

Comparative Study of Domestic Water Well Integrity to Coal Mine Blasting Summary Report

Prepared for

**Office of Surface Mining
Reclamation and Enforcement
Pittsburgh, Pennsylvania**

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Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 • Albuquerque, New Mexico 87109



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1. Introduction

The Appalachian coal region in the southeastern portion of the United States has been an important source of coal since it was first mined in the mid-1800s. Even after extensive mining, this region today still accounts for approximately 40 percent of total U.S. coal production (USGS, 1999). Surface coal mining is an important economic resource for residents of the Appalachian region and an important source of energy for the United States. However, many people living close to active mining operations believe that mining activities, such as blasting to remove overburden, adversely affect their well's yield and water quality.

To date, few studies have been performed looking at the possible effects of mining on domestic well water quality and quantity. Accordingly, the Office of Surface Mining Reclamation and Enforcement (OSMRE) contracted with Daniel B. Stephens & Associates, Inc. (DBS&A) to design and initiate a long-term study to investigate whether coal mining operations located close to domestic wells have caused or will contribute to the loss, diminution, or degradation of groundwater supplies and/or negatively affect domestic wells and their ability to supply water. The scope of work for this study included:

- Selecting suitable sites
- Equipping the selected wells with monitoring instruments
- Collecting data during an initial monitoring period
- Training state employees to collect monitoring data during the study

To ascertain the induced effects of blasting and pumping vibrations from nearby coal mining sites on domestic well integrity, water quality/chemistry, and well yield, DBS&A designed and initiated a quarterly monitoring program for domestic wells located near active mining operations in a tri-state (Virginia, West Virginia, and Kentucky) area. Following a discussion of groundwater conditions in the study areas (Section 2), this report describes the monitoring program, including site selection and descriptions (Section 3) and monitoring methods used (Section 4). The results obtained over the year of monitoring are discussed in Section 5.



2. Occurrence of Groundwater

Groundwater in Appalachian coal country is obtained from sedimentary rocks, glacial deposits, and alluvial fill. Most of the groundwater found in the sedimentary, coal-bearing rocks occurs in nearly vertical fractures and joints and along bedding planes. Some of these fractures are undoubtedly tectonic in origin and exhibit a regional pattern, but most of the fractures are more localized in nature and are the result of lateral stress relief associated with natural topographic development. The fractures tend to form networks that exhibit some of the characteristics of a water table aquifer, including:

- Water levels that respond to rainfall within 24 hours
- Water levels that do not respond to changes in atmospheric pressure
- Pumping rates (during pump tests) that decrease as the drawdown increases even though the power supply remains constant

A fracture system may not have a large lateral extent, but may form small sub-systems. In a study looking at blasting effects on groundwater supplies in Appalachia, Robertson et al. (1980) found that during pump tests, wells located 35 to 65 feet from the pumped wells exhibited more drawdown than observation wells only 10 feet away, while in other wells, no response to pumping was observed.

Coal-bearing strata found throughout the Pennsylvanian and Permian strata are very brittle and have a low tensile strength and, therefore, extensive vertical fracturing. Coal seams may act as conduits through which water from the overlying units can move downward to deeper units (Robertson et al., 1980). Groundwater is often associated with coal seams because (1) the high degree of fracturing in these strata increases the chances that water will move vertically from the surface to depth and (2) coal seams are often underlain by low-permeability plastic clays, causing groundwater to perch in the coal strata.



Wells constructed in Appalachia for industrial and municipal purposes may provide large yields, but domestic wells commonly have yields of 1 gallon per minute or less. This is due to many factors, including:

- Well locations selected based on convenience of access and proximity to the residential dwelling it will serve rather than sound geologic evidence
- Poor design, construction, and completion
- Inadequate formation transmissivity
- Inadequate well maintenance

Wells in the hollow valleys generally produce more water than those located near the tops of the hill. This is because the water table tends to mimic local topography, with recharge areas at the high points and groundwater moving toward discharge points in the valley (Robertson et al., 1980).

Groundwater in Appalachia tends to be high in manganese and iron and often exceeds regulatory limits for turbidity. Often, water in wells has higher dissolved oxygen than formation water, resulting in a reddish tint as ferrous iron is oxidized in the well. Iron-consuming bacteria may also be found in well water and, if so, contribute to the reddish color and unpleasant odor. The pH of the groundwater is relatively neutral, ranging between 6 and 8 (Robertson et al., 1980).



3. Site Selection and Descriptions

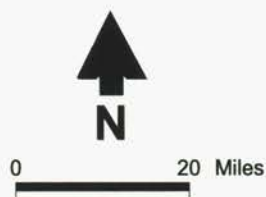
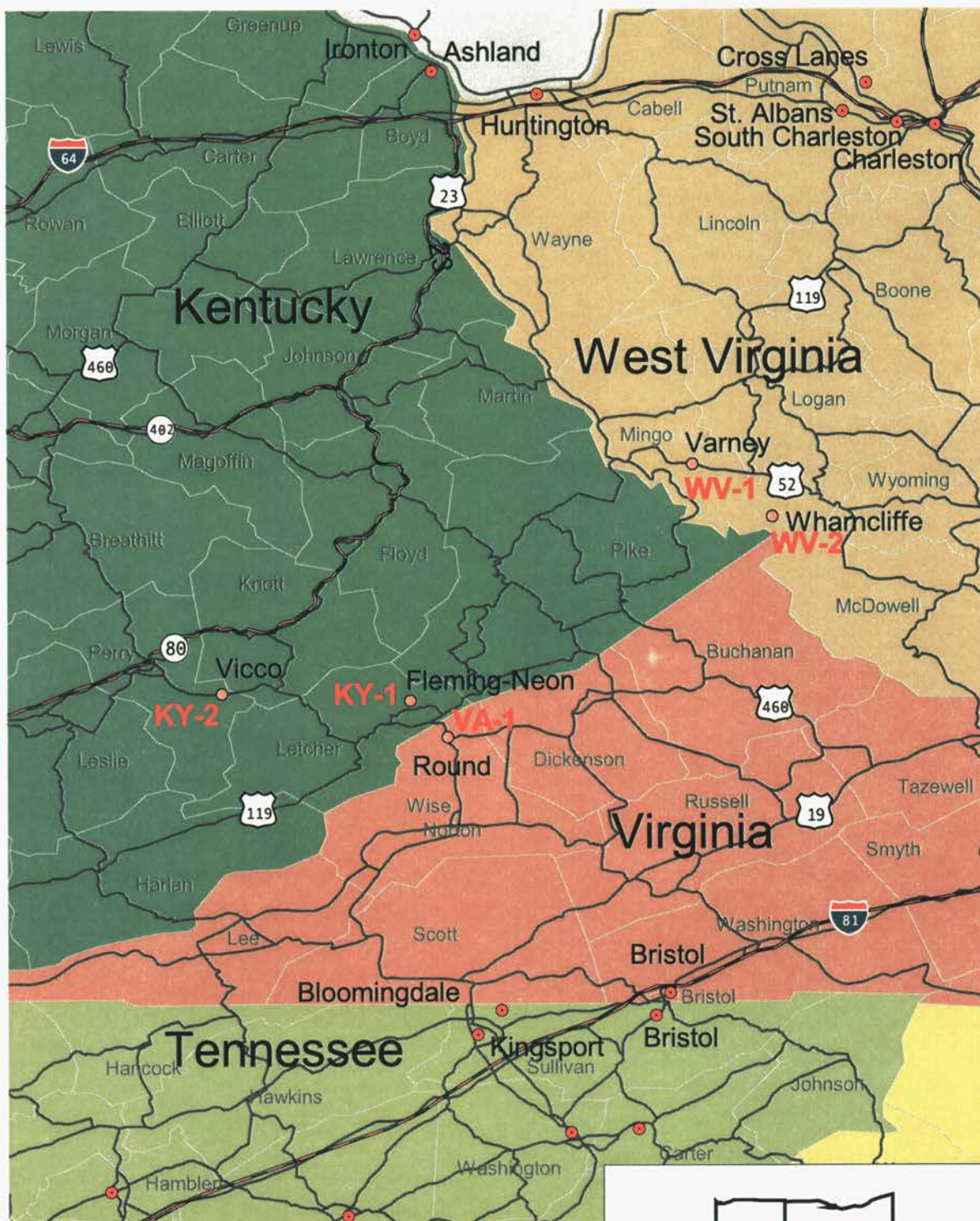
The domestic wells used in this study were selected by Office of Surface Mining (OSM) officials, with input by Virginia, West Virginia, and Kentucky state officials based upon current and past complaint information. To identify suitable sites that meet the study criteria, state representatives were to review sites and:

- Identify mine sites that would be blasting at least once a day
- Contact the individual coal mines to determine their blasting schedules.
- Find at least one, and preferably two, domestic well near each mine.
- Contact with the owners of the domestic wells to request and secure their participation in the study.
- Complete a nomination package that provides the location of the well site, the five most recent blast logs with plotted blast locations, pictures of the well installation, any technical reports done on the site, and anticipated dates of blasting near the wells.

Based on the nomination packages provided by the state representatives, five mine sites were selected for this study: one site in Virginia and two sites each in Kentucky and West Virginia (Figure 1, Table 1). At each of the sites in Kentucky and West Virginia, at least two domestic wells were selected for monitoring after OSM officials secured right-of-entry agreements from the individual homeowners. Only one domestic well suitable for this study was identified at the Virginia site. The wells selected represent a range of well construction types and proximity to surface coal mining operations. The ages of the wells were not determined, but it is assumed that the wells were completed when the homes were first occupied.

Blasting had been occurring near all of the sites for a significant time prior to the arrival of monitoring personnel and the installation of monitoring equipment. The data collected represent only a small amount of time compared to the total amount of time the well has been within the range of influence of an active mining/blasting operation.

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Explanation

- KY-1** Site ID
- Cities
- Towns
- Major roads
- Other highways
- County boundaries



OSM WELL STUDY
Study Area



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Figure 1

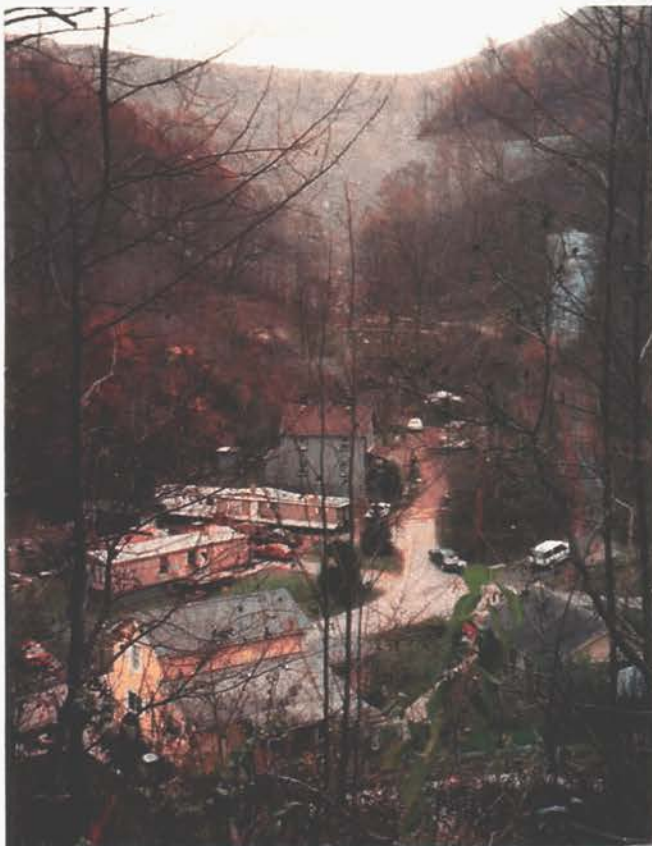


Table 1. Monitor Well Identifiers

State	County	Site ID	Well ID	Well owner
Virginia	Wise	VA-1	Well-1	Hylton
Kentucky	Letcher	KY-1	Well-1	Banks
			Well-2	Ratliff
	Perry	KY-2	Well-1	G. Hurley
			Well-2	Sumner
			Well-3	A. Hurley
West Virginia	Mingo	WV-1	Well-1	L. Dean Sr.
			Well-2	L. Dean Jr.
		WV-2	Well-1	G. Abbott
			Well-2	D. Abbott

The study sites were typical of Appalachian coal country, where residents live within hollows below coal outcrops, which generally exist where the slopes are steepest. Within the hollows, residential sites are typically founded on valley alluvial fills and glacial deposits comprising cobbles, gravels, and sands with some clay. Wells can penetrate sandstone formations that may be recharged by water moving through naturally occurring fractures in the upper elevation coal seams and porous rock units.

The domestic water wells at all the study sites are drilled within hollows at elevations far below mining activity. The photographs in Figure 2 show the typical terrain at all the sites investigated. Mining activity takes place beyond the ridgeline (shown at the top of each photograph) at the head of the hollow in which the houses are located. The ridgeline between the head of the hollow and the mining operations is formed of overburden fill (waste rock). Blasting activities take place within sandstone and shale formations along mountain contours and across the mountaintop (full mountaintop removal) (Figure 3). Rock blasting along contours produces blasting bench faces directed away from the hollow (Figure 4) or toward the hollow. At the Virginia study site, mountaintop removal has left a pinnacle of rock that rises above the surrounding mining operations upslope and below the waste rock ridgeline (Figure 3a). A typical mining scenario encountered at each site is shown in Figure 4.



2a. View of a hollow in Kentucky.



2b. View of a hollow in West Virginia.





3a. Final stages of mountain top removal in Virginia.



3b. Contouring overburden blasting in Perry County, Kentucky.

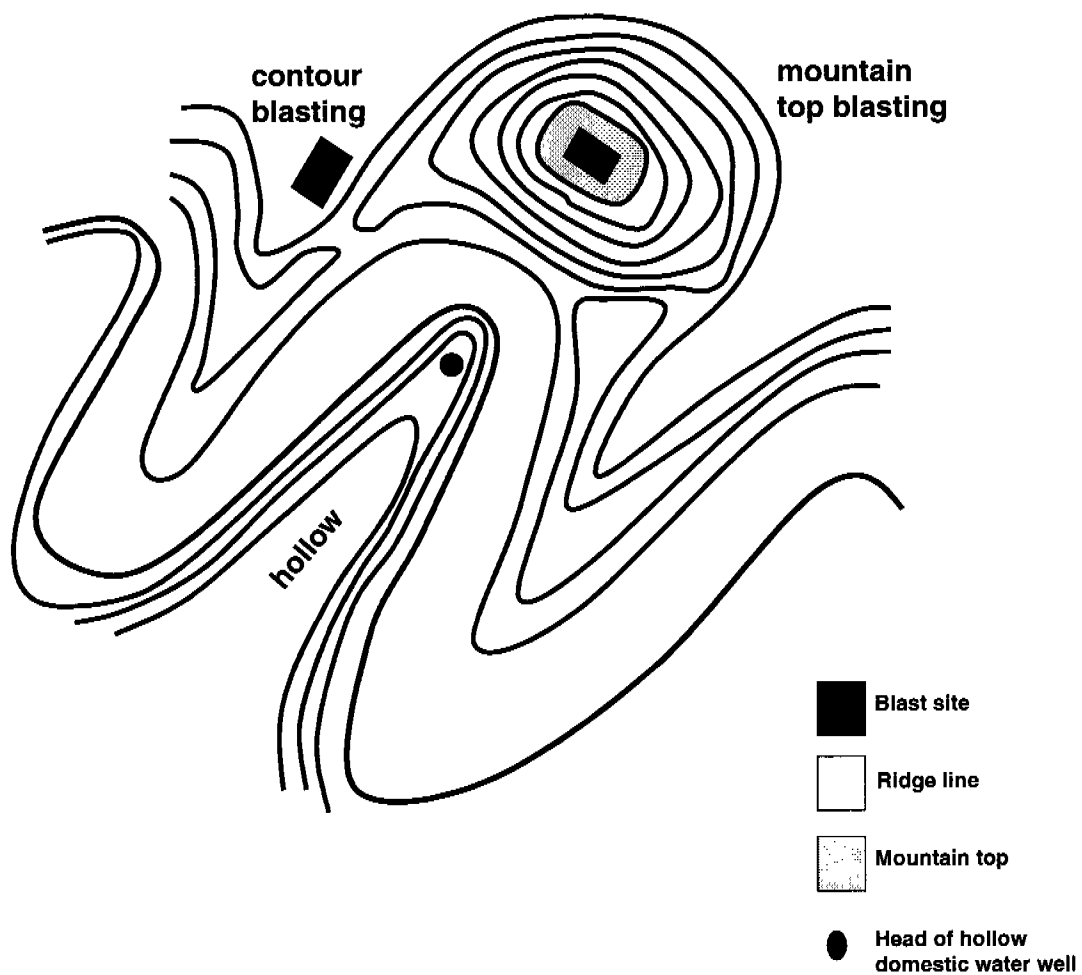


3c. Mountain top blasting in Perry County, Kentucky.



3d. Contour blasting at a mine in Letcher County, Kentucky.





OSM WELL STUDY
Typical Mining Scenario

Figure 4





4. Monitoring Methods and Training

Upon completion of site selection, collection of field data began. Fieldwork and instrumentation was conducted in two phases. Phase I took place during a three-week period in the Fall-Winter 2000 season and involved an intensive commitment to field instrument installation and data collection over four consecutive days of blasting at each site. Phase II involved the collection of data during the subsequent three seasons.

During Phase I, prior to the start of monitoring at each site, representatives of DBS&A and Aimone-Martin Associates (subcontractor to the project) met with mining operations personnel to obtain blasting information and general information on the anticipated locations of blasting during the monitoring phase. Representatives of DBS&A and Aimone-Martin Associates also visited individual homeowners to assess the nature of complaints regarding well responses to blasts and pumping vibrations (if any), to obtain previous water quality data for the domestic wells (if available), and to obtain well construction details (if available).

Following the initial meetings, a DBS&A hydrogeologist accessed the domestic wells at the sites to equip them with continuous water quality and well yield monitoring instrumentation. All instrumentation (seismic, water quality, and well yield monitoring instruments) was calibrated, tested, and quality-control checked prior to installation and the initiation of monitoring. During the Fall-Winter 2000 four-day monitoring event, DBS&A personnel measured turbidity and well yield, collected groundwater samples for laboratory analysis, and collected and analyzed data from the field instruments. In addition, state personnel were trained in the use of field data acquisition systems and retrieval of data so that they could collect data during subsequent monitoring events.

Each state agency assigned an employee to perform the following activities:

- Contacting mine officials and well owners and coordinating blasting and monitoring efforts at each site



- Field calibrating, testing, and installing the monitoring instruments
- Initiating continuous monitoring at each site (well yield, water quality, and vibration) during the monitoring period
- Collecting pre- and post- blast turbidity readings at a point between the well and the pressure tank of each residence with the use of a portable turbidimeter
- Downloading all water quality, well yield, and vibration data from dataloggers and transferring the data to DBS&A and Aimone-Martin Associates
- Removing all instrumentation from the well sites and preparing them for storage or shipment to DBS&A or the next monitoring site

Specific methods for each of the types of monitoring are described in Sections 4.1 through 4.3. The training conducted for state personnel is described in Section 4.4.

4.1 Domestic Well Water Quality Monitoring

The water quality of the individual domestic wells was evaluated using both field monitoring equipment and laboratory analysis. Field water quality monitoring was conducted prior to, during, and after a series of blasts at the five study sites.

Field water quality monitoring was conducted using electronic sensors (EC-Campbell Scientific CSI-247, pH-Innovative Sensors M11) connected to a Campbell Scientific 21X datalogger. The datalogger allowed for automated measurement at a frequency of the operator's discretion. The sensors (temperature, pH, and electrical conductivity [EC]) were installed in each well below the water level. If it was not possible to place the sensors in a particular well, they were inserted in a flow-through cell extending from a discharge line between the well and the pressure tank at the ground surface. Additionally, the turbidity of the domestic well water was measured at the surface using a Hach 2100P portable turbidimeter.



During the initial monitoring period (Fall-Winter 2000), water quality samples were collected from each of the individual domestic wells for laboratory analysis of total aluminum, iron, manganese, sulfate, total dissolved solids, and total suspended solids (TSS). At each well, samples were collected from faucets connected to the pressure tanks. The water quality samples were collected in laboratory-supplied containers, immediately preserved on ice in an insulated cooler with full chain-of-custody documentation, and shipped to Inter-Mountain Laboratories, Inc. in Farmington, New Mexico for analysis. A duplicate sample analysis was conducted at the KY-1 Well-2 site.

4.2 Domestic Well Yield and Discharge Monitoring

In order to determine the effects of mine blasting on the normal usage of the individual study wells, DBS&A and state personnel monitored variations in well yield by continuously monitoring volumetric flow and water level in the individual domestic wells before, during, and after blasting events. For the purposes of this study, well yield is defined as the volumetric flow rate of water from the well during a pumping cycle. Monitoring of well yield helps determine whether blasting affects the ability of a well to produce water at a reliable rate. A decrease in well yield could be due to blasting or other causes such as compaction of the material surrounding the well, changes in the fracture size or occurrence, deterioration of the well due to age, improper maintenance, and/or biological or mineral fouling. In order for this study to identify changes due to blasting, an acute change would have to be associated to a blast during a monitoring event.

Well yield was monitored using a Controlotron 1010n flow meter installed on the pipe between the well and the pressure tank. The Controlotron is equipped with an internal datalogger that was programmed to record data at approximately the same interval as that of the Campbell equipment (Section 4.1). Wells were also equipped with water level sensors (Druck 150 psi pressure transducers) connected to a Campbell Scientific 21X datalogger to record water levels (pressure head) within the wells at specified time intervals.

Continuous measurements of well yield and water levels were obtained for a period beginning one day prior to blasting and ending approximately one day following the tests. The durations of



the pre- and post-blast monitoring periods were adjusted slightly, depending on the degree of water level fluctuations observed in each well.

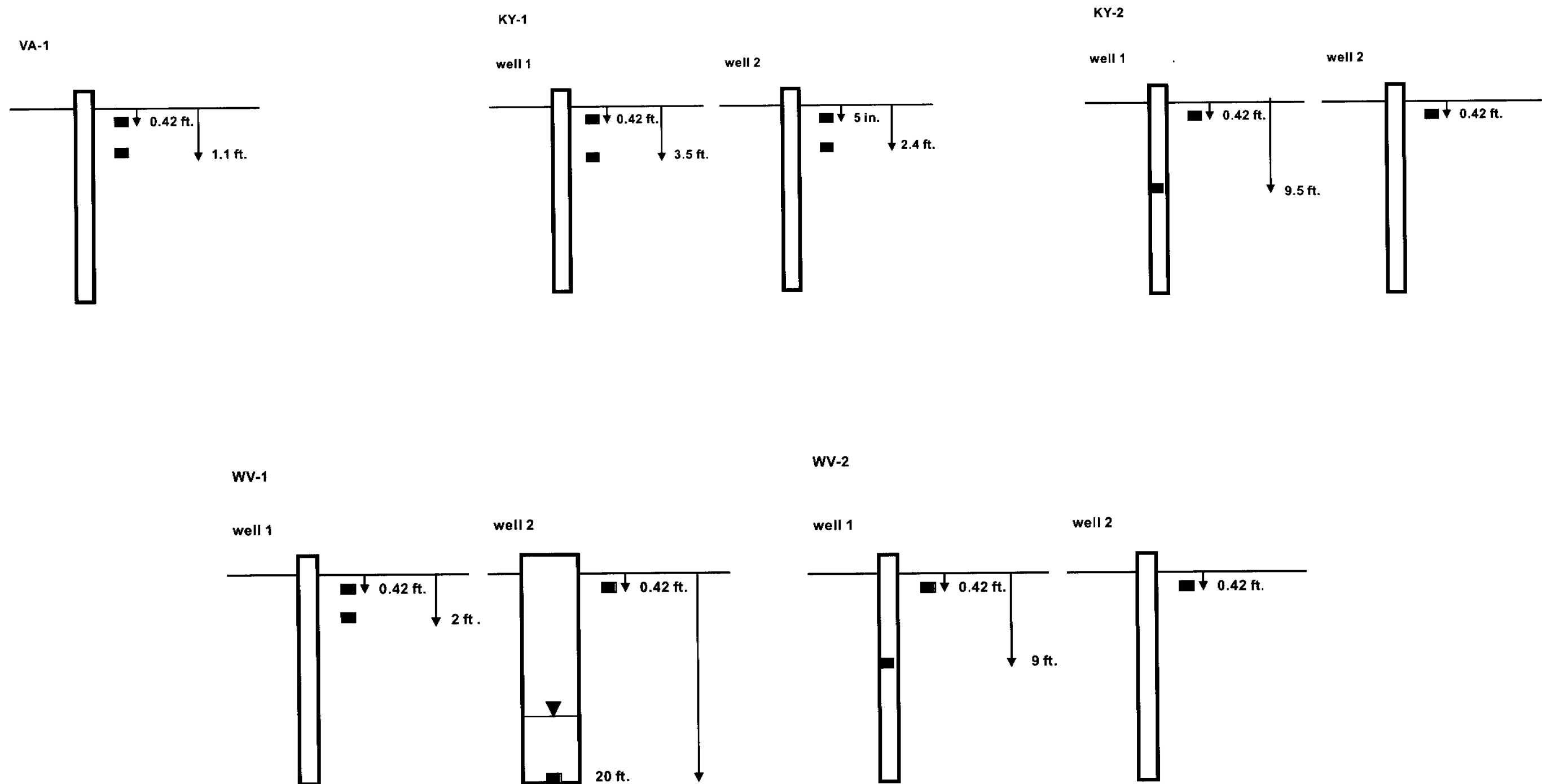
4.3 Vibration Monitoring

Ground motions adjacent to nine domestic water wells (ten during the initial monitoring period) were recorded during blasting events to determine the ground motion variation with depth below the ground surface. At each well selected for study, one tri-axial transducer was buried 0.42 foot from the surface near each wellhead. A second transducer was buried at depth, as outlined below:

- At three sites the second transducer was placed at depths between 9 and 20 feet in either an abandoned well casings (two sites) or a hand-dug well (one site).
- At four sites, an attempt was made to hand-dig holes as deep as possible to record ground motions. At most of these sites, however, the subsurface soils contained large gravels and cobbles, making it difficult to dig holes deeper than 3.5 feet from the surface.
- At two sites, it was not possible to dig into the ground any deeper than 0.42 foot from the surface. Therefore, no second transducer was used at these sites.

Figure 5 shows the locations of transducers placed in or adjacent to wells. Transducers placed in abandoned wells were either grouted in place or encapsulated in crushed stone. Those placed within the ground adjacent to wells were tamped with pressure to ensure good coupling.

Blasting-type seismographs manufactured by LARCOR of Dallas, Texas were used to monitor ground motions near wells. Sensors were embedded in epoxy within a watertight housing for long-term survivability. The sensors were attached to the housing using 50-foot cables aligned with the vertical transducer for ease of inserting at depth. Airblast was recorded using the surface seismograph.



OSM WELL STUDY
Transducer Locations within or
Adjacent to Wells



The following settings were used:

- Ground trigger level 0.02 inch per second (ips)
- Air trigger level 125 decibels (dB)
- Sample rate 1248 samples per second
- Record length 5 to 10 seconds
- Range 2.5 ips
- Lowest velocity detected 0.005 ips

4.4 Training

During the initial Fall-Winter 2000 monitoring period, the following state personnel from Kentucky, Virginia, and West Virginia were trained by DBS&A personnel to conduct the remaining three seasons of monitoring for the OSM well study:

- Leslie Bright, a geologist with the Division of Mined Land Reclamation, Department of Mines Mineral and Energy in Virginia
- Darcy White, Assistant Chief with the Office of Explosives and Blasting in West Virginia
- Ralph King, a Staff Scientist III with the Office of Surface Mining in Kentucky

These personnel were trained in the following tasks:

- Programming and data collection using the Campbell Scientific 21X datalogger and a laptop computer
- Wiring, calibrating, installing, and maintaining the Innovative Sensors M11 downhole pH sensor



- Wiring, calibrating, installing, and maintaining the Campbell Scientific CSI-247 downhole EC sensor
- Wiring and placement of the two Druck pressure transducers
- Calibrating and using the HACH 2100p turbidimeter
- Installing, programming, and collecting data from the Controlotron 1010n flow meter
- Using and calibrating the YSI-63 handheld pH, specific conductance, and temperature meter

Where applicable, the personnel were also trained in special procedures required at some of the sites (i.e., flow-through setups at the VA-1 Well-1 and KY-2 Well-2 locations).



5. Results

During each of the monitoring events, field personnel attempted to collect all three categories of data, including vibration/blasting data, water quality data, and well yield data. Throughout the study, wells were dropped from the monitoring program for various reasons. For example, the Kentucky sites were flooded before the second monitoring event, compromising the wells. The West Virginia sites were not monitored during the fourth quarter because blasting activities occurred too far from the well sites, and the Virginia site was dropped prior to the third monitoring event for the same reason, as well as discontinued use of the well due to hookup of the residence to a municipal water supply. Further details regarding the reasons for removing wells from the study are outlined in Table 2.

5.1 Vibration Data from Blasting

Ground motions adjacent to nine domestic water wells were recorded during blasting events to determine the ground motion variation with depth below the ground surface. Full waveform vibration data and summary tables are shown in Appendix A for all blast events that were recorded.

Detailed blasting records were available only during the Fall-Winter 2000 monitoring period. Hence, this data set is the most complete, with 54 shots recorded at nine wells. As the study continued mine blasting was being conducted at farther distances from the wells, and as a result, many mine blasts did not trigger the seismographs.

The maximum ground motion recorded during the study was 0.125 ips. The Fall-Winter 2000 data set shows average near-surface (0.42 foot) and at depth (from 1.1 to 20 feet) peak particle velocities (PPV) of 0.043 ips and 0.033 ips, respectively. In the Spring of 2001 as mining progressed away from the well site, the average PPV values decreased to 0.038 ips and 0.029 ips for the near-surface and at depth locations, respectively. In the Fall of 2001 ground motion was measured at the surface only and averaged 0.026 ips. In no case did the average ground motions at depth exceed those measured at the surface.



Table 2. Quarterly Monitoring Activities in Virginia, Kentucky, and West Virginia

State	Site ID	Well ID	Monitoring Performed				Comments
			Fall-Winter 2000	Spring 2001	Fall 2001	Winter 2001	
Virginia	VA-1	Well-1	FWQ, WY, LWQ, V	FWQ,WY	---	---	Resident on city water (third quarter) and no longer using well; dropped from study
Kentucky	KY-1	Well-1	FWQ, WY, LWQ, V	---	---	---	No access to wells due to flooding from sediment pond overflow (second quarter); site dropped from study
		Well-2	FWQ, WY, LWQ, V	---	---	---	No access to wells due to flooding from sediment pond overflow (second quarter); site dropped from study
	KY-2	Well-1	V	---	---	---	Well used only for vibration monitoring during initial monitoring period (well was dry).
		Well-2	FWQ, WY, LWQ, V	FWQ	V	---	Data not received (third quarter); residents refused access (fourth quarter)
		Well-3	FWQ, WY, LWQ	FWQ	V	---	Data not received (third quarter); residents refused access (fourth quarter)
West Virginia	WV-1	Well-1	FWQ, WY, LWQ, V	FWQ, WY, V	---	FWQ	West Virginia state personnel not on-site to supervise monitoring (third quarter)
		Well-2	FWQ, WY, LWQ, V	FWQ, WY, V	---	FWQ, V	West Virginia state personnel not on-site to supervise monitoring (third quarter)
	WV-2	Well-1	FWQ, WY, LWQ, V	FWQ,V	WY	---	West Virginia state personnel not on-site to supervise monitoring (third quarter); blasting took place too far away from site (fourth quarter)
		Well-2	FWQ, WY, LWQ, V	FWQ, WY,V	---	---	West Virginia state personnel not on-site to supervise monitoring (third quarter); blasting took place too far away from site (fourth quarter)

FWQ = Downhole field water quality parameter monitoring
WY = Well yield monitoring

LWQ = Laboratory water quality monitoring
V = Vibration monitoring

--- = No monitoring conducted; see Comments column for explanation



Frequencies at the PPV also tended to decrease with depth as the degree of confinement increased. Similarly, average frequencies decreased with successive monitoring periods. The average frequencies near the ground surface and at depth in 2000 were 17.5 Hz and 14.8 Hz. In the Spring of 2001, an average surface frequency of 18.8 Hz was measured. The ground motion data at depth fell within the resolution of the instrumentation and frequencies could not be reliably calculated.

The Fast Fourier Transform (FFT) frequency is a measure of the predominant frequency over the entire waveform and indicates the frequency containing most of the ground motion energy. In contrast, the frequency at the PPV (or peak frequency) is the frequency calculated from the zone-crossings for the cycle containing the PPV. Average values for PPV and frequency at the PPV by well site, as well as dominant waveform frequency obtained from the FFT are plotted on Figures 1 through 5 in Appendix A. The decrease in ground motion with depth is shown in Figure 1 (Appendix A) for the Fall-Winter 2000 monitoring season and Figures 2 and 3 (Appendix A) for 2000 and Spring 2001 combined. The linear trend for the averaged combined data is:

$$V \text{ (average)} = -0.0015 D + 0.0421 \quad (1)$$

where V = the average PPV
 D = the burial distance

The correlation coefficient (R^2) for the data is 0.38.

The average decrease in ground motion velocity was 0.0015 ips per foot below the ground surface, dependent on geology and coupling. Individual well site rates are provided in Figure 1 in Appendix A. For well-coupled burial depths (2 feet and below), this rate ranges between -0.002 and -0.0026 (the negative indicating a decrease with depth) ips per foot of burial. The best-fit trend line giving the decrease in frequency at the PPV with burial depth, shown in Figure 4 of Appendix A, is:

$$F \text{ (average)} = -0.232 D + 16.7 \quad (2)$$



where F = the average peak frequency
 D = the burial distance

Figure 5 of Appendix A shows the relationship between peak particle velocity and frequency at the peak for 2000 data, plotted on the OSM blasting level chart (1986).

It is difficult to distinguish the frequency differences between surface and buried ground motions. All data fell between 5.4 Hz and 34.1 Hz

5.2 Water Quality and Well Yield Data

As was the case with vibration monitoring, the data sets for field and laboratory water quality and well yield were most complete for the initial monitoring period. Analytical reports from water quality sampling and time-series graphs showing the results of downhole and well yield monitoring are included as Appendices B and C, respectively.

During the Fall-Winter 2000 monitoring event, water samples were collected from wells at each of the study sites prior to and after blasting (Table 3), and the results of the analyses are summarized in Table 4. Generally, parameters were stable throughout the monitoring period and showed no effects from blasting, as exemplified by the KY-1 Well-1 site. However, iron and TSS concentrations measured prior to and after blasting differed significantly in many wells (Table 4). It is theorized that these differences were caused by the stirring of sediments and sloughing of scale from both normal well operation and the introduction of monitoring equipment. Laboratory analysis was not performed during any of the subsequent monitoring events.

The dates and times of blasting events were placed on time-series graphs of data collected from field water quality monitoring, allowing identification of any changes in any of the parameters related to blasting (Appendix C). Throughout the study, where data are available, well yield and water level trends remained unchanged due to blasting. For example:



Table 3. Water Quality Sample Inventory

State	Site ID	Well ID	Pre-Test		Post-Test	
			Date	Sample ID	Date	Sample ID
Virginia	VA-1	Well-1	11/06/00	Boggs 1	11/18/00	Boggs 2
Kentucky	KY-1	Well-1	11/09/00	Ratliffe 1	11/18/00	Ratliff 2
		Well-2	11/09/00	Banks 1 ^a	11/18/00	Banks 2
	KY-2	Well-1	Well not sampled			
		Well-2	11/18/00	Sumner 1	11/25/00	Sumner-2
		Well-3	11/20/00	Hurley #1	11/25/00	Hurley-2
West Virginia	WV-1	Well-1	11/26/00	Dean 1-1	12/4/00	Dean 1-2
		Well-2	11/26/00	Dean 2-1	12/4/00	Dean 2-2
	WV-2	Well-1	12/04/00	Abbott 1-1	12/7/00	Abbott 1-2
		Well-2	12/04/00	Abbott 2-1	12/7/00	Abbott 2-2

Note: All samples analyzed by Inter-Mountain Laboratories, Inc. of Farmington, New Mexico

^a Duplicate analysis performed on sample



Table 4. Results of Laboratory Water Quality Analyses, Initial Quarterly Monitoring Event

State	Site ID	Well ID	Date	Concentration (mg/L)					
				General Parameters			Total Metals		
				TDS	TSS	Sulfate	Aluminum	Iron	Manganese
Virginia	VA-1	Well-1	11/06/00	1,740	19	991	<0.05	17.7	1.10
			11/18/00	1,710	9	955	<0.05	0.03	0.88
Kentucky	KY-1	Well-1	11/09/00	274	3	72	<0.05	3.48	0.44
			11/18/00	260	21	72	<0.05	24.8	0.35
		Well-1 Dup	11/09/00	272	10	72	<0.05	3.34	0.42
		Well-2	11/09/00	448	4	109	<0.05	4.17	0.36
			11/18/00	430	14	108	0.07	5.71	0.42
	KY-2	Well-1	Well not sampled						
		Well-2	11/18/00	250	<2	7	<0.05	20.8	0.89
			11/25/00	250	103	5	0.06	67.0	3.86
		Well-3	11/20/00	700	22	36	<0.05	12.9	1.51
			11/25/00	650	26	37	<0.05	14.7	1.46
West Virginia	WV-1	Well-1	11/26/00	400	75	145	0.07	28.4	1.00
			12/04/00	380	<2	144	<0.05	5.42	0.85
		Well-2	11/26/00	320	7	109	<0.05	4.62	0.39
			12/04/00	280	<2	109	<0.05	1.84	0.24
	WV-2	Well-1	12/04/00	180	<2	7	<0.05	0.89	0.10
			12/07/00	140	6	<5	<0.05	0.34	0.03
		Well-2	12/04/00	160	58	15	<0.05	16.4	0.55
			12/07/00	130	35	12	<0.05	5.16	0.07

mg/L = Milligrams per liter

TDS = Total dissolved solids

TSS = Total suspended solids



- The well yield from VA-1 Well-1 remained between 8 and 10 gallons per minute (gpm) during the entire Fall-Winter 2000 monitoring period, unaffected by blast timing. When VA-1 Well-1 was monitored again in Spring 2001 the well yield was in the same range.
- Where well yields were erratic, such as in KY-1 Well-2 during the Fall-Winter 2000 monitoring period, the erratic behavior did not correspond to the blast timing.
- Water level changes in wells, if any, were very regular and predictable and were related to household schedules. During periods of high water use for activities such as bathing and washing dishes, the pump cycles more often, resulting in a short-term lowering of the water level in the well. WV-2 Well-2 is a good example of these types of water level changes.

Field water quality parameters remained in similar ranges throughout the study (Table 5). The data from the downhole sensors fall into three categories:

- *Very little change in measured parameters.* A good example of this result can be seen in the temperature, pH, and EC data for WV-1 Well-1 during the Winter 2001 monitoring period, which remained nearly unchanged throughout the monitoring period.
- *Spikes in measured parameters related to household schedules.* For instance, during the Fall-Winter 2000 monitoring, VA-1 Well-1 showed spikes in temperature related to ground water being brought into the well during high use periods of the day.
- *Sensor drift.* Fouling of the instrument in the well can cause a gradually drifting data trend, or sensor drift. The slowly rising pH in well WV-2 Well-1 over the Spring 2001 monitoring period is a prime example of sensor drift. The continually increasing pH trend in this well is not disrupted by the blasts.



Table 5. Results of Field Turbidity Monitoring
Page 1 of 3

Site	Date	Time	Turbidity
VA-1 Well-1	11/05/00	15:45	30.9
	11/05/00	15:50	61.1
	11/05/00	15:59	54
	11/06/00	09:20	30.2
	11/06/00	09:40	22.7
	11/07/00	09:40	34.6
	11/07/00	10:00	30.5
	11/07/00	10:15	27.7
	11/07/00	16:01	29.4
	11/08/00	05:49	38.7
	11/08/00	06:04	11.3
	11/09/00	08:30	25.9
	11/09/00	09:00	23.4
	11/09/00	13:58	17.7
	11/09/00	16:14	39.1
	11/09/00	16:30	61
	11/09/00	16:43	61.5
	11/09/00	16:52	46.1
	11/09/00	17:00	40.1
	11/10/00	15:20	26.9
	11/10/00	15:35	25.8
	11/10/00	15:45	39.8
	11/11/00	13:54	30.5
	11/11/00	14:46	68.4
	11/11/00	15:50	18.3
KY-1 Well-1	11/09/00	13:58	17.7
	11/10/00	13:00	>1,000
	11/12/00	16:00	192
	11/13/00	09:53	NA
	11/13/00	10:14	26.3
	11/13/00	16:45	23.9
	11/14/00	12:59	23.2
	11/15/00	11:00	43.8
	11/16/00	09:53	24.2
	11/16/00	11:35	21.2
	11/17/00	11:55	90.9
	11/17/00	12:52	31.9



Table 5. Results of Field Turbidity Monitoring
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Site	Date	Time	Turbidity
KY-1 Well-2	11/09/00	11:25	2.59
	11/09/00	11:30	2.34
	11/09/00	13:30	13
	11/10/00	11:38	5.28
	11/12/00	09:03	177
	11/12/00	12:30	170
	11/13/00	10:08	20.3
	11/13/00	16:40	7.59
	11/14/00	13:10	20.9
	11/15/00	10:55	2.64
	11/16/00	09:58	24.2
	11/16/00	11:36	20.1
	11/17/00	12:03	2.78
	11/17/00	12:52	0.99
KY-2 Well-2	11/19/00	14:15	19
	11/20/00	17:10	24
	11/22/00	09:45	56.5
	11/25/00	18:50	101
KY-2 Well-3	11/20/00	14:55	2.82
	11/20/00	17:20	8.1
	11/22/00	09:25	4.22
	11/25/00	17:50	60.6
WV-1 Well-1	11/26/00	16:00	29.80
	11/27/00	12:57	54.1
	11/27/00	13:30	30.2
	11/28/00	12:54	67.9
	11/28/00	13:29	58.2
	11/29/00	11:24	54.8
	11/29/00	12:40	45.2
	12/02/00	10:40	17.9
	12/02/00	12:10	25.8
WV-1 Well-2	11/26/00	16:00	58
	11/27/00	12:58	29.2
	11/27/00	13:32	60.2
	11/28/00	12:50	35.6
	11/28/00	13:24	37.8
	11/29/00	11:22	6.48



Table 5. Results of Field Turbidity Monitoring
Page 3 of 3

Site	Date	Time	Turbidity
WV-1 Well-2 (cont.)	11/29/00	12:30	9.3
	12/02/00	10:40	9.22
	12/02/00	12:10	11.1
WV-2 Well-1	12/03/00	12:40	2.28
	12/04/00	11:50	3.45
	12/05/00	11:30	9.69
WV-2 Well-2	12/03/00	12:45	81.6
	12/04/00	11:50	39.9
	12/05/00	11:30	45.2



6. Summary and Conclusions

DBS&A was contracted by the OSMRE to design and initiate a long-term study to investigate possible effects of mining operations on groundwater quality and supply in domestic wells. The study was conducted between November 2000 and December 2001 and consisted of four field data collection periods and subsequent data analysis.

During each of the monitoring periods, field personnel attempted to collect data deemed necessary to determine effects of mining operations on nearby domestic wells, including vibration/blasting, water quality, and well yield data. Data from the initial monitoring period are the most complete. Unforeseen issues in data collection and removal of sites from the study for various reasons resulted in progressively less complete data sets in each of the remaining data collection periods, and during the final period, only one site of the original nine selected could be monitored.

Vibration data became more sparse as the study progressed because mine blasting was conducted at increasingly larger distances from the study sites. Ground movements produced by blasting activities were attenuated by the greater distances and were in many instances not strong enough to trigger the seismographs, indicating little vibratory effect in the ground surrounding the wells. No adverse impacts to domestic water wells from surface coal mine blasting were measured during this study. This lack of impact is valid for peak surface ground motions that fall within 0.125 ips (the maximum ground motion recorded at the surface during the study).

Few changes that could be directly attributed to a blast event were observed in the water quality and well yield data collected. Water quality parameters did change slightly over time during measuring periods, but none of these changes seem to be related to blasting, but appeared instead to be the result of sensor drift and mixing of the water in the well due to pump cycling. Well yield and water level remained in a constant range throughout each individual monitoring season.



References

U.S. Geological Survey (USGS). 1999. *Coal resource assessment in the northern and central Appalachian coal region*. USGS Fact Sheet 115-99. October 1999.

Office of Surface Mining. 1986. Federal Register Cite: 51 FR 19444 (19461).

Robertson D.A., J.A. Gould, J.A. Straw, and M.A. Dayton. 1980. *Survey of blasting effects on ground water supplies in Appalachia*. Prepared by Philip R. Berger & Associates, Bradfordwoods, Pennsylvania. Bureau of Mines, Washington, D.C. November 1980.

Appendix A

Vibration Monitoring Methods and Results

Ground Motions Measurements Adjacent to Domestic Water Wells

Ground motions adjacent to nine domestic water wells were recorded during blasting events to determine the ground motion variation with depth below the ground surface. At each well selected for study, one tri-axial transducer was buried 0.42 ft. from the surface near each wellhead. A second transducer was buried at depth.

Two abandoned well casings and one hand-dug well were used to place transducers at depths between 9 and 20 ft. At four wells, an attempt was made to hand-dig holes as deep as possible to record ground motions. At most sites, the subsurface soils contained large gravels and cobbles, making it difficult to dig holes deeper than 3.5 ft. from the surface. At two sites, it was not possible to dig into the ground any deeper than 0.42 ft from the surface. Therefore, no second transducer was used at these two wells.

During the initial monitoring period in 2000, detailed information on the blasting activities were obtained from the mine operators. The distances from the blasting site to the wells ranged 1293 ft. to 5140 ft. away and averaged 2607 ft. Charge weights used for blasting ranged from 126 to 2076 lbs. per 8 ms (milliscond) delay. The scaled distances ranged from 56 to 343 ft./lbs.^{1/2}.

Seismograph Equipment

Blasting-type seismographs, manufactured by LARCOR or Dallas, Texas, were used to monitor ground motions near wells. Sensors were embedded in epoxy within a water-tight housing for long-term survivability. Fifty-foot cables were used and attached to the housing aligned with the vertical geophone for ease of inserting at depth. Airblast was recorded using the surface seismograph.

Figure (1) shows the locations of geophones placed in or adjacent to wells. Geophones placed in abandoned wells were either grouted in place or encapsulated in crushed stone. Geophones placed within the ground adjacent to wells were tamped with pressure to ensure good coupling.

The following settings were used:

Ground trigger level	0.02 ips
Air trigger level	125 dB
Sample rate	1248 samples/sec.
Record length	5 to 10 sec.
Range	2.5 ips
Lowest velocity detected	0.005 ips

Results

Vibration Data from Blasting

Full waveform vibration data are shown in Volume II for all blast events that were recorded. Tables (1) through (4) summarize the seismographs data recorded during fall-winter 2000, spring 2001, fall 2001, and winter 2001, respectively. Peak particle velocity (PPV), in ips (inches per

second), the frequency at the PPV, in Hz (Hertz), and the airblast, in dB (decibels) are given. Detailed blasting records were available only during the fall-winter 2000 monitoring period. Hence, Table (1) provides information on distances from the blast to the seismographs, maximum pounds per 8 ms delay and scaled distance. This data set is the most complete with 54 shots recorded at nine wells. Subsequent monitoring periods were not as complete due to the loss of in Kentucky site KY-1 and Virginia as previously explained. Difficulties fielding equipment contributed to smaller data sets in the 2001 monitoring periods. Additionally, mine blasting was being conducted at farther distances from the wells during 2001, compared to the distances involved during the initial 2000 monitoring period, as mining moved away from the study sites. As such, many of the mine blasts did not trigger the seismographs.

The extensive 2000 data set shows average near-surface (0.42 ft.) and at depth (from 1.1 to 20 ft.) peak particle velocities (PPV) of 0.043 ips and 0.033 ips, respectively. In the spring of 2001 as mining progressed away from the well site, the average PPV values were 0.038 ips and 0.029 ips for the near-surface and at depth locations, respectively. The maximum ground motion recorded at the surface was 0.125 ips. In the fall of 2001, only surface measurements were taken. These averaged 0.026 ips, less than the average in 2000. In all cases, a decrease in average ground motions with depth was measured. In no case did ground motions at depth exceed those measured at the surface.

Frequencies at the PPV also tended to decrease with depth as the degree of confinement increased. Similarly, average frequencies decreased with successive monitoring periods. The average frequencies near the ground surface and at depth in 2000 were 17.5 Hz and 14.8 Hz. In the spring of 2001, an average surface frequency of 18.8 Hz was measured. The ground motion data at depth fell within the resolution of the instrumentation and frequencies could not be reliably calculated.

Average values for PPV and frequency at the PPV by well site are given in Tables (5) through (8). The dominant waveform frequency obtained from the Fast Fourier Transform (FFT) is also shown. The FFT frequency is a measure of the predominant frequency over the entire waveform and indicates the frequency containing most of the ground motion energy. In contrast, the frequency at the PPV (or peak frequency) is the frequency calculated from the zone-crossings for the cycle containing the PPV.

Data contained in these tables are plotting in Figures (1) through (5). The decrease in ground motion with depth is shown in Figure (1) for the initial monitoring season (2000) and Figures (2) and (3) for 2000 and spring 2001 combined. The linear trend for the averaged combined data is

$$V (\text{average}) = - 0.0015 D + 0.0421 \quad ()$$

where V is the average PPV, in ips, and D is the burial distance, in ft. The correlation coefficient (R^2) for the data is 0.38. The best-fit line through the data indicates that an average decrease in ground motion velocity of 0.0015 ips occurs per foot of depth below the ground surface. The rate of decrease is dependent on geology and coupling. Individual well site rates are given in Figure (1). For well-coupled burials depths (2 ft. and below), this rate ranges between -0.002 and -0.0026 (the negative indicating a decrease with depth) ips per ft. of burial.

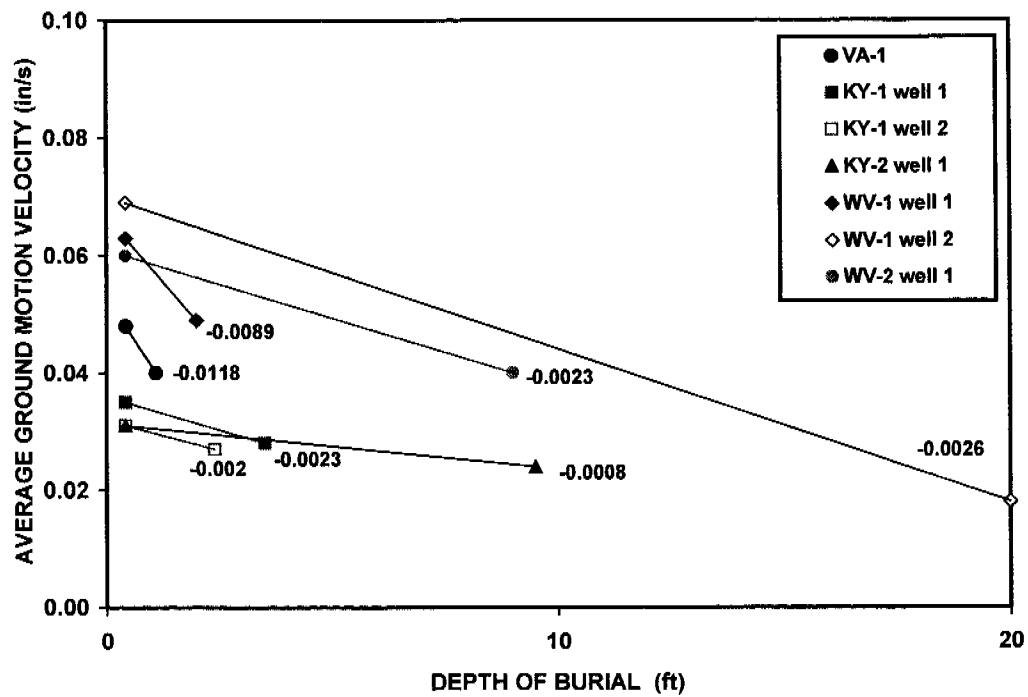


Figure (1) Average ground motion velocity versus depth of burial for fall-winter 2000 data showing the rate of decrease in ground motion velocity with depth

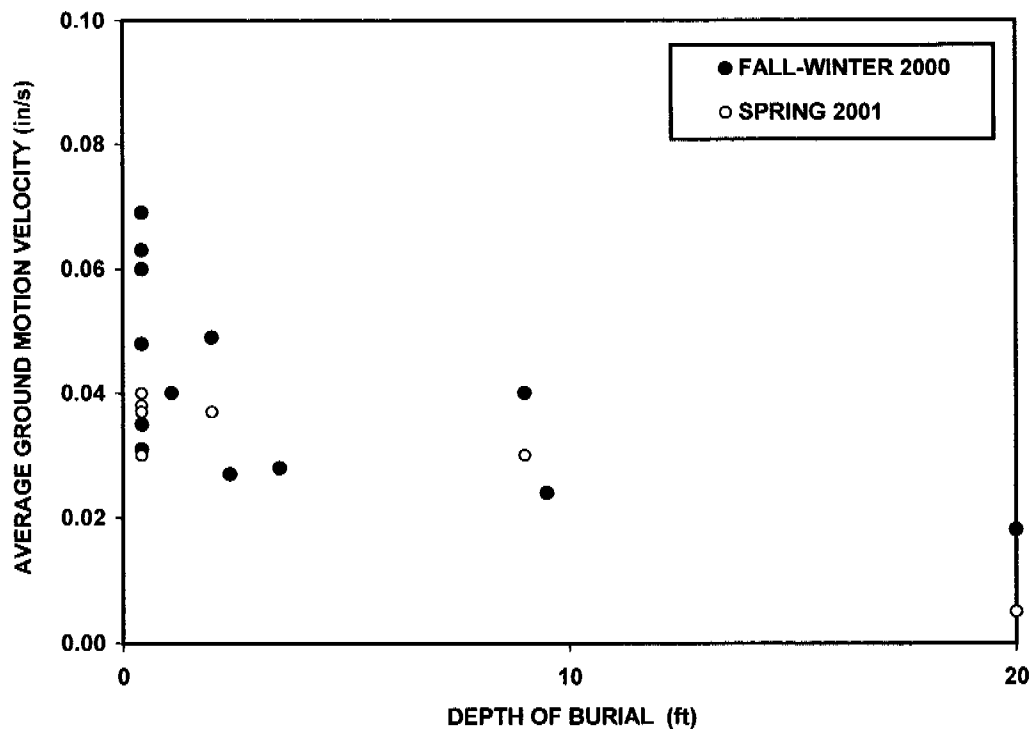


Figure (2) Average ground motion velocity versus depth of burial for fall-winter 2000 and spring 2001

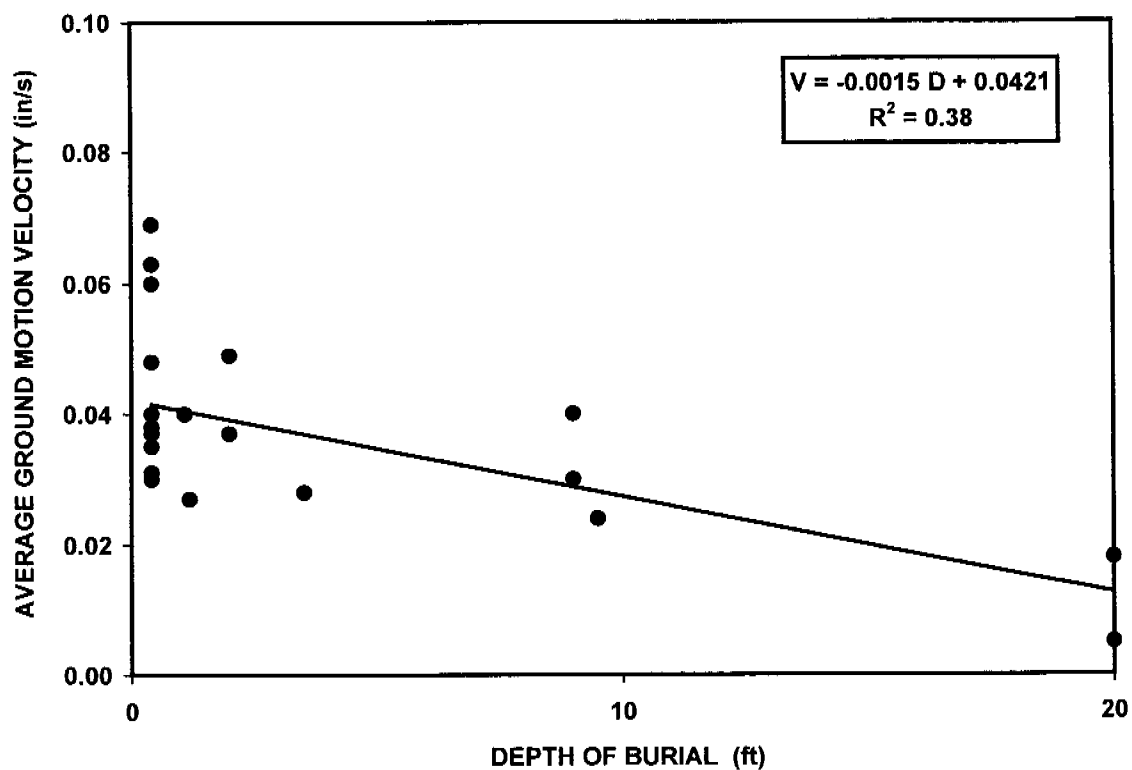


Figure (2) Average ground motion velocity versus depth of burial for fall-winter 2000 and spring 2001

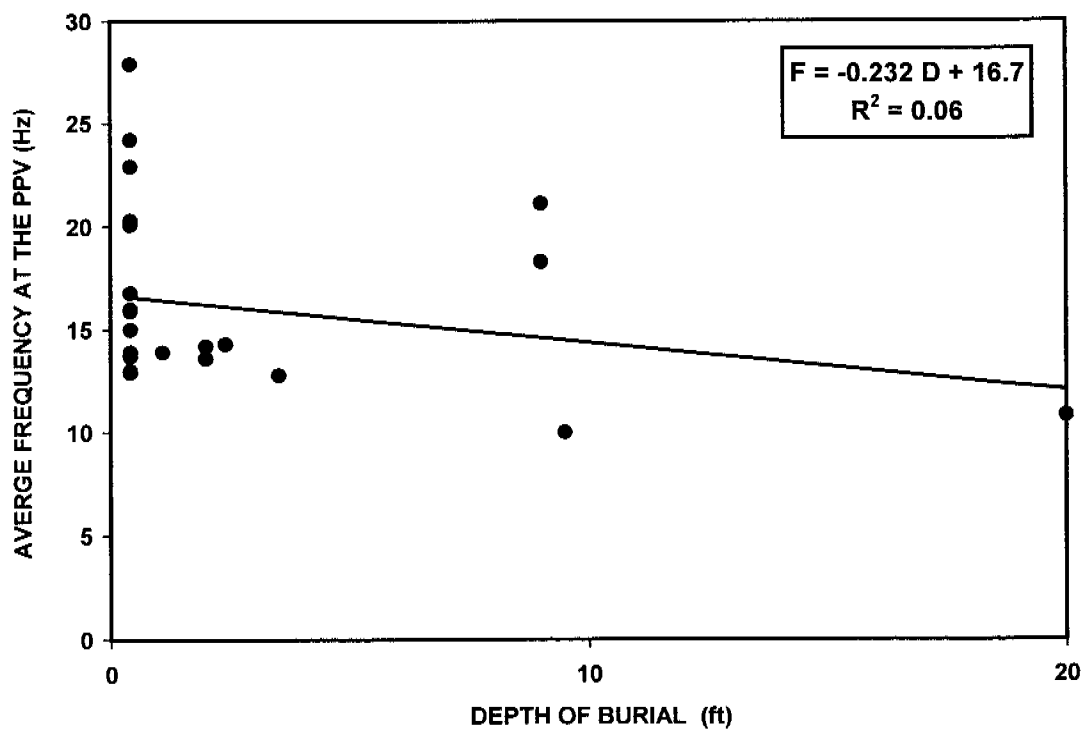


Figure (4) Average peak frequency versus depth of burial for fall-winter 2000 and spring 2001

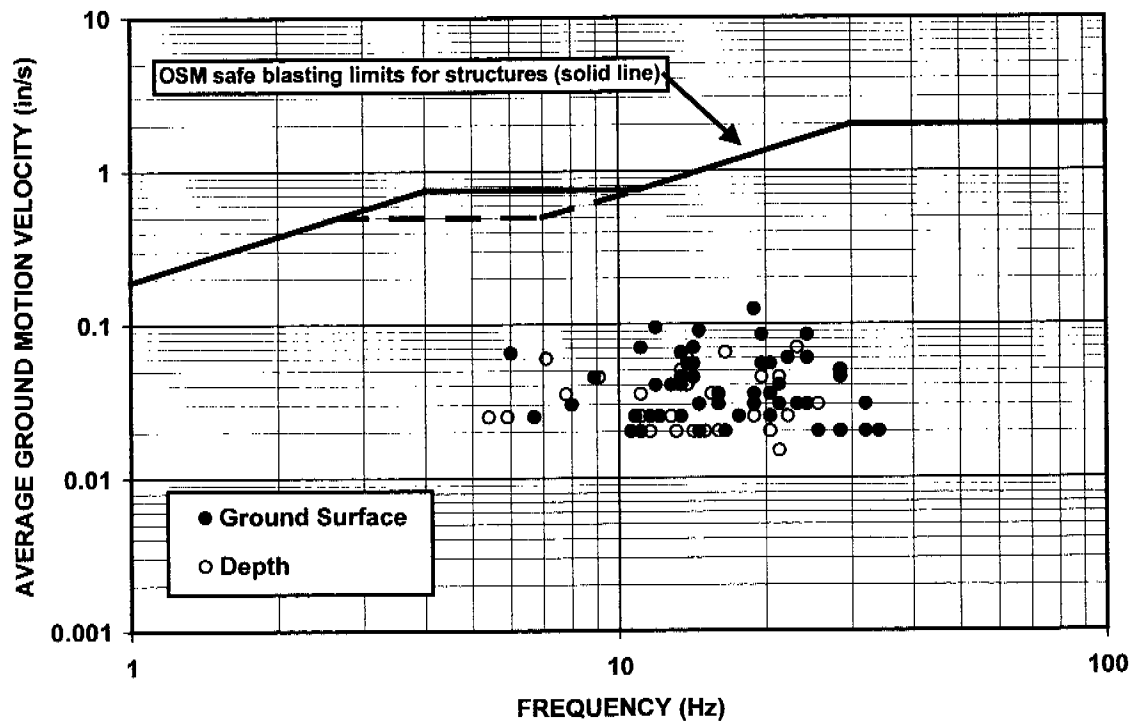


Figure (5) Peak particle velocity versus peak frequency for 2000 data

The best-fit trend line giving the decrease in frequency at the PPV with burial depth, shown in Figure (4), is

$$F (\text{average}) = - 0.232 D + 16.7 \quad ()$$

where F is the average peak frequency, in Hz, and D is the burial distance, in ft.

Figure (5) shows the relationship between peak particle velocity and frequency at the peak for 2000 data, plotted on the Office of Surface Mining (OSM) blasting- level chart (1986). It is difficult to distinguish the frequency differences between surface and buried ground motions. All data fell between 5.4 Hz and 34.1 Hz

Vibration Data from Well Pumping

Well pumping did not produce detectable ground motions. The geophone placed in WV-1 well 2 at 20 ft. depth did not trigger during the 2000 monitoring period. All other geophones at depth were placed in dry (abandoned) wells or in the ground near the pumping well. It is expected that ground water pumping may produce localized ground motions that are well below the detectable limits of blasting seismographs. Hence no motion data was recorded.

References

Office of Surface Mining, (1986) Federal Register Cite: 51 FR 19444 (19461)

Table Summary of shot records and vibration and airblast monitoring at wells during the fall and winter of 2000

Well location	Shot Date	Time	Distance	Charge Weight per Delay	Scaled Distance	GROUND MOTION AND AIRBLAST				AT DEPTH			
						UNIT	Peak Particle Velocity	Peak Frequency	Airblast	Geophone Depth	UNIT	Peak Particle Velocity	Peak Frequency
			(ft)	(lb)	(ft/lb ^{1/3})		(in/sec)	(Hz)	(dB)	(ft)		(in/sec)	(Hz)
VA-1	11/6/00	16:57	1293	337	70.4	1181	0.04	12.8	118	1.1	1180	0.04	11.9
	11/7/00	16:41	1380	361	72.6	1181	NO	TRIGGER			1180	0.02	15
	11/8/00	16:45	1293	361	68.1	1181	0.045	13.4	117		1180	0.04	13.8
	11/9/00	12:55	1380	313	78.0	1181	0.055	19.6	119		1180	0.045	19.6
	11/10/00	13:20	1353	361	71.2	1181	0.055	13.8	118		1180	0.055	13.8
	11/11/00	14:48	1298	361	68.3	1181	0.045	8.9	126		1180	0.045	9.1
KY-1 well 1	11/13/00	16:04	4800	684	183.5	804	0.030	24.3	100	3.5	809	NO	TRIGGER
	11/14/00	16:18	5000	936	163.4	804	0.025	13.4	106		809	0.020	16
	11/15/00	11:49	2020	828	70.2	804	0.055	20.4	112		809	NO	TRIGGER
	11/16/00	9:07	5140	1026	160.5	804	0.020	10.6	106		809	0.020	14.2
	11/16/00	16:00	2240	414	110.1	804	0.025	10.8	110		809	0.020	15
	11/17/00	12:15	1830	936	59.8	804	0.025	12.1	110		809	0.020	11.6
	11/17/00	12:34	2020	1044	62.5	804	0.065	6.0	120		809	0.060	7.1
KY-1 well 2	11/13/00	16:04	4760	684	182.0	849	0.03	21.3	<100	2.4	853	0.025	22.2
	11/14/00	16:18	4880	936	159.5	849	0.035	16.0	106		853	0.025	12.8
	11/15/00	11:49	2200	828	76.5	849	0.04	11.9	112		853	0.035	11.1
	11/16/00	9:07	5020	1026	156.7	849	0.025	17.6	100		853	0.02	20.4
	11/16/00	16:00	2420	414	118.9	849	0.025	11.6	106		853	0.025	11.1
	11/17/00	12:15	1720	936	56.2	849	0.025	20.4	110		853	0.02	15
	11/17/00	12:34	2310	1044	71.5	849	0.04	18.9	118		853	0.035	7.8
KY-2 well 1	11/20/00	13:03	2000	274	120.8	849	0.025	6.7	114	9.5	809	0.025	5.9
	11/20/00	16:08	2010	495	90.3	849	0.030	23.2	119		809	0.02	16.5
	11/20/00	16:45	2380	211	163.8	849	0.020	28.4	100		809	NO	TRIGGER
	11/21/00	14:37	2110	274	127.5	849	0.020	32.0	114		809	NO	TRIGGER
	11/21/00	15:35	1560	211	107.4	849	0.045	14.2	110		809	0.025	12.1
	11/21/00	16:43	3720	807	131.0	849	0.045	28.4	100		809	NO	TRIGGER
	11/22/00	10:13	1960	678	75.3	849	0.030	8	110		809	0.025	5.4
KY-2 well 2	11/20/00	10:32	4640	183	343.0	804	0.02	14.6	100	NOT MONITORED			
	11/20/00	16:09	1810	495	81.4	804	0.035	16	120				
	11/21/00	14:38	1960	274	118.4	804	0.03	16	118				
	11/21/00	15:35	1740	211	119.8	804	0.04	13.4	116				
	11/21/00	16:41	3810	808	134.0	804	0.03	14.6	110				
	11/21/00	16:43	2500	209	172.9	804	0.04	21.3	110				
	11/22/00	10:14	2210	678	84.9	804	0.02	11.1	114				
WV-1 well 1	11/27/00	16:56	2500	1037	77.6	1782	0.07	11.1	117	2.0	1781	0.065	16.5
	11/28/00	17:03	2230	126	198.7	1782	NO	TRIGGER			1781	0.02	13.1
	11/29/00	9:51	4300	2076	94.4	1782	0.055	14.2	110		1781	0.05	13.4
	11/30/00	11:53	3880	2076	85.2	1782	0.065	13.4	110		1781	0.06	13.8
WV-1 well 2	11/27/00	16:01	2600	1037	80.7	1780	0.095	11.9	122	20.0	1779	0.025	10.8
	11/28/00	17:05	2310	126	205.8	1780	0.020	14.6	114		1779	NO	TRIGGER
	11/29/00	9:56	3960	2076	86.9	1780	0.090	14.6	110		1779	0.015	
	11/30/00	11:58	3980	2076	87.4	1780	0.070	14.2	112		1779	0.015	
WV-2 well 1	12/4/00	12:23	1710	481	78.0	1782	0.125	18.9	112	9.0	1780	0.07	23.2
	12/4/00	17:01	2240	415	110.0	1782	0.085	24.3	112		1780	0.045	21.3
	12/5/00	12:05	2440	973	78.2	1782	0.05	28.4	116		1780	0.03	25.6
	12/5/00	16:51	2070	625	82.8	1782	0.06	22.2	116		1780	0.035	15.5
	12/5/00	16:52	2520	901	84.0	1782	0.02	34.1	112		1780	NO	TRIGGER
	12/6/00	12:22	2460	901	82.0	1782	0.02	25.6	112		1780	0.015	21.3
	12/6/00	16:48	1560	452	73.4	1782	0.085	19.6	114		1780	0.06	22.2
	12/7/00	12:13	2460	793	87.4	1782	0.035	20.4	106		1780	0.025	18.9
WV-2 well 2	12/5/00	12:05	2520	973	80.8	1779	0.030	18.9	117	NOT MONITORED			
	12/5/00	16:53	2130	625	85.2	1779	0.030	32	116				
	12/6/00	16:50	1630	452	76.7	1779	0.060	24.3	117				
	12/7/00	12:13	2520	793	89.5	1779	0.020	16.5	110				

Table Summary of vibration and airblast monitoring at wells during the spring of 2001

Well location	Shot Date	Time	GROUND MOTION AND AIRBLAST				AT DEPTH			
			UNIT	Peak Particle Velocity	Peak Frequency	Airblast	Geophone Depth	UNIT	Peak Particle Velocity	Peak Frequency
				(In/sec)	(Hz)	(dB)	(ft)		(In/sec)	(Hz)
VA-1	resident on city water - no longer using well									
KY-1	site flooded from sediment pond overflow - no access to wells									
KY-2	seismographs did not trigger for 15 shots (trigger level not indicated)									
WV-1 well 1	4/3/01	8:41	1781	0.03	12.1	114	2.0	1782	0.025	12.4
	4/3/01	13:51	1781	0.03	15	110		1782	0.03	15
	4/3/01	17:06	1781	0.025	10.8	114		1782	NO	TRIGGER
	4/4/01	11:20	1781	0.05	12.8	110		1782	0.045	13.1
	4/5/01	10:34	1781	0.055	16	106		1782	0.05	15
	4/6/01	10:22	1781	0.05	12.1	106		1782	0.05	12.4
	4/6/01	15:43	1781	0.06	13.8	112		1782	0.06	13.4
	4/9/01	12:41	1781	0.04	14.2	114		1782	0.03	15.5
	4/9/01	16:35	1781	0.025	12.8	110		1782	NO	TRIGGER
	4/10/01	15:45	1781	0.045	14.2	116		1782	0.04	13.8
	4/10/01	16:53	1781	0.035	13.4	100		1782	0.035	14.2
	4/11/01	9:57	1781	0.025	8.6	116		1782	NO	TRIGGER
	4/12/01	10:37	1781	0.035	11.6	114		1782	0.03	13.8
	4/12/01	12:22	1781	0.03	14.2	114		1782	0.03	12.4
	4/13/01	10:30	1781	0.035	11.9	112		1782	0.03	12.1
WV-1 well 2	4/2/01	8:38	1779	0.025	15.5	114	20.0	1780	NO	TRIGGER
	4/3/01	13:48	1779	0.035	14.2	110		1780	NO	TRIGGER
	4/3/01	17:03	1779	0.025	13.1	118		1780	0.005	
	4/4/01	11:18	1779	0.045	11.9	110		1780	NO	TRIGGER
	4/5/01	10:31	1779	0.080	14.2	106		1780	NO	TRIGGER
	4/6/01	10:19	1779	0.055	13.8	106		1780	NO	TRIGGER
	4/6/01	15:40	1779	0.055	14.6	114		1780	NO	TRIGGER
	4/9/01	12:39	1779	0.035	13.1	116		1780	NO	TRIGGER
	4/10/01	15:42	1779	0.035	18.2	118		1780	0.005	
	4/11/01	9:54	1779	0.005		119		1780	0.005	
	4/12/01	10:35	1779	0.030	12.8	119		1780	0.005	
	4/12/01	12:20	1779	0.030	14.2	116		1780	NO	TRIGGER
	4/12/01	17:02	1779	0.025	13.4	118		1780	0.005	
	4/13/01	10:27	1779	0.040	12.8	114		1780	NO	TRIGGER
	WV-2 well 1	4/16/01	16:50	1781	0.075	32		110	9.0	1782
4/18/01		16:51	1781	0.035	10.8	116	1782	NO		TRIGGER
4/18/01		16:54	1781	0.03	22.2	106	1782	0.025		10.4
4/19/01		8:55	1781	0.035	24.3	110	1782	0.025		22.2
4/19/01		16:52	1781	0.025	12.4	106	1782	NO		TRIGGER
WV-2 well 2	4/16/01	16:49	1779	0.035	30.1	112	na	1780	0.03	34.1
	4/18/01	16:50	1779	0.025	25.6	118		1780	NO	TRIGGER
na	not	available								

Table Summary of vibration and airblast monitoring at wells during the fall of 2001

Well location	Shot Date	Time	GROUND MOTION AND AIRBLAST				AT DEPTH			
			UNIT	Peak Particle Velocity	Peak Frequency	Airblast	Geophone Depth	UNIT	Peak Particle Velocity	Peak Frequency
				(in/sec)	(Hz)	(dB)	(ft)		(in/sec)	(Hz)
VA-1	resident on city water - no longer using well									
KY-1	site flooded from sediment pond overflow - no access to wells									
KY-2 well 2	9/21/01	14:25	809	0.020	14.2	125	NOT MONITORED			
	9/24/01	13:53	809	0.030	14.6	100				
	9/25/01	12:37	809	0.030	11.6	<100				
	9/25/01	15:44	809	0.025	23.2	116				
KY-2 well 3	9/21/01	10:32	813	0.03	9.4	118	NOT MONITORED			
	9/22/01	11:43	813	0.02	16.5	106				

ave 0.026 14.917 113.000

Table Summary of vibration and airblast monitoring at wells during the winter of 2001

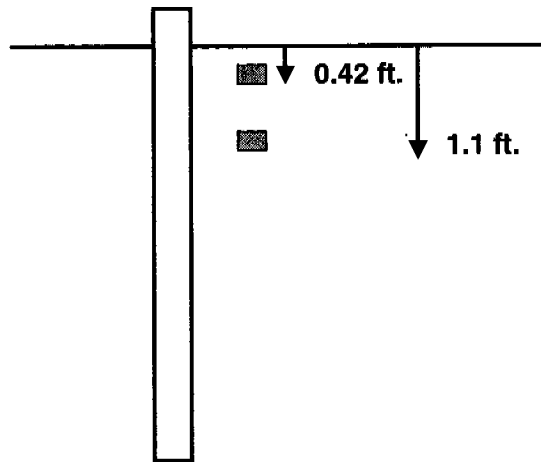
Well location	Shot Date	Time	GROUND MOTION AND AIRBLAST				AT DEPTH			
			UNIT	Peak Particle Velocity	Peak Frequency	Airblast	Geophone Depth	UNIT	Peak Particle Velocity	Peak Frequency
				(in/sec)	(Hz)	(dB)	(ft)		(in/sec)	(Hz)
VA-1	resident on city water - no longer using well									
KY-1	site flooded from sediment pond overflow - no access to wells									
KY-2	seismographs did not trigger for 15 shots (trigger level not indicated)									
WV-1 well 1	well not monitored - transducer at depth missing (NOTHING IN BUDROW'S NOTES!!)									
WV-1 well 2	12/4/01	16:44	1769	0.033	13.4	106	20.0	1905	NO	TRIGGER
	12/5/01	16:46	1769	0.033	15.5	110		1905	NO	TRIGGER
	12/5/01	16:50	1769	0.053	16	114		1905	NO	TRIGGER
WV-2 well 1	well not monitored									
WV-2 well 2	well not monitored									

Table Average ground motion, airblast and frequency values for wells measured during the fall of 2001

SITE	WELL	FALL 2001						
		Surface				At Depth		
		Peak Particle Velocity	Peak Frequency	FFT Frequency	Airblast	Peak Particle Velocity	Peak Frequency	FFT Frequency
		(ips)	(Hz)	(Hz)	(dB)	(ips)	(Hz)	(Hz)
VA-1	well 1	resident on city water - no longer using well						
KY-1	well 1	site flooded from sediment pond overflow - no access to wells						
	well 2							
KY-2	well-1	deep transducer cable cut						
	well-2	0.026	15.9	8.7	114	not monitored		
	well 3	0.025	13.0	NA	112	not monitored		
WV-1	well 1	not monitored						
	well 2	not monitored						
WV-2	well 1	not monitored						
	well-2	not monitored						

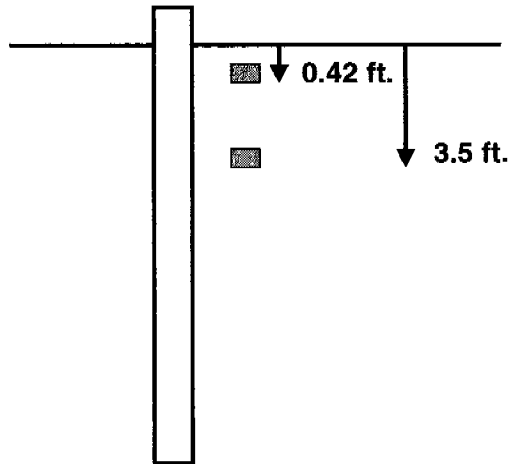
NA not available; data within the resolution of the seismograph and frequencies cannot be reliably calculated

VA-1



KY-1

well 1



well 2

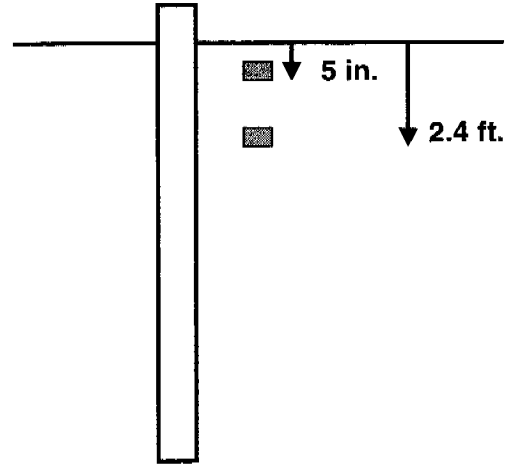
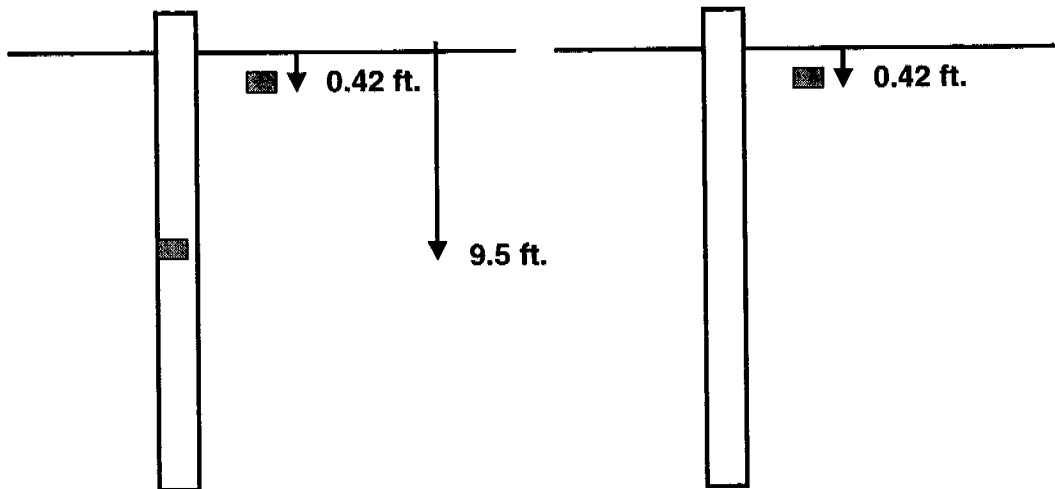


Figure 1 Geophone locations within or adjacent to wells

well 1

well 2



WV-1

well 1

well 2

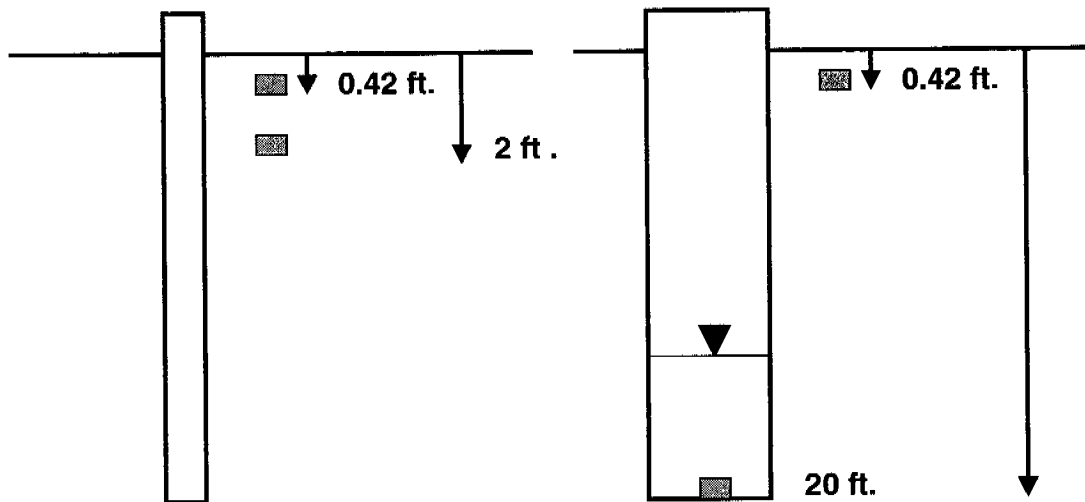


Figure 1 (cont.)

WV-2

well 1

well 2

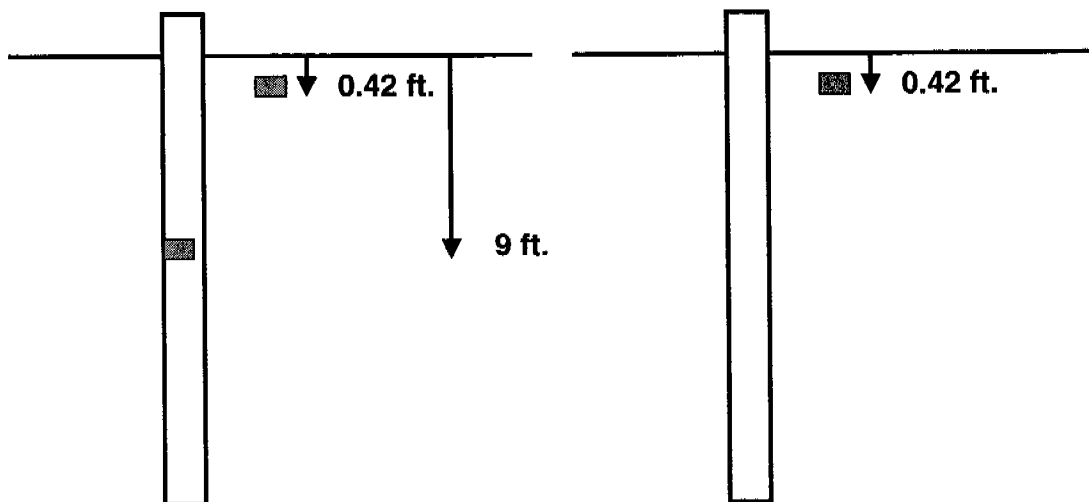


Figure 1 (cont.)

Volume II
Full Waveform Vibration Data

FALL-WINTER 2000

Hylton Well

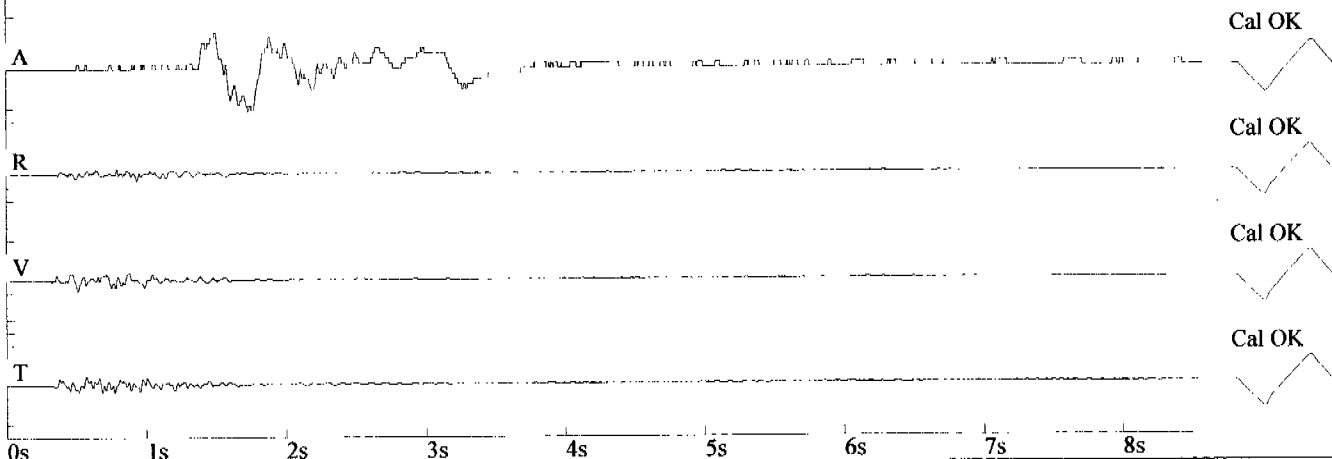
File: 01181062.DTB Event Number: 062 Date: 11/06/2000 Time: 16:57
 Acoustic Trigger: 126 dB Seismic Trigger: 0.03in/s 0.762mm/s Serial Number: 1181

Amplitudes and Frequencies

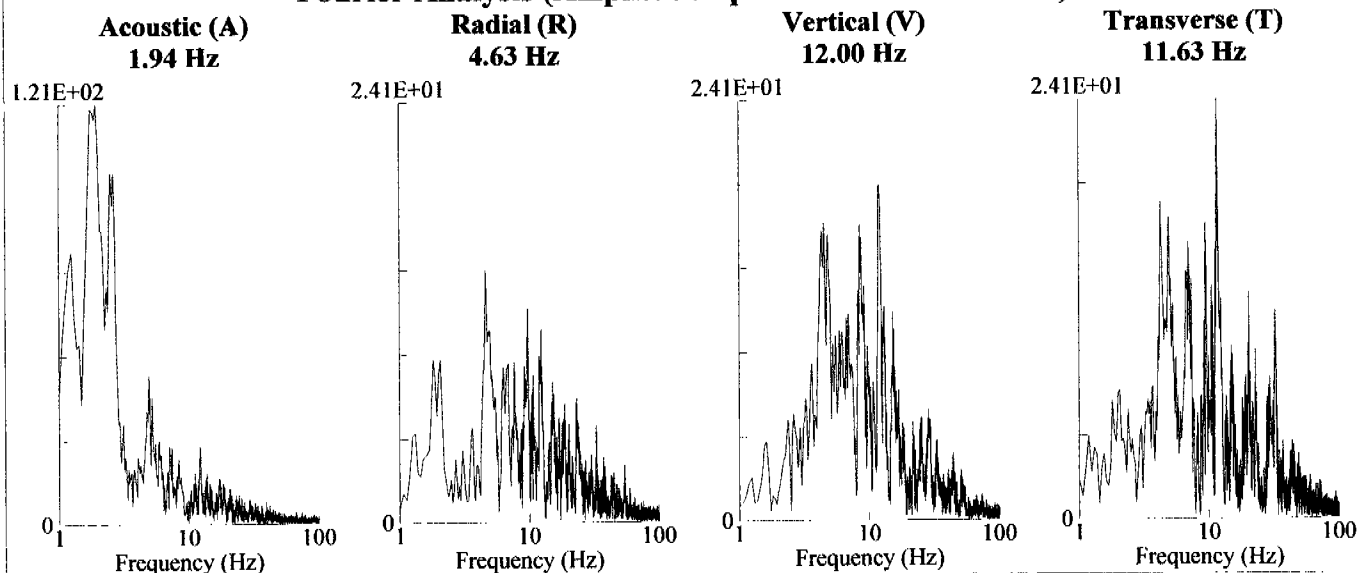
Acoustic (A): 118 dB @ 2.1 Hz
 (0.16Mb 0.0023psi 0.0160kPa)
Radial (R): 0.025in/s 0.635mm/s @ 21.3Hz
Vertical (V): 0.04in/s 1.016mm/s @ 12.8Hz
Transverse (T): 0.035in/s 0.889mm/s @ 10.6Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
 120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Hylton Well
26 in. deep

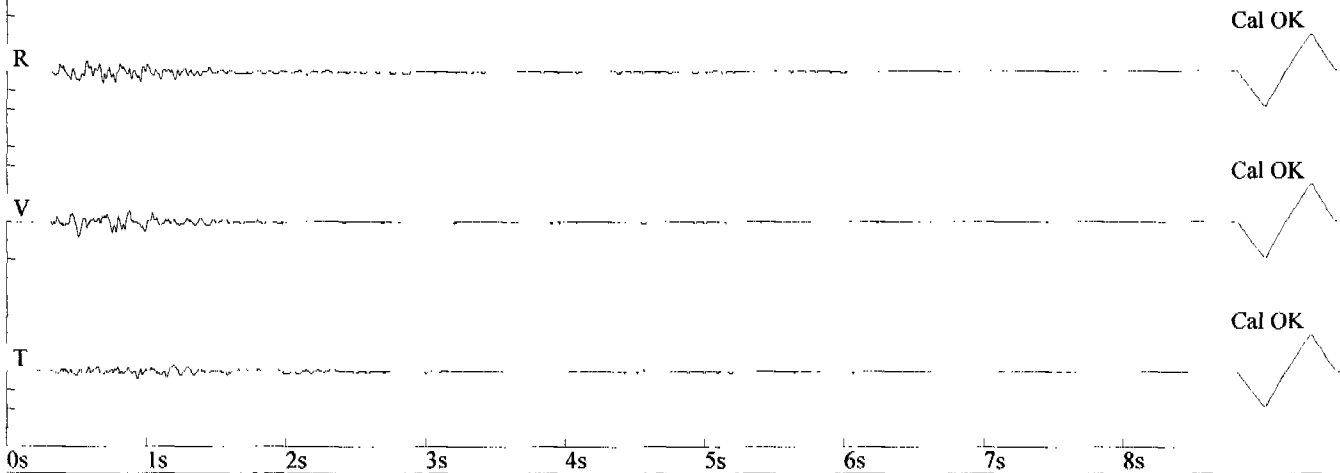
File: 01180000.DTB Event Number: 000 Date: 11/06/2000 Time: 16:57
Acoustic Trigger: 142 dB Seismic Trigger: 0.03in/s 0.762mm/s Serial Number: 1180

Amplitudes and Frequencies

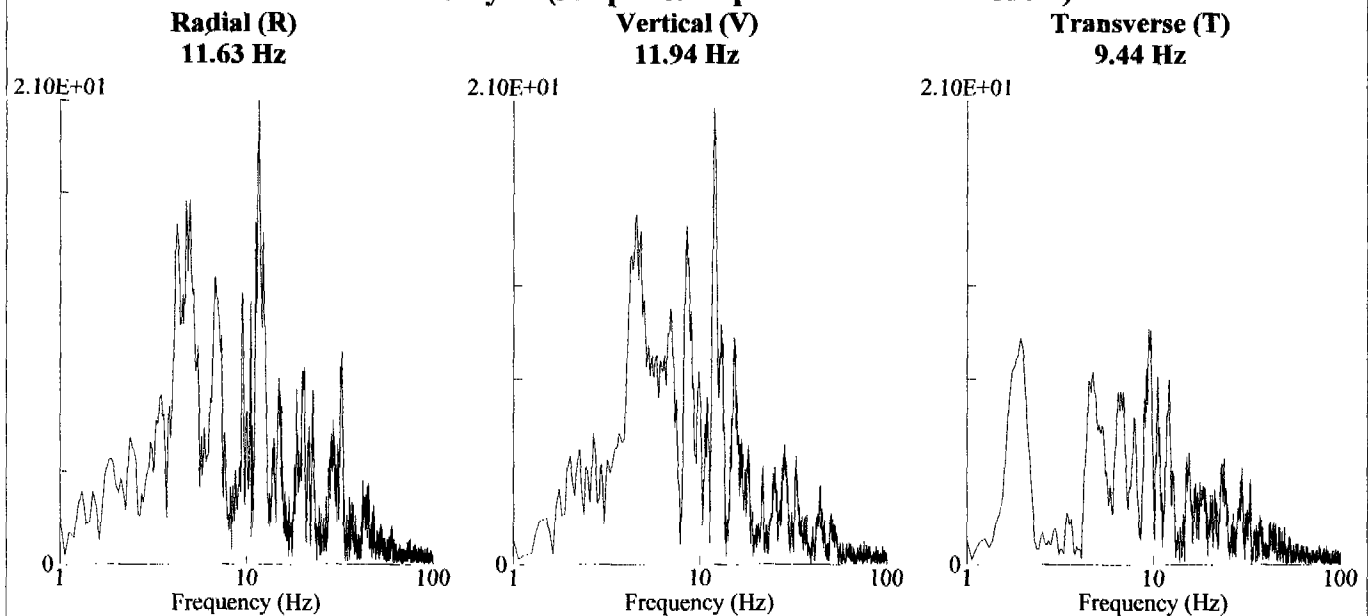
Radial (R): 0.03in/s 0.762mm/s @ 11.1Hz
Vertical (V): **0.04in/s 1.016mm/s @ 11.9Hz**
Transverse (T): 0.02in/s 0.508mm/s @ 20.4Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Hylton Well
26 in. deep

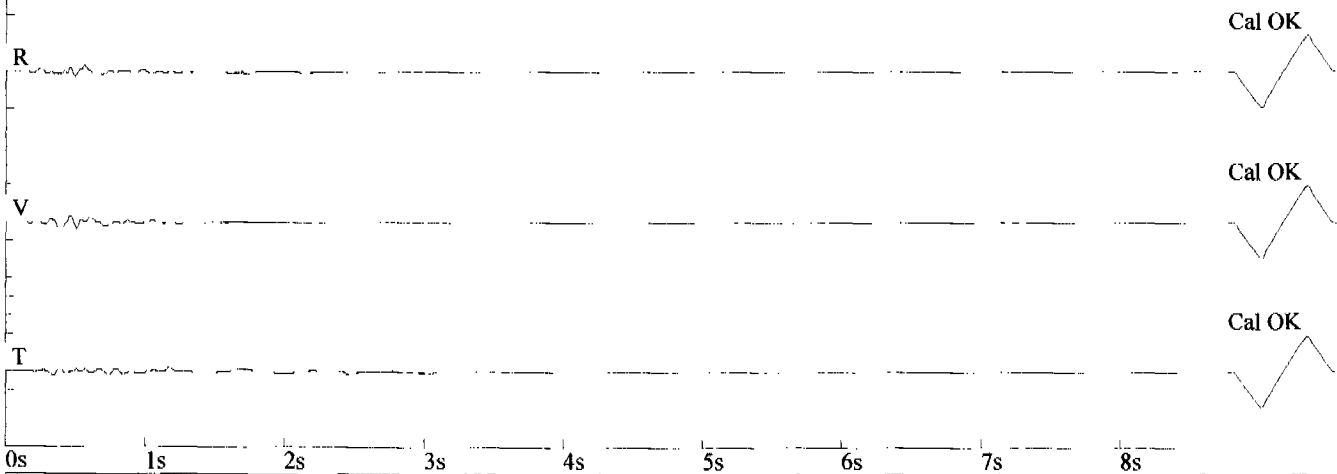
File: 01180001.DTB Event Number: 001 Date: 11/07/2000 Time: 16:41
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1180

Amplitudes and Frequencies

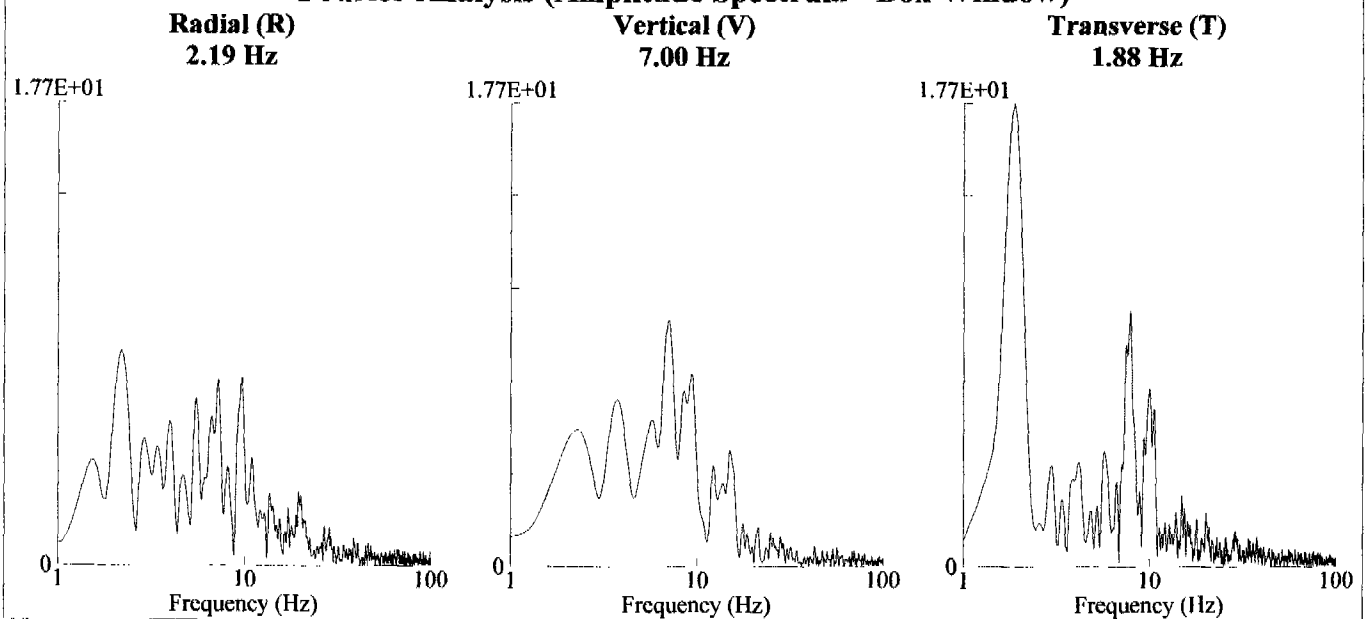
Radial (R): 0.015in/s 0.381mm/s @ 11.9Hz
Vertical (V): **0.02in/s 0.508mm/s @ 15.0Hz**
Transverse (T): 0.01in/s 0.254mm/s @ 10.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Hylton Well

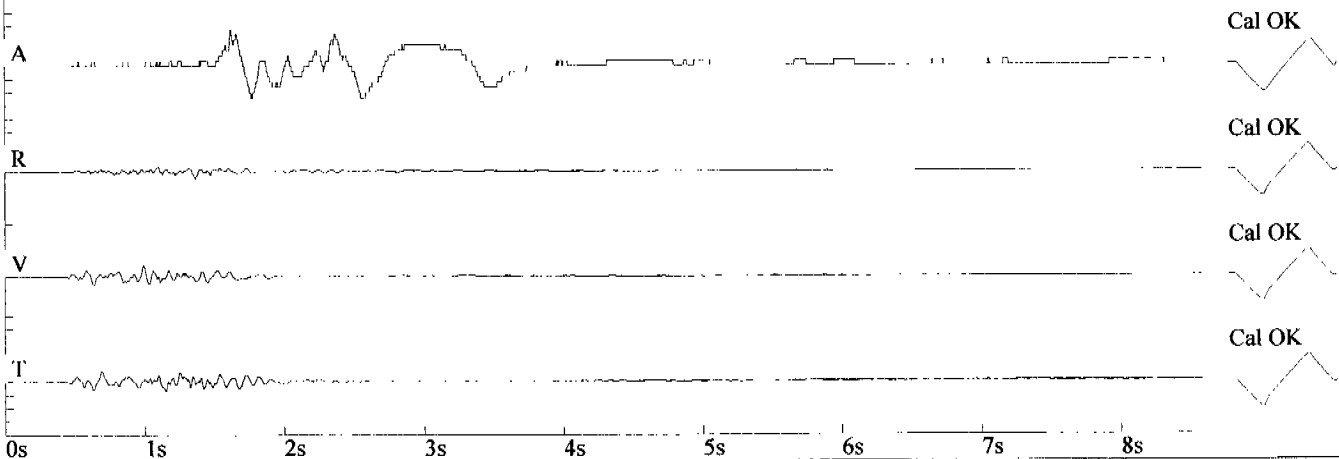
File: 01181063.DTB Event Number: 063 Date: 11/08/2000 Time: 16:45
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1181

Amplitudes and Frequencies

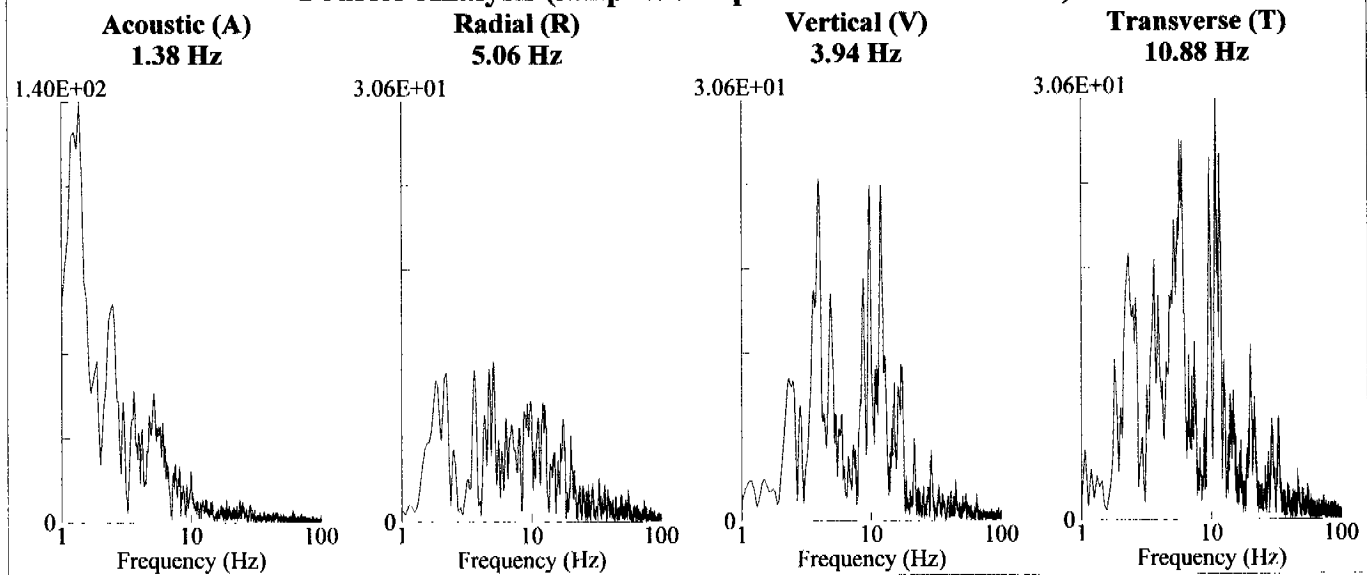
Acoustic (A): 117 dB @ 2.9 Hz
(0.14Mb 0.0020psi 0.0140kPa)
Radial (R): 0.025in/s 0.635mm/s @ 12.4Hz
Vertical (V): 0.045in/s 1.143mm/s @ 13.4Hz
Transverse (T): 0.04in/s 1.016mm/s @ 8.2Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**Hylton Well
26 in. deep**

File: 01180002.DTB Event Number: 002 Date: 11/08/2000 Time: 16:45
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1180

Amplitudes and Frequencies

Radial (R): 0.035in/s 0.889mm/s @ 9.4Hz

Vertical (V): **0.04in/s 1.016mm/s @ 13.8Hz**

Transverse (T): 0.02in/s 0.508mm/s @ 11.6Hz

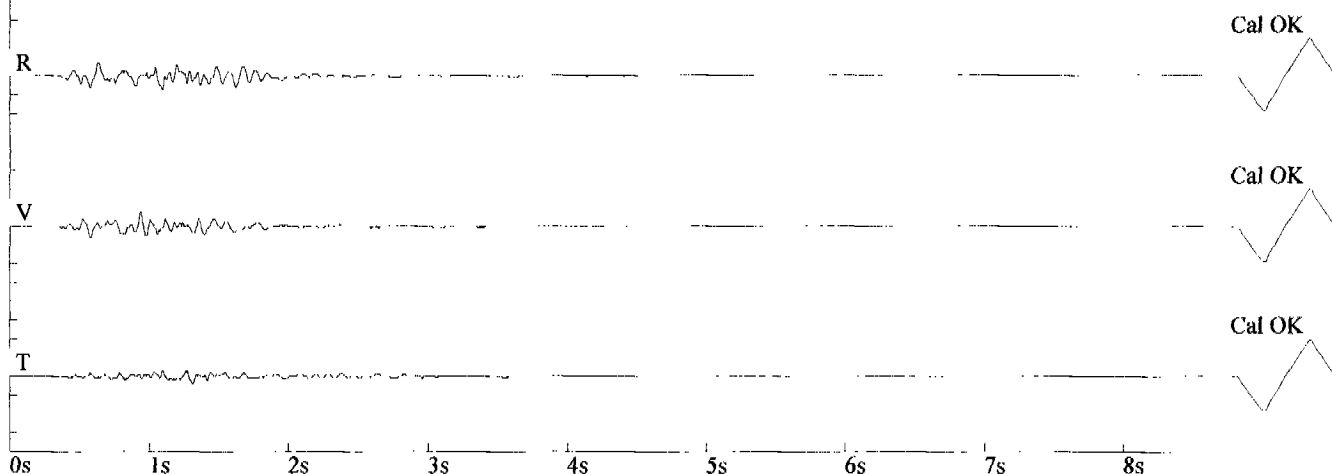
Graph Information

Duration: 0.000 sec To: 8.500 sec

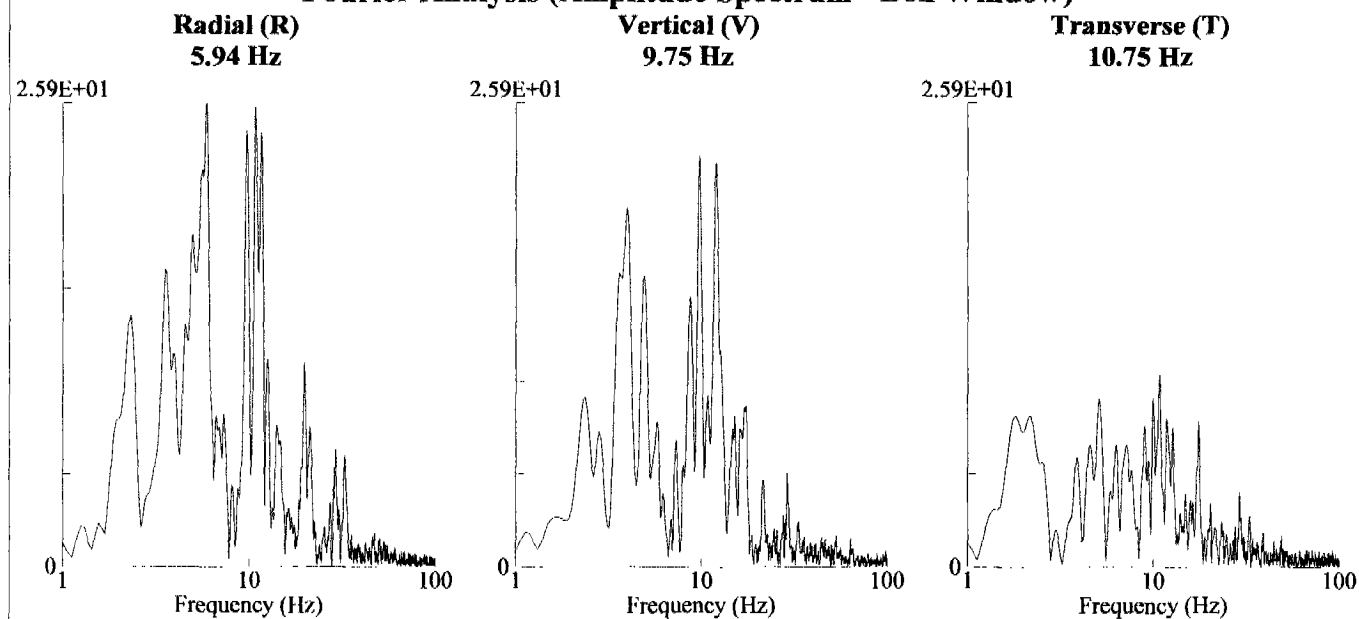
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Hylton Well

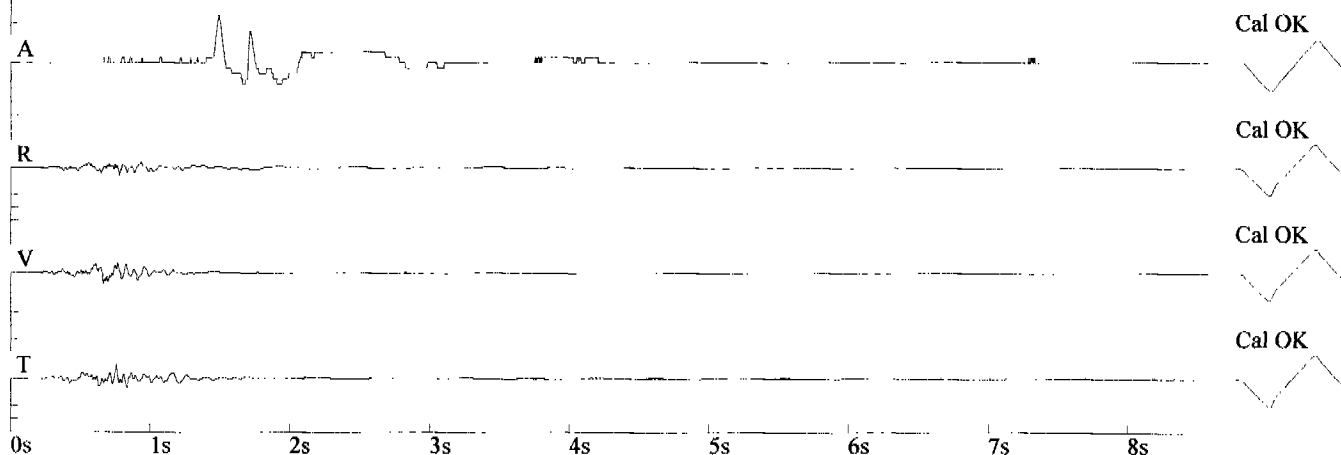
File: 01181064.DTB Event Number: 064 Date: 11/09/2000 Time: 12:55
 Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1181

Amplitudes and Frequencies

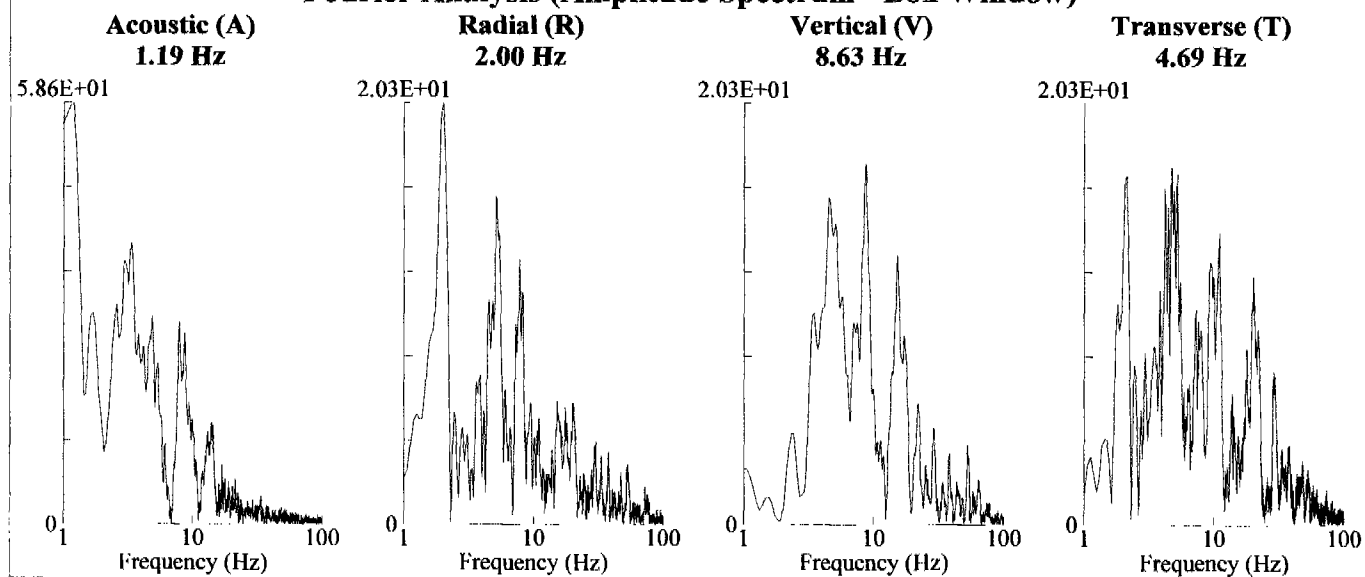
Acoustic (A): 119 dB @ 6.5 Hz
 (0.18Mb 0.0026psi 0.0180kPa)
Radial (R): 0.025in/s 0.635mm/s @ 8.2Hz
Vertical (V): 0.04in/s 1.016mm/s @ 10.6Hz
Transverse (T): 0.055in/s 1.397mm/s @ 19.6Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
 120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Hylton Well
26 in. deep

File: 01180003.DTB Event Number: 003 Date: 11/09/2000 Time: 12:55
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1180

