:

1. Extent of the Radiologically Impacted Material (RIM)
The full extent of the RIM has not been determined, specifically in the southwest portion of OU1 Area 1, east of and around the existing Transfer Station. Before design work can be completed for the IB, additional subsurface investigative work is necessary to determine the limits of the RIM as well as to collect geotechnical data necessary for design of the IB. Knowing the location and extent of RIM will:

    - for Alignment 1, allow the design to effectively address the RIM remaining on the south side of the IB.
    - for Alignment 3, allow the southern portion of the IB to be located where as much RIM as possible is located on the north side of the IB.

2. Comparison of IB Alignment Alternatives
To date, the information presented by the RPs regarding the design and construction of the IB is still conceptual. As such, this assessment is qualitative in nature and consists primarily of identifying the advantages and disadvantages of the proposed alignment alternatives when compared to each other. The advantages and disadvantages of each alignment carry risk and the extent of those risks and the ability to mitigate those risks must be carefully considered when selecting an alignment.

3. Duration of the IB Design and Construction Effort
Movement of the SSE present in the South Quarry of the Bridgeton Landfill is unpredictable and the length of time it would take for the SSE to reach the RIM in OU1 Area 1 is currently undetermined. Therefore, the length of time to design and construct

the IB must be considered in selecting an alignment. Because of the subsurface investigative work that remains to be completed and the technical challenges for an IB constructed within a landfill, the duration of the design and construction process will be lengthy. The total design effort could require as much as 18 months from the start of design to the start of construction. There may be opportunities to accelerate the design process; however, the design effort should not be shortened to the point of sacrificing the quality of the design. This IB will be a complicated construction project, and the success of the construction work depends on the thoroughness of the design and planning effort.

4. Legal Prohibition Against Exposing Landfill Waste Material
The Negative Easement Agreement (NEA) between the City of St. Louis/St. Louis Airport Authority and the RPs is a critical factor to be considered as part of the design and construction of the IB. The NEA prohibits any activity that will result in the landfill cover being compromised; therefore, a waiver to the NEA will be required to install the IB, no matter what alignment is selected. It is recommended that prior to the start of design, the RPs provide the City of St. Louis and St. Louis Airport Authority the information necessary for the City and Airport Authority to make a determination on which IB alignment(s) they would support.

2. Background

West Lake Landfill accepted RIM in 1973 when leached barium sulfate residues from uranium ore processing was mixed with soil, transported to West Lake, and used as daily cover for landfill operations. RIM is present in areas designated as OU1, Areas 1 and 2. Area 1 is located adjacent to the Bridgeton Sanitary Landfill, a former quarry that was converted to a landfill and operated under a Missouri Department of Natural Resources (MDNR) permit from 1979 until 2005. OU1 Area 2 is not physically connected to OU1 Area 1 or the Bridgeton Sanitary Landfill. The Bridgeton Sanitary Landfill, which consists of the North Quarry and the South Quarry areas, was closed in 2005 due to an expansion of the nearby Lambert Airport and the potential bird hazard the landfill operations could pose to air traffic. In 2010, elevated temperatures were identified in the South Quarry area of the Bridgeton Sanitary Landfill, indicating a possible SSE. The SSE was confirmed in 2012 through significant subsidence in a portion of the landfill surface. In May 2013, in response to an Order of Preliminary Injunction filed by the Missouri Attorney General and MDNR, the RPs prepared a North Quarry Contingency Plan which set temperature, settlement front movement, and carbon monoxide emission thresholds that, if exceeded, would trigger the RPs' response, which included installing an IB between the RIM in OU1 Area 1 and the SSE. Subsequent discussions between the RPs and regulating agencies resulted in the RPs deciding to install the IB prior to triggering the contingency plan thresholds.

3. RIM Isolation Alternatives

During June and July 2014, technical discussions involving USACE, EPA, ORD, and the RPs were conducted regarding potential RIM isolation alternatives. The two primary alternatives discussed consisted of: 1) construction of a concrete isolation barrier wall to prevent the SSE from progressing into the West Lake Landfill, or 2) excavation of waste to create an air gap that would interrupt the "waste to waste connection" between the Bridgeton Sanitary Landfill and the West Lake Landfill OU1 Area 1. Each of these alternatives is discussed below.

3.1 *Concrete Isolation Barrier Wall*

During the USACE, EPA, ORD, and the RPs' discussion of the concrete isolation barrier wall, three potential wall alignments were proposed by the RPs. The alignments are described below:

> Alignment 1 – The IB would be located in West Lake Landfill OU1 Area 1 starting from the eastern fence line and running in a west-southwest direction towards the current Transfer Station building, terminating east of the Transfer Station. In this alignment, the IB would not cross into the adjacent North Quarry landfill that overlies the southern portion of OU1 Area 1. The average depth of waste material along this alignment is estimated to be approximately 40 feet.
>
> Alignment 2 – The IB would be located far enough to the south of OU1 Area 1 to ensure that all RIM is located north of the IB. This would require the IB to be placed within the deepest part of the North Quarry landfill where the depth of waste material is reported to be 180 feet deep.
>
> Alignment 3 – The IB would utilize a similar alignment as Alignment 1 for the eastern half of the IB. Alignment 3 then deviates south of Alignment 1 and extends through a portion of the North Quarry landfill that overlies the southwest portion of OU-1 Area 1. This alignment would need to be located some distance north of the North Quarry's wall to minimize stresses caused by differential settlement of the more recent and deeper North Quarry landfill waste as compared to the older and shallower West Lake Landfill waste. The average depth of the waste material along the east end of Alignment 3 is expected to be approximately 40 feet and the depth of waste along the west end of Alignment 3 is expected to be approximately 80 feet. Extent of RIM determination is required near the western end of the IB to reduce the uncertainty of encountering RIM during IB installation and to determine if this alignment will allow all RIM to be on the northern side of the IB.

