Project Update and Facility Status

City of Malibu
Landslide Assessment District 98-1
Big Rock Mesa

November 9, 2020

CITY OF MALIBU
Incorporated March 28,1991

Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

Who is Yeh and Associates, Inc.

Yeh specializes in evaluating Geologic Hazards and providing recommendations to mitigate them.

Founded in 1999 in Denver, Colorado; 160 staff

- Geotechnical Engineers, Engineering Geologists, Construction Management
- California Offices: Ventura and Grover Beach

Key Personnel for this project:

- Loree Berry, PE
- Nick Simon, GIT
- John Duffy, PG, CEG

Familiarity with long-term Landslide Management and State of the Art Monitoring Technologies:

- Current - Ferguson Landslide, Yosemite Area, CA
- Current - Freemont Hall Landslide, CalPoly SLO, CA
- 2017 – Big Sur Coastal Landslides, Santa Cruz and Monterey Counties, CA
- Ongoing - Harbor Terrace, Avila Beach, CA
- Ongoing - City of Colorado Springs Studies, CO

Brief History of LAD 98-1

- WATER IN: imported water and rainfall/precipitation
- WATER OUT: wells, hydraugers, evaporation, collected surface drainage

Abbreviated Timeline:

1947 – Development Underway

1983 – Main Landslide- 137 acres

1986-1996 – Extensive Exploration and Studies/Installation of many of the existing facilities

1991 – City of Malibu Incorporated

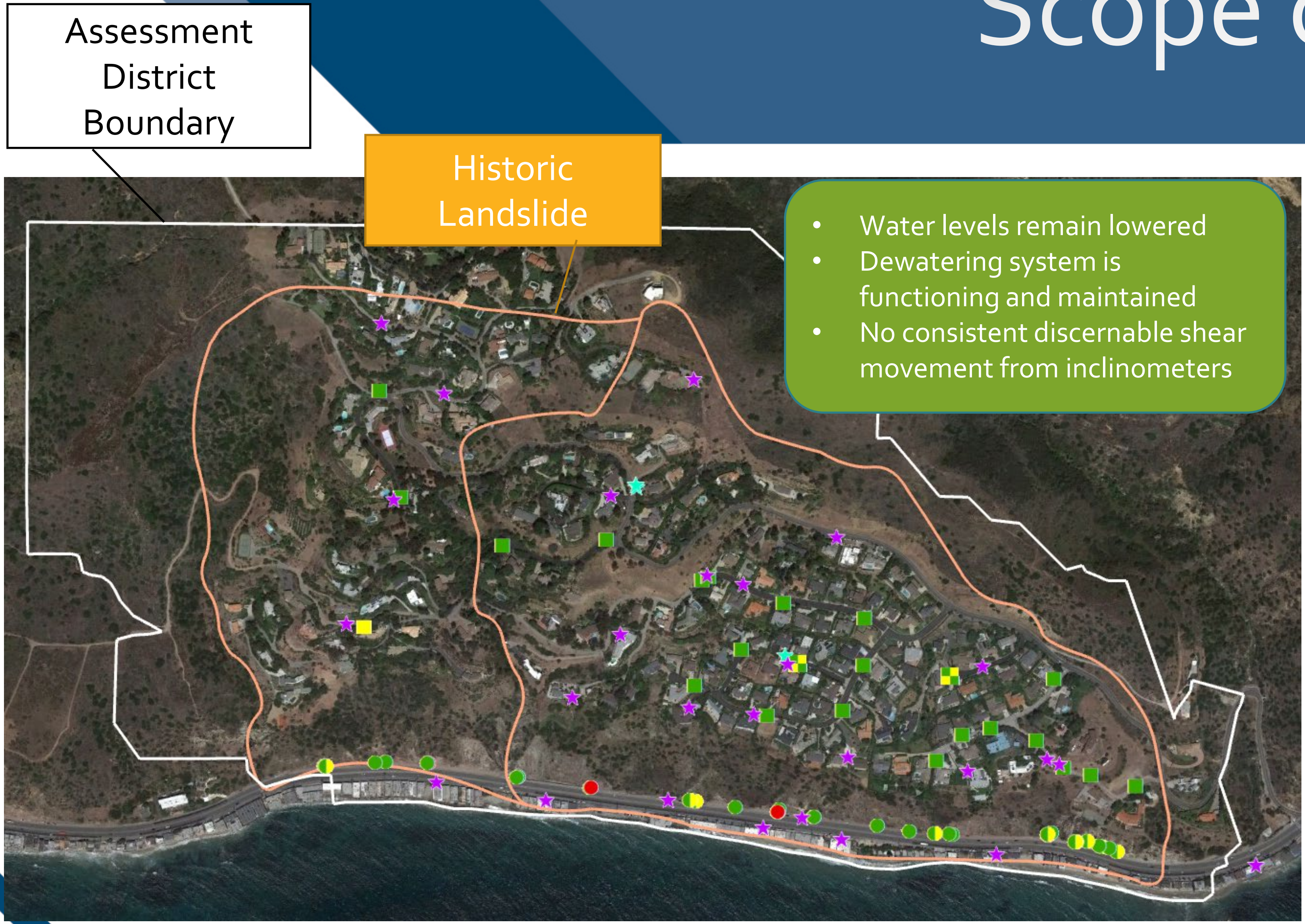
1998 – City forms LAD 98-1

Maintain stability of the Mesa by lowering groundwater with a dewatering system (wells and hydraugers).

- **Monitor slope inclinometers and water levels to assess the effectiveness of the dewatering.**
- **Manage Improvements to maintain, repair, and replace dewatering and monitoring facilities.**

2020 – Operating and Maintaining the same Assessment District 98-1

Scope of LAD 98-1



Yeh began work July 1, 2020 to maintain and monitor the existing LAD.

- ✓ Monitor and measure
  - Dewatering output
  - Water levels
- ✓ Survey slope inclinometers
- ✓ Maintain/repair equipment
- ✓ Replace equipment (CIP)
- ❑ Current Equipment Includes:
  - 23 dewatering wells
  - 37 hydraugers
  - 29 standpipes
  - 28 inclinometer casings
- ✓ Record rainfall and Water Usage

Monitoring and Maintenance since July 1, 2020

- Recorded Flow from 23 Dewatering Well Meters
- Measured and Recorded Discharge from 37 Hydraugers
- Measured and Recorded Water Level Measurements in 29 Standpipes
- Completed sampling and testing NPDES Permit

(3 months collected)

- Performed baseline surveys on Inclinometers
- Performed an inventory of facilities
- Scheduled maintenance of hydrauger conveyance along PCH
- Completed Maintenance and Repairs on the following dewatering wells:
  - Replaced pumps : W-2, W-17, BYA-1
  - Video Logged: W-2, W-3, W-17
  - Installed groundwater sounding tube: W-2, W-3, W-17, BYA-1
  - Repaired pump controls/electronics: W-8, W-18
  - Replaced flow meter: W-2, BYA-4
  - Repaired broken discharge line at vault: BYA-6

