RAI Volume 2, Chapter 2.1.1.7, Third Set, Number 1, Supplemental Question 6:

Clarify the rationale for calculating probable maximum flood water surface elevations along the three channel segments shown in the probable maximum flood inundation map provided as Figure 2 in the response to RAI 2.2.1.1.7-3-001. The probable maximum flood peak flows appear to be inconsistently applied to cross-sections upstream and downstream of the collection points. For channel segment 1, probable maximum flood peak flows for concentration points CP4 were applied to the upstream cross-section, while probable maximum flood peak flows for all concentration points except CP9 were applied to downstream cross-sections in channel segments 2 and 3.

1. RESPONSE

A generally accepted practice for modeling a stream reach is to increase the flow in a channel below the confluence of a tributary with the main channel so that each tributary's watershed contribution to channel flow is only accounted for below its confluence with the main channel. The HEC-1 hydrologic model was used to compute individual subbasin flood flows for the delineated subbasins and to increment main channel flood flows at the confluence points (collection points), with the assumption that the flow generated within a basin would reach the basin outlet where it would combine with the flow in the main channel. This approach works well in many cases; however, in some watersheds, overland flow (direct storm runoff contributions to the main channel) and flow from minor channels may augment the main channel's flow upstream of the subbasin outlet so that the flow along a channel reach increases gradually in the downstream direction rather than discretely at collection points. The calculation of a more gradual increase of flood flows along the main channel provides more precise resolution in terms of assigning representative flood flows to each channel cross-section, but requires further subdividing the subbasins into much smaller areas and, hence, increases the computational complexity.

The flows in the HEC-RAS hydraulic model were kept constant for all the cross-sections in a channel segment until reaching the next collection point, with the exception that some of the subbasin flood flows in the HEC-RAS calculations for the channel segments and confluence points were added upstream of the confluence points to conservatively account for complex hydraulic interactions (e.g., backwater effects or flooding from combined channels upstream of the confluence points) that may occur during large flood events at or near tributary confluences (BSC 2007, pp. 23 and 24).

The subbasin delineations, channel segment designations, and collection point designations were provided in Figure 1 of the response to RAI 2.2.1.1.7-3-001. Figure 2 of the same response provided the channel cross-section locations and the resulting probable maximum flood inundation boundaries.

In the clarification call with the NRC held on December 3, 2009, the NRC requested a channel-by-channel description. Modeling of subbasin flood flows in the different channel segments is discussed in the following sections.

1.1 CHANNEL SEGMENT 2

The generally accepted method (incrementing channel flood flows at the confluence points) was applied within channel segment 2, except where the floodplain of channel segment 2 combines with the floodplain from channel segment 1 near the base of subbasin SB5, as shown in the probable maximum flood inundation map (response to RAI 2.2.1.1.7-3-001, Figure 2). The flood flow from CP4 was applied to three channel cross-sections upstream of CP4, which encompass the combined floodplain from channel segments 1 and 2 to more accurately represent the area where the floodplains from the two channel segments join (BSC 2007, Table 7-3). The combined floodplain in this area would have a flood flow greater than the flood flow from either channel segment 1 or channel segment 2. Rather than dividing the combined flood flow between the two channels so that the water surface elevations match in each channel segment for the three channel cross-sections upstream of CP4, a more conservative approach was taken by applying the flood flow from CP4 to each channel segment and mapping the floodplain based on the channel segment that resulted in the higher water surface elevation.

Similarly, the flood flow at CP9, at the outlet of the entire watershed delineated for the HEC-1 analysis, was applied to the farthest downstream channel cross-section on channel segment 2 (BSC 2007, Table 7-3) to account for the combined floodplain at the confluence with channel segment 3. The highest calculated water surface elevation for either of the channel segments was conservatively used to map the combined floodplain at this location.

1.2 CHANNEL SEGMENT 3

For channel segment 3, the generally accepted method of increasing the flood flow at collection points was used downstream of CP5, CP6, and CP7. Some deviations from the standard practice method of incrementing flood flows were applied to channel segment 3 as follows:

(a) During the exercise of mapping the floodplain in the area around CP5, it was determined that the floodplain for channel segment 3 upstream of CP5 would be combining with flow from a portion of the adjoining subbasin SB8; therefore, the flood flow from CP5 was conservatively applied to the channel segment cross-sections upstream of the collection point (BSC 2007, Table 7-4).

(b) The flood flow from CP8, which is located at H Road, was also applied to the two channel segment 3 cross-sections upstream of the collection point to account for the total flood flow passing through the culverts under H Road (BSC 2007, Table 7-4).

(c) Related to the channel segment 2 description in Section 1.1, the flood flow from CP9 was applied upstream of that collection point, but only to the channel segment 3 cross-sections immediately downstream of the confluence with channel segment 2 for a more representative calculation of the probable maximum flood water surface elevations in this area (BSC 2007, Table 7-4).

1.3 CHANNEL SEGMENT 1

Flood flows for channel segment 1 were calculated from a single basin (SB5) at location CP4. The flood flow calculated with HEC-1 for the entire basin was applied to channel segment 1 cross-sections starting from the upstream end. In order to conservatively account for the combined floodplain effects in channel segment 1 upstream of location CP4 due to the floodplain merging with flood flows from channel segment 2 and from subbasin SB6, the channel 1 flood flow was increased to the flood flow at CP4 for calculation of the probable maximum flood water surface elevations for the nine channel segment 1 cross-sections upstream of CP4 (BSC 2007, Table 7-2).

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2007. *Yucca Mountain Project Drainage Report and Analysis*. 000-CDC-MGR0-00100-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20070924.0043.