Technical Report Iso-Settlement Survey Operable Unit 2 Landfills Former Fort Ord, California



Prepared for:

On behalf of:

U.S. Army Corps of Engineers Sacramento District 1325 J Street Sacramento, CA 95814-2922



U.S. Department of the Army Fort Ord Base Realignment and Closure 4463 Gigling Road, Room 101 Seaside, CA 93955

USACE Contract No.

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Amendment No. P00008

Task No. 6.2

Prepared by:

Ahtna

Ahtna Environmental, Inc. 296 12th Street Marina, CA 93933-6001

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Report Use and Limitations

Report Title:	Technical Report Iso-Settlement Survey Operable Unit 2 Landfills Former Fort Ord. California
Prime Contractor:	Ahtna Environmental, Inc.
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Ahtna Environmental, Inc. (Ahtna) prepared this report at the direction of the U.S. Army Corps of Engineers (USACE) for the sole use of the U.S. Department of the Army (Army), the intended beneficiary. No other party should rely on the information contained herein without the prior written consent of the Army. This report and its interpretations, conclusions, and recommendations use the information presented in other documents, as cited in the text and listed in the references. Therefore, this report is subject to the limitations and qualifications presented in the referenced documents.

Report Approval

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Derek S. Lieberman, P.E. Certificate No. C 57417 Ahtna Environmental, Inc. Project Manager

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Acronyms and Abbreviations

27CCR	Title 27 California Code of Regulations
Ahtna	Ahtna Environmental, Inc.
Army	U.S. Department of the Army
CAD	computer aided design
LLDPE	linear low-density polyethylene
OU2	Operable Unit 2
Polaris	Polaris Consulting
USACE	U.S. Army Corps of Engineers

1.0 Introduction

The former Fort Ord, located in northern Monterey County, California (Figure 1) was an active U.S. Army base from 1917 to 1994 encompassing approximately 28,000 acres. The U.S. Environmental Protection Agency added Fort Ord to the National Priorities List primarily on the basis of groundwater contamination discovered in 1990 beneath the Fort Ord Landfills area, which was subsequently designated as Operable Unit 2 (OU2). Fort Ord was placed on the Base Realignment and Closure list in 1991. As the lead agency, the U.S. Department of the Army (Army) manages the cleanup of the former Fort Ord in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, commonly known as Superfund.

1.1 Purpose of this Report

Ahtna Environmental, Inc. (Ahtna) prepared this Technical Report on behalf of the U.S. Army Corps of Engineers (USACE), Sacramento District, per Contract W91238-14-C-0048, Amendment No. P00008. This technical report presents the results of the iso-settlement survey conducted at the OU2 Landfills by Polaris Consulting (Polaris) in accordance with Title 27 of the California Code of Regulations (27CCR) Section 21090(e)(2).

1.2 Brief Summary of the Conceptual Site Model

The OU2 Landfills were active from 1955 to 1987 and were used for residential and on-base waste disposal typical of municipal landfills during that time. Waste was placed in parallel trenches 10 to 30 feet deep and then covered over with the native dune sand excavated during trenching operations. Detailed disposal records are not available; however, information gathered during field activities and from other sources indicates that household and on-base commercial refuse, dried sewage sludge, construction debris, and small amounts of chemical waste (paint, oil, pesticides, electrical equipment, ink and epoxy adhesive) were placed in the OU2 Landfills (Shaw, 2005).

The OU2 Landfills formerly included six landfill areas, one area north and five areas south of Imjin Parkway, covering approximately 150 acres, including the immediate surrounding area (Figure 2). The former Area A Landfill, north of Imjin Parkway, was approximately 33 acres separated from the Areas B through F Landfills to the south of Imjin Parkway. The Areas B through F Landfills encompass approximately 120 acres of undeveloped land. The former Area A was used from 1956 to 1966. Areas B through F were operated from 1960 until 1987, when interim closure of the facility began which effectively terminated waste disposal activities at the OU2 Landfills (Shaw, 2008).

2.0 Mapping Methodology

Polaris's methodology for developing the iso-settlement maps is provided in Attachment A. The 2018 aerial survey mapping meets or exceeds National Map Accuracy Standards. The vertical accuracy standard applied to elevation maps is that not more than 10 percent of the elevations tested can be in error of more than one-half the contour interval. For both the base topography and the 2018 topography, the contour interval is one foot. Spot elevations shown in the 2018 mapping (Attachment B) are within 0.1 foot of actual elevations. Given that the 1998/2003 mapping was prepared by a licensed land surveyor, it can be assumed that it also meets National Map Accuracy Standards. Thus, it can be concluded that the iso-settlement mapping also meets National Map Accuracy Standards.

2.1 Base Topography

Ahtna performed a review of OU2 Landfills related reports to determine a historical landfill survey chronology (Table 1), and provide Polaris with accurate base topography to use for comparison to the photogrammetric survey data collected on August 6, 2018 for generating the iso-settlement maps. The following reports were found to contain the most relevant information:

- Draft Final Remedial Action Construction Completion Report, Operable Unit 2 Landfills, Areas A through F (Shaw, 2005)
- Final Construction Quality Control and Quality Assurance Report, Area E, Phase I, Operable Unit 2 Landfills (Gilbane, 2014)

Base topography for Areas B, C, D and F was obtained from the computer aided design (CAD) file named BCDEF-Asblt.dwg, which was determined to be representative of the final cover in 1998 as depicted in the construction drawings, Sheet C80, File No. 1966E274 and Sheet C82, File No. 1966E276 (Attachment C).

