California Environmental Protection Agency

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March 28, 2025

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Subject: Review of the November 26, 2024, Revised Soil Reaction Break/Barrier Plan for the Chiquita Canyon Landfill Subsurface Elevated Temperature (SET) Event

Dear Ms. Gork:

CalRecycle staff is providing this letter in response to your request for technical assistance in reviewing the subject analysis to determine the next course of action.

The following comments are provided to the Los Angeles County Department of Public Health, a Local Enforcement Agency (LEA), as assistance in supporting the program in carrying out its responsibilities at permitted disposal sites. The final determination as to the comments to be provided to the responsible party is within the sole purview of the LEA, acting within the parameters of its discretion, in accordance with its vested authority under its certification as defined in Title 14, California Code of Regulations (14 CCR), Division 7, 27 CCR, Division 2, Subdivision 1 (Section 20005 et seq.), and Division 30 of the Public Resources Code.

Review Background

On March 27, 2024, the CCL submitted its initial Soil Reaction Break/Barrier Plan (Work Plan) to the United States Environmental Protection Agency (USEPA) in accordance with Condition No. 22.c.2 of the Unilateral Administrative Order EPA Docket No. RCRA 7003-09-2024-001 and CERCLA 106-09-2024-05 and to the Los Angeles County Department of Public Health Solid Waste Management Program [solid waste Local Enforcement Agency (LEA)] as required in Mitigation Measure #1A. The LEA provided comments on the Work Plan in a letter dated May 3, 2024. The LEA requested that the revised CCL Barrier plan address the

following:

1. Installation of an air/soil break that separates the waste with either an inert material or with an air break.
2. Investigate how each cell or phase was constructed and examine if air/soil breaks between cells/phases can be exploited. The investigation should include a review of where haul roads were constructed to determine if the inert roads can also be used as breaks. Information from the investigation should be used to develop where containment breaks should be placed.
3. Propose a set of criteria for the primary and secondary engagement lines, including the type of reaction breaks, barriers, and/or mitigations. These criteria shall be based on temperature, carbon monoxide levels, and possibly settlement rate. The primary engagement lines need to prevent the reaction from spreading in the main fill area close to the reaction. The secondary engagement lines need to prevent the reaction from entering the eastern and southern fill areas at the toe of the slope.
4. Construction plans for reaction breaks in the 160-care main fill area. The reaction break plans should include timelines and a construction method that aligns with the timelines and engagement lines.
5. Include the construction of reaction breaks/barriers between Canyons C, A, D, and Cell 5 in the event the reaction reaches the secondary engagement lines.
6. Use the best available technology, such as grout injection, to slow or contain reaction movement to the south and east.
7. Description of the criteria that will mandate the temporary suspension of placing new waste.

On July 8, 2024, CCL submitted a response regarding the LEA's comments. On September 20, 2025, CalRecycle staff again provided comments and recommendations to the LEA regarding the second Barrier Plan submitted by CCL. In general, the letter outlined the criteria for defining the reaction area, the expansion of the SET Event, and for installing a barrier and included barrier strategies, additional temperature probe installations, and measures to limit oxygen intrusion during landfill gas collection and control operations.

On November 28, 2025, CCL submitted the third Work Plan to the LEA. CalRecycle staff requested the following information to complete their review on December 16, 2024:

1. All downwell gas temperature data collected for 2023 and 2024 were per New Source Performance Standards (NSPS) protocols.
2. All gas well data, both vertical and horizontal, from SCS E-tools, including notes in an EXCEL format for 2023 and 2024 up to December 12, 2024.
3. Current gas collection map showing vertical and horizontal wells.
4. Access to the forward-looking infrared (FLIR) Images from October and December via the FLIR web portal.

5. Landfill Gas (LFG) Operational Manual for CCL.
6. Resubmittal of the Revised Soil Reaction Break/Barrier with a registered professional signature(s) as required by the California Professional Engineering Act.

As of March 24, 2025, the CCL has not provided the information requested in items 1, 4, and 5. In addition, the CCL provided most of the landfill gas data in Excel format, but did not include the notes section. Of the requested 34 downwell temperatures, only eight were provided because five were abandoned and the remaining 21 had Lorenz Pumps installed and the data was not available. The temperature data from the Lorenz Pumps is not NSPS compliant because the temperature is reported from only one depth and not at required 10-foot intervals. Neither data set is fully sufficient to adequately track the SET Event.

Subsurface Elevated Temperature Event Causes

SET Events are caused by several mechanisms, including air intrusion, spontaneous combustion, surface fires, smoldering, and/or reactive waste. A SET Event can generate significant heat through combustion or the exothermic reaction of waste, causing pyrolysis in surrounding materials such as plastics, paper, wood, cardboard, and other flammable substances. It is important to note that pyrolysis[1] is the chemical degradation of a substance by heat. In fire science, this refers to the fire stage before combustion, without requiring the presence or absence of oxygen. Combustion[2] is defined as a self-sustained, high-temperature oxidation reaction.

Most SET Events are typically caused by excessive oxygen into the waste mass near or on a side slope. SET Events can start locally at a gas extraction well, area of cap erosion, or other features that allow oxygen to enter the waste mass. If not adequately addressed, the SET Event may become a smolder and spread to the entire landfill facility if it is not isolated and contained.

The definition of a SET Event varies among landfill owners, consultants, and regulators. However, all include elevated temperatures in the municipal solid waste (MSW) increasing to a threshold, which begins to stress the biochemical decomposition processes. Some landfill operators attempt to change the terminology to avoid using the words "fire," “subsurface oxidation (SSO),” or "smolder," but federal regulations also state that the operating temperature value at a particular landfill gas well may not cause fires nor significantly inhibit anaerobic decomposition by killing methanogens. The operator must comply with both parts of the regulation.

SET Events also can (1) impact the integrity of bottom, top deck, and side slope

[1] Vytenis Babrauskas, Ignition Handbook 14,18 (2003).
[2] Id.

geosynthetic liner systems; (2) impact the efficacy of gas and leachate control infrastructure made from high-density polyethylene (HDPE) and/or polyvinyl chloride (PVC) materials (e.g., pipes, lines, and gas wells, due to softening and/or melting), (3) impact the quality of gas composition for renewable energy and operation of flare systems, (4) change in chemical profile of leachate from non-hazardous waste liquid to hazardous waste liquid due to increased benzene concentration, (5) slope instability, and (6) cause excessive and/or rapid settlement of the landfill surface.

A SET Event can result from a combination of reactions. For example, reactive industrial waste (e.g., aluminum dross, baghouse dust, salt cake, fly ash, incinerator ash, or other metal oxide waste) can generate sufficient heat to pyrolyze or ignite surrounding municipal solid waste (MSW) and cause high gas pressures at temperatures exceeding 212°F (100°C). A SET Event can also be caused by aggressively overpulling a gas collection and control system (GCCS) to address emissions and/or odors. This "doom loop" occurs when the operator attempts to correct one adverse condition by increasing the vacuum in the adjacent wells, which causes negative events (i.e., a spike in temperature or oxygen levels) in the surrounding gas wells, leading to further deterioration. This is precisely what CCL's industry expert recommended in his November 2024 EREF-sponsored presentation[3]. CalRecycle staff agree that the pressure in the landfill should be reduced, but not at the risk of initiating a new shallow SET Event by exceeding the oxygen threshold of 2 percent or requesting a temperature higher operating value.

To suggest that a SET Event cannot be related to a fire or smolder and can only be caused by a landfill accepting industrial waste that causes an unknown chemical reaction, as claimed by CCL, is not reasonable. A proper root cause analysis would show that the aforementioned scenario is the probable cause of the SET Event.

A root cause analysis for a SET Event must be based on the scientific investigation method. The study should employ a logical, step-by-step process that considers all possible mechanisms and utilizes measured parameters to eliminate mechanisms and determine the cause or causes of the SET Event. The analysis for a SET Event should follow pre-defined steps. The fact that Elevated Temperature Landfills (ETLFs) are limited to the United States (US), as confirmed by Dr. Morton A. Barlaz of North Carolina State University in his November 2024 EREF-sponsored presentation[4], suggests that ETLFs are primarily due to landfill operating standards, conditions, and practices in the US. For example, in 1999, the Department of Energy estimated that approximately 2 billion pounds of aluminum dross and salt cake materials were landfilled annually in the US. Past SET Events at Countywide and Middle Point MSW Landfills are directly related to

[3] Environmental Research & Education Foundation, A Deep Dive into Elevated Temperature Landfills, YouTube (Nov. 20, 2024), https://www.youtube.com/watch?v=sQQZBbtQ_w4.
[4] Id.

the documented acceptance of 1.28 million tons of aluminum dross waste, which created an exothermic reaction that thermally broke down surrounding MSW. At the Countywide MSW Landfill, leachate recirculation provided enough liquid to cause an exothermic reaction of the placed aluminum dross waste.

Subsurface Elevated Temperature Event Monitoring

Temperature is the key metric in tracking a SET Event. Other metrics include LFG such as carbon monoxide (CO), hydrogen (H_2), methane (CH_4), volatile organic compound (VOC) levels in the landfill gas, settlement, cover fissures, leachate outbreaks, damage to the GCCS, emissions and odors, reduction in effective well screen lengths and higher liquid levels, positive gas pressure, and liquid geysers from gas wells[5].

Landfill temperatures can be measured using various methods, including gas temperatures at wellheads, vertical profiles in gas wells, probes in the waste, liquid temperatures monitored with specific pumps, and surface temperatures measured with FLIR cameras.

Landfill gas methane content typically declines at 131°F (55 °C) because methanogenic activity decreases. At temperatures above 158°F (70°C), few methanogens will survive, and methane concentrations will drop below 15 percent.[6] [7] This upper threshold is crucial in maintaining compliance with Title 40 of the Federal Code of Regulations (40 CFR), as stated in multiple sections.[8] The operator must not operate a GCCS that causes a fire or significantly inhibits anaerobic decomposition by killing methanogens. The operator must also maintain waste temperatures below the level that damages the GCCS and liners.

CalRecycle staff recommends that temperatures above 131°F (55°C) be considered the threshold at which a SET Event is considered to have started. We recognize that USEPA revised its regulation under the National Emissions Standards for Hazardous Air Pollutants (NESHAP) 40 CFR 63.1958(c), effective September 27, 2021, which increased the operational standard temperature from 131°F (55°C) to 145°F (62.8°C). CalRecycle still recommends the more conservative temperature threshold of 131°F (55°C) to initiate a root cause analysis, restrict oxygen to less than two percent, and repair the cover to prevent a SET Event.

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[5] When Does a Municipal Solid Waste Landfill Become an Elevated Temperature Landfill (ETLF)? US EPA (Mar. 7, 2025), https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=CESER&dirEntryId=354569.

[6] Krause et al., Understanding Landfill Gas Behavior at Elevated Temperature Landfills, 165 Waste Management 83-93 (2023).

[7] Jafari, Progression of Elevated Temperatures in Municipal Solid Waste Landfills, (Mar. 23, 2017), https://cdn.prod.website-files.com/5977726d80d12837b9592f43/5c1751e2f58cb29ead2cffc9_Navid-Progression%20of%20Indicators-JGGE-2017.pdf.

[8] 40 C.F.R. § 63.1958 (2025), 40 C.F.R. § 62.16716 (2025), 40 C.F.R. § 60.34f (2025), 40 C.F.R. § 60.763 (2025)

CalRecycle staff also recommends a maximum operating temperature threshold of 140°F (60°C) for systems with PVC and HDPE pipe due to the risk of failure. Additionally, CalRecycle staff considers a temperature of 140°F (60°C) to be the threshold that impacts the service life of liners.[9] As discussed in "Service Life of HDPE Geomembranes Subjected to Elevated Temperatures," by Navid H. Jafari, PhD, Timothy D. Stark, Ph.D., P.E., and R. Kerry Rowe, Ph.D., P.Eng., a temperature of 140°F (60°C) decreases the service life to 15 to 20 years from 205 to 315 years at 86F (30°C).

Reaction Area Boundary

As part of a South Coast Air Quality Management District (SCAQMD) Stipulated Order of Abatement regarding the reaction at the CCL (Case No. 6177-4), a Reaction Committee was formed to review applicable data, estimate the extent of the SET Event, and determine the reaction area. The CCL's Reaction Committee uses the following criteria to track the SET Event:

- *Landfill gas (LFG) wellhead temperatures more than approximately 160 degrees Fahrenheit.*
- *Poor gas quality (defined as methane levels of less than 30 percent) in conjunction with methane-to-carbon dioxide (CH4:CO2) ratios less than 1.0.*
- *The concentration of hydrogen (H2) in the LFG measured greater than 2 percent by volume.*
- *Accelerated settlement of the landfill surface, defined as approximately 6 inches or greater within a 60-day period, and cracks in landfill cover.*
- *First-hand observations of landfill and/or SCS engineering, construction, and operations and maintenance (O&M) field personnel who are on-site related to:*
  1) atypical excess leachate quantities (presence and quantity of liquids);
  2) instances of pressurized liquids emitting from the landfill surface, from boreholes during drilling, and from LFG wells; and
  3) the characteristics of the odors originating from the select areas of the waste footprint (often described as "chemical-like" and distinctly different from typical LFG or landfill working face odors).
- *Observations of subsurface waste conditions and characteristics as noted on borehole drilling logs for recently installed new wells and/or probes.*
- *Initial subsurface temperatures recorded at the in-situ waste temperature probes that were commissioned in April 2024.*

Unfortunately, the Reaction Committee has taken a conservative approach in determining the reaction area. The Committee relies on a complex set of evaluations,

[9] Navid H Jafari et al., Service Life of HDPE Geomembranes Subjected to Elevated Temperatures, The Journal of Hazardous, Toxic and Radioactive Waste 1-3 (2014).

including wellhead temperatures, the presence of H_2, poor gas quality, odors, waste conditions from drilling logs, and some TMP data, to determine the reaction boundary.

Indications of a Smolder or SET Event

The Committee disregards the CO results, possibly because they assume this reaction is an unknown chemical reaction causing an ETLF event, rather than a smolder, SSO, or fire. Carbon monoxide concentrations have been used for over 40 years in the US and abroad as a measure to determine if a smoldering or SSO is extinguished. Carbon monoxide is also a sign of incomplete combustion, and the change of CO levels over time is a critical tool in determining the magnitude of the SET Event. This is also why USEPA requires CO measurements[10] at a wellhead or any point in the well greater than 170°F (76.7°C). CalRecycle staff is aware that CCL is tracking CO and providing a scale for intensity in SCSe Tool, but we are unsure why the Committee is disregarding a key metric. **Figure 1** provides the most current CO levels at the CCL.

As far back as 1984, SCS Engineers[11] discussed how to identify a subsurface fire. While the authors stated identification and size determination can be difficult, a subsurface fire is typically indicated by:

- Unusual or rapid settlement.
- Venting of smoke.
- CO in the GCCS.
- Combustion residue in header lines.
- Elevated LFG temperatures.

And the location and areal extent of a subsurface fire can involve:

- Thermographic scans.
- Excavation or boring to allow visual examination of refuse.
- Installation of test wells to allow for monitoring.

All of these steps have been done by CCL; however, CO is not being evaluated by the Reaction Committee. The CCL also notes that they are not observing smoke venting, concluding elevated temperatures must not be a result of a fire. CalRecycle staff have excavated many subsurface fires without initially seeing smoke. At times, a smolder will appear as steam venting, and only when CO sampling, excavation, and/or a FLIR survey is performed will the operator confirm a smolder. Additionally, compacted waste outside the smolder can act as a filter for particulate matter, depending on its depth and location. The 1984 SCS Engineer's article[12] acknowledges this, stating, "*Depending on the location of the subsurface fire, smoke could be drawn through the LFG extraction system unnoticed."* The absence of smoke does not confirm that a smolder is not present. CalRecycle staff is not implying that all SET Events are smolders; however,

[10] 40 CFR 63.1981(h)(8)
[11] Robert Stearns & Galen Petoyan, Identifying and Controlling Landfill Fires, 2 Waste Management & Research 303-309 (1984).
[12] Id 11.

smolders start from SET Events. Some SET Events can be tracked by other parameters, such as oxygen levels above 5 percent and/or the presence of H2, VOCs, or the occurrence of settlement and fissures. However, USEPA makes the distinction between smolders and SET Events, and that the owner or operator may establish a higher operating temperature, provided that it neither causes fires nor significantly inhibits anaerobic decomposition by killing methanogens. The demonstration must satisfy both criteria to be approved. Temperature above 160°F (71°C)[13] significantly inhibits the production of methane.

