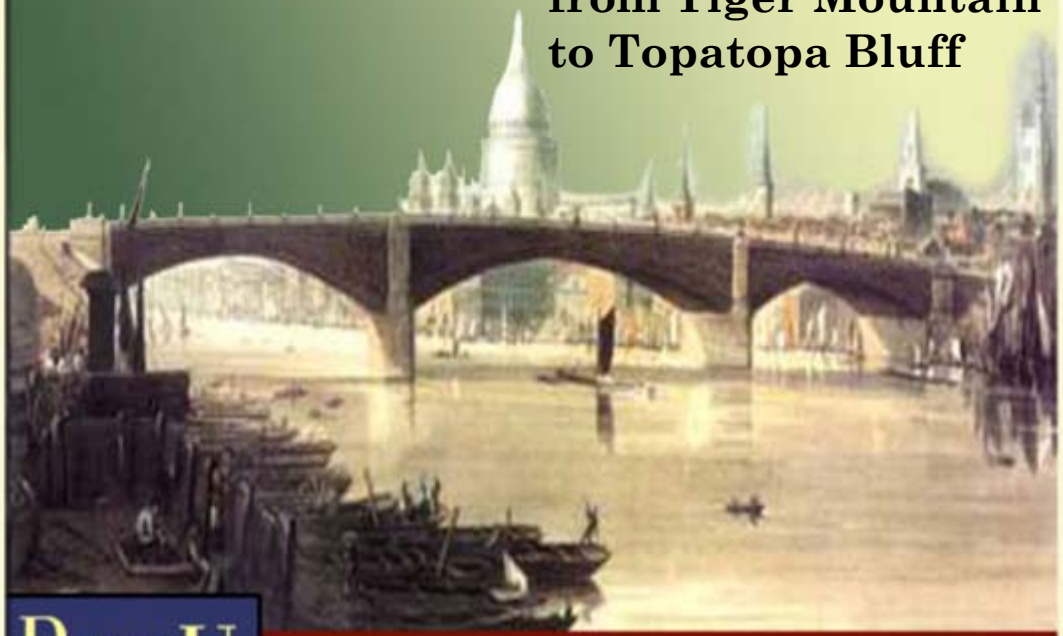
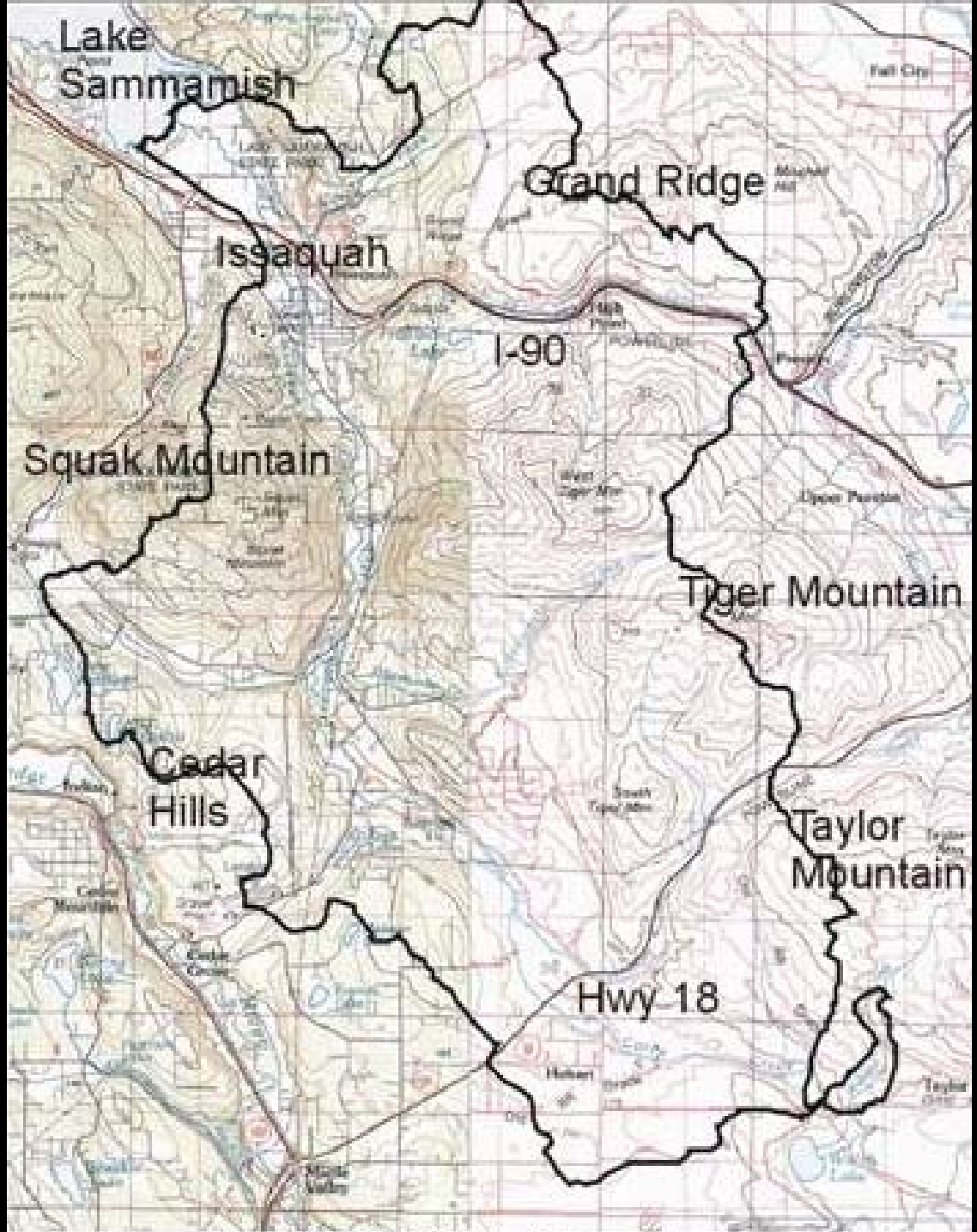
A Tale of Two Rivers

…or, it's a long way from Tiger Mountain to Topatopa Bluff

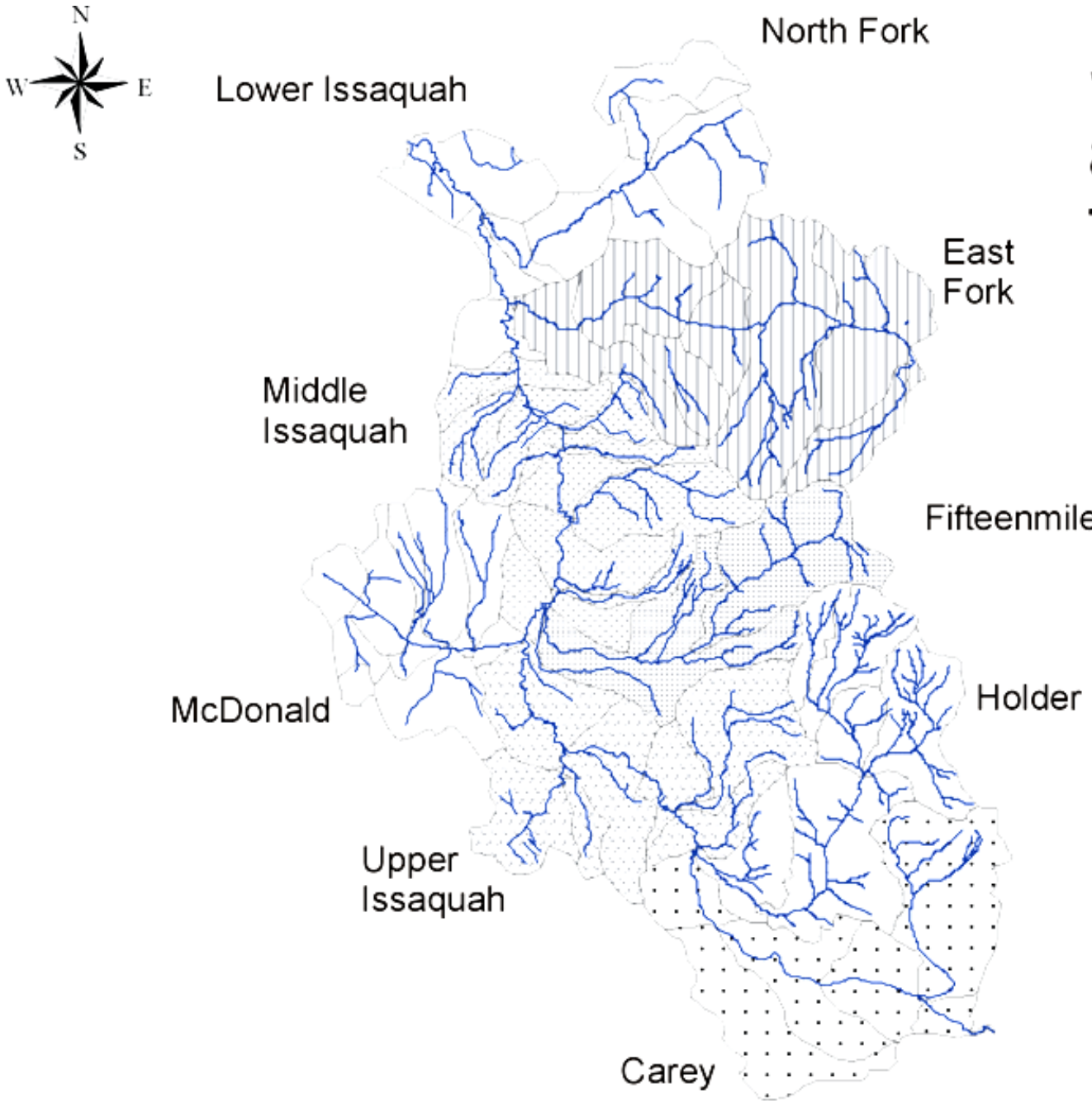


PocketU UNABRIDGED IN AUDIO

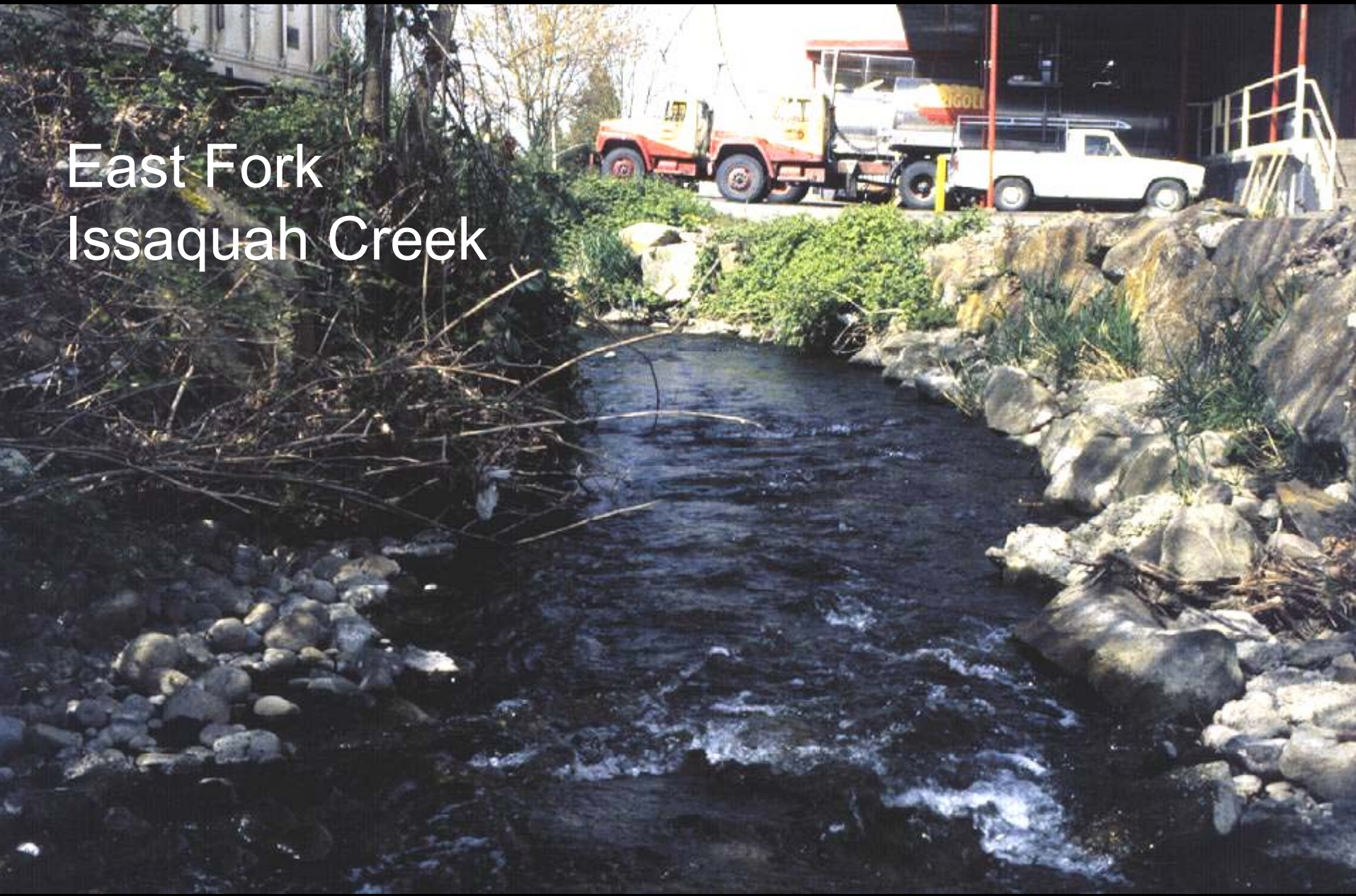

PUGET
SOUND
WATERSHED
SAMMAMISH WATERSHED
CEDAR RIVER
LAKE WASHINGTON WATERSHED
SNOQUALMIE-SKYKOMISH WATERSHED
GREEN-DUWAMISH RIVER WATERSHED
WHITE RIVER WATERSHED
Issaquah Creek watershed

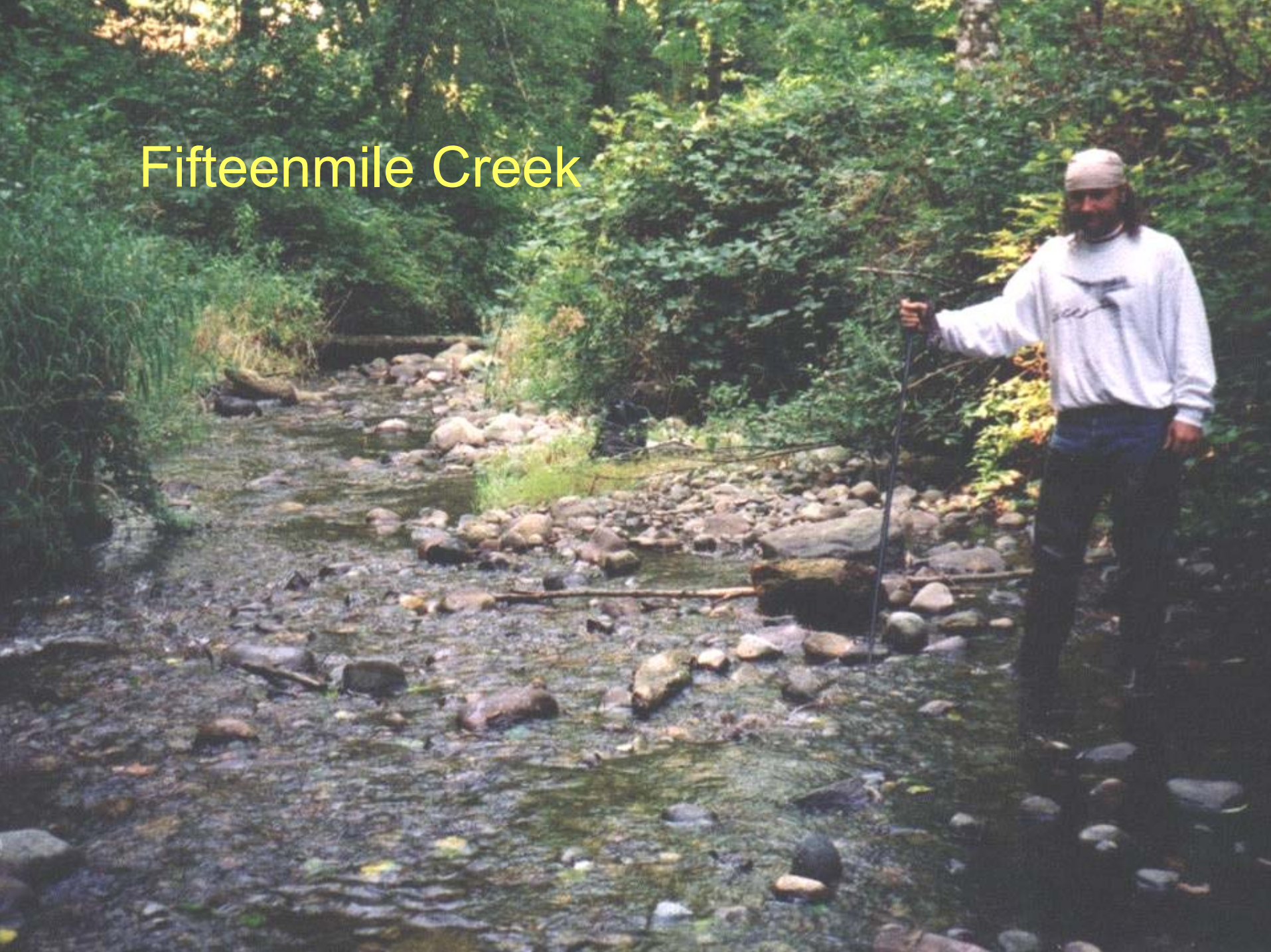

Lake
Sammamish
Grand Ridge
Issaquah
I-90
Squak Mountain
Tiger Mountain
Cedar
Hills
Taylor
Mountain
Hwy 18

