FHWA Experimentation #4-298(E)
Modified HAWK Signal and Bike Signal - Draft Report

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CITY OF PORTLAND BUREAU OF TRANSPORTATION

Table of Contents

List of Figures

List of Tables

FHWA Experimentation Number 4-298(E)
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Preface

On October 17, 2005, the City of Portland received permission from the U.S. Department of Transportation Federal Highway Administration to experiment with Modified High Intensity Activated Crosswalk ("HAWK") Signals for Pedestrian and Bicycle Crossings at two intersections in Portland, Oregon. This report documents the experience to date and the results of the city's evaluation of the effects on safety and road user behavior at these locations.

Between 1985 and 2002, pedestrians accounted for 4,174 (3%) of the 127,249 reported traffic injuries and 217 (29%) of the 748 fatalities. Fourteen percent of pedestrian injuries and fatalities occurred at non-signalized intersections. Bicycle traffic has tripled since 2001 but bicycle crashes have remained fairly constant, so the overall bicycle crash rate has actually decreased. Low crash rates and low-stress bikeways are needed if Portland is to reach its goal to have a quarter of all trips made on bicycles by 2030.

The city's commitment to walking and biking has made Portland one of the most bicycle and pedestrian-friendly communities in North America. Over the next twenty years Portland intends to add 300 additional miles of bikeways. Many of these bikeways will cross major arterials at non-signalized intersections; a solution is needed for safe crossings. As the safety of pedestrians and bicyclists crossing busy arterial streets is improved, walking and biking will become a more viable transportation option and the city's associated public health, economic, and livability goals will more likely be achieved.

Problem Statement

Pedestrians and bicyclists have trouble finding adequate gaps to cross at non-signalized intersections on arterial streets with high traffic volumes. Motorists driving on arterial streets do not always stop or yield to crossing pedestrians or bicyclists, unless forced by traffic signs or traffic signals, even though state law requires motorists to stop. Traditional methods such as flashing beacons, painted crosswalks and median refuge islands have relatively low motorist compliance rates when compared to traffic signals (See Reference 1). However, installing full traffic signals on arterial streets at minor intersections encourages additional vehicle traffic to use residential side streets. Additional traffic signals can cause vehicle delay, higher fuel consumption, more vehicle emissions, and increase total rear-end collisions.

In the mid-1970's, Portland installed half-signals at 48 intersections to provide an opportunity for pedestrians to cross major arterials at minor cross streets, and yet minimize vehicle access to residential neighborhoods. Half-signals have vehicle signals for the main street and stop signs controlling the side streets. Pedestrian signals are installed for pedestrians to cross the main street. The signals are activated by pedestrian pushbuttons. However, half-signals have not been allowed in the Manual on Uniform Traffic Control Devices (MUTCD) since 1971. Primary concerns regarding half-signals include:

- Side street motorists at the stop sign are confused when the main street traffic stops.
- Main street motorists don't expect vehicles to pull out from the side street while the main street has a green light.
- Half-signals dwell on Green for long periods of time and main street motorists may run a red light due inattention and the infrequency of pedestrian calls.
- Side street motorists don't always yield to pedestrians in the crosswalk.

Our with Half signals has shown that they have relatively few crashes. We are currently documenting our experience and drawing comparisons with HAWK and full signals through research with Portland State University. A follow up study will be completed in the next six months.

Study Objectives

The city of Portland obtained funding from the Oregon Department of Transportation's bicycle and pedestrian program to install and evaluate a signalized crossing on East Burnside and 41st Avenue. The purpose of the new signal is to facilitate bicycle travel along the city's eight-mile "40's Bikeway," which runs the entire north-south length of the city. In 1998, the city identified this intersection as the most difficult for bicyclists to cross along the 40's Bikeway corridor. Due to roadway geometry, a signal was the only viable option to provide a safe crossing, however the intersection did not meet traffic signal warrants.

Initially, a half-signal was proposed at East Burnside and 41st Avenue. However, the City chose instead to seek approval to install a **H**igh-intensity **A**ctivated cross-**W**al**K** (HAWK) signal, also known as a Pedestrian Hybrid Signal, modified to include bicycle crossing indications. HAWK signals had been successfully implemented in Tucson, Arizona and are being evaluated as part of a national experiment to determine the effectiveness of this type of treatment. The request was expanded to also include a HAWK signal to replace an existing half-signal on NE Sandy Boulevard at 18th Avenue. In 2005, the city received FHWA experimental approval for both locations.

The effectiveness of the HAWK Signal was evaluated by the following measures:

- Motorist compliance, measured by the percentage of motorists who obeyed the HAWK signal;
- Pedestrian & bicyclists confidence, measured by the percentage of use; and
- Safety, measured by the number of crashes.

Several operational adjustments were adopted based on observations and user feedback. These adjustments will be explained later in the report.

Data Collection Methods

Several methods were used to collect data:

- Time lapse video installed at E Burnside & 41st Avenue.
- Programmable Logic Controllers (PLCs) which collected the timing of traffic signal phases and related vehicle actuations from sampling loops that were installed in each travel lane on E Burnside within the intersection just beyond the crosswalk.
- Crash data from accident reports.
- Observations and user feedback.

Description of the Experimental HAWK Signal

The experimental HAWK and bicycle signal configuration was similar in design to the installations in Tucson, Arizona. The design of the HAWK signal consists of three signal sections, with a CIRCULAR YELLOW signal indication centered below two horizontally aligned CIRCULAR RED signal indications. Two signals were placed overhead on the mast arm signal pole. A CROSSWALK STOP ON RED (symbolic circular red) (R10-23) sign was mounted between to the overhead signal faces. For side street vehicle control, Stop signs (R1-1) were used. For pedestrian control crossing the main street standard pedestrian signal heads and push buttons were used. In addition to the HAWK signal, a signal face with red, yellow and green bicycle symbol lenses were installed for bicycle control, similar to those in the City of Denver's FHWA-approved Experimentation Number 9-76.

