OREGON GREEN LIGHT: A NETWORK PRE-CLEARANCE WEIGHT STATION CASE STUDY

Prepared by:

Randal Thomas
Oregon Department of Transportation
Salem, Oregon

Chris Bell, Ph.D., P.E.
Department of Civil, Construction and Environmental Engineering
Oregon State University
Corvallis, Oregon

Derek Trischuk
International Road Dynamics, Inc.
Saskatoon, Saskatchewan

Curtis Berthelot, Ph.D., P.Eng.
Department of Civil Engineering
University of Saskatchewan
Saskatoon, Saskatchewan

Arthur Bergan, Ph.D., P.Eng.
International Road Dynamics, Inc.
Saskatoon, Saskatchewan

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ABSTRACT

Commercial truck traffic throughout North America is increasing. Along the I-5 corridor from Salem to Portland, commercial truck traffic has increased almost 40 percent from 1990-1998. Two weigh stations located on I-5 between Portland and Salem were initially built in the mid-1980's to statically weigh 2,300 trucks a day. Today, truck traffic at these weigh stations has increased to over 5,500 trucks per day. As a result, enforcement exposure along I-5 had significantly decreased due to capacity restrictions of the existing weigh station facilities.

The Oregon Green Light Pilot Project was initiated in 1995 to deploy semi-automated pre-clearance weigh stations designed to improve the enforcement effectiveness of existing weigh station facilities. In all, the Oregon Green Light Pilot Project has modernized 21 Oregon weigh stations. A typical Oregon Green Light enforcement facility includes a pre-clearance/sorting system on the mainline employing weigh-in-motion (WIM) scales, and pole-mounted automatic vehicle identification (AVI) readers that interface with State computer databases. The pre-clearance system is capable of checking the compliance of commercial vehicle configuration, axle weights, and the credential records related to vehicle specific registration, tax payments, and safety as the vehicle approaches the weigh station. Upon processing the vehicle information, the driver is signaled with an in-cab device to either bypass (green light), or report (red light) to the weigh station.

During 1999, more than 200,000 mainline bypasses were recorded at Green Light equipped weigh stations. In 2000, a total of 641,302 trucks received green lights to bypass Oregon Green Light weigh stations. The annual number of pre-clearance bypasses is expected to continuously grow as more carriers enroll in the Green Light Program.

The Oregon Department of Transportation estimates the direct benefits of the Oregon Green Light Pilot Project to be $25 million per year in direct savings to the Oregon government and haul cost savings for the trucking industry. Additional savings are realized from increasing commercial vehicle enforcement exposure, improving safety on public roads by reducing the occurrence of unsafe commercial vehicles and preservation of the road infrastructure by reducing the occurrence of overloaded trucks. The Oregon Green Light Pilot Project is a model deployment that could result in significant savings to public road authorities and commercial carriers if implemented on a national basis. This paper summarizes the equipment deployed in the Oregon Green Light system, and quantifies the tangible and intangible costs and benefits of the Oregon Green Light Pilot Project.

Key words:
Commercial vehicle operations, automated weigh stations, weigh in motion (WIM), automatic vehicle identification (AVI), road preservation, intelligent transportation systems, traffic safety.
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1 BACKGROUND

The number of trucks has been steadily increasing throughout North America, resulting in strained capacity at weigh stations. For instance, the Port of Entry south of Portland on Interstate 5 was built in 1982 to weigh 2,300 trucks per day. This same Port of Entry now weighs more than 5,500 trucks per day. Truck traffic at other enforcement facilities within Oregon also has increased by comparable amounts. As a result, enforcement exposure has significantly decreased due to capacity restrictions of the existing weigh station facilities.

