FULL SCALE BIOREACTOR LANDFILL FOR CARBON SEQUESTRATION AND GREENHOUSE EMISSION CONTROL

Quarterly Technical Progress Report

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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. Liquid addition has commenced in the 3.5-acre anaerobic cell and the 6-acre anaerobic cell. Construction of the 2.5-acre aerobic cell is nearly complete with only the biofilter remaining and is scheduled to be complete by the end of August 2003. 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 water) 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.

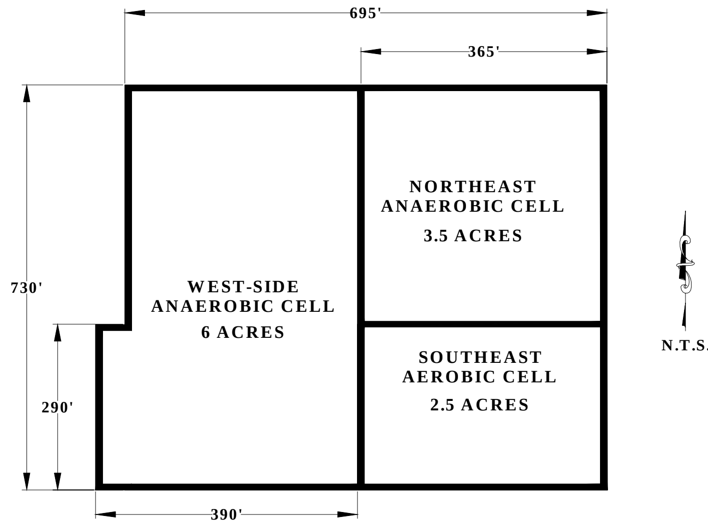
Because current Federal and California State regulations generally do not allow the addition (or recirculation) of leachate and other supplemental liquid to a lined landfill module, special regulatory flexibility was required to conduct this project. Yolo County applied for, and was granted the necessary 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. Phase 2 of the project has begun with the construction of the primary liner system and installation of 12 temperature and moisture sensors. Waste placement in Phase 2 began in November 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 1-1 and has been altered since the previous project schedule prepared in April 2003.

The project bioreactors are separated into three landfill cells, two cells will be operated anaerobically and one aerobically (Detail 1-1). We have designated the three bioreactor cells as the west-side anaerobic cell, the northeast anaerobic cell, and the southeast aerobic cell. This configuration allowed the northeast anaerobic cell to be constructed and operated 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 1-1. Overview of Module D Bioreactor Cells

The northeast anaerobic cell, the west-side anaerobic cell, and the southeast aerobic cell have been filled with waste and instrumentation. A total of 65,104 tons of waste was placed in the northeast anaerobic, 11,942 tons of waste was placed in the southeast aerobic module, and 166,294 tons of waste was placed in the west-side anaerobic cell. The gas collection systems have been completed in the northeast anaerobic cell, the west-side anaerobic cell, and the aerobic cell. the biofilter remains to be completed for the aerobic cell. The leachate injection system has been completed in the northeast anaerobic cell, west-side anaerobic cell, and the aerobic.

The installation of a reinforced polypropylene (RPP) membrane surface cover over the northeast anaerobic cell was completed in November 2001 and will allow precise quantification of the amount of landfill gas produced by eliminating surface emissions. The aerobic cell received a cover of 12-inches of soil overlaid by 12-inches of greenwaste alternative daily cover (ADC). The surface membrane cover for the west-side anaerobic cell is similar to the northeast anaerobic cell, with the exception that 40-mil linear low-density polyethylene (LLDPE) was used instead of RPP. Surface liner installation for the west-side anaerobic cell was completed in October 2002.

A Supervisory Control and Data Acquisition (SCADA) system has been installed and will monitor and control the operation of the bioreactor cells. To date, all instrumentation installed in the northeast and west-side anaerobic cells, 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. In January 2003, the SCADA system started to electronically collect temperature and moisture data from in the west-side anaerobic cell.

Landfill gas collection began in the northeast anaerobic cell in mid-December 2001. Through the end of June 2003, a total of 31.6 x 10^6 scf of methane (which is equivalent to approximately 5000 barrels of oil) has been collected and utilized at the on-site gas to energy facility. Landfill gas collection began in the west-side anaerobic cell in May 2002, and through the end of June 2003 a total of 9.7 x 10^6 scf of methane (which is equivalent to approximately 1500 barrels of oil) has been collected and utilized at the on-site gas to energy facility. Landfill gas was sampled from the northeast anaerobic cell and the west-side anaerobic cell submitted for laboratory analysis in May 2003. Gas composition (methane, carbon dioxide, and oxygen) continues to be monitored on a weekly basis.

Landfill gas collection from the aerobic cell began on January 13, 2003. Landfill gas from the aerobic cell is currently being collected and sent to the on-site gas to energy facility. Through the end of June, a total of 450,909 scf of methane has been collected. Once operation of the aerobic cell commences, the off-gas will be sent to the biofilter for treatment.

Leachate addition to the northeast anaerobic cell began on March 27, 2002. Through the end of June 2003, a total of 1,536,438, gallons of supplemental liquid has been added and 597,543 gallons of leachate recirculated to the northeast anaerobic cell. Leachate was monitored for field chemistry and sampled for laboratory analysis in May 2003.

Leachate addition to the west-side anaerobic cell began on June 5,2003. Through the end of June 2003, a total of 1,598,880 gallons of supplemental liquid has been added and 1,600 gallons of leachate recirculated to the west-side anaerobic cell. Leachate was monitored for field chemistry and sampled for laboratory analysis in May and June 2003.

Monitoring for methane surface emissions has been performed quarterly since April 2002. During this reporting period, a surface scan of was performed on the bioreactor cells in April 2003. The highest methane surface emissions detected on the west-side anaerobic cell in April 2003 were 126 parts per million (ppm). The high readings for the west-side anaerobic cell are due to small gaps (less than 1 inch) in the surface liner where piping exits the cell (pipe penetrations). The highest methane surface emissions detected in April 2003 from the northeast anaerobic cell were 6.7 ppm and from the aerobic cell were 3.6 ppm. The surface emissions can be attributed to wind currents carrying emissions from the west-side anaerobic cell. In order to eliminate emissions from the west-side anaerobic cell, Yolo County will be sealing the pipe penetrations.

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 began construction 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

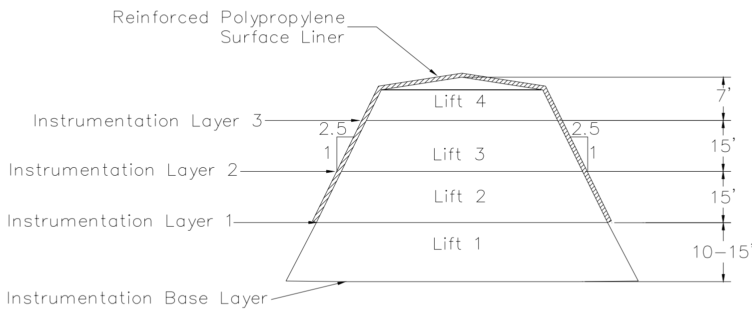
The experimental methods utilized are grouped into three categories: construction, monitoring, and operation. Each of these categories is discussed below.

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 3-1.

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 3-1). 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 3-2.



Detail 3-1. Northeast Anaerobic Cell Cross Section

3.1.1.2 Liquid Addition

Horizontal liquid injection lines were installed in each lift of waste (Image 3-1). Injection lines within the waste (between lifts 1 and 2, 2 and 3, 3 and 4) were placed approximately every 40 feet. Injection lines installed on top of lift 4 were installed every 25 feet, 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. Individual solenoid valves are installed on each leachate injection lateral and connected to the Supervisory Control and Data Acquisition (SCADA) system used to monitor the various sensors and control the operation of the bioreactor. A flow meter monitors the total volume and injection flow rate for the entire northeast anaerobic cell.

Image 3-1. 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 3-1) 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 3-2) 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 3-3. 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 conveys the gas to the on-site LFG-to-energy facility. Each LFG collection line incorporates a pre-manufactured wellhead capable of controlling flow and monitoring flow rate, temperature and pressure.

Image 3-2. Horizontal LFG collection line

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 3-3). 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 3-3. 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 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 (Image 3-4). Temperature and moisture sensors are connected to the SCADA system used to monitor and control the operation of the bioreactor. Refer to Appendix B, Details 3-2 through 3-5 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 3-4. 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 3-5). 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. 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 and Flow

Landfill gas composition and flow are measured from the pre-manufactured well heads 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.

Image 3-5. Gravel drainage layer and leachate collection sump

3.1.2.6 Surface Emissions

Under current federal guidelines (40 CFR 60.752), landfills exceeding a specific size must monitor for methane surface emissions and any reading in excess of 500 PPM (40 CFR 60.755) requires corrective action to be taken. The Yolo County Central Landfill is not currently required to test for methane surface emissions, however, as part of the FPA, the County has proposed to conduct quarterly surface scans to demonstrate the emissions (or lack of) from a controlled bioreactor landfill.

Surface emissions are typically monitored with a model TVA-1000 FID/Photo Ionization Detector (PID) instrument (Image 3-6). Under the FID setting, the TVA-1000 is capable of detecting methane in the parts-per-million (PPM) range and has an accuracy of ± 2.5 PPM or 25 percent of the reading, whichever is greater. In the event significant methane was detected, the unit could be switched to PID mode to detect volatile organic compounds (VOC). In March 2003, surface emissions were monitored with a model OVA-108 Flame Ionization Detector (FID) instrument. The OVA-108 is capable of detecting methane in the parts-per-million (PPM) range and has an accuracy of ± 20 percent of reading.

Image 3-6. Surface emission monitoring with the TVA 1000.

3.1.3 Operation

Operation of the northeast anaerobic cell as a bioreactor will began March 27, 2002 when supplemental liquid was first added to the cell.

3.1.3.1 Leachate Addition and Recirculation

Leachate addition to the northeast cell began on March 27, 2002 (Image 3-7). 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 3-7. 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.

During August 2002, leachate injection was temporarily halted due to scale buildup in the injection laterals which was significantly reducing the flow in the injection lines (Image 3-8). On September 11, 2002, approximately 3000 gallons of a citric acid solution (pH approximately 4) was added to the injection laterals on the northeast anaerobic cell to dissolve the scale buildup. The citric acid was added to the injection laterals and allowed to set overnight (approximately 14 hours). Groundwater was then flushed through the lines to remove the citric acid and scaling residue.

Image 3-8. Scale buildup on the northeast 3.5-acre leachate injection lines.

Liquid injection resumed in the northeast cell on September 24, 2002. Approximately 1,536,438 gallons of supplemental liquid has been added and 597,543 gallons of leachate recirculated through the end of June 2003 with 47 percent added to Layer 1, 36 percent added to Layer 2, 16 percent added to Layer 3, and 1 percent added to Layer 4 (Appendix C, Figure 3-1).

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. Layer 1 is represented by a 1, Layer 2 is represented by a 2, 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

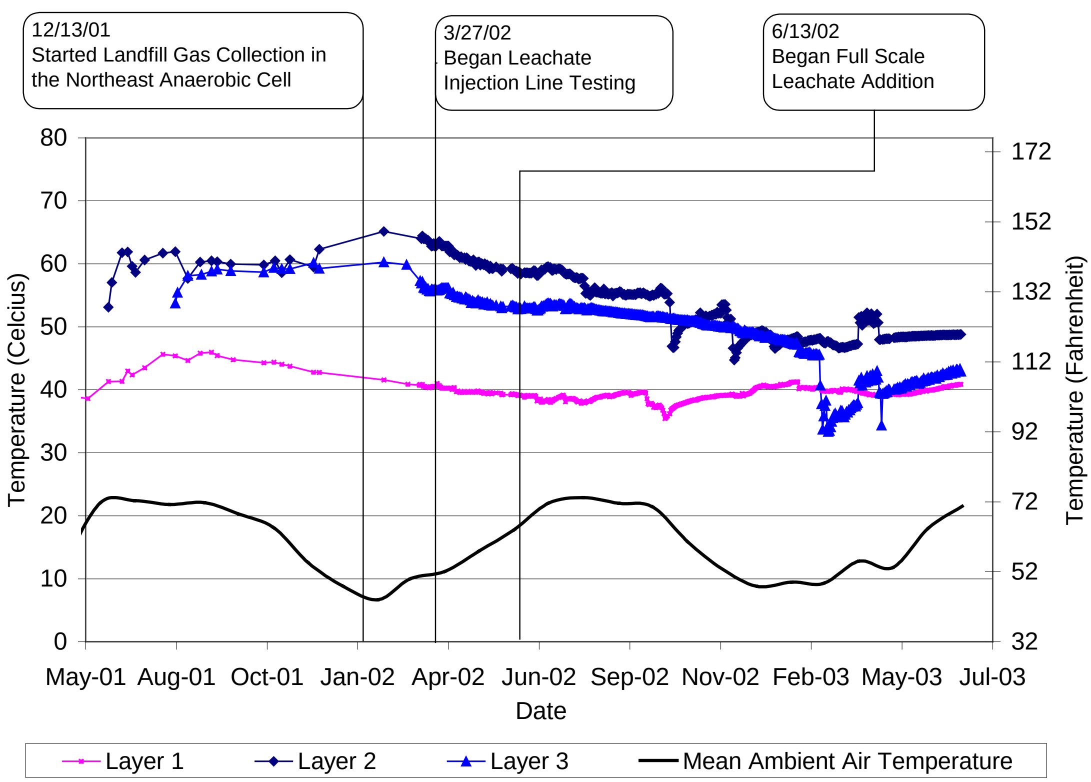
Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system 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.

Temperature results are presented in Appendix C, Figures 3-2 to 3-4. Sensors show fluctuations in temperatures that correspond to the onset of leachate injection line testing and subsequent full-scale liquid addition. Representative sensors that demonstrate the cooling trend during liquid injection and subsequent warming trend following liquid injection are provided in Appendix C, Figure 3-5. A summary of the results is presented below in Table 3-4 and Figure 3-6.

Table 3-4. Temperature Summary for the Northeast Anaerobic Cell

	Previous Reporting Period (1/1/03 to3/31/03)			Current Reporting Period (4/1/03 to 6/30/03)		
Layer	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**
1	29.5	55.1	40.3	29.6	49.4	39.8
2	38.3	57.1	47.7	43.4	53.1	48.3
3	7.6	67.6	43.1	20.9	66.7	40.8

Figure 3-6. Average Temperatures for the Northeast Anaerobic Cell



3.2.2 Moisture

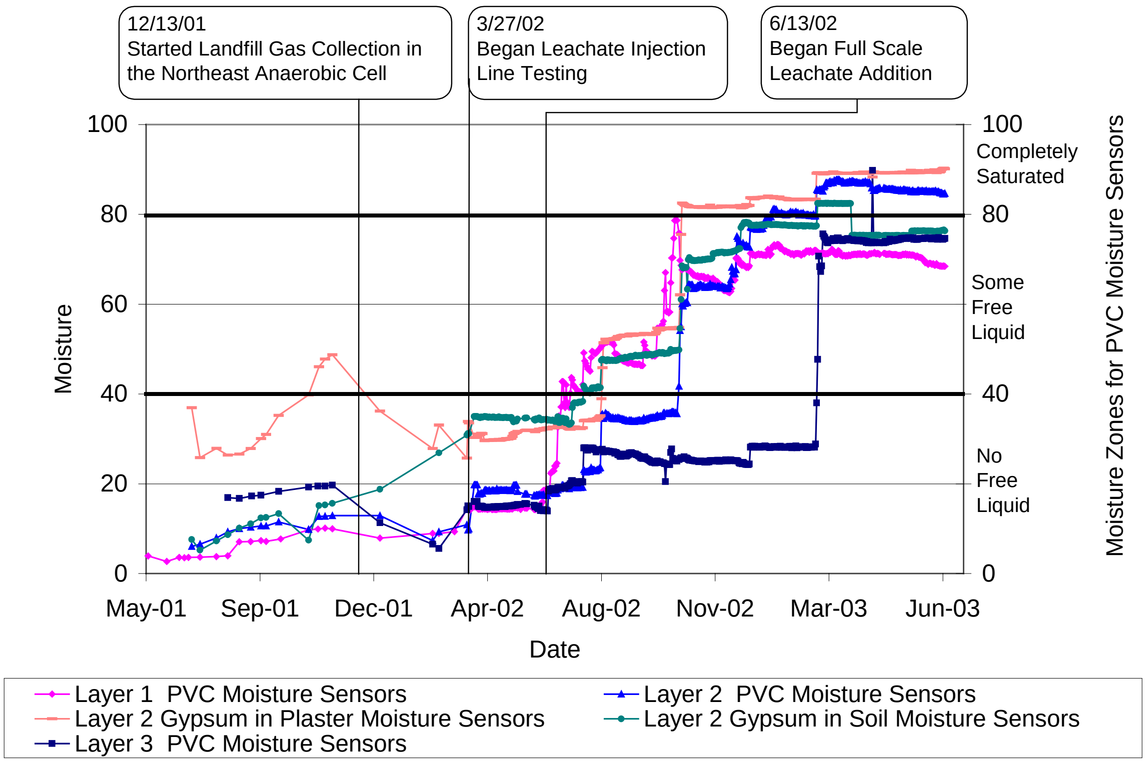
The SCADA system started electronically measuring moisture in March 2002. Moisture was previously measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. During the pilot scale project, Yolo County conducted laboratory tests with the PVC sensors to determine the relationship 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.

Moisture results are presented in Appendix C, Figures 3-7 to 3-11. Since the start of full-scale liquid addition in June 2002, the average moisture levels in Layer 1 and Layer 3 have increased to moisture levels in the some free liquid zone. .Moisture levels in Layer 2 have also increased since the start of liquid addition with average moisture levels in the some free liquid zone and the completely saturated zone. A summary of the results is presented below in Table 3-5 and Figure 3-12.

Table 3-5. PVC Moisture Summary for the Northeast Anaerobic Cell

	Previous Reporting Period (01/01/03 to03/31/03)			**Current Reporting Period (04/1/03 to 06/30/03)**		
Layer	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**
1	6.0	94.8	71.5	5.5	94.8	70.5
2	5.4	94.8	82.4	5.3	94.8	85.7
3	4.9	94.8	39.8	6.6	94.8	74.5

Figure 3-12. Average Moisture Levels for the Northeast Anaerobic Cell



3.2.3 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.

Landfill gas results are presented in Appendix C, Figures 3-13 to 3-16. Methane concentrations from the wellheads fluctuate based on the applied vacuum, barometric pressure, and the status of waste decomposition. 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. Due to mechanical problems at the gas to energy facility, gas flow rates fluctuated and dropped in May 2003 to 88 standard cubic feet per minute (scfm) and in June 2003 to 74 scfm and 34 scfm. A summary of the results is presented below in Table 3-6.

Table 3-6. Landfill Gas Summary for the Northeast Anaerobic Cell

Parameter	**Results**		
Cumulative Methane from December 16, 2001 to June 30, 2003	31.6×10^6 standard cubic feet (scf) (which is equivalent to approximately 5000 barrels of oil)		
LFG Flow Rate for the period of April 1, 2003 through June 30, 2003	Minimum	Maximum	Average
	39.3 scf	196.6 scf	153.6 scf
Methane Concentration for the period of April 1, 2003 through June 30, 2003	Minimum	Maximum	Average
	37.3 %	50.3 %	44.4 %

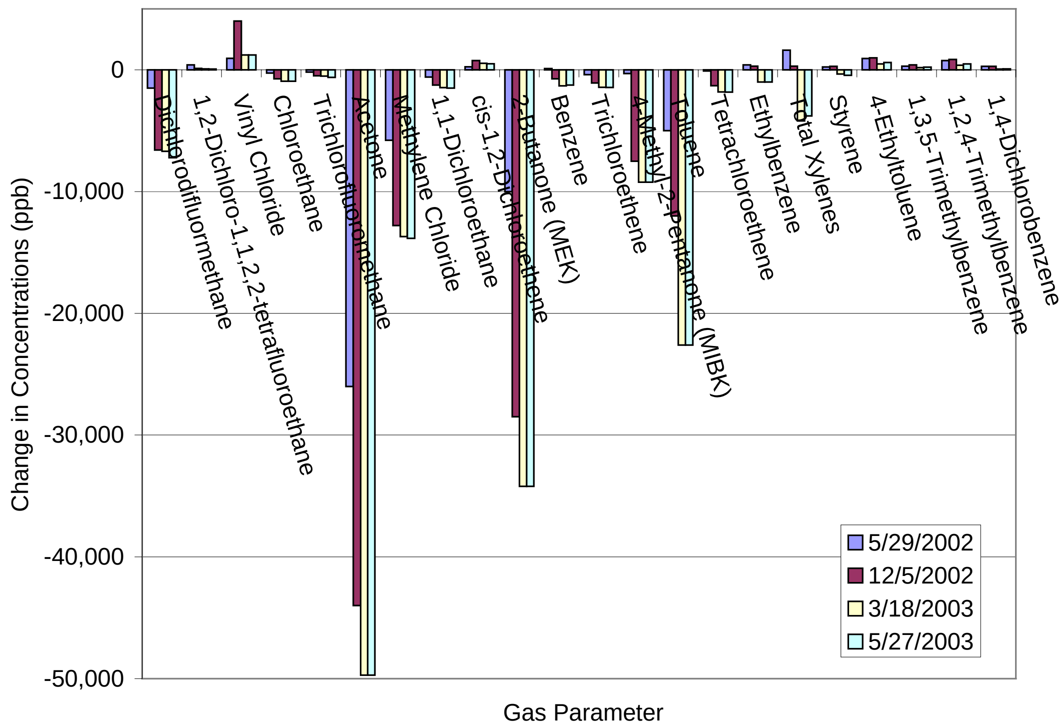
Landfill gas from the northeast cell was sampled in May 2003 and sent to an independent laboratory for analytical testing. Analytical results are presented in Appendix D, Table 3-7. Results show a general decline in volatile organic compounds (VOCs) since March 2002 as presented below in Figure 3-17.The decline in VOCs includes the decline in chlorofluorocarbons (CFCs) which are major contributors to ozone depletion.[3,4] The decline in CFCs includes a drop in constituents such as trichlorofluoromethane by 100 percent and dichlorodifluoromethane by 91 percent from March 2002 to May 2003. Other VOC's that have declined include several hazardous air pollutants listed by the Environmental Protection Agency that include methylene chloride and aromatic carbons such as benzene, toluene, and xylene[5].

[3] Cooper, c>, Alley, F., "Air Pollution Control, A Design Approach," Waveland Press, Inc. 1994

[4] *U.S. Environmental Protection Agancy (EPA) Home Page List of CFCs.* 17 July 2003. U.S. EPA. 22 July 2003 <http://www.epa.gov/ozone/ods.html>

[5] *U.S. Environmental Protection Agancy (EPA) Home Page.* 19 February 2003. U.S. EPA. 22 July 2003 <http://www.epa.gov/ttn/atw/orig189.html>

Figure 3-17. Change in VOC Concentrations since March 2002.



3.2.4 Leachate Quantity And Quality

After July 24, 2002, all leachate generated was recirculated back to the northeast anaerobic cell with the exception of 35,460 gallons of leachate removed during injection line cleaning between September 24, 2002 and October 4, 2002. Approximately 1,536,438 gallons of supplemental liquid has been added and 597,543 gallons of leachate has been recirculated to the northeast anaerobic cell since June 2002 (Appendix C, Figure 3-1).

Leachate was sampled for analytical testing on a monthly basis from May 2002 to October 2002 and thereafter was sampled on a quarterly basis. Analytical results are presented in Appendix E, Table 3-8. Field chemistry and selected analytical results are presented below in Table 3-9.

Table 3-9. Field Chemistry and Selected Laboratory Chemistry for Leachate Sampled from the Northeast Anaerobic Cell

PARAMETER	Date:	2/14/2002	5/14/2002	6/20/2002	7/23/2002	9/26/2002	10/17/2002	2/26/2003	5/27/2003
Field Parameters:	**Units**								
pH		7.13	7.40	7.60	7.44	7.47	7.35	8.16	7.02
Electrical Conductivity	µS	6583	6095	4054	11510	12440	10230	9351	11990
Oxidation Reduction Potential	mV	-119	80	94	-7	-35	-25	160	17
Temperature	C	19.9	25.9	26.5	30.5	28.4	26.0	23.5	33.3
Dissolved Oxygen	mg/L	0.65	1.4	2.04	0.33	3.66	2.96	6	2.80
Total Dissolved Solids	ppm	5244	4059	3062	9740	10770	8640	7850	9978
General Chemistry:									
Bicarbonate Alkalinity	mg/L	1740	1760	1110	3740	3960	4010	2680	3280
Total Alkalinity as CO_3	mg/L	1740	1760	1110	3740	3960	4010	2680	3280
BOD	mg O/L	20	19	10	200	1400	3000	44	85
Chemical Oxygen Demand	mg O/L	633	791	196	1620	2830	1810	120	1590
Chloride	mg/L	1070	1030	617	1950	1870	1380	1470	1670
Ammonia as N	mg/L	30	26.3	13.5	131	255	289	132	207
Nitrate-Nitrite as N	mg/L	<0.03	<1.5	<0.015	0.061	1.4	<0.009	17.3	13
Total Kjeldahl Nitrogen	mg/L	53.1	40	21.8	201	326	358	222	320
Total Dissolved Solids @ 180 C	mg/L	4440	3700	2500	7800	8000	6680	5720	7700
Total (Non-Volatile) Organic Carbon	mg/L	202	123	68.8	544	943	588	325	490
Total Sulfide	mg/L	1.3	1.3	0.74	1.2	1.1	1.4	0.034 (tr)	0.020 (tr)
Dissolved Iron	mg/L	1.1	0.39	0.19	2.9*	3.9	4	2.5	2.8
Dissolved Magnesium	mg/L	323	262	NA	535	480	437	359	265
Dissolved Potassium	mg/L	152	133	NA	215	319	348	371	372

Analytical results from the February and May 2003 sampling events indicate a dramatic decrease in BOD and increase in nitrate. Follow-up monitoring will be performed to confirm these readings and a split sample will be taken in July 2003 to eliminate laboratory error.

Results generally indicate a decline in VOC's which include chlorinated aliphatic hydrocarbons (CAHs) commonly found in contaminated ground water. The decline in CAHs include such compounds as tetrachloroethene (PCE), and trichloroethene (TCE)[6]. Additionally, *cis*-1,2,dichloroethene (*1,2*-DCE), which is a daughter product derived from the transformation of the PCE and TCE, has also shown an overall decline since March 2002. Over time, 1,2-DCE is expected to continue to decline and vinyl chloride (a product of 1,2-DCE) increase as the transformation of the parent compound PCE is completed. Other aliphatic halogenated compounds that contribute to ground water contamination have declined and include several aromatic hydrocarbons such as benzene, toluene, and xylene.

[6] Norris et al, "Handbook of Bioremediation,"Lewis Publishers, 1993.

3.2.5 Surface Emissions

Methane surface concentrations are monitored along the perimeter of the collection area and along a pattern that transverses the landfill at 15 meter intervals. Due to high winds and inclement weather, the surface scan scheduled for December 2002 was postponed until January 2003. A summary of the surface scans performed on the northeast anaerobic cell is presented below in Table 3-10.

Table 3-10. Summary of Surface Scans Performed on the Northeast Anaerobic Cell with Synthetic Surface Cover System

Surface Scan No.	Date	Max. Emissions Detected	Location of Max. Emissions
1	April 3, 2002	No fugitive emissions detected	Not Applicable
2	June 6, 2002	9 ppm	Southwest corner of the cell
3	September 19, 2002	8 ppm	Northwest corner of the cell
4	January 7, 2003	No fugitive emissions detected	Center north face of the cell
5	March 19, 2003	5 to 10 ppm	Along the entire northern perimeter of the cell.
6	April 15, 2003	6.7 ppm	At one location on the west face, approximately 15 meters from the western perimeter and 43 meters from the southern perimeter.

The detection of surface emissions is most likely due to landfill operations in nearby areas. While background concentrations were monitored prior to conducting the surface scan (and in some cases following the surface scan), changes in wind currents could have transported methane from adjacent areas. During June 2002 and September 2002, grading and waste filling activities in the adjacent west-side 6-acre area could have promoted the detection of gas emissions in the northeast 3.5-acre cell. Additionally, activities from Module D Phase II construction (which involved exposing waste from an adjacent unit to facilitate base liner installation) could have promoted the detection of gas emissions during the September 2002 surface scan. The surface emissions in March and April 2003 may be due to wind current from the northwest and southwest carrying emissions from the west-side anaerobic cell. Higher emissions have been measured in the west-side anaerobic cell due to leakage around the horizontal pipes penetrating in the surface liner.

As presented in the table above, methane surface emissions from the northeast 3.5-acre cell are extremely low, and essentially negligible. There are two major items that are responsible for this effective control of surface emissions, they are: 1) The installation of a synthetic cover over the entire cell, and 2) The use of an active landfill gas extraction system. The synthetic membrane not only limits gas transfer from the surface of the cell, it allows the active gas collection system to be operated at higher vacuum rates (without drawing in excess oxygen) thus further limiting the possibility if surface emissions.

4 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 was complete in August 2002 with a total of 166,294 tons of waste placed.

4.1 Experimental

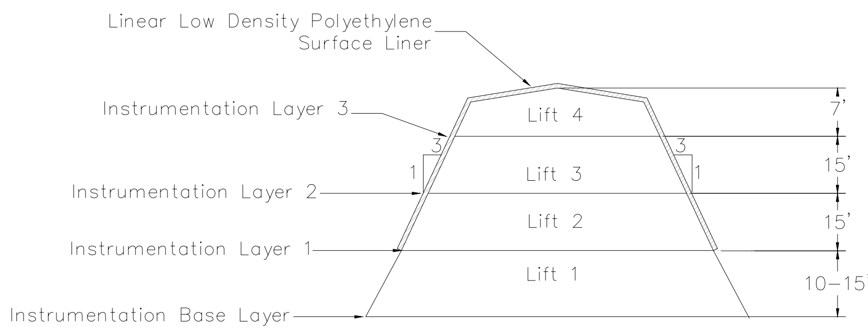
The experimental methods utilized are grouped into three categories: construction, monitoring, and operation. Each of these categories is discussed below.

4.1.1 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. A summary of current monitoring data for the west-side anaerobic cell is provided in Appendix A, Table 4-1.

4.1.1.1 Waste Placement

Waste placement began on March 8, 2001 and was completed on August 31, 2002. Waste was 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 4-1, Image 4-1). All waste received at the landfill was deposited in the west-side cell (i.e. no class of waste was excluded). 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. Instrumentation Layers 1, 2, and 3 were placed between lifts, and base layer instrumentation was installed on the Module 6D base liner.



Detail 4-1. Cross Section of West-Side Anaerobic Cell

Image 4-1. Waste placement in the west-side cell

4.1.1.2 Liquid Addition

Horizontal liquid injection lines were installed between lifts 2 and 3, and 3 and 4 approximately every 40 feet. In addition, three injection lines were installed on top of lift 4, spaced every 25 feet. Each injection line consists of a 1.25-inch-diameter high-density polyethylene (HDPE) pipe placed horizontally (east to west), which extends completely through the waste. Each injection line was perforated by drilling a $^{1}/_{8}$ or $^{3}/_{32}$-inch hole every 10 or 20 feet (depending on which line). A total of 7,185 feet of injection piping was installed with a total of 321 injection holes.

Each of the injection laterals is connected to a 4-inch-diameter HDPE injection header. Leachate injection for each lateral is manually controlled and monitored by individual valves and flow meters (Image 4-2). A flow meter will monitor the total volume and injection flow rate for the entire northeast anaerobic cell.

Image 4-2. Installation of valve and flow meter assembly on leachate injection lines

4.1.1.3 Gas Collection

Horizontal landfill gas (LFG) collection lines were installed between lifts 2 and 3, and 3 and 4, and on top of lift 4. The LFG collection lines consist of various combinations of alternating 4 and 6-inch diameter schedule 80 and schedule 40 polyvinyl chloride (PVC) pipe as well as several variations of corrugated metal pipe and electrical conduit. At each line, shredded tires were used as the permeable media. A total of eighteen LFG collection lines were installed. A summary of gas collection lines for the northeast anaerobic cell is provided in Appendix A, Table 4-2.

Each LFG collection line is connected to a 6-inch or 8-inch diameter LFG collection header that conveys the gas to the on-site LFG-to-energy facility (Image 4-3). Each LFG collection line incorporates a valve capable of controlling flow and a port for monitoring gas composition, temperature, pressure, and flow rate.

Image 4-3. LFG collection laterals connected to the main header line located on top the cell.

4.1.1.4 Surface Liner

Vector was retained to provide design, plans and specifications for a surface lining system (refer to section 3.1.1.4). In contrast to the northeast anaerobic cell, which utilized a reinforced polypropylene membrane (RPP), a 40-mil linear low-density (LLDPE) geomembrane material was selected because it offered a greatly reduced cost. The installation of the surface liner was completed in October 2002 (Image 4-4).

Image 4-4. West-side anaerobic cell surface liner.

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 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. Temperature and moisture sensors are connected to the Supervisory Control and Data Acquisition (SCADA) system used for monitoring and controlling the operation of the bioreactor. Refer to Appendix B, Details 4-2 through 4-4 for sensor location diagrams.

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 of liquid injection, 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 and Flow

Landfill gas composition and flow are measured from the well heads utilizing a GEM-500 combustible gas meter, manufactured by LANDTEC, in combination with a 1/8-inch diameter pitot tube, manufactured by DWYER Instruments, Inc.. 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 Surface Emissions

Under current federal guidelines (40 CFR 60.752), landfills exceeding a specific size must monitor for methane surface emissions and any reading in excess of 500 PPM (40 CFR 60.755 (c)) requires corrective action to be taken. The Yolo County Central Landfill is not currently required to test for methane surface emissions, however, as part of the FPA, the County has proposed to conduct quarterly surface scans to demonstrate the emissions (or lack of) from a controlled bioreactor landfill.

Surface emissions are typically monitored with a model TVA-1000 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 and has an accuracy of ± 2.5 PPM or 25 percent of the reading, whichever is greater. In the event significant methane was detected, the unit could be switched to PID mode to detect volatile organic compounds (VOC). In March 2003, surface emissions were monitored with a model OVA-108 Flame Ionization Detector (FID) instrument. The OVA-108 is capable of detecting methane in the parts-per-million (PPM) range and has an accuracy of ± 20 percent of reading.

4.1.3 Operation

Operation of the west-side anaerobic began once the leachate recirculation system was completed in June 2003.

4.1.3.1 Leachate Addition and Recirculation

Prior to the start of leachate addition, the west-side anaerobic cell leachate injection header line and laterals on the west 6-acre cell were flushed with groundwater to any residue or debris from construction activities (Image 4-5).

Full-scale leachate addition began on June 5, 2003. Through June 30, 2003, a total of 1,598,880 gallons of supplemental liquid was added and 1,600 gallons of leachate recirculated into Layers 3 and 4 of the west 6-acre area (Appendix C, Figure 4-1). On June 23, 2003, leachate injection on Layer 3 was stopped after approximately 508,750 gallons of liquid had been injected due to all of Layer 3 gas collection lines becoming blocked due to liquid build-up. Leachate injection on Layer 3 will resume once the liquid levels decline and the gas collection lines are again operational. Once liquid injection resumes, large volumes of liquid will be added to bring the waste to field capacity. Liquid injection will continue until the waste reaches field capacity.

4.1.3.2 Landfill Gas Collection

Landfill gas collection began May 7, 2002 from the leachate collection and removal system (LCRS). Gas collection from waste in the west-side anaerobic cell began on March 13, 2003.

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. Layer 1 is represented by a 1, Layer 2 is represented by a 2, 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

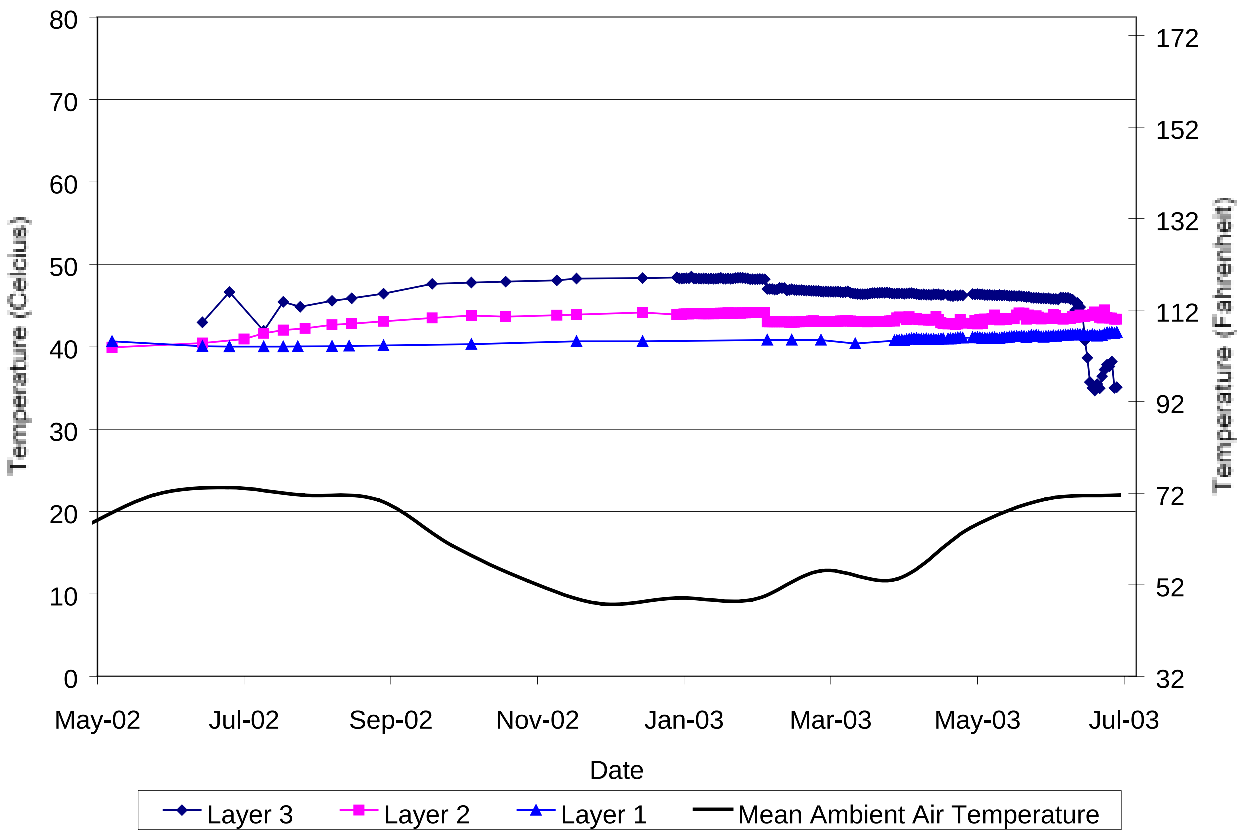
Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system located in the instrumentation shed starting in January 2003. Resistance was previously measured manually by connecting the sensor wires to a 26 III Multimeter manufactured by Fluke Corporation.

Temperature results are presented in Appendix C, Figures 4-2 to 4-4. Since the start of liquid addition in June 2003, the average temperature on Layer 3 has dropped approximately 10 degrees Celsius. Recent data indicates that the average temperature in Layer 2 has started to decline slightly. Liquid addition has not commenced on Layer 1 and average temperatures have started to increase. A summary of the results is presented below in Table 4-3 and Figure 4-5.

Table 4-3. Temperature Summary for the West-Side Anaerobic Cell

	Previous Reporting Period (01/01/03 to 03/31/03)			Current Reporting Period (04/01/03 to 06/30/03)		
Layer	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**
1	37.7	42.8	40.7	37.6	44.2	41.2
2	27.8	49.9	43.5	8.6	49.3	43.5
3	42.8	54.8	47.4	24.1	52.5	44.2

Figure 4-5. Average Temperatures for the West-Side Anaerobic Cell



4.2.2 Moisture

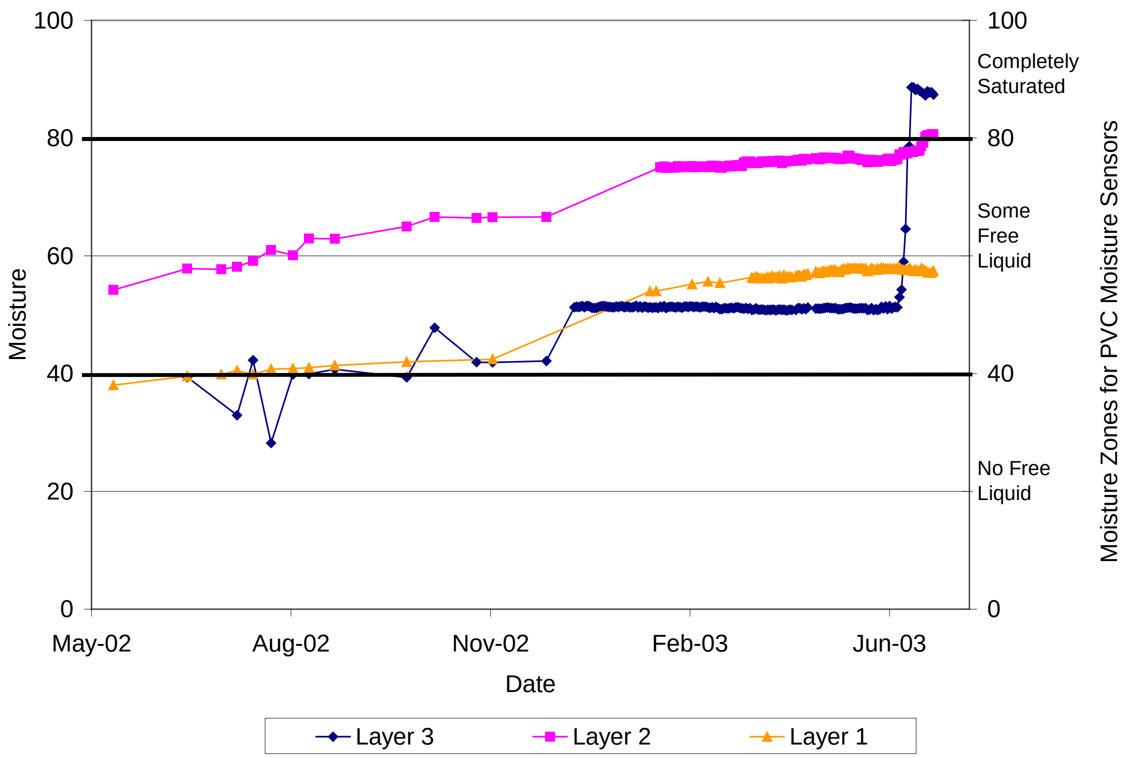
The SCADA system started electronically measuring moisture in January 2003. Moisture was previously measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. Moisture data are unitless numbers that give a qualitative assessment rather than a quantitative measure. During 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.

Moisture results are presented in Appendix C, Figures 4-6 to 4-8. Due to the start of liquid addition in June 2003, the average moisture levels in Layer 3 increased from the some free liquid zone to the completely saturated zone and the average moisture levels in Layer 2 steadily increased while remaining in the some free liquid zone. Since liquid addition has not commenced in Layer 1, moisture levels in Layer 1 have not started to increase. A summary of the results is presented below in Table 4-4 and Figure 4-9.

Table 4-4. PVC Moisture Summary for the West-Side Anaerobic Cell

	Previous Reporting Period (01/01/03 to06/30/03)			Current Reporting Period (04/1/03 to 06/30/03)		
Layer	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**
1	38.2	39.9	55.1	38.2	39.9	57.3
2	2.7	94.8	75.5	2.9	94.8	76.7
3	4.5	88.2	51.3	4.4	94.8	57.0

Figure 4-9. Average Moisture Levels for the West-Side Anaerobic Cell



4.2.3 Landfill Gas Collection System

Gas composition is measured from the base layer and the wellheads located on top of the west-side anaerobic cell with the GEM-500. Gas flow is measured by differential pressures utilizing a 1/8-inch diameter pitot tube by DWYER Instruments, Inc., in combination with the GEM-500. A thermal mass flow meter was installed in the main header pipeline on June 24, 2003 to record flow rate and total flow for west-side anaerobic cell.

Landfill gas results are presented in Appendix C, Figures 4-10 to 4-12. Methane concentrations from the wellhead fluctuate based on the applied vacuum, barometric pressure, and the status of waste decomposition. After surface liner installation in October 2002, the collection rate of landfill gas drastically increased. Additionally, methane and carbon dioxide concentrations increased while and oxygen and balance concentrations decreased. In April 2003, additional gas wells were opened resulting in increased methane and carbon dioxide levels and decrease in oxygen and balance gas levels. Fluctuations in landfill gas flow rates in May and June 2003 are due to mechanical problems at the on-site gas to energy facility. A summary of the results is presented below in Table 4-5.

Table 4-5. Landfill Gas Summary for the West-Side Anaerobic Cell.

