Publication No. 94-e14

Water-Level Monitoring, Bellingham Frozen Foods
September 14 through December 9, 1993
Bellingham, Washington

by
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February 16, 1994

Washington State Department of Ecology
Environmental Investigations and Laboratory Services

Water Body No. WA-01-1010GW

INTRODUCTION

This technical document describes the methods and results of the water level monitoring we conducted at Bellingham Frozen Foods. Bellingham Frozen Foods (BFF) applies vegetable processing wastewater to about 215 acres near the Nooksack River. Land application at the facility is subject to State Waste Discharge Permit requirements. One requirement of the permit is that land application of wastewater is not allowed when the unsaturated zone (the interval between the ground surface and the water table) is less than three feet. The permit requires that the depth to water be measured weekly during the application season from April 15 to November 15. Ecology's Water Quality Section at Northwest Regional Office requested that EILS monitor water levels continuously near the end of the wastewater application season to determine when the unsaturated zone is less than three feet.

METHODS

Water levels were measured at 1-hour intervals in three wells (MW2, MW3, and MW5) and at 30-minute intervals in one well (MW1) using pressure transducers and data loggers. Pressure transducers were installed September 14 and removed December 9. The transducers were installed at appropriate depths so that water levels three feet below ground surface were within the measurement range. The transducers are vented so that no barometric correction was needed. Table 1 lists pressure transducer ranges and depths for each well.

Data were stored in 64K byte Unidata data loggers. Data loggers were downloaded September 15, September 29, November 5 and December 9. Water levels were measured at each well using electric well probes during site visits. These water level measurements were used to adjust for transducer drift. Transducer data were adjusted mathematically assuming transducer drift was linear between electric probe measurements.

Table 1. Transducer range and depth settings.

Well ID	Transducer Range (meters)	Transducer Zero Depth (ft, Below Ground Surface)
MW1	0-1	4.7
MW2	0-5	7.3
MW3	0-1	4.4
MW5	0-1	5.7

RESULTS

The results of the water level monitoring are listed in Tables 2 through 5 for monitoring wells MW1, MW2, MW3, and MW5, respectively. The tables are attached to the end of this memorandum because of their large size. Electric well probe measurements and adjustments are also shown in the tables. Hydrographs for each well are shown in Figures 1 through 4. The figures are constructed with the depth to water increasing vertically upward. A 3-foot depth-to-water line is shown on each figure. If, in the figure, the hydrograph is below the 3-foot depth-to-water line the depth to water is less than three feet.

Note that at MW5 when the depth to water was greater than about 4.7 feet, water levels were below the transducer measurement range. Therefore measurements before November 16, 1993, are considered minimum depths, that is, the actual depth to water was greater than or equal to the depth shown. Measurements when the depth to water was less than 4.7 feet (after about November 16) are reliable.

DISCUSSION

Based on the water level monitoring results, the depth to water in each monitoring well increased during the survey and rose to within less than three feet of the ground surface. The dates and times that the depth to water was less than three feet are summarized in Table 6 (page 5 of this document).

We did not track waste application for this project. However, the water level information from this survey can be compared to wastewater application dates to determine if wastes were applied when the saturated zone was less than three feet thick.

