EARLY FLOOD WARNING: FORECASTING THE PACIFIC NORTHWEST

Scott Pattee,[1] Andreas Kammereck,[2]

ABSTRACT:

The idea of being able to forecast the intensity of floods in the Pacific Northwest has been a dream for many years. Just think of the potential. Cities could be evacuated, property could be protected, livestock removed, roads blocked, sandbags placed and most importantly -- lives saved.

As like pioneers crossing the Cascade Mountains in the 1800's, Whatcom County has revolutionized the concept of Early Flood Warning for the Pacific Northwest. A concept that has been used in other locations such as California and British Columbia has been built upon and expanded into a complete system.

INTRODUCTION:

Headline, November 1990 - Floods ravage Pacific Northwest. Lives lost, land destroyed , hundreds stranded. Millions of dollars in damage to homes, livestock, roads and utilities (Whatcom County alone estimated $21 Million). "Why couldn't we see this coming" and "there was no warning" exclaimed many after the devastating floods had passed.

Why indeed Whatcom County asked them selves. If only there was a way. After several years of careful consideration and study Whatcom County devised a plan. A comprehensive Flood Hazard Management Plan that is. A plan that is designed to produce solutions to flood-related problems.

From this plan came the Early Flood Warning System (EFWS) which became functional in September of 1995. Areas addressed by the system include flood forecasting, flood monitoring, flood warning, and flood response. Actions that have been implemented to date include a precipitation and river stage citizen spotter network, installation of the National Weather Service (NWS) HYDROMET Computer System, automation upgrades to United States Geological Survey (USGS) steam gauge stations, installation of two Snow Telemetry (SNOTEL) sites with Natural Resources Conservation Service (NRCS), and installation of additional automated low elevation climate stations. (Figure 2, page 4)

Implementation and coordination of these and other elements of the system is expected to reduce property damage and personal injury from future floods.

FLOOD MONITORING:

Whatcom County worked with the USGS to enhance the existing stream gauging stations on the Nooksack River system. The accessibility of real-time stream flow data during flood events is critical. Consequently, upgrades on existing stations involved retrofitting the Middle and South Fork Gauging stations to full time data acquisition and satellite telemeter data. The North Fork and Main Fork Gauges were currently on the GOES network. This enables the County to monitor stream flow in each of the upper Nooksack Forks on a real-time basis during flood events, as well as building a historic database of flow conditions.

[1] Water Supply Specialist, Natural Resources Conservation Service, Spokane, Washington

[2] Civil/Flood Engineer, Whatcom County Public Works, Bellingham, Washington

Presented at Western Snow Conference 1996, Bend, Oregon

With more comprehensive monitoring of peak flow time between the upper forks and main forks gages , County officials can better anticipate resultant flood conditions and more effectively allocate resources to address flood related problems.

Previously, available precipitation data within the Nooksack Basin was sparse at best. Limited data was available at the Glacier - Forest Service District office, however this data is far from adequate representation of the entire Nooksack Basin. River levels fluctuate dynamically on the Nooksack, driven by centralized storms in any or all of the North, Middle, and South Forks of the Nooksack River. Significant flood events are characterized not only by these large precipitation events, but in combination with "rain-on-snow" events. Whatcom County in cooperation with the NRCS installed two SNOTEL sites in the "rain-on-snow" zone (3000-4000 foot elevation) to capture the relationship between the snowpack and precipitation at higher elevations. SNOTEL sites monitor snowpack, precipitation, and air temperature. SNOTEL also has the capability of including wind, solar radiation and relative humidity monitoring. By monitoring these data, county flood control and emergency management officials can anticipate potential flood events, and evaluate the duration of ongoing events.

The greatest resource will be in the development of a historic database recording the ingredients of flood events. As the database grows, flood control and emergency operations staff will better recognize the factors characterizing flood events specific to the Nooksack watershed.

