San Diego County Chapter
SURFRIDER FOUNDATION

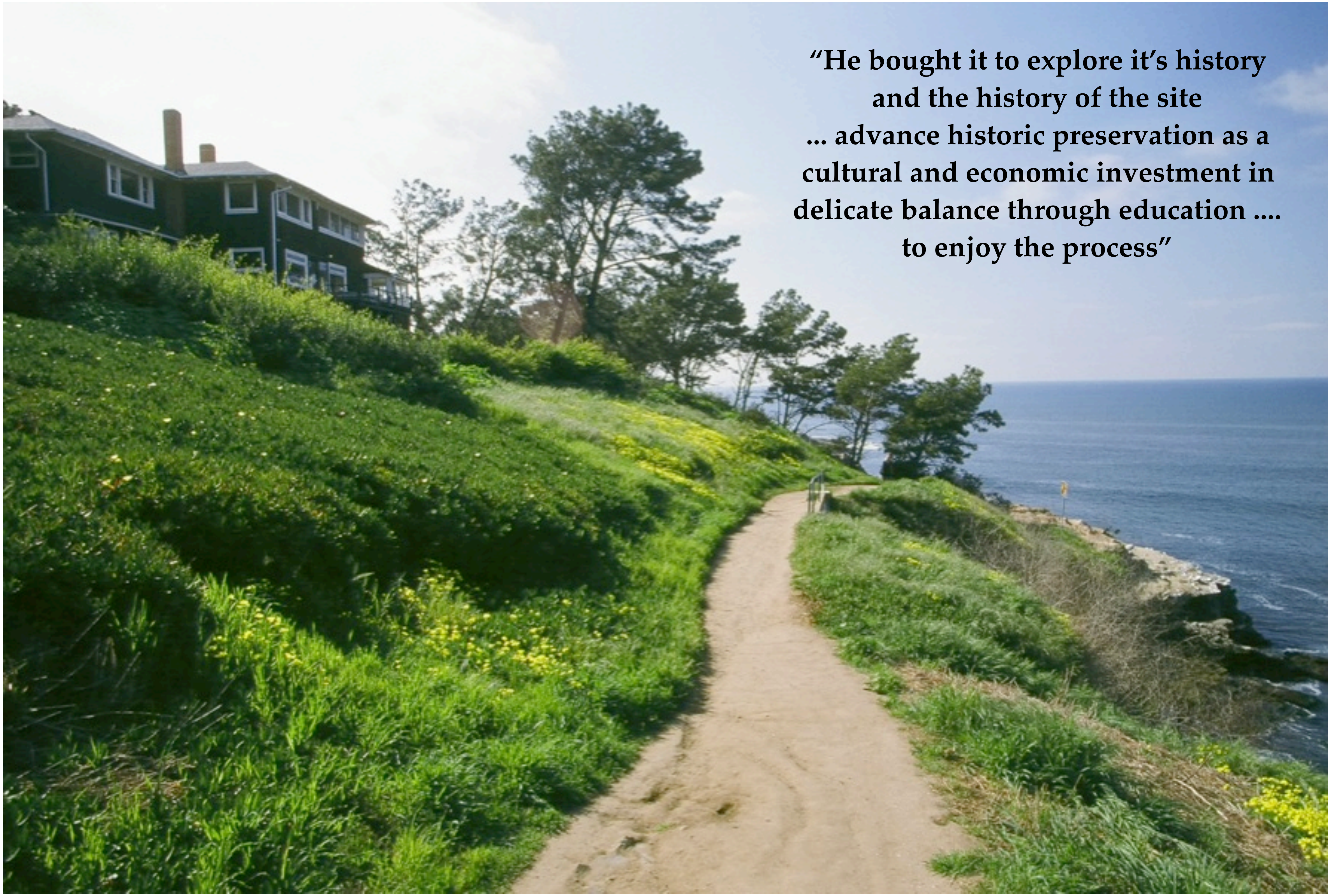
Defining the Moving Edge 20 years ago

Robert Thiele, Architect AIA

October 3, 2016

SeaCliff Story 1996

In 1995 my client purchased SeaCliff above the Seven Caves for $5.3 million, the highest real estate sale that year in La Jolla and he wanted me to design a house as close to the bluff edge as possible so people could not see him but he could see the ocean with breath taking views up the north coast.
He owned the Cave Store and the tunnel to the Sunny Jim Cave which was directly under the site.


"He bought it to explore it's history
and the history of the site
... advance historic preservation as a
cultural and economic investment in
delicate balance through education ....
to enjoy the process"

We decided to let **science** tell the story of SeaCliff and not take the adversarial road with the city to determine where the coastal bluff edge was located.

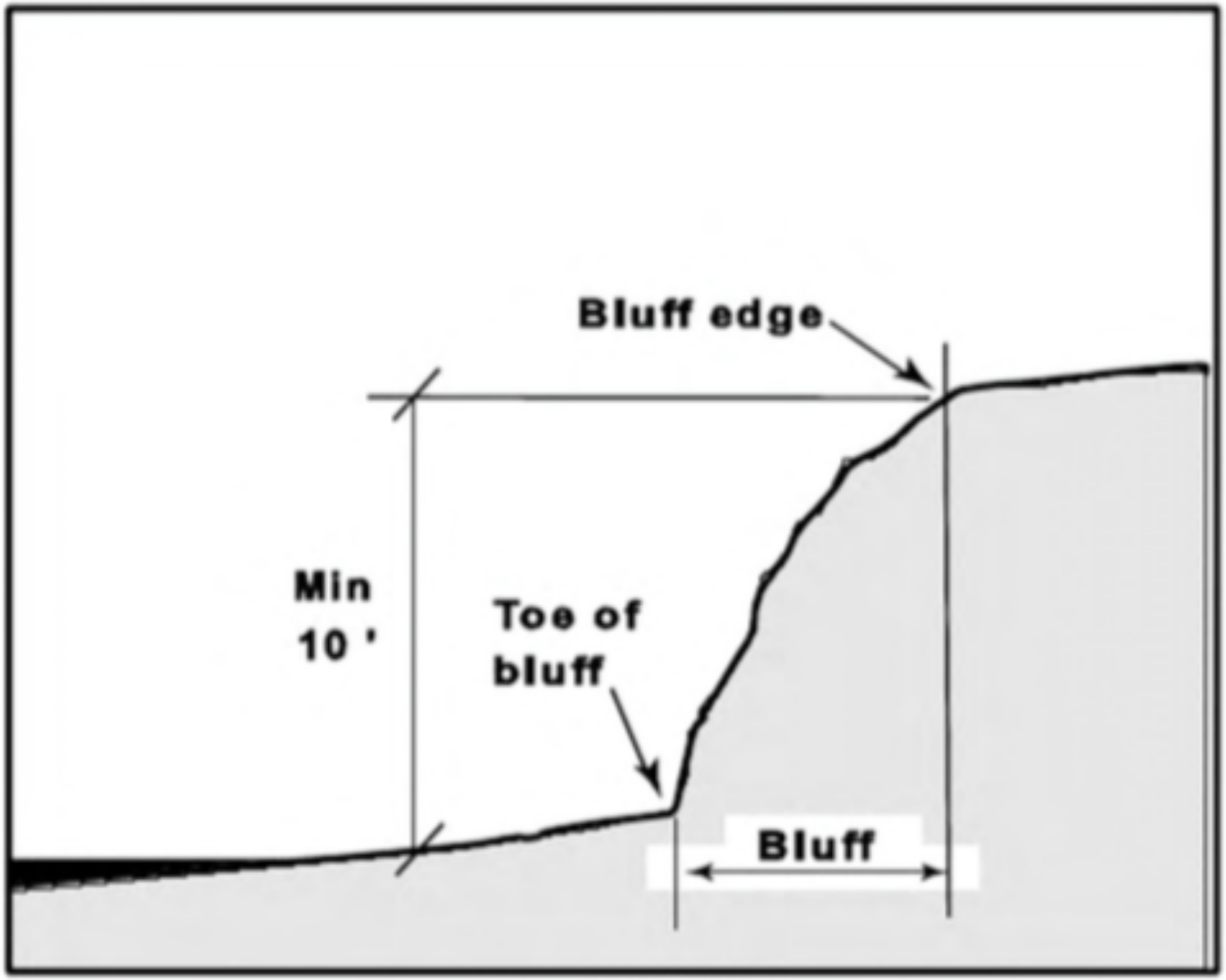
COASTAL BLUFF CONFERENCE
So we mapped the sea caves under the site to engage a conversation on coastal bluff erosion
and **defining the moving edge** with oceanographers, geologists, paleontologist, civil engineers, surveyors, architects, lawyers, code officials, politicians and the community.

let geology tell the story

These graphics are a result of those conversations and my professional curiosity.

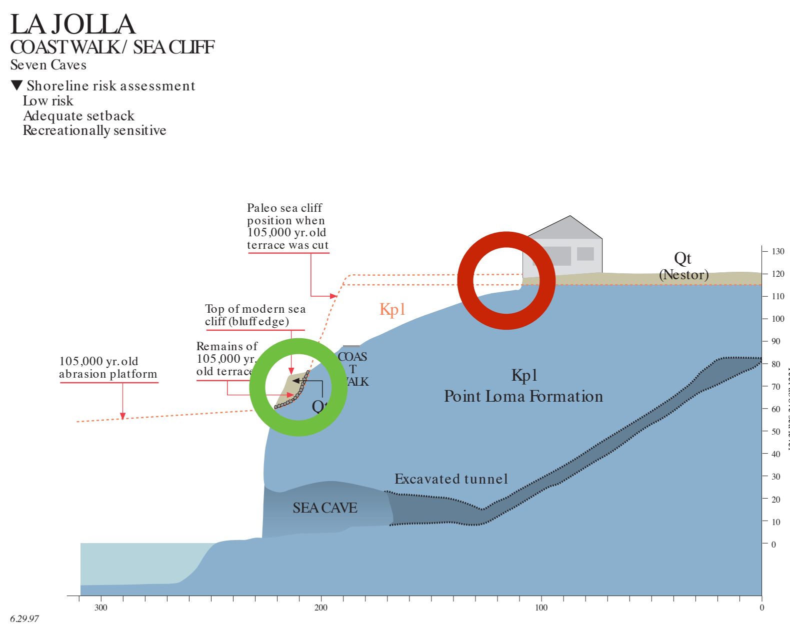
Thanks to Tom Demere, paleontologist, San Diego Natural History Museum for advice and Paul Horn, infographic illustrator.

DIAGRAM I-1: COASTAL BLUFF



Pleistocene

Upper Cretaceous



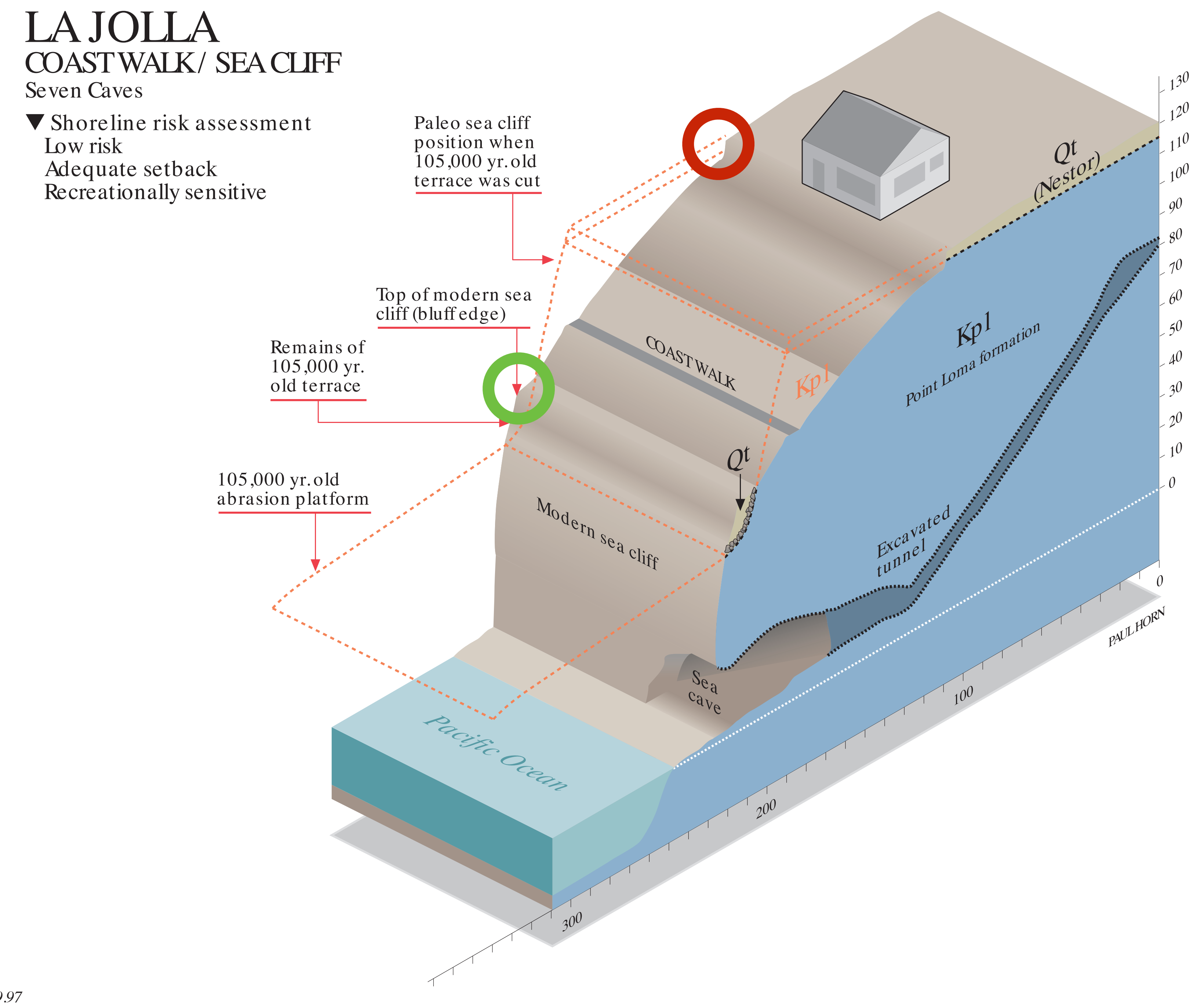


Illustration #10

Tom Rockwell, Phd Geology SDSU
Mike Hart, Engineering Geologist
Les Reed, Geotechnical Engineering Inc

The City of San Diego was building an observation deck down on Goldfish Point. **green circle**

I asked the planner where the coastal bluff edge was and he pointed to the top of the bluff next to the existing house. **red circle**

Somehow the city had a different setback then the private sector.

