FULL SCALE BIOREACTOR LANDFILL FOR CARBON SEQUESTRATION AND GREENHOUSE EMISSION CONTROL

Quarterly Technical Progress Report

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Principal Author(s)
Ramin Yazdani, Senior Civil Engineer, Yolo County Public Works, California
Jeff Kieffer, Associate Civil Engineer, Yolo County Public Works, California
Heather Akau, Junior Engineer, Yolo County Public Works, California

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Name and Address of Submitting Organization
Yolo County, Planning and Public Works Department
Attn: Ramin Yazdani
292 West Beamer Street
Woodland, CA 95695

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ABSTRACT

The Yolo County Department of Planning and Public Works is constructing a full-scale bioreactor landfill as a part of the Environmental Protection Agency's (EPA) Project XL program to develop innovative approaches for carbon sequestration and greenhouse emission control. The overall objective is to manage landfill solid waste for rapid waste decomposition and maximum landfill gas generation and capture for carbon sequestration and greenhouse emission control. Waste decomposition is accelerated by improving conditions for either the aerobic or anaerobic biological processes and involves circulating controlled quantities of liquid (leachate, groundwater, gray water, etc.), and, in the aerobic process, large volumes of air.

The first phase of the project entails the construction of a 12-acre module that contains a 6-acre anaerobic cell, a 3.5-acre anaerobic cell, and a 2.5-acre aerobic cell at the Yolo County Central Landfill near Davis, California. The cells are highly instrumented to monitor bioreactor performance. Construction is complete on the 3.5-acre anaerobic cell and liquid addition has commenced. Construction of the 2.5 acre aerobic cell is nearly complete with only the blower station and biofilter remaining. Waste placement and instrumentation installation is ongoing in the west-side 6-acre anaerobic cell. The current project status and preliminary monitoring results are summarized in this report.

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1 EXECUTIVE SUMMARY

In 1996, Yolo County began operation of a pilot-scale project to evaluate the costs and benefits of a relatively new concept in landfill operation, often termed “bioreactor” or “enhanced” landfilling. The basic concept of a bioreactor landfill is to increase the biological activity of the waste (through the addition of waster) to maximize the production of landfill gas for carbon sequestration and greenhouse emission control. The results of this pilot project were favorable and, as a result, Yolo County requested and gained approval from state and federal regulatory agencies to conduct this full-scale demonstration of bioreactor landfilling.

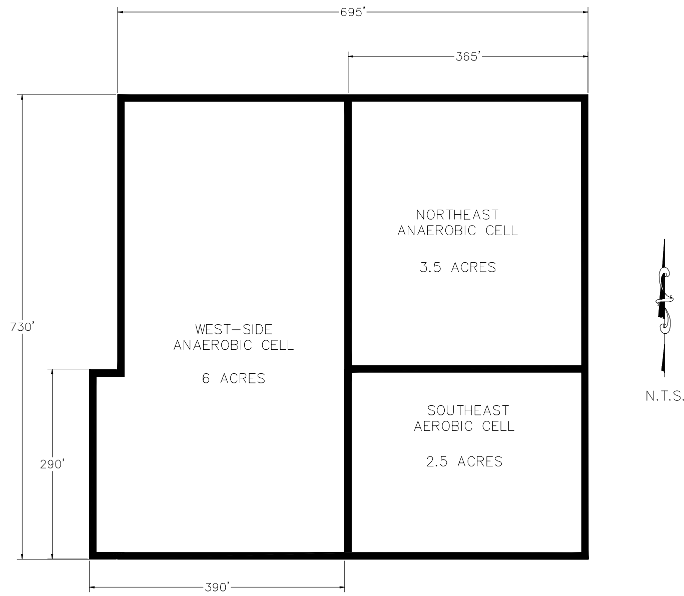
Because current Federal and California State regulations generally do not allow the addition (or recirculation) of leachate and other supplemental liquid to a lined landfill module, special regulatory flexibility was required to conduct this project. Yolo County applied for, and was granted the necessary flexibility through the Unites States Environmental Protection Agency XL Program which stands for "eXcellence and Leadership.” The XL program allows state and local governments, businesses and federal facilities to develop with EPA innovative strategies to test better or more cost-effective ways of achieving environmental and public health protection.

This report provides an update on Phase 1 of the Yolo County Accelerated Anaerobic and Aerobic Composting (Bioreactor) Project where carbon sequestration and greenhouse emission is controlled through either the anaerobic or aerobic process. Phase 1 of the project encompasses a 12-acre area of a 20-acre landfill module (Unit 6, Module D) at the Yolo County Central Landfill. At this time, Phase 2 of the project is anticipated to begin in Fall 2002.

1.1 Summary of Current Project Status

The majority of the bioreactor project continues on schedule with the only deviations related to the aerobic cell’s air collection system. The project schedule is located in Appendix A, Table 1 and has been altered slightly since the previous project schedule prepared in April 2002.

The configuration of the project bioreactor cells separates the northeast quadrant from the northwest and southwest quadrants, resulting in 3 separate landfill cells, two cells will be operated anaerobically and one aerobically (Detail 1). We have designated the three bioreactor cells as the west-side anaerobic cell, the northeast anaerobic cell, and the aerobic cell. This configuration allows the northeast anaerobic cell to be constructed and operation of the bioreactor to begin prior to completion of the west-side anaerobic cell. By separating the anaerobic bioreactor into two separate cells, experiences gained from construction of the northeast cell were incorporated into the west-side anaerobic cell.



Detail 1. Overview of Module D Bioreactor Cells

The northeast anaerobic cell and the southeast aerobic cell have been filled with waste and the instrumentation, leachate injection, and gas collection systems have been installed. A total of 65,104 tons of waste was placed in the northeast anaerobic module and 11,942 tons of waste was placed in the southeast aerobic module. The west-side anaerobic cell is still in the process of being filled with waste and is anticipated to be completely filled by August 2002.

The installation of a surface reinforced polypropylene (RPP) membrane cover over the northeast anaerobic cell was completed in November 2001 and will allow precise quantification of the amount of landfill gas produced. The aerobic cell received a cover of 12-inches of soil covered by 12-inches of greenwaste alternative daily cover (ADC). The planned surface membrane cover for the west-side anaerobic module will be similar to the northeast module, with the exception that 40-mil linear low density polyethylene (LLDPE) will be used instead of RPP.

A Supervisory Control and Data Acquisition (SCADA) system has been installed in a shed located at the southern limit of Module 6D and will monitor and control the operation of the bioreactor cells. All instrumentation installed in the northeast anaerobic cell, the aerobic cell, and on the Module 6D composite liner have been connected to a central processor which is radio linked to a computer located in our woodland office. In March 2002, the SCADA system started to electronically collect temperature and moisture data from in the northeast anaerobic cell, the aerobic cell, and on the Module 6D composite liner. Once the remaining instrumentation has been installed in the west-side anaerobic cell, it will be incorporated into the system.

Landfill gas collection began in the northeast anaerobic cell in mid-December 2001, and through the end of June 2002 a total of 3.83 x 10^6 scf of methane (which is equivalent to approximately 550 barrels of oil) has been collected. With the average age of the waste only about one year old, it is clear that significant amounts of landfill gas can be collected in a relatively short amount of time provided sufficient collection infrastructure exists. Landfill gas from the main gas extraction header on the northeast anaerobic cell was sampled and submitted for laboratory analysis in May 2002. Gas composition (methane, carbon dioxide, and oxygen) and pressure continues to be monitored on a weekly basis.

Leachate addition to the northeast cell began on March 27, 2002. Through the end of June 2002, a total of 178,895 gallons of liquid (leachate) was added to the northeast anaerobic cell.
Leachate was monitored for field chemistry and sampled for laboratory analysis in May 2002 and June 2002. Landfill gas was sampled in May 2002 from the northeast anaerobic cell main gas extraction line and from the leachate collection and removal system (LCRS) on the west-side anaerobic cell.

The first round of waste sampling for the bioreactor project was conducted on June 4, 2002 and June 5, 2002. Waste from the northeast anaerobic cell, the west-side anaerobic cell, and the aerobic cell were sampled to quantify the methane generation potential of each cell

Methane surface emission monitoring on the northeast anaerobic cell, the west-side anaerobic cell, and the aerobic cell was conducted on June 6, 2002. The maximum concentration of methane detected was 37 parts per million (ppm) in the active waste placement area of the west-side cell. Methane emissions from the remaining surfaces of the bioreactors were measured at between 0 and 10 ppm.

2 INTRODUCTION

Sanitary landfilling is the dominant method of solid waste disposal in the United States, accounting for about 217 million tons of waste annually (U.S. EPA, 1997). The annual production of municipal solid waste in the United States has more than doubled since 1960. In spite of increasing rates of reuse and recycling, population and economic growth will continue to render landfilling as an important and necessary component of solid waste management.

In a Bioreactor Landfill, controlled quantities of liquid (leachate, groundwater, grey-water, etc.) are added to increase the moisture content of the waste. Leachate is then recirculated as necessary to maintain the moisture content of the waste at or near it's moisture holding capacity. This process significantly increases the biodegradation rate of waste and thus decreases the waste stabilization and composting time (5 to 10 years) relative to what would occur within a conventional landfill (30 to 50 years or more). If the waste decomposes (i. e., is composted) in the absence of oxygen (anaerobically), it produces landfill gas (biogas). Biogas is primarily a mixture of methane, a potent greenhouse gas, carbon dioxide, and small amounts of Volatile Organic Compounds (VOC's). This by-product of anaerobic landfill waste composting can be a substantial renewable energy resource that can be recovered for electricity or other uses. Other benefits of a bioreactor landfill composting operation include increased landfill waste settlement and a resulting increase in landfill capacity and life, improved opportunities for treatment of leachate liquid that may drain from fractions of the waste, possible reduction of landfill post-closure management time and activities, landfill mining, and abatement of greenhouse gases through highly efficient methane capture over a much shorter period of time than is typical of waste management through conventional landfilling.

2.1 Description Of The Project And Its Purpose

The County of Yolo Planning and Public Works Department (Yolo County) is operating its next 20-acre landfill module near Davis, California as a controlled bioreactor landfill to attain a number of superior environmental and cost savings benefits. In the first phase of this 20-acre project, a 12-acre module will be constructed. This 12-acre module contains a 6-acre cell and a 3.5-acre cell, which will be operated anaerobically, and a 2.5-acre cell, which will be operated aerobically. The County will construct the second phase of Module 6D in Fall 2002 and depending on the results of the first phase of Module 6D, Yolo County may operate the second phase either anaerobically or aerobically.

Co-sponsors of the project with Yolo County are the Solid Waste Association of North America (SWANA) and Institute for Environmental Management (IEM, Inc.). As part of the EPA Project XL, Yolo County requested that U.S. EPA grant site-specific regulatory flexibility from the prohibition in 40 CFR 258.28 Liquid Restrictions, which may preclude addition of useful bulk or non-containerized liquid amendments. The County intends to use leachate and groundwater first but if not enough liquid is available then other supplemental liquids such as gray-water from a waste water treatment plant, septic waste, and food-processing wastes will be used. Liquid wastes such as these, that normally have no beneficial use, may instead beneficially enhance the biodegradation of solid waste.

Yolo County also requested similar flexibility on liquid amendments from California and local regulatory entities. Several sections of the California Code of Regulations (CCR), Title 27, Environmental Protection, address the recirculation of liquids in lined municipal solid waste landfills. While the regulations do not specifically endorse bioreactors, regulatory flexibility is provided by the State of California Title 27, Chapter 3, Subchapter 2, Article 2, section 20200, Part (d)(3), *Management of liquids at Landfills and Waste Piles*. For additional information on this regulatory flexibility, see Section IV A of the FPA.

2.2 Description Of The Facility And The Operations / Geographic Area

The Yolo County Central Landfill (YCCL) is an existing Class III non-hazardous municipal solid waste landfill. The site encompasses a total of 722 acres and is comprised of 17 distinct Class III solid waste management units and two Class II leachate surface impoundments. The YCCL is located at the intersection of Road 104 and Road 28H, 2 miles northeast of the City of Davis. The YCCL was opened in 1975 for the disposal of non-hazardous solid waste, construction debris, and non-hazardous liquid waste. Existing on-site operations include a thirteen-year-old landfill methane gas recovery and energy generation facility, a drop-off area for recyclables, a metal recovery facility, a wood and yard waste recovery and processing area, and a concrete recycling area.

There are approximately 28 residences scattered within a 2-mile radius of the landfill. The closest residence is located several hundred feet south of the landfill, on the south side of Road 29 south of the Willow Slough By-pass.

Groundwater levels at the facility fluctuate between 8 to 10 feet during the year, rising from lowest in the Fall to highest in the Spring. Water level data indicate that the water table level is typically 4 to 10 feet below ground surface during winter and spring months. During summer and fall months, the water table is typically 5 to 15 feet below ground surface. In January 1989, the County of Yolo constructed a soil/bentonite slurry cutoff wall to retard groundwater flow to the landfill site from the north. The cutoff wall was constructed along portions of the northern and western boundaries of the site to a maximum depth of 44 feet. The cutoff wall has a total length of 3,680 feet, 2,880 feet along the north side and 800 feet along the west. In the fall of 1990, irrigation practices to the north of the landfill site were altered to minimize the infiltration of water.

Additionally, sixteen groundwater extraction wells were installed south of the cutoff wall in order to lower the water table south and east of the wall, to provide vertical separation between the base of the landfill and groundwater.

Prior to placement of the slurry wall and dewatering system, the groundwater flow direction was generally to the southeast. Under current dewatering conditions, the apparent groundwater flow paths are towards the extraction wells located along the western portion of the northern site boundary. In essence, a capture zone is created by the cone of depression created by the ground water extraction system, minimizing the possibility of off-site migration of contamination.

3 NORTHEAST ANAEROBIC CELL

The northeast anaerobic cell occupies approximately 3.5 acres in the northeast quadrant of Phase 1, Module 6D.

3.1 Experimental

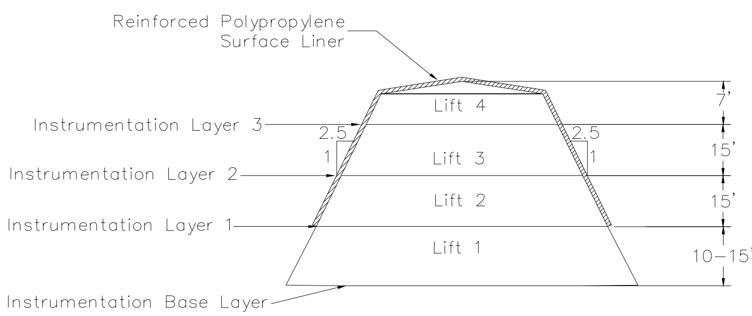
The experimental methods utilized are grouped into three categories: construction, monitoring, and operation. Each of these categories is discussed below.

3.1.1 Construction

Construction of the northeast anaerobic cell can be generally broken down into four major tasks: waste placement, liquid addition, gas collection, and surface liner installation. Each of these four tasks is discussed below. A summary of current monitoring data for the northeast anaerobic cell is provided in Appendix A, Table 2.

3.1.1.1 Waste Placement

Waste placement began on January 13, 2001 and was completed on August 3, 2001. Waste was placed in four separate lifts with an average thickness of 15 feet (Detail 2). In general, all waste received at the landfill was deposited in the northeast cell with the exception of self-haul waste. Because of the difficulties handling large volumes of self-haul vehicles in the limited area of the upper lifts, self-haul waste was not placed in lifts 3 and 4. The use of daily cover soil during waste filling was minimized to aid in the overall permeability of the waste. Whenever possible, greenwaste or tarps were used as alternative daily cover (ADC) and, in the event soil was placed (for example, access roads or tipping pad), the soil was removed prior to placing the next lift of waste. All side slopes were constructed at approximately 2.5 to 1 (horizontal to vertical) and received at least one foot of soil cover. Instrumentation Layers 1, 2, and 3 were placed between lifts, and base layer instrumentation was installed on the Module 6D base liner. A summary of sensors installed on each layer is provided in Appendix A, Table 3.



Detail 2. Northeast Anaerobic Cell Cross Section

3.1.1.2 Liquid Addition

Horizontal liquid injection lines were installed in each lift of waste (Image 1). Injection lines within the waste (between lifts 1 and 2, 2 and 3, 3 and 4) were placed at approximately 40-foot spacing. Injection lines installed on top of lift 4 were installed at approximately 25-foot spacing with an additional injection line following the perimeter of the top deck. Each injection line consists of a 1.25-inch-diameter high-density polyethylene (HDPE) pipe placed horizontally (north to south), which extends completely through the waste. Each injection line was perforated by drilling a $^{3}/_{32}$-inch hole every 20 feet. A total of 8,130 feet of injection piping was installed with a total of 342 injection holes.

Each of the injection laterals is connected to a 4-inch-diameter HDPE injection header. Flow rate and pressure will be monitored at each injection lateral. Leachate injection for each lateral will be monitored and controlled by individual solenoid valves connected to the SCADA system. A second, redundant flow meter will monitor the total volume and injection flow rate for the entire northeast anaerobic cell.

Image 1: Horizontal LFG and leachate injection lines installed and being coverd by shredded tires.

3.1.1.3 Gas Collection

Horizontal landfill gas (LFG) collection lines were installed between each lift of waste (Image 1) and directly under the reinforced polypropylene (RPP) geomembrane cover. LFG collection lines consist of various combinations of alternating 4 and 6-inch–diameter, schedule 80 polyvinyl chloride (PVC) pipe (Image 2) as well as several variations using corrugated HDPE pipe. A summary of gas collection lines for the northeast anaerobic cell is provided in Appendix A, Table 4. At each line, shredded tires were used as the permeable media. The gas collection lines between layers are spaced approximately 40 feet apart and the lines directly under the RPP membrane are spaced at 25 feet. A total of sixteen LFG collection lines were installed.

Each LFG collection line is connected to a 6-inch-diameter LFG collection header that will convey the gas to the on-site LFG-to-energy facility. Each LFG collection line will incorporate a pre-manufactured wellhead capable of controlling flow and monitoring flow rate, temperature and pressure.

Image 2: Horizontal LFG collection line installation

3.1.1.4 Surface Liner

The County retained the services of Vector Engineering (Vector) to design the surface membrane covers for each of the bioreactor cells (Image 3). Their scope of work included the following subtasks:

- Research the different commercially available membrane materials, including high and low density polyethylene, polyvinyl chloride, and reinforced polypropylene;
- Design of a biofilter to treat the off-gas from the aerobic cell;
- Prepare plans and specification for the installation of the surface liners; and
- Provide on-site construction quality assurance for the installation of the surface membrane.

Vector's scope of work was modified to include preparation of plans and specifications for the tie-in of the leachate injection and landfill gas collection piping.

Image 3: Northeast anaerobic surface liner

Based on Vector and County staff research, it was determined that a 36-mil reinforced polypropylene geomembrane (RPP) would be the preferred choice for an exposed geomembrane cover[1]. Reinforced polypropylene offered distinct advantages over the other potential materials including long service life (a 20-year warrantee was obtained), superior strength due to the nylon reinforcement, and low thermal expansion and contraction.

To expedite construction and reduce the overall cost of the project, the County decided to directly purchase the necessary membrane material and provide it to the contractor for installation. On June 29, 2001, the County issued a request for quotes for 350,000 square feet of 36-mil RPP. Quotes were received on July 9, 2001 with the lowest priced quote received from Colorado Linings International (Colorado).

The plans and specifications for the installation of the RPP surface liner were issued for bid on June 15, 2001. Later that month, Addendum Number 1 was issued to include a majority of the leachate injection and gas collection piping. Bids were due on July 13, 2001; however, no bids were received. The County inquired to each of the plan holders and generally found that bids were not submitted because the liner companies could not locate a subcontractor to perform the earthwork.

The County reissued the plans and specifications on July 23, 2001 and allowed three separate bid options. Option A was the entire project. Option B was only the installation of the liner, and Option C was only the earthwork. Bids were received on August 6, 2001 with the selected contractor being Colorado Linings International. Because Colorado's winning bid was significantly higher than the engineer's estimate and the potential difficulties with excessive pressure buildup under the aerobic liner, the covering of the aerobic cell was eliminated (for further discussion refer to Section 5.1).

The installation of surface liner and associated piping was completed in November 2001.

3.1.2 Monitoring

Temperature, moisture, leachate quantity and quality, and LFG pressure and composition are monitored through an array of sensors placed within the waste and in the leachate collection and recovery system (LCRS). Each sensor location on the base layer received a temperature sensor (thermistor), a linear low-density polyethylene (LLDPE) tube, and selected locations received a PVC moisture sensor. Each sensor location within the waste received a temperature sensor (thermistor), a linear low-density polyethylene (LLDPE) tube, and a moisture sensor (a PVC moisture sensor and in some cases a gypsum block). For protection, each wire and tube was encased in either a 1.25-inch HDPE pipe or run inside the LFG collection piping. Refer to Appendix B, Details 7 through 11 for sensor location diagrams.

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[1] Vector Engineering, "Design Report for the Surface Liners of the Module D Phase 1 Bioreactors at the Yolo County Central Landfill", October 2001.

Image 4: Moisture, temperature , and tube installation

Sensors on instrumentation Layers 1, 2, and 3 were placed on either a bedding of greenwaste (shredded yard waste), wood chips (chipped wood waste), bin fines (fine pieces of greenwaste), or pea gravel to protect against damage from the underlying waste. Sensors installed on the primary liner (prior to any waste placement) were placed on geocomposite and covered with pea gravel prior to the placement of the chipped tire operations layer.

3.1.2.1 Temperature

Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. To prevent corrosion, each thermistor was encased in epoxy and set in a stainless steel sleeve. All field wiring connections were made by first soldering the connection, then covering each solder joint with adhesive lined heat shrink tubing, and then encasing the joint in electrical epoxy. Changes in temperature are measured by the change in thermistor resistivity (ohms). As temperature increases, thermistor resistance decreases.

3.1.2.2 Moisture

Moisture levels are measured with polyvinyl chloride (PVC) moisture sensors and gypsum blocks. Both the PVC moisture sensors and gypsum blocks are read utilizing the same meter. The PVC sensors are perforated 2-inch-diameter PVC pipes with two stainless steel screws spaced 8 inches apart and attached to wires to form a circuit that includes the gravel filled pipe. The PVC sensors were designed by Yolo County and used successfully during the pilot scale project[2]. The PVC moisture sensor can provide a general, qualitative assessment of the waste's

[2] Yazdani, R., Moore, R. Dahl. K. and D. Augenstein 1998 Yolo County Controlled Landfill Bioreactor Project. Yolo County Public Works and I E M, Inc. Yolo County Public Works and I E M, Inc. report to the Urban Consortium Energy Foundation (UUCETF) and the Western Regional Biomass Energy Program, USDOE.

moisture content. A reading of 0 to 40 equates to no free liquid, 40 to 80 equates to some free liquid, and 80 to 100 means completely saturated conditions.

The gypsum blocks are manufactured by Electronics Unlimited and are typically used for soil moisture determinations in agricultural applications. Gypsum blocks establish equilibrium with the media in which they are placed and are, therefore, reliable at tracking increases in the soil's moisture content. However, the gypsum block can take considerable time to dry and therefore may not reflect the drying of the surrounding environment.

3.1.2.3 Leachate Quantity and Quality

Leachate that is generated from the northeast anaerobic cell drains to the eastside Module D leachate collection sump (Image 5). A dedicated pump is then used to remove the leachate and pump it to one of the on-site leachate storage ponds. A flow meter measures rate and total volume pumped from the sump.

Leachate is monitored for the following field parameters: pH, electrical conductivity, dissolved oxygen, oxidation-reduction potential, and temperature. When leachate is generated in sufficient quantities, the following parameters will be analyzed by a laboratory: dissolved solids, biochemical oxygen demand, chemical oxygen demand, organic carbon, nutrients (NH_3, TKN, TP), common ions, heavy metals and organic priority pollutants. For the first year, monitoring will be conducted monthly during the first six months and quarterly for the following six months. After the first year, monitoring will be conducted semi-annually (pH, conductivity, and flow rate will continue to be monitored on a monthly basis as required by the State of California's Waste Discharge Requirements in Order 5-00-134).

3.1.2.4 Pressure

Pressure within the northeast anaerobic cell is monitored with ¼-inch inner diameter and $^3/_8$-inch outer diameter LLDPE sampling tubes. Each tube can be attached to a pressure gage and supplemental air source. By first purging the tube with the air source (to remove any liquid blockages), and then reading the pressure, an accurate gas and/or water pressure can be measured at each sensor location.

3.1.2.5 Landfill Gas Composition

Gas composition is measured utilizing a GEM-500 combustible gas meter, manufactured by LANDTEC. The GEM-500 is capable of measuring methane (either as a percent by volume or percent of the lower explosive limit), carbon dioxide, and oxygen. A reading for "balance" gas is also provided, which is assumed to be nitrogen. Currently, gas composition is analyzed from the same sampling tubes used to measure pressure.

Image 5: Gravel drainage layer and leachate collection sump

3.1.2.6 Waste Sampling

Yolo County conducted the first waste sampling event for the northeast anaerobic cell on June 5, 2002. Waste was sampled to quantify the methane generation potential of the waste. Waste was drilled to an approximate depth of 50 feet with samples taken at 5-foot intervals. Waste will be sampled from the northeast anaerobic cell annually for the next two years to monitor the progress of waste decomposition and compare actual methane generation to laboratory methane generation.

3.1.2.7 Surface Scan

Surface scan monitoring is conducted to test for fugitive methane emissions. Methane is monitored for concentrations above 500 parts per million (ppm) with a model TVA-1000 Flame Ionization Detector (FID)/ Photo Ionization Detector (PID) instrument. Under the FID setting, the TVA-1000 is capable of detecting methane in the parts-per-million (PPM) range. In the event significant methane was detected, the unit could be switched to PID mode to detect volatile organic compounds (VOC). Methane surface concentrations are monitored along the perimeter of each collection area and along a pattern that transverses the landfill at 15 meter intervals.

The first surface scan on the northeast anaerobic cell was conducted on April 3, 2002 and no fugitive methane emissions were detected.

The second surface scan was conducted on June 6, 2002. The highest emissions detected were 9 ppm in the vicinity of the southeastern corner of the cell. The methane emissions were approximately 5.5 ppm above background concentrations upwind and 9 ppm above background concentrations downwind.

3.1.3 Operation

Operation of the northeast anaerobic cell as a bioreactor will begin once the surface liner, LFG collection system, leachate recirculation systems, and SCADA control systems are complete. Landfill gas collection began on December 13, 2001 and leachate addition began on March 27, 2002.

3.1.3.1 Leachate Recirculation

Leachate addition to the northeast cell began on March 27, 2002 (Image 6). Each of the horizontal liquid injection lines was initially tested by pumping approximately 1000 gallons into the line to confirm operation and correlate flow versus pressure for each injection lateral.

Image 6: Leachate injection header and laterals

With the initial testing phase complete, full-scale liquid addition has commenced. Once the waste reaches field capacity, only enough liquid to maintain field capacity will be added. Through the end of June 2002, a total of 178,895 gallons of liquid (leachate) was added to the northeast anaerobic cell with approximately 97 percent added to Layer 1.

3.1.3.2 Landfill Gas Collection

Landfill gas collection began December 13, 2001 once the necessary piping was installed at the end of November 2001. Gas collection prior to leachate addition was necessary to prevent "billowing" or excess gas pressure under the surface liner.

3.2 Results And Discussion

Sensor names are represented numerically by the instrumentation layer in which the sensor is located, followed by the assigned sensor number. The base layer is represented by a 0, Layer 1 is represented by a 1, and so forth. The complete name of the sensor is denoted by the layer number – the sensor number. For example, the second sensor on Layer 1 is named 1-02.

3.2.1 Temperature

Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system located in the instrumentation shed starting in March 2002. Resistance was previously measured manually by connecting the sensor wires to a 26 III Multimeter manufactured by Fluke Corporation.

Base Layer - The northeast base layer temperatures have slowly increased and range between 20°C and 27°C (68°F and 81°F) as presented in Appendix C, Figure 1. Lower temperature readings from sensor 0-46 may be due to the sensor's proximity to the perimeter of the cell and/or to less biodegradable material in the vicinity of the sensor.

Layer 1 - The majority of sensors within Layer 1 are recording temperatures ranging between approximately 35^{o}C to 46^{o}C (95^{o}F to 115^{o}F) as presented in Appendix C, Figure 2. Lower temperature readings from sensors 1-16, 1-17 and 1-18 are most likely due to their proximity to the surface of the module. Sensors 1-05, 1-06 1-09 are approaching temperatures measured in Layer 2 (53 ^{o}C to 59 ^{o}C or 127 ^{o}F to 138 ^{o}F). Sensor 1-09 indicates fluctuating temperatures that are not supported by nearby sensors, ambient temperature, leachate injection, or gas extraction rates. The fluctuations in temperature measured from the remaining sensors correspond to leachate injection, which initially results in cooling the waste.

Layer 2 - The elevated temperatures, between approximately 54^{o}C and 63^{o}C (129^{o}F and 145^{o}F), in Layer 2 appear to correspond to the beginning of the use of "bin fines" as the media surrounding the sensors and daily cover material (Appendix C, Figure 3). Wood chips were used on Layer 1 to cover the sensors, however, due to the low supply of this material, bin fines were used to cover the sensors on Layer 2. Bin fines seem to be a more readily biodegradable material than wood chips, as evidenced by the higher temperatures. During the month of June 2002, the sensors show temperatures converging towards approximately 60^{o}C (140 ^{o}F). After the start of leachate injection on March 27, 2002, the fluctuations in temperatures measured from sensors 2-14 and 2-02 correspond to the addition of leachate into the cell.

Layer 3 - Temperature readings for Layer 3 generally range between 54^{o}C and 67^{o}C (129^{o}F and 153^{o}F) as presented in Appendix C, Figure 4. Lower temperatures are being measured by sensors close to the surface (3-01, 3-03, 3-08, 3-11, and 3-13) with the remaining sensors recording higher temperatures.

3.2.2 Moisture

The SCADA system started electronically measuring moisture in March 2002. Due to a slight variation between how the SCADA system measures moisture compared to the manual meter, moisture readings generally increased a small fraction relative to their previous manually recorded readings. Because moisture data are unitless numbers that give a qualitative assessment rather than a quantitative measure, we feel that this slight change is not significant. Moisture was previously measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. During the pilot scale project, Yolo County conducted laboratory tests with the PVC sensors to determine the relationship between the multimeter readings and the presence of free liquid in the PVC sensor. It was determined that a meter reading of less than 40 corresponded to an absence of free liquid. A reading between 40 and 80 corresponds to the presence of free liquid in the PVC pipe but less than saturated conditions. Readings of greater than 80 indicate saturated conditions; i.e. the PVC sensor is full of liquid.

Base Layer - PVC moisture levels for the base layer are presented in Appendix C, Figure 5. Moisture levels generally remain below 22 in the no-free-liquid zone. Sensor 0-42 indicates high levels of moisture that are not supported by other temperature sensors, moisture sensors, or pressure readings from sampling tubes.

Layer 1 - PVC moisture levels for Layer 1 are presented in Appendix C, Figure 6. The moisture levels for this layer generally range between 0 and 30 in the no-free-liquid zone. Sensors 1-05 and 1-16 indicate higher moisture levels that equate to the some-free-liquid zone. During June 2002, sensors 1-08, 1-10, and 1-13 respond to leachate injection with moisture levels increasing and then fluctuating between the some free liquid zone and the completely saturated zone.

Layer 2 - PVC moisture readings generally lie in the no-free-liquid zone ranging between 30 and 38 (Appendix C, Figure 7). PVC moisture sensor 2-12 initially indicated some free liquid was present, however, it has since dropped to the no fee liquid zone. The elevated moisture levels initially recorded by PVC moisture sensor 2-12 were supported by gypsum in plaster sensor 2-12 (Appendix C, Figure 8); however, the gypsum in plaster sensor has remained at moderate moisture levels near 50. PVC moisture sensor 2-14 shows high moisture levels in the completely saturated zone that are not reflected by gypsum in plaster sensor 2-14 or gypsum in soil sensor 2-14 (Appendix C, Figure 9). Fluctuation in moisture measured by PVC sensors 2-04 and 2-15 in June 2002 correspond to leachate injection.

Gypsum in plaster sensors 2-04 and 2-10 exhibited high initial moisture readings, due to the plaster encasing the gypsum block not being fully dry prior to installation. High initial moisture readings from gypsum in plaster sensors 2-06, 2-11, and 2-12 are most likely a result of being wetted shortly after installation. The rise in moisture levels for gypsum sensors 2-03, 2-05, 2-10, and 2-15 during May 2002 and June 2002 is a response to leachate injection on Layer 2.

While many moisture readings from gypsum in plaster sensors do not quantitatively support measurements taken from gypsum in soil sensors, they generally support the measurements on a qualitative basis. This is shown by similar moisture trends at many sensor locations. The rise in moisture levels measured from gypsum in plaster sensor 2-05 corresponds to the rise in moisture levels measured from gypsum in soil sensor 2-05. In June 2002, fluctuations in moisture levels measured by gypsum in soil sensor 2-15 are supported by an increase in moisture levels measured by gypsum in plaster sensor 2-15. Additionally, moisture levels measured by gypsum sensors at location 2-06 show similar trends in retaining steady moisture levels. However, not all gypsum in plaster moisture trends support gypsum in soil moisture trends; while gypsum in soil readings indicate an increase in moisture, gypsum in plaster readings indicate a decline in moisture.

Layer 3 - With the exception of sensors 3-03, 3-04 and 3-05, Layer 3 moisture readings generally remain in the no-free-liquid zone. Sensor 3-04 moisture readings declined from the some free liquid zone to the no free liquid zone while sensor 3-05 moisture readings declined from the completely saturated zone to the some free liquid zone. In June 2002, readings from sensor 3-05 indicate an increase in moisture that corresponds to leachate injection. Additionally, sensor 3-03 moisture levels increased to the some free liquid zone due to leachate addition into the adjacent injection line (Appendix C, Figure 10).

3.2.3 Leachate Quantity And Quality

Prior to October 2001, leachate data reflects rainfall rather than actual leachate generation because the cells were only partially filled, and portions of the leachate collection and removal system were exposed to rainfall. Between October 2001 and June 2002, approximately 56,600 gallons of leachate from the northeast anaerobic cell and the southeast anaerobic base layer was collected in the east sump (Appendix C, Figure 11).

Leachate was sampled in May 2002 and June 2002 for analytical testing. Analytical results are presented in Appendix D, Table 20. Field chemistry and selected analytical results are presented below in Table 3-1. Analytical results from June 2002 are not available but will be presented on the next quarterly report. Leachate chemistry and analytical results prior to February 2002 are not reported because samples taken during the wet season were rainfall rather than leachate and low leachate levels following the rainy season did not allow collection of fresh leachate samples.

Table 3-1. Field Chemistry and Selected Laboratory Chemistry for Leachate Sampled from the Northeast Anaerobic Cell

PARAMETER	**Date:**	**2/14/2002**	**3/27/2002**	**5/14/2002**
Field Chemistry	**Units**			
PH		7.13	7.55	7.40
Electrical Conductivity	µmoh/cm	6583	6173	6095
Oxidation Reduction Potential	MV	-119	-12	80
Temperature	C	19.9	21.5	25.9
Dissolved Oxygen	Mg/L	0.65	2.13	1.4
Total Dissolved Solids	Ppm	5244	4860	4059
General Chemistry:				
Ammonia as N	Mg/L	30	24.4	26.3
Bicarbonate	Mg/L	1740	1550	1760
BOD	Mg O/L	20	34	19
Chemical Oxygen Demand	Mg O/L	633	488	791
Chloride	Mg/L	1070	1100	1030
Nitrate/Nitrite as N	Mg/L	<0.030	0.43	<1.5
Total (Non-Volatile) Organic Carbon	Mg/L	2.2	147	132
Total Alkalinity as CO_3	Mg/L	1740	1550	1760
Total Dissolved Solids @ 180 C	Mg/L	4440	3960	3700
Total Kjeldahl Nitrogen	Mg/L	53.1	71	40
Total Sulfide	Mg/L	1.3	0.18	1.3
Dissolved Iron	Mg/L	1.1	0.44	0.39
Dissolved Magnesium	Mg/L	323	248	262
Dissolved Potassium	Mg/L	152	124	133

3.2.4 Pressure

Pressure measurements are taken from sampling tubes with a DWYER Instruments, Inc., “Magnehelic” pressure gage. Pressure measurements can be either positive or negative, with positive pressures resulting from both the generation of landfill gas and saturated liquid conditions.

Base Layer - Pressure readings from the northeast base layer pressure tubes are currently positive and below 0.18 centimeters of water (0.07 inches of water).

Layer 1 - Pressure readings in Layer 1 are positive and generally remain below 4.6 centimeters of water (1.8 inches of water). Pressure readings from sampling tube 1-10 are currently at 13 centimeters of water (5 inches of water).

Layer 2 - Pressure readings in Layer 2 are positive and remain below 0.15 centimeters of water (0.06 inches of water).

Layer 3 - Pressure readings in Layer 3 are positive and remain below 0.81 centimeters of water (0.32 inches of water).

3.2.5 Landfill Gas Compositions
Gas composition is measured from sampling tubes on each layer of the cell with the GEM-500. Because liquid will damage the GEM, pressurized air is first forced through the tubes to remove any liquid, then the tube lines are purged with a vacuum pump and hooked up to the GEM to analyze the gas composition.

Base Layer – Methane concentrations measured from sampling tubes have decreased since the commencement of LFG extraction form the northeast cell as presented in Appendix C, Table 11.

Layer 1 – Low methane levels measured in June 2002 generally correspond to sensors located near open gas extraction lines while high methane levels have been measured from sensors located near closed gas extraction lines as presented in Appendix C, Table 12. Oxygen measured on Layer 1 is most likely the result gas extraction lines pulling in air from the shredded tires operation layer that covers the entire bottom of Module 6D.

Layer 2 - Gas compositions measured from sampling tubes generally indicate Layer 2 is in the anaerobic phase as presented in Appendix C, Table 13. Methane and carbon dioxide levels are generally steady and oxygen has been depleted.

Layer 3 - Gas compositions from sampling tubes show depleted oxygen levels and steady methane and carbon dioxide levels, indicating Layer 3 is in the anaerobic phase as presented in Appendix C, Table 14.

3.2.6 Landfill Gas Collection System
Gas composition is measured from the wellheads located on top of the northeast anaerobic cell with the GEM-500. Gas flow is measured by differential pressures at the well heads with a DWYER Instruments, Inc., “Magnehelic” pressure gage. A thermal mass flow meter installed in the main header pipeline near the instrumentation shed records flow rate and total for all of the northeast cell. The meter is equipped with two separate calibration curves (for different gas constituent concentrations) and automatically corrects for temperature and pressure and records in standard cubic feet.

Gas collection lines are represented numerically by the layer the line is located, followed by a “G” and the number that denotes the line on a specific layer. For example, the first gas collection line on layer 3 is denoted 3-G1.

