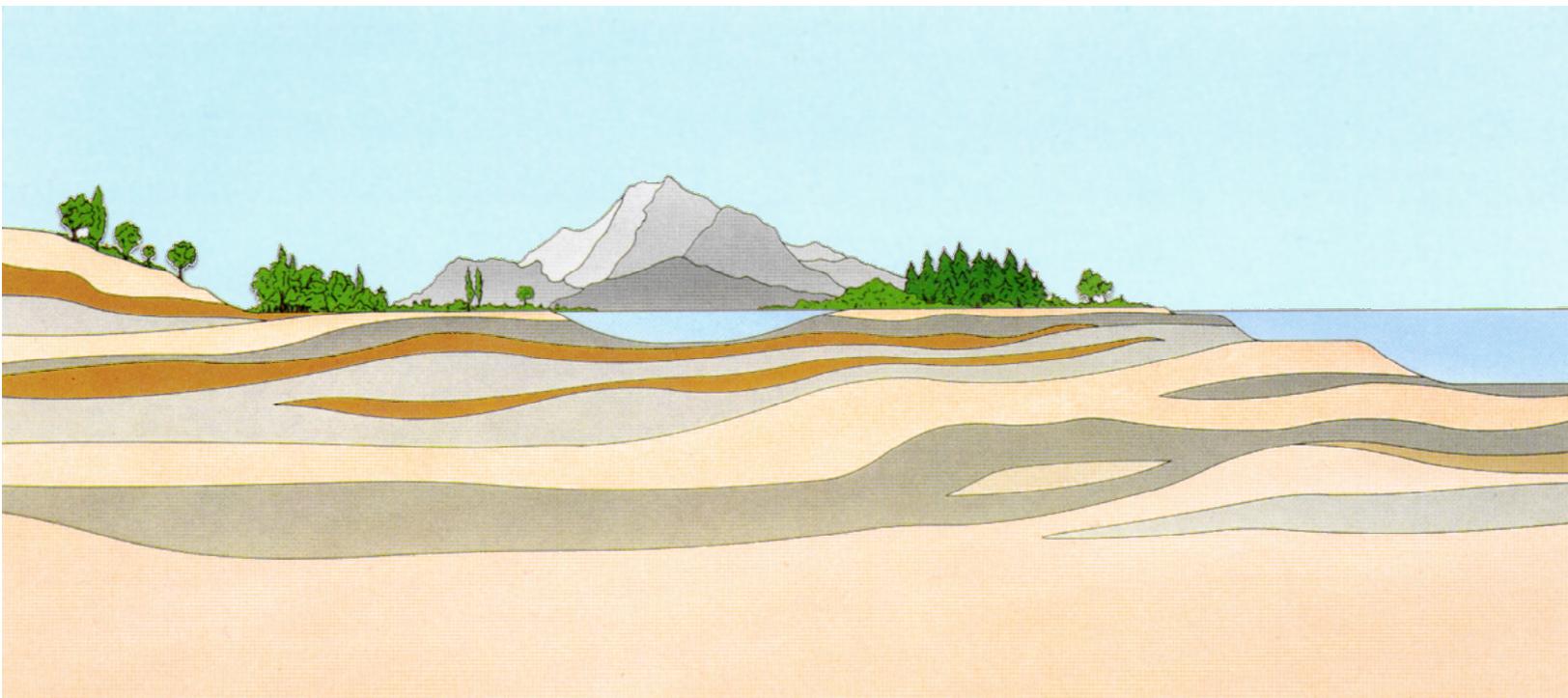




**ANNUAL REPORT  
JULY 2010 THROUGH JUNE 2011  
MALIBU ROAD LANDSLIDE ASSESSMENT DISTRICT  
MALIBU, CALIFORNIA**

Prepared for:  
CITY OF MALIBU

August 2011  
Fugro Project No. 04.B3399004





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August 29, 2011  
Project No. 04.B3399004

City of Malibu  
23825 Stuart Ranch Road  
Malibu, California 90265

Attention: Mr. Rob Duboux

Subject: Annual Report, July 2010 through June 2011, Malibu Road Landslide Assessment District

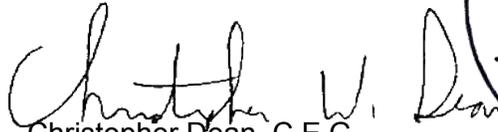
Dear Mr. Duboux,

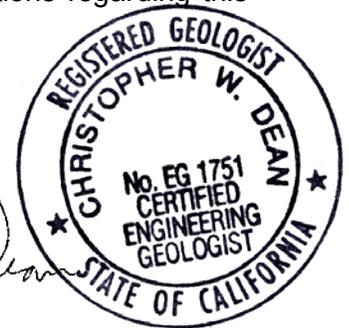
Fugro is pleased to present this annual report for the Malibu Road Landslide Assessment District. This report summarizes the monitoring and maintenance activities completed during the period of July 2010 through June 2011.

Fugro appreciates the opportunity to be of service to the City of Malibu and the District homeowners. Please contact us at (805) 650-7000, if you have any questions regarding this report.

Sincerely,  
FUGRO CONSULTANTS, INC.

  
Alexis M. Spencer  
Project Engineer/Project Manager

  
Christopher Dean, C.E.G.  
Senior Engineering Geologist



  
Lauren J. Doyel, P.E.  
Associate Engineer



Copies Submitted: (1) Addressee  
(1) City of Malibu - Geology & Soils Staff



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## 1.0 INTRODUCTION

### 1.1 AUTHORIZATION

Fugro Consultants, Inc. (Fugro), performed the work summarized in this report in accordance with our contract with the City of Malibu (City) and consistent with the cost estimate document "Exhibit A-FY 2010-2011 Maintenance Cost Estimate" presented in the Annual Assessment Report (Taussig, 2010).

### 1.2 BACKGROUND

The Malibu Road Landslide Assessment District was established in 1981 by the County of Los Angeles following the activation of a landslide on the west end of Malibu Road in 1978 (Plates 1 and 2). The assessment district provides permanent funding to maintain and monitor dewatering facilities with the purpose of stabilizing the landslide to the extent feasible using dewatering methods only. The County administered the assessment district until 1991 when the City incorporated. Since then, the City has administered the assessment district, utilizing consultants to maintain and monitor the district facilities.

### 1.3 SCOPE OF WORK

This annual report summarizes the monitoring and maintenance of the geotechnical instrumentation and dewatering facilities within the Malibu Road Assessment District for the period between July 1, 2010, and June 30, 2011 (hereafter, the "monitoring period").

Routine monitoring data collected during this monitoring period included the following:

- Review of annual rainfall data from a local rain gauge operated by the County of Los Angeles, Department of Public Works - Water Resources Division;
- Monthly groundwater level measurements from nine standpipes and eight pneumatic piezometers;
- Monthly dewatering production readings from nine dewatering wells owned by the Assessment District and three wells owned by a private homeowner on Bayshore Drive;
- Monthly dewatering production readings from 23 horizontal drains (hydraugers);
- Quarterly ground deformation measurements from five slope inclinometers; and
- Periodic maintenance of dewatering and monitoring facilities.

The operating condition of the instrumentation and dewatering facilities was checked during each field monitoring/observation visit and by evaluating preliminary data in the office as it was received. Maintenance was performed as needed based upon the field observations and preliminary data evaluation.

The scope of services includes monitoring and maintenance of the assessment district facilities. The services provided on an annual basis for the assessment district do not include an evaluation of the stability of the landslide.



## 1.4 REPORT ORGANIZATION

This report summarizes the monitoring data collected during the monitoring period and presents conclusions regarding the annual monitoring results. An outline of the report is presented as the Table of Contents. The location of the assessment district is illustrated on Plate 1 - Site Location Map. Locations of the geotechnical instrumentation are shown on Plate 2 - Assessment District Map. Tabulated and graphic summaries of monitoring data are presented in Appendix A through Appendix C as indicated in the Table of Contents.

## 1.5 REPORT AVAILABILITY

The annual assessment district reports are available for review in Malibu at City Hall. Reports may also be viewed on the City's website at <http://www.malibucity.org>. Paper copies or electronic versions on CD (pdf format) are also available for purchase from the City and Fugro.

## 2.0 MONITORING

### 2.1 RAINFALL DATA

Rainfall totals were tabulated based on recorded values from the Los Angeles County Rainfall Station 1239 - located at Big Rock Mesa. A combination graph of historical and annual cumulative monthly rainfall totals is shown on Plate 3 - Rainfall Graph.

Rainfall data indicate that approximately 24.16 inches of precipitation fell during the monitoring period from July 2010 through June 2011. The average rainfall total from 1968 to 2011 in the Malibu area for the period July through June is approximately 16.24 inches.

Rainfall data is usually analyzed in terms of the annual "rain season" that covers the time period October 1 through September 30. Rainfall for October 1, 2010, through June 30, 2011, was approximately 24.12 inches. This is approximately 141 percent of the average rainfall total of 16.24 inches for the rain seasons of 1968 through 2011.

### 2.2 GROUNDWATER MONITORING

The groundwater level data collected during this monitoring period are summarized in Appendix A. Groundwater levels fluctuate throughout the year and from year to year in response to natural and man-made influences. The primary natural influence is varying precipitation. Man-made influences include:

- Recharge from septic systems;
- Recharge from irrigation;
- Alterations to surface drainage by grading, landscaping, storm drains, and rain gutters;
- Accidental water discharges from leaking utilities (water, irrigation, sewer, storm drain), and swimming pools; and
- Dewatering activities including pumping dewatering wells and hydraugers.



Typically, groundwater levels rise relatively quickly following significant rainfall and gradually lower after the wet season ends. Groundwater levels measured in standpipe piezometers (wells) and pneumatic piezometers are depicted on Plates A1 through A5 in Appendix A. Groundwater levels at Malibu Road typically peak around late March to mid-April and gradually decline through late September to November.

### 2.2.1 Standpipe Piezometers

Nine standpipe piezometers (W-2A, W-3A, PZ-A, PZ-B, PZ-C, PZ-D, PZ-E, SI-5 and SI-6) were measured regularly over the monitoring period. Slope inclinometers/piezometers SI-5 and SI-6 were installed in 1998 along Bayshore Drive. Los Angeles County installed the other piezometers at earlier dates. The locations of the standpipe piezometers are depicted on Plate 2 - Assessment District Map, and groundwater hydrographs are presented in Appendix A.

### 2.2.2 Pneumatic Piezometers

Inclinometers installed within the assessment district after 1997 were typically outfitted with one or two pneumatic piezometer sensors. Nine sensors were measured regularly over the monitoring period; one piezometer was added (SI-1A) in August 2006. Each sensor records groundwater elevations by measuring differential air pressure between the instrument sensor and groundwater surface across a flexible bladder. The locations of the piezometers are depicted in Plate 2, and hydrographs are presented in Appendix A.

### 2.2.3 Groundwater Level Discussion

The groundwater data were reviewed by evaluating changes that occurred during the current monitoring period as well as changes in groundwater levels over extended periods. To analyze trends in seasonal groundwater fluctuations, the average (mean) annual and highest annual recorded groundwater elevation for each piezometer was calculated (Plate A-2).

Groundwater levels rose significantly following record rainfall in the winter of 2004 to 2005. Since about April 2005, groundwater levels generally declined, but are now starting to increase with above average rainfall during the last two monitoring periods. W-2A is well above average and PZ-E and W-3A are slightly above average. All other groundwater levels are at or below average. Groundwater levels at SI-5 have decreased significantly following the installation of the replacement dewatering well, W-14, in October 2008.

The average and highest annual groundwater levels are indicated below:

**Table 1. Summary of Average Groundwater Elevations by Area**

Location	Average Groundwater El. 2009-2010	Change vs. Prior Year Average	Peak Groundwater El. 2009-2010	Change vs. Prior Year Peak
Malibu Road	8.0	+0.5	9.5	+0.6
Bay Shore Drive	22.4	-1.5	23.6	-1.5

All units are in feet

## **2.3 DEWATERING PRODUCTION**

### **2.3.1 Dewatering Well Production**

A graph of the production rate for all dewatering wells is presented on Plate 4. Graphs showing production rates of individual wells are provided in Appendix B. Production data for the dewatering wells indicates the following:

- The average total well production rate for this monitoring period was approximately 1,141 gallons per day (gpd). This represents an increase of about 12 percent from the previous monitoring period of 1,081 gpd.

### **2.3.2 Hydrauger Production**

A graph of the production rate for all hydraugers is presented on Plate 4. A graph of production rates for all hydraugers is included in Appendix B. Data for the hydraugers indicates the following:

- The average production rate for all hydraugers over the monitoring period is approximately 884 gpd. This represents an increase of approximately 50 percent from the average production rate of 556 gpd for the previous monitoring period.

### **2.3.3 Total Dewatering Production**

A combined graph of the total dewatering rate for all dewatering wells and hydraugers is presented on Plate 4. Total dewatering production data for the hydraugers and wells indicates the following:

- The average total dewatering rate during the monitoring period was approximately 2,025 gpd. This represents a 29 percent increase in the average rate relative to the 1,574 gpd average recorded during the previous monitoring period.

## **2.4 SLOPE INCLINOMETER MEASUREMENTS**

Fugro monitored four slope inclinometers on a quarterly basis to measure subsurface ground deformation through June 2011. Slope inclinometer measurement plots are presented in Appendix C for each monitored inclinometer installation. Two plots for each slope inclinometer are presented. The first plot has a baseline reading from the final round of monitoring in the 2009 to 2010 monitoring year, showing any ground movement within the 2010 to 2011 monitoring year. The second plot has a baseline reading from the spring of 2005, except for SI-1A and SI-2A (as discussed below). Only readings with validated checksums<sup>1</sup> are presented.

SI-1A was installed in August 2006 and has a baseline reading from September 2006. SI-2A was installed in September of the current monitoring year with a baseline reading in

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<sup>1</sup> Checksums are a data validation technique for slope inclinometers where the "0" (downslope) and "180" (upslope) readings are summed and the theoretical result should be zero.



November 2010. Therefore, the first plot of SI-2A shows the current year readings, while the second plot shows the readings of SI-2 from 2005-2010.

Interpretation of inclinometer data along Malibu Road shows no significant movement during the 2010-2011 monitoring year except for SI-4, which showed significant movement at a depth of approximately 30 feet. There continues to be difficulty obtaining data below 28 feet in SI-4, indicating that SI-4 is expected to “shear off” in the winter of 2011. A replacement inclinometer is proposed for Fall of 2011.

Inclinometers SI-5 and SI-6 are located on Bayshore Drive, upslope and outside the defined limit of the most recent 1998 movement. No significant movement was observed during this monitoring year in SI-5 or SI-6.

