TIMOTHY D. STARK, Ph.D., P.E., BC.GE

Stark Consultants, Inc., 401 W. Indiana Avenue, Urbana, Illinois, 61803; tstark32@gmail.com; (217) 840 - 8263

To: Mr. Matthew Dwyer
Senior Project Manager
Regional Manager
Engineering/Remediation Resources Group, Inc. (ERRG, Inc.)
9727 Business Park Drive, Suite A
Sacramento, CA 95827
matthew.dwyer@errg.com

From: Timothy Stark, Ph.D., P.E., BC.GE, Dist.M.ASCE

Date: February 26, 2025

RE: Comments on November 26, 2024 Revised Soil Reaction Break/Barrier Plan and February 20, 2025 waste temperature data for Chiquita Canyon Landfill Subsurface Elevated Temperature (SET) Event

---

Pursuant to your request and Task Order #1 under my contract with ERRG, I have reviewed the November 26, 2024 Revised Soil Reaction Break/Barrier Plan[1], waste temperature data provided by SCS dated February 20, 2025[2], and the weekly tracking of fissures and tension cracks in the impacted area dated February 17, 2025[3] and submitted by the Chiquita Canyon Landfill (CCL) operated by Waste Connections, Incorporated to the Legal Enforcement Agency (LEA) on February 25, 2025.

Landfill Location and Description:

The CCL is located at 29,201 Henry Mayo Drive, Castaic, California, in northern Los Angeles County. This facility is a Class III non-hazardous municipal solid waste (MSW) landfill. The 639-acre landfill site began accepting waste in 1972. The landfill can receive up to 12,000 tons of MSW per day. The average daily tonnage in 2021 was reported to be 6,412 tons. The CCL only accepts non-hazardous solid waste for disposal, including municipal solid waste, green waste for composting or recycling, construction and demolition debris, and e-waste for recycling. The facility is prohibited from accepting hazardous waste that is ignitable, corrosive, reactive, or toxic. The landfill also does not accept biohazardous waste, household hazardous waste, radioactive materials, incinerator ash, sludge, automobile shredder fluff, or liquid waste.

The landfill site is a former limestone quarrying and crushing operation which began in 1939 and ended in 1988. The quarrying resulted in two quarry pits, the North Quarry Pit and the South Quarry Pit, which were excavated to a maximum depth of 240 feet below ground surface (bgs). The north and south quarry portions cover an area of approximately 52 acres.

---

[1] SCS Engineers, Revised Soil Reaction Break/Barrier Plan: Chiquita Canyon Landfill, Castaic, California, South Coast AQMD Facility No. 119219, Project #: 01204123.21-13, November 26, 2024, 198 p.
[2] SCS Engineers, Solid Waste Borehole Maximum Temperature Profiles Over 6 Weeks for 1/9/2025 to 2/19/2025, Project #: 07224053.00, February 20, 2025, 31 p.
[3] Chiquita Canyon, Weekly Report - 4050 Chiquita Reaction Area Tracking of Fissures and Tension Cracks, by Nancy Bahena Hernandez, February 17, 2025, 39 p.

Landfilling began in the North Quarry Pit in 1974 and continued in this area until 1985. In 1985, the landfill underwent expansion to the southwest into the area known as the South Quarry Pit. This continued until August 2005 when the landfill stopped accepting waste to reduce the potential for birds to interfere with nearby airport operations. The total waste thickness is approximately 320 feet which means about 80 feet is above ground surface and about 240 feet is below ground surface. The landfill accepted approximately 17,000,000 in-place cubic yards of waste, including commercial, and municipal solid wastes.

The permitted landfill disposal footprint totals 257 acres and is comprised of three separate areas designated as "Primary" Canyon, "Canyon B," and the Main Canyon (including Canyons A, C, D and subsequent fill modules). Currently, 231 acres of the footprint have been used for disposal. All areas except the Primary Canyon have geosynthetic bottom liner systems and leachate collection and removal systems. Leachate is collected and trucked off-site, but condensate from the gas extraction wells is injected into the flare.

Revised Barrier Plan:

The Revised Barrier Plan states a:

> "discrete portion of the waste mass in the northwestern section of the Landfill is experiencing elevated temperature landfill (ETLF) conditions. ETLF conditions can generally be characterized as when the typical waste decomposition processes and corresponding methanogenesis associated with anaerobic digestion of organic solid waste materials disposed in a landfill are impeded because of heat accumulation. As a result, certain abiotic (non-biological) processes and chemical reactions within the buried wastes occur instead."

Even though SCS Engineers (SCS) claims the Subsurface Elevated Temperature (SET) Event only is impacting a "discrete portion of the waste mass", they review five options for isolating and containing the SET Event to impede heat flow into other adjacent portions of the waste mass. These five options are:

(1) Air Break through avoidance of placement of additional waste lifts overlying existing buried wastes.

(2) Air Break through excavation to "cut out" existing buried wastes.

