

APPENDIX L

Line T-198

Evaluation of Normal Flood Elevations

Crossings over the Ashuelot River and South Branch Ashuelot River

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**Subject: Evaluation of Normal Flood Elevations
Communications Cable Crossings of the Ashuelot River**

Dear Ms. Games,

ENSR has completed the work to support the installation of a communications cable in the Northeast Utility transmission corridor in Swanzey, New Hampshire. The work included estimation of the "normal" flood elevation at 11 crossings designated A through J of the Ashuelot and South Branch Ashuelot Rivers to aid in determining minimum sail-boatable clearance distances between water surface elevations and low line elevation. This correspondence conveys the general findings of the survey. Specific observations for each of the crossings are provided in the attached appendix.

Though ideally based on flow records and stage observations, the normal flood level of a stream can be successfully approximated by direct observation of the geomorphic features of the stream channel, banks, and floodplain. For this analysis, we define the normal flood level as the flood elevation that is likely to occur on a one to two year recurrence interval. As such, the normal flood level can be equated to bankfull discharge, the discharge at which the stream channel is completely full. In the United States, bankfull discharge has a typical recurrence interval of approximately 1.5 years, but can range from 1 to 5 years depending on climactic conditions. Bankfull flow occurs frequently enough to be considered adequate in capturing the natural flood frequency of rivers.

Rivers typically adjust morphology to bankfull flow, which just fills the available cross-section. The frequency of bankfull flow corresponds to the frequency of flow that cumulatively transports the most sediment through the system. This flow, which has the greatest effect on the morphology of the stream channel, is known as the dominant discharge. Dominant discharge is defined as performing the most work on a stream (by means of moving sediment) and subsequently determining particular channel parameters such as cross-sectional capacity or meander wavelength. Visual indications of the effects of dominant discharge include bank erosion, sediment deposition, and the establishment and disruption of vegetation. ENSR staff, with training in the fluvial geomorphic principles that describe how river channels and their environments are created and modified by the forces associated with flowing water, visited Crossings A-D, F-H, and J on August 27, 2008. The objective of these visits was to observe the visual indications of dominant discharge, along with signs of aggradation and degradation, streamway stability, and floodplain interaction, to determine whether the dominant discharge, and therefore bankfull discharge, adequately represents the normal flood level of the Ashuelot and South Branch Ashuelot Rivers.

Based on our observations of the characteristics discussed above, we have determined that the bankfull flow that fills the channel to the top of bank is a conservative approximation of the normal flood level of the Ashuelot and South Branch Ashuelot Rivers at the crossings of the Monadnock-to-Emerald Street utility lines. A summary of the bankfull flow elevation results for each crossing is found in Table 1.

These values are based on the top-of-bank elevations found in the cross-section drawings provided by Vanderweil. Bounding values for top of bank elevations for sites that were not visited as part of the geomorphic survey were derived from interpolation between the elevations for sites that were visited. Specific descriptions of individual crossing structures are found in the attached appendix.

The normal flood level at crossing I (structures 122-124) was not evaluated by direct observation. Channel cross-section drawings suggest that the top-of-bank elevation, and therefore bankfull flow level, is 460.2 ft. However, interpolating between the bankfull flow elevations of crossings H (structures 121-122) and J (structures 130-131) indicates that the bankfull flow level at crossing I is 458.6 ft. The channel in the vicinity of crossings H and I is rather wide; at these locations, the river is actually better characterized as a backwater swamp. During increased flow conditions, this flatland would detain water over a larger surface area than what is defined by the channel proper, resulting in a decreased water surface elevation level during flood periods. Though not groundtruthed, it is likely that, because of the backwater nature of the river at this specific structure location, the top-of-bank elevation, as depicted in the channel cross-section drawings, would be an overly conservative indicator of bankfull discharge.

Table 1. Bankfull Flow Elevation at Each Line Crossing

Crossing	Bankfull Flow Elevation (ft), Cross-Sectional Drawings	Bankfull Flow Elevation (ft), Interpolated and Cross- Sectional Drawings
A (29-30)	880.8*	880.8*
B (71-72)	562.2	562.2
C (97-98)	464.8	464.8
D (99-100)	464.6	464.6
E (103-104)	461.8	461.7
F (105-106)	460.7	460.2
G (110-111)	456.4	456.4
H (121-122)	458.0	458.0
I (122-124)	460.2	458.6
J (130-131)	460.1	460.1

* Assumes water level at time of geomorphic survey is same as that of time of cross-sectional survey.

