Connell Rail Interchange

CITY OF CONNELL • WASHINGTON •

On-Track For Growth!

EASTERN WASHINGTON'S HARVESTLAND

ENGINEERING

City of Connell

Connell Rail Interchange Study

Engineering Basis of Design
Initial

August 2015

These criteria do not substitute for engineering judgment and sound engineering practices. Specific exceptions apply in special cases. The designers are responsible for identifying any necessary departure from the criteria contained in this document, and bringing it to the attention of the City of Connell and project stakeholders. Any changes to the criteria shall be reviewed and approved by the City of Connell prior to design. Application for change of criteria, addition to the criteria, and any other questions shall be submitted in writing to the City of Connell (see Section 1.6).

1.4 Project Goals

The basic goal of the Connell Rail Interchange Project is to provide the City of Connell and other stakeholders an improved interchange infrastructure. This will allow existing and future rail shippers to benefit from a modern interchange with greater capacity, enhancing current railroad service and providing additional capacity in the future. While an initial concept has been developed for the project, this study will examine other alternatives.

1.4.1 Key Criteria and Assumptions

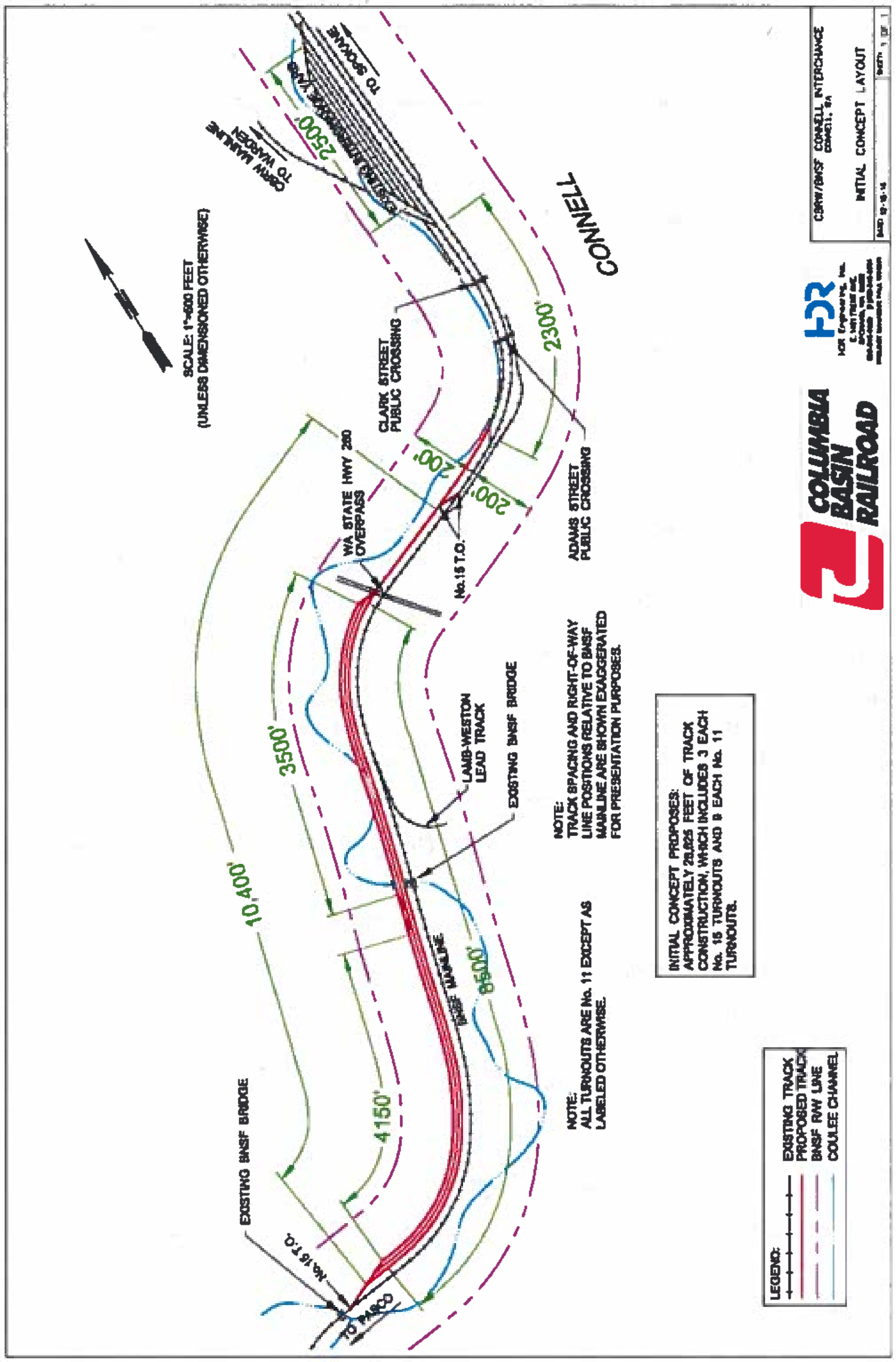
Essential elements and capacity include the following;

1. Provide expanded interchange which provides adequate length for all interchange operations to be performed clear of the BNSF main track. (All CBRW interchange operations occur on tracks not requiring access to BNSF main track.)
2. Provide track configuration and capacity which allows for BNSF to enter or exit the BNSF main track with trains to be interchanged in one continuous movement and from either direction.
3. Provide BNSF and CBRW a configuration that allows departures and arrivals using continuous forward movements.
4. Provide capacity for 7500' minimum length (8600' desirable) trains to clear the main track coming from either direction.
5. Provide second parallel track of 7500' minimum to allow locomotives to "run-around" train or be reconfigured for movement in opposite direction without fouling / occupying the main track.
6. Provide parallel continuous access road to at least one side of the two above mentioned tracks.
7. Provide one (possibly two), parallel track(s) which would provide approximately 3600' of capacity each (for staging shorter typical length trains).
8. Provide power operated #15 track switches on main track and power operated derails protecting BNSF main track.
9. Design interchange track(s) for 5.22 Million Gross Tons MGT (this train traffic volume represents the annual interchange of 208 trains consisting of 44 car merchandise trains, 24 trains consisting of 100 car unit trains, plus 100% growth allowance and 50% additional auxiliary use allowance).
10. Grades on interchange tracks shall be limited to 0.5% grade. Grades on leads and other tracks shall be limited to 1.0%.