Base topography for Area E differs from Areas B, C, D and F in that the northwestern portion of Area E (Interim Area E) was left open until December 2002 to accept waste from other Fort Ord remediation sites (Figure 2). The base topography data for Area E was obtained from the CAD file named 783751SJ-e33.dwg which was determined to be representative of the post-interim closure surface in 2003 as depicted in the construction drawings, Sheet C81, File No. 1966E275 (Attachment C).

Since 2002, other construction activities have occurred at Area E. Construction of the Area E vertical expansion involved placing additional remediation waste above the existing linear low-density polyethylene (LLDPE) geomembrane and providing a new cover consisting of a foundation layer, LLDPE geomembrane, and vegetative layer over the remediation waste. Remediation waste from the Site 39 Inland Ranges is placed over an approximately 17-acre area of Area E as part of the foundation layer; vertical expansion Phase 1 and Phase 2 areas were prepared in 2012 and 2013 to accept this remediation waste. Phase 1 was completed in 2013 with approximately 147,000 cubic yards of remediation waste placed at Area E and sealed above and below by an LLDPE geomembrane (Gilbane, 2014). The Phase 1 area topography is depicted in the record drawings, Sheet C-11 (Attachment C).

During Site 39 remediation activities in 2013, approximately 8,300 cubic yards of remediation waste were placed in the Phase 2 area on top of approximately 12 inches of the pre-existing vegetative soil

layer that covered the original Area E LLDPE geomembrane.¹ In 2015, the remediation waste was temporarily covered with approximately 12 inches of clean soil obtained from the OU2 Landfills borrow source area. Until the vertical expansion is complete, the remediation waste in the Phase 2 area will remain sealed below by an LLDPE geomembrane and covered by 12 inches of clean soil, which is being managed to prevent exposure of remediation waste to the environment. Details of the Area E vertical expansion design are provided in *the Final Design Report, Revised OU2 Landfill Area E Expansion Construction, Former Fort Ord, California* (Gilbane, 2012). Details of the Area E Phase 1 vertical expansion construction are provided in the *Final Quality Control and Quality Assurance Report, Area E Phase I, Operable Unit 2 Landfills, Former Fort Ord, California* (Gilbane, 2014).

2.2 Measurement Error

The relative measurement error of a surface volume calculation is a function of the error of the base surface (1998 for Areas B, C, D and F; 2003 for Area E) and the error of the comparison surface (2018). Three main factors that will impact the absolute error of any surface are terrain irregularity, data density and deviation within the individual measurements.

Metadata were not available for the base topography (1998 and 2003) that was used, so an error uncertainty cannot be reported for the base topography. Uncertainties or absolute error can be estimated based on ties to stable control from prior surveys, which held one point vertically (#81, 92L-16-WEST); however, this disk was no longer available for use. Subsequent mapping has reported elevations on two benchmark disks at the perimeter of the OU2 Landfills: BM-D and BM-F (Attachment B). Polaris was able to tie into both disks, holding one and using the second as validation of the adjustment; however, there are insufficient sample points to make an inference about absolute error. Due to the lack of metadata on the base topography, relative error on the surface comparison also cannot be determined.

¹ This volume is based on 2 feet of soil being placed on an approximately 2.6-acre area, which is the uncapped Phase 2 portion of the Area E vertical expansion.

3.0 Differential Settlement Findings

Comparison of 1998 base topography with 2018 photogrammetric survey data indicated no significant changes in surface elevations at Areas B, C, D, and F as shown on the iso-settlement maps for each area (Attachment B). Comparison of historical elevation data for settlement monuments on all the OU2 Landfills areas also demonstrates no significant changes in surface elevations (Table 2). This is likely due to the age of the waste in these areas, with waste last received at the OU2 Landfills in the western half of Area F in 1987 (Dames & Moore, 1993). Typically 20 percent of waste settlement occurs in the first 5 years after disposal as decomposition reduces the waste volume; therefore, most of the long-term settlement in the waste trenches in Areas B, C, D, and F had already occurred prior to construction of the engineered cover system in 1997 and 1998 (Ahtna, 2018).

Comparison of 2003 base topography with 2018 photogrammetric survey data for Area E indicated significant changes in surface elevations related to the Phase 1 vertical expansion and clean soil stockpiling in the Phase 2 area as shown on the iso-settlement map for Area E (Attachment B).

The following sections provide more detail on the findings of the iso-settlement survey for each area of the OU2 Landfills, with a focus on changes in surface topography that are greater than ±1 foot.

3.1 Area B

Area B accepted waste from 1966 to 1975 (Dames & Moore, 1993). Minor sloughing of the vegetative cover has occurred in isolated locations around the perimeter of Area B resulting in decreases in elevation of 1 foot to 2 feet relative to the 1998 base topography. The location with the most significant change in elevation is on the southeastern side of Area B where perimeter road improvements created a depression between Areas B and C as shown in Sheet C80 (Attachment C); however, this has not had an adverse effect on the engineered cover system as shown in Photograph 1.

Settlement monument SM-B1 is in the middle of Area B (Attachment C, Sheet C80). In the 20-year period following placement of waste and the engineered cover system in Area B, the elevation of SM-B1 has declined 0.20 of a foot (2.4 inches) (Table 2). As shown on the iso-settlement map for Area B in Attachment B, elevation differentials between 1998 and 2018 over most of Area B have been less than 1 foot, with a maximum differential of -4 to -5 feet in the area of the perimeter road improvements noted above.

Based on site history and the results of the iso-settlement mapping and settlement monument survey, elevation changes in Area B appear to be the result of historical slope stability issues and construction activities, and are not related to decomposition of the underlying waste.