Amplitudes and Frequencies

Radial (R): 0.045in/s 1.143mm/s @ 19.6Hz

Vertical (V): 0.04in/s 1.016mm/s @ 6.4Hz

Transverse (T): 0.02in/s 0.508mm/s @ 26.9Hz

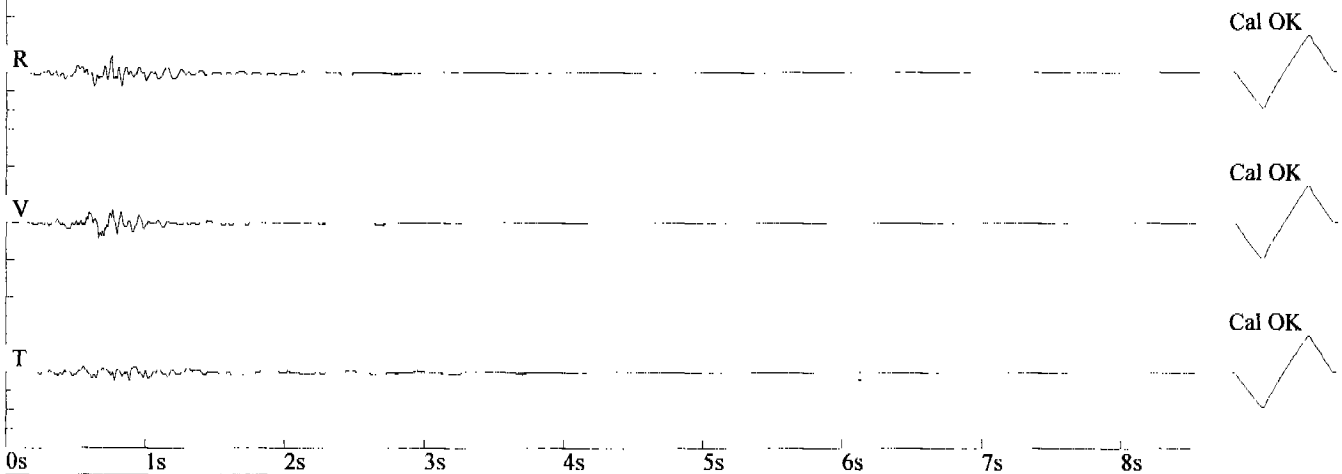
Graph Information

Duration: 0.000 sec To: 8.500 sec

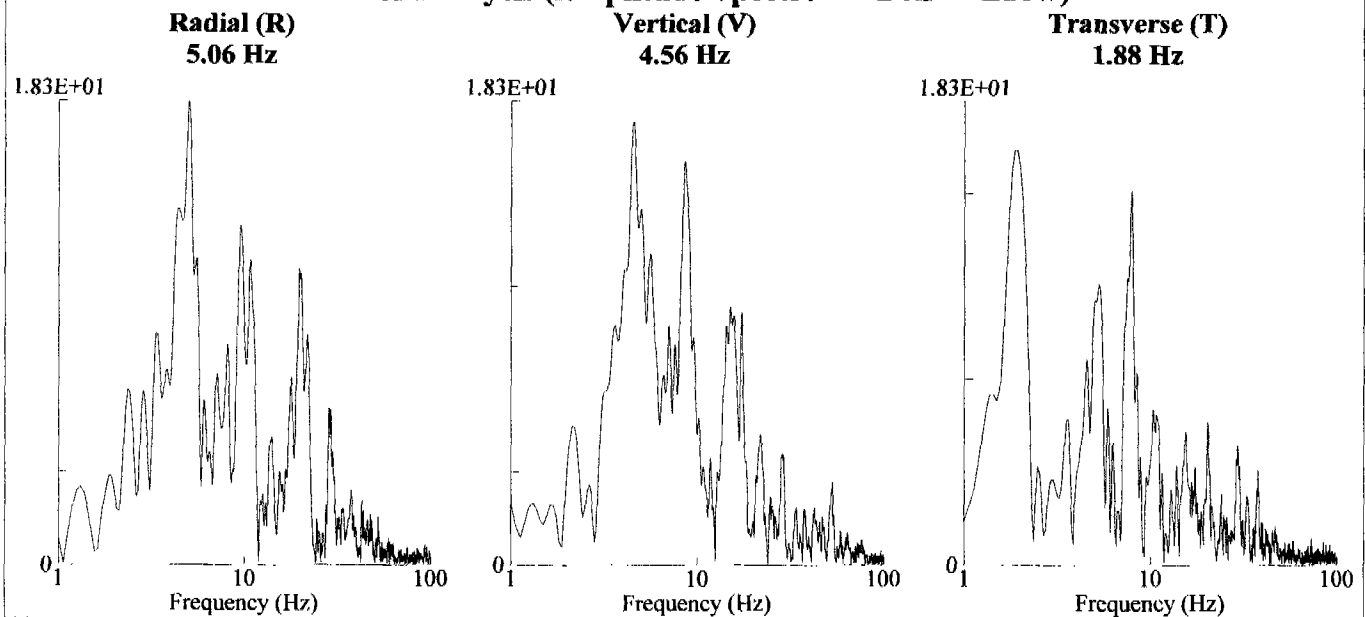
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Hylton Well

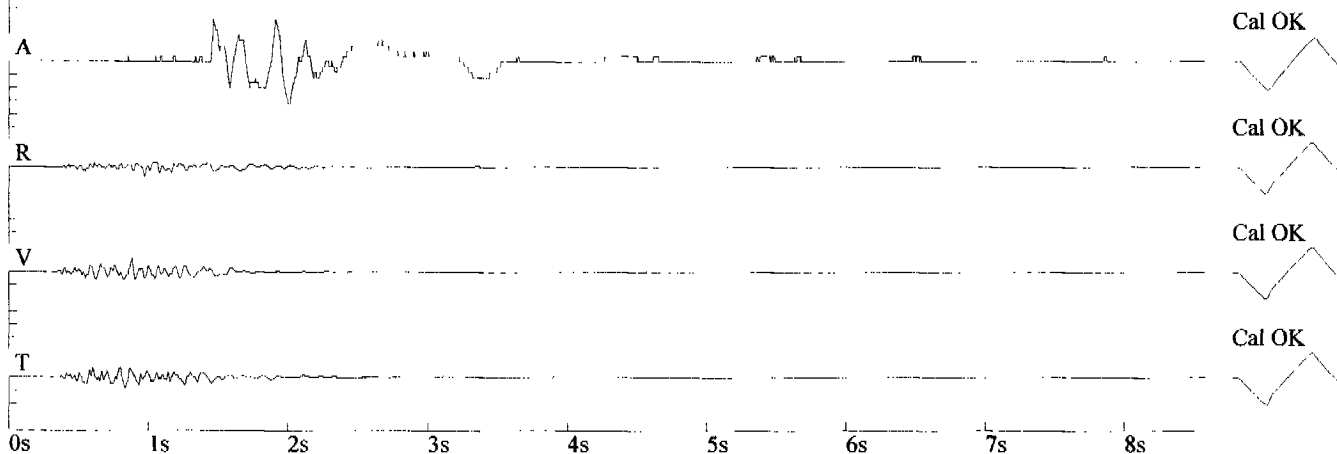
File: 01181066.DTB Event Number: 066 Date: 11/10/2000 Time: 13:20
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1181

Amplitudes and Frequencies

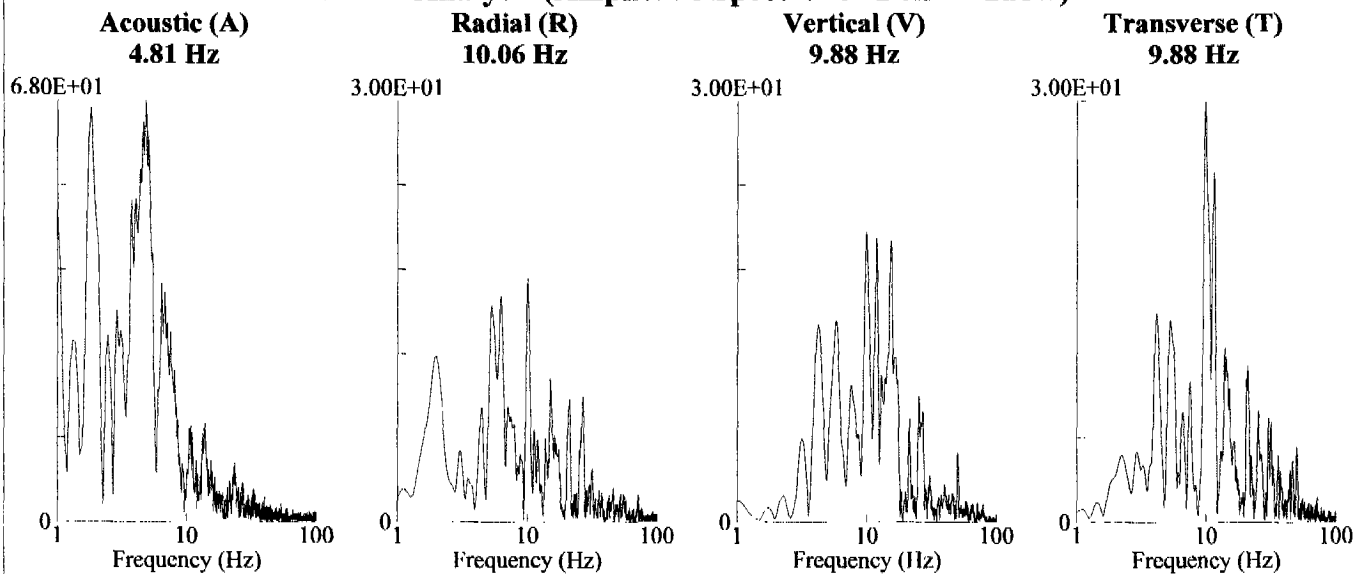
Acoustic (A): 118 dB @ 4.6 Hz
(0.16Mb 0.0023psi 0.0160kPa)
Radial (R): 0.035in/s 0.889mm/s @ 18.2Hz
Vertical (V): 0.055in/s 1.397mm/s @ 13.8Hz
Transverse (T): 0.04in/s 1.016mm/s @ 14.6Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Hylton Well
26 in. deep

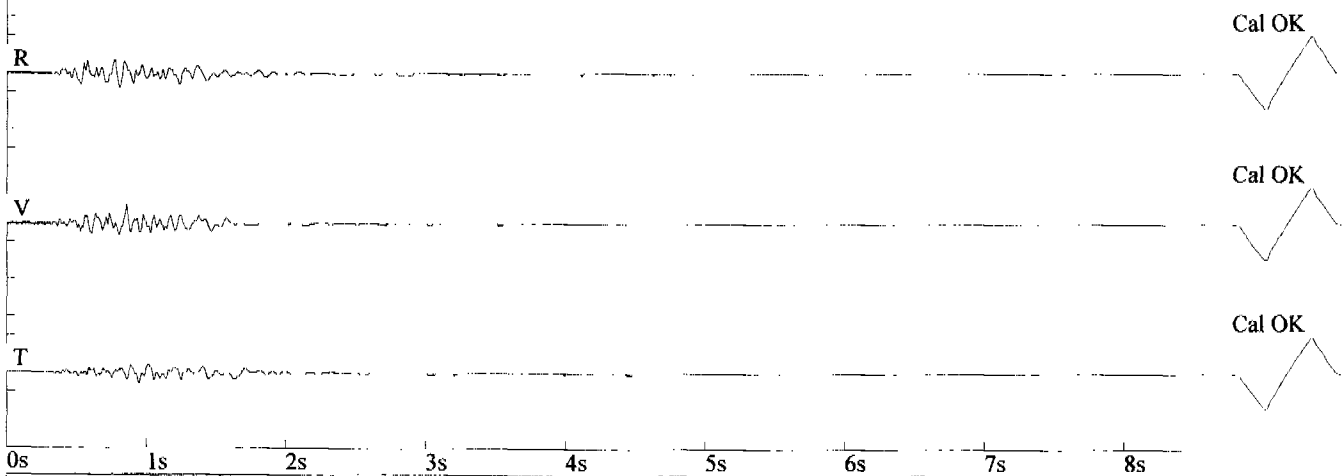
File: 01180004.DTB Event Number: 004 Date: 11/10/2000 Time: 13:20
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1180

Amplitudes and Frequencies

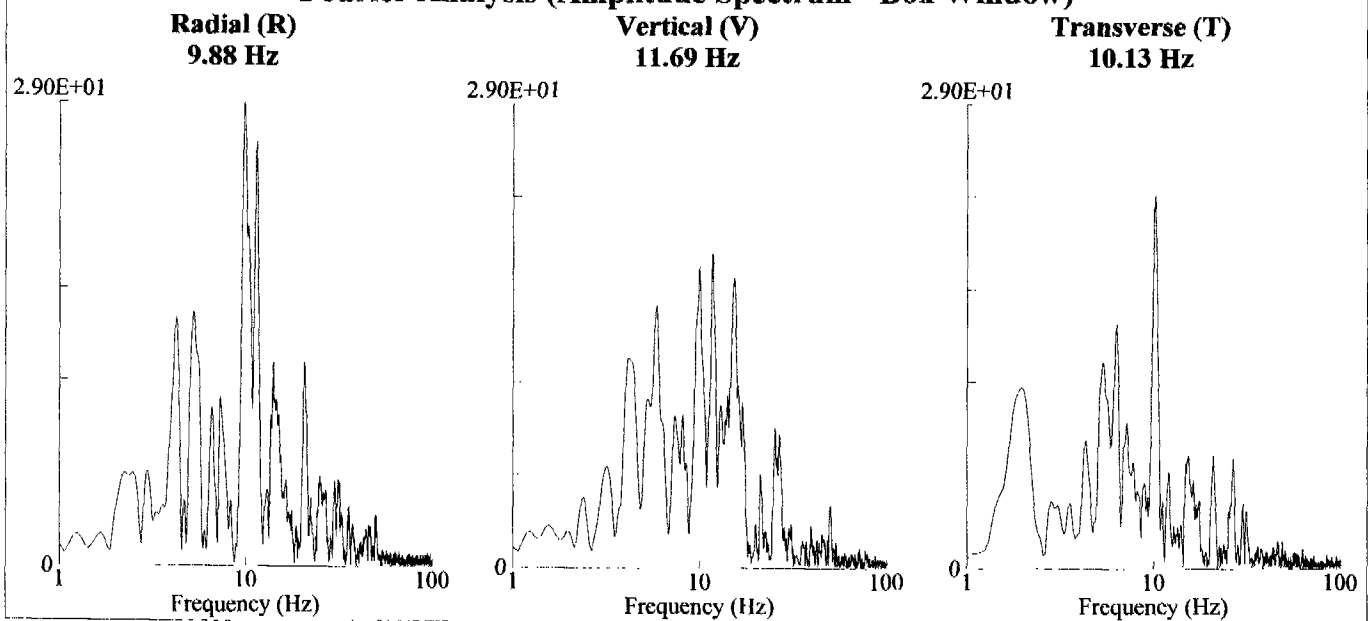
Radial (R): 0.04in/s 1.016mm/s @ 12.4Hz
Vertical (V): **0.05in/s 1.27mm/s @ 14.6Hz**
Transverse (T): 0.03in/s 0.762mm/s @ 8.2Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Hylton Well
26 in. deep

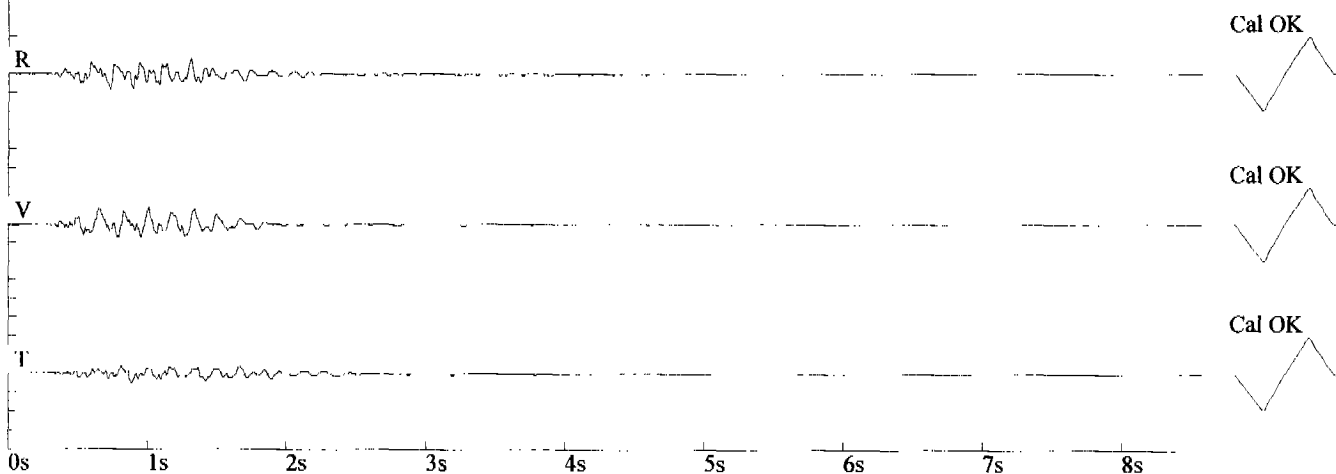
File: 01180005.DTB Event Number: 005 Date: 11/11/2000 Time: 14:48
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1180

Amplitudes and Frequencies

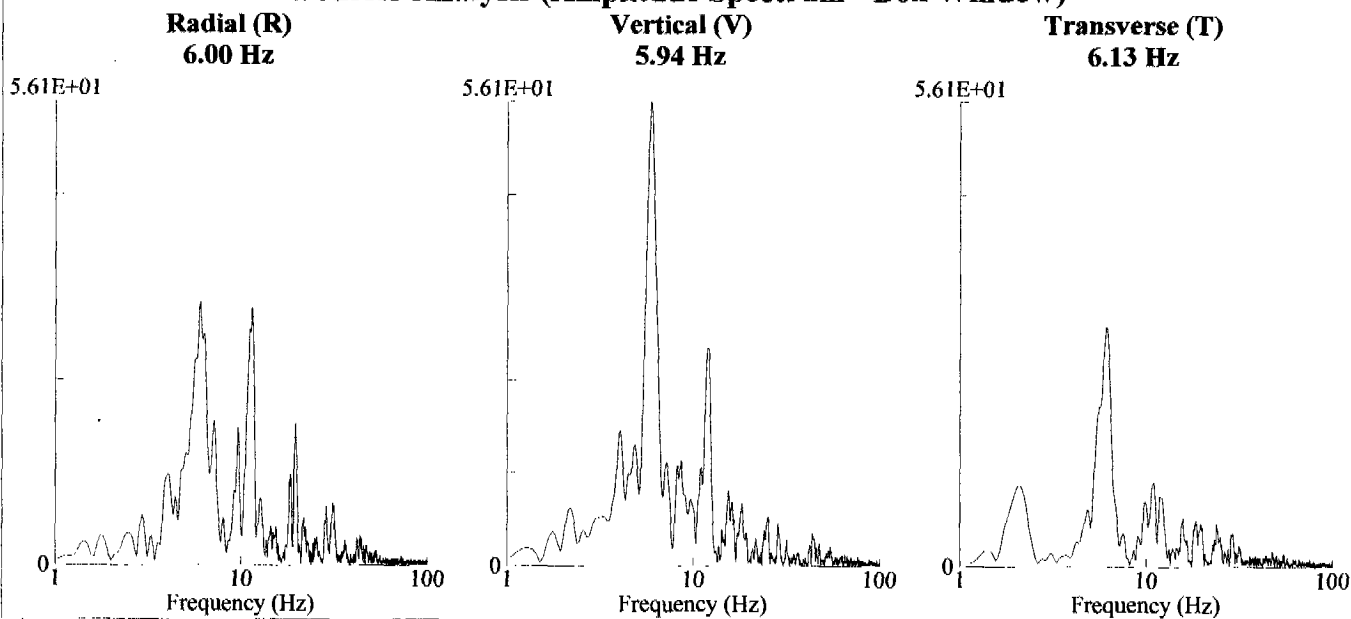
Radial (R): 0.045in/s 1.143mm/s @ 10.0Hz
Vertical (V): 0.045in/s 1.143mm/s @ 9.1Hz
Transverse (T): 0.025in/s 0.635mm/s @ 10.8Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Hylton Well

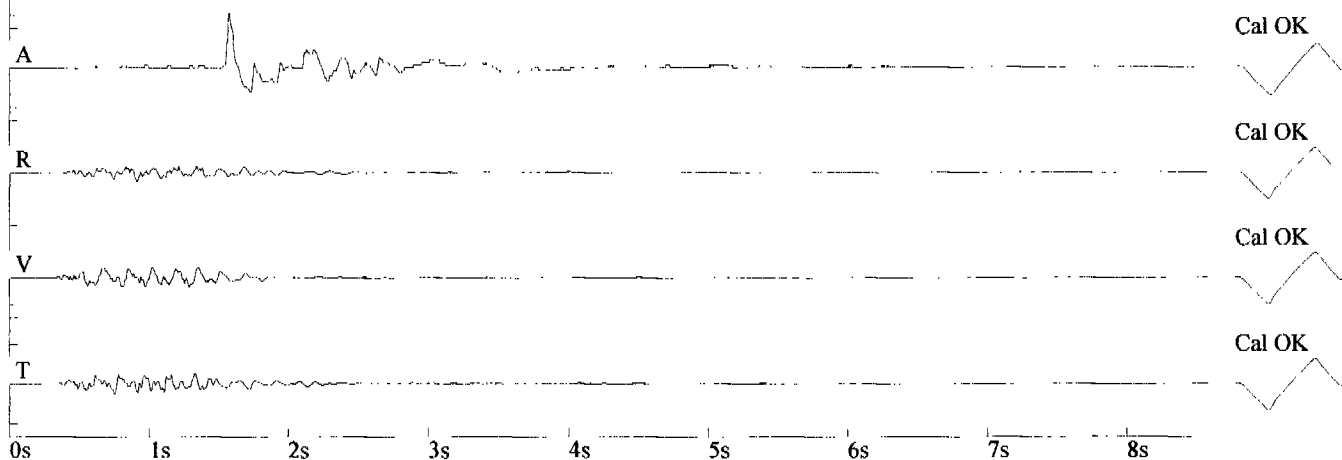
File: 01181067.DTB Event Number: 067 Date: 11/11/2000 Time: 14:48
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1181

Amplitudes and Frequencies

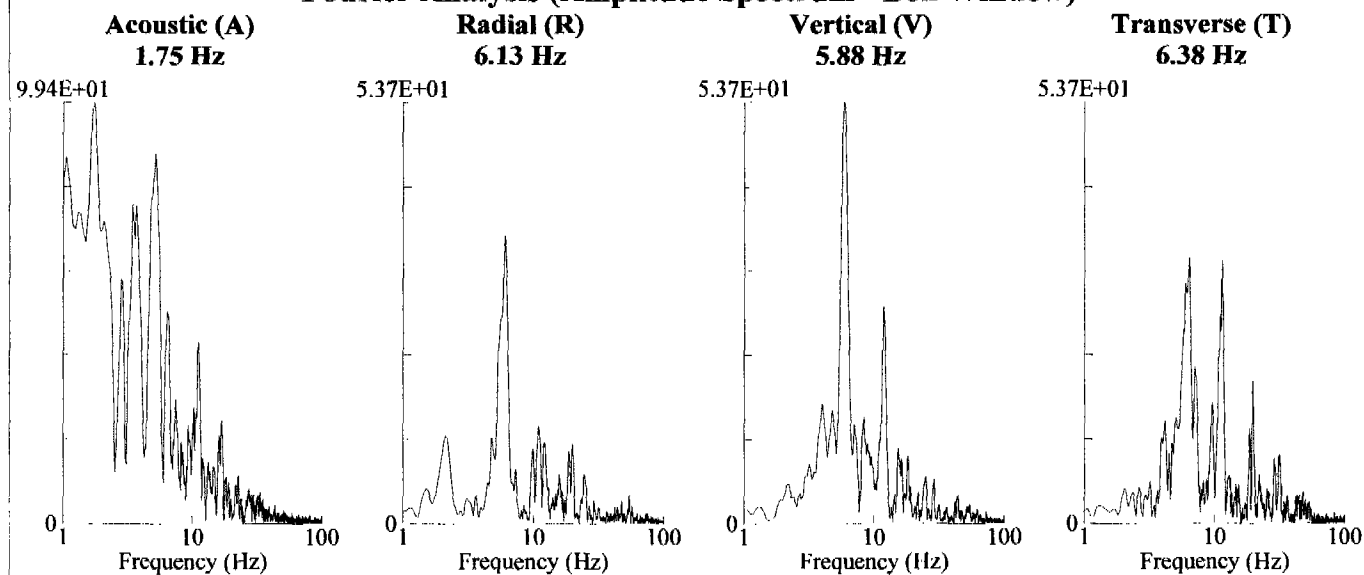
Acoustic (A): 126 dB @ 5.5 Hz
(0.42Mb 0.0061psi 0.0420kPa)
Radial (R): 0.035in/s 0.889mm/s @ 11.6Hz
Vertical (V): 0.045in/s 1.143mm/s @ 8.9Hz
Transverse (T): 0.04in/s 1.016mm/s @ 11.3Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
126dB 0.40Mb (0.100Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well

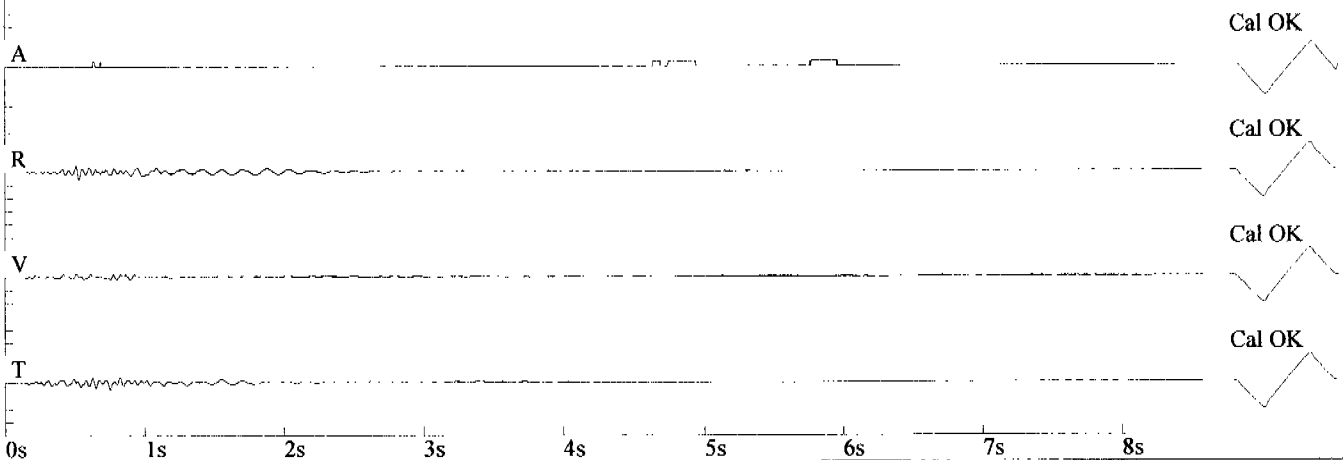
File: 00804032.DTB Event Number: 032 Date: 11/13/2000 Time: 16:04
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

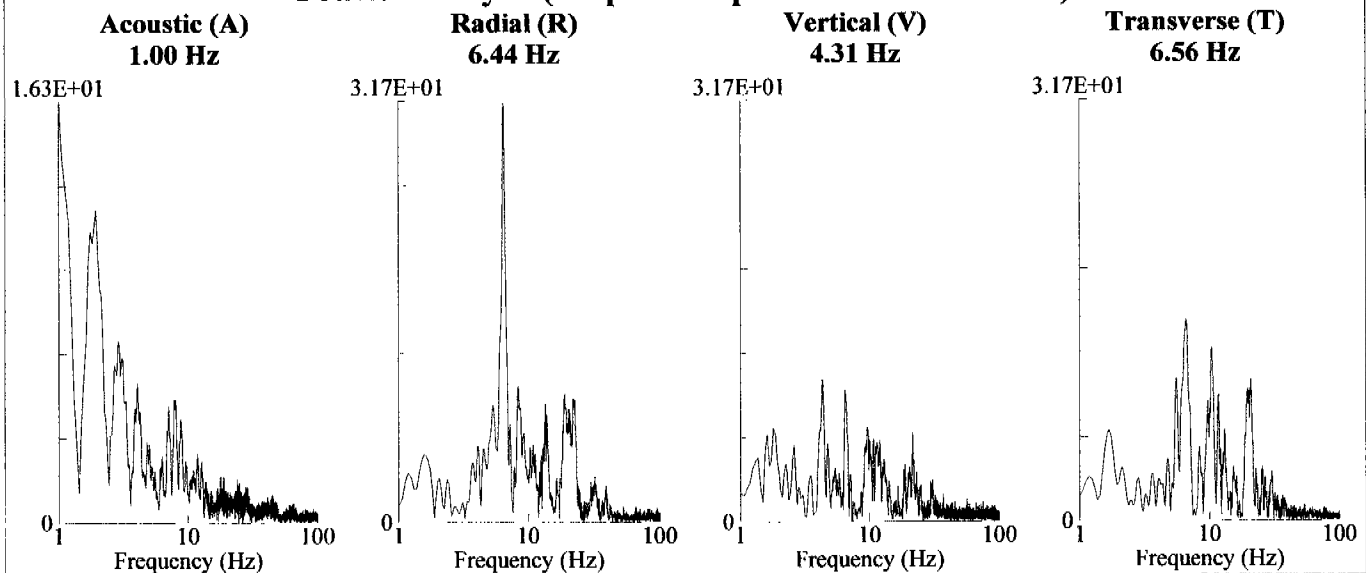
Acoustic (A): 100 dB @ 0.0 Hz
(0.02Mb 0.0003psi 0.0020kPa)
Radial (R): 0.03in/s 0.762mm/s @ 24.3Hz
Vertical (V): 0.015in/s 0.381mm/s @ 0.0Hz
Transverse (T): 0.025in/s 0.635mm/s @ 18.2Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well

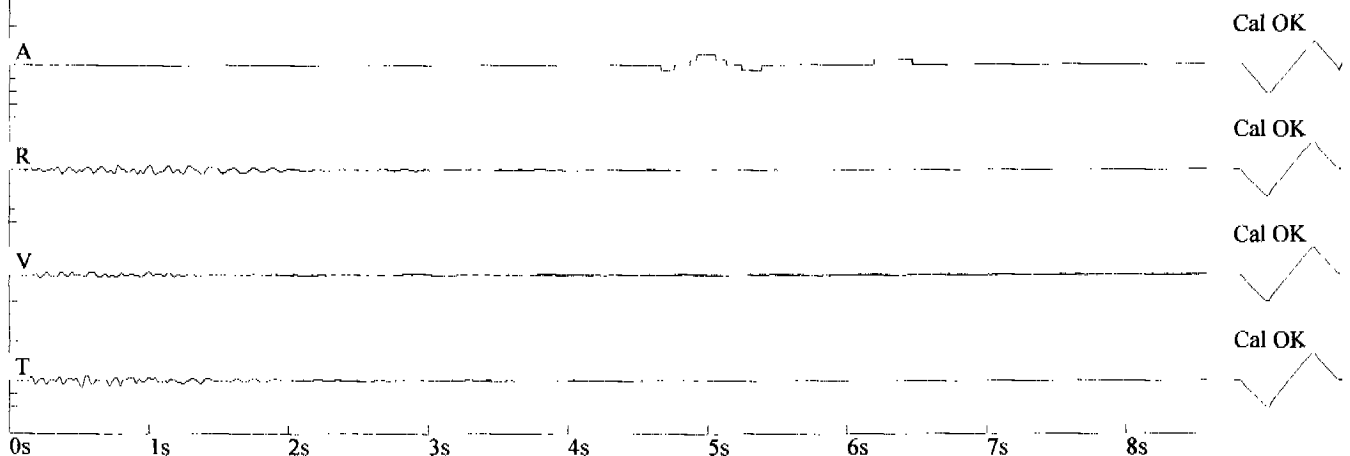
File: 00804040.DTB Event Number: 040 Date: 11/14/2000 Time: 16:18
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

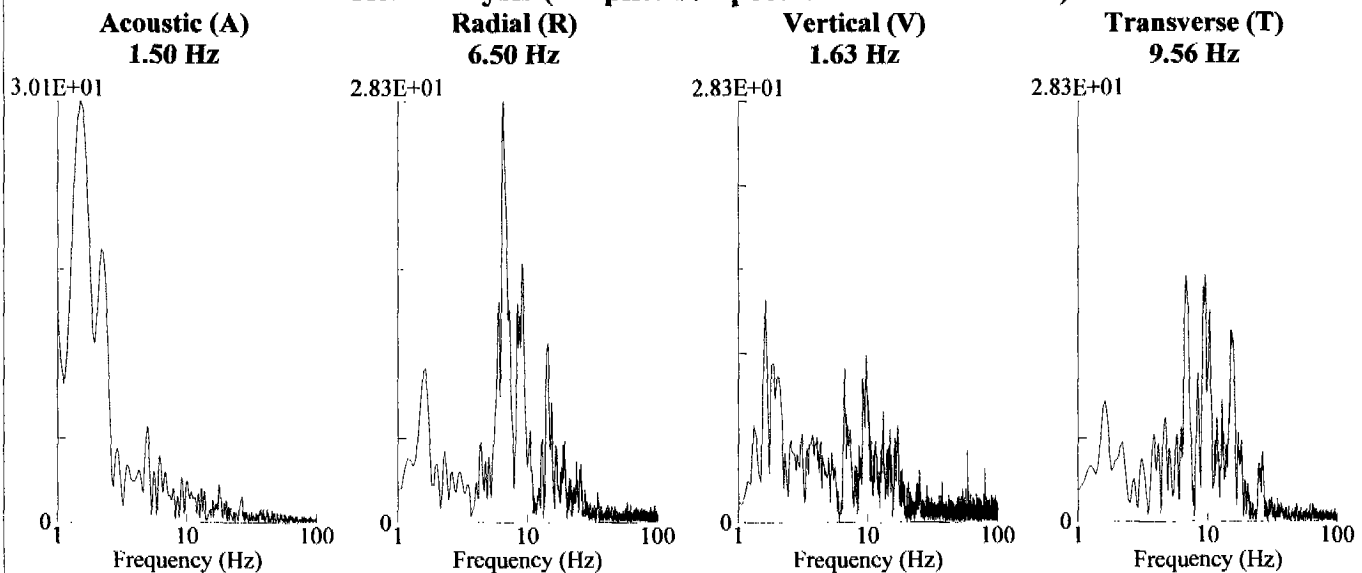
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.02in/s 0.508mm/s @ 8.3Hz
Vertical (V): 0.015in/s 0.381mm/s @ 0.0Hz
Transverse (T): 0.025in/s 0.635mm/s @ 13.4Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**Banks Well
3.5 ft. deep**

File: 00809081.DTB Event Number: 081 Date: 11/14/2000 Time: 15:15
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

Radial (R): 0.02in/s 0.508mm/s @ 16.0Hz

Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz

Transverse (T): 0.02in/s 0.508mm/s @ 14.2Hz

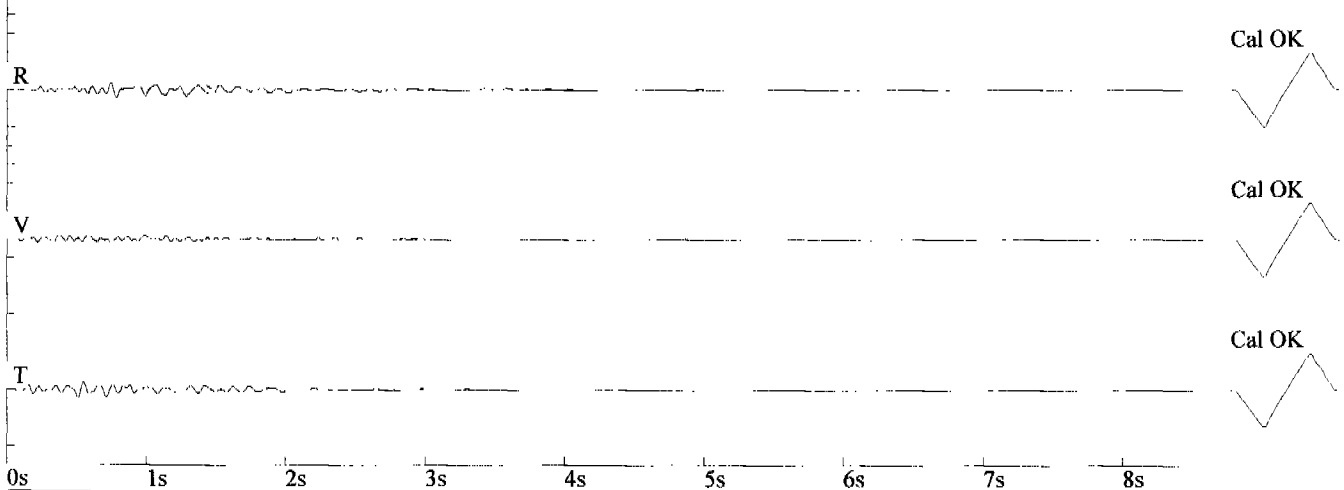
Graph Information

Duration: 0.000 sec To: 8.500 sec

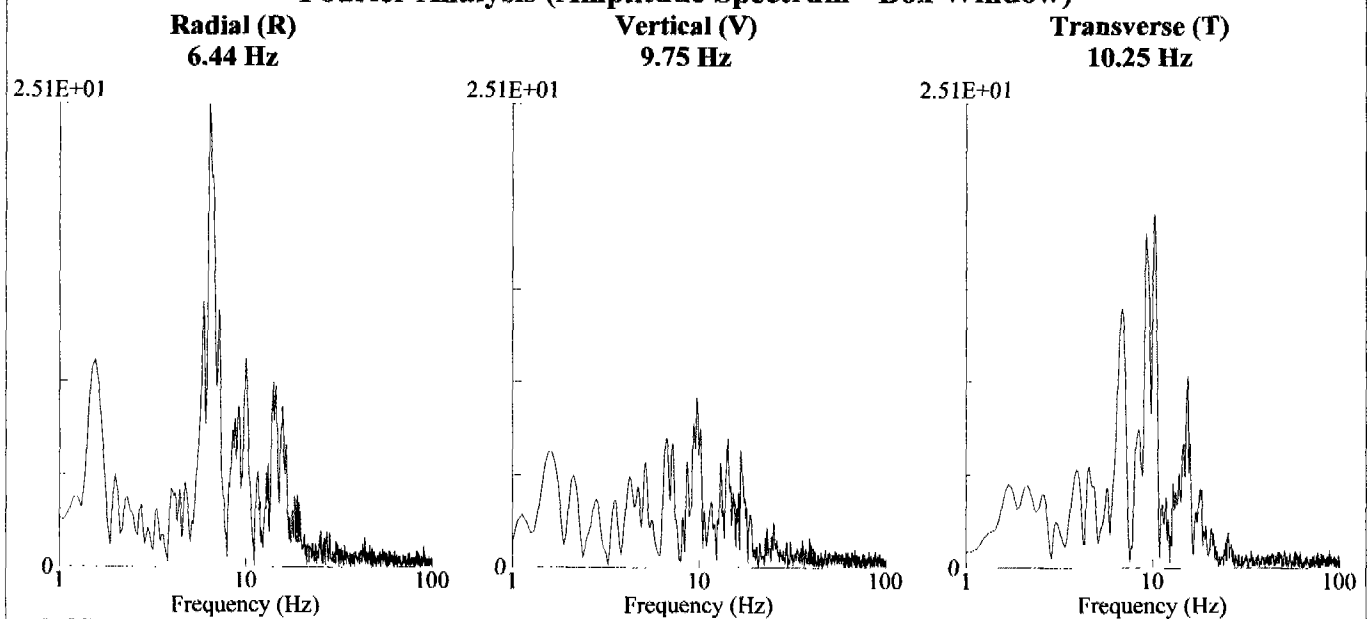
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well **(no depth)**

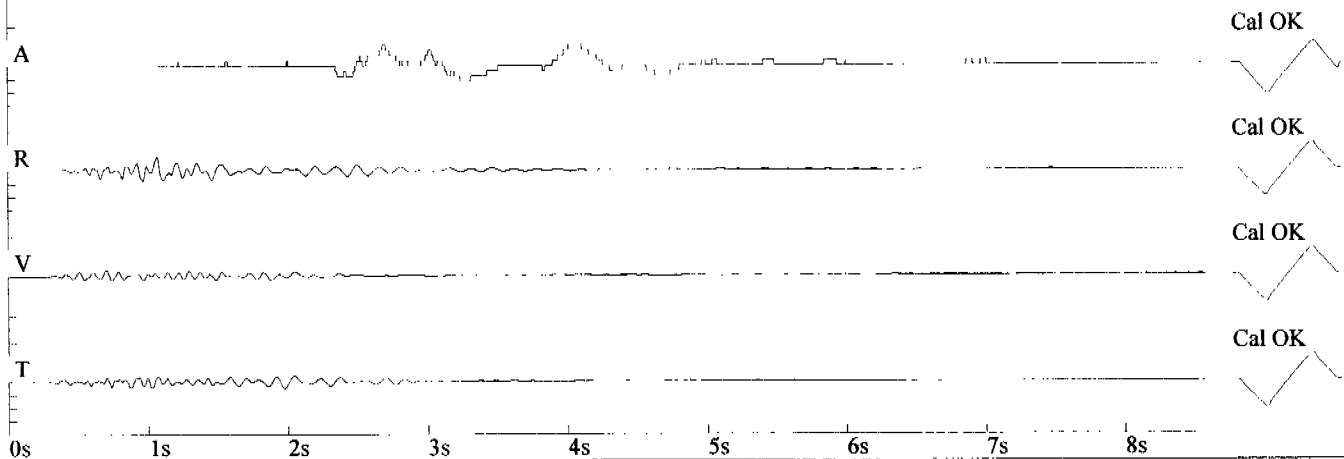
File: 00804042.DTB Event Number: 042 Date: 11/15/2000 Time: 11:49
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

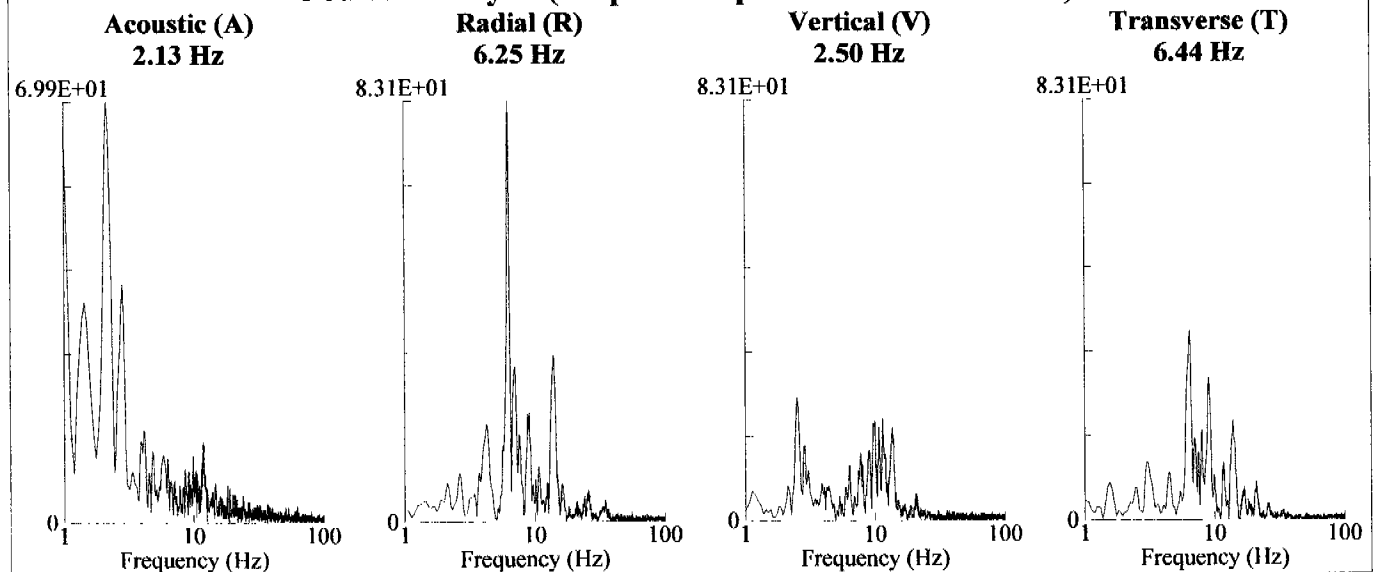
Acoustic (A): 112 dB @ 2.1 Hz
(0.08Mb 0.0012psi 0.0080kPa)
Radial (R): 0.055in/s 1.397mm/s @ 20.4Hz
Vertical (V): 0.025in/s 0.635mm/s @ 11.9Hz
Transverse (T): 0.025in/s 0.635mm/s @ 7.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well

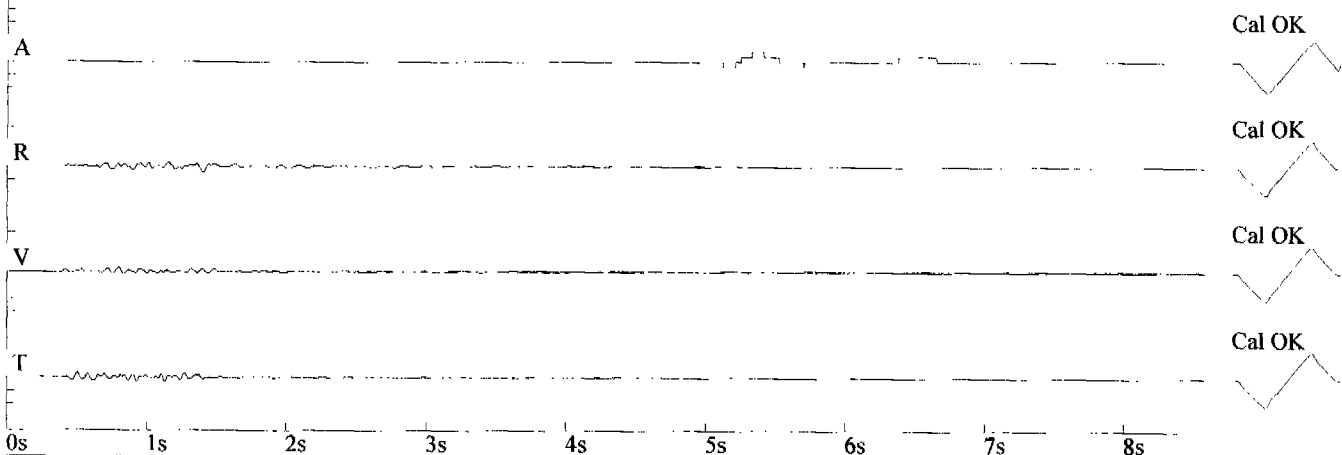
File: 00804045.DTB Event Number: 045 Date: 11/16/2000 Time: 09:07
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

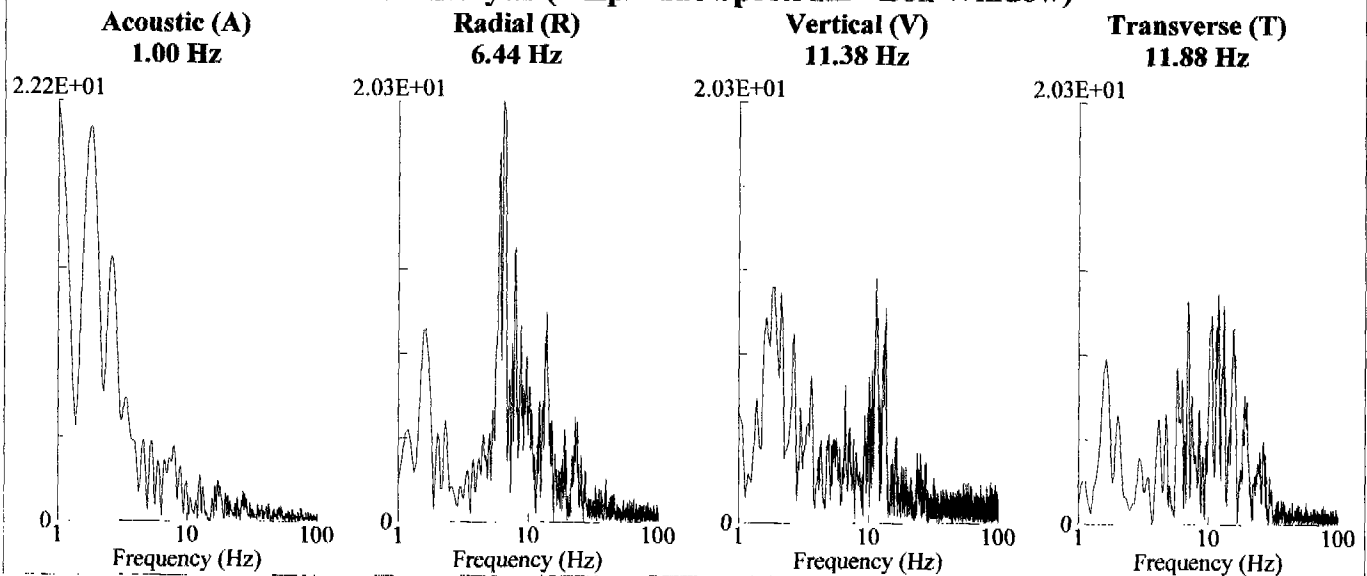
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.02in/s 0.508mm/s @ 10.6Hz
Vertical (V): 0.015in/s 0.381mm/s @ 0.0Hz
Transverse (T): 0.02in/s 0.508mm/s @ 16.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well
3.5 ft. deep

File: 00809083.DTB Event Number: 083 Date: 11/16/2000 Time: 09:06
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

Radial (R): 0.02in/s 0.508mm/s @ 14.2Hz

Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz

Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz

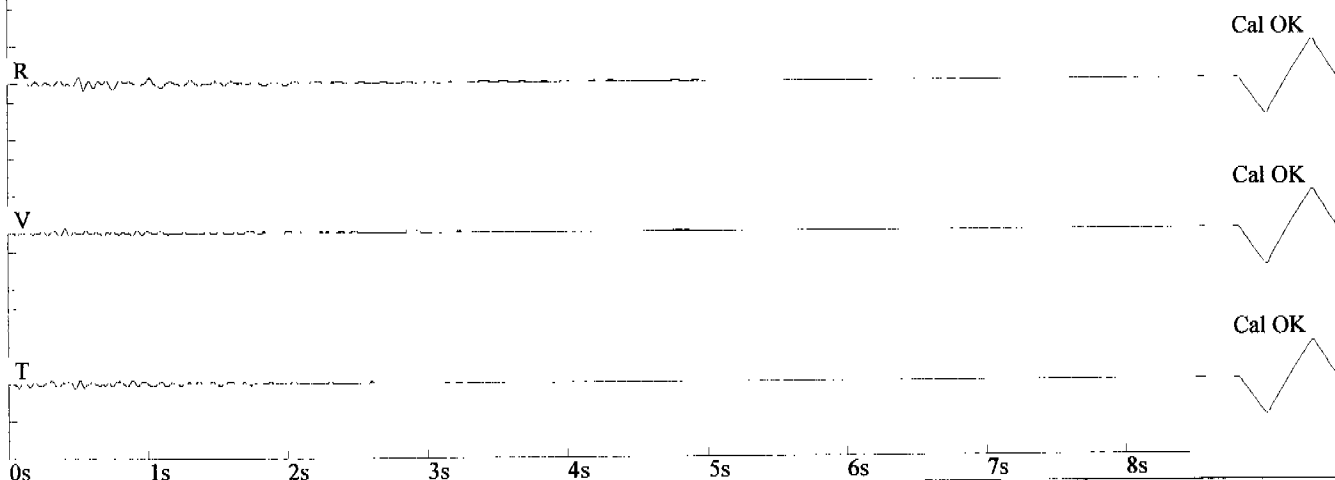
Graph Information

Duration: 0.000 sec To: 8.500 sec

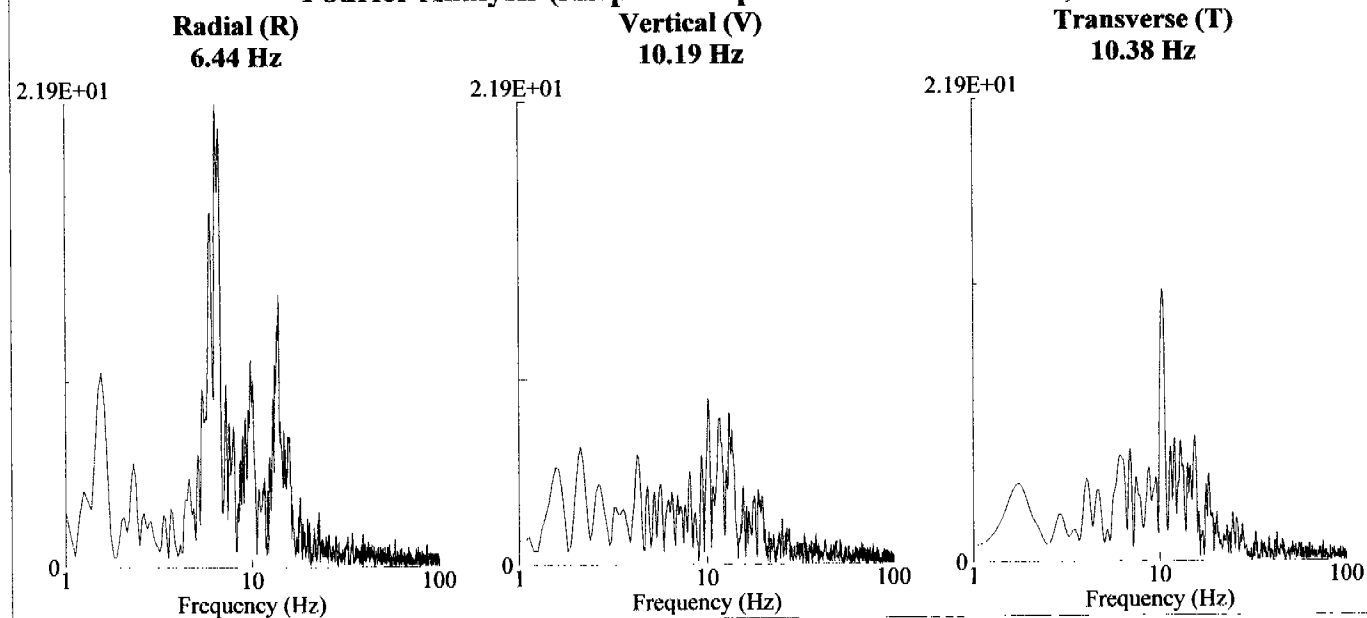
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well

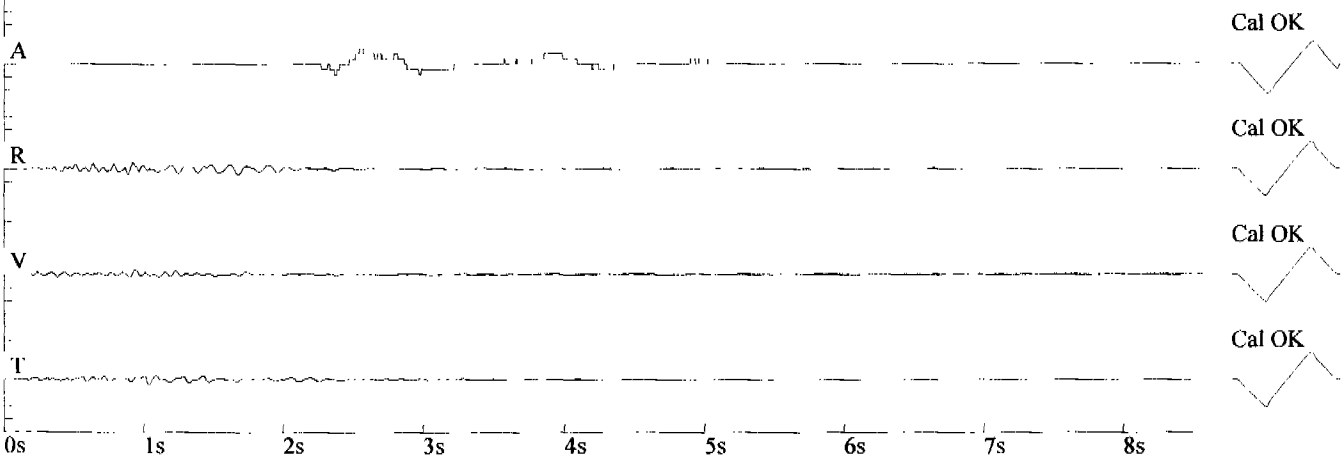
File: 00804048.DTB Event Number: 048 Date: 11/16/2000 Time: 16:00
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

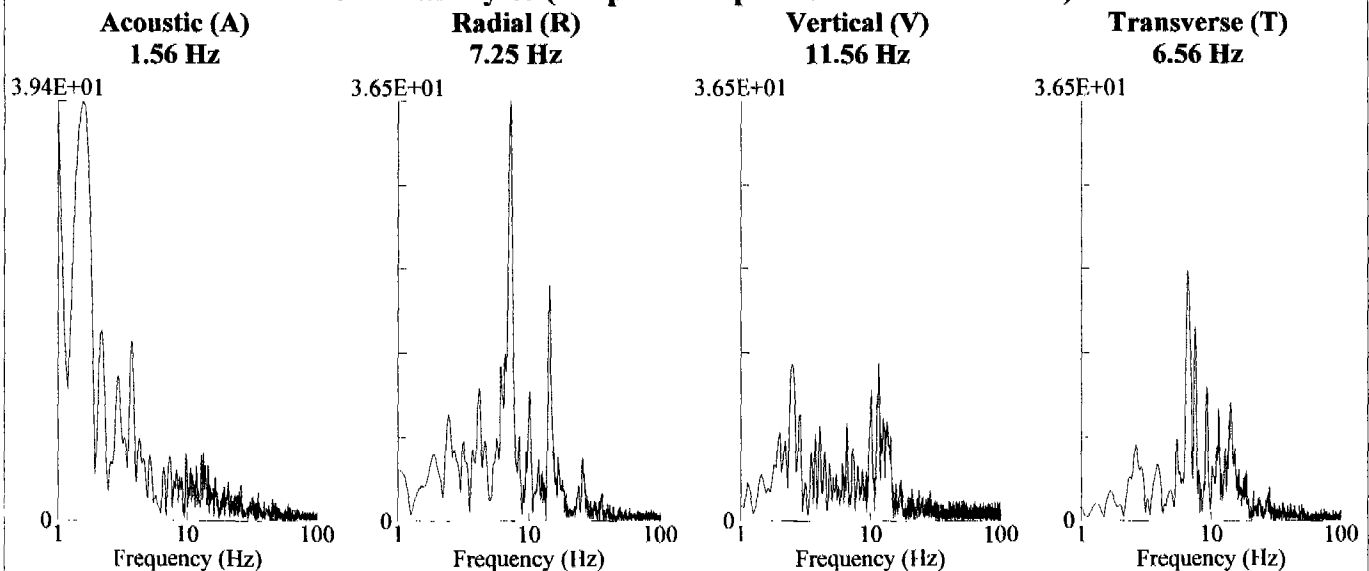
Acoustic (A): 110 dB @ 0.0 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.025in/s 0.635mm/s @ 10.8Hz
Vertical (V): 0.02in/s 0.508mm/s @ 11.6Hz
Transverse (T): 0.02in/s 0.508mm/s @ 13.8Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well

File: 00809084.DTB Event Number: 084 Date: 11/16/2000 Time: 15:59
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

Radial (R): 0.02in/s 0.508mm/s @ 15.0Hz

Vertical (V): 0.015in/s 0.381mm/s @ 0.0Hz

Transverse (T): 0.02in/s 0.508mm/s @ 14.2Hz

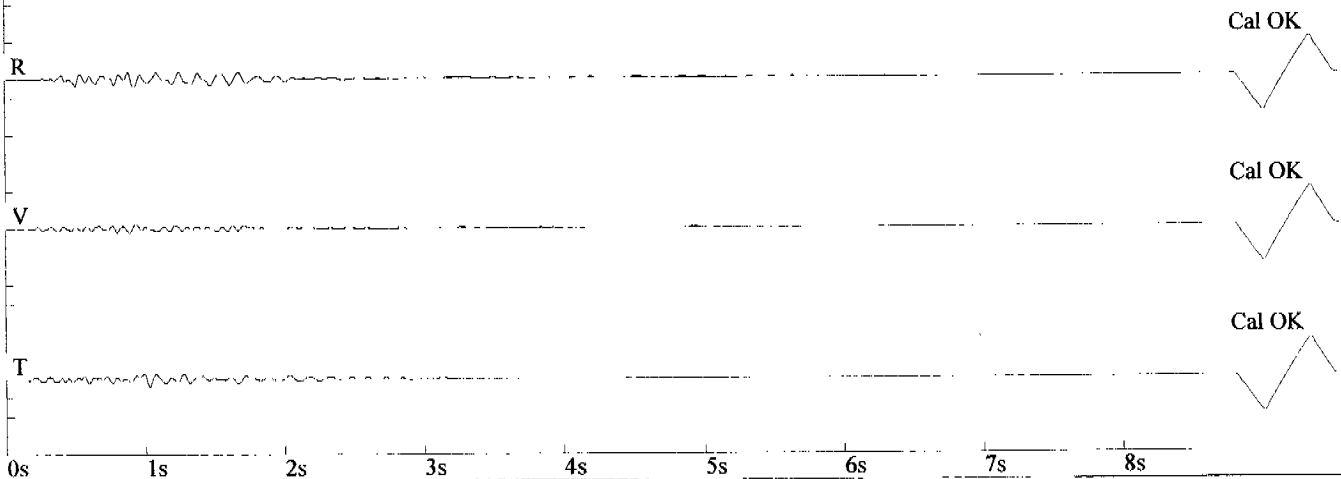
Graph Information

Duration: 0.000 sec To: 8.500 sec

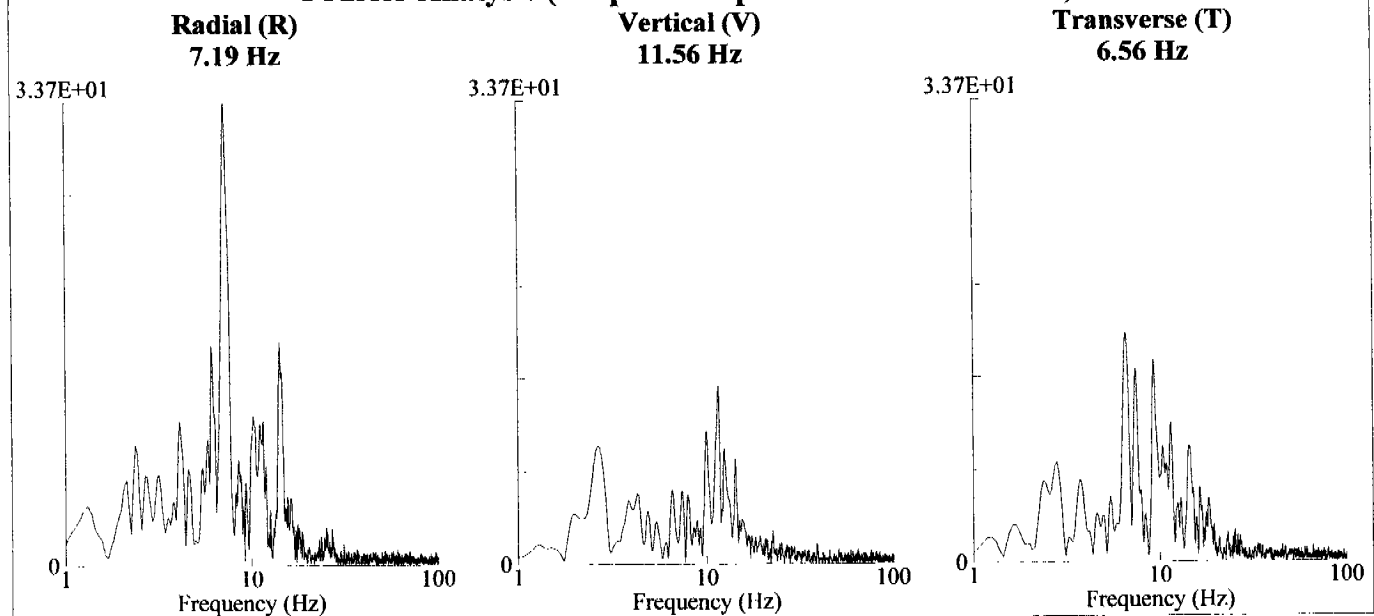
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well

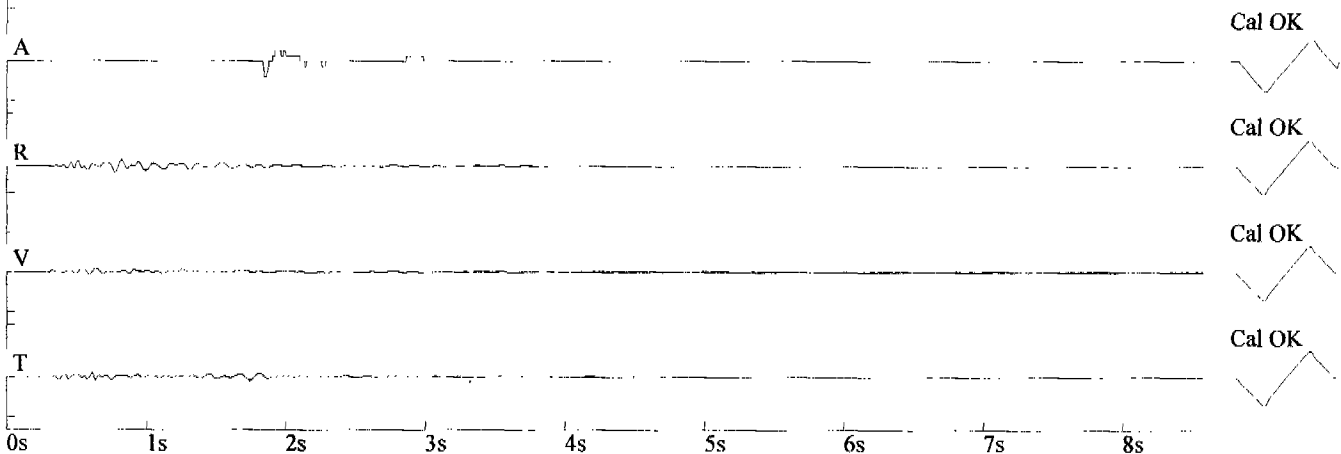
File: 00804056.DTB Event Number: 056 Date: 11/17/2000 Time: 12:15
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

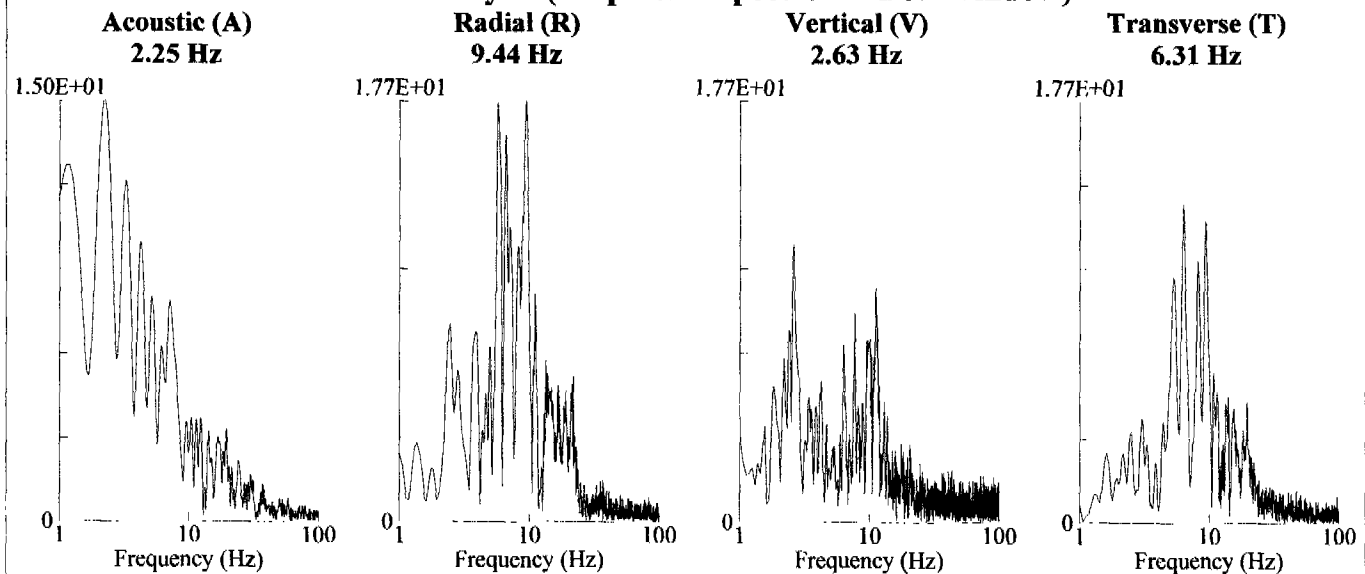
Acoustic (A): 110 dB @ 0.0 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.025in/s 0.635mm/s @ 12.1Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.015in/s 0.381mm/s @ 0.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well
3.5 ft. deep

File: 00809085.DTB Event Number: 085 Date: 11/17/2000 Time: 12:14
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

Radial (R): 0.02in/s 0.508mm/s @ 11.6Hz

Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz

Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz

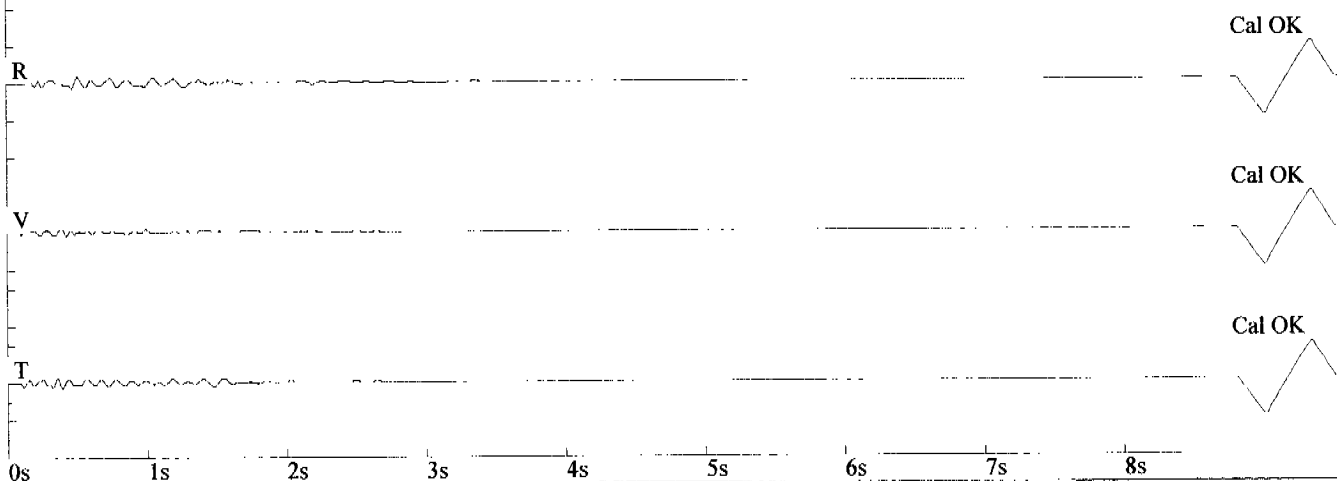
Graph Information

Duration: 0.000 sec To: 8.500 sec

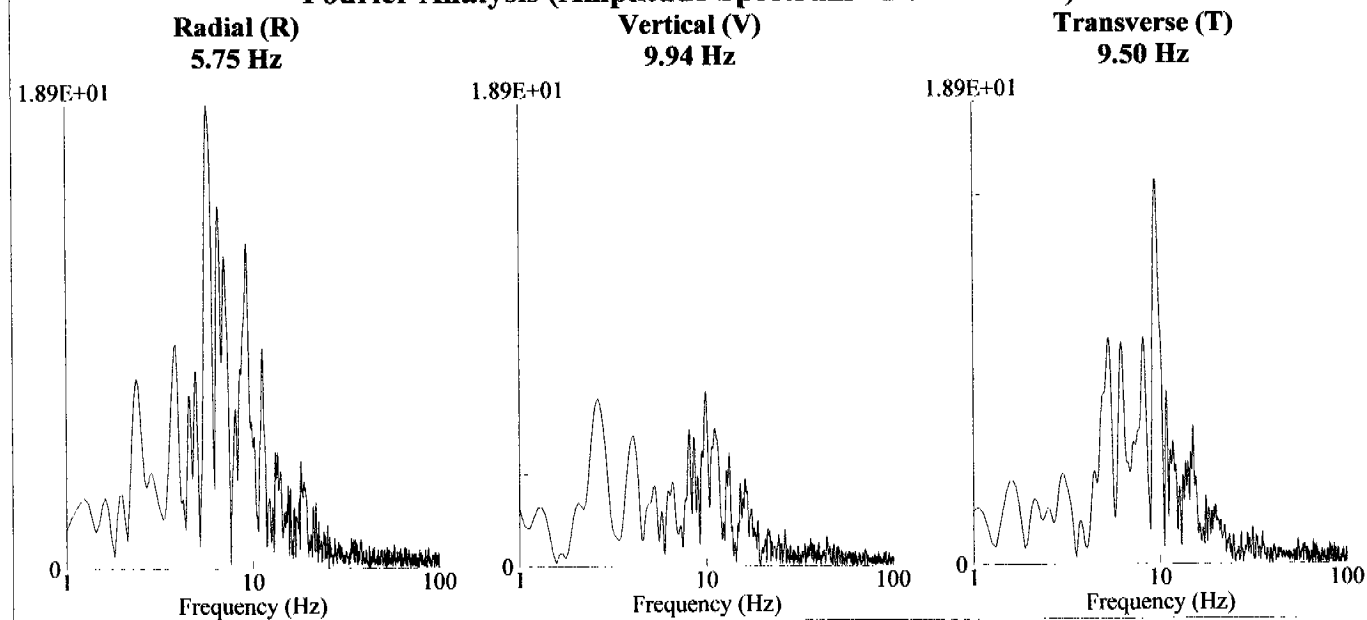
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well

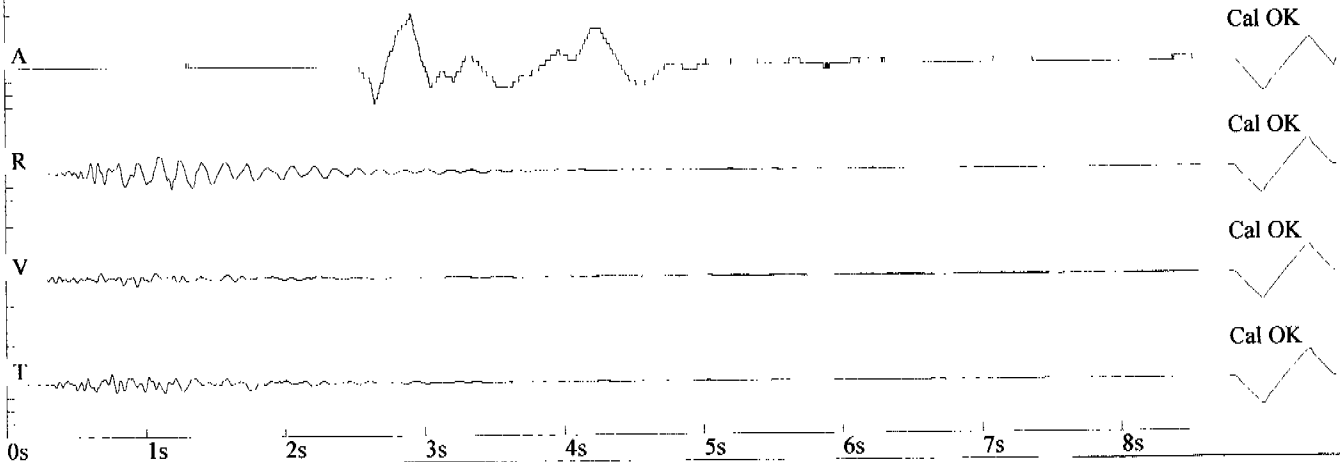
File: 00804058.DTB Event Number: 058 Date: 11/17/2000 Time: 12:34
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

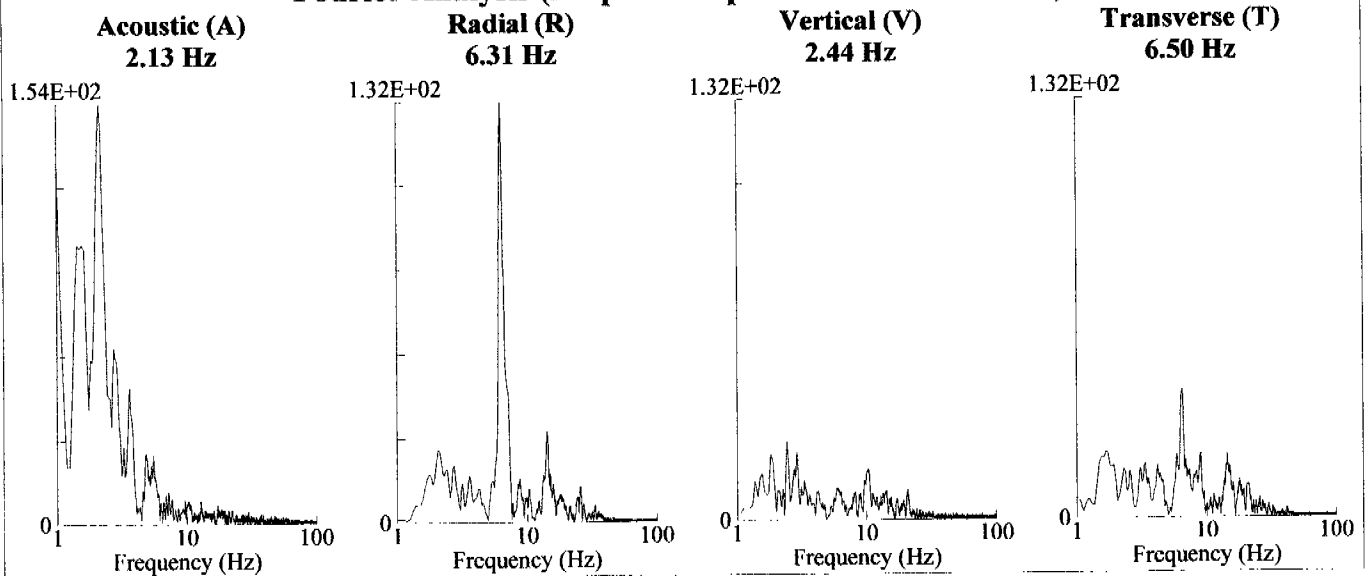
Acoustic (A): 120 dB @ 2.0 Hz
(0.20Mb 0.0029psi 0.0200kPa)
Radial (R): 0.065in/s 1.651mm/s @ 6.0Hz
Vertical (V): 0.025in/s 0.635mm/s @ 12.4Hz
Transverse (T): 0.04in/s 1.016mm/s @ 15.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Banks Well
3.5 ft. deep

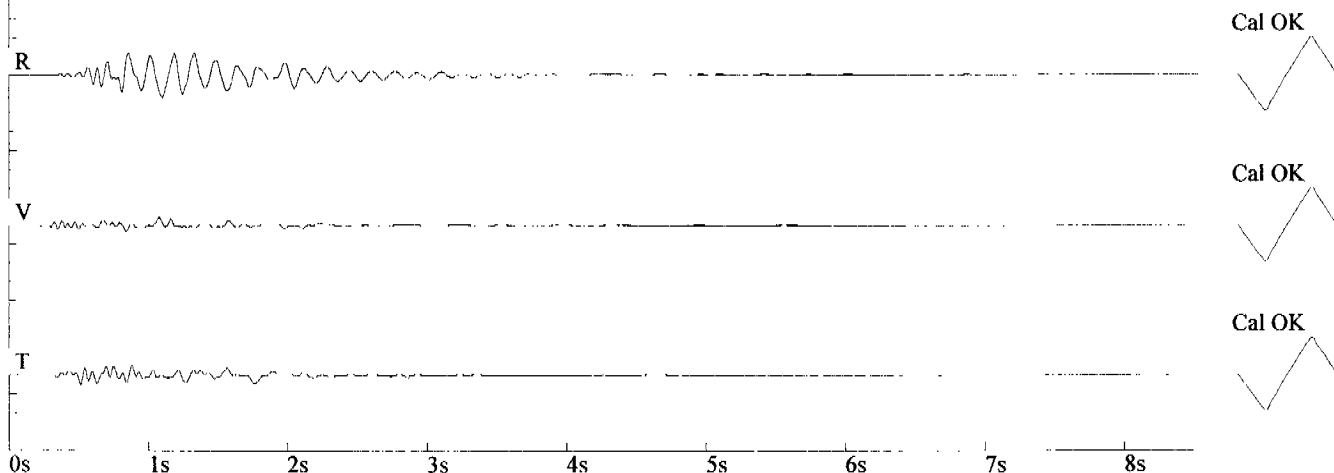
File: 00809086.DTB Event Number: 086 Date: 11/17/2000 Time: 12:33
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

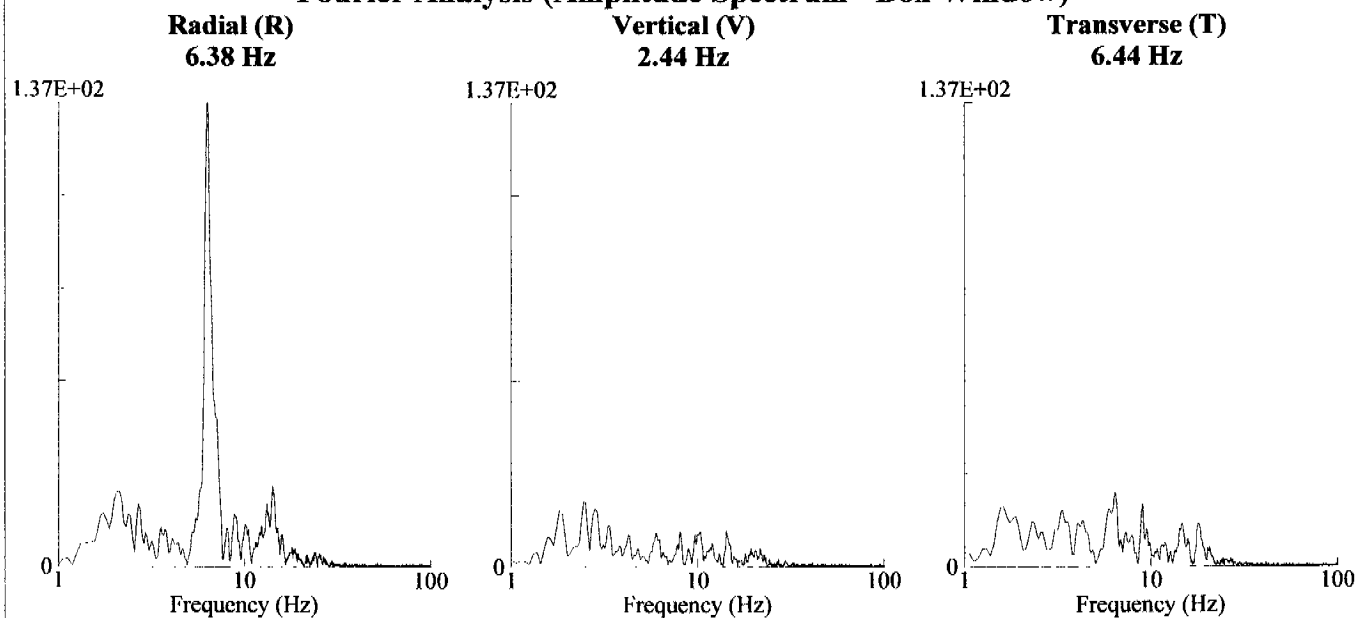
Radial (R): 0.06in/s 1.524mm/s @ 7.1Hz
Vertical (V): 0.025in/s 0.635mm/s @ 8.8Hz
Transverse (T): 0.03in/s 0.762mm/s @ 13.4Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well
(surface - no airblast)

File: 00849025.DTB Event Number: 025 Date: 11/13/2000 Time: 16:04
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

Acoustic (A): <100 dB

Radial (R): 0.03in/s 0.762mm/s @ 21.3Hz

Vertical (V): 0.02in/s 0.508mm/s @ 26.9Hz

Transverse (T): 0.025in/s 0.635mm/s @ 20.4Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec

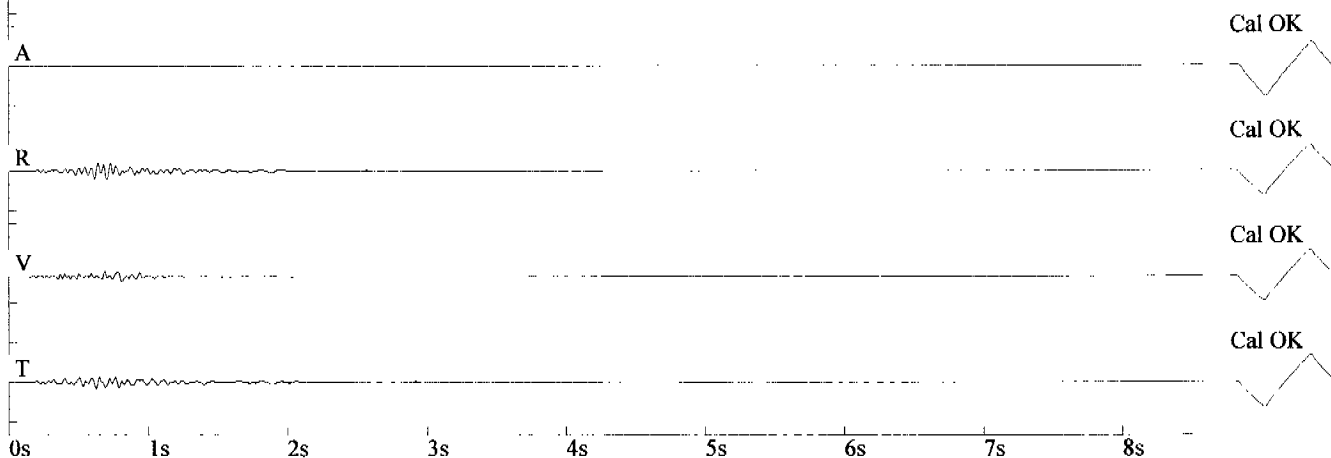
Acoustic Scale:

120dB 0.20Mb (0.050Mb/div)

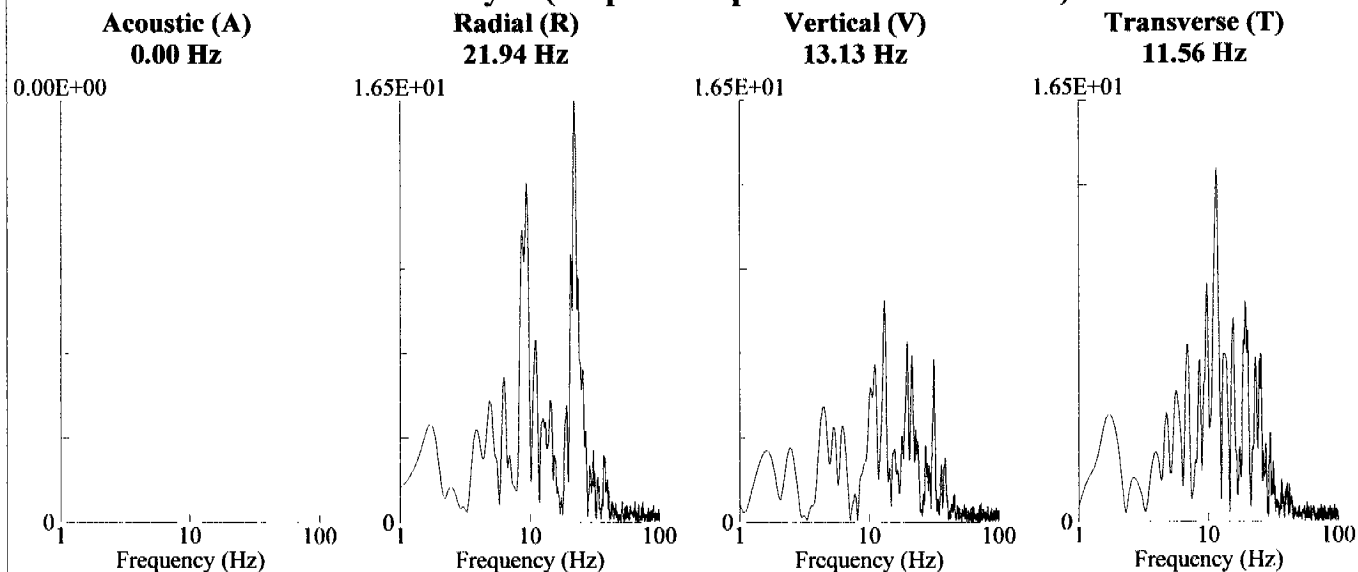
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well
29 in. deep

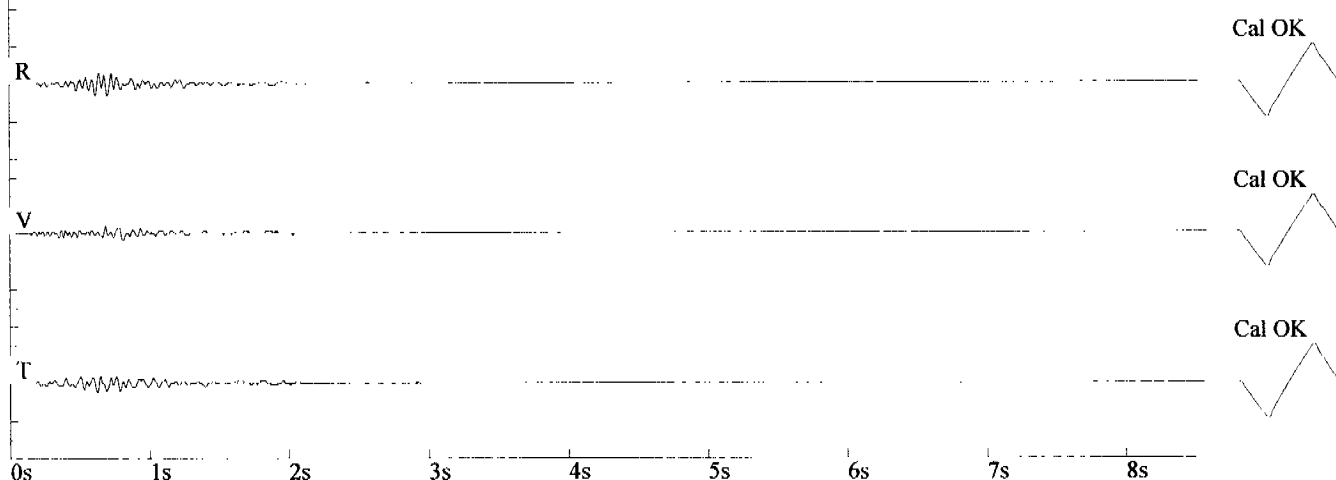
File: 00849025.DTB Event Number: 025 Date: 11/13/2000 Time: 16:04
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

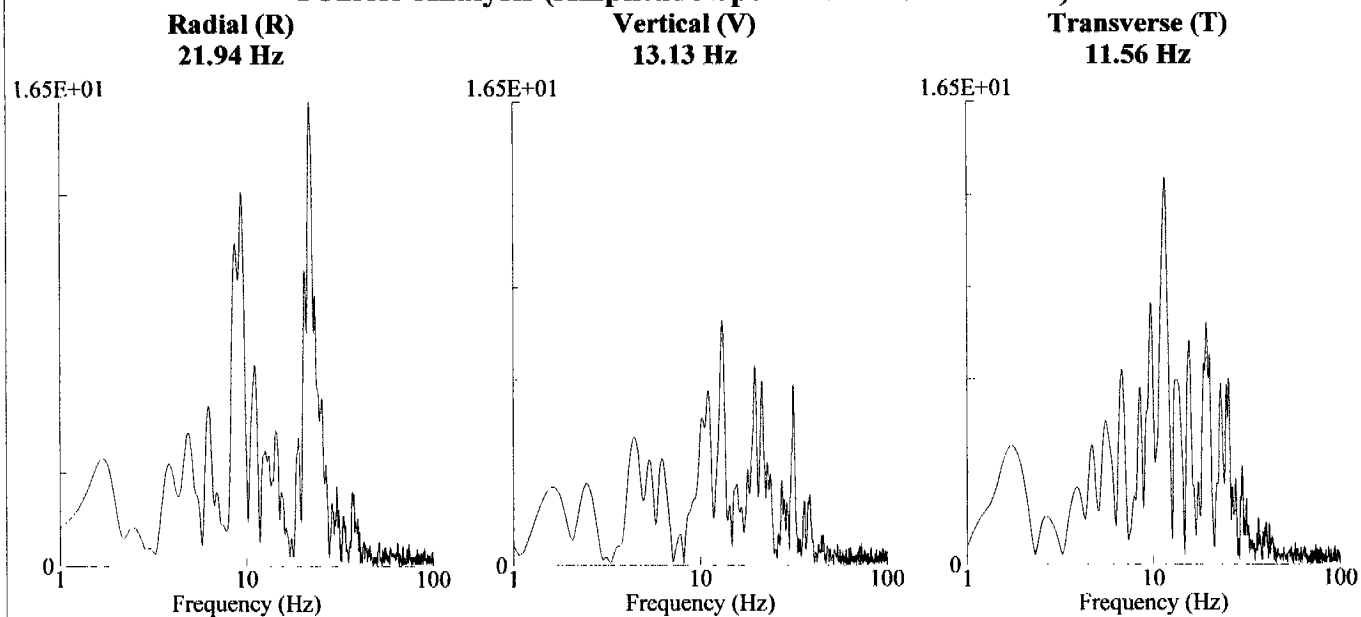
Radial (R): 0.03in/s 0.762mm/s @ 21.3Hz
Vertical (V): 0.02in/s 0.508mm/s @ 26.9Hz
Transverse (T): 0.025in/s 0.635mm/s @ 20.4Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well

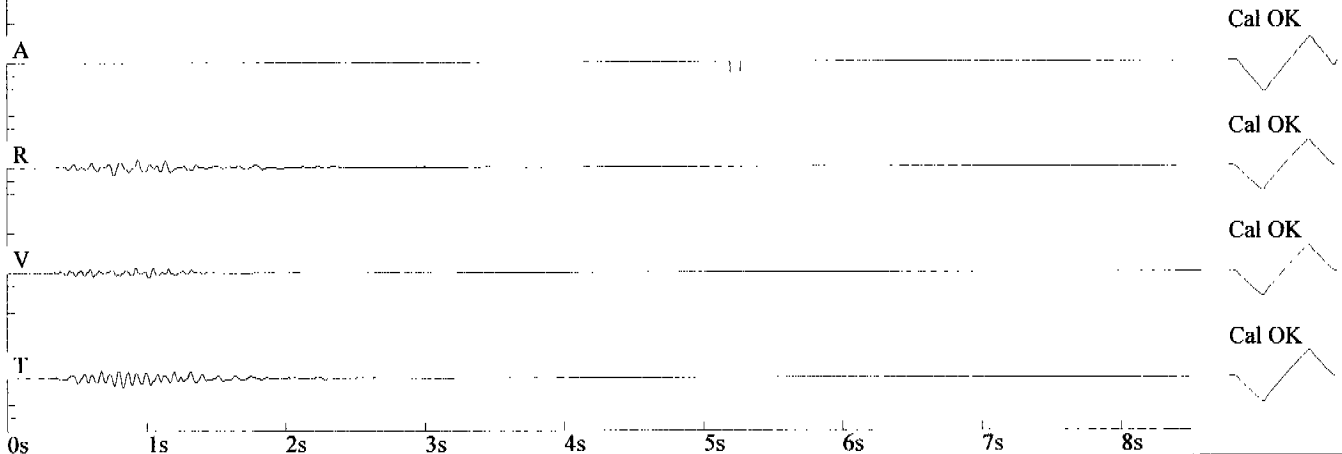
File: 00849026.DTB Event Number: 026 Date: 11/14/2000 Time: 16:18
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

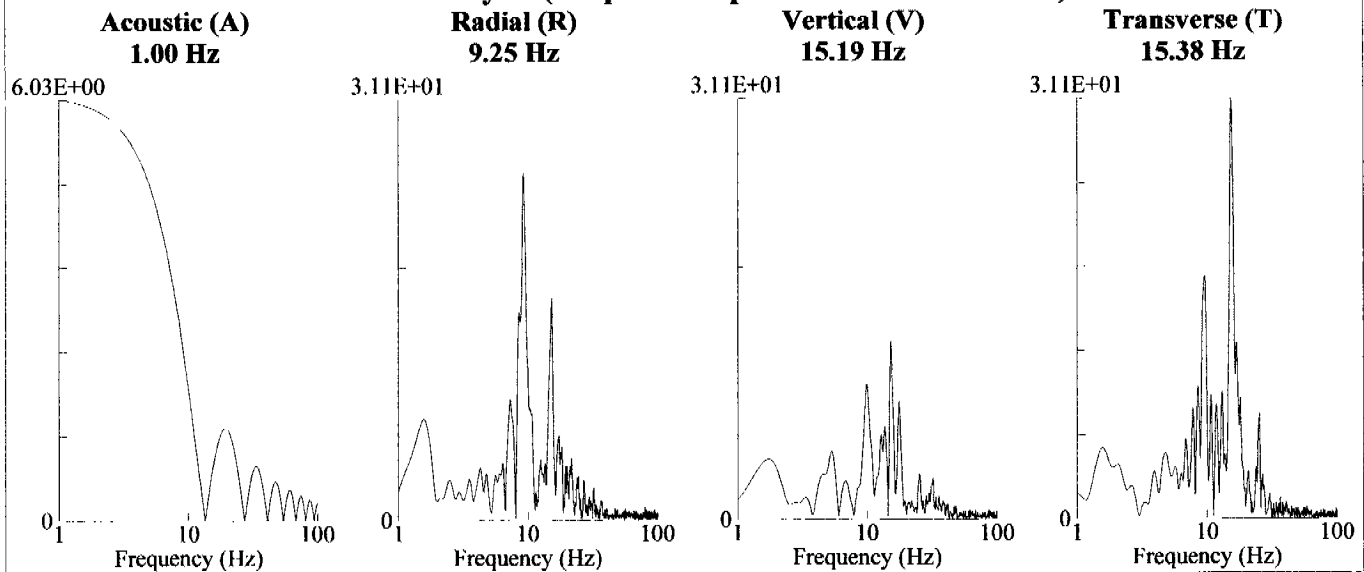
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.03in/s 0.762mm/s @ 13.1Hz
Vertical (V): 0.02in/s 0.508mm/s @ 19.6Hz
Transverse (T): 0.035in/s 0.889mm/s @ 16.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well
29 in. deep

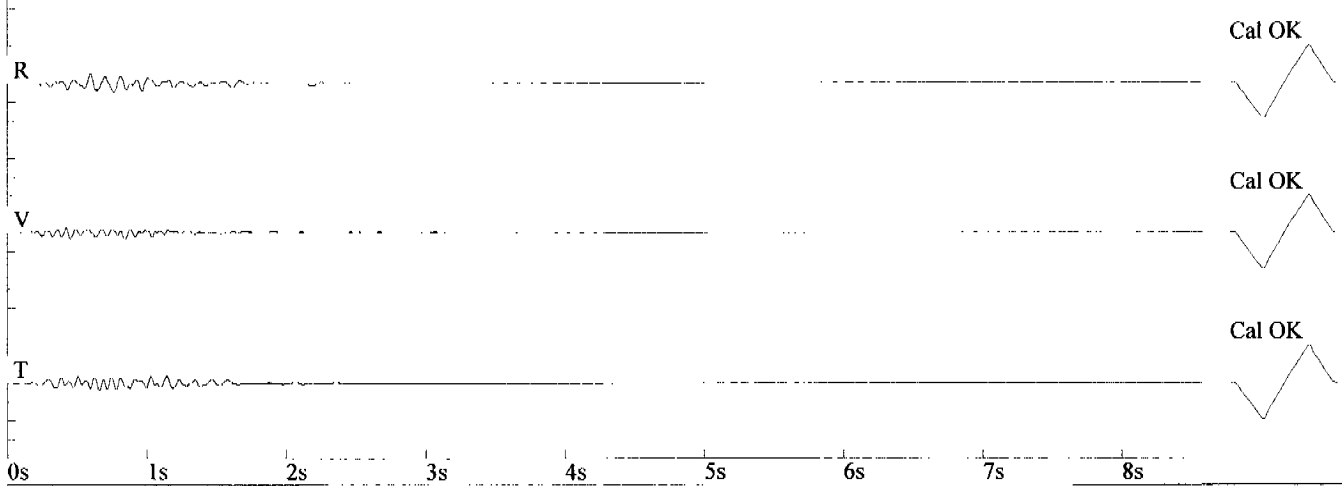
File: 00853078.DTB Event Number: 078 Date: 11/14/2000 Time: 16:18
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 853

Amplitudes and Frequencies

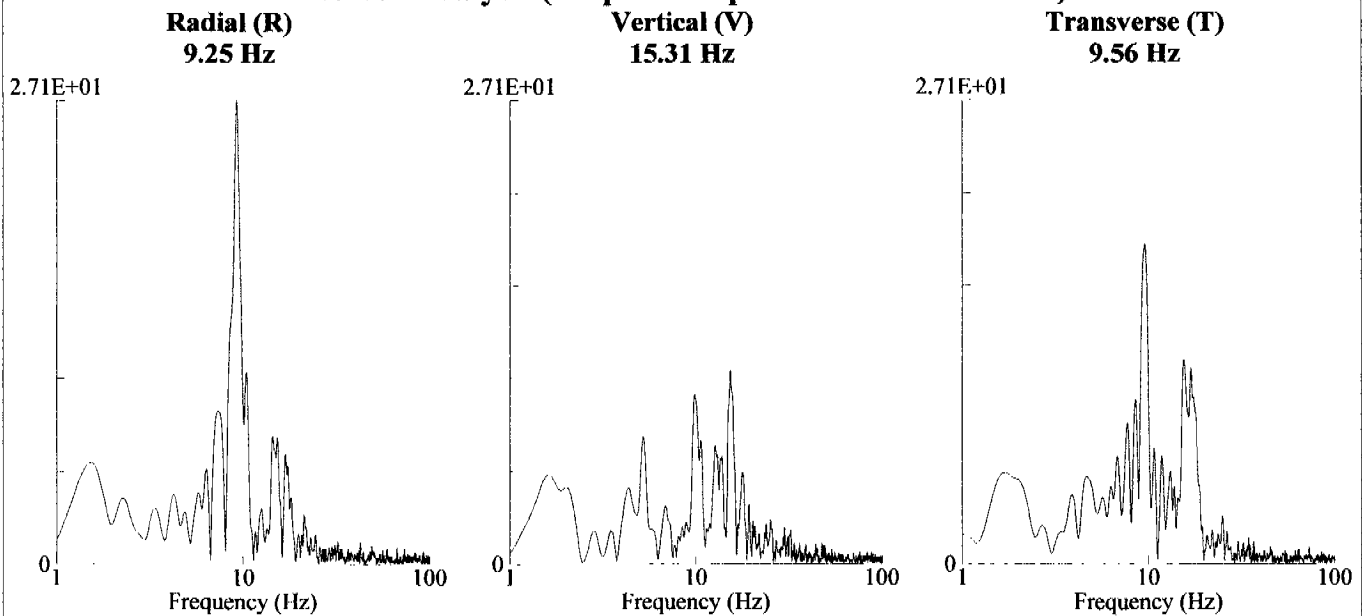
Radial (R): 0.025in/s 0.635mm/s @ 12.8Hz
Vertical (V): 0.015in/s 0.381mm/s @ 14.6Hz
Transverse (T): 0.02in/s 0.508mm/s @ 16.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well

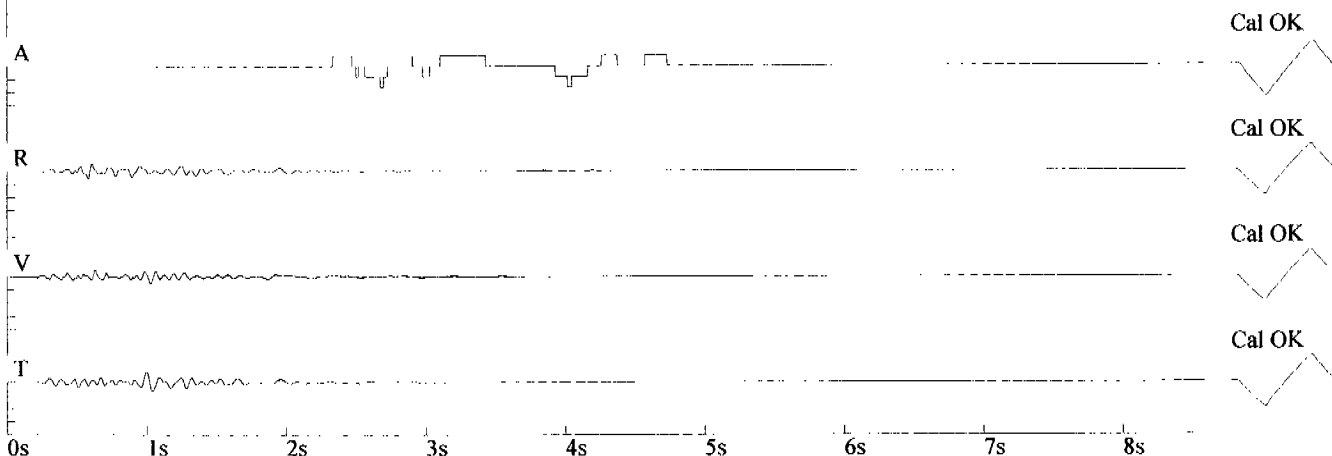
File: 00849027.DTB Event Number: 027 Date: 11/15/2000 Time: 11:49
Acoustic Trigger: 126 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

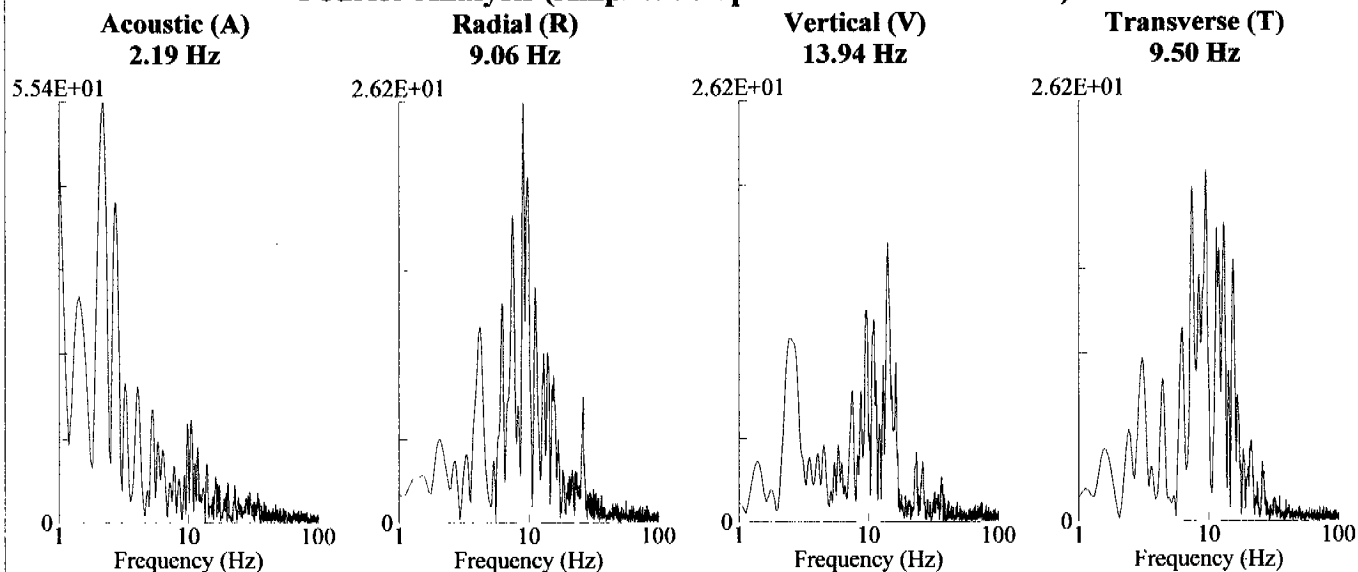
Acoustic (A): 112 dB @ 0.0 Hz
(0.08Mb 0.0012psi 0.0080kPa)
Radial (R): 0.03in/s 0.762mm/s @ 12.1Hz
Vertical (V): 0.025in/s 0.635mm/s @ 15.5Hz
Transverse (T): 0.04in/s 1.016mm/s @ 11.9Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well
29 in. deep

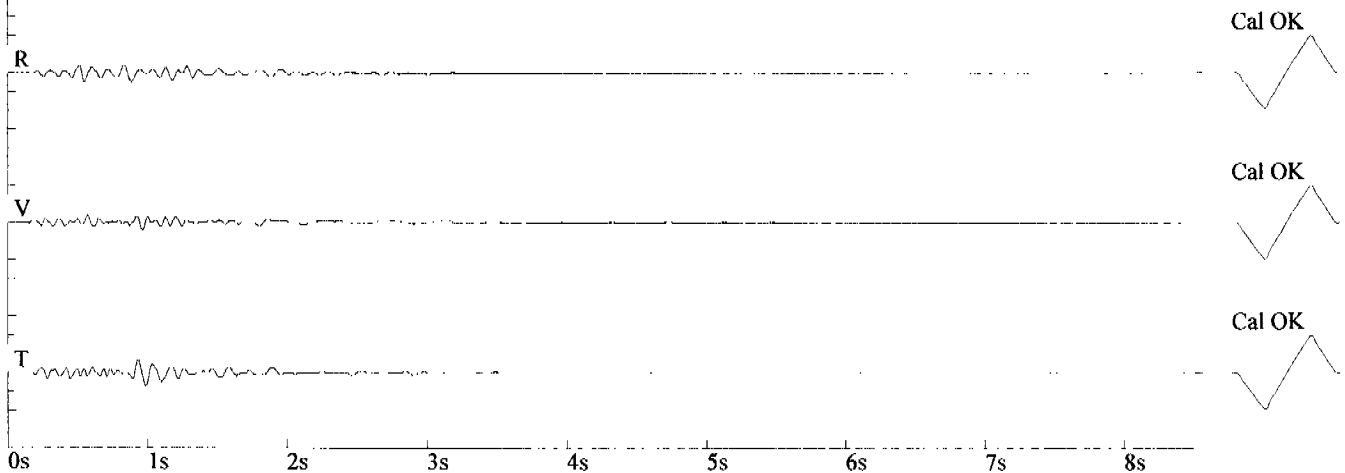
File: 00853079.DTB Event Number: 079 Date: 11/15/2000 Time: 11:48
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 853

Amplitudes and Frequencies

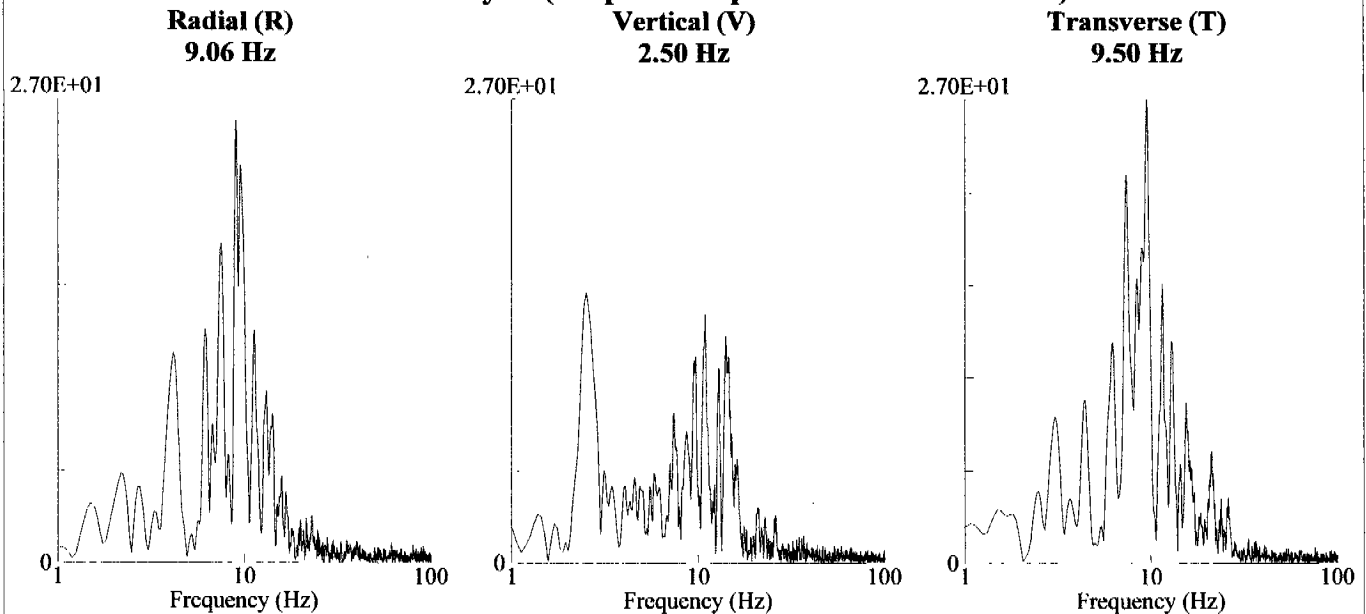
Radial (R): 0.025in/s 0.635mm/s @ 13.4Hz
Vertical (V): 0.02in/s 0.508mm/s @ 15.5Hz
Transverse (T): 0.035in/s 0.889mm/s @ 11.1Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well

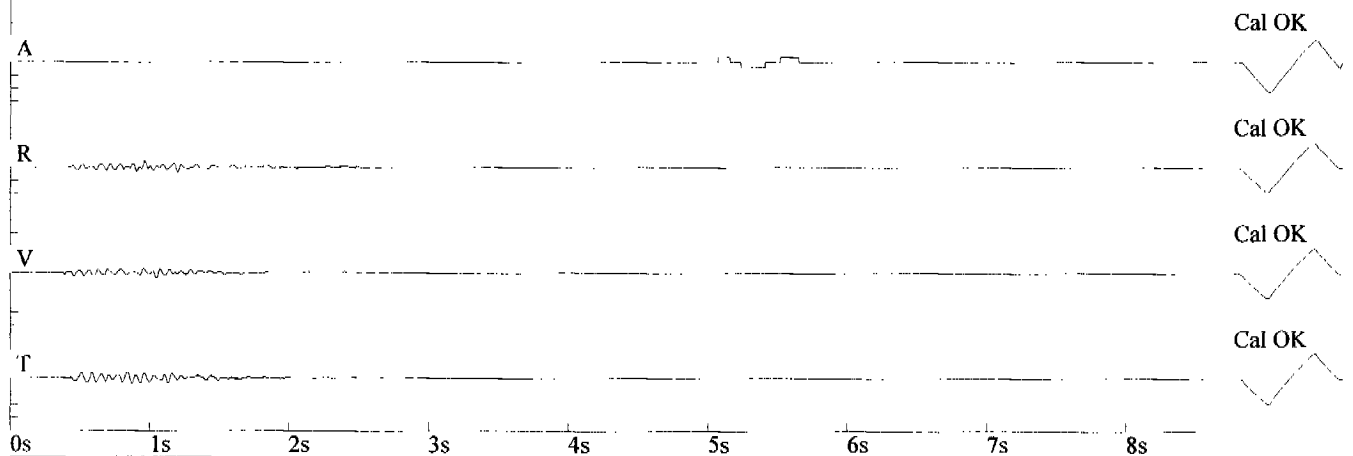
File: 00849028.DTB Event Number: 028 Date: 11/16/2000 Time: 09:07
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

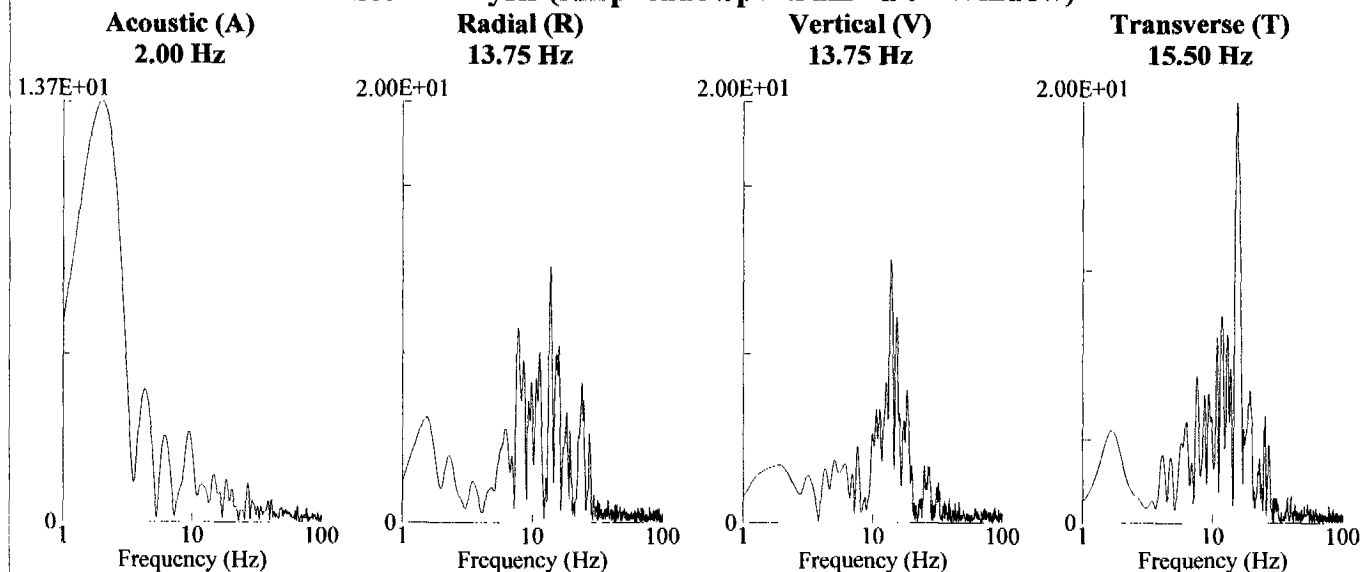
Acoustic (A): 100 dB @ 0.0 Hz
(0.02Mb 0.0003psi 0.0020kPa)
Radial (R): 0.025in/s 0.635mm/s @ 17.6Hz
Vertical (V): 0.02in/s 0.508mm/s @ 19.6Hz
Transverse (T): 0.025in/s 0.635mm/s @ 18.2Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well
29 in. deep

File: 00853080.DTB Event Number: 080 Date: 11/16/2000 Time: 09:06
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 853

