UPDATED TECHNICAL REPORT – MAY 2020 REVISION
GENERAL WASTE DISCHARGE REQUIREMENTS FOR COMPOSTING OPERATIONS

COMPOST SOLUTIONS, INC.
ORLAND, CALIFORNIA
ORDER WQ 2015-0121-DWQ

Prepared for

Compost Solutions, Inc

Prepared by

VESTRA Resources Inc.
5300 Aviation Drive
Redding, California 96002

MAY 2020

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May 15, 2020

GIS, Environmental, & Engineering Services

71801

Melissa Buciak
California Regional Water Quality Control Board
Central Valley Region
364 Knollcrest Drive, Suite 205
Redding, CA 96002

Via GeoTracker
Global ID T10000010322

RE: ~~Updated~~ Revised Technical Report – May 2020 Revision
General Waste Discharge Requirements for Composting Operations
Compost Solutions, Inc.
Order WQ 2015-0121-DWQ
Orland, California

Dear Ms. Buciak:

~~As requested by the Central Valley Regional Water Quality Control Board, an~~ The ~~Updated~~ Technical Report for Compost Solutions has been revised~~prepared~~ to address changes in activities at the ~~Compost Solutions~~ site since ~~the initial submittal in 2012~~2018 revision. These include:

- Removing biosolids as a feedstock
- Construction of an approximately 2-acre lined detention pond
- Revisions to site contours and drainage plan
- Addition of approximately 9 acres of additional compost working surface
- Abandonment of Monitoring Wells MW-1, MW-2, and MW-3

Please contact me if you have any questions at 530-223-2585.

Sincerely,

VESTRA Resources, Inc.

Wendy Johnston
Project Manager

John Andrews
P.G. 4269

CC: Scott Foster/CSI

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Compost Solutions, Inc.

This report was prepared under the direction
of a Professional Geologist

Prepared by

VESTRA Resources Inc.
5300 Aviation Drive
Redding, California 96002

70801

MAY 2020

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A. GENERAL INFORMATION

Compost Solutions, Inc., is an existing compost facility located approximately four miles south of the town of Orland in Glenn County, California. The site address was recently changed and is 6840~~is 6900~~ County Road 27. The facility began operating in the summer of 2007 under individual Waste Discharge Requirements (WDR) Order R5-2007-0088. A full Solid Waste Facility Permit (11-AA-0034) was issued for the facility by Glenn County Environmental Health Department in July 2012.

In December 2016, WDR Order R5-2007-0088 was rescinded and Compost Solutions is now regulated by the General Waste Discharge Requirements for Composting Operations, Order WQ 2015-0121-DWQ (General Order), adopted on August 4, 2015. The Solid Waste Facility Permit was last updated in April 2019.

A.1 Property Owner Contact Information

The property is owned by the Gary L. and Marcia Foster Trust. The facility is operated by Compost Solutions, Inc.

A.2 Operator Contact Information

Mr. Scott Foster
Compost Solutions, Inc.
6900 County Road 27
Orland, California 95963
Telephone: (530) 624-3206
Fax: (530) 865-4446
Email: scottnikkif@gmail.com

A.3 Legal Notices

Legal notices may be served to the address under A.2.

A.4 Legal Business Name and Location

The name of the facility is Compost Solutions, Inc., Composting Facility, hereafter referred to as the "facility." The facility is ~~owned and~~ operated by Compost Solutions, Inc.

The facility is located approximately four miles south of the town of Orland in Glenn County. It is situated on 28 acres in the northeast quadrant of the intersection of County Road N and Road 27 (See Figure 1). This property is in Section 12 of R. 3W, T. 21N, Mount Diablo Base and Meridian (MDBM). The Assessor's parcel number (APN) for the site is 024-030-031. The longitude and latitude of the site are 122.1537 and 39.6841, respectively.

A.5 Facility Description

A.5.a Assessor's Parcel Number(s)

The property is located on one parcel: APN 024-030-031.

A.5.b Legal Description

The property is located in Section 12 of Range 3W, Township 21N, MDBM.

A.5.c Operational Footprint

The 28-acre parcel currently contains approximately: 3 acres of parking and storage areas, 4 acres of vegetated area to act as a filter strip, and 21 acres of compost-turning area. This revision includes:

- The addition of a 12-acre parcel located to the east for a revised total of 40 acres
- Approximately 9 additional acres of compost working surface (summer use only)
- Addition of a retention pond to contain onsite stormwater
- Removal of and filling of previous filter strip
- Drainage revisions on current working face

The revised site layout is shown on Figure 2.

The incoming feedstock is stored in the three-acre storage area located in the southern portion~~west corner~~ of the site (Figure 2). This area is also used for equipment storage and parking. Feedstock may also be stored on the seasonal compost pad, if needed.

A.5.d Permitted Operational Capacity

The input capacity of compost feedstock is ~~up to 50,000 tons per year. Of this, 12,000 tons may be biosolids. Up to 12,000 cubic yard of biosolids, 76~~80,000 cubic yards of green material and ~~15~~20,000 cubic yards of manure and other material~~may be onsite at any time~~. ~~Less than 15,000 cubic yards of other materials is stored onsite.~~ The current processing capacity of the facility is 5,200 tons per day. This will not change.~~The volume of this capacity is approximately 77,800 cubic yards of feedstock annually.~~

A.5.e Surrounding Land Use

Land use within one mile of the facility is agricultural and low-density rural residential. Almond orchards are located on adjacent properties to the north, south, and west. The adjacent property east of the site is farmed for annual crops. Other crops grown within a mile of the site include corn and prunes. Five residences are located within 0.5 miles of the site. The closest of these are three houses are located about 0.4 miles to the east and southeast of the site. Seventeen residences are located within one mile of the site (see Figure 3).

A.5.f Water Supply

Water is used onsite for maintaining moisture in the compost windrows and for dust control. Water is obtained from an onsite agricultural well and applied by a water truck for both uses. In addition to well water, water retained during storm events is used to moisture condition the rows and provide dust control on the compacted soil pad. Water will also now be used from the retention pond until dry.

A.6 Detailed Site Map

A detailed site map, including the location of the water supply well onsite, is shown on Figure 2. Domestic and irrigation wells within one mile of the site are shown on Figure 3.

A.7 Background Information

The facility began operating in the summer of 2007 under individual WDR Order R5-2007-0088. A full Solid Waste Facility Permit (11-AA-0034) was issued for the facility by Glenn County Environmental Health Department in July 2012. In December 2016, WDR Order R5-2007-0088 was rescinded. Compost Solutions is now regulated by Order WQ 2015-0121-DWQ (General Order for Composting Operations), adopted on August 4, 2015. The Technical Report was revised in 2018 previously and the Solid Waste Facility Permit was revised in April 2019.

A.7.a Feedstock

The input capacity of compost feedstock is up to 50,000 tons per year. O~~f this, as much as 12,000 tons will be biosolids.~~ The volume of this capacity is approximately ~~77,800~~100,000 cubic yards of feedstock.

Feedstocks received are summarized in Table 1. The dairy products are obtained from local dairies, the green waste comes from commercial green waste collection operations from the City of Redding and City of Chico, and the wood chips are from local orchards. All of these materials are screened visually for garbage during all phases of handling and shipping.~~ No more than 40 percent of the feedstock by weight is from manure.~~

Table 1
FEEDSTOCK LIST

Feedstock	Pounds/Cubic Yard	Est. Annual Tons
Yard Waste/Greenwaste	200-1,500	1,000-15,000
~~Green Waste~~	~~400-1,500~~	~~15,000~~
Almond Byproducts	400-1,000	5,000
Walnut Byproducts	800-1,500	12,000
Wood Chips	400	500
Ash/Biochar	600	400
Rice Hulls/Straw	200	250
Small-Grain Straw	500-1,000	1,500
~~Biosolids~~	~~1,000-1,800~~	~~2,000 (permitted 12,000)~~
Clay	2,000-3,000	500
Manure	1,200	10,000
~~Cardboard (for biosolids)~~	~~400~~	~~100~~
Ammonium Sulfate	1,800	100
Potassium Sulfate	1,800	100
Phosphate Fertilizer	1,500	50
Micro Nutrients	1,000-3,000	10
Rinse Water	1,700-1,800	4,000
Feed Waste	1,200-1,500	500

~~As much as 12,000 tons of biosolids are processed annually. The biosolids are mixed to a ratio of roughly one part biosolids to one part bulking agent (cogeneration ash, green waste, agricultural waste, or compost) and then placed into windrows for composting. Biosolids compost is produced only during the dry season. Biosolids are composted separately. Shredded cardboard or paper may be incorporated into the biosolids composting process in the future and are considered a feedstock. A Biosolids Management Plan is included in Appendix A.~~

A.7.b Additives

The term "additives" means materials that are stockpiled onsite and mixed with feedstock to adjust the moisture level, carbon-to-nitrogen ratio, or other nutrient balance; to increase porosity; or to create a condition favorable to composting. Additives may include water, horse manure, cattle manure, chemical fertilizers, or other substances.

Manure is obtained from local dairies and used to provide nutrients and microbes to promote composting. Some compost is produced with no manure. In batches that use manure, loads are placed on the composting pad prior to placement of feedstock. The loads are spaced along the row to manage the proportion. Wider-spaced piles produce a lower proportion; closer-spaced piles produce a higher manure proportion. As much as 40 percent manure can be used for some batches. Small proportions of manure may be spread on top of the pile using a compost spreader. Manure moisture content is managed so that it does not create leachate when stockpiled or spread. Manure is delivered to the site on an as-needed basis to avoid stockpiling or may be stored in a bunker over winter as described previously.

Cogeneration ash/biochar ~~(wood ash)~~ may be added at a maximum of five percent by ~~weight~~volume . Ash is obtained from a wood-waste power or cogeneration plant. Wood ash is transported in bulk and dumped in a pile on a prepared pad or bunker. Generally, less than 100 tons (five truckloads) is stored at a given time.

Bone char is a sugar-processing byproduct consisting of lime and plant solids. Bone char, which may be added at a maximum of 10 percent of the total material, is obtained from an industrial sugar plant located in Crockett, California. Bone char is delivered in bulk and spread on the pile by the delivery truck using a side auger. This material is not stored over the winter.

Potassium sulfate may be added at a maximum rate of 10 percent by weight. It is obtained from a commercial fertilizer supplier. Potassium is a fertilizer that promotes biologic activity and composting. Potassium sulfate is delivered in bulk and spread by the delivery tuck. No fertilizer is stored onsite.

Dry urea may be added at a maximum rate of 5 percent by weight. It is obtained from a commercial fertilizer supplier. Urea provides concentrated nitrogen to promote biological activity. Urea is applied as needed, similar to other fertilizers, and is not stored onsite.

A.7.c. Amendments

The term "amendment" means a waste, material, or mineral aggregate, other than a manure or other bioactive waste or material, used for mixing, following composting, to improve the utility of the end product. Post-composting amendments may include fertilizers and/or lime and gypsum to adjust the pH. These amendments are added at the end of the process before the final turning.

A.7.d. Methods of Composting

The agricultural and green waste is stacked into windrows approximately 16 to 18 feet wide, 6 feet deep, and as much as 1,400 feet long (the length of the compost pad). The site has capacity for about 20 rows. Glenn County requires a 100-foot setback from Roads N and 27 on the west and south sides of the project, respectively. Road 27 is separated from the project by the feedstock storage area ~~and vegetative filter strip~~. Windrows are at least 100 feet from Road N. An accessway roughly 10 to 15 feet wide is left between windrows (the final width may be less from sloughing piles).

As feedstock is delivered, the trucks are directed to the composting pad where they dump their load at the end of a row. The dumped material is formed into a windrow using a loader or similar equipment. Unloading and forming proceeds from one end of the row to the other. The length of the windrow varies depending upon the rate of material placement and type of feedstock placed. Once all of the windrows are full, trucks are directed to unload in the feedstock-storage area.

While it is most efficient to place loads on the composting pads as they arrive, feedstock tends to be generated at a greater rate in the spring. Once windrows are filled, and prior to completion of other windrows, there is a period when feedstock must be stockpiled on a feedstock-storage pad (see Figure 2). As composting is completed, finished material is removed and material from the feedstock pile is placed in the vacant rows.

Additives are either placed in a row on the pad prior to the feedstock and incorporated into the feedstock during forming, or spread on top of the formed row and incorporated during tilling.

Compost is processed following guidelines set by the National Organic Program (NOP). These guidelines require a starting carbon-nitrogen ratio of between 25:1 and 40:1. They also require material in windrows to be maintained at a temperature of between 131 and 170 degrees Fahrenheit for a minimum of 15 days, during which time it must be turned a minimum of five times. Turning is performed by a commercial compost turner. Moisture content is measured often and regulated with a portable watering system to maintain a desirable moisture content. As stated by Section 205.203.c of the NOP Regulations (NOP, 2000), the final product *"must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances."*

Finished compost is screened to remove oversized material and stockpiled for shipment. Oversize screenings are placed back into the feedstock stream. Large materials are broken down into smaller pieces prior to reincorporation or removed to a permitted landfill or cogeneration facility.

The new 9-acre area will be used only in the summer months for the production of ultra-high-quality compost. This material is mixed to produce specifications and is covered during composting.

Biosolids are mixed with a bulking agent, such as wood chips, agricultural waste, green waste, or cogeneration ash and placed into windrows with the same configuration as non-biosolids feedstock.

A.7.e Process Flow Diagram

After forming of windrows, on average each row requires two weeks to achieve the required temperature, and a minimum of three weeks of composting time, during which each row is turned every three to seven days. After composting is complete, the compost is screened using a trommel and stockpiled. It is assumed that 2-½ months are required for complete composting and processing. A process flow diagram is included as Figures 4 and 4B.

The final product is approximately 3850,000 tons of finished agricultural and greenwaste compost and 12,000 tons of biosolids compost annually. Speciality compost mixes are also produced to customer specifications. These are generally processed during the summer with very controlled water and cover requirements.

A.7.f Residuals Removal

Non-decomposable material is described as inert trash, excessive soil, or materials that are semi-decomposable and do not decompose within a reasonable time period. Non-decomposable material could include plastic, metal, excessive paper, rock, concrete, brick, glass, masonry, logs, or other inert or semi-inert materials. Soil is inert, but minor amounts (less than 3 percent) of clean soil are not considered deleterious.

Feedstock and compost is visually inspected for non-decomposable materials during the unloading, spreading, turning, and preparation for shipment. Finished compost is run through a trammel to remove material over 1 inch in diameter. Trash and large sticks are picked out of this material and disposed appropriately.

B. SITE CONDITION INFORMATION

B.1 Climatology

B.1.a. Precipitation

The closest weather station is located in Orland, approximately five miles northwest of the facility. Precipitation data from the Orland station (046506) is provided in Table 2. Average precipitation for the period of record from 1903 to 2012 is 19.95 inches based upon Western Regional Climate Center data. The maximum annual precipitation recorded in 1983 was 48.35 inches and the minimum annual precipitation recorded in 1976 was 7.66 inches.

B.1.b. Evaporation

Average potential evapotranspiration (ETo) is defined as the amount of water that would evapotranspire if there was an unlimited amount of water available. A value for the ETo was obtained from Durham Station 12, as reported by the California Irrigation Management Information System (CIMIS). The Durham station is the closest active station to the facility. The station is located approximately 19 miles southeast of the site. Monthly ETo for the station ~~from February 2017 to January 2018~~ is shown in Table 2.

Table 2
PRECIPITATION SUMMARY

Month	Average Precipitation (inches)	Total ETo (inches)
January	4.04	~~0.97~~1.21
February	3.43	~~1.46~~1.95
March	2.66	~~3.24~~3.4
April	1.30	~~4.15~~4.89
May	0.73	~~6.96~~6.58
June	0.37	~~7.25~~7.35
July	0.04	~~7.73~~7.54
August	0.11	~~6.45~~6.61
September	0.37	~~4.82~~4.92
October	1.05	~~3.89~~3.53
November	2.32	~~1.18~~1.63
December	3.52	~~1.61~~1.63
Total	**19.~~95~~94**	**~~49.71~~50.46**

B.1.c. 25-year, 24-hour design storm event

According to National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Estimates, the 25-year, 24-hour storm event for the site is 3.89~~1~~ inches.

B.2 Geology

B.2.a Map and Cross-Sections

The project is located within the Central Valley Geomorphic Province of California. The site is underlain by river deposits of the Modesto Formation to a depth of 200 feet. Below these deposits is the Pliocene-age (two to five million years old) Tehama Formation to a depth of 1,800 feet. The Tehama Formation consists of interbedded gravels and sands and clayey and silty strata. The Tehama Formation is the principal water-bearing formation in the vicinity. Beneath the Tehama Formation lies the Neroly Formation to a depth of 2,200 feet. The Neroly Formation is a Miocene (between five and 23 million years old) marine to non-marine sedimentary formation. Below the Neroly Formation to a depth of approximately 4,000 feet is the Oligocene (between 23 and 38 million years old) marine sandstone called the Upper Princeton Gorge. Below this is the Cretaceous (between 65 and 144 million years old) Chico Formation. The Chico formation was formed in a shallow marine environment and contains connate saline water.

A geologic map is included as Figure 5.

B.2.b Materials

A soils map published by the United States Department of Agriculture Soil Conservation Service in 1967 shows three soil types within the site boundary (Figure 6). These soils are the Hillgate loam, the Arbuckle gravelly loam, and the Tehama silt loam. Descriptions of these soils are summarized in Table 3.

Table 3
SOILS OF INTEREST

Symbol	Name	Thickness	Description
HgA	Hillgate Loam, 0 to 2% slopes	>5'deep	Pale brown hard loam, grades to heavy loam and clay
AoA	Arbuckle Gravelly Loam, 0 to 2% slopes	>5'deep	Brown, hard, gravelly loam, grades to become more gravelly
Tm	Tehama Silt Loam, 0 to 3% slopes	>5'deep	Pale brown, hard silt loam, grades to a silty clay loam
Kb	Kimball Loam, 0 to 2% slopes	7.5' deep	Brown loam, grades to sandy loam

Soil designations are included in more detail in Appendix A. The designations in Figure 6~~this map, however,~~ are not entirely accurate because the field has been leveled for agricultural use, during which soil on the site was cut from high points and used to fill low points. ~~During a site visit on~~In August ~~3,~~ 2006, five test pits were excavated to depths of 8 feet each. The soil profiles of these test pits were logged under the supervision of a California Professional Geologist. These profiles are described in Appendix A~~B~~.

Results of analyses of soil samples collected from the test pits are described in Table 4 and Appendix A~~B~~.

Three groundwater monitoring wells were installed in July 2007. According to the boring logs (Appendix B~~C~~), the soil beneath the site consists of clayey silts, sands, and gravels with occasional lenses of sand and/or gravel. These wells are no longer sampled.

B.3 Hydrogeology

B.3.a General Hydrogeology

Based on groundwater measurements by the Department of Water Resources (DWR) in a well located about 0.5 miles northeast of the site (state well number 21N03W12C002M), the depth to groundwater beneath the site is estimated to be approximately 15 feet below ground surface (bgs) during a wet winter and over 40 feet bgs during the summer. The wet winter value is based on readings from the winter of 1998, during which precipitation exceeded the 100-year storm event. The summer value is based on the summer of 1992, which recorded the lowest water level in the previous 28 years. This depth to water could represent a semi-confined aquifer and may not be representative of perched or shallow groundwater conditions. The pond along the northeast corner of the property contributes to shallow groundwater elevations.

Water level data from three groundwater monitoring wells installed in July 2007 (logs are included in Appendix B~~C~~; the well dimensions are summarized in Table 5) indicate that water ranges between about 35 and 50 feet bgs and flows towards the southwest at between 0.015 and 0.018 ft/ft (Figure 7). During the drought period prior to 2012, the water levels fell to below the bottom of the casing in all of the wells. Two subsequent normal-rainfall years have brought the water levels back up within the well screen in all wells. Based on these observations, it appears that the range of groundwater elevation varies by over 20 feet with annual changes in rainfall.

B.3.b Hydraulic Conductivity

As discussed in the soils section, five test pits were excavated at the site on August 3, 2006. Soil profiles are described in Appendix A~~B~~. The soil profiles of these test pits were logged under the supervision of a California Professional Geologist. The soil test pit locations were included in the 2012 submittal. Results of the analysis of soil samples collected from the test pits were described in Table 4 and Appendix A~~B~~.

B.4 Nearby Water Supply Wells

Groundwater within one mile of the property is used for irrigation and domestic uses. Thirty-three wells were observed within approximately one mile of the site during a site visit by Lawrence, et al., on August 24, 2006. Eighteen well logs were obtained from DWR for the same area. Some of the locations described on the well logs did not have a well, indicating that they were mislocated by the driller. Many wells were found during the site reconnaissance that did not have a log on file with the DWR. Additional wells were identified during website review and a site visit in 2018. The approximate locations of the observed wells within one mile of the site were shown on Figure 3.

B.5 Floodplain

According to Flood Insurance Rate Map (FIRM) number 0600570375B, issued by the Federal Emergency Management Agency (FEMA), the site is located in Zone C and outside of the 500-year floodplain.

C. DESIGN INFORMATION

C.1 Facility Design

C.1.a(1) Existing Pad (Working Surface)

General

For the purpose of the following discussion, a "pad" is defined as a specific location in which (1) feedstock will be unloaded, processed, and stored; (2) feedstock will be composted; (3) bulk additives and amendments will be stored; or (4) finished compost will be stored (Figure 2). Some pads may have multiple uses at different times. Access roads and passageways between pads are not considered pads and may or may not be constructed to the same permeability standard.

Unpaved Pad Permeability

As required by the Compost Order, working surfaces of Tier II facilities must have a hydraulic conductivity of 1.0×10^{-5} centimeters per second (cm/sec) or less. The existing soil pad area has been compacted to have a permeability of no greater than 1×10^{-5} cm/sec.

During design of the pad, five test pits were installed, two types of soil were identified, and a composite sample was collected from the upper foot of soil for each soil type for laboratory analyses. One soil sample was composited from test pits 1 and 3, and the second sample was composited from test pits 2, 4, and 5. The soil samples were submitted to Vector Engineering in Grass Valley for the analyses listed in Table 4. The logs from the test pits are presented in Appendix A~~B~~.

Because the permeability easily met the 1×10^{-5} cm/sec standard using a compaction of 90 percent of maximum dry density, the pad was constructed using 90 percent compaction in two lifts to a total of 12 inches thick.

Table 4
LABORATORY ANALYSES OF COMPOSITE SOIL SAMPLES
TEST PITS AND CQA SAMPLES

Sample	Max Dry Density pcf ASTM D1557	Optimum Moisture% ASTM D1557	USCS Soil Type ASTM D318	Percent Passing 200 Sieve % ASTM D1140	Plasticity Index ASTM D4318	Remolded Perm, 90% cm/sec ASTM D5084	Remolded Perm 95% cm/sec ASTM D5084
Test Pit Samples							
TP 1,3	127.7	10	CL-ML	62.0	5	3×10^{-7}	5.1×10^{-8}
TP 2,4,5	132.7	6.9	SC-SM	42.4	6	1.4×10^{-6}	2.4×10^{-6}
As-Built Undisturbed Samples (June 2007)						**Undisturbed Perm cm/sec ASTM D5804**	
Sample 1			GC			5.9×10^{-7}	
Sample 2a			CL-ML			6.4×10^{-7}	
Sample 2b			GC			1.5×10^{-6}	
Sample 3			GC			3.5×10^{-6}	

After construction, the pad was tested in random locations for density using a nuclear gauge and was found to meet or exceed the compaction requirements. Confirmation that the soil achieved the required permeability was presented in the Construction Quality Assurance Plan for the project (Lawrence & Associates, 2007). Analysis of undisturbed samples indicated that the in-place permeability ranged between 3.5 x 10^{-6} cm/sec and 5.9 x 10^{-7} cm/sec when compacted to between 90 percent and 93 percent of maximum dry density per ASTM D1557 (Table 4).

Grade

The existing pad is graded to a flat plain draining 0.1 percent to the west and 0.2 percent to the south.

Pad

According to "The Plain English Guide to the EPA Part 503 Biosolids Rule," a treatment facility that stores biosolids for less than two years is not considered a land disposal site. Therefore, a treatment facility will not be subject to the construction requirements described in CFR Part 503.

C.1.a(2) New Pad Area (Working Surface)

The additional 9-acre working area soils are consistent with soils in the existing area. In addition, fines from the pond excavation will be spread in the new working pad area. The new working pad will be constructed in the future and be compacted to 90 percent of dry density in two lifts. This will be tested in the field and results submitted to the RWQCB prior to use.

C.1.b Stormwater/Leachate Pond

The General Order requires aAny detention pond used onsite must be designed, constructed, and maintained to prevent conditions contributing to, causing, or threatening to cause contamination, pollution, or nuisance, and must be capable of containing, without overflow or overtopping, all runoff from the working surfaces in addition to precipitation that falls into the detention pond from a 25-year, 24-hour peak storm event at a minimum~~, or equivalent alternative approved by the Regional Water Board~~.

As described above, the highest depth to water is greater than 20 feet bgs which, therefore, will allow a greater than 5-foot separation between the bottom of the pond and the uppermost groundwater.

CSI has determined water retention is the best solution for contact stormwater retention. An approximately 2.5-acre pond will be constructed on the parcel directly east of the site. The pond will contain the average annual precipitation at the site of 19.94 inches (see B.1.a) and the 25-year, 24-hour storm (3.89 inches) per the General Order. Design specifications and water balance are included in Appendix C.

Key design parameters include:

- Pond capacity = approximately 18.5 acre-feet
- Geosynthetic clay liner (GCL) and 60-mil textured HDPE liner
- Ditch not lined (property already 1 x 10^{-6})
- Runoff area = 20 acres
- Total pond surface area = 2 acres
- Runoff factor = 0.5
- Pond slope = 2:1
- 25-year, 24-hour storm = 3.89 inches

Pond design sheets are included in Appendix C.

~~Due to pond costs, CSI is currently reviewing alternative water treatment and use scenarios. The Water and Wastewater Management Plan, summarizing the currently reviewed alternatives, is included in Appendix D. CSI has five years (until 2020) to meet the requirements of the General Order.~~

Water is used onsite for maintaining moisture in the compost windrows and for dust control. Process water is obtained from an onsite agricultural well. Water is applied by a water truck for both uses. Water for operations is provided by an agricultural well located onsite. The well is capable of producing over 200 gpm, far more than the current and future needs of the facility. Retained stormwater is used to moisture condition the rows and provide dust control on the compacted soil pad.

~~C.1.d Current and Proposed Design of Runoff Detention Basins~~

~~Because agricultural and green waste are composted seasonally, runoff from the turning pad is currently treated for suspended solids using a filter strip and shallow detention basin. The detention basin has been constructed in the southeast corner of the property (Figure 2). A 4-acre vegetative filter strip is used to promote sediment removal prior to entry into the detention pond. Filter strips have the ability to remove sediment and nutrients from water that flows through them.~~

~~According to a report published by Montana State University, a filter strip 6 meters long, with similar topography and vegetation as the proposed filter strip, removed 94-99 percent of the sediment from the water running through it (Hook, 2002). A report generated by the Institute for Wetland and Waterfowl Research in 2001 cites many studies confirming that filter strips similar to the one proposed will remove approximately 90-100 percent of the nutrients and sediment from the processed runoff water (Gabor et al., 2001). Figure 2 showed the filter strip. CSI has determined that the current filter strip is not adequate to control site discharge.~~

C.2 Water and Wastewater Management Plan

C.1.c How Water, Compost Leachate, and Wash Water will be Managed

General

For this discussion, process water is defined as water used to wet compost to maintain biological activity. ~~Compost leachate is defined as water that has passed through the compost, potentially dissolving or entraining tannins, silt, and trace salts or other water that has commingled with leachate. (Another name for this water is compost "tea.")~~ Wash water is defined as water used to clean equipment. Stormwater is runoff caused by rainfall that has commingled with leachate. These liquids are controlled using Best Management Practices (BMPs).

Stormwater Conveyance for Control of Run-On and Runoff

The fields in which the composting occurs are~~is~~ located from 1 to 10 feet above the surrounding terrain (Figure 2); therefore, there is no run-on. The downslope edges of the property (east and south) sides have 12-foot-wide roads that prevent uncontrolled runoff onto neighboring properties. All of the water that does not evaporate flows to the southeast corner of the property, where it will flow~~s~~ into a ~~roadside~~ new ditch system and hence to the new retention pond. ~~CSI is currently evaluating various stormwater retention pond designs and plans to install a pond to capture stormwater.~~

The only water entering the site will be from the application of process water and precipitation. Process water will be applied to the compost to promote the health of the beneficial microbiological organisms responsible for the composting process. This water will be controlled by the facility manager and will not produce runoff or saturated conditions. Precipitation will account for all of the inflow of potential runoff water.

The tilling machine will require a wash-down pad to remove adhered compost prior to periodic maintenance. The site operator currently uses a portable wash-down pad constructed of heavy-duty plastic to contain the wash water. The wash water is then allowed to evaporate or applied to compost piles. Solid compost washed off of the tilling machine is placed back on the piles.

Grading and Conveyance of Water

Runoff water from the compost-turning area will now be~~is~~ routed to the south to a new drainage ditch~~east corner~~, where it will be conveyed to the stormwater retention pond~~currently passes through a 4-acre grass filter strip. Initially, water was to drain from the filter strip into a stormwater detention basin. This basin is not intended to be a "retention" or "wash water" basin as described in the WDRs. Its purpose was to detain water so that post-construction peak flow does not exceed pre-construction peak flow and to remove remaining sand-sized particles. This basin was not constructed and water from the filter strip discharges into an existing roadside swale from the southeast corner of the site.~~

~~CSI is currently evaluating alternative stormwater management methods.~~

~~Water Balance~~

~~A stormwater detention basin for the turning pad will need to have the capacity to detain enough water so that peak stormwater discharge from the constructed site does not exceed pre-construction discharge for peak flow from 25-year, 24-hour storms.~~

~~The peak runoff values for 100- and 25-year storms for a duration equaling the time of concentration before and after construction were previously calculated by Lawrence using the~~

~~Rational Method in the previous Technical Report submittal (Lawrence, 2012). The use of detention basins is still being evaluated.~~

~~A Water and Wastewater Management Feasibility Analysis for the facility is included in Appendix D.~~
Material generated from the construction of the new conveyance ditch and retention pond will be used to construct berms around the new 9-acre area and to fill low areas that have developed on the working face.

Wastewater Pond
Wastewater pond will be managed to control odors and vectors as follows:

- Use water as quickly as possible to dry pond by early summer. Water will be pumped to be used on compost rows.
- Limit weed growth on pond banks and in pond.
- Clean drainage ditch as needed to reduce sedimentation into pond.
- If required, aerate pond to reduce odor and provide mixing.

D. OPERATIONS AND MONITORING INFORMATION

As required by the Composting General Order, inspections are conducted in accordance with Attachment B of the Composting Order. Inspection forms are included in Appendix D~~E~~.

D.1 Annual Survey

The facility performs annual surveys of the facility to confirm that all containment structures are prepared for the pending wet season. The survey is conducted prior to the anticipated wet season, but no later than August 31, and any necessary construction, maintenance, or repairs are completed by October 31. The following information is included in the annual monitoring and maintenance report:

1) The observation data and time of the survey, along with the name of the inspector;
2) The type of deficiency/noncompliance observed;
3) The cause for the deficiency/noncompliance;
4) Map showing the area of deficiency/noncompliance;
5) The corrective actions undertaken, or planned to resolve the deficiency/non-compliance including the date and time of repairs;
6) The measures undertaken by the Discharger to prevent the recurrence of the observed deficiency/noncompliance; and
7) Photographs of the observed deficiencies/noncompliance with corresponding location on the map.

The annual survey form (Form C) is included in Appendix D~~E~~.

D.2 Inspection and Maintenance Program

As required by the Composting General Order, the quarterly inspections are performed of the operations area as well as the wastewater management system. The General Order also requires inspections of the facility after major storm events. Inspection forms for quarterly and storm inspections are included in Appendix D~~E~~. In addition to the inspections required by the Composting General Order, the operator also conducts daily inspections of the operating area for evidence of leachate.

D.2.1 Operations Area Quarterly Inspections

Quarterly inspections are performed of the working surfaces, berms, ditches, facility perimeter, erosion control BMPs, and any other operational surfaces. The following observations are made and included in the annual monitoring and maintenance report:

1) Date and time of inspections, along with the name of the inspector;
2) Evidence of areas of deficiency such as cracking or subsidence in the working surfaces;

3) Evidence of ponding over the working surfaces and within ditches (show affected area on a map);
4) Effectiveness of erosion control BMPs;
5) Maintenance activities associated with, but no limited to, the working surfaces, berms, ditches, and erosion control BMPs;
6) Evidence of any water or wastewater leaving or entering the facility, estimated size of affected area, and estimated flow rate (show affected area on a map);
7) Integrity of drainage systems during the wet season; and
8) Photographs of observed and corrected deficiencies.