Temperature

To simplify the discussion between the LEA and CCL, CalRecycle will use CCL's Reaction Committee value of 160°F (71°C) as the temperature at which the SET Event is expanding and inhibiting methanogenic bacteria from producing methane. Temperatures greater than of 160°F (71°C) will signify an increase in reaction intensity. Since the CCL has elected not to install a barrier, the previous installation criteria will not be used. Instead, a temperature of 160°F (71°C) will be the criterion to confirm that a SET Event has expanded.

To monitor the SET Event, CCL constructed 20 TMPs in the waste, which were operational in late April of 2024. Only two TMPs (TP-3 and TP-9) could be completed within the known reaction area. Other TMPs were scheduled to be placed in the Reaction Area, but due to unsafe conditions with pressurized leachate and thirteen geysering gas wells, CCL elected to wait. In January 2025, CCL added eight additional TMPs to act as sentinels adjacent to the Reaction Area. The TMP network collects data in real-time and reports daily.

The most accurate temperature measurement in a landfill is the in situ temperature, measured at various depths using TMPs. As discussed previously in CalRecycle's letter dated October 16, 2023, the enhanced monitoring of downwell temperatures at CCL, documented the 2023 First Semi-Annual NSPS and NESHAP Report showed two gas wells (CV-2201 and CV-1902S) with significant temperature differences in the shallow zone (i.e., less than 50 feet below ground) of waste. On June 27, 2023, CV-2201 had a wellhead temperature of 135°F (57°C). Twenty feet down from the well casing, the temperature was measured to be 36°F (20°C) higher at 171°F (77°C). On June 28, 2023, CV-1902S had a wellhead temperature of 141°F (60°C), and forty feet below, a downhole temperature of 188°F (87°C) indicated a difference of 47°F (27°C). While some of the downwell temperatures from the 2024 Semi-Annual Report enhanced monitoring requirements[14] showed temperatures within 10°F (5.5°C) of the wellhead temperature, several downhole logs showed temperature differences ranging from 40 to 120°F (23.8 to 37.7°C). Operators should not rely on wellhead temperatures in an area where the SET Event is expanding or where oxygen levels exceed 2 percent by volume. The operator should consider other indicators, such as downhole temperatures, TMPs, LFG data, or results for CO, H2, and VOCs, to verify the movement of the SET Event.

[13] Id 5,6.
[14] Id 9.

Using wellhead temperatures to determine SET Event boundaries is questionable. Past SET Events have documented temperature differentials between the wellhead temperature and downhole temperatures exceeding 100°F (37.7°C), and at the CCL, the differential was even higher at 120°F (48.8°C). Once the LFG temperatures stabilize, the operator can use the wellhead data to visually display the progression graphically. **Table 1** provides a summary of selected enhanced monitoring downwell temperatures from the 2023 and 2024 Semi-Annual Reports.

Table 1. Selected Wellhead and Downwell Temperature Differential at Chiquita Canyon Landfill (Source: Semi-Annual Reports 2023 to 2024)

Well ID	Date	Wellhead Temp (°F)	Downwell Temp (°F)	Downhole Depth (ft)	Temp (°F) Differential
CV-2201	6/27/23	135	171	20	**36**
CV-1902S	6/28/23	141	188	40	**47**
CV-1532A	12/5/23	148	194	34	**45**
CV-2310	11/16/23	184	226	125	**42**
CV-24034	1/6/24	166	196	11	**30**
CV-2001	1/17/24	60	165	37	**105**
CV-24139	1/31/24	74	180/194	15/25	**106/120**
CV-24140	1/31/24	99	175	12	**76**
CV-2352	8/26/24	104	166/200	15/25	**62/96**
CV-24017	8/29/24	140	165	3	**25**
CV-2341	11/10/24	140	165/170	3/33	**25/30**
CV-24139	11/17/24	127	190	13	**63**
CV-2339	12/26/24	168	195	12	**27**

The TMPs provide a more accurate account of temperature than wellhead monitoring for two distinct reasons. First, TMPs provide more accurate and in-depth waste mass temperatures compared to wellhead temperatures. Second, TMPs provide real-time data, unlike collecting LFG data, which is typically done only one or twice a month.

As an example of how wellhead temperatures can mask what is occurring in the waste, as shown in **Figure 2,** TMP-14 reported a temperature of 80°F (26.7 °C) on April 24, 2024, at the fifteen-foot probe. By March 19, 2024, the temperature at the 15-foot probe had increased to 133°F (56°C). This shallow temperature spike was not observed in gas well CV-1906, approximately 10 to 15 feet away, where the wellhead temperature was reported to be 68°F (20°C) on April 1, 2024, and 60°F (15.5°C) on March 19, 2025. There were also significant temperature swings in the wellhead temperature data for gas well CV-1906, where the temperature rose from 95°F (35°C) to 121°F (49°C) and then dropped to 73°F (22.7°C) within a month. However, all the wellhead temperatures are below the regulatory threshold and do not require further analysis. Data from TMP-14 indicated that on March 19, 2025, the temperature reached 133°F (56°C) and exceeded the 131°F (55 °C) threshold. CV-1906 is also experiencing a significant oxygen overdraw at this location. The percent oxygen has varied from 10.9 percent on March 4, 2024, to 18.7 percent on March 6, 2025. The average oxygen for the past year at this well is 8.4 percent. Continued high oxygen levels above 2 percent and temperature spikes will lead to a SET Event. This TMP and gas well are approximately 450 feet away from the CCL-defined reaction boundary and CalRecycle staff do not believe the shallow temperature increases are connected to the main reaction area. CalRecycle believes that the temperatures of 166 to 168°F (74.4 to 75.5°C) at the deeper probe (i.e., 125 to 150 ft) are connected. However, this data demonstrates that the operation of the GCCS must not sacrifice LFG operational objectives/standard operating procedures (i.e., limiting oxygen to 2 percent[15]) to control emissions and risk developing of new SET Events. **Table 2** and **Table 3** provide the LFG data and temperatures for gas well CV-1906 and TMP-14.

The Reaction Committee has disregarded a significant number of in situ TMP readings and does not consider shallow temperature spikes as indicative of SET Events or smolders. Again, in the SCS Engineers 1984 journal, they describe a gas temperature of 45°F (25°C) above baseline gas temperatures just before verification of a subsurface fire.

The Reaction Committee stated in November 2024, that the temperatures recorded by the 13 probes (TP-4, TP-6, TP-7, TP-8, TP-10, TP-11, TP-13, TP -14, TP-15, TP-17, TP-19, TP-20) outside the boundary during October 2024, are not indicative of a subsurface reaction and do not substantiate a decision to expand the boundary of the reaction area at this time. However, in January 2025, the CCL made an adjustment to the Reaction Area boundary that included TMP-15. **Figure 3** provides a map of the TMP's network as of December 2024, while **Figure 4** shows the most recent TMP network, which includes the seven installed TMPs (TP-25, TP-26, TP-29, TP-30, TP-31, TP-32) and the new Reaction Area boundary encompassing TP-15.

Of the primary twenty TMPs (TP-1 to TP-20), four TMPs (TP-8, TP-10, TP-11, TP-15) have shown or are exhibiting shallow temperature spikes above 160°F (71°C) at the shallow depths between 15 and 45 ft. Six other TMPs (TP-6, TP-13, TP-14, TP-17, TP-

[15] Todd Thalhamer, Expert Opinion of the Bridgeton Sanitary Landfill Incident, Bridgeton, Missouri, MO.gov (Sept. 1, 2025), https://dnrservices.mo.gov/bridgeton/docs/agobridgeeval92015.pdf.

19, TP-20) have temperatures that have been or are currently trending upwards since installation. The remaining ten are holding their current temperatures and have not cooled. Two TMPs (TP-6 and TP-8) have seen both increases and decreases. TP-6 reported a significant temperature decrease in the deeper probes at depths of 80, 100, and 120 ft; however, it also observed substantial temperature increases in the shallow probes at depths of 15, 30, 45, and 60 ft. TP-8 recorded substantial temperature increases on January 10, 2025, once TP-8 came back online. The CCL elected to take TP-8 offline in early October 2024, for a waste filling process. Temperature differentials of 30 to 90°F were observed in all TMPs. Two probes in TP-8 recorded temperatures of 230 to 232°F (110 to 111°C). Since January 2025, all temperatures have dropped, but not to the original temperatures measured in May 2024. As of April 2024, the two TMPs (TP-3 and TP-9) in the original waste area have maintained their maximum temperatures at 222°F (105.5°C) and 233°F (111.6°C), respectively. Attachment B provides graphs of the ten TMPs that have demonstrated or are currently experiencing temperature increases.

A review of the new temperature data from TMPs (TP-25, TP-26, TP-27, TP-29, TP-30, TP-31, TP-29, and TP-34) determined that all the temperatures in the new TMPs exceed the regulatory threshold of 145°F (62.8°C). Five TMPs (TP-26, TP-29, TP-30, TP-31, TP-32) have temperatures above 160°F (71.1°C), with the highest being TP-31 (with a temperature of 185°F (85°C) at a depth of 190 ft), located over 600 ft from the CCL-defined reaction boundary. It is also important to note that in January 2025, the CCL changed the probe depths of the new TMPs without notifying the LEA. The CCL elected to install the probes at 25, 40, and 50 ft instead of the approved design of 15, 30, and 45 ft. This change in probe depth will decrease the ability to track shallow SET Events. It is recommended that any future TMP be constructed in accordance with the approved plan. **Figure 5** provides the current maximum vertical temperature map for the TMPs at the CCL.

Table 2. LFG Data for Gas Well CV-1906 from March 2023 to March 2025. (Source: Chiquita Canyon Landfill Raw Gas Data)

Point Name	Record Date	CH4 [%]	CO2 [%]	O2 [%]	Bal Gas [%]	CH4:CO2	Init Temp [°F]
CV-1906	3/4/24	25.2	23.7	10.9	40.2	1.1	68.2
CV-1906	4/1/24	30.9	30.1	9.2	29.8	1.0	68.2
CV-1906	5/17/24	51.0	44.2	0.5	4.3	1.2	82.8
CV-1906	6/10/24	44.3	49.7	0.4	5.6	0.9	91.6
CV-1906	7/3/24	43.6	39.5	3.4	13.5	1.1	109.3
CV-1906	8/1/24	20.8	33.3	9.6	36.3	0.6	104.0
CV-1906	8/19/24	8.2	13.0	15.6	63.2	0.6	95.2
CV-1906	9/4/24	16.5	18.3	12.7	52.5	0.9	106.7
CV-1906	9/28/24	13.8	17.5	13.9	54.8	0.8	93.9
CV-1906	10/2/24	28.4	33.7	1.8	36.1	0.8	121.9
CV-1906	10/16/24	30.6	36.7	0.9	31.8	0.8	73.0
CV-1906	11/1/24	27.1	37.1	0.0	35.8	0.7	79.5
CV-1906	11/17/24	22.4	24.1	7.1	46.5	0.9	79.6
CV-1906	12/6/24	4.4	19.4	16.7	59.5	0.2	79.1
CV-1906	12/18/24	28.1	36.4	2.4	33.1	0.8	80.8
CV-1906	1/4/25	4.4	11.5	16.6	67.5	0.4	66.7
CV-1906	1/12/25	40.8	58.9	0.0	0.3	0.7	107.4
CV-1906	1/17/25	4.3	7.3	15.3	73.1	0.6	68.4
CV-1906	2/3/25	4.7	8.7	15.8	70.8	0.5	71.1
CV-1906	2/20/25	38.2	30.9	5.3	25.6	1.2	73.5
CV-1906	3/6/25	4.1	16.0	18.7	61.2	0.3	60.9

Table 3. TMP Monitoring Data for TP-14 at Chiquita Canyon Landfill. (Source: SCS Engineers TMP Data)

TMP Tracking	TP-14						
	Probe Depth (ft)						
Date	15 ft	30 ft	45 ft	75 ft	100 ft	125 ft	150 ft
Apr 24, 2024*	80	107	123	137	150	160	165
Aug 5, 2024	89	107	123	139	153	164	165
Sep 5, 2024	93	106	123	140	153	165	166
Sep 25, 2024	102	104	122	138	153	164	166
Oct 1, 2024	109	105	123	139	153	164	165
Nov 1, 2024	100	105	123	139	153	164	165
Dec 4, 2024	120	133	123	139	154	164	166
Jan 13, 2025	114	114	123	139	154	164	166
Feb 8, 2025	129	114	123	139	154	164	166
Mar 5, 2025	119	112	123	139	154	164	166
Mar 12, 2025	130	116	123	140	154	164	167
Mar 19, 2025	133	118	123	142	155	166	168

*Data estimated from SCS Engineers Temperature Profiles, raw data not submitted by CCL

It is also the opinion of CalRecycle staff that the CCL has caused other SET Events to occur in the shallow zone by overdrawing the GCCS. These shallow SET Events with temperatures above 160°F (71°C) were observed in the TMP network. Further gas wellhead data and downwell temperature surveys should be done to determine the magnitude of the problem.

CCL and the Reaction Committee have stated that the shallow temperature spikes are not significant in relation to the CCL-defined reaction area. CalRecycle staff have consistently cautioned CCL that overdrawing the GCCS will lead to independent and separate SET Events. The CCL and its consultant state this has not happened in the waste industry, nor has any case study been documented. However, this is not the case. In 2024, the waste industry published part of a case summary of a landfill that most likely had a combination of multiple SET Events. A review of the entire LFG data for oxygen exceedance is sufficient to confirm the overdraw of the GCCS was related to the smolder. On March 14, 2024, a consultant for Middle Point Landfill in Tennessee submitted a minor permit modification to place new MSW waste above an area where aluminum dross waste reacted for Middle Point Landfill. Although the permit request was later withdrawn, the report offered several valuable insights into SET Events. The Middle Point Landfill consultant documented that the facility had two distinct and separate SET Events. One was from the reaction of aluminum dross and the other was a smolder. Both SET Events produce temperatures that kill methanogenic bacteria, as well as high CO and H2 readings. A summary of some of the insights from both reactions from the report is provided below:

- The heat generated by the reaction is efficiently retained in the waste, leading to elevated temperatures. The elevated temperatures can continue to rise to levels that kill methanogenic bacteria found in landfills and may continue to rise, resulting in pyrolysis of organics in the waste.
- Pyrolysis contributes to rapid settlement observed at elevated temperature landfills by consuming organic waste much quicker than typical anaerobic degradation.
- Pyrolysis is an exothermic process and may begin as low as 212°F.
- Evaporation of the liquid from the organics requires a lot of energy to change from liquid to vapor. This may limit the propagation of the pyrolysis in the waste mass.
- The aluminum dross waste (APW) produced ammonia and hydrogen gas, as well as water, and caused pyrolytic reactions in the waste, resulting in the creation of carbon monoxide and other VOCs.
- Significant hydrogen production may occur in elevated temperature landfills without APW, such as Bridgeton Landfill in Missouri. The April 2016 Bridgeton Landfill Monthly Data submission revealed hydrogen concentrations in wells as high as 42 percent, elevated carbon monoxide levels, and decreased methane production.
- Carbon monoxide is typically a byproduct of incomplete combustion and may indicate a subsurface oxidation (SSO) event where MSW is smoldering beneath the landfill surface.
- Carbon monoxide may also be produced through reactions that generate hydrogen.
- The area near well series has been of interest for a number of years. At one time, this area was under close observation following a large, shallow subsurface oxidation (SSO) event that may have been related to the acceptance of APW; however, it was never determined that this event was a direct result of the exothermic reactions occurring in the subsurface.
- The SSO that occurred in this area was treated as a different event compared to the deeper reaction(s) occurring within the subsurface of the AWR.
- This SSO event was observed as an effort to mitigate the oxygen intrusion.

Other Data

There are several ways to increase the degree of certainty in determining the magnitude of a SET Event. Without all the available data, the operator or regulator must evaluate primary indicators such as temperature, LFG gas data, CO, H_2, and physical signs of a SET Event. If other reports or data are available, the operator should analyze this data and compare it to the primary tool. Other data would include FLIR imagery with reference temperature scale, settlement, leachate and gas chemical characteristics, fissures, slope stability reports, additional temperatures from liquid pumps in wells, 2D and 3D temperature modeling, iospatch modeling, odors and emissions, leachate outbreaks and generation, and individual LGF gas plots. The CCL is using isopatch software to track the settlement every quarter as shown in **Figure 6**. They also track the

settlement bi-monthly in the Cover Inspection Reports. The maps show the settlement area growth of more than 5 feet. **Figure 7** shows the most current settlement map.

The CCL Settlement and Fissure Reports also align with the TMP temperature spikes data in grids. CCL's consultant, Geo-Logic Associates, provided a summary map of the recently occurring fissures in February 2025 (see **Figure 8**). Significant fissures and areas where the soil collapsed were documented in Grids 146, 147, 148, and 154. CalRecycle also reviewed FLIR data from October 2024; however, CCL has refused to provide the temperature layer on each photo. All data should be available.

