

Technical Publication

Title: Project and Data Summary: Multiple Sample Point Nitrate Analysis

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Long Island, New York
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**ChemScan® UV-6100 Process Analyzer
Project and Data Summary
Multiple Sample Point
Nitrate Analysis**

**Suffolk County Water Authority
Long Island, New York**

Published by:

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Background

The Suffolk County Water Authority is a major water utility on Long Island serving more than two million customers. This utility maintains a network of more than 150 individual groundwater pumping stations feeding the water distribution network at strategic locations throughout the county.

Although a very good average water quality is maintained throughout the system, individual groundwater sources may exhibit high concentrations of nitrate, iron, manganese or other unwanted chemicals. Water from these wells require some degree of treatment prior to addition into the distribution system.

On-Line Monitoring Requirements

Where the water from a particular source exceeds quality or public health limits for a particular parameter such as nitrate or iron, treatment systems are installed to correct the problem by reducing the concentration of the parameter to acceptable levels. A typical treatment system uses chemical addition, pH adjustment and/or ion exchange to remove undesirable chemicals in a portion of the flow from the well. A blend of treated and untreated water results in a combined flow with chemical concentrations less than the water quality limit.

In order to assure good quality water is entering the distribution system, monitoring of three sample points is desired for each chemical parameter of interest. The points include the raw water extracted from the well, the treated water and the final blend of raw and treated water.

Since most pumping stations operate unattended for long periods of time, the monitoring system must operate automatically (on-line) and must produce accurate measurements of the chemical parameters of interest without frequent calibration, maintenance or adjustment. The monitoring system must also be capable of providing output signals that can be used for control, recording and/or alarm purposes.

The ChemScan UV-6100 Process Analyzer was evaluated to verify the ability of the system to provide the desired on-line chemical analysis without the need for elaborate maintenance or adjustment. Other possible benefits include the potential for multiple parameter and multiple sample point analysis and also include the ability of the system to perform a direct spectrophotometric analysis for major chemicals of interest such as iron and nitrate, without the use of chemical reagents.

On-Line Demonstration Objectives

Two demonstrations were conducted at Suffolk County Water Authority pumping stations. During the first demonstration, the objective was to show that the UV-6100 system could provide accurate, reliable on-line monitoring of nitrate in the raw water at a pumping station through comparison of results from the UV-6100 system to results from grab samples analyzed at the water Authority's central laboratory.

The objective for the second demonstration was to show reliable on-line analysis of multiple (three) sample lines using a manifold system in conjunction with the UV-6100 Process Analyzer.

On-Line Nitrate Analysis

The UV-6100 System was operated at the Middleville Road Station site from late April through mid July 1994. This site extracts water from a groundwater source which has a high concentration of nitrate-nitrogen.

The ChemScan UV-6100 Process Analyzer was calibrated for nitrate-nitrogen analysis using a combination of pure water standards and site samples. An analysis was performed by the ChemScan system every 20 minutes, with a 4-20 mA output from the system recorded on a circular chart recorder. See Figure 1.

Output was also recorded on a 1000 value internal data log which could be periodically downloaded onto a lap top computer. Figure 2 shows a graph of this output for a 2 week period during the demonstration. The raw water maintained a relatively constant nitrate-nitrogen concentration during the test period, within the 7.5 to 10.0 ppm range and with most values in the 8.0 to 9.0 ppm range.

The ChemScan system was operated with an initial calibration based on pure water standards and on an initial set of site specific samples. This calibration operated from late April 1994 to June 6, 1994. On June 7, 1994 a revised calibration was constructed using information from the prior base of files plus site specific samples that had been gathered and processed by Suffolk County personnel throughout the month of May. This revised calibration operated from June 7, 1995 through mid-July.