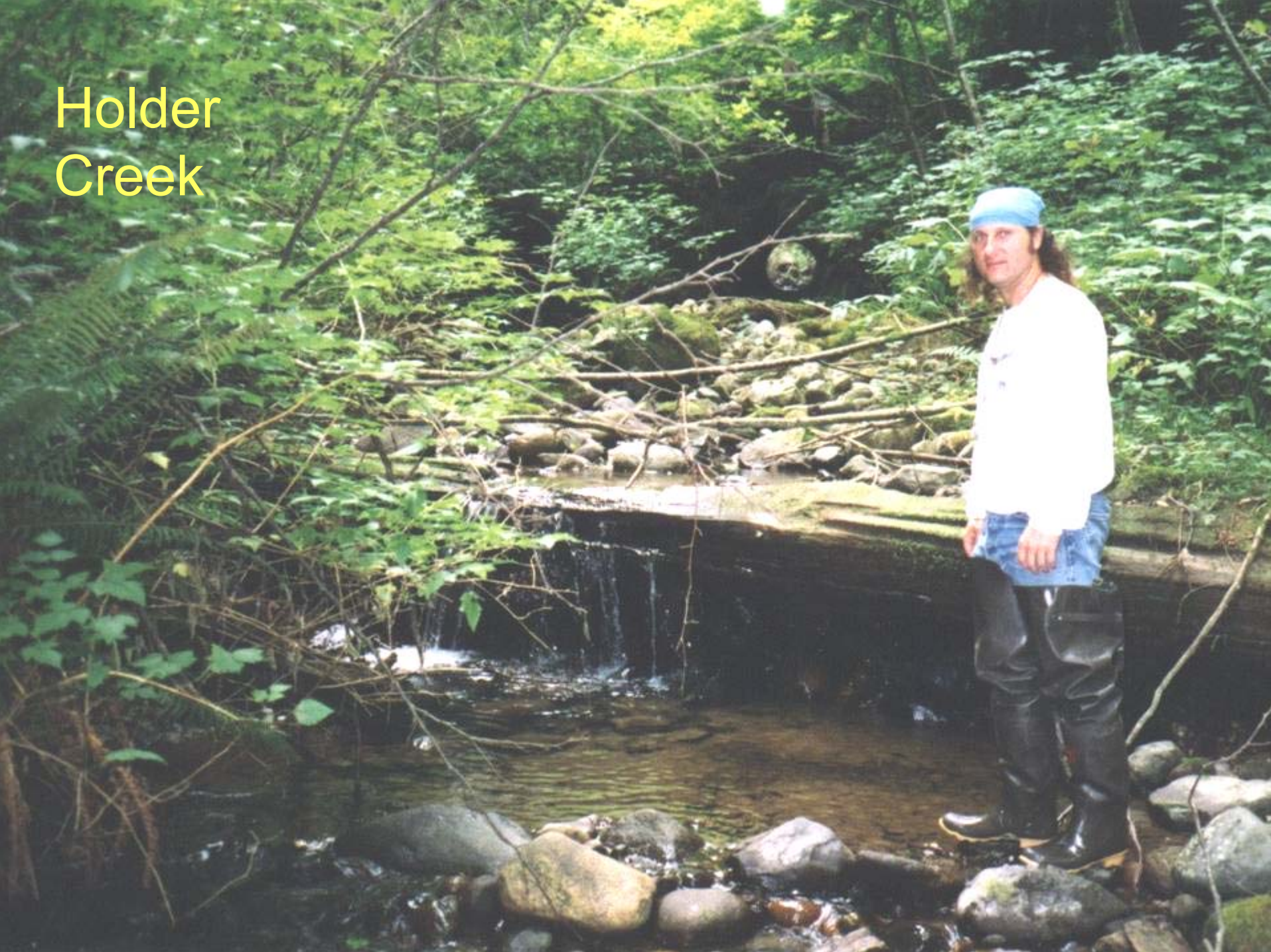
Sub-basins and Tributaries




East Fork Issaquah Creek

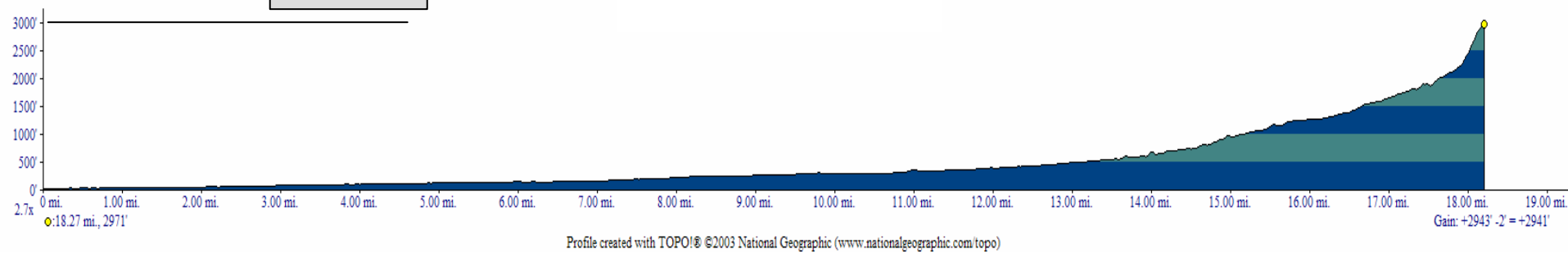

East Fork
Issaquah Creek


Fifteenmile Creek

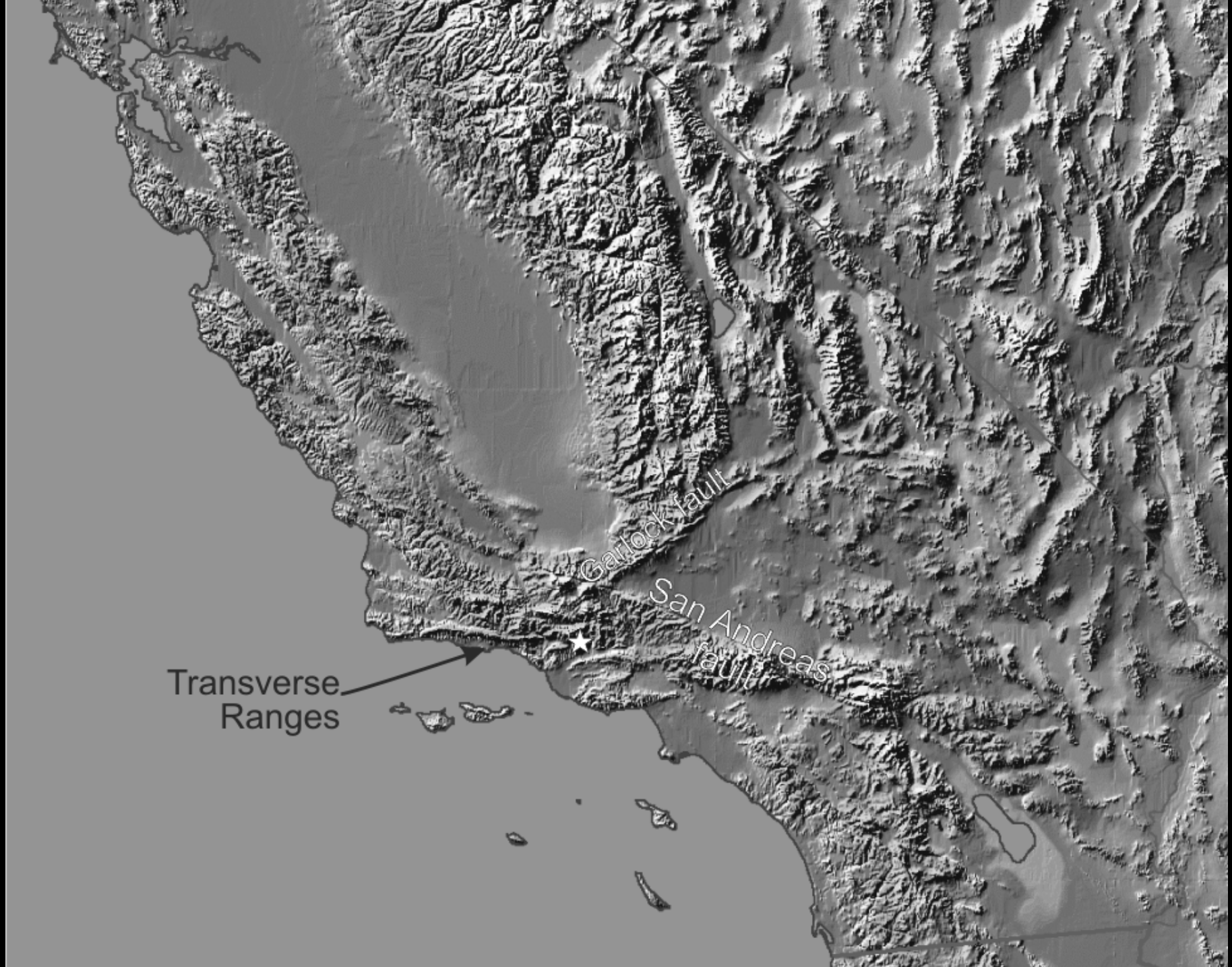

Holder
Creek


Mainstem
Issaquah Creek

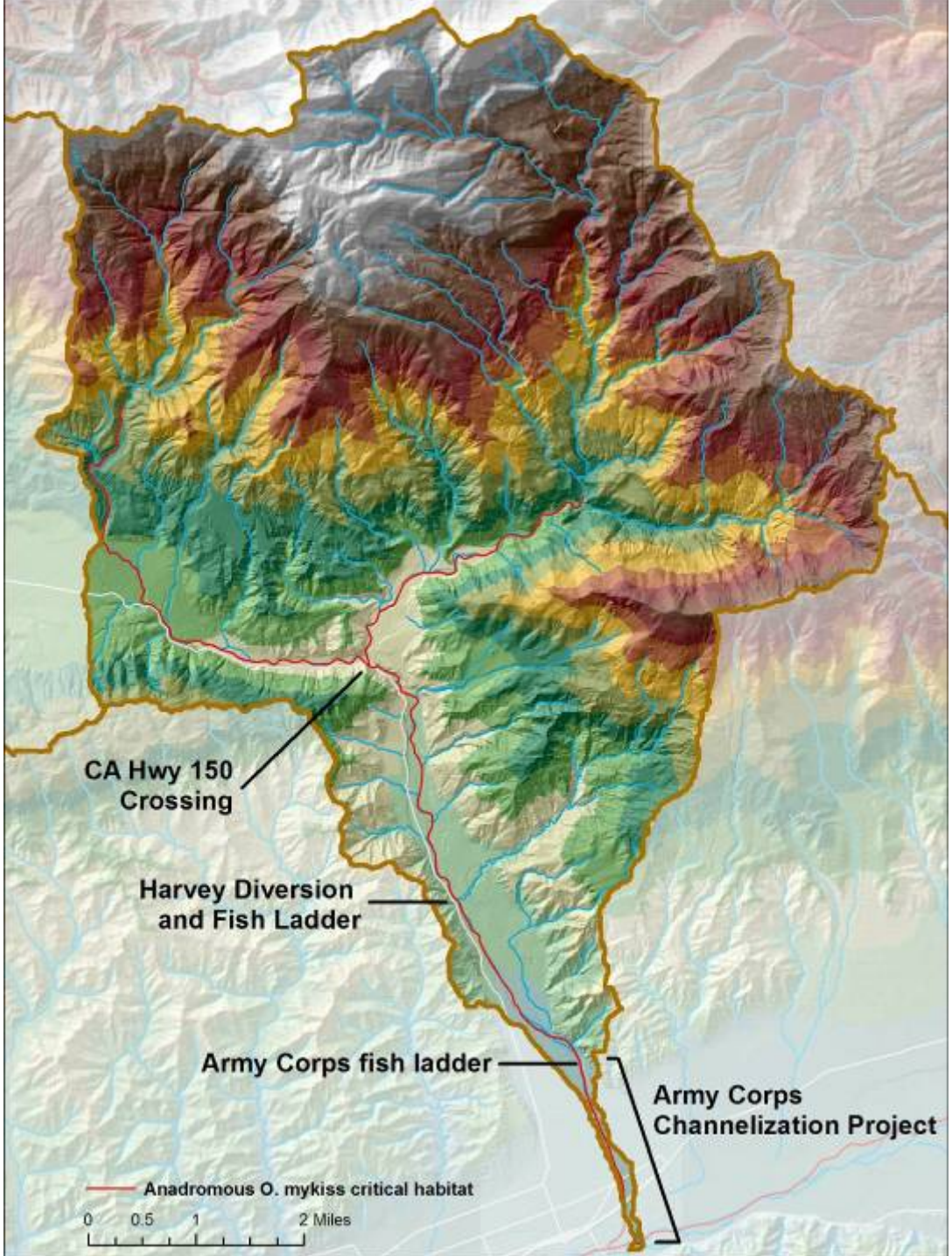
≈3000’ relief



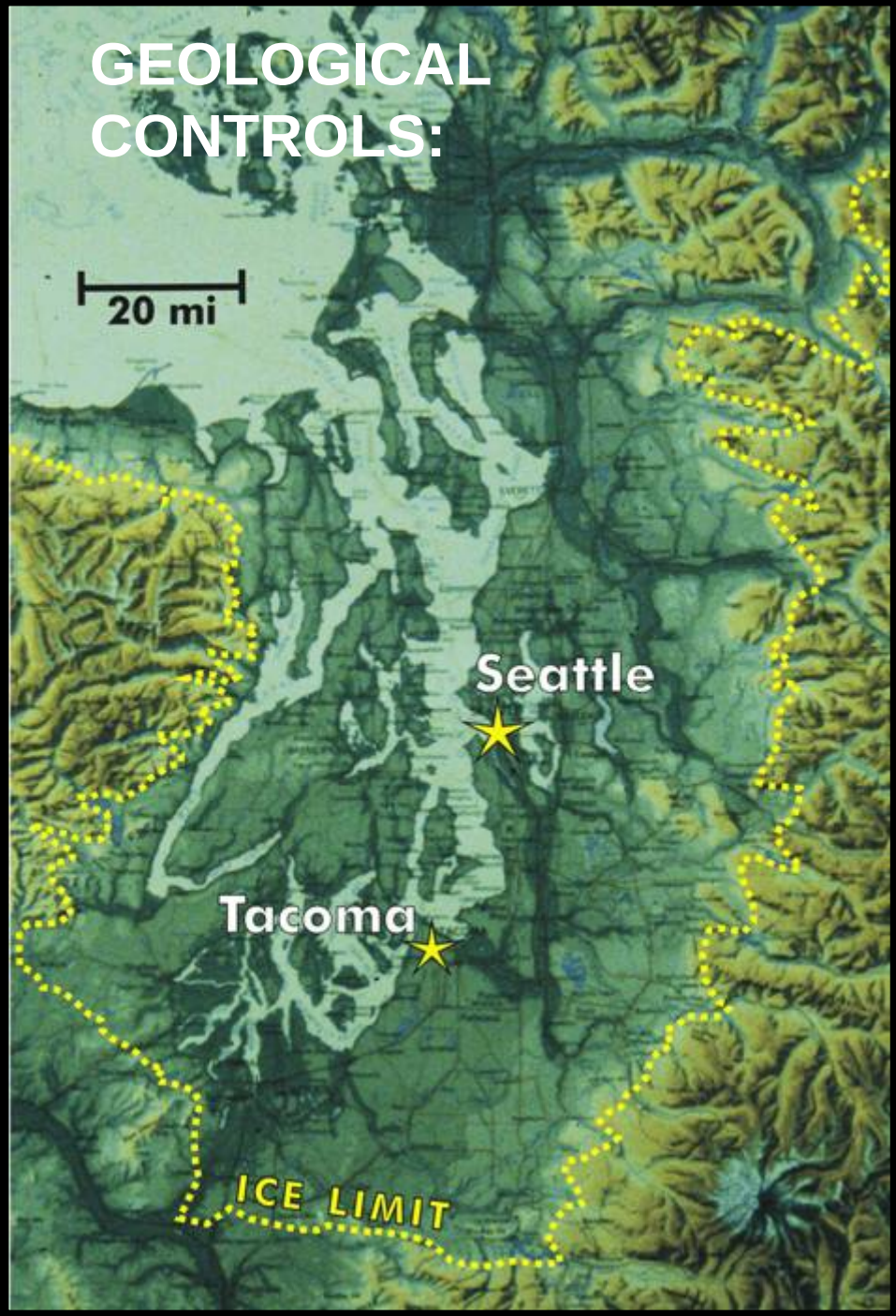
ISSAQUAH CREEK PROFILE

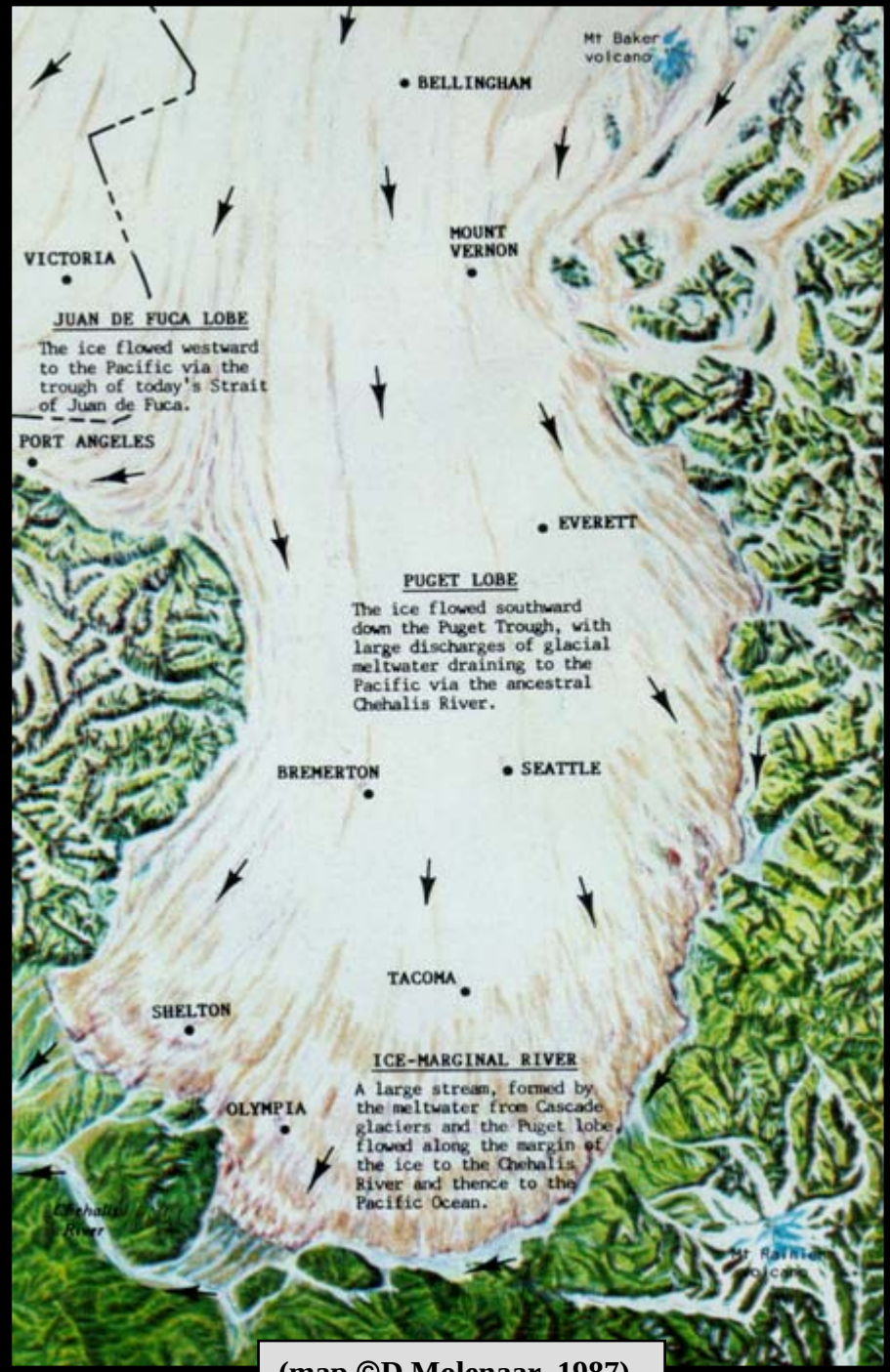

Garlock fault
San Andreas fault
Transverse Ranges


California
Santa Maria River
San Antonio Creek
Santa Ynez River
Santa Clara River
Los Angeles River
San Gabriel River
South Coast Watersheds
Ventura River
Northern Channel Islands
Calleguas Creek
Santa Monica Bay Watersheds
Santa Ana River
San Juan
Santa Margarita River
San Luis Ray River
Pacific Ocean
Southern Channel Islands
San Dieguito River
San Diego River
Sweetwater River
United States
Mexico
Tijuana River
National Park Service lands
USDA Forest Service lands
Major urban areas
Coastal southern California watersheds
0 25 50 100 Kilometers
0 12.5 25 50 Miles
N
W
E
S
Data sources: NASA Shuttle 3 arc-sec DEM hillshade; CalWater 2.2.1 watershed boundaries; Tijuana watershed boundary - SDSU; California Legacy Project public lands; ESRI urban areas.

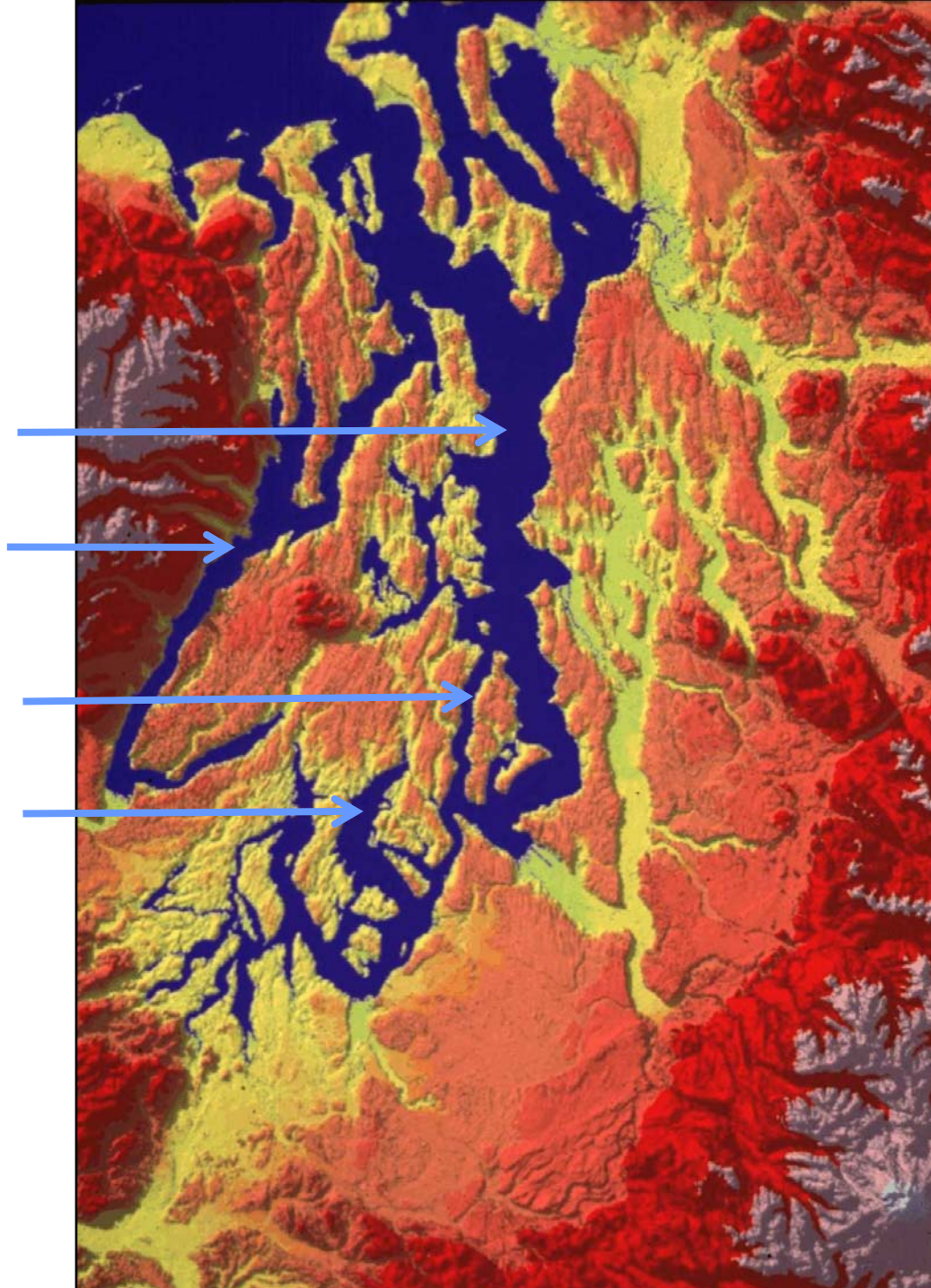

CA Hwy 150
Crossing
Harvey Diversion
and Fish Ladder
Army Corps fish ladder
Army Corps
Channelization Project
Anadromous O. mykiss critical habitat
0 0.5 1 2 Miles


2004



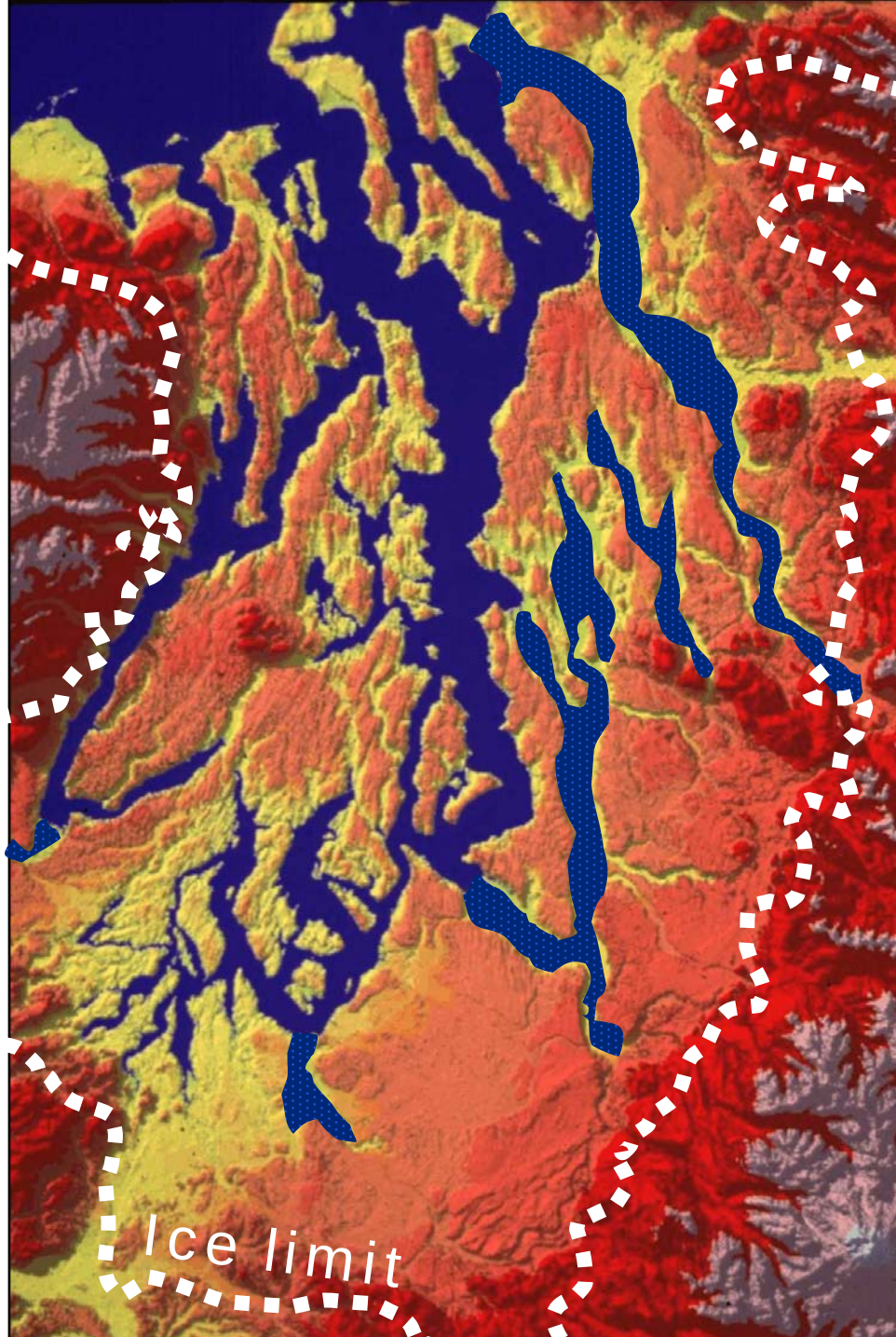


Troughs (subglacial channelways)—products of glacial meltwater



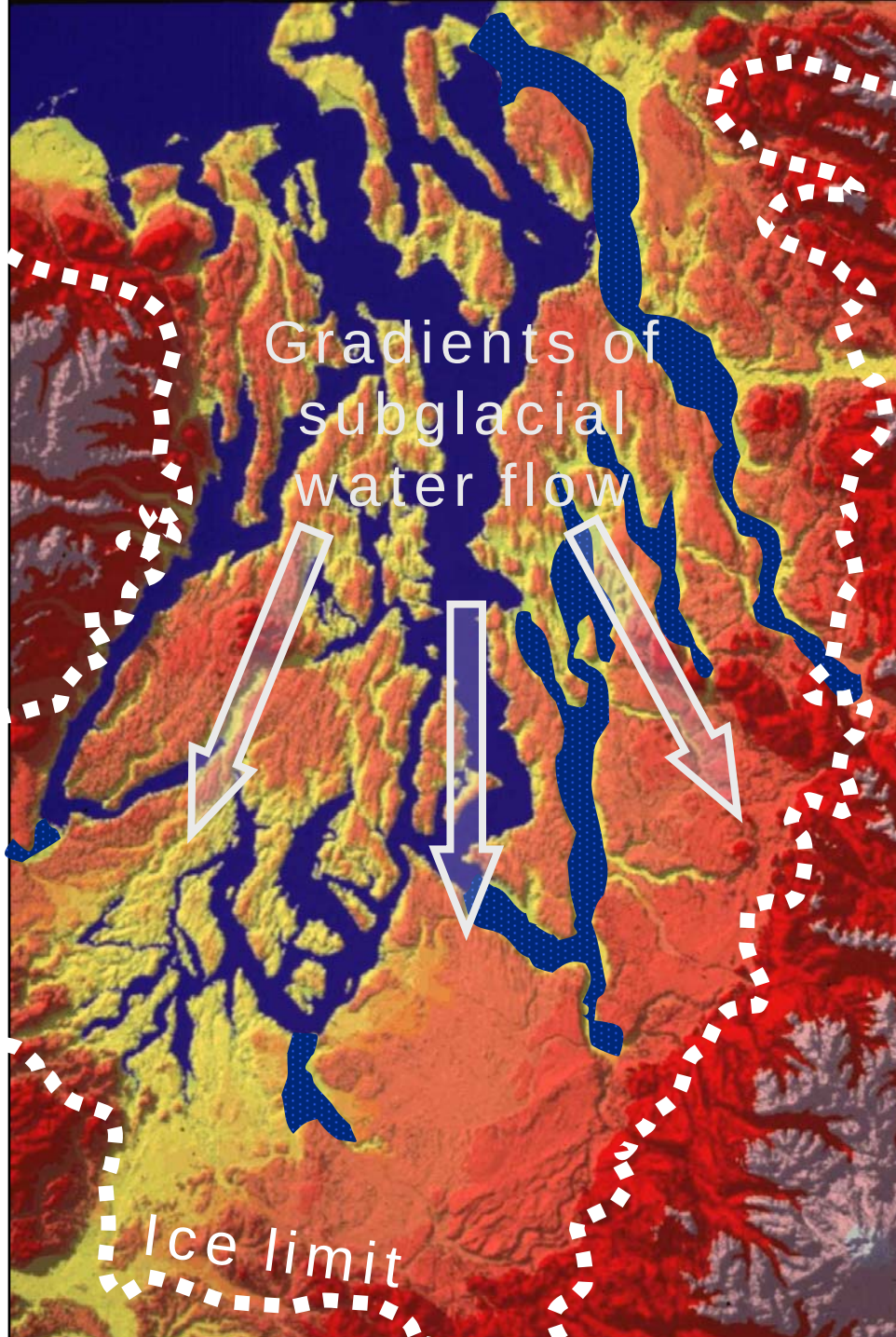
Troughs (subglacial channelways)—products of glacial meltwater

