LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

OLIN CHEMICAL CORPORATION

NIAGARA FALLS, NY

GROUND-WATER COLLECTION SYSTEM PERFORMANCE MONITORING REPORT

January 1998

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

January 27, 1998

Mr. Mike Bellotti
Olin Chemical Corporation
P.O. Box 248
Charleston, TN 37310

Subject: **Ground-Water Collection System Performance Monitoring Report**
Olin Chemical Corporation
Niagara Falls, NY
Law Engineering and Environmental Services Project No. 12000-8-0009

Dear Mr. Bellotti:

Law Engineering and Environmental Services, Inc. is pleased to submit this Ground-Water Collection System Performance Monitoring Report for Olin's Niagara Falls facility. The work was performed in accordance with our Performance Monitoring Proposal (12000-7-9027.0304.908) dated August 22, 1997.

Please contact us if you have any questions or comments regarding this report.

Sincerely,

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

Andrew M. Clark
Project Geologist

Neven Kresic, PhD
Senior Hydrogeologist

Gregory P. Roush
Principal Geologist

Frederick K. Marotte
Project Manager

112 TOWNPARK DRIVE • KENNESAW, GEORGIA 30144
(770) 421-3400 • FAX (770) 421-3486

OLIN CHEMICAL CORPORATION

NIAGARA FALLS, NY

GROUND-WATER COLLECTION SYSTEM PERFORMANCE MONITORING REPORT

Law Engineering and Environmental Services, Inc.

Kennesaw, Georgia

January 1998

Project 12000-8-0009

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1.0 BACKGROUND OBJECTIVES

A ground-water collection and treatment system was installed at the Olin-Niagara facility during the Fall of 1997 as detailed in the Construction Certification Report for Ground-Water collection and Treatment System and Storm-Water Management Grading and Paving to be issued in January 1998.

The ground-water collection system was put online and monitored in October, 1997 and November, 1997 to evaluate the effectiveness of the recovery well system. The objective of the performance monitoring was to evaluate the hydraulic effect of the ground-water remedial system on the upper water-bearing zones at the facility and its effectiveness in containing the contaminated ground-water plume at the site as agreed in response to the State of New York Department of Environmental Conservation's Order of Consent, Index # R9-4171-94-08, dated January 13, 1997. The data from October 1997 were used to establish pumping rates for the more extensive monitoring test in November 1997. This report summarizes the data collected from November 6 to 25, 1997 and provides conclusions on the system performance based on the collected data.

2.0 HYDROGEOLOGICAL SUMMARY

The hydrogeological conditions encountered at the site during installation of the Ground-Water Collection System were consistent with those previously reported. Ground-water was observed in the shallow soil, about two feet above the top of bedrock. The overburden soil ranges from approximately six to 12 feet below ground surface at the site. The upper water bearing zone, defined as the A-Zone, extends from the ground-water surface in overburden down to three feet into the underlying rock. A-Zone wells along the north end of the plant have historically fluctuated from being dry to having water present.

The bedrock encountered at the site is the Lockport Dolomite, which has been extensively studied in the vicinity of the Olin site. Ground-water flow in the dolomite is generally within dissolution channels which have developed along horizontal bedding planes and through vertical fractures and joints. During drilling for well installation for the Ground-Water Collection System, the dolomite was observed to be fractured along horizontal bedding planes with vertical fractures and gypsum filled voids and fractures. The B-Zone, as defined during previous site assessment activities, is the water bearing zone in the dolomite below the A-Zone to approximately 25 feet below ground surface.

A cross-section location map for the Ground-water Collection System is provided on Figure 2.1. The legend for the cross-sections is provided on Figure 2-2. Cross-sections A-A', B-B', C-C', D-D' are provided on Figures 2.3 through 2.6, respectively. On the west side of the site (Cross-section A-A') the bedrock is a relatively flat surface. Along the east side of the site (Cross-section B-B') the bedrock surface is more undulating.

Cross-sections C-C' and D-D' run west to east across the site with Cross-section C-C' running along the north side of the plant and D-D' along the south side. As shown in these cross-sections, the depth to the top of bedrock increases towards the east as the dolomite runs below Gill Creek.

doesn't the creek
sit on bedrock?

3.0 SYSTEM DESIGN SUMMARY

The ground-water collection system consists of five active recovery wells and five passive relief wells. The five active wells pump ground-water from the surficial water bearing zone (A-Zone) and the next lower fractured bedrock water bearing zone (B-Zone). The passive relief wells are constructed similarly to the active recovery wells except that pumps are not installed in the passive relief wells. The downward hydraulic gradient present at the site promotes downward drainage from the A-Zone to the B-Zone via the passive relief wells for capture by the active recovery wells.

4.0 METHODS AND MATERIALS

Originally, performance monitoring of the ground-water collection system was to proceed in three weekly pumping cycles. During the first week, three recovery wells were to be pumped at three different rates. During the second week, the remaining two recovery wells were to be pumped at three different rates. Data from the first two weeks was then to be used to determine pumping rates for all wells during the final week of performance monitoring.

The performance monitoring plan was modified after the first week of testing to allow a longer period of continuous pumping of all recovery wells. After the initial week of testing three recovery wells, it was agreed to modify the performance monitoring plan to proceed in two pumping cycles with the second cycle lasting close to three weeks. The data from the first cycle was used to establish pumping rates for continuous pumping during the second monitoring cycle. The first cycle lasted four days from October 21 - 25, 1997 and consisted of increasing the pump rate of three of the recovery wells (RW-1, RW-3, and RW-5) each day for three days while monitoring ground-water level response to the pumping.

The second monitoring cycle lasted approximately nineteen days from November 6 - 25, 1997. Monitoring of the ground-water collection system during the second monitoring cycle was performed by turning all of the recovery wells on at a predetermined pumping rate and monitoring the effect on ground-water elevations in surrounding monitoring wells, piezometers, and Gill Creek. Additionally, background-water levels were recorded on November 6, 1997 before the pumping wells were turned on. The five pumping wells were pumped at the following approximate rates, as summarized on Table 4-1:

RW-1: 1gpm
RW-2: 12-9 gpm
RW-3: 5 gpm
RW-4: 24-15 gpm
RW-5: 23.5-15 gpm

During the final four days of the monitoring, the flow rates of recovery wells RW-4 and RW-5 were decreased to approximately 15 gpm.

Both pressure transducers and manual water-level measurements were used to monitor changes in the ground-water elevations. A HERMIT 2000 Automatic Data Logger was used to record the drawdowns measured by the transducers. The transducer data was recorded on a log cycle while manual measurement were recorded approximately once a day. The method of water level measurement (transducer or manual) is summarized in Table 4.2.

Due to various start up difficulties, such as well encrustation and computer shutdowns, the recovery wells experienced various lengths of down time. For this report, data were chosen for presentation from the periods with the least amount of down time, which more closely represent long term operation of the system.

5.0 RESULTS

The results of ground-water elevation data from Day 0 (background), Day 6, Day 13 and Day 19 (the final day) of the test were chosen for this report as discussed above. The ground-water elevations and drawdown data are provided on Tables 5.1 and 5.2. The data were used to create water level profiles for cross-sections A-A; B-B; and C-C; a B-Zone background potentiometric surface map, A-Zone and B-Zone potentiometric surface maps for the final day of the test, and drawdown maps for days 6 and 13.

5.1 RECOVERY WELL PERFORMANCE

The performance of the recovery wells was monitored by observing fluctuations in flow rates and ground-water level drawdown in the wells over the course of the test. The performance of recovery wells RW-1 and RW-2, located along Buffalo Avenue, were affected by the encrustation of the pump with carbonates. The pump encrustation decreased the pumping rate and caused the ground-water elevations to increase at the wells. Under normal operation (non-encrusted), recovery well RW-1 maintained approximately 4.5 feet of drawdown at a flow rate of approximately 3 gpm, while RW-2 maintained approximately 6 feet of drawdown at approximately 13.5 gpm. As the pumps at both well locations encrusted, the flow rate at well RW-1 decreased to approximately 1 gpm with 1.5 feet of drawdown and the flow rate at well RW-2 decreased to approximately 8.5 gpm with approximately 4.2 feet of drawdown. As the encrustation of the pumps at wells RW-1 and RW-2 continued the flow rate decreased to below 1 gpm and the ground-water elevations returned to nearly background levels. Replacement pump design has been evaluated and installation of replacement pumps (peristaltic pumps) is planned for early 1998.

Recovery wells RW-3, RW-4 and RW-5 (located along Gill Creek) performed effectively throughout the performance monitoring test. Well RW-3 maintained a drawdown of approximately 7 feet with a pumping rate of approximately 5.5 gpm. The pump at well RW-4 was operated at full capacity and maintained a drawdown of approximately 3 feet with a pumping rate of approximately 24 gpm. The pump at well RW-5 was operated at full capacity and maintained a drawdown of approximately 1.5 feet with a pumping rate of approximately 23.5 gpm.

5.2 HYDRAULIC EFFECTIVENESS

A-Zone Water Levels

All of the A-Zone piezometers had measurable drawdowns on Day 6 of the test, as shown in Table 5.1 and on Figure 5.3.

The A-Zone water levels for the wells located along Gill Creek are depicted on cross section B-B' (Figure 5.1). The background ground-water elevations for piezometers PN-5A, PN-6A, PN-7A, and PN-8A and passive relief well PR-4 were above the surface-water elevation in Gill Creek, while the ground-water elevation of piezometer PN-4A was below the surface-water elevation in Gill Creek. After 6 days of pumping, the ground-water elevations in piezometers PN-4A, PN-5A, PN-7A, and passive relief well PR-4 were below the Gill Creek surface-water elevation. Water elevations at piezometers PN-6A and PN-8A had discussed but remained above the Gill Creek surface-water elevation.

Approximately 7 days into the test a large snow storm occurred and water elevations, in general, increased, in some cases to above background levels. The infiltration affected the ground-water elevations for the remainder of the test. On day 13, only the water elevation at piezometer PN-4A was below the water elevation of Gill Creek.

There was not sufficient pre-test ground-water elevation data to develop a potentiometric surface map for the A-Zone. However, a potentiometric surface map for the A-Zone was developed for the final day of the test and is provided on Figure 5.2. Under longer term steady state conditions, the collection system should be effective in capturing groundwater in the A-Zone. A potentiometric surface map (showing the 563 foot contour) for the A-Zone on the final day of the test is provided on Figure 5.2. Groundwater levels from monitoring wells, passive relief wells and recovery wells were used to develop the map. The 563 foot potentiometric contour was selected because it is lower than the Gill Creek surface water elevation of 563.3 feet (which represents a constant head boundary on the outer side of the facility). Based on this map. The groundwater flow direction is generally inward towards the facility and the groundwater collection system. However, there are several localized areas adjacent to the creek that have higher groundwater elevations than the surface water elevation. Under longer term steady state conditions, the collection systems should be effective in capture groundwater in the A-Zone.