Comparison of results between the UV-6100 analyzer and laboratory analysis of grab samples is shown in Figures 3 and 4. Figure 3 shows results for the period from the start through June 6, while Figure 4 shows results only from June 7 to the end of the test. A statistical summary of these results are shown below:

	Full Period	Prior to New Calibration	After New Calibration
Average Error	-0.48 ppm	-0.65 ppm	-0.25 ppm
Standard Deviation	0.49 ppm	0.55 ppm	0.28 ppm
Variance	0.24 ppm	0.30 ppm	0.08 ppm

The original calibration was heavily weighted in favor of pure water standards. As field samples were added to the calibration the average error was reduced, and the standard deviation and variance was significantly improved. This is due to the fact that the calibration had become more representative of the laboratory values. Even if the laboratory values reflect some inherent error of their own this error is incorporated into the instrument calibration, producing instrument results that are more consistant with the laboratory results used as a standard of comparison.

An operational problem related to surge protection for the 4-20 mA transmitter circuit was noted and corrected during the demonstration at the Middleville Road site.

Multiple Sample Line Manifold Test

A demonstration of on-line analysis of nitrate using the ChemScan multiple sample line manifold system was conducted in early 1995 at the Mount Sinai - Coram Road pumping station. This site was in the process of startup/test of a blending system to reduce the nitrate-nitrogen concentration in water from a high nitrate well.

A ChemScan UV-6100 system was installed at the site, but no attempt was made to develop a site

