Culvert Analysis Workshop

Introduction

This workshop will demonstrate the application of the HEC-RAS culvert capability. A proposed highway crossing of Napa Creek, with twin box culverts, will be analyzed. Figure 1 is a plan view of the study area, from a USGS 7.5 minute quadrangle. The new highway is shown running north-south and the Creek generally runs from west to east toward Napa River. Water surface profiles have been computed for the creek, starting at the Napa River. A local control (critical depth) was found at river station 3650; therefore, this analysis will start at that location.
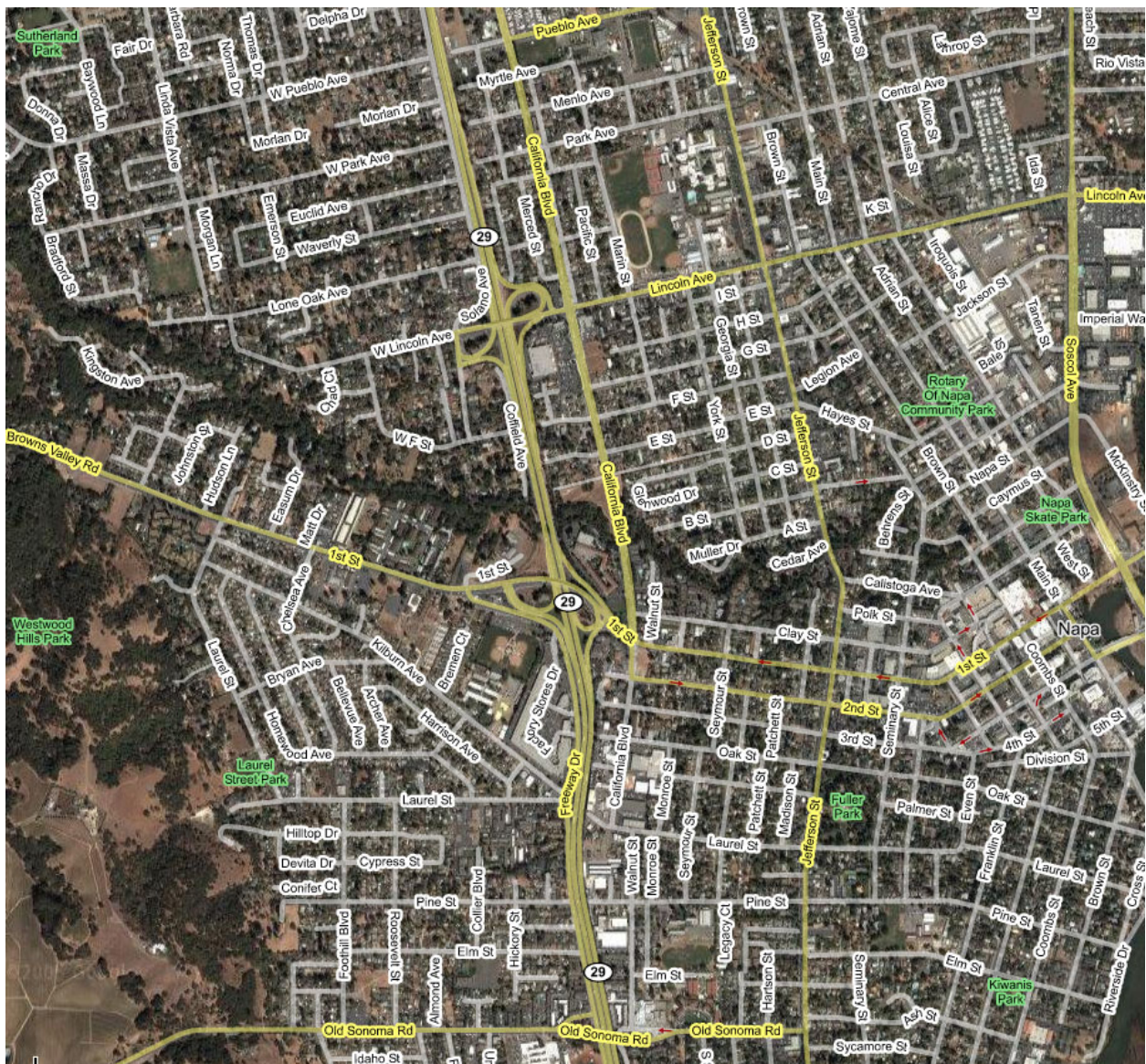

Figure 1 Napa creek at highway crossing

Problem

The **Napa Creek** project (filename = wk3.prj) is the existing conditions data file for the upper Napa Creek, starting at river station 3650. The flow file is **Napa Creek - Flood Flows**, which includes a recent flood (2,500 cfs), a one-percent chance flow (4,000 cfs) and a maximum flood of 6,500 cfs. All subcritical profiles start at critical depth at river station 3650. The **Napa Creek - existing conditions** Plan represents the base condition, without the highway crossing.

