ALAMITOS
BARRIER
PROJECT

Annual report on the control of seawater intrusion

2003 - 2004

authors....

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Department of Public Works

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Orange County Water District
Water Replenishment District of Southern California
Long Beach Water Department
Central Basin Municipal Water District
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Los Angeles County Flood Control District

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joint management committee

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TABLE OF CONTENTS

Page

Introduction 1
Summary 1
Design and Construction 3
Injection Operations 4
Extraction Operations 6
Maintenance 7
Hydrologic Effects 9
Chlorides 16
Financing and Costs 27
Hydroelectric Revenues 32

FIGURES

1. Monthly Amount of Water Injected 5
2. Annual Amount of Water Injected 5
3. Annual Amount of Water Extracted 7
4. Injection and Extraction Well Operating Status 8

Groundwater Elevation Graphs

5a. Recent Zone West of San Gabriel River 11
5b. Recent Zone East of San Gabriel River 11
6a. C-Zone West of San Gabriel River 12
6b. C-Zone East of San Gabriel River 12
7a. B-Zone West of San Gabriel River 13
7b. B-Zone East of San Gabriel River 13
8a. A-Zone West of San Gabriel River 14
8b. A-Zone East of San Gabriel River 14
9a. I-Zone West of San Gabriel River 15
9b. I-Zone East of San Gabriel River 15

TABLES

1. Injection Operations 4
2. Extraction Operations 6
3. Groundwater Elevation Summary 10
4. Quantity of Water Injected and Costs 28
5. Distribution of Services and Supplies Costs for Injection 29
6. Costs of Services and Supplies for Injection 30
7. Costs of Services and Supplies for Extraction 31

APPENDIX

Location of Facilities A-1
Well Location Map A-2
Groundwater Surface Profiles
    Along the Barrier..... A-3
    Along A-A and B-B Cross Sections A-4
    Along C-C Cross Section..... A-5
    Along D-D Cross Section..... A-6
Recent Aquifer Groundwater A-7
C-Zone Groundwater A-8
B-Zone Groundwater A-9
A-Zone Groundwater A-10
I-Zone Groundwater..... A-11
Recent Aquifer Chlorides..... A-12
C-Zone Chlorides..... A-13
B-Zone Chlorides..... A-14
A-Zone Chlorides..... A-15
I-Zone Chlorides A-16
Chloride Section Along Barrier..... A-17

INTRODUCTION

The Alamitos Barrier Project was designed and constructed to protect the groundwater supplies of the Central Basin of Los Angeles County and the southwest portion of the Coastal Plain area in Orange County from the intrusion of seawater through the Alamitos Gap area. The project facilities are located near the Los Angeles-Orange County line about two miles inland from the mouth of the San Gabriel River. They include injection wells to form a freshwater pressure ridge and extraction wells to form a trough to break the landward gradient of intruding seawater. A map of the area around the barrier and the location of major facilities are presented in page A-1 of the Appendix.

The Los Angeles County Department of Public Works operates and maintains the project and its physical facilities under the direction and approval of the Joint Management Committee acting on behalf of the Los Angeles County Flood Control District and the Orange County Water District.

This report summarizes operational activities, hydrologic effects, and project costs for the Fiscal Year 2003-2004, covering July 1, 2003 to June 30, 2004.

SUMMARY

During this report period, a total of 5880 acre-feet of water were injected at an average rate of 8.2 cubic feet per second. A total water cost of $2,512,669 was incurred. The Orange County Water District purchased 1,916 acre-feet at a cost of $814,376. The Water Replenishment District of Southern California purchased 3,964.2 acre-feet at a cost of $1,698,293.

The cost of services and supplies for injection, excluding the costs of water, was $124.26/acre-feet this year. The previous year, this cost amounted to $310.78/acre-feet, which was due to extensive redevelopment of injection wells.

Groundwater levels reported during the March and April 2004 months exhibited a significant increase in R, C and B zones from previous report period. Groundwater levels in the A and I Zones sustained similar levels to the ones during the previous year.

Intrusion of seawater across the barrier continues to be controlled along most of the alignment and the overall performance of the barrier has improved since the previous reporting period (FY 2002-03). Injection operations recovered after the barrier shutdown occurred during the previous reporting period. This contributed to the improvement of the groundwater quality at several wells along the barrier alignment. In particular, the area in the I Zone near the San Gabriel River / 7th Street intersection has recovered from high concentrations measured during the previous reporting period. However, several areas continue to record high chloride concentrations. For all zones, the southeastern end of the barrier continues to be subject to seawater intrusion. Additionally, the C, B, and A Zones in the area landward of the barrier near the Bouton Creek / Los Cerritos Channel intersection continuously exhibited high chloride concentrations. In the area seaward of the barrier, all aquifer zones remain contaminated with high chloride concentrations, especially in areas where the Recent Aquifer is merged with underlying aquifers.

DESIGN AND CONSTRUCTION

The design for the cathodic protection system for water supply pipelines and appurtenances are currently in progress. The final plans and specifications will be completed for construction in Fiscal Year 2005-06.

The design plans for the renovation of the pressure reduction vault are also being prepared and will be completed for construction in Fiscal Year 2005-06. The renovation includes replacement of the deficient pressure regulating valve and ball valves and removal of hydroelectric generation plant.

No construction occurred during this period.

INJECTION OPERATIONS

The injection volumes and costs during Fiscal Years 2003-2004 and 2002-2003 are shown in Table 1.

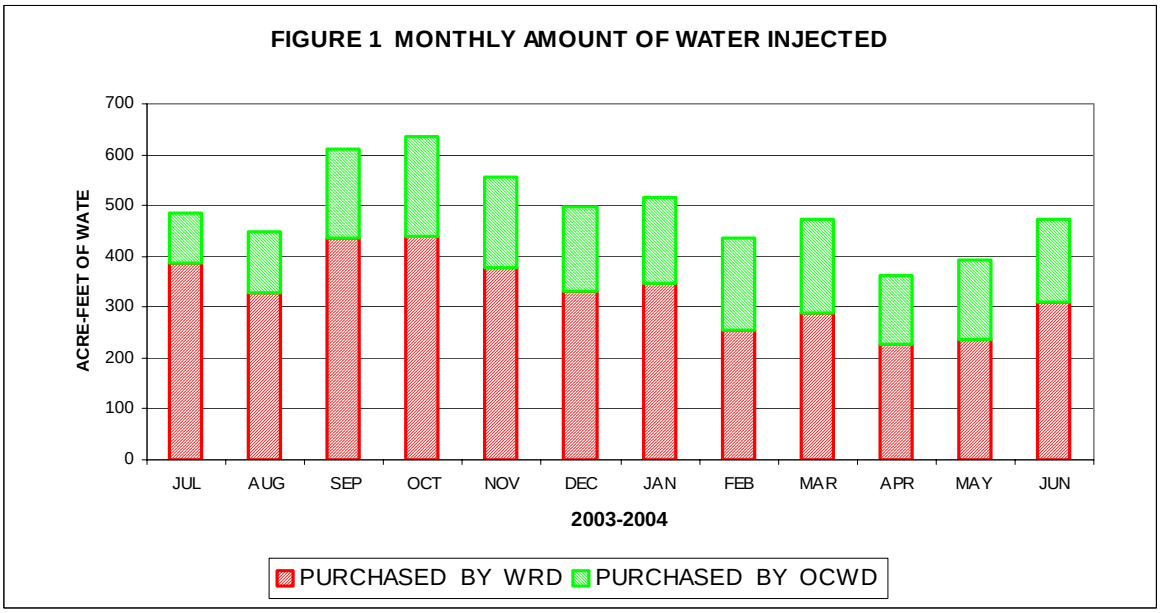
TABLE 1. INJECTION OPERATIONS

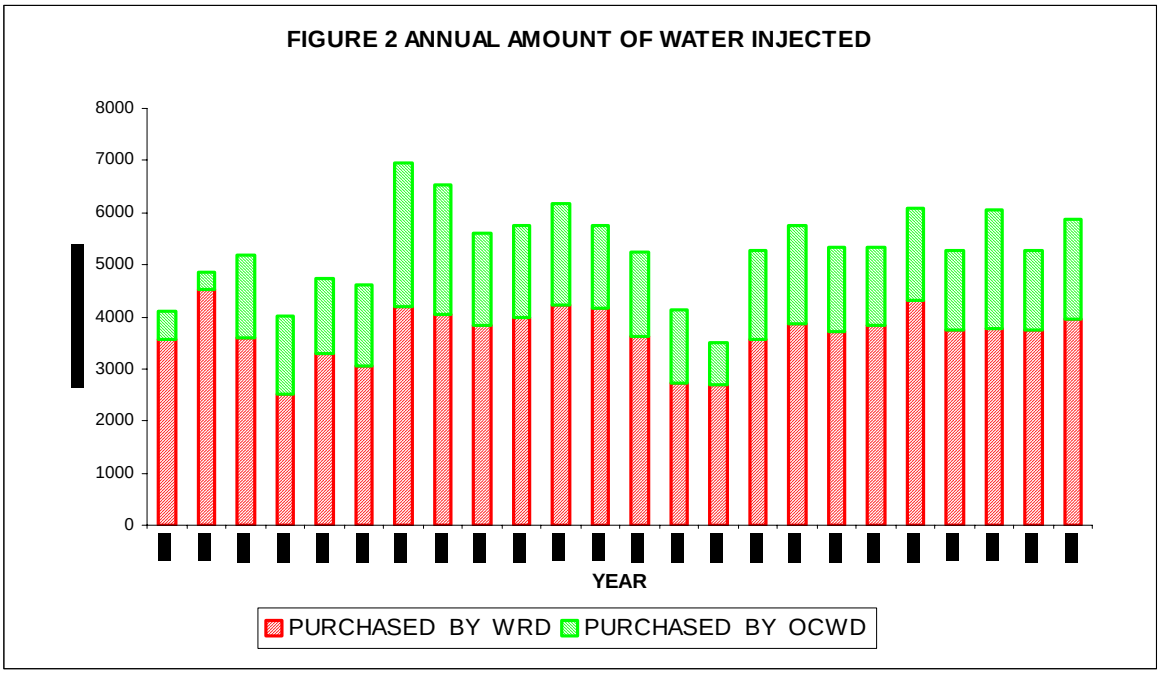
	Fiscal Year 2003-2004	Fiscal Year 2002-2003	Percent Change from Previous Year
	Volume of water injected in acre-feet		
OCWD[1]	1,916	1,391.5	38
WRD[2]	3,964	3,620.8	9
TOTAL	5,880	5,012.3	17
	Unit cost of water per acre-feet		
July – December 03	$413	$455	-9
November 03	445	$455	-2
December 03	$494	$455	9
January – June 04	$423	$413	2
	Cost of water purchased		
OCWD	$814,376	$625,698	30
WRD	$1,698,293	$1,590,538	7
TOTAL	$2,512,669	$2,216,236	13
	Average injection rate in cfs		
OCWD	2.68	1.9	41
WRD	5.55	5	11
TOTAL	8.2	6.9	19

[1] Orange County Water District

[2] Water Replenishment District of Southern California

Figure 1 presents the monthly amounts of water injected during the 2003-04 Fiscal Year. The maximum monthly injection of 635.3 acre-feet occurred in October 2003. The minimum monthly injection of 362.2 acre-ft occurred in April 2004 when injection was reduced to minimize surface leakage of the injected water at several observation wells. Figure 2 illustrates the annual amounts of water injected since 1980.





EXTRACTION OPERATIONS

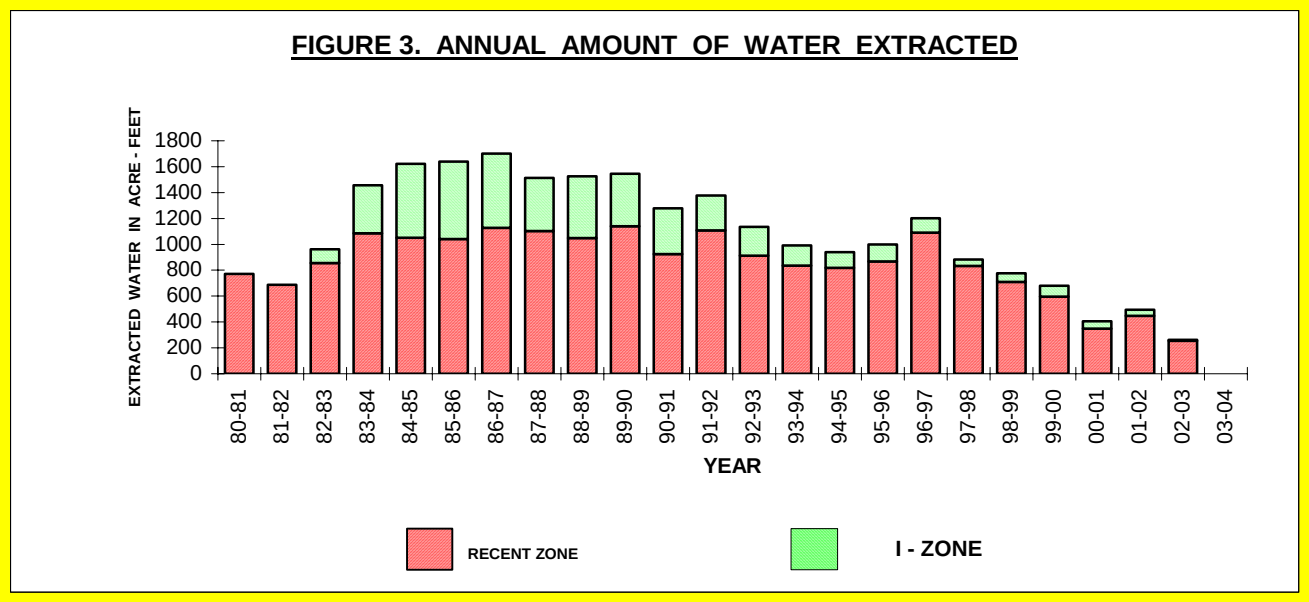
Table 2 presents the amount of water extracted during Fiscal Years 2003-04 and 2002-03.

TABLE 2. EXTRACTION OPERATIONS

Zones	Fiscal Year 2003-04	Fiscal Year 2002-03	Change in percent
	Volume of water extracted in acre-feet		
R Zone	0	255.2	N/A
I Zone	0	7.5	N/A
TOTAL	0	262.7	N/A

During the 2003-2004 Fiscal Year, no water was extracted because the extraction wells were turned off in 2002-2003 Fiscal Year as part the extraction well efficiency study. The study results demonstrated that the Chloride levels in the area decreased during the study period with all extraction wells turned off. The JMC subsequently recommended to keep the wells off temporally while the groundwater monitoring will still continue. The wells can be turned back on whenever the decreasing Chloride level trend is reversed. Regardless of the operational status, minimum maintenance of the extraction wells will continue on the electrical systems and well redevelopment.

Figure 3 illustrates the amount of water extracted for each reporting period since 1980.



MAINTENANCE

No observation wells were cleaned out at the Alamitos Barrier during the 2003-2004 Fiscal year. The purpose of cleaning is to remove accumulated sediment at the bottom of the well screens to facilitate chloride sampling of the wells.

During the 2003-2004 Fiscal Year, the Los Angeles County Flood Control District completed the redevelopment of the following injection wells 34H (A,I), 34Z, 34F (I), 34F (A), 34S (A). 34S(I), and 34S(C,B).

Figure 4 depicts the operating status of each injection and extraction well during the 2003-04 Fiscal Year.

FIGURE 4. INJECTION AND EXTRACTION WELL OPERATING STATUS

	2003																								2004																							
	JUL				AUG				SEP				OCT				NOV				DEC				JAN				FEB				MAR				APR				MAY				JUN			
Well No.																																																
33Gai																																																
33Jai																																																
33Lai																																																
33Nai																																																
33Q1cb																																																
33Qai																																																
33Sai																																																
33S1cb																																																
33Tai																																																
33U																																																
33U3cb																																																
33Vai																																																
33Wcbai	N	N	N	N																																												
33Xcbai																																																
33Ycbai																																																
33Z2a																																																
33Z2i																																																
33Zcbai																																																
34Dcbai							H																																H	H				H			
34Ebc																																																
34Ei																																																
34Fa																																							H	H	R							
34Fi																																							H	H	R							
34Gi																																					R	R										
34G2bc																																																
34G2i																																																
34Ha	R	R	R	R	R	R	R	R	R																																							
34Hi	R	R	R	R	R	R	R	R	R																																							
34Ja																																																
34Ji																																																
34Lcbai																																																
34Sa	H	H	H	H	H																																				R	R	R	R	R	H	H	H
34Si	H	H	H	H	H																																				R	R	R	R	R	H	H	H
34Scb	H	H	H	H	H																																				R	R	R	R	R	H	H	H
34Va	R	R																																														
34Vi	R	R																																														
34Vcb	R	R																																														
34Zi			R																																													
35Fai																																																
35Gi	R	R	R	R	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C														
35H1a	H	H	H	H	H	H	H	H	H	H																																						
35H1i	H	H	H	H	H	H	H	H	H	H																																						
35H2a	H	H	H	H	H	H	H	H	H	H																																						
* 33V'15P	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
* 34H'17P	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
* 34H'18P	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
* 34S'22P	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

*Extraction Well

- Well in Operation
- **R** - Redevelopment
- **S** - Surface Leakage
- **G** - Grouted
- **N** - Non - Operation
- **H** - Header Repair
- **C** - Casing Repair
- **T** - Tremie Repair
- **U** - Still Under Construction
- **W** - NPDES Water Quality Sampling
- **D** - Dissasembled

HYDROLOGIC EFFECTS

Groundwater Elevations

Table 3 summarizes average groundwater elevations taken during the Spring months of the last 10 years. The comparison of groundwater levels taken during Spring 2003 and 2004 presented in the last column of Table 3 shows on average a significant increase in groundwater levels in the R, C, and B Zones. This presents a good recovery from the previous reporting period's low groundwater levels which was due to shutdown of the eastern half of the barrier for an extended period of time for repair. The A and I zones on average showed minimal increases from the previous year.

