Modeling Process

CHAPTER 2

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Modeling the Pajaro River watershed's hydrologic and sediment frequency response is a crucial step for the success of the study for several reasons. The models themselves provide a tool to see how the flood potential at various locations changes with different land use conditions and rain intensities. One of the goals of the watershed study is to identify flood control projects. The models can be used to realize this goal and analyze the effect of various plans on downstream flooding. Even after the completion of the study, regional planners can predict the effects of various projects allowing them to minimize or reduce the flood risk in susceptible areas.

Creating a model also encourages the collection of the most recent data. Rather than relying solely on data collected around fifty years ago, models created for the Pajaro River Watershed Study rely on as much current data as is available, including field studies conducted exclusively for the PRWS. Current data leads to more accurate results and best represents current watershed flood potential.

The following sections examine the data collection processes and step through the creation of the two models. Strengths and weaknesses are identified as are limiting conditions.

Pajaro River to the Ocean Flood Model

The Pajaro River to the Ocean FLOod model (PRO-FLO) is designed to predict the frequency of 2-, 10-, 25-, 50-, 100-, 200-year floods at four catch points based on a synthetic design storm rainfall input. The rainfall is a normalized yet adjustable rainfall that is applied to the watershed surface. The watershed is divided into subwatersheds. The land use/soil type combinations for each sub-watershed are an indicator of the amount of runoff associated with a given amount of rainfall. The runoff is then routed through the streams and rivers to the catch points at which watershed discharge is predicted. Model outputs consist of annual peak flow and maximum average 3-day discharges at the four points.

PRO-FLO is a highly adaptable model. It is based on the most accurate data available to-date for rainfall, soil groups, land use, and subwatershed routing factors. Land use is one of the flooding factors that is sensitive to human influence and can have a rapid rate of change. The land use database is very flexible and the land uses within the sub-watersheds can be changed quickly and easily to reflect any scenario. PRO-FLO can also be altered to include routing changes such as dams and alternate channels.

The model is limited to the boundaries of the Pajaro River watershed. Calibrations for any model are individualized to fit particular settings or locales and PRO-FLO is no exception. Each sub-watershed has its own set of characteristics that sets it apart from others. The calibrations were done using data collected within those sub-watersheds and the model reflects their individuality. In addition to the unique calibration, the design storm and soil and land use datasets were created specifically for the Pajaro River watershed and are not applicable elsewhere.

The cornerstone of PRO-FLO is frequency analysis. This type of analysis allows a limited dataset to be substantially extrapolated using accepted methods to cover a wide range of flood events. In order for the probability and statistics to have any relevance to watershed flood control, the watershed must be homogeneous. A homogeneous watershed has not changed in a significant way over time. Small, natural changes occur constantly and average to no change across the watershed. Even man-made changes such as building a dam or urbanization, both considered to be irreversible, can occur without affecting the status of the watershed so long as they do not cause a significant change in the runoff. The watershed stream gage record was analyzed for homogeneity during the period of interest for this study, the 1940s through present. The watershed, while showing some minor trends, has been determined to be homogeneous. For specific details, please refer to Technical Memorandum (TM) 1.2.3 in the Appendix.

To understand how to apply and use the model, it is important to understand the model's major components and how they are put together. The following sections highlight and explain the most significant aspects of the model. The Appendix of this report contains further information regarding the models of the Pajaro River Watershed.

ESTABLISH BASIS OF COMPARISON

Establishing the basis of comparison is an absolutely crucial step in the modeling process. Models can be used to predict situations both quantitatively and qualitatively. The model outputs can be used quantitatively to size flood protection projects for specific flows or qualitatively to see varying effects of certain conditions or projects on watershed flooding. While results are not 100% accurate, they can be quite useful. These results are the best possible predictions and are also powerful tools when comparing results from several scenarios. The key watershed parameters and locations form the basis of comparison.

In general, the primary parameter used for comparing changes to watersheds is the annual instantaneous maximum peak discharge. This is the discharge in a stream channel and adjoining overbanks that is the greatest value at any time during a water year no matter how long the discharge lasts. A water year begins on October 1 and ends on September 30. Since the water year is split between two calendar years, it is assigned the calendar year corresponding to the September 30 date.

The secondary hydrologic parameter is the volume of flow in the stream. Generally the annual maximum 1-day average discharge value or 3-day average discharge is used in highlighting differences in runoff. For the Pajaro River watershed the annual maximum 3-day average discharge is used because the watershed is large and the 1-day average discharge would reflect the instantaneous peak discharge. Size is an issue because a larger watershed takes longer to drain and this affects the discharge measurement in the downstream reaches.

The use of both of these parameters allows for the characterization of the Pajaro River watershed. Key concepts are summarized in Table 2-1 below.

Table 2-1: PRO-FLO parameters and key concepts. Both parameters are annual maximum values within a water year.

Discharge Parameter	Key Concept
Instantaneous Peak	Duration does not matter
3-Day Average	Measured in consecutive 72-hour period

As mentioned before, the locations at which these parameters are to be predicted are essential to characterizing the watershed. Four points have been chosen to represent the watershed. Their locations and significance are listed below.

- San Benito River Upstream of Pajaro River Confluence: This point has historically been an important predictor for the flow conditions within the lower Pajaro River. The drainage area is approximately 664 square miles.
- Pajaro River Upstream at US Highway 101: Representing the other upper-watershed branch of the Pajaro watershed, this point predicts flow from 505 square miles including a significant storage area, Lower Soap Lake.
- Pajaro River at Chittenden: This critical point is the location of a long-term stream gage record and represents the discharge to the upper portions of the Corps flood control project. This point is two miles downstream of the Pajaro and San Benito confluence and the drainage area is 1,186 square miles.
- Pajaro River Downstream of Salsipuedes Creek: This flow represents the discharge along the lower portions of the Corps flood control project. The drainage area of this point is approximately 1,274square miles.

The locations are shown in Figure 2-1.

The wide range of frequencies, 2-, 10-, 25-, 50-, 100-, and 200-year return periods, spans the hydrologic spectrum of floods. The frequency given in terms of return period is the reciprocal of the annual exceedance probability. For example, a 50-year flood has a 2 percent chance of being equaled or exceeded in any given water year and a 100-year flood has a 1 percent chance. A more intuitive way to think of flood frequencies is, on average, a 50-year flood occurs once every fifty years. Similarly, a 100-year flood occurs every 100 years. This does not mean, however, that a storm of a given size cannot occur more than once in a given period, but only that the interval between occurrences will average that period.

ESTABLISH RAINFALL

One of the most critical inputs to any hydrologic model is the rainfall. A synthetic rainfall is used in this study for several reasons. They include:

- To compensate for a lack of rainfall gages or missing data
- To apply rainfall to the entire watershed
- To normalize to average precipitation in an area and not to any particular storm, which leads to a characteristic storm
- To eliminate the need for many different storms to characterize watershed response

By establishing a balanced design storm with a variable intensity, it is possible to mimic rainfall depths depending on spatial location and rainstorm frequency. Drier areas will receive less rainfall than wetter areas and more frequent events will be smaller and less intense than huge, infrequent storms.