3.2 Area C

Area C accepted waste from 1966 to 1975 (Dames & Moore, 1993). The location with the most significant decrease in elevation is on the western side of Area C where perimeter road improvements created a depression between Areas B and C as shown in Sheet C80 (Attachment C); however, this has not had an adverse effect on the engineered cover system as shown in Photograph 1. In addition, the northeastern corner of Area C exhibits increases in surface elevation of up to 4 feet when compared to the 1998 base topography that were likely the result of road construction and maintenance.

Settlement monument SM-C1 is in the middle of Area C (Attachment C, Sheet C80). In the 20-year period following placement of waste and the engineered cover system in Area C, the elevation of SM-C1 has declined 0.17 of a foot (2.0 inches) (Table 2). As shown on the iso-settlement map for Area C in Attachment B, elevation differentials between 1998 and 2018 over most of Area C have been less than 1 foot, with a maximum differential of 3 to 4 feet in the area of the road maintenance noted above.

Based on site history and the results of the iso-settlement mapping and settlement monument survey, elevation changes in parts of Area C appear to be the result of construction activities, and there is no indication of settlement related to decomposition of the underlying waste.

3.3 Area D

Area D accepted waste from 1966 to 1975 (Dames & Moore, 1993). Minor to moderate sloughing of the vegetative cover has occurred on the northwestern and southeastern slopes of Area D resulting in decreases in elevation of 1 foot to 3 feet relative to the 1998 base topography. Repair of the vegetative cover on the northwestern slope included the placement of a concrete-lined drainage ditch to mitigate erosion (Photograph 2).

Settlement monument SM-D1 is in the middle of Area D (Attachment C, Sheet C80). In the 20-year period following placement of waste and the engineered cover system in Area D, the elevation of SM-D1 has declined 0.25 of a foot (3.0 inches) (Table 2). As shown on the iso-settlement map for Area D in Attachment B, elevation differentials between 1998 and 2018 over most of Area D have been less than 1 foot, with a maximum differential of -5 to -6 feet in an isolated area of the northwestern slope. The iso-settlement map also shows increasing elevation differential of 1 to 4 feet that represents the top deck berm on the north side of Area D constructed after 1998 to manage storm water runoff and mitigate erosion of the northern slope.

Based on site history and the results of the iso-settlement mapping and settlement monument survey, differential settlement in parts of Area D appears to be the result of slope stability issues and is not related to decomposition of the underlying waste.

3.4 Area E

Area E accepted waste from 1960 to 1987, though from 1975 to 1987 only the northwest portion of Area E was actively receiving waste characterized as "demolition" debris and not household refuse (Dames & Moore, 1993). The base topography for Area E is from 2003 because closure of Interim Area E was completed in December 2002 (Shaw, 2005). Minor to moderate sloughing of the vegetative cover has occurred on the western slopes of Interim Area E resulting in decreases in elevation of 1 foot to 3 feet relative to the 2003 base topography. Repair of the vegetative cover on the western slope included the placement of a concrete-lined drainage ditch in 2015 and a subdrain system in 2017 to mitigate erosion (Ahtna, 2018).

The larger blue shaded area on the Area E iso-settlement map represents the increase in elevation associated with the Phase 1 vertical expansion completed in 2013, as depicted on Sheet C-11 in Attachment C. The smaller blue shaded areas west of the Phase 1 area represent recent placement of clean soils from construction and well installation projects at the former Fort Ord (Photograph 3). These

clean soils will be used as cover material when additional remediation waste is placed in the Phase 2 area at a future date.²

At the western extent of the Phase 2 area, a trench was left in place so a new LLDPE geomembrane may be secured to the existing LLDPE geomembrane to cover additional remediation waste from the Site 39 Inland Ranges to be brought to Area E sometime in the future. This "tie-in" trench is indicated by the narrow "open bracket" shape with surface elevations that are 1 foot to 3 feet lower than the 2003 base topography.

Four settlement monuments have been installed over time at Area E:

- SM-E1 is on the south side of Area E and is the oldest existing monument that represents changes in elevation since the original engineered cover system was constructed in 1998. In the 20-year period following construction of the original engineered cover system at Area E, the elevation of SM-E1 has declined by 0.60 of a foot (7.2 inches).
- SM-E2 was on the north side of Area E but was removed or buried during Area E vertical expansion construction in 2013; however, in the 10-year period following construction of the original engineered cover system at Area E, the elevation of SM-E2 declined by 0.42 of a foot (5 inches).
- SM-E3 is on the north side of Area E and was installed sometime after closure of Interim Area E in 2003 and first surveyed in 2008. In the 10-year period following the first survey event, the elevation of SM-E3 declined by 0.11 of a foot (1.3 inches).
- SM-E4 is in the middle of Area E and is the newest monument that represents changes in elevation since the Phase 1 vertical expansion was constructed in 2012. In the 5-year period following construction of the Phase 1 vertical expansion at Area E, the elevation of SM-E has declined by 0.37 of a foot (4.4 inches).

Based on site history and the results of the iso-settlement mapping and settlement monument survey, elevation changes in Area E appear to be the result of slope stability issues and construction activities, and are not related to decomposition of the underlying waste.

3.5 Area F

Area F accepted waste from 1966 to 1987 (Dames & Moore, 1993). Waste was placed primarily in northsouth oriented trenches then covered with the native soil that was excavated to create the trench. Due to the more recent placement of waste in this part of the OU2 Landfills, settlement related to waste decomposition in the trenches is indicated by areas with elevation loss of 1 foot to 2 feet in the Area F iso-settlement map. It is also apparent that, on the northern side of Area F, some east-west oriented trenches were used for waste disposal. Photograph 4 shows the differential settlement that has occurred since the placement of the engineered cover in 1998.