### 3.0 DEWATERING FACILITY MAINTENANCE

#### 3.1 FACILITY MAINTENANCE

The operating status of each dewatering well and hydrauger was checked monthly. When necessary, repair work was scheduled and undertaken (typically within a matter of a few hours to a few days of identifying a problem). Generally, repairs and maintenance consisted of well pump and electrical repairs, and cleanout of the hydrauger system. The repairs performed are summarized on the following table:

**Table 2. Maintenance Activities**

Date	Facility	Work Performed
July 27, 2010	Hydraugers	Reconnect HD-11
August 19, 2010	Slope Inclinometer	Site cleanup from the installation of SI-2A
October 4, 2010	Hydraugers	Observe disconnected non-producing hydraugers
October 21, 2010	Hydraugers	Observe disconnected non-producing hydraugers
November 11, 2010	NW-2	NW-2: well repairs include new pump and motor
November 24, 2010	Hydraugers	Repair conveyance line between HD-21 and NHD-B
January 4, 2011	Hydraugers	Maintenance to clogged hydrauger conveyance lines; repair HD-21; stabilize conveyance line
January 7, 2011	Hydraugers	Repairs to leak
January 22, 2011	Hydraugers	Repairs to leak
March 24, 2011	Hydraugers	Repairs to HD-21
April 22, 2011	W-5	New control box

#### 3.2 CAPITAL IMPROVEMENT PROJECTS

A replacement inclinometer, SI-2A, was installed during the first quarter of the 2010-2011 monitoring year to replace SI-2, which was sheared off during the previous monitoring

year. A replacement inclinometer is proposed for the first quarter of the 2010-2011 monitoring year to replace SI-4, which has become difficult to read below approximately 30 feet, or SI-3, which was sheared off during the 2004 to 2005 monitoring year.

## **4.0 SUMMARY AND CONCLUSIONS**

### **4.1 SUMMARY**

The status of the Malibu Road Landslide Assessment District can be summarized as follows:

- The 2010-2011 monitoring year had above average rainfall with 24.16 inches recorded in Malibu. Rainfall during the rainfall season was above the historical average.
- Groundwater levels in the assessment district area were below normal levels, except for W-2A, W-3A, and PZ-E.
- Readings for the four slope inclinometers show no significant movement during the 2010 to 2011 monitoring year, except for SI-4, which continues to be difficult to read below approximately 30 feet. A new inclinometer is proposed for 2010-2011 to replace SI-3 or SI-4 on Malibu Road`.
- Installed replacement inclinometer SI-2A during first quarter of monitoring year.
- Water conservation is encouraged throughout the Malibu Road area to reduce future groundwater level increases. Control of ground water levels within the landslide area is critical to maintaining the stability of the landslides. The following are suggested:
  1. Rain Gutters - Installation and Maintenance.
  2. Limit Irrigation.
  3. Use of low-flow toilet and plumbing fixtures.
- Groundwater production from existing dewatering wells and hydraugers should be expected to gradually decline over time as the efficiency of the wells and hydraugers decrease due to mineralization and aging of the facilities.

## 5.0 REFERENCES

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- \_\_\_\_\_ (2003), "Annual Observation & Maintenance Report for the Period July 2002 to June 2003, Malibu Road, Malibu, California," dated October.



David Taussig & Associated, Inc. (2009), "Annual Assessment District No. 98-3 (Malibu Road) FY 2009-2010," dated June 8.

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\_\_\_\_\_ (2007), "Annual Assessment District No. 98-3 (Malibu Road) FY 2006-07," dated June 25.

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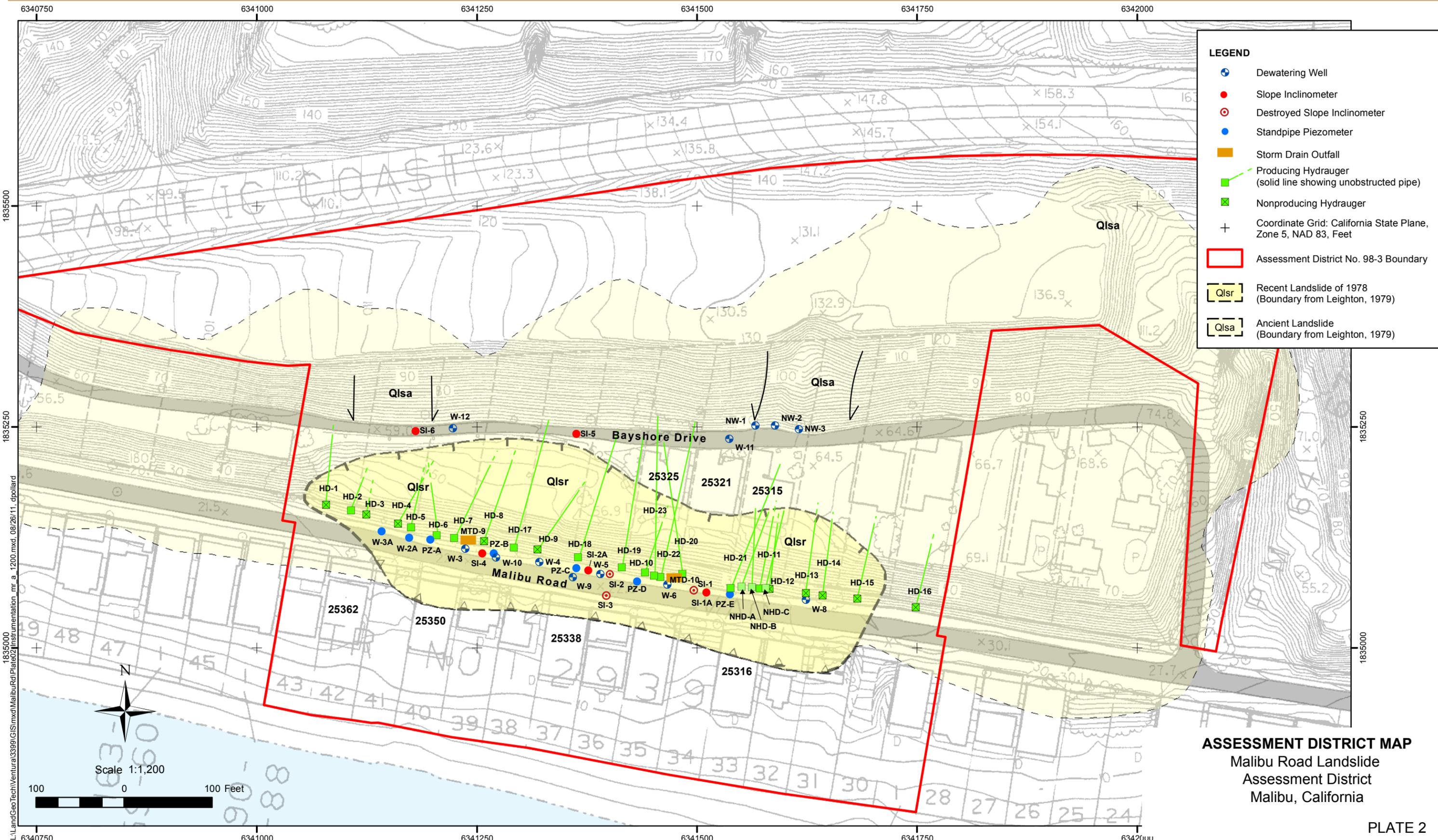
## PLATES



BASE MAP SOURCE: USGS 1:100,000-scale Metric Topographic Map of Los Angeles, California (1979).

**SITE LOCATION MAP**  
Malibu Road Landslide Assessment District  
Malibu, California

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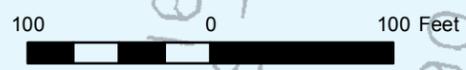
**LEGEND**

- ⊕ Dewatering Well
- Slope Inclinometer
- ⊙ Destroyed Slope Inclinometer
- Standpipe Piezometer
- Storm Drain Outfall
- Producing Hydrauger (solid line showing unobstructed pipe)
- - - Nonproducing Hydrauger
- + Coordinate Grid: California State Plane, Zone 5, NAD 83, Feet
- Assessment District No. 98-3 Boundary
- Qlsr Recent Landslide of 1978 (Boundary from Leighton, 1979)
- Qlsa Ancient Landslide (Boundary from Leighton, 1979)

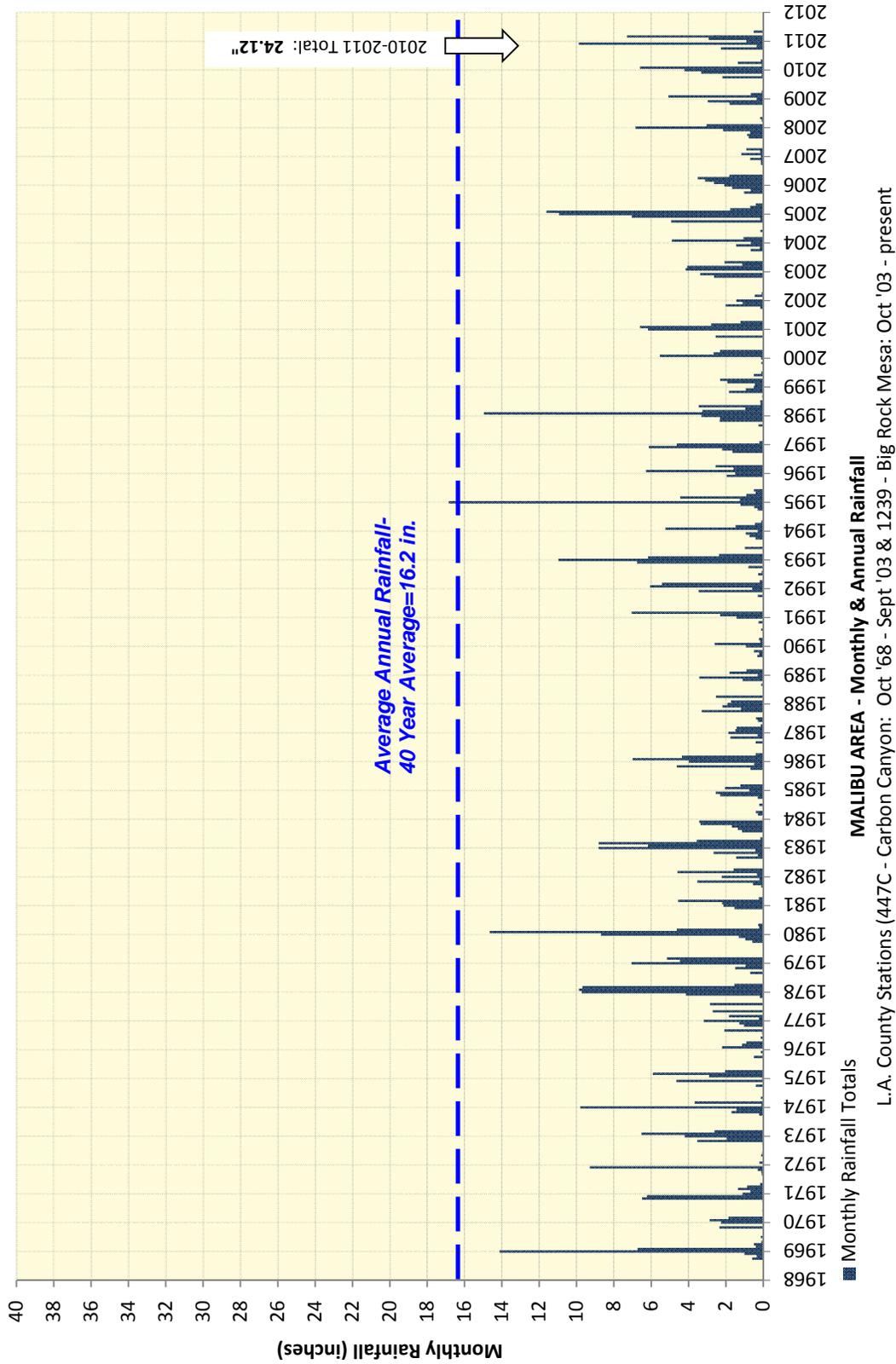
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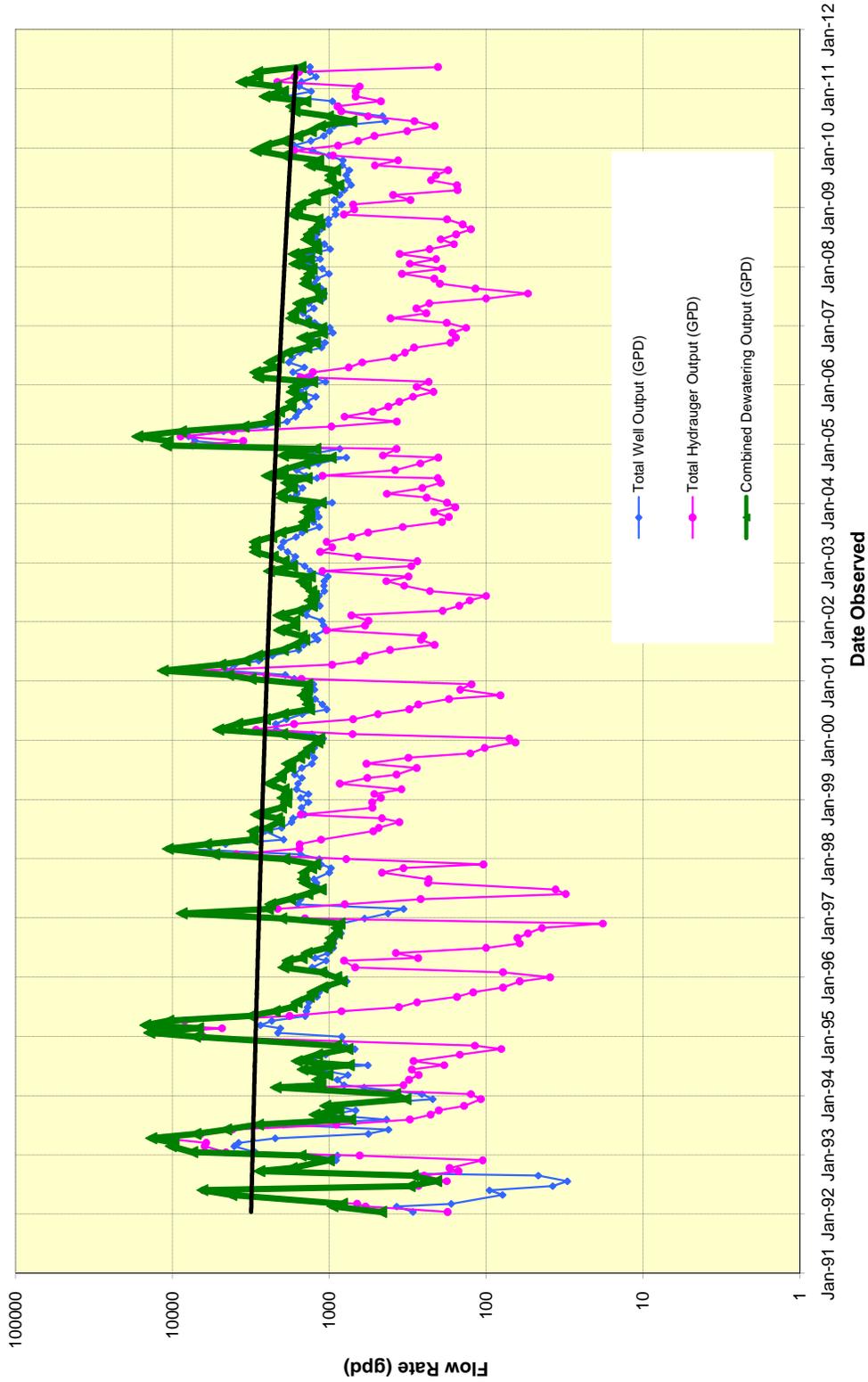
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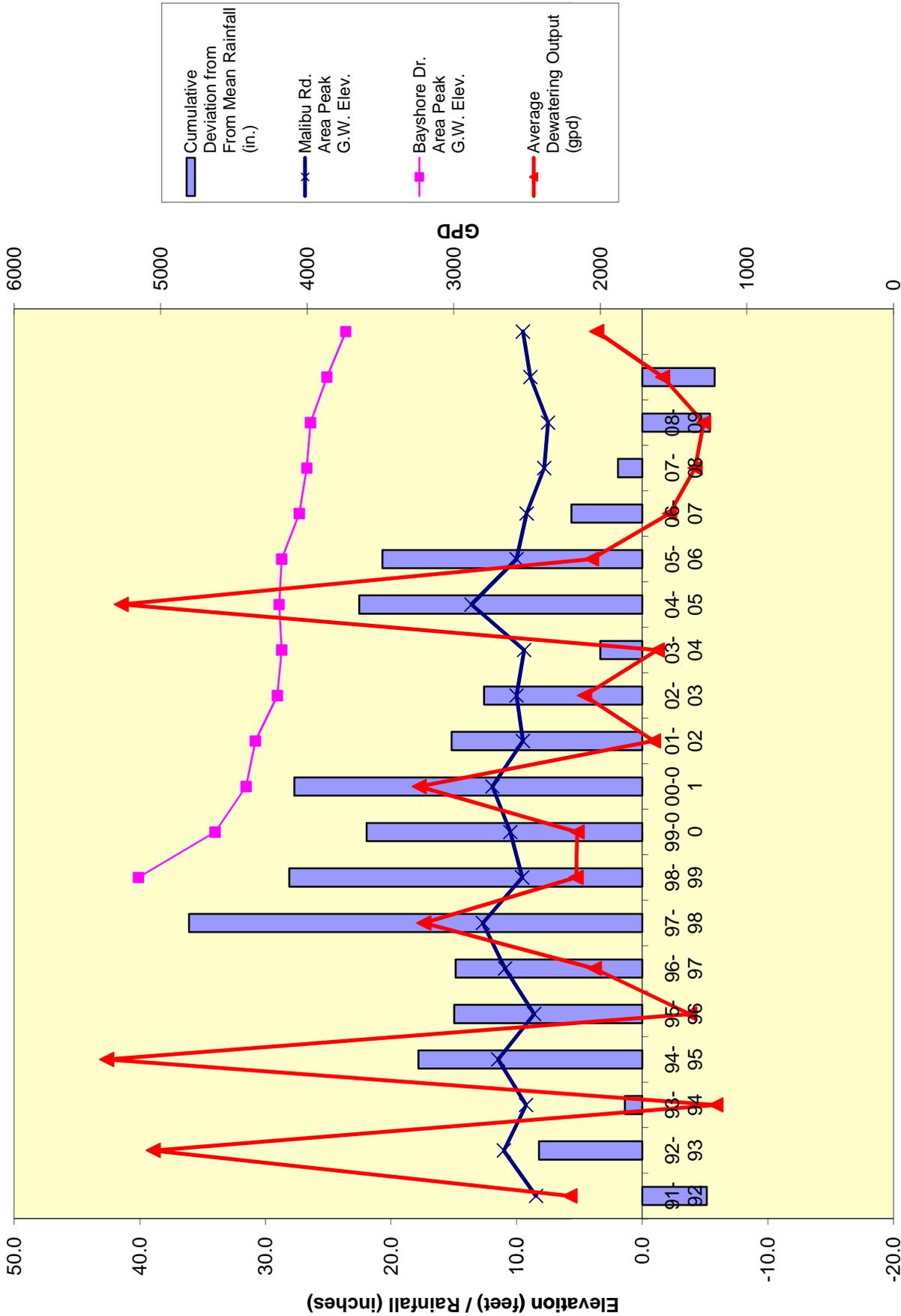
**ASSESSMENT DISTRICT MAP**  
Malibu Road Landslide  
Assessment District  
Malibu, California