Figures 5 through 9 show the average monthly groundwater elevation along the barrier alignment in the R, C, B, A, and I Zones, respectively. Two graphs were created for each aquifer to account for changes in groundwater elevation trends along the barrier alignment: wells east of the San Gabriel River and wells between the San Gabriel River and the Los Alamitos Channel. Not enough measurements exist east of Los Alamitos Channel for a groundwater elevation plot.

In each graph, monthly average groundwater elevations during the 2003-2004 Fiscal Year are compared with previous 9 year averages (1993-94 to 2002-2003 Fiscal Years). As evidenced in each graph groundwater levels have maintained historical values on both the West and East side of the San Gabriel River.

The Appendix (A-3 through A-6) also includes graphs of maximum and minimum groundwater elevations taken throughout the 2003-2004 Fiscal Year along the cross-sections identified in page A-2 of the Appendix. All elevations are measured in feet. Groundwater elevation contours for the R, C, B, A, and I Zone have been prepared from data taken in March and April of 2004. They are included in the Appendix (A-7 through A-11).

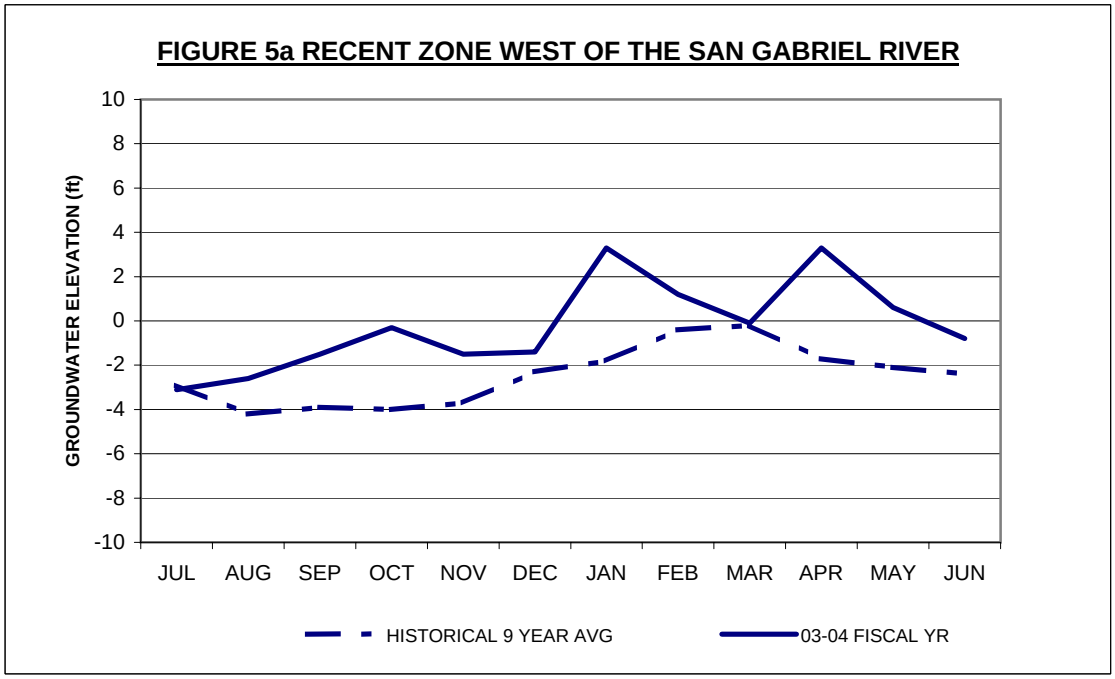


FIGURE 5a RECENT ZONE WEST OF THE SAN GABRIEL RIVER
GROUNDWATER ELEVATION (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
HISTORICAL 9 YEAR AVG
03-04 FISCAL YR

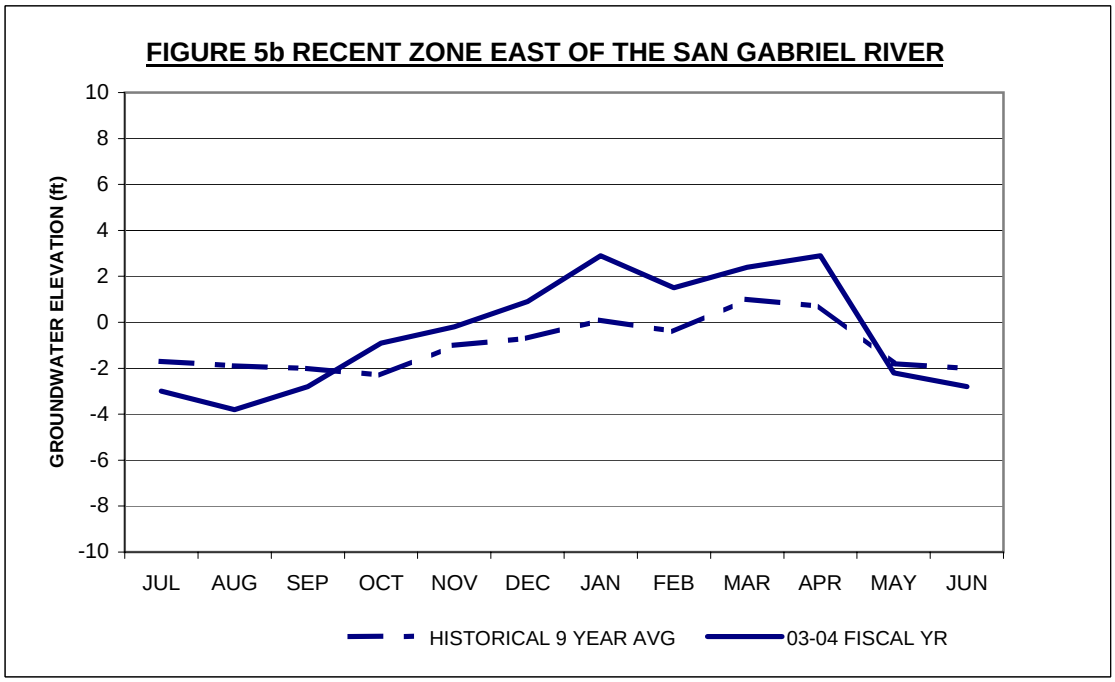


FIGURE 5b RECENT ZONE EAST OF THE SAN GABRIEL RIVER
GROUNDWATER ELEVATION (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
HISTORICAL 9 YEAR AVG
03-04 FISCAL YR

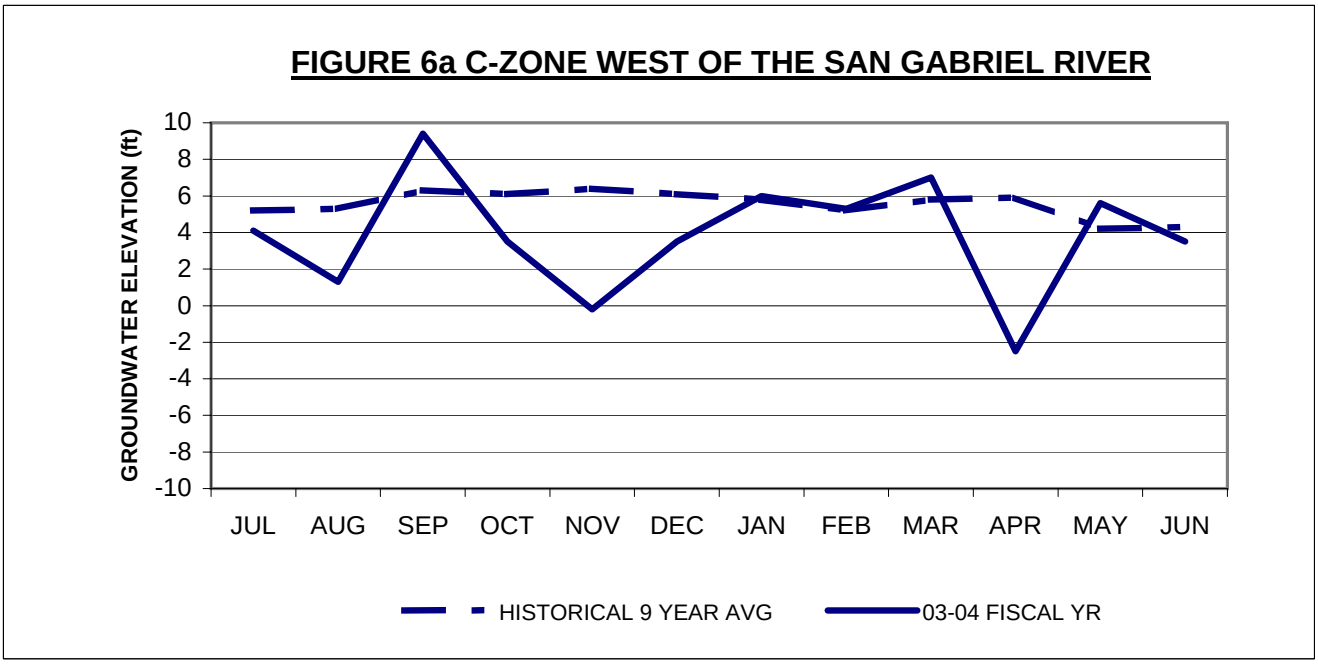


FIGURE 6a C-ZONE WEST OF THE SAN GABRIEL RIVER
GROUNDWATER ELEVATION (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
HISTORICAL 9 YEAR AVG
03-04 FISCAL YR

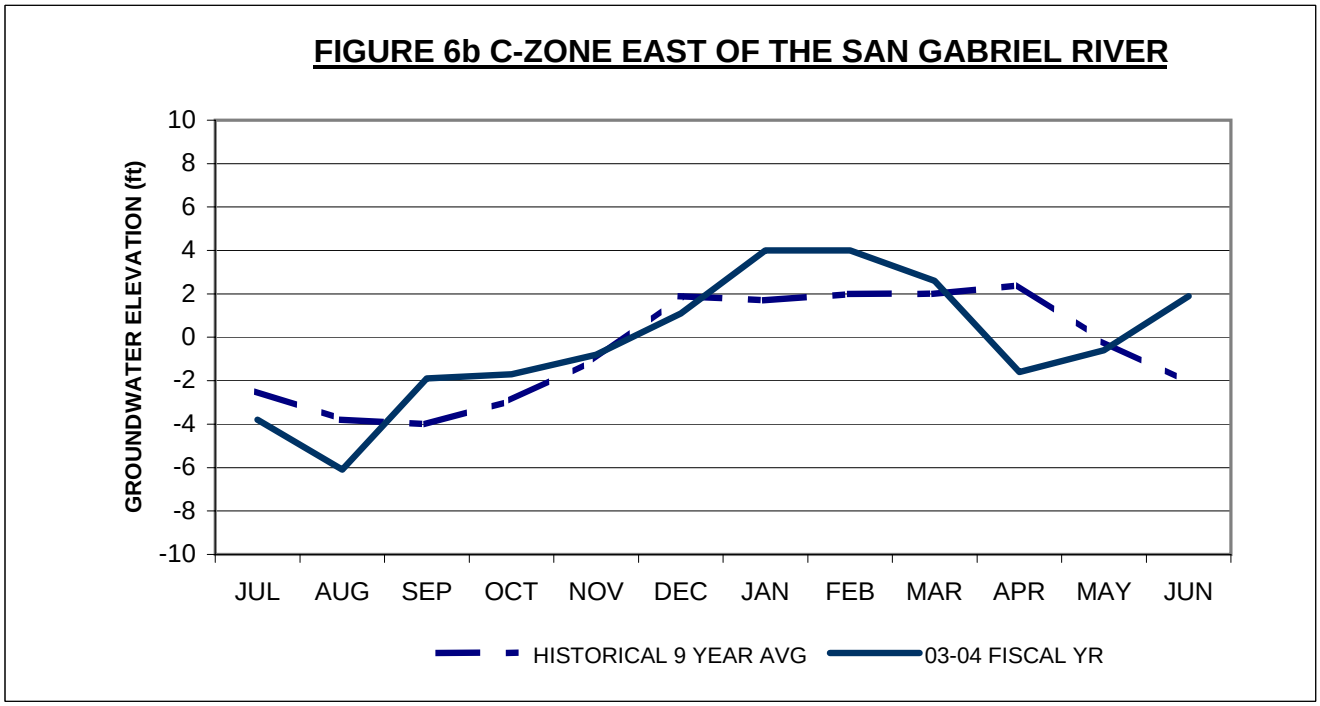


FIGURE 6b C-ZONE EAST OF THE SAN GABRIEL RIVER
GROUNDWATER ELEVATION (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
HISTORICAL 9 YEAR AVG
03-04 FISCAL YR

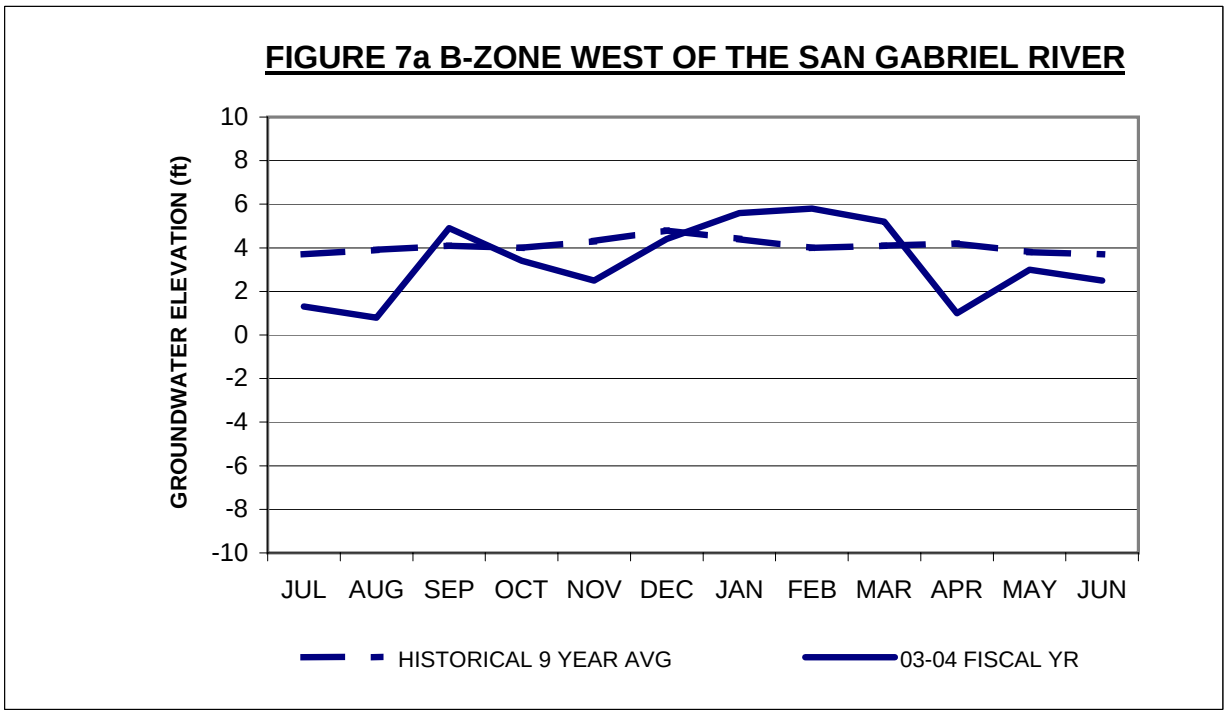


FIGURE 7a B-ZONE WEST OF THE SAN GABRIEL RIVER
GROUNDWATER ELEVATION (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN
HISTORICAL 9 YEAR AVG
03-04 FISCAL YR