B-Zone Water Levels

All of the B-Zone monitoring locations had measurable drawdowns on Day 6, Day 13, and Day 19 (the final day) of the test. Other than an isolated area in the vicinity of PR-3 at the north end of the site, ground-water in the B-Zone is being captured by the ground-water collection system.

A background potentiometric surface map for the B-Zone using November 6, 1997 data is provided on Figure 5.3. The potentiometric surface map shows a ground-water low area centered around Building 73 (the ground-water treatment system building) with a ground-water high located to the northwest extending approximately from RW-1 towards RW-2 and a ground-water high parallel to Gill Creek. Ground-water flow in the B-Zone is generally towards the north between the two ground-water high areas. Ground-water elevations in the B-Zone are consistently below the surface-water elevation of Gill Creek.

Drawdown maps for the site relative to background-water elevations measured on November 6, 1997 after 6 and 13 days of pumping are provided on Figures 5.4 and 5.5, respectively. The ground-water drawdown maps indicate capture in the B-Zone along Gill Creek and on the north side of the ground-water collection system, except for an isolated area in the vicinity of well PR-3. The ground-water in the vicinity of PR-3 is affected by recovery well RW-2 which became encrusted with carbonates during the course of the test. The decrease in flow rate at well RW-2 caused ground-water levels to rise which could have caused the localized high area in the vicinity of PR-3. Drawdown is generally greater after 6 days than 13 days of pumping due to the infiltration after the snow storm.

The water-level profiles for the B-Zone are provided on Figures 5.1, 5.6 and 5.7 and represent elevations for background, Day 6, and Day 13 of the test. Figure 5.6 coincides with cross-section A-A' and shows the effect on the B-Zone water elevations in the vicinity of RW-1, which was pumped intermittently due to pump encrustation. After 6 days of pumping, water levels in OBA-23B, PN-1B, and PR-1 decreased below background levels. After 13 days of intermittent pumping ground-water levels had increased slightly relative to the 6th day elevations but were still below background levels. The slight increase is most likely due to infiltration from the snow storm described above.

Figure 5.1 depicts water levels in the B-Zone along cross-section B-B', which were affected by recovery wells RW-3, RW-4, and RW-5. Drawdown was measured in all of the B-Zone monitoring locations after 6 days of pumping. After 13 days of pumping, drawdown increased in the recovery wells but decreased slightly in the piezometers and passive relief well relative to the 6 day measurements. Infiltration from the snow storm event was, again, most likely the reason for the slight increase in water elevations.

Figure 5.7 depicts water levels in the B-Zone along cross-section C-C' which were affected by recovery wells RW-2 and RW-3. Recovery well RW-2 was pumped intermittently throughout the test due to pump encrustation. Water levels dropped in all the piezometers and passive relief wells after 6 days of pumping. The water levels increased slightly after 13 days of pumping but remained lower than background levels. Infiltration from the snow storm most likely caused the slight increase in the water levels after 13 days of pumping.

Figure 5.8 presents the B-Zone potentiometric surface map from the final day of the test (Day 19). Ground-water levels from monitoring wells for the entire site were used to develop the potentiometric surface map. The flow rates at recovery wells RW-4 and RW-5 were decreased on Day 14 of the test to approximately 15 gpm. Despite the decreased flow rates, the potentiometric surface map indicates ground-water capture along Gill Creek and along the north side of the recovery systems, except for an isolated area in the vicinity of well PR-3.

6.0 CONCLUSIONS/RECOMMENDATIONS

The following conclusions on the performance of the ground-water collection system are made based on the data collected during the performance monitoring test from November 6 - 25, 1997.

Testing protocol:

Field conditions affecting the test included computer shut downs and pump encrustation at recovery wells RW-1 and RW-2. Also, a snow storm event occurred after 7 days into the test and infiltration from the snow melt had an effect on both A-Zone and B-Zone water levels as discussed above. Due to these conditions and to increase the length of time of continuous operation of the ground-water collection system, the monitoring plan was modified from a three cycle test to a two cycle test. During the first monitoring cycle, three recovery wells were operated and ground-water elevations were monitored. The data from the first cycle was used to establish continuous pumping rates for the recovery wells during the second cycle. The recovery system was operated for 19 days during the second cycle as opposed to the originally planned 7 days of continuous operation.

A-Zone Water Levels

The A-Zone water levels, as depicted on cross-section B-B' along Gill Creek responded to pumping as drawdown relative to background-water levels at all of the A-Zone monitoring locations. The A-Zone was drawn down below the elevation of Gill Creek at all locations except at piezometers PN-6A and PN-8A on Day 6 of the performance monitoring test. However, drawdown was observed at both of these piezometers, which indicates that the recovery wells are affecting the ground-water elevations at these locations.

Except for a few localized areas, the potentiometric surface map of the A-Zone for the final day of the test (Figure 5.2) indicates ground-water flow inward towards the collection system and the facility (and away from Gill Creek). The ground-water collection system was designed as a passive recovery system for the A-Zone. The length of the test did not provide enough time to fully drain the A-Zone into the B-Zone. The passive relief wells were also affected by pumping the recovery wells, indicating that drainage from the A-Zone to the B-Zone will occur at the site.

Under steady state conditions, the A-Zone will be further dewatered and this provide for caption, the ground-water elevations may fall below the Gill Creek surface-water elevation. The recommendation is to continue pumping at the rates listed in Table 4.1 and continue monitoring groundwater elevations to assess longer term effect on the A-Zone.

B-Zone Water Levels

Capture is being achieved in the B-Zone along Gill Creek and the north side of the collection system except for an isolated area in the vicinity of PR-3. The B-Zone water levels, as depicted along cross-sections A-A', B-B', C-C' (Figures 5.1, 5.6 and 5.7), responded to pumping as drawdown relative to background levels was observed at all of the B-Zone monitoring locations. The potentiometric map of the B-Zone for the final day of the test for pump rates listed in Table 4.1 indicate cones of depression indicative of B-Zone capture.

An isolated ground-water high was observed in the vicinity of PR-3 as indicated on the B-Zone Drawdown and Potentiometric Surface maps. The ground-water in the vicinity of PR-3 is affected by recovery well RW-2 which became encrusted with carbonates during the test. Replacement pump design for RW-1 and RW-2 has been evaluated and installation of the replacement peristaltic pumps is scheduled for early 1998. After the peristalic pump is installed at RW-2, continuous ground-water recovery will be maintained which could decrease the ground-water elevations in this area of the plant.

The B-Zone was affected by the snow melt infiltration as water levels were observed to rise in the B-Zone monitoring locations. However, continued pumping of the recovery wells during precipitation events should maintain a capture zone in the B-Zone as indicated by the water levels recorded on Day 13 and Day 19 of the test.

The depressed water elevations in the B-Zone should also enhance drainage from the A-Zone into the B-Zone by increasing the downward hydraulic gradient already present at the site. Over time, as the greater downward hydraulic gradient is maintained, water from the A-Zone will drain vertically to the B-Zone for capture by the recovery wells.

Recommendations

It is recommended to continue operating the ground-water collection system at the rates listed below. As noted above, replacement pumps will be installed at wells RW-1 and RW-2 to ensure attainment of the desired pump rates. The system will be monitored for the first quarter of 1998, allowing long term equilibration of the A-Zone.

The recommended pumping rates for continued operation of the ground-water collection system are as follows:

RW-1: 3 gpm

RW-2: 12 gpm

RW-3: 6 gpm

RW-4: 20 gpm

RW-5: 20 gpm

These pumping rates are recommended based on the data collected to date and assume the pump encrustation problems in recovery wells RW-1 and RW-2 are resolved. Also, over time, the continued operation of the ground-water collection system may induce greater drawdown at the recovery wells. If the recovery wells begin to cycle on and off due to greater drawdown at the above recommended pumping rates, the rates may be decreased to allow continued operation of the system.

Reporting

Quarterly Ground-Water data will be developed and reports prepared for NYSDEC per the Remedial Action Workplan. The data will be evaluated to summarize the ground-water elevations and provide potentiometric surface maps for the site. The reports will also provide conclusions on the ground-water collection system performance and make any necessary recommendations.

TABLES

TABLE 4.1
Recovery Well Pumping Rates

Recover Well	Pumping Rate (gpm) Day 6	Day 13	Day 19	Recommended
RW-1	0.75	1	1	3
RW-2	11.8	8.5	7	12
RW-3	5	5	5	6
RW-4	24	24	15	20
RW-5	23.5	23.5	15	20

TABLE 4.2
Method of Well Measurement

RW-1	transducer
RW-2	transducer
RW-3	transducer
RW-4	transducer
RW-5	transducer
PR-1	manual
PR-2	transducer
PR-3	transducer
PR-4	transducer
PR-5	transducer
PN-1A	manual
PN-1B	transducer/manual [1]
PN-2A	manual
PN-2B	transducer
PN-3A	transducer
PN-3B	transducer
PN-4A	transducer
PN-4B	transducer
PN-5A	transducer
PN-5B	transducer
PN-6A	transducer
PN-6B	transducer
PN-7A	transducer
PN-7B	transducer
PN-8A	transducer/manual [1]
PN-8B	transducer/manual [2]
OBA-23A	manual
OBA-23B	transducer
GC-1	manual
GC-2	manual

prepared by/date: AMC/1-2-98
checked by/date: MES/1-7-98

Notes:

All wells were measured manually as a check on the transducer.
If there was a discrepency between the manual and transducer water level,
the transducer data was corrected based on manual measurements

1) The transducer from PN-1B was transferred to PN-8A during the test.
   Manual measurements were used when there was no transducer in the piezometers
2) The transducer at PN-8B was replaced with a new transducer several days after being damaged.
   Manual measurements were used when there was no transducer in the piezometer

TABLE 5.1
A-Zone Water Elevations and Drawdown

Well	Background Elevation	Day 6 Elevation	Day 6 Drawdown	Day 13 Elevation	Day 13 Drawdown	Day 19 Elevation
PN-1A	563.82	563.26	0.56	564.07	-0.25	564.31
PN-2A	dry	NM	--	NM	--	563.34
PN-3A	562.68	561.8	0.88	562.7	-0.02	563.3
PN-4A	562.78	562.5	0.28	562.8	-0.02	563.2
PN-5A	563.39	563.1	0.29	563.3	0.09	563.7
PN-6A	563.97	563.5	0.47	563.6	0.37	564
PN-7A	563.28	563.1	0.18	563.2	0.08	563.4
PN-8A	565.03	564.3	0.73	564.5	0.53	564.5
Gill Creek-1	562.99	563.47	-0.48	563.17	-0.18	563.32
Gill Creek-2	562.95	563.45	-0.5	563.13	-0.18	563.31
PR-4 [1]	563.01	562.4	0.61	563.4	-0.39	563.8
OBA-2A	NM	NM	--	NM	--	Dry
OBA-4A	NM	NM	--	NM	--	561.32
OBA-5A	NM	NM	--	NM	--	564.79
OBA-9A	NM	NM	--	NM	--	563.93
OBA-9AR	NM	NM	--	NM	--	563.9
OBA-10A	NM	NM	--	NM	--	563.88
OBA-15A	NM	NM	--	NM	--	558.71
OBA-16A	NM	NM	--	NM	--	563.66
OBA-23A	NM	NM	--	NM	--	563.05

Notes:

Ground-water elevations taken from transducer data and corrected using manual measurements.

