Air Movement Study Report

Chiquita Canyon Landfill
29201 Henry Mayo Drive
Castaic, CA 91384

SCS ENGINEERS

01204123.21 | June 30, 2021

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Acronyms and Abbreviations

CCL	Chiquita Canyon, LLC
CCLF	Chiquita Canyon Landfill
deg	Degrees
ft	Feet
MET	Meteorological
m/s	Meters per second
Modified Order	Stipulated Order for Abatement as Modified on March 24, 2021
mph	Miles per hour
Order	Stipulated Order for Abatement
PDT	Pacific Daylight Time (Local Time)
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SCS	SCS Engineers
WD	Wind direction (direction from which the wind is blowing)
WS	Wind speed

1.0 INTRODUCTION AND BACKGROUND

Chiquita Canyon, LLC (CCL) and the South Coast Air Quality Management District (SCAQMD) entered into a Stipulated Order for Abatement (Order) as modified on March 24, 2021 (Modified Order), after CCL and the SCAQMD received odor complaints from residents in the Val Verde community located northwest of the Chiquita Canyon Landfill (CCLF).

Among other tasks, SCS Engineers (SCS) was contracted to undertake a study and provide two reports to the SCAQMD in accordance with Condition 32c of the Modified Order. Condition 32c of the Modified Order states:

> *"Additional study of air movement along the western perimeter of the Landfill (near Cells 6 and 8) to determine whether drainage areas may be creating a preferential path for air movement outside of the Landfill, including an assessment of the feasibility of a vegetative barrier or other air flow disruptors, and basic design concepts. The analysis and conclusions of the air movement study shall be documented in a report prepared for Respondent and shall be submitted to South Coast AQMD (attn: Larry Israel, lisrael@aqmd.gov; Harry Moon, hmoon@aqmd.gov; Kathryn Roberts, kroberts@aqmd.gov; Mary Reichert, mreichert@aqmd.gov) on or before June 30, 2021. The assessment of the feasibility of a vegetative barrier or other air flow disruptors, shall be documented in a report prepared for Respondent and shall be submitted to South Coast AQMD (attn: Larry Israel, lisrael@aqmd.gov; Harry Moon, hmoon@aqmd.gov, Kathryn Roberts, kroberts@aqmd.gov; Mary Reichert, mreichert@aqmd.gov) on or before July 27, 2021."*

This report covers the first portion of Condition 32c: the analysis and conclusions of the study of air movement along the western perimeter of the CCLF to determine whether drainage areas may be creating a preferential path for air movement outside of the CCLF. A subsequent study and report will address the feasibility of a vegetative barrier or other air flow disruptors.

SCS had previously undertaken a regional meteorological study and on-site meteorological study under Condition 18 of the Order, which is documented in the *Landfill Operations Assessment Report* (February 2021), prepared by SCS and Blue Ridge Services Montana, Inc. (February 2021 Report). The analysis in the February 2021 Report suggested that low to moderate winds with a southerly component could potentially move over and through low spots in the western ridgeline at the southwest corner of the CCLF.

In order to further investigate these conditions, during this Air Movement Study, SCS completed a series of smoke tracer releases from the CCLF disposal areas in and near Cells 6 and 8 during those previously identified wind conditions that were thought to have the potential to carry surface air from the point of release into the Val Verde community. Specifically, we focused on the low to moderate winds coming with a southerly component, as described above. We also attempted to investigate winds from the Northeast and East that were observed/experienced within the CCLF canyon to document if these winds could cause air movement outside of the CCLF to the West, which could become entrained in regional winds at a later time and move in/along Chiquito Canyon Road and into the Val Verde community.

This testing provided tangible information regarding transport mechanisms in the study region. Smoke releases were photographed from various ground based vantage points in conjunction with aerial drones flying at elevated vantage positions with regard to each smoke plume. This visual study provided documentation of how air plumes are transported within the CCLF cells and how air parcels could be transported over the western ridgeline into the Val Verde community area. **Figures 1 through 3** provide an illustration of assumed transport scenarios for air movement across and away from the CCLF, which were tested by this study.