(3) Soil Barrier through placement of soil layer atop existing landfill surface.

(4) Soil Barrier through excavation and backfilling of a deep trench.

5) Inert Material Barrier through Borehole Drilling, Dewatering, and Flowable Fill Injection.

SCS concludes an air break through avoidance of additional waste placement (option #1) or excavation (option #2) are "implausible" and thus are not being pursued by CCL. In addition, SCS deemed option #4 (soil barrier through excavation and backfilling) "implausible", and the technology involved in introducing an inert material for Option #5 "uncertain". As a result, options #4 and #5 are not being pursued by CCL.

Option #3 was deemed by SCS to be the "most plausible and may accomplish the desired objective without incurring substantial environmental and safety risks." Option #3 simply involves placing additional soil over the top of the landfill, i.e., to create a thicker soil cover. This option will be less effective for controlling odors and emissions from CCL than a geomembrane cover (discussed below) because of many issues including inadequate soil compaction especially on the sideslopes, differential settlement causing cracks in the soil cover, and creation of desiccation cracks during the hot and dry months.

The Revised Soil Reaction Break/Barrier Plan[4] was issued on November 26, 2024, which is important because CCL claims:

> "CCL has implemented extensive mitigation measures that reduce the likelihood that CCL will need to construct any form of the various reaction break concepts, including CCL's proposed additional mitigation measures. Previous experience at other ETLF landfills demonstrates that landfill reactions and resulting odors have been mitigated by best management practices, including increased gas extraction and liquid removal (e.g., through expanding systems and providing adequate LFG control capacity and leachate disposal capacity). Another best management practice is to improve cover integrity, which reduces infiltration of precipitation and limits the amount of excess liquids available to sustain various chemical reactions. Implementing these measures will help slow the reaction, impede the spread of the reaction to new areas, and mitigate impacts."

> "Further, Chiquita is constantly monitoring the landfill for signs of potential ETLF conditions so that it can react quickly in the event of changing conditions. CCL and SCS are confident that implementation of the best management practices developed by the landfill industry and EPA to contain and manage the reaction will succeed in slowing the propagation of the reaction area. Other landfills that have experienced widespread ETLF heating events during the past approximately 15 years have

[4] SCS Engineers, Revised Soil Reaction Break/Barrier Plan: Chiquita Canyon Landfill, Castaic, California, South Coast AQMD Facility No. 119219, Project #: 01204123.21-13, November 26, 2024, 198 p.

> successfully utilized these tools to contain those events. Continued application of the current mitigation measures will result in cooling of the buried wastes, which enable methanogenesis to ultimately be re-initiated within a large section of the affected waste mass. This in turn will mitigate and abate the detrimental impacts, such as odors, being experienced by surrounding off-site communities."

Unfortunately, the waste temperature data released on February 20, 2025[5] shows these "best management practices" have not "helped slow the reaction, impede the spread of the reaction to new areas, and mitigate impacts" as claimed by CCL and SCS above, as discussed in the next section. In summary, the removal of "hot" gas and leachate has not been successful in containing the SET Event.

Summary of Recent Temperature Data

SCS presents Waste Borehole Maximum Temperature Profiles Over 6 Weeks from January 9, 2025 to February 19, 2025.[6] An aerial image of CCL with a table of maximum temperatures is included in the subject SCS Report and reproduced in **Figure 1**. I have placed the maximum waste temperature from the table in **Figure 1** adjacent to some of the gas extraction wells to facilitate understanding the extent of the SET Event, especially on the east side of CCL. **Figure 1** shows waste temperatures of 183^0F and 185^0F at the eastern side of the top deck of the CCL. This means the SET Event has migrated from the western slope (TP03) to the eastern side of the CCL (TP31). Expansion of the SET Event has the following implications:

- Elevated temperatures (185^0F to 189^0F) surround the leachate tank farm (see red arrow in **Figure 1**). This area is going to undergo significant settlement, if it has not already started to do so, due to thermal breakdown of the buried waste. This settlement will cause differential movement of the leachate tanks, which could result in a leachate release. As a result, I recommend the leachate tank farm be moved off the top deck and to a site off the CCL and on native soil because the SET Event continues to expand.

- Waste temperatures of 183^0F and 185^0F are already present on the eastern side of the top deck of the CCL. As a result, it is not possible to "isolate and contain" this SET Event using a north-south vertical barrier as previously discussed. Thus, the only option for controlling odors and emissions is to cover the area with a geomembrane (discussed below) over which the temperature monitoring probes (TPs) have been installed. This means the geomembrane should cover from the west to the east side of the CCL and from the north

[5] SCS Engineers, Solid Waste Borehole Maximum Temperature Profiles Over 6 Weeks for 1/9/2025 to 2/19/2025, Project #: 07224053.00, February 20, 2025, 31 p.
[6] SCS Engineers, Solid Waste Borehole Maximum Temperature Profiles Over 6 Weeks for 1/9/2025 to 2/19/2025, Project #: 07224053.00, February 20, 2025, 31 p.

end to just south of TP06 shown in **Figure 1**. In other words, the exposed geomembrane cover would cover about 183 acres and leave only about 13 acres at the southern end of the CCL uncovered for current disposal operations.

