

# UNDERSTANDING RISK AND UNCERTAINTY

(A Non-Technical Perspective)

by

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## FIRST EXPOSURE

**How we started.** In the South Pacific Division, we were first exposed to the concept of “Risk and Uncertainty”, **R&U** for short, at a large **In Progress Review (IPR)** meeting for the American River Study. The Assistant Secretary’s Office, as well as our Headquarters, the Division, the District, and representatives from the Local Sponsor were present. At this meeting we were told that **all** projects would require an R & U analysis. Almost no one in the meeting had a clue what R & U was all about. Over protestations by some of us, and with the assurance from our Headquarters that it would only take two weeks to conduct an R & U analysis, we were on our way.

**What is R&U?** Shortly after the meeting broke up, most of the senior managers wanted to know what R & U was and what we were in for. How bad could it be? We were told it would only take a couple of weeks. After several attempts at explaining to my supervisor, the Director of Engineering, what I understood the R & U process to be, he asked for a “short paper” that explained R&U for the uninitiated. The big surprise was to have that paper faxed to us from Headquarters H&H as a paper that explained R&U.

**Problems.** After several schedule delays because of problems getting the R&U process going for the American River Study, it was apparent to all that this was not going to be an easy task. (See below and also the Paper on the “American River Study” by Mike Deering, HEC.)

## UNDERSTANDING R&U

**Communication.** We knew that we were going to have a considerable task explaining the results to our local sponsors when we were having problems getting our own planners and engineers to understand what we were reporting. “There is a .x chance of passing a .y flood with the project” A what? This was the first reaction, usually with glazed eyes and a blank stare. Explaining this to our local sponsors has turned out to be even more difficult.

**Where we stand.** At this time most of the engineers in the Hydraulics and Hydrology sections have an understanding of what R&U is all about, though there is an occasional instance where someone is just “plugging” in the numbers. Some of the staff in our Economics Sections have also acquired a good understanding of the process. If the Senior Staff does not completely understand, they have, for the most part, stopped asking questions. Our Local Sponsors..., well, that

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is another story. The usual question after they give up trying to understand the principles behind R&U is “Does the project get us out of the FEMA 100yr floodplain?”

Because of the controversial nature of the American River Study, (Auburn Dam and the potential change to the American River Canyon), Congress directed that the Academy of Engineering of the National Research Council review the work of the American River Study. They easily understood the process, but had some difficulty understanding some of the “practical” limitations of the early versions of the software and problems that we were encountering reaching consensus on the many assumptions required for the analysis.

## **TECHNICAL PROBLEMS**

**Code.** The first problems surfaced trying to use “stage-frequency” curves, rather than the more common “discharge-frequency” curves. We also had problems with the original program that we used for the Monte Carlo simulation, both problems overcome by HEC. We now have a very robust program that should handle all our applications.

**Procedure.** The original “program” was developed for a simple levee project. We have had to deal with complex regulated basins that were not envisioned as part of the original program such as in the American River Study. See Figures 1 and 2. Folsom Dam controls the American River to the design discharge just short of the 1 % event; that fact, together with the by-pass system makes it a very complex basin to study. As has been previously described, this was not an easy study.

“Sediment” has also been a problem in some of our studies, especially in alluvial plains, see Figure 3. In this case, the geo-morphology of the fan makes it very difficult to determine in future large events after the channel has silted up what pathway the “flood” will take. The problem here is the larger than normal number of variables, as well as the larger uncertainty of their values. The problem on this study is related to the sediment; but then again, sediment is always a problem, and would have been a problem under the “old” procedures.

We have a project that has been underway for some time, Merced County Streams, that should be a real challenge to complete, if we do R&U on that project. The project consists of 6 detention basins on tributary streams, some uncontrolled streams, channels, irrigation canals, a distributary system, all in a very flat floodplain that has few gages, and the gages that exist are by-passed in a co-mingled flood plain. See Figures 4 and 5. We presently have an exemption for this project from Headquarters.

Also, some of our “records” are so short, that the “uncertainty” is causing some of our projects to require large levees, giving us some problems. The point of all of this is to illustrate that experienced individuals are, more now than before, essential to the studies.