Assumptions:

1. BNSF and CBRW will own and maintain new track within the limits of their respective current right-of-ways / property boundaries. Additional property

Exhibit 1.1 – Initial Proposed Concept



- BNSF Railway Company Current Mainline Standards (most current).
- BNSF Railway Company Engineering Instruction (most current).
- BNSF UPRR Guidelines for Railroad Grade Separation Projects, 1/24/07.
- BNSF UPRR Guidelines for Temporary Shoring, October 25, 2004.
- BNSF Railway Company Utility Accommodation Policy, May 18, 2011
- Joint BNSF UPRR Common Standard Plans for Trackwork (most current)
- Railroad Engineering 2nd Ed, by Hay
- City of Connell Public Works Standard Specifications and Standard Plans
- Franklin County Design Standards for the Construction of Road and Bridges
- Washington State Department of Ecology Stormwater Management Manual for Eastern Washington
- The U.S. Department of Transportation, Manual on Uniform Traffic Control Devices
- American Association of State Highway and Transportation Officials (AASHTO), A Policy on Geometric Design of Highways and Streets as of 2011
- Illumination Engineers Society of North America
- Geotechnical Information – Various Sources

The specific WUTC Rules that govern are:

- WAC 480-60 - Railroad Companies Clearances
- WAC 480-62 - Railroad Companies Operations
- WAC 480-66 - Railroad Companies Sanitation
- WAC 197 - Department of Ecology

2.3 Manuals

Additional manuals are available from the City of Connell and should be used by the designer in specific circumstances.

- (None)

4.0 Track Geometry

4.1 Scope

This chapter establishes the criteria for the geometric alignment of the Connell Rail Interchange trackage, with the goals of optimum safety, utility, minimized long term maintenance costs, based on accepted railroad industry engineering practice and the experience of conventional freight railroad systems.

The values and formulae for design parameters presented in this chapter are to be used throughout the interchange facility. If, in the process of design, it becomes apparent that holding the values presented in this chapter will result in unreasonable cost or significant physical impact on adjacent property and facilities, exceptions to the criteria shall be presented to the City of Connell on a case-by-case basis (see Section 1.6).

Train speeds are governed by WAC 480-62-155 and railroad operating rules and practices. The new facilities will be operated at the same speed as currently operated interchange – 10 mph.

New track construction on new or modified alignments shall be constructed to not less than FRA Class 5 Standards geometry tolerances and operate at Class 1 speeds (10 mph). If integrated, rehabilitated track on existing alignments shall be designed and constructed to Class 3 Standards geometry and operate at Class 1 speed. Temporary connections, if used in construction, shall be designed to Class 2 tolerances.

Stationing and geometrics should be denoted along the centerline of the left track in the direction of increasing stationing. Independent stationing and geometries for each track are required when the tracks are not parallel, or where parallel tracks have independent profiles.

4.2 Design Procedure

Refer to AREMA Chapter 5.3 for a complete discussion of curve design.

All curves will be designed and constructed with simple curves (no spirals) consistent with BNSF Design Guidelines for Industrial Track Projects.

These design standards do not replace FRA track safety standards. Curves shall comply with all parts of Subpart C. In practice, designers set the overall parameters, and maintenance personnel are responsible for preventing any irregularities which could become exceptions to the FRA standards.

4.3 Horizontal Alignment

FRA Track Safety Standards, Part 213, Subpart C provide the absolute limiting cases for the maintenance of track geometry; these standards generally are more conservative and govern track design.

Table 4-2 Turnback Curves

Turnout No.	Turnback Curve Degree
9	9° 30'
11	5° 30'
15	3° 00'

4.3.5 Superelevation

Superelevation should be consistent through circular curves. It will be achieved by maintaining the top of the inside rail at the top-of-rail profile and raising the outside rail by an amount equal to the track superelevation.

Industry tracks shall be superelevated per Section 4.3.3. Curves will not be constructed with reverse superelevation.

4.3.6 Track Spacing

For existing tracks which will be repaired, the current track spacing will be maintained or corrected if possible to comply with BNSF current standards and WAC 480-60-060.

On new alignments and areas of reconstruction, track spacing will be in accordance with BNSF Design Guidelines for Industrial Track Projects and per WAC 480-60-060, except as noted in the Project Goals section.

4.3.7 Spirals

A transition spiral is defined as a curve that provides a gradual rate of change in curvature from a tangent path to a curve path. Consistent with BNSF Design Guidelines for Industrial Track Projects, spirals will not be used in the design of the Connell Rail Interchange.

4.4 Vertical Alignment

4.4.1 General

The profile grade represents the elevation of the top of the low rail (T/R).

When T/R profile is given for one track only, the T/R elevations of the other tracks should be equal to the profile track at points radially and perpendicularly opposite. Gradients and lengths of vertical curves should vary accordingly (slightly) to accommodate the differences in lengths through horizontal curves. When possible, adjacent tracks should be designed to the same vertical profile.

If the difference in top-of-rail profiles between new and existing parallel tracks varies by more than 6 inches at any given point, the vertical alignments of both the existing and proposed tracks should be evaluated and a recommendation made to the City of Connell to adjust either or both the existing or proposed vertical alignments.

4.4.2 Grades

The required grades should be designed in accordance with BNSF Design Guidelines for Industrial Track Projects and the BNSF Railway Engineering Instructions.

Generally, grades shall be no greater than the desired grades summarized in Table 4.3.

side of the turnout and will not be less than a No.9 geometry.

- Existing turnouts, which will be repaired, will remain the same geometry.
- Turnouts and switches will not be used on horizontal or vertical curves. Superelevation shall not be employed through a switch or turnout. To minimize exposure of pedestrians to moveable track components, turnouts should not be placed within crossings.
- The distance between facing point turnouts shall be per BNSF Design Guidelines for Industrial Track Projects and BNSF Railway Engineering Instructions.
- Gas or propane switch heaters are not required.

Crossovers shall:

- Be placed between tracks with whole foot (15 feet minimum) spacing.
- Have no curves between opposing frogs.

Turnouts (T.O.) for track work shall comply with BNSF / UPRR Common Standard Plans for Trackwork. See Table 4.4 for turnout data.

Table 4.4 Turnout Data

Turnout Data	PS to PI	Turnout Length (CL of Last Long Tie)	Frog Angle
#9	30.17	107.04'	6°21'35"
#11	31.25'	124.25'	5°12'18"
#15	39.97'	166.79'	3°49'06"

1 PS = Point of Switch

2 PI = Point of Intersection of Turnout

Main Line

Turnouts and switches should not be placed on horizontal or vertical curves. Superelevation shall not be employed through a switch or turnout.

All main line track turnouts shall be a minimum new No. 15 - 141 lb. and include a premium frog.

Operations may dictate that main line turnouts to be equipped with power switch machines and heaters.

Non-Main Line

For turnouts owned and maintained by the BNSF, minimum turnout should be a No. 11 - 136 lb., except as stated previously in this section, special circumstances may dictate use of a No.9 – 136 lb. turnout. All switch stands shall include a "30 Degree" handle.

The distance between facing point turnouts shall be per BNSF Design Guidelines for Industrial Track Projects and BNSF Railway Engineering Instructions.

