TSI
Transportation Solutions, Inc.

8250 - 165th Avenue NE
Suite 100
Redmond, WA 98052-6628
T 425-883-4134
F 425-867-0898
www.tsinw.com

HANFORD SITE

VEHICLE TRAFFIC SAFETY ASSESSMENT

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Prepared for:
Mission Support Alliance
and
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Richland, Washington

Prepared by:
Transportation Solutions, Inc.
8350 165th Ave Northeast, Suite 100
Redmond, Washington 98052
425-883-4134
tsinw.com

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Executive Summary

Transportation Solutions Incorporated provides the following assessment and recommendations for improving safety on the Hanford Site road system.

Hanford's rural arterial road system is operating in an over capacity and highly congested condition in several key locations on Beloit Road, Route 3 and Route 4 South. Traffic surges during the PM peak hour create congestion breakdowns of traffic flow at the "four corners" intersection of Routes 3 and 4 South, with backups in the eastbound direction of more than 600 feet on average. Occasionally these eastbound queues at the Route 3/Route 4 South intersection can extend for several thousand feet or more during the evening peak surge on extremely high traffic volume days during the year. Traffic simulations show that the queues can extend over a mile. This is consistent with complaints that have been reported. PM peak hour volumes measured in October 2009 suggest that the eastbound right turn movement is operating at a volume to capacity ratio (V/C) of 1.25. In other words volume is exceeding the capacity of the roadway at that intersection for that movement. Backups in the southbound direction on Beloit Road at the intersection with SR-240 have been reported to extend to the "S plant" which is located over 2 miles north of the Beloit Road/SR240 intersection.

In addition, the PM peak hour volumes measured in October 2009 at Milepost 9 on Route 4 South indicate that roadway is operating at a V/C ratio of 0.92. In other words volume is very nearly equal to the maximum capacity of the roadway at that location. Additional analysis of the segment between Mileposts 6 and 11 shows that commuters using Route 4 S spend more than 80% of their evening commute following other slower vehicles without an opportunity to pass which equates to a Level of Service (LOS) of E. Traffic simulation also shows that congestion on Route 4 South near the intersections with Baltimore and Canton may be metering the eastbound volume. During the peak 15 minute surge level of service failures are probably occurring at the locations on Route 4 South where eastbound lanes drop from 3 to 2 and from 2 to 1 at the existing "flying T" high speed merges. Typically, two-lane rural arterials are designed to operate at LOS C or better and drivers expect to be stuck following slower vehicles no more than 65% of the time. In the AM peak hour there are two locations (Route 2 S intersection with Route 4S, and Canton Avenue intersection with Route 4S) that experience LOS failures for left turns at the minor approach. However, traffic volumes tend to be very low for these movements in the AM peak at these intersections, and although individual vehicles may experience significant delays to make the desired movement, significant queues do not appear to develop.

Speed studies indicate that the 55 mph speed limit is set artificially low on several of the main roadways, leading to large speed differentials among vehicles. This large speed differential leads to large platoons of vehicles moving in one direction. This condition, combined with an extraordinarily high percentage of vehicles traveling in the same direction with very little opposing traffic, creates an inordinate amount of psychological pressure for aggressive drivers to pass large numbers of vehicles in one maneuver, often at high speeds and occasionally within "no-passing" zones. When passing vehicles encounter oncoming traffic or "no-passing" restrictions, these more aggressive drivers may attempt to abruptly force their way back into the middle of the vehicle platoon, causing some drivers to brake unexpectedly thereby creating disruption in traffic flow, worsening congestion and angering other drivers. These problems are exacerbated by a relative lack of speed enforcement on the Hanford site. The combination of artificially low speed limit and lack of enforcement has resulted in a very rare condition where the vast majority of drivers routinely exceed the speed limit just to stay within the flow of traffic.

As more workers are employed on the Hanford Site during the next several years, these problems will worsen if not addressed soon through a combination of engineering, operational, enforcement and educational approaches. Without significant changes in several key areas, traffic congestion and aggressive driving will worsen increasing the risk of serious accidents.

Because the Hanford remediation operations are a dynamic process, the approach to traffic management should evolve as the focus and intensity of operations evolve on site. The anticipated completion of remediation activities within the next 5 to 10 years in the 100 and other outlying areas, resulting in increased concentration of activities within the Central Plateau (200E and 200W) areas, will create both opportunities and challenges for traffic and road infrastructure management. Fortunately the traffic impact of these expected changes can be anticipated through modeling, and appropriate infrastructure and operational modifications can be made prior to or coincident with site activity changes.

Engineering Recommendations

TSI recommends the following as the most effective package of infrastructure improvements to address Hanford's traffic congestion and safety problems, at reasonable capital and operating costs, and with an expected overall reduction in fuel usage and greenhouse gas emissions:

- Channelization improvements to provide eastbound right turn channelization and merge lane at the intersection of Routes 3 and 4 South. These improvements should be designed to integrate with a future roundabout at the intersection of Route 3 and Route 4 South.
- Future roundabouts at the intersections of Route 4 South with Baltimore and Canton with 4 lane section on Route 4 South from west of Baltimore to the Canton roundabout. Completion of the 4 lane section east and north to Route 3 may also become necessary as activities in the Central Plateau increase over the next decade.
- Conversion of Route 4 South from Canton to the Wye Barricade to a reversible one-way two-lane arterial during the AM (inbound) and PM (outbound) peak travel periods. This conversion would eliminate speed differential conflicts, provide greater maneuverability within the traffic stream and provide needed capacity in the peak direction during the peak traffic time periods on the Hanford Site's most heavily used roadway.

In addition, there are some relatively simple traffic channelization practices that can be implemented to improve safety along the site's road corridors, particularly in response to the reports of frequent attempts to pass within striped no passing zones. Flexible yellow pylons can be installed on the centerline in areas striped as "no passing zones" with double yellow stripes. These pylons would discourage drivers from attempting to pass within designated "no passing zones." An alternative to flexible pylons would be centerline rumble strips which provide a tactile and audible warning to highlight the striped "no passing zone" designation. Shoulder rumble strips can also be utilized along routes where vehicles frequent leave the roadway due to driver inattentiveness or "drowsy driving."

TSI also recommends construction of periodic enforcement "pull-outs" or shoulder widening on Route 4 South and Beloit, and that the length of designated "no passing zones" be set for a design speed of 65 mph to provide a reasonable factor of safety recognizing that the 85^{th} percentile speeds are generally between 60 and 65 mph on most road corridors on the site.

Enforcement Recommendations

More effective enforcement must be a component of a comprehensive traffic safety approach on the Hanford Roads. This can be approached using additional and reconfigured service provided by the Benton County Sheriff's Office and/or by the potential expansion of Automated Camera Speed Enforcement to include the Hanford Site by the State Legislature, as well as adoption by the Benton County Commission of an ordinance to allow for the use of Automated Camera Speed Enforcement and to set penalties in accordance with RCW 46.63.170 (attached).

Operational Recommendations

TSI recommends that the speed limit be raised on selected roadways to 60 mph in concert with increased enforcement as identified above. While this may seem counterintuitive, we believe this change would improve safety and would allow for more effective enforcement. The expected result of this change would be an increase in speeds by lower-speed drivers, thereby reducing speed differentials, reducing the size of platoons, and reducing pressure to pass. Safety and congestion would be expected to improve somewhat as a result. Currently there is significant opposition to traffic enforcement by a large segment of Hanford Site workers. That is likely because many people believe that existing speed limits are too low, and they would be risking a traffic citation for traveling what they believe are safe and appropriate speeds. Increasing the speed limit to 60 mph would have the effect of shifting from less than 30 percent compliance to nearly 80 percent compliance with posted speeds on main commuter routes. The recommended change in speed limits would allow for more focused enforcement, and could increase the potential for acceptance of increased enforcement by a majority of Hanford workers.

Optimization of work schedules may be feasible to reduce high P.M. peak traffic surges at the 200 areas (particularly at the Rt 3/Rt 4 S intersection) and Rattlesnake Barricade intersection with SR 240. This would have a result of stabilizing traffic flow rates and reducing congestion. It is apparent that some staggering of work schedules is already being implemented. As the activity grows on site, particularly in the 200E and 200W areas, decisions regarding optimization of work schedules to meter traffic into and out of the Hanford site will be critical to avoiding severe congestion even with the recommended roadway improvements. Without significant infrastructure improvements, keeping vehicle traffic more uniform throughout the peak commute times and maintaining peak 15 minute flow rates below the capacity of the roadway corridors and intersections are critical operational imperatives to prevent the congestion that grips the Hanford site roadways periodically under current conditions.

Educational Recommendations

We recommend that Hanford leadership develop a strategic educational campaign to lay out the comprehensive approach to improving traffic safety and operations, with a goal of developing widespread support for the changes and improved compliance with traffic laws. The ultimate focus of the educational messaging will depend on the implementation actions taken related to the issues addressed in this report.

Introduction

Background

The Hanford Site is co-managed by the U.S. Department of Energy, Richland Office (DOE-RL) and the U.S. Department of Energy, Office of River Protection (DOE-ORP). The Mission Support Alliance, LLC, a team led by Lockheed Martin, Jacobs, and Wackenhut Services, Inc. was specifically created to provide infrastructure and site services in support of DOE and its contractors on the Hanford Site.

TSI, as a subcontractor to Vista Engineering, was retained by the Safety, Security and Environment branch of the Mission Support Alliance to assess and make recommendations regarding vehicle safety issues of concern to the operators, contractors and workers at the Hanford Site in Richland, Washington. As the "integrating contractor" for the Hanford site, MSA is responsible for providing overall management and direction to safety and security activities for all operations on the site. Currently there is significant and increasing activity at Hanford focused on environmental remediation of materials and facilities that were created over the last half of the 20th Century to develop and test nuclear technologies for defense, energy generation and research purposes. A recent increase in federal funding for the remediation activities has dramatically increased the number and intensity of commute and work trips on the site's limited road infrastructure. During the next five years the majority of that remediation activity is expected to be accomplished, with future work beyond 2015 focused in the Central Plateau, which encompasses the 200 Area.

Through correspondence and briefings during an October 20, 2009 kick-off meeting, TSI learned about significant concerns regarding perceived increases in congestion, and high-speed, reckless and aggressive driving on State Highway 240 (SR 240), which serves as a primary commuter route, as well as Route 4 South, Beloit Road and other internal site roadways. Although serious collisions had not been numerous recently, there had been several serious injury and fatal collisions within the past five years, and the increase in previously noted risk factors appeared to be increasing the potential for serious injury or fatality collisions in the near future.

Traffic Operations and Safety Overview

The dynamics of traffic in a road system are similar in many respects to an interconnected plumbing system. The road sections are like the pipes, and intersections and interferences are like metering valves or bottlenecks that constrict flow. The road geometry functions like the insides of the pipe. A low friction road operating at its optimum pressure will allow more traffic to pass through at a higher rate of speed, than a high friction road at either lower or higher than optimum pressure.

Physical or psychological interferences, such as rough pavement, narrow lanes, inefficient channelization, lack of shoulders, speed enforcement, or traffic controls, multiple driveway connections and disabled vehicles or distractions along the roadway, all can create friction in the system which will impede flow. Conversely, physical and psychological factors, such as smooth pavement, straight roads, properly banked turns, long sight distances, long travel distances, lack of intersections, efficient controls, can reduce friction within the system and increase flow. Traffic engineering studies consistently have shown that the vast majority of drivers will travel over a given roadway within a 10 mph speed band, regardless of posted speed. The speed driven is affected by the physical and psychological factors cited above, including the distance to be covered. Drivers tend to drive faster when traveling long distances on long, straight roads with few intersections or roadside interferences, and drive slower when traveling shorter distances on curving roads with numerous intersections or visual roadside distractions.

Other factors, such as highly directional travel patterns or lack of speed enforcement, can create large speed differentials which increase pressure to pass or move faster than the other vehicles. As pressure is increased, more volume moves through the system, until the system reaches a point of flow instability resulting in congestion and temporary failure of the system to move traffic efficiently.

Localized failure of the system by virtue of collisions or traffic volume in excess of road capacity, create localized congestion that increases pressure in other parts of the system. Like plumbing there is an optimum maximum traffic flow rate, where the volume and capacity are in balance (V/C ratio = 1.0). When the volume to capacity ratio approaches 1.0, the facility will accommodate the highest flow rate of traffic, although at far lower speeds than typical free flow conditions. However, it is important to note that transportation facilities operate very poorly at or near capacity and they are rarely planned to operate in this range because even minor disruptions in traffic flow can quickly lead to gridlock. When the volume to capacity ratio is low, the system will operate very well accommodating increased speeds, up to the limitations of the road geometry and the comfort of drivers, but will carry less traffic and technically be less efficient than facilities operating at higher volume to capacity ratios. When volume approaches capacity, (V/C ratios near or above 1.0) traffic flow becomes increasingly unstable, causing capacity to drop dramatically, and resulting in gridlock. Severe congestion will not decrease on a roadway until the volume demand drops for a sufficient period to allow speed to increase resulting in recovery of normal flow conditions.

Capacity of two-lane roads is determined by traffic volume flowing in both directions. Two-lane roads are different from multiple lane roads in that opposite flows interact to determine capacity and speed. Two lane roads operate most efficiently when the flow of vehicles is roughly equivalent in both directions. Highly directional distributions can create unusual operational inefficiencies and safety problems. As total volume increases on a two-lane road, speed decreases and vehicle density increases. Heavy vehicles also have a major impact on roadway capacity. Road systems are most efficient when all vehicles travel at the same speed, or the geometry of the road system allows for multiple lanes in the same direction to allow for speed stratification in the individual lanes. Human behavior is the most variable element of the system. Variations in the motivations of and abilities of individuals lead to vehicle speed differentials. On two-lane roads, the only relief for driver pressure to travel faster than other slower vehicles is by allowance for passing, either with passing lanes or in the oncoming lane of travel. This pressure in individual drivers to travel faster than the flow of traffic, coupled with calculated risk-taking behaviors inherent in passing operations increase the opportunities for and potential risk of serious collisions.

The Institute of Transportation Engineers (ITE) Traffic Engineering Handbook, 6th Edition, identifies four major factors that affect traffic safety: Engineering, Enforcement, Emergency Medical Service, and Education. That is, traffic safety can be analyzed within the context of these four "E" disciplines, and reduced or exacerbated by modifications to conditions falling within these categories.

