DAVID EVANS
AND ASSOCIATES INC.

MEMORANDUM

DATE: September 2, 2013

TO: City of Fife
Attn: Russ Blount
5411 – 23rd Street East
Fife, WA 98424

FROM: Al Tebaldi, PE

SUBJECT: **54th Avenue East Crossing Safety Memorandum**

PROJECT: FIFE0000-0177- 54th Avenue Crossing Safety Evaluation

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At the direction of the City of Fife, David Evans and Associates, Inc., (DEA), has undertaken an investigation of the potential safety issues at the at-grade crossing of 54th Avenue East over the Union Pacific rail line. Currently, the roadway is closed to general vehicle traffic, but the crossing is still used by emergency vehicles and as an evacuation route. The Puyallup Tribe has requested that the City reopen the roadway to general traffic.

This memorandum will examine the current geometric and safety conditions at the crossing and, using available research, examine the factors that would influence the potential and severity of a train-vehicle collision, train-pedestrian collision, or a train derailment at or near the crossing location. This memorandum also includes an analysis of the probability of a train-vehicle accident at the crossing using a standard data-driven method and reviews the crossing for adequate stopping sight distance for vehicles on 54th Avenue East.

Background

54th Avenue East is a two lane urban arterial with approximately 2-foot shoulders, running north/south and connecting Valley Avenue East and North Levee Road. Land use in the area is primarily residential, with a public school and a public park on the immediate north side of the rail line. The speed of the roadway is posted at 25 mph generally, with 20 mph limit during specific periods in the school zone. The alignment is straight from Valley Avenue East to Levee Road and is also generally flat, except for the slight rise at the railroad crossing. Before the roadway was closed to general traffic, approximately 2,000 vehicles used 54th Avenue east each day. The projected Annual Average Daily Traffic (AADT) is expected to be 4,800 when the roadway is reopened to general traffic. The existing rail line runs east/west on a tangent at the proposed crossing location, with a slight skew (less than 10 degrees from normal).

Train-Vehicle Collision

Factors that affect the likelihood of a train-vehicle collision include:

- train frequency
- train speeds
- number of tracks being crossed by the roadway
- type of warning devices at the crossing
- sight distance for motorists on 54th Avenue East
- number of roadway lanes crossing the tracks
- speed of the roadway vehicles

An examination of the Federal Railroad Administration (FRA) Office of Safety Analysis shows no accidents recorded at this crossing.

The rail line, owned and operated by the Union Pacific Railroad (UPRR), hosts approximately 14 to 16 freight trains per day. There are no passenger trains using this rail line. It is a single-track main line with two to three passing sidings that connects Seattle and Fife. UPRR trains reach Fife from Portland by using the BNSF Railways' main line from northern Portland to Tacoma, before crossing the Puyallup River and entering the Fife Yard. Fife Yard is about a half mile west of the 54th Avenue East crossing and the rail bridge over the Puyallup River is approximately 2 miles west of the 54th Avenue East crossing.

As trains leave the BNSF main line and cross the Puyallup River, they are travelling at a maximum of 15 mph. As trains enter and leave the Fife Yard, they are only traveling a maximum of 20 mph. While the speed limit for trains as they cross 54th Avenue East is 55 mph, they are usually travelling slower as they accelerate from or are approaching Fife Yard or the Puyallup River. The FRA crossing inventory data indicates a range of train speeds of between 40 and 45 mph at the 54th Avenue East crossing.

There is a single track crossing the roadway at 54th Avenue East, which eliminates the potential of one train clearing the crossing only to have a second arrive, which can cause driver confusion and limit driver sight distance. The crossing is protected by typical mast-mounted flashing lights and 2-quadrant gates that block vehicles approaching the crossing. According to FRA crossing inventory data, the lights start flashing automatically between 45 seconds and 1 minute before the fastest possible train arrives at the crossing; the gates descend between 5 and 10 seconds after the lights begin to flash.

Since the crossing has flashing lights and gates, the ability of vehicle drivers to see an approaching train is not critical, but the ability of drivers to see the flashing lights and gates in time to stop before reaching the crossing gates is important. Since there is only one lane in each direction and the roadway is relatively straight and flat, a driver's ability to see the flashing lights in time to stop is not an issue at this location.

On busy roadways with intersections nearby an at-grade crossing, vehicle queues can extend onto the tracks, creating the possibility of a stopped vehicle being hit by a train. Given the relatively low volume of traffic, the distances of the intersections from the crossing and that those intersections do not require

vehicles to stop except to yield to on-coming traffic during left turns, it does not appear likely that a queue will extend onto the tracks.

By comparison, 70th Avenue East, which is located about one track mile to the east, has roadway and track geometry very similar to the 54th Avenue east crossing, including two lanes, narrow shoulders, straight alignment from Valley Avenue East to Levee Road, a single rail crossing that is slightly skewed to the roadway and generally flat roadway except for the slight rise at the railroad crossing. 70th Avenue East has nearly double the vehicle traffic expected at 54th Avenue East; an AADT of 9,200 vehicles. Trains are likely to be travelling at 55 mph through the 70th Avenue East crossing, at least 20% faster than at 54th Avenue East. With 20% slower train speeds and 50% less vehicle traffic at 54th Avenue East, a collision of a vehicle and train is less likely than at the crossing of 70th Avenue East. The FRA Office of Safety Analysis shows no accidents recorded at the 70th Avenue East crossing. Therefore, the general potential for a vehicle train collision at the 54th Avenue East crossing is extremely low.

