

Exhibit No. _____
Docket No. TR-100127
Witness: Cary P. Stewart, P.E.

BEFORE THE WASHINGTON STATE
UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON STATE DEPARTMENT
OF TRANSPORTATION,

Petitioner,

v.

CENTRAL PUGET SOUND REGIONAL
TRANSPORTATION AUTHORITY; and
CITY OF LAKEWOOD,

Respondents.

DOCKETS TR-100127, TR-100128,
TR-100129, and TR-100131
(Consolidated)

WRITTEN DIRECT TESTIMONY OF

Cary P. Stewart, P.E.

SENIOR PROJECT MANAGER
HDR ENGINEERING, INC.

April 16, 2010

1 CARY P. STEWART testifies as follows:

2 I submit this testimony in support of the Washington State Department of
3 Transportation's petitions in the above-referenced dockets.

4 **Q. Please state your name and business address.**

5 A. My name is Cary P. Stewart. My business address is in care of HDR Engineering, Inc.,
6 500 – 108th Avenue NE, Bellevue, Washington 98004. Telephone is (425) 468-1585. My
7 email address is cary.stewart@hdrinc.com.

8 **Q. By whom are you currently employed and in what capacity?**

9 A. I am a Senior Project Manager and Northwest Traffic Signal Design Lead at HDR
10 Engineering, Inc. (HDR). I have been employed by HDR since 2006.

11 **Q. Please describe your educational background and work history that qualifies you
12 to provide your expertise in this matter.**

13 A. I have an engineering education from California State Polytechnic University, Pomona.
14 I am a Registered Professional Engineer in Washington, Idaho, Oregon, Alaska, and
15 California. I have worked with railroad crossings since 1990. As City Engineer for the City of
16 Santee, California, I worked on four at-grade crossings of city streets by the San Diego Trolley.
17 These crossings successfully incorporated rail detection into a synchronized traffic signal
18 system that allowed the light rail to continue through the crossings without stopping and
19 without disruption of traffic flows. We subsequently added two more at-grade vehicle
20 crossings and one pedestrian crossing of the light rail system. I have also worked on the traffic
21 signals/at-grade crossings on the Sound Transit M Street to Lakewood project, a grade
22 separation in the City of Spokane, a multiple track at-grade crossing in the City of Cheney, and
23 on quiet zone equipment at a crossing in the City of Mukilteo.

1 **Q. Please describe your role in the Point Defiance Bypass Project.**

2 A. In the Point Defiance Bypass Project I serve as traffic design manager, interacting with
3 HDR's and WSDOT's project managers to develop traffic signal designs that keep the track
4 clear in coordination with the railroad signaling system and roadway geometric designs.

5 **Q. What purpose is served by the proposed traffic signal design modifications?**

6 A. According to the **Railroad-Highway Crossing Handbook**:

7 If either of the two conditions listed below prevails, consideration should be
8 given to interconnecting traffic signals on public and private highways with
active warning devices at railroad crossings:

- 9 • Highway traffic queues have the potential for extending across a nearby
10 rail crossing; or
- 11 • Traffic backed up from a nearby downstream railroad crossing could
interfere with signalized highway intersections.

12 A crossing equipped with a passive control device may need to be upgraded to
13 include active warning devices so that preemption of the traffic signal can be
14 implemented effectively. Such improvements are particularly important when
15 the tracks are close to the signalized intersection or when certain conditions
exist, such as high-speed train or highway approaches; tracks in highway
medians; geometry such as steep grades; or special vehicles using the crossing,
such as trucks carrying hazardous material or school buses.¹

16 Both of these conditions are met by the crossings involved in the Point Defiance Bypass
17 Project. Traffic queues can back up across the tracks from the adjacent traffic signals and the
18 vehicles stopped during a train crossing can interfere with the adjacent traffic signal operations.
19 The signalized intersections adjacent to the crossings are close to the track, a high-speed train
20 will be using this track, and military vehicles will be using some of the crossings.