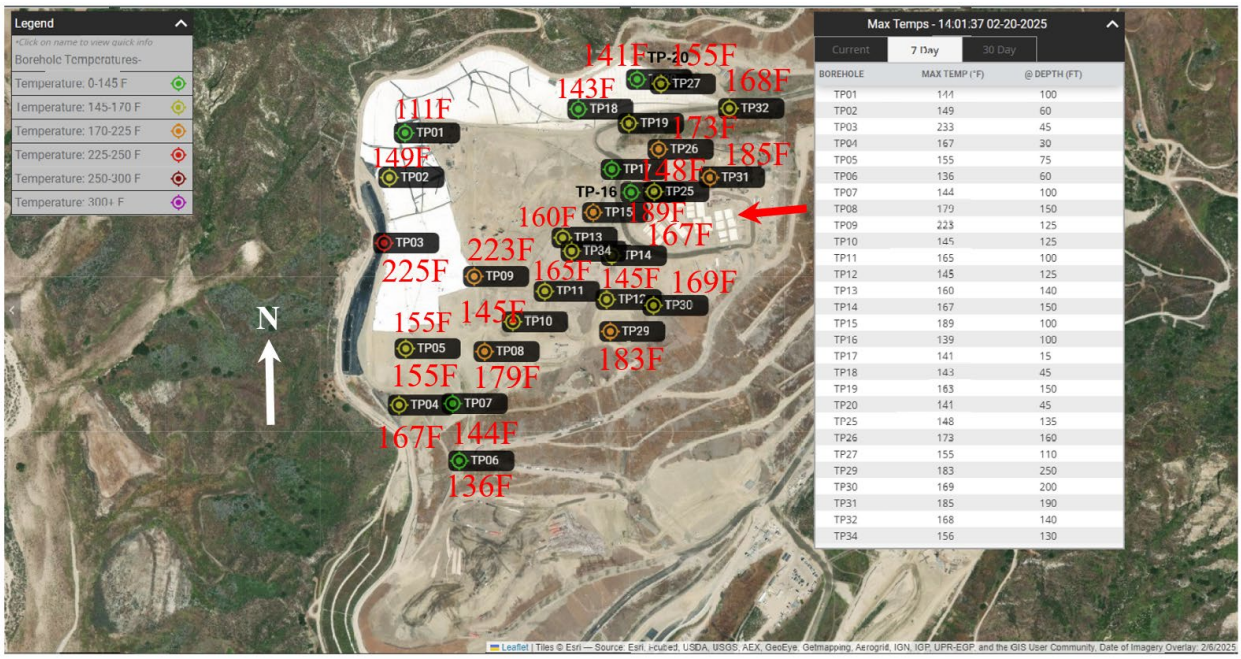


Figure 1. Temperature profiles over six weeks from 1/9/2025 to 2/19/2025 from SCS report dated February 20, 2025.

Figure 2 presents Sheet #1 from the SCS Report that presents the Waste Borehole Maximum Temperature Profiles Over 6 Weeks from January 9, 2025 to February 19, 2025.[7] The dashed pink line represents the extent of the SET Event as determined by SCS on February 20, 2025. This extent is slightly larger than the dashed blue line, which represents the extent of the SET Event on March 27, 2024 as reported by SCS in the initial Soil Reaction Break/Barrier Plan.[8] **Figure 2** also presents my extent of the SET Event as of February 26, 2025 (see dashed red line) based on the Waste Borehole Maximum Temperature Profiles Over 6 Weeks from January 9, 2025 to February 19, 2025.[9] **Figure 2** shows the western slope and entire top deck of the CCL is now part of the

[7] SCS Engineers, Solid Waste Borehole Maximum Temperature Profiles Over 6 Weeks for 1/9/2025 to 2/19/2025, Project #: 07224053.00, February 20, 2025, 31 p.
[8] SCS Engineers, Soil Reaction Break/Barrier Plan, Chiquita Canyon Landfill, Castaic, California, South Coast AQMD Facility No. 119219, Project #: 01204123.21-13, March 27, 2024, 17 p.
[9] SCS Engineers, Solid Waste Borehole Maximum Temperature Profiles Over 6 Weeks for 1/9/2025 to 2/19/2025, Project #: 07224053.00, February 20, 2025, 31 p.

SET Event, which is a significant increase over the extent reported by SCS on March 27, 2024[10] and February 20, 2025.[11] Based on **Figure 2**, SCS believes the SET Event only covers about 28 acres as of February 20, 2025 whereas my extent of the SET Event covers about 90 acres.