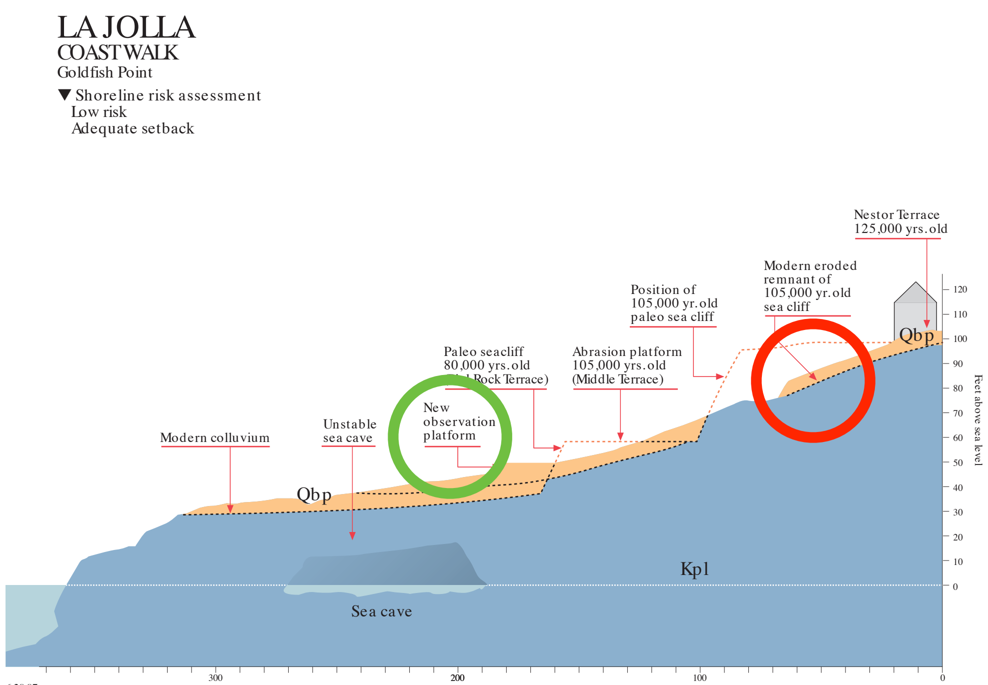


Illustration #11

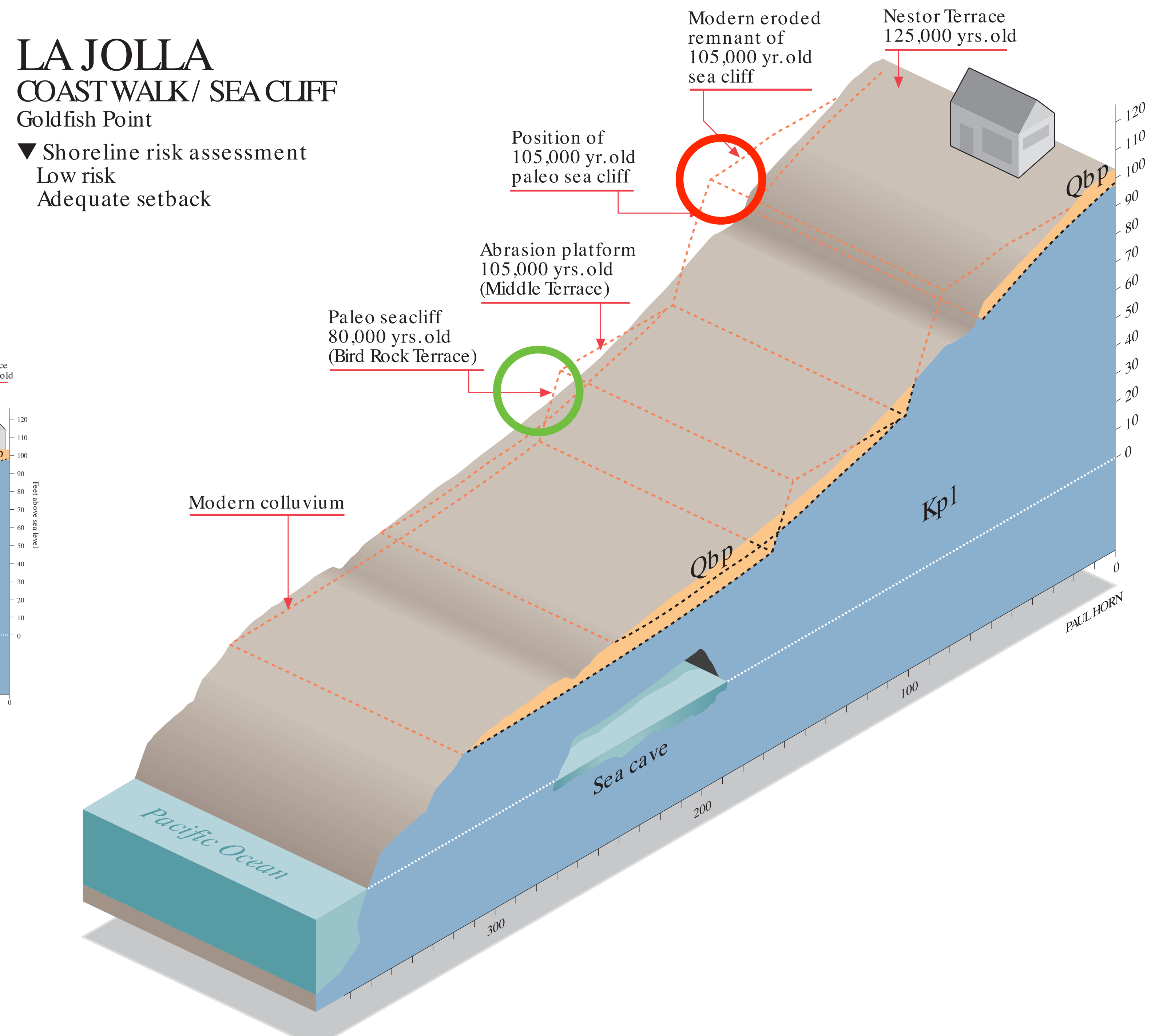


Illustration #11

Tom Rockwell, Phd
Mike Hart, Engineering Geologist
Les Reed, Geotechnical Engineering Inc

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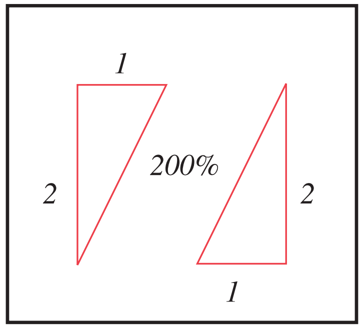
SENSITIVE COASTAL BLUFFS

▼ Steep escarpment generally 200%
Gullies
Sea caves



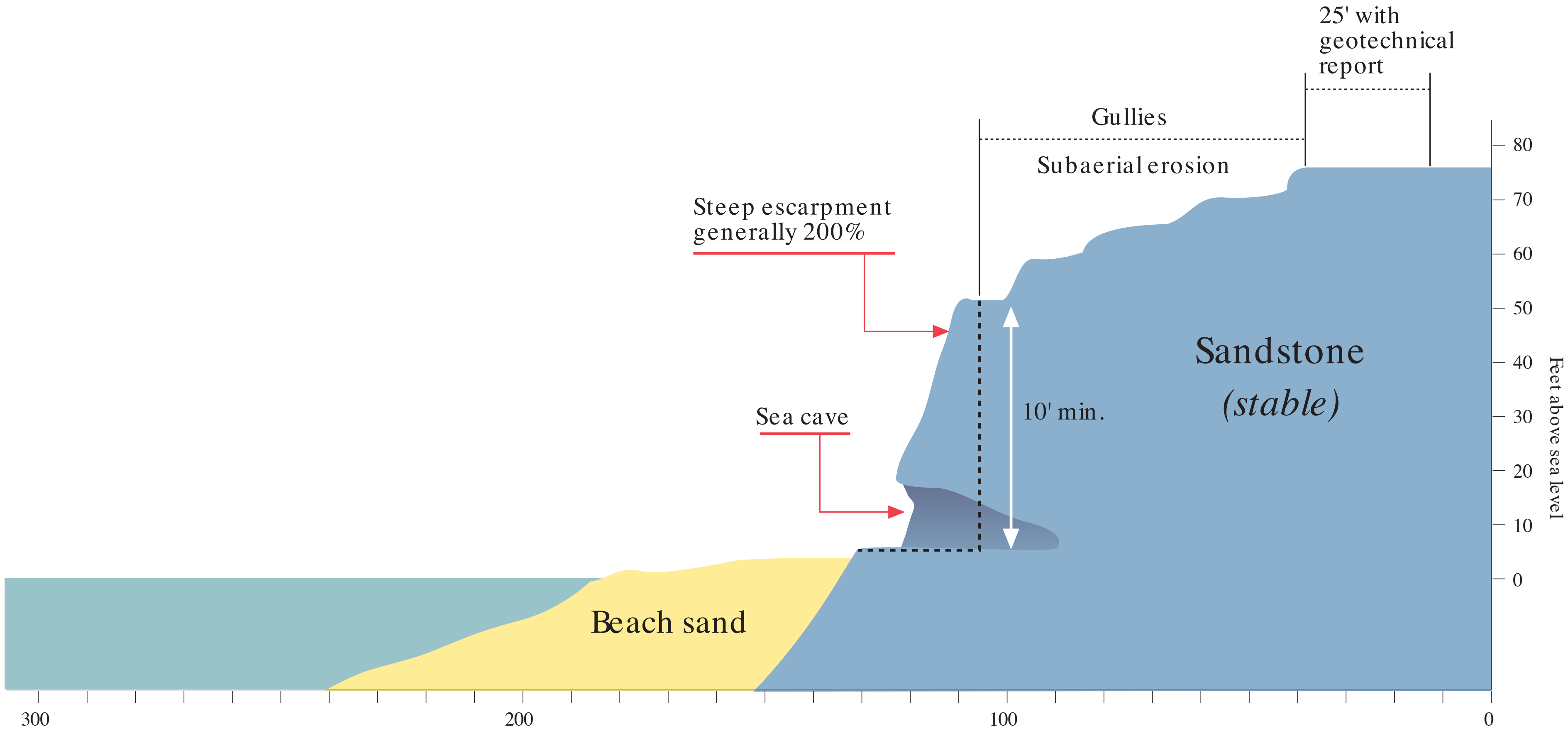


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Illustration A

PACIFIC
OCEAN
SAN DIEGO
MISSION
SAIL BAY
FIESTA BAY
Mission Beach
MISSION BAY

LA JOLLA
TOURMALINE BLUFFS

▼ Shoreline risk assessment
- High risk
- Inadequate setback
- Non-engineered rip rap
- Deteriorated structure
- Inadequate design

Pleistocene

Eocene

LA JOLLA
TOURMALINE BLUFFS
False Point

▼ Shoreline risk assessment
- High risk
- Inadequate setback
- Non-engineered rip rap
- Deteriorated structure
- Inadequate design