Laura V. Games
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If you have any questions, please do not hesitate to contact Matt Kennedy at 978-589-3373.

Sincerely yours,



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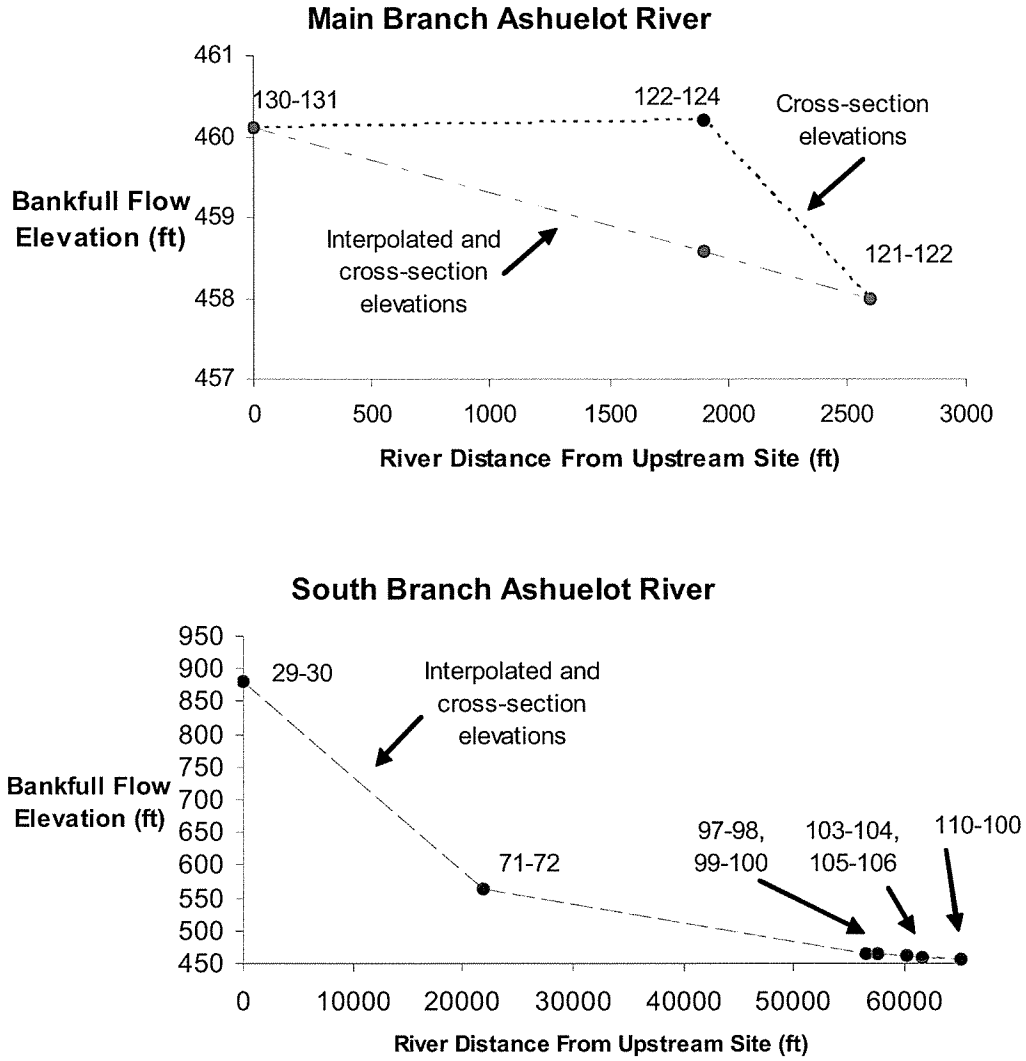


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Appendix A

Detailed Site Visit Results

Figure 1. Bankfull Flow Elevations for Ashuelot and South Branch Ashuelot Rivers.

