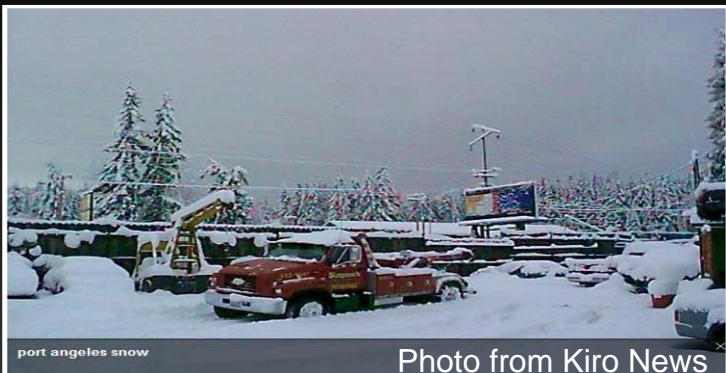


The Early December 2007 Series of Storms

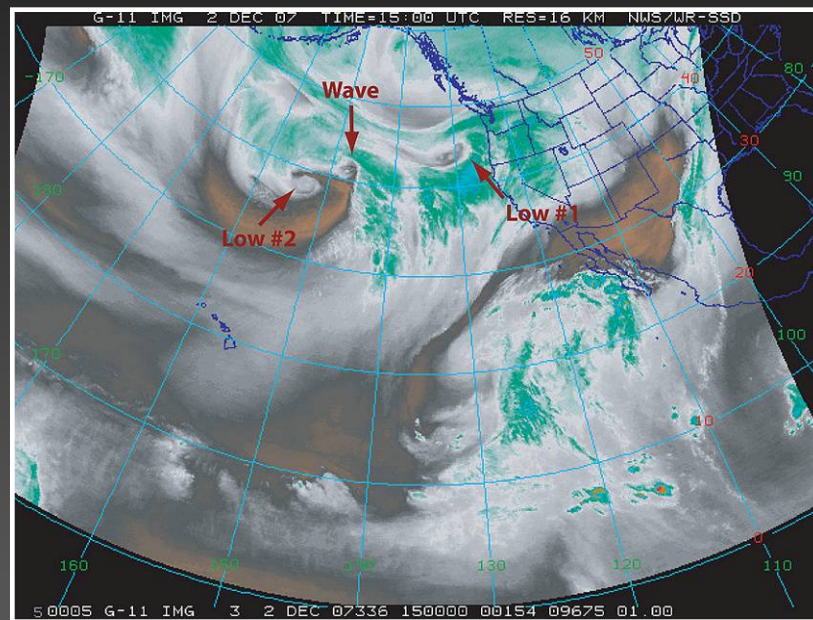
Snow



Wind



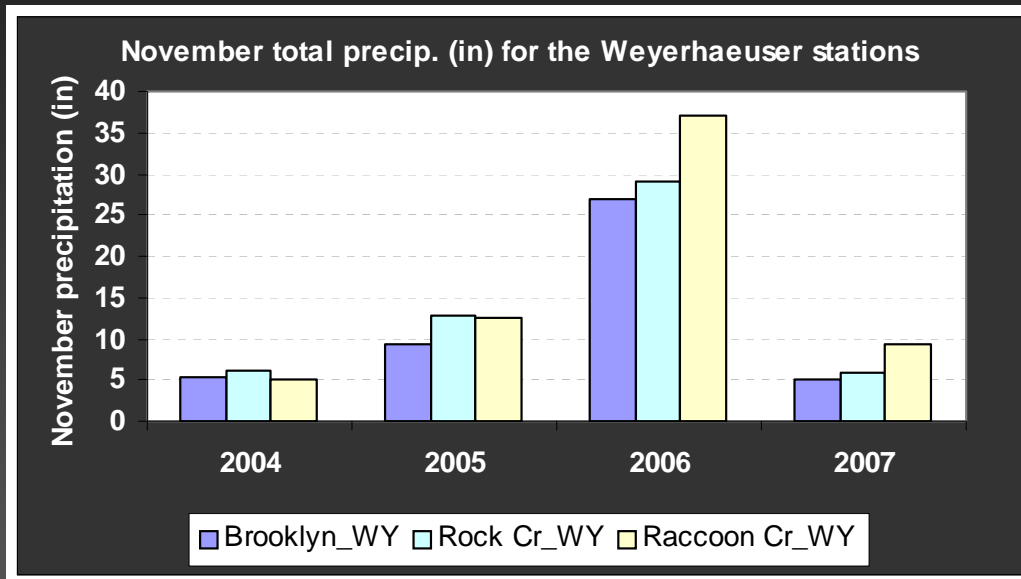
Rain



Maryanne Reiter, Hydrologist
Weyerhaeuser Company
PNW Weather Workshop
February 29, 2008

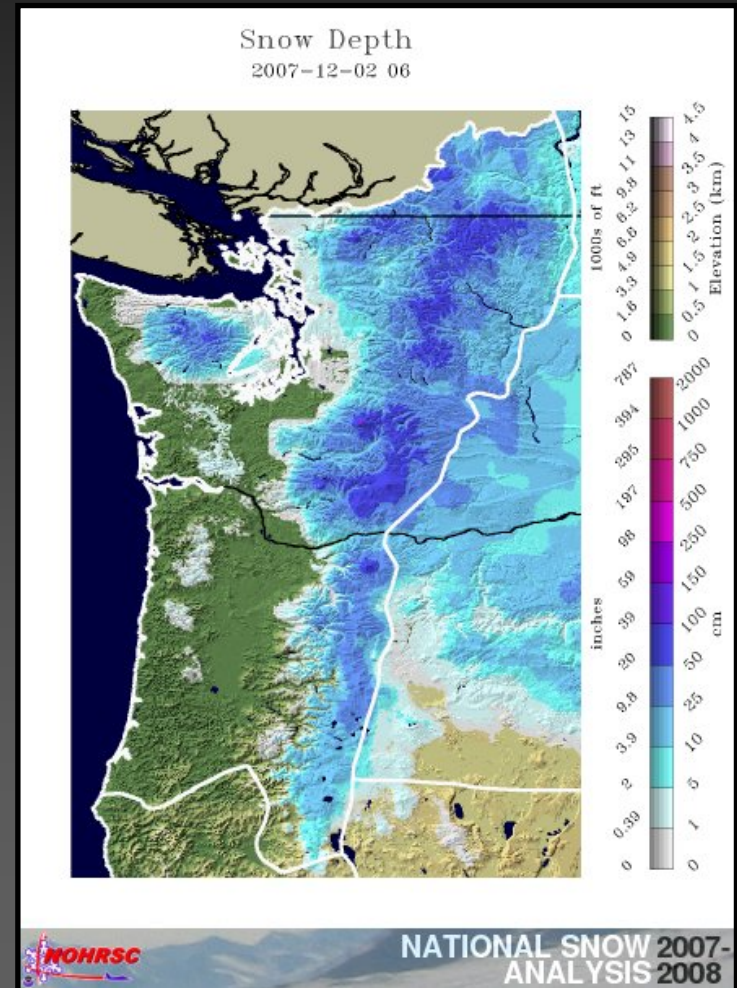
Antecedent conditions

Prior to the storm October had generally above normal precipitation while November was generally below normal.