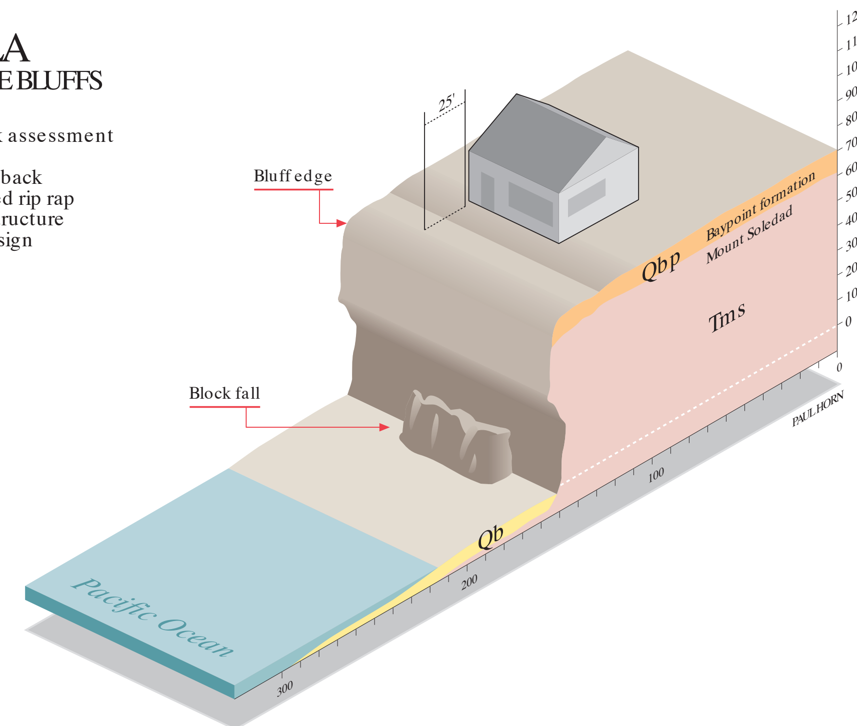

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Illustration #12

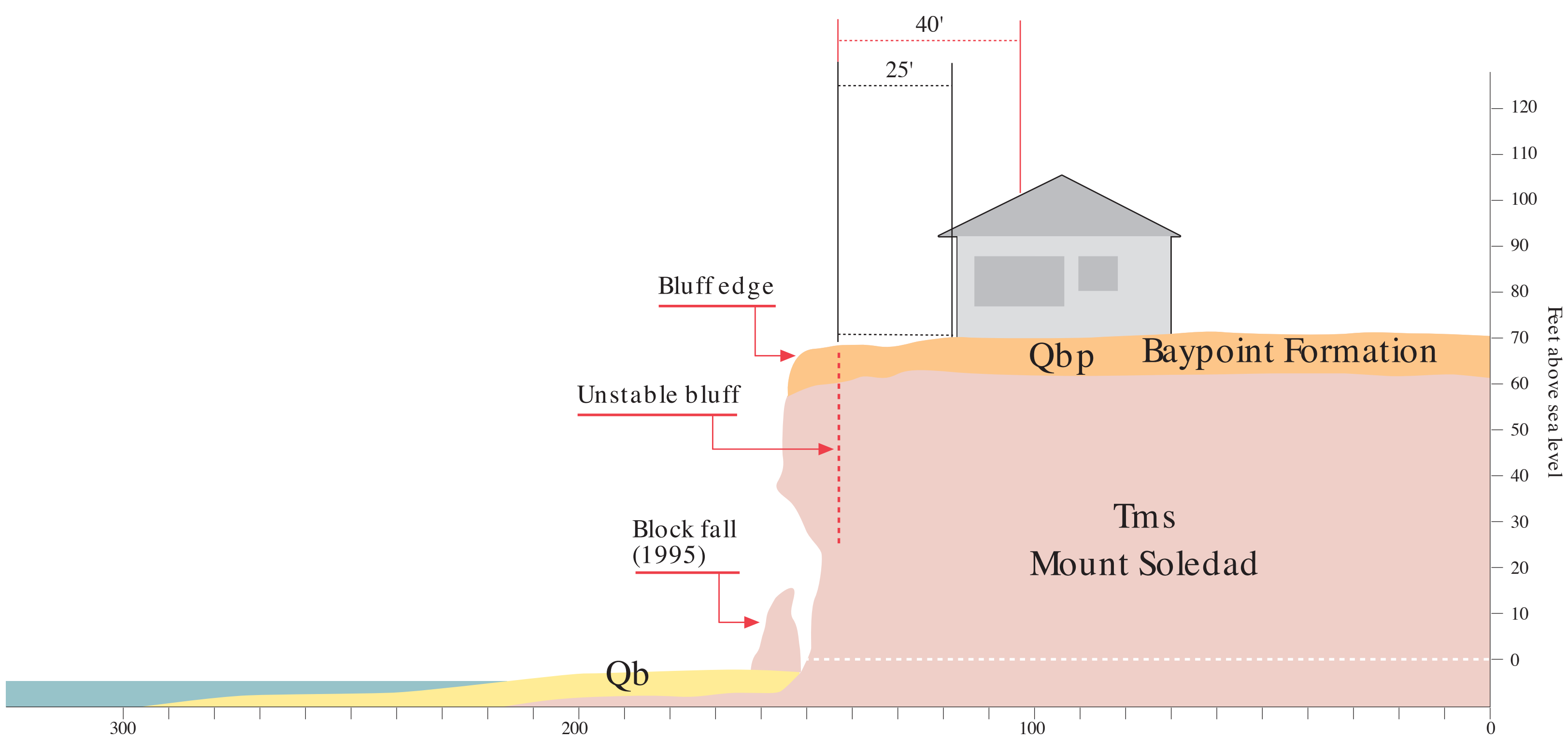

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Illustration #12

LA JOLLA
DEVIL'S SLIDE
Torrey Pines Road

▼ Shoreline risk assessment
High risk
Unfavorable geology
Inadequate setback

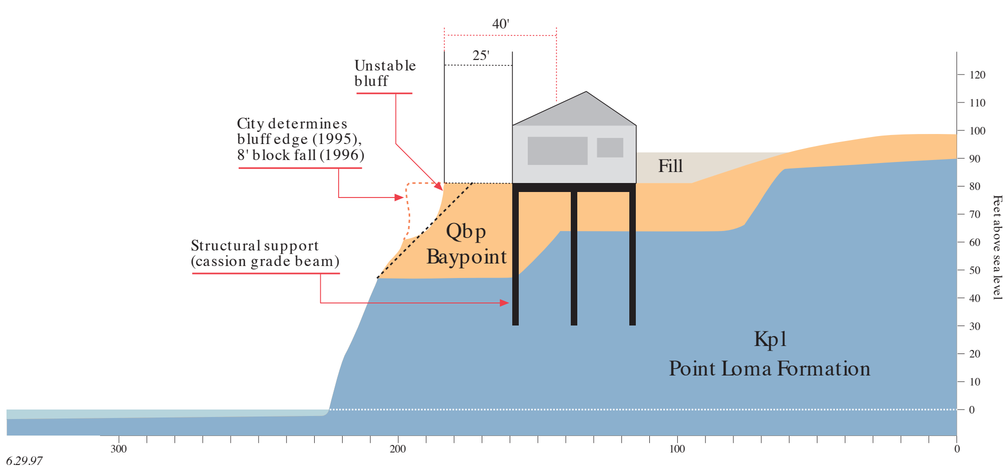

Illustration #9

LA JOLLA
DEVIL'S SLIDE
Torrey Pines Road

▼ Shoreline risk assessment
High risk
Unfavorable geology
Inadequate setback

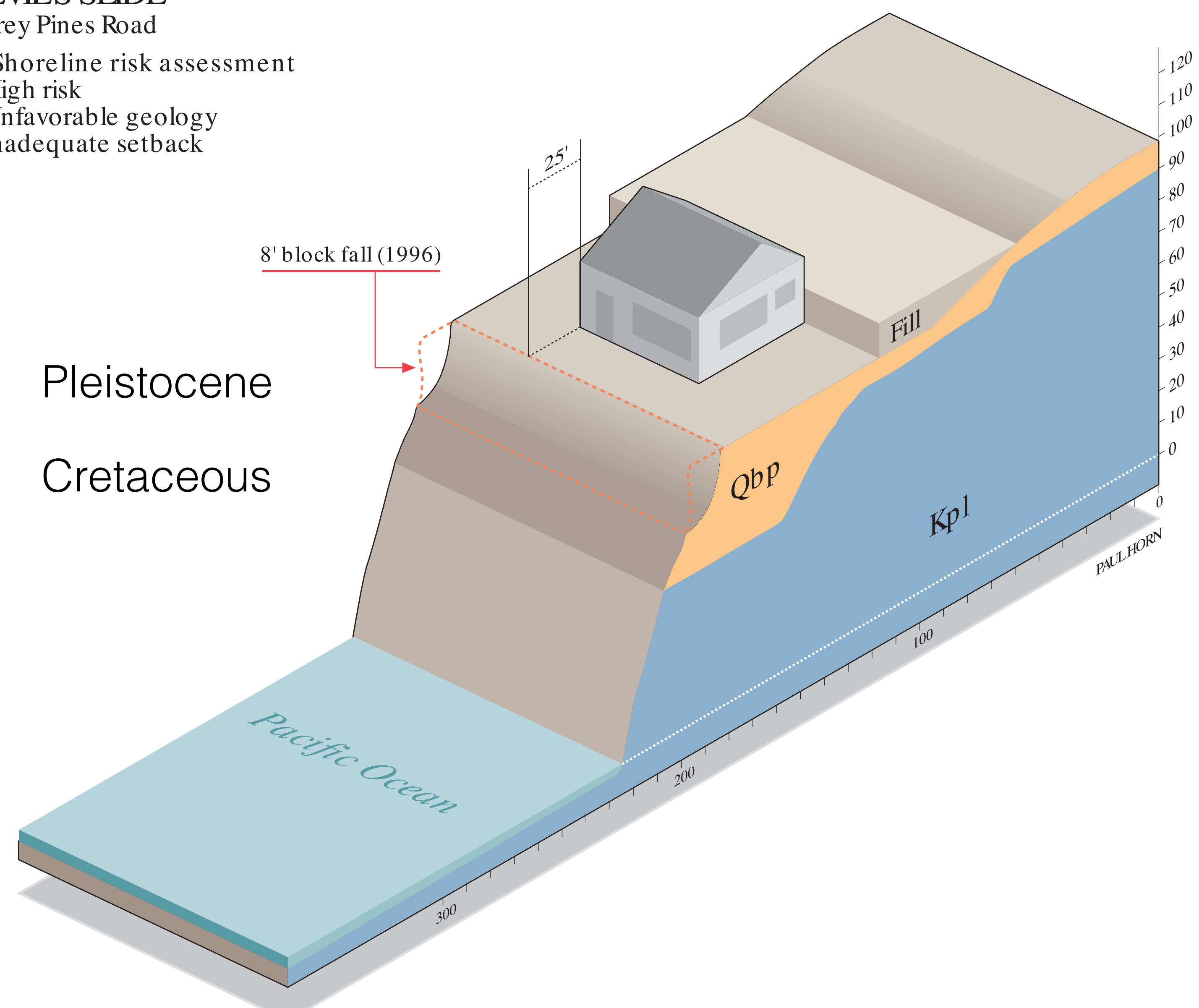

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Illustration #9

UNSTABLE BLUFF

▼ Unstable bluff with 40' setback
Steep escarpment

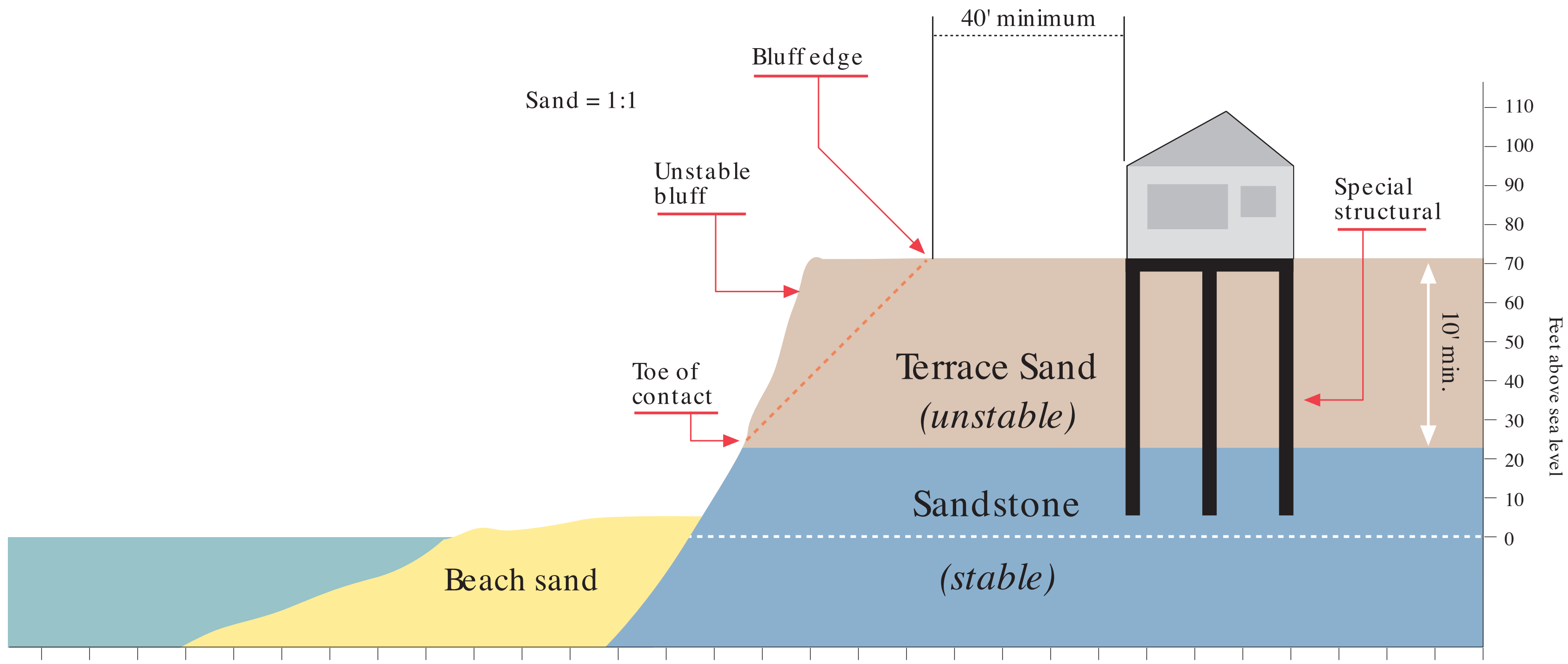

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Illustration B

Illustration B

LA JOLLA
SOUTHWEST MARINE FISHERIES

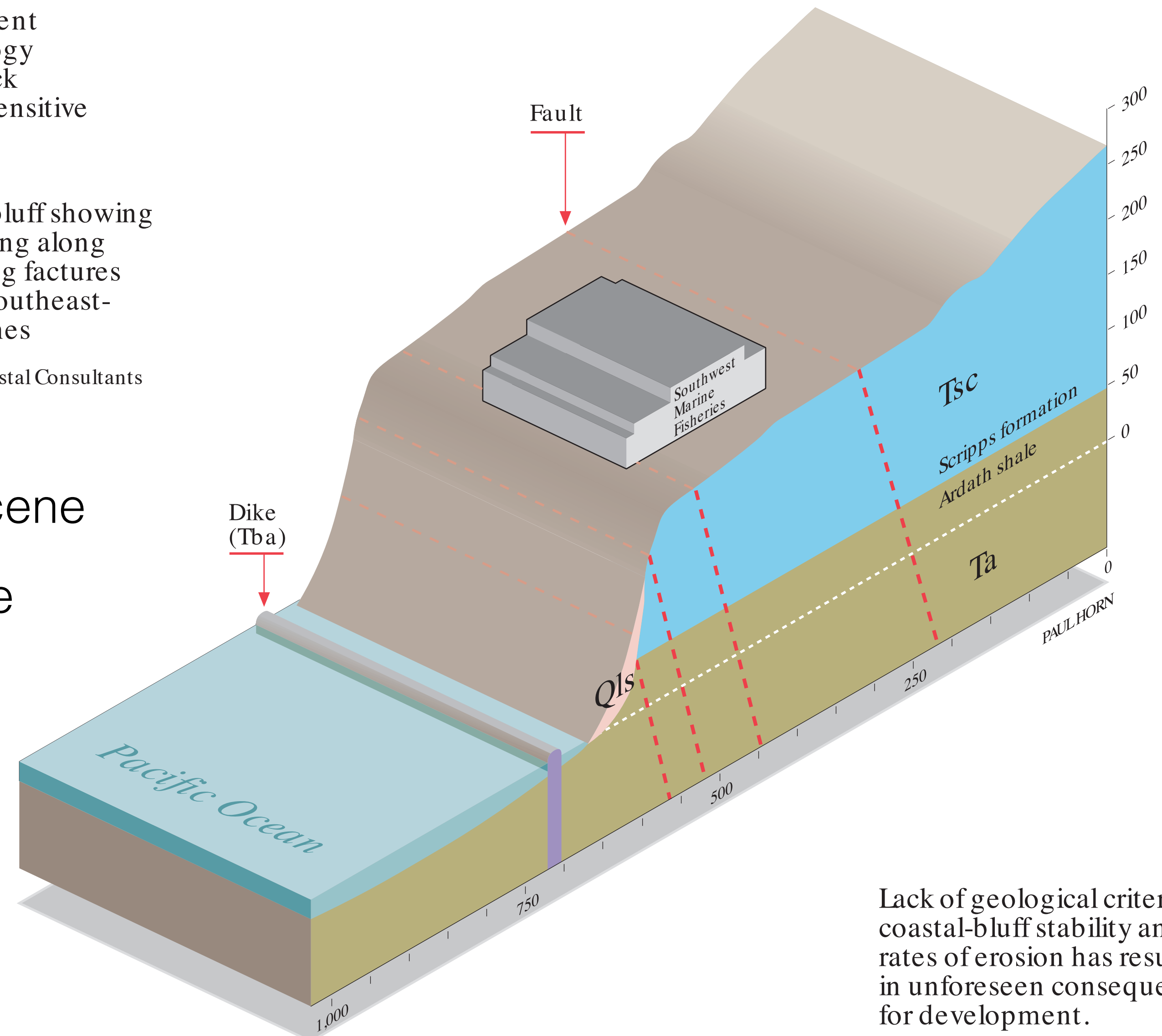
▼ Erosion assessment
Unfavorable geology
Inadequate setback
Environmentally sensitive
Narrow beach

▼ Cross-section of bluff showing block falls occurring along northwest-dipping factures associated with southeast-dipping fault planes