4.5.2 Speeds

Turnouts shall be selected based on operating speeds. Higher-speed and higher-

Auxiliary Track

The typical roadbed section for new auxiliary track construction will include either 7" high x 8" wide x 8'6" AREMA No. 4 (minimum) timber crossties on 12-inches of ballast, or concrete ties on 12-inches of ballast. Subballast with a 12 inch subballast depth on a compacted sub grade. The drainage includes a 2:1 toe of slope with a minimum 1.0 foot deep "V" ditch and a 1.5:1 back slope. Ditch will be modified according to drainage evaluation.

Walkways and Maintenance Access Road

Turnout walkways shall be a minimum of 8'-6" from centerline of track. Maintenance roads, 13 feet wide, shall be provided to access signal equipment, turnouts, and tracks where equipment inspections are to take place.

5.4.4 Turnouts

Turnouts will be constructed per BNSF Design Guidelines for Industrial Track Projects and BNSF Agricultural Products Unit Train Facility Design Guidelines. Geometry will be per Common Standard Drawings. Refer to the previous chapter for selection and location of turnouts.

Turnouts will be insulated as required when in proximity to signalized grade crossings and or wayside signal system. Common Standard turnouts will be furnished. Rail will be new 136 and 141 lb. CWR.

All switch stands will be either power switch machines or BNSF standard ergonomic handle stands.

5.4.5 Road Crossings

At-grade roadway crossings of track on primary permanent roads should be located in tangent track wherever possible and shall incorporate precast BNSF Common Standard concrete panels with pre-attached rubber flangeway fillers. Running rail through the crossing area shall be welded to eliminate conventional joints. No insulated joints or bonds shall be placed in a crossing or within 10 feet of a crossing. No turnouts or crossovers shall be located within a crossing.

Concrete panels shall be placed on 10-foot wood ties.

5.4.6 Derails

Derails shall be used to prevent out-of-control rail vehicles from fouling adjoining or adjacent tracks:

- Derails shall be placed on tracks per BNSF Design Guidelines for Industrial Track Projects. Derails shall be installed on all tracks directly connected to the main track. With approval, derails may be used at other track locations where they would be likely to prevent or minimize injury to personnel, and/or damage to equipment.
- Derails shall be located so that they derail equipment in a direction away from the main track.
- Derails protecting main track shall be placed a minimum of 100 feet behind the 14-foot clearance point, and placed on tangent track where possible.
- Derails protecting main line tracks and controlled sidings should be double switch point.

OTM design shall be consistent with 10 mph operations and 5.22 MGT per year.

5.5.4 Special Trackwork

Special trackwork shall conform to BNSF Design Guidelines for Industrial Track Projects, BNSF Common Standard Plans, and AREMA guidelines.

5.5.5 Ballast

Ballast shall conform to BNSF Design Guidelines for Industrial Track Projects, BNSF Engineering Instructions, and AREMA material requirements.

5.5.6 Subballast

Subballast material shall conform to BNSF Design Guidelines for Industrial Track Projects and AREMA guidelines for subballast. The subballast for all tracks in areas of total track construction or reconstruction on new alignments shall consist of a uniform 12-inch layer placed and compacted over the entire width of the roadbed following the profile and cross section of the roadbed. A thicker subballast section or geotextiles should be used when subsoil conditions dictate. Subballast shall be Washington State Department of Transportation Crushed Surfacing Base Course. In areas of total reconstruction on existing alignments, existing roadbed will be graded and re-compacted and will not have subballast installed below new ballast, if conditions allow.

Existing ballast and subballast should be used to support relocated and transition track segments except where existing ballast and subballast are contaminated with fines or organic material or are not adequately drained.

5.6 Joints and Welds

It is anticipated that continuous welded rail (CWR) will be used throughout the new construction of the Connell Rail Interchange, including track, special trackwork, and crossings.

5.7 Insulated Joints

Except as otherwise dictated by BNSF, insulated joints shall consist of new factory glued IJ plug rails per BNSF Standard Plans.

embankment might also be used to control the flow of water downstream by retaining some of the runoff in a storage basin. Compensatory flood storage should be considered in each instance where fill reduces the existing flood storage area.

<u>References</u>

The latest edition of the following standards, codes and guidelines shall be used in the design of the Connell Rail Interchange drainage facilities:

A. Primary Criteria:

- BNSF Railway Company General Information for Culverts (most current).
- WSDOT Standard Plans M 21-01, January 2004
- WSDOT Hydraulics Manual M 23-03, March 2004
- WSDOT Highway Runoff Manual M 31-16, March 2004
- WSDOT Standard Specifications M 41-10, 2004
- ES1801 Standard Roadbed Section
- American Railway Engineering and Maintenance of Way Association (AREMA), "Manual for Railway Engineering"
- Washington Department of Transportation (WSDOT) "Highway Design Manual", (HDM) Chapters 800 to 890 Highway Drainage Design
- Federal Highway Administration (FHWA) Hydraulic Engineering Circulars (HEC)
- American Public Works Association (APWA), "Standard Plans for Public Works Construction"

B. Additional Design References and Information Sources

- Washington State Department of Ecology Stormwater Management Manual for Eastern Washington
- Aquatic Habitat Guidelines, Design of Road Culverts for Fish Passage, Washington State Dept. of Fish and Wildlife, U.S. Fish and Wildlife Service, Washington State Dept. Of Transportation, U.S. Corps of Engineers and Washington State Dept. of Ecology, 2003
- Fish Passage Design at Road Culverts, Washington Department of Fish and Wildlife, March 3, 1999
- WSDOT Design Manual, Section 1210, M22-01, December 2003.

6.3 Hydraulics

6.3.1 Design Frequency

It is anticipated that the Connell Rail Interchange will require a formal Hydraulic Analysis. The information in Section 6 is intended to be used as a design guideline.

<u>Bridges</u>

Bridges and culverts that pass water from one side of the tracks to the other, and waterways with contributing areas greater that 0.5 square miles, shall be designed by developing water-surface profiles along the stream and through the structures. Water-surface profiles shall be computed using the Army Corps of Engineers' computer program HEC-RAS.

passing the peak runoff from a 50-year storm. Where damage to an at-grade track could occur due to the inability of any adjacent existing storm drain to pass the peak runoff from a 100-year storm, that storm drain shall also be rebuilt to pass runoff from the 100-year storm.

Pavement Drainage

Inlets and inlet spacing shall be designed for a 10-yr MRI storm. Lateral collection ditches and drains are to be sized for the 25-year MRI and for a 50-year MRI for sump condition. The gutter flow width should not exceed the shoulder width plus half the adjacent lane width. The hydraulic grade line is to be below structure rim elevation for peak design flow (pages 6-9, WSDOT Hydraulics Manual).