In order to improve the efficiency and effectiveness of commercial vehicle operations, as well as to increase capacity at existing weigh stations, the State of Oregon investigated the use of intelligent transportation systems. In 1984, Oregon began sorting heavy vehicles on the approach ramps at Ports-of-Entry (POE) by employing weigh-in-motion (WIM) and signal lights to sort and direct trucks based on weight compliance. Although ramp WIM sorting systems considerably improved the efficiency of existing weigh stations, significant increases in commercial truck volumes resulted in queues on the ramps, and at times, backups onto the mainline during peak flow periods. When queues form onto the mainline, all trucks must be instructed to bypass the facility for safety reasons. Therefore, non-compliant trucks have a higher probability of bypassing the enforcement facility during peak traffic times. Another disadvantage to conventional ramp sorters was the inability to perform safety and credential checks (Krukar & Evert, 1988).

In 1985, Oregon became a participant in the multi-state HELP/Crescent Demonstration project that was designed to use WIM with one-way Automatic Vehicle Identification (AVI) transponders (truck to AVI) to weigh and identify commercial vehicles approaching weigh station facilities. Messages to either report or bypass the static scale were communicated to the truck via roadside variable message signs. To reduce confusion among other motorists, due to misreading of signs, Oregon implemented a Port-of-Entry Advanced Sorting System (PASS) in 1992 using a two-way AVI-transponder communication system. The PASS system proved that
current technology could sort trucks on the mainline by signaling the driver in the cab to either bypass or enter a weigh station (Oregon Department of Transportation, 1998).

In 1995, Oregon partnered with International Road Dynamics Inc. to develop and deploy the Oregon Green Light system. The Oregon Green Light System integrated weigh station preclearance systems at the State wide network level to improve the efficiency and safety of commercial vehicle operations while improving the long term performance of the highway system. As of spring 2001, 21 weigh stations are capable of screening trucks electronically on the mainline using high-speed single load cell weigh-in-motion and two-way automatic vehicle identification/communication systems. Figure 1 illustrates all the locations of each Oregon Green Light preclearance weigh station throughout the state of Oregon.

Figure 1 - Location of Green Light Pre-Clearance Weight Enforcement Facilities in the State of Oregon
2 SYSTEM OVERVIEW

The intent of the Oregon Green Light mainline preclearance system is to allow commercial vehicles equipped with transponders to proceed unimpeded past weigh station facilities if the truck complies with Oregon weights, dimensions, credentials and safety regulations. Oregon Green Light facilities employ two fundamental mainline system layouts to sort trucks. Figure 2 illustrates a typical single lane sorter for truck volumes up to approximately 4000 trucks per day, and for higher volumes of commercial truck traffic, Figure 3 illustrates a dual lane mainline sorter system layout.

Oregon Green Light weigh stations are uniquely designed for specific geometric, traffic and environmental conditions at each site location. Considerations that influence weigh station layouts include: layout of the existing weigh station, truck traffic and total traffic volumes, possible WIM locations, land availability and usage, and overall site functionality. A typical single lane Oregon Green Light sorter system illustrated in Figure 2, includes inductive loops embedded in the pavement to activate a roadside computer, axle detectors, single load cell weigh-in-motion scales, and overheight detectors. Simultaneously, an AVI system activates the truck’s transponder and scans its unique acquisition signal to the roadside computer. The truck weights and dimensions along with the transponder information are sent via fiber optic cabling or radio frequency to the weigh station supervisory computer, which checks state records for vehicle registration, allowable weight declaration, tax status, and safety records. After the vehicle data is analyzed a signal is returned to a downstream roadside AVI device, which communicates a bypass (green light) signal if the truck complies with all Oregon regulations or a report (red light) signal if the system reveals a potential violation.

![Figure 2 Single Lane Oregon Green Light Mainline Preclearance System Layout](image-url)
Figure 3 illustrates an Oregon Green Light weigh station facility specifically designed for high truck traffic as is typical for I-5. The dual lane sorter system operates in a similar fashion to the single lane system in Figure 2, except trucks can be evaluated and communicated to using two lanes. Oregon’s Woodburn POE on Interstate 5 became the world’s first operational dual lane mainline pre-clearance system capable of sorting trucks on two lanes. The Oregon Green Light Network currently has two dual lane sorter systems operational, the second having been installed on the northbound side of I-5 at Woodburn (Oregon Department of Transportation, 1994).