Source: Anders Rindell, Coastal Consultants

Pleistocene

Eocene



Lack of geological criteria for coastal-bluff stability and rates of erosion has resulted in unforeseen consequences for development.

Illustration #8

LA JOLLA
SOUTHWEST MARINE FISHERIES

▼ Erosion assessment
Unfavorable geology
Inadequate setback
Environmentally sensitive
Narrow beach

▼ Cross-section of bluff showing block falls occurring along northwest-dipping factures associated with southeast-dipping fault planes

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Lack of geological criteria for coastal-bluff stability and rates of erosion has resulted in unforeseen consequences for development.

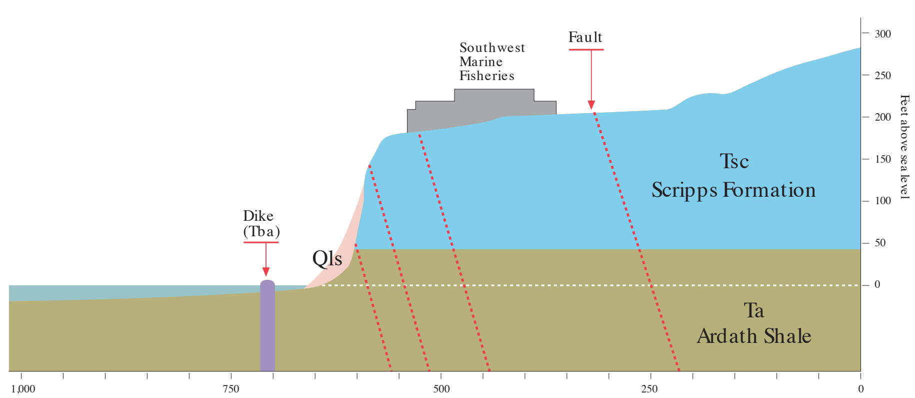

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Illustration #8

TORREY PINES
LANDSLIDE

▼ Shoreline risk assessment
Low risk
Unfavorable geology
Narrow beach
Environmentally sensitive

TORREY PINES
LANDSLIDE

▼ Shoreline Atlas
Risk assessment
Low risk
Unfavorable geology
Narrow beach
Environmentally sensitive