Train-Pedestrian Collision

For the purposes of this memorandum, a Train-Pedestrian Collision is considered one where a person or people are struck while crossing at a designated crossing either on foot or other mode, such as in a wheel chair or on a bicycle. This is different than a similar type of incident where a person or people are struck by a train while walking or biking along the tracks or crossing at a place that is not a designated crossing. The latter is considered a trespassing incident and is not a relevant situation for this analysis.

At designated pedestrian crossings or roadway crossings, a surface is provided to allow pedestrians to cross the track without stepping over the rails or walking through rough ballast. At these locations, the train is required to sound their horn or, in some cases, a fixed horn is provided to replace the train's horn. At many vehicle crossings with flashing lights and gates, there is also a bell that sounds as the lights flash, providing additional audible warning of a trains approach. In some locations, notably in Puyallup on the BNSF rail line that hosts passenger trains, there are separate gates over the sidewalks that are intended to deter pedestrians from crossing once the warning devices at the crossing are activated. Neither bells nor these pedestrian gates are absolute regulatory requirements, but are applied where significant pedestrian traffic is expected.

Trespassing incidents are far more frequent than "train-pedestrian collisions". The Washington Utilities and Transportation Commission (UTC) website[1] lists only two fatalities in 2012 at at-grade crossings, both being people in vehicles. The web page lists 10 trespassing fatalities in 2012. The same web page lists three grade crossing fatalities for the first four months of 2013, all involving pedestrians, and five trespassing fatalities in that same period.

Below is a table of data compiled from the UTC fatality descriptions for statewide railroad fatalities for the last five full years and the first four months of 2013. A review of the fatalities of pedestrians at grade crossings seems to indicate that most occur at locations were more than one track is being crossed, and many involved a higher speed passenger train.

[1] http://www.utc.wa.gov/publicSafety/railSafety/Pages/OLCrashStatistics.aspx

One incident on the UPRR rail line involved a 26 year-old female pedestrian who was struck by a Union Pacific freight train on the tracks, east of the Freeman Road East crossing, and died on April 13, 2008. Based on the FRA Accident Report, the Pierce County Medical Examiner determined the death was a suicide. Suicide is a factor in many fatalities classified as either pedestrian (Grade Crossing Fatalities not involving a Motor Vehicle) or trespassing.

Table 1 - Grade Crossing Fatalities 2008 through April 2013 (Source: Washington Utilities and Transportation Commission)

Year	Grade Crossing Fatalities involving a Motor Vehicle	Grade Crossing Fatalities not involving a Motor Vehicle	Trespassing Fatalities
2013 (thru 4/31/2013)	0	3	5
2012	2	0	10
2011	3	4	22
2010	1	3	15
2009	1	4	12
2008	1	3	12

The 54th Avenue East crossing has a fence and gate on one side that prevents pedestrians and other non-motorized vehicles from crossing except when opened for emergencies. The crossing surface is wide enough for the two vehicle lanes but provides less than 4 feet outside the striped roadway for pedestrians and non-motorized vehicles. If the fence were removed, pedestrians and others would likely have to enter the vehicle lane in order to cross the railroad tracks.

According to the FRA crossing inventory data, while the gates effectively block the crossing for vehicles and pedestrians alike, there is no audible bell that sounds while the flashing lights are activated.

Although the road is closed to general traffic, the crossing is still used by unauthorized pedestrians who either climb the fence or gate or who damage the fencing to pass through the resulting hole. Thus, these unauthorized users spend more time near the rail line than if the roadway were open. They also can become trespassers, as they often scale the fence or climb through holes in the fence away from the crossing to be less visible to authorities. This also makes them less visible to train crews.

If the roadway is reopened to general traffic, it would also be available for pedestrian and non-motorized traffic. The narrow crossing surface makes the crossing less desirable from a safety standpoint and a wider surface and sidewalks should be considered to reduce conflicts between vehicles and non-motorized vehicles and pedestrians. While the roadway is narrow through the crossing, the likelihood of a train-pedestrian collision is no more likely than at other grade crossings.

Train Derailments At or Near the Crossing Location

Derailments of trains can be caused by several factors. The most likely factors that cause a train to derail are two trains or groups of rail cars impacting each other, failure of one or more axles of a rail car, a broken rail, or a collision with a motor vehicle. Only the last cause is made more prevalent by the existence of an at-grade crossing.

There have been incidents where a train colliding with a vehicle has caused the train to derail. In a Transportation Research Board paper titled Analysis of Factors Affecting Train Derailments at Highway-Rail Grade Crossings (TRB 12-4396) three factors were examined as to their effect on the severity of a derailment: 1) type of highway vehicle involved in the collision, 2) speed at collision of highway user, and 3) speed at collision of train.