The frequencies listed above should be modified if the local jurisdictional agency has a more conservative standard. The top of rail elevation should be a minimum of 1 foot above the 100-year flood elevation.

6.3.2 Method for Calculating Runoff

Stormwater runoff volumes will be calculated using the Eastern Washington Stormwater Management Manual unless the jurisdictional agency has a more conservative calculation method.

6.4 Runoff Treatment

Stormwater runoff treatment will follow the Eastern Washington Stormwater Management Manual treatment procedures, or Chapter 2 of the WSDOT Highway Runoff Manual (HRM) which describes nine minimum requirements which shall be considered during the planning, design and construction phases of each project. The threshold and applicability information noted in each of the manuals must be considered when determining which of the minimum requirements must be applied. The minimum requirements that need to be used should be determined on a basin-by-basin basis.

6.4.1 Runoff Quantity Treatment

Refer to WSDOT Highway Runoff Manual (HRM) for treatment methodologies.

6.4.2 Runoff Quality Treatment

Refer to WSDOT Highway Runoff Manual (HRM) for treatment methodologies.

6.5 Hydrology

The engineer should initially plan on having the drainage structure for the new track replicate that which is currently in place for the existing track. The agency or municipality responsible for the drainage channel shall also be consulted prior to structure type selection.

The following procedures should be used in preparing hydrologic computations:

(To be provided at a later date.)

6.5.1 Design Discharge

No additional discharge expected.

minimum diameter of pipe for culverts under roadways shall be 18 inches. A culvert is defined as a drainage pipe crossing under a track or roadway embankment and connecting with open channels at both ends.

The minimum diameter of storm pipe for storm drains, including connections to inlets, shall be 18 inches. Minimum diameter of pipe slope drains shall be 12 inches.

6.7.2 Design Considerations

Where headroom is restricted, equivalent pipe arches may be used instead of circular pipe.

Abrupt changes in direction or slope of pipe should be avoided. Where such abrupt changes are required, an inlet or manhole should be placed at the point of change.

The minimum slope in a pipe shall be 0.35 percent.

6.7.3 Material

Culverts and storm drains passing beneath tracks or maintenance roadways shall be in accordance with BNSF Design Guidelines for Industrial Track Projects and AREMA material requirements.

All underground storm drain materials and design procedures, maintained by the City of Connell or Franklin County, shall be in accordance those agencies.

6.7.4 Location of Drains

In the track sections, placement of drainage structures should consider hydraulic requirements, economy, low points, and prior to crosswalks and intersections.

Drainage structures should be provided at changes in pipe slope, alignment and size, and at multiple pipe intersections.

Underdrain cleanouts shall be provided at maximum 300-foot centers along all drainage lines.

Track drains with lateral piping across the track shall have a clearance in accordance with the BNSF and AREMA Standards.

Drainage facilities should be located to prevent sheet flow across at-grade track.

6.7.5 Cover

Pipes shall have a minimum of 4 feet 6 inches of cover, measured from the top of pipe to base of rail. Pipes not under tracks shall have 3 feet minimum cover.

The tops of encasement pipes under tracks shall be at least 4 feet 6 inches below base of rail. In locations where this is not practicable, reduced clearance shall be provided with approval of the City of Connell and BNSF.

6.7.6 Outfall Pipes

Where the capacity of the outfall pipe of an existing system is less than the capacity of the pipe required by the design criteria at the track crossing, a relief structure within the railroad ROW shall be provided to preclude inundation of the track. Care should be exercised in designing the junction between the larger and smaller pipes to avoid an abrupt change of cross-section, which might cause deposition of debris and clogging of the drain.

- At low points in the profile, and 100 feet each side of a low point.
- Across the track or roadway at the downhill end of a cut.
- Along the periphery of any paved area under which groundwater is likely to collect; under drains should also be provided to collect track surface drainage along tracks, in retained cuts, on retained embankments, or where several sets of tracks are adjacent (e.g., in yards).

The minimum diameter of under drains shall be 12 inches with the pipe designed to run no more than half full. The top of under drainpipe shall be a minimum of 15 inches below bottom of ballast. Riser cleanout shall be provided at the beginning of all under drain runs and at 300-foot intervals.

6.12.2 Filter Material

Under drain pipe shall be bedded in aggregate filter material. Filter material gradations for fine and coarse aggregates shall be based on the findings of the soils engineering investigation.

6.13 Pump Stations

The use of pump stations should be avoided. The use of a pump station should be based on a comprehensive analysis of initial outlays for gravity drainage versus pumping, and future maintenance and operating costs of a pump station. A thorough economic analysis should be made to justify the use of pump stations.

8.0 Utilities

8.1 Scope

These design criteria should govern new utility construction outside of buildings, and the support, maintenance, relocation, and restoration of utilities encountered or affected by the Connell Rail Interchange construction. Consideration should be given to the needs of the rail system, the requirement and obligation of the public and private utility owners and the utility service needs of adjacent properties.

Existing utility crossings are typically covered by a license agreement between the railroad owner and the utility owner. These agreements govern how changes to the utility installation are made and should be referenced. In the case of conflict between the utility license and BNSF technical requirements, the technical requirements govern unless otherwise approved by BNSF. The City of Connell will follow standards of the affected utility companies for relocations and new installation. Utility work occurring in public ROW will be coordinated with the local jurisdiction in accordance with local permits and franchise requirements.

8.2 Standards, Codes and Guidelines

The latest editions of the following standards, codes and guidelines shall be used in the design of City of Connell utility work:

- BNSF Utility Accommodation Policy
- "FRA Track Safety Standards", 49 CFR Part 213 and "FRA Roadway Worker Safety" 49 CFR part 214
- "Minimum Federal Safety Standards for Gas Lines", Title 49, Code of Federal Regulations, Part 192
- American National Standards Institute (ANSI): "Standard for Liquid Petroleum – Transportation Piping Systems", Part B 31.4
- American Railway Engineering and Maintenance of Way Association (AREMA), "Manual of Railway Engineering", Chapter 1, "Pipelines"
- American Water Works Association (AWWA)
- American Society of Mechanical Engineers (ASME): Standard B 31.1 and "Guide for Gas Transmission and Distribution Systems of the ASME Gas Piping Standards Committee"
- API Recommended Practice for Crossing Highways and Railroad
- U.S. Department of Transportation, Part 195 of "Government Requirements for Transportation of Liquids by Pipeline
- National Electric Safety Code
- WAC Title 480
- Current Standards of Utility Owners

9.0 Structural

9.1 General

The Connell Rail Interchange structural design criteria for structures supporting railroad loading shall be consistent with standard railroad practice.

9.2 Scope

This section establishes the design criteria for the Connell Rail Interchange structures supporting railroad loading, including bridges, cut and cover structures, retaining walls, and miscellaneous structures.

