

Use of Signage and Blue Tubular Markers to Improve Access to Businesses During Construction.

TRB Paper Number 02-2185

By

Andrew Griffith, P.E.,

Research Group

Oregon Department of Transportation

200 Hawthorne Ave., Suite B-240

Salem, Oregon 97301-5192

Telephone: 503-986-3538

FAX: 503-986-2844

e-mail: andrew.s.griffith@odot.state.or.us

And

Joni Reid

Research Group

Oregon Department of Transportation

200 Hawthorne Avenue, Suite B-240

Salem, Oregon 97301-5192

Telephone: 503-986-5805

FAX: 503-986-2844

e-mail: joni.e.reid@odot.state.or.us

Submitted: on July 18, 2001

Number of words: 6,243 + 3 figures and 2 tables.

ABSTRACT

The study evaluated two non-standard traffic control devices intended to assist motorists in locating business accesses during highway construction. The devices, blue tubular markers and blue signs that read “Temporary Business Access” were used on two Oregon Department of Transportation projects in 1999 and 2000. The blue markers and business access signs were used to indicate open accesses during driveway, curb, and sidewalk construction. Analysis of traffic count data taken for the first project yielded inconclusive results about the effectiveness of the business access signs; however, when surveyed, both motorists and businesses found the signs useful. The second project supplemented the “Temporary Business Access” signs with blue tubular markers. Traffic counts at four typical business sites provided evidence that businesses were not significantly impacted during construction when the blue markers and signs were used. In a telephone survey, fifty percent of the businesses and the majority of motorists indicated the devices helped in locating the driveways. Based on the results of the research, the continued use of blue markers and business access signs on an experimental basis is recommended.

BACKGROUND

Maintaining access to businesses for customers during roadway construction projects is a common problem. The drivers’ task of locating a business driveway is often hampered by the presence of work zone traffic control devices.

Long rows of orange tubular markers/barrels are used frequently for lane closures, detours, shoulder work and curb construction. Although the orange markers provide guidance to through-traffic, they create visual clutter for the driver trying to locate a business access. Understandably, business owners are often apprehensive about the potential loss of revenue due to construction that impedes customer access.

The Oregon Department of Transportation (ODOT) recognized a need to aid motorists in entering and leaving businesses affected by highway construction. In reviewing the work of other DOTs, ODOT found very little research on methods to improve accessibility to businesses during construction. As a result, this research project was developed to evaluate two non-standard traffic control devices used to assist motorists. As shown in Figure 1, the devices included blue signs that read “Temporary Business Access,” and blue tubular markers used only to mark driveway entrances. Prior to their use, a request was made for the experiment in accordance with Part 1A-6 of Revision 3 of the 1988 Manual on Uniform Traffic Control Devices (MUTCD) through the Oregon Division Office of the Federal Highway Administration (FHWA). FHWA subsequently granted the request.

RESEARCH OBJECTIVES

The overall goal of the research was to find better methods to mitigate the impact of highway construction on businesses. Specific objectives included:

- To determine if, and to what degree, the use of non-conventional blue tubular markers and “Temporary Business Access” signs alter customer use of businesses located on highway construction projects.
- To determine public and business owner perception about these non-conventional traffic control devices.

RESEARCH METHODOLOGY

The following tasks were undertaken to accomplish the research objectives:

1. Identify construction projects where blue tubular markers and “Temporary Business Access” signs could be used and evaluated.
2. Perform a quantitative evaluation of customer traffic prior to, and during construction. Seven-day traffic counts were made at business access points to monitor customer use. A road tube connected to a pneumatic TT-4 counter at each access drive was used. The original intent was to obtain traffic counts during construction under two conditions: (1) using only standard traffic control devices, and (2) using the blue tubular markers and/or business access signage at driveways. However, it would have been difficult to ensure similar test environments for both the standard and non-standard devices. Therefore, the experiment design was changed to compare business traffic in the absence of construction activity with traffic during construction with blue tubular markers and signs. In the changed experiment design, it was the authors’ intent to concurrently count traffic on the highway outside the construction limits to account for weekly variations of traffic traveling

through the project site. By doing so, traffic counts to businesses could have been presented as a percentage of the corresponding main line traffic counts. However, the road tubes could not withstand the higher speeds and traffic volumes of the main highway. After losing several counts because of tubes ripping, the researchers decided to forego counting on the main highway.

3. Survey business owners and motorists affected by each project, to determine their perceptions on the impacts of construction and the effectiveness of the blue tubular markers and business access signs.
4. Analyze the data; formulate conclusions and recommendations.

RESEARCH DESIGN

Description of Modified Work Zone Traffic Control Devices

The blue tubular markers were made with urethane plastic, 900 mm high and 75 mm in diameter. Near the top of each marker were two bands of blue high intensity reflective sheeting. In 1999, the cost of each marker with a recycled tire rubber base was \$34.50. The blue Temporary Business Access signs were Type "B" 610 mm x 610 mm signs with 76 mm letters. When these devices were used together to delineate the driveways to a business during roadway construction, they were configured as shown in Figure 1.