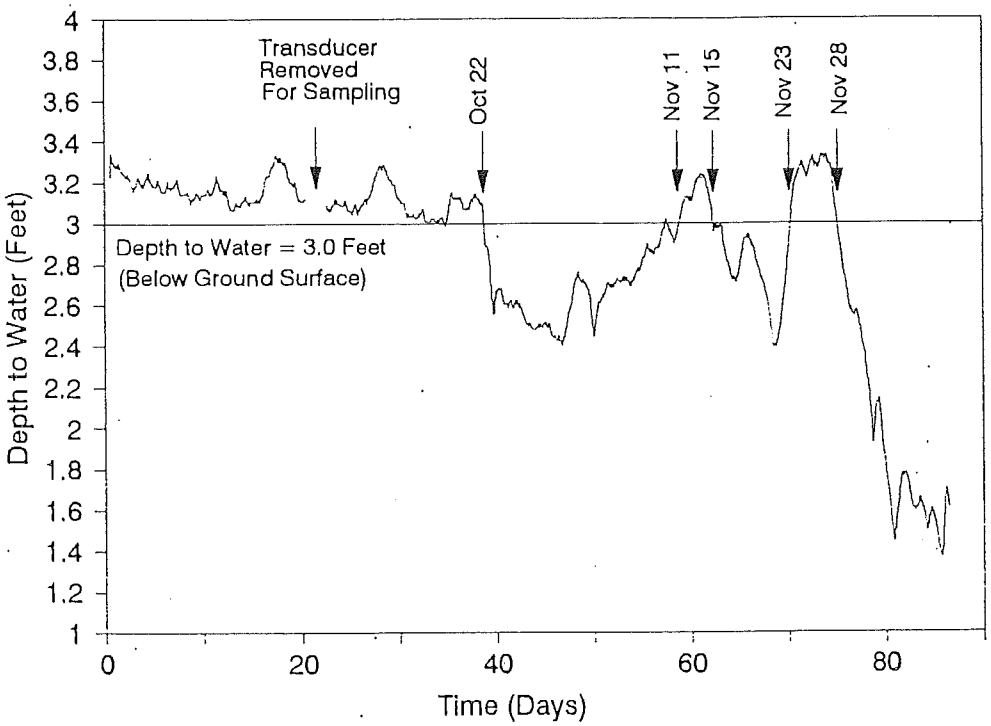

Figure 1. Hydrograph for MW1, September 14-December 9, 1993

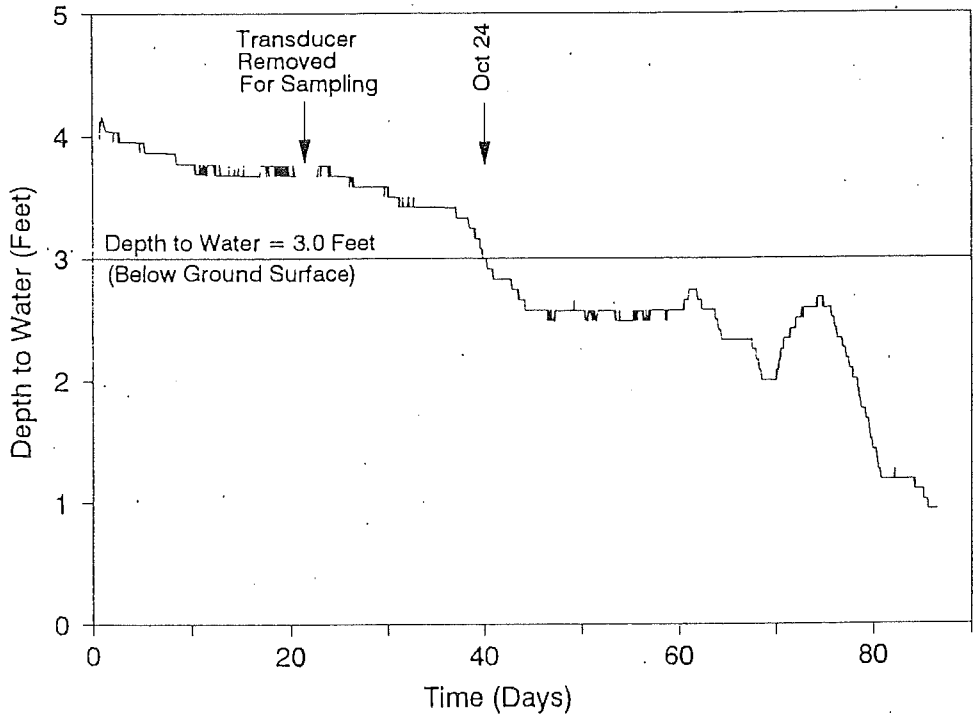

Figure 2. Hydrograph for MW2 September 14-December 9, 1993.

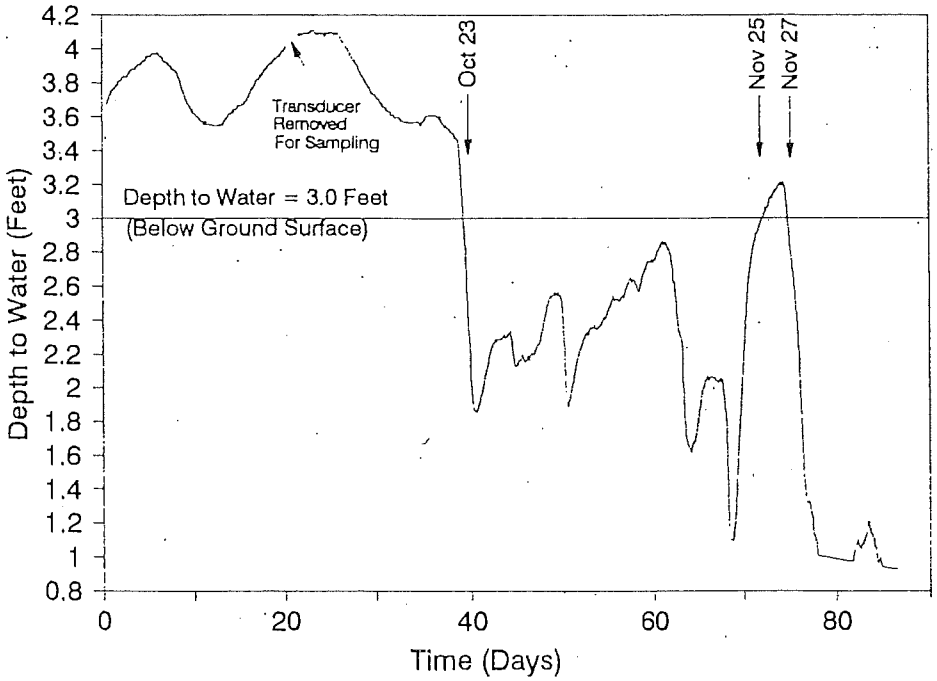

Figure 3. Hydrograph for MW3, September 14-December 9, 1993.