CalRecycle staff received the requested raw gas monitoring data (i.e., methane, carbon dioxide, oxygen, balance gas, pressure, flow, temperature, and field notes) for the years 2024 and 2025 on March 26, 2024, and additional comparison of well-to-well data over time for methane and temperatures or individual SET Events cannot be provided at this time. However, another way to evaluate whether the landfill is operating and maintaining air pollution control equipment and monitoring equipment in a manner consistent with safety and good air pollution control practices for minimizing emissions is to analyze the Semi-Annual and NESHAP Reports required by the EPA. As shown in Table 4, from the second semi-annual period of 2023 to 2024, the number of reported well readings for oxygen levels above 5 percent, temperatures exceeding 131°F (55°C), and positive pressure increased significantly. The percent change from 2023 to 2024 for wells with oxygen above 5 percent increased by 55 percent, wells with high temperatures increased by 41 percent, and wells with positive pressure rose by 33 percent. This metric indicates that the SET Event is intensifying in magnitude from July 2023 to December 2024, rather than decreasing.

Table 4. Summary of NSPS Reporting Requirement for Chiquita Canyon Landfill

NSPS Reports	Wells Above 5% Oxygen	Wells Above 131/145°F	Wells Under Positive Pressure
2023 Second Semi-Annual	>100	>115	>220
2024 First Semi-Annual	>110	>95	>280
2024 Second Semi-Annual	>225	>195	>330

Soil Reaction Break/Barrier Plan

On November 26, 2024, CCL submitted the third Soil Reaction Break/Barrier Plan. This revision has no proposed barrier and relies on the removal of gas and leachate as a control and containment strategy. The CCL has reported that over 77 million gallons of leachate were removed from January 2024 to February 2025. CCL has not provided any technical thermodynamic analysis demonstrating that removing the leachate or gas has contained the reaction. Only two TMPs have shown any significant decreases greater than 20°F (11°C) and both of those TMPs experienced significant temperature increases within the past six months. There are multiple areas on the landfill where the distance between the gas extraction wells exceeds 150 feet. Specifically, CalRecycle staff estimate that the boundary of the reaction area, where Geo-Logic has documented multiple fissures and cracks, is located to the east of and around Tank Farm #9 and TMP-17. The new reaction boundary has significant distances without extraction wells, extending from CV-2327 to CV-2322, CV-2464, CV-2454, CV-2449, CV-2442, and CV-144, as well as from CV-2305 to CV-2316.

CalRecycle staff is not aware of any published studies indicating that the removal of gas and liquid has contained a reaction similar to CCL. The removal of gas and leachate is critical, given the pressure and generation rate; however, as far as containing a SET Event, CalRecycle does not recognize this as a containment strategy.

Lastly, CalRecycle had requested CCL evaluate if there was any potential internal barrier, such as a haul road, cell separation, fire break, or other feature, that would prevent the SET Event from impacting the entire 190 acres of the main landfill. Based on CCL analysis, there is no internal barrier that could prevent the reaction from spreading to the entire facility.

Review Documents

While CalRecycle has not performed a complete review of the unedited 2024 and 2025 LFG data the CCL has just submitted, the evaluation of the Barrier Plan and reaction boundary is based on the following information and reports:

- Three versions of the Soil Reaction Break/Barrier Plan.
- Vertical Injection Barrier Plans.
- East fill proposals and correspondence.
- Two site visits, one on November 2, 2023, and the other on May 23, 2024.
- Hydrogen, carbon monoxide, VOCs reports and data.
- ERMAC meetings with CCL.
- Technical Memorandum from Dr. Stark, dated February 26, 2025, “Comments on the November 26, 2024 Revised Soil Reaction Break/Barrier Plan and February 20, 2025 Waste Temperature Data for the Chiquita Canyon Landfill Subsurface Elevated Temperature (SET) Event.”

- Eight years of Chiquita Canyon Landfill Semi-Annual New Source. Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP) Reports.
- Five years of Annual Rule 1150.1 Compliance Plan reports, Chiquita Canyon Landfill.
- Four years of Surface Emission Monitoring reports, Chiquita Canyon.
- Raw LFG data from 2022 to 2025.
- Landfill gas migration reports.
- Downwell temperature monitoring reports
- Lorenz pump temperature reports.
- Weekly TMP reports.
- Weekly Fissure and Settlement reports.
- Slope stability reports.
- Settlement reports
- Leachate metric reports.
- Elevated Temperature Landfill Causation Investigation report.
- SCAQMD orders.
- Reaction Committee reports.
- Odor reports.
- LFG designs and maps.
- FLIR Imagery.
- LEA orders, correspondence, temperature and settlement reviews, and general technical review.
- Other letters, correspondence, LFG laboratory reports, and other data files.
- Experience with other SET Events and smolder in the US and abroad.
- The letter from Dr. Stark, which provides additional details on the cover specifications, is included in Attachment C.

Evaluation

Based on the information above, the CCL has experienced the following conditions:

- Significant emissions and odors that have impacted the community of Val Verde and surrounding areas from 2023 to 2025. According to the SCAQMD, the CCL has received a total of 1,493 complaints and 16 Notices of Violations in 2025.
- The interim cover has experienced significant damage from settlement, leachate outbreaks, slope instability, and fissures.
- Leachate is currently being extracted at a rate of 228,624 gallons per day.
- The facility has had several leachate outbreaks and releases.
- The facility is treating a portion of the leachate for hazardous levels of benzene.
- 13 gas wells have observed geyserIng of leachate.

- Wellhead and downwell temperature differentials have been severe. Two wells have observed differentials over 100°F, and six had readings over 40°F.
- Temperatures have reached the maximum detectable limit of 250°F in the Lorenz Pumps for gas wells CV-2301, CV-2303, and CV-24017.
- Temperatures in TP-3 and TP-9 have remained constant (+/- 5°F) at 222°F and 233°F respectively.
- Temperatures in four TPs (TP-8, TP-10, TP-11, TP-15) have shown or are exhibiting shallow temperature spikes above 160°F in the shallow probes.
- TMP-14 is demonstrating a shallow SET Event.
- Temperatures in six TMPs (TP-6, TP-13, TP-14, TP-17, TP-19, TP-20) have been or are currently trending upwards since installation in April 2024.
- Five new TMPs (TP-26, TP-29, TP-30, TP-31, TP-32) temperatures are above 160°F, with the highest being TP-31 with 185°F at 190ft below the surface. TP-31 is located over 600 ft away from the CCL-defined reaction boundary.
- Nine wellhead temperature have exceeded 200°F and 83 have exceeded 170°F since 2023.
- Multiple LFG wells have been replaced due to integrity issues resulting from temperatures exceeding 140°F.
- Two slope instability incidents have occurred on the west slope.
- The facility is experiencing a decrease in methane production in the reaction area and along the boundary, with many gas wells now operating at less than 15 percent.
- The facility is observing CO above 1,500 ppmv, H_2 above 2 percent, and elevated VOC levels in the reaction and boundary areas.
- NSPS reporting data has increased significantly from July 2023 to December 2024. Wells with oxygen levels above 5 percent increased by 55 percent, temperatures exceeding 131°F increased by 41 percent, and positive pressure at the wellhead rose by 33 percent.
- Accelerated settlement continues to be documented by the CCL in the weekly reports and isopatch survey.
- Temperatures exceeding 140°F have affected the service life of a portion of the liner. Further data is required to perform a more comprehensive study.

Based on the documented conditions summarized above, CalRecycle staff conclude the following:

- The submitted barrier plan will not contain or control the reaction. There is no proposed barrier to prevent the reaction from consuming the entire facility.
- The reaction area is expanding, and the current containment strategy has failed. Install 40 to 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 outside the current geomembrane cover. Weld it to the existing 30-mil thick white HDPE geomembrane or place it in a suitable anchor trench. Submit a construction and quality assurance/quality control (QA/QC) plan for the installation.

- The independent SET Events are developing due to the current GCCS operations.
- While the removal of leachate and pressurized gas is critical, this is not a satisfactory containment method.
- Leachate Tank Farm nine must be relocated off the top deck to an area not impacted by the SET Event now or in the future.
- The expansion of the SET Event into Cell 8A must be prevented by connecting the previously constructed soil barrier to the west and eastern edges of Cell 8A. This soil barrier should provide a thermal block and remove any waste connection from Cells 6 to 8A. It is critical to prevent this expansion to 8A for two primary reasons. If a soil buttress must be constructed to stabilize the slope from the SET Event, this is the only area large enough to build a buttress. We must also allow the landfill to maintain a disposal area for self-generating waste in cell 8A.
- Install five new TMPs, as shown in Attachment A.

If you have any comments or questions, please contact Todd Thalhamer at (916) 341-6356 or email Todd.Thalhamer@Calrecycle.ca.gov.

Sincerely,

Todd Thalhamer, P.E.
Senior Waste Management Engineer
Engineering Support Branch

Attachments

A - Proposed Location of New TMPs for Chiquita Canyon Landfill

B - TMP Data from April 2024 to March 2025

C - Dr. Stark Memo February 26, 2025, Comments on November 26, 2024 Revised Soil Reaction Break/Barrier Plan

Cc Via Email:

Shikari Nakagawa-Ota, Los Angeles County Department of Public Health (sota@ph.lacounty.gov)
Todd Sax, CalEPA (todd.sax@calepa.ca.gov)

Jeff Lindberg, California Air Resources Board (jeff.lindberg@arb.ca.gov)
Terrence Mann, South Coast Air Quality Management District (tmann@aqmd.gov)
Larry Israel, South Coast Air Quality Management District (lisrael@aqmd.gov)
Jenny Newman, Los Angeles Regional Water Quality Control Board (Jenny.Newman@waterboards.ca.gov)
Enrique Casas, Los Angeles Regional Water Quality Control Board (enrique.casas@waterboards.ca.gov)
Thanne Berg, Department of Toxic Substances Control (thanne.berg@dtsc.ca.gov)
Laura Friedli, United States Environmental Protection Agency (friedli.laura@epa.gov)

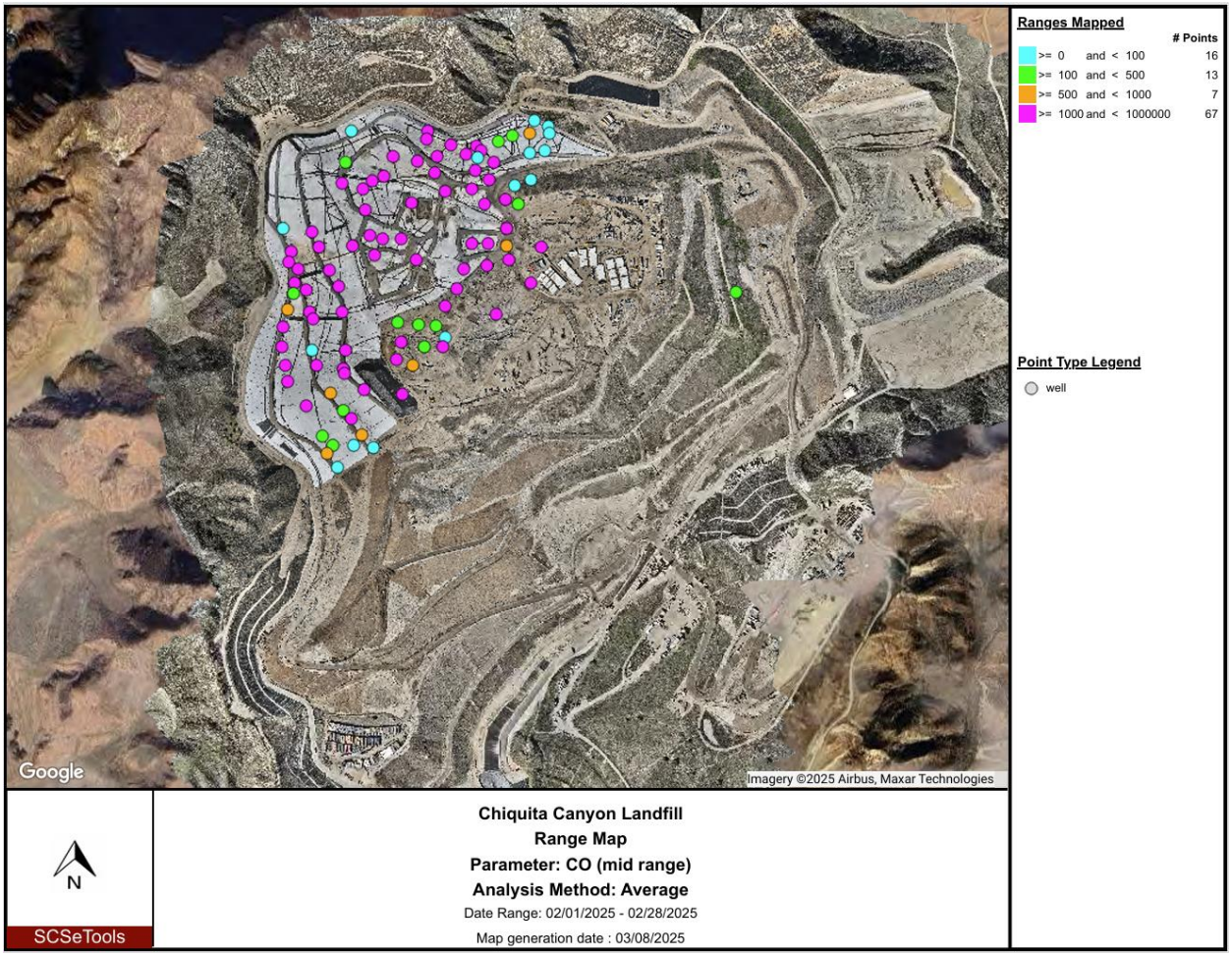


Figure 1. Chiquita Canyon Landfill CO Range Map, March 8, 2025. (Source: SCSe Tools)

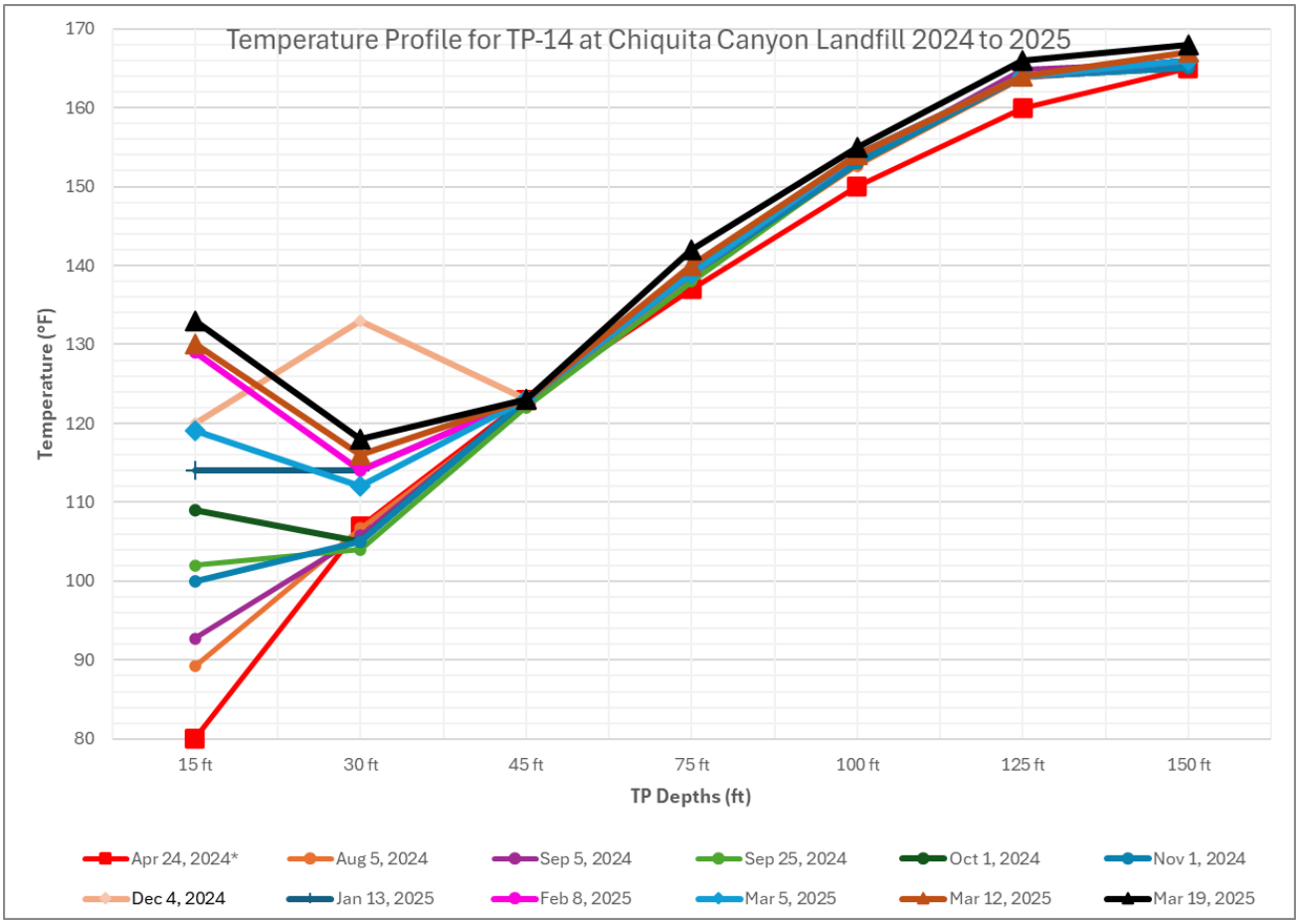


Figure 2. TMP-14 Temperature Profile Demonstrating a Shallow SET Event Developing at Chiquita Canyon, April 24, 2024, to March 19, 2025. (Source: SCS Engineers TMP Data)