Middleville Road Station

NO3-N, 20 min intervals

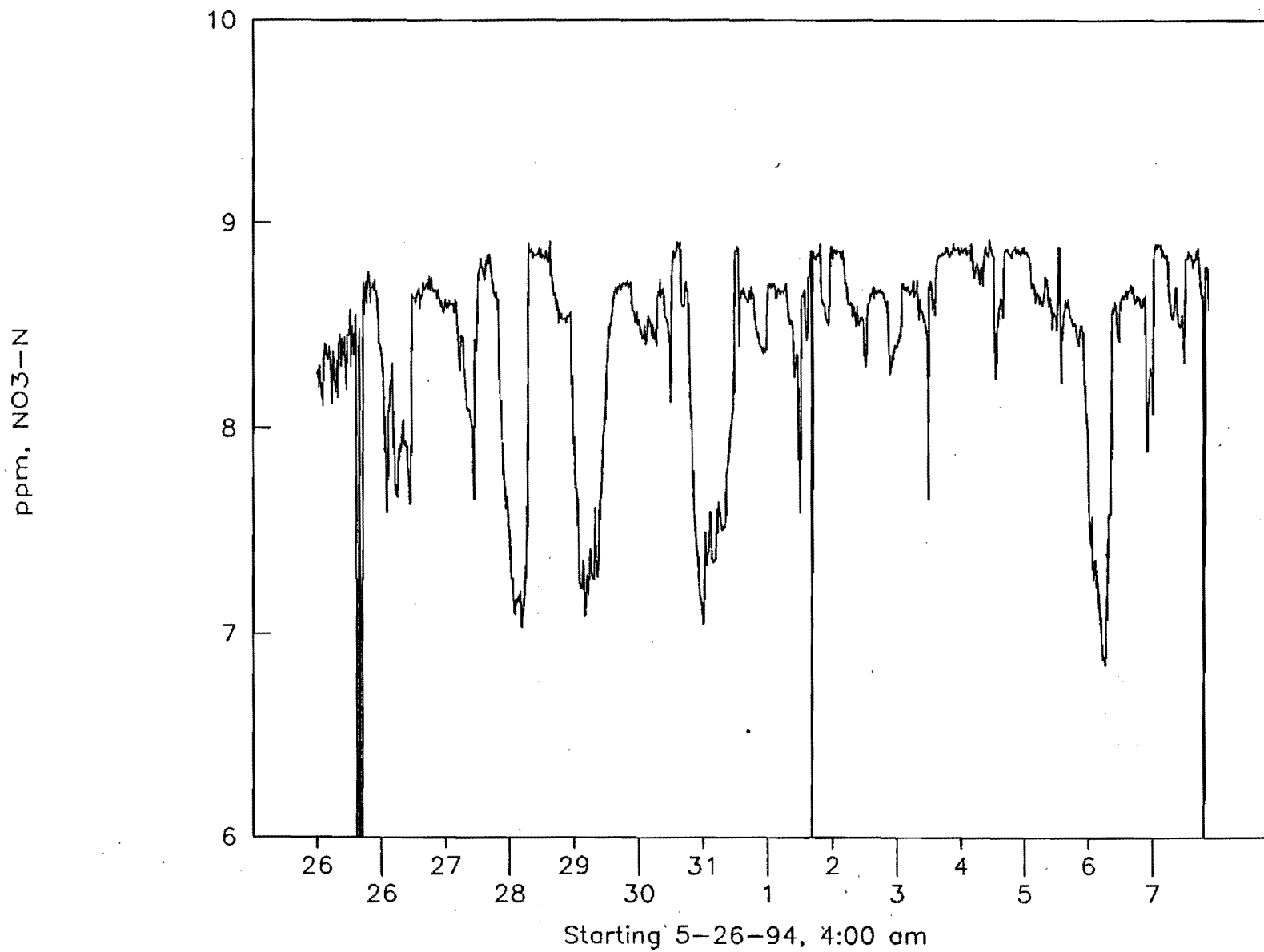


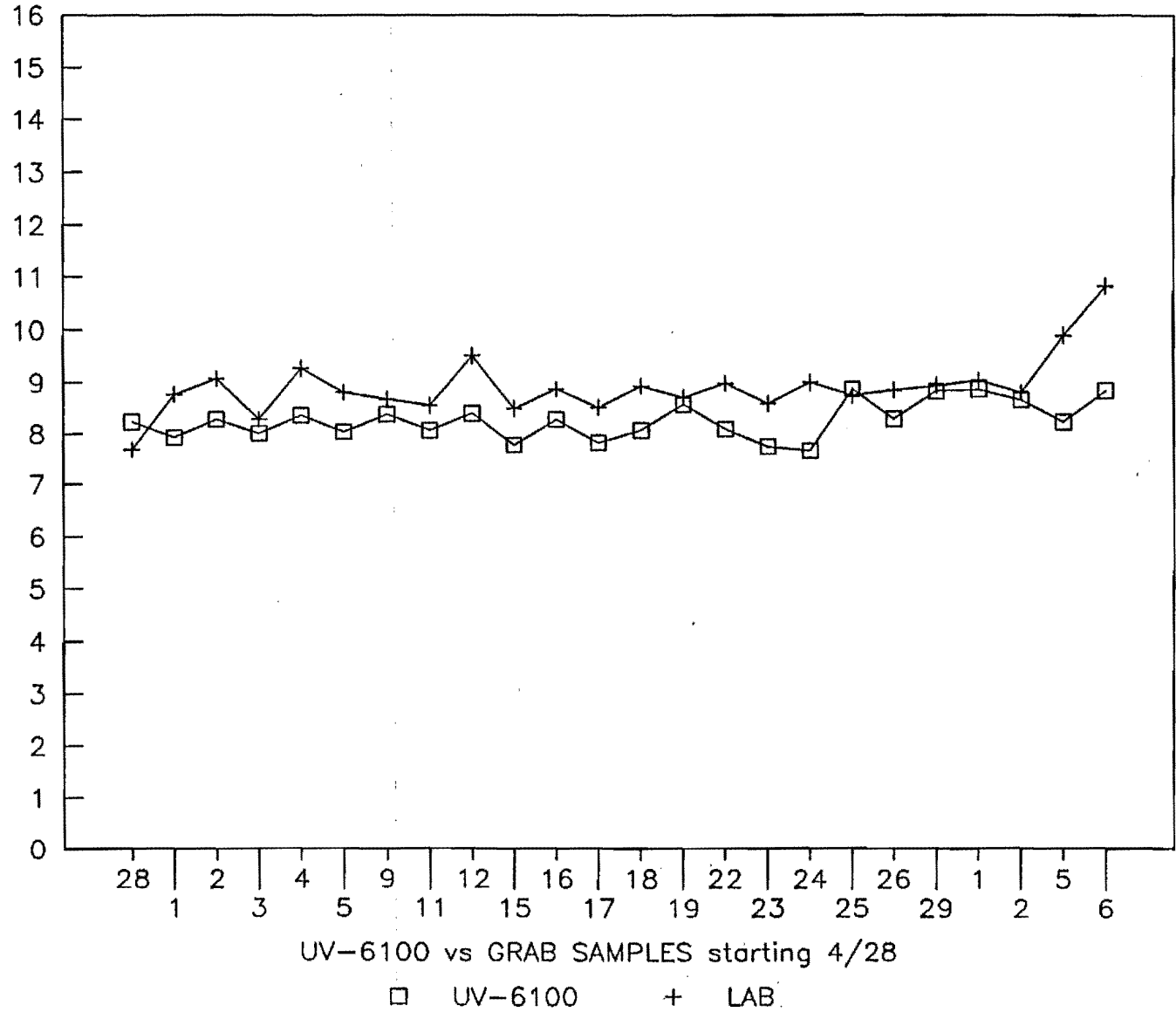
Figure 2

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Nitrate Analysis, Middleville Rd.

Figure 3

ppm, NO₃-N



UV-6100 vs GRAB SAMPLES starting 4/28

□ UV-6100 + LAB

Suffolk County Water Authority

Nitrate Analysis, Middleville Rd.