All three proposed alignments are conceptual and the RPs have not performed any detailed design calculations or produced any plans or specifications. Therefore, estimated waste depth and corresponding waste volumes requiring excavation used in this analysis are qualitative and for the purpose of alignment comparison only.

3.2 *Excavation to Create an Air Gap*

Another alternative considered to isolate the RIM from the SSE consists of excavating all waste at the southern edge of the West Lake Landfill down to bedrock and creating an air gap that interrupts the waste to waste connection between the Bridgeton Sanitary Landfill and the West Lake Landfill and prevents the SSE from moving beyond the gap. The alignment of the air gap excavation would be the same as Alignment 1. As with the Alignment 1 concrete barrier wall, the depth of the excavation along that alignment would average approximately 40 feet. For slope stability purposes, it was estimated that the excavation would need to be sloped at a ratio of between 2.5 to 3.0 horizontal to 1 vertical. The RPs estimated the volume of waste material excavated for this alternative, including bulking, was approximately 500,000-600,000 cubic yards.

While the air gap alternative would require no physical structure to be constructed, it was determined that it offered no other significant advantages over a concrete isolation barrier wall. It was also determined that the excessive waste excavation and handling would cause significant concerns with bird hazards, odor, on site waste management, and off-site waste transport. The large volume and the need to excavate through RIM would increase the safety risk to on-site workers and to off-site receptors. Additionally, because the air gap would essentially create a large depression in the ground, accumulated storm water runoff for such a feature would be complex and difficult to manage. Based on the significant disadvantages of this alternative, all parties agreed that this option would not be retained for further consideration at this time.

4. IB Alignment Alternatives Assessment

This section presents the assessment factors used during the assessment, identifies the advantages and disadvantages of each alignment, and provides a relative comparison of each alignment's advantages and disadvantages with respect to each assessment factor.

4.1 *Assessment Factors*

Advantages and disadvantages of each alignment were identified with respect to factors that directly or indirectly impact on-site workers, the surrounding community, the intended function of the barrier, and/or the time required to design and install the barrier. These factors are:

- Excavation Volume
- Odor Potential
- Bird Hazard Potential
- RIM Remaining South of the IB
- Potential for Future SSE North of IB
- On-Site Worker Safety
- Off-Site Public Safety
- Off-Site Waste Transportation and Disposal
- Duration of Design
- Duration of Construction
- Impact to Existing Infrastructure
- Technical Feasibility

During the assessment it was identified that the depth of the waste where the IB would be located drives the majority of the advantages and disadvantages. The deeper the waste, the larger the excavation volume, and the longer waste will remain exposed during the excavation process. The advantages and disadvantages of each alignment are listed below. It should be noted that as more information is obtained and decisions are made, the advantages and disadvantages identified below may change.

4.2 *IB Alignment Alternatives - Advantages and Disadvantages*

Alignment 1 – Advantages

- Least volume of waste to excavate, stage, screen, transport, and dispose
- Least odor potential to be emitted from the excavation due to shorter excavation time
- Least bird hazard due to lowest volume of waste
- Shortest design and construction duration due to smaller wall and shorter pre-design investigations
- No impact to existing infrastructure on North Quarry
- Technically Feasible
- Least likely to have future SSE occur on north side of IB

Alignment 1 – Disadvantages

- Highest RIM exposure potential for on-site workers due to IB being placed in area where RIM has been identified
- Higher off-site safety risk due to RIM excavation (dust generation)
- Higher risk due to off-site transportation of RIM and potential traffic accidents
- Leaves RIM on south side of IB where it could potentially be exposed to the SSE, requires further analysis and mitigation
- IB construction could disrupt transfer station operations and result in delayed or reduced trash service to impacted customers

Alignment 2 – Advantages

- No RIM anticipated to be encountered during excavation, extent of RIM must be determined to verify
- All RIM anticipated to be located north of the IB structure, extent of RIM must be determined to verify
- Lowest off-site safety risk with respect to airborne RIM exposure

Alignment 2 – Disadvantages

- Significantly more volume to be excavated than other alignment alternatives
- Highest odor potential due to longest duration for construction and volume of waste
- Highest risk of bird hazard potential due to the largest volume of waste and longest excavation time for all alignment alternatives
- Highest potential for a future SSE on the north side of the IB

- Highest on-site safety risk due to significantly high volumes of waste to be excavated and the uncertainty of contaminants other than RIM that may be encountered.
- Highest off-site general safety risk due to the significantly higher volume of waste that will require off-site disposal
- Longest design and construction time due to largest IB structure and largest volume of waste to be excavated
- Greatest impact to the North Quarry infrastructure that is used to balance landfill gas extraction and monitor for the SSE.
- At the limits of technical feasibility, potentially not feasible

Alignment 3 – Advantages

- Potentially less RIM is expected to be encountered during excavation compared to Alignment 1, requires site characterization to be completed to determine if RIM would be encountered during installation.
- Less RIM and potentially no RIM will remain on the south side of the IB, requires site characterization to be completed to verify
- Less on-site safety risk due to less RIM being encountered during excavation, although this will need to be verified once extent of RIM is determined
- Less off-site safety risk anticipated due to less airborne RIM
- Less off-site disposal of RIM anticipated, although this will need to be verified once extent of RIM is determined
- Less impact to transfer station operations during construction is anticipated
- Technically feasible