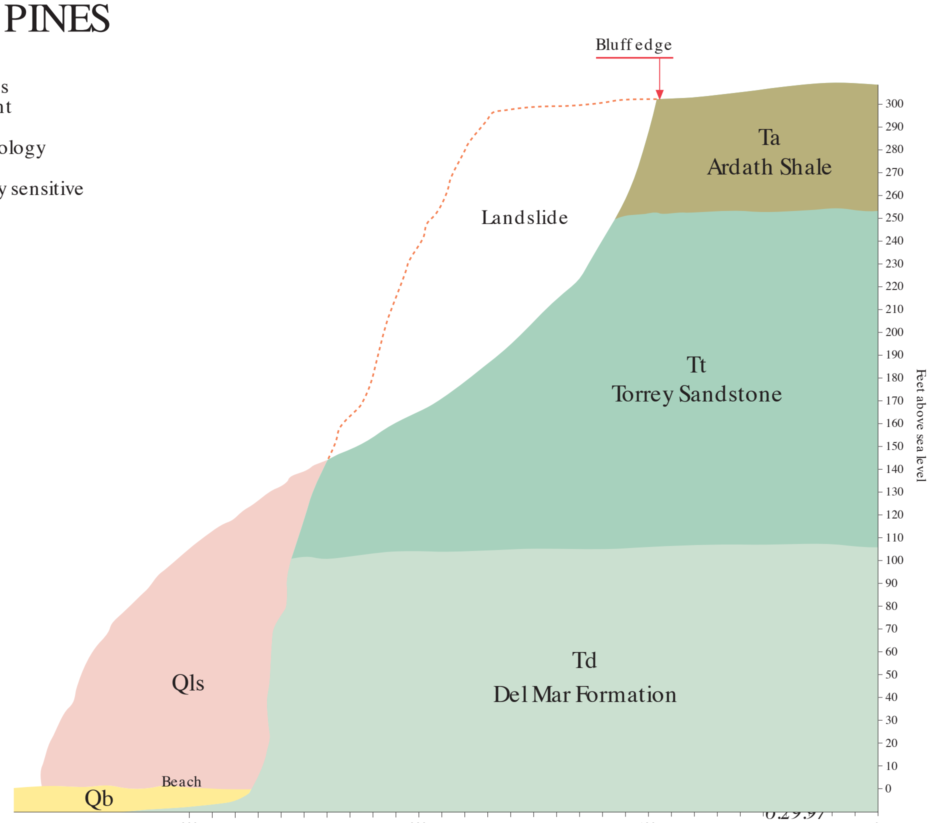

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Illustration #6

Pleistocene

Eocene

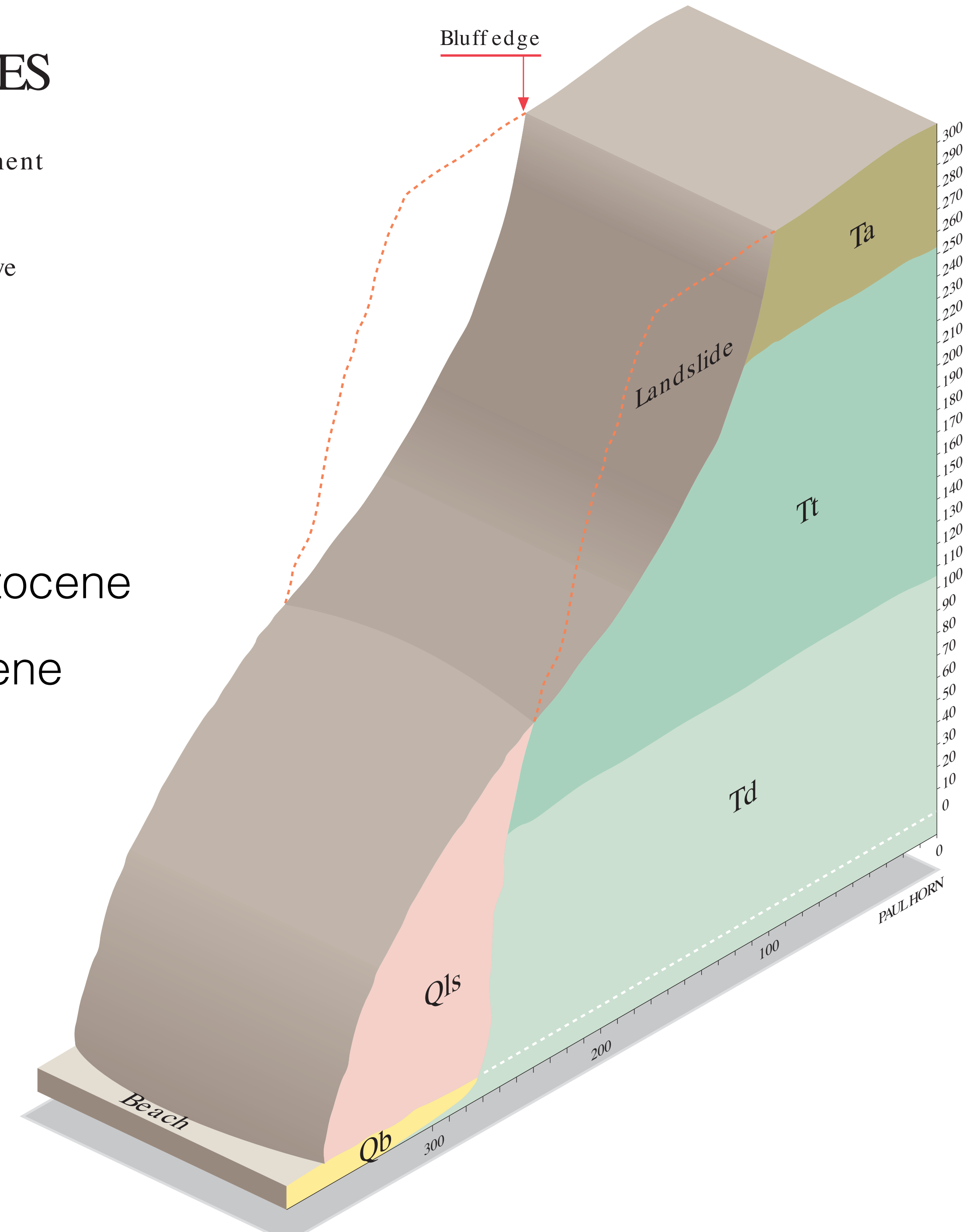
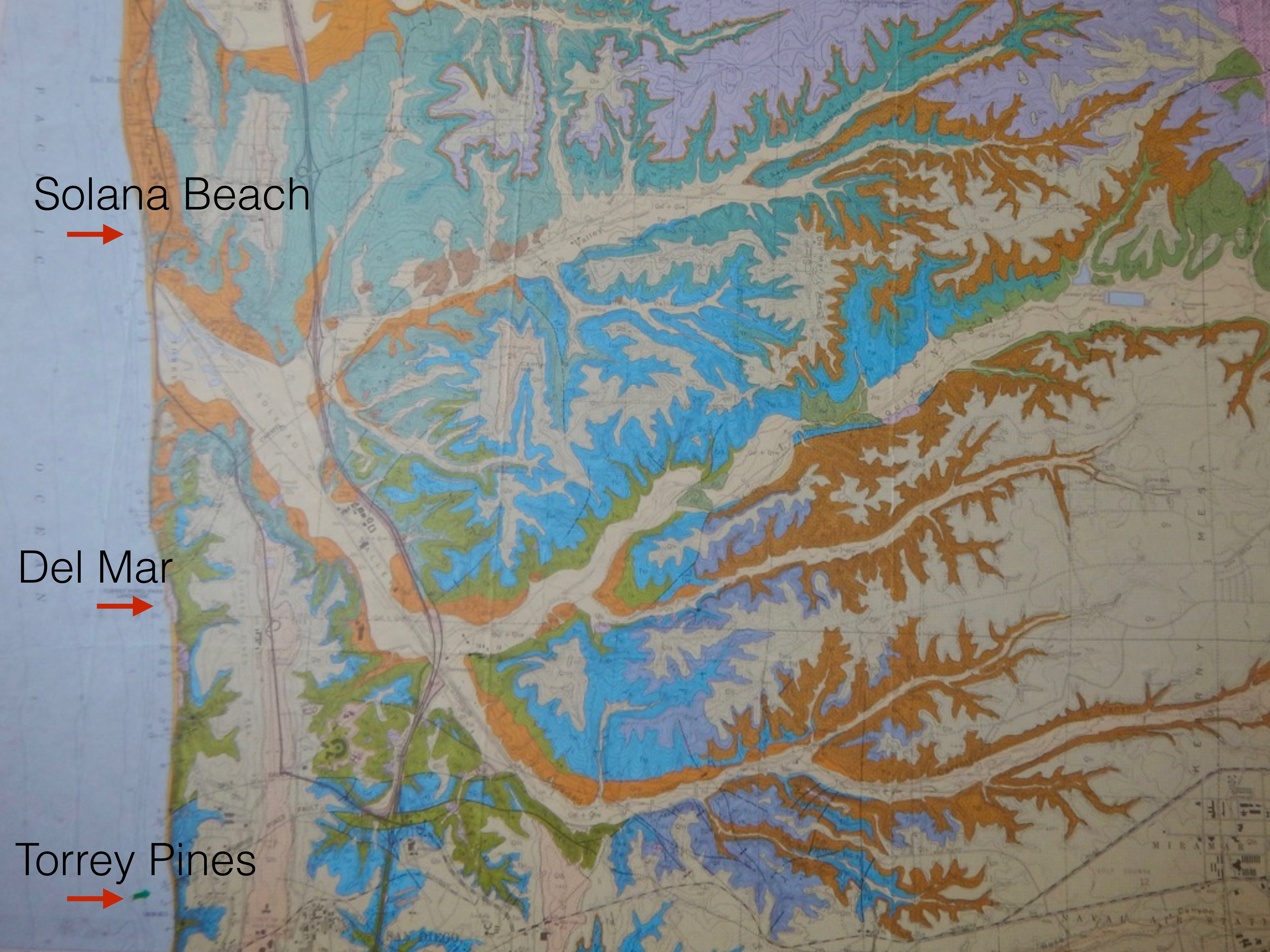


Illustration #6


Solana Beach
Del Mar
Torrey Pines

TORREY PINES
BLACKS BEACH

▼ Erosion assessment
- Unfavorable geology
- Environmentally sensitive
- Narrow beach
- Recreationally sensitive

TORREY PINES
BLACKS BEACH
▼ Erosion assessment
Unfavorable geology
Environmentally sensitive
Narrow beach
Recreationally sensitive

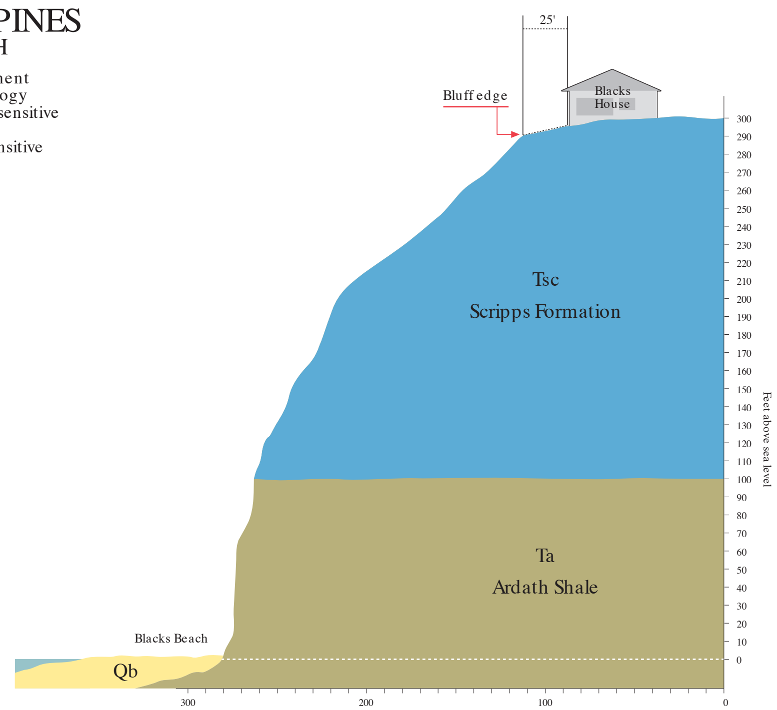


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Illustration #7

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Pleistocene

Eocene

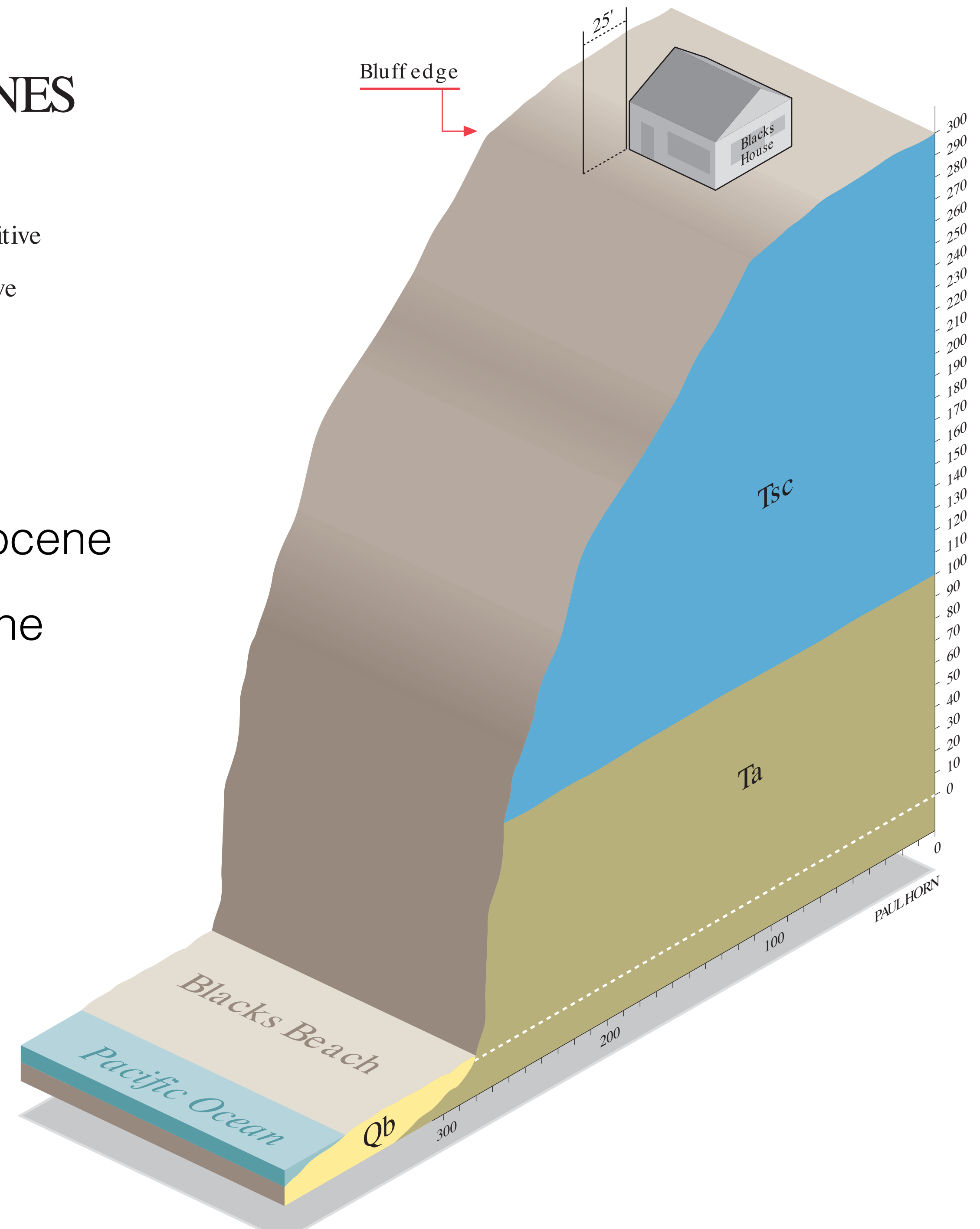

Illustration #7

So, what will happen when the sea level rises and the storm surge erosion eats away at the base of these bluffs?