Parameter	**Results**		
Cumulative Methane from May 7, 2002 to June 30, 2003	9.7 x 10^6 standard cubic feet (scf) (which is equivalent to approximately 1500 barrels of oil)		
LFG Flow Rate for the period of April 1, 2003 to June 30, 2003	Minimum	Maximum	Average
	38 scf	108 scf	75 scf
Methane Concentration for the period of April 1, 2003 to June 30, 2003	Minimum	Maximum	Average
	26.2 %	43.1 %	36.1 %

Landfill gas was sampled from the west-side anaerobic cell in May 2003 and sent to an independent laboratory for analytical testing. Analytical results are presented in Appendix D. Analytical results show a decline in several chlorofluorocarbons (CFCs) which are major contributors to ozone depletion[3, 4]. The decline in CFCs includes a drop in constituents such as trichlorofluoromethane by 84 percent and dichlorodifluoromethane by 95 percent from May 2002 to May 2003. Other VOC's that have declined include several hazardous air pollutants listed by the Environmental Protection Agency that include methylene chloride and vinyl chloride[5]. Landfill gas will be sampled on a quarterly basis since liquid addition has commenced in the west-side anaerobic cell.

4.2.4 Leachate Quantity And Quality

Full-scale leachate addition began on June 5, 2003 and all leachate generated after this date was recirculated back into the west-side anaerobic cell. To date approximately 1,598,880 gallons of supplemental liquid was added and 1,600 gallons of leachate recirculated into Layers 3 and 4 of the west 6-acre area (Appendix C, Figure 4-1).

Leachate was last sampled in February 2003 for analytical testing. Analytical results are presented in Appendix E, Table 4-6. Field chemistry and selected analytical results are presented below in Table 4-7. Analytical results show a recent decline in several VOC's including ground water contaminants toluene[6], methyl tertiary-butyl ether (MTBE)[7], and 4-methyl-2-pentanone (MIBK)[8]. Results also indicate a general decline in dissolved metals since February 2002.

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[3] Cooper, C., Alley, F., "Air Pollution Control, A Design Approach," Waveland Press, Inc. 1994
[4] *U.S. Environmental Protection Agancy (EPA) Home Page List of CFCs.* 17 July 2003. U.S. EPA. 22 July 2003 <http://www.epa.gov/ozone/ods.html>
[5] *U.S. Environmental Protection Agancy (EPA) Home Page.* 19 February 2003. U.S. EPA. 22 July 2003 <http://www.epa.gov/ttn/atw/orig189.html>
[6] Norris et al, "Handbook of Bioremediation,"Lewis Publishers, 1993
[7] *MTBE Water Contamination*. Lewis Saul and Associates, <http://www.mtbecontamination.com/>
[8] *U.S. Environmental Protection Agancy (EPA) Home Page.* September 1994. U.S. EPA. 22 July 2003 <http://www.epa.gov/opptinir/chemfact/f_mibk.txtl>

Table 4-7. Field Chemistry and Selected Laboratory Chemistry for Leachate Sampled from the West-Side Anaerobic Cell

PARAMETER	DATE:	2/14/2002	5/14/2002	6/20/2002	7/23/2002	8/13/2002	2/26/2003	5/29/2003	6/26/2003
Field Parameters:	**Units**								
pH		6.74	6.8	6.72	6.85	6.71	6.87	6.72	6.66
Electrical Conductivity	µS	3530	3851	3944	3899	3810	2320	2687	3056
Oxidation Reduction Potential	mV	-62	-46	-19	-38	-36	-56	-33	-75
Temperature	C	24.9	26.2	25.2	25.7	26.9	22.1	29.3	30.4
Dissolved Oxygen	mg/L	3.15	1.54	1.31	3.62	2.6	3.18	1.06	1.55
Total Dissolved Solids	ppm	2617	2871	2960	2965	2908	1703	1933	2227
General Chemistry:									
Bicarbonate Alkalinity	mg/L	1700	1780	1730	1710	1680	1000	1070	1210
Total Alkalinity as CO_3	mg/L	1700	1780	1730	1710	1680	1000	1070	1210
BOD	mg O/L	28	12	12	7.9	12	16	11	<6.0
Chemical Oxygen Demand	mg O/L	350	300	274	270	262	98.1	82.5	102
Chloride	mg/L	187	333	358	341	366	196	263	345
Ammonia as N	mg/L	20.3	23.5	21.2	23.8	25	9.5	10.3	13.7
Nitrate-Nitrite as N	mg/L	0.016(tr)	<1.5	<0.03	<0.015	<0.015	0.022 (tr)	<0.18	<0.09
Total Kjeldahl Nitrogen	mg/L	32.6	31.1	31.5	31.4	31	13.8	15.7	19.1
Total Dissolved Solids @ 180 C	mg/L	2220	2320	2410	2310	2280	1320	1480	1700
Total (Non-Volatile) Organic Carbon	mg/L	112	85.2	86.5	82.7	78.1	28.3	25.5	37.9
Total Sulfide	mg/L	0.033(tr)	<0.014	<0.014	0.023 (tr)	<0.014	<0.0093	<0.0093	<0.0093
Dissolved Iron	mg/L	0.4	0.035(tr)*	1.9	0.59	0.11	0.15	0.11	0.064 (tr)
Dissolved Magnesium	mg/L	198	343	NA	217	185	123	143	162
Dissolved Potassium	mg/L	55.2	58.6	NA	37.8	32.5	23.7	20.1	23.8

4.2.5 Surface Emissions

Methane surface concentrations are monitored along the perimeter of the collection area and along a pattern that transverses the landfill at 15 meter intervals. Due to high winds and inclement weather, the surface scan scheduled for December 2002 was postponed until January 2003. A summary of the surface scans performed on the west-side anaerobic cell is presented below in Table 4-8.

Table 4-8. Summary of Surface Scans Performed on the West-Side Anaerobic Cell

Surface Scan No.	Date	Max. Emissions Detected	Location of Max. Emissions
1	April 3, 2002	50 ppm	Southwest corner of the cell
2	June 6, 2002	37 ppm	On top the cell, along the access road leading to the active waste placement area
3	September 19, 2002	124 ppm	Southwest corner of the cell. This area was rescanned and surface concentrations decreased to approximately 10 ppm.
4	January 8, 2003	30 ppm	Along the northern perimeter near piping from the leachate collection and removal system (LCRS).
5	March 19, 2003	85 ppm	Detected at three locations: (1) The northern perimeter of the cell near the LCRS piping, (2) the north face of the cell directly south of the perimeter and approximately 15 merters east of the LCRS piping, and (3) directly south of the top deck hinge point and approximately 15 meters west of the centerline of the cell.
6	April 15, 2003	126 ppm	Detected at one location on the east face of the cell, approximately 75 meters from the south toe and 30 meters from the eastern perimeter of the cell.

Because the west-side cell was still undergoing active waste placement and a membrane cover had not been installed prior to the April 2002, June 2002 and September 2002 surface scans, greater methane emissions were detected from the west-side cell than from the northeast anaerobic cell. The detection of high surface emissions in March 2003 is due to unsealed areas (less than 1 inch) where piping penetrates the surface liner. During the April 2003 surface scan, lower emissions were detected in the areas that emitted high emissions in the March 2003 surface scan. The emissions detected in these areas were as follows: between 0 and 17 ppm were detected in location (1) on the northern perimeter of the cell near the LCRS piping, between 0 and 12 ppm near location (2) on the north face of the cell south of the LCRS piping, and between 0 and 79 ppm near location (3) on center of the top deck's northern hinge point. Higher emissions were detected in April on the east face of the cell near an unsealed area where piping penetrates the surface liner. Yolo County plans to repair the unsealed areas to prevent further surface emissions.

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

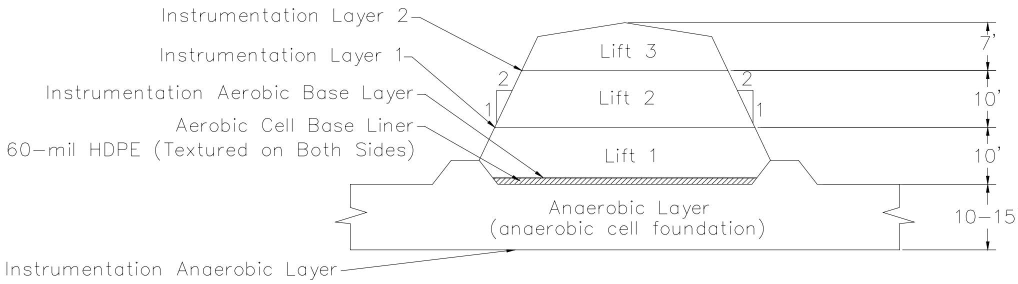
Construction of the aerobic cell can be generally broken down into five major tasks: waste placement, liquid addition, gas collection, air injection and surface liner installation. Each of the five tasks is discussed below. Refer to Appendix A, Table 5-1 for a summary of current monitoring data for the aerobic 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 5-1) 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 5-1. 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 5-1. 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 5-2.



Detail 5-1. 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) every 20 feet. 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 5-2). Because of the elevated temperatures expected in the aerobic cell, CPVC was installed a selected locations as a redundancy in the event the HDPE piping fails (CPVC is rated for service at temperatures up to 200^{o}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.

Image 5-2. Leachate injection laterals in trench

Each of the injection laterals is be connected to a 4-inch-diameter HDPE injection header. Individual solenoid valves were installed on each leachate injection lateral and connected to the Supervisory Control and Data Acquisition (SCADA) system used to monitor the various sensors and control the operation of the bioreactor. Liquid injection volumes will be monitored at individual flow meters installed on each injection lateral. 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 5-3.

Each air collection line is 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 incorporates a pre-manufactured wellhead capable of controlling flow and monitoring flow rate, temperature and pressure. Construction of the biofilter commenced in February 2003. Construction of the blower station and sensor installation in the biofilter were completed in June 2003. The remaining items to be completed include connecting the biofilter instrumentation to the SCADA system and placement of the biofilter media.

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 5-3) and in the leachate collection and recovery system (LCRS).

Image 5-3. Moisture, temperature, and tube installation

Each sensor location 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. Temperature sensors, moisture sensors, and pressure transducers are each connected to the Supervisory Control and Data Acquisition (SCADA) system used for monitoring and controlling the operation of the bioreactor. Refer to Appendix B, Details 5-2 through 5-5 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 5-4). 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 5-4. 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 and Flow

Landfill gas composition and flow are measured from the pre-manufactured well heads 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.

5.1.2.6 Surface Emissions

Under current federal guidelines (40 CFR 60.752), landfills exceeding a specific size must monitor for methane surface emissions and any reading in excess of 500 PPM (40 CFR 60.755 (c)) requires corrective action to be taken. The Yolo County Central Landfill is not currently required to test for methane surface emissions, however, as part of the FPA, the County has proposed to conduct quarterly surface scans to demonstrate the emissions (or lack of) from a controlled bioreactor landfill.

Methane concentrations are monitored 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 and has an accuracy of ± 2.5 PPM or 25 percent of the reading, whichever is greater. In the event significant methane was detected, the unit could be switched to PID mode to detect volatile organic compounds (VOC).

5.1.3 Operation

Operation of the aerobic cell as a bioreactor will begin once the biofilter is completed. At this time, we anticipate bioreactor operation to begin by the end of August 2003.

5.1.3.1 Leachate Addition and Recirculation

Initially, large volumes of liquid will be added to bring the waste to field capacity (Image 5-5). 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 5-5. Aerobic leachate injection header and lateral

5.1.3.2 Air Collection

The aerobic cell blower station was completed in June 2003 (Image 5-6). Construction of the biofilter began in February 2003. The biofilter base (constructed of wood chips) and its associated piping and instrumentation have been completed (Image 5-7). The remaining item to be completed is the placement of the biofilter media.

Image 5-7: Aerobic Cell Blower Station

Image 5-7. Construction of the biofilter

Landfill gas is currently being collected and sent to the on-site gas to energy facility. Once operation of the aerobic cell commences, off-gas will be collected and sent to the biofilter for treatment.

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

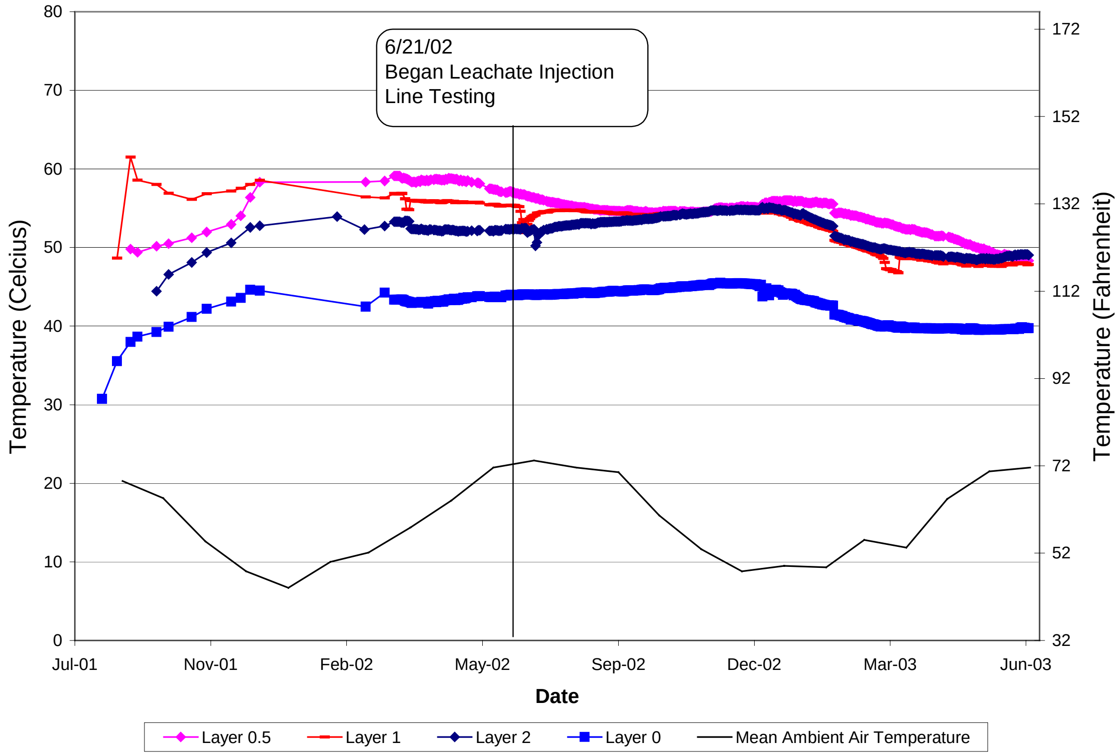
Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system 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.

Temperature results are presented in Appendix C, Figures 5-1 to 5-4. A summary of the results is presented below in Table 5-5 and Figure 5-4.

Table 5-4. Temperature Summary for the Aerobic Cell

	Previous Reporting Period (01/01/03 to 03/31/03)			Current Reporting Period (04/01/03 to 06/30/03)		
Layer	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**
0	25.4	61.2	41.6	25.6	56.3	39.7
0.5	47.3	61.5	54.4	40.7	57.7	50.4
1	17.4	72.1	51.0	5.9	63.5	48.0
2	34.5	72.2	51.7	48.4	65.7	48.7

Figure 5-5. Average Temperatures for the Aerobic Cell



5.2.2 Moisture

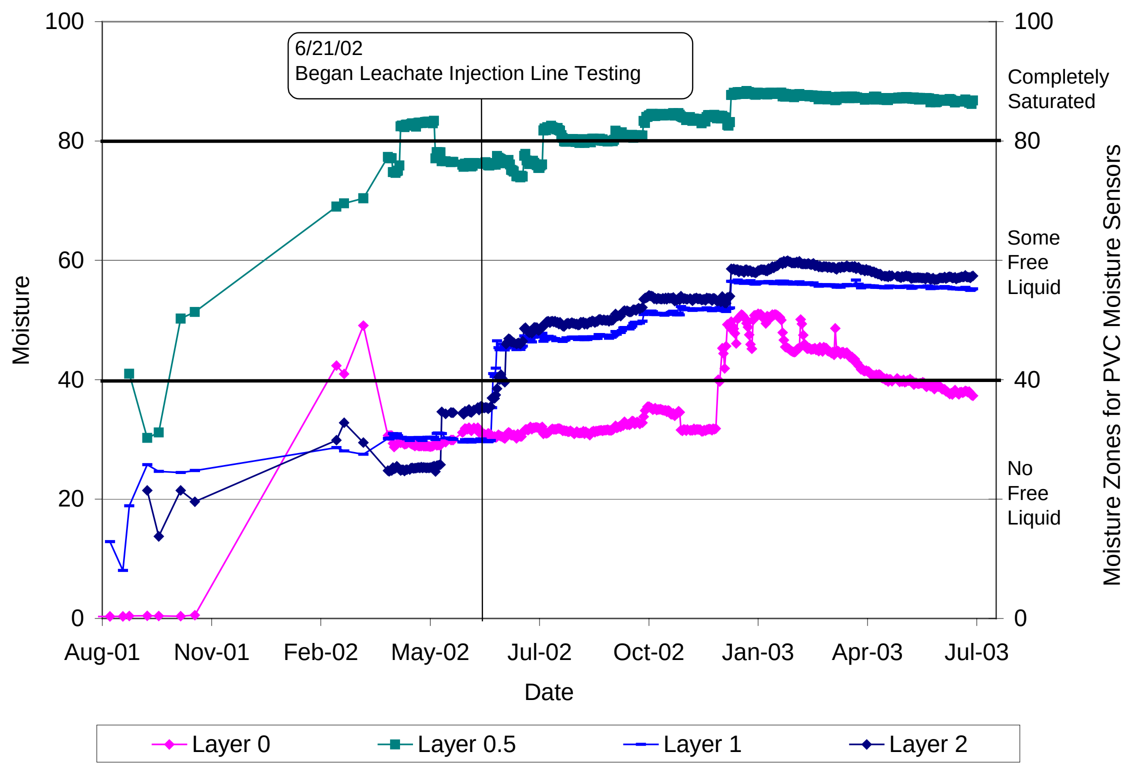
The SCADA system started electronically measuring moisture in March 2002. Moisture was previously measured manually with a Model MM 4 moisture meter manufactured by Electronics Unlimited. During the pilot scale project, Yolo County conducted laboratory tests with the PVC sensors to determine the relationship 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.

PVC moisture results are presented in Appendix C, Figures 5-6 to 5-9. A summary of the results is presented below in Table 5-5 and Figure 5-10.

Table 5-5. PVC Moisture Summary for the Aerobic Cell

	Previous Reporting Period (01/01/03 to 03/31/03)			Current Reporting Period (04/01/03 to 06/30/03)		
Layer	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**
0	3.2	46.9	94.8	3.7	91.9	39.4
0.5	80.2	94.4	87.2	80.0	93.9	87.0
1	10.3	89.9	56.1	9.5	88.9	55.5
2	6.2	90.6	58.9	5.1	86.6	57.4

Figure 5-10. Average Moisture Levels for the Aerobic Cell



5.2.3 *Landfill Gas Collection*

Gas composition is measured from the wellheads located on top of the aerobic cell with the GEM-500. Gas flow is measured by differential pressures utilizing a magnehelic pressure gauge by DWYER Instruments, Inc.

Landfill gas results are presented in Appendix C, Figures 5-11 through 5-13. Landfill gas composition from the aerobic cell shows elevated balance levels and low methane levels. A summary of the results is presented below in Table 5-6.

Table 5-6. Landfill Gas Summary for the Aerobic Cell.

Parameter	Results		
Cumulative Methane from January 13, 2003 to June 30, 2003	450,909 standard cubic feet (scf) (which is equivalent to approximately 71 barrels of oil)		
LFG Flow Rate for the period of April 1, 2003 to June 30, 2003	Minimum	Maximum	Average
	9.0 scf	12.9 scf	9.8 scf
Methane Concentration for the period of April 1, 2003 to June 30, 2003	Minimum	Maximum	Average
	10.4 %	14.8 %	12.4 %

Landfill gas was sampled from the west-side anaerobic cell in May 2003 and sent to an independent laboratory for analytical testing. Analytical results are presented in Appendix D. Analytical results show a decline in most VOC's while the concentration of sulfur compounds generally remain steady.

5.2.4 Leachate Quantity And Quality

Leachate was last sampled in May 2002 for analytical testing. Analytical results are presented in Appendix E, Table 5-7. Field chemistry and selected analytical results are presented below in Table 5-8. Leachate will be sampled on a monthly basis once liquid addition commences.

Table 5-8. Field Chemistry and Selected Analytical Results for Leachate Sampled from the Aerobic Cell

PARAMETER	DATE:	2/26/2002	3/27/2002	5/14/2002	5/29/2003
Field Parameters:	**Units**				
pH		7.75	8.17	8.48	8.48
Electrical Conductivity	µS	7026	7705	9048	9426
Oxidation Reduction Potential	mV	195	195	127	201
Temperature	C	15.1	15.2	21.1	27.9
Dissolved Oxygen	mg/L	5.45	5.73	6.8	1.67
Total Dissolved Solids	ppm	5673	NA	7448	7686
General Chemistry:					
Bicarbonate Alkalinity	mg/L	1120	935	1020	1480
Total Alkalinity as CO_3	mg/L	1120	935	1050	1510
BOD	mg O/L	3.3	5	89	35
Chemical Oxygen Demand	mg O/L	595	563	602	818
Chloride	mg/L	1610	1800	2290	1740
Ammonia as N	mg/L	2.8	1.1	0.60(tr)	36
Nitrate-Nitrite as N	mg/L	0.16	0.22	4.8(tr)	4.8
Total Kjeldahl Nitrogen	mg/L	19.9	19.2	11.1	69.1
Total Dissolved Solids @ 180 C	mg/L	4810	5200	5640	6330
Total (Non-Volatile) Organic Carbon	mg/L	766	149	168	215
Total Sulfide	mg/L	<0.014	0.015(tr)	<0.014	<0.0093
Dissolved Iron	mg/L	0.32	0.084(tr)	0.34	0.81
Dissolved Magnesium	mg/L	273	260	220	401
Dissolved Potassium	mg/L	NA	66.1	47.8	165

Analytical results show an increase in several parameters such as COD, sulfate, alkalinity, total kjeldahl nitrogen and several metals (i.e. potassium, sodium, and phosphorous, etc.). However, there has also been a decline in dissolved oxygen, total organic carbon, a few metals including manganese and calcium, and VOC's (i.e. cis-1,2-dichloroethene, trichloroethene, tetrachloroethene, etc). Additional data is needed for a thorough assessment of the leachate parameters.

5.2.5 Surface Emissions

Methane surface concentrations are monitored along the perimeter of the collection area and along a pattern that transverses the landfill at 15 meter intervals. Due to high winds and inclement weather, the surface scan scheduled for December 2002 was postponed until January 2003. The March 2003 aerobic cell surface scan was postponed until April 2003 due to technical difficulties with the instrument. A summary of the surface scans performed on the aerobic cell is presented below in Table 5-9.

Table 5-9. Summary of Surface Scans Performed on the Aerobic Cell

Surface Scan No.	Date	Max. Emissions Detected	Location of Max. Emissions
1	April 3, 2002	No fugitive emissions detected	Not applicable
2	June 6, 2002	8 ppm	Along the western perimeter of the cell
3	September 20, 2002	3 ppm	South face of the cell near the leachate collection sump
4	January 7, 2003	0.9 ppm	South face of the cell along a gas collection lateral.
5	April 30, 2003	3.6	Along the west perimeter, approximately 80 meters from the south toe of the cell.

The extremely low surface emissions detected from the aerobic cell are not surprising given the low moisture content of the waste (very little water has been added) and full scale operation of the cell has not commenced. Once operation begins, future surface scans should be able to demonstrate the surface emission potential of an aerobic bioreactor landfill.

The detection of surface emissions may also be due to landfill operations in nearby areas. While background concentrations were monitored prior to conducting the surface scan, changes in wind currents could have transported methane from adjacent areas. During June 2002 and September 2002, grading and waste filling activities in the adjacent west-side 6-acre area could have promoted the detection of gas emissions in the aerobic cell. Additionally, activities from Module D Phase II construction (which involved exposing waste from an adjacent unit to facilitate base liner installation) could have promoted the detection of gas emissions during the September 2002 surface scan. The surface emissions detected on the south face in January 2003 was due to a loose flex hose along a gas collection lateral that was immediately tightened. Surface emissions detected in April 2003 may be due to emissions from the west-side anaerobic cell. Higher surface emissions have been detected from the west-side anaerobic cell due to leakage from small gaps in the surface liner where piping exits the cell.

The true methane emissions detected are also a function of the accuracy of the surface scan equipment. The TVA-1000 FID instrument has an accuracy of ±25 percent of reading or ±2.5 ppm, whichever is greater, from 1.0 to 10,000 ppm. Thus many of the surface emissions are outside (below) the accuracy range and thereby assumed to be negligible.

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

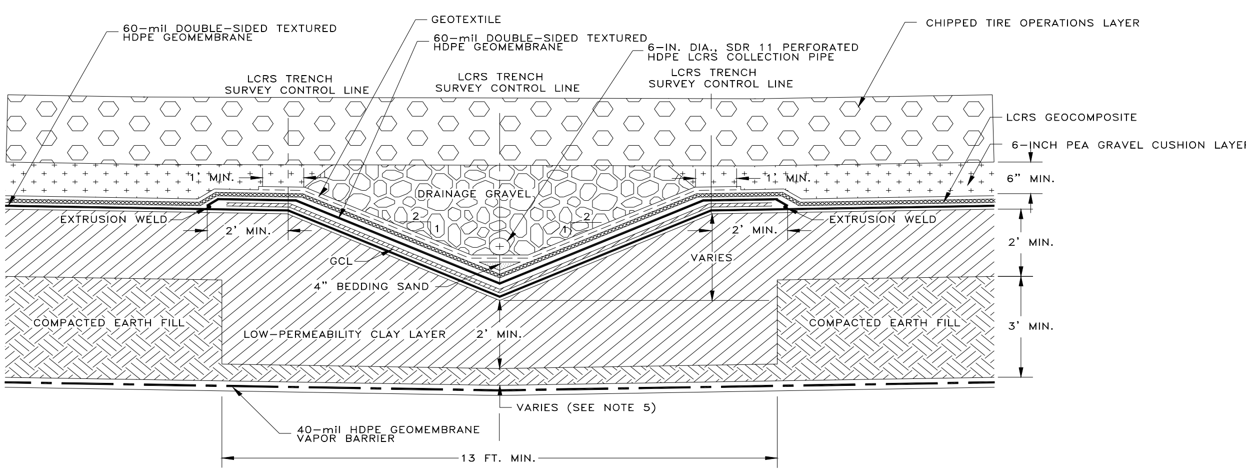
The experimental methods utilized are grouped into two categories: construction and monitoring. Each of these categories is discussed below.

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 6-1). Each of the trenches drain at 1 percent to their respective leachate collection sumps located at the south side of the module.



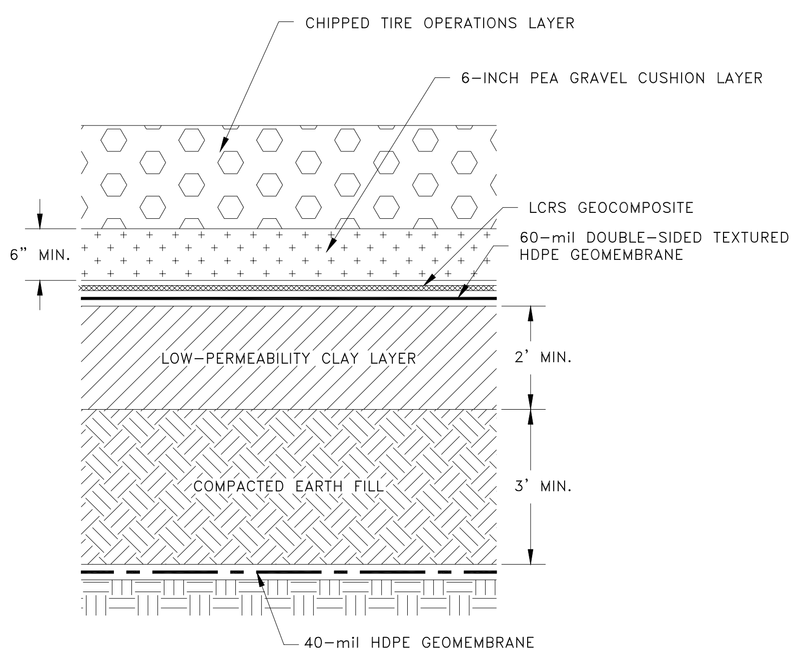
Detail 6-1. Module D Bottom Liner and Leachate Collection Trench Cross-Section

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 6-1), 6-inches of pea gravel, geocomposite drain net, a 60-mil high density polyethylene

Image 6-1. 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[9] (Detail 6-2).



Detail 6-2. Module D Bottom Liner Cross-Section

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

6.1.2 Monitoring

Temperature, moisture, and pressure 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 either a 1.25-inch HDPE pipe or run inside the LFG collection piping. Refer to Appendix B, Detail 6-3 for sensor location diagram.

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. A summary of sensors installed on the base liner is provided in Appendix A, Table 6-1.

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[10]. Head over the liner is monitored through a series of pressure transducers and sampling tubes either in or next to the leachate collection trenches (Appendix C, Figure 6-10). In addition, sampling tubes located on the Module 6D liner (designations 0-1 through 0-66) are utilized to monitor head over the liner.

6.1.2.1 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.

6.1.2.2 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.

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[10] 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.

6.1.2.3 Leachate Collection Trenches

Three LLDPE sampling tubes were installed in each of the leachate collection trenches (Image 6-2). 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 6-2). 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.

Image 6-2. 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 Temperature

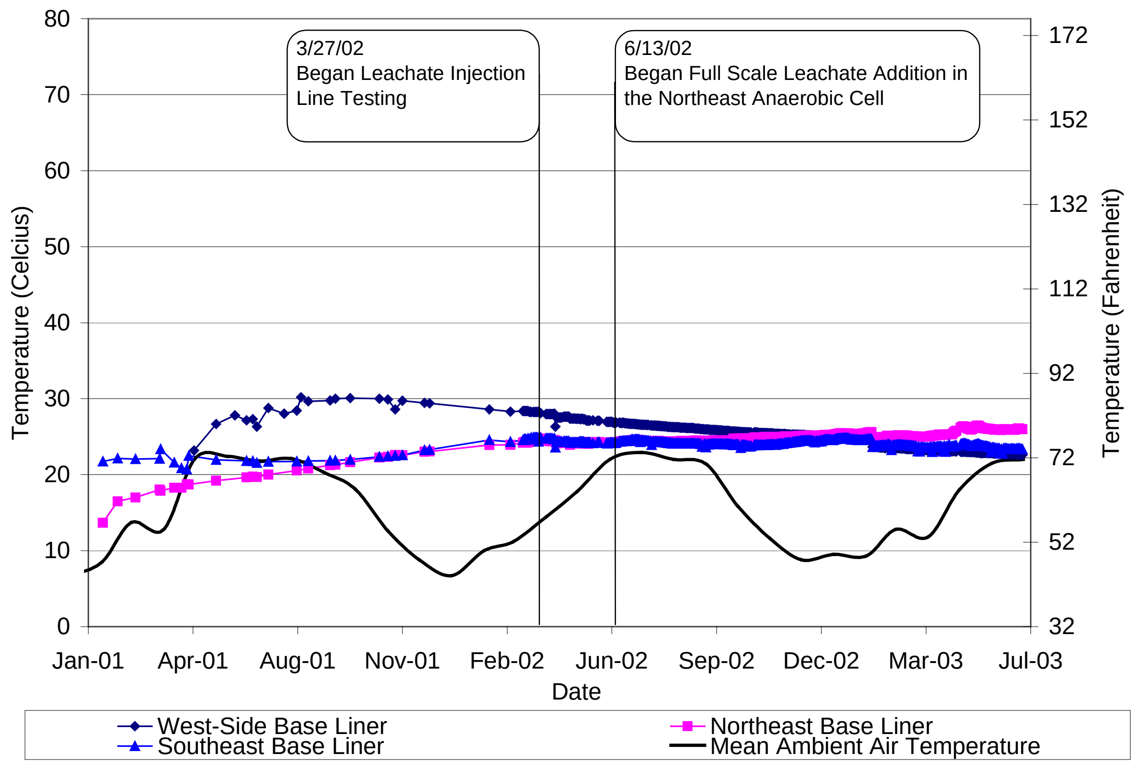
Temperature is monitored with thermistors manufactured by Quality Thermistor, Inc. Thermistors with a temperature range of 0°C to 100°C were chosen so they would be able to accommodate the temperature ranges expected in both the anaerobic and aerobic cells. Resistance was measured by the SCADA system 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.

Temperature results are presented in Appendix C, Figures 6-1 to 6-4. A summary of the results is presented below in Table 6-2 and Figure 6-5.

Table 6-2. Temperature Summary for the Base Liner

	Previous Reporting Period (01/1/03-03/31/03)			Current Reporting Period (04/01/03 to 06/30/03)		
Location	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**	**Minimum Temp. (°C)**	**Maximum Temp. (°C)**	**Average Temp. (°C)**
Northwest	8.2	30.1	24.0	6.5	28.5	22.9
Southwest	15.8	29.1	24.0	14.3	27.2	22.9
Northeast	12.2	30.8	25.2	12.3	31.2	25.8
Southeast	10.2	34.5	24.1	8.3	33.8	23.6

Figure 6-5. Average Temperatures on the Base Liner



6.2.2 Moisture

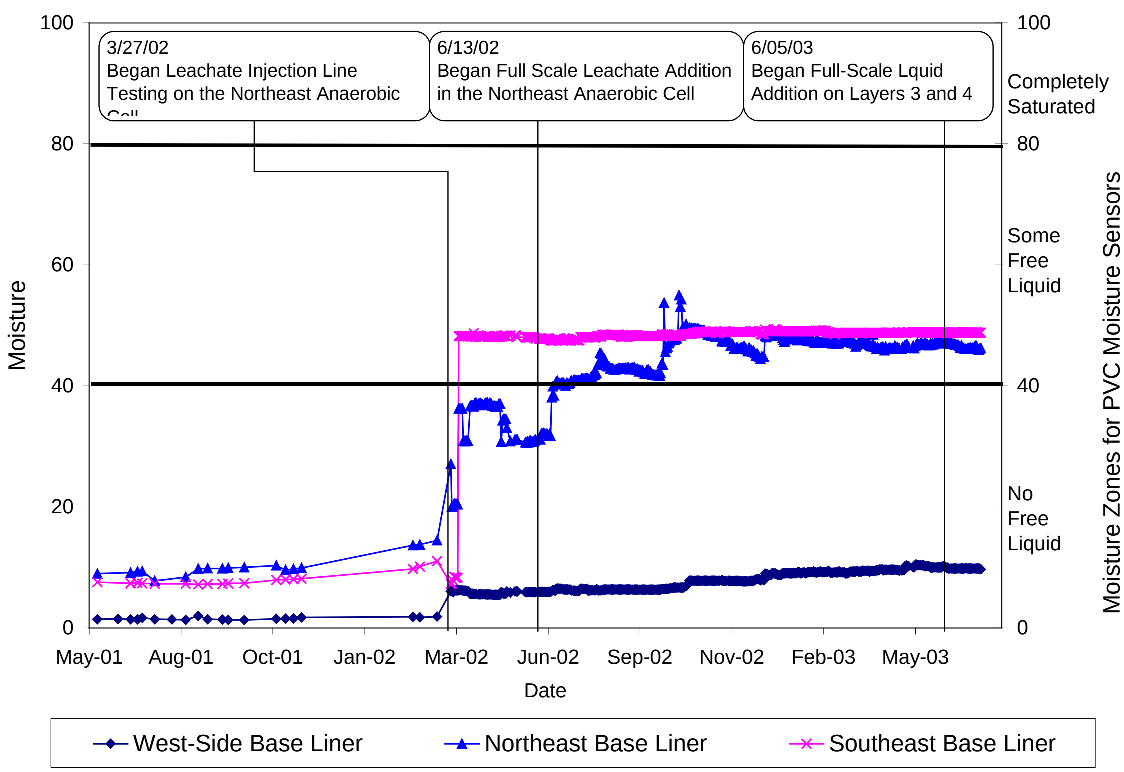
The SCADA system started electronically measuring moisture in March 2002. Due to a slight variation between how the SCADA system measures moisture compared to the manual meter, moisture readings generally increased a small fraction relative to their previous manually recorded readings. Because moisture 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.

Moisture results are presented in Appendix C, Figures 6-6 to 6-8. A summary of the results is presented below in Table 6-3 and in Figure 6-9.

Table 6-3. PVC Moisture Summary for the Base Liner

	Previous Reporting Period (01/01/03 to 03/31/03)			Current Reporting Period (04/01/03 to 06/30/03)		
Location	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**	**Minimum Moisture**	**Maximum Moisture**	**Average Moisture**
West-Side	6.5	20.3	9.2	6.8	20.2	9.9
Northeast	26.6	88.2	47.5	27.8	88.2	46.6
Southeast	8.8	88.2	48.9	9.3	88.2	48.8

Figure 6-9. Average Moisture Levels on the Base Liner



6.2.3 Leachate Collection Trenches

Liquid level data adjacent to the leachate collection trenches is presented in Appendix C, Figure 6-10. Pressure transducers three and four shows increasing liquid levels that are not supported by data from other sensors. In April 2003, pressure transducers were pulled from the base liner, tested for accuracy, and then pulled back to their original locations. To test the pressure transducers they were immersed in a barrel filled with water of varying depths and the actual depth of water was compared to the output signal of the transducer (Image 6-3). Several of the pressure transducers exhibited fluctuating readings although the depth of water was constant. Typically this fluctuation was plus or minus one-inch of the actual depth (e.g. if the actual depth of water was 12 inches the output signal of the transducer would drift between 11 and 13 inches.) In an effort to determine the cause of this problem, the manufacturer was contacted and it was determined that the most likely cause of the error was the presence of water in the pressure transducers vent line. Yolo County plans to remove the water by applying a gentile vacuum (approximately 8 psi, anything greater would adversely affect the transducer) to the vent line. The transducers will then be retested by immersing them in a barrel of water.

Image 6-3. Pressure transducers were tested for accuracy by submerging the sensors in water at various depths.

On May 22, 2003, pressure transducer six located on the bottom liner detected 9.21 inches of liquid. Refer to Appendix B, Detail 6-3 for the location of pressure transducer six. Within less than 10 hours, readings from the pressure transducer dropped to below 4 inches of water. Since this occurrence, head on the liner has not surpassed 4 inches. A summary of the results is presented below in Table 6-4.

Table 6-4. Leachate Level Summary for the Base Liner

	Previous Reporting Period (01/01/03 to 03/31/03)			Current Reporting Period (04/01/03 to 06/30/03)		
Pressure Transducer	Min. Level (In. of Water)	Max. Level (In. of Water)	Avg. Level (In. of Water)	Min. Level (In. of Water)	Max. Level (In. of Water)	Avg. Level (In. of Water)
1	0.22	0.40	0.30	0.26	0.42	0.36
2	0.32	0.62	0.46	0.54	0.70	0.62
3	1.41	2.02	1.85	1.40	2.01	1.69
4	0.01	0.46	0.11	0.01	0.22	0.09
5	0.29	0.48	0.37	0.01	0.58	0.30
6	0.01	0.15	0.04	0.01	9.21*	0.24

*On May 22, 2003, the leachate pump in the east sump was turned off for maintenance and therefore the water level briefly increased to 9.21 inches.

7 CONCLUSION

Full-scale operation is underway in the northeast anaerobic cell and the west-side anaerobic cell and results are generally as expected. In the northeast anaerobic cell, moisture sensors are indicating that injected liquid is being distributed relatively uniformly and temperatures within the cell are normal and within the range necessary for anaerobic decomposition.

Leachate addition began in the west-side anaerobic cell in June 2003. In response to leachate addition, moisture levels on Layer 3 have generally increased and indicate the waste is saturated while temperature levels temporarily declined due to the addition of cool liquid to the waste. Average moisture levels on Layer 2 have also increased, while remaining in the some free liquid zone, and temperatures on Layer 2 have only slightly increased.

Gas production has continued to increase in the bioreactor cells. Methane totaling 31.6 x 10^6 scf has been removed from northeast anaerobic cell, 9.7 x 10^6 scf has been removed from the west-side anaerobic cell, and 450,909 scf has been removed the aerobic cell. Additionally, several VOC's in landfill gas from the bioreactor cells have continued to decline.

Methane surface emissions from the aerobic cell and the northeast anaerobic cell generally remain low. Because liquid addition has not commenced in the aerobic cell, its full potential at eliminating fugitive surface emissions has yet to be evaluated. Two major items that are responsible for this effective control of surface emissions in the northeast anaerobic cell are the following: 1) The installation of a synthetic cover over the entire cell, and 2) The use of an active landfill gas extraction system. Higher methane emissions have been detected from the west-side anaerobic cell. The emissions detected in the March and April 2003 surface scan can generally be attributed to unsealed areas of the surface liner where piping exits the cell. We expect to detect lower surface emissions once the pipe penetrations have been sealed.

Final construction of the aerobic blower facilities has been completed. The remaining item to be completed includes placement of the biofilter media. The biofilter is scheduled to be complete and operation of the aerobic cell started by the end of August 2003.

8 REFERENCES

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4. *U.S. Environmental Protection Agancy (EPA) Home Page.* 17 July 2003. U.S. EPA. 22 July 2003 <http://www.epa.gov/ozone/ods.html>

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

10. 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.

APPENDIX A – EPA XL SCHEDULE AND SUMMARY OF MATERIALS INSTALLED

Table 1-1. 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 Project Agreement (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	June 2003
• Begin liquid addition to the northeast 3.5-acre anaerobic cell	November 2001
• Begin liquid addition and air injection in aerobic bioreactor	August 2003
• Complete the following for the west anaerobic 6-acre cell: waste placement, instrumentation, data acquisition and control system, leachate injection system, gas collection system, gas and leachate monitoring, and cover system	October 2002
• Begin liquid injection in the west side 6-acre anaerobic bioreactor	August 2003
• Data collection and reporting will continue	On-going until waste stabilization is complete, but dependent on sustained funding levels

Table 3-1. 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[1]	11,060 tons
Volume of Soil Within the Waste Mass[2]	5,970 cubic yards
As-Placed Biodegradable Waste Tonnage[3] As-Placed Biodegradable Greenwaste ADC Tonnage[3]	29,600 tons 7,700 tons
Ratio of Waste to Greenwaste ADC	5.9 to 1
Ratio of Waste to Greenwaste ADC and Soil	3.4 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[4] 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)[5] 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	7,990 feet 3,080 feet 2,450 feet 1,500 feet 960 feet
Total # of 3/32 inch Diameter Holes in Injection Line Layer 1 Layer 2 Layer 3 Layer 4	337 145 93 55 44
Surface Liner	36-mil[6] Reinforced Polypropylene

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

Table 3-2. Summary of Sensors for the Anaerobic Cells

Type of Instrumentation	FPA Proposed Location/Quantity/Spacing	Northeast Anaerobic Cell Actual Location/Quantity/Spacing	West-Side Anaerobic Cell Actual Location/Quantity/Spacing
Bubbler Gage for Liquid/Gas Pressure Measurement and Liquid/Gas Sampling	1. Top of the first lift of waste- 55 gages 2. Top of the second lift of waste-40 gages 3. Top of the third lift of waste-30 gages 4. Top of the final lift of waste-20 gages TOTAL= 145 gages	1. Top of the first lift of waste- 15 gages at 75 feet spacing 2. Top of the second lift of waste-13 gages at 75 feet spacing 3. Top of the third lift of waste- 13 gages at 75 feet spacing 4. Top of the final lift of waste- no gages TOTAL= 41 gages	1. Top of the first lift of waste- 6 gages at various spacing 2. Top of the second lift of waste-7 gages at various spacings 3. Top of the third lift of waste- no gages 4. Top of the final lift of waste- no gages TOTAL= 13
Moisture and Temperature Sensors	1. Top of the first lift of waste-55 temperature and moisture sensors 2. Top of the second lift of waste-40 temperature and moisture sensors 3. Top of the third lift of waste-30 temperature and moisture sensors 4. Top of the final lift of waste-20 temperature sensors TOTAL= 145 temperature sensors and 125 moisture sensors	1. Top of the first lift of waste-18 temperature and 18 moisture sensors at 75 feet spacing 2. Top of the second lift of waste-16 temperature and 39 moisture sensors at 75 feet spacing 3. Top of the third lift of waste-13 temperature and 13 moisture sensors at 75 feet spacing 4. Top of the final lift of waste- no sensors TOTAL= 47 temperature sensors and 70 moisture sensors	1. Top of the first lift of waste-6 temperature and 6 moisture sensors at various spacings 2. Top of the second lift of waste-43 temperature and 43 moisture sensors at various spacings 3. Top of the third lift of waste-14 temperature and 14 moisture sensors at various spacings 4. Top of the final lift of waste- no sensors TOTAL= 63 temperature sensors and 63 moisture sensors

Because the original project was altered from constructing one 9.5-acre anaerobic cell to constructing two anaerobic cells, one occupying 6-acres and one occupying 3.5-acres, waste placement area was lost in the valley separating the two anaerobic cells. This resulted in the installation of fewer sensors over the 9.5-acre area than initially proposed.