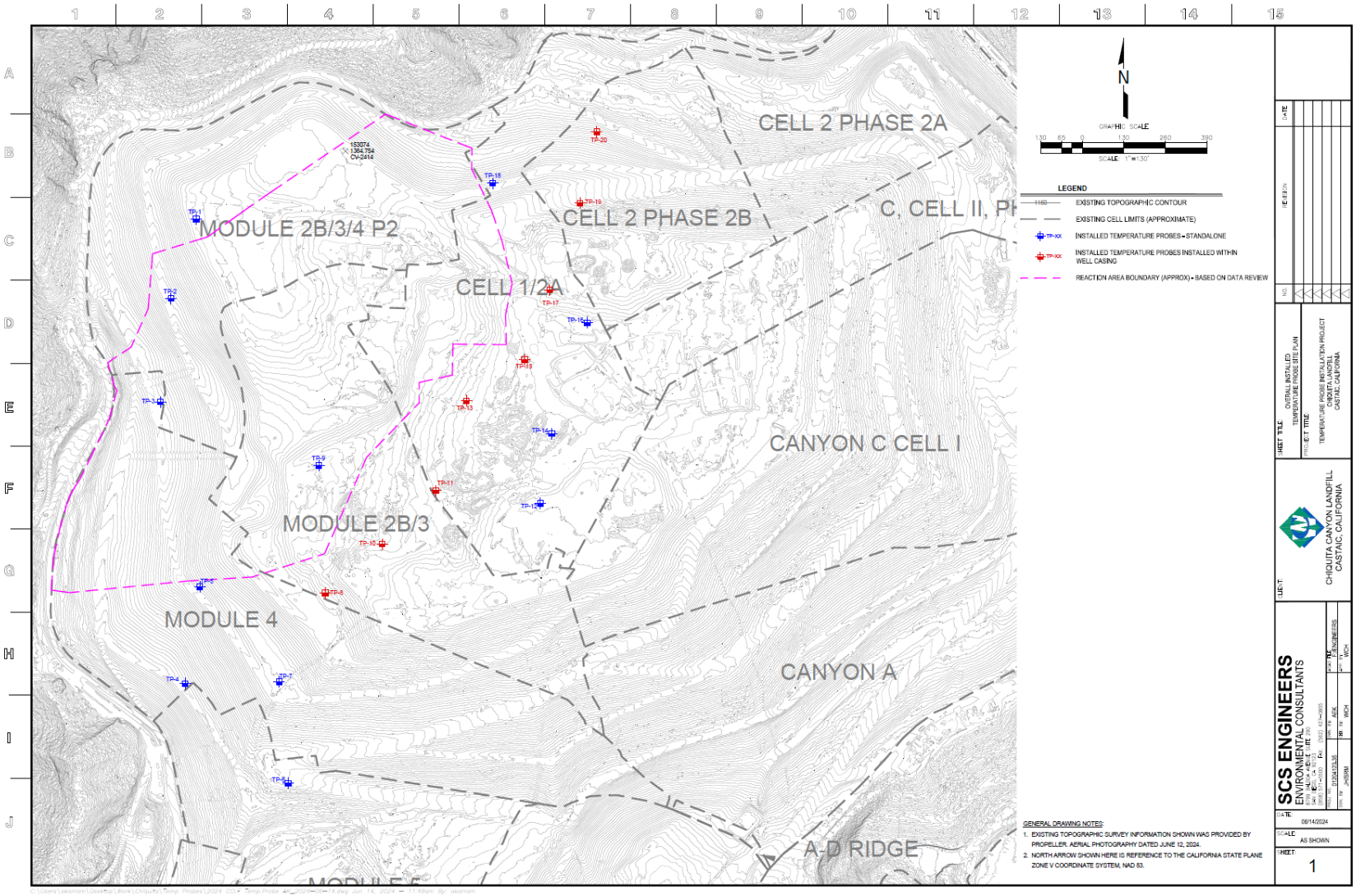


Figure 3. TMP Installation Map for Chiquita Canyon, 2024. (Source: SCS Engineers TMP Data December 2024)

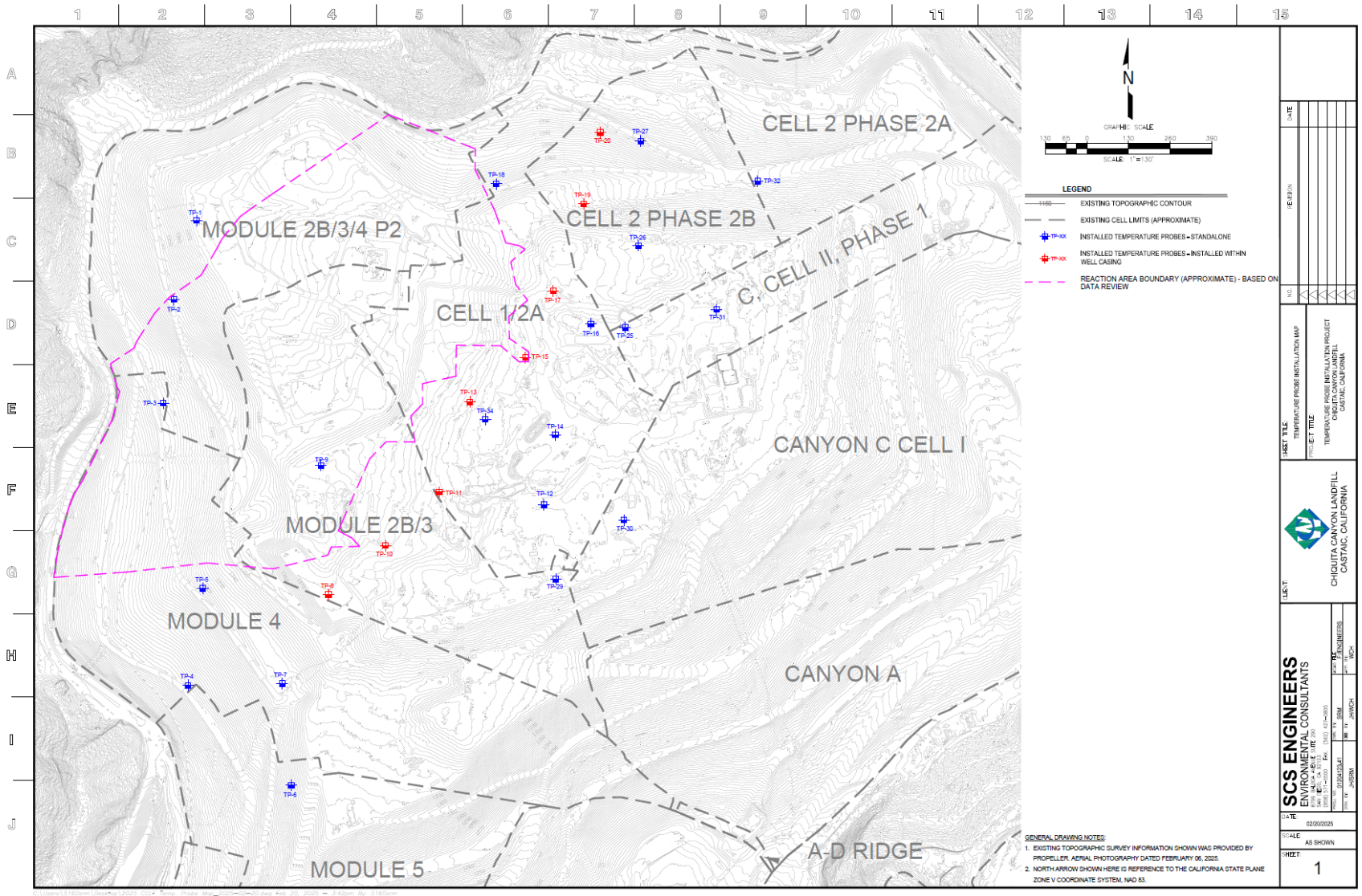
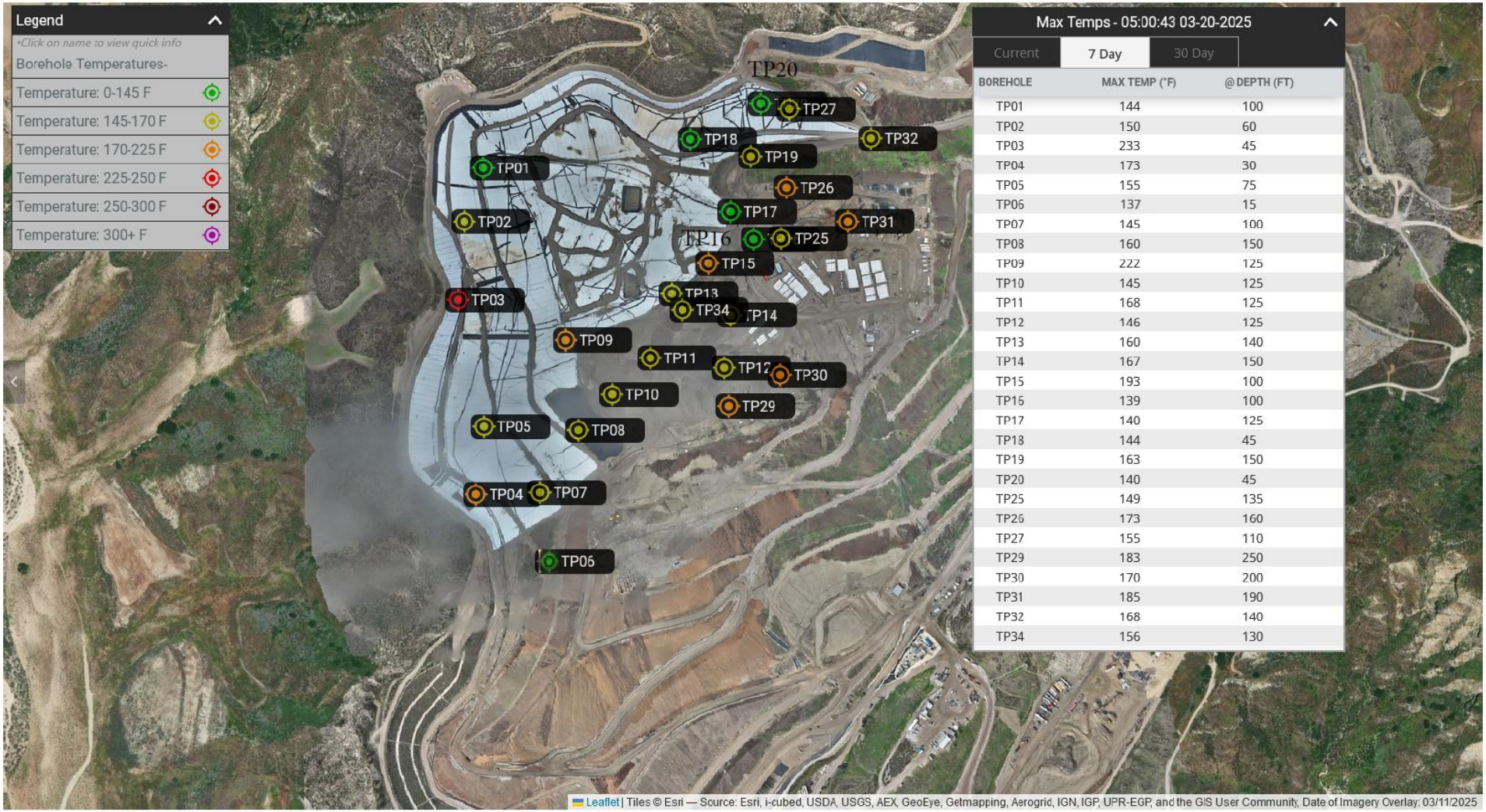


Figure 4. Revised TMP Installation Map Chiquita Canyon for 2025. (Source: SCS Engineers TMP Data March 2025)



Max Temps - 05:00:43 03-20-2025

Current | 7 Day | 30 Day

BOREHOLE	MAX TEMP (°F)	@ DEPTH (FT)
TP01	144	100
TP02	150	60
TP03	233	45
TP04	173	30
TP05	155	75
TP06	137	15
TP07	145	100
TP08	160	150
TP09	222	125
TP10	145	125
TP11	168	125
TP12	146	125
TP13	160	140
TP14	167	150
TP15	193	100
TP16	139	100
TP17	140	125
TP18	144	45
TP19	163	150
TP20	140	45
TP25	149	135
TP26	173	160
TP27	155	110
TP29	183	250
TP30	170	200
TP31	185	190
TP32	168	140
TP34	156	130

Figure 5. Maximum Vertical Temperature Map for TMPs for Chiquita Canyon for 2025. (Source: SCS Engineers TMP Data March 2025)

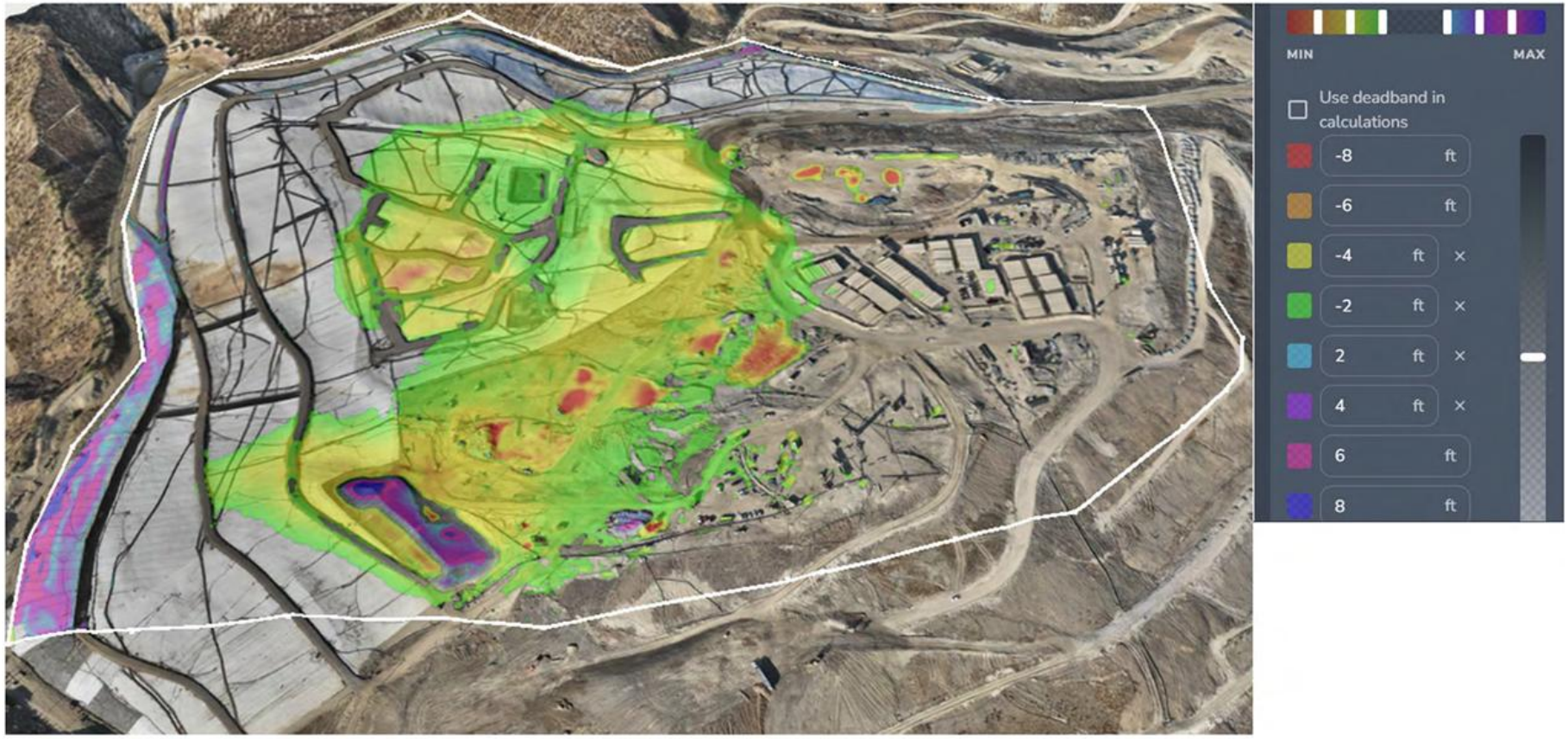


Figure 6. CCL Isopatch Settlement Map, January 3, 2025 Survey Image. October 2, 2024 vs January 3, 2025. (Source: CCL February 2025)

Figure 7. CCL settlement map showing the settlement area growth between 2/26/25 (in green) and 3/11/25 (in red). These polygons show the areas that have settled more than 5 feet. (Source: Bi-weekly Cover Reports by CCL).