TORREY PINES
LANDSLIDE

▼ Shoreline risk assessment
- Low risk
- Unfavorable geology
- Narrow beach
- Environmentally sensitive

Pleistocene

Eocene

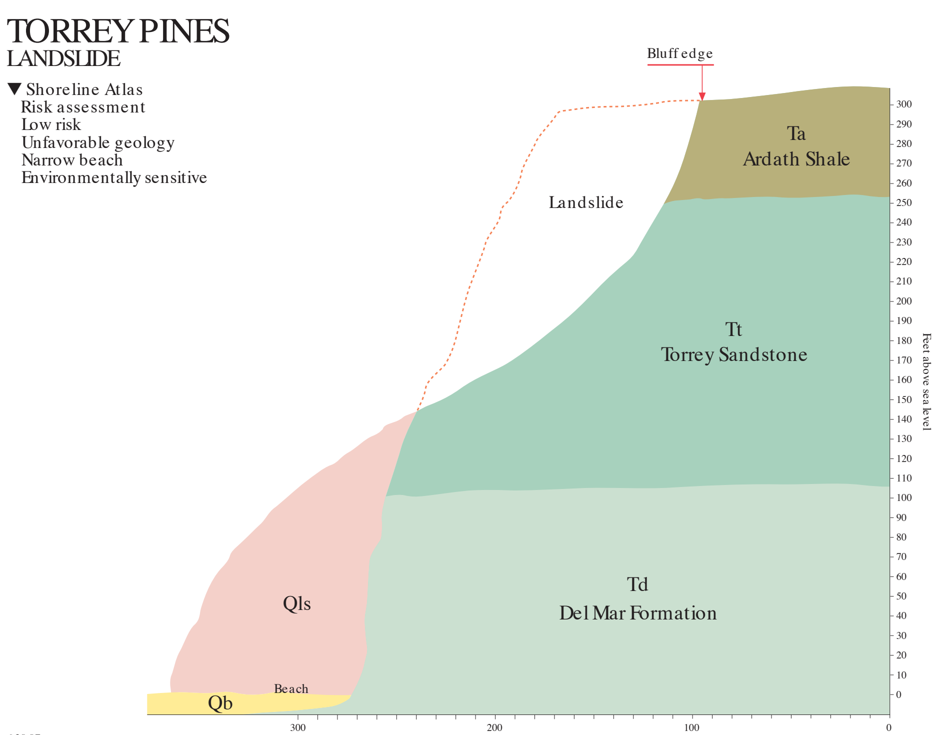

Illustration #6

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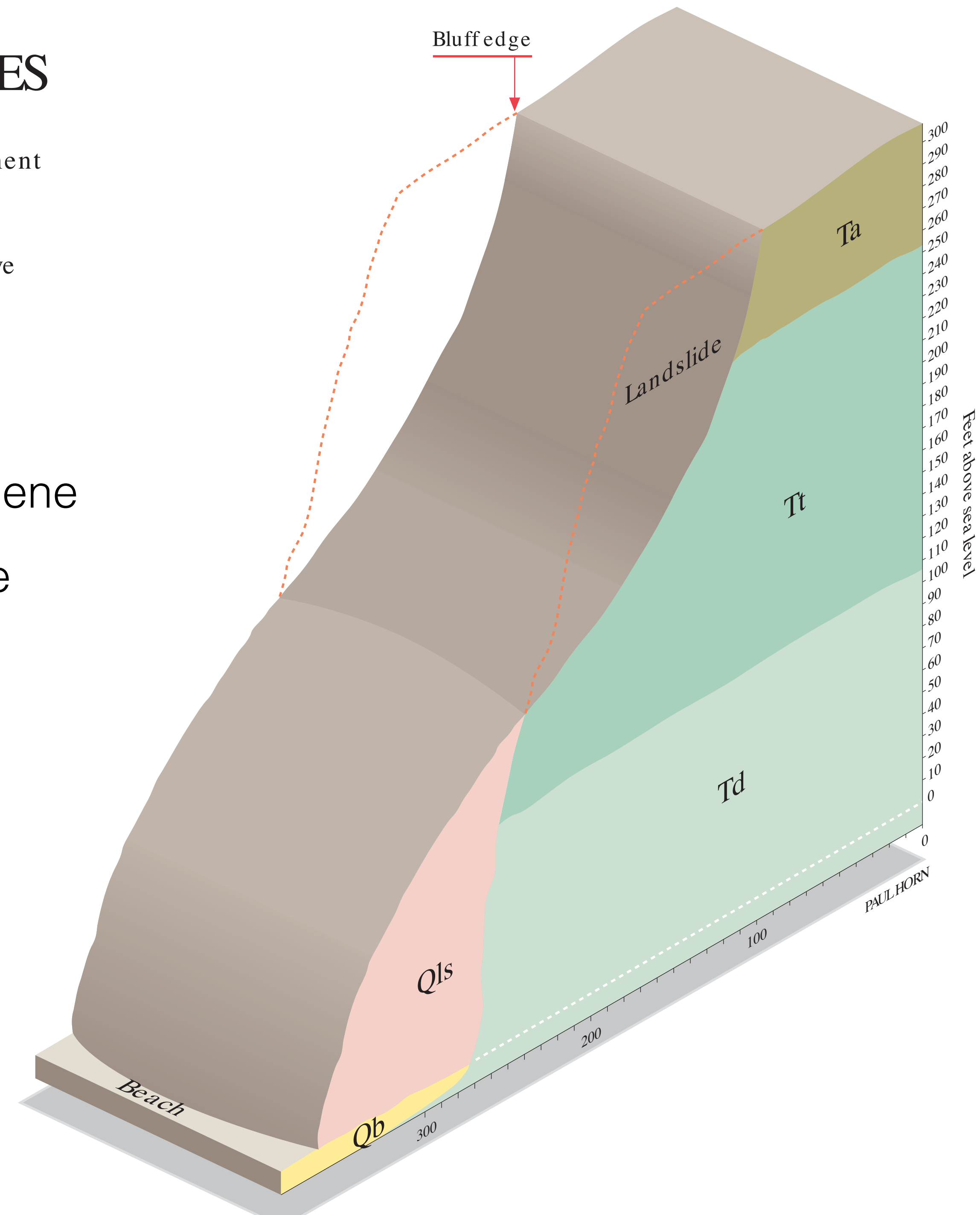

Illustration #6

DEL MAR
DEL MAR HEIGHTS RD.

▼ Erosion assessment
Adequate to inadequate setback
Narrow beach
Recreationally sensitive

DEL MAR
DEL MAR HEIGHTS RD.

▼ Shoreline Atlas
Erosion assessment
Adequate to inadequate setback
Narrow beach
Recreationally sensitive

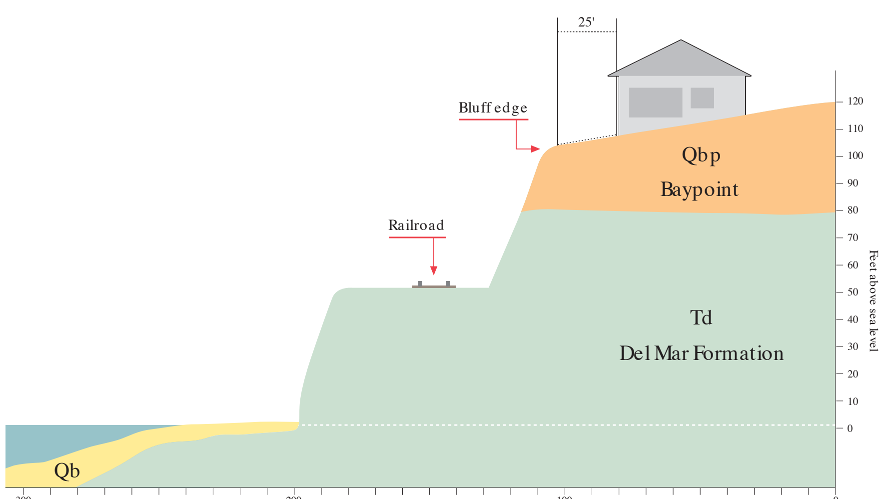

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Illustration #5

Pleistocene

Eocene

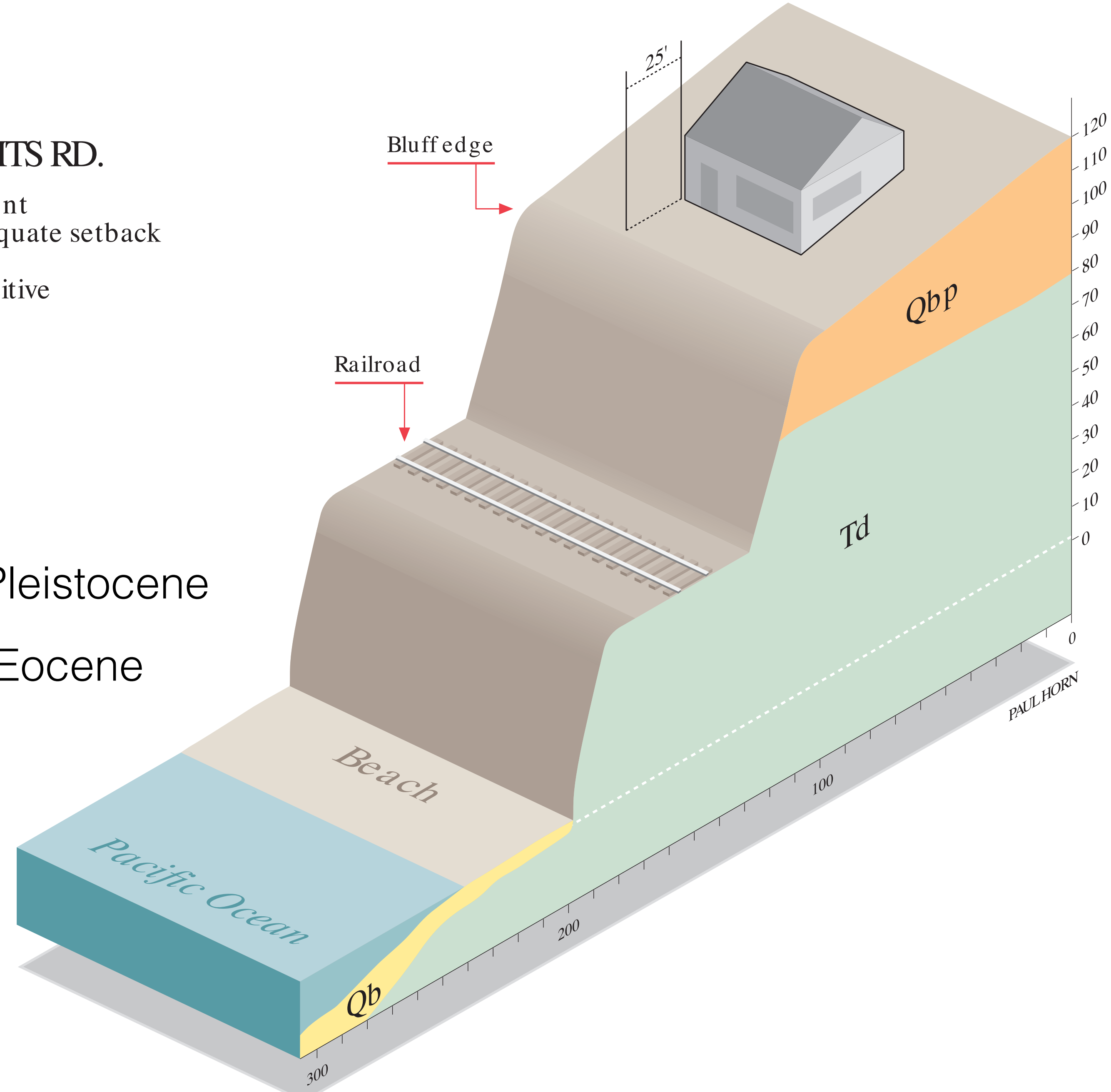

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Illustration #5

ENCINITAS
SEACLIFF COUNTY PARK
South end
▼ Shoreline Atlas
Erosion assessment
Moderate risk
Adequate setback
Recreationally sensitive