Alignment 3 – Disadvantages

- More volume of waste to excavate, stage, screen, transport, and dispose than Alignment 1. Will likely require multiple on-site staging areas
- Longer duration than Alignment 1 for odor to be emitted from the excavation due to larger volume of waste and longer excavation time
- Higher risk of bird hazard to air traffic than Alignment 1 due to larger volume of waste and longer excavation time
- Higher risk than Alignment 1 for a future SSE to occur north of the IB
- Longer design and construction durations expected compared to Alignment1
- North Quarry infrastructure used to balance landfill gas extraction and control/monitor for SSE will be impacted

4.3 *Relative Comparison of Alignment Alternatives by Assessment Factor*

Table 1 shows the comparison of each alignment's advantages and disadvantages by assessment factor.

Table 1: Relative Comparison of Alignment Alternatives

Factor	Alignment 1	Alignment 2	Alignment 3
Excavation Volume	Least volume than other alignments~50,000 CY ±	Largest volume to be excavated due to excavation for working platform and 180-foot depth in North Quarry, and increased thickness of wall to resist increased loads	Approximately twice as much as Alignment 1 ~95,000 CY ±, significantly less than Alignment 2
Odor Potential	Least odor potential due to the lowest volume of waste handling	Highest odor potential than both Alignment 1 and 3 due to highest volume of waste handling. Would be similar to active landfill operations.	Higher odor potential than Alignment 1 due to higher volume of waste handling
Bird Hazard Potential	Least bird hazard potential due to the lowest volume of waste handling	Highest bird hazard potential than both Alignment 1 and 3 due to highest volume of exposed waste. Would be similar to active landfill operations.	Higher bird hazard potential than Alignment 1 due to higher volume of waste handling
RIM Remaining South of Barrier	Most amount of RIM to remain south of IB compared to the other alignments although magnitude is unknown since extent of RIM has not been determined	None –assumes that no RIM material was placed in the North Quarry landfill	Least amount of RIM would remain south of IB compared to Alignment 1 and potentially no RIM would remain. Extent of RIM is required to verify this
Potential for Future SSE North of Barrier	Anticipated to have the lowest potential for future SSE on the north side of IB due to waste being older and likely more fully degraded.	Anticipated to be the highest potential for a future SSE on the north side of the IB due to highest volume of newer, less degraded waste remaining north of theIB.	Anticipated to be higher potential than Alignment 1for a future SSE on north side of the IB due to newer, less degraded waste remaining north of the IB but less than Alignment 2 due to less volume of newer waste remaining north of the IB
On-Site Safety	Potentially greater on-site safety risk than Alternative 3 due to known RIM being excavated.	Greatest on-site safety risk compared to Alignment 1 and 3 due to the significantly higher volume of waste excavated and handled. Lowest on-site safety risk due to RIM.	Lower on-site safety risk than Alignment 1 if little or no RIM excavated but higher general safety risk than Alignment 1. Higher on-site safety risk than Alignment 2 (with respect to RIM) if RIM is encountered.

Criteria	Alignment 1	Alignment 2	Alignment 3
Off-Site Safety	Potentially higher off-site safety risk than Alignment 3 during installation due to RIM excavation (dust generation) and off-site transportation of RIM (traffic accidents/spills).	Highest off-site safety risk due to the significantly higher volume of waste being excavated requiring off-site transportation, which increases truck traffic and risk for traffic accidents.	Lower off-site safety risk than Alignment 1 if no RIM (dust generation). Higher off-site safety risk than Alignment 1 due to off-site transportation (traffic accidents)
Off-Site Waste Transportation and Disposal	RIM waste excavated as part of wall installation will require off-site disposal.	Largest volume of off-site disposal of non-RIM waste will be required due to limited on-site waste disposal capacity	Off-site disposal potentially not required if all RIM is located north of alignment – unknown at this time since extent of RIM has not been determined
Duration of Design	Shortest design duration due to shortest wall and shorter pre-design investigations	Longest design duration due to more than 180-foot depth requiring pre-design investigation and highly complex design	Longer design duration than Alignment 1 due to longer duration of pre-design investigations and more complex wall design due to increased depth
Duration of Construction	Shortest construction duration due to shortest wall	Longest construction duration than both Alignment 1 and 3 due to 180-foot depth, significantly wider wall to handle increase loading	Longer construction duration than Alignment 1 due to 30 to 40-foot increased depth of wall
Impact to Existing Infrastructure	No impact to existing infrastructure on North Quarry but may impact operation of the transfer station, which could result in delayed or reduced trash service to impacted customers	Greatest impacts to the North Quarry Infrastructure used to balance landfill gas extraction and control/monitor the SSE	Moderate impacts to the North Quarry Infrastructure used to balance landfill gas extraction and control/monitor the SSE
Technical Feasibility	Technically Feasible	At the limits of technical feasibility – potentially not feasible	Technically Feasible although more difficult than Alignment 1

4.4 *Alignment 1 Advantages Discussion*

Of the three alignments, Alignment 1 is considered the most technically feasible and will require the least volume of waste to be excavated. The RPs have estimated the total volume of waste for Alignment 1 to be approximately 50,000 cubic yards. Because this alignment requires excavation of the least amount of waste, it is expected that it will have the shortest construction duration. A shorter construction duration will reduce the duration in which the community is exposed to odors from the excavation. Landfill odor has been an ongoing concern for the surrounding community and reduced duration for odor emissions would be a favorable advantage.