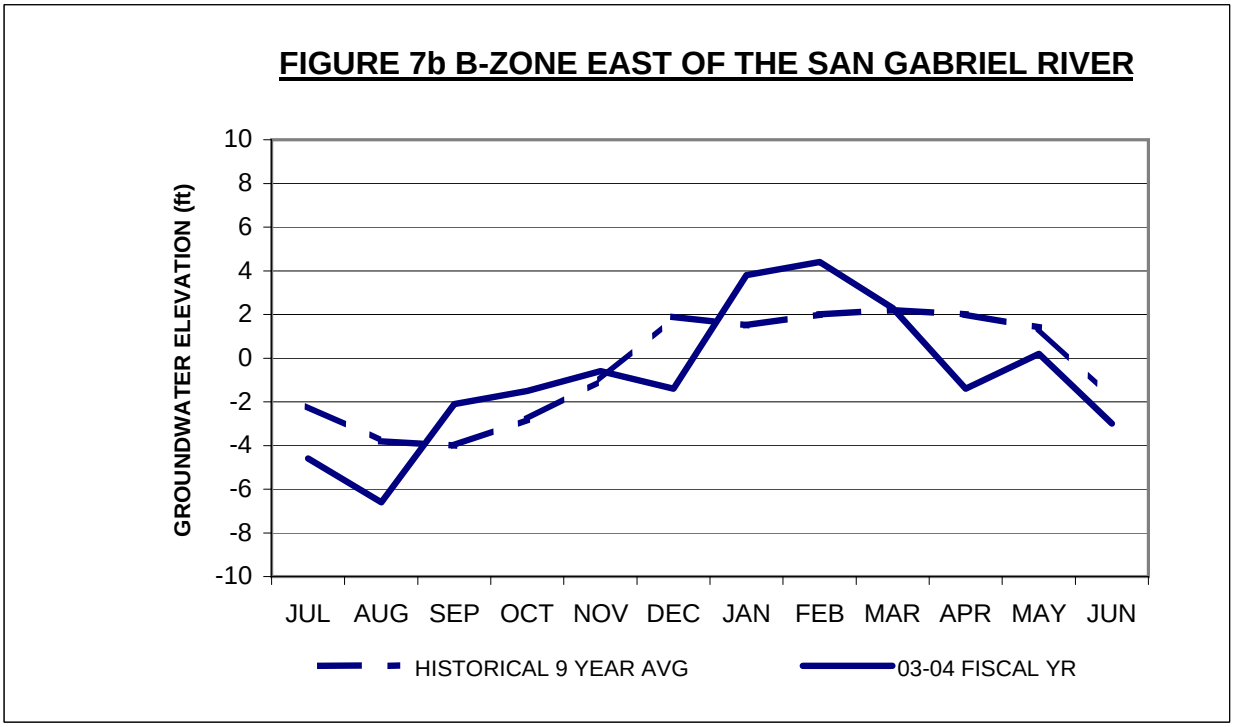


FIGURE 7b B-ZONE EAST OF THE SAN GABRIEL RIVER
GROUNDWATER ELEVATION (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN
HISTORICAL 9 YEAR AVG
03-04 FISCAL YR

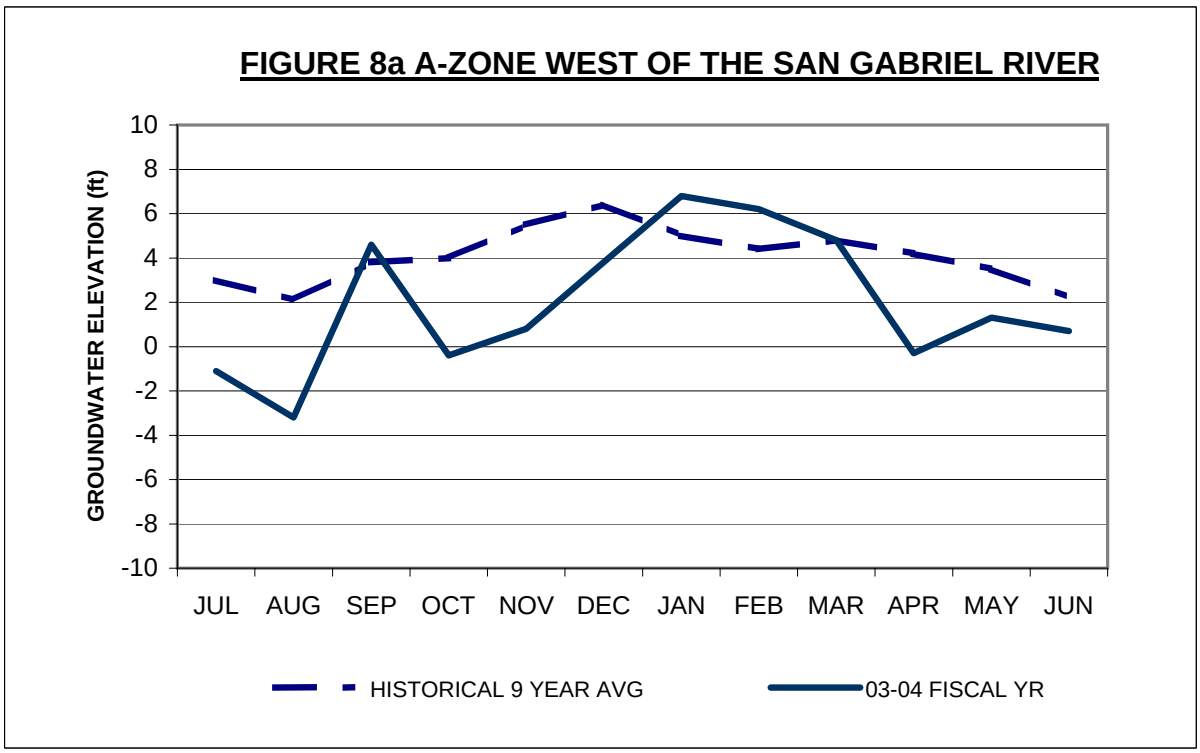


FIGURE 8a A-ZONE WEST OF THE SAN GABRIEL RIVER
GROUNDWATER ELEVATION (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
HISTORICAL 9 YEAR AVG
03-04 FISCAL YR

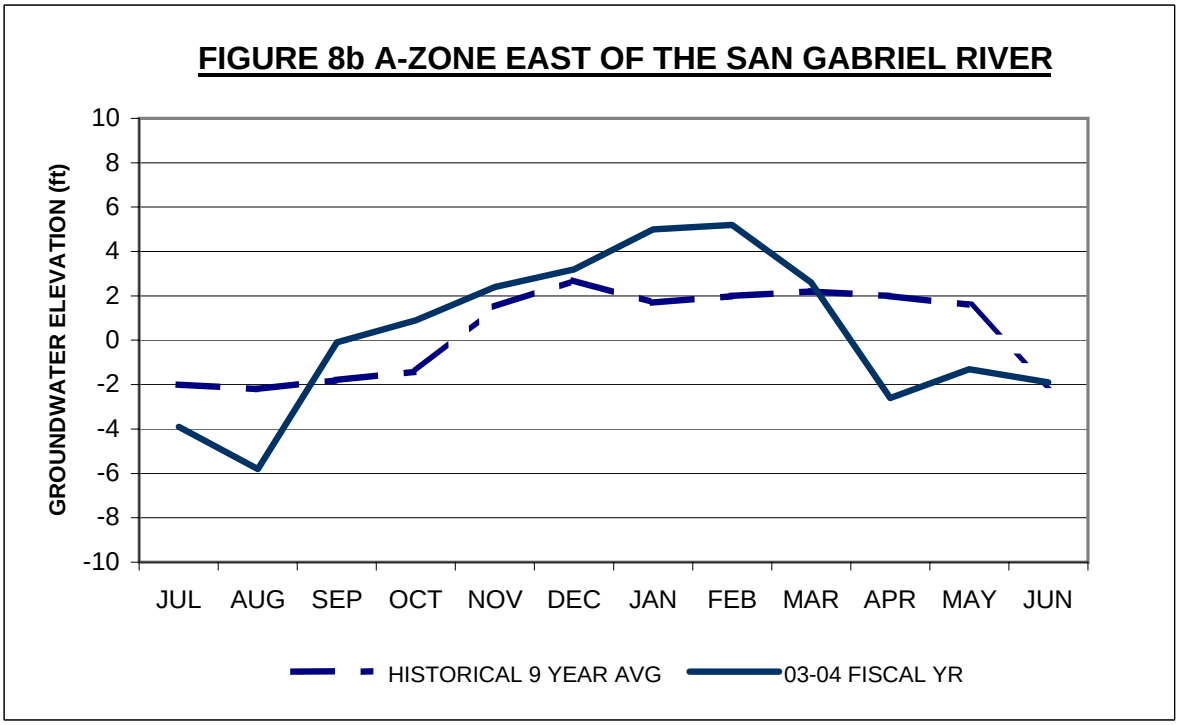


FIGURE 8b A-ZONE EAST OF THE SAN GABRIEL RIVER
GROUNDWATER ELEVATION (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
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MAY
JUN
HISTORICAL 9 YEAR AVG
03-04 FISCAL YR

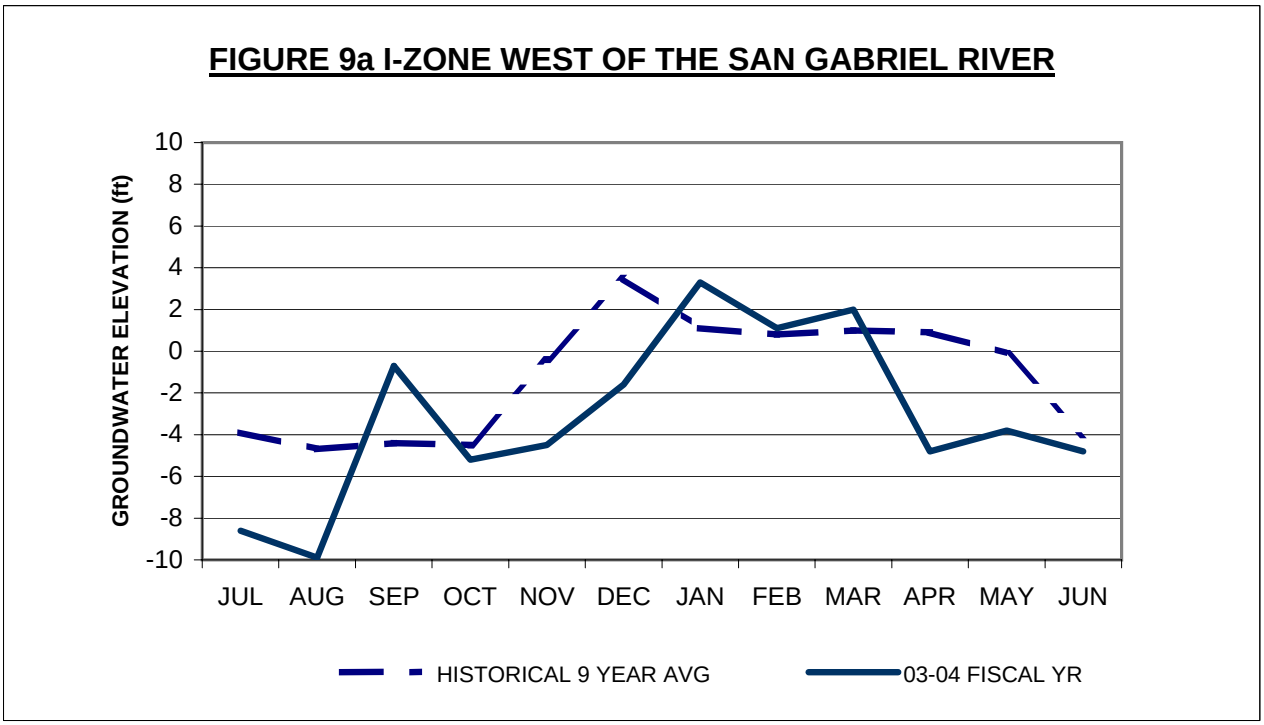
FIGURE 9a I-ZONE WEST OF THE SAN GABRIEL RIVER
GROUNDWATER ELEVATION (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
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MAY
JUN
HISTORICAL 9 YEAR AVG
03-04 FISCAL YR

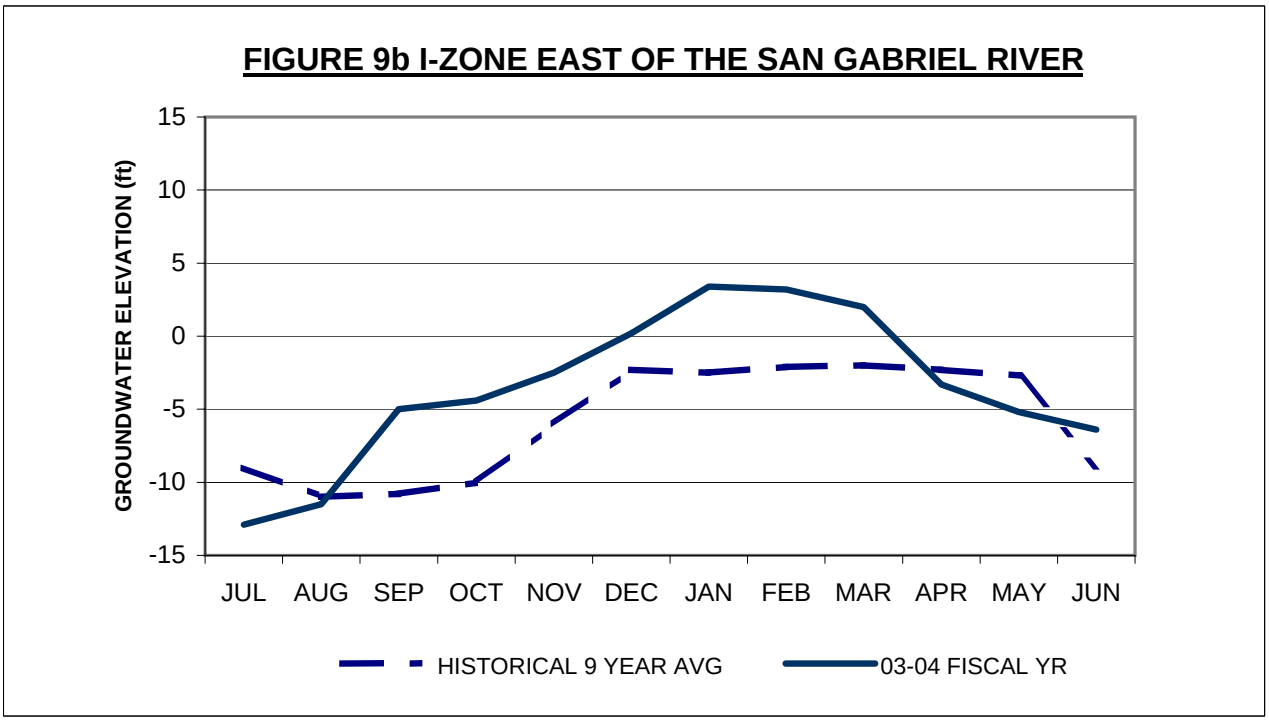


FIGURE 9b I-ZONE EAST OF THE SAN GABRIEL RIVER
GROUNDWATER ELEVATION (ft)
15
10
5
0
-5
-10
-15
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
HISTORICAL 9 YEAR AVG
03-04 FISCAL YR

CHLORIDES

Using the data collected between the period November 2003 and January 2004, chloride contour maps for the R , C, A, and I Zones have been prepared as presented in Figures A-12, A-13, A-15 and A-16, respectively. Because the limited amount of chloride data obtained in the B Zone were not sufficient to justify contours lines with confidence, chloride contour maps are not provided for this zone. However, individual chloride measurements in this zone are presented in Figure A-14. The chloride contour maps for this reporting period are based on the highest chloride ion concentration (in mg/L) measured at each observation well. Chloride data were gathered within the immediate vicinity of the barrier and do not represent basin-wide conditions for the groundwater basin protected by the barrier. Wells with chloride concentrations of 250 mg/L or less are considered fresh. Chloride measurements recorded during the current reporting period were taken between November 2003 and January 2004, while measurements recorded during the previous reporting period were taken between March and April of 2003.

Seawater intrusion in the individual aquifer zones is discussed below to help evaluate the operating effectiveness of the barrier.

RECENT ZONE (Figure A - 12)

In general, the Recent Zone continued to show high chloride concentrations in almost all areas both seaward and landward of the barrier. Unlike for the other zones, the chloride concentrations at wells seaward of the barrier are also discussed since at that location the Recent Zone provides an intrusion path at its mergence with the lower C, B, A, and I Zones

Along the Barrier

Compared to the previous reporting period, chloride concentrations in all R Zone wells along the barrier decreased.

- Wells 33U'0.5 and 34D0.1were not measured this sampling period because they have been severely damaged. Efforts will be made to repair these wells.
- Well 33Z'1 reported chloride concentration of 1,850 mg/L. This is a decrease from last year's level, 2,539 mg/L, but still slightly elevated compared to the range of concentrations, between 1,000 and 1,600 mg/L, measured at this well since the late 1980's.
- The chloride concentration at Well 34L'1 was measured at 4,950 mg/L. This is also a decrease from the previous reporting period's level, 14,259 mg/L, but still slightly elevated compared to the range of concentrations, between 2,000 and 6,000 mg/L, measured at this well historically.
- Well 35H11 measured a chloride concentration of 610 mg/L. This is an improvement over the previous reporting period's level, 2,699 mg/L, and consistent with historical data.