Methane concentrations from the wellheads fluctuate based on the applied vacuum, barometric pressure, and the status of waste decomposition. Recent methane concentrations for Layer 1, Layer 2, and Layer 3 gas collection lines range between 43 and 53 percent (Appendix C, Figure 12). Methane concentrations from the header line are currently near 43 percent, carbon dioxide concentrations near 30 percent, balance concentrations near 27 percent, and oxygen concentrations near zero percent (Appendix C, Figure 13). In June 2002, the increase in oxygen and balance concentrations and the decline in methane and carbon dioxide concentrations can be attributed to the increase in vacuum applied to the gas collection system. In order to reduce landfill gas emissions while drilling for waste samples, the vacuum applied to the gas extraction system was increased resulting in air intrusion into the northeast anaerobic cell. Subsequently, a leak in the gas collection header line was discovered, resulting in air intrusion into the gas collection system. Flow rates from each of the gas collection lines are variable and currently below 6 standard cubic feet per minute (scfm) as presented in Appendix C, Figure 14. In January 2002, valves to gas collection lines 1-G3 and 3-G1 were closed due to liquid build-up in the lines. In February 2002, these lines were reopened as shown by their rise in flow rates. Due to liquid build-up, line 1-G3 was closed again in May 2002. Approximately 3.83×10^6 scf of methane (which is equivalent to approximately 550 barrels of oil) has been collected from the northeast anaerobic cell between December 18, 2002 and June 28, 2002 (Appendix C, Figure 15).

Landfill gas from the northeast cell was sampled in May 2002 and sent to an independent laboratory for analytical testing. Analytical results are presented in Appendix E.

1 WEST-SIDE ANAEROBIC CELL

The west-side anaerobic cell is located on the western 6 acres of Phase 1, Module D. Filling in the west-side anaerobic cell is continuing with instrumentation, leachate injection and gas collection equipment being installed as filling proceeds.

1.1 Experimental

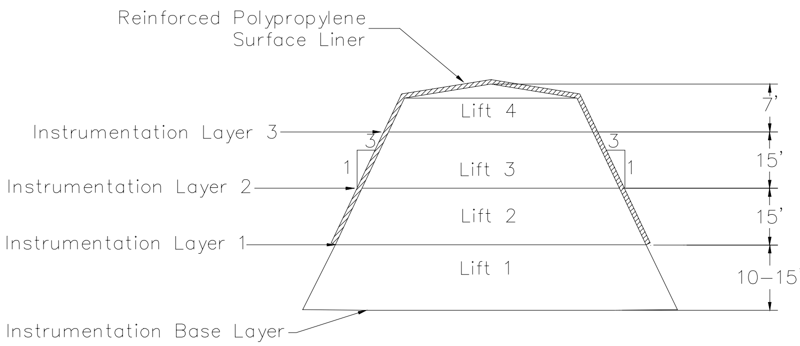
The experimental methods utilized are grouped into three categories: construction, monitoring, and operation. Each of these categories is discussed below.

Construction

Construction of the west-side anaerobic cell can be generally broken down into four major tasks: waste placement, liquid addition, gas collection, and surface liner installation. Each of these four tasks is discussed below.

1.1.1.1 Waste Placement

In the west-side anaerobic cell, waste will be placed in four lifts of approximately 15-foot thickness with 2.5:1 side slopes on interior slopes and 3:1 on exterior slopes (Detail 3, Image 7). Waste placement for lifts 1and 2 is complete. Waste is currently being placed in lift 3 and is approximately two-thirds complete. A summary of sensors installed on the base layer is provided in Appendix A, Table 3.



Detail 3. Cross Section of West-Side Anaerobic

Image 7: Waste placement in the west-side cell

4.1.1.2 Liquid Addition

Liquid addition piping is currently being installed in the west-side anaerobic cell. Leachate injection piping will be installed between lifts 2 and 3 and on top of lift 4.

4.1.1.3 Gas Collection

Gas collection piping is currently being installed in the west-side anaerobic cell. Gas collection piping will be installed between lifts 2 and 3 and on top of lift 4.

4.1.1.4 Surface Liner

A consultant was retained to provide design, plans and specifications for the surface lining systems. The west-side anaerobic cell is scheduled to be covered during the summer of 2002.

4.1.2 Monitoring

Temperature, moisture, leachate quantity and quality, and LFG pressure and composition are monitored through an array of sensors placed within the waste and in the leachate collection and recovery system (LCRS). Each sensor location on the base layer received a temperature sensor (thermistor), a linear low-density polyethylene (LLDPE) tube, and selected locations received a PVC moisture sensor. For protection, each wire and tube was encased in a PVC pipe. Refer to Appendix B, Detail 7 for a diagram of base layer sensor locations.

Sensors installed on the primary liner (prior to any waste placement) were placed on geocomposite and covered with pea gravel prior to the placement of the chipped tire operations layer.

4.1.2.1 Temperature

Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. To prevent corrosion, each thermistor was encased in epoxy and set in a stainless steel sleeve. All field wiring connections were made by first soldering the connection, then covering each solder joint with adhesive-lined heat shrink tubing, and then encasing the joint in electrical epoxy. Changes in temperature are measured by the change in thermistor resistivity (ohms). As temperature increases, thermistor resistance decreases.

4.1.2.2 Moisture

Moisture levels are measured with polyvinyl chloride (PVC) moisture sensors and gypsum blocks. Both the PVC moisture sensors and gypsum blocks are read utilizing the same meter. The PVC sensors are perforated 2-inch-diameter PVC pipes with two stainless steel screws spaced 8 inches apart and attached to wires to form a circuit that includes the gravel filled pipe. The PVC sensors were designed by Yolo County and used successfully during the pilot scale project. The PVC moisture sensor can provide a general, qualitative assessment of the waste's moisture content. A reading of 0 to 40 equates to no free liquid, 40 to 80 equates to some free liquid, and 80 to 100 means completely saturated conditions.

4.1.2.3 Leachate Quantity and Quality

Leachate that is generated from the west-side anaerobic cell drains to the west-side Module D leachate collection sump. A dedicated pump is then used to remove the leachate and pump it to one of the on-site leachate storage ponds. A flow meter measures rate and total volume pumped from the sump.

Leachate is monitored for the following field parameters: pH, electrical conductivity, dissolved oxygen, oxidation-reduction potential, and temperature. When leachate is generated in sufficient quantities, the following parameters will be analyzed by a laboratory: dissolved solids, biochemical oxygen demand, chemical oxygen demand, organic carbon, nutrients (NH_3, TKN, TP), common ions, heavy metals and organic priority pollutants. For the first year, monitoring will be conducted monthly for the first six months and quarterly for the following six months. After the first year, monitoring will be conducted semi-annually (pH, conductivity, and flow rate will continue to be monitored on a monthly basis as required by the State of California's Waste Discharge Requirements in Order 5-00-134).

4.1.2.4 Pressure

Pressure within the northeast anaerobic cell is monitored with ¼-inch inner diameter and $^{3}/_{8}$-inch outer diameter LLDPE sampling tubes. Each tube can be attached to a pressure gage and supplemental air source. By first purging the tube with the air source (to remove any liquid blockages) and then reading the pressure, an accurate gas and/or water pressure can be measured at each sensor location.

4.1.2.5 Landfill Gas Composition

Gas composition is measured utilizing a GEM-500 combustible gas meter manufactured by LANDTEC. The GEM-500 is capable of measuring methane (either as a percent by volume or percent of the lower explosive limit), carbon dioxide, and oxygen. A reading for "balance" gas is also provided, which is assumed to be nitrogen. Currently, gas composition is analyzed from the same sampling tubes used to measure pressure.

4.1.2.6 Waste Sampling

Yolo County conducted the first waste sampling event for the west-side anaerobic cell on June 5, 2002. Waste was sampled to quantify the methane generation potential of the waste. Waste was drilled to an approximate depth of 35 feet with samples taken at approximately 5 feet intervals. Waste will be sampled from the west-side anaerobic cell annually for the next two years to monitor the progress of waste decomposition and compare actual methane generation to laboratory methane generation.

4.1.2.7 Surface Scan

Surface scan monitoring is conducted to test for fugitive methane emissions. Methane is monitored for concentrations above 500 parts per million (ppm) with a model TVA-1000 Flame Ionization Detector (FID)/ Photo Ionization Detector (PID) instrument. Under the FID setting, the TVA-1000 is capable of detecting methane in the parts-per-million (PPM) range. In the event significant methane were was detected, the unit could be switched to PID mode to detect volatile organic compounds (VOC). Methane surface concentrations are monitored along the perimeter of each collection area and along a pattern that transverses the landfill at 15 meter intervals.

The first surface scan on the west-side anaerobic cell was conducted on April 3, 2002. The highest emissions detected were 50 ppm in the northern vicinity and southwestern vicinity of the cell. No methane emissions were detected in background measurements taken upwind and downwind of the cell. However, methane detection in these areas may be attributed to their proximity to the landfill gas-to-energy facility near the southwestern portion of the cell or to vehicle traffic along the access road on the northern portion of the cell.

The second surface scan was conducted on June 6, 2002. The highest emissions detected were 37 ppm along the access road to leading to the active waste placement area. No methane emissions were detected in background measurements taken upwind and downwind of the cell.

4.1.3 Operation

Operation of the west-side anaerobic cell will begin once waste placement, sensor installation, landfill gas (LFG) collection system, leachate recirculation systems, and SCADA control systems are complete.

4.1.3.1 Leachate Recirculation

Initially, large volumes of liquid will be added to bring the waste to field capacity. Once field capacity has been reached, only enough liquid to maintain field capacity will be added.

4.1.3.2 Landfill Gas Collection

Landfill gas collection will begin as soon as waste placement is completed and the necessary piping installed.

4.2 Results And Discussion

Sensor names are represented numerically by the instrumentation layer in which the sensor is located and by the assigned sensor number for that layer. The base layer is represented by a 0, Layer 1 is represented by a 1, and so forth. The complete name of the sensor is denoted by the layer number – the sensor number. For example, the second sensor on Layer 1 is named 1-02.

4.2.1 Temperature

Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system located in the instrumentation shed starting in March 2002. Resistance was previously measured manually by connecting the sensor wires to a 26 III Multimeter manufactured by Fluke Corporation.

Base Layer - Southwest base layer temperatures are converging and range between approximately 23°C and 32°C (73°F and 90°F) as presented in Appendix C, Figure 16. Northwest base layer temperatures are generally converging and range between approximately 23°C and 31°C (73°F and 88°F) as presented in Appendix C, Figure 17. Lower temperatures for sensors 0-16 and 0-17 may be due to the sensor's proximity to the perimeter of the cell and to less biodegradable material in the vicinity of the sensor.

4.2.2 Moisture

The SCADA system started electronically measuring moisture in March 2002. Due to a slight variation between how the SCADA system measures moisture compared to the manual meter, moisture readings generally increased a small fraction relative to their previous manually recorded readings. Because moisture data are unitless numbers that give a qualitative assessment rather than a quantitative measure, we feel that this slight change is not significant. Moisture was previously measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. During the pilot scale project, Yolo County conducted laboratory tests with the PVC sensors to determine the relationship between the multimeter readings and the presence of free liquid in the PVC sensor. It was determined that a meter reading of less than 40 corresponded to an absence of free liquid. A reading between 40 and 80 corresponds to the presence of free liquid in the PVC pipe but less than saturated conditions. Readings of greater than 80 indicate saturated conditions; i.e. the PVC sensor is full of liquid.

Base Layer - PVC moisture levels for the base layer are presented in Appendix C, Figure 18. Moisture levels range from approximately 0 to 8 indicating no free liquid.

4.2.3 Leachate Quantity And Quality

Prior to October 2001, leachate data reflects rainfall rather than actual leachate generation because the cells were only partially filled, and portions of the leachate collection and removal system were exposed to rainfall. Between October 2001 and June 2002, approximately 131,200 gallons of leachate was generated from the west-side cell (Appendix C, Figure 11).

Leachate was sampled in May 2002 and June 2002 for analytical testing. Analytical results are presented in Appendix D. Field chemistry results are presented below in Table 3-1. Analytical results for June 2002 are not reported and will be presented on the next quarterly report. Leachate chemistry and analytical results prior to February 2002 are not reported because samples taken during the wet season were rainfall rather than leachate and low leachate levels following the rainy season did not allow collection of fresh leachate samples.

Table 4-1. Field Chemistry and Selected Laboratory Chemistry for Leachate Sampled from the West-Side Anaerobic Cell

PARAMETER	**DATE:**	**2/14/2002**	**3/27/2002**	**5/14/2002**
Field Parameters:	**Units**			
PH		6.74	6.76	6.8
Electrical Conductivity	µmoh/cm	3530	3868	3851
Oxidation Reduction Potential	mV	-62	-59	-46
Temperature	C	24.9	25.9	26.2
Dissolved Oxygen	mg/L	3.15	1.09	1.54
Total Dissolved Solids	ppm	2617	2886	2871
General Chemistry:				
Ammonia as N	mg/L	20.3	20	23.5
Bicarbonate	mg/L	1700	1790	1780
BOD	mg O/L	28	18	12
Chemical Oxygen Demand	mg O/L	350	317	300
Chloride	mg/L	187	323	333
Nitrate/Nitrite as N	mg/L	0.016(tr)	<0.015	<1.5
Total (Non-Volatile) Organic Carbon	mg/L	112	95.7	85.2
Total Alkalinity as CO3	mg/L	1700	1790	1780
Total Dissolved Solids @ 180 C	mg/L	2220	2380	2320
Total Kjeldahl Nitrogen	mg/L	32.6	68.9	31.1
Total Sulfide	mg/L	0.033(tr)	0.015(tr)	<0.014
Dissolved Iron	mg/L	0.4	1.2	0.035(tr)*
Dissolved Magnesium	mg/L	198	211	343
Dissolved Potassium	mg/L	55.2	48.3	58.6

4.2.4 Pressure

Pressure measurements are taken from sampling tubes with a DWYER Instruments, Inc., "Magnehelic" pressure gage. Pressure measurements can be either positive or negative, although a vacuum has not yet been applied to the gas extraction lines, so negative pressures are not expected at this time. Positive pressures can result from both the generation of landfill gas and saturated liquid conditions.

Base Layer - Pressure readings from the west-side anaerobic cell are currently positive and remain below 1.1 centimeters of water (0.42 inches of water).

4.2.5 Landfill Gas Composition

Gas composition is measured from sampling tubes on each layer of the cells with the GEM-500. Because liquid will damage the GEM, pressurized air is first forced through the tubes and liquid is pushed out, then the tube lines are purged with a vacuum pump and hooked up to the GEM to analyze the gas composition.

Base Layer

Data from sampling tubes presented in Appendix C, Table 15 indicates increasing methane levels and depleted oxygen levels. Oxygen measured in the base layer is most likely the result of air intrusion into the permeable shredded tire operations layer (which was not completely covered by waste) that covers the entire bottom of Module 6D.

Landfill gas composition was sampled from the leachate collection and removal system (LCRS) on the west-side anaerobic cell in May 2002 and sent to an independent laboratory for analytical testing. Analytical results are presented in Appendix E.

5 AEROBIC CELL

The aerobic cell occupies approximately 2.5 acres in the southeast quadrant of Phase 1, Module 6D.

5.1 Experimental

The experimental methods utilized are grouped into three categories: construction, monitoring, and operation. Each of these categories is discussed below.

5.1.1 Construction

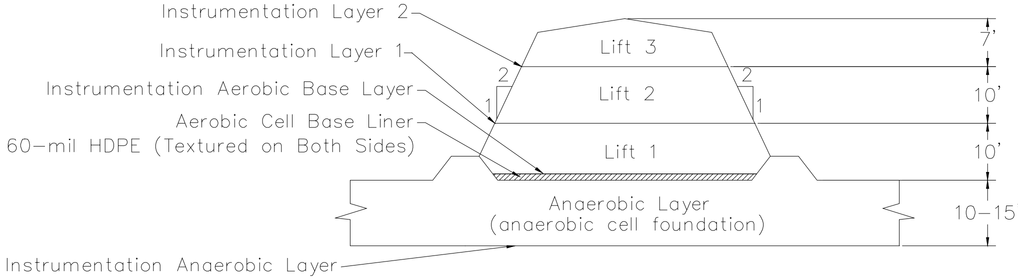
Construction of the aerobic cell can be generally broken down into five major tasks: waste placement, liquid addition, gas collection, air injection and surface liner installation. Each of the five tasks is discussed below. Refer to Appendix A, Table 5 for a summary of current monitoring data for the northeast anaerobic cell.

5.1.1.1 Waste Placement

Waste placement first began November 14, 2000 with an approximate 10-foot lift of waste placed on the Module 6D liner. This first lift of waste will act as a buffer between the Module 6D primary liner and the future aerobic cell. The waste was graded to promote drainage and a 60-mil HDPE geomembrane (Image 8) was installed to capture all leachate being generated by the aerobic cell. A sixteen-ounce geotextile was then placed on the membrane to act as a cushion for a shredded tire operations layer.

Image 8: Aerobic liner ready for shredded tire operations layer and waste placement.

Waste placement in the aerobic cell occurred between August 8, 2001 and September 26, 2001. Waste was placed in three 10-foot lifts with 2:1 side slopes on the north, east and west (internal side slopes), and a 3:1 side slope on the south (external side slope) as presented in Detail 4. Because of the limited tipping area of the aerobic cell, self-haul waste was excluded. The use of daily cover soil during waste filling was also minimized to aid in the overall permeability of the waste. Whenever possible, greenwaste or tarps were used as alternative daily cover (ADC) and, in the event soil was placed (for example, access roads or tipping pad), the soil was removed prior to placing the next lift of waste. To further aid permeability of the waste, compaction was restricted to only 1to 2 passes with a Caterpillar 826 compactor. Based on waste tonnage records and as-built topography, the in-place refuse density is approximately 800 pounds per cubic yard. Instrumentation Layers 1 and 2 were placed between lifts, and base layer instrumentation was installed on the aerobic cell base liner. A summary of sensors installed on each layer is provided in Appendix A, Table 6.



Detail 4. Aerobic Cell Cross Section Cell

5.1.1.2 Liquid Addition

Horizontal liquid injection lines were installed in each lift of waste. Injection lines within the waste (between lifts 1 and 2, 2 and 3) were placed horizontally (north to south) at approximately 20-foot spacing. Injection lines on top of lift 3 were placed east to west every 20 feet. Various combinations of 1¼-inch-diameter chlorinated polyvinyl chloride (CPVC) and 1¼-inch-diameter HDPE pipe were installed and perforated with $^{3}/_{32}$–inch-diameter holes spaced every 10 feet (Image 9). Because of the elevated temperatures expected in the aerobic cell, CPVC was

Image 9: Leachate injection laterals in trench

installed a selected locations as a redundancy in the event the HDPE piping fails (CPVC is rated for service at temperatures up to 200°F, however is approximately 4 times as expensive). A total of 4,780 feet of injection piping was installed with a total of 326 injection holes.

Each of the injection laterals will be connected to a 4-inch-diameter HDPE injection header. Flow rate and pressure will be monitored at each injection lateral. Leachate injection for each lateral will be monitored and controlled by individual solenoid valves connected to the SCADA system. A second redundant flow meter will monitor the total volume and flow rate being injected in the aerobic cell.

5.1.1.3 Air Collection

Horizontal air collection lines were installed between each lift of waste. Air collection lines consist of various combinations of alternating 4 and 6–inch-diameter CPVC pipe and 6 and 8–inch-diameter corrugated metal pipe. Each air collection line utilizes shredded tires as the permeable media. The air collection lines between layers are spaced approximately 40 feet apart. A total of 1660 feet of horizontal air collection lines were installed. A summary of the air collection lines for the aerobic cell is shown in Appendix A, Table 7.

Image 10: Horizontal air collection line

Each air collection line will be connected to a 12-inch-diameter air collection header that will convey the gas to and on-site blower and biofilter. Each air collection line will incorporate a pre-manufactured wellhead capable of controlling flow and monitoring flow rate, temperature and pressure.

5.1.1.4 Surface Liner

Vector was retained to provide design, plans and specifications for a surface lining system, including a biofilter for the treatment of the aerobic off-gas.

Since the operation of an aerobic bioreactor at the Yolo County Central Landfill was first considered, two methods of air management for oxygen delivery have been discussed. One method is to push air into the landfill and the other is to apply a vacuum and draw air through the landfill. Both methods have advantages and disadvantages. However, Yolo County has decided that the best alternative is to leave the aerobic cell covered with soil and greenwaste (shredded yard waste), but without an impermeable geomembrane, so that air could be drawn through the waste by applying a vacuum. In this way, air will enter through the cell surface and migrate to horizontal pipelines to which a vacuum is applied. Alternate operations plans could include using some of the installed pipelines as vents and others for vacuum.

Yolo County had intended to cover the aerobic cell with an exposed geomembrane with a biofilter at the top of the cell to provide some treatment of the off-gas. However, the weight of the geomembrane that would have been placed on the aerobic cell along with the weight of a sandbag surface ballast system would result in a pressure equivalent to only 0.17 inches of water. Calculations indicate that the required pressure present in the cell to force the air through the waste, to the top of the cell, and through the biofilter would result in a great deal of ballooning of the surface liner. Additionally, the expected high settlement rate would create a great deal of maintenance difficulties for the geomembrane surface liner.

Yolo County developed a design for a geomembrane surface liner for the aerobic cell and advertised for bids on the construction. The bids received were very expensive and not within the budget of the project. As a result of both the technical and economic difficulties encountered, it was decided that leaving the aerobic cell without a geomembrane liner is the preferred approach.

5.1.2 Monitoring

Temperature, moisture, leachate quantity and quality, and air pressure and composition are monitored through an array of sensors placed within the waste (Image 11) and in the leachate collection and recovery system (LCRS). Each sensor location on the base layer

Image 11: Moisture, temperature, and tube installation

received a temperature sensor (thermistor), a linear low-density polyethylene (LLDPE) tube, and selected locations received a PVC moisture sensor. Each sensor location within the waste received a temperature sensor (thermistor), a moisture sensor (a PVC moisture sensor and in some cases a gypsum block) and a linear low-density polyethylene (LLDPE) tube. For protection, each wire and tube was encased in a 1.25-inch-diameter HDPE pipe. Refer to Appendix B, Details 12 through 15 for sensor location diagrams.

Sensors on instrumentation Layers 0.5, 1, and 2 were placed on a bedding of greenwaste (shredded yard waste), or bin fines (fine pieces of greenwaste). Sensors installed on the primary liner (prior to any waste placement) were placed on the geotextile and covered with pea gravel prior to the placement of the shredded tire operations layer.

5.1.2.1 Temperature

Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. To prevent corrosion, each thermistor was encased in epoxy and set in a stainless steel sleeve. All field wiring connections were made by first soldering the connection, then covering each solder joint with adhesive-lined heat shrink tubing, and then encasing the joint in electrical epoxy. Changes in temperature are measured by the change in thermistor resistivity (ohms). As temperature increases, thermistor resistance decreases.

5.1.2.2 Moisture

Moisture levels are measured with polyvinyl chloride (PVC) moisture sensors and gypsum blocks. Both the PVC moisture sensors and gypsum blocks are read utilizing the same meter. The PVC sensors are perforated 2-inch-diameter PVC pipes with two stainless steel screws spaced 8 inches apart and attached to wires to form a circuit that includes the gravel filled pipe. The PVC sensors were designed by Yolo County and used successfully during the pilot scale project. The PVC moisture sensor can provide a general, qualitative assessment of the waste's moisture content. A reading of 0 to 40 equates to no free liquid, 40 to 80 equates to some free liquid, and 80 to 100 means completely saturated conditions.

The gypsum blocks are manufactured by Electronics Unlimited and are typically used for soil moisture determinations in agricultural applications. Gypsum blocks establish equilibrium with the media in which they are placed and are, therefore, reliable at tracking increases in the soil's moisture content. However, the gypsum block can take considerable time to dry and therefore may not reflect the drying of the surrounding environment.

5.1.2.3 Leachate Quantity and Quality

Leachate that is generated from the aerobic cell will drain to a separate leachate sump installed on top of the eastside Module D leachate collection sump (Image 12). A dedicated pump is then used to remove the leachate and pump it to one of the on-site leachate storage ponds. A flow meter will measure rate and total volume pumped from the sump.

Image 12: Aerobic sump installed and ready for backfill

Leachate is monitored for the following field parameters: pH, electrical conductivity, dissolved oxygen, oxidation-reduction potential, and temperature. When leachate is generated in sufficient quantities, the following parameters will be analyzed by a laboratory: dissolved solids, biochemical oxygen demand, chemical oxygen demand, organic carbon, nutrients (NH_3, TKN, TP), common ions, heavy metals and organic priority pollutants. For the first year, monitoring will be conducted monthly for the first six months and quarterly for the following six months. After the first year, monitoring will be conducted semi-annually (pH, conductivity, and flow rate will continue to be monitored on a monthly basis as required by the State of California's amended Waste Discharge Requirements in Order 5-00-134).

5.1.2.4 Pressure

Pressure within the aerobic cell is monitored with ¼-inch inner diameter and $^{3}/_{8}$-inch outer diameter LLDPE sampling tubes. Each tube can be attached to a pressure gage and supplemental air source. By first purging the tube with the air source (to remove any liquid blockages), and then reading the pressure, an accurate gas and/or water pressure can be measured at each sensor location.

5.1.2.5 Landfill Gas Composition

Gas composition is measured utilizing a GEM-500 combustible gas meter manufactured by LANDTEC. The GEM-500 is capable of measuring methane (either as a percent by volume or percent of the lower explosive limit), carbon dioxide, and oxygen. A reading for "balance" gas is also provided (to make up 100 percent) and is assumed to be nitrogen. Currently, gas composition is analyzed from the same sampling tubes used to measure pressure.

5.1.2.6 Waste Sampling

Yolo County conducted the first waste sampling event for the aerobic cell on June 5, 2002. Waste was sampled to quantify the methane generation potential of the waste. Waste was drilled to an approximate depth of 30 feet with samples taken at 5-foot intervals. Waste will be sampled from the aerobic cell annually for the next two years to monitor the progress of waste decomposition and compare actual methane generation to laboratory methane generation.

5.1.2.7 Surface Scan

Surface scan monitoring is conducted to test for fugitive methane emissions. Methane is monitored for concentrations above 500 parts per million (ppm) with a model TVA-1000 Flame Ionization Detector (FID)/ Photo Ionization Detector (PID) instrument. Under the FID setting, the TVA-1000 is capable of detecting methane in the parts-per-million (PPM) range. In the event significant methane was detected, the unit could be switched to PID mode to detect volatile organic compounds (VOC). Methane surface concentrations are monitored along the perimeter of each collection area and along a pattern that transverses the landfill at 15 meter intervals.

The first surface scan on the aerobic cell was conducted on April 3, 2002. No fugitive methane emissions were detected.

The second surface scan was conducted on June 6, 2002. The highest methane emissions detected were 8 ppm cell along the western perimeter of the cell, which was downwind from the active waste placement area on the west-side cell. These methane emissions are consistent with background measurements taken upwind at 9.54 ppm. No fugitive methane emissions were detected in background measurements taken downwind.

5.1.3 Operation

Operation of the aerobic cell as a bioreactor will begin once the air collection system, leachate recirculation systems, and SCADA control systems are complete. At this time, we anticipate bioreactor operation to begin in early 2002.

5.1.3.1 Leachate Recirculation

Initially, large volumes of liquid will be added to bring the waste to field capacity (Image 13). Once field capacity has been reached, only enough liquid to maintain field capacity will be added. We anticipate that greater volumes of liquid (compared to the anaerobic cells) will be necessary to maintain field capacity due to the removal of liquid by the air collection system.

Image 13: Aerobic leachate injection header and lateral

5.1.3.2 Air Collection

Air collection will begin as soon as the necessary piping, blower, and biofilter is installed, which is anticipated to be in early 2002.

5.2 Results And Discussion

Sensor names are represented numerically by the instrumentation layer in which the sensor is located and by the assigned sensor number. The base layer is represented by a 0, Layer 1 is represented by a 1, and so forth. The complete name of the sensor is denoted by the layer number – the sensor number . For example, the second sensor on Layer 1 is named 1-02.

5.2.1 Temperature

Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system located in the instrumentation shed starting in March 2002. Resistance was previously measured manually by connecting the sensor wires to a 26 III Multimeter manufactured by Fluke Corporation.

Anaerobic Base Liner - The Module 6D base liner temperatures range between 23^{o}C and 32^{o}C (73^{o}F and 90^{o}F) as presented in Appendix C, Figure 19. Lower temperatures for may be due to the sensor's proximity to the perimeter of the cell and to less biodegradable material in the vicinity of the sensor.

Aerobic Base Layer - Aerobic base layer temperatures range between 34^{o}C and 60^{o}C (93^{o}F and 140^{o}F) as presented in Appendix C, Figure 20. Lower temperatures generally correspond to areas with less overlying waste and higher temperatures correspond to areas with greater overlying waste. Because sensors 0-14 and 0-15 are in close proximity to the surface of the cell, their temperature trend appears to correspond to the rise in ambient air temperature.

Layer 0.5 - Temperatures from Layer 0.5 remain relatively steady and currently range from 53^{o}C and 60^{o}C (127^{o}F to 140^{o}F) as presented in Appendix C, Figure 21.

Layer 1 – Temperatures from Layer 1 currently range between 38^{o}C and 69^{o}C (100^{o}F to 156^{o}F) as presented in Appendix C, Figure 22. The drop in temperatures during June 2002 are due to leachate injection line testing.

Layer 2 – Temperatures from Layer 2 generally range between 48^{o}C and 60^{o}C (118^{o}F to 140^{o}F) as presented in Appendix C, Figure 23. The drop in temperatures during June 2002 are due to leachate injection line testing.

5.2.2 Moisture

The SCADA system started electronically measuring moisture in March 2002. Due to a slight variation between how the SCADA system measures moisture compared to the manual meter, moisture readings generally increased a small fraction relative to their previous manually recorded readings. Because moisture data are unitless numbers that give a qualitative assessment rather than a quantitative measure, we feel that this slight change is not significant. Moisture was previously measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. During the pilot scale project, Yolo County conducted laboratory tests with the PVC sensors to determine the relationship between the multimeter readings and the presence of free liquid in the PVC sensor. It was determined that a meter reading of less than 40 corresponded to an absence of free liquid. A reading between 40 and 80 corresponds to the presence of free liquid in the PVC pipe but less than saturated conditions. Readings of greater than 80 indicate saturated conditions; i.e. the PVC sensor is full of liquid.

Anaerobic Base Liner - PVC moisture levels for the base liner are presented in Appendix C, Figure 24. Moisture levels measured by sensor 0-62 have increased to the completely saturated zone. The high moisture levels are not supported by pressure readings from sampling tubes.

Aerobic Base Layer - Aerobic base layer PVC moisture levels are generally below 40 in the no free liquid zone as presented in Appendix C, Figure 25. The increase in moisture levels during February 2002 generally corresponds to the onset of the wet weather/rainy season. Some discrepancies between sensors exist; sensor 0-14 shows moisture levels declining to the no free liquid zone while sensor 0-07 shows moisture levels remaining high in the completely saturated zone. Because virtually no liquid is being generated from the aerobic cell, the elevated reading measured by sensor 0-07 may not be representative of actual conditions or could be localized wetting of waste.

Layer 0.5 - Layer 0.5 PVC moisture levels currently range between 73 and 79 in the some-free-liquid zone as presented in Appendix C, Figure 26.

Layer 1 - Layer 1 PVC moisture levels currently range between 9 and 86 as presented in Appendix C, Figure 27. The rise in moisture levels correspond to the start of leachate injection line testing on June 21, 2002.

Layer 2 - Layer 2 PVC moisture levels generally range between 0 to 50 as presented in Appendix C, Figure 28. Sensor 2-02 shows an increase in moisture to the some free liquid zone that corresponds to the onset of the wet weather/rainy season. In June 2002, sensors 2-03 and 2-06 rise in moisture from the no free liquid zone to the some free liquid zone due to leachate injection line testing.

5.2.3 Leachate Quantity And Quality

Analytical results for February 2002 and March 2002 are presented in Appendix D, Table 22. Analytical results are not available after March 2002 because leachate was not generated in sufficient quantities to allow for monitoring or testing. Field chemistry results are presented below in Table 5-1. Leachate chemistry and analytical results prior to February 2002 are not reported because samples taken during the wet season were rainfall rather than leachate and low leachate levels following the rainy season did not allow collection of fresh leachate samples.

Table 5-1. Field Chemistry for Leachate Sampled from the Aerobic Cell

PARAMETER	DATE:	2/26/2002	3/27/2002	5/14/2002
Field Parameters:	**Units**			
PH		7.75	8.17	8.48
Electrical Conductivity	µmoh/cm	7026	7705	9048
Oxidation Reduction Potential	mV	195	195	127
Temperature	C	15.1	15.2	21.1
Dissolved Oxygen	mg/L	5.45	5.73	6.8
Total Dissolved Solids	ppm	5673	NA	7448
General Chemistry:				
Ammonia as N	mg/L	2.8	1.1	0.60(tr)
Bicarbonate	mg/L	1120	935	1020
BOD	mg O/L	3.3	5	89
Chemical Oxygen Demand	mg O/L	595	563	602
Chloride	mg/L	1610	1800	2290
Nitrate/Nitrite as N	mg/L	0.16	0.22	4.8(tr)
Total (Non-Volatile) Organic Carbon	mg/L	766	149	168
Total Alkalinity as CO3	mg/L	1120	935	1050
Total Dissolved Solids @ 180 C	mg/L	4810	5200	5640
Total Kjeldahl Nitrogen	mg/L	19.9	19.2	11.1
Total Sulfide	mg/L	<0.014	0.015(tr)	<0.014
Dissolved Iron	mg/L	0.32	0.084(tr)	0.34
Dissolved Magnesium	mg/L	273	260	220
Dissolved Potassium	mg/L	NA	66.1	47.8

NA=Not Analyzed

5.2.4 Pressure

Pressure measurements are taken from sampling tubes with a DWYER Instruments, Inc., “Magnehelic” pressure gage. Pressure measurements can be either positive or negative, although a vacuum has not yet been applied to the air extraction lines, so negative pressures are not expected at this time. Positive pressures can result from both the generation of landfill gas and saturated liquid conditions.

Anaerobic Base Liner - Pressure readings from the anaerobic base liner sampling tubes are currently positive and below 0.51 centimeters of water (0.2 inches of water).

Aerobic Base Layer - Pressure readings from the aerobic base layer remain positive and currently below 0.25 centimeters of water (0.10 inches of water).

Layer 1 - Pressure readings from Layer 1 remain positive and currently below 3.6 centimeters of water (1.4 inches of water).

Layer 2 - Pressure readings from Layer 2 remain positive and generally below 2.3 centimeters of water (0.9 inches of water). Sensor 2-14 shows a drop in pressure from 4.8 to 0.06 inches of water which suggests the tube may have been be previously clogged or an error occurred during the previous measurement.

5.2.5 Landfill Gas Composition

Gas composition is measured from sampling tubes on each layer of the cells with the GEM-500. Because liquid will damage the GEM, pressurized air is first forced through the tubes to remove any liquid, then the tube lines are purged with a vacuum pump and hooked up to the GEM to analyze the gas composition.

Anaerobic Base Liner - Gas compositions from sampling tubes measured in June 2002 generally show lower methane levels than previously recorded as presented in Appendix C, Table 16. Lower methane levels are most likely due to gas extraction lines from the northeast lifts depleting landfill gas from the base layer and pulling in air from the shredded tire operations layer that covers the entire bottom of Module 6D.

Aerobic Base Layer - Gas compositions from sampling tubes indicate the aerobic base layer is still in the aerobic phase as presented in Appendix C, Table 17. The presence of oxygen is most likely due to air intrusion through the permeable surface cover.

Layer 1 - Gas compositions from sampling tubes indicate the aerobic base layer is still in the aerobic phase as presented in Appendix C, Table 18. The presence of oxygen is most likely due to air intrusion through the permeable surface cover.

Layer 2 - Gas compositions from sampling tubes indicate the aerobic base layer is still in the aerobic phase as presented in Appendix C, Table 19. The presence of oxygen is most likely due to air intrusion through the permeable surface cover.

6 MODULE 6D BASE LINER

The three bioreactor cells share a common composite liner system, designated the Module 6D primary liner. This composite liner system was constructed in 1999 and was designed to exceed the requirements of Title 27 of CCR and Subtitle D of the Federal guidelines.

6.1 Experimental

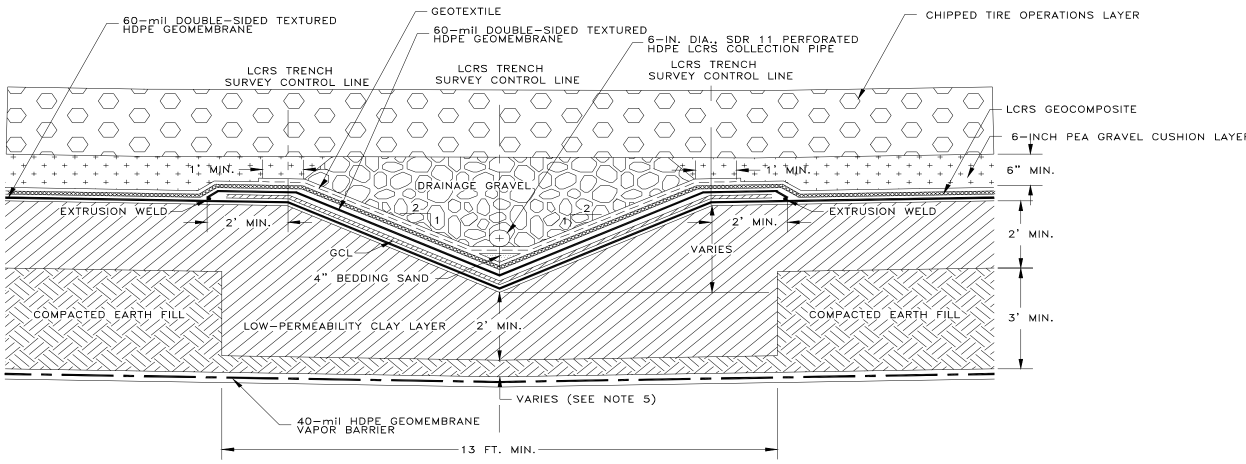
The experimental methods utilized are grouped into two categories: construction and monitoring. Each of these categories is discussed below.

6.1.1 Construction

Construction of the Module 6D primary liner system can generally be separated into two tasks: grading and base liner assembly.

6.1.1.1 Grading

The base layer of Module D was constructed in a ridge and swale configuration, enabling the west-side 6-acre anaerobic cell to be hydraulically separated from the northeast anaerobic cell and the aerobic cell in the southeast quadrant. The base layer slopes 2 percent inward to two central collection v-notch trenches located on the southeast and southwest side of Module D (Detail 5). Each of the trenches drain at 1 percent to their respective leachate collection sumps located at the south side of the module.