The most objective long term measures of traffic safety are the number and severity of vehicle crashes, with non-injury collisions of lesser concern than serious injury and fatality crashes. Therefore any assessment of safety must include an analysis of the factors that create risk for serious injury and fatality collisions and crashes. As noted in the following section, roadway and vehicle engineering and maintenance are relatively minor crash contributors, as human factors, such as driving too fast, inattentiveness, driving while intoxicated, or failure to yield, are involved in virtually all collisions and crashes.

While rates for various categories of collision are the most objective standard for evaluating safety, a high number of serious collisions in very recent data may not indicate especially unsafe conditions. Conversely a reduction in collisions following implementation of new road project or enhanced enforcement may not have been caused by the changed condition. These occurrences may have been the result of what is known as regression toward the mean. That is, a relatively safe facility could have several serious collisions in a short period of time, then experience very few serious accidents over a prolonged period, without any change in the Four E conditions. The converse is also true, that a deteriorating roadway or changing traffic or human behavioral conditions, such as recent increases in speed and volume of traffic, can generate increased risk for future serious collisions, even though collision rates currently may not be high.

Crash Factors

Traditionally vehicle crashes have been called “accidents”. However, the term “accident” is not used in this report as it connotes an unpredictable unavoidable incident. Instead we will use the terms “collision” and “crash”, which more objectively describe the totality of incidents that includes vehicle-vehicle collisions, vehicle-animal collisions, vehicle-pedestrian/bicycle collisions, vehicle-fixed object collisions and single-vehicle rollover crashes.

The Institute of Traffic Engineers (ITE) worldwide data indicate that approximately 95 percent of all crashes involve human factors. Road factors are involved in 28 percent of crashes and vehicle factors in 8 percent. As shown in the following tables, there are often multiple factors involved in a crash or collision. For example, of the 95 percent of crashes involving human factors, 67 percent result solely from human factors, while 24 percent also involve road factors, and 4 percent involve road factors. Of the 28 percent of crashes that involve road factors, 4 percent result solely from road factors, 24 percent are the result of both road and human factors, and less than a half a percent are the result of road and vehicle factors. The relationship of these factors is shown in the following graphics.

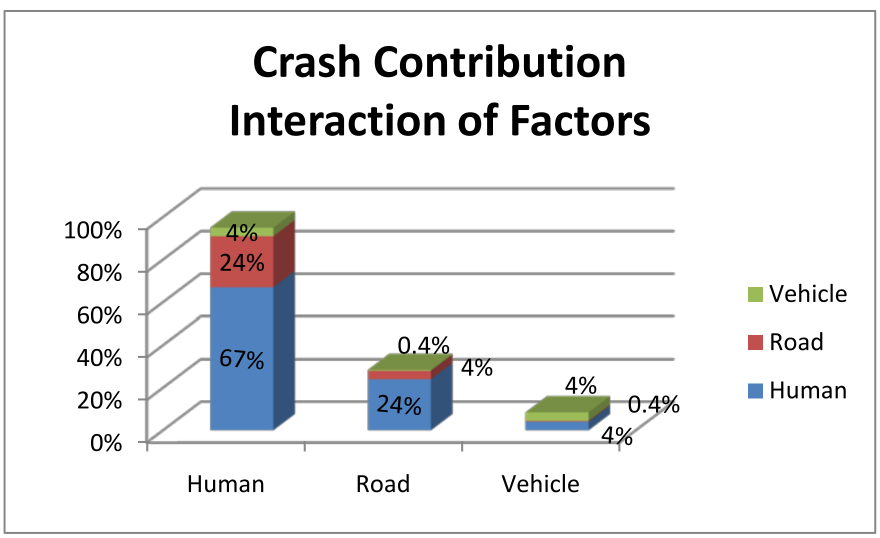


Figure 1 - Crash Contribution – Interaction of Factors

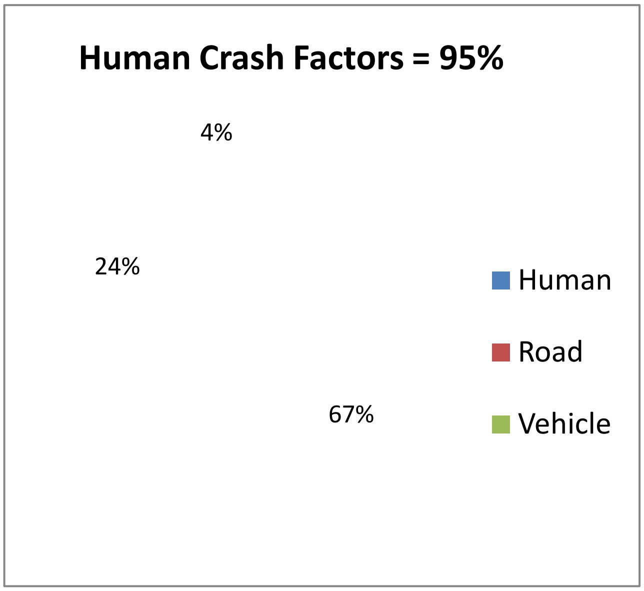


Figure 2 – Human Crash Factors

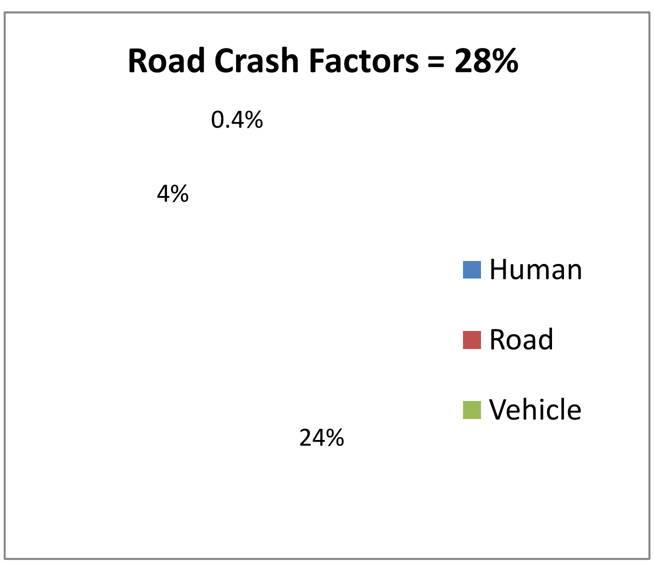


Figure 3 – Road Crash Factors

While human factors are the predominant cause of collisions, there are a variety of external factors, such as road maintenance, roadway design, speed limits, and traffic enforcement, which influence driver behaviors. Analysis and manipulation of those external factors can result in predictable changes to driving behaviors and modification of the risks for collisions and crashes.

The majority of serious collisions occur at intersections, and installation of roundabouts tends to reduce dramatically the risk of serious injury or fatality collisions, while providing many operational benefits. As a result, conversion of stop-controlled or signal-controlled intersections to roundabouts is an identified priority by the Federal Highway Safety Administration. See Appendices and http://www.fhwa.dot.gov/crt/lifecycle/roundabouts.cfm for additional detail.

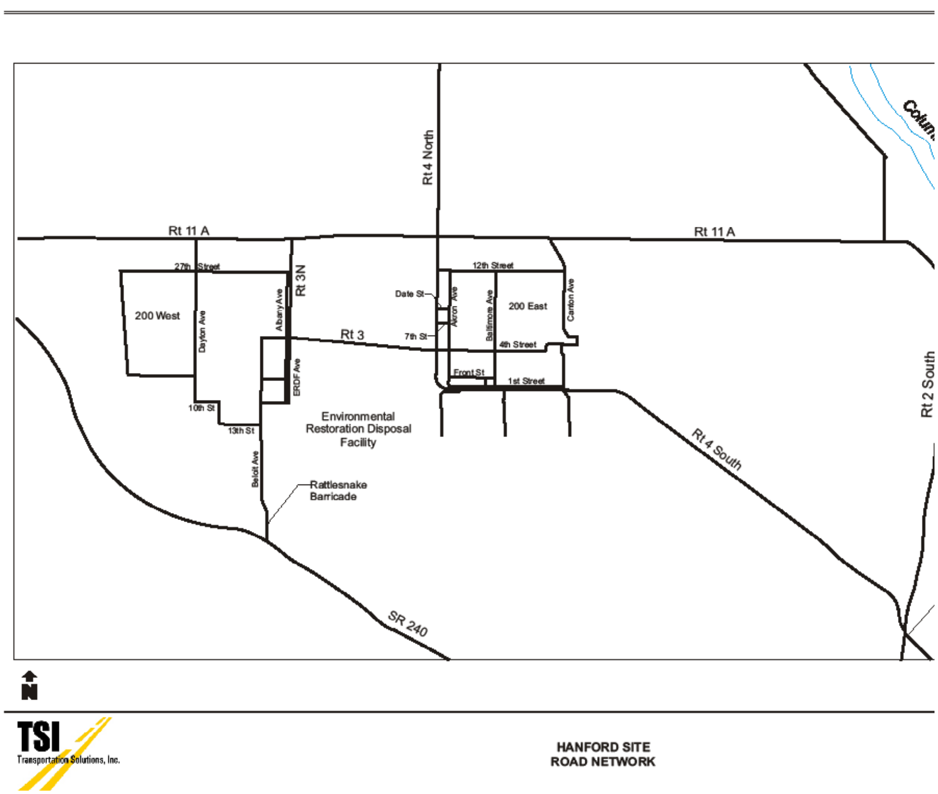
Adequate road maintenance to ensure a relatively smooth ride is more important on higher speed roadways than it is on low speed local streets. The Hanford Site is traversed by many long stretches of high speed roadways. Some are two lane and some are multi-lane. Allowing the road surfaces to deteriorate significantly can lead to serious crashes if potholes are allowed to get very large within the wheel path on high speed roadways, particularly those roadways with speed limits over 45 mph.

Existing Conditions

Roadway Infrastructure

The Hanford site is served by three gated barricade entrances that provide controlled access to the secure site: The Wye Barricade, the Rattlesnake Barricade, and the Yakima Barricade. The external road system providing access to those barricades is formed by SR-240, SR-24, Hanford Route 4 South (extension of Stevens Drive), and Hanford Route 10, which together account for approximately 140 lane miles. The road system within the barricades contains approximately 195 lane miles. The roadway terrain leading to and on the Hanford site is generally level with long mild grades. Straight sections of roads stretch up to 7 miles in several locations on SR-240, Route 4 South, and Route 10. Route 11 A is virtually straight – running West to East – for 15 miles from the Yakima Barricade to eastern boundary near the Columbia River. The roads within this system function as rural arterials, with a very unusual combination of physical and operational conditions that has fostered significant disregard for posted speeds by the vast majority of users, which increases the potential for very serious accidents.

Figure 4 – Vicinity Map



Commuter Access Routes –

The Wye Barricade, which serves approximately 5,800 vehicles per day, is the primary entrance to the secure 100 areas and 200 east area. The Wye Barricade is served from the south by Route 4 south (Wisconsin Road/Glade North Road) and by Route 10 (Hanford Road) via SR-240 (MP 20.4).

The Rattlesnake Barricade, which serves approximately 1,800 vehicles per day, provides direct access via Beloit Road to the 200 west areas and the ERDF. The Rattlesnake Barricade is served from the south by SR-240 at milepost 8.

The Yakima Barricade, which serves 700 vehicles per day, provides access to Hanford from the northwest and is used primarily by commuters from the Yakima, Prosser, and Vantage areas. The Yakima Barricade is located at the intersection of SR-24 (MP 39) and SR-240 (MP 0.0)

Route 4 South is a four-lane road with a painted median and merge lanes from the Wye Barricade to the 300 Area. South of the 300 Area this 4-lane road leaves the Hanford Reservation and is known as Stevens Drive in the City of Richland. From the 300 area Stevens Drive runs generally North-South to its terminus at the intersection of SR-240 and the By Pass Highway.

SR-240 forms essentially the southwest boundary of the secure Hanford site. It is generally a two-lane road with limited merge and turn lanes along the entire Hanford boundary from its intersection with By-Pass Highway and Stevens Drive to its northern terminus at SR-24 at the Yakima Barricade.

Traffic on these roads is highly directional, with traffic flowing primarily north in the morning and south in the afternoon.

Internal Site Roads – The Hanford site is served by a relatively sparse internal network of generally 2-lane rural arterial roads, with narrow or no shoulders. The exception is the 22 mile length of Route 11A/Route 2 South. This four-lane divided highway runs east from the Yakima Barricade, then turns south near the original Hanford town site and narrows to 2 lanes just north of the Wye Barricade.

- East-West: Route 1, Route 3 (portion), Route 4 S (portion), and Route 11A
- North-South: Route 2 South, Route 4 North, Route 4 S (portion), Route 6, Route 10, and Beloit Road
- Northwest-Southeast: Route 2 North, and Route 4 South

Volume

Tube count data provided to TSI, indicates that in the third quarter of 2009 approximately 8,300 vehicles passed in and out of the barricades each work day. Approximately 42% of the trips through the Hanford barriers occurred during the AM and PM peak hours. This is compared with approximately 20 percent on typical urban arterial roads, and 30 percent on typical rural arterial roads. Hanford's entire internal road system experiences a high percentage of trips during the peak hours, as shown in Table 1 below. During those peak hours, the trips are also highly concentrated in the peak 15 minute timeframe making the traffic flow rate during the peak 15 minutes equivalent to a flow rate normally associated with a much higher total peak hour volume.

Speed and Speed Limits

Typically, rural roadways are assumed to operate safely at or below the 85th percentile actual speed of actual drivers. This is typically the speed that should be used as the posted speed, barring other considerations. A posted speed limit that is significantly below the 85th percentile speed will not be observed by many drivers without regular enforcement and penalties.