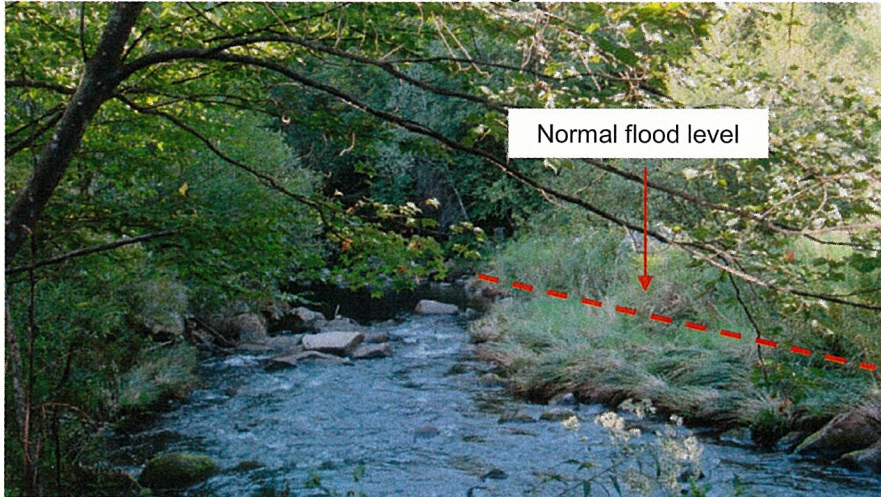


Crossing Structure and Channel Descriptions

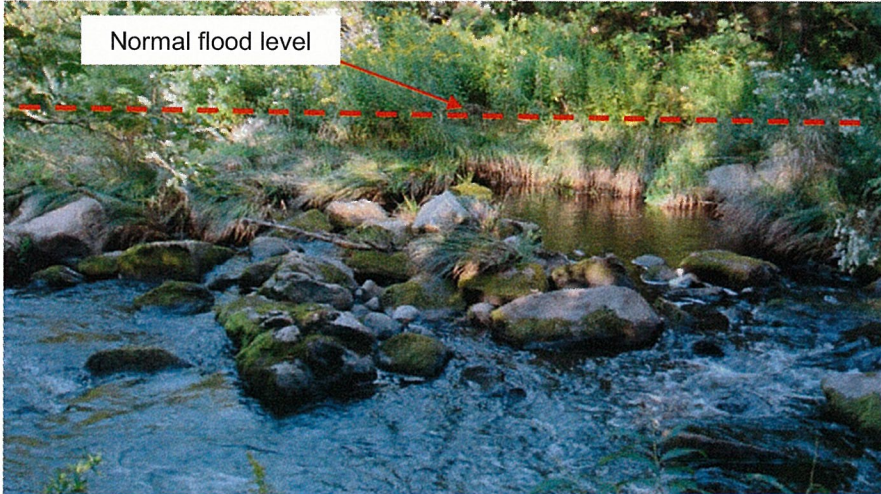
Structures 29-30

The top of bank within the active streamway (not depicted on provided cross-section drawings) can be considered the normal flood level, as the grassy vegetation within the active streamway suggests inundation up to the level portion of the channel bed. There is little erosion in this reach.

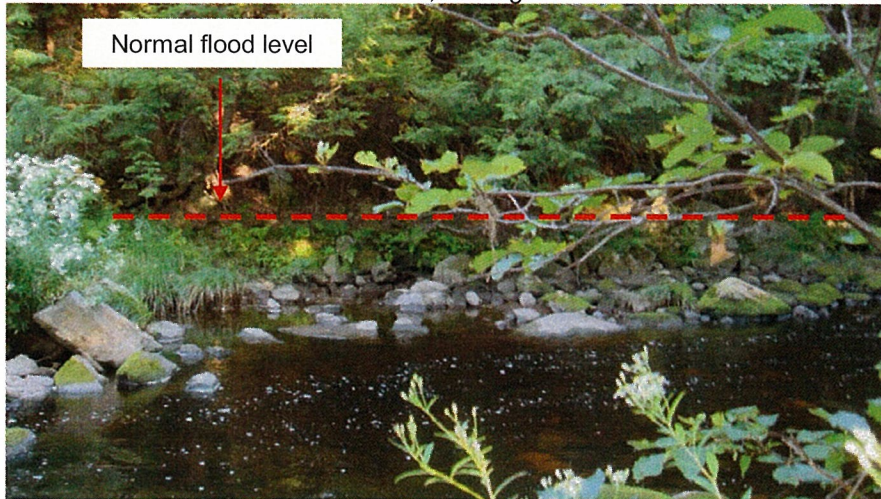
View across river toward Structure 29, looking northeast.