Project Location

The two ODOT projects selected for field trials were:

- *Sweet Home West City Limits(WCL) - Foster Dam Road Section* in Sweet Home, Oregon; and
- *Goshen - Pheasant Lane Section* in Pleasant Hill, Oregon

Sweet Home is located in the southeastern part of the Willamette Valley at the foothills of the western Cascades. Its population in 1999 was 7,592 (1). The Sweet Home WCL-Foster Dam Rd. Section project was on a 7.5 km section of U.S. Route 20 through the city of Sweet Home. The project consisted of cold plane pavement removal and placement of new asphalt concrete pavement. Additionally, the work included construction of concrete curbs, sidewalks, driveways and traffic islands. More than 90 businesses were located along the highway within the project limits. Construction occurred from May to September 1999.

The Goshen-Pheasant Lane Section project reconstructed and widened a 9.8 km section of OR Route 58 between April 1999 and November 2000. The project included work in the community of Pleasant Hill, an unincorporated area about 10 miles southeast of Eugene. The Census 2000 population for the Pleasant Hill *Census County Division* was 5,315 (2). Within the project limits, OR Route 58 is a two-lane highway with a continuous two-way left turn lane in the median. There were 22 businesses located adjacent to, or near the project in the Pleasant Hill business district.

Use of the Traffic Control Devices on Each Project

Initially, the Sweet Home project planned to use both blue tubular markers and the business access signs. However, the original scope of work was reduced from a full pavement reconstruction to a mill and inlay. Further, it was decided that the much of the paving would be accomplished at night to minimize disruption. These changes made the work areas shorter and the paving operations would move relatively quickly through the city. The more compact and dynamic work areas would require fewer orange tubular markers, so using blue markers seemed impractical. Although the changed project scope reduced the impact on businesses, there was still over 2,900 m² of driveway reconstruction that affected many of the businesses along the highway. A decision was made to use only the blue Temporary Business Access signs where business driveways were being reconstructed in Sweet Home. In Pleasant Hill, both blue tubular markers and blue signs were used during construction to designate the accesses to businesses.

DATA COLLECTION IN SWEET HOME

Traffic Counts

About 60% of the 90+ businesses within the Sweet Home project limits were in the downtown area. There, motorists typically accessed businesses using a connecting side street and shared parking areas behind the business. Additionally, most of the on-street parallel-parking spaces were removed by the construction. Because of the limited number of individual access drives, few counts were taken in the downtown core.

Prior to construction, seven-day traffic counts were recorded at ten business sites with driveways that would be directly affected by construction. Several sites contained more than one business and some of the businesses shared driveways. All of the sites had at least two driveways, which required counters to be placed at each entrance. Each site was counted at least one time, and additional baseline counts were taken when counters were available and the construction schedule allowed.

Once construction began, business access signs were placed at driveways when there were construction activities in the vicinity. Typically, these activities involved sidewalk and driveway construction, which blocked at least one driveway. As shown in Figure 2, the business access signs were mounted on portable supports in accordance with ODOT Standard Specifications for Highway Construction (3). Either an A-frame (Type II) barricade or a tripod support was used. At most locations, a directional arrow was also placed at the bottom of the sign to help guide traffic.

Most of the business sites were counted only once during construction, as typically, the work affecting a business access was completed within a one- to two-week timeframe. Also, there were several instances when counter tubes were damaged, negating a week-long count. The average seven-day counts for the ten sites that were counted both before and during construction are summarized in Table 1. To maintain the confidentiality of each business, the sites are described by category.

At six sites, average traffic counts decreased during construction. A fast food restaurant (63.9%) and a specialty retail store (59.3%) experienced the greatest percentage drops. Alternatively, a restaurant (62.4%) and a retail-gas outlet (36.6%) saw the greatest gains in traffic. Because of the limited number of counts, it is difficult to draw conclusions about whether certain types of business activity are more susceptible to changes due to construction.

U.S. Route 20 through Sweet Home is a major summer recreational travel corridor that typically sees the highest daily traffic volumes in July and August. The baseline traffic counts for most business locations were taken in May and June, prior to the heaviest seasonal traffic. Increases in traffic during construction at the four sites could be attributed to seasonal increases in traffic. Alternatively, seasonal variability could have also affected the six sites that showed traffic decreases, as it can be theorized that their decreases would have been greater if there were no seasonal influx of traffic.

Business and Motorist Surveys

Telephone surveys were conducted by the University of Oregon's Survey Research Laboratory in mid-October, 1999. Two surveys were conducted, one for businesses and another for motorists. The business survey included 28 respondents out of a total of 41 businesses that were contacted. The respondent was either the manager or business owner.

Fourteen said yes and 14 said no when asked, "Do you feel that customers had a difficult time locating the entrance to your business because of the construction?" Sixteen respondents believed that customers did not stop at their business because of reduced access caused by construction; 12 disagreed with this statement.

Fourteen managers/owners indicated that "business access" signs had been used to mark their driveways. When they were asked if these signs helped customers locate the driveways to their business, 12 answered yes.