Amplitudes and Frequencies

Radial (R): 0.015in/s 0.381mm/s @ 20.4Hz

Vertical (V): 0.015in/s 0.381mm/s @ 16.5Hz

Transverse (T): 0.02in/s 0.508mm/s @ 20.4Hz

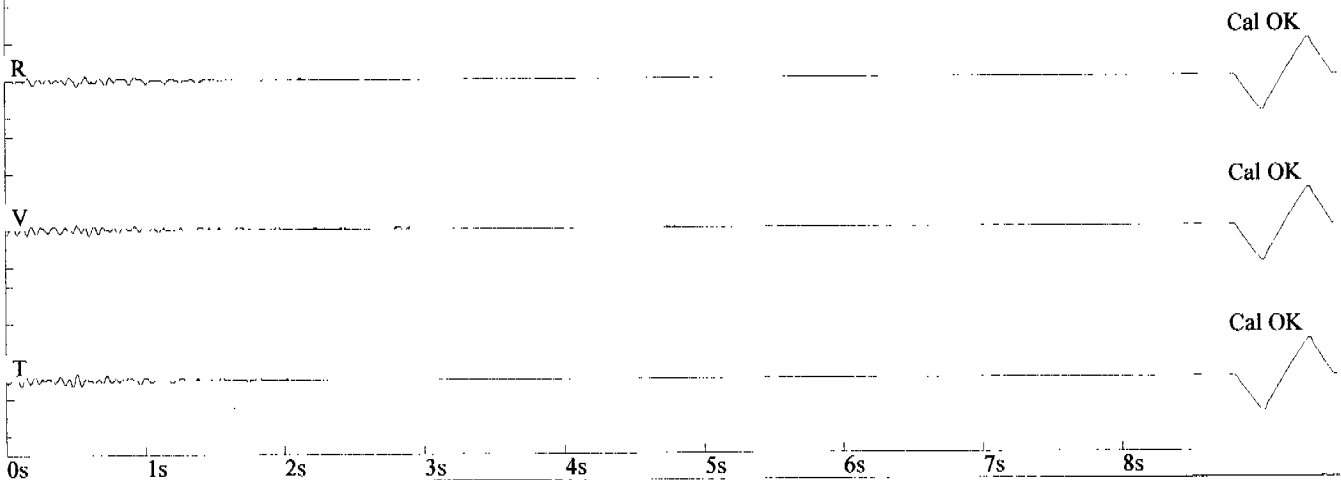
Graph Information

Duration: 0.000 sec To: 8.500 sec

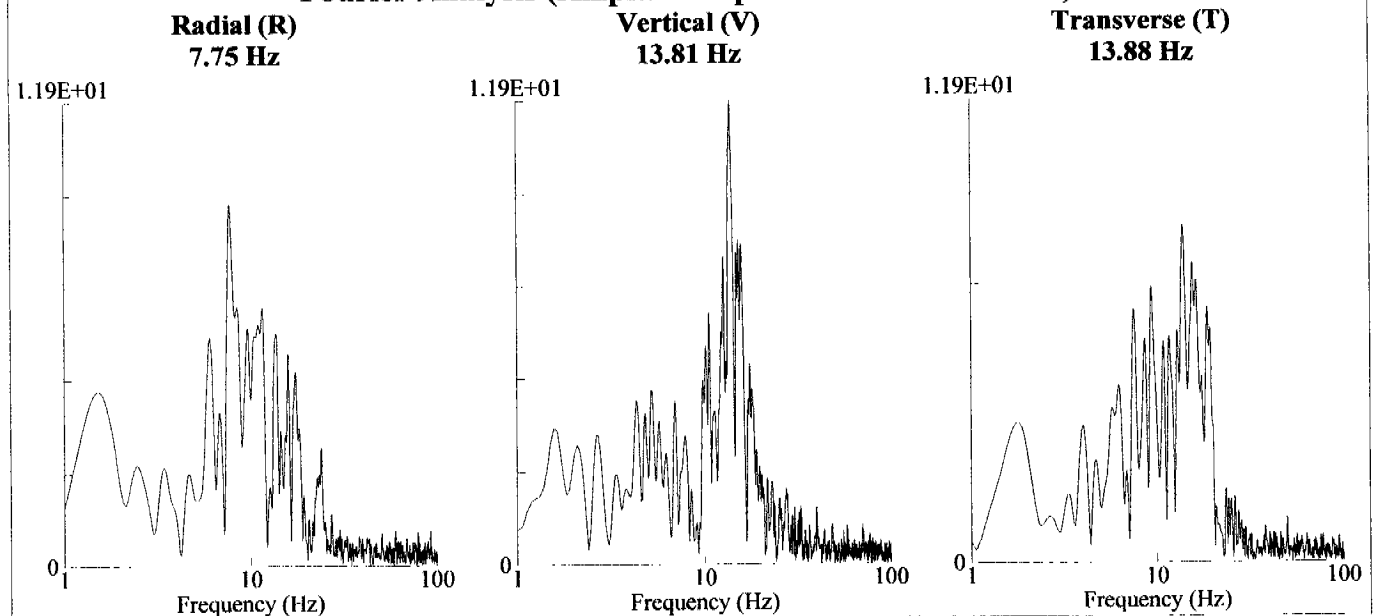
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well

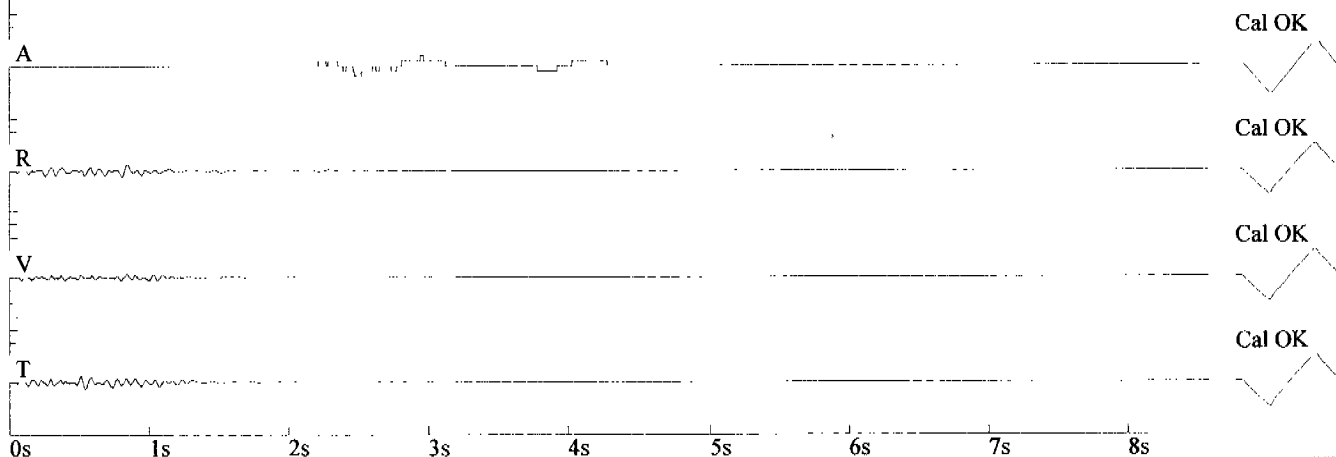
File: 00849029.DTB Event Number: 029 Date: 11/16/2000 Time: 16:00
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

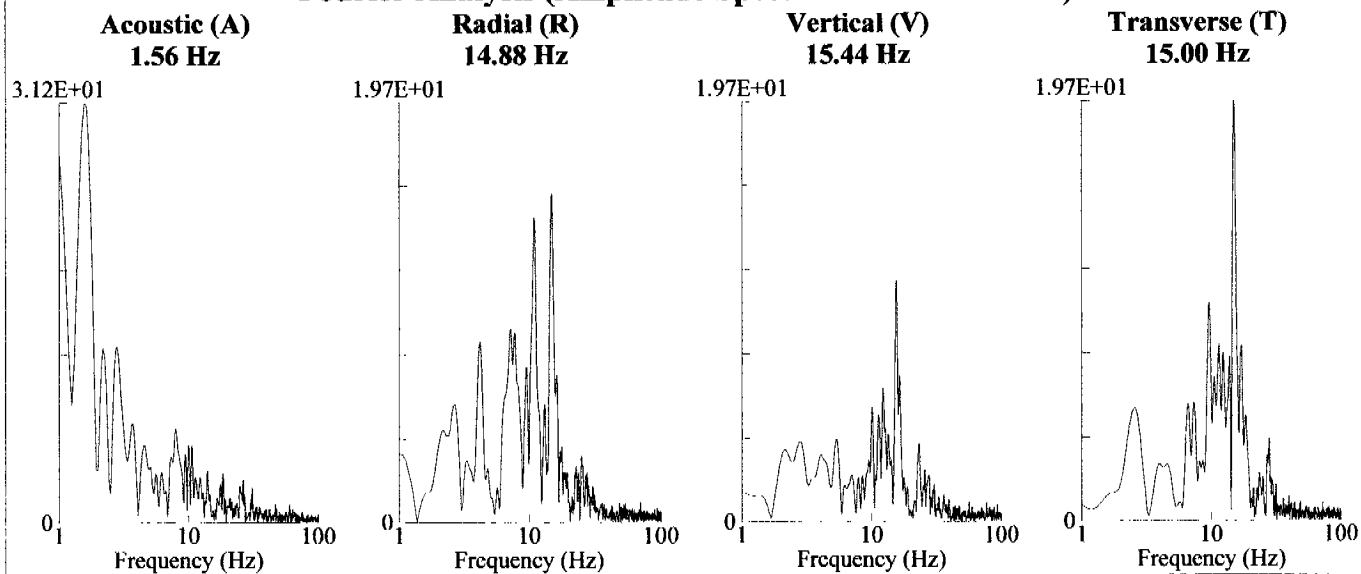
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.025in/s 0.635mm/s @ 11.6Hz
Vertical (V): 0.015in/s 0.381mm/s @ 19.6Hz
Transverse (T): 0.025in/s 0.635mm/s @ 17.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well

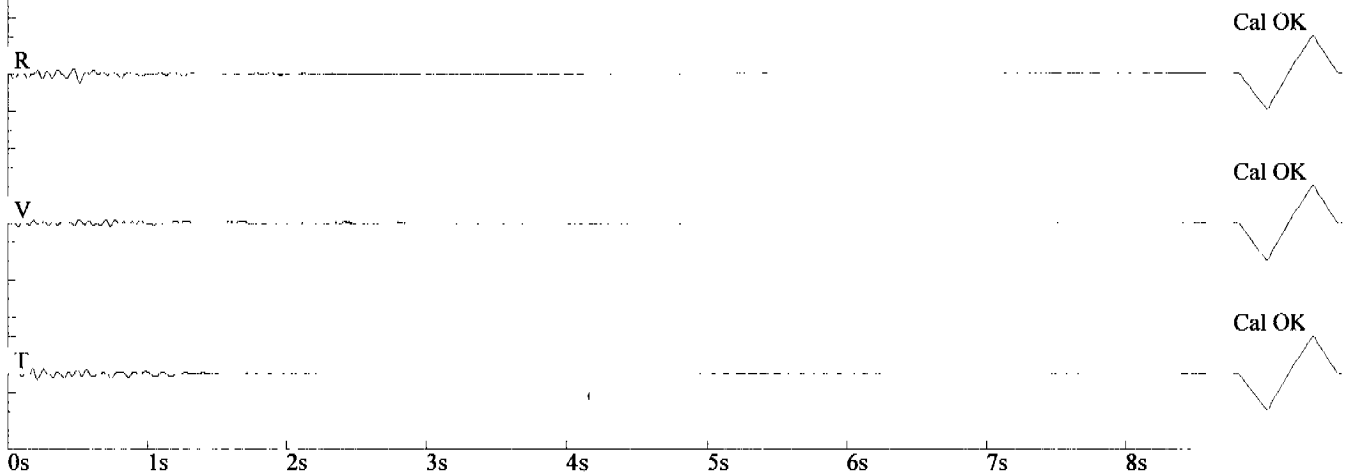
File: 00853081.DTB Event Number: 081 Date: 11/16/2000 Time: 15:59
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 853

Amplitudes and Frequencies

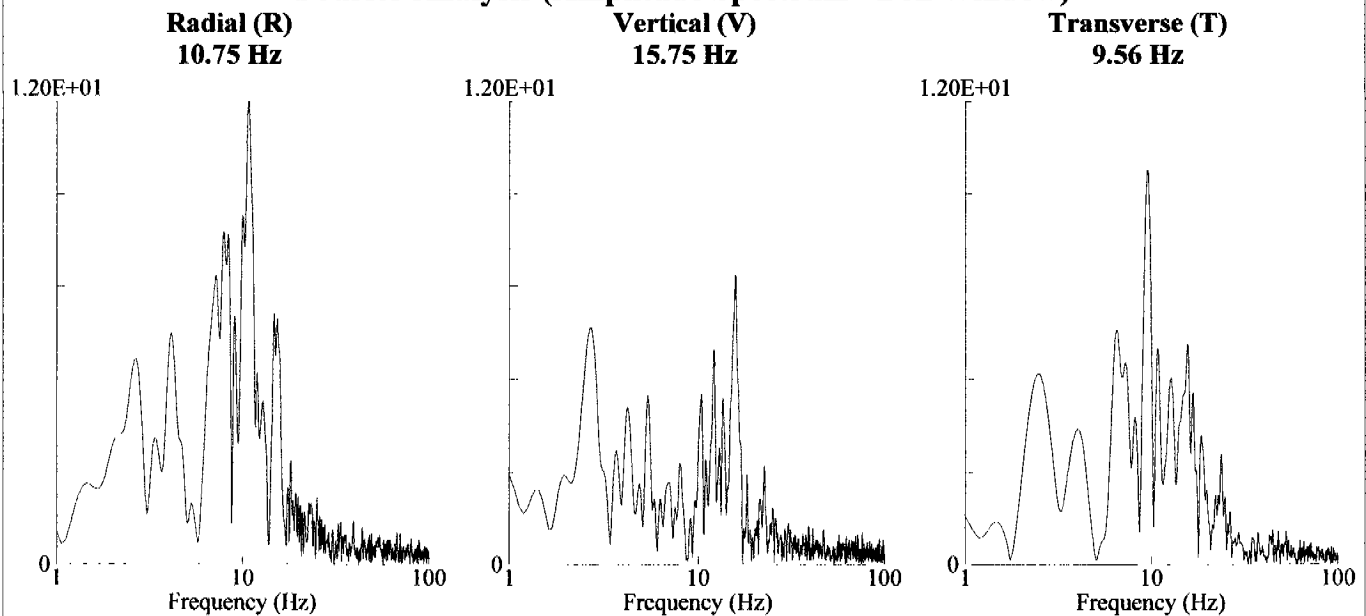
Radial (R): 0.025in/s 0.635mm/s @ 11.1Hz
Vertical (V): 0.01in/s 0.254mm/s @ 14.6Hz
Transverse (T): 0.015in/s 0.381mm/s @ 17.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well

File: 00849033.DTB Event Number: 033 Date: 11/17/2000 Time: 12:15
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

Acoustic (A): 110 dB @ 10.2 Hz

(0.06Mb 0.0009psi 0.0060kPa)

Radial (R): 0.025in/s 0.635mm/s @ 20.4Hz

Vertical (V): 0.02in/s 0.508mm/s @ 20.4Hz

Transverse (T): 0.02in/s 0.508mm/s @ 15.5Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec

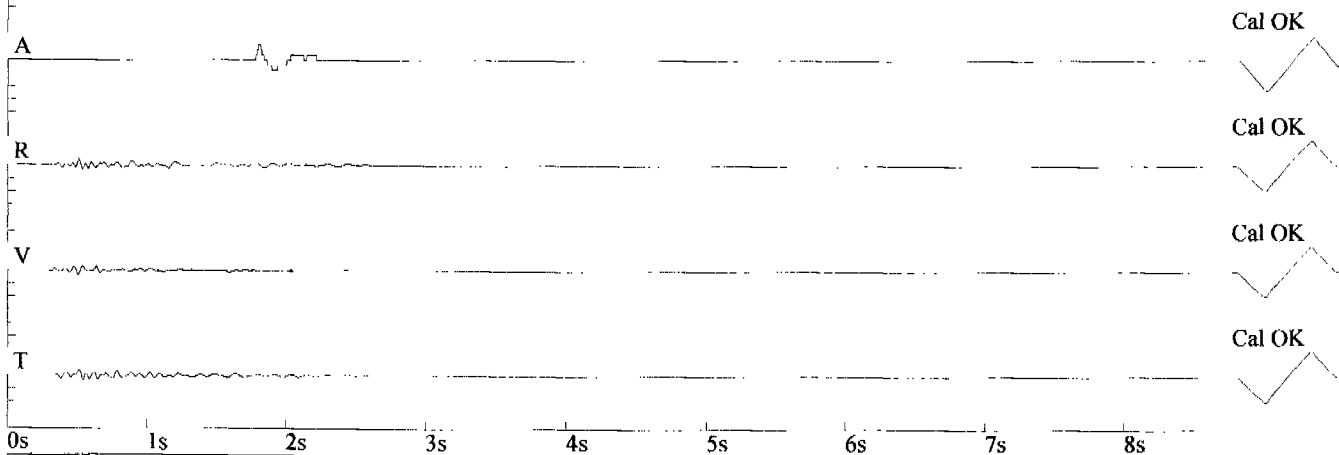
Acoustic Scale:

120dB 0.20Mb (0.050Mb/div)

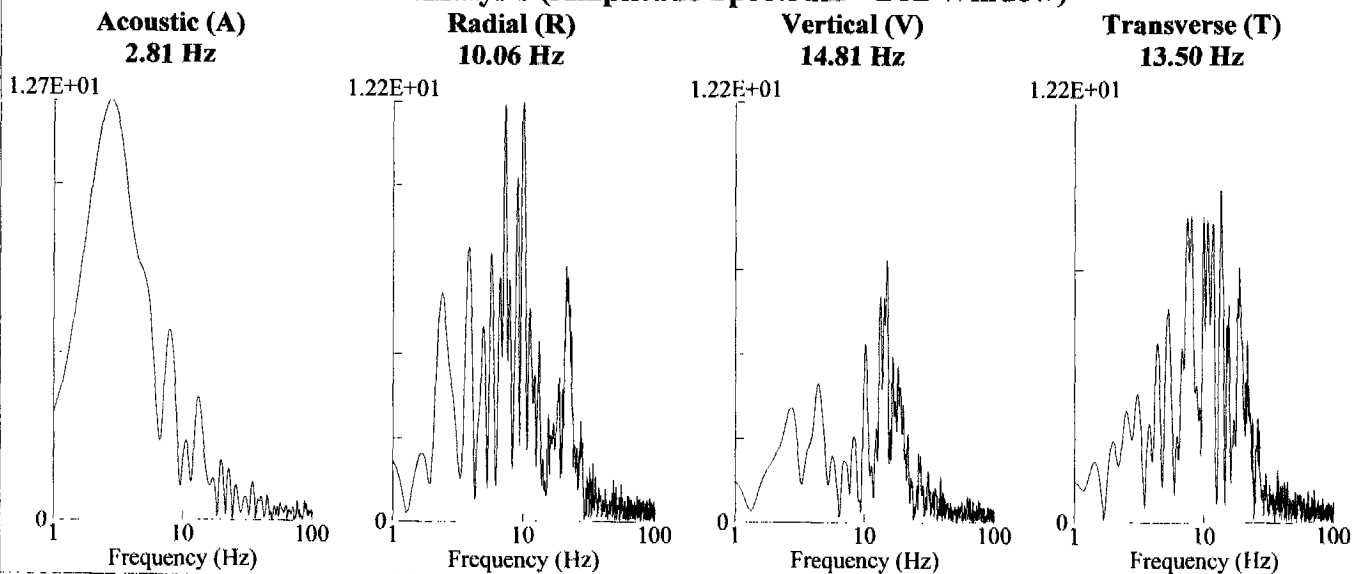
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well
29 in. deep

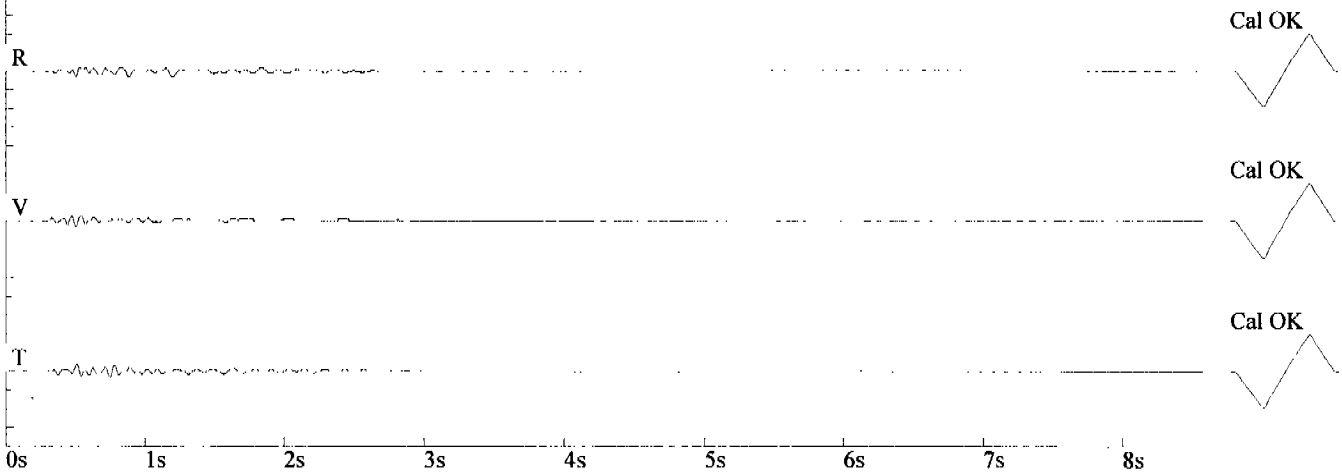
File: 00853082.DTB Event Number: 082 Date: 11/17/2000 Time: 12:14
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 853

Amplitudes and Frequencies

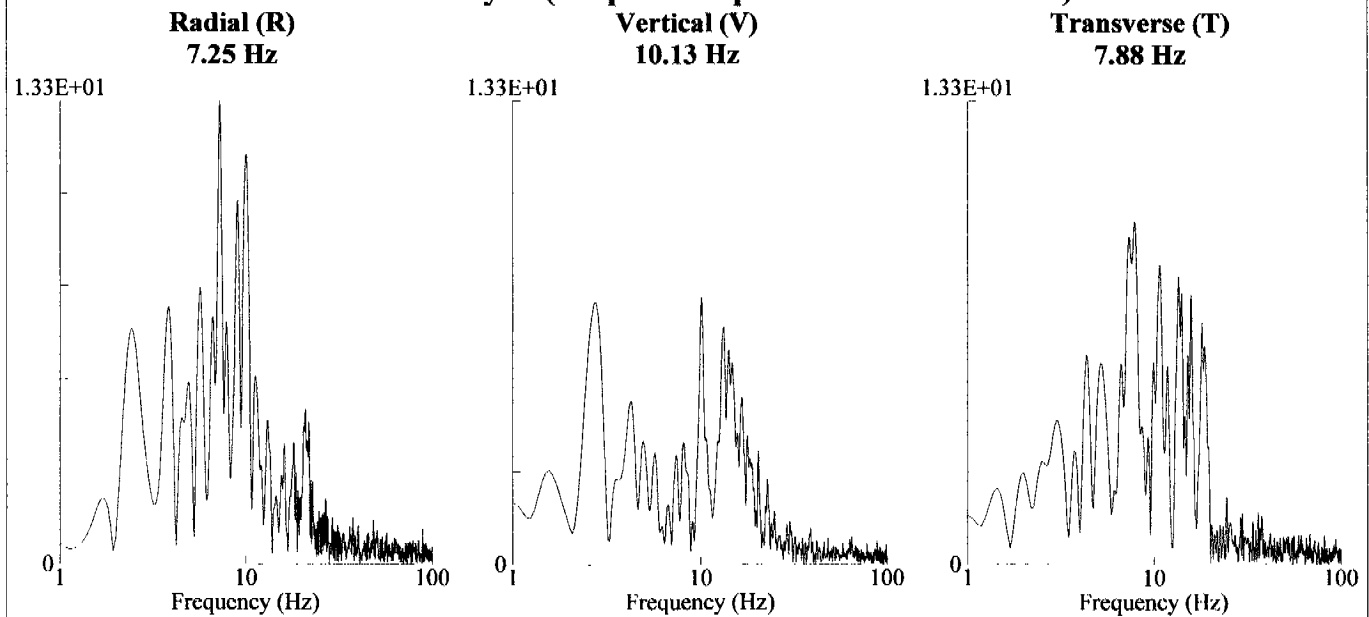
Radial (R): 0.015in/s 0.381mm/s @ 22.2Hz
Vertical (V): 0.015in/s 0.381mm/s @ 15.5Hz
Transverse (T): 0.02in/s 0.508mm/s @ 15.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well

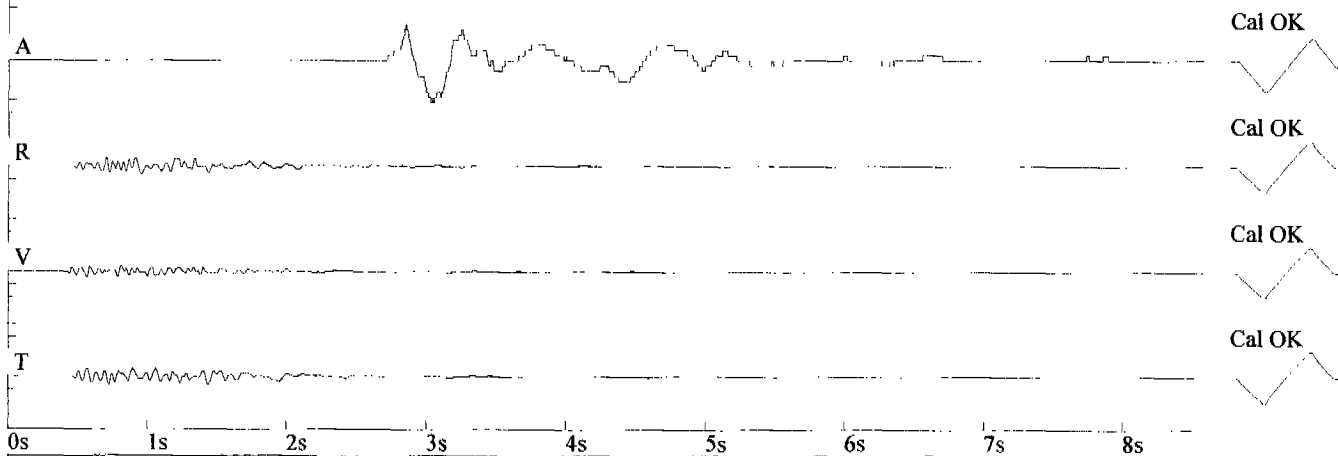
File: 00849034.DTB Event Number: 034 Date: 11/17/2000 Time: 12:34
Acoustic Trigger: 106 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

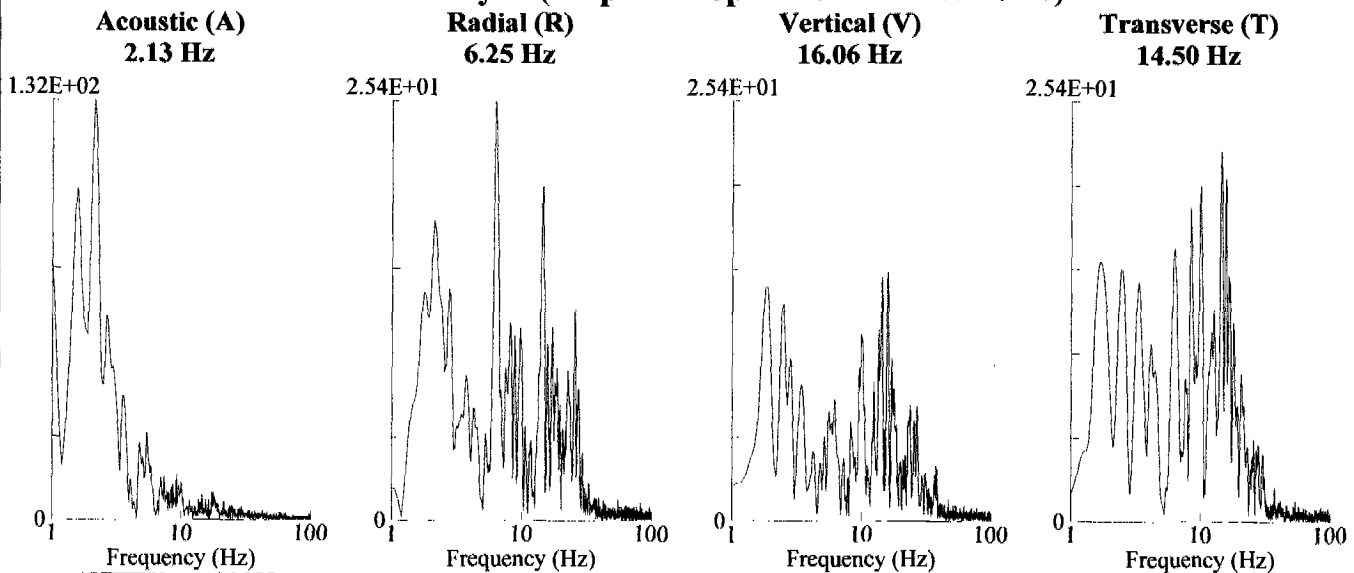
Acoustic (A): 118 dB @ 2.0 Hz
(0.16Mb 0.0023psi 0.0160kPa)
Radial (R): 0.03in/s 0.762mm/s @ 21.3Hz
Vertical (V): 0.025in/s 0.635mm/s @ 20.4Hz
Transverse (T): 0.035in/s 0.889mm/s @ 18.9Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Ratliff Well
29 in. deep

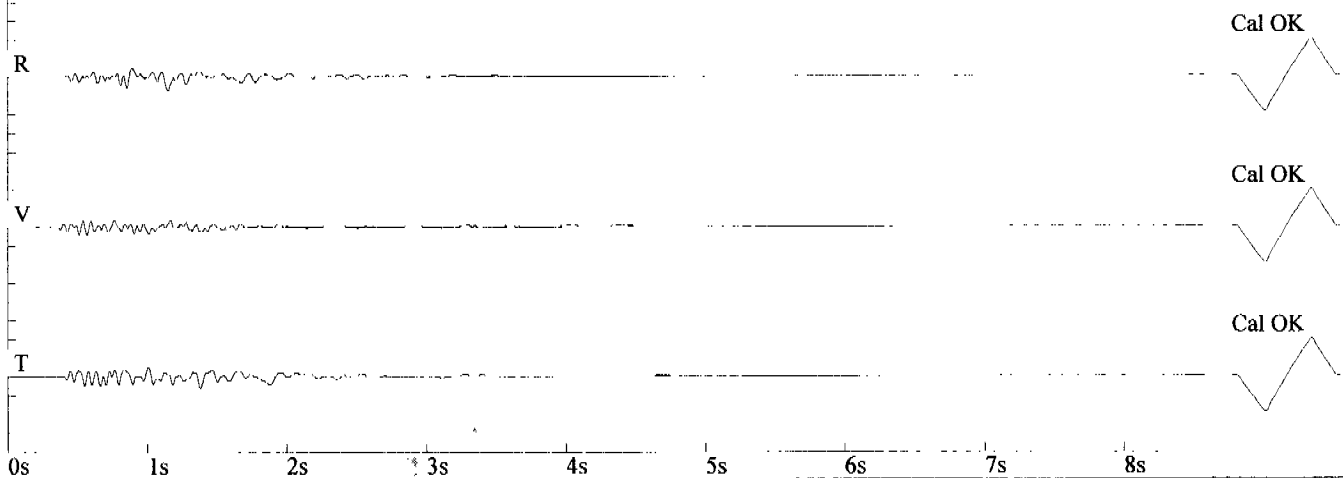
File: 00853083.DTB Event Number: 083 Date: 11/17/2000 Time: 12:34
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 853

Amplitudes and Frequencies

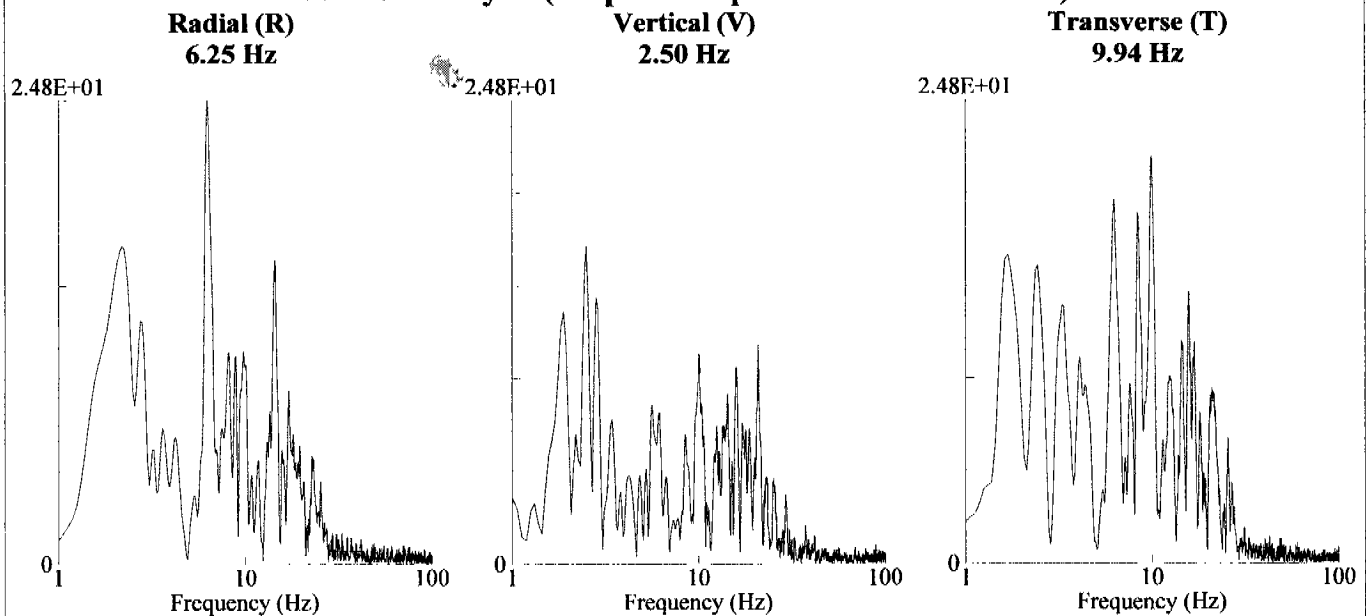
Radial (R): 0.035in/s 0.889mm/s @ 7.8Hz
Vertical (V): 0.02in/s 0.508mm/s @ 22.2Hz
Transverse (T): 0.03in/s 0.762mm/s @ 12.4Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



G. Hurley Well

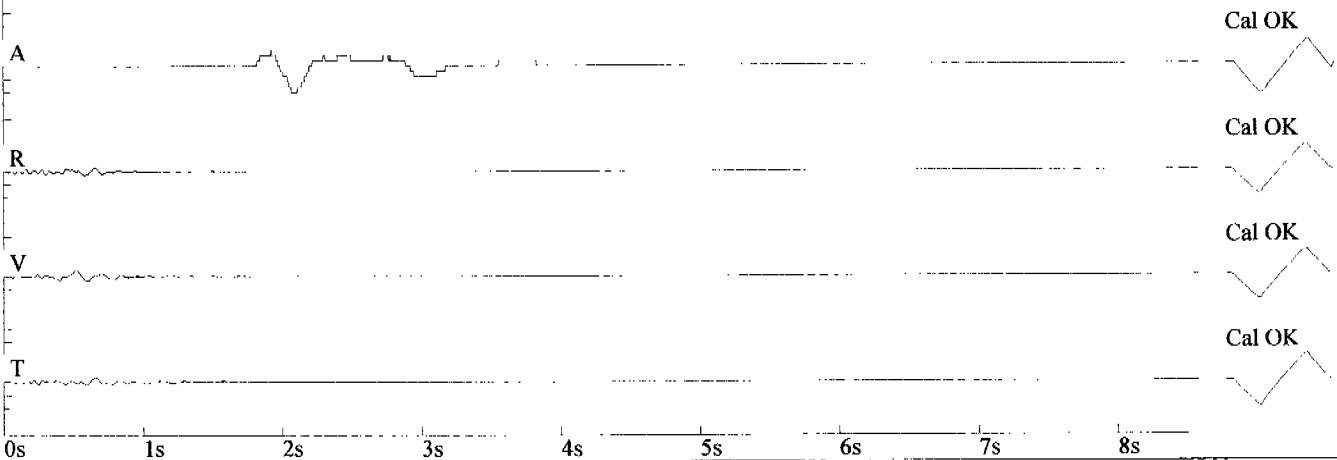
File: 00849036.DTB Event Number: 036 Date: 11/20/2000 Time: 13:03
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

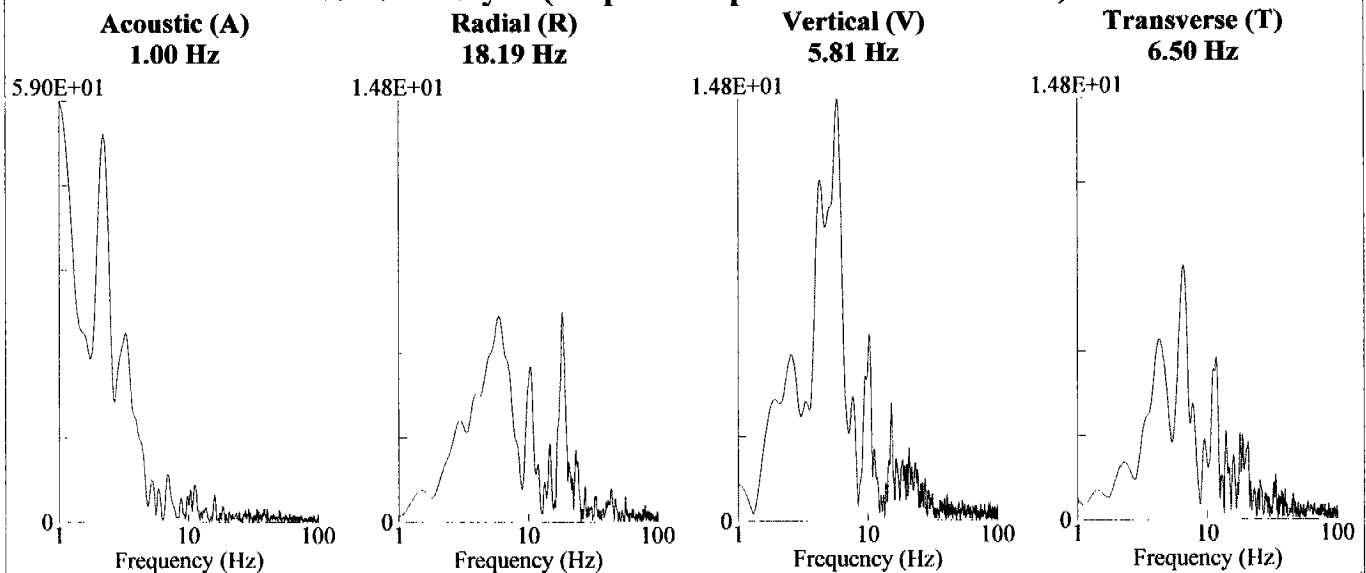
Acoustic (A): 114 dB @ 2.6 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.015in/s 0.381mm/s @ 11.3Hz
Vertical (V): 0.025in/s 0.635mm/s @ 6.7Hz
Transverse (T): 0.015in/s 0.381mm/s @ 8.6Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



G. Hurley Well
9.5 ft. deep

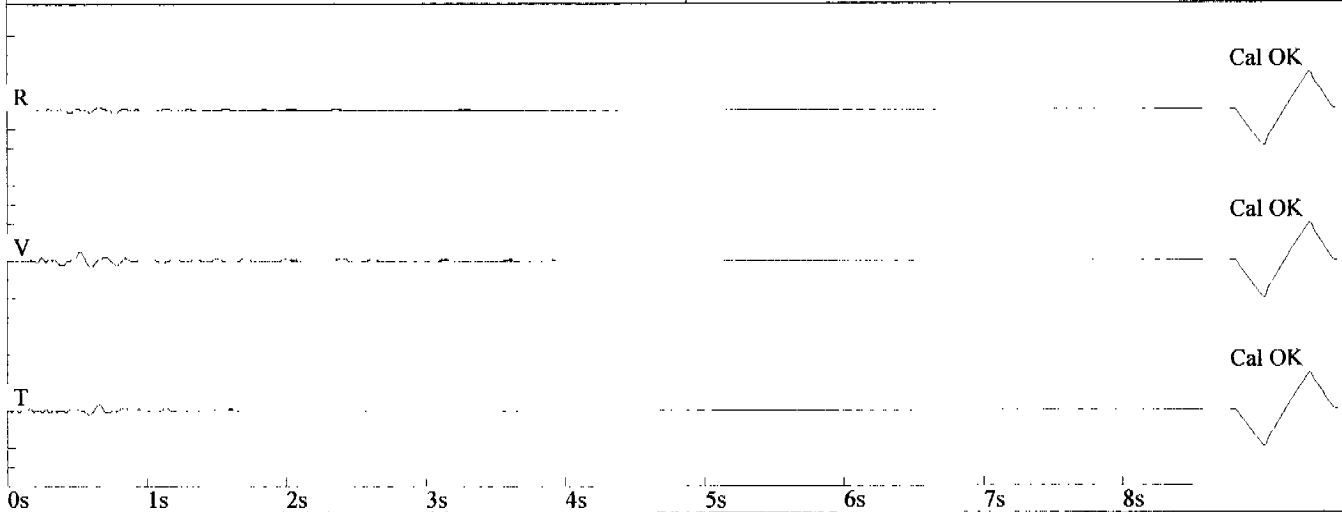
File: 00809090.DTB Event Number: 090 Date: 11/20/2000 Time: 13:03
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

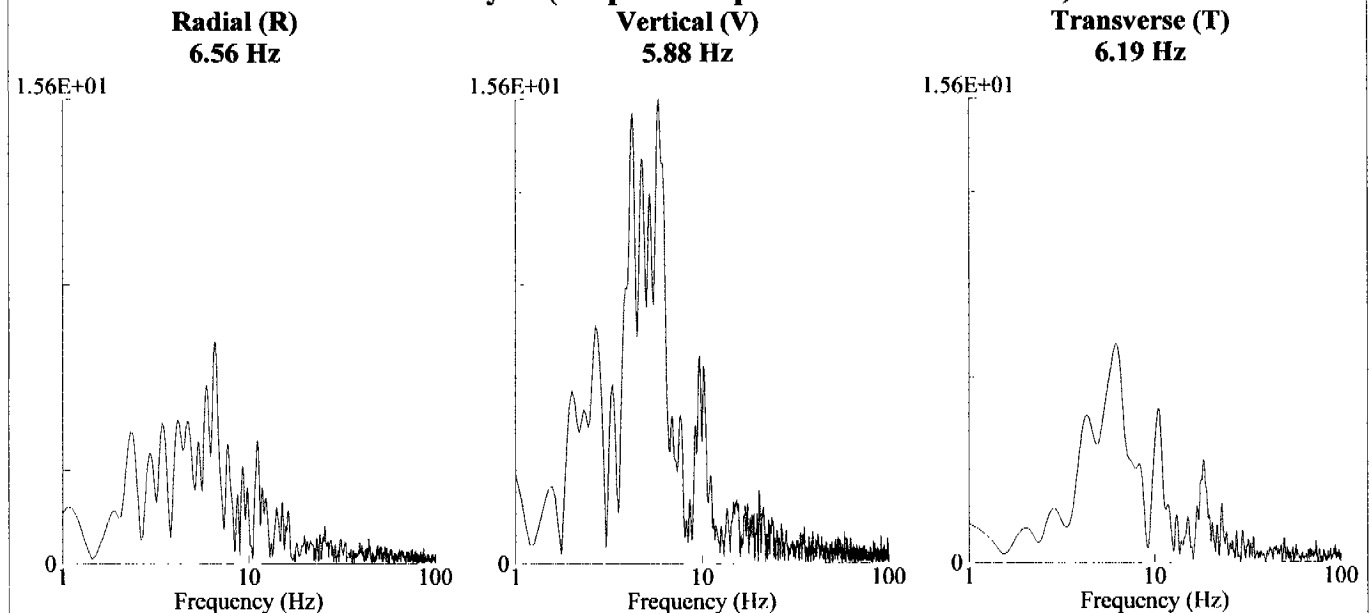
Radial (R): 0.01in/s 0.254mm/s @ 0.0Hz
Vertical (V): **0.025in/s 0.635mm/s @ 5.9Hz**
Transverse (T): 0.02in/s 0.508mm/s @ 9.1Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



G. Hurley Well

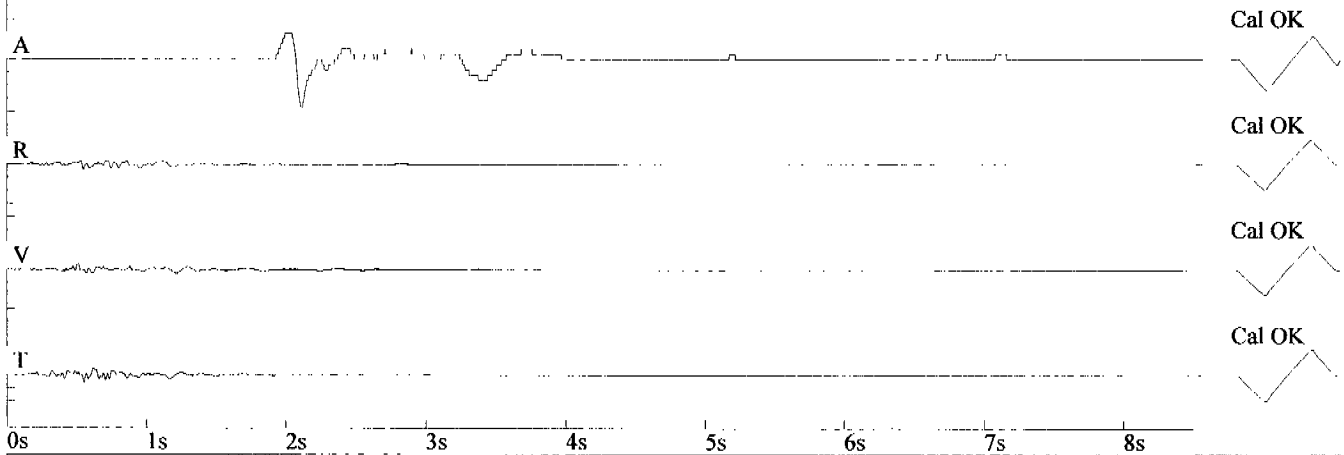
File: 00849037.DTB Event Number: 037 Date: 11/20/2000 Time: 16:08
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

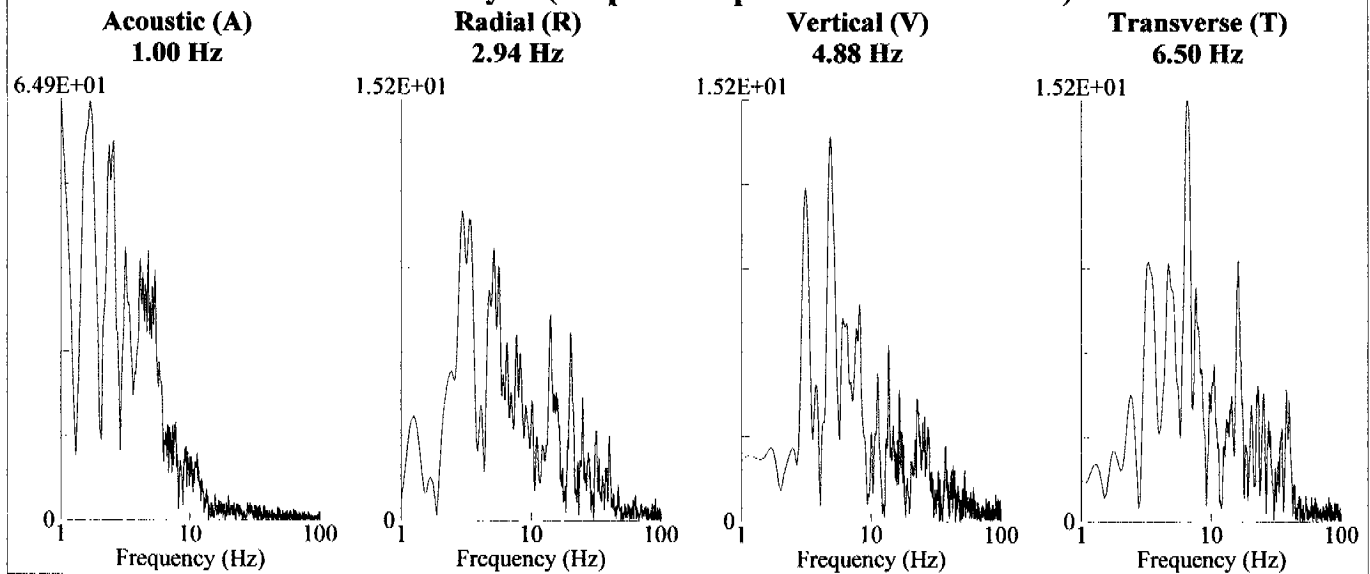
Acoustic (A): 119 dB @ 3.3 Hz
(0.18Mb 0.0026psi 0.0180kPa)
Radial (R): 0.02in/s 0.508mm/s @ 23.2Hz
Vertical (V): 0.02in/s 0.508mm/s @ 19.6Hz
Transverse (T): 0.03in/s 0.762mm/s @ 23.2Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



G. Hurley Well
9.5 ft. deep

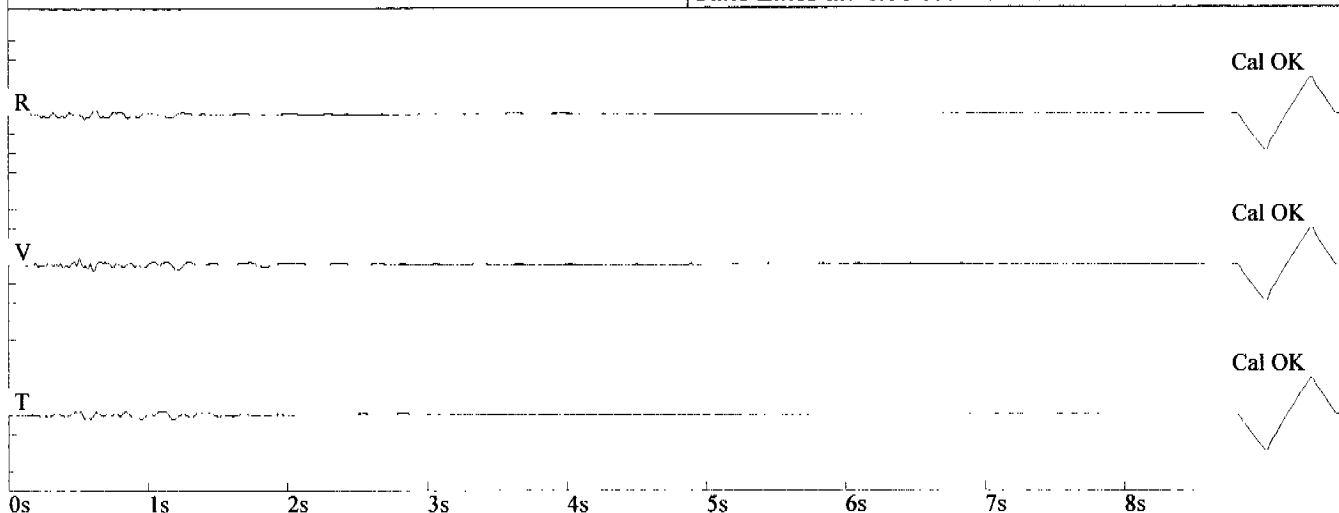
File: 00809091.DTB Event Number: 091 Date: 11/20/2000 Time: 16:08
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

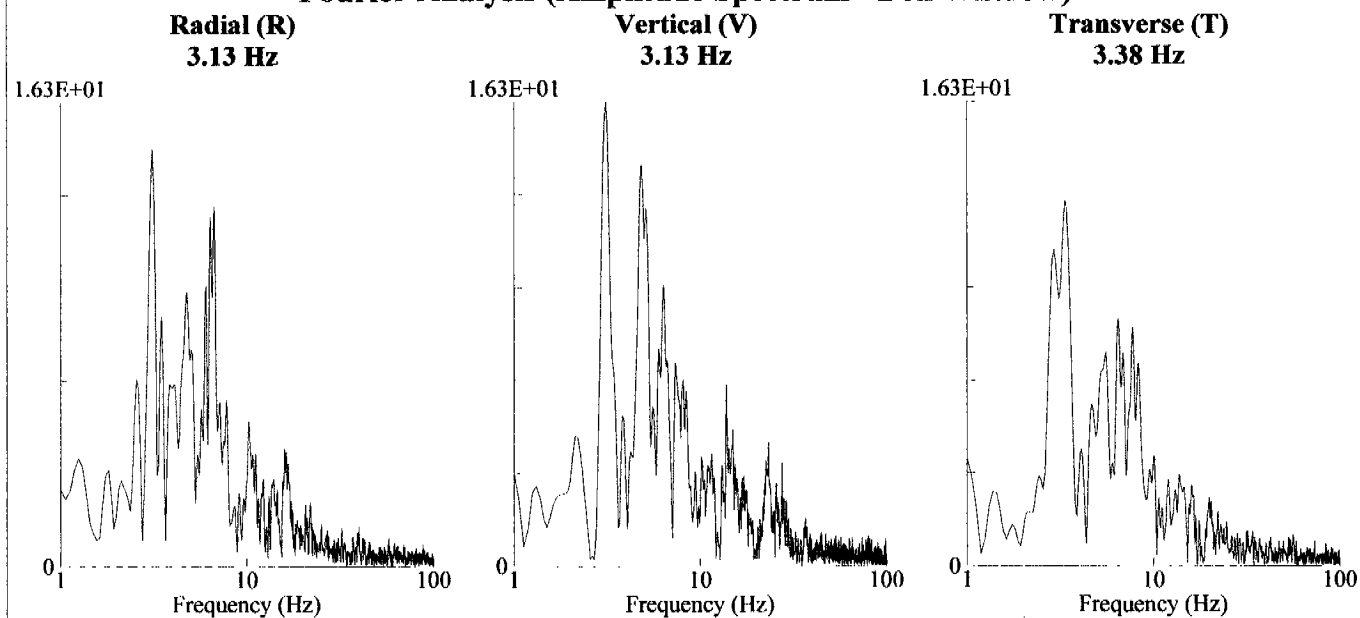
Radial (R): 0.015in/s 0.381mm/s @ 0.0Hz
Vertical (V): **0.02in/s 0.508mm/s @ 16.5Hz**
Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



G. Hurley Well

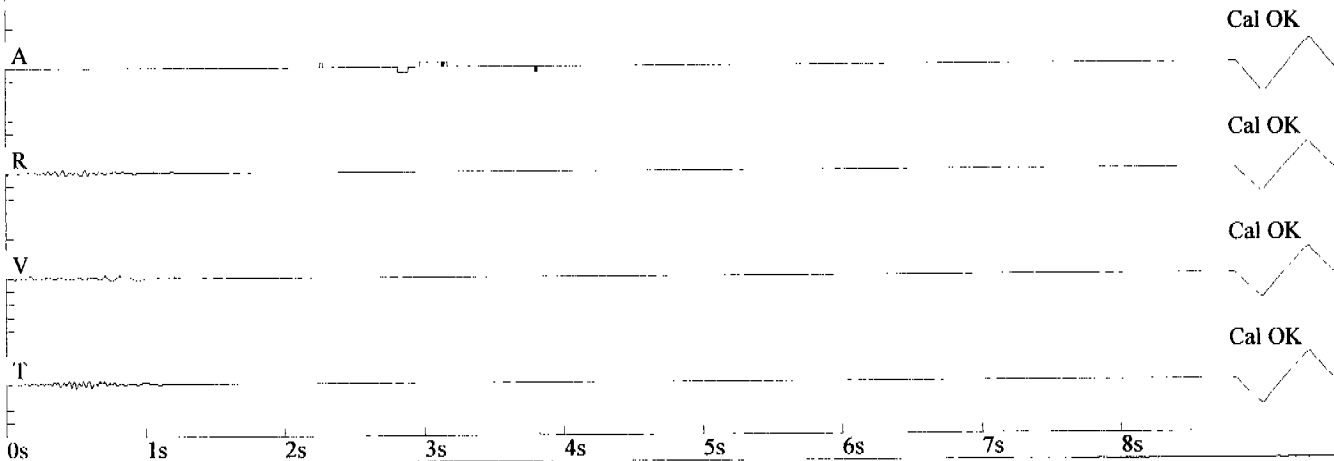
File: 00849038.DTB Event Number: 038 Date: 11/20/2000 Time: 16:45
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 849

Amplitudes and Frequencies

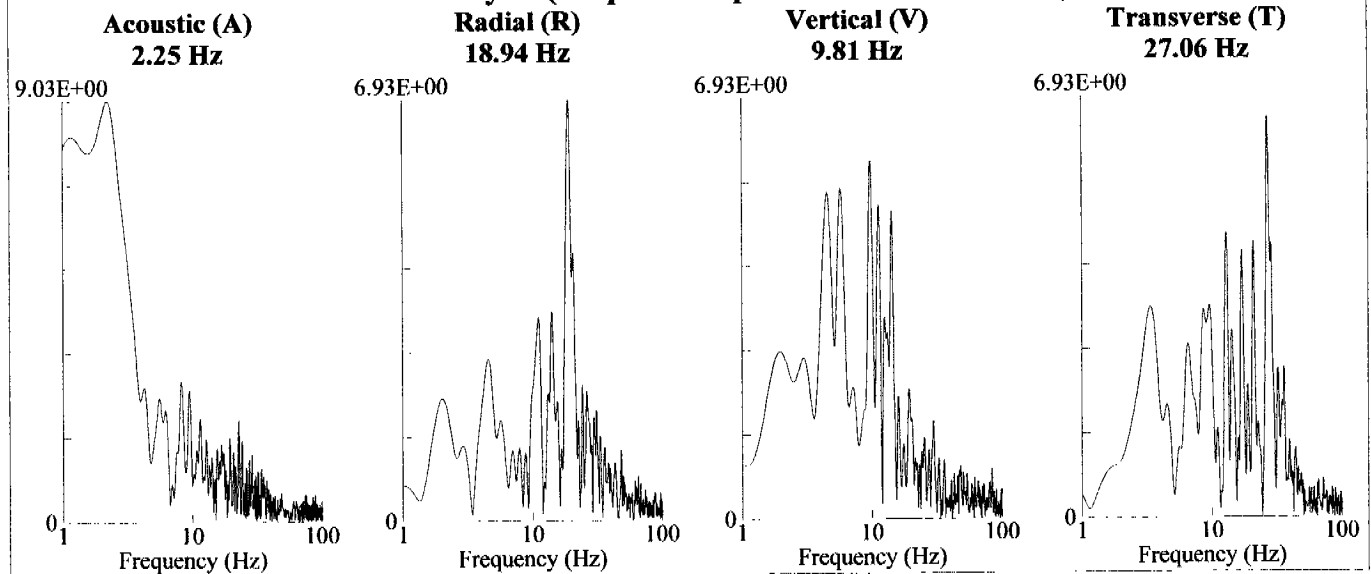
Acoustic (A): 100 dB @ 0.0 Hz
(0.02Mb 0.0003psi 0.0020kPa)
Radial (R): 0.015in/s 0.381mm/s @ 24.3Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.02in/s 0.508mm/s @ 28.4Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Sumner Well **5 in. (surface only)**

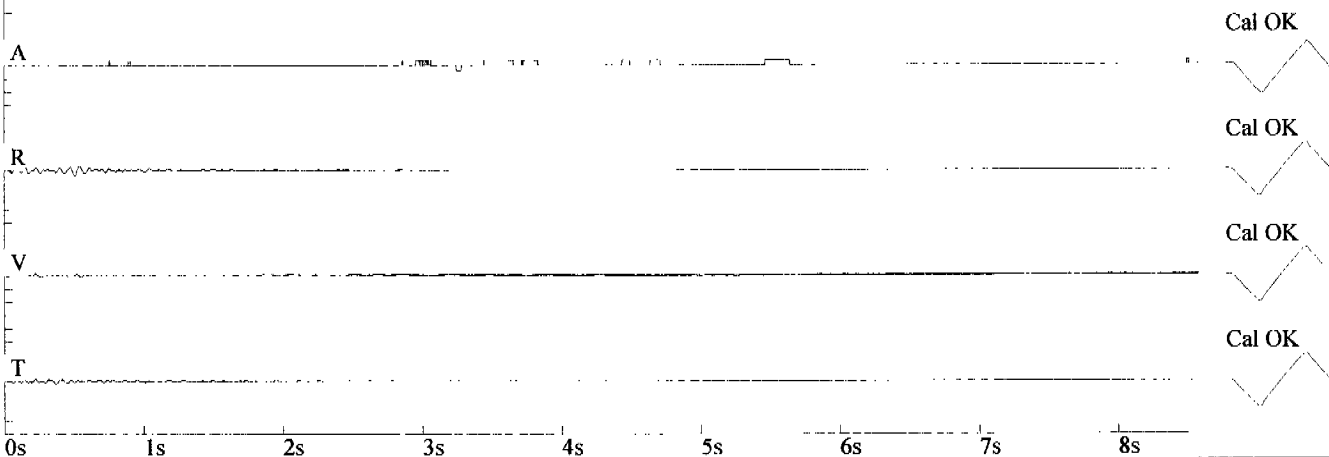
File: 00804072.DTB Event Number: 072 Date: 11/20/2000 Time: 10:32
 Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

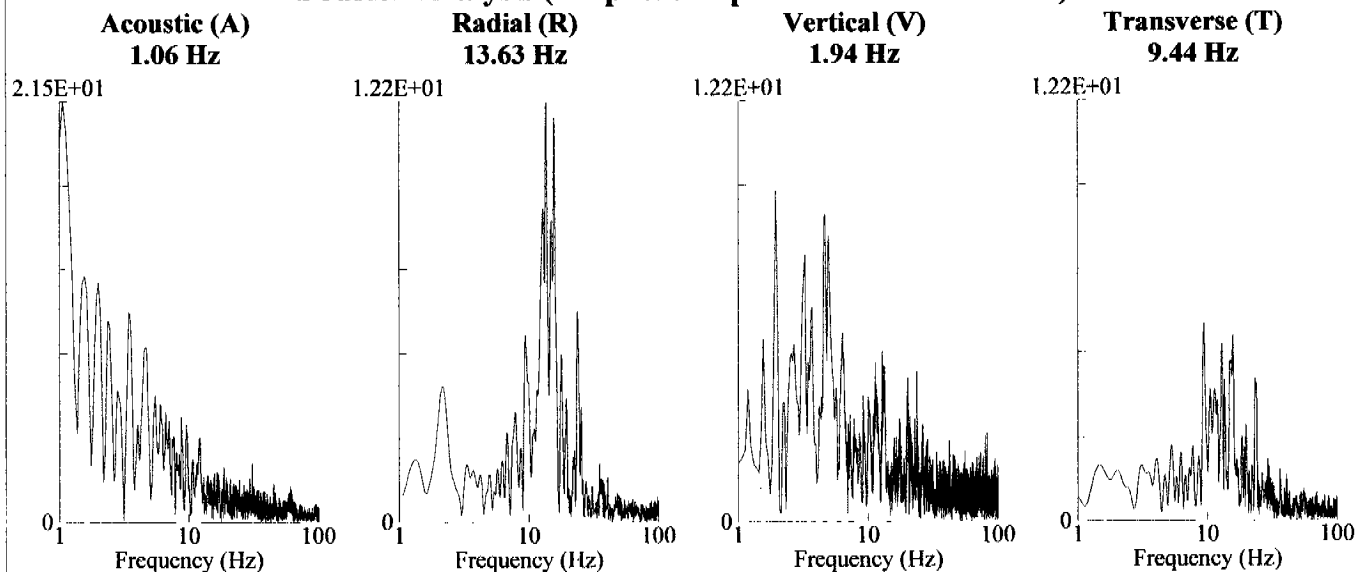
Acoustic (A): 100 dB @ 0.0 Hz
 (0.02Mb 0.0003psi 0.0020kPa)
Radial (R): 0.02in/s 0.508mm/s @ 14.6Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.005in/s 0.127mm/s @ 0.0Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
 120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Sumner Well **5 in. (surface only)**

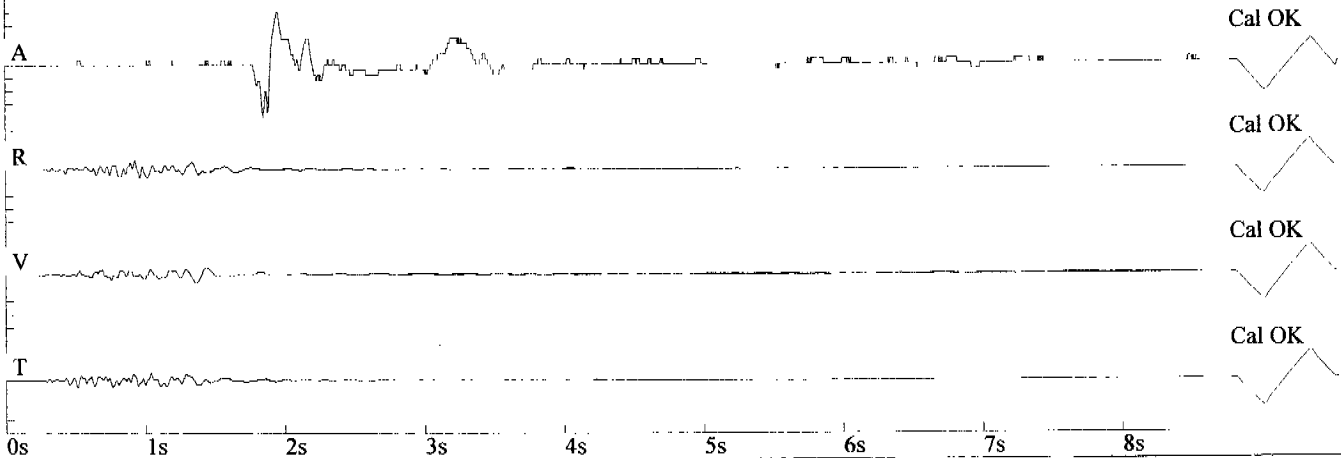
File: 00804075.DTB Event Number: 075 Date: 11/20/2000 Time: 16:09
 Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 804

Amplitudes and Frequencies

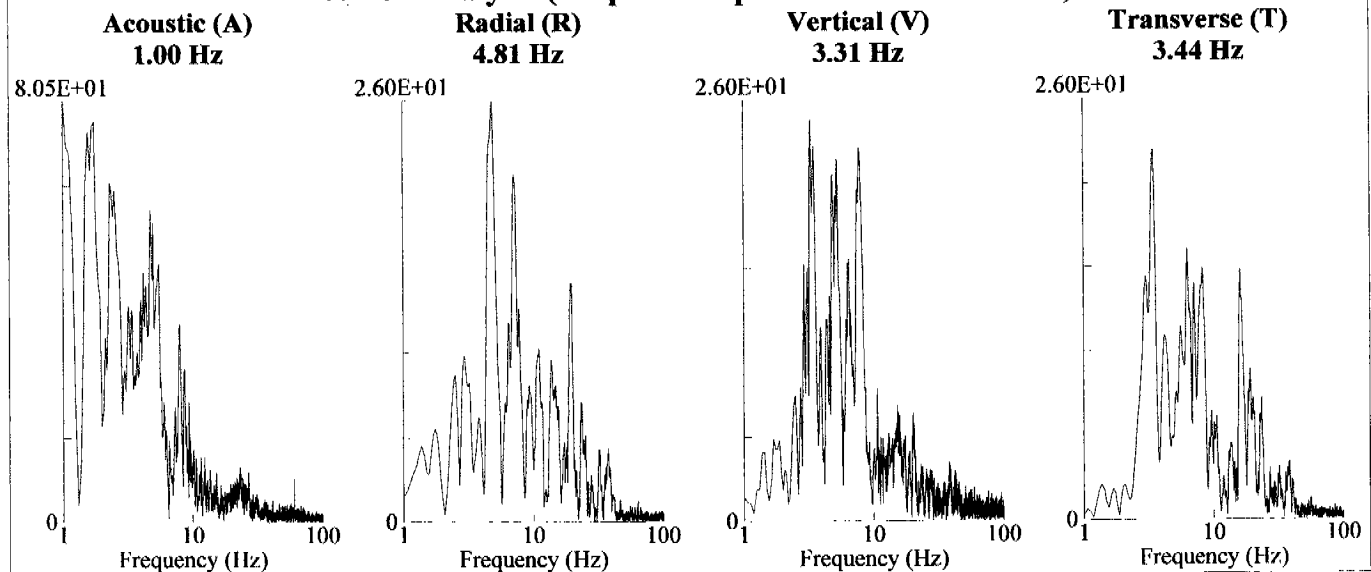
Acoustic (A): 120 dB @ 2.9 Hz
 (0.20Mb 0.0029psi 0.0200kPa)
Radial (R): 0.035in/s 0.889mm/s @ 16.0Hz
Vertical (V): 0.03in/s 0.762mm/s @ 7.4Hz
Transverse (T): 0.03in/s 0.762mm/s @ 7.5Hz

Graph Information

Duration: 0.000 sec To: 8.500 sec
Acoustic Scale:
 120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



SPRING 2001

**West Virginia
Dean Sr. surface**

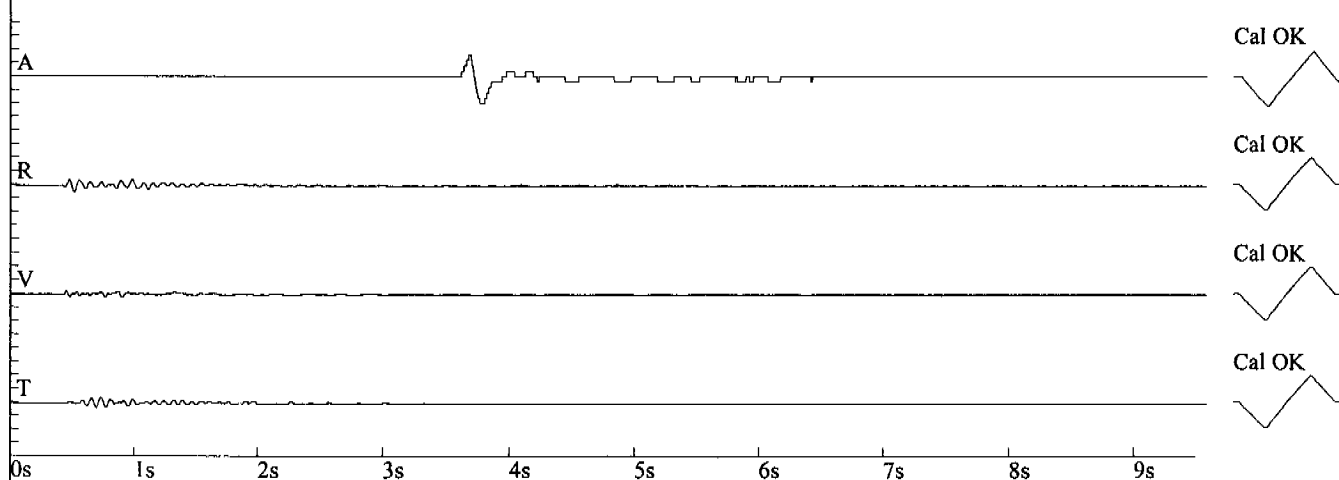
File: D1SAP001.DTB Event Number: 001 Date: 4/3/01 Time: 08:41
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

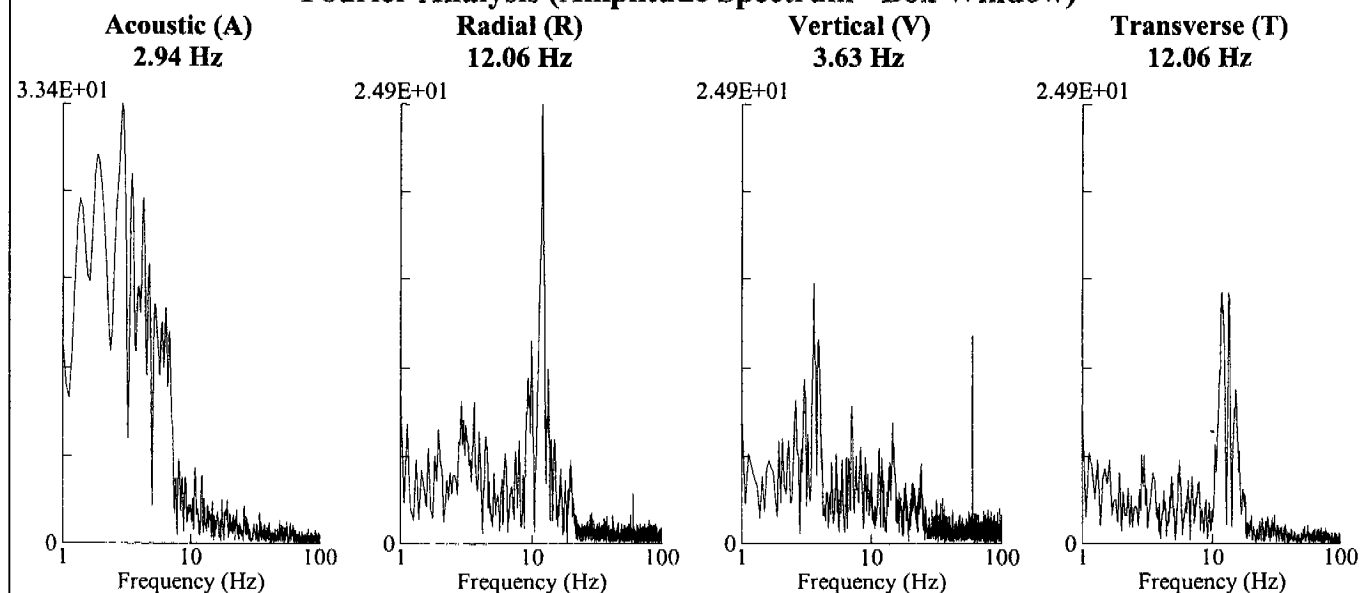
Acoustic (A): 114 dB @ 2.3 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.03in/s 0.762mm/s @ 12.1Hz
Vertical (V): 0.015in/s 0.381mm/s @ 16.0Hz
Transverse (T): 0.025in/s 0.635mm/s @ 13.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

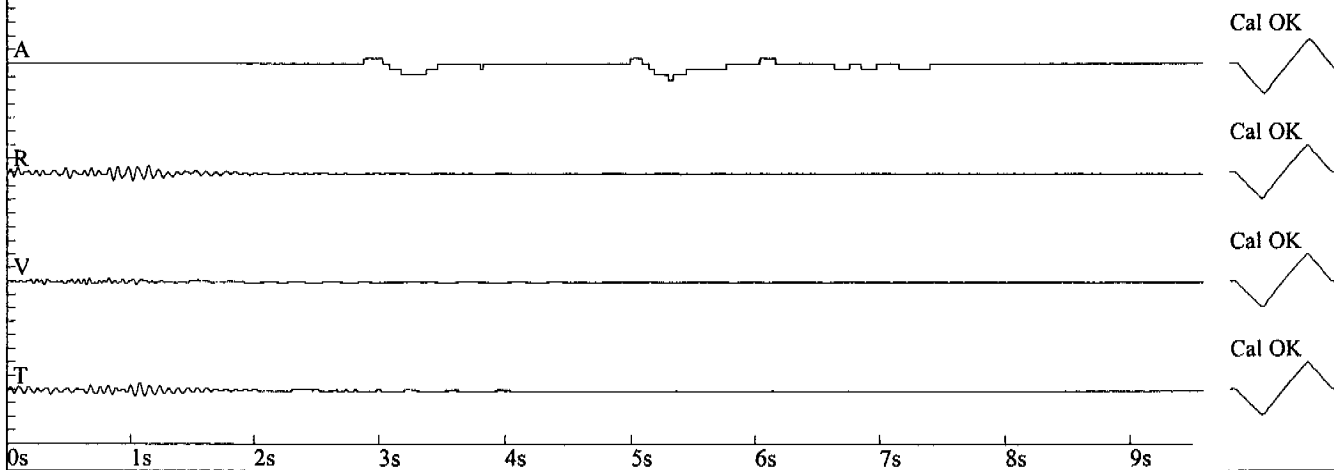
File: D1SAP002.DTB Event Number: 002 Date: 4/3/01 Time: 13:51
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

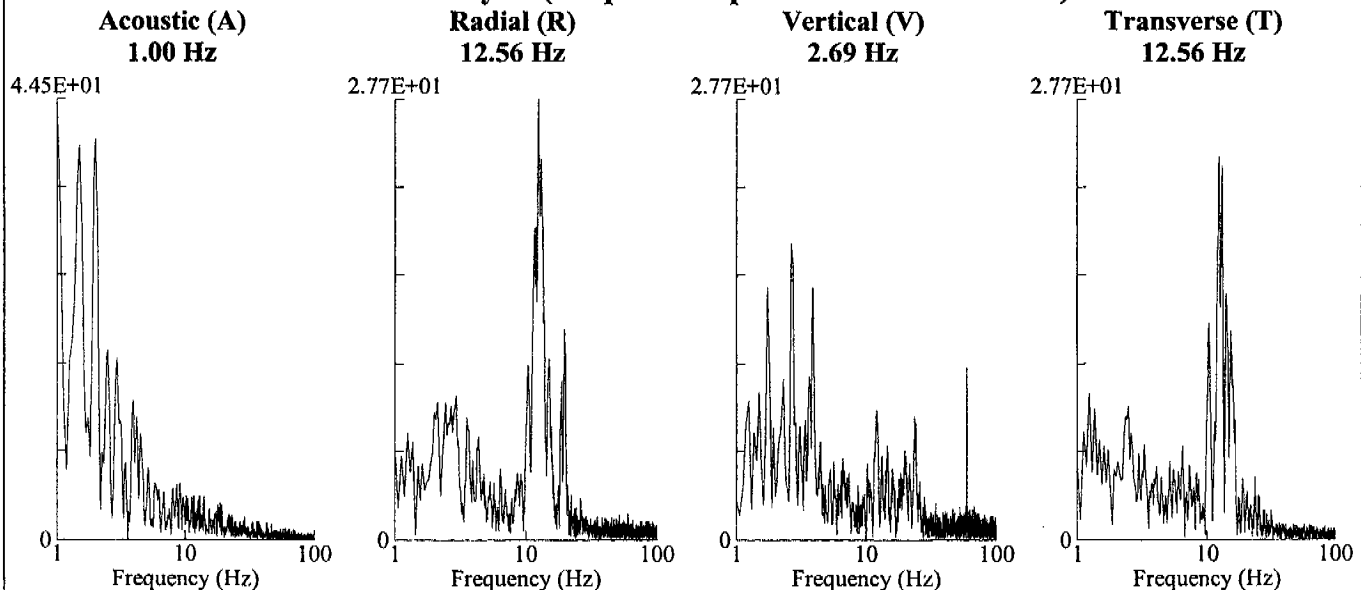
Acoustic (A): 110 dB @ 1.3 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.03in/s 0.762mm/s @ 15.0Hz
Vertical (V): 0.015in/s 0.381mm/s @ 24.3Hz
Transverse (T): 0.025in/s 0.635mm/s @ 15.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

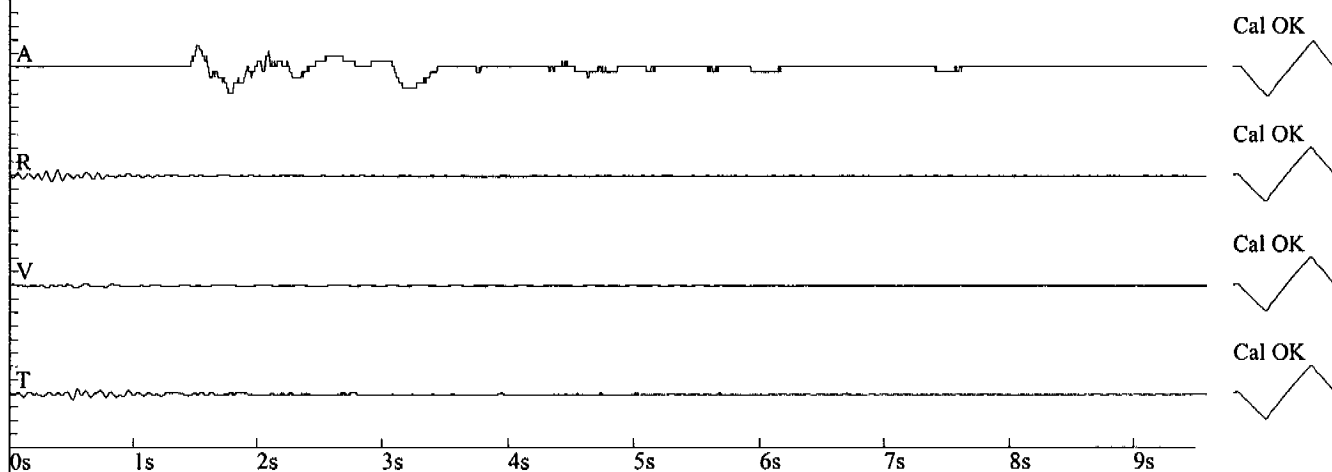
File: D1SAP003.DTB Event Number: 003 Date: 4/3/01 Time: 17:06
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

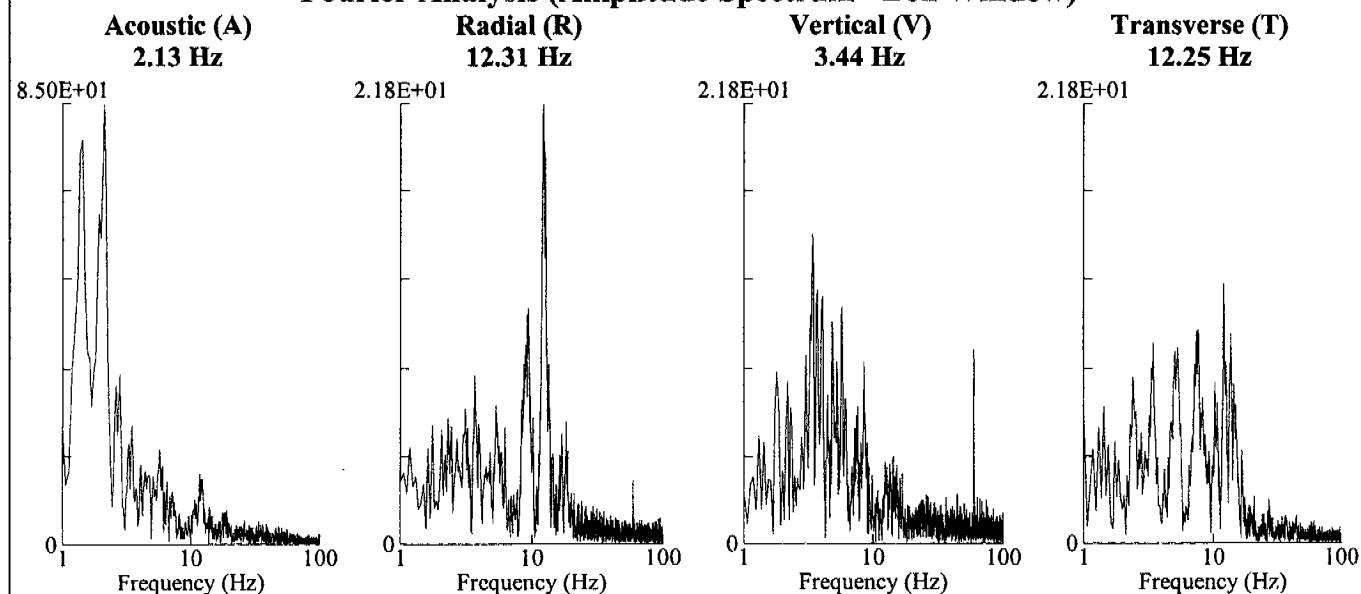
Acoustic (A): 114 dB @ 2.1 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.015in/s 0.381mm/s @ 14.6Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): **0.025in/s 0.635mm/s @ 10.8Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

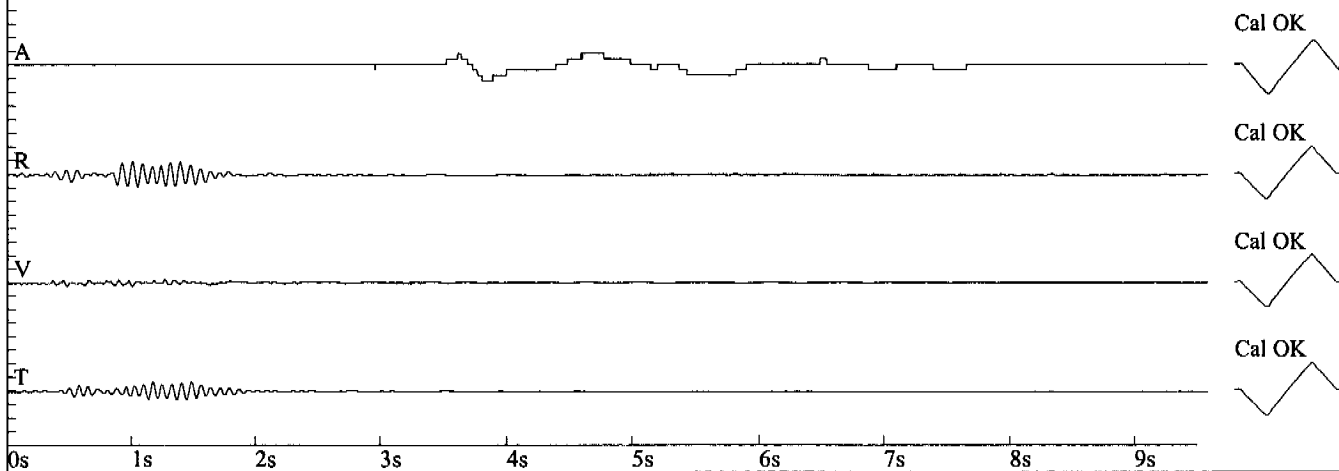
File: D1SAP004.DTB Event Number: 004 Date: 4/4/01 Time: 11:20
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

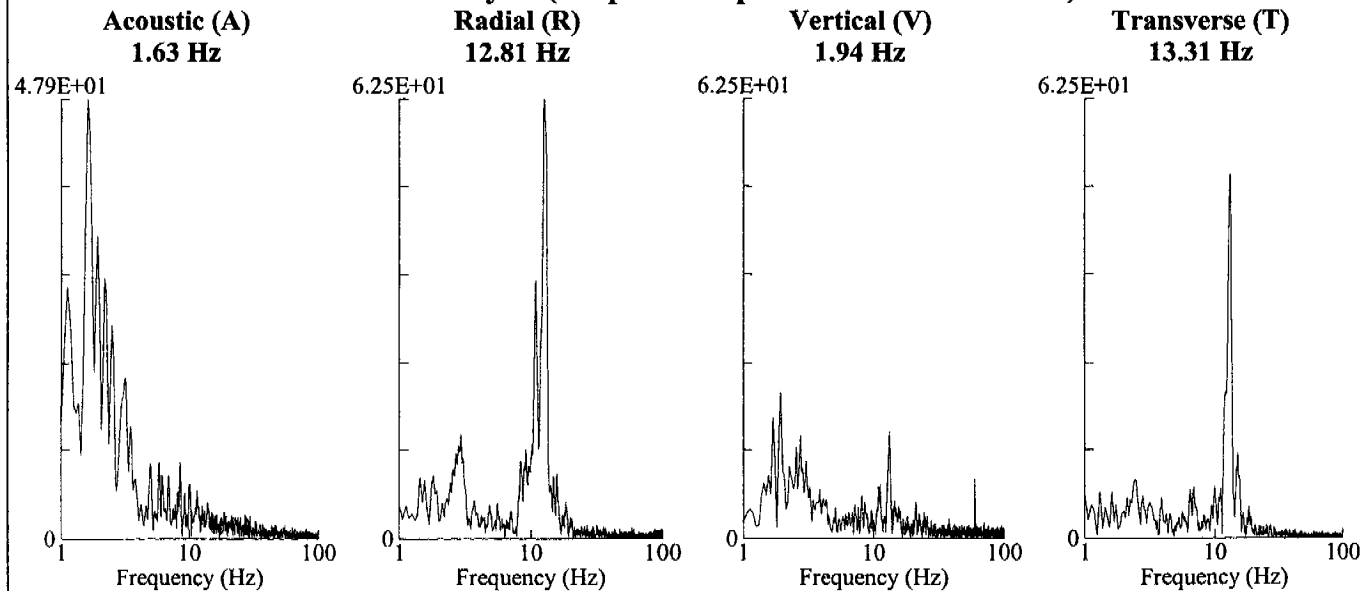
Acoustic (A): 110 dB @ 1.7 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.05in/s 1.27mm/s @ 12.8Hz
Vertical (V): 0.015in/s 0.381mm/s @ 15.0Hz
Transverse (T): 0.035in/s 0.889mm/s @ 13.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

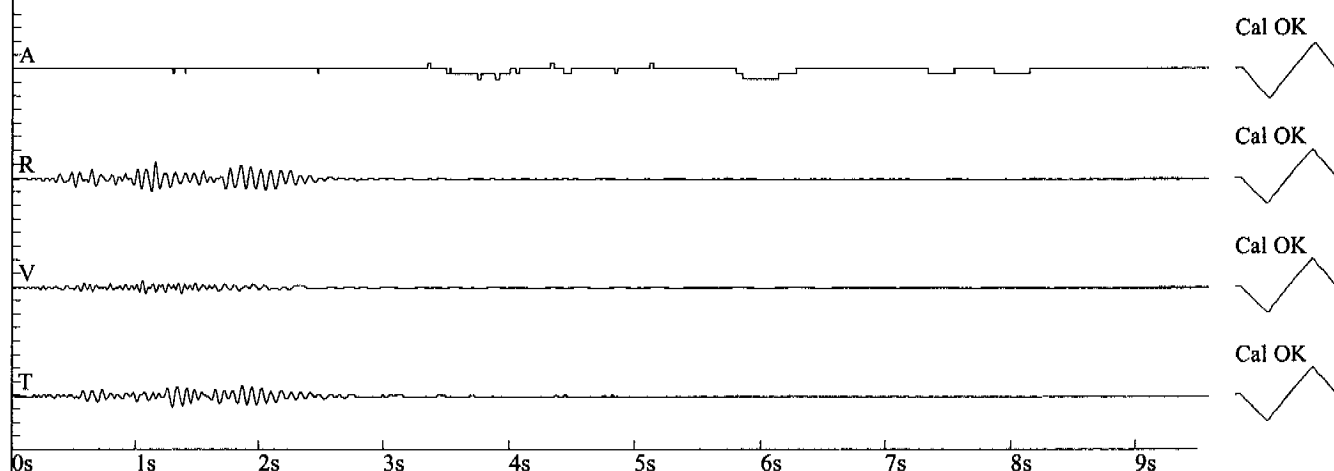
File: D1SAP006.DTB Event Number: 006 Date: 4/5/01 Time: 10:34
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

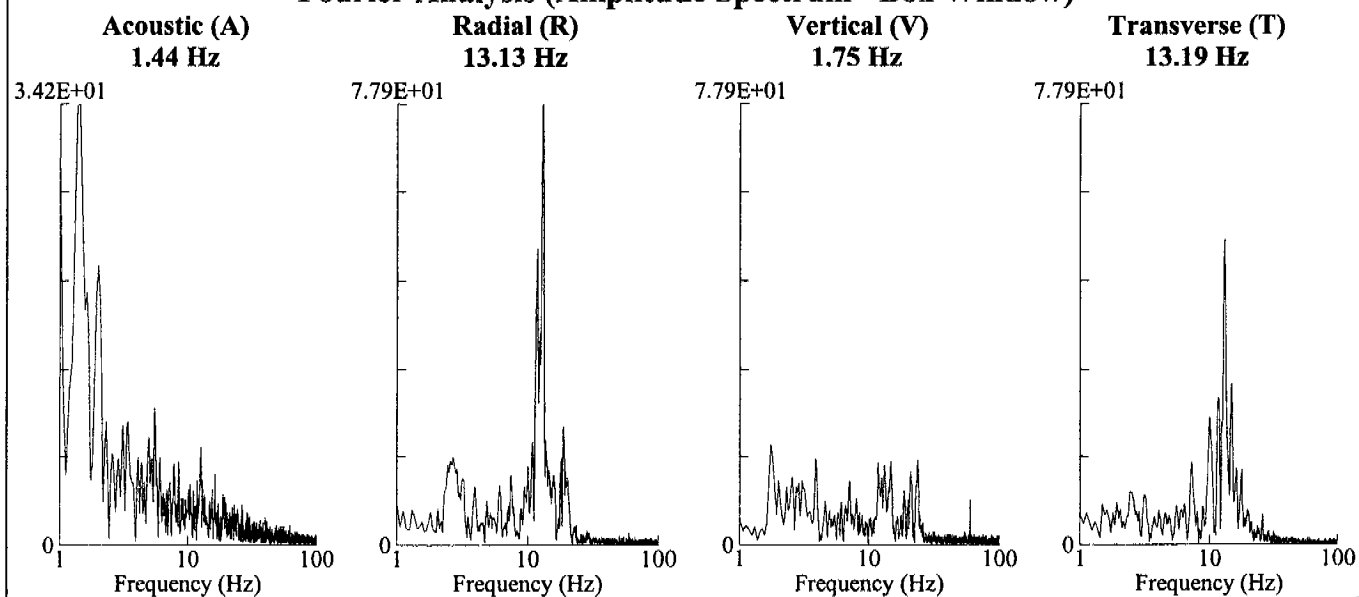
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.055in/s 1.397mm/s @ 16.0Hz
Vertical (V): 0.025in/s 0.635mm/s @ 21.3Hz
Transverse (T): 0.045in/s 1.143mm/s @ 12.4Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

File: D1SAP007.DTB Event Number: 007 Date: 4/6/01 Time: 10:22
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)

Radial (R): 0.05in/s 1.27mm/s @ 12.1Hz

Vertical (V): 0.02in/s 0.508mm/s @ 14.2Hz

Transverse (T): 0.05in/s 1.27mm/s @ 12.1Hz

Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec

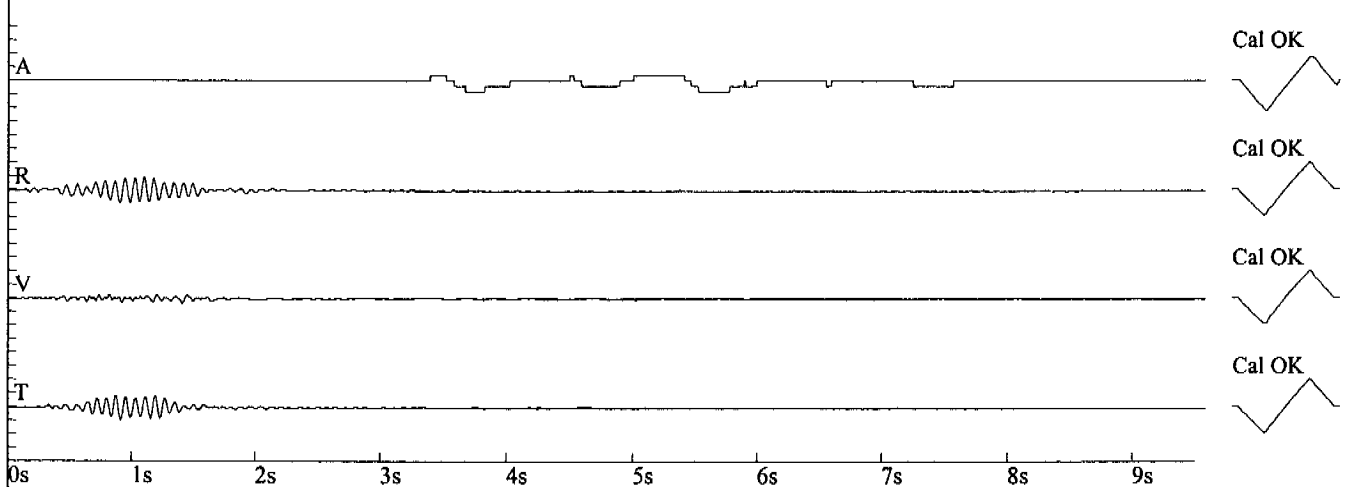
Acoustic Scale:

120dB 0.20Mb (0.050Mb/div)

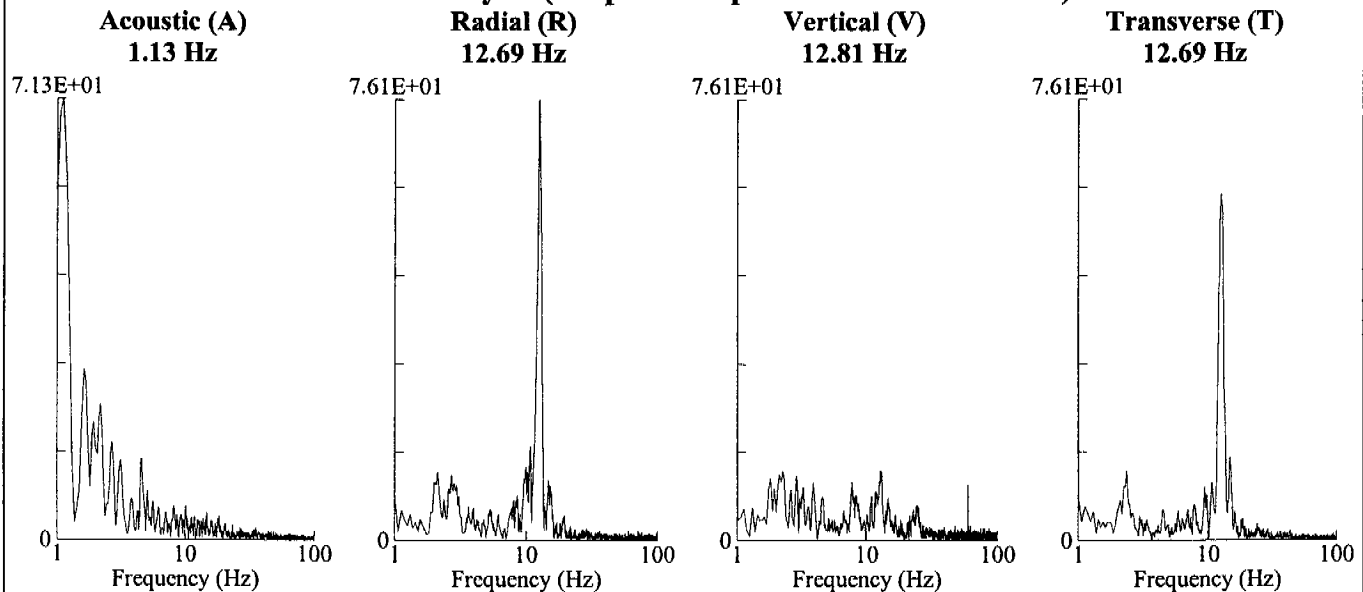
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

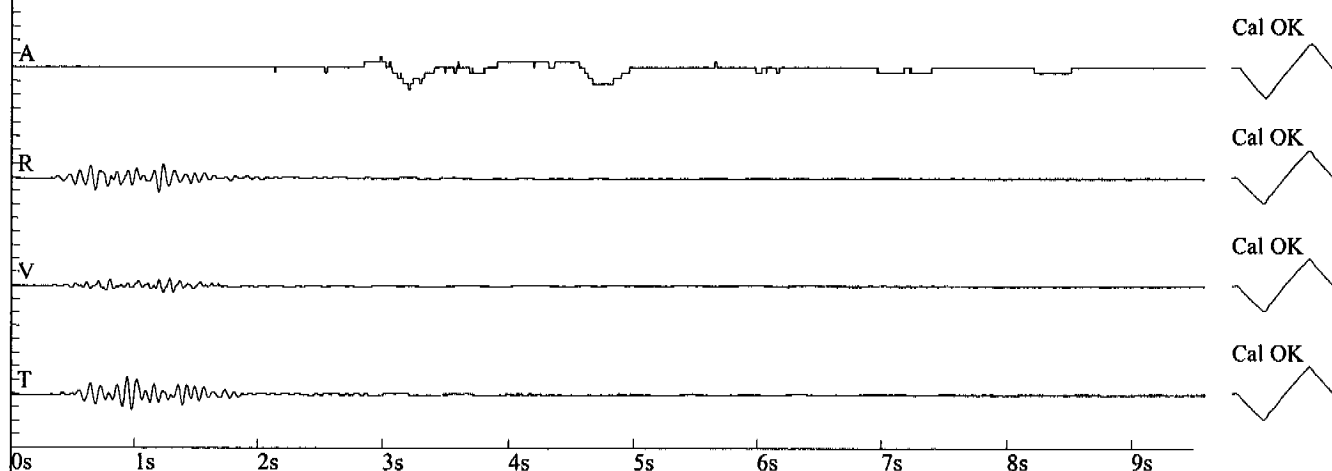
File: D1SAP009.DTB Event Number: 009 Date: 4/6/01 Time: 15:43
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

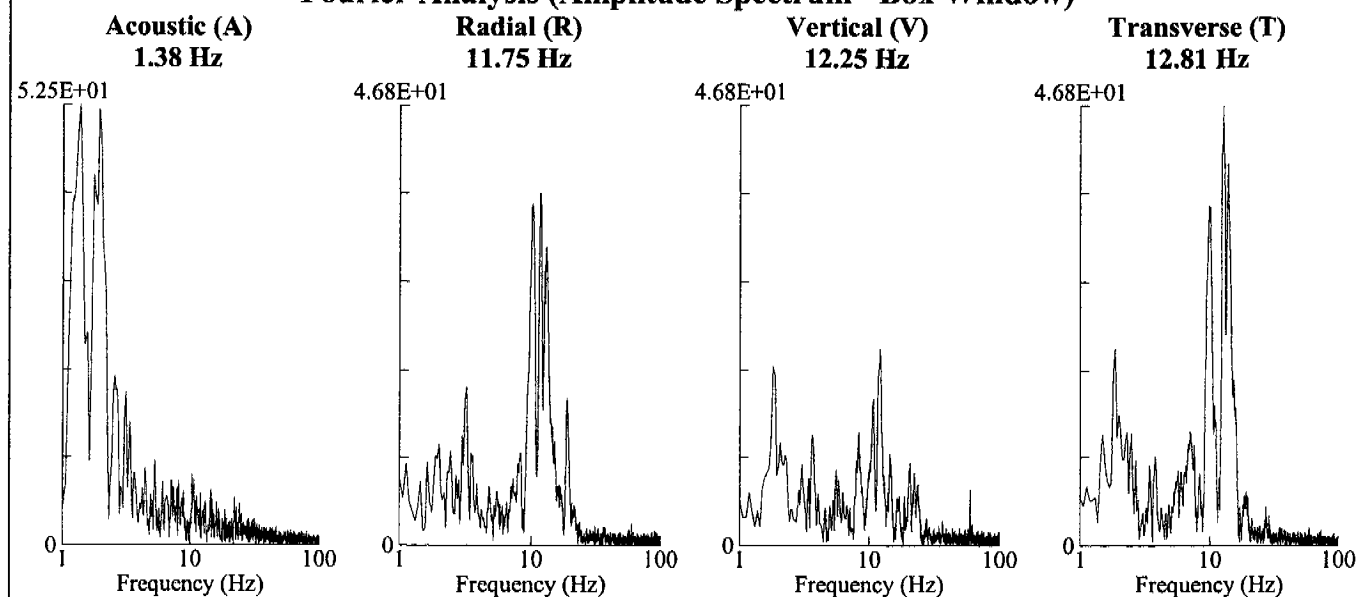
Acoustic (A): 112 dB @ 1.9 Hz
(0.08Mb 0.0012psi 0.0080kPa)
Radial (R): 0.055in/s 1.397mm/s @ 13.1Hz
Vertical (V): 0.03in/s 0.762mm/s @ 10.2Hz
Transverse (T): 0.06in/s 1.524mm/s @ 13.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia Dean Sr. shallow

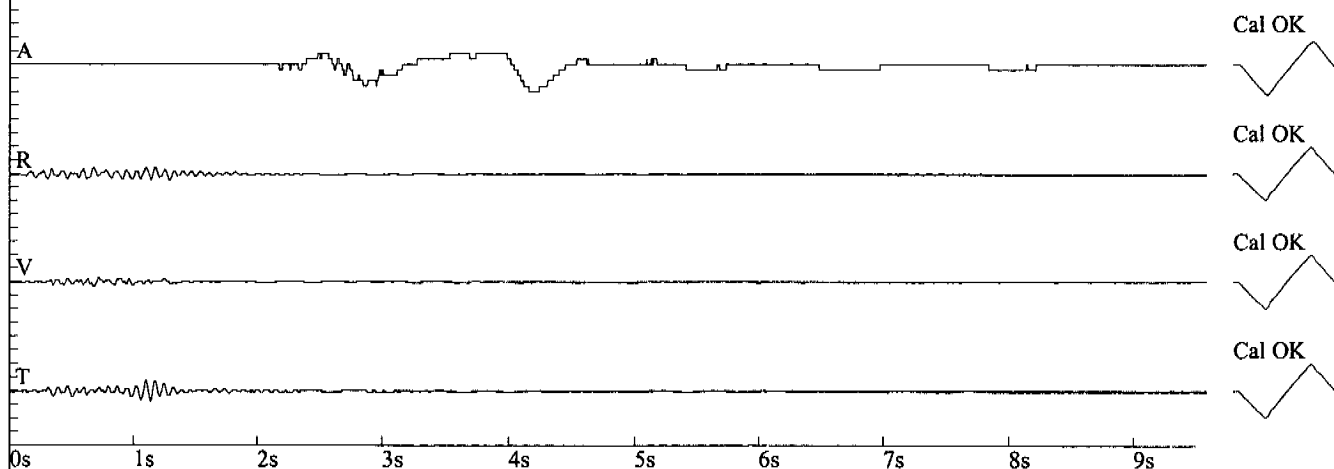
File: D1SAP019.DTB Event Number: 019 Date: 4/9/01 Time: 12:41
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

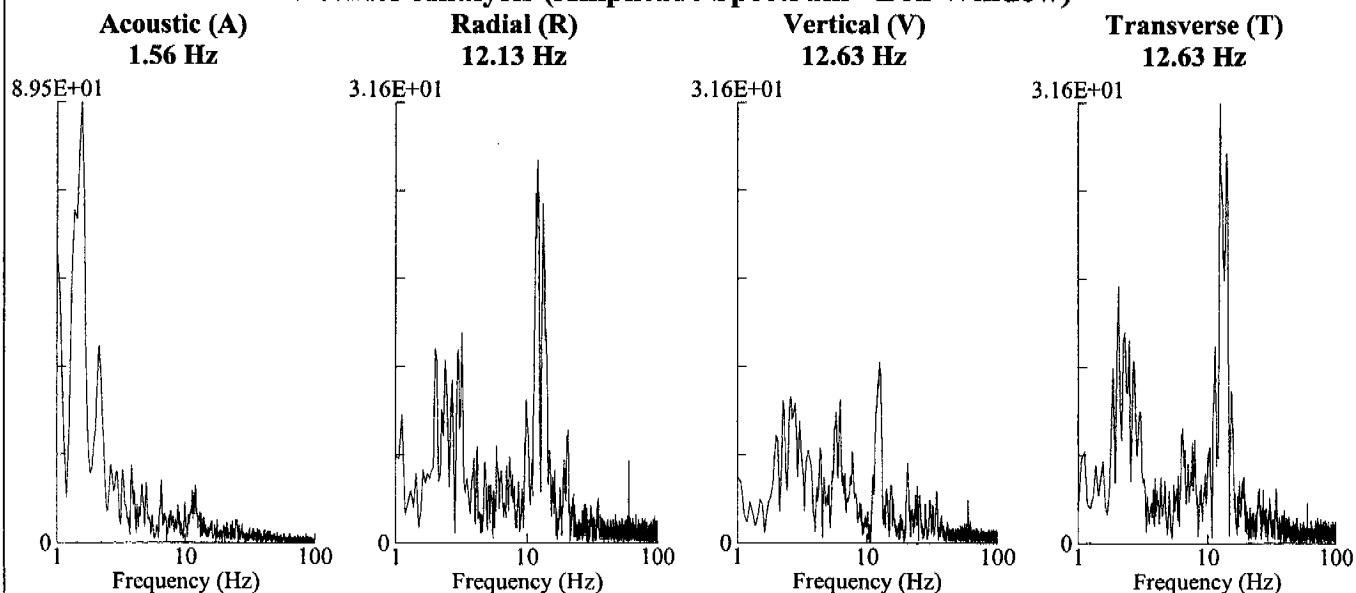
Acoustic (A): 114 dB @ 1.4 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.025in/s 0.635mm/s @ 17.0Hz
Vertical (V): 0.02in/s 0.508mm/s @ 13.4Hz
Transverse (T): 0.04in/s 1.016mm/s @ 14.2Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

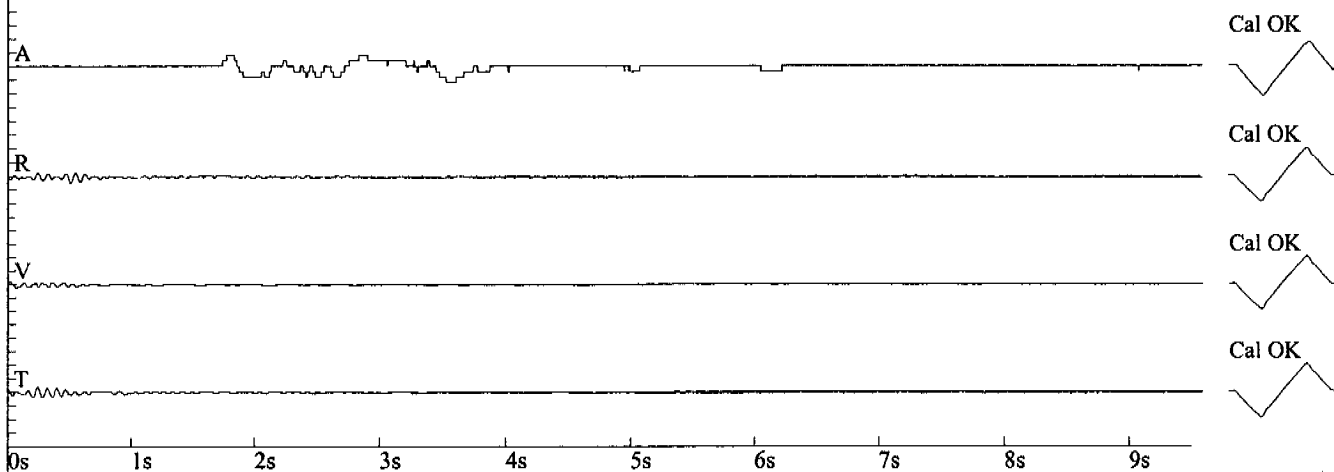
File: D1SAP020.DTB Event Number: 020 Date: 4/9/01 Time: 16:35
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

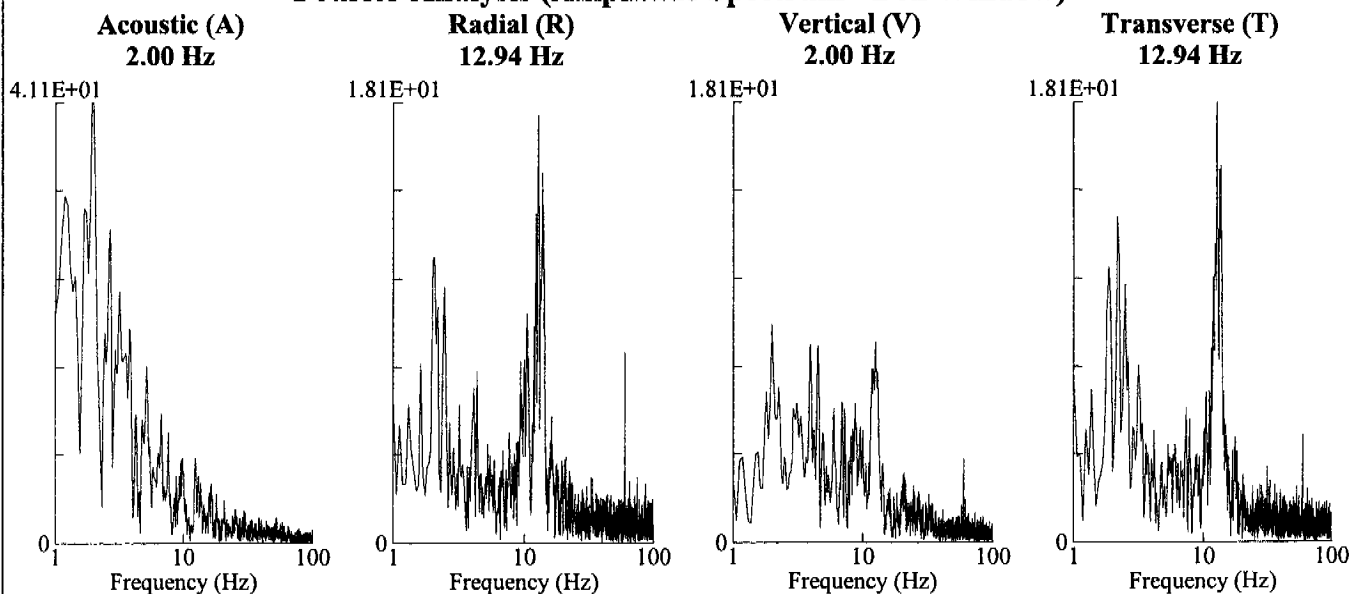
Acoustic (A): 110 dB @ 1.8 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.025in/s 0.635mm/s @ 12.8Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

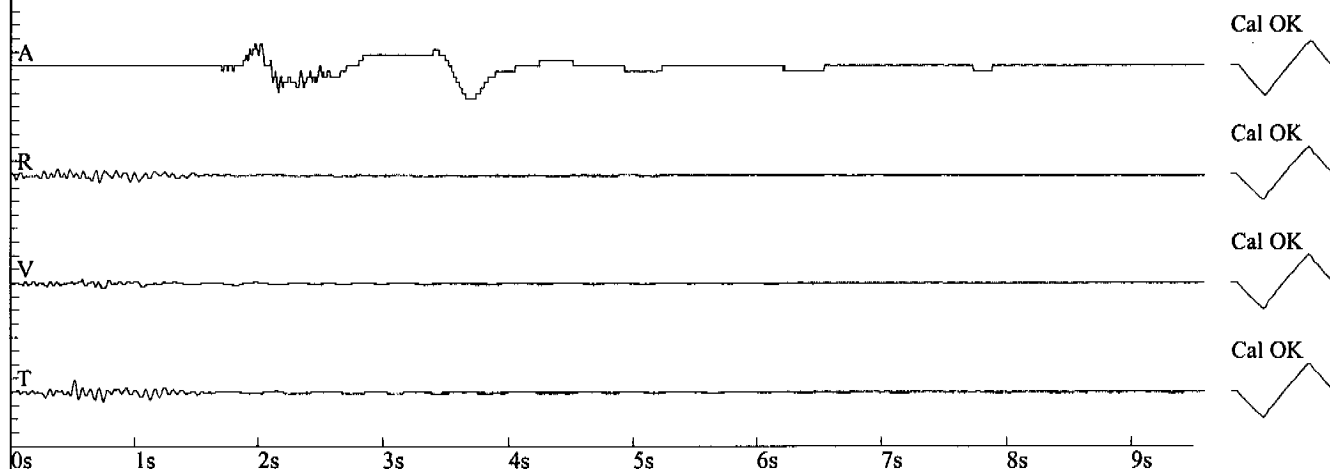
File: D1SAP021.DTB Event Number: 021 Date: 4/10/01 Time: 15:45
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