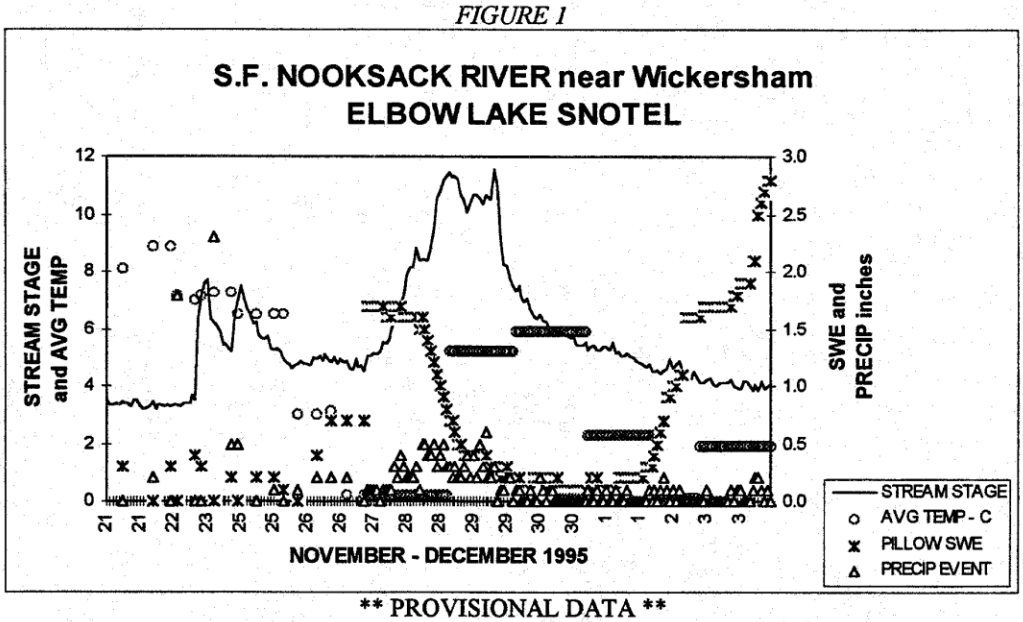
Whatcom County has also installed two additional precipitation monitoring stations at lower elevation.

RESULTS AND DISCUSSION:

The Pacific Northwest was once again hard hit by rampaging rivers.. The floods of November and December 1995 caused significant damage and threatened life and personal property.

The South Fork Nooksack River was particularly hard hit. Recorded stream stage levels at the USGS gauging station near Wickersham (figure 1) reached almost 12 feet. Normal levels at this station are near 3 feet. High runoff in the South Fork were attributed to the combination of rain-on-snow with sustained warm temperatures.

FIGURE 1



** PROVISIONAL DATA **

The Elbow Lake SNOTEL site (elevation 3080 ft.) located in the headwaters of the S. F. Nooksack recorded hourly snowpack, precipitation and air temperatures throughout the peak period of November 28-30. As indicated on the chart above, a minimal snow pack began loading with precipitation several days prior to the peak event. Some runoff and increased flows were experienced however temperatures dropped back to freezing and reduced runoff. SNOTEL then showed a major precipitation event occurring. Snow accumulated at a rapid rate while temperatures remained near freezing. Within a short time period temperatures jumped by five degrees C. Precipitation fell at rates exceeding one inch per hour and accumulated as much as eleven inches in twenty hours during the thirty-six hour event, resulting in complete meltout of all accumulated snowpack.

By utilizing all of the available data Whatcom County Flood Control and Emergency Management Officials determined that they were given at least ten to twenty hours lead time for flood control preparation over previous years. SNOTEL provided them with the first indicator of potential trouble from rain-on-snow and storm intensities. By these indicators officials were able to provide the first substantiated warnings to down-stream residents. Automation of upper fork stream gauges then gave them another ten hours of pre-warning before high flows from all forks converged on the main fork at Demming.

CONCLUSION:

Early Warning Flood Forecasting is a new and exciting concept for the Pacific Northwest. Some attempts have been made in the past but none as complete and comprehensive as what is occurring in Whatcom County. The cooperation and partnering effort by federal, state, and local agencies has been a milestone upon itself. It is obvious that no single entity has the capabilities to manage and complete such a task. Continued cooperation is imperative for the success of this program and any like it.

This first year has been a learning process for all interested and involved entities. Like any new program there have been inherent problems. Measures are being taken to overcome identified shortcomings of the system.

The key for success is going to be in building long-term data sets. These data sets will enable officials to recognize, identify, and classify storm events before they even reach the area. This ability will give even more lead time and accuracy for flood potential. Thus even more protection and warning for concerned citizens who battle mother natures uncontrollable phenomena's.

REFERENCES:

United States Geological Survey, real time stream flow data, ADAPS computer system, Tacoma, Washington.

Natural Resources Conservation Service, Centralized Forecast System and Centralized Data Base System, Portland, Oregon.

