Chapter 16
RAILROAD & PREEMPTION PLAN

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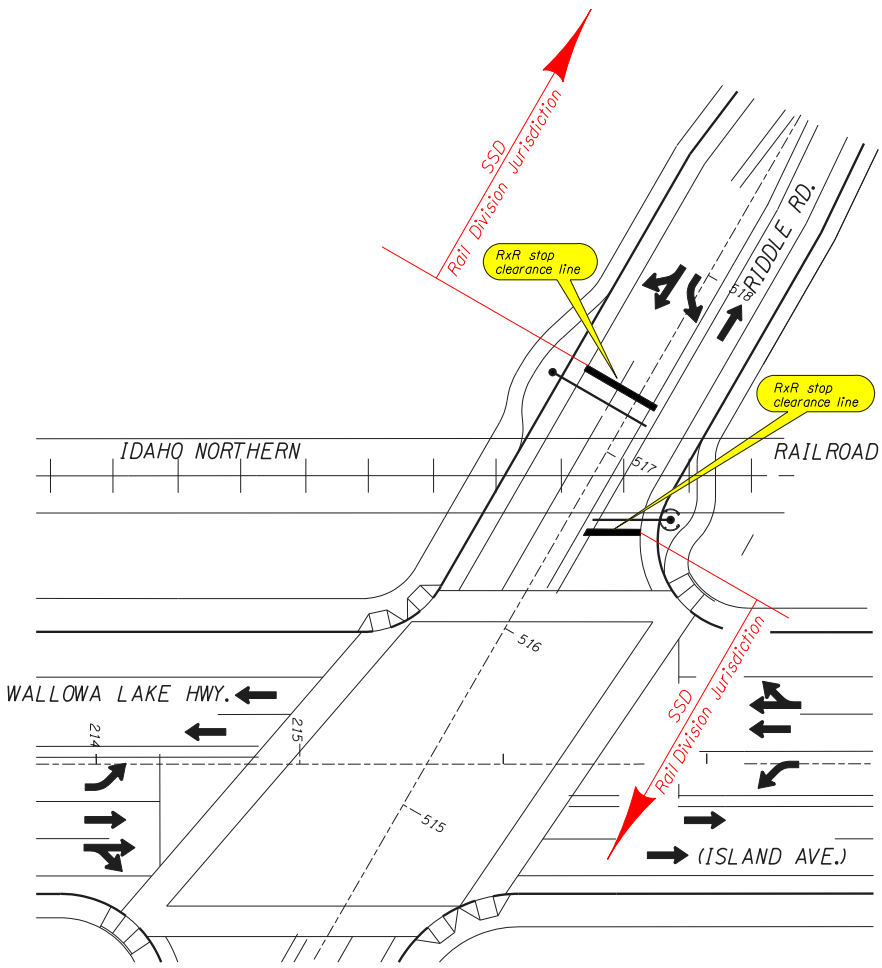
16 RAILROAD & PREEMPTION PLAN

ODOT Rail Division's jurisdiction for the regulation of railroad-highway grade crossings extends a distance equal to the safe stopping distance (SSD), for the posted or statutory speed, measured back from the location of the stop clearance line at the railroad crossing (OAR 741-100-0005).

Figure 16-1 | SSD at Railroad At-Grade Crossings and Signalized Intersections



SSD Requirements*	
Speed (MPH)	SSD (Feet)
15	80
20	115
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645

*When in doubt, contact ODOT Rail Division when a railroad crossing is located within **500 feet** of a traffic signal

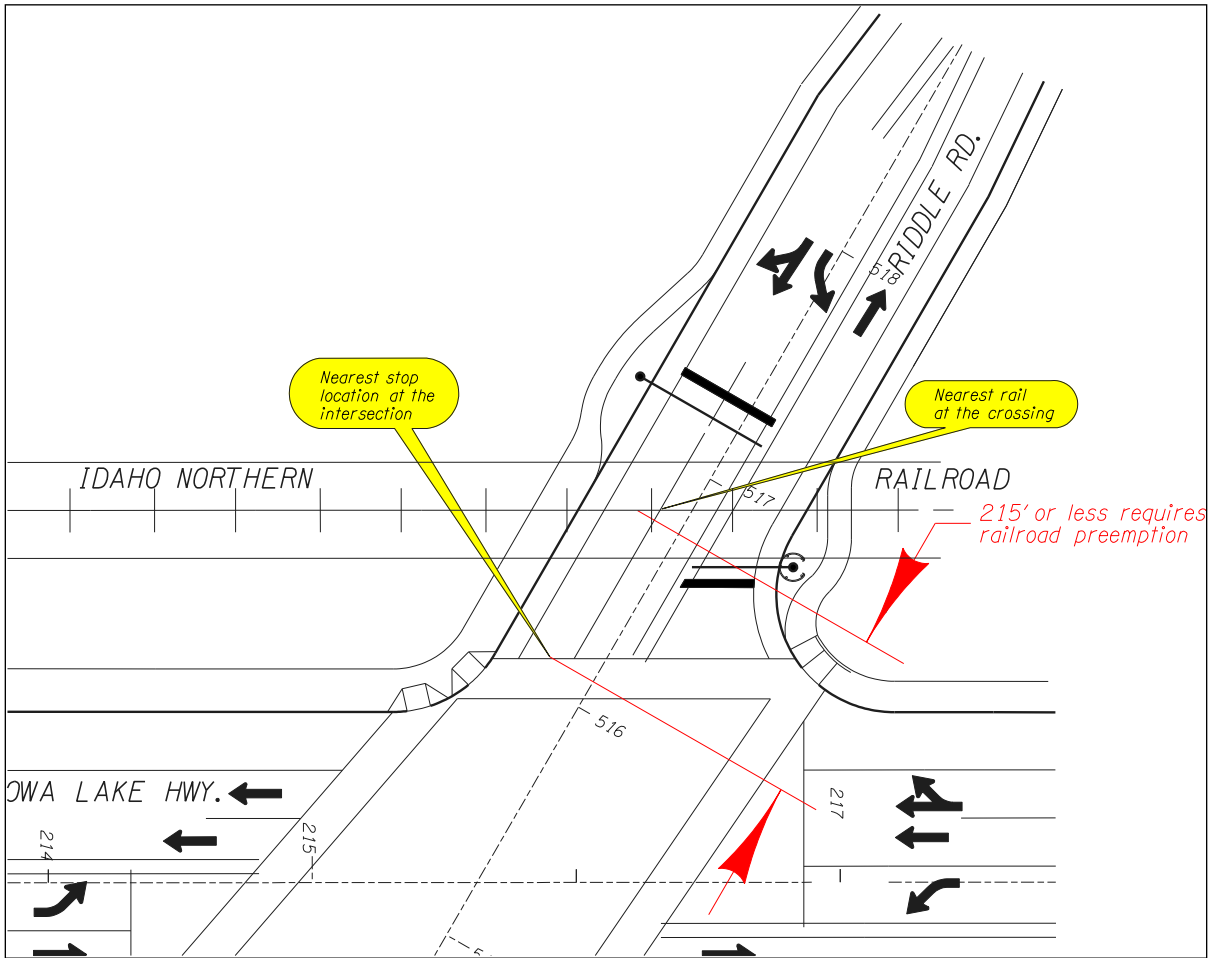
Because Rail Division has jurisdiction within the SSD from the stop clearance line, it is important to include them in the scoping project development so that there is enough time to obtain a Rail Crossing Order if needed. It is also important to include the Rail Division Manager in the scoping as they will be developing an agreement with the Railroad Company (*Right of Way Manual*, Chapter 10).