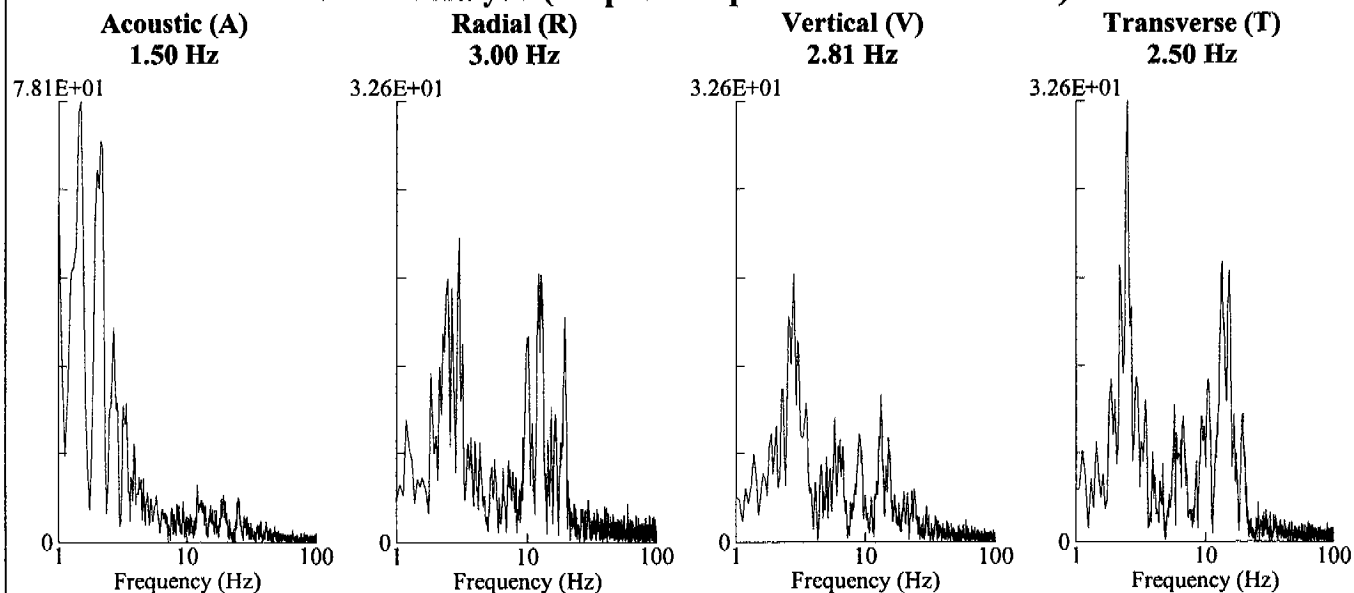
Acoustic (A): 116 dB @ 1.4 Hz
(0.12Mb 0.0017psi 0.0120kPa)
Radial (R): 0.03in/s 0.762mm/s @ 15.0Hz
Vertical (V): 0.02in/s 0.508mm/s @ 9.3Hz
Transverse (T): 0.045in/s 1.143mm/s @ 14.2Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

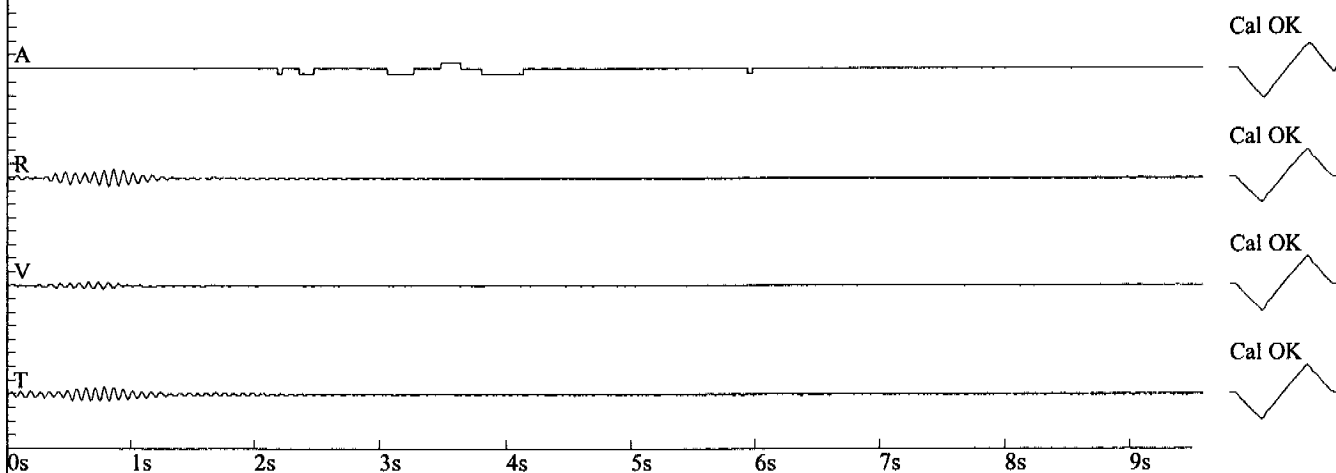
File: D1SAP022.DTB Event Number: 022 Date: 4/10/01 Time: 16:53
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

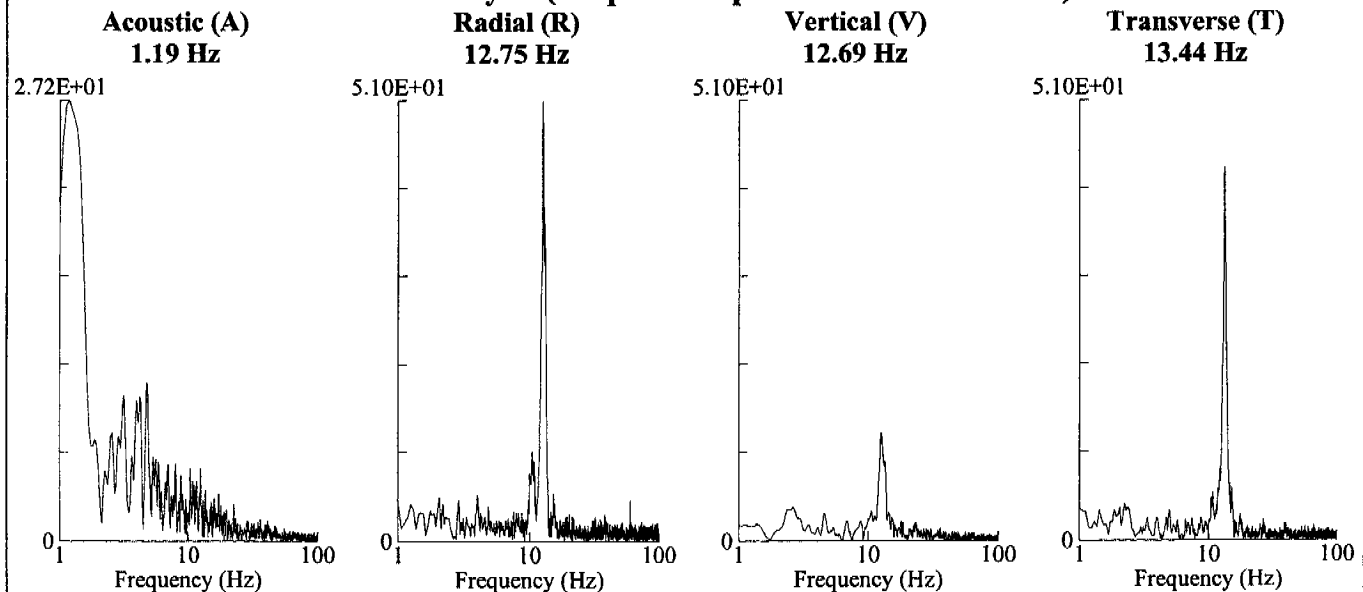
Acoustic (A): 100 dB @ 0.0 Hz
(0.02Mb 0.0003psi 0.0020kPa)
Radial (R): 0.035in/s 0.889mm/s @ 13.4Hz
Vertical (V): 0.015in/s 0.381mm/s @ 13.8Hz
Transverse (T): 0.025in/s 0.635mm/s @ 16.5Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

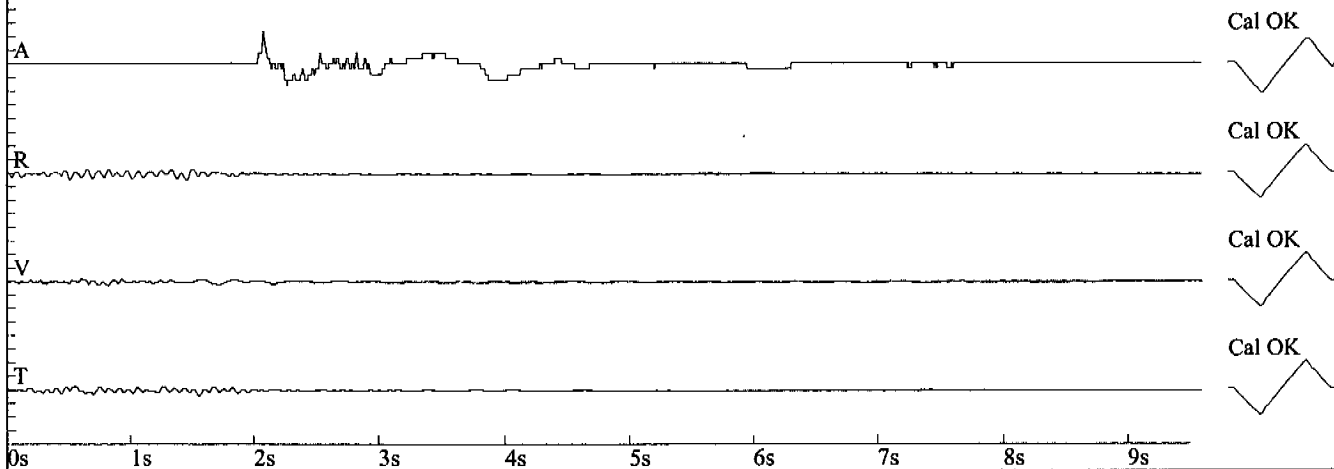
File: D1SAP040.DTB Event Number: 040 Date: 4/11/01 Time: 09:57
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

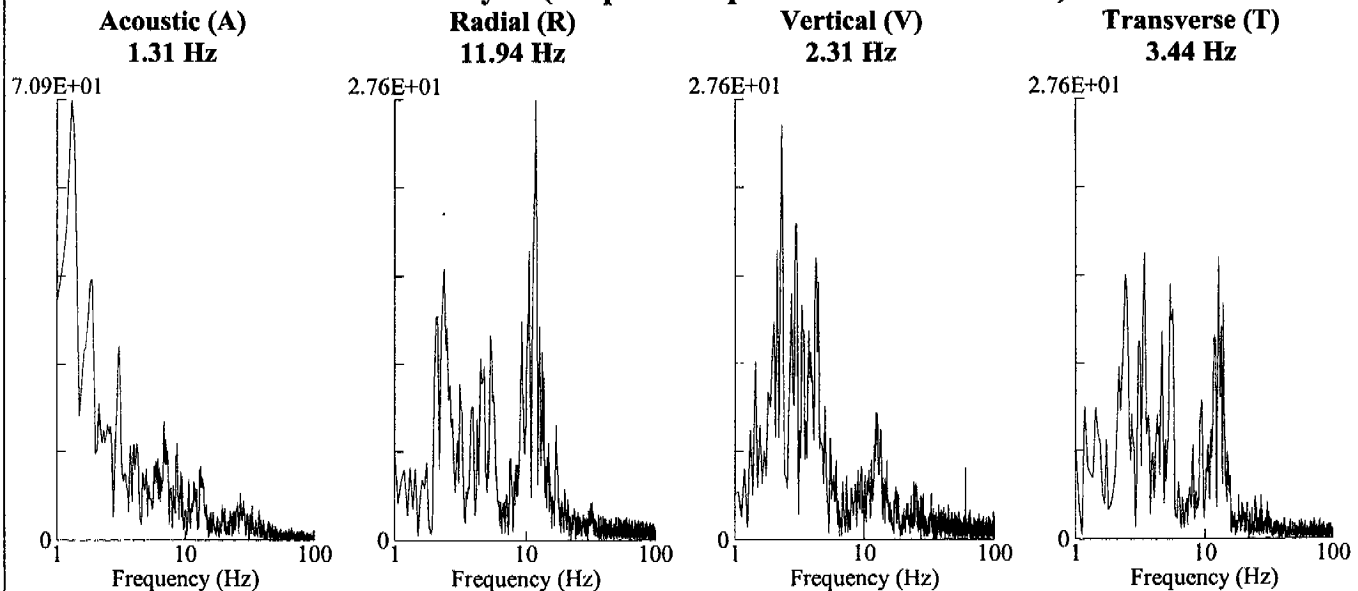
Acoustic (A): 116 dB @ 5.6 Hz
(0.12Mb 0.0017psi 0.0120kPa)
Radial (R): 0.025in/s 0.635mm/s @ 10.8Hz
Vertical (V): 0.015in/s 0.381mm/s @ 9.3Hz
Transverse (T): 0.025in/s 0.635mm/s @ 8.6Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

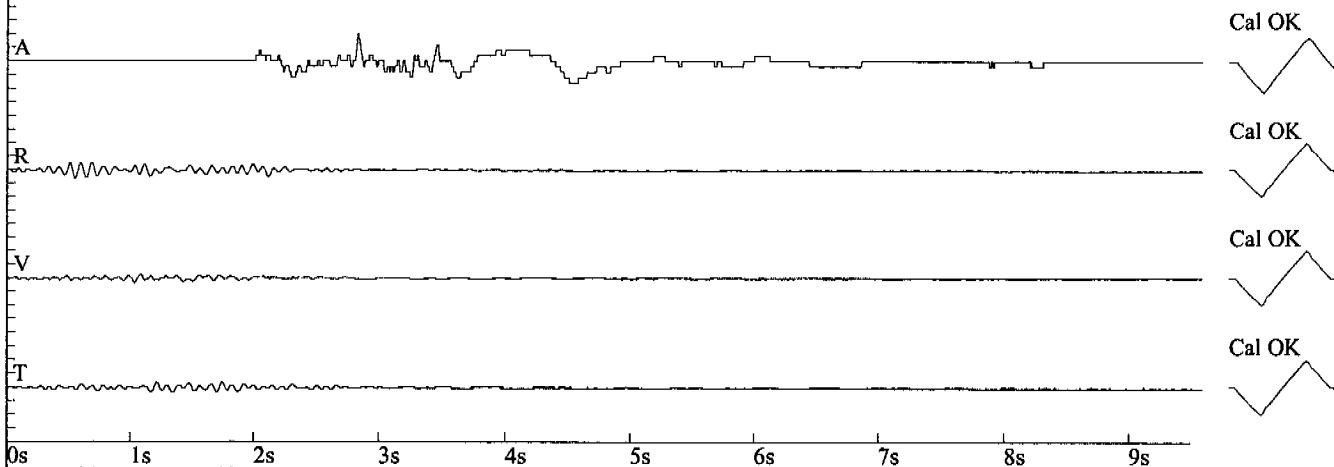
File: D1SAP042.DTB Event Number: 042 Date: 4/12/01 Time: 10:37
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

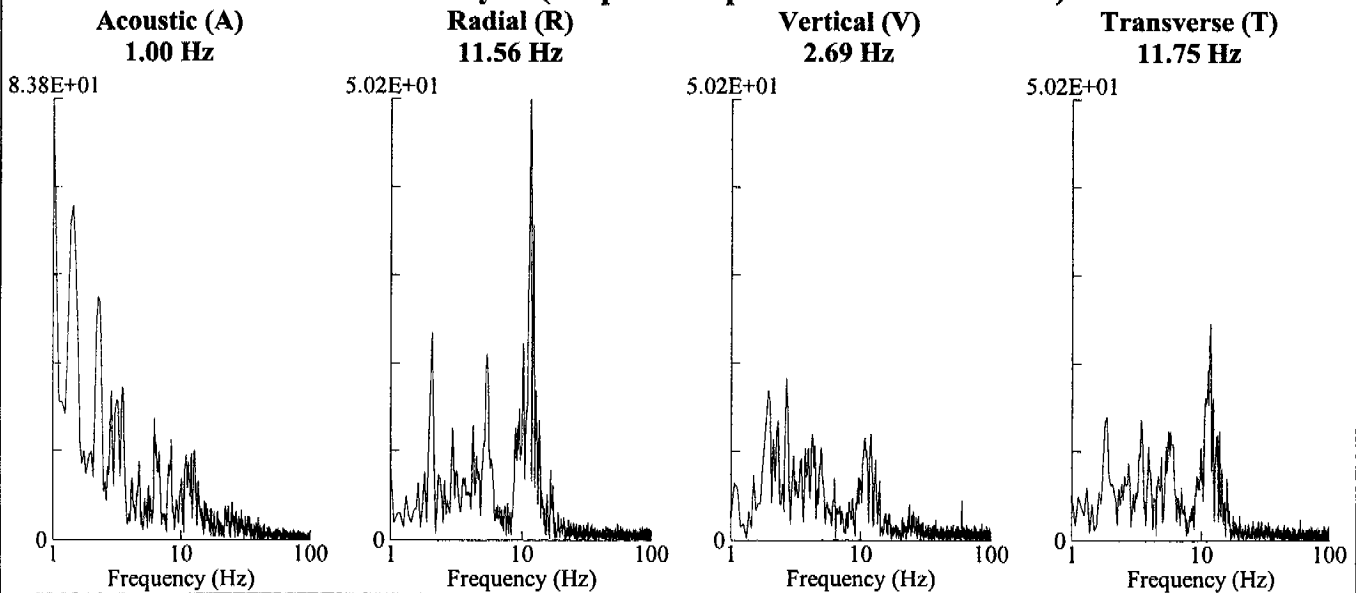
Acoustic (A): 114 dB @ 10.4 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.035in/s 0.889mm/s @ 11.6Hz
Vertical (V): 0.02in/s 0.508mm/s @ 12.1Hz
Transverse (T): 0.02in/s 0.508mm/s @ 11.1Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

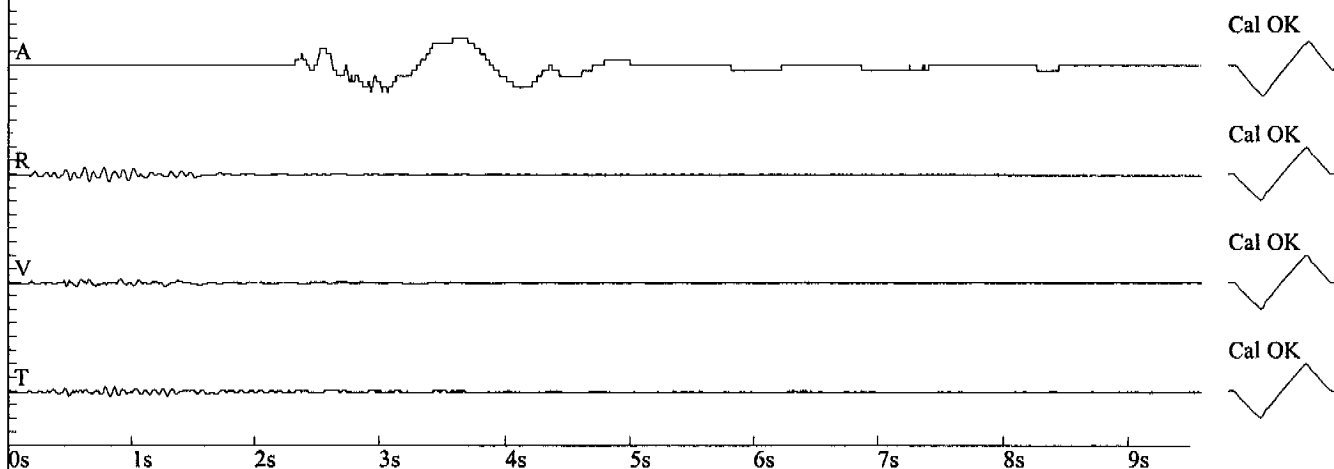
File: D1SAP043.DTB Event Number: 043 Date: 4/12/01 Time: 12:22
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

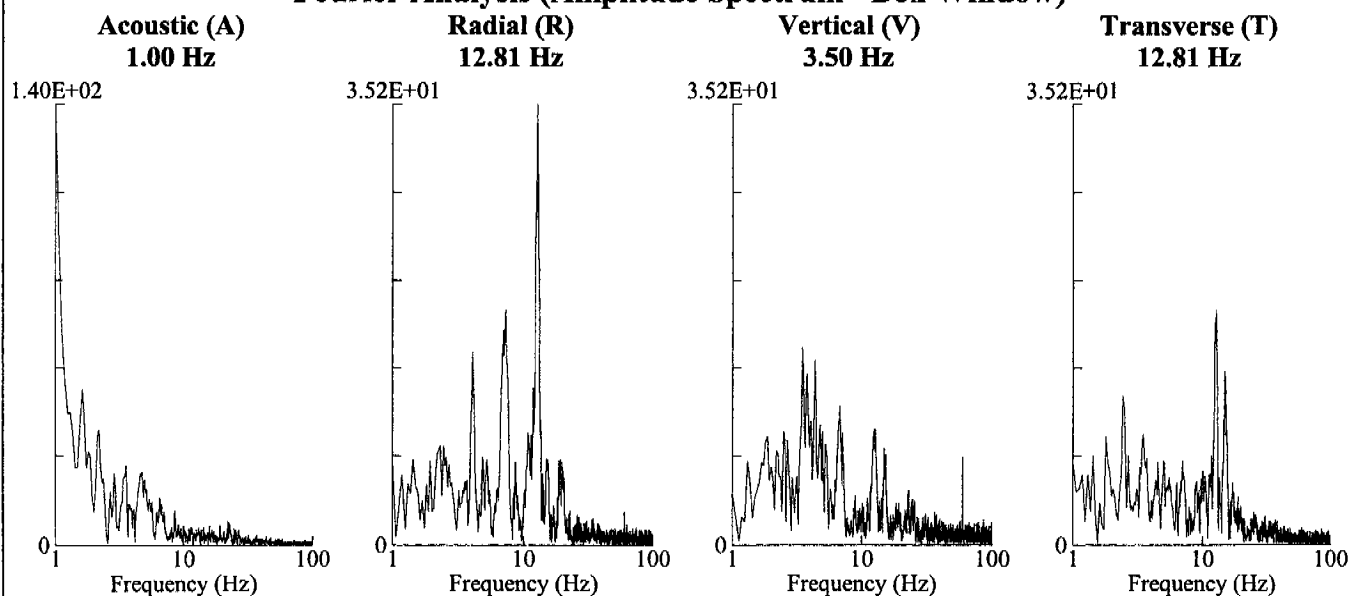
Acoustic (A): 114 dB @ 1.1 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.03in/s 0.762mm/s @ 14.2Hz
Vertical (V): 0.015in/s 0.381mm/s @ 11.6Hz
Transverse (T): 0.02in/s 0.508mm/s @ 13.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Sr. shallow**

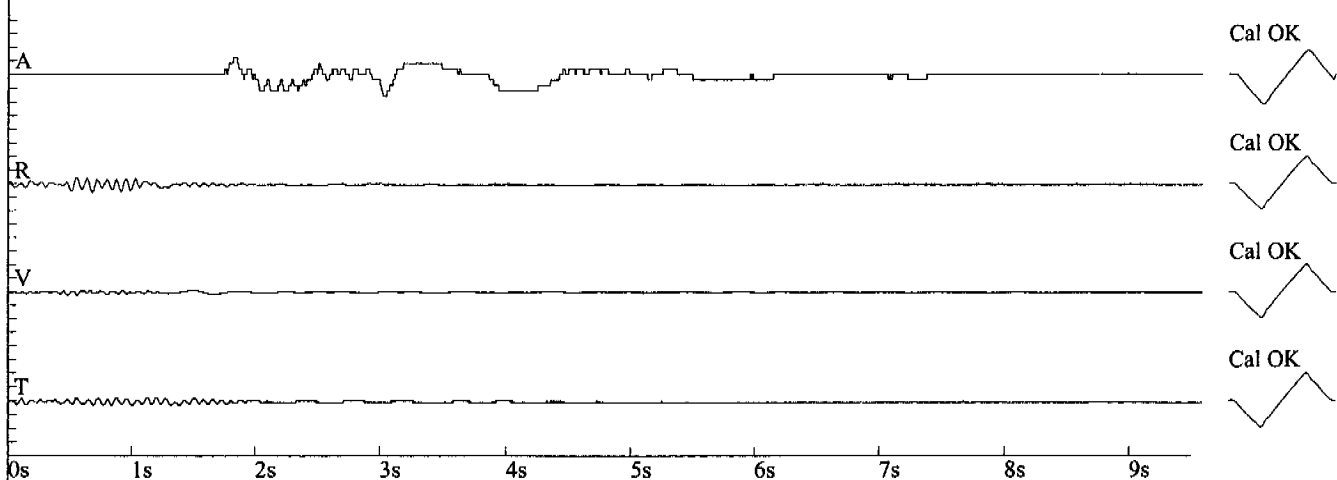
File: D1SAP046.DTB Event Number: 046 Date: 4/13/01 Time: 10:30
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

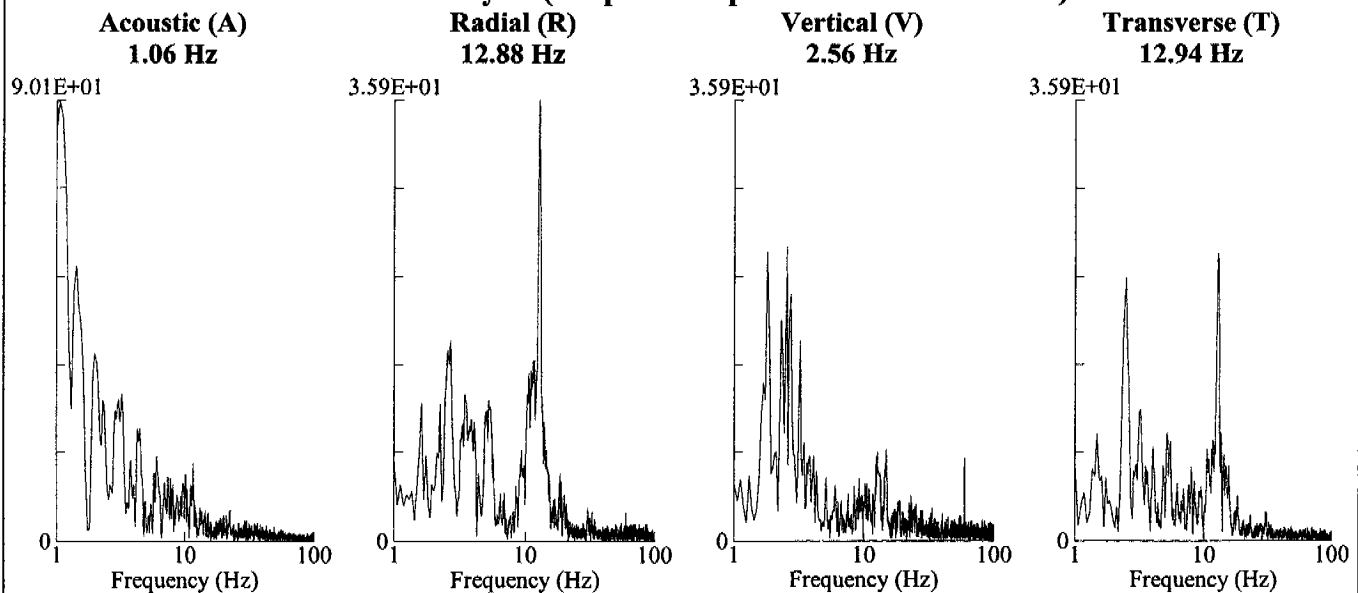
Acoustic (A): 112 dB @ 4.2 Hz
(0.08Mb 0.0012psi 0.0080kPa)
Radial (R): 0.035in/s 0.889mm/s @ 11.9Hz
Vertical (V): 0.015in/s 0.381mm/s @ 16.5Hz
Transverse (T): 0.015in/s 0.381mm/s @ 15.5Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dear Sr. deep**

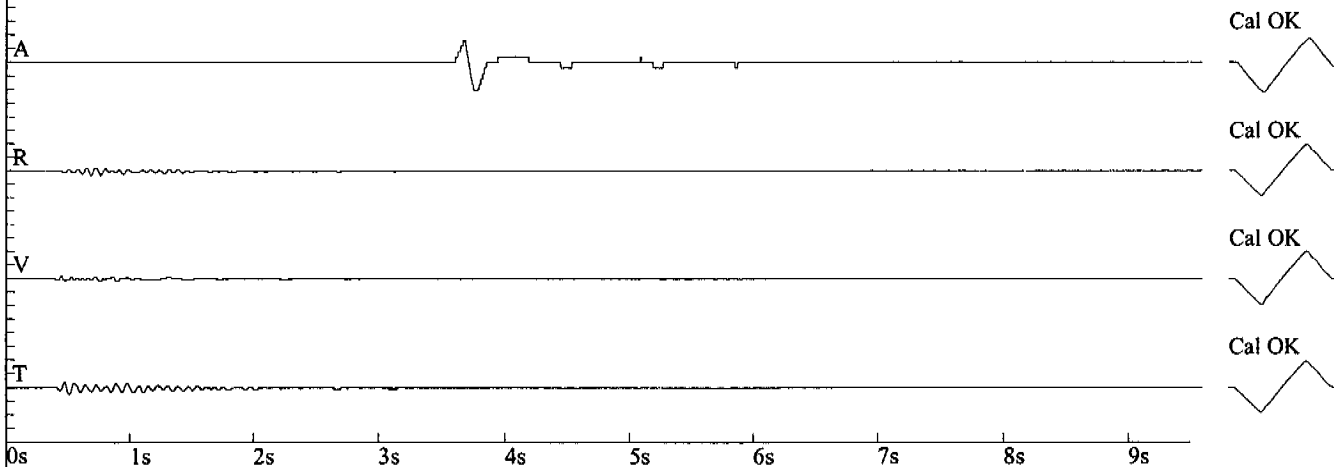
File: D1DAP003.DTB Event Number: 003 Date: 4/3/01 Time: 08:40
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

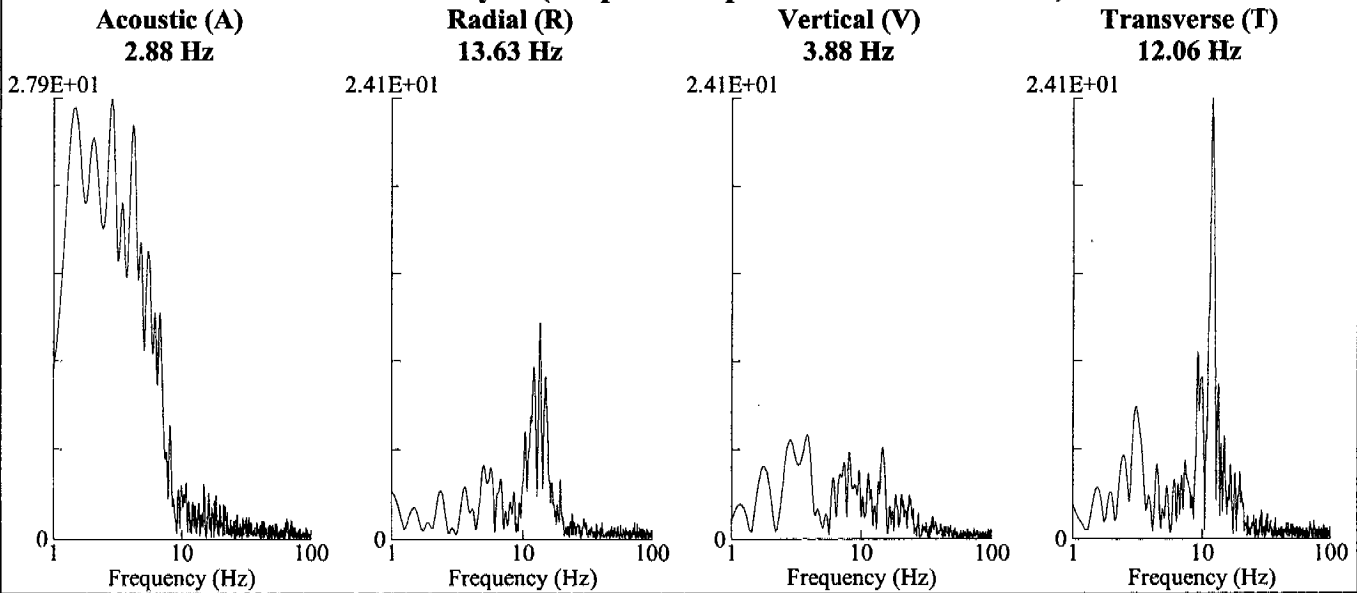
Acoustic (A): 114 dB @ 3.8 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.02in/s 0.508mm/s @ 16.0Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
***Transverse (T):* 0.025in/s 0.635mm/s @ 12.4Hz**
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dear Sr. deep**

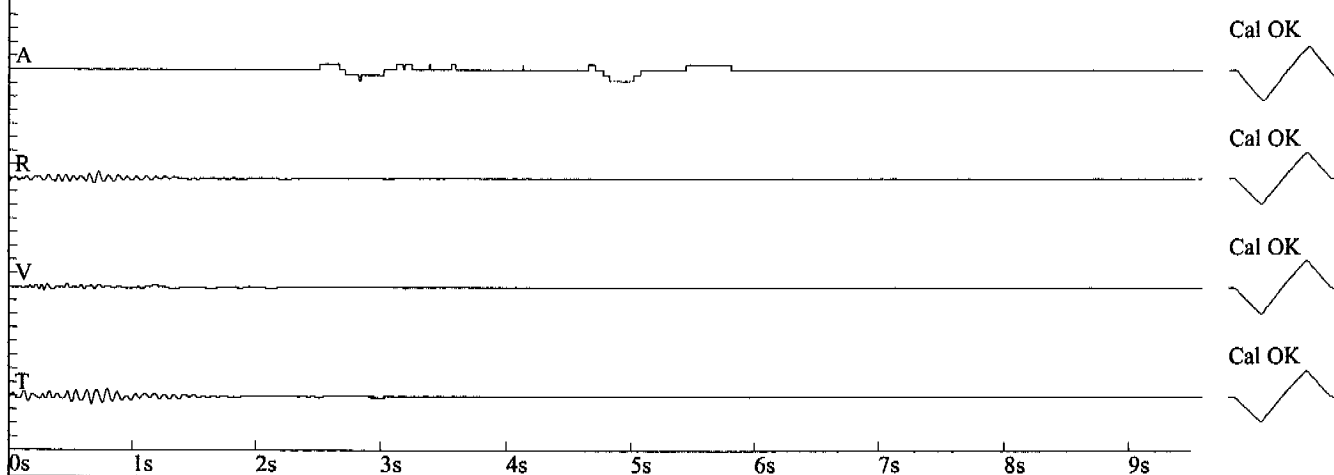
File: D1DAP004.DTB Event Number: 004 Date: 4/3/01 Time: 13:50
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

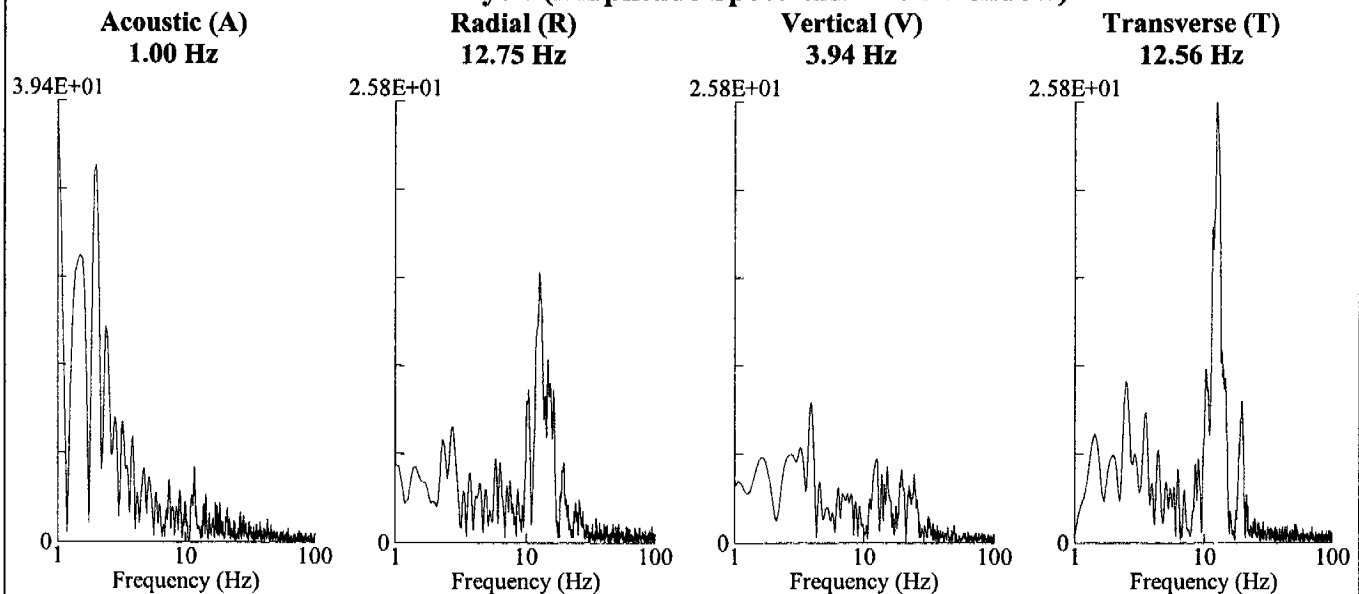
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.025in/s 0.635mm/s @ 15.0Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.03in/s 0.762mm/s @ 15.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dear Sr. deep**

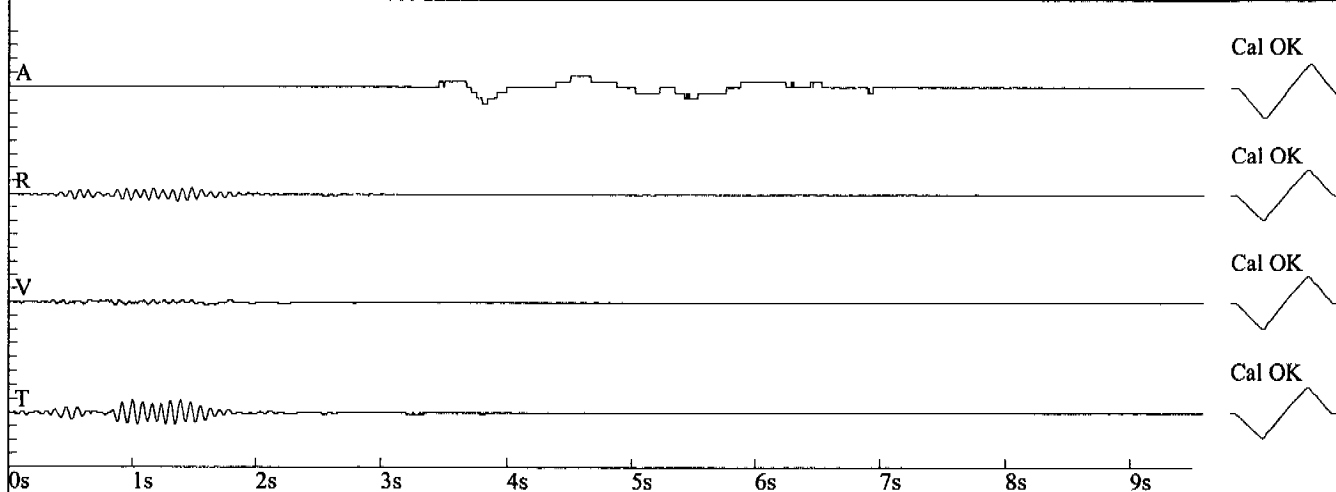
File: D1DAP005.DTB Event Number: 005 Date: 4/4/01 Time: 11:19
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

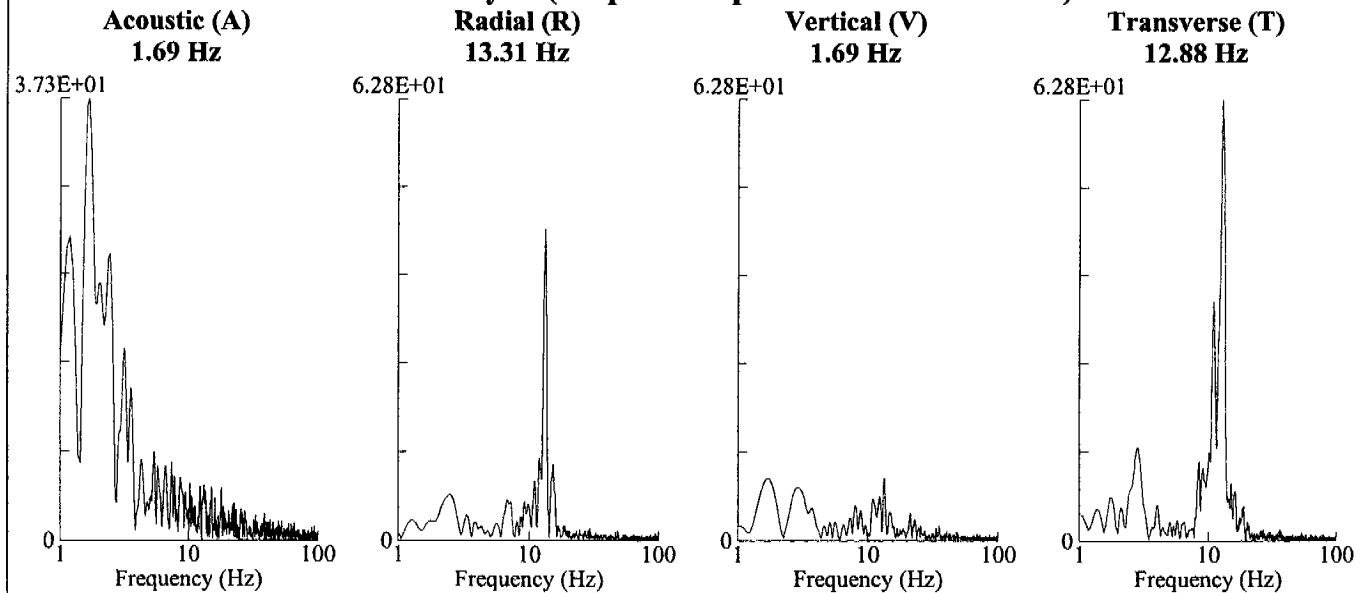
Acoustic (A): 110 dB @ 2.1 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.03in/s 0.762mm/s @ 13.4Hz
Vertical (V): 0.015in/s 0.381mm/s @ 16.0Hz
Transverse (T): 0.045in/s 1.143mm/s @ 13.1Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia Dear Sr. deep

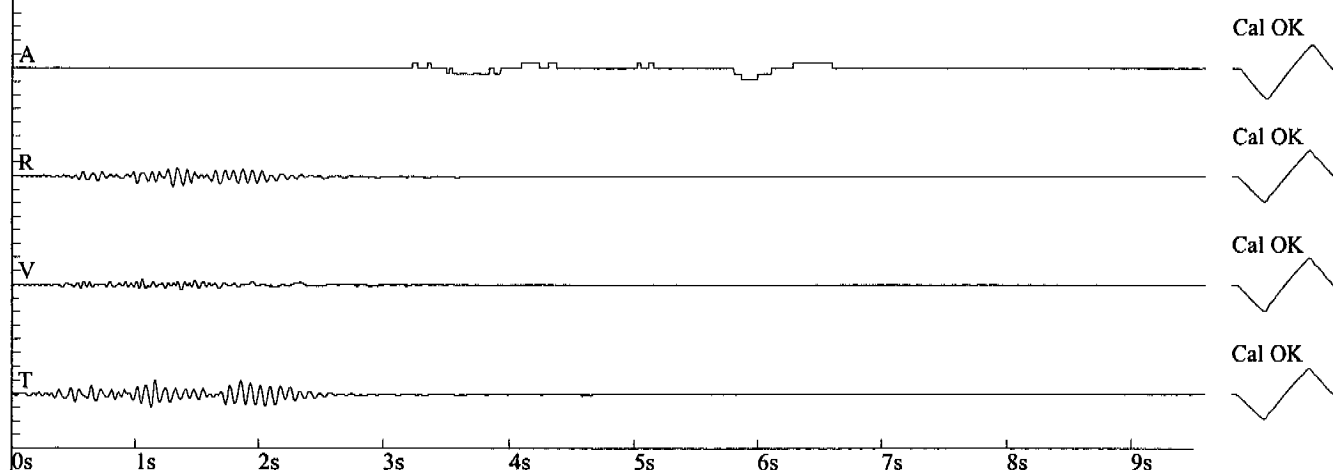
File: D1DAP006.DTB Event Number: 006 Date: 4/5/01 Time: 10:33
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

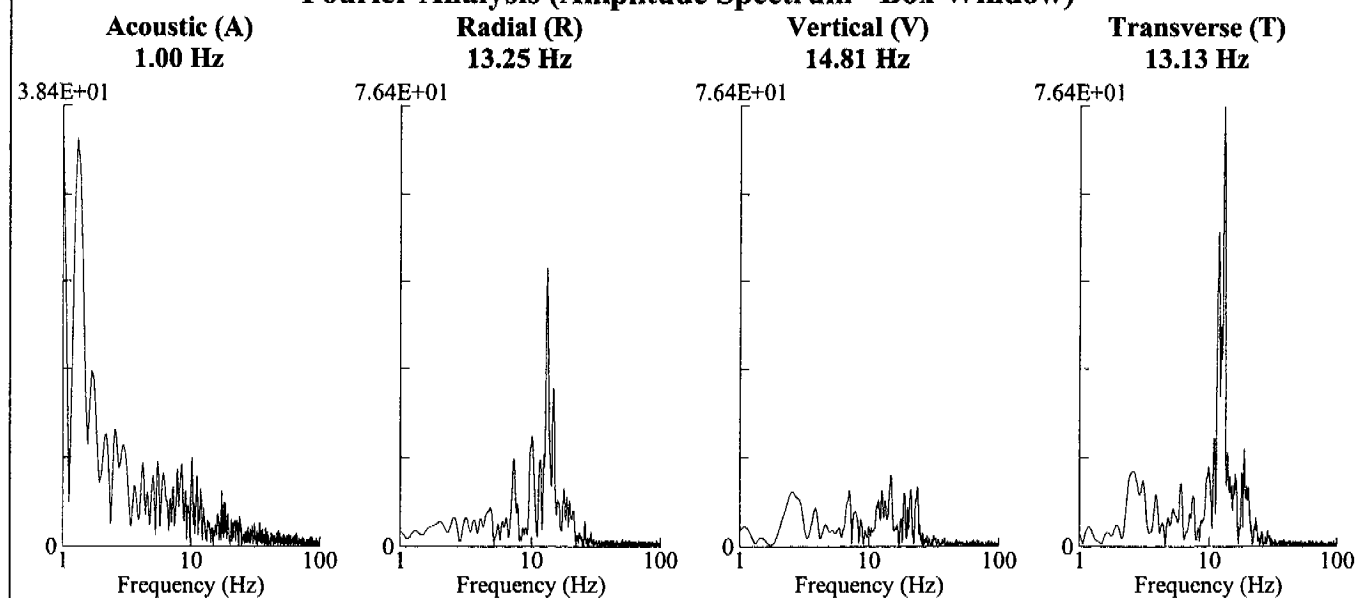
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.04in/s 1.016mm/s @ 13.8Hz
Vertical (V): 0.02in/s 0.508mm/s @ 21.3Hz
Transverse (T): 0.05in/s 1.27mm/s @ 15.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dear Sr. deep**

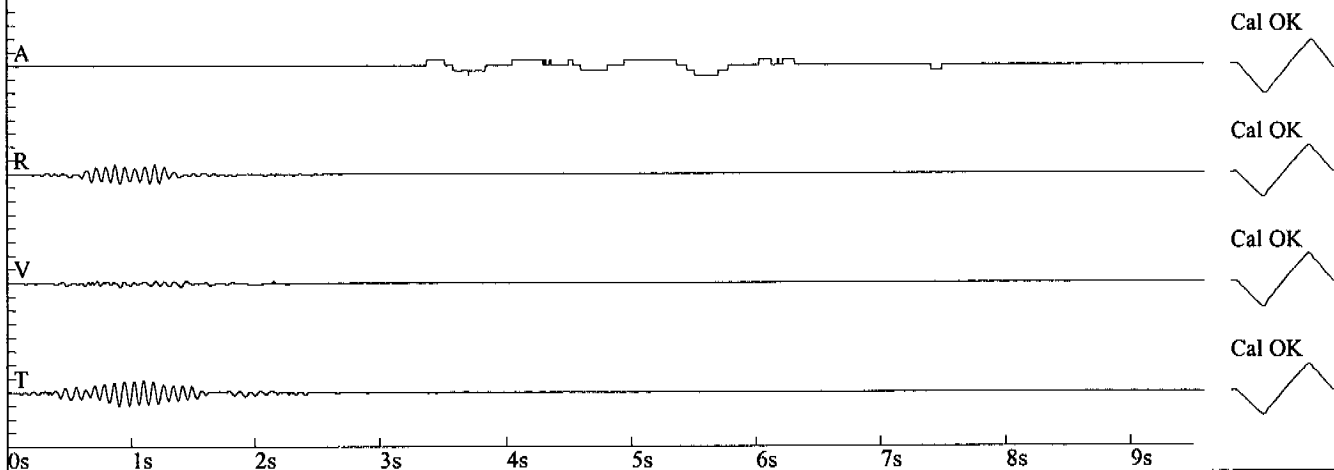
File: D1DAP007.DTB Event Number: 007 Date: 4/6/01 Time: 10:21
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

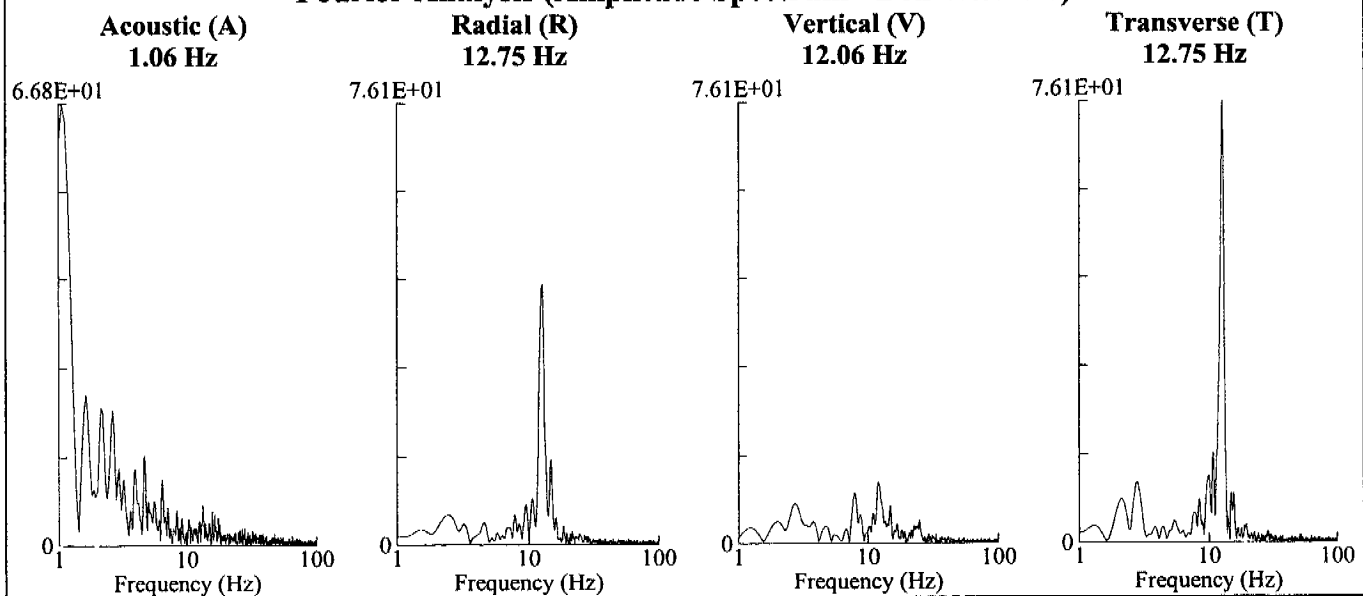
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.035in/s 0.889mm/s @ 14.6Hz
Vertical (V): 0.015in/s 0.381mm/s @ 17.0Hz
Transverse (T): 0.05in/s 1.27mm/s @ 12.4Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



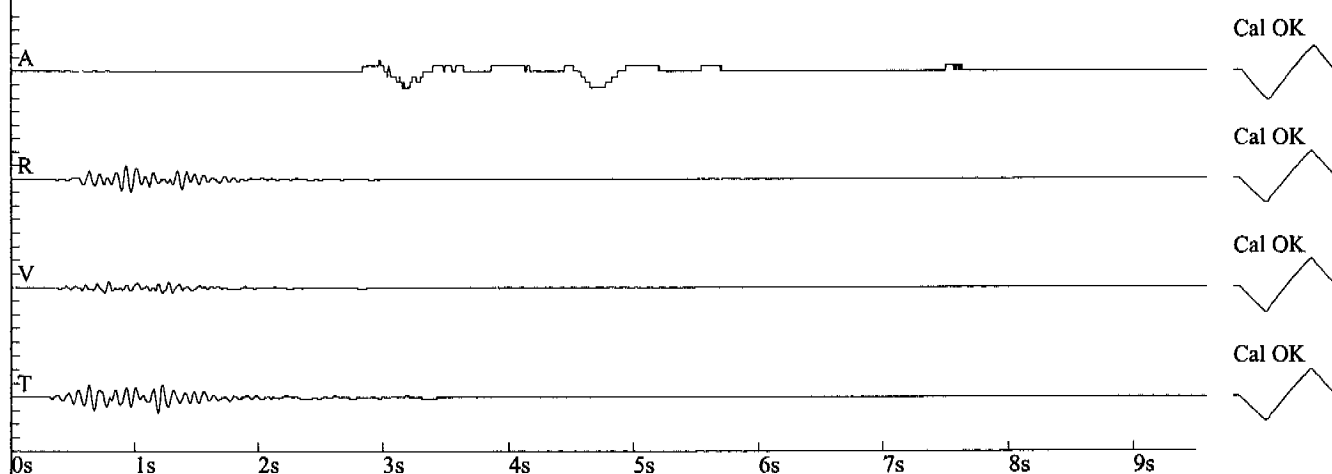
File: D1DAP008.DTB Event Number: 008 Date: 4/6/01 Time: 15:42
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

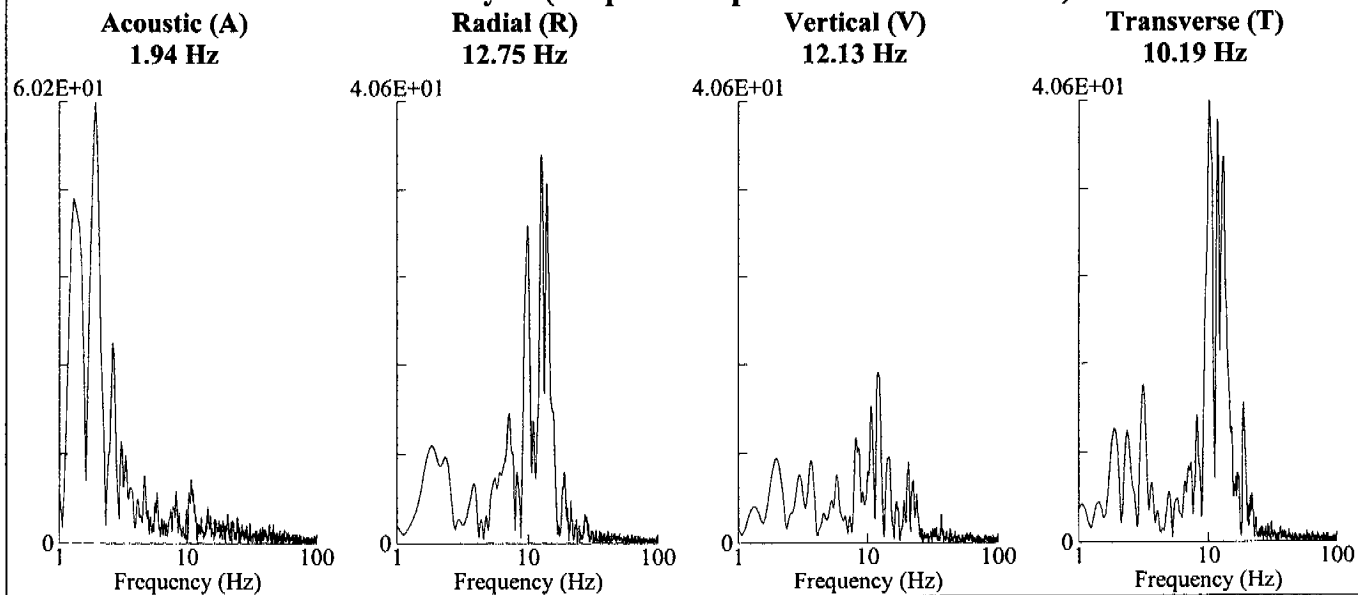
Acoustic (A): 110 dB @ 2.7 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.05in/s 1.27mm/s @ 13.4Hz
Vertical (V): 0.02in/s 0.508mm/s @ 18.9Hz
Transverse (T): 0.06in/s 1.524mm/s @ 13.4Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dear Sr. deep**

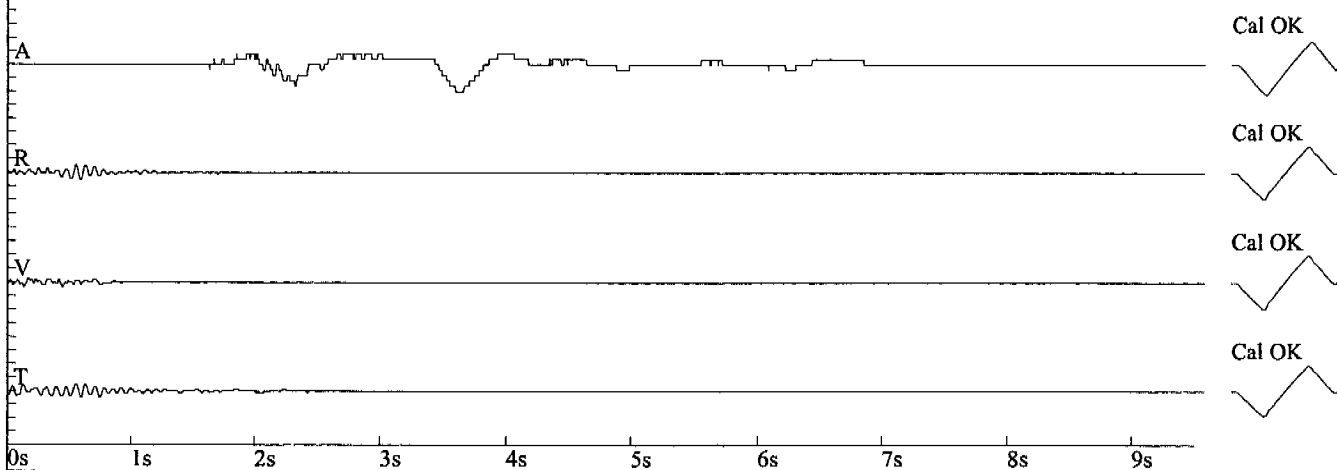
File: D1DAP015.DTB Event Number: 015 Date: 4/9/01 Time: 12:40
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

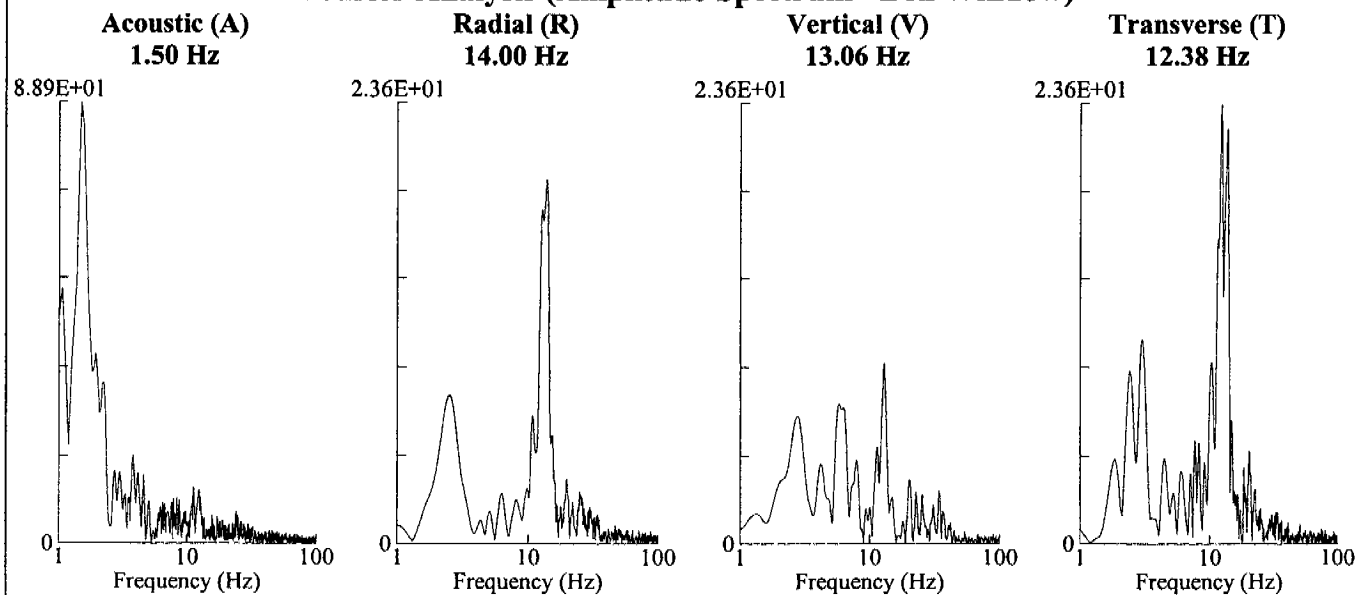
Acoustic (A): 114 dB @ 1.5 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.03in/s 0.762mm/s @ 15.5Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.025in/s 0.635mm/s @ 12.4Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dear Sr. deep**

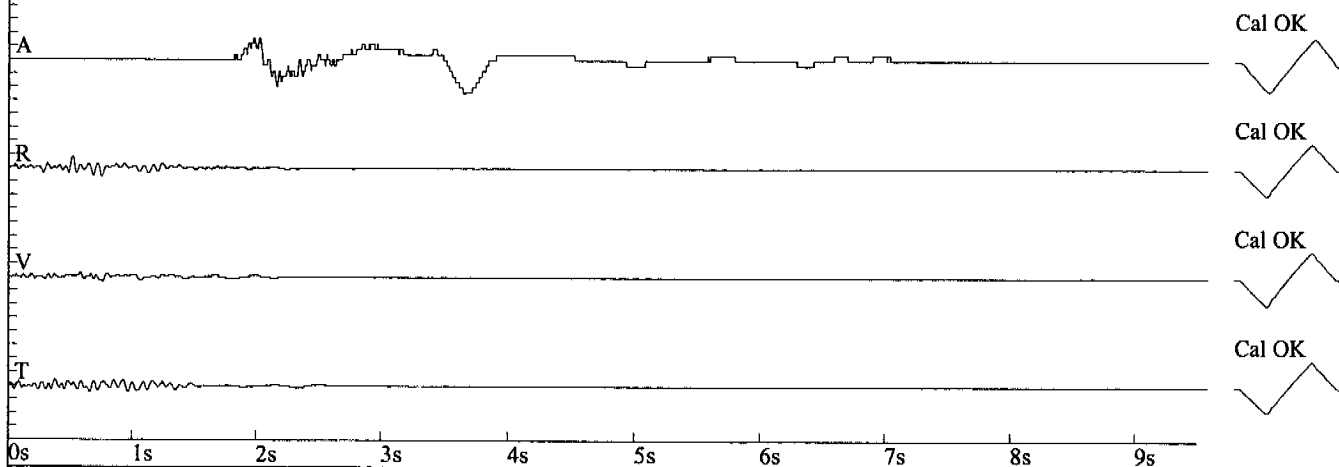
File: D1DAP016.DTB Event Number: 016 Date: 4/10/01 Time: 15:44
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

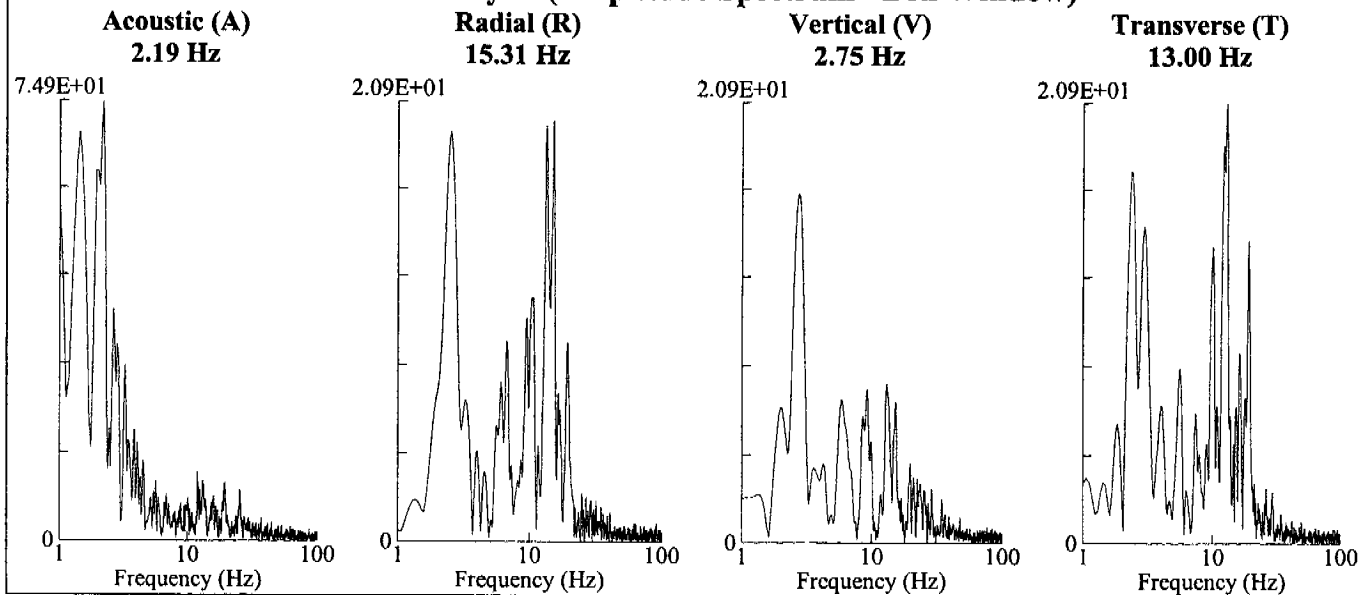
Acoustic (A): 116 dB @ 1.6 Hz
(0.12Mb 0.0017psi 0.0120kPa)
Radial (R): 0.04in/s 1.016mm/s @ 13.8Hz
Vertical (V): 0.02in/s 0.508mm/s @ 9.3Hz
Transverse (T): 0.025in/s 0.635mm/s @ 12.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dear Sr. deep**

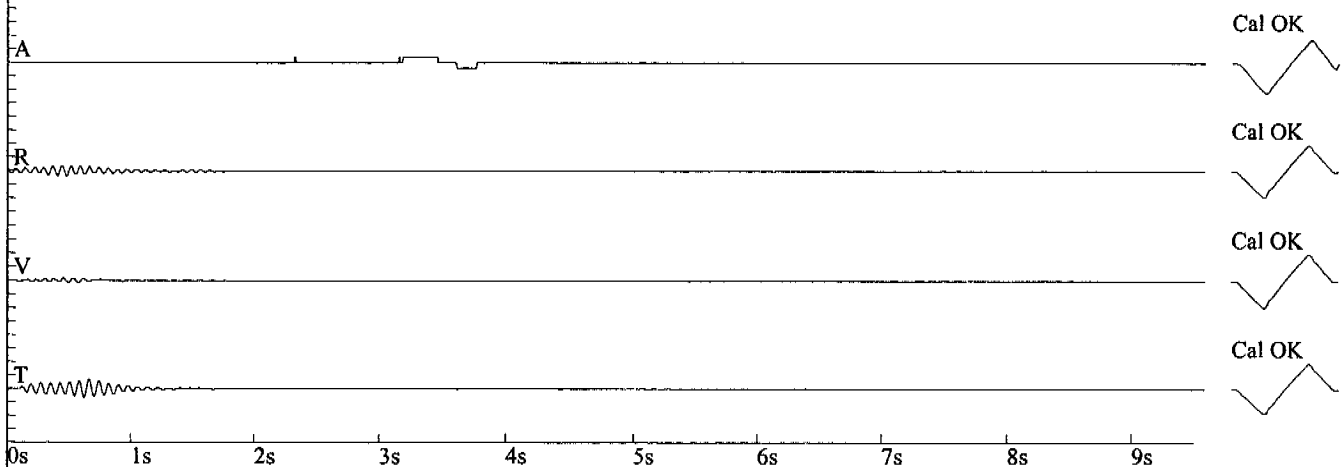
File: D1DAP017.DTB Event Number: 017 Date: 4/10/01 Time: 16:52
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

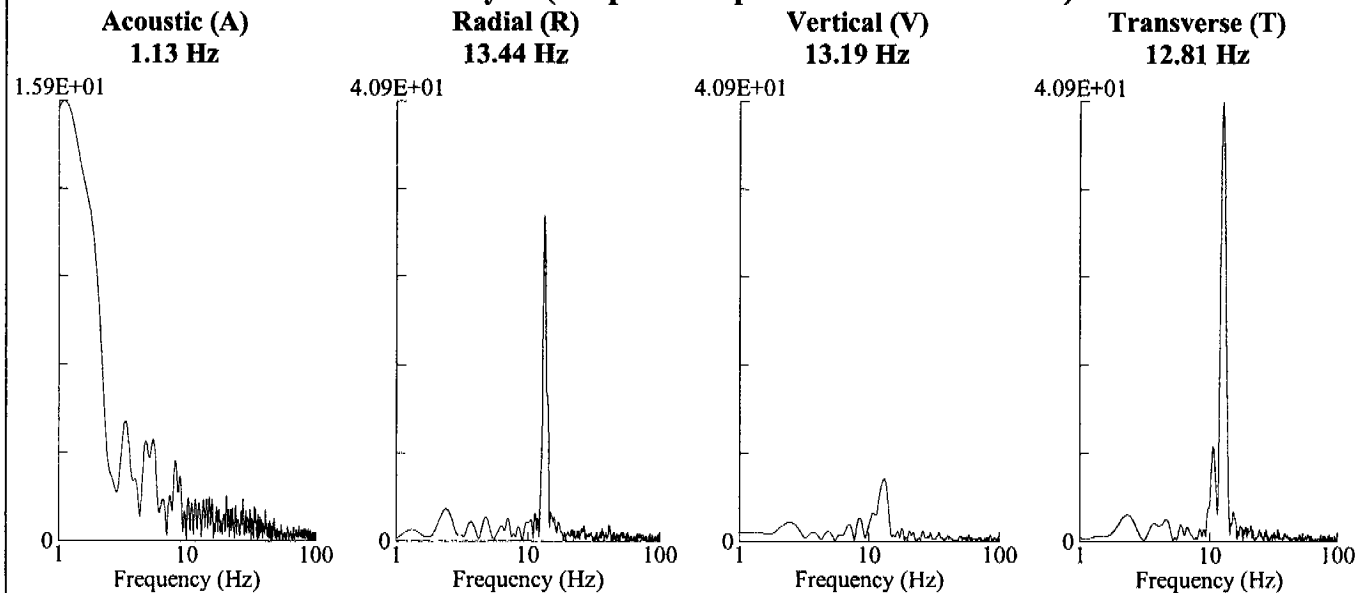
Acoustic (A): 100 dB @ 0.0 Hz
(0.02Mb 0.0003psi 0.0020kPa)
Radial (R): 0.02in/s 0.508mm/s @ 17.0Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.035in/s 0.889mm/s @ 14.2Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



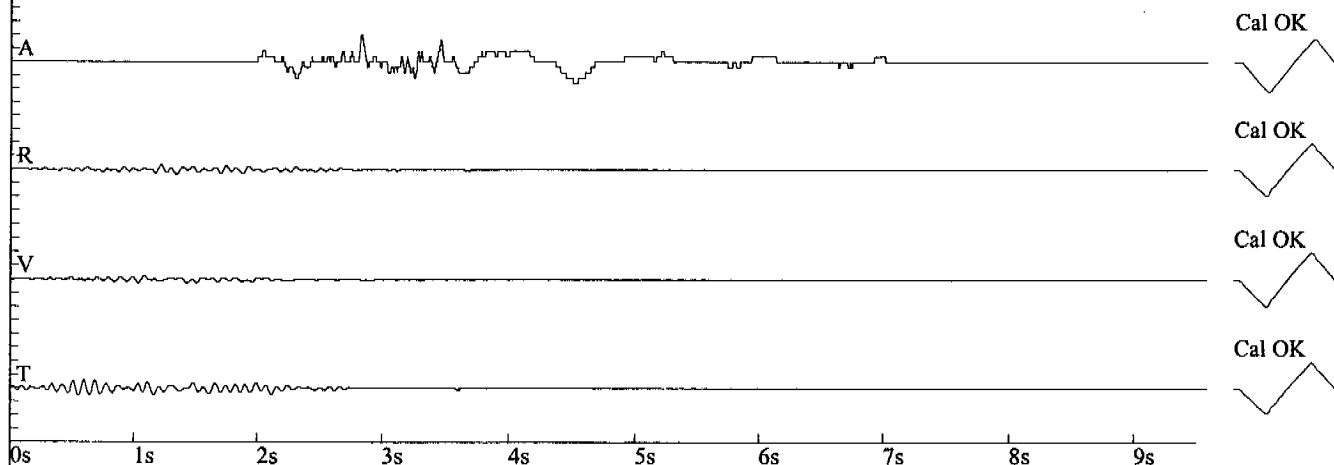
File: D1DAP026.DTB Event Number: 026 Date: 4/12/01 Time: 10:36
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

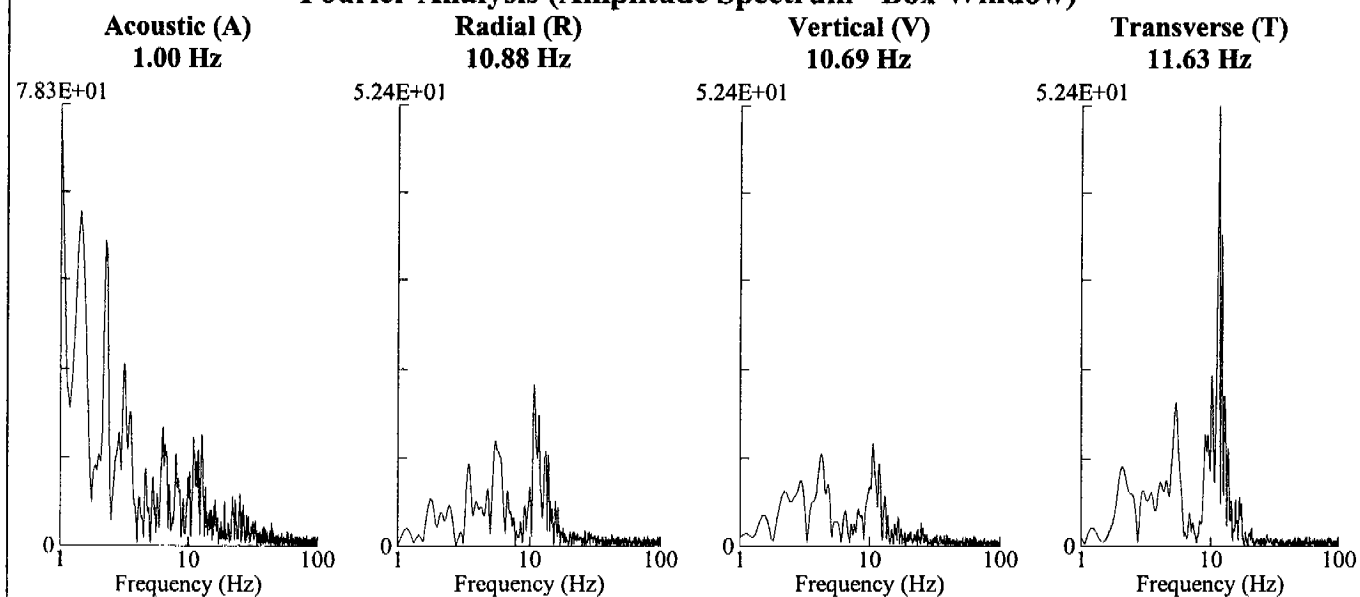
Acoustic (A): 114 dB @ 10.0 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.02in/s 0.508mm/s @ 13.4Hz
Vertical (V): 0.015in/s 0.381mm/s @ 12.8Hz
Transverse (T): 0.03in/s 0.762mm/s @ 13.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dear Sr. deep**

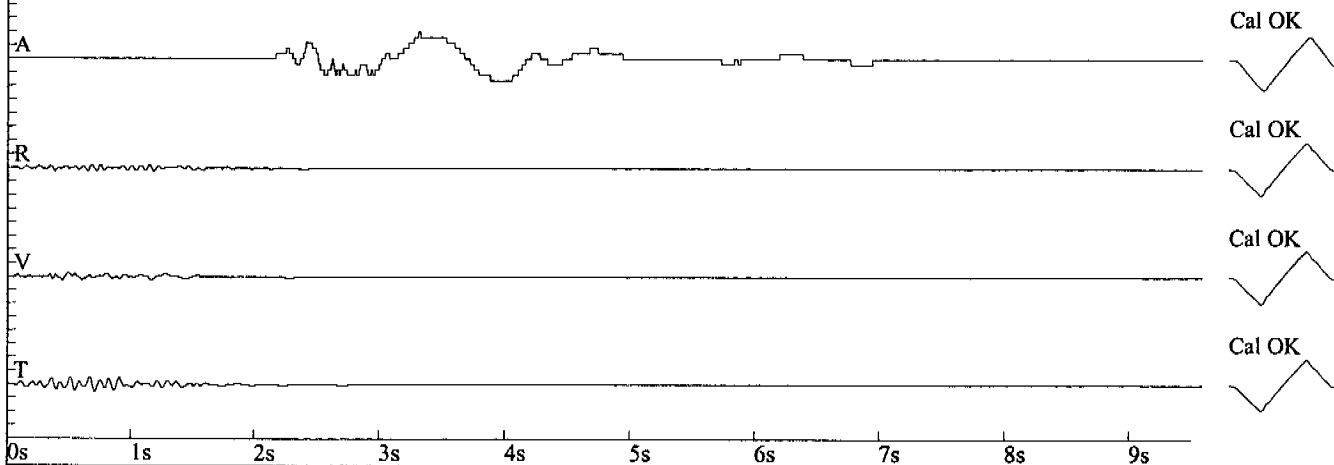
File: D1DAP027.DTB Event Number: 027 Date: 4/12/01 Time: 12:21
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

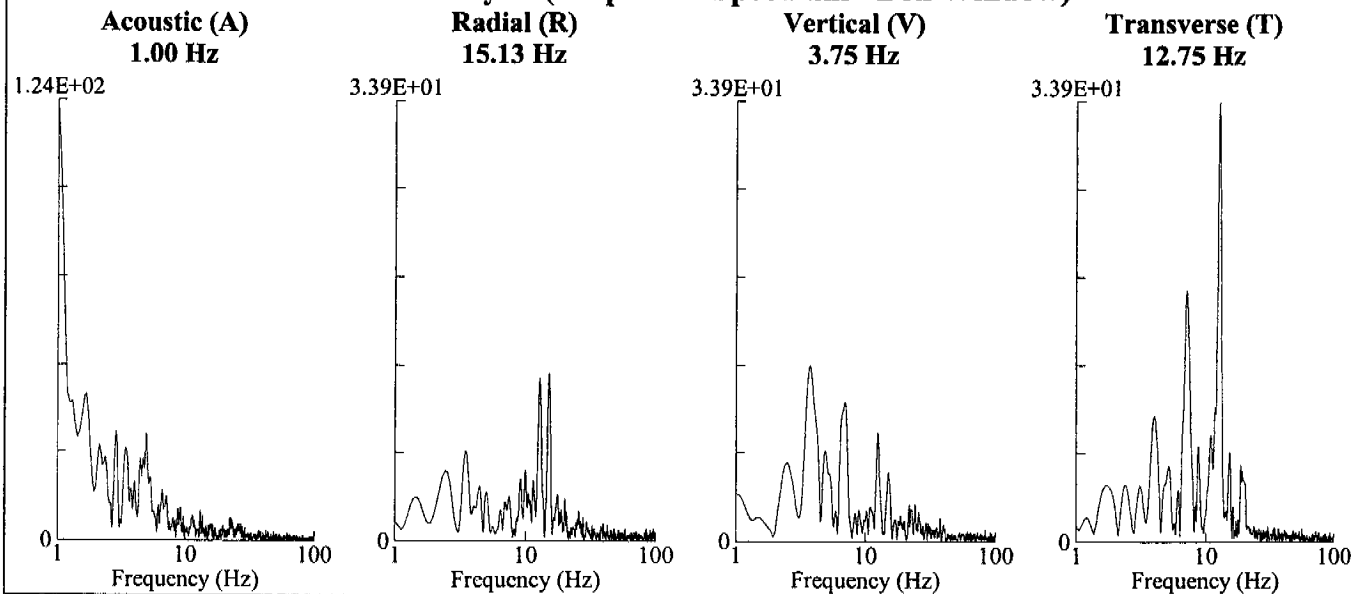
Acoustic (A): 114 dB @ 1.3 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.015in/s 0.381mm/s @ 20.4Hz
Vertical (V): 0.015in/s 0.381mm/s @ 8.6Hz
Transverse (T): 0.03in/s 0.762mm/s @ 12.4Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dear Sr. deep**

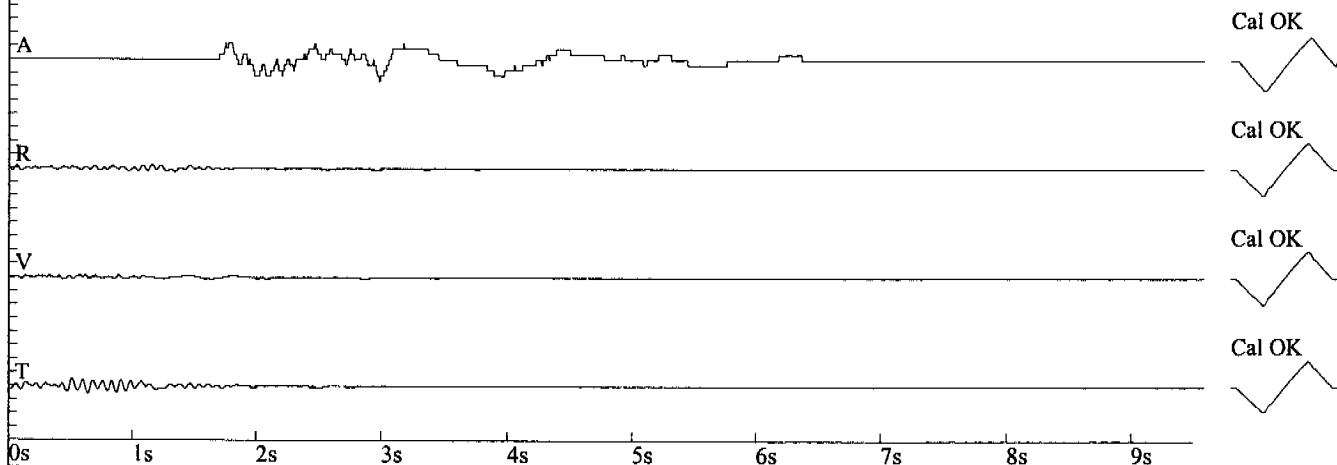
File: D1DAP028.DTB Event Number: 028 Date: 4/13/01 Time: 10:29
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

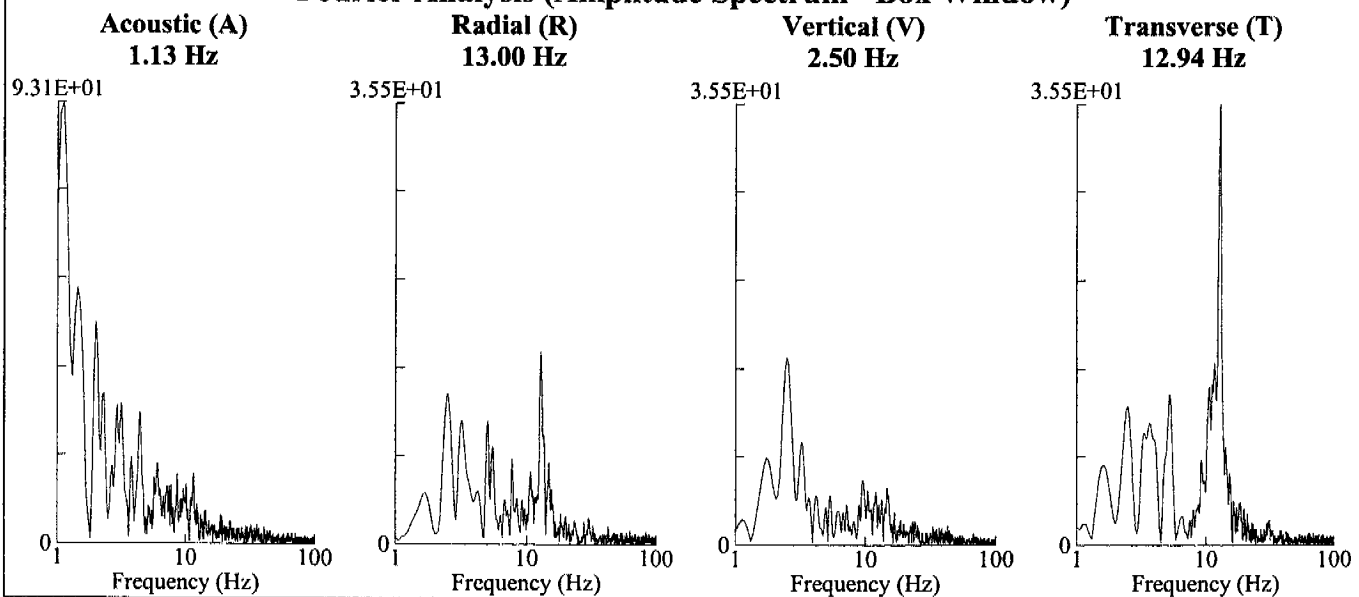
Acoustic (A): 112 dB @ 5.0 Hz
(0.08Mb 0.0012psi 0.0080kPa)
Radial (R): 0.015in/s 0.381mm/s @ 17.6Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.03in/s 0.762mm/s @ 12.1Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

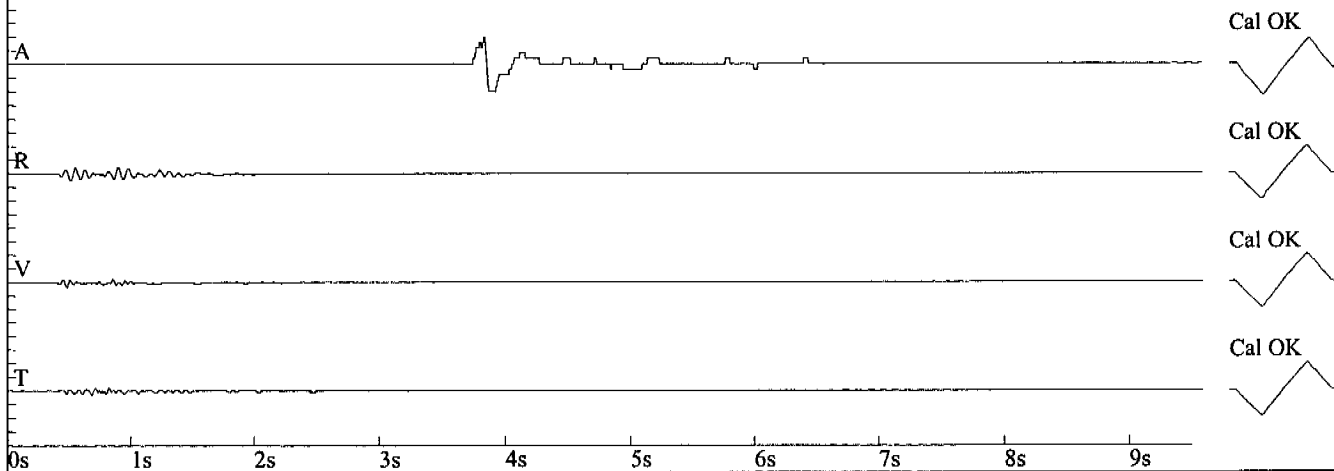
File: D2SAP005.DTB Event Number: 005 Date: 4/3/01 Time: 08:38
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

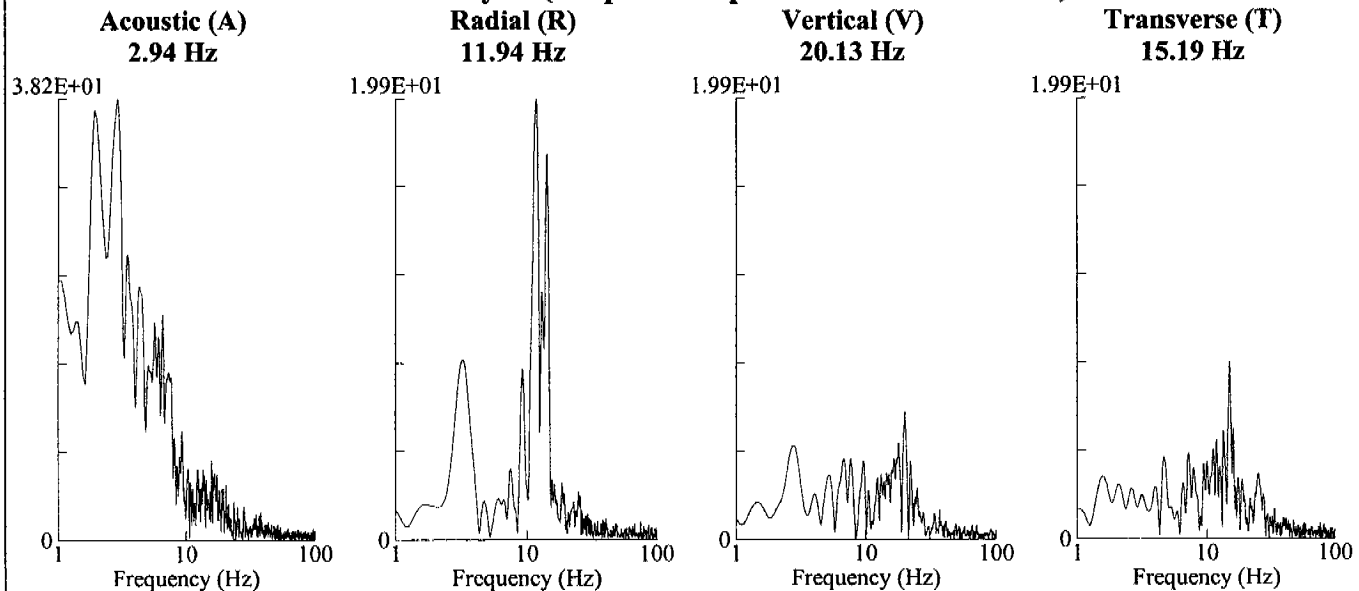
Acoustic (A): 114 dB @ 5.4 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.025in/s 0.635mm/s @ 15.5Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.015in/s 0.381mm/s @ 20.4Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

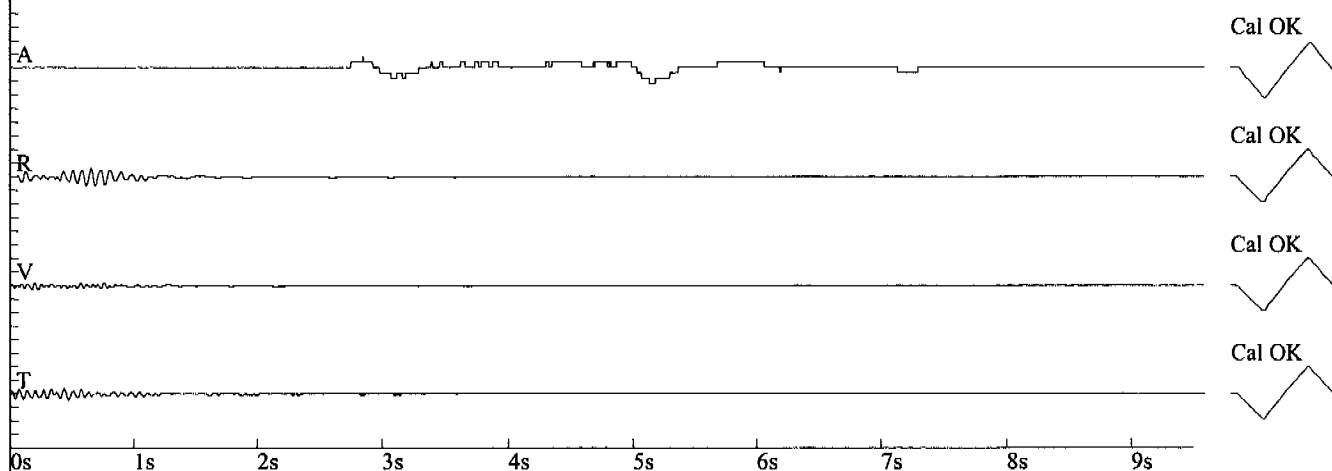
File: D2SAP007.DTB Event Number: 007 Date: 4/3/01 Time: 13:48
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

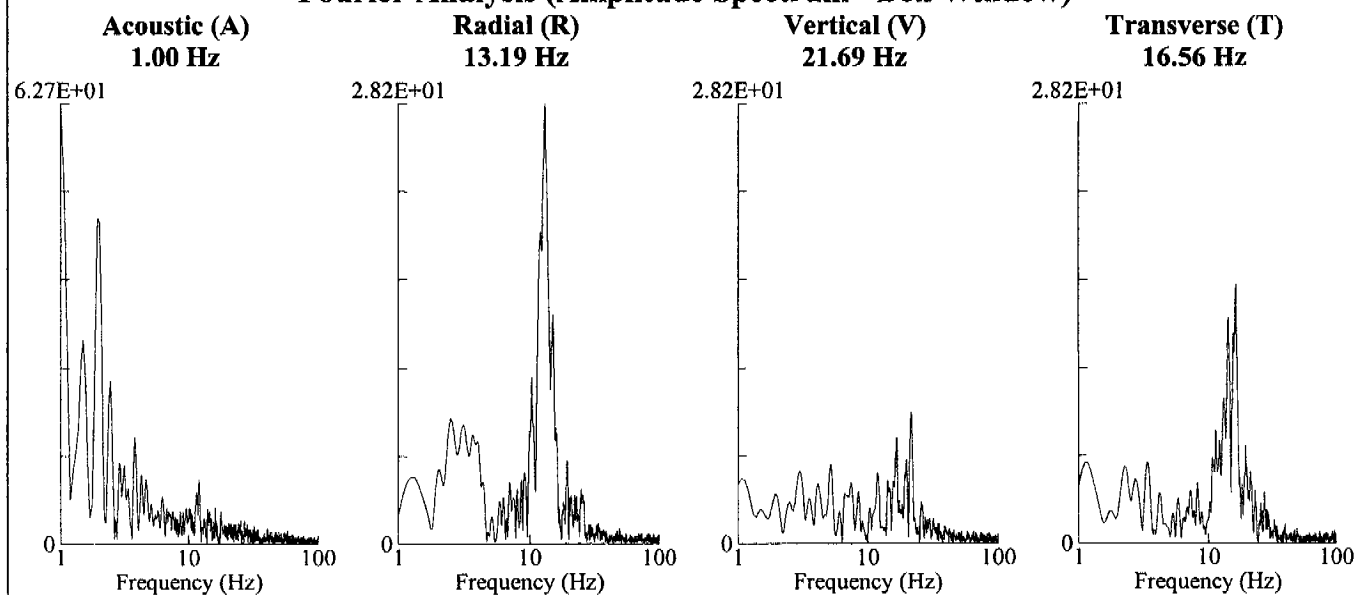
Acoustic (A): 110 dB @ 1.6 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.035in/s 0.889mm/s @ 14.2Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.015in/s 0.381mm/s @ 22.2Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

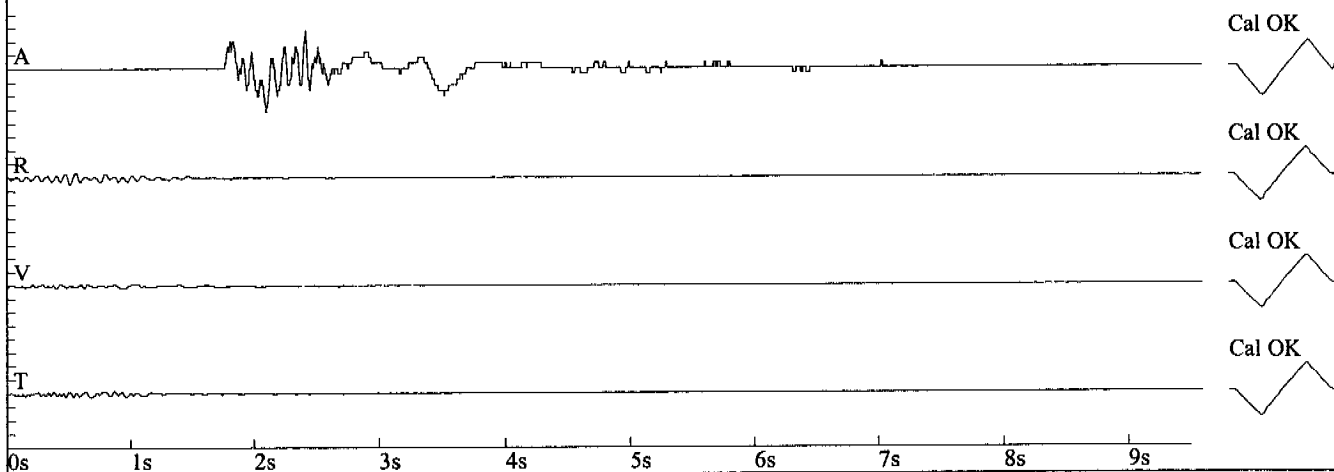
File: D2SAP008.DTB Event Number: 008 Date: 4/3/01 Time: 17:03
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

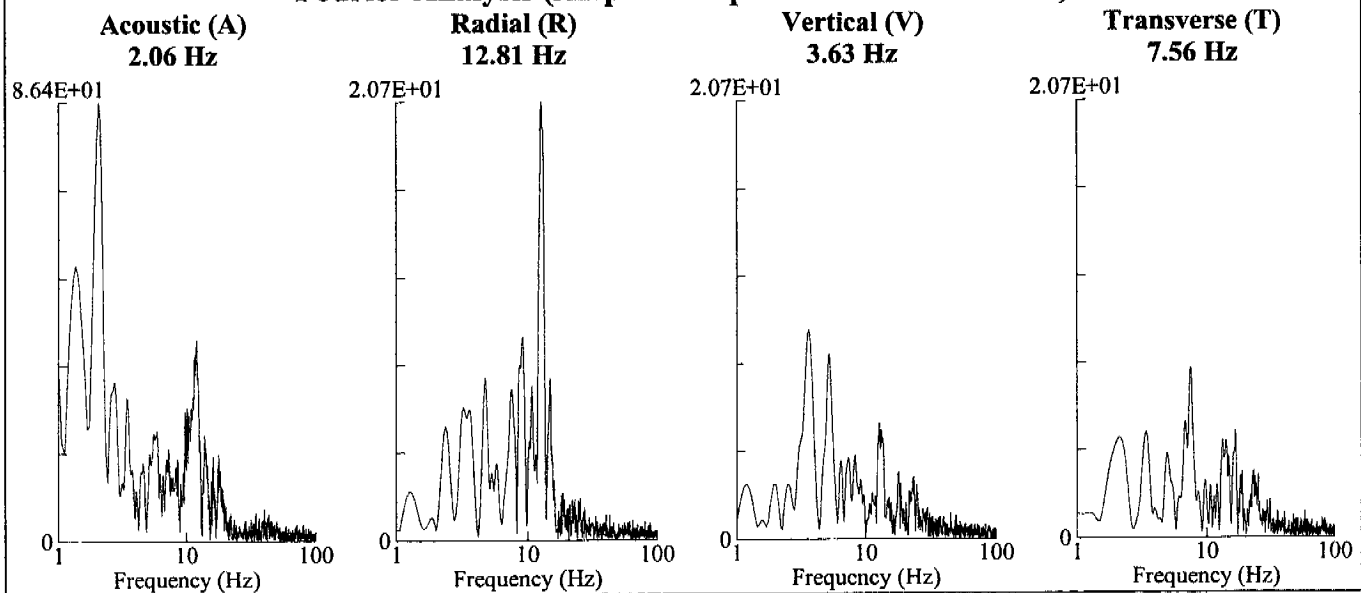
Acoustic (A): 118 dB @ 3.8 Hz
(0.16Mb 0.0023psi 0.0160kPa)
Radial (R): 0.025in/s 0.635mm/s @ 13.1Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.015in/s 0.381mm/s @ 8.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

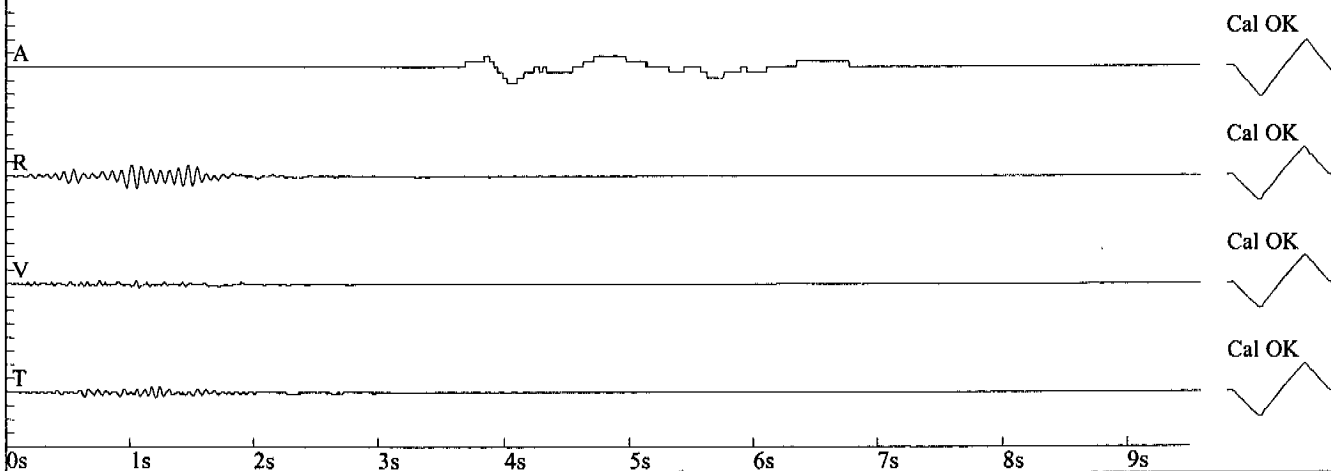
File: D2SAP010.DTB Event Number: 010 Date: 4/4/01 Time: 11:18
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

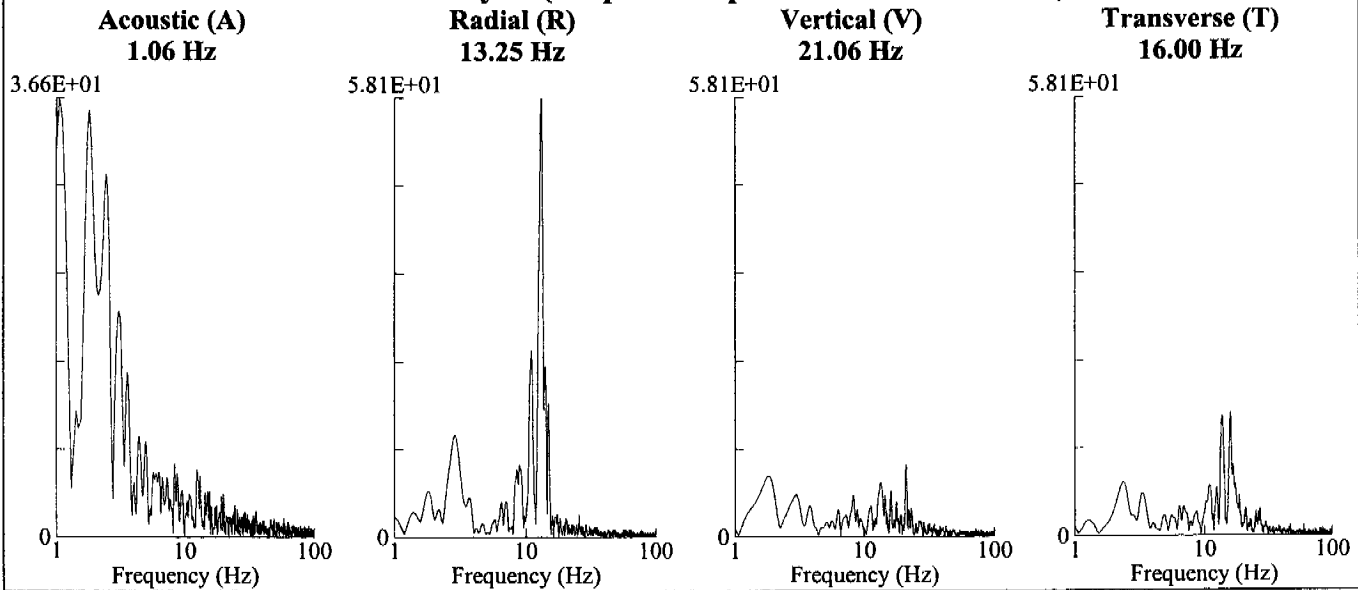
Acoustic (A): 110 dB @ 2.0 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.045in/s 1.143mm/s @ 11.9Hz
Vertical (V): 0.015in/s 0.381mm/s @ 10.0Hz
Transverse (T): 0.02in/s 0.508mm/s @ 21.3Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

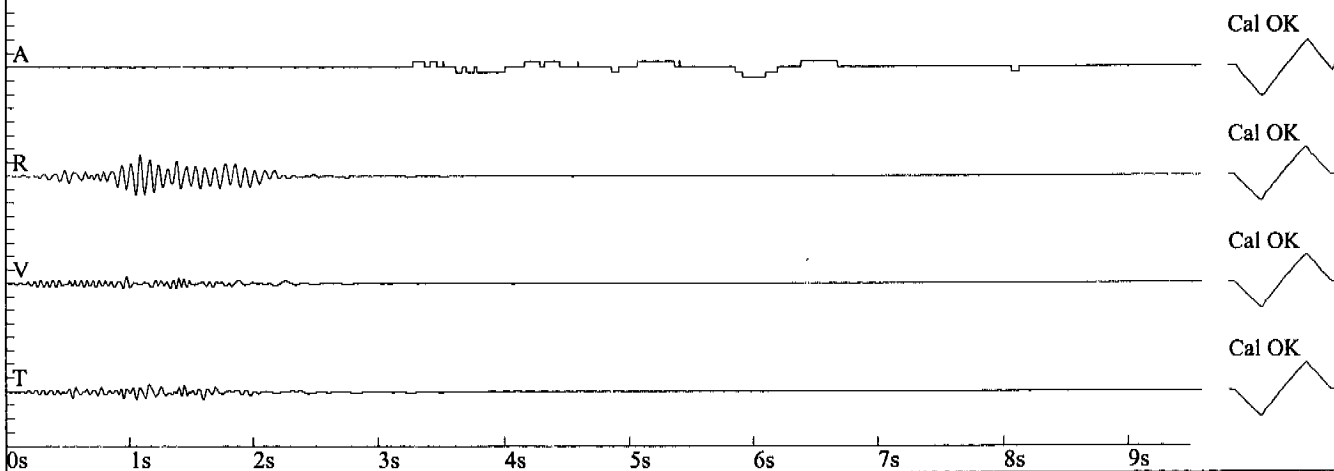
File: D2SAP011.DTB Event Number: 011 Date: 4/5/01 Time: 10:31
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

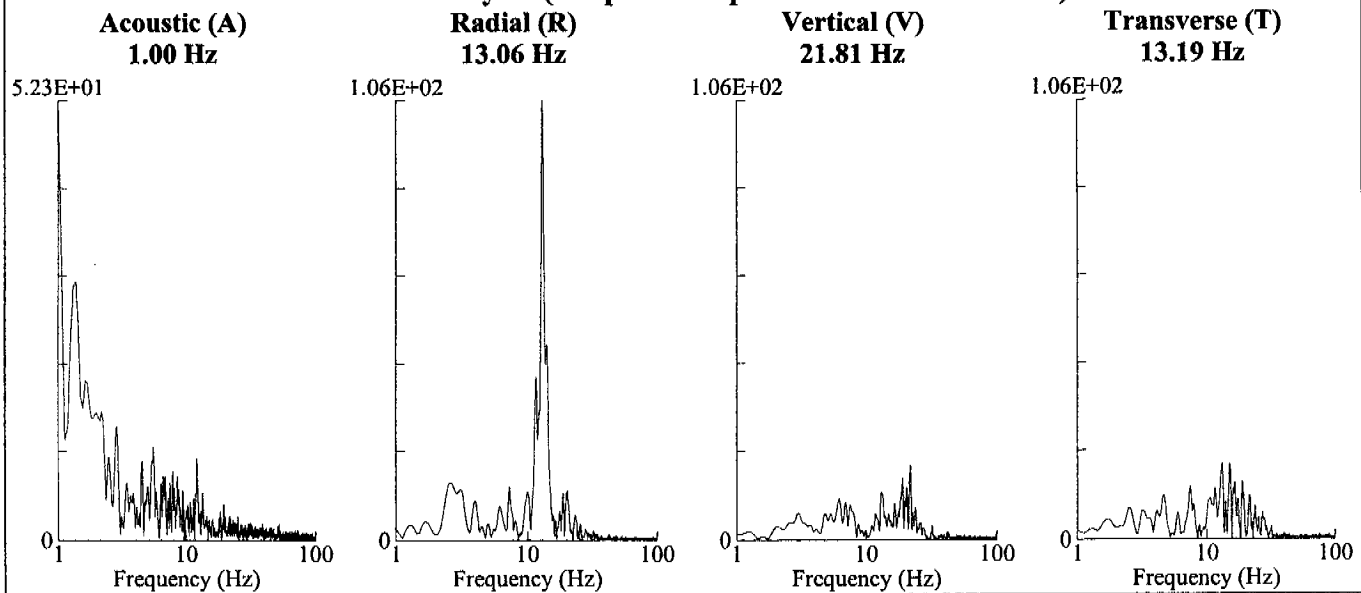
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.08in/s 2.032mm/s @ 14.2Hz
Vertical (V): 0.025in/s 0.635mm/s @ 18.2Hz
Transverse (T): 0.03in/s 0.762mm/s @ 17.6Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

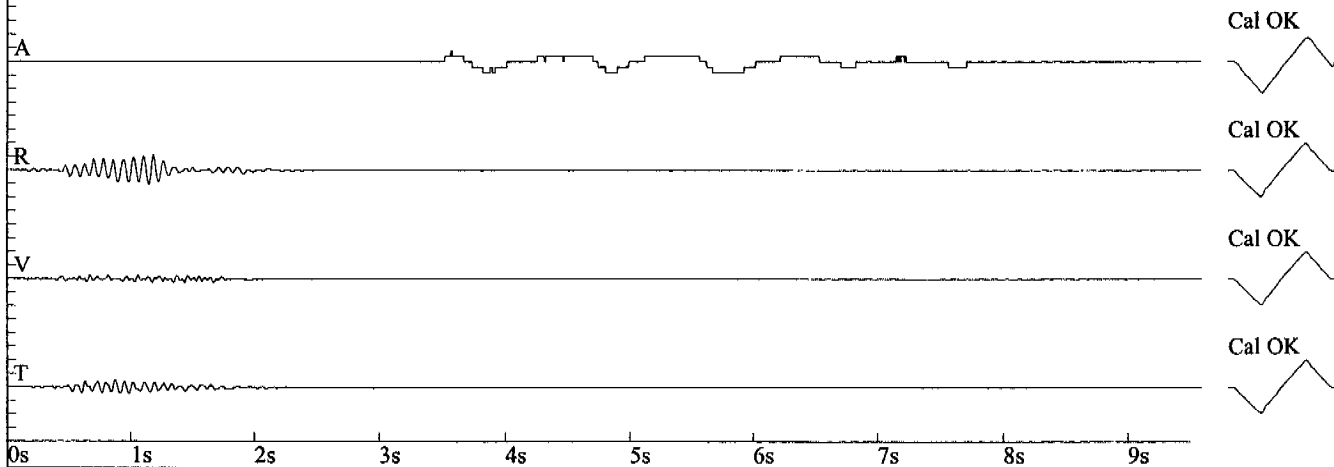
File: D2SAP012.DTB Event Number: 012 Date: 4/6/01 Time: 10:19
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

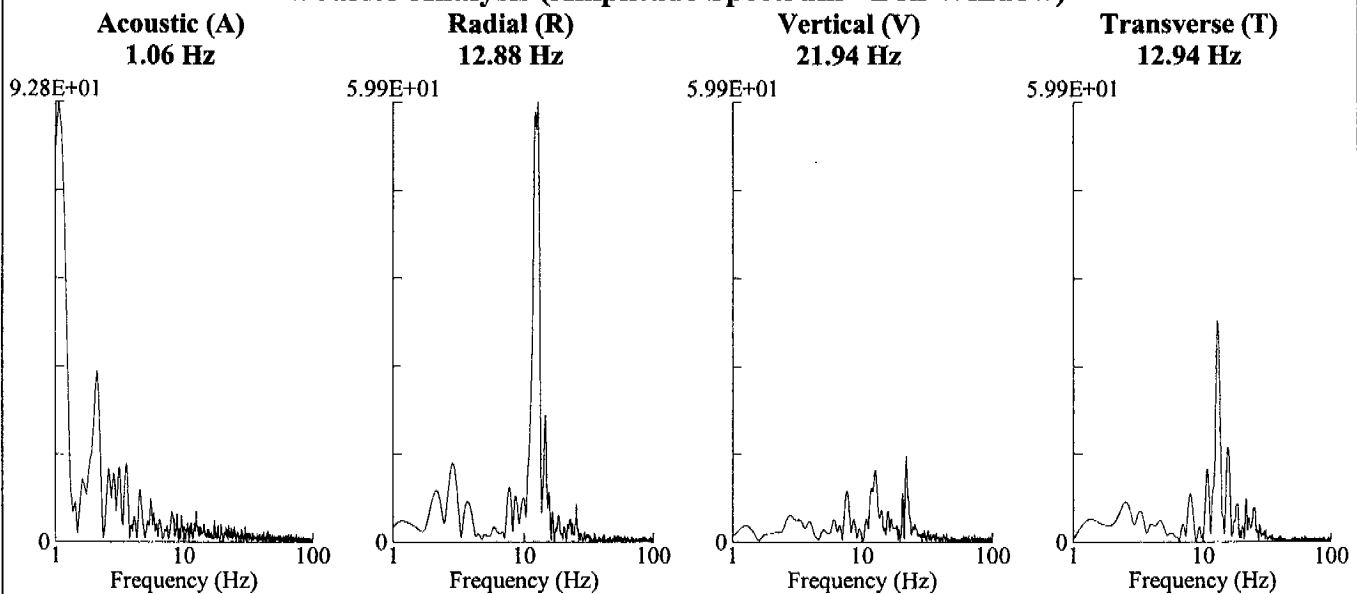
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.055in/s 1.397mm/s @ 13.8Hz
Vertical (V): 0.015in/s 0.381mm/s @ 24.3Hz
Transverse (T): 0.025in/s 0.635mm/s @ 15.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

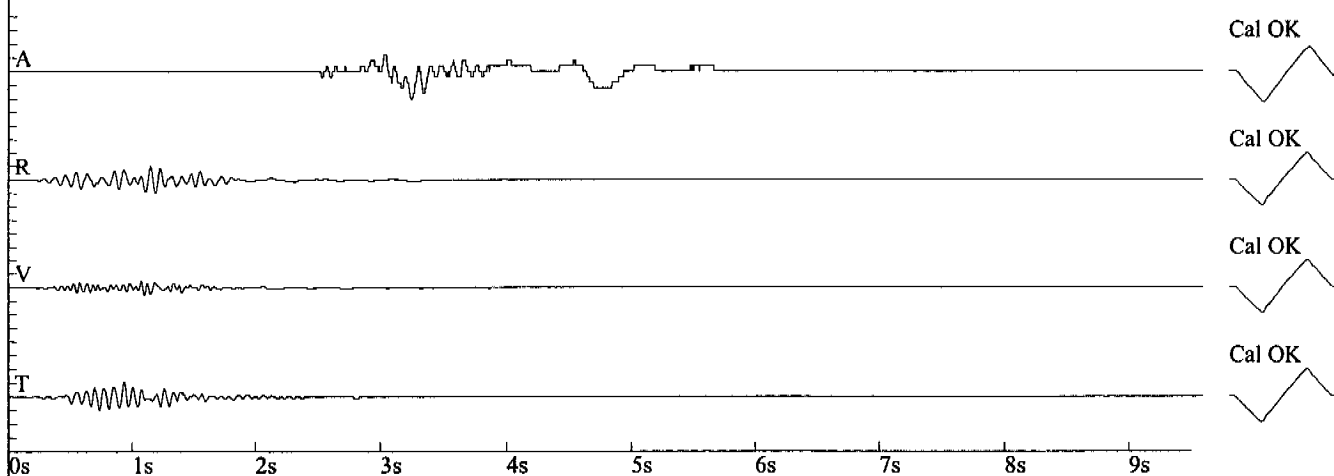
File: D2SAP013.DTB Event Number: 013 Date: 4/6/01 Time: 15:40
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