Detail 5. Module D Bottom Liner and Leachate Collection Trench Cross-Section

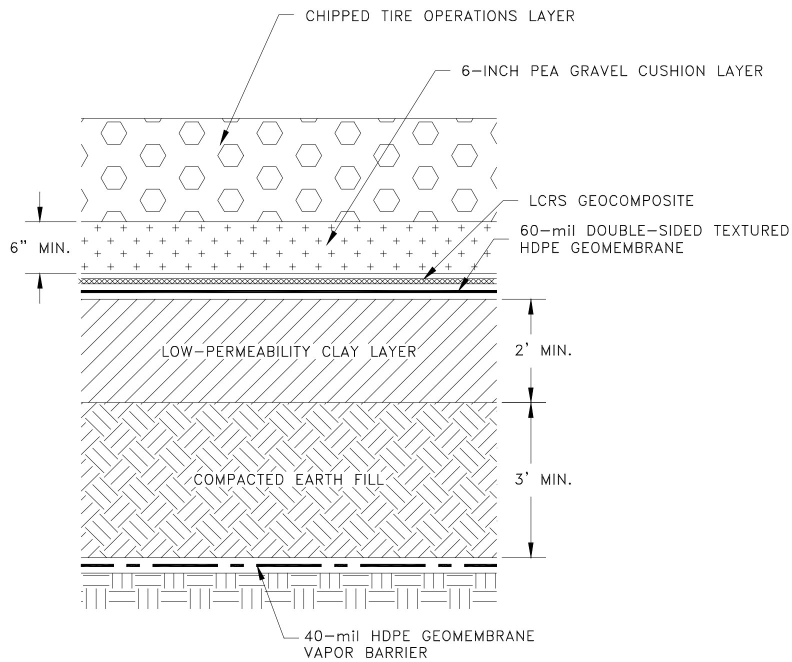
6.1.1.2 Base Liner Assembly

The liner is composed, from top to bottom, of the following materials: an operations/drainage layer consisting of 2 feet of chipped tires (permeability [k] > 1 centimeter per second [cm/s]) (Image 14), 6-inches of pea gravel, geocomposite drain net, a 60-mil high density polyethylene

Image 14: Shredded tire operations layer

(HDPE) geomembrane, a 2–foot-thick compacted clay liner ($k < 6 \times 10^{-9}$ cm/s), 3 feet of compacted earth fill ($k < 1 \times 10^{-8}$ cm/s), a 40-mil HDPE vapor barrier layer, and a clay subgrade with 90-percent (ASTM D1557) relative compaction[3] (Detail 6).

[3] Golder Associates, "Final Report, Construction Quality Assurance, Yolo County Central Landfill, WMU 6, Module D, Phase 1 Expansion", December 1999.



Detail 6. Module D Bottom Liner Cross-Section

6.1.2 Monitoring

As part of the requirements specified under Waste Discharge Requirements in Order 5-00-134, Yolo County is required to monitor liquid buildup on the liner. Under typical landfilling, liquid buildup on a Class III composite liner system must be maintained to less than 1 foot. In order to gain approval from the California Regional Water Quality Control Board to operate Module 6D as a bioreactor, Yolo County must maintain less than 4-inches of liquid buildup on the Module 6D primary liner[4]. Head over the liner is monitored through a series of pressure transducers and sampling tubes either in or next to the two leachate collection trenches. In addition, sampling tubes located on the Module 6D liner (designations 0-1 through 0-66) are utilized to monitor head over the liner. The sampling tubes are discussed in previous sections.

6.1.2.1 Leachate Collection Trenches

Three LLDPE sampling tubes were installed in each of the leachate collection trenches (Image 15). The tubes were installed inside a 2-inch-diameter PVC pipe for protection, and terminate at different points along the trenches. The sampling tubes can be hooked up to the same "Magnahelic" pressure gage, which reads directly in inches-of-water.

Pressure transducers were installed at three locations adjacent to each leachate collection trench. Additionally, tubes were installed that terminate adjacent to each of the pressure transducer locations (Appendix B. Detail 7). The pressure transducers provide an output current between 4 and 20 milliamps, which is directly proportional to pressure. The pressure transducers installed on the Module 6D liner are Model PTX 1830 manufactured by Druck, Inc. Their pressure range is 0 to 1 pounds per square inch (psi) and has+0 an accuracy of ±1 percent of full scale.

[4] California Regional Water Quality Control Board, Central Valley Region, "Waste Discharge Requirements for the Yolo County Central Landfill, No. 5-00-134", June 16, 2000.

Image 15: Pressure tubes installed in LCRS trench

6.2 Results And Discussion

Tubes located in the leachate collection trenches are referred to as trench liquid level (TLL) tubes. Pressure transducers and their accompanying tubes that are located adjacent to the leachate collection trenches are denoted as PT or PT-TUBE respectively.

6.2.1 Leachate Collection Trenches

Pressure transducers generally range between 0 and 2.5 centimeters of water (0 and 1.0 inches of water), and adjacent tubes range between 0 and 0.2 centimeters of water (0 and 0.08 inches of water) as presented in Appendix C, Figure 29. The difference between the pressure transducers and the adjacent tubes are within the range of measurement error and therefore tend to confirm each other.

Trench liquid levels range between 0 and 3.3 centimeters of water (0 and 1.3 inches of water). Because leachate generation and pumping data suggest very little leachate was present on the base liner it may be possible that some of the elevated readings may be due to partial collapse or failure of the tubes (Appendix C, Figure 30). Monitoring and evaluation of the trench liquid level tubes will continue.

7 SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA)

The Supervisory Control and Data Acquisition (SCADA) system will be used to monitor the various sensors and control the operation of the bioreactor. The field electronics will be linked by radio signal to a computer located in our Woodland office.

7.1 Hardware Installation

The data collection hardware has been installed in a shed located at the southern limit of Module 6D. All instrumentation installed in the northeast anaerobic, aerobic, and on the Module 6D composite liner have been connected to an Allen-Bradley central processor which will be radio linked to a computer located in our woodland office.

7.2 Software Programming

The SCADA programming using Wonderware software is currently being developed by a consultant, A-TEEM Electrical Engineering. The first phase of software development is complete and encompass data collection from the instrumentation installed on the Module 6D liner, northeast anaerobic, and southeast aerobic modules. Once the remaining instrumentation has been installed in the west-side anaerobic cell, it will be incorporated into the system.

8 CONCLUSION

With the initial construction phase of the project complete for the northeast anaerobic cell and nearly complete for the southeast aerobic cell Yolo County has gained valuable knowledge about the design and operation of bioreactor landfills. The following sections provide a summary of the knowledge we have learned to-date and recommendations for future bioreactor operation and areas that require additional research.

8.1 Installation of Bioreactor Systems

The use of alternative daily cover in the form of greenwaste or tarps was successfully during the waste filling phase of this project. By limiting the amount of soil placed in the landfill we hope to increase waste permeability which will allow for more uniform liquid distribution throughout the waste.

With close coordination with the waste placement contractor, the monitoring, landfill gas collection, and liquid injection systems were successfully installed concurrent with waste placement. In addition, the methods utilized to protect the various instruments and piping from construction equipment and subsequent waste placement (chipped or shredded greenwaste was utilized as bedding and shredded tires were used as cover) were successful.

8.2 Bioreator Stability

As part of the design and planed operation of a full-scale bioreactor landfill, we evaluated the effects of having a saturated waste mass on the overall stability of the landfill module. The County retained the services of Vector Engineering to perform laboratory tests on the materials used in constructing Module 6D (synthetic liner material, shredded tires, clay) and perform a stability analysis evaluating various fill configurations and different waste densities. The result of their analysis indicated that waste filling and bioreactor operation was possible with up to 2 to 1 (horizontal to vertical) side-slopes. A word of caution though, this analysis was specifically performed for the YCCL site and the specific material utilized in construction of Module 6D, Phase 1.

Based on the stability analysis performed for the YCCL, it is likely that other landfills could construct and operate a bioreactor module with an acceptable factor of safety. We would recommend any landfill operator perform a site specific stability analysis prior to considering bioreactor operation.

8.3 Landfill Gas Recovery

It is well established that by increasing the moisture content of waste undergoing anaerobic decomposition, increases in landfill gas generation will follow. As we have only just begun liquid addition, all of the landfill gas that has been generated to-date has occurred with the moisture content of the waste the same as the day it was placed. Through the end of June 2002 a total of 3.83×10^6 scf of methane has been collected. With the average age of the waste only about one year old, it is clear that significant amounts of landfill gas can be generated in a relatively short amount of time.

Early recovery of the landfill gas being generated by the northeast cell is only possible because the landfill gas collection system (horizontal gas collection lines) were installed during waste placement and subsequently connected to the site gas collection system shortly after completion of waste placement. In addition, the placement of the synthetic surface liner has ensured near complete capture of the landfill gas that is being generated.

It seems clear that the typical 3-5 years that elapses between waste placement and installation of landfill gas collection system components is resulting in an under utilization of a potential energy source and potentially allowing significant quantities of landfill gas to be emitted as fugitive emissions from the landfill surface.

8.4 Exposed Surface Membrane Cover

The installation of an exposed surface membrane cover as part of the bioreactor project ensures that accurate and complete data collection is possible regarding liquid addition volumes (by eliminating rainwater infiltration) and landfill gas collection. However, the installation of this surface liner accounted for a major portion of the costs of constructing the northeast anaerobic bioreactor. As part of the regulatory flexibility granted for this project, the County agreed to install a synthetic cover prior to bioreactor operation.

Because the early installation of a membrane cover represents a significant capitol outlay, an area for future research should involve the trial operation of a bioreactor module that is absent a synthetic cover. The purpose of this research would be to determine if surface emissions could be controlled without the installation of a synthetic cover. A possible alternative that would require demonstration would be the inclusion of a relatively thick layer of greenwaste or compost over the entire module that could act as a natural biofilter with sufficient moisture control and biological activity to destroy and VOC emissions.

9 REFERENCES

1. Vector Engineering, "Design Report for the Surface Liners of the Module D Phase 1 Bioreactors at the Yolo County Central Landfill", October 2001.

2. Yazdani, R., Moore, R. Dahl. K. and D. Augenstein 1998 Yolo County Controlled Landfill Bioreactor Project. Yolo County Public Works and I E M, Inc. Yolo County Public Works and I E M, Inc. report to the Urban Consortium Energy Foundation (UUCETF) and the Western Regional Biomass Energy Program, USDOE.

3. Golder Associates, "Final Report, Construction Quality Assurance, Yolo County Central Landfill, WMU 6, Module D, Phase 1 Expansion", December 1999.

4. California Regional Water Quality Control Board, Central Valley Region, "Waste Discharge Requirements for the Yolo County Central Landfill, No. 5-00-134", June 16, 2000.

5. Yolo County, IEM, SWANA, EPA, Final Project Agreement for the Yolo County Accelerated Anaerobic and Aerobic Composting (Bioreactor) Project, September 14, 2000.

6. Tchobanoglous et al, "Integrated Solid Waste Management, Engineering Principles and management Issues", McGraw-Hill, 1993.

APPENDIX A – EPA XL SCHEDULE AND SUMMARY OF MATERIALS INSTALLED

Table 1. Revised Project XL Delivery Schedule

Project Task	Delivery Date
• RWQCB approved the revised Waste Discharge Requirement Permit	June 22, 2000
• Final draft FPA circulated to stakeholders for comments	June 22, 2000
• Comments received for final FPA • Instrumentation installation began	July 3, 2000
• Finalize FPA and distribute for signature	July 21, 2000
• All parties sign FPA document	September, 2000
• Final Rule for Yolo County XL Project published in Federal Register	August 30, 2001
• First lift of waste completed in the southeast corner of Module 6D. This lift of waste is to be used as the foundation layer for the aerobic cell liner.	January 2001
• Waste placement begins in the northeast 3.5 acre anaerobic bioreactor	January 2001
• Begin monitoring temperature and moisture of waste	January 2001
• Begin waste placement in west 6-acre anaerobic cell (waste placement alternates between the west and northeast anaerobic bioreactors and the aerobic bioreactor to facilitate placement of instrumentation, piping, etc.)	March 2001
• Completed construction of aerobic cell liner and begin waste placement in aerobic cell	July, 2001
• Complete the following for the northeast anaerobic 3.5-acre cell: waste placement, instrumentation, leachate injection system, air injection system, and gas and leachate monitoring	September 2001
• Complete the following for the aerobic bioreactor: waste placement, instrumentation, data acquisition and control system, leachate injection system, air management system, gas and leachate monitoring	September 2002
• Begin liquid addition to the northeast 3.5-acre anaerobic cell	November 2001
• Begin liquid addition and air injection in aerobic bioreactor	September 2002
• Complete the following for the west anaerobic 6-acre cell: waste placement, instrumentation, data acquisition and control system, leachate injection system, air injection system, gas and leachate monitoring, and cover system	October 2002
• Begin liquid injection in the west side 6-acre anaerobic bioreactor	November 2002
• Data collection and reporting will continue	On-going until waste stabilization is complete, but dependent on sustained funding levels

Table 2. Summary of Data for the Northeast Anaerobic Cell

Description	Data
Footprint	3.4 acres
Average Waste Depth	35 feet
Construction of the Base Liner	1999
Waste Filling of Cells	1/13/2001 – 8/3/2001
Total # of Waste Lifts	4
Total Amount of Waste	65,104 tons
Total Amount of Greenwaste ADC[2]	11,060 tons
Volume of Soil[2] Within the Waste Mass	5,970 cubic yards
As-Placed Biodegradable Waste Tonnage[3,4] As-Placed Biodegradable Greenwaste ADC Tonnage[3,4]	29,600 tons 7,700 tons
Ratio of Waste to Greenwaste ADC	5.9 to 1
Ratio of Waste to Greenwaste ADC and Soil[3]	3.4 to 1
Average Density of Waste	1,162 pounds per cubic yard, lbs/cy (does not include soil or ADC)
Total # of Horizontal Gas Collection Lines[5] Layer 1 Layer 2 Layer 3 Layer 4	17 Spacing of approximately 6 40 feet on center 5 3 3
Total # of Liquid Addition Lines (HDPE Pipe)[6] Layer 1 Layer 2 Layer 3 Layer 4	25 Spacing of approximately 8 40 feet on center 7 5 5
Total Amount of Liquid Addition Piping Layer 1 Layer 2 Layer 3 Layer 4 (under construction)	34,997 feet 3080 feet 2,450 feet 1,500 feet to be determined
Total # of 3/32 inch Diameter Holes in Injection Line Layer 1 Layer 2 Layer 3 Layer 4 (under construction)	293 145 93 55 to be determined
Surface Liner	36-mil[7] Reinforced Polypropylene
Total # of Moisture Sensors PVC Gypsum	75 Spacing of 50 approximately 25 75 feet on center
Total # of Temperature Sensors	65

[1]Final Project Agreement, FPA
[2]ADC-Alternative Daily Cover
[3]This is an estimate
[4]Calculated using biodegradable fractions from Tchobanoglous et, al. (1993)
[5]Refer to Table 3 for a complete description of gas collection lines
[6]High Density Polyethylene, HDPE
[7]1-mil is equivalent to 0.001 inches and refers to the thickness of the liner

Table 3. Summary of Sensors for the Anaerobic Cells

Type of Instrumentation	FPA Proposed Location/Quantity/Spacing	Actual Location/Quantity/Spacing	Actual Location/Quantity/Spacing
Pressure Transducer	***Anaerobic Bioreactor***	***Northeast Bioreactor***	***West-Side Bioreactor***
	1. Eight over the primary liner near the LCRS trench at 200 spacing 2. Two over the primary liner within the leachate collection sump	1. 2 over the primary liner near the LCRS trench at 200 spacing 2. 1 over the primary liner within the leachate collection sump	1. 3 over the primary liner near the LCRS trench at 200 spacing 2. 1 over the primary liner within the leachate collection sump
Bubbler Gage for Liquid/Gas Pressure Measurement and Liquid/Gas Sampling	1. Top of primary bottom liner-66 gages at 75 feet spacing 2. Top of the first lift of waste- 55 gages 3. Top of the second lift of waste-40 gages 4. Top of the third lift of waste-30 gages 5. Top of the final lift of waste-20 gages TOTAL= 211 gages	1. Top of primary bottom liner-19 gages at 75 feet spacing 2. Top of the first lift of waste- 15 gages at 75 feet spacing 3. Top of the second lift of waste-13 gages at 75 feet spacing 4. Top of the third lift of waste- 13 gages at 75 feet spacing 5. Top of the final lift of waste- no gages TOTAL= 60 gages	1. Top of primary bottom liner-35 gages at 75 feet spacing 2. Still under construction 3. Still under construction 4. Still under construction 5. Still under construction TOTAL= Still under construction
Moisture and Temperature Sensors	1. Top of primary bottom liner-66 temperature sensors at 75 feet spacing and 12 moisture sensors 2. Top of the first lift of waste-55 temperature and moisture sensors 3. Top of the second lift of waste-40 temperature and moisture sensors 4. Top of the third lift of waste-30 temperature and moisture sensors 5. Top of the final lift of waste-20 temperature sensors TOTAL= 211 temperature sensors and 137 moisture sensors	1. Top of primary bottom liner-19 temperature sensors and 4 moisture sensors at 75 feet spacing 2. Top of the first lift of waste-18 temperature and 18 moisture sensors at 75 feet spacing 3. Top of the second lift of waste-15 temperature and 40 moisture sensors at 75 feet spacing 4. Top of the third lift of waste-13 temperature and 13 moisture sensors at 75 feet spacing 5. Top of the final lift of waste-20 temperature sensors TOTAL= 65 temperature sensors and 75 moisture sensors	1. Top of primary bottom liner-35 temperature sensors and 8 moisture sensors at 75 feet spacing 2. Top of the first lift of waste- 6 temperature sensors, and 6 moisture sensors. 3. Still under construction 4. Still under construction 5. Still under construction TOTAL= Still under construction

Table 4. Summary of Gas Collection Lines for the Northeast Anaerobic Cell

Gas Collection Line[1]	Description	Spacing
1-G1	Alternating 4 and 6 inch schedule 80 PVC[2].	50' from west toe
1-G2	Shredded tires with pipe at ends. The north end is 40 feet of schedule 40 PVC with a 10 foot section of 3 inch perforated schedule 80 PVC. The south end is 40 feet of 4 inch schedule 80 PVC, 5 feet of 3 inch schedule 80 PVC, and 10 feet of perforated HDPE.	40' from 1-G1-NE
1-G3	Alternating 4 and 6 inch schedule 80 PVC.	40' from 1-G2-NE
1-G4	Shredded tires with PVC pipe at ends. The south end is 40 feet of 4 inch schedule 80 PVC and 10 feet of 6 inch schedule 80 PVC. The north end is 40 feet of 4 inch schedule 40 PVC.	40' from 1-G3-NE
1-G5	Shredded tires with PVC pipes at ends. The south end is 40 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, 20 feet of 4 inch schedule 80 PVC, and 5 feet of 24 inch corrugated HDPE. The north end is 40 feet of 4 inch schedule 40 PVC.	40' from 1-G4-NE
1-G6	Shredded tires with PVC pipes at ends. The south end is 40 feet of 4 inch schedule 80 PVC, 20 feet of 3 inch perforated schedule 80 PVC, 10 feet of 6 inch schedule 80, and 20 feet of 3 inch perforated schedule 80 PVC. The north end is 40 feet of 4 inch schedule 40 PVC.	40' from 1-G5-NE
2-G1	Shredded tires with PVC pipes at ends. The south end is 40 feet of 4 inch schedule 80, 10 feet of 6 inch schedule 80, and 10 feet of 4 inch schedule 80 PVC. The north end is 40 feet of 4 inch schedule 40 PVC.	30' from West toe
2-G2	Alternating 4 and 6 inch schedule 80 PVC pipe for the entire length with 40 feet of 4 inch at the north and south end.	40' from 2-G1-NE
2-G3	Shredded tires with PVC pipe at the ends. The north end is 40 feet of 4 inch schedule 40 PVC. The south end 40 feet of 4 inch schedule 80 PVC, 20 feet of 3 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, and 20 feet 3 inch perforated schedule 80 PVC.	40' from 2-G2-NE
2-G4	Alternating 6 and 3 inch schedule 80 PVC pipe. The south end is 4 inch schedule 80 PVC and the north end is 4 inch schedule 40 PVC.	40' from 2-G3-NE
2-G5	Shredded tires with pipe at the ends. The north end is 40 feet of 4 inch schedule 40 PVC. The south end is 40 feet of 4 inch schedule 80 PVC, 20 feet of 3 inch schedule 80 PVC, 20 feet of 4 inch schedule 80 PVC, and 10 feet of 12 inch corrugated HDPE[3].	40' from 2-G4-NE
3-G1	Shredded tires with PVC pipe at the ends. The north end is 40 feet of 4 inch schedule 40 PVC. The south end is 40 feet 4 inch schedule 80 and 20 feet of 8 inch schedule 40.	45' from west toe
3-G2	Shredded tires with PVC pipe at the ends. The north end is 40 feet of 4 inch schedule 40 VC. The south end is 40 feet of 4 inch schedule 80 PVC, 20 feet of 8 inch HDPE, and 40 feet of 6 inch HDPE.	45' from 3-G1-NE
3-G3	Shredded tires with PVC pipe at the ends. The north end is 40 feet of 4 inch schedule 40 PVC. The south end is 40 feet of 4 inch schedule 80 PVC, 20 feet of 6 inch schedule 40 PVC, and 10 feet of 12 inch corrugated HDPE.	35' from 3-G2-NE

[1]Gas Collection Line Nomenclature: Layer # - G (for gas) and gas line #
[2]Polyvinyl chloride, PVC
[3]High Density Polyethylene, HDPE

Table 5. Summary of Data for the Aerobic Cell

Description	Data
Footprint	2.3 acres
Average Waste Depth	30 feet
Construction of the Base Liner	August 2001
Waste Filling of Cells	8/8/2001 – 9/26/2001
Total # of Waste Lifts	3
Total Amount of Waste	11,942 tons
Total Amount of Greenwaste ADC[2]	2,169 tons
Volume of Soil[2] Within the Waste Mass	347 cubic yards
Ratio of Waste to Greenwaste ADC	5.5 to 1
Ratio of Waste to Greenwaste ADC and Soil[3]	4.5 to 1
Average Density of Waste	pounds per cubic yard, lbs/cy (does not include soil or ADC)
Total # of Corrugated Metal Pipe Horizontal Air Collection Lines Layer 1 Layer 2	6 Spacings vary. 3 3
Total # of CPVC[4] Pipe Horizontal Air Collection Lines Layer 1 Layer 2	5 Spacings vary. 3 2
Total Amount of Air Collection Lines[5] Layer 1 Layer 2	1,660 feet 1,100 feet 560 feet
Total # of HDPE[6] Pipe Liquid Addition Lines Layer 1 Layer 2 Layer 3	21 Spacings approximately 10 40 feet on center to 8 alternate with CPVC pipe 3 for liquid addition lines.
Total # of CPVC [5] Pipe Liquid Addition Lines Layer 1 Layer 2	11 Spacings of approximately 6 40 feet on center to alternate 5 with HDPE pipe for liquid addition lines.
Total Amount of Liquid Addition Piping Layer 1 Layer 2 Layer 3	4,780 feet 2,870 feet 1,400 feet 510 feet
Total # of 3/32 inch Diameter Holes in Injection Lines Layer 1 Layer 2 Layer 3	326 186 97 43
Total # of Moisture Sensors	52 Spacings vary
Total # of Temperature Sensors	62

[1]Final Project Agreement, FPA
[2]ADC-Alternative Daily Cover
[3]This is an estimate
[4]Chlorinated Polyvinyl Chloride, CPVC
[5]Refer to table A for a complete description of air collection lines
[6]High Density Polyethylene, HDPE

Table 6. Summary of Sensors for the Aerobic Cell

Type of Instrumentation	FPA Proposed Location/Quantity/Spacing	Actual Location/Quantity/Spacing
Pressure Transducer	1. 2 over the primary liner at 200 feet spacing 2. 1 within the leachate sump	1. 1 over the primary liner 2. 1 within the leachate sump
Bubbler Gage for Liquid/Gas Pressure Measurement and Liquid/Gas Sampling	1. Top of the aerobic bottom liner-48 gages at 50 feet spacing 2. Top of the first lift of waste-24 gages 3. Top of the seconf lift of waste-20gages 4. Top of the final lift of waste-20 gages TOTAL=112 gages	1. Top of the bottom liner-12 gages at 75 feet spacing 2. Top of the first lift of waste-26 gages 3. Top of the second lift of waste-16 gages 4. Top of the final lift of waste-no gages TOTAL=54 gages
Moisture and Temperature Sensors	1. Top of the aerobic bottom liner-48 temperature and 12 moisture sensors 2. Top of the first lift of waste-24 temperature and moisture sensors 3. Top of the second lift of waste-20 temperature and moisture sensors 4. Top of the final lift of waste-20 temperature and moisture sensors TOTAL=112 temperature sensors and 76 moisture sensors	1. Top of the aerobic bottom liner-15 temperature and 2 moisture sensors at 75 feet spacing 2. Top of the first lift of waste-29 temperature (3 in the middle of the waste) and 29 moisture sensors at various spacings (3 in the middle of the waste) 3. Top of the second lift of waste-18 temperature and 21 moisture sensors at various spacings 4. Top of the final lift of waste-no temperature or moisture sensors TOTAL=62 temperature sensors and 52 moisture sensors

Table 7. Summary of Air Collection Lines for the Aerobic Cell

Air Collection Line[1]	Description	Spacing
1-A1	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC[2].	30’ from west toe
1-A2	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40’ from 1-A1-SE
1-A3	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40’ from 1-A2-SE
1-A4	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC.	40’ from 1-A3-SE
1-A5	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40’ from 1-A4-SE
1-A6	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC.	40’ from 1-A5-SE
2-A1	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	25’ from west toe
2-A2	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC.	40’ from 2-A1-SE
2-A3	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40’ from 2-A2-SE
2-A4	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC.	40’ from 2-A3-SE
2-A5	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40’ from 2-A4-SE

[1]Air Collection Line Nomenclature: Layer # - A (for air) and air collection line #
[2]Chlorinated Polyvinyl Chloride, PVC

APPENDIX B – PIPING AND INSTRUMENTATION PLAN

PRESSURE TRANSDUCER AND PRESSURE SENSING TUBE INSTALLED ON SS CABLE

THERMISTER AND PRESSURE SENSING TUBE

LEGEND

- (symbol) PRESSURE TRANSDUCER, DRUCK MODEL PTX 1830, 0–1 PSIG
- (symbol) THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C). AND PRESSURE SENSING TUBE, 1/4–INCH ID BY 3/8 OD LLDPE.
- (symbol) THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), PRESSURE SENSING TUBE, 1/4–INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.
- (symbol) PRESSURE SENSING TUBE, 1/4–INCH ID BY 3/8 OD LLDPE.

INSTRUMENT DESIGNATION

0–02	THERMISTER, MOISTURE SENSOR, AND PRESSURE SENSING TUBE DESIGNATION. 0–02 DESIGNATES LEVEL 0, INSTRUMENT NUMBER 2
PT–01	PRESSURE TRANSDUCER AND PRESSURE SENSING TUBE. PT–01 DESIGNATES PRESSURE TRANSDUCER NUMBER 1
TLL–01	TRENCH LIQUID LEVEL, LOCATION 1

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NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PUBLIC WORKS & TRANSPORTATION
DIVISION OF INTEGRATED WASTE MANAGEMENT
600 A STREET, ROOM 158 DAVIS, CALIFORNIA

DIRECTOR OF PUBLIC WORKS

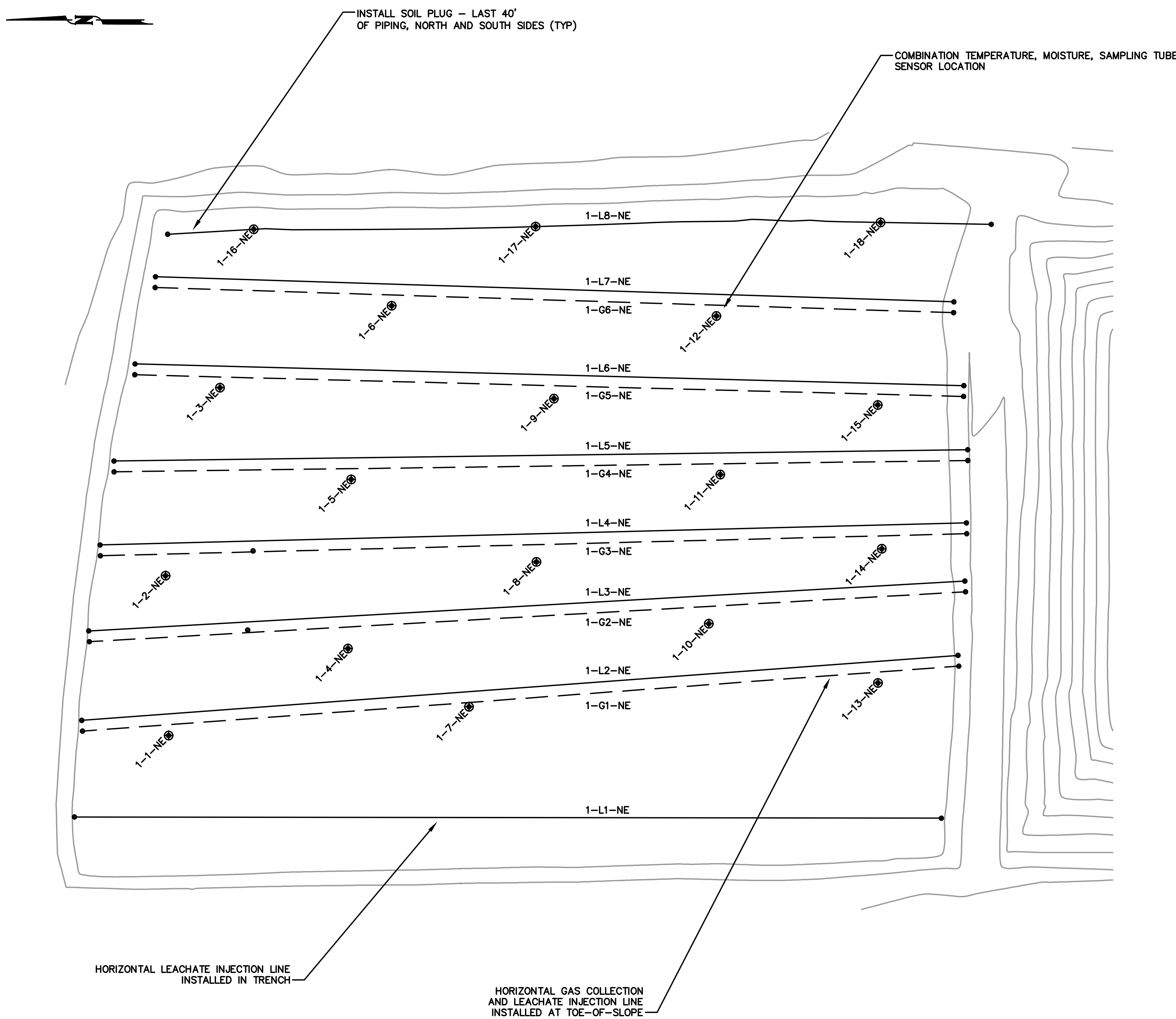
APPROVED ____________ 19 ______ R. E. NO. ______

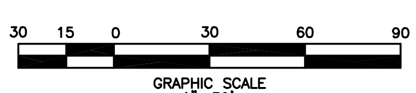
YOLO COUNTY CENTRAL LANDFILL
MODULE D, PHASE 1
BASE INSTRUMENTATION PLAN

DRAWING NO. ______

W.O. NO.	9209
F.B. NO.	?
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	BASE_INST
DATE	8/14/00

DETAIL 7





MONITORING POINT COORDINATES			
SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
1-1-NE	1980055	6651259	40
1-2-NE	1980057	6651433	39
1-3-NE	1980031	6651520	39.5
1-4-NE	1979972	6651399	39.5
1-5-NE	1979971	6651478	39
1-6-NE	1979952	6651588	40.5
1-7-NE	1979916	6651372	40
1-8-NE	1979885	6651440	39
1-9-NE	1979876	6651515	39.5
1-10-NE	1979805	6651411	39.5
1-11-NE	1979799	6651480	39
1-12-NE	1979801	6651554	40.5
1-13-NE	1979726	6651383	40
1-14-NE	1979724	6651446	39
1-15-NE	1979726	6651512	39.5
1-16-NE	1980016	6651594	40
1-17-NE	1979885	6651595	40
1-18-NE	1979725	6651597	40

LEGEND

— — — — HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C

———— HORIZONTAL GAS COLLECTION LINE, VARIOUS CONFIGURATIONS

⊛ THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), PRESSURE SENSING TUBE, 1/4-INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.

1-01-NE LEVEL 1, INSTRUMENT LOCATION 1, NORTHEAST ANAEROBIC MODULE

1-L1-NE LEVEL 1, LEACHATE INJECTION LINE 1, NORTHEAST ANAEROBIC MODULE

1-G1-NE LEVEL 1, GAS EXTRACTION LINE 1, NORTHEAST MODULE

AS-BUILT

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YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ______ 19 ____ R. E. NO. ______

YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

NE ANAEROBIC MODULE LEVEL 1 PIPING AND INSTRUMENTATION

DRAWING NO. ______

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	——
DATE	8/6/02

DETAIL
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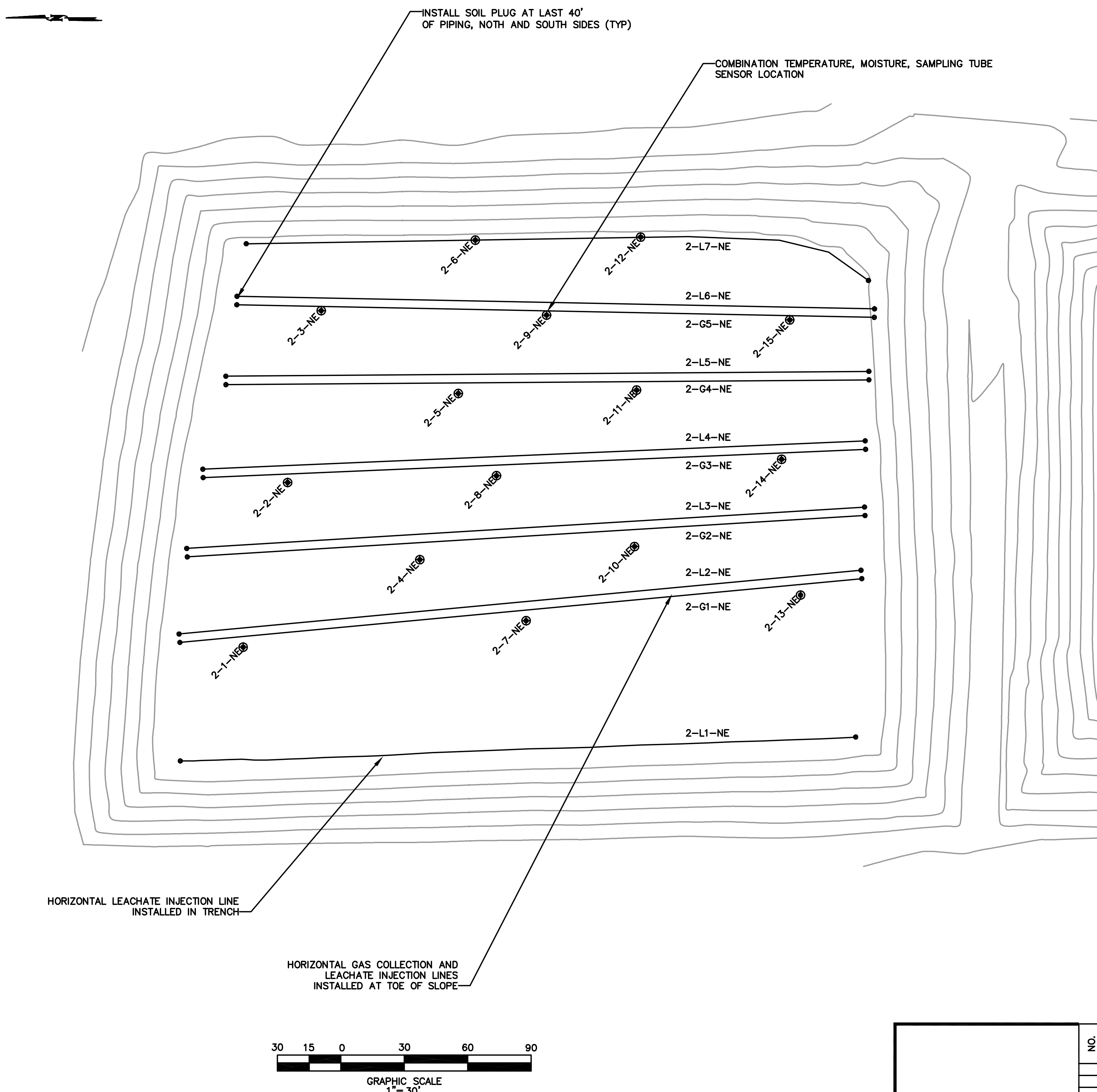

SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
2-1-NE	1980027	6651382	54
2-2-NE	1980006	6651460	52.5
2-3-NE	1979990	6651541	49.5
2-4-NE	1979944	6651423	53
2-5-NE	1979925	6651502	51
2-6-NE	1979917	6651574	49.5
2-7-NE	1979893	6651394	54
2-8-NE	1979907	6651463	52.5
2-9-NE	1979884	6651539	49.5
2-10-NE	1979842	6651430	53
2-11-NE	1979841	6651503	51
2-12-NE	1979839	6651576	49.5
2-13-NE	1979764	6651407	54
2-14-NE	1979772	6651471	52.5
2-15-NE	1979769	6651537	49.5

LEGEND

———	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C
———	HORIZONTAL GAS COLLECTION LINE, VARIOUS CONFIGHURATIONS
⊕	THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), PRESSURE SENSING TUBE, 1/4-INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.
2-01-NE	LEVEL 2, INSTRUMENT LOCATION 1, NORTHEAST ANAEROBIC MODULE
2-L1-NE	LEVEL 2, LEACHATE INJECTION LINE 1, NORTHEAST ANAEROBIC MODULE
2-G1-NE	LEVEL 2, GAS EXTRACTION LINE 1, NORTHEAST MODULE

AS-BUILT

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YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ______________ 19 ______ R. E. NO.

YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

NE ANAEROBIC MODULE LEVEL 2 PIPING AND INSTRUMENTATION

DRAWING NO.