NOTE: Failure to coordinate with ODOT Rail Division can result in excessive delays to your project schedule!

16.1 When is Railroad Preemption Needed?

Railroad preemption is required if a traffic signal has an approach located within 215 feet of a railroad crossing (*ODOT Traffic Signal Policy and Guidelines*). Depending on the site-specific circumstances, railroad preemption may be desirable or required for an approach located further than 215 feet from a railroad crossing. This will be determined by the Field Diagnostic Review. Rail Division also stores this information in its Rail Crossing Safety System database.

Figure 16-2 | Railroad Preemption Distances



16.2 Field Diagnostic Review

The Field Diagnostic Review is part of the requirements found in 23 CFR Part 646 – Railroads, part 646.214 – Design. This will occur early in the design process (Project Scoping or prior to DAP plans), and is coordinated by the Rail Division. The review will typically include the following members:

- Project Team Leader
- Rail Division representative
- Railroad Company representative
- Region Traffic Signal Operations representative
- Construction representative
- Designers (signal, roadway, and others as needed)

The field diagnostic review team will meet on-site to determine the required safety upgrades to the railroad crossing. The findings from the field diagnostic review will be the starting point for:

- Identifying design constraints and work to be done;
- Completing the Railroad-Highway Public Crossing Safety Application (which is required to obtain the Rail Crossing Order from Rail Division); and
- Obtaining any Region and/or State Traffic Roadway Engineer approvals.

16.3 Rail Crossing Order

Each public railroad crossing is required to have a Rail Crossing Order. Rail Crossing Orders are issued by the Rail Division and authorize the alterations to the grade crossing. Private crossings are not regulated by the Rail Division and therefore do not require a Rail Crossing Order. The majority of projects involving railroad crossings will require a Rail Crossing Order to alter the subject grade crossing. New at-grade crossings are rarely approved by Rail Division because state law directs ODOT to eliminate railroad crossings at-grade, wherever possible. Grade separated railroad crossings are strongly preferred by the railroads and ODOT.

Rail Crossing Orders contain specific requirements related to the installation, operation and maintenance of the traffic control devices, roadway geometry and roadway features. The Rail Crossing Order must be completed prior to PS&E. In order to obtain a Rail Crossing Order, a Railroad-Highway Public Crossing Safety Application must be completed and submitted to Rail Division. This application is typically done by the project team leader or designer, with assistance from the Rail Division.

Existing Rail Crossing Orders can be accessed at the following websites, or by contacting the Rail Division:

Internet site: https://ecm.odot.state.or.us/cf/railsearch/

IntrAnet site: https://ecmintra.odot.state.or.us/cf/railsearch/

NOTE: Failure to comply with the Rail Crossing Order is AGAINST THE LAW.

16.4 Railroad Utility Permits

If any signal equipment crosses over or under the railroad right-of-way, the railroad requires a utility permit. This permit is separate from other construction permits that the contractor must obtain as per standard specification 00170.02 and the Rail Crossing Order. It should be obtained as early as possible in the design phase (prior to PS&E) to avoid unnecessary delays during design and construction. Follow all design requirements stated in the permit.

Typical signal work that triggers the need for this permit includes conduits for detection, traffic signal interconnection and/or railroad interconnection. The signal designer should contact the State Utility and Railroad Liaison for assistance in obtaining this permit.

Contact: State Utility and Railroad Liaison
Heather Howe
503-986-3658
Heather.C.HOWE@odot.state.or.us

16.5 Railroad Preemption Operation

ODOT's standard for railroad preemption is comprised of the following sequence:

1. Pedestrian Clear-Out Interval (PCOI)
2. Vehicle Clear-Out Interval (VCOI)
3. Return to Normal Operation

The rail diagnostic team determines the type of preemption operation and necessary traffic control devices to accommodate the desired operation. The road authority may submit an engineering study to the State Traffic Engineer to request a deviation from the standards. The State Traffic Engineer in consultation with the ODOT Rail Crossing Safety Manager may authorize a signaled intersection operation consistent with the findings of the study.

16.5.1 Pedestrian Clear-Out Interval (PCOI) – Advance Preemption

This value is shown on the Railroad Preemption Plan sheet and is provided by the Region Traffic Operations Engineer.

The P.C.O.I. is used to give pedestrians time to finish crossing a crosswalk prior to the vehicle clear-out interval. Without the P.C.O.I. pedestrians may get stranded in the crosswalk when the vehicle clear-out interval sequence starts. This is because the traffic signal controller will immediately truncate the WALK or flashing DON'T WALK interval upon receiving the input go into the vehicle clear-out sequence.

The operation of a P.C.O.I requires train detection provided by the railroad to activate an "advance preemption railroad input". The advance preemption railroad input

initiates the "pedestrian inhibit" traffic signal software feature which starts the following operation:

1. No change to vehicle phase sequence
2. All active pedestrian phase WALK intervals immediately advance to and complete the flashing DON'T WALK interval
3. All pedestrian phase calls are inhibited from being serviced
4. PTR signs remain off
5. Rail crossing equipment (flashing lights, audible devices and gates) remain off and up.

The road authority calculates and supplies the railroad company with the P.C.O.I. value based the guidance given in the "ODOT Railroad Preemption Design and Operations" document. This value is placed in the railroad controller by railroad employees.

16.5.2 Pedestrian Clear-Out Interval (PCOI) – Advance Preemption Used to Move Vehicles

The P.C.O.I. may also be used to clear vehicles queued between the intersection and the tracks (like the V.C.O.I operation described in the following section) and help provide a free-flow condition for the V.C.O.I phases prior to the simultaneous preemption IF NO PEDESTRIAN CALLS ARE ACTIVE. The need for this type of operation will be determined by the diagnostic team. If this operation is used, the appropriate traffic signal railroad preemption sequence text used on the railroad preemption plan sheet can be found in the ODOT workspace under "Rail Matrix Advanced".