Businesses also described how they were impacted by construction. Most of the 28 respondents said they lost at least some business; several said they were severely impacted. Eight however, reported only minimal or no adverse impact. When asked, "Do you think ODOT could have done more to provide better access to businesses?" 9 of 28 answered yes. The nine who answered yes were asked: "What could ODOT have done to provide better access to your business?" Two commented about the signs; both felt the signs should be larger and more visible to the motorist.

In addition to the business survey, 371 motorists who lived in Sweet Home were also surveyed. All had driven through the highway construction area at least once. Almost half had driven through the project site over 50 times. The following is the breakdown of trip frequency.

- 1-2 trips – 5
- 3-5 trips – 19
- 6-10 trips – 35
- 11-20 trips – 39
- 11-50 trips – 87
- More than 50 trips – 186

Motorists were asked, “Did you experience difficulty in getting in and out of businesses because of the construction?” The majority (219 of 371) answered yes. When asked about their difficulty, many of their problems related to the following issues:

- Lane closures;
- Temporary detours;
- Blocking of cross-streets;
- Closure of a business access for construction;
- Parking difficulties;
- Problems accessing a business during paving ;
- Day to day changes in lane and business access closures;
- Elevation differences between the pavement surface and driveway after the existing pavement wearing course was removed and prior to new pavement being placed; and
- Turning movements from a travel lane into the business.

The survey also asked motorists if they had noticed the signs indicating “Temporary Business Access.” Eighty percent (292 of 371) had noticed the signs. The 292 people who noticed the signs were asked, “Do you feel the blue Temporary Business Access signs helped customers including yourself locate the driveways to businesses?” A substantial majority (242 of 292) answered yes.

To further analyze the responses, two cross tabulations were developed using the motorist survey data. One compared the answers to the question about noticing the business access signs by the frequency of trips made through the construction work areas. This showed that as the number of trips increase, a greater percentage of drivers noticed the signs. For instance, 88% of the respondents who made more than 50 trips through the project area noticed the signs, whereas only 65% who traveled 3-5 times noticed them.

Another cross tabulation looked at responses about whether the business access signs helped, compared to the frequency of trips made through the project area. The results showed that for each trip frequency, a similar proportion of respondents (81 to 87%) believed the signs helped customers locate the business access.

Although the motorist survey results show that business access signs made it easier for drivers to locate driveways, a majority of the people (59%) still reported difficulty getting in and out of businesses. Those experiencing difficulty were asked, “What do you think ODOT could have done to help customer access to businesses during construction?” Several people commented on the size and position of the signs. One respondent noted, “... the signs are kind of hard to see and at waist level so they need to be bigger and maybe fluorescent.” Another advocated, “... more noticeable signs, and at night ... we had no idea where to go.”

Further, the wording on the sign, “Temporary Business Access,” may have caused some confusion. Many times, the signs were used to indicate a permanent driveway to a business site that remained open while another driveway was being reconstructed. Some people commented about this. One remarked, “They put the blue signs in the normal entrances, so it was kind of funny that they were the same entrances as always but labeled differently.”

DATA COLLECTION IN PLEASANT HILL

Traffic Counts

Traffic counting at 22 Pleasant Hill businesses started in April 1999 prior to the start of construction work in the business area of OR Route 58. The businesses were located either adjacent to the highway or on a connecting side street. Seven businesses were located on side streets with driveways not affected by construction, while 15 were directly affected. One site housed 12 of the 15 affected businesses in a multi-use retail center that shared four access drives. The other three, a restaurant, a retail (gas and grocery) site and a retail (grocery) site, each had two individual unshared access drives.

Blue tubular markers and signs were placed at the open accesses when there was construction activity in the vicinity, such as sidewalk and driveway construction, shoulder and road construction, or drainage pipe installation. At each access, two signs were placed, one on each side of the driveway in front of the taper of blue tubular markers (see Figure 1). Signs were mounted on a Type II (A-frame) barricade.

Additionally, informational signs were placed at each end of the project to alert motorists as they entered the work zone about the meaning of blue tubular markers. The informational signs (1219 mm x 914 mm) displayed a blue tubular marker and text that read: “Indicates Business Access” on a white background.

Seven-day traffic counts were taken throughout the construction period at the four affected business sites. Since the construction period spanned 20 months, the number of counts was much higher than in Sweet Home. Table 2 summarizes the average counts for the four business sites. Throughout the 20-month period, construction

was taking place within the 9.8 km project length, but not necessarily in the business district. The data contained in the column headed “Average When There was No Construction Activity Present” is based on traffic counts taken when there was no construction occurring that directly affected customer accessibility to the business.

For three of the four business sites, average seven-day counts were higher when “construction was present and the signs and tubular markers used” than the averages for the “no construction present” periods. However, it seems impractical to conclude that the use of signs and blue tubular markers caused an increase in traffic to a particular business site. The large number of traffic counts recorded over two construction seasons allowed a more detailed analysis to better understand the impacts of construction on businesses and to assess the effectiveness of the blue tubular markers and signs. The seven-day counts for the four business sites were plotted over time to examine the impacts of construction. It was observed that for each of the sites, time of year greatly effected the counts. OR Route 58 is a major recreational route in the summer from the Willamette Valley to the Oregon Cascade Mountains. Summer traffic volumes are typically 60 to 70% higher than the winter period. To illustrate the effect of “time of year” on business traffic counts, Figure 3 shows a plotted history of counts from April 1999 to September 2000 at the four sites. Each data point corresponds to a seven-day count.