The American Association of State Highway and Transportation Officials (AASHTO) Geometric Design of Highways and Streets, Fifth Edition states:

> *"Posted speed limits, as a matter of policy, are not the highest speeds that might be used by drivers. Instead, such limits are usually set to approximate the 85th-percentile speed of traffic as determined by measuring speeds of a sizable sample of vehicles. The 85th-percentile speed is usually within the 'pace' or the 10-mph speed range used by most drivers. Speed zones cannot be made to operate properly if the posted speed limit is determined arbitrarily. In addition, speed zones should be determined from traffic engineering studies, should be consistent with prevailing conditions along the street and with the cross section of the street, and should be capable of reasonable enforcement."*

That is, only 15 percent of drivers typically will exceed the speed limit of a facility with appropriately determined speed limits. However, speed data gathered on the major Hanford routes indicate that the large majority of vehicles exceed the posted 55-mph speed limit. As shown in the following table average speeds during peak travel times range from 54 mph to 59 mph, with 85th percentile speeds ranging from 57 mph to 67 mph. On all straight roadways on the major routes, the vast majority of vehicles were driving above the posted speed limit.

There are several factors that contribute to this observed difference between posted speeds and actual driver behavior. The site's generally level terrain combined with straight roadways and long sight distances leads to a high effective design speed of the roads. These factors combine with highly directional travel patterns, relatively low posted speed limits, and a relative lack of effective speed enforcement to create average and 85th percentile speeds typically well in excess of the posted speed limit.

Table 1 – Roadway Speed and Volume Data, 2009

Road / Milepost / Direction	Date	ADT Mon-Thu	Peak Period	% ADT Peak Hr of Peak Period	Peak Hour Volume	Posted Speed (MPH)	Peak Hour 50th Percentile Speed (MPH)	Peak Hour Vehicles > Posted Speed (%)	Peak Hour 85th Percentile Speed (MPH)	Peak Hour Vehicles >75 MPH (%)
Rt 2N MP2 NB	Oct-09	178	5-7 AM	32	57	55	59.25	78.5	65.5	3.5
Rt 2S MP **2**.5 NB	Sep-09	184	5-7 AM	41	75	55	59.25	78	65.5	2.7
Rt 4S MP2.2 SB	Jun-09	1449	5-7 AM	33	478	55	53.5	35	56.8	0.1
Rt 4S MP0.9 **NB**	Jun-09	563	5-7 AM	23	129	55	56.9	70.5	61.5	0.4
Rt 4S MP9 NB	May-09	2283	5-7 AM	46	1050	55	56.75	72	60.75	0.7
Rt 4S MP9 **SB**	Oct-09	2983	4-6 PM	37	1104	55	55.5	55	60.75	2.1
Rt 4S MP21 SB	Jul-09	3907	4-6 PM	30	1172	55	56.75	70	61.25	0.4
Rt 4S MP21 **NB**	Jun-09	3426	5-7 AM	32	1096	55	59	81	64.4	0.7
Rt 4N MP2.2 NB	Oct-09	872	5-7 AM	21	183	55	57.5	72.5	62.75	1.9
Rt 10 MP4 SB	Oct-09	692	4-6 PM	45	311	55	59.8	85.5	66.75	3.1
Rt 11A MP13 EB	May-09	309	5-7 AM	48	148	55	56.8	69	61.75	0.7
Rt 11A MP13 WB	Oct-09	378	4-6 PM	48	181	55	57.75	73	62.5	1.0
Beloit UW Sign NB	Sep-09	908	5-7 AM	42	381	55	51.5	19	55.8	0.1

These data correspond reasonably with speed and volume data collected by Fluor Hanford and published in December 2007.

Table 2 – Roadway Speed and Volume Data, 2007

Road / Location	ADT	Average Speed (MPH)	< 55 MPH (%)	55 to 60 MPH (%)	60 to 75 MPH (%)	> 75 MPH	Max Speed (MPH)
Rt 4S	4,315	60	9	54	36	1	96
Rt 4N	1,455	58	22	42	35	1	99
Rt 10	1,001	62	4	32	63	1	99
Rt 11A	647	61	8	45	45	2	90
Beloit at RS Barricade	1,680	54	40	43	16	1	85

The data indicate that a small percentage of drivers are exceeding the speed limit by more than 20 mph. Some of this excessive speeding occurs during the heaviest commute traffic periods on the most heavily traveled two-lane roads. This suggests that these drivers are accelerating to high speeds as they pass large platoons of vehicles on long straight stretches of roads. This conclusion also is supported by multiple interviews conducted for this evaluation, which indicate that it is not unusual for individuals to attempt to pass 10 or more vehicles at a time while accelerating to a high rate of speed.

Speed limits for Hanford roads are set by Benton County, and must comply with Washington State Law (RCW 46.61.400), which provides for a maximum posted speed limit of 60 mph for rural arterial roads.

When set according to traffic engineering principles, a speed limit will reduce the range of speeds traveled, and thereby also reduce the potential for collisions. It is our observation that Hanford speed limits are set artificially low. Absent rigorous effective enforcement, these lower than necessary speed limits encourage large speed differentials and may increase the potential for collisions.

The Washington State Department of Transportation (WSDOT) provides the following guidance:

> *"Speed limits encourage consistent travel speeds, fostering safety for the traveling public by reducing the speed differentials between motor vehicles.*
>
> *Speed limits reflecting the speed most motorists naturally drive are selected in part by determining the "85th percentile speed" (the speed that 85 out of 100 vehicles travel at or below). This method is based on the principle that reasonable drivers will consider roadway and roadside conditions when selecting travel speeds.*
>
> ***When setting speed limits, engineers also consider other factors like:***
>
> - *Roadway characteristics, shoulder condition, grade, alignment, and sight distance*
> - *Roadside development and lighting*
> - *Parking practices, e.g., angle parking, and pedestrian and bicycle activity*
> - *Collision rates and traffic volume trends*
> - *Right lane/entering traffic conflicts (for freeways)*
>
> *The range of travel speeds is reduced when speed limits are set near the 85th percentile speed and adjusted for the other influencing factors. "*

Vehicle Speed Differentials

Several factors inherent to the Hanford road system, such as long distances traveled, generally level terrain, straight roads, and long available sight distances coupled with artificially low posted speed limits, encourage significant vehicle speed differentials. These large speed differentials, which may be exacerbated by the mixing of light and heavy vehicles, can create large platoons on heavily used two-lane roadways. As volume increases on one direction relative to the other there is increased time spent following other vehicles, which builds pressure in more drivers to pass slower traffic. As flow increases in the opposing direction, there are reduced opportunities to pass. When there is little flow in the opposing direction, aggressive drivers will attempt to pass multiple vehicles in order to get in front of the "platoon" or even portions of the "platoon".

Collisions

Serious vehicle-vehicle collisions, and single vehicle crashes have occurred on SR240, but have been somewhat rare within the Hanford internal road system.

Deer-Vehicle Collisions

The most frequent cause of collisions is deer crossing the roads in the dark, sometimes darting in front of a vehicle. Deer-vehicle collisions (DVC) occur fairly frequently throughout the reservation, in part because the deer populations are not controlled by hunting. DVCs are especially likely to occur on sections of Hanford Route 4S and Route 2S during fawning in the Spring and during the Fall rutting season, especially during the period from dusk to dawn as deer move between bedding areas, nighttime forage and the Columbia River. Other areas of the state, including similar areas where generally arid lands border the Columbia and Okanogan Rivers, have similarly high DVC rates. Hanford has quite a few deer silhouette signs erected along the road system to alert drivers that deer may be in the roads.

Measures that have been used to prevent motor-vehicle collisions with deer include the following: warning signs, speed restrictions, exclusion fencing, underpasses and overpasses for animals, vehicle-mounted whistles, roadside reflectors (to deflect headlight beams toward the sides of the road to alert the deer), and reduction in deer populations through recreational hunting. Hanford Patrol Officer Marshall Almarode has presented information to the Traffic Safety Committee, advocating for creating flat "clear zones" along the sides of the roadways to eliminate deer hiding places and allow drivers to better see deer approaching the highway.

We were unable to find any research reports or accounts of using this approach for reducing DVCs. While there may be some merit to the belief that this approach would reduce deer strikes there also are significant environmental and other costs associated with widespread clearing and grading of clear zones along the many miles of Hanford roads.

The following excerpt from study on *Spatial and Temporal Patterns of Deer-Vehicle Collisions* presented to the 2005 International Conference on Ecology & Transportation in San Diego summarizes research on several of these various reduction approaches:

> *"Numerous options have been explored nationwide to reduce the number of DVC with mixed results.*
>
> ***Deer whistles** are a popular and inexpensive option available to the public. These whistles are fixed to the front bumper of a vehicle, and airflow from the moving vehicle creates a sound at 16 to 20 kHz to warn animals of approaching vehicles. There is no research to show deer are startled by sound at any particular frequency or decibel level (DeNicola et al. 2000). One study showed that deer whistles did not alter deer behavior enough to prevent them from crossing highways (Romin and Dalton 1992). It was suspected that animals could not hear the sound of the whistle over the sound of the oncoming engine. Thus, it can be assumed that deer warning whistles are not an effective strategy to avoid deer. People who use such devices should not rely on them to avoid deer, and should remain alert when driving wooded roads during twilight hours.*
>
> ***Light reflectors** are also devices that have been used to try to deter deer from roadsides. These devices deflect the headlights of oncoming vehicles parallel to the road, thus creating a "wall" of light that may or may not discourage deer from crossing. Usage of these reflectors has had mixed results (Gilbert 1982, Gladfelter 1982, Schafer and Penland 1985, Ford and Villa 1993). Even if reflectors are effective, they can only function in the presence of an*

oncoming vehicle, allowing deer behavior to go unaltered in the absence of vehicles (Putman 1997).

Reed et al. (1975) found that an ***underpass i****n west central Colorado was successful in permitting about 61 percent of a local mule deer (Odocoileus hemionus) population to migrate safely under the highway. Foster and Humphrey (1995) On the Road to Stewardship 487 Wildlife-Vehicle Collisions found that fencing and a series of underpasses constructed to permit crossing of Florida panther (Felis concolor coryi) along Highway 84 (Alligator Alley) were also successful in allowing bobcat (Lynx rufus), white-tailed deer, raccoon (Procyon lotor), alligator (Alligator mississipiensis), and black bear (Ursus americanus) to safely cross. However, highway underpasses are difficult to construct under already existing roads in urban areas. They are also very expensive.*

Fencing has been proven effective at reducing DVC *along stretches of highway in Colorado (Ward 1982), Minnesota (Ludwig and Bremicker 1983), and Pennsylvania (Feldhamer et al. 1986). Fencing must be 2.4 to 3.0 m high and inspected regularly, as deer can and will utilize openings in the fence and will crawl between the fence and the ground. Fencing is a proven and cost-effective solution along short lengths of highway, but can get expensive and laborious over long stretches. Fencing should be utilized in areas of high DVC.*

Static road signs *alerting motorists about the possible presence of deer in the area are often are ignored as there are so many of them, and few motorists have actually been involved in a DVC in the vicinity of these signs (Putman 1997). Pojar et al. (1975) experimented with a lighted and animated deer crossing sign in Colorado. They found no difference in the number of DVC with the sign on and with the sign off. Average vehicle speed decreased 4.83 km/hr (3.00 mph) with sign on, 10.09 km/hr (6.27 mph) with sign on and three deer carcasses placed on the road, and 12.63 km/hr (7.85 mph) with carcasses in place and signs off.*

The study suggests that spatio-temporal models can be used to predict high risk areas based on season and vegetation conditions. While deer warning signs do not help people get a search image for deer or get them to slow down very much, carcasses appear to have a substantial impact on speed. They suggest that moveable warning signs and displays can be used to reduce deer vehicular collisions. They suggest that targeted displays can be moved to the appropriate hotspots based on changing vegetation and seasonal conditions.

Aggressive Driving

Aggressive driving, such as failure to yield to merging traffic and passing of large platoons at high speeds, was listed as one of the main concerns by multiple interviewees for this assessment. It is our opinion from analyzing provided data that these driving behaviors are occurring and are exacerbated by the same factors that foster general disregard for posted speed limits.

Enforcement

Benton County Sheriff

Traffic enforcement is provided on the Hanford Site on contract to DOE-Richland by the Benton County Sheriff's Department. Traffic enforcement services to be provided are identified in accordance with provisions of Section C1 of the contract. Relevant contract language is excerpted and highlighted below:

> ***C-1 OPERATIONS***
>
> *The Contractor shall be responsible for providing law and traffic enforcement services within juristic authority at the facilities specified in the Section F, paragraph F-2. The Contractor shall furnish all necessary labor, equipment, transportation, and materials (except as may be expressly set forth in this contract as furnished by the Government) in performing the following services:*
>
> *(c)* ***Provide traffic enforcement to the Hanford roadways. As a minimum two traffic patrols are necessary during the peak hours of traffic on the Hanford Site, i.e., 0600- 0800 and 1530-1730 hours. Outside of these peak hours of traffic, random traffic patrols will be acceptable. During off-hours of operations and holidays, only an emergency response to traffic accidents or mutual aid requests for assistance will be required.***
>
> *(e)* ***To facilitate the provision of effective law enforcement at Hanford, the Sheriff shall station at the Hanford Site for duty such full-time and part-time Deputy Sheriffs of the county as may be required. With exception to item (c) above, the number of such full-time and part-time Deputy Sheriffs to be provided shall be at the sole discretion of the Sheriff.*** *However, it is understood that the Sheriff will station one clerk through FY 2006 at the Hanford Site, and/or as agreed upon by the Sheriff and the RL Contracting Officer, and provide 24-hour law enforcement coverage on the site through the application of the equivalent of seven (7) Deputy Sheriffs.*
>
> *(f) Unless otherwise agreed by the parties hereto, the county Sheriff shall notify the Contracting Officer 30 days in advance of any intended increase or decrease in the number of Deputy Sheriffs or other personnel to be stationed at the Hanford Site and will obtain written authorization from the Contracting Officer.*
>
> *(k)* ***It is recognized that the Contractor serves as an emergency service provider to the Benton County community as well as DOE-RL. Therefore, while the Contractor shall use all good faith effort to satisfy the previously listed requirements and schedules, it is understood that on occasion emergency circumstances exist in other areas of its jurisdiction that may call resources away from the specific services of this contract.*** *The Contractor shall make all reasonable efforts to comply with the letter of this statement of work.*

This contract indicates that approximately 8 person-hours per day of enforcement are intended to be directed toward traffic enforcement. However, interviews conducted for this evaluation suggest that enforcement provided under this contact does not provide meaningful deterrent to prevent violations of the posted speed limit. Sheriff's Office staff report that the two-lane road system's general lack of shoulders makes traffic enforcement during the peak commute times very difficult. They are concerned that stopping traffic to issue citations could exacerbate congestion and increase the potential for collisions. Hanford employees reported that Sheriff's vehicles are readily recognized, and it is generally understood that once you have passed a Sheriff's vehicle, you won't encounter another one. Several Hanford Patrol officers and others indicated that the Benton County deputies assigned to Hanford often are dispatched to calls outside of Hanford, as each officer assigned to Hanford is responsible for patrolling a sector that includes a significant amount of territory outside Hanford, as well. This condition is anticipated by provision C1 (k) of the Sheriff's contract and is not unusual for Sheriffs' departments providing contract services in Washington State.