16.5.3 Vehicle Clear-Out Interval (VCOI) – Simultaneous Preemption

This value is NOT shown on the Railroad Preemption Plan sheet, but the vehicle clear-out phases and the limited service vehicle phases are listed on the Railroad Preemption Plan Sheet.

The V.C.O.I. is used to give vehicles on the road approach crossing the railroad track (stopped between the railroad tracks and intersection) time to advance through the intersection and away from the railroad crossing. This accomplished by providing green signal indications to the signal phase that crosses the track (commonly called "green clear-out"). In the past, a flashing yellow indication was used for the V.C.O.I. (commonly called "yellow clear-out"), but this practice was ended in the late 1990's because it tended to result in driver confusion.

The V.C.O.I. requires train detection equipment that will provide a "simultaneous preemption railroad input" to activate the rail crossing equipment and the V.C.O.I signal operation sequence. The simultaneous preemption railroad input follows the advance preemption railroad input (and operation sequence of the P.C.O.I.) and initiates the

"railroad preemption" traffic signal software feature which starts the following operation at the traffic signal:

1. PTR signs turn on
2. Rail crossing equipment (flashing lights and audible devices) activate. After a three to six second delay, the railroad automatic gates start to descend. The total time from activation of the flashing lights to when the gates are horizontal may be 10 to 15 seconds.
3. All active pedestrian phase flashing DON'T WALK intervals immediately advance to solid DON'T WALK.
4. Any active vehicle clear out phase displaying GREEN remains GREEN and all non-vehicle clear out phases displaying GREEN immediately terminate by advancing through their YELLOW and RED clearance intervals.
5. Once all vehicle clear out phases display GREEN simultaneously, the signal controller programmed V.C.O.I. is timed followed by the vehicle clear out phases advancing through their YELLOW and RED clearance intervals.
6. All programmed Limited Service vehicle phases and their associated pedestrian phase are serviced in their normal sequence based on demand. Limited Service vehicle phases consist of any phase that does not conflict with crossing the track.

The road authority calculates the V.C.O.I. value based on the guidance given in the "ODOT Railroad Preemption Design and Operations" document. This value is placed in the signal controller.

A V.C.O.I. is not always required. If the diagnostic team determines that vehicles should stop prior to the track under normal signal operation (typically because the distance between the intersection and the track is less than the length of a passenger vehicle) the V.C.O.I. is usually not needed (no vehicles to clear-out between the intersection and the track). This type of operation typically includes a post mounted "STOP HERE ON RED" sign at the railroad stop line, with a "NO TURN ON RED" sign mounted on signal pole or mast arm.

Figure 16-3 | V.C.O.I. is Not Required, Example 1

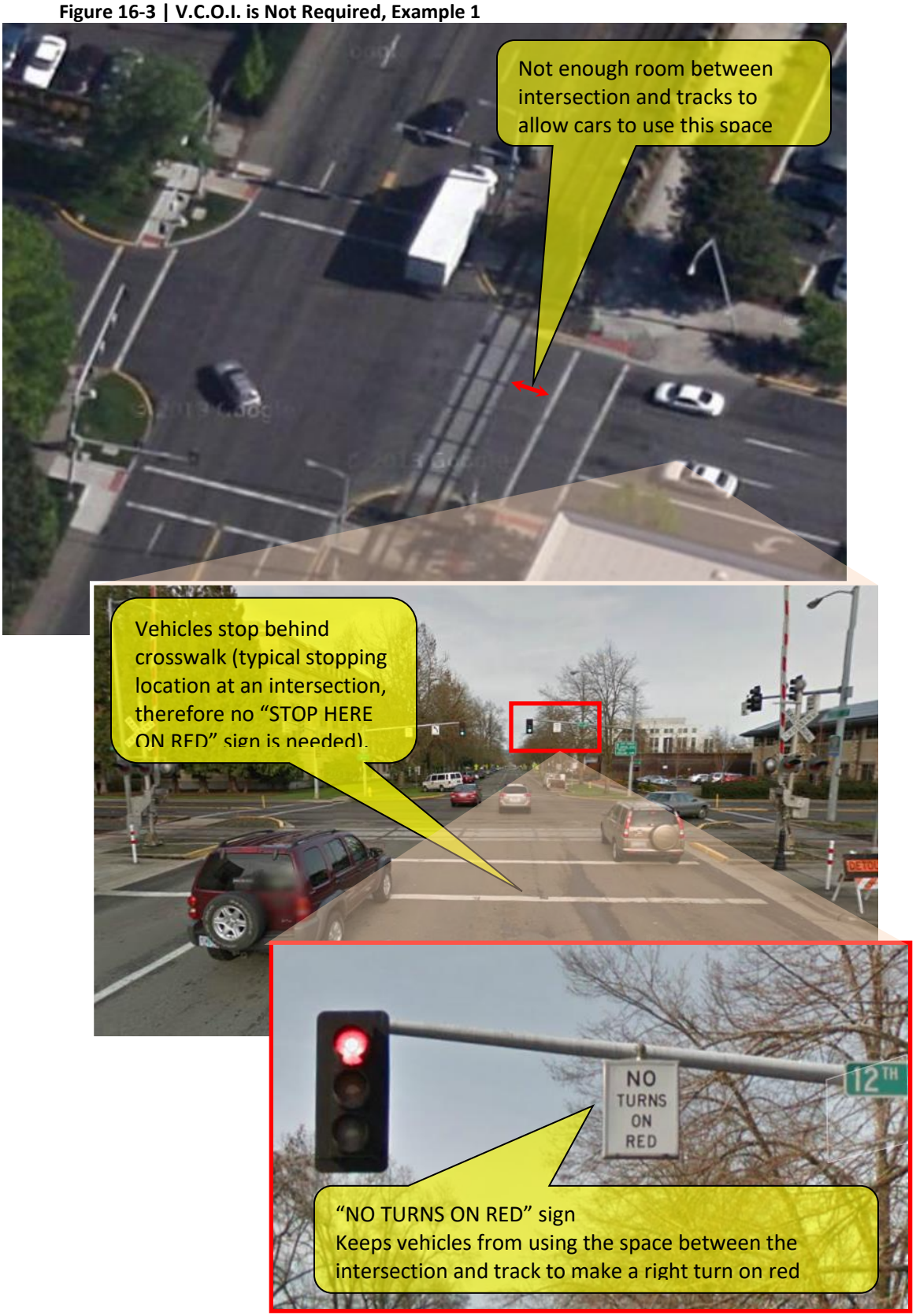
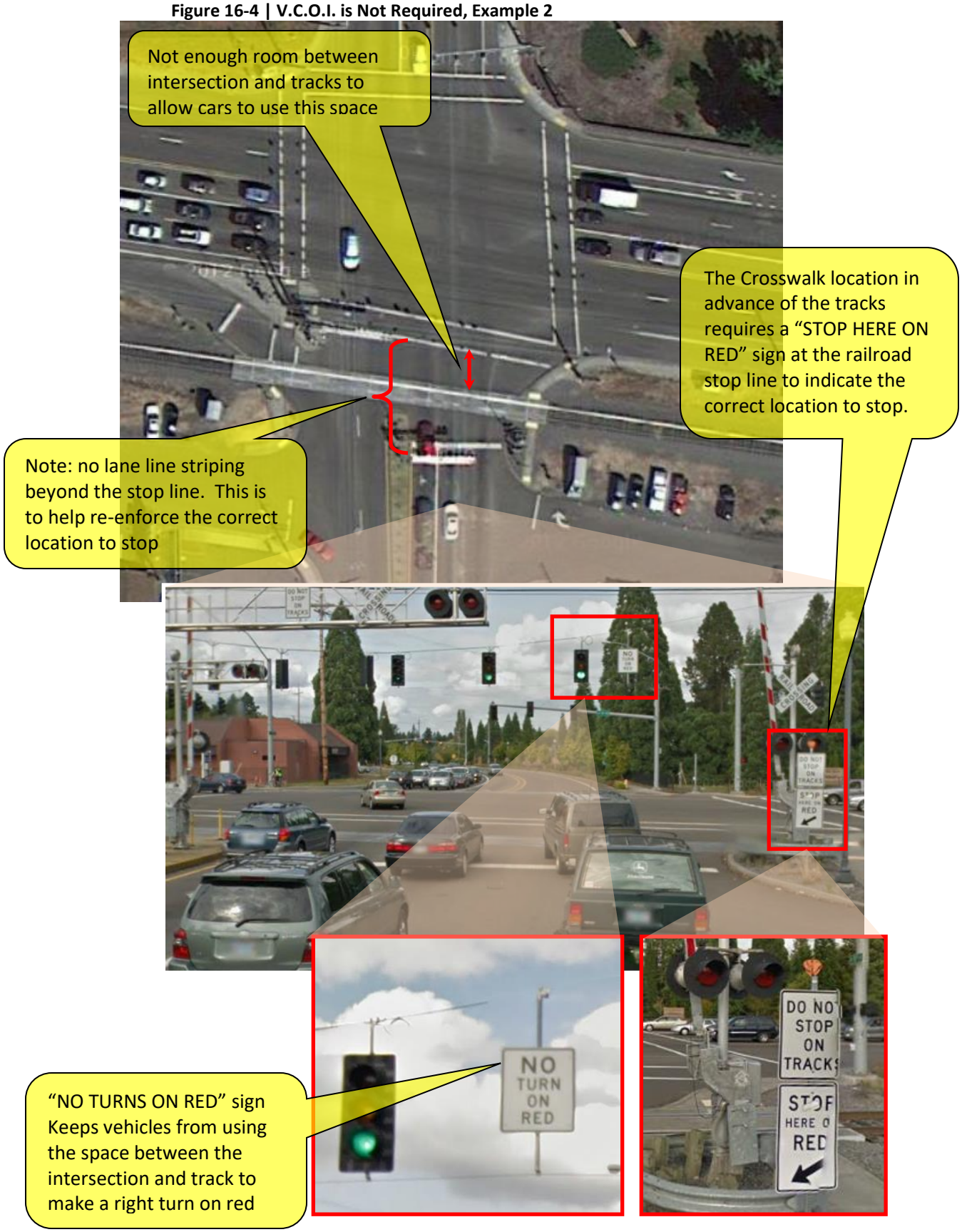