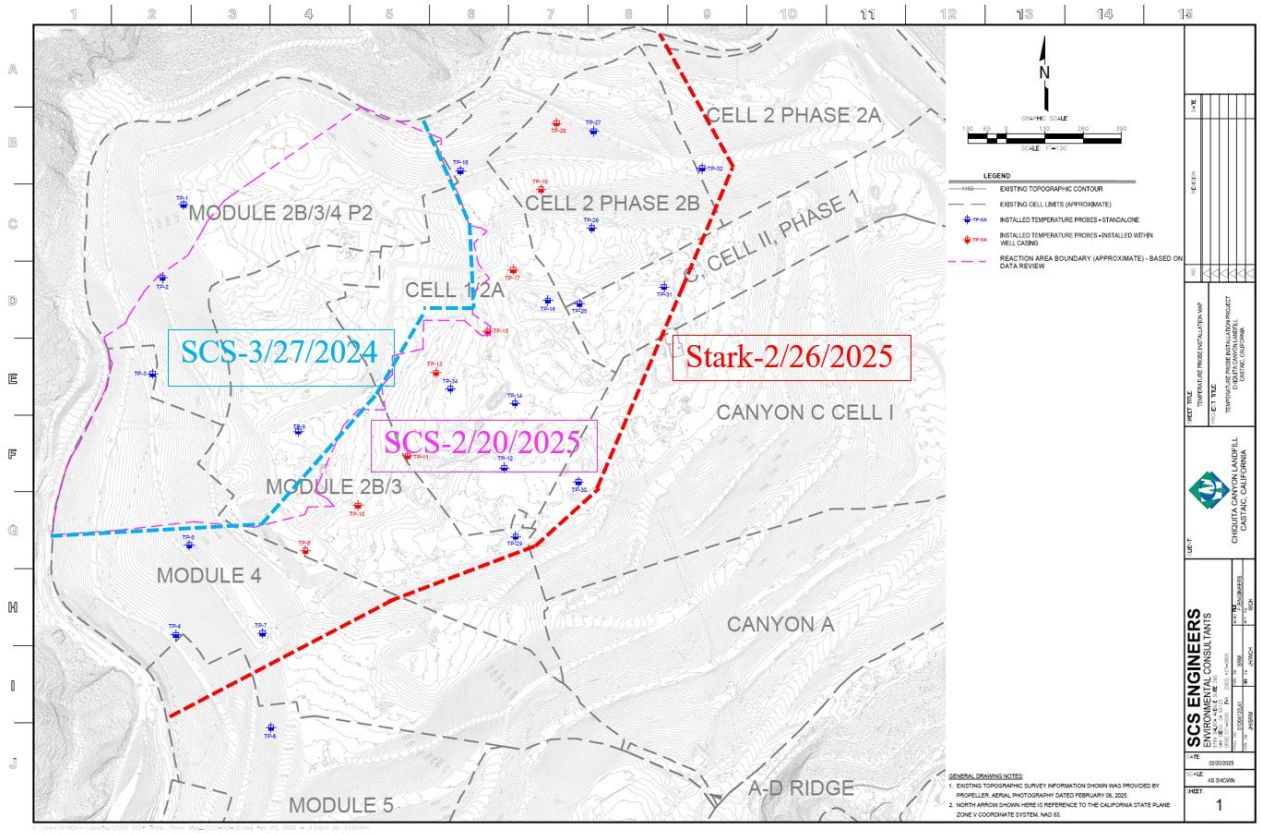


Figure 2. Extent of elevated temperatures from March 27, 2024 to February 26, 2025.

[10] SCS Engineers, Soil Reaction Break/Barrier Plan, Chiquita Canyon Landfill, Castaic, California, South Coast AQMD Facility No. 119219, Project #: 01204123.21-13, March 27, 2024, 17 p.
[11] SCS Engineers, Solid Waste Borehole Maximum Temperature Profiles Over 6 Weeks for 1/9/2025 to 2/19/2025, Project #: 07224053.00, February 20, 2025, 31 p.

Weekly Fissures and Tension Cracks Report Dated February 17, 2025

CCL also presented their 4050 – Chiquita Reaction Area Tracking of Fissures and Tension Cracks weekly report on February 17, 2025[12]. This report presents: (1) observations of new fissures and tension cracks, which are usually due to landfill settlement and/or slope instability, (2) exposed geomembrane tears and defects, and (3) other geosynthetic cover issues.

This weekly report dated February 17, 2025[13] confirms that settlement has started to occur around the leachate tank farm, which reinforces the recommendation above that the tanks should be moved off the top deck and to a site off the CCL and on native soil. In particular, Area #148, which is just north of the tank farm (see red dot in **Figure 3**), experienced opening of significant fissures and tensions cracks that have been remediated but are likely to reappear as additional buried waste undergoes thermal breakdown. Area #154, which is located just south of the tank farm (see **Figure 3**), also recently experienced fissuring and tension crack development. Even more concerning is Area #147 experienced a significant sinkhole, which indicates a significant thermal breakdown of buried waste that resulted in a void developing below the interim soil cover. Area #147 is the next grid area north of Area #148.