Clearance requirements for the Connell Rail Interchange tracks to all adjacent structures above top of rail are discussed in Chapter 3 – "Clearances". The designer shall consider these requirements in the design of all structures.

9.3 Standards, Codes, and Guidelines

The latest edition of the following standards, codes and guidelines shall be used in the design of structures as set forth in this chapter. At the outset of the design of the structure, editions to be used for a design shall be identified.

- American Railway Engineering and Maintenance of Way Association (AREMA), "Manual of Railway Engineering," referred to in these criteria as "AREMA Manual"
- (For roadway and non-railroad supporting retaining walls only) Washington Department of Transportation (WSDOT): design sections, specifications and standard drawings, including all revisions, amendments and deletions, referred to in these criteria as "WSDOT Criteria"
  - Bridge Design Manual / BDM
  - WSDOT Standard Plans for Road, Bridge and Municipal Construction
  - WSDOT Standard Specifications for Road, Bridge and Municipal Construction
  - WSDOT Standard Bridge Standard Drawings
- American National Standards Institute (ANSI), "American Standard Building Code," referred to in these criteria as "ANSI Code"
- The code used by the local municipality where the structure is located, referred to in these criteria as the "local code"
- American Concrete Institute (ACI), "Building Code Requirements for Structural Concrete - ACI 318," including its commentary, referred to in these criteria as "ACI 318"
- Underwriters' Laboratories. Inc. (UL), "Testing for Public Safety, Building Materials List" referred to in these criteria as "UL List"

9.6 Deep Foundations

9.6.1 General

Deep foundations include driven and drilled piles and drilled piers, which are otherwise known as drilled shafts. A deep foundation should be used when a shallow foundation cannot be designed to carry the applied loads safely and economically. It should also be used where scour, erosion, or unacceptable settlement may occur, and the soil conditions permit its use, even though the bearing capacity of the soil is sufficient to make practical use of shallow foundations. Shallow, spread footing foundations should not be utilized on bridges supporting railroad track unless founded on solid bedrock.

In these criteria, the term "pile" is used only for members with a diameter less than 30 inches, where "diameter" is understood to mean the diameter of the smallest circle circumscribing the cross-section. A drilled, cast-in-place concrete member with a diameter of 24 inches or greater is referred to in these criteria as a drilled pier or drilled shaft.

The criteria in this subsection apply not only to the design of track support structures, but also to buildings and retaining structures.

9.6.2 Criteria for Driven and Drilled Piles – Railroad Bridges

Criteria for Driven Piles – Railroad Bridges

The design of driven and drilled piles shall be in accordance with the AREMA Manual, Chapter 8.

Criteria for Drilled Piers or Drilled Shafts – Railroad Bridges

The design of drilled piers or drilled shafts shall be in accordance with AREMA Chapter 8.

9.7 Earth Retaining Structures

9.7.1 General

This section establishes criteria for the design of abutments, wing walls, retaining walls and other earth retention structures that are required for the Connell Rail Interchange project.

Earth retention structures supporting railroad tracks shall be designed in accordance with criteria prescribed in the AREMA Manual Chapter 8.

Structures owned by local governments or other owners not supporting railroad tracks shall be designed in accordance with criteria specified by each owner, unless specific approval is obtained from the owner to use the criteria in this section.

9.7.2 Live Loads

Live loads consist of trains, street or highway traffic, and other loading conditions. Live loads from trains shall be applied as outlined in AREMA Chapter 8, or using the equivalent fluid pressure method to determine surcharge loading. Highway traffic live loading shall be applied in accordance with WSDOT criteria.

Live loads due to railroad trains shall be determined in accordance with the AREMA Manual Chapter 8 using Cooper's E-80 loading.

9.8.2 Features of Design

Bridges shall be designed in accordance with the AREMA Manual and these design criteria.

Clearances

The clearance between the bridge and privately owned or publicly owned streets, highways, railways, utility lines and other structures or property shall be in accordance with the requirements for state-owned highways and city streets, and as prescribed by the agencies involved, and as required in Section 3 of these standards.

Horizontal Alignment

Except where tracks diverge or converge, the edge of the bridge structure deck should be parallel to the layout line used for the structure.

9.8.3 Substructure

Bridge substructures supporting the tracks shall be designed in accordance with the AREMA Manual. As provided in AREMA Chapter 8, pier protection for bridges over the tracks shall be included when piers and abutments are within 25 feet of the railroad centerline.

9.9 Seismic Design

9.9.1 General

Bridge and earth retaining structures supporting track shall be designed according to the AREMA Manual Chapter 9 and this criteria.

9.10 Retaining Walls

Retaining walls supporting railroad loading or tracks shall be permanent cast-in-place concrete cantilever style or steel H-pile supporting precast concrete panels as lagging. Alternative design methods using equivalent fluid pressure are acceptable. Walls shall meet AREMA Manual design requirements.

9.11 Seismic Procedures

9.11.1 Criteria

Criteria is based on the following publications:

- 2015 AREMA Manual for Railway Engineering
- AASHTO LRFD Specifications for Highway Bridges , 7th Edition with 2015 interim revisions
- CALTRANS Memo to Designers 6-5 for Reinforced Concrete Pier Walls.
- ATC-32 Improved Seismic Design Criteria for Washington Bridges: Provisional Recommendations

9.11.2 Purpose

The purpose of this section is to provide a seismic design procedure for new railroad bridges in areas of high seismicity.

3. Using these factors, weighted return periods for each seismic event shall be calculated per AREMA 9-1.3.2.2.4. The Geotechnical Engineer shall provide peak ground accelerations based on the return periods derived using the AREMA Manual algorithm of Step 2. Alternatively, the Geotechnical Engineer shall provide peak ground accelerations for return periods of 100 years, 500 years and 2500 years and, using a log scale (similar to what's shown in AREMA Figure 9-1-1), and the Bridge Engineer can interpolate the design accelerations.

   In accordance with AREMA 9-1.4.4.3, the Seismic Response coefficient (Cm) shall be calculated for each of the two principal directions of the structure.

   The Low Period Reduced Response of the structure shall be considered to reduce the seismic design forces. The AREMA Manual, Section 9-1.4.4.4, addresses this issue.

4. Simple analysis using the Equivalent Lateral Force method shall be used in accordance with AREMA 9-1.4.5.3, unless Modal Analysis is deemed necessary. Lateral seismic loads should be applied at the top of the pier cap, not at the center of gravity of the superstructure, because the connections do not typically transfer the moment that would be generated by applying the load at the superstructure center of gravity.

   Railroad bridges are typically tangent structures so the two principal horizontal axes are oriented parallel to bridge centerline and normal to bridge centerline. In order to follow AREMA naming conventions, consider Principal Direction 1 as parallel to bridge centerline and Principal Direction 2 as normal to bridge centerline in the following text.