D.2.2 Wastewater Management System Quarterly Inspections

Quarterly inspections are performed of the wastewater management system and the following observations and records are submitted in the annual monitoring and maintenance report:

1) Date and time of inspections, along with name of inspector;
2) The overall condition of the wastewater management system (i.e. pond liner, storage tank construction, municipal wastewater connection points);
3) The available capacity within storage systems (i.e. pond liner, storage tank construction, municipal wastewater connection points);
4) Presence of odors from the wastewater management system – characterization, source, and distance from source;
5) Volume of wastewater treated and discharged, if applicable; and
6) Volume of wastewater disposed at an offsite treatment system and name and location of the wastewater treatment facility, if applicable.

D.2.3 Major Storm Events Inspections

All precipitation, diversion, and drainage facilities are inspected for damage within seven days following major storm events. Necessary repairs are completed within thirty days of the inspection. Any damage and subsequent repairs including photographs of the problem and repairs are reported in the annual monitoring and maintenance report.

D.2.4 Daily Inspections

In addition to the inspections required by the Compost Order, the operator monitors all active and finished compost, additives, and amendments for generation of leachate on a daily basis. The operator's log records whether leachate was observed and, if so, the location, estimated quantity, and whether it was collected and returned to the compost.

If leachate is detected, action is taken immediately to correct the problem. If the source of the leachate is from the irrigation system, such as a broken pipe or overwatering, the system is turned off immediately and the problem repaired.

D.3 Compost Operations Controls

The practices employed at the facility to ensure the composting operation does not cause, threaten to cause, or contribute to conditions of contamination, pollution, or nuisance are described in this section.

D.3.1 Dust Control

The composting and storage aspects of the operation are conducted in a manner that does not cause, or threaten to cause, a condition of pollution, or nuisance. Dust is controlled by applying water to the material when it is in danger of becoming airborne, such as during windy conditions or during handling. The materials and the pads are continually wetted during the operating season. This additional moisture weighs down soil and compost particles, decreasing the likelihood to become airborne.

D.3.2 Odors

Odors are prevented by the aerobic conditions of the composting environment. The material is turned and watered, as described above, to create a healthy aerobic environment for biological organisms. In an aerobic environment, biological organisms consume air, water, and carbon and release energy in the form of heat. Most of the gas produced from this process is carbon dioxide from the respiration of biological organisms, along with a substantial amount of water vapor caused by the heat produced. Neither carbon dioxide, nor water vapor, create odors. An Odor Minimization Plan prepared previously by Lawrence & Associates (2016) and updated by VESTRA (2018) for Compost Solutions is included in Appendix E~~F~~.

D.3.3 Methods to Control Litter, Dust, Rodents, and Insects

Dust is controlled by watering the alleyways between rows with a water truck as needed. The rows are watered, as needed, to keep the moisture at an optimal level which generally reduces windblown dust. Prior to tilling, the pile is watered using the watering line to ensure that the moisture is optimal to control dust. The moisture of the compost is such that water is rarely needed to prevent dust when screening the finished compost using a trommel. A spray nozzle is used to wet the compost if it becomes too dry.

Litter is generally not present in the feedstock and, when found, is picked out by hand and properly disposed. Any litter accumulated is removed to a refuse receptacle. The compost is generally not attractive to insects and rodents, as it does not provide a food source for them. Agricultural feedstock rarely contains fruit that would attract rodents and insects, and to date there has not been a problem with the feedstock attracting such pests.

D.3.4 BMPs to Prevent Contaminants from Impacting Runoff

The facility is being designed as a closed system, with no water running onto or off of the site. ~~Stormwater management options are currently being evaluated.~~

Feedstock
Agricultural and/or green-waste feedstock is received during any time of the year. Feedstock may be received during rainy periods as long as it placed in the year-round operating pad. During dry weather periods in the winter months, feedstock is turned to prevent excess heat buildup.

Additives
Fertilizer, bone char (described below), potassium sulfate, and dry urea are not stored outside during the winter. ~~As much as 10,000 tons of m~~Manure may be stored onsite any time of the year. Manure that is stored onsite is accepted only with 50 percent or less moisture content by weight. As much as 100 tons (100 to 200 cubic yards) of cogeneration ash may be stored onsite in a manner similar to manure.

~~Biosolids~~
~~As much as 12,000 wet tons of biosolids will be stored onsite. The biosolids are mixed to a ratio of roughly one part biosolids to one part bulking agent (cogeneration ash, green waste, agricultural waste, or compost) and then placed into windrows for composting. Biosolids compost will only be produced during the dry season. During the winter/wet season, any biosolids that remain onsite are covered.~~

D.3.5 Emergency Provisions for Power Failure or Equipment

Backup equipment is available in the rental market for use as needed.

D.3.6 Unusual Peak Loadings

Compost Solutions is a private operation and is not required to accept feedstock; therefore, there is little chance of unusual peak loadings. If the facility has reached its capacity to process and store feedstock, they will simply not accept material until enough has been sold to provide area to accept more.

D.4 Wet Weather Operations

Material handling exposure to precipitation is minimized during the wet season. As described previously, feedstock received during rainy periods is placed on the year-round operating pad. Fertilizer, bone char, potassium sulfate, and dry urea will not be stored outside during the winter. Biosolids compost will only be produced during the dry season, and any residuals are covered during the wet season.

Equipment may be needed to operate on the site during wet conditions. There are no hills or steep grades onsite, so access for large equipment is not a problem. Also, the compost-handling areas is compacted to at least 90 percent maximum dry density.

D.5 Groundwater Protection Monitoring

Groundwater monitoring is not required at the facility, as the site meets the permeability requirements of the General Order. Three groundwater monitoring wells were installed at the facility in July 2007 as part of the individual waste discharge requirements. This Technical Report proposes abandonment of Monitoring Wells MW-1, MW-2, and MW-3 shown on Figure 2.

D.5.a Map

The locations of the groundwater monitoring wells were shown on Figure 3.

D.5.b Plans and Specifications

Three groundwater monitoring wells were installed at the site in July 2007. Logs and well dimensions are included in Appendix BC. The monitoring well dimensions are summarized in Table 5.

Table 5
MONITORING WELL DIMENSIONS

Parameter	MW-1	MW-2	MW-3
Location	downgradient	crossgradient	upgradient
Latitude (degrees)	39.6882	39.6849	39.6840
Longitude (degrees)	-122.1572	-122.1591	-122.1561
Top of casing elevation (ft, MSL)	200.85	204.39	198.05
Total depth (ft bgs)	55	60	50
Screened interval (ft bgs)	35 to 55	40 to 60	40 to 50

D.5.c Inspection Procedures

The monitoring wells were installed in 2007. A No new groundwater monitoring system is not proposed to be constructed at the facility.

D.5.d Sampling and Analysis

The previous groundwater monitoring program is included in Table 6. No additional groundwater sampling is proposed.

Groundwater samples have been collected quarterly in the three monitoring wells when water was available. Prior to collecting groundwater samples, the groundwater levels are measured using a water-level indicator to the nearest hundredth of a foot. Prior to collecting samples and after measuring the water level, each monitoring well is adequately purged to remove water that is standing within the well screen and casing that may not be representative of formation water (minimum of three well volumes). Samples are collected using new disposable polyethylene bailers and transferred directly into laboratory-supplied containers. Immediately following

~~collection, samples are placed into laboratory-supplied coolers, on ice, and transferred to a California-certified analytical laboratory.~~

~~Table 6~~ ~~PREVIOUS GROUNDWATER MONITORING PROGRAM~~			
~~Constituent~~	~~Units~~	~~Sampling Frequency~~	~~Reporting Frequency~~
~~Groundwater Elevation[a]~~	~~0.01 Feet~~	~~Quarterly~~	~~Annually~~
~~Depth to Groundwater~~	~~0.01 Feet~~	~~Quarterly~~	~~Annually~~
~~Gradient~~	~~Feet/Feet~~	~~Quarterly~~	~~Annually~~
~~Gradient Direction~~	~~Degrees~~	~~Quarterly~~	~~Annually~~
~~pH~~	~~Std. Units~~	~~Quarterly~~	~~Annually~~
~~Total Dissolved Solids~~	~~mg/L~~	~~Quarterly~~	~~Annually~~
~~Nitrate as Nitrogen~~	~~mg/L~~	~~Quarterly~~	~~Annually~~
~~Sodium~~	~~mg/L~~	~~Quarterly~~	~~Annually~~
~~Chloride~~	~~mg/L~~	~~Quarterly~~	~~Annually~~
~~Total Coliform Organisms[b]~~	~~MPN/100 mL~~	~~Quarterly~~	~~Annually~~

~~D.5.e Proposed Data Analysis Method~~

~~The groundwater monitoring well network will be abandoned following determination of the water management plan for the site.~~

D.6 Detention Basin Monitoring

Any discharger enrolled under the General Order that has a ~~detention~~ retention pond to manage wastewater onsite must conduct quarterly monitoring of the wastewater within the detention pond, when there is sufficient water, and analyze the samples for the parameters in Table 6~~7~~.

Table 6~~7~~ DETENTION POND MONITORING			
Constituent	Units	Sampling Frequency	Reporting Frequency
pH	Std. units	Quarterly	Annually
Dissolved Oxygen	mg/L	Quarterly	Annually
Total Dissolved Solids	mg/L	Quarterly	Annually
Fixed Dissolved Solids	mg/L	Quarterly	Annually
Total Nitrogen	mg/L	Quarterly	Annually
Specific Conductance	Umhos/cm	Quarterly	Annually

~~It is yet undetermined if CSI will install a detention basin. In lieu of lysimeter monitoring, CSI may retain a nearby monitoring well.~~

~~D.7 Biosolids Monitoring~~

~~Biosolids are accepted at the facility under the Materials Screening Program. CSI requires sampling and analyses of biosolids and has limits regarding these substances and moisture~~

~~content. The instructions for materials screening and biosolids acceptance criteria are included in Appendix A.~~

~~Compost Solutions will provide analytical results from a certified laboratory to demonstrate that biosolids meet, at a minimum, the ceiling concentrations listed in Table 1 of 40 CFR 503. Biosolids may be characterized by CSI or by the entity that generates or otherwise processes the material.~~

~~The biosolids must meet the ceiling concentrations in Table 1 (40 CFR 503) or require monitoring. The screening criteria at the facility meet all the ceiling concentrations, except for molybdenum (75 ppm vs 350 ppm). Need to revise screening criteria or perform biosolids monitoring.~~

E. SITE CLOSURE INFORMATION

At least 90 days prior to ceasing composting operations, the discharger will submit a site closure plan to the Central Valley Regional Water Board for approval. The discharger will jointly notify the appropriate Regional Water Quality Control Board and Local Enforcement Agency (LEA) in writing at the conclusion of site closure activities that describes closure in accordance with the site closure plan and Regional Water Board requirements.

The clean-closure plan, in addition to all activities required under Section 17870 of Title 14, will address returning the surface soils and drainage patterns to their pre-project state, to the extent feasible, and establishing soil erosion control by planting a suitable mixture of vegetation. ~~A clean closure plan for the site is included in Appendix G and described below.~~

Site restoration will follow the requirements of Section 17870 of Title 14 of the Public Resources Code, as follows:

(a) The operator will provide the LEA written notice of intent to perform site restoration at least 30 days prior to beginning site restoration.

(b) The operator(s) and owner(s) will provide site restoration necessary to protect public health, safety, and the environment.

(c) The operator will ensure that the following site restoration procedures are performed upon completion of operations and termination of service:

  (1) The operation and facility grounds, ponds, and drainage areas will be cleaned of all residues including, but not limited to, compost materials, construction scraps, and other materials related to the operations, and these residues legally recycled, reused, or disposed of.

  (2) All machinery will be cleaned and removed or stored securely.

  (3) All remaining structures will be cleaned of compost materials, dust, particulates, or other residues related to the composting and site restoration operations.

In addition to Title 14 regulations, site restoration will include restoring soil and topography characteristics.

The soil at the site will be ripped and tilled to return it to its previous farm field condition. Sediment from the detention pond will be spread on adjacent agricultural fields. The pond may be retained once sediment is removed.~~ and the detention pond removed.~~ Prior to winter, the field will be planted with a winter cover crop.

F. COMPLIANCE SCHEDULE (EXISTING FACILITIES)

~~Groundwater monitoring and inspection plans are already in effect. Following completion of the stormwater management system, the facility will review and evaluate the need for groundwater monitoring.~~

Compost Solutions will complete pond construction by the end of 2021. ~~continues to review stormwater management scenarios (see Appendix D) and will have the selected alternative in place by the end of 2020.~~

G. REFERENCES

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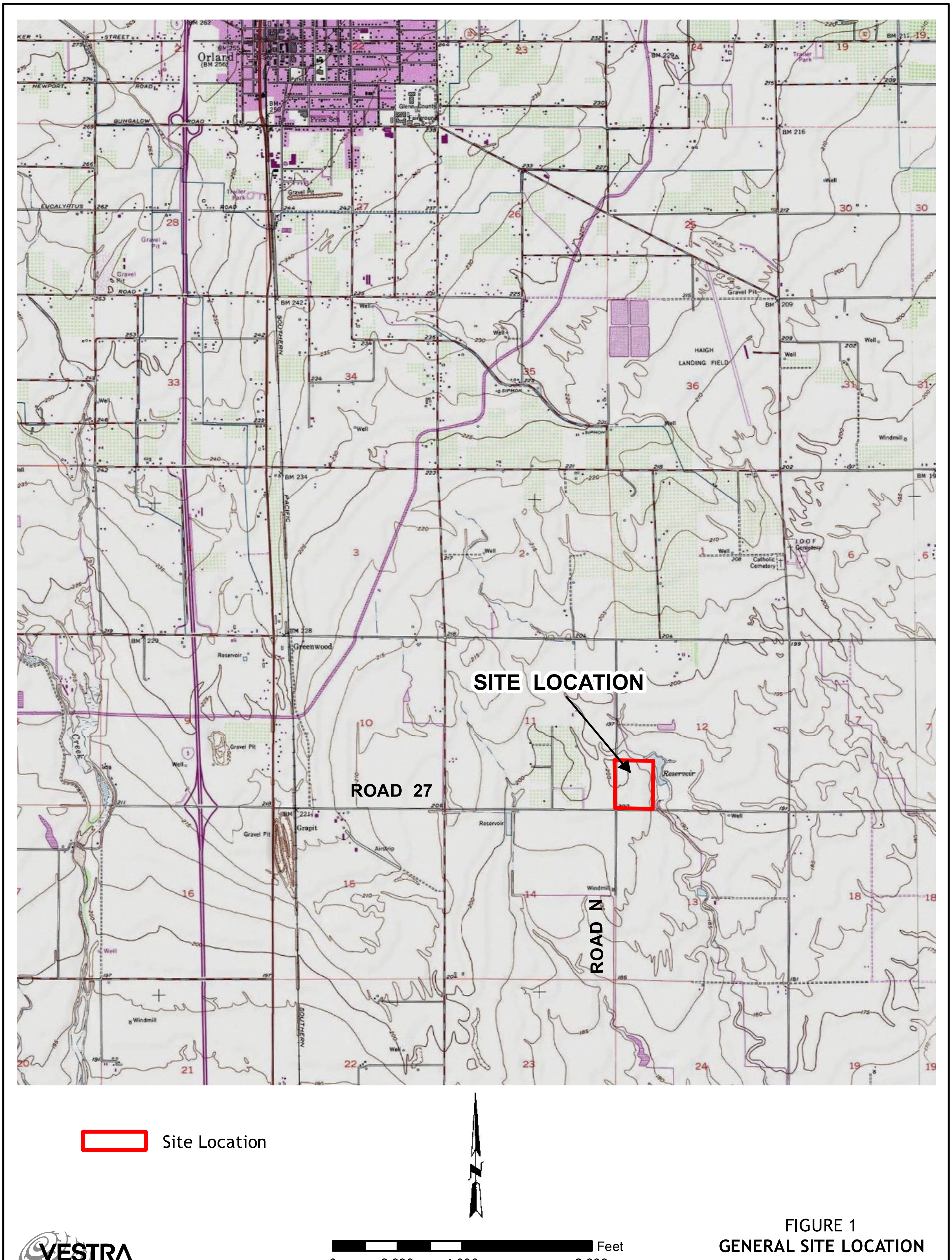
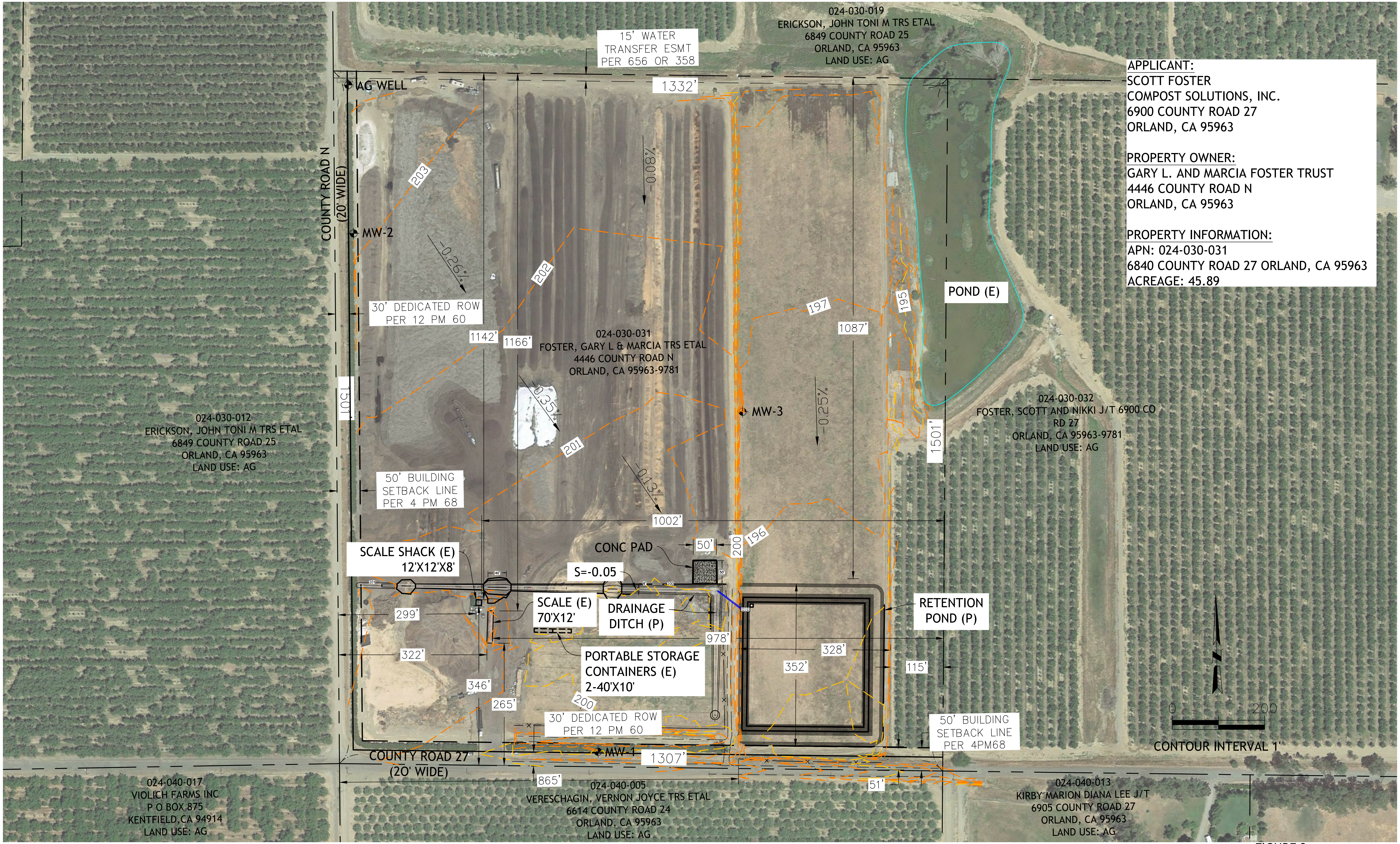
Figures



SOURCE: USGS 7.5' TOPOGRAPHIC MAP, ORLAND QUADRANGLE

FIGURE 1
GENERAL SITE LOCATION
COMPOST SOLUTIONS, INC.
GLENN COUNTY, CALIFORNIA

P:\GIS\71801\Figures\TechnicalReport\71801_GeneralSiteLocation.mxd



VESTRA

PREPARED BY:
CHRIS SCHEIDE, VESTRA RESOURCES, INC.
5300 AVIATION DRIVE, REDDING, CA 96002
(530)-223-2585
DATE OF PREPARATION: 04/07/2020

FIGURE 2
SITE PLAN
COMPOST SOLUTIONS, INC
ORLAND, CALIFORNIA

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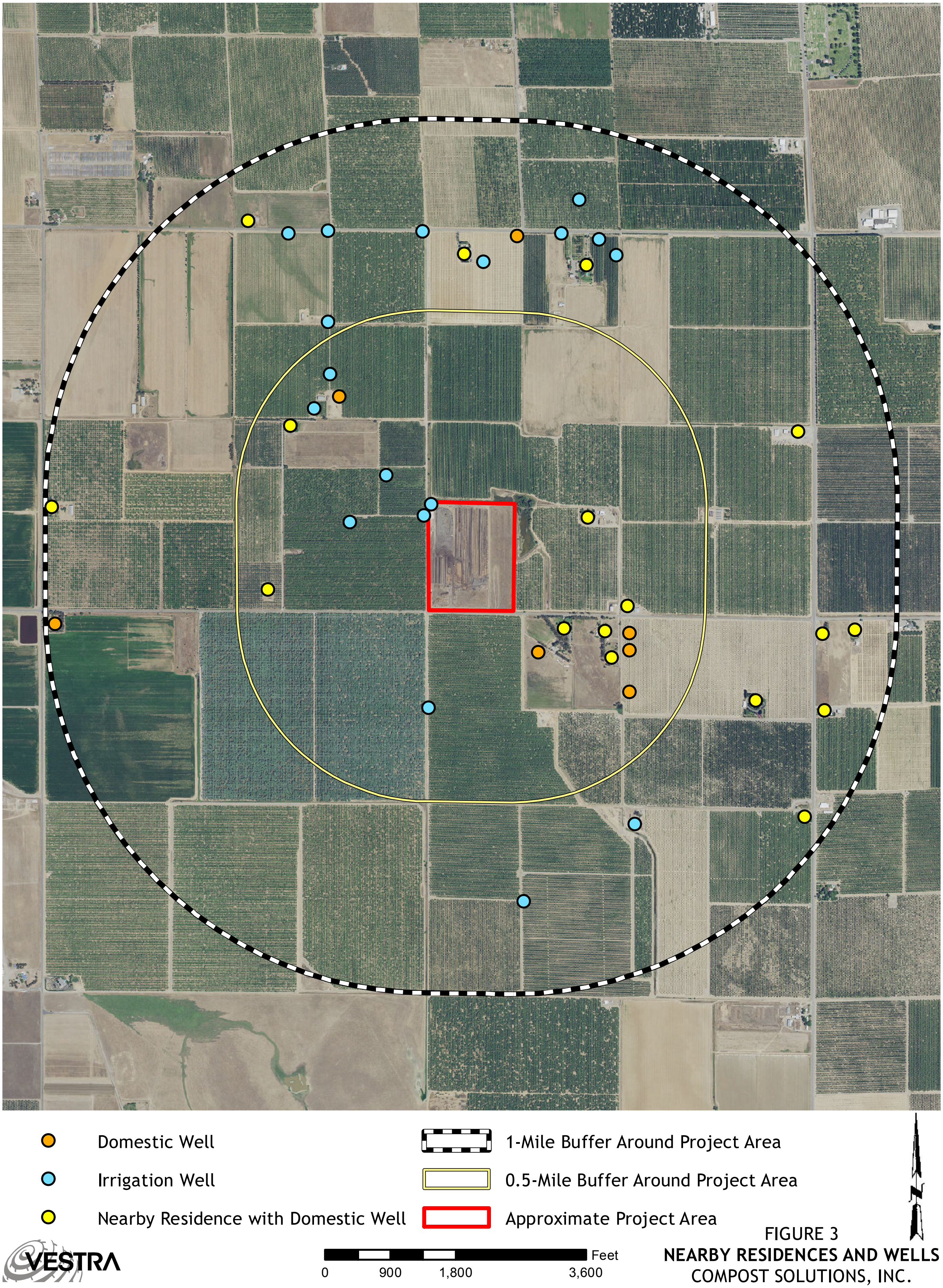

FIGURE 3
NEARBY RESIDENCES AND WELLS
COMPOST SOLUTIONS, INC.
GLENN COUNTY, CALIFORNIA

SOURCE: USDA NAIP 2016 AERIAL PHOTOGRAPH

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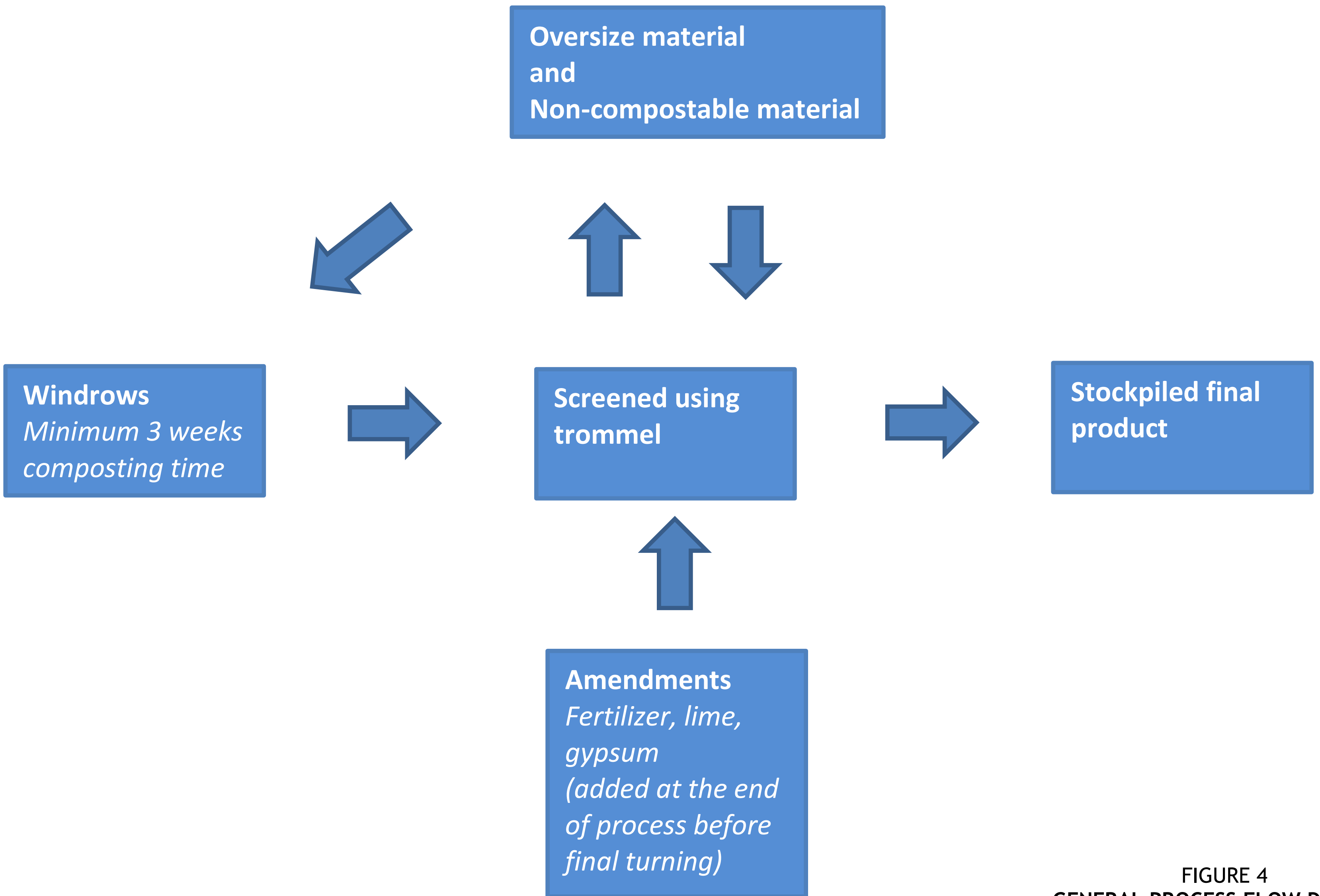

FIGURE 4
GENERAL PROCESS FLOW DIAGRAM
COMPOST SOLUTIONS, INC
GLENN COUNTY, CALIFORNIA

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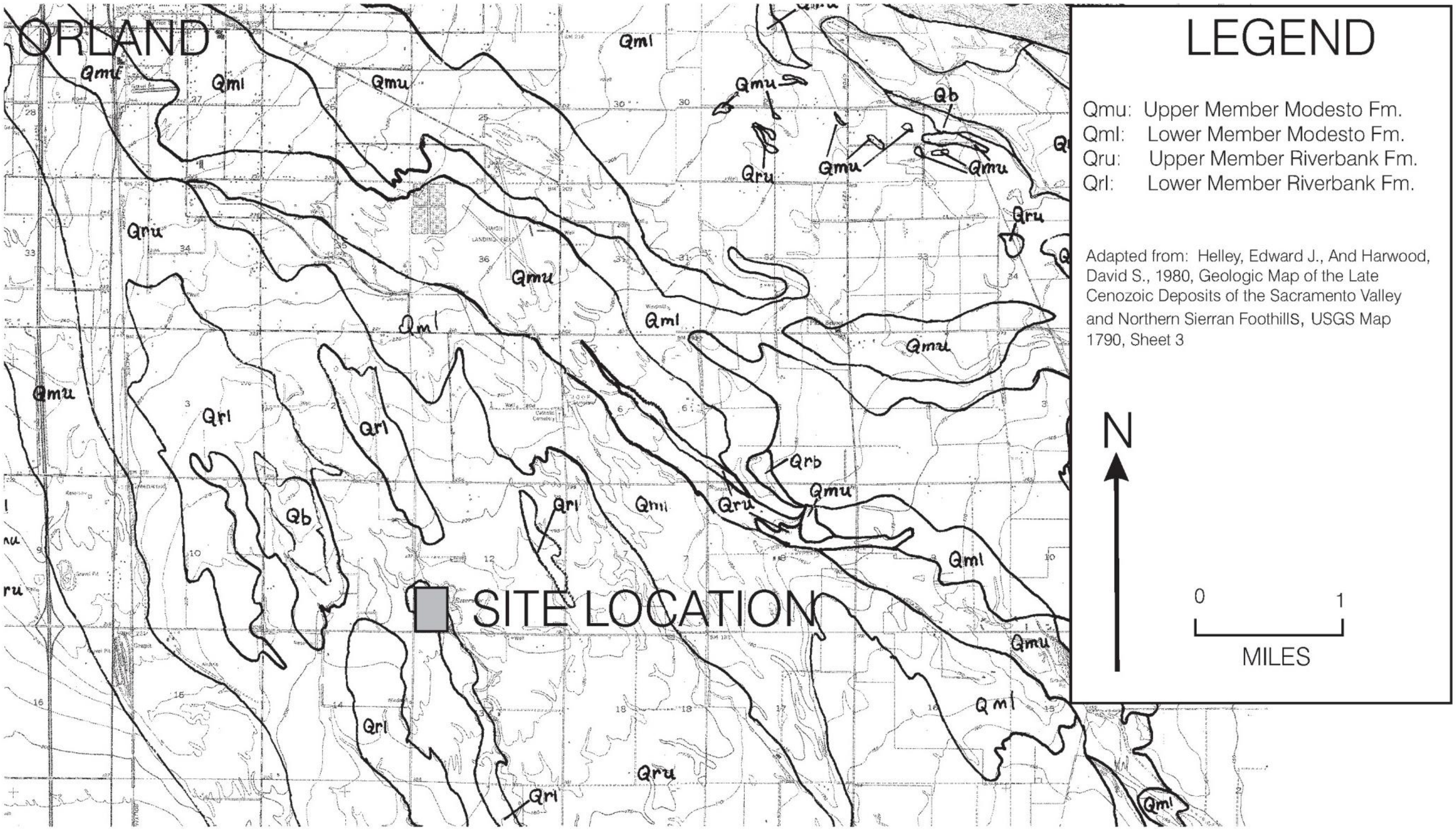