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	—
DATE	8/6/02

DETAIL

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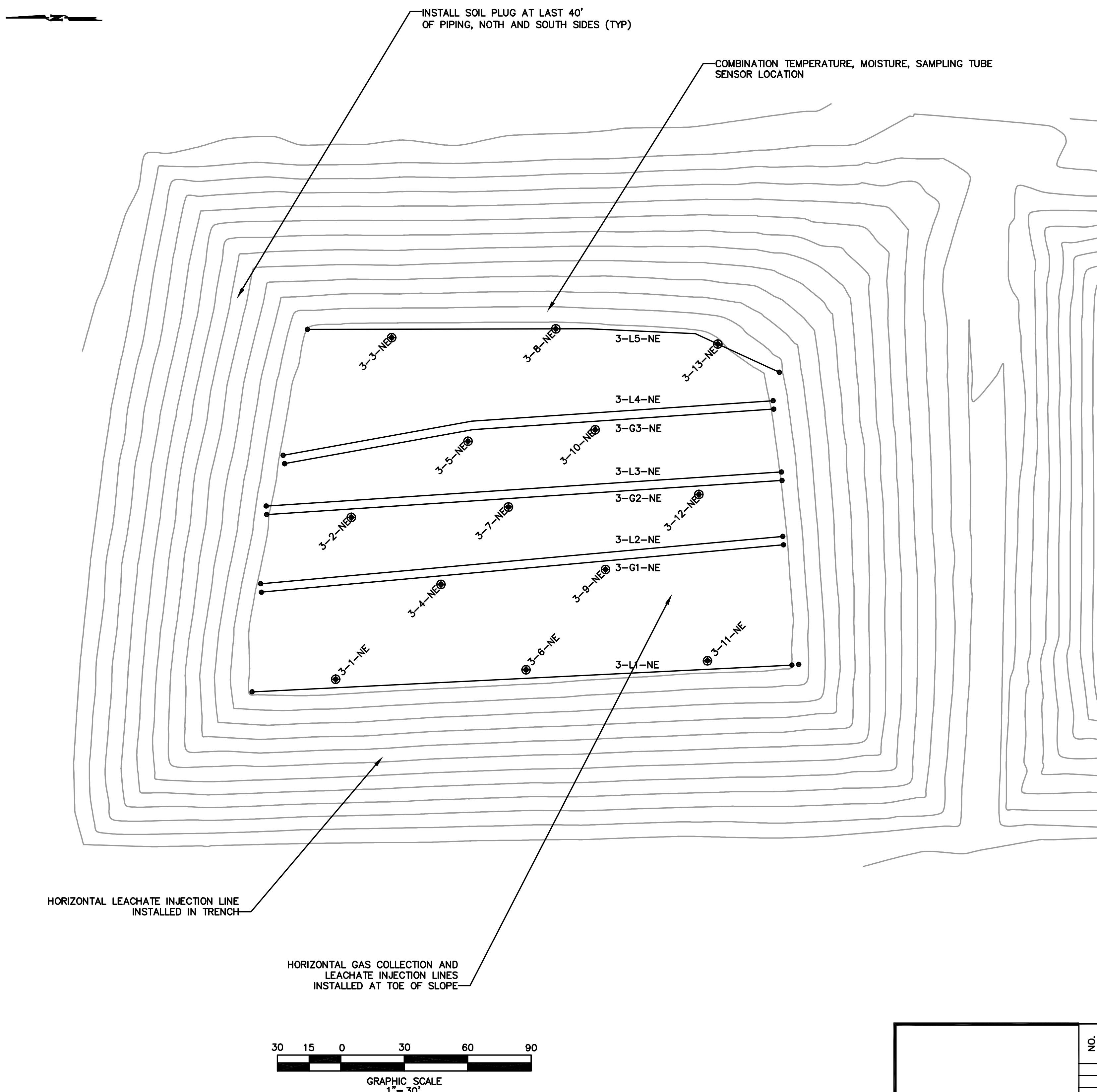

SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
3-1-NE	1979983	6651367	65
3-2-NE	1979976	6651443	65
3-3-NE	1979957	6651528	64
3-4-NE	1979934	6651412	65.5
3-5-NE	1979921	6651479	64.5
3-6-NE	1979893	6651371	65
3-7-NE	1979902	6651448	65
3-8-NE	1979879	6651532	64
3-9-NE	1979856	6651419	65.5
3-10-NE	1979861	6651485	64.5
3-11-NE	1979808	6651376	65
3-12-NE	1979812	6651454	65
3-13-NE	1979803	6651525	64

LEGEND

———	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C
———	HORIZONTAL GAS COLLECTION LINE, VARIOUS CONFIGHURATIONS
⊛	THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0-100°C), PRESSURE SENSING TUBE, 1/4-INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.
3-01-NE	LEVEL 3, INSTRUMENT LOCATION 1, NORTHEAST ANAEROBIC MODULE
3-L1-NE	LEVEL 3, LEACHATE INJECTION LINE 1, NORTHEAST ANAEROBIC MODULE
3-G1-NE	LEVEL 3, GAS EXTRACTION LINE 1, NORTHEAST MODULE

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292 WEST BEAMER ST., WOODLAND, CA 95695

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YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

NE ANAEROBIC MODULE LEVEL 3 PIPING AND INSTRUMENTATION

DRAWING NO. ______

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	——
DATE	8/6/02

DETAIL
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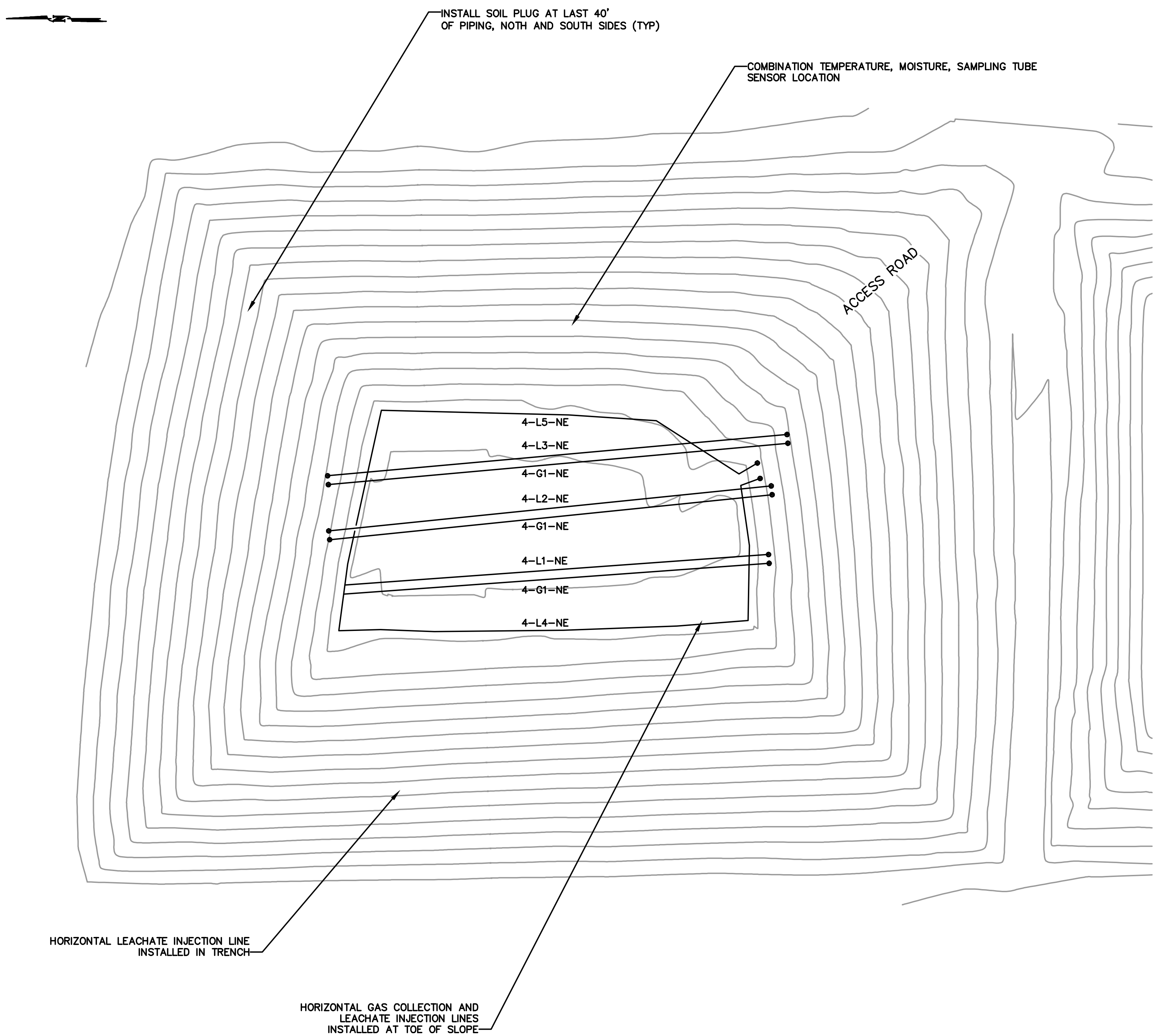

30 15 0 30 60 90

GRAPHIC SCALE
1" = 30'

LEGEND

———	HORIZONTAL LEACHATE INJECTION LINE, 1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C
———	HORIZONTAL GAS COLLECTION LINE, VARIOUS CONFIGHURATIONS
4-L1-NE	LEVEL 4, LEACHATE INJECTION LINE 1, NORTHEAST ANAEROBIC MODULE
4-G1-NE	LEVEL 4, GAS EXTRACTION LINE 1, NORTHEAST MODULE

AS-BUILT

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YOLO COUNTY
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DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ____________ 19 ____ R. E. NO. ____

YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

NE ANAEROBIC MODULE LEVEL 4 PIPING AND INSTRUMENTATION

DRAWING NO. ____

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	—
DATE	8/6/02

DETAIL
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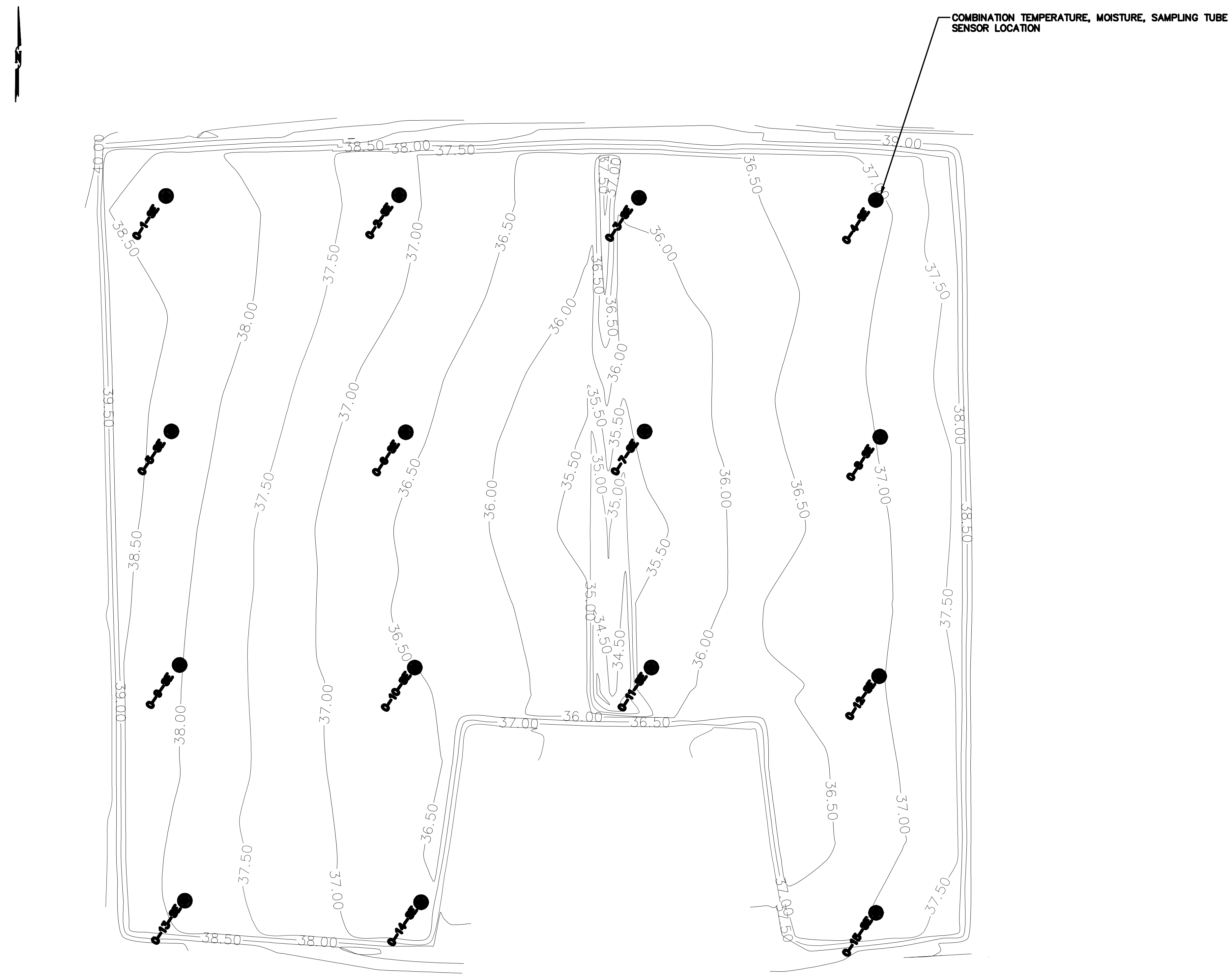


SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
0–1–SE	1979642	6651322	38.4
0–2–SE	1979642	6651406	37
0–3–SE	1979642	6651482	36
0–4–SE	1979641	6651557	37
0–5–SE	1979567	6651334	38.2
0–6–SE	1979567	6651408	36.6
0–7–SE	1979567	6651484	35.5
0–8–SE	1979566	6651559	37
0–9–SE	1979493	6651336	38
0–10–SE	1979493	6651411	36.5
0–11–SE	1979493	6651486	35.6
0–12–SE	1979490	6651558	37
0–13–SE	1979419	6651338	37.9
0–14–SE	1979418	6651413	36.7
0–15–SE	1979415	6651557	37

LEGEND

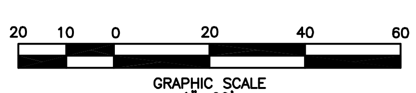
● THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), PRESSURE SENSING TUBE, 1/4–INCH ID BY 3/8 OD LLDPE, AND, AT LOCATIONS 05, 07, 14, AND 15, A PVC MOISTURE SENSOR.

0–1–SE LEVEL 0, INSTRUMENT LOCATION 1, SOUTHEAST ANAEROBIC MODULE

NOTES

1. STRIPS OF GEOCOMPOSITE DRAIN NET PLACED UNDER LINER COOLING AND LINER COOLING/SETTLEMENT PIPES TO PROMOTE BETTER DRAINAGE INDER PIPES.

AS-BUILT



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NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ______ 19 ______ R. E. NO. ______

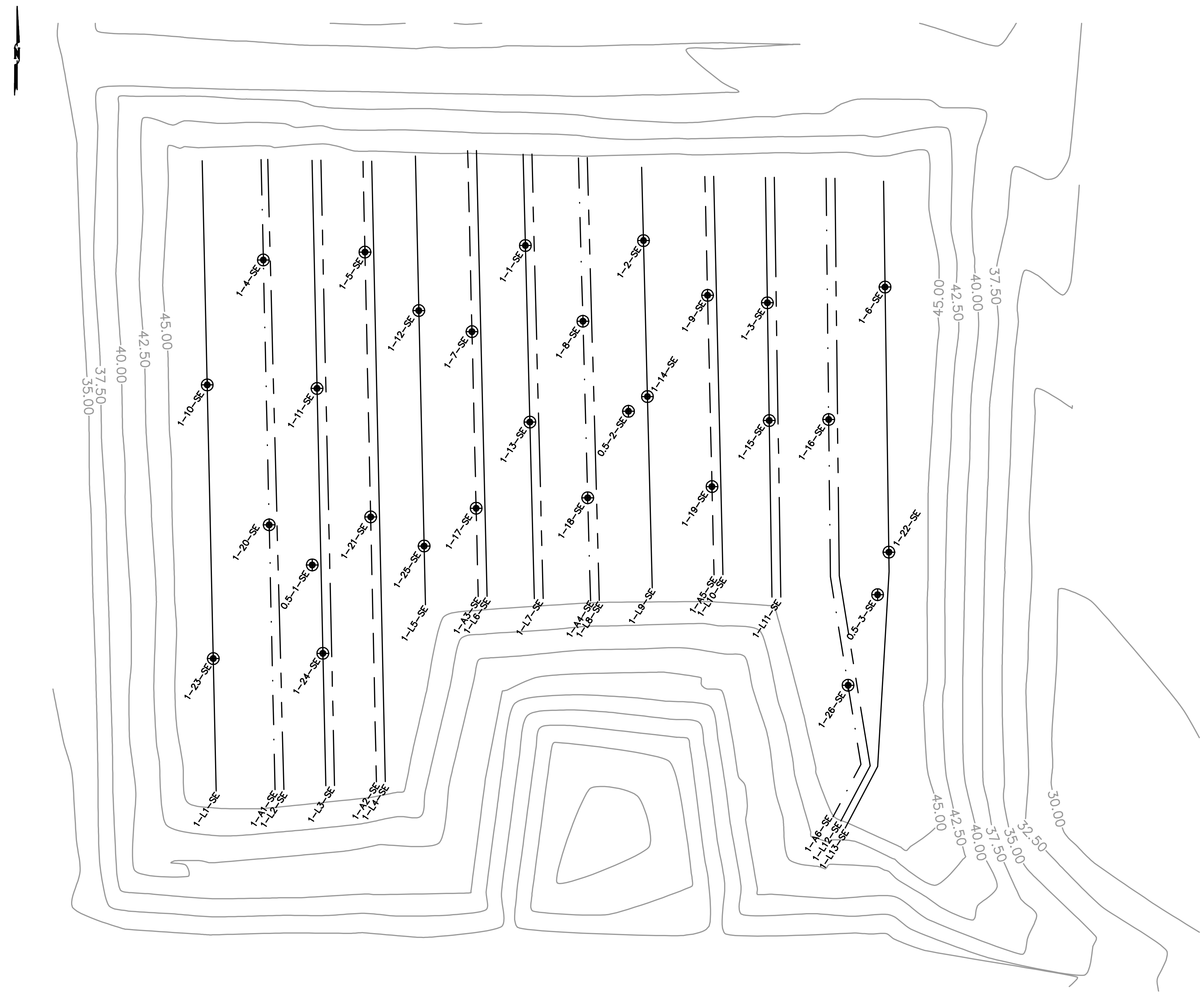
YOLO COUNTY CENTRAL LANDFILL
FULL–SCALE BIOREACTOR

SE AEROBIC MODULE LEVEL 0 PIPING AND INSTRUMENTATION

DRAWING NO. ______

W.O. NO. 9207
F.B. NO. T.9N.R.3E.
DESIGN BY JDK
DRAWN BY JDK
CHECKED BY RY
FILE NAME ——
DATE 8/6/02

DETAIL 12



SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
1–1–SE	1979615	6651443	42
1–2–SE	1979617	6651484	43
1–3–SE	1979596	6651526	46
1–4–SE	1979611	6651354	44.5
1–5–SE	1979613	6651389	44
1–6–SE	1979601	6651566	47
1–7–SE	1979586	6651425	42
1–8–SE	1979590	6651463	43
1–9–SE	1979599	6651505	46
1–10–SE	1979568	6651335	44.5
1–11–SE	1979567	6651373	44.5
1–12–SE	1979593	6651407	44
1–13–SE	1979555	6651445	42
1–14–SE	1979564	6651485	43
1–15–SE	1979556	6651526	46
1–16–SE	1979556	6651546	47
1–17–SE	1979526	6651427	42
1–18–SE	1979530	6651465	43
1–19–SE	1979534	6651507	46
1–20–SE	1979521	6651356	44.5
1–21–SE	1979523	6651391	44
1–22–SE	1979511	6651567	47
1–23–SE	1979475	6651337	44.5
1–24–SE	1979477	6651375	44.5
1–25–SE	1979513	6651409	44
1–26–SE	1979466	6651553	47
0.5–1–SE	1979507	6651371	41
0.5–2–SE	1979559	6651478	39.5
0.5–3–SE	1979497	6651563	41

LEGEND

HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 10' O/C

HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, sCHEDULE 80 CPVC WITH 3/32" ø DRILLED HOLES @ 10' O/C

HORIZONTAL AIR COLLECTION LINE, ALTERNATING 4 AND 6–INCH CPVC

HORIZONTAL AIR COLLECTION LINE, ALTERNATING 6 AND 8–INCH COORIGATED METAL PIPE WITH HDPE INJECTION LINE INSIDE.

⊛ THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), PRESSURE SENSING TUBE, 1/4–INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.

0.5–1–SE LEVEL 0.5, INSTRUMENT LOCATION 1, SOUTHEAST ANAEROBIC MODULE

1–1–SE LEVEL 1, INSTRUMENT LOCATION 1, SOUTHEAST ANAEROBIC MODULE

1–L1–SE LEVEL 1, LEACHATE INJECTION LINE 1, SOUTHEAST ANAEROBIC MODULE

1–A1–SE LEVEL 1, AIR COLLECTION LINE 1, SOUTHEAST MODULE

NOTES

1. ALL PIPING AND INSTRUMENTATION INSTALLED IN 3–FOOT WIDE BY 2–FOOT DEEP TRENCH. ALL TRENCHES WERE BACKFILLED WITH TIRES.
2. SENSORS DESIGNATED 0.5 WERE INSTALLED APPROXIMATELY 4–FEET ABOVE THE AEROBIC LINER.

AS-BUILT

<u>WARNING:</u> THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.

20 10 0 20 40 60

GRAPHIC SCALE
1"= 20'

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ____________ 19 ______ ____________ R. E. NO.

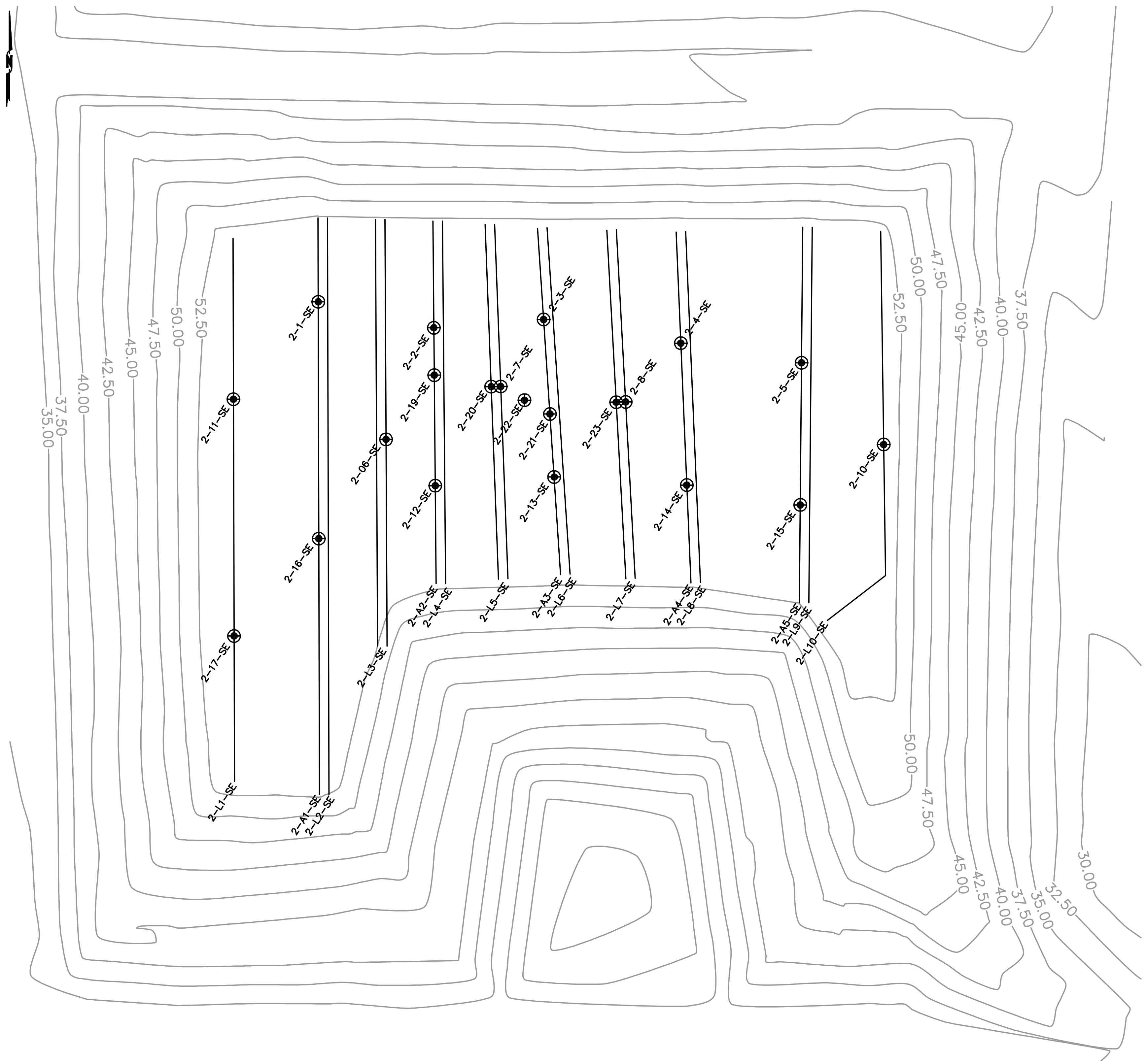
YOLO COUNTY CENTRAL LANDFILL
FULL–SCALE BIOREACTOR

SE AEROBIC MODULE LEVEL 1 PIPING AND INSTRUMENTATION

DRAWING NO. ____________

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	—
DATE	8/6/02

DETAIL
13



SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
2-1-SE	1979604	6651380	51
2-2-SE	1979596	6651417	51
2-3-SE	1979599	6651452	52
2-4-SE	1979591	6651495	52.5
2-5-SE	1979585	6651533	52
2-6-SE	1979561	6651402	51
2-7-SE	1979572	6651438	51.5
2-8-SE	1979572	6651478	52
2-9-SE	NOT INSTALLED		
2-10-SE	1979559	6651559	52
2-11-SE	1979573	6651354	51
2-12-SE	1979546	6651418	51
2-13-SE	1979549	6651455	52
2-14-SE	1979546	6651497	52.5
2-15-SE	1979540	6651533	52
2-16-SE	1979529	6651381	51
2-17-SE	1979498	6651354	51
2-18-SE	SENSOR LOST		
2-19-SE	1979581	6651417	51
2-20-SE	1979577	6651435	56
2-21-SE	1979569	6651454	57
2-22-SE	1979573	6651446	56
2-23-SE	1979572	6651475	57

LEGEND

(solid line)	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 10' O/C
(long-short dashed line)	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, sCHEDULE 80 CPVC WITH 3/32" ø DRILLED HOLES @ 10' O/C
(dash-dot line)	HORIZONTAL AIR COLLECTION LINE, ALTERNATING 4 AND 6-INCH CPVC
(dashed line)	HORIZONTAL AIR COLLECTION LINE, ALTERNATING 6 AND 8-INCH COORIGATED METAL PIPE WITH HDPE INJECTION LINE INSIDE.
⊕	THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0-100°C), PRESSURE SENSING TUBE, 1/4-INCH ID BY 3/8 OD LLDPE, AND PVC MOISTURE SENSOR.
2-1-SE	LEVEL 2, INSTRUMENT LOCATION 1, SOUTHEAST ANAEROBIC MODULE
2-L1-SE	LEVEL 2, LEACHATE INJECTION LINE 1, SOUTHEAST ANAEROBIC MODULE
2-A1-SE	LEVEL 2, AIR COLLECTION LINE 1, SOUTHEAST MODULE

NOTES

1. ALL PIPING AND INSTRUMENTATION INSTALLED IN 3-FOOT WIDE BY 2-FOOT DEEP TRENCH. ALL TRENCHES WERE BACKFILLED WITH TIRES.
2. SENSORS DESIGNATED 0.5 WERE INSTALLED APPROXIMATELY 4-FEET ABOVE THE AEROBIC LINER.

AS-BUILT

WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.

20 10 0 20 40 60

GRAPHIC SCALE
1"= 20'

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YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
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292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ________ 19 ______ R. E. NO. ______

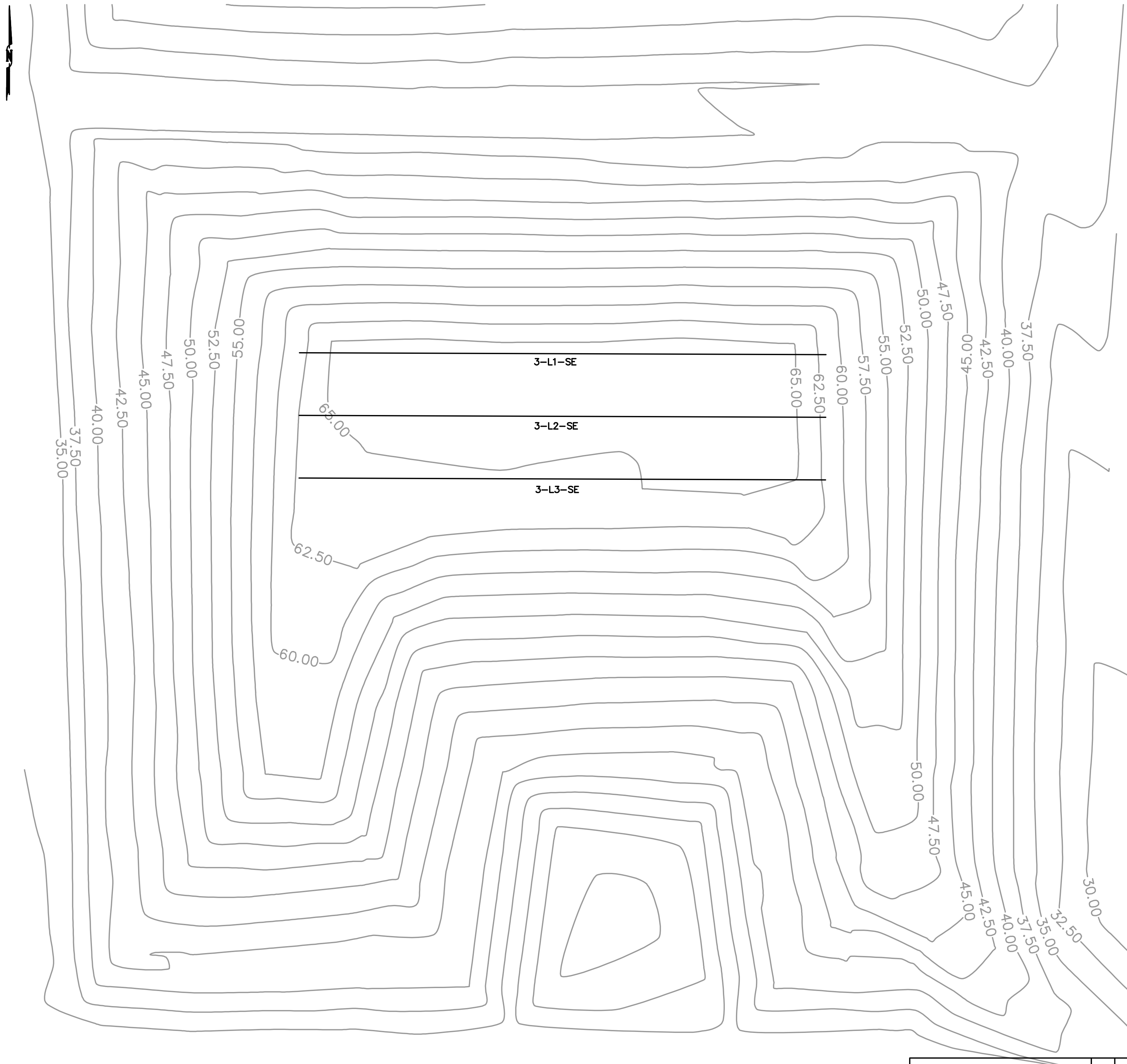
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

SE AEROBIC MODULE LEVEL 2 PIPING AND INSTRUMENTATION

DRAWING NO. ______

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	----
DATE	8/6/02

DETAIL
14



20 10 0 20 40 60

GRAPHIC SCALE
1"=20'

LEGEND

HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 10' O/C

3-L1-SE — LEVEL 3, LEACHATE INJECTION LINE 1, SOUTHEAST ANAEROBIC MODULE

NOTES

1. ALL PIPING AND INSTRUMENTATION INSTALLED IN 3-FOOT WIDE BY 2-FOOT DEEP TRENCH. ALL TRENCHES WERE BACKFILLED WITH TIRES.

AS-BUILT

WARNING: THE ORIGINAL DOCUMENTS CONTAIN A RED COLORED PROFESSIONAL SEAL AND BLACK SIGNATURE.

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
DEPARTMENT OF PLANNING & PUBLIC WORKS
DIVISION OF INTEGRATED WASTE MANAGEMENT
292 WEST BEAMER ST., WOODLAND, CA 95695

ASSISTANT DIRECTOR OF PUBLIC WORKS

APPROVED ____________ 19 ______ R. E. NO.

YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR
SE AEROBIC MODULE LEVEL 3 PIPING AND INSTRUMENTATION

DRAWING NO.