Figure 3. Red dot shows location for fissures and tension cracks identified in weekly CCL report dated February 17, 2025[14].

[12] Chiquita Canyon, Weekly Report - 4050 Chiquita Reaction Area Tracking of Fissures and Tension Cracks, by Nancy Bahena Hernandez, February 17, 2025, 39 p.
[13] Chiquita Canyon, Weekly Report - 4050 Chiquita Reaction Area Tracking of Fissures and Tension Cracks, by Nancy Bahena Hernandez, February 17, 2025, 39 p.
[14] Chiquita Canyon, Weekly Report - 4050 Chiquita Reaction Area Tracking of Fissures and Tension Cracks, by Nancy Bahena Hernandez, February 17, 2025, 39 p.

Figure 4 shows a tension crack in Grid #148 near the leachate tank farm on the top deck of the CCL. This photograph also reinforces the recommendation above that the tanks should be moved off the CCL. This photograph was taken during a South Coast Air Quality Management District (SCAMD), Inspection of the CCL on February 27, 2025.

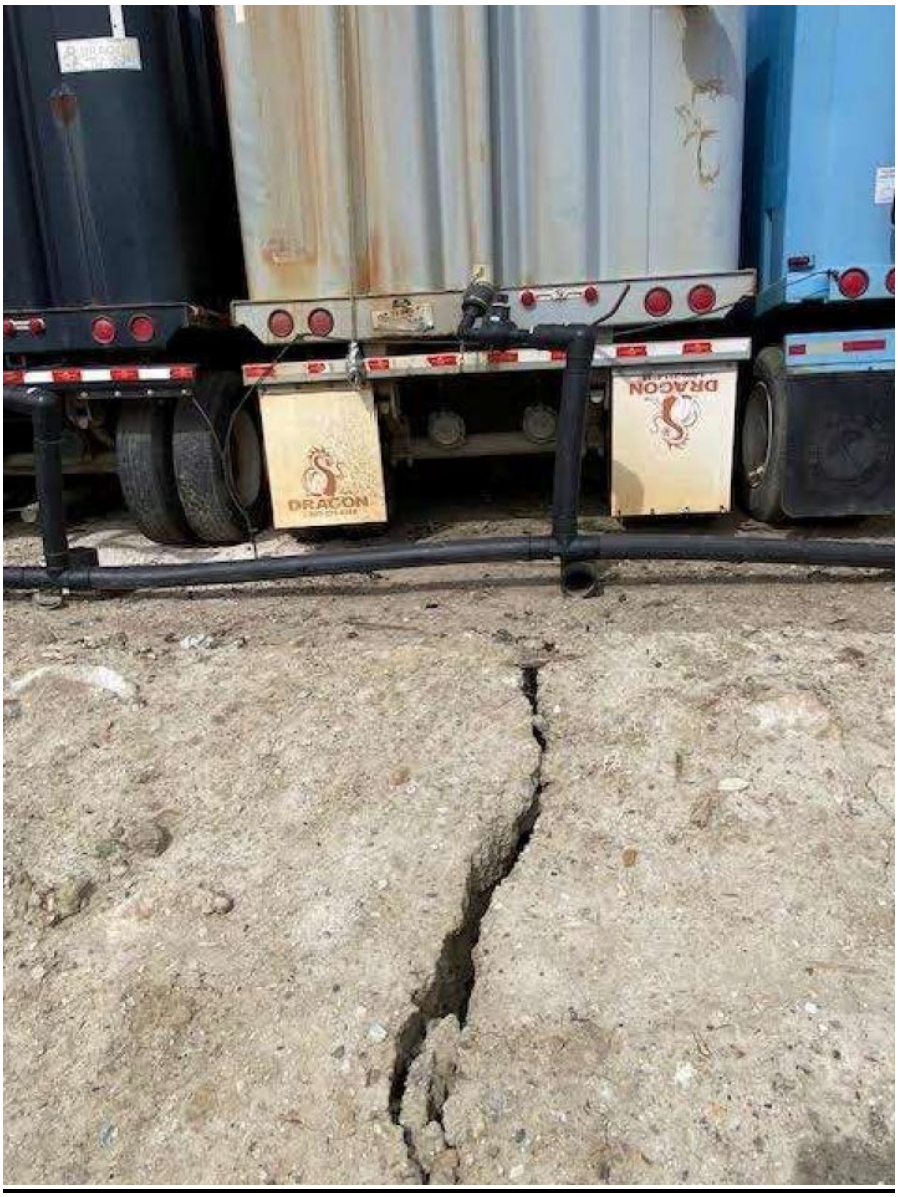


Figure 4. Photograph of tension crack in Grid #148 near leachate tanks on top of CCL dated February 27, 2025[15].