Discussion of Traffic Count Plots Shown in Figure 3

For each business site, the diamond shaped data points in Figure 3 represent seven-day traffic counts taken when “no construction was present” near the business accesses. The square-shaped data points represent counts taken when “construction activity was in the vicinity of the business accesses and blue tubular markers and signs were used.” As expected, the highest traffic counts occurred during the summer.

A trend-line based on a polynomial regression of the “no construction present” data is also plotted in Figure 3 for each site. The independent variable was time of the year, which was used to predict seven-day traffic counts. This “no construction present” regression curve was used to evaluate the effectiveness of the signs and blue markers by comparing the curve to counts made during construction when these devices were used. A residual value was calculated for each square-shaped data point (counts taken when both construction and devices were present). The residuals are the difference from the data point to its corresponding predicted Y value given by the regression equation. When the residual values are low, the counts taken when “construction and devices were present” are close to the predicted counts. If this condition exists, it could be inferred that when the signs and blue markers were utilized during construction, there was no significant impact to businesses. However, a closer examination of each site is needed before conclusions can be made.

Mixed Use Retail Site

Traffic counts were conducted at the mixed-use retail site 34 times during the construction period. Eleven of the counts were taken when construction activity was in the vicinity of the accesses and blue tubular markers and signs were used. The remaining data points represent the counts taken when no construction was present near the business accesses.

The plot exhibits a seasonal pattern, with the highest traffic counts occurring in the summer. The coefficient of determination (R^2) for the regression curve is 0.52. Thus, the time of year when a count was taken explains 52% of the variation in traffic counts at this particular business site. The data points of counts taken when signs and markers were used are distributed almost evenly on both sides of the regression curve; six are above and five are below. The net residual (sum of residuals) is -386 and the average residual is -35. The small average residual indicates that when construction was present, and the blue signs and markers were used, there was no significant variation from the normally expected travel.

Gas/Grocery Site

The two accesses at the gas/grocery site were counted 30 times during the construction period. Six of the counts were taken when construction activity was in the vicinity and blue markers and signs were used at each access. The regression curve R^2 value is 0.43. Three counts taken when signs and markers were used fell above the regression curve; one of the three represents the highest count recorded at this site, in the week ending August 31, 1999. The last three counts recorded when the signs and markers were used fell below the curve. The net residual (sum of residuals) was 1,074 and the average residual was 179.

The average residual is relatively low and is a positive value, but is skewed by the data point for August 31. Discounting this data point, which had a residual value of 1,008, yields a net residual closer to zero. Therefore, a reasonable assertion might be that when construction activity was present and blue markers and business access signs were used, the traffic counts remained close to what was normally expected.

Restaurant Site

The two accesses at the restaurant site were counted 35 times. Seven of the counts were taken with construction activity nearby and blue markers and signs at each access. The R^2 value for the regression curve was 0.34; the time of the year when a count is taken can only explain 34% of the variance in the traffic counts at this site. The net residual (sum of residuals) is -2,240. The average residual is -459.

In examining the data points, six of the seven counts taken with signs and markers fall below the regression curve. These counts were recorded during August and September 2000. From this data, it might be inferred that the blue markers and signs did not mitigate the construction impacts at this business site. However, the five preceding points, representing counts with “no construction present” recorded in late July to August, are also below the regression curve. Additionally, all of the data points for the summer months of 2000 are widely dispersed around the curve, making it difficult to reach any suitable conclusions about the traffic count data.

Grocery Site

Counts were made at the grocery site’s two accesses 18 times. The total number of counts was lower for this site because in June 2000, the business owner asked ODOT to stop counting. The polynomial regression curve of the “no construction present” data appears to show a seasonal pattern. However, the extent of the summer peak in 2000 could not be fully developed because of the cessation of traffic counts.

The three data points of counts taken when signs and tubular markers were used were above the trend line. The average residual is 198. The data seems to support the notion that when construction activity is present, and blue markers and signs are employed, the traffic counts will be higher than what is normally expected.

Discussion of the Traffic Count Data Results

The analysis of the time series data show that two of the four business sites (gas/grocery and grocery) experienced higher traffic counts during construction when business access signs and blue tubular markers were in place. At the mixed-use retail site, the average residual (-35) was only slightly negative, indicating that traffic counts during construction closely mirror the regression curve. The traffic count data at the restaurant site was too widely dispersed to judge the markers’ and signs’ effects, but the other locations indicate the signs and markers had a positive effect on accessibility to the business site.

However, the reader should view these findings with a degree of caution; only four business sites representing 15 businesses were counted. A broader focus would have been desirable, although having a limited number of sites allowed for a greater depth of study. Secondly, other variables could not be accounted for that might have affected traffic into a business, such as a sale or other special event. Additionally, at the multi-use retail site, the impacts on individual businesses could not be measured because counts were taken at shared driveways.