Locations, Equipment and Signs of Experimental HAWK Signals

East Burnside Street at 41st Avenue

A HAWK signal at this intersection was installed to create gaps for bicycle and pedestrian crossings, especially during peak hours. Many school children and pedestrians cross at this intersection to get to Laurelhurst Elementary School, which is located to the north. East Burnside Street has four travel lanes and is classified as a district collector with an ADT of 23,000. The speed limit is 35 MPH.

Figure 1 shows a schematic of the intersection with the HAWK signal, which was turned-on on October 2006. Advance heads were installed on both east and west approaches due to the curvature of East Burnside Street. Pushbuttons to activate the HAWK signal were installed for bicyclists and pedestrians. Pushbuttons were placed on posts near the curb for bicyclists to activate the crossing signal system. System detectors (sampling loops) were installed and connected to PLCs to record vehicles entering the intersection while the approach signal was red.

Figure 2 shows the HAWK Signal with a Bicycle/Pedestrian Crossing Warning Sign installed overhead on the mast arm. Crossing warning signs were also installed on ground

mounted poles. Bicycle signals were installed on poles for each approach crossing the main street.

Figure 1: Schematic of East Burnside and 41st Avenue

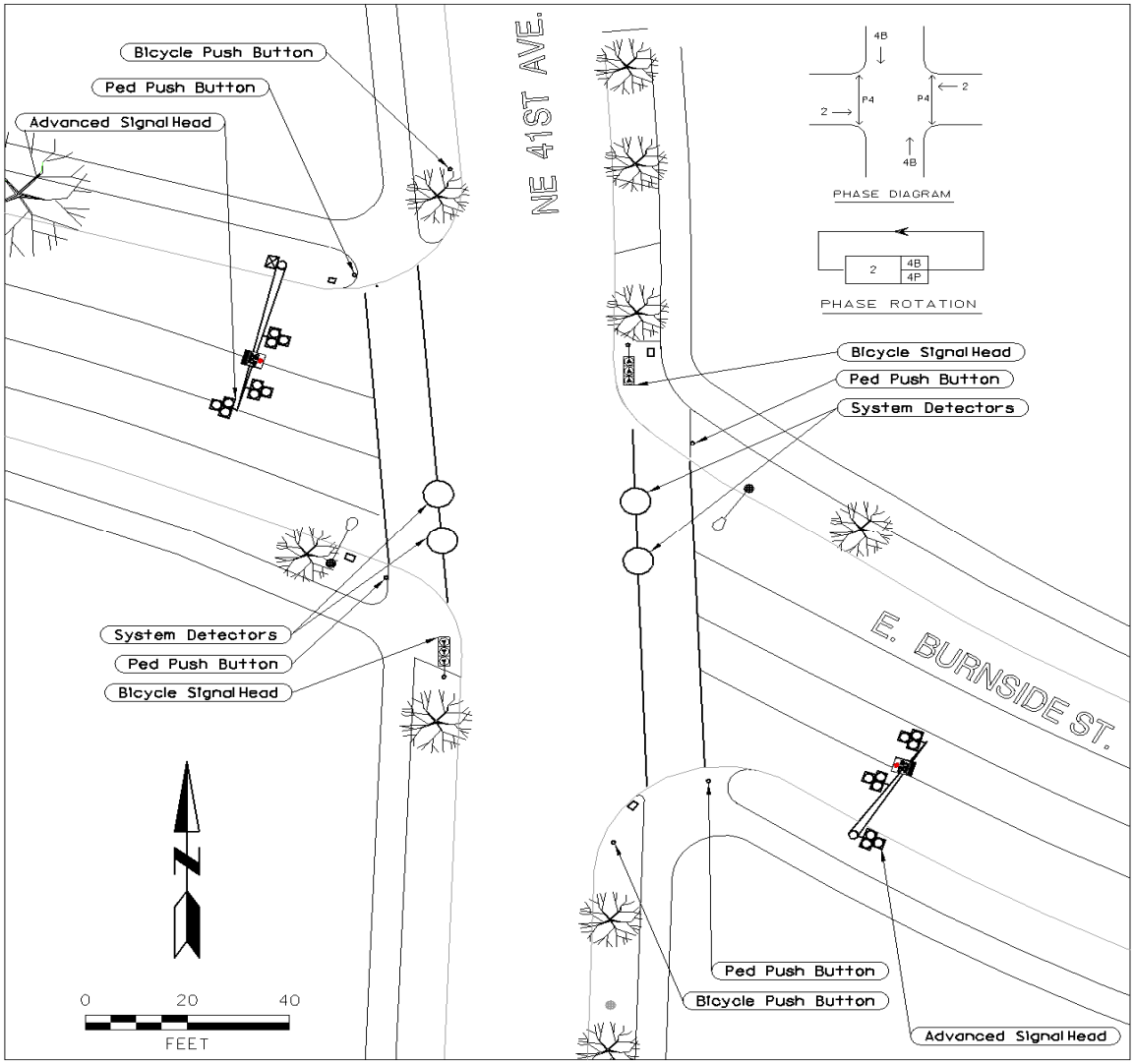


Figure 2: E. Burnside Bike Signal and Pedestrian/Bicyclist Crossing Warning Sign

NE Sandy Boulevard at 18th Avenue

This intersection originally was one of the 48 intersections with half-signals. NE Sandy Boulevard was being resurfaced and the majority of the signals were being upgraded. This provided an opportunity to convert an intersection with an existing half-signal to a HAWK signal.

Overhead regulatory signs CROSSWALK - STOP ON RED similar to that of Tucson were installed on both mast arms. Pedestrian Crossing Warning signs were also installed on ground mounted poles for both approaches of NE Sandy Boulevard. NE Sandy Boulevard has four travel lanes with parking on both sides of the street and is classified as Major Traffic Street with an ADT of 21,000. The speed limit is 30 MPH.

Figure 3 provides a schematic of the intersection with the HAWK signal, which was turned-on in September 2007. The intersection has zebra-striped crosswalks. HAWK signals are mounted over each travel lane on mast arms. Pedestrian signals and push buttons are mounted on ornamental street light poles at each corner.