² The sampling of stockpiles and analytical results will be discussed in the 2018 OU2 Landfills Annual Operations and Maintenance Report.

Minor to significant sloughing of the vegetative cover has occurred on the northern slope of Area F resulting in decreases in elevation of 1 foot to 2 feet relative to the 1998 base topography. Repair of the vegetative cover on the northern slope included the placement of a subdrain system in 2017 to mitigate erosion (Ahtna, 2018). As shown on the iso-settlement map for Area F in Attachment B, elevation differentials between 1998 and 2018 over most of Area F have been less than 1 foot, with isolated settlement areas of -1 to -2 feet in the waste disposal trenches. A maximum differential of 3 to 4 feet is observed at the western extent of Area F in an area of access road improvements.

Based on site history and the results of the iso-settlement mapping and settlement monument survey, differential settlement in Area F appears to be the result of slope stability issues, particularly on the northern slope, and decomposition of the underlying waste in the parallel disposal trenches.

4.0 Conclusions and Recommendations

The majority of settlement related to waste decomposition had already occurred in Areas B, C, and D prior to the placement of the engineered cover system in 1997 because these areas had stopped receiving waste by 1975. Other than differential settlement of the vegetative cover related to construction and minor erosion, no significant changes were observed in these areas when the 2018 surface elevations were compared to 1998 surface elevations.

Because Area F continued to receive decomposable waste until interim closure of the OU2 Landfills in 1987, this area showed evidence of settlement related to waste decomposition in areas that correspond to the locations of waste disposal trenches. However, no significant changes were observed in Area F when the 2018 surface elevations were compared to 1998 surface elevations.

Monuments were installed at the OU2 Landfills after placement of remediation waste and construction of the engineered cover system to monitor landfill settlement. Surveyors have measured monument elevations three times since construction of the engineered cover system for Areas B, C, D, and F was completed in 1998 (Table 2). In the 20-year period following placement of waste and the engineered cover system in these areas at the OU2 Landfills, settlement of the monuments has ranged from 0.17 of a foot (2 inches) at Area C to 0.69 of a foot (8¼ inches) at Area F, with an average settlement of 0.34 of a foot (4 inches) in these areas.

Differential settlement related to waste decomposition could not be assessed for all of Area E because of the amount of construction changes that have occurred there since 1998; however, the change in elevation of less than one foot at settlement monument SM-E1 indicates minimal settlement since 1998. Differential settlement at Area E may continue to be a challenge to assess because more remediation waste from the Site 39 Inland Ranges will be placed in the Phase 2 vertical expansion area within the next few years.

The limited amount of differential settlement demonstrates the design and construction of the OU2 Landfills engineered cover system is sufficient because no adverse impacts related to settlement have occurred and none are expected.

It is recommended iso-settlement mapping be completed again in 2023 in accordance with 27CCR Section 21090(e)(2).

5.0 References³

Ahtna Environmental, Inc. (Ahtna), 2018. *Final Annual Report 2017, Operations and Maintenance, Operable Unit 2 Landfills, Former Fort Ord, California*. May 18. AR# OU2-712.

California Code of Regulations, Title 27, Section 21090(e)(2) (27CCR).

- Dames & Moore, 1993. Final Remedial Investigation Report, Remedial Investigation/Feasibility Study, Fort Ord Landfills, Fort Ord, California. June 8. AR# OU2-222.
- ITSI Gilbane Company (Gilbane), 2012. Final Design Report, Revised OU2 Landfill Area E Expansion Construction, Former Fort Ord, California. August 10. AR# OU2-683B.
- Gilbane, 2014. Final Quality Control and Quality Assurance Report, Area E Phase I, Operable Unit 2 Landfills, Former Fort Ord, California. October 8. AR# OU2-687B.
- Shaw Environmental, Inc. (Shaw), 2005. Draft Final Remedial Action Construction Completion Report, Operable Unit 2 Landfills, Areas A through F, Former Fort Ord, California. January 31. AR# OU2-630B.
- Shaw, 2008. Final Construction Completion Report, Landfill Gas System Expansion, Operable Unit 2 Landfills, Former Fort Ord, California, Revision 0. September 11. AR# OU2-662F.

³ At the end of references included in the Fort Ord Administrative Record are the Administrative Record Numbers (AR#s) (e.g. BW-1234). To find the referenced document, this number may be typed into the Online Search tool at: http://www.fortordcleanup.com/documents/search/. Please note the referenced documents were available in the Fort Ord Administrative Record at the time this document was issued; however, some may have been superseded by more current versions and were subsequently withdrawn.

Figures





Tables

Table 1. Chronology of Surveys and Related Events

Dates	Event
15-Sep-94	Fort Ord Military Reservation topographic maps prepared photogrammetically by Hammon, Jensen,
	Wallen and Associates using aerial photography from June 6, 1994.
Dec-97	Vegetative cover installation and hydroseeding in Areas B, C, and D completed.
Aug-98	Vegetative cover installation on Area F completed.
Aug-98	Vegetative cover installation on a portion of Area E completed.
Nov-98	Hydroseeding on portions of Areas E and F completed.
29-Oct-99	Survey of location and elevation of OU2 Landfills settlement monitoring points.
Dec-02	LLDPE geomembrane and vegetative cover at Interim Area E, as-built survey completed.
Jan-03	Hydroseeding on Interim Area E completed.
3-Jun-08	Survey of location and elevation of OU2 Landfills settlement monitoring points.
May-11	Survey of Area E existing topography.
Jul-13	Survey of Area E Phase 1 topography.
Aug-13	Area E vertical expansion Phase 1 completed.
6-Nov-13	Survey of location and elevation of Area E settlement monitoring points.
24-Jul-18	Survey of location and elevation of OU2 Landfills settlement monitoring points.
26-Oct-18	OU2 Landfills topographic maps prepared photogrammetically by Polaris Consulting using aerial
	photography from August 6, 2018.