**RAINFALL GRAPH**  
Malibu Road Landslide Assessment District  
Malibu, California



**DEWATERING GRAPH**  
Malibu Road  
(Total Output - All Wells & Hydraugers)



\* Graph shows the average of the highest groundwater elevations recorded in each well/piezometer during the monitoring period..

**SUMMARY GRAPH**  
**Groundwater Levels, Dewatering, & Rainfall**

**APPENDIX A  
GROUNDWATER DATA**



<b>MALIBU ROAD - Standpipe Piezometer Information</b>					
<b>Well Identification</b>	<b>Previous Reference Elevation (8/91)</b>	<b>Updated Reference Elevation (4/00)</b>	<b>Depth (ft.)*</b>	<b>Perforation Interval</b>	<b>Installed By</b>
W-2A	22.6	20.6	9.0	Unknown	LA COUNTY
W-3A	22.0	20.5	32.5	Unknown	LA COUNTY
PZ-A	20.0	19.8	17.2	Unknown	LA COUNTY
PZ-B	20.0	19.1	27.9	Unknown	LA COUNTY
PZ-C	20.0	19.4	29.7	Unknown	LA COUNTY
PZ-D	20.0	19.2	24.7	Unknown	LA COUNTY
PZ-E	20.0	21.4	15.8	Unknown	LA COUNTY
SI-5 <sup>+</sup>	59.0	59.3	78.0	-19.0 to -14.0	BYA
SI-6 <sup>++</sup>	57.0	58.0	78.0	-21.0 to -16.0	BYA

Note: + Formerly designated as MR-5  
 ++ Formerly designated as MR-6

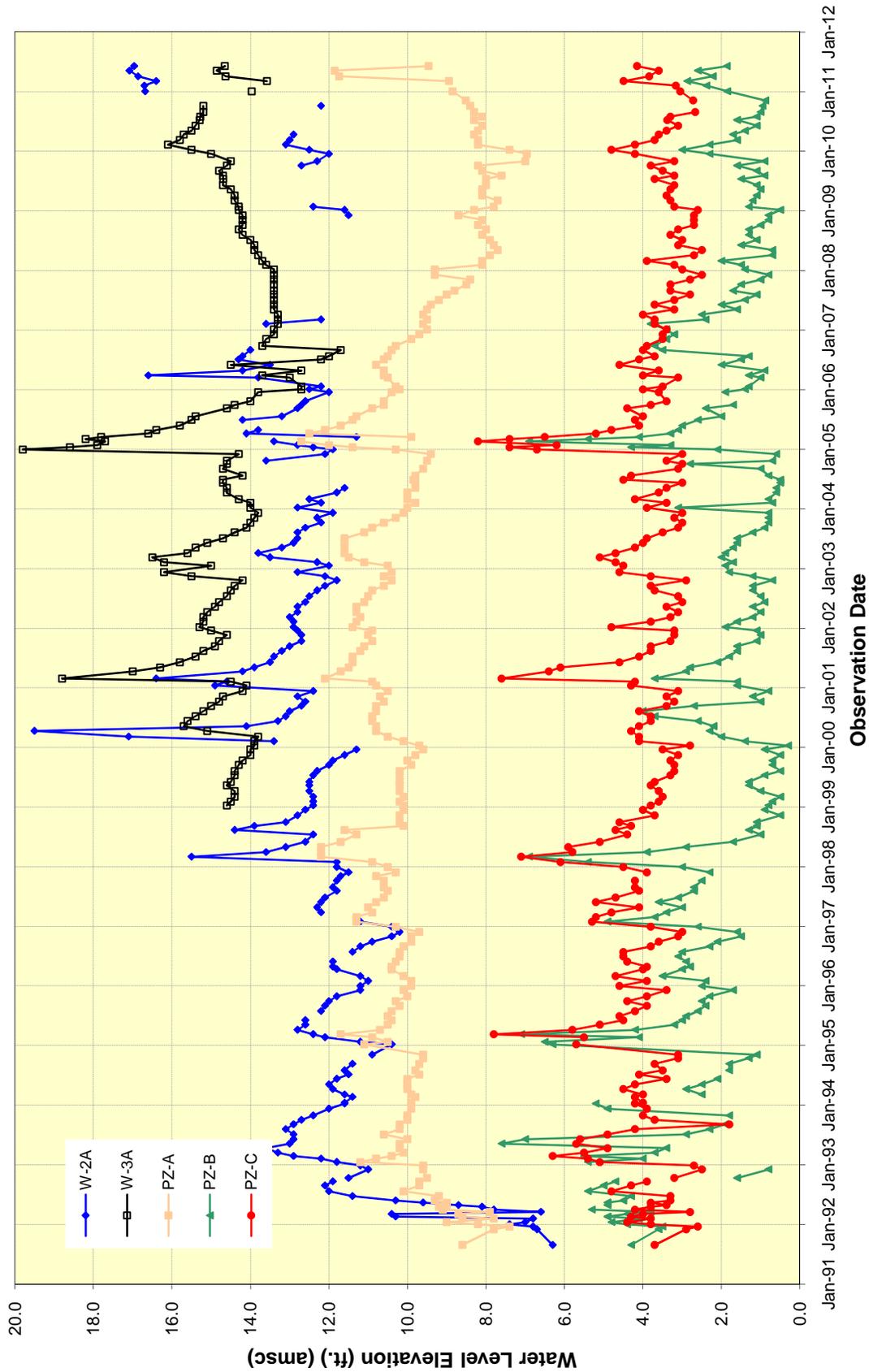
<b>MALIBU ROAD - Pneumatic Piezometer Information</b>					
<b>Well Identification</b>	<b>Previous Reference Elevation (8/91)</b>	<b>Updated Reference Elevation (4/00)</b>	<b>Tip Depth (ft.)</b>	<b>Tip Elev (ft.)</b>	<b>Installed By</b>
SI-1	20.0	20.1	34.6	-14.6	BYA
SI-2	20.0	19.7	65.1	-45.1	BYA
SI-3	20.0	20.3	49.8	-29.8	BYA
SI-4	22.0	18.9	43.9	-21.9	BYA
SI-5 Tip 1	59.0	59.3	60	-1	BYA
SI-5 Tip 2	59.0	59.3	40	19	BYA
SI-6 Tip 1	57.0	58.0	60	-3	BYA
SI-6 Tip 2	57.0	58.0	40	17	BYA
SI-1A	20.0	20.0	50		FUGRO

Note: SI-1 thru SI-4 were previously designated MR98-1 thru MR98-4  
 SI-5 and SI-6 were previously designated MR-5 and MR-6