Part 1.   The proposal is to carry the highway crossing over two concrete box culverts. The size and locations are as follows:

    Two 18' wide x 12' high concrete box culverts
    80' long, centered between river stations 4042 and 4142, see figures below.
    90 degree head wall, with inlet edges beveled ¾ inch on three sides
    upstream invert = 17.0'
    downstream invert = 16.7'
    Centerline station = 65' and 85'

Select appropriate coefficients based on the tables in Chapter 6, Hydraulics Reference manual. The top-of-road profile is shown, based on cross-sectional stationing:

Station:	0	50	100	160
Elevation:	36,5	34.5	34.5	37.0

The top of the road is 60 feet wide, and the upstream edge of the road profile is 20 feet from the cross section just upstream of the road embankment.

The design requirements state that the one-percent flow profile (4,000 cfs) should not increase more than one foot above base conditions and that the maximum flood (6,500 cfs) should not overtop the roadway.
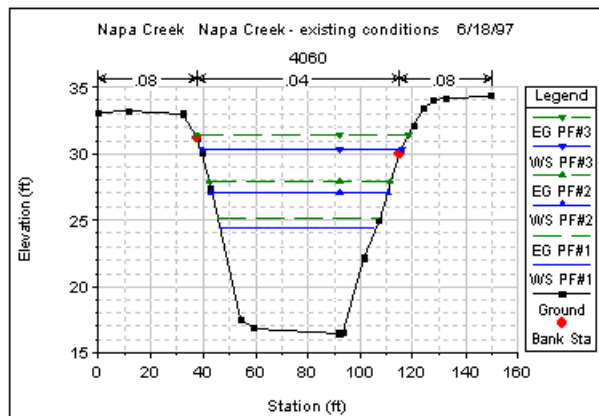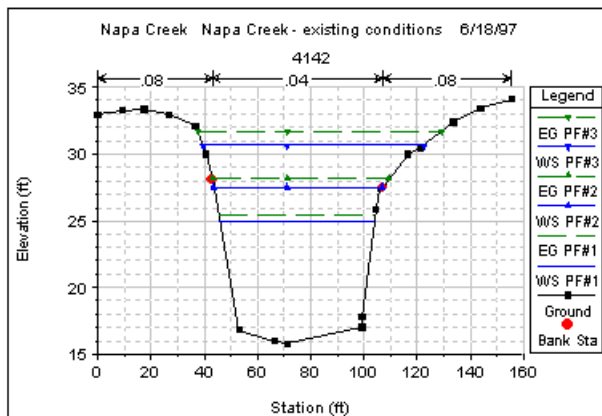
Tasks

1. Assemble the necessary added data and run the model with culverts. Don't forget to set the effective-area option on the adjacent cross sections. Save the geometry file under a new name.

2. Start a new plan and run the model with the same flow and starting conditions applied to the geometry file with culverts. This will facilitate evaluation.

3. Evaluate the model results for completeness and accuracy. Make necessary corrections and run again until satisfied with the results. Then evaluate based on design criteria.

    a. Does the maximum flow exceed the roadway?

    b. Does the upstream water surface profile exceed the one-foot criterion?

    c. Is the culvert solution based on inlet or outlet control?

    d. Is the solution sensitive to the culvert Manning's n value or inlet condition?

Part 2.

If after completing Part 1 you find that the design criteria are not met, a second option includes adding two corrugated metal culverts to provide added high-flow capacity. Add two 6 foot culverts, one on either side of the box culverts, so they fit within the natural cross section and increase high flow capacity sufficiently to meet the criteria. Assume the added culverts will fit into the 90 degree head wall. Culverts should have a slope of 0.5 feet over their 80 foot length.

Again, be sure to save the new geometry file and run under a new plan label to facilitate comparison between base conditions and the new model.

Were you able to meet the design requirements? Record the centerline stationing and invert elevations for your report.