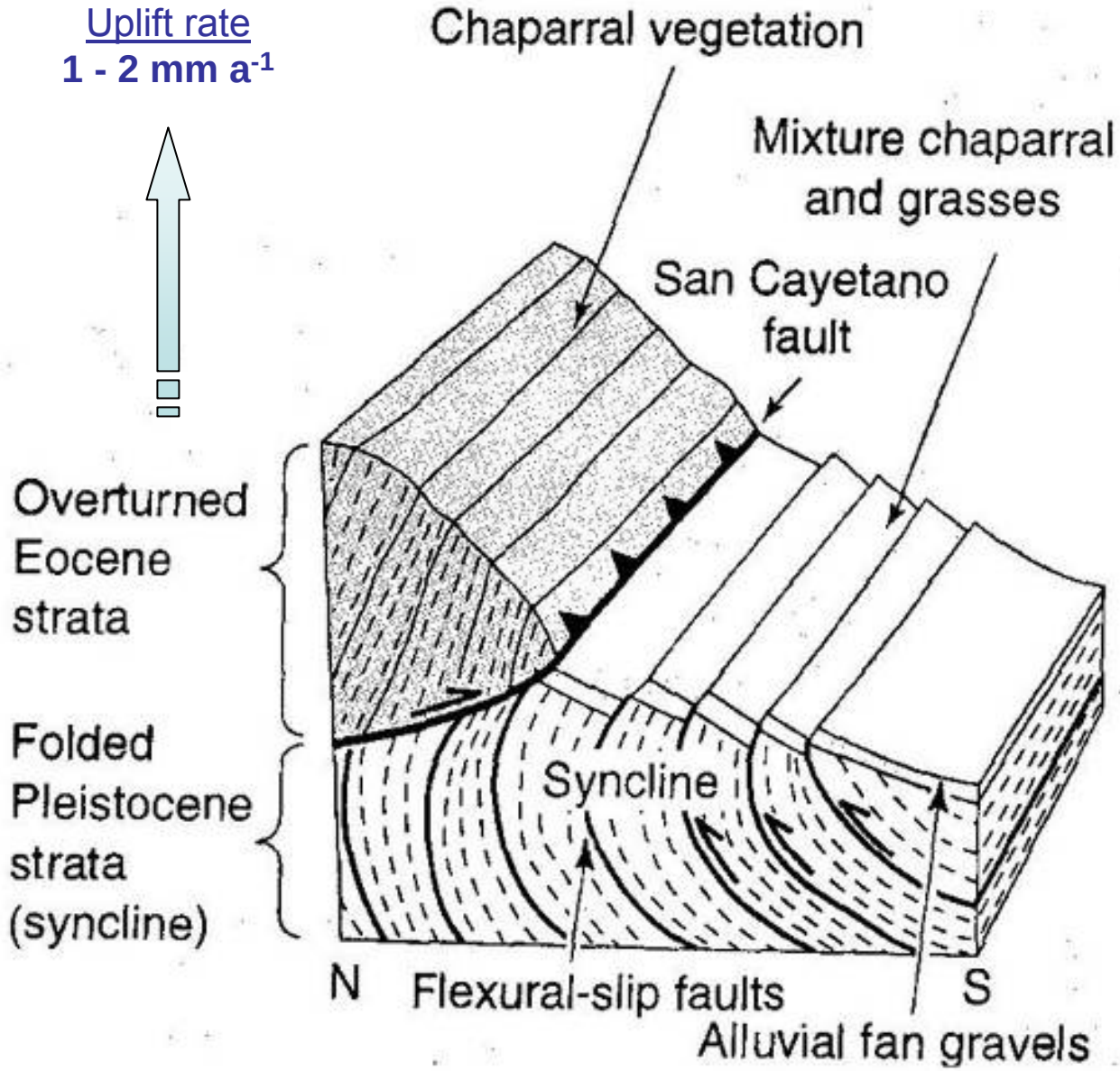
= troughs filled in by late-recessional or postglacial alluvium or mudflows



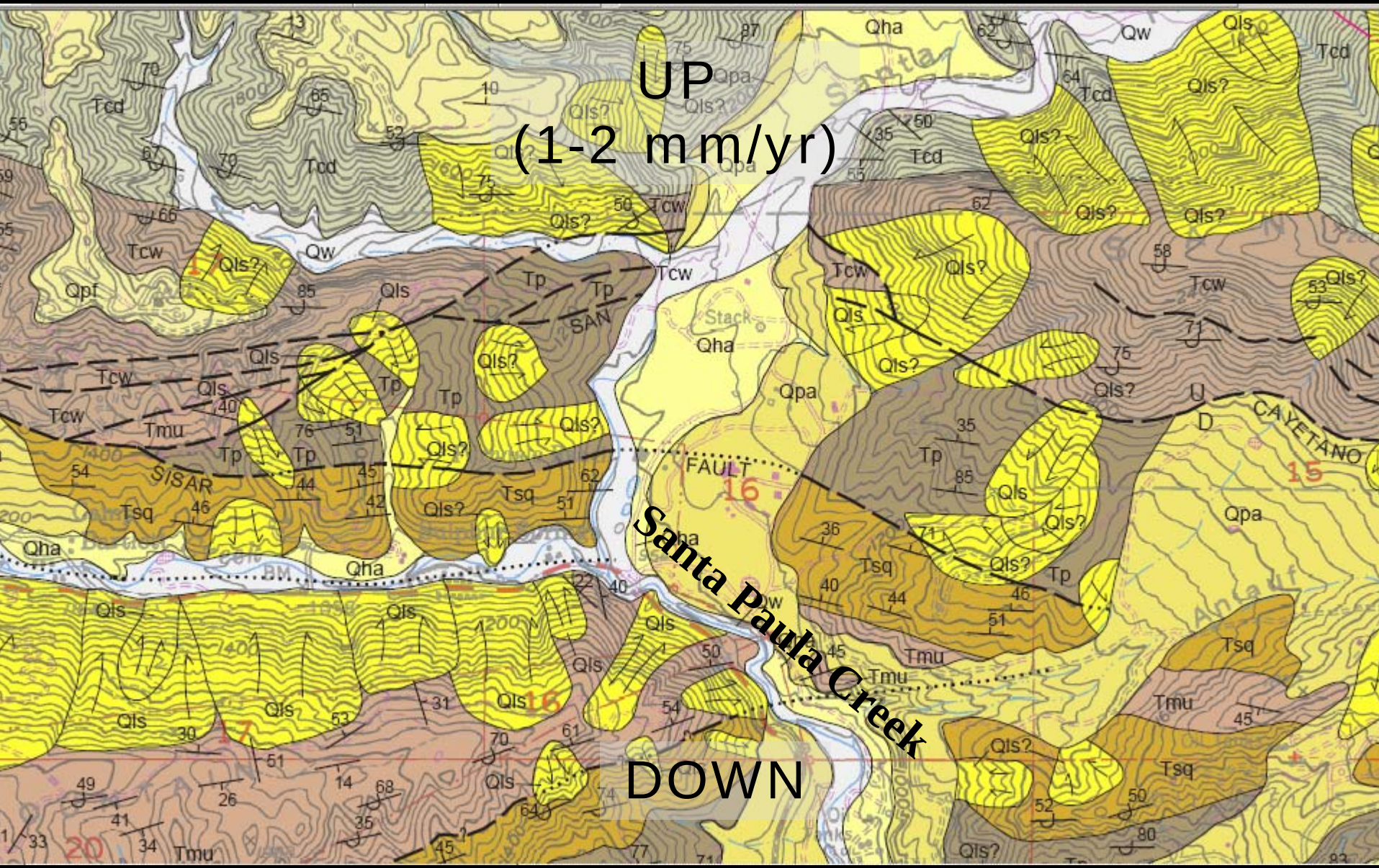
Troughs (subglacial channelways)—products of glacial meltwater

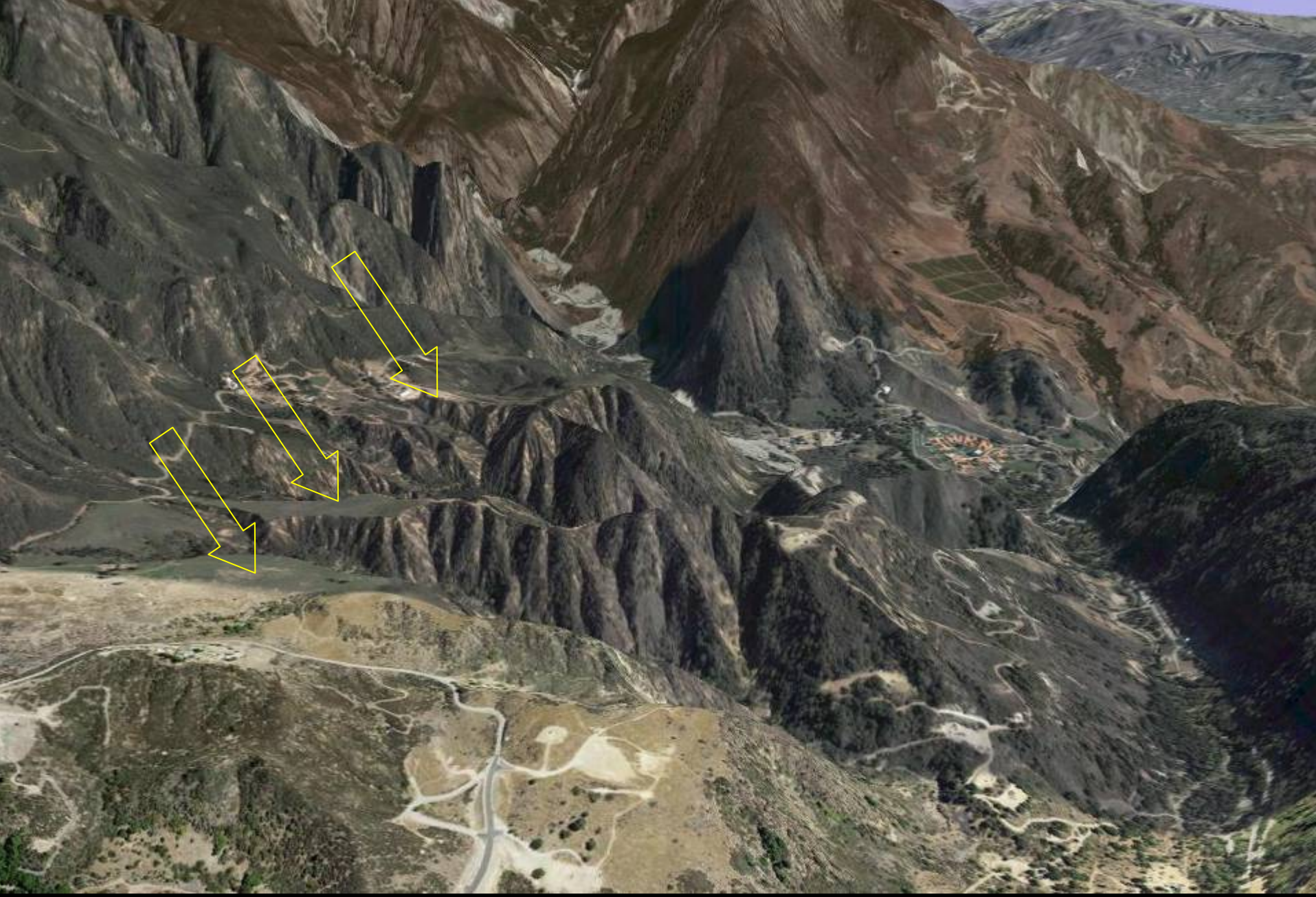
= troughs filled in by late-recessional or postglacial alluvium or mudflows





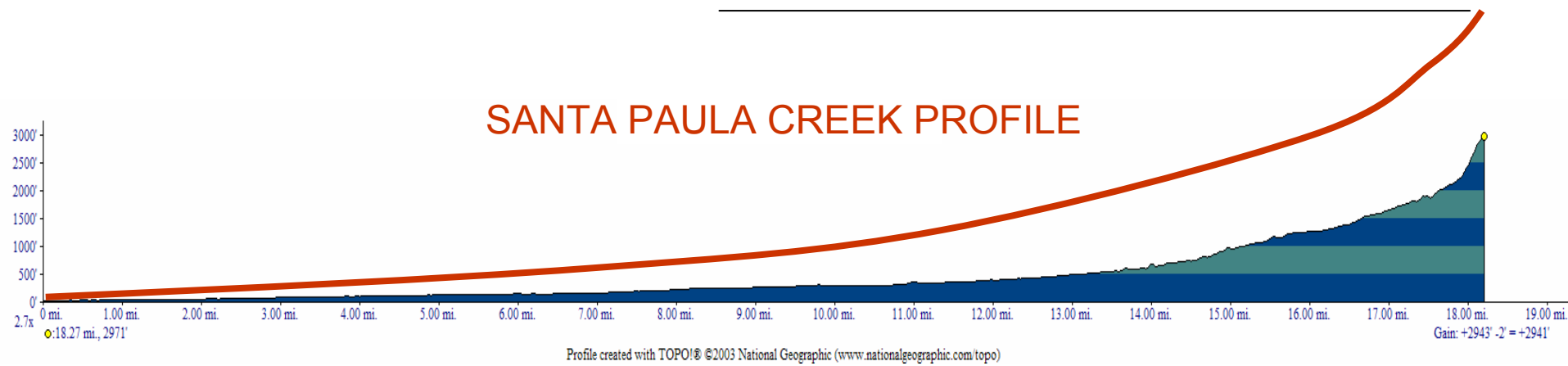
From Keller and Pinter (2002)


UP
(1-2 mm/yr)
DOWN
Santa Paula Creek
SAN
SISAR
FAULT
CAYETANO
Qha
Qpa
Qpf
Qw
Qls
Qls?
Tcd
Tcw
Tp
Tmu
Tsq
Stack
16
15
17
20

