UNION PACIFIC RAILROAD
SCOPE OF HYDROLOGIC/HYDRAULIC
DESIGN ENGINEERING AND PERMITTING SERVICES
FOR SIZING WATERWAY OPENINGS
AT NEW AND REPLACEMENT STRICTURES

These flood passage criteria were developed exclusively to protect Union Pacific Railroad (UPRR) infrastructure from flood damages and apply only to design and construction of new or replacement structures (such as bridges and culverts). Existing structures were designed and installed to protect UPRR facilities. For existing structures, UPRR relies upon guidance regarding 49 C.F.R. 213.33 found in the Federal Railroad Administration *Track Safety Standards Compliance Manual*: "Most railroad drainage structures have existed for many years and, if properly maintained and kept free of debris, they are considered adequately designed to accommodate expected water flow, even though recent high-water marks may be slightly above the inlet opening."

As part of investigating potential new or replacement structures, the hydraulic performance of the existing structure may be compared to these criteria. This is done only to establish a baseline condition for evaluation of alternatives, does not imply applicability of these criteria to an existing structure, and in no way reflects the ability of the existing structure to fully meet the standards of care in force at the time the structure was designed and constructed.

UPRR criteria for sizing waterway openings under bridges and through culverts are as follows:

1. New and replacement openings shall be sized for two high water events, designated "low chord" and "subgrade."

    - For subdivisions and for any lines in urban areas (regardless of classification), the low chord event is the 50-year flood and the subgrade event is the 100-year flood.[1]

    - For industrial leads and for customer-owned trackage (not in urban areas), these events are the 25-year and 50-year floods, respectively.

    - If the structure is in a FEMA designated floodplain, however, the water surface elevations for a 100-yr event shall be determined regardless of line classification or FEMA zone.

2. The new or replacement opening will be sized, if possible, so that the water surface for a "low chord" event will rise no higher than the crown of the culvert or the low chord of the bridge.

3. The new or replacement opening will be sized, if possible, so that the energy grade line for a "subgrade" event will not rise above the adjacent subgrade elevation (defined as 2 feet below base of rail elevation).

[1] This document refers to flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 25-, 50-, or 100-year period (recurrence interval). These events, commonly termed the 25-, 50-, and 100-year floods, are more correctly identified as the 4-, 2-, and 1-percent-annual-chance floods, and have a 4-, 2-, and 1-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods can occur at shorter intervals or even within the same year.

4. Both the UPRR criteria and local flood flow criteria shall be evaluated, and the more conservative of the two shall be adopted in sizing the waterway opening for the new or replacement structure.

5. If the existing bridge or culvert waterway opening exceeds that required by the replacement criteria, a smaller opening will be recommended, based on the criteria.

6. If the waterway opening for an existing bridge or culvert is less than that required by the replacement criteria, a larger opening will be proposed. This enlargement will be lateral to the extent possible. If it is found that insufficient channel area exists to meet the criteria, even with maximum widening, consideration will be given to adding relief structures on the overbank floodplain, raising the railroad grade, or other alternatives.

The Consultant will typically observe the following procedures:

1. Review descriptive documents provided by UPRR. These will typically include railroad alignment maps, profile maps, and condensed profile pages. These documents, and any other information that may be supplied by UPRR, are proprietary to UPRR and are not to be used for any purpose other than the assigned study without the written consent of UPRR.

2. Research the site. Locate the bridge on a USGS quad map. Determine if the assigned bridge or culvert appears to be one of multiple structures which receive runoff from one drainage area. Contact federal, state, and local agencies to ascertain permit requirements and schedule a meeting in the field if required. Obtain local and state information and/or previous studies regarding historical or calculated flows at the site. Ascertain if the assigned structure is within a regulated floodplain. If so, obtain the Flood Insurance Rate Map, Flood Insurance Study, and regulatory hydraulics model, if available.

3. Using researched data, perform hydrologic calculations to establish preliminary low chord and subgrade event (including 100-year if needed) peak flow rates at the sites, using peak flow formula procedures or runoff hydrograph analysis, e.g. rational method, regression equations, SCS TR-55, HEC-1, HEC-HMS (Clark’s or Snyders method), or other generally accepted methods for determination of runoff quantities at specified probablities.