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	RY
FILE NAME	
DATE	8/6/02

DETAIL
15

APPENDIX C – GRAPHS AND DATA TABLES

Figure 1. Northeast Anaerobic Cell Base Layer Temperature Readings

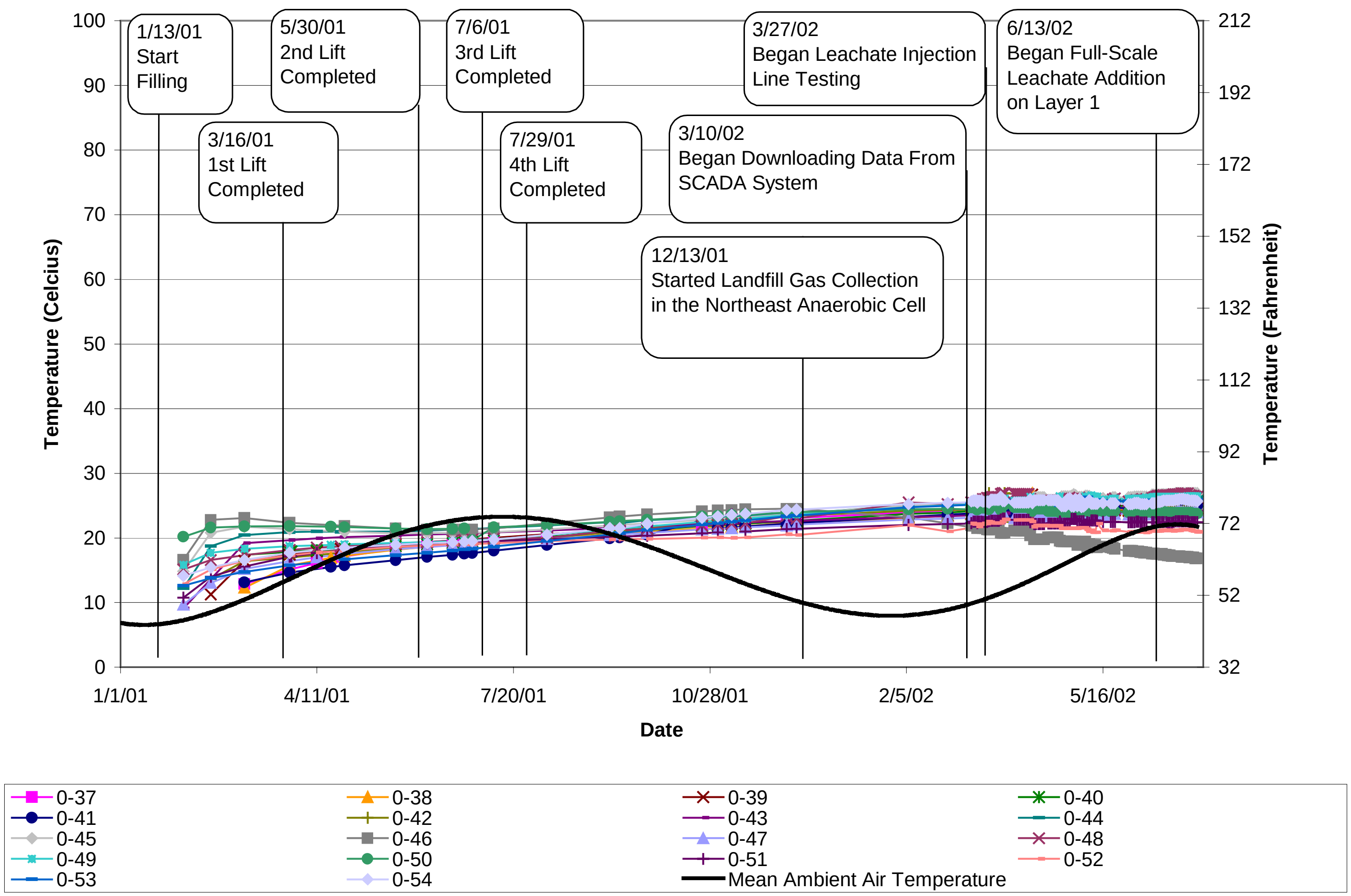


Figure 2. Norheast Anaerobic Cell Layer 1 Temperature Readings

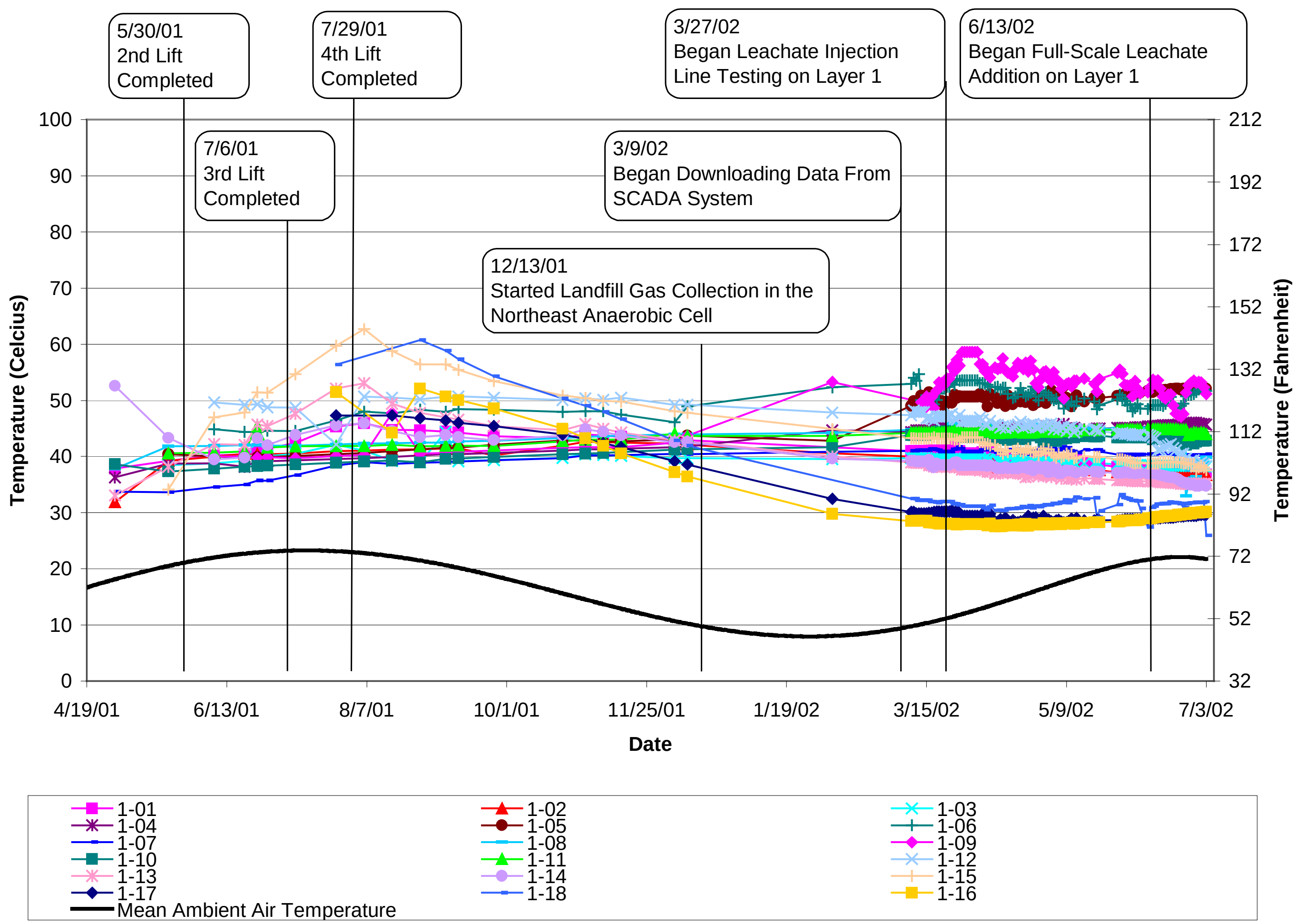


Figure 3. Northeast Anaerobic Cell Layer 2 Temperature Readings

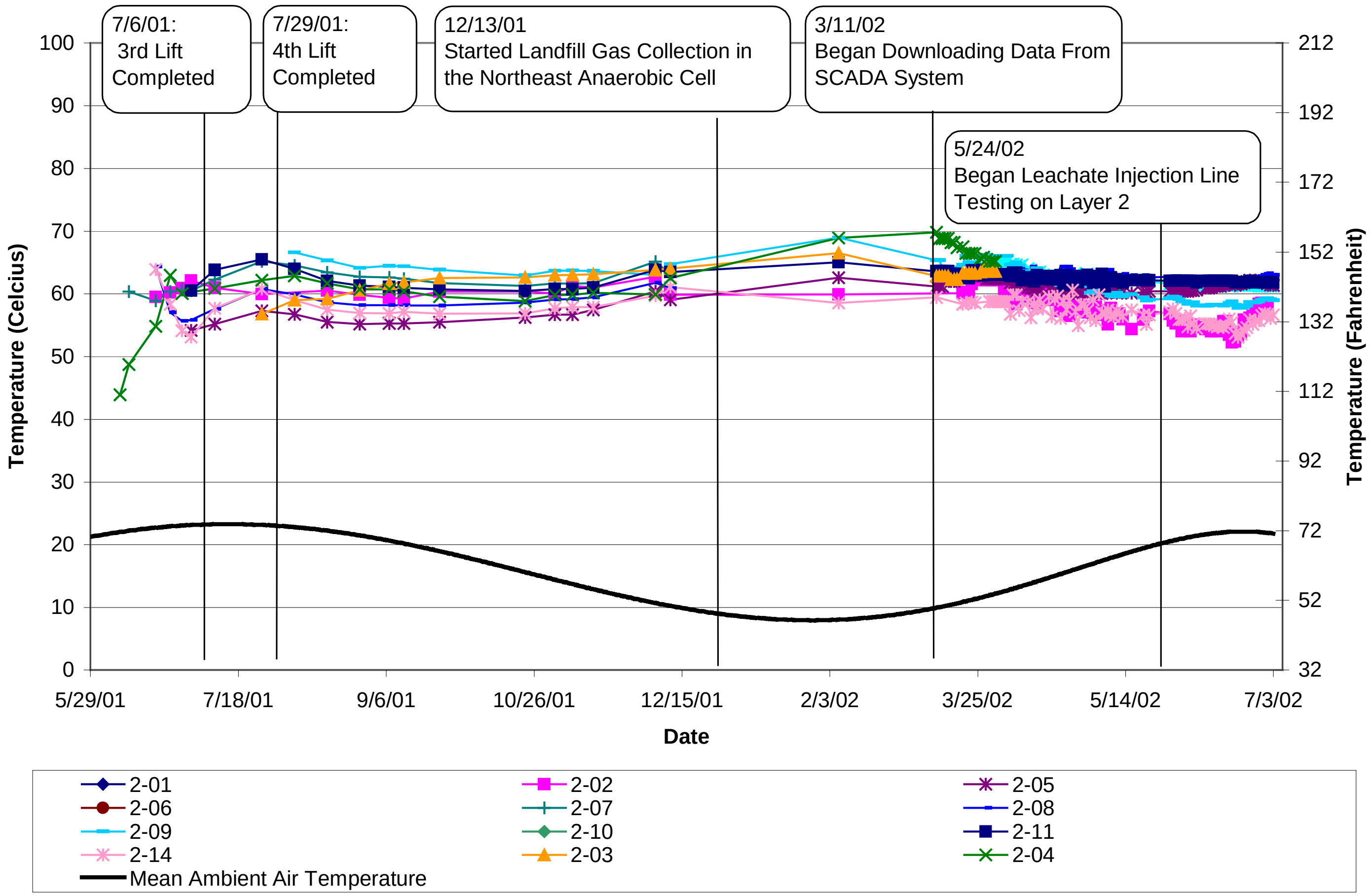


Figure 4. Northeast Anaerobic Cell Layer 3 Temperature Readings

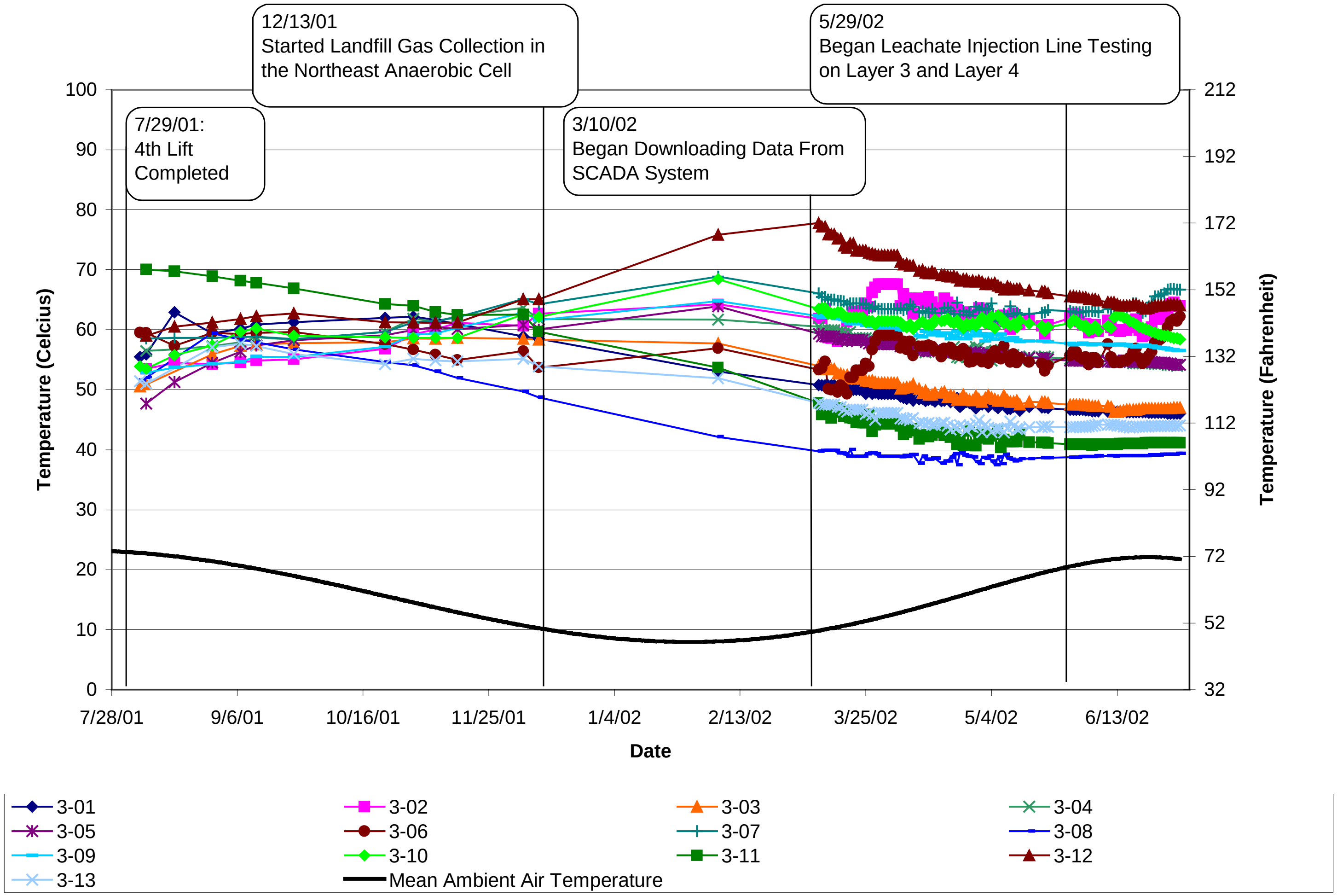


Figure 5. Northeast Anaerobic Cell Base Layer Moisture Readings (PVC Moisture Sensors)

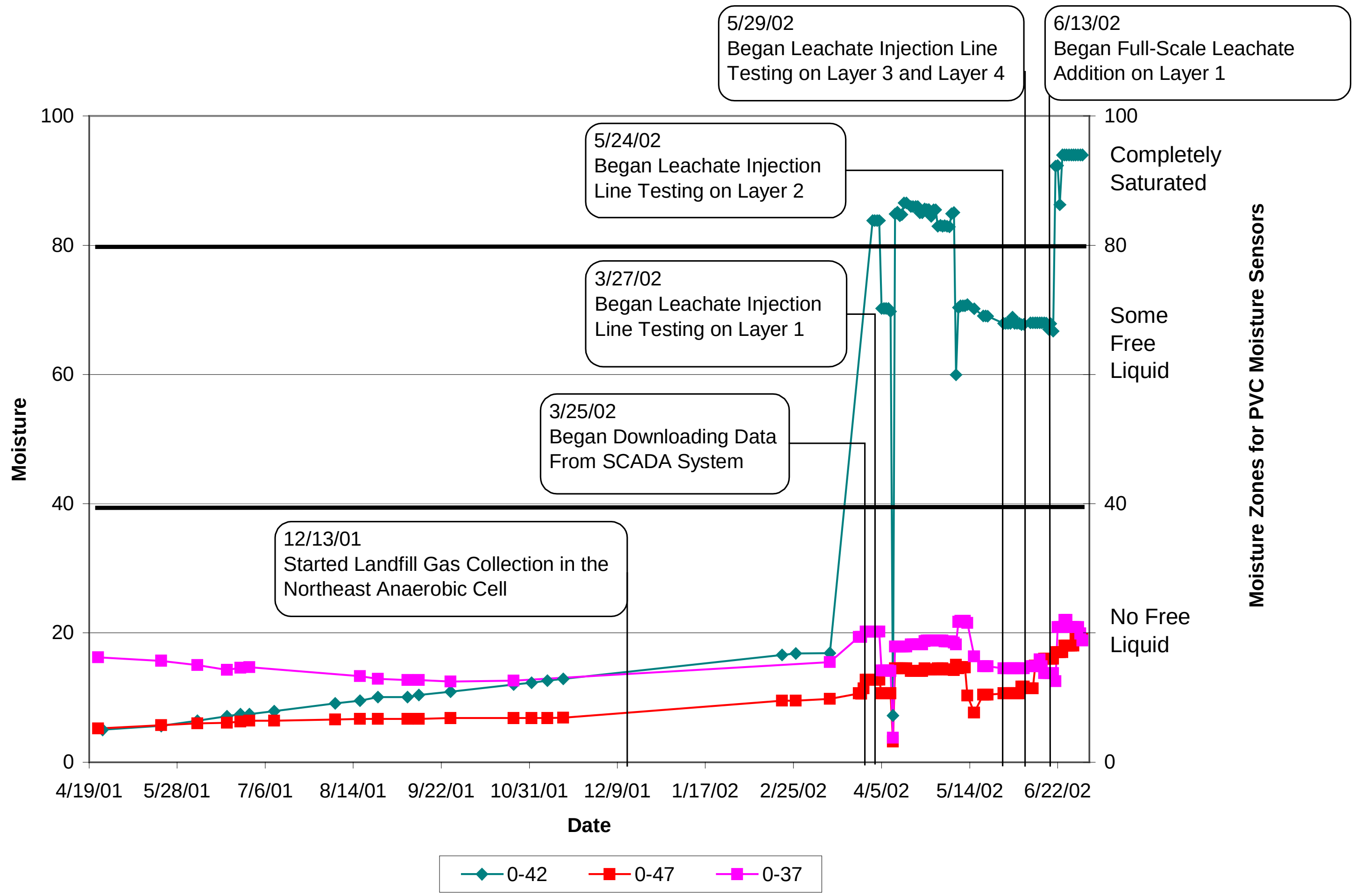


Figure 6. Northeast Anaerobic Cell Layer 1 Moisture Readings (PVC Moisture Sensors)

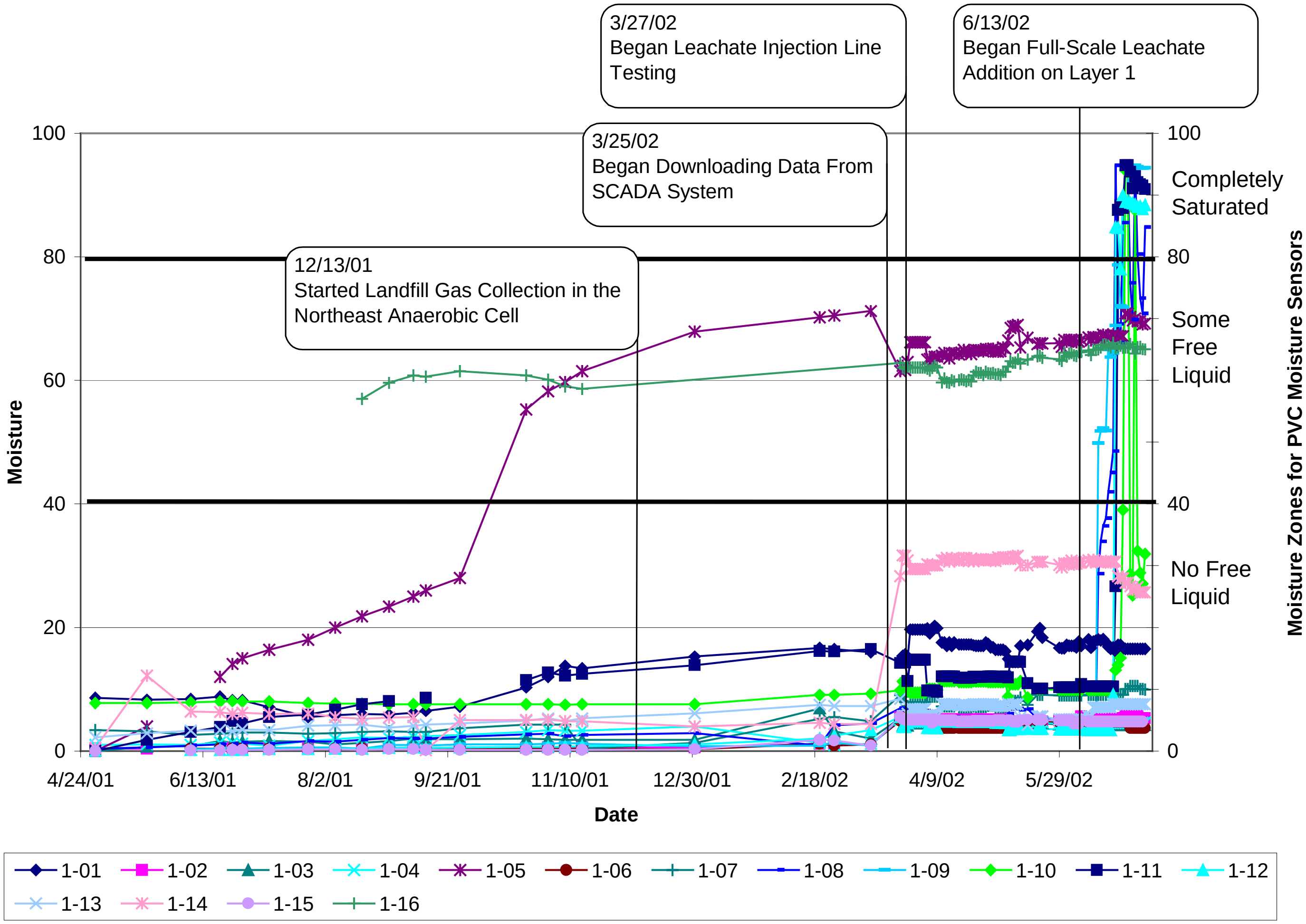


Figure 7. Northeast Anaerobic Cell Layer 2 Moisture Readings (PVC Moisture Sensors)

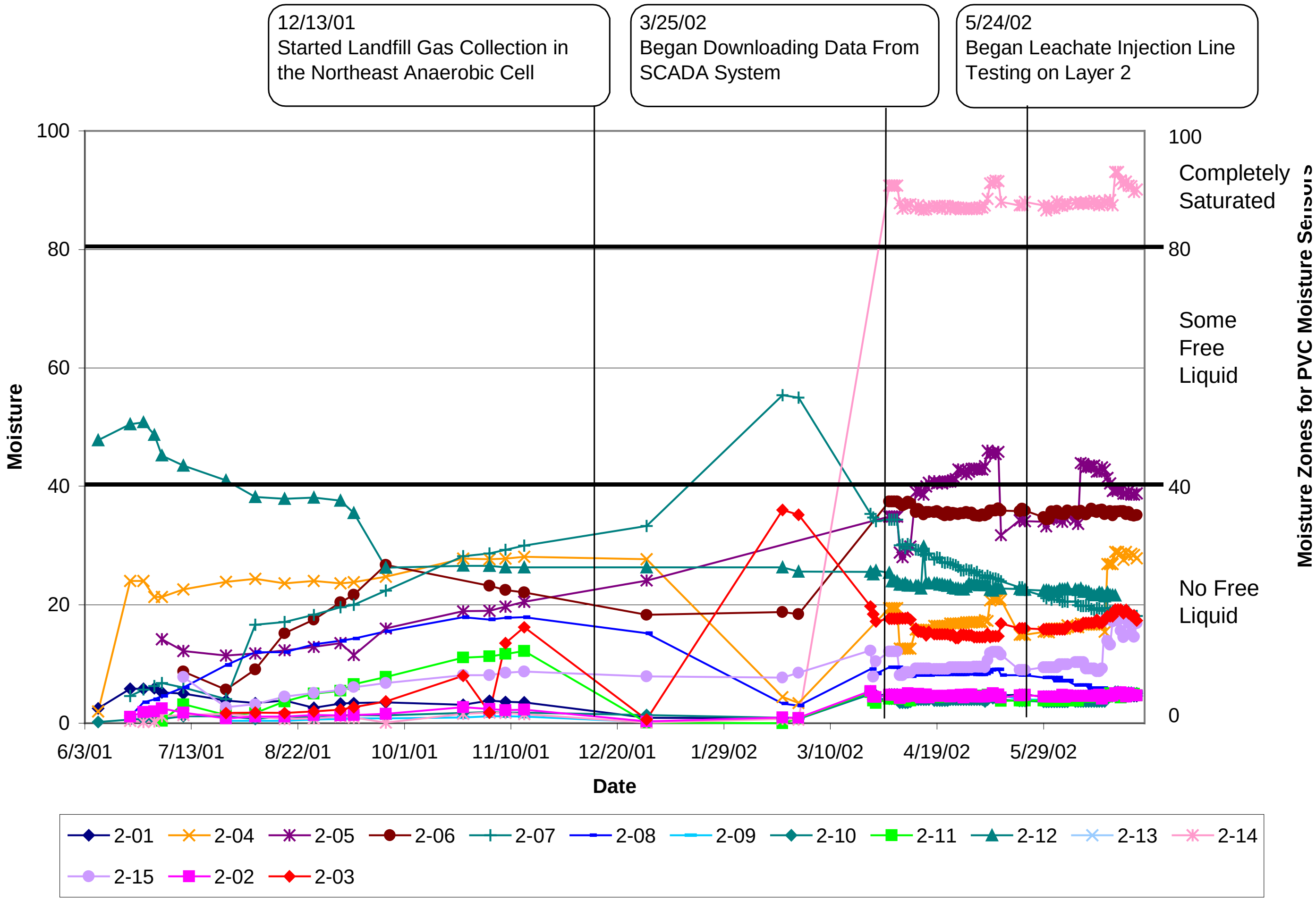


Figure 8. Northeast Anaerobic Cell Layer 2 Moisture Readings (Gypsum in Plaster Moisture Sensors)

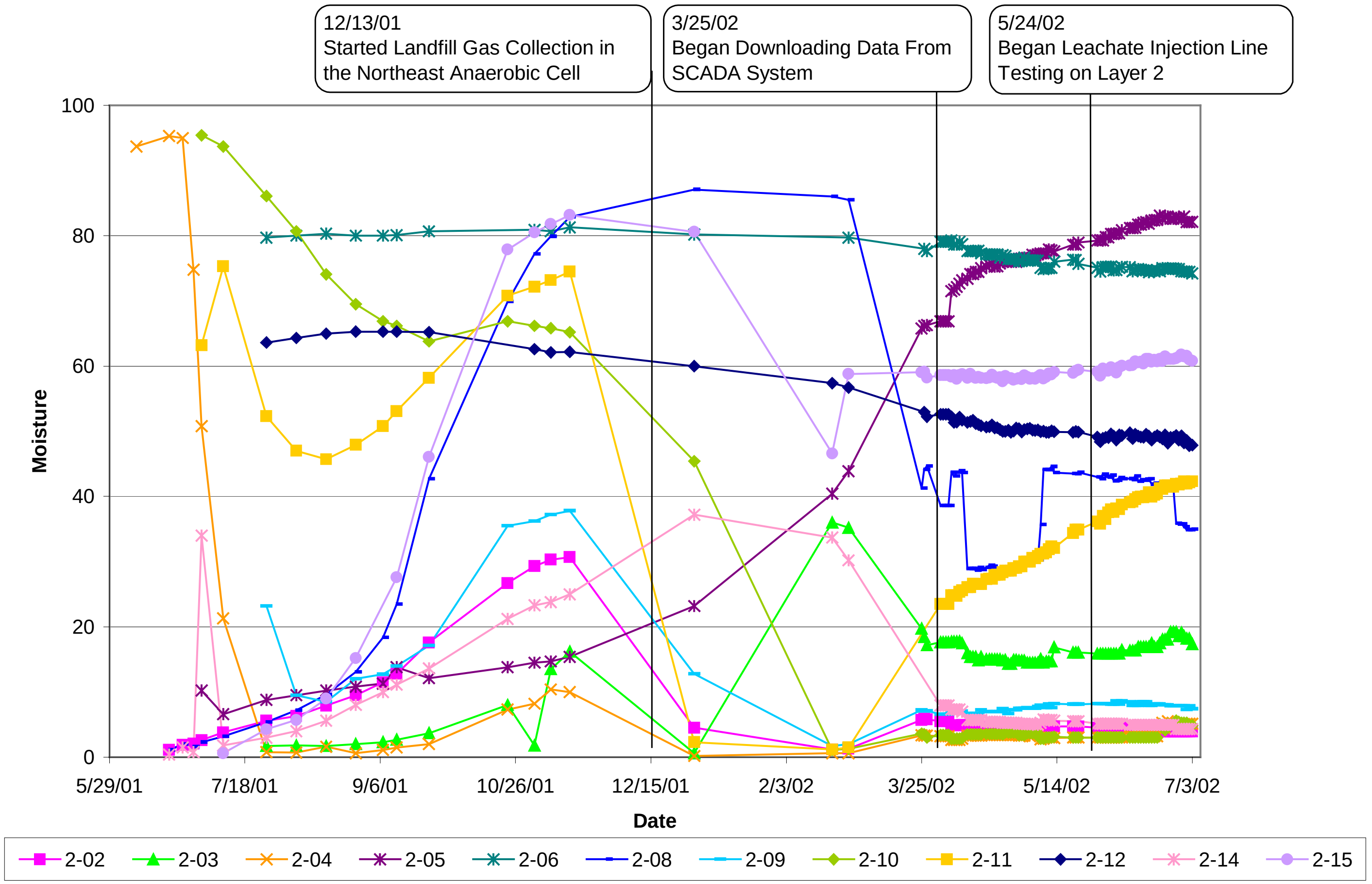


Figure 9. Northeast Anaerobic Cell Layer 2 Moisture Readings (Gypsum in Soil Moisture Sensors)

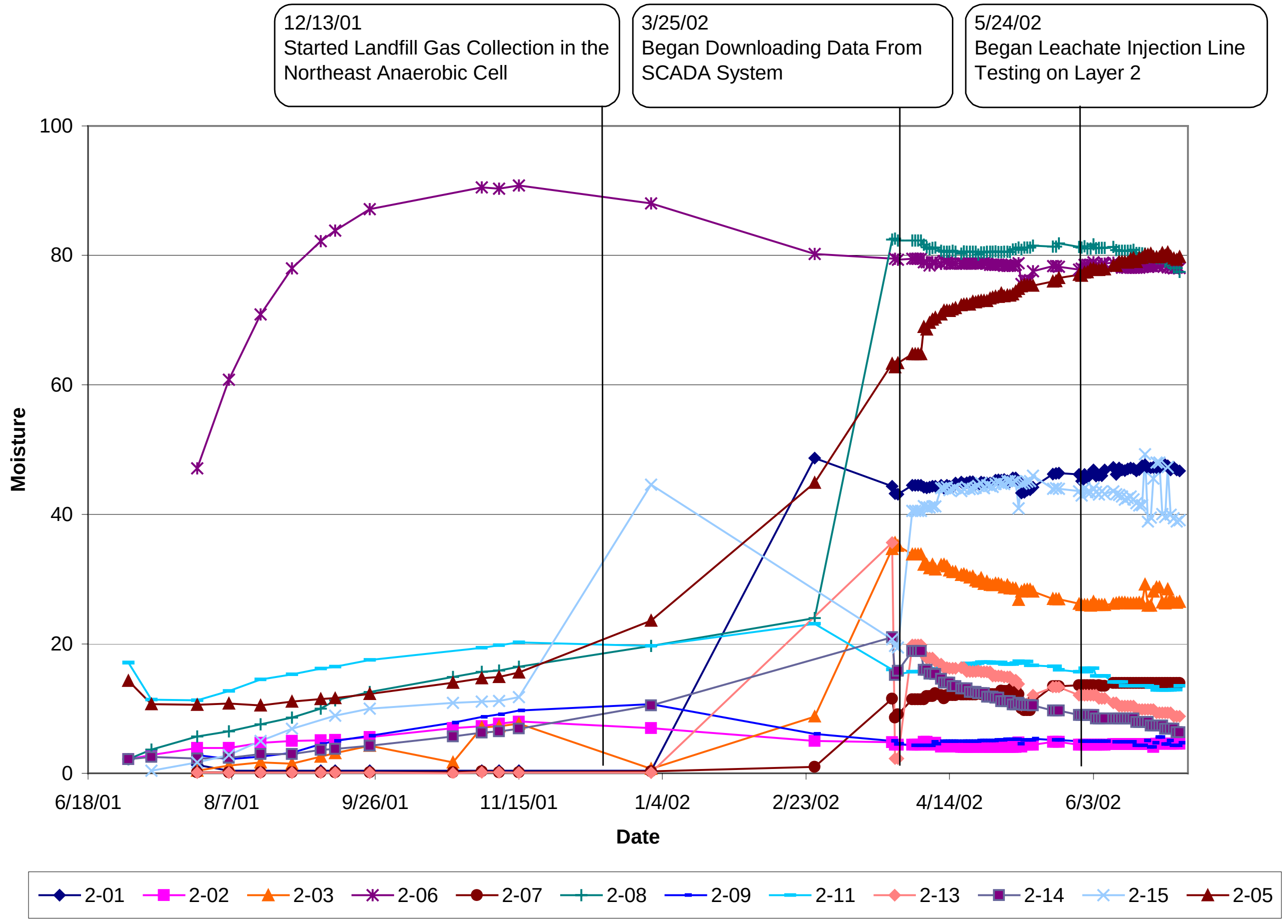


Figure 10. Northeast Anaerobic Cell Layer 3 Moisture Readings (PVC Moisture Sensors)

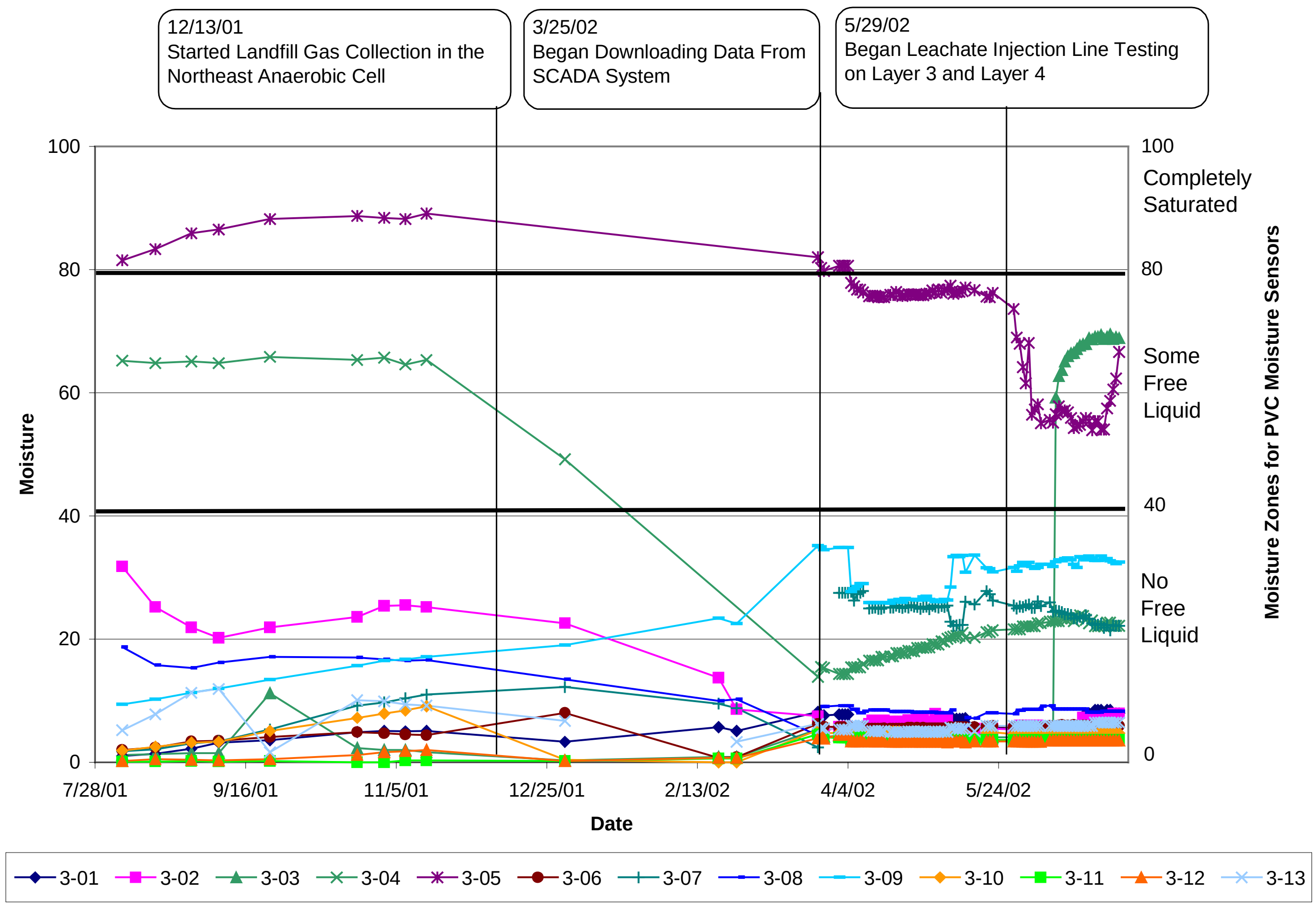


Figure 11. Module D Cumulative Leachate from the Leachate Collection and Removal System (LCRS)

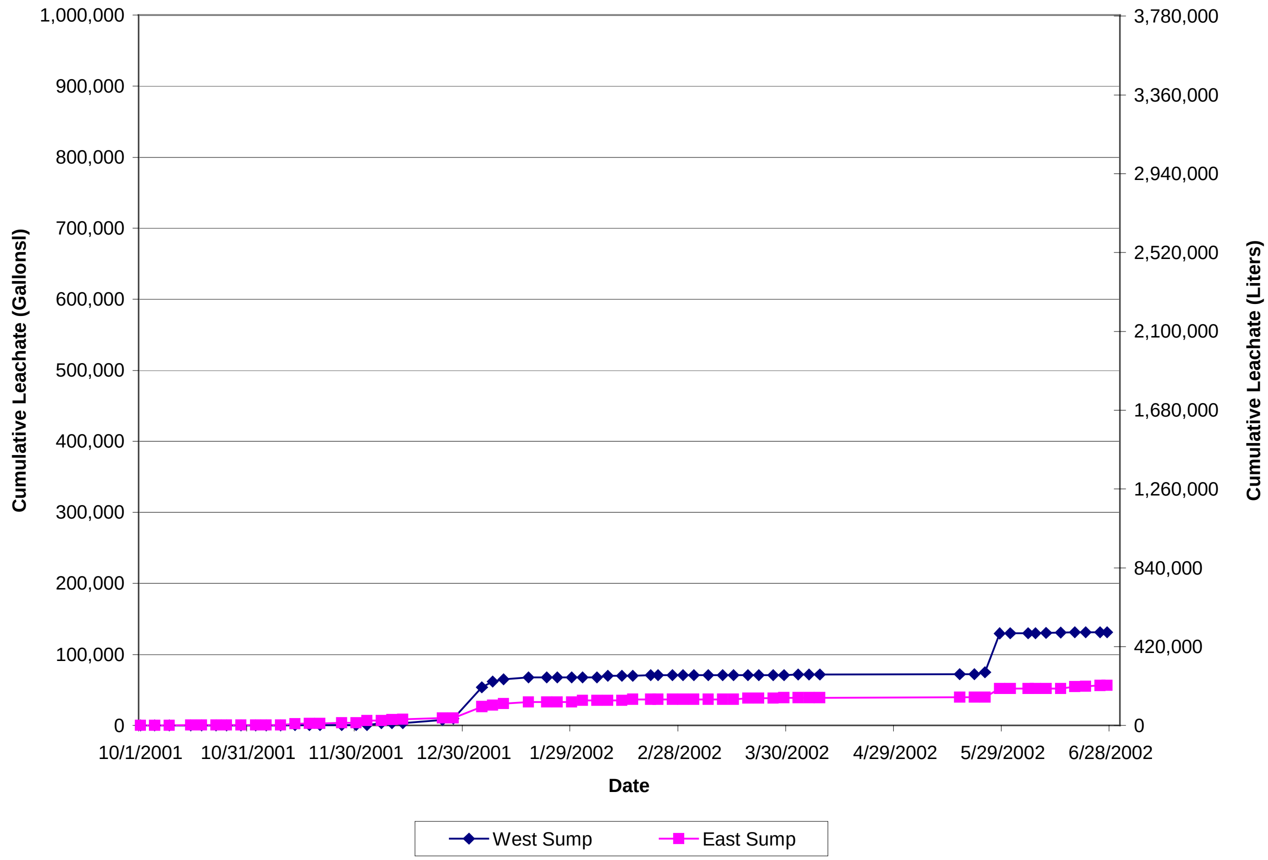


Table 11. Northeast Anaerobic Cell Base Layer Gas Compositions from Sampling Tubes

Sensor[1]	0-36				0-39				0-44				0-47			
Date Installed:	7/28/2000				7/28/2000				7/28/2000				7/28/2000			
Date Covered [2]:	2/16/2001				2/16/2001				2/2/2001				2/2/2001			
Date Monitored	% CH_4	% CO_2	% O_2	% Balance[3]	%CH_4	% CO_2	% O_2	% Balance	%CH_4	% CO_2	% O_2	% Balance	%CH_4	% CO_2	% O_2	% Balance
5/30/2001					18.9	57.6	0.4	22.8								
7/3/2001	21.6	55.6	0	22.4					28.8	57.9	0	12.9				
7/10/2001	45.3	54.6	0	0	40.4	59.7	0.1	0.7	31.7	59.1	0	9.4				
7/11/2001													25.4	53.7	0.3	21
8/22/2001					50.3	48.8	0	0	37.5	55.8	0	604				
9/6/2001					52.9	47.1	0	0	39.2	54.1	0	7.1				
9/21/2001	51.3	49.1	0	0					40.3	55.8	0	3.3				
12/31/2001					35.5	43.2	0.9	20.6	13.7	31	0	55.3				
2/7/2001					17.1	31.5	0	51.4	11	26	0	63				
2/28/2002					33.4	41.6	0	25	19.3	41.7	0	39				
6/27/2002	10.6	24.9	0	64.5	14	26.2	0	59.8	1.1	17.2	1.8	80	7.9	23.4	0	68.7

Sensor[1]	0-48				0-51				0-54			
Date Installed:	7/28/2000				7/28/2000				7/28/2000			
Date Covered[2]:	2/2/2001				2/2/2001				2/2/2001			
Date Monitored	%CH_4	% CO_2	% O_2	% Balance	%CH_4	% CO_2	% O_2	% Balance	%CH_4	% CO_2	% O_2	% Balance
5/30/2001					18.4	54.9	0	26.7				
7/3/2001					23.2	51.4	0	24.6				
7/10/2001												
7/11/2001									41.2	53.8	0.2	0.7
8/22/2001					31.7	49	0	19.3	44.2	54.2	0	1.2
9/6/2001	42.1	56.2	0	1.7								
12/31/2001	10.6	28.2	2.1	58.7								
2/7/2001	6.1	24.9	0	69	19.2	32.9	3.1	44.5				
2/28/2002	23	44	0	33	40	51	0	9				
6/27/2002	4.4	26.4	0	69.2	4.1	25.4	0	70.5	6	25.6	1.8	66.6