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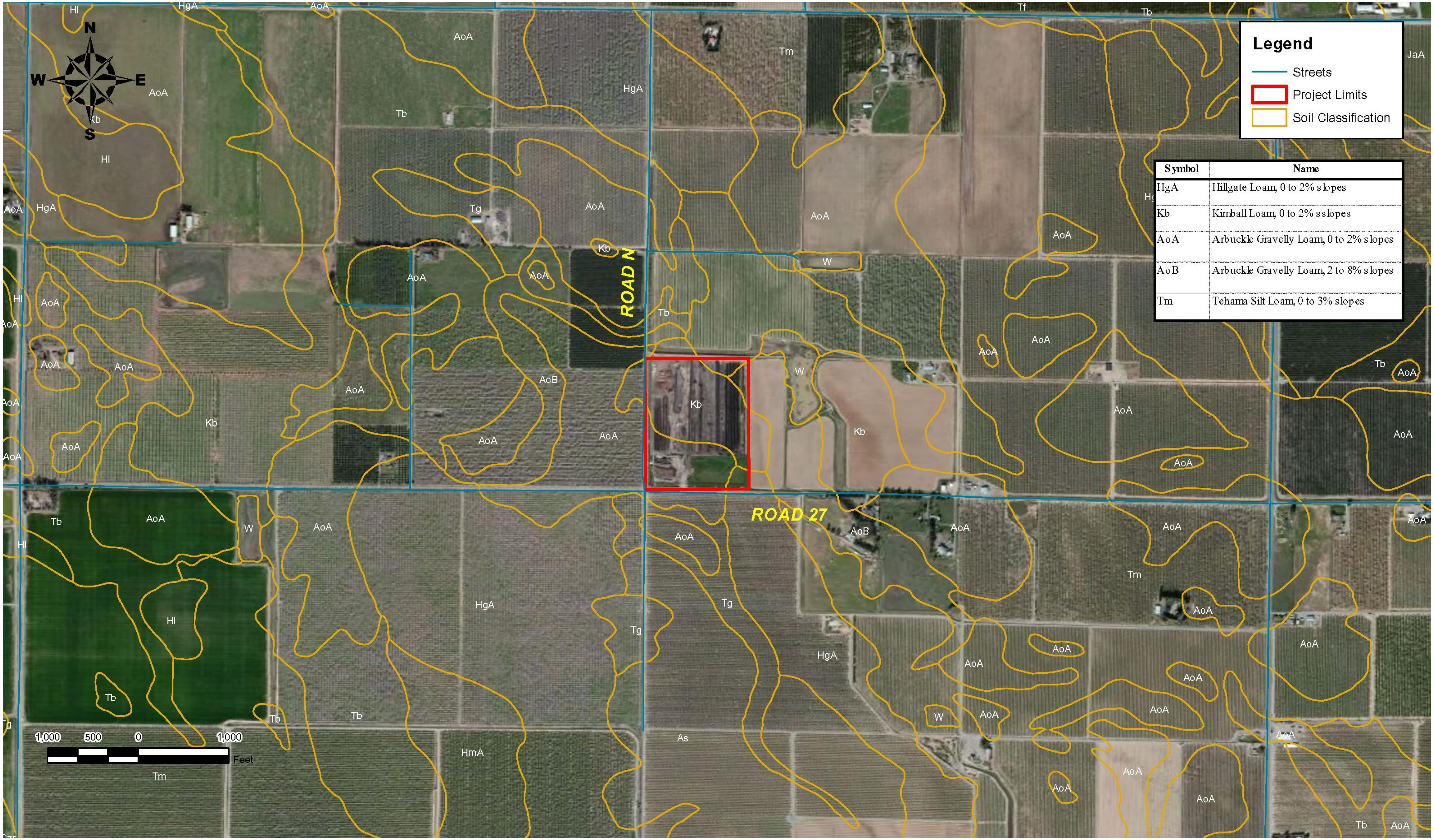
SOURCE: LAWRENCE AND ASSOCIATES 2006

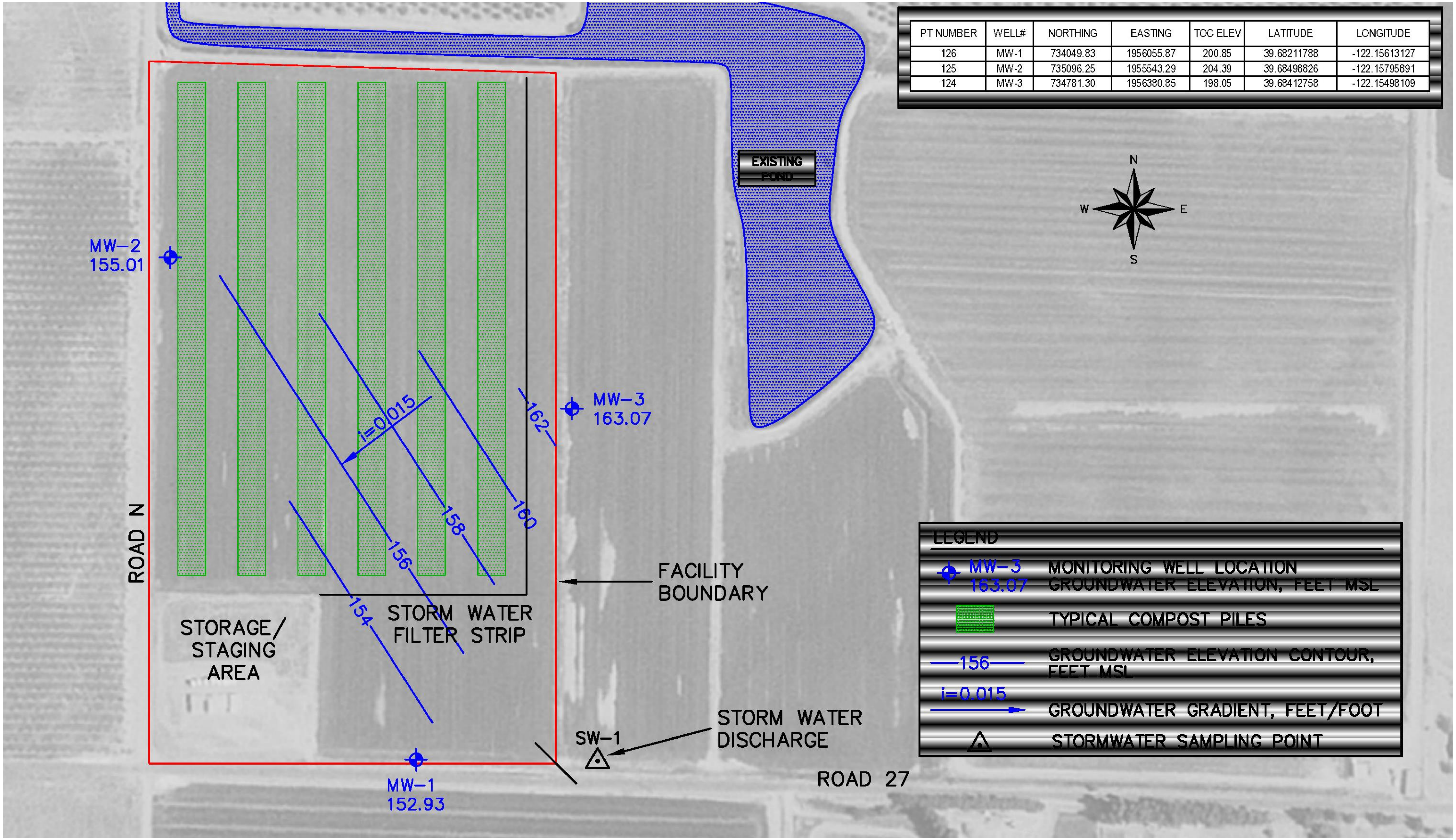
FIGURE 5
GEOLOGY
COMPOST SOLUTIONS, INC.
GLENN COUNTY, CALIFORNIA



VESTRA

SOURCE: LAWRENCE AND ASSOCIATES, 2012

FIGURE 6
SOILS
COMPOST SOLUTIONS, INC.
GLENN COUNTY, CALIFORNIA



PT NUMBER	WELL#	NORTHING	EASTING	TOC ELEV	LATITUDE	LONGITUDE
126	MW-1	734049.83	1956055.87	200.85	39.68211788	-122.15613127
125	MW-2	735096.25	1955543.29	204.39	39.68498826	-122.15795891
124	MW-3	734781.30	1956380.85	198.05	39.68412758	-122.15498109

VESTRA

SOURCE: LAWRENCE AND ASSOCIATES, 2012

FIGURE 7
GROUNDWATER CONTOURS
COMPOST SOLUTIONS, INC.
GLENN COUNTY, CALIFORNIA

Appendix A

Soils, Test Pit Logs, and Permeability Results

USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Glenn County, California

March 30, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

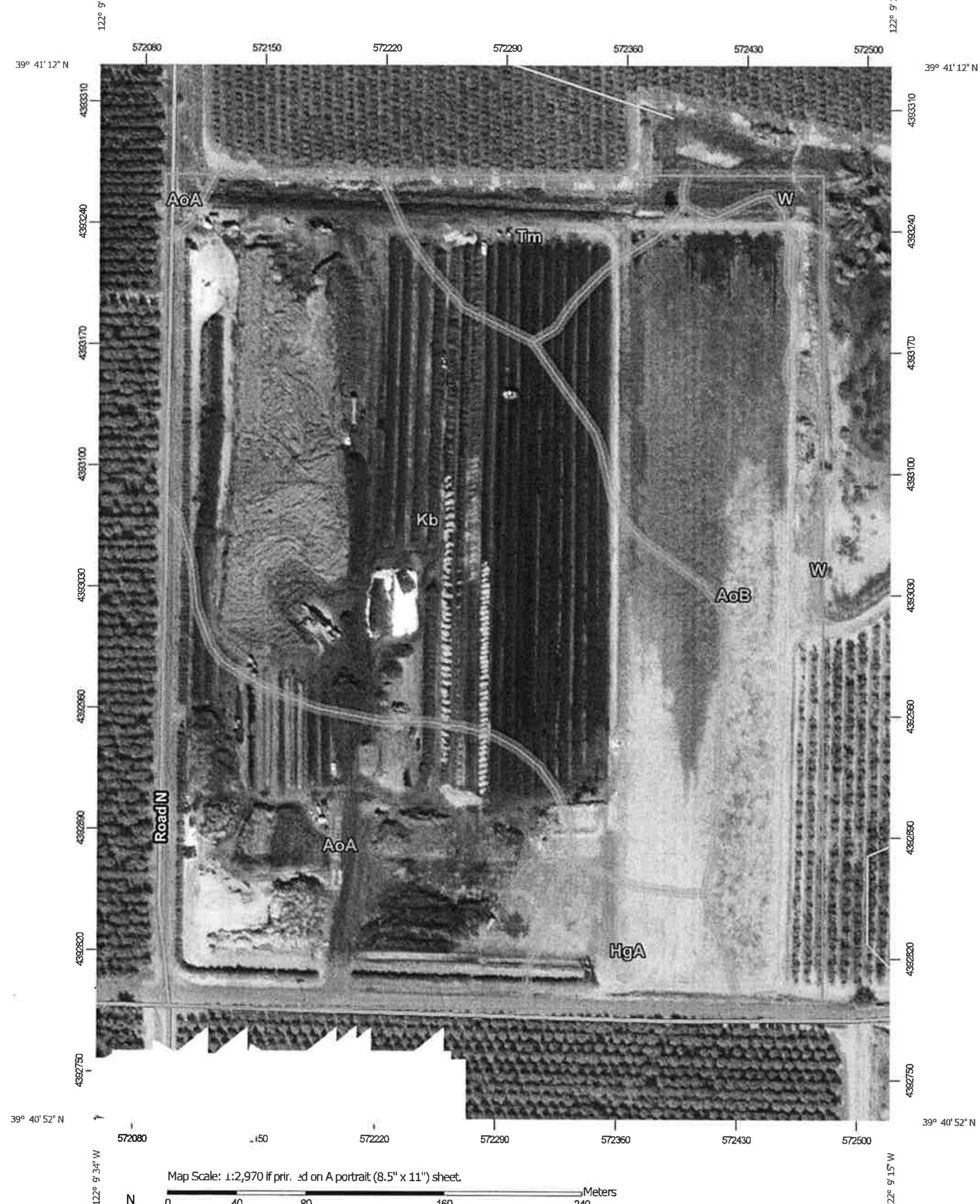
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:2,970 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 40, 80, 160, 240

Feet: 0, 100, 200, 400, 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Glenn County, California
Survey Area Data: Version 15, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 30, 2017—Nov 4, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AoA	Arbuckle gravelly loam, 0 to 2 percent slopes, MLRA 17	10.2	22.3%
AoB	Arbuckle gravelly loam, 0 to 8 percent slopes, MLRA 17	9.9	21.7%
HgA	Hillgate loam, 0 to 2 percent slopes, MLRA 17	1.9	4.3%
Kb	Kimball loam, 0 to 2 percent slopes	20.1	44.0%
Tm	Tehama silt loam, 0 to 3 percent slopes, MLRA 17	2.6	5.8%
W	Water	0.9	2.0%
Totals for Area of Interest		**45.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Glenn County, California

AoA—Arbuckle gravelly loam, 0 to 2 percent slopes, MLRA 17

Map Unit Setting

National map unit symbol: 2t7r8
Elevation: 30 to 1,420 feet
Mean annual precipitation: 20 to 32 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 200 to 280 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Arbuckle and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arbuckle

Setting

Landform: Stream terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from metamorphic and sedimentary rock

Typical profile

A1 - 0 to 2 inches: gravelly loam
A2 - 2 to 14 inches: gravelly loam
Bt1 - 14 to 25 inches: gravelly loam
Bt2 - 25 to 59 inches: gravelly sandy clay loam
Bt3 - 59 to 72 inches: very gravelly loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.28 to 1.28 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.3 to 0.5 mmhos/cm)
Available water storage in profile: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Maywood
Percent of map unit: 5 percent
Hydric soil rating: No

Hillgate
Percent of map unit: 5 percent
Hydric soil rating: No

Cortina
Percent of map unit: 5 percent
Hydric soil rating: No

AoB—Arbuckle gravelly loam, 0 to 8 percent slopes, MLRA 17

Map Unit Setting
National map unit symbol: 2w8cy
Elevation: 140 to 1,400 feet
Mean annual precipitation: 23 to 31 inches
Mean annual air temperature: 59 to 63 degrees F
Frost-free period: 231 to 318 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Arbuckle and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arbuckle

Setting
Landform: Fan remnants, stream terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Linear, convex
Parent material: Alluvium derived from metamorphic and sedimentary rock

Typical profile
Ap - 0 to 6 inches: gravelly loam
A - 6 to 13 inches: gravelly loam
Bt1 - 13 to 21 inches: gravelly loam
Bt2 - 21 to 32 inches: gravelly loam
Bt3 - 32 to 60 inches: gravelly loam

Properties and qualities
Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline (0.2 to 0.5 mmhos/cm)
Available water storage in profile: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Tehama

Percent of map unit: 5 percent
Hydric soil rating: No

Hiilgate

Percent of map unit: 5 percent
Hydric soil rating: No

Newville

Percent of map unit: 3 percent
Hydric soil rating: No

Unnamed

Percent of map unit: 2 percent
Landform: Depressions
Hydric soil rating: Yes

HgA—Hillgate loam, 0 to 2 percent slopes, MLRA 17

Map Unit Setting

National map unit symbol: 2t7q5
Elevation: 20 to 1,180 feet
Mean annual precipitation: 17 to 21 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 225 to 250 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Hillgate, loam, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hillgate, Loam

Setting

Landform: Terraces

Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from metamorphic and sedimentary rock

Typical profile

A1 - 0 to 3 inches: loam
A2 - 3 to 11 inches: loam
A3 - 11 to 19 inches: loam
2Bt1 - 19 to 38 inches: clay
2Bt2 - 38 to 53 inches: clay loam
2Bt3 - 53 to 63 inches: clay loam
2Bt4 - 63 to 73 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 6 to 32 inches to abrupt textural change
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Gypsum, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 4.0
Available water storage in profile: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: C
Ecological site: Loamy Fan Remnant 8-10" P.Z. (R017XE061CA)
Hydric soil rating: No

Minor Components

Capay, clay loam

Percent of map unit: 3 percent
Landform: Basin floors
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Altamont, silty clay

Percent of map unit: 2 percent
Landform: Hills
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ayar, clay

Percent of map unit: 2 percent
Landform: Hills
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Unnamed

Percent of map unit: 1 percent
Landform: Channels
Hydric soil rating: Yes

Riverwash

Percent of map unit: 1 percent
Landform: Channels
Hydric soil rating: Yes

Arand, very gravelly sandy loam

Percent of map unit: 1 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Kb—Kimball loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: hd8t
Elevation: 30 to 1,000 feet
Mean annual precipitation: 12 to 25 inches
Mean annual air temperature: 59 to 64 degrees F
Frost-free period: 250 to 300 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Kimball and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kimball

Setting

Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 16 inches: loam
H2 - 16 to 27 inches: clay
H3 - 27 to 60 inches: sandy clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: About 16 inches to abrupt textural change
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.3 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Unnamed

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Unnamed

Percent of map unit: 5 percent
Hydric soil rating: No

Moda

Percent of map unit: 5 percent
Hydric soil rating: No

Tm—Tehama silt loam, 0 to 3 percent slopes, MLRA 17

Map Unit Setting

National map unit symbol: 2srj8
Elevation: 100 to 1,180 feet
Mean annual precipitation: 17 to 21 inches
Mean annual air temperature: 63 degrees F
Frost-free period: 180 to 260 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Tehama and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tehama

Setting

Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Fine-silty alluvium derived from metamorphic and sedimentary rock

Typical profile

Ap - 0 to 9 inches: silt loam
BAt - 9 to 12 inches: silty clay loam
Bt1 - 12 to 19 inches: silty clay loam
Bt2 - 19 to 27 inches: silty clay loam
BCtk1 - 27 to 38 inches: silty clay loam
BCtk2 - 38 to 50 inches: silty clay loam
BCtk3 - 50 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 3 percent
Available water storage in profile: High (about 11.0 inches)

Interpretive groups

Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Arbuckle

Percent of map unit: 5 percent
Hydric soil rating: No

Hillgate

Percent of map unit: 5 percent
Hydric soil rating: No

Plaza

Percent of map unit: 5 percent
Hydric soil rating: No

W—Water

Map Unit Composition

Water: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Setting

Landform: Drainageways

Down-slope shape: Linear

Across-slope shape: Linear

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Glossary

Many of the terms relating to landforms, geology, and geomorphology are defined in more detail in the following National Soil Survey Handbook link: "National Soil Survey Handbook."

ABC soil

A soil having an A, a B, and a C horizon.

Ablation till

Loose, relatively permeable earthy material deposited during the downwasting of nearly static glacial ice, either contained within or accumulated on the surface of the glacier.

AC soil

A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil

The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil

Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial cone

A semiconical type of alluvial fan having very steep slopes. It is higher, narrower, and steeper than a fan and is composed of coarser and thicker layers of material deposited by a combination of alluvial episodes and (to a much lesser degree) landslides (debris flow). The coarsest materials tend to be concentrated at the apex of the cone.

Alluvial fan

A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes. It is shaped like an open fan or a segment of a cone. The material was deposited by a stream at the place where it issues from a narrow mountain valley or upland valley or where a tributary stream is near or at its junction with the main stream. The fan is steepest near its apex, which points upstream, and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

Alluvium

Unconsolidated material, such as gravel, sand, silt, clay, and various mixtures of these, deposited on land by running water.

Alpha,alpha-dipyridyl

A compound that when dissolved in ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction implies reducing conditions and the likely presence of redoximorphic features.

Animal unit month (AUM)

The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Aquic conditions

Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon

A subsoil horizon characterized by an accumulation of illuvial clay.

Arroyo

The flat-floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in unconsolidated material. It is usually dry but can be transformed into a temporary watercourse or short-lived torrent after heavy rain within the watershed.

Aspect

The direction toward which a slope faces. Also called slope aspect.

Association, soil

A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity)

The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low: 0 to 3
Low: 3 to 6
Moderate: 6 to 9
High: 9 to 12
Very high: More than 12

Backslope

The position that forms the steepest and generally linear, middle portion of a hillslope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below.

Backswamp

A flood-plain landform. Extensive, marshy or swampy, depressed areas of flood plains between natural levees and valley sides or terraces.

Badland

A landscape that is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes and narrow interfluves. Badlands develop on surfaces that have little or no vegetative cover overlying unconsolidated or poorly cemented materials (clays, silts, or sandstones) with, in some cases, soluble minerals, such as gypsum or halite.

Bajada

A broad, gently inclined alluvial piedmont slope extending from the base of a mountain range out into a basin and formed by the lateral coalescence of a series of alluvial fans. Typically, it has a broadly undulating transverse profile, parallel to the mountain front, resulting from the convexities of component fans. The term is generally restricted to constructional slopes of intermontane basins.

Basal area

The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Base saturation

The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Base slope (geomorphology)

A geomorphic component of hills consisting of the concave to linear (perpendicular to the contour) slope that, regardless of the lateral shape, forms an apron or wedge at the bottom of a hillside dominated by colluvium and slope-wash sediments (for example, slope alluvium).

Bedding plane

A planar or nearly planar bedding surface that visibly separates each successive layer of stratified sediment or rock (of the same or different lithology) from the preceding or following layer; a plane of deposition. It commonly marks a change in the circumstances of deposition and may show a parting, a color difference, a change in particle size, or various combinations of these. The term is commonly applied to any bedding surface, even one that is conspicuously bent or deformed by folding.

Bedding system

A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock

The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography

A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bench terrace

A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum

Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout (map symbol)

A saucer-, cup-, or trough-shaped depression formed by wind erosion on a preexisting dune or other sand deposit, especially in an area of shifting sand or loose soil or where protective vegetation is disturbed or destroyed. The adjoining accumulation of sand derived from the depression, where recognizable, is commonly included. Blowouts are commonly small.

Borrow pit (map symbol)

An open excavation from which soil and underlying material have been removed, usually for construction purposes.

Bottom land

An informal term loosely applied to various portions of a flood plain.

Boulders

Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breaks

A landscape or tract of steep, rough or broken land dissected by ravines and gullies and marking a sudden change in topography.

Breast height

An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Brush management

Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management increases forage production and thus reduces the hazard of erosion. It can improve the habitat for some species of wildlife.

Butte

An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments; commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying rocks.

Cable yarding

A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

Calcareous soil

A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche

A general term for a prominent zone of secondary carbonate accumulation in surficial materials in warm, subhumid to arid areas. Caliche is formed by both geologic and pedologic processes. Finely crystalline calcium carbonate forms a nearly continuous surface-coating and void-filling medium in geologic (parent) materials. Cementation ranges from weak in nonindurated forms to very strong in indurated forms. Other minerals (e.g., carbonates, silicate, and sulfate) may occur as accessory cements. Most petrocalcic horizons and some calcic horizons are caliche.

California bearing ratio (CBR)

The load-supporting capacity of a soil as compared to that of standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Canopy

The leafy crown of trees or shrubs. (See Crown.)

Canyon

A long, deep, narrow valley with high, precipitous walls in an area of high local relief.

Capillary water

Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena

A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material and under similar climatic conditions but that have different characteristics as a result of differences in relief and drainage.

Cation

An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity

The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps

See Terracettes.

Cement rock

Shaly limestone used in the manufacture of cement.

Channery soil material

Soil material that has, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a channer.

Chemical treatment

Control of unwanted vegetation through the use of chemicals.

Chiseling

Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

Cirque

A steep-walled, semicircular or crescent-shaped, half-bowl-like recess or hollow, commonly situated at the head of a glaciated mountain valley or high on the side of a mountain. It was produced by the erosive activity of a mountain glacier. It commonly contains a small round lake (tarn).

Clay

As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay depletions

See Redoximorphic features.

Clay film

A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Clay spot (map symbol)

A spot where the surface texture is silty clay or clay in areas where the surface layer of the soils in the surrounding map unit is sandy loam, loam, silt loam, or coarser.

Claypan

A dense, compact subsoil layer that contains much more clay than the overlying materials, from which it is separated by a sharply defined boundary. The layer restricts the downward movement of water through the soil. A claypan is commonly hard when dry and plastic and sticky when wet.

Climax plant community

The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil

Sand or loamy sand.

Cobble (or cobblestone)

A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material

Material that has 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

COLE (coefficient of linear extensibility)

See Linear extensibility.

Colluvium

Unconsolidated, unsorted earth material being transported or deposited on side slopes and/or at the base of slopes by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.

Complex slope

Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil

A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Concretions

See Redoximorphic features.

Conglomerate

A coarse grained, clastic sedimentary rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Conservation cropping system

Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage

A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil

Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the "Soil Survey Manual."

Contour stripcropping

Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section

The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat)

A type of limnic layer composed predominantly of fecal material derived from aquatic animals.

Corrosion (geomorphology)

A process of erosion whereby rocks and soil are removed or worn away by natural chemical processes, especially by the solvent action of running water, but also by other reactions, such as hydrolysis, hydration, carbonation, and oxidation.

Corrosion (soil survey interpretations)

Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop

A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management

Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cropping system

Growing crops according to a planned system of rotation and management practices.

Cross-slope farming

Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

Crown

The upper part of a tree or shrub, including the living branches and their foliage.

Cryoturbate

A mass of soil or other unconsolidated earthy material moved or disturbed by frost action. It is typically coarser than the underlying material.

Cuesta

An asymmetric ridge capped by resistant rock layers of slight or moderate dip (commonly less than 15 percent slopes); a type of homocline produced by differential erosion of interbedded resistant and weak rocks. A cuesta has a long, gentle slope on one side (dip slope) that roughly parallels the inclined beds; on the other side, it has a relatively short and steep or clifflike slope (scarp) that cuts through the tilted rocks.

Culmination of the mean annual increment (CMAI)

The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave

The walls of excavations tend to cave in or slough.

Decreasers

The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing

Postponing grazing or resting grazing land for a prescribed period.

Delta

A body of alluvium having a surface that is fan shaped and nearly flat; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Dense layer

A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depression, closed (map symbol)

A shallow, saucer-shaped area that is slightly lower on the landscape than the surrounding area and that does not have a natural outlet for surface drainage.

Depth, soil

Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Desert pavement

A natural, residual concentration or layer of wind-polished, closely packed gravel, boulders, and other rock fragments mantling a desert surface. It forms where wind action and sheetwash have removed all smaller particles or where rock fragments have migrated upward through sediments to the surface. It typically protects the finer grained underlying material from further erosion.

Diatomaceous earth

A geologic deposit of fine, grayish siliceous material composed chiefly or entirely of the remains of diatoms.

Dip slope

A slope of the land surface, roughly determined by and approximately conforming to the dip of the underlying bedrock.

Diversion (or diversion terrace)

A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Divided-slope farming

A form of field stripcropping in which crops are grown in a systematic arrangement of two strips, or bands, across the slope to reduce the hazard of water erosion. One strip is in a close-growing crop that provides protection from erosion, and the other strip is in a crop that provides less protection from erosion. This practice is used where slopes are not long enough to permit a full stripcropping pattern to be used.

Drainage class (natural)

Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained.* These classes are defined in the "Soil Survey Manual."

Drainage, surface

Runoff, or surface flow of water, from an area.

Drainageway

A general term for a course or channel along which water moves in draining an area. A term restricted to relatively small, linear depressions that at some time move concentrated water and either do not have a defined channel or have only a small defined channel.

Draw

A small stream valley that generally is shallower and more open than a ravine or gulch and that has a broader bottom. The present stream channel may appear inadequate to have cut the drainageway that it occupies.

Drift

A general term applied to all mineral material (clay, silt, sand, gravel, and boulders) transported by a glacier and deposited directly by or from the ice or transported by running water emanating from a glacier. Drift includes unstratified material (till) that forms moraines and stratified deposits that form outwash plains, eskers, kames, varves, and glaciofluvial sediments. The term is generally applied to Pleistocene glacial deposits in areas that no longer contain glaciers.

Drumlin

A low, smooth, elongated oval hill, mound, or ridge of compact till that has a core of bedrock or drift. It commonly has a blunt nose facing the direction from which the ice approached and a gentler slope tapering in the other direction. The longer axis is parallel to the general direction of glacier flow. Drumlins are products of streamline (laminar) flow of glaciers, which molded the subglacial floor through a combination of erosion and deposition.

Duff

A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Dune

A low mound, ridge, bank, or hill of loose, windblown granular material (generally sand), either barren and capable of movement from place to place or covered and stabilized with vegetation but retaining its characteristic shape.

Earthy fill

See Mine spoil.

Ecological site

An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Eluviation

The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation

A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

Eolian deposit

Sand-, silt-, or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess.

Ephemeral stream

A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Episaturation

A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

Erosion

The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (accelerated)

Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Erosion (geologic)

Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion pavement

A surficial lag concentration or layer of gravel and other rock fragments that remains on the soil surface after sheet or rill erosion or wind has removed the finer soil particles and that tends to protect the underlying soil from further erosion.

Erosion surface

A land surface shaped by the action of erosion, especially by running water.

Escarpment

A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Most commonly applied to cliffs produced by differential erosion. Synonym: scarp.

Escarpment, bedrock (map symbol)

A relatively continuous and steep slope or cliff, produced by erosion or faulting, that breaks the general continuity of more gently sloping land surfaces. Exposed material is hard or soft bedrock.

Escarpment, nonbedrock (map symbol)

A relatively continuous and steep slope or cliff, generally produced by erosion but in some places produced by faulting, that breaks the continuity of more gently sloping land surfaces. Exposed earthy material is nonsoil or very shallow soil.

Esker

A long, narrow, sinuous, steep-sided ridge of stratified sand and gravel deposited as the bed of a stream flowing in an ice tunnel within or below the ice (subglacial) or between ice walls on top of the ice of a wasting glacier and left behind as high ground when the ice melted. Eskers range in length from less than a kilometer to more than 160 kilometers and in height from 3 to 30 meters.

Extrusive rock

Igneous rock derived from deep-seated molten matter (magma) deposited and cooled on the earth's surface.

Fallow

Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fan remnant

A general term for landforms that are the remaining parts of older fan landforms, such as alluvial fans, that have been either dissected or partially buried.

Fertility, soil

The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat)

The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity

The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fill slope

A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil

Sandy clay, silty clay, or clay.

Firebreak

An area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

First bottom

An obsolete, informal term loosely applied to the lowest flood-plain steps that are subject to regular flooding.

Flaggy soil material

Material that has, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 60 percent flagstones, and extremely flaggy soil material has more than 60 percent flagstones.

Flagstone

A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

Flood plain

The nearly level plain that borders a stream and is subject to flooding unless protected artificially.

Flood-plain landforms

A variety of constructional and erosional features produced by stream channel migration and flooding. Examples include backswamps, flood-plain splays, meanders, meander belts, meander scrolls, oxbow lakes, and natural levees.

Flood-plain splay

A fan-shaped deposit or other outspread deposit formed where an overloaded stream breaks through a levee (natural or artificial) and deposits its material (commonly coarse grained) on the flood plain.

Flood-plain step

An essentially flat, terrace-like alluvial surface within a valley that is frequently covered by floodwater from the present stream; any approximately horizontal surface still actively modified by fluvial scour and/or deposition. May occur individually or as a series of steps.

Fluvial

Of or pertaining to rivers or streams; produced by stream or river action.

Foothills

A region of steeply sloping hills that fringes a mountain range or high-plateau escarpment. The hills have relief of as much as 1,000 feet (300 meters).

Footslope

The concave surface at the base of a hillslope. A footslope is a transition zone between upslope sites of erosion and transport (shoulders and backslopes) and downslope sites of deposition (toeslopes).

Forb

Any herbaceous plant not a grass or a sedge.

Forest cover

All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type

A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fragipan

A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Genesis, soil

The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai

Commonly, a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of clayey soils that shrink and swell considerably with changes in moisture content.

Glaciofluvial deposits

Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces.

Glaciolacustrine deposits

Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are bedded or laminated.

Gleyed soil

Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Graded stripcropping

Growing crops in strips that grade toward a protected waterway.

Grassed waterway

A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel

Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravel pit (map symbol)

An open excavation from which soil and underlying material have been removed and used, without crushing, as a source of sand or gravel.

Gravelly soil material

Material that has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Gravelly spot (map symbol)

A spot where the surface layer has more than 35 percent, by volume, rock fragments that are mostly less than 3 inches in diameter in an area that has less than 15 percent rock fragments.

Green manure crop (agronomy)

A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water

Water filling all the unblocked pores of the material below the water table.

Gully (map symbol)

A small, steep-sided channel caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage whereas a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock

Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hard to reclaim

Reclamation is difficult after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Hardpan

A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Head slope (geomorphology)

A geomorphic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway. The overland waterflow is converging.

Hemic soil material (mucky peat)

Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

High-residue crops

Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill

A generic term for an elevated area of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline. Slopes are generally more than 15 percent. The distinction between a hill and a mountain is arbitrary and may depend on local usage.

Hillslope

A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of a hill.

Horizon, soil

A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the "Soil Survey Manual." The major horizons of mineral soil are as follows:

O horizon: An organic layer of fresh and decaying plant residue.

L horizon: A layer of organic and mineral limnic materials, including coprogenous earth (sedimentary peat), diatomaceous earth, and marl.