	Coord (NAD 83, S Californi	inates tate Plane, a Zone 4)	Settlement Monument Elevations (feet MS				SL)
Settlement Monument	Northing	Easting	10/29/1999	6/3/2008	11/6/2013	7/24/2018	Change in Elevation 1999-2018
SM-B1	2135608.561	5744527.897	197.61	197.29	NM	197.41	-0.20
SM-C1	2135215.617	5745255.639	221.47	221.22	NM	221.30	-0.17
SM-D1	2135682.304	5745804.664	237.74	237.55	NM	237.49	-0.25
SM-E1	2134079.443	5746245.577	254.54	253.93	NM	253.94	-0.60
SM-E2	2134687.315	5746193.998	248.05	247.63	NA	NA	NA
SM-E3	2134867.429	5746005.352	NA	253.39	NM	253.28	-0.11
SM-E4	2134397.730	5746295.800	NA	NA	264.18	263.81	-0.37
SM-F1	2135361.418	5747027.801	218.09	217.86	NM	217.69	-0.40
SM-F2	2135224.354	5747981.878	207.76	207.06	NM	207.07	-0.69

Table 2. Settlement Evaluation

Notes:

NA = not available (settlement monument not yet constructed or destroyed).

NM = not measured.

SM-E2 was removed or buried during Area E vertical expansion construction in 2012.

SM-E3 was installed sometime between closure of Interim Area E in 2003 and June 2008.

SM-E4 was installed after the Area E Phase 1 vertical expansion was completed in 2013.

Photographs



Photograph 1. Areas B/C Road Crossing



Photograph 2. Western Area D Concrete V-Ditch



Photograph 3. Area E Construction Soils/Drill Cuttings



Photograph 4. Area F Waste Trench Settlement

Attachments

Attachment A

Professional Land Surveyor's Statement of Mapping Methods



Polarís Consulting

Professional Land Surveying Services

P. O. Box 1378, Carmel Valley, CA 93924 (831) 659-9564 E-mail: polarisconsulting@comcast.net

October 26, 2018

Derek Lieberman Via email: dlieberman@ahtna.net

Re: OU2 Landfill Iso-Settlement Mapping Ahtna Environmental, Inc. 110 W 38th Avenue, Suite 200B Anchorage, Alaska 99503

Dear Mr. Lieberman:

We've completed the Iso-Settlement mapping of the OU2 Landfills south of Imjin Parkway. We mapped the existing site features and existing elevations on the OU2 Landfill property based on ties to existing landfill control and referenced to California State Plane Coordinates, Zone 4 NAD83 (1992), NGVD 1929, using an aerial survey.

We prepared the enclosed Iso-Settlement map that shows 2018 contours and their relationship to the baseline surfaces that we compiled. The Iso-Settlement map indicates all areas where differential settlement has been noted since the baseline map submittal. We were not provided a comprehensive basemap of the OU2 Landfill areas south of Imjin Parkway that reflected post closure conditions. We spent considerable time compiling existing data sources into a uniform basemap. I will detail the compilation process below.

Iso-Settlement Mapping Methods

We worked with AHTNA staff to determine the applicable drawing files to use to compile the baseline surfaces. For Areas B, C, D and F we used the drawing named BCDEF-Asblt.dwg. This drawing was assumed to be representative of final cover conditions in 1998. For Area E, we used the drawing named 783751SJ-e33.dwg. This drawing was assumed to be representative of post-interim closure conditions in 2003.

We made separate Civil 3D surfaces for each landfill area. These surfaces were saved in the drawing named OU2 Landfill Cells IsoSettlement Surface Model Baseline.dwg. We created the 2018 CompilationX.dwg to perform the surface analysis. This drawing has the 1998 and 2003 baseline surfaces and the 2018 existing conditions surface. Volume surfaces were built for each OU2 cell using the 1998 and 2003 surfaces as the Base Surface and the 2018 surface as the Comparison Surface. The volume surface is modeled by elevation banding on a 1 foot interval. The 2018 Compilation

Derek Lieberman Via email: dlieberman@ahtna.net

Re: OU2 Landfill Iso-Settlement Mapping Ahtna Environmental, Inc. 110 W 38th Avenue, Suite 200B Anchorage, Alaska 99503

> drawing and all associated drawings are being provided electronically via download link and CD. Hard copies will follow in the mail.