Figure 16-4 | V.C.O.I. is Not Required, Example 2



16.5.4 Return to Normal Operation

After the railroad preemption inputs return to non-preempt status, normal operation of the signal phasing resumes, the PTR sign turns off, the rail signal equipment turns off and gates go up.

16.6 Required Plan Sheets

On a project with railroad preemption, there will be coordination between the Rail Company, the Road Authority and the Rail Division for determining who is responsible for installation, maintenance, and costs of the required traffic control devices. Depending on the scope of the project and the requirements in the Rail Crossing Order, some or all of the plan sheets will be required:

1. Signal Plan Sheet
2. Railroad Preemption Plan Sheet
3. Other Plan Sheets (disciplines outside of signal design, such as Roadway, Striping and Signing)

Refer to the following sections for more in depth information.

16.7 Signal Plan Sheet

The signal plans will need to detail all work that the contractor will be responsible for. DO NOT detail work that the contractor is NOT responsible for.

Listed below is signal equipment that is specific to railroad preemption design and should be detailed on the signal plan sheet:

- Conduit and Wiring from the traffic signal cabinet to the railroad cabinet
- Signs mounted to the signal poles/mast arm/span wires
    - PTR signs
    - NO TURN ON RED signs
- Type 7 signal head

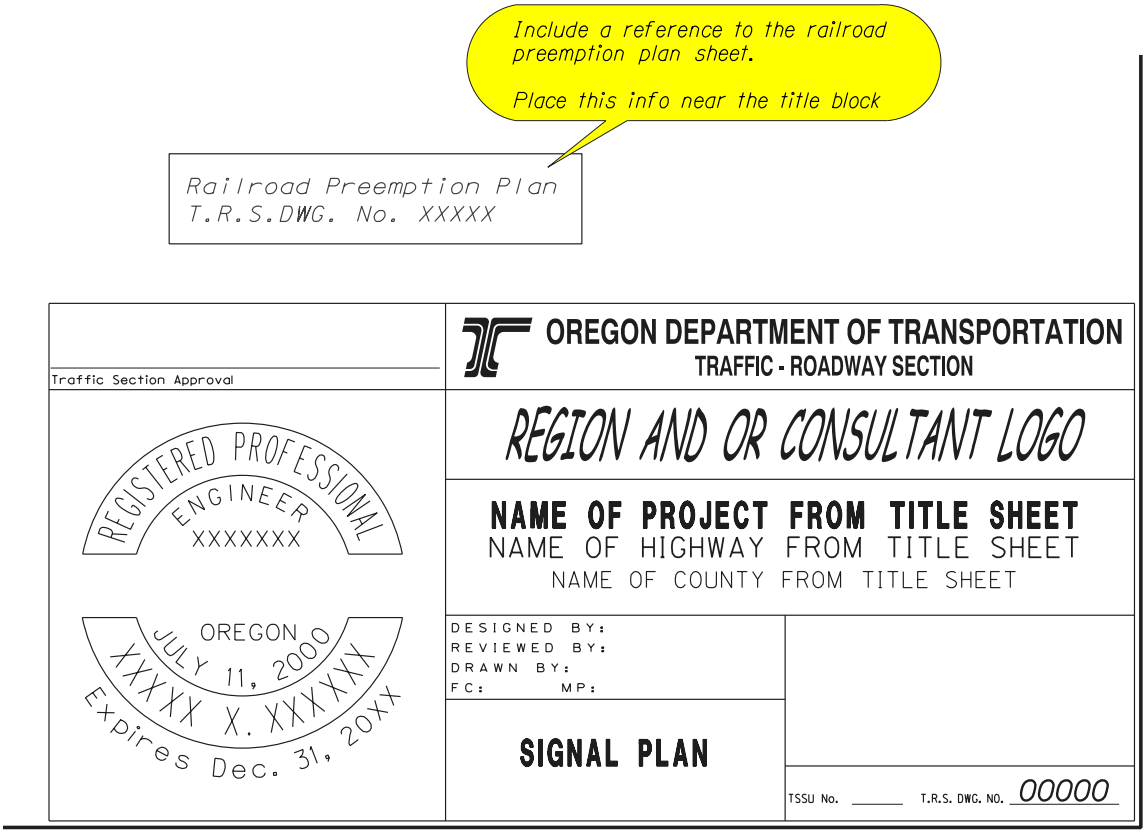
Refer to the following sections for more in depth information on railroad preemption design elements.