[1]Sensor nomenclature: Instrumentation layer # the senor is located - Sensor # on that layer

[2]Date covered refers to the date waste was placed over the sensor

[3]Balance is assumed to be nitrogen

*Gas Compositions measured by the GEM-500 by Landtec

Table 12. Northeast Anaerobic Cell Layer 1 Gas Compositions from Sampling Tubes

Sensor[1]	1-07				1-02				1-05				1-11			
Date Installed:	4/13/2001				4/25/2001				5/8/2001				5/9/2001			
Date Covered[2]:	4/15/2001				4/26/2001				5/9/2001				5/12/2001			
Date:	% CH_4	% CO_2	% O_2	% Balance	% CH_4	% CO_2	% O_2	% Balance	% CH_4	% CO_2	% O_2	% Balance	% CH_4	% CO_2	% O_2	% Balance
5/8/2001	25.4	67.8	0.1	6.7	29.2	54.3	0.1	16.4								
5/30/2001	31.1	60.7	0	8.2									25.1	68.5	0	6.4
7/5/2001					37.7	50.2	2.5	9.3								
7/11/2001					45.4	52.7	0.3	2.1	51	47.3	1.9	0				
8/3/2001													24.7	52.3	0	22.9
8/22/2001					49.7	50.3	0	0	50.2	49.8	0	0				
9/26/2001	44.2	55.3	0	0.6	53.8	46.2	0	0					48.2	51.8	0	0
11/1/2001	43.2	46.1	0	10.7	43.2	46.1	0	10.7								
11/28/2001	45.8	50.8	0	3.5					54.6	45.4	0	0				
2/26/2002	29	43.6	0	27.4					46.2	43.6	0	10.2				
6/27/2002	24.3	38.7	0	37	24	32.2	0.7	43.1	48.9	40.1	0.7	10.3	37.5	48.7	0.1	13.7

Sensor	1-03			
Date Installed:	5/14/2001			
Date Covered:	5/14/2001			
Date:	% CH_4	% CO_2	% O_2	% Balance
5/8/2001				
5/30/2001				
7/5/2001				
7/11/2001	3.8	10.7	12.6	72.6
8/3/2001				
8/22/2001	43.6	53.2	0	2.5
9/26/2001				
11/1/2001				
11/28/2001	50.2	47.5	0	2.6
2/26/2002	45.2	41.7	0	13.1
6/27/2002	48	39.7	0	12.3

*Table Is Organized Based On Cover Dates

[1]Sensor nomenclature: Instrumentation layer # the senor is located - Sensor # on that layer

[2]Date covered refers to the date waste was placed over the sensor

[3]Balance is assumed to be nitrogen

*Gas Compositions measured by the GEM-500 by Landtec

Table 13. Northeast Anaerobic Cell Layer 2 Gas Compositions from Sampling Tubes

Sensor[1]	2-07				2-01				2-04				2-09			
Date Installed:	6/1/2001				6/1/2001				6/7/2001				7/5/2001			
Date Covered[2]:	6/5/2001				6/6/2001				6/8/2001				7/6/2001			
Date:	% CH_4	% CO_2	% O_2	% Balance	% CH_4	% CO_2	% O_2	% Balance	% CH_4	% CO_2	% O_2	% Balance	% CH_4	% CO_2	% O_2	% Balance
6/11/2001	0.4	4.3	17	78.3	0.4	5.2	16.4	77.9								
7/2/2001																
7/12/2001	0.3	4	18.1	77.6	0.7	4.5	17.6	77	0.1	4.8	15.9	79.1	0	3.5	18.8	77.6
8/22/2001									0.5	13.2	18.4	77.9	0.4	5.4	18.1	76.3
9/26/2001					22.8	37.1	1.8	38.7					21	55.4	0.2	23.6
11/1/2001					35.2	42.2	0.5	22.2	37	56.6	0	6.3	24.3	44.9	0	31
11/28/2001					39.5	46.6	0	13.9	21.2	31.2	7.8	39.8				
2/28/2002	36.8	46.2	0.3	16.6	41.3	44.7	0	14					13.9	22.6	8.3	55.2
6/27/2002	51	48	0	1	37	41	0	23	21	44	0	15	7	15	11	66

*Table Is Organized Based On Cover Dates

[1]Sensor nomenclature: Instrumentation layer # the senor is located - Sensor # on that layer

[2]Date covered refers to the date waste was placed over the sensor

[3]Balance is assumed to be nitrogen

*Gas Compositions measured by the GEM-500 by Landtec

Table 14. Northeast Anaerobic Cell Layer 3 Gas Compositions from Sampling Tubes

Sensors[1]	3-01				3-09				3-02				3-10			
Date Installed:	7/13/2001				7/17/2001				7/20/2001				7/27/2001			
Date Covered[2]:	7/17/2001				7/19/2001				7/23/2001				7/29/2001			
Date:	%CH_4	%CO_2	%O_2	%Balance[3]	%CH_4	%CO_2	%O_2	%Balance	%CH_4	%CO_2	%O_2	%Balance	%CH_4	%CO_2	%O_2	%Balance
9/21/2001	31.6	30.2	0	17.7	27.5	61.2	0	11.5	19.3	62.6	0	18.1				
9/26/2001	28.7	48.6	0	13.2	26	57.8	0	16.1								
11/1/2001	36.9	52	0	10	24.4	50.2	0	25.3					23.7	57	0	20.3
11/28/2001	45.1	50.4	0	4.4					19.6	55.1	0	24.5	19.3	48	0	32.7
2/7/2002	41.7	45.5	0	12.8												
6/27/2002	37	41	0	22	36	40	0	24					32	46	0	22

*Table Is Organized Based On Cover Dates

[1]Sensor nomenclature: Instrumentation layer # the senor is located - Sensor # on that layer

[2]Date covered refers to the date waste was placed over the sensor

[3]Balance is assumed to be nitrogen

*Gas Compositions measured by the GEM-500 by Landtec

Figure 12. Northeast Anaerobic Cell Methane Concentrations from LFG Extraction WellHeads

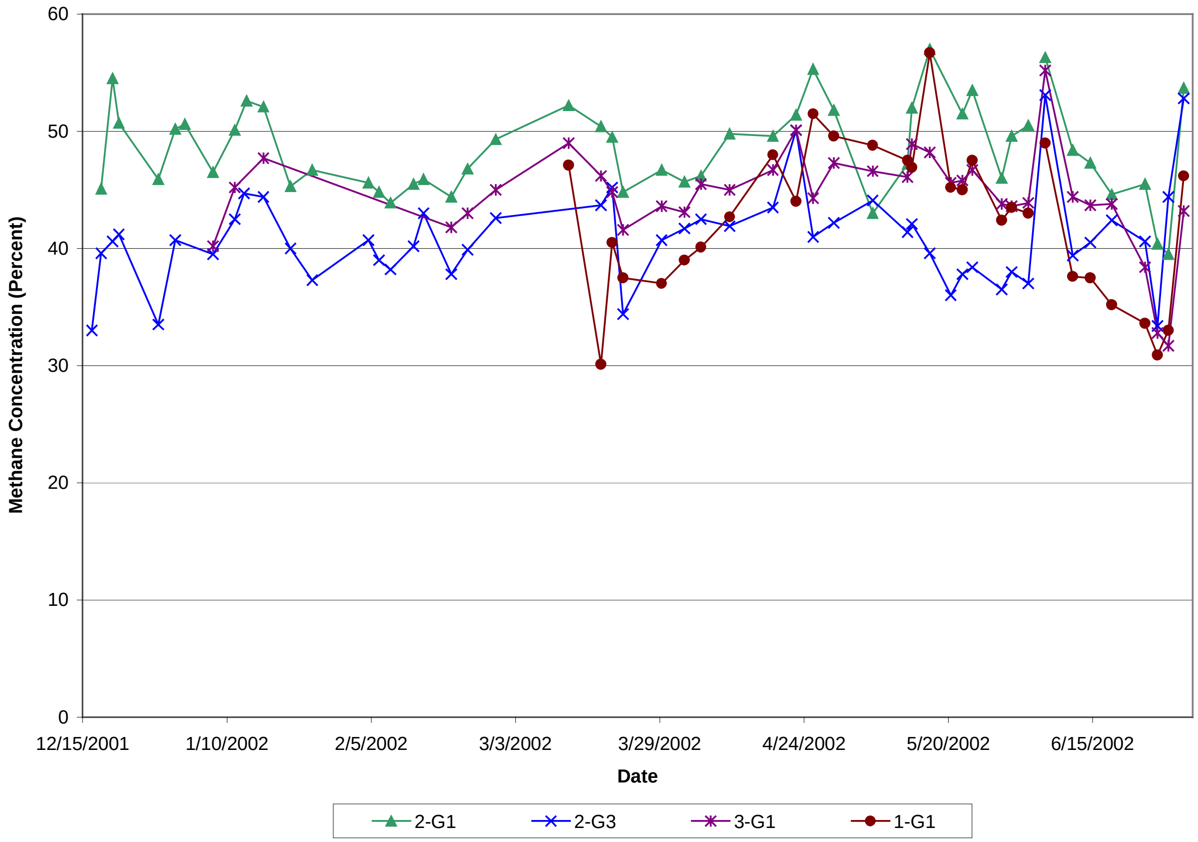


Figure 13. Northeast Anaerobic Cell Landfill Gas Concentrations from Header Line

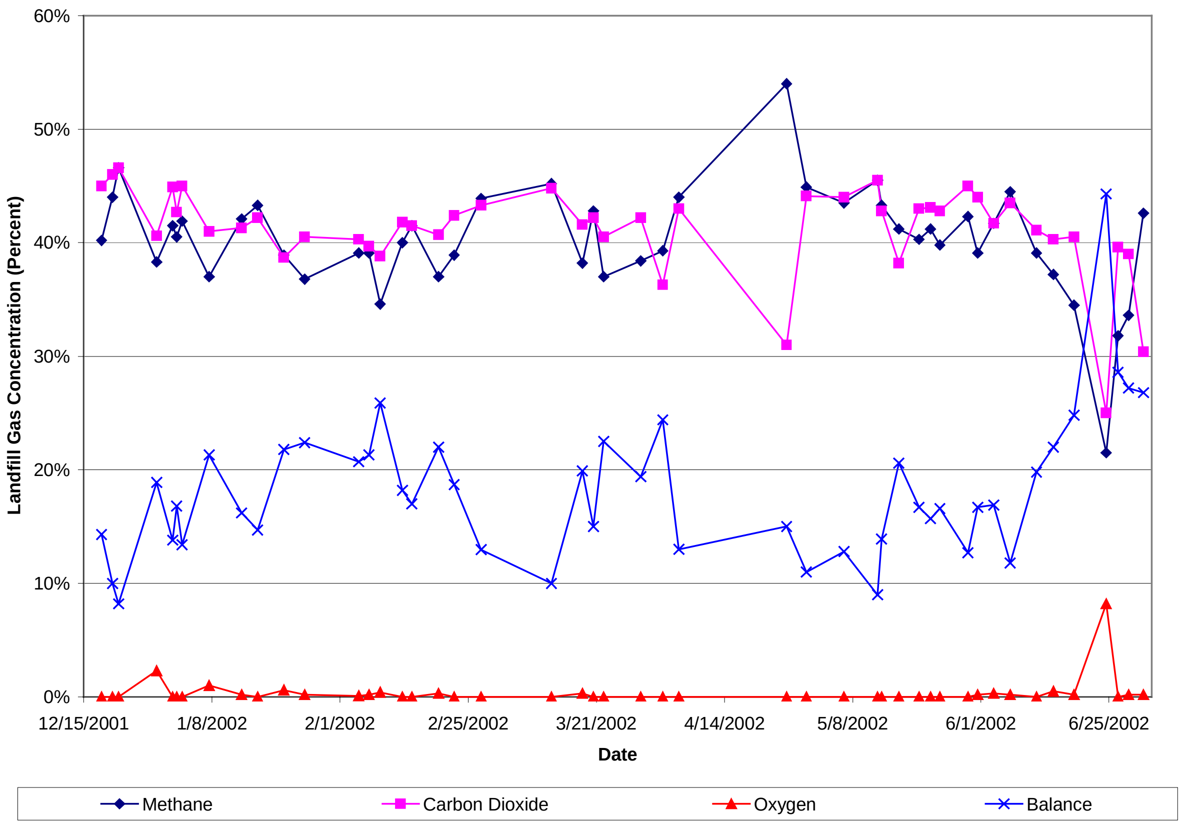


Figure 14. Northeast Anaerobic Cell Methane Flow Rates from Wellheads

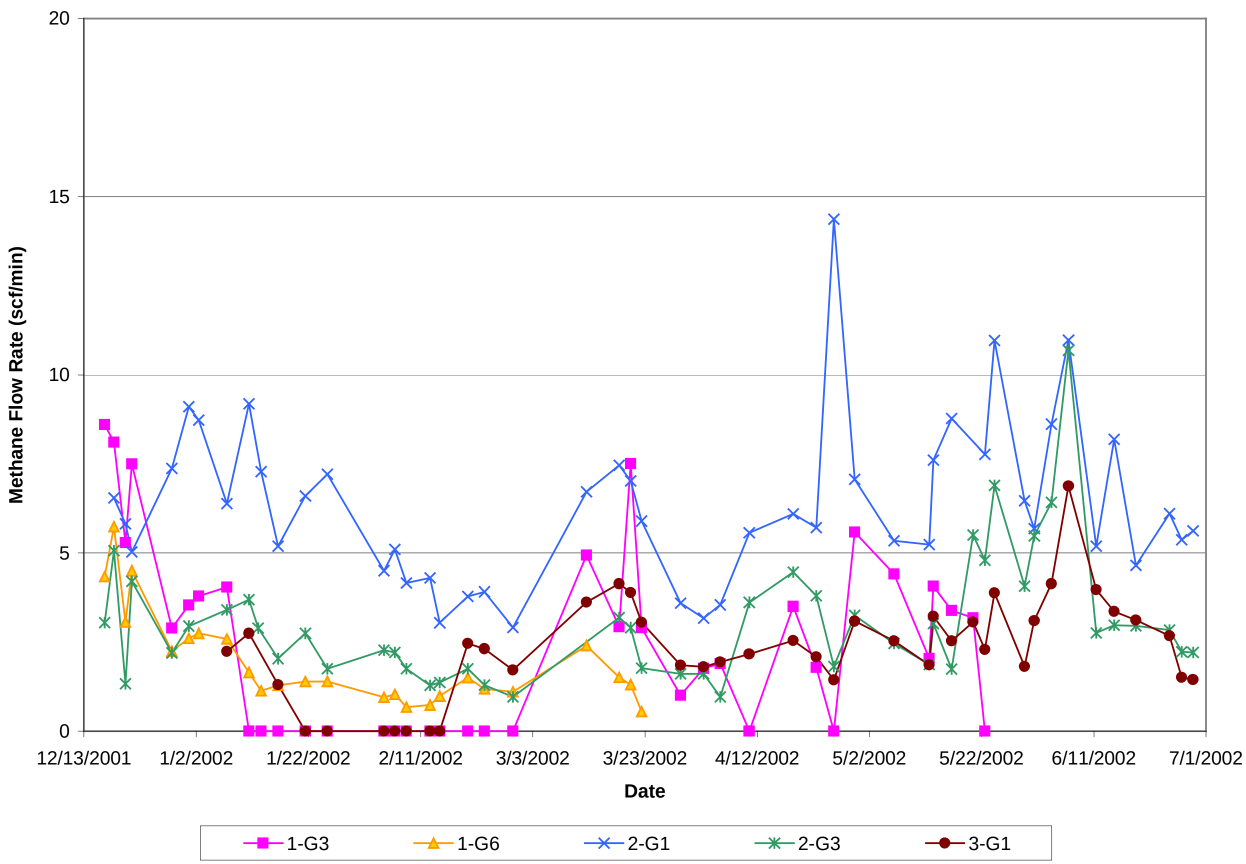


Figure 15. Northeast Anaerobic Cell Cumulative Methane

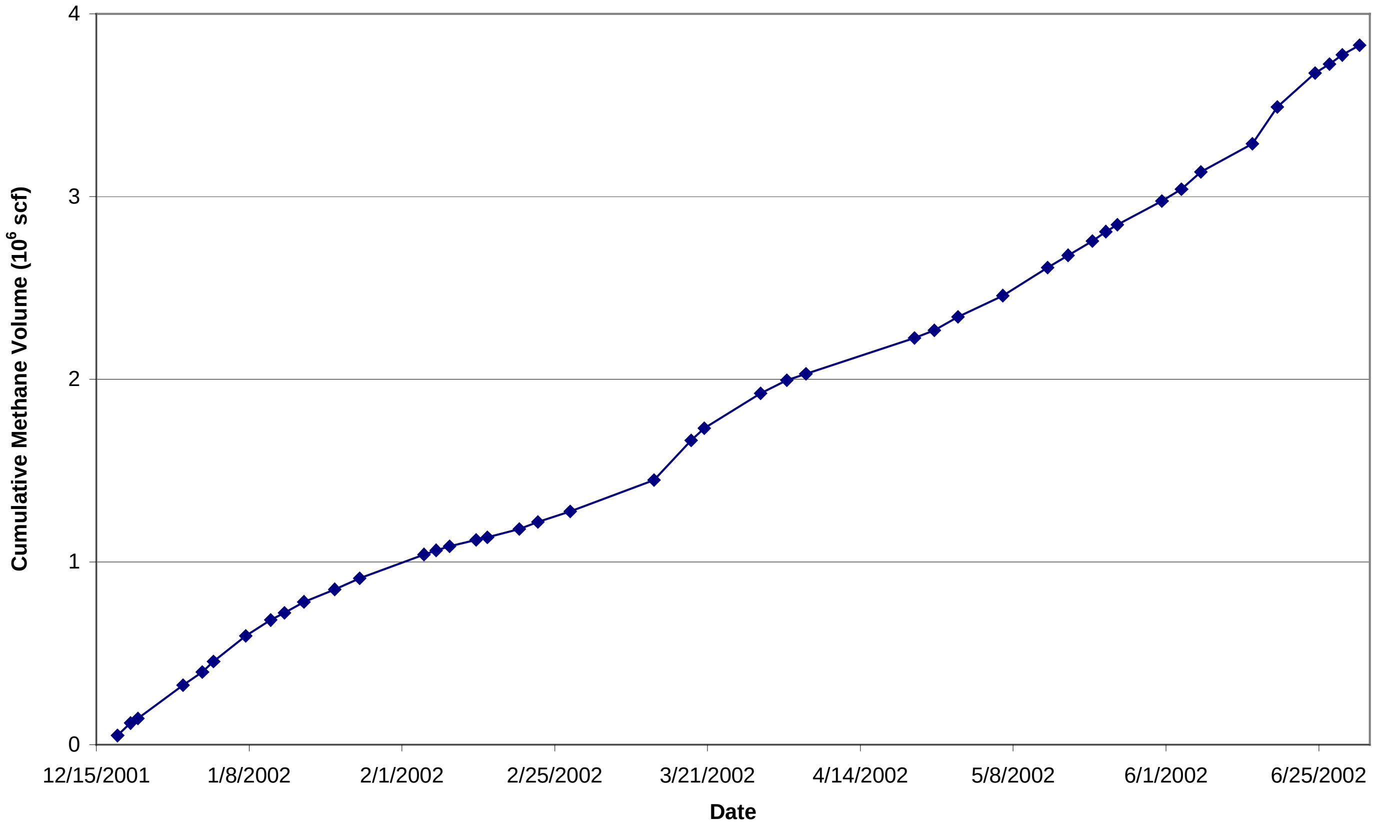


Figure 16. West-Side Anaerobic Cell (Southwest Quadrant) Base Layer Temperature Readings

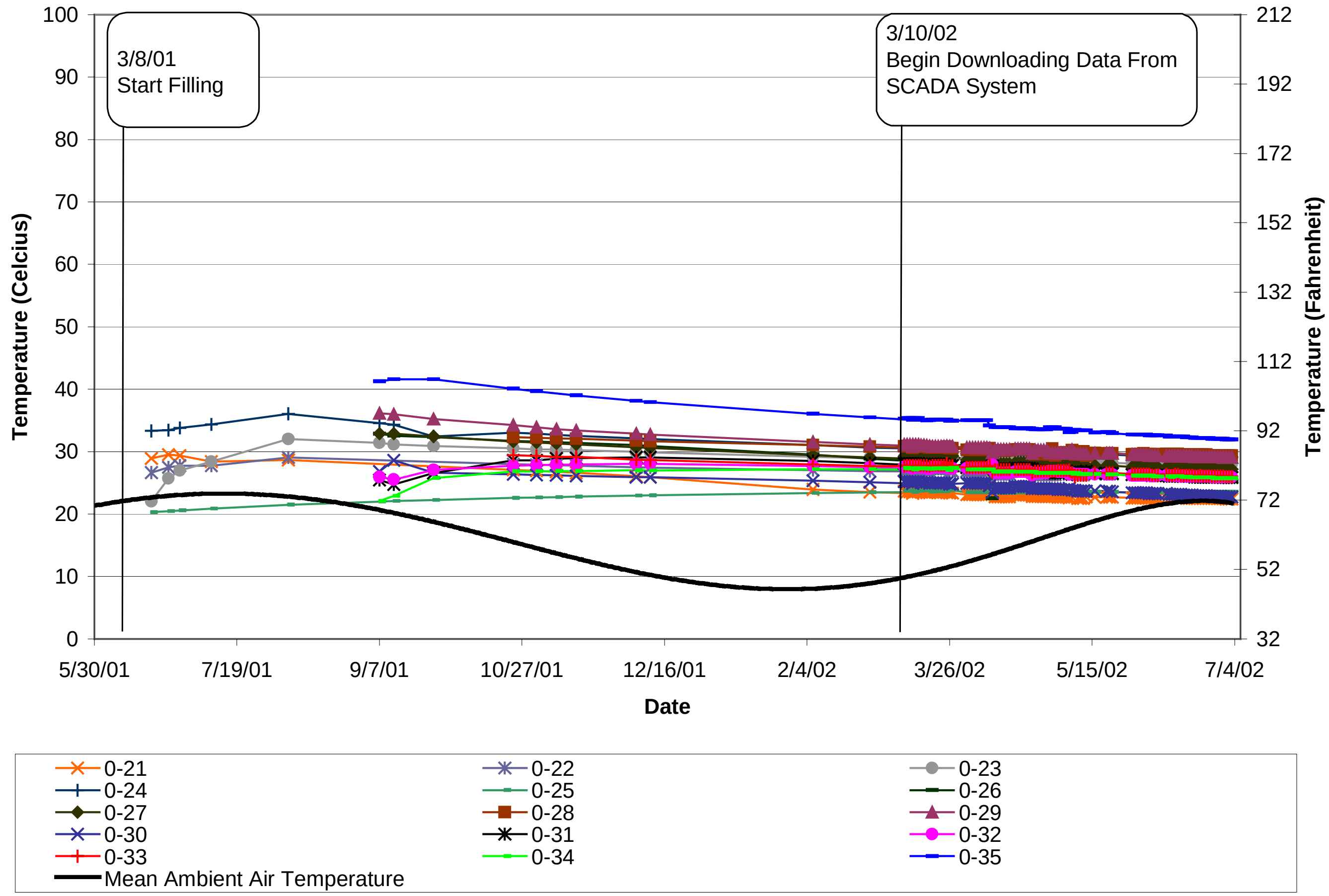


Figure 17. West-Side Anaerobic Cell (Norththwest Quadrant) Base Layer Temperature Readings

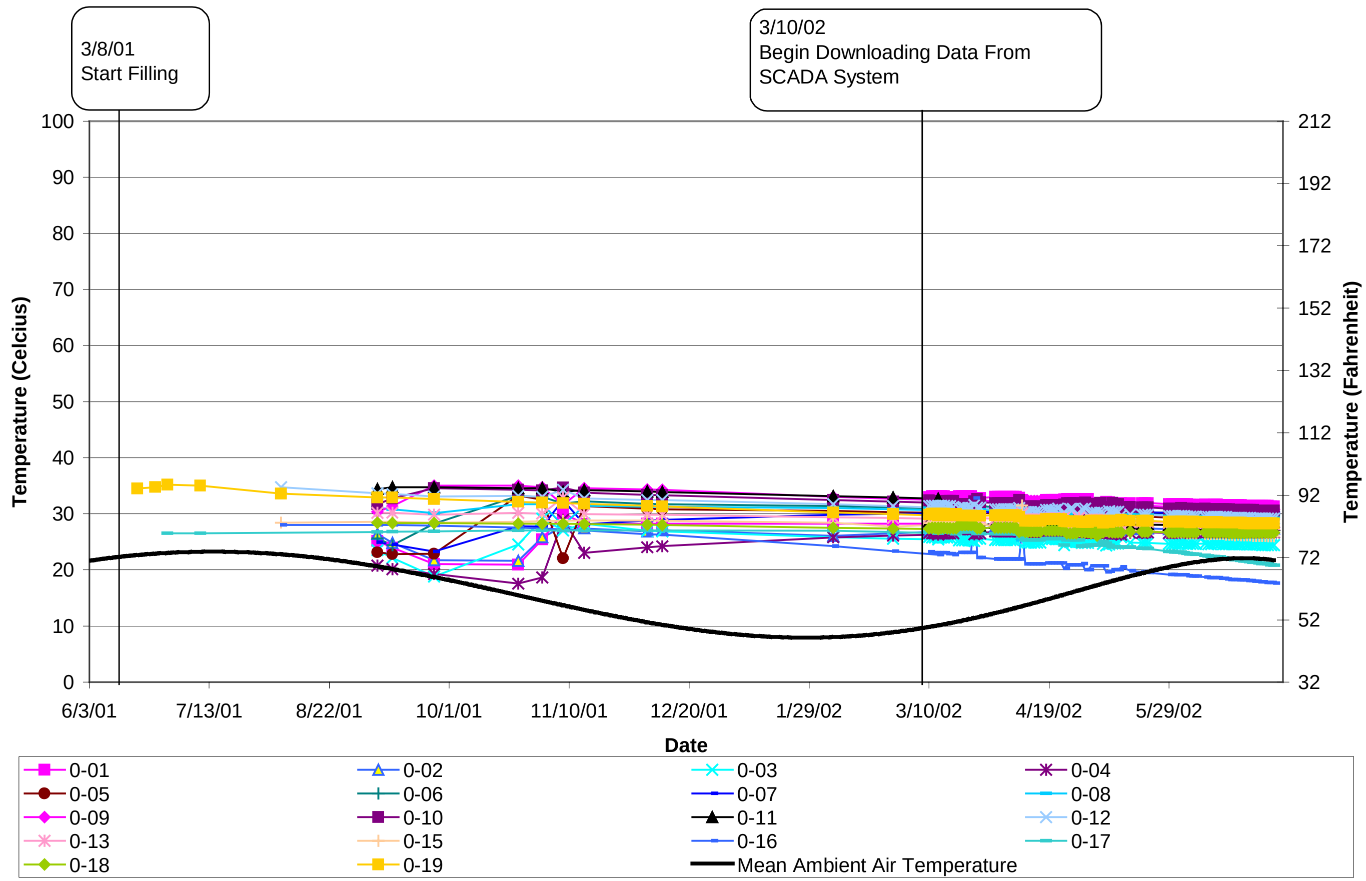


Figure 18. West-Side Anaerobic Cell Base Layer Moisture Readings (PVC Moisture Sensors)

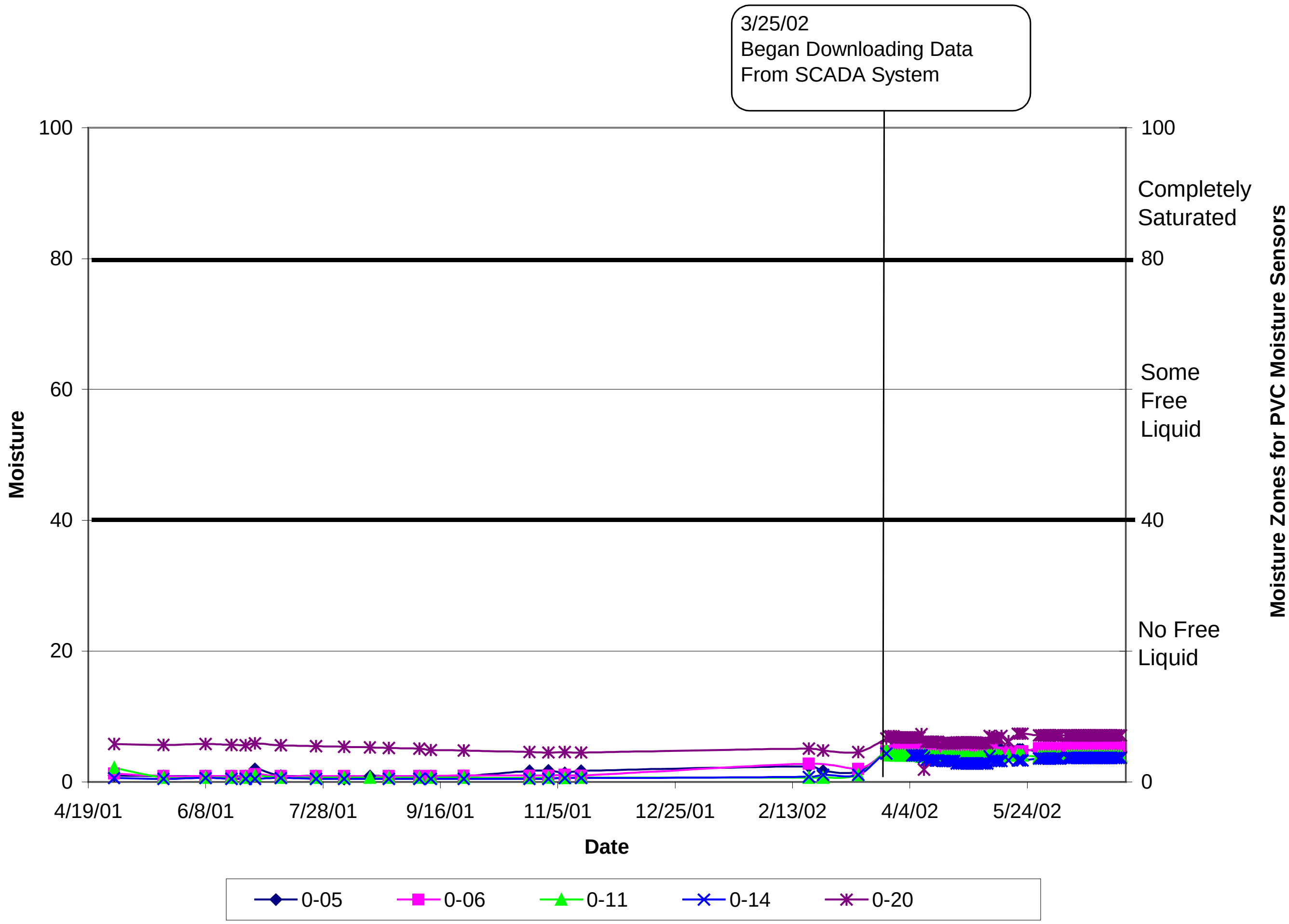


Table 15. West-Side Anaerobic Cell Base Layer Gas Compositions from Sampling Tubes

Sensor[1]	0-04				0-17				0-19				0-34			
Date Installed:	10/9/2000				10/9/2000				10/9/2000				10/11/2000			
Date Covered[2]:	11/1/2001				6/18/2001				6/18/2001				9/20/2001			
Date Monitored	% CH_4	% CO_2	% O_2	% Balance[3]	% CH_4	% CO_2	% O_2	% Balance	% CH_4	% CO_2	% O_2	% Balance	% CH_4	% CO_2	% O_2	% Balance
7/3/2001																
7/10/2001									7.1	22.6	9.9	60.2				
8/21/2001					7.2	34.7	0	58.1	25.1	40.5	0	34.3				
9/6/2001					5.4	30.7	0.1	63.8								
9/21/2001									46.6	41.3	0	12.2				
12/31/2001	18.6	57	0.6	24									16.2	53.9	0.3	29.3
2/7/2002	38.5	57.1	0.6	3.8	23.7	58.7	0	17.6	27	57.1	0.2	15.7	22	60.2	0	17.8
2/28/2002	40.9	59.1	0	0	33.3	58.1	0	0.6	31.3	58.7	0	10	22	60.2	0	17.8
4/9/2002	38.6	54.1	0	7.3	30.9	64.3	0	4.8								
6/27/2002	42.3	56.6	0.3	0.6	42.8	57.2	0.1	0	36.9	60.1	0	3	42.1	57.9	0	0

[1]Sensor nomenclature: Instrumentation layer # the senor is located - Sensor # on that layer