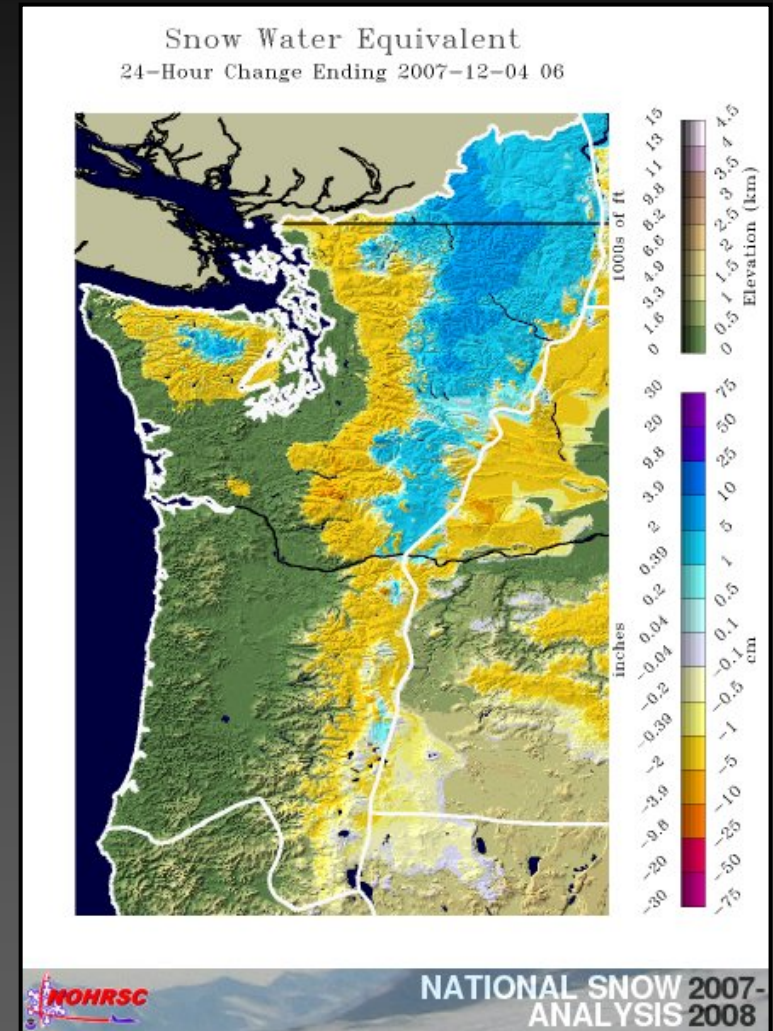
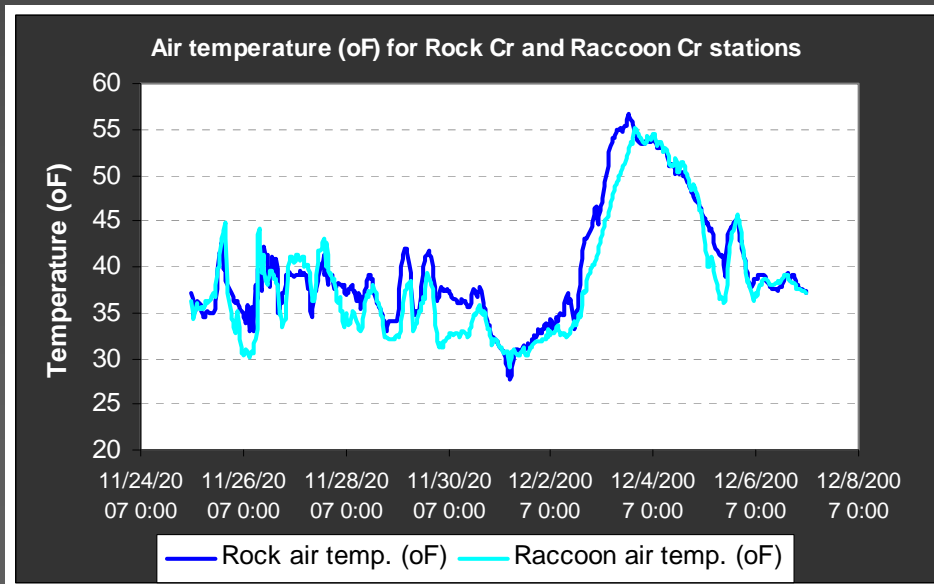
Snowfall

In late November-early December up to 1" of snow fell around Seattle while several higher elevation areas of the Cascades received well over a foot of snow. In the Willapa Hills there was around 18" at 1,800 ft.



Snowmelt

The warm temperatures early in the storm caused much of the new snow to melt. However, because the new snow did not contain high amounts of water (low snow water equivalent) and because there was not a significant low elevation snowpack, snowmelt amounts were minimal (1-3") for areas below 4,000 ft compared to the high rainfall.



Wind

Saturday, December 1, 2007
2:48 PM

**...“HURRICANE
FORCE WIND
WARNING IN EFFECT
FROM SUNDAY
EVENING THROUGH
MONDAY
MORNING” ...National
Weather Service.**

Maximum Gust Speed (mph)

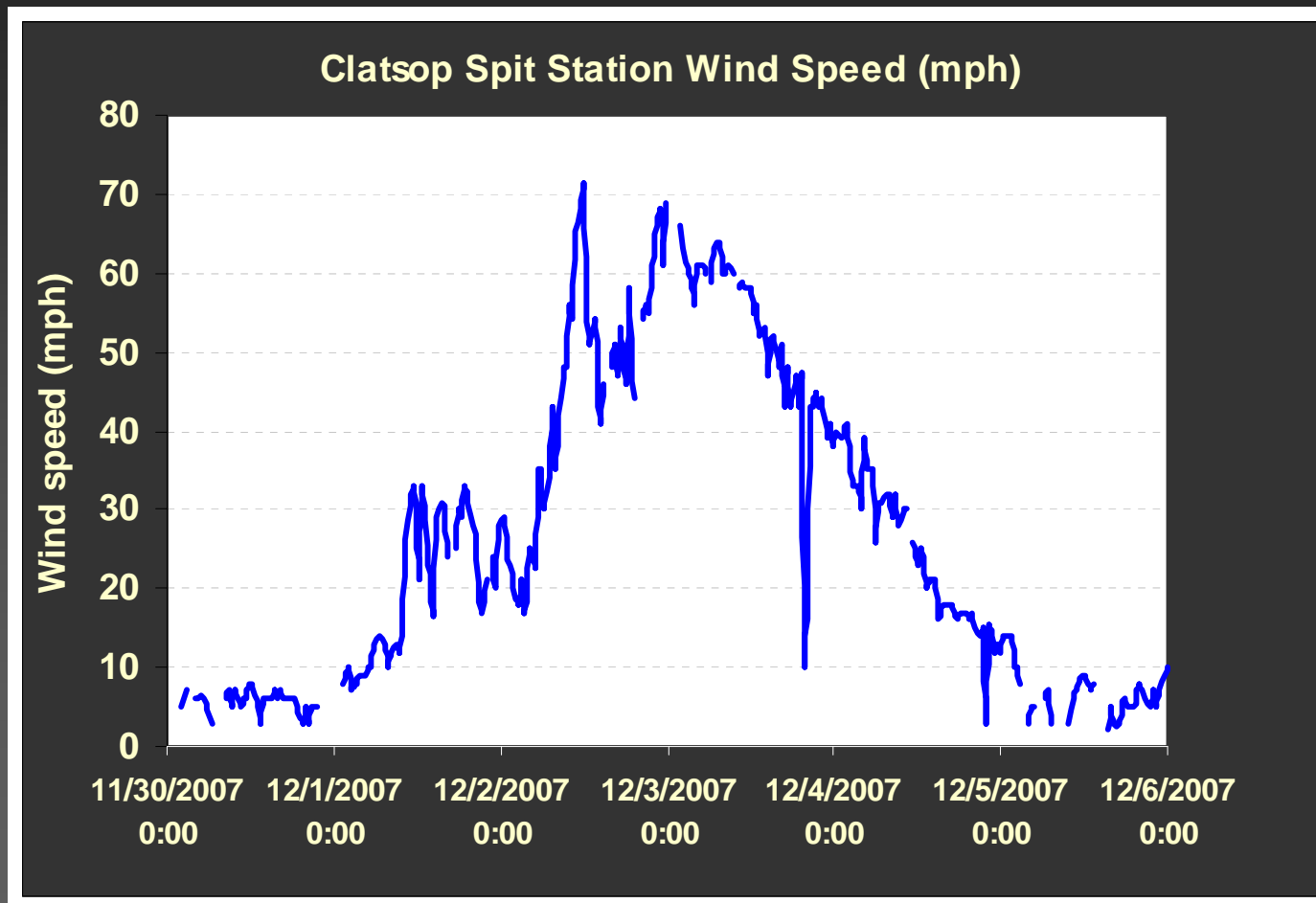


Figure developed by Wolf Read and available on the Oregon Climate Service webpage, The Great Coastal Gale: <http://www.ocs.oregonstate.edu/index.html>

Wind Duration

PUBLIC INFORMATION STATEMENT
NATIONAL WEATHER SERVICE PORTLAND OR
1245 PM PST MON DEC 3 2007

..A STRONG PACIFIC SYSTEM CONTINUES TO ROCK THE COASTAL REGION THIS AFTERNOON...