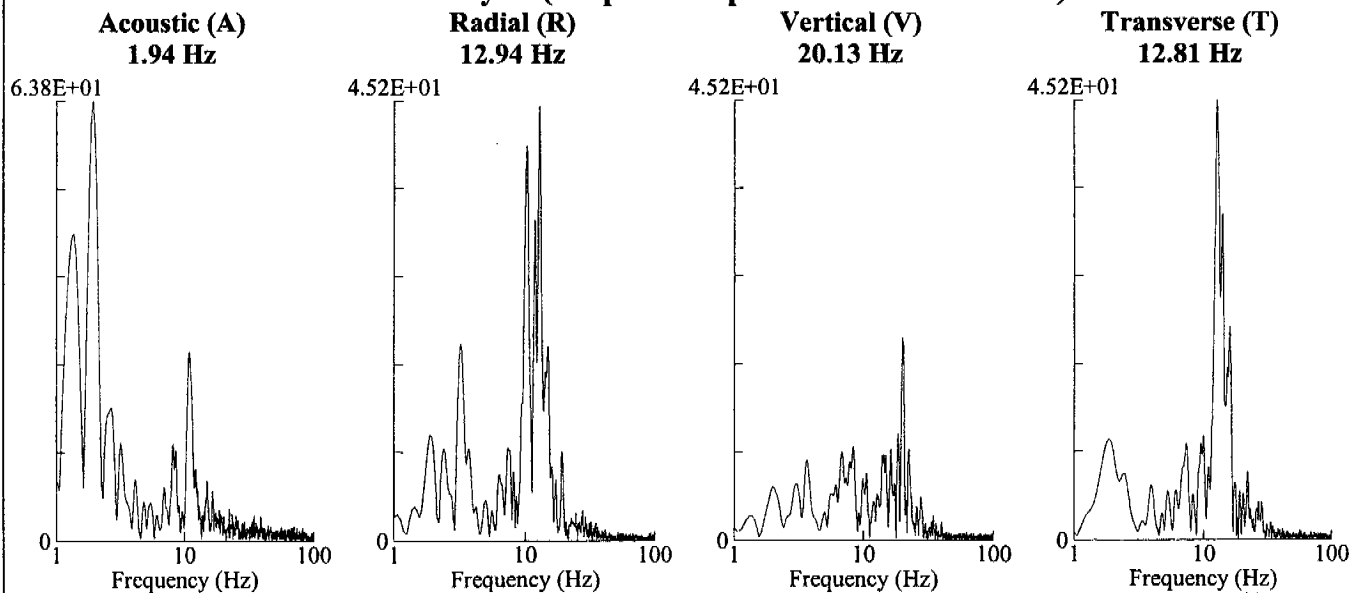
Acoustic (A): 114 dB @ 6.4 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.05in/s 1.27mm/s @ 13.4Hz
Vertical (V): 0.03in/s 0.762mm/s @ 19.6Hz
Transverse (T): 0.055in/s 1.397mm/s @ 14.6Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

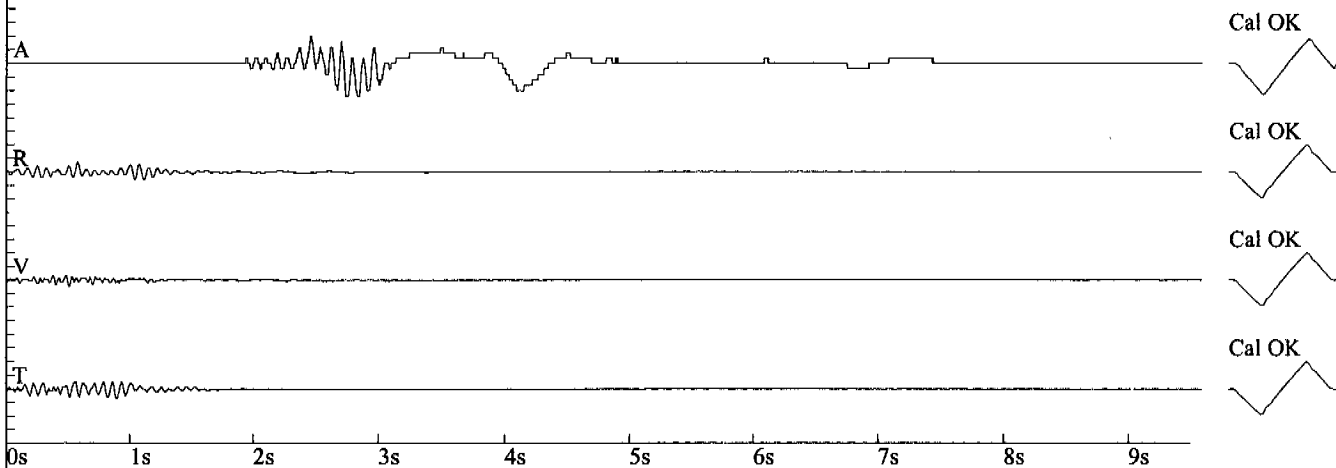
File: D2SAP016.DTB Event Number: 016 Date: 4/9/01 Time: 12:39
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

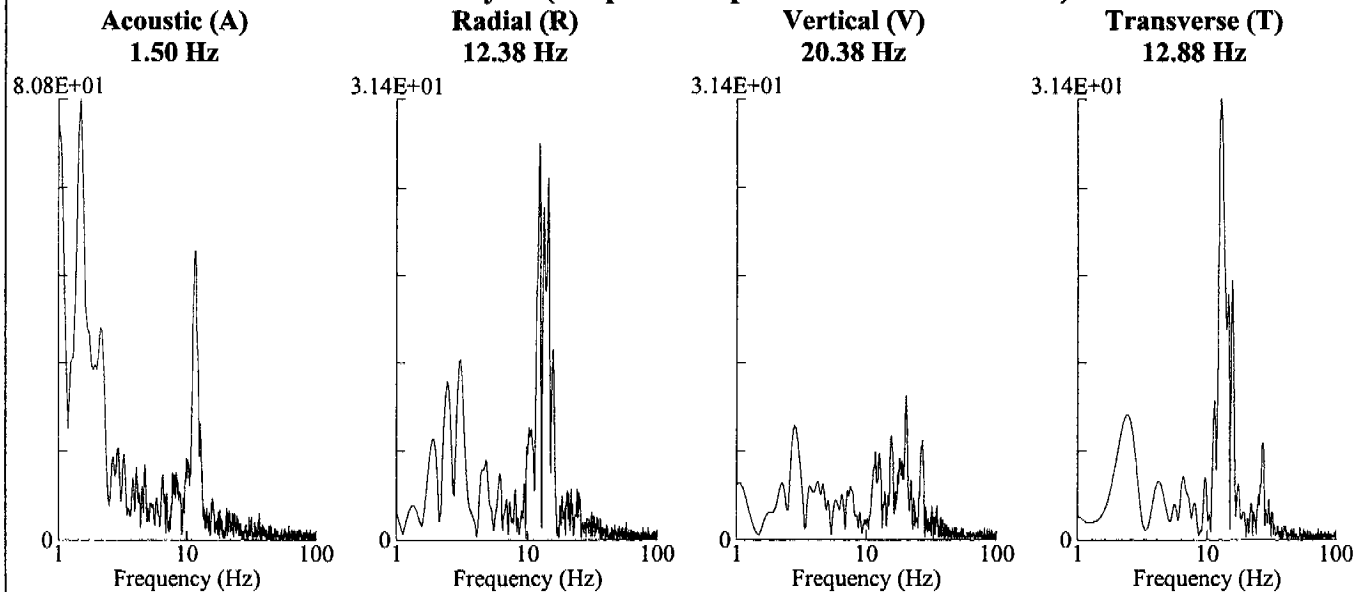
Acoustic (A): 116 dB @ 9.3 Hz
(0.12Mb 0.0017psi 0.0120kPa)
Radial (R): 0.035in/s 0.889mm/s @ 14.6Hz
Vertical (V): 0.025in/s 0.635mm/s @ 19.6Hz
Transverse (T): 0.035in/s 0.889mm/s @ 13.1Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia Dean Jr. surface

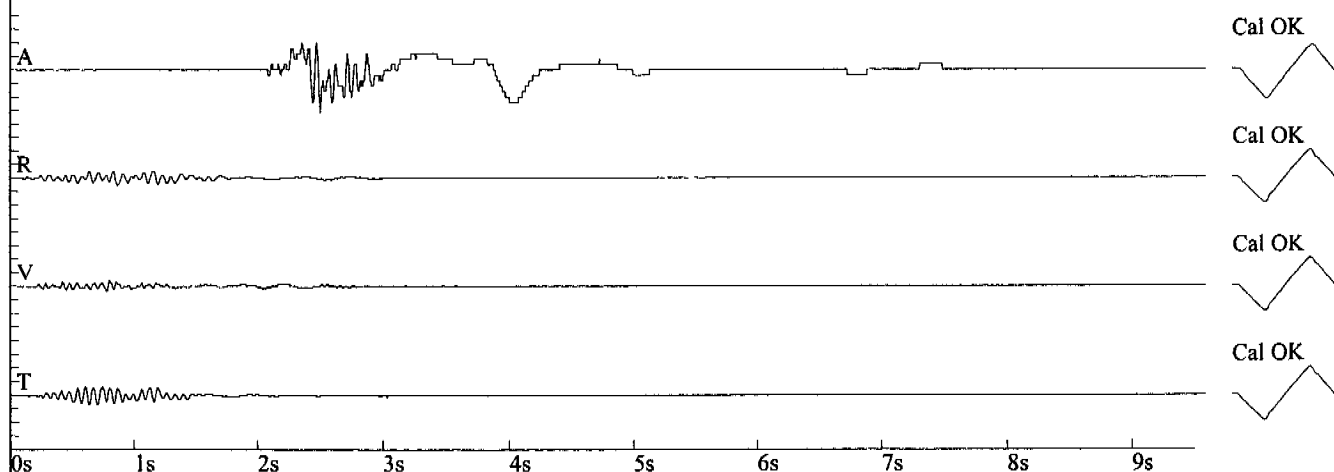
File: D2SAP018.DTB Event Number: 018 Date: 4/10/01 Time: 15:42
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

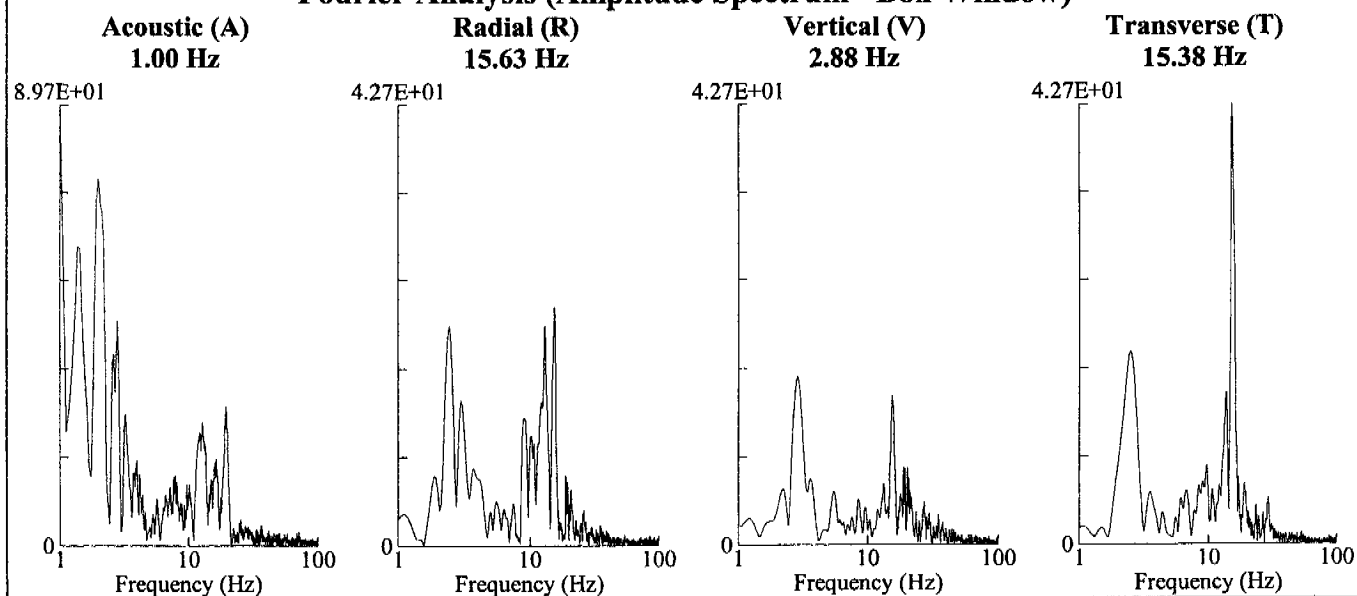
Acoustic (A): 118 dB @ 6.4 Hz
(0.16Mb 0.0023psi 0.0160kPa)
Radial (R): 0.03in/s 0.762mm/s @ 10.8Hz
Vertical (V): 0.02in/s 0.508mm/s @ 17.0Hz
Transverse (T): 0.035in/s 0.889mm/s @ 18.2Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia Dean Jr. surface

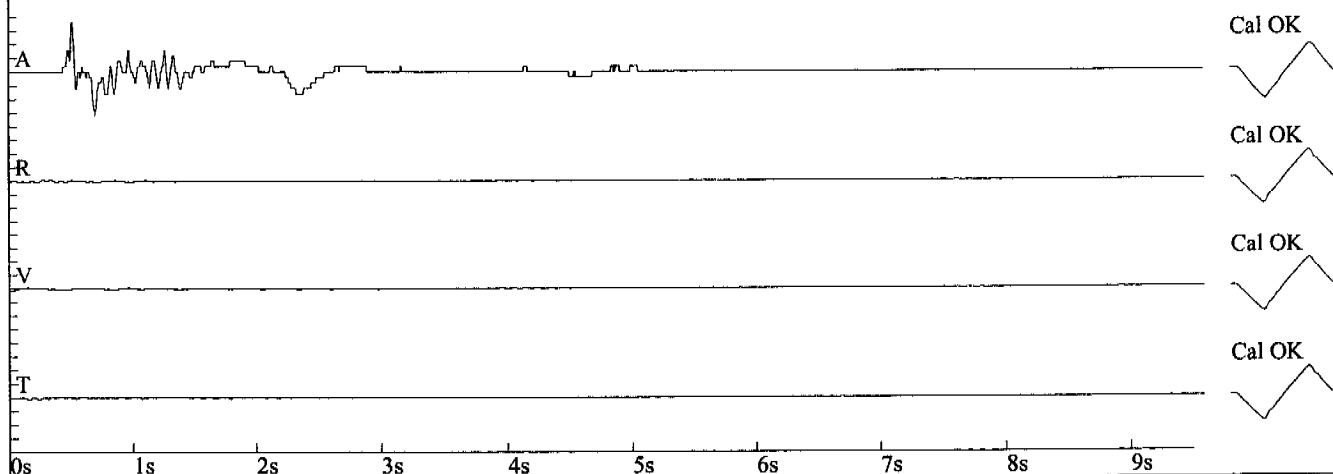
File: D2SAP024.DTB Event Number: 024 Date: 4/11/01 Time: 09:54
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

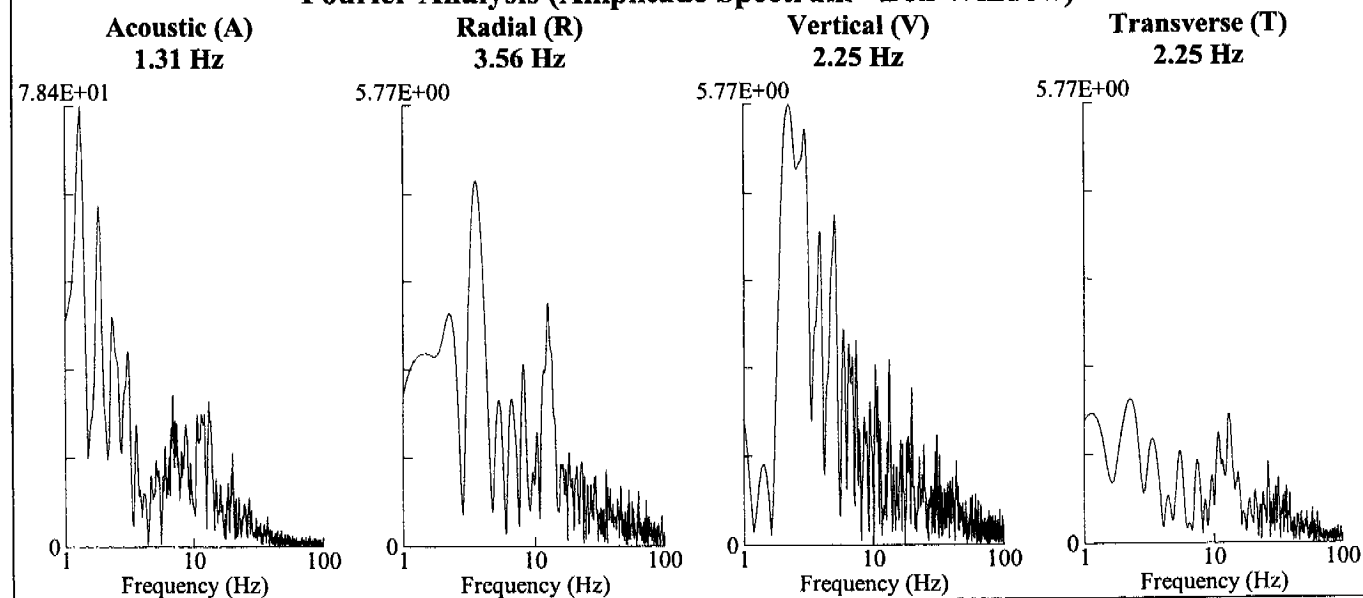
Acoustic (A): 119 dB @ 7.4 Hz
(0.18Mb 0.0026psi 0.0180kPa)
Radial (R): 0.005in/s 0.127mm/s @ 0.0Hz
Vertical (V): 0.005in/s 0.127mm/s @ 0.0Hz
Transverse (T): 0.005in/s 0.127mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

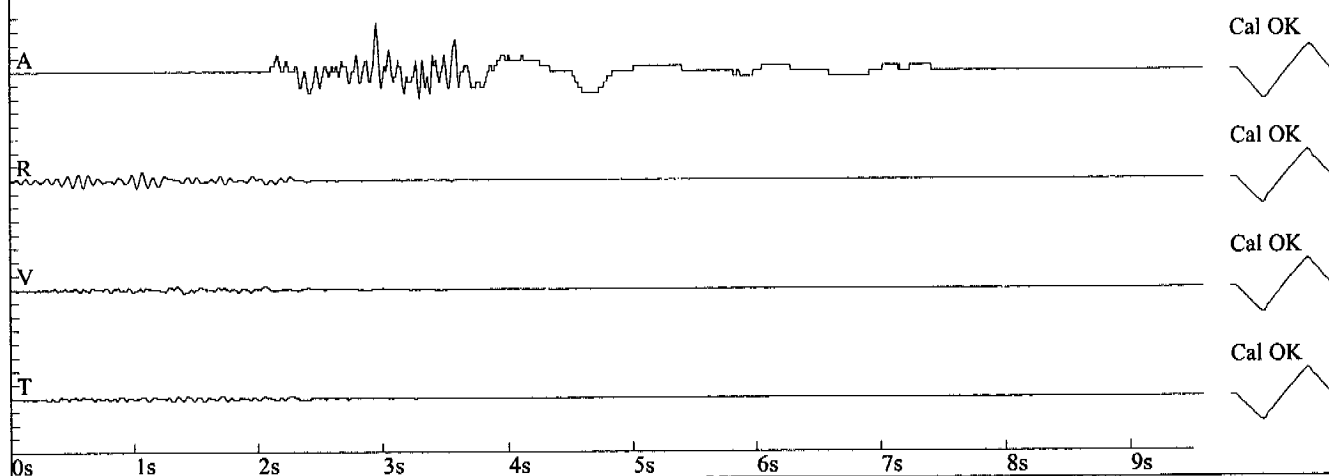
File: D2SAP025.DTB Event Number: 025 Date: 4/12/01 Time: 10:35
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

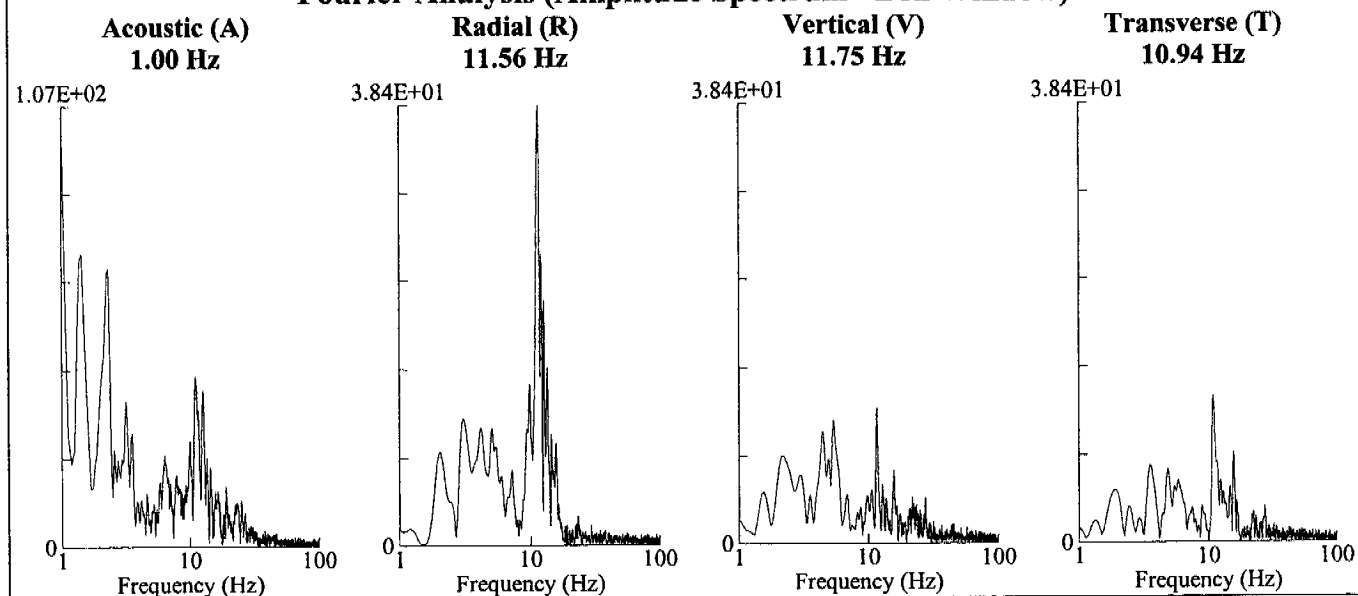
Acoustic (A): 119 dB @ 10.6 Hz
(0.18Mb 0.0026psi 0.0180kPa)
Radial (R): 0.03in/s 0.762mm/s @ 12.8Hz
Vertical (V): 0.015in/s 0.381mm/s @ 7.1Hz
Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

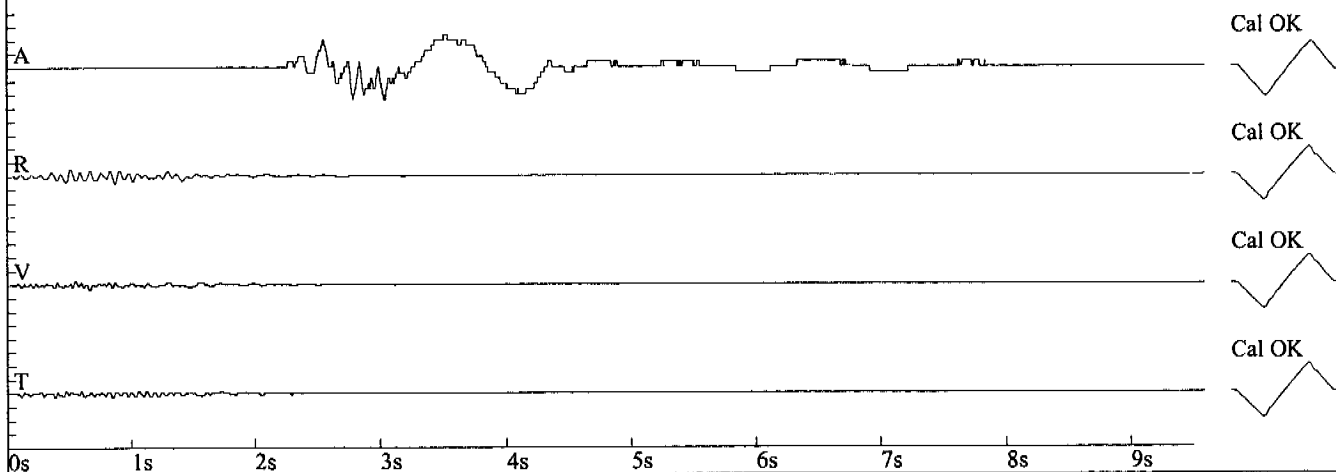
File: D2SAP026.DTB Event Number: 026 Date: 4/12/01 Time: 12:20
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

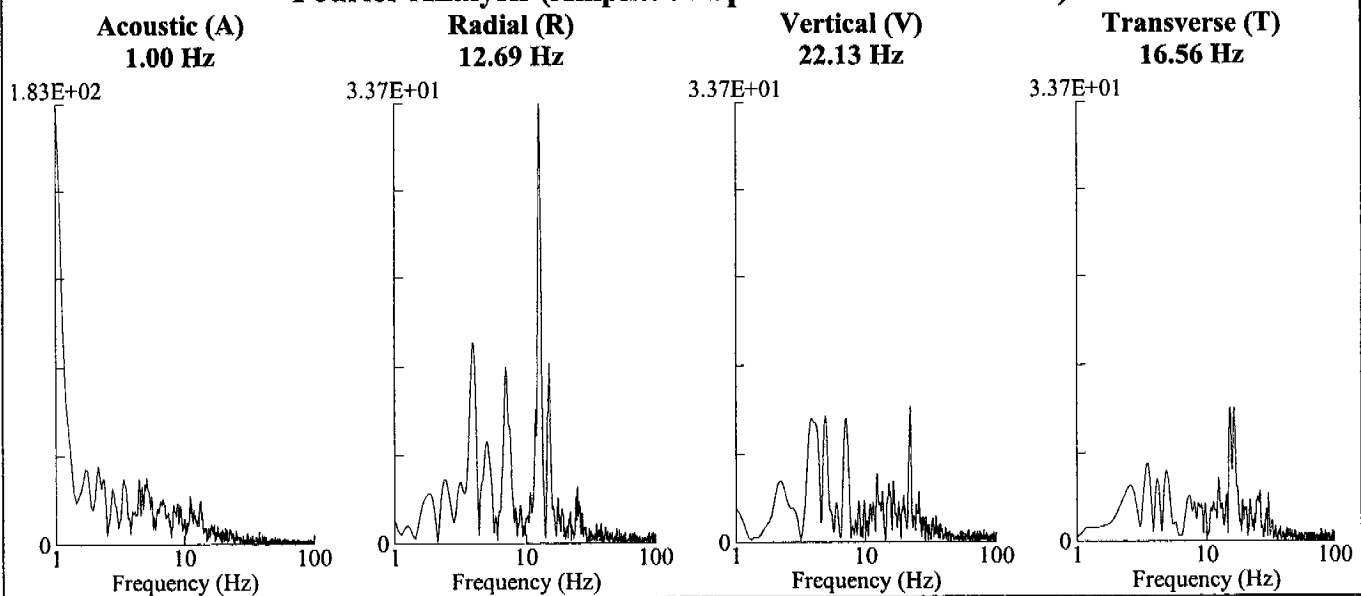
Acoustic (A): 116 dB @ 1.1 Hz
(0.12Mb 0.0017psi 0.0120kPa)
Radial (R): 0.03in/s 0.762mm/s @ 14.2Hz
Vertical (V): 0.02in/s 0.508mm/s @ 16.5Hz
Transverse (T): 0.015in/s 0.381mm/s @ 21.3Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

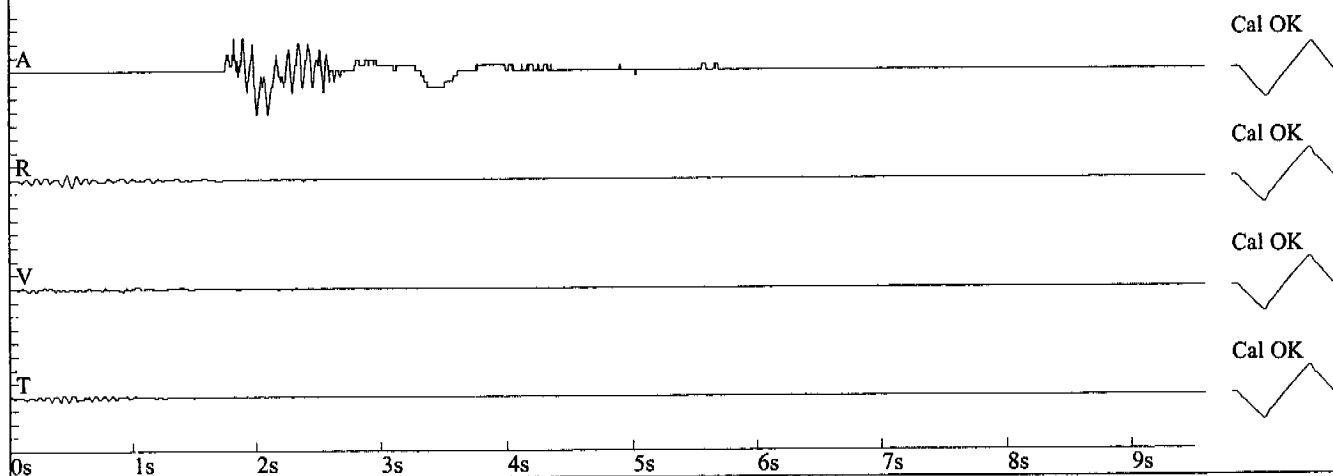
File: D2SAP027.DTB Event Number: 027 Date: 4/12/01 Time: 17:02
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

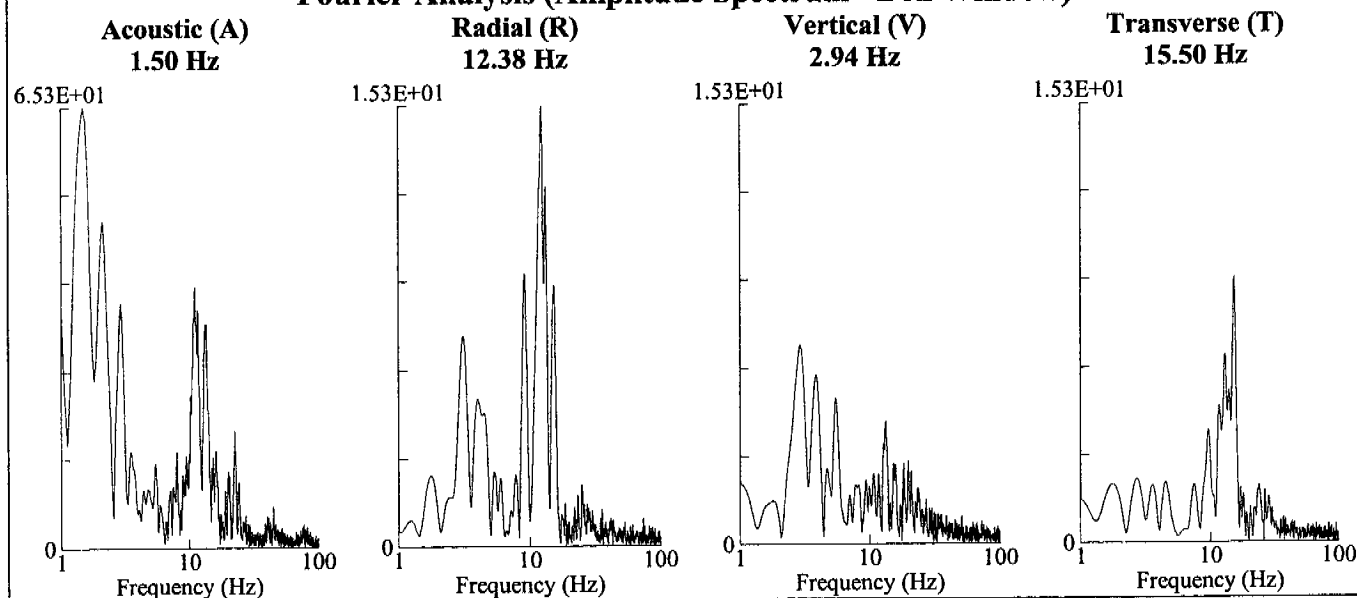
Acoustic (A): 118 dB @ 3.1 Hz
(0.16Mb 0.0023psi 0.0160kPa)
Radial (R): 0.025in/s 0.635mm/s @ 13.4Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. surface**

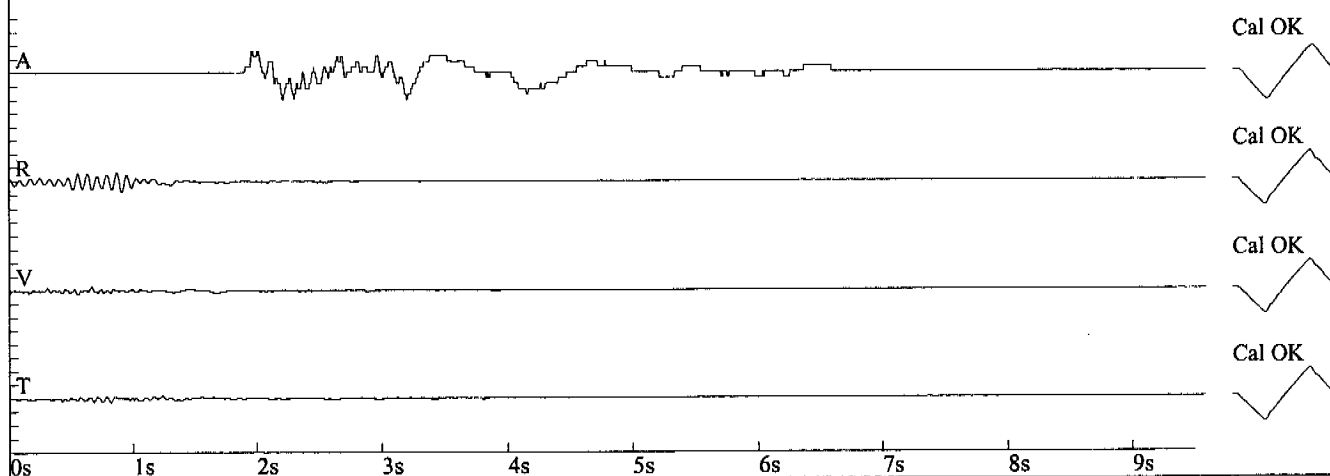
File: D2SAP030.DTB Event Number: 030 Date: 4/13/01 Time: 10:27
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

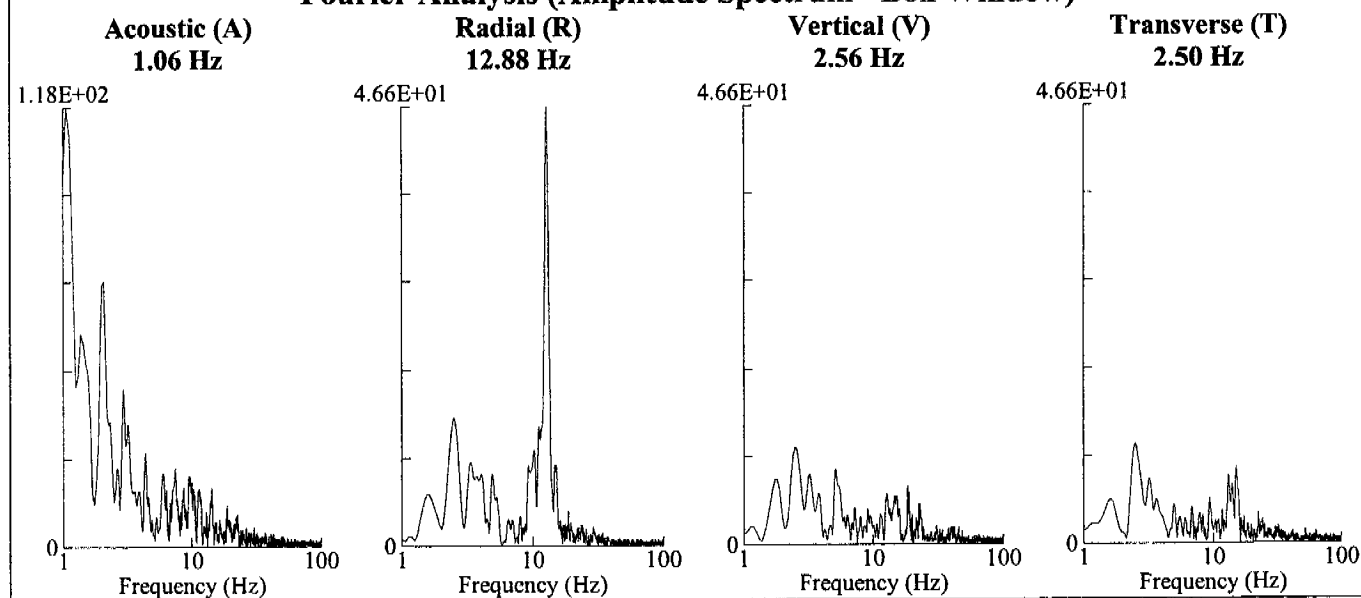
Acoustic (A): 114 dB @ 2.5 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.04in/s 1.016mm/s @ 12.8Hz
Vertical (V): 0.015in/s 0.381mm/s @ 23.2Hz
Transverse (T): 0.015in/s 0.381mm/s @ 19.6Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. deep**

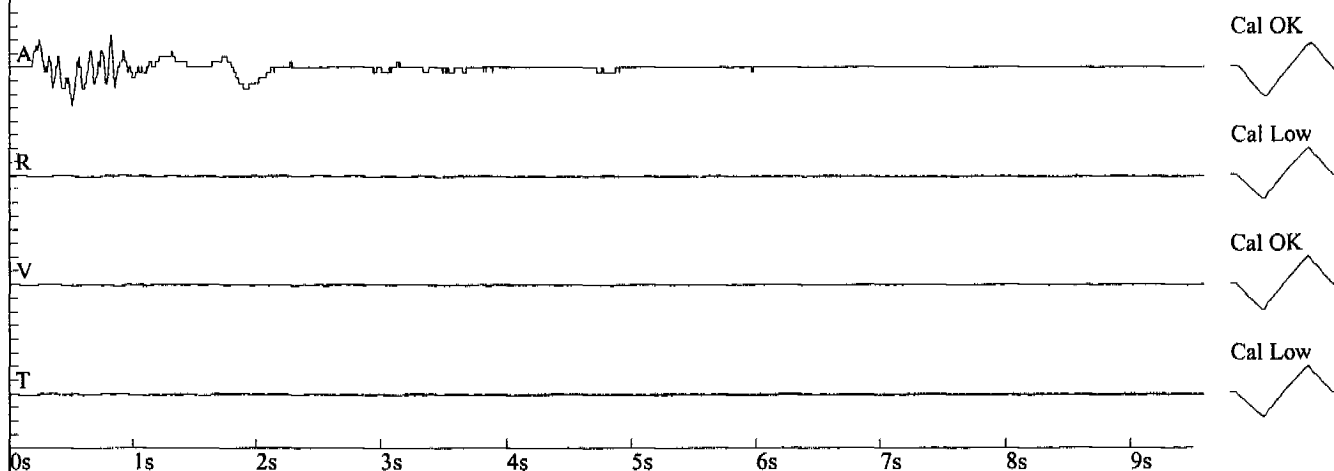
File: D2WAP005.DTB Event Number: 005 Date: 4/3/01 Time: 17:03
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1780

Amplitudes and Frequencies

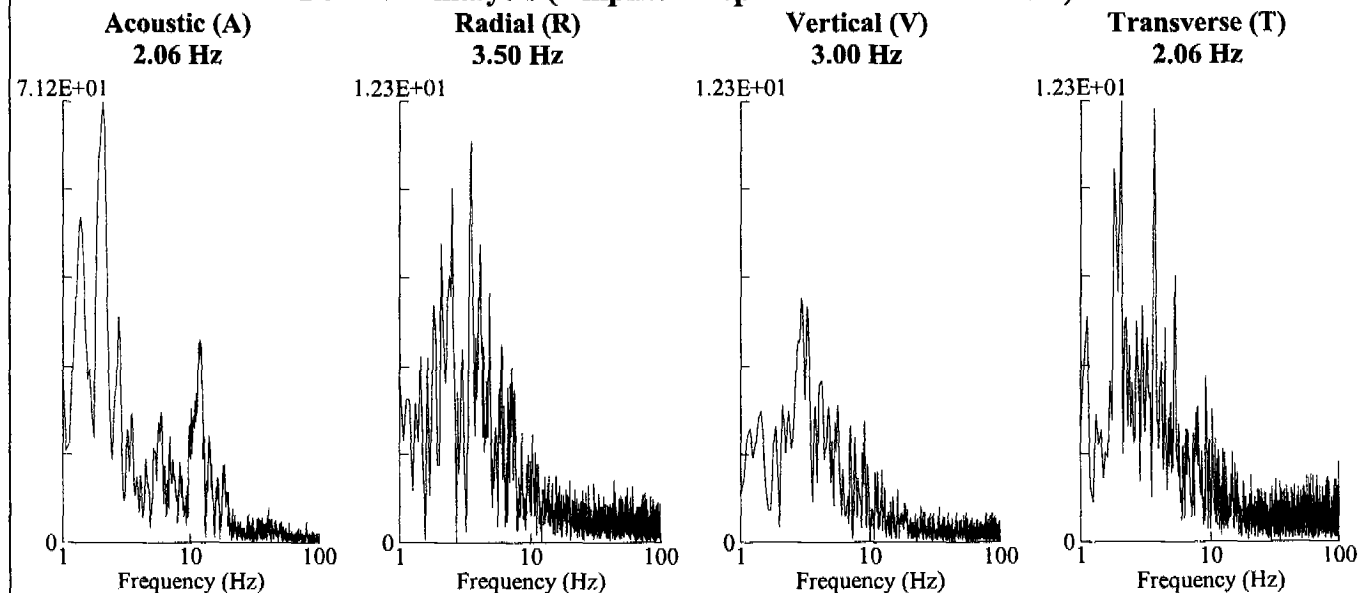
Acoustic (A): 117 dB @ 3.9 Hz
(0.14Mb 0.0020psi 0.0140kPa)
Radial (R): 0.005in/s 0.127mm/s @ 0.0Hz
Vertical (V): 0.005in/s 0.127mm/s @ 0.0Hz
Transverse (T): 0.005in/s 0.127mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. deep**

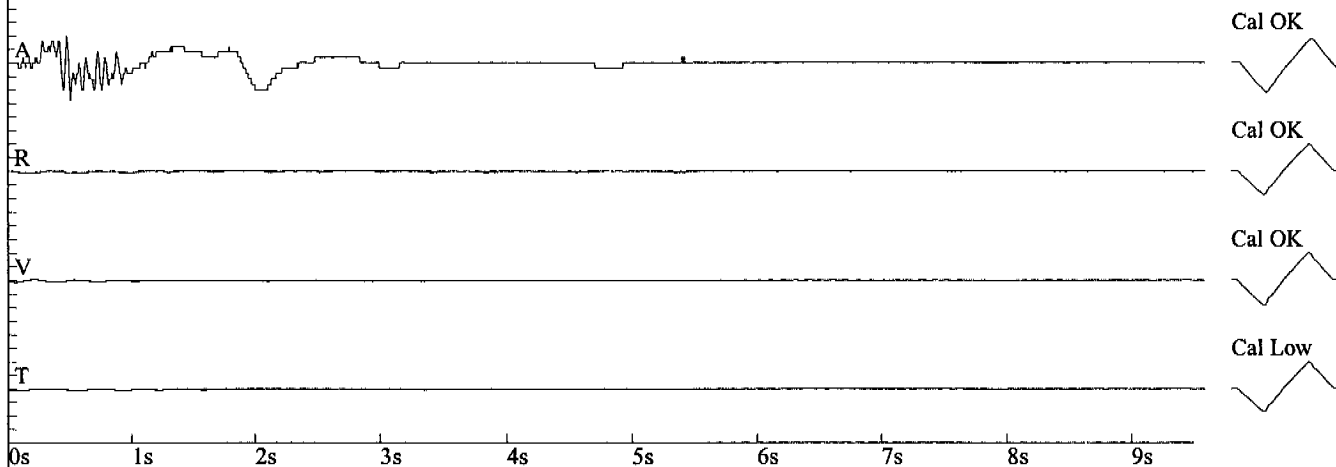
File: D2WAP011.DTB Event Number: 011 Date: 4/10/01 Time: 15:42
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1780

Amplitudes and Frequencies

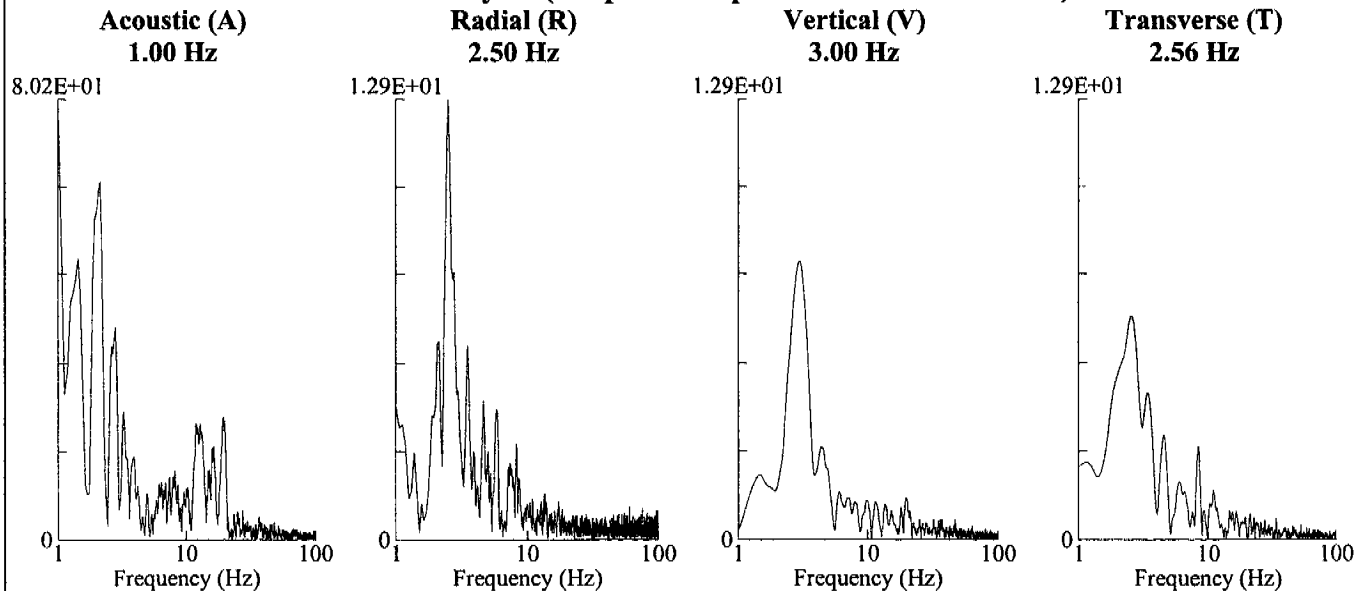
Acoustic (A): 117 dB @ 6.4 Hz
(0.14Mb 0.0020psi 0.0140kPa)
Radial (R): 0.005in/s 0.127mm/s @ 0.0Hz
Vertical (V): 0.005in/s 0.127mm/s @ 0.0Hz
Transverse (T): 0.005in/s 0.127mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. deep**

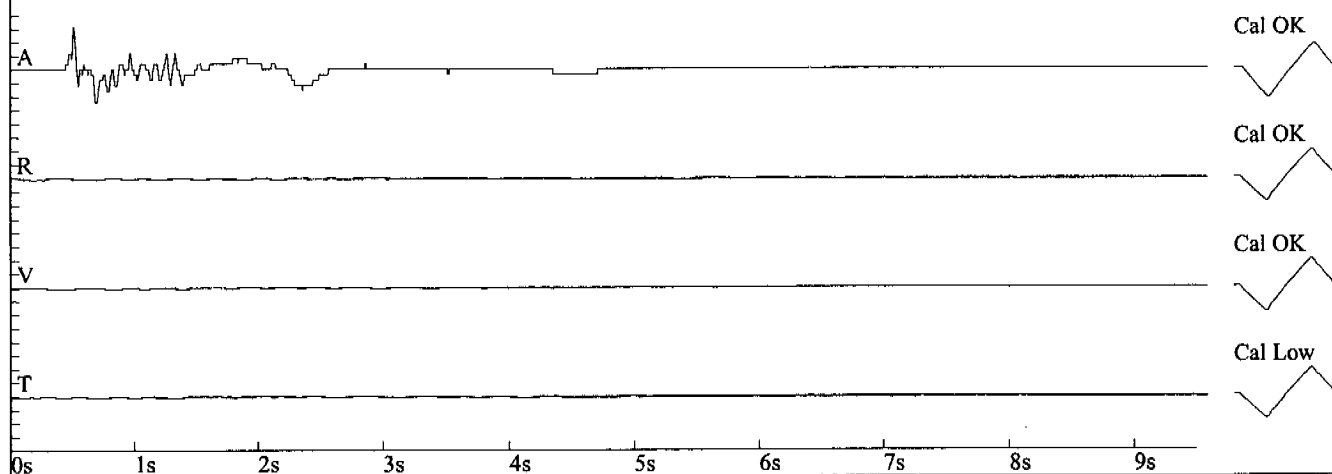
File: D2WAP032.DTB Event Number: 032 Date: 4/11/01 Time: 09:54
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1780

Amplitudes and Frequencies

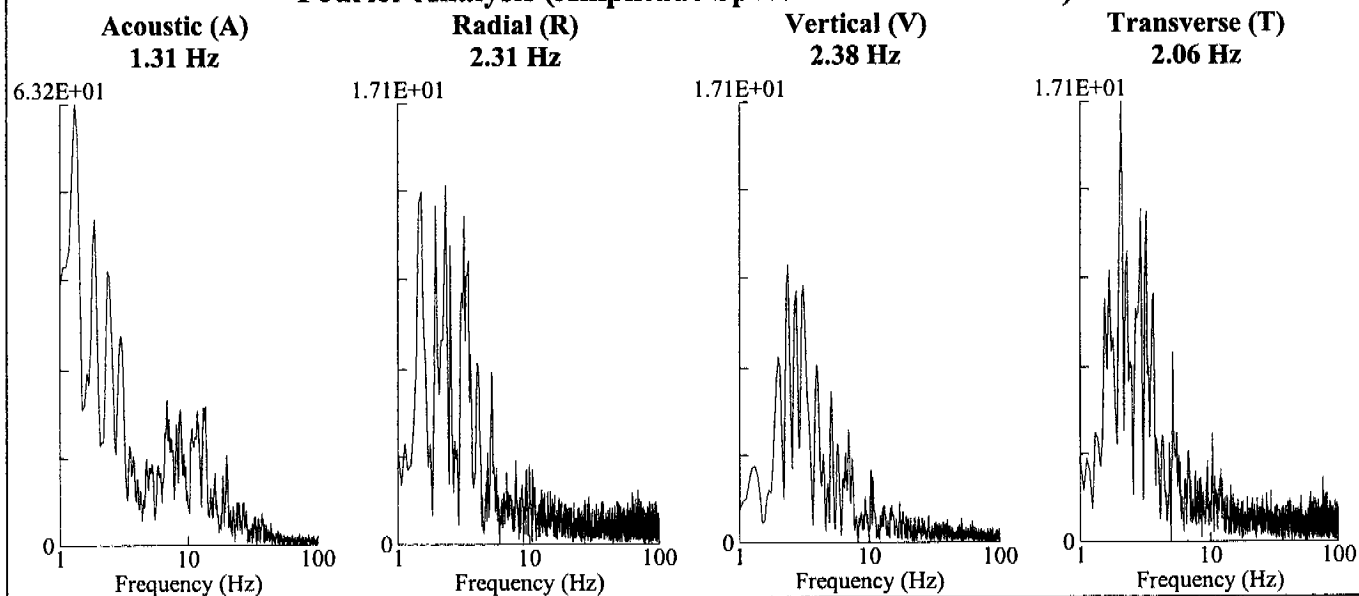
Acoustic (A): 118 dB @ 7.5 Hz
(0.16Mb 0.0023psi 0.0160kPa)
Radial (R): 0.005in/s 0.127mm/s @ 0.0Hz
Vertical (V): 0.005in/s 0.127mm/s @ 0.0Hz
Transverse (T): 0.005in/s 0.127mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. deep**

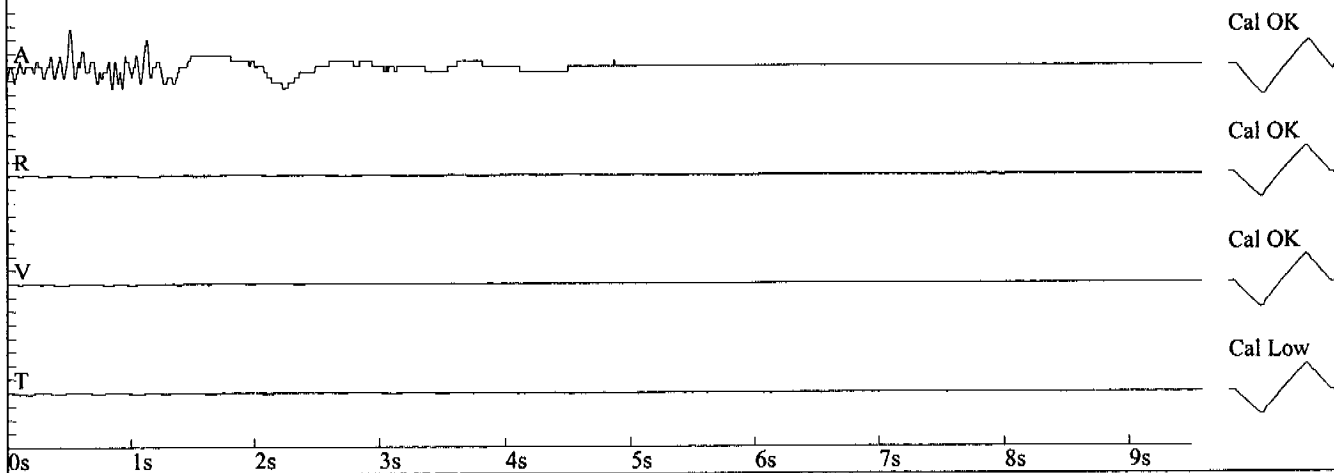
File: D2WAP033.DTB Event Number: 033 Date: 4/12/01 Time: 10:34
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1780

Amplitudes and Frequencies

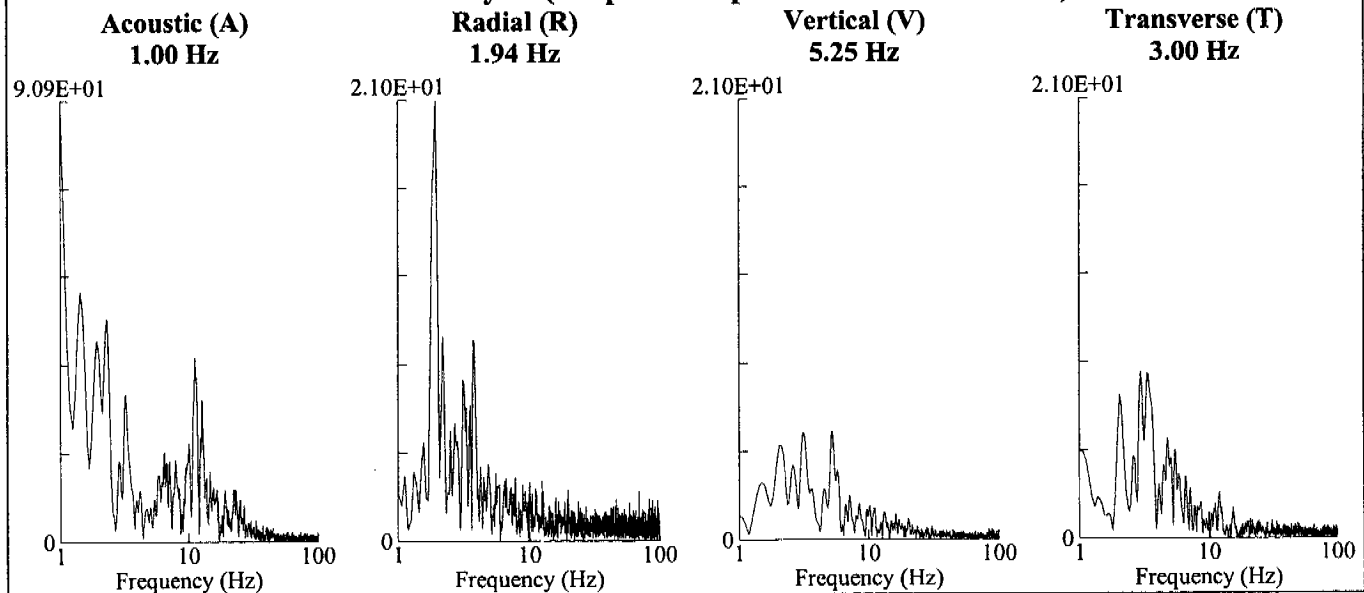
Acoustic (A): 117 dB @ 11.1 Hz
(0.14Mb 0.0020psi 0.0140kPa)
Radial (R): 0.005in/s 0.127mm/s @ 0.0Hz
Vertical (V): 0.005in/s 0.127mm/s @ 0.0Hz
Transverse (T): 0.005in/s 0.127mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Dean Jr. deep**

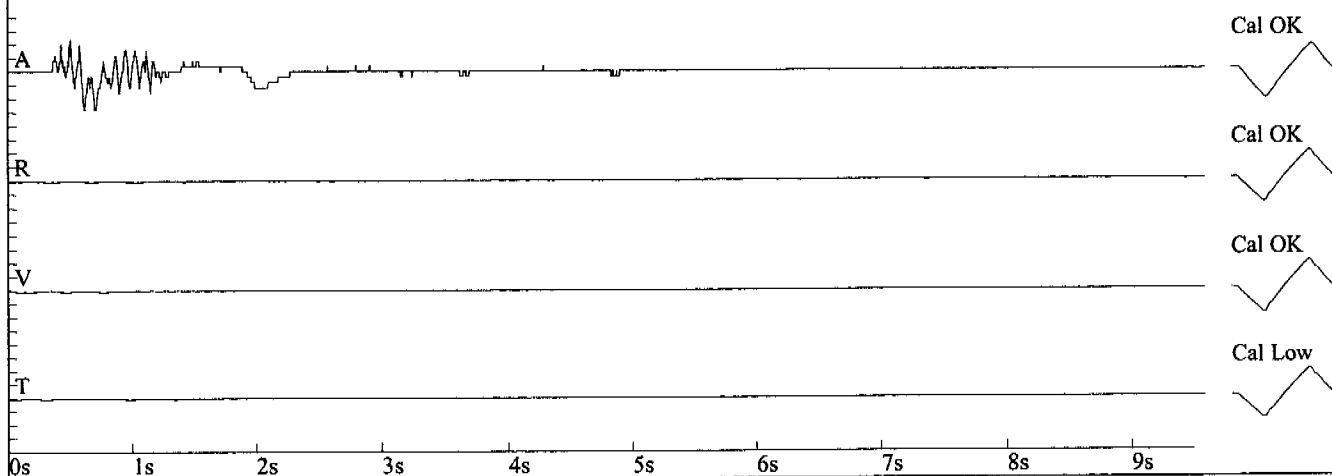
File: D2WAP034.DTB Event Number: 034 Date: 4/12/01 Time: 17:01
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1780

Amplitudes and Frequencies

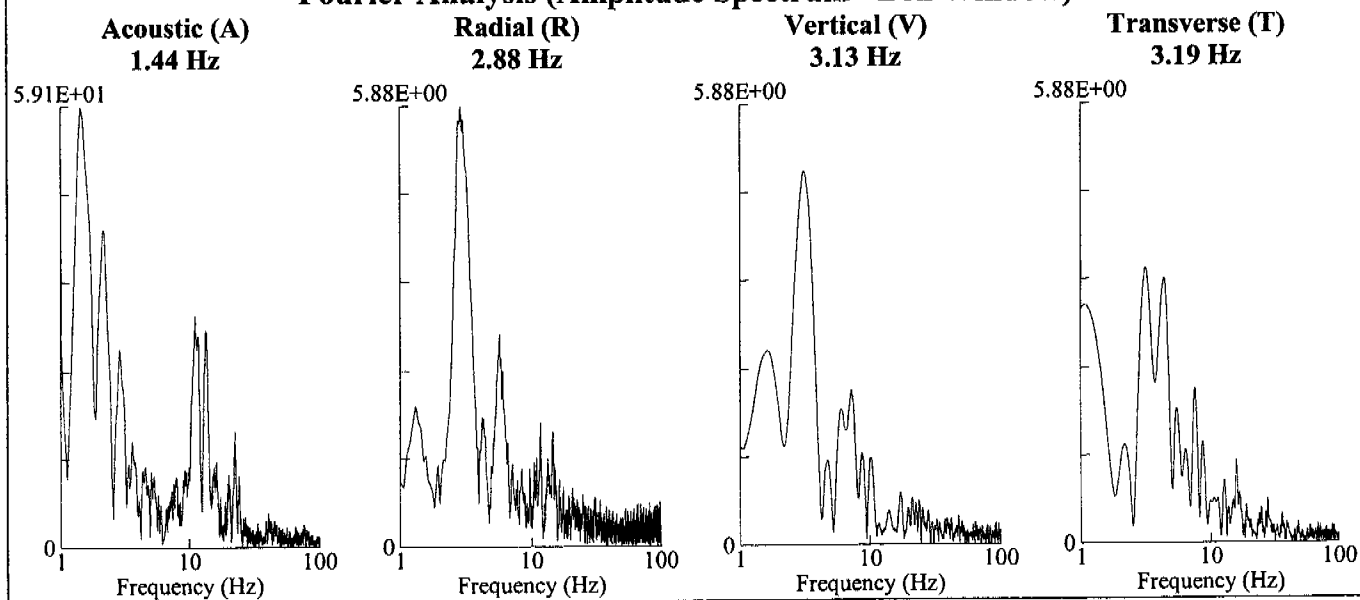
Acoustic (A): 117 dB @ 3.1 Hz
(0.14Mb 0.0020psi 0.0140kPa)
Radial (R): 0.005in/s 0.127mm/s @ 0.0Hz
Vertical (V): 0.005in/s 0.127mm/s @ 0.0Hz
Transverse (T): 0.005in/s 0.127mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Abbott 1 shallow**

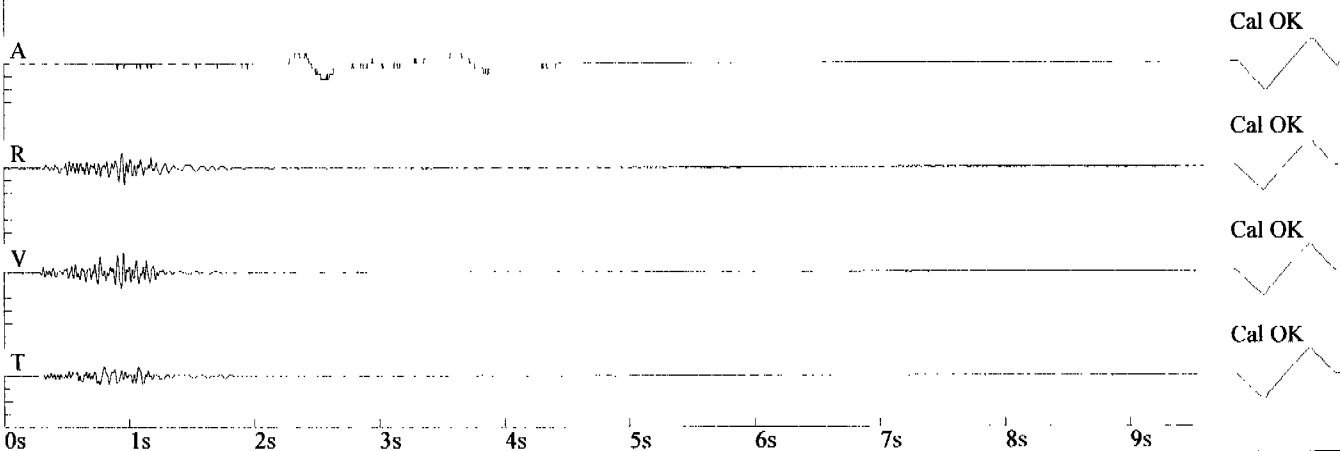
File: A1SAP016.DTB Event Number: 016 Date: 04/16/2001 Time: 16:50
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

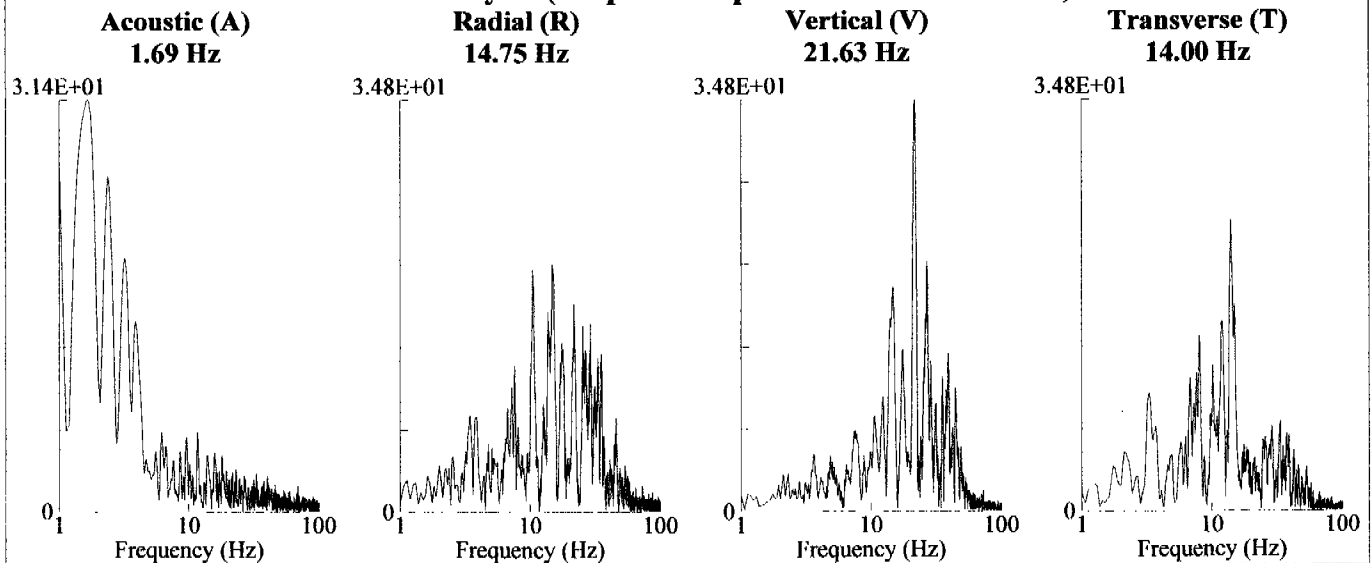
Acoustic (A): 110 dB @ 1.8 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.065in/s 1.651mm/s @ 28.4Hz
***Vertical (V):* 0.075in/s 1.905mm/s @ 32.0Hz**
Transverse (T): 0.035in/s 0.889mm/s @ 12.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Abbott 1 deep**

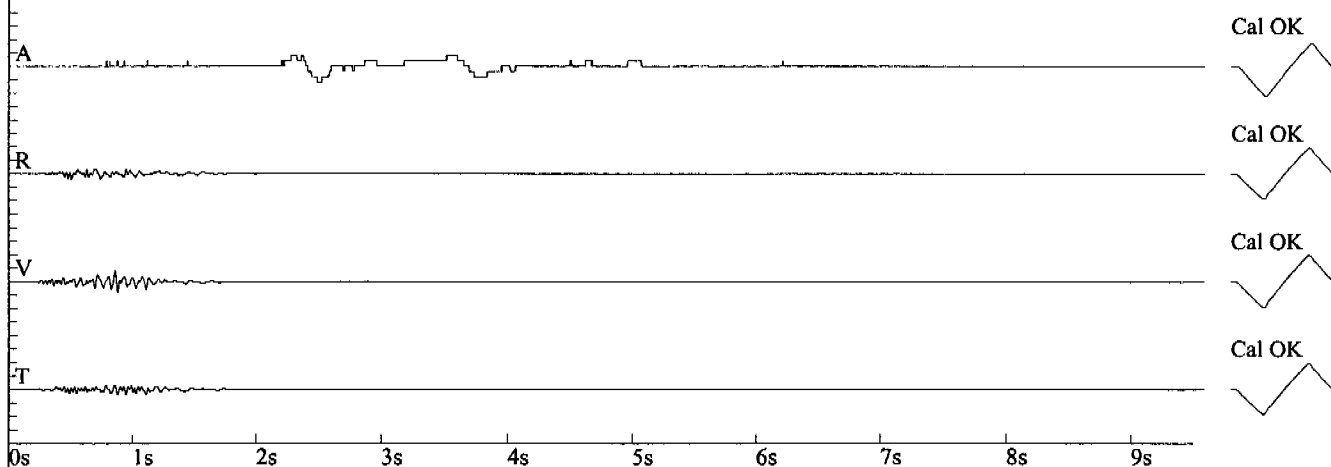
File: A1DAP004.DTB Event Number: 004 Date: 4/16/01 Time: 16:50
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

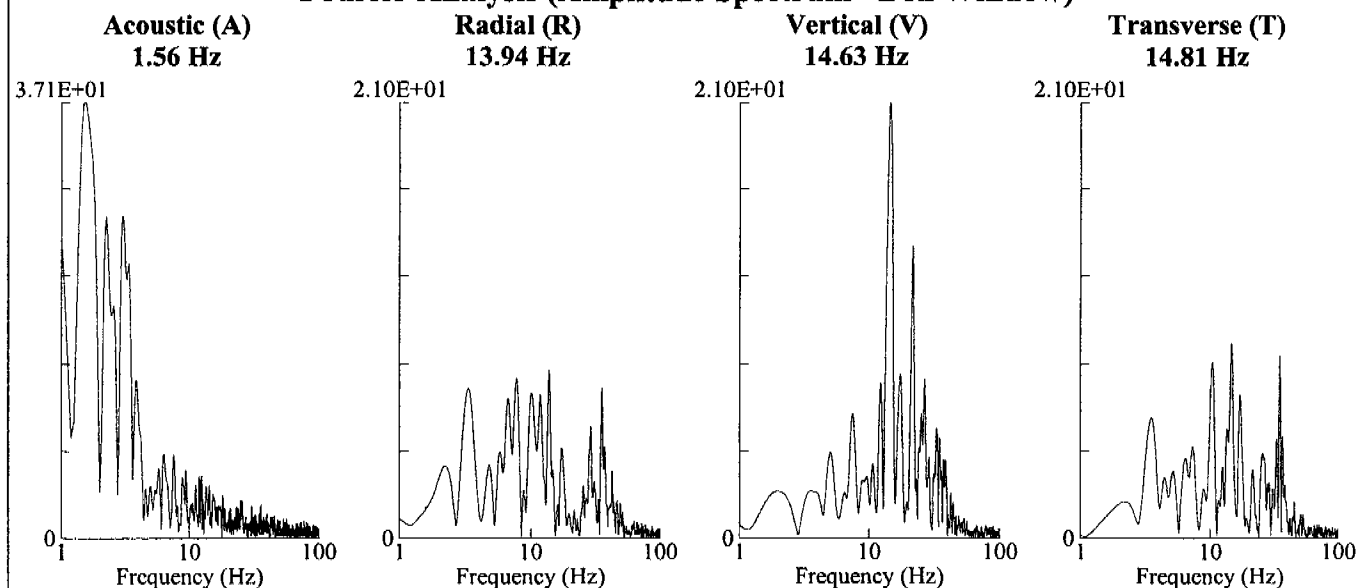
Acoustic (A): 110 dB @ 3.2 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.025in/s 0.635mm/s @ 26.9Hz
Vertical (V): 0.04in/s 1.016mm/s @ 22.2Hz
Transverse (T): 0.02in/s 0.508mm/s @ 25.6Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Abbott 1 shallow**

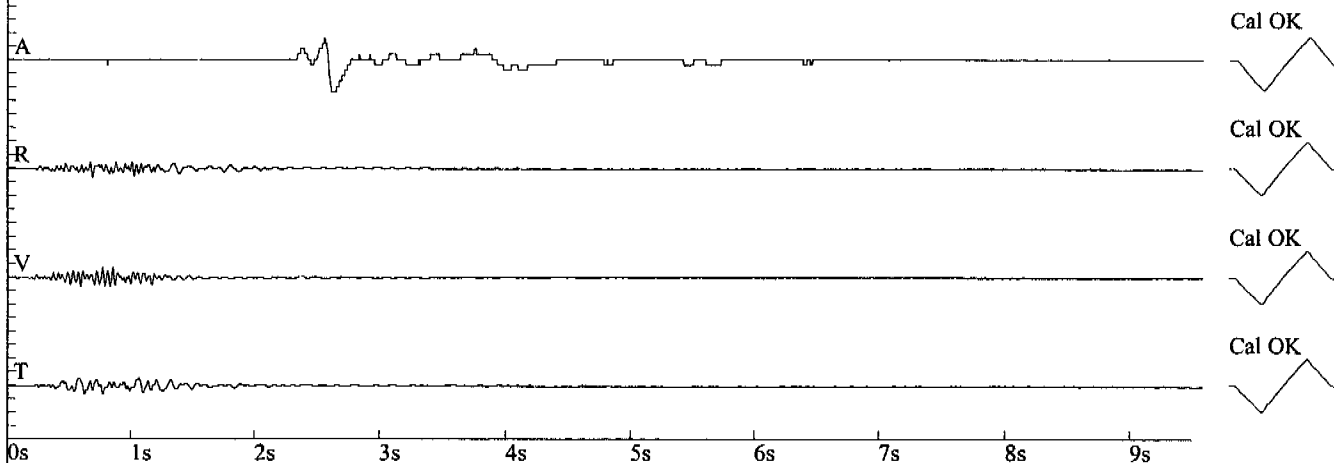
File: A1SAP026.DTB Event Number: 026 Date: 4/18/01 Time: 16:51
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

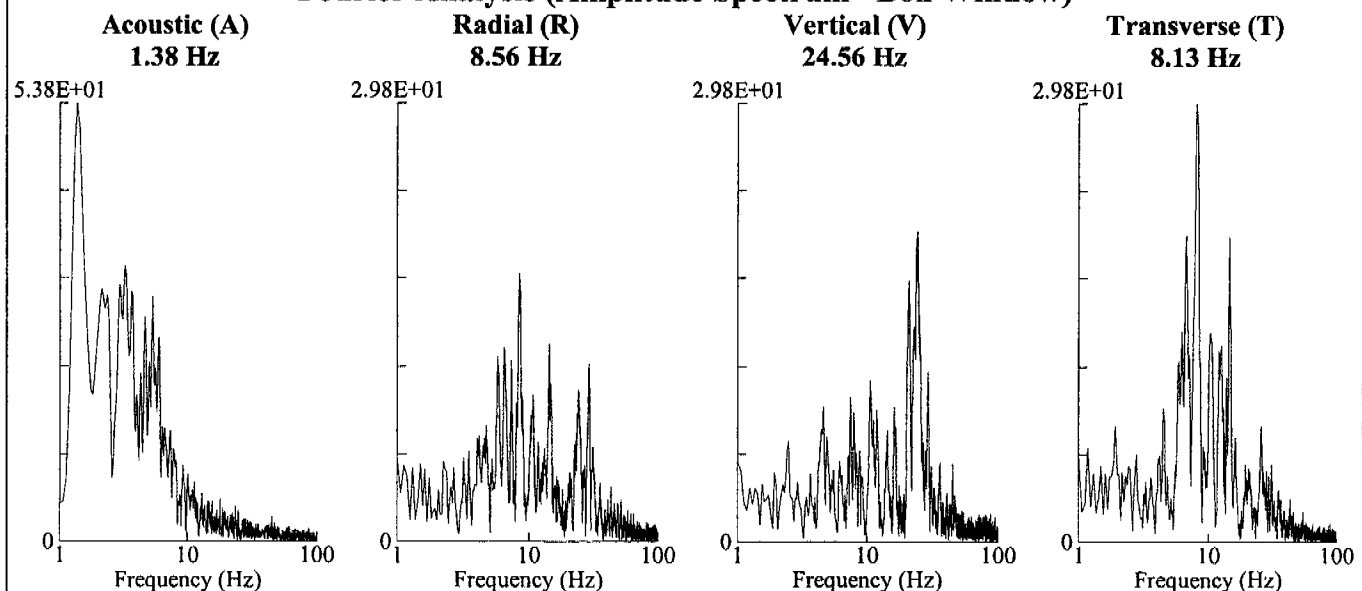
Acoustic (A): 116 dB @ 2.8 Hz
(0.12Mb 0.0017psi 0.0120kPa)
Radial (R): 0.035in/s 0.889mm/s @ 23.2Hz
Vertical (V): 0.035in/s 0.889mm/s @ 26.9Hz
Transverse (T): 0.035in/s 0.889mm/s @ 10.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Abbott 1 shallow**

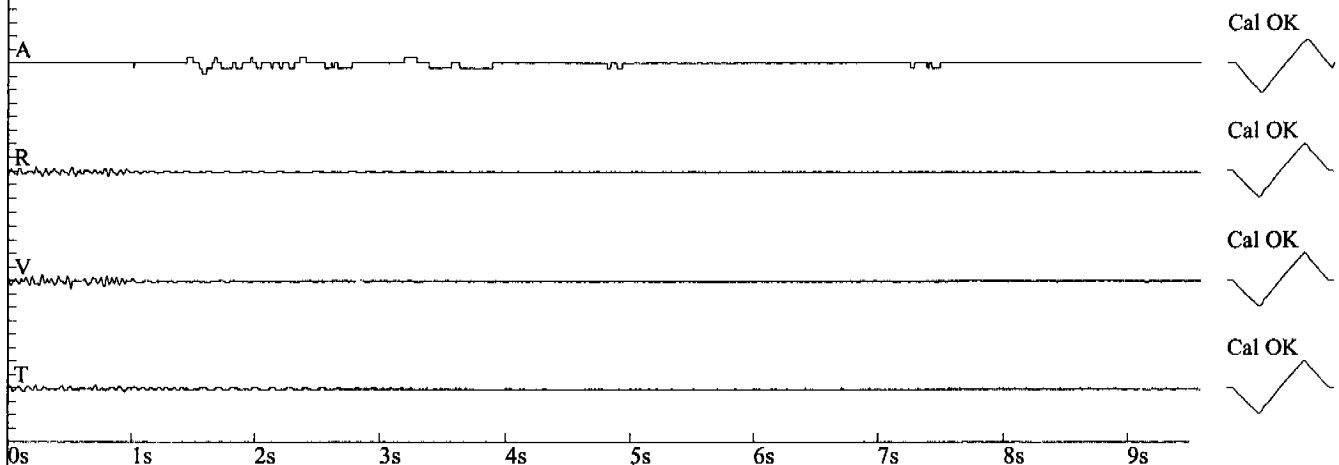
File: A1SAP027.DTB Event Number: 027 Date: 4/18/01 Time: 16:54
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

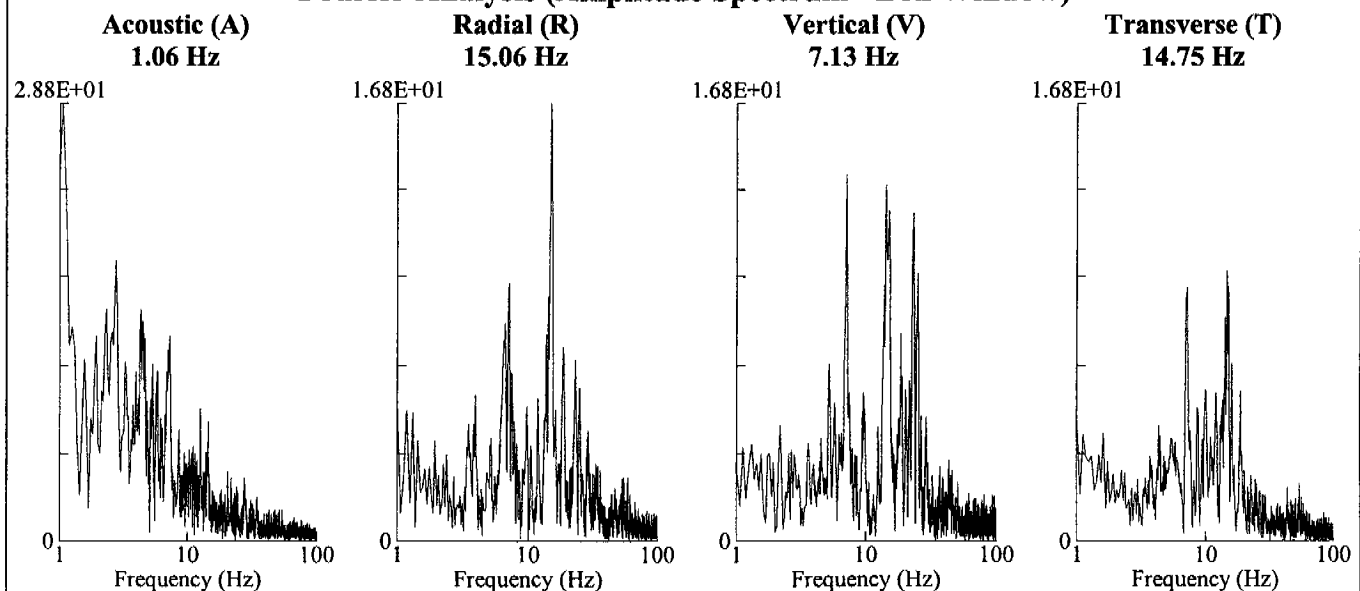
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.02in/s 0.508mm/s @ 19.6Hz
Vertical (V): 0.03in/s 0.762mm/s @ 22.2Hz
Transverse (T): 0.015in/s 0.381mm/s @ 12.8Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Abbott 1 deep**

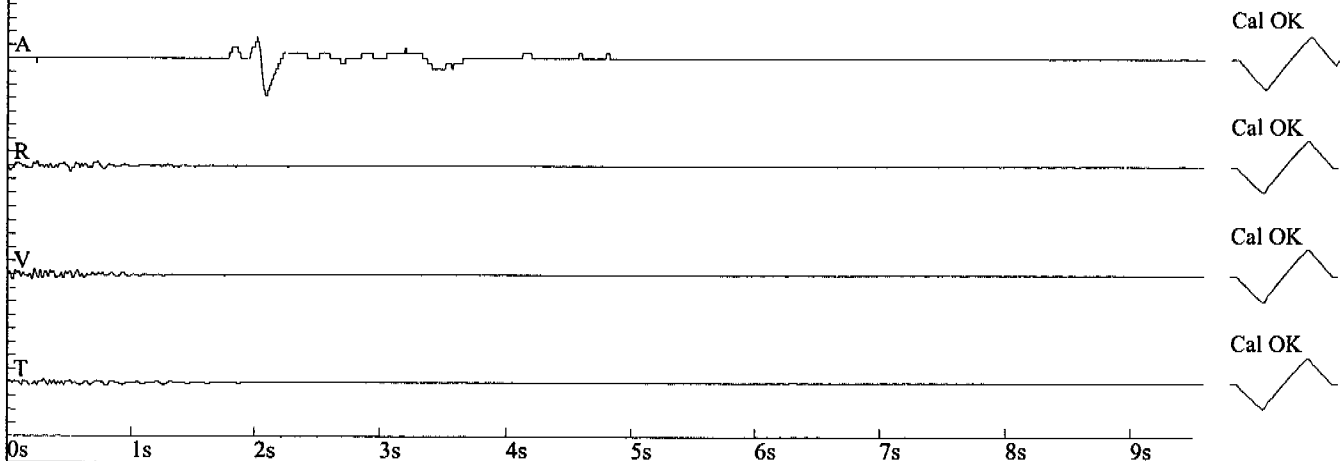
File: A1DAP006.DTB Event Number: 006 Date: 4/18/01 Time: 16:51
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

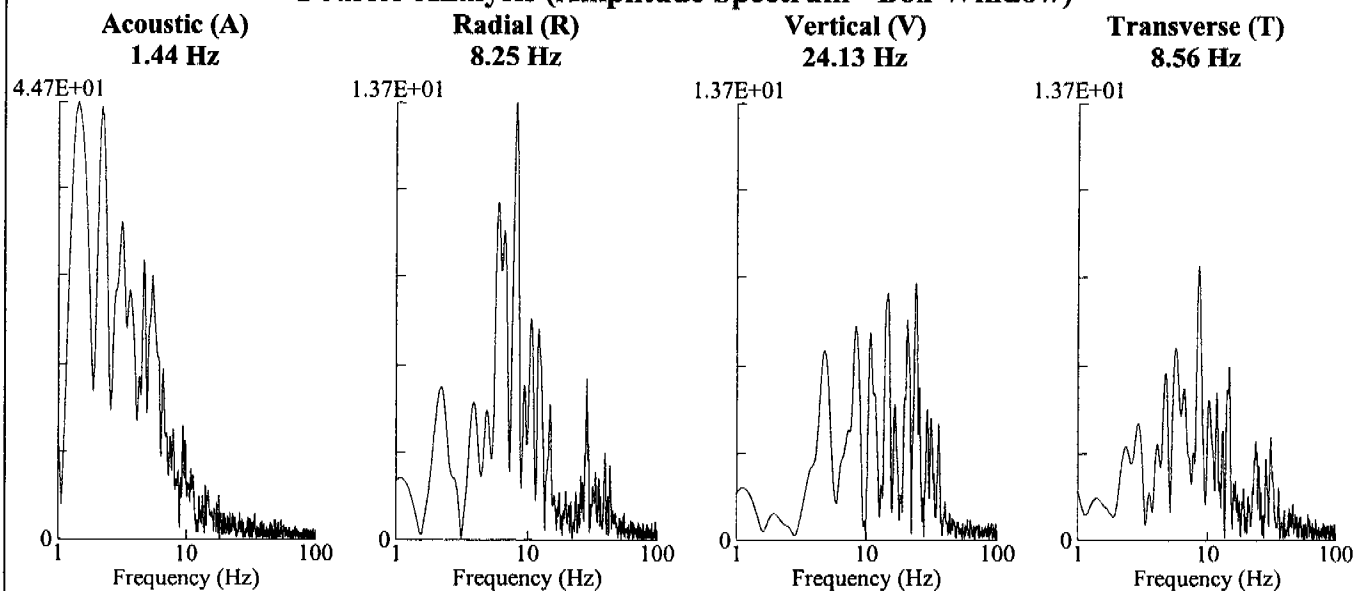
Acoustic (A): 117 dB @ 3.3 Hz
(0.14Mb 0.0020psi 0.0140kPa)
Radial (R): 0.025in/s 0.635mm/s @ 10.4Hz
Vertical (V): 0.015in/s 0.381mm/s @ 21.3Hz
Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Abbott 1 shallow**

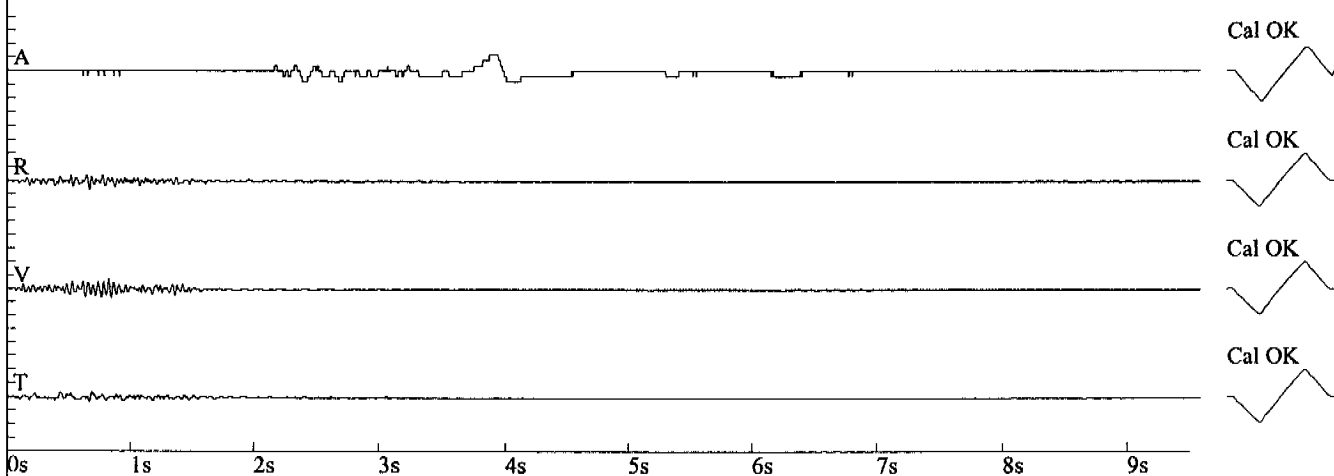
File: A1SAP028.DTB Event Number: 028 Date: 4/19/01 Time: 08:55
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

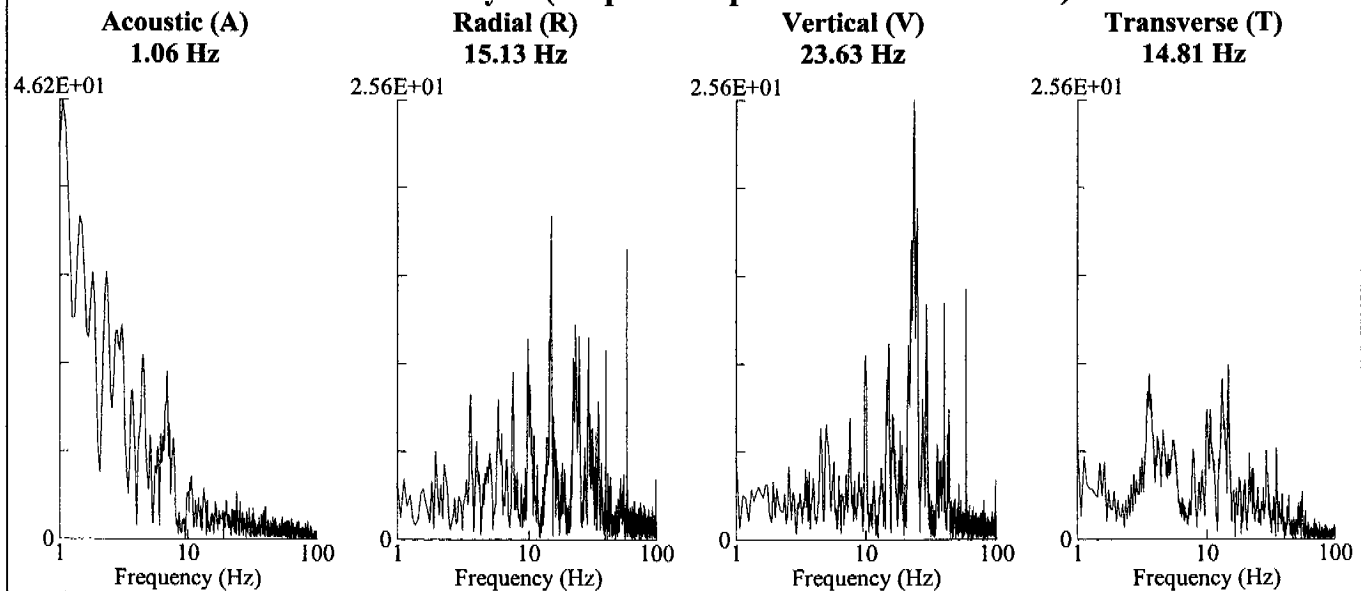
Acoustic (A): 110 dB @ 3.1 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.035in/s 0.889mm/s @ 24.3Hz
Vertical (V): 0.035in/s 0.889mm/s @ 28.4Hz
Transverse (T): 0.02in/s 0.508mm/s @ 23.2Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Abbott 1 deep**

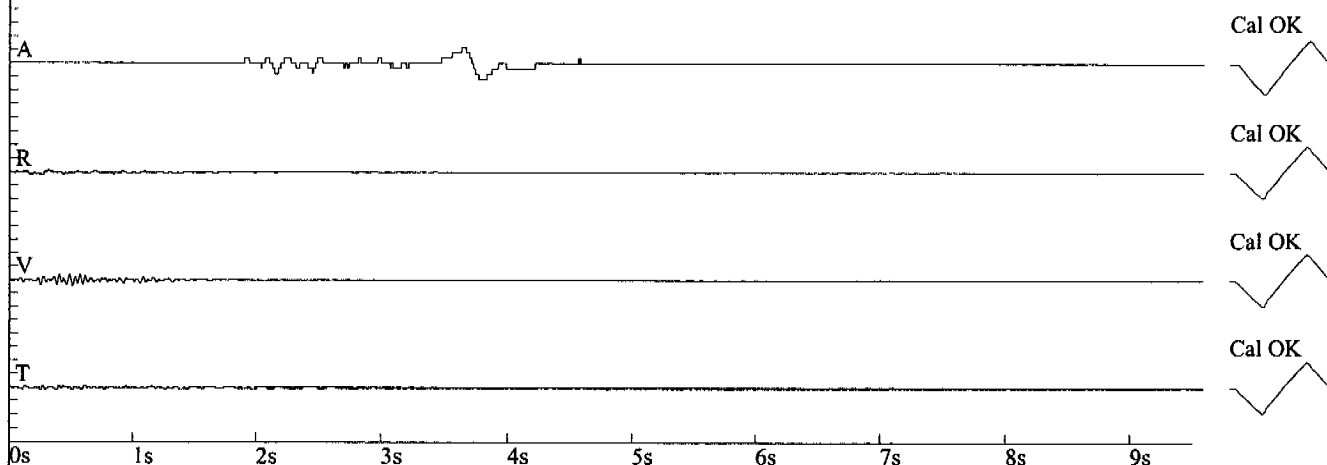
File: A1DAP007.DTB Event Number: 007 Date: 4/19/01 Time: 08:55
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1782

Amplitudes and Frequencies

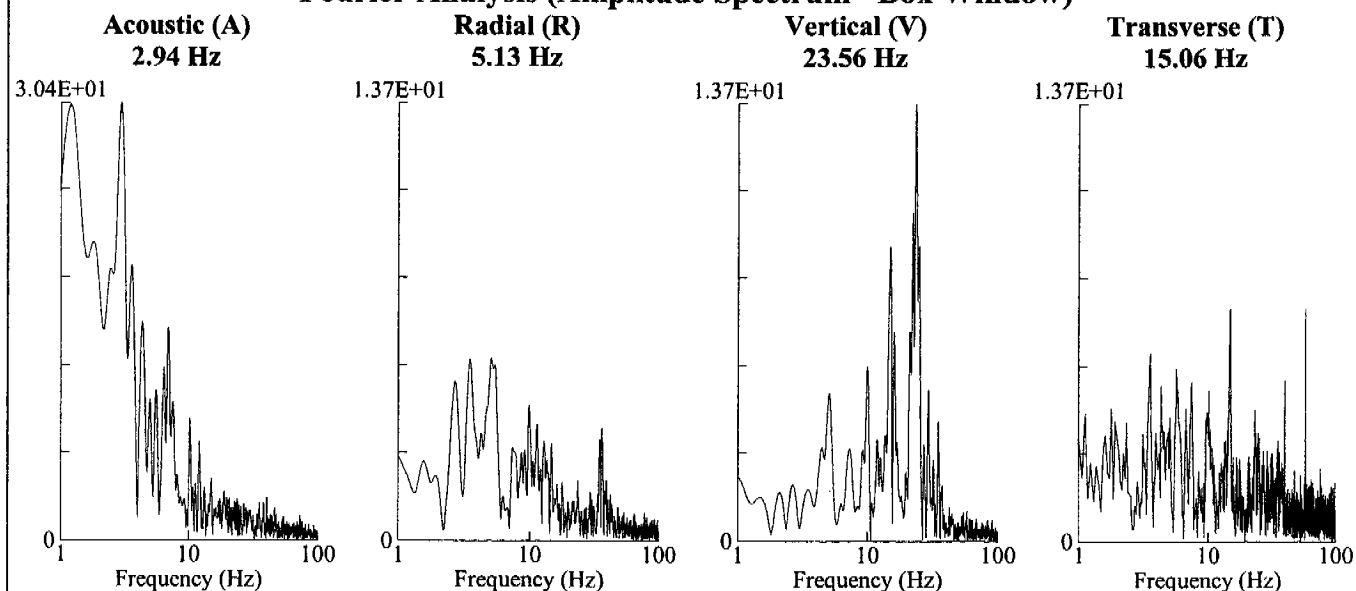
Acoustic (A): 110 dB @ 5.5 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.01in/s 0.254mm/s @ 0.0Hz
Vertical (V): 0.025in/s 0.635mm/s @ 22.2Hz
Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Abbott 1 shallow**

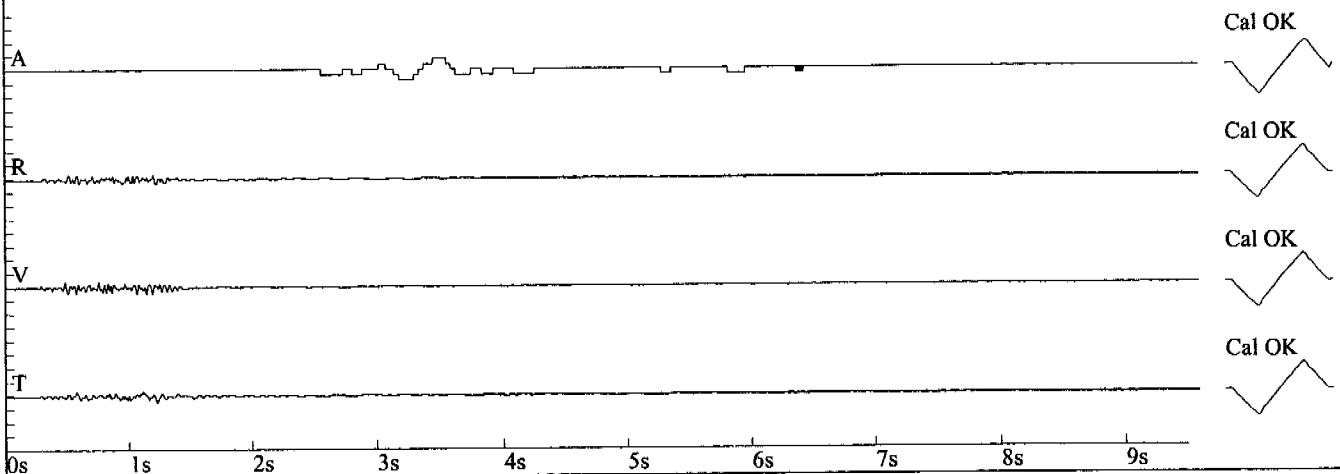
File: A1SAP033.DTB Event Number: 033 Date: 4/19/01 Time: 16:52
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1781

Amplitudes and Frequencies

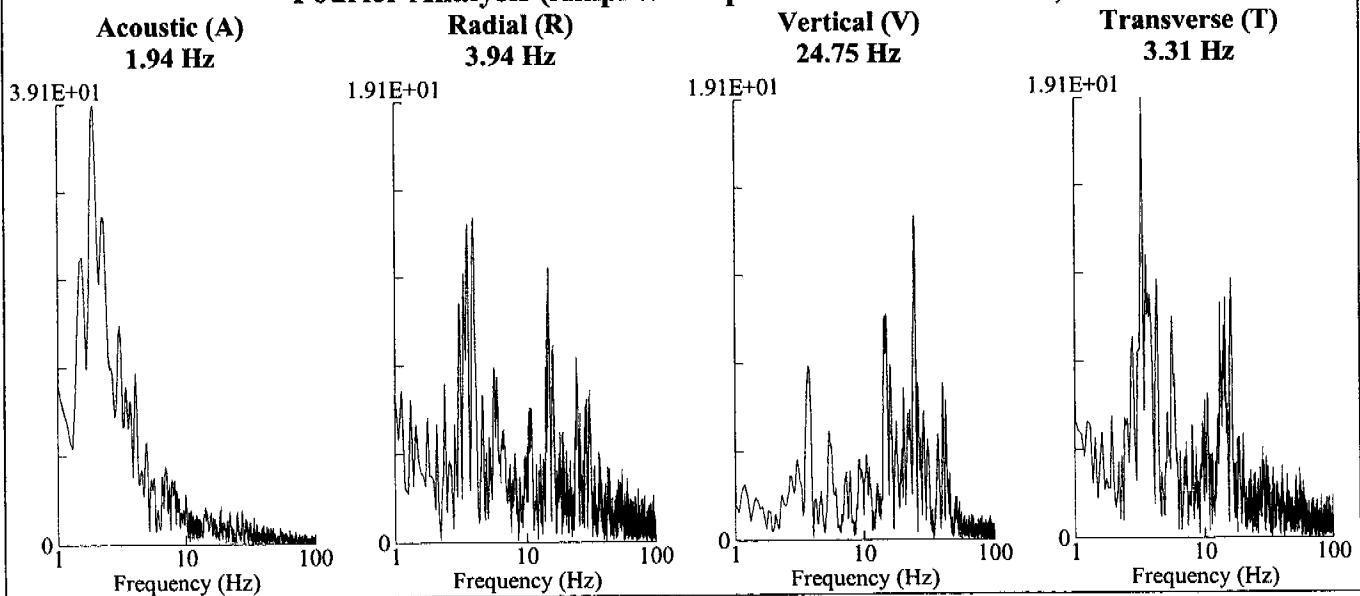
Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.02in/s 0.508mm/s @ 9.4Hz
Vertical (V): 0.025in/s 0.635mm/s @ 22.2Hz
Transverse (T): 0.025in/s 0.635mm/s @ 12.4Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



**West Virginia
Abbott 2 shallow**

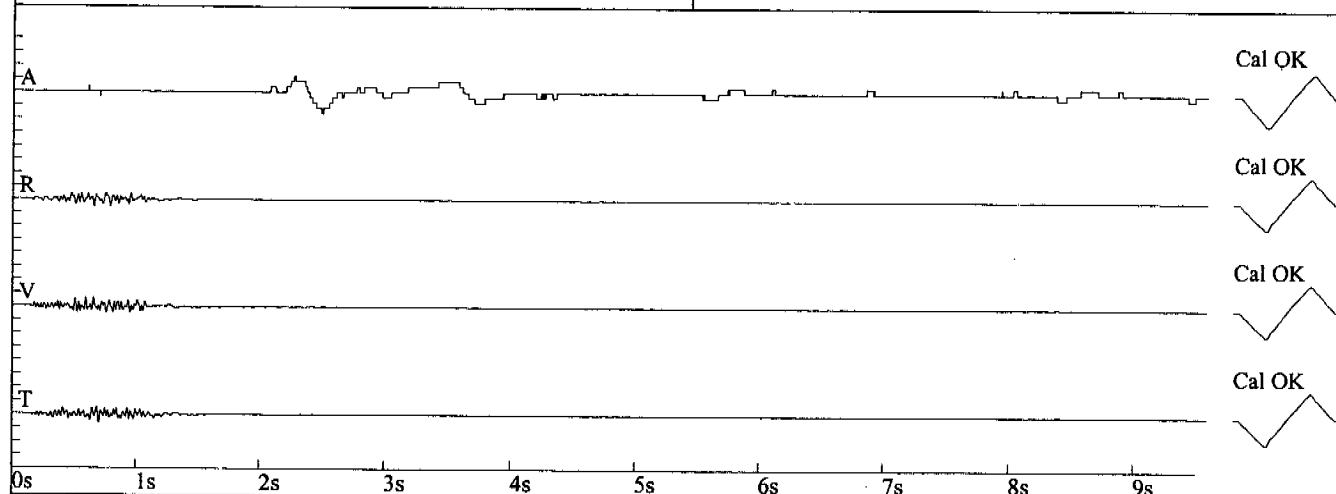
File: A2NS4020.DTB Event Number: 020 Date: 4/16/01 Time: 16:49
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

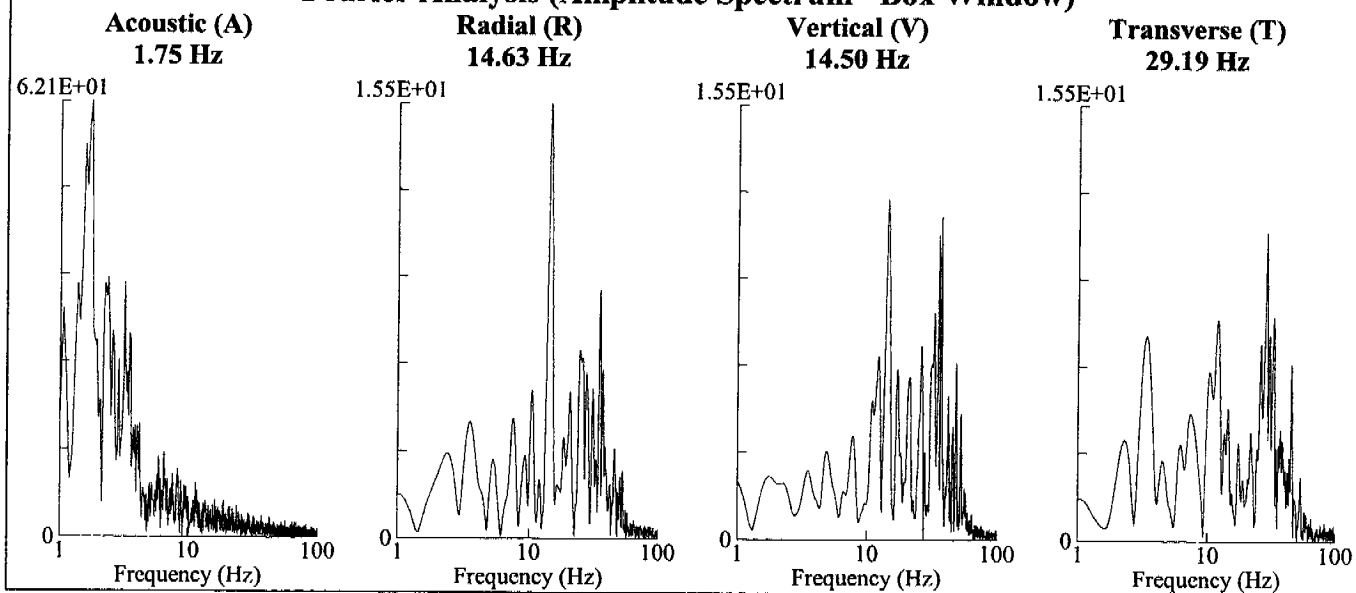
Acoustic (A): 112 dB @ 2.5 Hz
(0.08Mb 0.0012psi 0.0080kPa)
Radial (R): 0.03in/s 0.762mm/s @ 30.1Hz
Vertical (V): 0.03in/s 0.762mm/s @ 39.3Hz
Transverse (T): 0.035in/s 0.889mm/s @ 30.1Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia Abbott 2 deep

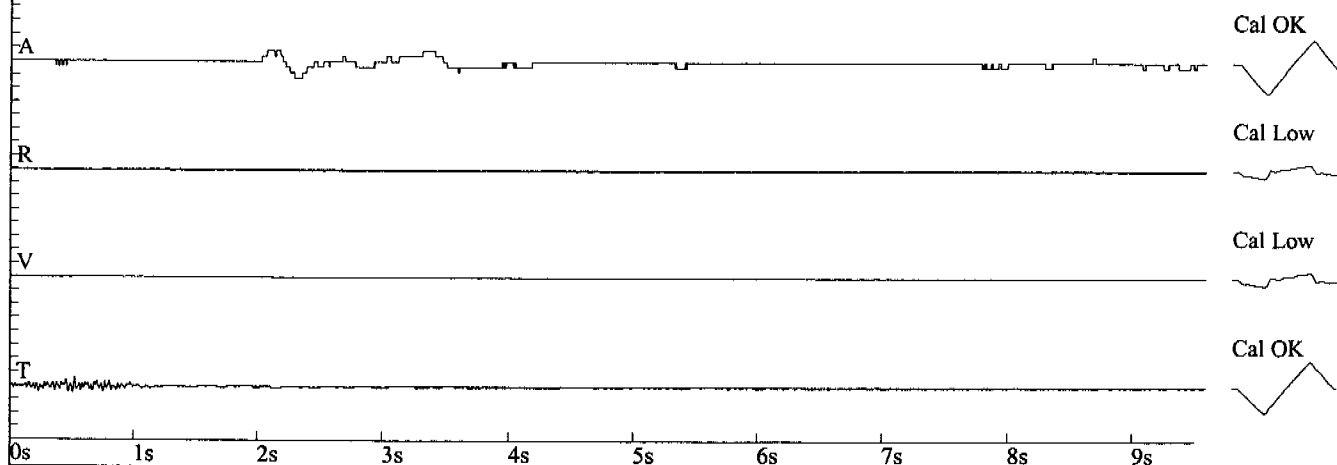
File: A2SP4017.DTB Event Number: 017 Date: 4/16/01 Time: 16:45
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1780

Amplitudes and Frequencies

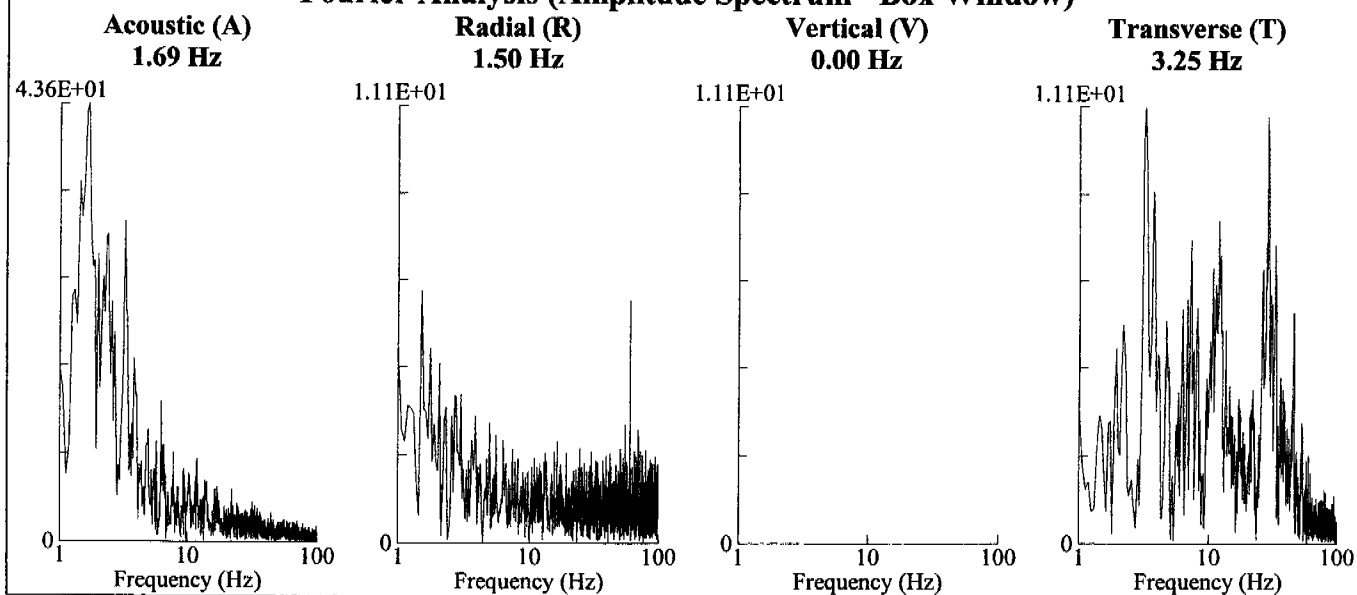
Acoustic (A): 110 dB @ 2.6 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.005in/s 0.127mm/s @ 0.0Hz
Vertical (V): 0.00in/s 0.00mm/s @ 0.0Hz
Transverse (T): 0.03in/s 0.762mm/s @ 34.1Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



West Virginia Abbott 2 shallow

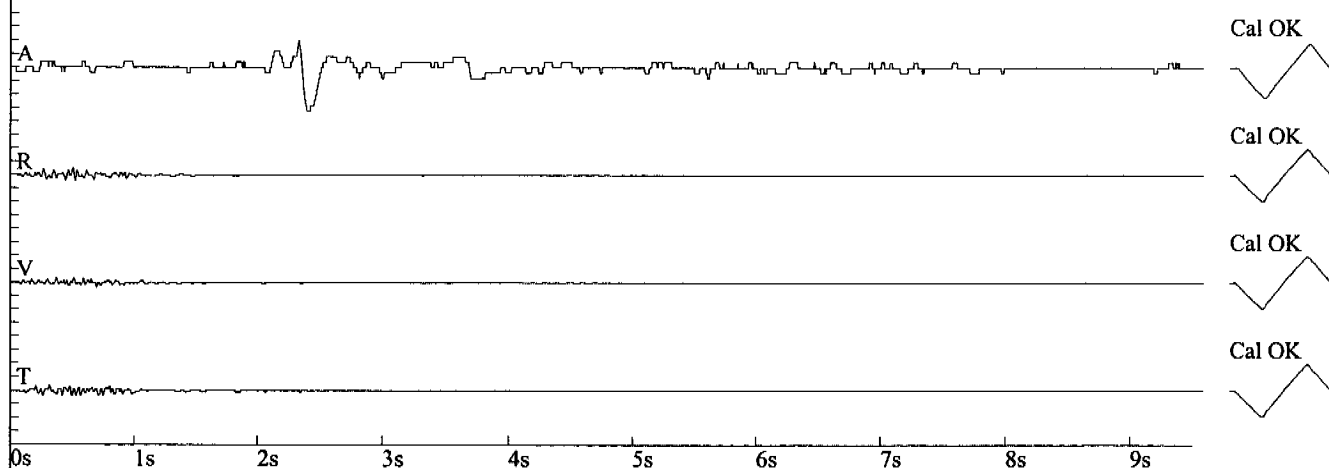
File: A2NS4072.DTB Event Number: 072 Date: 4/18/01 Time: 16:50
Acoustic Trigger: 114 dB Seismic Trigger: 0.025in/s 0.635mm/s Serial Number: 1779

Amplitudes and Frequencies

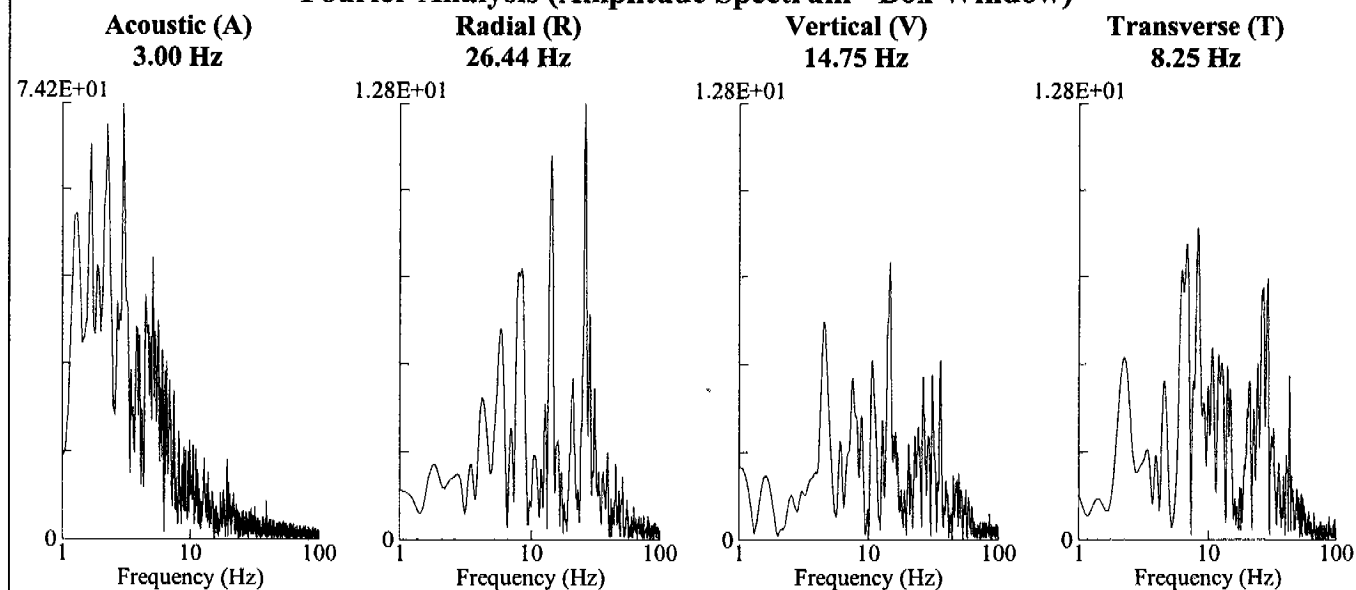
Acoustic (A): 118 dB @ 3.3 Hz
(0.16Mb 0.0023psi 0.0160kPa)
Radial (R): 0.025in/s 0.635mm/s @ 25.6Hz
Vertical (V): 0.02in/s 0.508mm/s @ 28.4Hz
Transverse (T): 0.02in/s 0.508mm/s @ 28.4Hz
Calibration Date (yyyy/mm/dd): 2000/11/22