A horizon: The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon: The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon: The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon: The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon: Soft, consolidated bedrock beneath the soil.

R layer: Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

M layer: A root-limiting subsoil layer consisting of nearly continuous, horizontally oriented, human-manufactured materials.

W layer: A layer of water within or beneath the soil.

Humus

The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups

Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties include depth to a seasonal high water table, the infiltration rate, and depth to a layer that significantly restricts the downward movement of water. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Igneous rock

Rock that was formed by cooling and solidification of magma and that has not been changed appreciably by weathering since its formation. Major varieties include plutonic and volcanic rock (e.g., andesite, basalt, and granite).

Illuviation

The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil

A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers

Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration

The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity

The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate

The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate

The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Very low: Less than 0.2

Low: 0.2 to 0.4

Moderately low: 0.4 to 0.75

Moderate: 0.75 to 1.25

Moderately high: 1.25 to 1.75

High: 1.75 to 2.5

Very high: More than 2.5

Interfluve

A landform composed of the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. An elevated area between two drainageways that sheds water to those drainageways.

Interfluve (geomorphology)

A geomorphic component of hills consisting of the uppermost, comparatively level or gently sloping area of a hill; shoulders of backwearing hillslopes can narrow the upland or can merge, resulting in a strongly convex shape.

Intermittent stream

A stream, or reach of a stream, that does not flow year-round but that is commonly dry for 3 or more months out of 12 and whose channel is generally below the local water table. It flows only during wet periods or when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders

On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Iron depletions

See Redoximorphic features.

Irrigation

Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin: Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border: Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding: Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation: Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle): Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow: Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler: Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation: Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding: Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame

A low mound, knob, hummock, or short irregular ridge composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier; by a supraglacial stream in a low place or hole on the surface of the glacier; or as a ponded deposit on the surface or at the margin of stagnant ice.

Karst (topography)

A kind of topography that formed in limestone, gypsum, or other soluble rocks by dissolution and that is characterized by closed depressions, sinkholes, caves, and underground drainage.

Knoll

A small, low, rounded hill rising above adjacent landforms.

Ksat

See Saturated hydraulic conductivity.

Lacustrine deposit

Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Lake plain

A nearly level surface marking the floor of an extinct lake filled by well sorted, generally fine textured, stratified deposits, commonly containing varves.

Lake terrace

A narrow shelf, partly cut and partly built, produced along a lakeshore in front of a scarp line of low cliffs and later exposed when the water level falls.

Landfill (map symbol)

An area of accumulated waste products of human habitation, either above or below natural ground level.

Landslide

A general, encompassing term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials caused by gravitational forces; the movement may or may not involve saturated materials. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones

Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Lava flow (map symbol)

A solidified, commonly lobate body of rock formed through lateral, surface outpouring of molten lava from a vent or fissure.

Leaching

The removal of soluble material from soil or other material by percolating water.

Levee (map symbol)

An embankment that confines or controls water, especially one built along the banks of a river to prevent overflow onto lowlands.

Linear extensibility

Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $^{1}/_{3}$- or $^{1}/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

Liquid limit

The moisture content at which the soil passes from a plastic to a liquid state.

Loam

Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess

Material transported and deposited by wind and consisting dominantly of silt-sized particles.

Low strength

The soil is not strong enough to support loads.

Low-residue crops

Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Marl

An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions; formed primarily under freshwater lacustrine conditions but also formed in more saline environments.

Marsh or swamp (map symbol)

A water-saturated, very poorly drained area that is intermittently or permanently covered by water. Sedges, cattails, and rushes are the dominant vegetation in marshes, and trees or shrubs are the dominant vegetation in swamps. Not used in map units where the named soils are poorly drained or very poorly drained.

Mass movement

A generic term for the dislodgment and downslope transport of soil and rock material as a unit under direct gravitational stress.

Masses

See Redoximorphic features.

Meander belt

The zone within which migration of a meandering channel occurs; the flood-plain area included between two imaginary lines drawn tangential to the outer bends of active channel loops.

Meander scar

A crescent-shaped, concave or linear mark on the face of a bluff or valley wall, produced by the lateral erosion of a meandering stream that impinged upon and undercut the bluff.

Meander scroll

One of a series of long, parallel, close-fitting, crescent-shaped ridges and troughs formed along the inner bank of a stream meander as the channel migrated laterally down-valley and toward the outer bank.

Mechanical treatment

Use of mechanical equipment for seeding, brush management, and other management practices.

Medium textured soil

Very fine sandy loam, loam, silt loam, or silt.

Mesa

A broad, nearly flat topped and commonly isolated landmass bounded by steep slopes or precipitous cliffs and capped by layers of resistant, nearly horizontal rocky material. The summit width is characteristically greater than the height of the bounding escarpments.

Metamorphic rock

Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement at depth in the earth's crust. Nearly all such rocks are crystalline.

Mine or quarry (map symbol)

An open excavation from which soil and underlying material have been removed and in which bedrock is exposed. Also denotes surface openings to underground mines.

Mine spoil

An accumulation of displaced earthy material, rock, or other waste material removed during mining or excavation. Also called earthy fill.

Mineral soil

Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage

Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area

A kind of map unit that has little or no natural soil and supports little or no vegetation.

Miscellaneous water (map symbol)

Small, constructed bodies of water that are used for industrial, sanitary, or mining applications and that contain water most of the year.

Moderately coarse textured soil

Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil

Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon

A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Moraine

In terms of glacial geology, a mound, ridge, or other topographically distinct accumulation of unsorted, unstratified drift, predominantly till, deposited primarily by the direct action of glacial ice in a variety of landforms. Also, a general term for a landform composed mainly of till (except for kame moraines, which are composed mainly of stratified outwash) that has been deposited by a glacier. Some types of moraines are disintegration, end, ground, kame, lateral, recessional, and terminal.

Morphology, soil

The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil

Irregular spots of different colors that vary in number and size. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Mountain

A generic term for an elevated area of the land surface, rising more than 1,000 feet (300 meters) above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can occur as a single, isolated mass or in a group forming a chain or range. Mountains are formed primarily by tectonic activity and/or volcanic action but can also be formed by differential erosion.

Muck

Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mucky peat

See Hemic soil material.

Mudstone

A blocky or massive, fine grained sedimentary rock in which the proportions of clay and silt are approximately equal. Also, a general term for such material as clay, silt, claystone, siltstone, shale, and argillite and that should be used only when the amounts of clay and silt are not known or cannot be precisely identified.

Munsell notation

A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Natric horizon

A special kind of argillic horizon that contains enough exchangeable sodium to have an adverse effect on the physical condition of the subsoil.

Neutral soil

A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules

See Redoximorphic features.

Nose slope (geomorphology)

A geomorphic component of hills consisting of the projecting end (laterally convex area) of a hillside. The overland waterflow is predominantly divergent. Nose slopes consist dominantly of colluvium and slope-wash sediments (for example, slope alluvium).

Nutrient, plant

Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter

Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low: Less than 0.5 percent
Low: 0.5 to 1.0 percent
Moderately low: 1.0 to 2.0 percent
Moderate: 2.0 to 4.0 percent
High: 4.0 to 8.0 percent
Very high: More than 8.0 percent

Outwash

Stratified and sorted sediments (chiefly sand and gravel) removed or "washed out" from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of a glacier. The coarser material is deposited nearer to the ice.

Outwash plain

An extensive lowland area of coarse textured glaciofluvial material. An outwash plain is commonly smooth; where pitted, it generally is low in relief.

Paleoterrace

An erosional remnant of a terrace that retains the surface form and alluvial deposits of its origin but was not emplaced by, and commonly does not grade to, a present-day stream or drainage network.

Pan

A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material

The unconsolidated organic and mineral material in which soil forms.

Peat

Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped

An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedisediment

A layer of sediment, eroded from the shoulder and backslope of an erosional slope, that lies on and is being (or was) transported across a gently sloping erosional surface at the foot of a receding hill or mountain slope.

Pedon

The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation

The movement of water through the soil.

Perennial water (map symbol)

Small, natural or constructed lakes, ponds, or pits that contain water most of the year.

Permafrost

Ground, soil, or rock that remains at or below 0 degrees C for at least 2 years. It is defined on the basis of temperature and is not necessarily frozen.

pH value

A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Phase, soil

A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

Piping

Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting

Pits caused by melting around ice. They form on the soil after plant cover is removed.

Plastic limit

The moisture content at which a soil changes from semisolid to plastic.

Plasticity index

The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plateau (geomorphology)

A comparatively flat area of great extent and elevation; specifically, an extensive land region that is considerably elevated (more than 100 meters) above the adjacent lower lying terrain, is commonly limited on at least one side by an abrupt descent, and has a flat or nearly level surface. A comparatively large part of a plateau surface is near summit level.

Playa

The generally dry and nearly level lake plain that occupies the lowest parts of closed depressions, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff. Playa deposits are fine grained and may or may not have a high water table and saline conditions.

Plinthite

The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Plowpan

A compacted layer formed in the soil directly below the plowed layer.

Ponding

Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded

Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Pore linings

See Redoximorphic features.

Potential native plant community

See Climax plant community.

Potential rooting depth (effective rooting depth)

Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning

Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

Productivity, soil

The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil

A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use

Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and promotes the accumulation of litter and mulch necessary to conserve soil and water.

Rangeland

Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil

A measure of acidity or alkalinity of a soil, expressed as pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid: Less than 3.5
Extremely acid: 3.5 to 4.4
Very strongly acid: 4.5 to 5.0
Strongly acid: 5.1 to 5.5
Moderately acid: 5.6 to 6.0
Slightly acid: 6.1 to 6.5
Neutral: 6.6 to 7.3
Slightly alkaline: 7.4 to 7.8
Moderately alkaline: 7.9 to 8.4
Strongly alkaline: 8.5 to 9.0
Very strongly alkaline: 9.1 and higher

Red beds

Sedimentary strata that are mainly red and are made up largely of sandstone and shale.

Redoximorphic concentrations

See Redoximorphic features.

Redoximorphic depletions

See Redoximorphic features.

Redoximorphic features

Redoximorphic features are associated with wetness and result from alternating periods of reduction and oxidation of iron and manganese compounds in the soil. Reduction occurs during saturation with water, and oxidation occurs when the soil is not saturated. Characteristic color patterns are created by these processes. The reduced iron and manganese ions may be removed from a soil if vertical or lateral fluxes of water occur, in which case there is no iron or manganese precipitation in that soil. Wherever the iron and manganese are oxidized and precipitated, they form either soft masses or hard concretions or nodules. Movement of iron and manganese as a result of redoximorphic processes in a soil may result in redoximorphic features that are defined as follows:

1. Redoximorphic concentrations.—These are zones of apparent accumulation of iron-manganese oxides, including:
    - A. Nodules and concretions, which are cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal organization. A concretion typically has concentric layers that are visible to the naked eye. Nodules do not have visible organized internal structure; *and*
    - B. Masses, which are noncemented concentrations of substances within the soil matrix; *and*
    - C. Pore linings, i.e., zones of accumulation along pores that may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.
2. Redoximorphic depletions.—These are zones of low chroma (chromas less than those in the matrix) where either iron-manganese oxides alone or both iron-manganese oxides and clay have been stripped out, including:
    - A. Iron depletions, i.e., zones that contain low amounts of iron and manganese oxides but have a clay content similar to that of the adjacent matrix; *and*
    - B. Clay depletions, i.e., zones that contain low amounts of iron, manganese, and clay (often referred to as silt coatings or skeletans).
3. Reduced matrix.—This is a soil matrix that has low chroma *in situ* but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air.

Reduced matrix

See Redoximorphic features.

Regolith

All unconsolidated earth materials above the solid bedrock. It includes material weathered in place from all kinds of bedrock and alluvial, glacial, eolian, lacustrine, and pyroclastic deposits.

Relief

The relative difference in elevation between the upland summits and the lowlands or valleys of a given region.

Residuum (residual soil material)

Unconsolidated, weathered or partly weathered mineral material that accumulated as bedrock disintegrated in place.

Rill

A very small, steep-sided channel resulting from erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. A rill generally is not an obstacle to wheeled vehicles and is shallow enough to be smoothed over by ordinary tillage.

Riser

The vertical or steep side slope (e.g., escarpment) of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural, steplike landforms, such as successive stream terraces.

Road cut

A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments

Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rock outcrop (map symbol)

An exposure of bedrock at the surface of the earth. Not used where the named soils of the surrounding map unit are shallow over bedrock or where "Rock outcrop" is a named component of the map unit.

Root zone

The part of the soil that can be penetrated by plant roots.

Runoff

The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil

A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Saline spot (map symbol)

An area where the surface layer has an electrical conductivity of 8 mmhos/cm more than the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has an electrical conductivity of 2 mmhos/cm or less.

Sand

As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone

Sedimentary rock containing dominantly sand-sized particles.

Sandy spot (map symbol)

A spot where the surface layer is loamy fine sand or coarser in areas where the surface layer of the named soils in the surrounding map unit is very fine sandy loam or finer.

Sapric soil material (muck)

The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saturated hydraulic conductivity (Ksat)

The ease with which pores of a saturated soil transmit water. Formally, the proportionality coefficient that expresses the relationship of the rate of water movement to hydraulic gradient in Darcy's Law, a law that describes the rate of water movement through porous media. Commonly abbreviated as "Ksat." Terms describing saturated hydraulic conductivity are:

Very high: 100 or more micrometers per second (14.17 or more inches per hour)

High: 10 to 100 micrometers per second (1.417 to 14.17 inches per hour)

Moderately high: 1 to 10 micrometers per second (0.1417 inch to 1.417 inches per hour)

Moderately low: 0.1 to 1 micrometer per second (0.01417 to 0.1417 inch per hour)

Low: 0.01 to 0.1 micrometer per second (0.001417 to 0.01417 inch per hour)

Very low: Less than 0.01 micrometer per second (less than 0.001417 inch per hour).

To convert inches per hour to micrometers per second, multiply inches per hour by 7.0572. To convert micrometers per second to inches per hour, multiply micrometers per second by 0.1417.

Saturation

Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Scarification

The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

Sedimentary rock

A consolidated deposit of clastic particles, chemical precipitates, or organic remains accumulated at or near the surface of the earth under normal low temperature and pressure conditions. Sedimentary rocks include consolidated equivalents of alluvium, colluvium, drift, and eolian, lacustrine, and marine deposits. Examples are sandstone, siltstone, mudstone, claystone, shale, conglomerate, limestone, dolomite, and coal.

Sequum

A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil

A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Severely eroded spot (map symbol)

An area where, on the average, 75 percent or more of the original surface layer has been lost because of accelerated erosion. Not used in map units in which "severely eroded," "very severely eroded," or "gullied" is part of the map unit name.

Shale

Sedimentary rock that formed by the hardening of a deposit of clay, silty clay, or silty clay loam and that has a tendency to split into thin layers.

Sheet erosion

The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Short, steep slope (map symbol)

A narrow area of soil having slopes that are at least two slope classes steeper than the slope class of the surrounding map unit.

Shoulder

The convex, erosional surface near the top of a hillslope. A shoulder is a transition from summit to backslope.

Shrink-swell

The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Shrub-coppice dune

A small, streamlined dune that forms around brush and clump vegetation.

Side slope (geomorphology)

A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel. Side slopes are dominantly colluvium and slope-wash sediments.

Silica

A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio

The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt

As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone

An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive mudstone in which silt predominates over clay.

Similar soils

Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole (map symbol)

A closed, circular or elliptical depression, commonly funnel shaped, characterized by subsurface drainage and formed either by dissolution of the surface of underlying bedrock (e.g., limestone, gypsum, or salt) or by collapse of underlying caves within bedrock. Complexes of sinkholes in carbonate-rock terrain are the main components of karst topography.

Site index

A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slickensides (pedogenic)

Grooved, striated, and/or glossy (shiny) slip faces on structural peds, such as wedges; produced by shrink-swell processes, most commonly in soils that have a high content of expansive clays.

Slide or slip (map symbol)

A prominent landform scar or ridge caused by fairly recent mass movement or descent of earthy material resulting from failure of earth or rock under shear stress along one or several surfaces.

Slope

The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope alluvium

Sediment gradually transported down the slopes of mountains or hills primarily by nonchannel alluvial processes (i.e., slope-wash processes) and characterized by particle sorting. Lateral particle sorting is evident on long slopes. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of rock fragments and may be separated by stone lines. Burnished peds and sorting of rounded or subrounded pebbles or cobbles distinguish these materials from unsorted colluvial deposits.

Slow refill

The slow filling of ponds, resulting from restricted water transmission in the soil.

Slow water movement

Restricted downward movement of water through the soil. See Saturated hydraulic conductivity.

Sodic (alkali) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodic spot (map symbol)

An area where the surface layer has a sodium adsorption ratio that is at least 10 more than that of the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has a sodium adsorption ratio of 5 or less.

Sodicity

The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to Ca^{++} + Mg^{++}. The degrees of sodicity and their respective ratios are:

Slight: Less than 13:1
Moderate: 13-30:1
Strong: More than 30:1

Sodium adsorption ratio (SAR)

A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock

Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil

A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief and by the passage of time.

Soil separates

Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand: 2.0 to 1.0

Coarse sand: 1.0 to 0.5

Medium sand: 0.5 to 0.25

Fine sand: 0.25 to 0.10

Very fine sand: 0.10 to 0.05

Silt: 0.05 to 0.002

Clay: Less than 0.002

Solum

The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Spoil area (map symbol)

A pile of earthy materials, either smoothed or uneven, resulting from human activity.

Stone line

In a vertical cross section, a line formed by scattered fragments or a discrete layer of angular and subangular rock fragments (commonly a gravel- or cobble-sized lag concentration) that formerly was draped across a topographic surface and was later buried by additional sediments. A stone line generally caps material that was subject to weathering, soil formation, and erosion before burial. Many stone lines seem to be buried erosion pavements, originally formed by sheet and rill erosion across the land surface.

Stones

Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony

Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stony spot (map symbol)

A spot where 0.01 to 0.1 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surrounding soil has no surface stones.

Strath terrace

A type of stream terrace; formed as an erosional surface cut on bedrock and thinly mantled with stream deposits (alluvium).

Stream terrace

One of a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream; represents the remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition.

Stripcropping

Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

Structure, soil

The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are:

Platy: Flat and laminated
Prismatic: Vertically elongated and having flat tops
Columnar: Vertically elongated and having rounded tops
Angular blocky: Having faces that intersect at sharp angles (planes)
Subangular blocky: Having subrounded and planar faces (no sharp angles)
Granular: Small structural units with curved or very irregular faces

Structureless soil horizons are defined as follows:

Single grained: Entirely noncoherent (each grain by itself), as in loose sand
Massive: Occurring as a coherent mass

Stubble mulch

Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil

Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling

Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum

The part of the soil below the solum.

Subsurface layer

Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow

The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Summit

The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

Surface layer

The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil

The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Talus

Rock fragments of any size or shape (commonly coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of such loose broken rock formed chiefly by falling, rolling, or sliding.

Taxadjuncts

Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terminal moraine

An end moraine that marks the farthest advance of a glacier. It typically has the form of a massive arcuate or concentric ridge, or complex of ridges, and is underlain by till and other types of drift.

Terrace (conservation)

An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geomorphology)

A steplike surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, lake, or seashore. The term is usually applied both to the relatively flat summit surface (tread) that was cut or built by stream or wave action and to the steeper descending slope (scarp or riser) that has graded to a lower base level of erosion.

Terracettes

Small, irregular steplike forms on steep hillslopes, especially in pasture, formed by creep or erosion of surficial materials that may be induced or enhanced by trampling of livestock, such as sheep or cattle.

Texture, soil

The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer

Otherwise suitable soil material that is too thin for the specified use.

Till

Dominantly unsorted and nonstratified drift, generally unconsolidated and deposited directly by a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders; rock fragments of various lithologies are embedded within a finer matrix that can range from clay to sandy loam.

Till plain

An extensive area of level to gently undulating soils underlain predominantly by till and bounded at the distal end by subordinate recessional or end moraines.

Tilth, soil

The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toeslope

The gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear and are constructional surfaces forming the lower part of a hillslope continuum that grades to valley or closed-depression floors.

Topsoil

The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements

Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Tread

The flat to gently sloping, topmost, laterally extensive slope of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural steplike landforms, such as successive stream terraces.

Tuff

A generic term for any consolidated or cemented deposit that is 50 percent or more volcanic ash.

Upland

An informal, general term for the higher ground of a region, in contrast with a low-lying adjacent area, such as a valley or plain, or for land at a higher elevation than the flood plain or low stream terrace; land above the footslope zone of the hillslope continuum.

Valley fill

The unconsolidated sediment deposited by any agent (water, wind, ice, or mass wasting) so as to fill or partly fill a valley.

Variegation

Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve

A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Very stony spot (map symbol)

A spot where 0.1 to 3.0 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surface of the surrounding soil is covered by less than 0.01 percent stones.

Water bars

Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering

All physical disintegration, chemical decomposition, and biologically induced changes in rocks or other deposits at or near the earth's surface by atmospheric or biologic agents or by circulating surface waters but involving essentially no transport of the altered material.

Well graded

Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wet spot (map symbol)

A somewhat poorly drained to very poorly drained area that is at least two drainage classes wetter than the named soils in the surrounding map unit.

Wilting point (or permanent wilting point)

The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

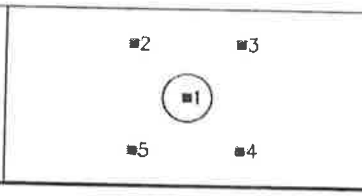
Windthrow

The uprooting and tipping over of trees by the wind.

LAWRENCE & ASSOCIATES
2001 MARKET STREET, RM. 523
REDDING, CA 96001
PHONE : (530) 244-9703
FAX : (530) 244-5021

PROJECT: COMPOST FACILITY	SHEET 1 OF 1
	HOLE#: TP-1
JOB #: 006122.00	DATE: 7/25/06
LOGGED BY: C. KLINESTEKER	DRILLER: LAWRENCE & ASSOCIATES
HOLE INFO: N/A	
EQUIPMENT AND SPECIFICATIONS: BACKHOE PROVIDED BY CLIENT	

FIELD LOCATION OF WELL



DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	LITHOLOGY PROFILE		DESCRIPTION
0			ML/CL		0 – 2'	SILT WITH CLAY, DRY, LOW TOUGHNESS, LOW PLASTICITY, BLOCKY STRUCTURE, PEDS UP TO 18" LONG, MODERATE CEMENTATION, FINE ROOTS COMMON FROM 0-3", FINE ROOTS PRESENT TO 2', CRACKS OBSERVED ON GROUND SURFACE UP TO 3/4" WIDE AND OVER 8' LONG, <5% GRAVEL, REDDISH BROWN (5YR 4/4)
					3'	OBSERVED VEIN OF BLUE CLAY, 1" WIDE
5			GP		2' – 8'	SANDY GRAVEL, SHARP CONTACT @2', LOOSE, MOIST, GRAVEL FRAGMENTS UP TO 3" LONG, SUB-ROUNDED, ALLUVIAL, GRADES TO MORE GRAVEL, LOW ABUNDANCE OF ROOTS PRESENT DOWN TO 8', REDDISH-BROWN (5YR 4/4)
10						
15						
20						
25						
30						

NOTES:

LAWRENCE & ASSOCIATES
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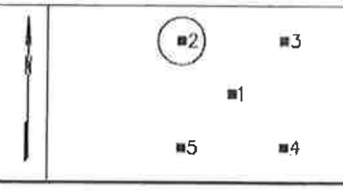
REDDING, CA 96001
PHONE : (530) 244-9703
FAX : (530) 244-5021

PROJECT: COMPOST FACILITY	SHEET 1 OF 1
	HOLE#: TP-2
JOB #: 006122.00	DATE: 7/25/06
LOGGED BY: C. KLINESTEKER	DRILLER: LAWRENCE & ASSOCIATES
HOLE INFO: N/A	
EQUIPMENT AND SPECIFICATIONS: BACKHOE PROVIDED BY CLIENT	

FIELD LOCATION OF WELL



DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	LITHOLOGY PROFILE	DESCRIPTION
0 – 1'			ML		SANDY SILT WITH GRAVEL ~35% SAND, 15% GRAVEL, GRANULAR TO BLOCKY, STRUCTURE, PEDS UP TO 1' LONG, DRY, MODERATE CEMENTATION, NO CRACKS OBSERVED ON SURFACE, FINE FIBROUS ROOTS PRESENT TO 1', STRONG BROWN (7.5YR 5/8)
1' – 5'			ML		WELL-GRADED GRAVELLY SILT, LOW-MODERATE CEMENTATION, SLIGHT SILT MATRIX, ENOUGH TO HOLD GRAVEL TOGETHER LOOSELY, BLOCKY STRUCTURE, NO ROOTS OBSERVED, GRADES TO MORE GRAVEL AND MORE MOISTURE, STRONG BROWN (7.5YR 5/6)
5' – 8'			SP		COURSE SAND, POORLY GRADED, MOIST, LOOSE, SUB-ROUNDED FRAGMENTS, NO CEMENTATION, SILT LENSES PRESENT IN LOW ABUNDANCE-<1' LONG, SLIGHTLY STICKY, SOME GRAVEL FRAGMENTS UP TO 3" LONG, PIT EASILY CAVED IN STARTING AT 6', DARK BROWN (7.5YR 4/2)

Depth scale: 0, 5, 10, 15, 20, 25, 30

NOTES:

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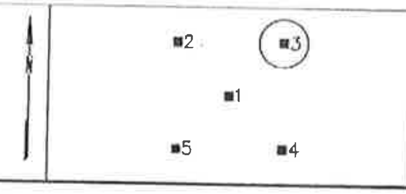
PROJECT: COMPOST FACILITY	SHEET 1 OF 1
	HOLE#: TP-3
JOB #: 006122.00	DATE: 7/25/06
LOGGED BY: C. KLINESTEKER	DRILLER: LAWRENCE & ASSOCIATES
HOLE INFO: N/A	
EQUIPMENT AND SPECIFICATIONS: BACKHOE PROVIDED BY CLIENT	

FIELD LOCATION OF WELL



DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	LITHOLOGY PROFILE	DESCRIPTION
0 – 1'			ML–CL		SILT WITH CLAY, MODERATE CEMENTATION, LOW–PLASTICITY, LOW TOUGHNESS, POORLY GRADED, DRY, FINE ROOTS TO 6", DARK BROWN (7.5YR 4/4)
1' – 6'			ML		SILT, SOFT, MOIST, HOMOGENOUS STRUCTURE, LOW PLASTICITY, LOW TOUGHNESS, NO ROOTS OBSERVED, ~5% CLAY, GRADES DOWN TO ~5% GRAVEL, DARK BROWN (7.5YR 4/4)
6' – 8'			SW–SM		GRAVELLY SAND WITH SILT, WEAK CEMENTATION, ROUNDED FRAGMENTS, MOIST, WELL–GRADED, DARK BROWN (7.5YR 4/4)

Depth scale: 0, 5, 10, 15, 20, 25, 30

NOTES:

P:\006122.00_Compost Solution Inc\TP-3.dwg D.B.Z. 11/14/2006

LAWRENCE & ASSOCIATES
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REDDING, CA 96001
PHONE : (530) 244-9703
FAX : (530) 244-5021

PROJECT: COMPOST FACILITY

SHEET 1 OF 1

HOLE#: TP-4

JOB #: 006122.00

DATE: 7/25/06

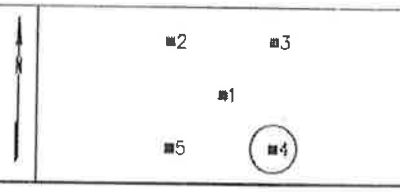
LOGGED BY: C. KLINESTEKER

DRILLER: LAWRENCE & ASSOCIATES

HOLE INFO: N/A

EQUIPMENT AND SPECIFICATIONS:
BACKHOE PROVIDED BY CLIENT

FIELD LOCATION OF WELL



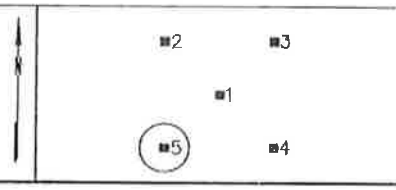
DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	LITHOLOGY PROFILE		DESCRIPTION
0			SW-SM		0 – 1'	SAND WITH SILT AND GRAVEL, WELL-GRADED, DRY, MODERATE CEMENTATION, FINE ROOTS PRESENT IN LOW ABUNDANCE, SUB-ROUNDED FRAGMENTS, STRONG BROWN (7.5YR 4/6)
			SW-SM		1' – 4'	SAND WITH SILTY GRAVEL, WELL-GRADED, MOIST, SUB-ROUNDED FRAGMENTS UP TO 2" LONG, FINE ROOTS TO 2', STRONG BROWN (7.5YR 4/6)
5			SW		4' – 8'	GRAVELLY SAND, ROUNDED FRAGMENTS, SLIGHTLY STICKY, NO CEMENTATION, MOIST, TRACE SILT PRESENT, GRAVEL UP TO 3" LONG, STRONG BROWN (7.5YR 4/6)
10						
15						
20						
25						
30						

NOTES:

LAWRENCE & ASSOCIATES
2001 MARKET STREET, RM. 523
REDDING, CA 96001
PHONE : (530) 244-9703
FAX : (530) 244-5021

PROJECT: COMPOST FACILITY	SHEET 1 OF 1
	HOLE#: TP-5
JOB #: 006105.00	DATE: 7/25/06
LOGGED BY: C. KLINESTEKER	DRILLER: LAWRENCE & ASSOCIATES
HOLE INFO: N/A	
EQUIPMENT AND SPECIFICATIONS: BACKHOE PROVIDED BY CLIENT	

FIELD LOCATION OF WELL



DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	LITHOLOGY PROFILE	DESCRIPTION
0 – 2'			ML		SANDY SILT WITH GRAVEL, ~10% GRAVEL, NO PLASTICITY, BLOCKY STRUCTURE, MODERATE CEMENTATION, GRAVEL FRAGMENTS ARE SUB-ROUNDED AND UP TO 1.5" LONG, DRY SILT IS VERY POWDERY AND DUSTY, FINE ROOTS PRESENT IN LOW ABUNDANCE, DARK BROWN (5YR 4/4)
2' – 6'			SW-SM		GRAVELLY SAND WITH SILT, SUB-ANGULAR FRAGMENTS, WEAK CEMENTATION, BECOMES MOIST AT 4.5', FINE ROOTS PRESENT IN LOW ABUNDANCE, DARK BROWN (5YR 4/4)
6' – 8'			SW		GRAVELLY SAND WITH COBBLES, SUB-ROUNDED FRAGMENTS, LOOSE, MOIST, FINE ROOTS PRESENT TO DEPTH OF 7' IN LOW ABUNDANCE, ~10% COBBLES UP TO 5" LONG

Depth scale: 0, 5, 10, 15, 20, 25, 30

NOTES:

Soils Data Used for Design in 2005

VECTOR
ENGINEERING, INC.

DATE: September 11, 2006

TO: Clayton Coles
Lawrence & Assoc. Inc.
2001 Market St. suite 523
Redding, CA 96001

JOB NO: 051700.03
LAB LOG: 1918.0

RECEIVED
SEP 2 0 2006

RE: **Lab Report: Total Soil Solutions**

Enclosed are results for: Samples Received - August 8, 2006

Code	Item	Quantity
11504	Modified Compaction-4" ASTM D-1557	2
19534	Atterberg Limits, ASTM D-4318	2
18568	Hydraulic Conductivity-Flex-wall, Remolded, ASTM D-5084	4
19522	Percent Finer than # 200 Sieve, ASTM D-1140 (C-117)	2

Thank you for consulting Vector Engineering for your material testing requirements. We look forward to working with you again. If you have any questions or require any additional information, please call us at 1-530-272-2448.