Even with limitations, the traffic-count data yields noteworthy results. Further, the results of the business and motorist surveys presented in the next section provide additional credence to the effectiveness of the blue tubular markers and business access signs.

Business and Motorist Survey

Telephone surveys were conducted by the University of Oregon’s Survey Research Laboratory in September 2000. Twenty-two businesses were surveyed about the construction impacts and access problems. The majority of business owners/managers (15 of 22) said that they believed many customers were not stopping because of reduced access caused by the construction. When asked how the construction had impacted their business, 12 respondents said that the construction hurt their business. Some said that because of delays in traffic due to lane closures, people were less apt to stop at a business. One business owner felt that motorists were taking alternate routes to bypass Pleasant Hill, and two others mentioned effects caused by the closure of one of their driveways. Yet several businesses indicated the impacts were minimal. When asked if the blue markers and signs had been placed at their driveways, 12 answered yes. Nine of those 12 were co-located in the multi-use retail site. Six of the 12 said that the devices helped customers locate their driveways during construction; four said no and two had no opinion.

The motorist survey consisted of 381 respondents who lived along a 30-mile OR Route 58 corridor. Those surveyed had driven through the highway construction area at least once in the previous two months. The following shows the trip frequency of the 381 respondents over the prior two months.

- 1-2 trips – 73
- 3-9 trips – 106
- 10-29 trips – 80
- 20-49 trips – 39

- 50-79 trips – 26
- More than 80 trips – 57

Most of those surveyed indicated they experienced no difficulty accessing businesses. Only 61 (16%) answered yes when asked, “Have you had any difficulty getting into or out of any business in Pleasant Hill?” When elaborating on the nature of their problems, 12 people commented about the long waiting periods in traffic due to a lane closure. There were ten separate comments about the blocking of driveways to businesses. Eight people said they had difficulty finding the business entrance. Seven others described difficulty entering a business because of the elevation difference between highway surface and the driveway after the highway was paved but prior to the driveway being brought to final grade.

A substantial majority (315) had no difficulty getting to and from businesses. Several reasons could account for this. First, there are a relatively small number of businesses in Pleasant Hill. Secondly, more than half of the respondents had driven through the area more than ten times in the previous two months, and thus, were familiar with the site. Third, because of the long project length (9.8 km), much of the construction did not directly affect business accesses.

Another reason could be that the blue markers and signs helped motorists locate business accesses. How effective were they? Of the 381 surveyed, 237 (62%) noticed the blue tubular markers and business access signs. When they were asked if the devices helped customers including themselves locate the business accesses, 78% (185) responded yes.

A cross tabulation of those who noticed the blue markers and signs by their frequency of trips through the construction area showed that as the frequency of trips increased, so did the awareness of the markers and signs. For instance, of those who traveled in the project area 1-2 times, 36% (26 of 73) noticed the blue tubular markers and signs. At between 3 and 9 trips, the percentage was 53%, and at 80 or more trips, it was 86%.

Another cross tabulation compared the distribution of respondents who said the blue tubular markers and signs helped by the frequency of trips made through the project area. It showed that the proportion of people saying the markers and signs helped was at about the same (80 to 83%) for each trip frequency category. The only exception was the “50-79” times frequency, which was slightly lower at 71%.

Overall, the survey results indicate that the use of the blue markers and signs was instrumental in helping motorists locate business entrances. Still, a sizable number of those surveyed, 111 of 381 (29%), believed ODOT could be doing more to help businesses with customer access during construction. When asked to elaborate about what ODOT could do, 30 comments referred to either the signs or markers. Some said the signs needed to be large enough to be seen from the highway, so people could recognize them in time to turn safely. Others wanted the signs and markers to be used more consistently. Additionally, several people suggested that ODOT do more advertising about the purpose of the signs and blue markers.

CONSIDERATIONS AND OBSERVATIONS

Several issues about the use of the business access signs and blue tubular markers should be considered if these traffic control devices are used on future projects. The comments are based on the authors’ personal observations during the course of their fieldwork in 1999 and 2000.

Sign Mounting

In both projects, the signs were mounted on a Type II (A-frame) barricade; a tripod was also tested in Sweet Home. During the study, some of the signs supports were broken or bent, perhaps because they were frequently moved, blown over by the wind, or knocked over by motorists or pedestrians. Another problem was sign visibility. At some locations, no matter where the sign was placed, it was very hard to see (especially if left-hand turns were required to enter the business). The height of the sign bottom edge was only about 500 mm above the pavement. On future projects, a possible solution to both problems would be to use a skid-mounted wood sign support, already specified by ODOT for many of its temporary work zone signs. This support meets NCHRP 350 requirements and its clearance from pavement surface to sign bottom is over 2 m. However, these sign supports are harder to move and occupy more space.

Consistency in Sign and Marker Use

A second issue was consistency in the use of the signs and markers. There were instances where construction affected the business access, yet no signs were put in place. Since the use of the signs was a new requirement for the contractor, their placement was not part of the traffic control routine. The contractors needed to be reminded of when and where to place signs.