**PIEZOMETER INFORMATION**  
 Malibu Landslide Assessment District  
 Malibu, California

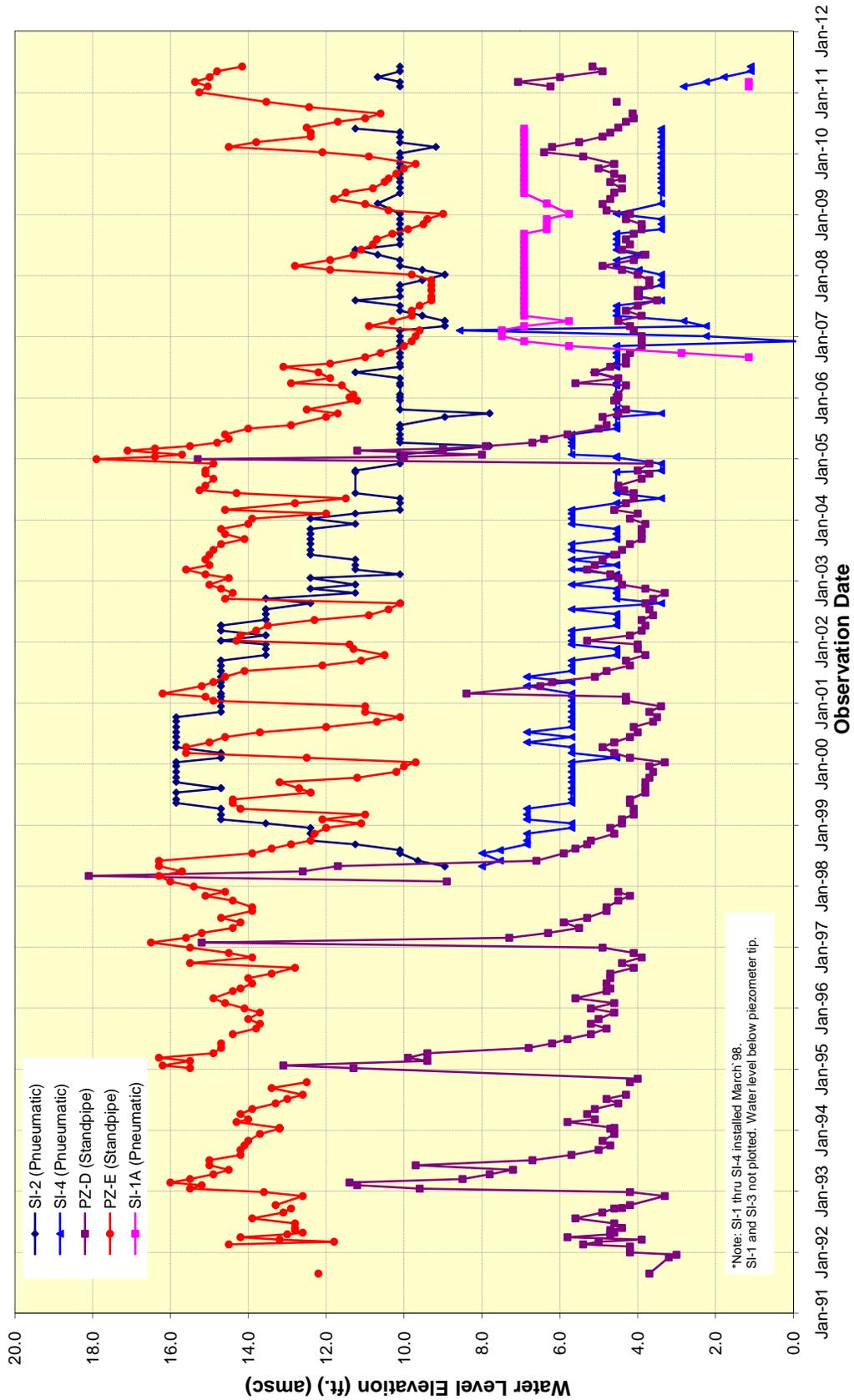


MALIBU ROAD - SUMMARY OF GROUNDWATER DATA																										
Piezometer I.D.	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	Highest Recorded	Mean '91-'11	Stand Dev.	10-11 vs 97-98	10-11 vs mean	
<b>MALIBU ROAD - Standpipe Piezometers</b>																										
W-2A	8.3	12.3	12.1	11.8	11.7	11.2	12.4	12.8	13.5	13.7	12.9	12.6	12.3	12.8	13.4	13.7	--	--	--	--	Apr-00	12.3	1.3	--	--	
Highest El.	11.4	13.6	13.1	12.8	12.2	12.3	15.5	14.4	19.5	16.4	13.4	13.8	12.8	14.1	16.6	14.3	--	--	--	--	19.5	14.1	2.0	--	--	
Mean El.								14.5	14.4	15.5	15.0	15.3	14.3	16.4	13.9	13.1	13.6	14.3	15.2	14.7	19.5	14.6	0.9		0.1	
Highest El.								14.6	15.7	18.8	15.4	16.5	14.7	19.8	15.5	13.7	13.9	14.7	16.1	15.3	19.8	15.7	1.8		-0.5	
PZ-A	8.6	10.1	10.0	10.4	10.2	10.5	11.1	10.4	10.2	11.2	11.0	10.3	10.8	10.7	9.9	8.5	8.1	7.9	9.2	10.0	10.0	10.0	1.0	1.0	-1.8	-0.8
Highest El.	9.3	11.2	10.6	11.7	10.5	11.3	12.2	11.6	10.9	12.1	11.4	11.6	11.6	12.7	11.4	10.6	9.3	8.7	8.3	11.9	12.7	10.9	1.2	1.2	-0.4	0.9
Mean El.	4.4	4.5	2.9	3.7	2.6	2.9	3.4	1.0	1.3	2.3	1.3	1.5	1.0	2.8	1.7	2.7	1.3	1.0	1.6	1.8	2.3	2.3	1.1	1.1	-1.6	-0.5
Highest El.	5.3	7.6	5.2	7.1	3.5	4.9	6.9	1.3	2.6	4.0	1.9	2.0	3.1	6.9	2.6	3.8	2.0	1.3	3.0	2.9	7.6	3.9	2.0	2.0	-4.0	-1.0
PZ-C	3.6	4.6	3.9	4.7	4.2	4.2	5.1	4.0	3.6	4.5	3.6	4.1	3.4	5.2	3.9	3.7	3.0	3.0	3.7	3.4	Mar-05	4.0	0.6	1.4	-1.6	-0.5
Highest El.	4.4	6.3	4.9	7.8	4.7	5.3	7.1	4.7	4.3	7.6	4.8	5.1	4.2	8.2	4.6	4.1	3.9	3.4	4.8	4.5	8.2	5.2	1.4	1.4	-2.6	-0.7
PZ-D	4.4	6.9	5.1	7.6	5.0	5.9	7.8	4.7	4.0	4.8	4.2	4.3	4.1	7.0	4.7	4.2	4.0	4.4	5.1	5.2	Mar-98	5.2	1.2	1.2	-2.7	0.0
Highest El.	5.8	11.4	6.7	13.1	5.8	15.2	18.1	5.9	4.9	8.4	5.3	5.3	4.6	15.3	5.6	4.7	4.9	4.9	6.4	7.1	18.1	8.0	4.2	4.2	-1.0	-0.9
PZ-E	13.0	14.3	13.9	14.5	14.2	14.6	15.2	12.8	12.7	13.3	12.5	14.1	13.8	15.6	12.1	10.5	10.4	11.6	13.5	15.5	Jan-05	13.2	7.5	7.5	-1.7	0.4
Highest El.	14.5	16.0	15.0	16.3	14.9	16.5	16.3	14.4	15.6	16.2	14.3	15.6	14.9	17.9	14.0	13.1	12.8	11.8	14.5	15.4	17.9	15.0	1.4	1.4	-0.9	0.4
Area Average	7.0	8.8	8.0	8.8	8.0	8.2	9.2	8.6	8.5	9.3	8.7	9.0	8.5	10.1	8.6	8.2	6.8	6.9	7.5	8.0		8.3	0.8	0.8	-0.4	-0.4
Highest El.	8.5	11.0	9.3	11.5	8.6	10.9	12.7	9.6	10.5	11.9	9.5	10.0	9.4	13.6	10.0	9.2	7.8	7.5	8.9	9.5		10.0	1.6	1.6	-0.4	-0.5
Change vs Prior	1.7	-0.8	0.8	-0.8	0.3	0.9	-0.6	-0.1	0.8	-0.6	0.3	-0.5	1.6	-1.5	-0.4	-1.4	-0.4	0.1	0.6	0.5						
Highest El.	2.6	-1.8	2.2	-2.9	2.3	1.8	-3.1	0.9	1.4	-2.4	0.5	-0.6	4.1	-3.5	-0.9	-1.4	-0.3	1.4	0.6							
<b>Bayshore Drive - Standpipe Piezometers</b>																										
SI-5								35.5	32.2	30.7	30.1	29.3	29.0	28.6	28.2	27.8	27.3	26.3	22.6	18.8	Nov-98	28.2	4.2	4.2	-9.4	-9.4
Highest El.								37.8	33.4	31.2	30.4	29.7	29.2	29.0	28.4	28.0	27.5	27.0	24.3	20.5	37.8	29.0	4.1	4.1	-8.4	-8.4
Mean El.								38.8	32.6	31.2	29.9	27.9	27.7	27.2	27.9	26.0	25.7	25.4	25.3	26.1	Nov-98	28.6	3.8	3.8	-2.5	-2.5
Highest El.								42.4	34.6	31.9	31.2	28.4	28.2	28.8	29.0	26.5	25.9	25.7	25.8	26.7	42.4	29.6	4.7	4.7	-3.0	-3.0
Area Average								37.2	32.0	31.0	30.0	28.6	28.3	27.9	28.0	26.5	26.5	25.8	23.9	22.4		28.4	3.8	3.8	-6.0	-6.0
Highest El.								40.1	34.0	31.5	30.8	29.1	28.7	28.9	28.7	27.3	26.7	26.4	25.1	23.6		29.3	4.3	4.3	-5.7	-5.7
Change vs Prior								-4.7	-1.5	-1.0	-1.3	-0.3	-0.4	0.2	-1.2	-0.4	-0.6	-1.9	-1.5							
Highest El.								-6.1	-2.5	-0.7	-1.8	-0.4	0.2	-0.2	-0.2	-1.5	-0.6	-0.3	-1.3	-1.5						
<b>MALIBU ROAD - Pneumatic Piezometers</b>																										
Piezometer Not Functioning																										
SI-1																										
SI-1A																										
Mean El.																										
Highest El.																										
SI-2																										
Mean El.																										
Highest El.																										
SI-3																										
Mean El.																										
Highest El.																										
SI-4																										
Mean El.																										
Highest El.																										
<b>Bayshore Drive - Pneumatic Piezometers</b>																										
Piezometer Not Functioning																										
SI-5 Tip 1																										
Mean El.																										
Highest El.																										
SI-5 Tip 2																										
Mean El.																										
Highest El.																										
SI-6 Tip 1																										
Mean El.																										
Highest El.																										
SI-6 Tip 2																										
Mean El.																										
Highest El.																										

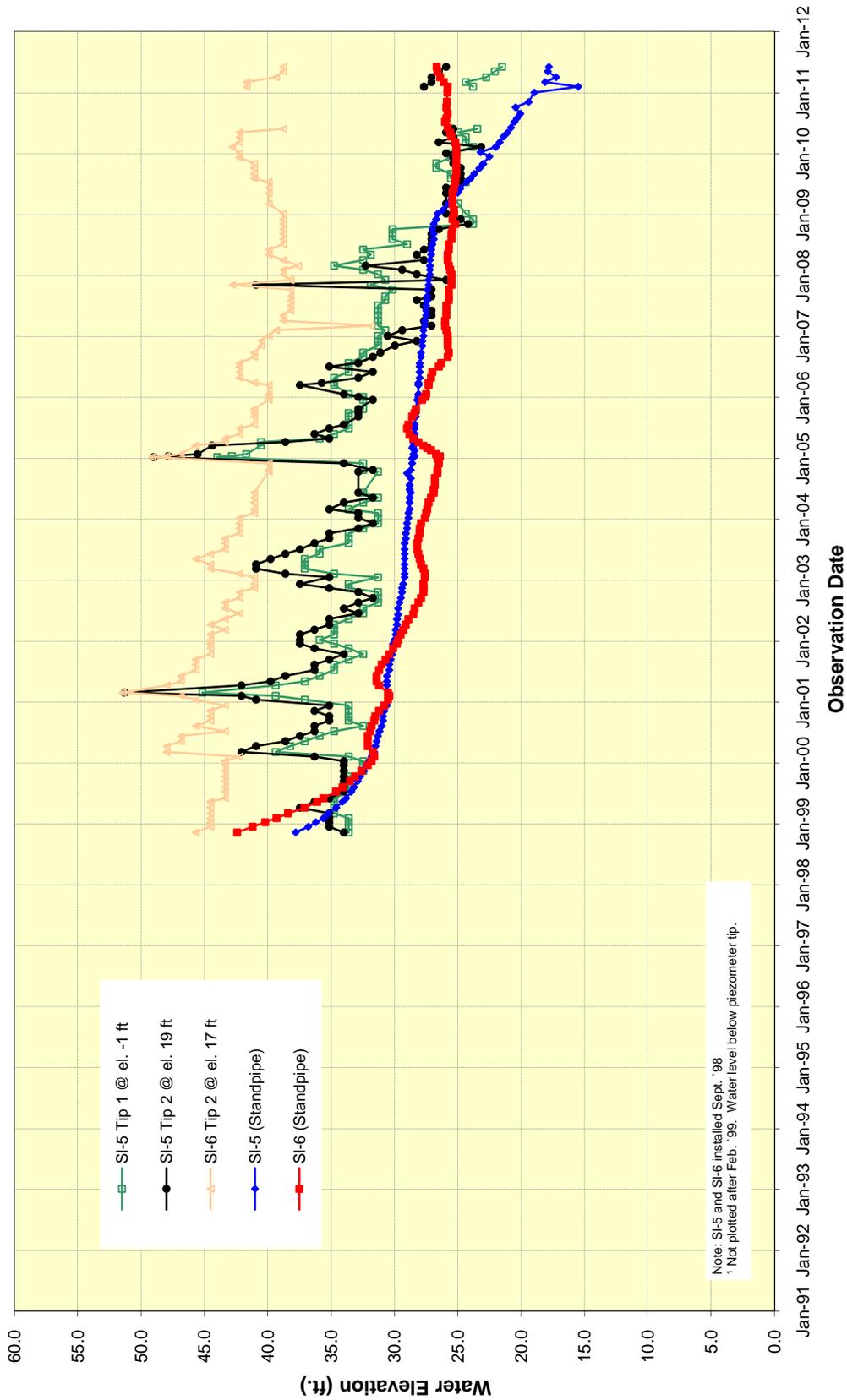


\*Note: W-3A uncovered in Jan. '99

**GROUNDWATER HYDROGRAPH**  
Malibu Road (West End)



**GROUNDWATER HYDROGRAPH**  
 Malibu Road (East End)



**GROUNDWATER HYDROGRAPH**  
Baysshore Drive

**APPENDIX B  
DEWATERING DATA**



<b>MALIBU ROAD - Dewatering Well Information</b>							
Well ID	Vault Elevation (ft.)	Bottom Elevation (ft.)	Pump Elevation (ft.)	Pump Size (hp)	2010-2011 Pumping Rate* (gpd)	% of Total Well Production	Installed By
W-3	19.5	-4.0	Unknown	1/2	307	27%	LA Co.
W-4	20.0	-9.0	Unknown	1/2	26	2%	LA Co.
W-5	19.0	-9.5	Unknown	1/2	377	33%	LA Co.
W-6	20.0	-4.5	Unknown	1/2	65	6%	LA Co.
W-8	27.5	11.0	Unknown	1/2	147	13%	LA Co.
W-9	20.0	-40.0	-35.0	1/3	9	1%	LA Co.
W-10	19.0	-40.0	-35.0	1/3	14	1%	LA Co.
W-11	61.0	1.0	13.0	1/3	34	3%	BYA
W-12	58.0	-2.0	8.0	1/3	46	4%	BYA
W-14	60.0	-20.0		1/3	58	5%	Fugro
NW-1					17	1%	Homeowner
NW-2					33	3%	Homeowner
NW-3					9	1%	Homeowner