   In Principal Direction 2, loads shall be assumed to be distributed to the piers and abutments according to their tributary span length. Assuming the spans are pinned to the pier caps, 50% of the mass from each span shall be distributed to the corresponding pier and abutment.

   For longitudinal seismic loads, various span support conditions (pin, sliding) shall be investigated. For Principal Direction 1, pinned connections shall be assumed to support 100% of the superstructure mass. In the design of the pier/column bent that supports the sliding connection, 10% of the superstructure vertical dead load reaction shall be assumed (due to friction or other means of transferring inertial loads). Typically, the support configuration that distributes the longitudinal loads most uniformly to each substructure unit should be selected.

   It is assumed that Live load mass is "zero" in the seismic analysis.

5. Two load cases shall be investigated consistent with AREMA 9-1.4.5.3c:
   Load Case 1: Combine the forces in Principal Direction 1 with 30% of the forces from Principal Direction 2. This load case is labeled EQ1.

   Load Case 2: Combine the forces in Principal Direction 2 with 30% of the forces from Principal Direction 1. This load case is labeled EQ2.

6. Two load combinations shall be applied to the structure per AREMA 9-1.4.6. These are considered factored loads, i.e., load factor = 1.0:

   Load Combination 1: 1.0 * (D + E + B + EQ1) (9.2)

   Load Combination 2: 1.0 * (D + E + B + EQ2) (9.3)

Moment magnification for slenderness effects should also be considered in the design. The columns should also be analyzed with cracked section stiffness. This method results in longer periods, which lower the lateral forces and thus result in a smaller size of footings and foundations.

4. Cap beams shall be designed for the forces due to plastic hinging at the top of the columns.

9.11.8 Foundation Design

1. Piles, drilled shafts, and spread footings shall be designed in accordance with AREMA foundation guidelines. Typically, Load Combination 3 satisfies AREMA 8-3.4.2 for designing foundations for the lesser of 1.3 Mn or Level 3 seismic loads. These criteria is to ensure that the foundation can withstand the maximum anticipated load that the column can transfer to the footing.

2. Three Level 1 load combinations shall be considered:

   D + E + B + EQ1 (9.4)

   D + E + B + EQ2 (9.5)

   1.3 Mn (plastic capacity) for wall pier in the weak direction; 1.3 Mn (plastic capacity) for round and oval columns in each of the principal directions

3. Foundation (shaft, pile caps) and columns are designed such that plastic hinging develops in the column elements first (AREMA 9-1.4.7.3.1C), and the column or wall cannot transfer any more force than developed to the foundation. Typically the amount of transverse reinforcing (ties, spirals, crossties) used in the drilled shafts need not meet AREMA 8-2.11.2. The volumetric ratio equation is not applicable for shaft design and is not meant for reinforcing cover of more than 3 inches. It is recommended that ATC-32 Improved Seismic Design Criteria for Washington Bridges: Provisional Recommendations be reviewed for this condition. Typically, the maximum spacing requirement of AREMA 8-2.11.2.a(3) controls. Drilled shafts shall be reinforced their entire length.

   Due to soil conditions and varying construction methods drilled shaft concrete will be placed in wet condition. A reduced concrete design strength of 0.85 f'c shall be used.

9.11.9 Anchor Bolt Design

1. Anchor bolts shall be designed for the maximum lateral seismic shear from Level 1 loading:

   V = Cm x Weight of superstructure tributary to the seismic load, taking care to consider slotted holes in the sole plates for sliding and round holes for pinned connections

2. The anchor bolts shall be designed using a reduction factor R = 0.85, similar to what is used for connection design under AASHTO seismic design criteria. This takes into account that the bolts are not loaded simultaneously nor uniformly and to ensure that the Level 1 inertial loads can be transferred between superstructure and substructure. Hence, the design load requirement shall be for Vu = 1.0 * V / 0.85, with Phi = 0.75 for ultimate shear capacity.

10.0 Grade Crossings and Roadways

10.1 General

With the goal of improving the overall safety of rail system, the closure, consolidation, or grade separation of existing crossings is generally positive. The Connell Rail Interchange project does not anticipate adding additional or removing existing crossings. Modifications to existing crossings shall incorporate the recommendations of the affected agency(s) as well as the recommendations of the consultant(s) reviewing the project.

10.2 Regulations and Standards

10.2.1 Washington Utilities and Transportation Commission (WUTC)

The WUTChas regulatory authority over public grade crossings outside of Class 1 cities such as Yakima or Richland.

10.2.2 Standards and References

- American Railway Engineering and Maintenance of Way Association (AREMA) Manual for Railway Engineering
- Federal Railway Administration Regulations
- Portfolio of Trackwork Plans
- American Public Works Association (APWA)

  Standard Plans for Public Works Construction

  Standard Specifications for Public Works Construction
- American Association for State Highway Officials (AASHTO)

  A Policy on Geometric Design of Highways and Streets

  Roadside Design Guide
- Manual on Uniform Traffic Control Devices
- Hydraulic Engineering Circular No. 12 "Drainage of Highway Pavements," March
- Washington Department of Transportation (WSDOT)

  1.1 Standard Plans

  1.2 Standard Specifications

  1.3 Highway Design Manual

  1.4 Traffic Manual

  1.5 Uniform Sign Charts

  1.6 Storm Water Pollution Prevention Plan Handbook

  1.7 Manual on High and Low Risk Underground Facilities physically restricted areas make it impossible to obtain adequate queuing distance between the main track and a highway intersection, the following should be considered:

- Interconnection of the highway traffic signals with the grade crossing signals to enable vehicles to clear the grade crossing when a train approaches.
- Placement of a "Do Not Stop on Track" sign on the roadway approach to the grade crossing.

10.3.3 Vertical Alignment

The intersection of highway and railroad should be as level as practical for sight distance, smooth travel surface, braking, and acceleration distances. Vertical curves should be of sufficient length to ensure an adequate view of the crossing.

In some instances, the roadway vertical alignment may not meet acceptable geometrics for a given design speed because of restrictive topography or limitations of right-of-way. To prevent drivers of low-clearance vehicles from becoming caught on the tracks, the crossing surface shall be at the same plane as the top of the rails for a distance of 2 feet outside the rails. The surface of the highway shall also not be more than 3 inches higher or lower than the top of the nearest rail at a point 30 feet from the rail unless track superelevation makes a different level appropriate. Vertical curves should be used to traverse from the highway grade to a level plane at the elevation of the rails. Rails that are superelevated, or a roadway approach section that is not level, necessitates a site specific analysis for rail clearances.