Landward of the Barrier

Compared to the previous reporting period, chloride concentrations at wells landward of the barrier showed both increases and decreases. However, the relative magnitude of the chloride changes was not significant.

- Well 33S18, which is located in the area near the Bouton Creek / Los Cerritos Channel intersection, measured a chloride concentration of 12,200 mg/L. This measurement is consistent with historical data. In the C, B, and A Zones, high concentrations are also observed in the same area.

Seaward of the Barrier

Most R Zone Wells seaward of the barrier, with exception of 34E'13, continue to remain contaminated with high chloride concentrations. There were some significant decreases in chloride concentration at wells 33T'13, 33W'14, 34H'17, and 34J'12 since the last time they were sampled. These wells are located near the extractions wells that have remained off as part of a one year-study to evaluate their effectiveness; the implication of these changes in chloride concentration will be discussed in further detail after the study's completion.

C ZONE (Figure A - 13)

Elevated chloride concentrations continued to be recorded at the southeastern end of the barrier, but have been improved compared to the previous sampling period. Chloride concentrations at the barrier alignment near the Los Cerritos Channel also showed improvement, even though the area along the channel inland of the barrier remains contaminated; however, the origin of this isolated area of high concentration may not be the same as the seawater intrusion pathway typically observed seaward of the barrier. Wells that exhibited high chloride concentration or registered significant changes in chloride concentration since the last reporting period are discussed below.

Along the Barrier

All C Zone wells showed fresh groundwater quality along the barrier during this reporting period.

- Well 33ST showed notable improvement with a chloride concentration of 108 mg/L compared to the 684 mg/L measured in the previous reporting period.
- Well 33U'0.5 was not measured during the reporting period because it was severely damaged.

Landward of the Barrier

Most wells have shown relatively fresh groundwater quality and chloride concentrations have decreased in several locations. However, a few isolated locations continue to record high chloride concentrations.

- Well 33S18 measured a chloride concentration of 3,200 mg/L. Even though this in an improvement over the chloride concentration of 6,350 mg/L last measured at this well in 2002, this measurement continues to suggest the presence of elevated chloride concentrations in the area along the Los Cerritos Channel inland of the barrier alignment.
- The chloride concentration of 790 mg/L measured at Well 33T13 improved from the 1,179 mg/L measured during the previous reporting period. However, similar to the measurement at Well 33S18, it also suggests the presence of elevated chloride concentrations in the area along the Los Cerritos Channel inland of the barrier alignment.
- Well 33U11 measured a chloride concentration of 220 mg/L, a drastic decrease from the 2,528 mg/L measured in the previous reporting period. Between 1999 and 2002, the chloride concentrations at this well were recorded around 800 mg/L.

B ZONE (Figure A - 14)

Overall, there was slight improvement in water quality during this reporting period, but chloride levels did not change significantly. Slightly elevated chloride levels measured at the southeastern end of the barrier suggest that intrusion may continue to occur in this area. High chloride levels were again measured at the area inland of the western end of the barrier near the Los Cerritos Channel; however, the origin of this isolated area of

high concentration may not be the same as the seawater intrusion pathway typically observed seaward of the barrier. Wells that exhibited high chloride concentration or registered significant changes in chloride concentration since the last reporting period are discussed below.

Along the Barrier

Most of the wells have shown relatively fresh groundwater quality along the barrier.

- At the west end of the barrier, well 33ST recorded chloride levels of 110 mg/L, improving from the 685 mg/L recorded in the previous reporting period. The well recorded levels between 2,000 and 15,000 mg/L prior to 2000 but has improved to be fresh from January 2000 to January 2002.
- Well 33U'0.5 was not measured during the reporting period because it was severely damaged.
- Well 34JL recorded a chloride level of 455 mg/L. This is a slight improvement over the level of 577 mg/L recorded in the previous reporting period, but still a slightly elevated level compared to the fresh groundwater conditions measured at this well from 1996 to 2002.
- The remaining monitoring wells along the barrier remained fresh.

Landward of the Barrier

With the exception of wells inland of the eastern and western ends of the barrier, most wells showed fresh groundwater quality.

- Well 33Q15 recorded high chloride levels of 6,050 mg/L. This area near the Bouton Creek / Los Cerritos Channel intersection has historically shown high chloride levels.
- Well 33Q9 recorded slightly elevated chloride levels of 362 mg/L. The well had been recording fresh conditions since 1999.
- Well 33T13 was not sampled during this reporting period because its casing was obstructed above the perforations. Efforts will be made to repair this well. The well registered fresh conditions in January 2002 and chloride levels in the range of 200 to 400 mg/L between January 1999 and June 2000.

- Well 33X20 was not sampled during this reporting period because its casing was obstructed above the perforations. It has historically recorded fresh conditions. Efforts will be made to repair this well.
- Well 34U8 recorded chloride levels of 1,640 mg/L. Chloride levels between 500 and 1,500 mg/L have been consistently measured at this well since 1998.
- Well 35F20, located inland of the southeastern end of the barrier, recorded chloride levels of 455 mg/L. The well recorded chlorides of 370 mg/L last April and previously recorded chlorides in the 300 to 450 mg/L range from November 1996 to February 1998. It recorded fresh conditions from April 1993 to November 1996.
- The remaining wells inland of the barrier remained fresh.

A ZONE (Figure A - 15)

The A Zone continues to record high chloride levels compared to the R, C, and B Zones. The southeastern end of the barrier shows considerably high chloride levels even though they decreased from the previous reporting period. High chlorides levels also persist west and further north of the Bouton Creek / Los Cerritos Channel intersection, as was also observed in the C and B Zones. The origins of these elevated chloride concentrations are unclear and may not be the same as the seawater intrusion pathways that are typically observed seaward of the barrier. Chloride concentrations along and inland of the other parts of the barrier generally remained fresh and showed only slight changes. Wells that exhibited high chloride concentration or registered significant changes in chloride concentration since the last reporting period are discussed below.

<u>Along the Barrier</u>

Most of the wells have shown relatively fresh groundwater quality. Even though the chloride concentrations improved notably at the southeastern end of the barrier, their magnitude suggests continued intrusion in this area.

- Well 33UV recorded chloride levels of 170 mg/L. The well had recorded fresh conditions since 1991 but recorded a level of 365 mg/L in the previous reporting

period.

- Well 35E0.1 continued to record fresh conditions. It had recorded chloride levels of 800 mg/L in 2000 and 2001, and chloride levels ranging from 3,000 mg/L to 8,000 mg/L from 1992 to 1996. The well appears to be benefiting from recharge provided by injection well 35F, which went into operation in 2001.
- Chloride levels at well 35H12 showed great improvements compared to the previous reporting period. The well recorded chloride levels of 175 mg/L after reporting elevated chloride conditions of 730 mg/L in the previous reporting period. This improvement suggests the importance of injection wells 35H1 and 35H2. With the exception of a level of 978 mg/L in July 2001, well 35H12 has been recording fresh conditions since the injection wells went into operation in March of 2001.
- Chloride levels at Well 35H11also decreased significantly since the previous reporting period. The well recorded chloride levels of 6,050 mg/L compared to the 9,015 mg/L measured in the previous reporting period. Even though this improvement also highlights the importance of injection wells 35H1 and 35H2, the chloride concentration of 6,050 mg/L is still elevated compared to the concentrations (between 100 and 5,700 mg/L) historically measured at well 35H11.
- The chloride level of 1,700 mg/L measured at well 35J1 is consistent with the chloride levels recorded since its construction in 2001.
- Well 35K1 showed fresh groundwater conditions (183 mg/L) after recording levels between 270 and 300 mg/L since its construction in 2001.
- All other wells along the barrier remained fresh.

<u>Landward of the Barrier</u>

Except for the high chloride concentration north and west of the Bouton Creek/Los Cerritos Channels intersection, most of the wells have shown relatively fresh groundwater quality.

- Well 33L23 recorded a maximum chloride concentration of 4,450 mg/L. This well was not sampled during the previous reporting period, but this measurement is

consistent with measurements taken in 2001 and 2002.

- Well 33S20 recorded elevated chloride concentrations at 1,460 mg/L. The well had recorded fresh conditions since 1972.
- A chloride level of 800 mg/L was measured at well 33S52. This is a slight increase from the chloride concentration of 375 mg/L measured in June of 2002, but still a definite improvement from the high chloride concentrations (between 1,300 and 7,000 mg/L) consistently measured at the well between 1989 and 2000.
- Well 33Q15 recorded a chloride level of 266 mg/L. This represents a slight increase from the 96 mg/L measured in August of 2002, but a slight drop from the 390 mg/L and 505 mg/L measured at this well in 2000 and 2001, respectively.
- Wells 33W11 and 33X20 recorded greatly improved chloride concentrations of 100 and 365 mg/L in contrast with the chloride levels of 1,010 and 1,444 mg/L measured during the previous reporting period, respectively. However, this drop is not considered an actual improvement since the concentrations reported during the previous reporting period were questionable. With the exception of those taken in the previous reporting period, the current reporting period measurements are consistent with measurements taken at both of these wells in the past five years.
- All other wells landward of the barrier remained fresh.

I ZONE (Figure A - 16)

In general, chloride concentrations along and landward of the barrier alignment have shown improvement since the previous reporting period. However, areas of high chloride concentration remain and seawater intrusion in the I Zone appears to be more advanced than in the other zones. The I Zone continues to record high chloride levels at the southeastern end of the barrier even though notable decreases occurred since the previous sampling period. Chloride concentrations at or slightly seaward of the barrier alignment near the San Gabriel River, the Los Alamitos Channel, and 7th Street suggest fresh groundwater conditions in an area that recorded significantly elevated chloride concentrations during the previous reporting period. Notable increases in chloride concentration were recorded slightly north of the San Gabriel River / 7th Street

Intersection, as well as north-west of the western end of the barrier alignment. Wells that exhibited high chloride concentration or registered significant changes in chloride concentration since the last reporting period are discussed below.

Along the Barrier

With the exception of the southeastern end of the barrier, all wells displayed fresh groundwater conditions. Well 33U'3 recorded fresh groundwater conditions at 200 mg/L, compared to the 690 mg/L measured in June of 2002.

- Well 34DG showed significant improvement with a maximum chloride concentration of 90 mg/L, compared to the 8,550 mg/L recorded in the previous reporting period. In the same general area, the chloride concentrations at well 34HJ improved to of 95 mg/L from the 845 mg/L measured in the previous reporting period.
- Well 34LS was not sampled this reporting period because it was obstructed above the perforations. The well has historically exhibited fresh groundwater conditions.
- Well 34T0.1 reported fresh groundwater conditions at a chloride concentration of 245 mg/L, an improvement over the 380 mg/L measured in the previous reporting period. The well experienced fresh groundwater quality between 1990 and 2002.
- Well 35E0.1 improved significantly this reporting period. The chloride concentration of 5,600 mg/L is low in comparison with the 11,754 mg/L measured in the previous reporting period, but still consistent with the historical range of measurements at the well.
- Well 35H11 recorded a chloride concentration of 1,350 mg/L. This is an improvement over the 1,580 mg/L measured in the previous reporting period, but still consistent with the historical range of measurements at the well.
- The chloride concentration of 1,700 mg/L measured at well 35J1 is considerably lower than chloride concentrations (around 2,800 mg/L) measured at this location between January 2002 and the previous reporting period.
- All other wells along the barrier remained fresh.

Landward of the Barrier

Most areas have shown relatively fresh groundwater quality with the exception of the following areas: north-west of the western end of the barrier, slightly north of the San Gabriel / 7th Street intersection, and inland of the southeastern end of the barrier.

- Well 32V22 exhibited a slight increase in chloride concentration. The 750 mg/L measured at this location north-west of the western end of the barrier is an increase from the 450 mg/L measured when the well was last sampled in 2002, as well as the fresh groundwater conditions encountered at the well between 1971 and 2001.
- Wells 33S20 and 33T12.5 were not sampled because they were obstructed above the perforations. Both wells have tested fresh historically.
- Well 33X10 reported an elevated chloride concentration of 1,790 mg/L, compared to the 95 mg/L measured in the previous reporting period. Since 1984, the well located along the San Gabriel channel north of the channel's intersection with 7th Street, had mostly exhibited fresh groundwater conditions, with the exception of chloride concentrations between 400 and 800 mg/L measured from 1994 to 2000.
- Well 33X20 was not sampled because it was obstructed above the perforations. It was last sampled in 1993 and has historically registered chloride concentrations between 4,000 and 6,000 mg/L.
- Wells 34F10 and 34H25, both located north-east of the San Gabriel River / 7th Street intersection, measured slightly lowered chloride concentrations of 940 and 620 mg/L in comparison to 1,010 and 805 mg/L measured at these locations in the previous reporting period, respectively.
- Well 34V20 recorded fresh groundwater conditions at 88 mg/l in comparison to the 290 mg/L measured in the previous reporting period. These chloride concentrations are also an improvement compared to the chloride concentrations measured at this location from 1996 to 2002 (between 1,000 and 2,000 mg/L).
- Well 35F20, located inland of the southeastern end of the barrier, reported a chloride concentration of 2,750 mg/L. This is an improvement over the historical

high of 3,974 mg/L measured in the previous reporting period. However, this measurement is still high compared to earlier measurements which have gradually increased from completely fresh conditions before 1993 to current chloride levels.

CHLORIDE SECTION ALONG THE BARRIER (Figure A-17)

A cross-sectional view of chloride concentrations along the barrier alignment is illustrated in Figure A-17. All zones at the southeastern end of the barrier, particularly the B and A Zones, exhibit high chloride concentrations. The remainder of the barrier maintained relatively fresh groundwater quality, with the exception of the R Zone near Well 34JL.

FINANCING AND COSTS

This section of the report is divided into three parts: Water Costs, Services and Supplies Costs (operation and maintenance), and Fixed Assets Costs (capital outlay). Under the terms of the Cooperative Agreement, fixed assets are divided into facilities paid for by the Los Angeles County Flood Control District, facilities paid for by the Orange County Water District, and joint facilities paid for by both agencies.

WATER COSTS

During the 2003-04 fiscal year, 5,880 acre-foot of water were injected at a total cost of $2,512,669. The water rates from July 2003 to June 2004 varied monthly depending on the periods which are shown in Table 1. The monthly quantity of water injected and the water costs paid by the respective agencies are shown in Table 4.

TABLE 4. QUANTITY OF WATER INJECTED AND COSTS

MONTH	WATER REPLENISHMENT DISTRICT AF	ORANGE COUNTY WATER DISTRICT AF	TOTAL AF
Jul-03	385.3	98.60	483.80
Aug-03	327.0	121.00	448.40
Sep-03	435.2	174.60	609.80
Oct-03	438.50	196.80	635.30
Nov-03	378.50	177.10	555.60
Dec-03	331.90	166.80	498.70
Jan-04	348.40	166.8	515.20
Feb-04	256.20	178.4	434.60
Mar-04	289.6	181.7	471.30
Apr-04	226.4	135.8	362.20
May-04	237.3	155.1	392.40
Jun-04	309.7	162.7	472.40
TOTAL (AF)	3964.0	1915.4	5879.7
COST ($)	**$1,698,293**	**$814,376**	**$2,512,669**

SERVICES AND SUPPLIES COSTS

A total of $736,720 was expended on services and supplies during the 2003-04 fiscal year (not including liability insurance and water costs). Of this total, $6,068 was charged to extraction well maintenance. Pursuant to the Cooperative Agreement, the Orange County Water District pays a percentage of the services and supplies costs for injection operations proportional to the percentage of the total amount of injection water paid for by the District. The distribution of 2003-04 services and supplies costs for injections are summarized in Table 5:

TABLE 5. DISTRIBUTION OF SERVICES AND SUPPLIES COSTS FOR INJECTION AND EXTRACTION ACTIVITIES

ITEM	LOS ANGELES COUNTY	ORANGE COUNTY	TOTAL
Operation and Maintenance of Injection Facilities	$486,517	$217,184	$703,701
Operation and Maintenance of Extraction Facilities	$6,068	$0	$6,068
Special Programs	$26,951	$0	$26,951
SUBTOTAL	**$519,536**	**$217,184**	**$736,720**
Liability Insurance	$7,010	$7,010	$14,020
TOTALS	**$526,546**	**$224,194**	**$750,740**

The costs of the services and supplies for injection operations for past years, excluding water costs, are shown in Table 6.