Figure 4 is a photograph of the easterly crosswalk showing the HAWK mast arm signals and the overhead regulatory sign.

Figure 3: Schematic Drawing of NE Sandy Blvd at 18th Ave

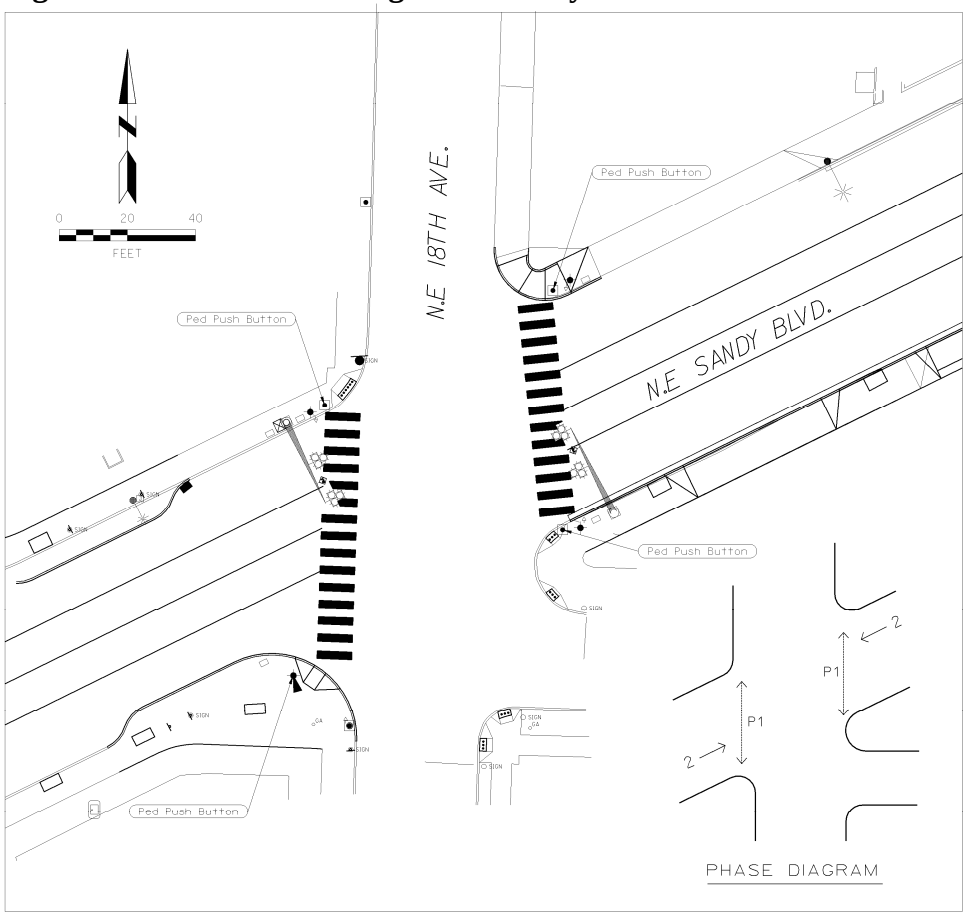


Figure 4 NE Sandy Blvd at 18th Ave Looking East

Experimental HAWK Signal Operation

Portland's experimental HAWK signal operation differs from the Tucson application in a several ways.

1. The HAWK signal does not alternate Flashing Red (wig-wag) so that the signal does not mimic railroad crossing signals. Both Red indications flash simultaneously.
2. Portland tested the option to light the steady DON'T WALK indication while the HAWK signal was dark.
3. Portland tested the option to have Steady Red during the Flashing DON'T WALK indication.
4. The HAWK signal at East Burnside & 41st Avenue includes a bicycle signal in addition to pedestrian indications.

East Burnside Street at 41st Avenue Initial Signal Sequence

The operation sequence that was proposed for experimentation is illustrated in Figure 5. The HAWK signal rests in Dark, the bike signal in Dark, and the pedestrian signal in Dark until a pedestrian and/or bicyclist activates the signal by pressing a pushbutton. At that moment, the vehicle signals display Flashing Yellow (FY) for 3 seconds. Following Flashing Yellow, steady Yellow (Y) is displayed for 4 seconds, which is based on the ITE recommended method for calculating Yellow times. Once steady Yellow is terminated, an all-Red clearance of 2 seconds is displayed. Following the all-Red clearance, the bike signal displays steady Green (G) for 12 seconds, which is based on AASHTO guidelines (Reference 2), followed by 6 seconds of steady Yellow. At the start of the bicycle Green interval, 8 seconds of Walk (W) and 14 seconds of FDW is displayed on the pedestrian signals. The total FDW time is based on the crossing distance and a walking speed of 3.5 feet/second. Following the FDW, the vehicle signals display Flashing Red (FR), which includes 3 seconds plus an additional 1 second for a total of 8 seconds for the clearance phase for the minor street bicycle traffic. Following the FR interval, the HAWK signal returned to rest.

Figure 5: Initial Sequence Interval Operations, E Burnside at 41st Ave

				
Interval	**Vehicle**	**Bike**	**Ped**	**Length (sec)**
1	Dark	Dark	DW	Rest
2	FY	R	DW	3
3	Y	R	DW	4
4	R	R	DW	2
4	R	G	W	8
5	R	G	FDW	4
6	R	Y	FDW	6
7	R	R	FDW	4
8	FR	FR	DW	3
9	FR	FR	DW	1
10	Dark	Dark	Dark	Rest

NE Sandy Blvd at 18th Avenue Initial Signal Sequence

The initial operation sequence is illustrated in Figure 6. The HAWK signal rests in Dark and the pedestrian signal in Dark until the signal is activated by a pedestrian pressing a pushbutton. At that moment, the pedestrian signals displays DW and the vehicle signals display FY for a period of 3 seconds, followed by a steady yellow (Y) for 4 seconds. The steady yellow time is based on the ITE recommended method for calculating yellow times. Once the steady Yellow is terminated, an all-Red clearance is displayed for 2 seconds. Eight seconds of Walk (W) begins for the pedestrians, followed by 20 seconds of FDW. When the FDW ends, the vehicle heads display a Flashing Red (FR) for 3 seconds. Following the Flashing Red interval, the HAWK signal returned to rest. Count down pedestrian signals were used at this location.