[15] South Coast Air Quality Management District (SCAMD), Inspection Report - Chiquita Canyon Landfill, by Larry Israel, Gerardo Vergara, and Christin Ojeda, February 27, 2025, 21 p.

The weekly report dated February 17, 2025[16] also discusses recent tears and defects in the exposed 30 mil thick white HDPE geomembrane cover. In particular, this weekly report presents photographs of four significant tears in the exposed geomembrane. For example, **Figure 5** presents two of these tears, which were repaired using an extrusion welded patch. Unfortunately, the location of these two tears is not identified in the weekly report dated February 17, 2025[17]. This indicates the 30-mil thick white HDPE geomembrane may be deteriorating in the presence of the SET Event temperatures and related activities and equipment, which is discussed below.



Photo 1



Photo 2

Figure 5. Photographs of exposed geomembrane tears identified in weekly CCL report dated February 17, 2025[18].

The weekly report dated February 17, 2025[19] also discusses other "Geosynthetic Cover" issues. In particular, this report presents fourteen photographs illustrating "instability under the cover".

[16] Chiquita Canyon, Weekly Report - 4050 Chiquita Reaction Area Tracking of Fissures and Tension Cracks, by Nancy Bahena Hernandez, February 17, 2025, 39 p.
[17] Chiquita Canyon, Weekly Report - 4050 Chiquita Reaction Area Tracking of Fissures and Tension Cracks, by Nancy Bahena Hernandez, February 17, 2025, 39 p.
[18] Chiquita Canyon, Weekly Report - 4050 Chiquita Reaction Area Tracking of Fissures and Tension Cracks, by Nancy Bahena Hernandez, February 17, 2025, 39 p.
[19] Chiquita Canyon, Weekly Report - 4050 Chiquita Reaction Area Tracking of Fissures and Tension Cracks, by Nancy Bahena Hernandez, February 17, 2025, 39 p.

For example, **Figure 6** presents two of these photographs, which show settlement under the geomembrane due to thermal breakdown of the buried waste.



Photo 3



Photo 4

Figure 6. Photographs of other exposed geomembrane issues identified in weekly CCL report dated February 17, 2025[20].

Temporary Exposed Geomembrane Cover

Given the west side and top deck of the CCL are experiencing elevated temperature, I unfortunately think the only remedial option is to cover the entire landfill north of TP06 or north of the red and blue dashed line shown in **Figure 7**. The elevated temperatures have not manifested themselves on the eastern slope yet, but I anticipate leachate outbreaks could start occurring because elevated temperatures (183^0F and 185^0F as shown in **Figure 1**) are present at the crest of the eastern slope.

Currently, CCL is using a 30-mil thick high-density polyethylene (HDPE) geomembrane with a white reflective and textured surface. This geomembrane was manufactured by Solmax and shipped in 22.5 ft wide rolls from Canada to the CCL. An Ethylene Vinyl Alcohol (EVOH) geomembrane has been found to be better at containing odors and omissions during other long-term SET Events, e.g., Bridgeton Landfill. EVOH geomembranes are manufactured as a "sandwich" with the outside layers comprised of HDPE with an inner layer of semi-crystalline thermoplastic resin that resists odor and gas transmission.

Bridgeton Landfill near St. Louis has been experiencing a SET Event since 2011 and is covered with green colored 60 mil thick EVOH geomembrane. Given there is no mechanism to "isolate and contain" the CCL SET Event, I am anticipating this facility will continue to generate odors and emissions for many years to come. As a result, I recommend the CCL consider installing an

[20] Chiquita Canyon, Weekly Report - 4050 Chiquita Reaction Area Tracking of Fissures and Tension Cracks, by Nancy Bahena Hernandez, February 17, 2025, 39 p.

exposed EVOH geomembrane over the area to the north of the red and blue dashed line shown in **Figure 7**.

The exposed EVOH geomembrane could consist of a tan (easier to UV stabilize, reduces heat, and better matches dry surroundings) or green (less visible during wet periods) 40 or 60 mil thick EVOH textured geomembrane underlain be a minimum 6 ounce per square yard (oz/sy) nonwoven geotextile. A tan EVOH geomembrane color is recommended because there are number of tan geomembranes that have been in exposed for a number of years, so a suitable UV stabilized formulation is available.

The EVOH geomembrane should be continuously seamed and continuously tied into the existing exposed 30 mil HDPE geomembrane cover along the top deck. The EVOH geomembrane can be welded to the existing 30 mil thick HDPE exposed geomembrane because the outside layers are comprised of HDPE and thus can be welded with traditional HDPE welding equipment. As the existing 30-mil thick exposed white HDPE geomembrane deteriorates with time, it should be replaced with the selected EVOH geomembrane.