Bird hazards to air traffic are a significant safety concern to the St. Louis Airport Authority as West Lake Landfill is located within 10,000 feet of the nearest Lambert St. Louis Airport runway (see Section 7). Alignment 1 will result in the least amount of excavated waste and will therefore present less risk of bird hazards and other nuisance species (insects, rodents) that can, in turn, attract more birds, when compared to the other alignments. While this alignment offers the least bird hazard risk, mitigation efforts will still be required to minimize waste exposure during excavation and handling of waste material.

Based on a 2013 bird survey performed during well installation and toe drain excavation activities in the North and South Quarries of the Bridgeton Sanitary Landfill, 256 gulls, geese, doves, and raptors were observed within a 20-day period. According to the Federal Aviation Administration (Dolbeer et al, 2014), these bird species were among the species most frequently struck by airplanes between 1990 and 2013. It is expected that geese and doves would not be attracted to the excavation and waste handling operations to be undertaken as they typically do not consume decomposed waste. However, gulls and raptors are expected to be attracted to the site operations as they will seek out easy food sources including decomposed waste. With gulls, mitigation efforts such as sudden loud noises from bird scaring devices (canons, warning horns) are effective only for a period of a few days as gulls can rapidly adapt to these sounds (Airport Operators Association and General Aviation Awareness Council, 2006). Additionally, since gulls tend to feed at operating landfills as the trucks hauling in trash are "tipped", it is expected that gulls will likewise feed as excavation is being conducted and trucks are being loaded to move the excavated waste to the staging areas and to load trucks for off-site waste transport. Therefore, minimizing the amount of excavation exposed and reducing the duration of construction will be one of the best bird hazard mitigation strategies for the site.

Storm water management will also require mitigation efforts as birds are attracted to standing water sources. For work previously performed at the Bridgeton Sanitary Landfill, the RPs have ensured that detention basins drain within 24 hours, thereby not providing a continued standing water source to attract birds. It is expected that a similar mitigation method for storm water management would be implemented for each of the IB alignments.

Alignment 1 would be located where there will be no newer waste located on the north side of the IB and will be placed in an area with a maximum waste depth of approximately 40 feet. The extent of waste decomposition and the pressure and insulating conditions in a landfill (often determined by the depth or thickness of the waste) are two of several factors that can contribute to the generation of a future SSE. Older waste and shallower waste located north of the Alignment 1 IB are considered an advantage as these conditions are less likely to support the generation of a future SSE than the newer and deeper waste of Alignments 2 and 3.

Another advantage of Alignment 1 is that the design time would likely be shorter than the design time for Alignment 3 primarily because some of the data required for design of the IB has already been collected. Some geotechnical data would still be required to be collected before design could begin, but these pre-design investigations would likely be shorter in duration than those that would be required for the other alignments, therefore allowing design efforts to be completed in a shorter duration than the other alignments.

Alignment 1 also has an advantage of not having to remove existing North Quarry infrastructure (monitoring wells, landfill gas collection wells, and associated piping) for the installation of Alignment 1. The North Quarry infrastructure was installed as part of the May 2013 First Agreed Order of Preliminary Injunction for the RPs to install infrastructure to monitor for the SSE and control landfill gas. Therefore, the least impact to the existing infrastructure will minimize the design and construction duration as the RPs will not have to remove, redesign, and reinstall the North Quarry infrastructure.

4.5 *Alignment 1 Disadvantages Discussion*

While Alignment 1 has comparatively more advantages than Alignments 2 and 3, the disadvantages of Alignment 1 carry some amount of risk that must be considered. While it may be possible to manage the risk associated with these disadvantages, these risks must be considered when selecting an alignment.

The first disadvantage of Alignment 1 is that although the vast majority of RIM will be isolated north of the IB, some RIM will remain on the south side of the IB. Since the purpose of installing the IB is to prevent the SSE in the Bridgeton Sanitary Landfill, from coming into contact with RIM in the West Lake Landfill, leaving some RIM on the south side of the IB would not completely fulfill that purpose. To mitigate this significant disadvantage, the Alignment 1 design would need to include a means for mitigating the RIM remaining on the south side of the IB. To be able to effectively evaluate options for addressing RIM left on the south side of the IB, the extent of RIM must first be determined. At this time, the extent of RIM at OU1 Area 1 has not been determined. Field and laboratory results from the recent sampling performed by the RPs must be evaluated to determine what additional characterization data is required and a determination must be made regarding what information is required to evaluate technologies for addressing the remaining RIM. Section 5 includes a list of potential options that the RPs could consider to address remaining RIM.

The second disadvantage of Alignment 1 is that the IB would be installed through RIM. Handling RIM during excavating, staging, screening, transporting, and disposal of the RIM are activities that must be appropriately planned during design and carefully managed during construction due to the potential impact to the safety of on-site workers and the potential for RIM release during off-site transportation to disposal facilities.

The on-site worker safety risks can be mitigated through the preparation and thorough execution of Health and Safety Plans; however, preparing and following these procedures does add time to the construction process. Similarly, off-site disposal of RIM will require some over the road transportation. This will result in increased truck traffic in the vicinity of the site and could lead to increased risk for traffic accidents, which could result in spilling RIM along the transportation route.