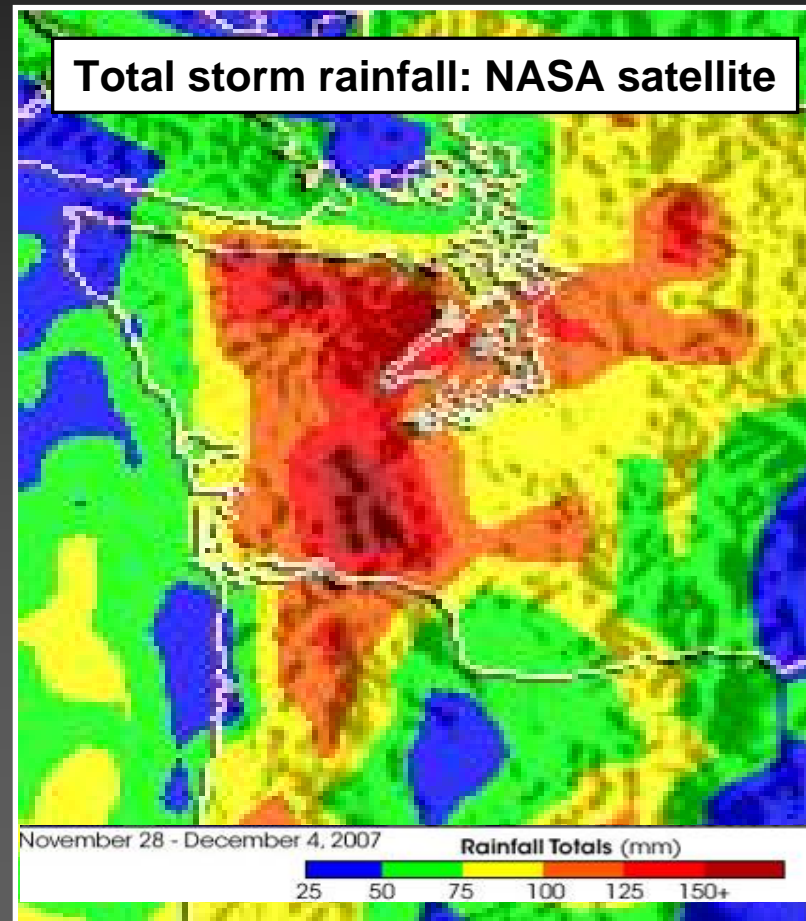


Blow down patterns



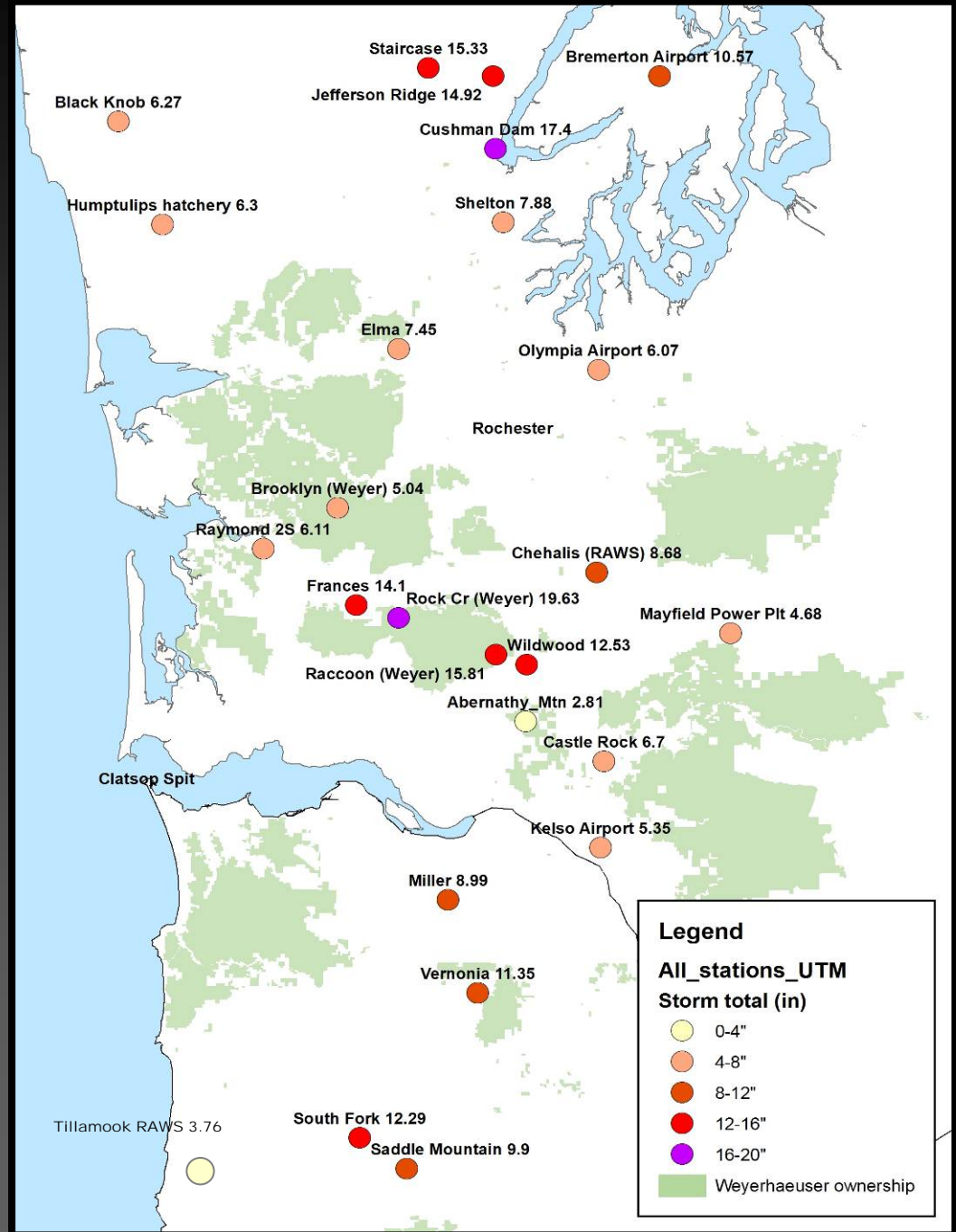
Rain

The most significant of the three storms arrived December 3rd with near record high temperatures and a moist tropical air which led to record rainfall in many areas of southwestern Washington and northwestern Oregon (Wolf Read, OWSC).



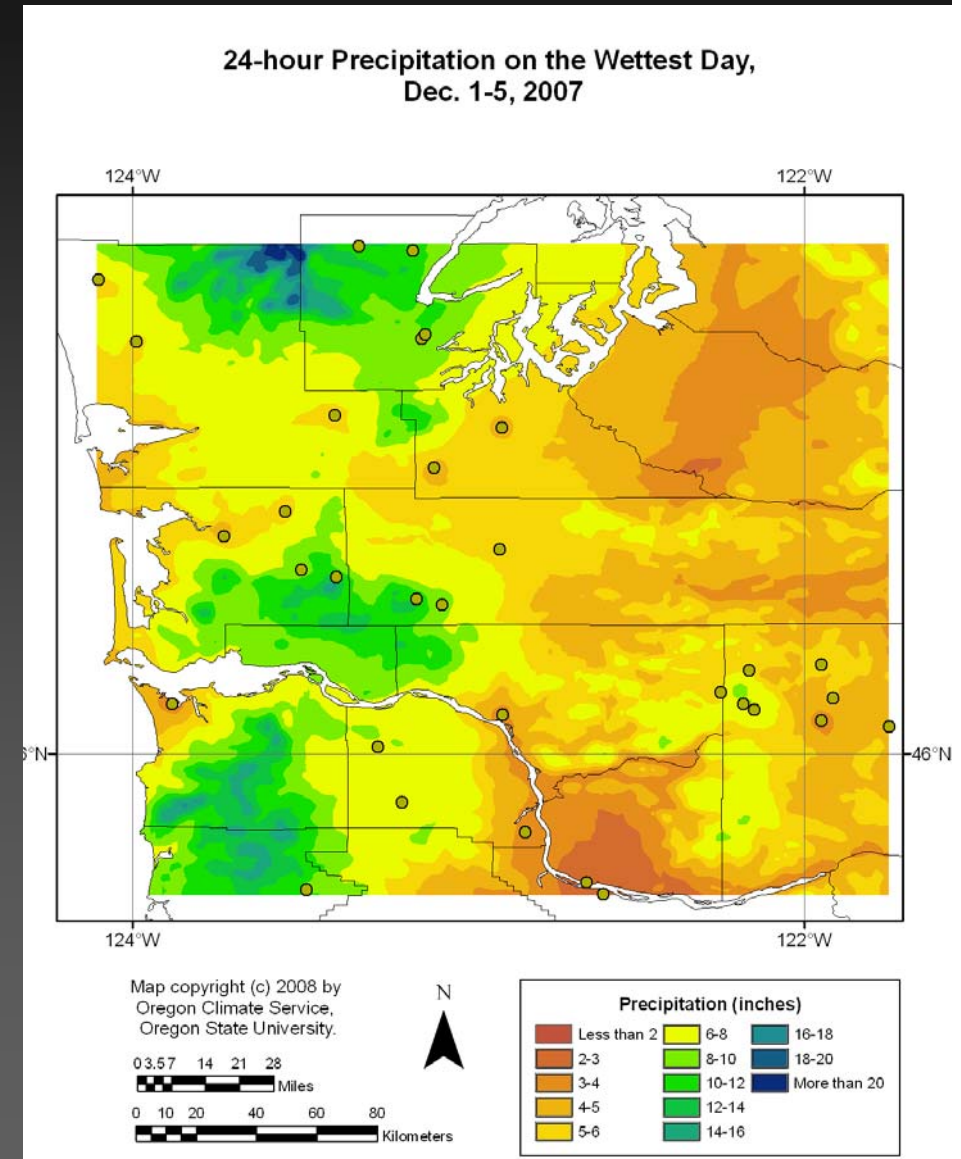
This image shows rainfall totals as recorded by the Multi-satellite Precipitation Analysis (MPA) at NASA Goddard Space Flight Center.