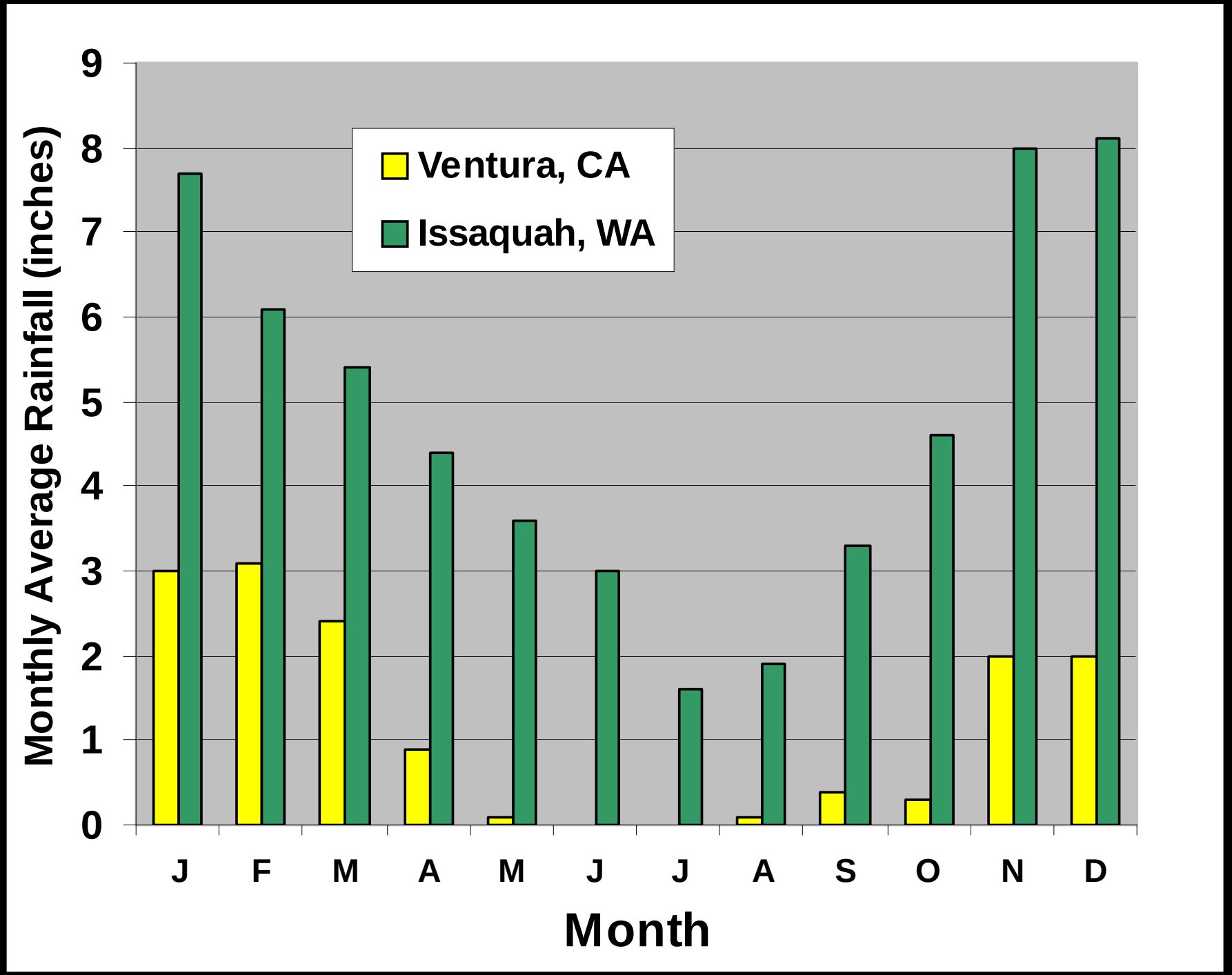


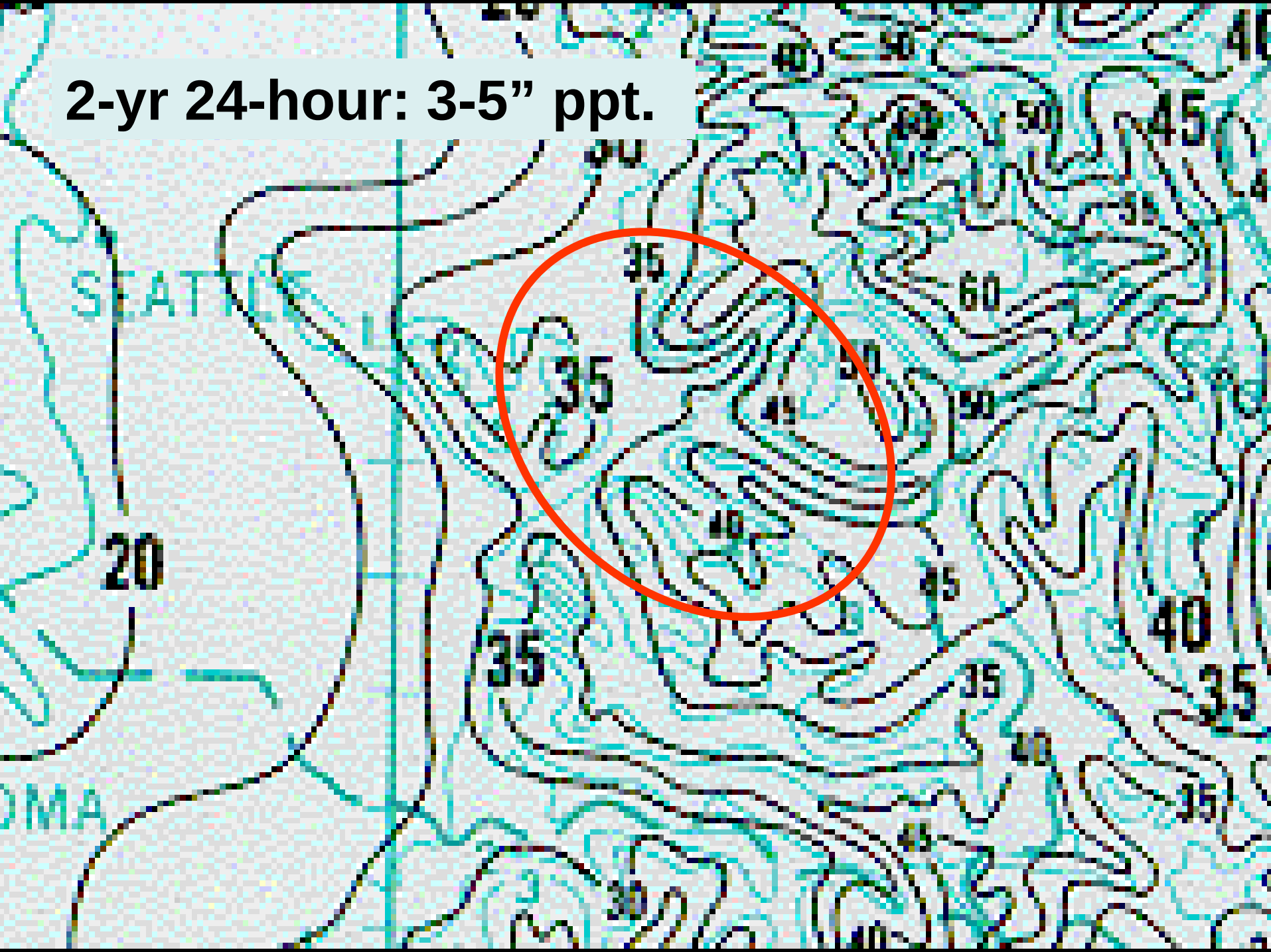
≈5000’ relief

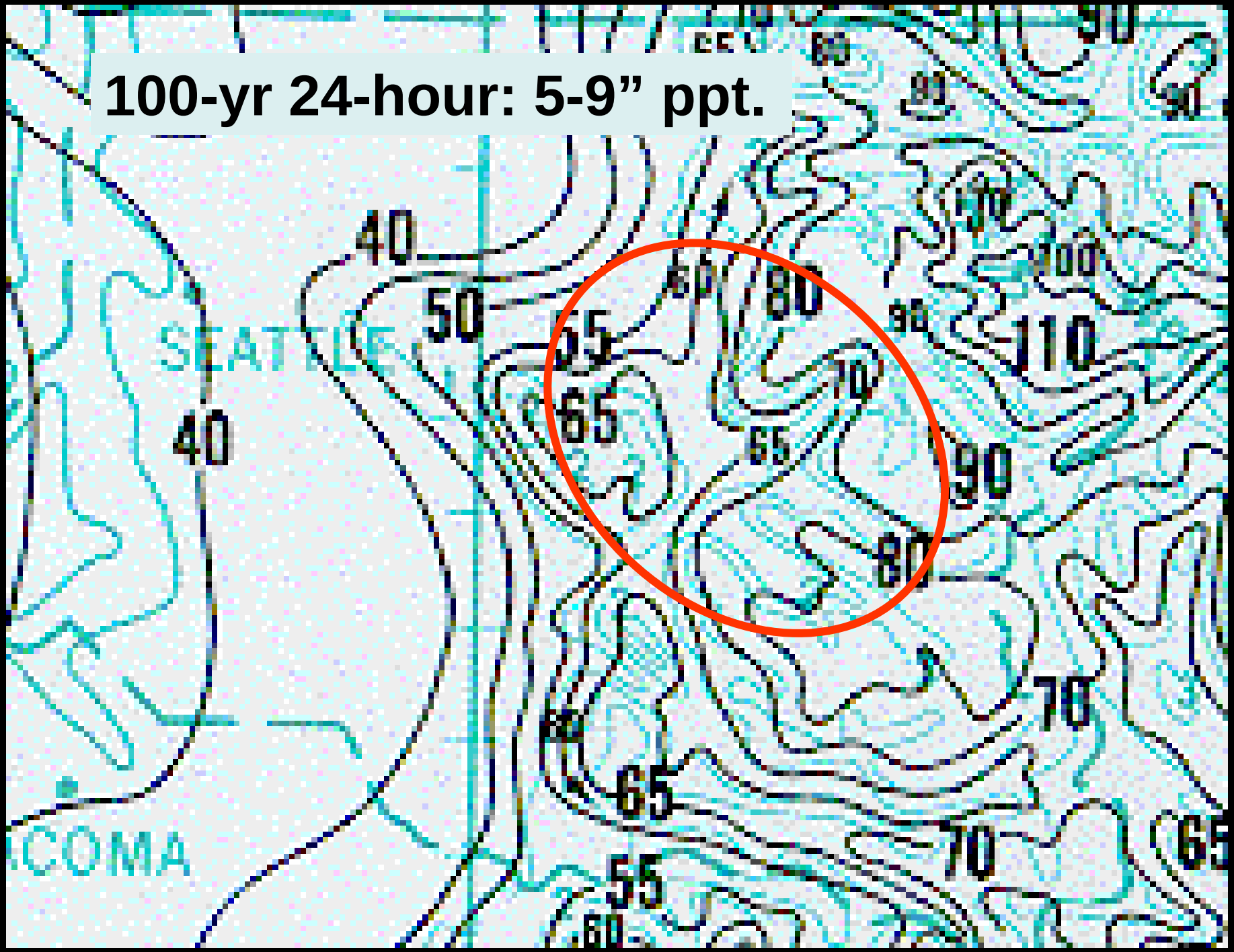
SANTA PAULA CREEK PROFILE



ISSAQUAH CREEK PROFILE

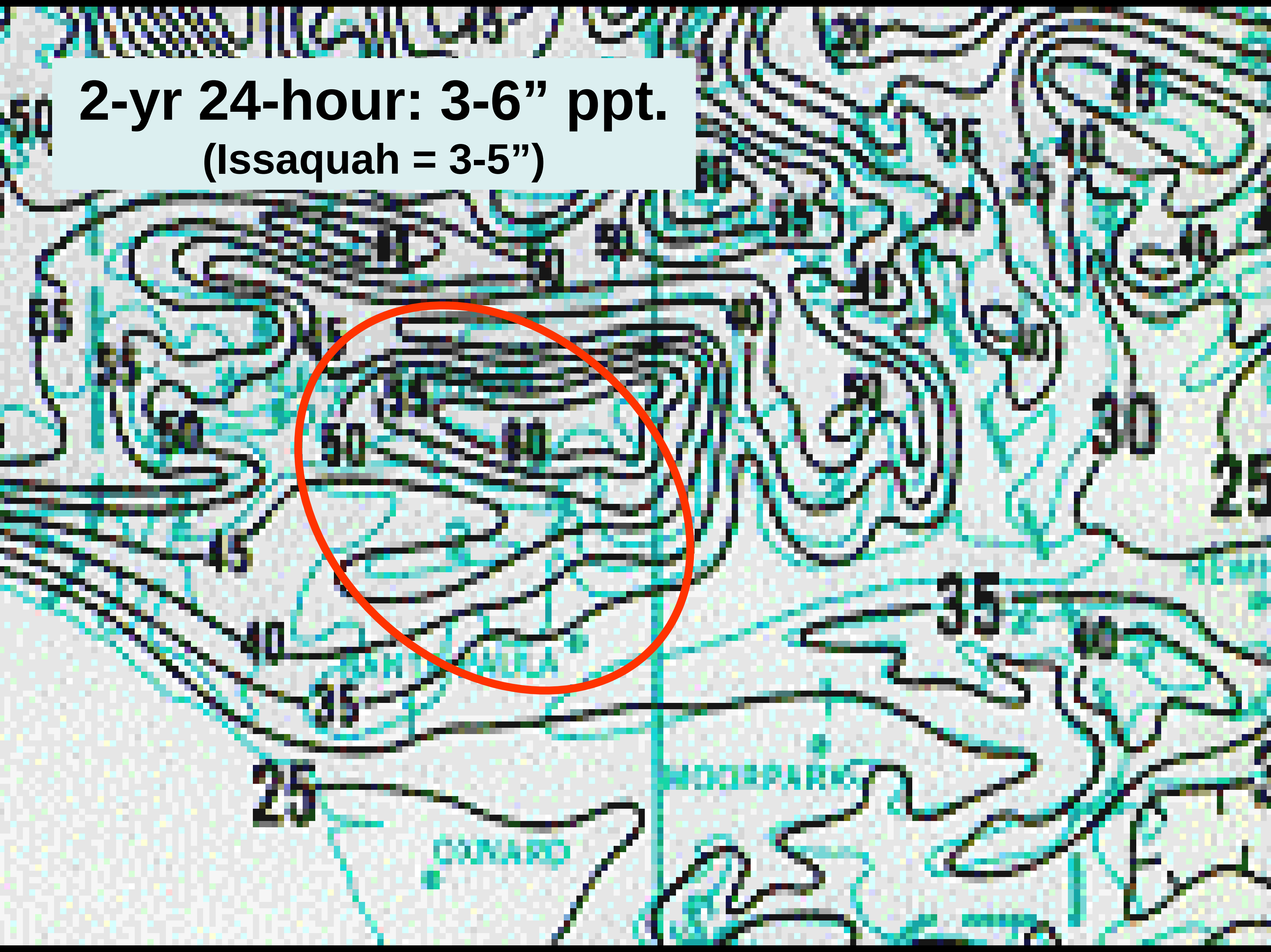

Monthly Average Rainfall (inches)
0
1
2
3
4
5
6
7
8
9
Ventura, CA
Issaquah, WA
J
F
M
A
M
J
J
A
S
O
N
D
Month

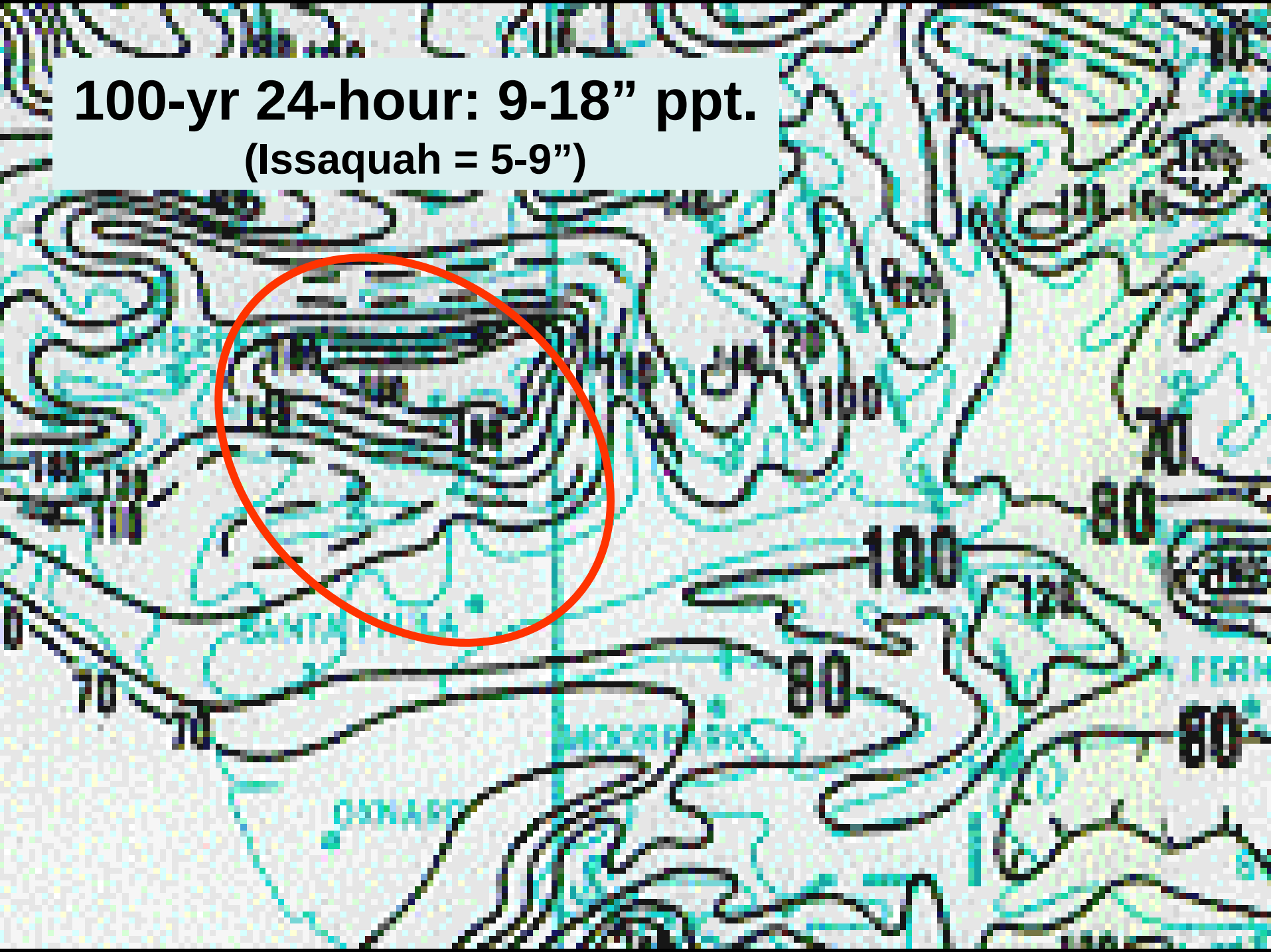

2-yr 24-hour: 3-5” ppt.
35
35
35
20
35
40
45
50
60


100-yr 24-hour: 5-9” ppt.
SEATTLE
TACOMA
40
50
55
65
80
70
90
110
100
60
70
65
55

2-yr 24-hour: 3-6” ppt.

(Issaquah = 3-5”)



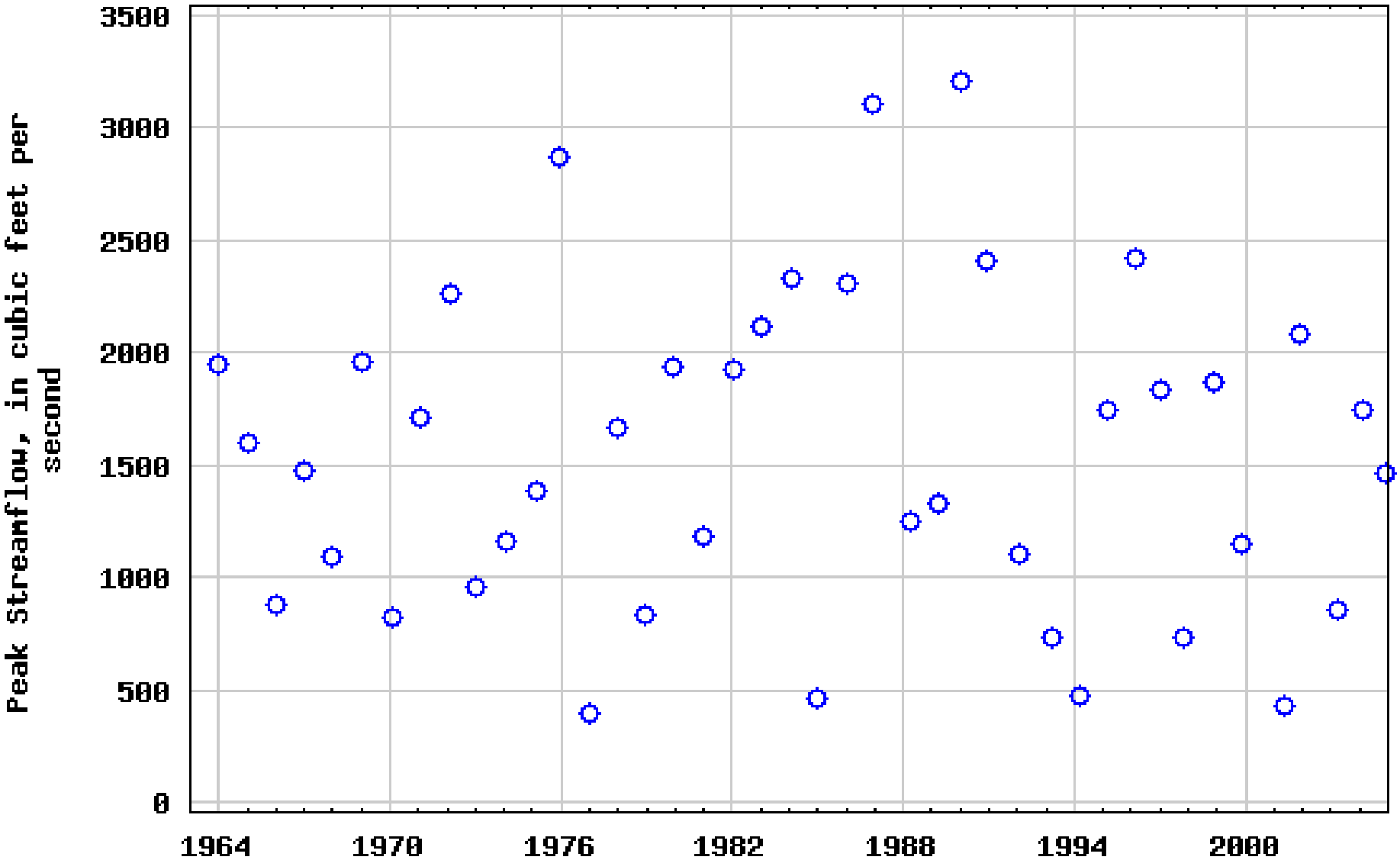

100-yr 24-hour: 9-18” ppt.
(Issaquah = 5-9”)

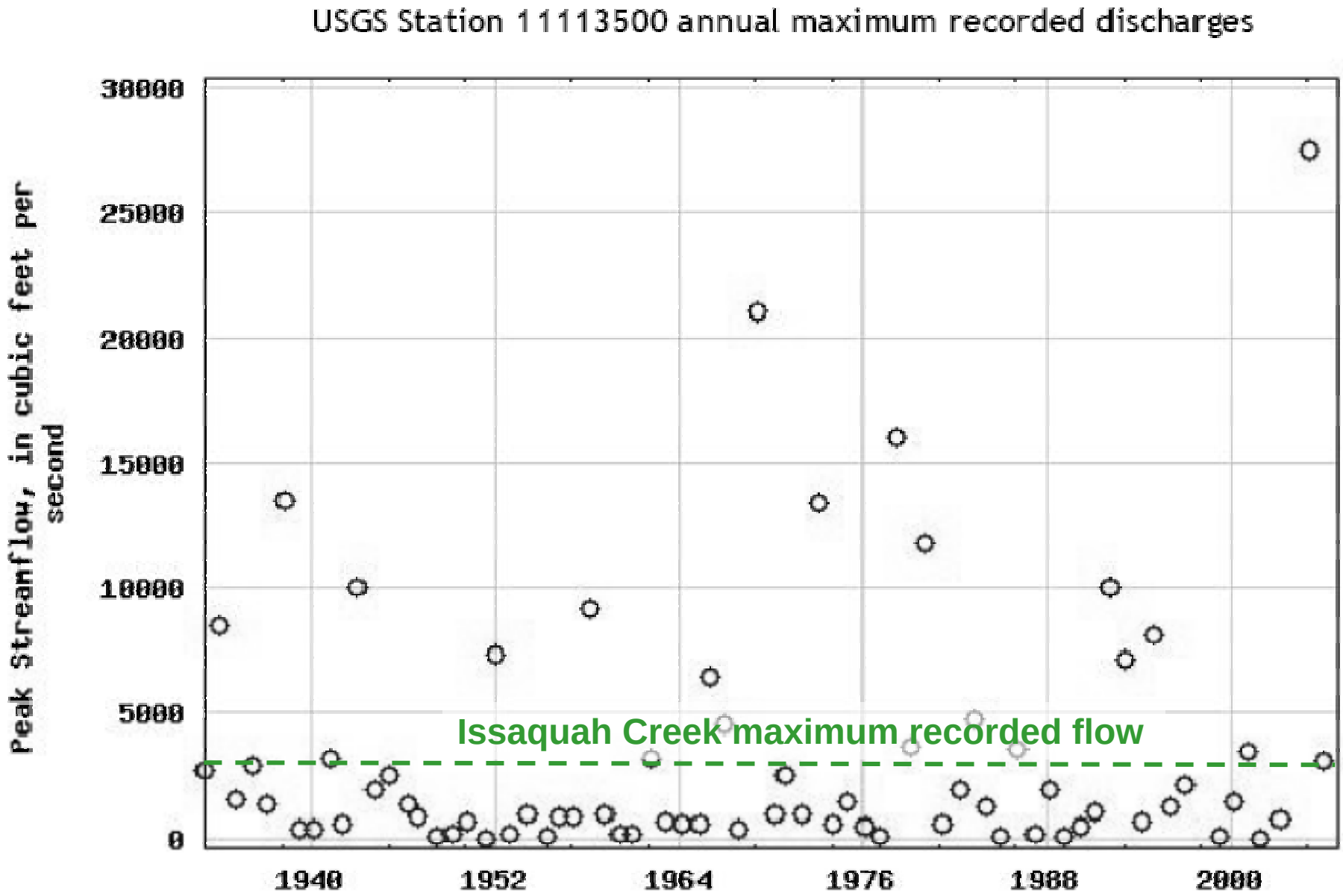
“The maximum intensity of precipitation for periods of 12 hours or longer which might be expected at intervals of 10 to 100 years is greater in portions of the San Gabriel and San Bernardino Mountains in southern California than anywhere else in the continental United States.”

Western Regional Climate Center
(http://www.wrcc.dri.edu/)

USGS

USGS 12121600 ISSAQUAH CREEK NEAR MOUTH NEAR ISSAQUAH, WA

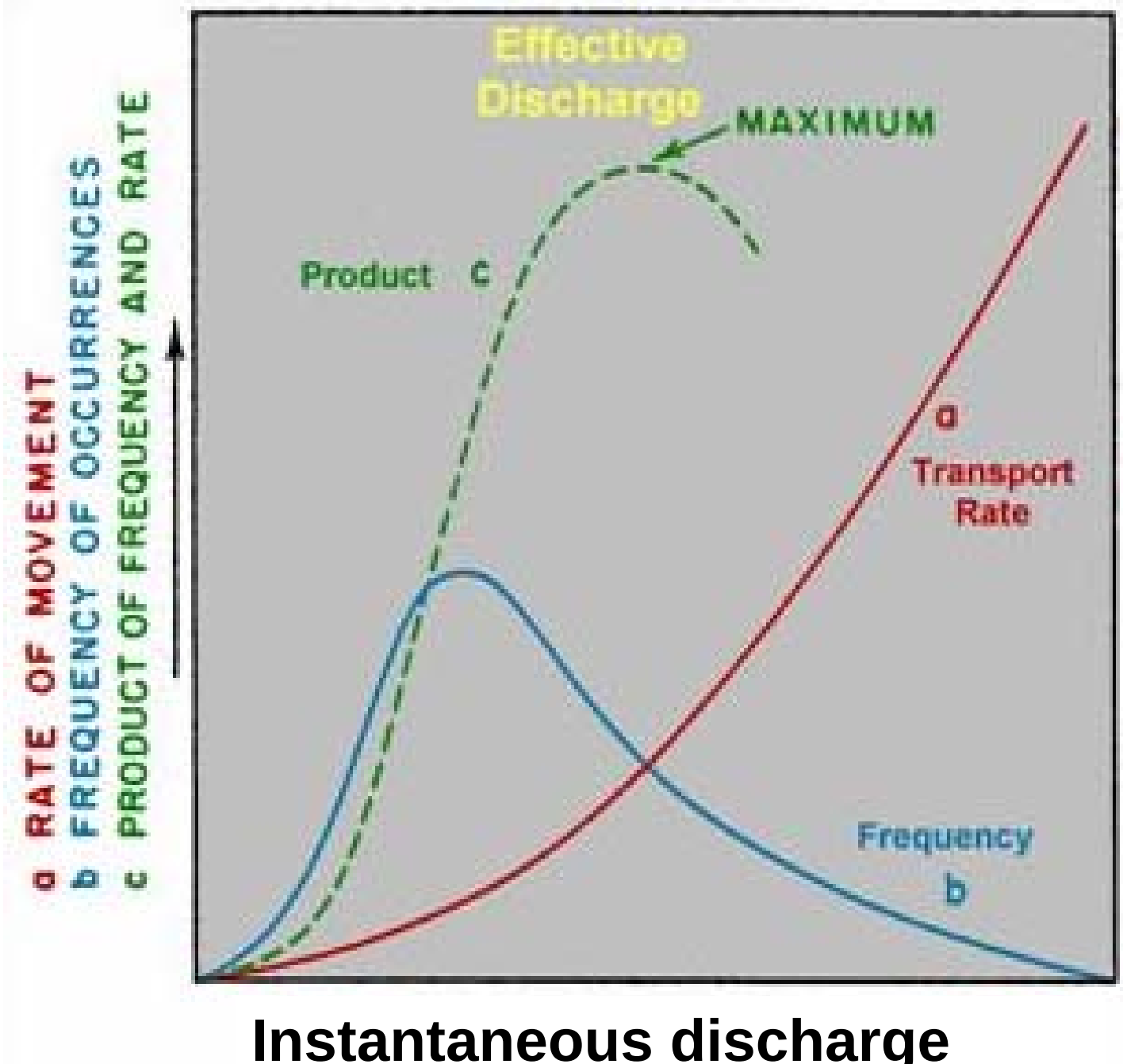



USGS Station 11113500 annual maximum recorded discharges
Peak Streanflow, in cubic feet per second
30000
25000
20000
15000
10000
5000
0
1940
1952
1964
1976
1988
2000
Issaquah Creek maximum recorded flow

Issaquah Creek peak discharge = 3300 cfs (42 years of record, 56 sq. mi. watershed area)

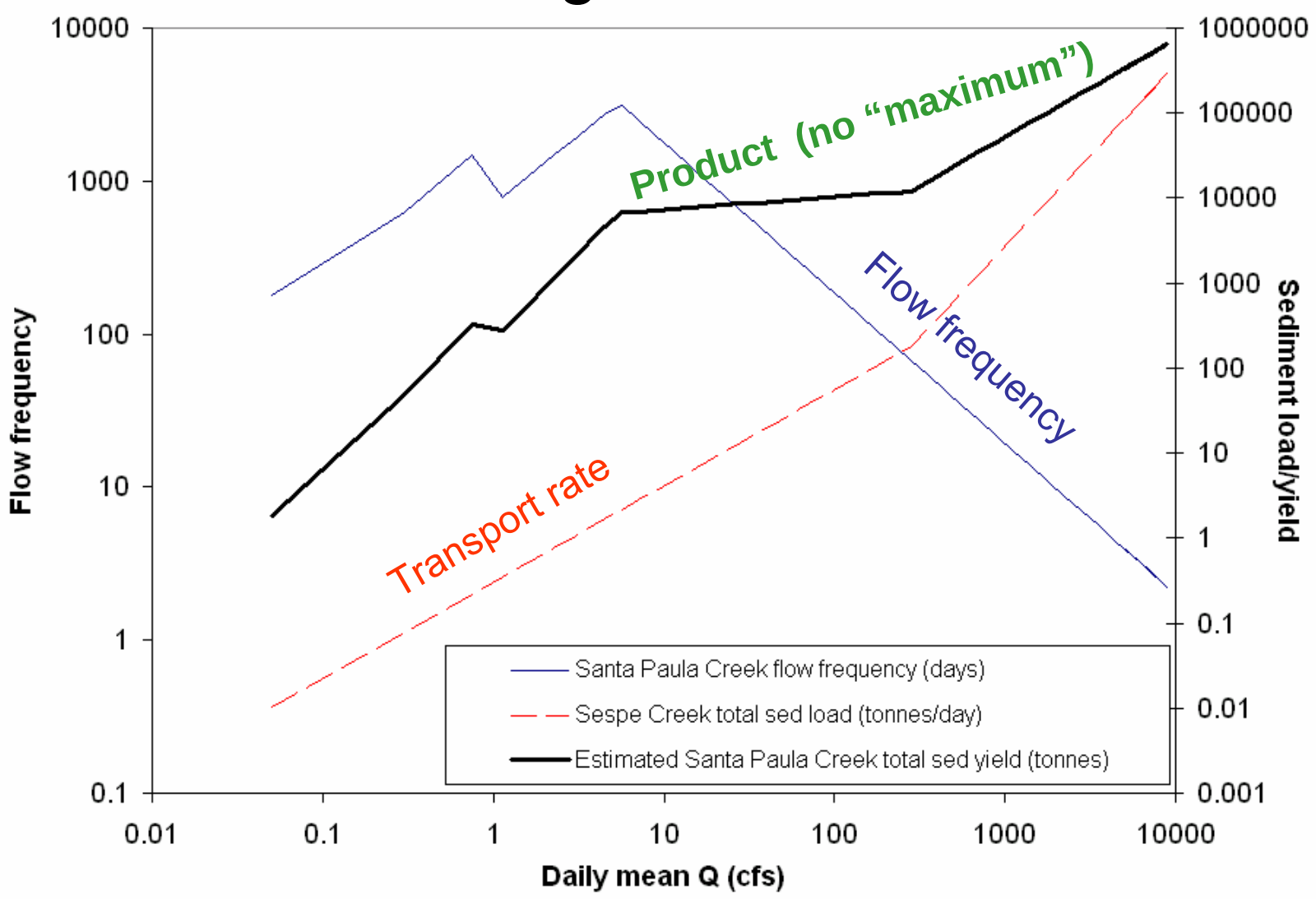
Flood Event (year)	Peak Flow (cfs)	Peak Time (hours)	[illegible]nches)	(feet)	[illegible]f (inches)	Volume (ac-ft)
2	1300	17.833	3.65	3.32	0.33	658
5	4580	16.667	4.92	3.95	0.97	1958
10	8900	16.167	6.30	4.39	1.91	3835
20	15400	15.750	8.23	4.81	3.42	6868
50	28500	15.417	12.09	5.32	6.77	13596
100	42900	[illegible]250	[illegible]	[illegible]	[illegible]	21172
200	62600	15.1[illegible]	[illegible]	[illegible]	[illegible]	31949
500	99200	15.083	[illegible]	[illegible]	[illegible]	52542