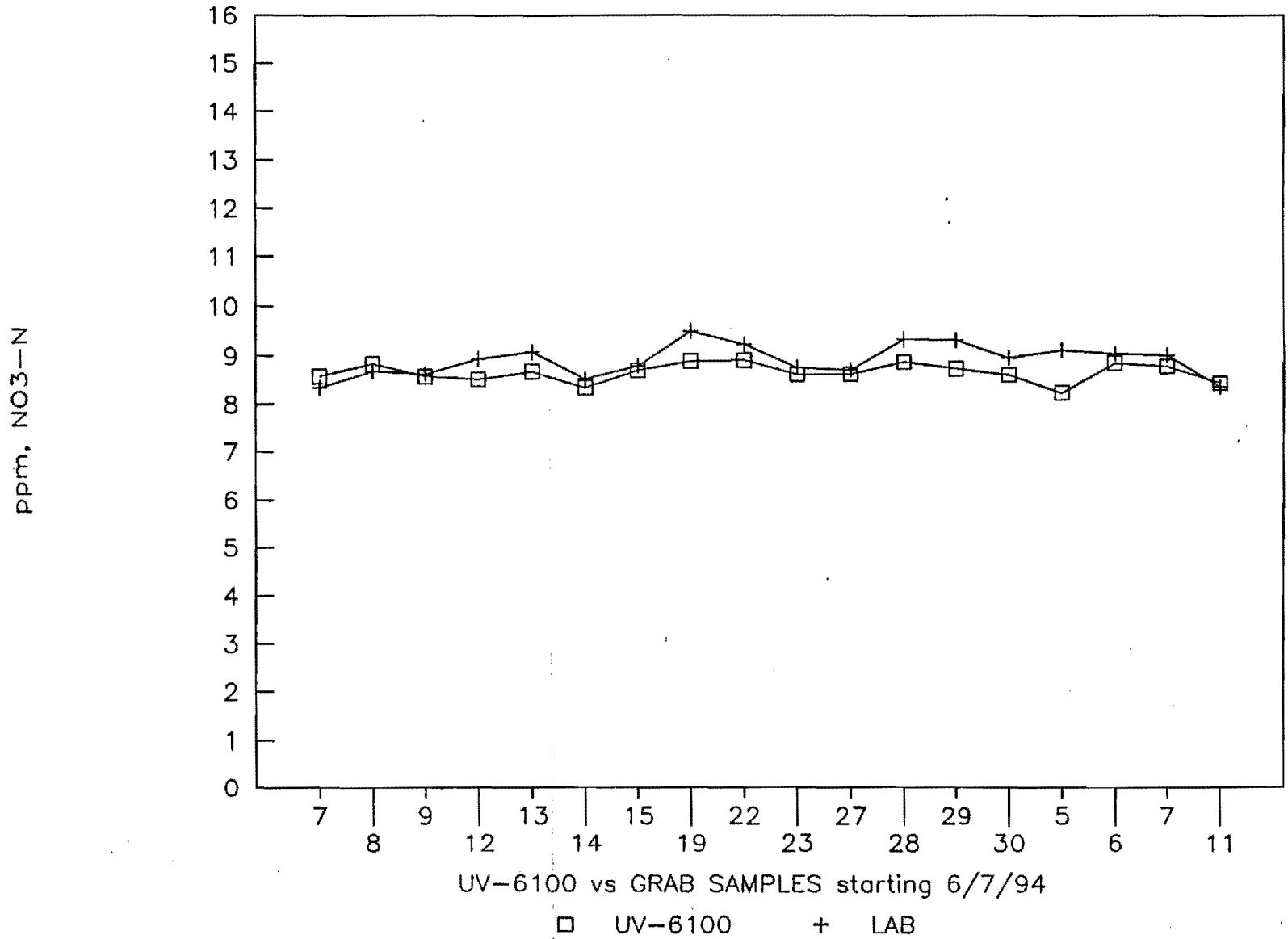


Figure 4

specific calibration for the instrument. A different UV-6100 instrument was used, but with a nitrate calibration taken from the instrument used at the Middleville Road test site. (Note: The UV-6100 system is designed to allow calibrations to be constructed from files obtained using different UV-6100 instruments. The system is also designed, with certain limits, to allow calibration files to be transported from one instrument to another. The limiting factor is the performance of a wavelength calibration to standardize the optical response of the instrument. A wavelength calibration was not performed on the demonstration system at the Mt. Sinai - Coram Site.)

A manifold system controlled by software in the UV-6100 analyzer was installed. This manifold is designed to automatically switch the sample flow to the UV-6100 instrument based on a preset interval and sequence. An analysis performed by the UV-6100 instrument is communicated over an RS-232 connection to a programmable logic controller located within the manifold system. The analysis results are converted to 4-20 mA signals using isolated surge protected circuits within the manifold and are output over the appropriate output channel. A circular chart recorder was dedicated to each sample line output at the Mt. Sinai - Coram Site.

These sample lines were monitored: the raw well water, a supply of treated (booster) water used to mix with the raw water and the combined raw plus booster water. Based on laboratory tests conducted over the period of February 26 to March 6, the raw water has a consistently high nitrate concentration of 14 to 16 ppm $\text{NO}_3\text{-N}$. The booster water has a much lower background nitrate concentration of 3 to 5 ppm $\text{NO}_3\text{-N}$, resulting in a blend with nitrate concentrations of 6 to 9 ppm $\text{NO}_3\text{-N}$. Laboratory test results for each sample line are illustrated in Figure 5.

The treatment system was only in operation for several hours each day, starting at 9:00 A.M. and ending at 3:00 P.M., as illustrated for raw water in Figure 6. During off times for the treatment system test, sample flow to the manifold for the raw water line and for the combined water line was maintained using booster water. Figure 6 shows the "raw" water nitrate concentration returning to booster water levels following the end of the test period each day.

Samples were obtained during the times when the treatment system was in operation. The UV-6100 nitrate values for each sample line were recorded at the time the samples were extracted. Figure 7 shows results from the UV-6100 for the period from February 22 to March 6, which are comparable to the results from laboratory analysis in Figure 5 and comparable to the expected results, that is, high raw water nitrate concentration, low booster water nitrate concentration and intermediate nitrate concentration in the combined water.

No attempt was made to optimize the comparative results for this site, since the accuracy of the UV-6100 system for nitrate analysis had already been demonstrated at Middleville Road.