Figure 6: Initial Sequence and Interval Operations, NE Sandy Blvd at 18th Ave

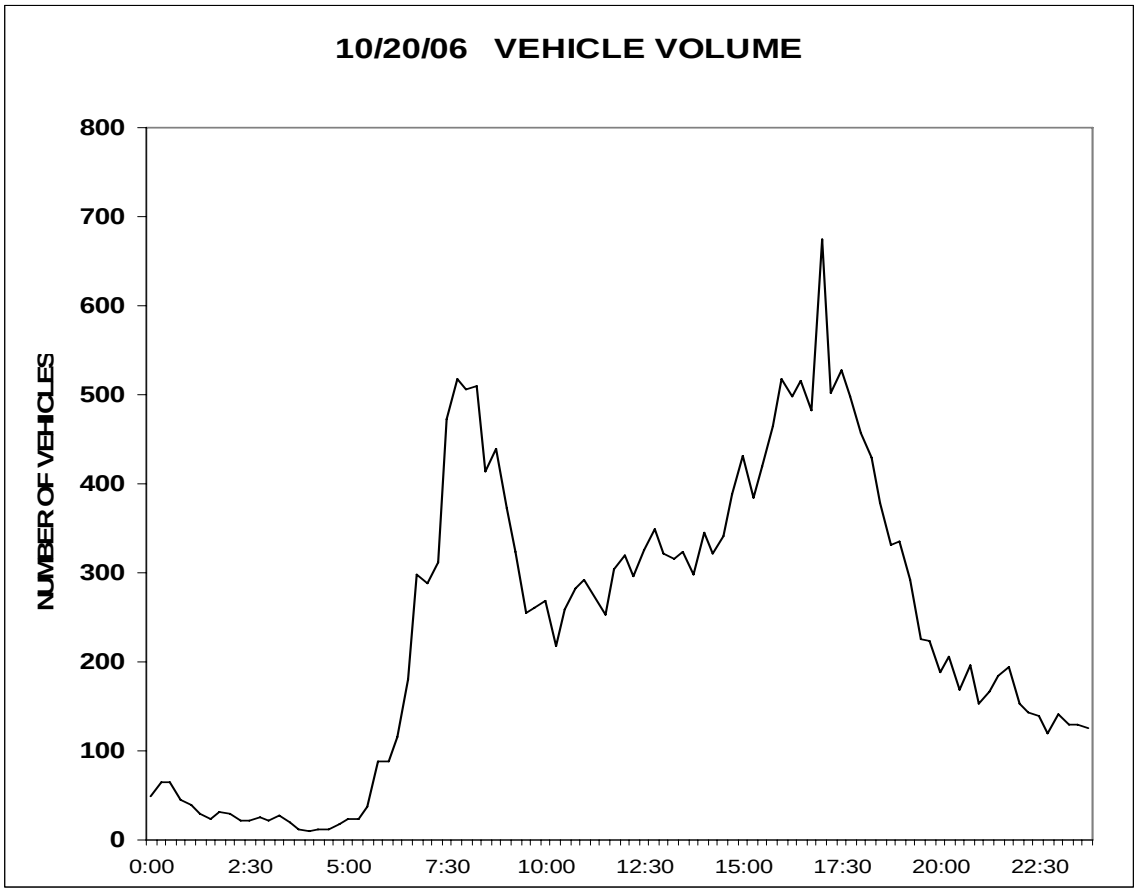
			
Interval	**Vehicle**	**Ped**	**Length (sec)**
1	**Dark**	**Dark**	**Rest**
2	**FY**	**DW**	**3**
3	**Y**	**DW**	**4**
4	**R**	**DW**	**2**
5	**R**	**W**	**8**
6	**FR**	**FDW**	**20**
7	**FR**	**DW**	**3**
8	**Dark**	**DW**	**Rest**

Evaluation Results

Motorist Compliance

An evaluation of motorist compliance was performed at the intersection of East Burnside and 41st Avenue. Video logs and Programmable Logic Controller (PLC) data were reviewed. Figure 7 shows hourly traffic volumes on East Burnside that were counted on October 20, 2006, fifteen days after the HAWK signal was installed. Since the majority of traffic (16,681 out of 23,319 or 71.5%) occurred between the hours of 7 am (0700) and 6 pm (1800), the video logs and PLC data were retrieved for that time frame.

Figure 7: 2006 Traffic Counts, Burnside/41st



Several observations were made from video logs that were taken shortly after the signal was installed:

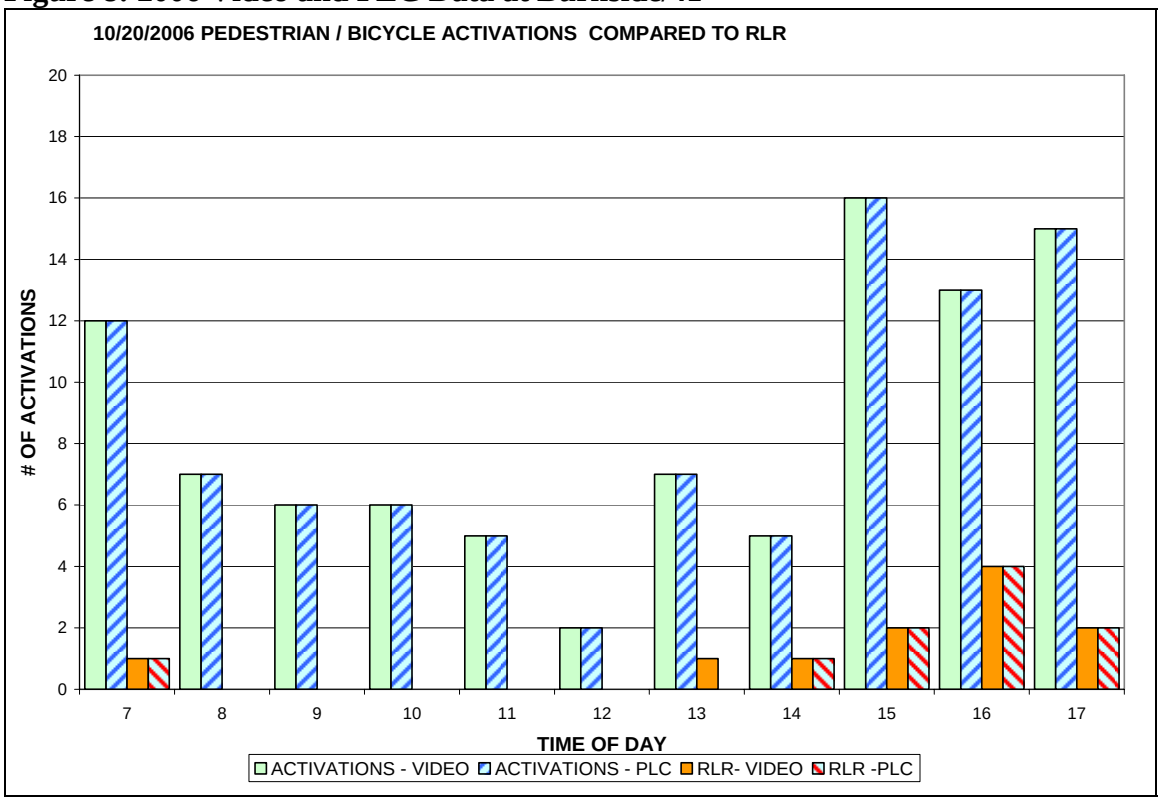
- Initially some motorists stopped when seeing the dark signal, yet drivers have become familiar with the intersection and this behavior has diminished. There exist some concerns that motorists will adapt this to intersections that lose power.
- Drivers would stop beyond the crosswalk and back-up behind the stop bar, after seeing the red indications displayed overhead.
- As expected, passengers of vehicles on the side street got out and used the bicycle push button to activate the HAWK signal, which provided gaps for them to cross or enter the main street.
- Some vehicles on the side street took advantage of the green indication of the bicycle signal to cross or enter the main street, using the pedestrian and/or bicycle indication.

Observations from video logs and data collected by the PLC indicated that, initially, Red Light Runners (RLR) occurred randomly during the signal operations. However, as drivers became accustomed to the operation of the HAWK signal, there were fewer RLR and the majority of RLR occurred during or immediately after the main street clearance interval. The video logs for October 20, 2006 showed 7 out of 11 or 64% RLR occurred

during the Yellow to Red transition and 4 out of 11 or 36% RLR occurred during the steady Red indication.

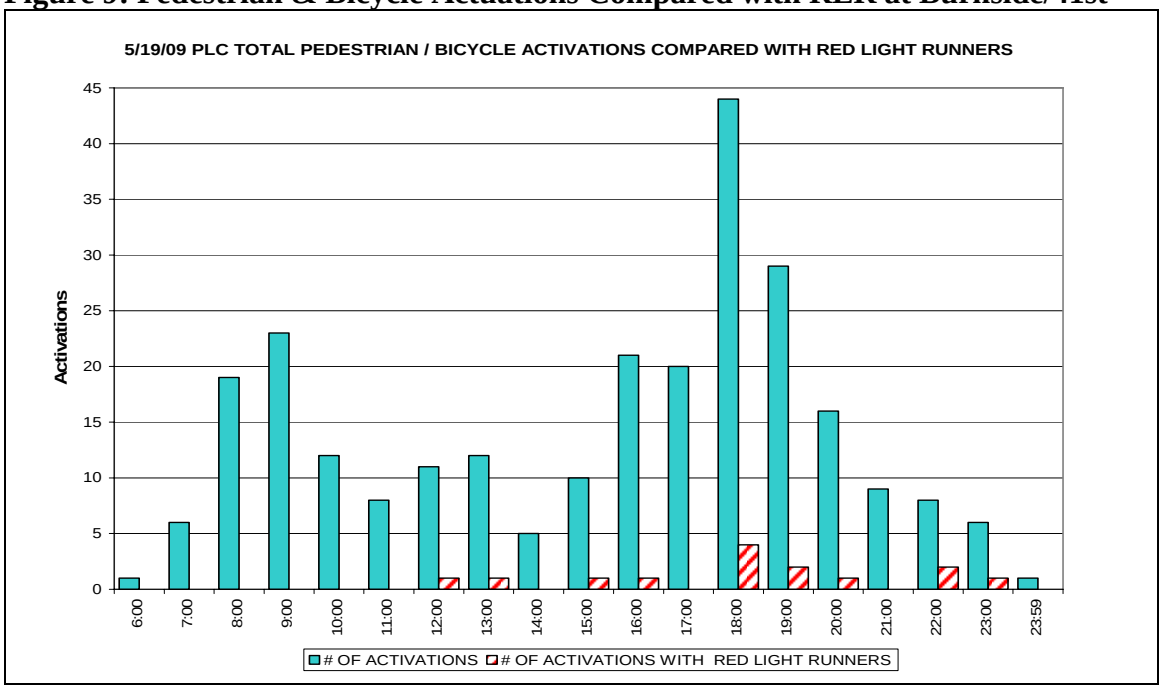
In order to determine the initial motorist compliance rate, the total number of activations (complete HAWK signal cycles) and the number of activations with RLR were compared to determine the percentage of activations without RLR. Figure 8 summarizes observations taken from video logs as well data from the PLC. The video logs and PLC data were reviewed for Friday, October 20, 2006, from 7 am (0700) to 6 pm (1800). The video logs showed seven RLR events or a 92% compliance rate. The PLC data indicated ten RLR events or 89% compliance. This percentage is lower than the percentages published in NCHRP Report 562 (Reference 1), which reported a compliance rate for HAWK signals in the range of 94% to 100%.