21 The goal of the Point Defiance Bypass Project traffic signal design is to provide safe
22 track crossings while minimizing the impact on traffic flow. A new interconnected traffic
23 signal system is proposed for North Thorne Lane SW, Berkeley Street SW, and Barksdale
24 Avenue SW (DuPont Road).

25 ¹ *Railroad-Highway Grade Crossing Handbook - Revised Second, Edition 2007*, Federal Highway
26 Administration Report No. FHWA-SA-07-010.

1 **Q. What considerations were taken into account in developing and designing the**
2 **proposed traffic signal modifications?**

3 A. The crossings were evaluated based on three criteria: (1) advance pre-emption time, (2)
4 queue clearance time, and (3) track clearance time based on the existing operation. A project
5 traffic analysis was then developed for each crossing to simulate and compare traffic flows
6 during regular and pre-empted operation.

7 **Q. Can you explain what pre-emption time refers to in terms of these proposed traffic**
8 **signal modifications?**

9 A. Pre-emption refers to the transfer of normal operation of traffic signals to a special
10 control mode—stopping or preventing highway traffic from entering into the zone adjacent to
11 the railroad crossing. Advance pre-emption time refers to the notification of an approaching
12 train being forwarded to the highway traffic signal controller unit by railroad equipment for a
13 period of time prior to activating the railroad active warning devices. The pre-emption phase
14 of a traffic signal refers to the time from which a traffic signal controller receives indication of
15 an approaching train and continues until the traffic signal controller receives indication that the
16 track is clear.²

17 **Q. What is queue clearance time?**

18 A. Queue clearance time is the length of time required for the vehicle stopped within the
19 minimum track clearance distance to start up and move through the minimum track clearance
20 distance. For the purposes of the proposed modifications at the four at-grade crossings that are
21 the subject here, the vehicle refers to the motor vehicles stopped on the road. Minimum track
22 clearance distance is the length along a highway at one or more railroad tracks, measured from
23 the railroad stop line, warning device, or 12 ft. perpendicular to the track centerline, to 6 ft.

24
25 _____
26 ² *Guide for Traffic Signal Preemption Near Railroad Grade Crossings*. Texas Transportation Institute,
Texas A&M University, College Station, TX, 2000.

1 beyond the track(s), measured perpendicular to the far rail, along the centerline or right edge
2 line of the highway, as appropriate, to obtain the longest distance.

3 **Q. What is track clearance time?**

4 A. Track clearance time refers to the time assigned to clear stopped vehicles from the track
5 area on the approach to the signalized intersection.

6 Each of these variables (advance pre-emption time, queue clearance time, and track
7 clearance time) can change dependent upon the number of railroad tracks and the speed of the
8 train at the crossing.

9 **Q. Can you please explain what traffic analysis was done, and how it was used in this
10 design?**

11 A. Traffic turning movement counts were conducted in both the 7 a.m. to 9 a.m. and
12 4 p.m. to 6 p.m. peak hours between August 22 and August 24, 2006 (Tuesday through
13 Thursday). Additionally, morning peak hour counts were gathered for several interchanges
14 near the military installments between the hours of 5 a.m. to 7 a.m. These additional counts
15 were collected to capture military heavy traffic activity. The early morning counts were
16 conducted at the following five crossing locations:

- 17 • Bridgeport Way SW
- 18 • North Thorne Lane SW
- 19 • Berkeley Street SW
- 20 • 41st Division Drive
- 21 • Barksdale Avenue SW

22 Because overseas military deployment may have resulted in distorted data, the Pierce County
23 Transportation Travel Demand Model was used to determine that a 10 percent increase
24 adjustment factor for the crossings was needed.