View across river toward Structure 29, looking east.



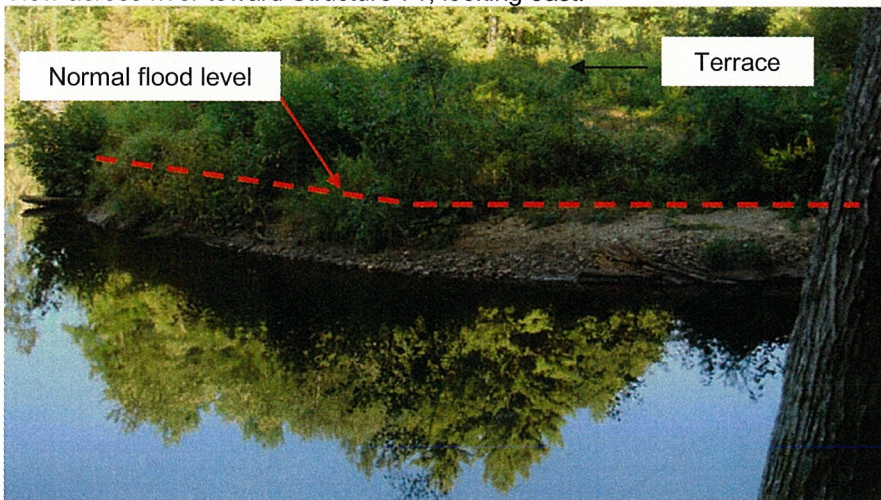
View across river toward Structure 29, looking southeast.



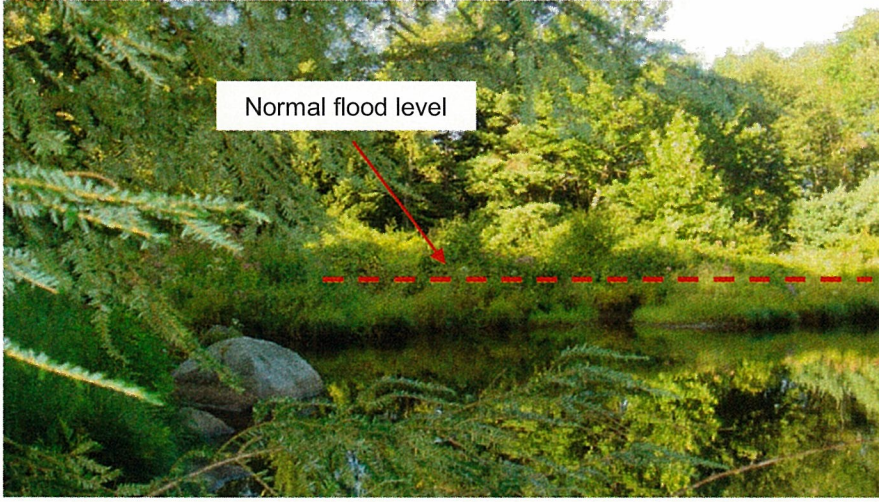
Structures 71-72

The stable, mature vegetation on the sand bar in inner bank suggests rare inundation above the top of bank; the sand deposits at higher elevations on this bank are likely due to the 10-year flood, which is above the top of bank. Thick vegetation is found along the outer edge of the bend (the side where Structure 72 is located), including on sand bars and the terrace. The flat terrace structures on the outer edge of bend are not depicted in cross section; they are vegetated but likely rarely inundated. Overhang of vegetation and slight erosion suggests that top of bank (considering presence of terrace) is normal flood level.

View across river toward Structure 71, looking east.