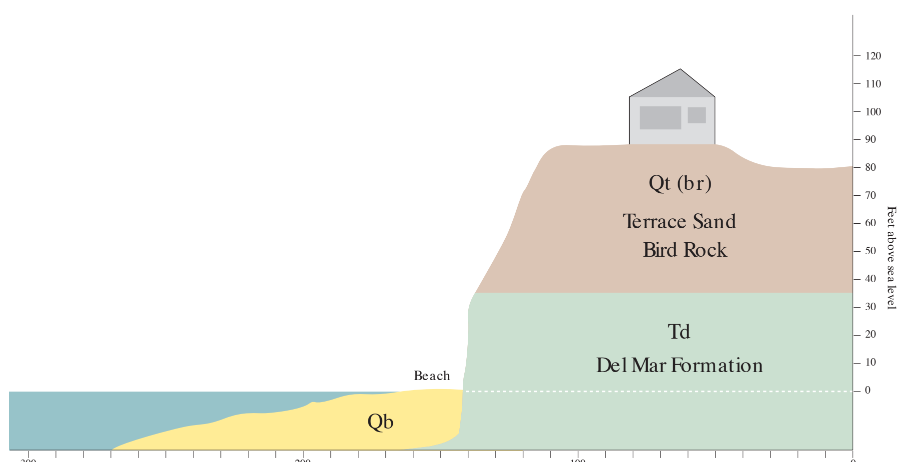

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Illustration #3

ENCINITAS
SEACLIFF COUNTY PARK
South end

▼ Erosion assessment
Moderate risk
Adequate setback
Recreationally sensitive

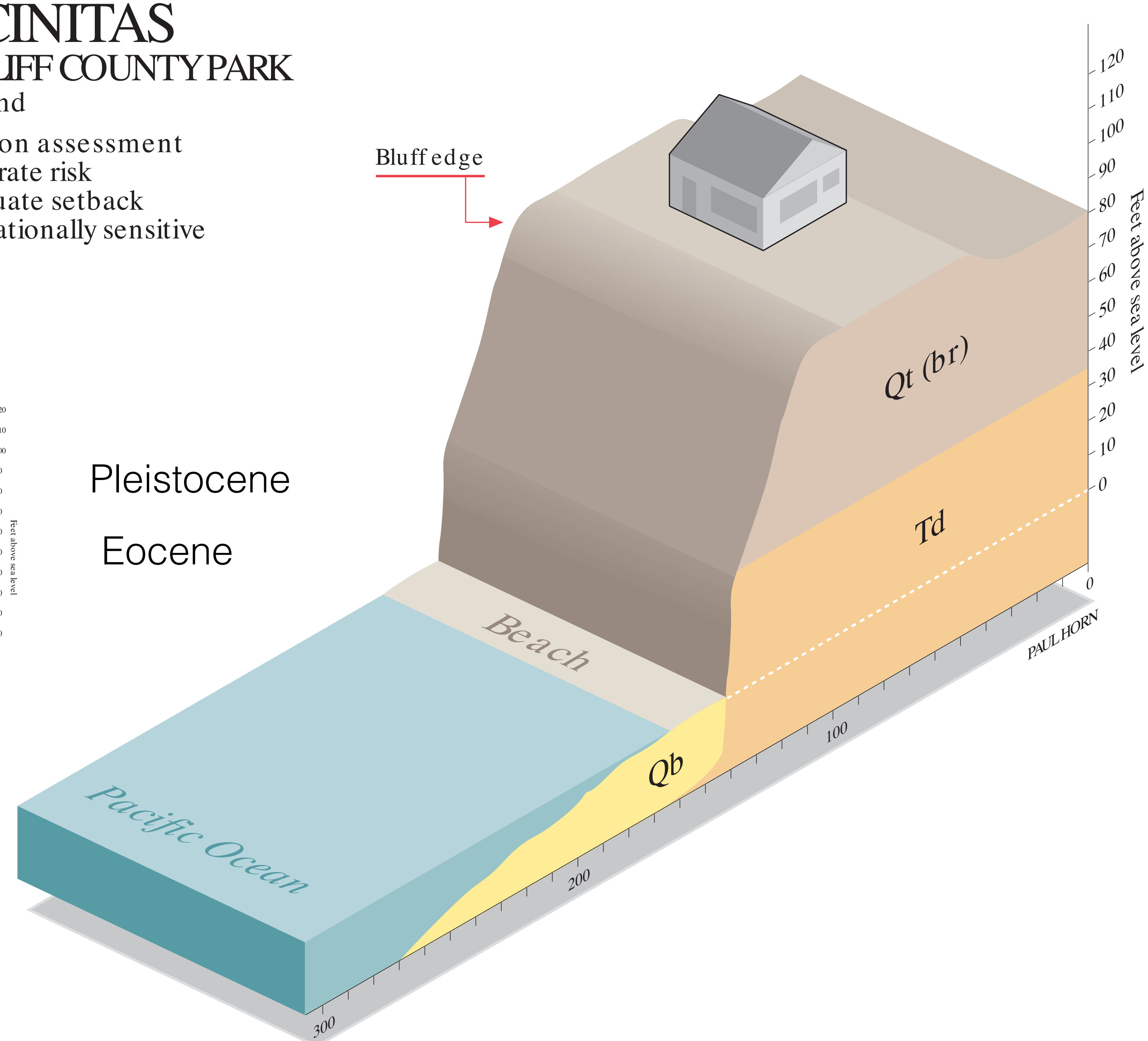

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Illustration #3

LEUCADIA
828 NEPTUNE
Leucadia Park

▼ Shoreline risk assessment
High risk
Unfavorable geology
Inadequate and adequate setback

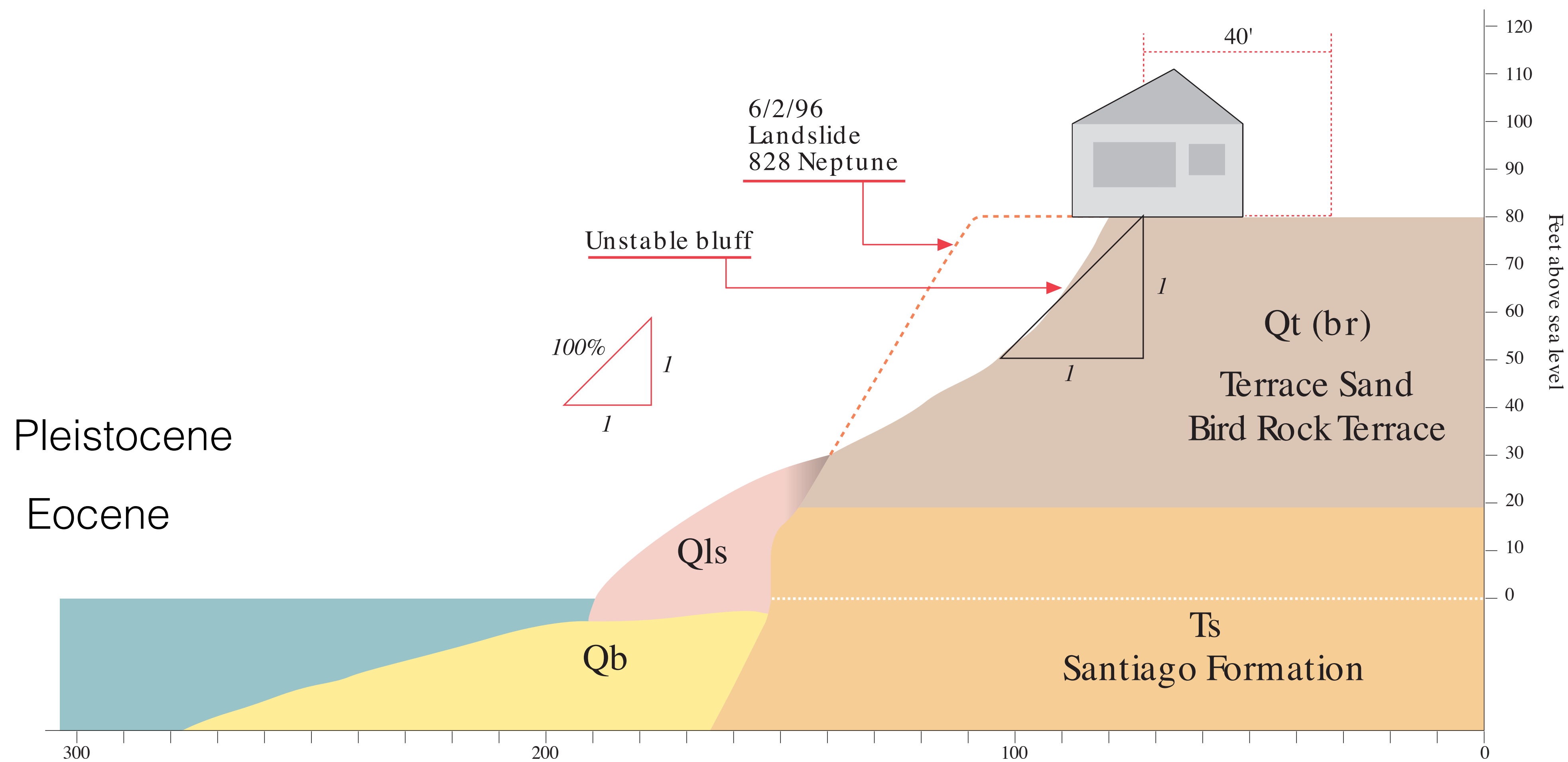

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Illustration #1

LEUCADIA
BATIQUITOS LAGOON
Moonlight Beach

▼ Shoreline Atlas
Risk assessment
High to moderate risk
Unfavorable geology
Inadequate and adequate setback
Inadequate design

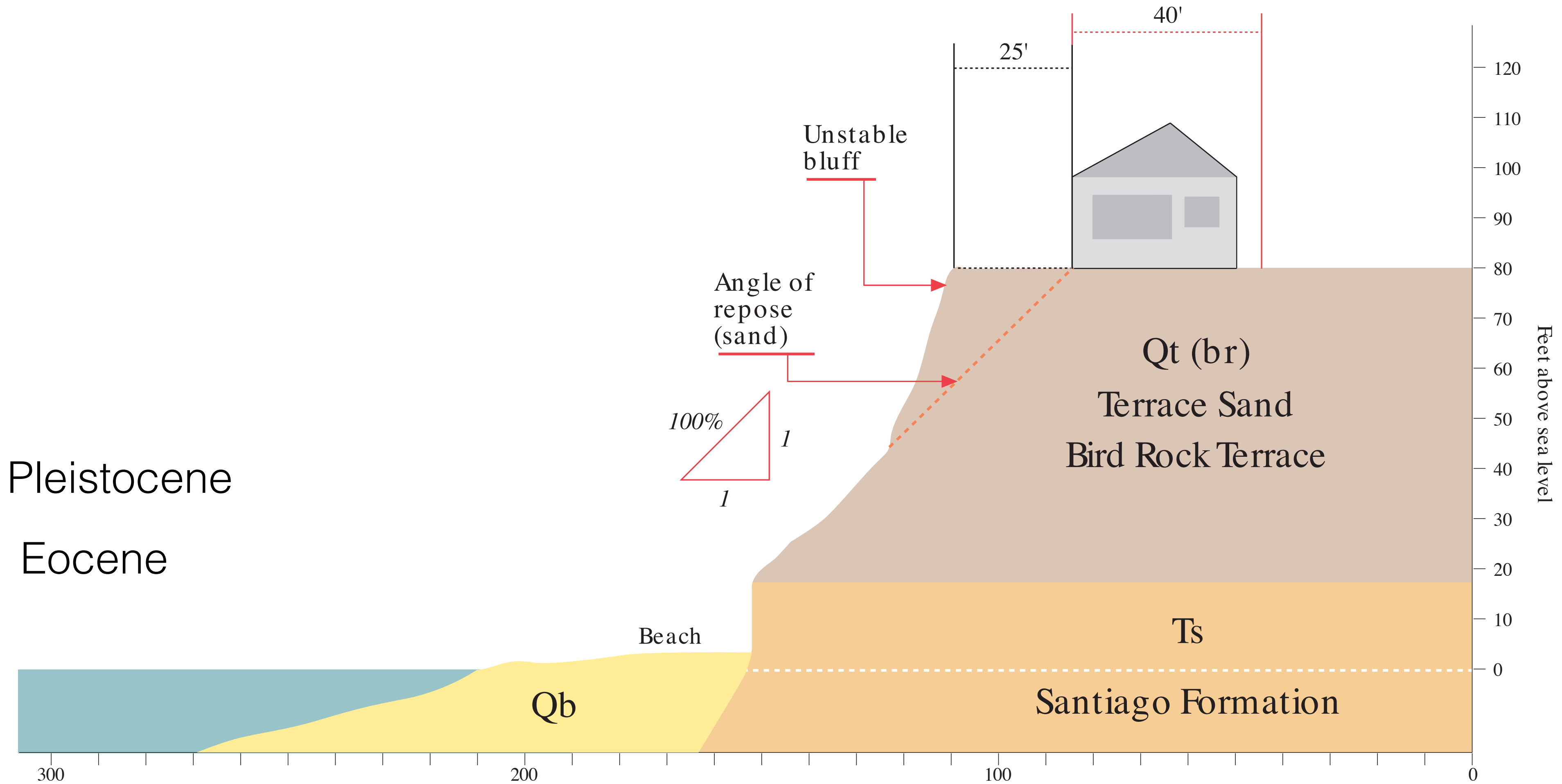

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Illustration #2

So, what happens when the earth starts shaking?