TABLE 6. COSTS OF SERVICES AND SUPPLIES FOR INJECTION

Fiscal Year	Volume of Water Injected (Ac-Ft)	Total Cost ($)	Cost Per Ac-Ft Injected ($)
1965-66	4,076.3	171,888	42.17
1966-67	3,647.1	159,711	43.79
1967-68	4,530.9	210,115	46.37
1968-69	5,530.9	160,983	29.11
1969-70	4,605.9	131,929	28.64
1970-71	4,185.5	136,937	32.72
1971-72	4,820.6	138,043	28.64
1972-73	4,999.6	105,883	21.18
1973-74	6,893.9	181,518	26.33
1974-75	5,926.6	201,183	33.95
1975-76	4,744.5	213,504	45.00
1976-77	5,233.1	279,440	53.40
1977-78	5,017.5	225,982	45.04
1978-79	5,070.8	233,358	46.02
1979-80	4,842.3	252,359	52.12
1980-81	4,107.3	319,641	77.82
1981-82	4,858.9	436,558	89.85
1982-83	5,197.7	403,241	77.58
1983-84	4,024.0	489,302	121.60
1984-85	4,724.4	457,116	96.76
1985-86	4,609.9	427,278	92.69
1986-87	6,958.3	433,325	62.27
1987-88	6,537.8	441,706	67.56
1988-89	5,599.3	723,965	129.30
1989-90	5,755.8	515,964	89.64
1990-91	6,167.7	464,584	75.33
1991-92	5,757.5	865,016	150.24
1992-93	5,240.8	692,864	132.21
1993-94	4,144.8	584,975	141.13
1994-95	3,495.7	651,845	186.47
1995-96	5,269.0	509,377	96.67
1996-97	5,739.4	408,064	71.10
1997-98	5,335.8	923,342	173.05
1998-99	5,330.4	795,044	149.15
1999-00	6,077.9	589,168	96.94
2000-01	5,398.8	961,649	178.12
2001-02	6,061.7	713,299	117.67
2002-03	5,012.3	1,555,921	310.42
2003-04	5,880	730,652	124.27

The costs of the services and supplies for extraction operations for past years, including electrical costs, are shown in Table 7.

TABLE 7. COSTS OF SERVICES AND SUPPLIES FOR EXTRACTION

Fiscal Year	Volume of Water Extracted (Ac-Ft)	Total Cost ($)	Cost Per Ac-Ft Extracted ($)
1965-66	2,429.3	33,654	13.85
1966-67	2,215.4	48,594	21.93
1967-68	1,748.6	57,451	32.86
1968-69	1,832.8	50,658	27.64
1969-70	1,615.7	39,862	24.67
1970-71	1,420.5	32,963	23.21
1971-72	1,407.3	23,719	16.85
1972-73	1,078.6	14,189	13.16
1973-74	843.9	36,209	42.91
1974-75	133.5	93,303	698.90
1975-76	1,134.5	84,837	74.78
1976-77	1,283.4	85,199	66.39
1977-78	1,363.9	84,029	61.61
1978-79	1,326.6	53,744	40.51
1979-80	1,215.7	34,737	28.57
1980-81	722.6	79,540	110.07
1981-82	686.6	97,808	142.45
1982-83	962.3	90,630	94.18
1983-84	1,466.6	64,734	44.14
1984-85	1,621.3	105,058	64.80
1985-86	1,640.3	92,586	56.44
1986-87	1,700.7	84,447	49.65
1987-88	1,513.9	71,700	47.36
1988-89	1,522.4	99,315	65.24
1989-90	1,544.8	66,717	43.19
1990-91	1,278.0	172,230	134.77
1991-92	1,378.4	151,520	109.92
1992-93	1,136.1	99,099	87.23
1993-94	992.0	169,621	170.99
1994-95	940.7	148,122	157.46
1995-96	998.4	130,901	131.11
1996-97	1,200.9	51,077	42.53
1997-98	883.5	64,774	73.32
1998-99	775.6	52,043	67.10

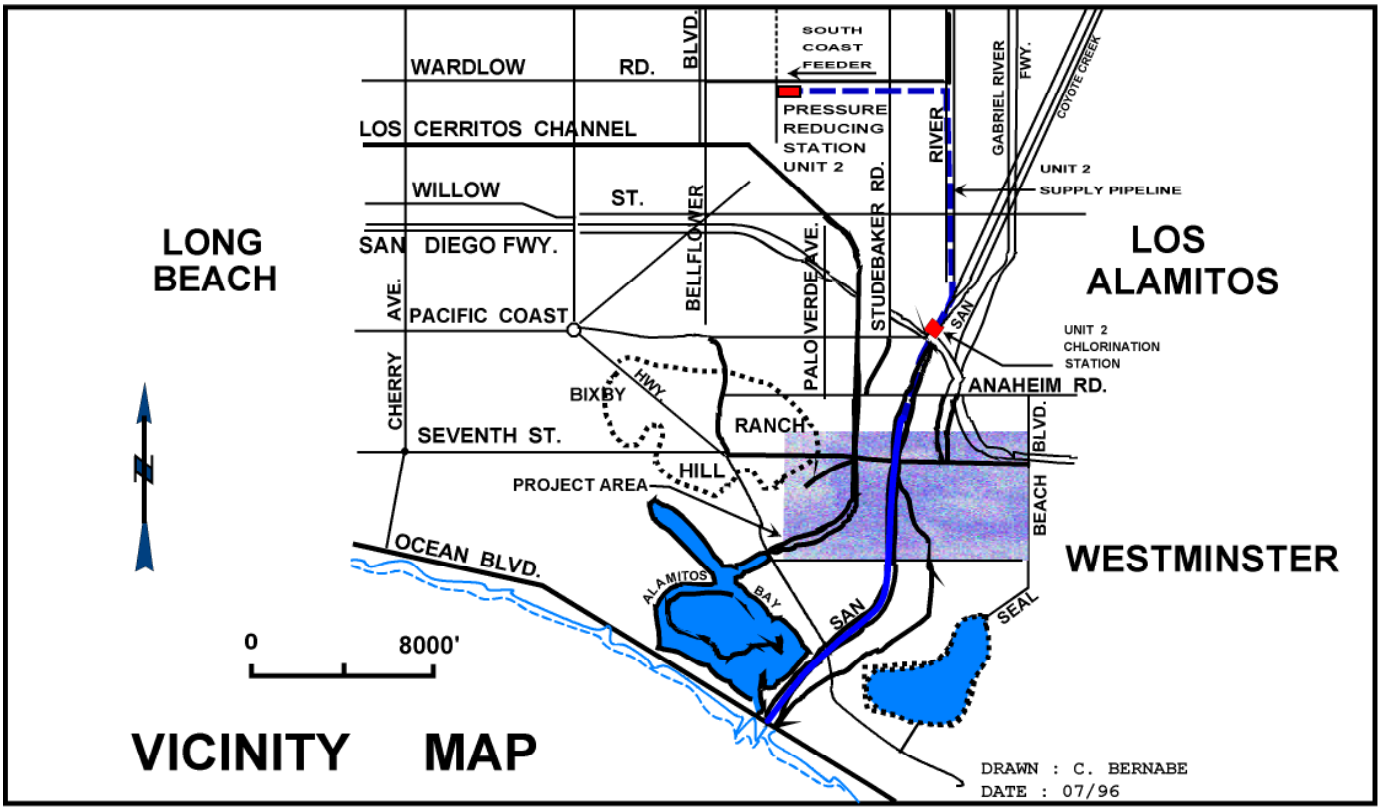
1999-00	679.9	41,320	60.77
2000-01	404.8	49,769	122.95
2001-02	495.0	53,153	107.38
2002-03	262.7	63,165	240.45
2003-04	0	6,068	N/A

HYDROELECTRIC REVENUES

No hydroelectric power was generated at the water supply pressure regulation station during the 2003-2004 Fiscal year.

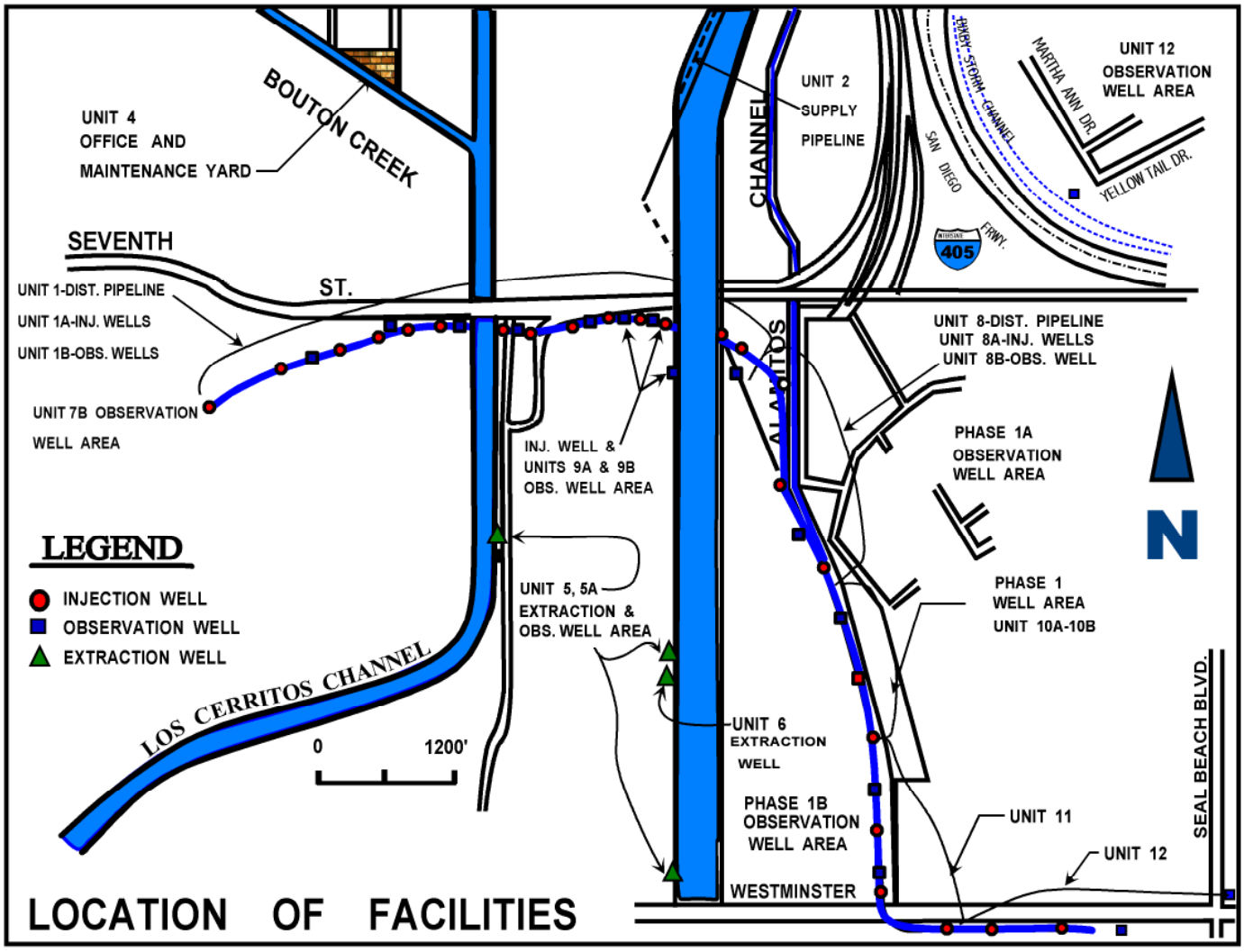
The hydroelectric plant is no longer in service and will be decommissioned as part of the pressure reduction vault renovation.