Rain: storm totals



Rain: Maximum 24 hour precipitation

| Station Name | Elevation (ft) | 24hr maximum precipitation (in) |
|-----------------|----------------|---------------------------------|
| Rock Cr (Weyer) | 1424 | 14.35 |
| Raccoon (Weyer) | 1086 | 13.85 |
| Cushman Dam | 76 | 13.10 |
| Staircase | 762 | 12.09 |
| Jefferson Ridge | 2200 | 10.73 |
| Frances | 230 | 9.70 |
| South Fork | 2257 | 9.49 |
| Wildwood | 370 | 9.29 |
| Cedar | 2220 | 9.18 |
| Vernonia | 755 | 8.31 |
| Rye Mountain | 2000 | 7.29 |
| Shelton | 269 | 6.42 |
| Miller | 1031 | 6.40 |
| Chehalis (RAWS) | 262 | 5.38 |
| Black Knob | 588 | 5.17 |



Rainfall metrics important for landslide initiation

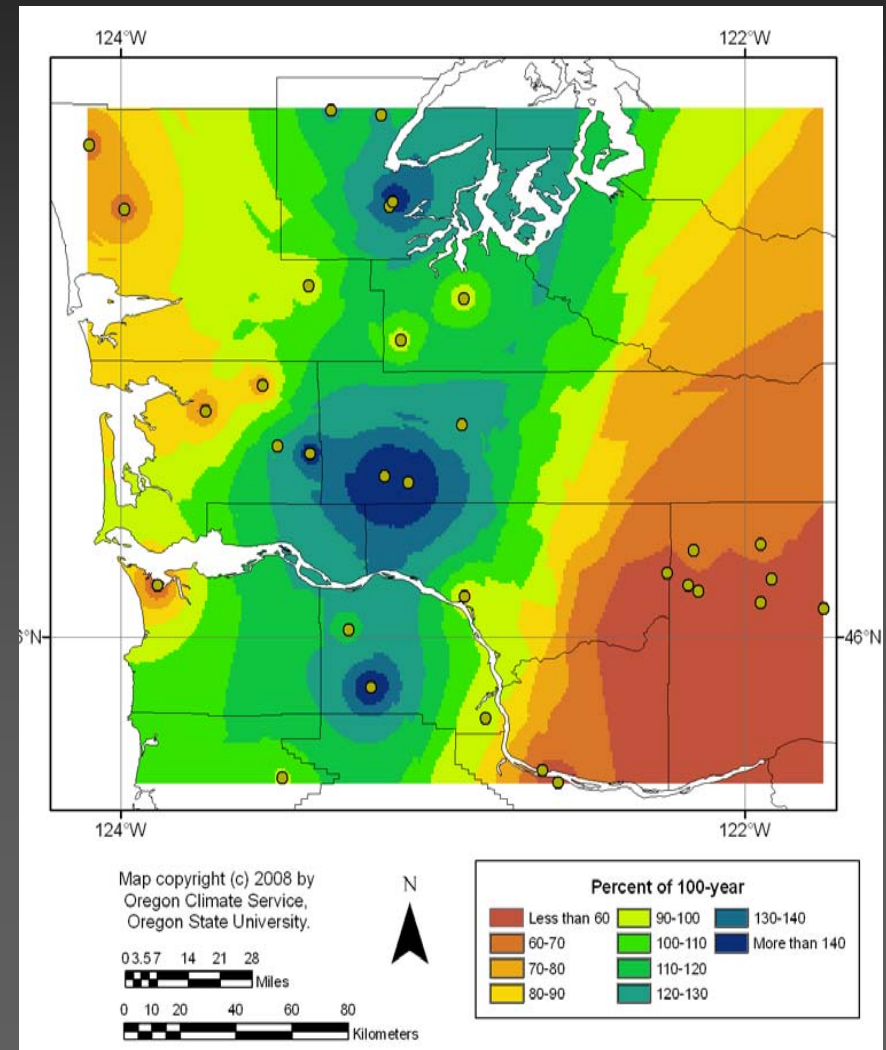
SPECIAL WEATHER STATEMENT
NATIONAL WEATHER SERVICE SEATTLE WA
1210 PM PST MON DEC 3 2007

...INCREASED RISK FOR LANDSLIDES TODAY IN WESTERN WASHINGTON DUE TO PAST AND CURRENT HEAVY RAIN...

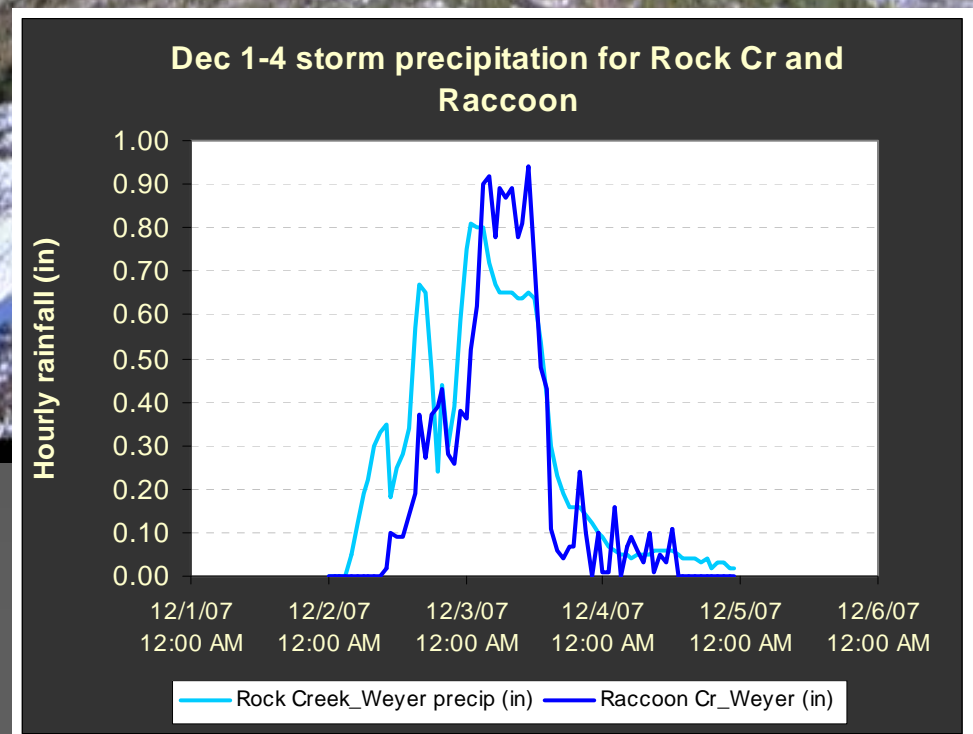
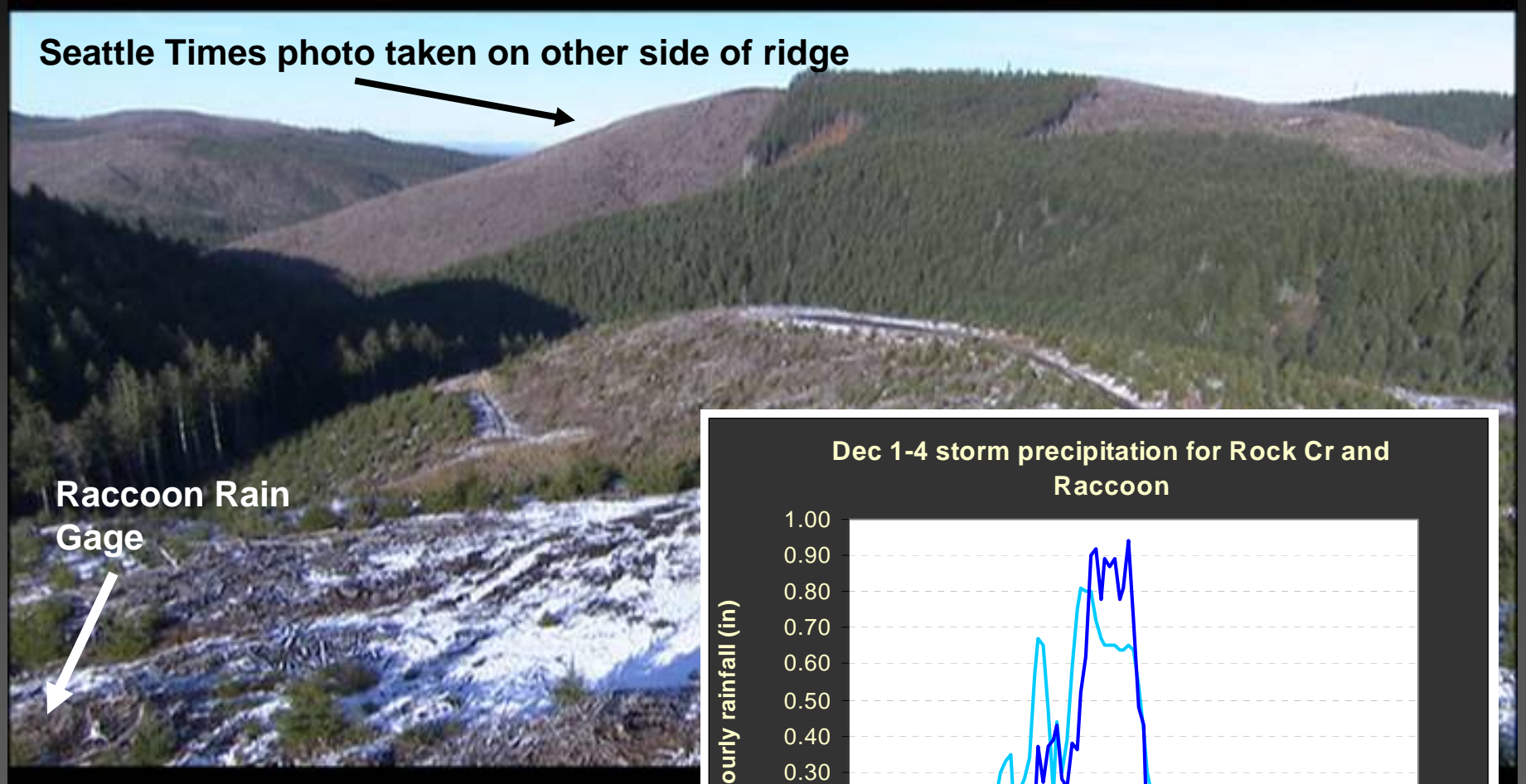
Four rainfall attributes strongly affect landslide initiation (Sidle and Ochiai 2006):