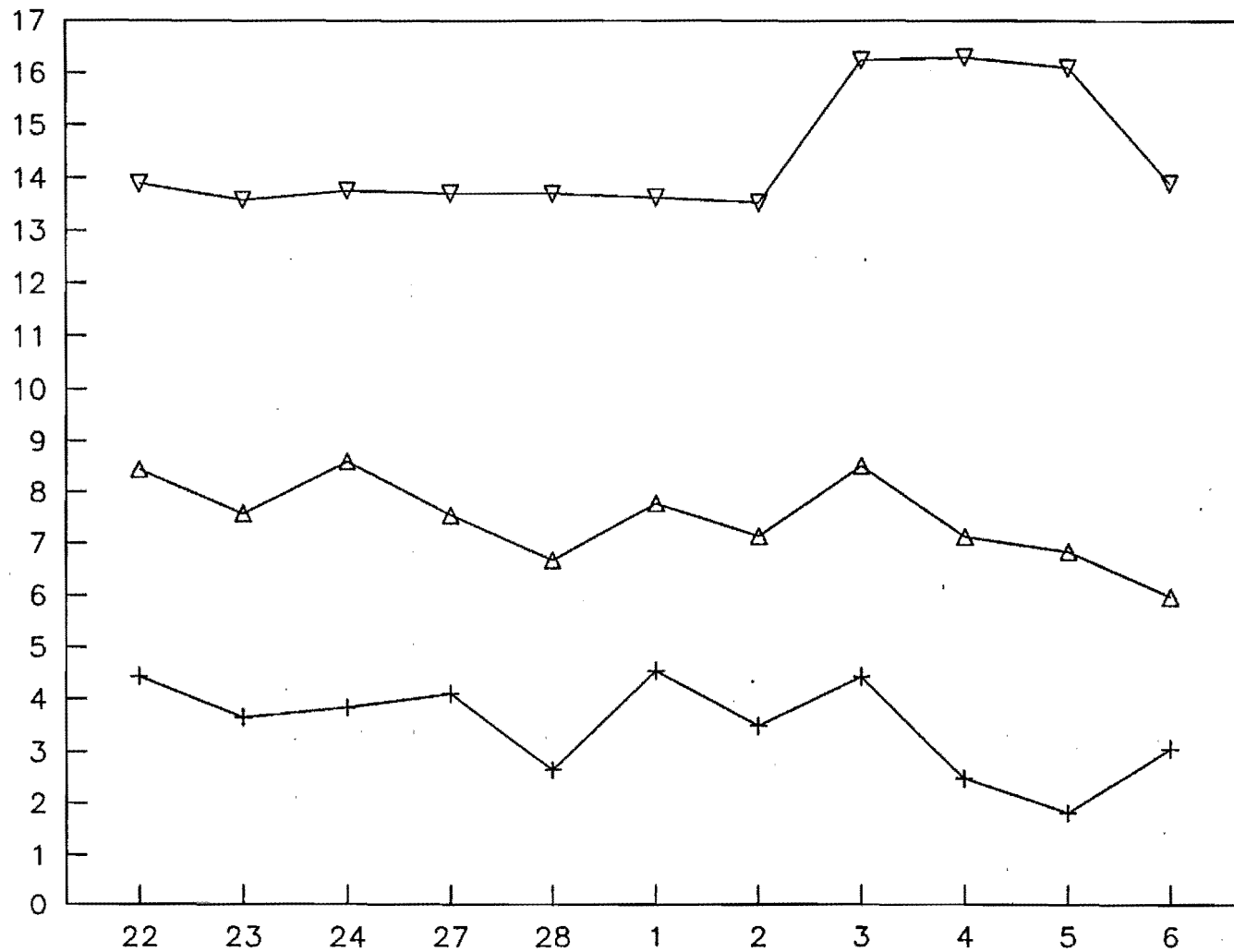
The Mt. Sinai - Coram test demonstrated that the UV-6100 system with multiple sample line manifold could provide reliable monitoring of nitrate in water for multiple sample lines at unmanned pump stations.