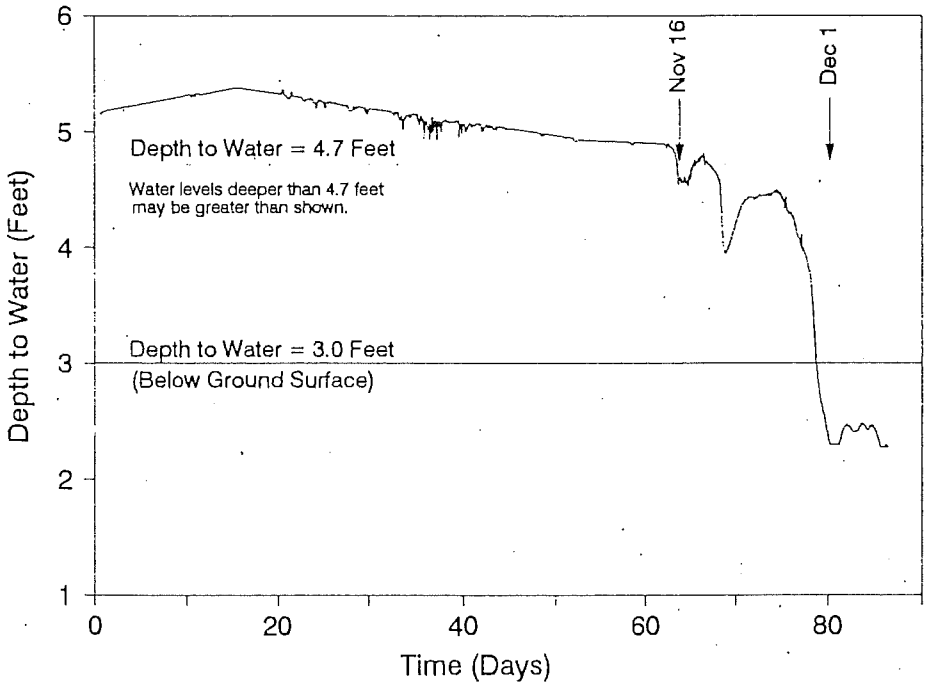

Figure 4. Hydrograph for MW5, September 14-December 9, 1993.

Table 6. Time periods when depth to water (below ground surface) was less than three feet.

Well ID	Begin Date and Time	End Date and Time	Remarks
MW1	Oct 22 @ 1730	Nov 10 @ 0800	
	Nov 10 @ 1330	Nov 11 @ 1900	
	Nov 15 @ 0530	Nov 16 @ 0130	Water level fluctuating at less than and greater than 3.00 feet.
	Nov 16 @ 0130	Nov 23 @ 0530	
	Nov 28 @ 0330	Dec 9 @ 1100	End of Survey
MW2	Oct 24 @ 0700	Dec 9 @ 1100	End of Survey
MW3	Oct 23 @ 0500	Nov 25 @ 0200	
	Nov 27 @ 2200	Dec 9 @ 1100	End of Survey
MW5	Dec 1 @ 1800	Dec 9 @ 1000	End of Survey

Of secondary interest for this project was whether water levels at MW1 were tidally influenced. Water levels for tidally influenced ground water are expected to show 12-hour or 24-hour periodicity. High and low ground water levels should correspond to tidal highs and lows with a consistent time lag. The water levels at MW1 (Figure 1) show small, what appear to be daily, fluctuations. But the detail of the figure is inadequate to be conclusive. More detailed hydrographs for MW1 are shown in Figures 5 and 6. Figure 5 shows a 10-day period from September 14-23 and Figure 6 shows the period from November 5-14. The September time period was selected because water levels were relatively stable. The November time period was selected because the lowest tides of the study period occurred November 9. Note that the vertical scales for the figures are different. Water levels in Figure 5 show a daily fluctuation on the order of about 0.02 to 0.04 feet. This fluctuation may be related to tidal influence. However, the magnitude of fluctuation is about the same as the expected resolution or "noise" of transducer readings. In Figure 6 water levels are generally declining. Superimposed on the declining hydrograph is a periodic variation. The length of each period is about two days. This is not consistent with tidally influenced ground water. Therefore, the observed periodicity in Figure 6 is probably not tidal. In conclusion the tidal influence at MW1, if it exists, is small and on the order of 0.02 to 0.04 feet.