10.3.4 Warning Devices

The geometric design of railroad-highway grade crossings should be made jointly with the regulatory agencies when determining the warning devices to be used. When only passive warning devices such as signs and pavement markings are used, the highway drivers are warned of the crossing location but must determine whether or not there are train movements for which they should stop. On the other hand, when active warning devices such as flashing light signals or automatic gates are used, the driver is given a positive indication of the presence or the approach of a train at the crossing. A large number of significant variables should be considered in determining the type of warning device to be installed at a railroad grade crossing. For certain low-volume highway crossings where adequate sight distance is not available, additional signage is needed.

Traffic control devices for railroad-highway grade crossings consist primarily of signs, pavement markings, flashing light signals, and automatic gates. Criteria for design, placement, installment, and operation of these devices are covered in the MUTCD, as well as the use of various passive warning devices. Some of the considerations for evaluating the need for active warning devices at a grade crossing include the type of highway, volume of vehicular traffic, volume of railroad traffic, maximum speed of the railroad trains, permissible speed of vehicular traffic, volume of pedestrian traffic, crash history, sight distance and geometrics of the crossing. The potential for complete elimination of grade crossings without active traffic control devices should be given primary consideration.

10.4 Basis of Roadway Design

10.4.1 General

The roadway geometrics derived in the preliminary engineering design phase should be used as a guide for final design. Roadway geometry should be evaluated utilizing

10.5 Drainage

Drainage improvements at crossings and on roads shall maintain current conditions as a minimum and, if possible, follow the local jurisdiction's requirements. Street surface or gutter runoff shall not be permitted to flow into the track structure. For drainage within the crossing, a sub-drainage system per BNSF Standards shall be provided. Adjacent right-of-way drainage should be collected by inlets and conveyed to storm drains in the street.

10.6 Traffic

The traffic design standards of the local roadway authority apply. In the absence of local standards, WSDOT standards shall be used.

10.6.1 Design Manuals, Standards, and Specifications

The following standards provide the basic general requirements for City of Connell related improvements. These standards are based on the WSDOT Highway Design Manual and Traffic Manuals. For improvements under the jurisdiction, ownership and maintenance of other local or state agencies, their respective standards, procedures and specifications apply, so long as they (a) are not inconsistent with any aspect of driver expectancy which could diminish safety or operational efficiency, (b) do not place the City of Connell or railroad in a position of increased liability, and (c) do not cost appreciably more than the equivalent City of Connell standard treatment.

Applicable standards for each element of each project or segment should be verified by the designer early on to prevent conflicts or late changes.

10.6.2 Traffic Signalization

Application and design of traffic signals, where installed or modified as a part of the project, shall be in accordance with requirements and philosophies set forth in Chapter 4 of the WSDOT Traffic Manual and the relevant local jurisdiction. Equipment, materials and installation processes shall be as specified in the latest editions of the WSDOT Standard Plans and WSDOT Standard Specifications.

10.6.3 Traffic Signing

Application of traffic regulatory, warning, and guide signs installed as a part of the project shall be in accordance with the requirements and philosophies set forth in Chapter 2 of the WSDOT Traffic Manual. Equipment, materials, and installation processes shall be as specified in the latest editions of the WSDOT Standard Plans and WSDOT Standard Specifications.

Placement of signs should be coordinated with actual site conditions to prevent masking or blocking of safety-sensitive signs.

10.6.4 Traffic Striping and Markings

Application of traffic striping, raised pavement markers, delineators, pavement legends, arrows and other markings installed as a part of the project shall be in accordance with the requirements and philosophies set forth in Chapter 3 of the WSDOT Traffic Manual. Where local jurisdictions have unique templates for arrows and/or other pavement design elements, and where such templates provide a design element which is deemed satisfactory, those design elements should be incorporated into the design and

11.0 Mapping, Survey and Right-of-Way

11.1 Surveying and Mapping

11.1.1 Horizontal Controls

All horizontal controls are based on Washington State Coordinate System, NAD '83/'91 in the appropriate zone.

The precision of any Secondary horizontal ground control surveys shall be at a minimum, 1:50,000, Second Order, Class I as defined by the Federal Geodetic Control Committee and published under the title, "Standards and Specifications for Geodetic Control Networks," authored by the Federal Geodetic Control Committee in September 1984.

All subsequent horizontal surveys shall, as a minimum, have a precision of 1:20,000, Second Order, Class II as defined by the Federal Geodetic Control Committee and published under the title "Standards and Specifications for Geodetic Control Networks," authored by the Federal Geodetic Control Committee in September 1984.

11.1.2 Vertical Controls

Vertical controls for this project are based on the NAVD88.

The precision of the vertical ground control and of supporting vertical ground surveys shall be at least Second Order, Class II, as defined by the Federal Geodetic Control Committee and published under the title "Standards and Specifications for Geodetic Control Networks," authored by the Federal Geodetic Control Committee in September 1984.

11.1.3 Surveys and Monumentation

Using field surveys, record information, and computations, the designer shall prepare individual plats of survey in accordance with requirements. The final plats shall comply with the recording requirements set forth by Franklin County. The railroads right-of-way envelope shall be as described by existing records of surveys for the pertinent portions of all tracts, subdivisions, U.S. lands, parcels and other areas which are affected by the envelope are similarly described. Coordinates and elevations further describing the right-of-way and existing property corners shall be shown on the plans. Coordinates shall be provided for all angle and curve points along the limits of the right-of-way.

Where construction disrupts or removes existing survey monuments which must be replaced following construction, the new monuments should carry the appropriate survey marker. Those that are not on BNSF property should carry City of Connell or Franklin County markings. All existing BNSF monuments should be replaced in kind.

Permanent survey monuments shall not be placed on, or within 10 feet of tracks because trackwork may disturb such monuments. Design and construction of all Connell Rail Interchange facilities should minimize impacts to the existing track or roadbed.

11.1.4 Line Segment, Milepost and Stationing Designation

Railroads define track locations by connecting mainline Division, Subdivision and Milepost locations, line segment, and survey stations.

For the Connell Rail Interchange project, the current track segment numbers assigned to each track will remain. Typically when a track branches off another track at a switch

Storm Drainage

Open ditches – The minimum total width for surface drainage easements is governed by local agency requirements, but in no case shall it be less than 6 feet for paved ditches and channels and 8 feet for unpaved ditches.

Underground drainage – Easement widths for underground drainage systems shall be approved by the local agency. As a guideline, the minimum easement width is 10 feet, with 2 feet minimum clearance from outside edge of structure to easement line.

Roadway Construction

In sidewalk sections, easements (construction or permanent) beyond ROW may be required due to grade difference, retaining walls, etc., between sidewalk and private property.

At intersections, additional ROW may be required behind the sidewalk for placement of signal poles and controller cabinets.

11.2.3 Right-of-Way Information Requirements

Property lines shall be shown on civil drawings that show new improvements, such as waterlines, storm sewers, sanitary sewers, electrical, communications, street and sidewalk and landscaping improvements. Property lines shall also be shown on drawings, as needed, to define responsibilities associated with use and maintenance.