Sincerely, afford

Lynn A. Kovach L. S. 5321

Attachment B

Iso-Settlement Maps



- 1. BASE TOPOGRAPHIC DATA WAS PROVIDED BY AHTNA ENVIRONMENTAL, INC. AREAS B, C, D AND F WERE DERIVED FROM THE AUTOCAD DRAWING BCDEF-ASBLT.DWG AND ARE ASSUMED TO BE REPRESENTATIVE OF CONDITIONS IN 1998. AREA E WAS DERIVED FROM THE AUTOCAD DRAWING 783751SJ-e33.DWG AND IS ASSUMED TO BE REPRESENTATIVE OF CONDITIONS IN 2003.
- 3. CONTOURS SHOWN HEREON ARE BASED ON EXISTING SITE CONDITIONS.
- 4. EXISTING SITE TOPOGRAPHY IS BASED ON AN AERIAL PHOTOGRAMMETRIC SURVEY PROVIDED BY POLARIS CONSULTING, DATE OF PHOTOGRAPHY 8-6-18. DATA ARE BASED ON CALIFORNIA STATE PLANE COORDINATE SYSTEM, ZONE 4, NAD 83. HORIZONTAL CONTROL WAS DERIVED FROM FOUND MONUMENTS PER RECORD OF SURVEY FILED WITH THE COUNTY OF MONTEREY IN VOLUME 19 OF SURVEYS AT PAGE 20, SHOWN AS POINTS 58 AND 59 THEREON. POINTS ARE IRON PIPES AND PLASTIC PLUG STAMPED BESTOR RCE 15310. PRIOR MAPPING OF THE OU-2 LANDFILLS USED VERTICAL CONTROL 81 (92L-16-WEST) BEING A BRASS DISK ON REBAR. POINT 81 IS DESTROYED. THEREFORE, BM-F WAS HELD FOR VERTICAL CONTROL. VERTICAL DATUM IS NGVD 1929 BASED ON BM-F SHOWN HEREON, ELEVATION = 199.47'. TABLE A LISTS THE SURVEY CONTROL MONUMENTS.
- 5. SETTLEMENT MONITORING PLATES WERE MEASURED AS PART OF THIS SURVEY. TABLE B SUMMARIZES THE MEASURED CHANGES IN ELEVATION.
- 6. INDIVIDUAL OU-2 LANDFILL AREAS ARE DEPICTED ON SHEETS 2-6. TABLE C SUMMARIZES THE SURFACE ELEVATION DIFFERENCES BETWEEN THE BASE MAPPING AND EXISTING CONDITIONS.

Point #	Northing	Easting	Elevation	Designation/Description			
58	2135523.39	5742608.27	183.32	1" IRON PIPE, TAG ILLEGIBLE			
59	2135839.97	5743605.00	176.78	1" IRON PIPE, TAGGED BESTOR RCE 15310			
100	2136128.43	5745923.34	235.46	BM-D			
101	2135497.71	5748490.84	199.47	BM-F			

Table A. OU-2	able A. OU-2 Landfill Survey Control							
Point #	Northing	Easting	Elevation	Designation/Description				
58	2135523.39	5742608.27	183.32	1" IRON PIPE, TAG ILLEGIBLE				
59	2135839.97	5743605.00	176.78	1" IRON PIPE, TAGGED BESTOR RCE 15310				
100	2136128.43	5745923.34	235.46	BM-D				
101	2135497.71	5748490.84	199.47	BM-F				

EXISTING CONDITIONS





- 1. BASE TOPOGRAPHIC DATA WAS PROVIDED BY AHTNA ENVIRONMENTAL, INC. AREAS B, C, D AND F WERE DERIVED FROM THE AUTOCAD DRAWING BCDEF-ASBLT.DWG AND ARE ASSUMED TO BE REPRESENTATIVE OF CONDITIONS IN 1998. AREA E WAS DERIVED FROM THE AUTOCAD DRAWING 783751SJ-e33.DWG AND IS ASSUMED TO BE REPRESENTATIVE OF CONDITIONS IN 2003.
- 3. CONTOURS SHOWN HEREON ARE BASED ON EXISTING SITE CONDITIONS.
- 4. EXISTING SITE TOPOGRAPHY IS BASED ON AN AERIAL PHOTOGRAMMETRIC SURVEY PROVIDED BY POLARIS CONSULTING, DATE OF PHOTOGRAPHY 8-6-18. DATA ARE BASED ON CALIFORNIA STATE PLANE COORDINATE SYSTEM, ZONE 4, NAD 83. HORIZONTAL CONTROL WAS DERIVED FROM FOUND MONUMENTS PER RECORD OF SURVEY FILED WITH THE COUNTY OF MONTEREY IN VOLUME 19 OF SURVEYS AT PAGE 20, SHOWN AS POINTS 58 AND 59 THEREON. POINTS ARE IRON PIPES AND PLASTIC PLUG STAMPED BESTOR RCE 15310. PRIOR MAPPING OF THE OU-2 LANDFILLS USED VERTICAL CONTROL 81 (92L-16-WEST) BEING A BRASS DISK ON REBAR. POINT 81 IS DESTROYED. THEREFORE, BM-F WAS HELD FOR VERTICAL CONTROL. VERTICAL DATUM IS NGVD 1929 BASED ON BM-F SHOWN HEREON, ELEVATION = 199.47'. TABLE A LISTS THE SURVEY CONTROL MONUMENTS.
- SETTLEMENT MONITORING PLATES WERE MEASURED AS PART OF THIS SURVEY. TABLE B 5. SUMMARIZES THE MEASURED CHANGES IN ELEVATION.
- 6. INDIVIDUAL OU-2 LANDFILL AREAS ARE DEPICTED ON SHEETS 2-6. TABLE C SUMMARIZES THE SURFACE ELEVATION DIFFERENCES BETWEEN THE BASE MAPPING AND EXISTING CONDITIONS.