Figure 8: 2006 Video and PLC Data at Burnside/41st



In order to determine the current motorist compliance rate, PLC data was collected on Tuesday, May 5, 2009, two years and seven months after the installation of the HAWK signal at E Burnside & 41st Avenue. Figure 9 summarizes PLC data that was collected. The number of activations without RLR is 97% representing only eight RLR's. This percentage is consistent with the compliance rates published in NCHRP Report 562 (Reference 1), which reported a compliance rate for HAWK signals in the range of 94% to 100%.

Figure 9: Pedestrian & Bicycle Actuations Compared with RLR at Burnside/41st



Pedestrian / Bicyclist Confidence

Video tapes were reviewed to determine Pedestrian and Bicyclist confidence. Table 1 provides a summary of the number of pedestrian and bicyclists seen on video logs using push buttons to activate the HAWK signal. The ratio of pedestrians and bicyclists using push buttons to activate the signal increased over time, which is an indication of familiarity with the signal as well as user patience. Table 1 shows that from 7 am to 8 pm on a weekday, October 19, 2006, 64.9% of a total of 77 observed bicyclists activated the signal and that for a similar time period on May 15, 2009, 75.5% of 220 observed bicyclists activated the signal. In October 2006, 80.3% of 61 observed pedestrians activated the signal and 80.8% of 104 observed pedestrians did so in May 2009. The majority of activations occurred during peak traffic hours.

Table 1: Statistical Data from Recorded Videos, E. Burnside & 41st Avenue

October 19, 2006

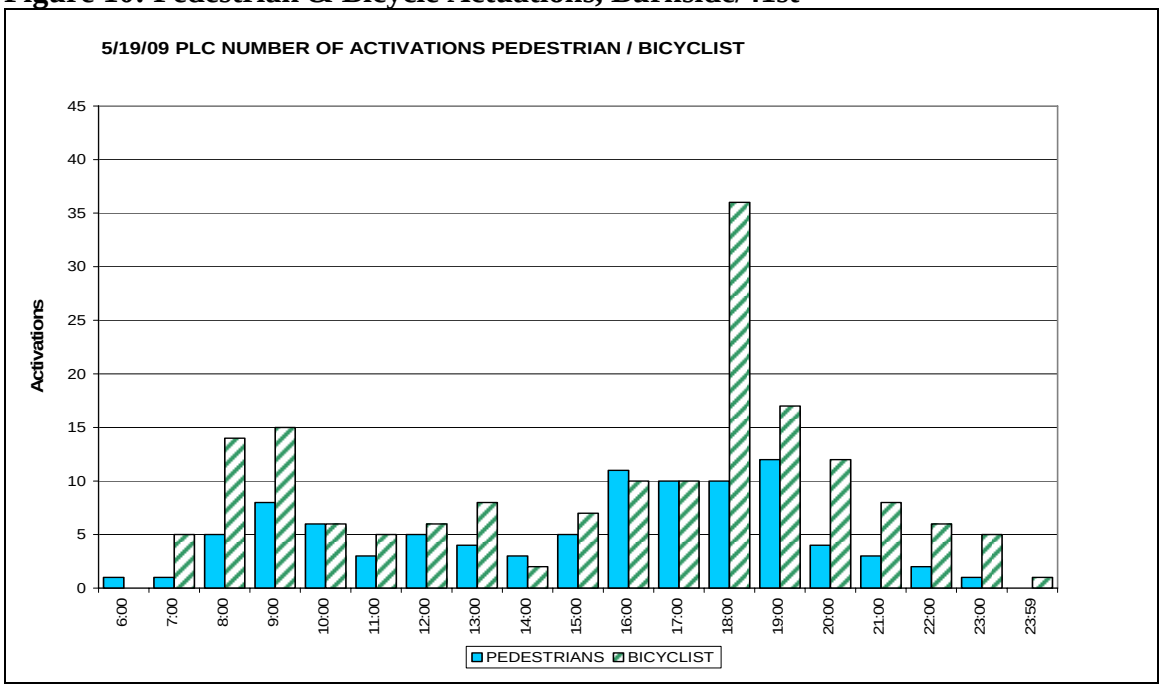
Total Crossing Counts		
	Bicycle	Pedestrian
Using	50	49
No-Button	27	12
Sum	77	61
% Using Button	64.9%	80.3%

May 15, 2009

Total Crossing Counts		
	Bicycle	Pedestrian
Using	166	84
No-Button	54	20
Sum	220	104
% Using Button	75.5%	80.8%

Figure 10 shows the pedestrian and bicycle actuations over a 24 hour period at the intersection of East Burnside & 41st Avenue, which was taken from PLC data recorded on May 19, 2009. The number of actuations increased during the peak hours, which may be indicative of the use of the HAWK signal to obtain crossing gaps when there were high traffic volumes on the arterial street.

Figure 10: Pedestrian & Bicycle Actuations, Burnside/41st



Crash Data

Tables 3 and 4 show crash data before and after the HAWK Signal installations. The total number of crashes over a two-year period at East Burnside increased from 3 prior to installation to 7 crashes after installation. This may be due to the fact that there was no signal at this location prior to the installation of the HAWK signal. The total number of crashes at NE Sandy Blvd was 2 crashes per year prior to installation and 3 per year after the installation. The data indicates there were no pedestrians or bicyclists involved in crashes before and after the installations at both locations.

Table 1: Before and After Crash Data, Burnside & 41st (No Prior Signal)

Crash Data	
2 years before installation (Oct, 2004-Oct., 2006)	2 years after installation (Nov., 2006–Nov., 2008)
2 Rear-end 1 Fix	5 Rear-end 1 Head-on 1 Side-swipe

Table 2: Before and After Crash Data, NE Sandy & 18th (HAWK replacement of Existing Half-Signal)

Crash Data	
2 years before installation (Sept., 2005-Sept., 2007	1 Year after installation (Oct., 2007–Oct., 2008)
3 Rear-end 1 Fix	2 Rear-end 1 Angle

Operational Adjustments

Several operational adjustments were made based on observation and user feedback. The most common user feedback were that users reported dark indications as signal malfunctions and that the new operations of standard pedestrian and bicycle signals were inconsistent with typical usage throughout the city. These adjustments are described below.