## FEMA CERTIFICATION

**History.** When we first ran a “shot-gun” R&U on the American River Study, we were just short, or right at, our jointly (COE & FEMA) agreed upon criteria, (50 % reliability), for us certifying that the existing levee system would pass the “Base Flood”. This was a bit of a “shock” after working on the study and knowing how close we had come to losing the levee system during the flood of February, 1986, a flood slightly smaller than the presently estimated “base flood”. This development caused considerable discussion in the H&H community as to the criteria; i.e., 50% chance of passing the Base Flood. This was causing problems to the study team, especially deciding how to present the concept of “reliability” in the report. In this particular study, with a highly controlled basin up to about the “100yr” frequency, there is no margin of safety beyond the frequency at which the discharge can no longer be controlled. We have several projects in our Division that are “certified” by us to FEMA as passing the Base Flood using this criteria, though none as critical as this one.

**Present Criteria.** The present criteria (90% or 95% confidence limit) will certainly give “safer” results. See Figure 6. The potential problems that this criteria may cause are surely to get us into the political arena. It is going to be very difficult to explain to our sponsors that we will be unable to “certify” some of our projects unless some additional levee height is added in order to achieve the desired “confidence” limit. There will probably be instances where our present criteria will require a higher levee than the existing FEMA criteria requires. This will probably lead to “criteria shopping” on the part of our sponsor’s. This will surely also cause a problem for both the Corps and FEMA and may lead to more confusion than exists even now.

I would propose criteria that allows us to “certify” a levee if it meets the existing FEMA (3 foot of freeboard) criteria also, with perhaps a minimum 50% reliability.