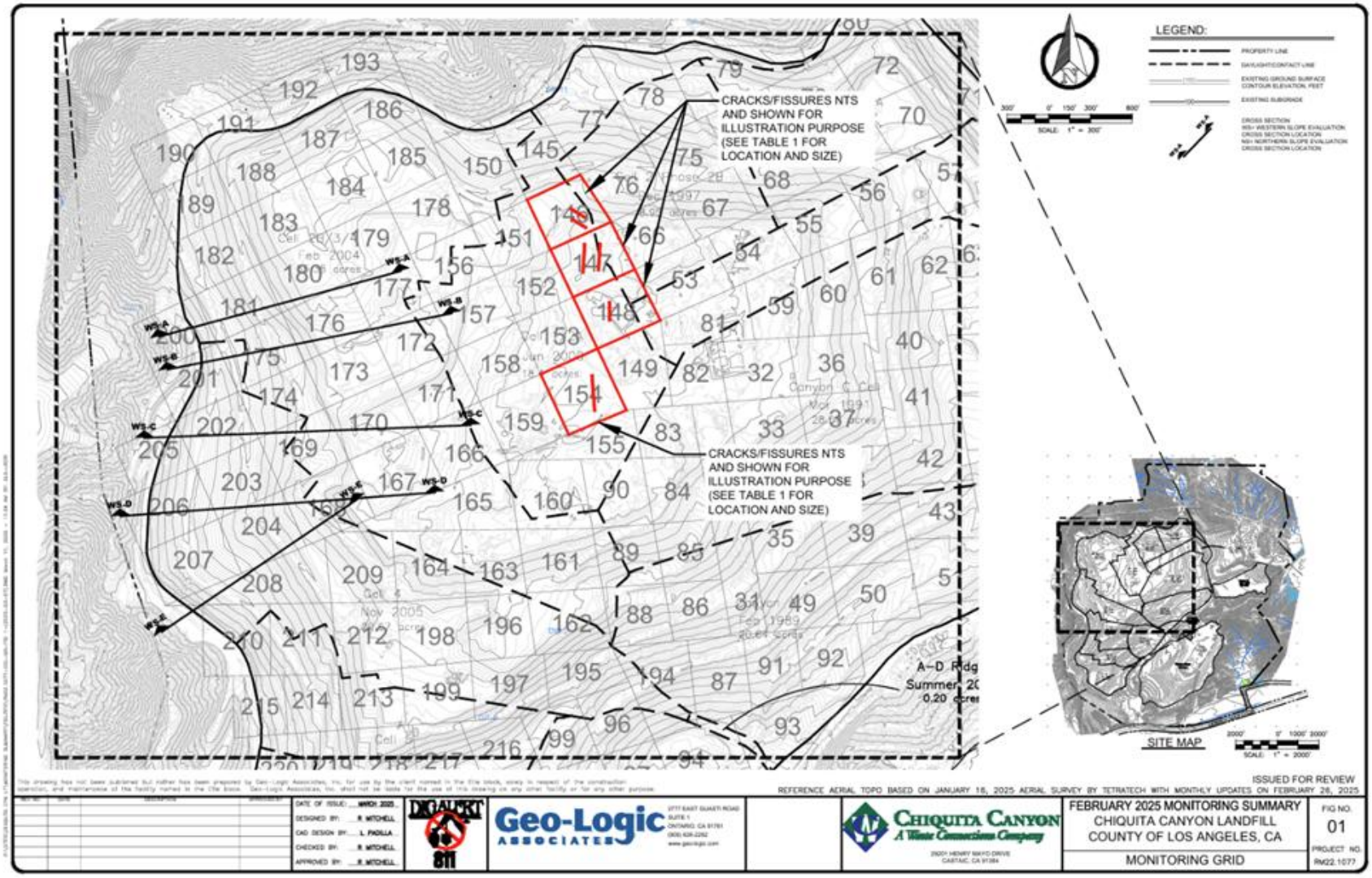
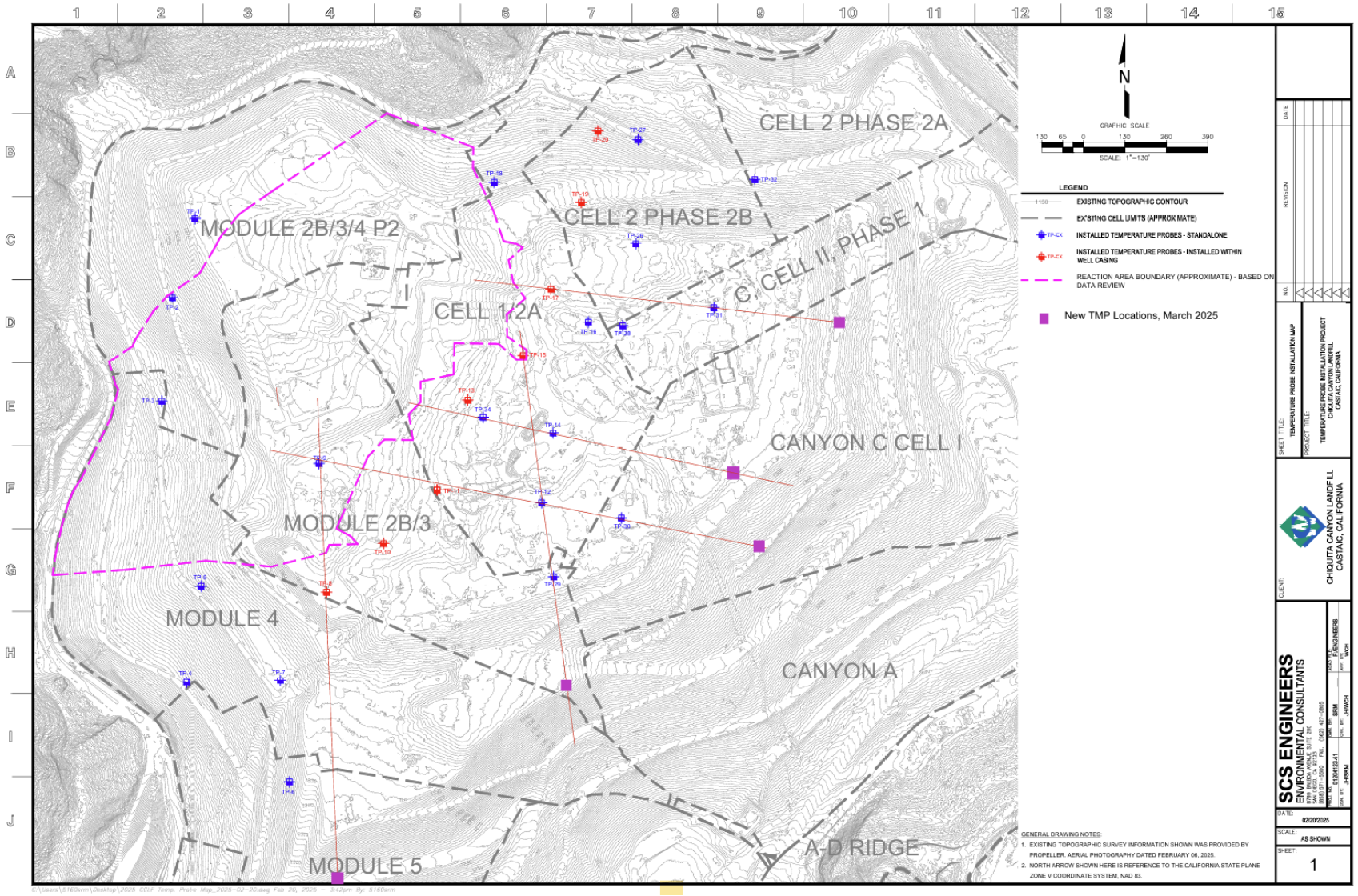


Figure 8. Fissure and Crack Monitoring Report for February 2025. (Source: Geo-Logic Associates)

Attachment A

Proposed Location of New TMPs for Chiquita Canyon Landfill

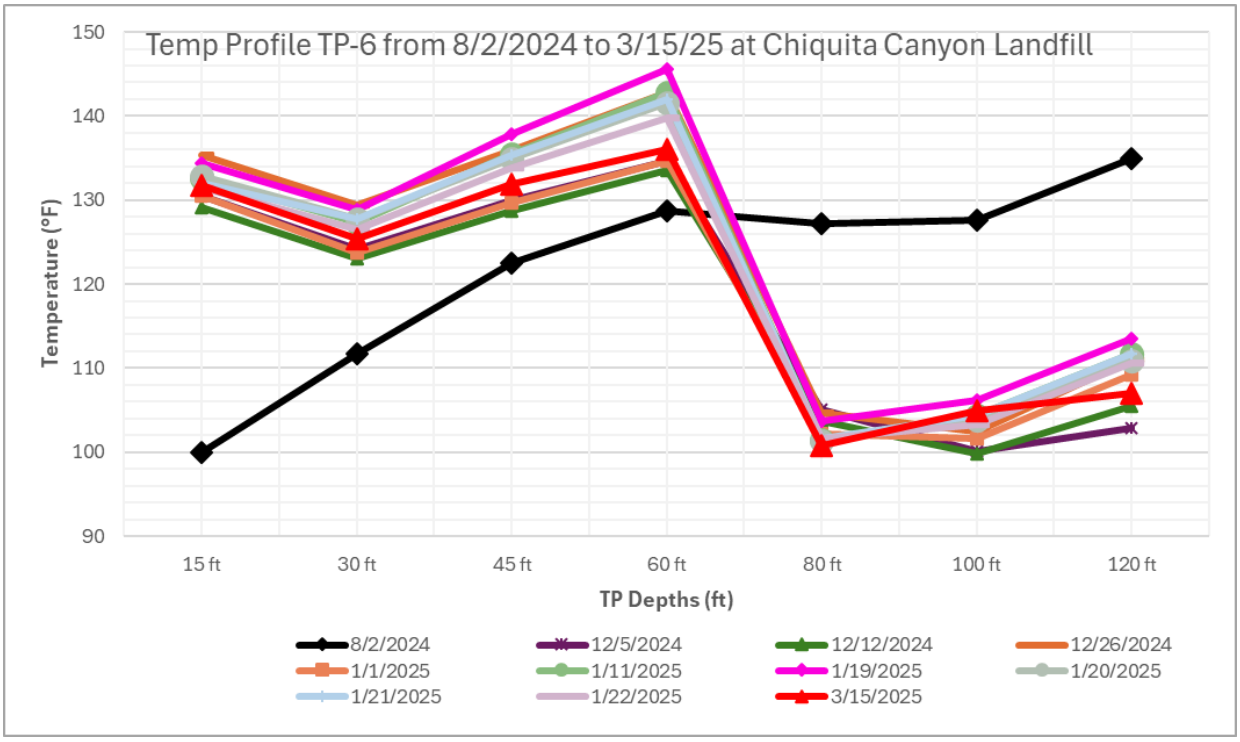
New TMPs for Chiquita Canyon Landfill, March 2025



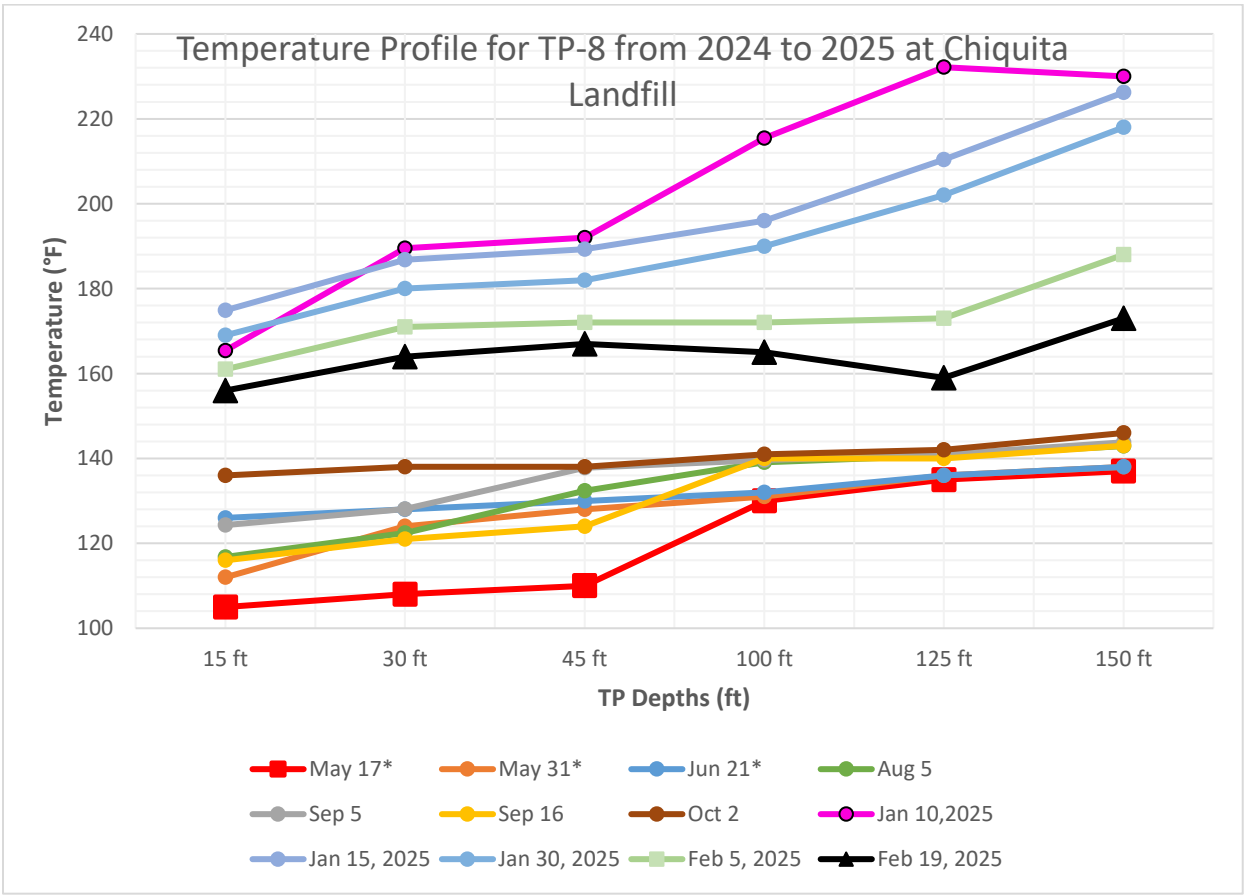
Attachment B

Chiquita Canyon Landfill TMP Profiles with Significant Changes
April 2024 to March 2025