![Dual Weigh Station Sorter System](image)

**Figure 3 - Dual Weigh Station Sorter System**

In order to ensure optimal reliability and accuracy for sorting trucks based on weigh compliance, the Oregon Green Light System employs Type III weigh-in-motion systems as specified by ASTM Designation: E 1318-94, Standard Specifications for Highway Weigh-in-Motion Systems. ASTM E 1318 categorizes weigh in motion into three types of systems based on accuracy at 95 percent probability of conformity: Type III has a +/- 6 percent error, Type I has a +/- 10 percent error and Type II has a +/- 15 percent error at highway speeds.

### 3 USER OPERATIONAL COST SAVINGS

Reductions in time delay resulting from mainline electronic screening of truck traffic are acknowledged as one of the primary benefits of the Oregon Green Light system. The operating
cost of a typical commercial vehicle has been estimated by the American Trucking Association to be $1.92 per mile (American Trucking Association, Annual Report, 1997). Given an average speed of 39 miles-per-hour from departure to destination, this equates to a cost of $1.24 per minute. Early field operational tests conducted by the FHWA with respect to the time saved by mainline electronic screening estimated average savings of 4.5 minutes per bypass (Belella et al, 1998). Based on another study at the Williamsville weigh station in Springfield, Illinois, the average delay time at the weigh station was determined to be 4.95 min/truck, with a range of 3.56 to 137.62 min/truck (Benekohal, RF; El-Zohairy, YM; Forrler, E; Aycin, MF., 1997) In 2000, a total of 641,302 trucks received green lights to bypass Oregon Green Light weight stations. Table 1 lists the preclearance activity recorded at each Green Light weigh station.

<table>
<thead>
<tr>
<th>Green Light Weigh Station</th>
<th>Average Preclearance Activity (bypass/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodburn Port of Entry (Interstate-5 South)</td>
<td>20,444</td>
</tr>
<tr>
<td>Woodburn Weigh Station (Interstate-5 North)</td>
<td>7,406</td>
</tr>
<tr>
<td>Wilber Weigh Station (Interstate-5 South)</td>
<td>1,915</td>
</tr>
<tr>
<td>Booth Ranch Weigh Station (Interstate-5 North)</td>
<td>1,185</td>
</tr>
<tr>
<td>Ashland Port of Entry (Interstate-5 North)</td>
<td>8,054</td>
</tr>
<tr>
<td>Ashland Weigh Station (Interstate-5 South)</td>
<td>1,453</td>
</tr>
<tr>
<td>Cascade Locks Port of Entry (Interstate-84 East)</td>
<td>N/A</td>
</tr>
<tr>
<td>Wyeth Weight Station (Interstate-84 West)</td>
<td>N/A</td>
</tr>
<tr>
<td>La Grande Weigh Station (Interstate-84 East)</td>
<td>297</td>
</tr>
<tr>
<td>Emigrant Hill Weigh Station (Interstate-84 West)</td>
<td>670</td>
</tr>
<tr>
<td>Olds Ferry Weigh Station (Interstate-84 East)</td>
<td>501</td>
</tr>
<tr>
<td>Farwell Bend Port of Entry (Interstate-84 West)</td>
<td>4,281</td>
</tr>
<tr>
<td>Umatilla Port of Entry (Interstate-82 South)</td>
<td>4,723</td>
</tr>
<tr>
<td>Juniper Butte Weigh Station (US Hwy 97 North)</td>
<td>445</td>
</tr>
<tr>
<td>Juniper Butte Weigh Station (US Hwy 97 South)</td>
<td>342</td>
</tr>
<tr>
<td>Klamath Falls Port of Entry (US Hwy 97 North)</td>
<td>1,332</td>
</tr>
<tr>
<td>Klamath Falls Weigh Station (US Hwy 97 South)</td>
<td>342</td>
</tr>
<tr>
<td>Lowell Weigh Station (OR Hwy 58 West)</td>
<td>150</td>
</tr>
<tr>
<td>Brightwood Weigh Station (US Hwy 26 West)</td>
<td>153</td>
</tr>
<tr>
<td>Brightwood Weigh Station (US Hwy 26 East)</td>
<td>219</td>
</tr>
<tr>
<td>Rocky Point Weigh Station (US Hwy 30 West)</td>
<td>339</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>641,302</strong></td>
</tr>
</tbody>
</table>