Sincerely,

Prepared By: Margaret Dell-Era
Laboratory Administrator

Reviewed By: Kenneth R. Criley
Technical Director

143E Spring Hill Drive • Grass Valley, California 95945 • (530) 272-2448 • Fax (530) 272-8533

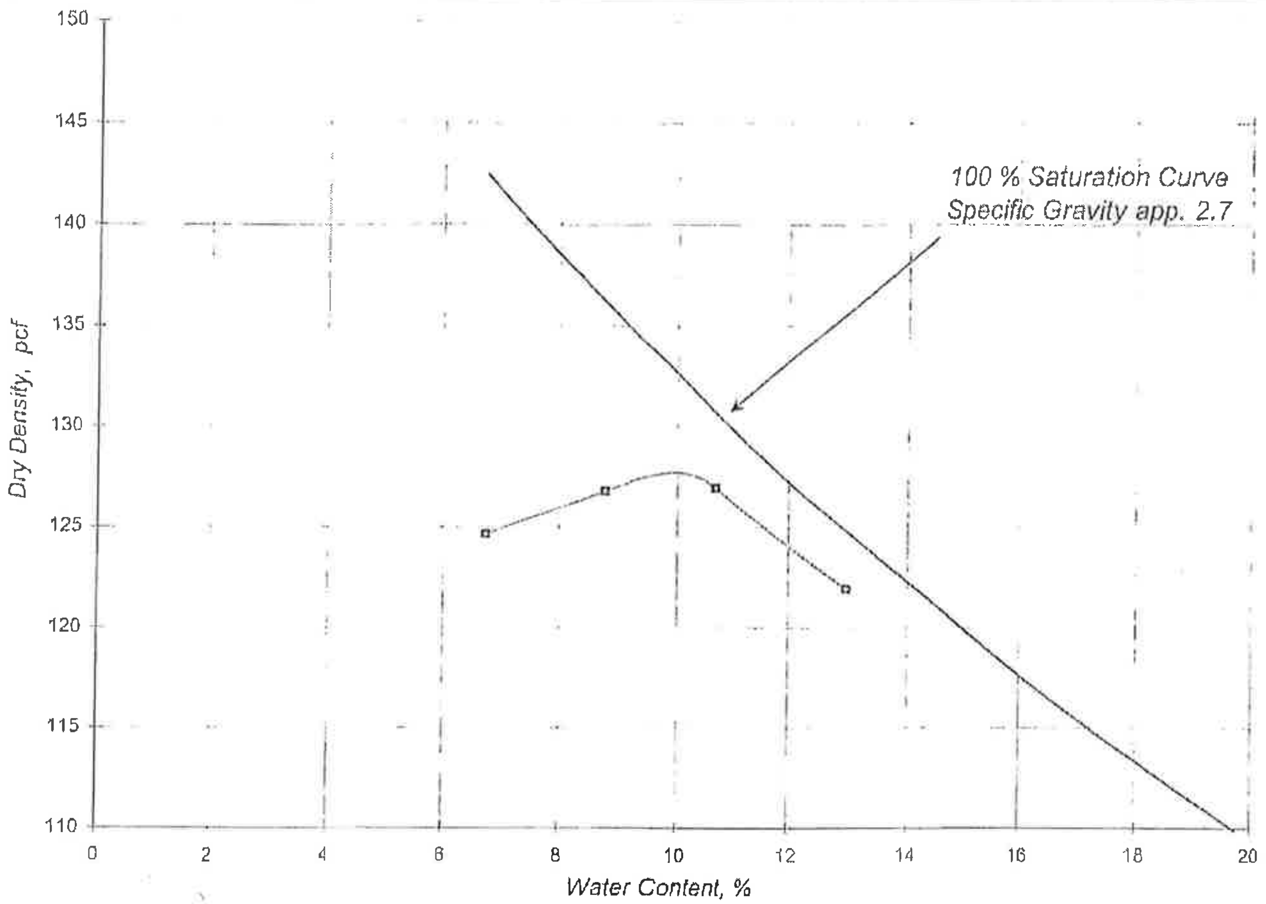
Vector Engineering Inc.
143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

MOISTURE / DENSITY RELATIONSHIPS

TEST REPORT

ASTM D - 1557

Client: Lawrence & Associates Inc.	Project No: 051700.03	Lab Log No: 1918A
Project Name: Total Soil Solutions		Report Date: August 14, 2006



Symbol	Lab No.	Sample Identification	Description	Maximum Dry Density pcf	Maximum Dry Density kg / m³	Optimum Water Content %
▣	1918A	TP - 1, 3 (Sampled 8/3/06) Rec'd. 8/8/06	Brown Sandy Silty Clay	127.7	2.05	10

Corrected Values For Oversized Particles, per ASTM D-4718

▣ 1918A with 0 Percent + #4 Gravel, the maximum Dry Density = 127.7 10.0

Note: The test was conducted as method A with 0 percent retained on the no. 4 sieve (minus#4)

Test By: SMC, JM Enter By: SMC Ck By: [signature]

Vector Engineering Inc.

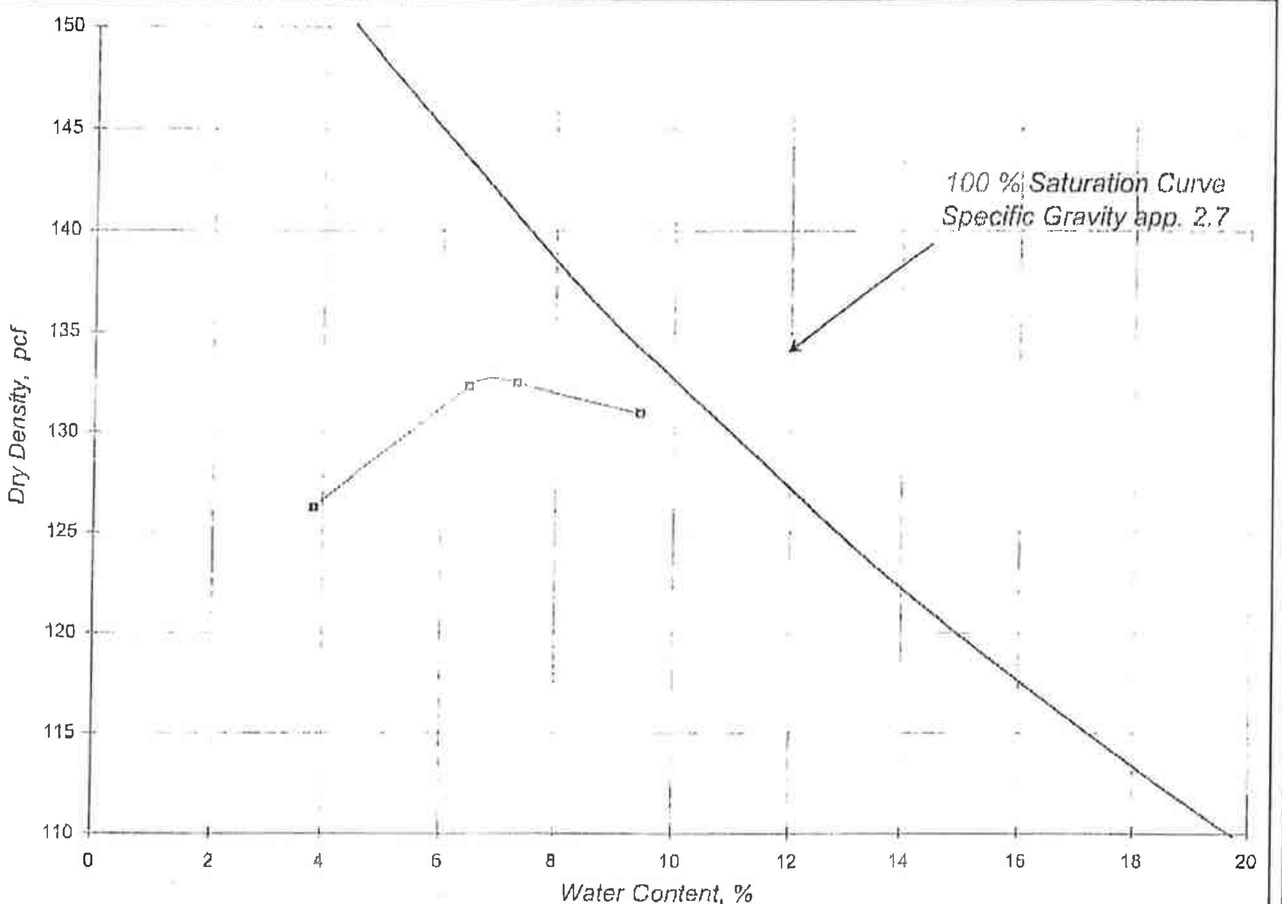
143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

MOISTURE / DENSITY RELATIONSHIPS

TEST REPORT

ASTM D - 1557

Client	Project No.	Lab Log No.
Lawrence & Associates Inc.	051700.03	1918B
Project Name: Total Soil Solutions		**Report Date:** August 15, 2006



Symbol	Lab No.	Sample Identification	Description	Maximum Dry Density pcf	Maximum Dry Density kg / m³	Optimum Water Content %
▫	1918B	TP-2, 4, 5 (Sampled 8/3/06) (rec'd. 8/8/06)	Brown Silty Clayey Sand w/ Gravel	132.7	2.13	6.9

Corrected Values For Oversized Particles, per ASTM D-4718

▪ 1918B with 5 Percent + 3/4" Gravel, the maximum Dry Density : 134.1 6.5

Note: The test was conducted as method A with 16.6 percent retained on the no. 4 sieve (minus3/4")

Test By: SMC/JM Enter By: JM Ck. By: [signature]

Vector Engineering Inc.

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LABORATORY SERVICES

ATTERBERG LIMITS

Summary Report

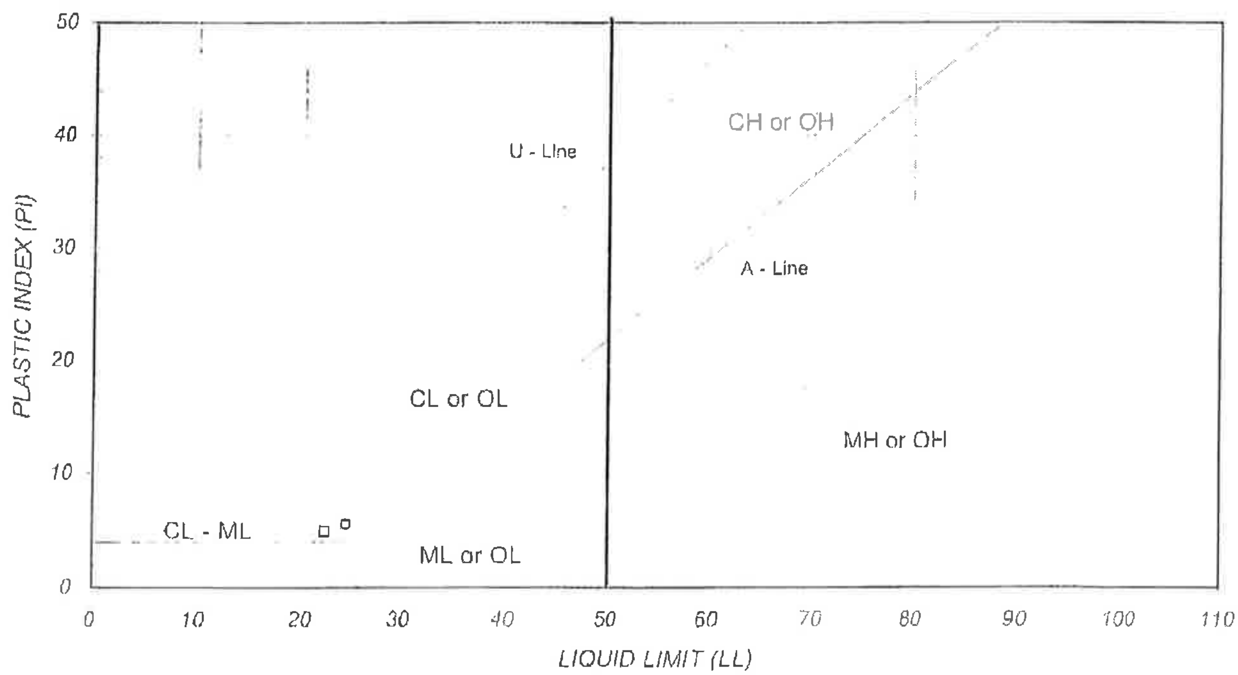
ASTM D-4318

Client	Project No	Lab Log No
Lawrence & Associates Inc.	051700.03	1918A

Project Name	Report Date
Total Soil Solutions	August 31, 2006

LSN	SYMBOL	SAMPLE IDENTIFICATION	SAMPLE DESCRIPTION	UNIFIED SYMBOL	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
1918A	□	TP-1,3	Brown Sandy Silty Clay	CL-ML	22	17	5
1918B	○	TP-2, 4, 5	Brown Silty Clayey Sand w/ Gravel	SC-SM	24	19	6

PLASTICITY CHART



Print Date | Entered By | Rev. By | Lab Log No: 1918A

Vector Engineering, Inc.

143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448

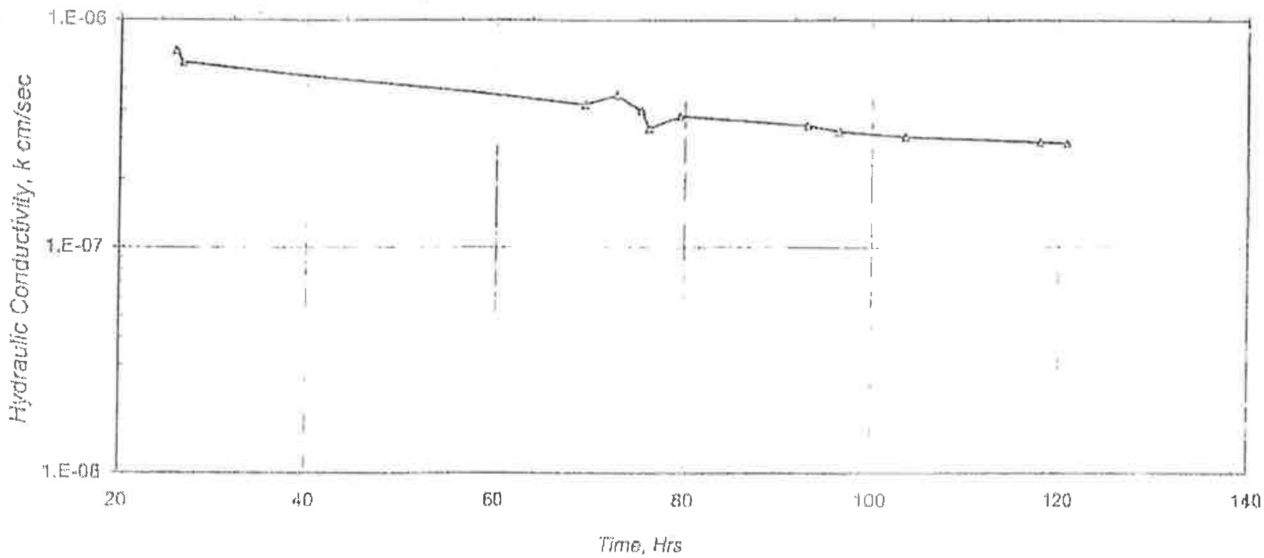
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No:	Lab Sample Number:
Lawrence & Assoc. Inc./Total Soil Solutions	051700.03	1918A

Sample ID:	Report Date:
TP-1, 3 (Sampled 8/3/06)	August 31, 2006

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID:	TP-1, 3 (Sampled 8/3/06)	
DESCRIPTION:	Brown Sandy Silty Clay	
	INITIAL	FINAL
HEIGHT, in.	3.0	3.0
DIAMETER, in.	2.4	2.4
WATER CONTENT, %	12.2	17.2
DRY DENSITY, pcf	116	115
SATURATION, %	72	100
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf	127.7	
OPTIMUM WATER CONTENT, %	10.0	
SPECIFIED COMPACTION, %	90.0	
ACHIEVED COMPACTION, %	90.8	

COMMENTS

Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	2 psi
GRADIENT RANGE:	1 - 12
IN / OUT RATIO:	1.00
"B" PARAMETER:	0.98

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
6	76.2	3.4E-07
7	79.5	3.8E-07
8	93.5	3.4E-07
9	96.7	3.2E-07
10	103.4	3.1E-07
11	118.0	2.9E-07
12	120.9	2.9E-07
AVERAGE LAST 4 :		3.0E-07

Vector Engineering, Inc.

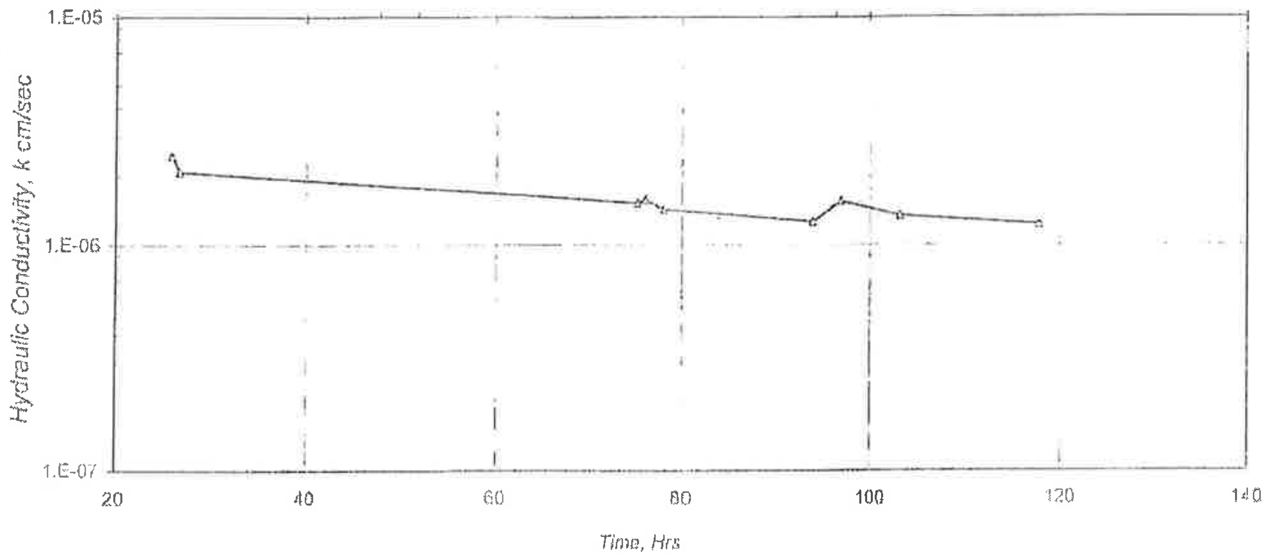
143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No:	Lab Sample Number
Lawrence & Assoc. Inc./Total Soil Solutions	051700.03	1918B

Sample ID:	Report Date:
TP-2, 4, 5 (Sampled 8/3/06)	August 31, 2006

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID: TP-2, 4, 5 (Sampled 8/3/06)

DESCRIPTION: Brown Silty Clayey Sand w/ Gravel

	INITIAL	FINAL
HEIGHT, in.	3.0	3.0
DIAMETER, in.	3.0	3.0
WATER CONTENT, %	9.0	14.4
DRY DENSITY, pcf	119	120
SATURATION, %	59	96
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf	132.7	
OPTIMUM WATER CONTENT, %	6.9	
SPECIFIED COMPACTION, %	90.0	
ACHIEVED COMPACTION, %	90.0	

COMMENTS:

Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	2 psi
GRADIENT RANGE:	0 - 11
IN / OUT RATIO:	1.10
"B" PARAMETER:	0.98

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
3	75.4	1.5E-06
4	76.2	1.6E-06
5	78.2	1.4E-06
6	93.6	1.3E-06
7	96.7	1.6E-06
8	103.4	1.3E-06
9	117.8	1.2E-06
AVERAGE LAST 4:		1.4E-06

1918B

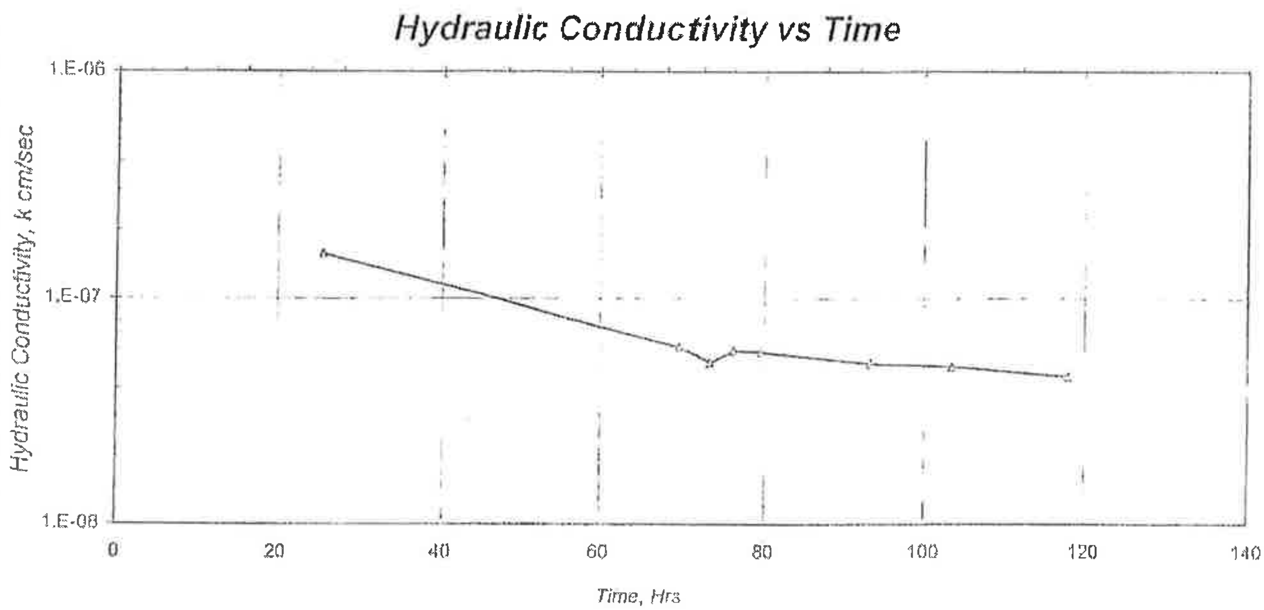
Vector Engineering, Inc.

143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No	Lab Sample Number
Lawrence & Assoc. Inc./Total Soil Solutions	051700.03	1918C

Sample ID	Report Date
TP-1, 3 (Sampled 8/3/06) (1918A)	August 31, 2006



SPECIMEN DATA

SAMPLE ID: **TP-1, 3 (Sampled 8/3/06) (1918A)**

DESCRIPTION: Brown Sandy Silty Clay

	INITIAL	FINAL
HEIGHT, in.	3.0	3.0
DIAMETER, in.	2.4	2.4
WATER CONTENT, %	12.4	15.0
DRY DENSITY, pcf	120	120
SATURATION, %	83	99

(Specific Gravity assumed as 2.7)

MAXIMUM DRY DENSITY, pcf	127.7
OPTIMUM WATER CONTENT, %	10.0
SPECIFIED COMPACTION, %	95.0
ACHIEVED COMPACTION, %	94.0

COMMENTS:

Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	2 psi
GRADIENT RANGE:	6 - 10
IN / OUT RATIO:	1.12
"B" PARAMETER:	0.98

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
2	69.7	6.1E-08
3	73.1	5.2E-08
4	76.1	5.9E-08
5	79.5	5.8E-08
6	93.5	5.2E-08
7	103.5	5.0E-08
8	118.0	4.5E-08
AVERAGE LAST 4		5.1E-08

Checked By / Reviewed By: (initials)

1918C

Vector Engineering Inc.
7 Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

WATER CONTENT & MINUS # 200 % with GRAVEL

QC Data Check

Client: Lawrence & Assoc. Inc. | Project: Total Soil Solutions | Project Number: 051700.03 | Lab Log: 1918

Lab Sample Number (LSN)	1918A	1918B								
Sample Identification										
Description										
INITIAL PREPARATION										
Date / By:										
Tare Name.:										
A Total Wet Soil Mass & Tare (g):		25566.6								
B Tare Mass (g):	0	0	0	0	0	0	0	0	0	0
C Total Wet Soil Mass (g):		25566.60								
D Plus # 4 (Gravel) Mass (g):	0	5311.6	0	0	0	0	0	0	0	0
WATER CONTENT %										
E Tare Name:	B104	B108								
F Tare + Wet Soil Mass (g):	181.62	193.35								
G Tare + Dry Soil Mass (g):	171.18	183.43								
H Moisture Loss Mass (g):	10.44	9.92								
I Tare Mass (g):	85.02	84.13								
J Dry Soil Mass (g):	86.16	99.30								
K Tare + Washed Dry Soil Mass (g):	117.75	129.14								
L Uncorrect (# 4 Portion) -200 (%):	62.01	54.67								
M Minus # 4 - Water Content (%):	12.12	9.99								
TOTAL SAMPLE										
PERCENT GRAVEL (+ # 4)	**0.0**	**22.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
PERCENT SAND (- # 4)	**38.0**	**35.2**								
WATER CONTENT, (Total Sample) (%):	**12.1**	**7.8**								
PERCENT PASSING # 200	**62.0**	**42.4**								

Print Date: 09/10/06 | Entered By: AC | Rev by: | LLN: 1918

Vector Engineering, Inc.

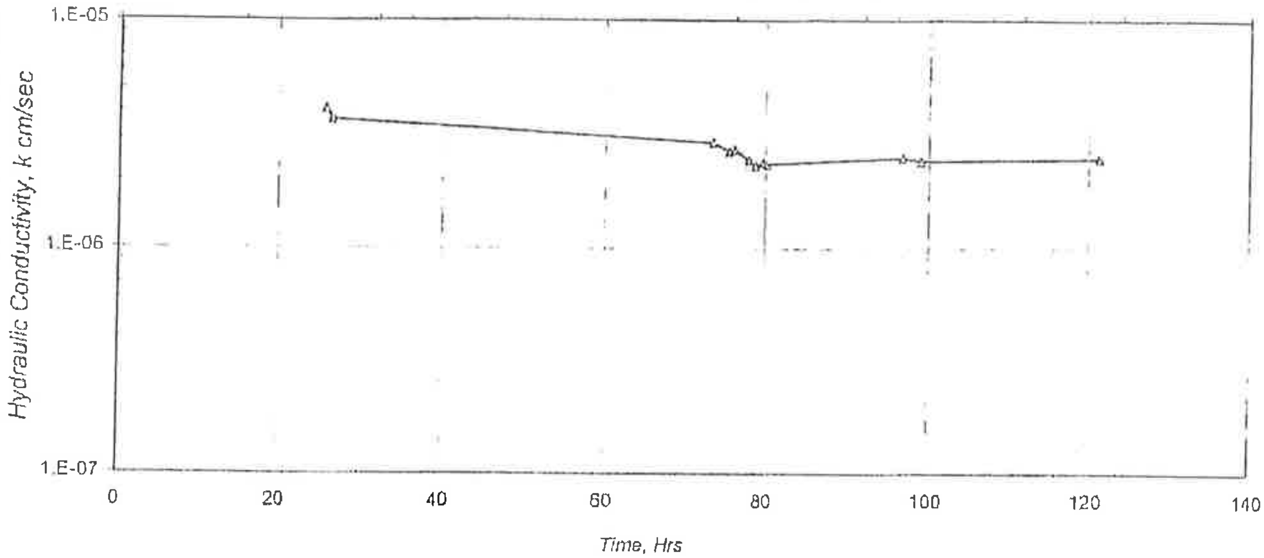
143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name	Project No:	Lab Sample Number:
Lawrence & Assoc. Inc./Total Soil Solutions	051700.03	1918D

Sample ID:	Report Date:
TP-2, 4, 5 (Sampled 8/3/06) (1918B)	August 31, 2006

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID:	TP-2, 4, 5 (Sampled 8/3/06) (1918B)	
DESCRIPTION:	Brown Silty Clayey Sand w/ Gravel	
	INITIAL	FINAL
HEIGHT, In.	3.0	3.0
DIAMETER, in.	3.0	3.0
WATER CONTENT, %	7.4	12.4
DRY DENSITY, pcf	127	126
SATURATION, %	61	100
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf	132.7	
OPTIMUM WATER CONTENT, %	6.9	
SPECIFIED COMPACTION, %	95.0	
ACHIEVED COMPACTION, %	95.7	

COMMENTS:

Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	2 psi
GRADIENT RANGE:	1 - 11
IN / OUT RATIO:	0.99
"B" PARAMETER:	0.98

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
6	77.8	2.5E-06
7	78.7	2.3E-06
8	79.7	2.4E-06
9	80.1	2.3E-06
10	96.8	2.5E-06
11	99.0	2.4E-06
12	121.3	2.5E-06
AVERAGE LAST 4:		2.4E-06

Soils Data from CQA Testing of Composting Pad

VECTOR
ENGINEERING, INC.

DATE: July 16, 2007

TO: Woody Pollard
Lawrence & Assoc. Inc.
2001 Market St. suite 523
Redding, CA 96001
FAX: 530-244-5021

JOB NO: 051700.06
LAB LOG: 2222.0

RE: **Lab Report: Orland Compost Facility**

Enclosed are results for: Samples Received - June 27, 2007

Code	Item	Quantity
18572	Hydraulic Conductivity-Flex-wall, ASTM D-5084	4

Thank you for consulting Vector Engineering for your material testing requirements. We look forward to working with you again. If you have any questions or require any additional information, please call us at 1-530-272-2448.

Sincerely,

Prepared By: Margaret Dell-Era
Laboratory Administrator

Reviewed By: Erik Olhoffer
Laboratory Manager

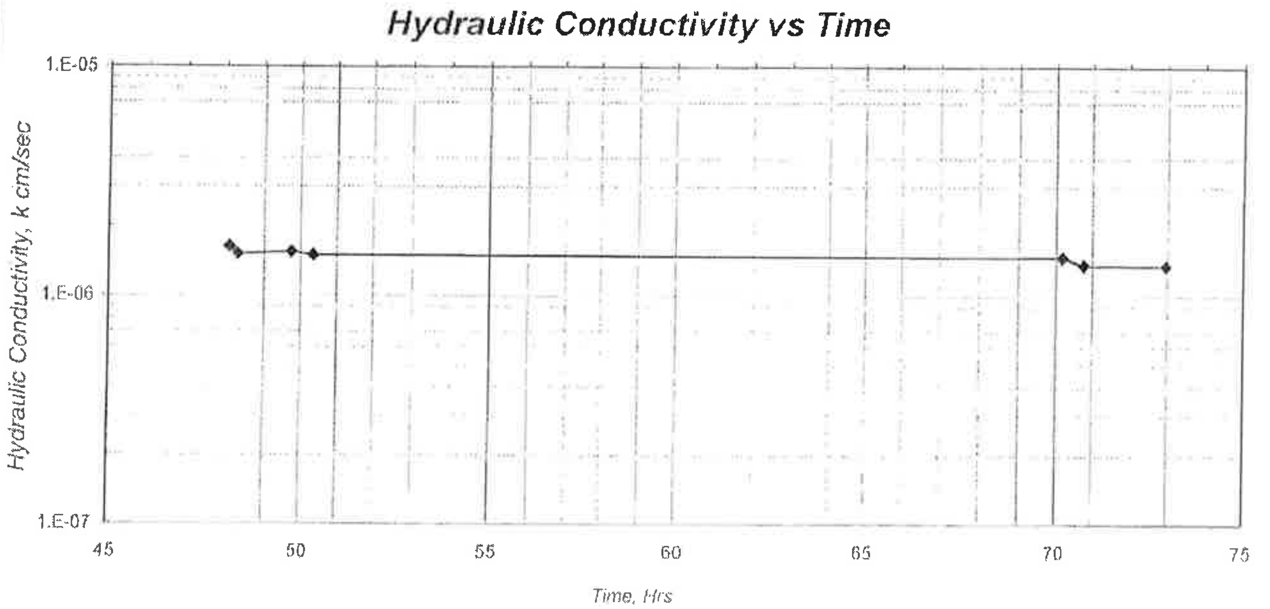
143E Spring Hill Drive • Grass Valley, California 95945 • (530) 272-2448 • Fax: (530) 272-8533
USA • Central & South America • Philippines

Vector Engineering, Inc.