1 As described in the Point Defiance Bypass Project Traffic and Transportation Discipline
2 Report³ an existing operations traffic analysis was performed based on the methodologies
3 provided in the *2000 Highway Capacity Manual* (HCM).⁴ The analysis must consider a wide
4 variety of prevailing conditions, including the amount and distribution of traffic movements,
5 traffic composition, geometric characteristics, and details of intersection signalization. The
6 primary output of the method is a ranking of level-of-service (LOS), which refers to the degree
7 of congestion at an intersection, measured in average control delay. LOS A represents freeflow
8 conditions (motorists experience little or no delay and traffic levels are well below roadway
9 capacity), LOS F represents forced-flow conditions (motorists experience very long delays and
10 traffic levels exceed roadway capacity), and LOS B to E represent decreasingly desirable
11 conditions.

12 A traffic operation analysis and level-of-service analysis of existing traffic conditions
13 were performed at 25 existing intersections within the study area. The traffic analysis software
14 program *Synchro* (Version 6, Build 614) was used to analyze 22 of the 25 intersections.
15 *Synchro* is a macroscopic modeling program. The 3 intersections at the Berkeley Street SW
16 crossing were analyzed using the traffic analysis software program *VISSIM* (Version 4.3,
17 Build 3). *VISSIM* is a microscopic modeling program that can analyze the different
18 interactions between the closely spaced unsignalized and signalized intersections, military
19 kiosk, and railroad crossing more accurately than *Synchro*. Macroscopic traffic models
20 simulate traffic flow, taking into consideration cumulative traffic stream characteristics (speed,
21 flow, and density) and their relationships to each other. Microscopic traffic flow models
22 simulate single vehicle driver units, thus the dynamic variables of the models represent
23 microscopic properties like the position and velocity of a single vehicle.

24 ³ *Point Defiance Bypass Project Traffic and Transportation Discipline Report, Point Defiance Bypass*
25 *Project Environmental Assessment*, Prepared by HDR Engineering, Inc., Washington State Department of
26 Transportation, 2008. Exhibit CS01.

⁴ *Highway Capacity Manual*, Transportation Research Board, Washington DC, 2000.

1 Forecasted year (2020) traffic volumes were developed by applying a two percent
2 annual growth rate to 2006 traffic volumes. The Pierce County Travel Demand Model was
3 used to verify the growth percentage. The two percent rate was accurate for all but two of the
4 crossings—the Barksdale Avenue SW and North Thorne Lane SW areas. At these two
5 locations, the travel demand model produced a greater annual growth rate of four percent; this
6 greater rate is used in the analysis.

7 The same traffic volume methodology described above was applied to the five crossing
8 locations near the military bases to calculate the 2020 volumes. Peak hours occurred during
9 the same 5-9 a.m. and 4-6 p.m. time periods as the existing conditions.

10 Using the same methodology, traffic during the noon peak hour (11 a.m. to 2 p.m.) was
11 also projected for 2020 at Berkeley Street SW and Union Avenue SW.

12 Traffic delays caused by commuter rail crossing at-grade were calculated at the selected
13 locations in the design year of 2020. Daily peak hours were identified by the collected traffic
14 counts. The common morning peak hour is 7:15 to 8:15 a.m. and the common afternoon peak
15 hour is 4:30 to 5:30 p.m. No Amtrak trains will cross the study area during morning peak
16 hour.

17 During the noon and afternoon peak hour, there will be one Amtrak *Cascades* train that
18 will affect all of the study crossings. The Amtrak *Cascades* train affects all of the crossings
19 because it passes through the entire study area on its route between Seattle and Oregon.

20 The traffic volumes present at the crossings are highest during the afternoon peak hour;
21 therefore it was selected for the analysis. During the afternoon peak hour, the 108th Street SW
22 crossing will experience the highest average delay per vehicle of 25 seconds during
23 pre-emption. Average delay per vehicle is the total delay during the peak hour divided by the
24 total number of vehicles passing over the crossing.