1) PR-4 is included as an A-Zone well as the ground-water elevation is similar to the A-Zone piezometers.

prepared by/date: AMC/1-2-98

checked by/date: MES/1-7-98

TABLE 5-2
B-Zone Water Elevations and Drawdown

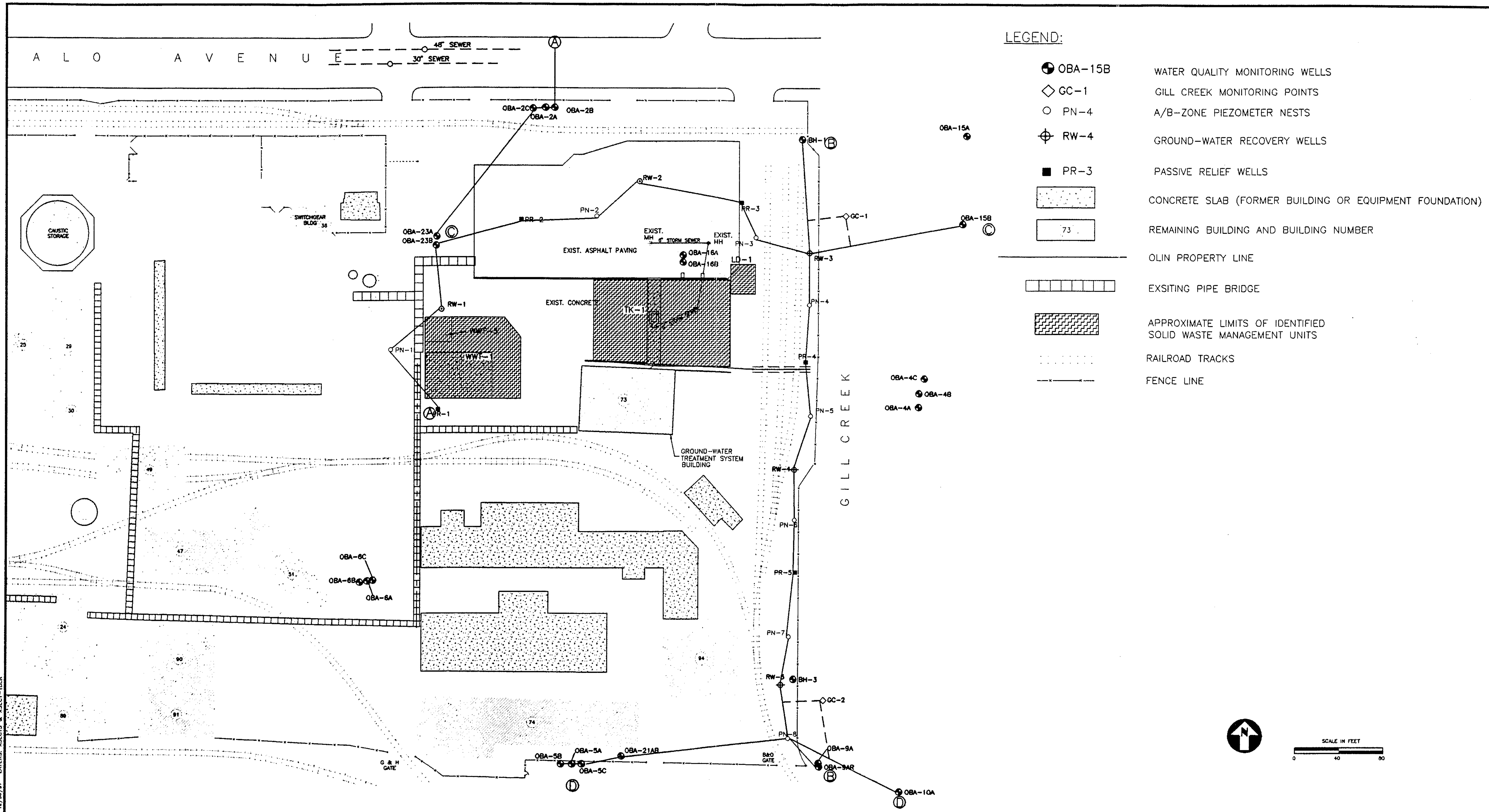
Well	Background Elevation	Day 6 Elevation	Day 6 Drawdown	Day 13 Elevation	Day 13 Drawdown	Day 19 Elevation
RW-1	559.97	558.6	1.37	558.7	1.27	559.2
RW-2	559.24	553.8	5.44	555	4.24	556.7
RW-3	559.55	553	6.55	552.2	7.35	553.9
RW-4	559.17	557.6	1.57	556.4	2.77	556.9
RW-5	559.58	557.3	2.28	556.7	2.88	557.3
PR-1	559.23	558.68	0.55	558.84	0.39	559.27
PR-2	559.14	558.6	0.54	558.8	0.34	559.3
PR-3	559.42	558.7	0.72	558.9	0.52	559.1
PR-4	563.01	562.4	0.61	563.4	-0.39	563.8
PR-5	559.51	558.9	0.61	559	0.51	559.5
OBA-23B	559.83	559.25	0.58	559.5	0.33	559.8
PN-1B	560.03	559.4	0.63	559.7	0.33	559.9
PN-2B	559.8	558.5	1.3	558.9	0.9	559.04
PN-3B	559.07	558.5	0.57	558.7	0.37	559
PN-4B	559.07	558.6	0.47	558.7	0.37	559.1
PN-5B	559.08	558.6	0.48	558.7	0.38	559.2
PN-6B	559.17	558.6	0.57	558.7	0.47	559.2
PN-7B	559.68	559	0.68	559.2	0.48	559.6
PN-8B	559.33	558.8	0.53	559.2	0.13	559.4
OBA-2B	NM	NM	--	NM	--	558.6
OBA-4B	NM	NM	--	NM	--	559.86
OBA-5B	NM	NM	--	NM	--	561.4
OBA-15B	NM	NM	--	NM	--	558.48
OBA-16B	NM	NM	--	NM	--	558.95

Notes:

Ground-water elevations taken from transducer data and corrected using manual measurements.

prepared by/date: AMC/1-2-98
checked by/date: MES/1-7-98

FIGURES



CAD DRAWING – DO NOT CHANGE MANUALLY

CAD File: D10003A Diskette No: ______

CADD FILE: /DWG2/OLIN/NIAGRA/CONST/D10003A DATE: 12/30/97 LAYERS: XSECTS & XSECT-TBLK

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, P.C. KENNESAW, GEORGIA

E.S.R. NO.	C.A.R. NO.	REV.	DESCRIPTION	DRAWN	DATE	CHKD.	APPR.

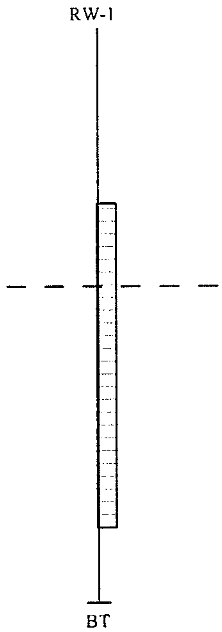
DRAWN / DATE / CHECKED / DATE / APPROVED

Olin CHEMICALS PLANT NIAGARA FALLS, NY.

FIGURE 2.1

CROSS – SECTION LOCATIONS

PROJECT NO.	C.A.R. NO.	SCALE	DRAWING NO.	REV.
		AS NOTED		



LEGEND

BT — Boring Terminated

Monitoring Interval

— — Interpreted Contact

▽ : Ground water elevation on 11/6/97

DOLOSTONE: Generally, Gray to light gray massive to finely bedded, vuggy, saccharoidal, with fractures along horizontal bedding and some vertical fractures, with gypsum filled voids, limonite staining, and some sphalerite.

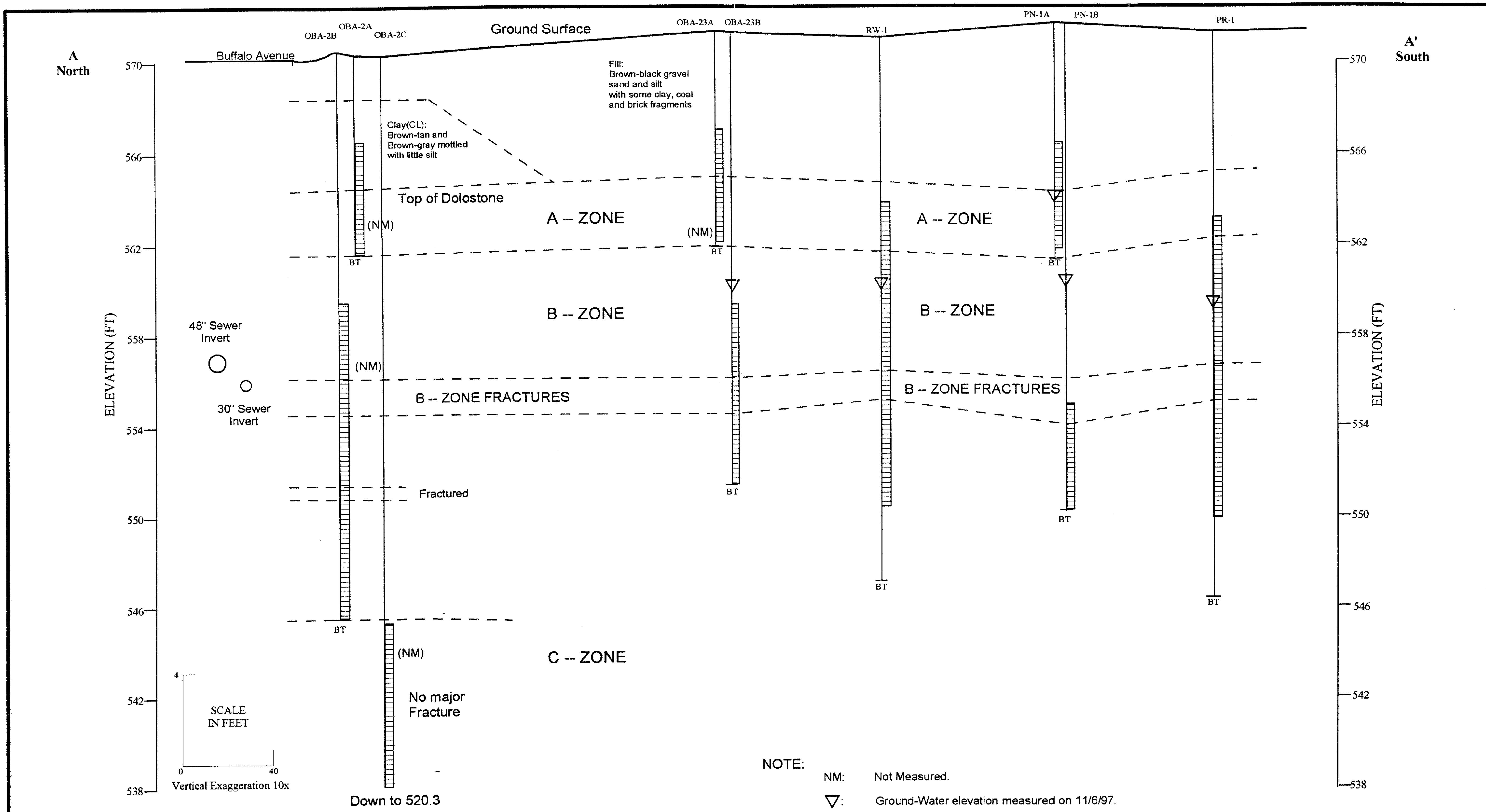
A – ZONE: Ground-Water surface extending into the upper three feet of bedrock.