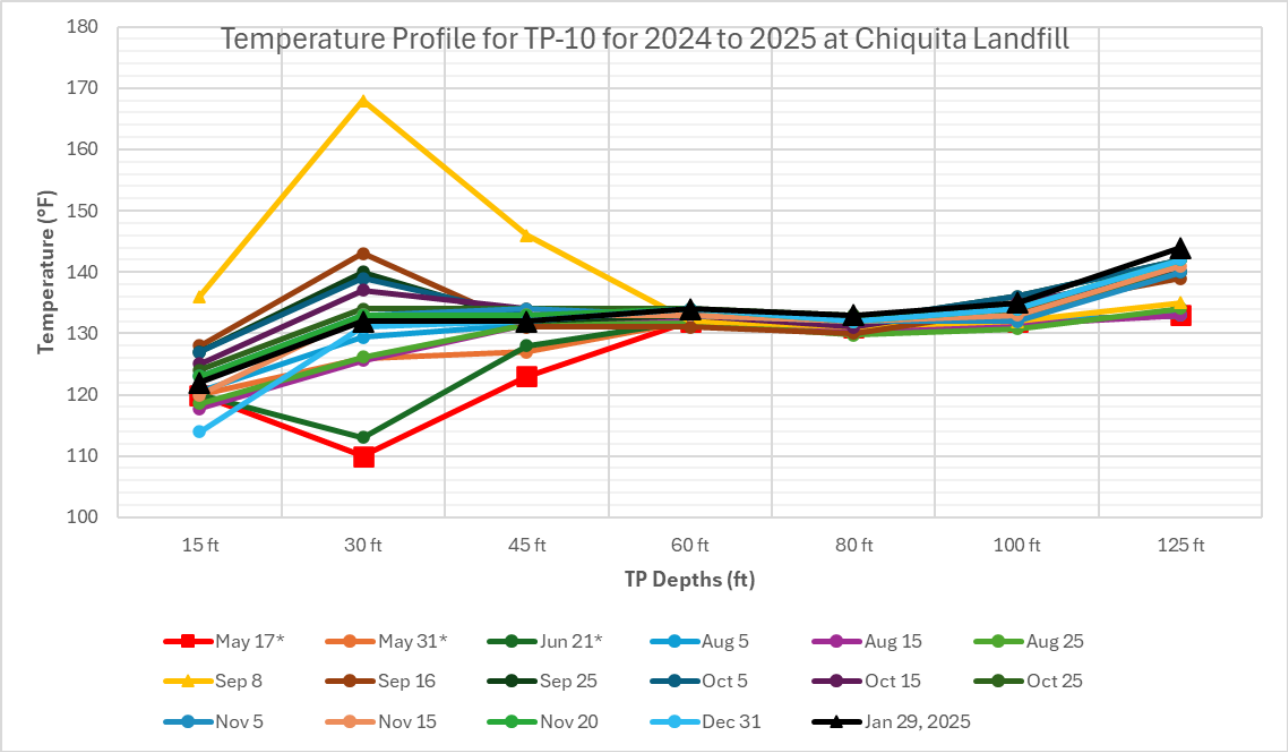
TP-6


Temp Profile TP-6 from 8/2/2024 to 3/15/25 at Chiquita Canyon Landfill
Temperature (°F)
150
140
130
120
110
100
90
15 ft
30 ft
45 ft
60 ft
80 ft
100 ft
120 ft
TP Depths (ft)
8/2/2024
12/5/2024
12/12/2024
12/26/2024
1/1/2025
1/11/2025
1/19/2025
1/20/2025
1/21/2025
1/22/2025
3/15/2025

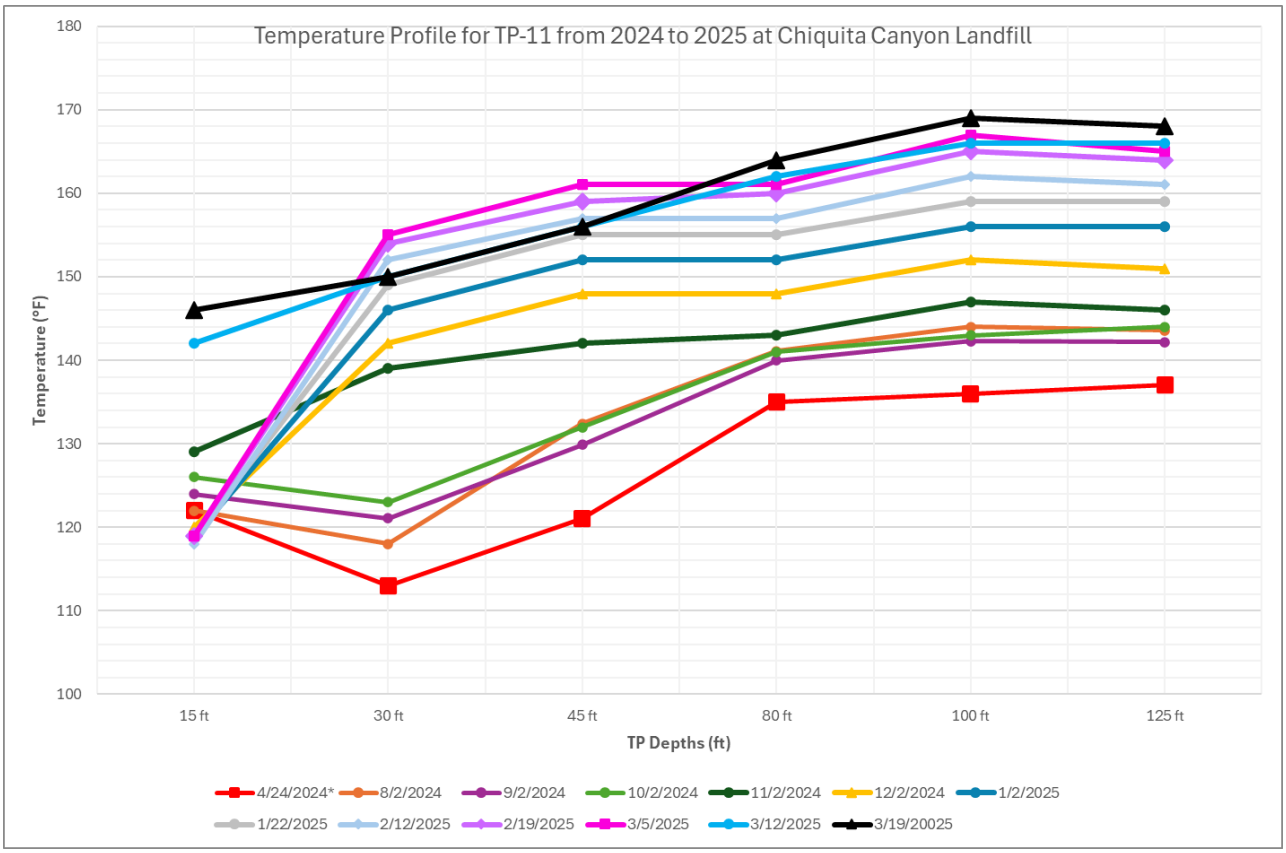
TP-8


Temperature Profile for TP-8 from 2024 to 2025 at Chiquita Landfill
Temperature (°F)
240
220
200
180
160
140
120
100
15 ft
30 ft
45 ft
100 ft
125 ft
150 ft
TP Depths (ft)
May 17*
May 31*
Jun 21*
Aug 5
Sep 5
Sep 16
Oct 2
Jan 10,2025
Jan 15, 2025
Jan 30, 2025
Feb 5, 2025
Feb 19, 2025

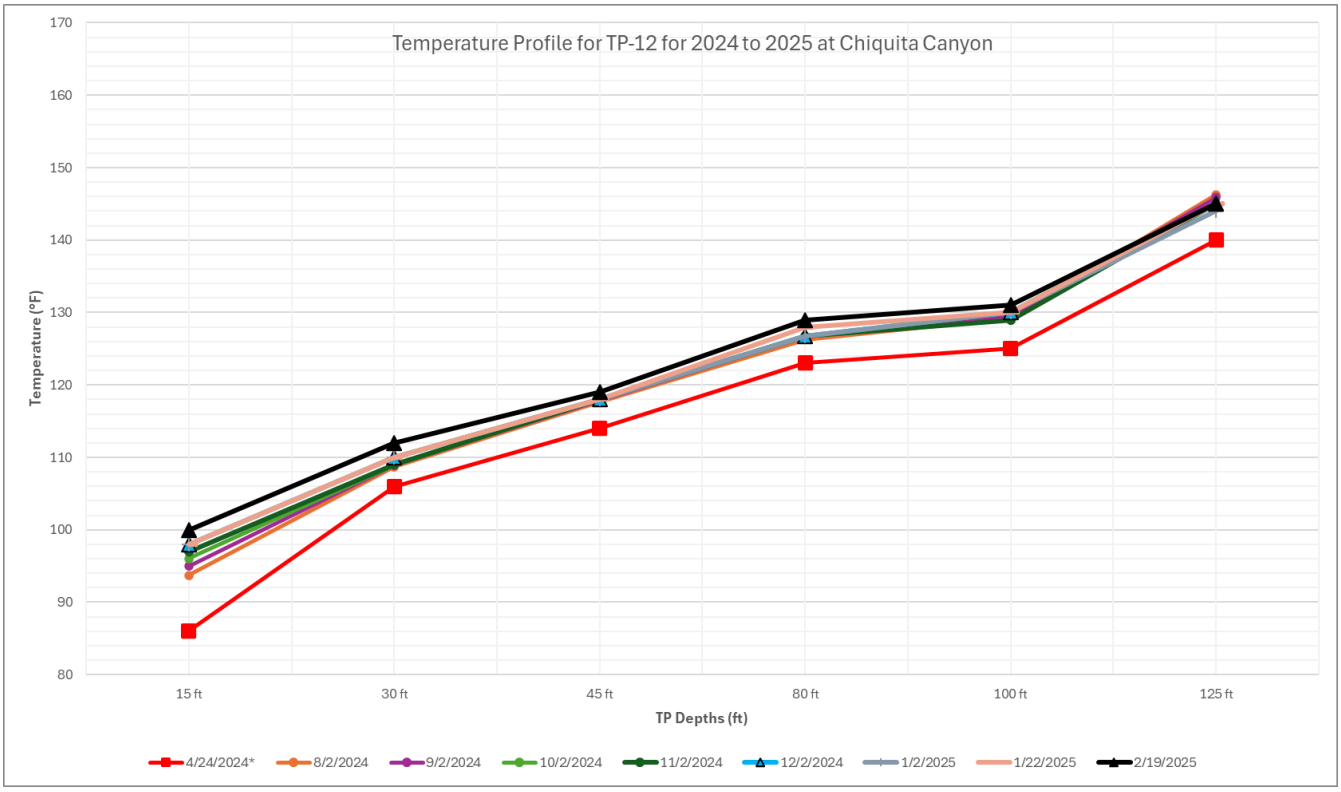
TP-10


Temperature Profile for TP-10 for 2024 to 2025 at Chiquita Landfill
Temperature (°F)
180
170
160
150
140
130
120
110
100
15 ft
30 ft
45 ft
60 ft
80 ft
100 ft
125 ft
TP Depths (ft)
May 17*
May 31*
Jun 21*
Aug 5
Aug 15
Aug 25
Sep 8
Sep 16
Sep 25
Oct 5
Oct 15
Oct 25
Nov 5
Nov 15
Nov 20
Dec 31
Jan 29, 2025

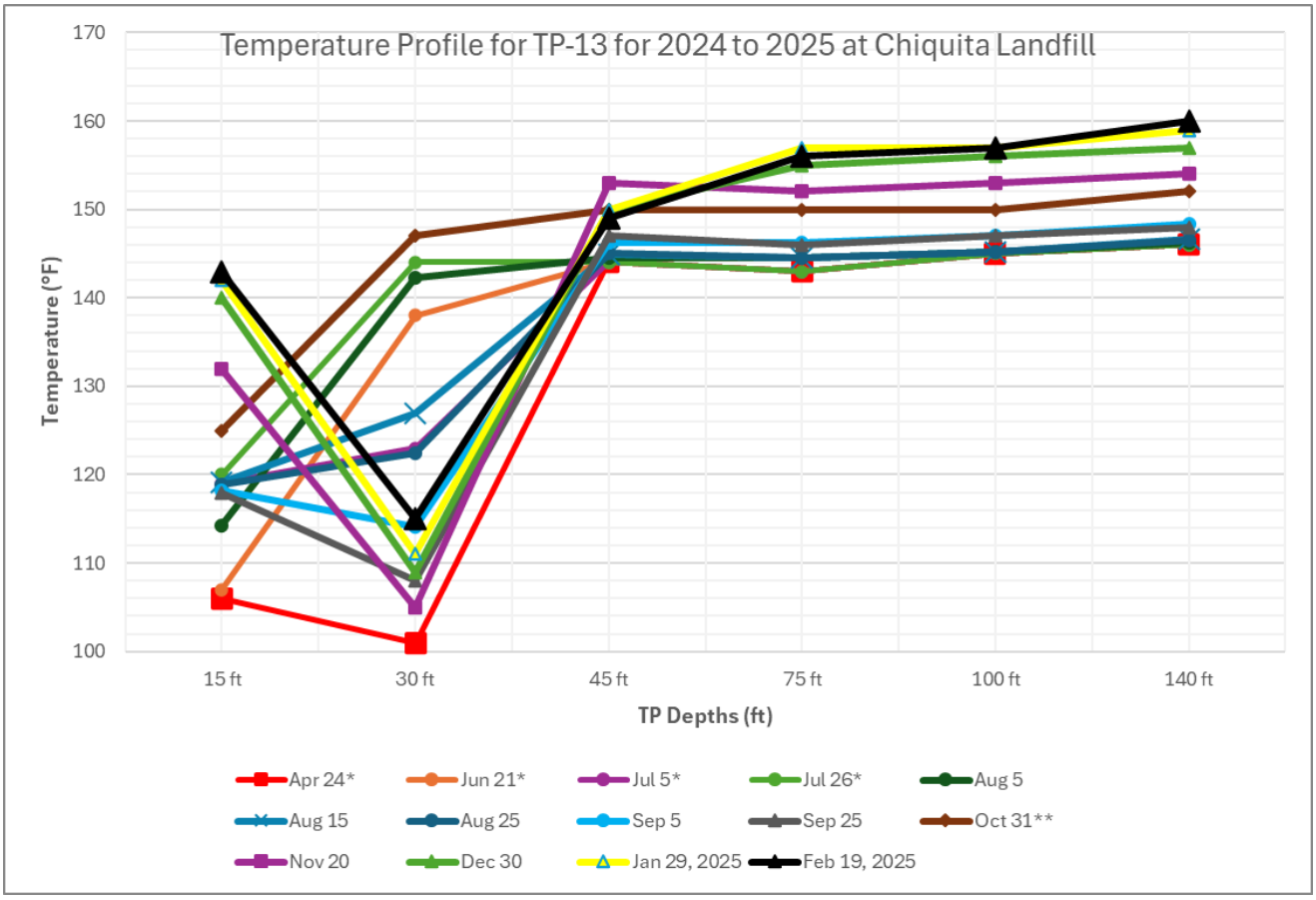
TP-11


Temperature Profile for TP-11 from 2024 to 2025 at Chiquita Canyon Landfill
Temperature (°F)
180
170
160
150
140
130
120
110
100
15 ft
30 ft
45 ft
80 ft
100 ft
125 ft
TP Depths (ft)
4/24/2024*
8/2/2024
9/2/2024
10/2/2024
11/2/2024
12/2/2024
1/2/2025
1/22/2025
2/12/2025
2/19/2025
3/5/2025
3/12/2025
3/19/20025