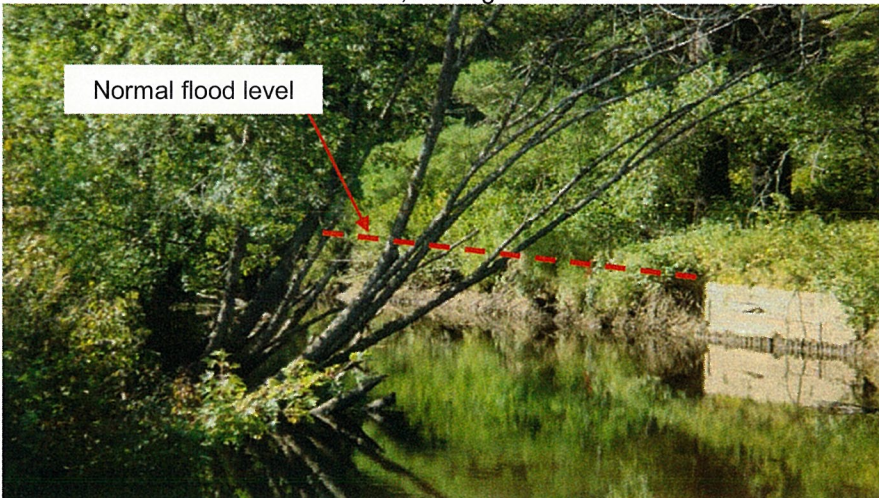
View across river toward Structure 72, looking northeast.



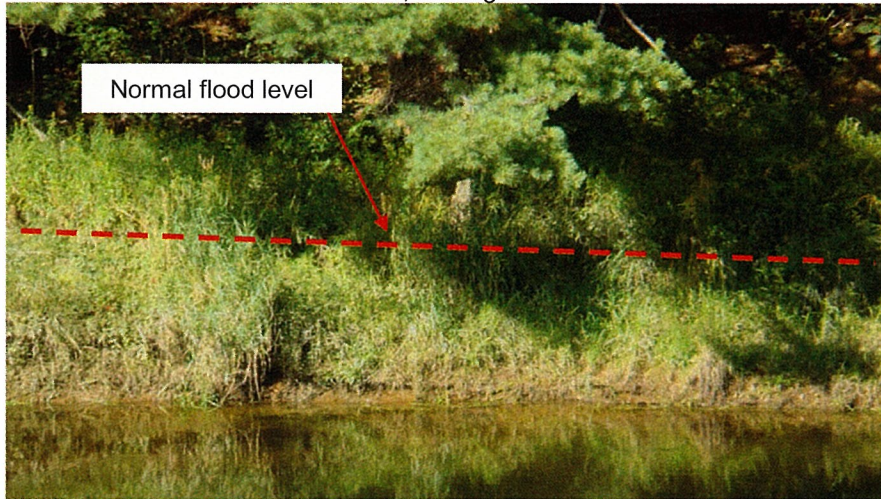
Structures 97-98

The north side of the bank at this crossing is vegetated with grass and goldenrod; the transition to goldenrod indicates the level of the top of bank. Evidence of bank erosion extend halfway up to the top of bank, and the south side of the bank is similarly eroded downstream of the Route 32 bridge crossing. Top of bank is a comfortable normal flood level at this location.

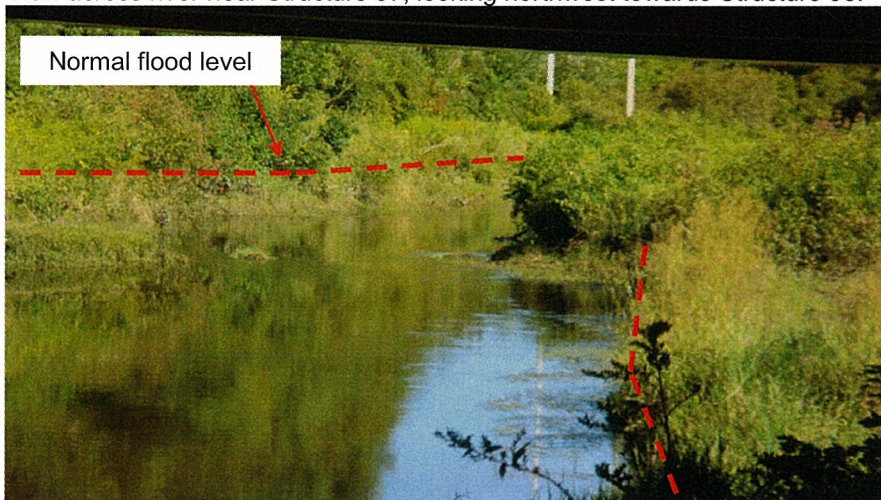
View across river near Structure 97, looking southwest.