APPENDIX

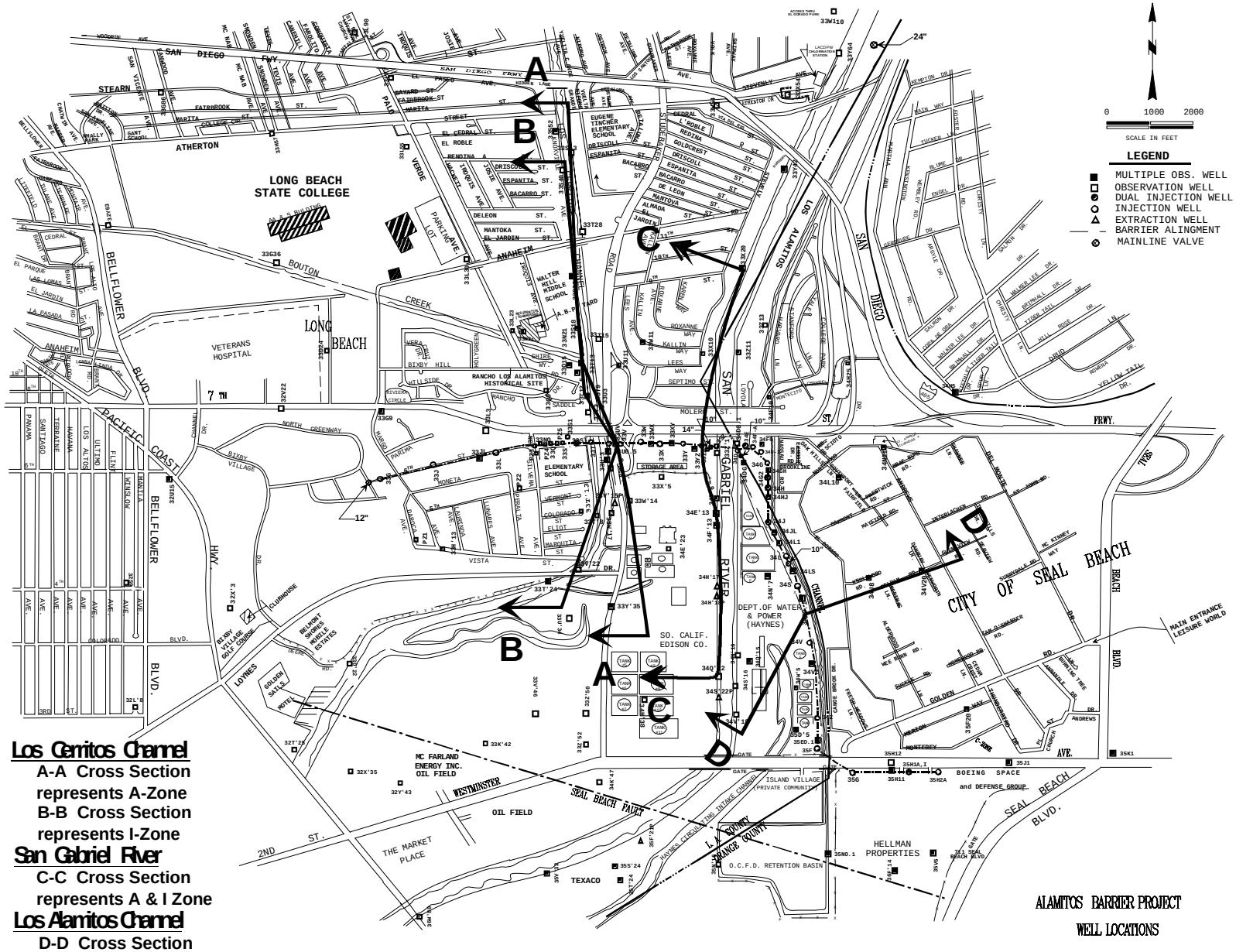


VICINITY MAP

DRAWN : C. BERNABE
DATE : 07/96



LOCATION OF FACILITIES



Los Cerritos Channel

A-A Cross Section represents A-Zone

B-B Cross Section represents I-Zone

San Gabriel River

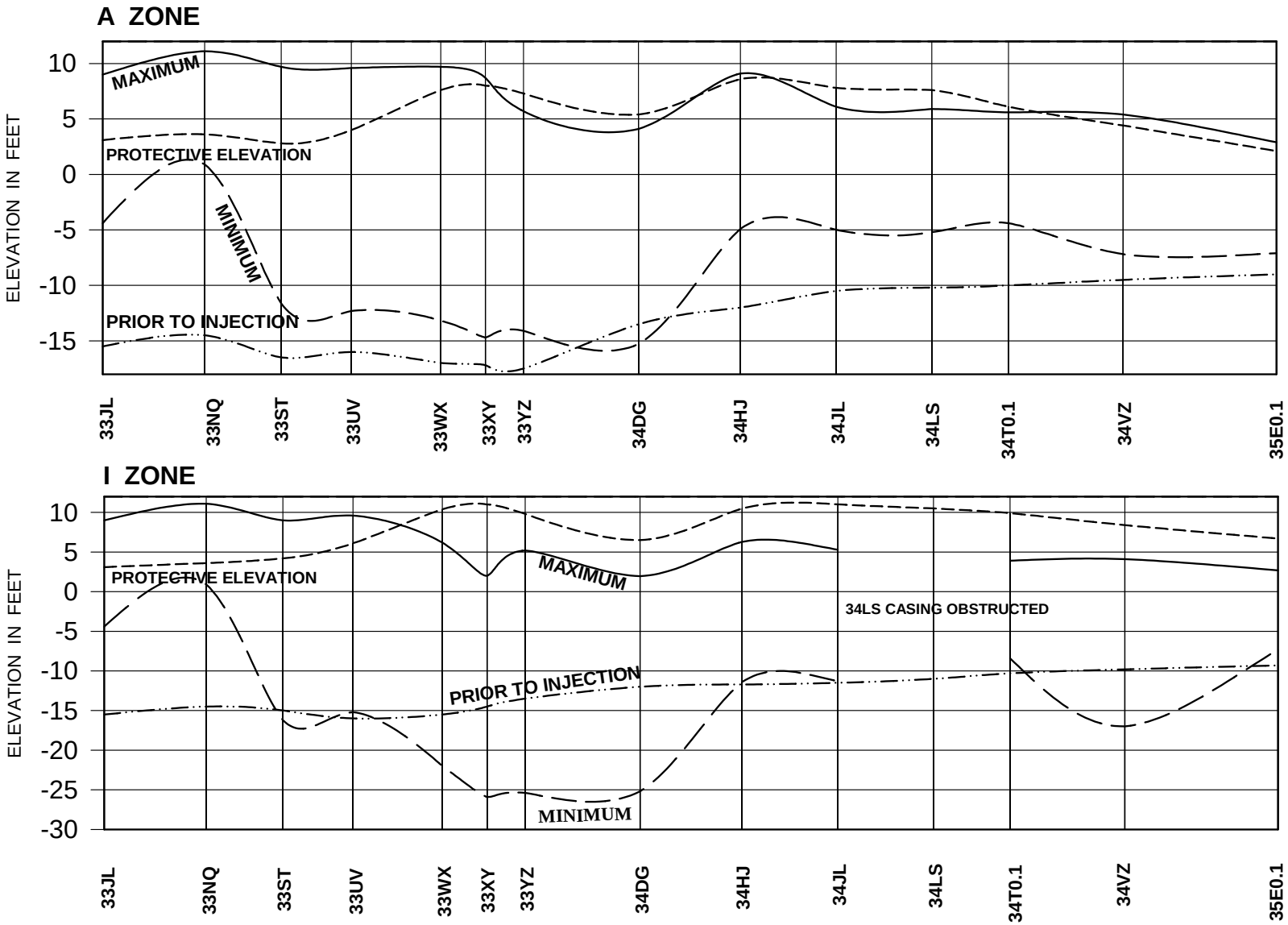
C-C Cross Section represents A & I Zone

Los Alamitos Channel

D-D Cross Section represents A & I Zone

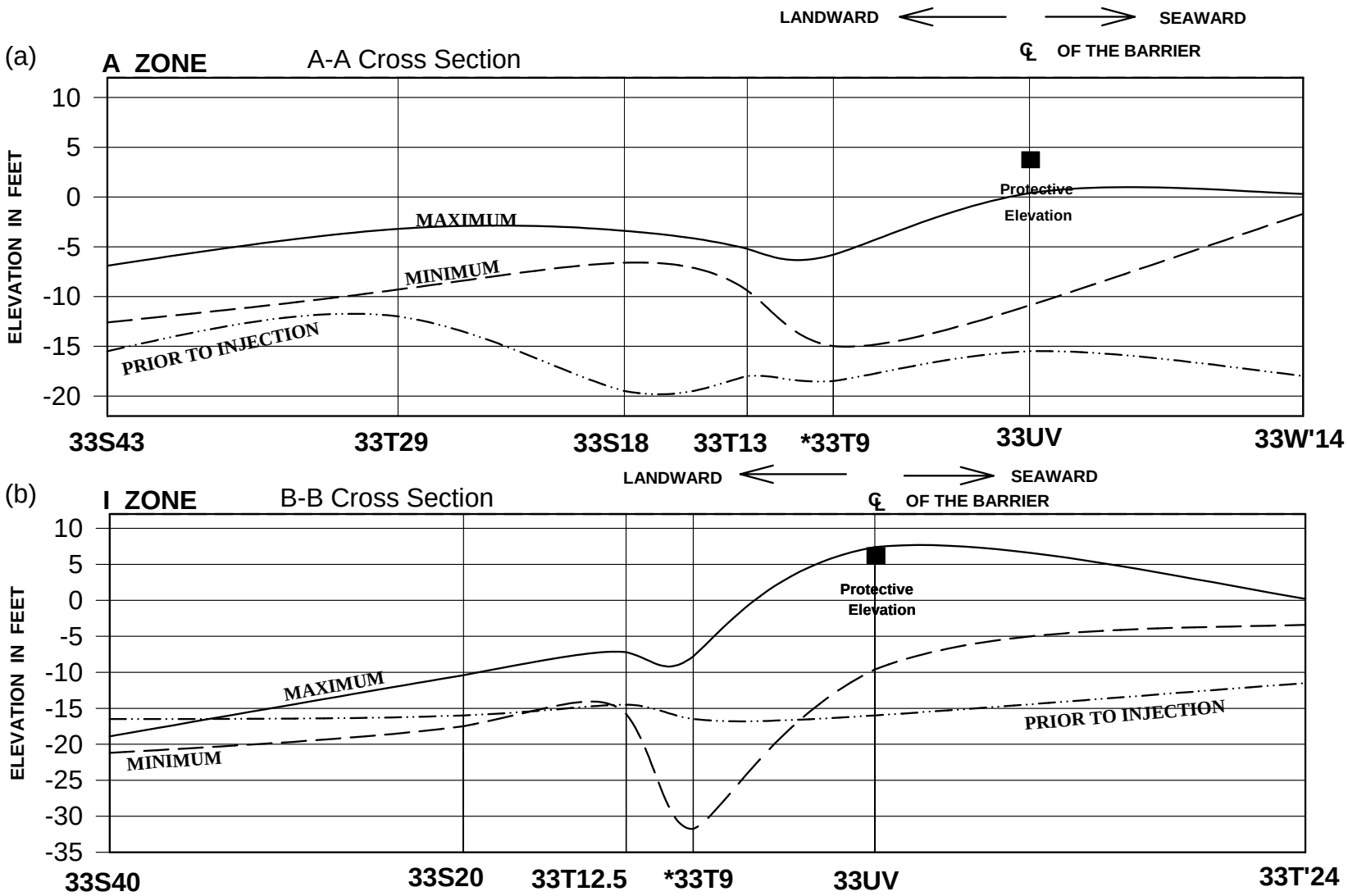
ALAMITOS BARRIER PROJECT

WELL LOCATIONS



Groundwater surface profiles along the barrier

MAXIMUM:	'A' AND 'I' ZONES	01-04
MINIMUM:	'A' AND 'I' ZONES	08-03
PRIOR TO INJECTION:		02-65



Groundwater surface profiles

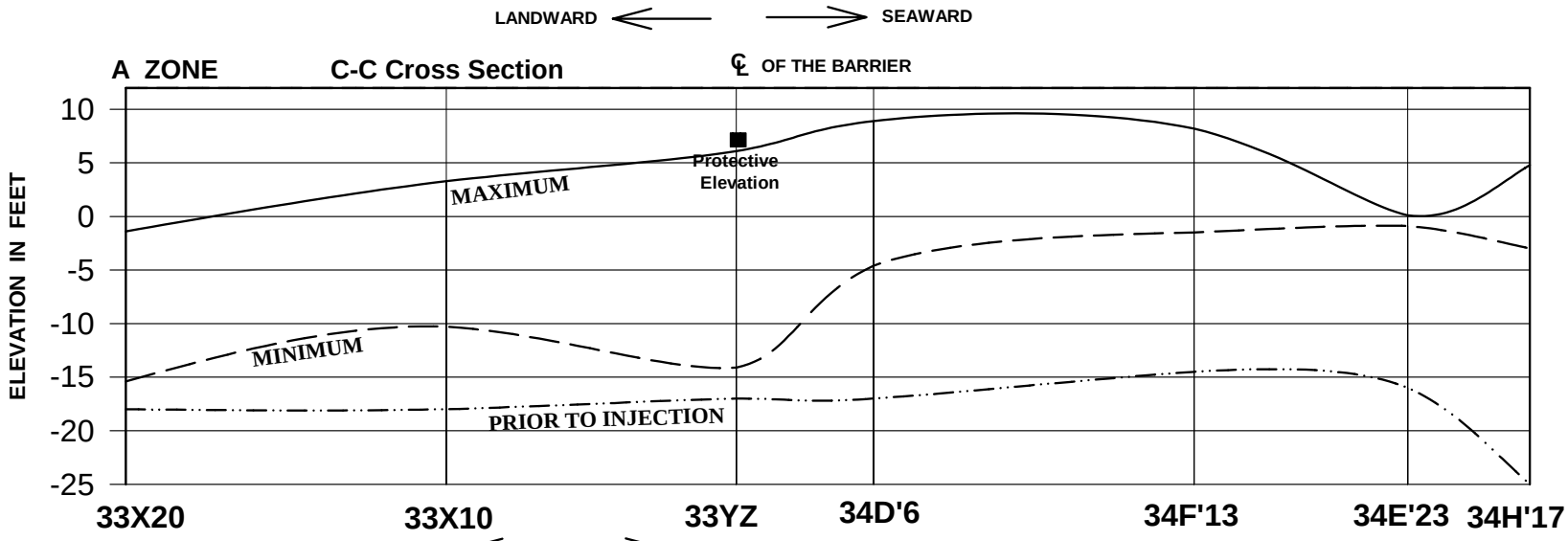
NORMAL to the barrier, along the Los Cerritos Channel