Pedestrian DON'T WALK Indication During Dark Signal Display

When the HAWK signal was initially installed on East Burnside at 41st Avenue, the pedestrian display was dark during the intervals in which the traffic signal was dark. However, the steady DON'T WALK indication was turned-on during the dark traffic display intervals for the following reasons:

- Both video and direct observations of pedestrian behavior showed that pedestrians would approach the crosswalk, look at the pedestrian display, press the pedestrian push button, observe the immediate change to solid DON'T WALK and immediately step into the street.
- When steady DON'T WALK was turned on during the dark traffic signal intervals, this behavior was no longer observed. Most pedestrians would then wait for the WALK display. Some pedestrians chose to disregard the DON'T WALK pedestrian signal when there was a gap in traffic.

Bicycle Signal Indication During Dark Vehicle Signal Display

When the HAWK signal was initially installed on East Burnside at 41st Avenue, the bicycle signals were dark during the dark vehicle display. When the signal is not activated, the warning signs function in a manner similar to a passive crossing. Bicyclists sometimes elected to cross without activating the signal, mostly during off peak hours when sufficient crossing gaps were readily available.

In response to user complaints, the bicycle Red indication was turned on during the dark vehicle display in June 2009. Users complained about the dark bicycle indications, thinking that these signals were malfunctioning and did not understand the meaning of a dark bicycle signal.

Flashing Vehicle Red or Steady Red During FLASHING DON'T WALK (FDW)

The initial operation of the Hawk signals displayed a flashing Red vehicle signal during the FDW pedestrian indication. This was changed shortly after the signal turn-on due to several field observations:

- Vehicles that were stopped due to steady Red would observe the signal change to flashing Red. Although the meaning of flashing Red requires each vehicle in the queue to stop at the stop bar, vehicles in the queue would proceed without stopping. These motorists did not check to the left or right for a second pedestrian or slower pedestrians who were obscured from their view by another vehicle.
- The use of countdown pedestrian signals also played a part in that the able bodied often start crossing after the beginning of FDW because pedestrians assume protection until the count gets to zero.
- At a typical signalized intersection, pedestrian WALK and FDW indications convey to the pedestrian that they have the right of way, so they do not expect main street vehicles to enter the intersection or traverse the crosswalk.
- Vehicles stopped at the stop bar for a short period of time and continued through the intersection when pedestrians were in the crosswalk. Motorists did not obey Oregon's 1.5 lane pedestrian clearance rule.

The Portland Bureau of Transportation (PBOT) desires a variance from the guidance from MUTCD to allow use of vehicle Steady Red during the FDW interval. This way, the operation of the FDW is consistent with user expectations at typical signalized intersections. The variance will result in additional delay to motorists but in our opinion a safer operation for pedestrians, which is a higher priority.

Current Sequence and Interval Operations

Based upon the operation adjustments that were made during the initial installations, several modifications to the sequence and interval operations were adopted, pending further evaluation, which is discussed in "Next Steps." The following figures illustrate the interim sequence and interval operations.

Current HAWK/Bicycle/Pedestrian Signal Operation at E. Burnside & 41st Ave

Figure 11 illustrates the current sequence and interval operations for the HAWK Signal with pedestrians and bicycle signals at E Burnside & 41st Avenue. Primary features which differ from the initial proposal include:

- Steady DON'T WALK during the Vehicle Dark interval
- Steady Bicycle Red during the Vehicle Dark interval
- Steady Vehicle Red during all FDW intervals

Figure 11: Current HAWK/Bike/Pedestrian Sequence & Interval Operations

				
Interval	**Vehicle**	**Bike**	**Ped**	**Length (sec)**
1	**Dark**	**R**	**DW**	**Rest**
2	**FY**	**R**	**DW**	**3**
3	**Y**	**R**	**DW**	**4**
4	**R**	**R**	**DW**	**2**
4	**R**	**G**	**W**	**8**
5	**R**	**G**	**FDW**	**4**
6	**R**	**Y**	**FDW**	**6**
7	**R**	**R**	**FDW**	**4**
8	**FR**	**R**	**DW**	**3**
9	**FR**	**R**	**DW**	**1**
10	**Dark**	**R**	**DW**	**Rest**

Current HAWK/Pedestrian Signal Operation at NE Sandy & 18th Ave

Figure 12 illustrates the current sequence and interval operation for the HAWK signal without a bicycle signal at NE Sandy & 18th Avenue. Primary features which differ from the initial proposal include:

- Steady DON'T WALK during the Vehicle Dark interval
- Steady Red during all FDW intervals
- Countdown Pedestrian Signals

Figure 12: Current HAWK/Pedestrian Sequence and Interval Operations

			
Interval	**Vehicle**	**Ped**	**Length (sec)**
1	**Dark**	**DW**	**Rest**
2	**FY**	**DW**	**3**
3	**Y**	**DW**	**4**
4	**R**	**DW**	**2**
5	**R**	**W**	**8**
6	**R**	**FDW**	**20**
7	**FR**	**DW**	**3**
8	**Dark**	**DW**	**Rest**

Summary of Findings and Conclusions

When the HAWK signals were initially installed, motorists were unfamiliar with the HAWK operation, sometimes stopping because the vehicle signal was dark or running the red light. Data collected two and a half years later indicate that motorists grew accustomed to the HAWK signal. The initial driver compliance rate was low; however the current compliance rate is within the range reported in NCHRP 562.

Motorists on side streets learned how to use the HAWK to their advantage by pushing the pedestrian or bicycle pushbuttons to stop main street traffic or to simply go with the green bicycle signal and ignore their stop sign. The HAWK Signal did not noticeably increase traffic volumes or speed on the side streets.

Pedestrian and bicyclist use of the HAWK signal increased over time. The HAWK signals provided adequate gaps in traffic for pedestrian and bicyclist crossings and the percent of bicycle and pedestrian activations increased 7% and 10%, respectively.

Pedestrians and bicyclists use the crossing without activating the HAWK signal. The use of the pedestrian and bicycle warning signs help to emphasize the crossing. The overhead regulatory sign CROSSWALK - STOP ON RED at NE Sandy Blvd & 18th also emphasizes the crossing and explains the meaning of the HAWK signal to motorists.