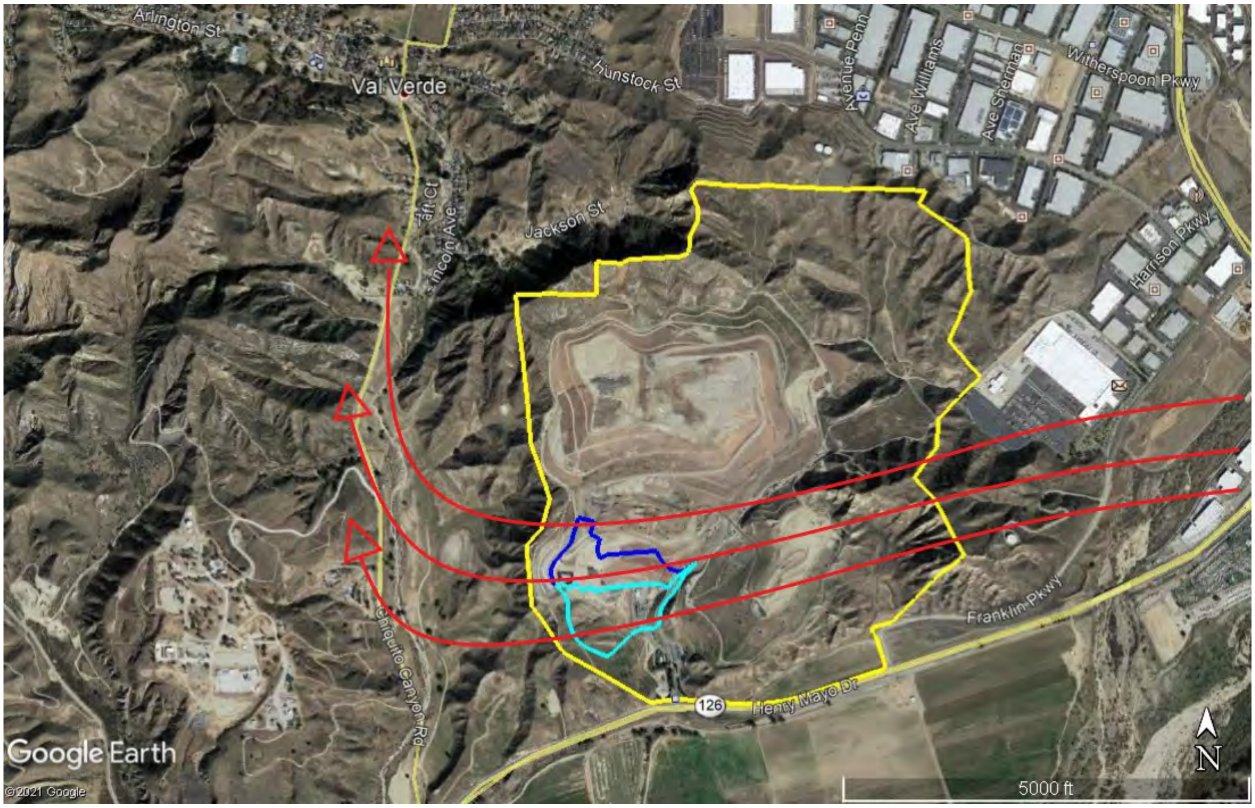
Smoke tests were each comprised of 20-minute (approximate) point releases of a visible smoke tracer. During each day of testing, four to six separate tests were executed. SCS conducted meteorological forecasting in an effort to ensure that testing was done under wind conditions with the potential to move air toward Val Verde as identified in the February 2021 Report. A total of three days of testing were conducted in late May 2021, which comprised of a total of 16 tests, each having dual smoke release locations. SCS conducted drone flights and fixed photographic surveys of the smoke transport during each test. The actual release times and release configurations are documented in this report along with a sample of photographic data that support our analysis and conclusions. In support of this study, efforts were made to coordinate with ongoing CCLF operations while tests were conducted and ensure safe access to Cells 6 and 8.

Following this Introduction, Section 2 summarizes the methodology and results from this study. Section 3 then presents the analysis and conclusions. Finally, the appendices provide supporting documentation.

Figure 1. Assumed Southeast Wind Pathways of Air Parcels Moving from CCLF to Val Verde

Based on the February 2021 Report, winds from a southerly direction represent the conditions during which approximately 75% of the odor complaints were reported. In particular, Southeast winds are considered to have the greatest potential to contribute to impacts in Val Verde, which is the primary hypothesis of this study.