Some of the blue markers were also damaged, knocked down, or lost during the course of the construction. On occasion, the damaged tubular markers were left on site and not repaired or replaced the same day. Daily inspection of these devices by the contractor was not part of their regular routine. It is expected that, if these devices are used in future projects, contractors will become familiar and knowledgeable about their use.

Some motorists also had a visibility problem with the blue tubular markers. As discussed earlier, 38% of those surveyed in Pleasant Hill did not notice the blue markers and signs. The authors observed that after the road surface was paved, the blue markers became harder to distinguish, as their darker color blended in with the new asphalt. One possible solution to improve contrast is to use alternating white and blue bands (two each) of reflective sheeting near the top of the tubular marker. This would provide added contrast to the tubular marker during daylight hours, while still distinguishing the blue tubular markers from the orange markers at night.

Use of Both Markers and Signs

In Sweet Home, as noted earlier, a decision was made not to use blue tubular markers in conjunction with the signs because of the nature of construction. However, there were instances, in the authors' opinions, where blue markers could have been used to better delineate the business access. For example, when a work zone was established near a multi-use retail site that was about 100 m in length, orange tubular markers were used to designate the work zone and business access signs marked the entrances. In this circumstance, the use of blue tubular markers at each driveway within the work zone could have been helpful to motorists.

CONCLUSIONS

The use of business access signs in Sweet Home and blue tubular markers and access signs in Pleasant Hill was a positive step in mitigating impacts to businesses during highway construction. The following summarizes the findings regarding the use of these devices on each of the projects.

U.S. 20 in Sweet Home

The analysis of traffic count data in Sweet Home yielded inconclusive results. While six of the sites experienced decreases in traffic counts during construction, three of the remaining four sites showed dramatic increases of over 20% or more. Still, because of the limited counts, the effectiveness of the signs could not be determined from the data. Seasonal variations in traffic and the activities of individual businesses to generate increased customer traffic may have affected the counts but could not be specifically measured.

The business and motorist survey data demonstrated the usefulness of the business access signs. Twelve of 14 businesses said the presence of the signs helped customers locate the driveways to their business. Similarly, in the motorist survey, 242 of 292 respondents indicated the signs helped them locate the business access.

Several people felt the signs should be more visible to both directions of traffic. There was also some confusion with the wording on the signs when they were placed at the regular business entrances.

OR Route 58 in Pleasant Hill

The traffic count data for four business sites in Pleasant Hill provided evidence that business traffic was not significantly impacted when blue tubular markers and business access signs were used during construction. The seven-day counts demonstrated a seasonal pattern at each site. The counts were higher in the summer months and lower during the winter, but did not vary significantly between the periods of "no construction activity present" and "during construction with signs and markers."

Six of the 12 business owners/managers that had markers and signs at their accesses, said the devices helped their customers locate the driveways. Four of the business owners thought the blue markers and signs didn't help, and two others had no opinion.

In the motorist survey, 315 of 381 respondents said that they did not have any difficulty getting into and out of businesses. When asked if they noticed the blue markers and business access signs, almost 62% (237) of those surveyed replied that they had noticed them. Of those 237, 185 felt these devices helped them locate the business driveways.

Although the surveys yield favorable results about the blue markers and signs, it is difficult to make a universal statement about their effectiveness. Pleasant Hill is a small community and the businesses are spread out more than in a typical setting (like in Sweet Home). Consequently, although the majority of respondents believed they were helped by the blue tubular markers and business access signs, the low percentage of people who experienced difficulty in accessing businesses might be attributed to less congestion and fewer traffic conflicts in Pleasant Hill. However, the strong public support for the markers and signs demonstrates their potential for future use.

RECOMMENDATIONS

1. Blue tubular markers and business access signs should be used again in an experimental basis on future urban arterial projects where business accesses are impacted.
2. The wording on the “Temporary Business Access” sign should be changed to “Business Access” in future trials.
3. The signs used on future projects, should be mounted higher on NCHRP tested supports that are durable enough to withstand the rigors of construction and relocation and meet MUTCD requirements.
4. In future trials, four alternating bands of white and blue high-intensity reflective sheeting should be used on the blue tubular marker. The bands should be 75 mm wide, the spacing in between bands should be about 25 mm, and the uppermost band should be no more than 50 mm from the top of the marker.
5. Greater public awareness about business access signs and tubular markers needs to be established in the local community prior to the project starting.
6. Contractors need to fully understand their requirements for placing, monitoring, and relocating signs and tubular markers at business accesses.

REFERENCES

1. Center for Population Research. 1999. *1999 Oregon Population Report*. Portland State University, School of Urban and Public Affairs. Portland OR.
2. U. S. Census Bureau. 2000. *Census 2000 Summary File (SF 1) 100 Percent Data*. <http://www.census.gov/>. Accessed on June 28,2000.
3. Oregon Department of Transportation. 1996. *Standard Specifications for Highway Construction*. Salem OR.