[2]Date covered refers to the date waste was placed over the sensor

[3]Balance is assumed to be nitrogen

*Gas Compositions measured by the GEM-500 by Landtec

Figure 19. Southeast Quadrant Anaerobic Base Liner Temperature Readings

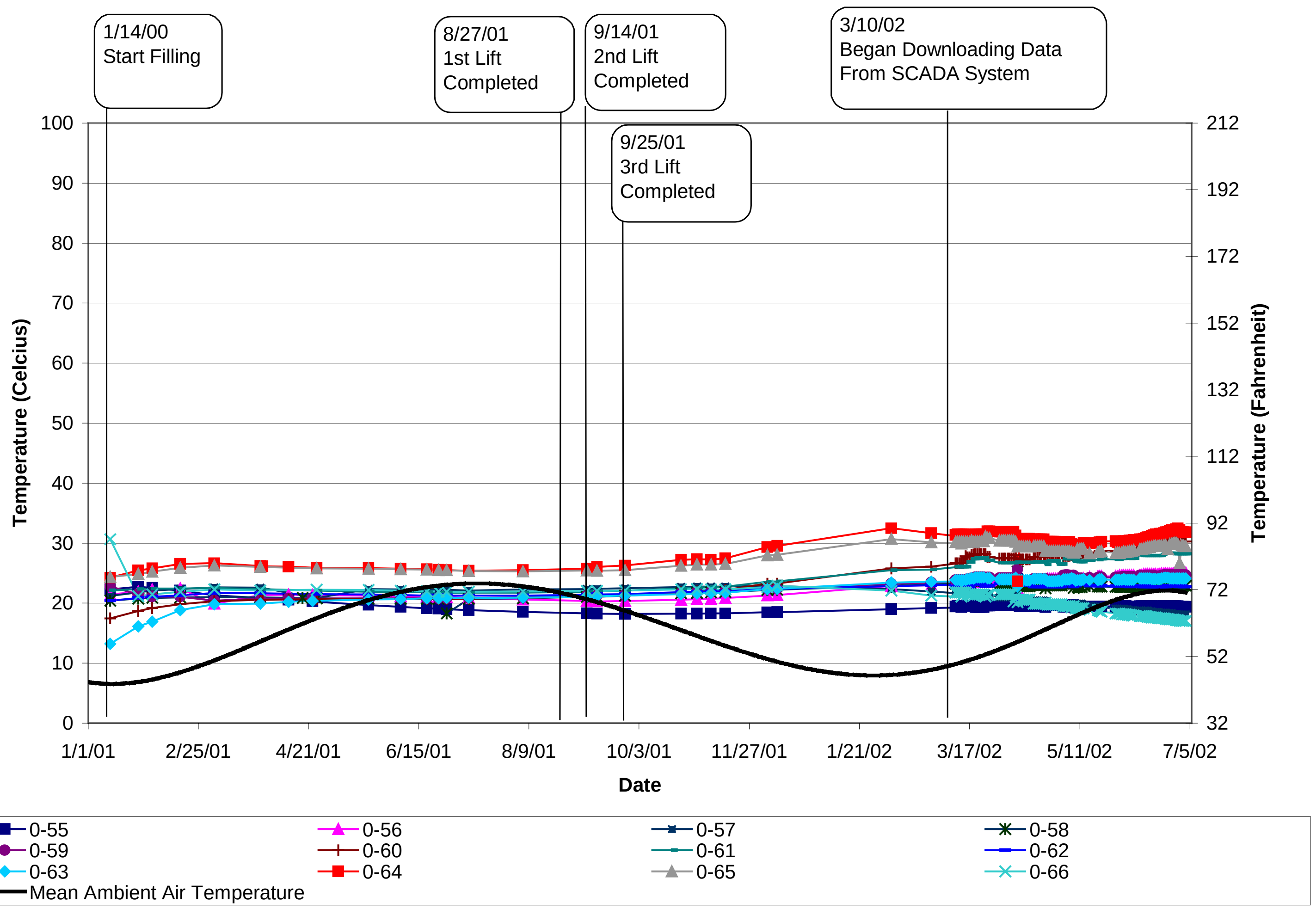


Figure 20. Aerobic Cell Base Layer Temperature Readings

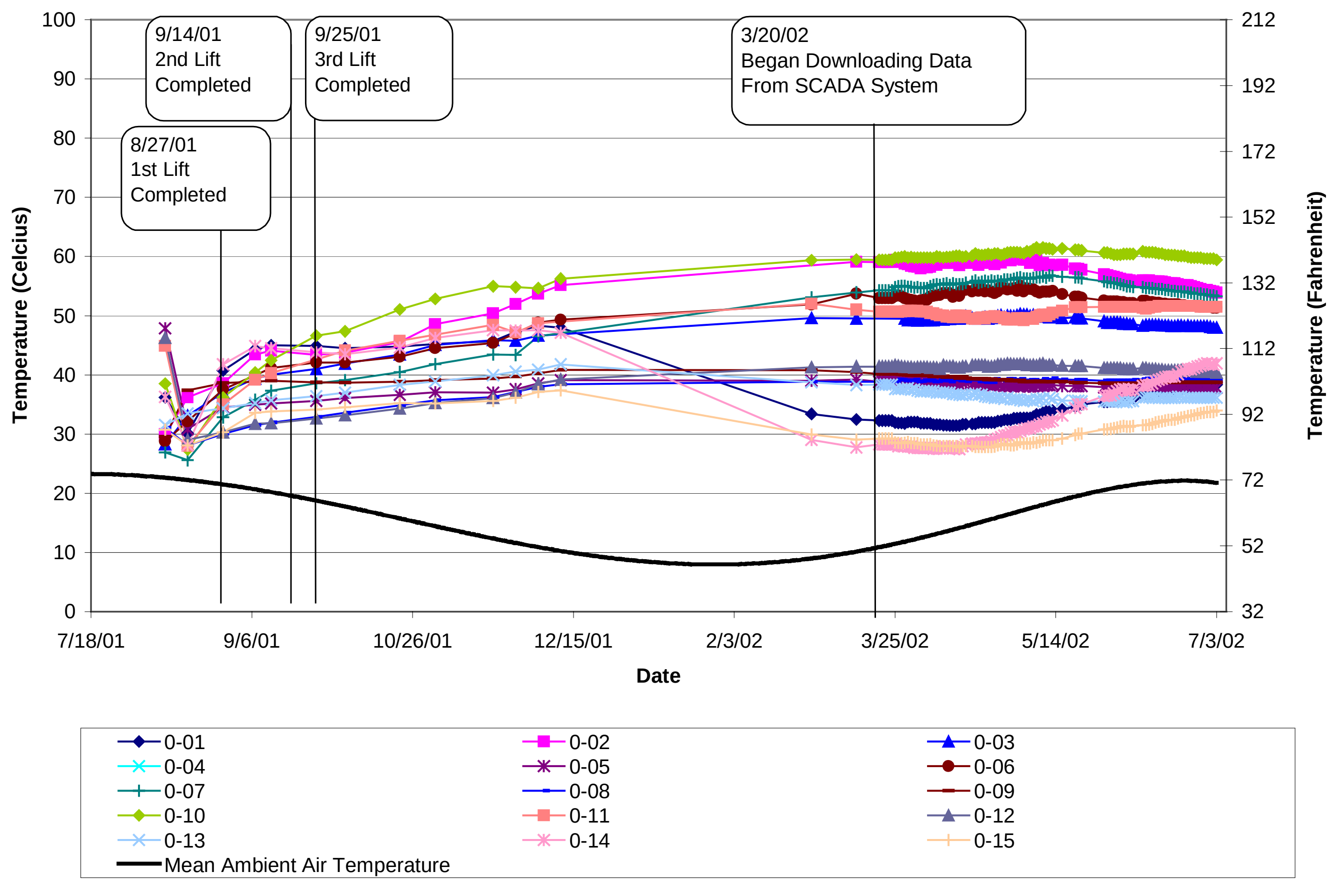


Figure 21. Aerobic Cell Layer 0.5 Temperature Readings

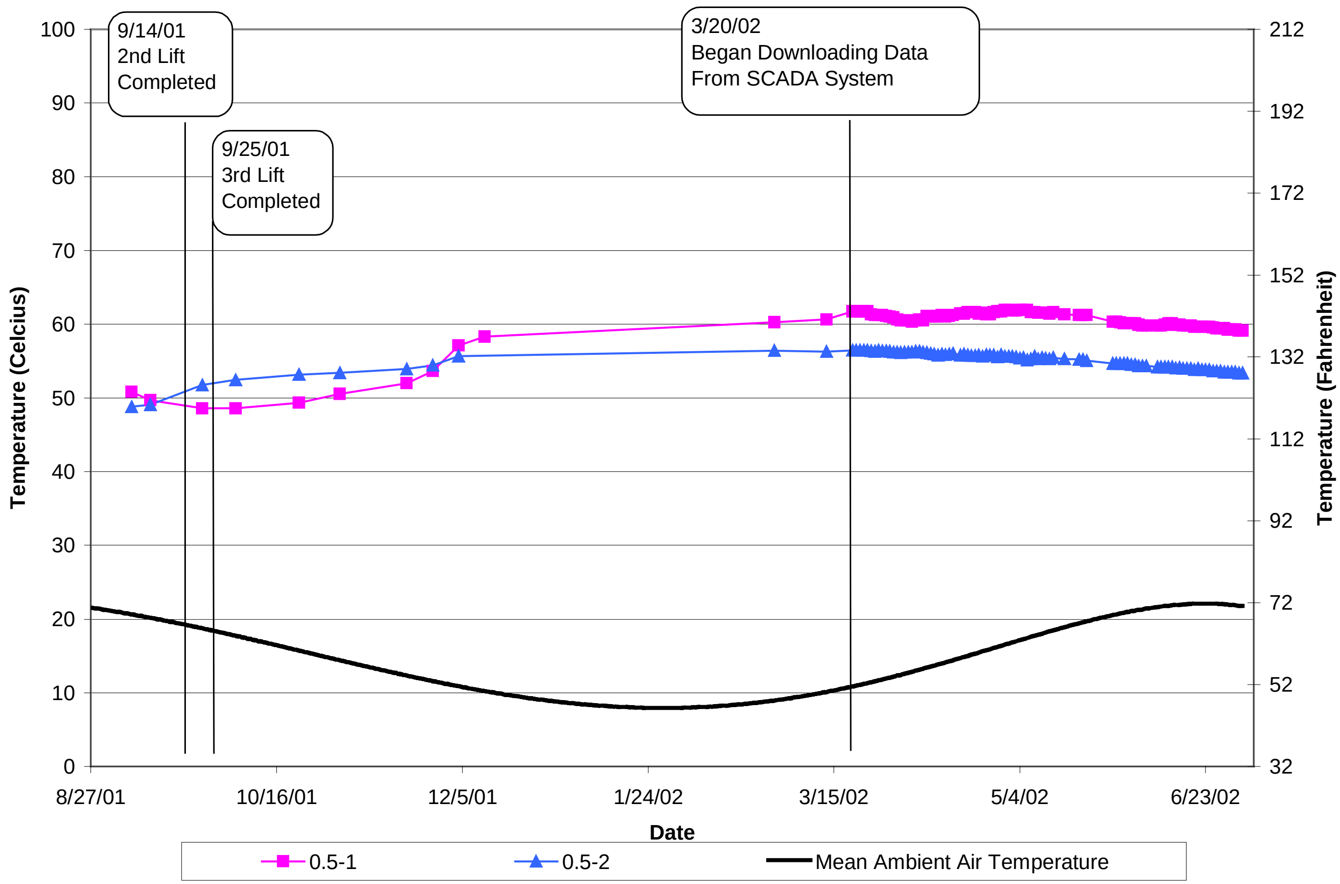


Figure 22. Aerobic Cell Layer 1 Temperature Readings

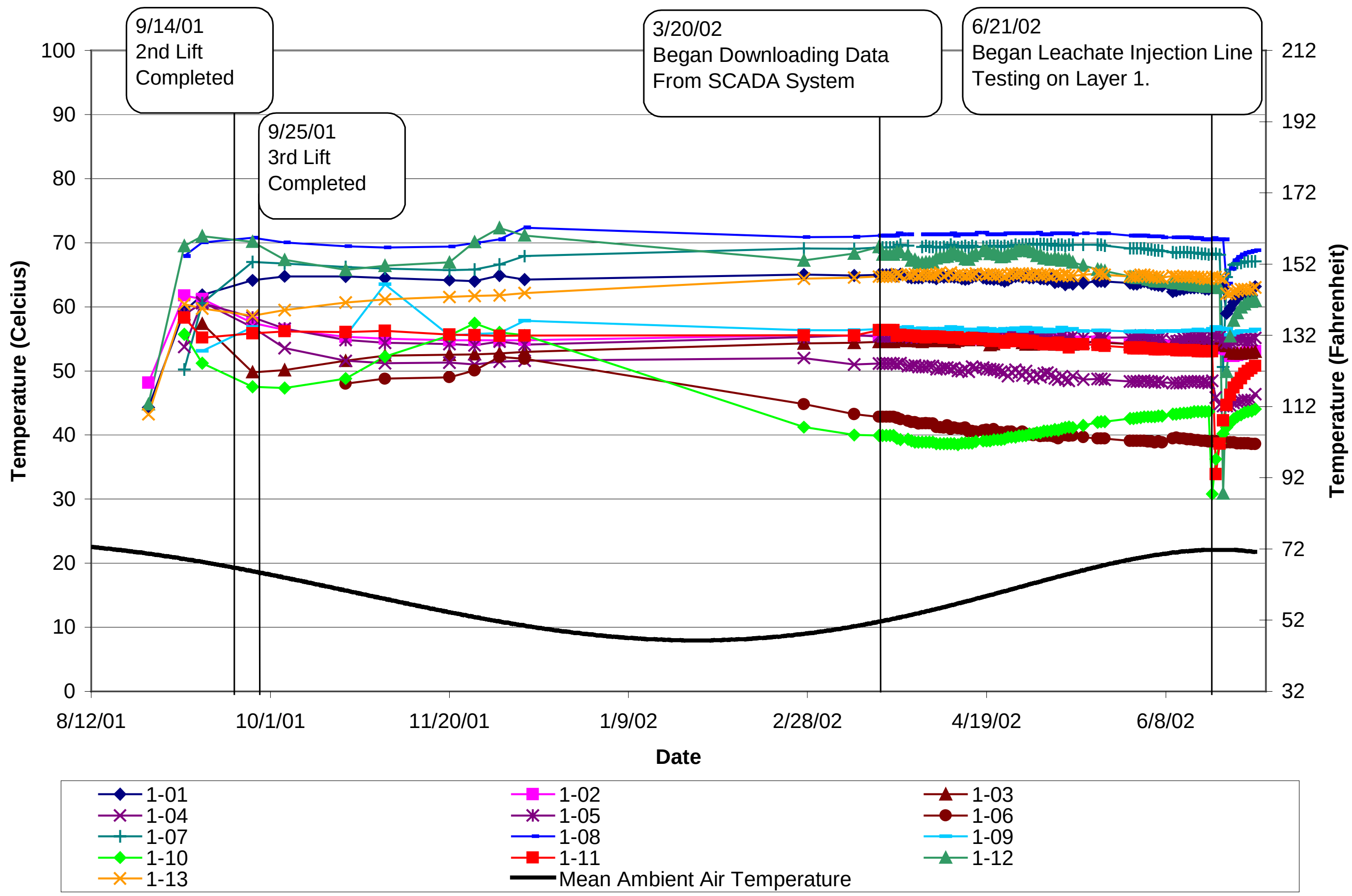


Figure 23. Aerobic Cell Layer 2 Temperature Readings

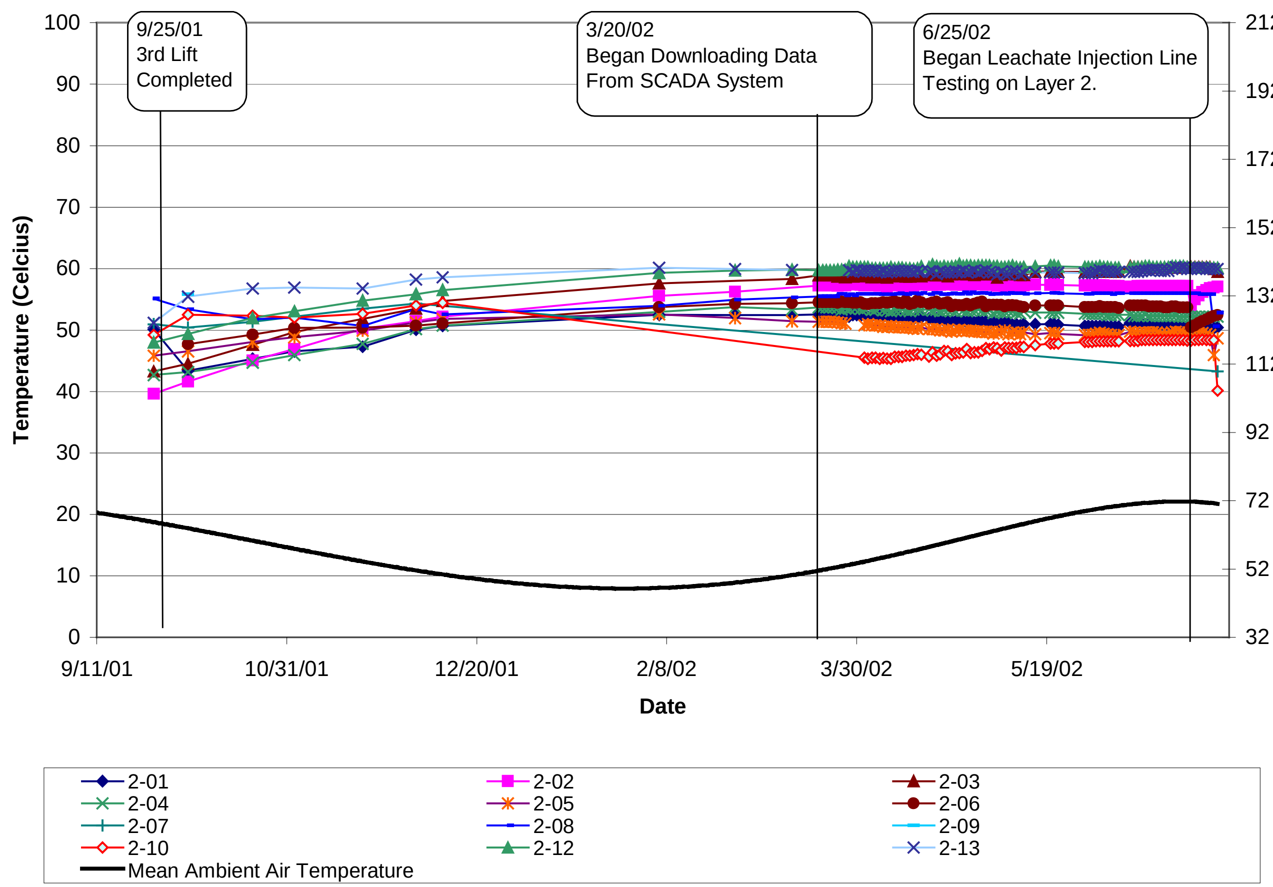


Figure 24. Southeast Quadrant Anaerobic Base Liner Moisture Readings (PVC Moisture Sensors)

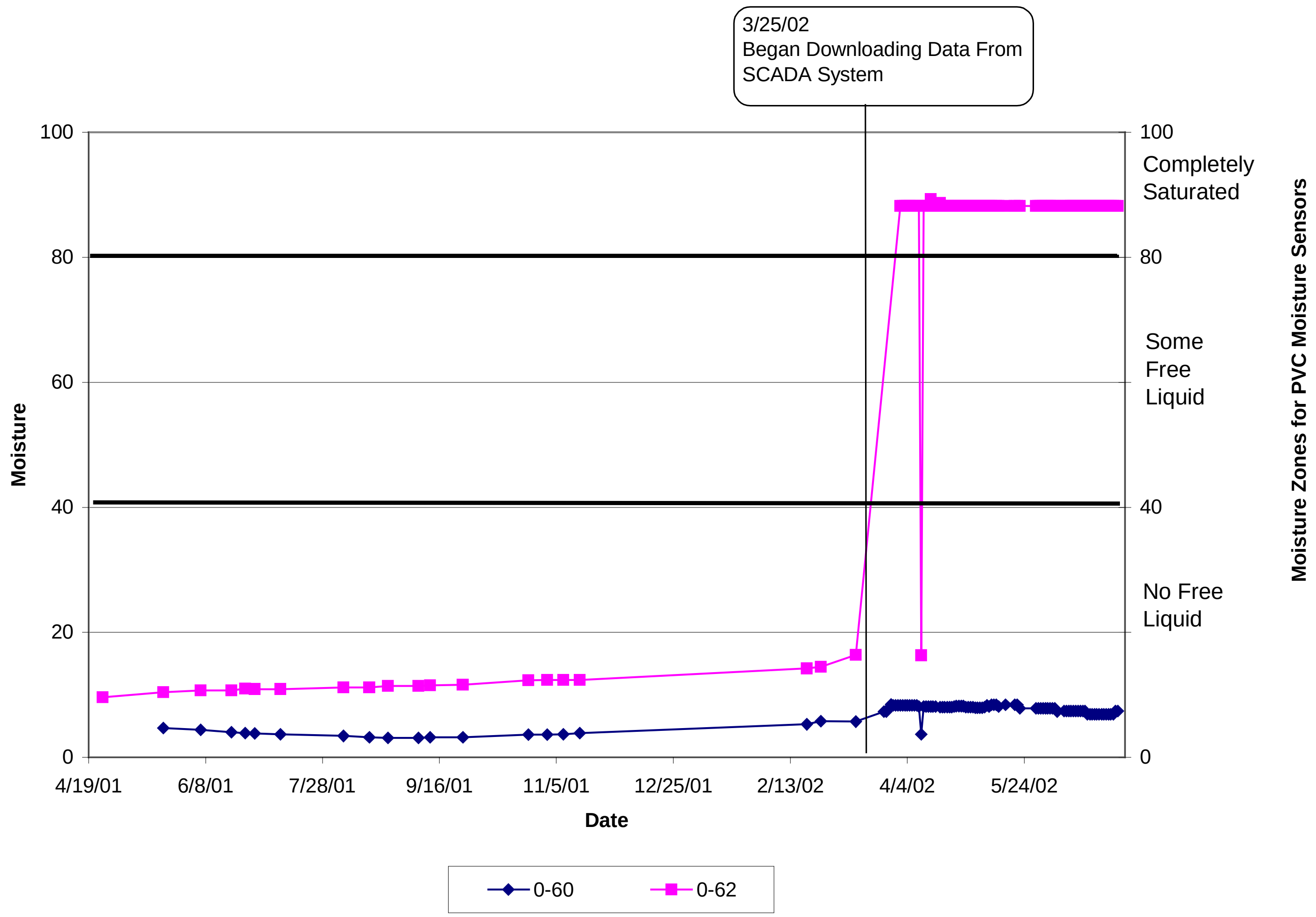


Figure 25. Aerobic Cell Base Layer Moisture Readings (PVC Moisture Sensors)

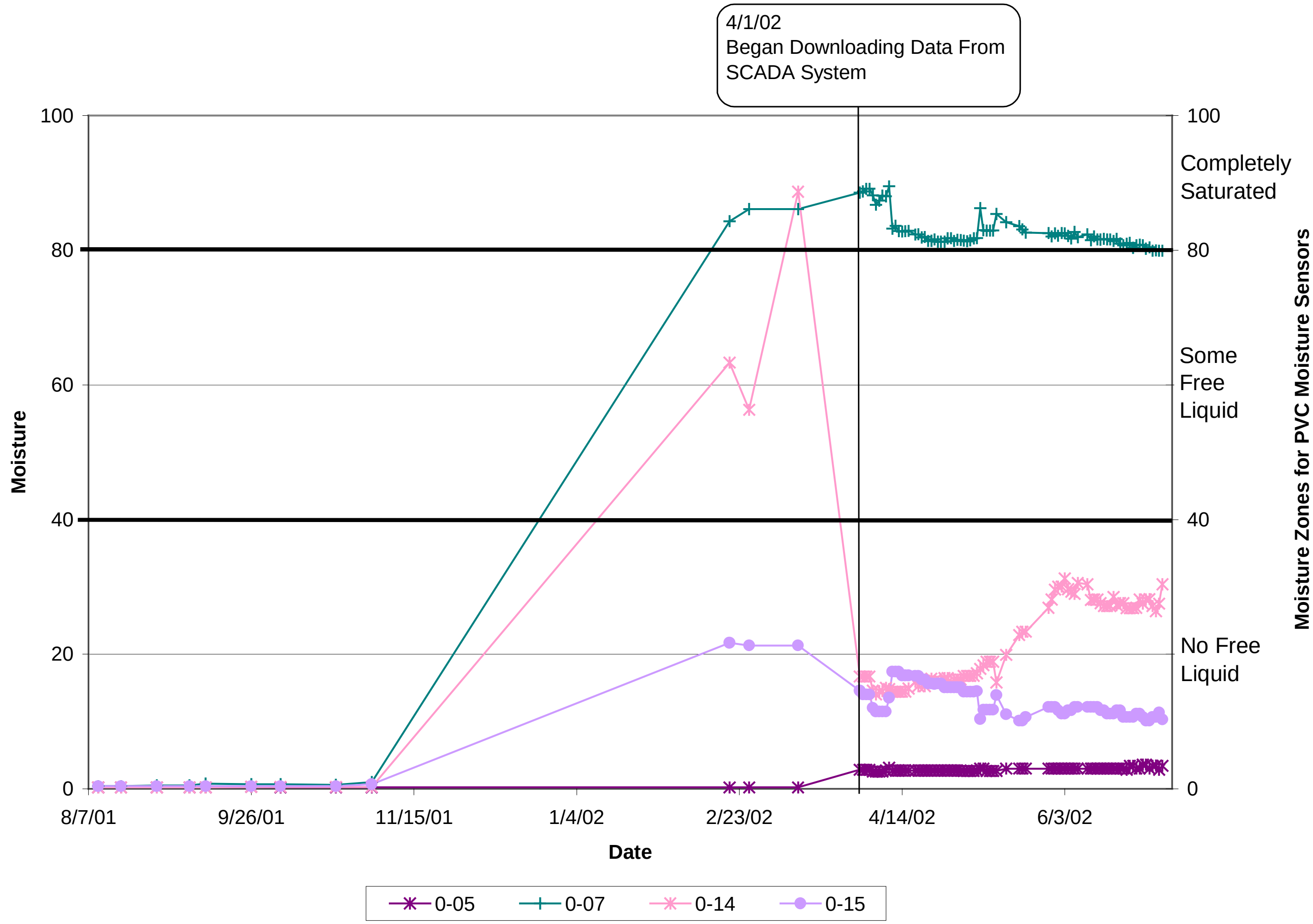


Figure 26. Aerobic Cell Layer 0.5 Moisture Readings (PVC Moisture Sensors)

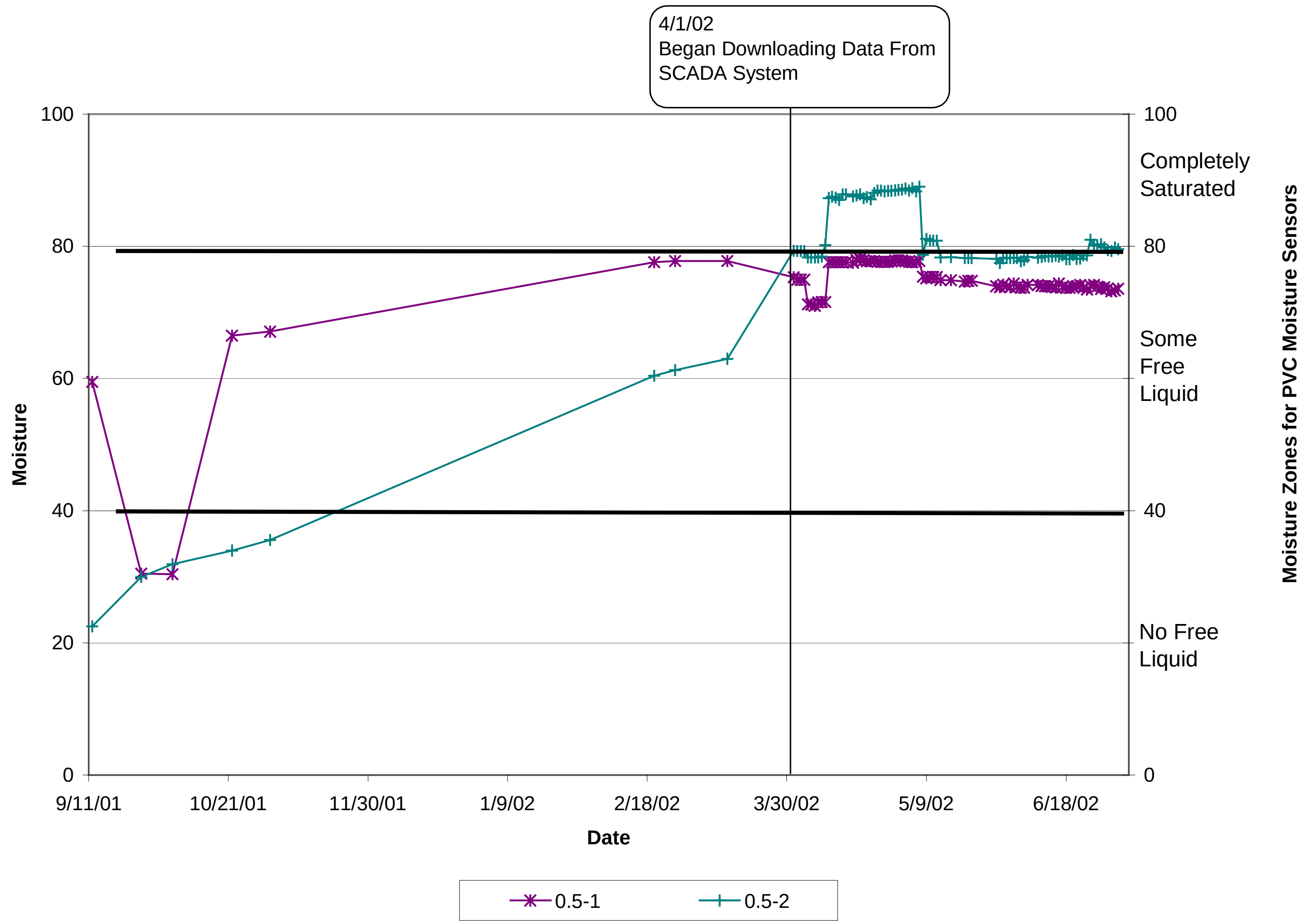


Figure 27. Aerobic Cell Layer 1 Moisture Readings (PVC Moisture Sensors)

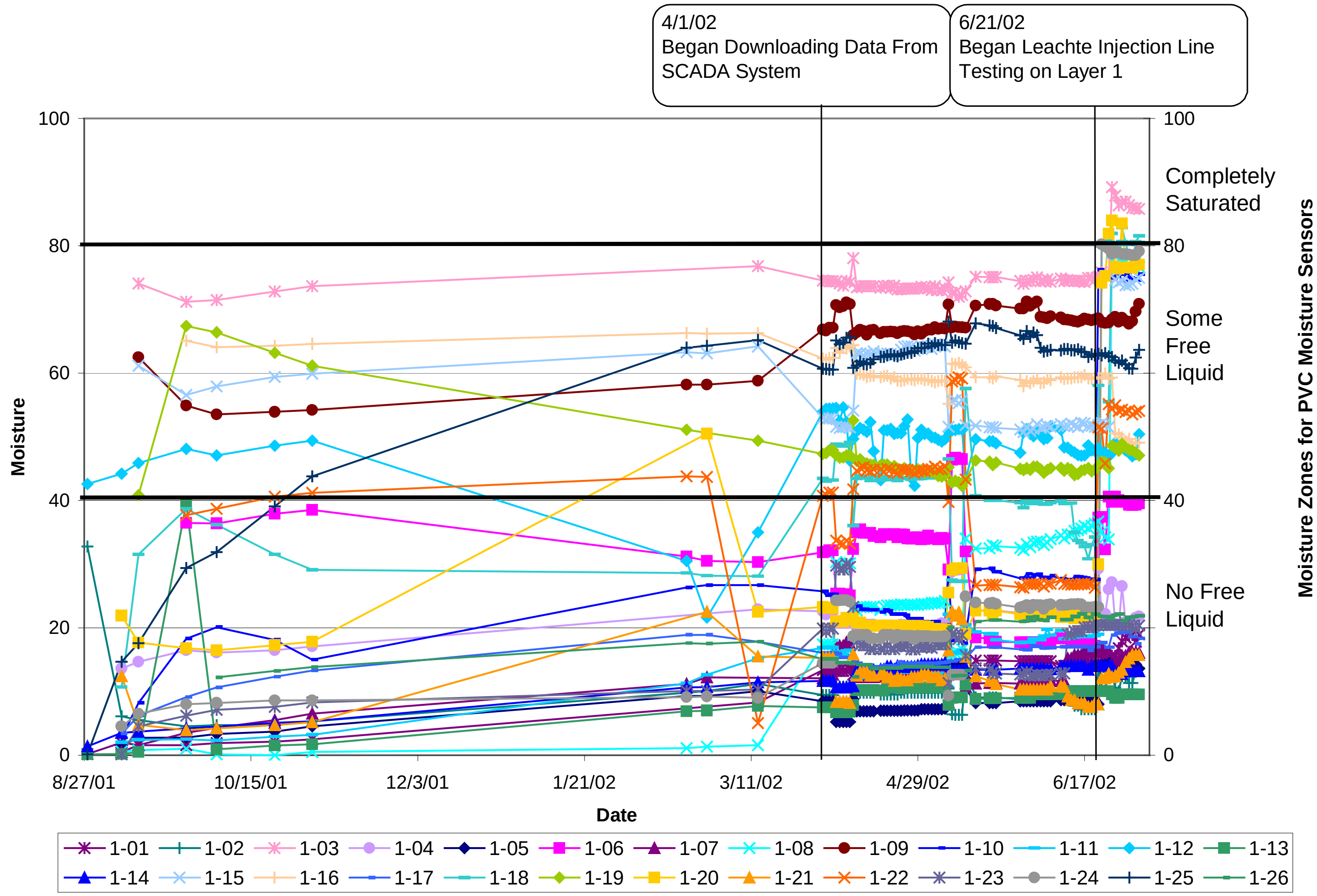


Figure 28. Aerobic Cell Layer 2 Moisture Readings (PVC Moisture Sensors)

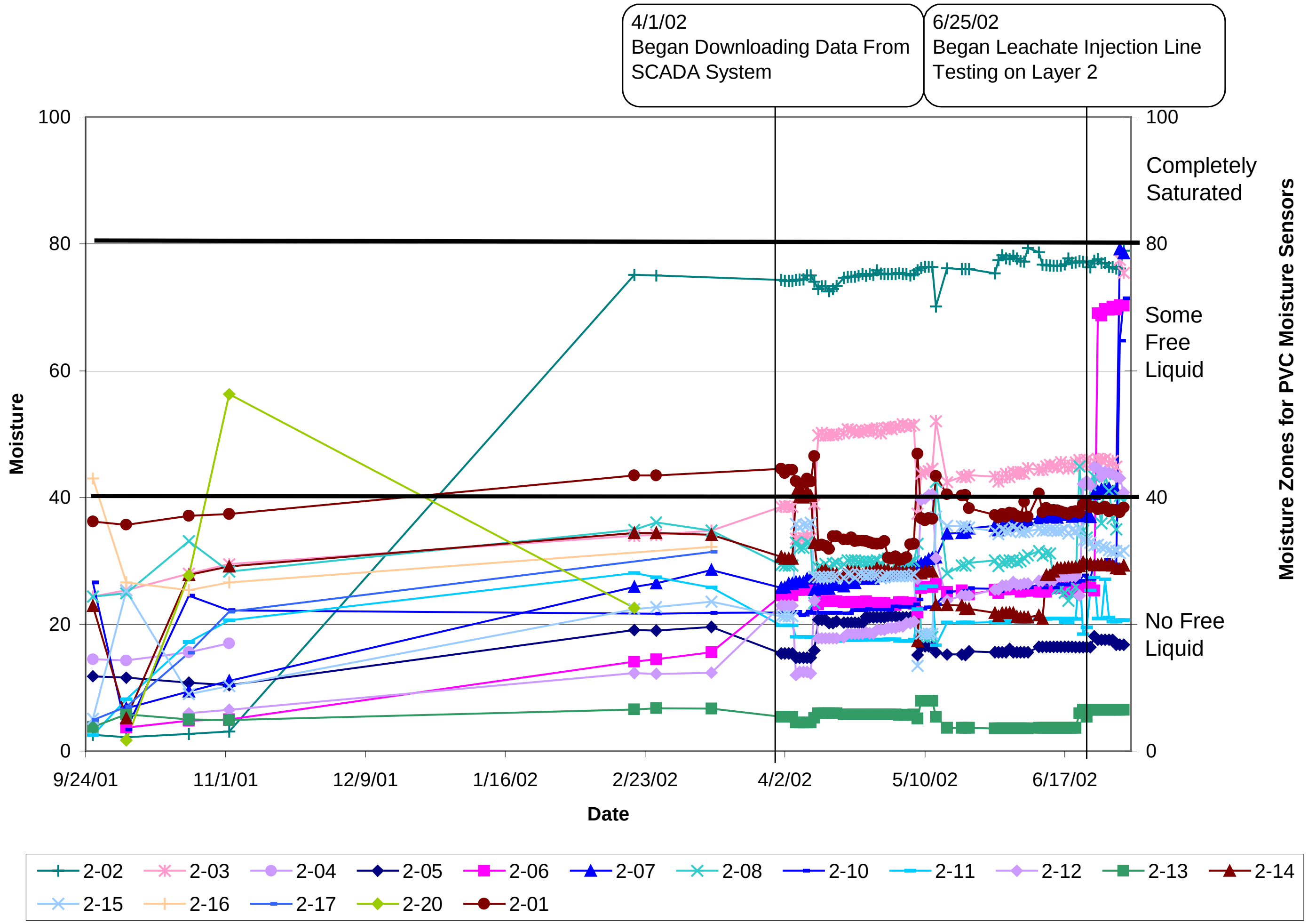


Table 16. Southeast Quadrant Anaerobic Base Liner Gas Compositions from Sampling Tubes

Sensor[1]	0-55				0-57				0-59				0-62			
Date Installed:	9/30/2000				9/30/2000				9/30/2000				9/30/2000			
Date Covered[2]:	1/12/2001				12/29/2000				1/12/2001				12/29/2000			
Date Monitored	$\%CH_4$	$\% CO_2$	$\% O_2$	% Balance[3]	$\%CH_4$	$\% CO_2$	$\% O_2$	% Balance	$\%CH_4$	$\% CO_2$	$\% O_2$	% Balance	$\%CH_4$	$\% CO_2$	$\% O_2$	% Balance
7/3/2001													9.6	37.5	0	52.7
7/10/2001	20	46.8	1.1	31.9	32	58.2	0	9.9	13.3	30.6	8.2	48				
7/11/2001					28.3	48.5	3.2	20								
8/3/2001									32.4	52.8	0	14.8	14	40.7	0	15.3
8/21/2001									30.6	53.5	0	8.1				
9/6/2001	36.2	48.5	1	14.7												
9/21/2001	42.4	51.6	0.2	5.3									14.3	39.7	0	46
12/31/2001					23.5	43.7	0	32.6	13.4	36.6	1.7	48.3				
2/7/2002	32.5	46.2	0	21.3					19.5	41.7	0.3	38.5	17.1	41.2	0.4	41.1
2/28/2002	43.6	53.3	0	3.1					39.4	53.1	0	7.5	25.3	49.7	0	25
6/27/2002	17	37.1	0.1	5.8	8.7	28.5	5.2	57.6	9.8	30.2	0.6	59.4	40.2	57.3	0	2.5

[1]Sensor nomenclature: Instrumentation layer # the senor is located - Sensor # on that layer

[2]Date covered refers to the date waste was placed over the sensor

[3]Balance is assumed to be nitrogen

*Gas Compositions measured by the GEM-500 by Landtec

Table 17. Aerobic Cell Base Layer Gas Compositions from Sampling Tubes

Sensor[1]	0-04				0-05				0-08				0-14			
Date Installed:	8/1/2001				8/1/2001				8/1/2001				8/1/2001			
Date Covered:	8/6/2001				8/6/2001				8/6/2001				8/6/2001			
Date:	$\% CH_4$	$\% CO_2$	$\% O_2$	%Balance	$\% CH_4$	$\% CO_2$	$\% O_2$	%Balance	$\% CH_4$	$\% CO_2$	$\% O_2$	%Balance	$\% CH_4$	$\% CO_2$	$\% O_2$	%Balance
8/20/01													0	0.9	20.5	78.7
10/2/01	1.8	23.3	4.3	70.4	2.3	29.9	0.9	66.8					3.6	32.5	0.6	63.3
11/1/01	4.3	23.9	0	71.8									1	14.7	3.8	80.1
11/20/01	4.4	25.8	0.2	69.7	4.7	25.3	1.1	68.7					0.1	5.1	15.7	79.2
12/4/01	0.7	10.4	7.4	81.4	1.9	16.7	1.2	80								
12/11/01	0.3	9.3	11.7	78.8	1.1	16.2	2.8	79.9								
2/7/2002	1.8	22.3	0	75.9	6.4	25.6	0	68					2.7	26.3	0	71
2/28/2002	1.8	22.3	0	75.9	6.4	25.6	0	68					2.7	26.3	0	71
4/9/2002					2.9	26	0	71.1	3.5	25.3	0.1	71.1				
6/27/2002	0.8	18.2	4.7	76.3	1	22.8	0.2	76	1.8	23.9	0	74.3	0	15.9	2.7	81.4

Sensor	0-15			
Date Installed:	8/1/2001			
Date Covered:	8/6/2001			
Date:	$\% CH_4$	$\% CO_2$	$\% O_2$	%Balance
8/20/01	1.6	40.7	1.3	56.6
10/2/01				
11/1/01	2.6	29	0	68.4
11/20/01				
12/4/01				
12/11/01				
2/7/2002				
2/28/2002				
4/9/2002				
6/27/2002	0	15.8	1.4	82.8

[1]Sensor nomenclature: Instrumentation layer # the senor is located - Sensor # on that layer

[2]Date covered refers to the date waste was placed over the sensor

[3]Balance is assumed to be nitrogen

*Gas Compositions measured by the GEM-500 by Landtec

Table 18. Aerobic Cell Layer 1 Gas Compositions from Sampling Tubes

Sensor[1]	1-05				1-16				1-19			
Date Installed:	8/29/2001				9/13/2001				9/11/2001			
Date Covered:	8/29/01				9/13/01				9/11/01			
Date:	CH_4%	CO_2%	O_2%	Balance %	CH_4%	CO_2%	O_2%	Balance %	CH_4%	CO_2%	O_2%	Balance %
10/2/2001	7.9	41.1	0.4	50.7	7	60	0	33	9.8	63.1	0.1	26
11/1/2001					6.7	42.2	0	51.4				
11/27/2001												
12/4/2001	4.6	21.3	0	74.1	2.9	22.1	0	75				
12/11/2001	5.3	22.1	0.1	72.3	3.2	21.7	0	75.1				
2/7/2002	6.8	23.7	0	69.5	15.1	32.4	0	52.5	7.2	26	0	66.8
2/28/2002	8.5	22.9	0	68.9	12.9	33.1	0	54	6.3	24.2	0	69.5
4/9/2002	6.4	20.9	0.2	72.5	7.4	30.4	0	62.2	2.7	20.8	0	76.5
6/27/2002	7.7	24.2	0.1	68	4.7	29.5	0	65.8	2.3	22.5	0	75.2

[1]Sensor nomenclature: Instrumentation layer # the senor is located - Sensor # on that layer

[2]Balance is assumed to be nitrogen

*Gas Compositions measured by the GEM-500 by Landtec

Table 19. Aerobic Cell Layer 2 Gas Compositions from Sampling Tubes

Sensor [1]	2-01				2-06				2-07				2-14			
Date Installed:	9/24/2001				9/19/2001				9/19/2001				9/17/2001			
Date Covered:	9/24/2001				9/19/2001				9/19/2001				9/17/2001			
Date:	CH_4%	CO_2%	O_2%	Balance %[2]	CH_4%	CO_2%	O_2%	Balance %	CH_4%	CO_2%	O_2%	Balance %	CH_4%	CO_2%	O_2%	Balance %
10/2/2001	5.2	61.4	0.2	33.5	6.8	37.2	0.6	55.1	5.5	43	2.2	49.2	4.6	59.2	0.5	35.5
11/1/2001																
11/27/2001	8.3	34.6	0.1	56.7	4.6	27.9	0.2	67.3	4	22.5	0.2	73.2	9.7	38	0.3	51
12/4/2001	7.3	30	0	62.7	4.3	22.2	0.1	73.4	2.8	20.9	0.1	76.2	5.2	20.9	0.1	76.2
12/11/2001	6.3	26.6	0	67.1									6.7	26.5	0.2	66.6
2/28/2002	8.1	31	0	60.9	4.6	22.7	0	72.7					13.6	37.2	0	49.2
4/9/2002	6.1	26.6	0	67.3	3.2	20.8	0	76	4.8	22.3	0	72.9	10.4	32.5	0.1	57
6/27/2002	34.6	37.8	0.9	26.7	8.6	23.9	0	67.5	8.7	23.7	0	67.6	1.1	6.4	16.7	75.8