B – ZONE: Water-bearing zone in the fractured bedrock beneath the A – ZONE to approximately 25 feet below ground surface.

B – ZONE FRACTURES: Interpreted fractured and weathered zone within the B – ZONE. Generally characterized by finely bedded, highly weathered dolostone and drilling water loss.

C – ZONE: Water-bearing fractured zone approximately 25 to 35 feet below ground surface, when present.

OLIN CHEMICALS PLANT NIAGARA FALLS, NY	LAW ENGINEERING AND ENVIRONMENTAL SERVICES	Legend for Hydrogeologic Cross Section Job Number 12000-8-0009 Figure 2.2



OLIN CHEMICALS PLANT
NIAGARA FALLS, NY

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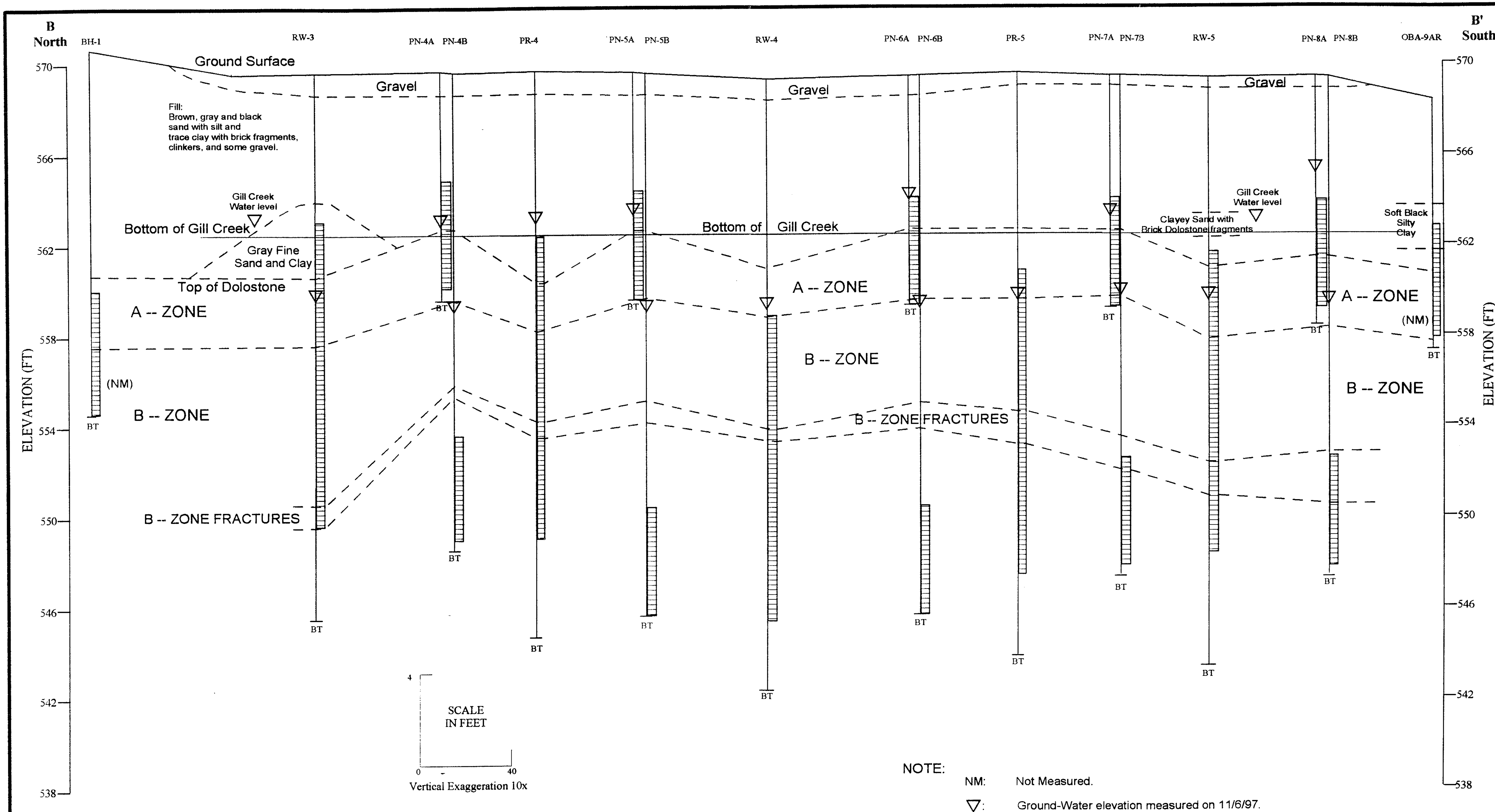
Hydrogeologic Cross Section AA'

Job Number 12000-8-0009

Figure 2.3



OLIN CHEMICALS PLANT
NIAGARA FALLS, NY

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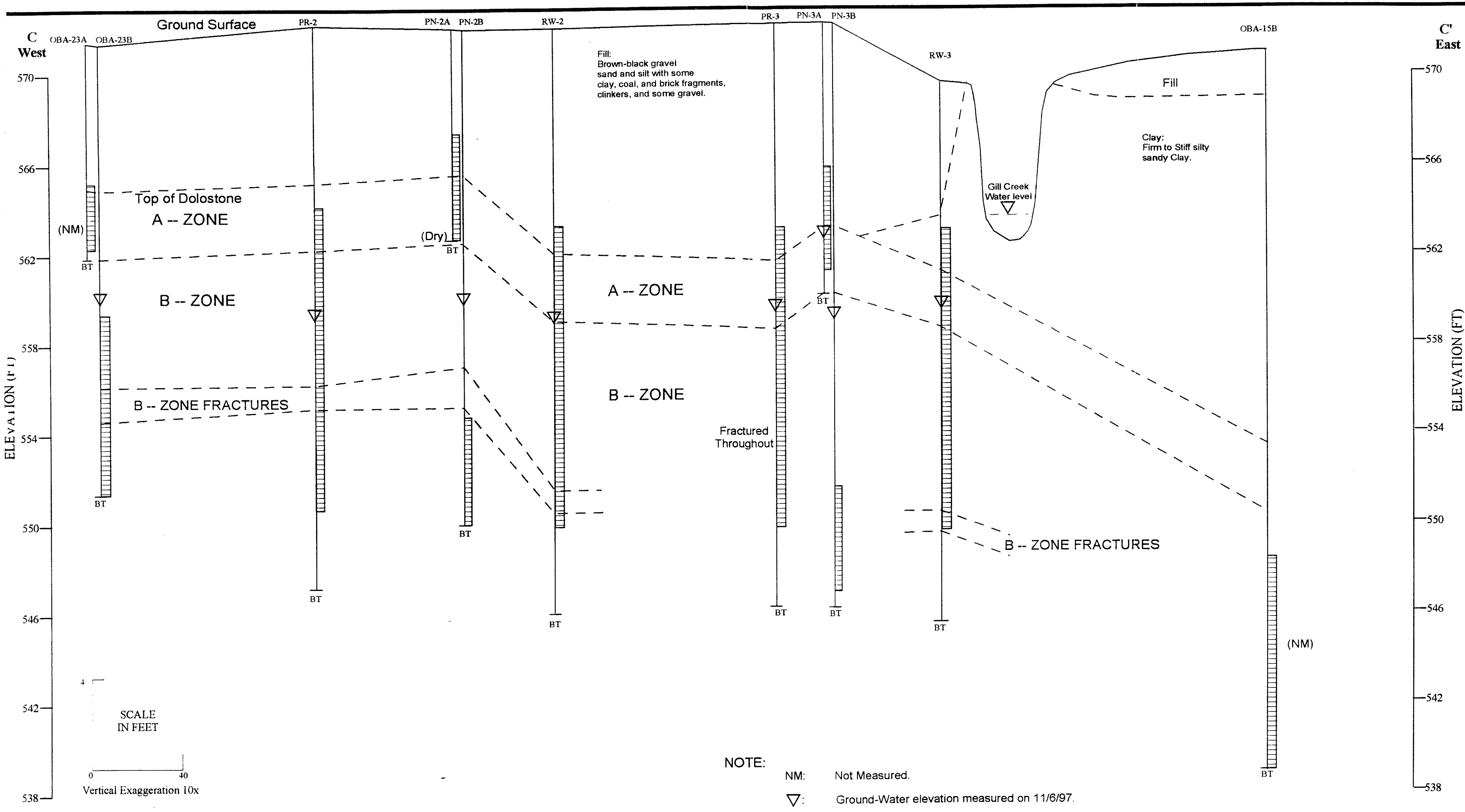
Hydrogeologic Cross Section BB'