Table 3-3. 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 4-1. Summary of Data for the West-Side Anaerobic Cell

Description	Data
Footprint	6 acres
Average Waste Depth	35 feet
Construction of the Base Liner	1999
Waste Filling of Cells	3/8/2001 – 8/31/2002
Total # of Waste Lifts	4
Total Amount of Waste	166,294 tons
Total Amount of Greenwaste ADC[1]	27,570 tons
Total # of Horizontal Gas Collection Lines[2] Layer 1 Layer 2 Layer 3 Layer 4	18 Spacing of approximately 0 80 feet on center 9 (Layer 4 spacing of 7 approximately 50 feet) 2
Total # of Liquid Addition Lines (HDPE Pipe)[3] Layer 1 Layer 2 Layer 3 Layer 4	27 Spacings vary 0 17 7 3
Total Amount of Liquid Addition Piping Layer 1 Layer 2 Layer 3 Layer 4	7,185 feet 0 feet 4,350 feet 1,185 feet 1,650 feet
Total # of 3/32 and 1/8 inch Diameter Holes in Injection Line Layer 1 Layer 2 Layer 3 Layer 4	321 0 122 62 137
Surface Liner	40-mil[4] LLDPE[5] geomembrane

[1]ADC-Alternative Daily Cover
[2]Refer to Table 3 for a complete description of gas collection lines
[3]High Density Polyethylene, HDPE
[4]1-mil is equivalent to 0.001 inches and refers to the thickness of the liner
[5] Linear Low Density PolyproplyeneTable 4-2. Summary of Gas Collection Lines for the West-Side Anaerobic Cell

Table 4-2. Summary of Gas Collection Lines for the West-Side Anaerobic Cell

Gas Collection Line[1]	Description	Spacing
2-G1	Shredded tires with pipe at ends. The east end is 45 feet of 4 inch schedule 80 PVC[2], 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 50 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC.	80' from 2-G2
2-G2	Shredded tires with pipe at ends. The east end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC.	80'from 2-G3
2-G3	Shredded tires with pipe on ends. The east and west ends are 40 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, 10 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC.	80' from 2-G4
2-G4	Shredded tires with pipe on ends. The east end is 20 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, 10 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 20 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, 10 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, 10 feet of 4 inch schedule 80 PVC, and 20 feet of 24 inch corrugated metal pipe.	80' from 2-G5
2-G5	Alternating 10-foot lengths of 4 inch schedule 40 electrical conduit and 6 inch corrugated metal. The east end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 40 feet of schedule 80 PVC and 10 feet of 6 inch schedule 40 electrical conduit.	80'from 2-G6
2-G6	Shredded tires with pipe at ends. The east end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 12 inch schedule 40 PVC, 10 feet of 4 inch schedule 80 PVC, 10 feet of 12 inch schedule 40 PVC, and 10 feet of 4 inch schedule 80 PVC.	80' from 2-G7
2-G7	Shredded tires with pipe on ends. The east end is 40 feet of 4 inch schedule 40 PVC, 10 feet of 6 inch schedule 80 PVC, and 10 feet of 4 inch schedule 80 PVC. The west end is 40 feet of 4 inch schedule 80 PVC, 10 feet of 6 inch schedule 80 PVC, and six sets of alternating 10 foot lengths of 4 inch schedule 80 PVC telescoped with 12 inch schedule 40 PVC.	80'from 2-G8
2-G8	Same as 2-G2	80' from 2-G9
2-G9	Same as 2-G2	40'from south toe
3-G1	Shredded tires with pipe on west end. No pipe on east end. The west end is 40 feet of 4 inch schedule 80 PVC, and three sets of alternating 10 foot lengths of 6 inch schedule 80 PVC telescoped with 4 inch schedule 80 PVC.	80' from 3-G2
3-G2	Same as 3-G1	80' from 3-G3
3-G3	Same as 3-G1	80' from 3-G4
3-G4	Same as 3-G1	80' from 3-G5
3-G5	Same as 3-G1	80' from 3-G6
3-G6	Shredded tires with pipe on west end. No pipe on east end. The west end is 50 feet of 4 inch schedule 80 PVC, and 60 feet of alternating 10 foot lengths of 6 inch and 4 inch schedule 80 PVC.	80' from 3-G7
3-G7	Same as 3-G1	40' from south toe
4-G1	Shredded tires with pipe on ends. The north and south ends are 3 sets of alternating 10 foot lengths of 6 inch schedule 80 PVC and 6 inch schedule 40 PVC, and one additional10 foot length of 6 inch schedule 80 PVC.	40' from south toe
4-G2	Same as 4-G1	50' from 4-G1

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

Table 5-1. 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[1]	2,169 tons
Total # of Corrugated Metal Pipe Horizontal Air Collection Lines Layer 1 Layer 2	6 Spacings vary. 3 3
Total # of CPVC[2] Pipe Horizontal Air Collection Lines Layer 1 Layer 2	5 Spacings vary. 3 2
Total Amount of Air Collection Lines[3] Layer 1 Layer 2	1,660 feet 1,100 feet 560 feet
Total # of HDPE[4] 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 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

[1]ADC-Alternative Daily Cover
[2]Chlorinated Polyvinyl Chloride, CPVC
[3]Refer to table A for a complete description of air collection lines
[4]High Density Polyethylene, HDPE

Table 5-2. Summary of Sensors for the Aerobic Cell

Type of Instrumentation	FPA Proposed Location/Quantity/Spacing	Aerobic Cell Actual Location/Quantity/Spacing
Pressure Transducers	1. Two over the primary liner at 200 feet spacing 2. One within the leachate collection sump	1. Two over the primary liner at 200 feet spacing 2. One within the leachate collection 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 second lift of waste-20 gages 4. Top of the final lift of waste-20 gages TOTAL= 112 gages	1. Top of the aerobic 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. Between bottom liner and the top of the first lift of waste- no sensors 3. Top of the first lift of waste- 24 temperature and moisture sensors 4. Top of the second lift of waste-20 temperature and moisture sensors 5. Top of the final lift of waste-20 temperature and moisture sensors	1. Top of the aerobic bottom liner-12 temperature and 2 moisture sensors at 75 feet spacing 2. Between bottom liner and the top of the first lift of waste- 3 temperature sensors and 3 moisture sensors at various spacings. 3. Top of the first lift of waste- 26 temperature and 26 moisture sensors at various spacings 4. Top of the second lift of waste-18 temperature and 21 moisture sensors at various spacings 5. Top of the final lift of waste-no temperature or moisture sensors
	TOTAL= 112 temperature sensors and 76 moisture sensors	TOTAL= 59 temperature sensors and 52 moisture sensors

Table 5-3. Summary of Air Collection Lines for the Aerobic Cell

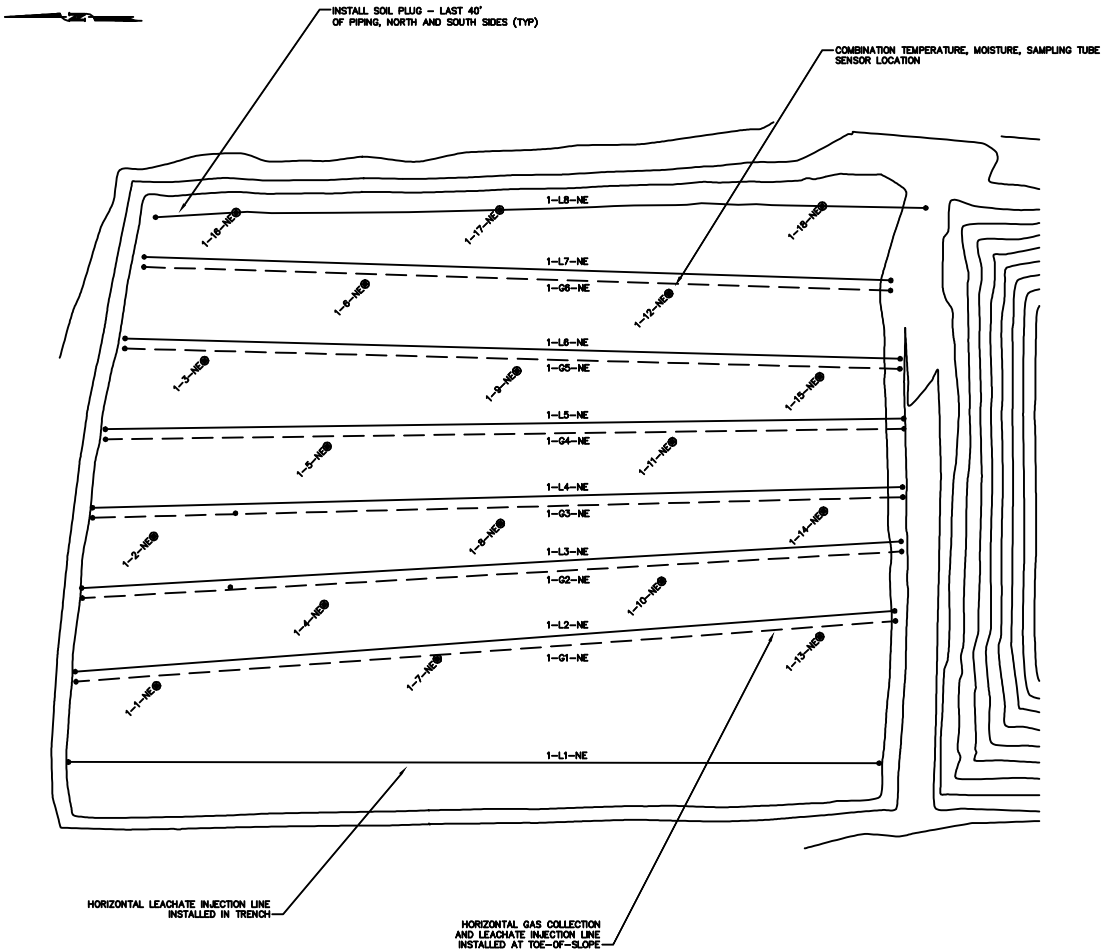
Air Collection Line[1]	Description	Spacing
1-A1	Alternating 10 foot lengths of 4 and 6 inch schedule 80 CPVC[2].	30' from west toe
1-A2	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40' from 1-A1-SE
1-A3	Alternating 10 foot lengths of 6 and 8 inch corrugated metal pipe.	40' from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

Table 6-1. Summary of Sensors for the Module 6D Base Liner

Type of Instrumentation	FPA Proposed Location/Quantity/Spacing	Module 6D Base Liner Actual Location/Quantity/Spacing
Pressure Transducer	1. Eight over the primary liner near the LCRS trench at 200 feet spacing 2. Two over the primary liner within the leachate collection sumps	1. Six over the primary liner at 200 feet spacing (three near the west LCRS and three near the east LCRS) 2. Four over the primary liner within the leachate collection sumps
Bubbler Gage for Liquid/Gas Pressure Measurement and Liquid/Gas Sampling	Top of primary bottom liner-66 gages at 75 feet spacing	Top of primary bottom liner-66 gages at 75 feet spacing
Moisture and Temperature Sensors	Top of primary bottom liner-66 temperature sensors at 75 feet spacing and 12 moisture sensors	Top of primary bottom liner-66 temperature sensors at 75 feet spacing and 12 moisture sensors

APPENDIX B – PIPING AND INSTRUMENTATION PLAN



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

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

30 15 0 30 60 90

GRAPHIC SCALE
1"=30'

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.

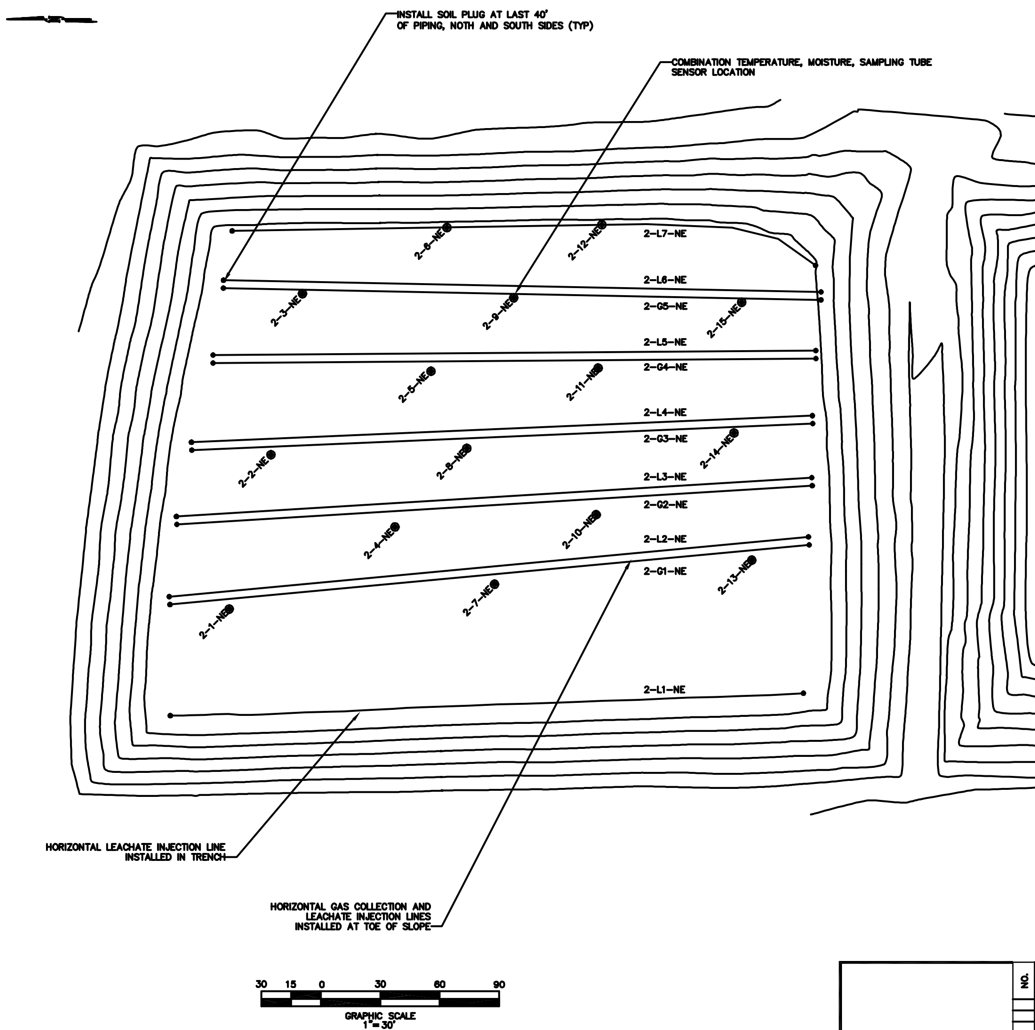
YOLO COUNTY CENTRAL LANDFILL
FULL–SCALE BIOREACTOR

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
3–2



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" ∅, SDR 11 HDPE WITH 3/32" ∅ 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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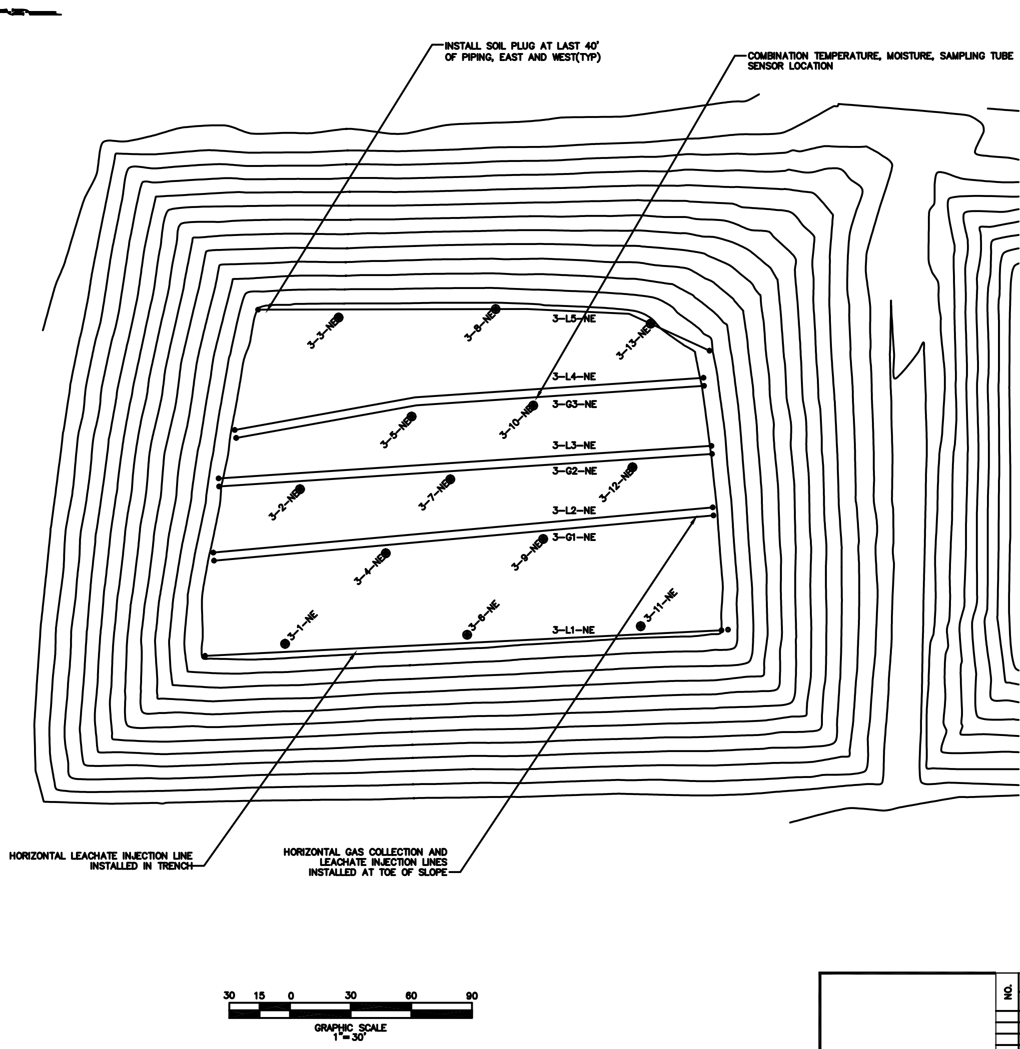
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

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 3-3



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

AS-BUILT

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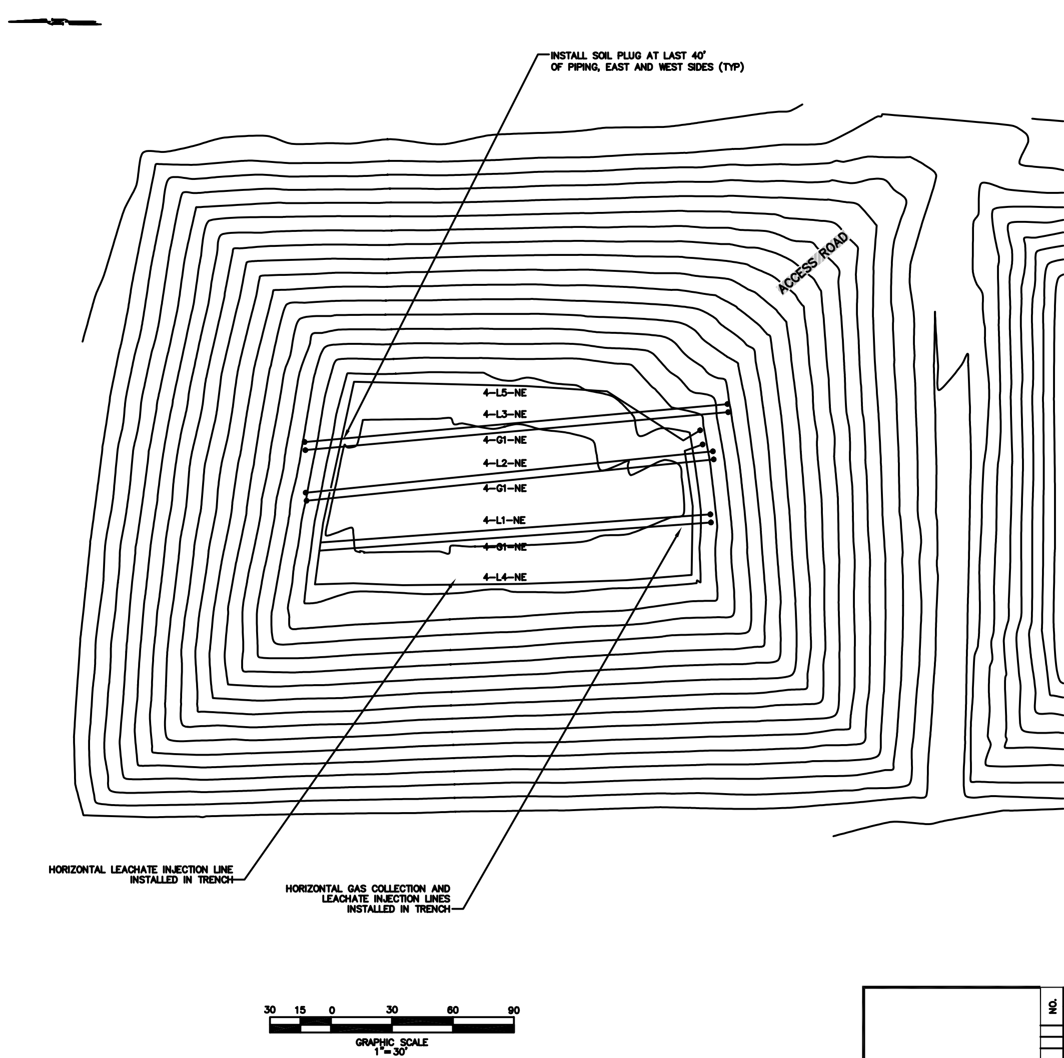
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

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 3-4



LEGEND

———— (leachate line)	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C
———— (gas line)	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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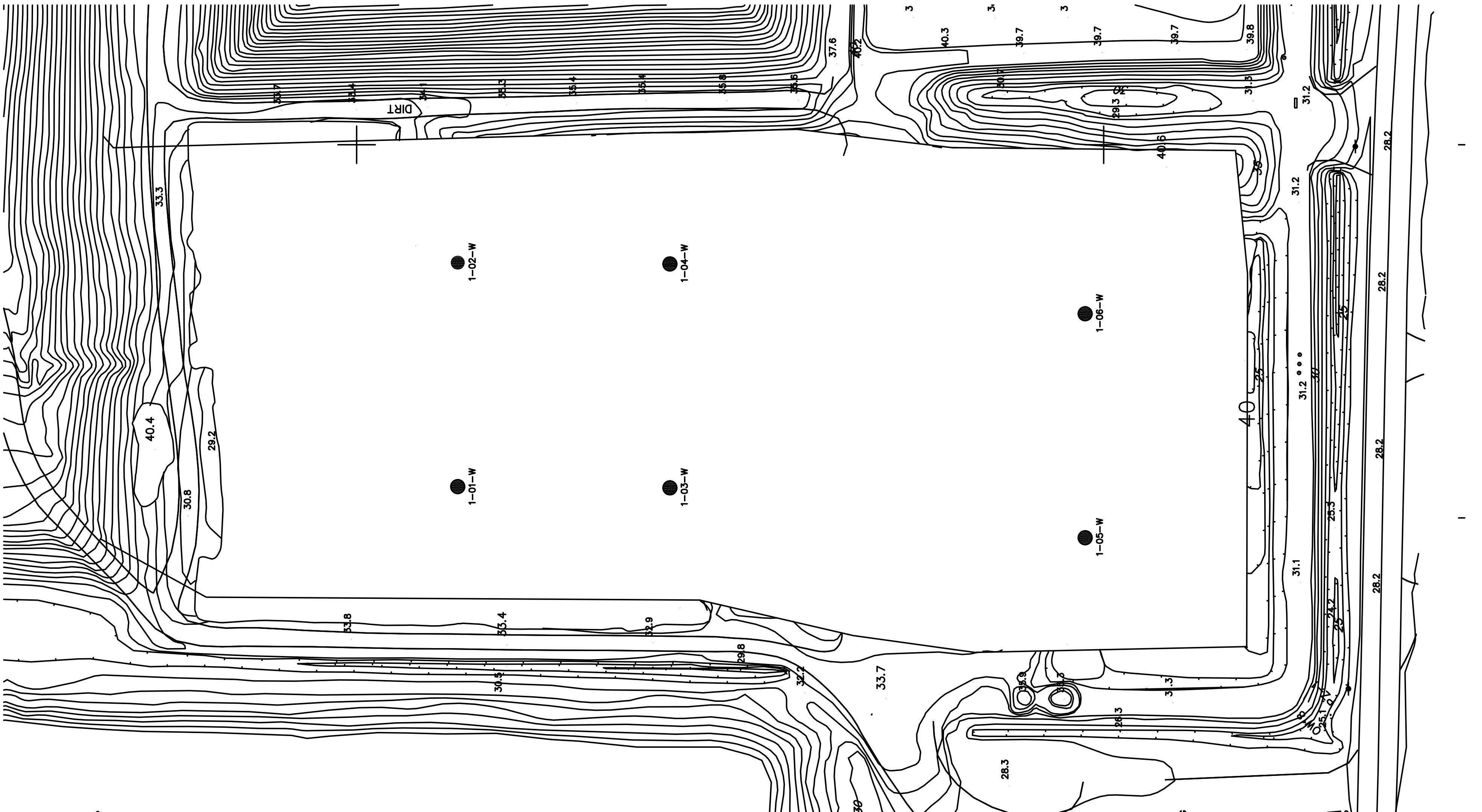
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

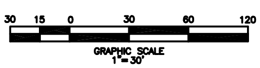
NE ANAEROBIC MODULE LEVEL 4 PIPING AND INSTRUMENTATION

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 3-5





LEGEND

● THERMISTER, QUALITY THERMISTER NTC PROBE, 10,000 OHM RESISTANCE AT 25°C, TOLERANCE ±0.2°C (0–100°C), AND PVC MOISTURE SENSOR.

1-01-W LEVEL 1, INSTRUMENT LOCATION 1, WEST ANAEROBIC MODULE

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

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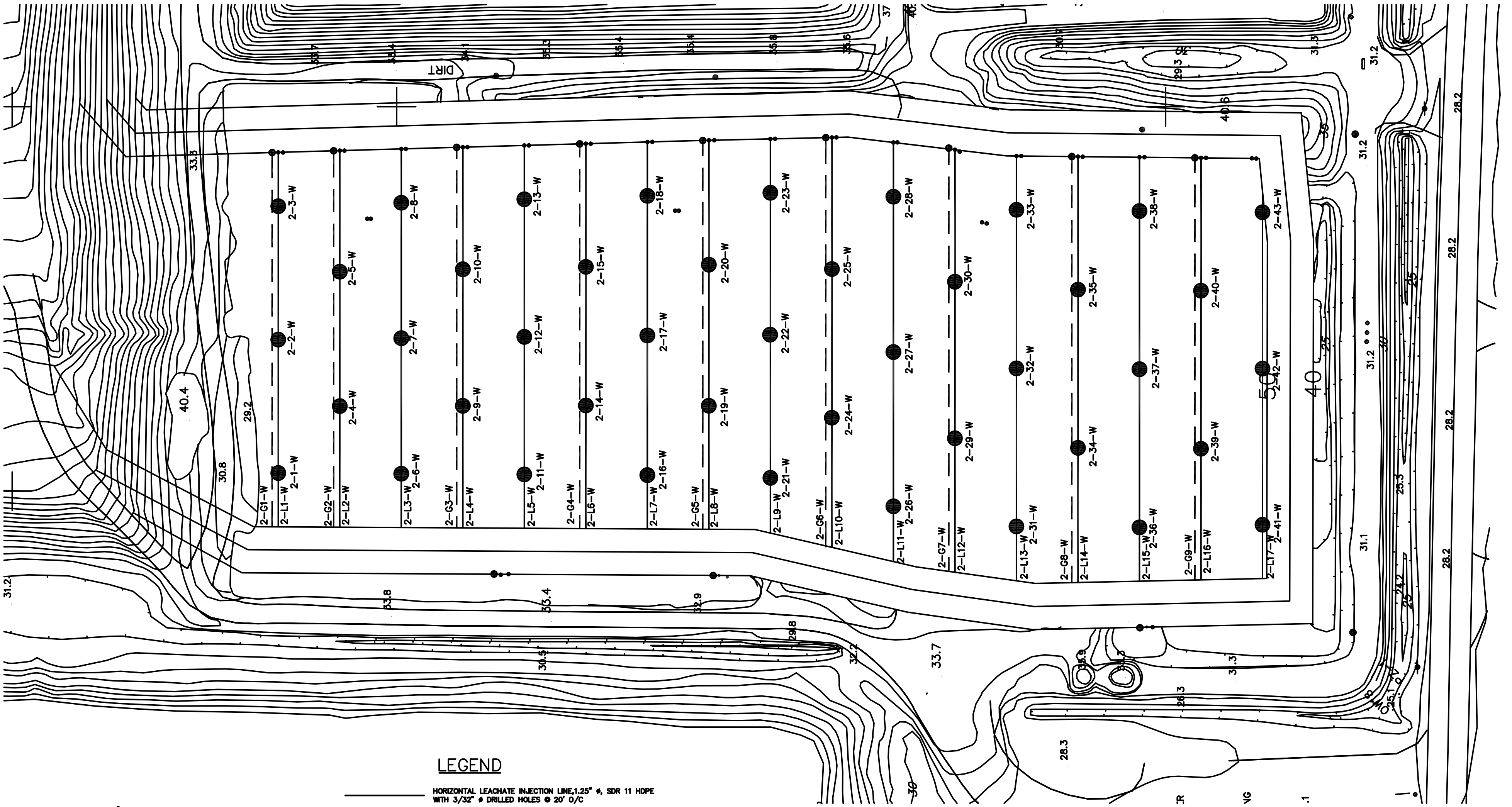
YOLO COUNTY CENTRAL LANDFILL

FULL SCALE BIOREACTOR WEST SIDE, LEVEL 1 PIPING AND INSTRUMENTATION PLAN

DRAWING NO. ______

W.O. NO. 9207
F.B. NO. T.9N.R.3E.
DESIGN BY JDK
DRAWN BY JDK
CHECKED BY XX
FILE NAME
DATE 2/21/02

DETAIL 4-2



LEGEND

(solid line)	HORIZONTAL LEACHATE INJECTION LINE, 1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 20' O/C
(dashed line)	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), AND PVC MOISTURE SENSOR.
2–01–W	LEVEL 2, INSTRUMENT LOCATION 1, WEST ANAEROBIC MODULE
2–L1–W	LEVEL 2, LEACHATE INJECTION LINE 1, WEST ANAEROBIC MODULE
2–G1–W	LEVEL 2, GAS EXTRACTION LINE 1, WEST ANAEROBIC MODULE

GRAPHIC SCALE 1"=30' (30 15 0 30 60 120)

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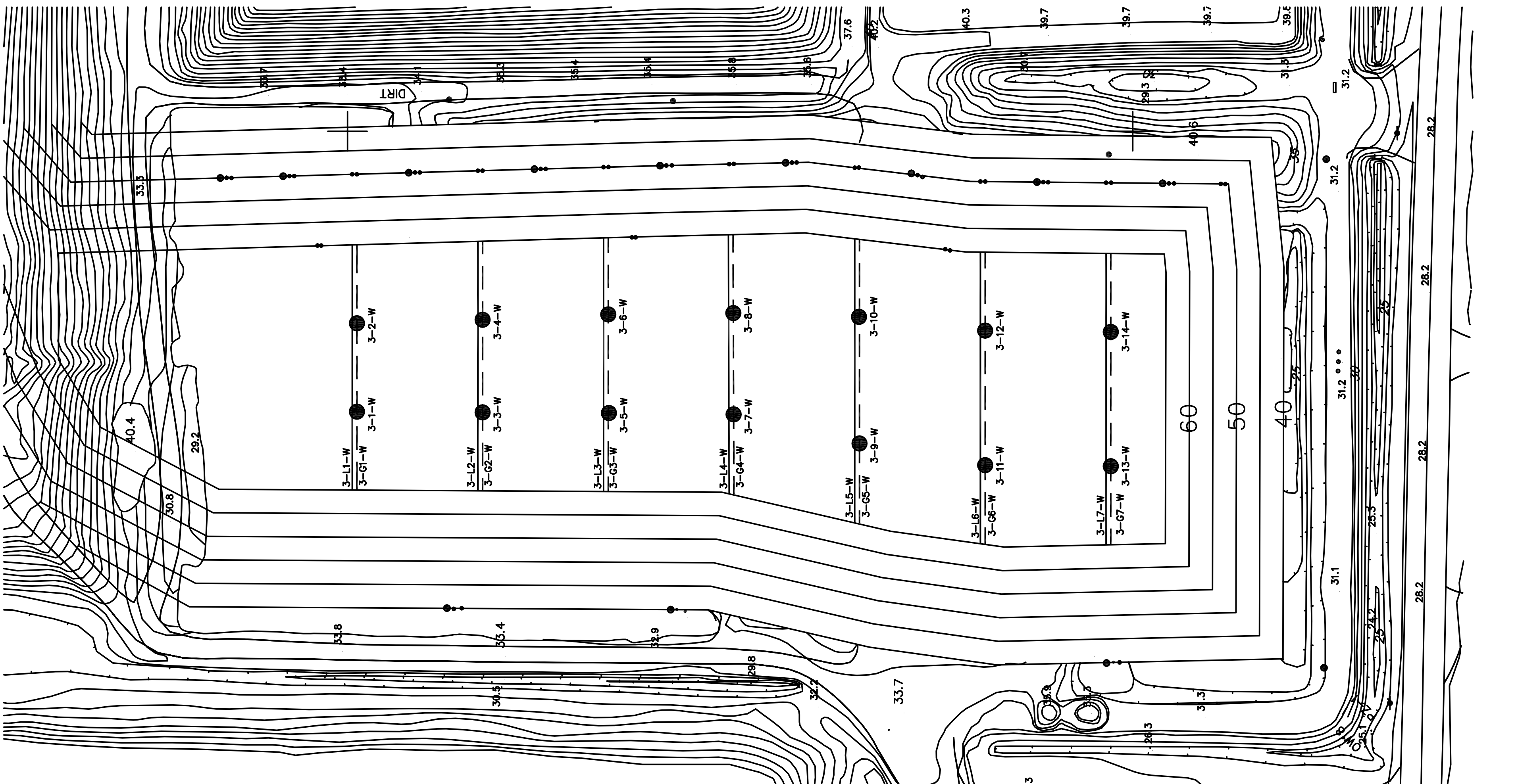
YOLO COUNTY CENTRAL LANDFILL

FULL SCALE BIOREACTOR WEST SIDE, LEVEL 2 PIPING AND INSTRUMENTATION PLAN

DRAWING NO. ______

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	XX
FILE NAME	
DATE	2/21/02

DETAIL 4–3



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

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), AND PVC MOISTURE SENSOR.
3-01-W	LEVEL 3, INSTRUMENT LOCATION 1, WEST ANAEROBIC MODULE
3-L1-W	LEVEL 3, LEACHATE INJECTION LINE 1, WEST ANAEROBIC MODULE
3-G1-W	LEVEL 3, GAS EXTRACTION LINE 1, WEST ANAEROBIC MODULE

30 15 0 30 60 120

GRAPHIC SCALE
1"=30'

NO.	REVISIONS DESCRIPTIONS	DATE	APPV

YOLO COUNTY
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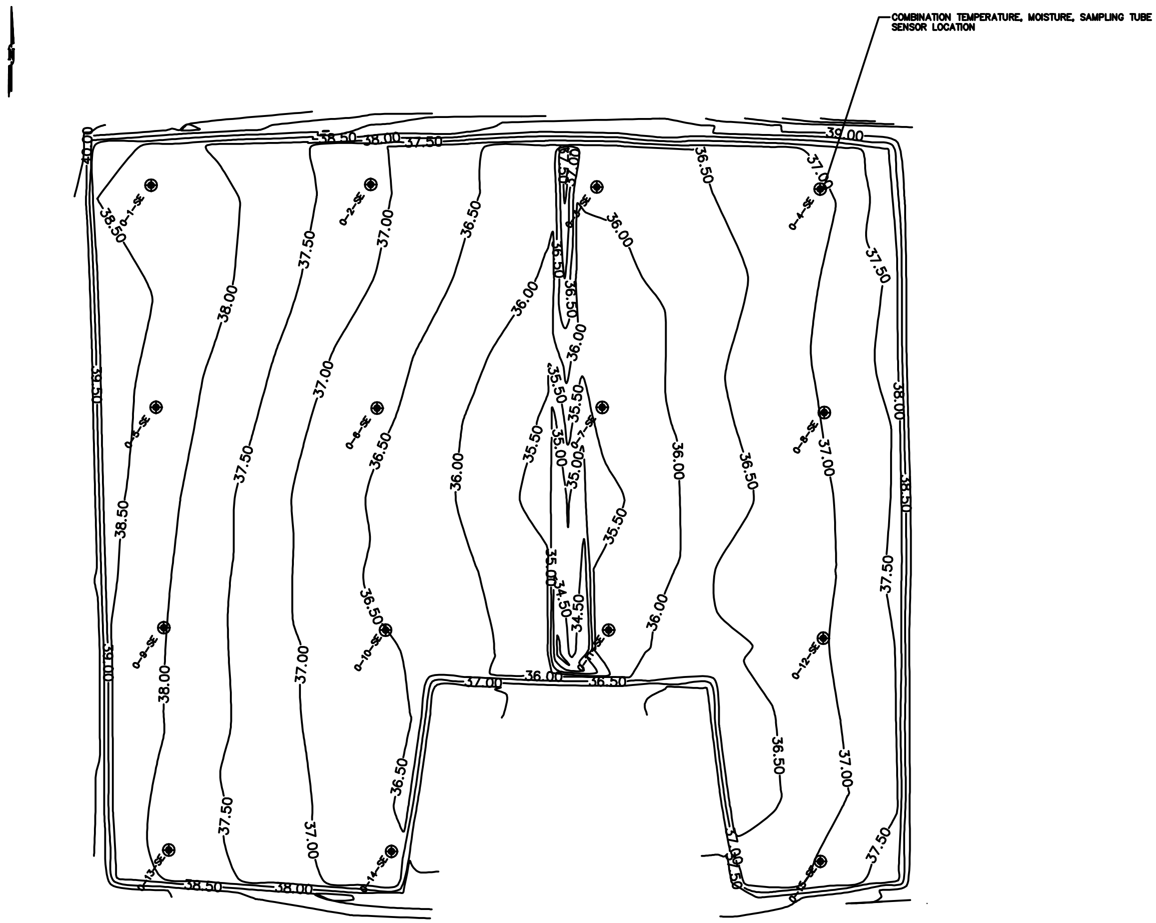
YOLO COUNTY CENTRAL LANDFILL

FULL SCALE BIOREACTOR WEST SIDE, LEVEL 3 PIPING AND INSTRUMENTATION PLAN

DRAWING NO. ________

W.O. NO.	9207
F.B. NO.	T.9N.R.3E.
DESIGN BY	JDK
DRAWN BY	JDK
CHECKED BY	XX
FILE NAME	
DATE	2/21/02

DETAIL 4-4



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.

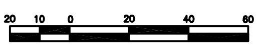
0–1–SE LEVEL 0, INSTRUMENT LOCATION 1, SOUTHEAST ANAEROBIC MODULE

NOTES

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

AS-BUILT

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



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.

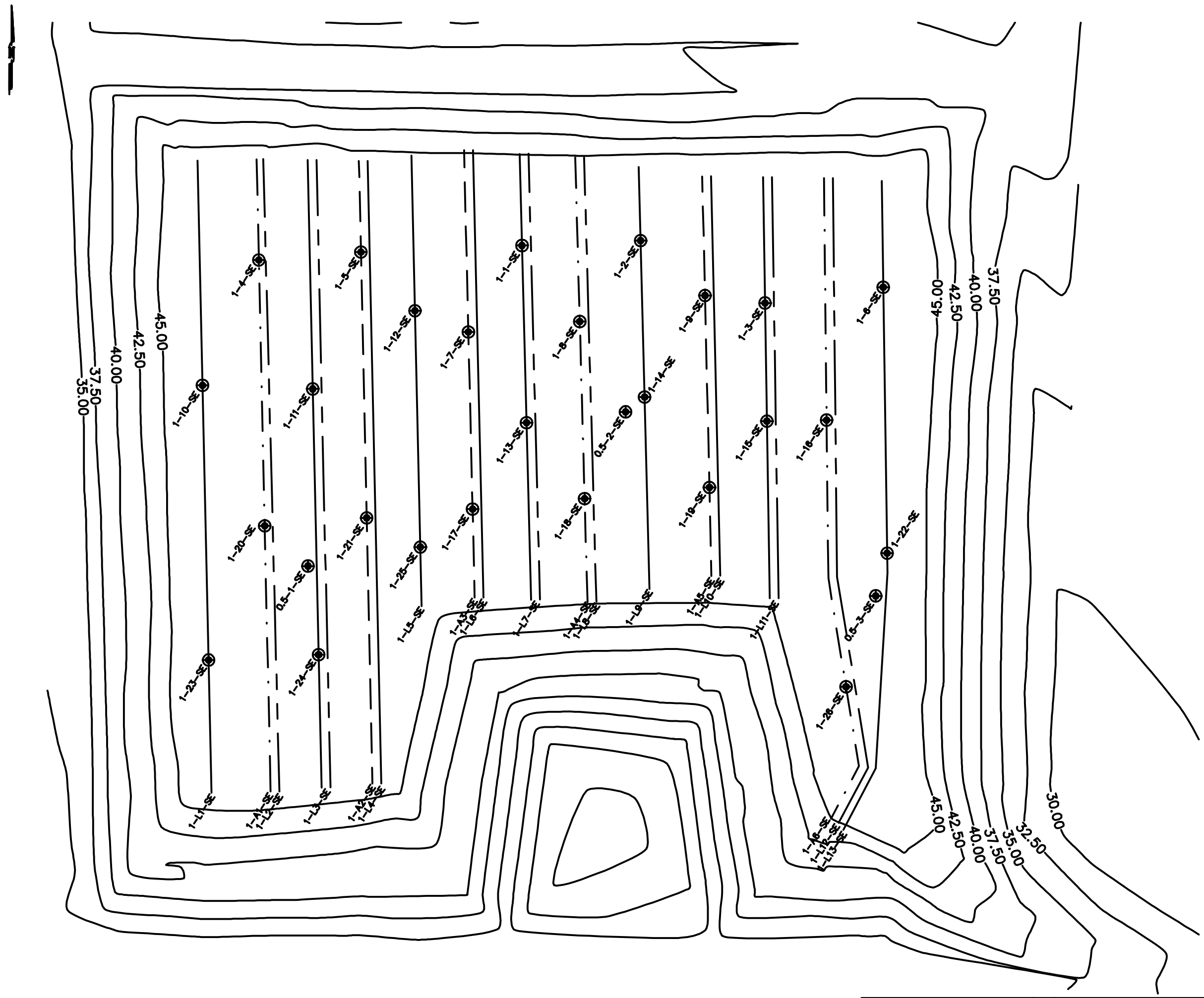
YOLO COUNTY CENTRAL LANDFILL
FULL–SCALE BIOREACTOR

SE AEROBIC MODULE LEVEL 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
5–2



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

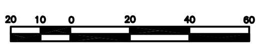
———————— (solid line)	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, SDR 11 HDPE WITH 3/32" ø DRILLED HOLES @ 10' O/C
— — — — (dashed line)	HORIZONTAL LEACHATE INJECTION LINE,1.25" ø, sCHEDULE 80 CPVC WITH 3/32" ø DRILLED HOLES @ 10' O/C
— · — · — (dash-dot line)	HORIZONTAL AIR COLLECTION LINE, ALTERNATING 4 AND 6-INCH CPVC
—— —— —— (long dash 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.
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

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



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.