Santa Paula Creek peak discharge = 27,000 cfs (70 years of record, 42 sq. mi. watershed area)



Instantaneous discharge

Dominant Discharge—Santa Paula Creek

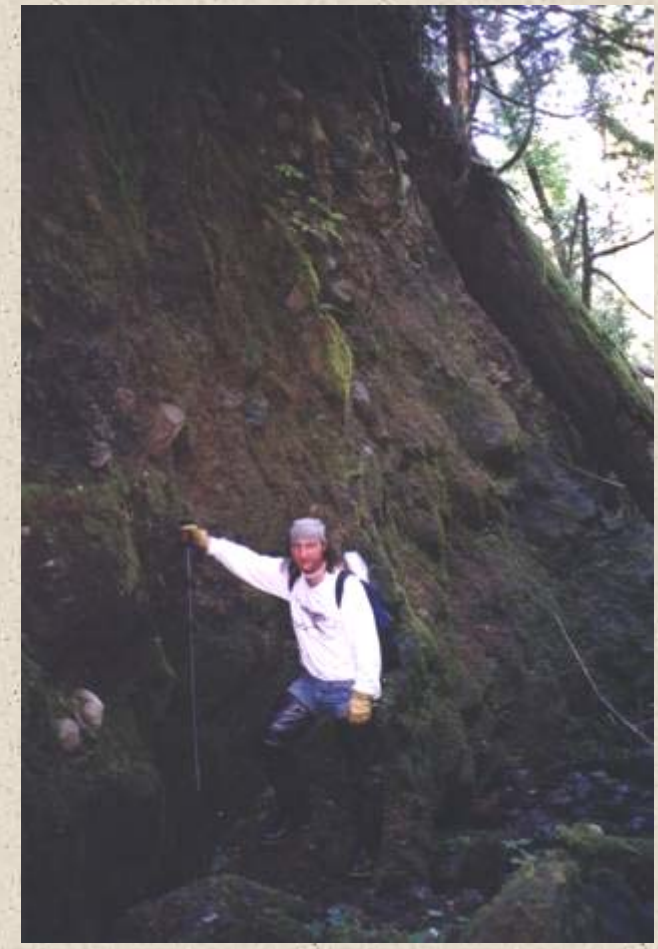


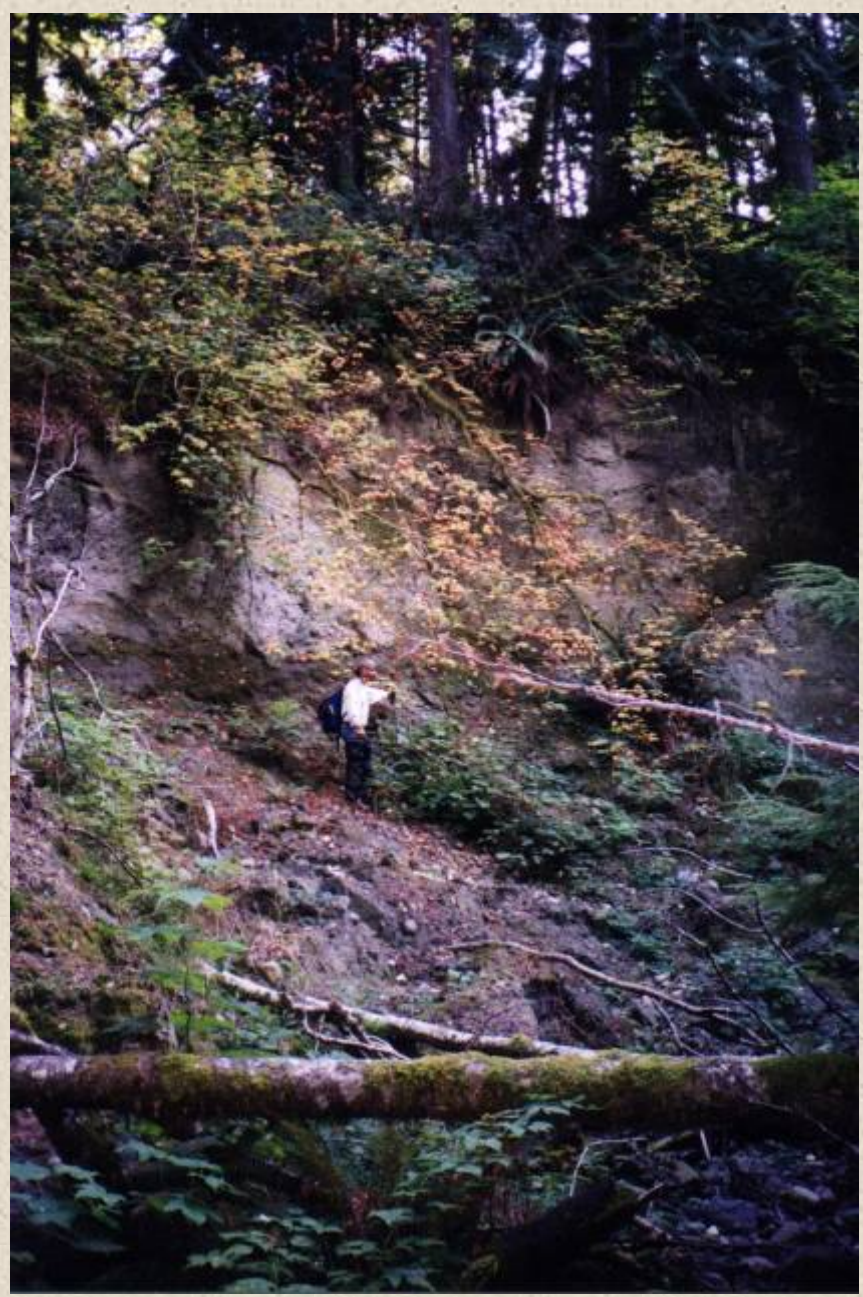

Harvey Diversion Dam

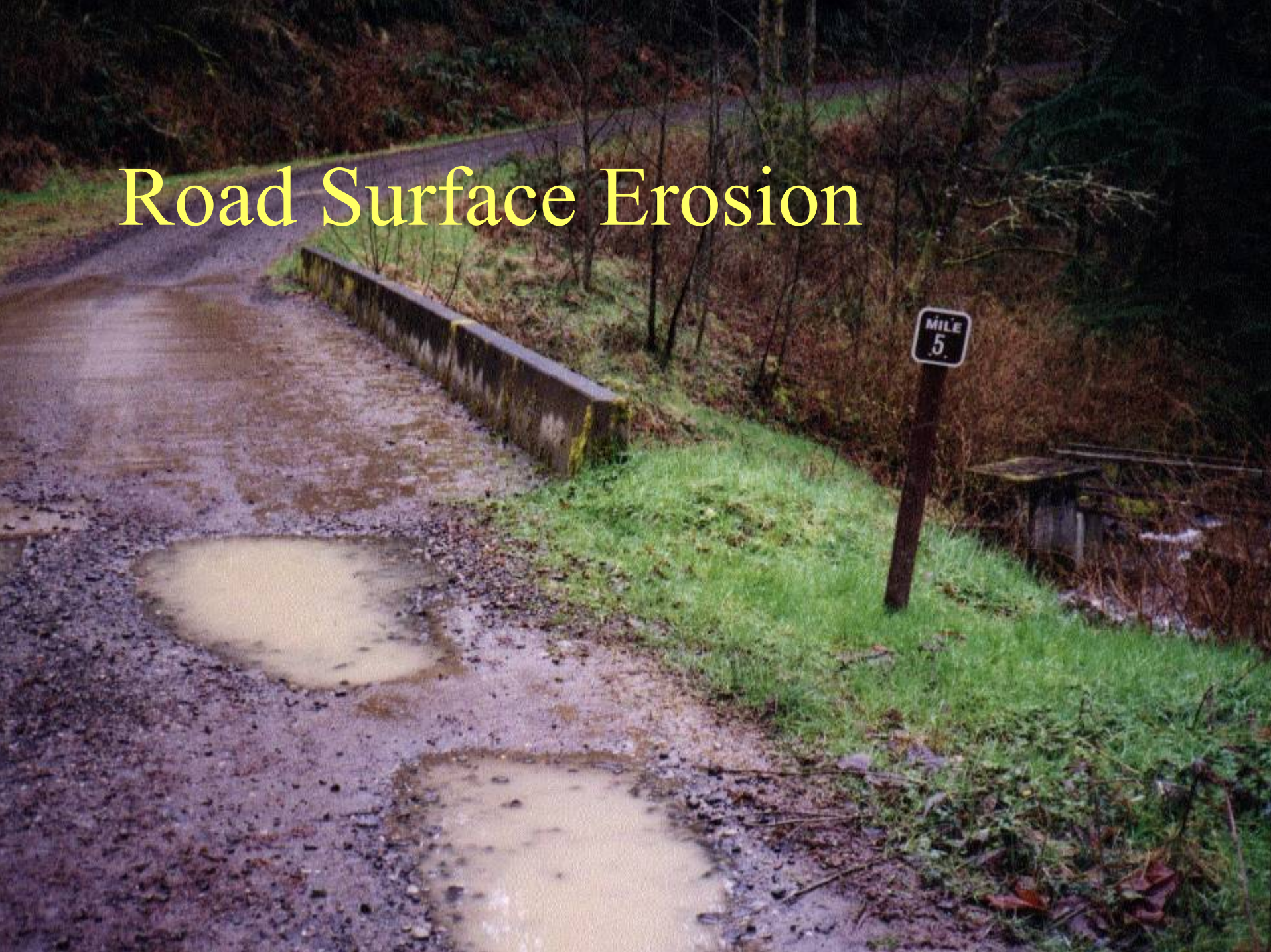
Watershed sediment production

1. Issaquah Creek watershed

Landslides

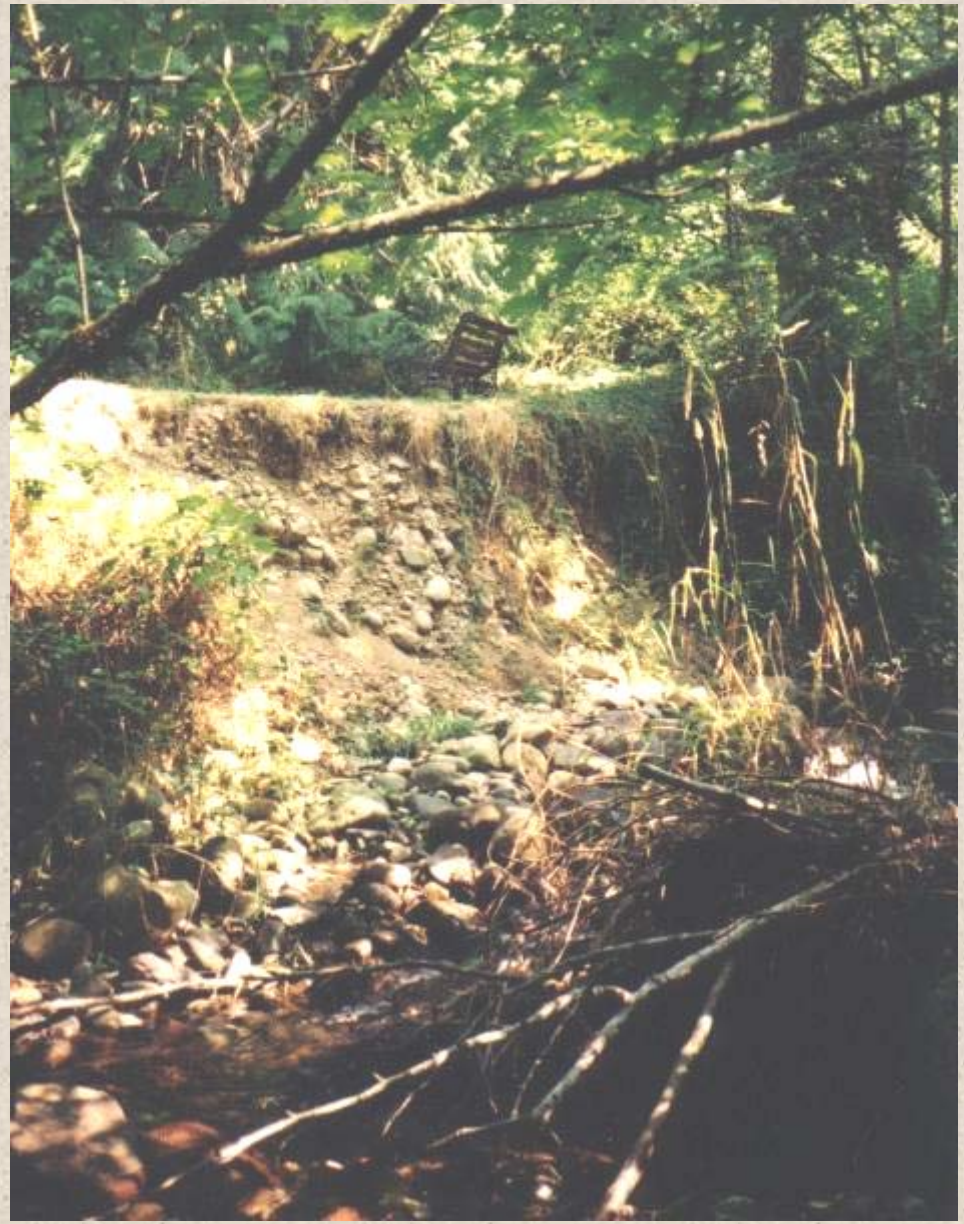




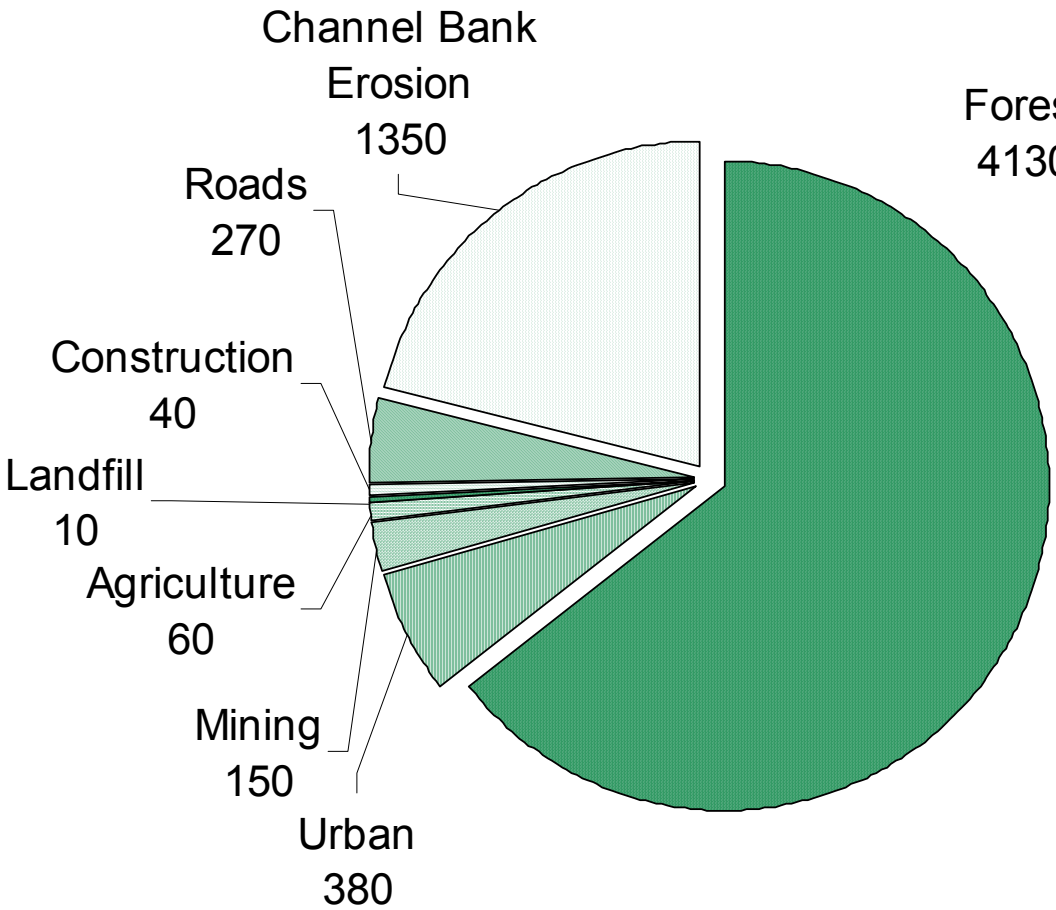


Road Surface Erosion

Channel Bank Erosion

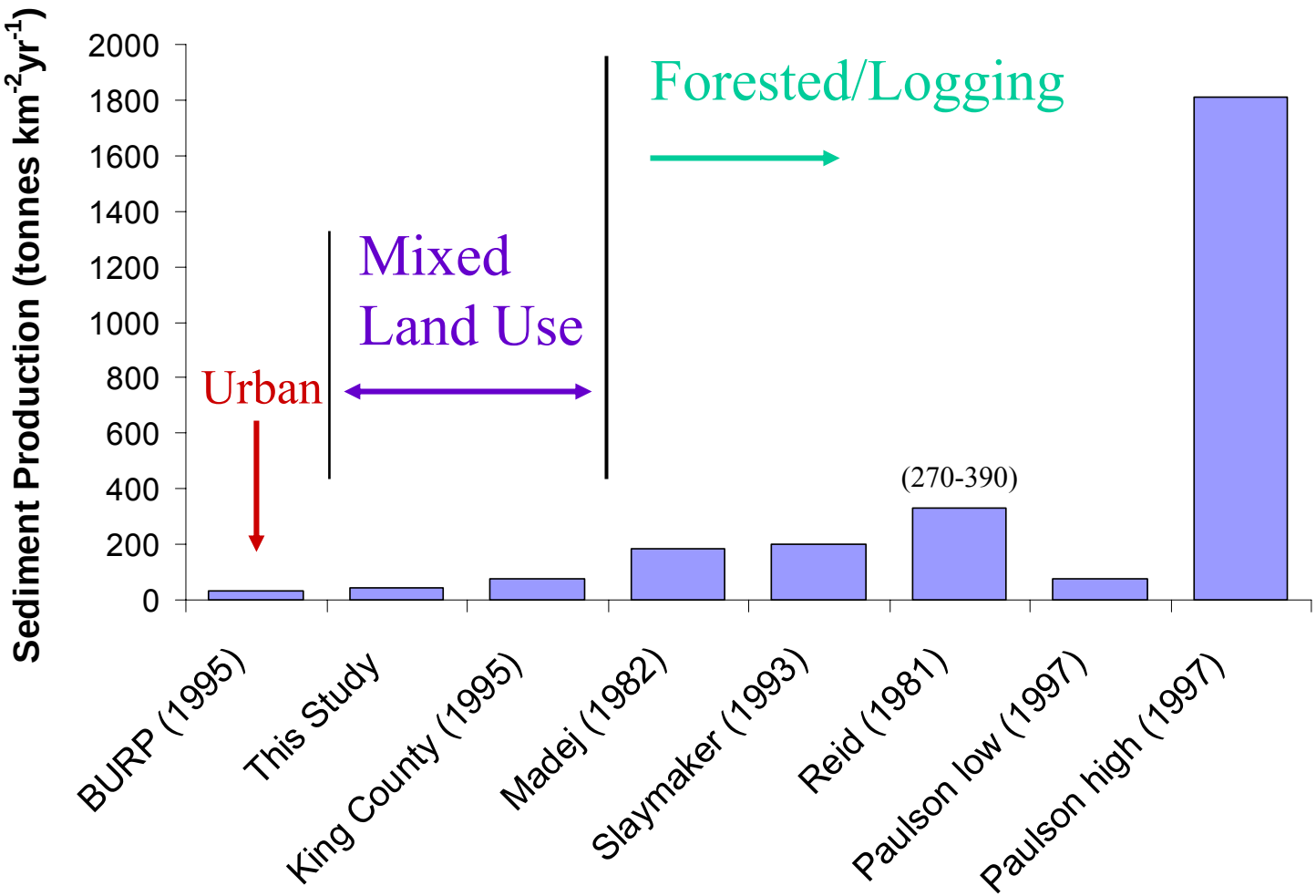


Total Sediment Production

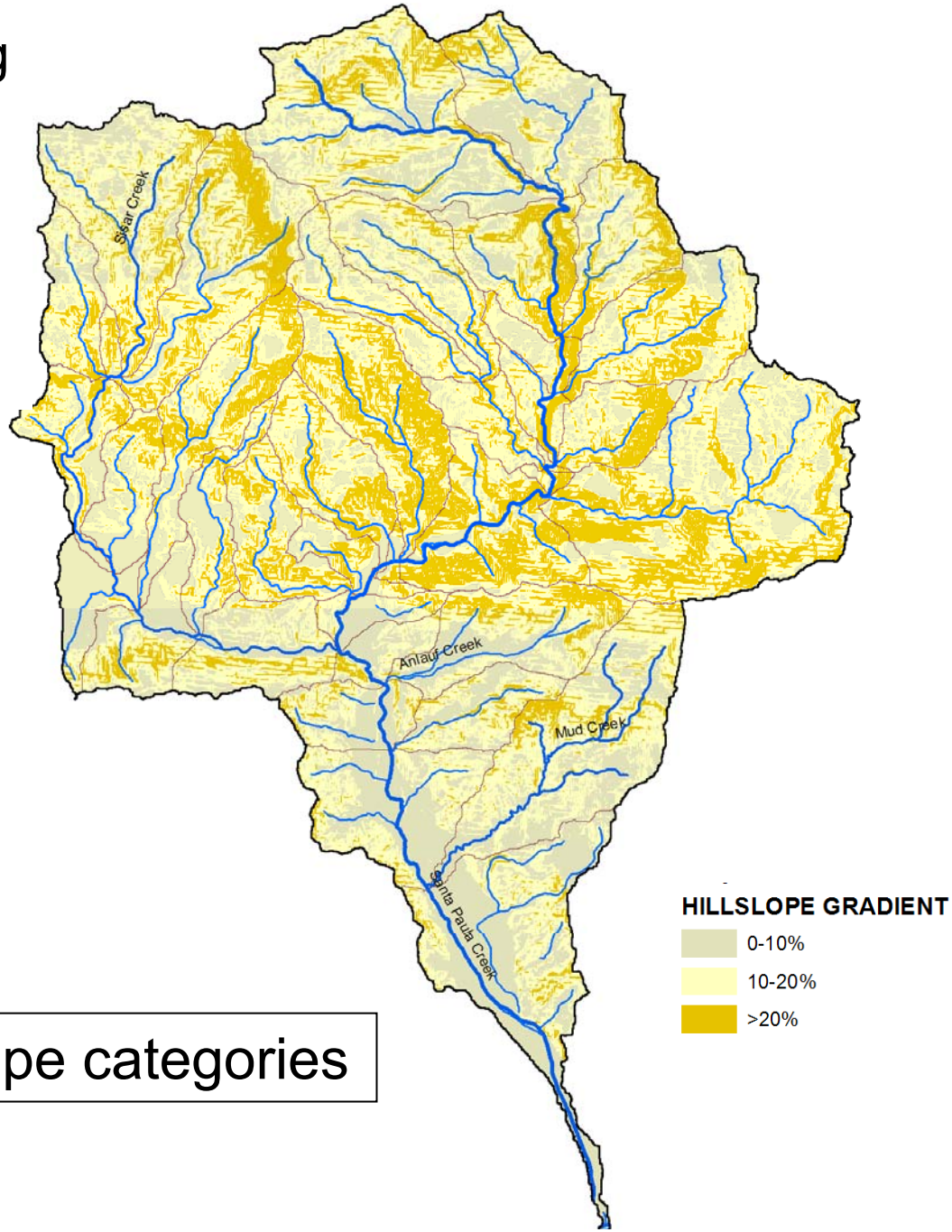


Total Sediment Production
6400 tonnes/year (≈50 t/km^2/yr)