Job Number 12000-8-0009

Figure 2.4



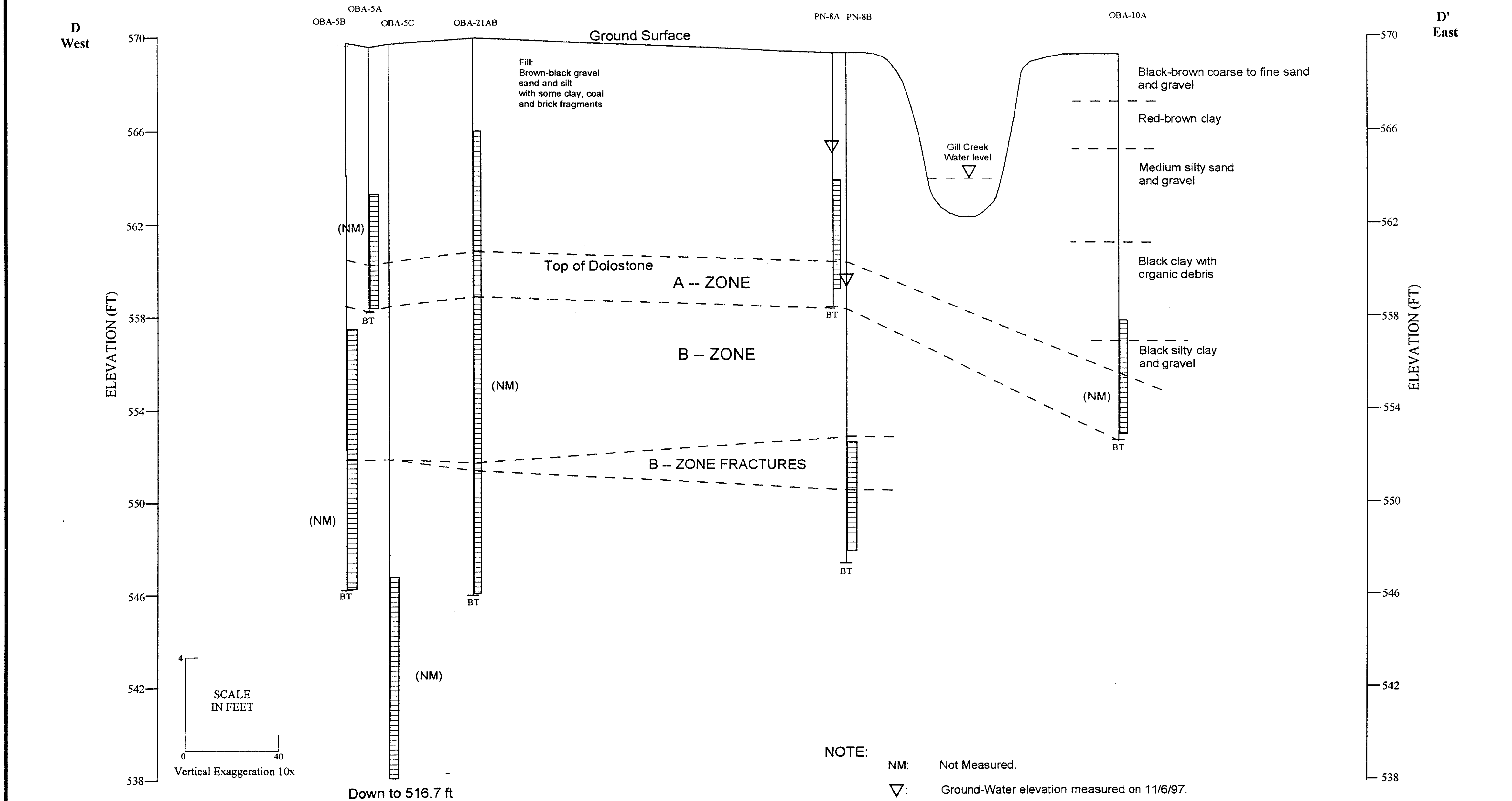
OLIN CHEMICALS PLANT
NIAGARA FALLS, NY

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

Hydrogeologic Cross Section CC'

Job Number 12000-8-0009

Figure 2.5



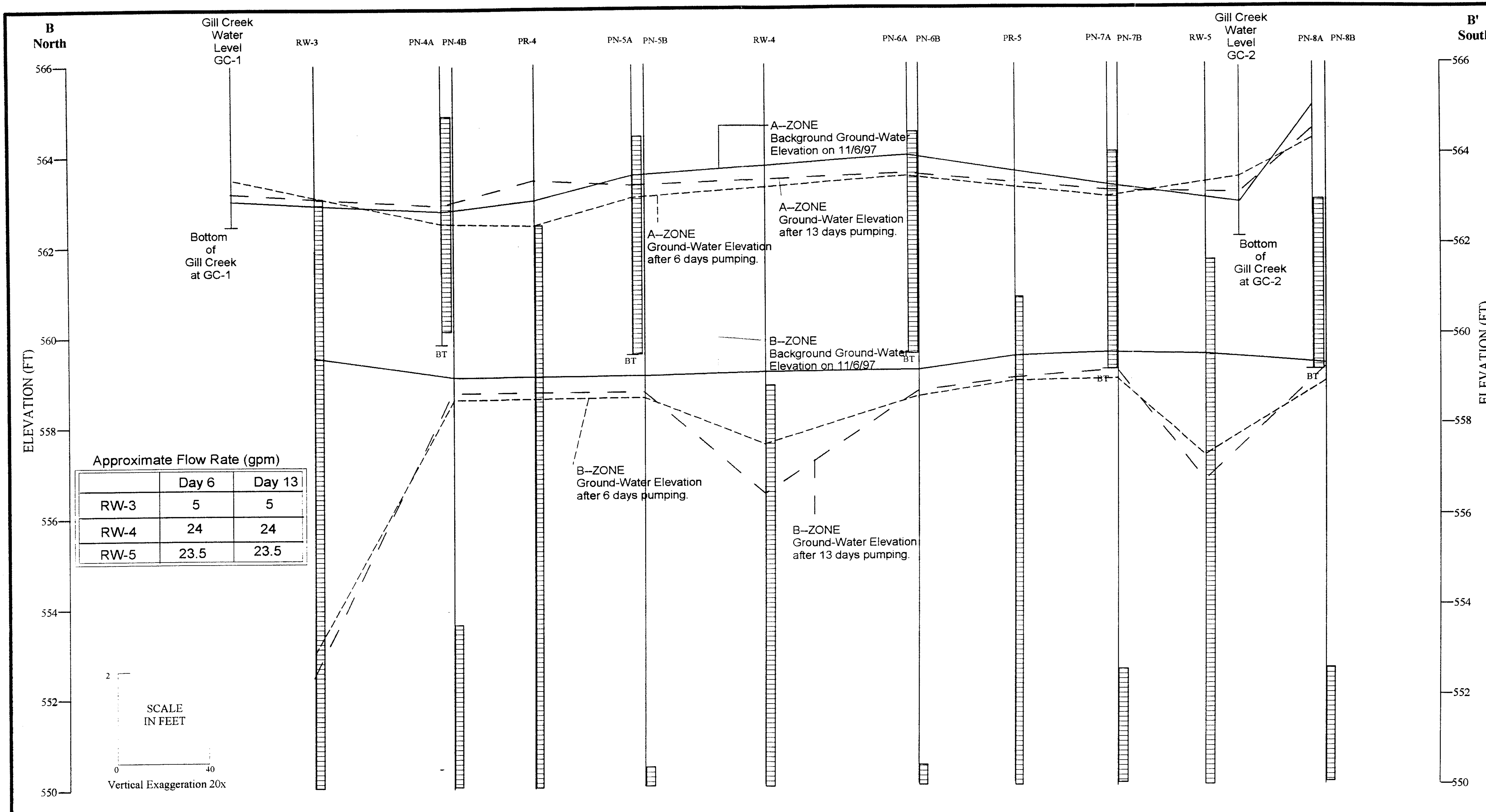
OLIN CHEMICALS PLANT
NIAGARA FALLS, NY

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

Hydrogeologic Cross Section DD'

Job Number 12000-8-0009

Figure 2.6



Approximate Flow Rate (gpm)

	Day 6	Day 13
RW-3	5	5
RW-4	24	24
RW-5	23.5	23.5

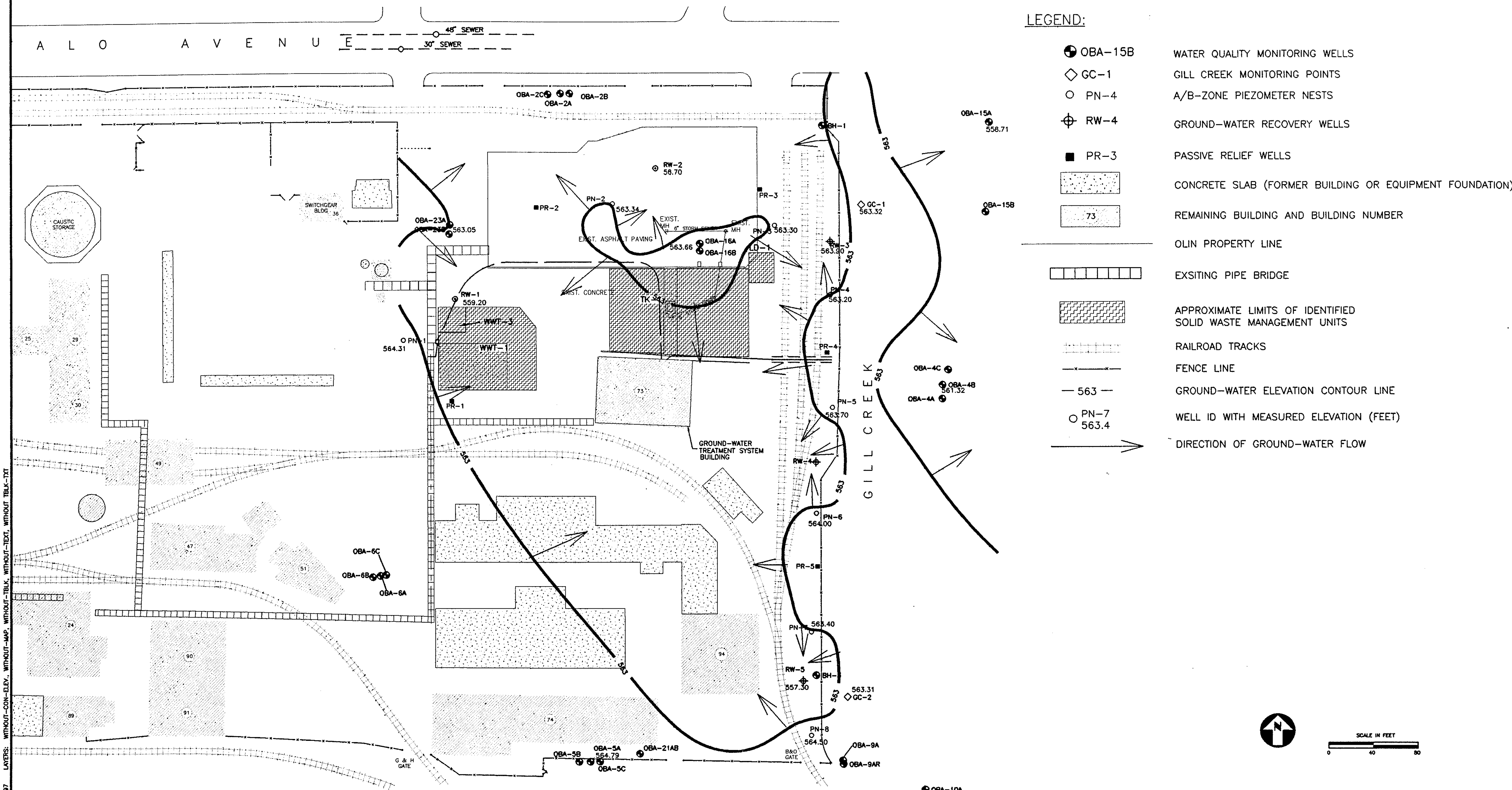
OLIN CHEMICALS PLANT
NIAGARA FALLS, NY

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

A-ZONE and B-ZONE Water Levels
Cross Section BB'

Job Number 12000-8-0009

Figure 5.1



LAW ENGINEERING AND ENVIRONMENTAL SERVICES, P.C. KENNESAW, GEORGIA

E.S.R. NO.	C.A.R. NO.	REV.	DESCRIPTION	DRAWN	DATE	CHKD.	APPR.