Historical Data Trends –Dewatering

Sources

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2. Hyd

Lower D

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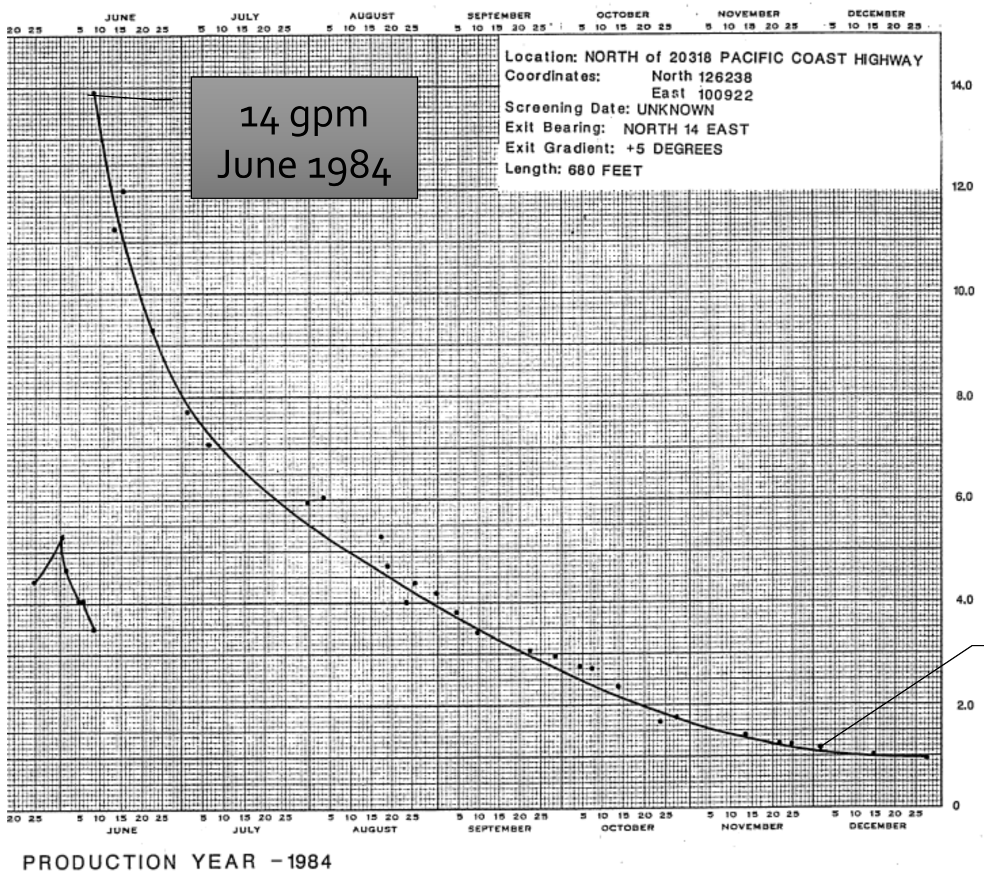
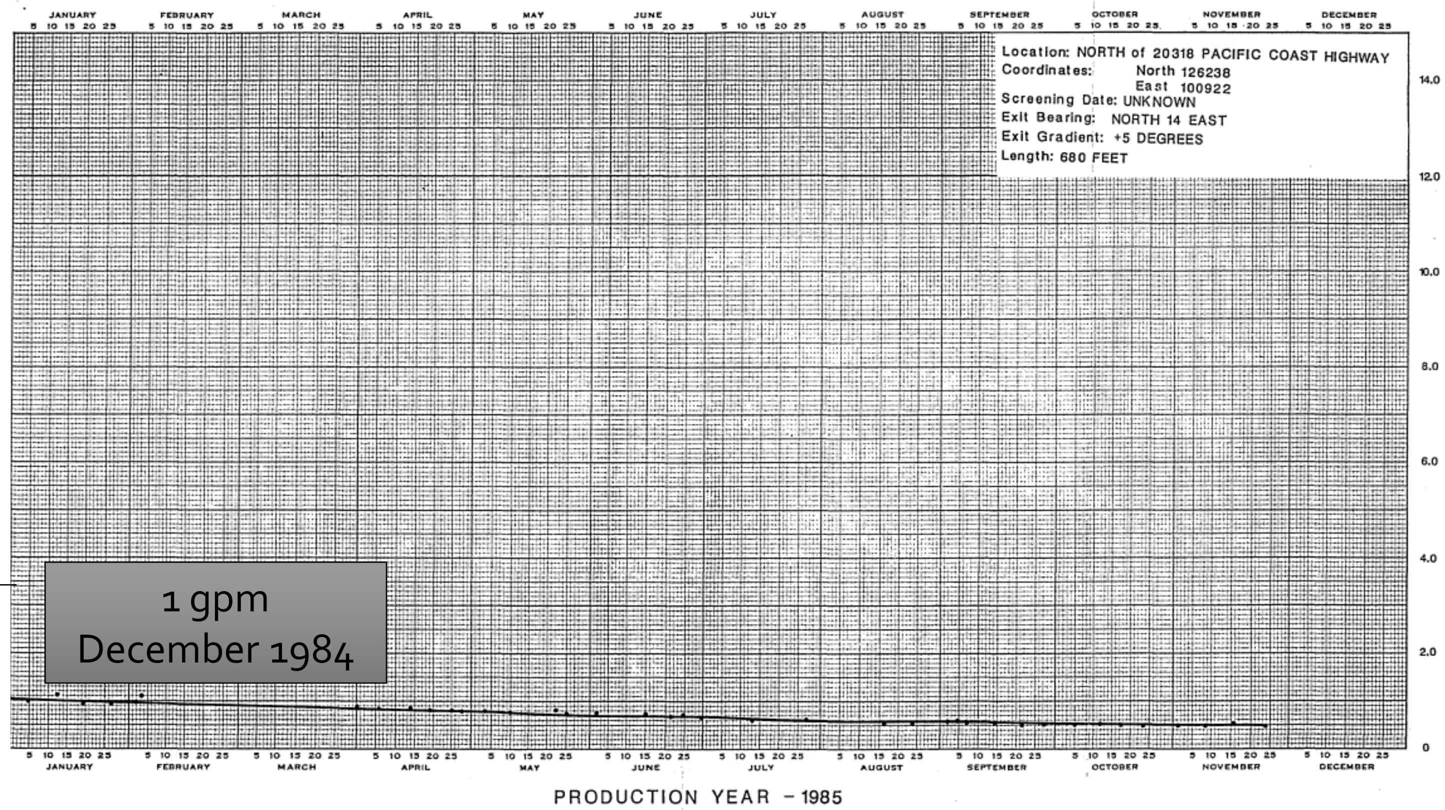
Historical Data Trends – Hydraugers