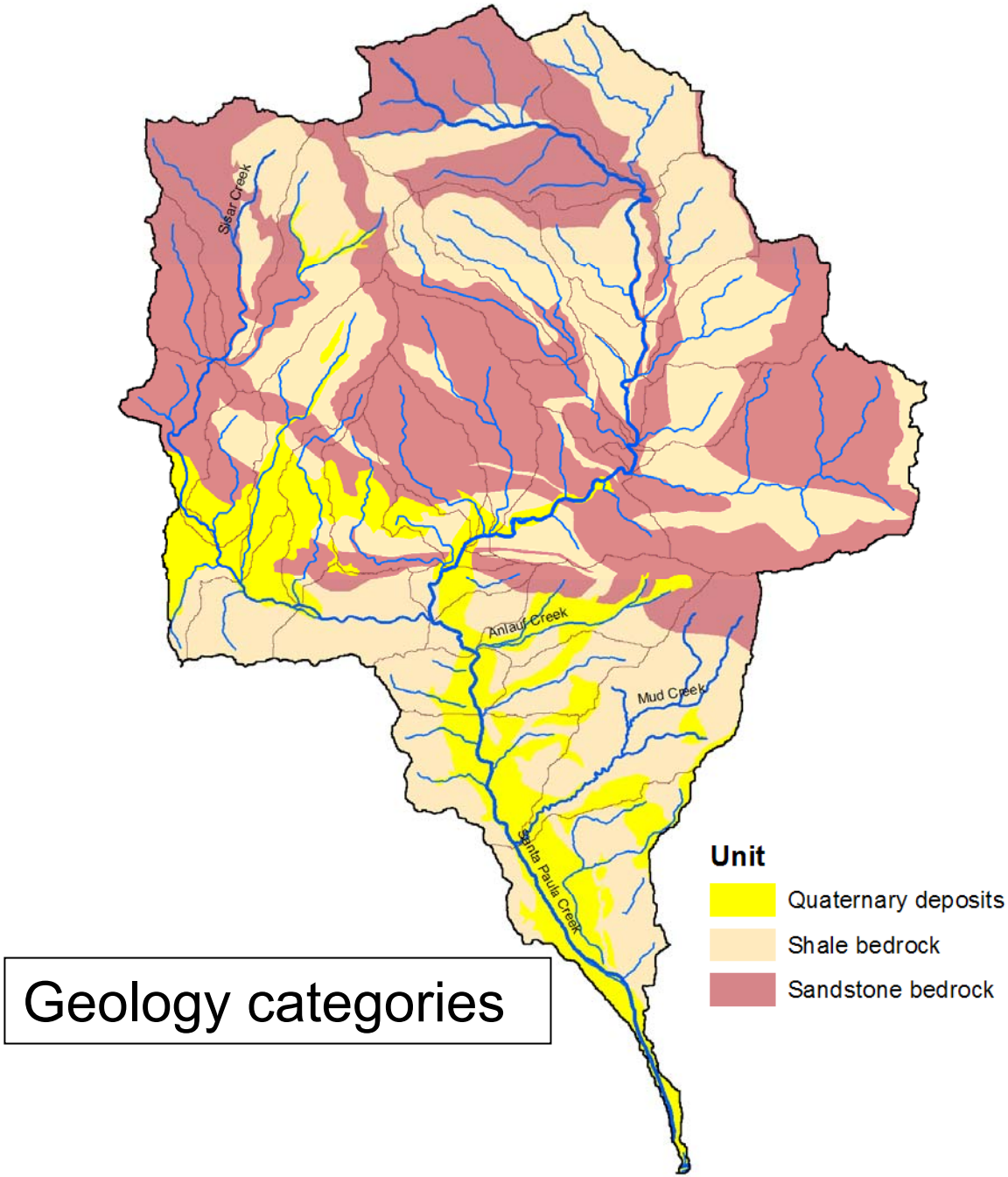
Comparison to Other PNW Studies



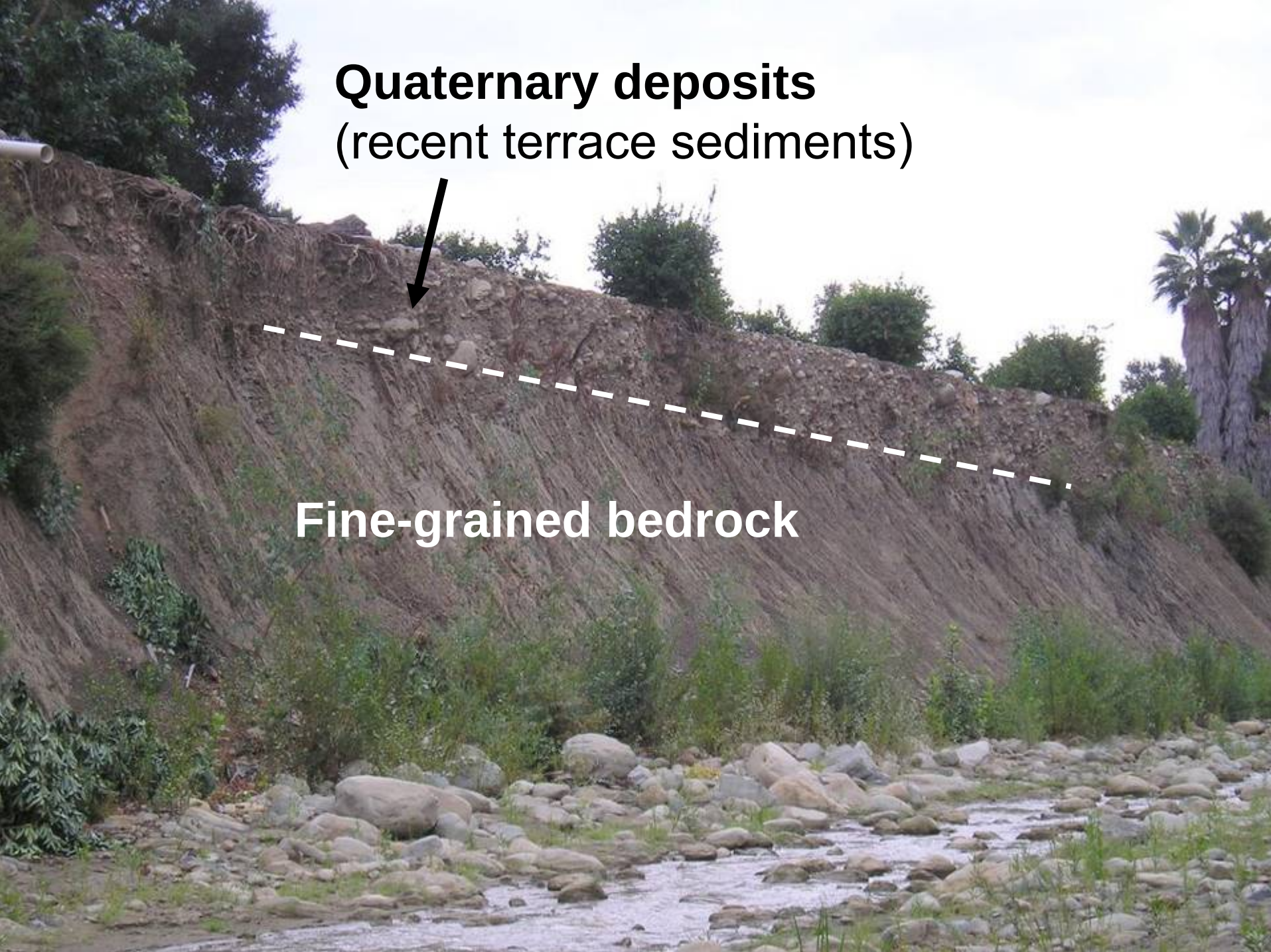
2. Characterizing sediment production in the Santa Paula Creek watershed:

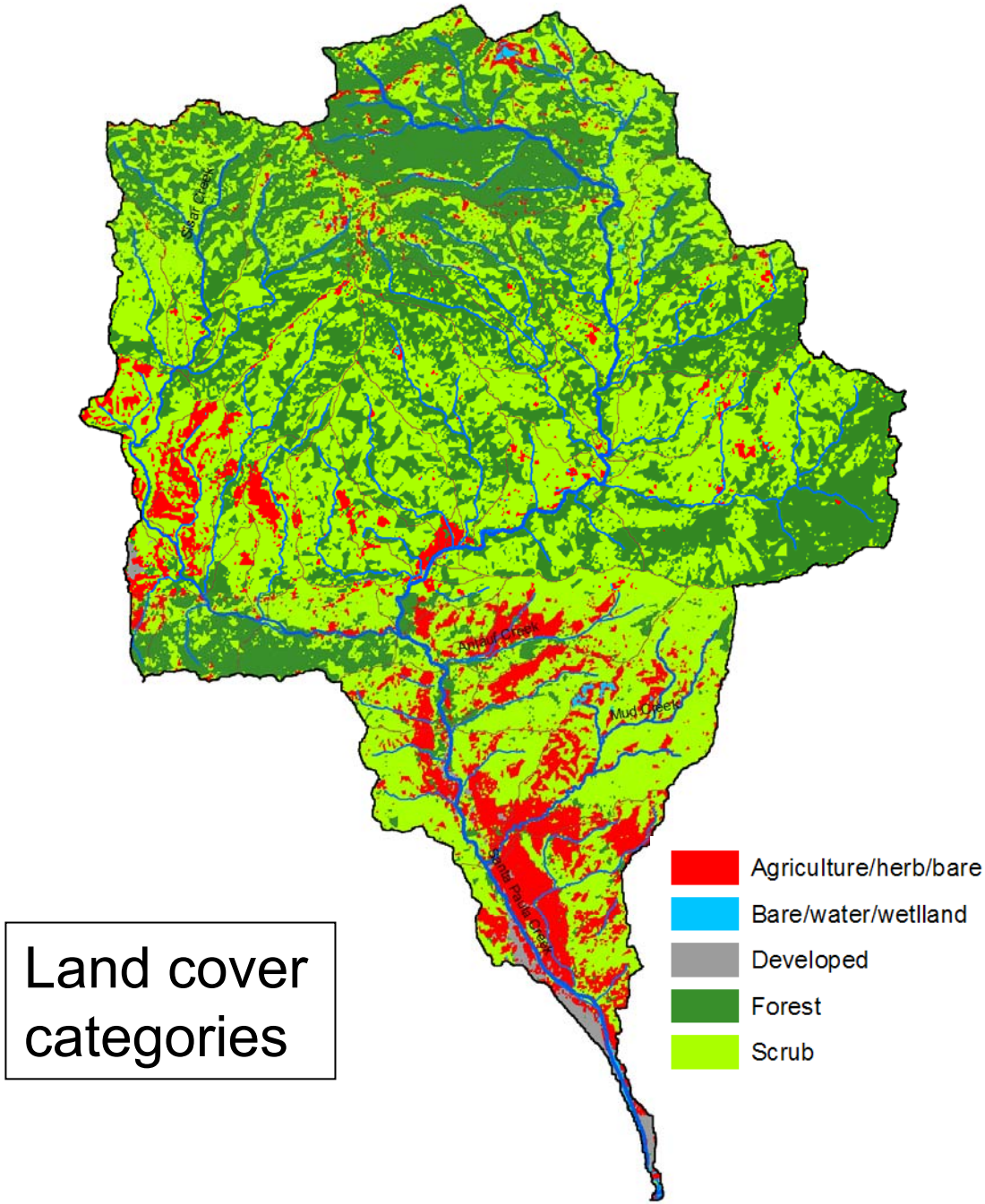


Slope categories

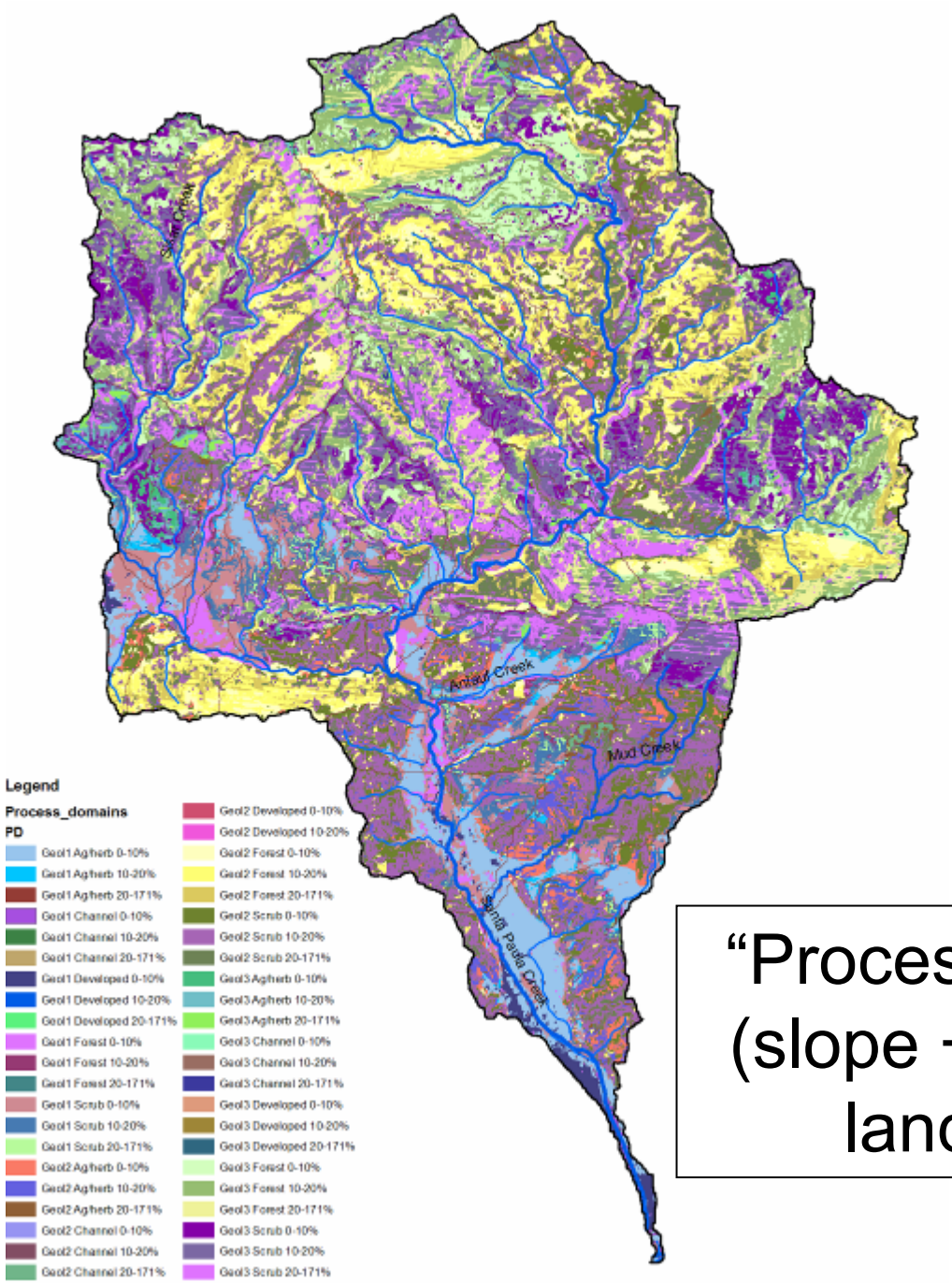


Geology categories

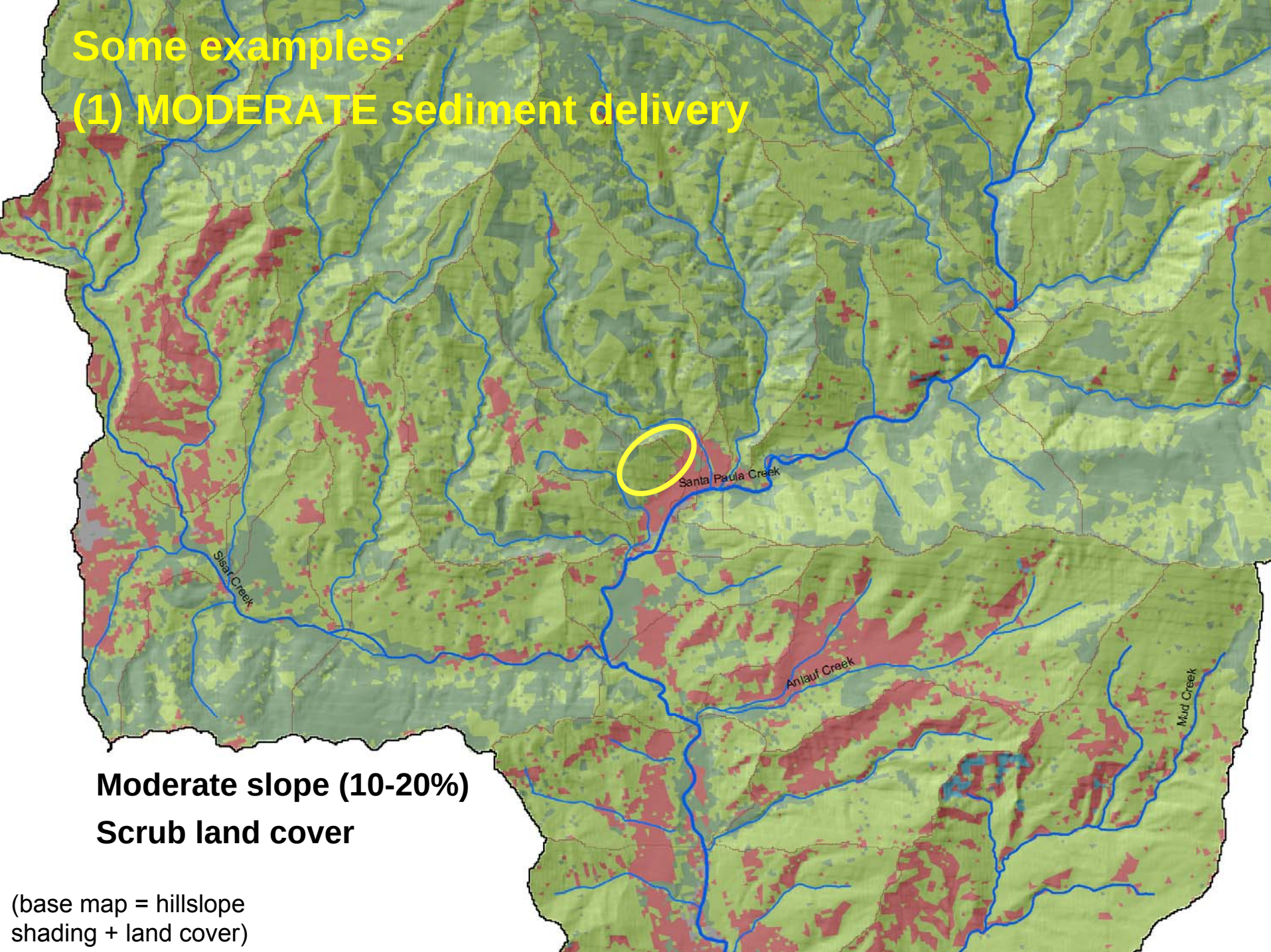

Quaternary deposits
(recent terrace sediments)
Fine-grained bedrock



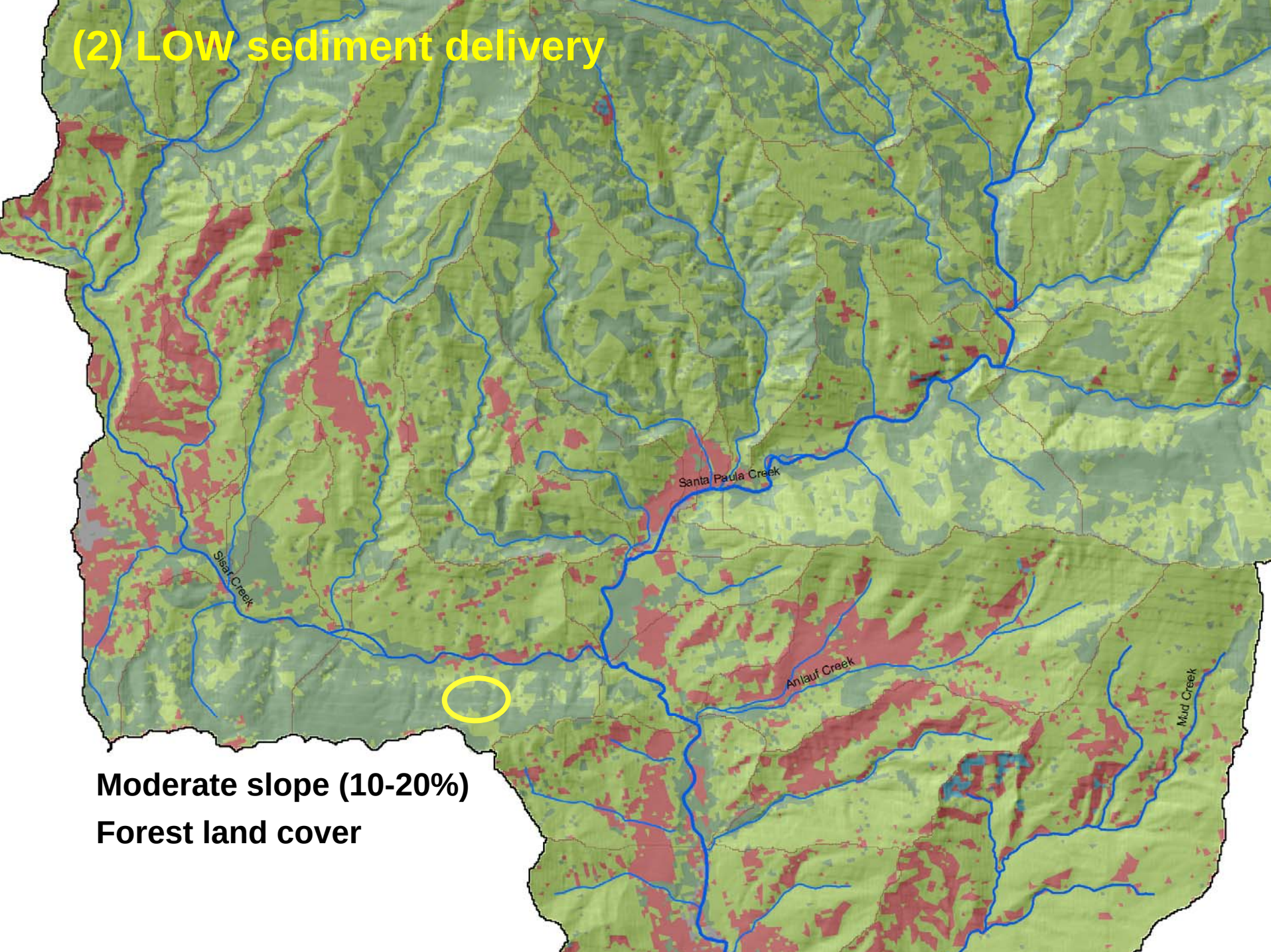
Land cover categories



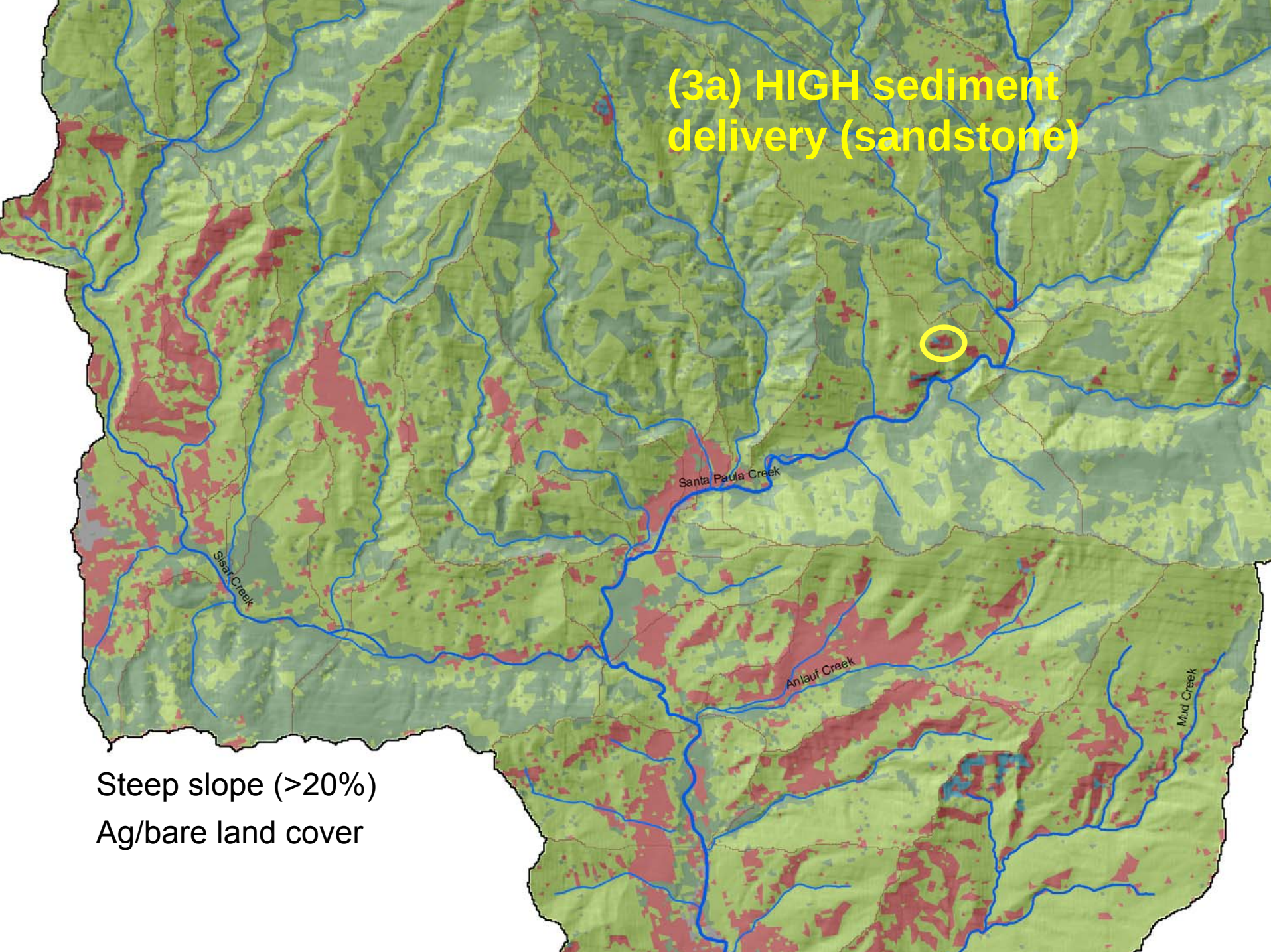
"Process domains" (slope + geology + land cover)