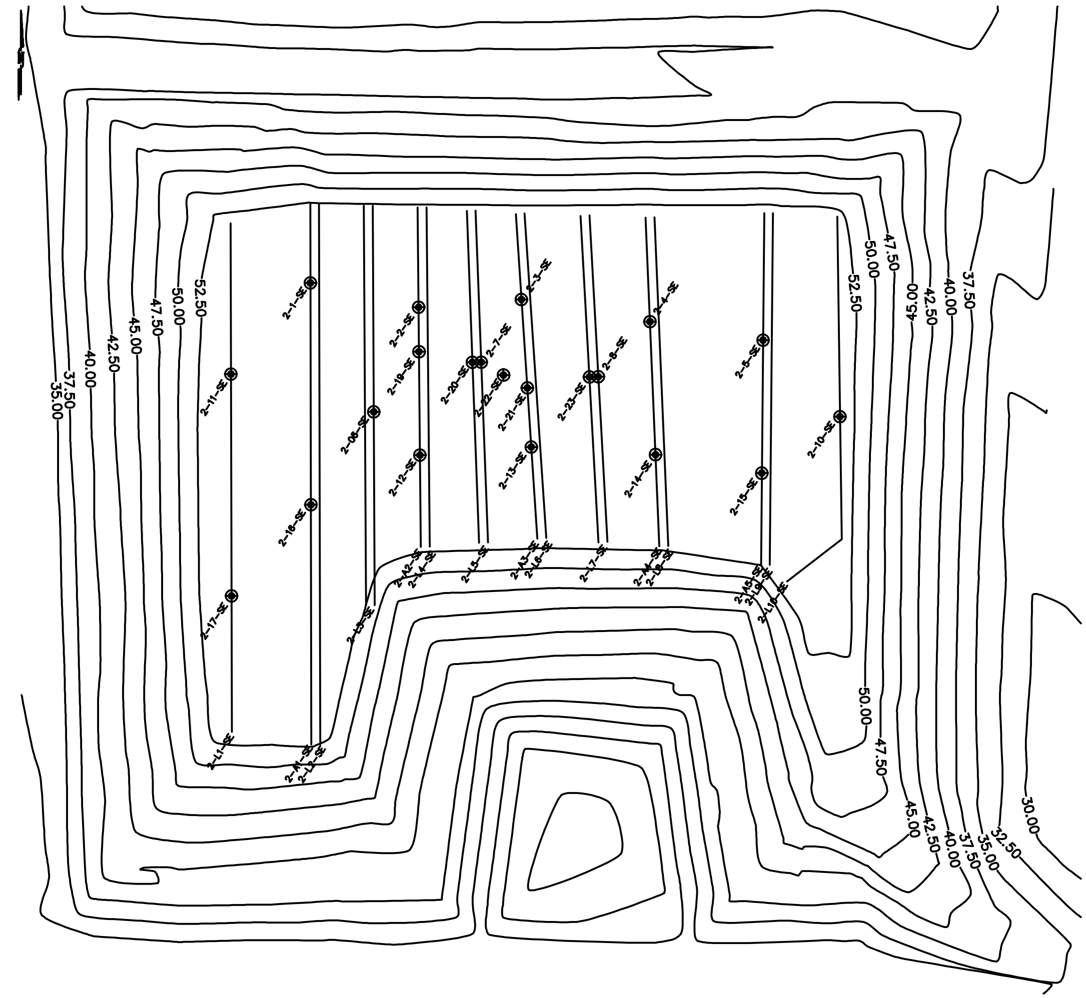
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

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
5-3



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

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.

2-1-SE LEVEL 2, INSTRUMENT LOCATION 1, SOUTHEAST ANAEROBIC MODULE

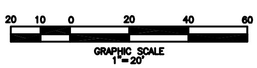
2-L1-SE LEVEL 2, LEACHATE INJECTION LINE 1, SOUTHEAST ANAEROBIC MODULE

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



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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.

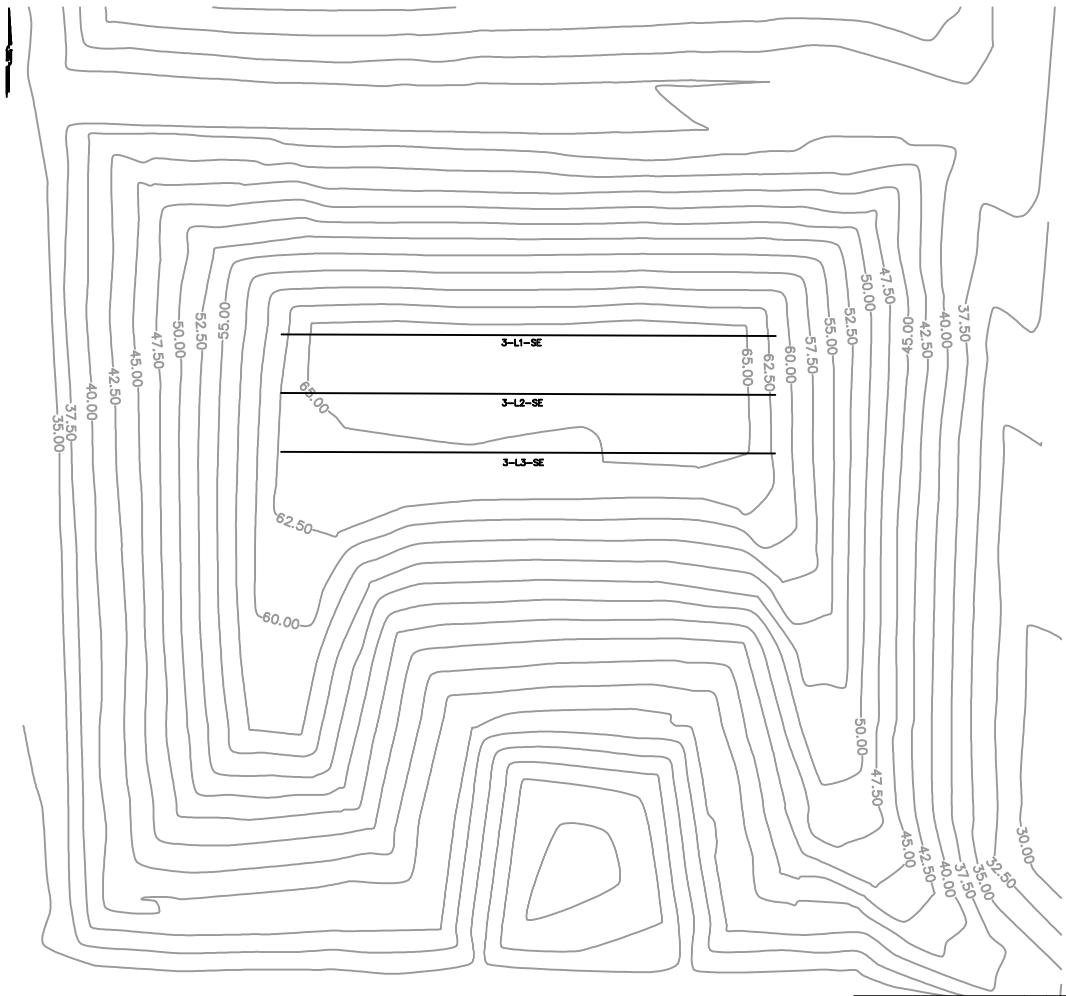
YOLO COUNTY CENTRAL LANDFILL
FULL-SCALE BIOREACTOR

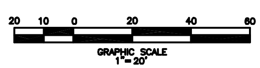
SE AEROBIC MODULE LEVEL 2 PIPING AND INSTRUMENTATION

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 5-4





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
5-5

MONITORING POINT COORDINATES			
SENSOR DESIGNATION	NORTHING	EASTING	ELEVATION (MSL)
0–01	1980033	6650992	29
0–02	1980033	6651067	28
0–03	1980033	6651142	28
0–04	1980033	6651217	29
0–05	1979958	6650992	29
0–06	1979958	6651067	27.5
0–07	1979958	6651142	27.5
0–08	1979958	6651217	29
0–09	1979883	6650992	28
0–10	1979883	6651067	27
0–11	1979883	6651142	27
0–12	1979883	6651217	28.5
0–13	1979808	6650992	28
0–14	1979808	6651067	26.5
0–15	1979808	6651142	26.5
0–16	1979808	6651217	28
0–17	1979733	6650992	27.5
0–18	1979733	6651067	26
0–19	1979733	6651142	26
0–20	1979733	6651217	27.5
0–21	1980030	6651362	29
0–22	1980030	6651437	27.5
0–23	1980030	6651512	27.5
0–24	1979955	6651362	28
0–25	1979955	6651437	27
0–26	1979955	6651512	27
0–27	1979955	6651587	28.5
0–28	1979880	6651362	28
0–29	1979880	6651437	26.5
0–30	1979880	6651512	26.5
0–31	1979880	6651587	28
0–32	1979805	6651362	27.5
0–33	1979805	6651437	26
0–34	1979805	6651512	26
0–35	1979805	6651587	27.5
0–36	1979730	6651362	27
0–37	1979730	6651437	25.5
0–38	1979730	6651512	25.5
0–39	1979730	6651587	27
0–40	1979604	6650917	28
0–41	1979604	6650922	26
0–42	1979604	6651067	25
0–43	1979604	6651142	25
0–44	1979604	6651217	26.5
0–45	1979529	6650917	27
0–46	1979529	6650922	26
0–47	1979529	6651067	24.5
0–48	1979529	6651142	24.5
0–49	1979529	6651217	26
0–50	1979454	6650917	27
0–51	1979454	6650922	25.5
0–52	1979454	6651067	24
0–53	1979454	6651142	24
0–54	1979454	6651217	25.5
0–55	1979604	6651362	26
0–56	1979604	6651437	24.5
0–57	1979604	6651512	24.5
0–58	1979604	6651587	26
0–59	1979529	6651362	25.5
0–60	1979529	6651437	24
0–61	1979529	6651512	24
0–62	1979529	6651587	25.5
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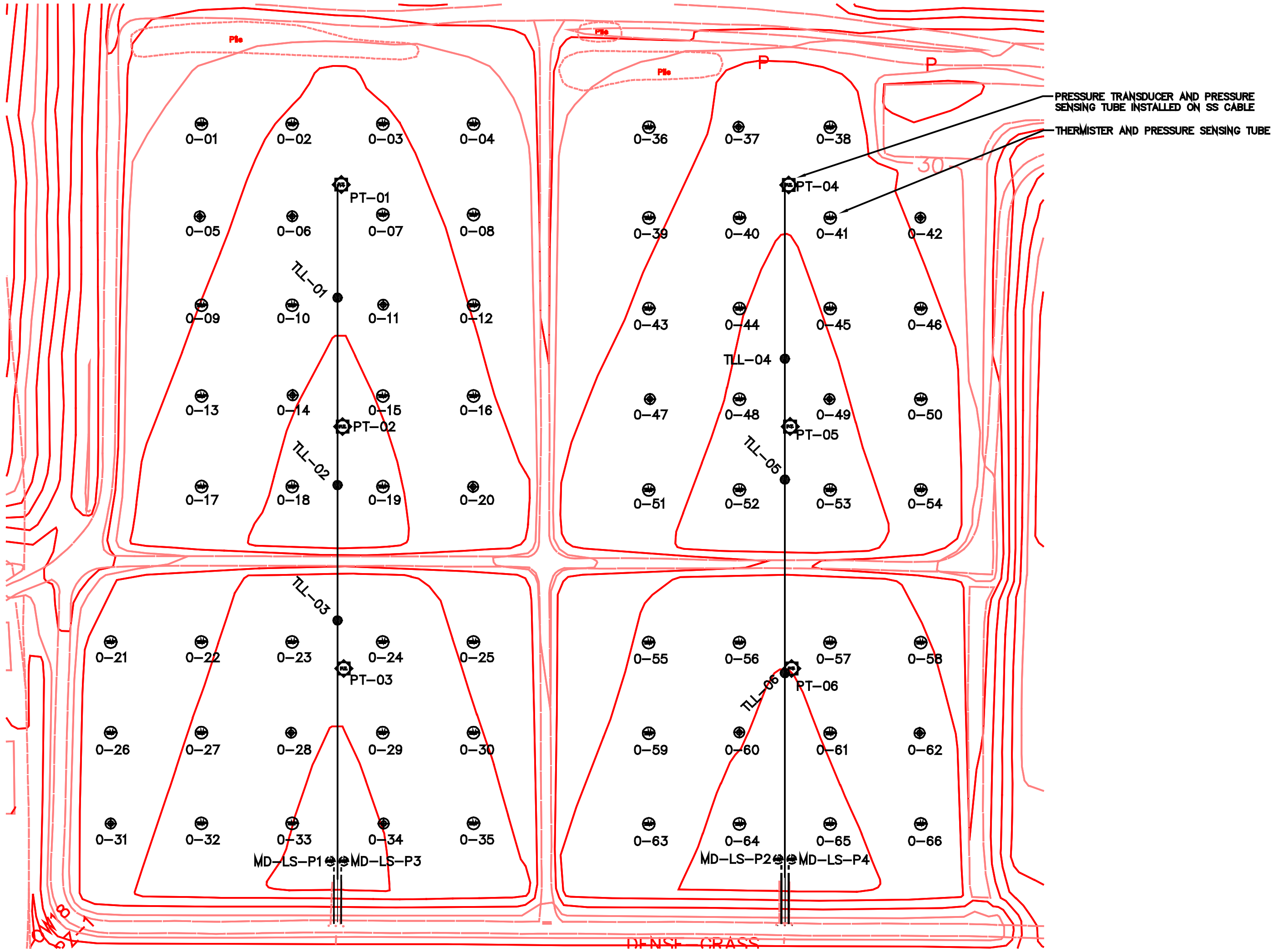
0–66	1979454	6651587	25



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

LEGEND

- PRESSURE TRANSDUCER, DRUCK MODEL PTX 1830, 0–1 PSIG
- 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.
- 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.
- PRESSURE SENSING TUBE, 1/4–INCH ID BY 3/8 OD LLDPE.

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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 ____________ 20____ ____________ R. E. NO.

YOLO COUNTY CENTRAL LANDFILL
FULL SCALE BIOREACTOR
BASE LINER
INSTRUMENTATION
PLAN

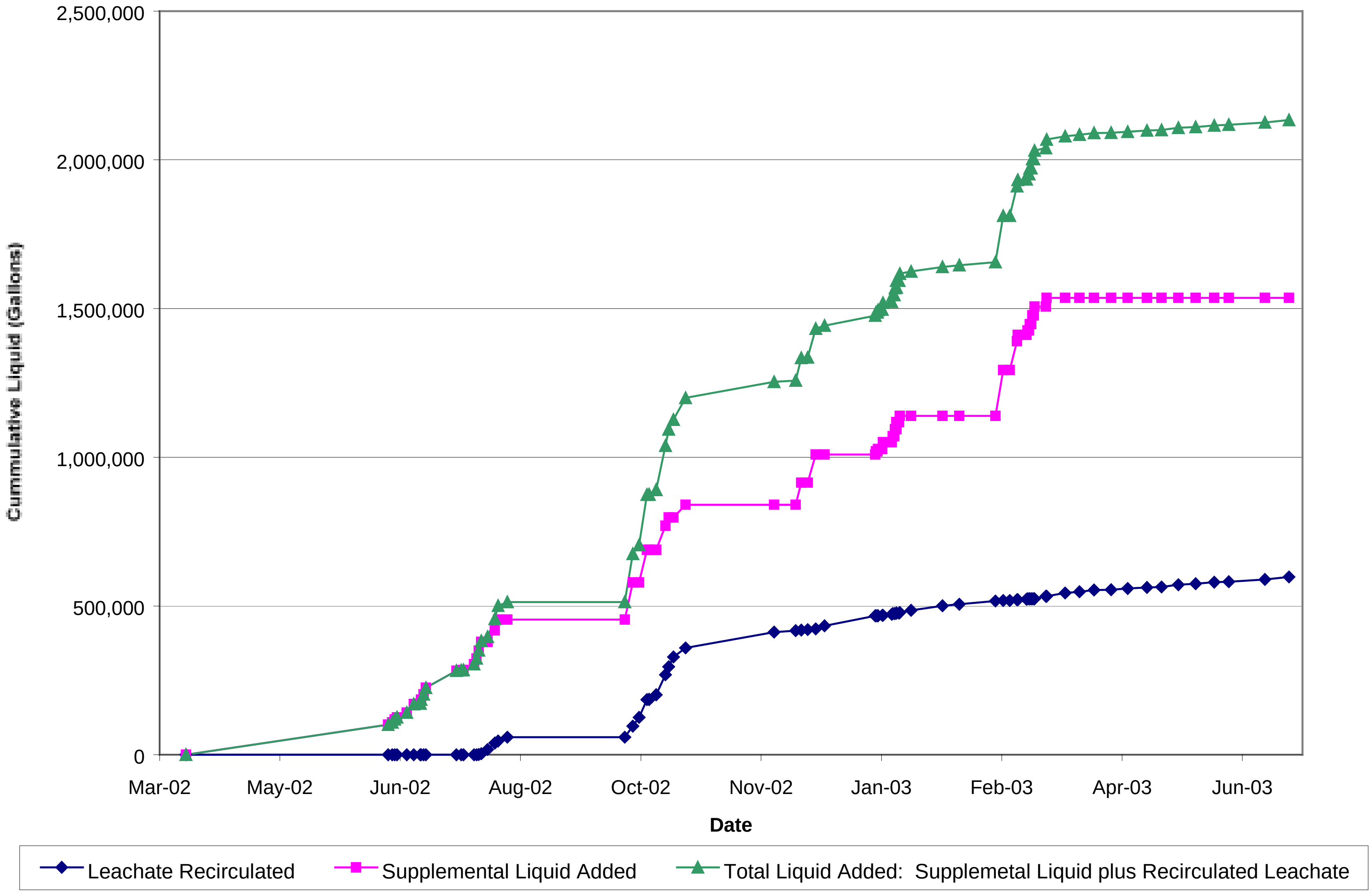
DRAWING NO. ____________

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
6–3

APPENDIX C – GRAPHS

Figure 3-1. Northeast Anaerobic Cell Liquid Recirculation and Addition Volumes



Between September 24, 2002 and October 4, 2002 35,460 gallons of liquid was removed from the sump during injection line cleaning.

Figure 3-2. Northeast Anaerobic Cell Layer 1 Temperature Readings

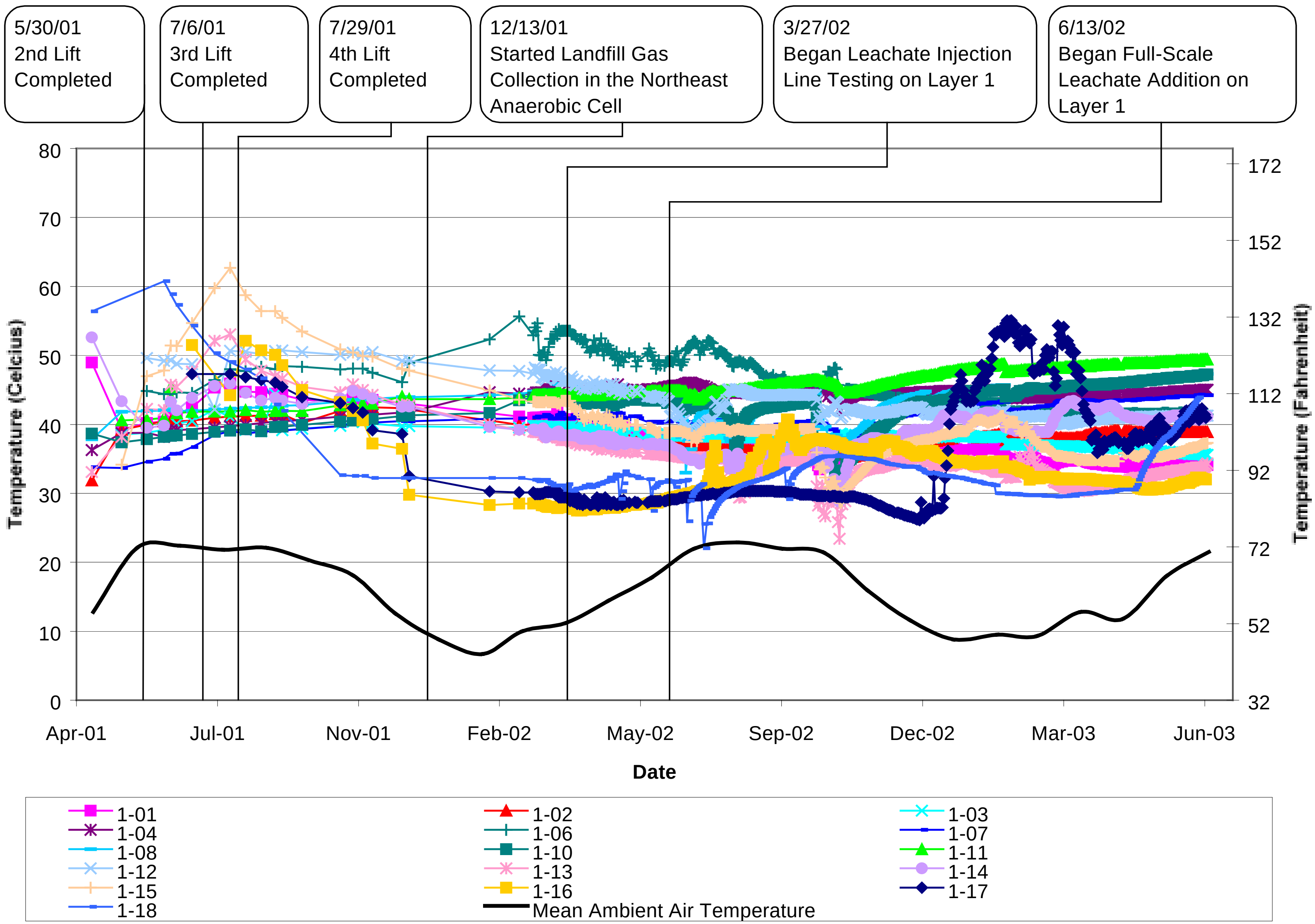


Figure 3-3. Northeast Anaerobic Cell Layer 2 Temperature Readings

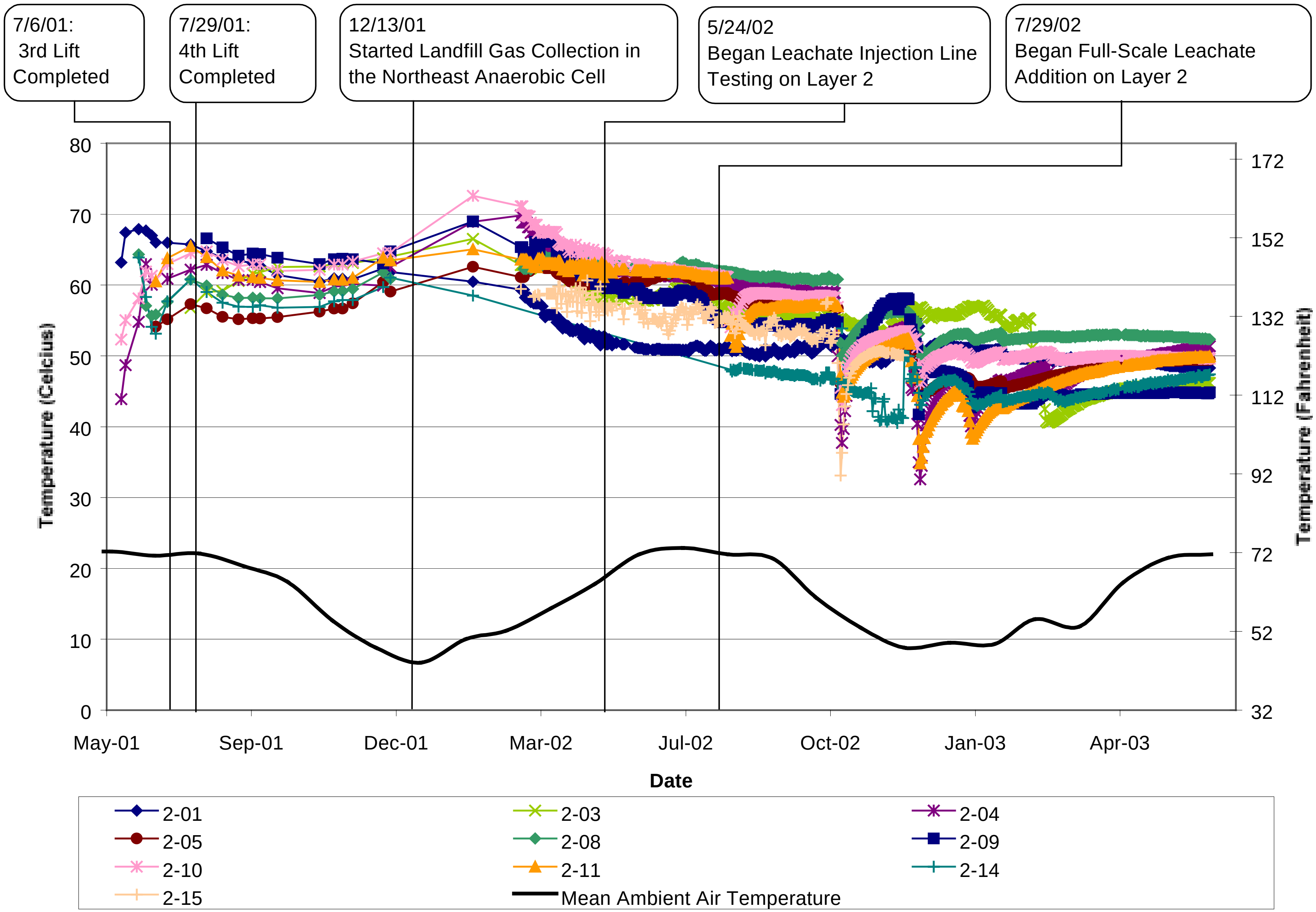


Figure 3-4. Northeast Anaerobic Cell Layer 3 Temperature Readings

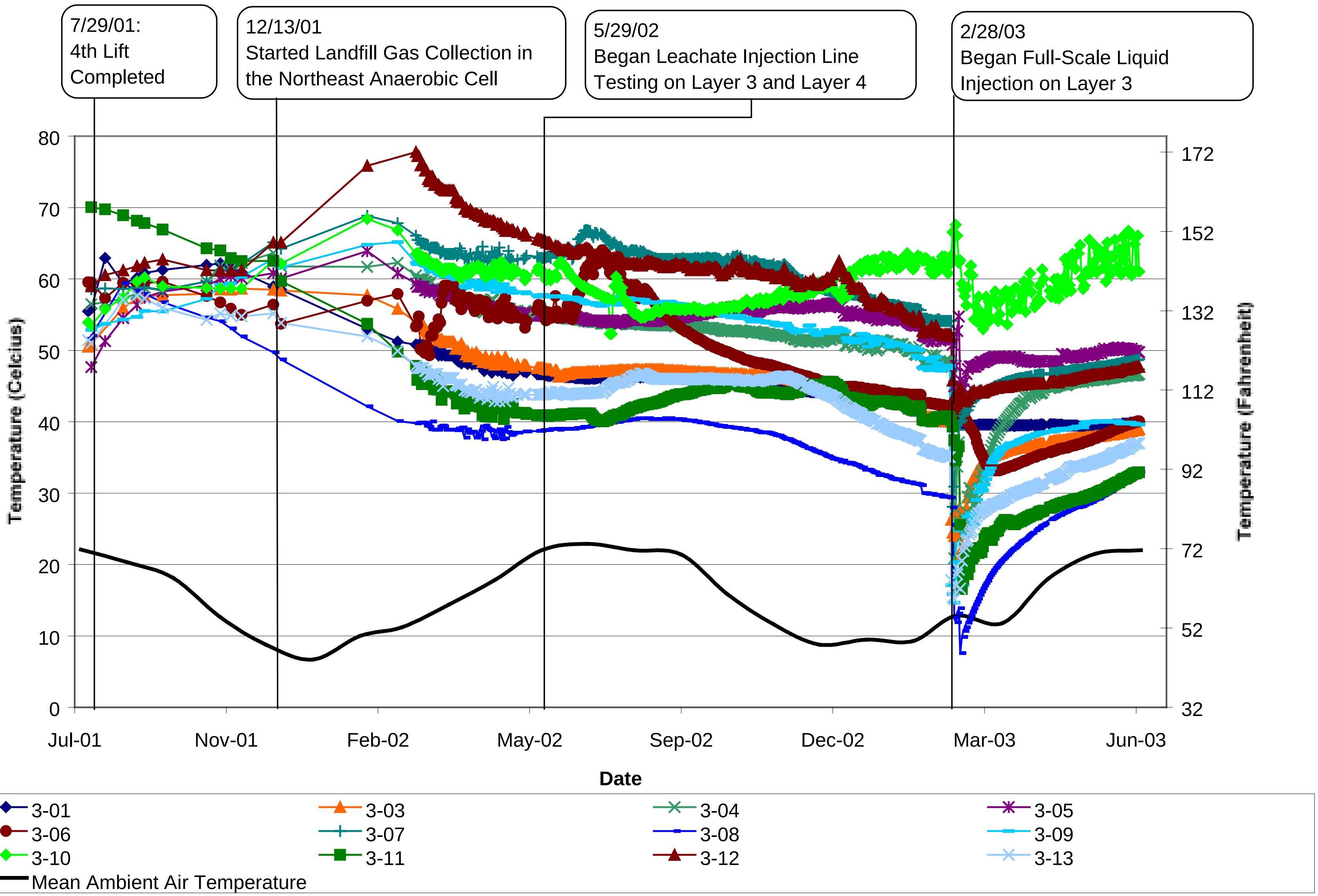


Figure 3-5. Northeast Anaerobic Cell Selected Temperature Readings

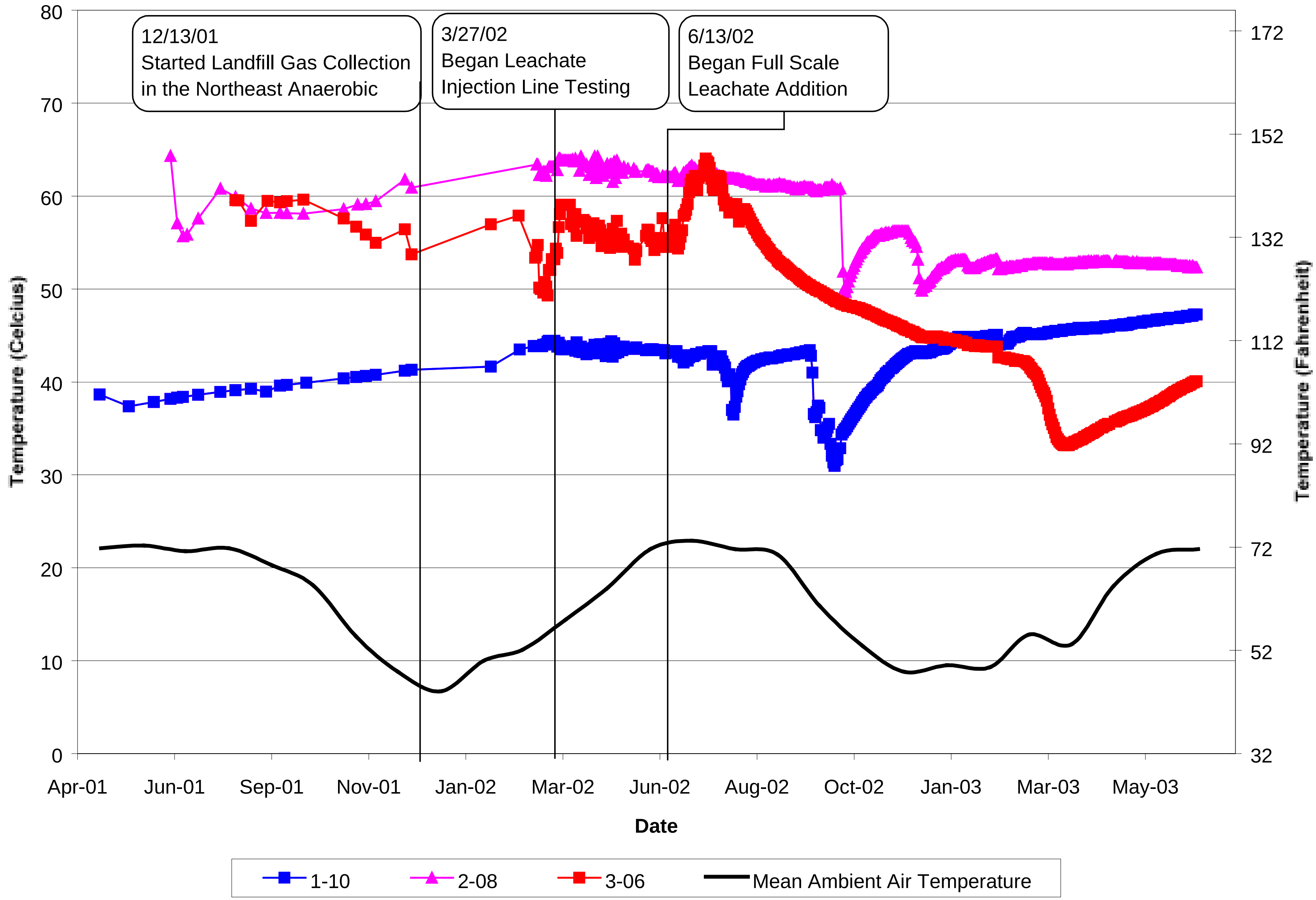


Figure 3-7. Northeast Anaerobic Cell Layer 1 PVC Moisture Readings

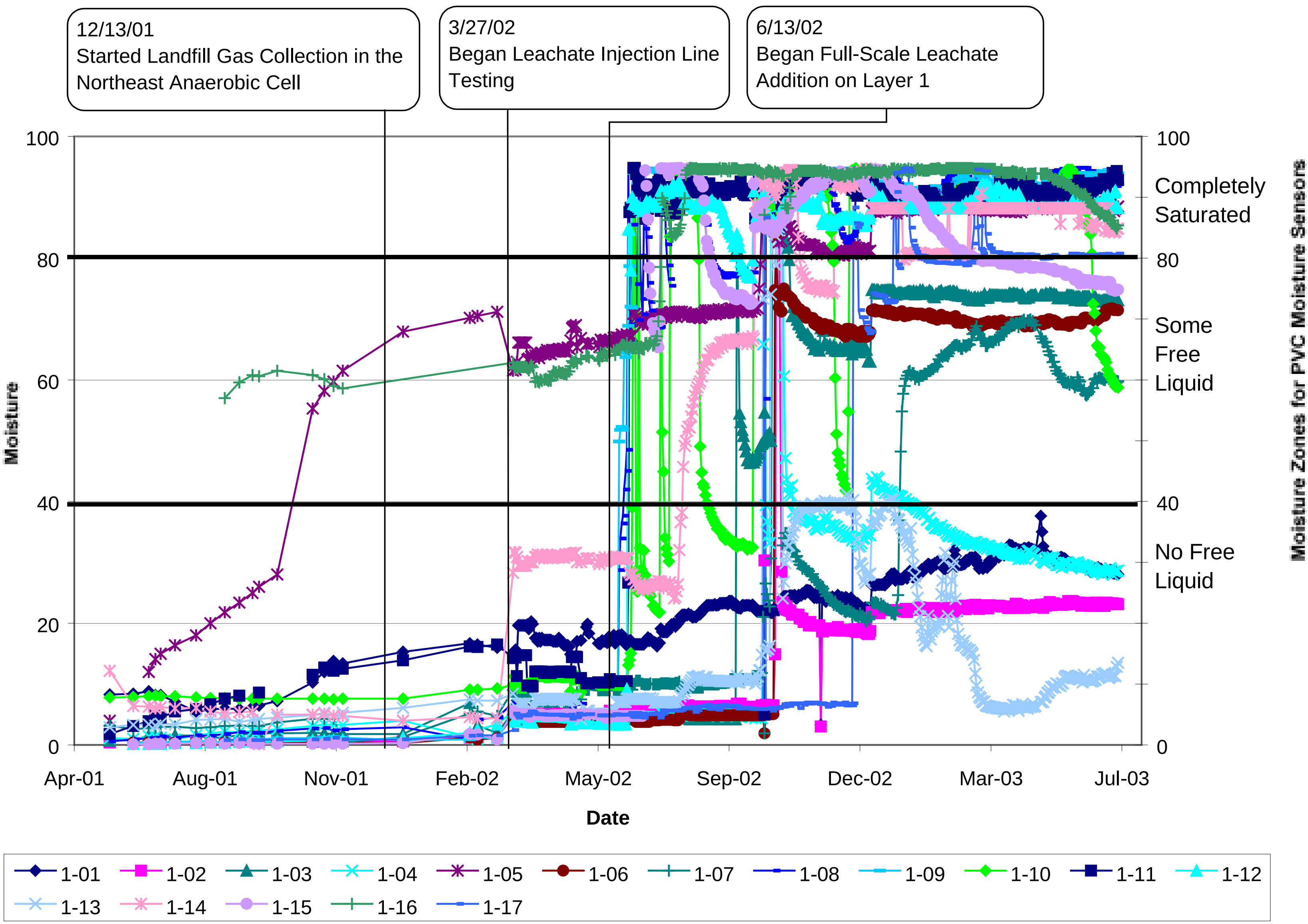


Figure 3-8. Northeast Anaerobic Cell Layer 2 PVC Moisture Readings

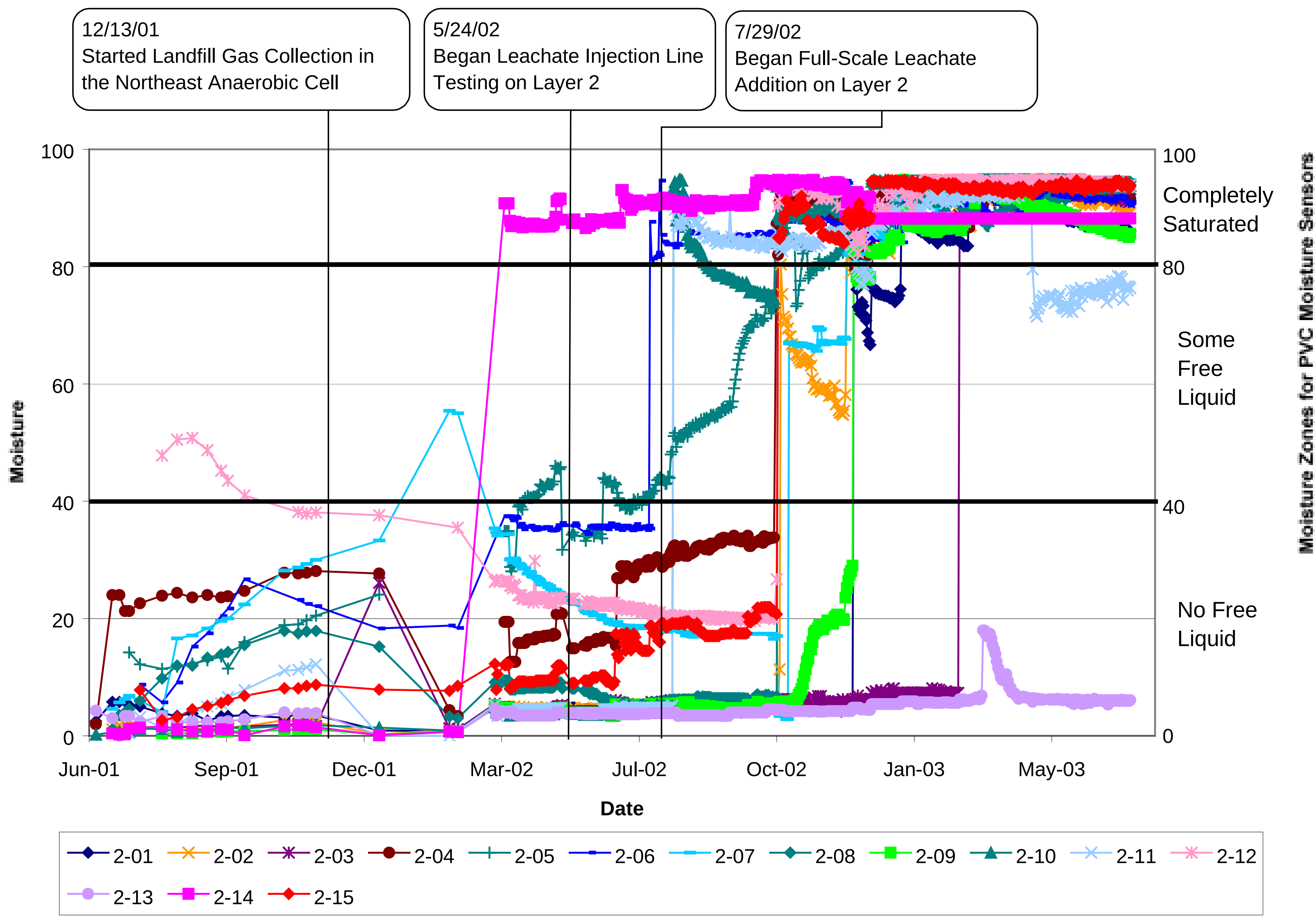


Figure 3-9. Northeast Anaerobic Cell Layer 2 Gypsum in Plaster Moisture Readings

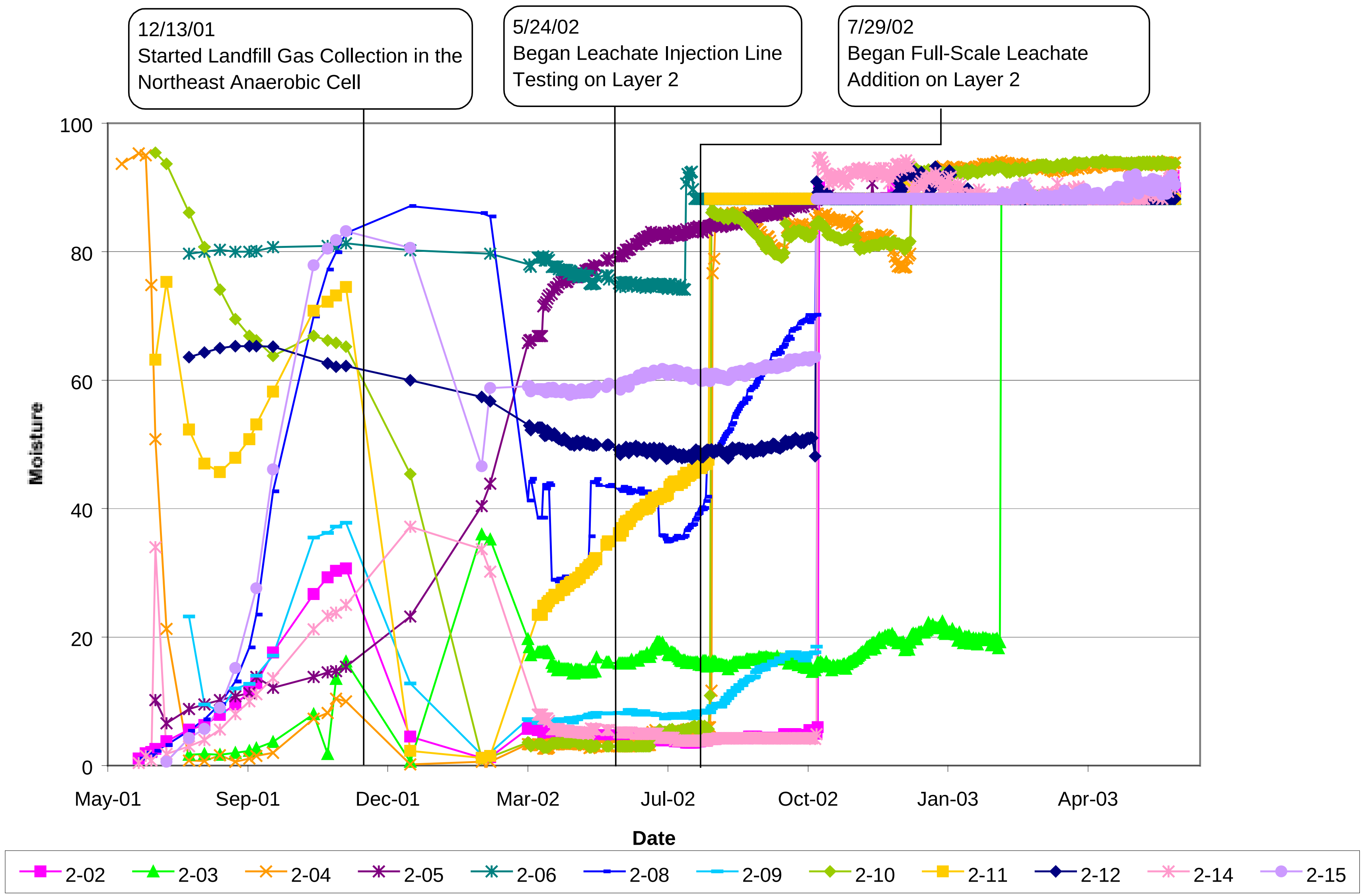


Figure 3-10. Northeast Anaerobic Cell Layer 2 Gypsum in Soil Moisture Readings

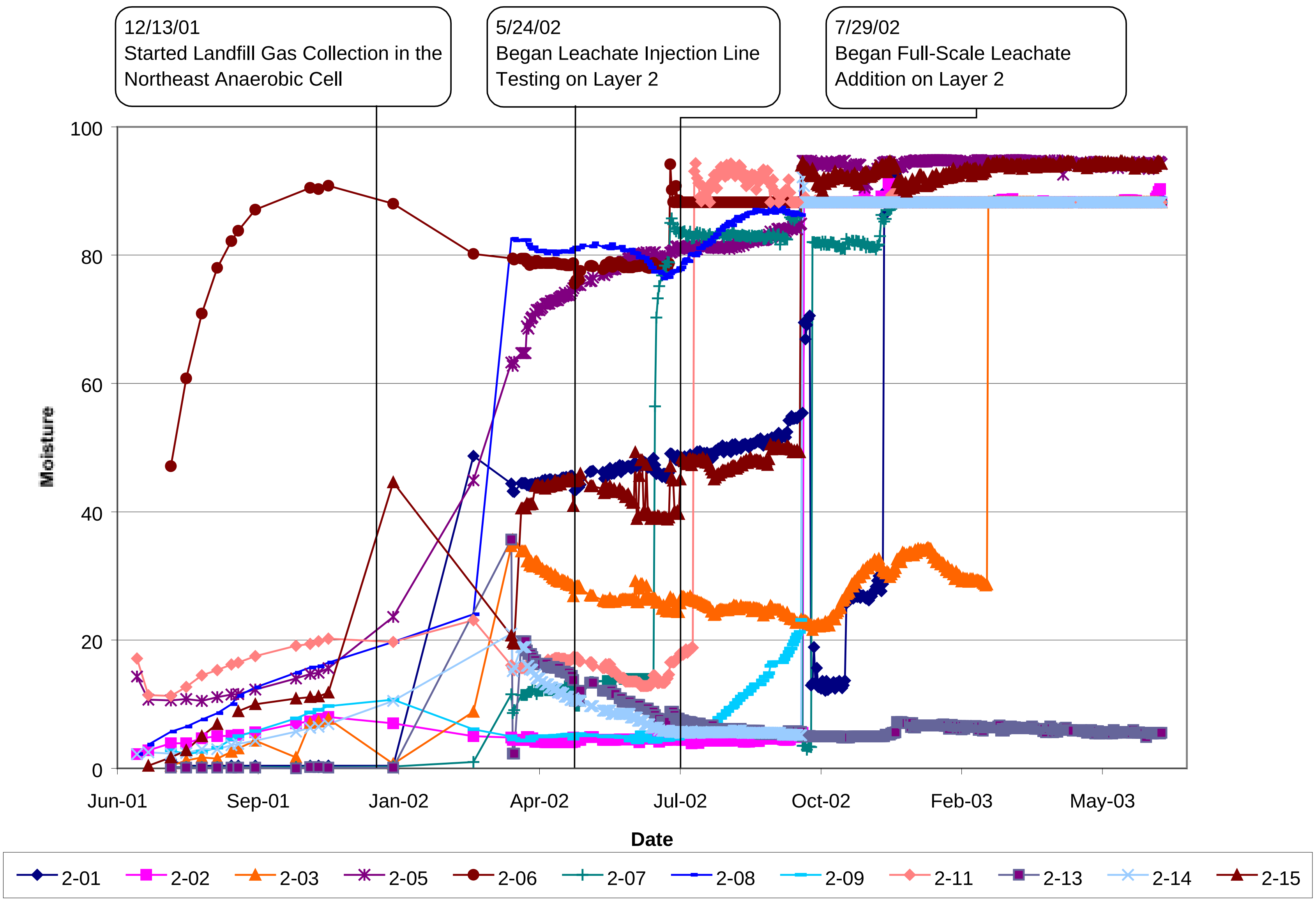


Figure 3-11. Northeast Anaerobic Cell Layer 3 PVC Moisture Readings

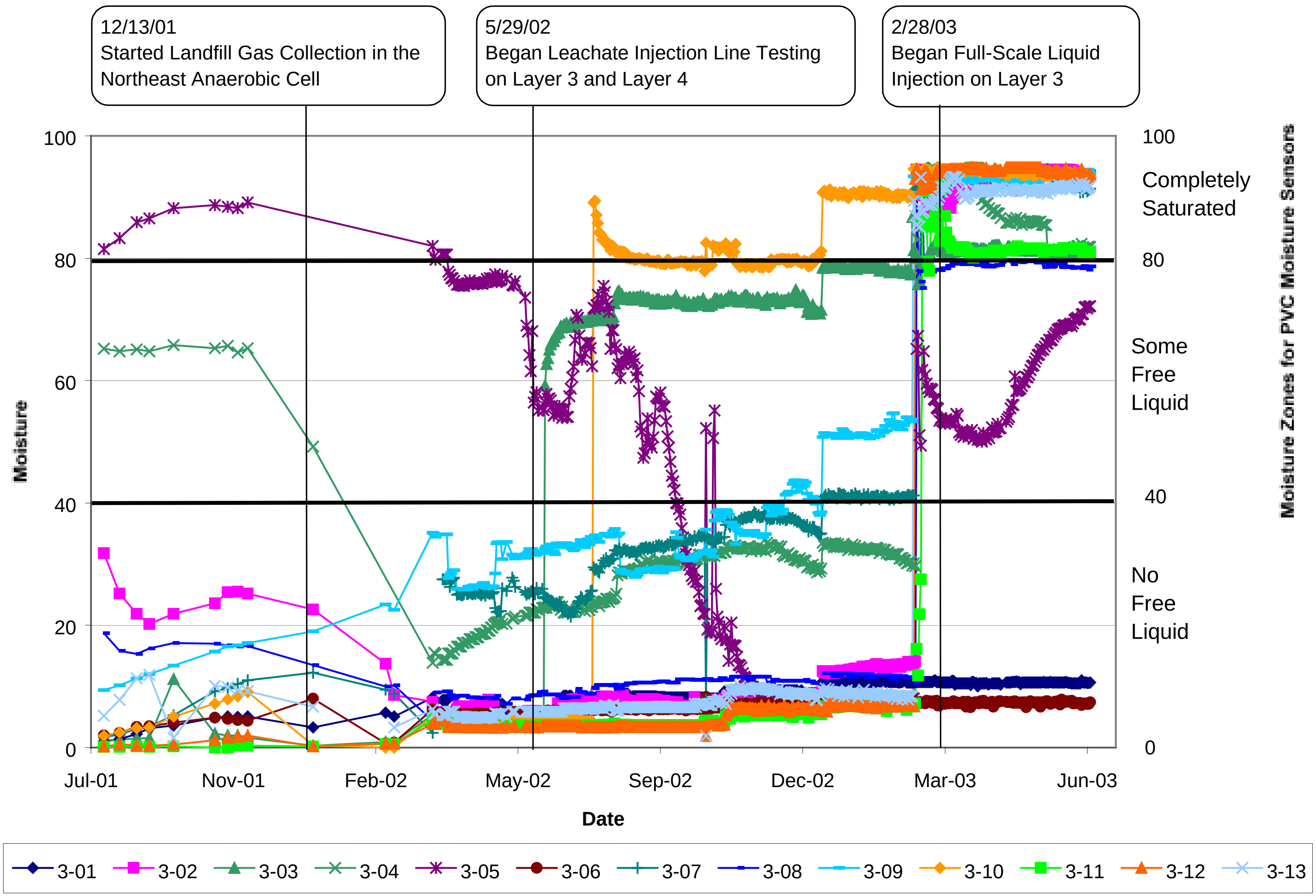


Figure 3-13. Northeast Anaerobic Cell Landfill Gas Concentrations from Header Line