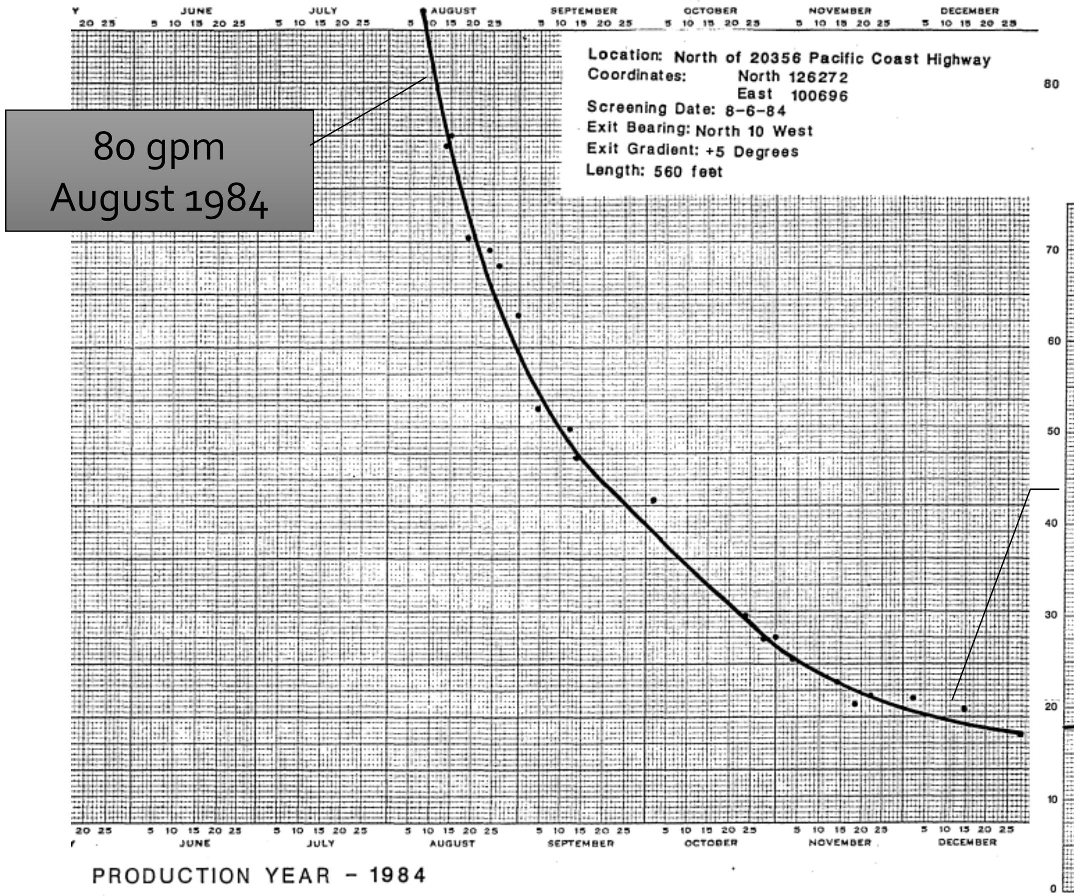
H-4

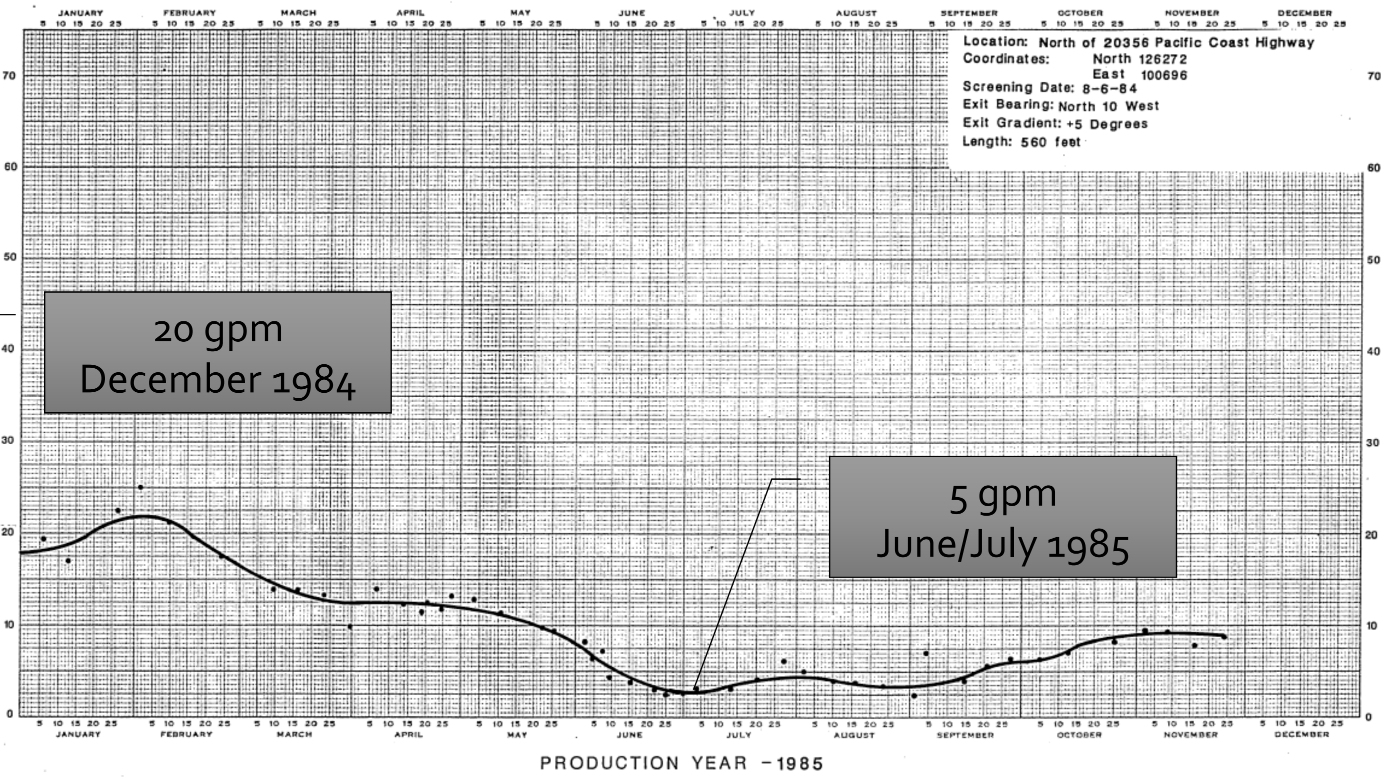




Historical Data Trends – Hydraugers

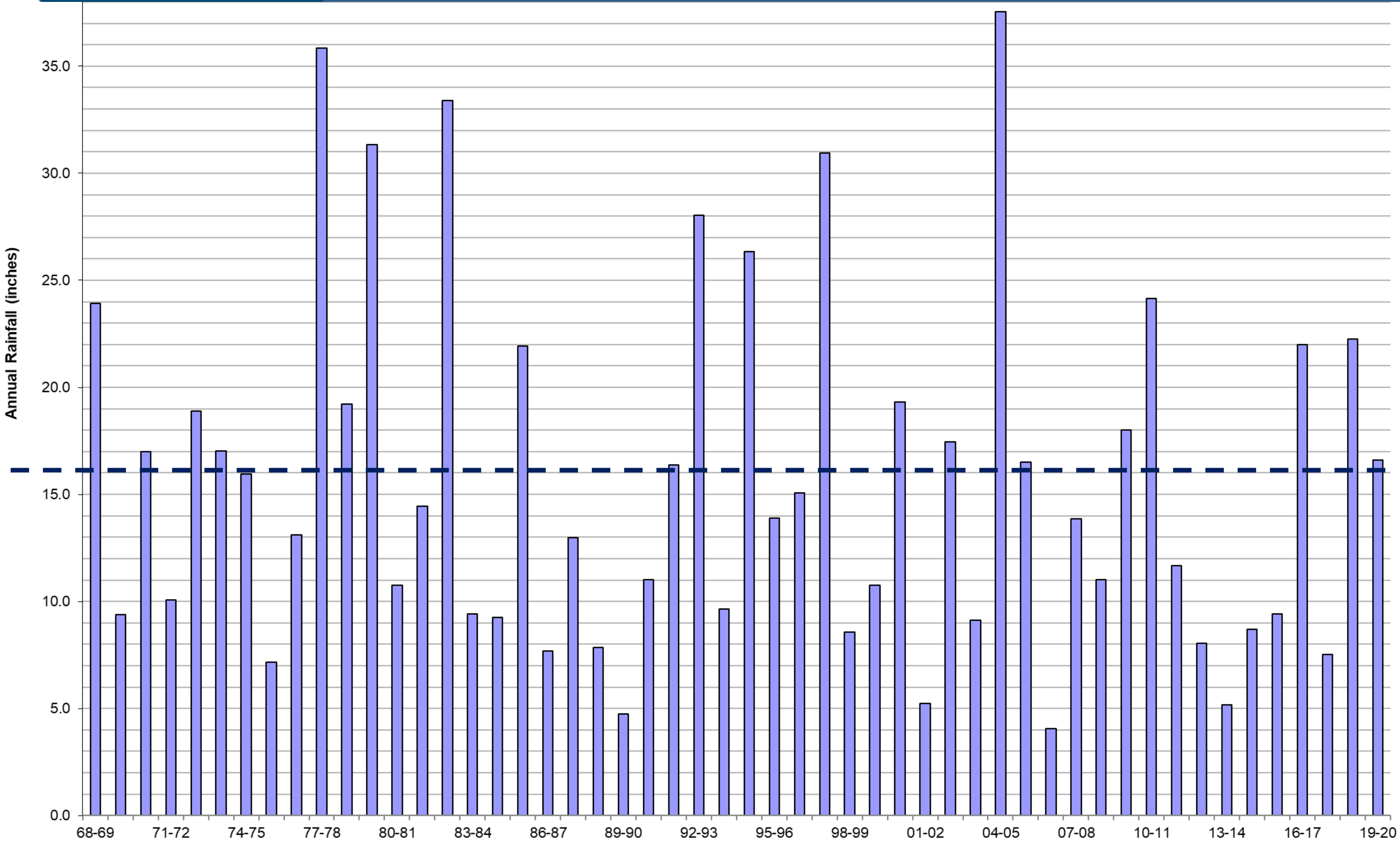
HD-3



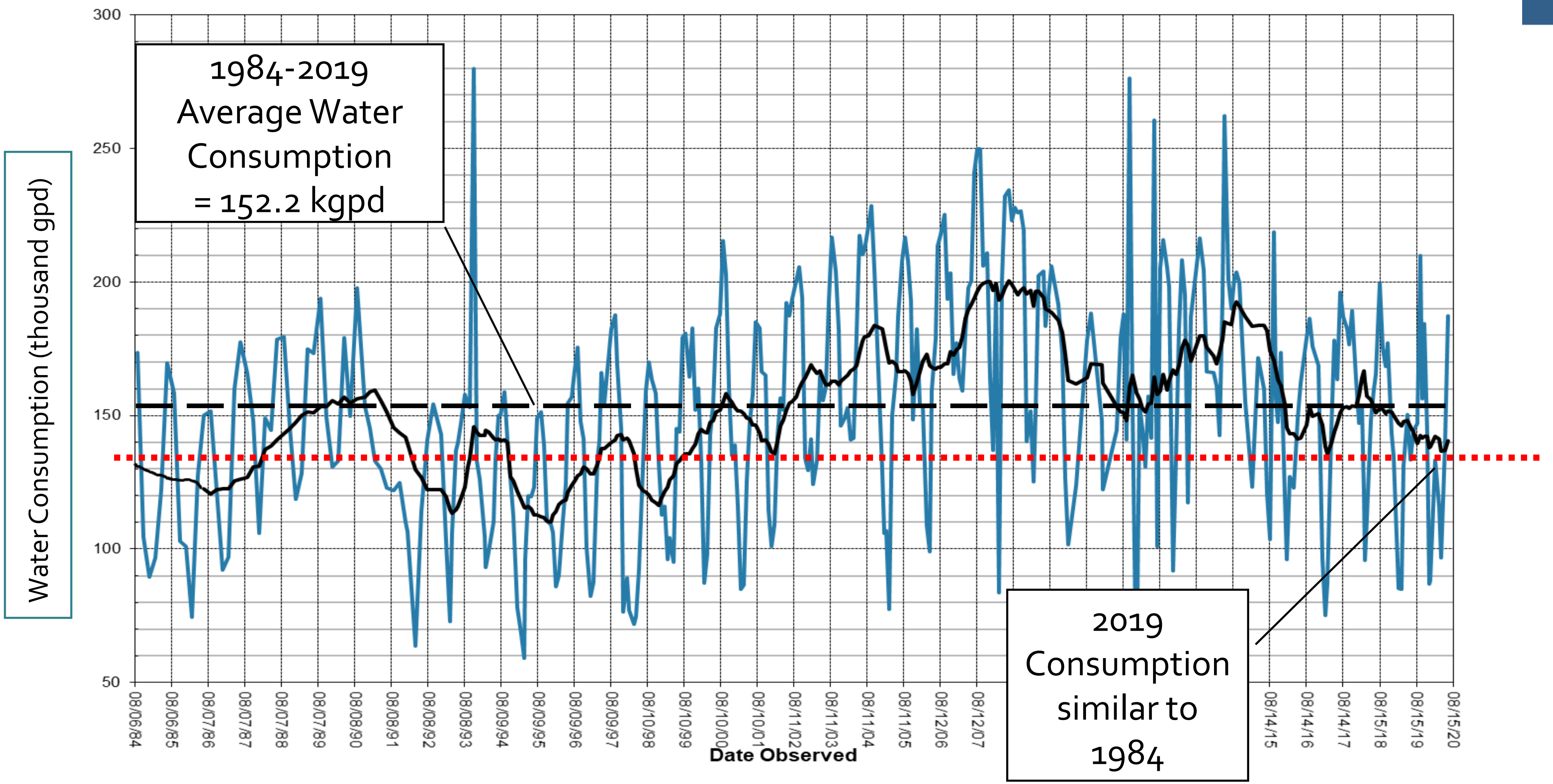


Historical Data Trends – Rainfall

Ave: 15.4"
(1968-2020)



Historical Data Trends – Water Usage



Historical Data Trends – Water Levels

Facility Type	ID	Earliest Reading	Depth to Water (feet) (earliest)	Water Depth** October 2020 (feet)	Difference in Water Level
D. Well	W-1	1983	63.3	125.0	**-61.7 feet**
Standpipe	SP-33	1985	98.0	245.0	**-147.0 feet**
D. Well	W-3	1983	13.5	161.5	**-148.0 feet**
D. Well	W-8	1983	54.7	161.0	**-106.3 feet**