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Mt. Sinai - Coram Site

Figure 5

ppm, NO₃-N



Lab Results Starting 2/22/95

+ Booster Water Δ Combined ▽ Raw Water

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Mt. Siani-Coram Site

ppm, NO₃-N (SMOOTHED 70/30)

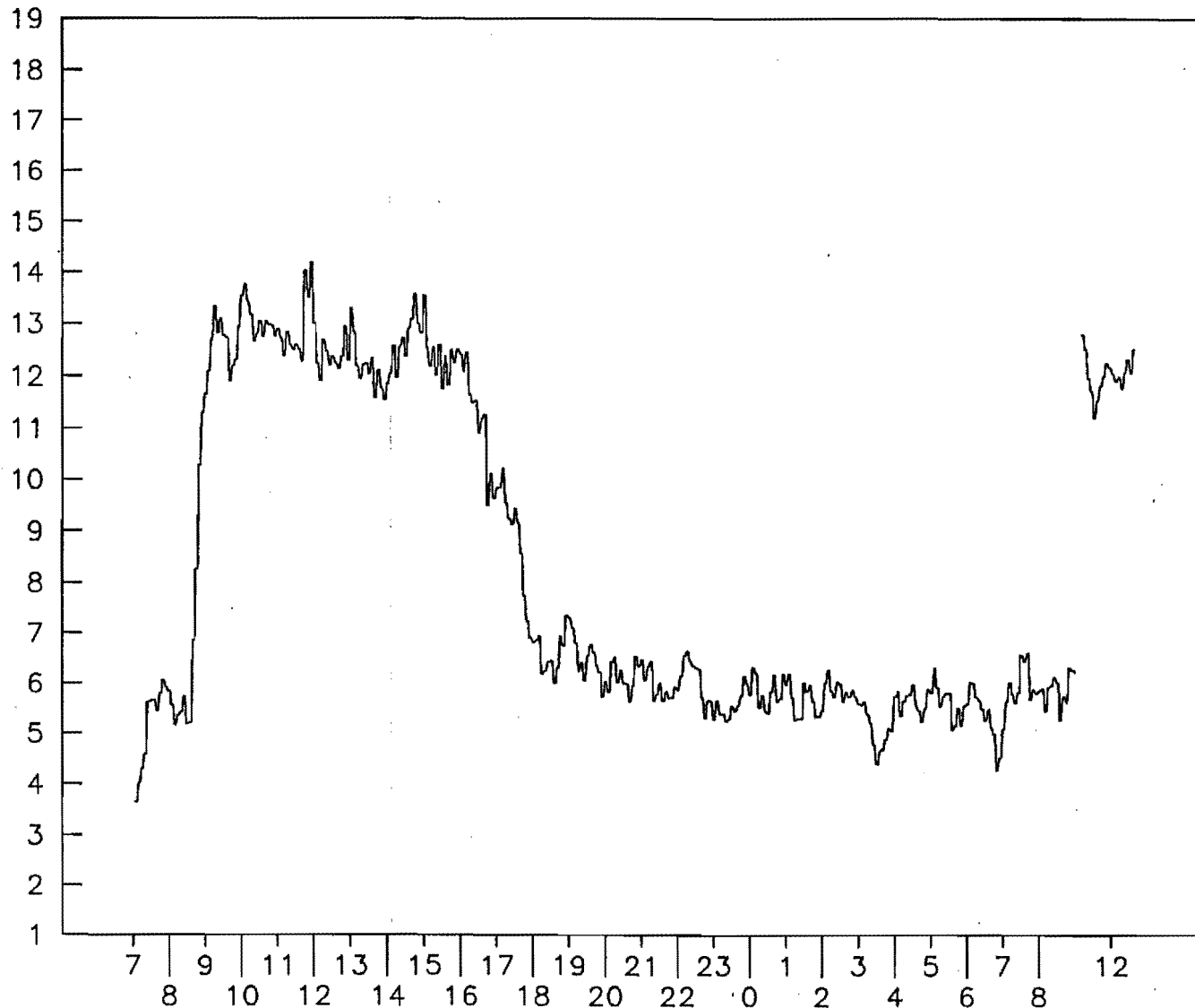


Figure 6

Raw Water, 7am 2/26 to 1pm 2/27

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Mt. Sinai - Coram Site

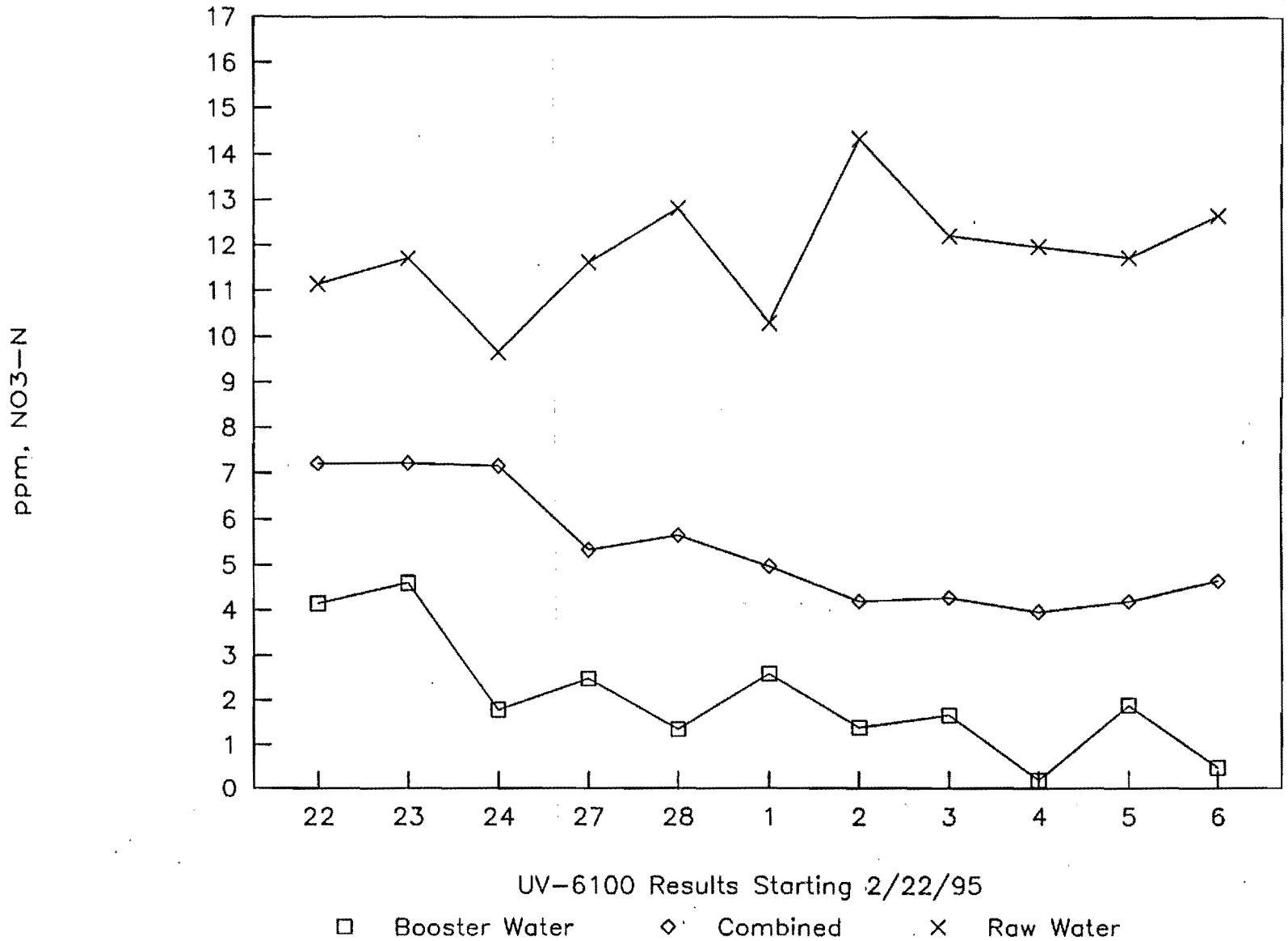


Figure 7