Curve Data

Circular curves are the only types acceptable for recording purposes. Curve data should be shown on the right-of-way plan sheet in a table of curve data. Tangent sections may be used in lieu of curves to show the limits of the right-of-way when curves are extremely flat.

Continuous Right-of-Way

Although City of Connell may not require acquisition of public space, all plans shall show the right-of-way envelope as being continuous when crossing public as well as private space. Such private space should be identified.

Isolated Right-of-Way

The boundary for easement areas supporting all new construction, such as substations, stairs, and retaining walls, shall be defined geometrically with ties shown wherever the location is not contiguous to the right-of-way.

Vaults

1. Vaults affected by track construction shall be shown and their disposition noted. The vaults shall be labeled as follows:
    - Category "A" – vaults that must be removed during construction.
    - Category "B" – vaults that lie within the influence line of construction, but may not require removal.
2. The influence line generally should be considered to project outward on a 1:1 slope from the lowest point of excavation nearest the property line. Vaults not in Category "A", but within the influence line, could experience cracking and utility lines could be subject to rupture. The owner could be required to abandon use of such vaults during construction.

12.0 Railroad Signals

12.1 Scope

This Chapter establishes the criteria for the highway crossing signal systems. The design of all highway grade crossing warning signal systems shall insure safe and efficient operation.

12.2 Regulations and Codes

The following parts of the Code of Federal Regulations, Title 49, Transportation, apply:

A. Part 234 Grade Crossing Signal System Safety

B. Part 236 Rules, Standards, and Instructions Governing the Installation, Inspection, Maintenance, and Repair of Signal and Train Control Systems, Devices, and Appliances

The Contractor is responsible for adherence to all of the above Federal Railroad Administration (FRA) rules.

Highway grade crossing warning devices shall conform to the requirements of the Washington Manual of Uniform Traffic Control Devices and all Washington Department of Transportation rules and regulations.

All electrical equipment, unless specifically excluded herein, shall conform to the standards of the National Electrical Manufacturers Association (NEMA), the Underwriters' Laboratories, Inc. (UL), the Electrical Testing Laboratories (ETL), the National Electrical Testing Association, Inc. (NETA), or the Electronic Industries Association (EIA), wherever applicable. Unless specifically excluded herein, all materials and designs shall conform to the requirements of the National Electrical Code (NEC), Standards of the American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), and any applicable local ordinances.

Wherever reference is made to any of the standards mentioned previously, the reference shall be interpreted as the code, order, or standard in effect on the day the Notice to Proceed with Work is dated.

12.3 Standards and Recommended Practices

All signal designs shall conform to the standards and recommended practices in the General Code of Operating Rules.

In addition to the regulations and code requirements specified, materials and equipment for signal systems shall conform to the latest standards and recommended practices of the Association of American Railroads (AAR) and the American Railway Engineering and Maintenance of Way Association (AREMA).

All designs shall adhere to equipment manufacturer's application guidelines.

12.4 Standard Typical Drawings and Software

All drawings should use railroad-provided standard typical drawings, typical circuits, and typical symbol libraries as much as practicable. All drawings shall be done in AUTOCAD® format.

All microprocessor-based interlocking logic should use railroad-provided standard typical application software as much as practicable

2. Relays (vital or safety type as defined by AAR). Open or shorted coil, or high contact resistance.
3. Transformers. Open or shorted primary or secondary turns, primary to secondary shorts, or combinations thereof.
4. Capacitors. Shorted, open, or leakage.
5. Resistors. Increase or decrease in resistance.
6. Transistors. Shorted, open, leakage, or loss of gain (beta).
7. Diodes. Shorted, open, or reverse leakage.
8. Coils. Open or shorted turns.
9. Power Sources. Loss or degradation of power supply.
10. Noise. Abnormal electronic signal or noise levels, frequencies, or delays.
11. Interference. Effects of electromagnetic interference.
12. Electrical Inputs. Absence of or abnormal electrical input signals
13. Internal Circuitry. Open or shorted circuits on circuit traces, in internal equipment wiring, at inputs, or at outputs
14. Mechanical Vibration or Shock. Sensitivity of electronic components to mechanical forces
15. Drift. Potential instability of amplifiers, receivers, transmitters, oscillators, switching circuits, and power supplies under varying ambient operating conditions
16. Deterioration. Aging and exposure to elements of contacts, connectors, terminals, solder connections, printed circuits, circuit adjusting devices, and mechanical devices

Fail-safe equipment proposed for vital signal applications shall be of a type approved by BNSF for the purpose intended.

12.6 Highway Crossing Signal System Specifications

12.6.1 General

FRA regulations Part 234 apply to the project.

12.6.2 Battery Capacity

The power supply storage cell capacity shall be sufficient to provide a minimum of 72 hours standby capacity and 12 hours of continuous operation of gates and flashers.

12.6.3 Special Circuits

Highway crossing equipment should not utilize any special circuits or accessories to provide quick acceleration detection.

12.6.4 Traffic Preemption

Preemption operation at highway-rail at-grade crossings located adjacent to signalized highway intersections shall be coordinated with the highway agency that has jurisdiction. The HD should not require traffic preemption.

13.0Appendices

APPENDIX A

DEVIATION REQUEST FORM

APPENDIX B

Definition of types of ROW

The following is a simplified reference list of the types of property interests that could be encountered in the design of various rail improvements within the BPIC HD project limits. Actual legal descriptions and applicable property laws take precedence over these summarized descriptions.

Fee Simple

Full ownership of property extends radially from the center of the earth outward through specified lateral limits on the surface of the earth to the sky. Fee ownership should be considered first for all rail facilities.

Easements granted to City of Connell or Railroad

A non-possessing interest held by one party in land or another whereby the first party is accorded partial use of such land for a specific purpose.

Permanent Surface Easement

An easement that provides space for the rail facility when it is not practical or advisable to acquire a fee interest. This easement shall have the same parameters as fee ownership. Upper limits shall be described only where passing under an existing structure.

Franchise or Right-of-Use Agreement

An easement that provides space for the rail facility through a public street or other right-of-way.

Rail-only Easement

An easement that provides space for the rail facility for rail purposes only or rail support activities such as structures, layover yards, equipment storage.

Temporary Construction Easement

An easement, temporary in nature but with a definite duration that provides sufficient space to allow for the use of property by the contractor during construction.

Utility Easements

An easement that encompasses utility facilities that will be controlled by outside agencies. This easement is permanent in nature and shall be in accordance with local and utility regulations.

Easements granted by BNSF

Operating Easements (Trackage Rights)

BNSF may grant a railroad the nonexclusive right to utilize certain trackage for the sole and exclusive purposes of moving trains, equipment and power of that railroad.

Grade Crossing Easements

An easement granted by BNSF to an outside agency or private entity for public or private road crossing.