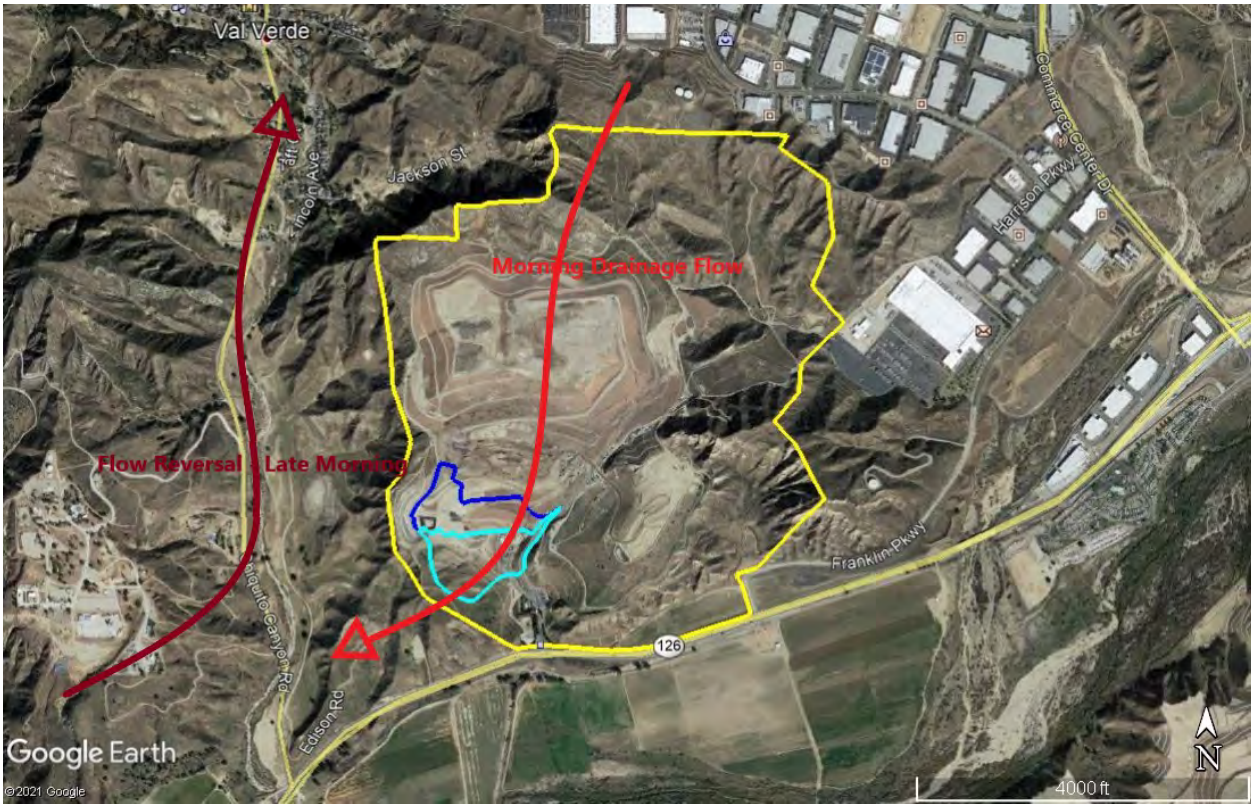
Figure 2. Assumed East Wind Pathways of Air Parcels Moving from CCLF to Val Verde



Yellow polygon: Landfill boundary
Blue polygon: Cell 6 boundary
Light blue polygon: Cell 8 boundary

Winds from the East do not occur frequently at the CCLF; however, they can occur during transitional periods when the wind direction shifts from a northerly to southerly direction. During the days of testing described below, there were periods of East winds, so **Figure 2** represents the working hypothesis of how wind from the East could result in air movement from the CCLF toward the Val Verde community. It should be noted that in many cases, on-site winds can differ from regional winds. Therefore, there are periods of time when on-site winds could be coming from the East; however, regional winds may be coming from the Southeast or South.

Figure 3. Assumed Northeast Wind Pathways of Air Parcels Moving from CCLF to Val Verde



Yellow polygon: Landfill boundary
Blue polygon: Cell 6 boundary
Light blue polygon: Cell 8 boundary

Winds from the Northeast are fairly common at the CCLF, although they do not commonly occur during the morning hours when the largest number of complaints (98%) were logged per the February 2021 Report. During the days of testing described below, there were periods of Northeast winds, so **Figure 3** represents the working hypothesis of how wind from the Northeast could result in air movement from the CCLF toward the Val Verde community if changes in wind direction occur during the same time frame. It should be noted that in many cases, on-site winds can differ from regional winds. Therefore, there are periods of time when on-site winds could be coming from the Northeast; however, regional winds may be coming from the Southeast or South.