Based on an objective review of speed data alone, it is clear that the traffic enforcement services provided under this contract have been insufficient to generate general compliance with posted speeds. In fact, it appears to be generally understood by the majority of Hanford staff that exceeding the speed limit is highly unlikely to result in a traffic citation and fine.

There appear to be two main reasons for this demonstrated lack of enforcement effectiveness:

1) Insufficient resources are dedicated in a coordinated way to traffic enforcement, in comparison to the number of lane miles and volume of traffic
2) Insufficient roadway infrastructure exists on highly traveled routes for safe enforcement activities

Prior to the contracting with Benton County Sheriff, the Hanford Patrol provided traffic enforcement on a 24/7 basis. Although not all Hanford Patrol officers were assigned to traffic enforcement, the traffic officers' vehicles were virtually indistinguishable from the rest of the force. . As a result, the mere presence of Hanford Patrol vehicles on the roadways deterred speeding. As noted above, Benton County Sheriff's vehicles are few and readily identifiable. Thus it is generally assumed that if you pass one Sheriff's vehicle, you can exceed the speed limit without recourse. Sheriff's Office and Hanford Patrol personnel interviewed for this analysis all voiced frustration with the existing situation.

The enforcement effectiveness has been the subject of much work by the Hanford Traffic Safety Enhancement Committee. The committee has developed employee educational materials, monitored traffic compliance, explored the potential for use of video radar for issuing speeding citations, and grappled with the complexities of potential employer administered disciplinary sanctions for traffic violations.

Automated Speed Enforcement

Prior to the 2009 Washington Legislative Session, Washington State Law allowed for the use of automated camera detection systems only for enforcement of red light running, rail crossing violations, toll-zone violations, and school zone speed enforcement. Since initial passage in 2005, several amendments have been passed to incrementally add opportunities for use of camera detection. In 2009, the law was expanded to allow enforcement of speed violations using automated camera detection systems within cities with population greater than 500,000 (Seattle) under certain conditions.

Congestion

When density increases and speed decreases below that necessary to maintain stable flow, there is a rapid decrease in speed and traffic flow, and severe congestion occurs. TSI's preliminary analysis indicates that congestion occurs on certain Hanford roads at peak hour volumes somewhat below levels that typically would create unstable traffic flow. The primary reason for this phenomenon appears to be shift schedules that generate an extremely high peak flow rate over short time durations, quantified by a low Peak Hour Factor (PHF), the ratio of total peak hour volume divided by four times the 15 minute peak volume. The limited road network leading into and out of Hanford experiences short periods of intense flow, leading to severe congestion, primarily during the evening commute. The short-lived peaking of traffic volumes leads to flow instability, which can persist over a fairly long period of time until recovery. Until flows stabilize and speeds recover, the road system will experience significant congestion. Specific areas of focused congestion include Beloit Road approaching the Rattlesnake Barricade and the 200 W access roads and driveways, the intersection of Route 4S with Route 3, and Route 4S approaching the 200 E access roads and driveways. The area surrounding the intersection of Stevens Drive, SR-240 and the By Pass Highway south to Interstate Highway 182 in Richland also is subject to intense congestion, during the morning and afternoon weekday Hanford commute periods.

Road Operations

The Highway Capacity Manual (HCM) provides methodology for evaluating the operational performance of a variety of transportation facilities. The service measures applicable to the roadways within the access controlled areas of the Hanford site include: delay for evaluating the stop controlled intersections; speed and percent time spent following for evaluating the two lane rural highway segments; and vehicle density for evaluating the multi-lane rural highway segments. TSI has concentrated our efforts on analyzing reported trouble spots at intersections, certain two lane road segments of uninterrupted flow, and the transition points from multi-lane roads where those lanes merge down to one lane in each direction on the Hanford Reservation. The uninterrupted flow multi-lane segments of roads on the Hanford Reservation (Route 11A and Route 2 South) appear to operate quite well and were not analyzed in great detail. Traffic volume data suggests that the multi-lane segments of road on the Hanford site all operate at V/C ratios less than 0.5 and free flow speeds of about 60 to 65 mph where there are two or more lanes in each direction. This equates to LOS C or better. However, even areas of multi-lane road may experience severe congestion upstream of congested intersections and locations where the facility transitions from multi-lane highway to two lane highway.

Turning movement traffic volumes at various intersections and directional volumes on specific road segments have been extrapolated from traffic speed and traffic volume tube count data provided to TSI by MSA staff. The data included vehicle volume counts by direction in 15 minute increments. The effect of surges in traffic during the hour long peak period of analysis is evaluated based on the ratio of the hourly volume to 4 times the peak 15 minute volume. The turning movements at specific intersections have been estimated based on through volume counts upstream and downstream of each intersection. Where intersections are clustered together and tube counts were not taken between intersections, TSI assigned a proportion of the traffic volume to/from a given area based on the intersection configuration and the density of activity served by the minor street. A more detailed analysis of anticipated problem intersections will require specific turning movement counts at selected intersections. Two analysis periods are presented in this report, the AM peak hour and the PM peak hour.

Intersection Operations

The intersections on the Hanford Reservation that were reported to be experiencing traffic problems are all two-way-stop-controlled (TWSC) intersections. The Level of Service (LOS) for TWSC intersections is determined by computed control delay for each minor movement controlled by a stop sign. Each movement at a TWSC intersection faces a different set of conflicts that are directly related to the nature of the movement. Control delay is estimated by determining the expected number of available gaps in the conflicting traffic stream of sufficient time to allow one minor street vehicle to enter the intersection against the number of vehicles trying to make that particular maneuver. The analysis is performed for each maneuver within a given lane on the minor street. The LOS criteria expressed in terms of control delay for unsignalized intersections (LOS A-F) is shown in the following table. LOS A is considered very good and LOS F is considered very poor.

Table 3 - Level of Service Criteria for Unsignalized Intersections

Level of Service (LOS)	Average Control Delay (seconds/vehicle)
A	0 – 10
B	>10 – 15
C	>15 – 25
D	>25 – 35
E	>35 – 50
F	>50

TSI evaluated the LOS and queuing of the following intersections for both the PM peak hour and the AM peak hour using Synchro 7, a computer program that automates the LOS calculation methodology of the HCM and the results are shown in Tables 4 and 5 below.

PM Peak Operations

Most of the intersections operate very well in the PM peak period, with two very notable exceptions. The eastbound right turn at the Route 3/Route 4 South intersection operates at LOS F with frequent significant queuing and the southbound left turn at the Beloit Avenue/SR-240 intersection operates at LOS F with periodically severe queuing. Other intersections along Route 4 South along the south margin of the 200E area appear to operate poorly not due to intersection capacity problems, but more likely due to through movement capacity constraints where the eastbound lanes drop from either 3 to 2 to 1 or 2 to 1 lane and the protected southbound (flying “T”) merging movements into the uninterrupted 55 mph eastbound through movement create upstream queuing problems. This phenomenon will be further discussed in the Two-lane Road Segment Operations section of the report.

AM Peak Operations

Most of the intersections operate very well in the AM peak period, with two exceptions. The westbound left from Route 2 South onto southbound Route 4 South operates poorly at LOS E, but the volume is very low and does not create queuing problems and thereby does not create much concern due to the low volume served. The southbound left from Canton Ave to Route 4 South also operates poorly at LOS F, but the volume of this movement is also very low. There are no queuing problems noted for this movement either.

Table 4 – 2009 PM Peak Hour Intersection LOS

Intersection	Direction/ (Worst Movement)	PM Peak LOS (Delay in sec)	95% Queue (ft) Synchro	95% Queue (ft) SimTraffic[1]
Route 2 South/ Route 4 South	EB	N/A	N/A	-
	WB (L)	A (9.8)	19	348
	NB	A (0.0)	0	21
	SB	A (0.0)	0	10
Canton Ave/ Route 4 South	EB	A (7.3)	0	0[2]
	WB	A (0.0)	0	0
	NB	N/A	N/A	-
	SB (L)	A (9.3)	11	66
Baltimore Ave/ Route 4 South	EB	A (7.3)	0	1,410[2]
	WB	A (0.0)	0	0
	NB	N/A	N/A	-
	SB (L)	B (11.3)	48	136
Route 3/ Route 4 South	EB(R)	F (203.2)	626	6159
	WB	F (>250.0)	*	48
	NB	A (0.0)	0	64
	SB	A (0.0)	0	13
Route 11A/ Route 4 North	EB	A (1.2)	0	52
	WB	A (1.2)	0	42
	NB (L,Th)	B (10.8)	23	54
	SB (L,Th)	B (13.8)	73	50
Route 1/ Route 4 North	EB (R)	A (9.9)	31	28
	WB	N/A	N/A	0
	NB (L)	A (3.7)	0	0
	SB	A (0.0)	0	0
Route 11A/ Route 2 North	EB (L)	A (0.1)	0	11
	WB	A (0.0)	0	0
	NB	N/A	N/A	-
	SB	A (9.5)	8	42
Route 11A/ Route 3 North	EB	A (0.0)	0	0
	WB (L)	A (7.5)	1	0
	NB	A (9.6)	3	27
	SB	N/A	N/A	-
Route 11A/ SR24/ SR240	EB	B (10.5)	3	37
	WB	B (12.1)	35	69
	NB	A (0.4)	0	0
	SB	A (0.4)	0	0
Route 3/ 20th Street/ ERDF Ave	EB	A (0.2)	0	0
	WB	A (0.8)	0	0
	NB	B (10.8)	2	19
	SB	B (10.2)	4	35
Beloit Ave/ 10th Street	EB	C (16.8)	83	58
	WB	N/A	N/A	-
	NB	A (8.1)	0	0
	SB	A (0.0)	0	0
Beloit Ave/ SR240	EB (L)	A (7.4)	0	0
	WB	A (0.5)	0	0
	NB	A (8.8)	0	10
	SB (L)	F (154.0)	889	287

[1] SimTraffic results are preliminary. Model requires additional calibration, and some additional data inputs.

[2] Eastbound volume at Canton/Rt 4 metered by upstream queue at Baltimore/Rt 4, which is associated with the "flying T" lane drop eastbound from 3 lanes to 2 to 1. If there were no capacity restriction at the Baltimore/Rt 4 "flying T" merge, then the queue would form at Canton/Rt 4 where the eastbound direction drops from 2 lanes to 1 and the queue would likely be greater than 2,100 feet.

Table 5 – 2009 AM Peak Hour Intersection LOS

Intersection	Direction/ (Worst Movement)	AM Peak LOS (Delay in sec)	95% Queue (ft) Synchro	95% Queue (ft) SimTraffic[1]
Route 2 South/ Route 4 South	EB	N/A	N/A	-
	WB (L)	E (39.5)	1	26
	NB	A (0.0)	0	0
	SB (L)	B (13.7)	0	10
Canton Ave/ Route 4 South	EB(L)	C (17.3)	3	17
	WB	A (0.0)	0	0
	NB	N/A	N/A	-
	SB (L)	C (20.3)	3	37
Baltimore Ave/ Route 4 South	EB	A (10.0)	1	19
	WB	A (0.0)	0	0
	NB	N/A	N/A	-
	SB (L)	C (18.2)	3	38
Route 3/ Route 4 South	EB	C (17.9)	26	64
	WB	C (22.7)	11	40
	NB	A (0.0)	0	0
	SB	A (0.0)	0	8
Route 11A/ Route 4 North	EB	A (3.7)	0	18
	WB	A (3.0)	0	8
	NB (L,Th)	C (17.3)	59	84
	SB (L,Th)	B (12.2)	2	24
Route 1/ Route 4 North	EB	B (12.1)	1	18
	WB	N/A	N/A	N/A
	NB	A (7.2)	20	13
	SB	A (0.0)	0	0
Route 11A/ Route 2 North	EB (L)	A (2.3)	1	0
	WB	A (0.0)	0	0
	NB	N/A	N/A	N/A
	SB	A (8.8)	8	22
Route 11A/ Route 3 North	EB	A (0.0)	0	0
	WB	A (1.9)	0	16
	NB	A (8.8)	1	17
	SB	N/A	N/A	-
Route 11A/ SR24/ SR240	EB	B (11.3)	32	66
	WB	A (9.7)	1	16
	NB	A (0.4)	0	0
	SB	A (1.1)	0	0
Route 3/ 20th Street/ ERDF Ave	EB	A (0.6)	0	0
	WB	A (0.4)	0	0
	NB	A (9.5)	2	29
	SB	A (9.2)	1	29
Beloit Ave/ 10th Street	EB	B (13.8)	2	24
	WB	N/A	N/A	-
	NB	A (7.6)	12	8
	SB	A (0.0)	0	0
Beloit Ave/ SR240	EB (L)	A (7.3)	0	0
	WB	A (0.0)	0	0
	NB	A (0.0)	0	17
	SB (L)	A (9.1)	2	38

Two-lane Road Segment Operations

The two lane road segments on the Hanford Reservation were analyzed using the HCM methodology for two lane rural highways. Although Benton County's Level of Service Standards for two-lane rural highways may not be directly applicable to the private federal roads on the Hanford

Reservation, understanding the level of service expectations of drivers using the Hanford road network can be readily determined by comparing the two-lane highway LOS of the Hanford two lane road segments to the Benton County LOS standards. The Benton County Comprehensive Plan sets a goal to maintain LOS C on two-lane highways classified as arterials. The Level of Service is measured based on percent time spent following other vehicles and average travel speed. The criteria apply differently for Class I versus Class II highways. On Class I highways mobility is paramount and access is less important. Both travel speed and percent time spent following are important for Class I highways. On Class II highways, mobility is less important and the LOS is defined only in terms of time spent following. The two lane highways on the Hanford Reservation are best described as Class I highways. The LOS criteria for Class I two-lane highways are shown in the following table.