- (1) total rainfall*
- (2) short term intensity*
- (3) antecedent storm precipitation*
- (4) storm duration*

Maximum 24 hour storm precipitation as a percent of 100-year 24 hour precipitation



Hourly rainfall for Weyerhaeuser gages in the Upper Chehalis



Landslides and rainfall intensity

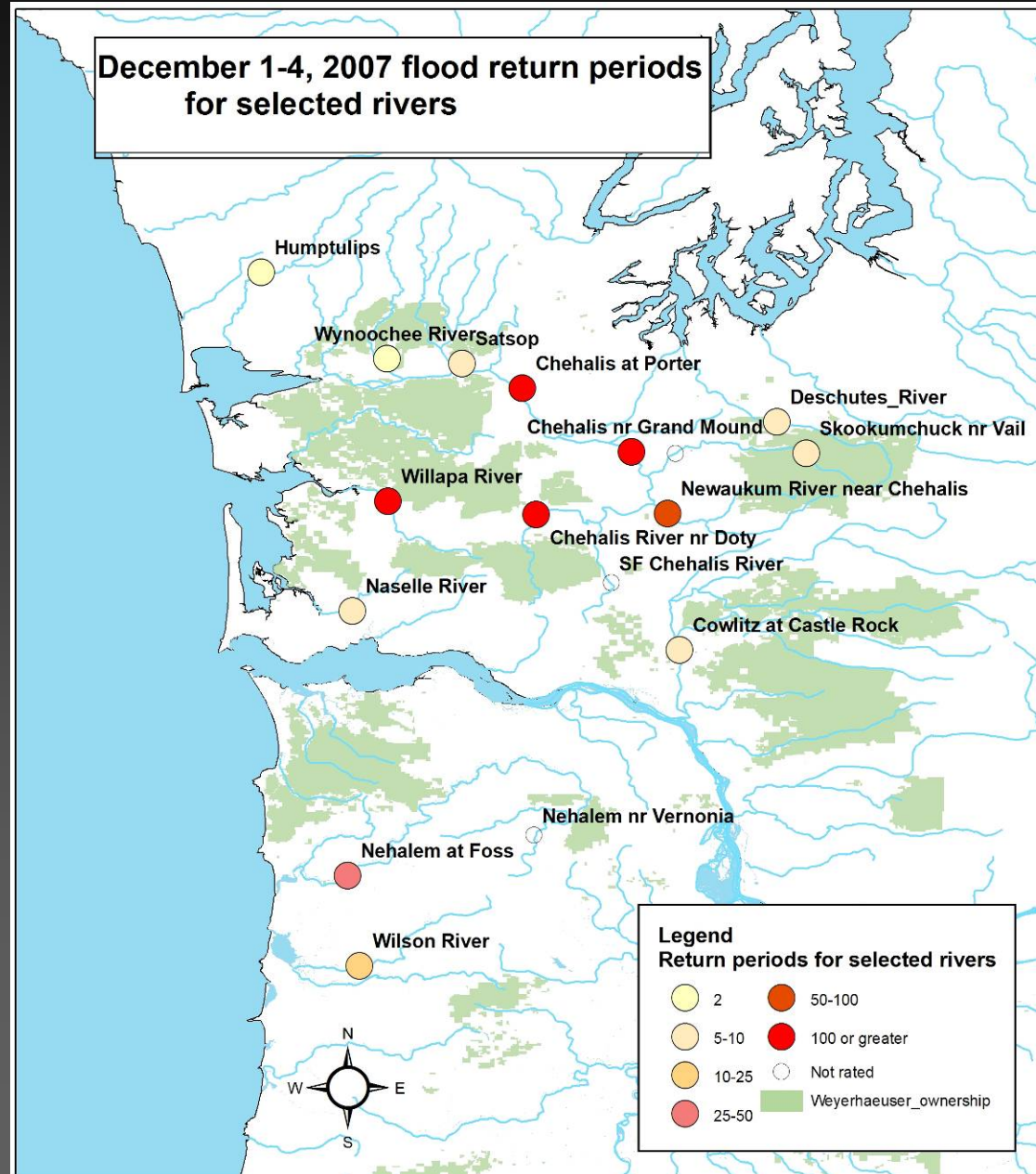


Landslides were concentrated in areas of extremely high precipitation intensity. Areas with intensities near 24-hr 100 year amounts had little damage.

In the upper Chehalis landslides occurred in a variety of vegetation patterns (i.e., clearcuts, mature timber).

Landslides occurred on different landforms on both steep and gentle ground. Types of landslides range from deep (>10 ft) to shallow debris slides on gentle slopes (which were highly unusual)

Floods: magnitude for selected rivers



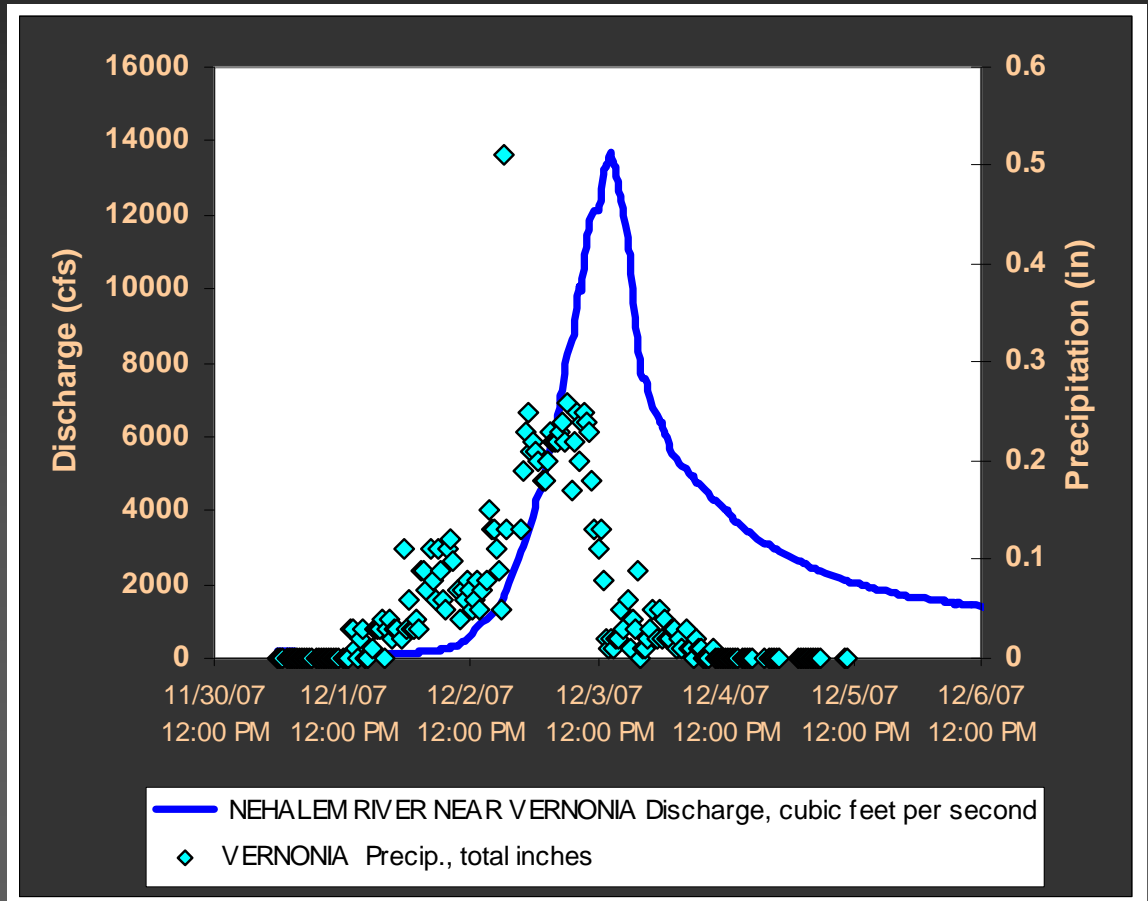
Some data is provisional and subject to revision