The smoke studies described below were used to determine whether the air flow hypotheses detailed in **Figures 1 through 3** represent the likely pathways for air movement across the CCLF and toward Val Verde.

2.0 AIR MOVEMENT STUDY

2.1 METHODOLOGY

Meteorological forecasting was first used to predict dates and times when conditions would be suitable for testing. Suitability for testing was based on Condition 3 of the Modified Order, which identified winds from the South (including Southeast and East-Southeast winds) with low to moderate wind speeds (0-5 mph) as unfavorable wind conditions more likely to result in air movement off-site toward Val Verde. For this study, May 24, May 26, and May 27, 2021 were selected for testing based on a review of meteorological forecasts by SCS's meteorologist. During each day of testing, four to six separate tests were conducted. For each test:

- Smoke was released from two on-site locations, one near Cell 8 (Release Point A) and one near Cell 6 (Release Point B) for 15 to 20 minutes. Exact locations differed slightly for each test:
  - Release Point A typically used one green smoke candle at the onset, followed by five to six white smoke candles; and
  - Release Point B typically used one red smoke candle at the onset, followed by five to six white smoke candles.
- Additional colored and white smoke candles were used as needed at Release Points A and B to emphasize plume behavior or to extend the release time.
- Videos and photographs were taken from various vantage points using two drones, three Go-Pro cameras, and two cell phones. Relevant example photographs are provided in this report, including a description of the vantage point from where the photo was taken and the direction the photographer is facing. These vantage points can be referenced to the maps of smoke test release points.
- Specific release points for each day of testing are detailed below.

A total of 16 tests were conducted over the three days selected. Following the three days of testing, conclusions were made based upon analysis of the imagery collected and the corresponding meteorological data. In all, a total of about 700 gigabytes of plume movement imagery were collected with this study. Only portions of that imagery are presented in this report due to size.

2.2 RESULTS

2.2.1 May 24, 2021 Smoke Tests

SCS conducted six smoke tests on May 24, 2021 as shown in **Table 1** and **Figure 4**. See **Figures 5 to 10** for various example images recorded during these smoke tests.

3.0 ANALYSIS AND CONCLUSIONS

3.1 ANALYSIS

Based on the smoke study, it is clear that the regional wind direction as well as local terrain and on-site structures of the CCLF can individually or collectively influence wind patterns found at Cells 6 and 8 and the movement of air off-site. If regional winds are from the South or Southeast, then the up-sloping contours of Cell 6 divert surface winds vertically to an altitude that eventually mixes into the more defined regional flow (primarily from the Southeast during unfavorable wind conditions). The altitude at which this mixing occurs depends upon the strength of the regional winds, but it was observed to be generally greater than 100 feet above the CCLF boundary peaks (which are the high points of the ridgeline surrounding the CCLF). Once mixed into the regional flow, air parcels follow regional wind trajectories beyond the boundaries of the CCLF, which could be toward Val Verde under certain unfavorable wind conditions.

Regional winds from the Northeast or East were observed to produce a slightly different pattern of surface winds in Cells 6 and 8 although the result was similar in terms of vertical plume rise. Such winds can promote more of a vortex within these cells. This action eventually causes surface air to climb vertically until mixed in more regional flow patterns above. This phenomenon was also observed during West winds that occurred during the testing program but to a lesser degree. Smoke plumes under these wind conditions rose an estimated 100 feet to 200 feet above the CCLF boundary peaks. Regional wind flow from the Northeast seems to produce the formation of this surface vortex in Cells 6 and 8 more often than regional winds from the West, East, or South sectors, although the plume rise was observed under all regional wind conditions that occurred during the smoke testing. Under these vortex conditions with winds from the Northeast, East, or West subsequent air flow toward Val Verde can only happen if the regional winds at higher elevations come from the South or Southeast during time periods immediately following these conditions.

See **Figures 46 through 48** for examples of observed plume heights after rapid rising of a plume, including vortex conditions, and plume movement that is heavily influenced or channeled by local terrain characteristics. **Figure 49** provides a graphical illustration of how the vertical plume rise can eventually result in air parcels moving off-site to the Northwest.