Excavation through RIM can also lead to off-site exposure risks associated with airborne dust, which could contain RIM. Mitigation is planned through use of an air monitoring network to monitor for RIM and through proper dust control during excavation activities. Proper planning and response plans to include these mitigation actions will be required to reduce the risk but the preparation and implementation of these mitigation efforts will increase the design and construction durations.

Off-site waste transportation itself is a risk for not only safety reasons, but due to how it can impact the duration of construction. The time it takes to stage, screen, segregate, sample, load, and transport the RIM can add significant time to the construction duration. The exact impacts to the design and construction efforts cannot be quantified at this time and will need to be addressed by the RPs as they determine how the RIM will be managed. The amount of RIM, the saturation of the waste, how the waste will be transported, and the location, permitting, and sampling requirements of the disposal facility will contribute to the schedule risk associated with handling RIM.

4.6 *Alignment 2 Advantages Discussion*

The primary advantage of Alignment 2 is that this alignment is expected to segregate all RIM from the existing SSE in the Bridgeton Sanitary Landfill. This is a significant advantage as that is the primary reason for the installation of the IB.

Another advantage is that from an off-site safety standpoint, because no RIM is anticipated to be encountered, the risk for on-site and off-site exposure to RIM is low.

4.7 *Alignment 2 Disadvantages Discussion*

The primary disadvantage of Alignment 2 is the significant volume of waste that would need to be excavated. Because the depth of the IB would be approximately 180 feet and the potential for differential settling of the waste on the opposite sides of the IB, the IB design would have to be significantly wider than the IB for Alignment 1 or 3 to be capable of handling those differential stresses. This effort will significantly increase the design duration as additional time will be required to ensure the design is structurally sound and that the proper cooling system is incorporated. Additional geotechnical data will also need to be collected and getting that data from a deeper depth will take longer. One potential way to mitigate the width of the Alignment 2 IB would be to implement an on-going operation and maintenance plan that restores the surface of the settled waste to prevent the overturning stresses caused by differential settlement of the wastes adjacent to the barrier. The RPs will need to make a determination on which means is most effective for addressing this issue, should this alignment alternative be selected.

Due to the large depth and width of the excavation, the length of time the excavation would remain open would be significantly increased and the odor potential and duration of the odor would, in turn, be significantly increased. The negative impact of the odor and the duration of the odor to the quality of life for the nearby community may not be acceptable.

The significant volume of waste and the length of time to excavate will also significantly increase the bird hazard potential. As discussed in Section 4.4, gulls and raptors are expected to be attracted to the site operations as they will seek out easy food sources. Due to their ability to rapidly adapt to loud and active surroundings, mitigation techniques would have to be aggressive and vary frequently due to the significant duration required to construct this alternative. Additionally, since gulls would be expected to feed as excavation is being conducted and trucks are being loaded to move the excavated waste to the staging areas and to load trucks for off-site waste transport, bird mitigation for this alignment alternative is expected to be challenging over the extended construction duration expected for this alignment alternative.

Alignment 2 would be located within the Bridgeton Sanitary Landfill, therefore, a large amount of the newer waste in this landfill will be located on the north side of the IB. The maximum depth on the north side of the IB would be approximately 180'. The greatest depth of this newer waste would be located between the IB and the Quarry wall, which could potentially increase the pressure and insulating factors, which, if other conditions are right, could contribute to a future SSE on the north side of the IB.

Alignment 2 would be located in the North Quarry of the Bridgeton Sanitary Landfill and should not encounter RIM because there has been no evidence that RIM was placed in this area. Because of this, the risk to the safety of on-site workers due to RIM is determined to be the lowest compared to the other alternatives. However, because of the significant volume and depth to be excavated, the construction techniques, and the length of construction required to install the IB, the general construction safety risk to workers is considered significantly higher than Alignments 1 and 2.

With regards to off-site safety, due to the large volume of waste and limited space on site for staging, off-site disposal will be required. The increased truck traffic in the vicinity of the site will increase the risk for traffic accidents. Additionally, the increased truck traffic waiting to enter and exit the site will impact the existing Transfer Station operations. This could disrupt some of the Transfer Station's operations including customer's trash collection services.

Another disadvantage of Alignment 2 is that monitoring wells, gas collection lines, and gas extraction wells located in the North Quarry would have to be removed prior to installation of the IB and then reinstalled after construction is completed. Due to the long construction duration, that North Quarry infrastructure would not be in place for a long duration. The North Quarry infrastructure was installed as part of an Order for Preliminary Injunction for the RPs to monitor temperature fluctuations, carbon monoxide emissions, and control landfill gas. This infrastructure is important for detecting potential movement of the SSE and controlling landfill gas.

The volume of waste to be excavated with Alignment 2 would result in daily conditions that are considered similar to those of an operating landfill. The number and the significance of the disadvantages of Alignment 2 far outweigh the Alignment 2 advantages. Therefore, all parties were in agreement of not supporting selection of Alignment 2.

4.8 *Alignment 3 Advantages Discussion*

The primary advantages of Alignment 3 are that it is technically feasible and requires a significantly less volume of waste to be excavated compared to Alignment 2 while minimizing the potential amount of RIM remaining south of the IB and potentially exposed to the SSE when compared to Alignment 1. At this time, the extent of RIM has not been determined near the southwestern portion of OU1 Area 1. Once the extent of RIM has been determined, it is still possible that the western portion of IB Alignment 3 may have to be placed such that some RIM may still remain south of this IB alignment. This is because there is a limitation on how far south Alignment 3 can be shifted without being impacted by the North Quarry wall and settlement of the deeper and less degraded North Quarry waste. Since the extent of RIM is not fully characterized, it is difficult to quantify the magnitude of advantage this alignment may offer over Alignment 1. If this alignment could fully isolate the RIM north of the IB, this would be considered a significant advantage.