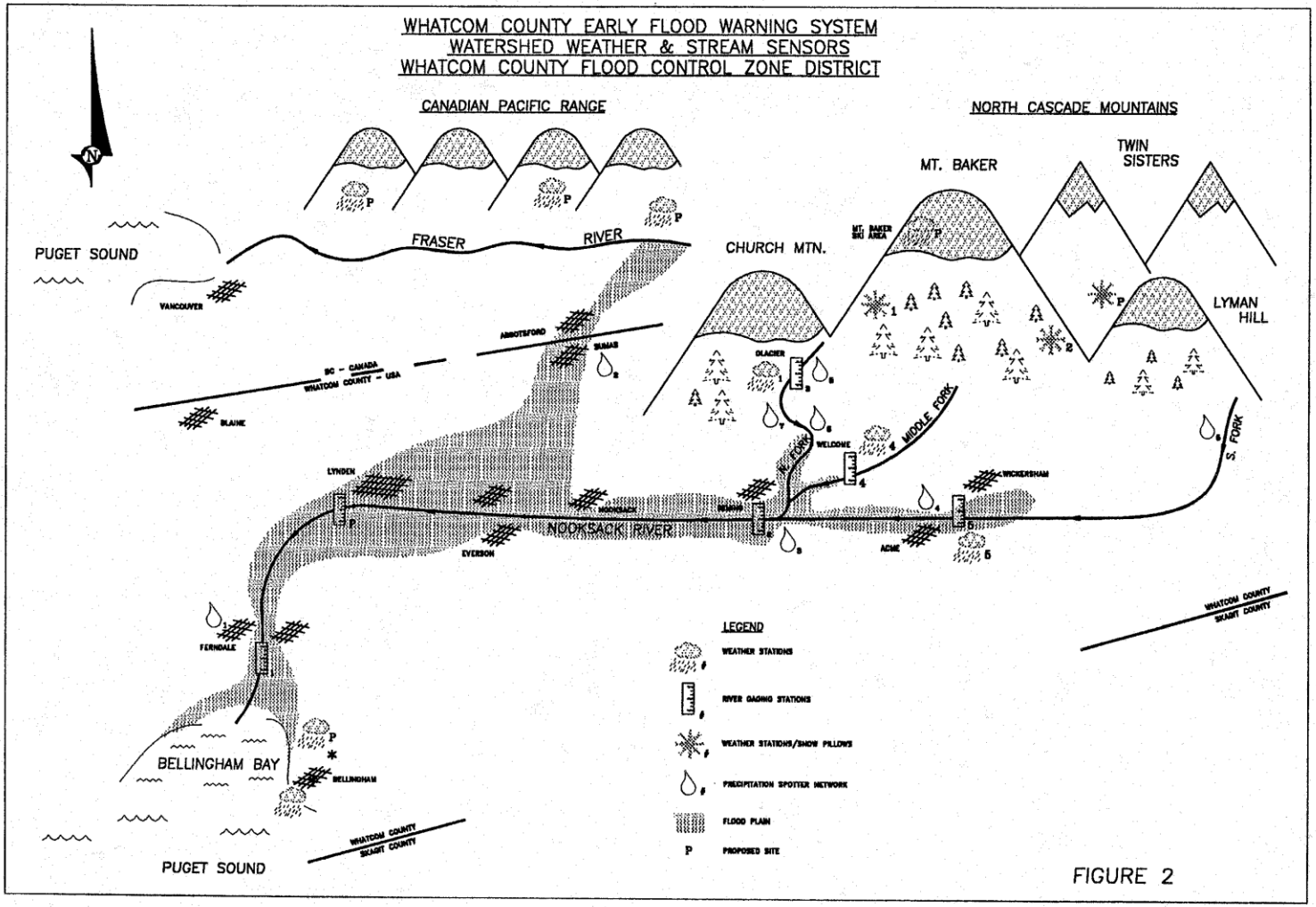

WHATCOM COUNTY EARLY FLOOD WARNING SYSTEM
WATERSHED WEATHER & STREAM SENSORS
WHATCOM COUNTY FLOOD CONTROL ZONE DISTRICT
CANADIAN PACIFIC RANGE
NORTH CASCADE MOUNTAINS
MT. BAKER
TWIN SISTERS
LYMAN HILL
CHURCH MTN.
PUGET SOUND
FRASER RIVER
VANCOUVER
ABBOTSFORD
SUMAS
BC - CANADA
WHATCOM COUNTY - USA
BLAINE
GLACIER
MT. BAKER SKI AREA
MIDDLE FORK
N. FORK
S. FORK
WELCOME
LYNDEN
NOOKSACK
DEMING
WICKERSHAM
EVERSON
ACME
NOOKSACK RIVER
FERNDALE
BELLINGHAM BAY
BELLINGHAM
WHATCOM COUNTY
SKAGIT COUNTY
PUGET SOUND
LEGEND
WEATHER STATIONS
RIVER GAGING STATIONS
WEATHER STATIONS/SNOW PILLOWS
PRECIPITATION SPOTTER NETWORK
FLOOD PLAIN
P PROPOSED SITE

FIGURE 2