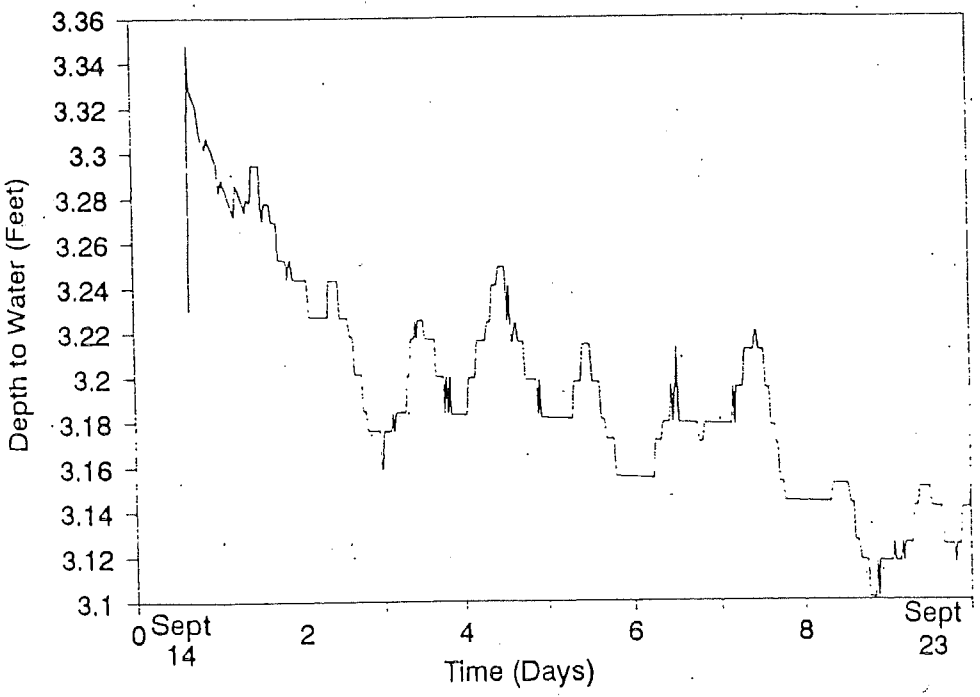

Figure 5. Hydrograph for MW1, September 14-23,1993.

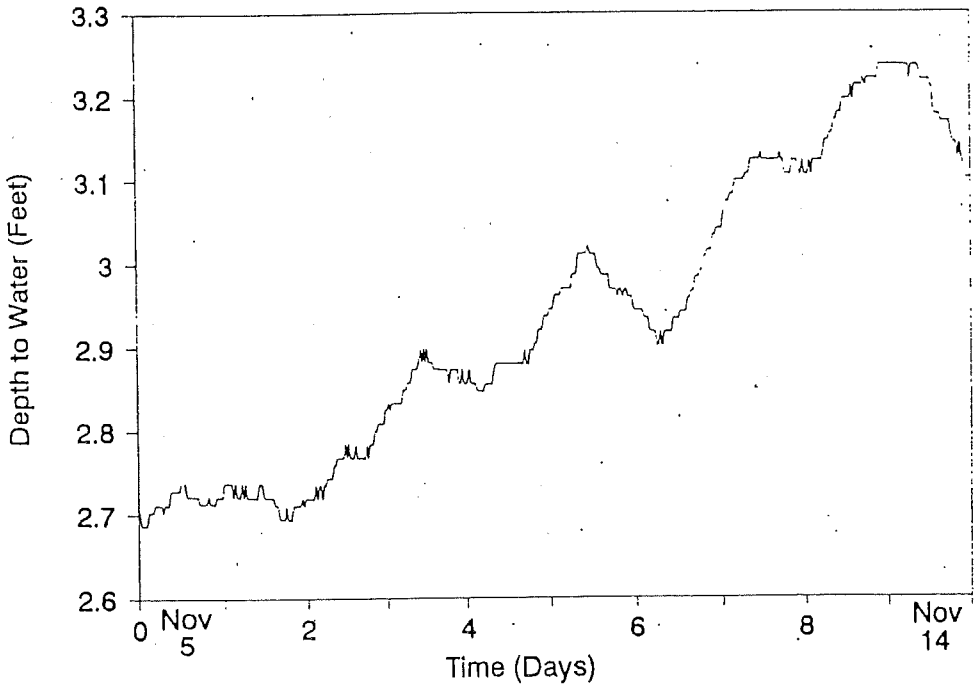

Figure 6. Hydrograph for MW1, November 5-14,1993.