Another advantage of Alignment 3 is that the on-site safety risk to workers will be lower than either Alignment 1 or Alignment 2 if the extent of RIM investigation identifies that no additional RIM is encountered east of the last sampling locations.

4.9 *Alignment 3 Disadvantages Discussion*

Although Alignment 3 has significantly less volume of waste to be excavated than Alignment 2, the volume of waste to be excavated for Alignment 3 is considered a disadvantage when compared with the volume of waste to be excavated for Alignment 1. Alignment 3 could have as much as double the volume of waste as Alignment 1. As previously stated, the volume of waste drives the disadvantages with each alignment, so doubling the volume of waste will increase the risk associated with those disadvantages.

Alignment 3 will have less potential for odor than Alignment 2, but will have a greater potential for odor than Alignment 1 due to the increased volume of waste to be excavated. In addition to the longer excavation duration, multiple staging areas will also be required for Alignment 3 in order to stage the larger amount of excavated waste so it can be screened prior to disposal. Having multiple staging areas will also contribute to the longer overall construction duration and odor potential. As odor is a quality of life issue for the community, this could be considered a significant disadvantage to the community.

Alignment 3 will also have a significantly less potential for bird hazard compared to Alignment 2 due to the lower volume of excavated waste; however, when compared to Alignment 1, the bird hazard potential increases and therefore, is considered a disadvantage. As discussed in Section 4.4, gulls and raptors are expected to be attracted to the waste and some mitigation efforts are not expected to be effective for more than a few days. Additionally, since gulls tend to feed as the excavated material is loaded onto trucks for transport, netting or other means of mitigation will likely be required to minimize bird hazards.

Alignment 3 would be located within the West Lake Landfill, but the western portion of the IB would cross into a portion of the Bridgeton Sanitary Landfill North Quarry waste that overlays the southeastern portion of the West Lake Landfill. As a result, some of the newer waste in North Quarry will be located on the north side of the Alignment 3 IB. Additionally, this overlay area when combined with the West Lake Landfill Area 1 waste below it, has a maximum depth of waste of approximately 80 feet. The additional depth of waste from the North Quarry overlay and the newer waste located on the north side of the Alignment 3 IB are two factors that can contribute to the generation of a future SSE on the north side of the IB. Because these conditions would exist if this alignment were installed, they are considered a disadvantage.

The on-site safety risk for Alignment 3 would be lower when compared to Alignment 1 if little or no RIM is excavated to install this IB. However, until the extent of RIM is determined and Alignment 3 is definitized, this relative risk cannot be confirmed. The relative risk for Alignment 3 RIM exposure would be higher compared to Alignment 2 as no RIM is expected to be encountered during excavation of Alignment 2. From a general construction standpoint (not considering RIM), the on-site safety risk for Alignment 3 is higher than Alignment 1 due to the length of the construction duration. The general on-site safety risk for Alignment 3 is considered significantly less than Alignment 2 due to the width and depth of excavation and the amount of material handling required for Alignment 2.

Alignment 3's off-site risk for exposure to airborne dust containing RIM is considered lower than Alignment 1's risk if the alignment is able to be placed where there is no RIM. Qualitative assessment of the relative off-site risk due to airborne RIM exposure if the IB is placed through RIM would be dependent upon the depth of the RIM and the RPs' material handling processes. As indicated in the Alignment 1 discussion, mitigation measures, including air monitoring and dust control, can be employed to control risks during excavation and waste handling. Relative off-site safety risk due to increased truck traffic to dispose of RIM is not able to be estimated for this alternative until the extent of RIM is fully characterized.

The duration of design for Alignment 3 will be longer than Alignment 1 due to the need to determine the extent of RIM and to gather geotechnical data necessary to design the IB. The depth of the waste will increase the amount of timer required to collect the data necessary for design. Additionally, because the IB will be deeper in the western portion of the alignment, additional design time will be required due to more complex loadings and structural requirements of the wall. The construction duration for Alignment 3 will also be longer than Alignment 1 due to the increased depth of the western portion of the IB.

Another disadvantage of this IB alignment is the impact to existing infrastructure. The monitoring wells, gas collection lines, and gas extraction wells located in the North Quarry would have to be removed prior to installation of the IB and then reinstalled after construction is completed.

Summary: The assessment conducted consists primarily of identifying the advantages and disadvantages of the proposed alignment options and comparing these options to each other. The advantages and disadvantages of each alignment carry risk and the extent of those risks and the ability to mitigate those risks must be carefully considered when selecting an alignment.

5. Design Considerations

Options to address some of the technical challenges anticipated during design and construction were identified. Following are some of those

For Alignment 1 and potentially for Alignment 3, the possibility of encountering RIM during excavation exists. During discussions, the RPs indicated they were considering utilizing a panel wall construction method to install the IB. Utilizing a panel wall construction method would reduce the amount of excavated materials and drilling fluids/slurry that would come into contact with RIM when compared to a continuous trench excavation; however, there could still be a significant volume of waste and fluids resulting from the in panel wall construction that would require handling and disposal as RIM. Because the safe handling and disposing of additional material as RIM will increase the overall duration and cost of the project, alternative construction methods that could further minimize the potential amount of radiologically impacted slurry or drilling fluids should be investigated.