View across river near Structure 97, looking west.



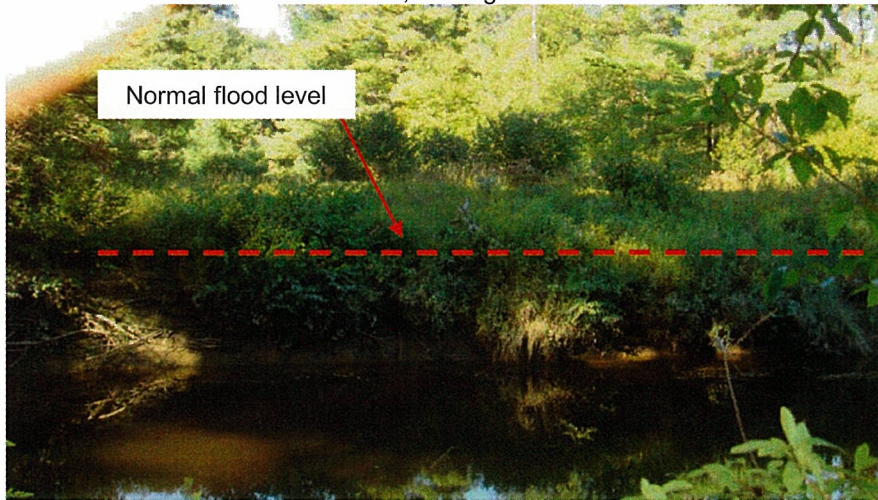
View across river near Structure 97, looking northwest towards Structure 98.



Structures 97-98

Both banks at this crossing are eroded to approximately $\frac{1}{2}$ - $\frac{3}{4}$ bank height; where they are not eroded, vegetation indicates frequent inundation to same level. The dense, established vegetation above the top of bank suggests infrequent interaction between the river and terrace. Top of bank is a conservative estimate of normal flood level for this crossing.

View across river near Structure 99, looking northeast.



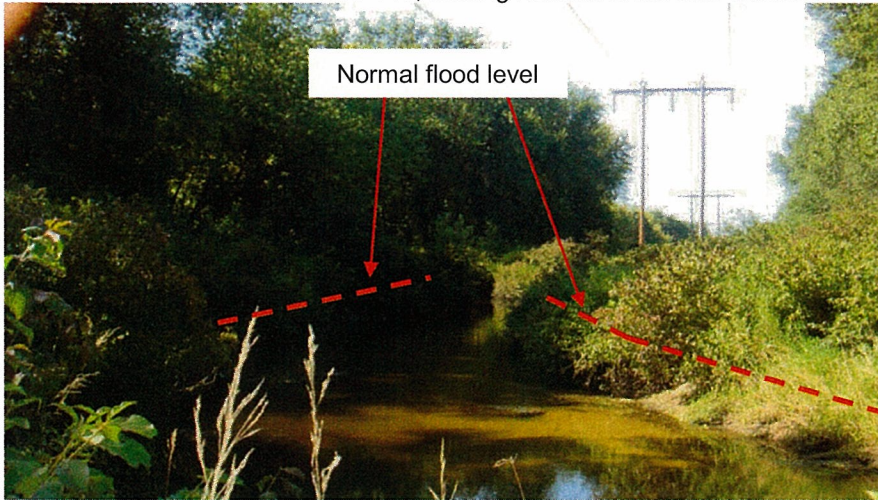
View across river near Structure 99, looking southeast.