D. Well	W-16	1984	94.9	179.7	**-85.0 feet**
Standpipe	SP-16	1984	61.0	147.11	**-86.1 feet**
D. Well	BYA-4	1991	142.0	247.9	**-105.9 feet**
Standpipe	SP-10	1983	160.0	251.0	**-91.0 feet**

** Measurements taken after nearby pumps were turned off for 24 hours or more

2020 Groundwater Levels vs. BYA 1992 Cross Sections

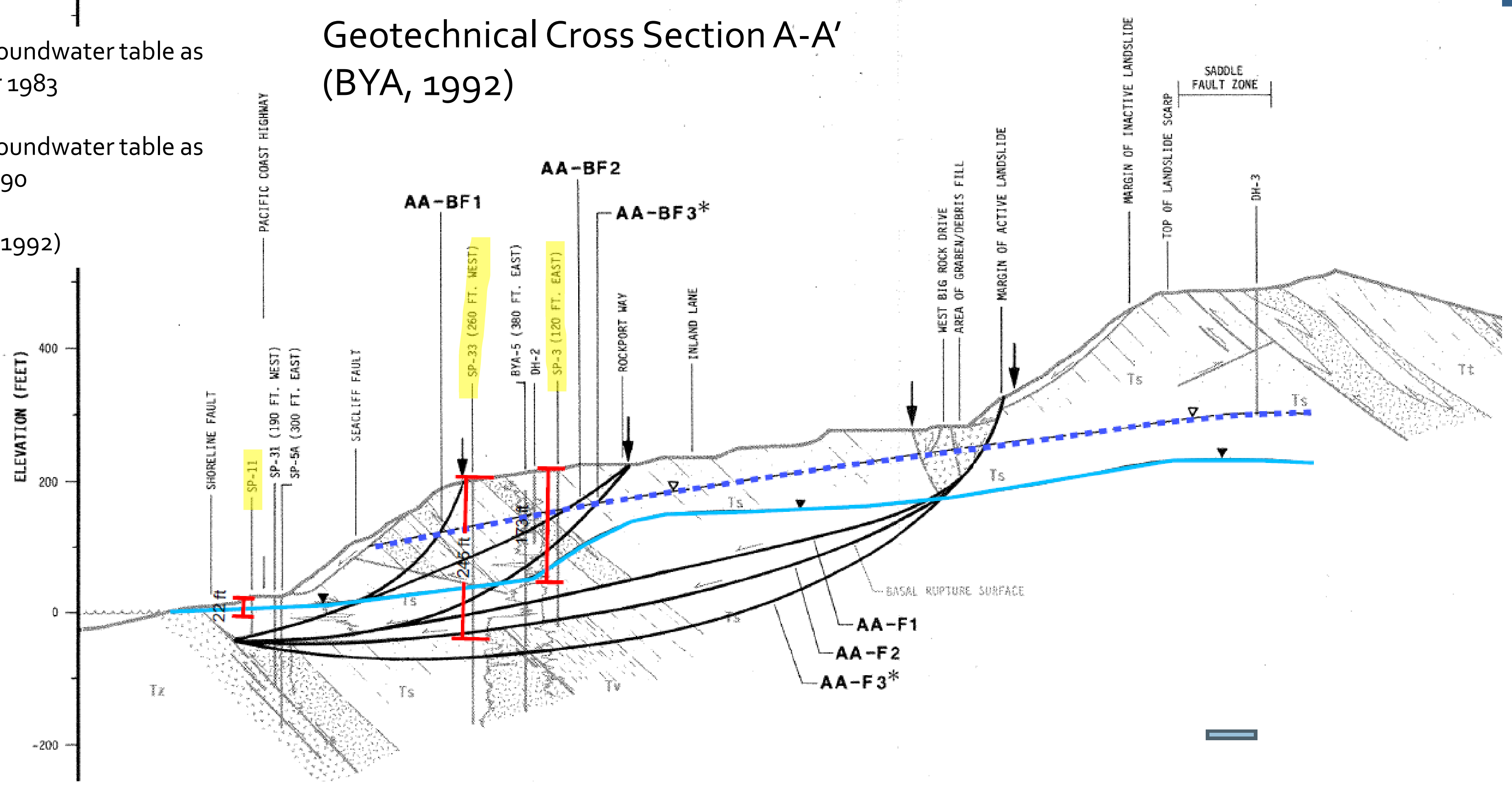
2020 Groundwater Levels vs. BYA 1992 Cross Sections

Estimated Groundwater table as of September 1983

Estimated Groundwater table as of October 1990

Source: BYA (1992)

Geotechnical Cross Section A-A' (BYA, 1992)



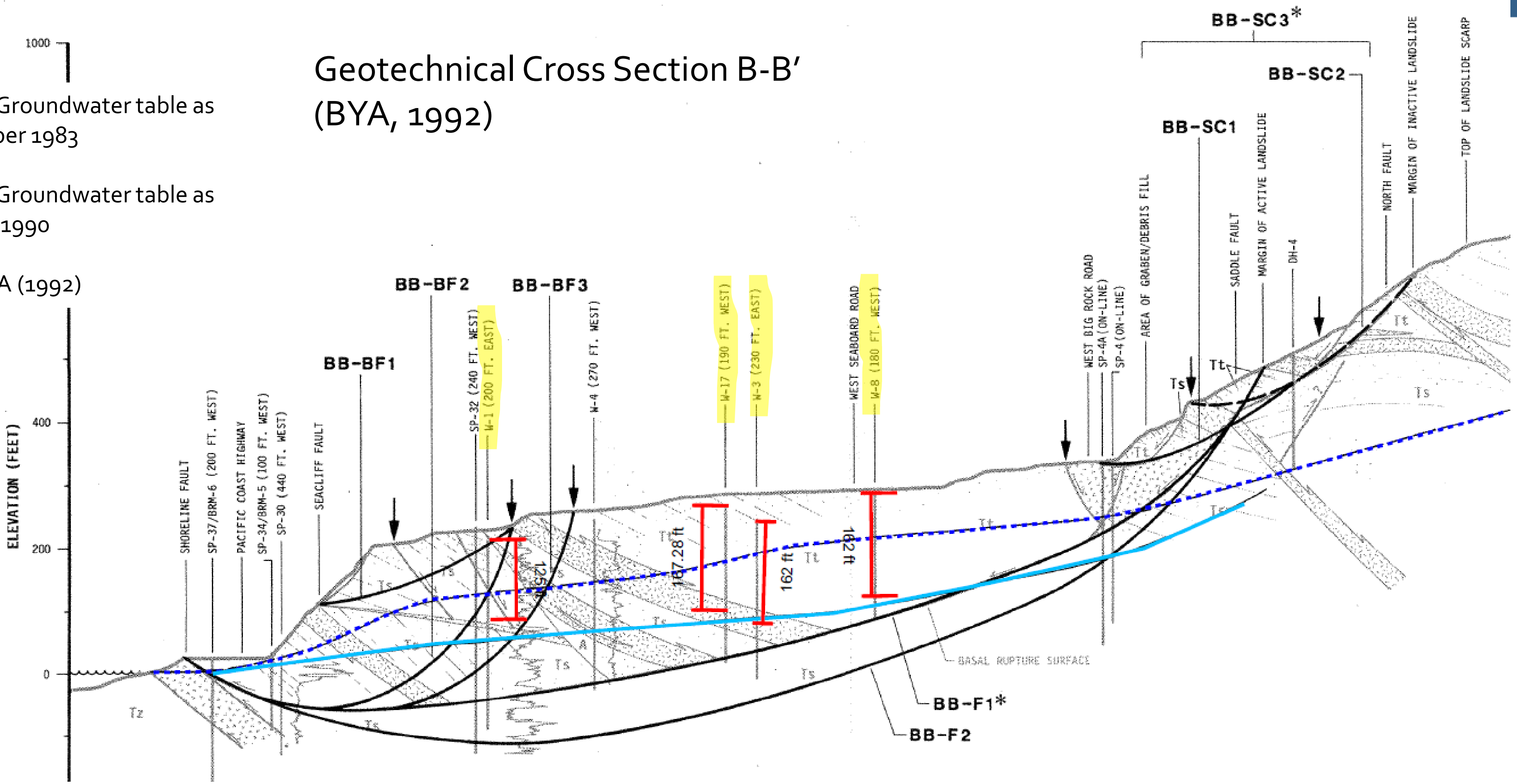
2020 Groundwater Levels vs. BYA 1992 Cross Sections