16.7.1 Signal Plan Sheet

Notes

The signal plan sheet should contain a note that references the railroad preemption plan sheet. See Figure 16-5.

Figure 16-5 | Plan Sheet Notes

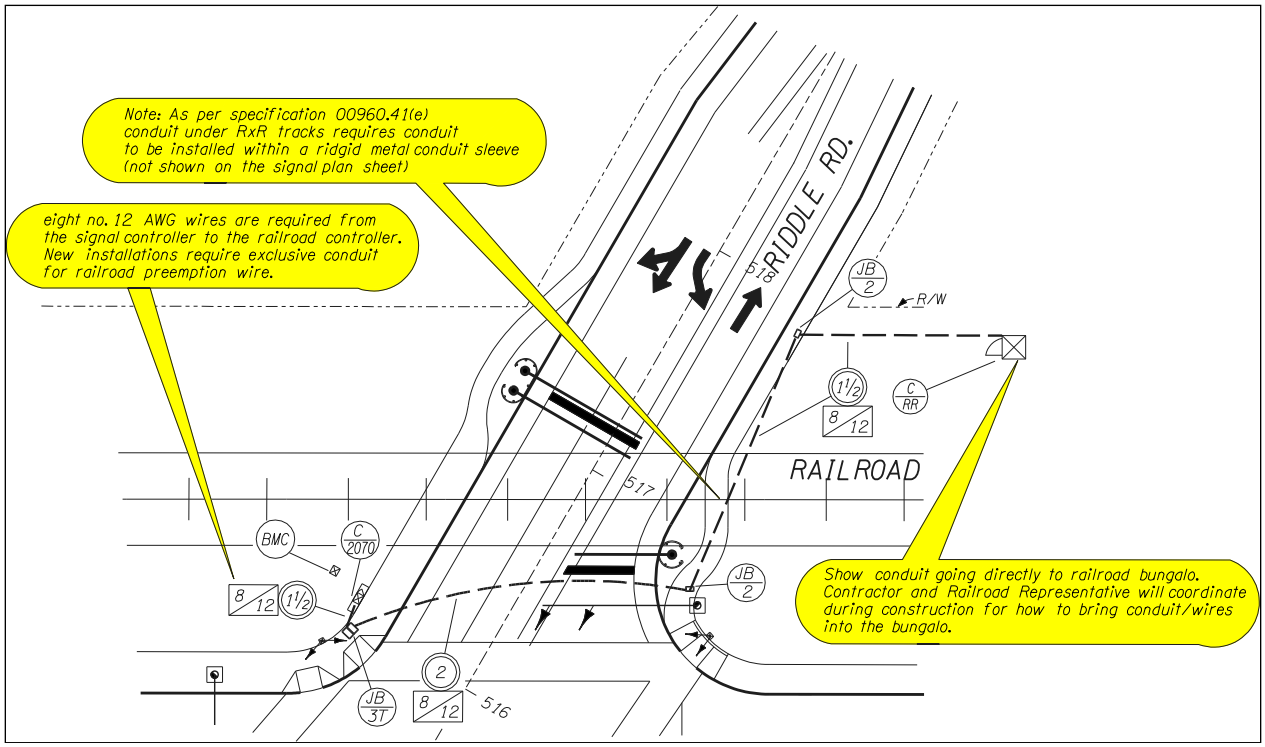


Conduit and Wiring

The railroad preemption operation is triggered by the railroad controller that monitors the railroad tracks and detects an approaching train. These preemption impulses are sent to the signal controller cabinet via wiring from the railroad control cabinet.

The conduit and wiring required to connect the ODOT controller to the railroad controller, providing the ability for railroad preemption, is shown on the signal plan sheet. This wiring consists of eight No. 12 AWG THWN wires or one 10 conductor 12 AWG gauge control cable (as per Region Electrical Crew preference) from the controller cabinet to the railroad cabinet. An exclusive conduit for this wire should be used for new construction. Figure 16-6 shows an example of how this should be detailed on the signal plan sheet.

Figure 16-6 | Railroad Preemption Wiring Example



Signs

Part-time restriction signs may be required at the traffic signal based on the field diagnostic review. These signs typically state a turn restriction, such as “NO LEFT TURN” or “NO RIGHT TURN” during the railroad preemption and are mounted on the signal mast arm. If needed, these signs will be shown on the signal plan sheet.

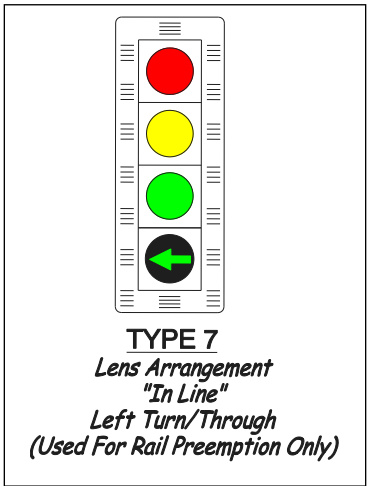
Other static signs such as STOP HERE ON RED, NO TURN ON RED, DO NOT STOP ON TRACKS signs, etc. may be required traffic control devices. If these signs are ground mounted, they should be detailed in a sign plan sheet (not in the signal plan sheet). If these signs are mounted on the signal, they should be detailed in the signal plan sheet.

Figure 16-7 | Part-Time Restriction Sign Example

Type 7 Signal Head

A Type 7 Signal head is required for the vehicle clear-out phase when the vehicle clear-out phase contains a permissive only left turn movement. This allows use of a GREEN arrow only during the Vehicle Clear-Out Interval (V.C.O.I) so that vehicles will be aware they have a protected left turn movement during the railroad preemption sequence. In the past when GREEN balls were used during the V.C.O.I., motorists would often hesitate when making a left turn as they weren’t sure if/why the opposing through traffic was stopping.