This methodology works well for many types of two lane highways including long stretches of two lane highway with uniform cross section. However, some two lane highway segments are too complex to be addressed with this HCM methodology. In particular, two lane highways that include interactions between multiple passing and climbing lanes or flying tee intersections with downstream drop lanes are better analyzed with computer simulation to evaluate operations. The queuing information provided in the previous section analyzing intersection operations is probably a better measure of the actual quality of service on Rt 4S between Rt 3 and Canton. The HCM two lane highway methodology is also highly sensitive to the peak hour factor which quantifies the peak 15 minute surge of traffic within the peak hour. Very low peak hour factors (around 0.5) can degrade highway operations very quickly resulting in LOS F even if the hourly volume is well below capacity.

Table 6 - Level of Service Criteria for Class I Two-lane Highways

LOS	Percent Time Spent Following	Average Travel Speed (mph)
A	≤35	>55
B	>35 – 50	>50 – 55
C	>50 – 65	>45 – 50
D	>65 – 80	>40 – 45
E	>80	≤40
NOTE: LOS F applies whenever the flow rate exceeds segment capacity.		

LOS A describes completely free flow conditions. The operation of vehicles is virtually unaffected by the presence of other vehicle, and operations are constrained only by the geometric features of the highway and driver preference. Maneuverability within the traffic stream is good. Minor disruptions to flow are easily absorbed without a change in travel speed.

LOS B also indicates free flow, although the presence of other vehicles becomes noticeable. Average travel speeds are the same as in LOS A, but drivers have slightly less freedom to maneuver. Minor disruptions are still easily absorbed, although local deterioration in LOS will be more obvious.

In LOS C, the influence of traffic density on operations becomes marked. The ability to maneuver within the traffic stream is clearly affected by other vehicles. Minor disruptions can cause serious local deterioration in service, and queues will form behind any serious traffic disruption.

At LOS D, the ability to maneuver is severely restricted due to traffic congestion. Travel speed is reduced by the increasing volume. Only minor disruptions can be absorbed without extensive queues forming and the service deteriorating.

LOS E represents operations at or near capacity, an unstable level. The densities vary depending on the Free Flow Speed (FFS). Vehicles are operating with minimum spacing for maintaining uniform flow. Disruptions cannot be dissipated readily, often causing queues to form and service to deteriorate to LOS F. Passenger car mean speeds from 42 to 55 mph, but are highly variable and unpredictable.

LOS F represents forced or breakdown flow. It occurs either when vehicles arrive at a rate greater than the rate at which they are discharged or when the forecast demand exceeds the computed capacity of a planned facility. Although operations at these points-and on sections immediately downstream-appear to be at capacity, queues form behind these breakdowns. Operations within queues are highly unstable, with vehicles experiencing brief periods of movement followed by stoppages. This is commonly called "stop and go" traffic conditions. Travel speeds within queues are generally less than 30 mph. The term LOS F can be used to characterize both the point of the breakdown and the operating condition within the queue. Although the point of breakdown causes the queue to form, operations within the queue generally are not related to deficiencies along the highway segment.

There are two significant segments of two-lane highway serving Hanford commuters that would certainly be considered arterials if they were public roads, Route 4 S and Beloit Avenue. TSI evaluated the two lane segment of LOS of Route 4 South between Milepost 6 and Milepost 11 and Beloit Avenue from 10th Street to the Rattlesnake Barricade. The tube count data indicated a relatively low Peak Hour Factor (PHF) for most of the road segments on the Hanford Reservation. This indicates that a disproportionately high amount of the peak hour traffic volume occurs within one peak 15 minute period within the peak hour. This can be significant in traffic operations because a 15 minute surge of traffic can overwhelm a road segment very quickly and cause a breakdown that takes over an hour to dissipate even though the peak hour demand volume may not have exceeded the capacity of the road segment. A PHF of 1.0 would be indicative of perfectly uniform 15 minute flow rates. Each of the four 15 minute periods within the hour would be the same. Peak hour factors less than 0.75 are not common. They are often related to an event like a shift change at a large factory or a sporting event. The data suggest that some road segments on the Hanford Site experience highly variable traffic flow within the peak hour with PHF values recorded of less than 0.5. The highest PHF value recorded was on Route 4 S at Milepost 9 where the PHF was about 0.75.

The LOS, percent time following, and calculated average travel speed of Route 4 South and Beloit Avenue are tabulated below for the PM Peak and AM Peak hour time periods.

Table 7 - Two-Lane Highway LOS PM Peak

Road Segment	LOS	Percent Time Spent Following	Average Travel Speed (mph)
Route 4 South MP6 to MP11	E	83.5%	60.5 mph
Route 4 South MP2 to MP4.5	F	91.0%	54.9 mph
Beloit Avenue (10th St – Rattlesnake)	C	57.5%	60.7 mph

Table 8 - Two-Lane Highway LOS AM Peak

Road Segment	LOS	Percent Time Spent Following	Average Travel Speed (mph)
Route 4 South MP6 to MP11	D	77.0%	60.5 mph
Route 4 South MP2 to MP4.5	E	85.5%	60.5 mph
Beloit Avenue (10th St – Rattlesnake)	C	63.4%	60.7 mph

Analysis of the data provided suggests that both of these two lane road segments (Beloit Avenue and Route 4 S) experience periods during the evening (PM) and morning (AM) commutes time periods with highly unstable traffic operations particularly at locations where traffic disruptions are common. Such locations are probably more severe in the evening commute at the locations where the multi-lane segments of road transition from 2 or 3 lanes in one direction down to 1 lane when the peak 15 minute traffic flow rate is approaching the directional single lane capacity of 1,700 vehicles per hour. This can occur when peak 15 minute directional traffic volumes approach 425 vehicles in any given 15 minute period. Route 4 S functions at LOS D in the morning peak and LOS E in the evening peak. Beloit Avenue operates at LOS C in both the morning and evening peak hours. However, the morning LOS C is approaching the transition point from LOS C to LOS D based on time spent following and the evening LOS C does not reflect the impact of southbound queues at the Beloit/SR-20 intersection which likely makes Beloit Avenue operate at LOS F periodically for long stretches upstream of the intersection during the evening commute.

Another reason that morning commute traffic operations are better than evening commute traffic operations on Route 4 South between Canton and Route 3 is related to the converging or diverging nature of the traffic streams at key intersections. In the morning the inbound traffic stream is diverging at key intersections (Canton, Baltimore, and Route 3) with very little opposing volume. Also, the inbound traffic at Baltimore and Canton is turning right which is an easier movement than a left. The diverging traffic is somewhat like a zipper being opened. Traffic congestion pressure is relieved at diverging traffic streams. Through traffic is unimpeded as long as there is sufficient space to store the diverging traffic as it slows to make the movement. In the evening commute, the outbound traffic stream is converging at those same intersections, somewhat like a zipper being closed. Traffic congestion pressure increases at converging traffic streams. This is very noticeable when the combined traffic flow is approaching the capacity of the roadway as is the case on Route 4 South in the outbound evening commute in the eastbound direction.

Road maintenance appears to be generally adequate on most of the high speed road segments. However, there is evidence of some significant pavement degradation on segments of Route 11A and Route 2 South. Route 1 between Route 2 North and Route 4 North is also badly degraded, but that route has been closed by MSA staff until the road can be rebuilt. MSA staff have developed a comprehensive list of proposed pavement maintenance and pavement reconstruction projects that are necessary to maintain the site roads in an acceptable condition to reduce the risk of crashes due to road factors. As parts of the Hanford Site wind down operations over the next 10 years, some of the more remote routes may be candidates for abandonment when their mobility and access functions are no longer required. This should minimize long term road maintenance cost on the site.

Opportunities and Recommendations

Speed Limits

We recommend an increase in speed limits to 60 mph for selected portions of Routes 2S, 2N, 4S, 4N, 11A, and 10 within the Hanford Road system. This would tend to increase compliance with speed limits, and would not be expected to increase collisions. This conclusion is supported by research conducted by the Federal Highway Administration, Office of Safety and Traffic Operations R&D, which found:

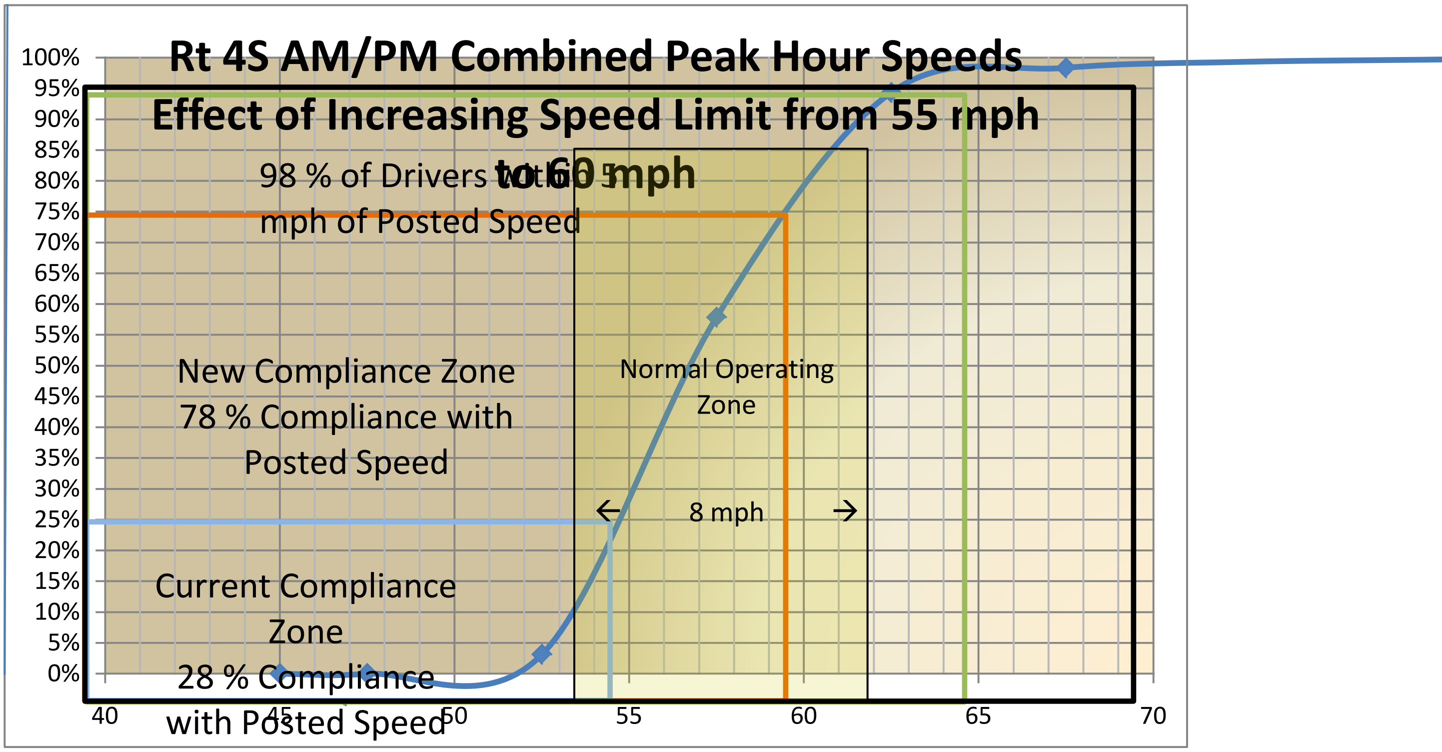
> *"Lowering speed limits below the 50th percentile does not reduce accidents, but does significantly increase driver violations of the speed limit. Conversely, raising the posted speed limits did not increase speeds or accidents."*

Raising the speed limit would be expected to have the following related beneficial effects:

- Reduction in vehicle speed differentials
- Reduction in size of vehicle platoons
- Reduction in time spent following
- Reduction in pressure to pass
- Reduction in aggressive passing behaviors
- Reduction in congestion
- Reduction in collision risks
- Possible reduction in 95^{th} percentile speeds
- Dramatic increase in compliance with posted speeds

The following chart illustrates the anticipated effect on speeds and compliance on Rt 4S:

Figure 5 – Route 4S Speed Limit Compliance



While modification of the speed limit would not entirely eliminate congestion and high speed driving on the main routes, it should narrow the speed differentials, thereby reducing platoon size and the pressure to pass large numbers of vehicles at high speed.

Enforcement

More effective enforcement must be a fundamental component in any effective approach to enhancing vehicle safety on Hanford roads. While ultimate decisions about the best approach must be made by DOE-Richland and Benton County, we offer the following suggested options.

Benton County Sheriff

1. Selectively increase Benton County enforcement of traffic laws by focusing on Beloit, Route 3 and Route 4 S. Instead of requiring 2 deputies to enforce traffic daily during each of morning and afternoon peak commute periods (40 hrs/week), provide more effective traffic enforcement four commute periods (2 days) per week, randomly determined, using 4 to 8 deputies (32 to 64 hours/week).
2. Consider coordination and support of Benton County enforcement of traffic laws using Hanford Patrol resources. Utilize Hanford Patrol officers who hold Benton County Sheriff's Office commissions to provide enhanced enforcement of traffic laws. This would likely require additional training of Hanford Patrol officers, as well as use of certified radar speed detection equipment provided by Benton County Sheriff's Office.
3. Provide Benton County Sheriff vehicles painted to resemble Hanford Patrol vehicles.

Automated Camera Detection Speed Enforcement

As noted above, the state law for use of Automated Camera Systems was expanded in 2009 to include speed enforcement within cities greater than 500,000. This was clearly a limited exception sought by the City of Seattle, and approved by the Legislature. We believe that Hanford is an appropriate location for an Automated Camera Speed Enforcement pilot project, should Hanford management and Benton County be supportive of this approach.

The National Committee on Uniform Traffic Laws suggests the use of Automated Camera Speed Enforcement in the following situations:

> *The objective of automated traffic law enforcement is reduced traffic crashes and improved adherence to traffic laws through the use of photographic and electronic technology as a supplement for traditional traffic law enforcement. This type of enforcement should be used at high crash sites, at other high-risk locations, or in situations where traffic law enforcement personnel cannot be utilized, either due to the pressing needs of other law enforcement activities or where inherent on-site problems make traditional law enforcement difficult.*
>
> *Automated traffic law enforcement is not intended to replace traditional law enforcement personnel nor to mitigate safety problems caused by deficient road design, construction or maintenance. Rather, it provides enforcement at times and locations when police manpower is unavailable or its use raises safety concerns.*

Our analysis indicates that Hanford meets the following conditions noted above:

1. Increasing risk of serious and fatal accidents
2. Traffic enforcement is ineffective due lack of adequate staffing and the site road designs makes traditional law enforcement difficult and would be expected to cause safety risks.