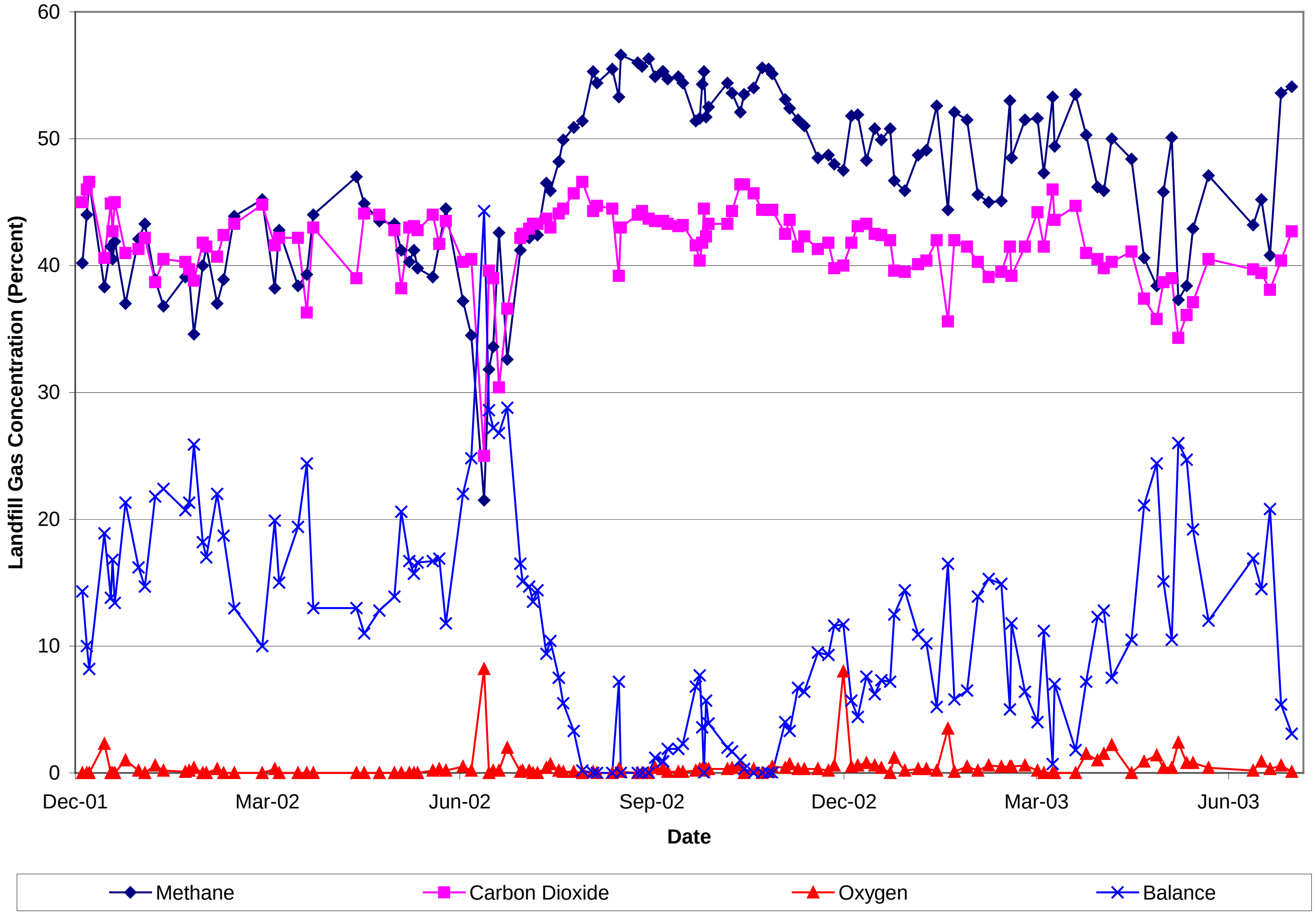
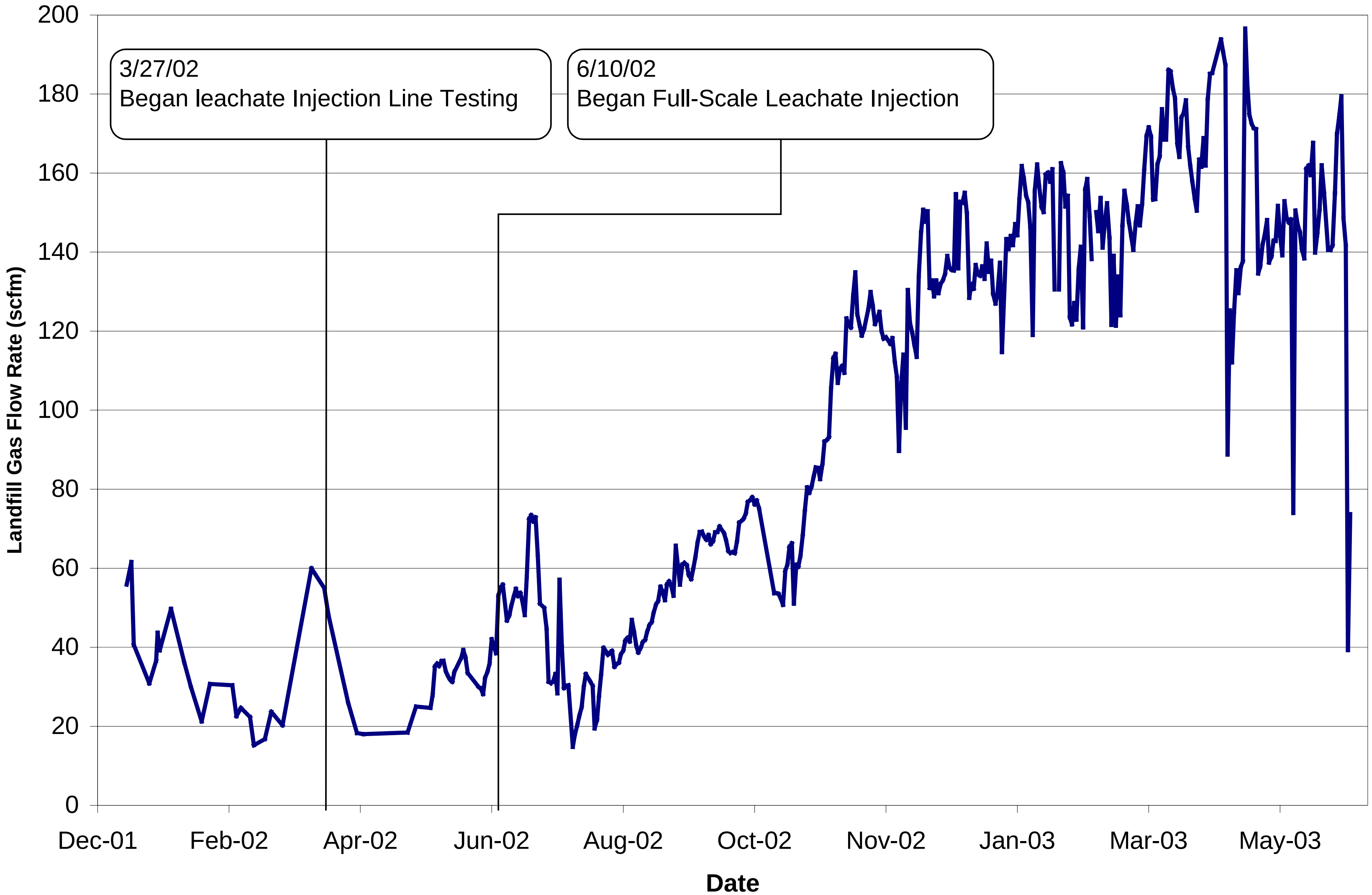


Figure 3-14. Northeast Anaerobic Cell Landfill Gas Flow Rate



Low flow rates were recorded on May 5, 2003, June 4, 2003, and June 29 and 30, 2003 as a result of the gas to energy facility temporarily shutting down.

Figure 3-15. Northeast Anaerobic Cell Cumulative Methane

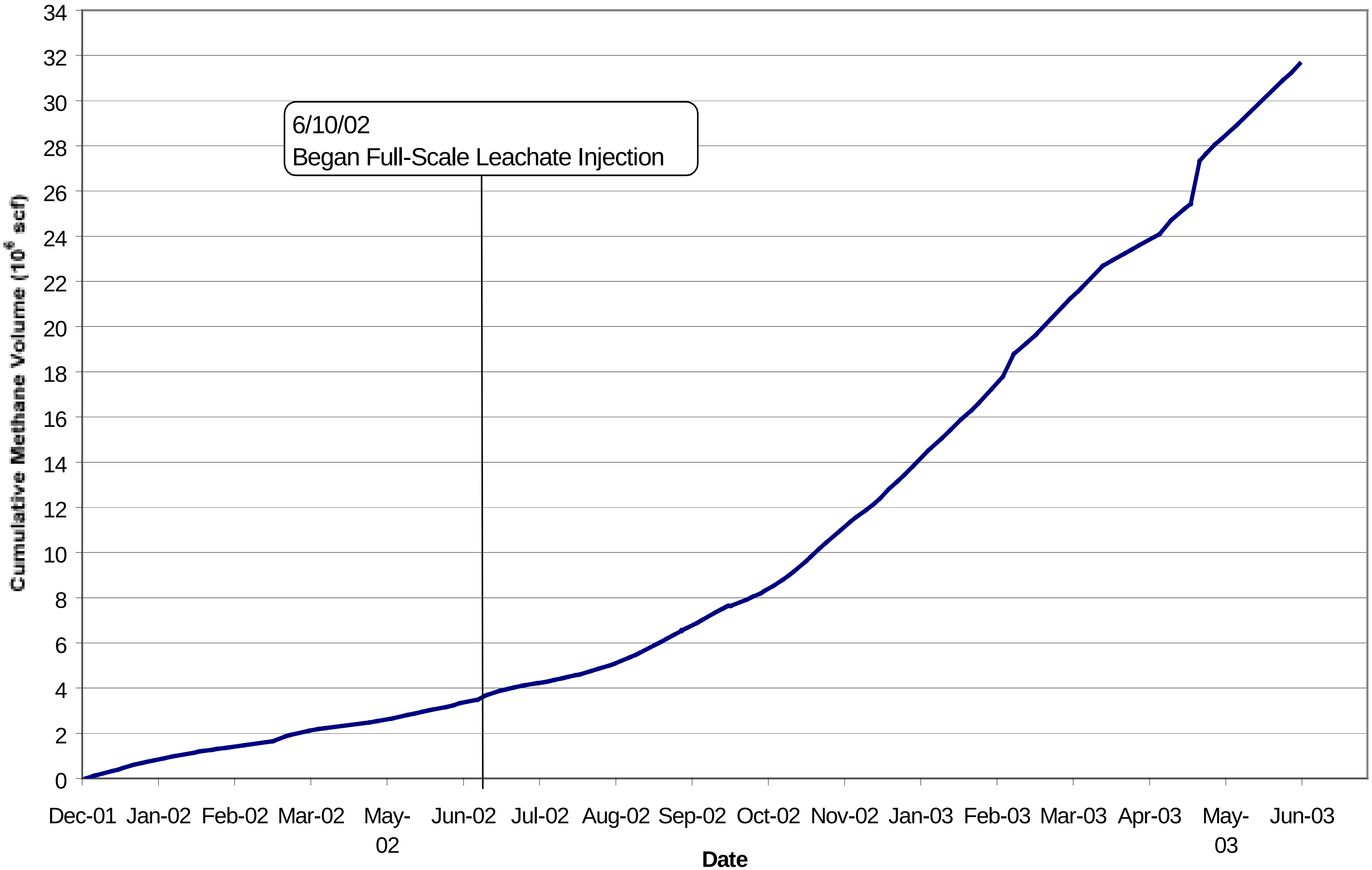


Figure 3-16. Cumulative Methane from the Northeast Anaerobic Cell and the Enhanced Cell from the Pilot Scale Project

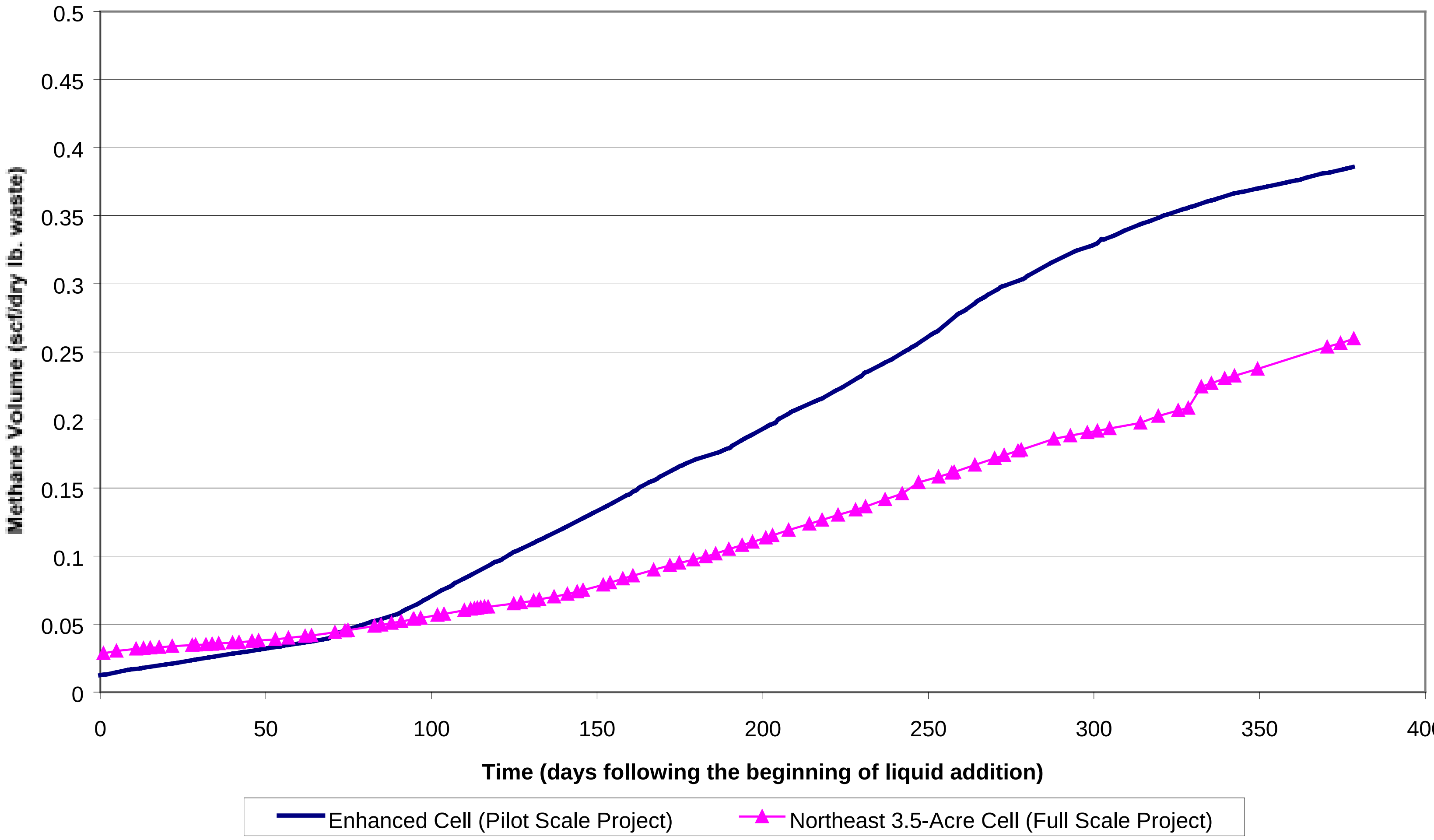


Figure 4-1. Cumulative Leachate Removed from the West-Side Leachate Collection and Removal System (LCRS)

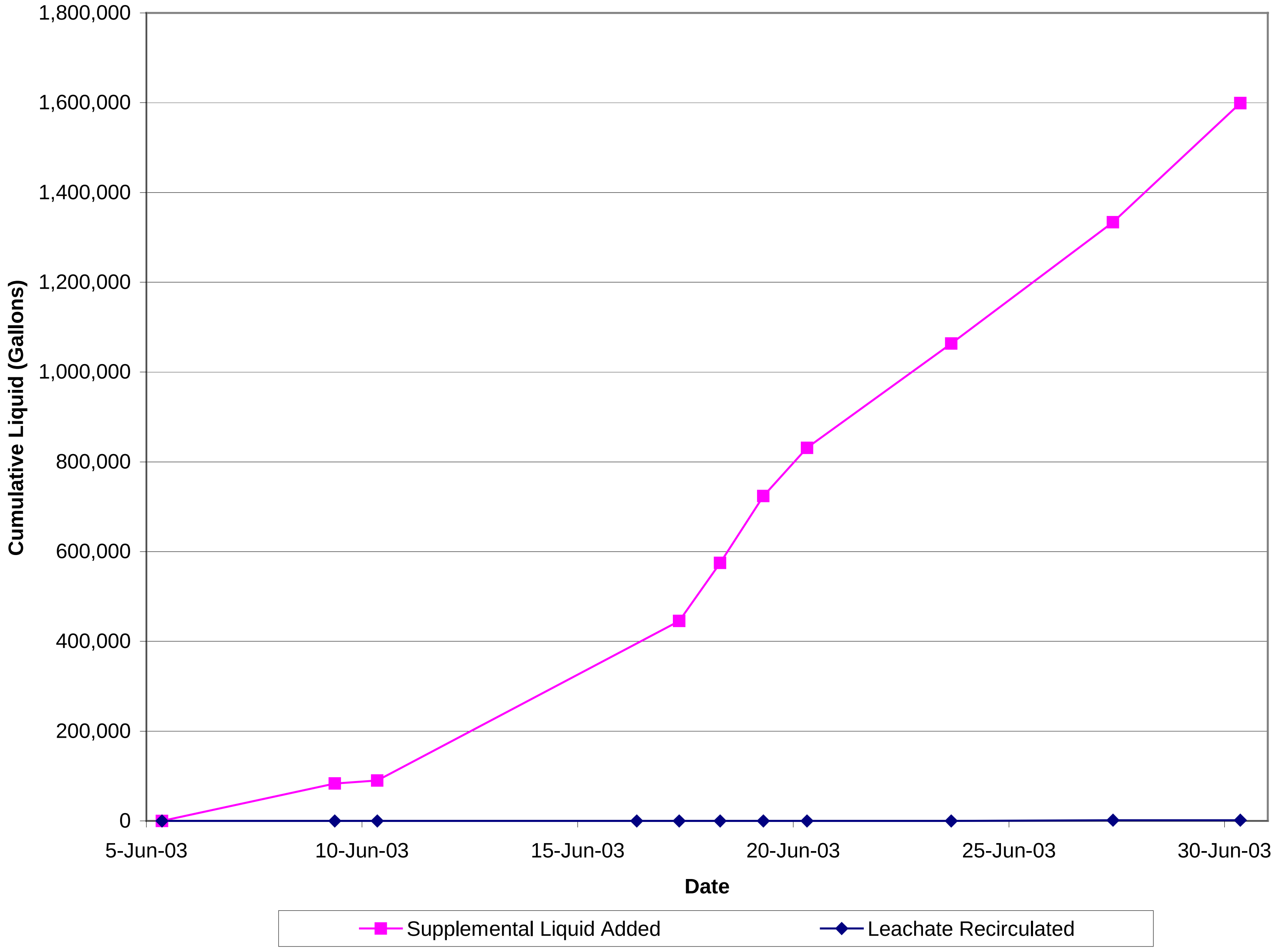


Figure 4-2. West-Side Anaerobic Cell Layer 1 Temperature Readings

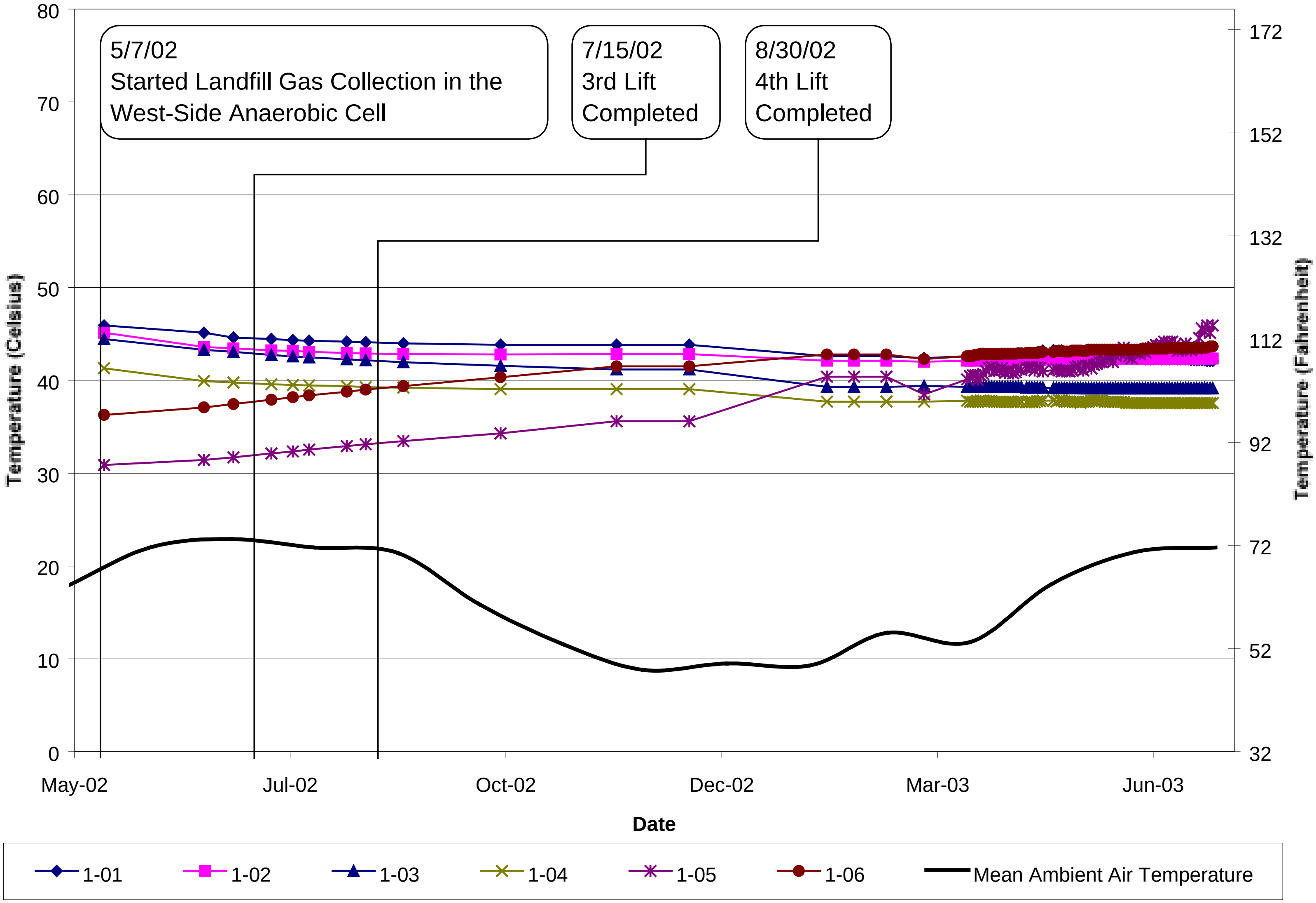


Figure 4-3. West-Side Anaerobic Cell Layer 2 Temperature Readings

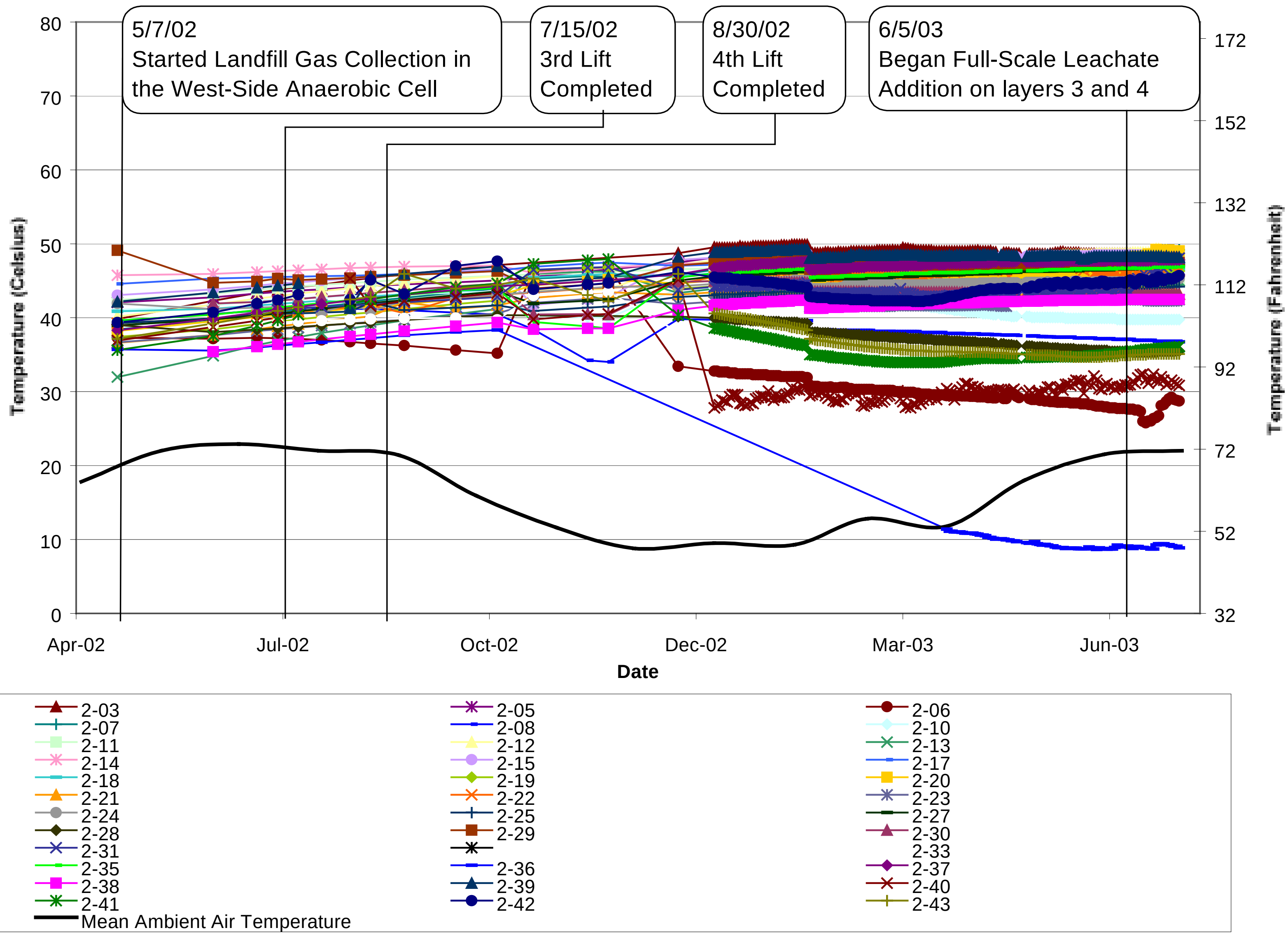


Figure 4-4. West-Side Anaerobic Cell Layer 3 Temperature Readings

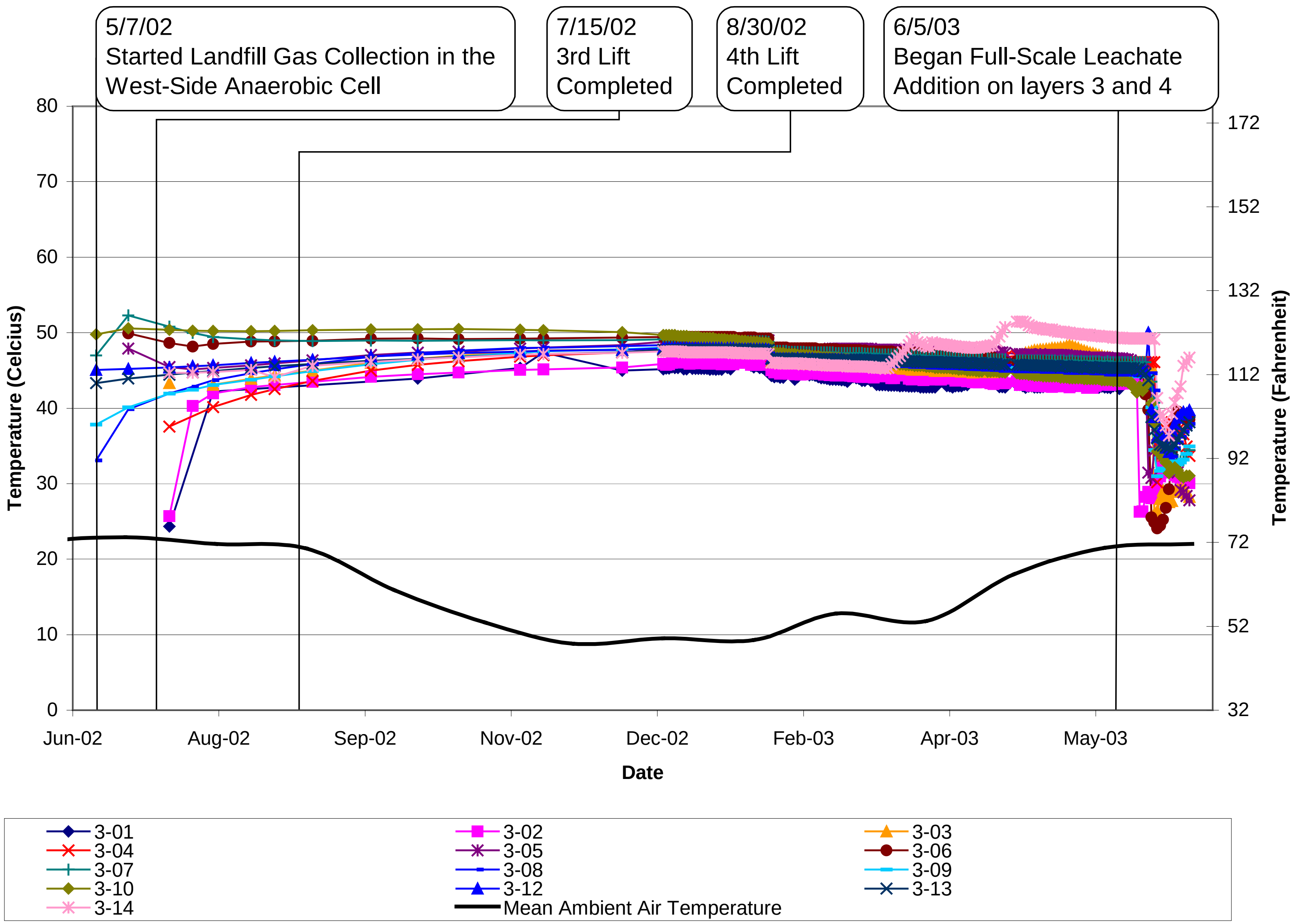


Figure 4-6. West-Side Anaerobic Cell Layer 1 PVC Moisture Readings

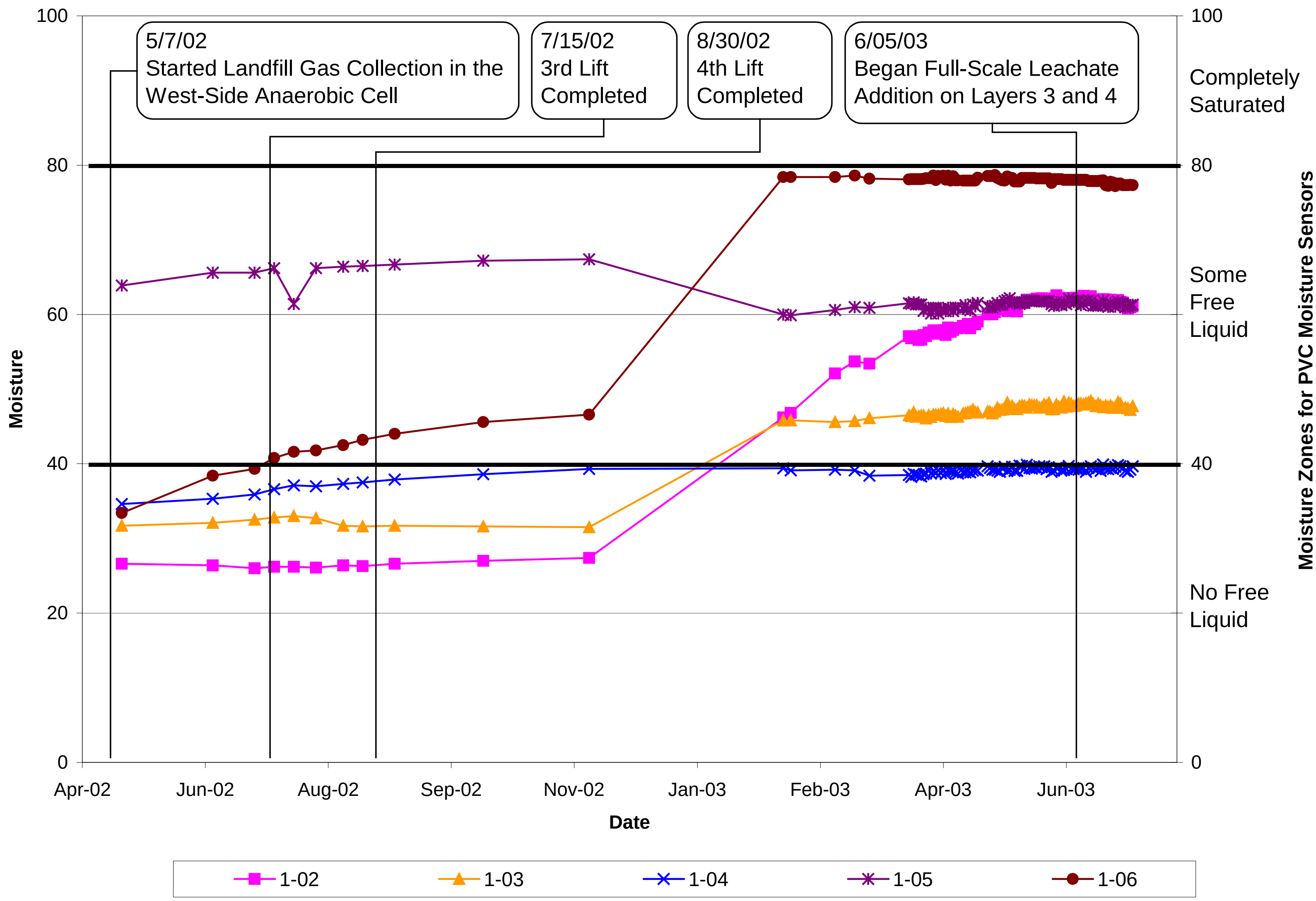


Figure 4-7. West-Side Anaerobic Cell Layer 2 PVC Readings

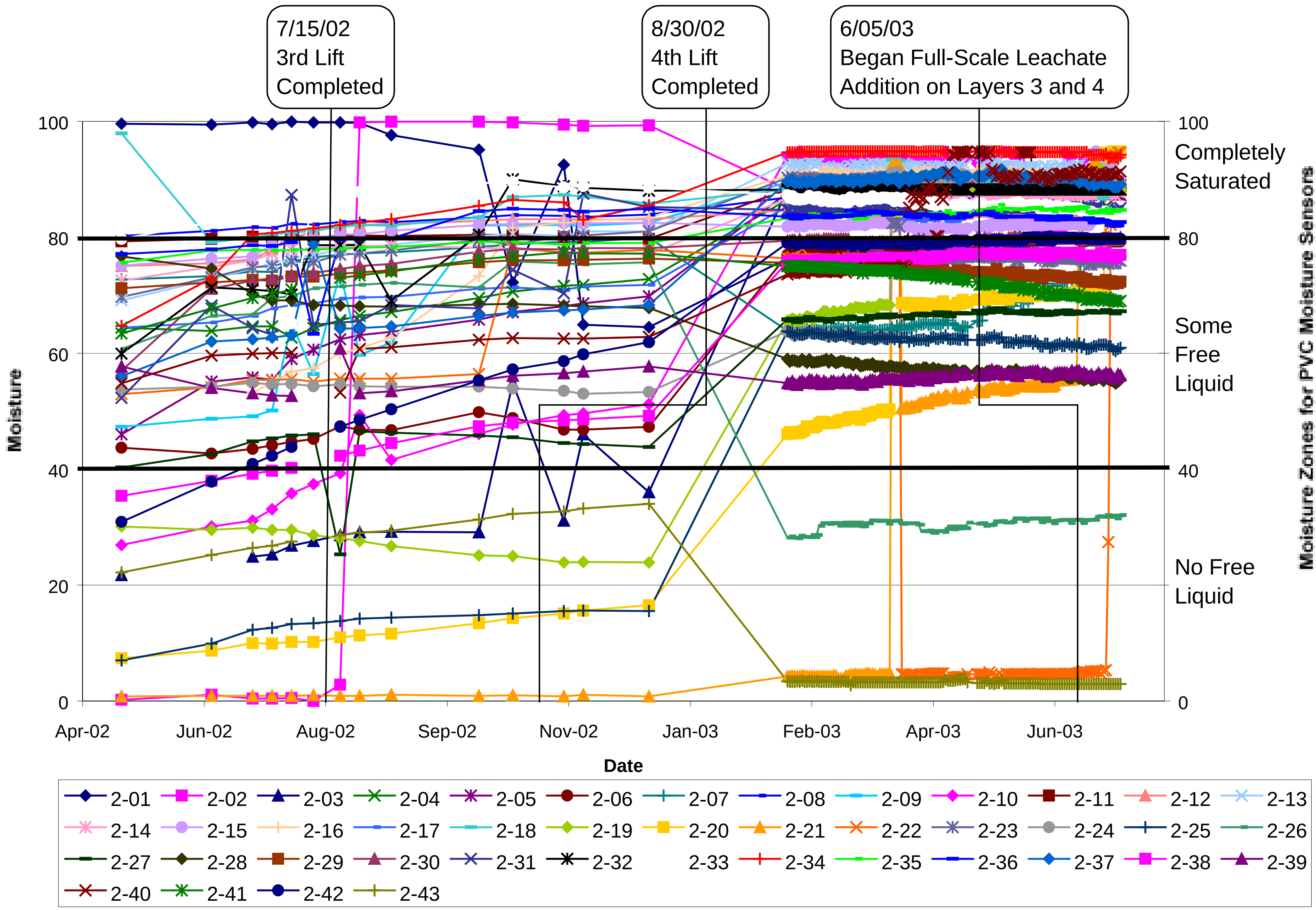


Figure 4-8. West-Side Anaerobic cell Layer 3 PVC Moisture Readings

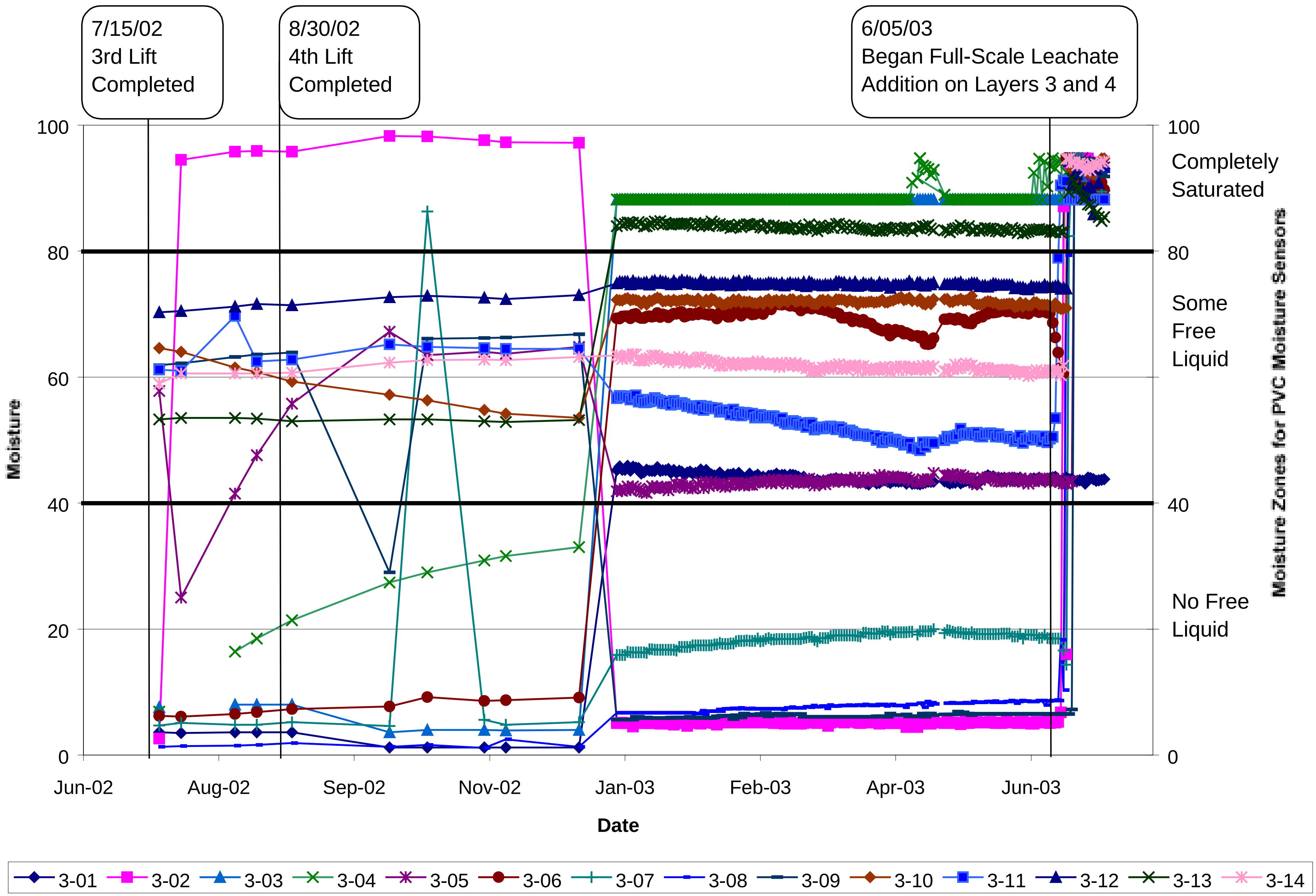


Figure 4-10. West-Side Anaerobic Cell Landfill Gas Concentrations from Header Line