4. Visit the site. Contact the appropriate UPRR Manager Bridge Maintenance prior to the site visit to establish communications, schedule the trip, inquire as to any recommendations or special conditions to be considered, obtain guidance regarding access, and (in cases of difficult access) secure transportation to the site. The Structures Design group will provide UPRR alignment and profile maps, if available, for the vicinity.

5. Research and data collection shall include, but not be limited to, the following: (1) photograph the bridge opening, channel, abutments, and footings; (2) examine local scour problems and other site conditions, such as the presence of wetlands or potential critical habitat for threatened or endangered species; (3) obtain information, if available, on flow and foundation conditions at other existing bridges in near proximity, (4) inspect the main channel and portions of the overbank area and obtain cross-section information required for hydraulic analysis, and, unless specifically directed otherwise, (5) obtain top-of-rail elevations (at bridge

backwalls, even stations, and any other significant feature) and other survey information to develop profile and location plans. During the site visit, also inspect the bed and bank area and the existing abutments and footings to assess whether bed and embankment erosion problems might exist. If it is apparent that previous floods have caused damage to the existing structure, or if there appears to be a potential for damage to UPRR, provide recommendations to UPRR regarding measures that might be considered for protection. Note any obvious foundation concerns, particularly whether driving piles might be difficult.

6. Using acquired maps, reports, field data, and local criteria, interpret data and refine hydrologic calculations to establish final low chord and subgrade event (including 100-year if needed) peak flow rates at the sites.

7. For the computed flow rates, evaluate the hydraulics of the existing structure using HEC-RAS, HY-8, WSPRO, HEC-2 or other techniques acceptable to UPRR and governing agencies. Compare the results with the current hydraulic criteria for flood passage, taking care not to imply that the existing structure is or ever was required to meet these standards.

8. Propose a waterway opening to meet the current UPRR hydraulic criteria, using the same technique as for the existing structure. Unless directed otherwise, evaluate the replacement structure by maintaining the existing track and embankment alignment and elevation. If more than one type of structure may be feasible, propose openings for each practical structure type.

9. In the event a practical and reasonable replacement structure meeting these criteria cannot be obtained, contact the UPRR Manager Structures Design for direction. Possible alternatives for discussion include raising the track and subgrade elevations and/or relaxing UPRR hydraulic criteria, but only with UPRR direction.

10. If it appears likely that a significant reduction from the existing bridge size can be made by further refining the hydrologic analysis, such as incorporating hydrograph routing, prepare a cost estimate for the additional analysis and then contact the UPRR Manager Structures Design for direction.

11. Assemble relevant data regarding the hydrology, existing structure hydraulics, and proposed structure hydraulics on a Union Pacific H&H Recommendation Form. Meet with the Structures Design staff (preferably in person) and present the recommendation form, field survey drawing, and photographs. Discuss the analysis and recommendation and obtain approval from UPRR to proceed with permitting for the adopted replacement structure.

12. On behalf of UPRR, make all contacts with permitting agencies, obtain and submit permit applications, and track progress of each permit. When permits have been obtained, transmit a “Permits Issued” letter, complete with original and one copy of permit documents, to UPRR for handling with construction forces. (Obtain all permits related to the new structure. If so directed by the Mananger Structures Design, obtain additional permits related to construction activities.)

Inasmuch as no two sites are alike, assumptions are made regarding availability of information, degree of difficulty in obtaining data, accessibility of the site, availability of suitable maps, technological complexities, etc. The following paragraphs give general guidelines.