Therefore, we recommend that the MSA and DOE-Richland consider seeking the assistance of local state legislators, and the support of Benton County in seeking a similarly narrow expansion of the existing laws to provide for a pilot project of Automated Camera speed enforcement on Route 4 South, Beloit Road, and other Hanford arterial roads.

Collisions

As noted in the Existing Conditions section, Hanford has not experienced a large number of serious vehicle/vehicle collisions or one-vehicle crashes. However, with the increase in traffic and other factors inherent to the two-lane arterial system, we believe that serious and/or fatal crashes are becoming more likely as more workers are added for site remediation.

Deer-Vehicle Collisions

A comprehensive search of research literature on Deer Strikes indicates that deer-vehicle collisions are a serious problem in many parts of the U.S. and Canada. Deer exclusion fencing, wildlife under/overpass facilities, specialized roadside reflector systems, and dynamic use of warning signs have shown some reductions in DVCs in some areas.

Roadside Reflectors – Deer warning reflectors have been tried with varying results in many areas of the U.S and Canada. However there has been very little scientific research to determine their effectiveness. A six-year study by Purdue University of the Strieter-Lite reflector system along Interstate 80/90 in Indiana is the most rigorous study we have been able to find. It concluded that the Strieter-Lite system *"provides an expected reduction in deer-vehicle collisions of 19% with 95% confidence limits of 5% to 30%. Maximum reduction is associated with 100 ft spacing regardless of the reflector color, median with or without reflectors, single or double reflectors."*

Fencing is probably the most effective approach to reduction of DVCs, when used in combination with underpass/overpass facilities. It is important when installing fencing that the deer be provided with a safe place to cross the highway. Otherwise the fence simply concentrates the crossings into a smaller area. In addition, some deer will defeat the fence, enter the highway, and become trapped on the roadway.

Over/underpasses can provide effective deer crossing, but must be carefully placed to take advantage of fencing and terrain features that would tend to channel deer to them.

While a well designed fencing/overpass system can be effective, it is a very expensive approach, and likely would not be justified for the Hanford road system.

We recommend that a test section of Strieter-Lite reflectors be installed in a 1 to 2 mile section with high numbers of historical deer collisions, and that the DVC rates for that section be monitored to determine if more extensive installation of reflectors is warranted.

Scheduling

One of the primary factors affecting the severe congestion that periodically manifests at specific intersection and road segments on the Hanford Reservation appears to be the 15 minute peak spikes of traffic associates with scheduling shift changes in the PM peak time period at various locations on the Hanford Reservation. Although it may on its face seem fair to release the workers at the remote site earlier than the workers in the Central Plateau Area, it may be that very fact that produces extreme 15 minute spikes of traffic at key junctions in the Central Plateau Area that can tie up traffic for extended periods of time. If the workers from the 100 Areas are arriving at key junctions in the 200 Area at the same time that 200 Area workers are ending their shift, it can cause a severe confluence of concentrated traffic at key junctions that may tie up the entire road network for extended periods of time. Specific locations that may be affected by this phenomenon appear to be the Route 4 South intersection with Route 3, the Beloit Avenue intersection with SR240, the Route 4 South intersection with Baltimore Avenue, and the Route 4 South intersection with Canton Avenue. At those locations, there may be times when the main line traffic flow spike may be coincident with the 15 minute peak traffic flow spike of vehicles trying to exit the 200 area work locations to access the commute routes out of the Hanford Reservation.

Roadway Operations and Traffic Controls

There are several areas within the Hanford site, where congestion could be reduced through modifications in channelization, controls and/or operations. The following options were evaluated. Approaches recommended by TSI for <u>immediate implementation are shown in underlined</u> text. Approaches recommended by TSI for *potential future implementation are shown in italic text*.

Beloit Road intersection with SR 240. Options include:

1. <u>Refinements of staggered work shift arrival and release times</u>
2. Install "flying T" and slip lane channelization on SR240 with SB dual left turn lanes on Beloit
3. Install traffic signal if warranted
4. *Construct a roundabout.*

Rt 3 Intersection with ERDF Road

1. Refinements of staggered work shift arrival and release times
2. Install an all-way stop if warranted

3. Install a traffic signal if warranted
4. Construct a roundabout

Rt 3 Intersection with Rt 4S
1. <u>Refinements of staggered work shift arrival and release times</u>
2. <u>Install EB right turn channelization on Route 3 and a receiving/merge lane on Route 4 South</u>
3. Install traffic signal if warranted
4. *Construct a roundabout*

Rt 4S from Rt 3 to Baltimore or Canton
1. <u>Refinements of staggered work shift arrival and release times</u>
2. *Construct a 4 lane or 5 lane cross section (2 travel lanes in each direction with or without a center turn lane*
3. Install traffic signals at Baltimore and Canton if warranted
4. *Construct roundabouts with slip lanes at Canton and Baltimore.*

Rt 4S Hill Climb Lane
1. Extend the uphill passing lane beyond the crest of the hill to allow slower moving vehicles to accelerate to the speed of the pack to encourage better utilization of the hill climb lane on a more regular basis. (Not applicable if additional lanes or reversible operations are implemented on Rt 4S.)

Rt 4S from Canton to Wye Barricade
1. <u>Increase the speed limit on Route 4 South from the Wye Barricade to Canton Avenue to 60 mph.</u> (Only in conjunction with increased enforcement)
2. Install yellow flexible pylons or rumble strips on the centerline in the no passing zone to discourage downhill passing in the areas of limited sight distance. (Not applicable if additional lanes or reversible operations are implemented on Rt 4S.)
2. Install shoulder rumble strips in areas where vehicles frequently leave the roadway due to driver inattention or "drowsy driving".
3. <u>Install enforcement pull-outs on Route 4 South between Canton and the Wye Barricade.</u>
4. Convert Rt 4s to one way two lane eastbound traffic only and divert all inbound westbound traffic to Rt 2S/Rt 11A. This may require additional lanes on Rt 2S and traffic channelization changes at the Route 4 South intersection with Route 2 South and the intersection of Route 4 South with Canton Avenue such as installation of a multi-lane roundabout with manual or automatic gates to implement the one way traffic patterns.
5. Convert Rt 4s to one way two lane westbound traffic only and divert all outbound westbound traffic to Rt 2S/Rt 11A. This may require additional lanes on at the southern terminus of Rt 2S and traffic channelization changes such as a roundabout at the Route 4 South intersection with Route 2 South and installation of a multi-lane roundabout with manual or automatic gates at the intersection of Route 4 South with Canton Avenue to implement the one way traffic patterns.
6. <u>Convert Route 4 South to one way two lane eastbound traffic only in the AM and PM Peak periods and divert all inbound westbound traffic to Route 2 South/Route 11A during that period.</u> This may require traffic channelization changes at the Route 4 South intersection with Route 2 South and the intersection of Route 4 South with Canton Avenue with manual barricades, or manual or automatic gates to implement the one way traffic patterns. Long

term reversible operations would be facilitated by construction of multi-lane roundabouts at these intersections.

7. *Consider extension of AM and PM peak period reversible operations to the portion of Route 4 South from Route 3 to Canton.*
8. Consider additional passing lane segments in both directions if Canton to Wye conversion to one-way outbound or reversible one way operations is not implemented.

MSA staff also asked TSI to evaluate a contractor's request to change the traffic control at the Route3/20th Street/ERDF Road intersection. Traffic volumes in the AM and PM peak periods support keeping the traffic controls in their current configuration with the east-west directions free and the north-south directions stop controlled. The predominant traffic flow is east-west. The north-south traffic flow is minimal throughout the day. The intersection operates at LOS A in the AM and PM peak periods with virtually no queuing. It is TSI's understanding that one of the contractors would like the traffic control changed to allow free-flow movements north-south to improve traffic operations for their truck movements taking material to the ERDF. Making this change would create unnecessary traffic delays for the higher volume east-west commuter traffic in the AM and PM peak periods. A roundabout could be considered if MSA wishes to improve the daytime north-south truck movements while minimizing impacts to the east-west commuters. However, TSI does not recommend construction of a roundabout at this location based on current traffic volumes. Another option would be for the contractor to provide flaggers and manually control traffic during truck hauling operations. Flagging operations would have no affect on the east-west commuters as long as the flagging operations began after the AM commute and ended prior to the beginning of the PM commute.

Matrix 1 comparing the cost and estimated effectiveness of these individual approaches follows this section. Matrix 2 compares the effectiveness and relative costs of potential packages of roadway enforcement, operations and engineering, options. The matrices were developed using Synchro and SimTraffic modeling of operations based on Hanford volume data collected in 2009, paving cost estimates for other Hanford projects, as well as cost information developed by TSI based on our experience with roundabouts, signals, and other non-paving improvements. The rough cost estimates are for planning level budgeting and scale comparison among the alternatives only.

TSI believes that the most cost effective overall package approach to resolving congestion and safety issues is represented by a staged implementation of package 3B shown in Matrix 2, along with selected operational and enforcement improvements:

<u>Immediate/Near term:</u>

- <u>Refine the workforce arrival/departure staggered schedules to reduce peak-hour congestion.</u>
- <u>Enhance traffic enforcement through modifications to the Benton County Sheriff contract</u>
- <u>Increase of the speed limit to 60 mph on Rt 4 South from Canton to the Wye Barricade</u>
- <u>Eastbound right –turn channelization improvements to integrate with potential future construction of a roundabout at the intersection of Route 3 and Route 4 South (below)</u>
- <u>Convert Route 4 South to a 1-way reversible route during the evening and morning commute periods, with diversion of opposing traffic to Beloit Road, and Route 11A and Route 2S</u>
- <u>Paving of periodic enforcement pull-outs or widened shoulders on Route 4 South</u>

Future/Potential

- *Increase the number of lanes on Route 4 South to a 4 or 5 lane cross section from Route 3 to Canton Avenue*
- *Install roundabouts on Route 4 South at Route 3, Baltimore Avenue and Canton Avenue (design to accommodate largest truck operating on site)*
- *Authorize and implement Automated Camera Speed Enforcement through either Sheriff's Office authority or administrative/safety regulations*
- *Install a roundabout at the intersection of Beloit Road and SR-240*

This package of improvements would be expected to provide the best value for dramatically improved traffic operations for areas accessing the Hanford Site's most heavily traveled roads, as well as reducing speed violations, enhancing safety and reducing environmental impact when compared with current conditions. While other approaches may provide the same or slightly superior congestion relief, they cannot be justified either because of their substantially higher cost or because of their significant increase in carbon emissions and fuel consumption.

As noted in the matrices, we recommend that several of these recommended engineering and operational approaches be phased to allow for near-term operations improvements to be realized prior to completion of authorization, funding and design, more complex improvements.

Table 9 – Alternatives Comparison Matrix 1

Location / Alternative	Problems Addressed	Cost to Implement	Time to Implement (Months)	Process Difficulty / Complexity	Positives	Negatives	Value	Comments
General Operational Alternatives								
GO.1 Changes in work shift arrival and release times	AM/PM Congestion, LOS Failure	Low	2 to 6	High Mod	Low Mod Congestion Relief	Complex to maintain and enforce	Low Mod	May be difficult / complex to maintain and enforce over long term ; may reduce work efficiency and carpool/vanpool utilization
GO.2 Increase and revamp Benton County Sheriff Enforcement	Speed violations, Aggressive Passing	$0 to $150,000 per yr	2 to 12 months	Mod	Reduce high speed and aggressive driving	Ongoing Cost if not offset by Camera Enforcement Revenue	High	Do not implement 6.O.1 if enforcement is not enhanced
GO.3 Expand use of Automated Camera Speed Enforcement for Hanford Roads	Speed Violations	Low	6 to 24	High Mod	Revenue for Sheriff Contract, Effective speed enforcement, Reduce enforcement safety risk	Potential resistance to legislative change or automated citations	High	
Location Specific Engineering and Operational Alternatives								
1. Beloit Road intersection with SR 240								
E.1. double "flying T" and slip lane on SR240 w/ SB dual left turn lanes on Beloit	Reduce PM Congestion / LOS Failure	$475,000	24 to 36	High	Works at Current Traffic Volumes	Potential increase in collisions. May not handle future volumes	Mod	Complex WSDOT approval process
E.2. traffic signal		$500,000	24 to 36	High	Reduction in serious collision potential	Potential increase in overall collisions	Mod	Probably not warranted; Complex WSDOT approval process
E.3. roundabout		$825,000	24 to 36	High Mod	Decrease in collisions. Reduces Congestion	Slows traffic speed for thru volumes	High Mod	Complex WSDOT approval process
2. Rt 3 Intersection with 20th & ERDF Road								
E.1. all-way stop	Hauling Operations Issue	$1,500	1 to 4	Low	Mod Efficiency gain for haul	Increased Congestion	Low	Not warranted by volumes
E.2. traffic signal		$225,000	6 to 12	Low Mod		Increased Congestion / Potential Increase in collisions	Low	Not warranted by volumes
E.3. roundabout		$500,000	8 to 24	Low Mod	More efficient operations	None	Mod	Volumes may not justify. Handles daily traffic fluctuations
E.4. flagger		Contractor Cost	1	Low	Flexible / Mod Efficiency gain for haul	Ongoing cost	Low Mod	Only during off-peak