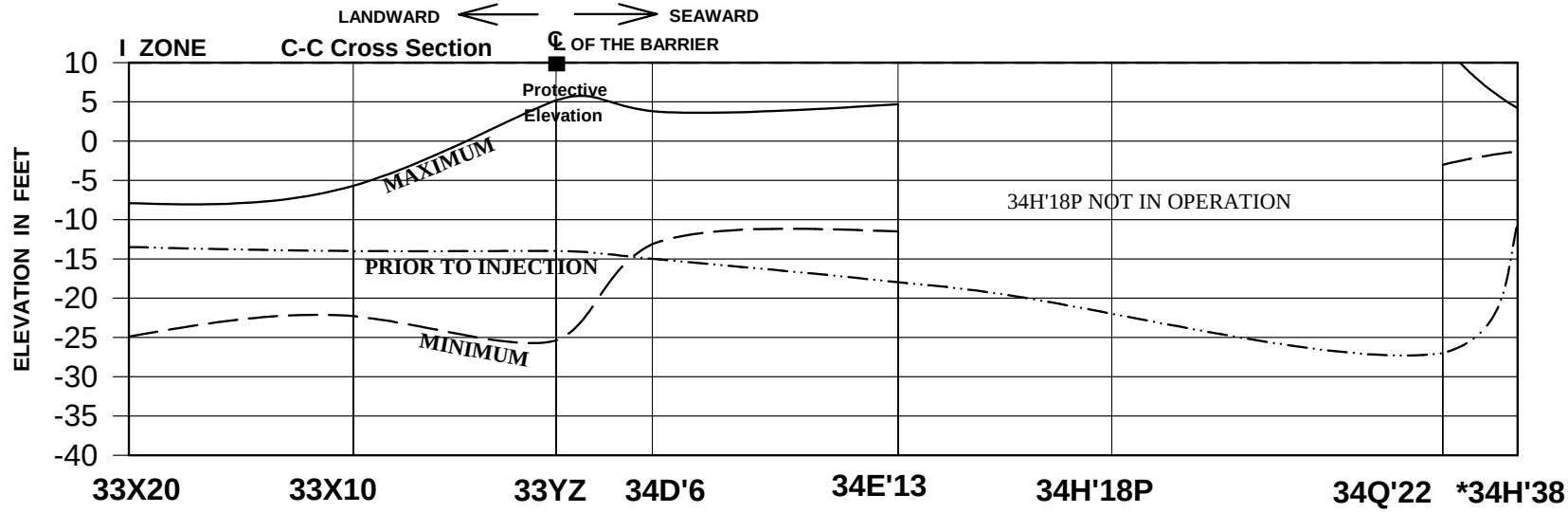
MAXIMUM: 'A' AND 'I' ZONES 01-04

MINIMUM: 'A' AND 'I' ZONES 08-03

PRIOR TO INJECTION: 02-65

*** DATA IS LAST YEARS REPORT**

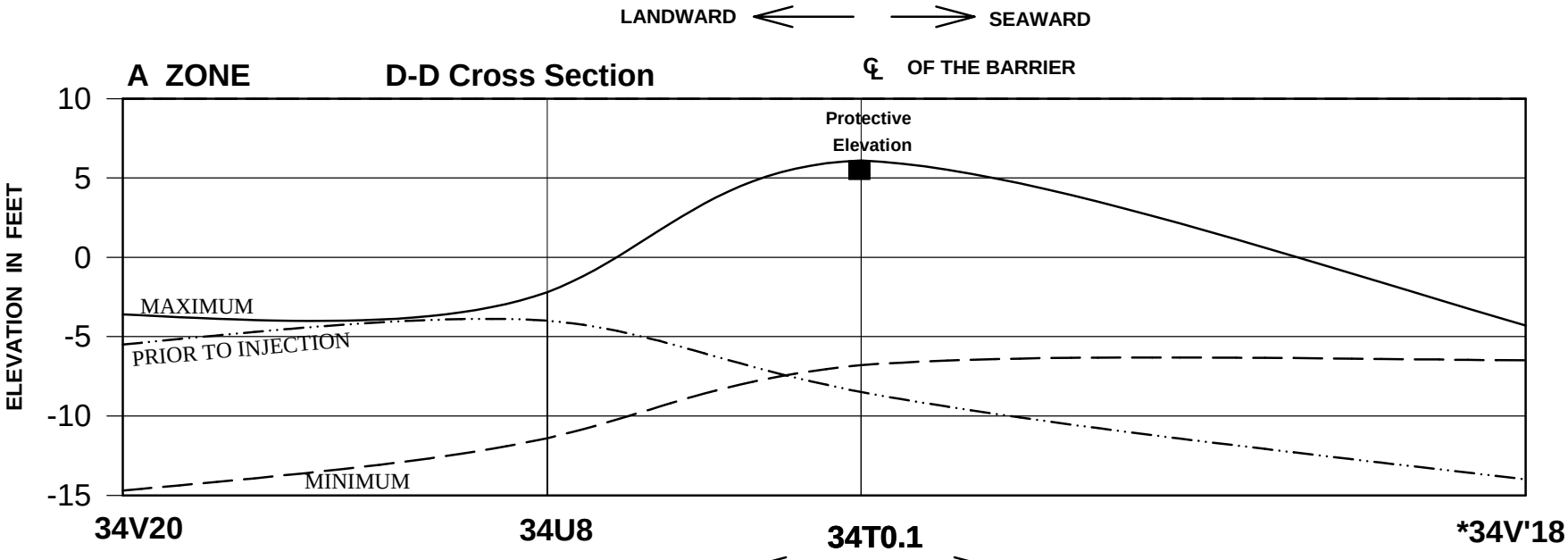


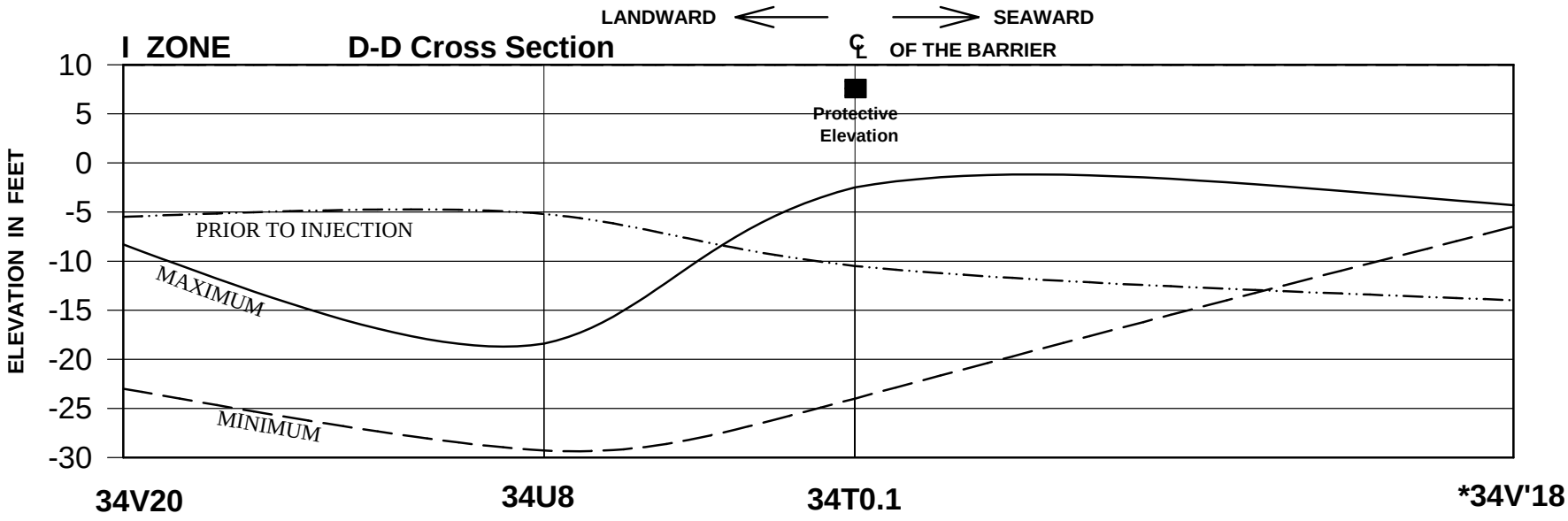


Groundwater surface profiles

NORMAL to the barrier, along the San Gabriel River

———	MAXIMUM:	'A' AND 'I' ZONES 01-04
— — —	MINIMUM:	'A' AND 'I' ZONES 08-03
—·—·—	PRIOR TO INJECTION:	02-65



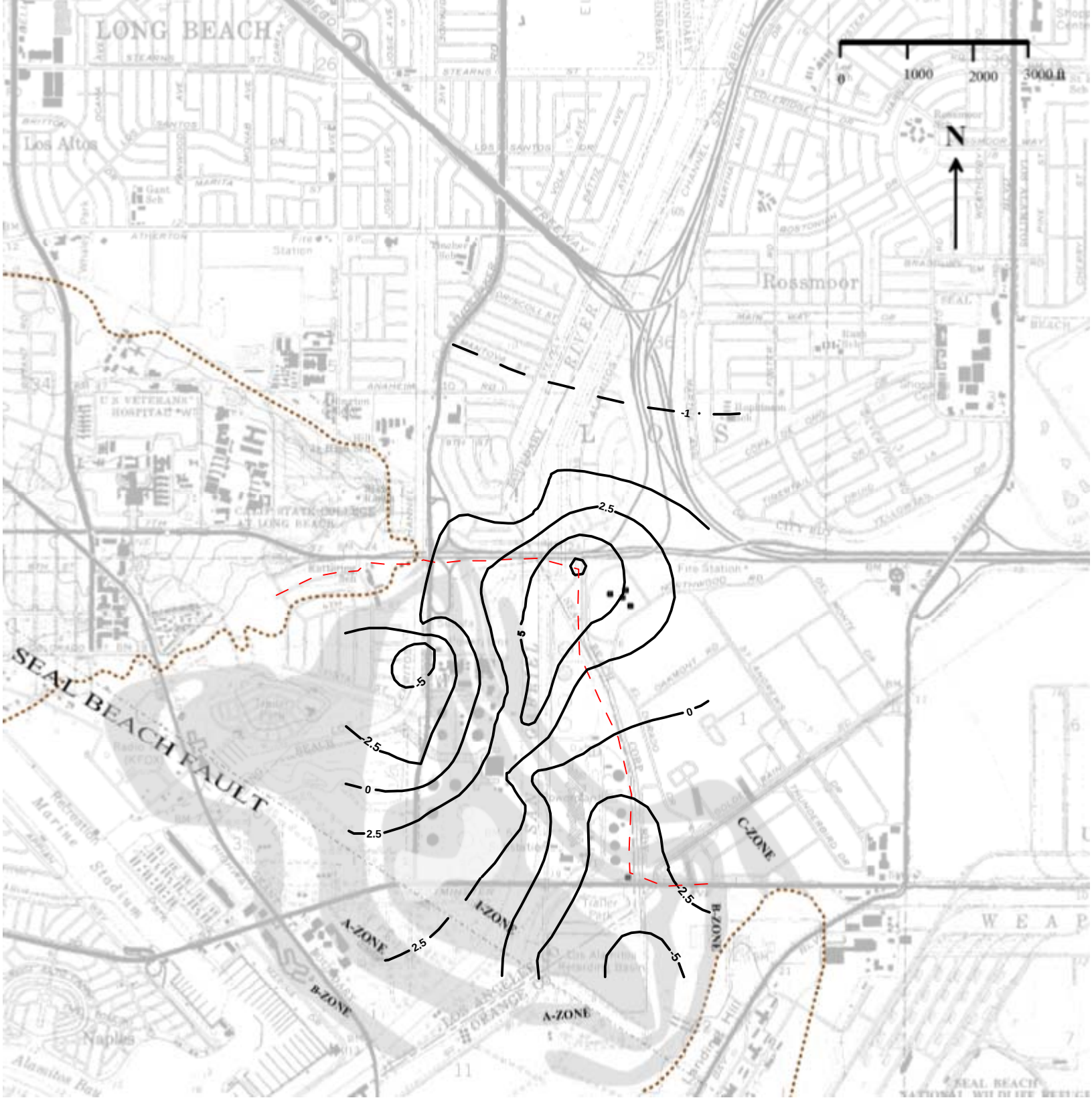


Groundwater surface profiles

NORMAL to the barrier, across the Los Alamitos Channel

———	**MAXIMUM:**	**'A' AND 'I' ZONES 01-04**
— — —	**MINIMUM:**	**'A' AND 'I' ZONES 08-03**
—·—·—	**PRIOR TO INJECTION:**	**02-65**

* AVERAGE FOR LAST YEAR RECORDED DATA

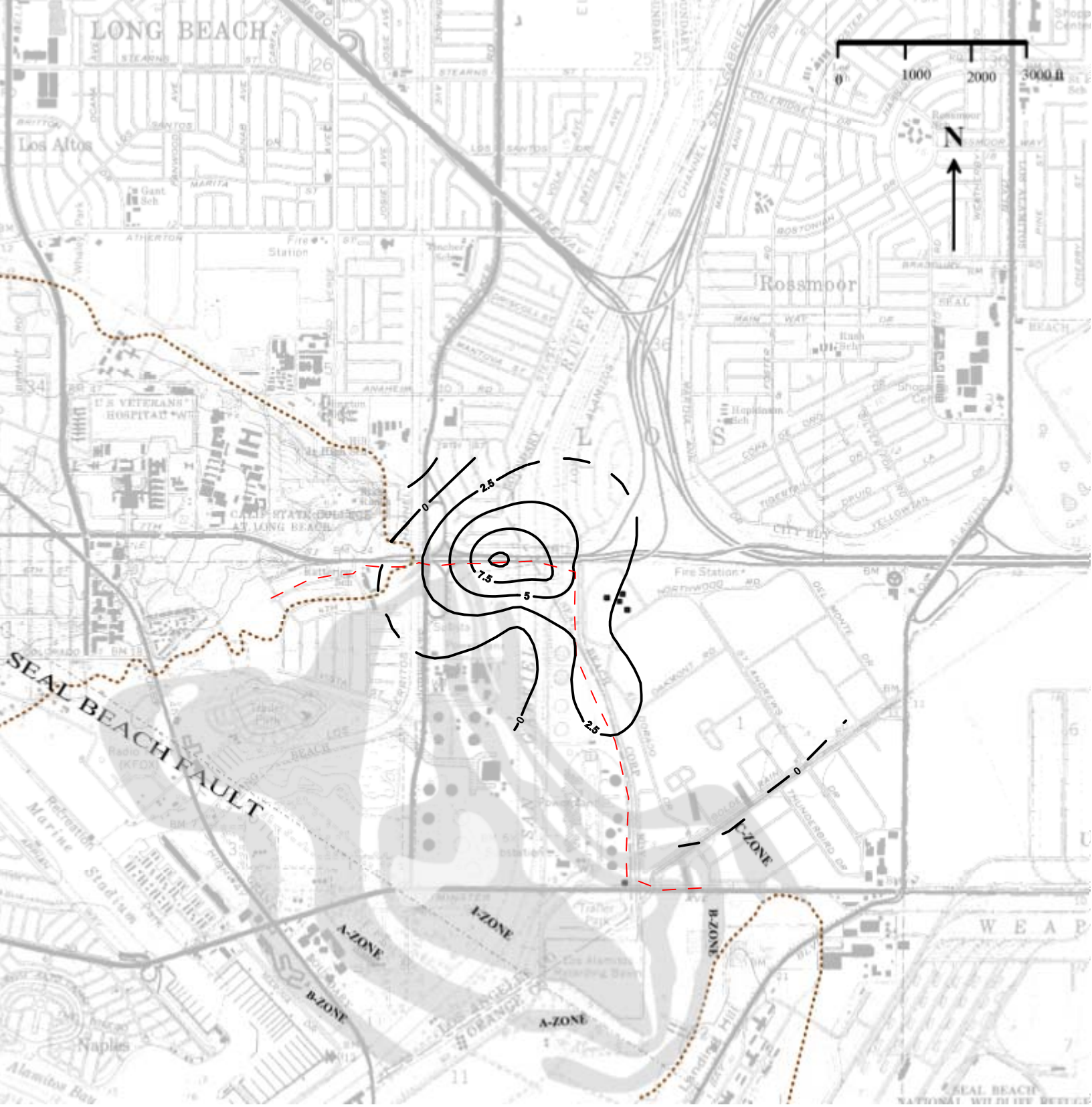


Alamitos Barrier Project

Groundwater Elevation (ft) Contours
R-Zone

March & April 2004

Recent Zone Boundary
Recent Zone Mergence
Barrier Alignment
Extrapolated Groundwater Elevation
Groundwater Elevation



Alamitos Barrier Project

Groundwater Elevation (ft) Contours

C-Zone

March & April 2004

Recent Zone Boundary

Recent Zone Mergence

Barrier Alignment

Extrapolated Groundwater Elevation

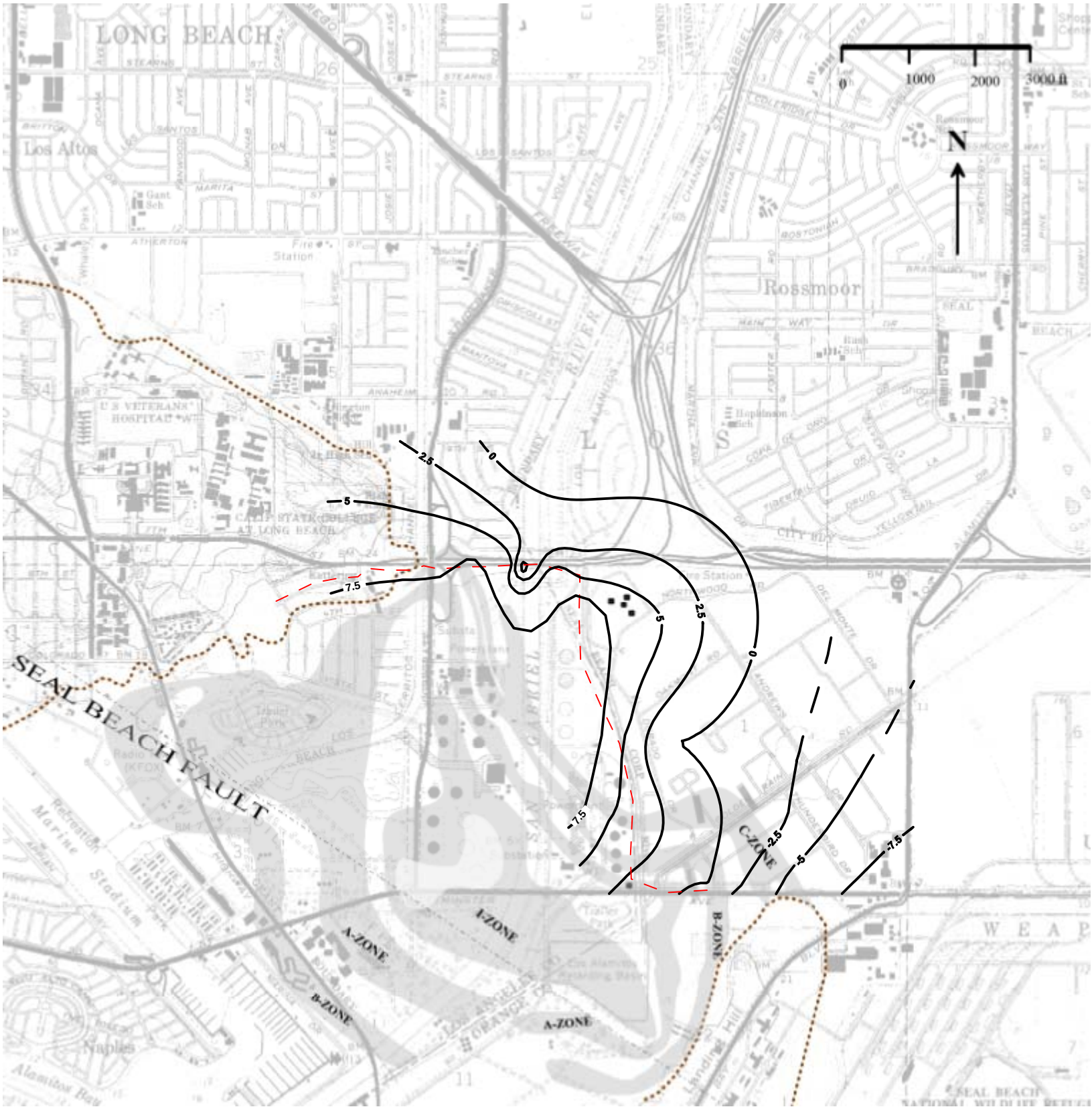
Groundwater Elevation

Alamitos Barrier Project

Groundwater Elevation (ft) Contours
B-Zone

March & April 2004

Recent Zone Boundary
Recent Zone Mergence
Barrier Alignment
Extrapolated Groundwater Elevation
Groundwater Elevation

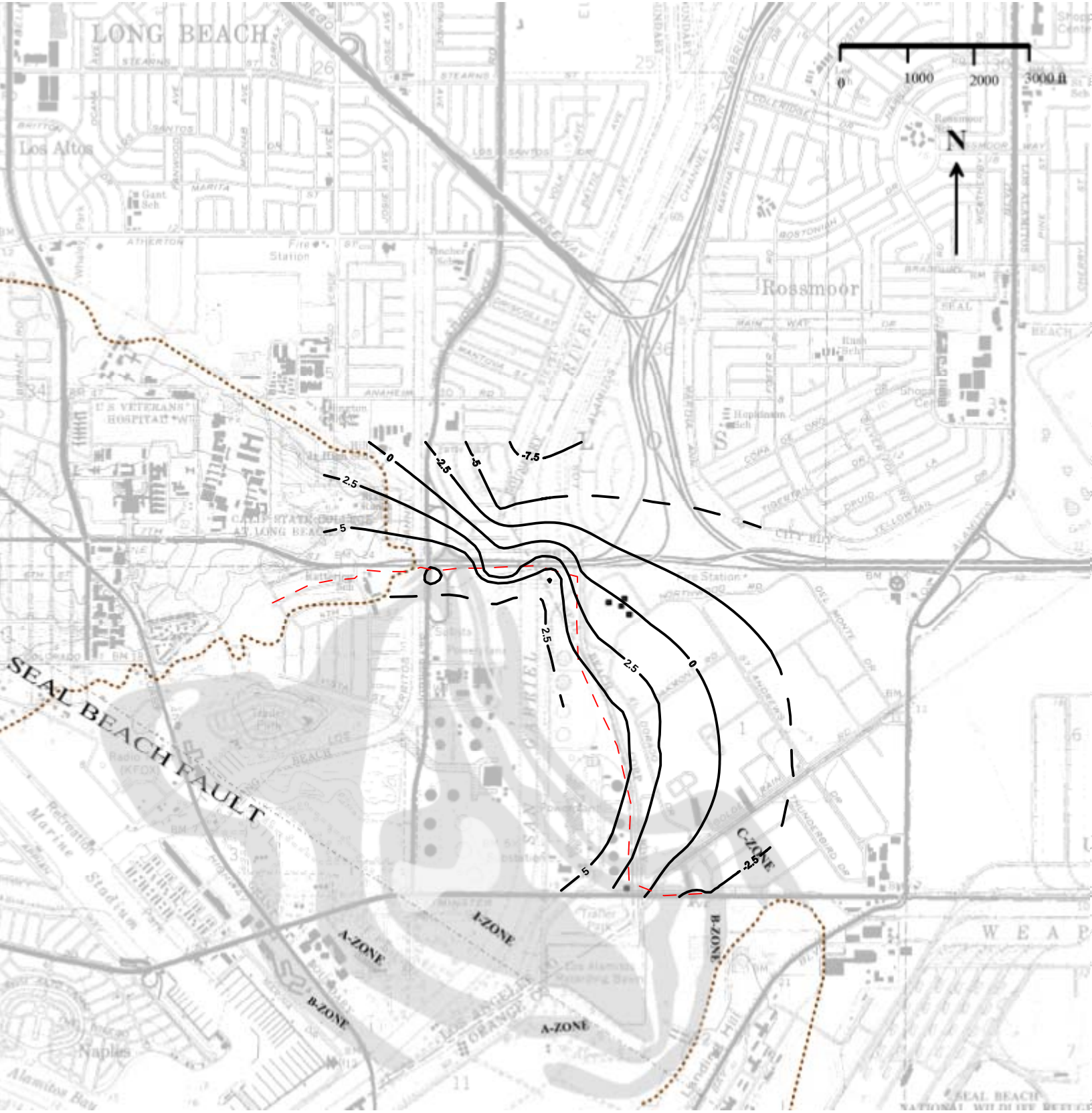


Alamitos Barrier Project

Groundwater Elevation (ft) Contours
A-Zone

March & April 2004

Recent Zone Boundary
Recent Zone Mergence
Barrier Alignment
Extrapolated Groundwater Elevation
Groundwater Elevation