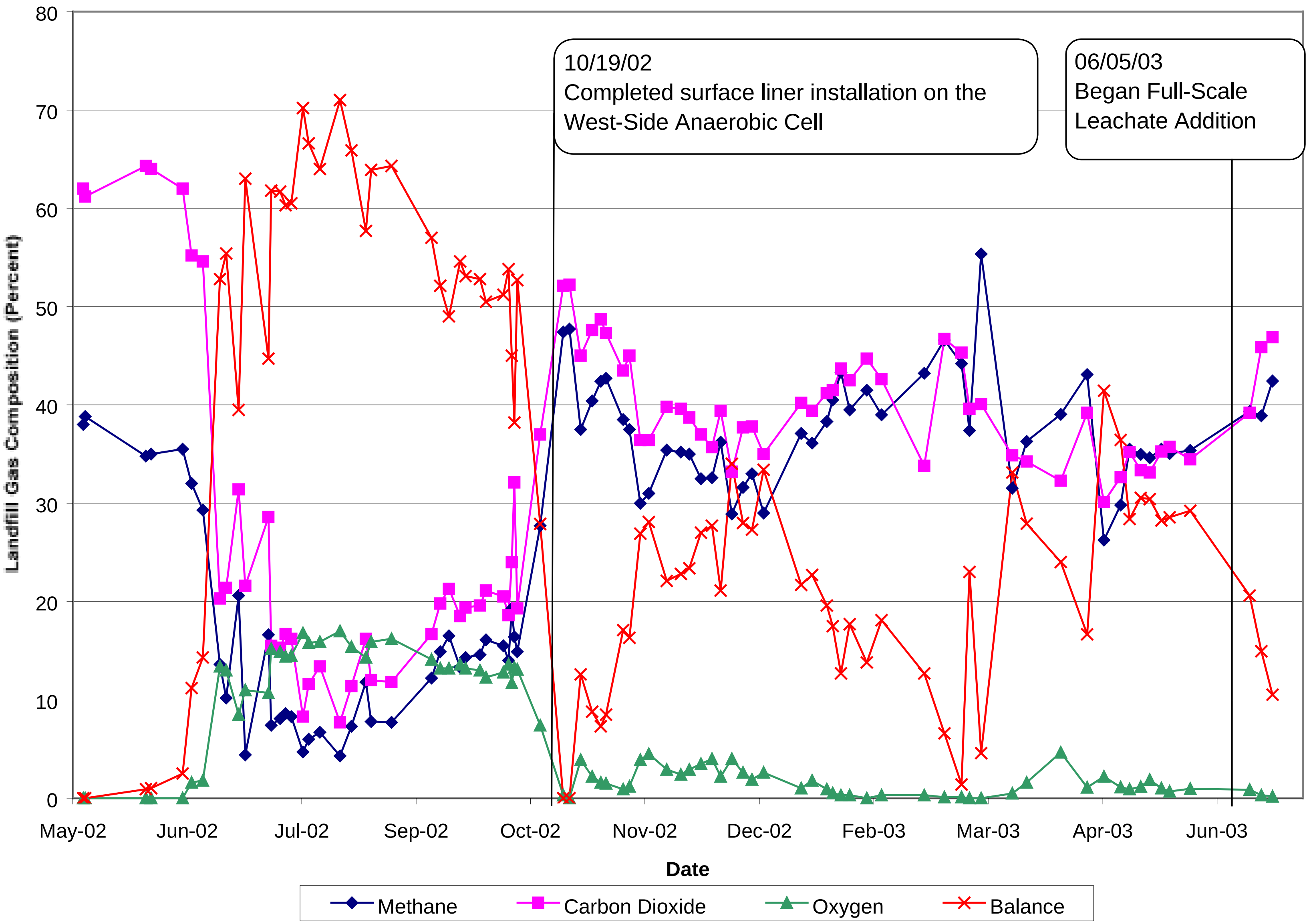


Figure 4-11. West-Side Anaerobic Cell Landfill Gas Flow Rate

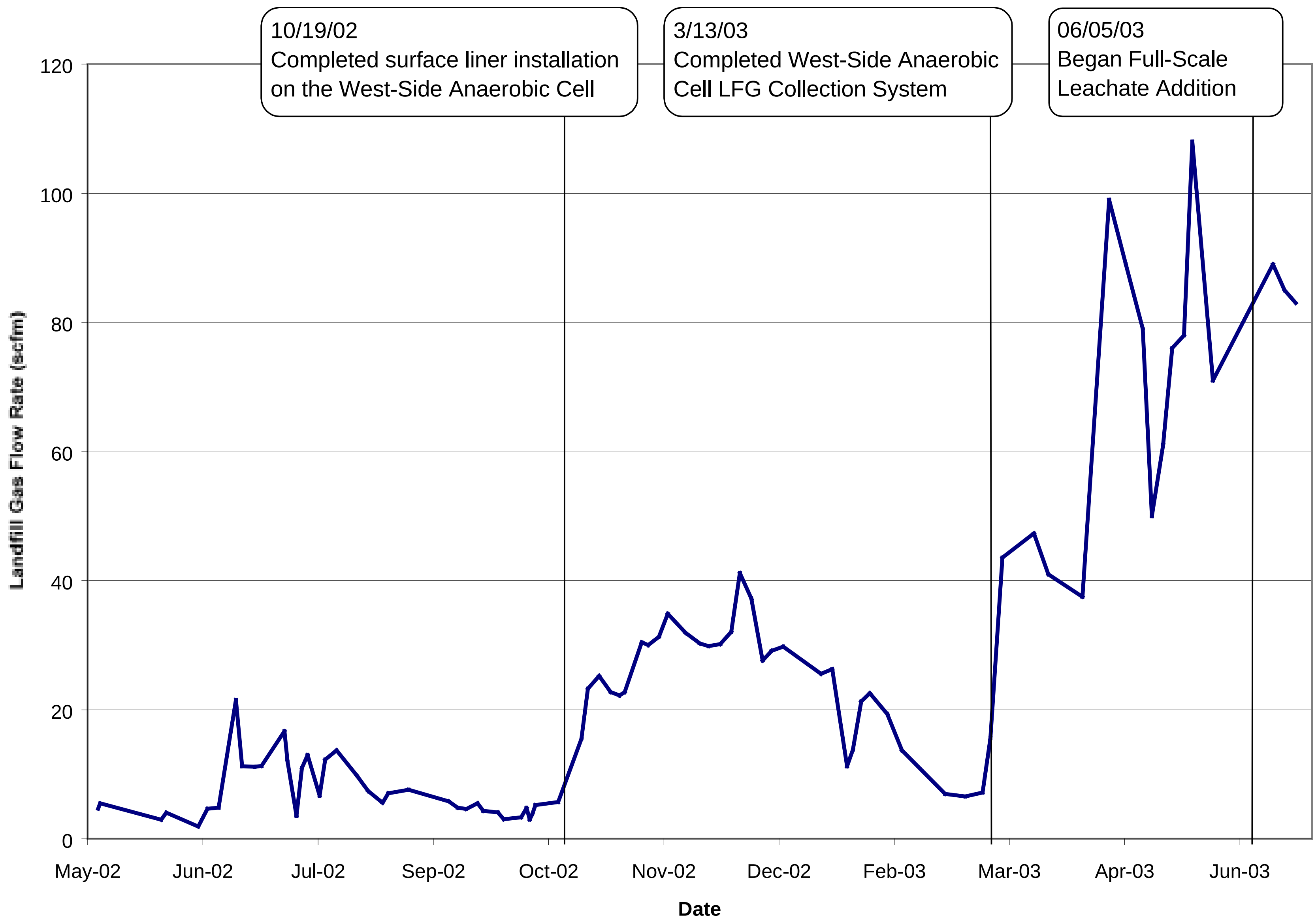


Figure 4-12. West-Side Anaerobic Cell Cumulative Methane

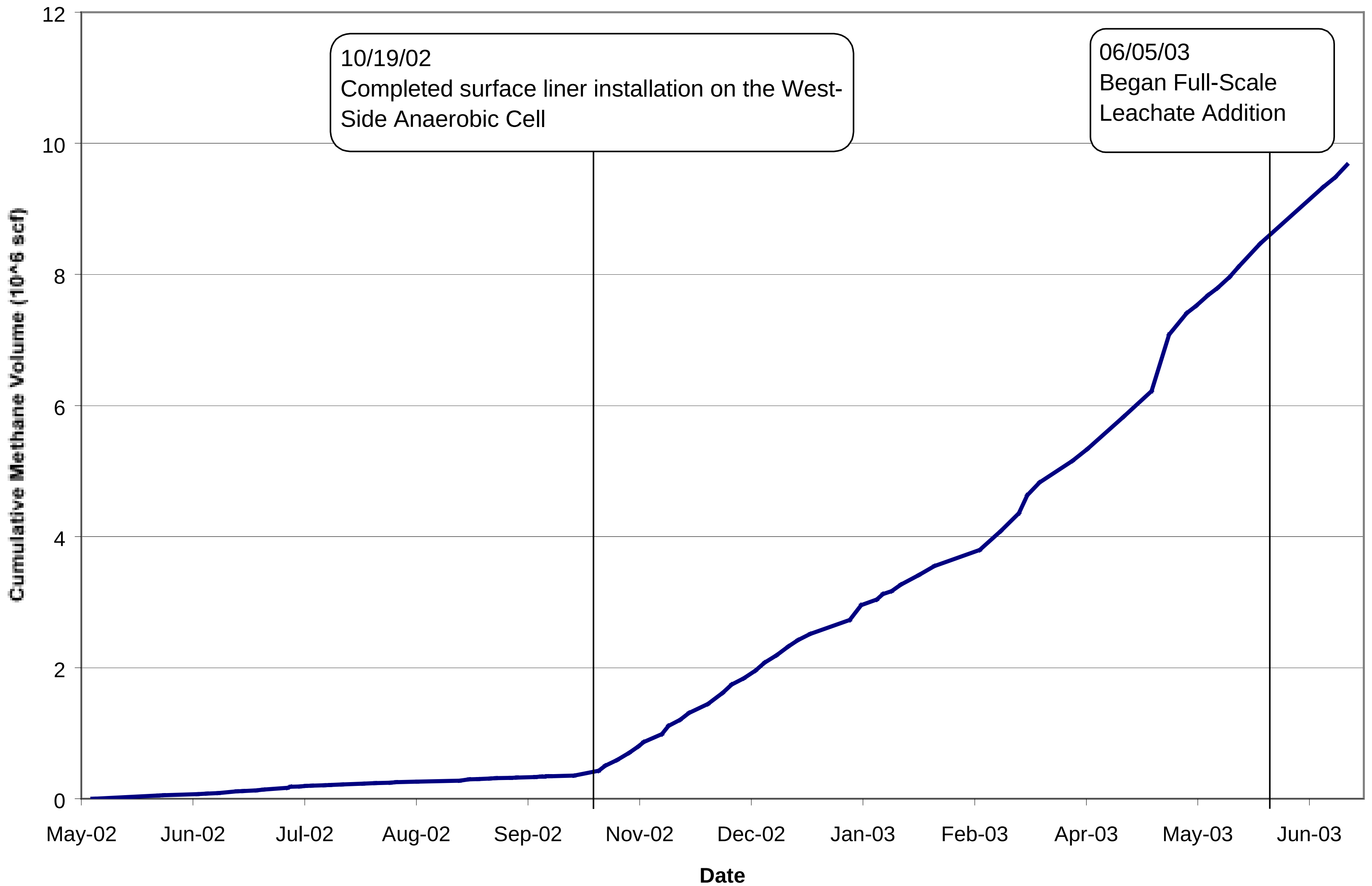


Figure 5-1. Aerobic Cell Base Liner Temperature Readings

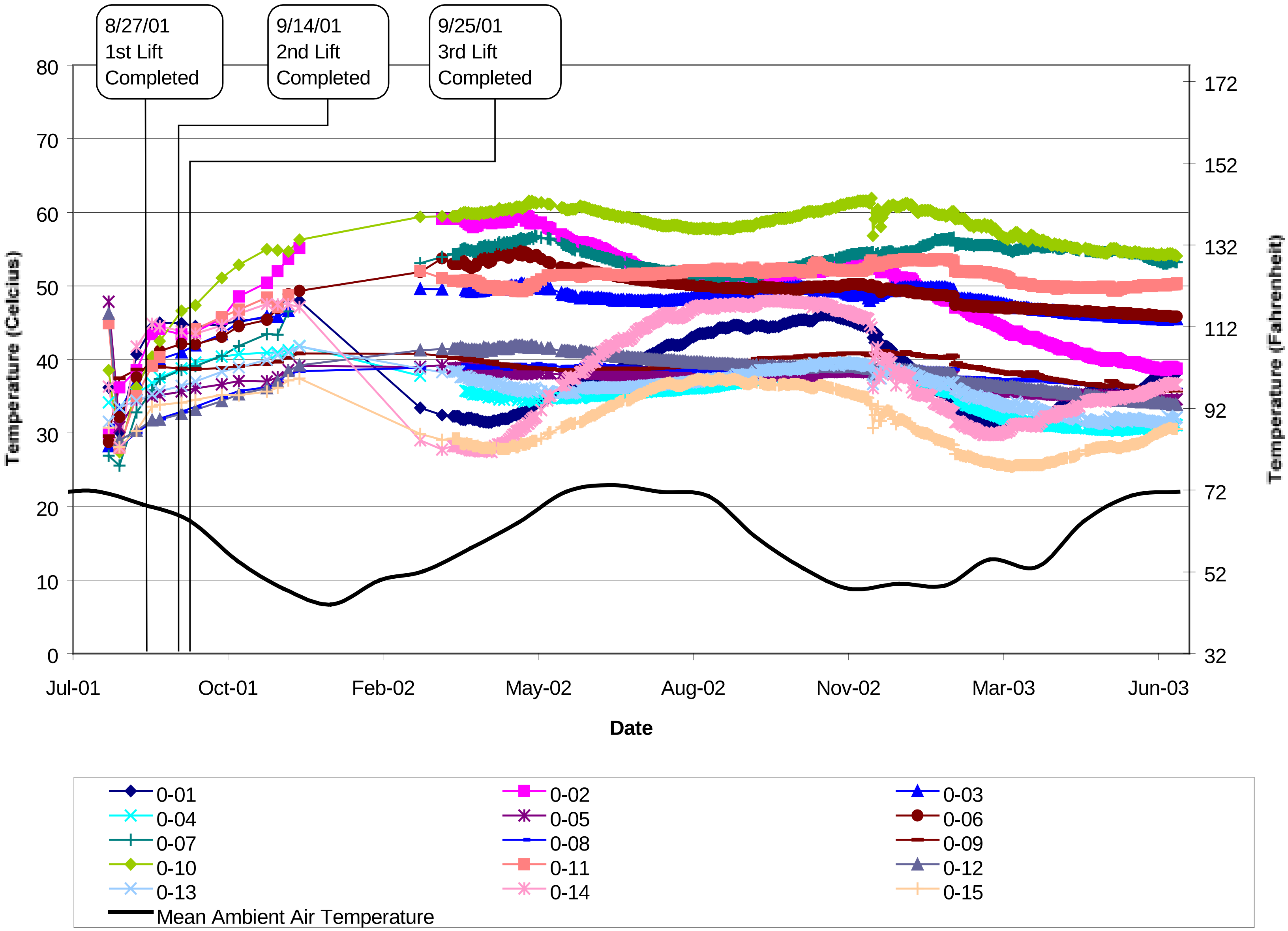


Figure 5-2. Aerobic Cell Layer 0.5 Temperature Readings

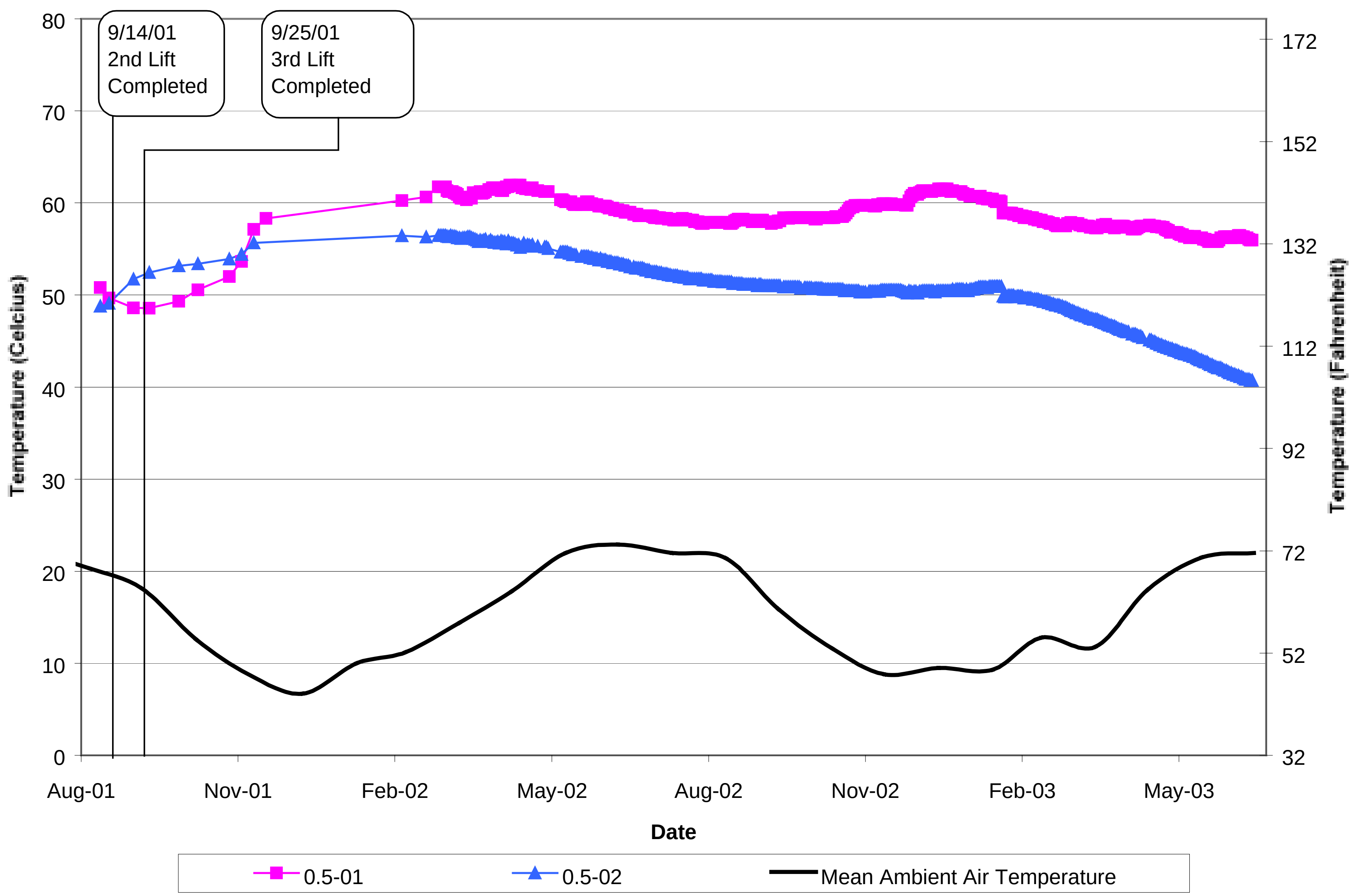


Figure 5-3. Aerobic Cell Layer 1 Temperature Readings

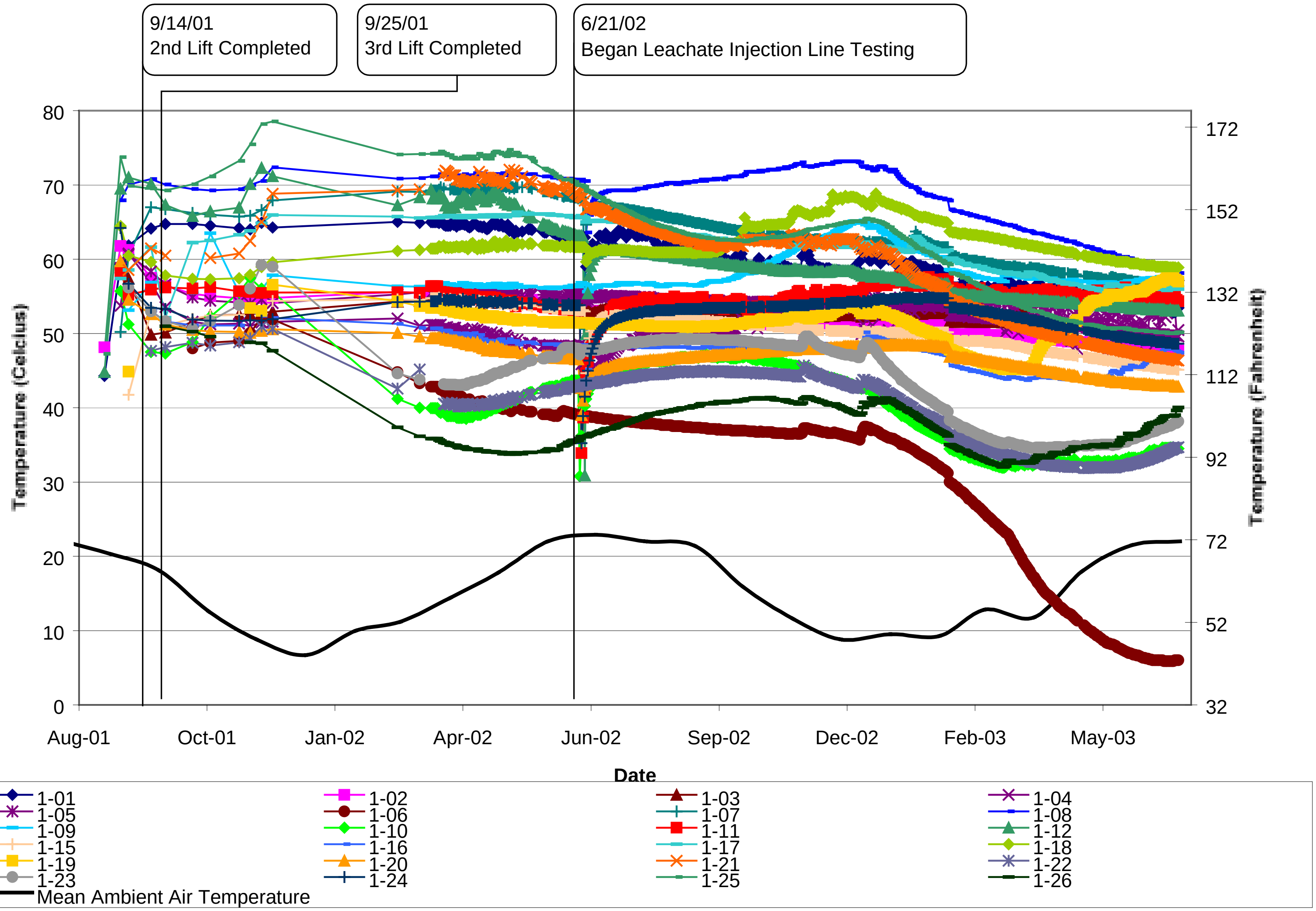


Figure 5-4. Aerobic Cell Layer 2 Temperature Readings

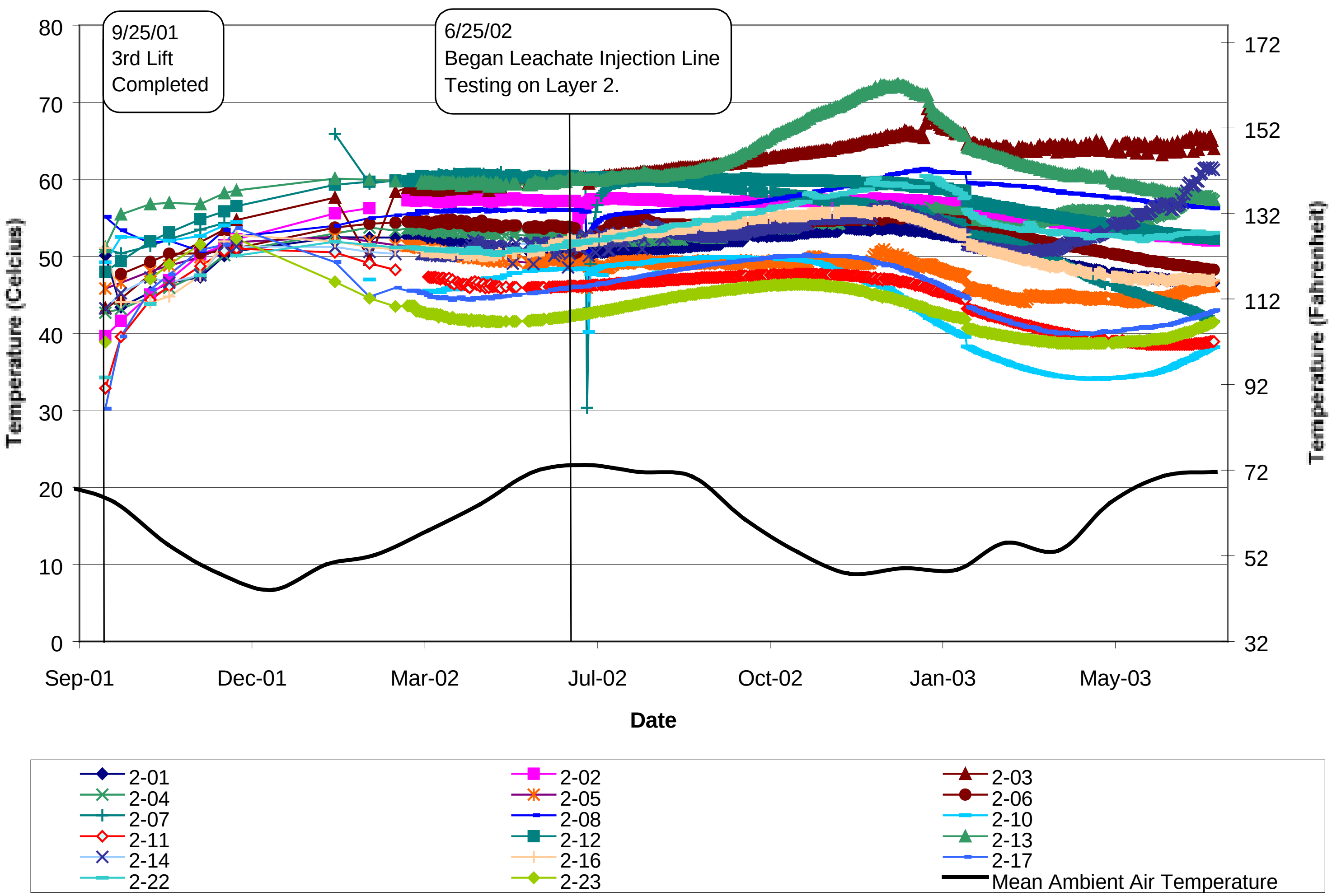


Figure 5-6. Aerobic Cell Base Liner PVC Moisture Readings

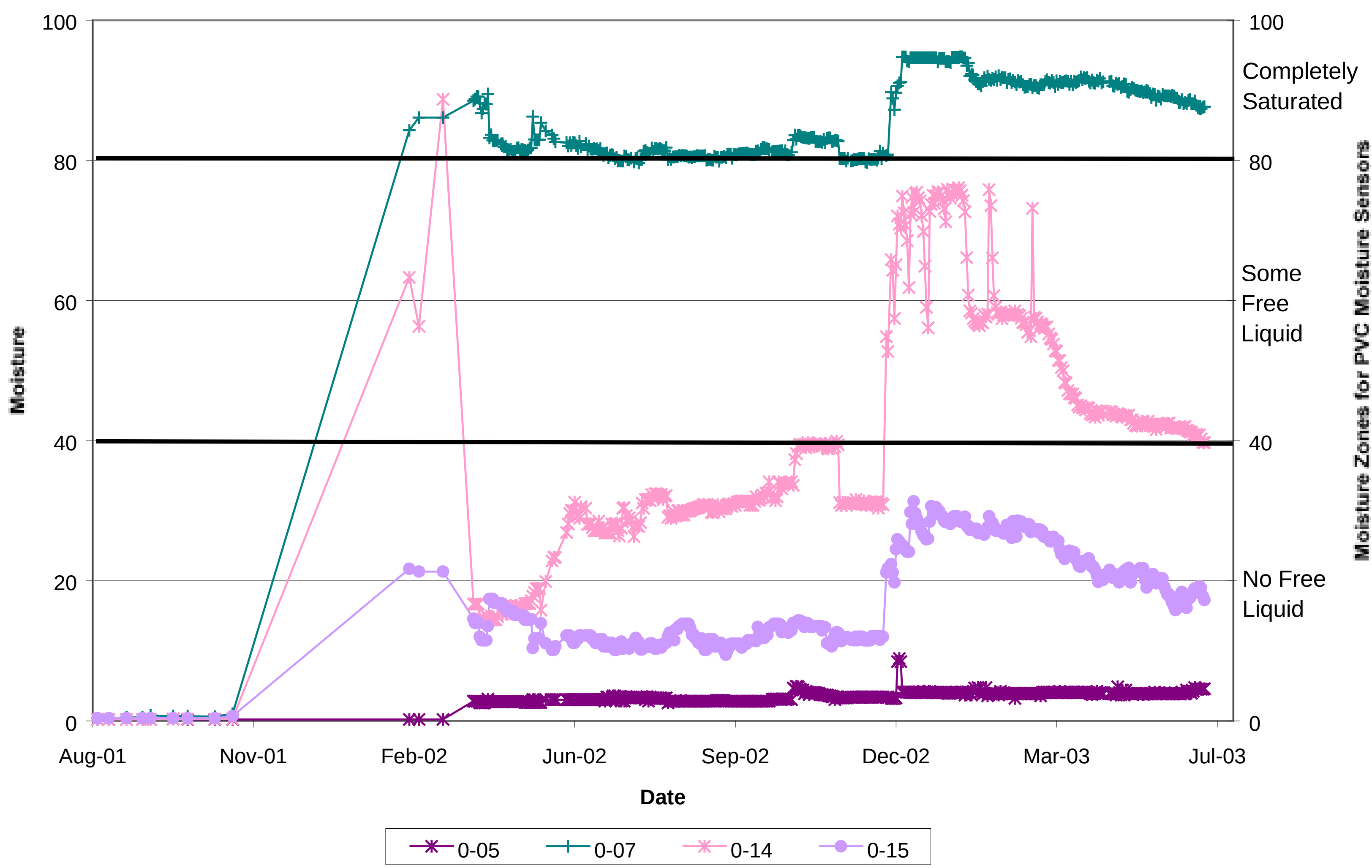


Figure 5-7. Aerobic Cell Layer 0.5 PVC Moisture Readings

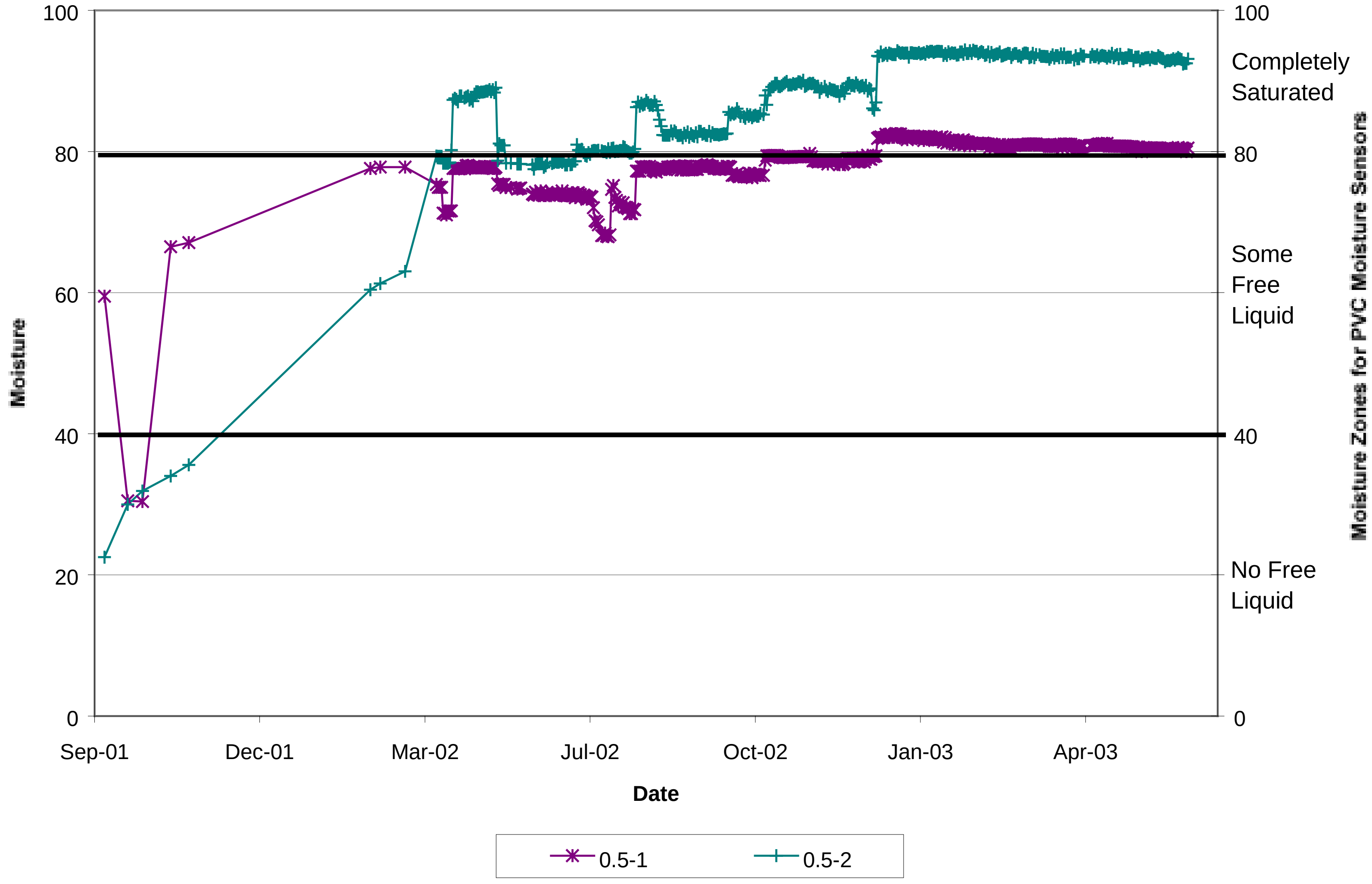


Figure 5-8. Aerobic Cell Layer 1 PVC Moisture Readings

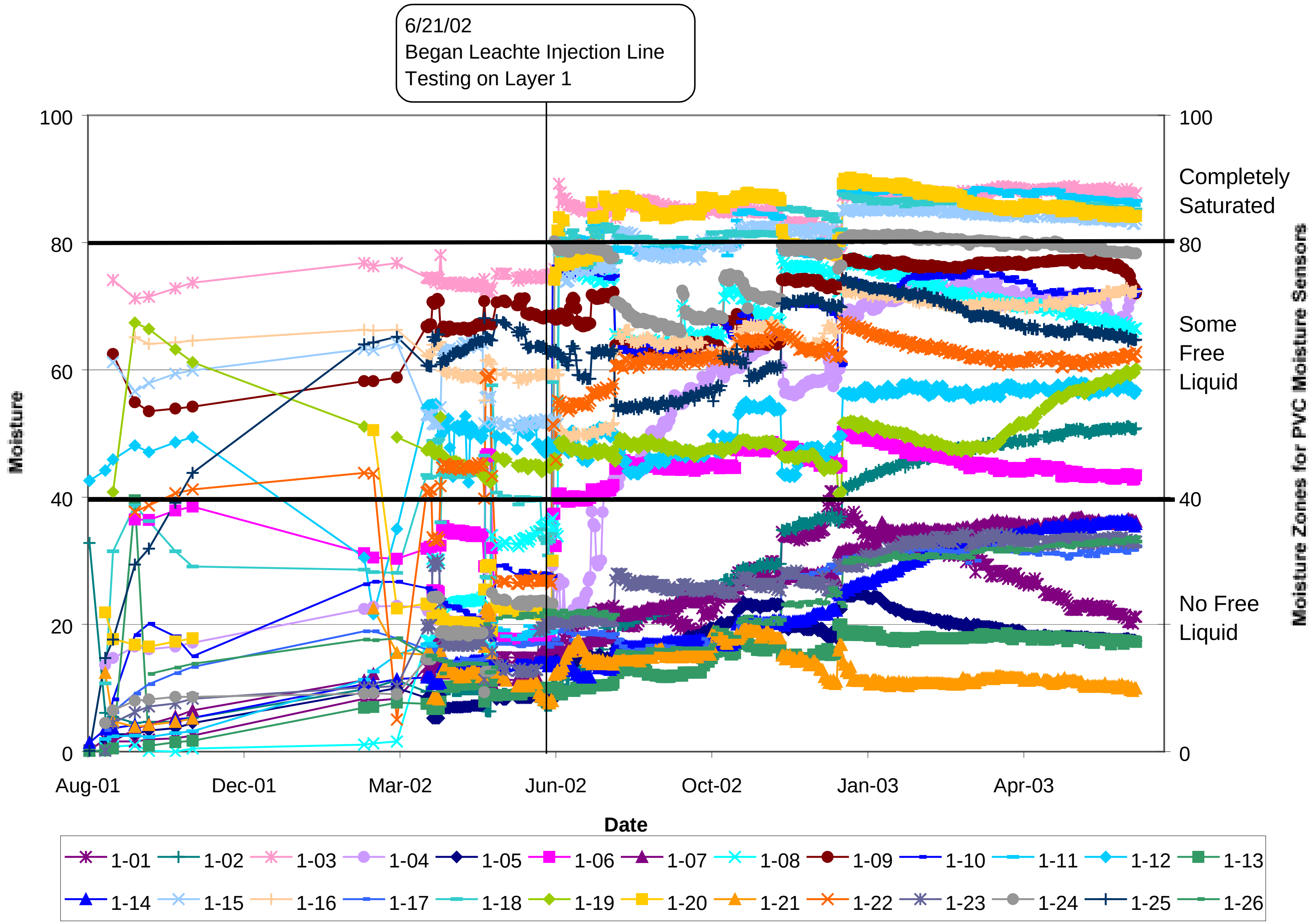


Figure 5-9. Aerobic Cell Layer 2 PVC Moisture Readings

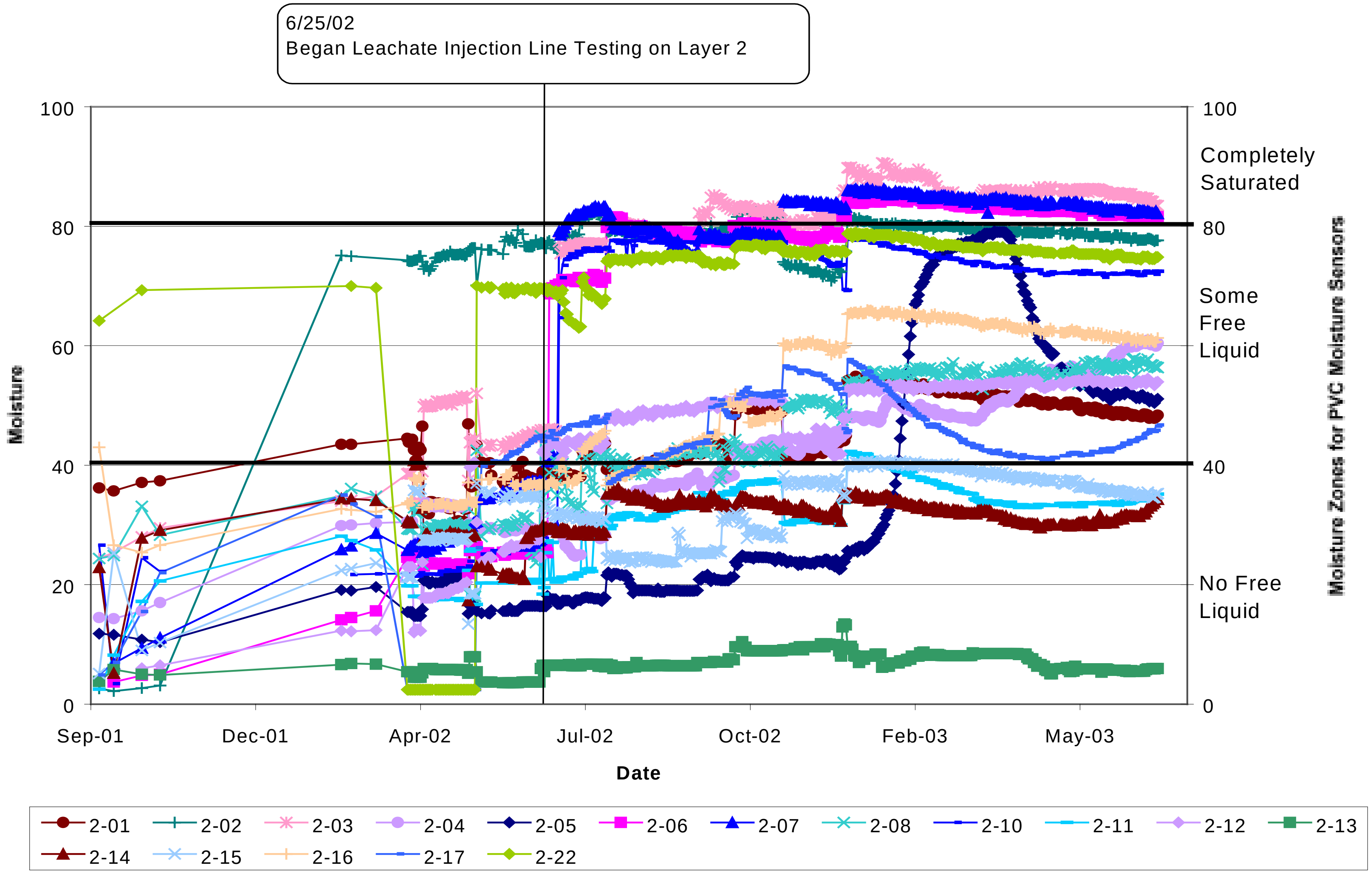


Figure 5-11. Aerobic Cell Landfill Gas Concentrations

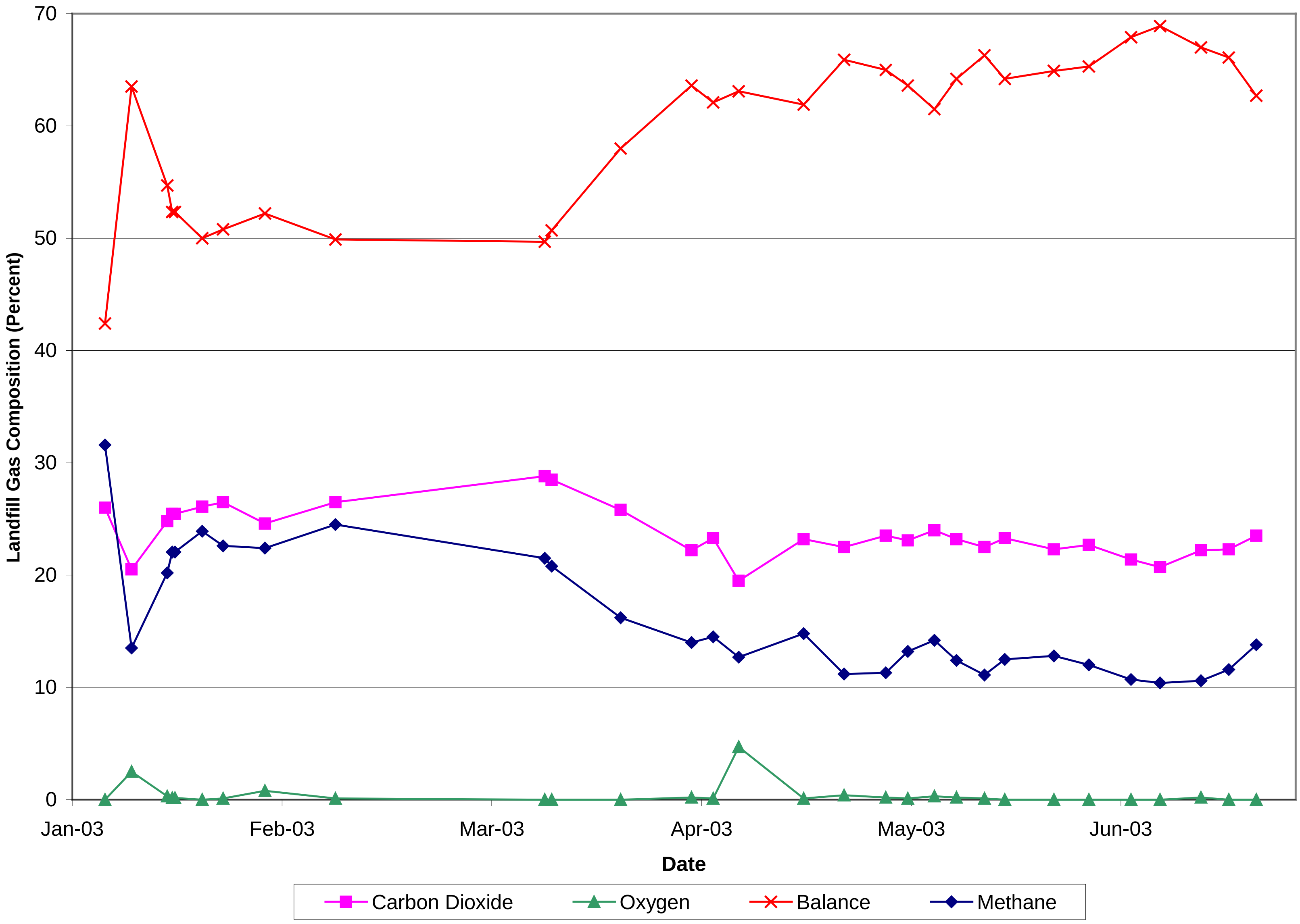


Figure 5-12. Aerobic Cell Landfill Gas Flow Rate

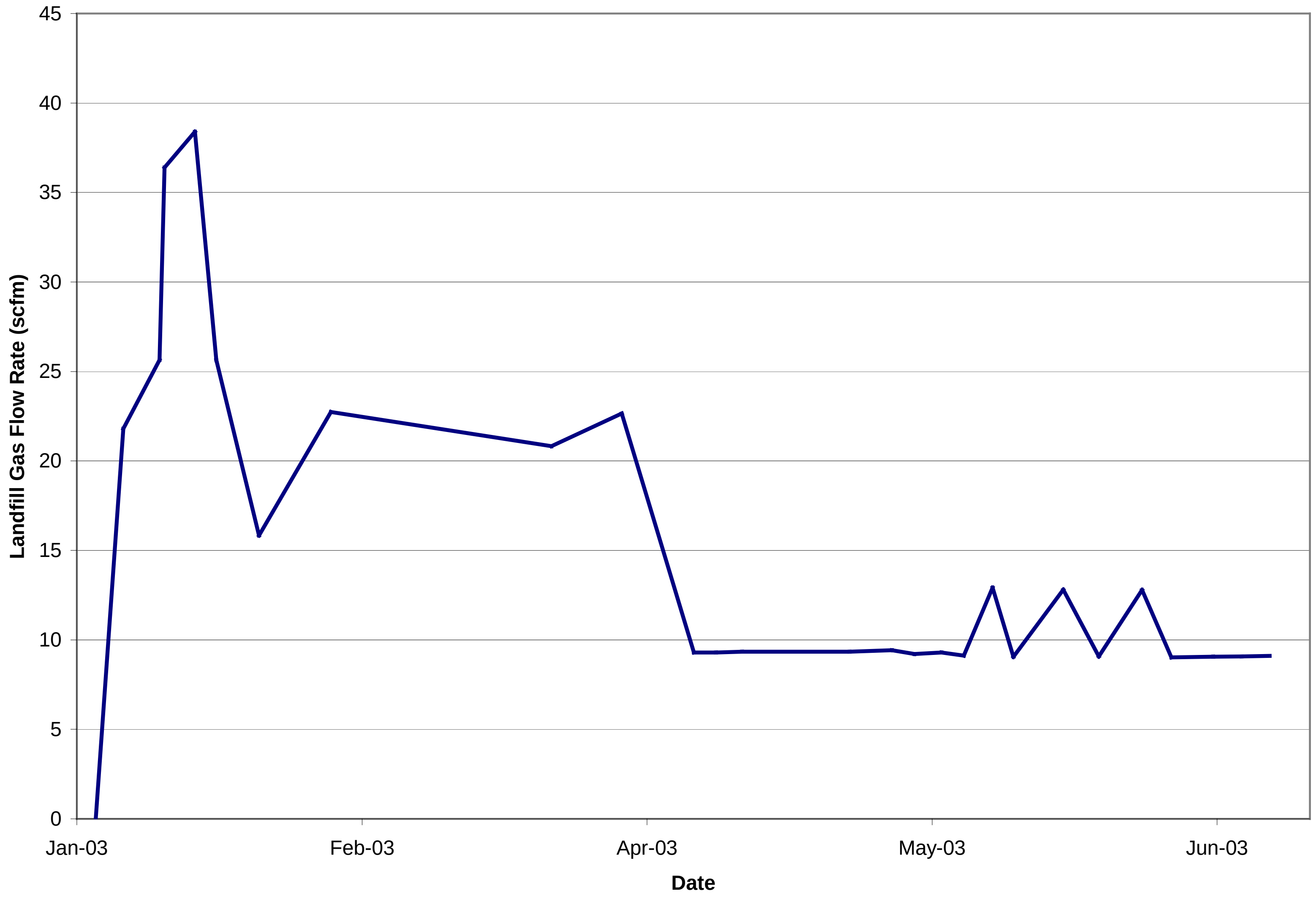