Table B. Settlement Monitoring Plate Data

Point #	Designation	2018 Measured Elevation (ft)	Published Elevation (ft)	Difference (ft)
102	SM-B1	197.41	197.61	-0.20
103	SM-C1	221.30	221.47	-0.17
104	SM-D1	237.49	237.74	-0.25
105	SM-F1	217.69	218.09	-0.40
106	SM-F2	207.07	207.76	-0.69
107	SM-E1	253.94	254.54	-0.60
206	SM-E4	263.81		
207	SM-E3	253.28		
		•		

Table C. OU-2 Landfill Area 2018 Settlement Data

Volume Surface Area Designation	Minimum Elevation (ft)	Maximum Elevation (ft)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)	Cut
В	-4.96	3.50	2,044	2,250	205	F
С	-2.88	4.08	767	2,982	2,215	F
D	-5.62	3.18	1,654	7,059	5,405	F
E	-2.81	17.30	5,259	155,010	149,751	F
F	-2.31	3.12	10,528	6,607	3,922	C

ISO-SETTLEMENT MAP

OF FORMER FORT ORD OU-2 LANDFILLS SOUTH OF IMJIN PARKWAY

MARINA, CALIFORNIA

LEGEND

SETTLEMENT MONITORING POINT

Volume Surface showing the change in elevation from 1998 to 2018 at Area B

Elevations Table						
Number	Minimum Elevation	Maximum Elevation	Color			
1	-5.000	-4.000				
2	-4.000	-3.000				
3	-3.000	-2.000				
4	-2.000	-1.000				
5	-1.000	0.000				
6	0.000	1.000				
7	1.000	2.000				
8	2.000	3.000				
9	3.000	4.000				



SCALE IN FEET

PREPARED FOR: AHTNA ENVIRONMENTAL, INC. SURVEYED BY: POCARIS CONSUCTING P. O. BOX 1378 CARMEL VALLEY, CA 93924 831-659-9564

SCALE: 1'' = 40' VIEW: AREA B FILE NAME: 2018 Compilation.dwg JOB #18186 Sheet 2 of 6

120

DATE: October 26, 2018



- 1. BASE TOPOGRAPHIC DATA WAS PROVIDED BY AHTNA ENVIRONMENTAL, INC. AREAS B, C, D AND F WERE DERIVED FROM THE AUTOCAD DRAWING BCDEF-ASBLT.DWG AND ARE ASSUMED TO BE REPRESENTATIVE OF CONDITIONS IN 1998. AREA E WAS DERIVED FROM THE AUTOCAD DRAWING 783751SJ-e33.DWG AND IS ASSUMED TO BE REPRESENTATIVE OF CONDITIONS IN 2003.
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- 5. SETTLEMENT MONITORING PLATES WERE MEASURED AS PART OF THIS SURVEY. TABLE B SUMMARIZES THE MEASURED CHANGES IN ELEVATION.
- 6. INDIVIDUAL OU-2 LANDFILL AREAS ARE DEPICTED ON SHEETS 2-6. TABLE C SUMMARIZES THE SURFACE ELEVATION DIFFERENCES BETWEEN THE BASE MAPPING AND EXISTING CONDITIONS.

Point #	Designation	2018 Measured Elevation (ft)	Published Elevation (ft)	Difference (ft)
102	SM-B1	197.41	197.61	-0.20
103	SM-C1	221.30	221.47	-0.17
104	SM-D1	237.49	237.74	-0.25
105	SM-F1	217.69	218.09	-0.40
106	SM-F2	207.07	207.76	-0.69
107	SM-E1	253.94	254.54	-0.60
206	SM-E4	263.81		
207	SM-E3	253.28		

Table C. OU-2 Landfill Area 2018 Settlement Data

Volume Surface Area Designation	Minimum Elevation (ft)	Maximum Elevation (ft)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)	Cut/Fill	
В	-4.96	3.50	2,044	2,250	205	Fill	
С	-2.88	4.08	767	2,982	2,215	Fill	
D	-5.62	3.18	1,654	7,059	5,405	Fill	
E	-2.81	17.30	5,259	155,010	149,751	Fill	
F	-2.31	3.12	10,528	6,607	3,922	Cut	

ISO-SETTLEMENT MAP

OF FORMER FORT ORD OU-2 LANDFILLS SOUTH OF IMJIN PARKWAY

MARINA, CALIFORNIA

LEGEND

SETTLEMENT MONITORING POINT

Volume Surface showing the change in elevation from 1998 to 2018 at Area C Elevations Table

Number	Minimum Elevation	Maximum Elevation	Color
1	-3.000	-2.000	
2	-2.000	-1.000	
3	-1.000	0.000	
4	0.000	1.000	
5	1.000	2.000	
6	2.000	3.000	
7	3.000	4.000	
8	4.000	5.000	

PREPARED FOR: AHTNA ENVIRONMENTAL, INC. SURVEYED BY: POCARIS CONSUCTING P. O. BOX 1378 CARMEL VALLEY, CA 93924 831-659-9564

SCALE: 1" = 40' VIEW: AREA C DATE: October 26, 2018 FILE NAME: 2018 Compilation.dwg JOB #18186 Sheet 3 of 6



- 1. BASE TOPOGRAPHIC DATA WAS PROVIDED BY AHTNA ENVIRONMENTAL, INC. AREAS B, C, D AND F WERE DERIVED FROM THE AUTOCAD DRAWING BCDEF-ASBLT.DWG AND ARE ASSUMED TO BE REPRESENTATIVE OF CONDITIONS IN 1998. AREA E WAS DERIVED FROM THE AUTOCAD DRAWING 783751SJ-e33.DWG AND IS ASSUMED TO BE REPRESENTATIVE OF CONDITIONS IN 2003.
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- 6. INDIVIDUAL OU-2 LANDFILL AREAS ARE DEPICTED ON SHEETS 2-6. TABLE C SUMMARIZES THE SURFACE ELEVATION DIFFERENCES BETWEEN THE BASE MAPPING AND EXISTING CONDITIONS.