1 **Q. Can you briefly explain what a phasing and timing plan is?**

2 A. A phasing and timing plan is the order in which vehicle movements at an intersection
3 are taken and how long a green light they get. An example of a phase would be opposing
4 left-turn movements going at the same time or left-turn and through movements going while
5 the opposite side is stopped by a red light. One example of a phasing plan would be the
6 left-turn movements going first, then the through movements for the main street, followed by
7 the left-turn movements, and then through movements for the cross street. The complete
8 rotation of all the phases is called a cycle. *See Exhibit CS03, pp. 1-4, for examples of what*
9 *each phase of such a cycle might look like.*

10 A timing plan starts with the total amount of time assigned to the cycle. This is
11 typically 90 to 120 seconds. Each phase is assigned a green time and a 5-second yellow. The
12 time for these phases along with a one second all red between each phase will add up to the 90
13 to 120 seconds. In the phasing example given above of a main street and cross street a typical
14 90-second cycle could be 10 seconds of green for each of the left-turn movements, 35 seconds
15 green for the main street, and 20 seconds green for the cross street.

16 **Q. Is the use of traffic volumes from August 2006 as a baseline for development of the**
17 **phasing and timing plans still appropriate?**

18 A. The 2006 volumes as used for this traffic analysis are still an appropriate baseline for
19 current traffic operations. Current (2010) volumes remain similar due to continued
20 deployment from the surrounding military bases. The 2006 volumes were used to establish a
21 baseline for traffic operations and future 2020 traffic projections as described in the above
22 response. Since 2006, no major developments, freeway construction, or change to military
23 bases have occurred that would affect traffic operations. Additionally, the 2020 traffic
24 projections that were based on the 2006 traffic counts are typically significantly higher than the
25 current 2030 Pierce County transportation travel demand model.

1 **Q. How would an increase in traffic volume affect the plan?**

2 A. It is important to recognize that daily volumes vary by 10 percent or more on any given
3 day. Even a 10-20 percent increase in traffic volumes from the current 2030 traffic projections
4 will only bring the volumes into the range of the 2020 projections completed for the project
5 traffic analysis.

6 **Q. What will the changes be to the operation of the grade crossings?**

7 A. The project has incorporated design features to promote safety for trains, motor
8 vehicles, and non-motorized users. With the increase in rail service, train speed, and traffic
9 volume in 2020, these features will provide advanced warning of the arrival of train at grade
10 crossings. These features include:

- 11 • Interconnection between traffic signals and rail signals which will assist the
12 modified signal phasing schemes to help dissipate vehicles which may be near
13 the railroad tracks.
- 14 • Detection loops, which will help detect the presence of queues which may
15 extend across the railroad tracks.
- 16 • Coordinated pre-signals to deter traffic from queuing in the crossing area.

17 In conjunction with new or upgraded crossing gates, flashing lights, roadway striping, and
18 signage, the project will provide better warning to the road users of the presence of the grade
19 crossing and the possibility of approaching trains.

20 **Q. Would you please describe the current conditions at the North Thorne Lane SW**
21 **crossing?**

22 A. North Thorne Lane SW extends approximately east-west and is three lanes wide at the
23 single track crossing; the existing lanes are relatively narrow. The southbound Interstate 5
24 off/on ramps intersect North Thorne Lane SW immediately south of the grade crossing. The
25 existing traffic signal at the intersection is interconnected with the crossing equipment to
26 provide pre-emption. This current pre-emption only involves giving a red light indication to

1 vehicle movements towards the crossing. The Point Defiance Bypass Project Traffic and
2 Transportation Discipline Report, Exhibit CS01, indicates that there is queuing across the
3 crossing in both directions. Southbound traffic queues as it waits at the signalized intersection
4 at the southbound I-5 ramps. Northbound traffic queues as a result of left-turn delays at the
5 unsignalized intersection with Union Avenue, approximately 150' north of the crossing.

6 The southbound dedicated right-turn lane is approximately 9' wide. Approximately 20'
7 south of the tracks are the southbound on/off ramps for Interstate 5. North Thorne Lane SW
8 continues across I-5 on an overpass, and eventually reaches an entrance gate and guard post to
9 Fort Lewis. The crossing currently has a cantilever over the northbound lane, a curbside
10 flasher for the two southbound lanes (but no gates), and a traffic signal interconnection. The
11 lights on the flasher unit intrude into the dedicated right turn lane.