LIST OF TABLES AND FIGURES

TABLE 1 Summary of Average Seven-Day Traffic Counts for Businesses in Sweet Home, Oregon

TABLE 2 Summary of Average Seven-Day Traffic Counts for Business Sites in Pleasant Hill

FIGURE 1 Typical layout of blue tubular markers and signs at business accesses.

FIGURE 2: Business Access sign with directional arrow mounted on Type II barricade.

FIGURE 3: Plots of traffic counts recorded: (1) “When No Construction Activity Was Present” and (2) “When Construction Activity Present, and Signs and Tubular Markers Used.”

TABLE 1 Summary of Average Seven-Day Traffic Counts for Businesses in Sweet Home, Oregon

| Business Category | Average When There was No Construction Activity Present | Number of Weeks Counted | Average During Construction With Signs in Place | Number of Weeks Counted | Difference in Average Counts | % Difference in Average Counts |
|--------------------------|--|--------------------------------|--|--------------------------------|-------------------------------------|---------------------------------------|
| Mixed Use Retail | 12,098 | 4 | 11,636 | 1 | -462 | -3.8 |
| Retail – Grocery | 6,120 | 3 | 5,183 | 1 | -937 | -15.3 |
| Retail - Gas/Grocery | 4,398 | 3 | 5,294 | 4 | 896 | 20.4 |
| Retail – Grocery | 3,338 | 1 | 2,906 | 1 | -432 | -12.9 |
| Mixed Use Retail | 3,075 | 3 | 3,134 | 1 | 59 | 1.9 |
| Retail – Gas | 1,088 | 2 | 1,486 | 2 | 398 | 36.6 |
| Fast Food Restaurant | 972 | 2 | 924 | 1 | -48 | -4.9 |
| Fast Food Restaurant | 939 | 1 | 339 | 1 | -600 | -63.9 |
| Retail – Specialty | 610 | 1 | 248 | 2 | -362 | -59.3 |
| Restaurant | 162 | 1 | 263 | 2 | 101 | 62.4 |

TABLE 2 Summary of Average Seven-Day Traffic Counts for Business Sites in Pleasant Hill

| Business Category | Average When There was No Construction Activity Present | Number of Weeks Counted | Average During Construction Using Signs and Tubular Marker | Number of Weeks Counted |
|--------------------------|--|--------------------------------|---|--------------------------------|
| Mixed Use Retail | 10,527 | 24 | 10,545 | 11 |
| Retail – Gas/Grocery | 3,290 | 23 | 3,742 | 7 |
| Restaurant | 2,851 | 28 | 2,434 | 7 |
| Retail – Grocery | 908 | 15 | 1,261 | 3 |