143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name:	Project No.	Lab Sample Number
Lawrence & Assoc, Inc./ Orland Compost Facitliy	051700.06	2222A
Sample ID:		**Report Date:**
Sample #2 (sampled 6/22)		July 4, 2007



SPECIMEN DATA

SAMPLE ID:	Sample #2 (sampled 6/22)	
DESCRIPTION:	Brown Clay w/gravel	
	INITIAL	FINAL
HEIGHT, in.	4.6	4.5
DIAMETER, in.	4.0	4.0
WATER CONTENT, %	11.6	14.2
DRY DENSITY, pcf	118	118
SATURATION, %	74	89
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:

Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	2 psi
GRADIENT RANGE:	3 - 7
IN / OUT RATIO:	0.89
"B" PARAMETER:	0.95

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
1	48.1	1.6E-06
2	48.3	1.5E-06
3	49.7	1.5E-06
4	50.4	1.5E-06
5	70.2	1.5E-06
6	70.8	1.4E-06
7	73.0	1.4E-06
AVERAGE LAST 4 :		**1.4E-06**

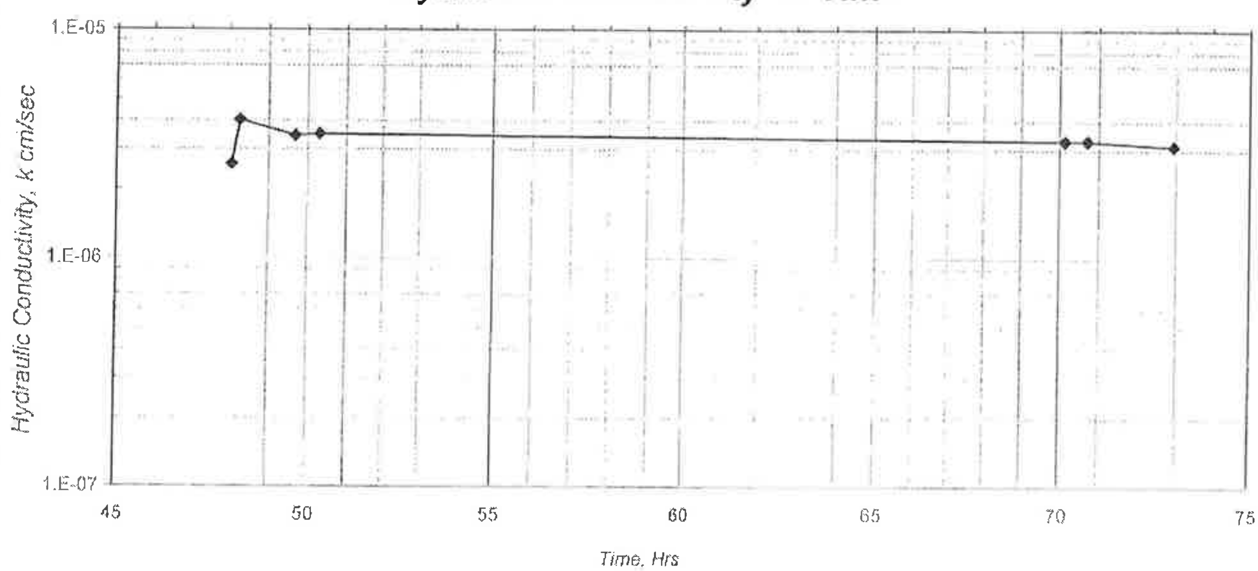
Vector Engineering, Inc.

143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name: Lawrence & Assoc, Inc./ Orland Compost Facitliy
Project No: 051700.06
Lab Sample Number: 2222B
Sample ID: Sample #3 (samples 6/27)
Report Date: July 4, 2007

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID: **Sample #3 (samples 6/27)**
DESCRIPTION: Brown Clay w/gravel

	INITIAL	FINAL
HEIGHT, in.	4.6	4.6
DIAMETER, in.	4.0	4.1
WATER CONTENT, %	10.5	14.9
DRY DENSITY, pcf	118	110
SATURATION, %	66	76
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:
Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS: 2 psi
GRADIENT RANGE: 1 - 7
IN / OUT RATIO: 0.91
"B" PARAMETER: 0.95

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
1	48.1	2.6E-06
2	48.3	4.0E-06
3	49.7	3.4E-06
4	50.3	3.5E-06
5	70.1	3.3E-06
6	70.7	3.3E-06
7	72.9	3.1E-06

AVERAGE LAST 4 : **3.3E-06**

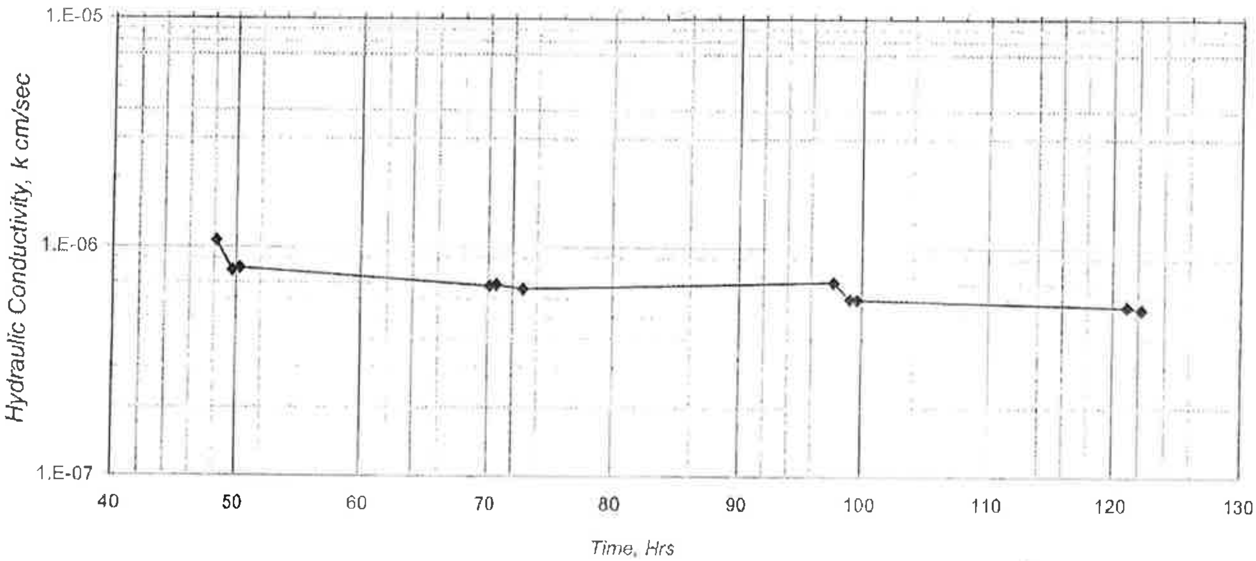
Vector Engineering, Inc.

143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448
LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name: **Lawrence & Assoc, Inc./ Orland Compost Facitliy**
Project No: **051700.06**
Lab Sample Number: **2222C**
Sample ID: **Sample #1 (sampled 6/22)**
Report Date: **July 4, 2007**

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID: **Sample #1 (sampled 6/22)**
DESCRIPTION: Brown Clay w/gravel

	INITIAL	FINAL
HEIGHT, in.	4.6	4.5
DIAMETER, in.	4.0	4.1
WATER CONTENT, %	9.5	12.7
DRY DENSITY, pcf	124	120
SATURATION, %	72	84
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:
Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS: 2 psi
GRADIENT RANGE: 4 - 8
IN / OUT RATIO: 1.03
"B" PARAMETER: 0.95

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
5	70.7	6.9E-07
6	72.9	6.6E-07
7	97.8	7.1E-07
8	99.1	6.0E-07
9	99.6	6.0E-07
10	121.1	5.5E-07
11	122.3	5.4E-07

AVERAGE LAST 4 : **5.7E-07**

L : Labexcel \ Projects \2005 \ 051700 \ 2222C-txk
Print Date: 07/16/07
Reviewed By:
LSN: 2222C

DCN: TXK-QC-GRAPH (rev. 5/23/07)

Vector Engineering, Inc.

143E Spring Hill Drive, Grass Valley, CA 95945 (530) 272-2448

LABORATORY SERVICES

HYDRAULIC CONDUCTIVITY REPORT

Client / Project Name: Lawrence & Assoc, Inc./ Orland Compost Facitliy

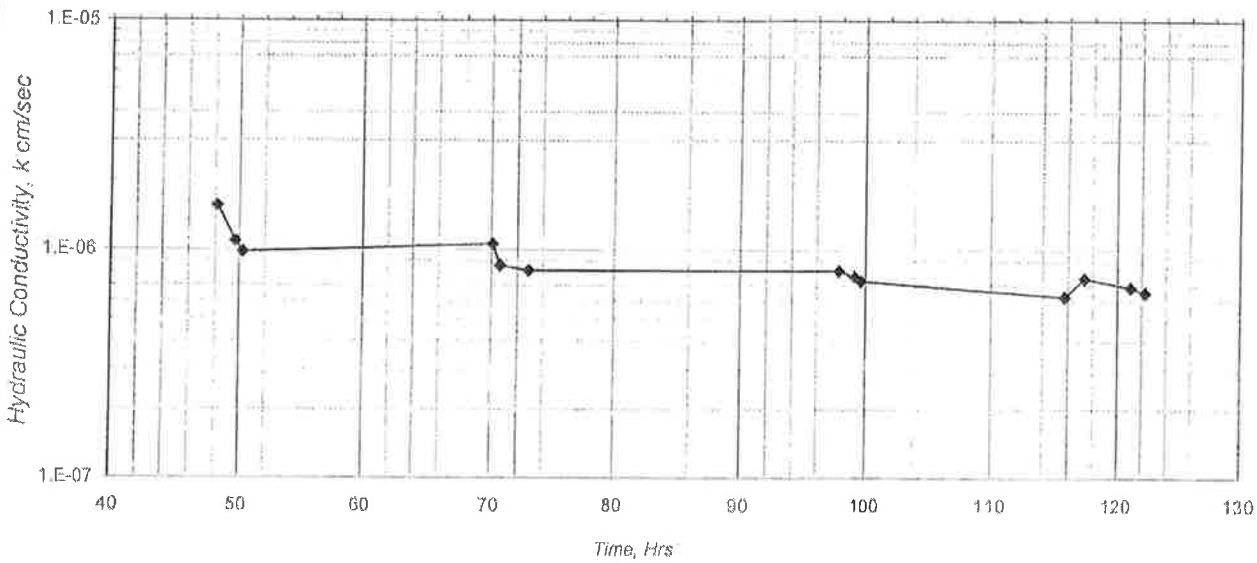
Project No: 051700.06

Lab Sample Number: 2222D

Sample ID: Sample #4 (sampled 6/27)

Report Date: July 4, 2007

Hydraulic Conductivity vs Time



SPECIMEN DATA

SAMPLE ID: **Sample #4 (sampled 6/27)**

DESCRIPTION: Brown Clay w/gravel

	INITIAL	FINAL
HEIGHT, in.	3.8	3.9
DIAMETER, in.	4.0	4.1
WATER CONTENT, %	11.6	15.1
DRY DENSITY, pcf	119	112
SATURATION, %	75	81
(Specific Gravity assumed as 2.7)		
MAXIMUM DRY DENSITY, pcf		
OPTIMUM WATER CONTENT, %		
SPECIFIED COMPACTION, %		
ACHIEVED COMPACTION, %		

COMMENTS:

Tap water used as permeant.

TEST DATA

ASTM D-5084, Method C

EFFECTIVE STRESS:	2 psi
GRADIENT RANGE:	1 - 9
IN / OUT RATIO:	1.07
"B" PARAMETER:	0.95

TRIAL nos.	TIME hrs.	HYDRAULIC CONDUCTIVITY cm / sec
7	97.8	8.1E-07
8	99.1	7.6E-07
9	99.6	7.4E-07
10	115.7	6.3E-07
11	117.3	7.6E-07
12	121.1	6.9E-07
13	122.3	6.5E-07

AVERAGE LAST 4 : **6.8E-07**

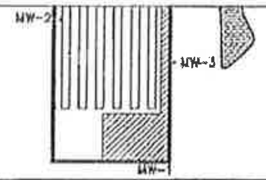
Appendix B

Well Installation Logs

LAWRENCE & ASSOCIATES
2001 MARKET STREET, RM. 523
REDDING, CA 96001
PHONE : (530) 244-9703
FAX : (530) 244-5021

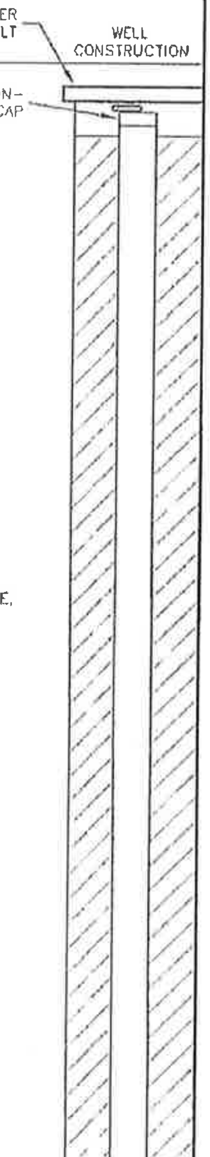
PROJECT: ORLAND COMPOST FACILITY		SHEET 1 OF 2
		HOLE #: MW-1
JOB #: 006122.00		DATE: 7/31/07
LOGGED BY: WJP	DRILLER: RANDY/TIM	
HOLE INFO: 200.85'		
EQUIPMENT AND SPECIFICATIONS: CME-55 10"ø HOLLOW STEM AUGER – 0'–50' AIR ROTARY – 50'–62'		

FIELD LOCATION OF WELL



DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	DEPTH INTERVAL	DESCRIPTION
0				0–1'	DISCED SOIL, SILTY GRAVEL
5	X	18 28 18	GP	1–6.75'	SANDY GRAVEL, DRY, MEDIUM DENSE, MASSIVE, FINE SAND, FINE GRAVEL, GRAY BROWN
10	X	9 14 21	SP/SC	6.75–13'	CLAYEY GRAVELLY SAND, DAMP, DENSE, MASSIVE, FINE TO MEDIUM SAND, FINE GRAVEL, GRAY BROWN
15	X	9 10 9	SC	13–17.5'	CLAYEY SAND WITH GRAVLE, VERY MOIST TO WET, LOOSE TO SLIGHTLY DENSE, MASSIVE, MEDIUM TO COARSE SAND, FINE GRAVEL, LIGHT BROWN
20	X	3 4 5	MH	17.5–28'	CLAYEY SILT, MOIST, SOFT, MASSIVE, MOTTLED, BROWN
25	X	5 8 14			CLAYEY SILT, MOIST, SOFT TO SLIGHTLY STIFF, MOTTLED, MASSIVE, GRAY BROWN @ 25'
30	X	20 18	SC	28–60'	CLAYEY SAND WITH GRAVEL, MOIST, DNESE, MASSIVE, MEDIUM TO COARSE SAND, FINE GRAVEL, BROWN

WELL CONSTRUCTION



NOTES:

WELL CONSTRUCTION SYMBOLS

- SCH. 40, 2-INCH PVC SCREEN, 20-SLOT (0.020-INCH SLOTS)
- #8 SILICA SAND
- BENTONITE SEAL
- SAND-CEMENT SEAL

FIGURE 3

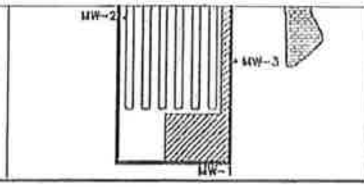
P:\006122.00_Compost Solution Inc\MW-1.dwg D.B.Z. 9/17/2007

LAWRENCE & ASSOCIATES
2001 MARKET STREET, RM. 523
REDDING, CA 96001
PHONE (530) 244-9703
FAX : (530) 244-5021

PROJECT: ORLAND COMPOST FACILITY	SHEET 2 OF 2
	HOLE#: MW-1
JOB #: 006122.00	DATE: 7/31/07
LOGGED BY: WJP	DRILLER: RANDY/TIM
HOLE INFO: 200.85'	

EQUIPMENT AND SPECIFICATIONS:
CME-55
10"ø HOLLOW STEM AUGER - 0'-50'
AIR ROTARY - 50'-62'

FIELD LOCATION OF WELL



DESCRIPTION

DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	DESCRIPTION	WELL CONSTRUCTION
30	X	20 19 22			
					BENTONITE SEAL
35	X	19 32	SC	SANDY GRAVEL, DRY, MEDIUM DENSE, MASSIVE, FINE SAND, FINE GRAVEL, GRAY BROWN	
40				CLAYEY GRAVELLY SAND, DAMP, DENSE, MASSIVE, FINE TO MEDIUM SAND, FINE GRAVEL, GRAY BROWN	
				0-50' HOLLOW STEM AUGER DRILLING	
45					
50					GW = 50' (7/31/07) ▽
				50-62' AIR ROTARY DRILLING	
55				TOTAL DEPTH = 55', BORING DRILLED TO 62', CAVED IN TO 55' WHILE SETTING CASING	CAVED IN (55')
60					

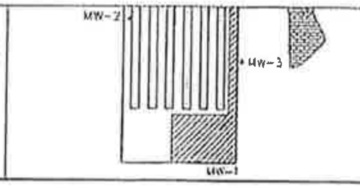
NOTES:

WELL CONSTRUCTION SYMBOLS

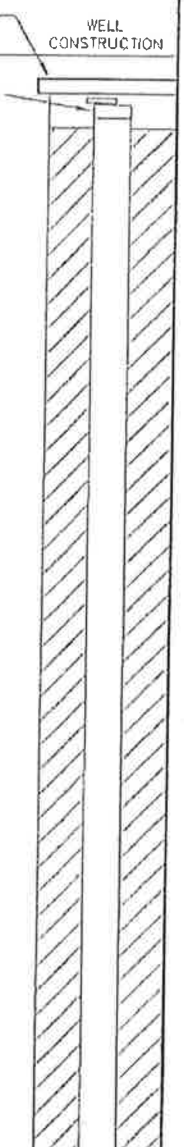
- SCH. 40, 2-INCH PVC SCREEN, 20-SLOT (0.020-INCH SLOTS)
- BENTONITE SEAL
- #8 SILICA SAND
- SAND-CEMENT SEAL

FIGURE 3

LAWRENCE & ASSOCIATES 2001 MARKET STREET, RM. 523 REDDING, CA 96001	PHONE : (530) 244-9703 FAX : (530) 244-5021	PROJECT: ORLAND COMPOST FACILITY	SHEET 1 OF 2
			HOLE#: MW-2
		JOB #: 006122.00	DATE: 7/24/07
FIELD LOCATION OF WELL		LOGGED BY: WJP DRILLER: RANDY/TIM	
		HOLE INFO: 204.39'	
		EQUIPMENT AND SPECIFICATIONS: CME-55 10"ø HOLLOW STEM AUGER – 0'-50' AIR ROTARY – 50'-60'	



DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	LITHOLOGY PROFILE	DESCRIPTION	
0					0-1'	DISCED SOIL
			MH		1-3'	CLAYEY SILT, DRY, LOOSE, OXIDIZED, SCATTERED FINE GRAVEL, ABUNDANT ORGANIC DEBRIS (ROOTS, GRASS) ORANGE BROWN
5	X	7 / 13 / 25	CL		3-7'	SILTY CLAY, SLIGHTLY MOIST, STIFF, TRACE FINE SAND, TRACE FINE GRAVEL, BROWN
					@ 7'	COARSE GRAVEL LAYER
10	X	16 / 34 / 35	GP		7-13'	SANDY GRAVEL, SLIGHTLY MOIST, LOOSE TO SLIGHTLY DENSE, SAND IS FINE GRAINED, COARSE GRAVEL, GRAY BROWN
			GM		13-15'	SITLY COARSE GRAVEL
15	X	7 / 14 / 15	SC		15-18'	CLAYEY SAND WITH GRAVEL, WET, MEDIUM DENSE, MEDIUM TO COARSE SAND, FINE GRAVEL, PERCHED GROUND WATER, MEDIUM BROWN
20	X	22 / 16 / 16	GC		18-30'	CLAYEY SANDY GRAVEL, WET, MEDIUM DENSE, MEDIUM TO COARSE SAND, FINE GRAVEL, BROWN GRAY
					@ 20'	CLAYEY SANDY GRAVEL, WET, MEDIUM DENSE, MEDIUM TO COARSE SAND, FINE GRAVEL, BROWN GRAY
25	X	12 / 26 / 50			@ 25'	CLAYEY SANDY GRAVEL, WET, DENSE TO VERY DENSE, MEDIUM SAND, FINE GRAVEL, RED BROWN AND GRAY
30	X	14 / 25	SC			



NOTES:

WELL CONSTRUCTION SYMBOLS

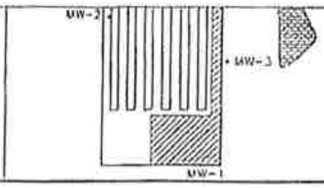
SCH. 40, 2-INCH PVC SCREEN, 20-SLOT (0.020-INCH SLOTS)	BENTONITE SEAL
#3 SILICA SAND	SAND-CEMENT SEAL

FIGURE 4

P:\006122.00_Compost Solution Inc\MW-2.dwg D.B.Z. 9/17/2007

LAWRENCE & ASSOCIATES 2001 MARKET STREET, RM. 523 REDDING, CA 96001	PHONE : (530) 244-9703 FAX : (530) 244-5021	PROJECT: ORLAND COMPOST FACILITY	SHEET 2 OF 2
			HOLE #: MW-2
		JOB #: 006122.00	DATE: 7/31/07

FIELD LOCATION OF WELL



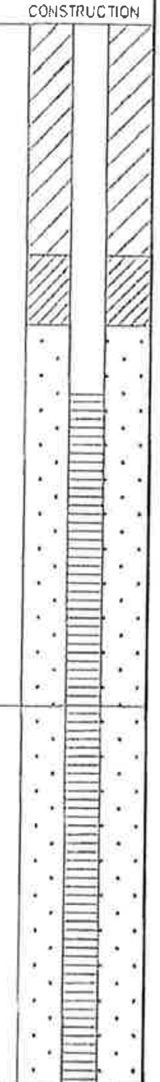
LOGGED BY: WJP DRILLER: RANDY/TIM

HOLE INFO: 200.85'

EQUIPMENT AND SPECIFICATIONS:
CME-55
10"⌀ HOLLOW STEM AUGER - 0'-50'
AIR ROTARY - 50'-60'

DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	LITHOLOGY PROFILE	DESCRIPTION
30	X	14 / 25 / 39	SC		
35	X	13 / 17 / 28	SC		@ 35' CLAYEY SAND WITH GRAVEL, SLIGHTLY MOIST, DENSE, MEDIUM TO COARSE SAND, FINE TO COURSE GRAVEL, GRAY BROWN
40	X	16 / 21 / 30	GC		@ 40' CLAYEY SANDY GRAVEL, MOIST, MEDIUM DENSE, MEDIUM TO COARSE SAND, FINE GRAVEL, PALE BROWN
45			GC		0-50' HOLLOW STEM AUGER DRILLING
50			GC		GW = 49' (7/31/07) ▽ @ 50' CLAYEY SANDY GRAVEL, MOIST, MEDIUM DENSE, MEDIUM TO COARSE SAND, FINE GRAVEL, PALE BROWN, SOME WATER IN HOLE @ 50', DOES NOT RISE WITH TIME
55			GC		50-60' AIR ROTARY DRILLING
60					TOTAL DEPTH = 60'

WELL CONSTRUCTION



NOTES.

WELL CONSTRUCTION SYMBOLS

- SCH 40, 2-INCH PVC SCREEN, 20-SLOT (0.020-INCH SLOTS)
- BENTONITE SEAL
- #8 SILICA SAND
- SAND-CEMENT SEAL

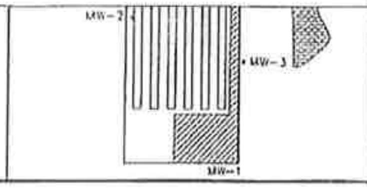
FIGURE 4

P:\006122.00_Compost Solution Inc\MW-2.dwg D.B.Z. 9/17/2007

LAWRENCE & ASSOCIATES
2001 MARKET STREET, RM. 523
REDDING, CA 96001
PHONE : (530) 244-9703
FAX : (530) 244-5021

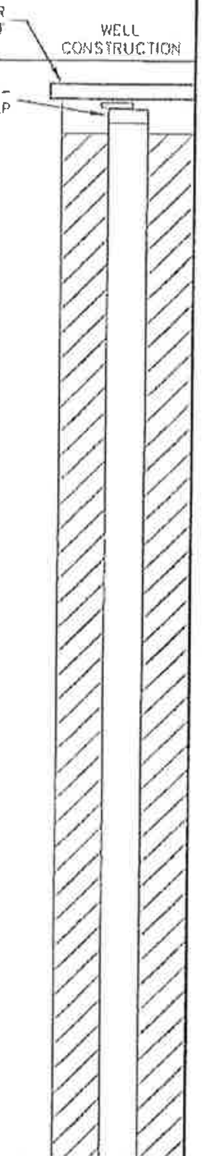
PROJECT: ORLAND COMPOST FACILITY	SHEET 1 OF 2
	HOLE#: MW-3
JOB #: 006122.00	DATE: 7/30/07
LOGGED BY: WJP	DRILLER: RANDY/TIM
HOLE INFO: 198.05'	
EQUIPMENT AND SPECIFICATIONS: CME-55, 10"ø HOLLOW STEM AUGER	

FIELD LOCATION OF WELL



DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	LITHOLOGY PROFILE	DESCRIPTION
0					0-1' DISCED SOIL
5	X	7, 10, 7	SC/GP		1-7' CLAYEY SAND WITH GRAVELS, MOIST, LOOSE TO SLIGHTLY DENSE, MASSIVE, SAND IS MEDIUM TO COARSE GRAINED, FINE GRAVEL, BELOW 5' COARSE GRAVEL, BROWN
10	X	9, 9, 13	GC/GM		7-12.5' CLAYEY SANDY GRAVEL, MOIST TO VERY MOIST, LOOSE TO SLIGHTLY DENSE, MASSIVE, COARSE SAND, FINE TO COARSE GRAVEL, RED BROWN AND GRAY
15	X	14, 20, 20	SP/SC		12.5-17' CLAYEY GRAVELLY SAND, MOIST TO VERY MOIST, SLIGHTLY DENSE, MASSIVE, COARSE SAND, FINE TO COARSE GRAVEL, MEDIUM BROWN
20	X	9, 9, 13	SC		17-23' CLAYEY SAND, VERY MOIST TO WET, SLIGHTLY DENSE, MASSIVE, MEDIUM TO COARSE SAND, TRACE OF FINE GRAVEL, YELLOW BROWN
25	X	9, 14, 19	GP/GC		23-50' CLAYEY SANDY GRAVEL, VERY MOIST TO WET, SLIGHT TO MEDIUM DENSE, MASSIVE, MEDIUM TO COARSE SAND, FINE GRAVEL, YELLOW BROWN
30	X	13, 18, 20			

WELL CONSTRUCTION



NOTES:

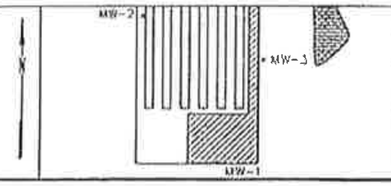
WELL CONSTRUCTION SYMBOLS

- SCH. 40, 2-INCH PVC SCREEN, 20-SLOT (0.020-INCH SLOTS)
- BENTONITE SEAL
- #8 SILICA SAND
- SAND-CEMENT SEAL

FIGURE 5

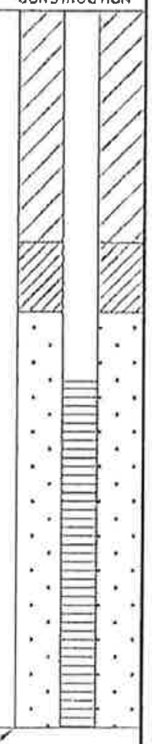
P:\006122.00_Compost Solution Inc\MW-3.dwg D.B.Z. 9/17/2007

LAWRENCE & ASSOCIATES 2001 MARKET STREET, RM. 523 REDDING, CA 96001 PHONE : (530) 244-9703 FAX : (530) 244-5021	PROJECT: ORLAND COMPOST FACILITY JOB #: 006122.00
	SHEET 2 OF 2 HOLE#: MW-3 DATE: 7/30/07
FIELD LOCATION OF WELL	LOGGED BY: WJP DRILLER: RANDY/TIM HOLE INFO: 198.05' EQUIPMENT AND SPECIFICATIONS: CME-55 10"ø HOLLOW STEM AUGER



DEPTH (FT)	SOIL SAMPLE LOCATION	BLOW COUNTS	SOIL GROUP USCS SYMBOL	LITHOLOGY PROFILE	DESCRIPTION
30	X	13 / 18 / 20	GP/GC		@ 30' CLAYEY SANDY GRAVEL, MOIST, MEDIUM DENSE, MASSIVE, MEDIUM TO COARSE SAND, FINE TO COARSE GRAVEL, YELLOW GRAY BROWN
35	X	13 / [illegible] / 36	GP/GC		@ 35' SANDY GRAVEL WITH CLAY, MOIST, DENSE, MASSIVE, MEDIUM SAND, FINE TO COARSE GRAVEL, GRAY BROWN
40	X		GP/GC		
45					
50	X	3 / 7 / 8	SM		@ 50' TOP HALF OF SAMPLE: SILTY SAND, VERY MOIST, SOFT, MASSIVE, FINE SAND, BROWN BOTTOM HALF OF SAMPLE: CLAYEY SILT, MOIST, SOFT, MASSIVE, BROWN TOTAL DEPTH = 50'
55					
60					

WELL CONSTRUCTION



GW = 50' (7/30/07)

TOTAL DEPTH (50')

NOTES:

WELL CONSTRUCTION SYMBOLS

- SCH. 40, 2-INCH PVC SCREEN, 20-SLOT (0.020-INCH SLOTS)
- #8 SILICA SAND
- BENTONITE SEAL
- SAND-CEMENT SEAL

FIGURE 5

P:\006122.00_Compost Solution Inc\MW-3.cwg D.B.Z. 9/17/2007

Appendix C

Water Balance & Design Sheets

Appendix C

DETENTION POND DESIGN AND CONSTRUCTION INFORMATION

Compost Solutions Incorporated (CSI) proposes to upgrade its compost facility in Orland, California, by installing a detention pond in accordance with the requirements outlined in the General Waste Discharge Requirements for Compost Operations Order WQ 2015-0121-DWQ. The most recent Updated Technical Report for the CSI facility was submitted to the Regional Water Quality Control Board (RWQCB) in March 2018. Design drawings for the detention pond are attached. The detention pond will be constructed and operational by 1 October 2021.

AVERAGE ANNUAL WATER BALANCE

The detention pond was designed based on the following water storage criteria:

1) Direct precipitation and runoff from the average annual rainfall with 2-feet of freeboard,
2) Direct precipitation and runoff from the 24-hour, 25 year storm, and
3) Sufficient surface area to evaporate the stored water prior to the next rainy season.

To design the detention pond to meet these water storage criteria, a monthly annual water balance for the pond was completed. Key input parameters for the water balance are presented in Table 1 (Climate Data Summary) and Table 2 (Water Balance Input Parameters). The monthly annual water balance, additional details and supporting information are attached.

Table 1
CLIMATE DATA SUMMARY
CSI – UPDATED TECHNICAL REPORT

Month	Precipitation Average Monthly (inches) [1]	Evaporation Average Monthly (inches) [2]
10	1.05	3.33
11	2.32	1.63
12	3.52	1.05
1	4.04	1.21
2	3.43	1.95
3	2.66	3.40
4	1.30	4.89
5	0.73	6.58
6	0.37	7.35
7	0.04	7.54
8	0.11	6.61
9	0.37	4.92
Annual Sum	19.94	50.46

[1] Average Monthly - Based on monthly precipitation data from Orland, California (04506), period of record from 03/01/1903 to 06/10/2016. WRCC (2020).
[2] Average Monthly - From CIMIS Monthly Average ETo Report (Durham Station # 12).

Table 2 WATER BALANCE INPUT PARAMETERS CSI – UPDATED TECHNICAL REPORT			
Parameter	**Value**	**Units**	**Source**
Average Annual Precipitation	19.94	inches	See Table 1
Average Annual ETo	50.46	inches	See Table 1
Evaporation Factor	1.0	---	To be conservative it has been assumed that pond evaporation is equal to reference ETo
Average Pond Surface Area (berm elevation)	2.0	acres	See Table 4
Average Pond Surface Area (2 feet below berm elevation)	1.7	acres	See Table 4
Runoff Area	20	acres	See Table 4, Berms areas sloped toward the ponds.
Runoff Factor	0.5	fraction	Berm will be graveled.
Direct Precipitation and Runoff from 24 hour, 25 year storm	1.91	feet	Equivalent freeboard
Freeboard	2	feet	Freeboard
Infiltration Rate	0	in/hour	Detention pond will be lined

Based the input parameters summarized in Tables 1 and 2 and the monthly annual water balance attached, the Required Storage Capacity for the detention pond is approximately **805,500 cubic feet** or 18.5 acre-feet.

POND DESIGN DRAWINGS

The pond design drawings are attached. Based on the design drawings, the pond dimensions and Total Pond Capacity are summarized in Table 3.

Table 3 DIMENSIONS AND TOTAL POND CAPACITY CSI – TECHNICAL REPORT UPDATE AMENDMENT				
Parameter	**Value**	**Units**	**Value**	**Units**
Length	290	feet	---	---
Width	305	feet	---	---
Slope	2:1	h:v	--	--
Average Depth (from top of berm)	10	feet	---	---
Pond Surface Area (berm elevation)	88,450	sft	2.03	acres
Pond Surface Area (5-feet below berm elevation)	76,931	sft	1.77	acres
Bottom Area	63,172	sft	1.45	acres
Runoff Area	864,077	sft	19.84	acres
Total Pond Capacity	**867,909**	cft	19.92	acre-feet

Based on the pond dimensions summarized in Table 3, the Total Pond Capacity of approximately 868,000 cubic feet or 20 acre-feet exceeds the Required Storage Capacity of approximately 805,500 cubic feet or 18.5 acre-feet. The pond, when constructed as described in the design drawings, will have sufficient capacity to exceed the prescribed water holding criteria.