12 **Q. Would you please describe the current conditions at the Berkeley Street SW**
13 **crossing?**

14 A. Berkeley Street SW extends north-south; if a motorist were to progress southward
15 along Berkeley Street towards the grade crossing, he would first encounter a four-way
16 intersection (with a full traffic signal which currently operates as a four-way flashing red) with
17 Union Avenue (to the east) and the entrance gate and guard shack to Camp Murray (to the
18 west). Approximately 150' south of this intersection is the grade crossing.

19 At the crossing, Berkeley Street SW is one lane northbound and two lanes
20 southbound—a through lane leading across Interstate 5, and a dedicated right lane leading to
21 the southbound on-ramp to I-5. The dedicated right-turn lane is approximately 9' wide.
22 Approximately 20' south of the tracks are the southbound on/off ramps for Interstate 5.
23 Berkeley Street SW continues across I-5 on an overpass, and eventually reaches the entrance
24 gate and guard post to Fort Lewis. The crossing currently has a cantilever over the northbound
25 lane, a curbside flasher for the two southbound lanes (but no gates), and a traffic signal
26 interconnection.

1 Originally a standard traffic signal was installed at the Union Avenue intersection.
2 However, reports from members of the Diagnostic Team indicate that it was not coordinated
3 with the signal at the southbound ramps to I-5, which led to significant congestion problems.
4 Changing the signal to a four-way flashing red appeared to mitigate these problems. The
5 proposed design intends to correct this by operating both intersections with the same traffic
6 signal controller.

7 At the intersection with the I-5 ramps, the northbound traffic signals on Berkeley Street
8 SW are mounted just in front of the crossing cantilever and interfere with the normal
9 placement of the crossing flashers to such an extent that the flashers have been mounted on
10 extensions to raise them above the traffic signal. At the same location, the southbound
11 crossing flasher is mounted so close to the roadway that the lights extend into the narrow right
12 turn lane. These situations result in reduced visibility of and confusion by drivers of the
13 indications for traffic signal and railroad signals. The proposed design intends to correct this.

14 Currently, northbound traffic headed into Camp Murray must wait at the intersection at
15 Berkeley and Union Streets until the queue at the guard shack clears. The clearance time for
16 this queue is entirely dependent upon the guards and the thoroughness of the vehicle
17 inspections at Camp Murray. Existing traffic operations do not prevent vehicles from queuing
18 on the track. When the backups occur the proposed design will assist drivers from queuing on
19 the crossing by the use of queue cutter signals.

20 **Q. Would you please describe the current conditions at the Barksdale Avenue SW**
21 **(Steilacoom – DuPont Road) crossing?**

22 A. The crossing at Barksdale Avenue SW currently has 5 lanes across the tracks. To the
23 south is the 3-lane overpass across Interstate 5. At the crossing itself, one of the northbound
24 lanes is a free-flow right (not required to stop) from the southbound I-5 off ramp. The other
25 northbound lane is a through lane from the south side of the freeway. The three southbound
26

1 lanes at the crossing include a free-flow right onto the southbound I-5 on ramp, and two
2 through lanes across the overpass.

3 The crossing is equipped with cantilevers and gates (dual gates on the southbound
4 lanes). There is a median barrier between the northbound and southbound lanes on the north
5 side of the crossing (that median has one set of gates for the southbound lanes in the middle).