Some examples:
(1) MODERATE sediment delivery
Santa Paula Creek
Sisar Creek
Adams Canyon
Mud Creek
Moderate slope (10-20%)
Scrub land cover
(base map = hillslope shading + land cover)

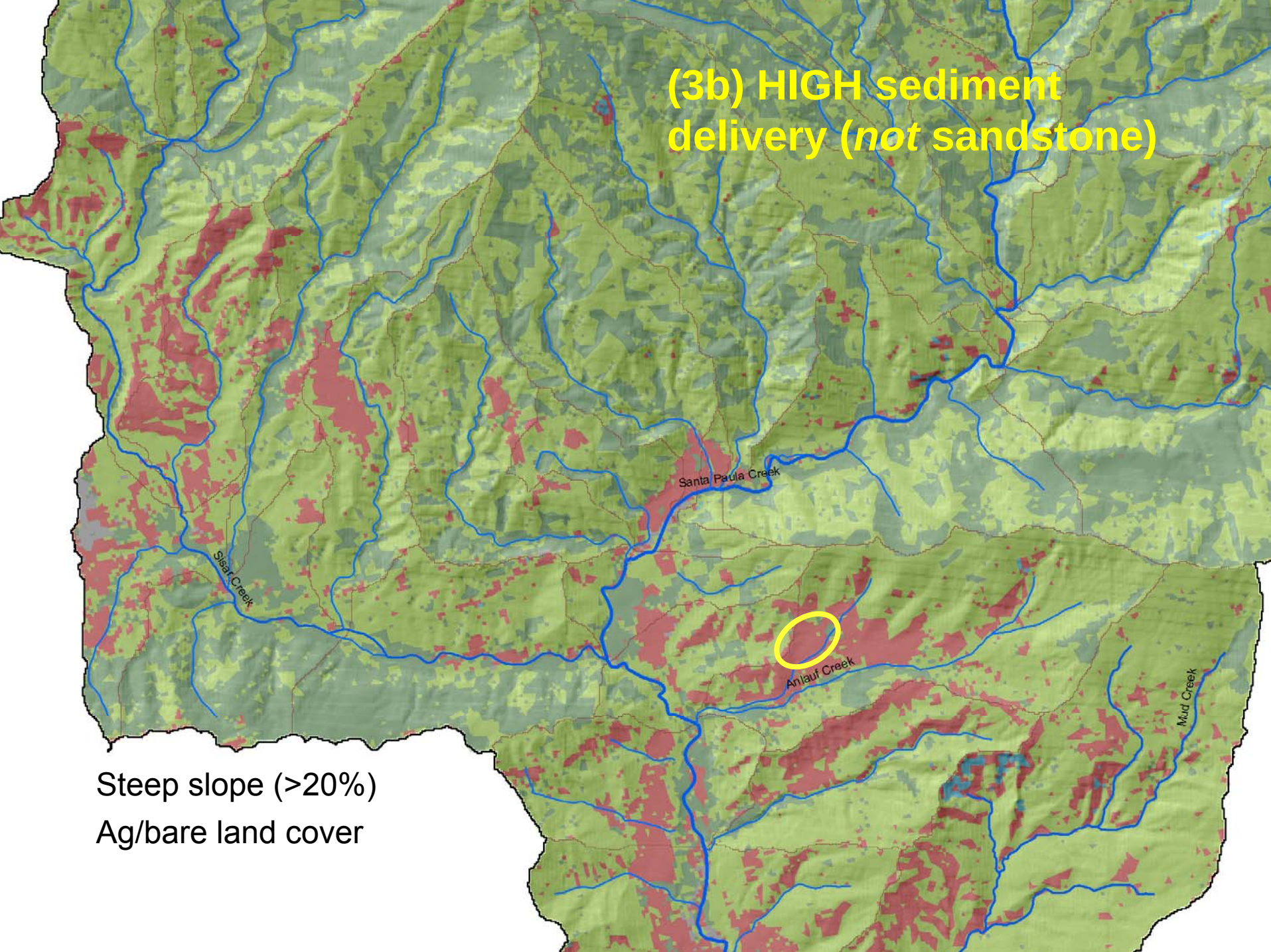
MODERATE sediment delivery


(2) LOW sediment delivery
Santa Paula Creek
Sisar Creek
Antlauf Creek
Mud Creek
Moderate slope (10-20%)
Forest land cover

LOW sediment delivery


(3a) HIGH sediment delivery (sandstone)
Santa Paula Creek
Sisar Creek
Adams Canyon
Mud Creek
Steep slope (>20%)
Ag/bare land cover

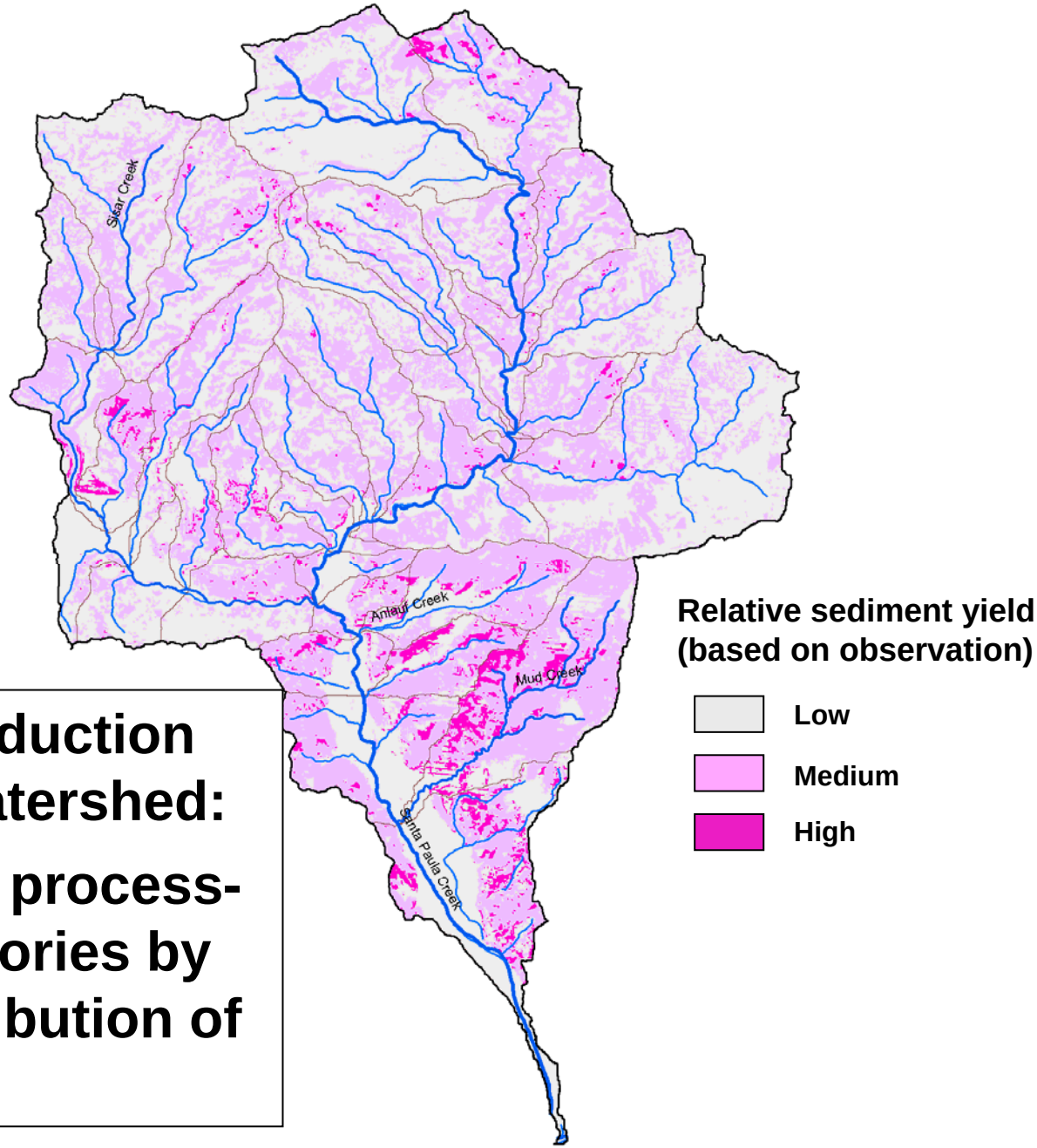

HIGH sediment delivery
(sandstone)

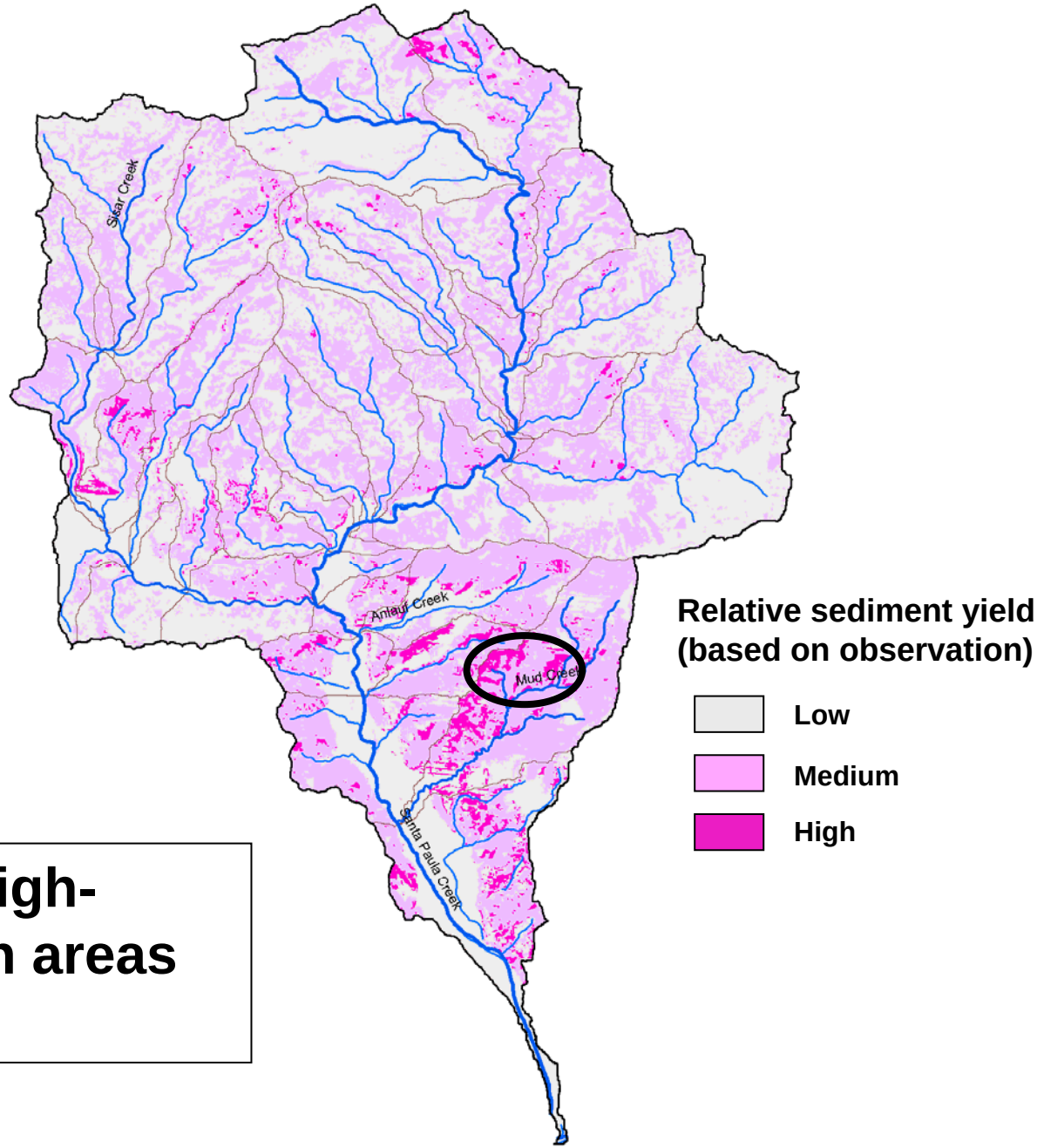

(3b) HIGH sediment delivery (*not* sandstone)
Santa Paula Creek
Sisar Creek
Antlauf Creek
Mud Creek
Steep slope (>20%)
Ag/bare land cover


HIGH sediment delivery
(*not* sandstone)

Sediment production across the watershed:

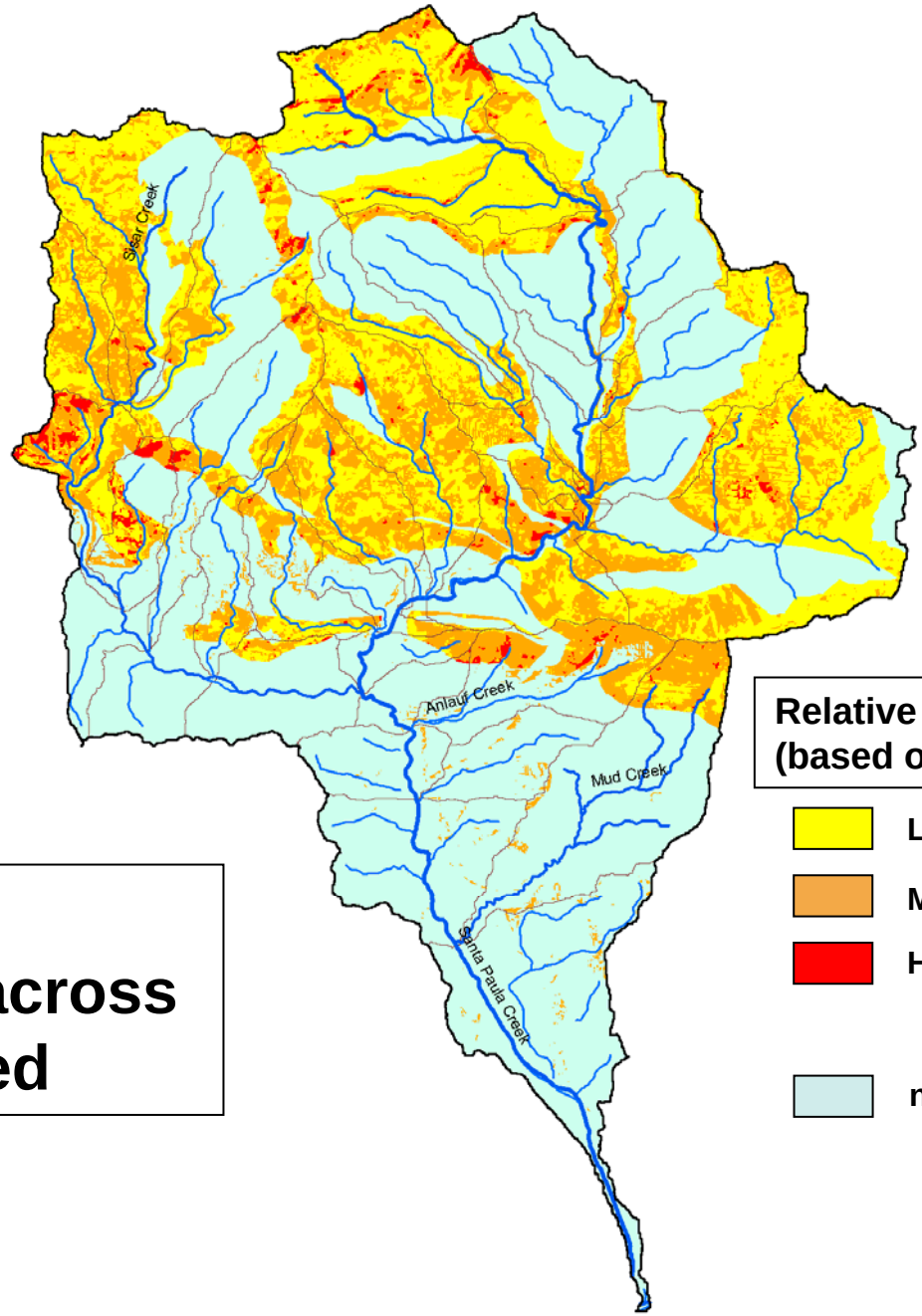
Integration of process-domain categories by relative contribution of sediment





What do high-production areas look like?

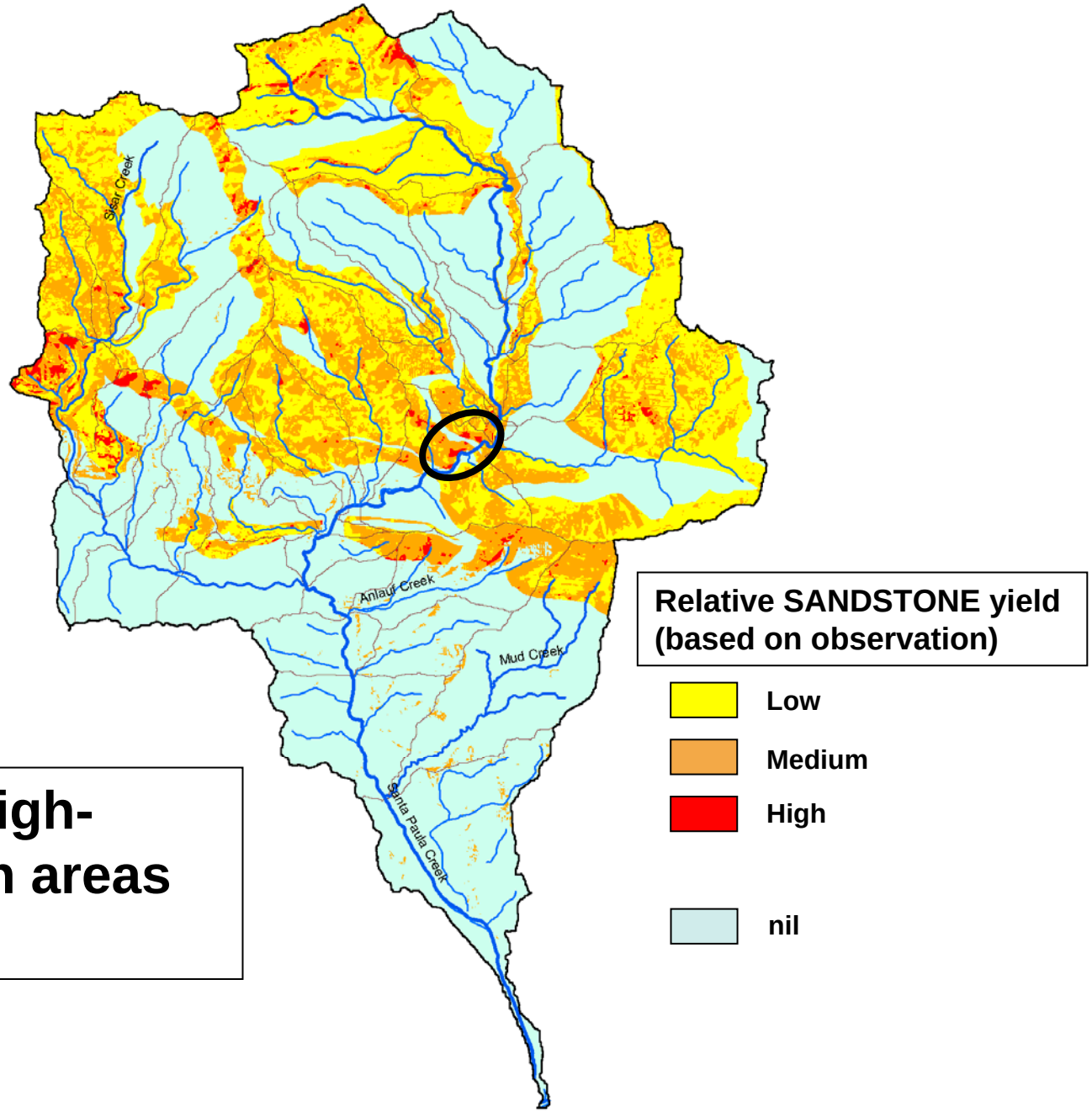
Sandstone production across the watershed



Relative SANDSTONE yield (based on observation)

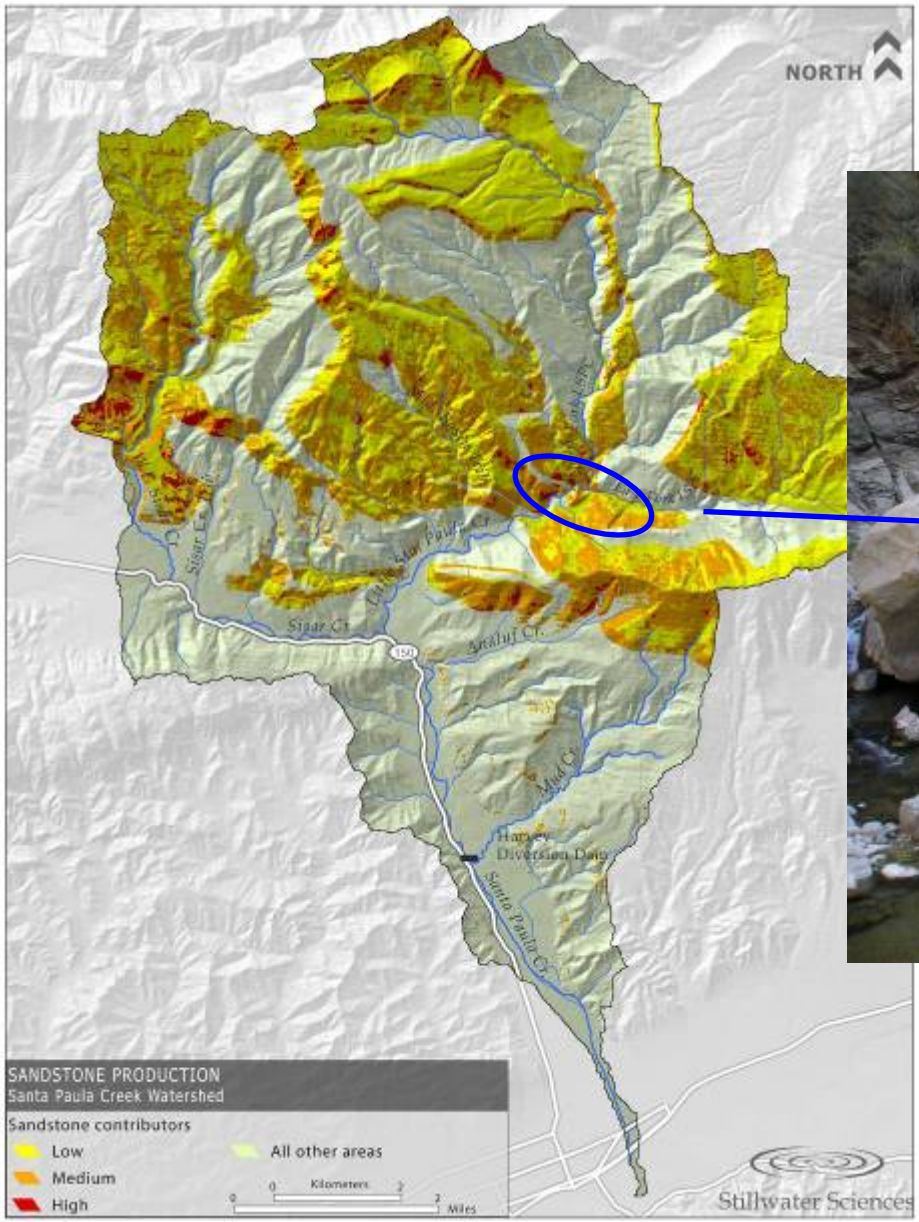
- Low
- Medium
- High
- nil

What do high-production areas look like?