Estimated Groundwater table as of September 1983

Estimated Groundwater table as of October 1990

Source: BYA (1992)

Geotechnical Cross Section B-B' (BYA, 1992)



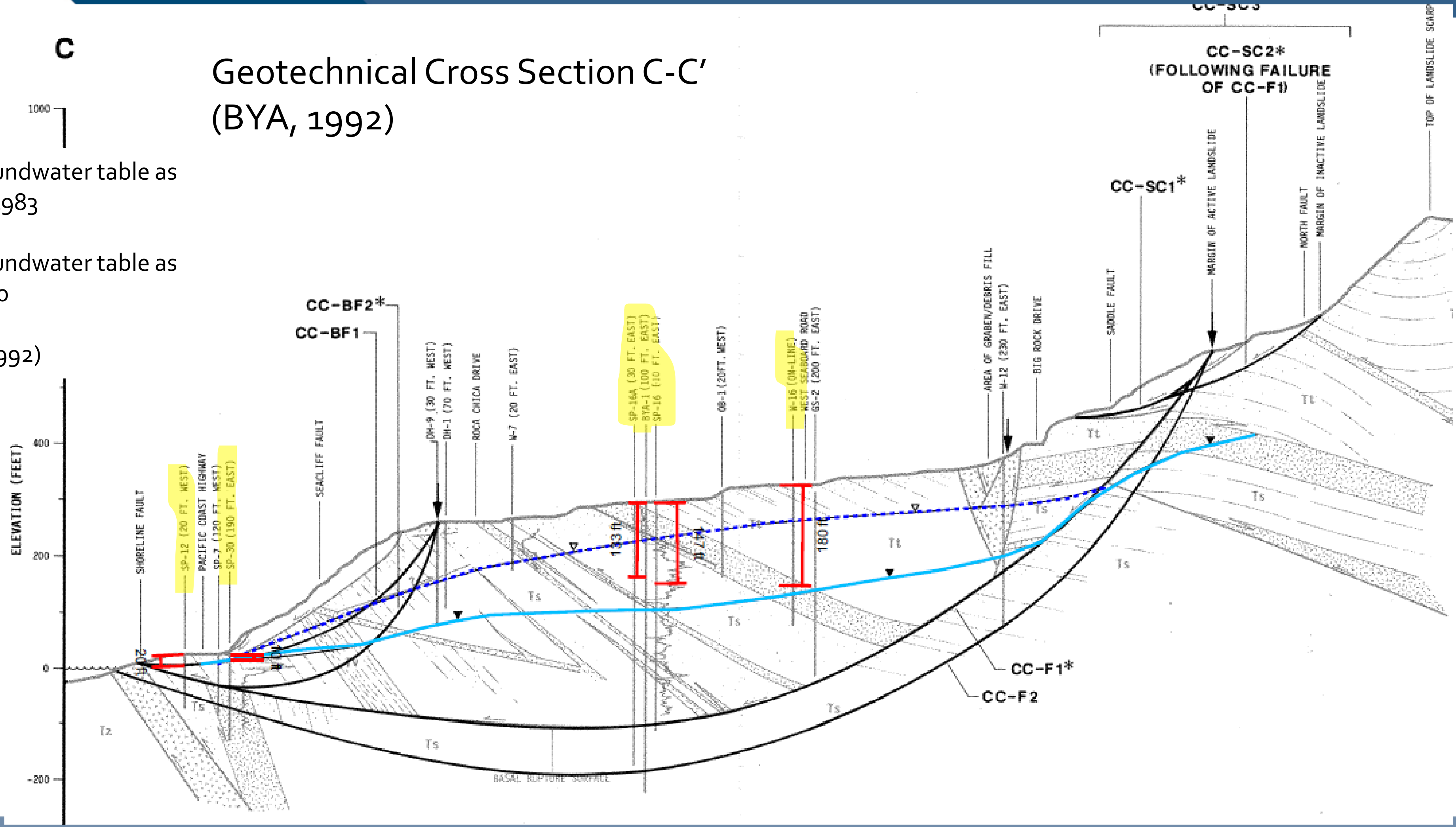
2020 Groundwater Levels vs. BYA 1992 Cross Sections

Geotechnical Cross Section C-C’ (BYA, 1992)

Estimated Groundwater table as of September 1983

Estimated Groundwater table as of October 1990

Source: BYA (1992)



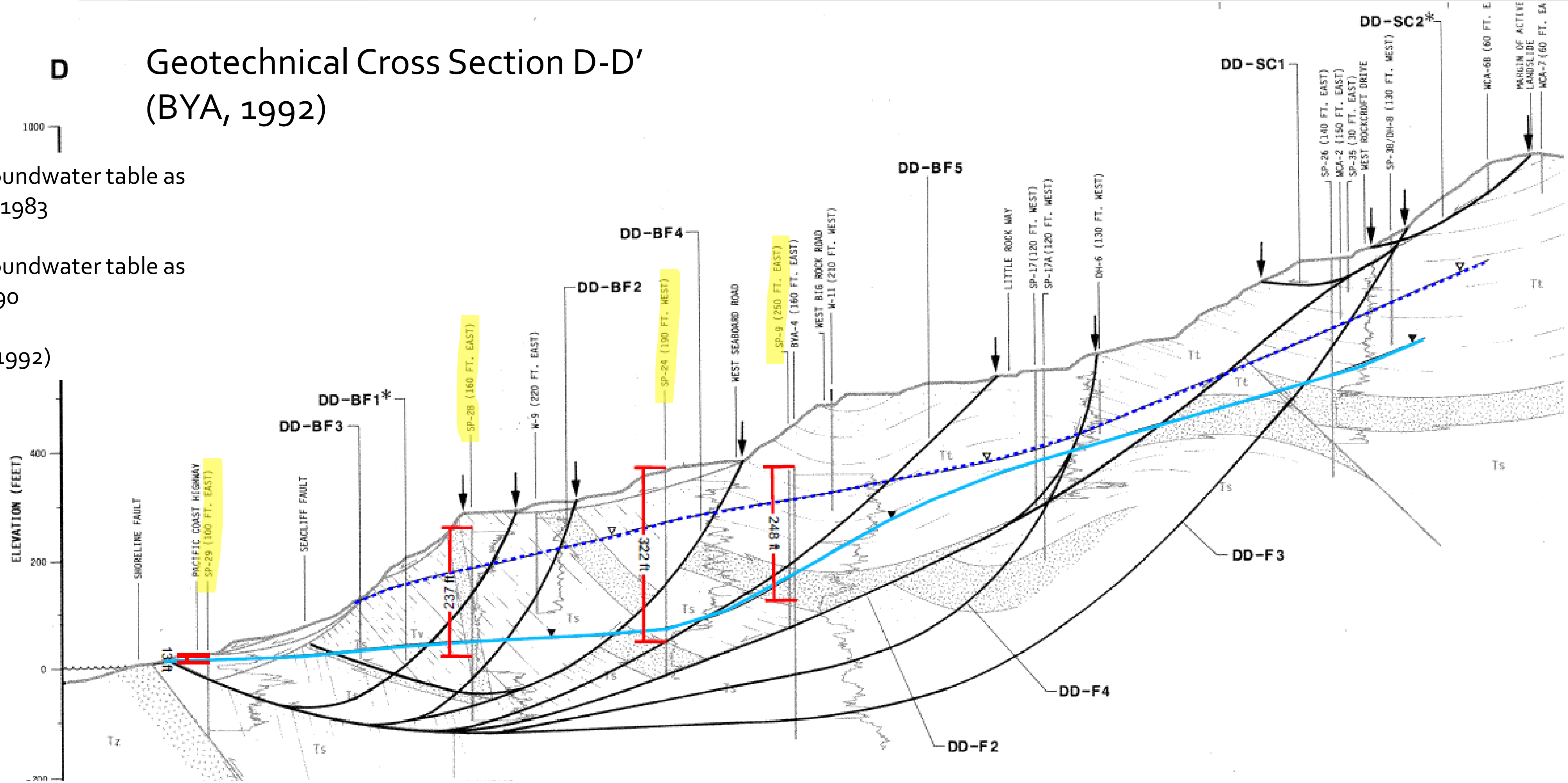
2020 Groundwater Levels
BYA 1992 Cross Sections