The selected EVOH geomembrane (GM) should have a life span of about 10 years due to the large amount of waste that is being impacting by the SET Event. Given the long and steep slopes, a double-sided textured EVOH GM may be required. However, to facilitate walking on the EVOH GM, the exposed side should probably be textured. The EVOH GM also should be able to withstand a temperature of about 180^0F because TP15 is showing a waste temperature of 175^0F at a depth of only 15 feet. Finally, the EVOH GM should exhibit a methane permeance of less than $2.5x10^{-13}$ m/s obtained using ASTM D1434[21] to control benzene and other emissions.

The total area proposed for the EVOH geomembrane cover is about 100 acres, i.e., the area not covered with the 30-mil thick white HDPE geomembrane. The nonwoven geotextile underlying the EVOH geomembrane will be installed on a prepared subgrade and provide a cushion and gas and liquid transmission layer under the geomembrane. Alternatively, a geonet with two heat-bonded nonwoven geotextiles could underlie the EVOH geomembrane and provide a higher transmissivity than a geotextile.

The EVOH geomembrane could be installed by deploying the manufactured rolls across the top deck and down the sideslopes. The perimeter edge of the new EVOH geomembrane cover will either be welded to the existing 30 mil thick white HDPE geomembrane or anchored along the perimeter of the CCL. Of course, the CCL should design appropriate long-term ballasting for the existing HDPE geomembrane and the proposed EVOH geomembrane because of the long duration of other SET Events. The EVOH geomembrane should be installed by an experienced contractor

[21] ASTM D1434-23, Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting, ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428, https://compass.astm.org/document/?contentCode=ASTM%7CD1434-23%7Cen-US&proxycl=https%3A%2F%2Fsecure.astm.org&fromLogin=true.

and crews in accordance with CCL project specifications and an accompanying QA/QC Plan. Given the long-term application of the EVOH geomembrane, the installation should be monitored in accordance with the QA/QC Plan by an experienced third-party engineering firm. A final certification report should be prepared under the direction of a certified engineer and be submitted to the CCL and proper local authority, e.g., Los Angles Regional Water Quality Control.

Pipe penetrations of the HDPE and EVOH geomembrane cover should be sealed utilizing a suitable pipe boot and pipe clamp or seal. These boots can be the source of significant odor release and/or oxygen intrusion so these pipe boots and seals should be inspected and monitored regularly for vapor emissions so defects due to total and differential can be remediated quickly.

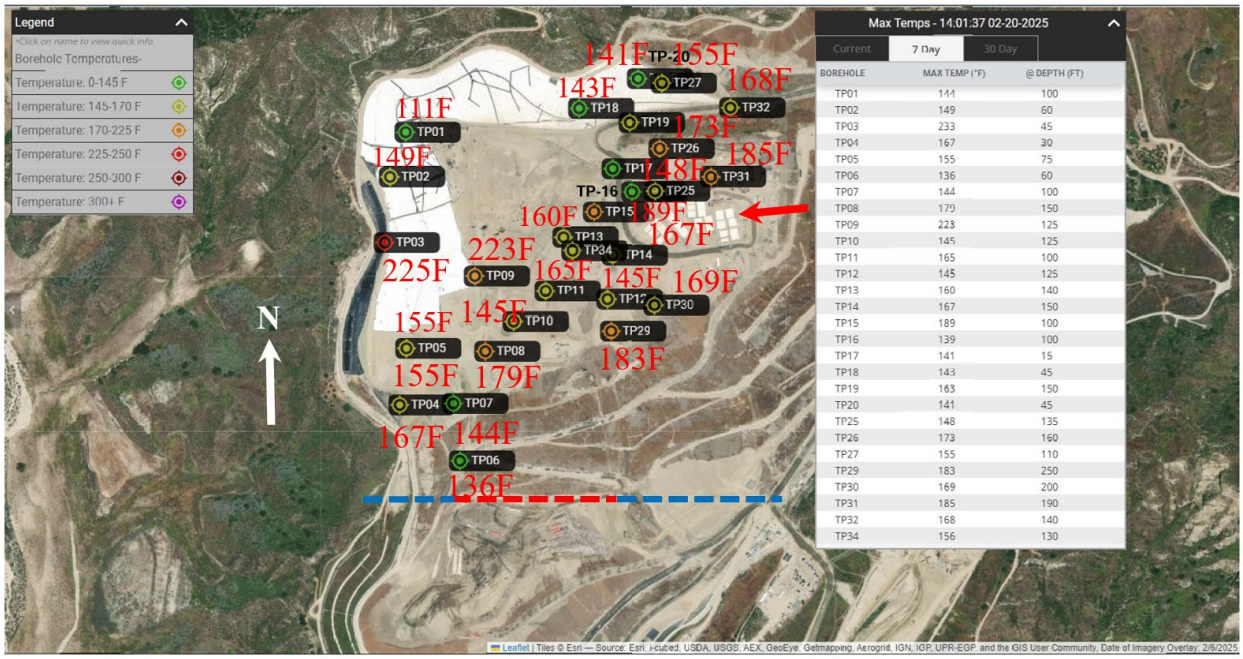


Figure 7. Extent of elevated temperatures on February 26, 2025 and location of a possible vertical barrier to isolate southernmost 13 acres.