DRAWN
DATE
CHECKED
DATE
APPROVED

Olin
CHEMICALS PLANT
NIAGARA FALLS, NY.

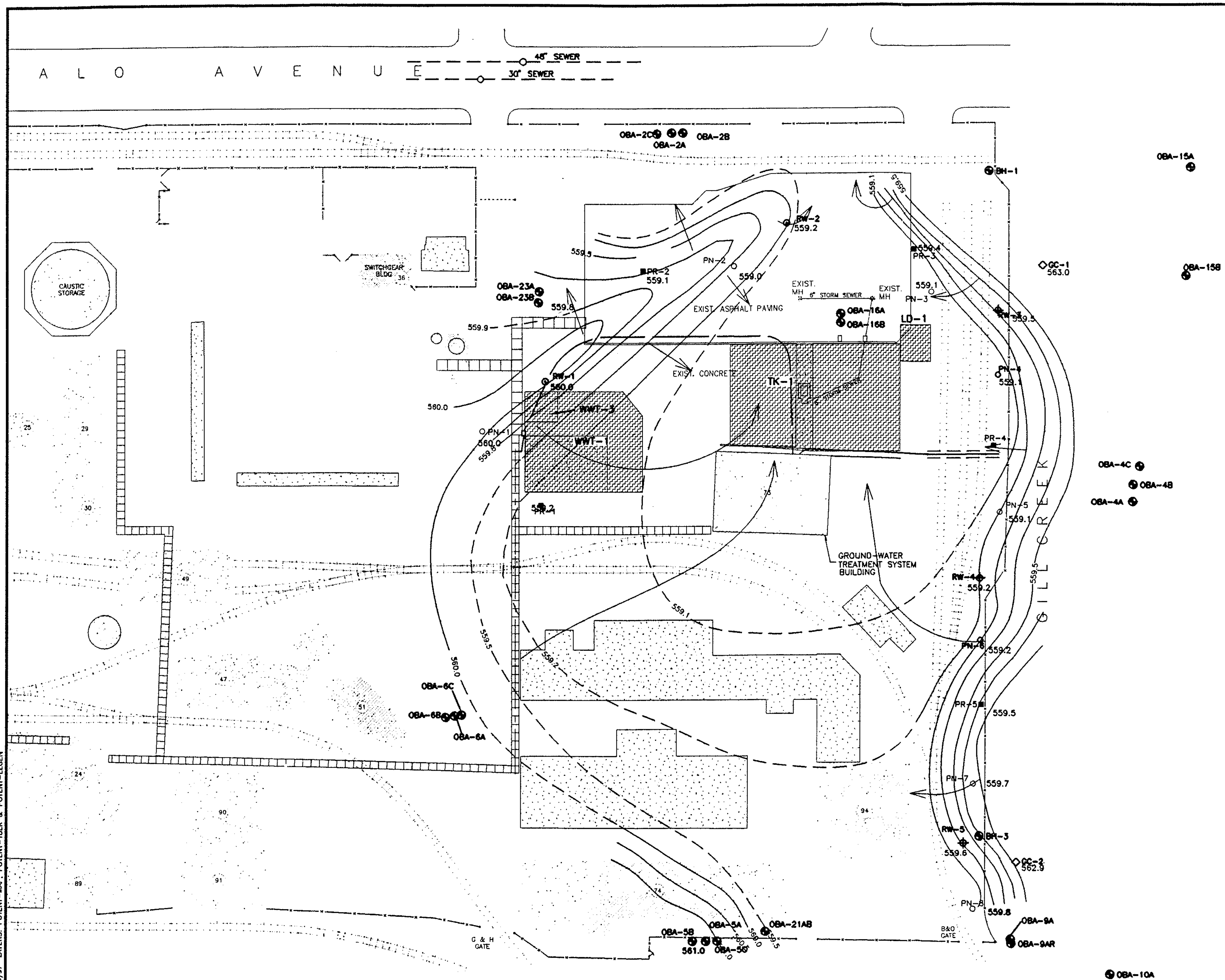
FIGURE 5.2

A-ZONE POTENTIOMETRIC SURFACE
11/25/97
FINAL DAY OF TEST

PROJECT NO.	C.A.R. NO.	SCALE	DRAWING NO.	REV.
	A	AS NOTED		

CAD DRAWING – DO NOT CHANGE MANUALLY
CAD File: D10003 Diskette No: ______

CADD FILE: /DWG2/OLIN/NIAGRA/CONST/D10003A DATE: 12/30/97 LAYERS: WITHOUT-CON-ELEV, WITHOUT-MAP, WITHOUT-TBLK, WITHOUT-TEXT, WITHOUT TBLK-TXT



LEGEND:

OBA-15B	WATER QUALITY MONITORING WELLS
GC-1	GILL CREEK MONITORING POINTS
PN-4	A/B-ZONE PIEZOMETER NESTS
RW-4	GROUND-WATER RECOVERY WELLS
PR-3	PASSIVE RELIEF WELLS
	CONCRETE SLAB (FORMER BUILDING OR EQUIPMENT FOUNDATION)
73	REMAINING BUILDING AND BUILDING NUMBER
	OLIN PROPERTY LINE
	EXSITING PIPE BRIDGE
	APPROXIMATE LIMITS OF IDENTIFIED SOLID WASTE MANAGEMENT UNITS
	RAILROAD TRACKS
	FENCE LINE
— 559.5 —	POTENTIOMETRIC SURFACE CONTOUR LINE (ELEVATION IN FEET)
PN-7 559.7	WELL ID WITH MEASURED ELEVATION (FEET)
→	DIRECTION OF GROUND WATER FLOW

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, P.C. KENNESAW, GEORGIA

E.S.R. NO.	C.A.R. NO.	REV.	DESCRIPTION	DRAWN	DATE	CHKD.	APPR.

DRAWN / DATE / CHECKED / DATE / APPROVED

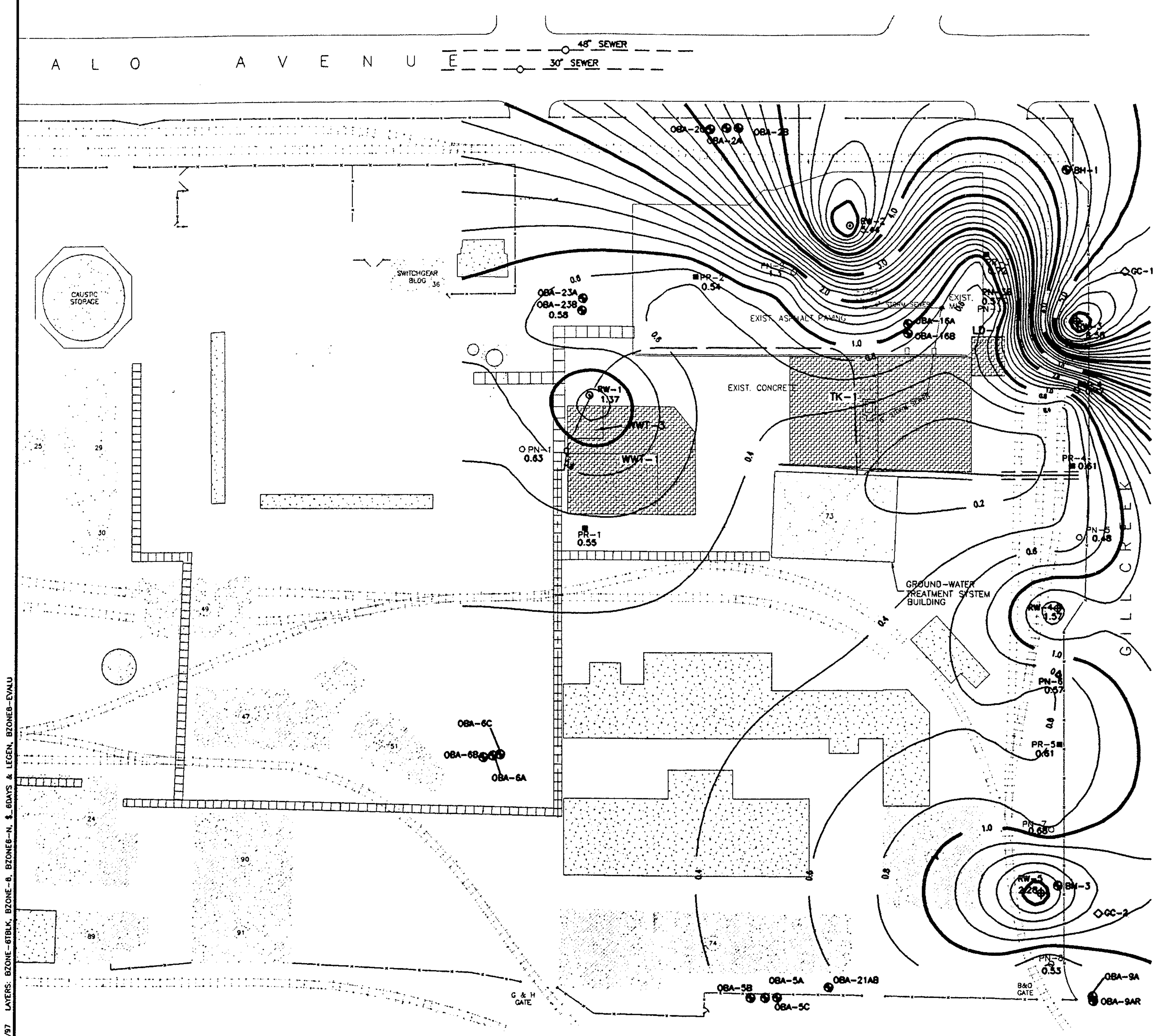
Olin CHEMICALS PLANT NIAGARA FALLS, NY.