Alamitos Barrier Project

Groundwater Elevation (ft) Contours
I-Zone

March & April 2004

- Recent Zone Boundary
- Recent Zone Mergence
- Barrier Alignment
- Extrapolated Groundwater Elevation
- Groundwater Elevation

Alamitos Barrier Project

Chloride Concentration (mg/L) Contours

R-Zone

November 2003 - January 2004

Recent Zone Boundary

Recent Zone Mergence

Barrier Alignment

Extrapolated Chloride Concentration

Chloride Concentration

Alamitos Barrier Project

Chloride Concentration (mg/L) Contours
C-Zone

November 2003 - January 2004

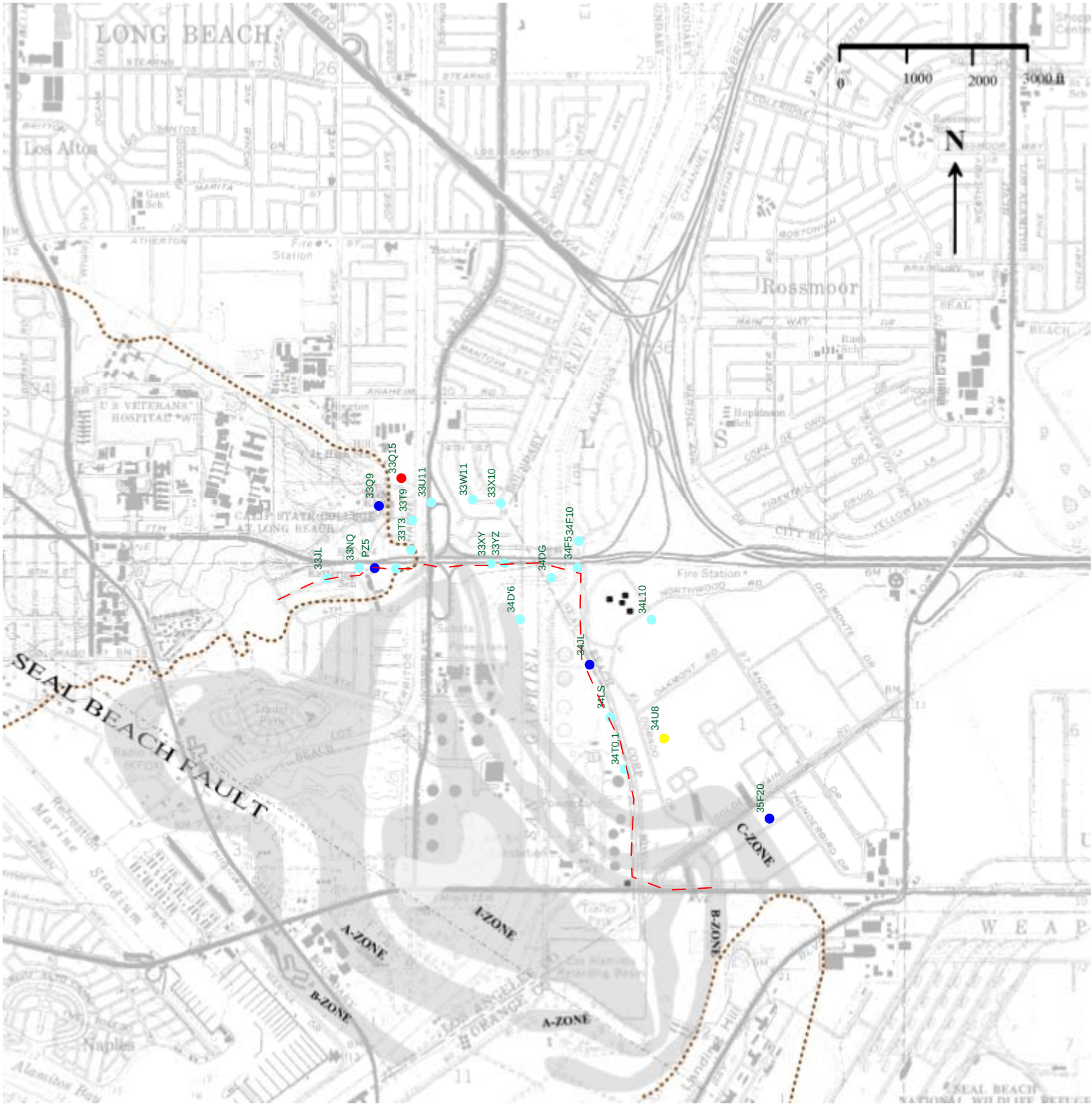
Recent Zone Boundary

Recent Zone Mergence

Barrier Alignment

Extrapolated Chloride Concentration

Chloride Concentration



Alamitos Barrier Project

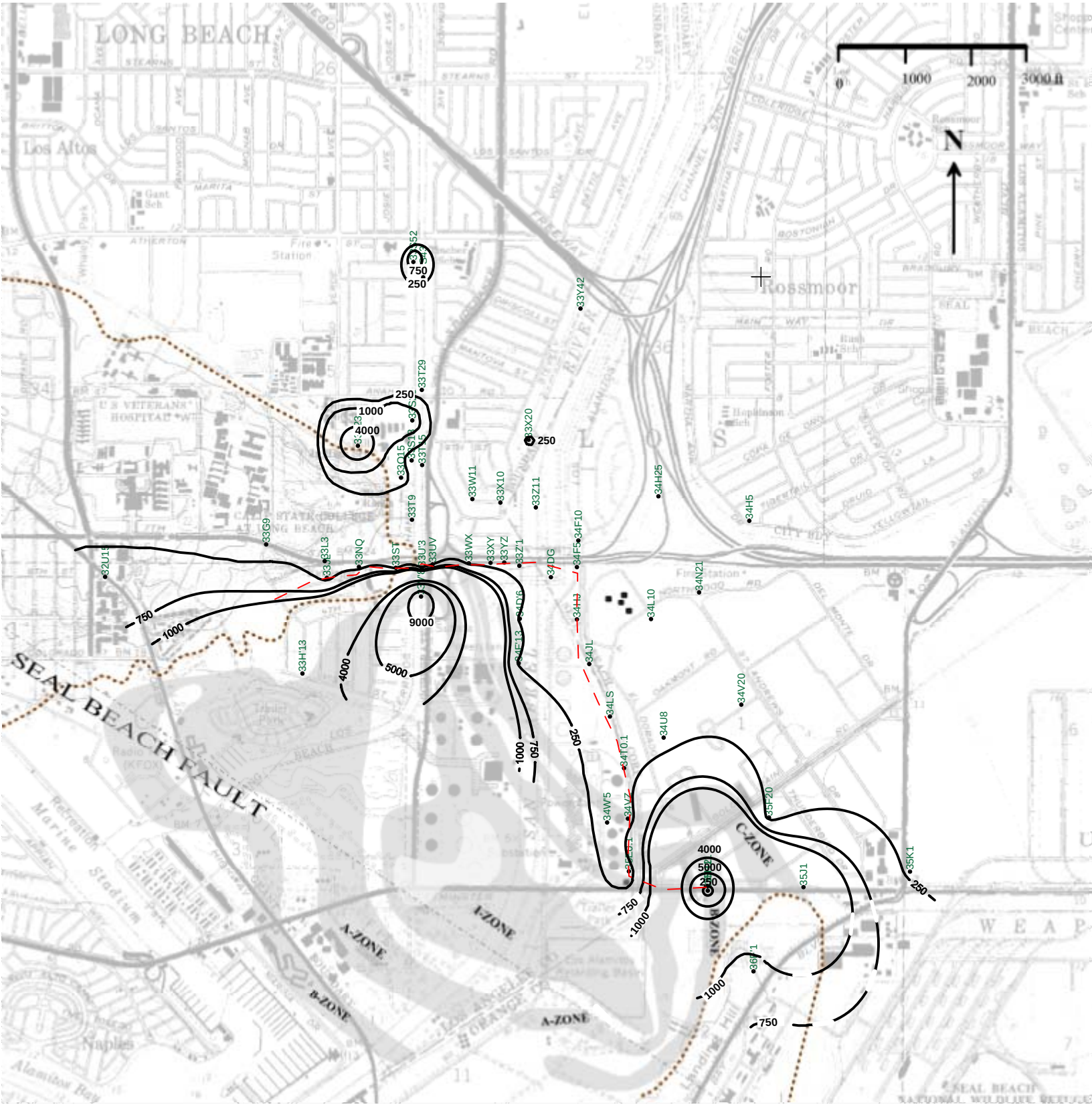
Chloride Concentration (mg/L) Contours

B-Zone

November 2003 - January 2004

- 0 to 250
- 250 to 500
- 500 to 750
- 750 to 1250
- 1250 to 2500
- 2500 to 5000
- 5000 to 10000

- Recent Zone Boundary
- Recent Zone Mergence
- Barrier Alignment
- Extrapolated Chloride Concentration
- Chloride Concentration



Alamitos Barrier Project

Chloride Concentration (mg/L) Contours

A-Zone

November 2003 - January 2004

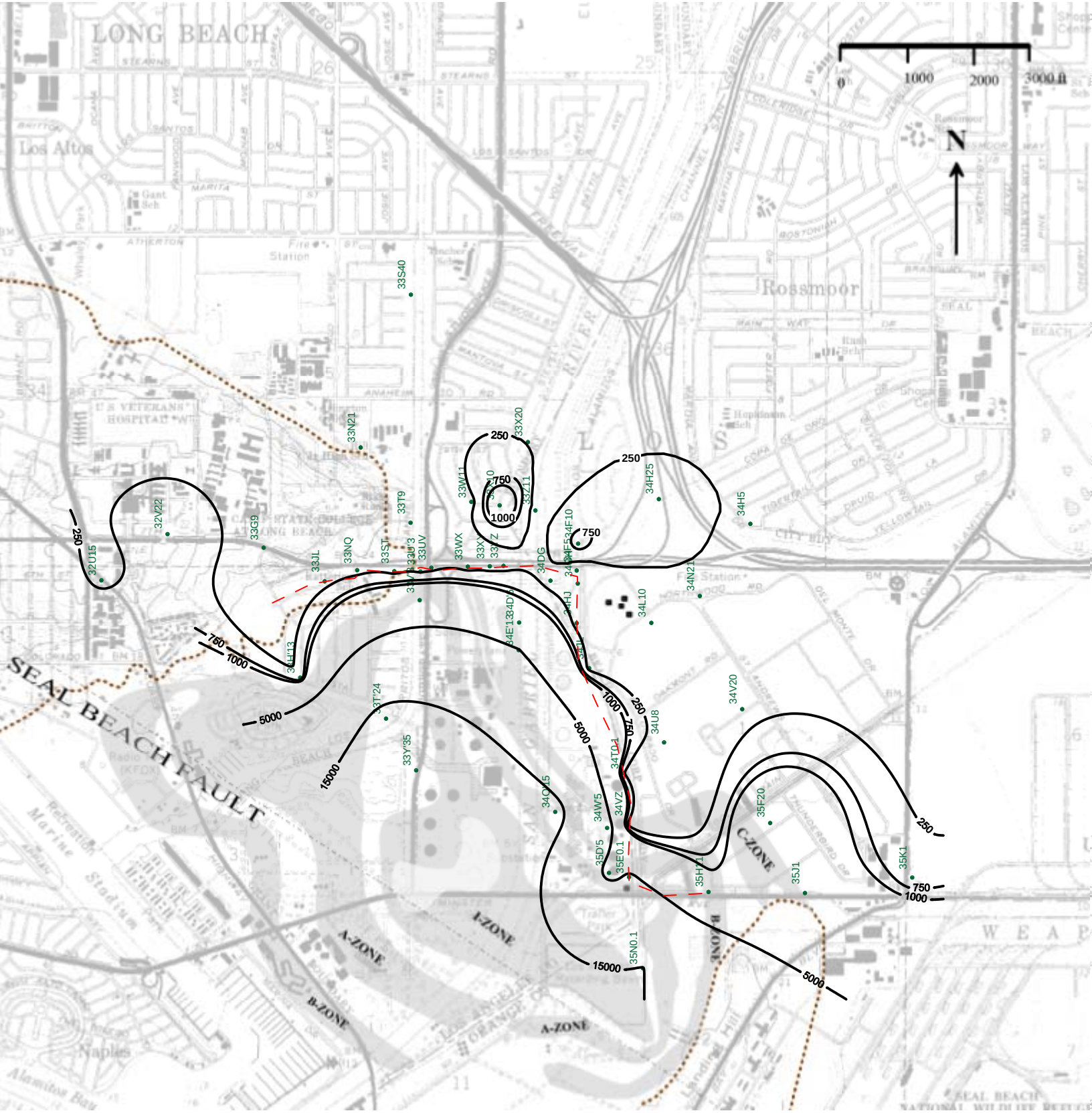
Recent Zone Boundary

Recent Zone Mergence

Barrier Alignment

Extrapolated Chloride Concentration

Chloride Concentration



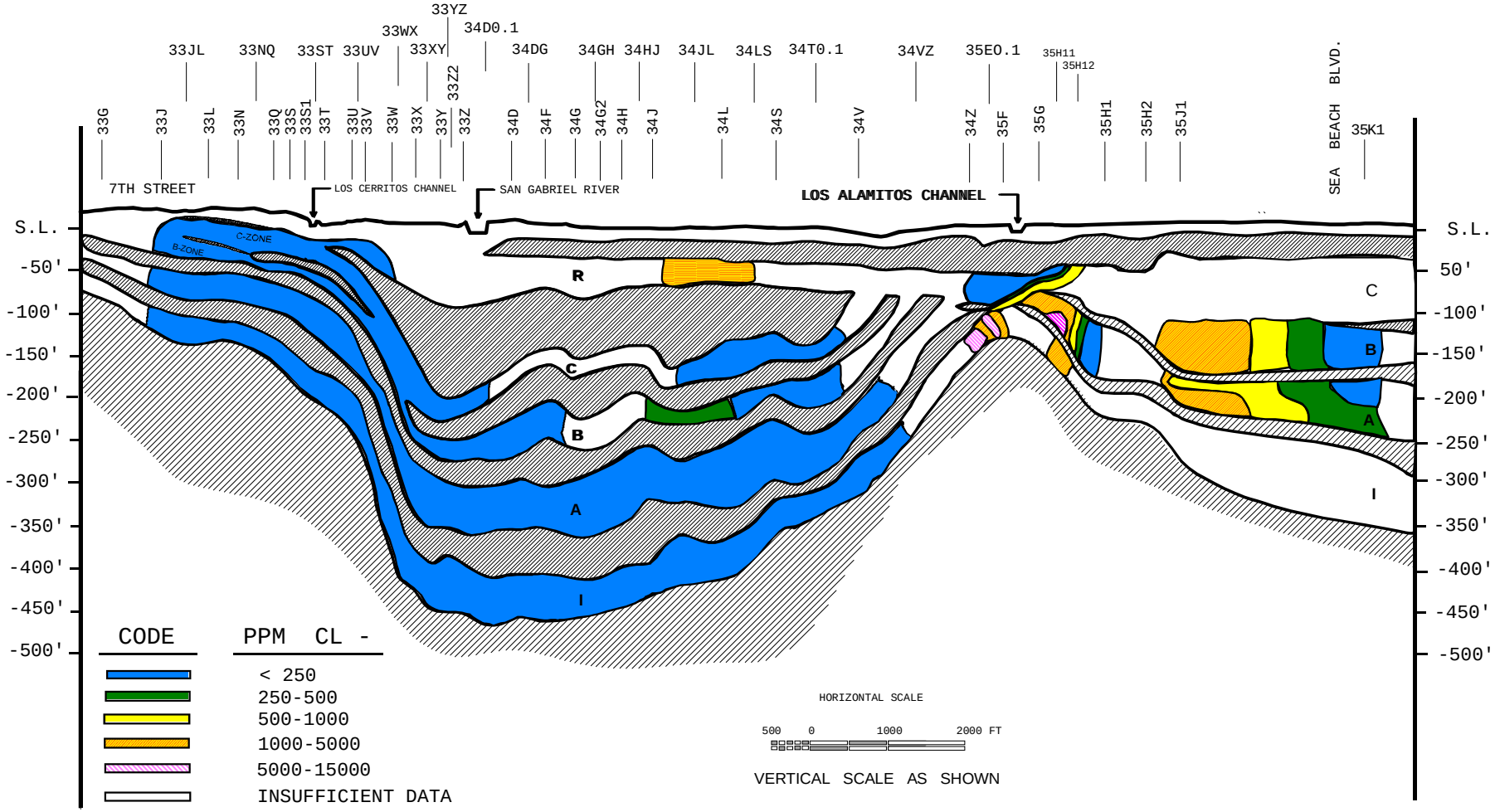
Alamitos Barrier Project

Chloride Concentration (mg/L) Contours

I-Zone

November 2003 - January 2004

- Recent Zone Boundary
- Recent Zone Mergence
- Barrier Alignment
- Extrapolated Chloride Concentration
- Chloride Concentration



CHLORIDE SECTION ALONG THE BARRIER

November 2003 - January 2004