Proposed Vertical Barrier

This section discusses installing a thermal barrier south of TP06 (see dashed red and blue line in **Figure 7**). A thermal barrier is recommended along the dashed red and blue line in **Figure 7** for at least the following reasons:

- CCL is using the approximately 13 acres south of the dashed red and blue line in **Figure 7** for disposal operations so elevated temperatures should be prevented from reaching this area, so the landfill continues to have an area to dispose of on-site wastes.

- Ensure continued ingress and egress from the CCL.

- Reduce the amount of waste that can be consumed by the SET Event and thus reduce the duration of odors and emissions to the surrounding communities.

- Maintain stability of the southern sideslope.

The red dashed line in **Figure 7** roughly delineates the location of a thermal barrier already constructed by CCL. The extent and depth of the thermal barrier are not known, so I request this information be provided by CCL. The blue dashed lines in **Figure 7** indicate the existing thermal barrier should be extended east and west so the SET Event cannot go around or under the existing thermal barrier.

If the existing thermal barrier does not extend to near below the leachate level, vertical elements can be used to create a vertical thermal barrier to prevent the SET Event from impacting the southernmost 13 acres of the CCL. The vertical elements involve excavating a vertical shaft using a three or four-foot bucket auger drill rig, which is being used to install gas extraction wells at CCL. These vertical elements would be constructed along the dashed red and blue lines in **Figure 7**. After excavating the shaft, it could be backfilled with a soil-bentonite or soil-cement mix. The shafts would be tangent, i.e., touching, or overlapped (see **Figure 7**) to create a continuous barrier across the toe of the southern sideslope to prevent the SET Event from consuming the southernmost 13 acres. If heat transfer calculations require a wider thermal barrier, a second row of vertical elements could be constructed north or south of the initial row (see **Figure 7**). The secondary row would be tangent to the initial row and be centered at each intersection of the initial row as shown below (see **Figure 7**).

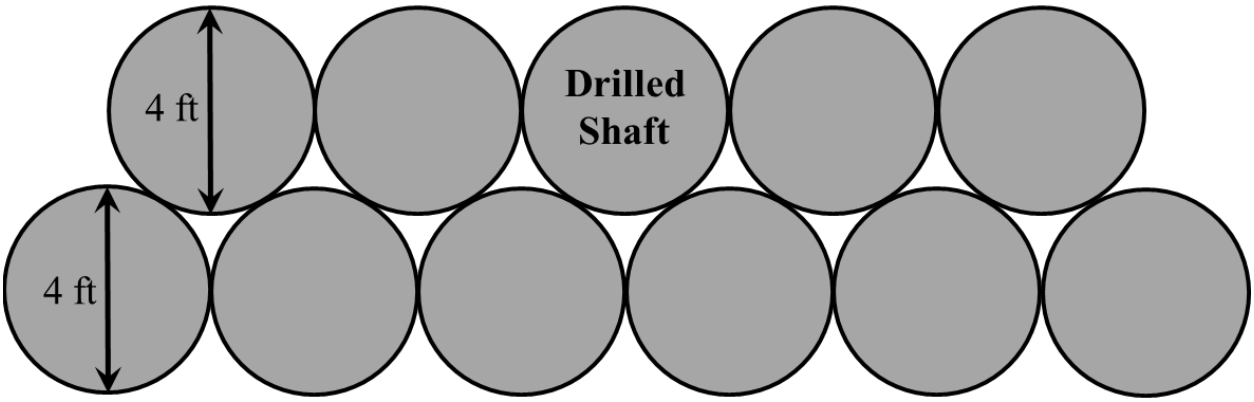


Figure 8. Possible configurations of 3 to 4 ft diameter vertical elements to comprise a heat barrier system south of TP06 to isolate southernmost 13 acres.

Summary

This section summarizes the main findings and recommendations presented in this report:

1. SET Event has expanded to the east side of the top deck of the CCL,
2. Leachate Tank Farm should be relocated off the top deck because the CCL is undergoing settlement under the tanks,
3. Due to the movement of the SET Event, the Tank Farm should be relocated to a site off the CCL and on native soil,
4. Given the extent of the SET Event, install 40 or 60 mil thick tan or green HDPE EVOH textured geomembrane underlain by a minimum 6 ounce per square yard (oz/sy) nonwoven geotextile over the approximately 100 acres currently exposed and weld it to the existing 30-mil thick white HDPE geomembrane or place it in a suitable anchor trench,
5. Submit a Request For Information (RFI) regarding the current extent and depth of the thermal barrier installed near the southern end of the CCL (see red dashed line in **Figure 7**), and
6. Expand the current thermal barrier so it reduces the potential for the SET Event to impact the southernmost 13 acres of the CCL.