FIGURE 5.3
B-ZONE POTENTIOMETRIC SURFACE
11/6/97
BACKGROUND

PROJECT NO.	C.A.R. NO.	SCALE	DRAWING NO.	REV.
		AS NOTED		

CAD DRAWING - DO NOT CHANGE MANUALLY
CAD File: D10003A Diskette No: ______

CADD FILE: /DWG2/OLIN/NIAGRA/CONST/D10003A DATE: 12/30/97 LAYERS: POTENT-MAP, POTENT-TBLK & POTENT-LEGEN



LEGEND:

OBA-15B	WATER QUALITY MONITORING WELLS
GC-1	GILL CREEK MONITORING POINTS
PN-4	A/B-ZONE PIEZOMETER NESTS
RW-4	GROUND-WATER RECOVERY WELLS
PR-3	PASSIVE RELIEF WELLS
	CONCRETE SLAB (FORMER BUILDING OR EQUIPMENT FOUNDATION)
73	REMAINING BUILDING AND BUILDING NUMBER
	OLIN PROPERTY LINE
	EXSITING PIPE BRIDGE
	APPROXIMATE LIMITS OF IDENTIFIED SOLID WASTE MANAGEMENT UNITS
	RAILROAD TRACKS
	FENCE LINE
— 0.6 —	GROUND-WATER DRAWDOWN CONTOUR (FEET)
PN-7 0.68	WELL ID WITH MEASURED DRAW DOWN (FEET)

NOTES:

WELL	APPROXIMATE FLOW RATE (GPM)
RW-1	0.75
RW-2	11.5
RW-3	5
RW-4	24
RW-5	23.5

SCALE IN FEET 0 40 80

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Olin CHEMICALS PLANT NIAGARA FALLS, NY.

FIGURE 5.4

"B" ZONE DRAWDOWN AFTER 6 DAYS OF PUMPING

E.S.R. NO.	C.A.R. NO.	REV.	DESCRIPTION	DRAWN	DATE	CHKD.	APPR.

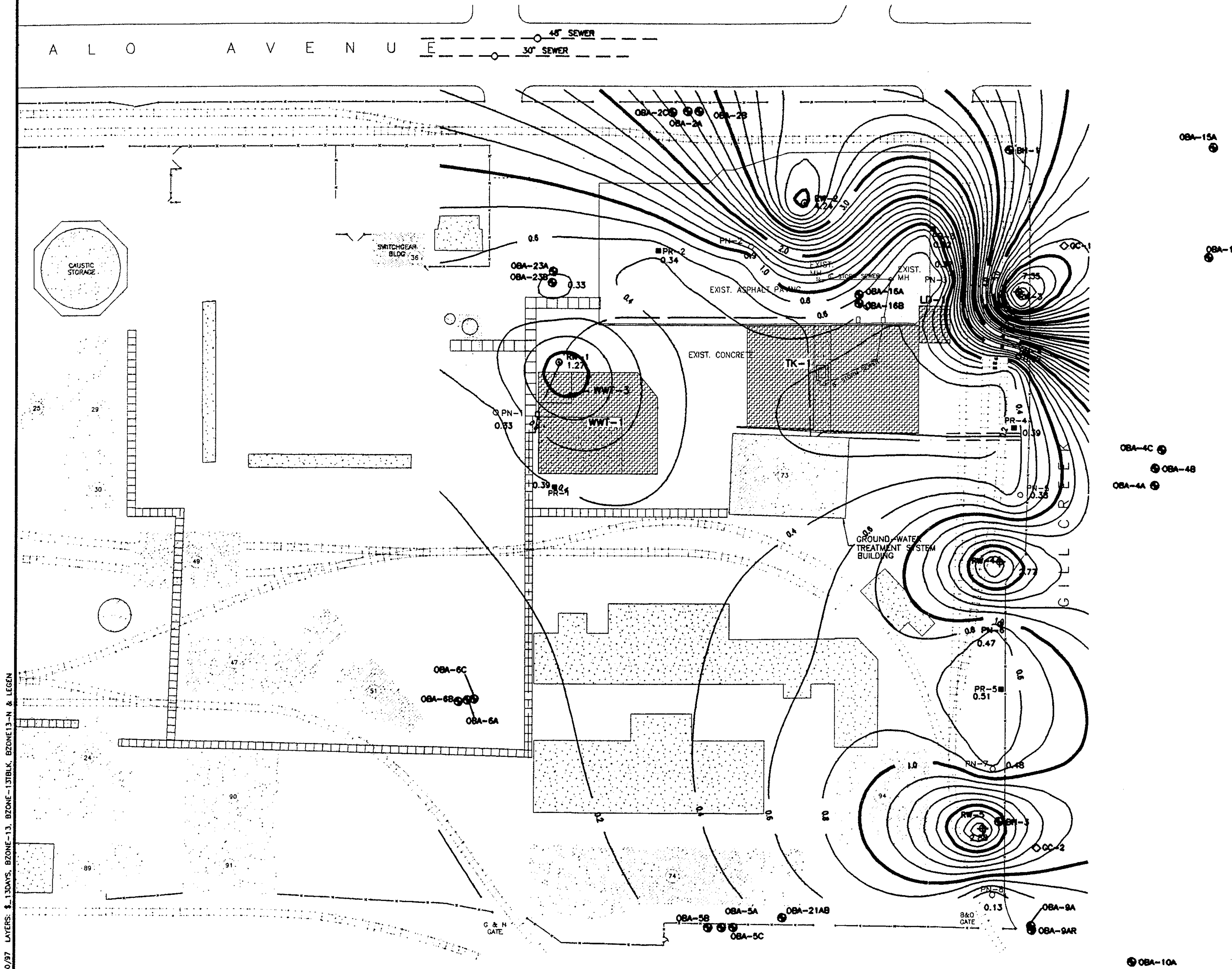
DRAWN / DATE / CHECKED / DATE / APPROVED

PROJECT NO.	C.A.R. NO.	SCALE	DRAWING NO.	REV.
		AS NOTED		

CAD DRAWING - DO NOT CHANGE MANUALLY

CAD File: D10003A Diskette No: ________

CADD FILE: /DWG2/OLIN/NIAGRA/CONST/D10003A DATE: 12/30/97 LAYERS: BZONE-BTBLK, BZONE-B, BZONE-N, $, 6DAYS & LEGEN, BZONE6-EVALU



LEGEND:

OBA-15B	WATER QUALITY MONITORING WELLS
GC-1	GILL CREEK MONITORING POINTS
PN-4	A/B-ZONE PIEZOMETER NESTS
RW-4	GROUND-WATER RECOVERY WELLS
PR-3	PASSIVE RELIEF WELLS
	CONCRETE SLAB (FORMER BUILDING OR EQUIPMENT FOUNDATION)
73	REMAINING BUILDING AND BUILDING NUMBER
	OLIN PROPERTY LINE
	EXSITING PIPE BRIDGE
	APPROXIMATE LIMITS OF IDENTIFIED SOLID WASTE MANAGEMENT UNITS
	RAILROAD TRACKS
	FENCE LINE
0.6	GROUND-WATER DRAWDOWN CONTOUR
PN-7 0.48	WELL ID WITH MEASURED DRAWDOWN (FEET)

NOTES:

WELL	APPROXIMATE FLOW RATE GPM)
RW-1	1
RW-2	8.5
RW-3	5
RW-1	24
RW-5	23.5

SCALE IN FEET 0 40 80

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, P.C. KENNESAW, GEORGIA

E.S.R. NO.	C.A.R. NO.	REV.	DESCRIPTION	DRAWN	DATE	CHKD.	APPR.	DRAWN DATE CHECKED DATE APPROVED

Olin CHEMICALS PLANT NIAGARA FALLS, NY.

FIGURE 5.5

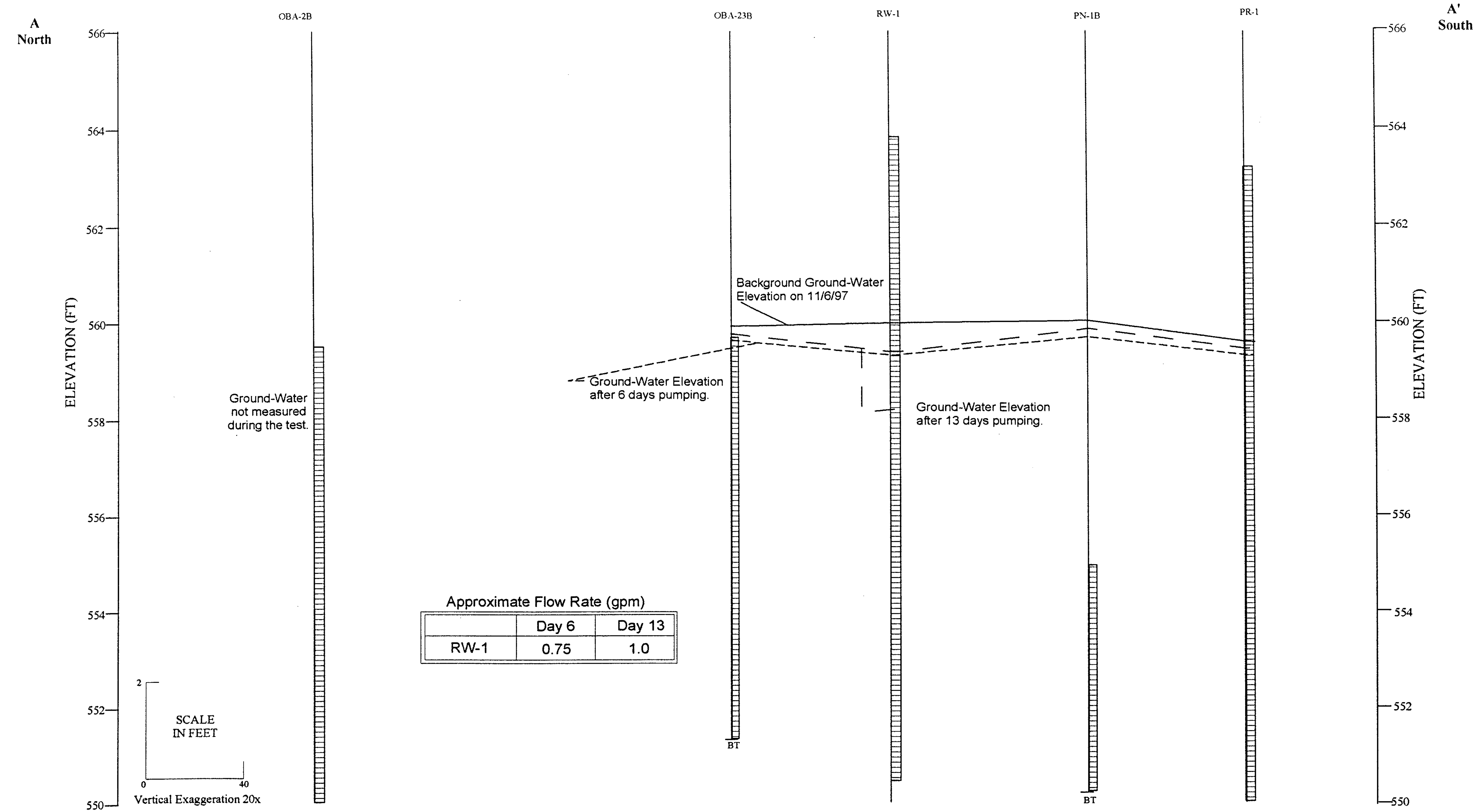
"B" ZONE DRAWDOWN AFTER 13 DAYS OF PUMPING