San Diego / Tijuana Earthquake Planning Scenario Update

M 6.9 on the Rose Canyon Fault

Earthquake Engineering Research Institute

Rose Canyon Fault Ruptures at
10:10 am October 20, 2017

Design Earthquake

M 6.9

Crustal Strike Slip

Right Lateral

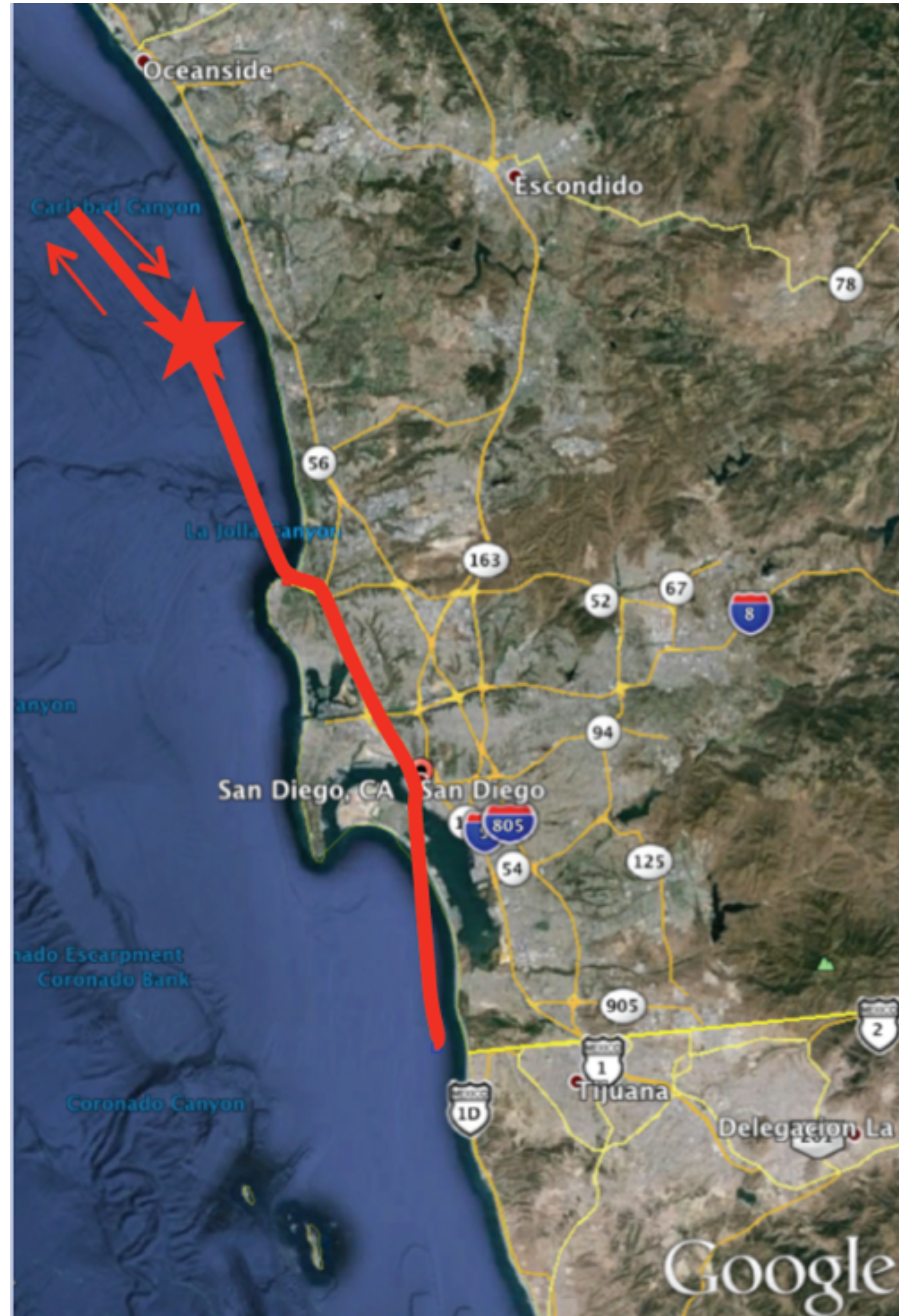
Surface Rupture

Southeast - South
Offshore - LJ-OT-SD Silver Strand
Length 69 km (43 miles)
Slip 2 m max (6.6 ft Horizontal)
Unilateral Rupture
Directly Towards Tijuana

Epicenter

Location N33.01 W117.32
Depth 7.7 km (4.8 miles)

Recurrence Interval
1000 years
2mm/yr Slip Rate (0.08 inches)



PAGER

Prompt Assessment of Global Earthquakes for Response

15 minutes after earthquake

Estimates

100 - 1000 Fatalities

$10 -100 billion in economic loss

Earthquake Shaking Red Alert

M 6.9, Shakeout 2015 SD-TJ Scenario (Wills 2015 Hybrid Vs30 + TJ Overlay)

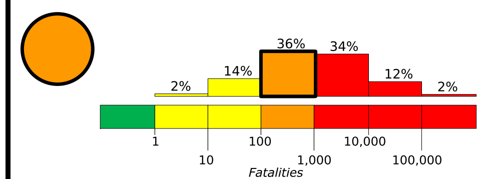
PAGER Version 1

Origin Time: Thu 2015-04-30 18:00:00 UTC (11:00:00 local)

Location: 33.01 N 117.32 W Depth: 7 km

Created: 15 minutes, 0 seconds after earthquake

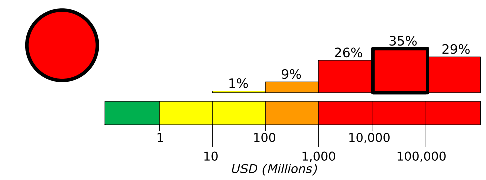
Estimated Fatalities



Red alert level for economic losses. Extensive damage is probable and the disaster is likely widespread. Estimated economic losses are 0-3% GDP of the United States. Past events with this alert level have required a national or international level response.

Orange alert level for shaking-related fatalities. Significant casualties are likely.

Estimated Economic Losses



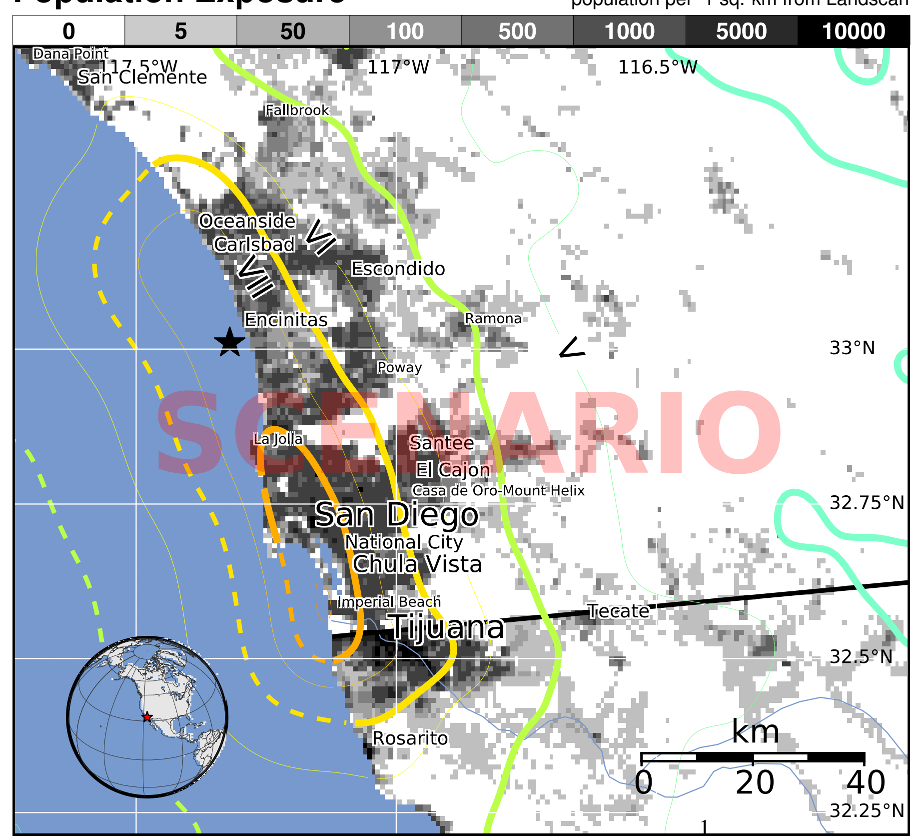
Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)		- -*	- -*	- -*	114k*	1,195k	2,772k	1,048k	18k	0
ESTIMATED MODIFIED MERCALLI INTENSITY		I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING		Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

*Estimated exposure only includes population within the map area

Population Exposure

population per 1 sq. km from Landscan



Structures:
Overall, the population in this region resides in structures that are highly resistant to earthquake shaking, though some vulnerable structures exist. The predominant vulnerable building types are reinforced masonry and reinforced concrete frame construction.

Historical Earthquakes (with MMI levels):

Date (UTC)	Dist. (km)	Mag.	Max MMI(#)	Shaking Deaths
1979-10-15	158	6.5	IX(3k)	0
1987-10-01	139	5.9	VIII(20k)	8
1994-01-17	172	6.7	IX(181k)	33

Recent earthquakes in this area have caused secondary hazards such as landslides and liquefaction that might have contributed to losses.

Selected City Exposure
from GeoNames.org

MMI	City	Population
VIII	**San Diego**	**1,307k**
VIII	Coronado	19k
VIII	**Imperial Beach**	**26k**
VIII	**Encinitas**	**60k**
VIII	Solana Beach	13k
VIII	Del Mar	4k
VIII	**Tijuana**	**1,376k**
VII	**Chula Vista**	**244k**
VII	**Carlsbad**	**105k**
VII	**Oceanside**	**167k**
VI	**Escondido**	**144k**

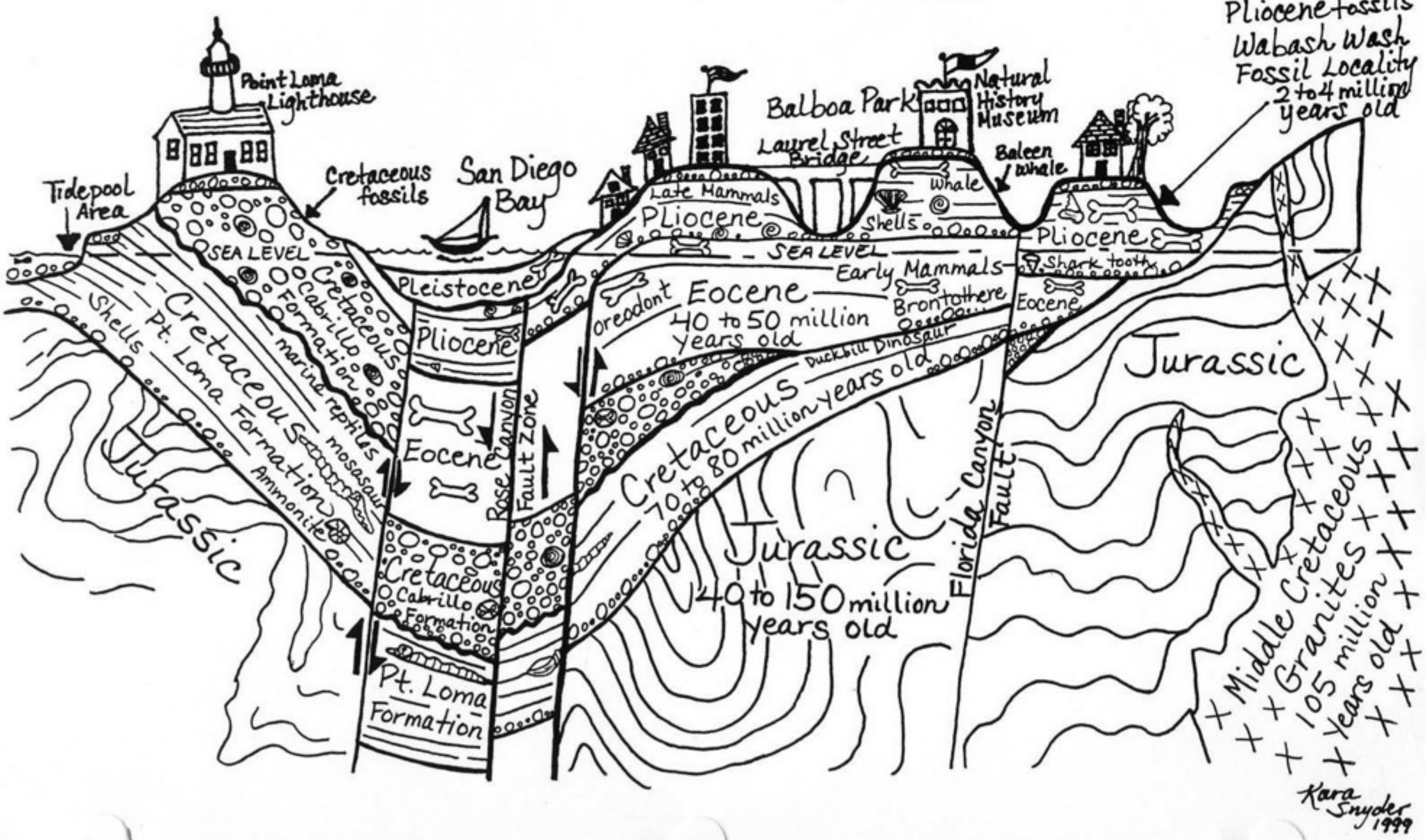
bold cities appear on map (k = x1000)

PAGER content is automatically generated, and only considers losses due to structural damage. Limitations of input data, shaking estimates, and loss models may add uncertainty.

http://earthquake.usgs.gov/pager

Event ID: usshakeout_sdtj2015_hybridvs30_tj_se

SAN DIEGO GEOLOGY




thank you for listening