The report stated that large highway vehicles were four times more likely to cause a derailment; however, statistically "once a motor vehicle has caused a derailment, the severity of that derailment is little affected by the size of the vehicle that caused it." The report further found no "strong" relationship between the speed of the roadway vehicle which strikes the train and if or how severely a derailment occurs.

Finally, it was found that a slower moving train colliding with a vehicle is more likely to result in a derailment than a faster moving train. The report suggested that the faster train is more likely to knock the vehicle out of the way while a slower train will simply push the vehicle along until the train stops or until another solid object, such as a switch or crossing surface is hit. The report did not state a threshold for what a "faster" train is, but a graph comparing the speed of the train at impact and the resulting derailment or non-derailment seems to suggest that the threshold might be between 31 and 35 mph.

As currently signed, trucks are not allowed on 54th Avenue East on either side of the crossing, which makes a train impacting a large vehicle and then derailing unlikely. This also makes the reverse, a large vehicle impacting a train and causing the train to derail, also unlikely.

Regardless of the size of the vehicle a train might impact, there is not a switch or another crossing surface for about one-half mile in either direction to push the vehicle into that would cause a sudden stopping of the train and a derailment. This further reduces the likelihood that a train striking a vehicle would cause a derailment.

Accident Prediction:

There is a standard method to calculate the potential for an accident at a highway-rail grade crossing using Federal Highway Administration guidelines. The main data required includes the warning system at the crossing, the roadway configuration, the number of tracks, and volumes on both the roadway and rail line.

Traffic volumes were based on the memorandum from Don Samdahl, et al, of Fehr and Peers, dated August 9, 2013 under the subject Travel Demand Analysis for 54th Avenue E and the Union Pacific Railroad Crossing. These were predicted to be a maximum of 5,400 average daily vehicles under the worst case scenario.

Using the maximum of 16 trains that use the rail line, the Crossing Exposure is calculated as: *16 trains per day X 5,400 AADT = 86,400.* The methodology used to prepare an accident prediction model for the proposed crossing was developed using principles consistent with USDOT Accident Prediction Model (http://safety.fhwa.dot.gov/xings/com_roaduser/07010/sec03.htm). It should also be noted that the accident history for this crossing shows no accidents.

The basic formula provides an initial hazard ranking based on a crossing's characteristics. The crossing's characteristics are assumed as follows:

Warning Device	**Crossing Gate**	**Roadway Surface**	**Paved**
AADT	5,400	Maximum Train Speed	55 MPH
Trains per day	16	Highway Type	Urban Minor Arterial
Main Tracks	1	Highway Lanes	2

The Basic formula is:
$a=K \times EI \times MT \times DT \times HP \times MS \times HT \times HL$,
where:
a = initial collision prediction, collisions per year at the crossing
K = formula constant
EI = factor for exposure index based on product of highway and train traffic
MT = factor for number of main tracks
DT = factor for number of through trains per day during daylight
HP = factor for highway paved
MS = factor for maximum timetable speed
HT = factor for highway type
HL = factor for number of highway lanes

Based on the proposed crossing characteristics and using Table 19 from the *Railroad-Highway Grade Crossing Handbook - Revised Second Edition 2007*, the following factors to be used in the basic formula are:

K = 0.001088
EI = 55.67
MT = 1.34
DT = 1.0
HP = 1.0
MS = 1.0
HT = 1.0
HL = 1.11

The resulting factor "a" from the basic formula is 0.090.

Based on Table 24 of the *Railroad-Highway Grade Crossing Handbook - Revised Second Edition 2007*, the "a" value determined above, and no reported accidents at the crossing in the FRA database for the last 5 years and longer, the resulting Final Accident Prediction is 0.053 accidents per year. This is typical of a low volume roadway protected with flashing lights and gates. Put another way, this is roughly equal to one accident

every 19 years. As the Federal Railroad Administration database does not list any accidents at this crossing since the 1970's (about 35 years) even one accident every 19 years might be conservative.

Sight Distance:

The attached drawing shows that the sight distance of vehicles approaching the crossing is 272 feet in the southbound direction and 288 feet in the northbound direction. The required stopping sight distance for the posted speed of 25 mph is 155 feet, much less than the actual stopping sight distance. If the higher design speed of 35 mph is considered, the required sight distance is 250 feet. Here, too, the existing sight distance exceeds that requirement. As such, sight distance over the crossing does not need to be improved for stopping sight distance.

Conclusion:

Based on the foregoing information and the impeccable safety history at the similar 70th Avenue East crossing, reopening the 54th Avenue East crossing to general traffic will not result in unusual safety issues. Other crossings within the City of Fife are open to vehicle and pedestrian traffic and have not experienced any reported accidents. Pedestrian safety at the 54th Avenue East crossing can be enhanced with the widening of the crossing and construction of sidewalks. The opening of the crossing to vehicular traffic will not have an appreciable effect on the likelihood of a derailment in the vicinity of the 54th Avenue East crossing.

Feel free to contact me or Kevin Jeffers if you have questions or require additional information.

Attachments/Enclosures: Sight Distance Exhibit

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