Table B. Settlement Monitoring Plate Data

Point #	Designation	2018 Measured Elevation (ft)	Published Elevation (ft)	Difference (ft)
102	SM-B1	197.41	197.61	-0.20
103	SM-C1	221.30	221.47	-0.17
104	SM-D1	237.49	237.74	-0.25
105	SM-F1	217.69	218.09	-0.40
106	SM-F2	207.07	207.76	-0.69
107	SM-E1	253.94	254.54	-0.60
206	SM-E4	263.81		
207	SM-E3	253.28		

OU2 LANDFILL AREA D

Table C. OU-2 Landfill Area 2018 Settlement Data

Volume Surface Area Designation	Minimum Elevation (ft)	Maximum Elevation (ft)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)	Cut/Fill
В	-4.96	3.50	2,044	2,250	205	Fill
С	-2.88	4.08	767	2,982	2,215	Fill
D	-5.62	3.18	1,654	7,059	5,405	Fill
E	-2.81	17.30	5,259	155,010	149,751	Fill
F	-2.31	3.12	10,528	6,607	3,922	Cut

ISO-SETTLEMENT MAP

OF FORMER FORT ORD OU-2 LANDFILLS SOUTH OF IMJIN PARKWAY

MARINA, CALIFORNIA

LEGEND

SETTLEMENT MONITORING POINT

Volume Surface showing the change in elevation from 1998 to 2018 at Area D

Elevations Table						
Number	Minimum Elevation	Maximum Elevation	Color			
1	-6.000	-5.000				
2	-5.000	-4.000				
3	-4.000	-3.000				
4	-3.000	-2.000				
5	-2.000	-1.000				
6	-1.000	0.000				
7	0.000	1.000				
8	1.000	2.000				
9	2.000	3.000				
10	3.000	4.000				



PREPARED FOR: AHTNA ENVIRONMENTAL, INC. SURVEYED BY: POCARIS CONSUCTING P. O. BOX 1378 CARMEL VALLEY, CA 93924 831-659-9564

FILE NAME: 2018 Compilation.dwg JOB #18186 Sheet 4 of 6

SCALE: 1" = 40' VIEW: AREA D DATE: October 26, 2018

Table B	. Settlement	Monitoring	Plate Data
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229.4 228

220.2 221.0

248.0 249.5

248.4

249.2

246.4

212.1

227.8

226.6

Point #	Designation	2018 Measured Elevation (ft)	Published Elevation (ft)	Difference (ft)
102	SM-B1	197.41	197.61	-0.20
103	SM-C1	221.30	221.47	-0.17
104	SM-D1	237.49	237.74	-0.25
105	SM-F1	217.69	218.09	-0.40
106	SM-F2	207.07	207.76	-0.69
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206	SM-E4	263.81		
207	SM-E3	253.28		
		•		•

Table C. OU-2 Landfill Area 2018 Settlement Data

Volume Surface Area Designation	Minimum Elevation (ft)	Maximum Elevation (ft)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)	Cut/Fill
В	-4.96	3.50	2,044	2,250	205	Fill
С	-2.88	4.08	767	2,982	2,215	Fill
D	-5.62	3.18	1,654	7,059	5,405	Fill
E	-2.81	17.30	5,259	155,010	149,751	Fill
F	-2.31	3.12	10,528	6,607	3,922	Cut



Volume Surface showing the to 2018 at Area E

	Elevation	s Table	-
Number	Minimum Elevation	Maximum Elevation	С
1	-3.000	-2.000	
2	-2.000	-1.000	
3	-1.000	0.000	
4	0.000	1.000	
5	1.000	2.000	
6	2.000	3.000	
7	3.000	4.000	
8	4.000	5.000	
9	5.000	6.000	
10	6.000	7.000	
11	7.000	18.000	

ISO-SETTLEMENT MAP

OF FORMER FORT ORD OU-2 LANDFILLS SOUTH OF IMJIN PARKWAY

MARINA, CALIFORNIA

LEGEND

SETTLEMENT MONITORING POINT

NOTES

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change in elevation from 2003



ISO-SETTLEMENT MAP

OF FORMER FORT ORD OU-2 LANDFILLS SOUTH OF IMJIN PARKWAY

MARINA, CALIFORNIA

LEGEND

SETTLEMENT MONITORING POINT

Table B. Settlement Monitoring Plate Data

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104	SM-D1	237.49	237.74	-0.25
105	SM-F1	217.69	218.09	-0.40
106	SM-F2	207.07	207.76	-0.69
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Table C. OU-2 Landfill Area 2018 Settlement Data

Volume Surface Area Designation	Minimum Elevation (ft)	Maximum Elevation (ft)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)	Cut/Fill
В	-4.96	3.50	2,044	2,250	205	Fill
С	-2.88	4.08	767	2,982	2,215	Fill
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F	-2.31	3.12	10,528	6,607	3,922	Cut

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DATE: October 26, 2018

PREPARED FOR: AHTNA ENVIRONMENTAL, INC.



-2.000

-1.000

0.000

1.000

2.000

3.000

4.000

Elevations Table

Number | Minimum Elevation | Maximum Elevation | Color

-3.000

-2.000

-1.000

0.000

1.000

2.000

3.000

1

2

3

4

5

6

7

Attachment C

Record Drawings