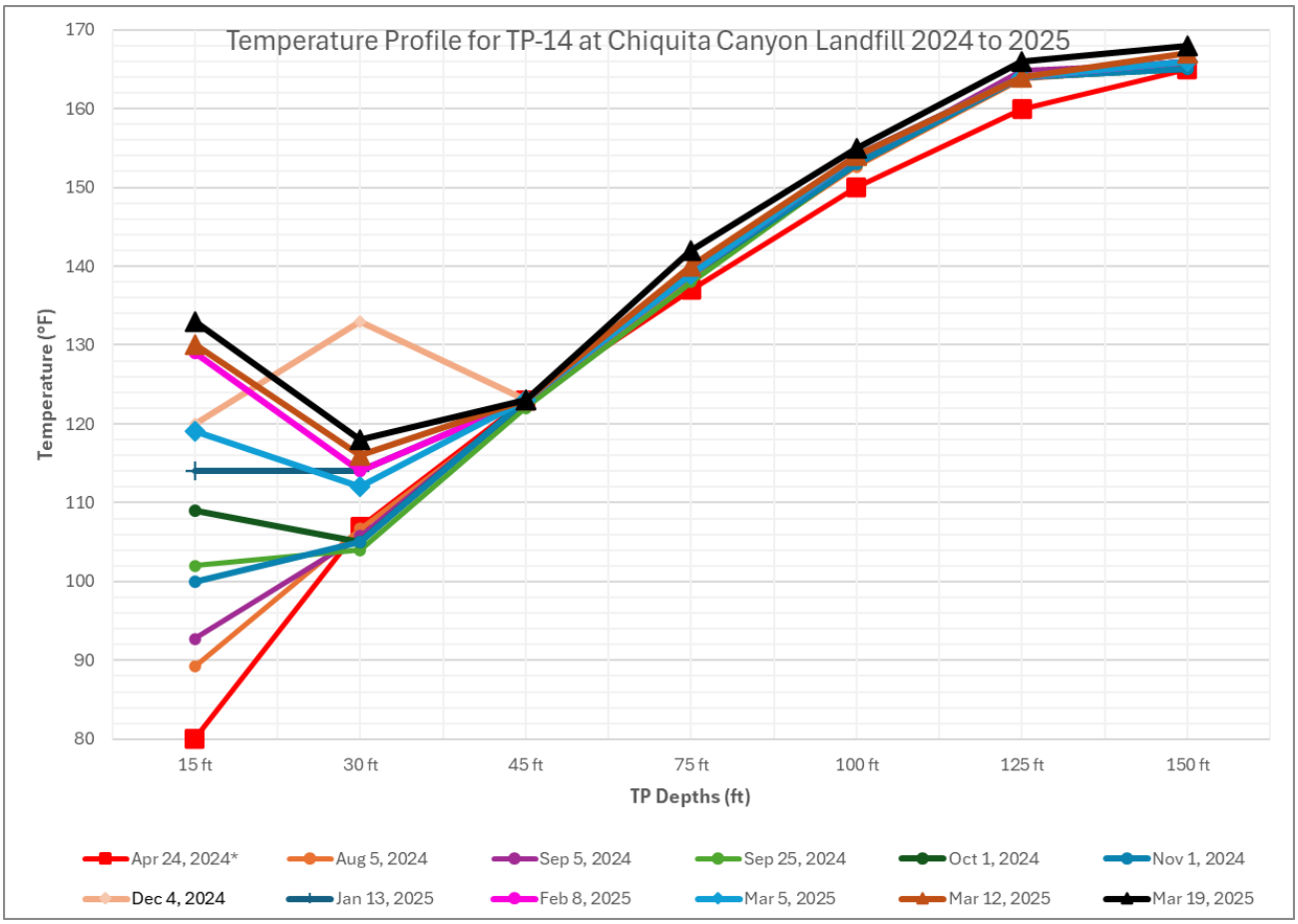
TP-12


Temperature Profile for TP-12 for 2024 to 2025 at Chiquita Canyon
Temperature (°F)
170
160
150
140
130
120
110
100
90
80
15 ft
30 ft
45 ft
80 ft
100 ft
125 ft
TP Depths (ft)
4/24/2024*
8/2/2024
9/2/2024
10/2/2024
11/2/2024
12/2/2024
1/2/2025
1/22/2025
2/19/2025

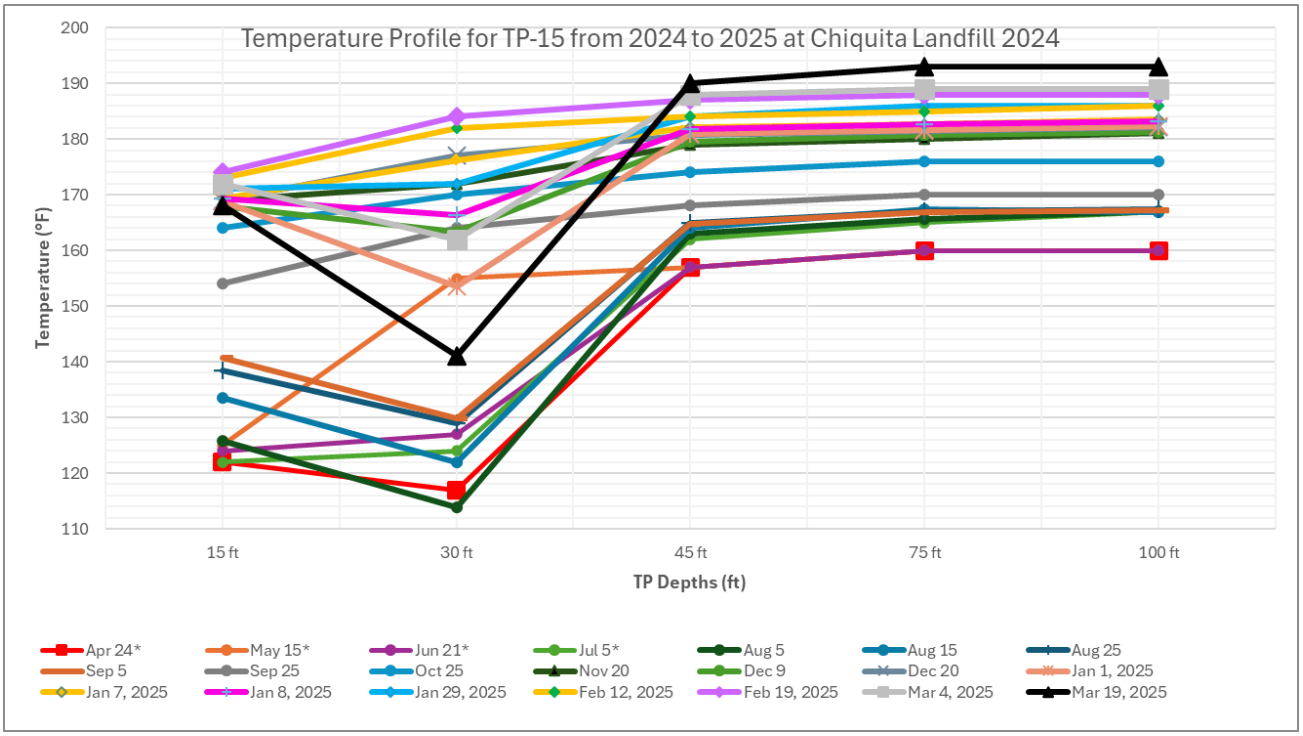
TP-13


Temperature Profile for TP-13 for 2024 to 2025 at Chiquita Landfill
Temperature (°F)
170
160
150
140
130
120
110
100
15 ft
30 ft
45 ft
75 ft
100 ft
140 ft
TP Depths (ft)
Apr 24*
Jun 21*
Jul 5*
Jul 26*
Aug 5
Aug 15
Aug 25
Sep 5
Sep 25
Oct 31**
Nov 20
Dec 30
Jan 29, 2025
Feb 19, 2025

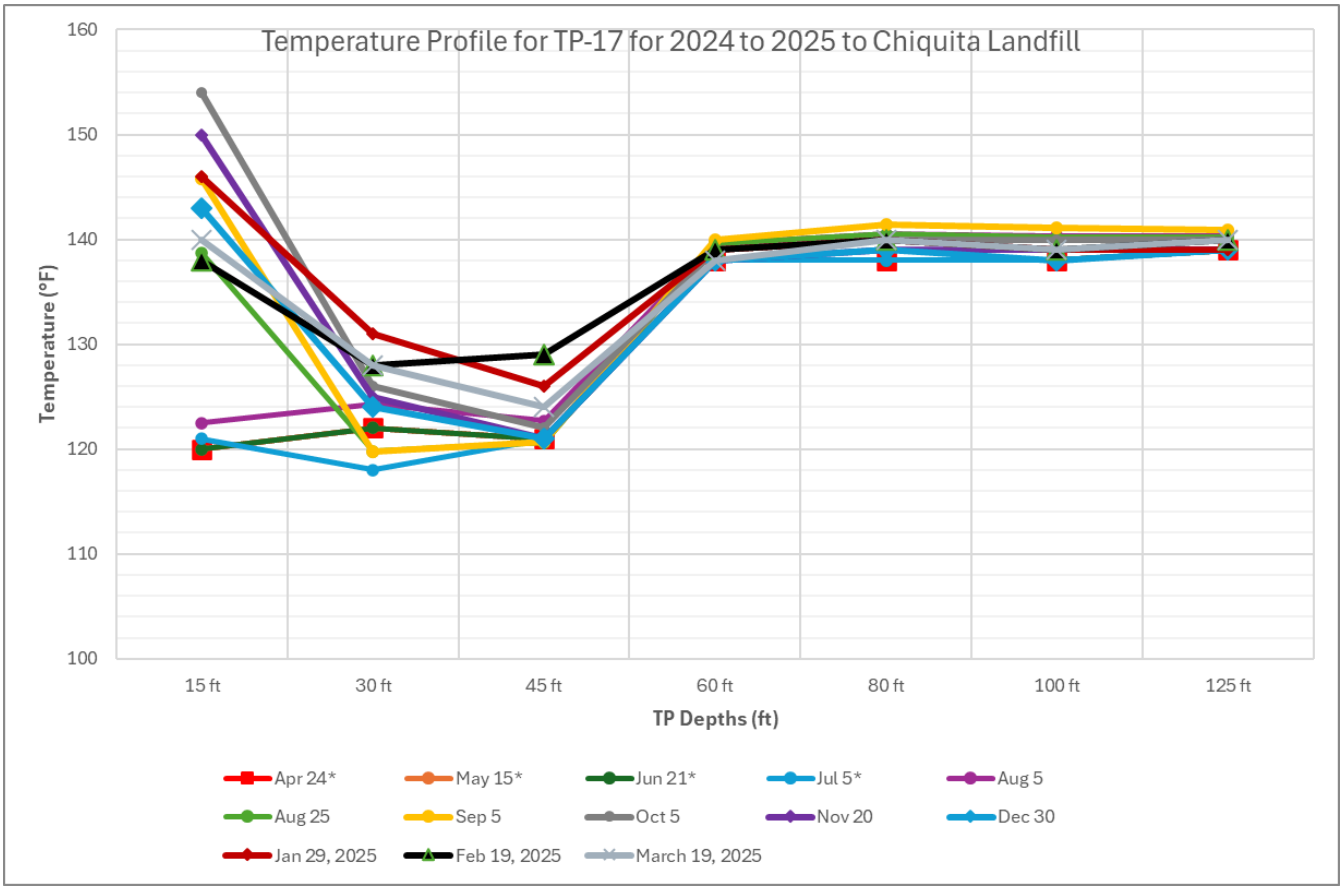
TP-14


Temperature Profile for TP-14 at Chiquita Canyon Landfill 2024 to 2025
Temperature (°F)
170
160
150
140
130
120
110
100
90
80
15 ft
30 ft
45 ft
75 ft
100 ft
125 ft
150 ft
TP Depths (ft)
Apr 24, 2024*
Aug 5, 2024
Sep 5, 2024
Sep 25, 2024
Oct 1, 2024
Nov 1, 2024
Dec 4, 2024
Jan 13, 2025
Feb 8, 2025
Mar 5, 2025
Mar 12, 2025
Mar 19, 2025

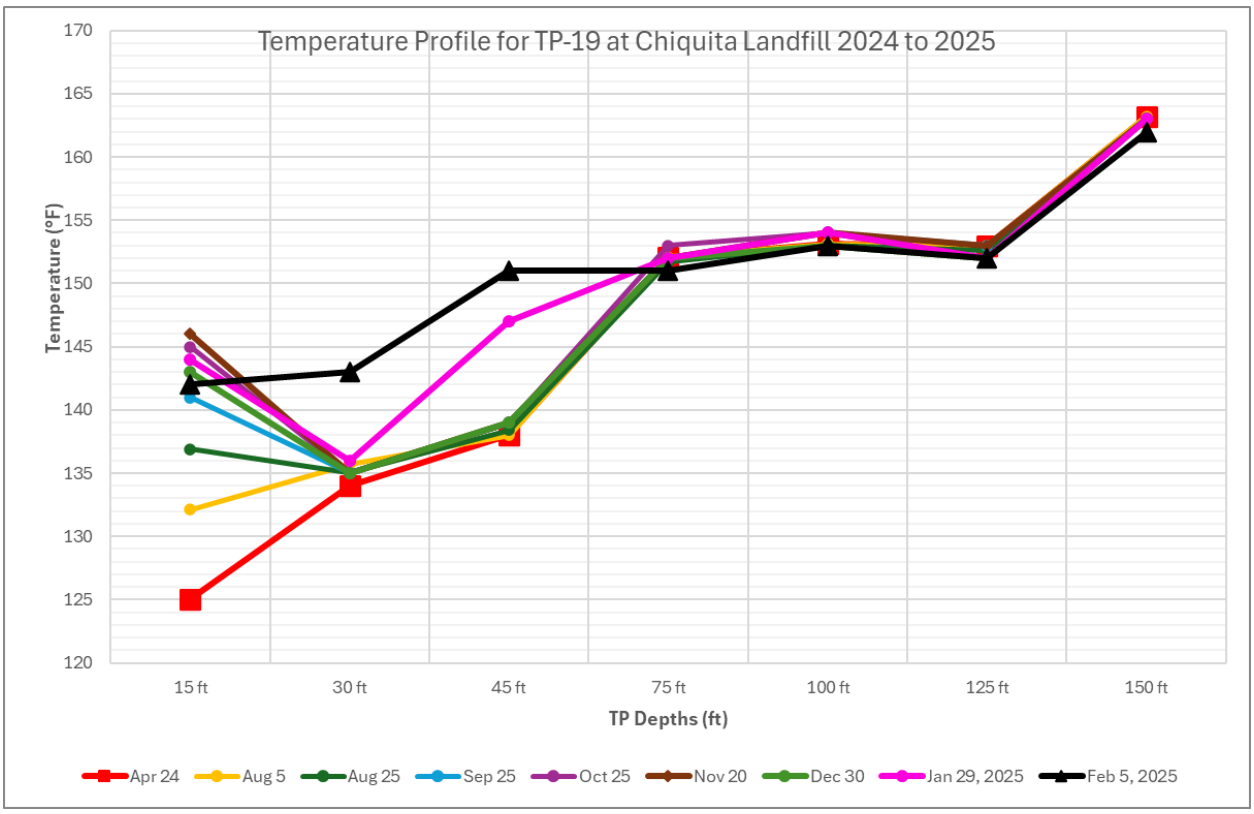
TP-15


Temperature Profile for TP-15 from 2024 to 2025 at Chiquita Landfill 2024
Temperature (°F)
200
190
180
170
160
150
140
130
120
110
15 ft
30 ft
45 ft
75 ft
100 ft
TP Depths (ft)
Apr 24*
May 15*
Jun 21*
Jul 5*
Aug 5
Aug 15
Aug 25
Sep 5
Sep 25
Oct 25
Nov 20
Dec 9
Dec 20
Jan 1, 2025
Jan 7, 2025
Jan 8, 2025
Jan 29, 2025
Feb 12, 2025
Feb 19, 2025
Mar 4, 2025
Mar 19, 2025

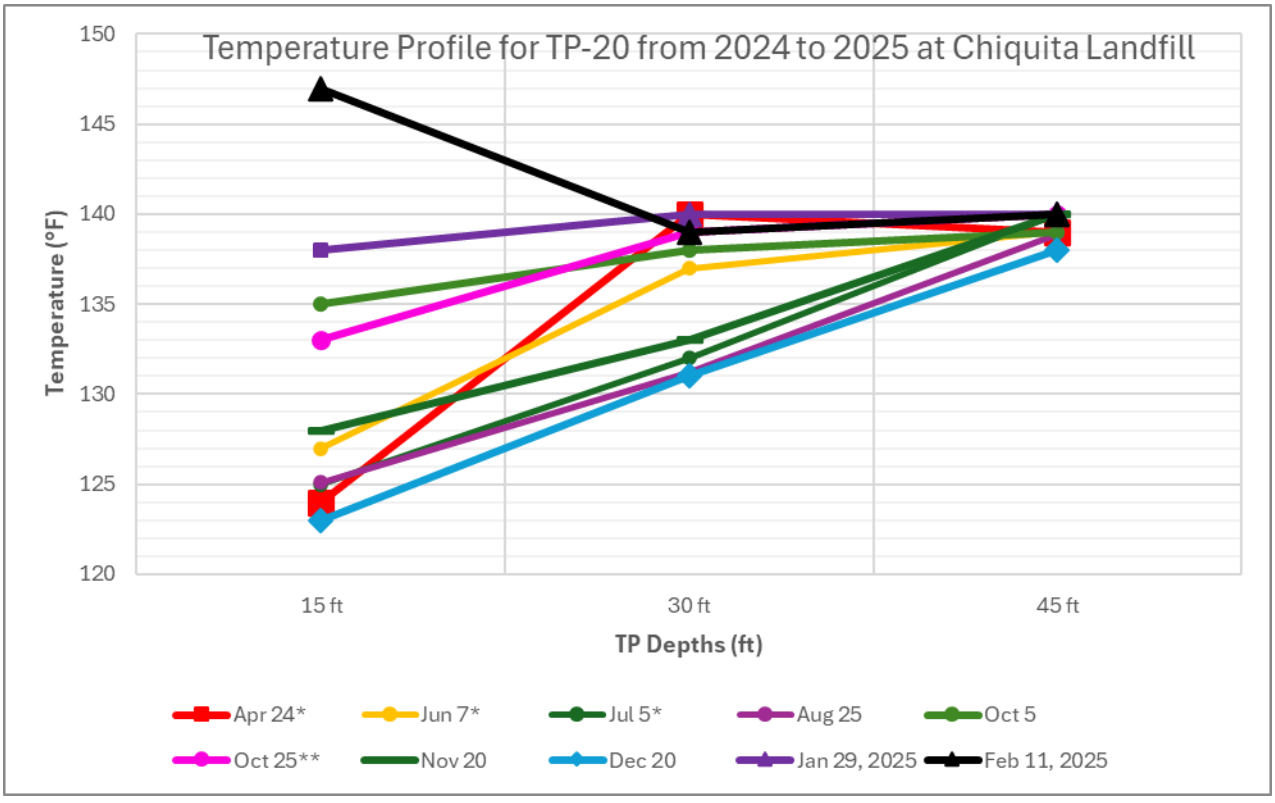
TP-17


Temperature Profile for TP-17 for 2024 to 2025 to Chiquita Landfill
160
150
140
130
120
110
100
Temperature (°F)
15 ft
30 ft
45 ft
60 ft
80 ft
100 ft
125 ft
TP Depths (ft)
Apr 24*
May 15*
Jun 21*
Jul 5*
Aug 5
Aug 25
Sep 5
Oct 5
Nov 20
Dec 30
Jan 29, 2025
Feb 19, 2025
March 19, 2025

TP-19


Temperature Profile for TP-19 at Chiquita Landfill 2024 to 2025
Temperature (°F)
170
165
160
155
150
145
140
135
130
125
120
15 ft
30 ft
45 ft
75 ft
100 ft
125 ft
150 ft
TP Depths (ft)
Apr 24
Aug 5
Aug 25
Sep 25
Oct 25
Nov 20
Dec 30
Jan 29, 2025
Feb 5, 2025

TP-20


Temperature Profile for TP-20 from 2024 to 2025 at Chiquita Landfill
Temperature (°F)
150
145
140
135
130
125
120
15 ft
30 ft
45 ft
TP Depths (ft)
Apr 24*
Jun 7*
Jul 5*
Aug 25
Oct 5
Oct 25**
Nov 20
Dec 20
Jan 29, 2025
Feb 11, 2025

Attachment C

Technical Memorandum from Dr. Stark dated February 26, 2025

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

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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.