It is evident from the video and photographic data collected in this study that surface air parcels found in Cells 6 and 8 eventually make their way out of the CCLF area as they are mixed in regional flow at higher altitudes after the noted plume rise. This regional flow seems to dominate a couple hundred feet above the boundary peaks of the CCLF. Under Southerly or Southeasterly regional wind conditions, the smoke plumes from Cells 6 and 8 eventually were transported toward the immediate offsite canyon or valley regions to the West/Northwest and then were further dispersed vertically in both a downward and upward direction as the plumes moved away from the CCLF boundary, with disbursement back to ground level in the Val Verde community to the Northwest. We observed Northeasterly winds causing this same effect when there was a change in wind direction immediately after the Northeasterly winds, with subsequent regional winds coming from the South.

During the study, differences in air movement between Cells 6 and 8 were observed. These conditions were more prominent when winds were from the Northeast and East; however, some variation could be seen at all times. This divergence in wind patterns diminishes when regional winds were coming from a more Southerly direction. This was evident when comparing winds and plume movement from the second day of testing to the testing accomplished on the first and third days. Smoke releases from Cell 6 appeared to move more directly toward the Northwest with less dilution as they moved through and out of the CCLF. While smoke releases from Cell 8 did follow the same pattern, it appeared that more mixing and dilution occurred prior to the plume leaving the site. This could be due to the variable winds that could exist at different times at Cell 8 versus Cell 6.

3.2 CONCLUSIONS

One of the key areas of analysis for this air movement study was the possibility that low points or "saddles" along the western ridgeline are preferential pathways for air parcels to exit the CCLF. Based on the smoke study, these saddles may have a negligible influence on plumes that originate in Cells 6 and 8 in terms off-site air movement; they are not the primary influence on such movement and are not as prominent as originally thought. As noted above, the rapid ascent of plumes, which are then mixed into the regional flow above, represents the primary factor in how air parcels from Cells 6 and 8 can leave the site to the West/Northwest. The regional winds dipped in elevations near the low points identified along the western boundary of the CCLF, and therefore these low points represent the lowest elevation at which rising air parcels could mix with regional winds. However, we observed that the plume rise continued above the elevation of the saddles and mixing occurred at a higher elevation above the level of the saddles, and we did not observe any smoke plumes leaving directly through the saddles.

In accordance with Condition 32c of the Modified Order, the next study will address the feasibility of airflow disruptors. Based upon our conclusions in this report, we believe that any attempt to enhance additional vertical mixing (i.e., mixing of the plume while it is rising vertically) of air parcels from Cells 6 and 8, beyond what already occurs with the plume rise, is not an effective approach for reducing potential downwind impacts since this mixing is already occurring. The purpose of a vegetative barrier is to create vertical mixing. As such, a vegetative barrier, for example, placing tree stands or other shrubs or plants, along the western ridgeline, will not alleviate downwind impacts outside the CCLF boundary since these barriers are unlikely to intersect or influence any plumes originating from Cells 6 and 8. Such plumes are already entrained in the rising air masses, which are experiencing increasing elevation and vertical mixing at a rapid pace that would carry them well over any vegetative barriers. Due to the rapid plume rise observed and the plume heights reached at the CCLF boundary (approximately 100 to 200 feet above the boundary peaks), it is clear that air parcels would be carried up and over any vegetative barriers along the ridgeline.

However, we believe that additional mixing of the plume along a cross-wind plain that extends horizontally may be more effective in reducing odors, which otherwise might eventually impact the Val Verde area. Enhanced horizontal mixing will redirect air parcel trajectories over a wider region near the source, which will serve to spread out and mix any plume. Limited horizontal mixing is occurring presently. Such spreading will distribute the plume over a wider area thus resulting in lower concentrations at any downwind locations. Our next report will focus on the feasibility and implementation of airflow distribution systems and methods that will improve horizontal mixing of air parcels, and to confirm the general conclusion of this study and report that increased vertical mixing through installation of a vegetative barrier will be an ineffective odor control measure.

Figure 46. Example of Rapid Plume Rise from Cell 6

Photo taken Southwest of Release Point A with a viewing angle of Northeast.

Figure 47. Plume Movement Influenced by Terrain

Photo taken East of Release Point B with a viewing angle of West.

Figure 48. Example of Plumes Moving in Opposite Directions Caused by a Local Vortex

Photo taken Southeast of Release Point A with a viewing angle of Northwest.

Figure 49. Schematic of Canyon Wind Flow