Alternatives Comparison Matrix 1 –Page 2

Location / Alternative	Problems Addressed	Cost to Implement	Time to Implement (Months)	Process Difficulty / Complexity	Positives	Negatives	Value	Comments
3. Rt 3/ Rt 4 Intersection								
E.1. EB right turn channelization on Rt 3 w/ receiving/merge lane on Rt 4S	Reduce PM Congestion / EB Queuing	$275,000	4 to 12	Low	High Mod EB Queue, Congestion Relief	No benefit to WB Ennis	High Mod	Reduced queues on EB Rt 3; No benefit to WB Ennis; Design to integrate with future roundabout or signal channelization
E.2. traffic signal		$275,000	6 to 12	High Mod	Improve EB and WB movements	Increased NB/SB Congestion / Potential Increase in collisions	Mod	Reduced queues on EB Rt 3; Improve egress from WB Ennis; Increased potential for collisions. Creates NB/SB queues
E.3. roundabout		$1,100,000[2]	8 to 12	Low Mod	Improve EB and WB movements	None	High	Reduced queues on EB Rt3 and WB Ennis; Safest and best overall solution for reducing congestion)
4. Rt 4S from Rt 3 to Canton								
O.1. reduction in speed limit to 45 mph from west of Baltimore to just east of Canton	Reduce AM and PM Congestion / PM SB Queuing	$5,000	Coincident with 4.E.2 or 4.E.3	Low	Low Mod Congestion Relief	May not be observed without increased enforcement	Mod	Reduced speed improves merge efficiency in area with multiple minor accesses. Consider if additional accesses developed in this area. Should be combined with 4.E.2 or 4.E.3
E.1. construct 4 lane or 5 lanes cross section from Rt 3 intersection to Canton		$1,600,000	24 to 36	Low Mod	Improve Capacity / Some Congestion Relief	None	Mod	Consider if additional accesses developed in area. Should be combined with 4.E.2 or 4.E.3
E.2. traffic signals at Baltimore and Canton		$1,600,000		High Mod	Reduced Queues on Baltimore and Canton	Potential collision increase on 4S	Mod	If Warranted. Assumes 4+ lanes from west of Baltimore to Canton. Moves congestion on 4S to east of Canton if 4S capacity isn't increased from Canton to Wye.
E.3. roundabouts with slip lanes at Canton and Baltimore.		$1,700,000		Low Mod	Reduced queues on Canton and Baltimore; Provides best overall flows	None	High	Assumes 4+ lanes from west of Baltimore to Canton. Works best if GO.1 implemented; Moves congestion on 4S to east of Canton if 4S capacity isn't increased from Canton to Wye; Integrates best with 6.E.3.; Safest and best overall solution
5. Rt 4S Hill Climb Lane								
E.1. Extend uphill passing lane beyond the crest of the hill	Underuse of merge lane. Platoon size.	$275,000	8 to 12	Low	Improves capacity and aids merge back into travel lane	None	Mod	Allows slower moving vehicles to accelerate for easier merge.

[2] Includes cost of 3E1

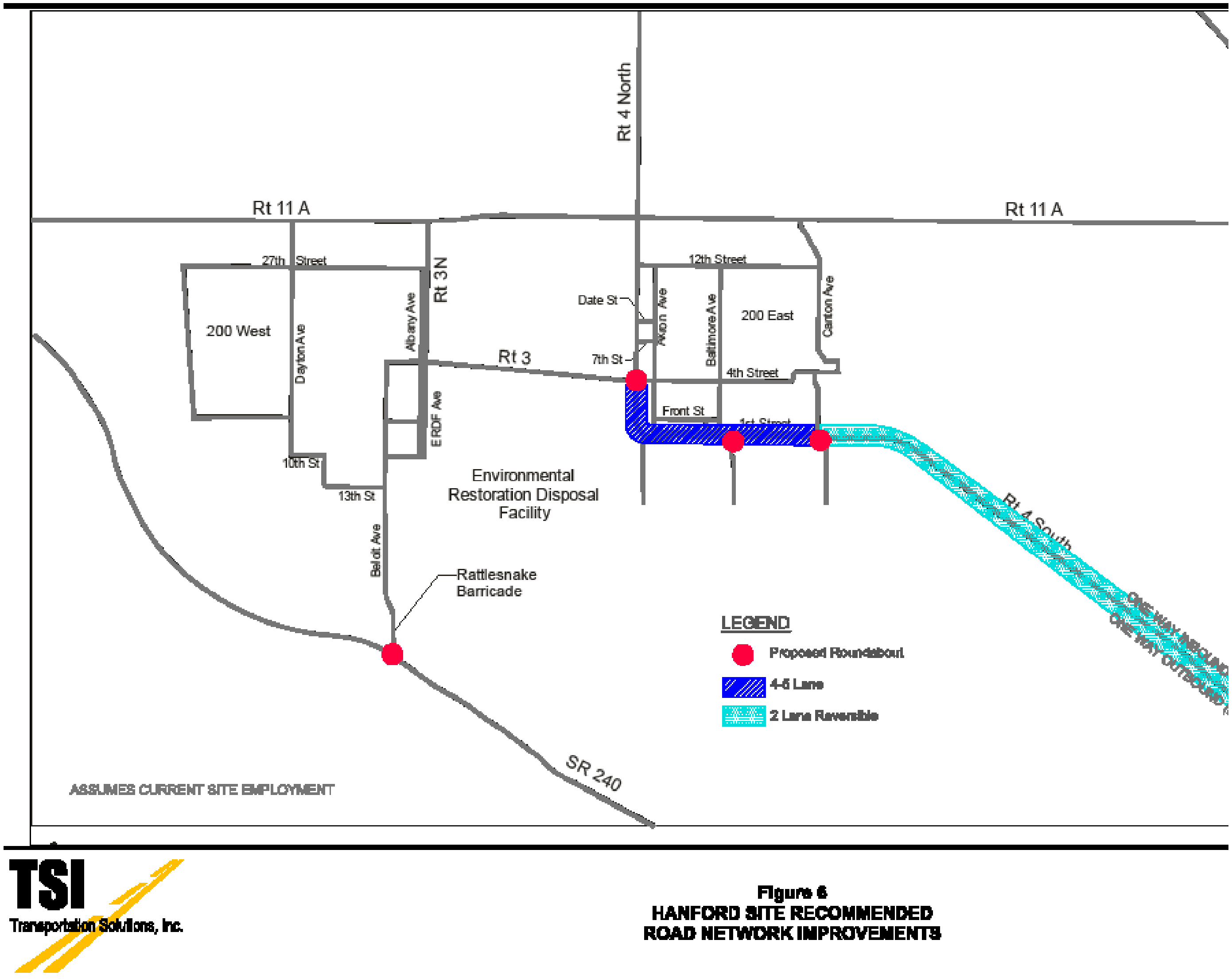
Alternative Comparison Matrix 1 – Page 3

Location / Alternative	Problems Addressed	Cost to Implement	Time to Implement (Months)	Process Difficulty / Complexity	Positives	Negatives	Value	Comments
6. Rt 4S from Canton to Wye Barricade								
O.1. Raise speed limit to 60 mph: 79th percentile speed	Platoon Size. Aggressive Passing.	$50,000	8 to 24	Requires Benton County Approval, based on Traffic Study	Improve speed compliance. Reduce platoon size / Aggressive Passing	Should not be done if enforcement not improved	High	Only if GO.2 and/or GO.3 are implemented
E.1. Install yellow flexible delineators on the centerline in all no passing zones		$50,000 initial plus $25,000 ongoing cost	2 to 3	Low	Discourage passing in no-passing zones	Damage / ongoing maintenance from snow removal activities	High Mod	Discourage passing in no-passing zones
E.2.A Convert Rt 4S to 1-way 2-lane EB only and divert all WB traffic to Rt 2 South/Rt 11A;	AM and PM Capacity / Congestion. Platoon Size. Aggressive Passing.	$1,400,000	2 to 6	Requires thorough education process.	Increase capacity, Reduce congestion, Eliminates Aggressive Passing / Platoon Issues on 4S	Significant increases in emissions and overall vehicle miles traveled	Low Mod	Additional lanes on Canton or other N access to 200E to mitigate increase in congestion on Canton south of Rt11A, as well as other roads within 200E. Build NB lane from Rt4/Rt2S intersection to meet existing 4 lane section.
E.2.B Convert Rt 4S to 1-way 2-lane WB only and divert all EB traffic to Rt 2S / Rt 11A		$1,400,000						Extend 4-lanes of 2S to new roundabout at intersection with 4S
E.3. Convert Rt 4S to 1-way 2-lane reversible during peak commute periods (WB in AM and EB in PM); divert other traffic to Rt 2S/Rt 11A during those periods.		$200,000	6 to 12	Requires thorough education process. Establish operational process / protocols.	Increase capacity, Reduce congestion, Eliminates Aggressive Passing / Platoon Issues on 4S	Requires implementation of daily sweeps and operational protocols. Minor inconvenience for opposing small volume traffic	High	Channelization changes at Rt 4S / Rt 2S and Rt4S/Canton Ave intersections: moveable barriers, by existing staff. Lower capital cost offset by higher operational cost.
		$2,000,000						Channelization changes at Rt 4S / Rt 2S and Rt4S/Canton Ave intersections: multi-lane roundabout w/ manual or auto gates, cameras, and ITS approaches. Higher capital cost offset by lower operational cost
E.4. Add single reversible lane from Canton to Wye Barricade		$4,600,000	24 to 36	Significant funding Process. Establish operational process / protocols.	Increase capacity, Reduce congestion, Eliminates Aggressive Passing / Platoon Issues on 4S	Complex ops protocols and barrier requirements than 6.E.2 or 6.E.3. More pavement maint	Low	Improvement may not offset high initial and ongoing cost. Requires thorough education process.
E.5. Add two lanes (not reversible) from Canton to Wye Barricade		$8,500,000	24 to 36	Significant funding Process.	Provides most capacity. No operational issues	More pavement to maintain.	Low Mod	Improvement may not offset high initial and ongoing cost.
E.6 Add periodic pullouts, shoulder widening	Enforcement Safety and Effectiveness	$825,000	2 to 6	Low	Provides for safer enforcement activities	Increased enforcement could cause congestion	High	Increases Enforcement effectiveness and safety (assumes 6 pullouts ¼ mile each)

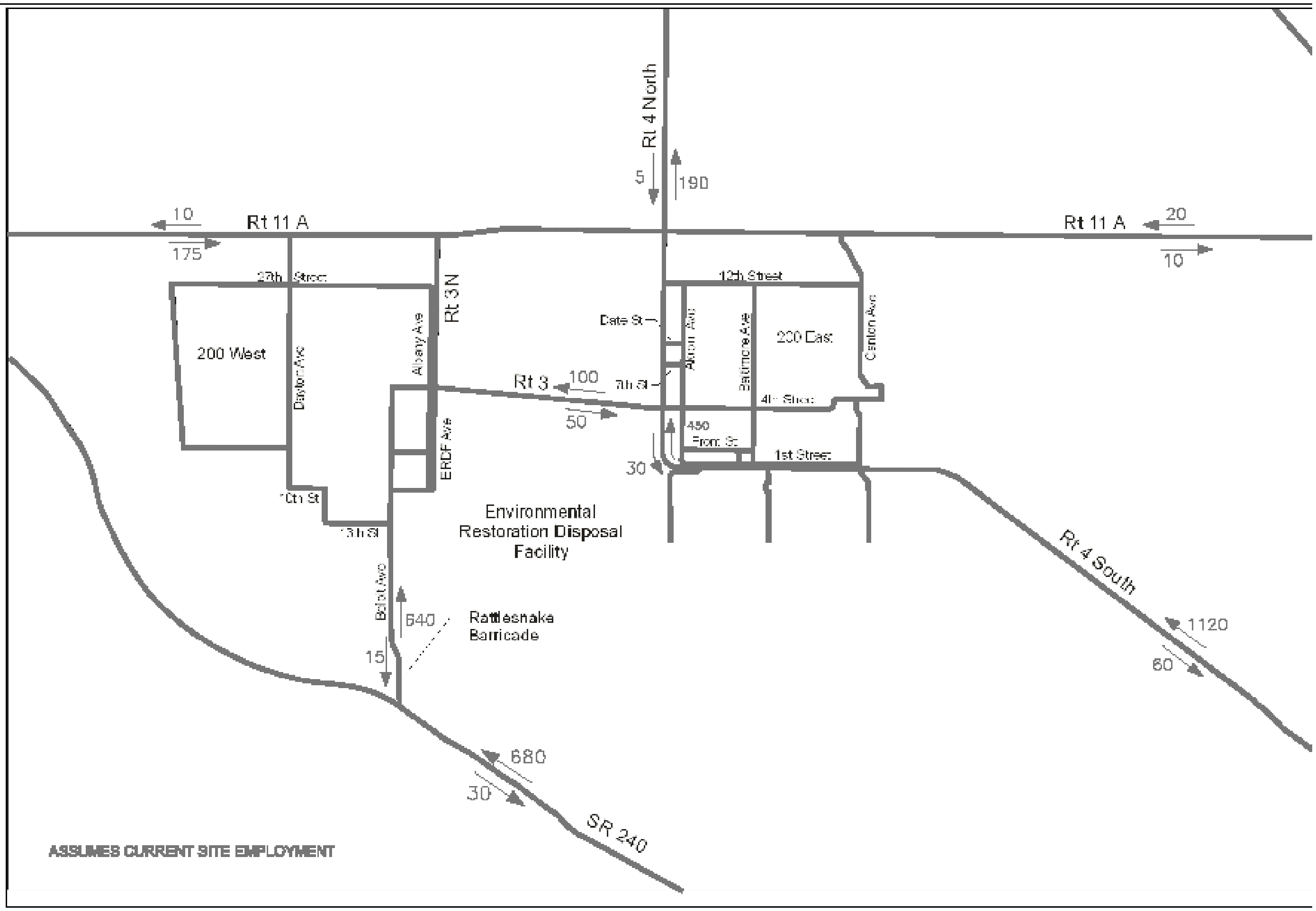
Table 10 – Alternatives Comparison Matrix 2