Note: \* Average pumping rate during this monitoring period

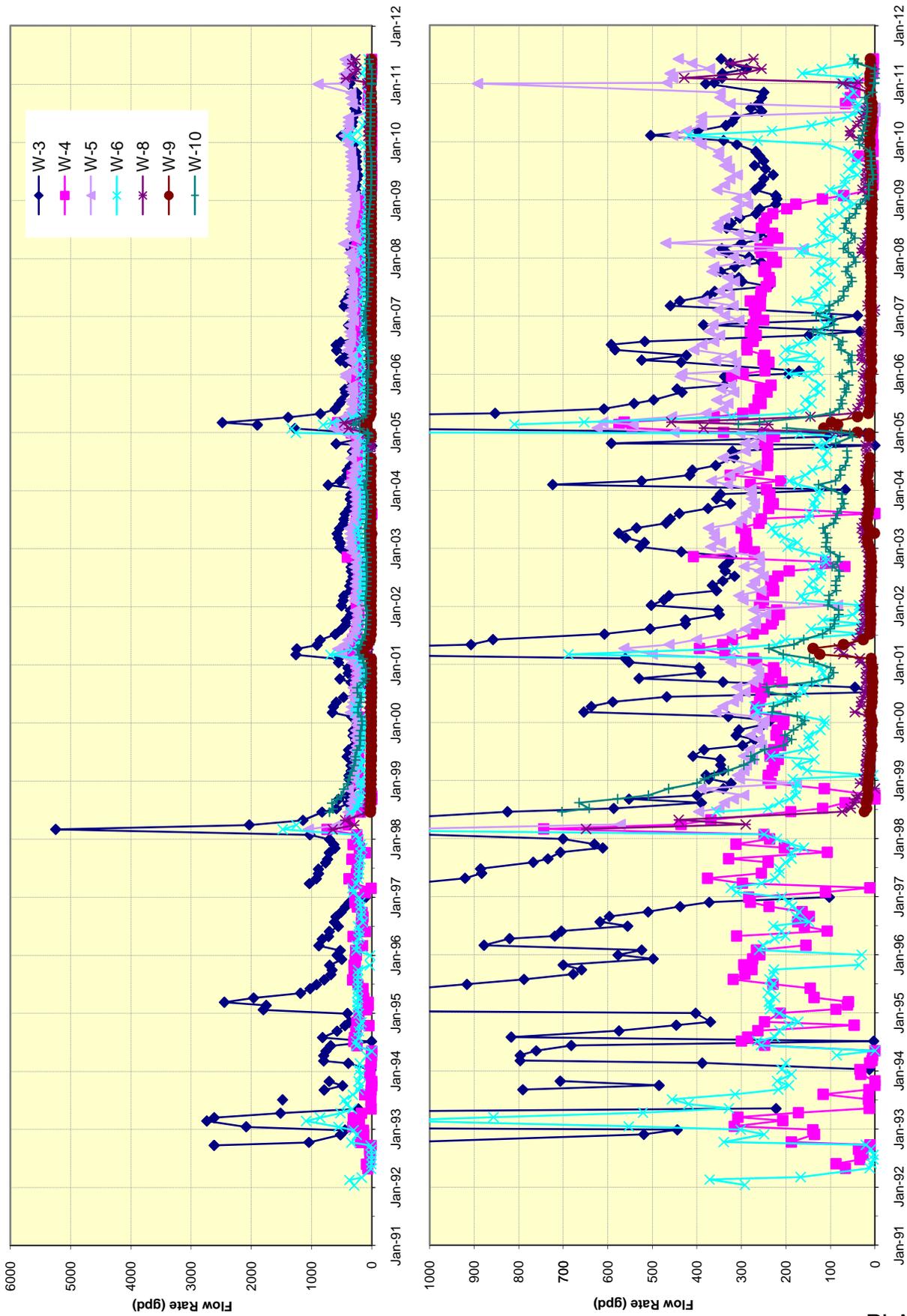
<b>MALIBU ROAD - Hydrauger Information</b>						
Hydrauger ID	Installed Length (ft.)	Bearing	Funtional Length** (ft)	2010-2011 Flow Rate* (gpd)	% of Total Production	Installed By
HD-1	Unknown	N05E	74	0.0	0%	LA Co.
HD-2	Unknown	N21E	34	0.0	0%	LA Co.
HD-3	Unknown	N06E	13	0.0	0%	LA Co.
HD-4	Unknown	N29E	53	0.0	0%	LA Co.
HD-5	Unknown	N13E	41	141.9	16%	LA Co.
HD-6	Unknown	N08W	55	0.0	0%	LA Co.
HD-7	Unknown	N26E	87	9.4	1%	LA Co.
HD-8	Unknown	N19E	92	0.0	0%	LA Co.
HD-9	Unknown	N34E	76	0.0	0%	LA Co.
HD-10	Unknown	N19E	55	0.0	0%	LA Co.
HD-11	Unknown	N11E	78	118.0	13%	LA Co.
HD-12	Unknown	N08E	70	0.0	0%	LA Co.
HD-13	Unknown	N09E	79	0.0	0%	LA Co.
HD-14	Unknown	N08E	80	0.0	0%	LA Co.
HD-15	Unknown	N14E	82	0.0	0%	LA Co.
HD-16	Unknown	N15E	69	0.0	0%	LA Co.
HD-17	150	N15E	150	208.6	23%	BYA
HD-18	150	N18E	150	106.1	12%	BYA
HD-19	150	N10E	150	1.2	0%	BYA
HD-20	150	N09W	150	122.4	14%	BYA
HD-21	150	N22E	150	26.8	3%	BYA
HD-22	180	N13E	180	90.8	10%	FugroWest
HD-23	160	N01E	160	76.6	8%	FugroWest

Note: \* Average flow rate during this monitoring period

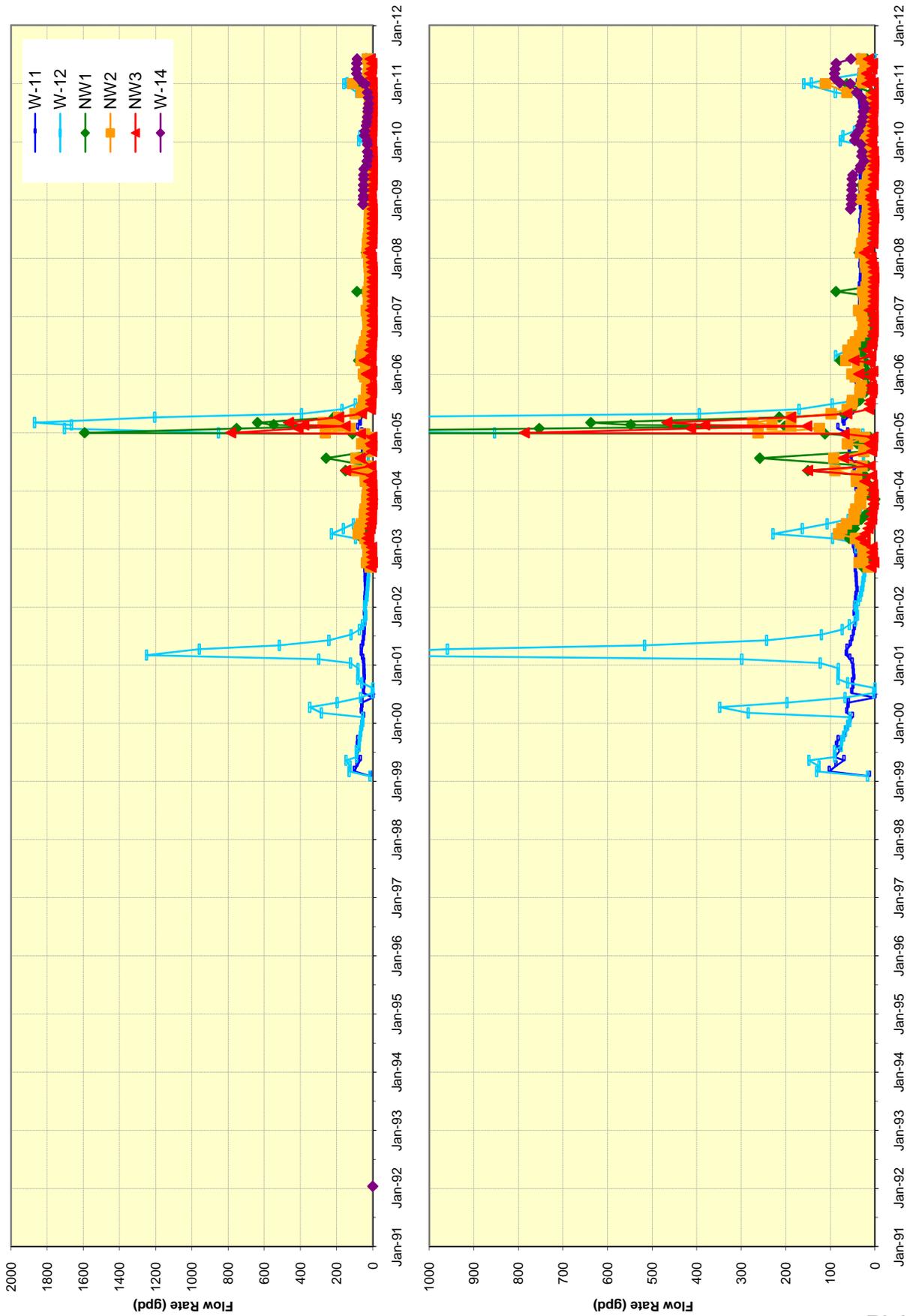
\*\* Measured on 4/1/98 (except HD-22 and HD-23 installed 1/22/05)

**DEWATERING WELL & PIEZOMETER INFORMATION**

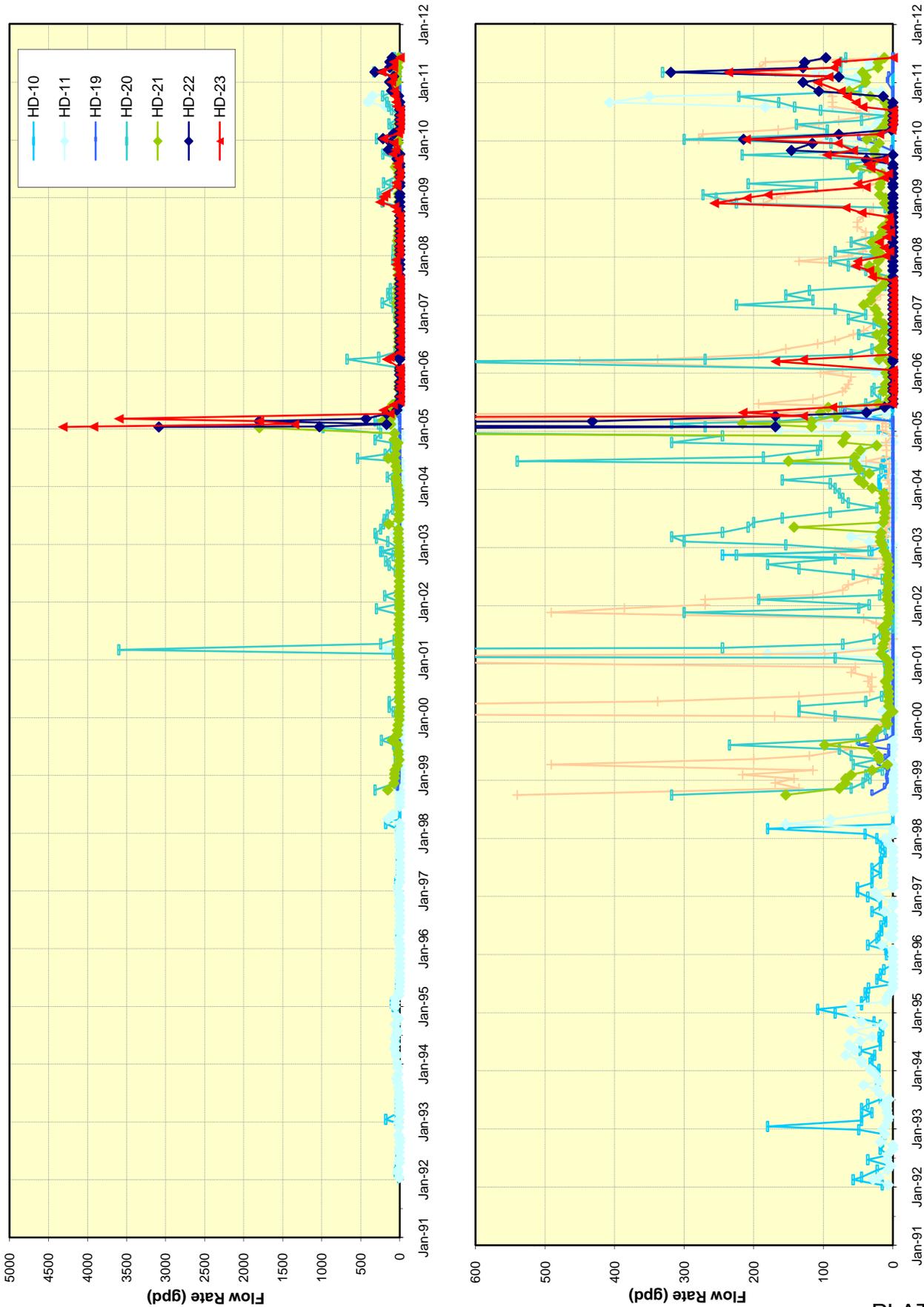
Malibu Landslide Assessment District  
Malibu, California



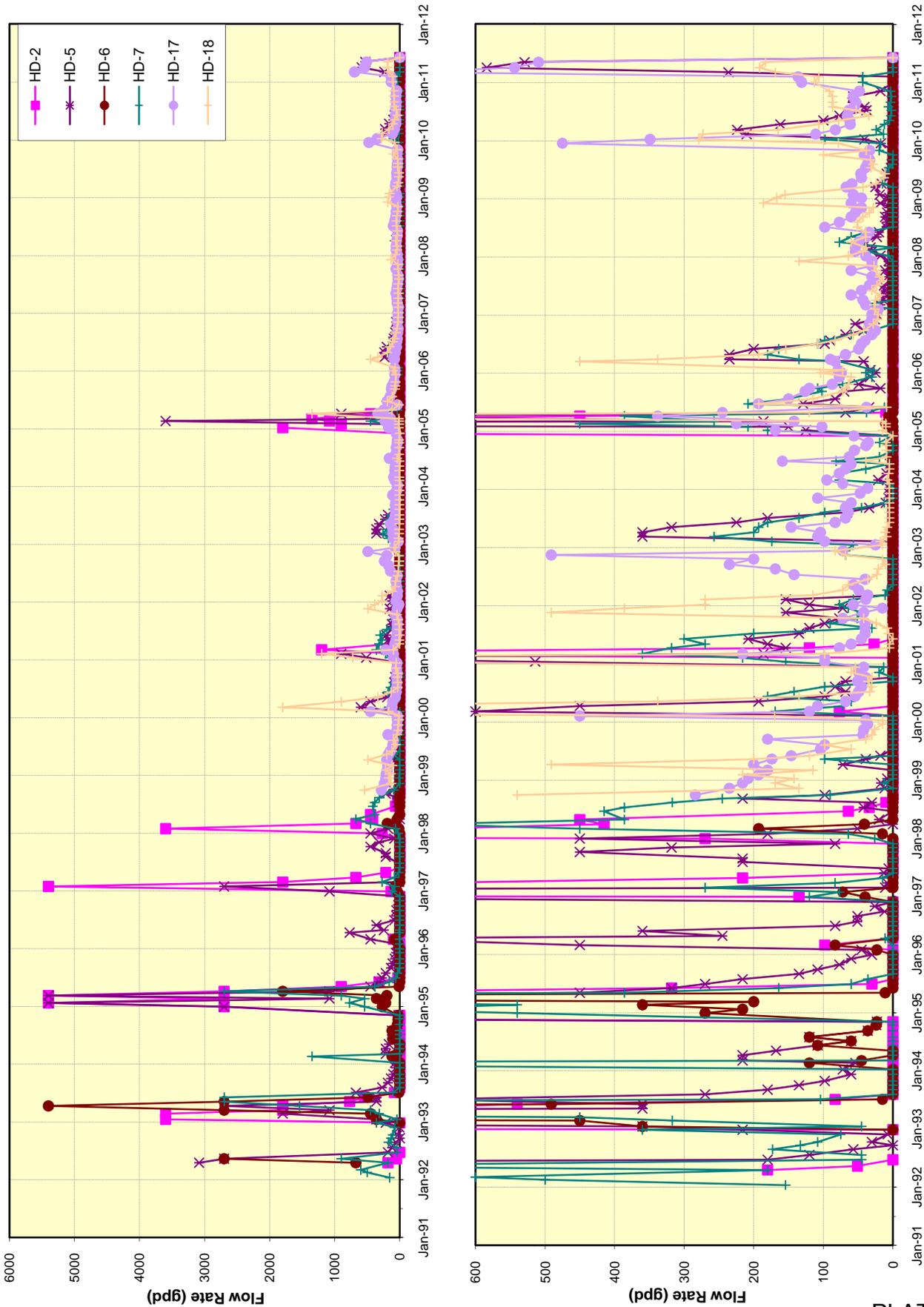
**DEWATERING WELL GRAPH**  
Discharge Rates for Malibu Road Dewatering Wells  
(Same Chart at Different Scales)