Figure 5-13. Aerobic Cell Cumulative Methane

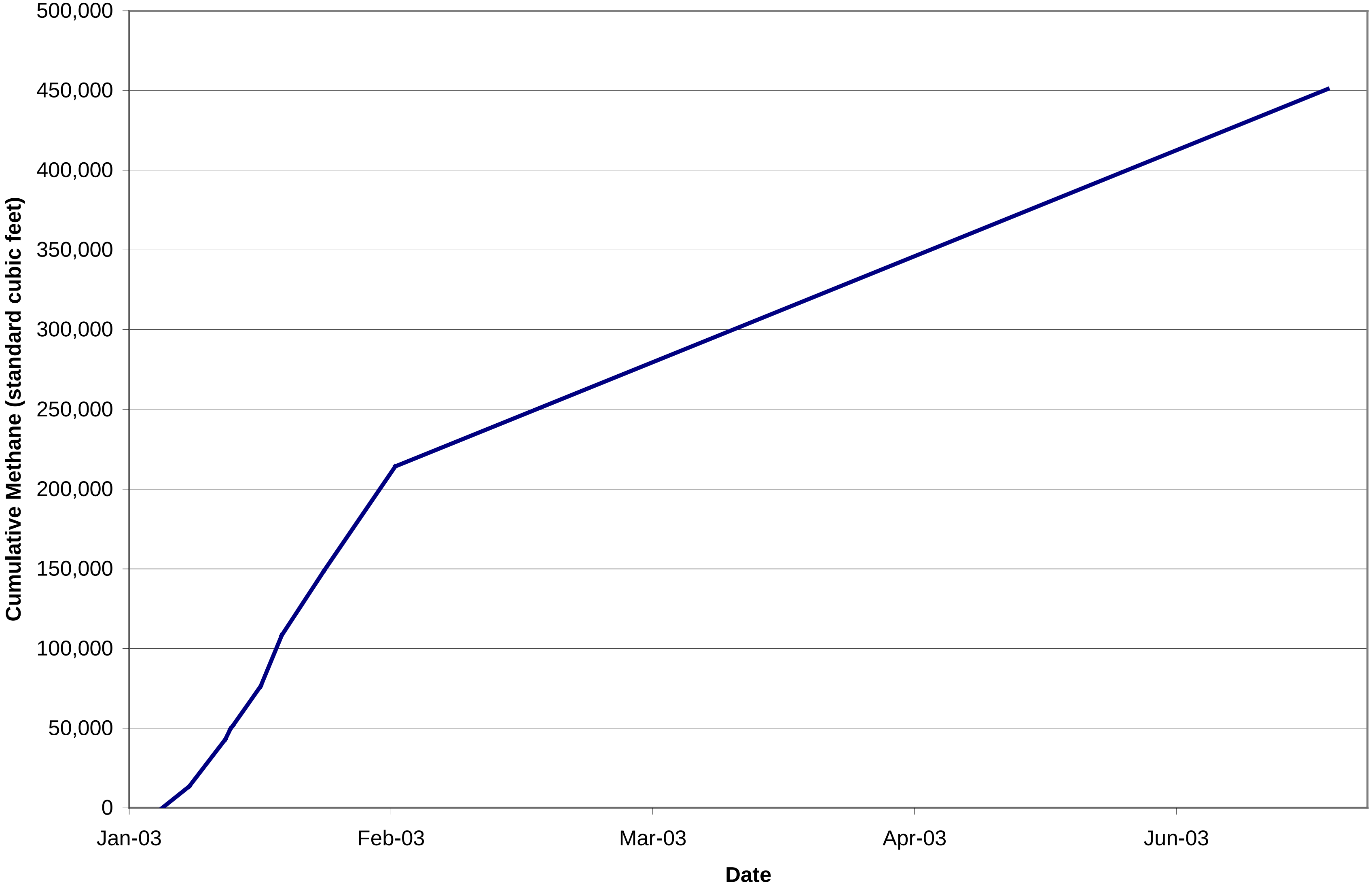


Figure 6-1. Module D Base Liner Temperature Readings (Northwest Quadrant)

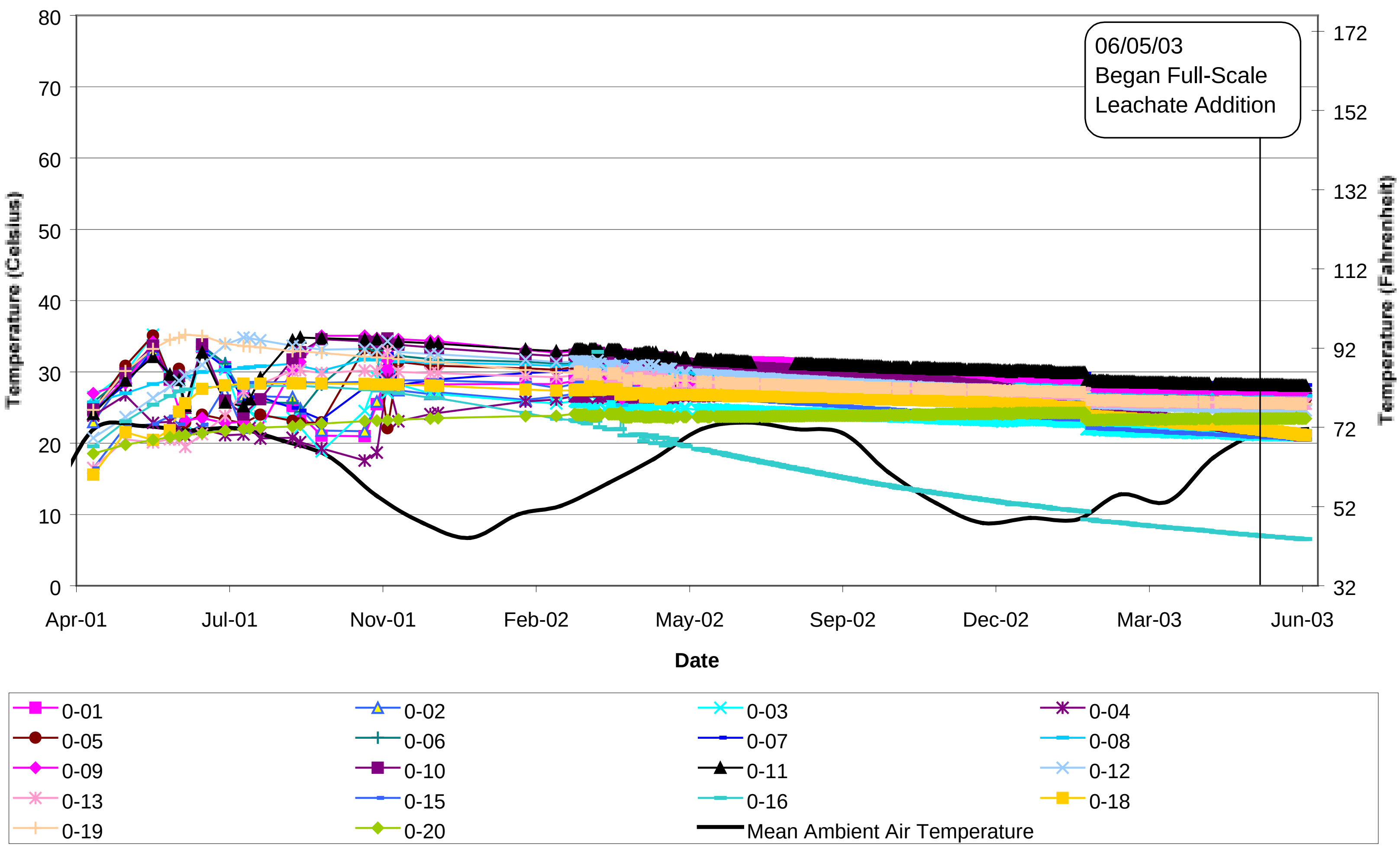


Figure 6-2. Module D Base Liner Temperature Readings (Southwest Quadrant)

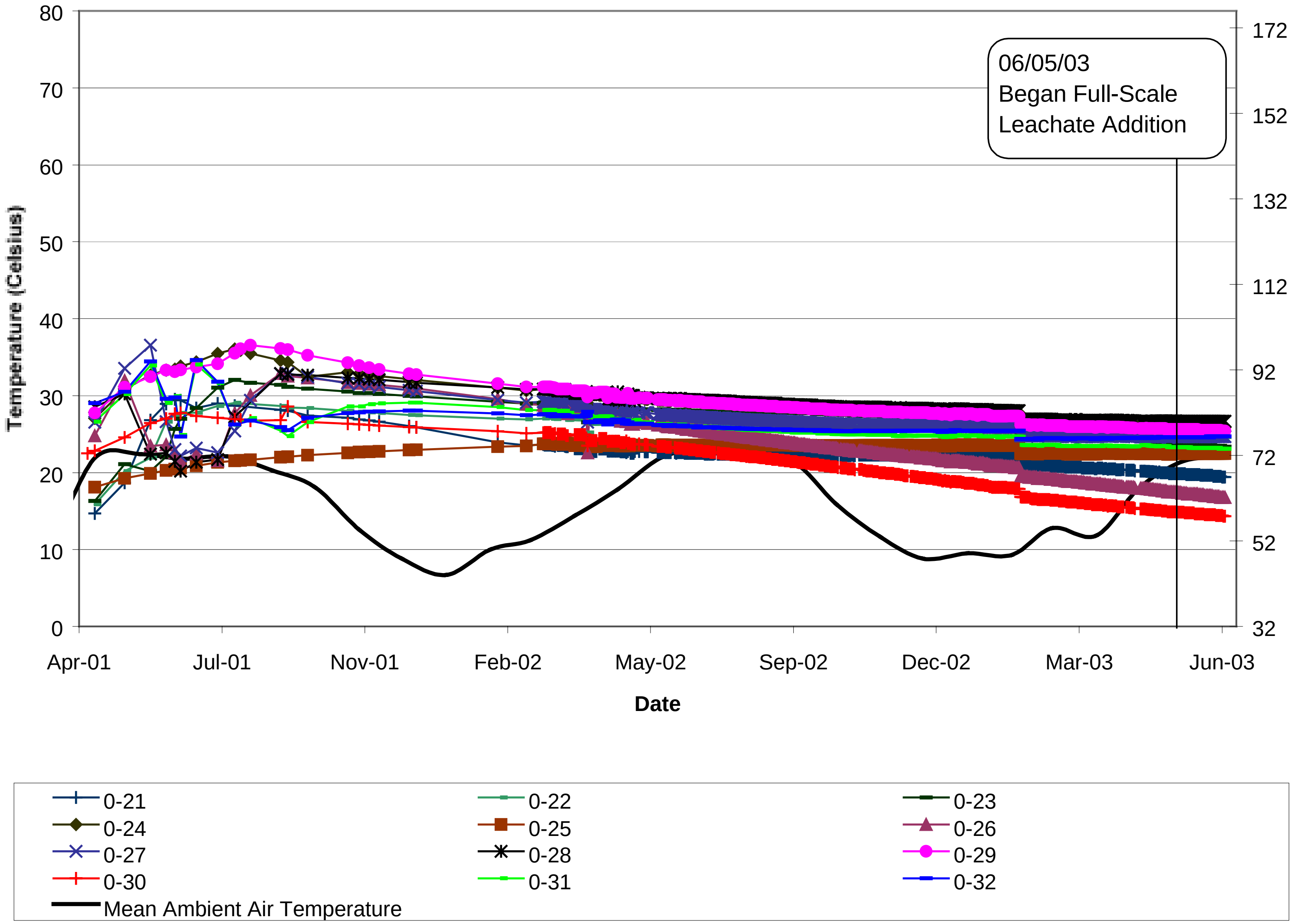


Figure 6-3. Module D Base Liner Temperature Readings (Northeast Quadrant)

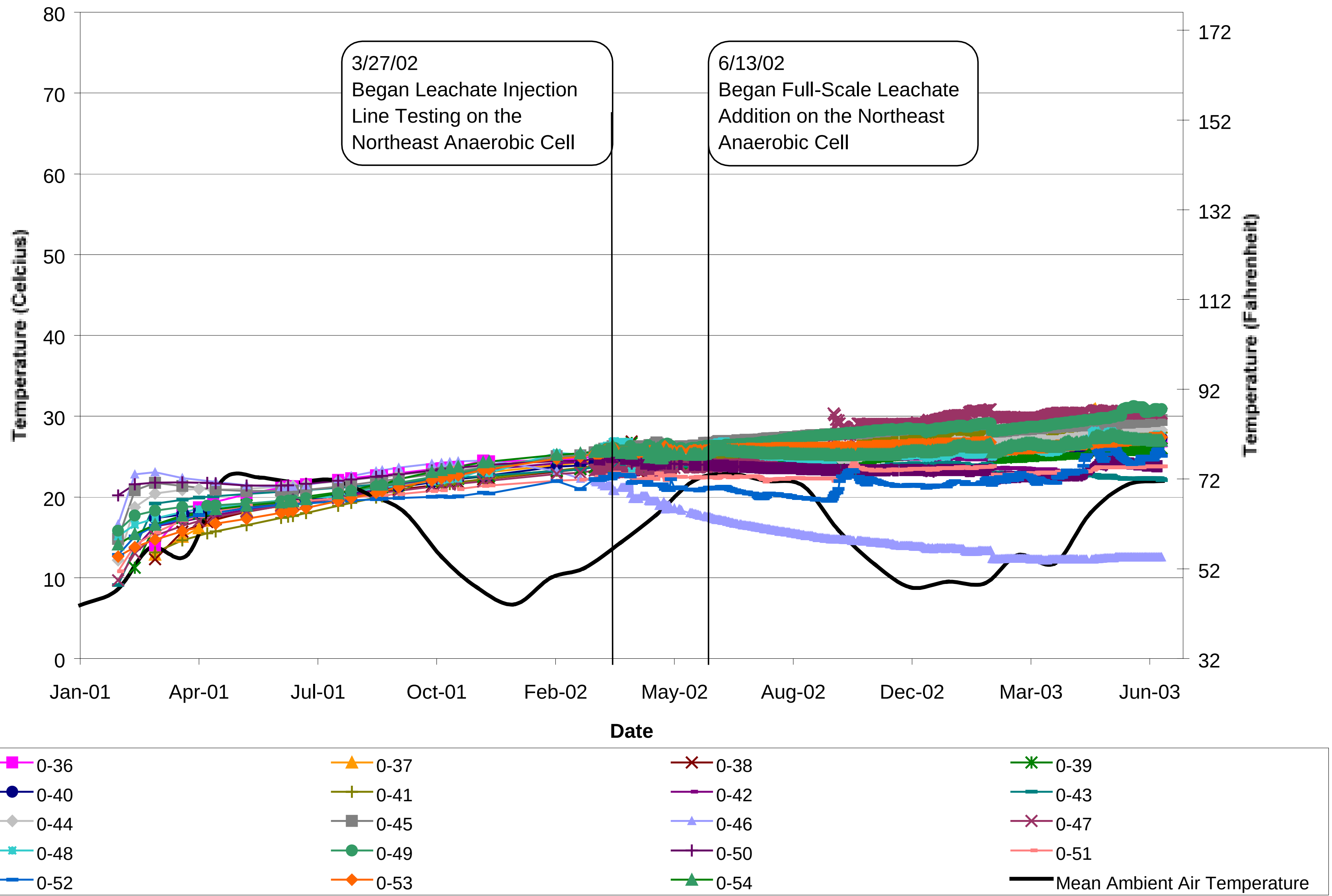


Figure 6-4. Module D Base Liner Temperature Readings (Southeast Quadrant)

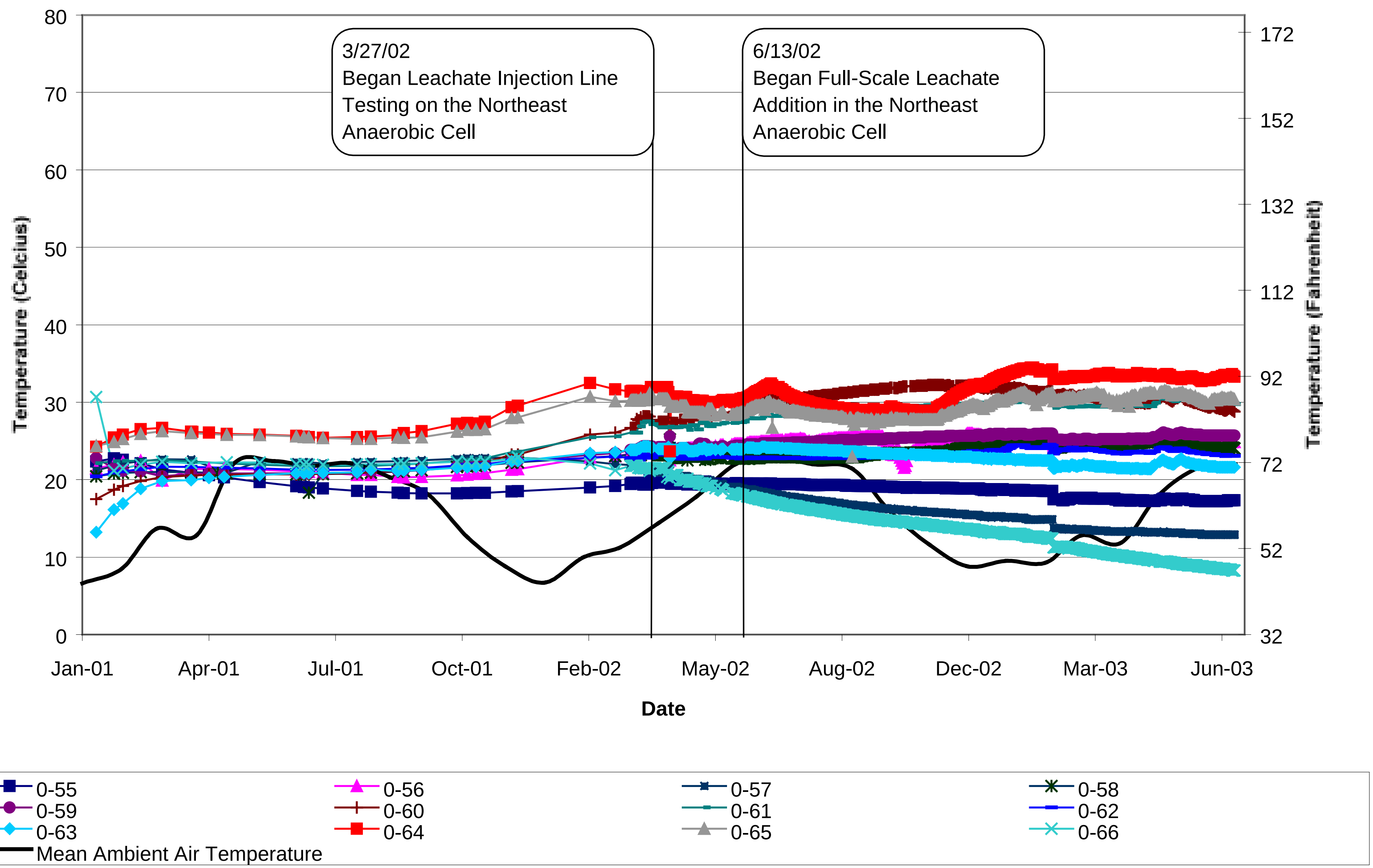


Figure 6-6. Module D Base Liner PVC Moisture Readings (Northwest and Southwest Quadrants)

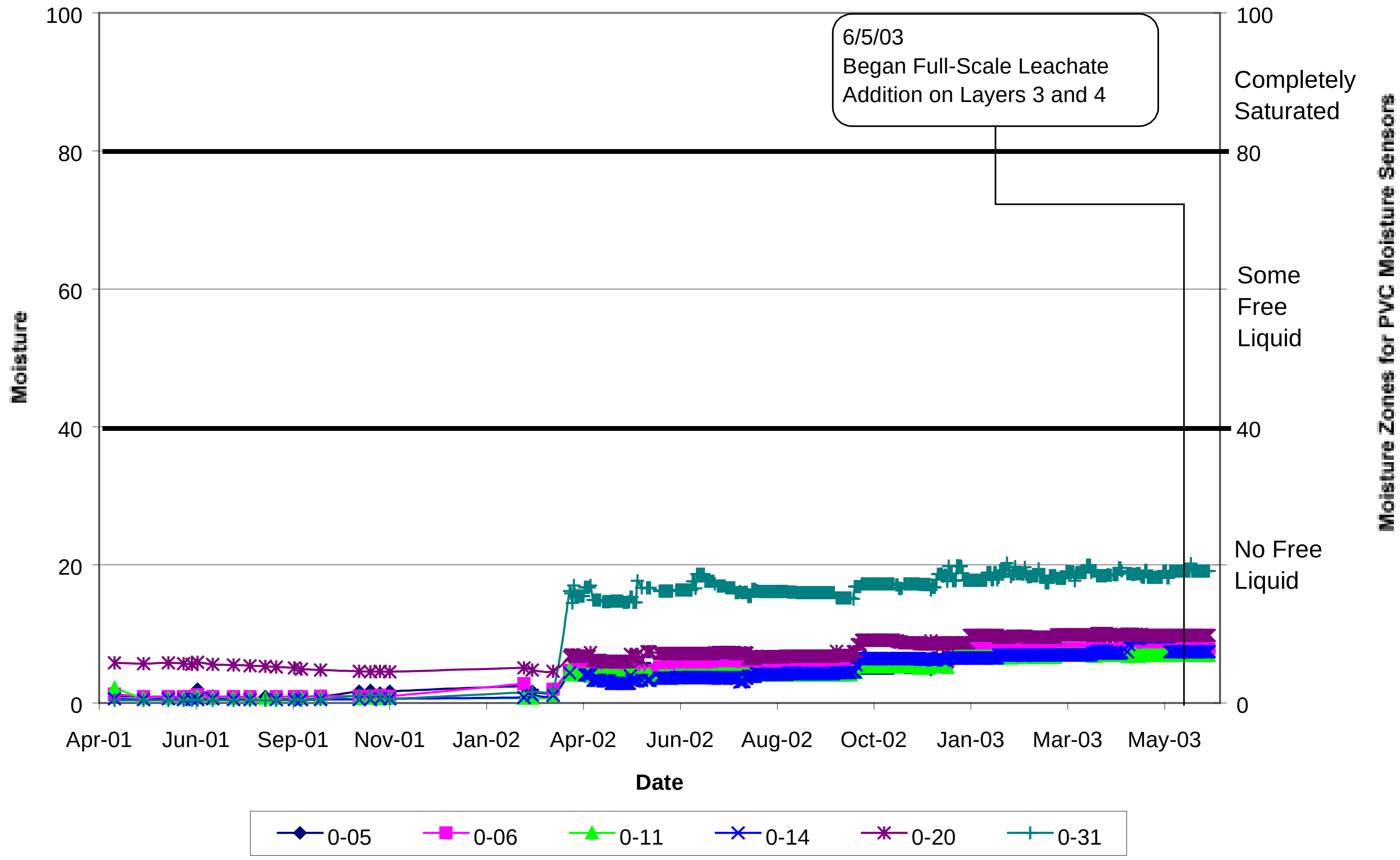


Figure 6-7. Module D Base Liner PVC Moisture Readings (Northeast Quadrant)

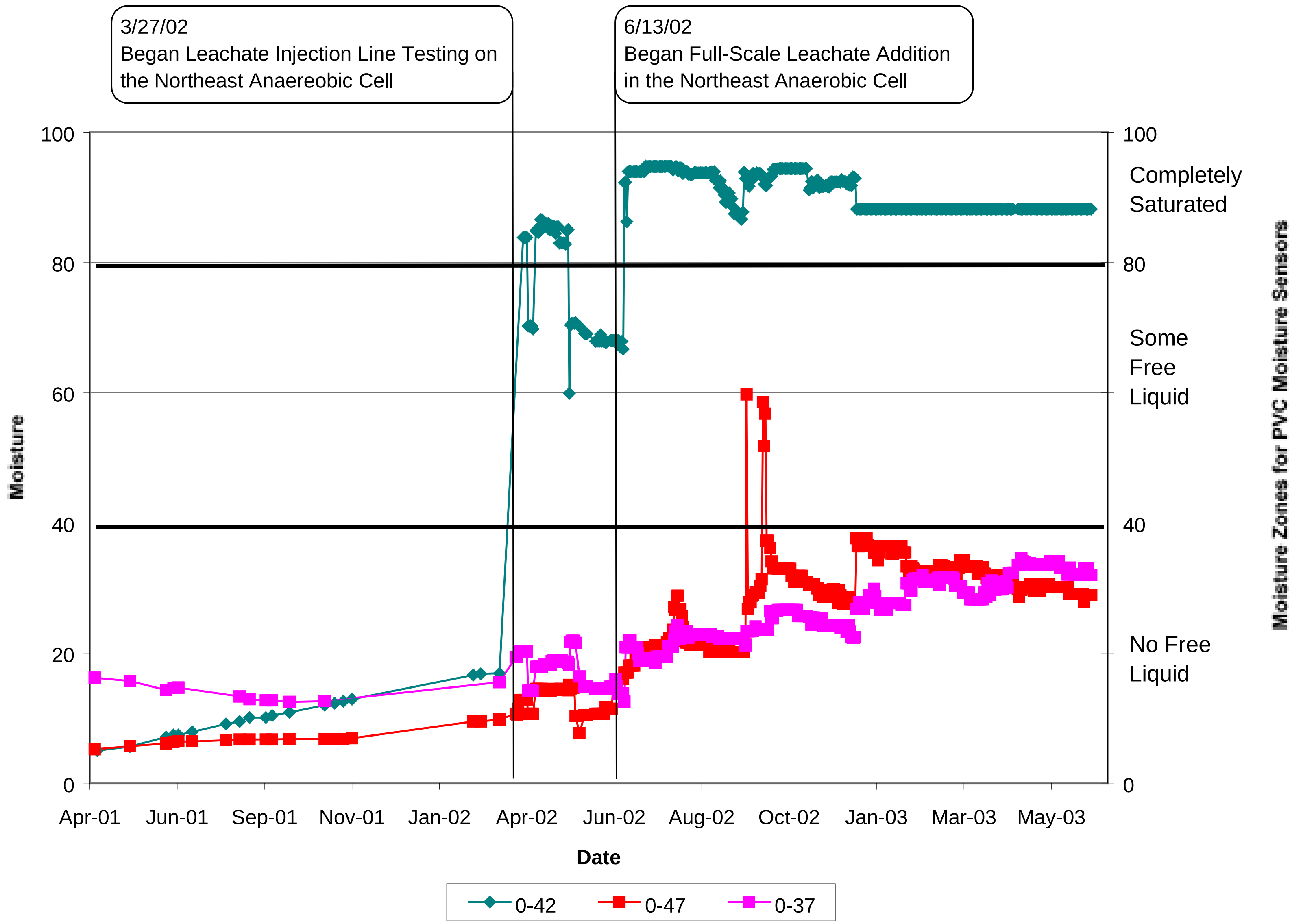


Figure 6-8. Module D Base Liner PVC Moisture Readings (Southeast Quadrant)

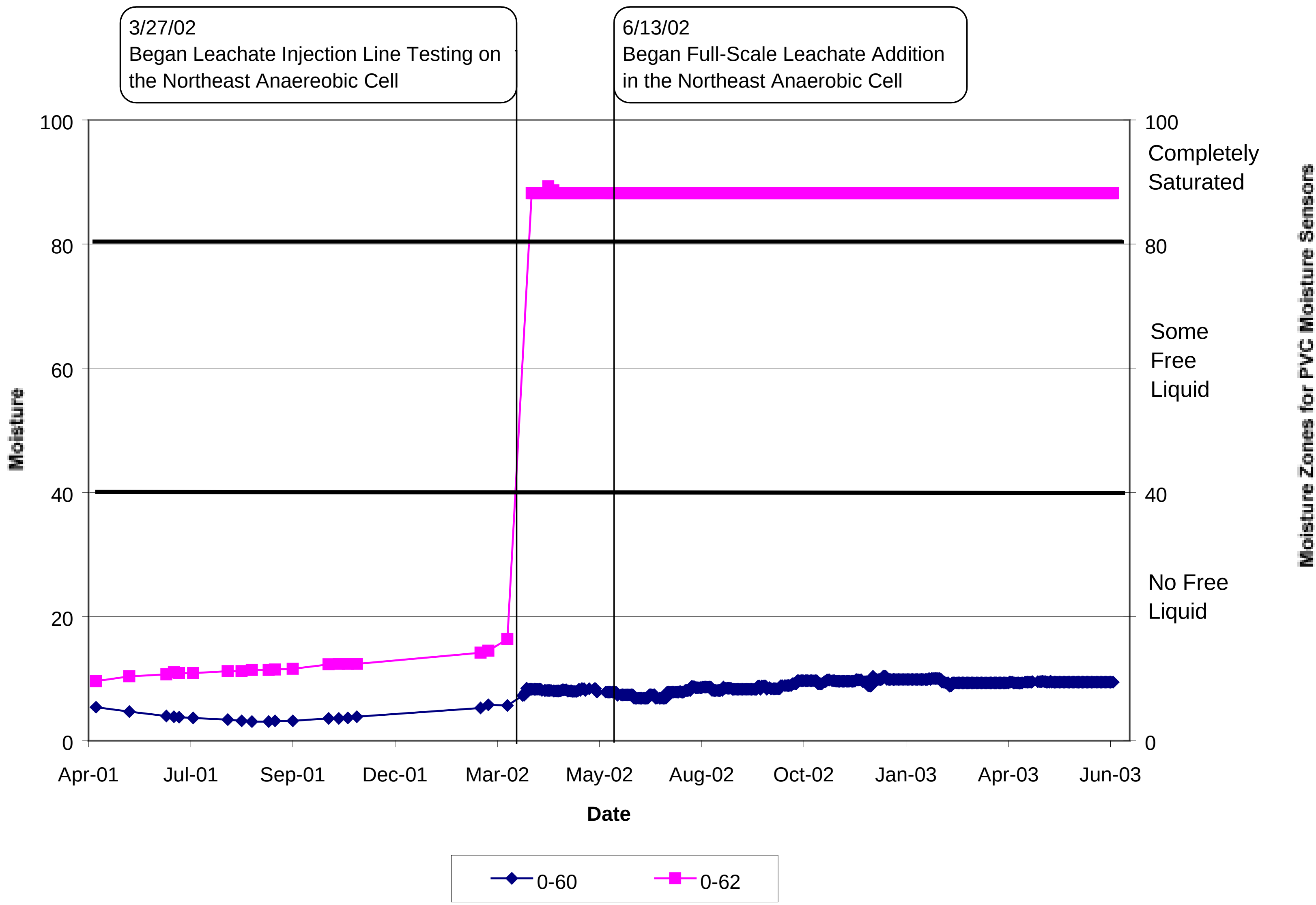
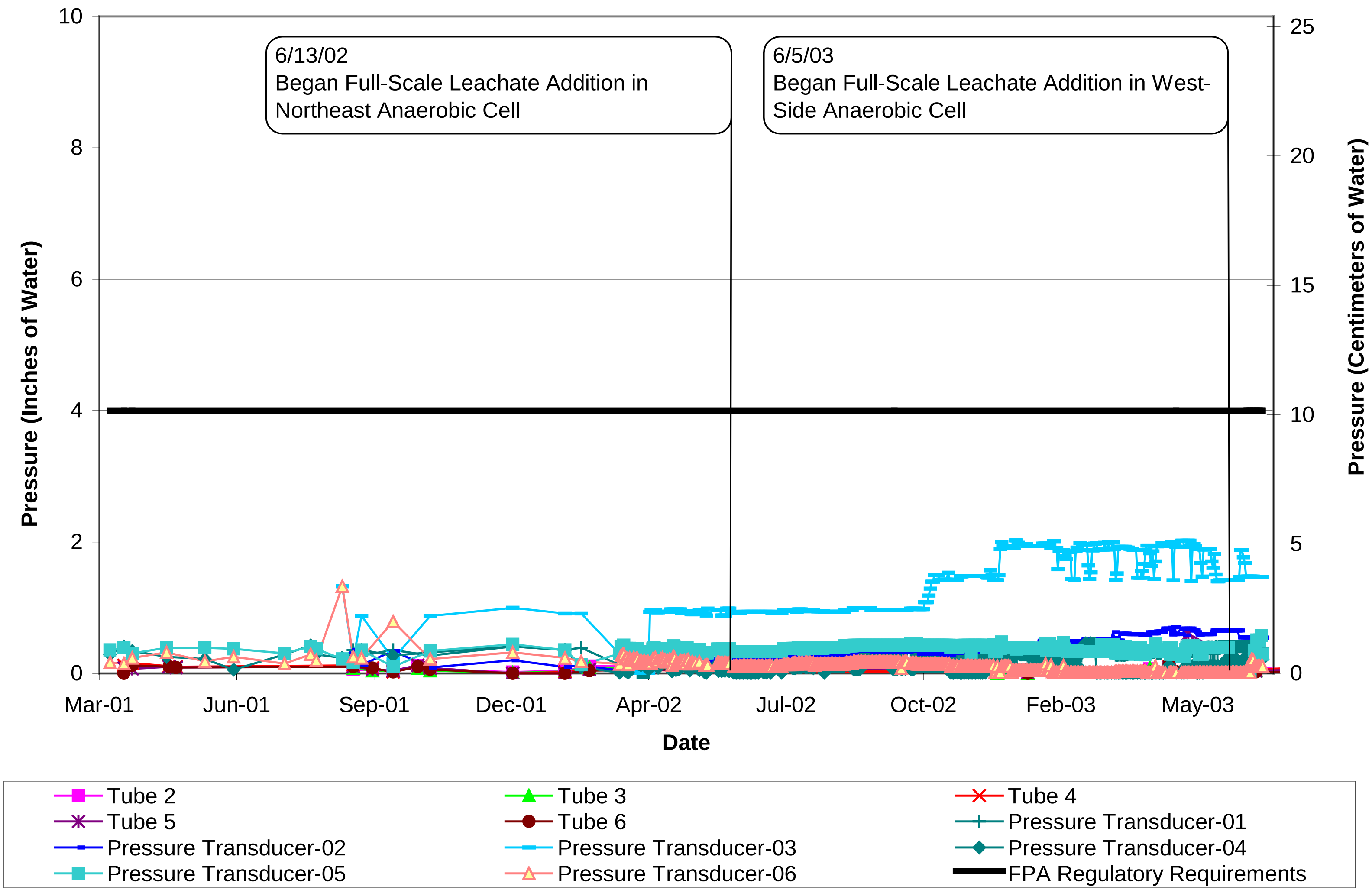


Figure 6-10. Module D Base Liner Pressure Transducers and Adjacent Tubes



On May 22, 2003 the leachate pump in the east sump was turned off for maintenance and therefore the water level briefly increased to 9.21 inches.