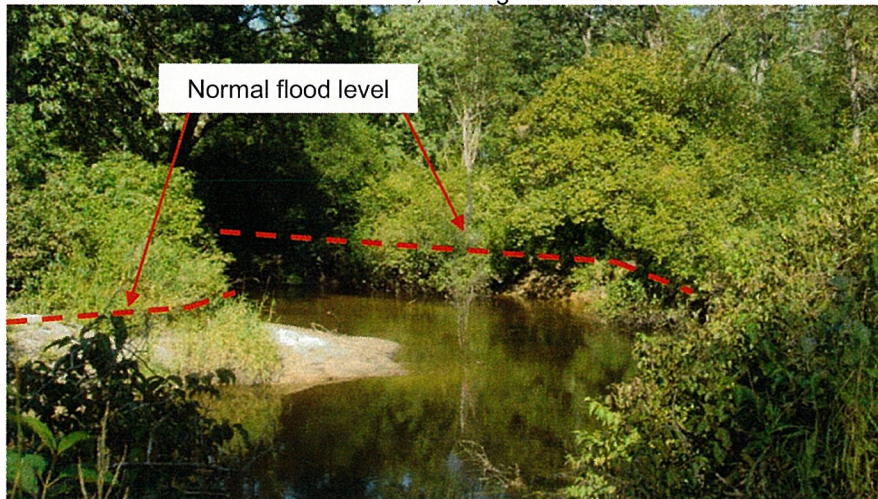
Structures 110-111

A significant sand bar exists on the inner bank; sediment deposits higher than the top of bank are likely from flows less frequent than baseflow, while those on the lower part of the bank result from flows that occur with higher frequency. The outer bank is eroded along the length of the bend. The damage suggests that flows typically reach $\frac{1}{2}$ - $\frac{3}{4}$ bankfull but infrequently exceed that level. Dense, established vegetation on the terrace of the outer bank indicates that the normal flood level is no higher than the top of bank.

View across river near Structure 110, looking northwest towards Structure 111.



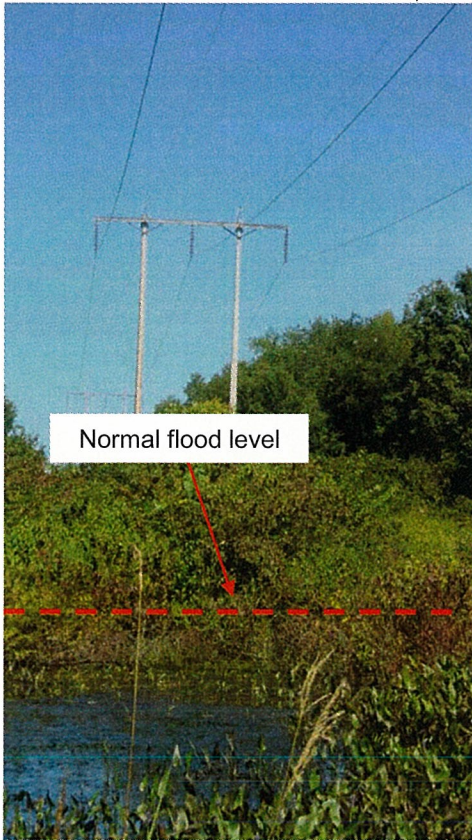
View across river near Structure 110, looking northeast.



Structures 121-122

The Ashuelot River at this crossing is wide and swampy. The tributary entering from the northeast meanders within a wide, active streamway. Vegetation below the top of bank shows evidence of inundation, while established vegetation above bank indicates bankfull flow as the normal flood level. The wide and generally flat structure of this area provides room for lateral spreading and detention of water.

View across river near Structure 121, looking north towards Structure 122.



View near Structure 121, looking northeast.