ADDITIONAL DESIGN DETAILS

The following details are included on the design sheets.

Liner System

The detention pond liner system consists of the following, in ascending order, 1) prepared subgrade, 2) Geosynthetic Clay Liner (GCL) and 3) 60-mil high-density polyethylene (HDPE).

A pan lysimeter monitoring device manufactured by Soil Moisture Equipment Corporation will be installed under the lowest point of the pond to provide the earliest possible detection of a release from the pond.

The detention pond includes a 12-inch emergency overflow pipe.

Improvements to existing drainage channels to convey runoff into the detention pond.

CONSTRUCTION SCHEDULE

The detention pond will be constructed and operational no later than 1 October 2021.

Compost Solutions
Apr-20

Precip — Orland - from WRCC, 2019
ET — Durham - from CIMIS, 2019

Notes:
1 - No note 1
2 - No note 2
3 - Freeboard Calculation

24 hour/25 year design storm	3.89	inches	From NOAA
Total pond surface area	2.03	acres	From below Input
Runoff area	19.84	acres	From below Input
Runoff factor	0.5		From below Input
Minimum Required Freeboard Estimate	**1.91**	**feet**	**Calculated - Use this Number for Required Freeboard on Line 33**

4- Monthly water application to compost is 10,000 gallons per month per acre of compost = 0.0307 acre-feet per acre of compost per month, excluding Oct thru Feb.

Compost Water Usage	0.1151	acre-feet/acre/month Enter 0.0306 if water is being reapplied to compost. If not, enter 0.
Fraction Runoff Area w/Compost	1.00	

Note: 30,000 gallons per day over 20 acres = 30,000 gallons per month/acre (assuming you apply water 20 days per month)

gal/month/acre	aft/acre/month		aft/month (20 acres)	
10,000	0.0307			
15,000	**0.0460**		**0.92**	**October, November and December**
30,000	**0.0921**	**GF/CSI Average Estimate**	**1.84**	
33,000	0.1013	10 percent more		
36,000	0.1105	20 percent more		
37,500	**0.1151**	**25 percent more**	**2.30**	**March through September**
39,000	0.1197	30 percent more		
45,000	0.1381	50 percent more	2.76	

Same as gal/day over 20 acres assuming 20 days per month

Compost Solutions **Average Annual Precip + 24 Hour/25 Year Storm + 2 Feet Freeboard**
Apr-20 **0.00** End of Sept. Pond Balance (aft)

PW=generic

Input

Total Pond Surf. Area	2.03	Acres	From pond design sheets, Used for direct precipitation into ponds [water surface area at berm elevation]
Avg. Pond Surf. Area	1.77	Acres	From pond design sheets, Used for evaporation and infiltration from ponds [water surface areas 5-feet below berm elevation]
Runoff Area	19.84	Acres	Site survey
Runoff Factor	0.5	Fraction	Composite value for entire runoff area.
Precip Factor	1	Fraction	If you think site precip is more or less than input data
Evap Factor	1	Fraction	See Terms below - Monthly Evap
Irrigated Area	0	Acres	Assumed to be outside runoff area.
Required Freeboard	3.91	Feet	At a minimum, this should equal the Minimum Required Freeboard from above or, conservatively, add an aditional 2 feet.
Potential Infiltration Rate	0	In/hour	Use 0 to be conservative. 10-6 cm/sec = 0.0014 inches/hour

Calcs

Dilution Factor (see Notes): 1

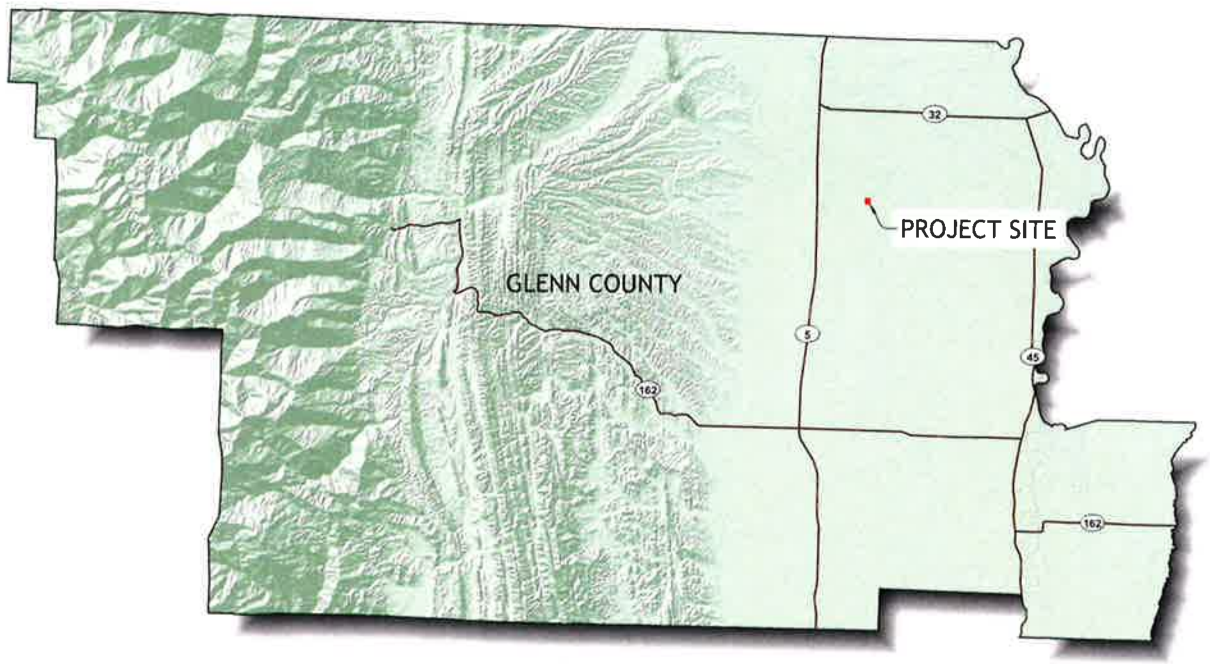
Month	Average Monthly Precip. (inches)	Adjusted Monthly Precip. (inches)	Monthly Evap (see Terms) (inches)	Adjusted Evap. (inches)	Beginning Water Volume (aft)	Monthly Precip. In (aft)	Monthly Runoff In (aft)	Monthly Process In (aft)	Monthly Total In (aft)	Potential Monthly Pond Infiltr. Out (aft)	Potential Monthly Pond Evap. Out (aft)	Monthly Irrigation Out (aft)	Monthly Treatment Out (aft)	Monthly Compost Out (aft)	Total Potential Monthly Out (aft)	End of Month Balance (aft)	Freeboard or Design Storm Volume (aft)	Required Pond Storage (aft)	Monthly Accumulation (aft)	Equivalent Monthly Discharge (gpm)
10	1.05	1.05	3.33	3.33	0.00	0.18	0.87	0.00	1.05	0.00	0.49	0.00	0.00	0.92	1.41	0.00	7.94	7.94	0	0
11	2.32	2.32	1.63	1.63	0.00	0.39	1.92	0.00	2.31	0.00	0.24	0.00	0.00	0.92	1.16	1.15	7.94	9.09	1.15	9
12	3.52	3.52	1.05	1.05	1.15	0.60	2.91	0.00	3.51	0.00	0.15	0.00	0.00	0.92	1.07	3.58	7.94	11.52	2.43	19
1	4.04	4.04	1.21	1.21	3.58	0.68	3.34	0.00	4.02	0.00	0.18	0.00	0.00	0.00	0.18	7.43	7.94	15.36	3.84	30
2	3.43	3.43	1.95	1.95	7.43	0.58	2.84	0.00	3.42	0.00	0.29	0.00	0.00	0.00	0.29	10.55	7.94	18.49	3.13	24
3	2.66	2.66	3.4	3.40	10.55	0.45	2.20	0.00	2.65	0.00	0.50	0.00	0.00	2.28	2.79	10.42	7.94	18.35	0.00	0
4	1.30	1.30	4.89	4.89	10.42	0.22	1.07	0.00	1.29	0.00	0.72	0.00	0.00	2.28	3.00	8.71	7.94	16.64	0.00	0
5	0.73	0.73	6.58	6.58	8.71	0.12	0.60	0.00	0.73	0.00	0.97	0.00	0.00	2.28	3.25	6.18	7.94	14.12	0.00	0
6	0.37	0.37	7.35	7.35	6.18	0.06	0.31	0.00	0.37	0.00	1.08	0.00	0.00	2.28	3.37	3.18	7.94	11.12	0.00	0
7	0.04	0.04	7.54	7.54	3.18	0.01	0.03	0.00	0.04	0.00	1.11	0.00	0.00	2.28	3.40	0.00	7.94	7.94	0.00	0
8	0.11	0.11	6.61	6.61	0.00	0.02	0.09	0.00	0.11	0.00	0.97	0.00	0.00	2.28	3.26	0.00	7.94	7.94	0.00	0
9	0.37	0.37	4.92	4.92	0.00	0.06	0.31	0.00	0.37	0.00	0.73	0.00	0.00	2.28	3.01	0.00	7.94	7.94	0.00	0
Annual	**19.94**	**19.94**	**50.46**	**50.46**		**3.37**	**16.48**		**19.86**											

Monthly Discharge Rate For Discharge or Treatment (applies to Monthly Accumulation and Equivalent Monthly Discharge columns)

0.00	Adjust pond size or irrigated acres until this number = 0
18.49	Maximum Required Storage Capacity (aft)
805,444	Maximum Required Storage Capacity (cft)

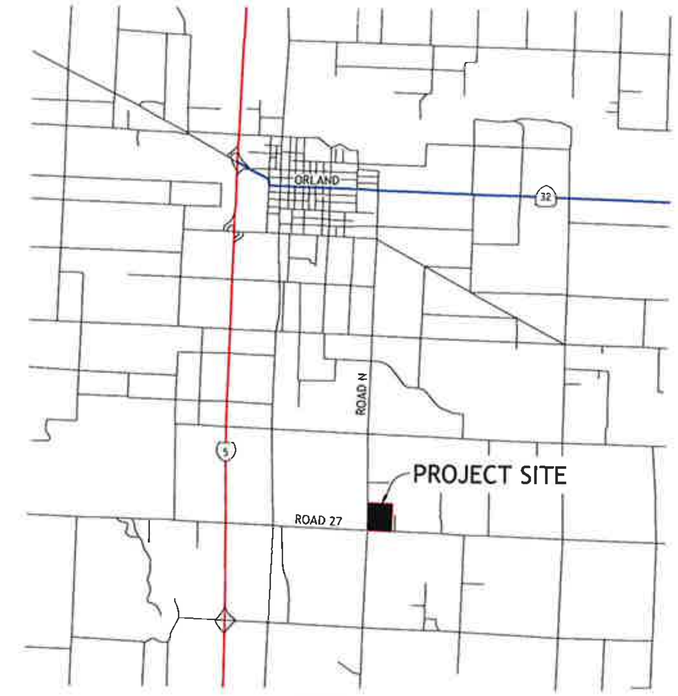
Terms

Average Monthly Precip. - Take from WRRC web site
Monthly Evap. - If irrigating, enter Eto from nearest CIMIS station here and an Evap Factor (if necessary) to estimate pond evap (Adjusted Evap). If not irrigating, you can enter pan/pond directly and use1 for Evap Factor.
Adjusted Evap. - Adjusted to get pan/pond evaporation
Beginning Water Volume - Assume volume is 0 on October 1 (ie, you want to end up with zero at end of month 9)
Monthly Runoff In - Calculated for runoff area specified and runoff factor.
Monthly Process In - Enter monthly values manually
Monthly Total In - Sum of monthly runoff plus monthly process plus monthly precipitation, actual value
Monthly Pond Infiltrtration Out - Calculated from infiltration rate entered (if you want to be conservative, use 0). Infiltration is the potential rate assuming water is present.
Monthly Pond Evaportation Out, potential value
Monthly Irrigation Out - Water out for irrigation etc (set up to be based on adjusted pan evap rate and irrigated acres), potential value, zero if precip > Eto
Monthly Total Out - Sum of monthly infiltration, monthly evaporation and irrigation out, potential value.
EOM Balance - Beginning monthly water volume plus Actual Monthly Total In minus Potential Monthly Total Out, Zero if negative



LOCATION MAP
NTS

INDEX TO SHEETS



VICINITY MAP
NTS

SITE LAYOUT
SCALE: 1" = 300'

GENERAL NOTES

1. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THESE DRAWINGS AND ATTACHED SPECIFICATIONS.
2. LANDOWNER SHALL BE RESPONSIBLE FOR OBTAINING ANY NEEDED PERMITS, EASEMENTS, AND/OR RIGHT-OF-WAYS.
3. LANDOWNER WILL BE RESPONSIBLE FOR LOCATING AND PROTECTING ALL UTILITIES. SPECIAL SAFETY PRECAUTIONS TO BE TAKEN WHEN WORKING IN THE VICINITY OF GAS, OIL, AND ELECTRICAL LINES.
4. CAL-OSHA SAFETY REQUIREMENTS SHALL BE IN EFFECT DURING ALL CONSTRUCTION.
5. ALL LINES AND GRADES SHOWN ON THESE DRAWINGS ARE APPROXIMATE. THE PROPOSED STRUCTURE'S LOCATION, EXCAVATION LIMITS, AND FILL LIMITS WILL BE STAKED IN THE FIELD BY THE ENGINEER.
6. BENCHMARK TO BE PROVIDED TO CONTRACTOR PRIOR TO START OF CONSTRUCTION.

P:\CAD\71801 COMPOST SOLUTIONS\DWG\71801 COMPOST SOLUTIONS—GRADING PLAN.DWG

REGISTERED PROFESSIONAL ENGINEER
SUSAN DIANE GOODWIN
No. 81687
CIVIL
STATE OF CALIFORNIA

VESTRA
5300 AVIATION DRIVE - REDDING, CA 96002
www.vestra.com
(530) 223-2585
FAX (530) 223-1145

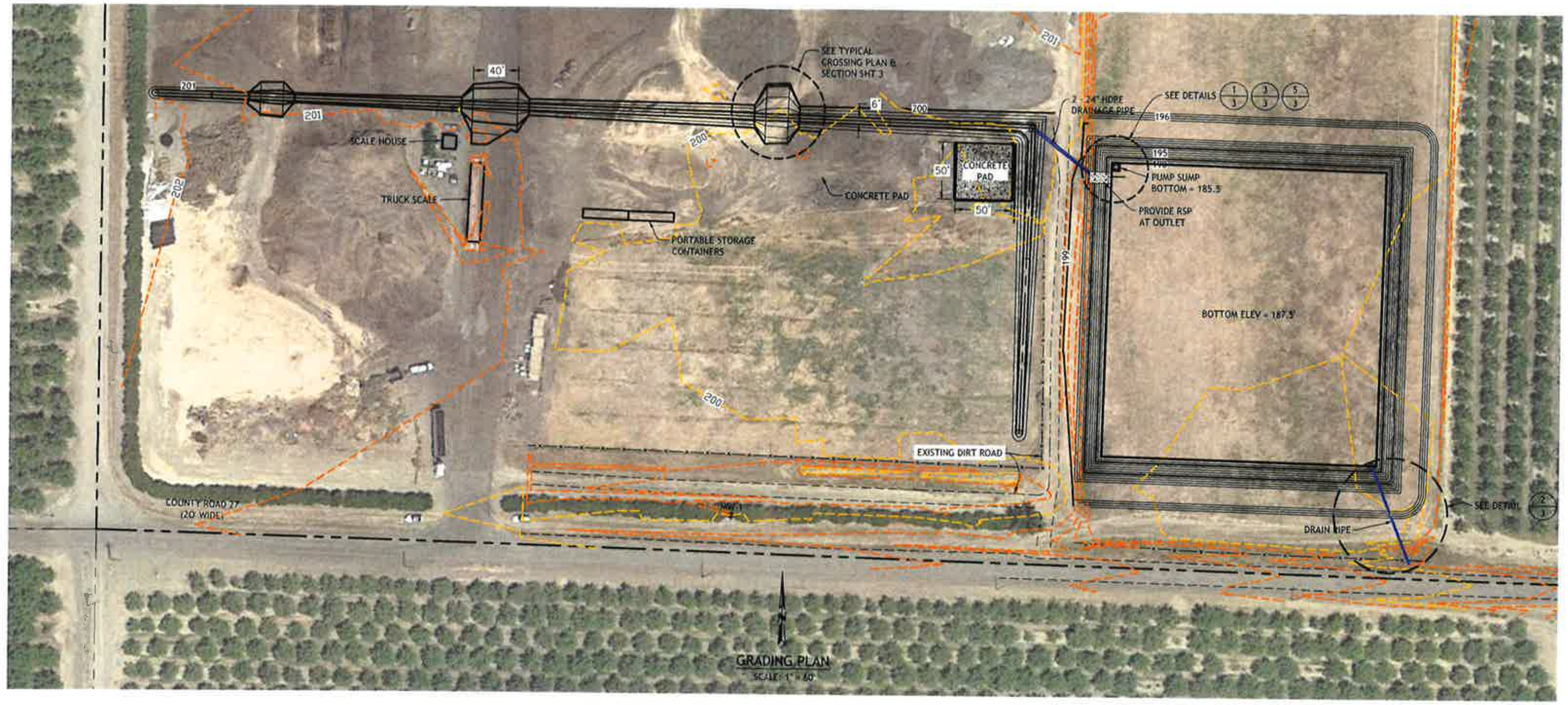
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

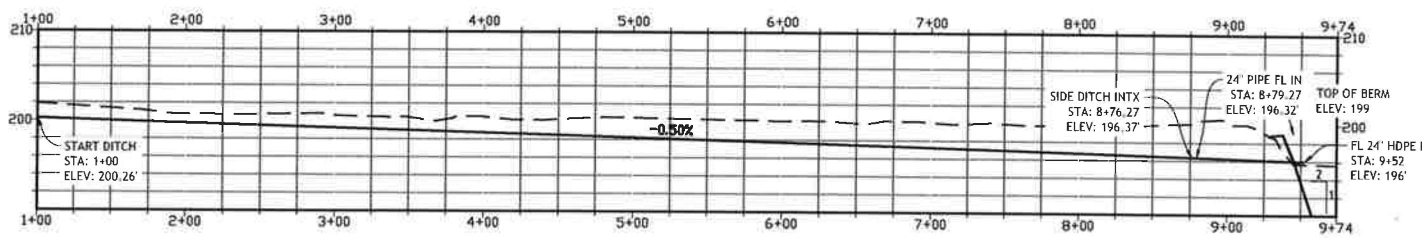
NO.	DATE	REVISION	BY

DSGN: SG
DR: CS
CHK: SG
APVD: SG

TITLE SHEET
RETENTION POND DESIGN
COMPOST SOLUTIONS, INC.
ORLAND, CA

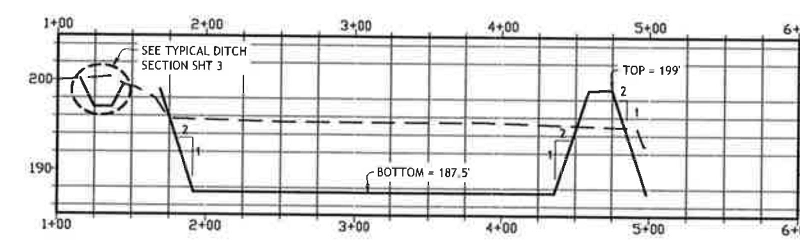
SHEET 1 OF 3
DATE 04/10/20
JOB NO. 71801





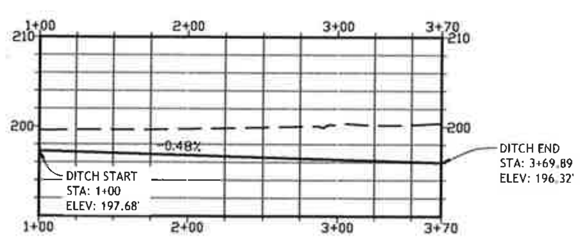
MAIN DITCH

HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 10'



TYPICAL POND SECTION

HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 10'



SIDE DITCH

HORIZONTAL SCALE: 1" = 60'
VERTICAL SCALE: 1" = 10'

P:\CAD\71801 COMPOST SOLUTIONS\DWG\71801 COMPOST SOLUTIONS-GRADING PLAN.DWG

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING

0 — 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

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VESTRA

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NO.	DATE	REVISION	BY

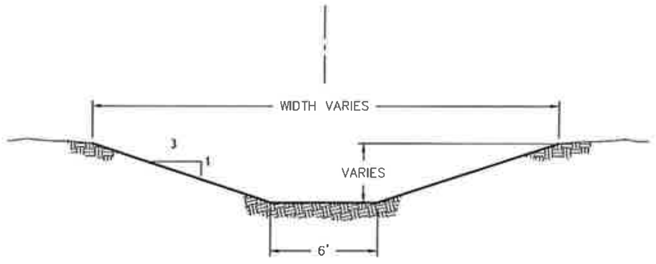
DSGN: SG | DR: CS | CHK: SG | APVD: SG

GRADING PLAN / PROFILES
RETENTION POND DESIGN
COMPOST SOLUTIONS, INC.
ORLAND, CA

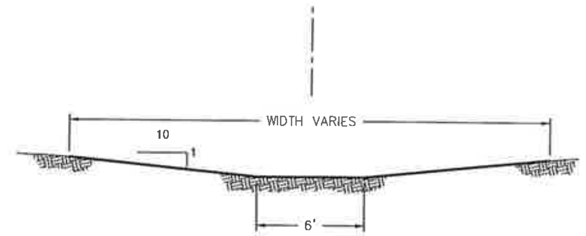
SHEET 2 OF 3

DATE 04/10/20

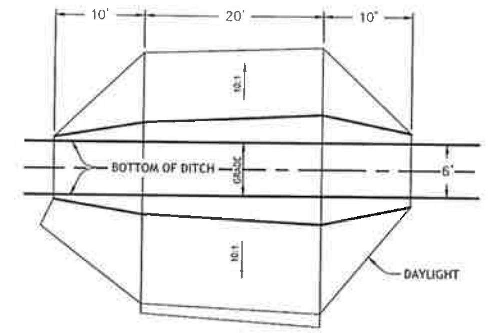
JOB NO. 71801



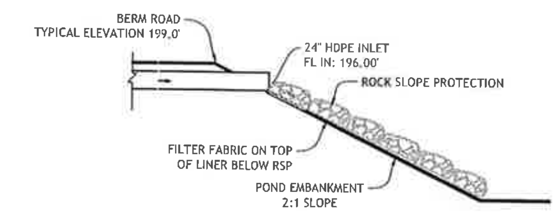
TYPICAL DITCH SECTION
SCALE: 1" = 5'



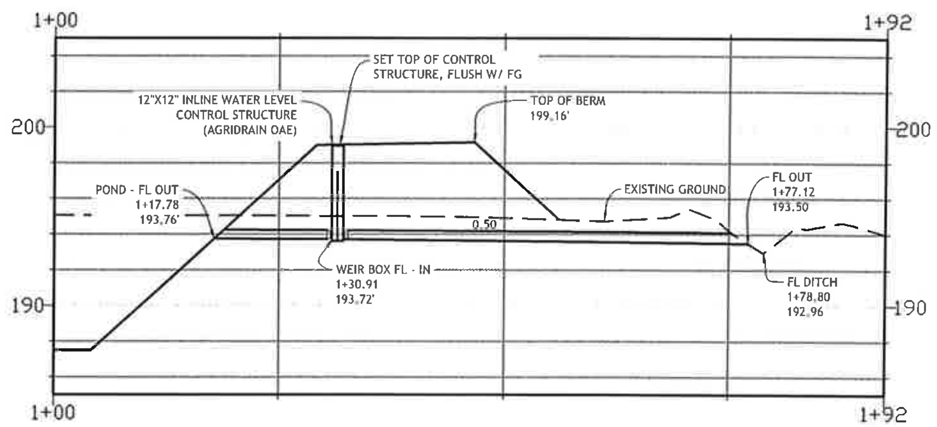
TYPICAL DITCH CROSSING SECTION
SCALE: 1" = 5'



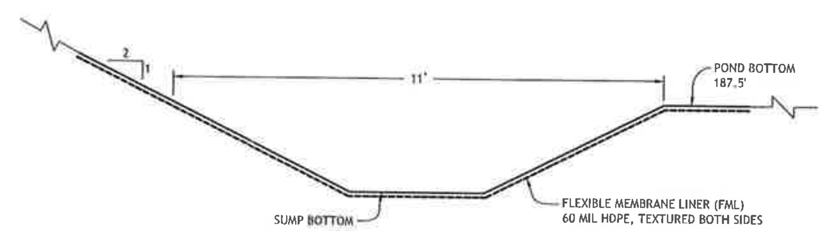
TYPICAL DITCH CROSSING PLAN
SCALE: 1" = 10'



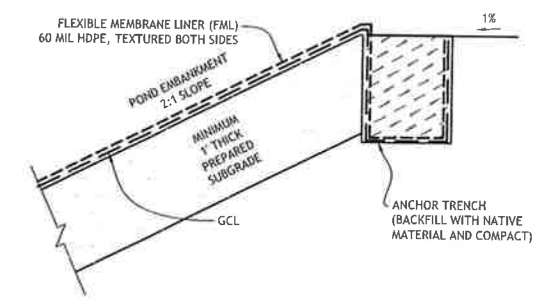
1 RETENTION POND INFLUENT DETAIL
NOT TO SCALE



2 OUTLET WEIR DETAIL
HORIZONTAL SCALE: 1" = 10'
VERTICAL SCALE: 1" = 5'

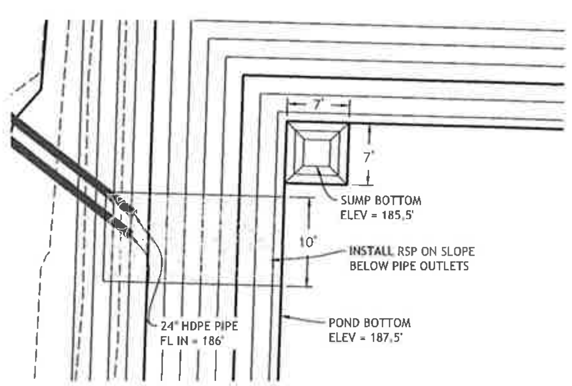


3 SUMP DETAIL
SCALE: 1" = 5'



RETENTION POND CELL SUBGRADE PREPARATION NOTE:
REMOVE NATIVE GROUND TO A DEPTH OF 1-FOOT AND REPLACE TO 90% COMPACTION.

4 LINER DETAIL
SCALE: 1" = 10'



5 ROCK SLOPE PROTECTION DETAIL
INLET PIPE & SUMP
SCALE: 1" = 10'

P:\CAD\71801 COMPOST SOLUTIONS\DWG\71801 COMPOST SOLUTIONS-GRADING PLAN.DWG

REGISTERED PROFESSIONAL ENGINEER
SUZAN DIANE GOODWIN
Exp. 6/30/21
No. 61587
CIVIL
STATE OF CALIFORNIA

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

VESTRA
www.vestra.com
(530) 223-2585
FAX (530) 223-1145
5300 AVIATION DRIVE - REDDING, CA 96002

NO.	DATE	REVISION	BY

DSGN: SG
DR: CS
CHK: SG
APVD: SG

DETAILS
RETENTION POND DESIGN
COMPOST SOLUTIONS, INC.
ORLAND, CA

SHEET 3 OF 3
DATE 04/10/20
JOB NO. 71801

Appendix D

Inspection Forms

OPERATIONS AREA QUARTERLY INSPECTION REPORT - FORM A

Quarterly inspections are required of the working surfaces, berms, ditches, facility perimeter, erosion control best management practices (BMPs), and any other operational surfaces. Make sure to have a copy of a site map and a camera with you during the inspection to note the location of any deficiencies and photograph any observed deficiencies in the operations area. Attach photographs of observed and corrected deficiencies to this form. These observations must be included in the Annual Monitoring and Maintenance Report.

FACILITY NAME: Compost Solutions, Inc.	**INSPECTION TIME:**		**DATE:**
INSPECTOR NAME:	**INSPECTOR SIGNATURE:**		
I. OPERATIONS AREA QUARTERLY INSPECTION			
Working Surfaces (receiving processing, and storage areas): • Is there evidence of cracking or subsidence in the working surfaces? • Are the working surfaces sloped to prevent ponding and convey wastewater to approved wastewater management systems? • Is there evidence of ponding over the working surface? If yes, show the affected area on a map.	**Yes**	**No**	**Findings and Remedial Action Documentation:**
Erosion Control BMPs: • Is there evidence of erosion of any working surfaces? • Is there evidence of erosion along ditches? • Is there any evidence of erosion of berms? • Are the erosion control BMPs in place in the operations area effective? • Are additional erosion control BMPs necessary to control erosion in any portions of the operations areas?	**Yes**	**No**	**Findings and Remedial Action Documentation:**
Maintenance Activities: • Are the working surfaces, berms, ditches, and erosion control BMPs in good condition? • Is any additional maintenance of the working surfaces, berms, ditches, or erosion control BMPs required?	**Yes**	**No**	**Findings and Remedial Action Documentation:**
Water and Wastewater: • Is any storm water run-on entering the working surface? Is all storm water runoff from the working surface controlled? • Is any is there any evidence of water or wastewater leaving or entering the facility? ○ If yes, estimate the size of the affected area, and estimated flow rate (show affected area on a map).	**Yes**	**No**	**Findings and Remedial Action Documentation:**
Drainage Systems: • Are ditches clear of sediment and debris? • Is there evidence of ponding within drainage ditches or on working surfaces ? (show affected area on a map) • Is the drainage system functioning correctly?	**Yes**	**No**	**Findings and Remedial Action Documentation:**

II. CORRECTIVE ACTION: Additional space to describe inspection findings and corrective actions required to correct deficiencies if needed. Attach photographs of corrected deficiencies.

WASTEWATER MANAGEMENT SYSTEM QUARTERLY INSPECTION REPORT - FORM B

Quarterly inspections are required to be performed of the wastewater management system. The following observations must be included in the Annual Monitoring and Maintenance Report.

FACILITY NAME: Compost Solutions, Inc.	**INSPECTION TIME:** **DATE:**
INSPECTOR NAME:	**INSPECTOR SIGNATURE:**

I. OVERALL CONDITION

Describe the overall condition of the wastewater management system (i.e. pond liner, storage tank construction, municipal wastewater connection points):

____

____

____

____

____

____

____

____

____

____

II. CAPACITY

Available capacity within storage systems: ______________________________

Current volume of wastewater (gallons) or solids (cubic yards) contained: ______________________________

III. ODORS

Are any odors from the wastewater management system present? ☐ Yes ☐ No

Odor characteization: ______________________________

Source of odors: ______________________________

Distance from the source: ______________________________

IV. WASTEWATER TREATMENT

Volume of wastewater treated and discharged, if applicable: ______________________________

V. WASTEWATER DISPOSAL

Volume of wastewater disposed at an off-site treatment system, if applicable: ______________________________

Name of wastewater treatment facility: ______________________________

Address of wastewater treatment facility: ______________________________

ANNUAL SURVEY - FORM C

An annual survey of the facility must be performed to confirm that all containment structures (e.g. berms, pads, detention ponds, tanks, run-on/run-off control structures, etc.) are prepared for the pending wet season. Make sure to have a copy of a site map as well as a camera during the survey to document any observed deficiencies/non-compliance. The survey must be conducted prior to the anticipated wet season, but no later than **August 31**. All necessary construction, maintenance, or repairs must be completed by **October 31**. This information must be included in the Annual Monitoring and Maintenance Report.

FACILITY NAME: Compost Solutions, Inc.	**OBSERVATION TIME:** **DATE:**
INSPECTOR NAME:	**INSPECTOR SIGNATURE:**
ARE ALL CONTAINMENT STRUCTURES (E.G. BERMS, PADS, DETENTION PONDS, TANKS, RUN-ON/OFF CONTROL STRUCTURES, ETC.) PREPARED FOR THE PENDING WET SEASON? ☐ **YES** ☐ **NO**	
Description of any deficiency/non-compliance observed. Indicate the deficiency/non-compliance on a map and attach the map and photographs of the deficiency/non-compliance to this form. Include the corresponding location of the photographs on the map.	
Cause of the deficiency/non-compliance.	

Describe the corrective actions undertaken, or planned to resolve the deficiency/non-compliance.

Date and time repairs completed:

Describe the measures undertaken by the Discharger to prevent the recurrence of the observed deficiency/non-compliance

MAJOR STORM EVENTS INSPECTION REPORT - FORM D

The Discharger shall inspect all precipitation, diversion, and drainage facilities for damage within **7 days** following major storm events. Necessary repairs shall be completed within **30 days** of the inspection. The discharger shall report any damage and subsequent repairs including photographs of the problem and repairs in the Annual Monitoring and Maintenance Report.