[1]Sensor nomenclature: Instrumentation layer # the senor is located - Sensor # on that layer

[2]Balance is assumed to be nitrogen

*Gas Compositions measured by the GEM-500 by Landtec

Figure 29. Base Liner Pressure Transducers and Adjacent Sampling Tube Readings

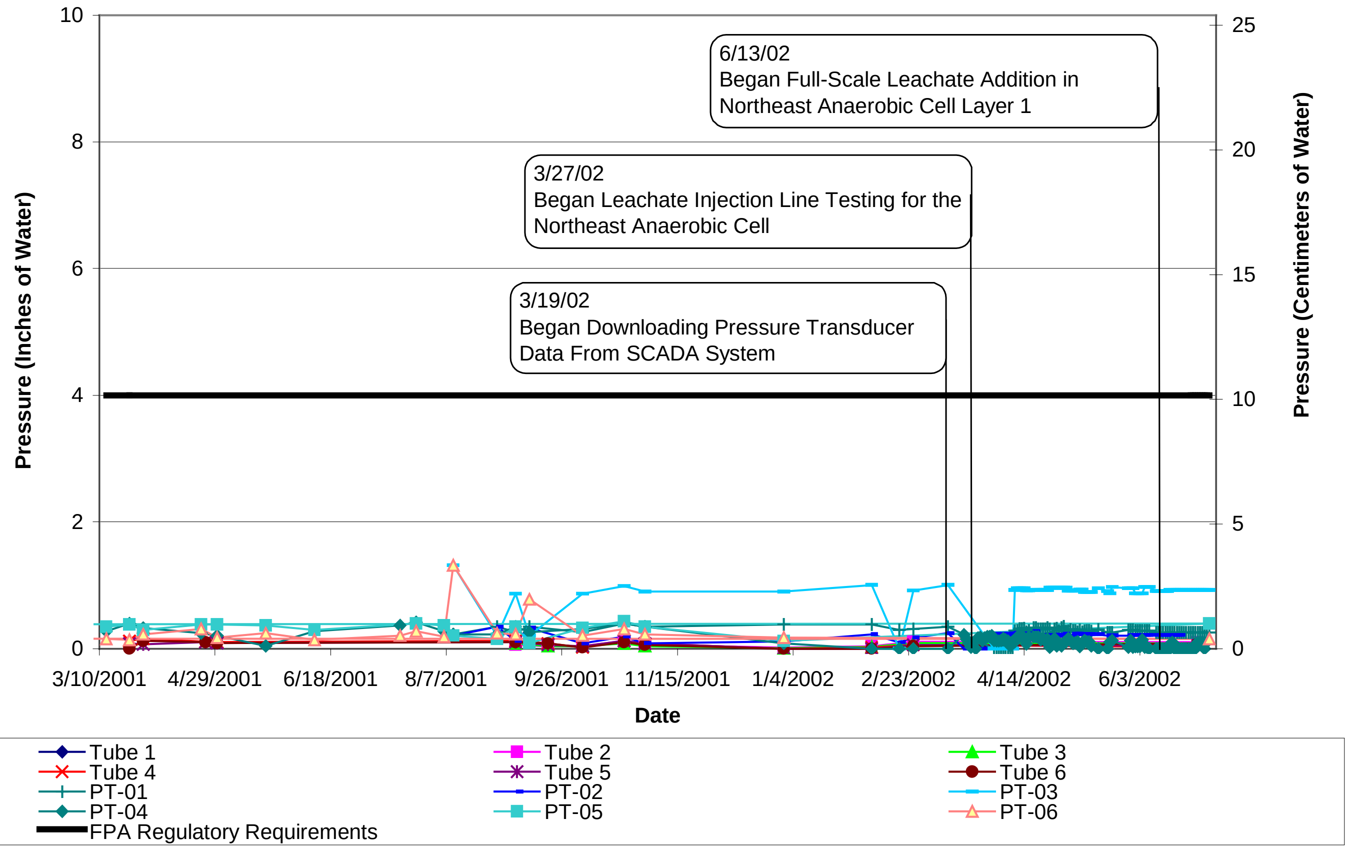
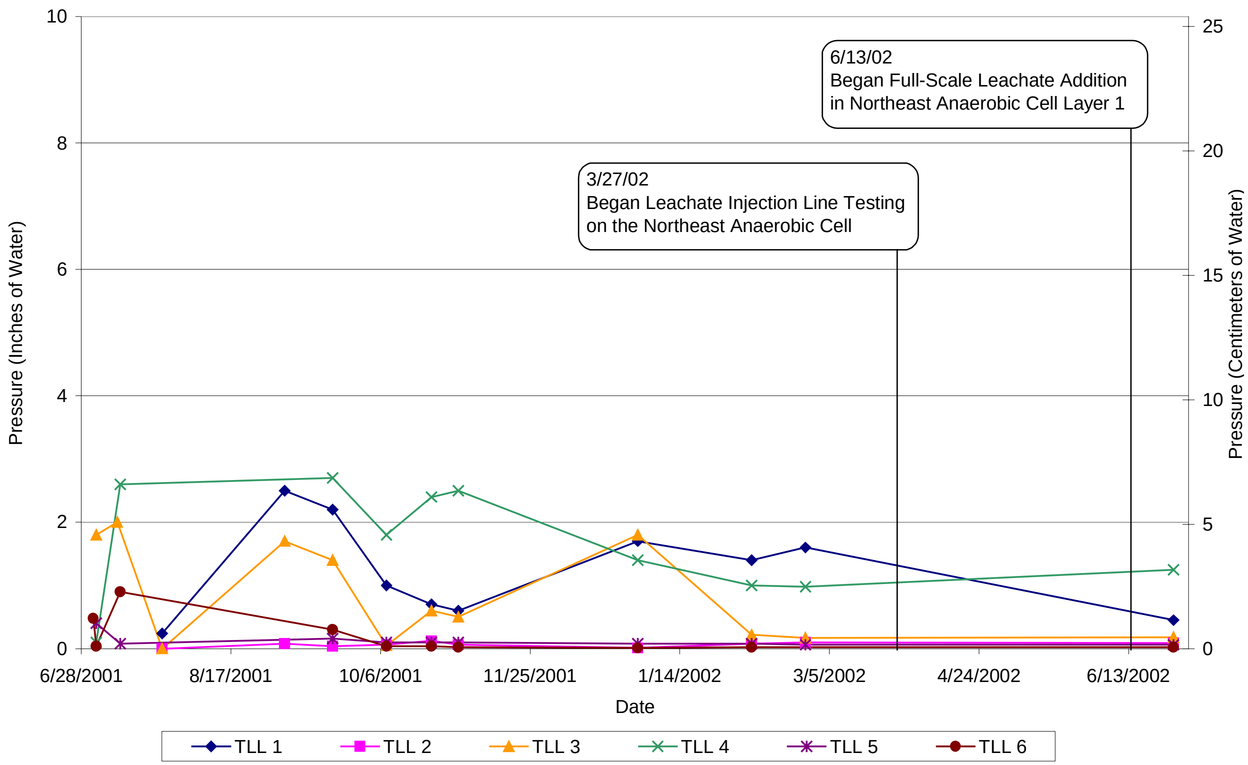


Figure 30. Trench Liquid Level Readings from Sampling Tubes



APPENDIX D – LEACHATE LABORATORY CHEMISTRY

Table 20. Field Chemistry and Analytical Results for Leachate Removed from the Northeast Anaerobic Cell (East Sump)

PARAMETER	Date:	2/14/2002	3/27/2002	5/14/2002
Field Parameters:	**Units**			
pH		7.13	7.55	7.40
Electrical Conductivity	µmoh/cm	6583	6173	6095
Oxidation Reduction Potential	mV	-119	-12	80
Temperature	C	19.9	21.5	25.9
Dissolved Oxygen	mg/L	0.65	2.13	1.4
Total Dissolved Solids	ppm	5244	4860	4059
General Chemistry:				
Ammonia as N	mg/L	30	24.4	26.3
Bicarbonate	mg/L	1740	1550	1760
BOD	mg O/L	20	34	19
Carbonate	mg/L	<5.0	<5.0	<5.0
Chemical Oxygen Demand	mg O/L	633	488	791
Chloride	mg/L	1070	1100	1030
Hydroxide	mg/L	<5.0	<5.0	<5.0
Nitrate/Nitrite as N	mg/L	<0.030	0.43	<1.5
Sulfate	mg/L	322	210	94.3(tr)
Total (Non-Volatile) Organic Carbon	mg/L	2.2	147	132
Total Alkalinity as CO_3	mg/L	1740	1550	1760
Total Dissolved Solids @ 180 C	mg/L	4440	3960	3700
Total Kjeldahl Nitrogen	mg/L	53.1	71	40
Total Phosphorus	mg/L	1.9	1.3	1.1
Total Sulfide	mg/L	1.3	0.18	1.3
Metals:				
Dissolved Aluminum	mg/L	0.14	<0.043	0.10(tr)
Dissolved Antimony	mg/L	0.0022	0.0015(tr)	0.0012(tr)
Dissolved Arsenic	mg/L	0.029	0.026	0.028
Dissolved Barium	mg/L	0.84	0.56	0.92
Dissolved Beryllium	mg/L	<0.000078	<0.000078	<0.00078
Dissolved Boron	mg/L	7.9	7.1	7.4
Dissolved Cadmium	mg/L	<0.000074	<0.000074	<0.000074
Dissolvd Calcium	mg/L	183	137	158
Dissolved Chromium	mg/L	0.036	0.024	0.025
Dissolved Cobalt	mg/L	0.007	0.0058	0.0049
Dissolved Copper	mg/L	0.0054	0.004(tr)	0.002
Dissolved Iron	mg/L	1.1	0.44	0.39
Dissolved Lead	mg/L	0.00046(tr)	0.00016(tr)	0.0020(tr)
Dissolved Magnesium	mg/L	323	248	262
Dissolved Maganese	mg/L	4.1	3.2	4.5
Dissolved Mercury	mg/L	<0.000049	<0.000049	<0.000049
Dissolved Molybdenum	mg/L	0.012(tr)	<0.0046	<0.0046
Dissolved Nickel	mg/L	0.13	0.14	0.13
Dissolved Potassium	mg/L	152	124	133
Dissolved Phosphorus	mg/L	1.9	0.96	1.9
Dissolved Selenium	mg/L	<0.00034	<0.0017	<0.
Dissolved Silver	mg/L	NA	0.000031(tr)	<0.0017

Dissolved Sodium	mg/L	875	774	759
Dissolved Thallium	mg/L	NA	<0.00034	<0.00034
Dissolved Tin	mg/L	<0.022	<0.022	<0.022
Dissolved Vanadium	mg/L	0.059	0.03(tr)	0.031(tr)
Dissolved Zinc	mg/L	0.032	0.034	0.035
Volatile Organic Compounds:				
Acetone	µg/L	16	10	6.4
Acrylonitrile	µg/L	<10	<10	<10
Benzene	µg/L	<0.13	0.28*	0.22(tr)
Bromobenzene	µg/L	<0.18	<0.18	<0.18
Bromochloromethane	µg/L	<0.31	<0.31	<0.31
Bromodichloromethane	µg/L	<0.14	<0.14	<0.14
Bromoform	µg/L	<0.10	<0.10	<0.10
Bromomethane	µg/L	<0.08	<0.08	0.68(tr)
Carbon Disulfide	µg/L	<1.0	<1.0	1.1(tr)
Carbon Tetrachloride	µg/L	<0.15	<0.15	<0.15
Chlorobenzene	µg/L	<0.12	<0.12	<0.12
Chloroethane	µg/L	<0.34	<0.34	<0.34
Chloroform	µg/L	<0.12	<0.12	<0.12
Chloromethane	µg/L	<0.25	<0.25	<0.25
cis-1,2-Dichloroethene	µg/L	0.58(tr)	1.2	1.8
cis-1,3-Dichloropropene	µg/L	<0.22	<0.22	<0.22
Dibromochloromethane	µg/L	<0.40	<0.40	<0.40
Dibromomethane	µg/L	NA	NA	<0.21
Dichlorodifluoromethane	µg/L	<0.16	0.17(tr)	0.24(tr)
Ethyl Benzene	µg/L	<0.27	<0.27	<0.27
Hexachlorobutadiene	µg/L	<0.22	<0.22	<0.22
Iodomethane	µg/L	<1.0	<1.0	<1.0
Isopropylbenzene	µg/L	<0.12	<0.12	<0.12
Methylene Chloride	µg/L	1.5	<0.35	0.46(tr)
Methyl-tert-butyl ether (MTBE)	µg/L	14	10	16
Naphthalene	µg/L	<0.15	0.45(tr)*	<0.15
n-Butylbenzene	µg/L	<0.12	<0.12	<0.12
n-Propylbenzene	µg/L	<0.15	<0.15	<0.15
p-Isopropyltoluene	µg/L	<0.13	<0.13	0.13(tr)
sec-Butylbenzene	µg/L	<0.12	<0.12	<0.12
Styrene	µg/L	<0.15	<0.15	<0.15
tert-Butylbenzene	µg/L	<0.14	<0.14	<0.14
Tetrachloroethene	µg/L	<0.38	0.84(tr)	<0.38
Toluene	µg/L	1.3*	0.98(tr)	2.9
Total Xylenes	µg/L	<0.10	<1.0	0.30(tr)
trans-1,2-Dichloroethene	µg/L	<0.11	<0.11	<0.11
trans-1,3-Dichloropropene	µg/L	<0.30	<0.30	<0.30
trans-1,4-Dichloro-2-butene	µg/L	<1.0	<1.0	<1.0
Trichloroethene	µg/L	0.33(tr)	0.77(tr)	<0.31
Trichlorofluoromethane	µg/L	<0.23	<0.23	<0.23
Vinyl Acetate	µg/L	<1.0	<1.0	<1.0
Vinyl Chloride	µg/L	<0.12	<0.12	0.30(tr)
1,1-Dichloroethane	µg/L	0.77(tr)	0.50(tr)	0.77(tr)
1,1-Dichloroethene	µg/L	<0.36	<0.36	<0.36
1,1-Dichloropropene	µg/L	<0.15	<0.14	<0.14

1,2-Dibromo-3-chloropropane	µg/L	<0.22	<0.95	<0.95
1,2-Dibromoethane	µg/L	<0.22	<0.21	<0.22
1,2-Dichlorobenzene	µg/L	<0.14	<0.14	<0.14
1,2-Dichloroethane	µg/L	<0.36	<0.22	<0.22
1,2-Dichloropropane	µg/L	<0.20	<0.15	<0.15
1,3-Dichlorobenzene	µg/L	<0.11	<0.11	<0.11
1,3-Dichloropropane	µg/L	NA	<0.20	<0.20
1,4-Dichlorobenzene	µg/L	<0.13	<0.13	<0.13
1,1,1-Trichloroethane	µg/L	<0.41	<0.41	<0.41
1,1,2-Trichloroethane	µg/L	<0.31	<0.31	<0.31
1,2,3-Trichlorobenzene	µg/L	<0.14	<0.14	<0.14
1,2,3-Trichloropropane	µg/L	<0.30	<0.30	<0.30
1,2,4-Trichlorobenzene	µg/L	<0.23	<0.23	<0.23
1,2,4-Trimethylbenzene	µg/L	<0.12	<0.12	<0.12
1,3,5-Trimethylbenzene	µg/L	<0.14	0.27(tr)	<0.14
1,1,1,2-Tetrachloroethane	µg/L	<0.10	<0.10	<0.10
1,1,2,2-Tetrachloroethane	µg/L	<0.37	<0.37	<0.37
2-Butanone (MEK)	µg/L	<1.0	<1.0	<1.0
2-Chlorotoluene	µg/L	<0.26	<0.26	<0.26
4-Chlorotoluene	µg/L	<0.10	<0.10	<0.10
2,2 Dichloropropane	µg/L	NA	<0.13	<0.13
2-Hexanone	µg/L	<0.13	<1.0	<1.0
4-Methyl-2-pentanone (MIBK)	µg/L	2	<1.0	<1.0

Footnotes:
NA=Not Analyzed
MDL=Method Detection Limit
PQL=Practical Quantification Limit
<=Less than the MDL
tr=trace: the amount detected was above the MDL but below the PQL
* = this parameter was alo detected in the method blank

Table 21. Analytical Results for Leachate Removed from the West-Side Anaerobic Cell (West Sump)

PARAMETER	DATE:	2/14/2002	3/27/2002	5/14/2002
Field Parameters:	**Units**			
pH		6.74	6.76	6.8
Electrical Conductivity	µmoh/cm	3530	3868	3851
Oxidation Reduction Potential	mV	-62	-59	-46
Temperature	C	24.9	25.9	26.2
Dissolved Oxygen	mg/L	3.15	1.09	1.54
Total Dissolved Solids	ppm	2617	2886	2871
General Chemistry:				
Ammonia as N	mg/L	20.3	20	23.5
Bicarbonate	mg/L	1700	1790	1780
BOD	mg O/L	28	18	12
Carbonate	mg/L	<5.0	<5.0	<5.0
Chemical Oxygen Demand	mg O/L	350	317	300
Chloride	mg/L	187	323	333
Hydroxide	mg/L	<5.0	<5.0	<5.0
Nitrate/Nitrite as N	mg/L	0.016(tr)	<0.015	<1.5
Sulfate	mg/L	1.7(tr)	1.5(tr)	<10
Total (Non-Volatile) Organic Carbon	mg/L	112	95.7	85.2
Total Alkalinity as CO3	mg/L	1700	1790	1780
Total Dissolved Solids @ 180 C	mg/L	2220	2380	2320
Total Kjeldahl Nitrogen	mg/L	32.6	68.9	31.1
Total Phosphorus	mg/L	0.13	1.6*	1.1
Total Sulfide	mg/L	0.033(tr)	0.015(tr)	<0.014
Metals:				
Dissolved Aluminum	mg/L	0.13(tr)	<0.043	0.053(tr)*
Dissolved Antimony	mg/L	0.0013(tr)	0.00091(tr)	0.00065(tr)
Dissolved Arsenic	mg/L	0.27	0.02	0.018
Dissolved Barium	mg/L	1.8	1.8	0.45
Dissolved Beryllium	mg/L	<0.000078	<0.000078	<0.000078
Dissolved Boron	mg/L	3.2	3.5	18.9
Dissolved Cadmium	mg/L	<0.000074	<0.000074	<0.000074
Dissolvd Calcium	mg/L	241	234	58.2
Dissolved Chromium	mg/L	0.0088	0.0069	0.0064
Dissolved Cobalt	mg/L	0.0038	0.0043	0.003
Dissolved Copper	mg/L	0.0018(tr)	0.0022	0.0011(tr)*
Dissolved Iron	mg/L	0.4	1.2	0.035(tr)*
Dissolved Lead	mg/L	0.00024 (tr)	0.000066(tr)	0.000078(tr)*
Dissolved Magnesium	mg/L	198	211	343
Dissolved Maganese	mg/L	24.6	22.9	0.0062(tr)
Dissolved Mercury	mg/L	<0.000049	<0.000049	<0.000049
Dissolved Molybdenum	mg/L	<0.0046	<0.0046	0.044
Dissolved Nickel	mg/L	0.042	0.053	0.052
Dissolved Potassium	mg/L	55.2	48.3	58.6
Dissolved Phosphorus	mg/L	0.28(tr)	0.14(tr)	1
Dissolved Selenium	mg/L	<0.0017	<0.0017	<0.0017

Dissolved Silver	mg/L	<0.00003	<0.00003	<0.00003
Dissolved Sodium	mg/L	260	281	1500*
Dissolved Thallium	mg/L	<0.00034	<0.00034	<0.00034
Dissolved Tin	mg/L	<0.022	<0.022	<0.022
Dissolved Vanadium	mg/L	0.0056(tr)	0.0038(tr)	0.017(tr)
Dissolved Zinc	mg/L	0.068	0.07	0.039
Volatile Organic Compounds:				
Acetone	µg/L	<50	28	22
Acrylonitrile	µg/L	<500	<100	<100
Benzene	µg/L	<6.5	3.3(tr)*	2.3(tr)
Bromobenzene	µg/L	<9.0	<1.8	<1.8
Bromochloromethane	µg/L	<16	<3.1	<3.1
Bromodichloromethane	µg/L	<7.0	<1.4	<1.4
Bromoform	µg/L	<5.0	<1.0	<1.0
Bromomethane	µg/L	<4.0	<0.80	<0.80
Carbon Disulfide	µg/L	<50	<10	<10
Carbon Tetrachloride	µg/L	<7.5	<1.5	<1.5
Chlorobenzene	µg/L	<6.0	<1.2	<1.2
Chloroethane	µg/L	<17	<3.4	<3.4
Chloroform	µg/L	<6.0	<1.2	<1.2
Chloromethane	µg/L	<12	<2.5	<2.5
cis-1,2-Dichloroethene	µg/L	<5.0	2.3(tr)	1.9(tr)
cis-1,3-Dichloropropene	µg/L	<11	<2.2	<2.2
Dibromochloromethane	µg/L	<20	<4.0	<4.0
Dibromomethane	µg/L	<10	<2.1	<2.1
Dichlorodifluoromethane	µg/L	<8.0	2.4(tr)	4.2(tr)
Ethyl Benzene	µg/L	<14	<2.7	<2.7
Hexachlorobutadiene	µg/L	<11	<2.2	<2.2
Iodomethane	µg/L	<50	<10	<10
Isopropylbenzene	µg/L	<6.0	<1.2	<1.2
Methylene Chloride	µg/L	<18	<3.5	<3.5
Methyl-tert-butyl ether (MTBE)	µg/L	<50	190	160
Naphthalene	µg/L	<7.5	<1.5	<1.5
n-Butylbenzene	µg/L	<6.0	<1.2	<1.2
n-Propylbenzene	µg/L	<7.5	<1.5	<1.5
p-Isopropyltoluene	µg/L	<6.5	<1.3	<1.3
sec-Butylbenzene	µg/L	<6.0	<1.2	<1.2
Styrene	µg/L	<7.5	<1.5	<1.5
tert-Butylbenzene	µg/L	<7.0	<1.4	<1.4
Tetrachloroethene	µg/L	<19	<3.8	<3.8
Toluene	µg/L	150*	42	20
Total Xylenes	µg/L	<5.0	4.0(tr)	3.8(tr)
trans-1,2-Dichloroethene	µg/L	<5.5	<1.1	<1.1
trans-1,3-Dichloropropene	µg/L	<15	<3.0	<3.0
trans-1,4-Dichloro-2-butene	µg/L	<50	<10	<10
Trichloroethene	µg/L	<16	<3.1	<3.1
Trichlorofluoromethane	µg/L	<12	<2.3	2.7(tr)
Vinyl Acetate	µg/L	<50	<10	<10
Vinyl Chloride	µg/L	<6.0	<1.2	<1.2
1,1-Dichloroethane	µg/L	<5.0	4.6(tr)	7.4(tr)
1,1-Dichloroethene	ug/L	<18	<3.6	<3.6

1,1-Dichloropropene	µg/L	<7.0	<1.4	<1.4
1,2-Dibromo-3-chloropropane	µg/L	<48	<9.5	<8.5
1,2-Dibromoethane	µg/L	<11	<2.2	<2.2
1,2-Dichlorobenzene	µg/L	<7.0	<1.4	<1.4
1,2-Dichloroethane	µg/L	<11	2.5(tr)	3.5(tr)
1,2-Dichloropropane	µg/L	<7.5	<1.5	<1.5
1,3-Dichlorobenzene	µg/L	<5.5	<1.1	<1.1
1,3-Dichloropropane	µg/L	<10	<2.0	<2.0
1,4-Dichlorobenzene	µg/L	<6.5	<1.3	<1.3
1,1,1-Trichloroethane	µg/L	<20	<4.1	<4.1
1,1,2-Trichloroethane	µg/L	<16	<3.1	<3.1
1,2,3-Trichlorobenzene	µg/L	<7.0	<1.4	<1.4
1,2,3-Trichloropropane	µg/L	<7.0	<3.0	<3.0
1,2,4-Trichlorobenzene	µg/L	<12	<2.3	<2.3
1,2,4-Trimethylbenzene	µg/L	<6.0	<1.2	<1.2
1,3,5-Trimethylbenzene	µg/L	<7.0	<1.4	<1.4
1,1,1,2-Tetrachloroethane	µg/L	<5.0	<1.0	<1.0
1,1,2,2-Tetrachloroethane	µg/L	<18	<3.7	<3.7
2-Butanone (MEK)	µg/L	<50	<10	<10
2-Chlorotoluene	µg/L	<13	<2.6	<2.6
2-Hexanone	µg/L	<50	<10	<10
2,2 Dichloropropane	µg/L	<6.5	<1.3	<1.3
4-Chlorotoluene	µg/L	<5.0	<1.0	<1.0
4-Methyl-2-pentanone (MIBK)	µg/L	<50	19(tr)	52

Footnotes:
NA=Not Analyzed
MDL=Method Detection Limit
PQL=Practical Quantification Limit
<=Less than the MDL
tr=trace: the amount detected was above the MDL but below the PQL
* = this parameter was alo detected in the method blank

Table 22. Analytical Results for Leachate Removed from the Aerobic Cell Manhole

PARAMETER	**DATE:**	**2/26/2002**	**3/27/2002**	**5/14/2002**
Field Parameters:	**Units**			
pH		7.75	8.17	8.48
Electrical Conductivity	µmoh/cm	7026	7705	9048
Oxidation Reduction Potential	mV	195	195	127
Temperature	C	15.1	15.2	21.1
Dissolved Oxygen	mg/L	5.45	5.73	6.8
Total Dissolved Solids	ppm	5673		7448
General Chemistry:				
Ammonia as N	mg/L	2.8	1.1	0.60(tr)
Bicarbonate	mg/L	1120	935	1020
BOD	mg O/L	3.3	5	89
Carbonate	mg/L	NA	<5.0	24.8
Chemical Oxygen Demand	mg O/L	595	563	602
Chloride	mg/L	1610	1800	2290
Hydroxide	mg/L	<5.0	<5.0	<5.0
Nitrate/Nitrite as N	mg/L	0.16	0.22	4.8(tr)
Sulfate	mg/L	290	478	526
Total (Non-Volatile) Organic Carbon	mg/L	766	149	168
Total Alkalinity as CO3	mg/L	1120	935	1050
Total Dissolved Solids @ 180 C	mg/L	4810	5200	5640
Total Kjeldahl Nitrogen	mg/L	19.9	19.2	11.1
Total Phosphorus	mg/L	0.51	0.19	0.85*
Total Sulfide	mg/L	<0.014	0.015(tr)	<0.014
Metals:				
Dissolved Aluminum	mg/L	<0.043	<0.043	0.082(tr)*
Dissolved Antimony	mg/L	0.002	0.0016(tr)	0.002
Dissolved Arsenic	mg/L	0.012	0.015	0.017
Dissolved Barium	mg/L	0.43	0.54	1.9
Dissolved Beryllium	mg/L	<0.000078	<0.000078	<0.000078
Dissolved Boron	mg/L	NA	12.2	3.8
Dissolved Cadmium	mg/L	0.00013(tr)	0.00016(tr)	0.0062
Dissolvd Calcium	mg/L	NA	57	257
Dissolved Chromium	mg/L	0.01	0.0062	0.0062
Dissolved Cobalt	mg/L	0.0095	0.0073	0.004
Dissolved Copper	mg/L	0.016	0.014	0.019
Dissolved Iron	mg/L	0.32	0.084(tr)	0.34
Dissolved Lead	mg/L	0.00026(tr)	<0.000066	0.00061(tr)
Dissolved Magnesium	mg/L	273	260	220
Dissolved Maganese	mg/L	1.1	0.77	23.9
Dissolved Mercury	mg/L	<0.000049	0.000059	0.000074(tr)
Dissolved Molybdenum	mg/L	0.026(tr)	0.033(tr)	<0.0046
Dissolved Nickel	mg/L	0.14	0.11	0.11
Dissolved Potassium	mg/L	NA	66.1	47.8
Dissolved Phosphorus	mg/L	NA	0.47	<0.312
Dissolved Selenium	mg/L	<0.0085	0.0034	0.0053
Dissolved Silver	mg/L	<0.00003	<0.00003	<0.00003
Dissolved Sodium	mg/L	NA	1260	284
Dissolved Thallium	mg/L	<0.00034	<0.00034	<0.00034
Dissolved Tin	mg/L	<0.022	<0.022	<0.022
Dissolved Vanadium	mg/L	0.023(tr)	0.018(tr)	<0.0032

Dissolved Zinc	mg/L	0.027*	0.032	0.018
Volatile Organic Compounds:				
Acetone	µg/L	12	23	8.8
Acrylonitrile	µg/L	<10	<10	<10
Benzene	µg/L	0.43(tr)*	0.27(tr)*	0.17(tr)
Bromobenzene	µg/L	<0.18	<0.18	<0.18
Bromochloromethane	µg/L	<0.31	<0.31	<0.31
Bromodichloromethane	µg/L	<0.14	<0.14	<0.14
Bromoform	µg/L	<0.10	<0.10	<0.10
Bromomethane	µg/L	<0.08	<0.08	0.23(tr)
Carbon Disulfide	µg/L	<1.0	<1.0	<1.0
Carbon Tetrachloride	µg/L	<0.15	<0.15	<0.15
Chlorobenzene	µg/L	2	2.8	0.23(tr)
Chloroethane	µg/L	<0.34	<0.34	<0.34
Chloroform	µg/L	<0.12	<0.12	<0.12
Chloromethane	µg/L	<0.25	0.46(tr)	0.33(tr)
cis-1,2-Dichloroethene	µg/L	0.38(tr)	0.20(tr)	<0.10
cis-1,3-Dichloropropene	µg/L	0.38(tr)	<0.22	<0.22
Dibromochloromethane	µg/L	<0.40	<0.40	<0.40
Dibromomethane	µg/L	<0.21	<0.21	<0.21
Dichlorodifluoromethane	µg/L	0.27(tr)	<0.16	<1.0
Ethyl Benzene	µg/L	<0.27	<0.27	<0.27
Hexachlorobutadiene	µg/L	<0.22	<0.22	<0.22
Iodomethane	µg/L	<1.0	<1.0	<1.0
Isopropylbenzene	µg/L	<0.12	<0.12	<0.12
Methylene Chloride	µg/L	0.35(tr)	<0.35	<0.35
Methyl-tert-butyl ether (MTBE)	µg/L	3	<1.0	1.3(tr)
Naphthalene	µg/L	<0.15	<0.15	<0.15
n-Butylbenzene	µg/L	<0.12	<0.12	<0.12
n-Propylbenzene	µg/L	<0.15	<0.15	<0.15
p-Isopropyltoluene	µg/L	<0.13	<0.13	<0.13
sec-Butylbenzene	µg/L	<0.12	<0.12	<0.12
Styrene	µg/L	<0.15	<0.15	<0.15
tert-Butylbenzene	µg/L	<0.14	<0.14	<0.14
Tetrachloroethene	µg/L	0.67(tr)	0.60(tr)	0.88(tr)
Toluene	µg/L	0.35(tr)	0.27(tr)*	<0.25
Total Xylenes	µg/L	0.34(tr)	0.10(tr)	<0.10
trans-1,2-Dichloroethene	µg/L	<0.11	<0.11	<0.11
trans-1,3-Dichloropropene	µg/L	<0.30	<0.30	<0.30
trans-1,4-Dichloro-2-butene	µg/L	<1.0	<1.0	<1.0
Trichloroethene	µg/L	1.6	0.83(tr)	<0.31
Trichlorofluoromethane	µg/L	<0.23	<0.23	<0.23
Vinyl Acetate	µg/L	<1.0	<1.0	<1.0
Vinyl Chloride	µg/L	<0.12	<0.12	<0.12
1,1-Dichloroethane	µg/L	0.32(tr)	0.16(tr)	<0.10
1,1-Dichloroethene	µg/L	<0.36	<0.36	<0.36
1,1-Dichloropropene	µg/L	<0.14	<0.14	<0.14
1,2-Dibromo-3-chloropropane	µg/L	<0.95	<0.95	<0.95
1,2-Dibromoethane	µg/L	<0.22	<0.22	<0.22
1,2-Dichlorobenzene	µg/L	<0.14	<0.14	<0.14
1,2-Dichloroethane	µg/L	<0.22	<0.22	<0.22
1,2-Dichloropropane	µg/L	<0.15	<0.15	<0.15
1,3-Dichlorobenzene	µg/L	<0.11	<0.11	<0.11
1,3-Dichloropropane	µg/L	<0.20	<0.20	<0.20
1,4-Dichlorobenzene	µg/L	<0.13	<0.13	<0.13

1,1,1-Trichloroethane	µg/L	<0.41	<0.41	<0.41
1,1,2-Trichloroethane	µg/L	<0.31	<0.31	<0.31
1,2,3-Trichlorobenzene	µg/L	<0.14	<0.14	<0.14
1,2,3-Trichloropropane	µg/L	<0.30	<0.30	<0.30
1,2,4-Trichlorobenzene	µg/L	<0.23	<0.23	<0.23
1,2,4-Trimethylbenzene	µg/L	<0.12	<0.12	<0.12
1,3,5-Trimethylbenzene	µg/L	<0.14	<0.14	<0.14
1,1,1,2-Tetrachloroethane	µg/L	<0.10	<0.10	<0.10
1,1,2,2-Tetrachloroethane	µg/L	<0.37	<0.37	<0.37
2-Butanone (MEK)	µg/L	2.5	<1.0	<0.12
2-Chlorotoluene	µg/L	<0.26	0.31(tr)	<0.26
2-Hexanone	µg/L	<1.0	<1.0	<1.0
2,2 Dichloropropane	µg/L	<0.13	<0.13	<0.13
4-Chlorotoluene	µg/L	<0.10	<0.10	<0.10
4-Methyl-2-pentanone (MIBK)	µg/L	3.8	<1.0	3.3

Footnotes:
NA=Not Analyzed
MDL=Method Detection Limit
PQL=Practical Quantification Limit
<=Less than the MDL
tr=trace: the amount detected was above the MDL but below the PQL
* = this parameter was alo detected in the method blank

APPENDIX E – LANDFILL GAS LABOATORY CHEMISTRY

Table 23. Gas Analytical Results from Module D

		Northeast Anaerobic Cell		West-Side Anaerobic Cell
GAS ANALYSIS PARAMETERS	**Units**	**3/8/2002**	**5/29/2002**	**5/29/2002**
Method CFR60 EPA 25C Mod:				
Methane	ppm	280,000	280,000	230,000
Total Non-Methane Hydocarbons as Methane	ppm	10,000	9,500	5,100
Method CFR60A EPA 15/16:				
Dimethyl Sulfide	ppm	18	12	5.2
Hydrogen Sulfide	ppm	ND	ND	ND
Carbonyl Sulfide	ppm	ND	ND	ND
Methyl Mercaptan	ppm	ND	ND	ND
Ethyl Mercaptan	ppm	ND	ND	ND
Carbon Disulfide	ppm	0.64	0.54	ND
Dimethyl Disulfide	ppm	0.52	ND	ND
Method CFR60 EPA 3C:				
Carbon Dioxide	%	41	41	68
Carbon Monoxide	%	ND	ND	ND
Methane	%	28	28	23
Nitrogen	%	26	27	11
Oxygen	%	0.83	0.21	ND
Method EPA-21 to-14A				
Dichlorodifluormethane	ppb	7,900	6,400	17,000
Chloromethane	ppb	ND	ND	ND
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ppb	ND	400	1,100
Vinyl Chloride	ppb	ND	950	1,200
Bromomethane	ppb	ND	ND	ND
Chloroethane	ppb	1,100	820	780
Trichlorofluoromethane	ppb	620	430	7,900
1,1-Dichlorethane	ppb	ND	ND	ND
Carbon Disulfide	ppb	ND	ND	ND
1,1,2-Trichloro-1,2,2-trifluoroethane	ppb	ND	ND	960
Acetone	ppb	54,000	28,000	13,000
Methylene Chloride	ppb	14,000	8,200	4,800
trans-1,2-Dichloroethene	ppb	ND	ND	ND
1,1-Dichloroethane	ppb	1,600	1,000	880
Vinyl Acetate	ppb	ND	ND	ND
cis-1,2-Dichloroethane	ppb	ND	240	ND
2-Butanone (MEK)	ppb	38,000	28,000	6,000
Chloroform	ppb	ND	ND	ND
1,1,1-Trichloroethane	ppb	ND	ND	680
Carbon Tetrachloride	ppb	ND	ND	ND
Benzene	ppb	1,700	1,800	490
1,2-Dichloroethane	ppb	ND	ND	120
Trichloroethene	ppb	1,700	1,300	220
1,2-Dichloropropane	ppb	ND	ND	ND
Bromoodichloromethane	ppb	ND	ND	ND
cis-1,3-Dichloropropene	ppb	ND	ND	ND
4-Methyl-2-Pentanone (MIBK)	ppb	10,000	9,700	5,400
Toluene	ppb	31,000	26,000	3,400

trans-1,3-Dichloropropene	ppb	ND	ND	ND
1,1,2-Trichloroethane	ppb	ND	ND	ND
Tetrachloroethene	ppb	2,300	2,200	350
2-Hexanone	ppb	ND	ND	ND
Dibromochloromethane	ppb	ND	ND	ND
1,2-Dibromoethane (EDB)	ppb	ND	ND	ND
Chlorobenzene	ppb	ND	ND	ND
Ethylbenzene	ppb	2,800	3,200	170
Total Xylenes	ppb	9,400	11,000	480
Styrene	ppb	700	930	ND
Bromoform	ppb	ND	ND	ND
1,1,2,2-Tetrachloroethane	ppb	ND	ND	ND
Benzyl Chloride	ppb	ND	ND	ND
4-Ethyltoluene	ppb	ND	930	ND
1,3,5-Trimethylbenzene	ppb	ND	290	ND
1,2,4-Trimethylbenzene	ppb	ND	760	ND
1,3-Dichlorobenzene	ppb	ND	ND	ND
1,4-Dichlorobenzene	ppb	ND	270	ND
1,2-Dichlorobenzene	ppb	ND	ND	ND
1,2,4-Trichlorobenzene	ppb	ND	ND	ND
Hexachlorobutadiene	ppb	ND	ND	ND

ND=Not Detected