One potential construction method that could be considered to minimize the use of fluids or slurry is the use of a secant pile wall for that portion of the IB that extends through RIM. A secant pile wall would not require use of a slurry, so it would minimize the potential spread of RIM and eliminate handling of RIM contaminated slurry. It is also suitable for installation in difficult subsurface conditions. It also can be used in combination with panel wall installation (panel wall installation on the east portion of the IB and a secant pile wall installation on the west portion of the IB). The primary disadvantage of a secant pile wall installation is that there is less certainty in the continuity of the wall; however, there are installation and down-hole verification techniques to minimize this uncertainty. The RPs would also need to determine how to incorporate an internal cooling system with both the secant pile wall and the panel wall construction methods.

Depending upon the alignment selected, there may be some RIM remaining on the south side of the IB wall that needs to be addressed as part of the IB design. Table 2 summarizes some potential mitigation measures to consider.

Table 2 - Options to Address Remaining RIM

Option	Description	Advantages	Disadvantages
Excavate RIM	Excavate identified RIM remaining on south side of IB	Minimizes risk of RIM contact with SSE	RIM handling, screening, transport, disposal
			Open excavation and increase in odor
			Open excavation and increase in bird hazard to air traffic
			Ensuring IB stability while RIM excavation is conducted adjacent to the IB. This is a significant disadvantage and will increase the size of the IB, the volume of waste to be excavated, and other associated risks. It is possible that excavation after IB installation may not be technically feasible depending upon the location of the remaining RIM with respect to the IB structure.
			Off-site hauling for disposal may increases risk of traffic accidents and RIM release.
In-Situ Stabilization	Utilize deep soil mixing techniques to auger down to RIM, inject cement grout, and mix grout with the waste to immobilize the RIM and adjacent waste into a hardened block less susceptible to the SSE	Reduces the amount of waste to be handled, transported, and disposed	Effects of SSE in contact with stabilized RIM are unknown. Will likely require bench scale testing to verify
		Reduces the amount of exposed waste and therefore reduces the amount of odor	May be difficult to implement in the landfill due to potential loss of grout (in situ deep soil mixing has been successful in normal soil conditions). Some components of waste may hinder hydration of waste so bench scale testing would be required to determine the appropriate stabilization agents.
		Reduces the amount of exposed waste and therefore reduces the bird hazard	Requires thorough identification of RIM to know area requiring stabilization
Liquid N_2 or CO_2 Injection	Inject liquid N_2 or CO_2 into the subsurface as the SSE approaches to cool the subsurface and extinguish the SSE	Effective for smaller areas of RIM	Requires ability to identify location of SSE. Difficult to detect SSE movement
		Waste handling/disposal would be limited to waste generated for injection well installation	Reliable supply of liquid N_2 and CO_2 is not currently available.
		Limited odors- no open excavation	Increased worker safety issues when handling liquid N_2
		Limited bird hazard-no open excavation	
Synthetic Landfill Cover & Gas Collection System	Install synthetic cover over top of landfill south of IB where remaining RIM is located. Install gas collection system	Allows for capture of landfill gas.	Landfill gas collected may require treatment prior to discharge.
		Eliminates excavation, reduces need to handle, transport , or dispose of waste	
		Eliminates excavation, minimizes bird hazard.	Any cover could potentially be susceptible to damage from SSE or natural events.
		RPs already planning to install synthetic cover at North Quarry	

If any of these options were to be incorporated, the RPs would need to evaluate each one and, if necessary, conduct the appropriate studies required for design and construction. As part of the design to address any RIM remaining south of the IB, the RPs should evaluate the possible risks to receptors should the SSE come into contact with the remaining RIM.

6. Design Schedule Considerations

Due to the unpredictable nature and movement of the SSE, the length of time for the SSE to reach the RIM in OU1, Area 1 is currently unknown. Therefore, length of time required to design and install the IB was a consideration during this assessment.

The standard industry practice is to complete the design in stages with reviews conducted at each stage. Typical design stages are the 30%, 60%, 90% and 100% design stages. The 30% design stage is conceptual and many of the specific details of the design are not complete and are still being evaluated. The 60% and 90% design stages are more complete with almost all of the details defined. The Final Design represents the completed design product. It is USACE's understanding that a similar design process will be followed for the IB effort and that the documents produced at each stage of the design will be subject to government review and comment.

This staged approach to the design allows for good quality control and helps ensure that all design objectives are met. However, at each stage in the process, a set of documents is produced that requires sufficient time to prepare, review, and then respond to any technical review comments so that those revisions may be carried forward into the next stage. There may be ways to shorten the time required to complete each design stage. Typical methods to speed up the design process are: increase the number of designers; conduct "over the shoulder" or "in progress" reviews while the design team continues working instead of requiring the designers to stop and respond to review comments in between each stage; and reduce the time allowed for the reviewers to perform their review. Each of these methods introduces some chance of error. Rushing the design and quality control reviews in order to start construction earlier may result in problems or delays during construction because those problems were not fully evaluated during the design process.

During a July 2014 meeting between USACE, EPA and the RPs, major pre-design and design tasks were discussed and a general timeline of activities was drafted. Following is the estimated timeline for pre-design and design activities based upon these discussions. The following timeline does not include the time required to conduct the extent of RIM investigation. The extent of RIM investigation can be conducted concurrently with the geotechnical investigation, but the duration of the RIM investigation is dependent upon availability of sonic drill rigs capable of sampling for RIM.