APPENDIX D – LANDFILL GAS LABORATORY CHEMISTRY

Table 3-7. Analytical Results for Landfill Gas Sampled from Module D

		Northeast Anaerobic Cell						West-Side Anaerobic Cell			Aerobic Cell	
GAS ANALYSIS PARAMETERS	**DATE:**	**3/8/2002**	**5/29/2002**	**8/29/2002**	**12/5/2002**	**3/18/2003**	**5/27/2003**	**5/29/2002**	**3/18/2003**	**5/27/2003**	**3/18/2003**	**5/27/2003**
Method CFR60 EPA 25C Mod:	**Units**											
Methane	ppm	280,000	280,000	460,000	400,000	390,000	450,000	230,000	180,000	310,000	100,000	63000
Total Non-Methane Hydocarbons as Methane	ppm	10,000	9,500	6,200	3,000	1,600	1,500	5,100	2,200	6,200	7,700	8100
Method CFR60A EPA 15/16:												
Dimethyl Sulfide	ppm	18	12	11	4.5	2.7	ND	5.2	5	7	10	6.3
Hydrogen Sulfide	ppm	ND	ND	1.8	220	160	230	ND	66	81	ND	ND
Carbonyl Sulfide	ppm	ND	ND	ND	0.47	0.43	ND	ND	0.91	0.81	ND	ND
Methyl Mercaptan	ppm	ND	ND	0.38	0.87	0.44	ND	ND	1.3	1.5	1	0.95
Ethyl Mercaptan	ppm	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ppm	0.64	0.54	ND	ND	ND	ND	ND	0.89	0.52	ND	ND
Dimethyl Disulfide	ppm	0.52	ND	ND	ND	ND	ND	ND	ND	0.22	0.84	1.1
Method CFR60 EPA 3C:												
Carbon Dioxide	%	41	41	43	37	40	37	68	19	34	24	21
Carbon Monoxide	%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methane	%	28	28	46	40	39	45	23	18	30	10	6.3
Nitrogen	%	26	27	6.9	20	15	13	11	49	31	62	68
Oxygen	%	0.83	0.21	0.26	1.9	1.5	0.66	ND	11	1.1	1.9	1.3
Method EPA-2 TO -15:												
Dichlorodifluormethane	ppb	7,900	6,400	1,400	1,300	1,200	680	17,000	3,800	2,700	1,400	ND
Chloromethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	19
1,2-Dichloro-1,1,2,2-tetrafluoroethane	ppb	ND	400	320	110	85	68	1,100	340	240	ND	ND
Vinyl Chloride	ppb	ND	950	3,600	4,000	1,200	1,200	1,200	170	180	ND	ND
Bromomethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ppb	1,100	820	550	360	170	160	780	320	380	ND	ND
Trichlorofluoromethane	ppb	620	430	280	130	92	ND	7,900	370	370	ND	ND

1,1-Dichlorethene	ppb	ND	ND	ND	ND	ND	ND	ND	440	620	580	ND
Carbon Disulfide	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloro-1,2,2-trifluoroethane	ppb	ND	ND	ND	ND	ND	ND	960	ND	ND	ND	ND
Acetone	ppb	54,000	28,000	22,000	10,000	4,300	4,300	13,000	16,000	22,000	50,000	90
Methylene Chloride	ppb	14,000	8,200	3,900	1,200	300	160	4,800	3,500	3,900	1,700	2.6
trans-1,2-Dichloroethene	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ppb	1,600	1,000	850	340	130	95	880	440	ND	ND	ND
Vinyl Acetate	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	ppb	ND	240	670	760	520	500	ND	290	310	ND	ND
2-Butanone (MEK)	ppb	38,000	28,000	29,000	9,500	3,800	3,800	6,000	23,000	23,000	28,000	78
Chloroform	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ppb	ND	ND	ND	ND	42	ND	680	ND	ND	ND	ND
Carbon Tetrachloride	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ppb	1,700	1,800	1,500	960	380	450	490	980	1,300	1,300	2.9
1,2-Dichloroethane	ppb	ND	ND	ND	ND	ND	ND	120	ND	150	220	ND
Trichloroethene	ppb	1,700	1,300	1,200	620	260	240	220	860	1,000	620	2.7
1,2-Dichloropropane	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoodichloromethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone (MIBK)	ppb	10,000	9,700	8,100	2,500	760	760	5,400	4,500	4,400	14,000	46
Toluene	ppb	31,000	26,000	25,000	19,000	8,400	8,400	3,400	21,000	22,000	20,000	130
trans-1,3-Dichloropropene	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ppb	2,300	2,200	1,600	1,000	480	470	350	1,100	1,700	1,500	13
2-Hexanone	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dibromoethane (EDB)	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ppb	2,800	3,200	3,000	3,100	1,800	1,800	170	5,100	3,600	2,300	52
Total Xylenes	ppb	9,400	11,000	9,700	9,700	5,200	5,600	480	14,000	11,000	6,500	200
Styrene	ppb	700	930	950	980	350	250(tr)	ND	890	1400	310	25
Bromoform	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

1,1,2,2-Tetrachloroethane	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl Chloride	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Ethyltoluene	ppb	ND	930	710	980	470	600	ND	590	1100	500	45
1,3,5-Trimethylbenzene	ppb	ND	290	260	390	170	210	ND	230	350	ND	15
1,2,4-Trimethylbenzene	ppb	ND	760	640	840	380	480	ND	370	750	370	47
1,3-Dichlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ppb	ND	270	190	280	66	78	ND	ND	ND	ND	21
1,2-Dichlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ppb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Footnotes:
ND=Not Detected

APPENDIX E – LEACHATE LABORATORY CHEMISTRY

Table 3-8. Field Chemistry and Analytical Results for Leachate Sampled from the Northeast Anaerobic Cell

PARAMETER	Date:	2/14/2002	3/27/2002	5/14/2002	6/20/2002	7/23/2002	8/13/2002	9/26/2002	10/17/2002	2/26/2003	5/27/2003
Field Parameters:	**Units**										
pH		7.13	7.55	7.40	7.60	7.44	7.48	7.47	7.35	8.16	7.02
Electrical Conductivity	µS	6583	6173	6095	4054	11510	15860	12440	10230	9351	11990
Oxidation Reduction Potential	mV	-119	-12	80	94	-7	43	-35	-25	160	17
Temperature	C	19.9	21.5	25.9	26.5	30.5	30.5	28.4	26.0	23.5	33.3
Dissolved Oxygen	mg/L	0.65	2.13	1.4	2.04	0.33	1.31	3.66	2.96	5.56	2.80
Total Dissolved Solids	ppm	5244	4860	4059	3062	9740	14050	10770	8640	7850	9978
General Chemistry:											
Bicarbonate Alkalinity	mg/L	1740	1550	1760	1110	3740	5150	3960	4010	2680	3280
Carbonate Alkalinity	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CO_3	mg/L	1740	1550	1760	1110	3740	5150	3960	4010	2680	3280
BOD	mg O/L	20	34	19	10	200	490	1400	3000	44	85
Chemical Oxygen Demand	mg O/L	633	488	791	196	1620	2820	2830	1810	120	1590
Chloride	mg/L	1070	1100	1030	617	1950	2830	1870	1380	1470	1670
Hydroxide	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Ammonia as N	mg/L	30	24.4	26.3	13.5	131	264	255	289	132	207
Nitrate-Nitrite as N	mg/L	<0.03	0.43	<1.5	<0.015	0.061	0.22 (tr)	1.4	<0.009	17.3	13
Total Kjeldahl Nitrogen	mg/L	53.1	71	40	21.8	201	354	326	358	222	320
Sulfate	mg/L	322	210	94.3(tr)	256	5.3	8.2(tr)	155	7	315	45.3
Total Dissolved Solids @ 180 C	mg/L	4440	3960	3700	2500	7800	9860	8000	6680	5720	7700
Total (Non-Volatile) Organic Carbon	mg/L	202	147	123	68.8	544	713	943	588	325	490
Total Phosphorus	mg/L	1.9	1.3	1.1	1.6	1.9	2.7	3.7	3.4	1.8	3.3
Total Sulfide	mg/L	1.3	0.18	1.3	0.74	1.2	2.5	1.1	1.4	0.034(tr)	0.020 (tr)
Metals:											
Dissolved Aluminum	mg/L	0.14 (tr)	<0.043	0.10(tr)	<0.043	0.097(tr)	0.11(tr)	0.058(tr)	0.096(tr)	0.063(tr)	0.099(tr)
Dissolved Antimony	mg/L	0.0022	0.0015(tr)	0.0012(tr)	0.0008(tr)	0.012	<0.031	0.0089	0.0072	0.0072	0.0057
Dissolved Arsenic	mg/L	0.029	0.026	0.028	0.037	0.054	0.062	0.058	0.062	0.043	0.06
Dissolved Barium	mg/L	0.84	0.56	0.92	0.39	1.6	1.6	2.5	1.7	0.88	1.2
Dissolved Beryllium	mg/L	<0.000078	<0.000078	<0.00078	<0.000078	<0.000078	<0.00009	<0.000078	<0.000078	<0.000078	<0.00039

Dissolved Boron	mg/L	7.9	7.1	7.4	NA	12.8	20.1	15.7	11.6	11.1	10.9
Dissolved Cadmium	mg/L	<0.000074	<0.000074	<0.000074	<0.000074	<0.000074	<0.0031	<0.000074	<0.000074	0.00018 (tr)	0.00015 (tr)
Dissolvd Calcium	mg/L	183	137	158	NA	175	92	174	221	114	89.8
Dissolved Chromium	mg/L	0.036	0.024	0.025	0.0099	0.086	0.075	0.074	0.073	0.071	0.14
Dissolved Cobalt	mg/L	0.007	0.0058	0.0049	0.0034	0.011	0.014(tr)	0.018	0.016	0.037	0.048
Dissolved Copper	mg/L	0.0054	0.004	0.002	0.0024	0.0052*	0.004 (tr)	0.0044*	0.0044	0.03*	0.016
Dissolved Iron	mg/L	1.1	0.44	0.39	0.19	2.9*	1.8	3.9	4	2.5	2.8
Dissolved Lead	mg/L	0.00046(tr)	0.00016(tr)	0.00020(tr)	<0.000066	0.001	0.0016	0.0011	0.00078 (tr)	0.0014	0.004
Dissolved Magnesium	mg/L	323	248	262	NA	535	655	480	437	359	265
Dissolved Manganese	mg/L	4.1	3.2	4.5	2.9	2	0.33	3	0.94	0.68	1.1
Dissolved Mercury	mg/L	<0.000049	<0.000049	<0.000049	<0.000049	<0.000049	0.000081(tr)*	<0.000049	<0.000049	<0.000064	<0.000064
Dissolved Molybdenum	mg/L	0.012(tr)	<0.0046	<0.0046	0.0048(tr)	0.0048 (tr)	<0.0046	<0.0046	<0.0046	0.013 (tr)	0.015 (tr)
Dissolved Nickel	mg/L	0.13	0.14	0.13	0.08	0.26	0.3	0.23	0.2	0.38	0.4
Dissolved Potassium	mg/L	152	124	133	NA	215	336	319	348	371	372
Dissolved Phosphorus	mg/L	1.9	0.96	1.9	NA	1.6	2	3.6	2.6	1.8	3.3
Dissolved Selenium	mg/L	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	<0.0017	0.0077	<0.0017	0.002	<0.0017
Dissolved Silver	mg/L	0.000083 (tr)	0.000031(tr)	<0.00003	<0.00003	0.0002(tr)	<0.0032	0.0001(tr)	0.000061 (tr)	0.000084 (tr)	0.00018 (tr)
Dissolved Sodium	mg/L	875	774	759	NA	1370	2340	1820	1330	1440*	1410
Dissolved Thallium	mg/L	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.0034	<0.00034	<0.00034	<0.00034	<0.00034
Dissolved Tin	mg/L	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	0.0062 (tr)	0.058 (tr)
Dissolved Vanadium	mg/L	0.059	0.03(tr)	0.031(tr)	0.013(tr)	0.21	0.1	0.071	0.054	0.061	0.093
Dissolved Zinc	mg/L	0.032	0.034	0.035	0.015	0.13(tr)	0.13	0.17	0.13	0.15	0.14
Volatile Organic Compounds:											
Acetone	µg/L	16	10	6.4	6.9	170*	1500 (tr)	2300	650	49	39
Acrylonitrile	µg/L	<10	<10	<10	<10	<50	<100	<1000	<200	<20	<20
Benzene	µg/L	<0.13	0.28 (tr)*	0.22(tr)	<0.13	<0.65	<1.3	<13	<2.6	0.36 (tr)	1.1 (tr)
Bromobenzene	µg/L	<0.18	<0.18	<0.18	<0.18	<0.90	NA	<18	<3.6	<0.36	<0.36
Bromochloromethane	µg/L	<0.31	<0.31	<0.31	<0.31	<1.6	<3.1	<31	<6.2	<0.62	<0.62
Bromodichloromethane	µg/L	<0.14	<0.14	<0.14	<0.14	<0.70	<1.4	<14	<2.8	<0.28	<0.28
Bromoform	µg/L	<0.10	<0.10	<0.10	<0.10	<0.50	<1.0	<10	<2.0	<0.20	<0.20
Bromomethane (Methly bromide)	µg/L	<0.08	<0.08	0.68(tr)	<0.08	6.2*	<0.80	37(tr)*	<1.6	0.96 (tr)	<0.16
2-Butanone (MEK)	µg/L	<1.0	<1.0	<1.0	1.1(tr)	240	2200	4300	1400	3.8 (tr)	<2.0
n-Butylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	NA	<12	<2.4	<0.24	<0.24

sec-Butylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	NA	<12	<2.4	<0.24	<0.24
tert-Butylbenzene	µg/L	<0.14	<0.14	<0.14	<0.14	<0.70	NA	<14	<2.8	<0.28	<0.28
Carbon Disulfide	µg/L	<1.0	<1.0	1.1(tr)	<1.0	<5.0	<10	<100	<20	<2.0	<2.0
Carbon Tetrachloride	µg/L	<0.15	<0.15	<0.15	<0.15	<0.75	<1.5	<15	<3.0	<0.30	<0.30
Chlorobenzene	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	<1.2	<12	<2.4	0.67 (tr)	1.1 (tr)
Chloroethane	µg/L	<0.34	<0.34	<0.34	<0.34	<1.7	<3.4	<34	<6.8	<0.68	26
Chloroform	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	<1.2	<12	7.5 (tr)	<0.24	<0.24
Chloromethane (Methyl chloride)	µg/L	<0.25	<0.25	<0.25	<0.25	<1.2	<2.5	<25	<5.0	1.6 (tr)	<0.50
2-Chlorotoluene	µg/L	<0.26	<0.26	<0.26	<0.26	<1.3	NA	<26	<5.2	<0.52	0.62 tr)
4-Chlorotoluene	µg/L	<0.10	<0.10	<0.10	<0.10	<0.50	NA	<10	<2.0	<0.20	<0.20
Dibromochloromethane	µg/L	<0.40	<0.40	<0.40	<0.40	<2.0	<4.0	<40	<8.0	<0.80	<0.80
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	<0.22	<0.95	<0.95	<0.95	<4.8	<9.5	<95	<19	<1.9	<1.9
1,2-Dibromoethane (EDB)	µg/L	<0.22	<0.21	<0.22	<0.22	<1.1	<2.2	<22	<4.4	<0.44	<0.44
Dibromomethane (Methly bromide)	µg/L	<0.21	<0.21	<0.21	<0.21	<1.0	<2.1	<21	<4.2	<0.42	<0.42
1,2-Dichlorobenzene	µg/L	<0.14	<0.14	<0.14	<0.14	<0.70	<1.4	<14	<2.8	<0.28	<0.28
1,3-Dichlorobenzene	µg/L	<0.11	<0.11	<0.11	<0.11	<0.55	NA	<11	<2.2	<0.22	<0.22
1,4-Dichlorobenzene	µg/L	<0.13	<0.13	<0.13	<0.13	<0.65	<1.3	<13	<2.6	<0.26	<0.26
trans-1,4-Dichloro-2-butene	µg/L	<1.0	<1.0	<1.0	<1.0	<5.0	<10	<100	<20	<2.0	<2.0
Dichlorodifluoromethane (Freon 12)	µg/L	<0.16	0.17(tr)	0.24(tr)	<0.16	<0.80	NA	<16	<3.2	<0.32	<0.32
1,1-Dichloroethane (1,1-DCA)	µg/L	0.77(tr)	0.50(tr)	0.77(tr)	0.54(tr)	<0.50	<1.0	<10	<2.0	0.36 (tr)	0.55 (tr)
1,2-Dichloroethane (1,2-DCA)	µg/L	<0.22	<0.22	<0.22	<0.22	<1.1	<2.2	<22	<4.4	<0.44	<0.44
1,1-Dichloroethene (1,1-DCE)	µg/L	<0.36	<0.36	<0.36	<0.36	<1.8	<3.6	<36	<7.2	<0.72	<0.72
cis-1,2-Dichloroethene (cis-1,2-DCE)	µg/L	0.58(tr)	1.2	1.8	1.5	2.3(tr)	1.8(tr)	<10	<2.0	<0.20	0.85 (tr)
trans-1,2-Dichloroethene (trans-1,2-DCE)	µg/L	<0.11	<0.11	<0.11	<0.11	<0.55	<1.1	<11	<2.2	<0.22	<0.22
1,2-Dichloropropane	µg/L	<0.15	<0.15	<0.15	<0.15	<0.75	<1.5	<15	<3.0	<0.30	<0.30
1,3-Dichloropropane	µg/L	<0.20	<0.20	<0.20	<0.20	<1.0	NA	<20	<4.0	<0.40	<0.40
2,2 Dichloropropane	µg/L	<0.13	<0.13	<0.13	<0.13	<0.65	NA	<13	<2.6	<0.26	<0.26

1,1-Dichloropropene	µg/L	<0.14	<0.14	<0.14	<0.14	<0.70	NA	<14	<2.8	<0.28	<0.28
cis-1,3-Dichloropropene	µg/L	<0.22	<0.22	<0.22	<0.22	<1.1	<2.2	<22	<4.4	<0.44	<0.44
trans-1,3-Dichloropropene	µg/L	<0.30	<0.30	<0.30	<0.30	<1.5	<3.0	<30	<6.0	<0.60	<0.60
Ethylbenzene	µg/L	<0.27	<0.27	<0.27	<0.27	<1.4	<2.7	<27	<5.4	<0.54	<0.54
Hexachlorobutadiene	µg/L	<0.22	<0.22	<0.22	<0.22	<1.1	NA	<22	<4.4	<0.44	<0.44
2-Hexanone (Methyl butyl ketone)	µg/L	<1.0	<1.0	<1.0	<1.0	<5.0	26	<100	<20	<2.0	<2.0
Iodomethane (Methyl iodide)	µg/L	<1.0	<1.0	<1.0	<1.0	<5.0	<10	<100	<20	<2.0	<2.0
Isopropylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	NA	<12	<2.4	0.43 (tr)	1.0 (tr)
p-Isopropyltoluene	µg/L	<0.13	<0.13	0.13(tr)	<0.13	<0.65	NA	<13	<2.6	<0.26	0.88 (tr)
Methyl-tert-butyl ether (MTBE)	µg/L	14	10	16	6.3	44	76	150(tr)	110	8.7	10
4-Methyl-2-pentanone (MIBK)	µg/L	2	<1.0	<1.0	<1.0	100	520	1000	700	<2.0	<2.0
Methylene Chloride	µg/L	1.5	<0.35	0.46(tr)	<0.35	<1.8	<3.5	<35	<7.0	<0.70	<0.70
Naphthalene	µg/L	<0.15	0.45(tr)*	<0.15	<0.15	<0.75	NA	<15	<3.0	<0.30	0.77 (tr)
n-Propylbenzene	µg/L	<0.15	<0.15	<0.15	<0.15	<0.75	NA	<15	<3.0	<0.30	<0.30
Styrene	µg/L	<0.15	<0.15	<0.15	<0.15	<0.75	<30	<15	<3.0	<0.30	<0.30
1,1,1,2-Tetrachloroethane	µg/L	<0.10	<0.10	<0.10	<0.10	<0.50	<20	<10	<2.0	<0.20	<0.20
1,1,2,2-Tetrachloroethane	µg/L	<0.37	<0.37	<0.37	<0.37	<1.8	<74	<37	<7.4	<0.74	<0.74
Tetrachloroethene (PCE)	µg/L	<0.38	0.84(tr)	<0.38	<0.38	<1.9	<76	<38	<7.6	<0.76	<0.76
Toluene	µg/L	1.3*	0.98(tr)	2.9	0.44(tr)	8.3	<50	<25	24	<0.50	1.0 (tr)
1,2,3-Trichlorobenzene	µg/L	<0.14	<0.14	<0.14	<0.14	<0.70	NA	<14	<2.8	<0.28	<0.28
1,2,4-Trichlorobenzene	µg/L	<0.23	<0.23	<0.23	<0.23	<1.2	NA	<23	<4.6	<0.46	<0.46
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	<0.41	<0.41	<0.41	<0.41	<2.0	<82	<41	<8.2	<0.82	<0.82
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	<0.31	<0.31	<0.31	<0.31	<1.6	<62	<31	<6.2	<0.62	<0.62
Trichloroethene (TCE)	µg/L	0.33(tr)	0.77(tr)	<0.31	0.46(tr)	<1.6	<62	<31	<6.2	<0.62	<0.62
Trichlorofluoromethane (Freon 11)	µg/L	<0.23	<0.23	<0.23	<0.23	<1.2	<46	<23	<4.6	<0.46	<0.46
1,2,3-Trichloropropane	µg/L	<0.30	<0.30	<0.30	<0.30	<1.5	<60	<30	<6.0	<0.60	<0.60
1,2,4-Trimethylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12	<0.60	NA	<12	<2.4	<0.24	<0.24
1,3,5-Trimethylbenzene	µg/L	<0.14	0.27(tr)	<0.14	<0.14	<0.70	NA	<14	<2.8	<0.28	<0.28
Vinyl Acetate	µg/L	<1.0	<1.0	<1.0	<1.0	<5.0	<200	<100	<20	<2.0	<2.0

Vinyl Chloride	µg/L	<0.12	<0.12	0.30(tr)	<0.12	<0.60	<24	<12	<2.4	<0.24	<0.24
Total Xylenes	µg/L	<0.10	0.13 (tr)	0.30(tr)	<0.10	<0.50	<20	<10	2.5 (tr)	<0.20	0.46 (tr)

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 4-6. Analytical Results for Leachate Sampled from the West-Side Anaerobic Cell

PARAMETER	DATE:	2/14/2002	3/27/2002	5/14/2002	6/20/2002	7/23/2002	8/13/2002	2/26/2003	5/29/2003	6/26/2003
Field Parameters:	**Units**									
pH		6.74	6.76	6.8	6.72	6.85	6.71	6.87	6.72	6.66
Electrical Conductivity	µS	3530	3868	3851	3944	3899	3810	2320	2687	3056
Oxidation Reduction Potential	mV	-62	-59	-46	-19	-38	-36	-56	-33	-75
Temperature	C	24.9	25.9	26.2	25.2	25.7	26.9	22.1	29.3	30.4
Dissolved Oxygen	mg/L	3.15	1.09	1.54	1.31	3.62	2.6	3.18	1.06	1.55
Total Dissolved Solids	ppm	2617	2886	2871	2960	2965	2908	1703	1933	2227
General Chemistry:										
Bicarbonate Alkalinity	mg/L	1700	1790	1780	1730	1710	1680	1000	1070	1210
Carbonate Alkalinity	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total Alkalinity as CO_3	mg/L	1700	1790	1780	1730	1710	1680	1000	1070	1210
BOD	mg O/L	28	18	12	12	7.9	12	16	11	<6.0
Chemical Oxygen Demand	mg O/L	350	317	300	274	270	262	98.1	82.5	102
Chloride	mg/L	187	323	333	358	341	366	196	263	345
Hydroxide	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Ammonia as N	mg/L	20.3	20	23.5	21.2	23.8	25	9.5	10.3	13.7
Nitrate-Nitrite as N	mg/L	0.016(tr)	<0.015	<1.5	<0.03	<0.015	<0.015	0.022 (tr)	<0.18	<0.09
Total Kjeldahl Nitrogen	mg/L	32.6	68.9	31.1	31.5	31.4	31	13.8	15.7	19.1
Sulfate	mg/L	1.7(tr)	1.5(tr)	<10	0.80(tr)	2.2	0.75(tr)	<0.70	3.4 (tr)	<0.28
Total Dissolved Solids @ 180 C	mg/L	2220	2380	2320	2410	2310	2280	1320	1480	1700
Total (Non-Volatile) Organic Carbon	mg/L	112	95.7	85.2	86.5	82.7	78.1	28.3	25.5	37.9
Total Phosphorus	mg/L	0.13	1.6*	1.1	0.6	0.057	0.049(tr)	<0.12	<0.12	<0.12
Total Sulfide	mg/L	0.033(tr)	0.015(tr)	<0.014	<0.014	0.023 (tr)	<0.014	<0.0093	<0.0093	<0.0093
Metals:										
Dissolved Aluminum	mg/L	0.13(tr)	<0.043	0.053(tr)*	<0.043	<0.043	<0.043	<0.043	<0.043	<0.043
Dissolved Antimony	mg/L	0.0013(tr)	0.00091(tr)	0.00065(tr)	0.0006 (tr)	0.0008(tr)	<0.031	0.00090 (tr)	0.00074 (tr)	0.00036 (tr)
Dissolved Arsenic	mg/L	0.27	0.02	0.018	0.019	0.017	0.01	0.012	0.012	0.0028
Dissolved Barium	mg/L	1.8	1.8	0.45	1.8	1.6	1.4	1.1	1	1.3
Dissolved Beryllium	mg/L	<0.000078	<0.000078	<0.000078	<0.000078	<0.000078	<0.00009	<0.000078	<0.00039	<0.000078

Dissolved Boron	mg/L	3.2	3.5	18.9	NA	3.7	3.2	<0.000078	3.6	4.2
Dissolved Cadmium	mg/L	<0.000074	<0.000074	<0.000074	<0.000074	<0.000074	<0.0031	<0.000074	<0.000074	<0.000074
Dissolvd Calcium	mg/L	241	234	58.2	NA	231	193	108	115	131
Dissolved Chromium	mg/L	0.0088	0.0069	0.0064	0.0059	0.0054	0.0035(tr)	0.0019 (tr)	0.0033	0.0021
Dissolved Cobalt	mg/L	0.0038	0.0043	0.003	0.0025	0.0025	<0.0074	0.0015	0.0039 (tr)	0.0021
Dissolved Copper	mg/L	0.0018(tr)	0.0022	0.0011(tr)*	0.002	0.0023	0.0035(tr)	0.002*	0.0018 (tr)	0.0035
Dissolved Iron	mg/L	0.4	1.2	0.035(tr)*	1.9	0.59	0.11	0.15	0.11	0.064 (tr)
Dissolved Lead	mg/L	0.00024 (tr)	0.000066(tr)	0.000078(tr)*	<0.000066	<0.000066	<0.000066	<0.000066	0.00026 (tr)	<0.000066
Dissolved Magnesium	mg/L	198	211	343	NA	217	185	123	143	162
Dissolved Manganese	mg/L	24.6	22.9	0.0062(tr)	21.4	19.3	15.9	10.9	9.8	11.3
Dissolved Mercury	mg/L	<0.000049	<0.000049	<0.000049	<0.000049	<0.000049	0.000078(tr)*	<0.000064	0.000083 (tr)	<0.000064
Dissolved Molybdenum	mg/L	<0.0046	<0.0046	0.044	<0.0046	<0.0046	<0.0046	<0.0046	0.0084 (tr)	<0.0046
Dissolved Nickel	mg/L	0.042	0.053	0.052	0.047	0.046	0.041	0.018	0.026	0.027
Dissolved Potassium	mg/L	55.2	48.3	58.6	NA	37.8	32.5	23.7	20.1	23.8
Dissolved Phosphorus	mg/L	0.28(tr)	0.14(tr)	1	NA	<0.12	<0.12	<0.12	<0.12	<0.12
Dissolved Selenium	mg/L	<0.0017	<0.0017	<0.0017	<0.0017	0.002	<0.0017	<0.0017	<0.0017	<0.0017
Dissolved Silver	mg/L	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.0032	<0.000030	<0.000030	<0.000030
Dissolved Sodium	mg/L	260	281	1500*	NA	268	234	226	266	282
Dissolved Thallium	mg/L	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034	<0.00034
Dissolved Tin	mg/L	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	<0.0014	0.048 (tr)	0.023 (tr)
Dissolved Vanadium	mg/L	0.0056(tr)	0.0038(tr)	0.017(tr)	<0.0032	<0.0032	<0.0032	<0.0032	<0.0032	<0.0032
Dissolved Zinc	mg/L	0.068	0.07	0.039	0.037	0.05	0.006(tr)	0.042	0.042	0.043
Volatile Organic Compounds:										
Acetone	µg/L	<50	28	22	22	14(tr)*	33 (tr)	13 (tr)	33 (tr)	15 (tr)
Acrylonitrile	µg/L	<500	<100	<100	<100	<50	<100	<50	<50	<50
Benzene	µg/L	<6.5	3.3(tr)*	2.3(tr)	<1.3	3.5(tr)	3.6(tr)	2.6 (tr)	2.4 (tr)	3.2 (tr)
Bromobenzene	µg/L	<9.0	<1.8	<1.8	<1.8	<0.90	NA	<0.90	<0.90	<0.90
Bromochloromethane	µg/L	<16	<3.1	<3.1	<3.1	<1.6	<3.1	<1.6	<1.6	<1.6
Bromodichloromethane	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	<1.4	<0.70	<0.70	<0.70
Bromoform	µg/L	<5.0	<1.0	<1.0	<1.0	<0.50	<1.0	<0.50	<0.50	<0.50
Bromomethane (Methly bromide)	µg/L	<4.0	<0.80	<0.80	<0.80	4.6(tr)*	<0.80	<0.40	<0.40	<0.40
2-Butanone (MEK)	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0
n-Butylbenzene	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	NA	<0.60	<0.60	<0.60
sec-Butylbenzene	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	NA	<0.60	<0.60	<0.60

tert-Butylbenzene	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	NA	<0.70	<0.70	<0.70
Carbon Disulfide	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0
Carbon Tetrachloride	µg/L	<7.5	<1.5	<1.5	<1.5	<0.75	<1.5	<0.75	<0.75	<0.75
Chlorobenzene	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	<1.2	<0.60	<0.60	<0.60
Chloroethane	µg/L	<17	<3.4	<3.4	<3.4	<1.7	<3.4	3.1 (tr)	<1.7	2.8 (tr)
Chloroform	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	<1.2	<0.60	<0.60	<0.60
Chloromethane (Methyl chloride)	µg/L	<12	<2.5	<2.5	<2.5	<1.2	<2.5	<1.2	<1.2	<1.2
2-Chlorotoluene	µg/L	<13	<2.6	<2.6	<2.6	<1.3	NA	<1.3	<1.3	<1.3
4-Chlorotoluene	µg/L	<5.0	<1.0	<1.0	<1.0	<0.50	NA	<0.50	<0.50	<0.50
Dibromochloromethane	µg/L	<20	<4.0	<4.0	<4.0	<2.0	<4.0	<2.0	<2.0	<2.0
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	<48	<9.5	<9.5	<9.5	<4.8	<9.5	<4.8	<4.8	<4.8
1,2-Dibromoethane (EDB)	µg/L	<11	<2.2	<2.2	<2.2	<1.1	<2.2	<1.1	<1.1	<1.1
Dibromomethane (Methly bromide)	µg/L	<10	<2.1	<2.1	<2.1	<1.0	<2.1	<1.0	<1.0	<1.0
1,2-Dichlorobenzene	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	<1.4	<0.70	<0.70	<0.70
1,3-Dichlorobenzene	µg/L	<5.5	<1.1	<1.1	<1.1	<0.55	NA	<0.55	<0.55	<0.55
1,4-Dichlorobenzene	µg/L	<6.5	<1.3	<1.3	<1.3	<0.65	<1.3	<0.65	<0.65	<0.65
trans-1,4-Dichloro-2-butene	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0
Dichlorodifluoromethane (Freon 12)	µg/L	<8.0	2.4(tr)	4.2(tr)	<1.6	16	NA	<0.80	<0.80	<0.80
1,1-Dichloroethane (1,1-DCA)	µg/L	<5.0	4.6(tr)	7.4(tr)	9.5(tr)	12	13	1.5 (tr)	2.9 (tr)	3.0 (tr)
1,2-Dichloroethane (1,2-DCA)	µg/L	<11	2.5(tr)	3.5(tr)	4.0 (tr)	4.8(tr)	5.8(tr)	4.0 (tr)	5.5	5.9
1,1-Dichloroethene (1,1-DCE)	ug/L	<18	<3.6	<3.6	<3.6	<1.8	<3.6	<1.8	<1.8	<1.8
cis-1,2-Dichloroethene (cis-1,2-DCE)	µg/L	<5.0	2.3(tr)	1.9(tr)	<1.0	3.3(tr)	3.5(tr)	3.7 (tr)	2.5 (tr)	2.6 (tr)
trans-1,2-Dichloroethene (trans-1,2-DCE)	µg/L	<5.5	<1.1	<1.1	<1.1	<0.55	<1.1	<0.55	<0.55	<0.55
1,2-Dichloropropane	µg/L	<7.5	<1.5	<1.5	<1.5	<0.75	<1.5	<0.75	<0.75	<0.75
1,3-Dichloropropane	µg/L	<10	<2.0	<2.0	<2.0	<1.0	NA	<1.0	<1.0	<1.0
2,2 Dichloropropane	µg/L	<6.5	<1.3	<1.3	<1.3	<0.65	NA	<0.65	<0.65	<0.65
1,1-Dichloropropene	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	NA	<0.70	<0.70	<0.70
cis-1,3-Dichloropropene	µg/L	<11	<2.2	<2.2	<2.2	<1.1	<2.2	<1.1	<1.1	<1.1
trans-1,3-Dichloropropene	µg/L	<15	<3.0	<3.0	<3.0	<1.5	<3.0	<1.5	<1.5	<1.5
Ethylbenzene	µg/L	<14	<2.7	<2.7	<2.7	<1.4	<2.7	1.4 (tr)	1.4 (tr)	1.5 (tr)
Hexachlorobutadiene	µg/L	<11	<2.2	<2.2	<2.2	<1.1	NA	<1.1	<1.1	<1.1

2-Hexanone (Methyl butyl ketone)	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0
Iodomethane (Methyl iodide)	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0
Isopropylbenzene	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	NA	<0.60	<0.60	<0.60
p-Isopropyltoluene	µg/L	<6.5	<1.3	<1.3	<1.3	<0.65	NA	<0.65	<0.65	<0.65
Methyl-tert-butyl ether (MTBE)	µg/L	210	190	160	160	180	170	110	90	130
4-Methyl-2-pentanone (MIBK)	µg/L	1200	19(tr)	52	<10	<5.0	26	7.1 (tr)	7.7 (tr)	<5.0
Methylene Chloride	µg/L	<18	<3.5	<3.5	<3.5	2.1(tr)	<3.5	<1.8	<1.8	2.3 (tr)
Naphthalene	µg/L	<7.5	<1.5	<1.5	<1.5	<0.75	NA	<0.75	<0.75	<0.75
n-Propylbenzene	µg/L	<7.5	<1.5	<1.5	<1.5	<0.75	NA	<0.75	<0.75	<0.75
Styrene	µg/L	<7.5	<1.5	<1.5	<1.5	<0.75	<1.5	<0.75	<0.75	<0.75
1,1,1,2-Tetrachloroethane	µg/L	<5.0	<1.0	<1.0	<1.0	<0.50	<1.0	<0.50	<0.50	<0.50
1,1,2,2-Tetrachloroethane	µg/L	<18	<3.7	<3.7	<3.7	<1.8	<3.7	<1.8	<1.8	<1.8
Tetrachloroethene (PCE)	µg/L	<19	<3.8	<3.8	<3.8	<1.9	NA	<1.9	<1.9	<1.9
Toluene	µg/L	150*	42	20	22	22	20	14	7.6	6.6
1,2,3-Trichlorobenzene	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	NA	<0.70	<0.70	<0.70
1,2,4-Trichlorobenzene	µg/L	<12	<2.3	<2.3	<2.3	<1.2	NA	<1.2	<1.2	<1.2
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	<20	<4.1	<4.1	<4.1	<2.0	<4.1	<2.0	<2.0	<2.0
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	<16	<3.1	<3.1	<3.1	<1.6	<3.1	<1.6	<1.6	<1.6
Trichloroethene (TCE)	µg/L	<16	<3.1	<3.1	<3.1	<1.6	<3.1	<1.6	<1.6	<1.6
Trichlorofluoromethane (Freon 11)	µg/L	<12	<2.3	2.7(tr)	<2.3	<1.2	<2.3	<1.2	<1.2	<1.2
1,2,3-Trichloropropane	µg/L	<15	<3.0	<3.0	<3.0	<1.5	<3.0	<1.5	<1.5	<1.5
1,2,4-Trimethylbenzene	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	NA	<0.60	<0.60	<0.60
1,3,5-Trimethylbenzene	µg/L	<7.0	<1.4	<1.4	<1.4	<0.70	NA	<0.70	<0.70	<0.70
Vinyl Acetate	µg/L	<50	<10	<10	<10	<5.0	<10	<5.0	<5.0	<5.0
Vinyl Chloride	µg/L	<6.0	<1.2	<1.2	<1.2	<0.60	<1.2	2.3 (tr)	<0.60	3.3 (tr)
Total Xylenes	µg/L	<5.0	4.0(tr)	3.8(tr)	<1.0	3.4(tr)	4.0(tr)	2.8 (tr)	2.1 (tr)	2.4 (tr)

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 5-7. Analytical Results for Leachate Sampled form the Aerobic Cell Manhole

PARAMETER	DATE:	2/26/2002	3/27/2002	5/14/2002	5/29/2003
Field Parameters:	**Units**				
pH		7.75	8.17	8.48	8.48
Electrical Conductivity	µS	7026	7705	9048	9426
Oxidation Reduction Potential	mV	195	195	127	201
Temperature	C	15.1	15.2	21.1	27.9
Dissolved Oxygen	mg/L	5.45	5.73	6.8	1.67
Total Dissolved Solids	ppm	5673	NA	7448	7686
General Chemistry:					
Bicarbonate Alkalinity	mg/L	1120	935	1020	1480
Carbonate Alkalinity	mg/L	NA	<5.0	24.8	34.6
Total Alkalinity as CO_3	mg/L	1120	935	1050	1510
BOD	mg O/L	3.3	5	89	35
Chemical Oxygen Demand	mg O/L	595	563	602	818
Chloride	mg/L	1610	1800	2290	1740
Hydroxide	mg/L	<5.0	<5.0	<5.0	<5.0
Ammonia as N	mg/L	2.8	1.1	0.60(tr)	36
Nitrate-Nitrite as N	mg/L	0.16	0.22	4.8(tr)	4.8
Total Kjeldahl Nitrogen	mg/L	19.9	19.2	11.1	69.1
Sulfate	mg/L	290	478	526	544
Total Dissolved Solids @ 180 C	mg/L	4810	5200	5640	6330
Total (Non-Volatile) Organic Carbon	mg/L	766	149	168	215
Total Phosphorus	mg/L	0.51	0.19	0.85*	1.2
Total Sulfide	mg/L	<0.014	0.015(tr)	<0.014	<0.0093
Metals:					
Dissolved Aluminum	mg/L	<0.043	<0.043	0.082(tr)*	<0.043
Dissolved Antimony	mg/L	0.002	0.0016(tr)	0.002	0.0037
Dissolved Arsenic	mg/L	0.012	0.015	0.017	0.027
Dissolved Barium	mg/L	0.43	0.54	1.9	0.54
Dissolved Beryllium	mg/L	<0.000078	<0.000078	<0.000078	<0.00039
Dissolved Boron	mg/L	NA	12.2	3.8	14.3
Dissolved Cadmium	mg/L	0.00013(tr)	0.00016(tr)	0.0062	0.00017 (tr)
Dissolvd Calcium	mg/L	NA	57	257	46
Dissolved Chromium	mg/L	0.01	0.0062	0.0062	0.046
Dissolved Cobalt	mg/L	0.0095	0.0073	0.004	0.014
Dissolved Copper	mg/L	0.016	0.014	0.019	0.0090 (tr)
Dissolved Iron	mg/L	0.32	0.084(tr)	0.34	0.81
Dissolved Lead	mg/L	0.00026(tr)	<0.000066	0.00061(tr)	0.0017
Dissolved Magnesium	mg/L	273	260	220	401
Dissolved Manganese	mg/L	1.1	0.77	23.9	0.29
Dissolved Mercury	mg/L	<0.000049	0.000059	0.000074(tr)	<0.000064
Dissolved Molybdenum	mg/L	0.026(tr)	0.033(tr)	<0.0046	0.024 (tr)
Dissolved Nickel	mg/L	0.14	0.11	0.11	0.12
Dissolved Potassium	mg/L	NA	66.1	47.8	165
Dissolved Phosphorus	mg/L	NA	0.47	<0.312	1.2
Dissolved Selenium	mg/L	<0.0085	0.0034	0.0053	0.0038
Dissolved Silver	mg/L	<0.00003	<0.00003	<0.00003	0.000043 (tr)

Dissolved Sodium	mg/L	NA	1260	284	1430
Dissolved Thallium	mg/L	<0.00034	<0.00034	<0.00034	<0.00034
Dissolved Tin	mg/L	<0.022	<0.022	<0.022	0.042 (tr)
Dissolved Vanadium	mg/L	0.023(tr)	0.018(tr)	<0.0032	0.033 (tr)
Dissolved Zinc	mg/L	0.027*	0.032	0.018	0.057
Volatile Organic Compounds:					
Acetone	µg/L	12	23	8.8	59
Acrylonitrile	µg/L	<10	<10	<10	<10
Benzene	µg/L	0.43(tr)*	0.27(tr)*	0.17(tr)	0.88 (tr)
Bromobenzene	µg/L	<0.18	<0.18	<0.18	<0.18
Bromochloromethane	µg/L	<0.31	<0.31	<0.31	<0.31
Bromodichloromethane	µg/L	<0.14	<0.14	<0.14	<0.14
Bromoform	µg/L	<0.10	<0.10	<0.10	<0.10
Bromomethane (Methly bromide)	µg/L	<0.08	<0.08	0.23(tr)	0.72 (tr)
2-Butanone (MEK)	µg/L	2.5	<1.0	<0.12	5
n-Butylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12
sec-Butylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12
tert-Butylbenzene	µg/L	<0.14	<0.14	<0.14	<0.14
Carbon Disulfide	µg/L	<1.0	<1.0	<1.0	<1.0
Carbon Tetrachloride	µg/L	<0.15	<0.15	<0.15	<0.15
Chlorobenzene	µg/L	2	2.8	0.23(tr)	4.8
Chloroethane	µg/L	<0.34	<0.34	<0.34	<0.34
Chloroform	µg/L	<0.12	<0.12	<0.12	<0.12
Chloromethane (Methyl chloride)	µg/L	<0.25	0.46(tr)	0.33(tr)	3.9
2-Chlorotoluene	µg/L	<0.26	0.31(tr)	<0.26	<0.26
4-Chlorotoluene	µg/L	<0.10	<0.10	<0.10	<0.10
Dibromochloromethane	µg/L	<0.40	<0.40	<0.40	<0.40
1,2-Dibromo-3-chloropropane (DBCP)	µg/L	<0.95	<0.95	<0.95	<0.95
1,2-Dibromoethane (EDB)	µg/L	<0.22	<0.22	<0.22	<0.22
Dibromomethane (Methly bromide)	µg/L	<0.21	<0.21	<0.21	<0.21
1,2-Dichlorobenzene	µg/L	<0.14	<0.14	<0.14	<0.14
1,3-Dichlorobenzene	µg/L	<0.11	<0.11	<0.11	<0.11
1,4-Dichlorobenzene	µg/L	<0.13	<0.13	<0.13	<0.13
trans-1,4-Dichloro-2-butene	µg/L	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane (Freon 12)	µg/L	0.27(tr)	<0.16	<1.0	<0.16
1,1-Dichloroethane (1,1-DCA)	µg/L	0.32(tr)	0.16(tr)	<0.10	<0.10
1,2-Dichloroethane (1,2-DCA)	µg/L	<0.22	<0.22	<0.22	<0.22
1,1-Dichloroethene (1,1-DCE)	µg/L	<0.36	<0.36	<0.36	<0.36
cis-1,2-Dichloroethene (cis-1,2-DCE)	µg/L	0.38(tr)	0.20(tr)	<0.10	<0.10
trans-1,2-Dichloroethene (trans-1,2-DCE)	µg/L	<0.11	<0.11	<0.11	<0.11
1,2-Dichloropropane	µg/L	<0.15	<0.15	<0.15	<0.15
1,3-Dichloropropane	µg/L	<0.20	<0.20	<0.20	<0.20
2,2 Dichloropropane	µg/L	<0.13	<0.13	<0.13	<0.13
1,1-Dichloropropene	µg/L	<0.14	<0.14	<0.14	<0.14
cis-1,3-Dichloropropene	µg/L	0.38(tr)	<0.22	<0.22	<0.22

trans-1,3-Dichloropropene	µg/L	<0.30	<0.30	<0.30	<0.30
Ethylbenzene	µg/L	<0.27	<0.27	<0.27	<0.27
Hexachlorobutadiene	µg/L	<0.22	<0.22	<0.22	<0.22
2-Hexanone (Methyl butyl ketone)	µg/L	<1.0	<1.0	<1.0	<1.0
Iodomethane (Methyl iodide)	µg/L	<1.0	<1.0	<1.0	<1.0
Isopropylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12
p-Isopropyltoluene	µg/L	<0.13	<0.13	<0.13	<0.13
Methyl-tert-butyl ether (MTBE)	µg/L	3	<1.0	1.3(tr)	<1.0
4-Methyl-2-pentanone (MIBK)	µg/L	3.8	<1.0	3.3	1.7 (tr)
Methylene Chloride	µg/L	0.35(tr)	<0.35	<0.35	<0.35
Naphthalene	µg/L	<0.15	<0.15	<0.15	<0.15
n-Propylbenzene	µg/L	<0.15	<0.15	<0.15	<0.15
Styrene	µg/L	<0.15	<0.15	<0.15	<0.15
1,1,1,2-Tetrachloroethane	µg/L	<0.10	<0.10	<0.10	<0.10
1,1,2,2-Tetrachloroethane	µg/L	<0.37	<0.37	<0.37	<0.37
Tetrachloroethene (PCE)	µg/L	0.67(tr)	0.60(tr)	0.88(tr)	<0.38
Toluene	µg/L	0.35(tr)	0.27(tr)*	<0.25	<0.25
1,2,3-Trichlorobenzene	µg/L	<0.14	<0.14	<0.14	<0.14
1,2,4-Trichlorobenzene	µg/L	<0.23	<0.23	<0.23	<0.23
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	<0.41	<0.41	<0.41	<0.41
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	<0.31	<0.31	<0.31	<0.31
Trichloroethene (TCE)	µg/L	1.6	0.83(tr)	<0.31	<0.31
Trichlorofluoromethane (Freon 11)	µg/L	<0.23	<0.23	<0.23	<0.23
1,2,3-Trichloropropane	µg/L	<0.30	<0.30	<0.30	<0.30
1,2,4-Trimethylbenzene	µg/L	<0.12	<0.12	<0.12	<0.12
1,3,5-Trimethylbenzene	µg/L	<0.14	<0.14	<0.14	<0.14
Vinyl Acetate	µg/L	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride	µg/L	<0.12	<0.12	<0.12	<0.12
Total Xylenes	µg/L	0.34(tr)	0.10(tr)	<0.10	1.2

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