Flooding in Oregon: Vernonia

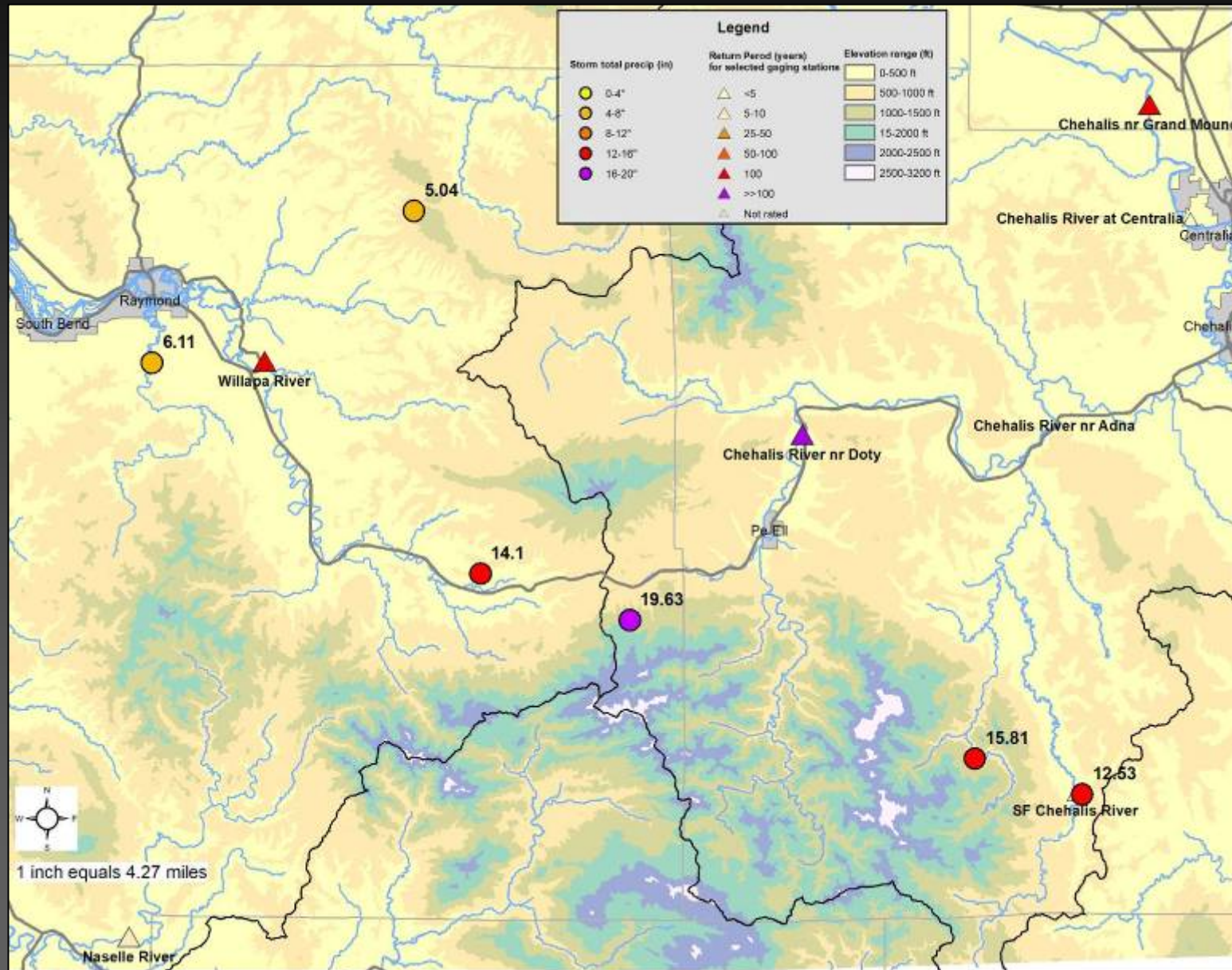
Vernonia residents: Flooding is worse than 1996



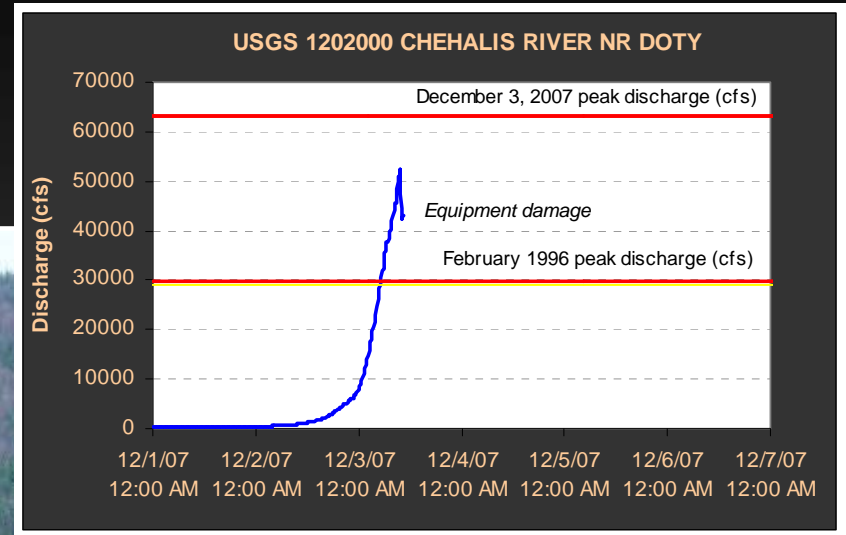
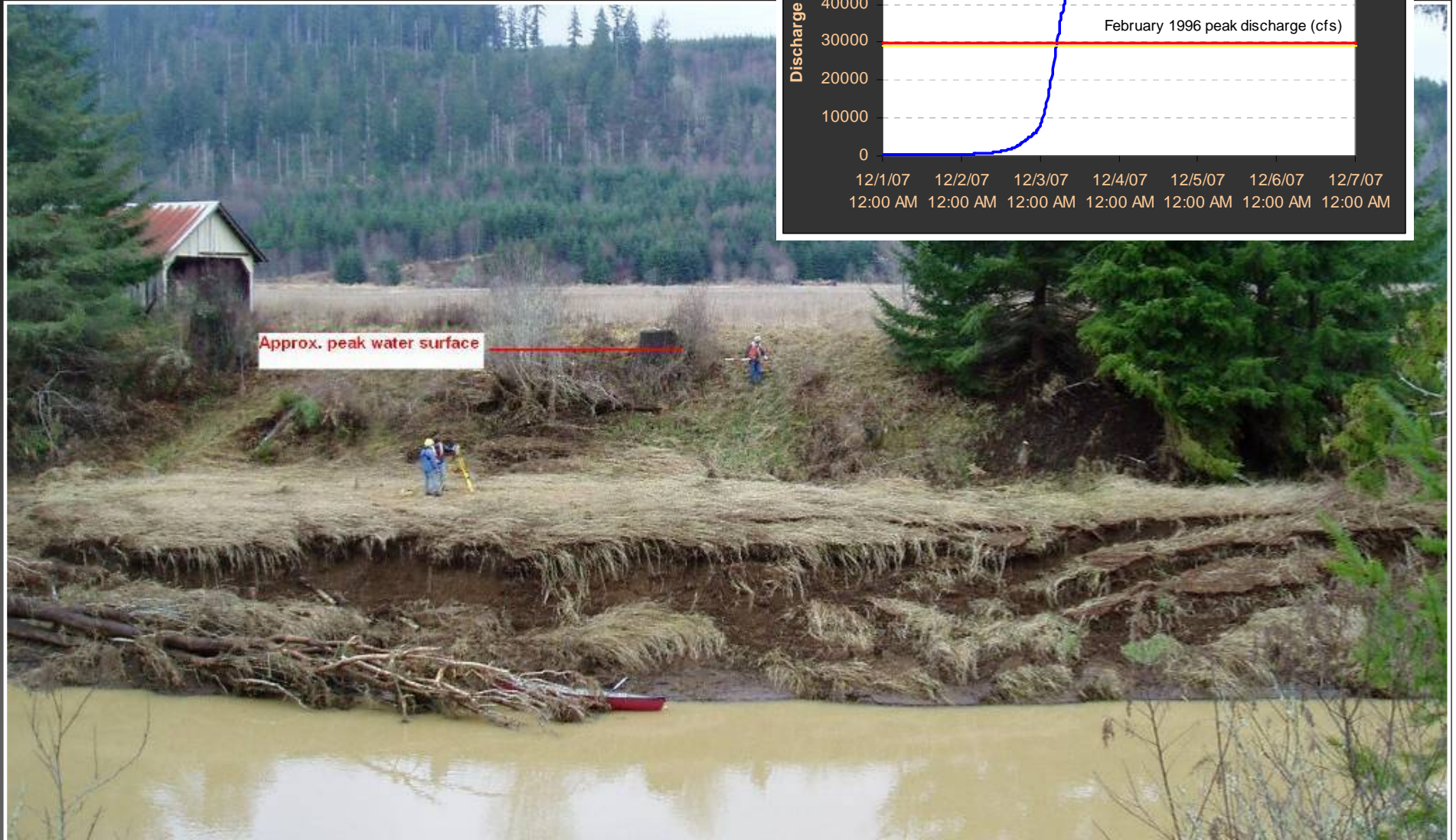
Flooded streets are shown Tuesday, Dec. 4, 2007, in Vernonia, Ore.
Story Published: Dec 4, 2007 at 1:04 PM PST
By KATU Web Staff