Graph Information

Duration: 0.000 sec To: 9.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 1.00 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



FALL 2001

Kentucky Sumner

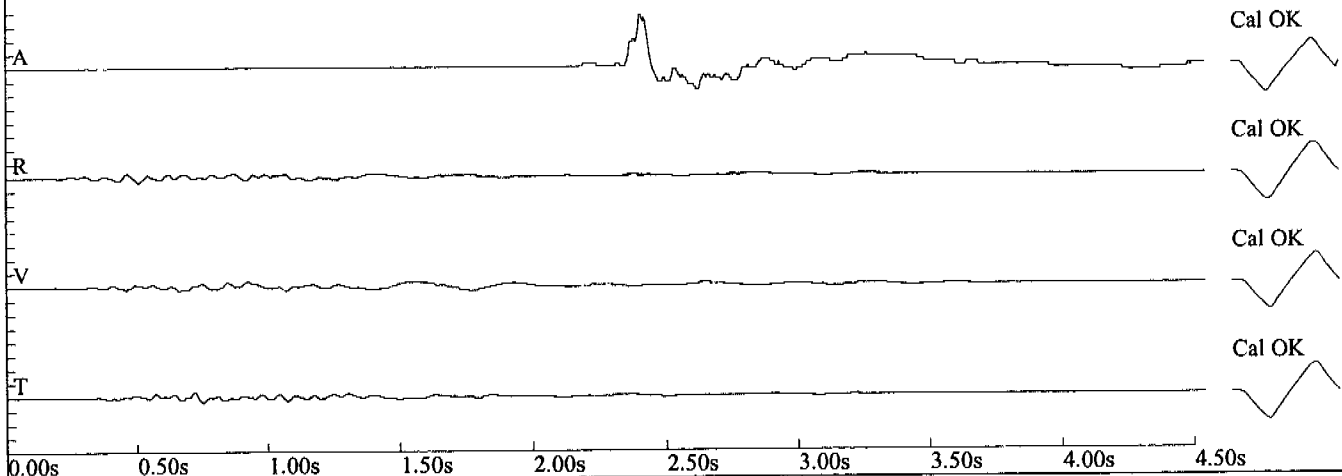
File: 608@@135.DTA Event Number: 135 Date: 9/21/01 Time: 14:25
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

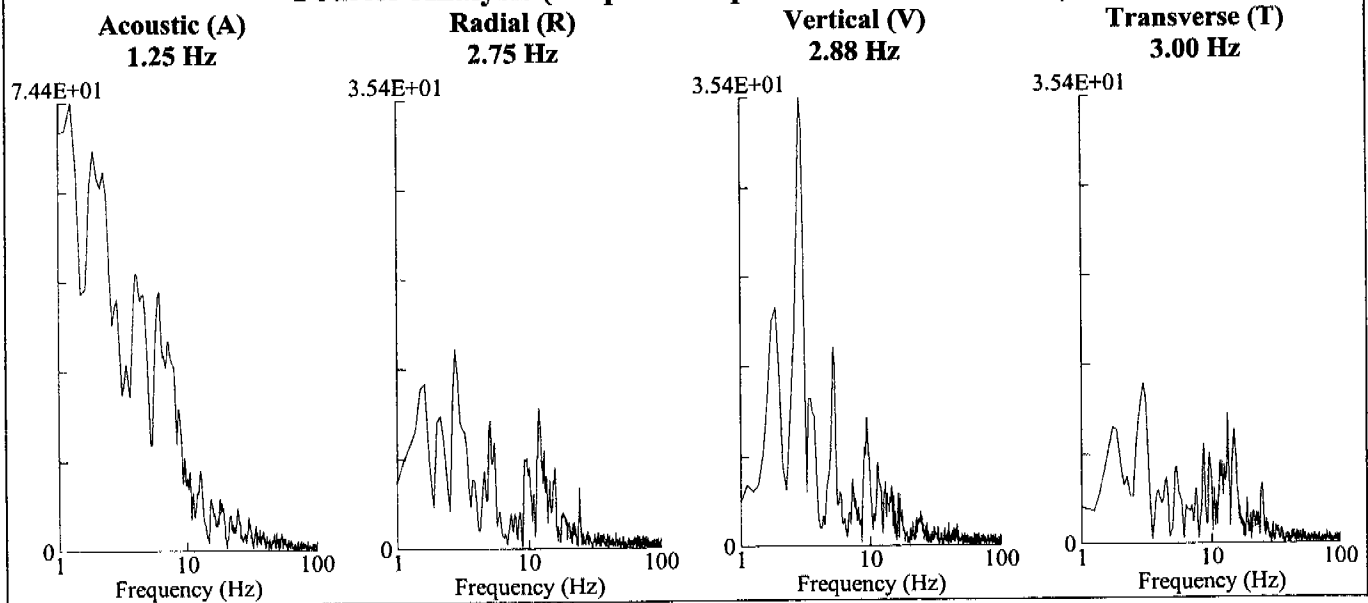
Acoustic (A): 125 dB @ 5.5 Hz
(0.34Mb 0.0049psi 0.0340kPa)
Radial (R): 0.02in/s 0.508mm/s @ 14.2Hz
Vertical (V): 0.02in/s 0.508mm/s @ 7.0Hz
Transverse (T): 0.02in/s 0.508mm/s @ 20.4Hz

Graph Information

Duration: 0.000 sec To: 4.500 sec
Acoustic Scale:
125dB 0.36Mb (0.090Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Kentucky Sumner

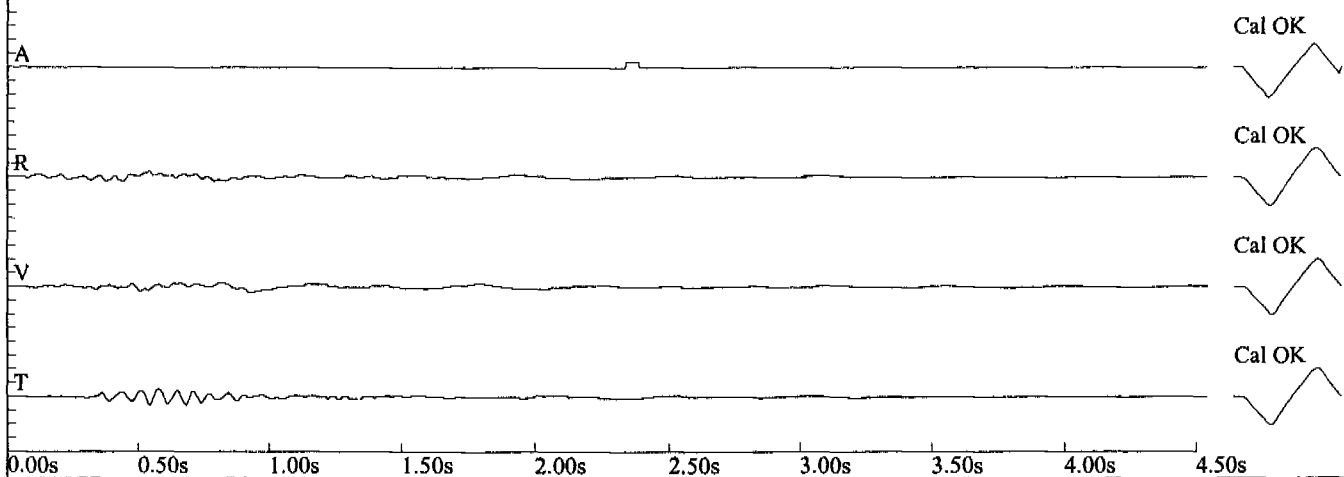
File: 608@@144.DTA Event Number: 144 Date: 9/24/01 Time: 13:53
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

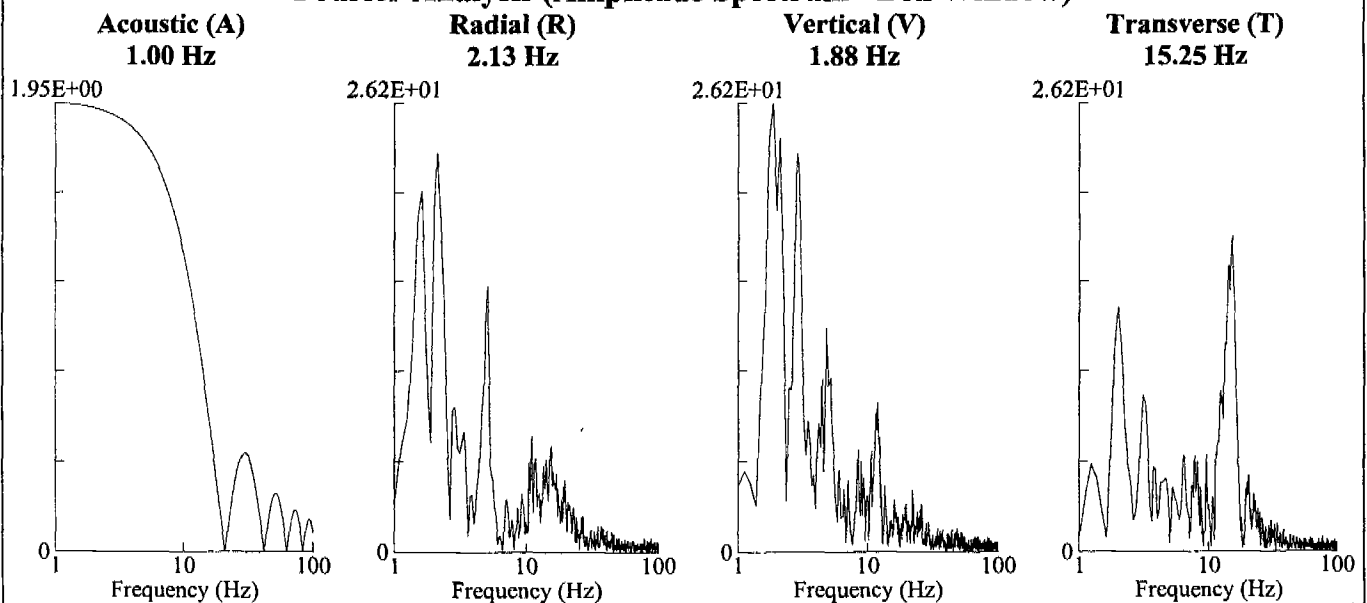
Acoustic (A): 100 dB @ 0.0 Hz
(0.02Mb 0.0003psi 0.0020kPa)
Radial (R): 0.02in/s 0.508mm/s @ 4.0Hz
Vertical (V): 0.02in/s 0.508mm/s @ 4.1Hz
Transverse (T): 0.03in/s 0.762mm/s @ 14.6Hz

Graph Information

Duration: 0.000 sec To: 4.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Kentucky Sumner

File: 608@@145.DTA Event Number: 145 Date: 9/25/01 Time: 12:37
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

Acoustic (A): <100 dB

Radial (R): 0.015in/s 0.381mm/s @ 6.8Hz

Vertical (V): 0.02in/s 0.508mm/s @ 2.8Hz

Transverse (T): 0.03in/s 0.762mm/s @ 11.6Hz

Graph Information

Duration: 0.000 sec To: 4.500 sec

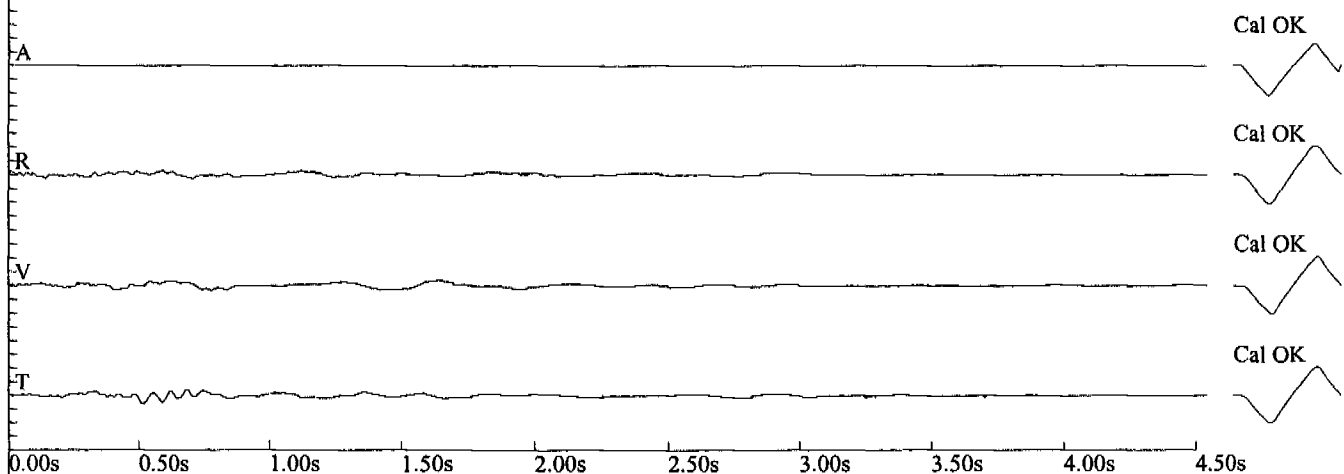
Acoustic Scale:

120dB 0.20Mb (0.050Mb/div)

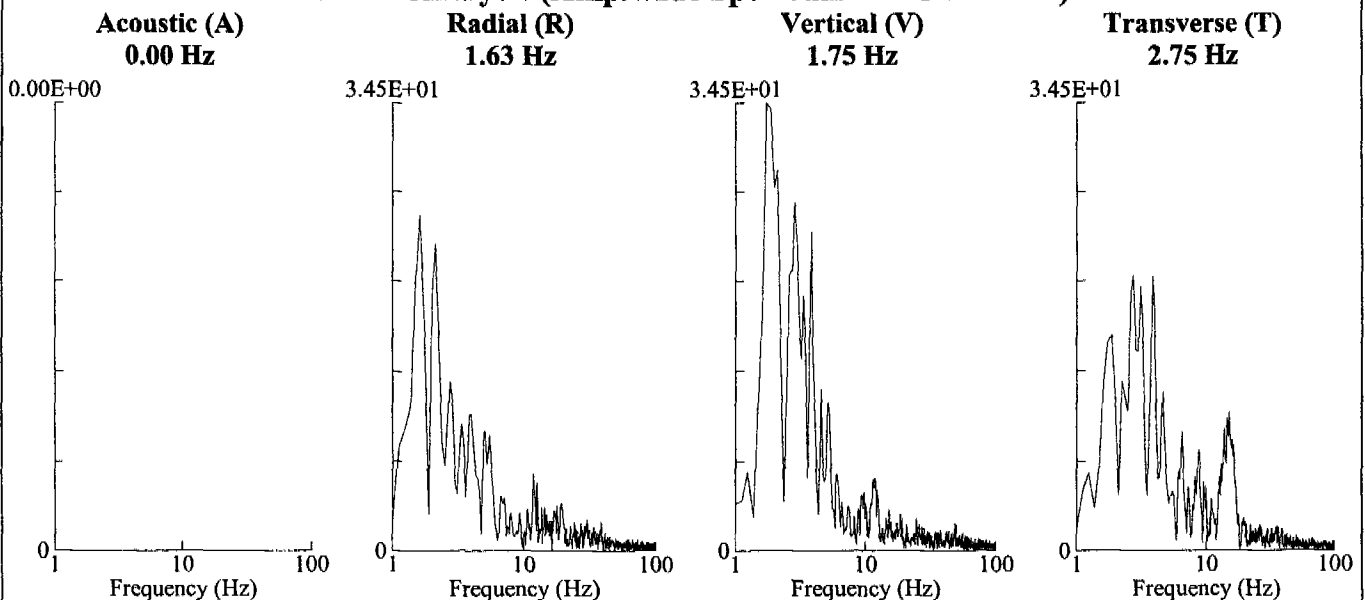
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Kentucky Sumner

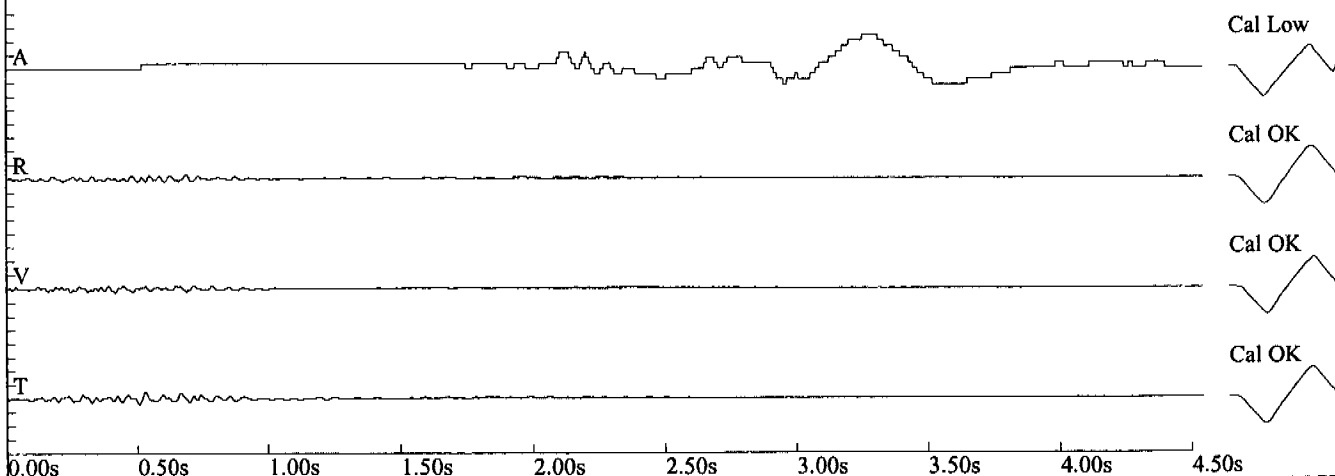
File: 608@@@146.DTA Event Number: 146 Date: 9/25/01 Time: 15:44
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 809

Amplitudes and Frequencies

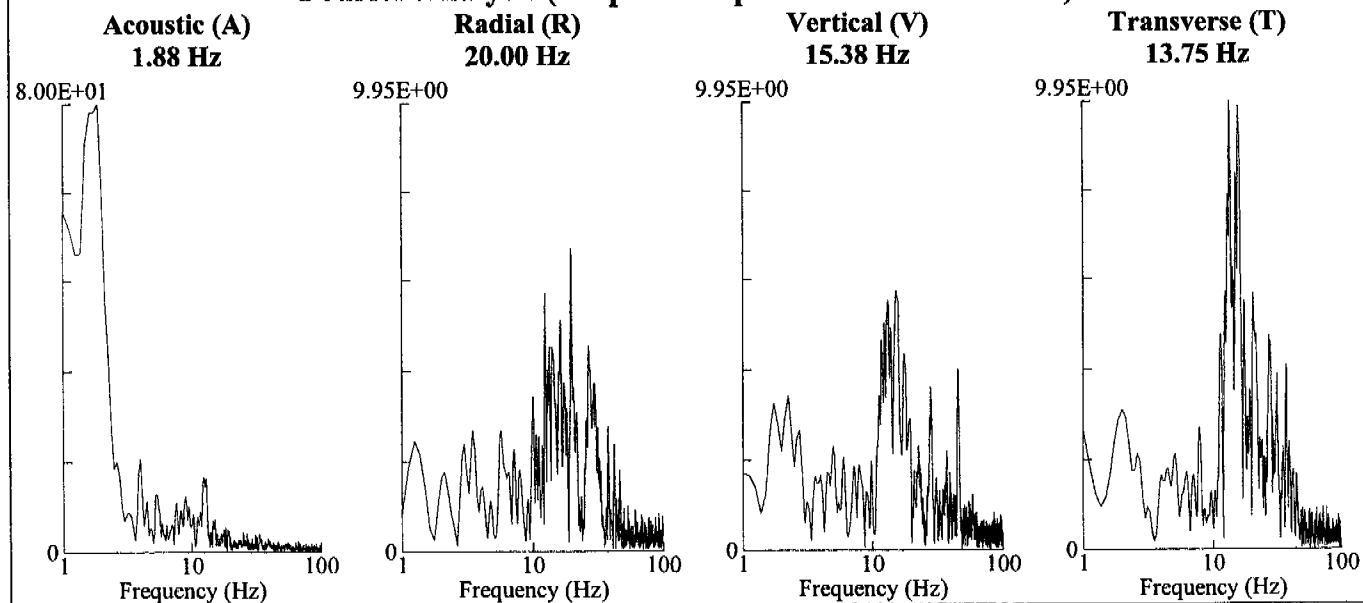
Acoustic (A): 116 dB @ 1.5 Hz
(0.12Mb 0.0017psi 0.0120kPa)
Radial (R): 0.015in/s 0.381mm/s @ 34.1Hz
Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz
Transverse (T): 0.025in/s 0.635mm/s @ 23.2Hz

Graph Information

Duration: 0.000 sec To: 4.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Kentucky Hurley

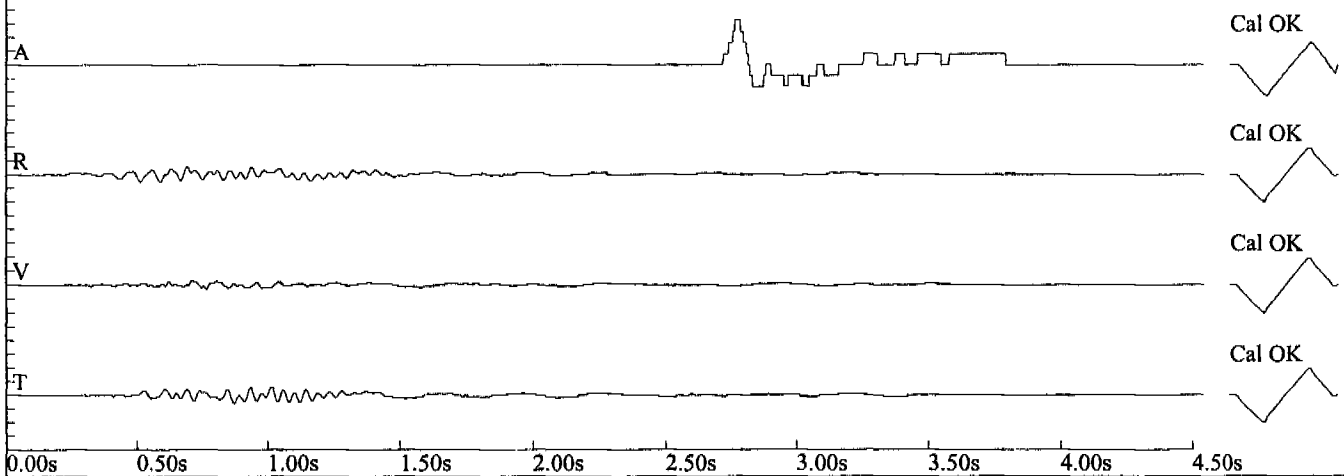
File: 813@@065.DTA Event Number: 065 Date: 9/21/01 Time: 15:20
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 813

Amplitudes and Frequencies

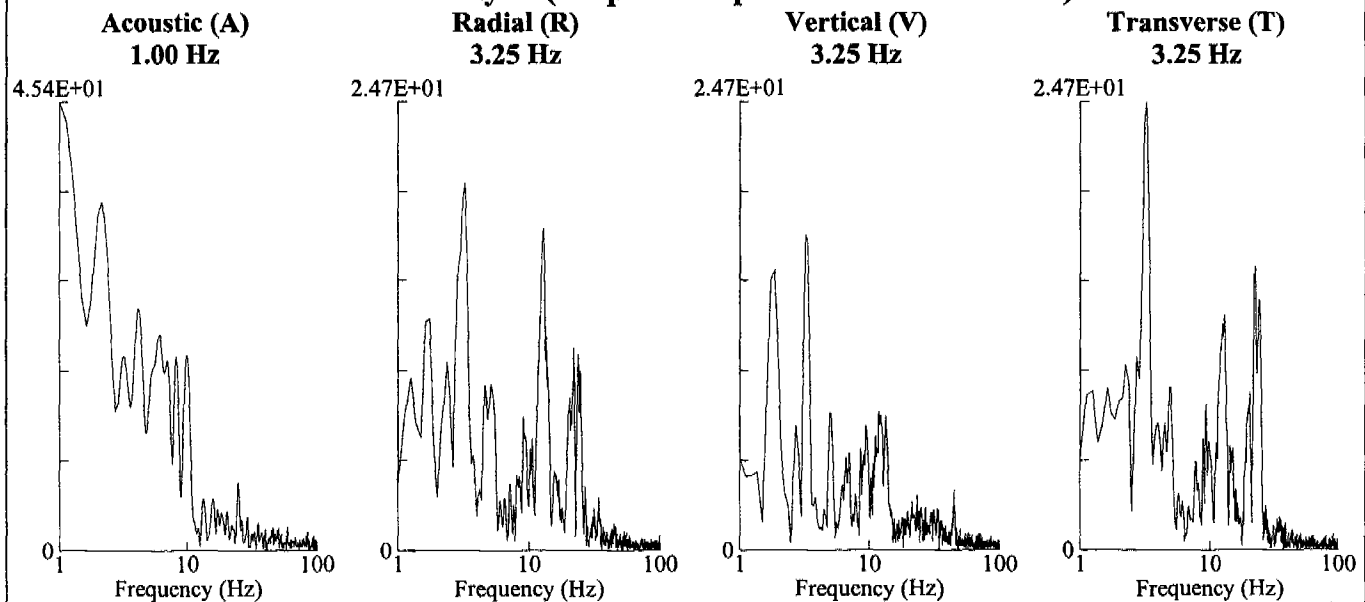
Acoustic (A): 118 dB @ 6.7 Hz
(0.16Mb 0.0023psi 0.0160kPa)
Radial (R): 0.03in/s 0.762mm/s @ 9.4Hz
Vertical (V): 0.015in/s 0.381mm/s @ 34.1Hz
Transverse (T): 0.03in/s 0.762mm/s @ 23.2Hz

Graph Information

Duration: 0.000 sec To: 4.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Kentucky Hurley

File: 813@@066.DTA Event Number: 066 Date: 9/22/01 Time: 11:43
Acoustic Trigger: 120 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 813

Amplitudes and Frequencies

Acoustic (A): 106 dB @ 0.0 Hz
(0.04Mb 0.0006psi 0.0040kPa)

Radial (R): 0.02in/s 0.508mm/s @ 16.5Hz

Vertical (V): 0.01in/s 0.254mm/s @ 0.0Hz

Transverse (T): 0.01in/s 0.254mm/s @ 0.0Hz

Graph Information

Duration: 0.000 sec To: 4.500 sec

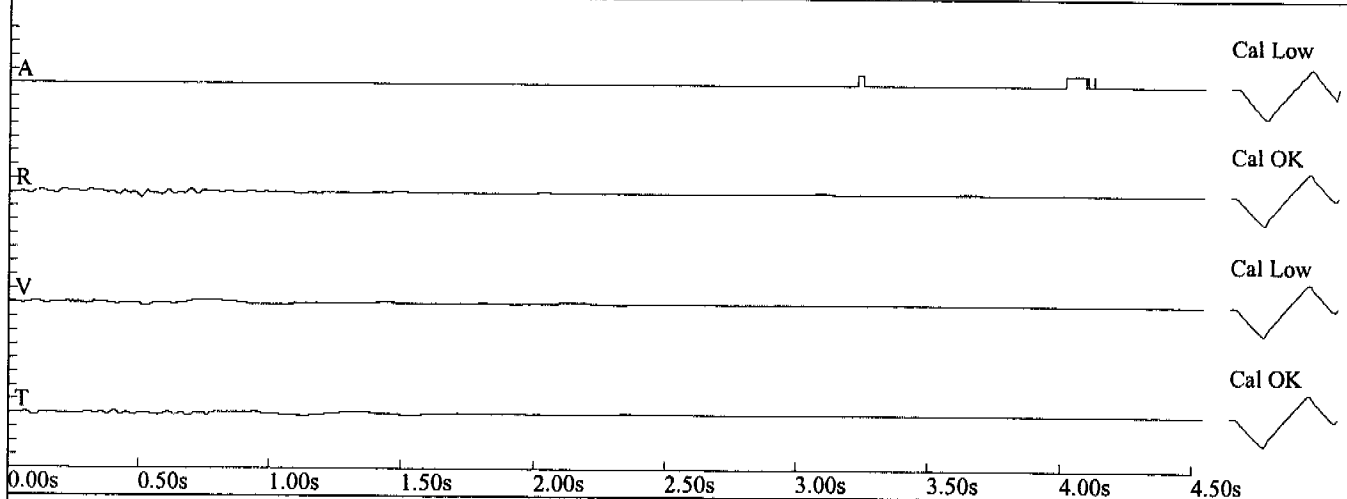
Acoustic Scale:

120dB 0.20Mb (0.050Mb/div)

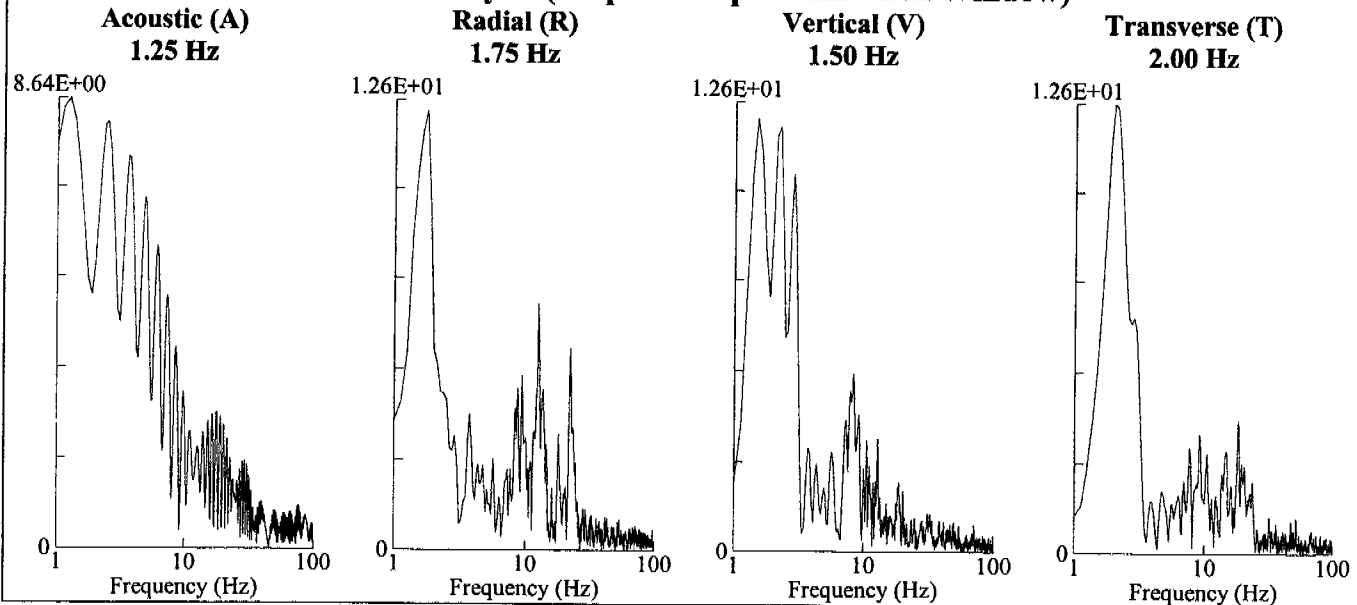
Seismic Scale:

0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)

Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



WINTER 2001

Dean Jr. Well - surface transducer

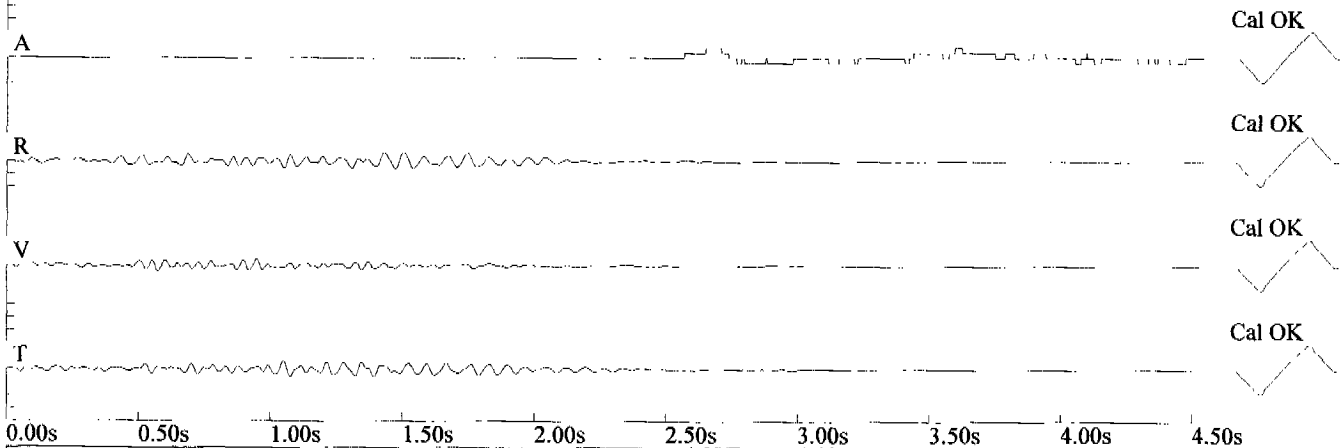
File: 01769224.DTB Event Number: 224 Date: 12/04/2001 Time: 16:44
 Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1769

Amplitudes and Frequencies

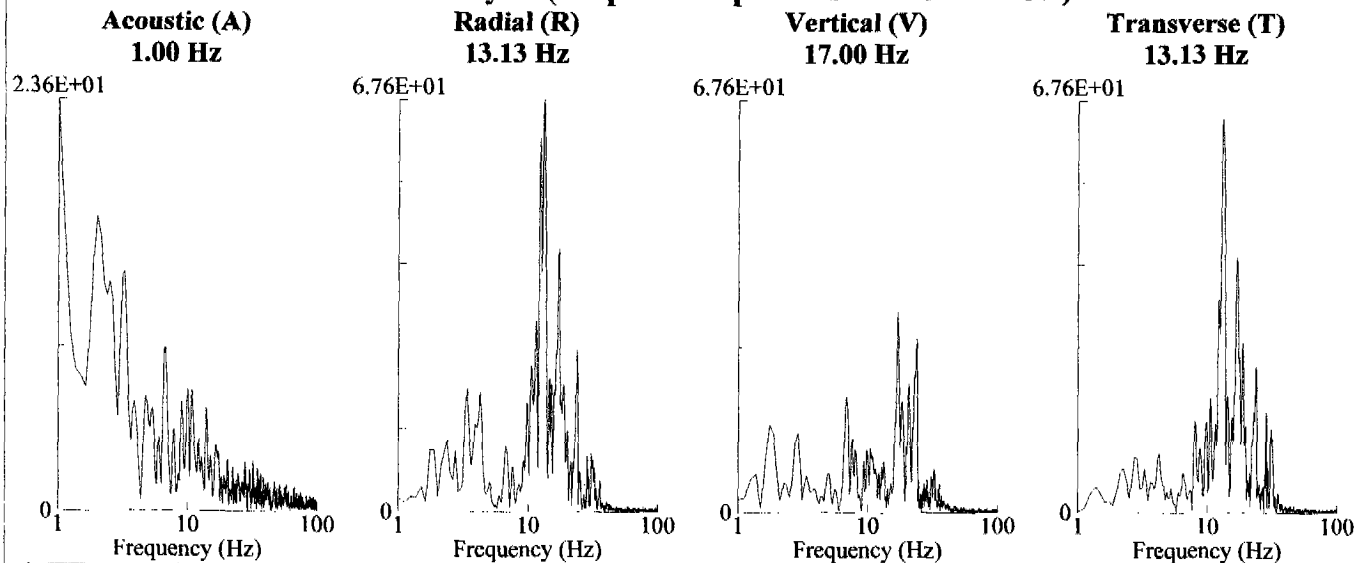
Acoustic (A): 106 dB @ 0.0 Hz
 (0.04Mb 0.0006psi 0.0040kPa)
Radial (R): 0.0325in/s 0.8255mm/s @ 13.4Hz
Vertical (V): 0.025in/s 0.635mm/s @ 19.6Hz
Transverse (T): 0.0325in/s 0.8255mm/s @ 18.9Hz
 Calibration Date (yyyy/mm/dd): 2000/09/22

Graph Information

Duration: 0.000 sec To: 4.500 sec
Acoustic Scale:
 120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
 0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Dean Jr. Well - surface transducer

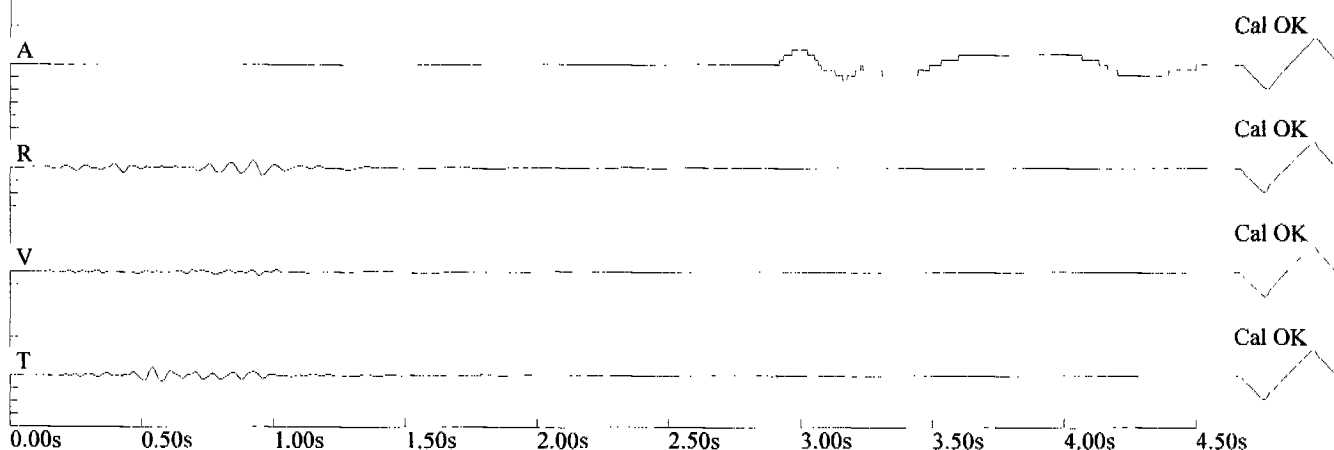
File: 01769229.DTB Event Number: 229 Date: 12/05/2001 Time: 16:46
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1769

Amplitudes and Frequencies

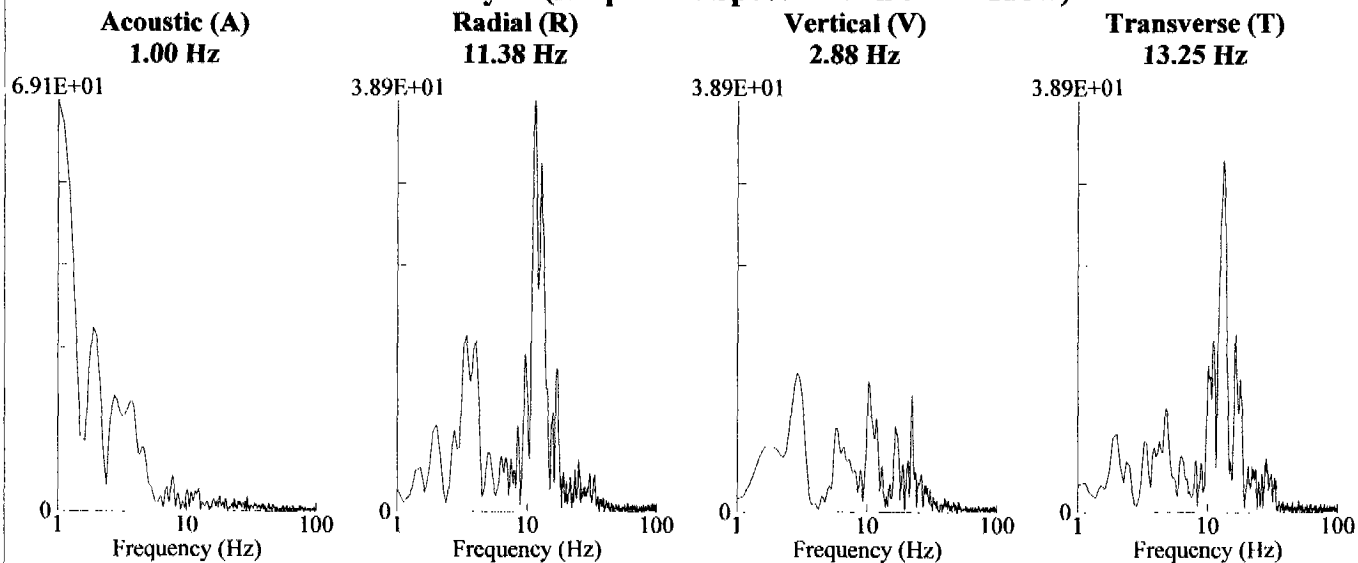
Acoustic (A): 110 dB @ 3.8 Hz
(0.06Mb 0.0009psi 0.0060kPa)
Radial (R): 0.03in/s 0.762mm/s @ 12.1Hz
Vertical (V): 0.0125in/s 0.3175mm/s @ 17.0Hz
Transverse (T): 0.0325in/s 0.8255mm/s @ 15.5Hz
Calibration Date (yyyy/mm/dd): 2000/09/22

Graph Information

Duration: 0.000 sec To: 4.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Dean Jr. Well - surface transducer

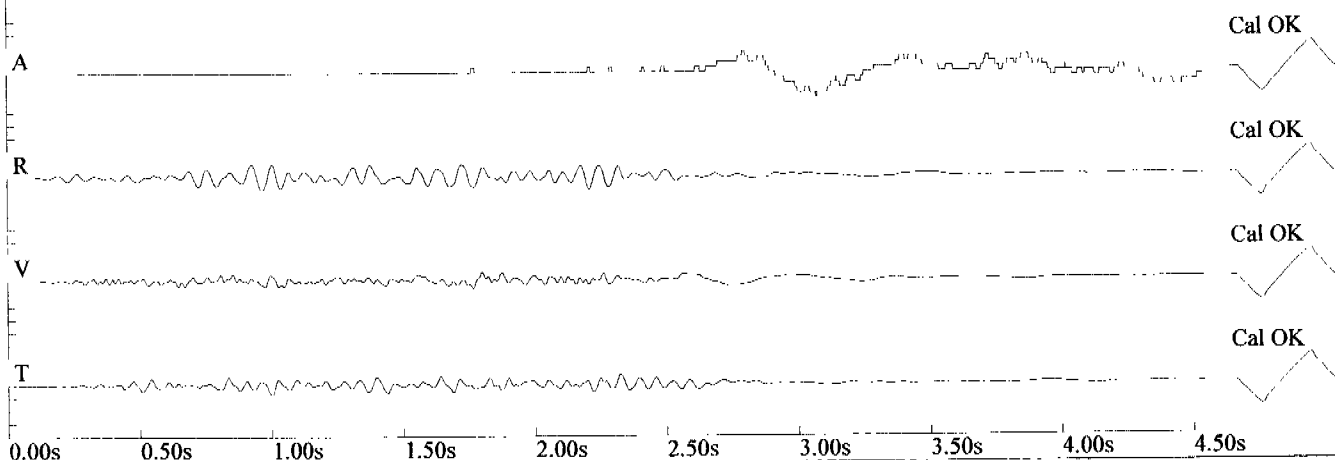
File: 01769230.DTB Event Number: 230 Date: 12/05/2001 Time: 16:50
Acoustic Trigger: 142 dB Seismic Trigger: 0.02in/s 0.508mm/s Serial Number: 1769

Amplitudes and Frequencies

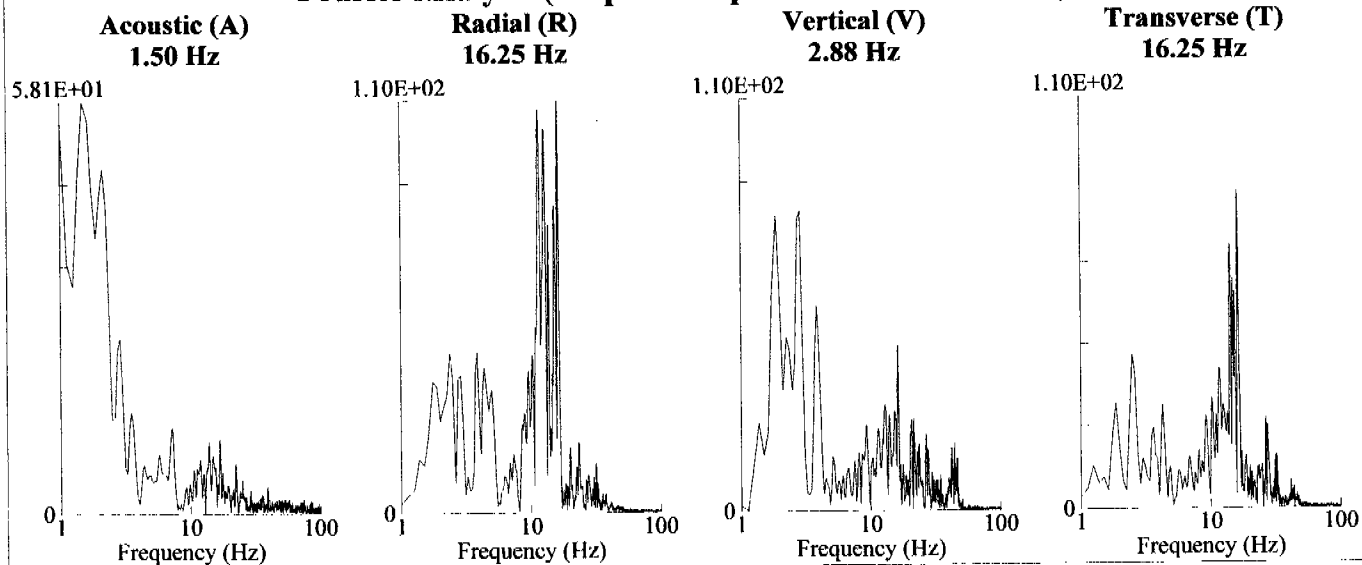
Acoustic (A): 114 dB @ 1.6 Hz
(0.10Mb 0.0015psi 0.0100kPa)
Radial (R): 0.0525in/s 1.3335mm/s @ 16.0Hz
Vertical (V): 0.0325in/s 0.8255mm/s @ 10.0Hz
Transverse (T): 0.0375in/s 0.9525mm/s @ 14.6Hz
Calibration Date (yyyy/mm/dd): 2000/09/22

Graph Information

Duration: 0.000 sec To: 4.500 sec
Acoustic Scale:
120dB 0.20Mb (0.050Mb/div)
Seismic Scale:
0.20in/s (0.050in/s/div) 5.08mm/s (1.270mm/s/div)
Time Lines at: 0.50 sec intervals



Fourier Analysis (Amplitude Spectrum - Box Window)



Appendix B

**Laboratory Analysis
Results**



Date: 11/29/00
Client: Daniel B. Stephens
Lab ID: 0300W04998 - 5000
Project: Norton, VA

Dear Client:

The samples were received for analysis at Inter-Mountain Laboratories (IML), Farmington, New Mexico. Enclosed are the results of these analyses.

Comment:

Analytical results were obtained by approved methods. Sample analyses were obtained within the method specific holding times. Practical Quantitation Limits (PQL's) are based on method requirements, and any dilutions necessary to maintain proper method response without matrix interference.

If you have any questions, please call me at (505) 326-4737.

A handwritten signature in black ink, appearing to read 'William Lipps', is positioned above the printed name.

William Lipps
IML-Farmington, NM



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: RATLIFFE 1

Lab ID: 0300W04998

Matrix: Water

Condition: Cool/Intact

Date Received: 11/10/00

Date Reported: 11/29/00

Date Sampled: 11/09/00

Time Sampled: 1115

Parameter	Analytical		Units	Units	PQL	Method	Analysis		
	Result						Date	Time	Init.
General Parameters									
Solids - Total Dissolved	448	mg/L			2	EPA 160.2	11/13/00	1455	FP
Solids - Total Suspended	4	mg/L			2	EPA 160.2	11/10/00	1455	KA
Sulfate	109	mg/L			5	EPA 300.0	11/29/00	0900	KA
Total Metals									
Aluminum	<0.05	mg/L			0.05	EPA 200.7	11/22/00	1447	WL
Iron	4.17	mg/L			0.02	EPA 200.7	11/22/00	1447	WL
Manganese	0.36	mg/L			0.01	EPA 200.7	11/22/00	1447	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: _____



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: BANKS 1

Lab ID: 0300W04999

Matrix: Water

Condition: Cool/Intact

Date Received: 11/10/00

Date Reported: 11/29/00

Date Sampled: 11/09/00

Time Sampled: 1355

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis		
						Date	Time	Init.
General Parameters								
Solids - Total Dissolved	274	mg/L		2	EPA 160.2	11/13/00	1455	FP
Solids - Total Suspended	3	mg/L		2	EPA 160.2	11/10/00	1455	KA
Sulfate	72	mg/L		5	EPA 300.0	11/29/00	0900	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	11/22/00	1450	WL
Iron	3.48	mg/L		0.02	EPA 200.7	11/22/00	1450	WL
Manganese	0.44	mg/L		0.01	EPA 200.7	11/22/00	1450	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: _____



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: BOGGS 1

Lab ID: 0300W05000

Matrix: Water

Condition: Cool/Intact

Date Received: 11/10/00

Date Reported: 11/29/00

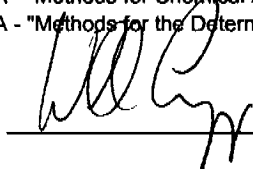
Date Sampled: 11/06/00

Time Sampled: 0930

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis		
						Date	Time	Init.
General Parameters								
Solids - Total Dissolved	1,740	mg/L		2	EPA 160.2	11/13/00	1455	FP
Solids - Total Suspended	19	mg/L		2	EPA 160.2	11/10/00	1455	KA
Sulfate	991	mg/L		5	EPA 300.0	11/29/00	0900	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	11/22/00	1459	WL
Iron	17.7	mg/L		0.02	EPA 200.7	11/22/00	1459	WL
Manganese	1.10	mg/L		0.01	EPA 200.7	11/22/00	1459	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 

Quality Control Report
Duplicate Analysis

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: BANKS 1

Lab ID: 0300W04999

Matrix: Water

Condition: Cool/Intact

Report Date: 11/29/00

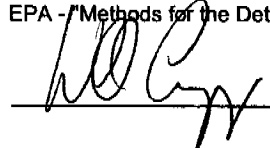
Receipt Date: 11/10/00

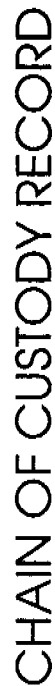
Sample Date: 11/09/00

Time Sampled: 1355

Parameter	Original Conc.	Duplicate Conc.	Relative % Diff.	PQL	Units
Solids - Total Dissolved	274	272	1	2	mg/L
Solids - Total Suspended	3	10	7**	2	mg/L
Sulfate	72	72	0	5	mg/L
Aluminum	<0.05	<0.05	NC*	0.05	mg/L
Iron	3.48	3.34	4	0.02	mg/L
Manganese	0.44	0.42	5	0.01	mg/L

*NC - Non-Calculable RPD due to value(s) less than DL ** - Difference used for results < 5 X Detection Limit

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.Reviewed By: 



CHAIN OF CUSTODY RECORD

Client/Project Name		Project Location		ANALYSES / PARAMETERS	
Sampler: (Signature)		Chain of Custody Tape No.		Remarks	
DBS-1A / OSM Well Study	Noton, Va.	NA			
Sample No./ Identification	Date	Time	Lab Number	Matrix	No. of Containers
Bottle 1	11/6/00	1115	W04998	Water	2
Bottle 1	11/9/00	1355	W04999	Water	2
Bottle 1	11/6/00	0930	W05000	Water	2
Relinquished by: (Signature) Date Time Relinquished by: (Signature) Date Time Relinquished by: (Signature) Date Time					

☐ 555 Absaraka
 Sheridan, Wyoming 82801
 Telephone (307) 674-7506

☐ 1633 Terra Avenue
 Sheridan, Wyoming 82801
 Telephone (307) 672-8945

☒ 1701 Phillips Circle
 Gillette, Wyoming 82718
 Telephone (307) 682-8945

☒ 2506 West Main Street
 Farmington, NM 87401
 Telephone (505) 326-4737

☐ 11183 State Hwy. 30
 College Station, TX 77845
 Telephone (979) 776-8945

Inter-Mountain Laboratories, Inc.

70664



December 7, 2000

Todd Stein
Daniel B. Stevens Consulting
6020 Academy Rd. NE, Suite 100
Albuquerque, NM 87109

Mr. Stein:

Enclosed please find the reports for the samples received by our laboratory for analysis on November 21, 2000.

If you have any questions about the results of these analyses, please don't hesitate to call me at your convenience.

Thank you for choosing IML for your analytical needs!

Sincerely,

A handwritten signature in black ink, appearing to read 'William Lipps', is written over the typed name and title.

William Lipps
Assistant Lab Manager/IML-Farmington

Enclosure

xc: File



DANIEL B. STEVENS

Case Narrative

On November 21, 2000, four water samples were submitted to Inter-Mountain Laboratories - Farmington for analysis. The parameters performed on the samples are indicated on the accompanying Chain of Custody.

It is the policy of this laboratory to employ, whenever possible, preparatory and analytical methods which have been approved by regulatory agencies. The methods used in the analysis of the samples reported herein are found in: EPA: "Methods for Chemical Analysis of Water and Wastes (MCAWW)" – EPA/600/4-79-020 – March 1983, "Methods for the Determination of Metals in Environmental Samples", Supplement I-600/R-94-111 – May, 1994.

If there are any questions regarding the information presented in this report package, please feel free to contact us at your convenience.

Sincerely,

A handwritten signature in black ink, appearing to read 'William Lipps', is written over the printed name and title.

William Lipps
Assistant Lab Manager/IML-Farmington



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Boggs 2

Lab ID: 0300W05150

Matrix: Water

Condition: Intact

Date Received: 11/21/00

Date Reported: 12/05/00

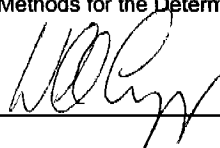
Date Sampled: 11/18/00

Time Sampled: 1515

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis		
						Date	Time	Init.
General Parameters								
Solids - Total Dissolved	1,710	mg/L		10	EPA 160.1	11/22/00	0930	FP
Solids - Total Suspended	9	mg/L		2	EPA 160.2	11/17/00	0900	KA
Sulfate	955	mg/L		5	EPA 300.0	12/01/00	1339	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	12/05/00	1344	WL
Iron	0.03	mg/L		0.02	EPA 200.7	12/05/00	1344	WL
Manganese	0.88	mg/L		0.01	EPA 200.7	12/05/00	1344	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Ratliff 2

Lab ID: 0300W05151

Matrix: Water

Condition: Intact

Date Received: 11/21/00

Date Reported: 12/05/00

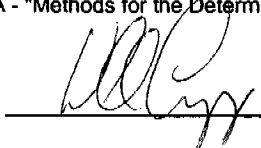
Date Sampled: 11/18/00

Time Sampled: 1425

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis		
						Date	Time	Init.
General Parameters								
Solids - Total Dissolved	430	mg/L		10	EPA 160.1	11/22/00	0930	FP
Solids - Total Suspended	14	mg/L		2	EPA 160.2	11/17/00	0900	KA
Sulfate	108	mg/L		5	EPA 300.0	12/01/00	1406	KA
Total Metals								
Aluminum	0.07	mg/L		0.05	EPA 200.7	12/05/00	1347	WL
Iron	5.71	mg/L		0.02	EPA 200.7	12/05/00	1347	WL
Manganese	0.42	mg/L		0.01	EPA 200.7	12/05/00	1347	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Banks 2

Lab ID: 0300W05152

Matrix: Water

Condition: Intact

Date Received: 11/21/00

Date Reported: 12/05/00

Date Sampled: 11/18/00

Time Sampled: 1430

Parameter	Analytical		Units	PQL	Method	Analysis		
	Result	Units				Date	Time	Init.
General Parameters								
Solids - Total Dissolved	260	mg/L		10	EPA 160.1	11/22/00	0930	FP
Solids - Total Suspended	21	mg/L		2	EPA 160.2	11/17/00	0900	KA
Sulfate	72	mg/L		5	EPA 300.0	12/01/00	1416	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	12/05/00	1350	WL
Iron	24.8	mg/L		0.02	EPA 200.7	12/05/00	1350	WL
Manganese	0.35	mg/L		0.01	EPA 200.7	12/05/00	1350	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: _____



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Sumner 1

Lab ID: 0300W05153

Matrix: Water

Condition: Intact

Date Received: 11/21/00

Date Reported: 12/05/00

Date Sampled: 11/18/00

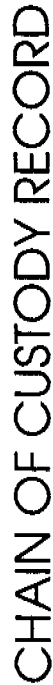
Time Sampled: 1605

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis		
						Date	Time	Init.
General Parameters								
Solids - Total Dissolved	250	mg/L		10	EPA 160.1	11/22/00	0930	FP
Solids - Total Suspended	<2	mg/L		2	EPA 160.2	11/17/00	0900	KA
Sulfate	7	mg/L		5	EPA 300.0	12/01/00	1425	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	12/05/00	1353	WL
Iron	20.8	mg/L		0.02	EPA 200.7	12/05/00	1353	WL
Manganese	0.89	mg/L		0.01	EPA 200.7	12/05/00	1353	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: _____



100
90
80
70
60



Date: 12/12/00
Client: Daniel B. Stephens
Lab ID: 0300W05218
Project: Norton, VA

Dear Client:

The samples were received for analysis at Inter-Mountain Laboratories (IML), Farmington, New Mexico. Enclosed are the results of these analyses.

Comment:

Analytical results were obtained by approved methods. Sample analyses were obtained within the method specific holding times. Practical Quantitation Limits (PQL's) are based on method requirements, and any dilutions necessary to maintain proper method response without matrix interference.

If you have any questions, please call me at (505) 326-4737.

A handwritten signature in black ink, appearing to read 'William Lipps', is written above the printed name.

William Lipps
IML-Farmington, NM



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Hurley #1

Lab ID: 0300W05218

Matrix: Water

Condition: Intact

Date Received: 11/22/00

Date Reported: 12/12/00

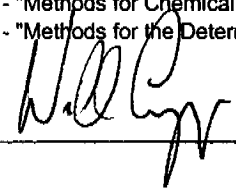
Date Sampled: 11/20/00

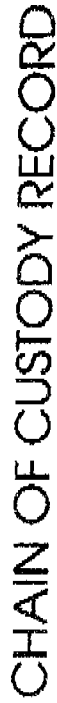
Time Sampled: 1418

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis		
						Date	Time	Init.
General Parameters								
Solids - Total Dissolved	700	mg/L		10	EPA 160.1	11/29/00	1200	KA
Solids - Total Suspended	22	mg/L		2	EPA 160.2	11/28/00	1200	KA
Sulfate	36	mg/L		5	EPA 300.0	12/05/00	1002	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	12/05/00	1416	WL
Iron	12.9	mg/L		0.02	EPA 200.7	12/05/00	1416	WL
Manganese	1.51	mg/L		0.01	EPA 200.7	12/05/00	1416	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

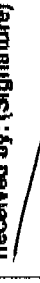
Reviewed By: 



Worton, Va

ANALYSES / PARAMETERS

Remarks

Disinfectant by: (Signature) 	Date 11/20/00	Time 1953	Received by: (Signature) 	Date	Time
Disinfectant by: (Signature) 	Date	Time	Received by: (Signature) 	Date	Time
Disinfectant by: (Signature) 	Date	Time	Received by laboratory: (Signature) 	Date 11/29/00	Time 1953

Inter-Mountain Laboratories, Inc.

 555 Absaraka
Sheridan, Wyoming 82801
Telephone (307) 674-7506

 1633 Terra Avenue
Sheridan, Wyoming 82801
Telephone (307) 672-8945

 1701 Phillips Circle
Gillette, Wyoming 82718
Telephone (307) 682-8945

☒ 2506 West Main Street
Farmington, NM 87401
Telephone (505) 326-4737

 11183 State Hwy. 30
College Station, TX 77845
Telephone (979) 776-8945

7032



Date: 12/15/00
Client: Daniel B. Stephens
Lab ID: 0300W05257 - 60
Project: Norton, VA

Dear Client:

The samples were received for analysis at Inter-Mountain Laboratories (IML), Farmington, New Mexico. Enclosed are the results of these analyses.

Comment:

Analytical results were obtained by approved methods. Sample analyses were obtained within the method specific holding times. Practical Quantitation Limits (PQL's) are based on method requirements, and any dilutions necessary to maintain proper method response without matrix interference.

If you have any questions, please call me at (505) 326-4737.

A handwritten signature in black ink, appearing to read 'William Lipps', is written over the printed name.

William Lipps
IML-Farmington, NM



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Sumner-2

Lab ID: 0300W05257

Matrix: Water

Condition: Intact

Date Received: 11/28/00

Date Reported: 12/15/00

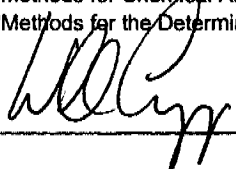
Date Sampled: 11/25/00

Time Sampled: 1800

Parameter	Analytical		Units	PQL	Method	Analysis		
	Result	Units				Date	Time	Init.
General Parameters								
Solids - Total Dissolved	250	mg/L		10	EPA 160.1	11/29/00	1200	KA
Solids - Total Suspended	103	mg/L		2	EPA 160.2	12/01/00	1130	KA
Sulfate	5	mg/L		5	EPA 300.0	12/06/00	1018	WL
Total Metals								
Aluminum	0.06	mg/L		0.05	EPA 200.7	12/06/00	1356	WL
Iron	67.0	mg/L		0.02	EPA 200.7	12/06/00	1356	WL
Manganese	3.86	mg/L		0.01	EPA 200.7	12/06/00	1356	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Hurley-2

Lab ID: 0300W05258

Matrix: Water

Condition: Intact

Date Received: 11/28/00

Date Reported: 12/15/00

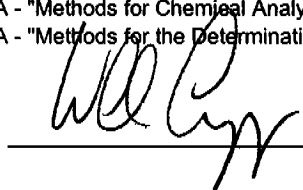
Date Sampled: 11/25/00

Time Sampled: 1900

Parameter	Analytical		Units	Units	PQL	Method	Analysis		
	Result						Date	Time	Init.
General Parameters									
Solids - Total Dissolved	650	mg/L			10	EPA 160.1	11/29/00	1200	KA
Solids - Total Suspended	26	mg/L			2	EPA 160.2	12/01/00	1130	KA
Sulfate	37	mg/L			5	EPA 300.0	12/06/00	1018	WL
Total Metals									
Aluminum	<0.05	mg/L			0.05	EPA 200.7	12/06/00	1359	WL
Iron	14.7	mg/L			0.02	EPA 200.7	12/06/00	1359	WL
Manganese	1.46	mg/L			0.01	EPA 200.7	12/06/00	1359	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Dean 1-1

Lab ID: 0300W05259

Matrix: Water

Condition: Intact

Date Received: 11/28/00

Date Reported: 12/15/00

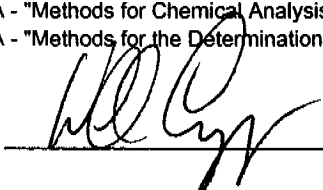
Date Sampled: 11/26/00

Time Sampled: 1615

Parameter	Analytical	Units	Units	PQL	Method	Analysis		
	Result					Date	Time	Init.
General Parameters								
Solids - Total Dissolved	400	mg/L		10	EPA 160.1	11/29/00	1200	KA
Solids - Total Suspended	75	mg/L		2	EPA 160.2	12/01/00	1130	KA
Sulfate	145	mg/L		5	EPA 300.0	12/06/00	1018	WL
Total Metals								
Aluminum	0.07	mg/L		0.05	EPA 200.7	12/06/00	1402	WL
Iron	28.4	mg/L		0.02	EPA 200.7	12/06/00	1402	WL
Manganese	1.00	mg/L		0.01	EPA 200.7	12/06/00	1402	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Dean 2-1

Lab ID: 0300W05260

Matrix: Water

Condition: Intact

Date Received: 11/28/00

Date Reported: 12/15/00

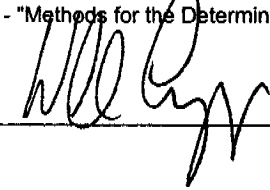
Date Sampled: 11/26/00

Time Sampled: 1620

Parameter	Analytical	Units	Units	PQL	Method	Analysis		
	Result					Date	Time	Init.
General Parameters								
Solids - Total Dissolved	320	mg/L		10	EPA 160.1	11/29/00	1200	KA
Solids - Total Suspended	7	mg/L		2	EPA 160.2	12/01/00	1130	KA
Sulfate	109	mg/L		5	EPA 300.0	12/06/00	1018	WL
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	12/06/00	1410	WL
Iron	4.62	mg/L		0.02	EPA 200.7	12/06/00	1410	WL
Manganese	0.39	mg/L		0.01	EPA 200.7	12/06/00	1410	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



DANIEL B. STEPHENS & ASSOCIATES, INC.

Chain of Custody

To:

Inter-Mountain Laboratories, Inc. Date 11/26/00 Project No. _____

Client DBSA OSM Well Study

Relinquished by Mike Devine 11/26/00 2153

Sent by: ☒ Fed Ex ☐ DHL ☐ Other _____

Purpose of Shipment Sample Analysis

Possible Contaminants _____

Item No.	Sample No.	Analysis to be Done	Sample Container	Comments
	Summer-2	IL-504, TDS, TSS 1250ml Total Al, Fe, + Mn	2	Jced 11/25/00 1800 1 Ag
	Harley-2	"	2	Jced 11/25/00 1900 1 Ag
	Dean 1-1	"	2	Jced 11/26/00 1615 1 Ag
	Dean 2-1	"	2	Jced 11/26/00 1620 1 Ag
		PRO	2	Jced

Date Received 11-28-00 by J. Williams Company Representative 11/10

Received the above articles in good condition

Except as noted _____



Date: 12/20/00
Client: Daniel B. Stephens
Lab ID: 0300W05356 - 59
Project: Norton, VA

Dear Client:

The samples were received for analysis at Inter-Mountain Laboratories (IML), Farmington, New Mexico. Enclosed are the results of these analyses.

Comment:

Analytical results were obtained by approved methods. Sample analyses were obtained within the method specific holding times. Practical Quantitation Limits (PQL's) are based on method requirements, and any dilutions necessary to maintain proper method response without matrix interference.

If you have any questions, please call me at (505) 326-4737.

A handwritten signature in black ink, appearing to read 'William Lipps', is written over a horizontal line.

William Lipps
IML-Farmington, NM



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Dean 1-2

Lab ID: 0300W05356

Matrix: Water

Condition: Intact

Date Received: 12/05/00

Date Reported: 12/20/00

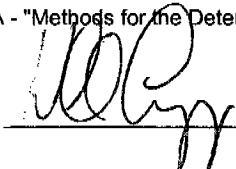
Date Sampled: 12/04/00

Time Sampled: 1305

Parameter	Analytical Result	Units	Units	PQL	Method	Analysis		
						Date	Time	Init.
General Parameters								
Solids - Total Dissolved	380	mg/L		10	EPA 160.1	12/08/00	1600	FP
Solids - Total Suspended	<2	mg/L		2	EPA 160.2	12/06/00	1100	KA
Sulfate	144	mg/L		5	EPA 300.0	12/06/00	1018	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	12/19/00	1437	WL
Iron	5.42	mg/L		0.02	EPA 200.7	12/19/00	1437	WL
Manganese	0.85	mg/L		0.01	EPA 200.7	12/19/00	1437	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Dean 2-2

Lab ID: 0300W05357

Matrix: Water

Condition: Intact

Date Received: 12/05/00

Date Reported: 12/20/00

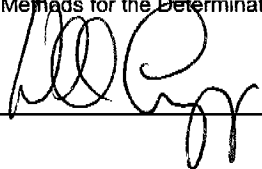
Date Sampled: 12/04/00

Time Sampled: 1324

Parameter	Analytical		Units	PQL	Method	Analysis		
	Result	Units				Date	Time	Init.
General Parameters								
Solids - Total Dissolved	280	mg/L		10	EPA 160.1	12/08/00	1600	FP
Solids - Total Suspended	<2	mg/L		2	EPA 160.2	12/06/00	1100	KA
Sulfate	109	mg/L		5	EPA 300.0	12/06/00	1018	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	12/19/00	1445	WL
Iron	1.84	mg/L		0.02	EPA 200.7	12/19/00	1445	WL
Manganese	0.24	mg/L		0.01	EPA 200.7	12/19/00	1445	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Abbott 1-1

Lab ID: 0300W05358

Matrix: Water

Condition: Intact

Date Received: 12/05/00

Date Reported: 12/20/00

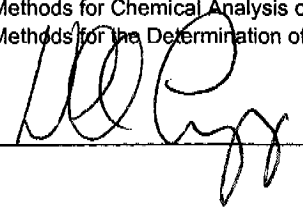
Date Sampled: 12/04/00

Time Sampled: 1240

Parameter	Analytical	Units	Units	PQL	Method	Analysis		
	Result					Date	Time	Init.
General Parameters								
Solids - Total Dissolved	180	mg/L		10	EPA 160.1	12/08/00	1600	FP
Solids - Total Suspended	<2	mg/L		2	EPA 160.2	12/06/00	1100	KA
Sulfate	7	mg/L		5	EPA 300.0	12/06/00	1018	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	12/19/00	1448	WL
Iron	0.89	mg/L		0.02	EPA 200.7	12/19/00	1448	WL
Manganese	0.10	mg/L		0.01	EPA 200.7	12/19/00	1448	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: Abbott 2-1

Lab ID: 0300W05359

Matrix: Water

Condition: Intact

Date Received: 12/05/00

Date Reported: 12/20/00

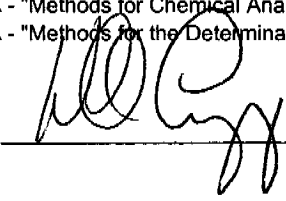
Date Sampled: 12/04/00

Time Sampled: 1245

Parameter	Analytical		Units	PQL	Method	Analysis		
	Result	Units				Date	Time	Init.
General Parameters								
Solids - Total Dissolved	160	mg/L		10	EPA 160.1	12/08/00	1600	FP
Solids - Total Suspended	58	mg/L		2	EPA 160.2	12/06/00	1100	KA
Sulfate	15	mg/L		5	EPA 300.0	12/06/00	1018	KA
Total Metals								
Aluminum	<0.05	mg/L		0.05	EPA 200.7	12/19/00	1451	WL
Iron	16.4	mg/L		0.02	EPA 200.7	12/19/00	1451	WL
Manganese	0.55	mg/L		0.01	EPA 200.7	12/19/00	1451	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



DANIEL B. STEPHENS & ASSOCIATES, INC.

Chain of Custody

To: Inter-Mountain Laboratories, Inc. Date 12/4/00 Project No. 9290
Client DBS&A OSM Well Study
Relinquished by Nilo Revue 12/4/00 1445
Sent by: ☒ Fed Ex ☐ DHL ☐ Other Fax - 1-505-888-0258
Purpose of Shipment Lab Analysis
Possible Contaminants N/A

Item No.	Sample No.	Analysis to be Done	Sample Container	Comments
	Dean 1-2	1L - SO ₄ , TDS, TSS 1250ml - Total Al, Fe, & Mn	1-1L 1-1250ml	Ag, 12/4/00 1305 W05356
	Dean 2-2	"	"	Ag, 12/4/00 1324 5357
	Abbott 1-1	"	"	Ag, 12/3/00 1240 5358
	Abbott 2-1	"	"	Ag, 12/3/00 1245 5359

Date Received 12/5/00 by Sharon Williams
Company Representative

Received the above articles in good condition

Except as noted



Date: 1/25/01
Client: Daniel B. Stephens
Lab ID: 0301W00307 - 08
Project: Norton, VA

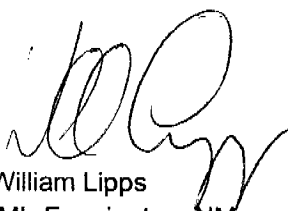
Dear Client:

The samples were received for analysis at Inter-Mountain Laboratories (IML), Farmington, New Mexico. Enclosed are the results of these analyses.

Comment:

Analytical results were obtained by approved methods. Sample analyses were obtained within the method specific holding times. Practical Quantitation Limits (PQL's) are based on method requirements, and any dilutions necessary to maintain proper method response without matrix interference.

If you have any questions, please call me at (505) 326-4737.



William Lipps
IML-Farmington, NM



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: ABBOTT 1-2

Lab ID: 0301W00307

Matrix: Water

Condition: Cool/Intact

Date Received: 01/11/01

Date Reported: 01/25/01

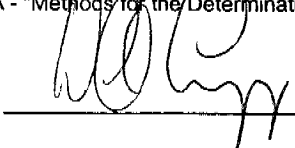
Date Sampled: 12/07/00

Time Sampled: 1813

Parameter	Analytical	Units	Units	PQL	Method	Analysis			
	Result					Date	Time	Init.	
General Parameters									
Solids - Total Dissolved	140	mg/L		10	EPA 160.1	01/15/01	1000	FP	
Solids - Total Suspended	6	mg/L		2	EPA 160.2	01/12/01	0820	KA	
Sulfate	<5	mg/L		5	EPA 300.0	01/11/01	0941	KA	
Total Metals									
Aluminum	<0.05	mg/L		0.05	EPA 200.7	01/25/01	1204	WL	
Iron	0.34	mg/L		0.02	EPA 200.7	01/25/01	1204	WL	
Manganese	0.03	mg/L		0.01	EPA 200.7	01/25/01	1204	WL	

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 



Inter-Mountain Laboratories, Inc.

Phone (505) 326-4737 Fax (505) 325-4182

2506 West Main Street, Farmington, NM 87401

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: ABBOTT 2-2

Lab ID: 0301W00308

Matrix: Water

Condition: Cool/Intact

Date Received: 01/11/01

Date Reported: 01/25/01

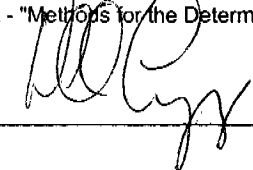
Date Sampled: 12/07/00

Time Sampled: 1620

Parameter	Analytical		Units	Units	PQL	Method	Analysis		
	Result	Units					Date	Time	Init.
General Parameters									
Solids - Total Dissolved	130	mg/L			10	EPA 160.1	01/15/01	1000	FP
Solids - Total Suspended	35	mg/L			2	EPA 160.2	01/12/01	0820	KA
Sulfate	12	mg/L			5	EPA 300.0	01/11/01	0941	KA
Total Metals									
Aluminum	<0.05	mg/L			0.05	EPA 200.7	01/25/01	1207	WL
Iron	5.16	mg/L			0.02	EPA 200.7	01/25/01	1207	WL
Manganese	0.07	mg/L			0.01	EPA 200.7	01/25/01	1207	WL

Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.

EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.

Reviewed By: 

Quality Control Report
Duplicate Analysis

Client: Daniel B. Stephens

Project: Norton, VA

Sample ID: ABBOTT 2-2

Lab ID: 0301W00308

Matrix: Water

Condition: Cool/Intact

Report Date: 02/05/01

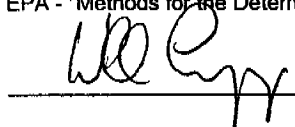
Receipt Date: 01/11/01

Sample Date: 12/07/00

Time Sampled: 1620

Parameter	Original Conc.	Duplicate Conc.	Relative % Diff.	PQL	Units
Solids - Total Dissolved	130	150	14	10	mg/L
Solids - Total Suspended	35	46	27	2	mg/L
Sulfate	12	12	0**	5	mg/L
Aluminum	<0.05	<0.05	NC*	0.05	mg/L
Iron	5.16	5.57	8	0.02	mg/L
Manganese	0.07	0.07	0	0.01	mg/L

*NC - Non-Calculable RPD due to value(s) less than DL ** - Difference used for results < 5 X Detection Limit

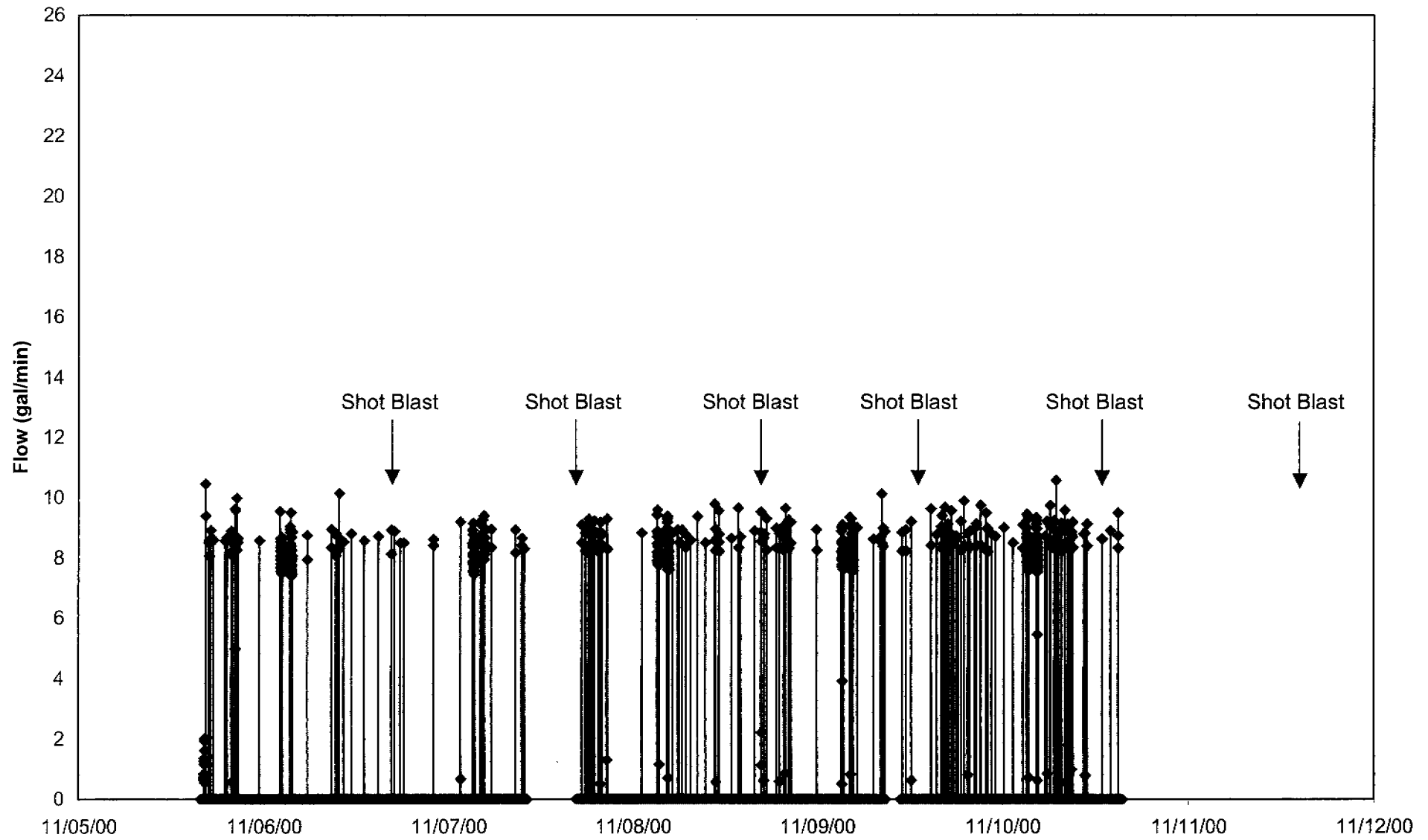
Reference: EPA - "Methods for Chemical Analysis of Water and Wastes (MCAWW)" - EPA/600/4-79-020 - March, 1983.
EPA - "Methods for the Determination of Metals in Environmental Samples" - Supplement I - 600/R-94-111 - May, 1994.Reviewed By: 

Appendix C

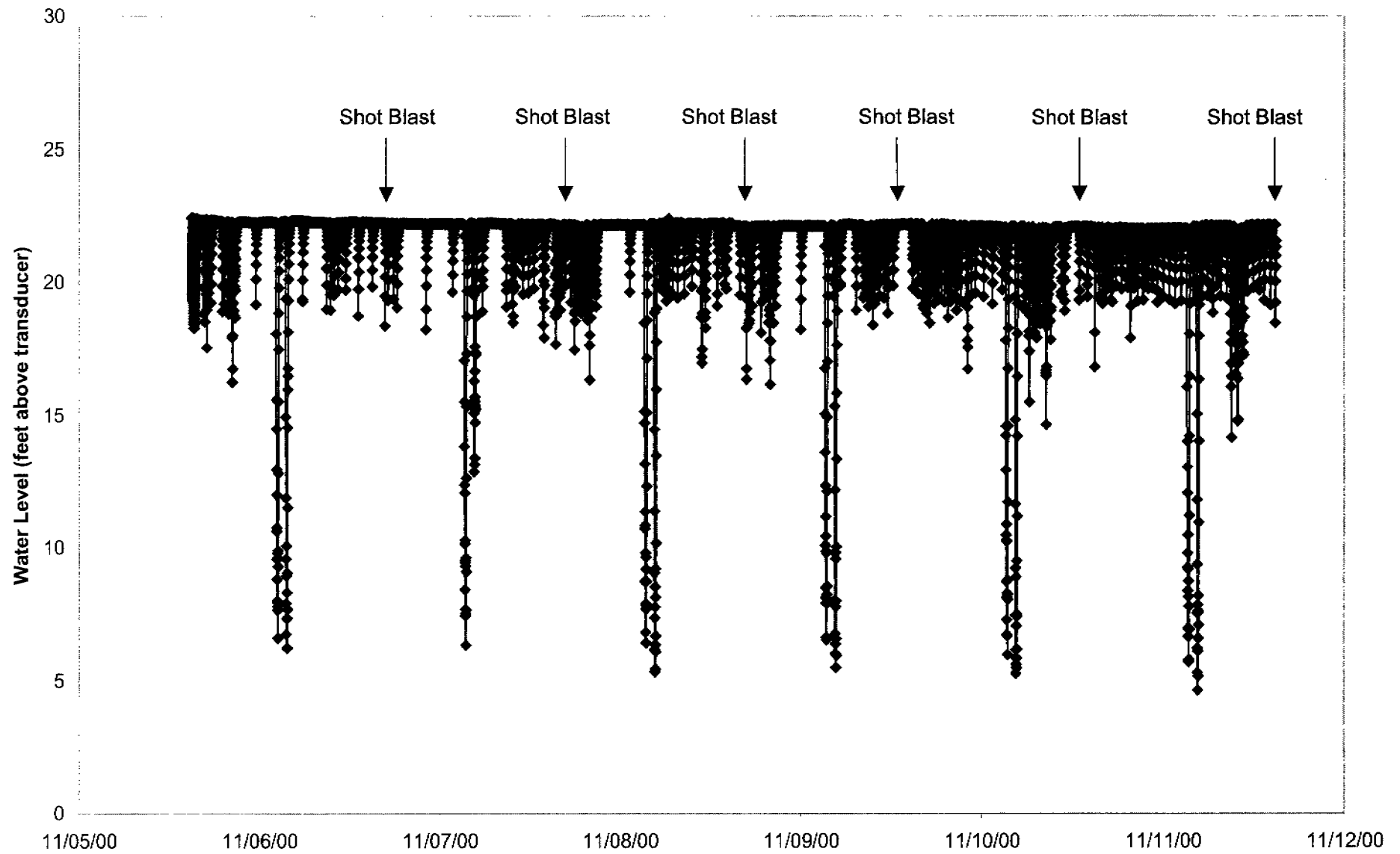
**Graphs of Quarterly
Monitoring Data**

Appendix C1
Fall-Winter 2000

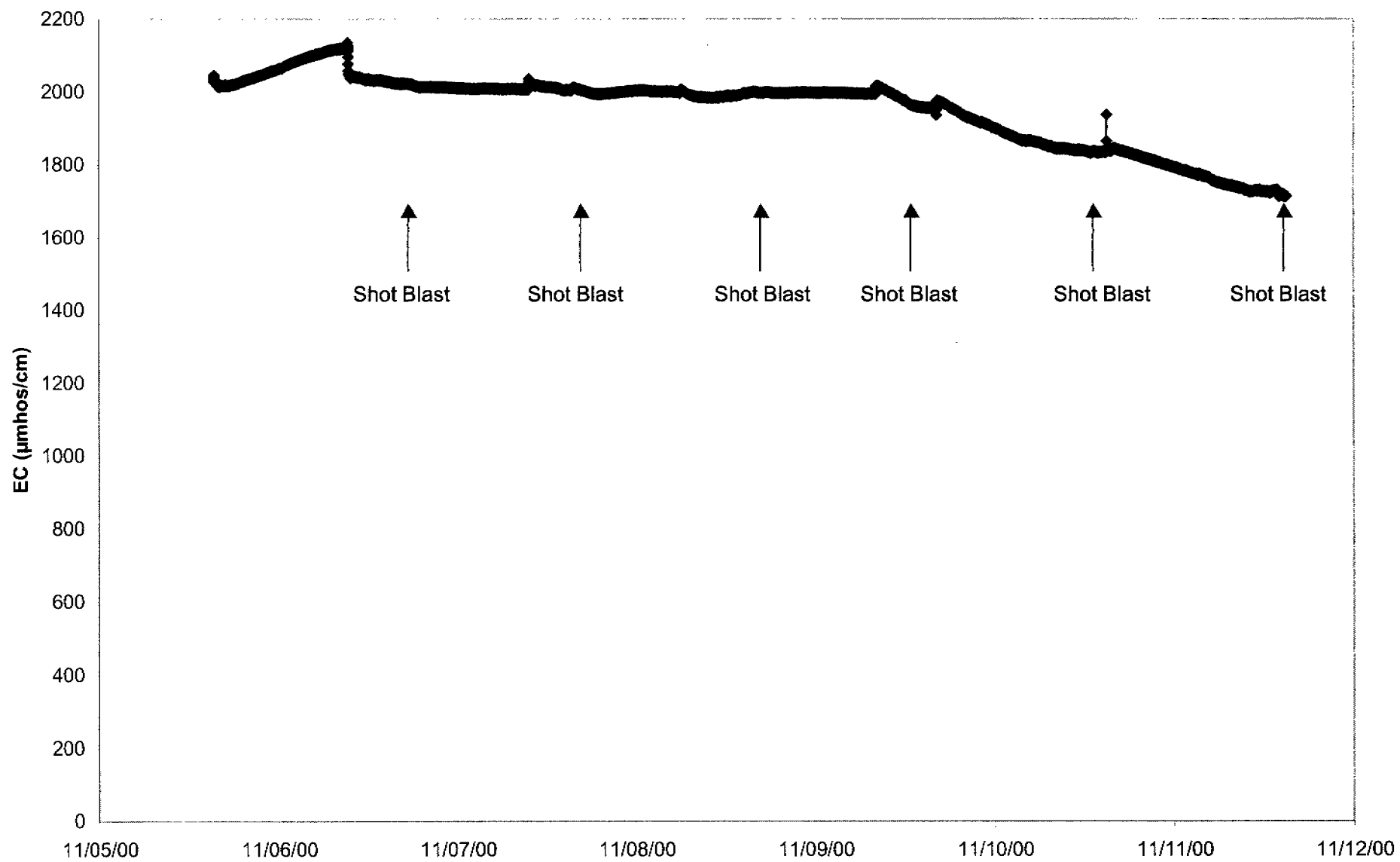
Well Yield
Site VA-1 Well-1
Fall-Winter 2000



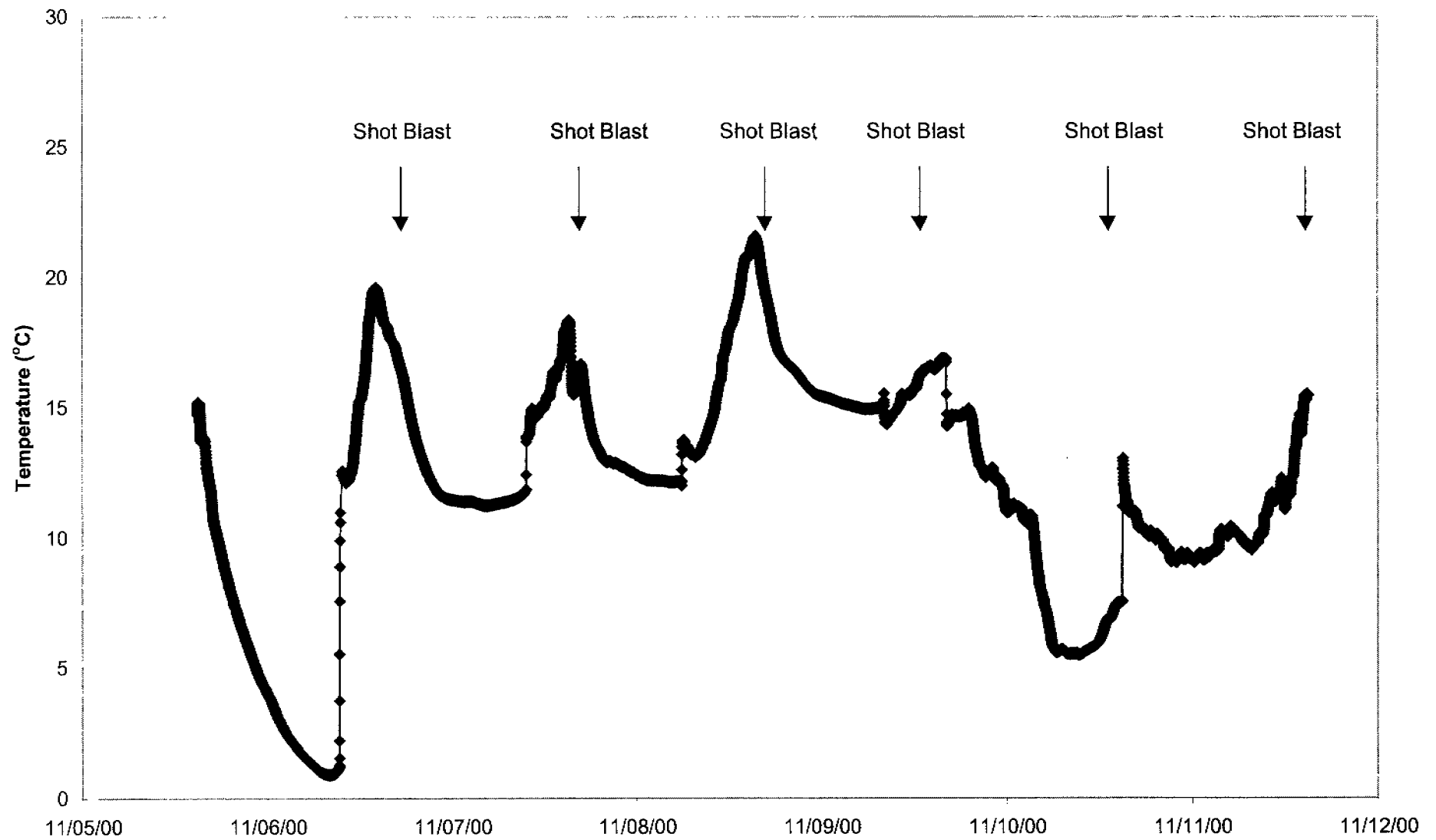
Water Level
Site VA-1 Well-1
Fall-Winter 2000



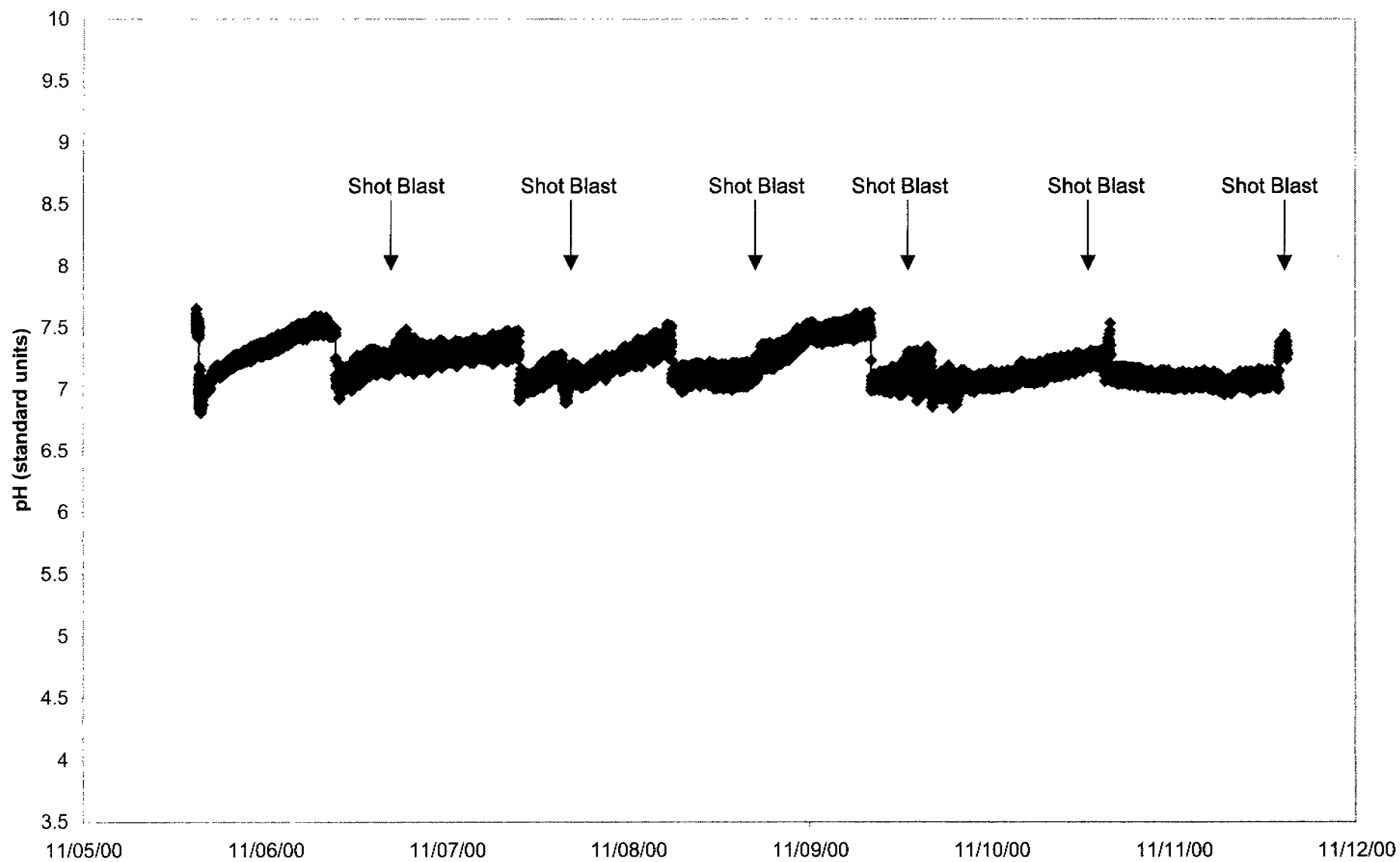
Well EC
Site VA-1 Well-1
Fall-Winter 2000



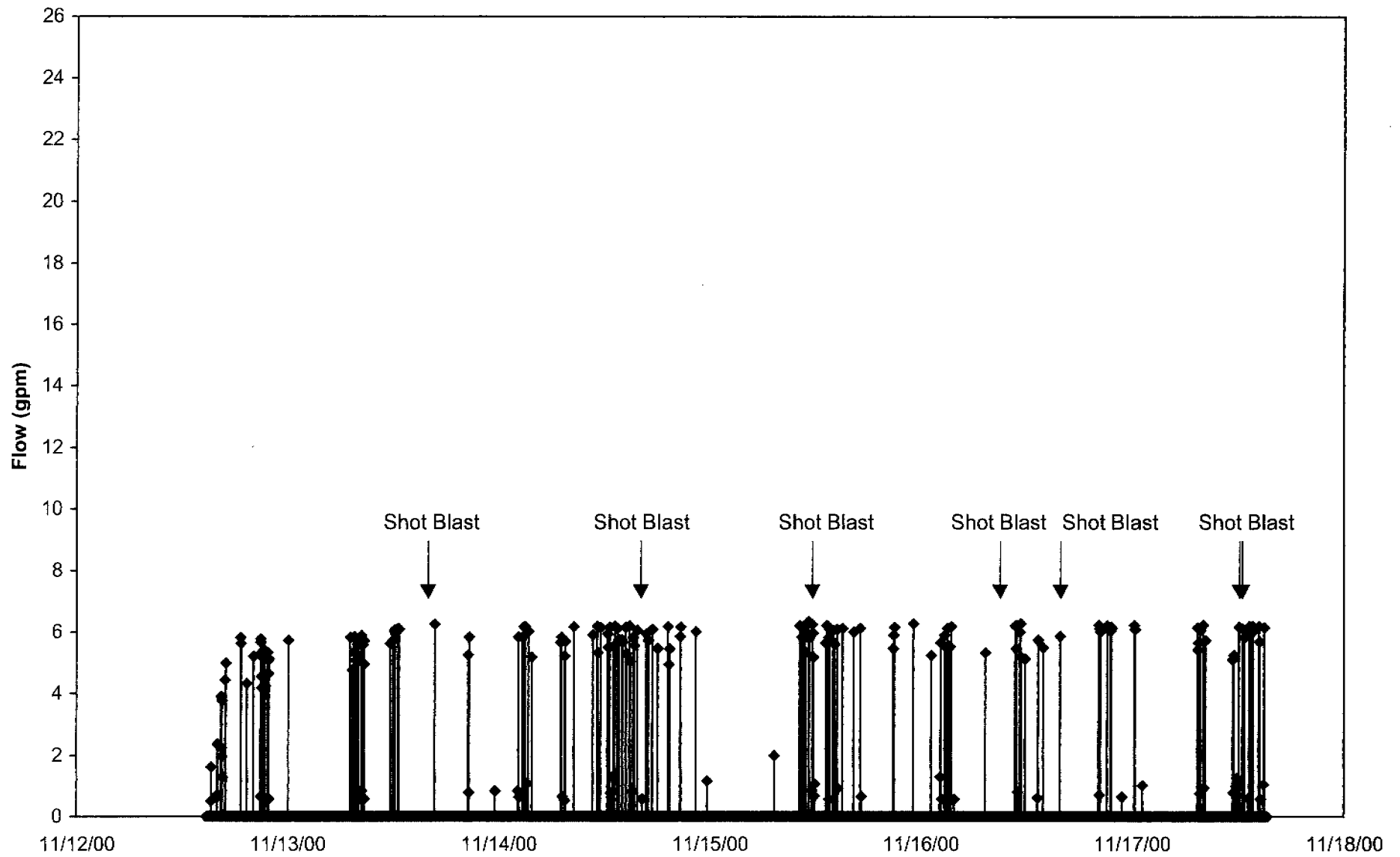
Water Temperature
Site VA-1 Well-1
Fall-Winter 2000



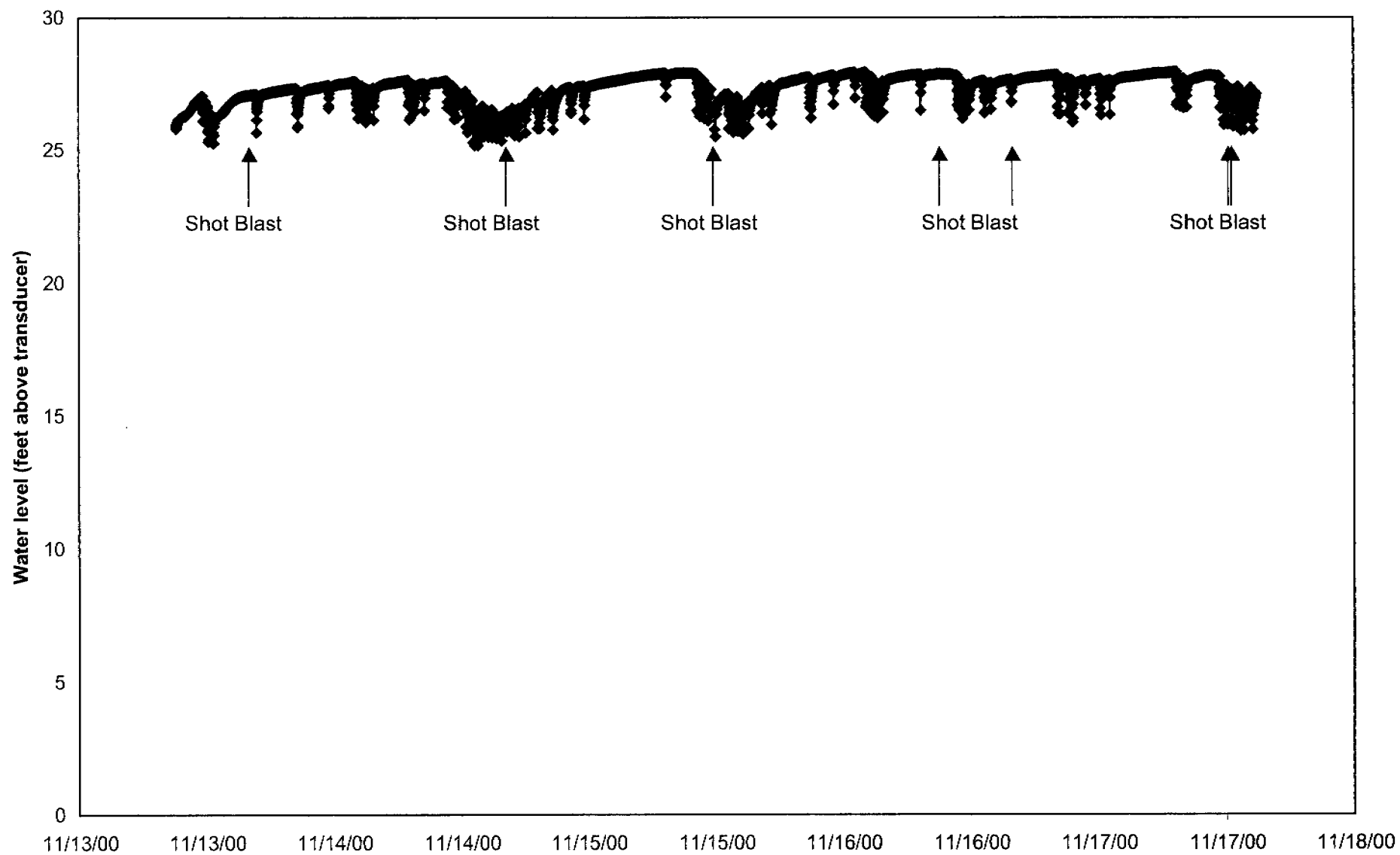
Water pH
Site VA-1 Well-1
Fall-Winter 2000



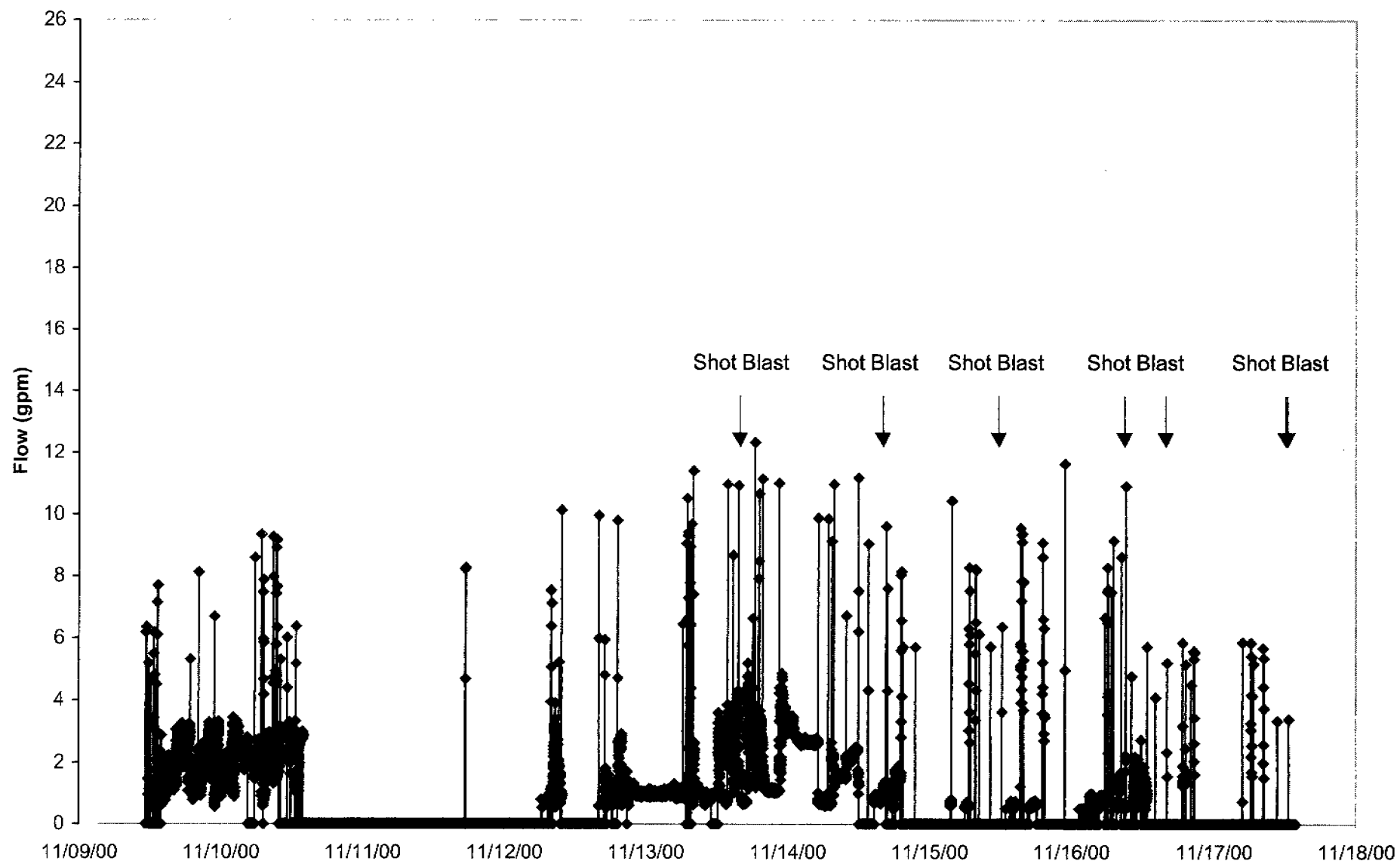
Well Yield
Site KY-1 Well-1
Fall-Winter 2000



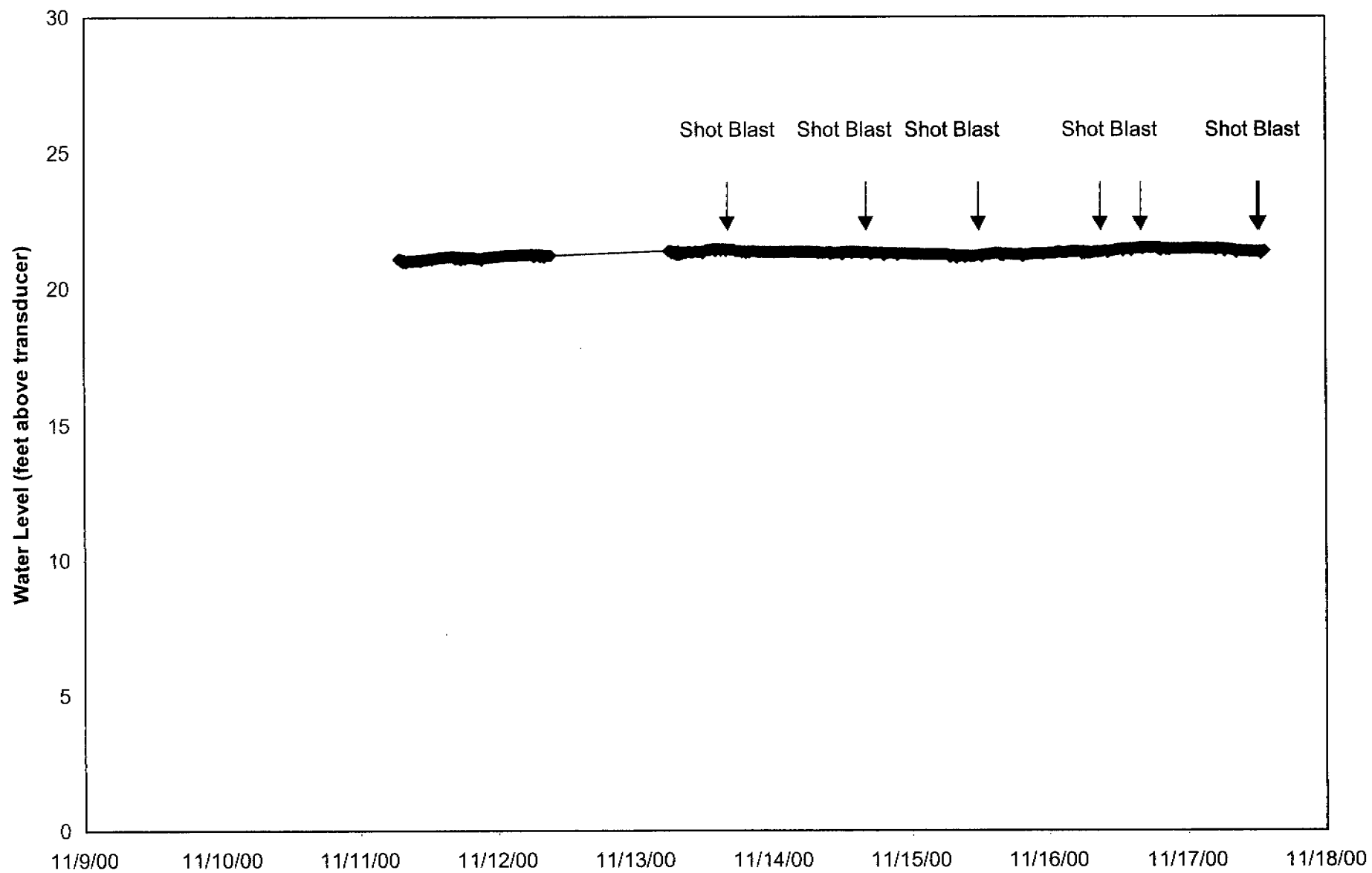
Water Level
Site KY-1 Well-1
Fall-Winter 2000



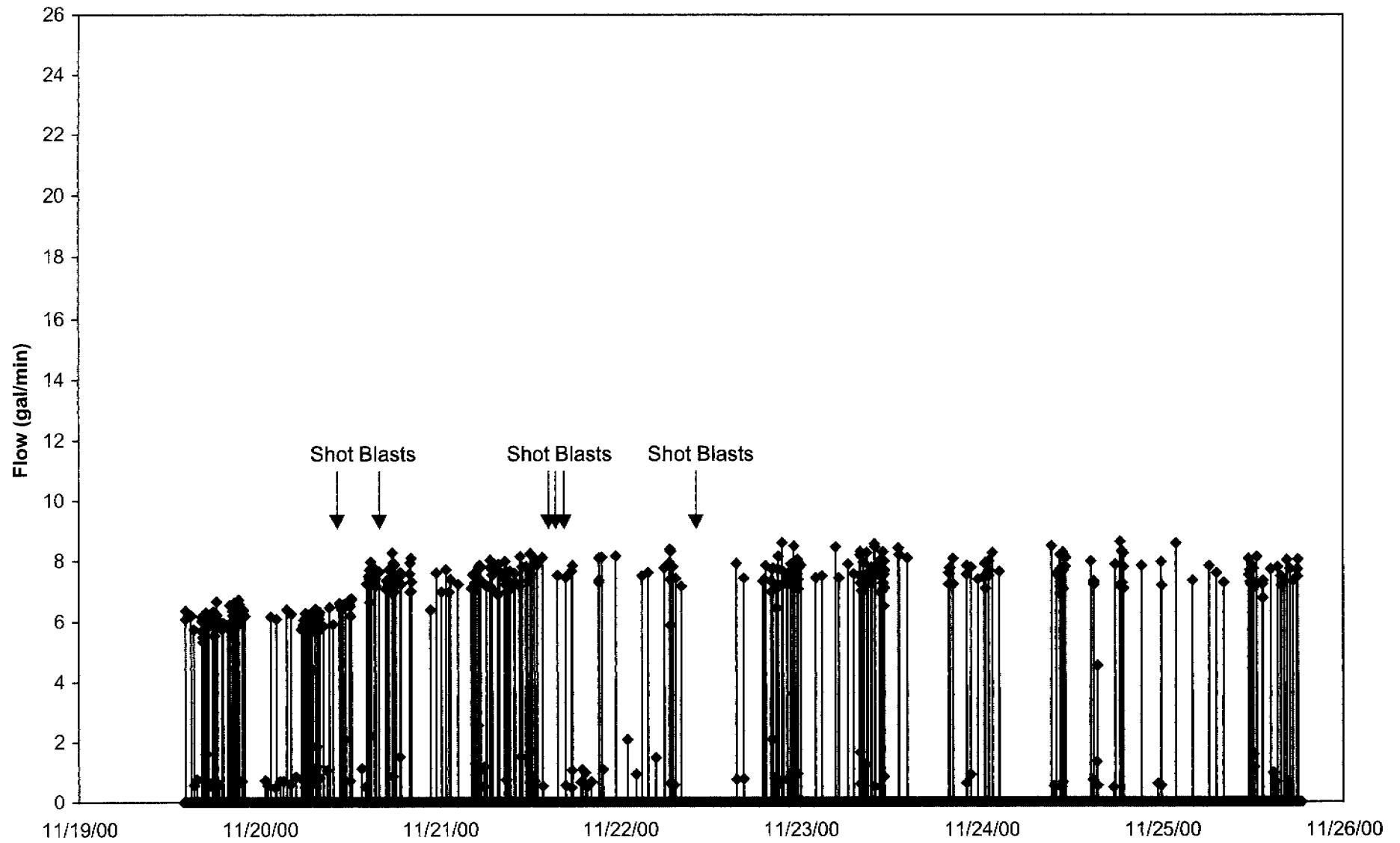
Well Yield
Site KY-1 Well-2
Fall-Winter 2000



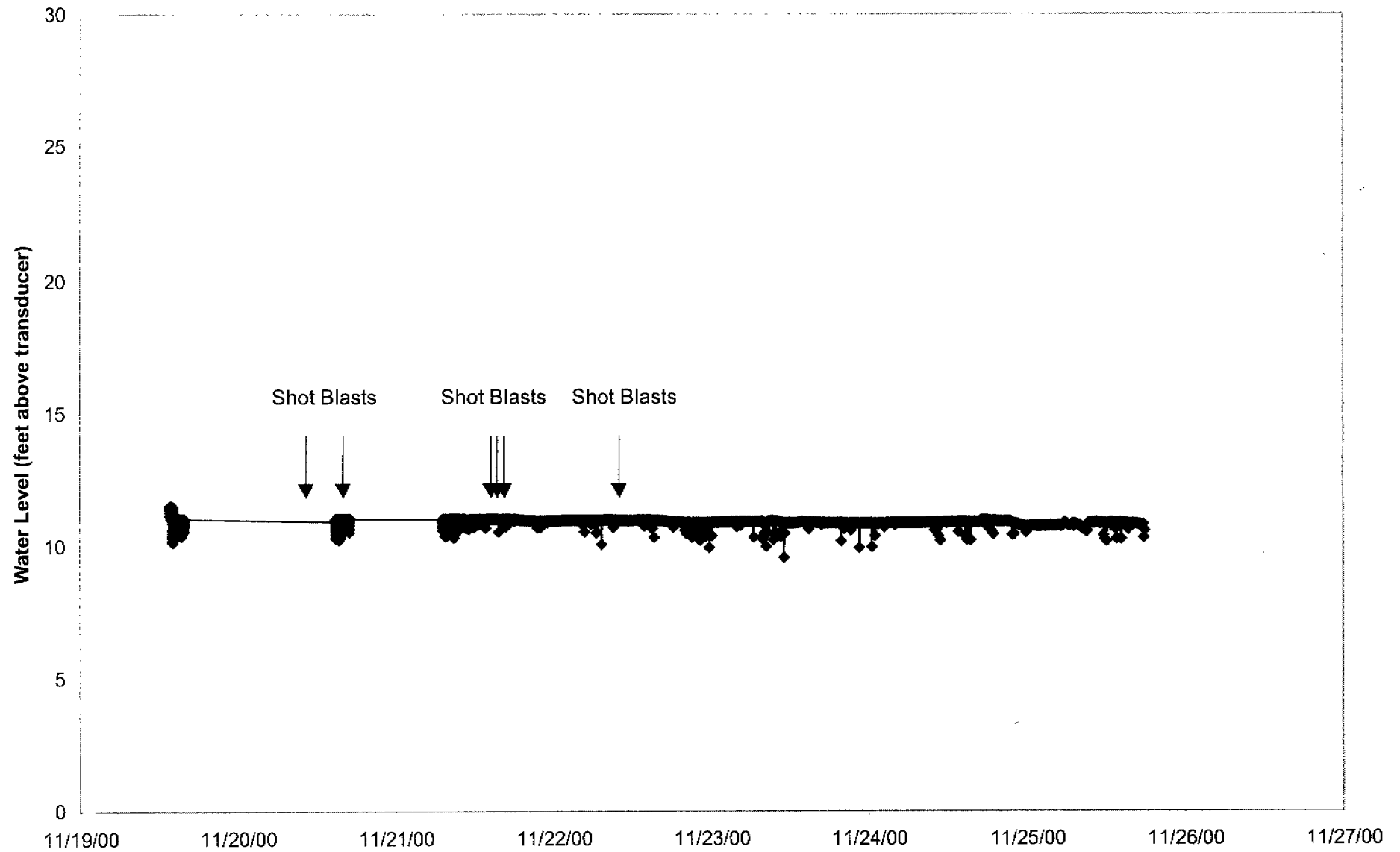
Water Level
Site KY-1 Well-2
Fall-Winter 2000