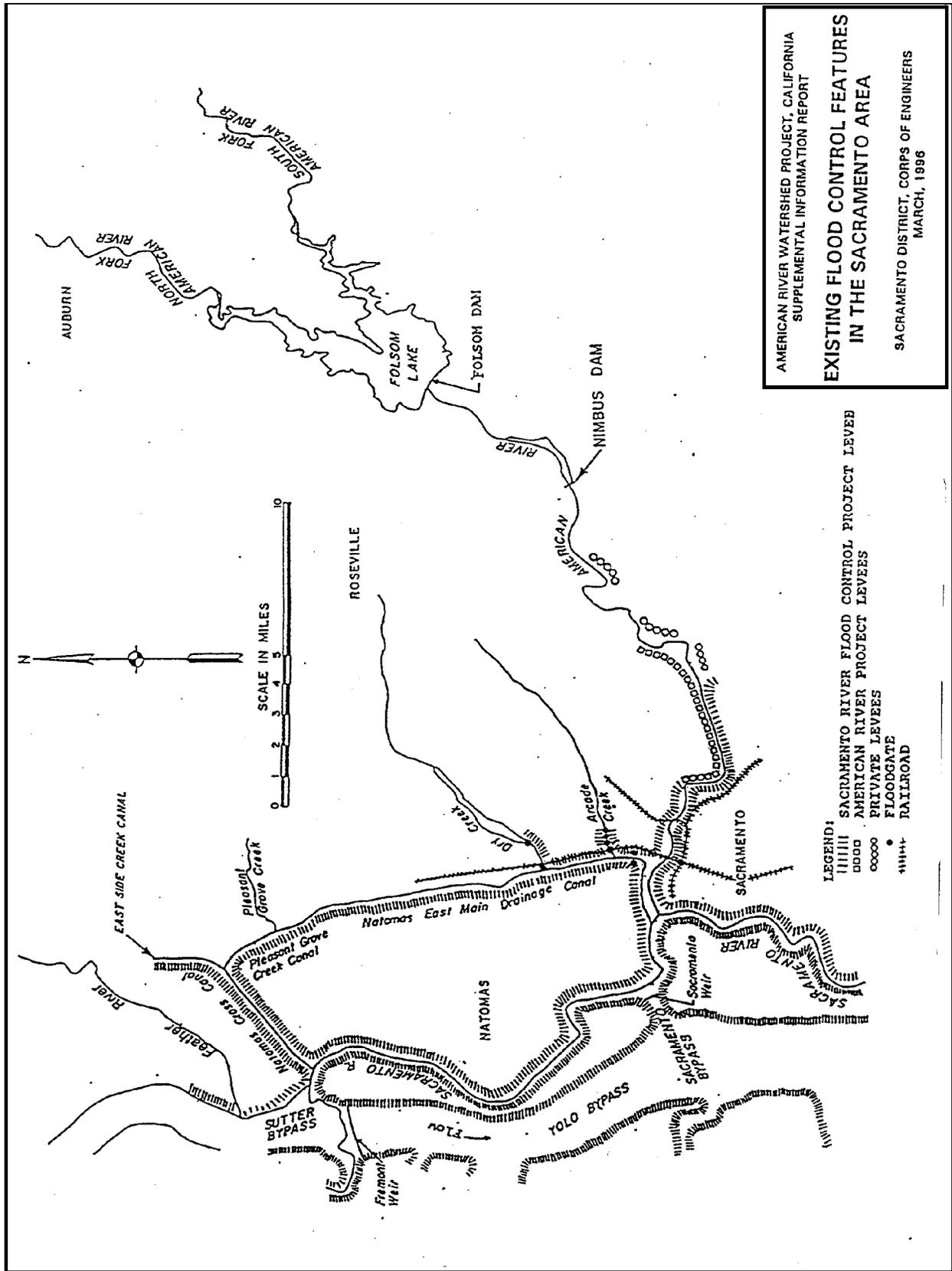
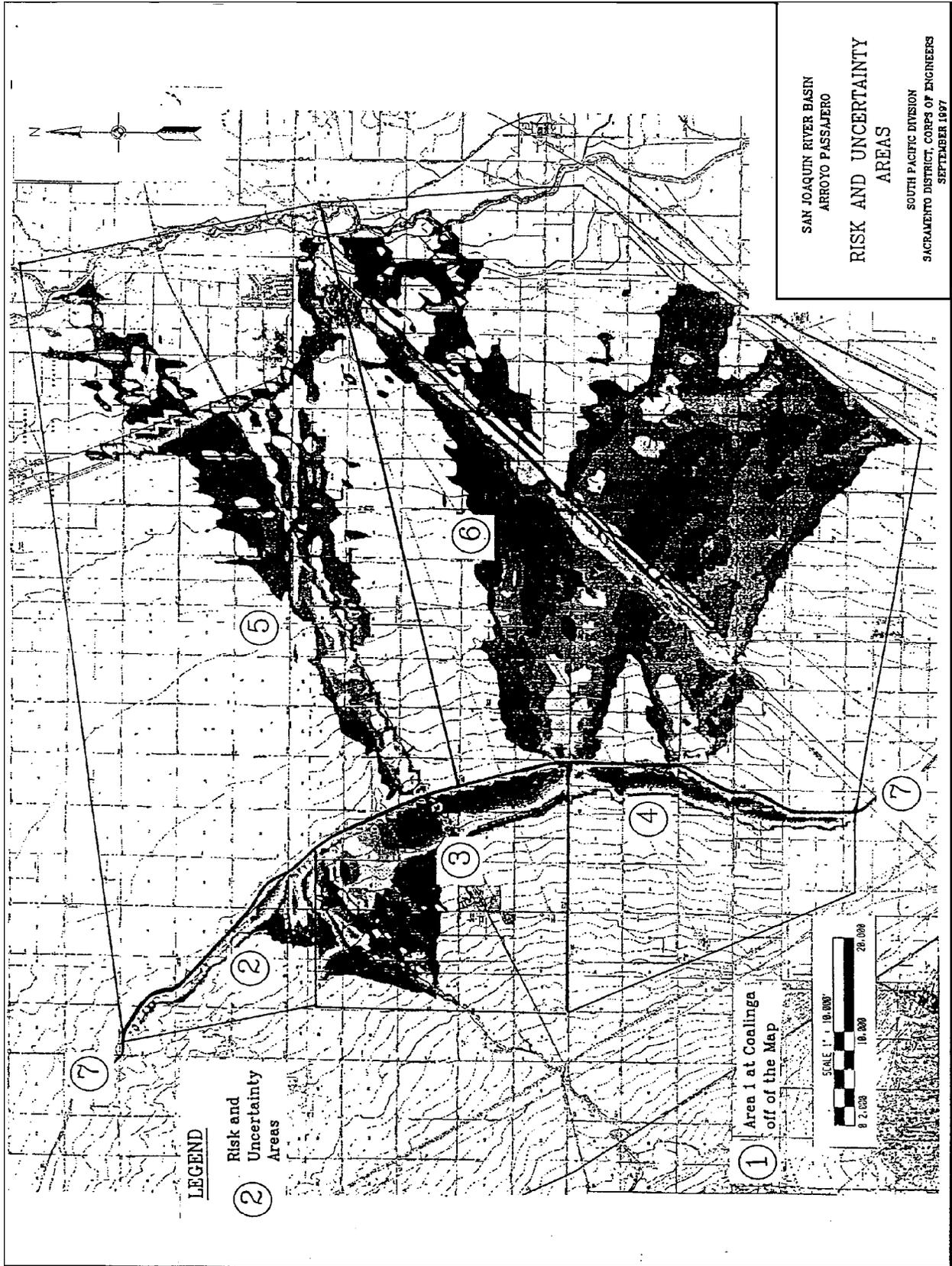