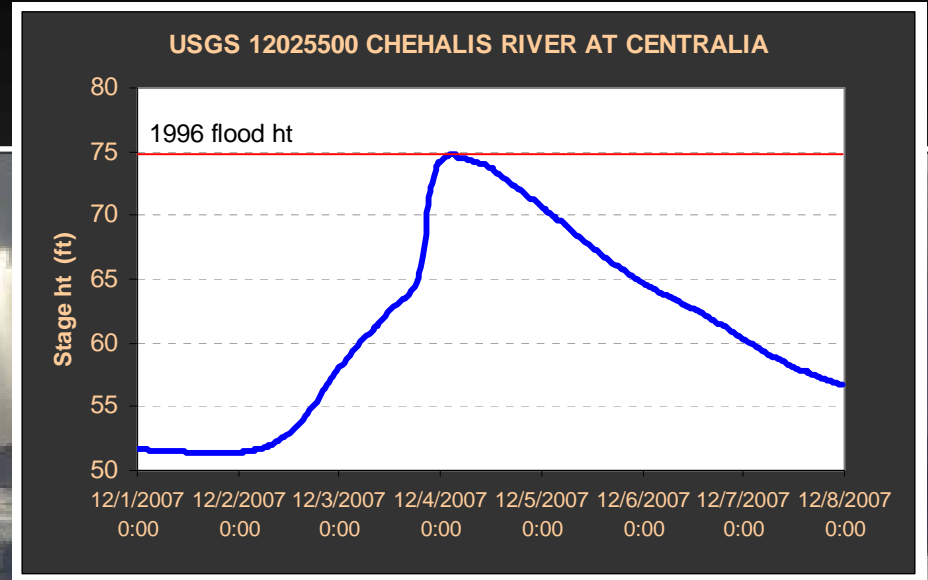
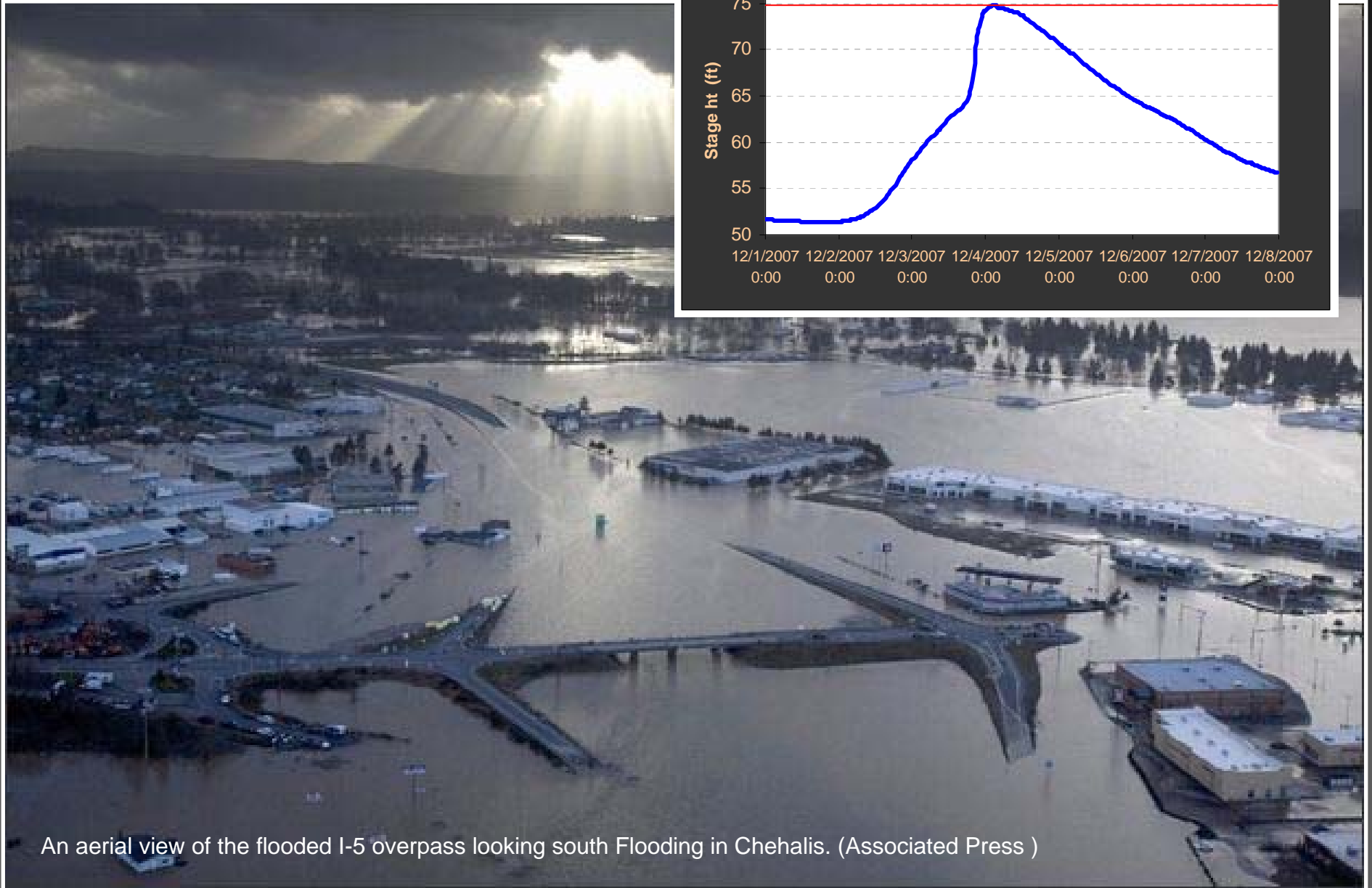
The upper Chehalis River: rainfall-runoff