Figure 16-8 | Type 7 Signal Head



Pedestrian Features

When upgrading existing traffic signals that have railroad preemption, the P.C.O.I. time will need to be recalculated using the 2009 MUTCD guidelines. The recalculated P.C.O.I. will likely result in a longer P.C.O.I., which requires a Rail Crossing Order for the alteration of the rail detection equipment. If funding is available and the project time line allows, a Rail Crossing Order and alteration of the rail detection equipment should be completed.

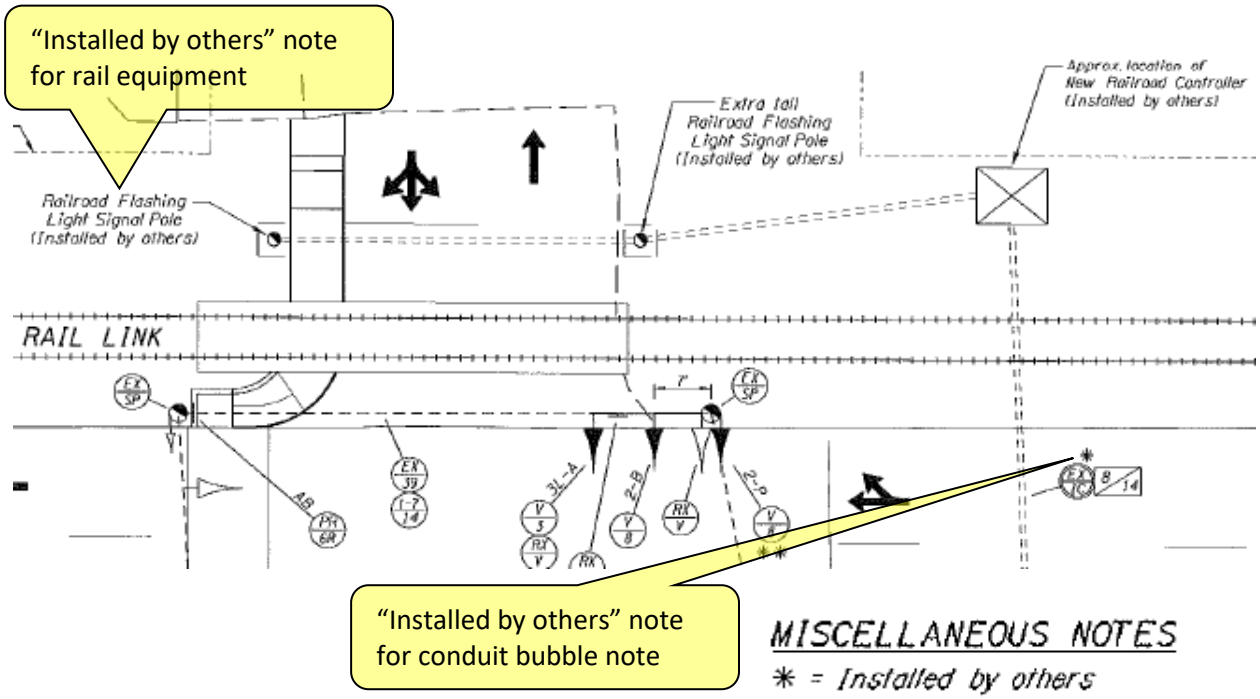
In situations where the recalculated P.C.O.I. is longer than the existing P.C.O.I. and funding is not available or there is not enough time to process a Rail Crossing Order, the use of two pedestrian change intervals may be used. See Chapter 5 "Extended Pushbutton Press Feature" section for more information.

16.8 Other Work – Railroad Grade Crossing System

The railroad company is typically responsible for installing the grade crossing system, including train detection equipment on the rails, gate arms, railroad flashing beacon assemblies, and the railroad cabinet. This work is paid for through Railroad Agreements and typically not shown in ODOT contract plans. The Project Manager's Office will coordinate with the contractor and the Railroad Company to install these items.

The grade crossing system may be symbolically shown, but not detailed, on the signal plan sheets. If needed, these features may also be noted as "installed by others" to clarify which features the contractor is NOT responsible for. See Figure 16-9.

Figure 16-9 | Railroad Equipment Installed by Others



Other disciplines will be responsible for detailing work that may need to be completed as per the Rail Crossing Order.

Roadway plans will detail the following:

- The location of the crossing signal equipment, foundations, railroad signal house.
- The quantity of new crossing surfacing materials
- Sidewalk work to be constructed up to the crossing surface

Sign plans will detail ground mounted signs required by the Rail Crossing Order.

Striping plans will detail the pavement markings required by the Rail Crossing Order.

16.8.1 Railroad Preemption Plan Sheet

Rail Division requires a separate, sealed railroad preemption plan sheet to be included with the Railroad-Highway Public Crossing Safety Application. This plan sheet contains the operational requirements of the preemption. In the past, this plan sheet was included in the contract plans, but is now contained solely within the Rail Crossing Order (as it doesn't include any information pertinent to the contractor's work).

NOTE: The rail diagnostic team determines the type of preemption operation and necessary traffic control devices to accommodate the desired operation. The railroad preemption plan sheet is part of the operational documentation required for the Rail Crossing Order.

The railroad preemption plan sheet will be completed early on in the project, DAP or preliminary plans, prior to completion of the other signal plan sheets for the project. Therefore, the Traffic-Roadway Section will issue a T.R.S. Drwg. No. for ONLY the railroad preemption plan sheet at this time.

The rail preemption plan sheet shall be reviewed by Region Traffic, ODOT Rail Division, and the Traffic Signal Standards Unit.

The final signed and stamped rail preemption plan sheet mylar should be sent to the Traffic Signal Standards Unit for approval. The Traffic Signal Standards Unit will then submit an electronic copy of the approved plan sheet to the ODOT Rail Division for use in the Rail Crossing Order and archive the mylar.

NOTE: The Railroad Preemption Plan Sheet is NOT part of the contract plan set!

Figure 16-10, Figure 16-11, and Figure 16-12 show examples of railroad preemption plan sheets. Each example highlights a few common scenarios:

- Figure 16-10 shows a standard 8 phase signal operation, with a P.C.O.I, V.C.O.I and PTR sign. Note the very simplified plan view that is drafted from an old as-built or from google maps, which is acceptable if a surveyed base map is not available.

- Figure 16-11 shows a 6 phase signal operation with mainline flashing yellow arrow, a PCOI, VCOI, and PTR sign. Note the Type 7 signal head and the FYA; how they are labeled on the plan view and described in the preemption text.

- Figure 16-12 shows a 6 phase signal operation, a P.C.O.I, NO V.C.O.I, and PTR sign. Note the changes shown when a V.C.O.I is not used; how it is described in the preemption text and labeling of additional signs that are critical when omitting the V.C.O.I (i.e. NO TURN ON RED and STOP HERE ON RED).