**DEWATERING WELL GRAPH**  
Discharge Rates for Bayshore Drive Dewatering Wells  
(Same Chart at Different Scales)



**HYDRAUGER GRAPH**  
Discharge Rates for all Hydraulaugers  
(Same Chart at Different Scales)



**HYDRAUGER GRAPH**  
Discharge Rates for all Hydraugers  
(Same Chart at Different Scales)

**APPENDIX C**  
**SLOPE INCLINOMETER DATA**



**MALIBU ROAD - Slope Inclinometer Interpretation Summary**

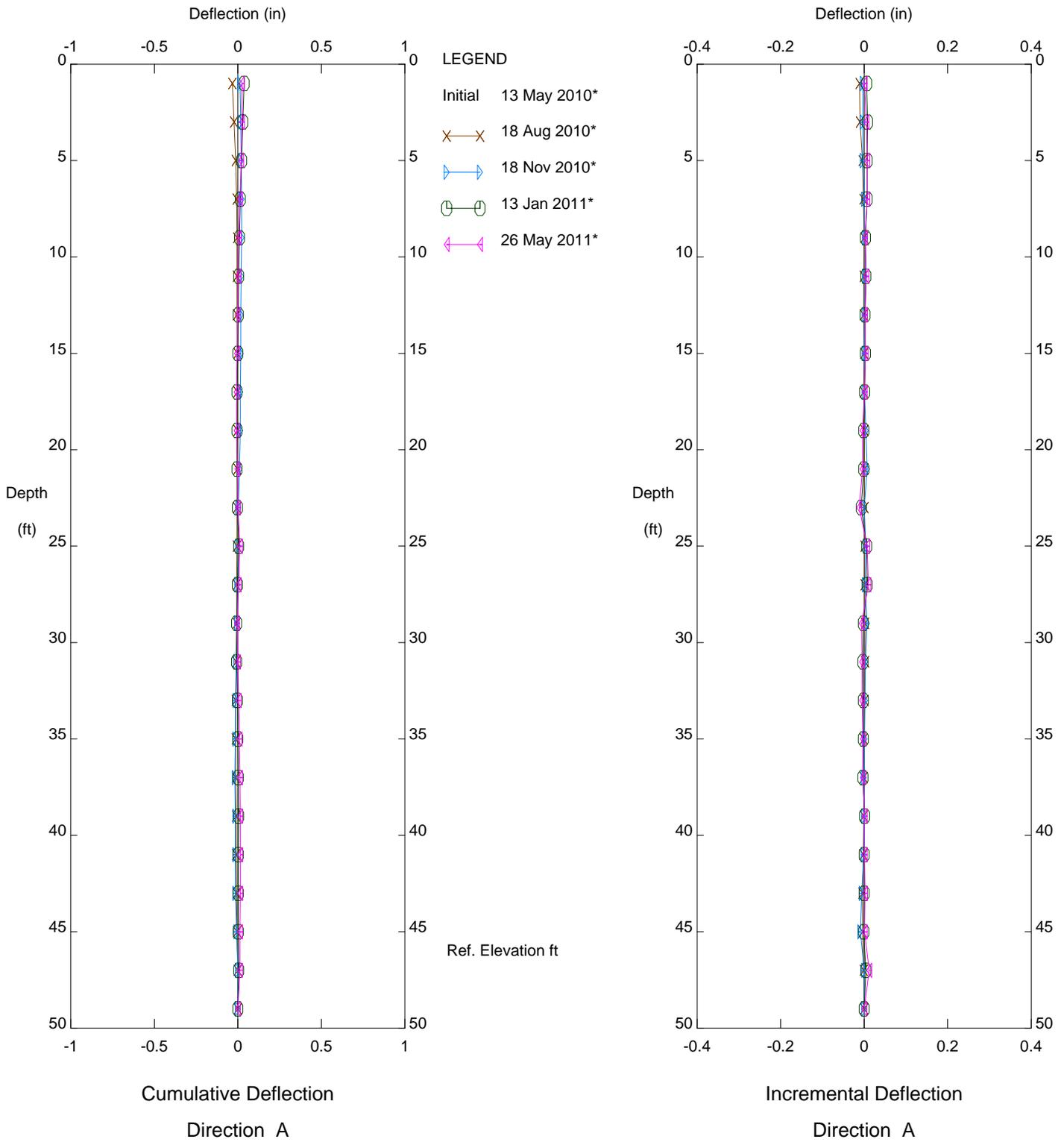
	SI-1 (MR98-1)	SI-1A	SI-2 (MR98-2)	SI-3 (MR98-3)	SI-4 (MR98-4)	SI-5	SI-6
<b>Installation Details</b>							
Previous Ref.Elev.(8/91)	20.0	20.0	20.0	20.0	22.0	59.0	57.0
Updated Ref.Elev.(4/00)	20.1	20.0	19.7	20.3	18.9	59.3	58.0
Depth (ft.)	34	50	64	49	43	78	78
Install Date	Apr-98	Aug-08	Apr-98	Apr-98	Apr-98	Apr-98	Apr-98
A+ Axis orientation (deg)	184		201	190	204	176	186
Casing	RST	SI	RST	RST	RST	SI	SI
Installer	BYA	FWI	BYA	BYA	BYA	BYA	BYA
Interpreted Rupture Depth (ft)	30-32	30-32	28-32	35-38	32-34	unknown	unknown
Reading Interval	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
<b>Interpretation Movement (inches)</b>							
2010-2011	NR	--	--	NR	0.6	--	--
2009-2010	NR	--	NR	NR	--	--	--
2008-2009	NR	--	< 0.1 *	NR	--	--	--
2007-2008	NR	--	--	NR	--	--	--
2006-2007	NR	N/A	--	NR	--	--	--
2004-2005	0.5 (3)	NA	0.4	>1(3)	0.4 to 0.5	~ 0.2 *	--
2003-2004 (1)	--	NA	--	--	--	--	--
2002-2003	~ 0.2 *	NA	~ 0.1 *	--	--	--	--
2001-2002	--	NA	--	--	--	--	--
2000-2001	0.5	NA	0.4	0.3	0.6	--	--
1999-2000	--	NA	--	--	--	--	--
1998-1999	3.1	N/A	1.5	4.1	1.3 (2)	--	--

**NOTES:**

- (1) Readings only through March 2004
- (2) Readings are through 2000, although majority of movement occurred in 1998
- (3) Inclinometer sheared off in January, 2005, no readings below slide plane
- (4) Inclinometer sheared off winter of 2009, no readings below slide plane
- NR No readings
- No clearly defined interpreted movement.
- ~ 0.05 \* Indicated displacement is less than reliable instrument accuracy. Interpreted movement is theoretical.



Fugro West, Inc. - Ventura, CA

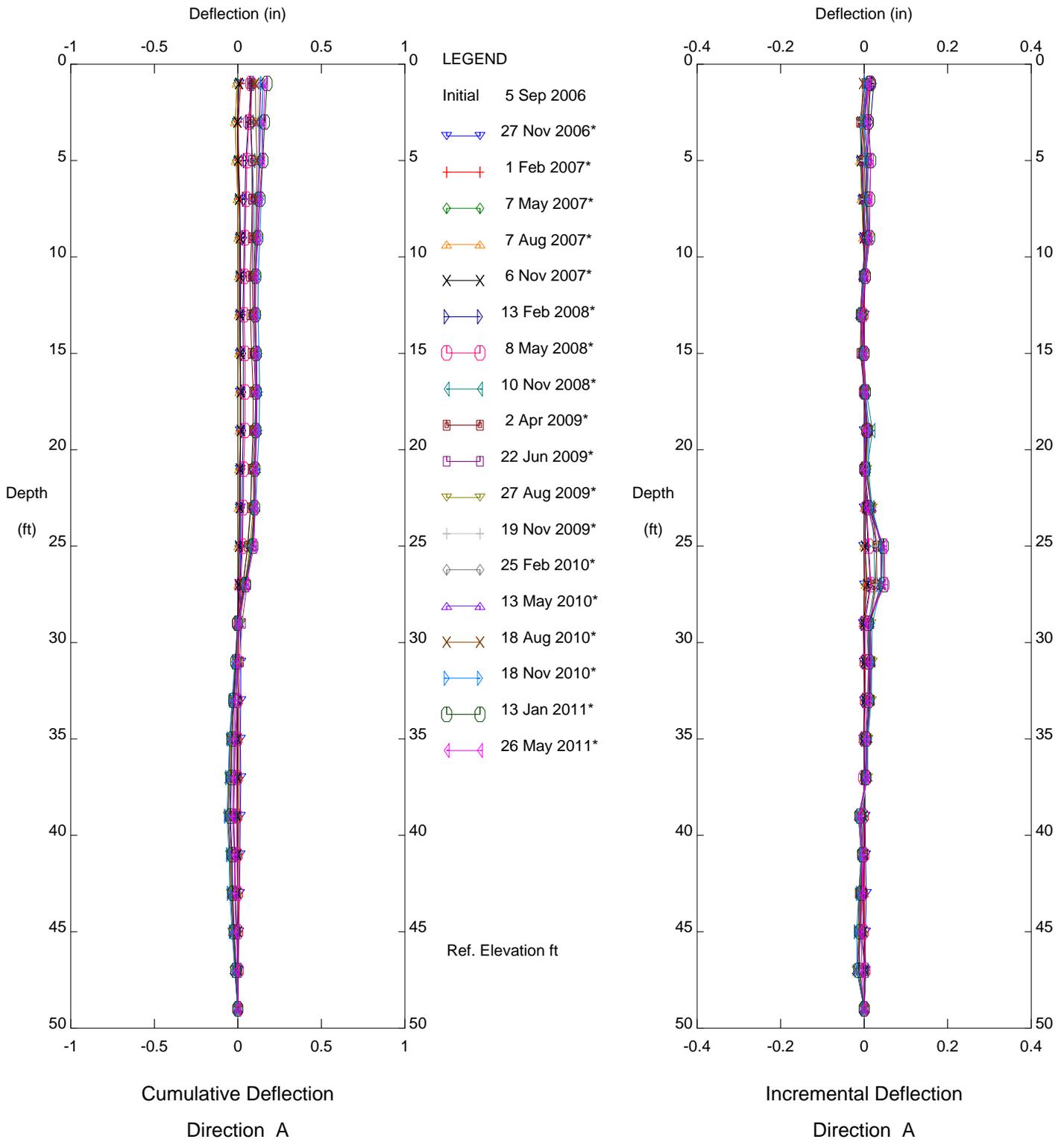


MAL-RD, Inclinometer SI1A

Sets marked \* include zero shift and/or rotation corrections.



Fugro West, Inc. - Ventura, CA

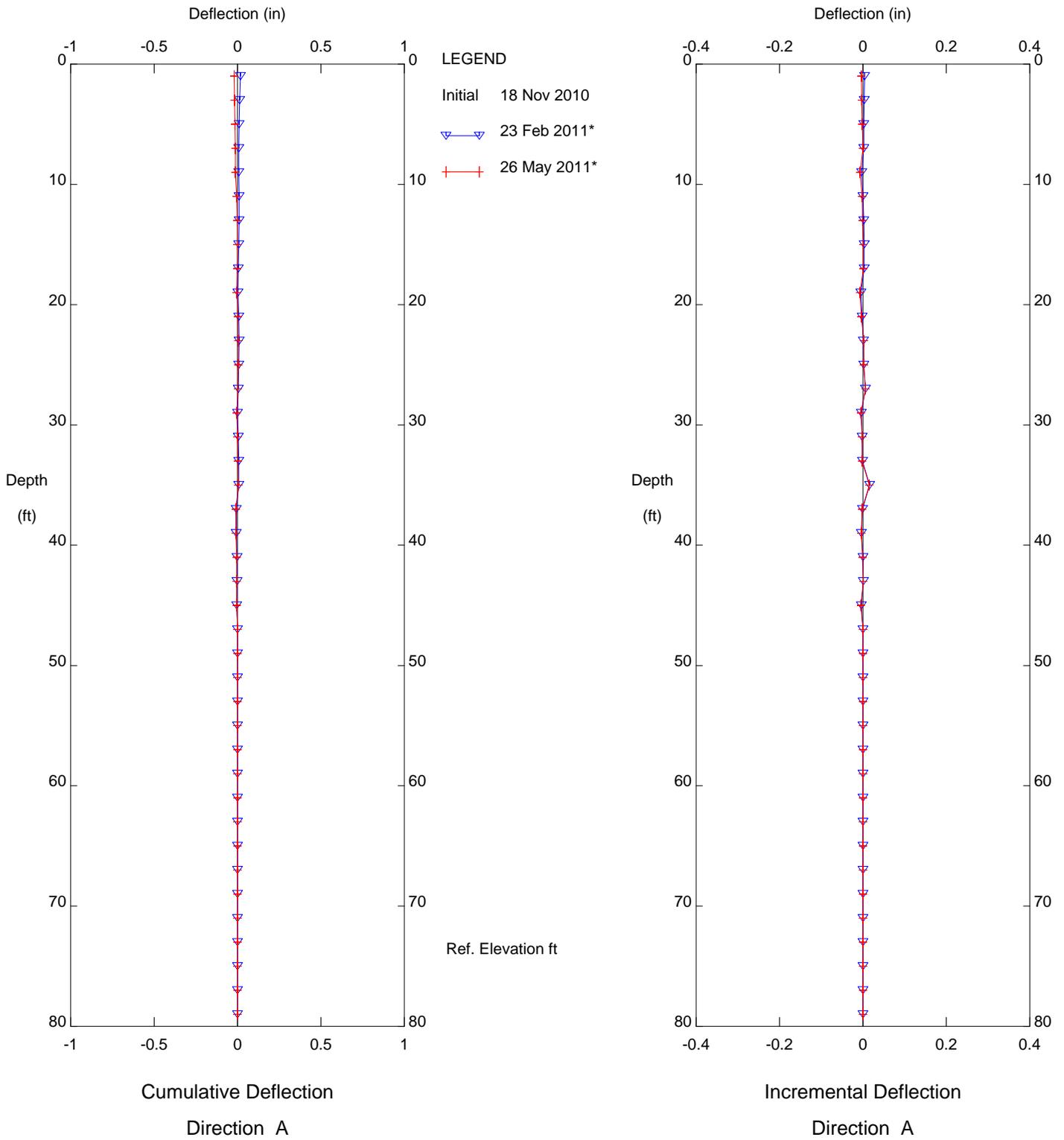


MAL-RD, Inclinometer S11A

Sets marked \* include zero shift and/or rotation corrections.