Figure 2 American River



**Figure 3** Arroyo Pasajero

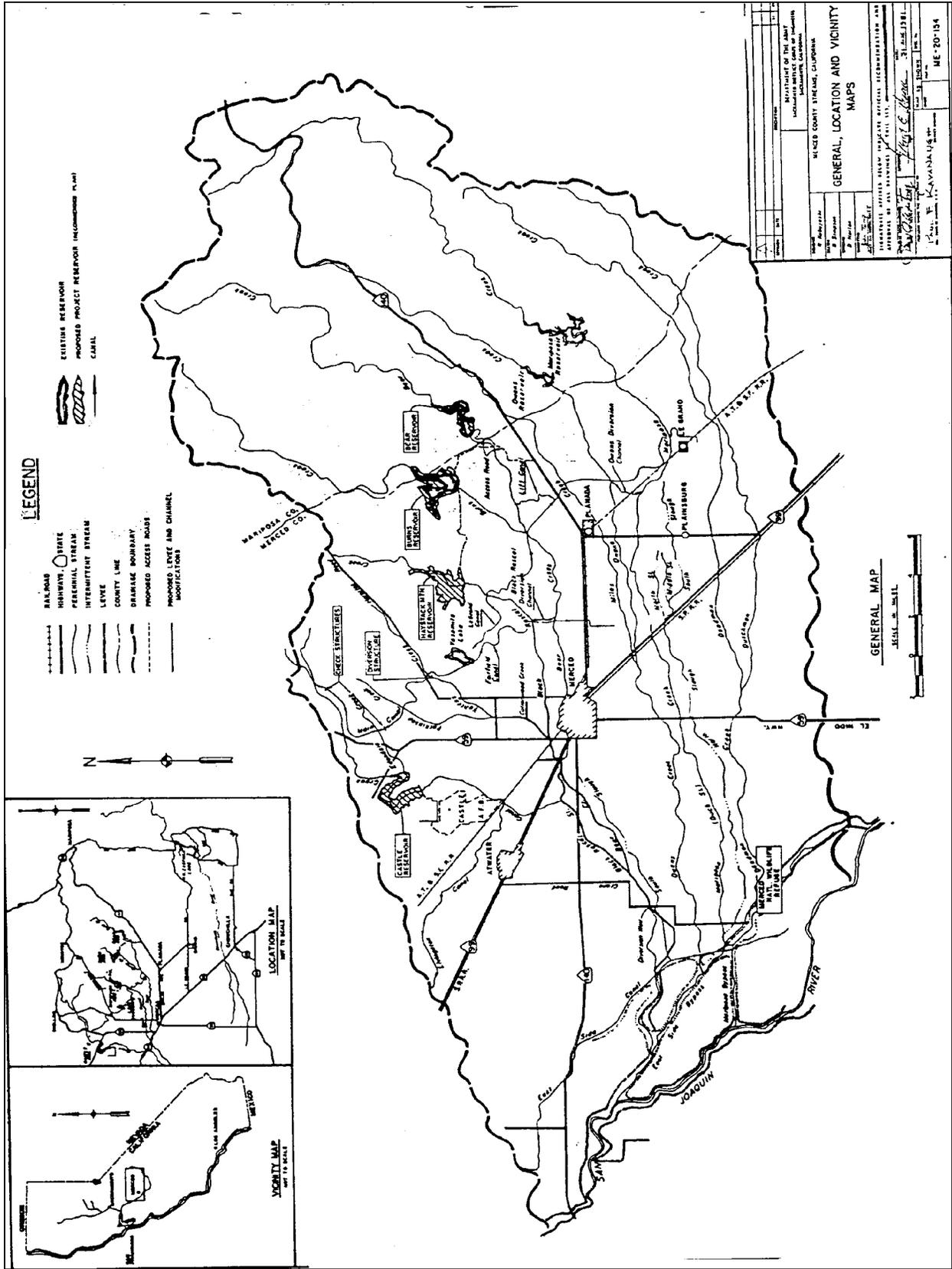
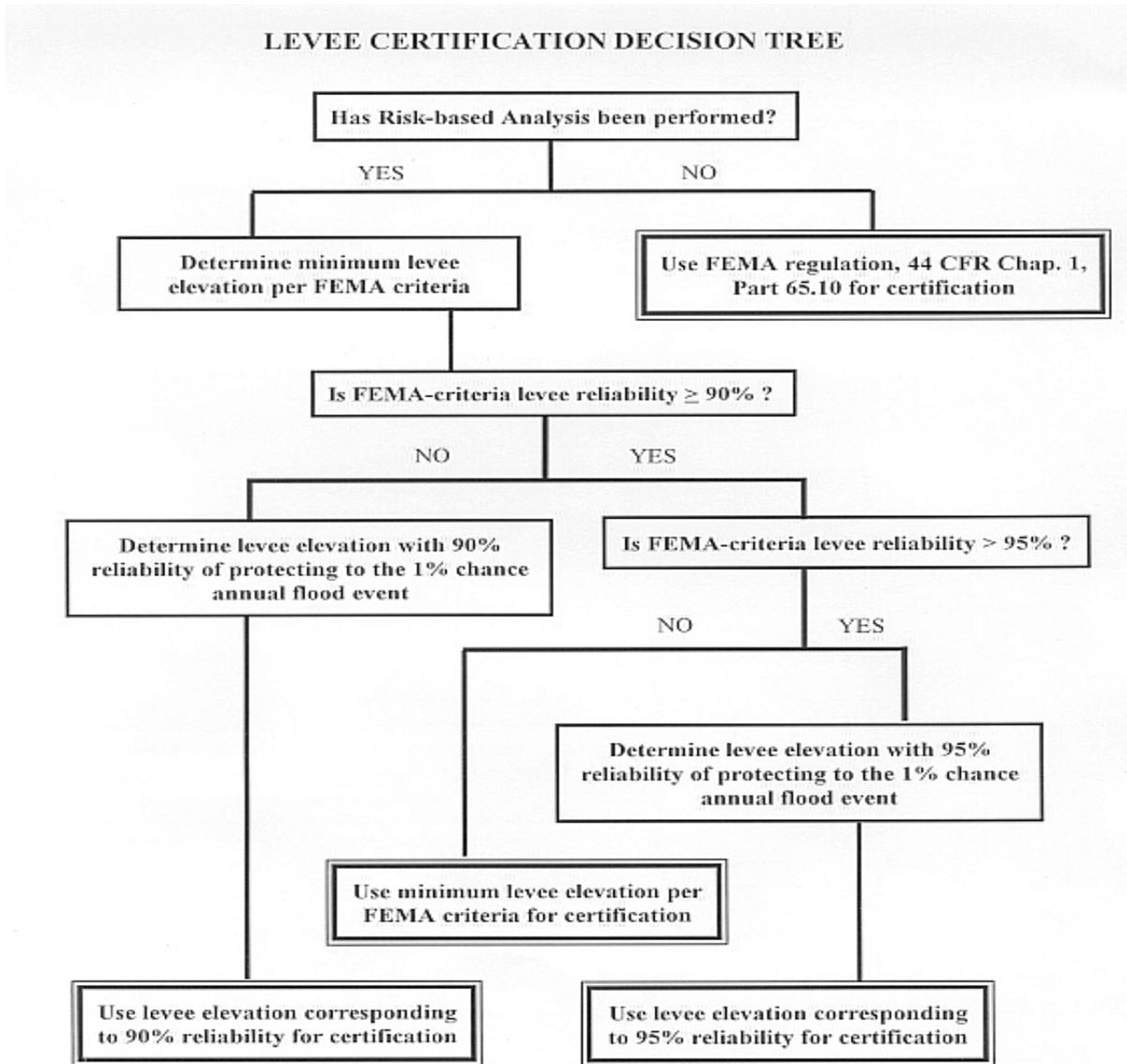


Figure 4 Merced County Streams





FEMA Criteria = 1% chance median annual flood event plus three feet of freeboard  
 RELIABILITY = % chance non-exceedance given the 1% chance annual event occurs

**Figure 6** Levee Certification Decision Tree