Figure 16-10 | Sample Railroad Preemption Plan, Example 1

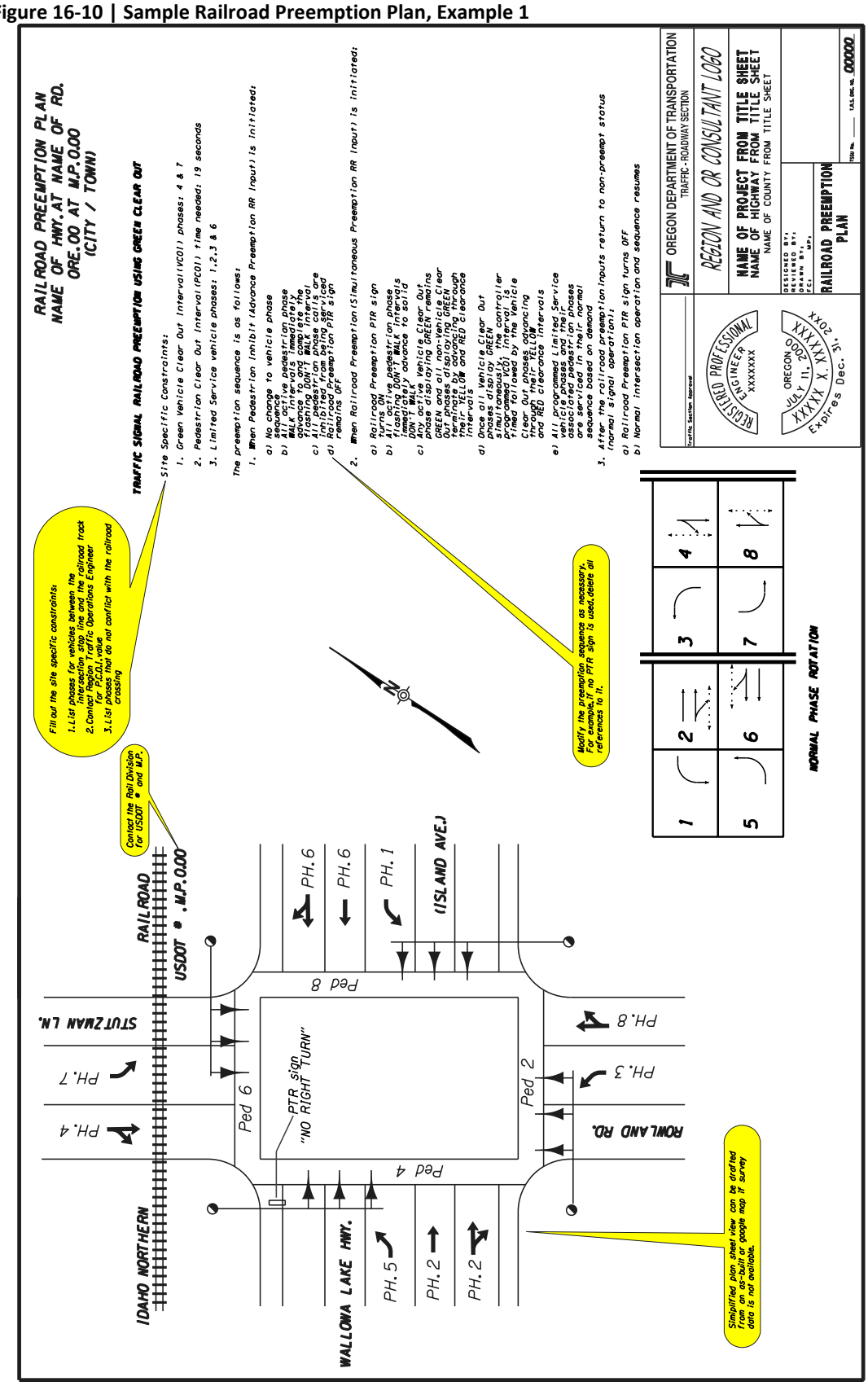


Figure 16-11 | Sample Railroad Preemption Plan, Example 2

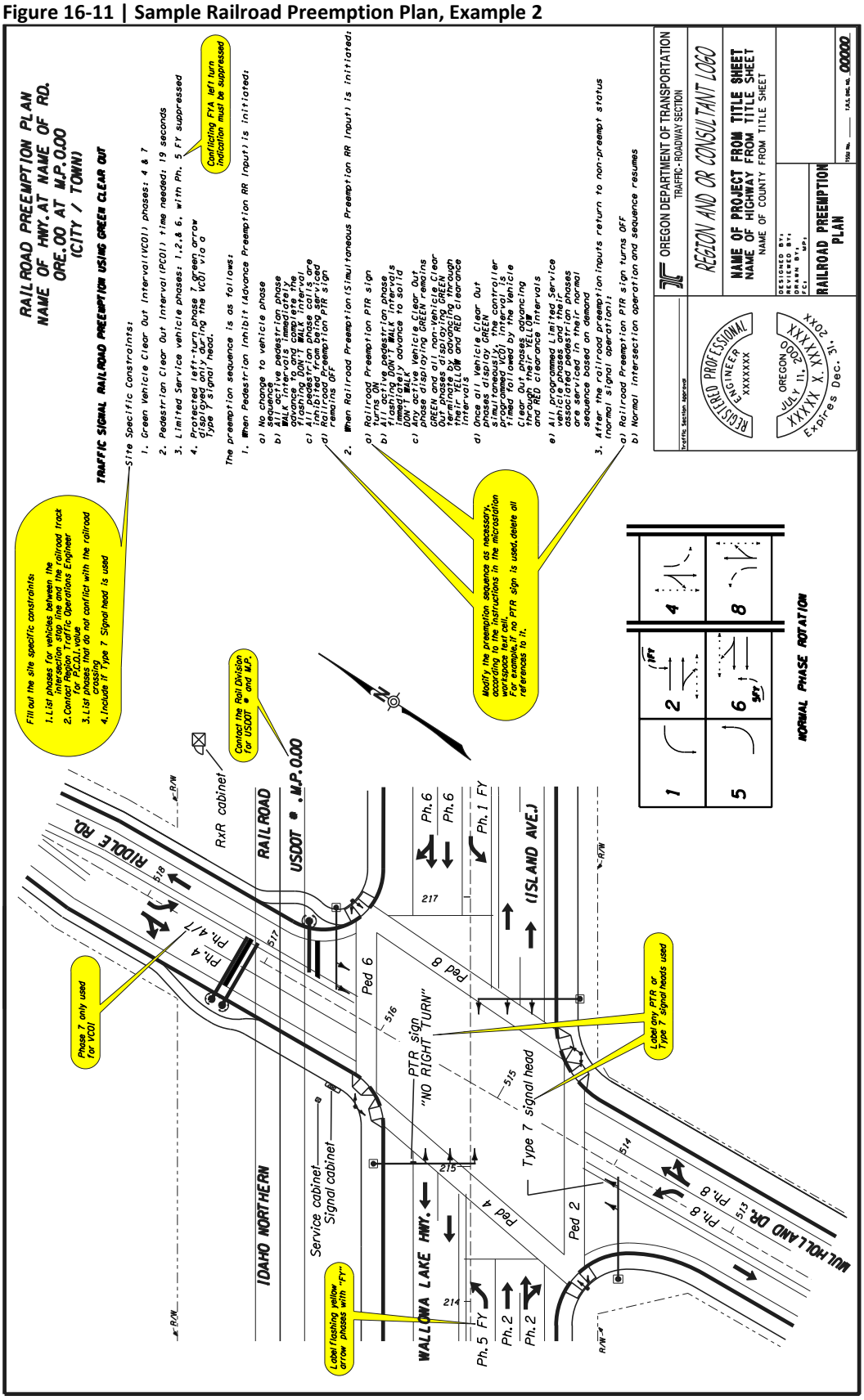
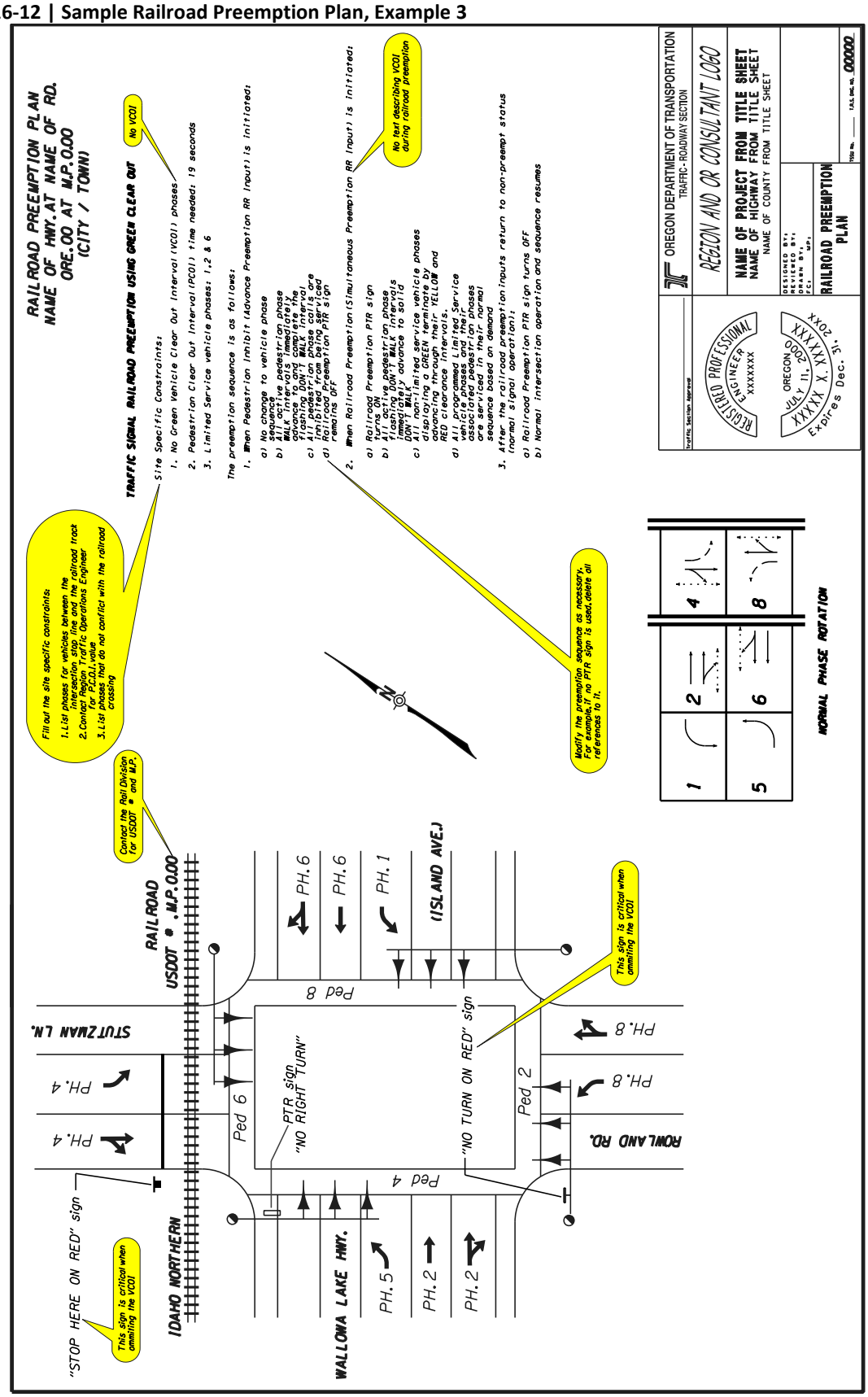


Figure 16-12 | Sample Railroad Preemption Plan, Example 3



The railroad preemption plan sheet shall contain the following:

- Traffic Signal Title Block and upper right hand title information
- T.R.S. Drawing Number
- T.R.S. approval signature
- North arrow
- USDOT Crossing number and railroad milepoint (obtained from the Rail Division)
- Normal phase rotation diagram
- Traffic signal railroad preemption sequence text ("Rail Matrix" in the ODOT workspace), modified to accurately represent the site specific conditions:
    - V.C.O.I. green clear-out phases (if they exist)
    - P.C.O.I. value (obtained by Region Traffic Operations Engineer)
    - P.C.O.I used to serve V.C.O.I phases ("Rail Matrix Advanced" in the ODOT workspace)
    - Limited service phases. If a conflicting FYA indication is present, it must be listed
    - Use of Type 7 signal heads
    - Use of PTR signs
- A plan view of the intersection and railroad crossing (either to scale or graphically represented not to scale) with the following elements labeled:
    - Highway and street names
    - Signal equipment shown symbolically, but not labeled (signal poles, mast arms, vehicle heads)
    - Signal equipment shown symbolically and labeled:
        - PTR signs
        - Type 7 signal heads
    - Pedestrian phases labeled in the corresponding crosswalk
    - Vehicular phases labeled in the corresponding approach lanes
    - Signs (ground mounted or overhead) that directly related to the preemption operation, shown symbolically and labeled:
        - "STOP HERE ON RED" sign
        - "NO TURN ON RED" sign

The railroad preemption plan sheet may contain the following additional features:

- The RxR cabinet
- The signal cabinet
- The service cabinet
- The pedestrian signal heads shown symbolically, but not labeled
- The RxR gate locations
- Stationing (if the plan view is to scale)
- Right-of-way