The Consultant shall prepare a field survey drawing showing the following, with all elevations recorded to the nearest hundredth of one foot:

- Location map.
- Bridge elevation showing locations and dimensions of abutments, footings, piers, pile bents, and cut off piles from previous structures.
- Cross section at bridge or culvert showing flow line profile.
- Typical embankment cross section adjacent to bridge or culvert.
- Plan view showing relative adjacent structures such as switches, signs, utilities, bench marks, etc.
- Top-of-rail profile for at least 1000 feet either side of bridge or culvert (longer if necessary to include vertical and horizontal curves).
- When located within the survey limits, top-of-rail elevations at each side of road crossings, point and frog of railroad turnouts, backwalls of other bridges, etc.
- Location and set elevation of temporary bench mark at project site. The temporary bench mark shall be at a secure location and clearly identified.

Base of rail elevation shall be calculated based on height of rail weight present, subtracted from the surveyed top-of-rail elevation.

For superelevated track, the controlling elevation for the profile is at the low rail.

If the existing substructure is steel, concrete, or a composite of steel and concrete the Consultant shall prepare a supplemental field survey drawing showing the following:

- Elevations of all bridge seats referenced to the benchmark and base of rail of the hydrologic and hydraulic survey.
- Lateral and longitudinal dimensions including lateral offsets from centerline of track of all bridge seats.
- Longitudinal dimensions locating the backwalls and centerline of bridge seats.
- If there are any riser blocks, grillages, or shims between the bridge seat and the structure, detailed drawings shall be completed showing all dimensions.

Base of rail elevation at one end of existing structure should generally be set at elevation 100.00. If elevations can be referenced to a nearby benchmark, provide the conversion from the assumed datum to a geodetic datum.

New and replacement bridge structures shall generally be steel beam spans, double-cell concrete box beams or slab beams, concrete box culverts, circular corrugated metal pipe culverts, or smooth steel pipe culverts. Unless otherwise directed, structures will be per UPRR structure standards, including roadbed sections for track construction, prestressed concrete trestles, corrugated metal pipe culverts, and reinforced concrete box culverts.

Measurements of cross-sections for hydraulic analysis generally shall be referenced to base-of-rail at the assumed elevation datum, and not a local geodetic system. Elevations are to be recorded to the

nearest one-hundredth ft. It is assumed that four to six channel cross sections will be surveyed at each site. Estimates of ordinary high water elevation and zero damage elevation for upstream developed properties are to be obtained.

It is assumed that horizontal control can be obtained from available topographic maps. If required by local or state criteria, horizontal and/or vertical control shall be established by the Consultant.

For tidal areas, it is assumed that hydrology can be obtained using the same techniques as for non-tidal sites. If, in the judgment of the Consultant, further refinement is required, he will so recommend and obtain approval from the UPRR Manager Structures Design before proceeding.

If an assigned bridge or culvert appears to be one of multiple structures which receive runoff from one drainage area, the Consultant shall bring this to the attention of the UPRR Manager Structures Design prior to making the site visit. When so directed, the Consultant shall obtain field information on all affected structures and include them in the analysis.

For travel to sites, the Consultant will make every reasonable effort to group sites so that field work can be completed for several sites during one trip. Airfare discounts for advance purchase should be obtained as standard practice, except when specifically directed otherwise by UPRR.

Permit letters shall conform to the following:

1. Permit letters shall identify what UPRR proposes to do, what additional information is included, a request for permit determination, and where additional information can be obtained or questions answered.

2. Requests for permits shall be made to all agencies that have jurisdiction. Some agencies will request notification only and have no formal permit requirements. Some agencies may claim jurisdiction without legal authority; the Consultant should verify, as much as possible, validity of jurisdiction.

3. All permits and forms will be completed and signed by the Consultant acting on behalf of UPRR.

4. One letter shall be used to notify as many agencies as practical.

5. All required figures, tables, and supporting information, as well as a photograph of the existing structure, will be included with the permit letter.

6. Where permits require payment of fees, supporting forms and documents will be submitted in completed form and payment made by the Consultant.

7. Consultant will type and sign all final correspondence. UPRR will receive a copy of all correspondence.

8. Upon receipt of permit approvals from the agencies, the Consultant shall transmit a “Permits Issued” letter to UPRR stating that relevant permits have been issued and summarizing those

permits. The Consultant shall also name any known permits that have not been obtained and are expected to be obtained by construction forces.

Revised 1 November 2010