Geotechnical Cross Section D-D’
(BYA, 1992)

Estimated Groundwater table as of September 1983

Estimated Groundwater table as of October 1990

Source: BYA (1992)



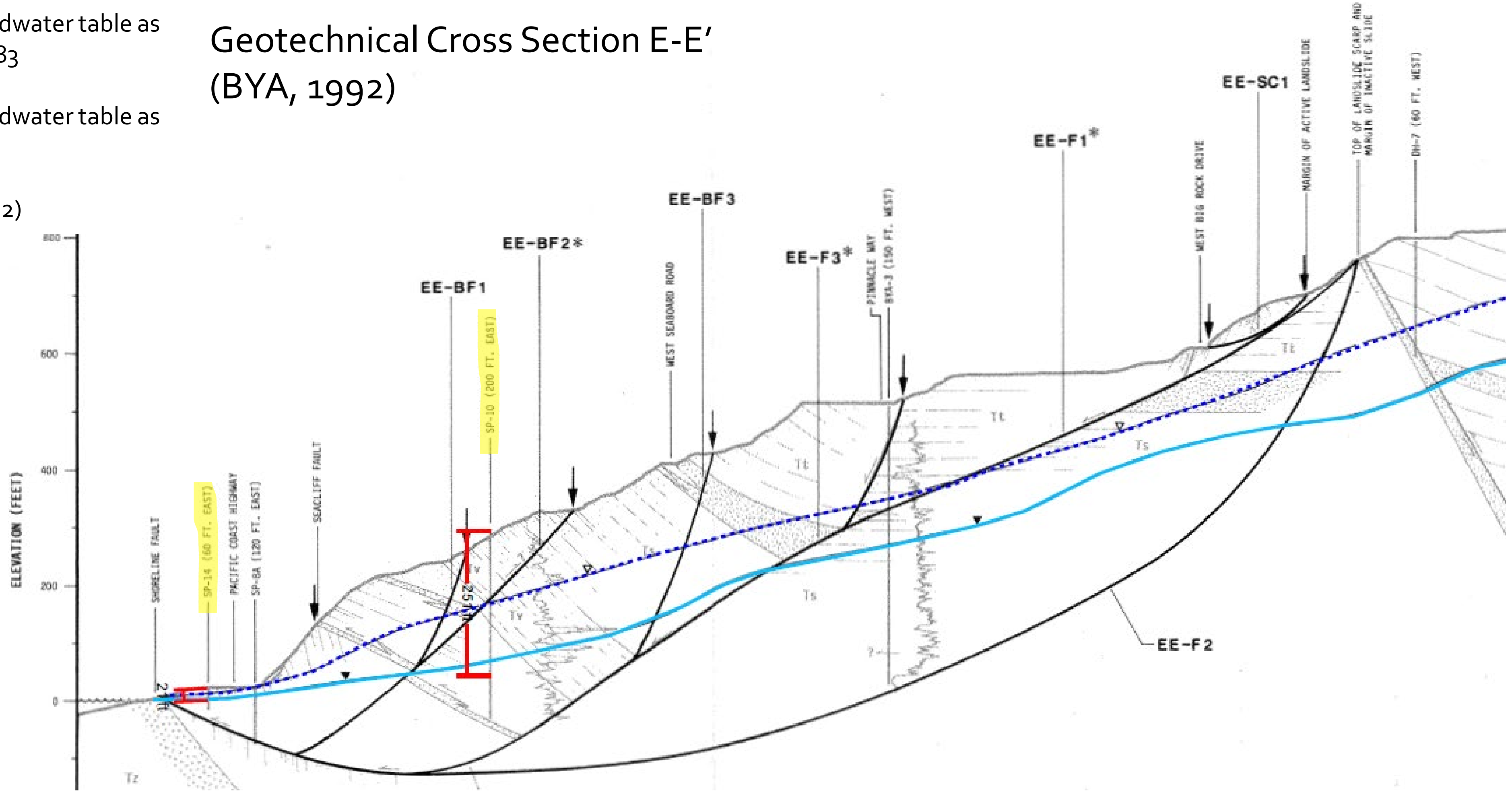
2020 Groundwater Levels vs. BYA 1992 Cross Sections

Estimated Groundwater table as of September 1983

Estimated Groundwater table as of October 1990

Source: BYA (1992)

Geotechnical Cross Section E-E' (BYA, 1992)



Response to E.D. Michaels (relative to LAD98-1 SOW)

1. The project dewatering wells and hydraugers are functioning :
   - 23 of 23 dewatering wells are functioning
   - 34 of 37 hydraugers have consistent flow or seasonal flow
     - Remaining 4 are checked but have not shown flow in many years
2. Groundwater level measurements in standpipes and dewatering wells indicate 2020 water levels are well below 1983 water levels and near or below 1991 water levels
3. Lowered dewatering production combined with lowered groundwater levels = dewatering system <u>IS</u> functioning
4. 2019 water usage is similar to 1984
5. Slope inclinometer data does <u>NOT</u> reveal a consistent pattern of discernable shear

Next Steps for 2020 Fall/Winter

- Monthly Monitoring, as-needed Maintenance within our SOW
- Compliance testing and reporting for NPDES Permit
- Pressure transducers in 6 locations (CIP)
  - (W-2, W-3/PC-1, BYA-1, SP-9A, SP-20)
  - to continuously monitor groundwater levels through the next rain season
  - to assist in interpreting if reading is measuring a wet casing or the actual water level
- Replace BYA-1 electrical equipment box (CIP)
- Plan and schedule hydrauger cleanout cycle (CIP)

Function of Dewatering Facilities

WHERE DO WE GO FROM HERE?

- ❑ Developed basic rating procedure to help identify next improvements
- ❑ Assigned Functionality Status to Wells and Hydraugers -

Green = functioning and maintained

Yellow = functioning but flagged for improvement

Red = not functioning

[go through maps] –

10 Year Capital Improvement Plan

FACTS regarding existing Capital Improvement Planning

- Currently ~$100,000 per year
- Intended for: hydrauger flushing, major rehabilitation or replacement of wells, hydraugers, inclinometers
- Only **1** improvement every one to three years
- Difficult to prioritize over that period of time

FY 20/21 ($100k)

- Replace pump in BYA-1 - $11k *(completed)*
- BYA-1 electrical box replacement- $45k
- Install 6 pressure transducers - $8k
- Partial hydrauger flushing - $36k

	Next Capital Improvements	Estimated Cost*
1	Deepen BYA-1	$300k
2	Install 3 new Hydraugers	$100k
3	Deepen BYA-15	$250k
4	Deepen W-3	$250k
5	Flush Hydraugers (assume 1,200 lin ft)	$100k

Recommended Improvements

Recommended Items to Improve the District	Benefits	Approx. Cost
<u>Increase funding of assessment district for:</u> • Increase capital improvement to fully fund CIP well improvements • Increase funding for water quality testing and improvements • Increase funding to create a reserve fund – add'l $100k per year for a maximum of $300k	Provides adequate funding to perform additional capital projects and improve water quality testing. Having a reserve fund will help during emergency situations.	$600k per year $100k to $200k – one – time cost and $50k to $150k per year
<u>Increase scope of work to include:</u> • Historic and future InSAR data for monitoring surface movement (2015-2020 + upcoming 12 mos) - $18k one time, $12k annually	This recommended item will aid in the ability to recognize potential trends of ground movement to supplement the inclinometer data, prioritize locations for monitoring or improvement, early warning of movement.	$18k - one-time cost and $12k per year
• Include the repair and maintenance of the drainage area along the headscarp region and between the homes on Seaboard Road.	Reduce amount water entering ground. However, this would require additional easements from private property owners and annual maintenance	$70k – one-time cost and $15k – annual maintenance

Other Recommended Improvements

	Other Recommended Items	Benefits	Approx. Cost
1	Increase scope of work to include: • Replace dewatering pumps with dedicated pressure transducer controls – $20k per well x 23 wells • Install digital flow meters connected by cellular (23 meters) for $35k	These recommended items will allow us to obtain continuous groundwater level data in all wells, refine pump controls for maximum efficiency, and assist in making the data more accessible	$500k - one-time cost
2	Increase scope of work to include: • Permanent Slope Inclinometers with pressure transducer or sim. • Install remote transmitter to record and view data remotely monitoring • Web-based system • $30k to 35k per location @ 29 locations	This recommendation will reduce the labor hours associated with manual survey of inclinometers, provide frequent measurements and early warning of movement, would be installed with vibrating wire piezometers to water levels at same location	$1M – one-time cost