PROJECT NO.	C.A.R. NO.	SCALE	DRAWING NO.	REV.
		AS NOTED		

CAD DRAWING - DO NOT CHANGE MANUALLY

CAD File: D10003 Diskette No:

CADD FILE: /DWG2/OLIN/NIAGRA/CONST/D10003A DATE: 12/30/97 LAYERS: $_13DAYS, BZONE-13, BZONE-13TBLK, BZONE13-N & LEGEN



Approximate Flow Rate (gpm)

	Day 6	Day 13
RW-1	0.75	1.0

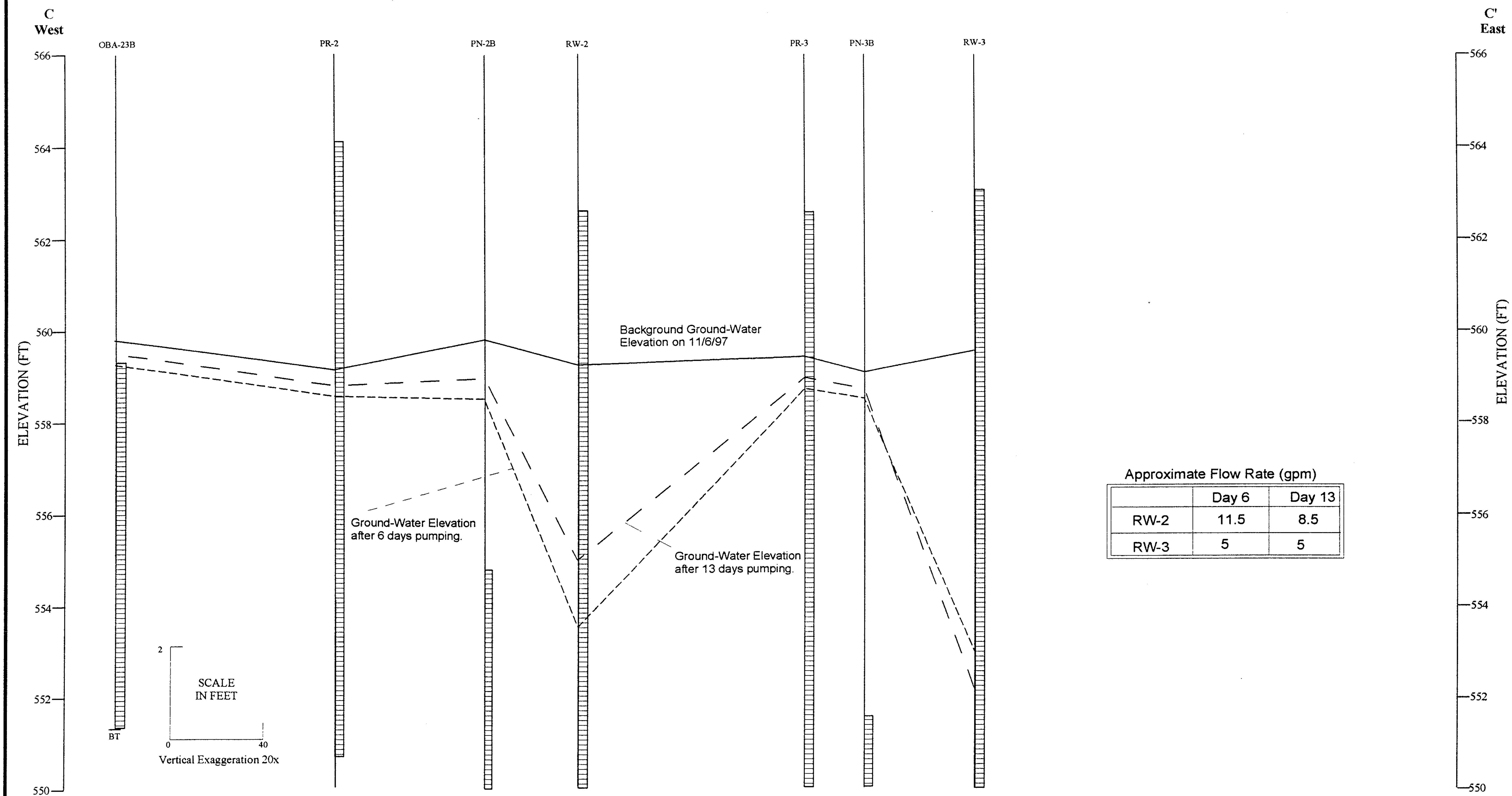
OLIN CHEMICALS PLANT
NIAGARA FALLS, NY

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

B-Zone Water Levels
Cross Section AA'

Job Number 12000-8-0009

Figure 5.6



Approximate Flow Rate (gpm)

	Day 6	Day 13
RW-2	11.5	8.5
RW-3	5	5

OLIN CHEMICALS PLANT
NIAGARA FALLS, NY

LAW
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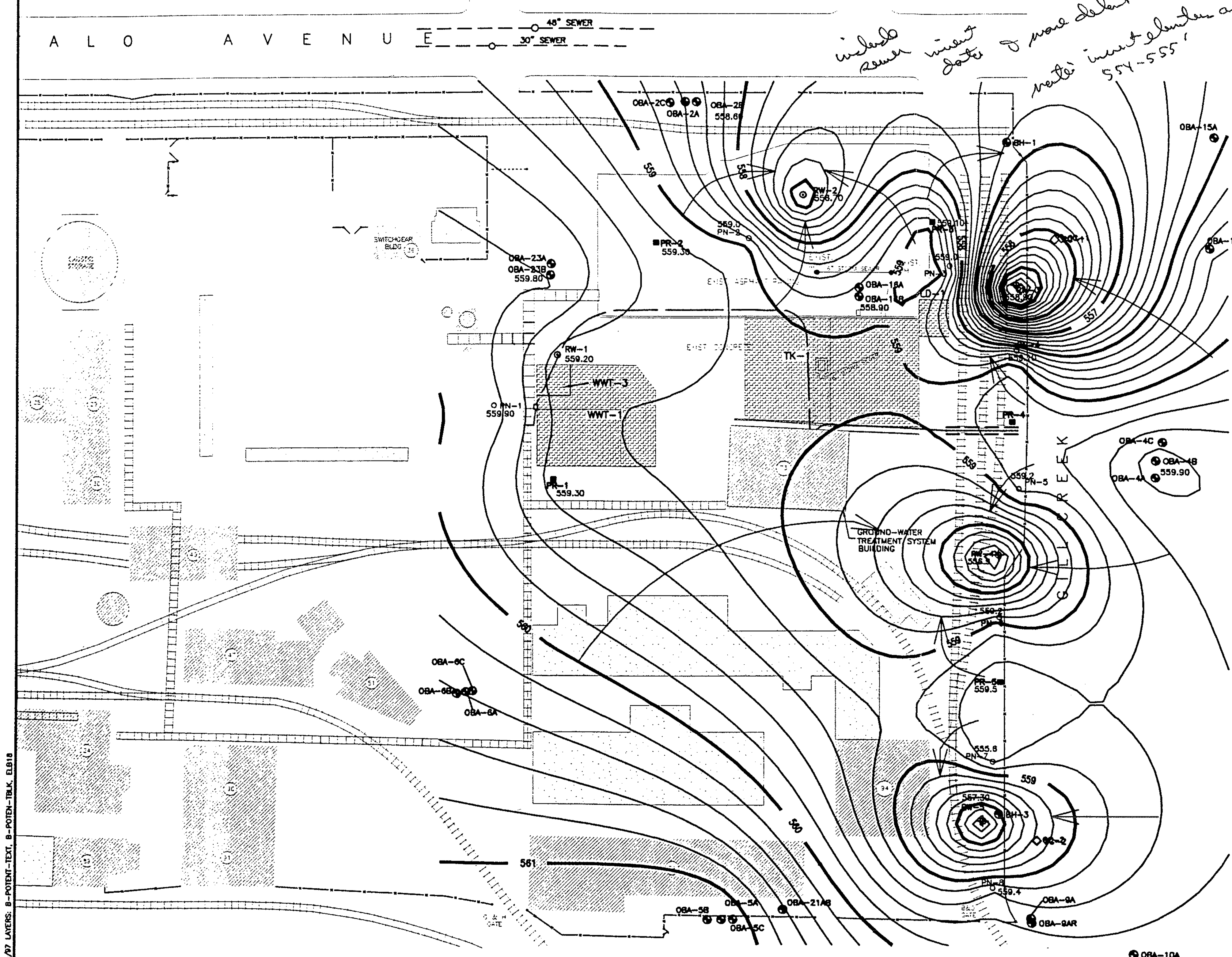
B-Zone Water Levels
Cross Section CC'

Job Number 12000-8-0009

Figure 5.7



LEGEND:

OBA-15B	WATER QUALITY MONITORING WELLS
GC-1	GILL CREEK MONITORING POINTS
PN-4	A/B-ZONE PIEZOMETER NESTS
RW-4	GROUND-WATER RECOVERY WELLS
PR-3	PASSIVE RELIEF WELLS
	CONCRETE SLAB (FORMER BUILDING OR EQUIPMENT FOUNDATION)
73	REMAINING BUILDING AND BUILDING NUMBER
	OLIN PROPERTY LINE
	EXSITING PIPE BRIDGE
	APPROXIMATE LIMITS OF IDENTIFIED SOLID WASTE MANAGEMENT UNITS
	RAILROAD TRACKS
	FENCE LINE
— 559 —	GROUND-WATER ELEVATION CONTOUR LINE
⟶	GROUND-WATER FLOW DIRECTION
PN-7 559.60	WELL ID WITH MEASURED GROUND-WATER ELEVATION (FEET)

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, P.C. KENNESAW, GEORGIA

E.S.R. NO.	C.A.R. NO.	REV.	DESCRIPTION	DRAWN	DATE	CHKD.	APPR.

DRAWN
DATE
CHECKED
DATE
APPROVED

Olin
CHEMICALS PLANT
NIAGARA FALLS, NY.

FIGURE 5.8

B-ZONE POTENTIOMETRIC SURFACE
11/25/97
FINAL DAY OF TEST

PROJECT NO.	C.A.R. NO.	SCALE	DRAWING NO.	REV.
		AS NOTED		

CAD DRAWING - DO NOT CHANGE MANUALLY

CAD File: D10003a Diskette No: ________

CADD FILE: /DWG2/OLIN/NIAGRA/CONST/D10003A DATE: 12/30/97 LAYERS: B-POTENT-TEXT, B-POTEN-TBLK, ELB18