In late 2000, the Oregon Green Light system was pre-clearing an average of 70,000 trucks per month statewide. If each commercial truck saves 4.5 minutes per bypass, the monthly savings to industry is estimated to be $390,600. Therefore, if Oregon Green Light continues to
pre-clear 70,000 trucks per month, it can be projected that over ten years, the Oregon Green Light system will save the trucking industry 630,000 hours of travel time, resulting in a present worth of $34.5 million in reduced commercial vehicle operating costs at a 6 percent annual discount rate. However, with the ongoing growth of the Oregon Green Light program, Oregon expects to far exceed the current level of user benefits. To illustrate, assuming a 5, 15, and 25 percent annual growth in the number of commercial vehicles participating in the Oregon Green Light program, the resulting present worth of the operational cost savings for carriers are $42.4, $65.6 and $103.5 million respectively, as shown in Figure 4.

![Figure 4](image)

**Figure 4**  Truck Cost Savings over 10 years

Oregon Green Light promotes further benefits for participating carriers through the Oregon Trusted Carrier Program. Trucking companies that enroll in the Green Light program and pass a 12-month operational review and 24-month safety record review, meet the enrollment criteria of the Oregon Trusted Carrier Program and receive additional benefits. These additional
benefits include weigh station preclearance privileges, waiver of ODOT tax bond, and no random safety inspections unless warranted, and no random safety compliance reviews.

4 SAFETY BENEFITS

Other benefits accrued from the Oregon Green Light System are related to improved safety. With electronic screening and the issuance of bypasses to trucks operating on the mainline fewer lane changes, and passing operations around commercial vehicles slowing to enter a weigh station, are required. Therefore there are additional benefits to be gained from decreased risk of accidents from traffic queues at weigh stations (Brock, 1999).

Another safety benefit results from carriers with known history of good safety, weights, dimensions, and credentials compliance, being bypassed on the mainline without having to enter the weight enforcement facility. Thus, safety inspections can concentrate on carriers that report to the weigh station, which are more likely to need the time and attention of enforcement officers (Montagne, 2000). As a result, the Oregon Green Light system provides commercial carriers with the incentive to improve their safety record in order to enroll in Oregon’s Trusted Carrier program.

5 GOVERNMENT BENEFITS

There are an estimated 500,000 interstate trucking firms with operating authority in the United States of America with over five million operational trucks. Truck volumes are increasing by about 5 percent per year. The number of trucks traveling through Oregon has been steadily increasing over recent years and straining capacity at weigh stations. Since 1990, truck traffic has increased between 27 to 40 percent on various corridors within Oregon. For instance, the Port of Entry south of Portland on I-5 was built 18 years ago to weigh 2,300 trucks a day. The Port of Entry now weighs more than 5,500 trucks per day. Truck traffic at other enforcement facilities within Oregon has increased by comparable amounts.

In order to effectively enforce commercial vehicle regulations in light of the significant increases in truck traffic, ODOT would be forced to spend an estimated $2.3 million per site at 11 weigh stations to extend entry and exit ramps and add static scales. Over time, another five
weigh stations would be rendered obsolete because of land restrictions. Assuming replacement facilities could be built within reasonable proximity to the current sites, the cost of construction is estimated at approximately $14 million per site for a total of $224 million. As a result, the Green Light system is enabling technology to more cost effectively manage growing truck traffic at these facilities. Without the Green Light system, Oregon may have been forced to close existing weigh station facilities, which would compromise commercial vehicle size and weigh enforcement presence within the state of Oregon.