FACILITY NAME: Compost Solutions, Inc.	**INSPECTION TIME:** **DATE:**
INSPECTOR NAME:	**INSPECTOR SIGNATURE:**
DATE OF MAJOR STORM EVENT:	
IS THERE ANY EVIDENCE OF DAMAGE TO THE PRECIPITATION, DIVERSION, OR DRAINAGE FACILITIES OF THE SITE? ☐ Yes ☐ No	

Description of damage, if applicable. Attach photographs of the problem to this form:

Description of subsequent repairs, if applicable. Attach photographs of the repairs to this form:

Date repairs completed:

Appendix E

Odor Impact Minimization Plan

ODOR IMPACT MINIMIZATION PLAN
COMPOST SOLUTIONS, INC.

1.0 INTRODUCTION

This Odor Impact Minimization Plan (OIMP) has been prepared for Compost Solutions, Inc., in Orland, California. It is intended to provide guidance to onsite personnel in the handling, storage, and removal of compostable materials, in accordance with Title 14, California Code of Regulations, Section 17863.4. This OIMP will be maintained onsite and revised as necessary to reflect any changes in the design or operation of the site. A copy of the revisions will be provided to the enforcement agency within 30 days of the changes. In addition, this OIMP will be reviewed annually to determine if any revisions are necessary.

1.1 Project Contacts

Project Name:	Compost Solutions, Inc.
Project Location:	6900 Co. Rd. 27 Orland, California 95963
Mailing Address:	4446 Co. Rd. 27 Orland, California 95963
Landowner:	Gary and Marcia Foster 4446 Co. Rd. N Orland, California 95963
Project Contact:	Mr. Scott Foster Compost Solutions, Inc. 6900 Co. Rd. 27 Orland, California 95963
Regulatory Contact:	John H. Wells, M.S. REHS Glenn County Environmental Health 247 North Villa Avenue Willows, California 95988

1.2 Project Description

This Odor Impact Minimization Plan (OIMP) has been developed to provide guidance to the onsite personnel on the handling, storage and processing of compostable materials. The facility has been operating for ten years, over the course of which time valuable experience has been gained in how to plan for and mitigate potential odor issues.

Incoming materials currently include manure from dairies, harvest waste from almond and walnut production, greenwaste, animal bedding, drilling mud, biomass ash, and rice straw.

Commercial fertilizers may be added to the mixes at the request of purchaser. A full list of materials is included in Table 1, Appendix D, of the RCSI.

No more than 100,000 cubic yards of feedstock, amendments and/ or compost is proposed to be onsite at any one time. The compostable materials remain onsite for varying times, depending upon the nature of the feedstock. For example, the dairy manure is immediately incorporated into windrows and the harvest waste can remain onsite for up to one year (from harvest time to the following summer).

Odor generation is an inevitable result of the decomposition of raw materials, the biological process of which compost is the result. Initially, many involved in the industry believed that odor generation was an indicator of problems with the composting process; however, with the wealth of experience gained in recent decades, most observers have come to recognize that the formation of odorous compounds is an unavoidable fact of life for the composter and it is more efficient to focus one's efforts on managing and improving facility operations rather than trying to perfect the process itself. Naturally, the ideal outcome of any odor minimization attempt is to eliminate the impacts completely; it is perhaps more realistic to recognize an achievable goal, to reduce impacts of odors on the local community to acceptable levels.

The compost facility will include compacted compost areas and landscaped buffer. Because agricultural and greenwaste are composted seasonally, runoff from the turning pad is currently treated for suspended solids using a filter strip and shallow detention basin. The detention basin has been constructed in the southeast corner of the property. A 2.5-acre vegetative filter strip is used to promote sediment removal prior to entry into the detention pond. Filter strips have the ability to remove sediment and nutrients from water that flows through them. Additional water treatment methods are discussed in Section 5.6 of this document.

1.3 Sources of Odor

The primary sources of composting-related odors are:

(1) Feedstock management (delivery, storage and handling)
(2) Active composting (surface emissions, turning windrows, tearing down piles)
(3) Curing (surface emissions, turning windrows, and tearing down piles)

Other minor sources of composting-related odor include mixing of feedstocks into windrows, finished product loading, and poor site management (runoff, leachate, surface ponding, and road spillage).

Type of feedstock, condition of the feedstock, and the stage of composting will determine odor contribution. Feedstocks that decompose rapidly may produce odors at higher concentrations than those feedstocks that decompose at a slower rate. The delivery, storage, and handling of feedstocks can also greatly affect odors. If incoming feedstocks are not expeditiously processed, they may decay and begin to produce odors.

If portions of the windrows become anaerobic, actual turning of the windrow can result in the release of odors. Odors produced at early stages of composting are principally the result of the decomposition or breakdown of proteins that contain sulfur and nitrogen compounds.

These compounds generally break down during the first 14 days of composting, and odor generation is significantly reduced after this initial stage of decomposition.

Odors can be released from windrow surfaces during non-turning periods. Although surface emissions are the greatest overall source of odors from windrows, turning results in higher short-term spikes in concentration and intensity of odors. The fresher the material in the windrow, the greater the odor potential. Material that has been in the windrow for long periods of time is more stable and generates fewer odors.

When the windrows are torn down, the potential for odors is considerably lower than for the initial composting process, because the compost has become more stable with time. In addition, odors from finished compost are usually not considered to be offensive, unlike fresh composting feedstocks. Odor levels are generally minimal during final loading of the finished compost product for shipment offsite, and the characteristics of the odor from this process is that of a soil-like material. Odors can also be generated if runoff and leachate remain on the composting facility surface in sufficient amounts to form ponds.

Epstein (2004) identifies sources of odors during the composting process and the relative contribution of individual sources in comparison to total odor generation by composting facility operations. These are shown in Table 1. The relative odor contributions are expressed as a percentage of the total odor emissions typically generated.

Table 1
ODOR RELATIVE CONTRIBUTIONS BY PROCESS AND POTENTIAL CHARACTERISTICS

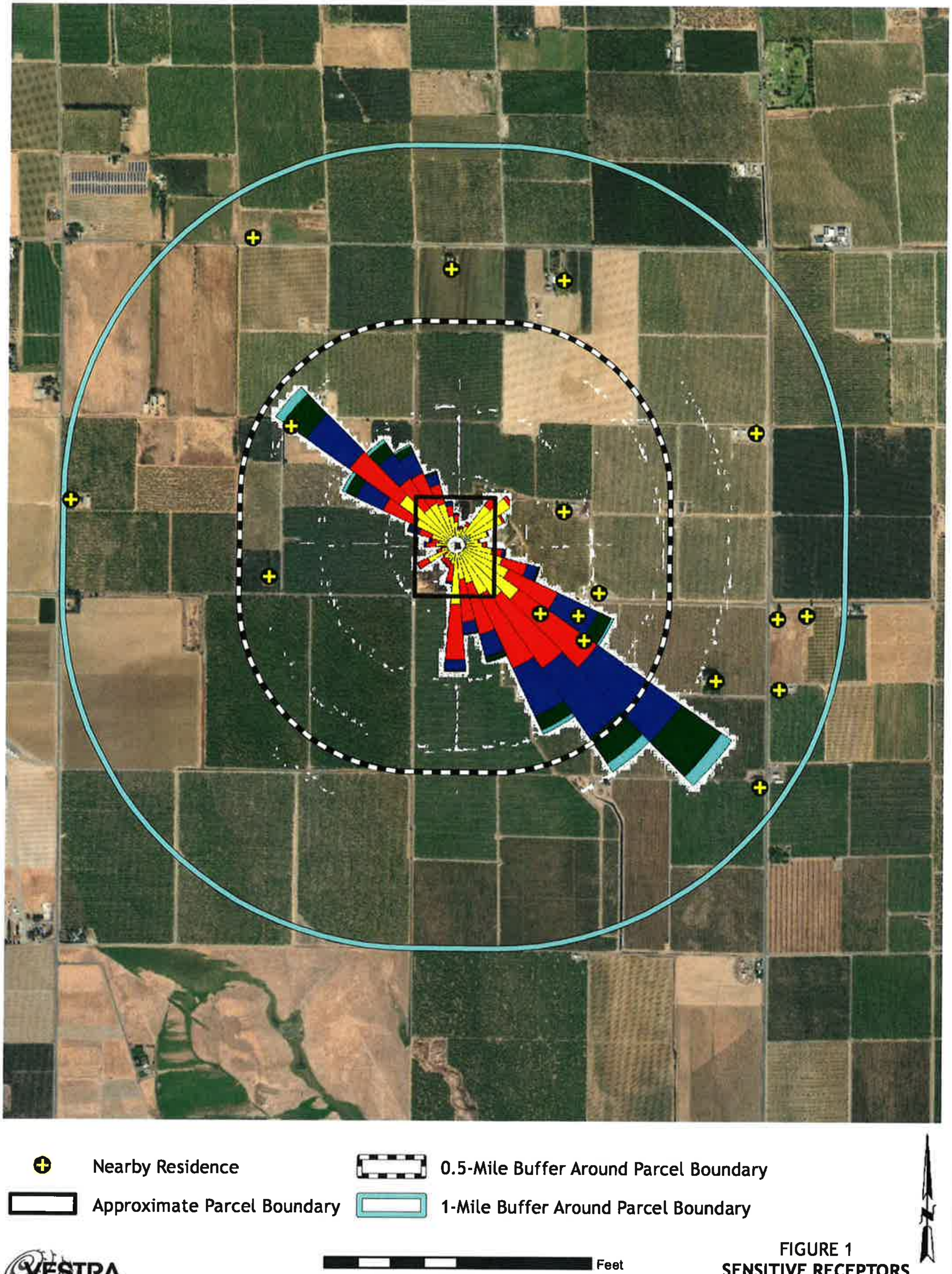
Odor Sources & Area Sources	Relative Odor Contribution	Potential Odor Characteristics
Feedstock Storage	4%	Woody
Composting Windrows, 0-6 days old	30%	Stinky, sulfurous, fish, ammonia
Composting Windrows, 7-11 days old	10%	Stinky, sulfurous
Composting Windrows, 12-27 days old	40%	Earthy, mulch
Curing Windrows, 28-61 days old	11%	Earthy, soil-like
Curing Windrows, 61-90 days old	3%	Earthy, soil-like

2.0 ODOR MONITORING PROTOCOL

2.1 Proximity of Odor Receptors

The compost site is surrounded by agricultural land uses. The closest receptors to the composting trial site would be Compost Solutions employees responsible for monitoring and/or managing the compost.

Land use within one mile of the facility is agricultural and low-density rural residential. Almond orchards are located on adjacent properties to the north, south, and west. The adjacent property east of the facility is farmed for annual crops. Other crops grown within a mile of the site include corn, walnuts, olives and prunes. Seven homes are located within about 0.5 miles of the site (see Figure 1). The closest of these are three houses about 0.4 miles to the east and



VESTRA

FIGURE 1
SENSITIVE RECEPTORS
COMPOST SOLUTIONS, INC.
GLENN COUNTY, CALIFORNIA

SOURCE: DIGITALGLOBE 2017 AERIAL PHOTOGRAPH

P:\GIS\71801\Figures\71801_SensitiveReceptors.mxd southeast of the site. There are seventeen homes located within one mile of the site. Traffic near the site is very light, consisting of mostly farm vehicles and equipment.

2.2 Method of Assessing Odor Impacts

Each operating day, Compost Solutions personnel will evaluate onsite odors and operations for potential release of objectionable odors in the course of their usual work. If questionable or objectionable onsite odors are detected by site personnel, the following protocol will be implemented:

1. Investigate and determine the likely source of the odor.
2. Assess the effectiveness of available onsite management practices to resolve the odor event and immediately take steps to reduce the odor-generating capacity of the onsite material. Possible management practices are shown in Table 2.
3. Determine if the odor traveled offsite by surveying the site perimeter and noting existing wind patterns.
4. If it is determined possible odor impacts occurred, contact appropriate enforcement agency and/or neighboring residences.
5. Record the event for further operational review in an odor log.

Table 2
SOURCES OF ODOR AND POSSIBLE MANAGEMENT TECHNIQUES

Source of Odor	Possible Cause	Management Approach
Feedstock receiving	Materials arrive with odors	• Mix materials upon receipt • Stockpile bulking agent or high carbon amendments as receiving basin • Make smaller piles • Consider blanketing odiferous materials with a six-inch to one-foot layer of bulking agent, high carbon amendments or finished compost • Add lime or wood ash to piles to adjust pH
	Material sitting too long prior to being processed or mixed	• Expedite material processing • Consider blanketing odiferous materials with a 6-inch to 1-foot layer of bulking agent, high carbon amendments or finished compost
Grinding	Grinding volatizes particles	• Add light misting of water or odor neutralizer to grinder at discharge points • Consider scheduling grinding to coincide with favorable atmospheric dispersion conditions • Consider grinding green materials with woodier materials

Table 2 SOURCES OF ODOR AND POSSIBLE MANAGEMENT TECHNIQUES		
Source of Odor	**Possible Cause**	**Management Approach**
Mixing and Material Handling	Mixing volatilizes particles	• Create windrows/piles that are sufficiently blended • Combine materials to achieve high C:N ratio (greater than 30:1) • Create piles with good porosity • Reduce mixing/materials handling activity during stagnant air conditions • Reduce mixing/materials handling activity when wind is in direction of receptors • Mist water or odor neutralizer at dust generation points
Composting	Less than ideal conditions	• Reduce turning and/or material handling activity during stagnant air conditions • Reduce turning/material handling activity when wind is in direction of nearby receptors • Turn regularly to reinvigorate the composting process • Maintain sufficient moisture in windrows • Avoid over-watering windrows • Make smaller windrows to increase passive aeration • Diligently monitor and manage the composting process • Increase porosity and bulk density • Consider blanketing odiferous materials in a six inch to one-foot layer of bulking agent, high carbon amendments or finished compost (water lightly to reduce odor releases • Adopt forced aeration
Screening	Screening volatizes particles	• Reduce screening activity during stagnant air conditions • Reduce screening activity when wind is in direction of nearby receptors • Mist water or neutralizer at dust generation points
Site	Water allowed to pond	• Grade the site to eliminate puddles, depressions, and wheel ruts where water collects • Absorb ponded water with wood chips/other absorbent, fill pothole with soil/pad material
Curing Piles	Excessive temperature	• Decrease curing pile size (height) • Review moisture content of in-process compost • Screen after curing to maintain porosity • Aerate curing piles
Stormwater Pond	Excessive nutrients in stormwater runoff	• Remove particles from water draining into stormwater pond • Filter stormwater through filter berm or sock

3.0 METEOROLOGICAL CONDITIONS

3.1 Precipitation

The closest weather station is located in Orland, approximately five miles northwest of the facility. Precipitation data from the Orland station (046506) is provided in Table 3. Average precipitation for the period of record from 1903 to 2016 is 19.95 inches based upon Western Regional Climate Center data. The maximum annual precipitation recorded in 1983 was 48.35 inches and the minimum annual precipitation recorded in 1976 was 7.66 inches.

Table 3 PRECIPITATION SUMMARY		
Month	**Average Precipitation (inches)**	**Percent of Year**
January	4.04	20.3
February	3.43	17.2
March	2.66	13.3
April	1.3	6.5
May	0.73	3.7
June	0.37	1.9
July	0.04	0.2
August	0.11	0.6
September	0.37	1.9
October	1.05	5.3
November	2.32	11.6
December	3.52	17.6
Total	**19.95**	

3.2 Temperature

Based on data for the Orland Weather Station (No. 046506), average daily minimum temperatures in the project area range from 36.7 degrees Fahrenheit (°F) in January to 62.5 °F in July. Average daily maximum temperatures range from 54.2 °F in January to 96.7 °F in July.

3.3 Wind Rose

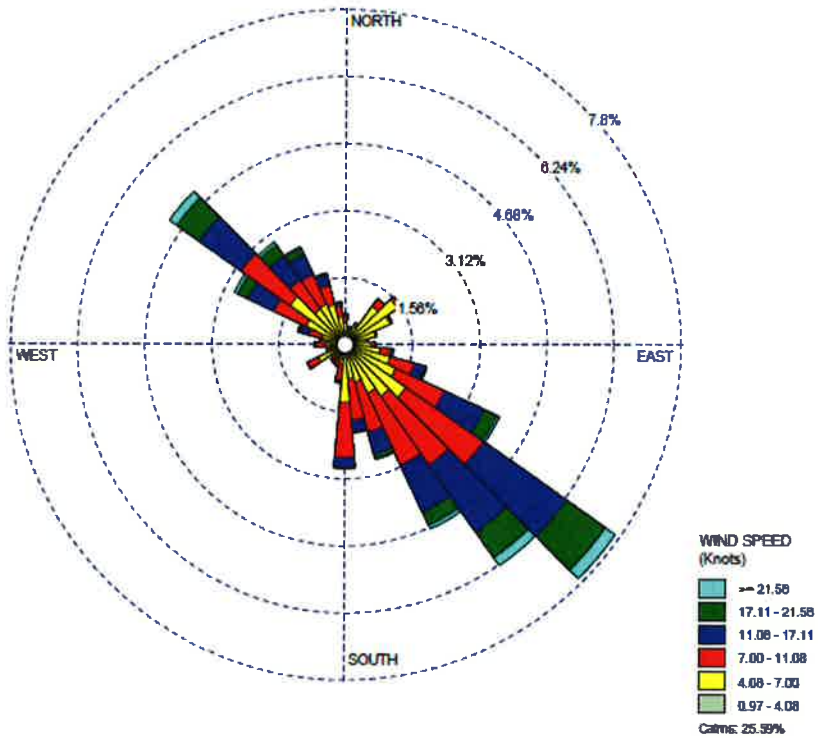
Winds primarily from the North at velocities from 5-15 mph are common. North winds of up to 30-40 mph are not uncommon in the spring and fall periods. Winds from the south usually precede rain events or cloudy conditions and primarily occur in the October-May time frame. South wind velocities are commonly 5-25 mph. Wind data is available from the Chico Municipal Airport station (No. 93203) located about 25 miles to the east of the compost facility. A wind rose for data collected between 2009 and 2014 are included on Figure 2.

WIND ROSE PLOT:

Chico Municipal Airport
Station #93203

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: Start Date: 1/1/2009 - 01:00 End Date: 1/2/2014 - 23:59	COMPANY NAME:	
		MODELER:	
	CALM WINDS: 25.59%	TOTAL COUNT: 39612 hrs.	
	AVG. WIND SPEED: 6.59 Knots	DATE: 8/14/2018	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

Figure 2
Wind Rose

4.0 COMPLAINT RESPONSE PROTOCOL

In the event that an odor complaint is received, the following procedures will be followed by Compost Solutions personnel:

1. If possible, the operator will visit the location of the complaint to verify if the site may be responsible for the odor. Otherwise, the operator shall investigate the probable source of the odor complaint and implement operational changes to minimize odors.
2. Discuss investigation and response with complainant.
3. Inform Local Enforcement Agency (LEA) of complaint and response.
4. Document the complaint(s) on the odor investigation report form (copy included as Appendix A).

5.0 DESIGN CONSIDERATIONS/OPERATING PROCEDURES TO MINIMIZE ODORS

The composting site is located in a rural area. The compost area is surrounded by olive orchards and almond trees, which will provide a vegetative buffer between odor sources and any offsite receptors.

Effective odor management is dependent upon containing volatile organic compounds (VOCs). This is done primarily by limiting excess moisture in the feedstock and materials that are actively composting. In addition, a correct initial C:N ratio is essential in sequestering VOCs. Compost Solutions will work to attain the proper C:N ratio and limit excess moisture in the initial compost feedstock blend. Additional water will be added to the compost on an as-needed basis only. Proper management of water additions eliminates excess moisture in the compost.

A self-propelled windrow turner is used to thoroughly incorporate and mix the feed stock material. Proper aeration is essential to prevent the generation of malodorous emissions. The turning requirements as per Organic guidelines keep the feedstocks from becoming anaerobic and therefore fragrant.

Tarping of materials is generally not done. Any material in danger of becoming too wet due to weather is piled in large coned-shaped rows in order to minimize surface area per given volumes.

5.1 Feedstock Characteristic and Quality/Moisture Content

The feedstocks usually arrive onsite with much less than the desired 50 percent moisture required for proper composting. Water is added as needed to the windrows via water truck or a self-propelled hose cart that is attached to a source of water.

The input capacity of compost feedstock is up to 50,000 tons per year. Of this, as much as 12,000 tons will be biosolids. The volume of this capacity is approximately 100,000 cubic yards of feedstock.

Feedstocks received are summarized in Table 4. The dairy products are obtained from local dairies, the greenwaste comes from commercial greenwaste collection operations from the City of Redding and City of Chico, and the wood chips are from local orchards. All of these materials are screened visually for garbage during all phases of handling and shipping. No more than 40 percent of the feedstock by weight is from manure.

Table 4
FEEDSTOCK LIST

Feedstock	Pounds/Cubic Yard	Est. Annual Tons
Yard Waste	200-500	1,000
Greenwaste	400-1,500	15,000
Almond Byproducts	400-1,000	5,000
Walnut Byproducts	800-1,500	12,000
Wood Chips	400	500
Ash	600	400
Rice Hulls	200	250
Biosolids	1,000-1,800	2,000 (permitted 12,000)
Clay	2,000-3,000	500
Manure	1,200	10,000
Cardboard (for biosolids)	400	100
Ammonium Sulfate	1,800	100
Potassium Sulfate	1,800	100
Phosphate Fertilizer	1,500	50
Micro Nutrients	1,000-3,000	10
Rinse Water	1,700-1,800	4,000
Feed Waste	1,200-1,500	500

As much as 12,000 tons of biosolids may be processed annually. The biosolids are mixed to a ratio of roughly one part biosolids to one part bulking agent (cogeneration ash, greenwaste, agricultural waste, or compost) and then placed into windrows for composting. Biosolids compost is produced only during the dry season. Biosolids are composted separately (see RCSI, Figure 2). Shredded cardboard or paper may be incorporated into the biosolids composting process in the future and are considered a feedstock. A Biosolids Management Plan is included in Appendix A.

5.1.a. Additives

The term "additives" means materials that are stockpiled onsite and mixed with feedstock to adjust the moisture level, carbon-to-nitrogen ratio, or other nutrient balance; to increase porosity; or to create a condition favorable to composting. Additives may include water, horse manure, cattle manure, chemical fertilizers, or other substances.

Manure is obtained from local dairies and used to provide nutrients and microbes to promote composting. Some compost is produced with no manure. In batches that use manure, loads are placed on the composting pad prior to placement of feedstock. The loads are spaced along the row to manage the proportion. Wider-spaced piles produce a lower proportion; closer-spaced piles produce a higher manure proportion. As much as 40 percent manure can be used for some batches. Small proportions of manure may be spread on top of the pile using a compost spreader. Manure moisture content is managed so that it does not create leachate when stockpiled or spread. Manure is delivered to the site on an as-needed basis to avoid stockpiling or may be stored in a bunker over winter as described previously.

Cogeneration ash (wood ash) may be added at a maximum of 5 percent by weight. Ash is obtained from a wood-waste power or cogeneration plant. Wood ash is transported in bulk and dumped in a pile on a prepared pad or bunker. Generally, less than 100 tons (five truckloads) is stored at a given time.

Bone char is a sugar-processing byproduct consisting of lime and plant solids. Bone char, which may be added at a maximum of 10 percent of the total material, is obtained from an industrial sugar plant located in Crockett, California. Bone char is delivered in bulk and spread on the pile by the delivery truck using a side auger. This material is not stored over the winter.

Potassium sulfate may be added at a maximum rate of 10 percent by weight. It is obtained from a commercial fertilizer supplier. Potassium is a fertilizer that promotes biologic activity and composting. Potassium sulfate is delivered in bulk and spread by the delivery tuck. No fertilizer is stored onsite.

Dry urea may be added at a maximum rate of 5 percent by weight. It is obtained from a commercial fertilizer supplier. Urea provides concentrated nitrogen to promote biological activity. Urea is applied as needed, similar to other fertilizers, and is not stored onsite.

5.1.b. Amendments

The term "amendment" means a waste, material, or mineral aggregate, other than a manure or other bioactive waste or material, used for mixing, following composting, to improve the utility of the end product. Post-composting amendments may include fertilizers and/or lime and gypsum to adjust the pH. These amendments are added at the end of the process before the final turning.

Temperature will be monitored during composting too ensure that the process is progressing as planned. Monitoring these parameters could allow correction of conditions that may lead to excessive odors.

5.2 Aeration

The processing at the compost facility will be passive. The rows will be turned regularly to provide aeration.

5.3 Airborne Emission Controls

Activities such as material handling, grinding, turning, and screening could generate dust and odor emissions. Maintaining proper moisture in materials onsite would prevent generation of dust. As necessary, water will be added to material to prevent dust via a water truck or a self-propelled hose cart that is attached to a source of water. Additional measures to control airborne emissions from the site include reducing turning and material handling when wind is in the direction of nearby receptors, and reducing turning and material handling during stagnant air conditions.

5.4 Drainage Controls

The compost pad was constructed so as to promote rapid drainage of stormwater. This feature helps to prevent oversaturation of composting materials. Any holes or developed depressions in the pad are periodically filled in to prevent puddling. High rainfall events are managed onsite through the use of straw bales and a vegetative filter strip. The construction design of the site slows rainwater runoff in order to prevent downstream flooding due to decreased permeability of the composting pad. There is no run-on to the site as the facility does not lie within even a 500-year floodplain.

5.5 Pad Maintenance

The pad will be graded and maintained to discourage any ponding of water which could lead to odors at the site.

5.6 Process/Wastewater Controls

The compost facility will not generate a process/wastewater. Leachate generation is expected to be minimal as the heat of the windrows will result in water evaporation. Any wastewater generated by watering the piles would drain into a 2.5-acre vegetative filter strip. The filter strip has a gravel berm bisecting it. The berm is constructed with 2-inch diameter rock and is designed to slow water flow through the filter.

Compost Solutions is currently exploring alternatives for long-term wastewater management at their facility. The plan of capturing and treating stormwater that can then be applied at agronomic rates to their 12-acre field and adjacent 36-acre walnut orchard are as follows. The stormwater will be captured in a pond (approximately 2 acres), treated, and applied to cropland and/or orchards at agronomic rates. Approximately 10,000 gallons per day will be used to hydrate compost and the remaining will be retained in a pond and treated. The treated water will be compared to background. If constituents exceed background but are less than screening criteria, Best Management Practices (BMPs) will be identified for the specific situation and implemented. Based on the screening comparison, an anti-degradation analysis may be required.

5.7 Storage Practices

The agricultural and greenwaste is stacked into windrows approximately 16 to 18 feet wide, 6 feet deep, and as much as 1,400 feet long (the length of the compost pad). The site has capacity for about 20 rows. Glenn County requires a 100-foot setback from Roads N and 27 on the west and south sides of the project, respectively. Road 27 is separated from the project by the feedstock storage area and vegetative filter strip. Windrows are at least 100 feet from Road N. An access way roughly 10 to 15 feet wide is left between windrows (the final width may be less from sloughing piles). Compost piles are trapezoidal in cross-section.

As feedstock is delivered, the trucks are directed to the composting pad where they dump their load at the end of a row. The dumped material is formed into a windrow using a loader or similar equipment. Unloading and forming proceeds from one end of the row to the other. The length of the windrow varies depending upon the rate of material placement and type of feedstock placed. Once all of the windrows are full, trucks are directed to unload in the feedstock-storage area.

While it is most efficient to place loads on the composting pads as they arrive, feedstock tends to be generated at a greater rate in the spring. Once windrows are filled, and prior to completion of other windrows, there is a period when feedstock must be stockpiled on a feedstock-storage pad. As composting is completed, finished material is removed and material from the feedstock pile is placed in the vacant rows.

Additives are either placed in a row on the pad prior to the feedstock and incorporated into the feedstock during forming, or spread on top of the formed row and incorporated during tilling.

Compost is processed following guidelines set by the National Organic Program (NOP). These guidelines require a starting carbon-nitrogen ratio of between 25:1 and 40:1. They also require material in windrows to be maintained at a temperature of between 131 and 170 degrees Fahrenheit for a minimum of 15 days, during which time it must be turned a minimum of five times. Turning is performed by a commercial compost turner. Moisture content is measured often and regulated with a portable watering system to maintain a desirable moisture content. As stated by Section 205.203.c of the NOP Regulations (NOP, 2000), the final product *"must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances."*

Finished compost is screened to remove oversized material and stockpiled for shipment. Oversize screenings are placed back into the feedstock stream. Large materials are broken down into smaller pieces prior to reincorporation or removed to a permitted landfill or cogeneration facility.

Biosolids are mixed with a bulking agent, such as wood chips, agricultural waste, greenwaste, or cogeneration ash and placed into windrows with the same configuration as non-biosolids feedstock.

5.8 Weather Event Impacts

It is not anticipated that extreme weather events could significantly interfere with composting operations. Winds could cause migration of odor from the site, but will not result in odor-causing material leaving the property. Measures to control airborne emissions from the piles include reducing turning and material handling when wind is in the direction of nearby receptors, and reducing turning and material handling during stagnant air conditions.

5.9 Contingency Plans

Water will be supplied by an onsite well. If needed, water could be delivered to the site by tanker truck if the water supply was interrupted. The composting equipment onsite will be diesel-powered and will not require electricity. Power outage would not impact composting operations. All equipment will be maintained per the manufacturer recommendations. In the event of equipment failure, the operator will rent or lease equipment from local rental companies while repairs are made. Multiple employees will be trained in composting procedures and equipment operation to ensure operations can continue in the absence of key personnel. In the event of an odor complaint when a key employee is out, enough supplementary personnel are trained and equipped to address any issues.

5.10 Personnel Training

Personnel will be trained in the proper use of facility equipment. Potential hazards and safety features will be stressed as well as handling procedures to minimize production of odors. All equipment operators will be trained before running each piece of machinery. Training records will be kept on file.

5.11 Tarping

Tarping of materials is generally not done. Any material in danger of becoming too wet due to weather is piled in large coned-shaped rows in order to minimize surface area per given volumes.

5.12 Biofiltration

Biofiltration will not be used as an odor control method at this time.

Appendix A

Odor Incident Investigation Report Form

ODOR INCIDENT INVESTIGATION REPORT (OIR)

Note: This is not intended to be an "inspection" report per se (to indicate the regulatory agent's verification of the odor). It is more of an evaluation to determine the cause of the odor incident.

GENERAL Date: ____________

Facility Name: ____

Address:

____

Town: ________________, State: ______, Zip code: __________ County: __________

Facility contact:

____

Phone:

____

Email:

____

Regulatory jurisdiction:

____

Regulatory contact:

____

ODOR COMPLAINT:

Nature of the complaint:

____

Date of 1st complaint: _____________ Day of week: ___________

Time(s) during day:

____

Source of Complaint(s):

___ Residence ___ School ___ Business ___ Vehicle

Other: ____

Odor character: ___ Pungent ____ Rotten ___ Putrid ___ Other

____

Intensity ___ Strong ___ Strong-mild ___ Mild ____
Faint

Consistency: ___ Constant___ Irregular/consistent___ Irregular/sporadic
___ Rare/brief

Duration of incident: ______________ hours

Time of day first detected ________________

Time of day no longer apparent: __________________

Location(s) where odor detected:

Direction from facility (circle all that apply): N NE E SE S SW W NW

Distance to nearest complaint: ________ ___ Upslope or ___ down slope?

Distance to FURTHEST complaint: ________ ___ Upslope or ___ down slope?

Facility and Community history

Previous complaints for site: __ Many __ Occasional __ Few __ None

Previous complaints by complainant(s) __ Many __ Occasional __ Few __ None

SITE CONDITIONS AT TIME OF COMPLAINT

Feedstocks generally handled :

____

Feedstocks received on day of complaint and/or previous day:

Material	Day	AM/PM	Condition
________________		______	______________
________________		______	______________
________________		______	______________
________________		______	______________

Activities on day of complaint and/or previous day:

Activity (e.g. turning, pile moved, delivery)	Day of Week	AM/PM
______________________	________	______
______________________	________	______
______________________	________	______
______________________	________	______

Extraordinary circumstances

(e.g. spill, equipment breakdown, employee incident, odorous load, etc.):

____

____

____

Resolution of the above:

____

APPROXIMATE WEATHER CONDITIONS (e.g.warm, hot, windy, sunny, light rain, etc)

At time of 1st Previous	Morning of Same	Afternoon of Same	Previous

	complaint	Day	Day	Afternoon	Night
Temperature	________ ________ ________		________ ________		
Cloud cover	________ ________ ________		________ ________		
Prevailing wind	________ ________ ________		________ ________		
Wind conditions	________ ________ ________		________ ________		
Precipitation	________ ________ ________		________ ________		
Humidity	________ ________ ________		________ ________		

Unusual weather conditions (e.g. very strong wind, temperature inversion):

____

____

____

Description of weather character for previous five days (e.g. hot and humid for 3 days followed by heavy rain and mild temperatures):

____

____

____