6 **Q. Please describe the proposed traffic signal operations for the three crossings**
7 **described above.**

8 A. An interconnection of all three traffic signals with a single traffic signal controller, in
9 conjunction with gates and flashers, will stop vehicles before the gates and allow clearing of
10 the queue lengths during a pre-emption phase (explained above). All traffic movements
11 heading toward the crossing will be given a red light and all traffic movements heading away
12 from the crossing will have a green light. *See* Exhibit CS03, p. 5.⁵ This will prevent vehicles
13 from crossing the tracks and will clear all vehicles off the tracks once pre-emption starts. A
14 single traffic signal controller at each crossing eliminates conflicts between signals and
15 maintains coordination at all times. To further guarantee operation of the traffic signals,
16 backup power is being provided by a standby generator being placed at each of the three
17 locations discussed earlier.

18 Once a train is detected and a pre-emption phase starts, all traffic movements that are
19 heading to cross the tracks and all traffic movements that conflict with track clearance
20 immediately receive a yellow light, followed by a red light regardless of where that signal was
21 in its normal phase. Pedestrian movements heading towards the tracks also immediately get a
22 flashing “DON’T WALK” following by a static “DON’T WALK”. As soon as all traffic
23 movements that are heading to cross the tracks and all traffic movements that conflict with
24

25 ⁵ Exhibit CS03 illustrates the various signal operations at Berkeley Street SW—four phases of normal
26 operations and the railroad pre-emption operation. Both North Thorne Lane SW and Barksdale Avenue SW
follow similar, if not quite identical, signal operations.

1 track clearance movements receive a red light, all clearance movements receive a green light.
2 See Exhibit CS03, p. 5. The timing of the pre-emption will be such that there is adequate time
3 for the yellow/red/green signals necessary to clear the tracks. All right turns conflicting with
4 clearance movements will have LED signs prohibiting turns during pre-emption.

5 **Q. How will the proposed traffic signal modifications for the crossings subject to**
6 **these petitions affect the safety of the crossings and affect vehicular traffic?**

7 A. The purpose of the design is to achieve track crossings that are as safe as possible. The
8 term used for railroad signaling equipment is “failsafe.” To achieve this we have provided
9 comprehensive traffic signal designs with constant communication with the railroad equipment
10 and backup power. The proposed design provides the following at all of above crossings:

- 11 • Crossing gates;
- 12 • Advance pre-emption input to the traffic signal controllers for each train arrival;
- 13 • Queue cutter signal operations to clear the track at all times not just during pre-
14 emption; and
- 15 • Signal operations and LED signs to prevent vehicle from approaching the
16 crossings during preemption.

17 The number of trains, and the fact that as currently scheduled they run mostly outside of peak
18 traffic hours, means that pre-emption as proposed will have little impact on traffic.
19 Additionally, a single traffic signal controller means that there will be no operational conflicts
20 between the three intersections.

21 **Q. What impact will the proposed signal modifications and safety warning devices**
22 **have on the average delay to traffic experienced at these crossings as compared to the**
23 **configurations that currently exist?**

24 A. As mentioned above, the proposed signal modifications and safety warning devices will
25 have little to no impact on traffic at the crossings. As shown on Exhibit CS04 the seconds of
26 delay and levels of service are relatively the same in almost all cases for 2010 and 2020 vehicle

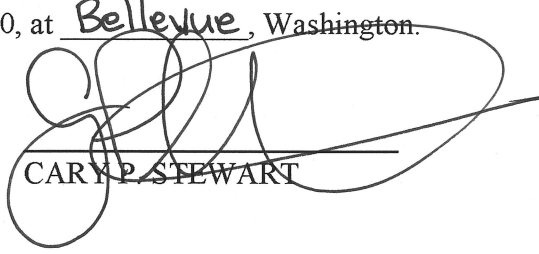
1 operations without trains and with trains. This means the queues of vehicles will be
2 approximately the same, but with the proposed signal modifications and safety warning
3 devices there will not be any vehicles on the track.

4 **Q. Does this conclude your testimony?**

5 A. Yes, it does.

6 I declare under penalty of perjury under the laws of the State of Washington that the
7 foregoing is true and correct to the best of my knowledge.

8 DATED this 15th day of April 2010, at Bellevue, Washington.

9 
10 _____
11 CARY P. STEWART