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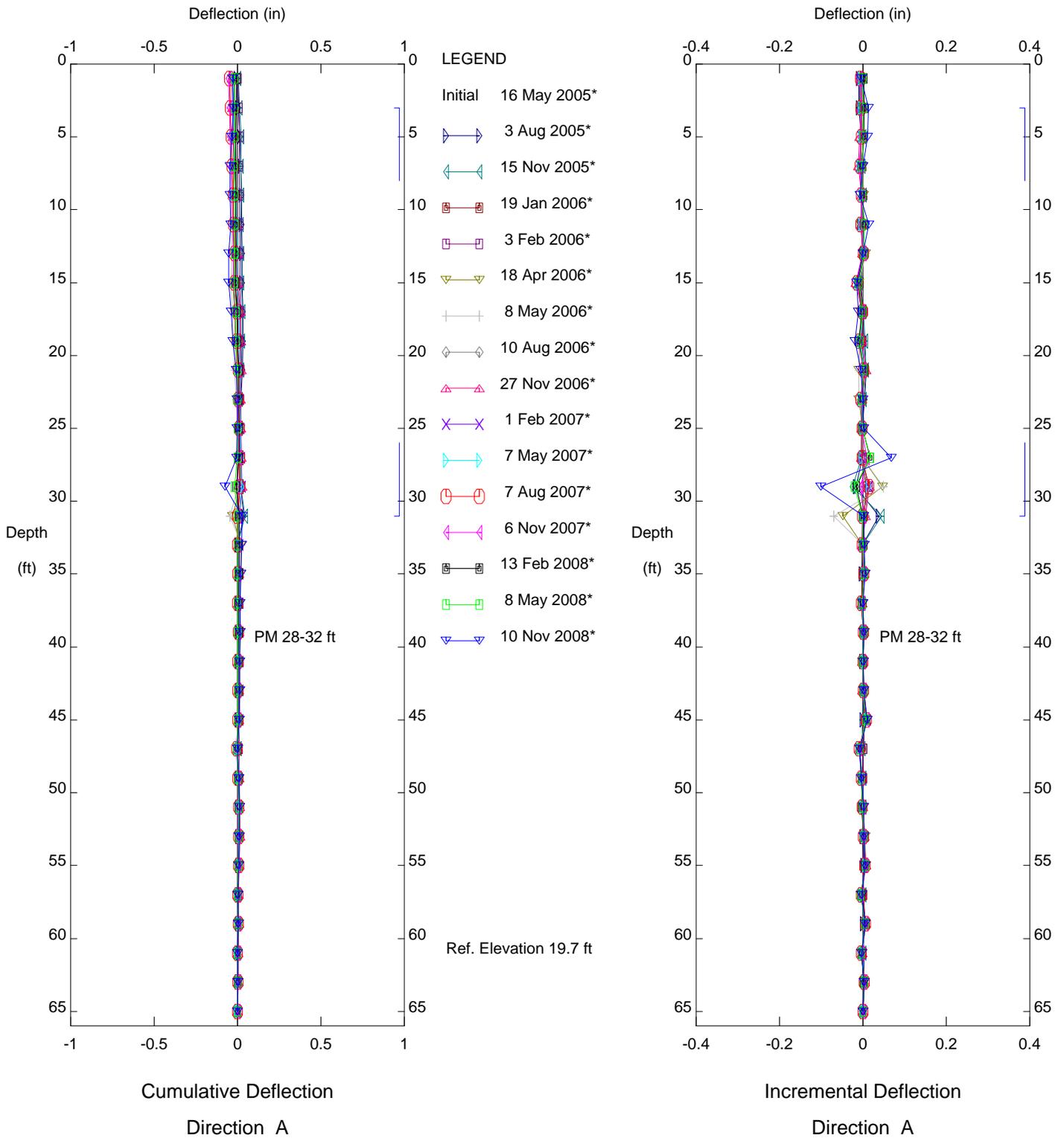
MAL-RD, Inclinator SI-2A

Depth of Readings = 50 ft

Sets marked \* include zero shift and/or rotation corrections.



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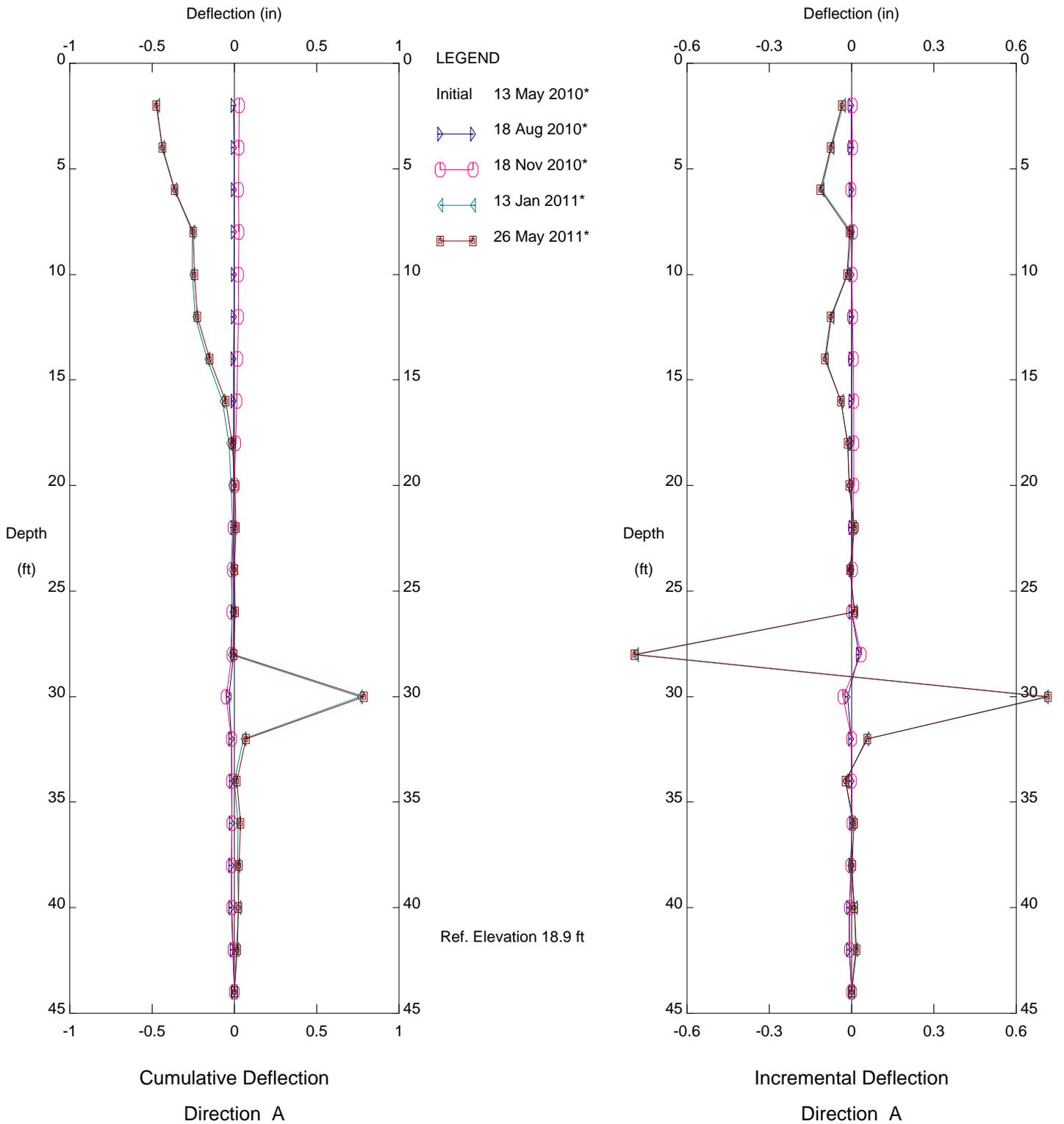
MALIBU ROAD, Inclinometer SI-2

Depth of readings = 66 ft

Sets marked \* include zero shift and/or rotation corrections.



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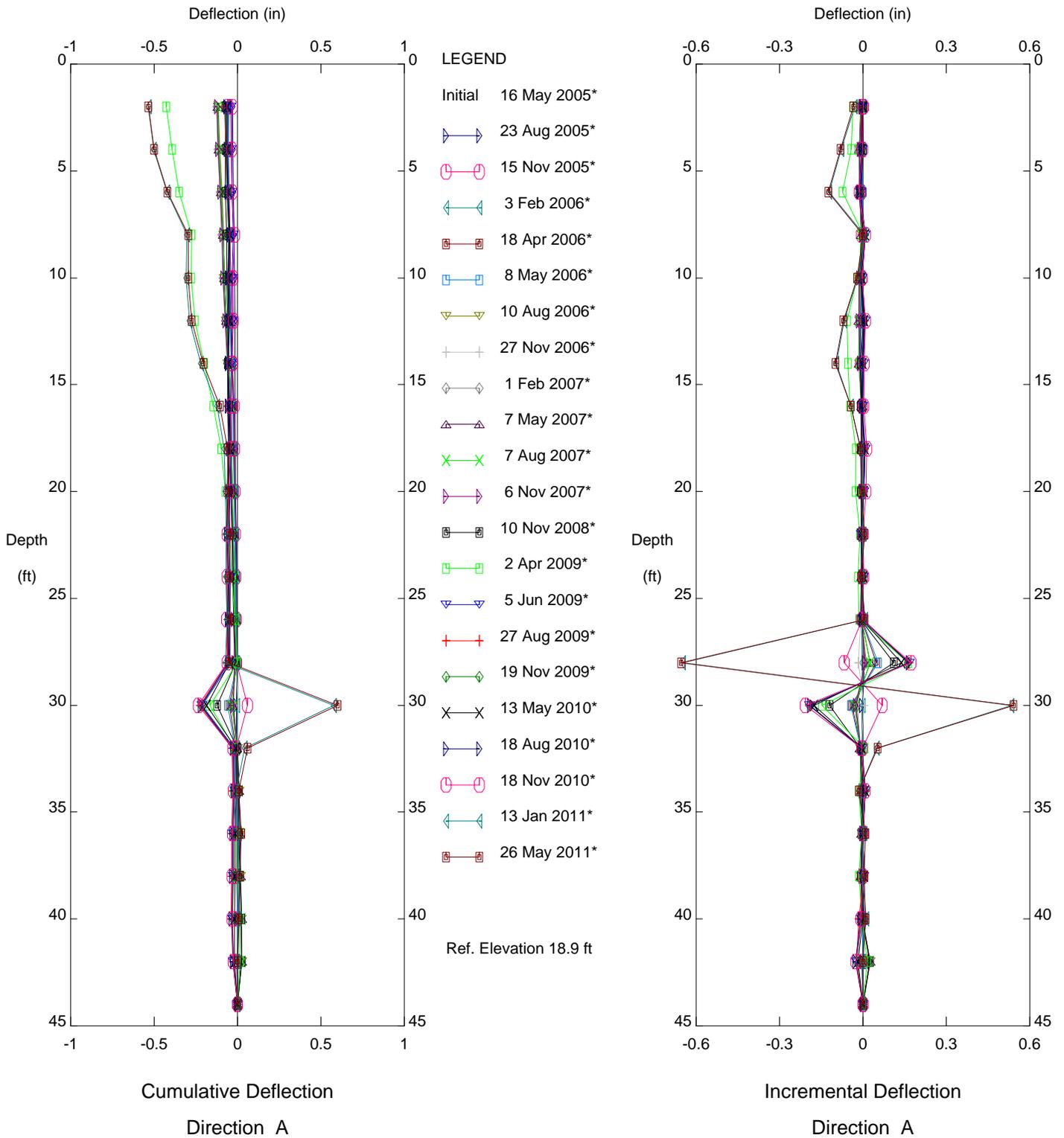
MALIBU ROAD, Inclinometer SI-4

Depth of readings = 41 ft

Sets marked \* include zero shift and/or rotation corrections.