Other Recommended Improvements

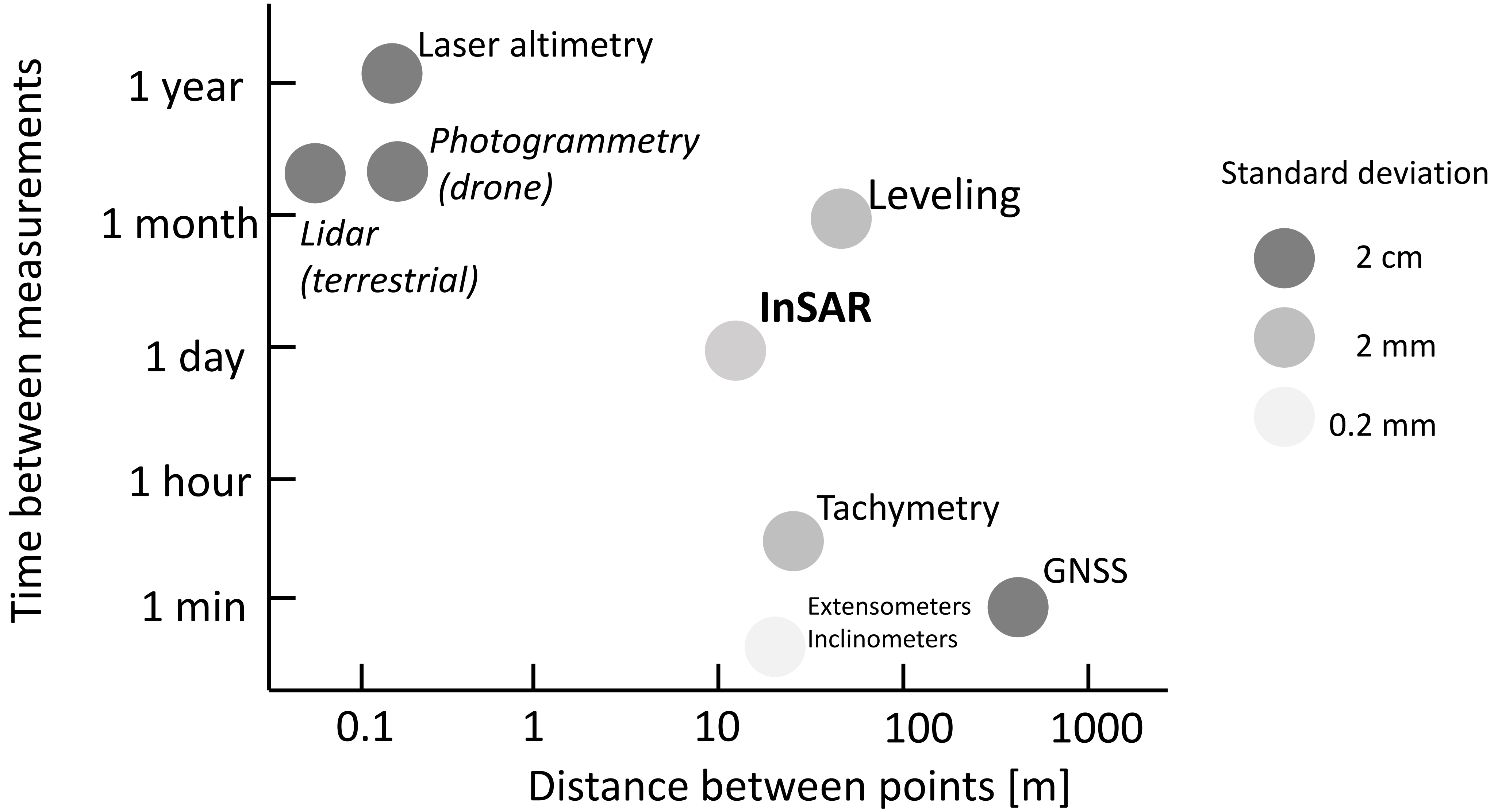
	Recommended Improvements	Benefits	Approx. Cost
3	Complete 10-year recommended capital projects in concurrently and as soon as possible	This accelerates the installation of important system improvements that are recommended now	$1M – one-time cost
4	Increase scope of work to include: • Slope Stability Modelling and Analysis of the Big Rock Mesa Landslide complex	Labor vs Results have relatively low benefit relative to improving and maintaining Big Rock Mesa	$300-400k – one-time cost

Thank you…

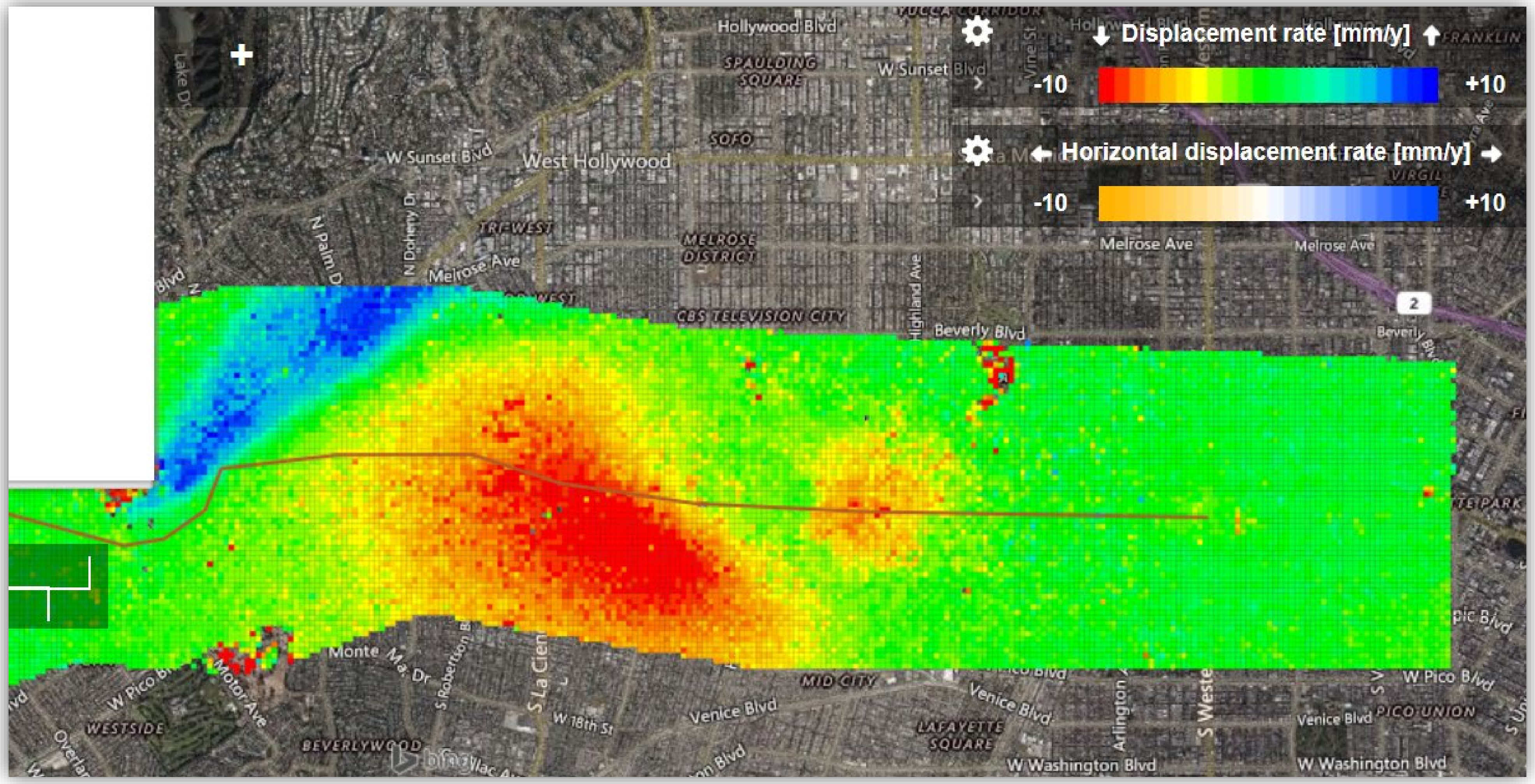
Comparing LiDAR, Photogrammetry, and InSAR

	LIDAR (aerial)	Photogrammetry	InSAR
Revisit Frequency (realistic)	Weeks/Months	Weeks/Months	Days/weeks
Detection Limit (between passes)	20+ cm	10+ cm	5+ mm
Cost (relative to area covered, and total data availability)	$$$	$$	$
Need for Instrumentation on the Ground	Yes (for referencing + accuracy)	Yes (for referencing + accuracy)	No
Historical Analysis Possible	No	No	Yes
Note	Repeated flights a logistical challenge and costly	Big Rock Drive area of interest is relatively large	Only method for mm-level accuracy. Historical archive accessible. Not intrusive