The upper Chehalis River hydrograph



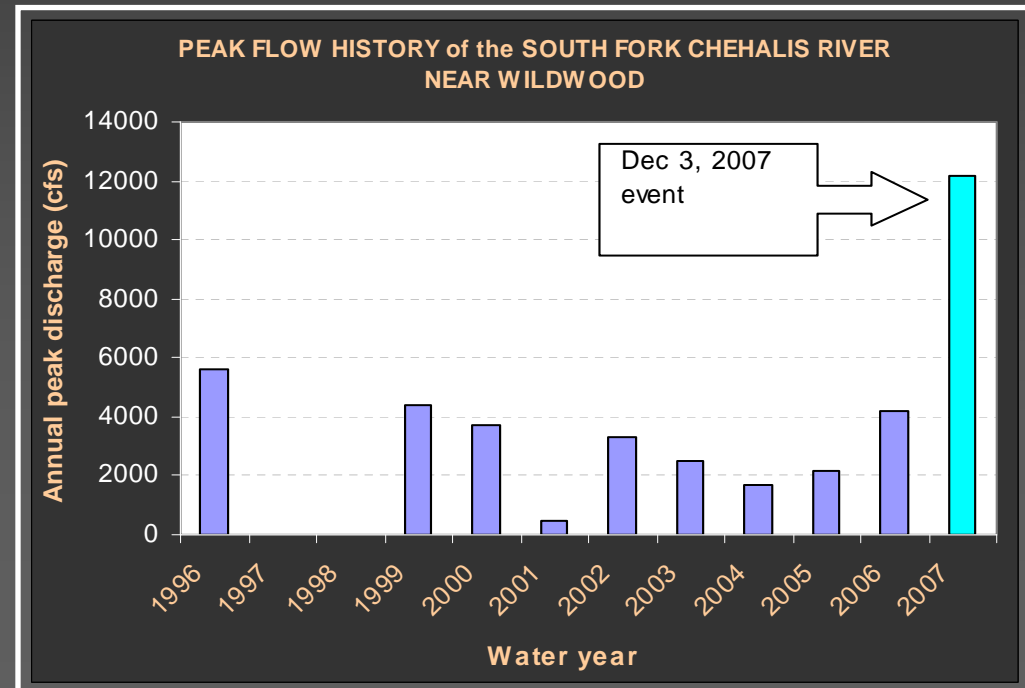
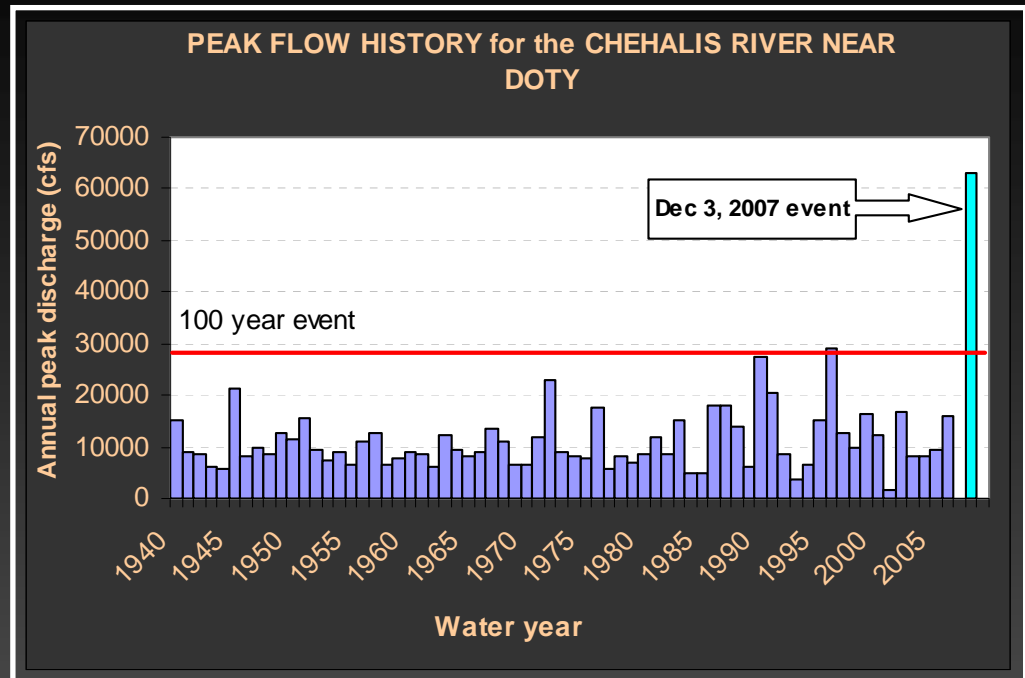
Flooding in Centralia



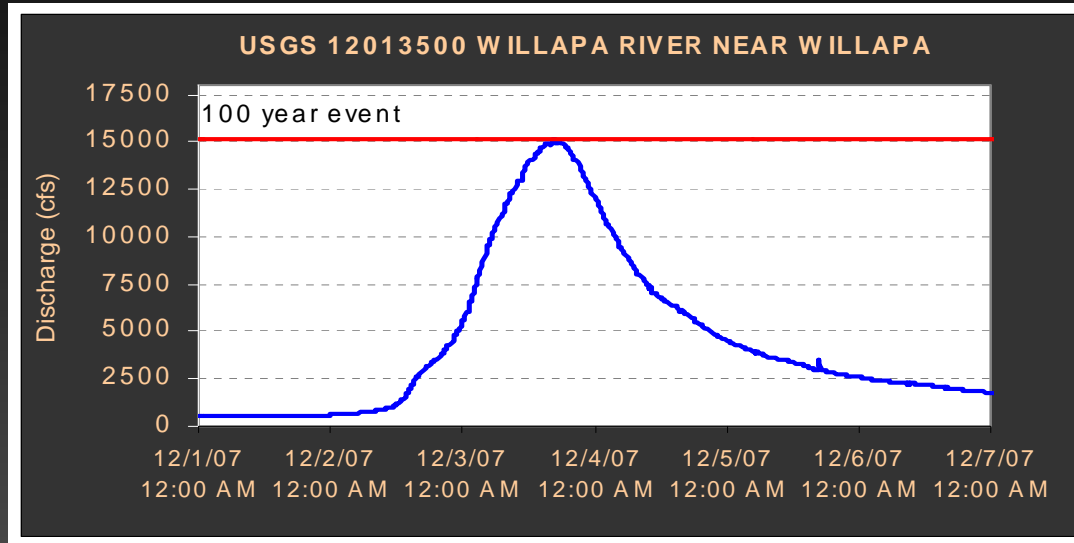
An aerial view of the flooded I-5 overpass looking south Flooding in Chehalis. (Associated Press)

Floods: upper Chehalis peak flow history

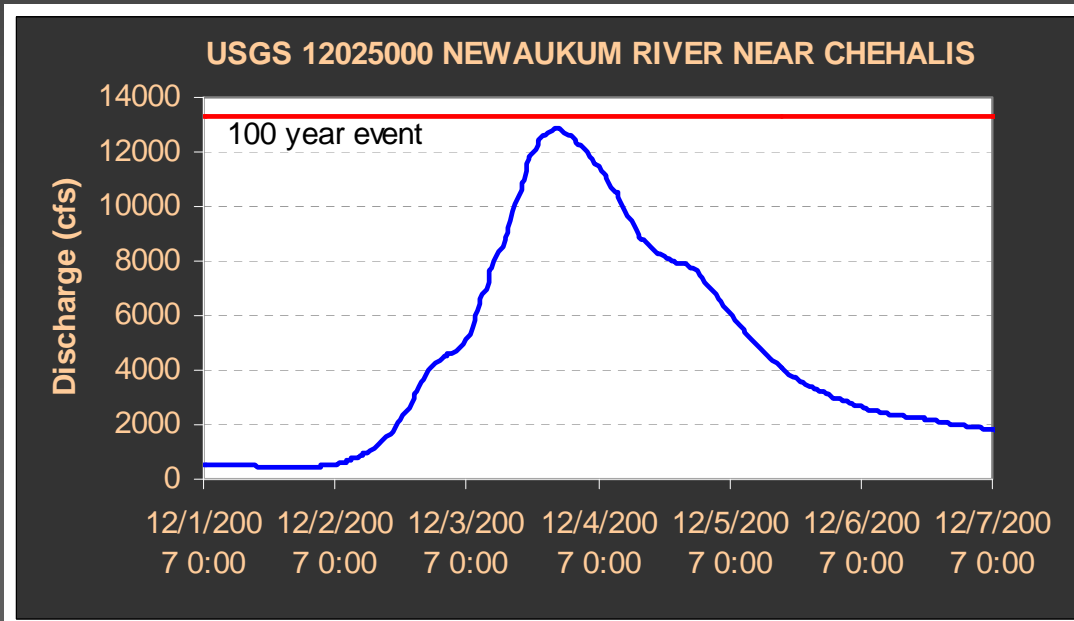
These charts show the December 2007 peak flows compared to historic flows for selected gages where the recent event is now the flood of record. The Chehalis River basin had 5 new records set as a result of the storm.



Floods: surrounding rivers



Willapa River



Newaukum River

Summary

As Cleanup Continues, Storms Stick Out as State's Top News Story in 2007

By PAUL QUEARY Associated press

Monday, December 31, 2007



Elaine Thompson |
Associated Press

- The first ever hurricane-force wind warning issued by NWS. Maximum recorded wind gust of 147 mph. It was also a long-duration wind event.
- Extremely high rainfall fell in NW OR and SW WA. Several climate stations had 24 hour rainfall well in excess of the 100 year 24 hr amount.
- Ten rivers exceeded their floods of record. In the Chehalis River basin 5 all-time high records were broken. The Chehalis River near Doty and the South Fork Chehalis had flows that were double the previous flood of record (Feb 1996)

Acknowledgments

This report would not have been possible without the invaluable contributions of data and discussion from several agency scientists: Brent Bower, National Weather Service; Larry Schick, U.S. Army Corps of Engineers; Bob Kimbrough, U.S. Geological Survey; Dr. Philip Mote, Office of the Washington State Climatologist; George Taylor, Oregon Climate Service and Wolf Read, a Masters candidate at UBC studying wind-tree interactions.