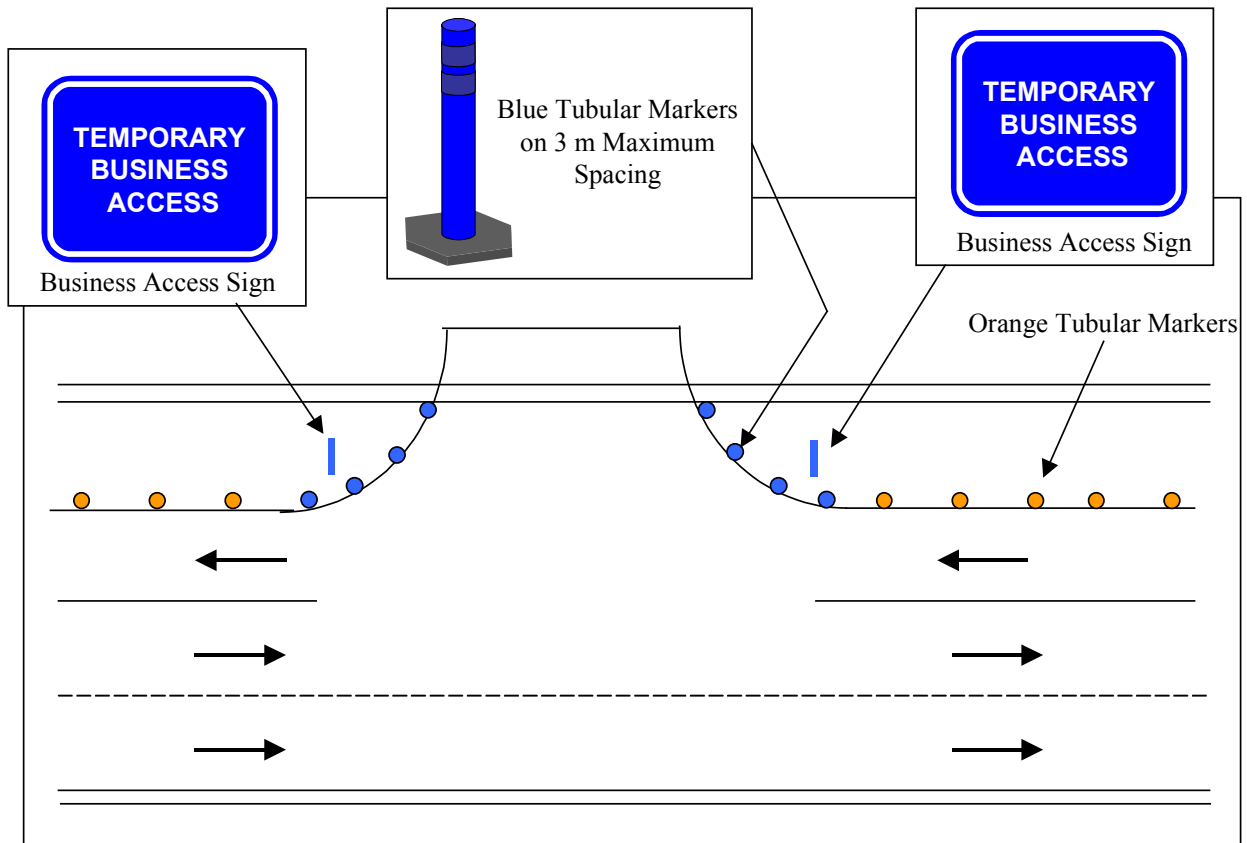


FIGURE 1 Typical layout of blue tubular markers and signs at business accesses.



FIGURE 2 Business Access sign with directional arrow mounted on Type II barricade.

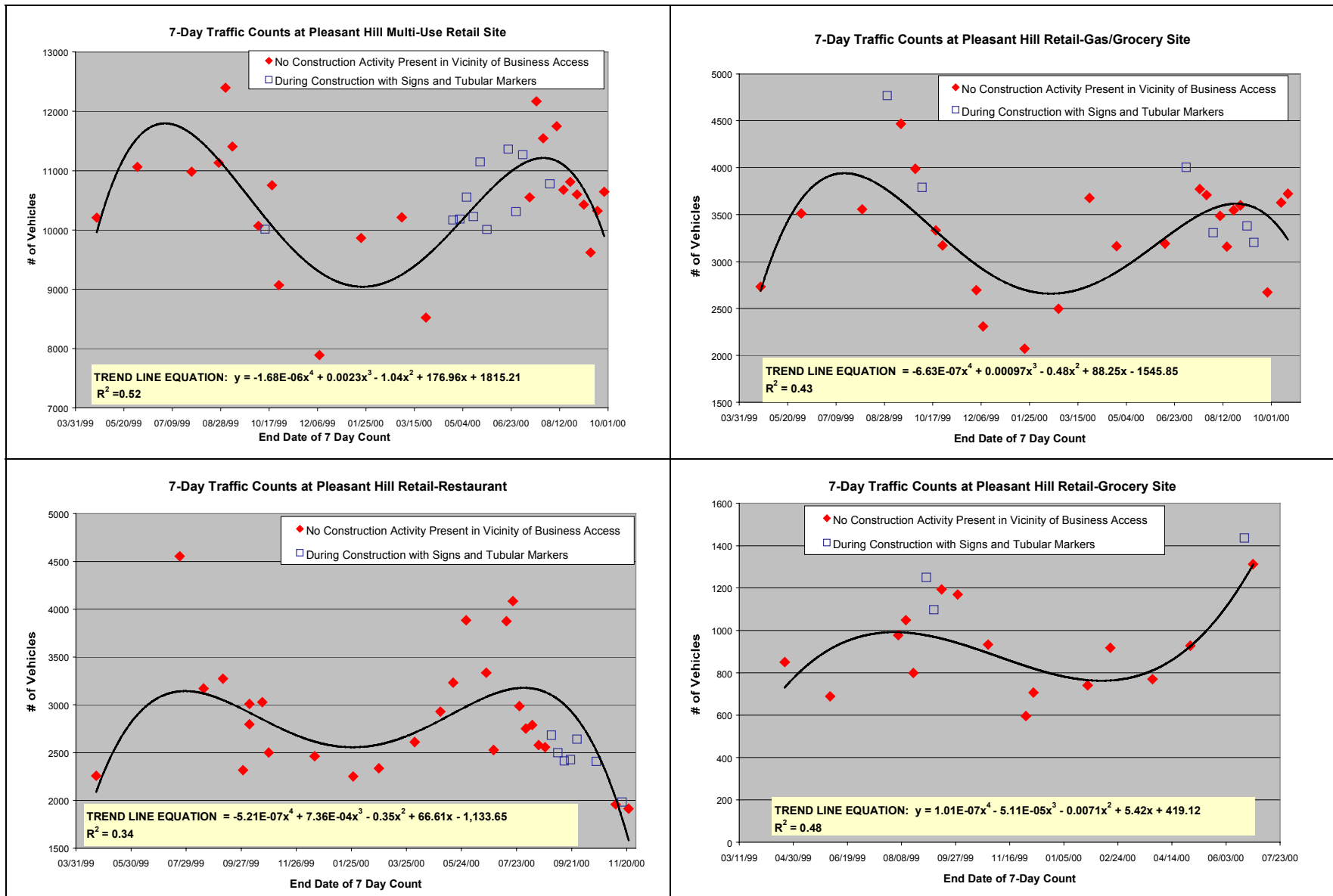


FIGURE 3 Plots of traffic counts recorded: (1) “When No Construction Activity Was Present” and (2) “When Construction Activity Present, and Signs and Tubular Markers Used.”