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[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.

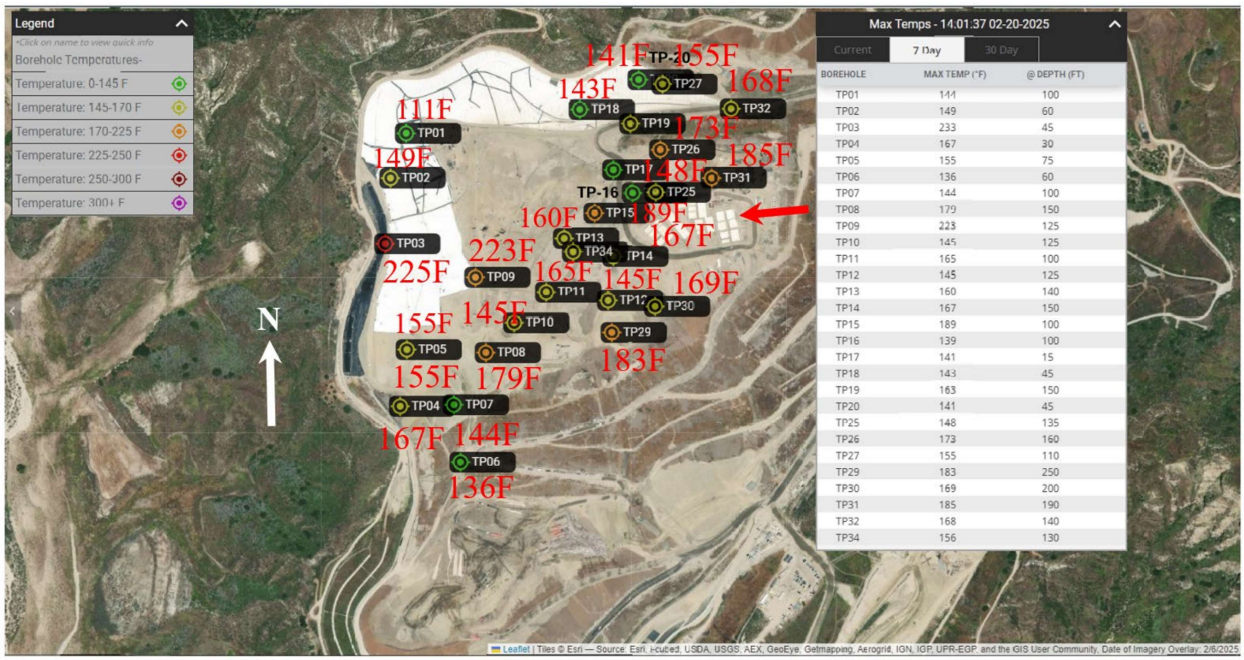

Figure 1. Temperature profiles over six weeks from 1/9/2025 to 2/19/2025 from SCS report dated February 20, 2025.

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.

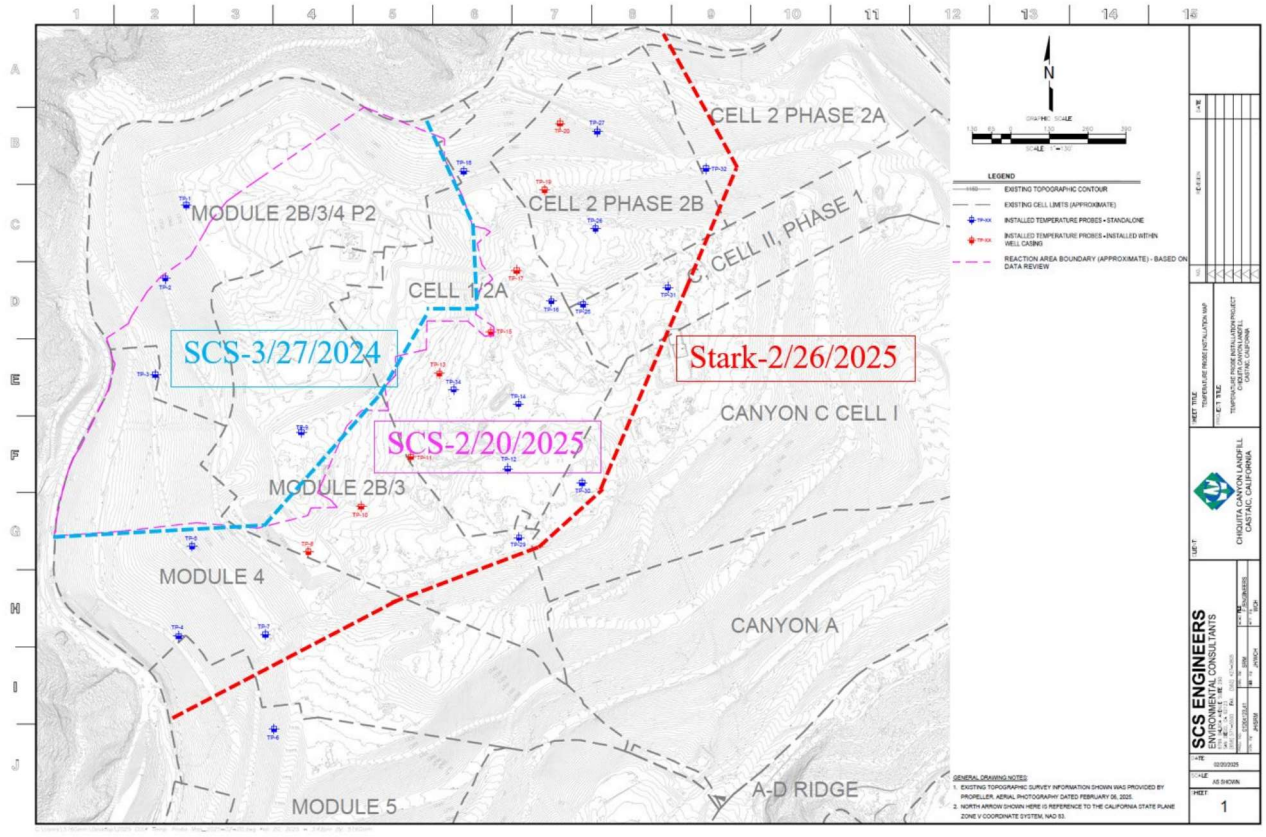

Figure 2. Extent of elevated temperatures from March 27, 2024 to February 26, 2025.

[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.

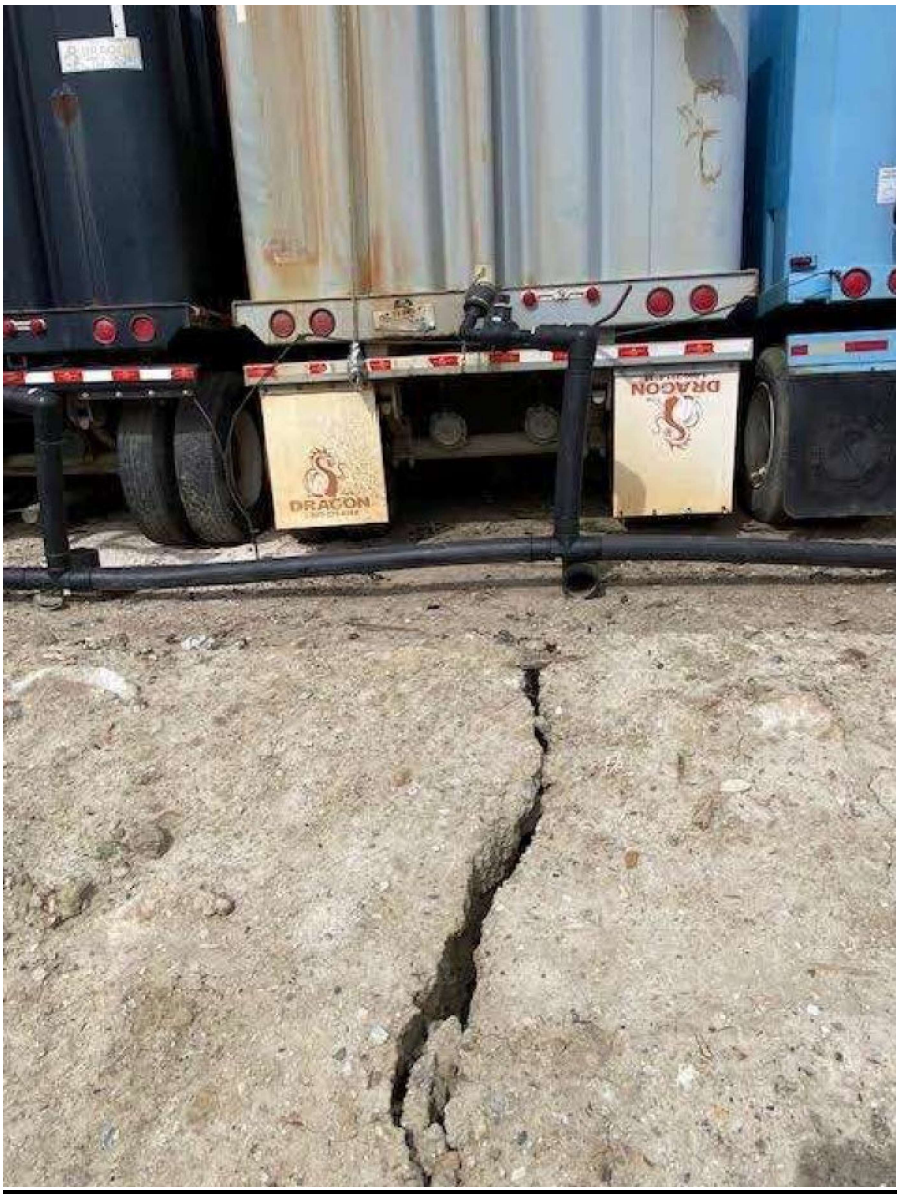

Figure 4. Photograph of tension crack in Grid #148 near leachate tanks on top of CCL dated February 27, 2025[15].

[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.

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.

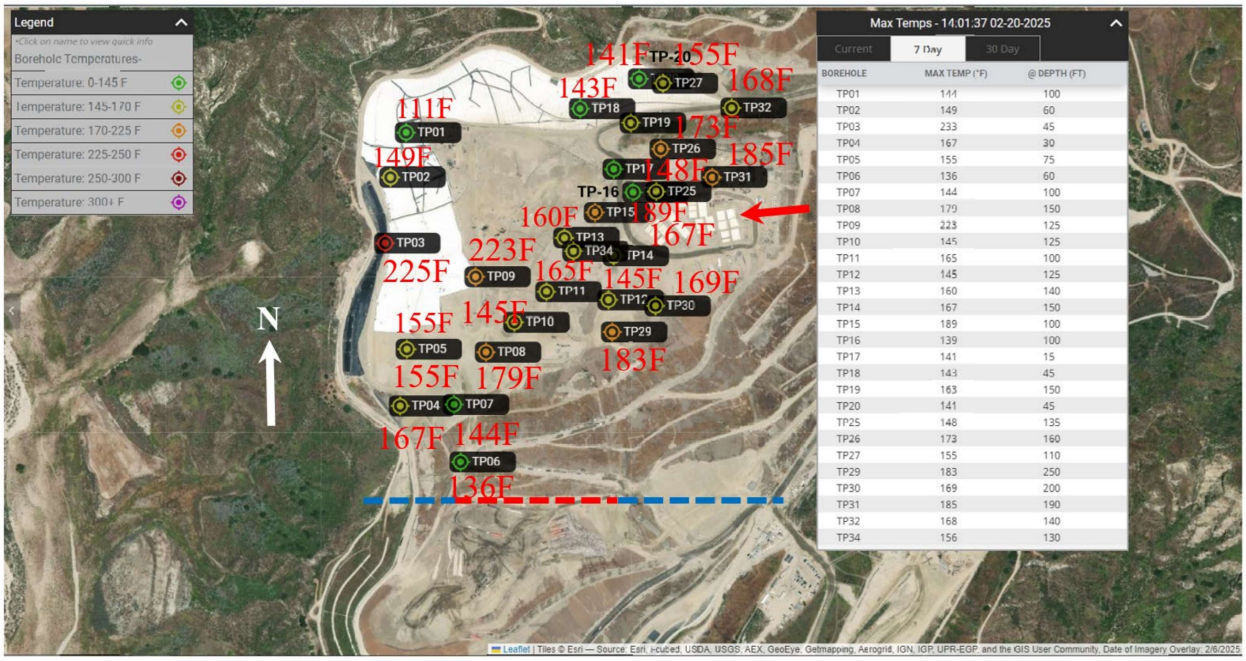

Figure 7. Extent of elevated temperatures on February 26, 2025 and location of a possible vertical barrier to isolate southernmost 13 acres.

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**).

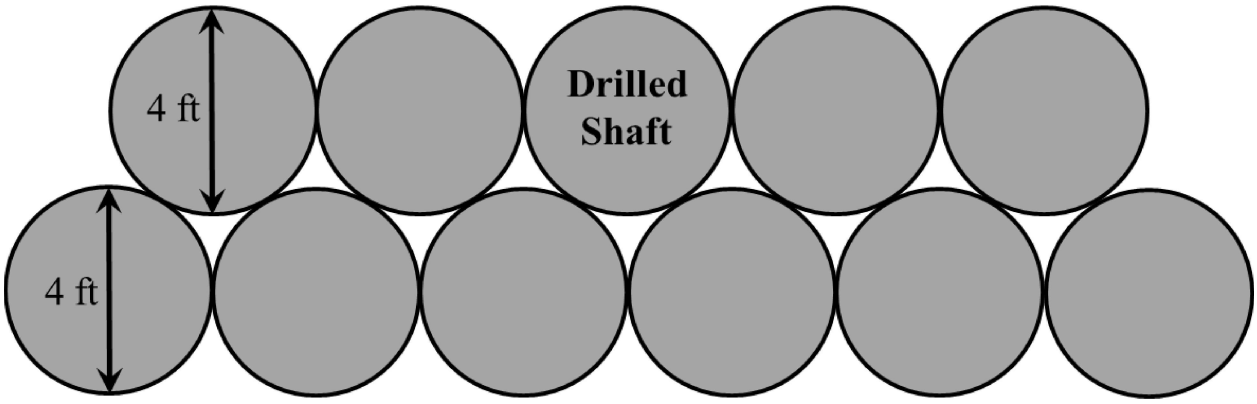

Figure 8. Possible configurations of 3 to 4 ft diameter vertical elements to comprise a heat barrier system south of TP06 to isolate southernmost 13 acres.

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.