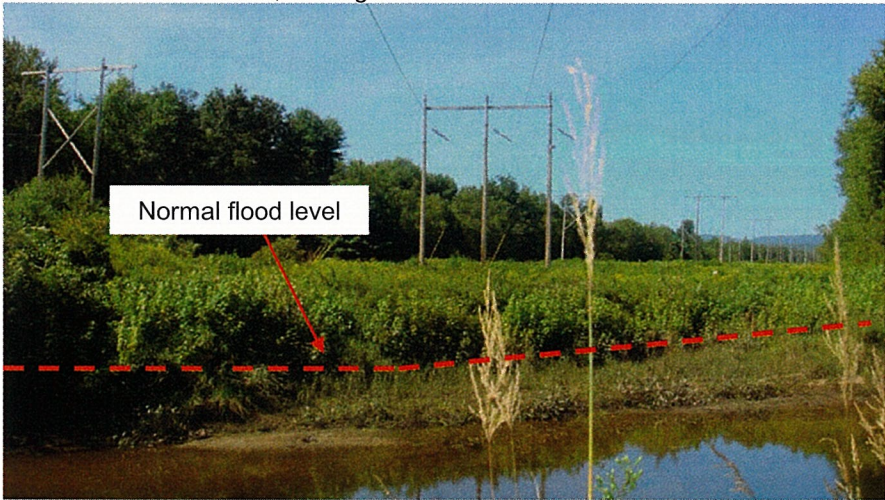


Structures 130-131

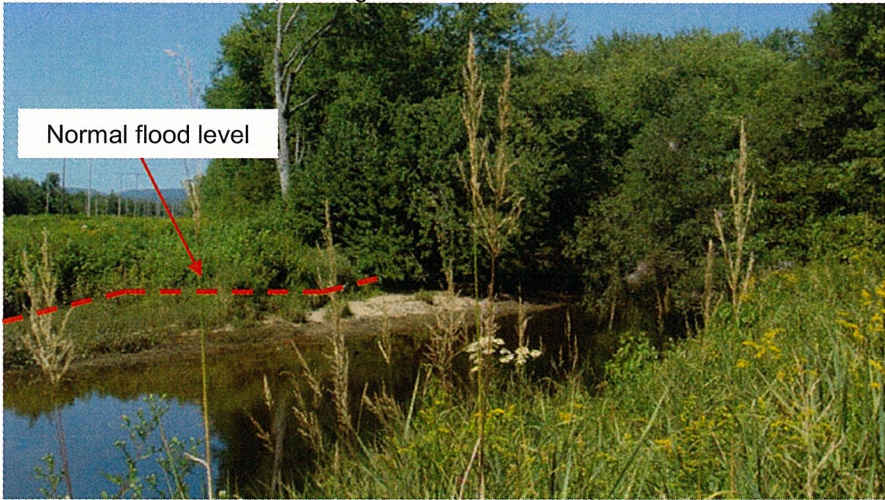
The sand bar on west bank of this reach, just north of the crossing, is large and shows frequent annual deposition. This and vegetation change from grass to shrubs indicates infrequent inundation beyond the top of bank. The banks at all other locations have been eroded up to $\frac{3}{4}$ of

the height of the top of bank. Vegetation indicates frequent annual inundation to the same level, but no frequent interaction between the terrace and stream. Bankfull flow is a conservative approximation of the normal flood level at this crossing.

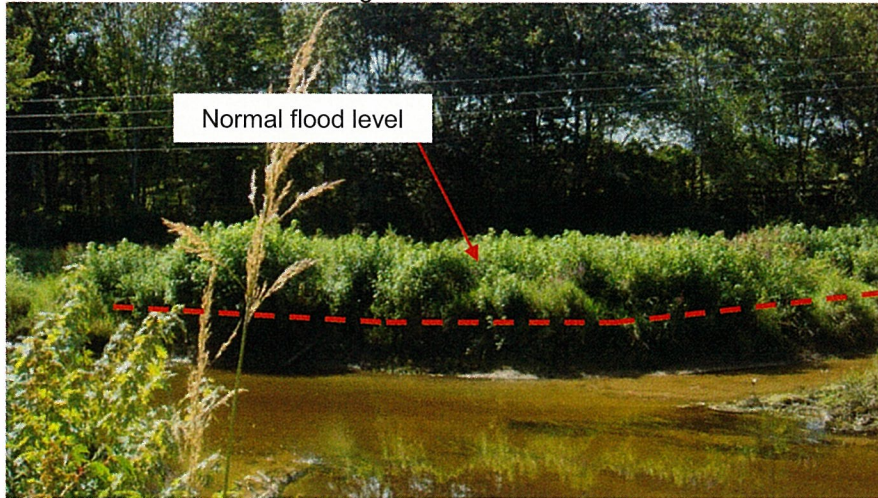
View near Structure 130, looking north toward Structure 131.



View near Structure 130, looking northeast.



View near Structure 130, looking west.



Other Structures

The crossings that were not visited include Structures 103-104, 105-106, and 122-124. However, structures in the same area were evaluated (i.e., 121-122). There was little variation in the applicability of bankfull flow as the normal flood level from Structures 29-30 up to 130-131. This observation and evaluation of channel cross-sections suggest that the characteristics at structures 103-104 and 105-106 do not drastically vary from those at other stations in the system. We are confident that the normal flood level at these locations is adequately characterized by the bankfull flow that reaches the top of bank.