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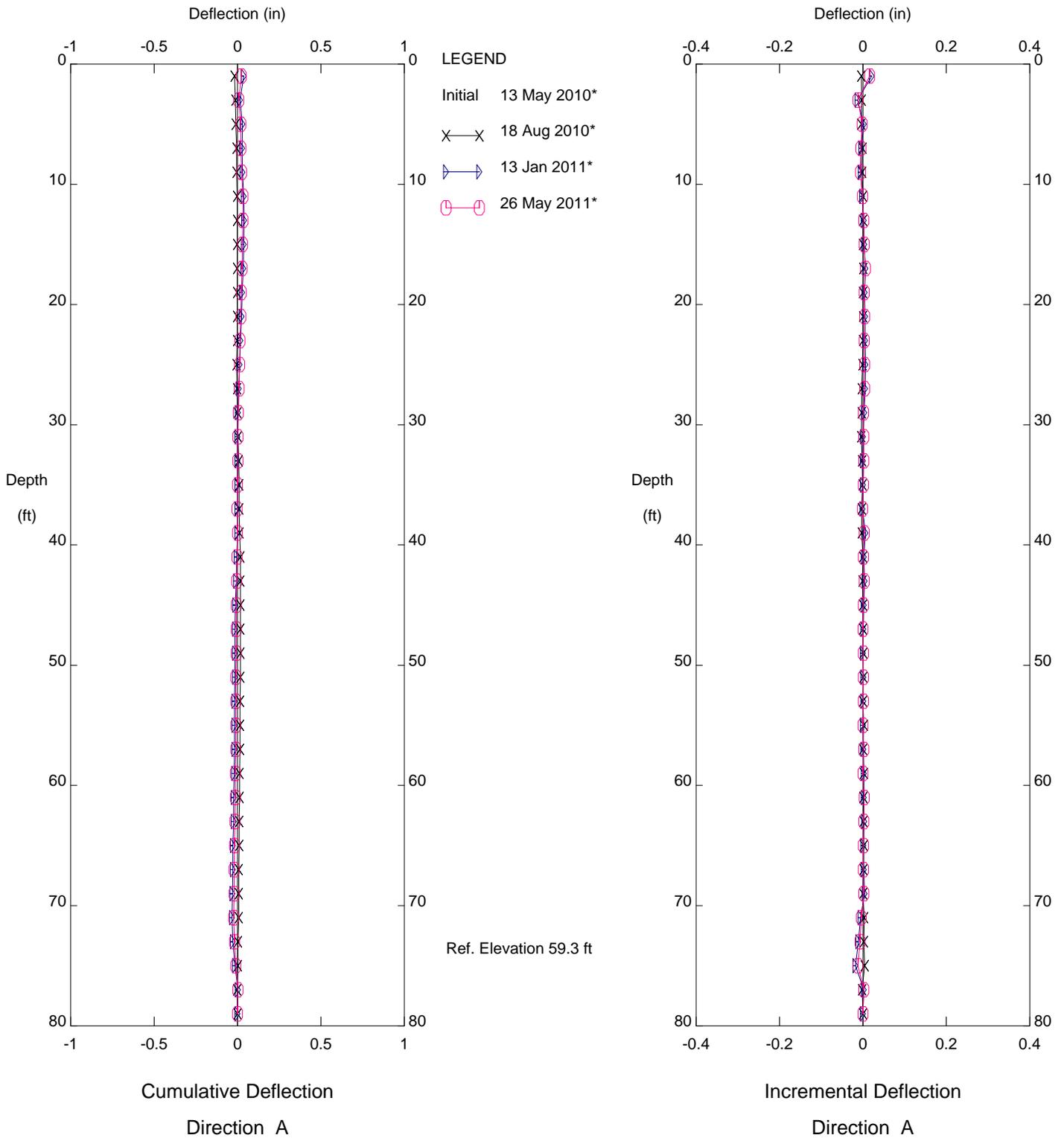
MALIBU ROAD, Inclinometer SI-4

Depth of readings = 41 ft

Sets marked \* include zero shift and/or rotation corrections.



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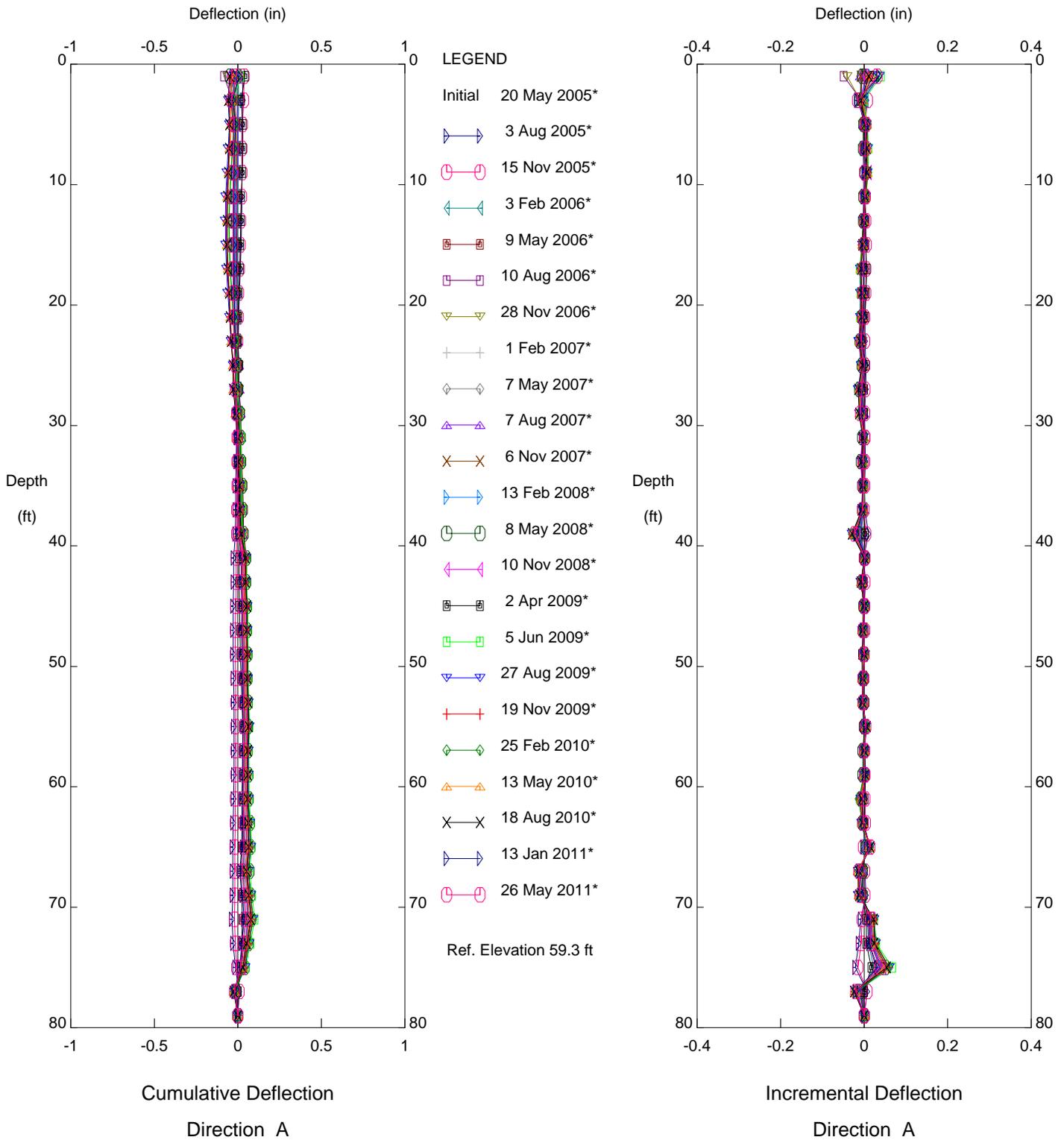
MALIBU ROAD, Inclinometer SI-5

Depth of readings = 78 ft

Sets marked \* include zero shift and/or rotation corrections.



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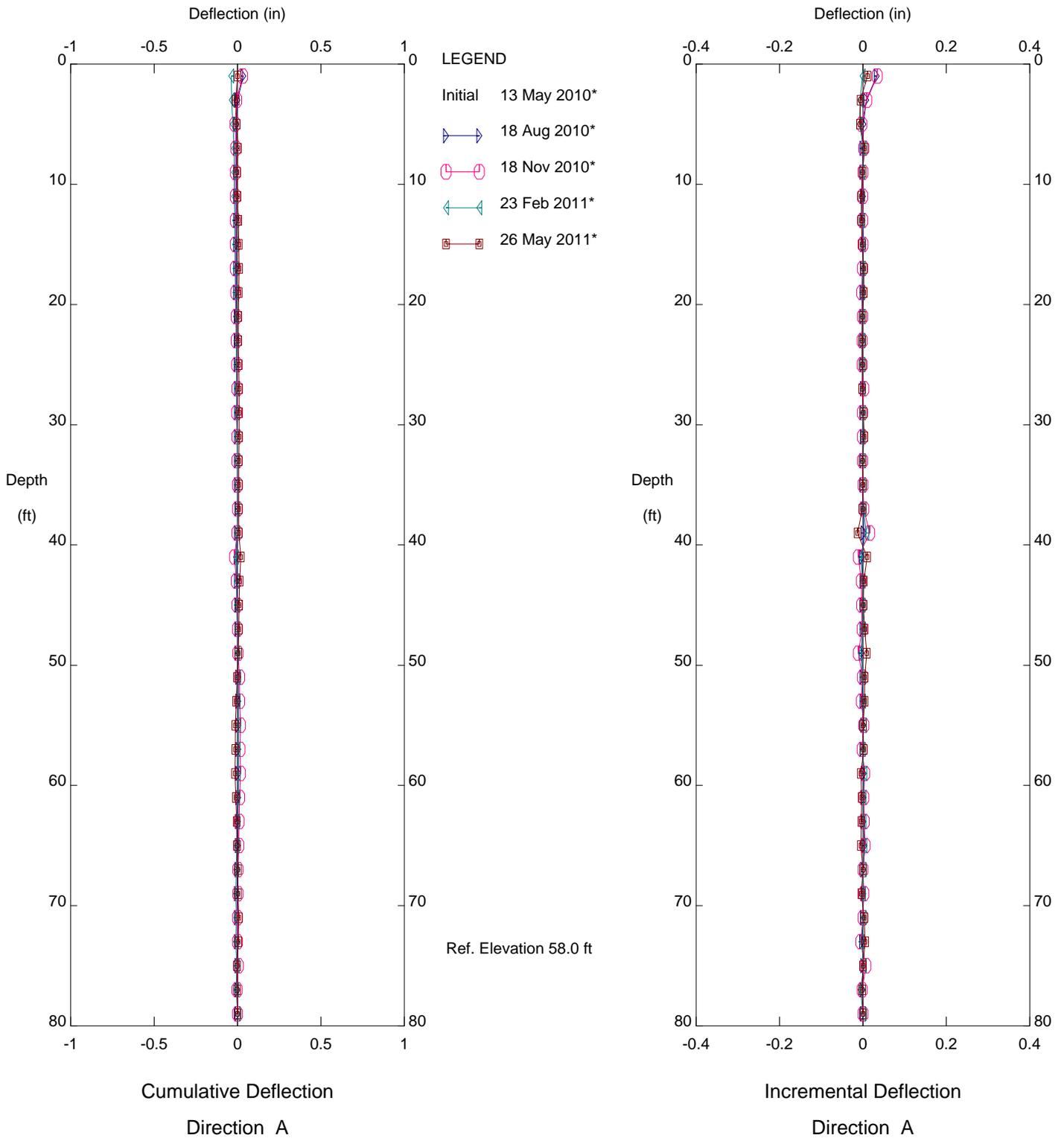
MALIBU ROAD, Inclinometer SI-5

Depth of readings = 78 ft

Sets marked \* include zero shift and/or rotation corrections.



Fugro West, Inc. - Ventura, CA



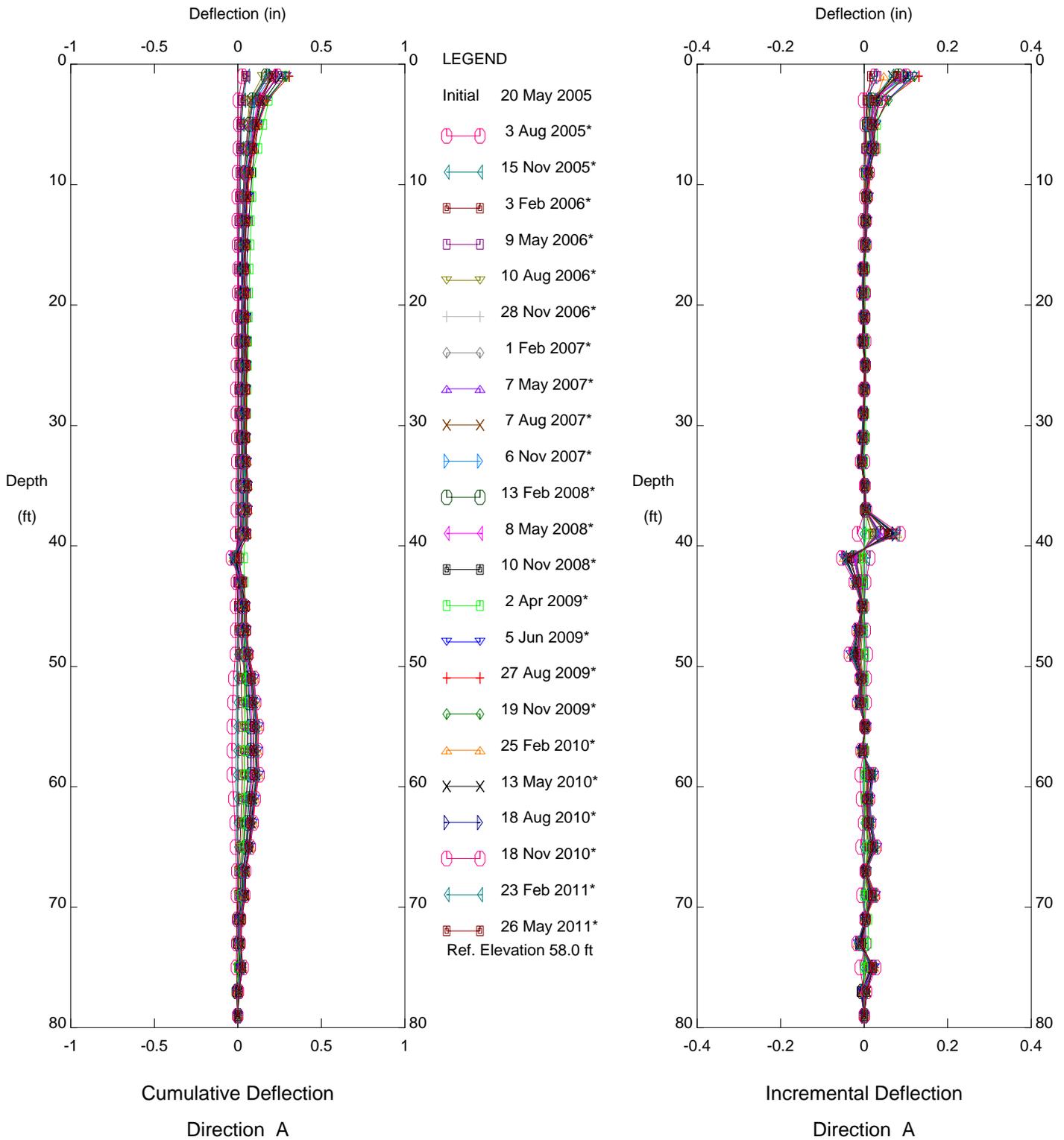
MALIBU ROAD, Inclinometer SI-6

Depth of readings = 78 ft

Sets marked \* include zero shift and/or rotation corrections.



Fugro West, Inc. - Ventura, CA



MALIBU ROAD, Inclinometer SI-6

Depth of readings = 78 ft

Sets marked \* include zero shift and/or rotation corrections.