Monitoring Technique Characteristics

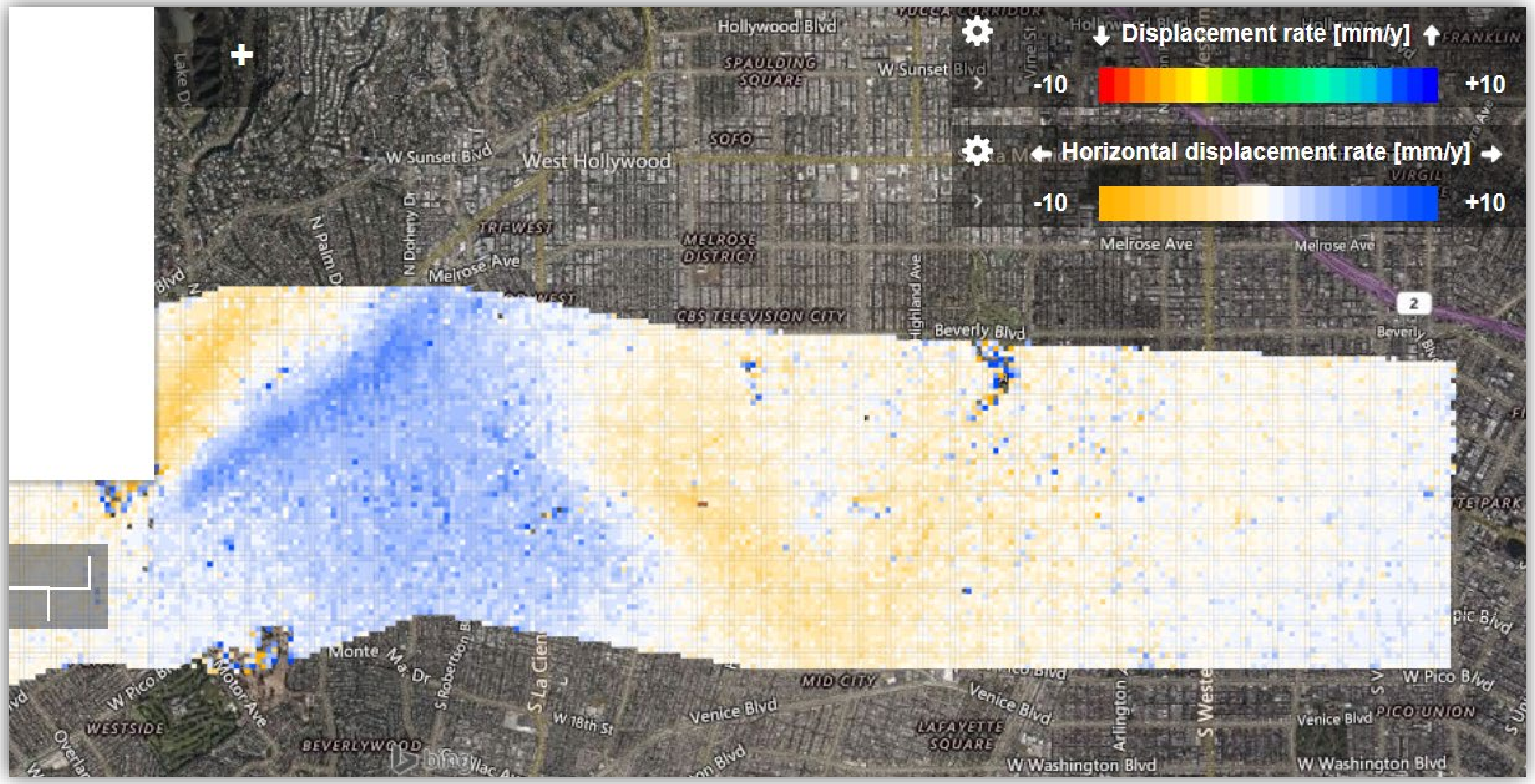


West Hollywood Area sample with Fault Lines Clearly Visible



Sentinel-1 Data Exhibiting Uplift in Blue and Subsidence in Red.

West Hollywood Area sample with Fault Lines Clearly Visible

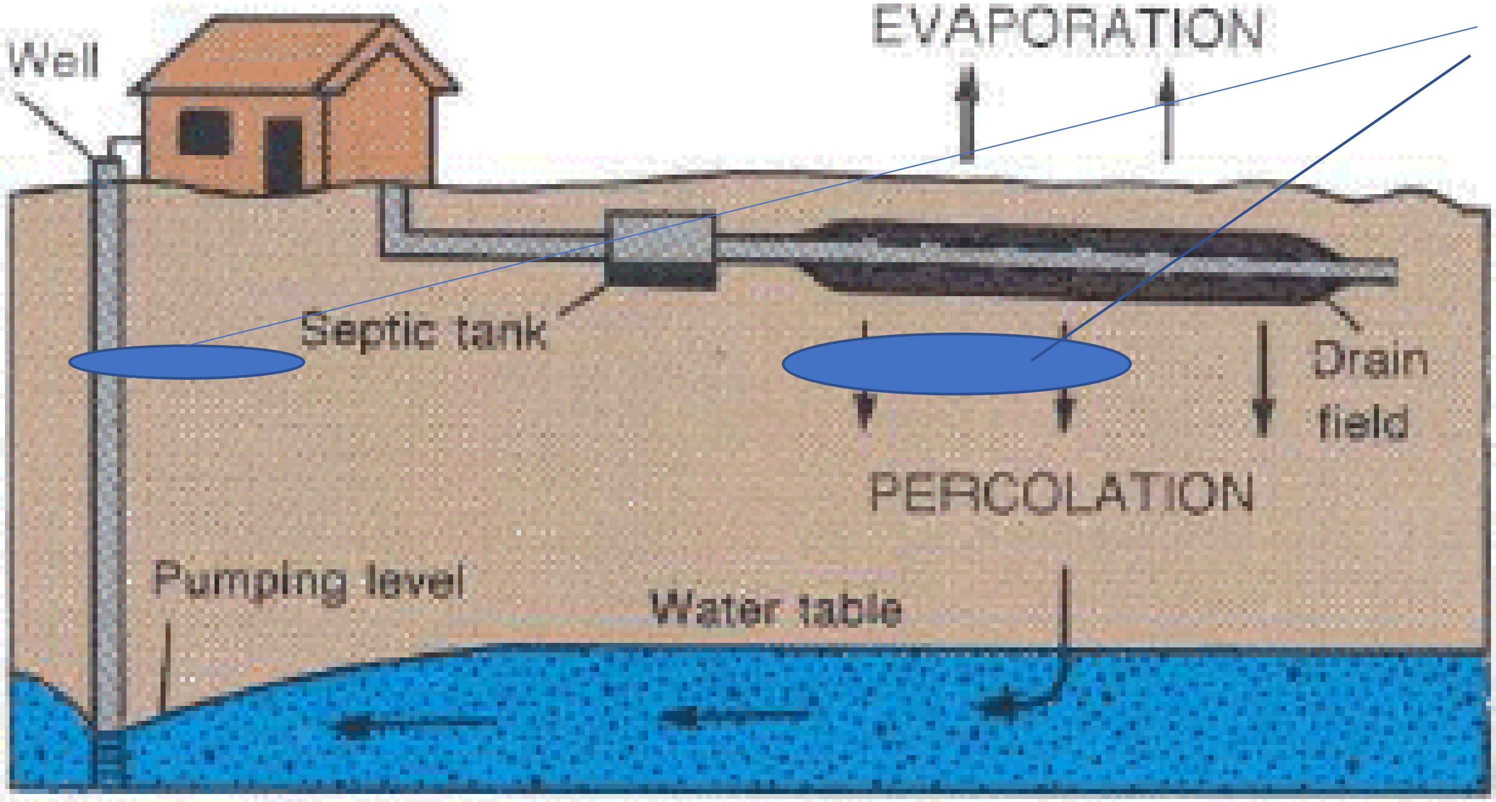


Sentinel-1 Data Exhibiting Horizontal Trend (E/W) Displacements.

2020 Water Levels in the Western Extension

Facility ID	Earliest Reading	Water Depth at Earliest Reading	Water Depth in 1991	Water Depth in September 2020
SP-23	1984	320 ft	377.4 ft	>390 ft (dry)
SP-22	1984	284 ft	329.3 ft	313.6 ft
SP-21	1984	203 ft	310.0 ft	266.6 ft
BYA-15	2002	298 ft	n/a	>303 ft (0 psi)
SP-20	1984	93 ft	275.0 ft	289.2 ft

What is Perched Water?



Perched Water
Water ponds on low or impermeable soil or rock surface
localized condition