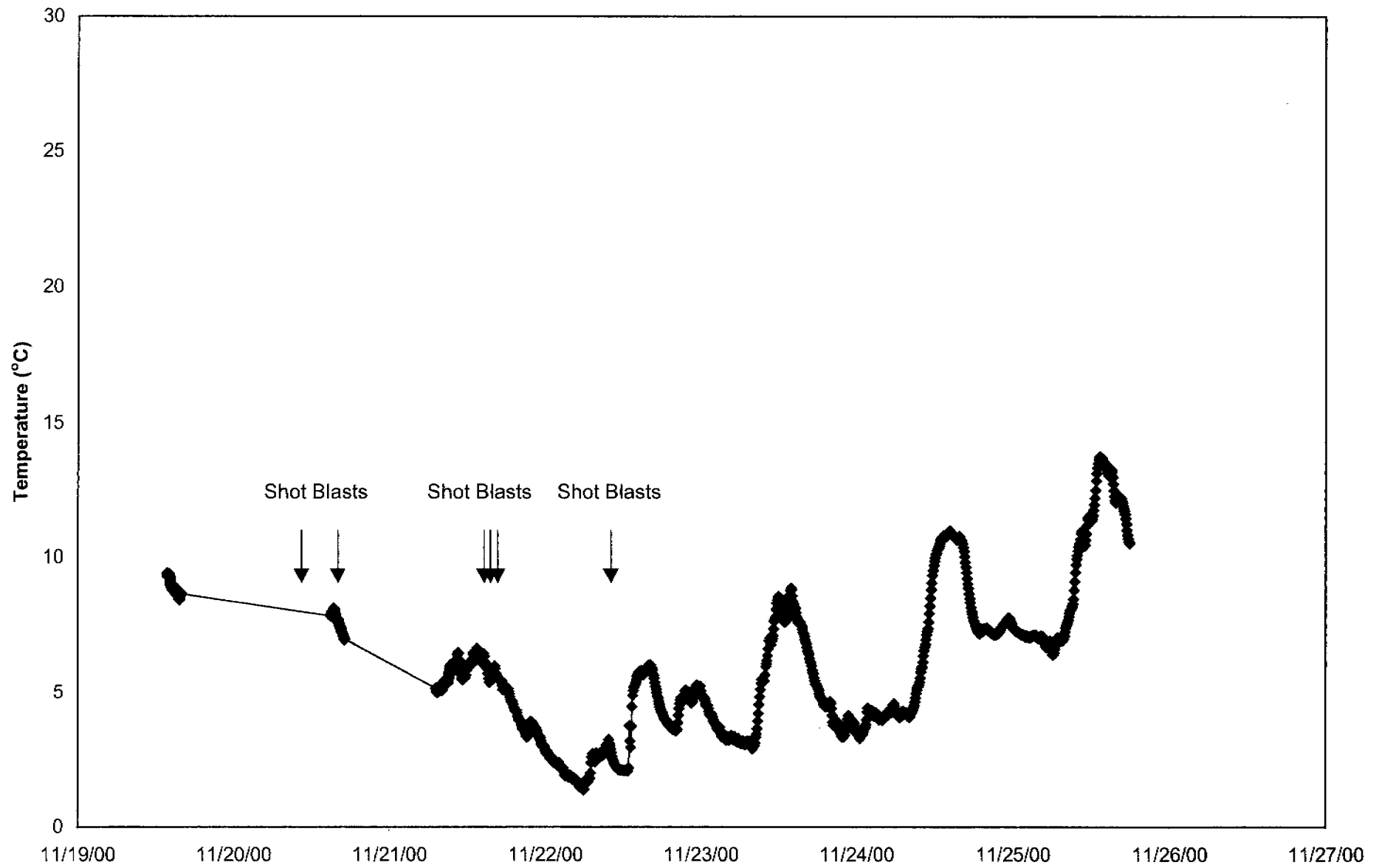
Well Yield
Site KY-2 Well-2
Fall-Winter 2000



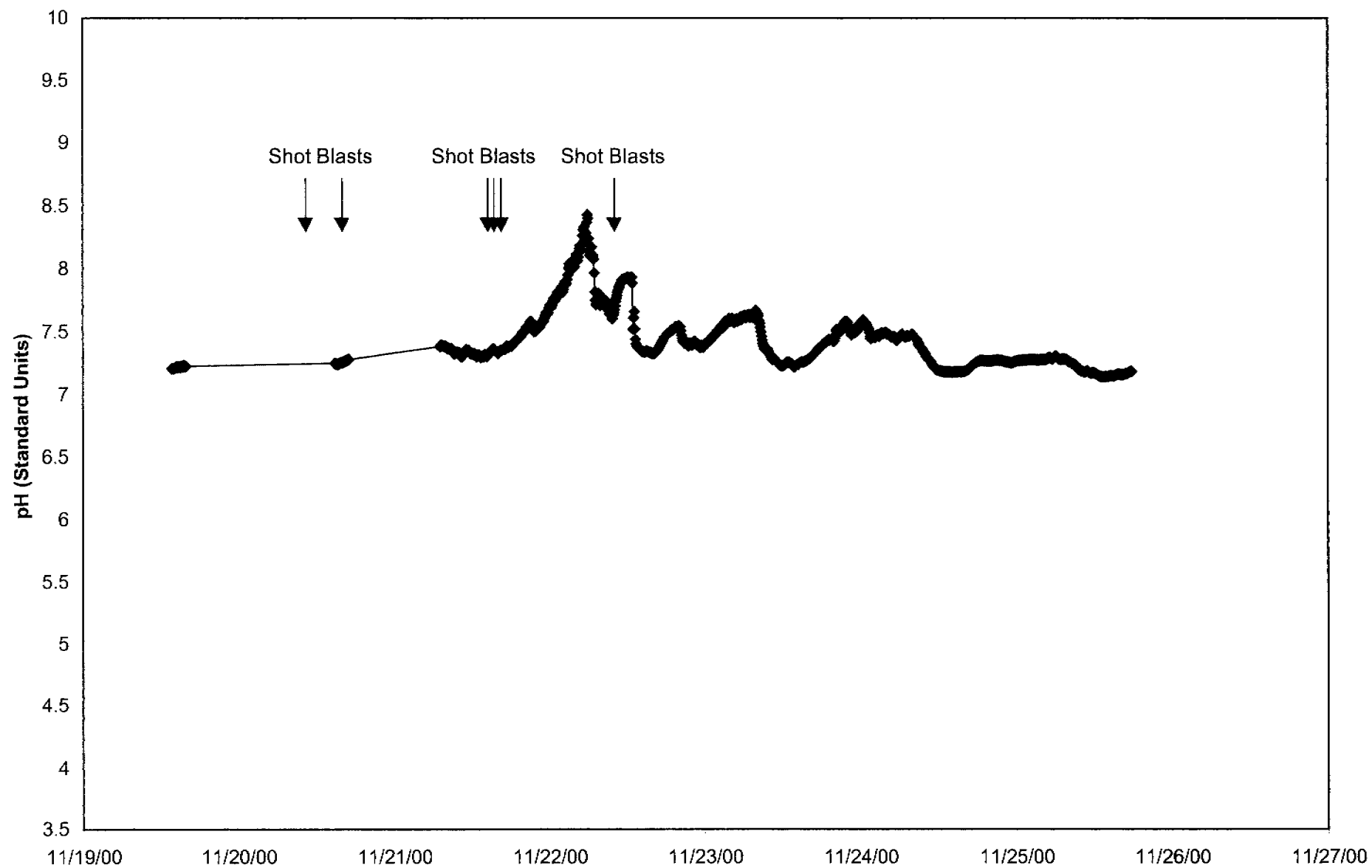
**Water Level
Site KY-2 Well-2
Fall-Winter 2000**



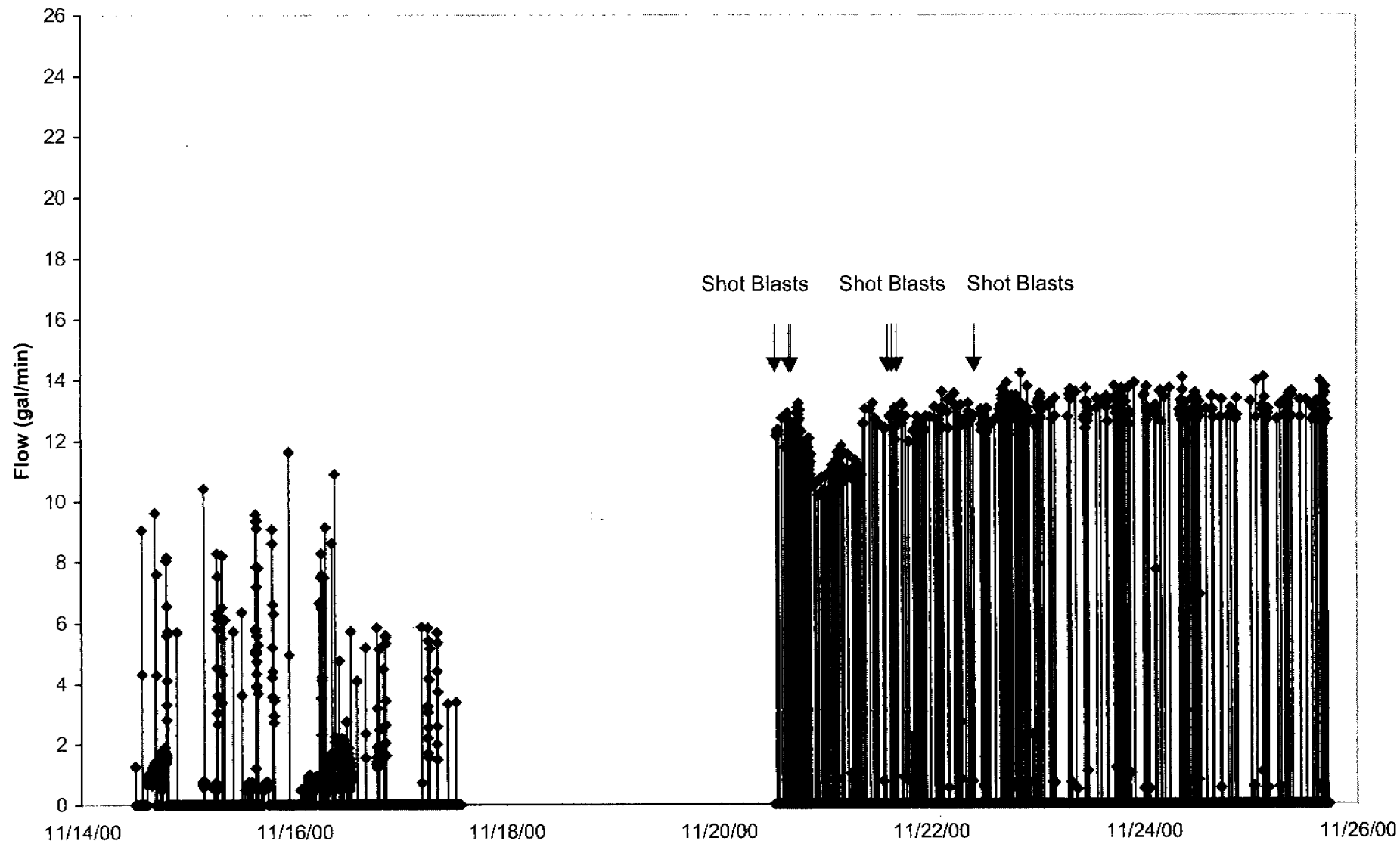
Water Temperature
Site KY-2 Well-2
Fall-Winter 2000



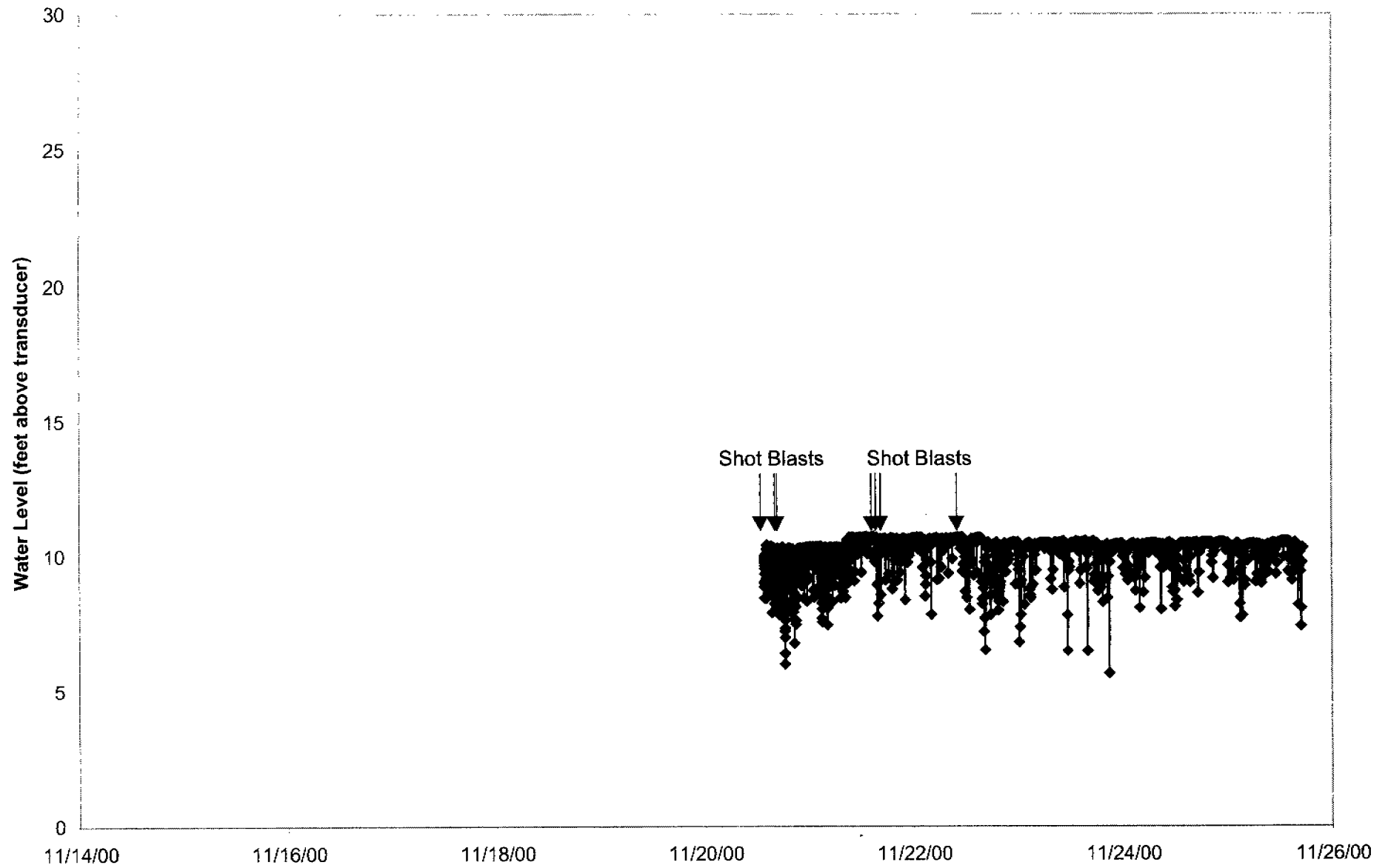
Water pH
Site KY-2 Well-2
Fall-Winter 2000



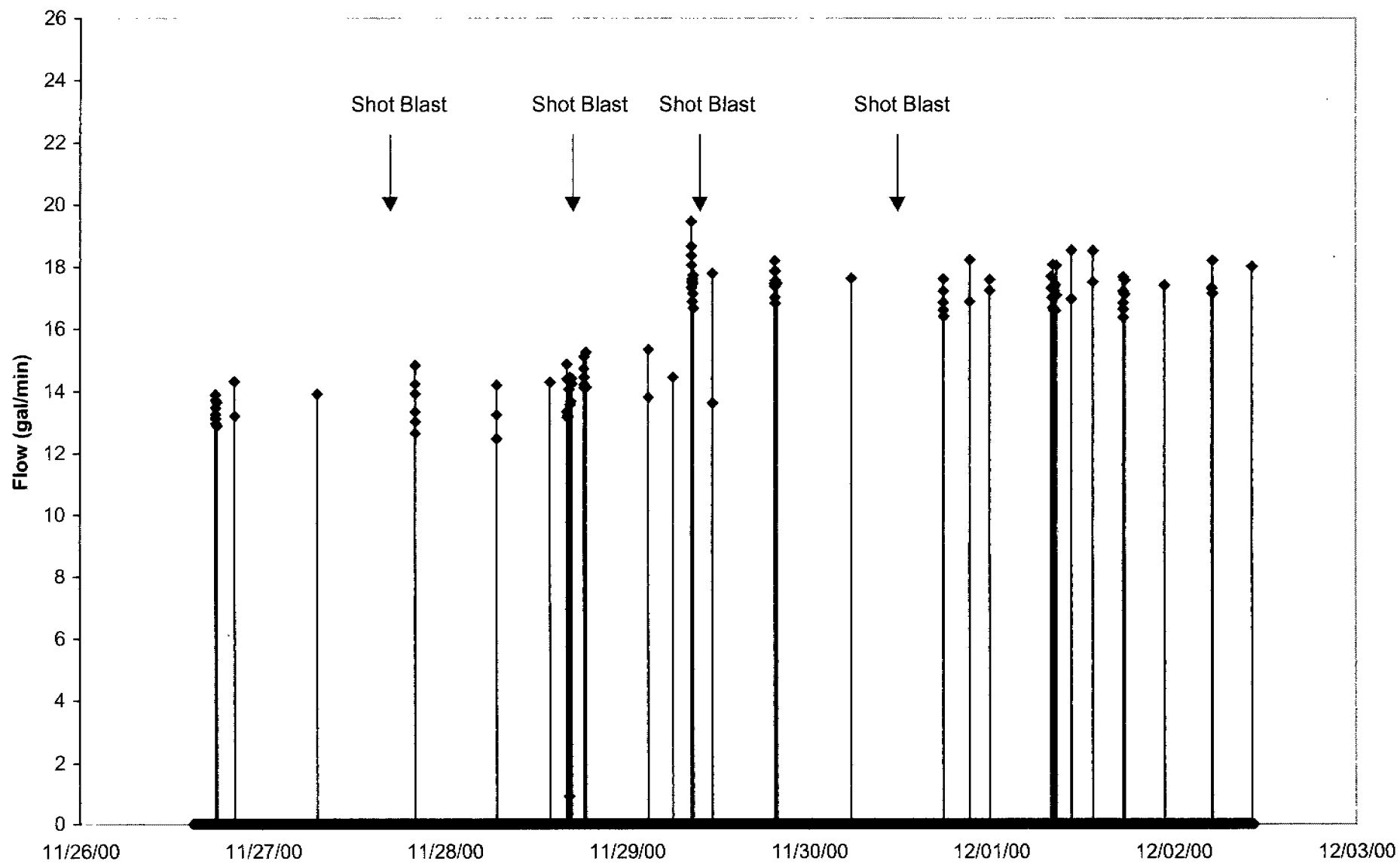
Well Yield
Site KY-2 Well-3
Fall-Winter 2000



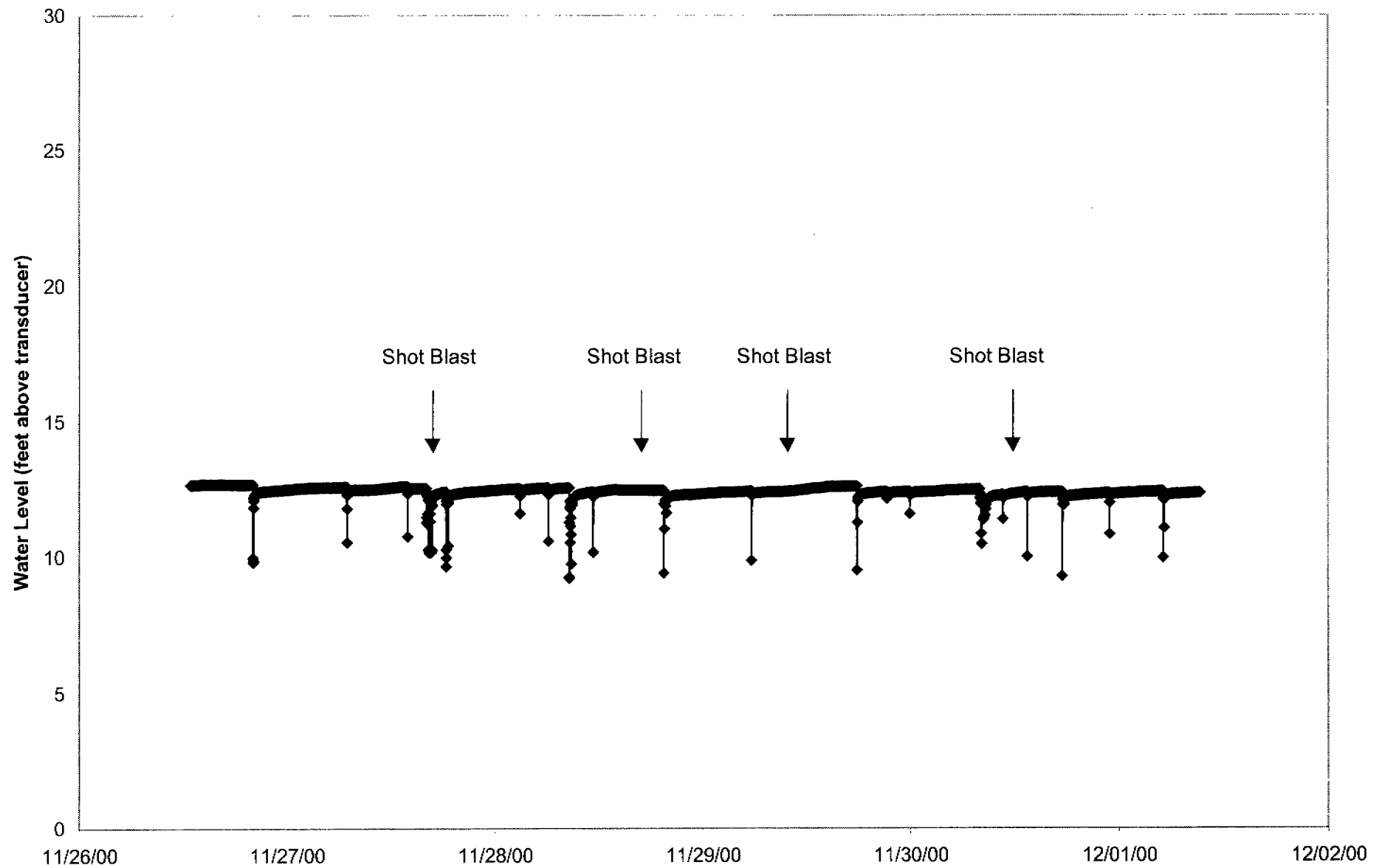
Water Level
Site KY-2 Well-3
Fall-Winter 2000



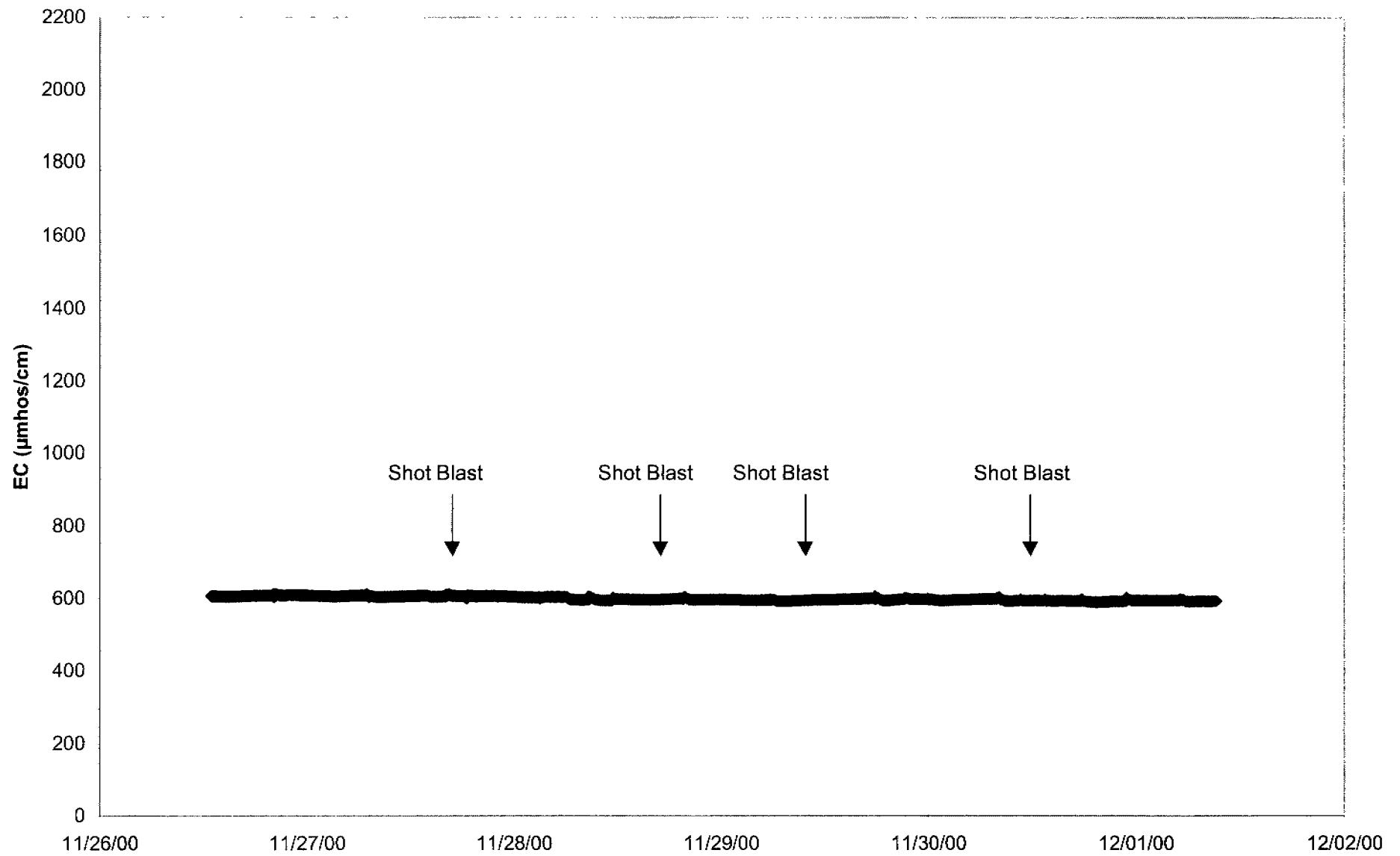
Well Yield
Site WV-1 Well-1
Fall-Winter 2000



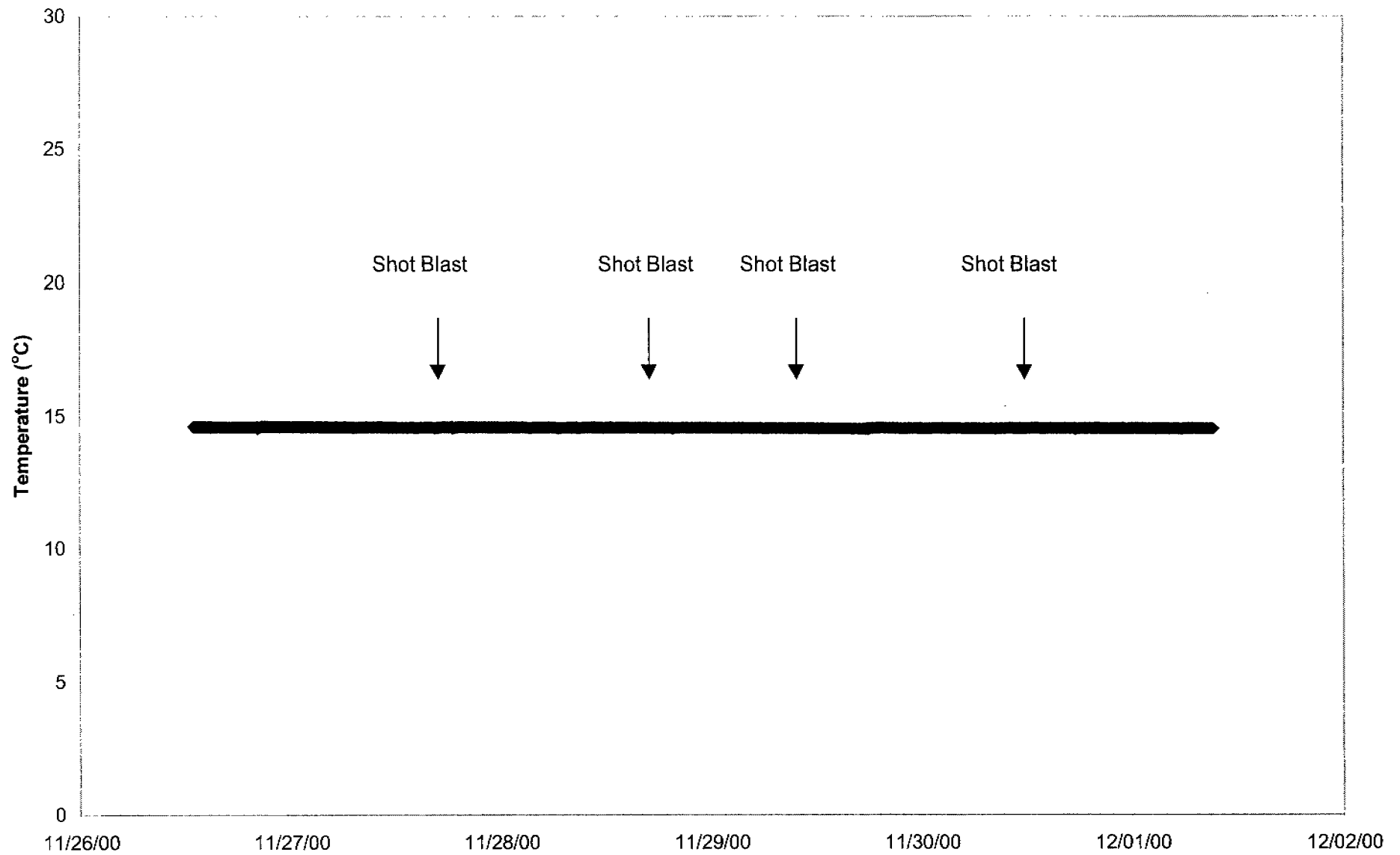
Water Level
Site WV-1 Well-1
Fall-Winter 2000



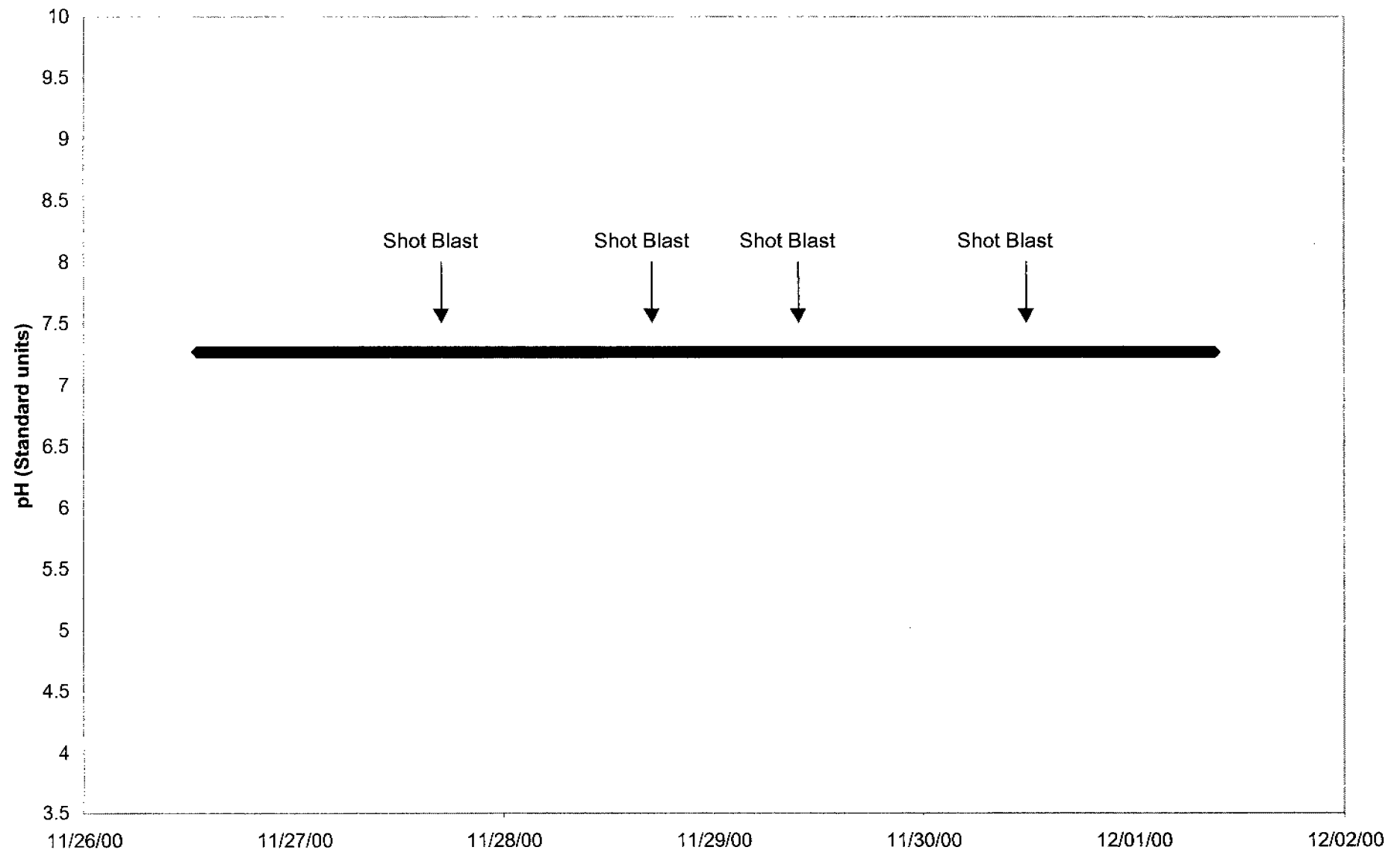
Well EC
Site WV-1 Well-1
Fall-Winter 2000



**Water Temperature
Site WV-1 Well-1
Fall-Winter 2000**

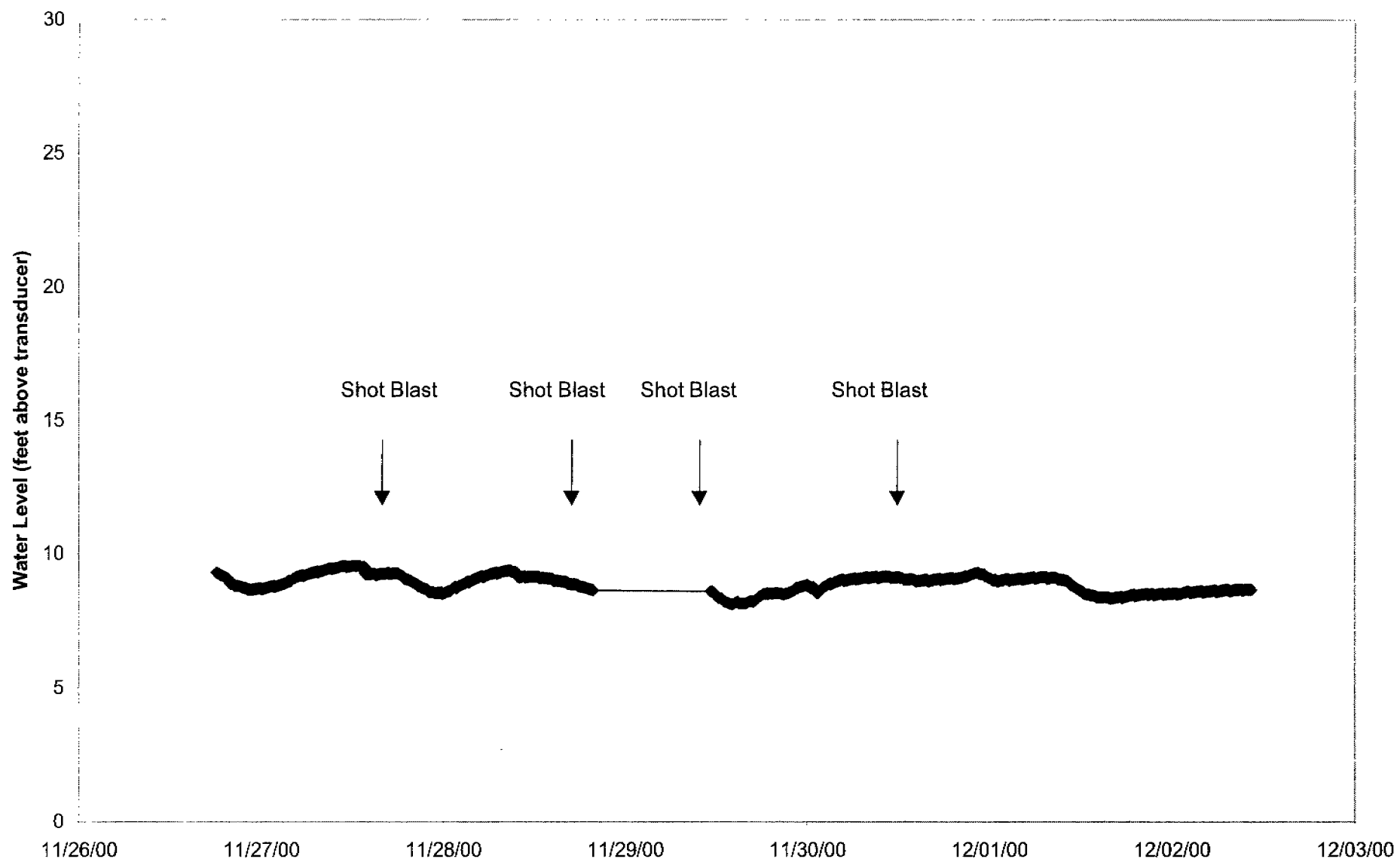


Water pH
Site WV-1 Well-1
Fall-Winter 2000

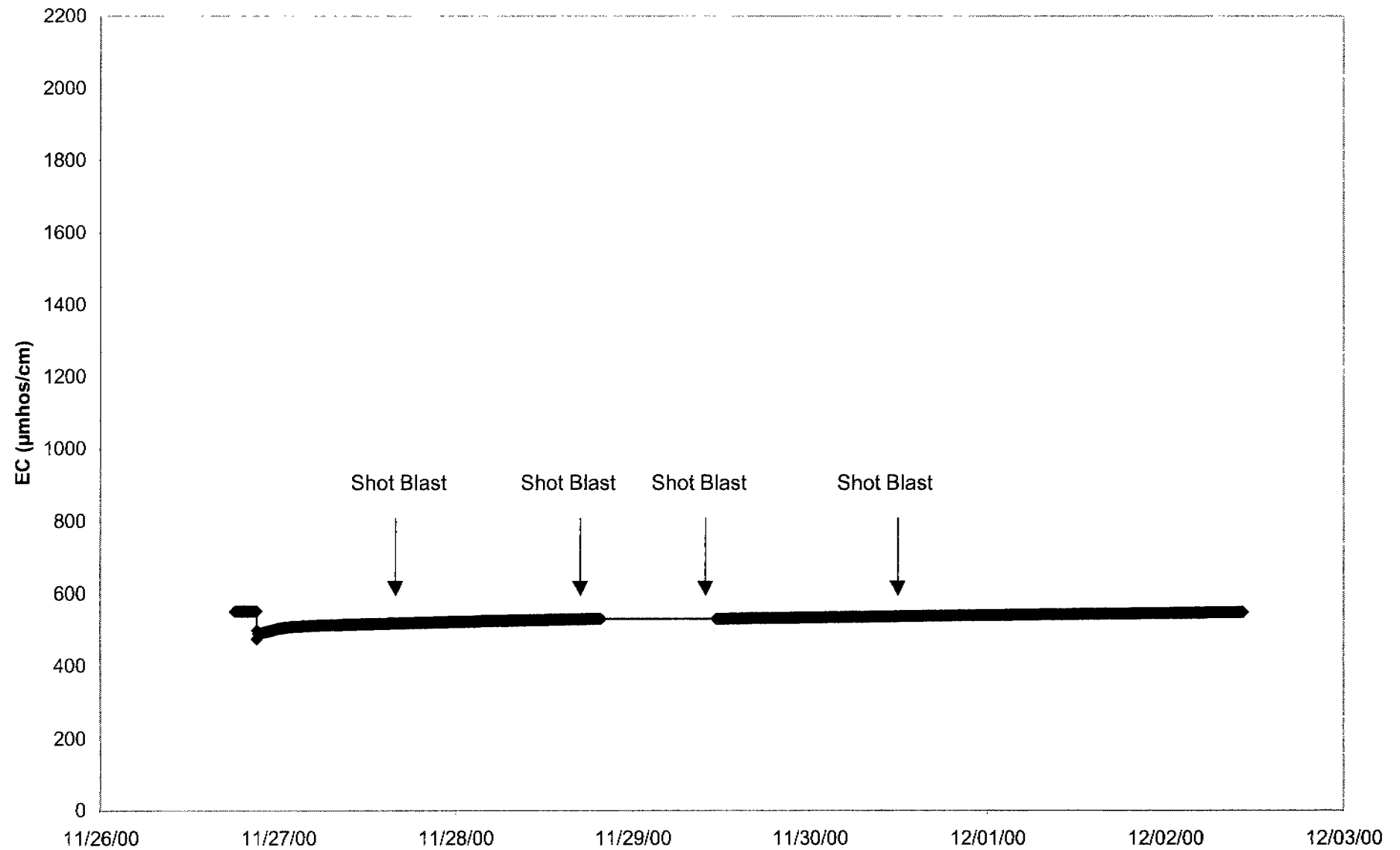


The graph displays flow rate data over a period of seven days. The y-axis is labeled 'Flow (gal/min)' and ranges from 0 to 26 in increments of 2. The x-axis shows dates from 11/26/00 to 12/03/00. The flow rate is generally stable, fluctuating between 4 and 6 gal/min. There are four distinct events labeled 'Shot Blast' with arrows pointing to the data points on 11/27/00, 11/28/00, 11/29/00, and 11/30/00. During these events, the flow rate drops to zero. The flow rate returns to its baseline level after each event.

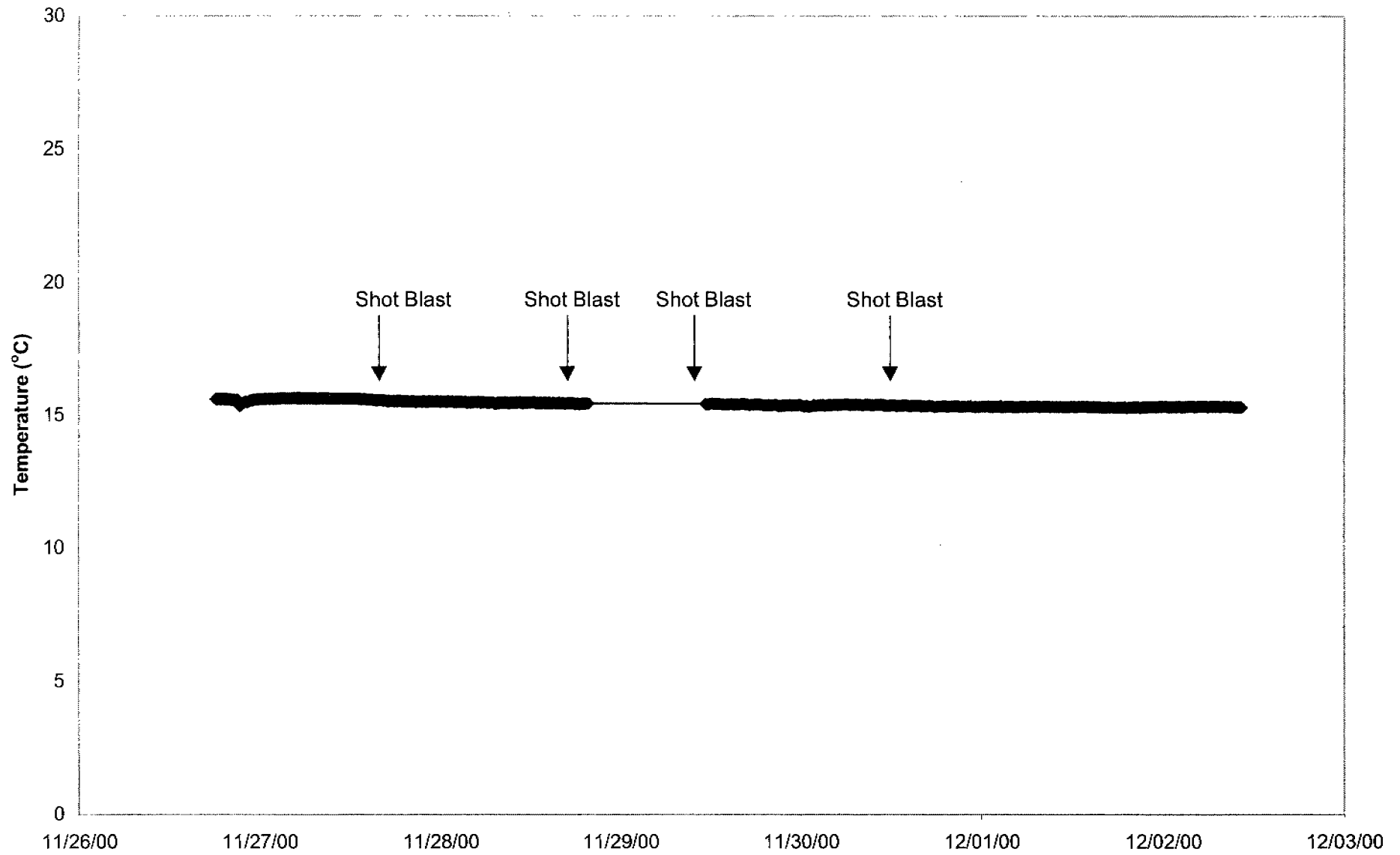
Water Level
Site WV-1 Well-2
Fall-Winter 2000



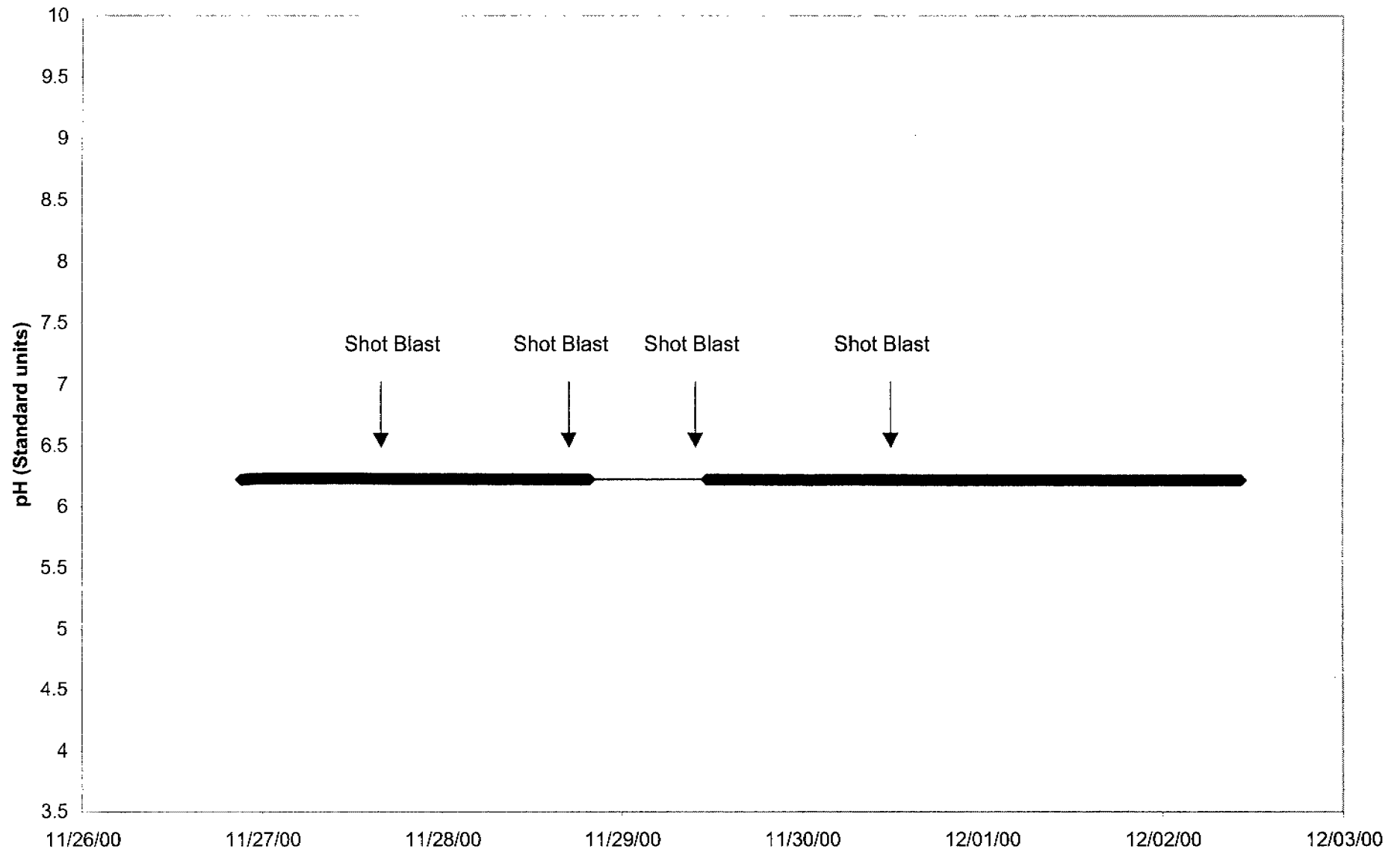
Well EC
Site WV-1 Site-2
Fall-Winter 2000



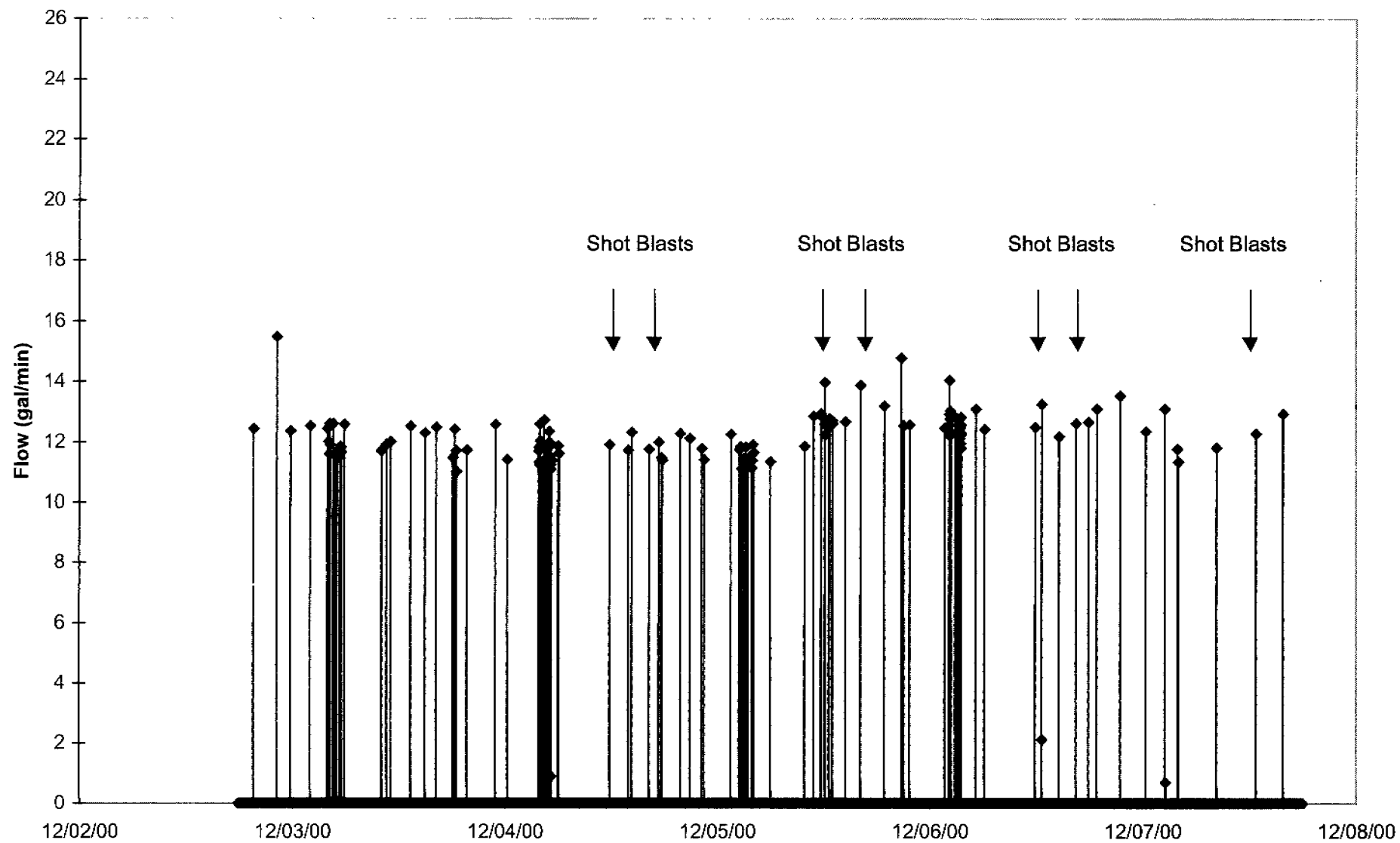
Water Temperature
Site WV-1 Well-2
Fall-Winter 2000



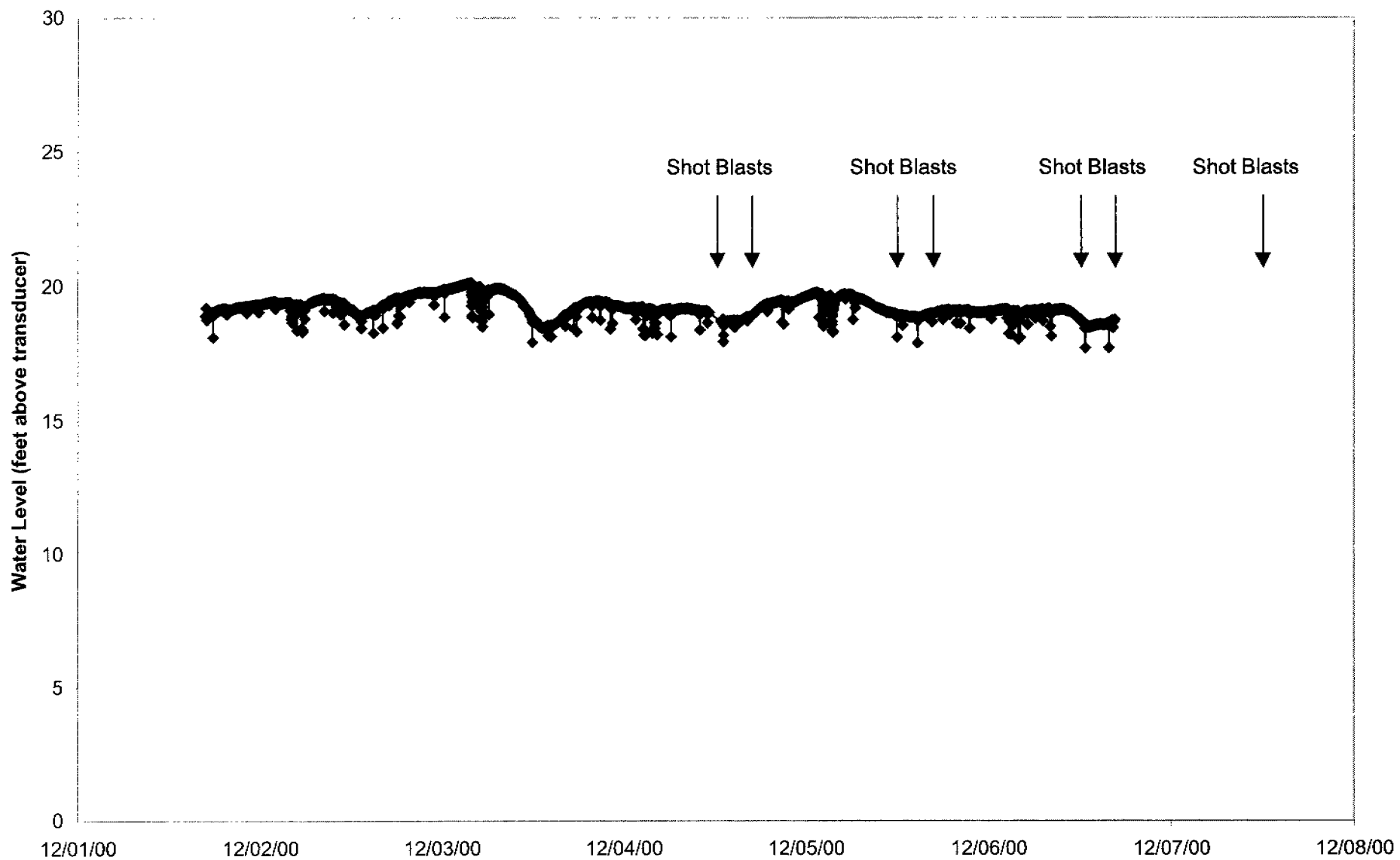
Water pH
Site WV-1 Well-2
Fall-Winter 2000



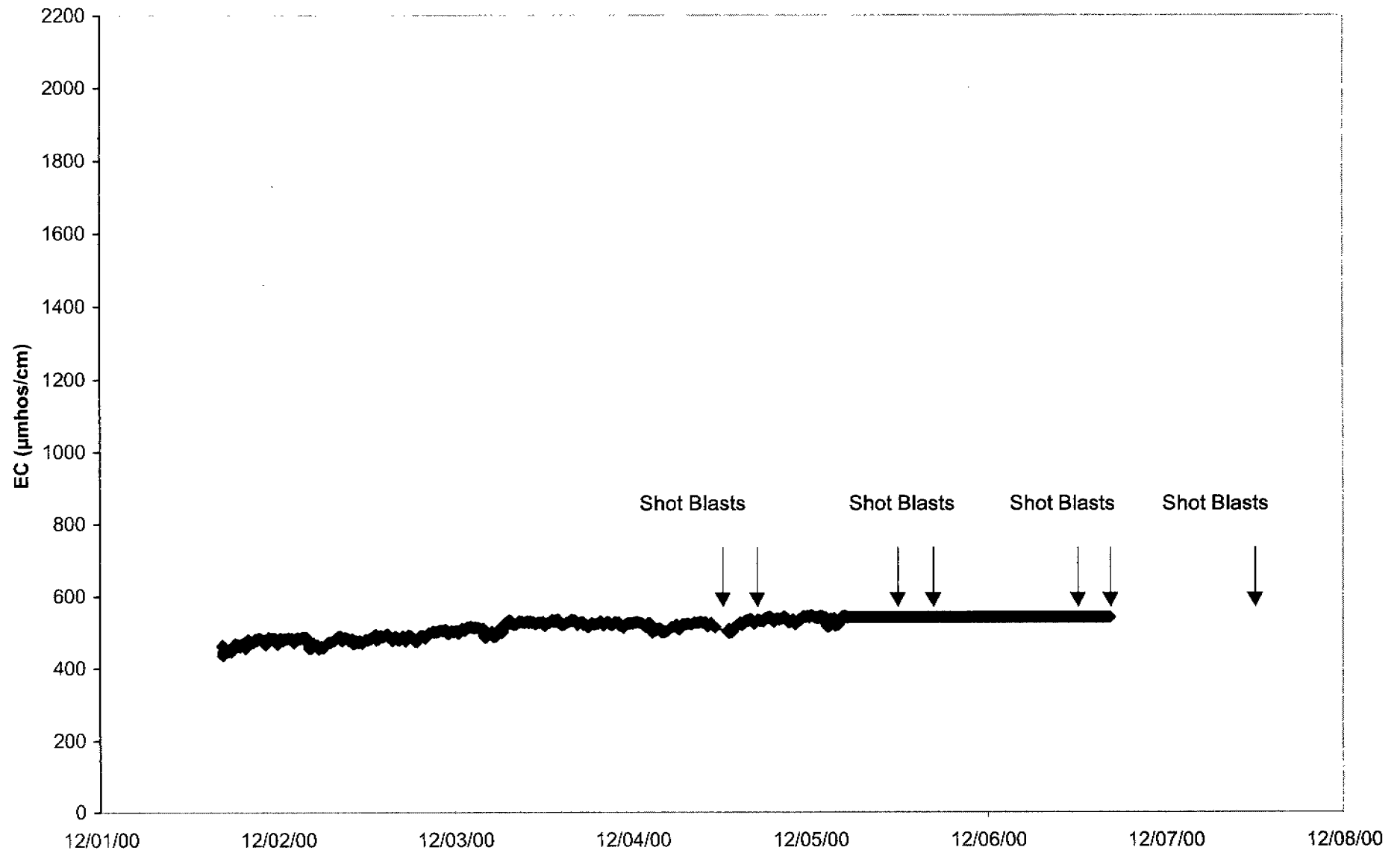
Fall-Winter 2000



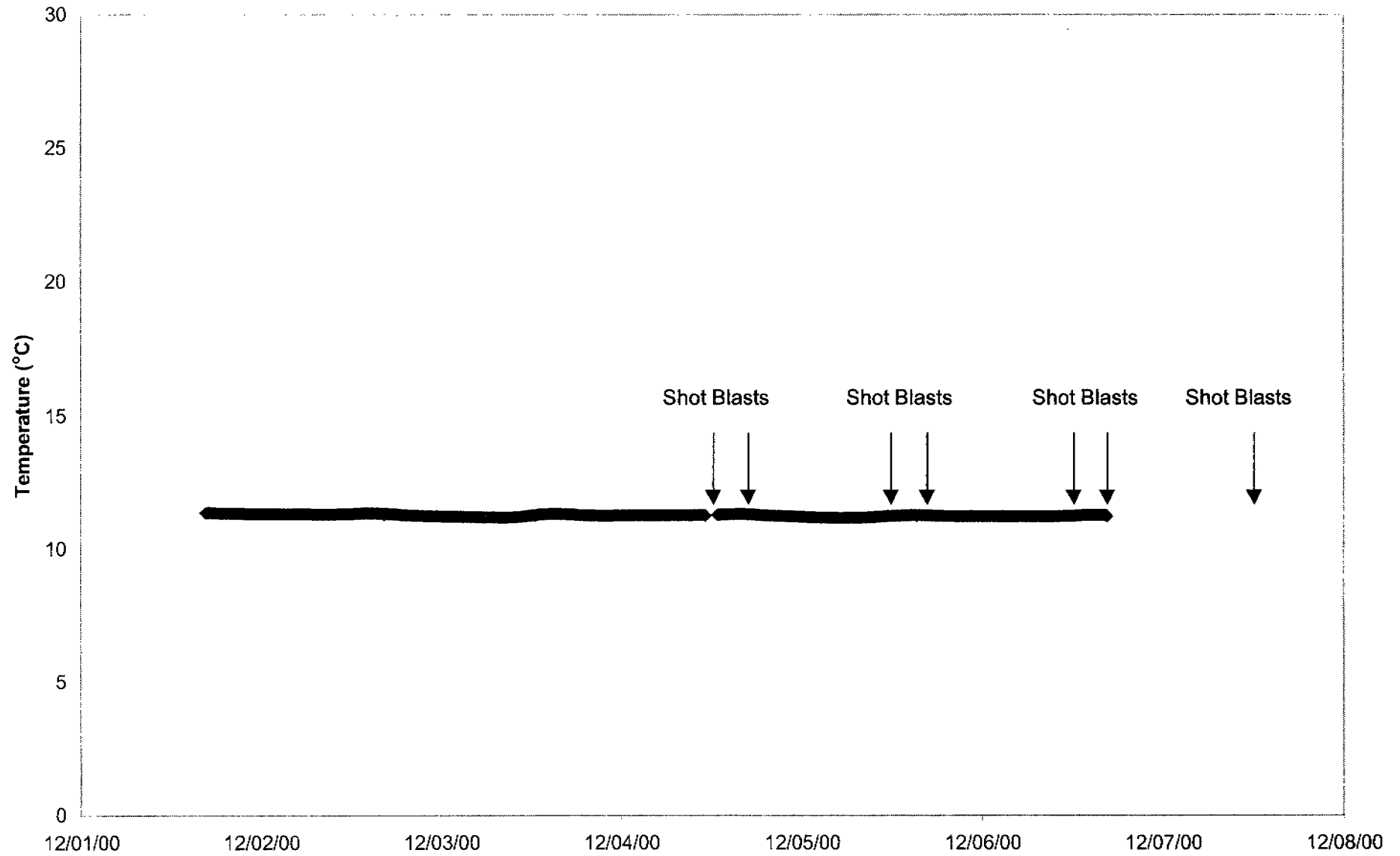
**Water Level
Site WV-2 Well-1
Fall-Winter 2000**



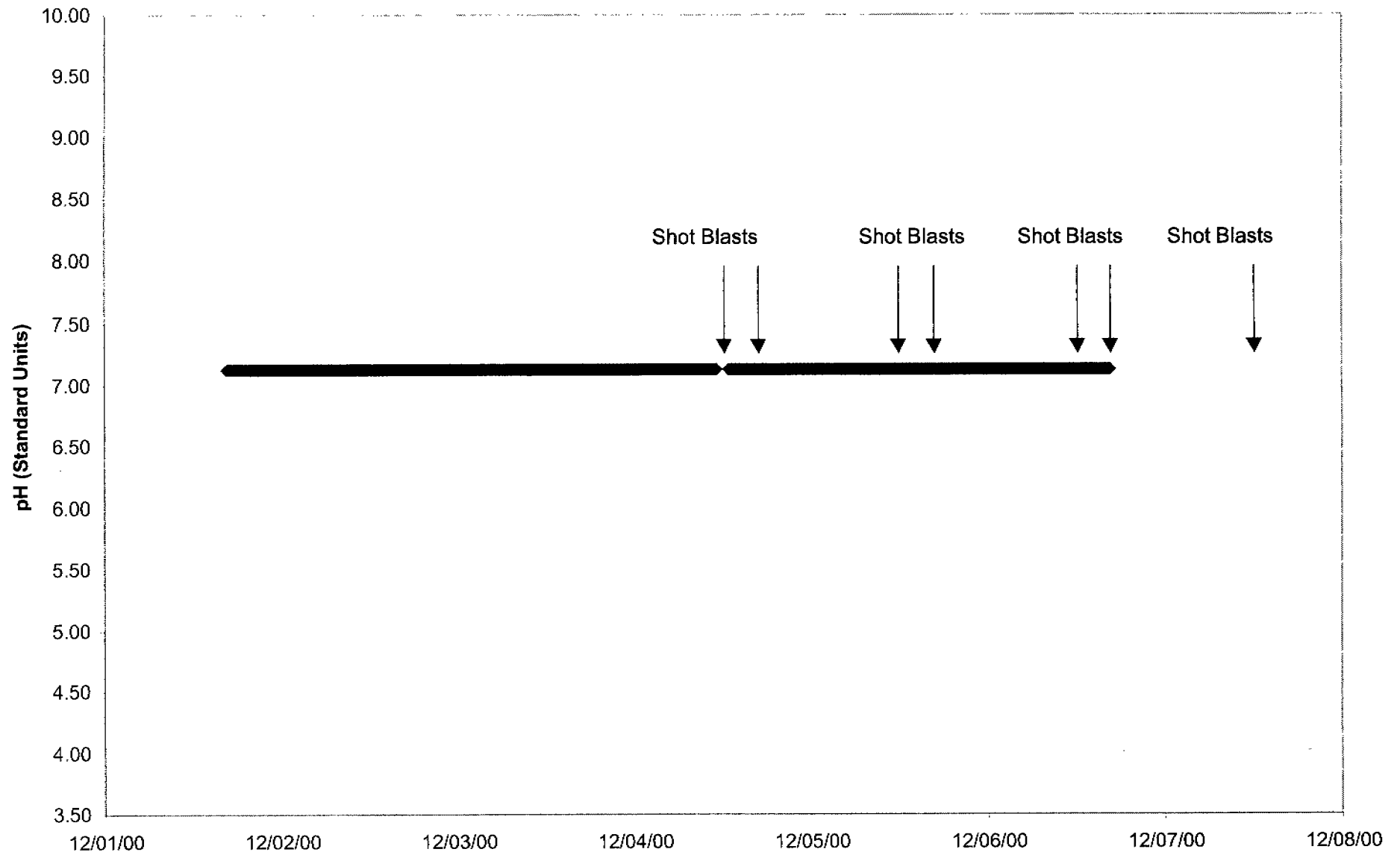
Well EC
Site WV-2 Well-1
Fall-Winter 2000



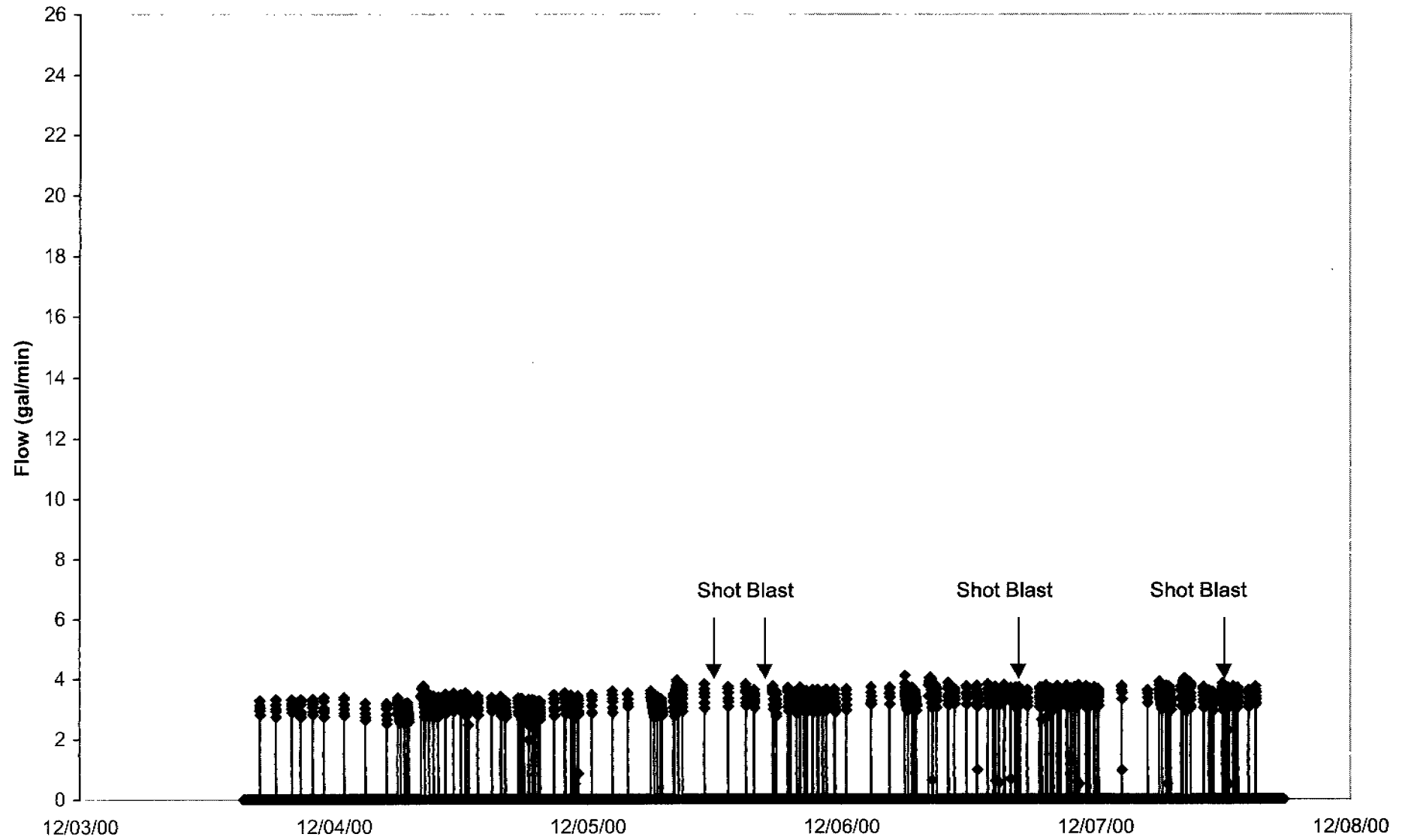
Water Temperature
Site WV-2 Well-1
Fall-Winter 2000



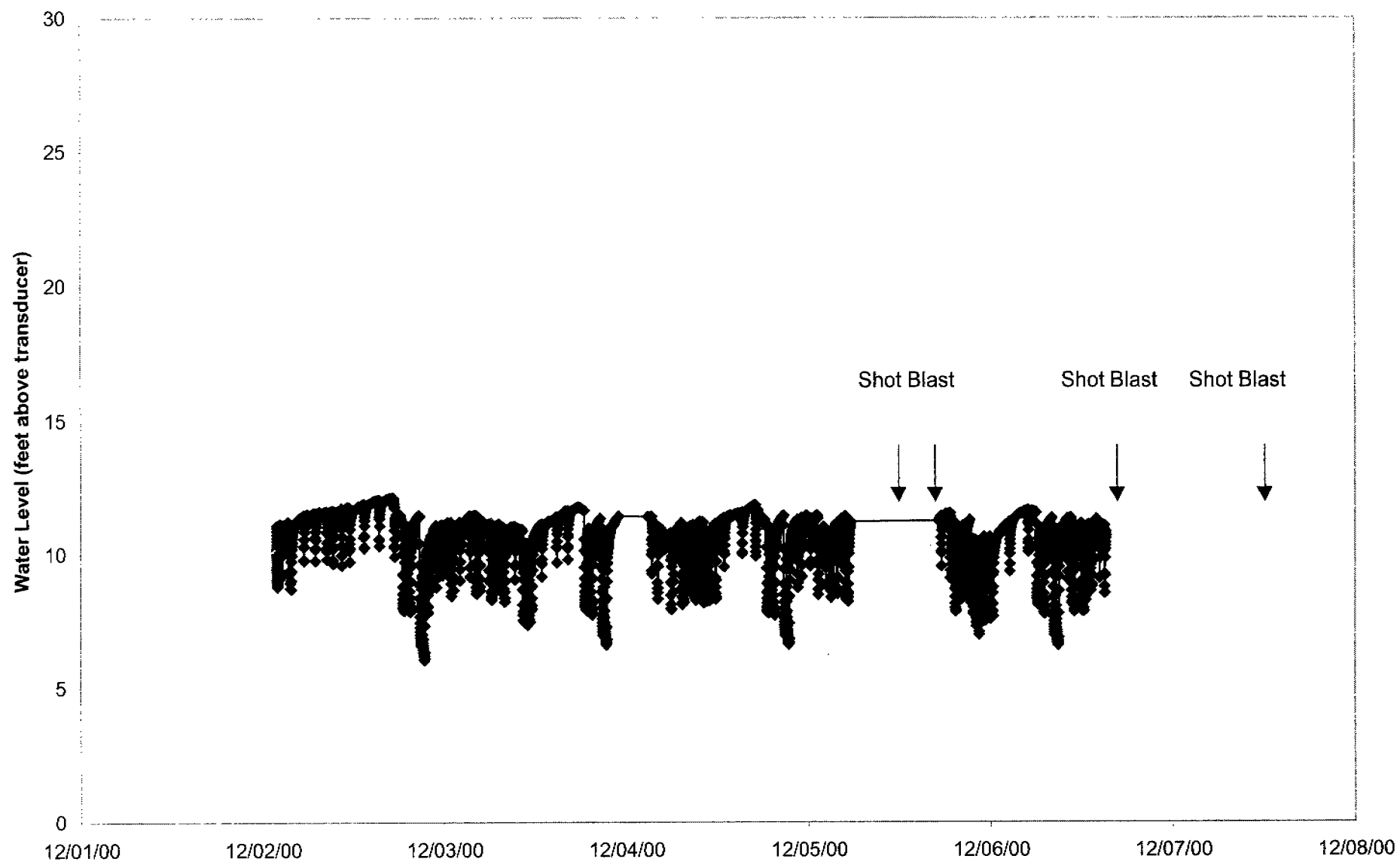
**Water pH
Site WV-2 Well-1
Fall-Winter 2000**



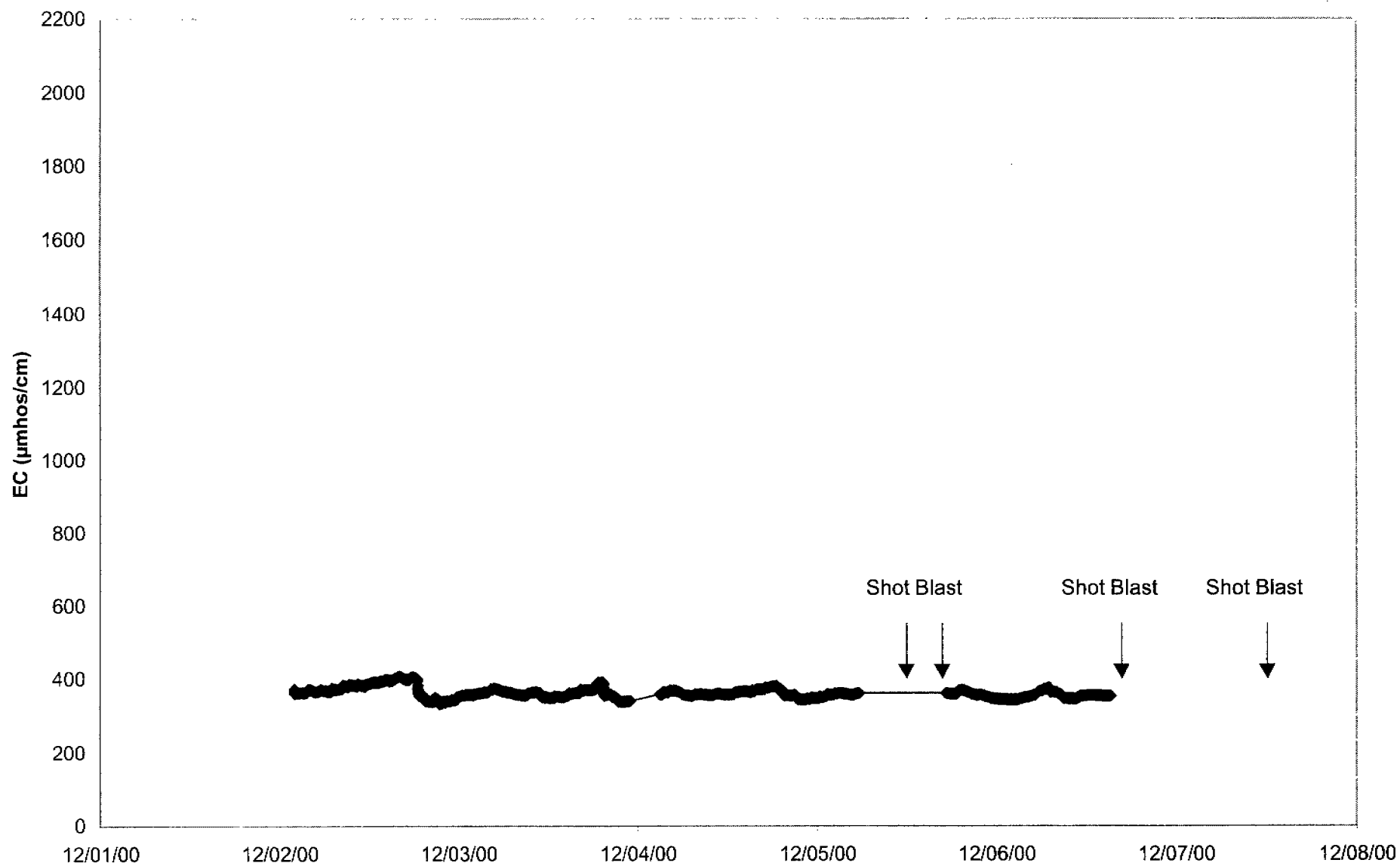
Well Yield
Site WV-2 Well-2
Fall-Winter 2000



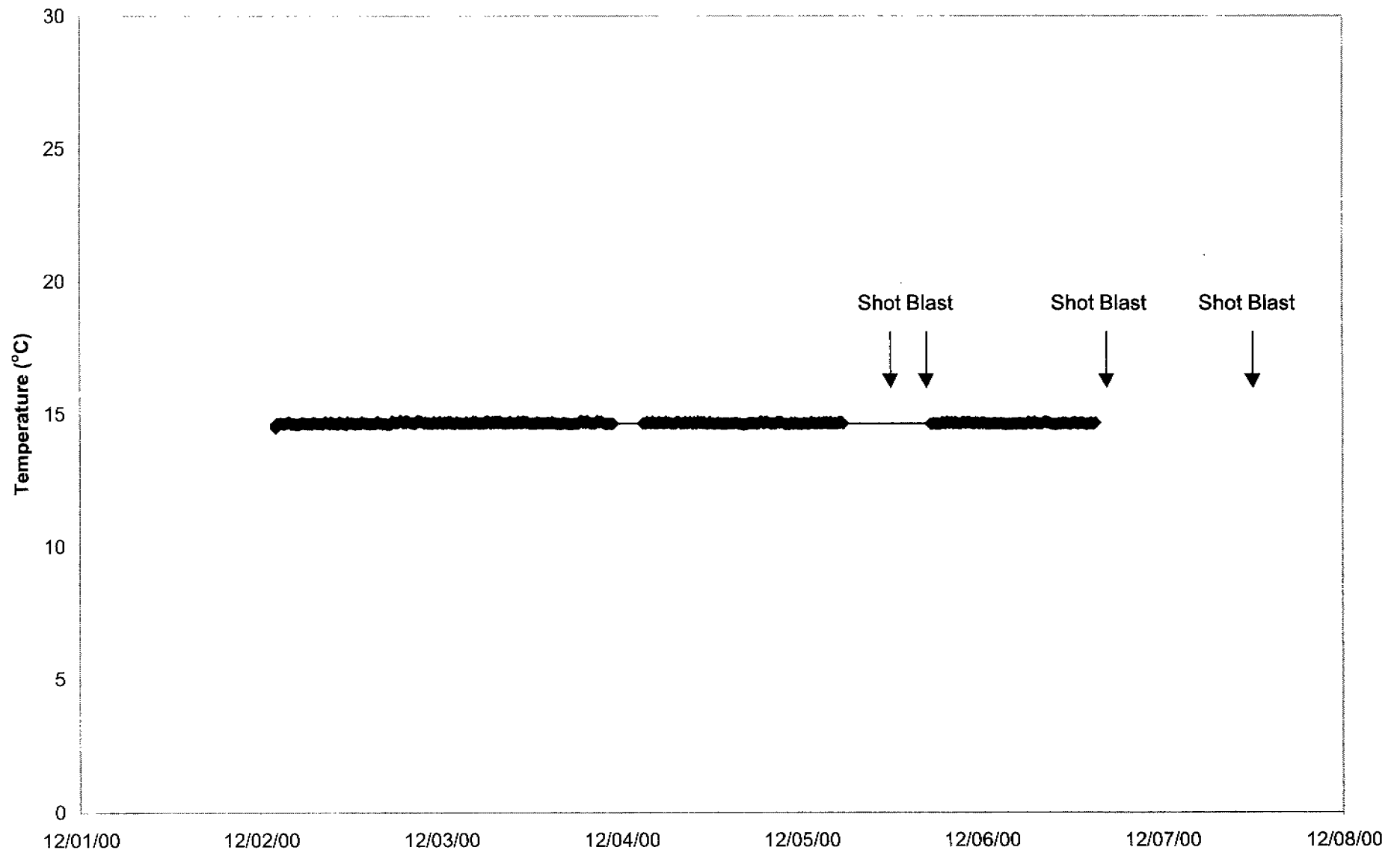
Water Level
Site WV-2 Well-2
Fall-Winter 2000



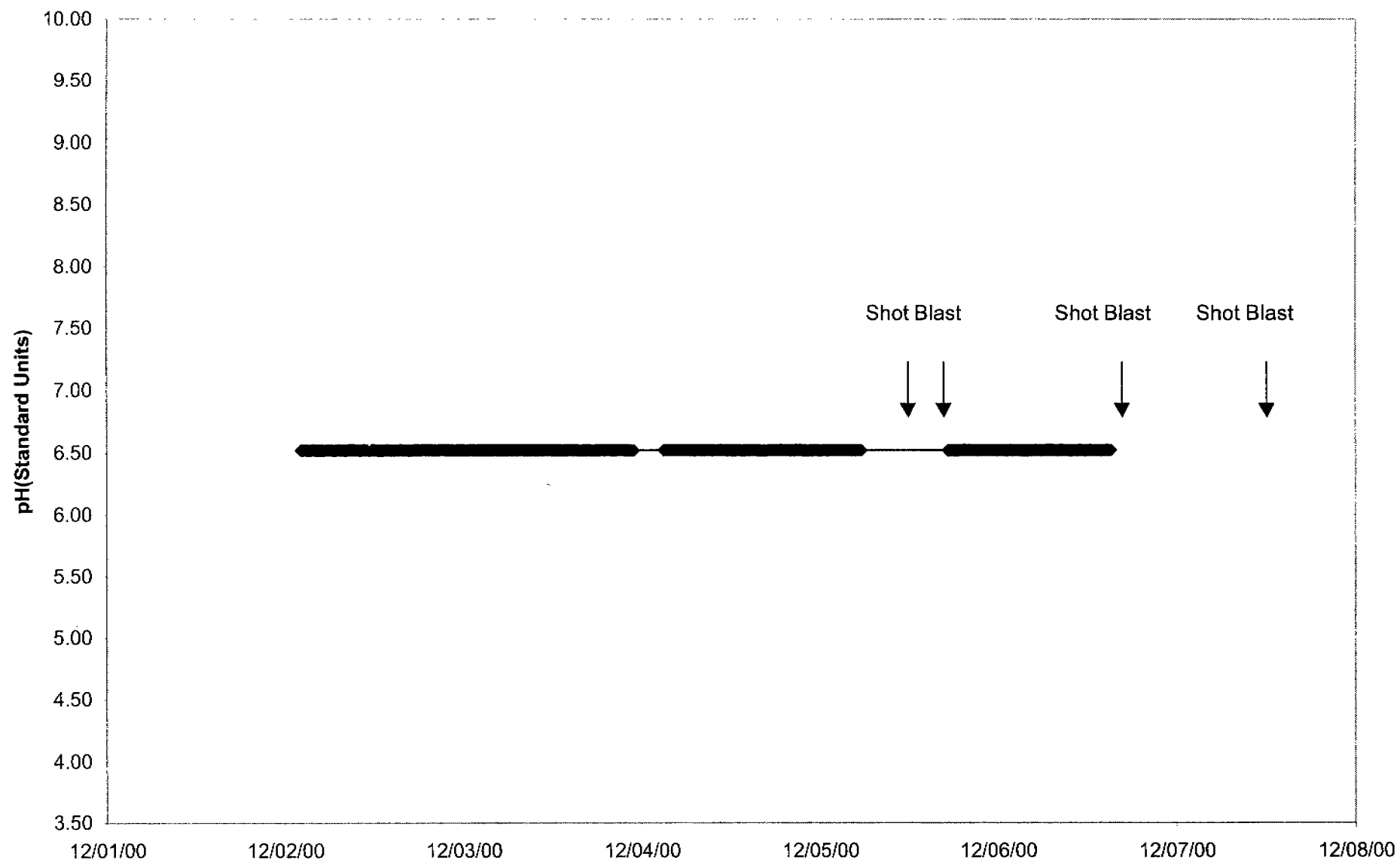
Well EC
Site WV-2 Well-2
Fall-Winter 2000



Water Temperature
Site WV-2 Well-2
Fall-Winter 2000



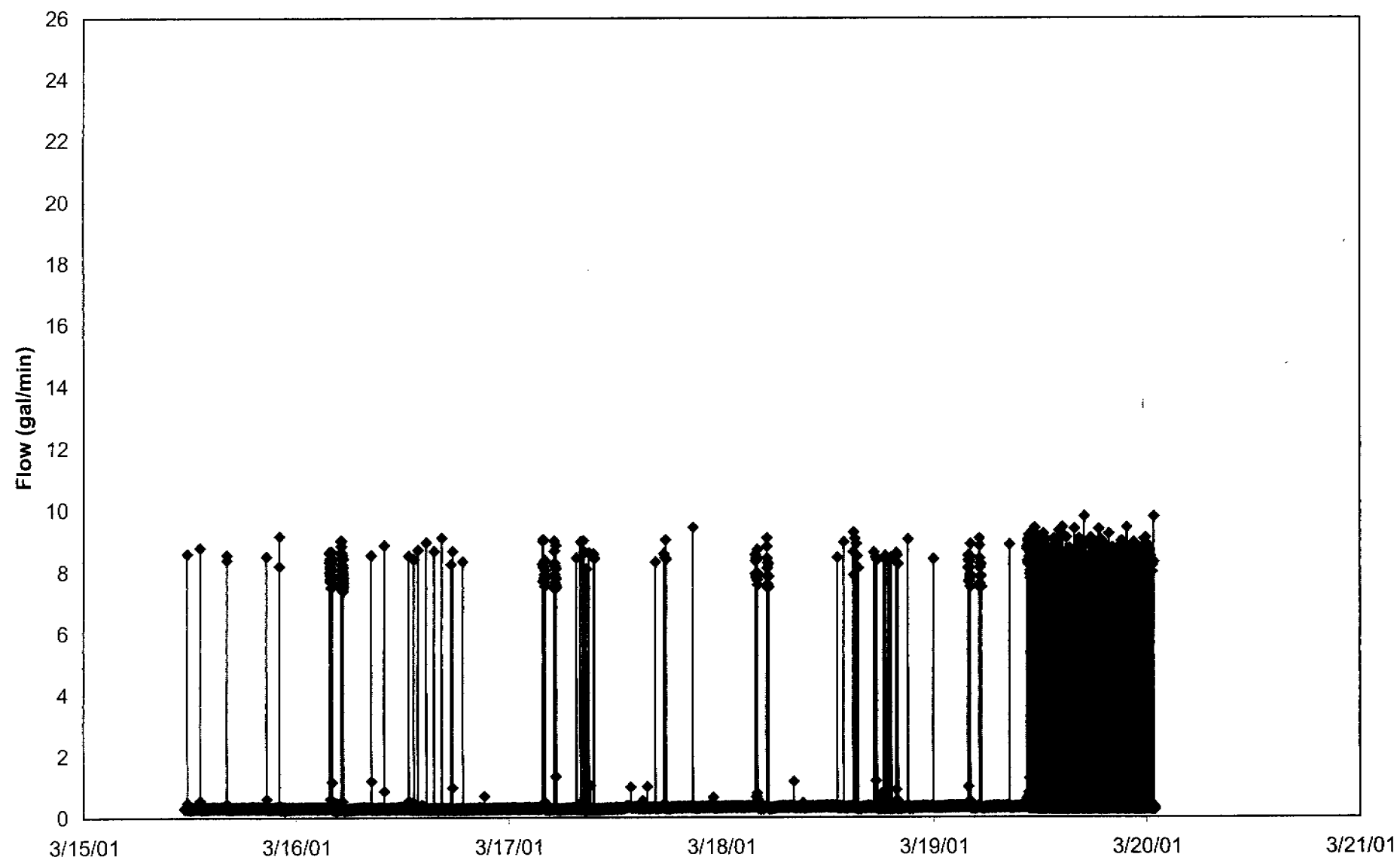
Water pH
Site WV-2 Well-2
Fall-Winter 2000



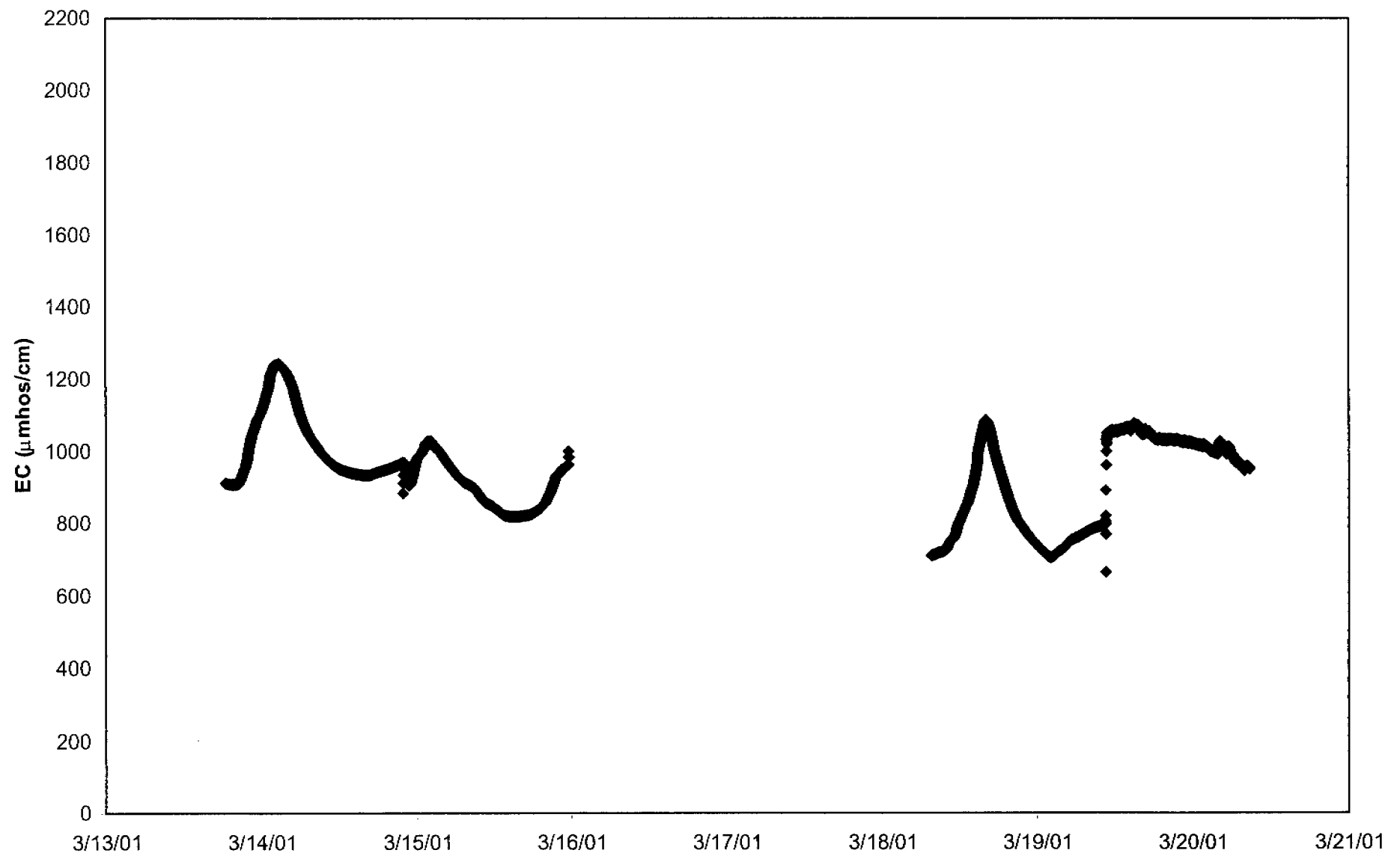
Appendix C2

Spring 2001

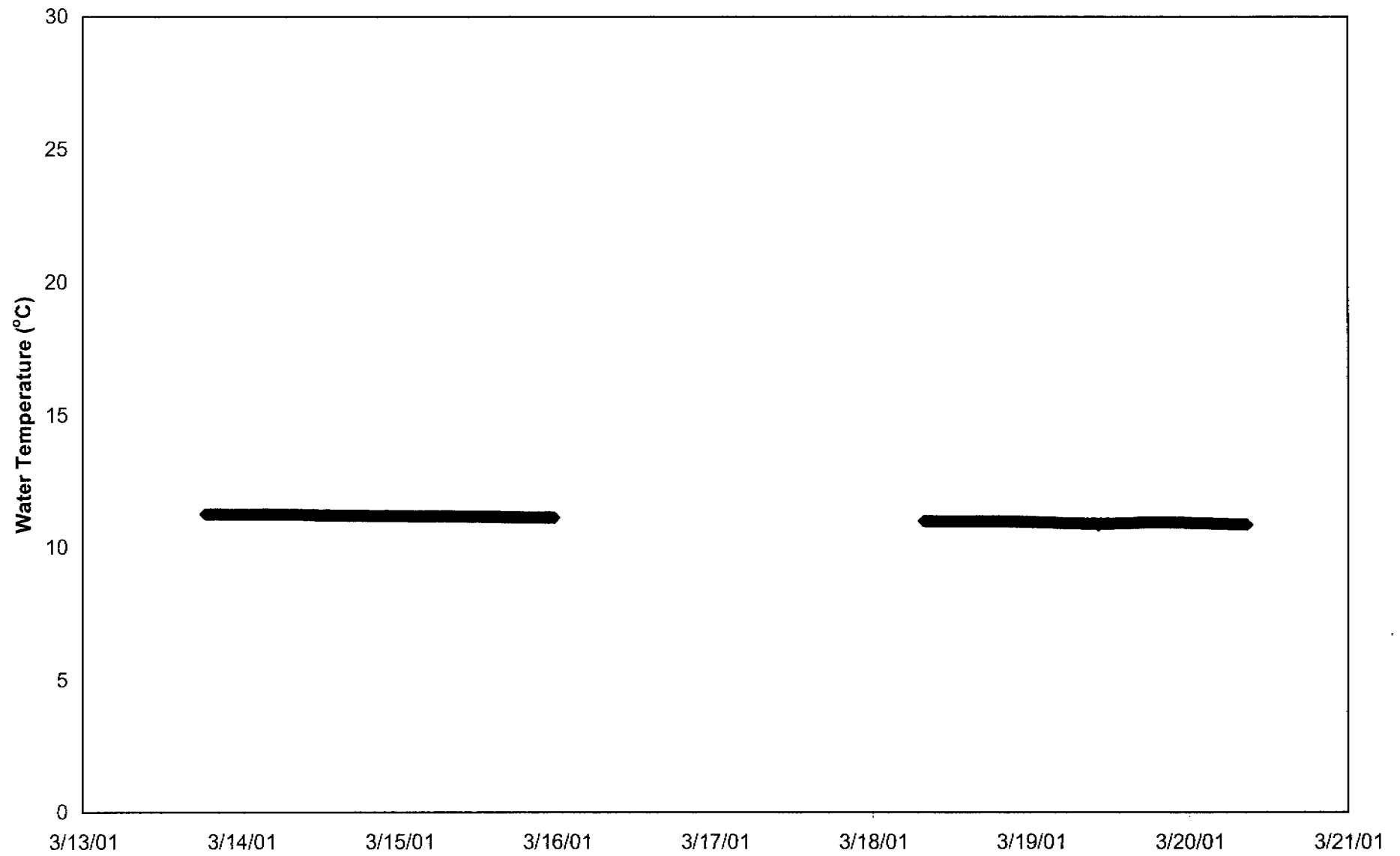
Well Yield
Site VA-1 Well-1
Spring 2001



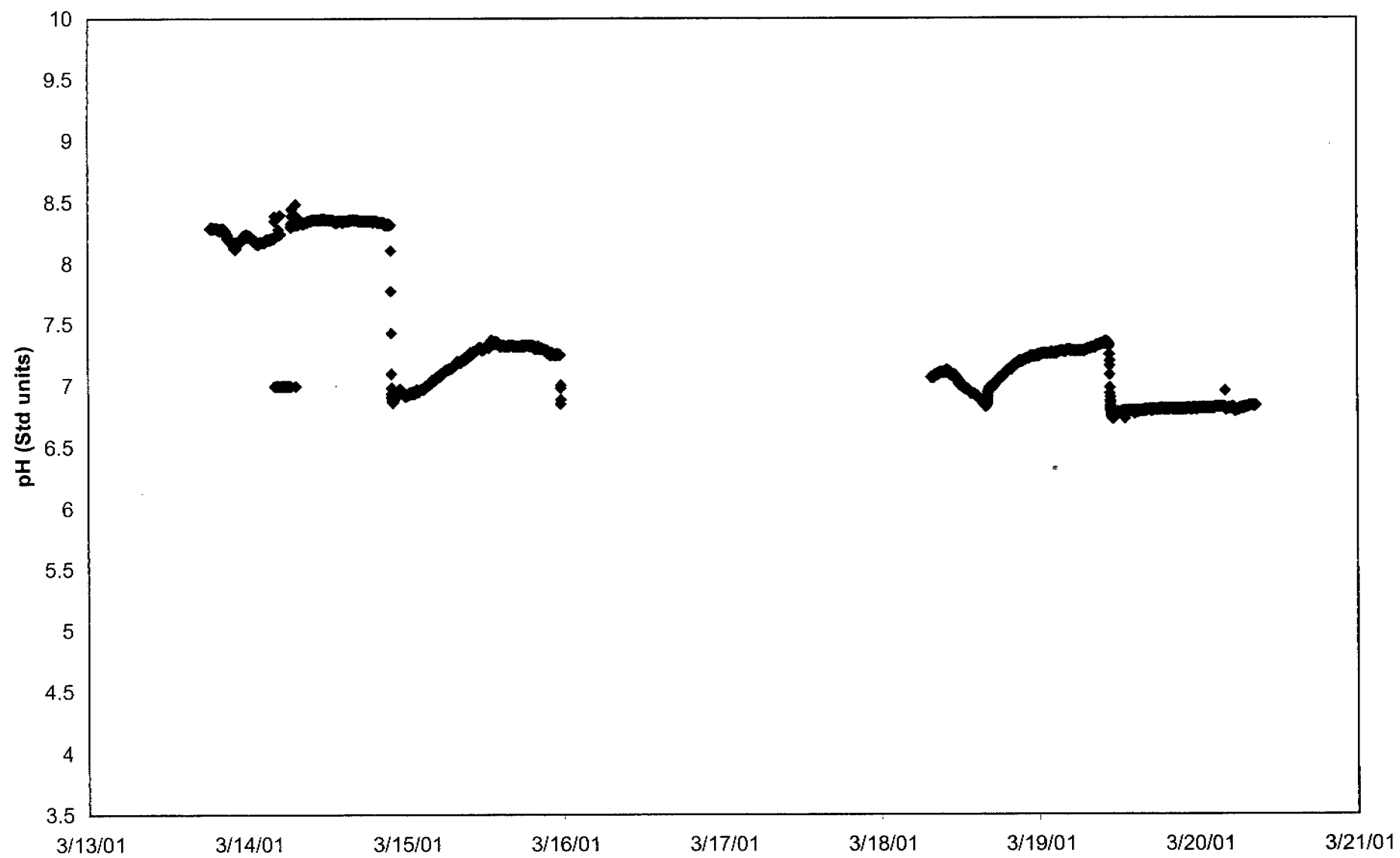
Well EC
Site VA-1 Well-1
Spring 2001



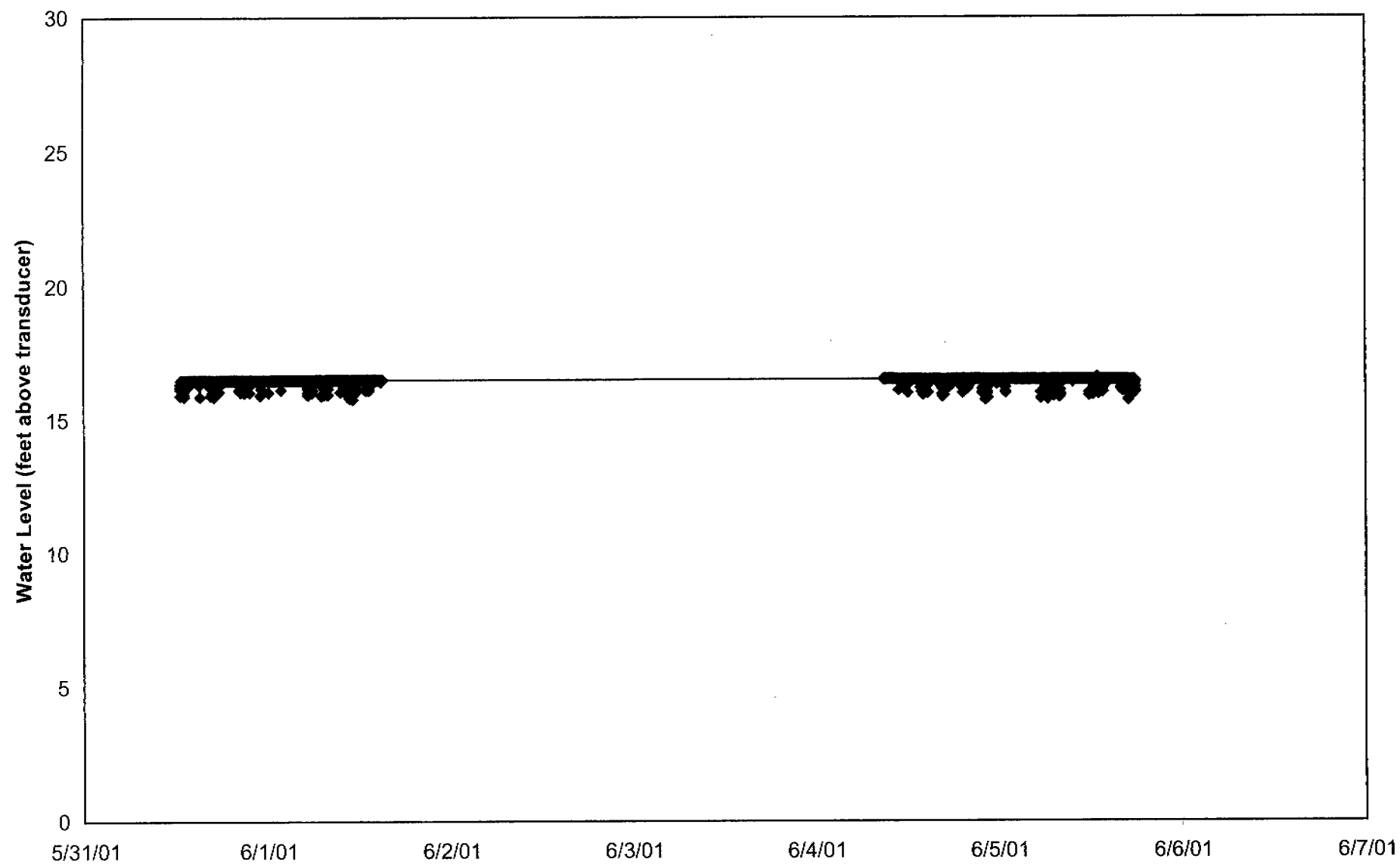
Water Temperature
Site VA-1 Well-1
Spring 2001



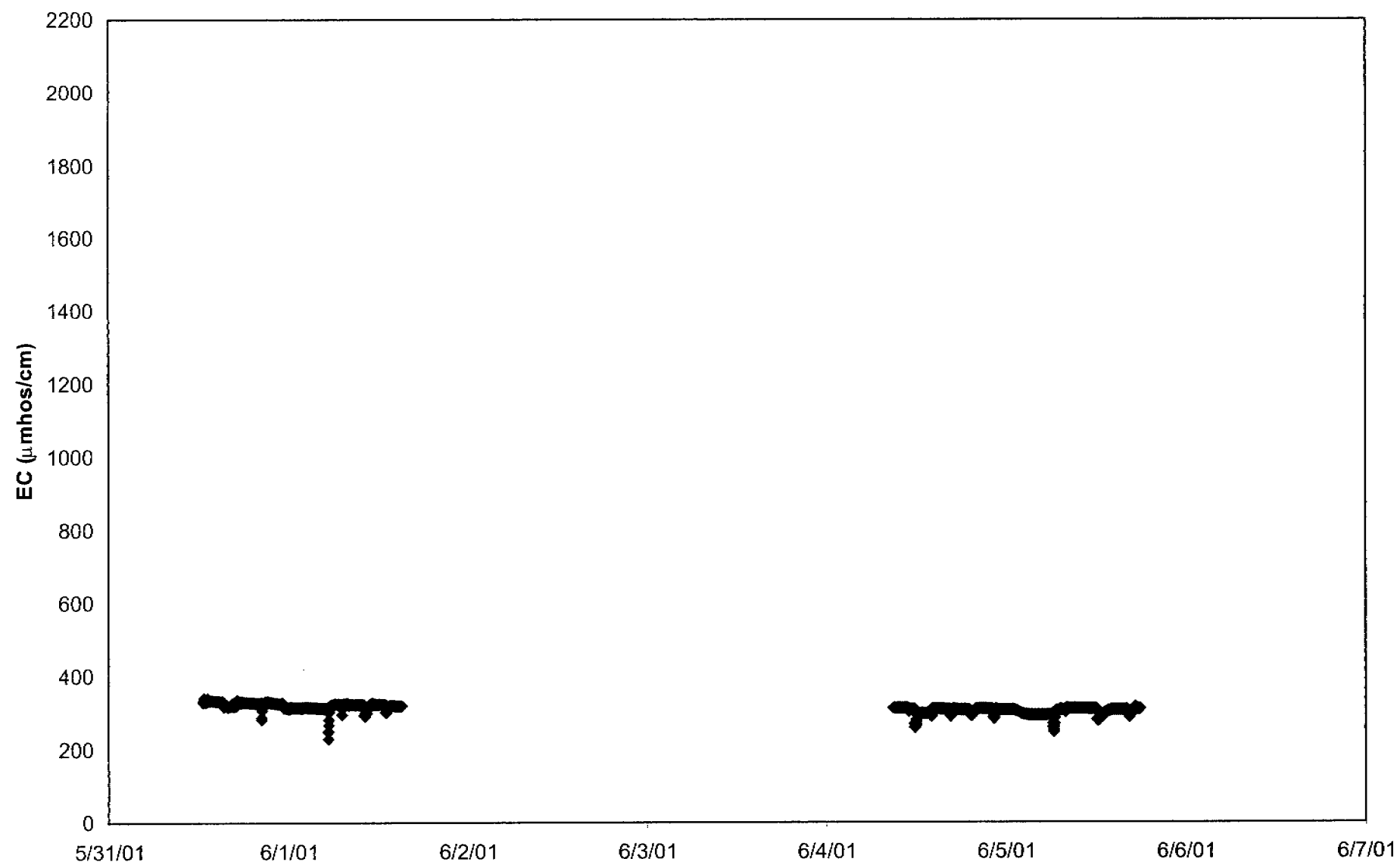
Water pH
Site VA-1 Well-1
Spring 2001



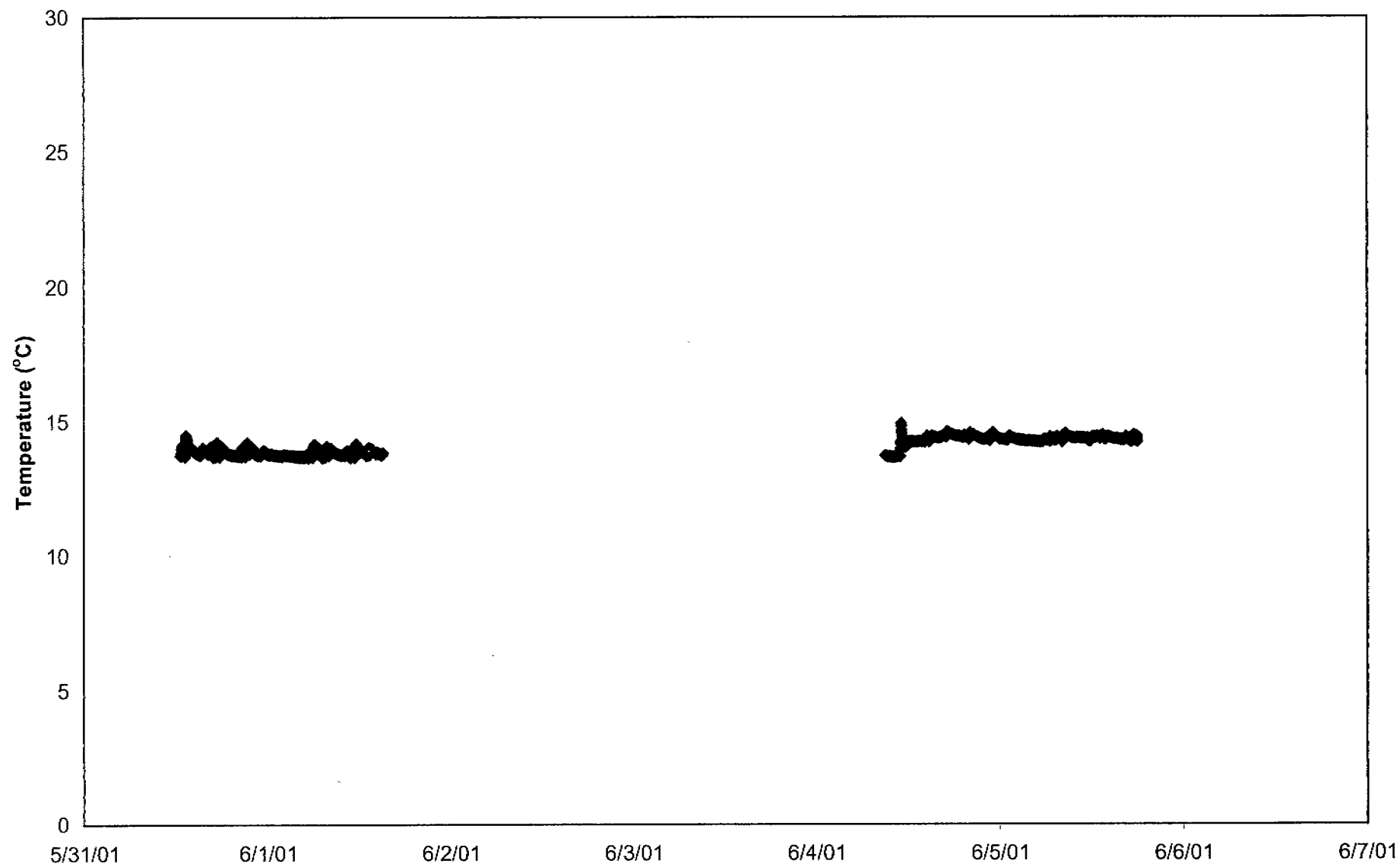
Water Level
Site KY-2 Well-2
Spring 2001