Oregon Green Light mainline preclearance systems significantly increase the operational capacity of existing weigh stations. Therefore, increased weigh station efficiency provides the financial benefits of capital cost avoidance to the state of Oregon. The Oregon Green Light system provides the enabling technology for the State of Oregon to increase the performance of roadside facilities without having to physically expand them. Mainline sorting also reduces congestion at weigh stations, eliminating the need to add additional lanes and scales at the facilities.

Most importantly, Oregon protects and preserves the public investment in the highway infrastructure by improving enforcement efficiency and stopping overloaded trucks, trucks that would otherwise be allowed to proceed and cause millions of dollars in highway pavement damage. In 1999, enforcement officers at Oregon weigh stations issued 13,254 citations and 18,602 warnings to truckers operating over-weight (Oregon Department of Transportation, POE and weigh station summary, 1999). In the first six months of 2000, the Green Light system screened more than 270,000 transponder-equipped trucks and sent a red light signal to 5,000 of them (less than 2 percent) because they were overweight. Yet, without Green Light systems to manage truck traffic, Oregon weigh stations would have to periodically close due to congestion, allowing the potential for overweight trucks to illegally bypass the facility.

Researchers in Idaho have developed a model for estimating the cost benefits of weigh stations by preventing premature pavement damage in a typical highway setting. The model indicates that a single weigh station covering a road length of 160 miles prevents approximately $4 million in pavement damage over the course of ten years (Parkinson et al, 1992). An earlier FHWA study found that, nationwide, overloaded truck axles cause up to $670 million per year in incremental pavement damage (Taylor et al, 2000 and TRB Special Report 225, 1990).
Thus, with 21 improved weigh stations enhancing the ability to minimize overloaded trucks in Oregon, it is estimated that Oregon could save well in excess of $80 million during the next 10 years in reduced road impact damage due to commercial vehicle overloading. These benefits are associated with: (1) the effect of deteriorating pavement conditions on fuel economy, tire wear, and other related maintenance costs, (2) time delays suffered during pavement resurfacing, reconstruction, rehabilitation, and maintenance, and, (3) time delays suffered due to traffic control related to remodeling, upgrading, and/or reconstruction of weigh stations.

6 SUMMARY

Oregon’s Green Light mainline preclearance system was deployed to improve commercial vehicle enforcement efficiency throughout the State of Oregon. In total, 21 Green Light pre-clearance weigh stations have been integrated into the Oregon Green Light system, which clearly makes the Oregon Green Light system the worlds most advanced and efficient network level weight enforcement program. By late 2000, more than 14,000 trucks had received 70,000 bypasses per month at Oregon Green Light facilities, resulting in millions of dollars in timesavings each year. These savings are expected to grow substantially as more motor carriers enroll in the program. Additional savings will also be realized from increasing commercial vehicle enforcement exposure, improving safety on public roads by reducing the occurrence of unsafe commercial vehicles, and preservation of the road infrastructure by reducing the occurrence of overloaded trucks. In addition, Oregon Green Light reduces congestion at weigh stations, which eliminates the need to add lane and scale capacity.

Oregon Green Light has provided enforcement officials a cost effective alternative to improve the efficiency of the Oregon weight enforcement program in order to meet growing enforcement requirements due to increasing truck traffic. The Oregon Green Light Pilot Project is a model deployment that generates significant savings to public road authorities and commercial carriers if implemented on a national basis.
7 FUTURE DEVELOPMENTS

Oregon Green Light could generate additional savings if compatible AVI transponder protocols were adopted with other states pre-clearance systems. Currently, the Oregon Green Light system is sending red light signals to tens of thousands of compatible transponder-equipped trucks each month, resulting in thousands of unnecessary reports at Green Light weigh stations. Companies that have transponders issued by other preclearance systems are not currently permitted to register transponder identification numbers in Green Light (Bell, 2000). Because the transponders can’t be turned off, Oregon’s AVI system reads the constantly emitted signal from each of those transponders and sends a red light signal to the vehicle. Future cooperation between compatible pre-clearance programs could result in additional savings resulting from the Oregon Green Light system.

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