Although the HAWK/Bicycle Signal at East Burnside & 41st Avenue had a favorable motorist compliance rate, the before and after crash data over a two-year period increased

from 3 prior to installation when there was no traffic signal to 8 crashes after installation. The crash data will continue to be monitored to determine if crash rates become less of a factor for implementation of the HAWK/Bicycle signal.

The motorist compliance data for HAWK signals is similar to Half Signals and the total number of crashes was about the same per year at NE Sandy & 18th where a HAWK signal replaced an existing Half-Signal.

Based on observations of pedestrians stepping out into the street when the DON'T WALK turned on, it appears that displaying the steady DON'T WALK during the Dark Signal Display may be a safer operation than dark pedestrian display. Some pedestrians disregard steady DON'T WALK if there are gaps in traffic.

Bicyclists and pedestrians did not understand the meaning of a dark pedestrian signal and/or a dark bicycle signal display and assumed that the signals were malfunctioning.

The Flashing Red vehicle display during the FDW appeared to confuse pedestrians and motorists. Pedestrians expected to have the right of way and did not expect motorists to enter the intersection. Motorists queued up during the Steady Red interval and entered the intersection in platoons when Steady Red changed to Flashing Red. Some motorists did not yield to pedestrians in the crosswalk and/or obey Oregon's 1.5 lane pedestrian clearance rule.

Next Steps

Next steps in the evaluation of the HAWK signal should include the following:

- PBOT requests a variance from the guidance from MUTCD to allow use of vehicle Steady Red during the FDW interval. This variance will make the operation of the FDW consistent with user expectations at signalized intersections. The variance should result in safe operations for pedestrians.
- Guidance to use vehicle Flashing Red indication during the FDW interval should be further evaluated. Although the vehicle Flashing Red during the FDW may reduce vehicle delay and increase efficiency, the Steady Red indication during the FDW interval seemed safer and easier to understand. Vehicle Steady Red during FDW is typical of traffic control and changing to vehicle Flashing Red during FDW differs from usual pedestrian and motorists' expectations.
- Dark bicycle and pedestrian displays during the dark vehicle display should be further evaluated. Users assume that dark signals are malfunctioning since bicycle and pedestrian signals are not left dark at all other locations. The HAWK signal is different enough that resting in dark may not be a problem, but pedestrian signals are standard indications that are always on. Bicycle signals in Portland are always on.
- Use of flashing red for cyclists to reinforce the stop sign on the intersecting street. The use of a flashing red as opposed to a dark signal will increase safety.
- Use of flashing yellow for HAWK display as opposed to the dark HAWK signal could be studied to determine whether that results in less confusion. A survey conducted by Portland State University will study this further.

Acknowledgements

Bill Kloos, P.E., obtained permission from FHWA to evaluate the HAWK Signal for Pedestrian and Bicycle Crossings in Portland, Oregon. Regrettably, Bill passed away on November 4, 2009 before this report was written.

Peter Koonce, P.E. and Tod Rosinbum, P.E., Signals, Street Lighting & ITS Division were the primary authors of this document.

Norberto Adre, P.E., Portland Signals, Street Lighting & ITS Division, was the primary investigator for this experiment.

Travis Hall, Portland Signals, Street Lighting & ITS Division was the assistant investigator for this experiment.

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Paul Zebell, Portland Signals, Street Lighting & ITS Division, gathered PLC data and implemented the signal operations

Oregon State Department of Transportation Bicycle and Pedestrian Program provided funding for the East Burnside & 41st Avenue signalized crossing

The U.S. Department of Transportation Federal Highway Administration allowed the experimentation of the Modified HAWK Signal and Bike Signal.

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3. Manual on Uniform Traffic Control Devices for Streets and Highways, 2003 Edition. U.S. Department of Transportation, Federal Highway Administration.

Appendix 1 NEWS RELEASE

East Burnside & 41st Avenue HAWK Signal – Frequently Asked Questions

Portland Office of Transportation (PDOT) - October 9, 2006

Q. What is it?
A. A new experimental bicycle/pedestrian-only traffic signal on East Burnside at 41st Avenue.

Q. What is its purpose?
A. To create a safe crossing for cyclists and pedestrians on 41st without making 41st, a local street, a more attractive route for automobiles.

Q. Why here?
A. The signal will facilitate bicycle travel along the city's "40's Bikeway," which runs the entire north-south breadth of the city between NE Holman Rd in the north and the Springwater Corridor in the south. PDOT identified this intersection as the most difficult for cyclists to navigate over the entire 8-mile 40's Bikeway corridor. Because of the roadway conditions including the curve on E Burnside, providing a signal was the only option to allow for a safe crossing. In addition to cyclists, many school children and their parents cross at this intersection to get to Laurelhurst Elementary School, which is just north of Burnside.

Q. How does it work?
A. The signal on Burnside will stay dark unless activated by a cyclist or pedestrian. When the call button is pressed, the signal will stop all automotive movements along Burnside and allow cyclists and pedestrians to safely cross Burnside. No signal protection will be provided for drivers on 41st Avenue as they will continue to just have a stop sign. A special bicycle traffic signal will control cyclist movement across Burnside, while pedestrians will have a traditional pedestrian signal. After the bike/pedestrian cycle is complete, the system will be switched off, allowing traffic to flow normally again. The automobile signals on Burnside will be the first of its kind in Portland, featuring one yellow light below two red lights in a "Mickey Mouse" configuration with no green light.

Q. Why is this called "experimental"?
A. Portland is part of a national experimental study to determine the effectiveness of this type of special signal - modeled after similar signals in Tucson, Arizona. The operation will be evaluated by City staff and PSU students.

Q. How was this funded?
A. This new signal was funded by a $140,000 grant from the Oregon DOT's Bicycle and Pedestrian Program.

Q. Anything that motorists using Burnside should know?
Motorists using E. Burnside will see these signal heads with no lights on. Motorists should not stop for these dark signal heads on Burnside. The 41st auto traffic still has to obey their stop sign.