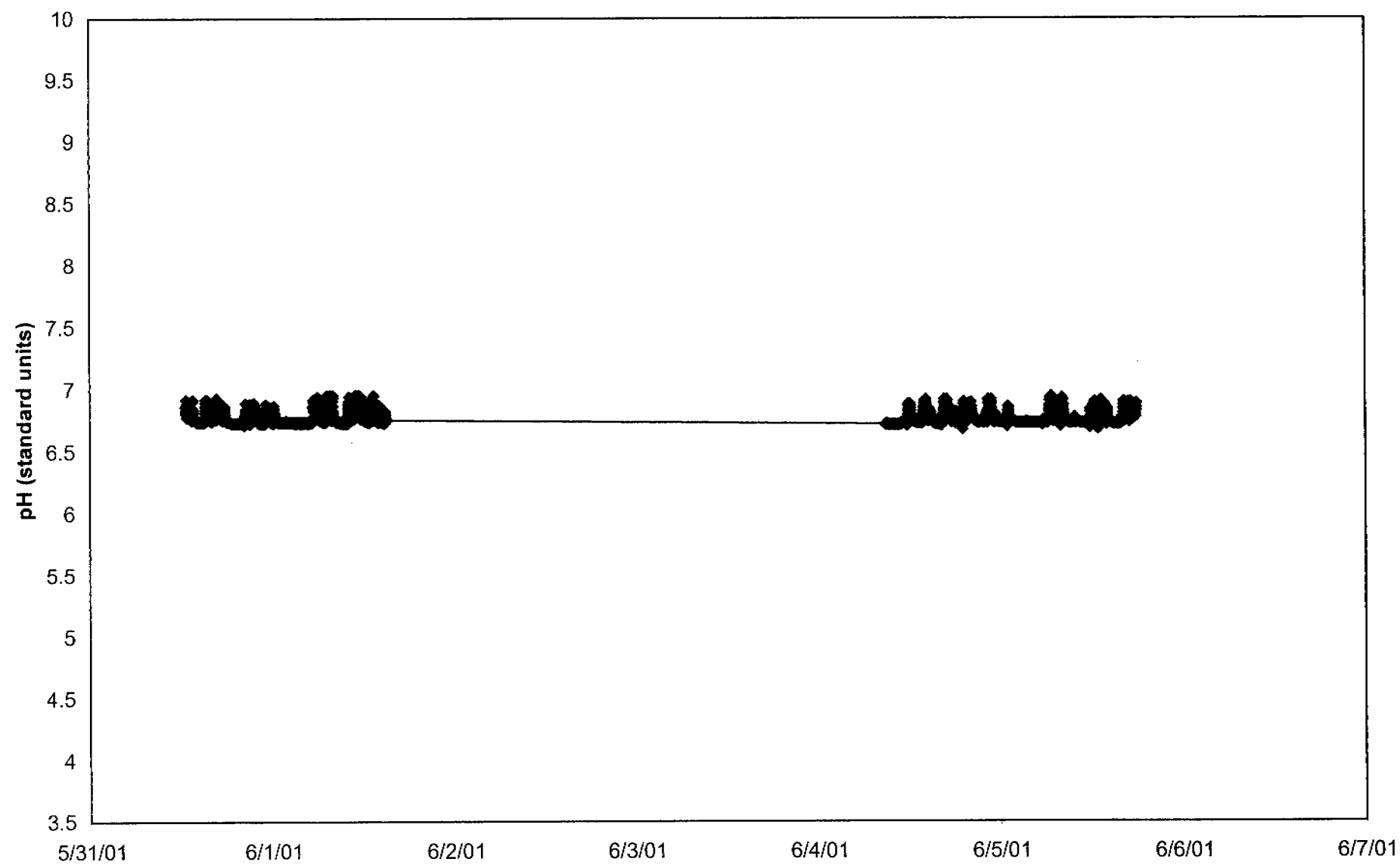
Well EC
Site KY-2 Well-2
Spring 2001



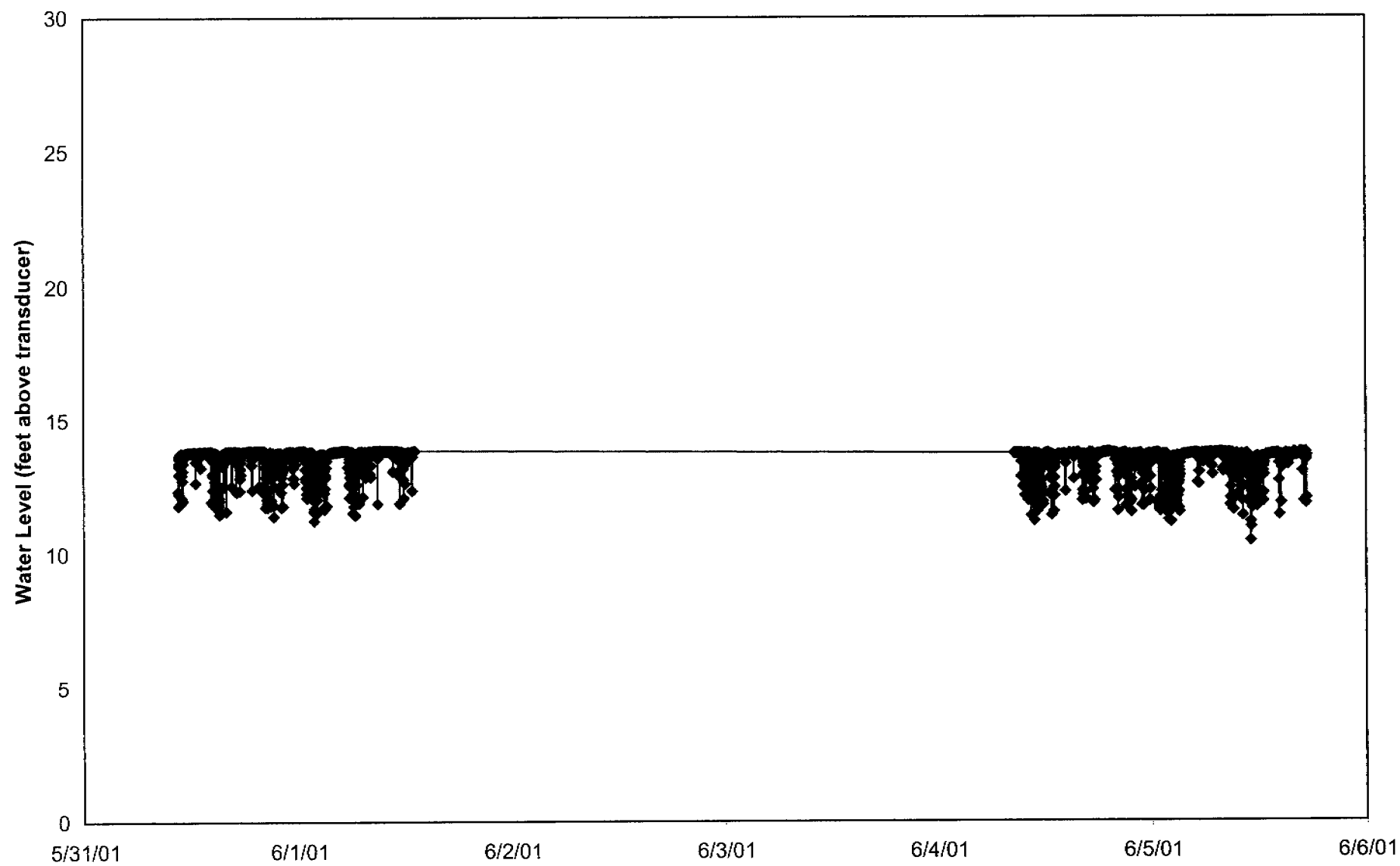
Water Temperature
Site KY-2 Well-2
Spring 2001



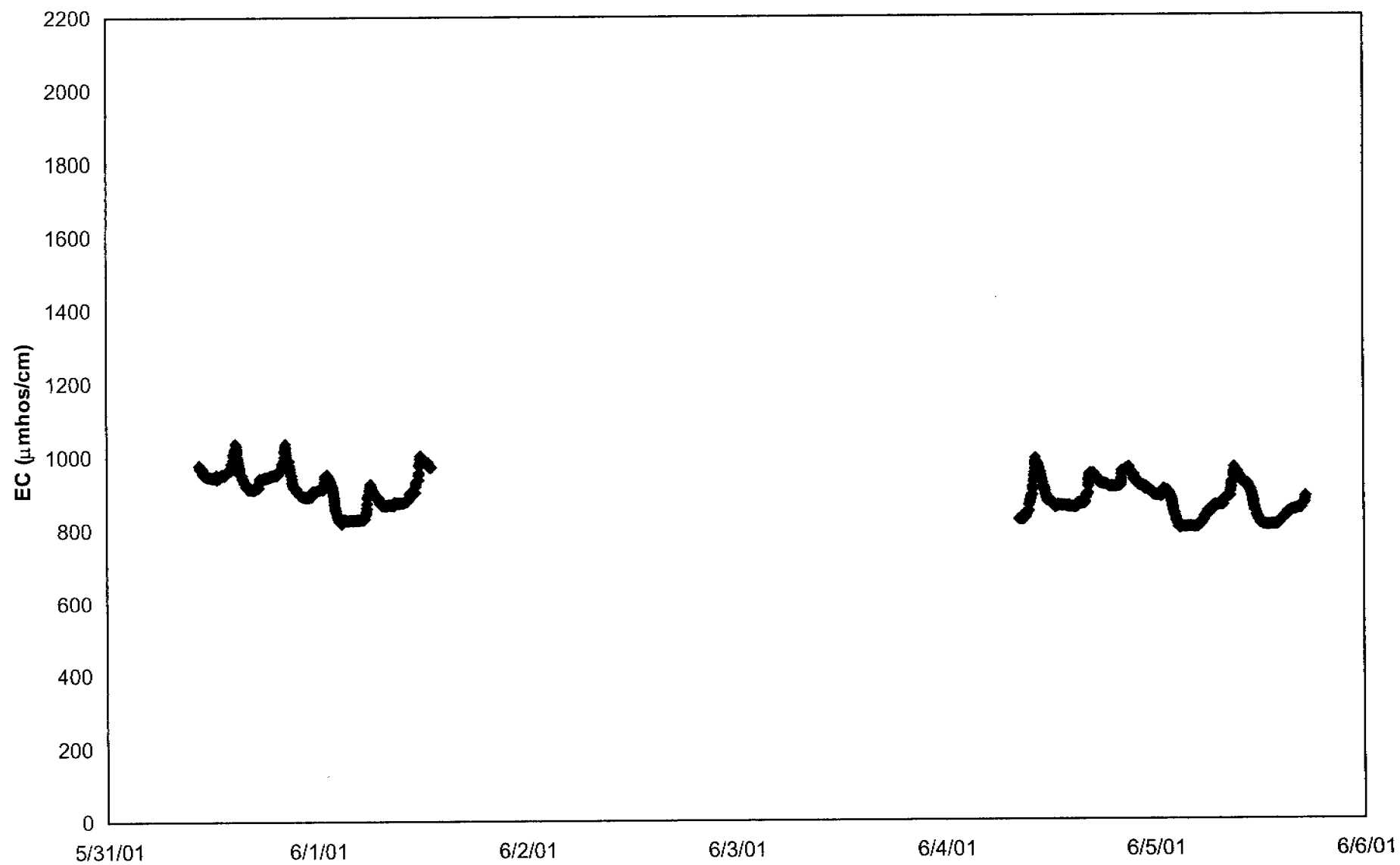
Water pH
Site KY-2 Well-2
Spring 2001



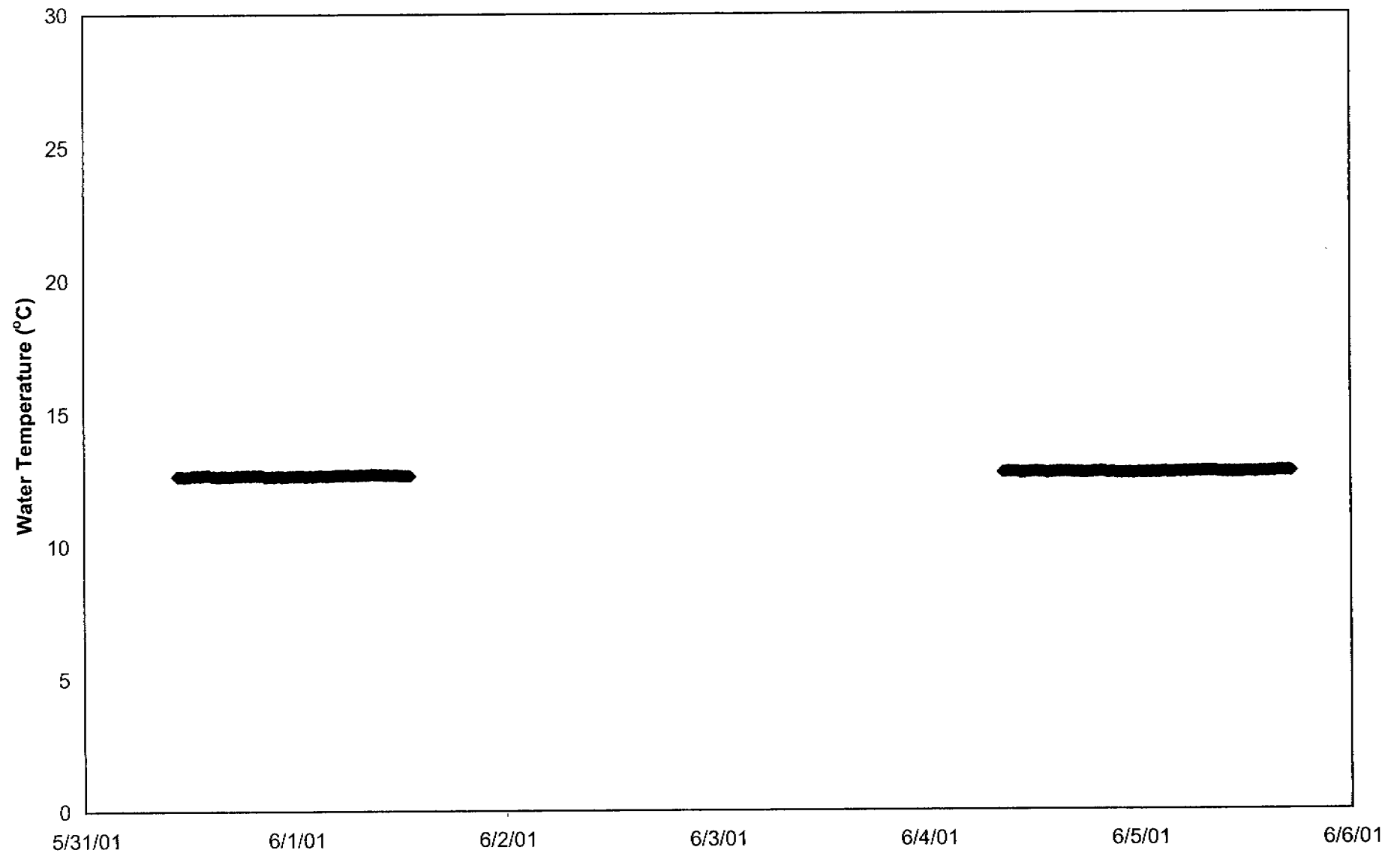
Water Level
Site KY-2 Well-3
Spring 2001



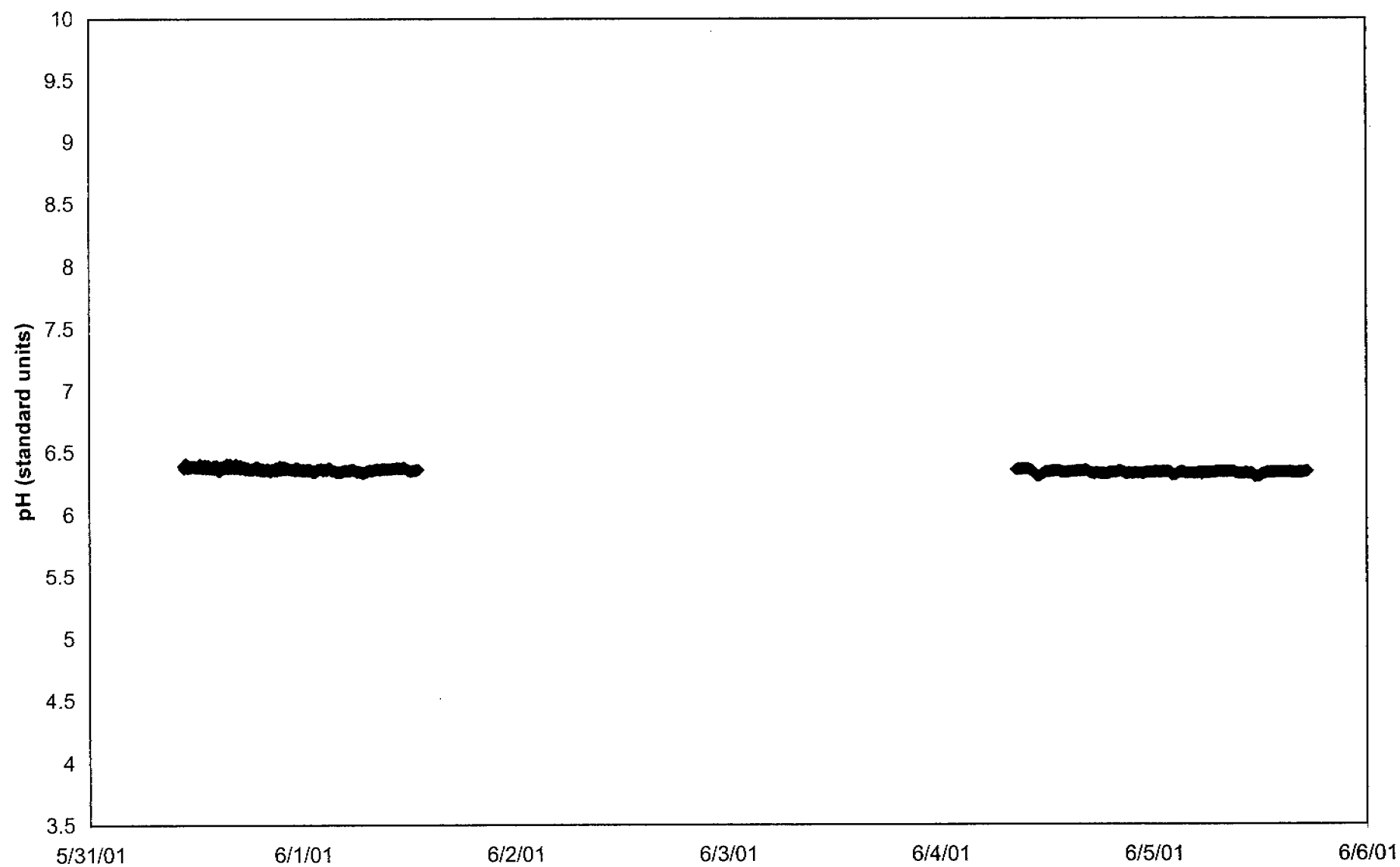
Well EC
Site KY-2 Well-3
Spring 2001



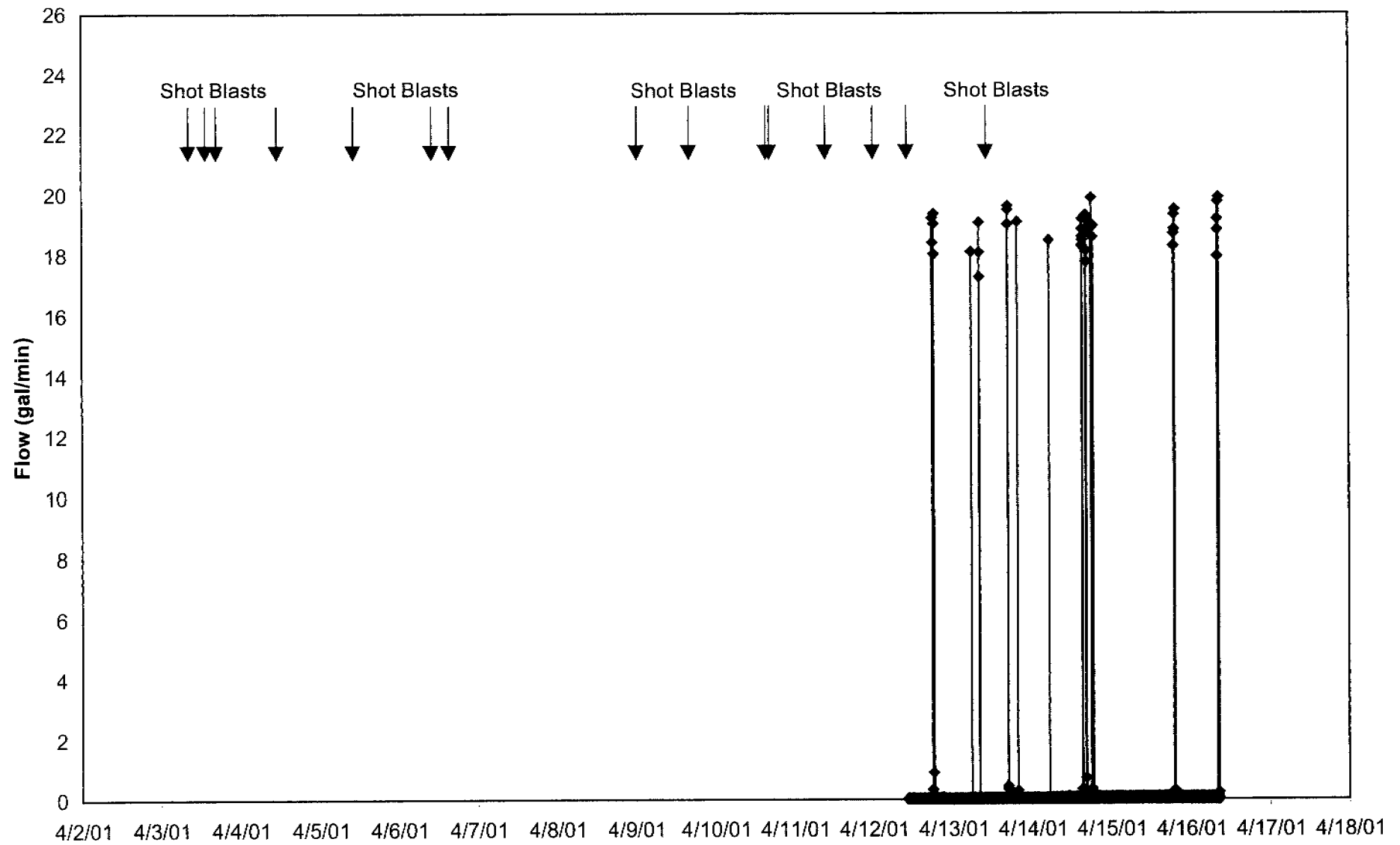
Water Temperature
Site KY-2 Well-3
Spring 2001



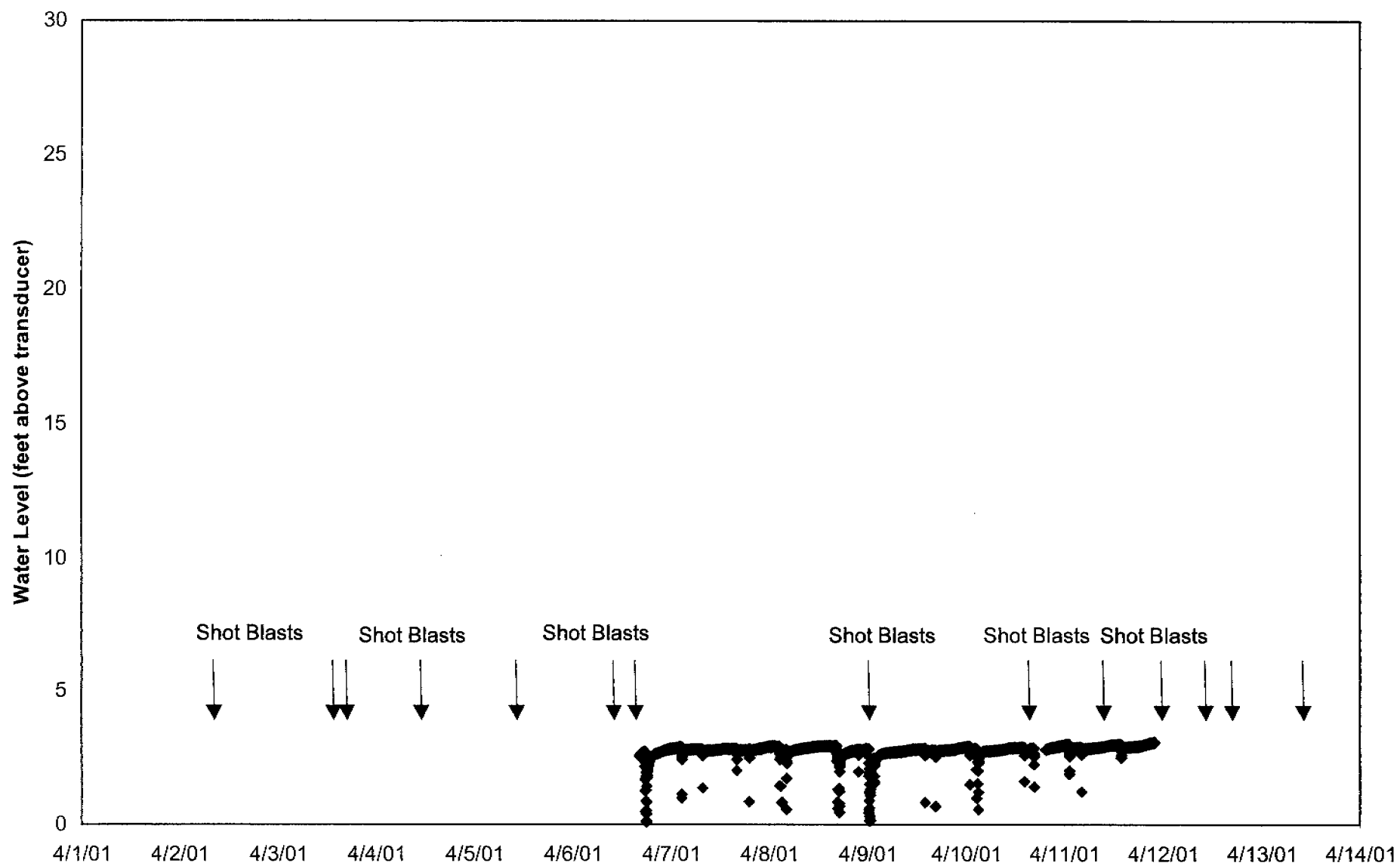
Water pH
Site KY-2 Well-3
Spring 2001



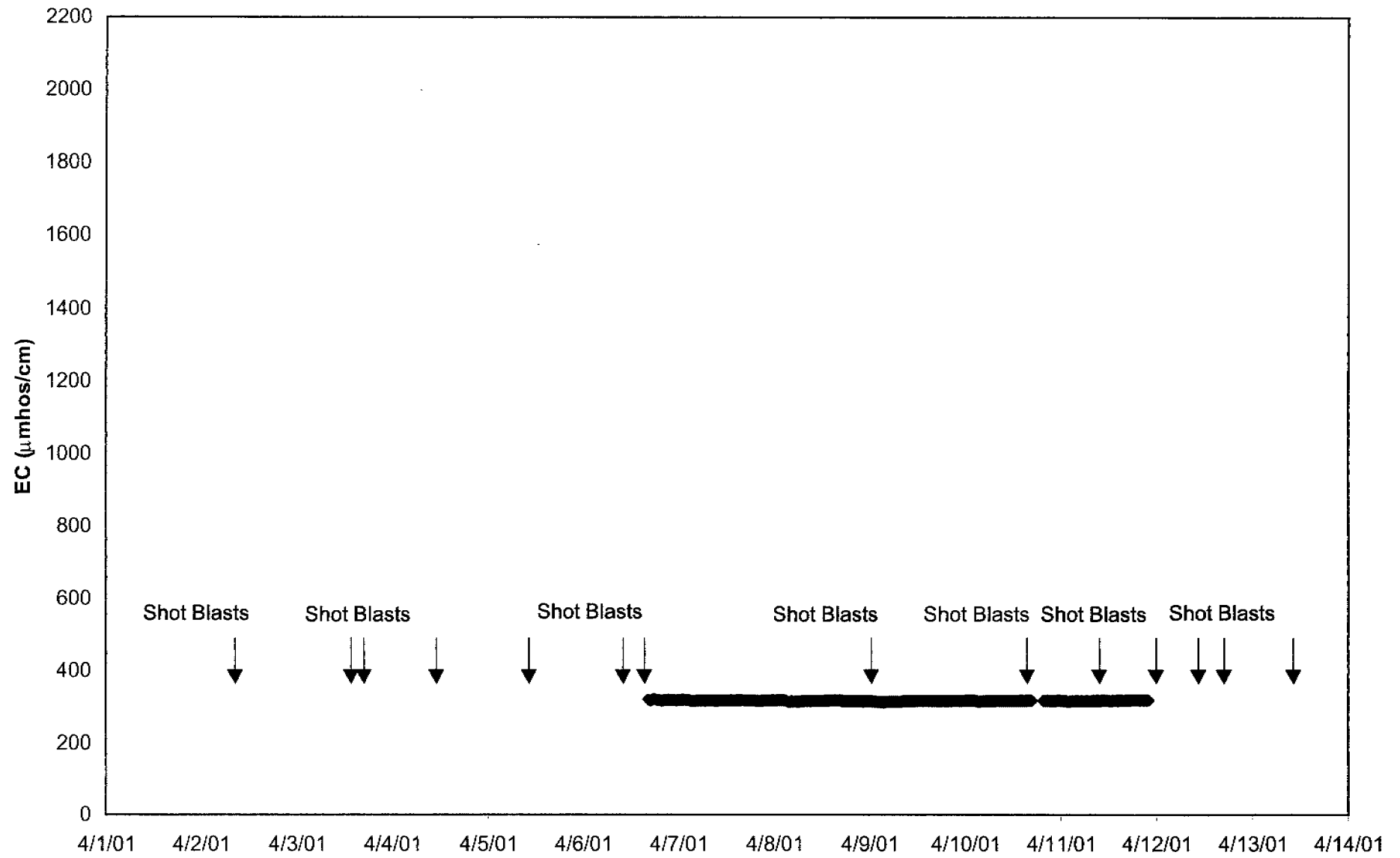
Well Yield
Site WV-1 Well-1
Spring 2001



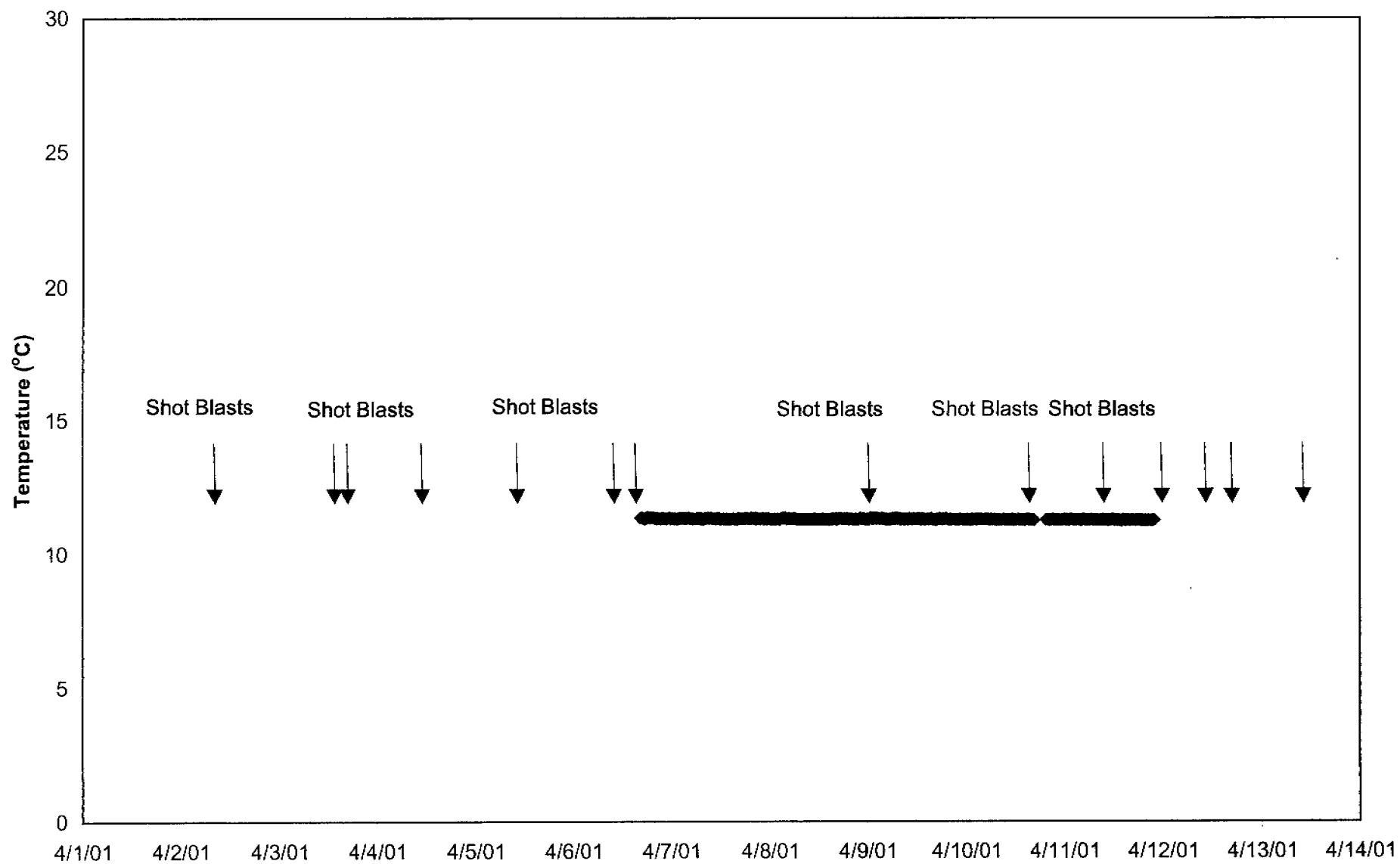
Water Level
Site WV-1 Well-1
Spring 2001



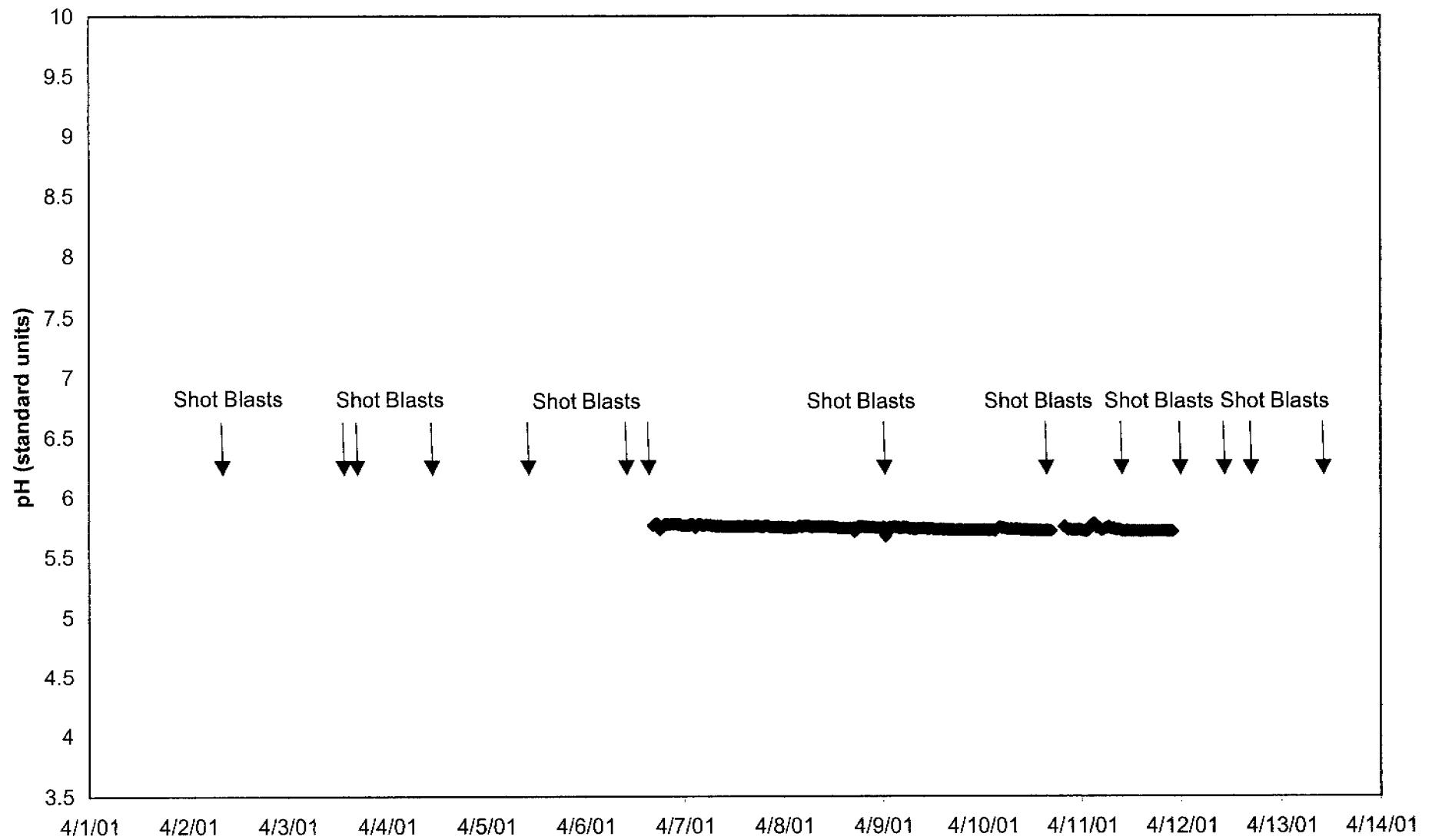
Well EC
Site WV-1 Well-1
Spring 2001



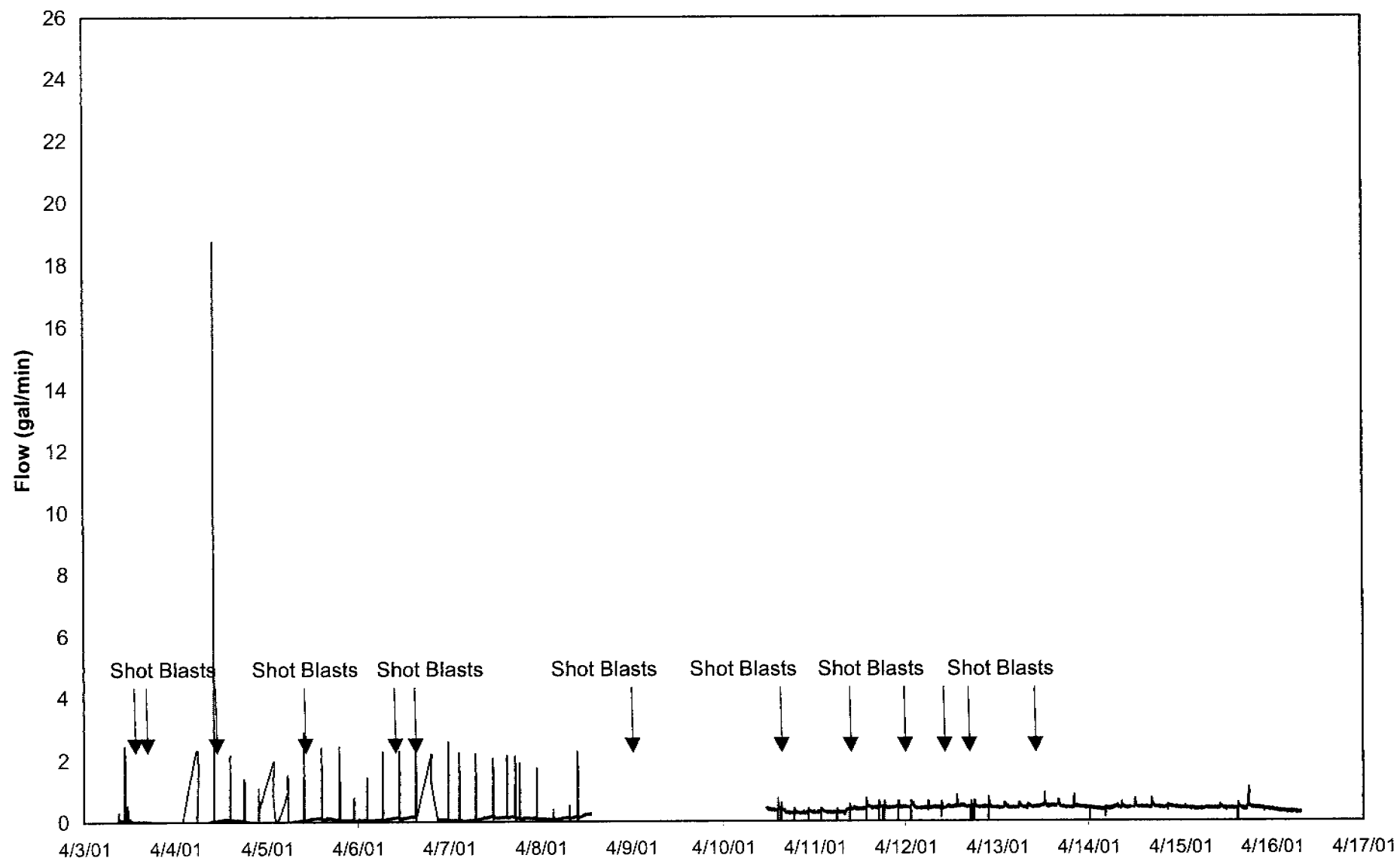
Water Temperature
Site WV-1 Well-1
Spring 2001



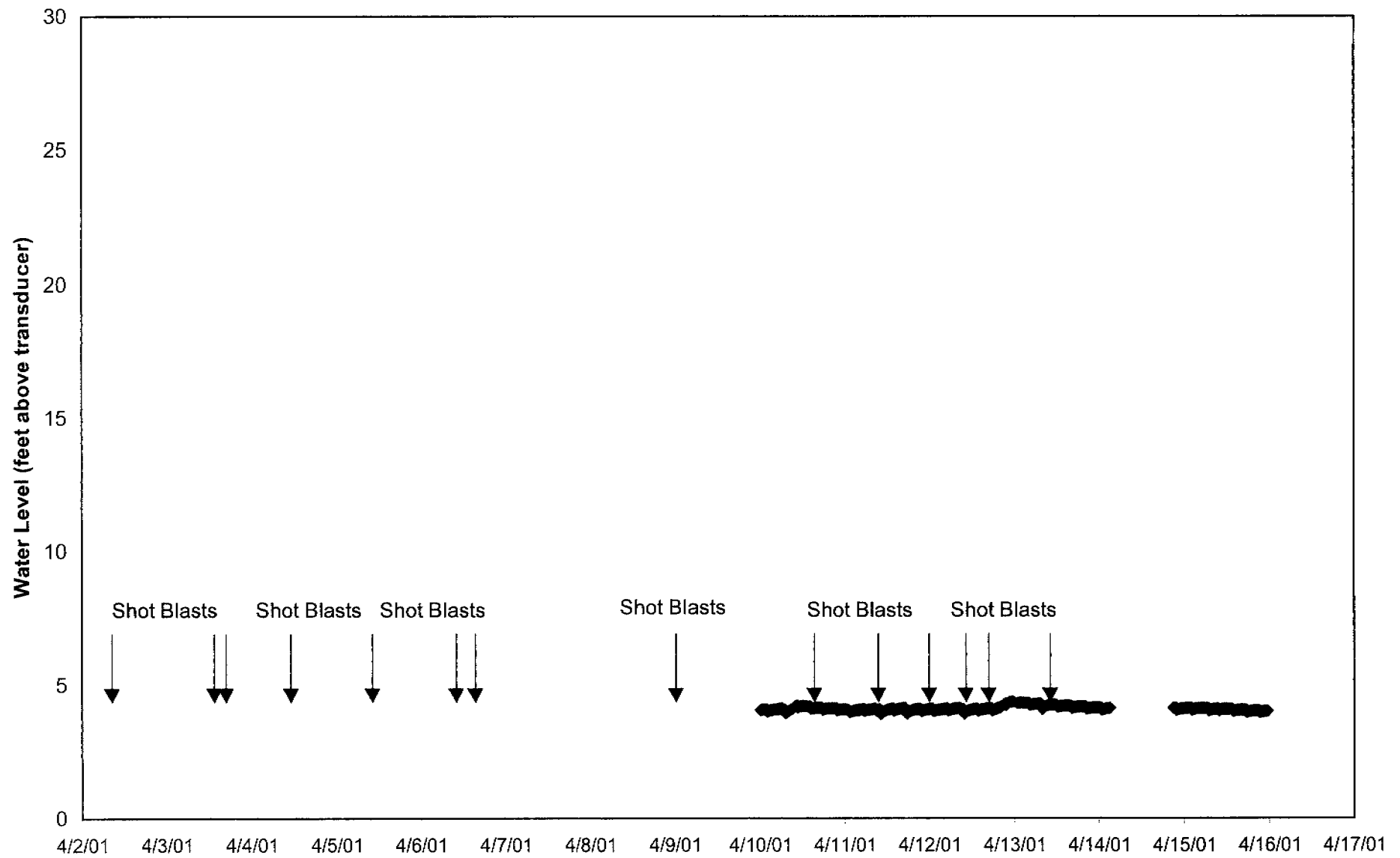
Water pH
Site WV-1 Well-1
Spring 2001



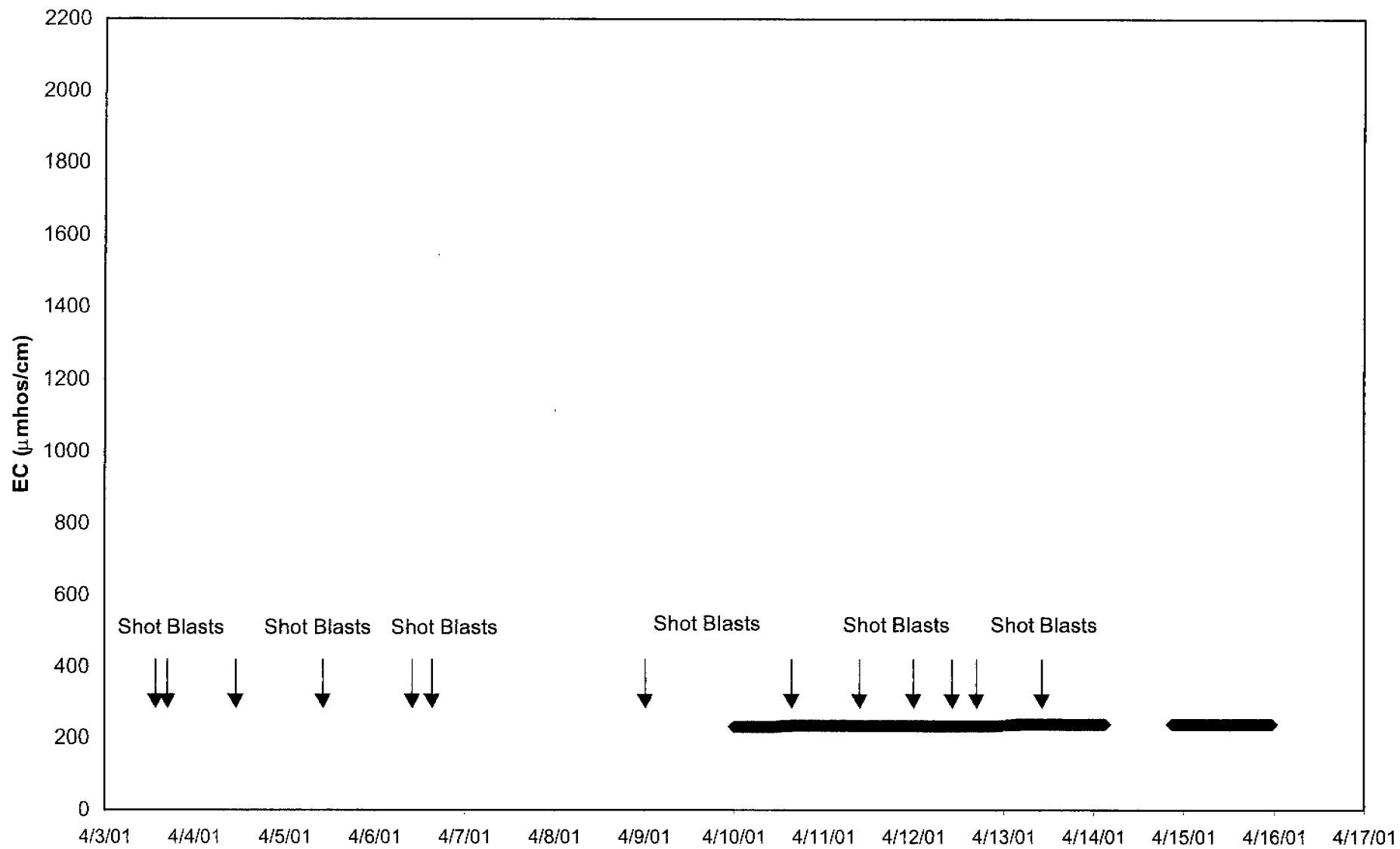
Well Yield
Site WV-1 Well-2
Spring 2001



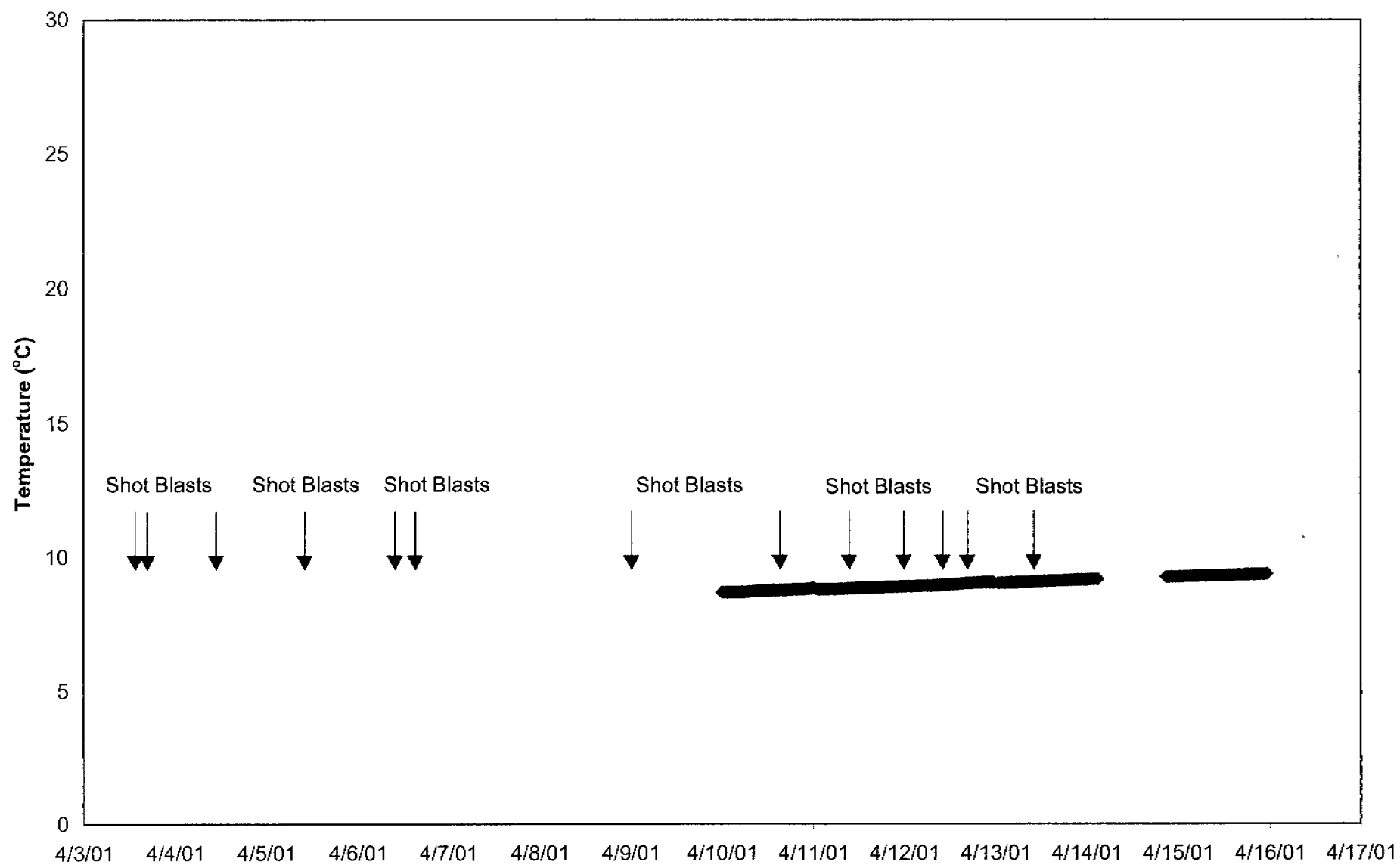
Water Level
Site WV-1 Well-2
Spring 2001



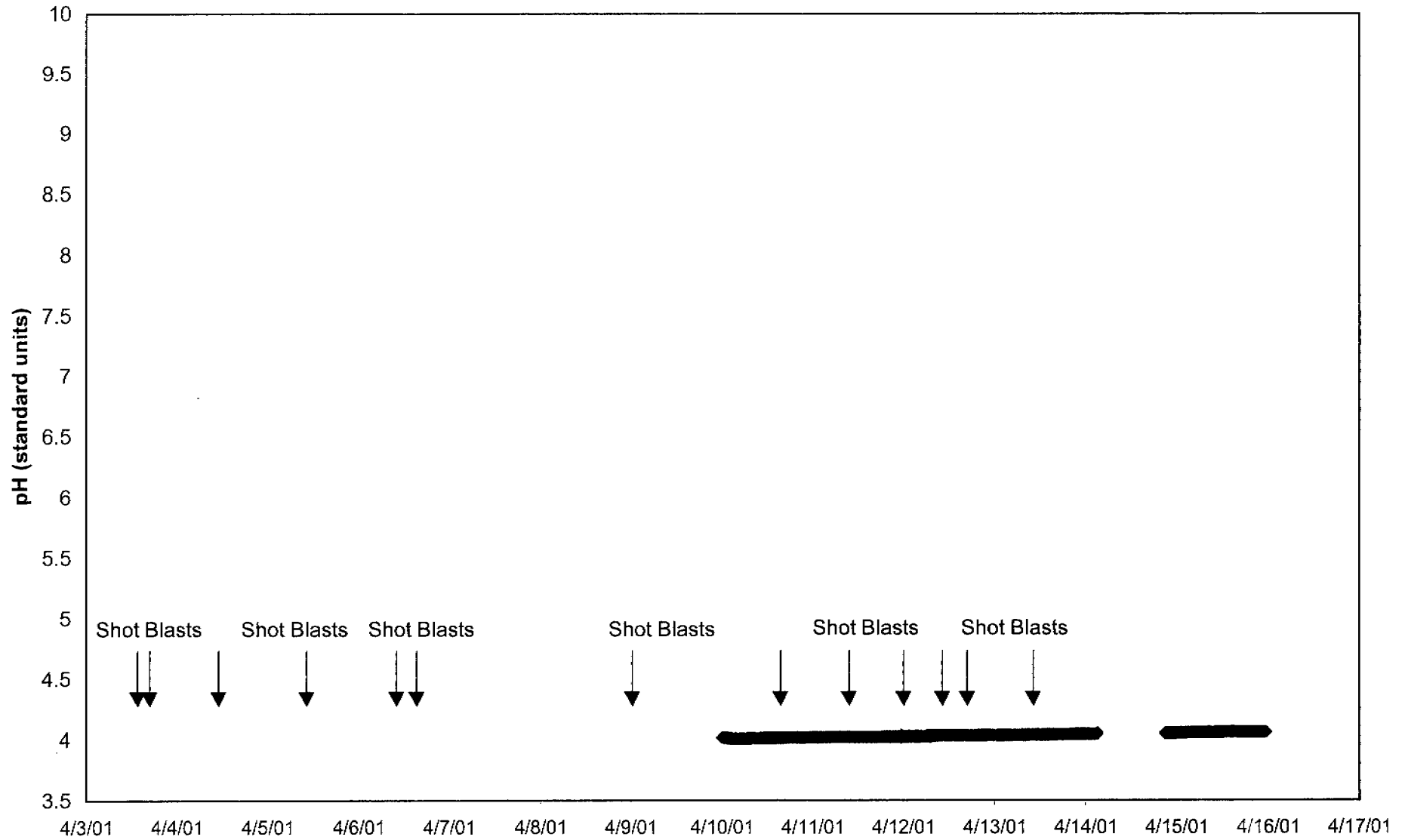
Well EC
Site WV-1 Well-2
Spring 2001



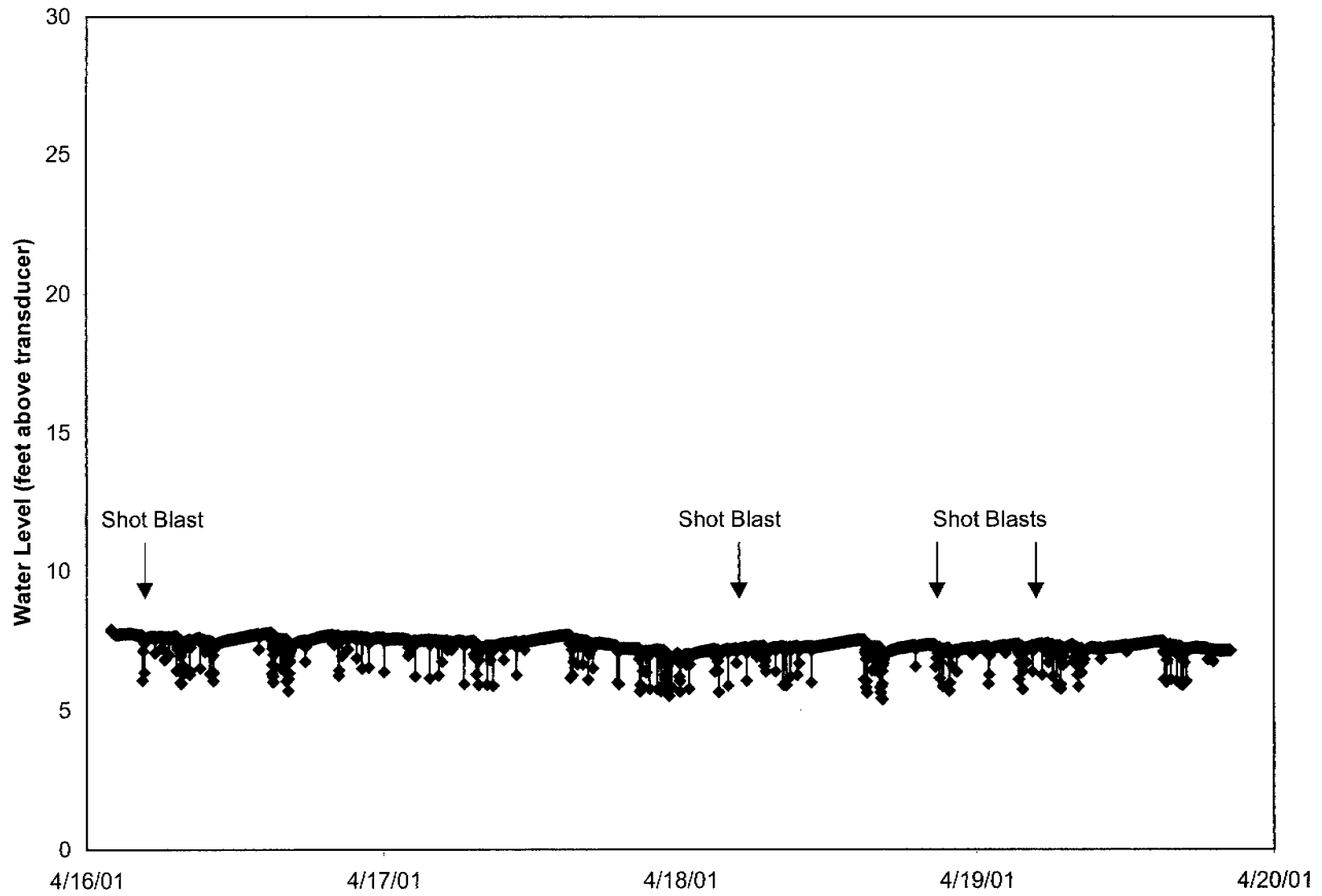
Water Temperature
Site WV-1 Well-2
Spring 2001



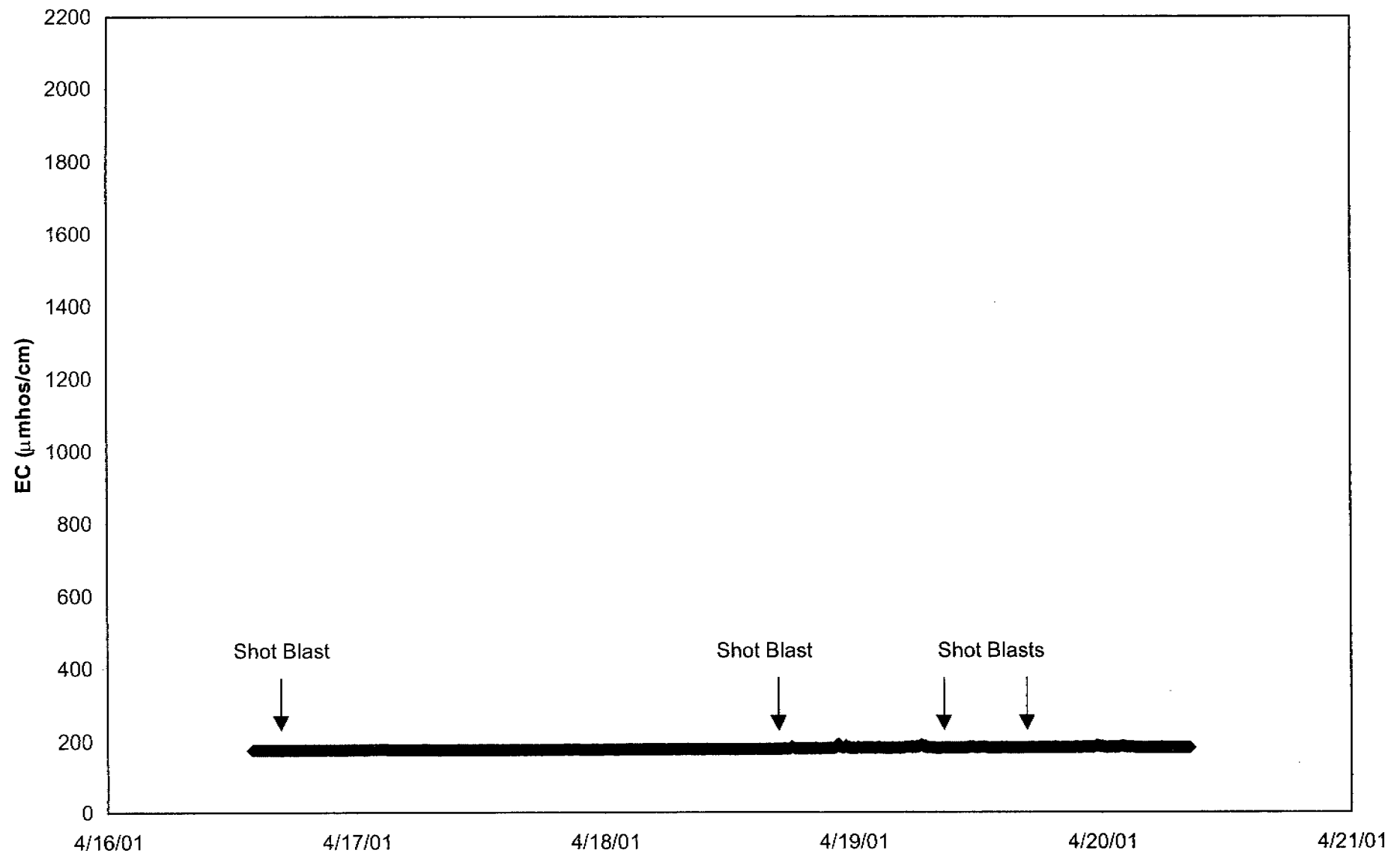
Water pH
Site WV-1 Well-2
Spring 2001



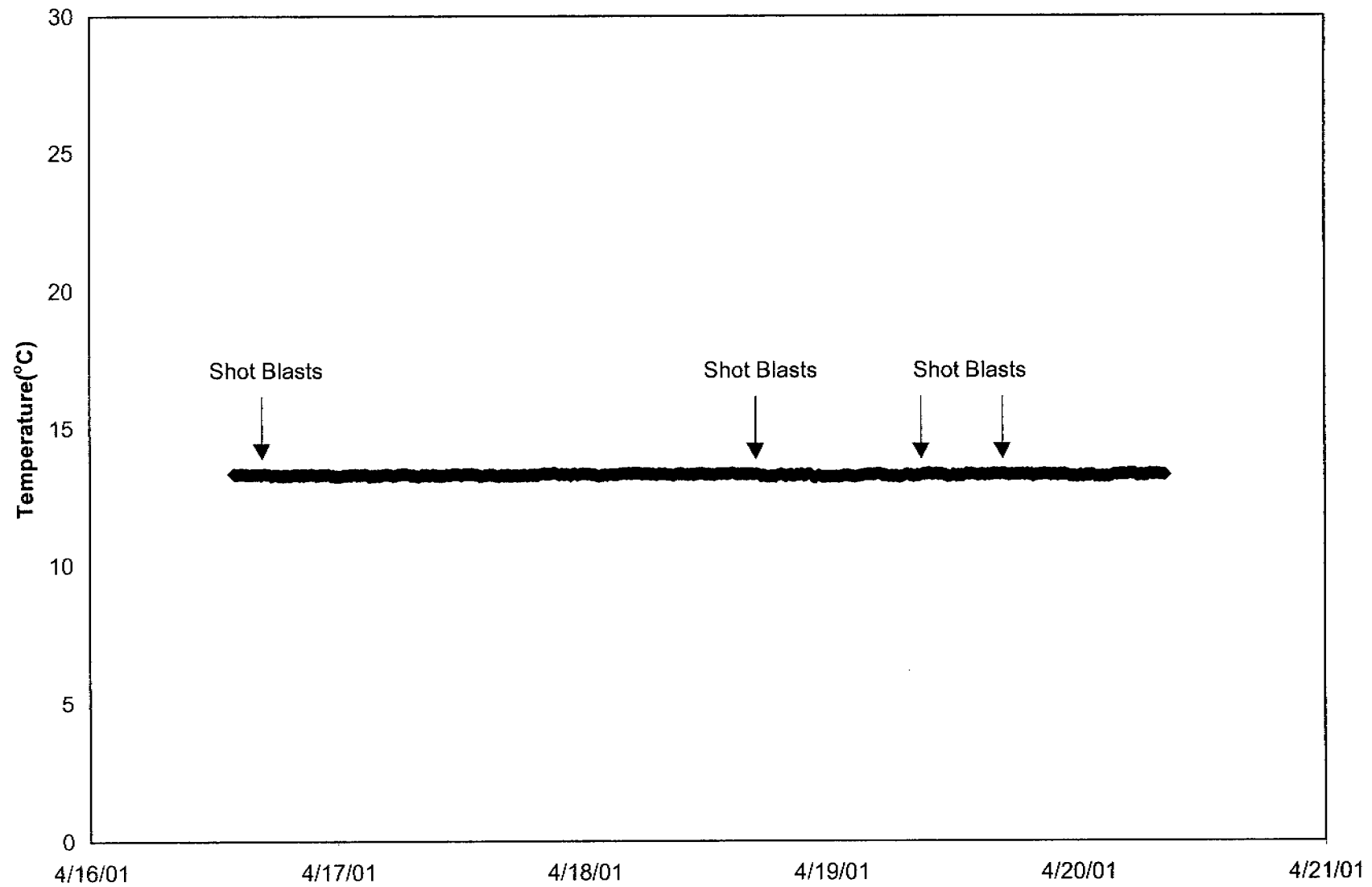
Water Level
Site WV-2 Well-1
Spring 2001



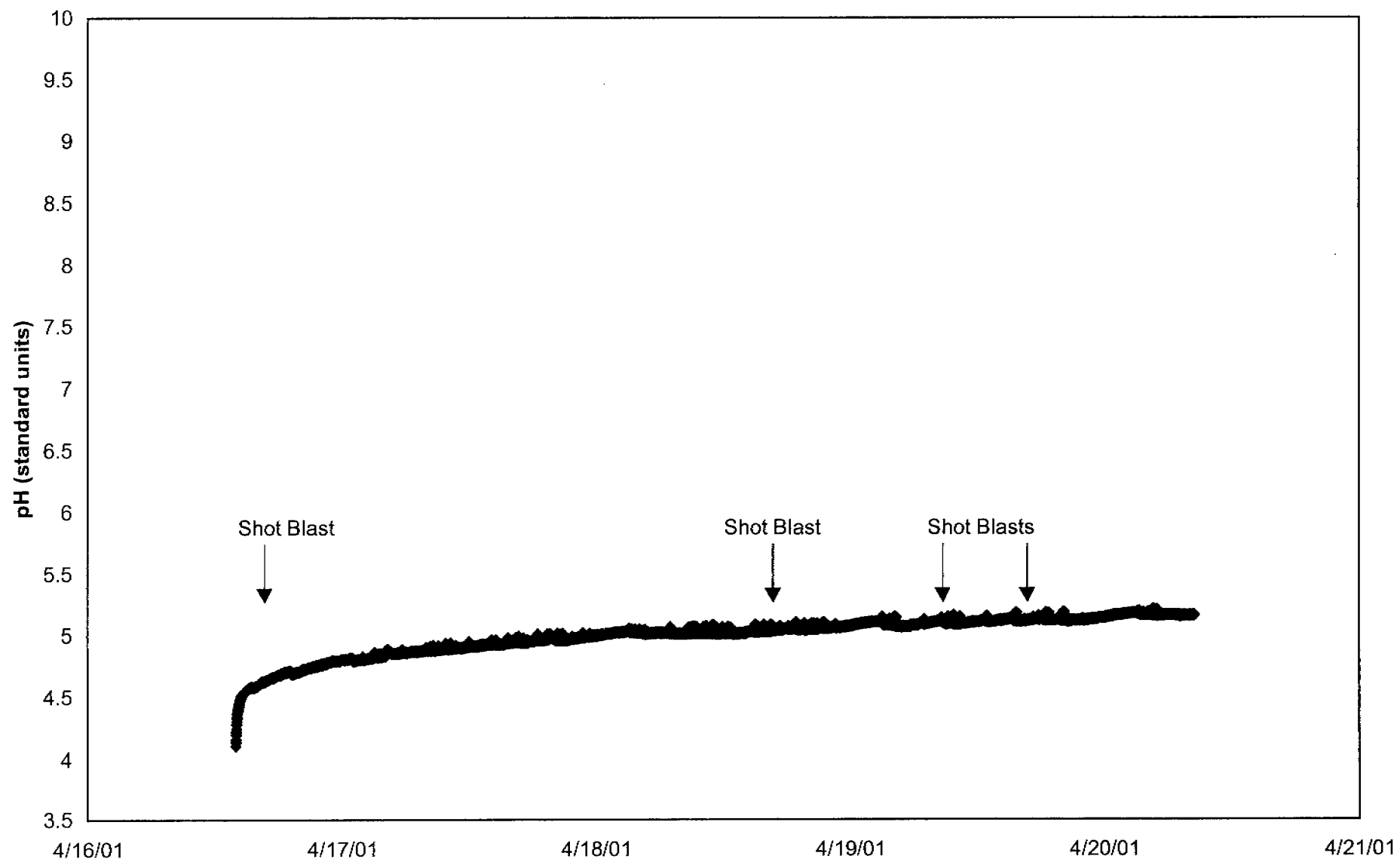
Well EC
Site WV-2 Well-1
Spring 2001



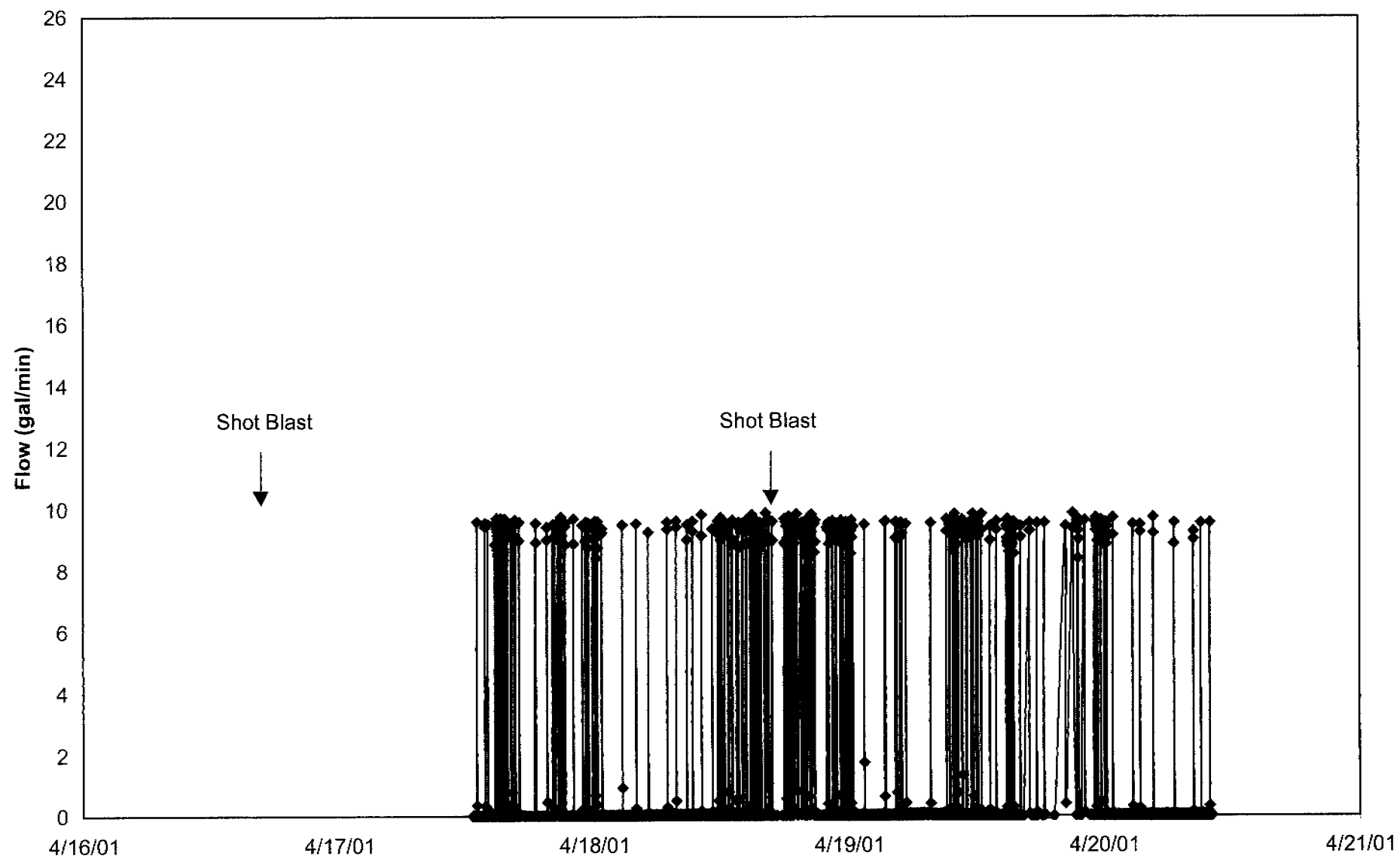
Water Temperature
Site WV-2 Well-1
Spring 2001



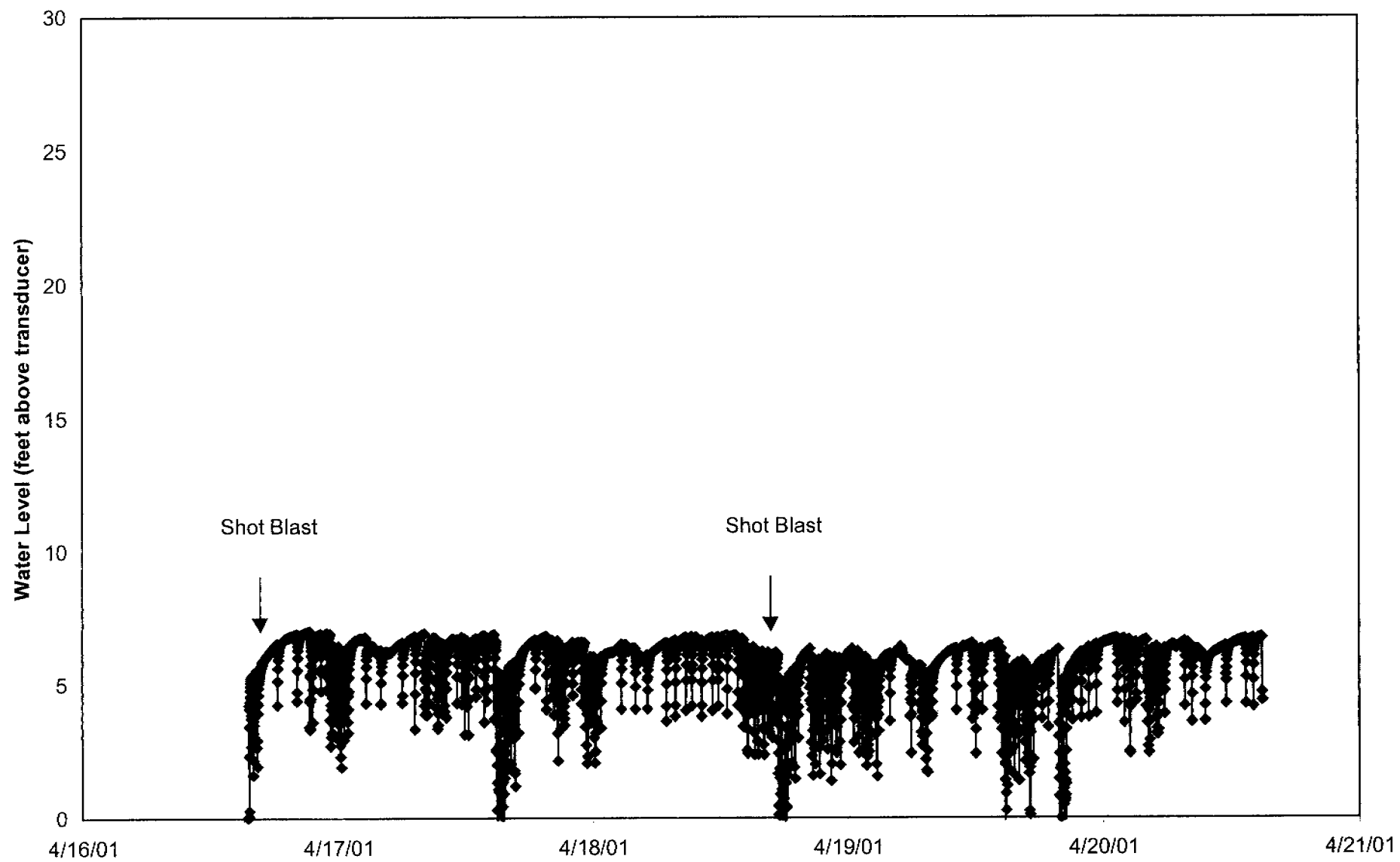
Water pH
Site WV-2 Well-1
Spring 2001



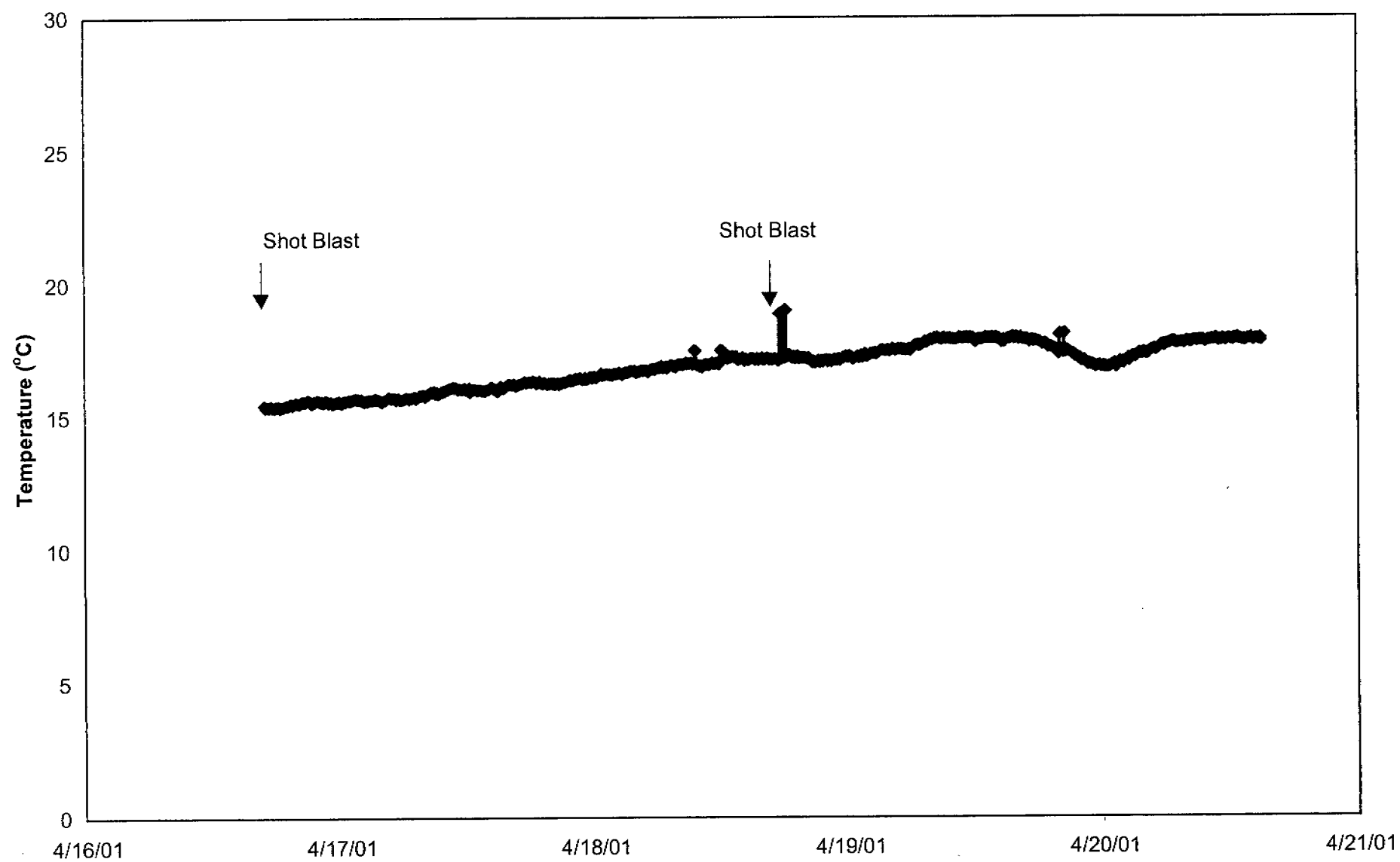
Well Yield
Site WV-2 Well-2
Spring 2001



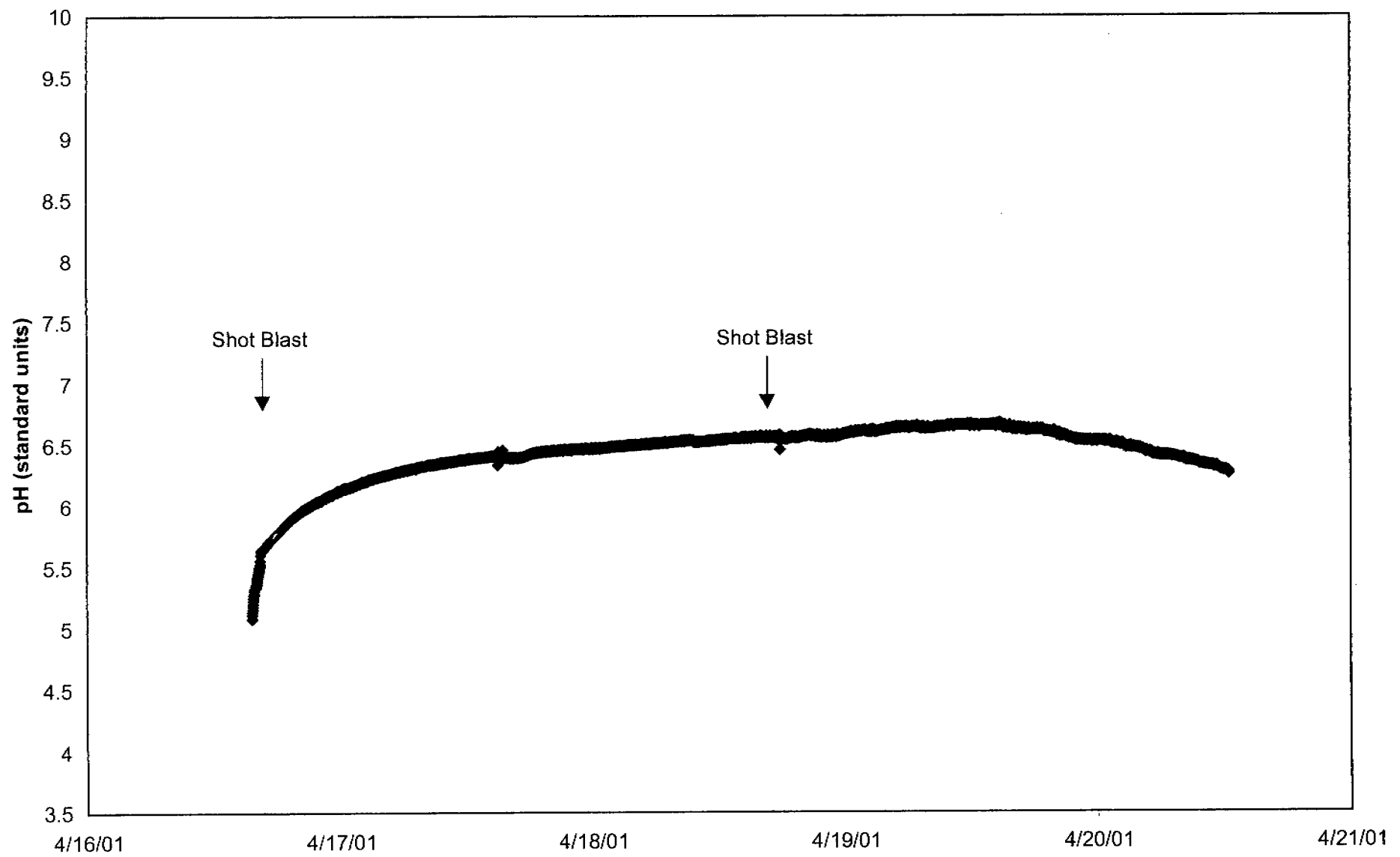
Water Level
Site WV-2 Well-2
Spring 2001



Water Temperature
Site WV-2 Well-2
Spring 2001



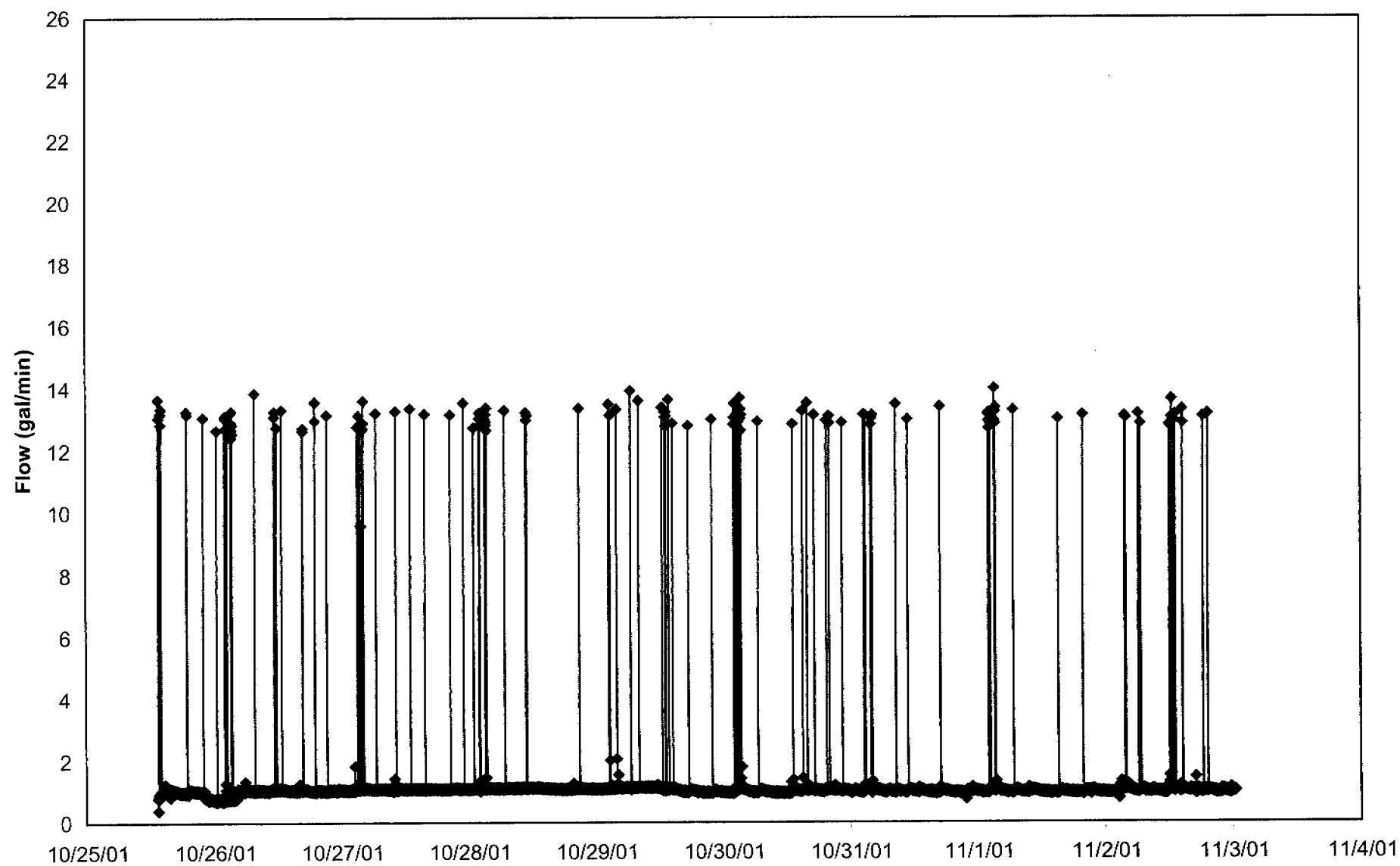
Water pH
Site WV-2 Well-2
Spring 2001



Appendix C3

Fall 2001

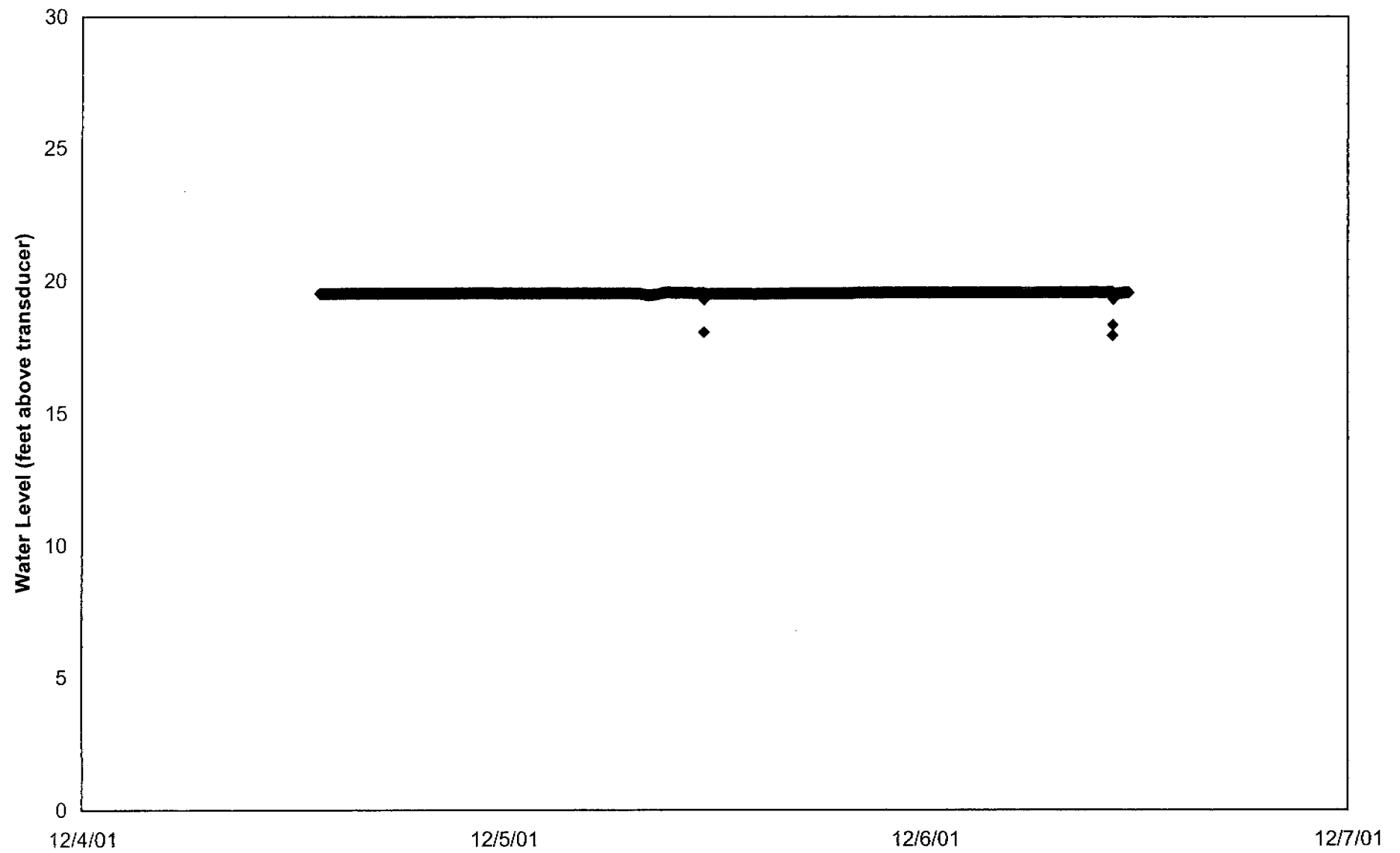
Well Yield
Site WV-2 Well-1
Fall 2001



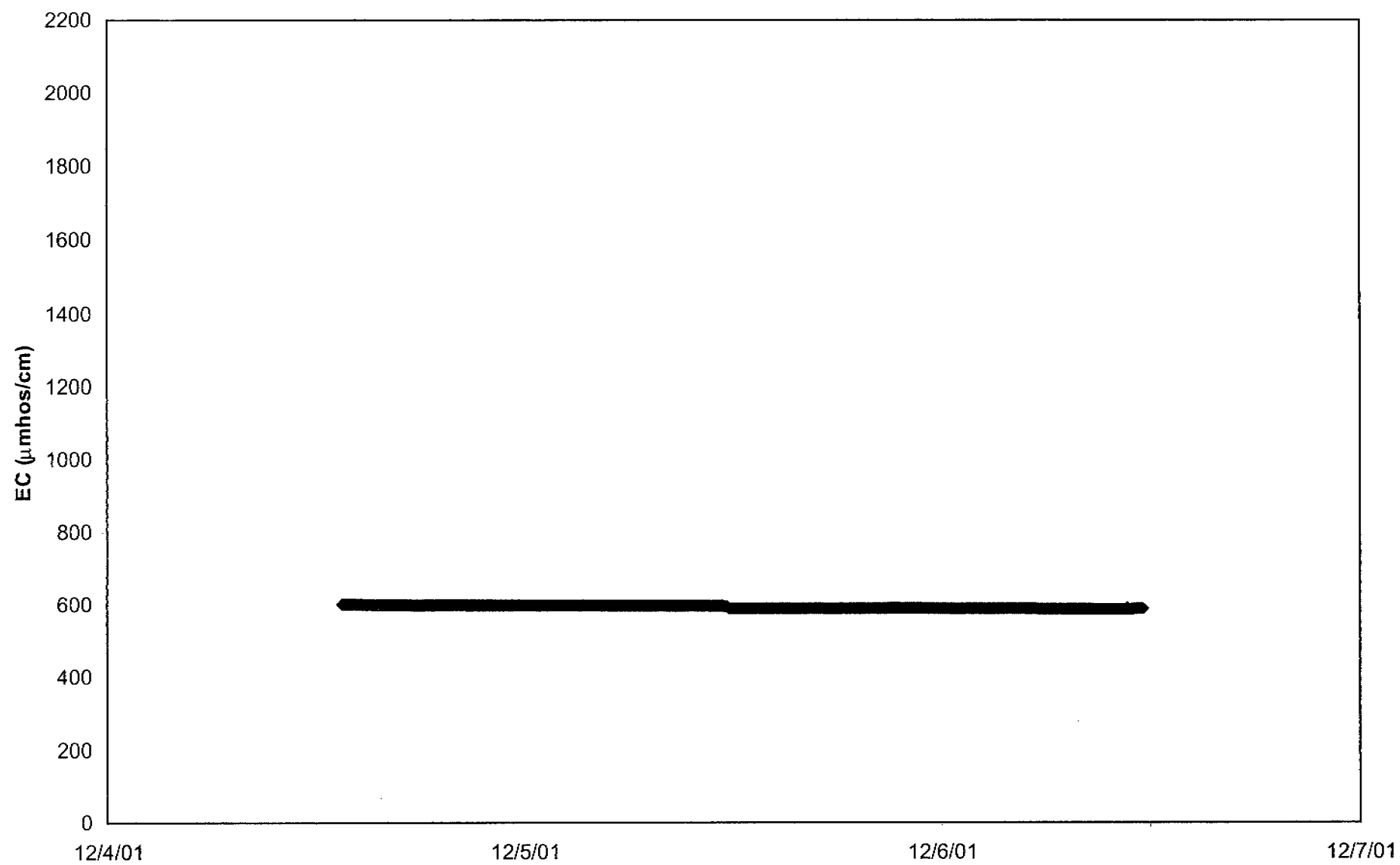
Appendix C4

Winter 2001

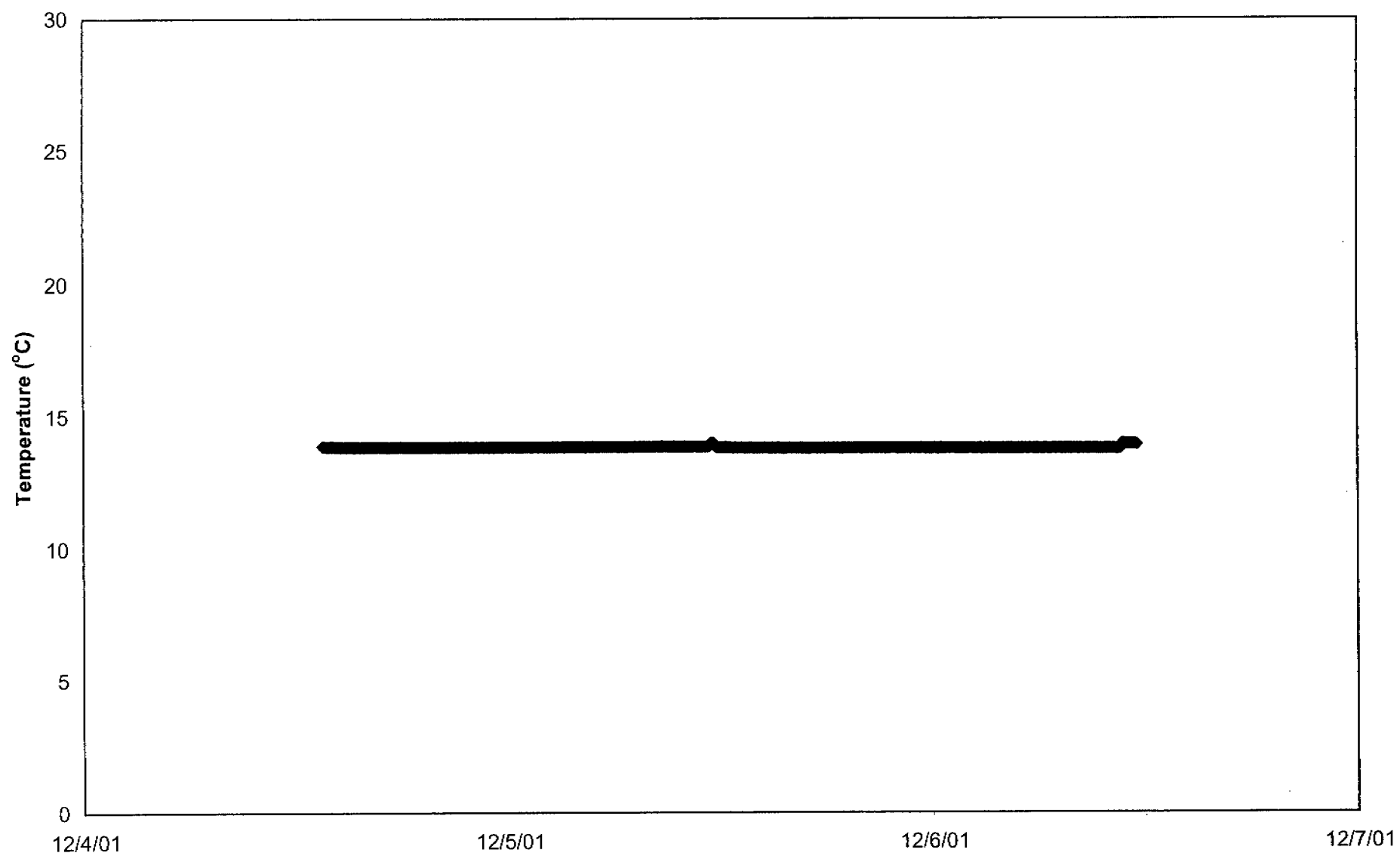
Water Level
Site WV-1 Well-1
Winter 2001



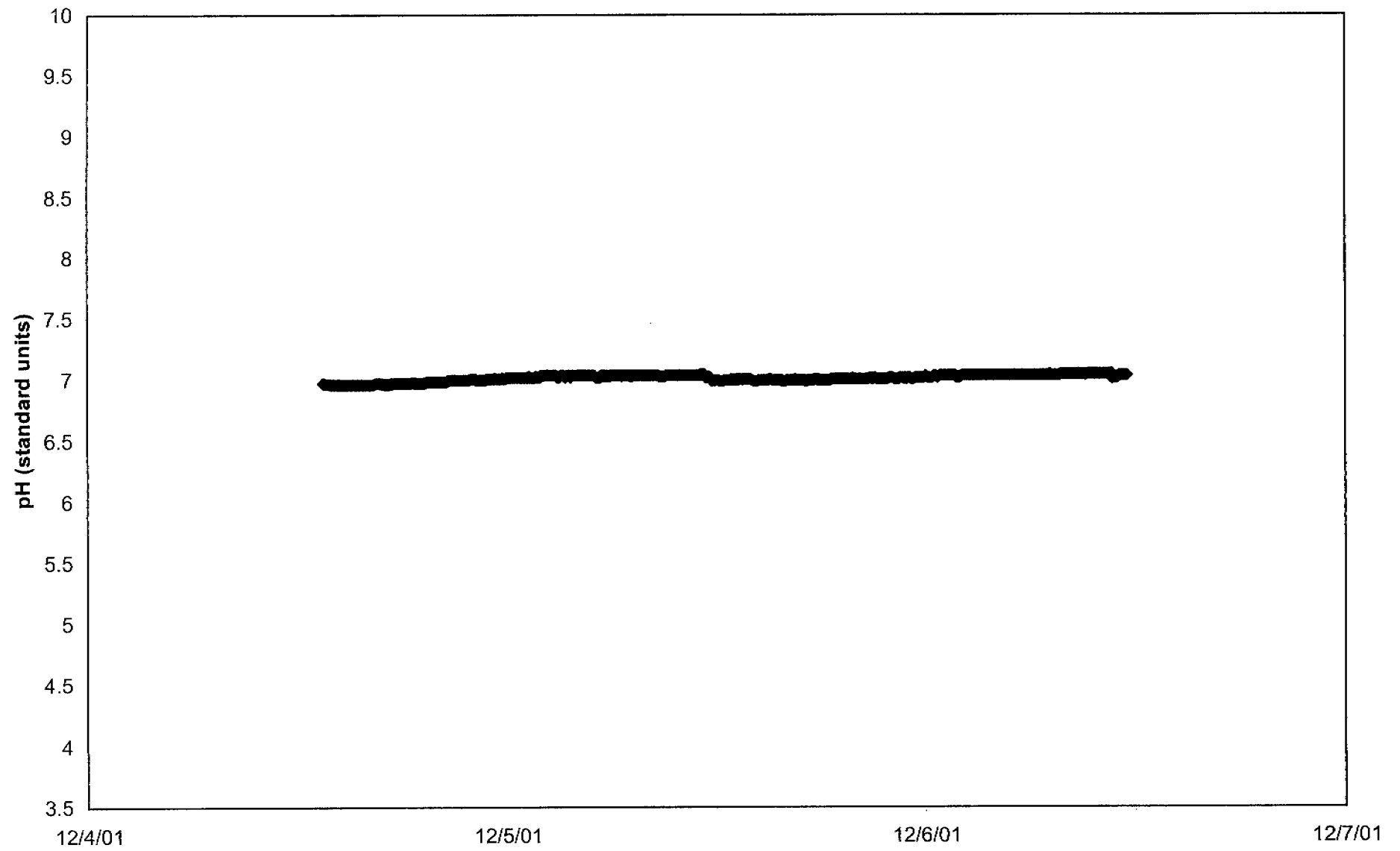
Well EC
Site WV-1 Well-1
Winter 2001



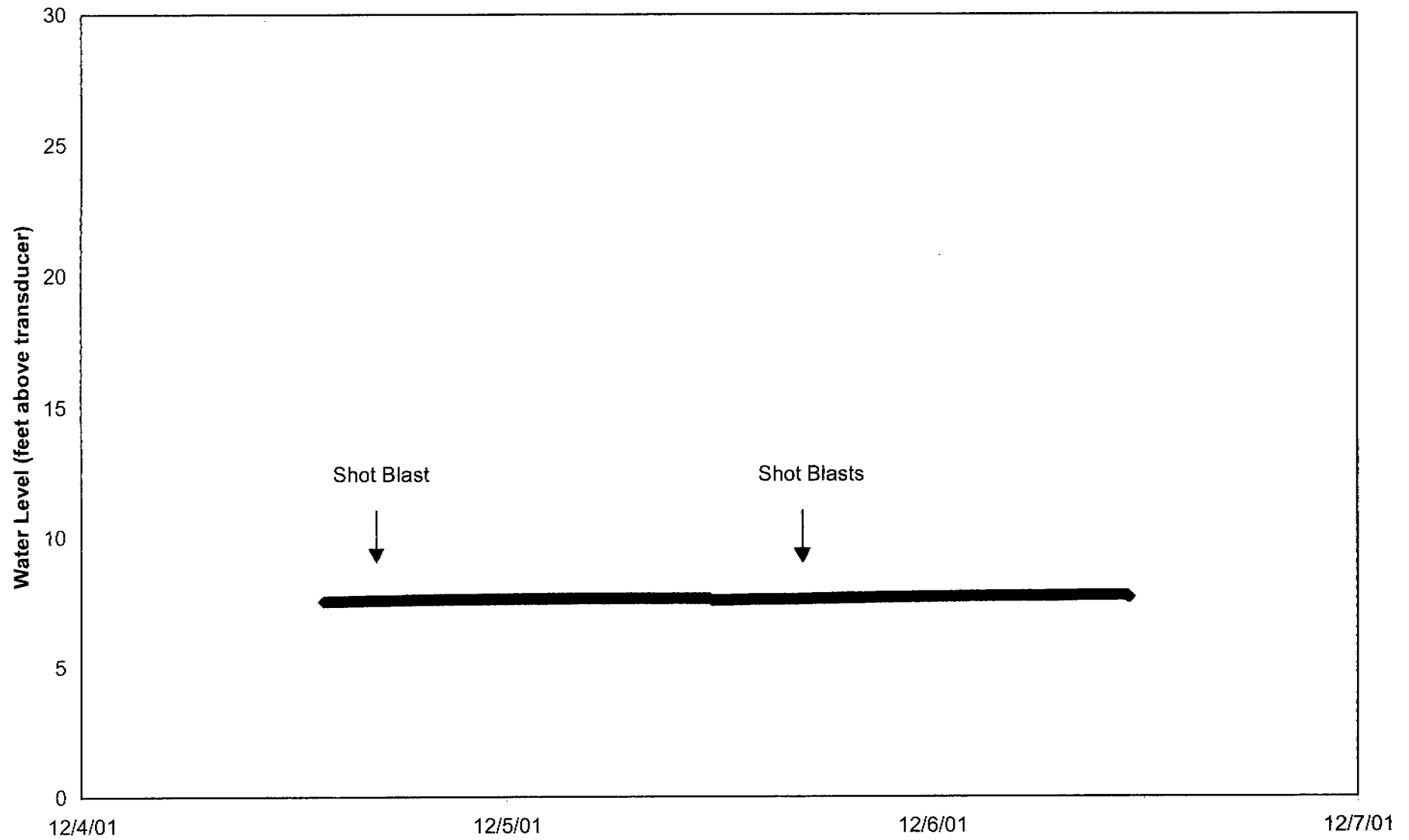
Water Temperature
Site WV-1 Well-1
Winter 2001



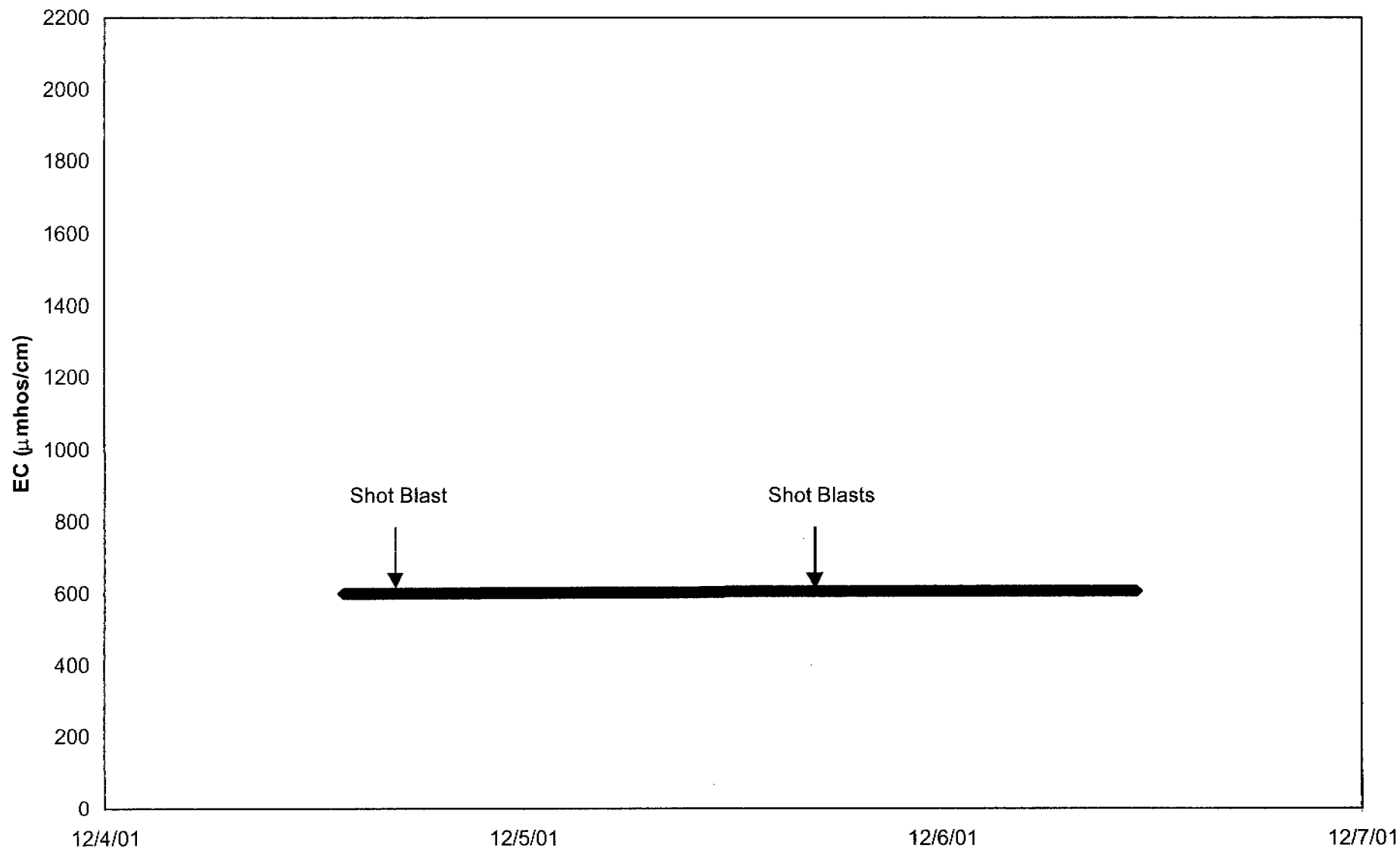
Water pH
Site WV-1 Well-1
Winter 2001



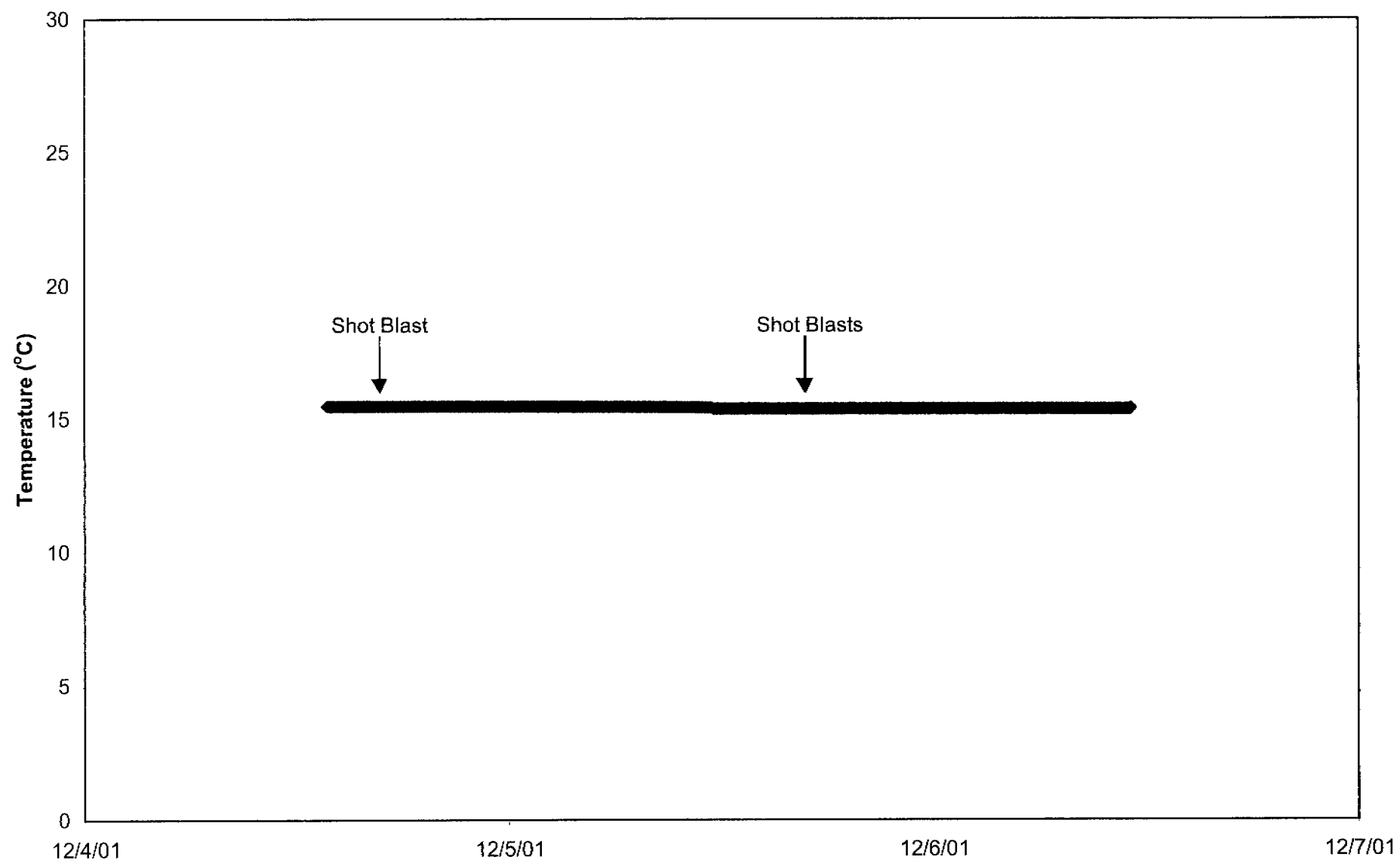
Water Level
Site WV-1 Well-2
Winter 2001



Well EC
Site WV-1 Well-2
Winter 2001



Water Temperature
Site WV-1 Well-2
Winter 2001



Water pH
Site WV-1 Well-2
Winter 2001