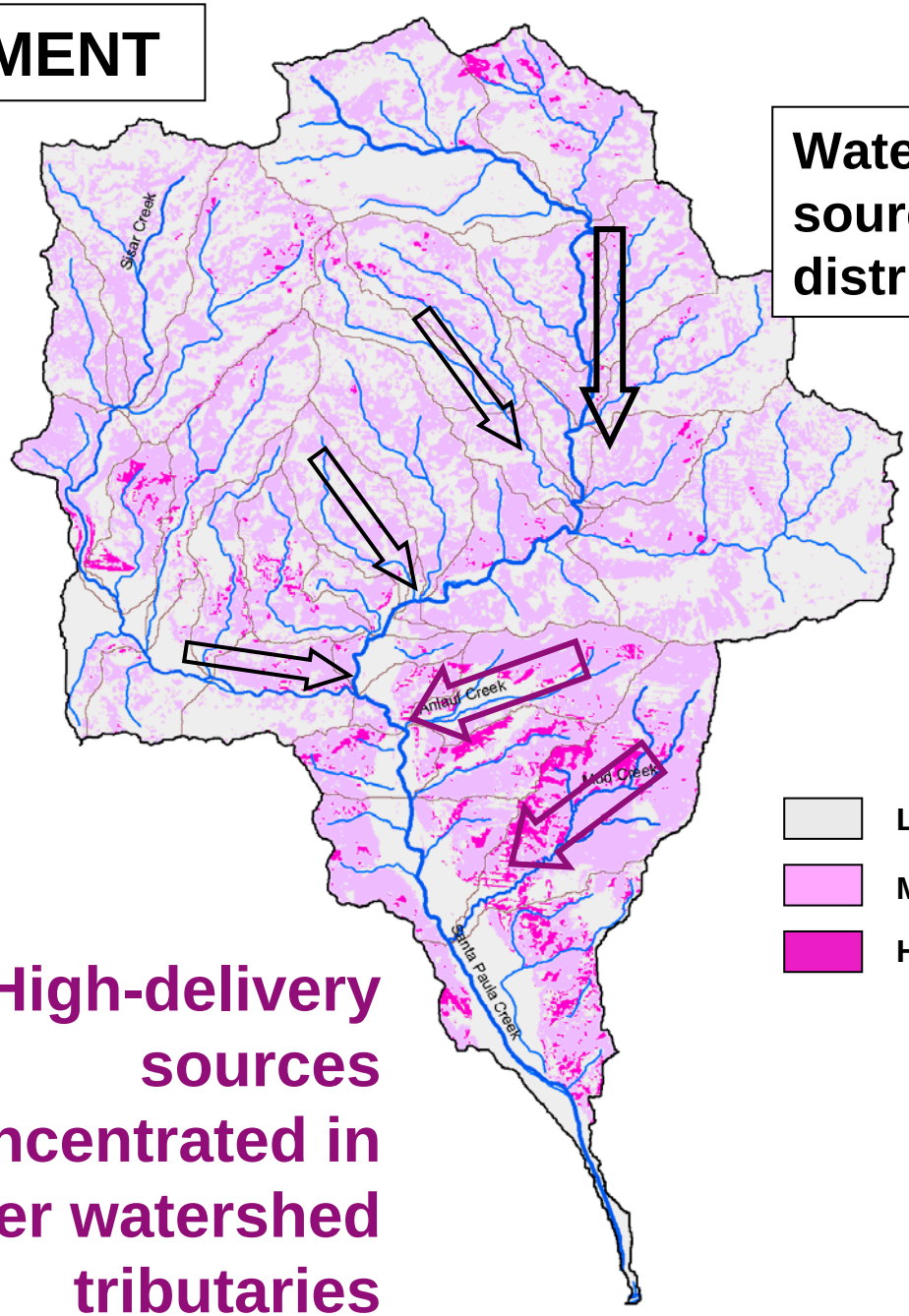



Sandstone bedrock
6” notebook
for scale

Local Bedrock Constrictions



“FINE” SEDIMENT

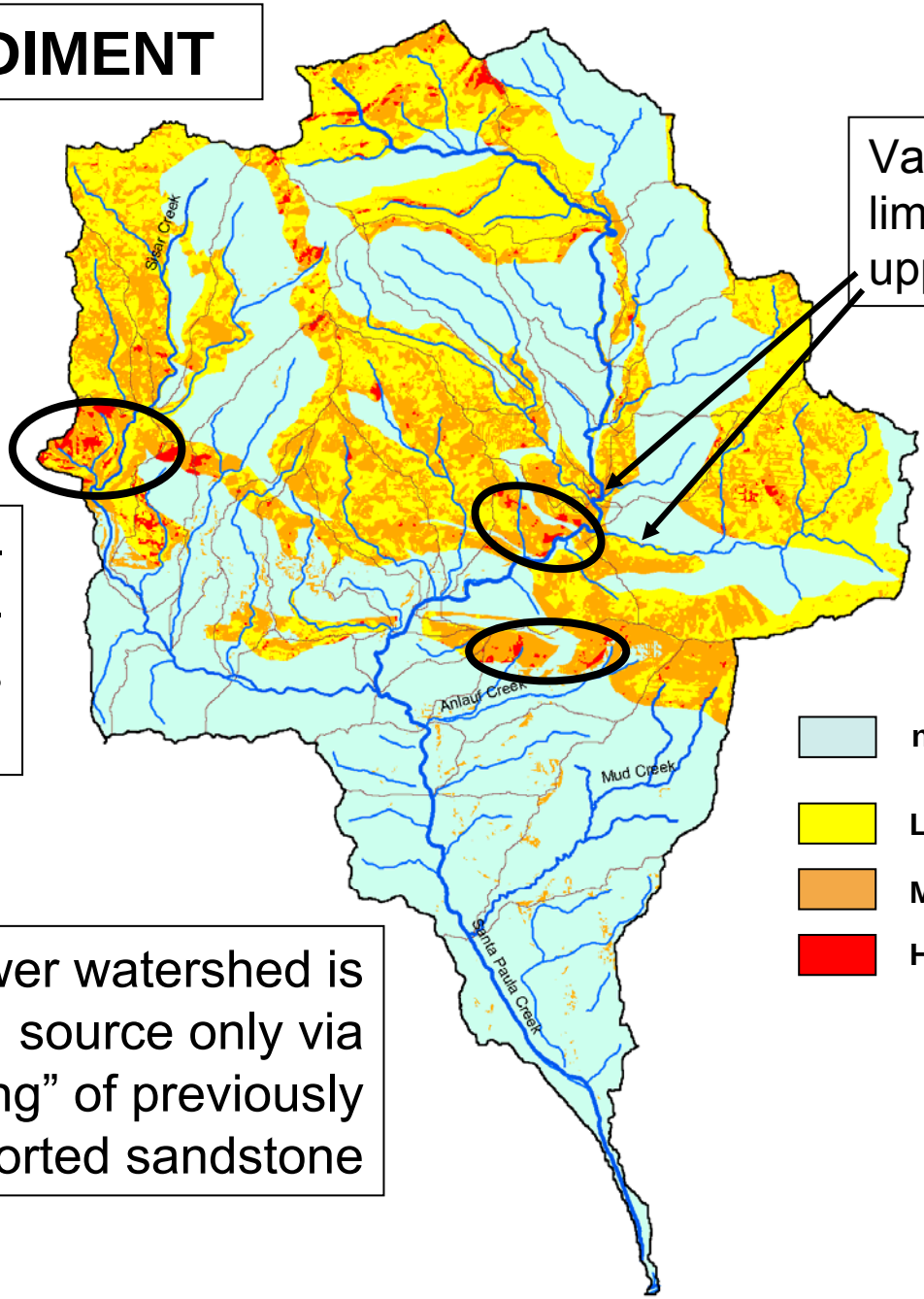


Watershed-wide sources, well-distributed

Low
Medium
High

High-delivery sources concentrated in lower watershed tributaries

COARSE SEDIMENT



Valley constrictions limit contribution from upper watershed

Network-accessible high-delivery sources are limited

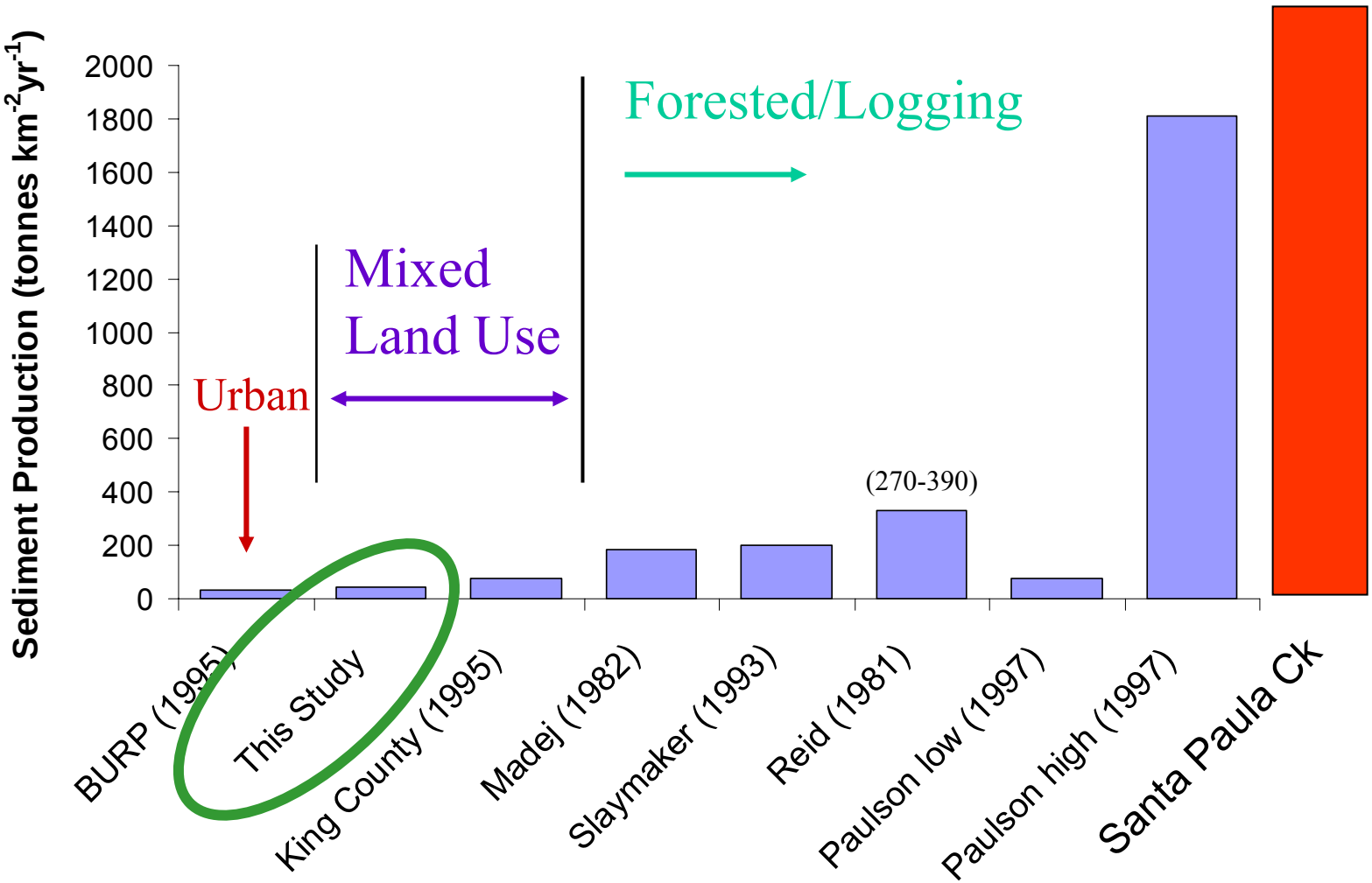
Lower watershed is source only via "recycling" of previously transported sandstone

Hillslope Sediment Delivery by Subwatershed

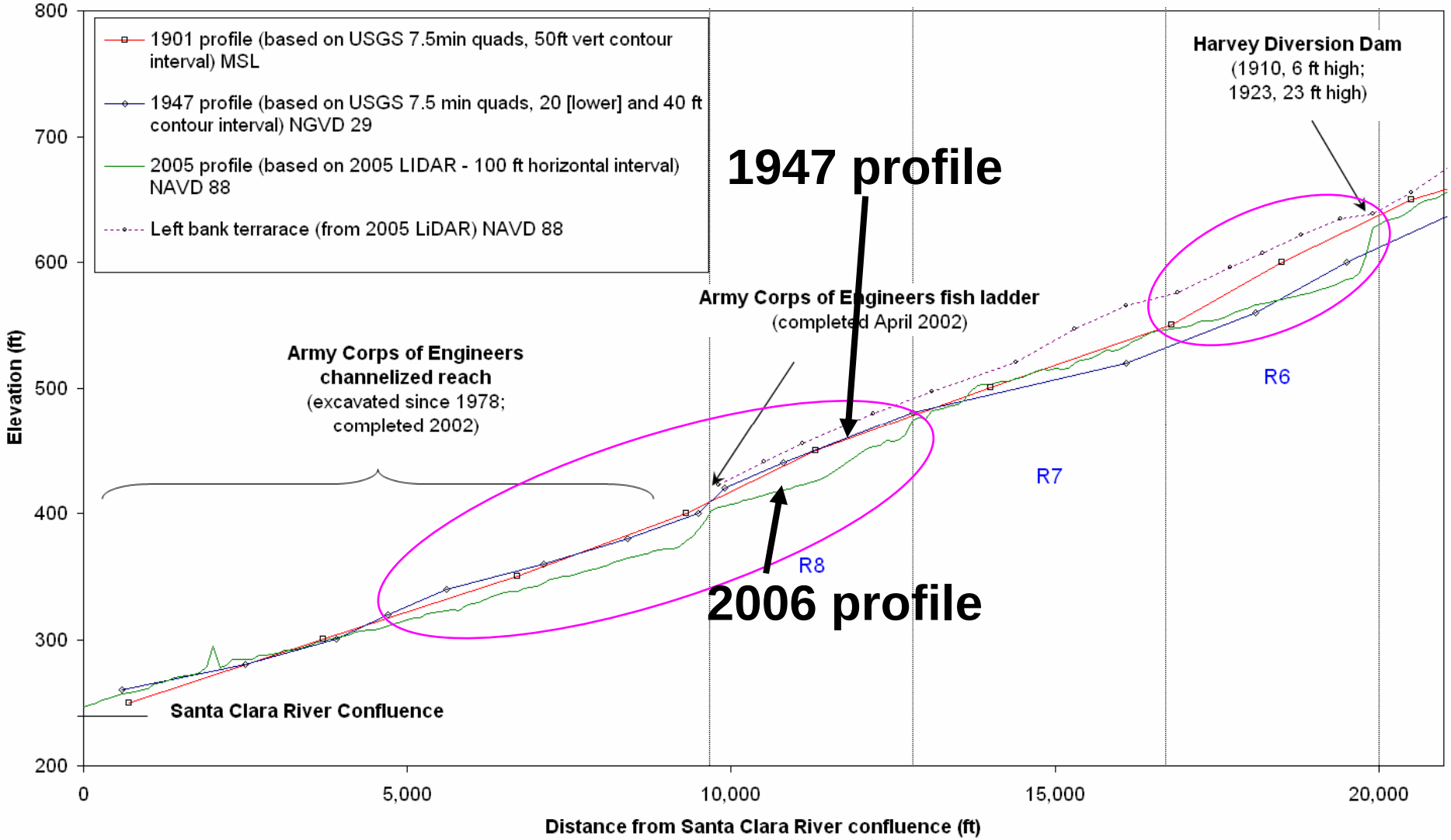
Tributary	Total annual load ($t\ a^{-1}$)	Annual load ($t\ km^{-2}\ a^{-1}$)	Landscape lowering rate ($mm\ a^{-1}$)
Sisar Creek	44,000	2,300	0.9
Upper Santa Paula Creek (to Sisar Ck. confluence)	73,000	1,700	0.7
SPC at Harvey Diversion Dam	146,000	2,100	0.8
Mud Creek	24,000	5,800	2.2
Santa Paula Creek at mouth	**252,000**	**2,200**	**0.8**

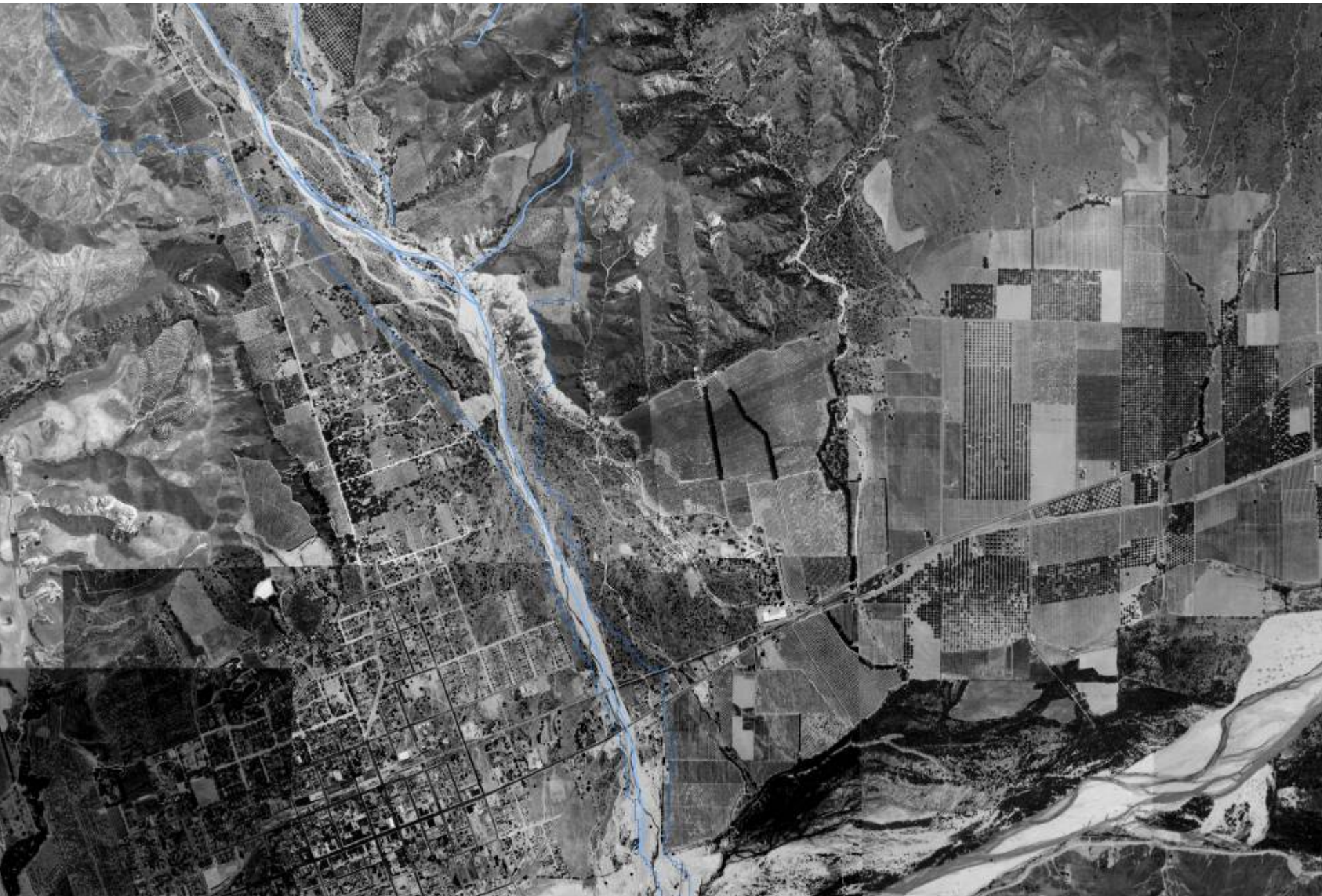
2200 tonnes per square km per year!

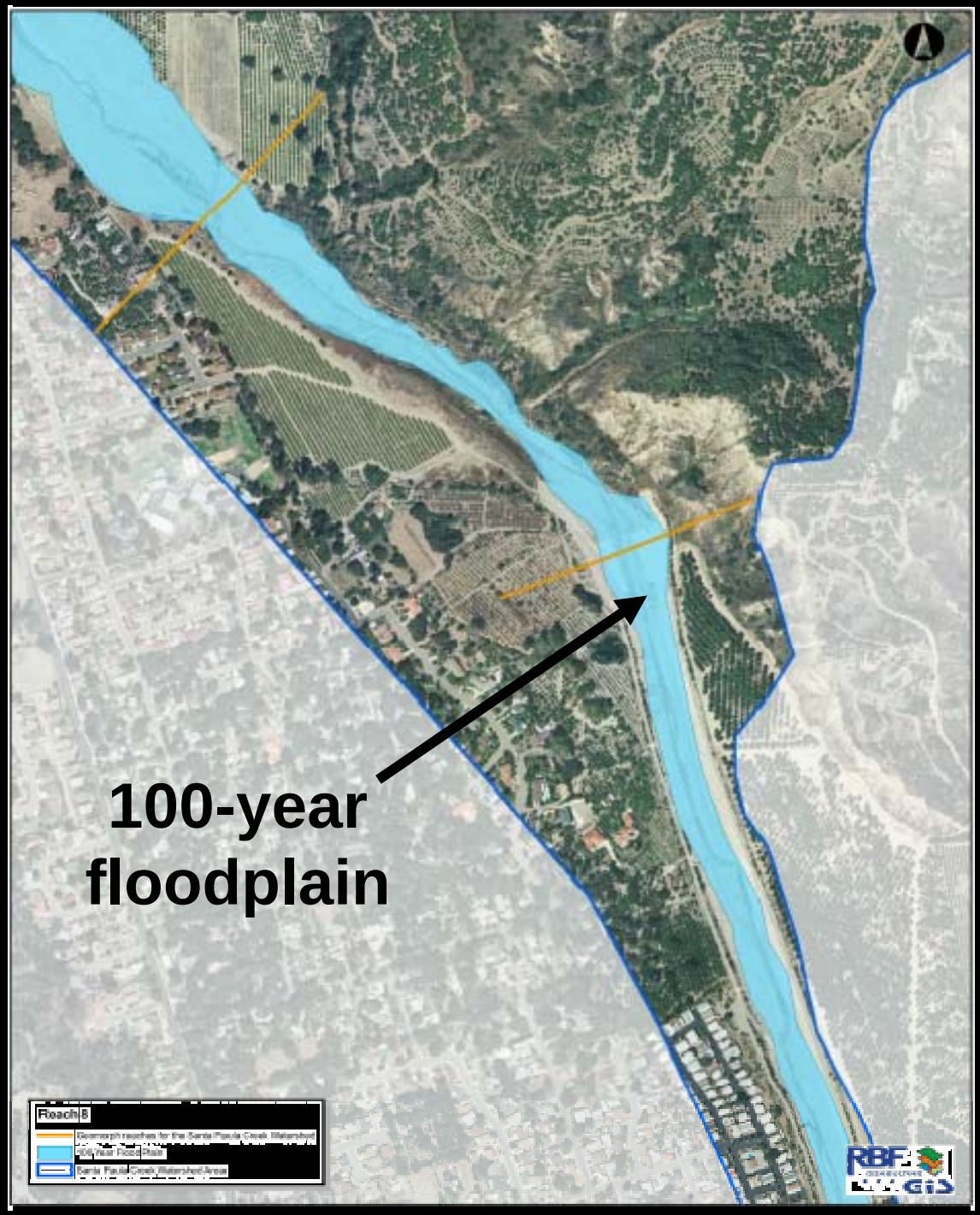
Comparison to Other PNW Studies



Channel Incision—Santa Paula Creek






100-year
floodplain
Reach 8