Alignment 1 Estimated Pre-Design & Design Schedule:

- 130 calendar days to complete geotechnical investigation, receive and evaluate results
- 60 calendar days to complete 30% Design
- 80 calendar days to complete 60% Design

- 80 calendar days to complete 90% Design
- 40 calendar days to complete Final Design
- 40 calendar days to prepare for start of construction (time to hire subcontractors, obtain applicable construction permits, order supplies & materials, make preparations to begin full-scale construction work)
- Total Design Duration Estimate = 430 days = approximately 14 months from IB alignment decision

<u>Alignment 3 Estimated Pre-Design and Design Duration:</u>

- 180 calendar days to complete geotechnical investigation, receive and evaluate results
- 60 calendar days to complete 30% Design
- 110 calendar days to complete 60% Design
- 110 calendar days to complete 90% Design
- 50 calendar days to complete Final Design
- 40 calendar days to prepare for start of construction (time to hire subcontractors, obtain applicable construction permits, order supplies & materials, make preparations to begin full-scale construction work)
- Total Design Duration Estimate = 550 days = approximately 18 months from IB alignment decision

Because Alignment 2 was not supported by the RPs, USACE, EPA, or ORD, an estimate for design duration was not considered.

Starting construction as soon as possible is important; however, until the extent of RIM is identified, a complete design cannot be accomplished regardless of the alignment selected. If Alignment 1 is selected, a method and design for addressing the RIM remaining on the south side of the IB cannot be determined until the extent of RIM is defined. If Alignment 3 is selected, the extent of contamination must be determined to know if RIM will be encountered during IB installation and to select an alignment that will allow as much RIM as possible to be located on the north side of the IB.

Because the eastern portions of Alignment 1 and 3 have essentially the same alignment and the extent of RIM is known in this area, the design work for the eastern half of the IB could be completed concurrent with the additional investigation work in the southwestern area of OU1 Area 1. This would allow the design work to start sooner rather than waiting until the investigation work is complete.

Summary: Because of the subsurface investigative work that remains to be completed, and the complexity of building a barrier in a landfill, the duration of the design will be long. One estimate for duration of the design effort could be as much as 18 months before construction commences. In general, there may be a few opportunities to accelerate the design process. However, the design effort should not be shortened to the point of sacrificing the quality of the design itself. Installation of the IB will be a complicated construction project and the success of the construction work depends on the thoroughness of the design and planning effort. The length *of construction cannot be estimated until an alignment is selected and the RPs determine their construction approach.*

7. Airport Negative Easement Agreement

In 1998, the Federal Aviation Administration (FAA) completed a Record of Decision (ROD) that allowed the Lambert St. Louis International Airport (Airport) to expand its operations. The Airport is owned by the City of St. Louis and operated by the St. Louis Airport Authority. At that time, the Bridgeton Sanitary Landfill was open and actively placing new waste into the landfill. Because the waste material is attractive to birds and other nuisance species (small rodents and other vermin that also attract predator birds), and because of the documented risk that bird populations pose to air traffic safety, the City and the landfill operators entered into a legally binding Negative Easement Agreement (NEA) that forced the landfill operators to stop accepting or placing new waste in the landfill. The NEA went into effect in 2005, and the Bridgeton Sanitary Landfill was closed. This action has been very successful in reducing the wildlife (bird) hazards to aircraft operating at the Airport.

The NEA specifically prohibits placement of any waste above, in, or below the landfill, and requires proper landfill cover at all times in accordance with applicable regulations. Additionally, any variance to these prohibitions requires the City of St. Louis and the St. Louis Airport Authority to issue a waiver to the NEA. Because of the waiver requirement, this NEA carries significant weight in determining the IB alignment. During an August 2014 meeting, the City of St. Louis and the Airport Authority requested additional information before they can determine which alignments they can support. The information requested includes, but may not be limited to:

- Estimated volume of waste for each alignment
- The estimated duration for construction of each alignment
- A plan for how bird hazards would be mitigated for each alignment including all aspects of excavation, loading, staging, and loading for transportation off-site and/or placement into an on-site cell
- A plan for how storm water will be managed to mitigate bird hazards

Another consideration is the RPs indicated in their Pre-Construction Work Plan that they plan to place excavated non-RIM waste back into the landfill. On-site placement of non-RIM wastes into the closed landfill units as proposed will also require a waiver to the NEA. Additionally, a regulatory determination should be made to determine if relocating waste from one closed landfill unit to another closed landfill unit would constitute operating a landfill or opening a new landfill site.

The impact of not being able to place the non-RIM waste back into the landfill is longer construction duration due to having to haul and dispose of waste at an off-site location. As previously stated, longer construction times increase the risk for not only bird hazards, but other risks as well. The extent of impact to construction duration cannot be assessed at this time as it will depend upon a number of items that the RPs will need to determine during design including the size and number of the staging areas, the RIM screening rate and disposal analysis turn-around time, the number of loaders to load disposal trucks, the number of trucks hauling waste to the off-site disposal site, and the distance to the disposal site.

Summary: The Negative Easement Agreement (NEA) between the City of St. Louis and the RPs is a critical factor to be considered as part of the design and construction of the IB. The NEA prohibits any activity that will result in the landfill cover being compromised; therefore, a waiver to the NEA will be required to install the IB. It is recommended that prior to the start of design, the RPs provide the City of St. Louis and St. Louis Airport Authority the information necessary for the City and Airport Authority to make a determination on which IB alignment(s) they would support.

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