Package	Rt 4S Canton to Wye Segment			Beloit / SR 240 Intersection			Rt 3 / Rt 4S Intersection			Rt 4S from Rt 3 to Canton			Cost
	Improvement	PM Peak Hr LOS		Improvement	Peak Hr LOS		Improvement	Peak Hr LOS		Improvement	Peak Hr LOS		
		PM	AM		PM	AM		PM	AM		PM	AM	
Existing Conditions		E	D	Existing	F	A	Existing	F	C	Existing	F	E	N/A
1A	Hill Climb Lane Extension and Pull-outs Only	E	D	Double Left Flying T	C	A	EB Right Turn and Merge Lane	D (EB L, Th)	C	4-lane Cross Section, flying T's	B	A	$ 4,589,789
1B		E	D	Roundabout	A	A	Roundabout w/EB Turn/Merge lane	A	A	4-lanes & Roundabouts	B	A	$ 6,310,322
2A OUT	One-way outbound 4S and Pull-Outs	B	N/A	Double Left Flying T	C	A	EB Right Turn and Merge Lane	D (EB L, Th)	C	Add 1-lane EB, keep flying T's	B	A	$ 2,943,618
2B OUT		B	NA	Roundabout	A	A	Roundabout w/EB Turn/Merge lane	A	A	Add 1-lane EB, Roundabouts	B	A	$ 4,664,151
2A IN	One-way inbound 4S and Pull-Outs	N/A	B	Double Left Flying T	C	A	EB Right Turn and Merge Lane	D (EB L, Th)	C	Add 1-lane WB, keep flying T's	B	A	$ 2,943,618
2B IN		N/A	B	Roundabout	A	A	Roundabout w/EB Turn/Merge lane	A	A	Add 1-lane WB; Roundabouts	B	A	$ 4,664,151
3A	Reversible operation on 4S with existing lane capacity and Pull-Outs	B	A	Double Left Flying T	C	A	EB Right Turn and Merge Lane	D (EB L, Th)	C	4-lane Cross Section, flying T's	B	A	$ 4,315,427
3B		B	A	Existing	F	A	EB Right Turn and Merge Lane	D (EB L, Th)	C	Existing	F	E	$ 1,097,447
3C		B	A	Roundabout	A	A	Roundabout w/EB Turn/Merge lane	A	A	4-lane Cross Section, flying T's	B	A	$ 6,035,960
4A	Reversible lane on 4S with additional lane capacity and Pull-Outs	B	A	Double Left Flying T	C	A	EB Right Turn and Merge Lane	D (EB L, Th)	C	4-lane Cross Section, flying T's	B	A	$ 8,156,493
4B		B	A	Roundabout	A	A	Roundabout w/EB Turn/Merge lane	A	A	4-lane Cross Section, Roundabouts	B	A	$ 9,877,026
5A	Keeping everything two-way and adding lane capacity and Pull-Outs	B	A	Double Left Flying T	C	A	EB Right Turn and Merge Lane	D (EB L, Th)	C	4-lane Cross Section, flying T's	B	A	$ 11,997,558
5B		B	A	Roundabout	A	A	Roundabout w/EB Turn/Merge lane	A	A	4-lane Cross Section, Roundabouts	B	A	$ 13,718,091

Figure 6 – Hanford Site Recommended Road Network Improvements

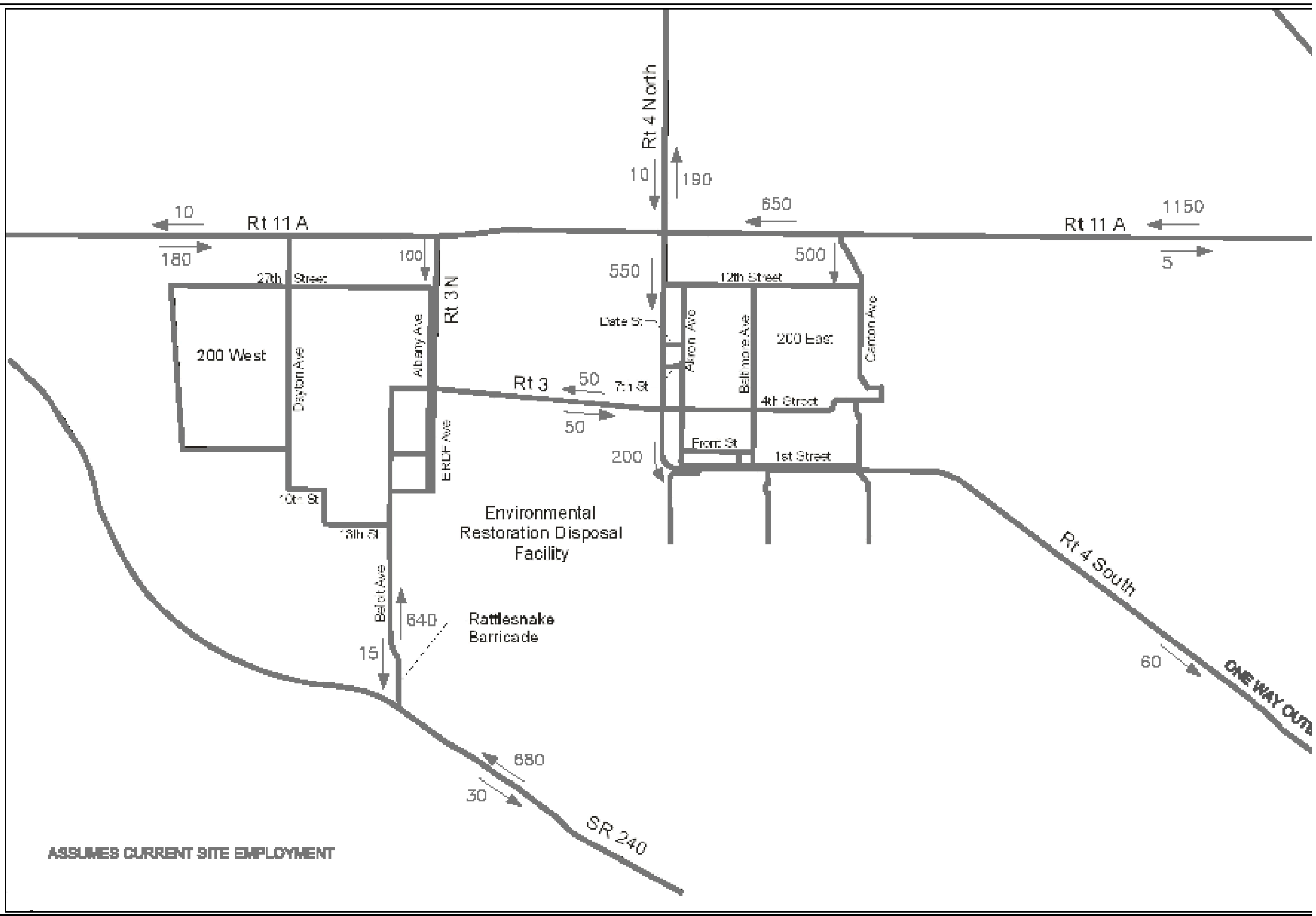


Figures 7A-D Weekday A.M. Corridor Volumes – Existing and Alternatives



TSI
Transportation Solutions, Inc.

Figure 7A
WEEKDAY AM PEAK CORRIDOR VOLUMES
2009 EXISTING, ALTERNATIVE 1



TSI Transportation Solutions, Inc.

Figure 7B
WEEKDAY AM PEAK CORRIDOR VOLUMES
ALTERNATIVE 2 (ROUTE 4 SOUTH OUTBOUND ONLY)

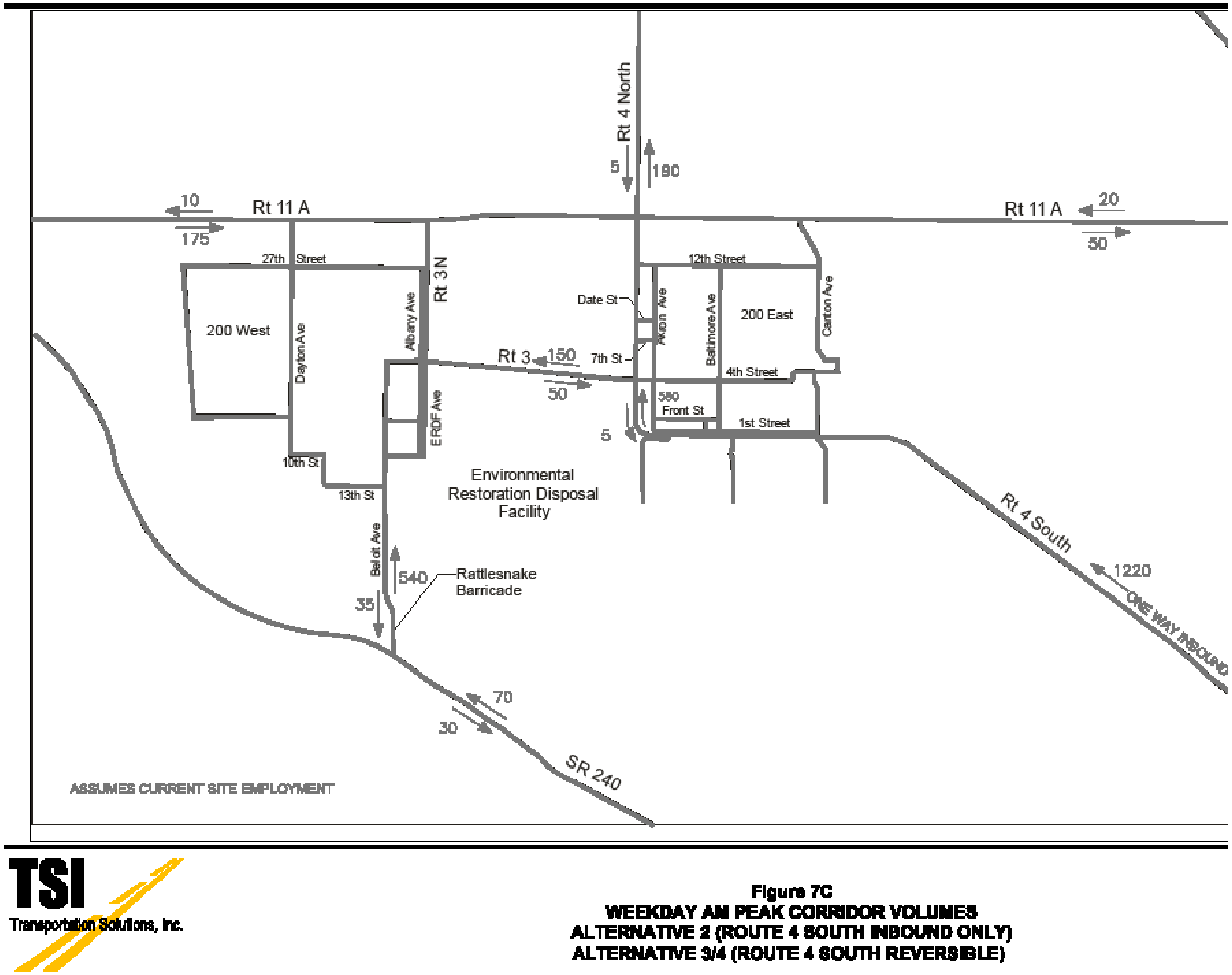
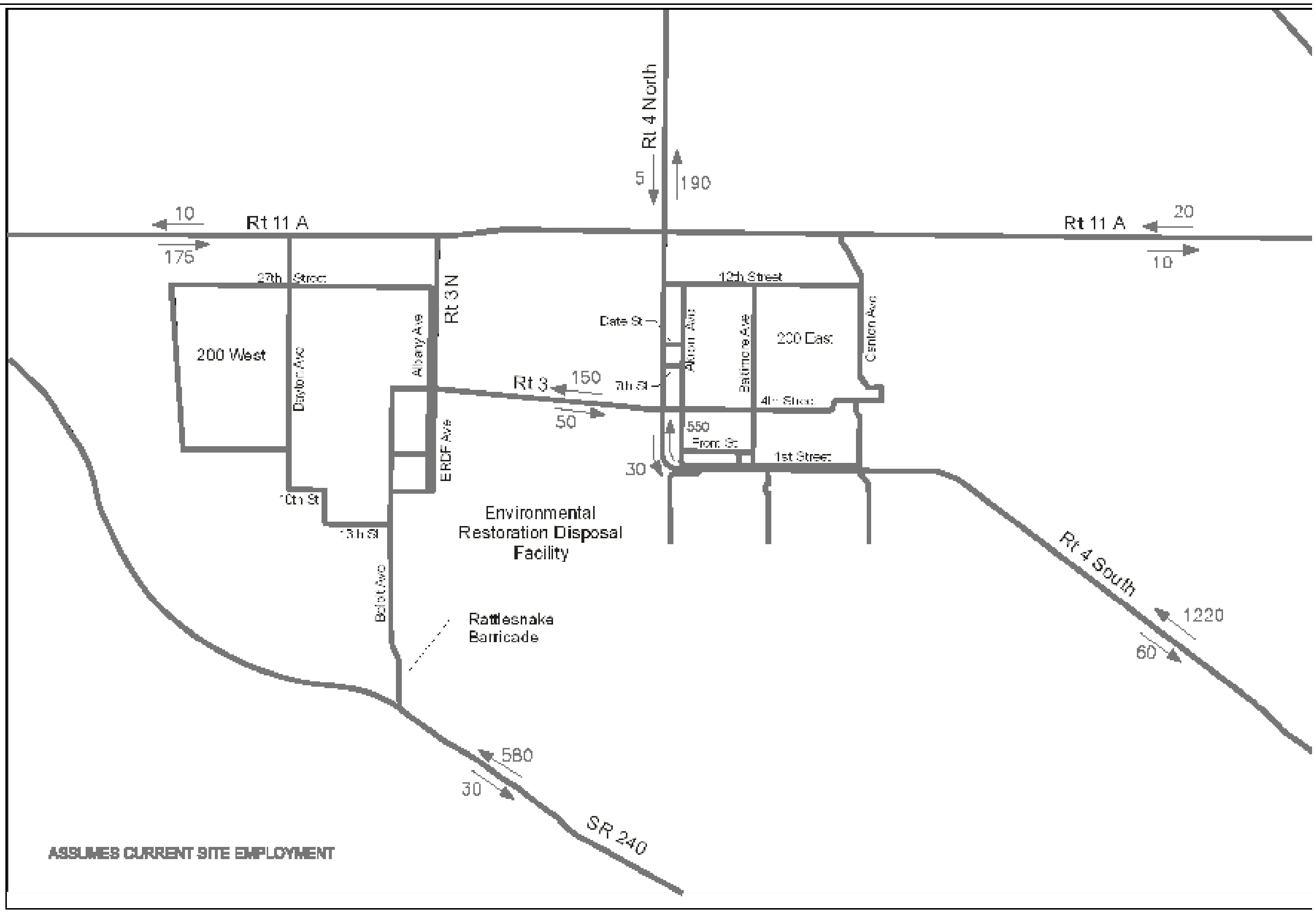


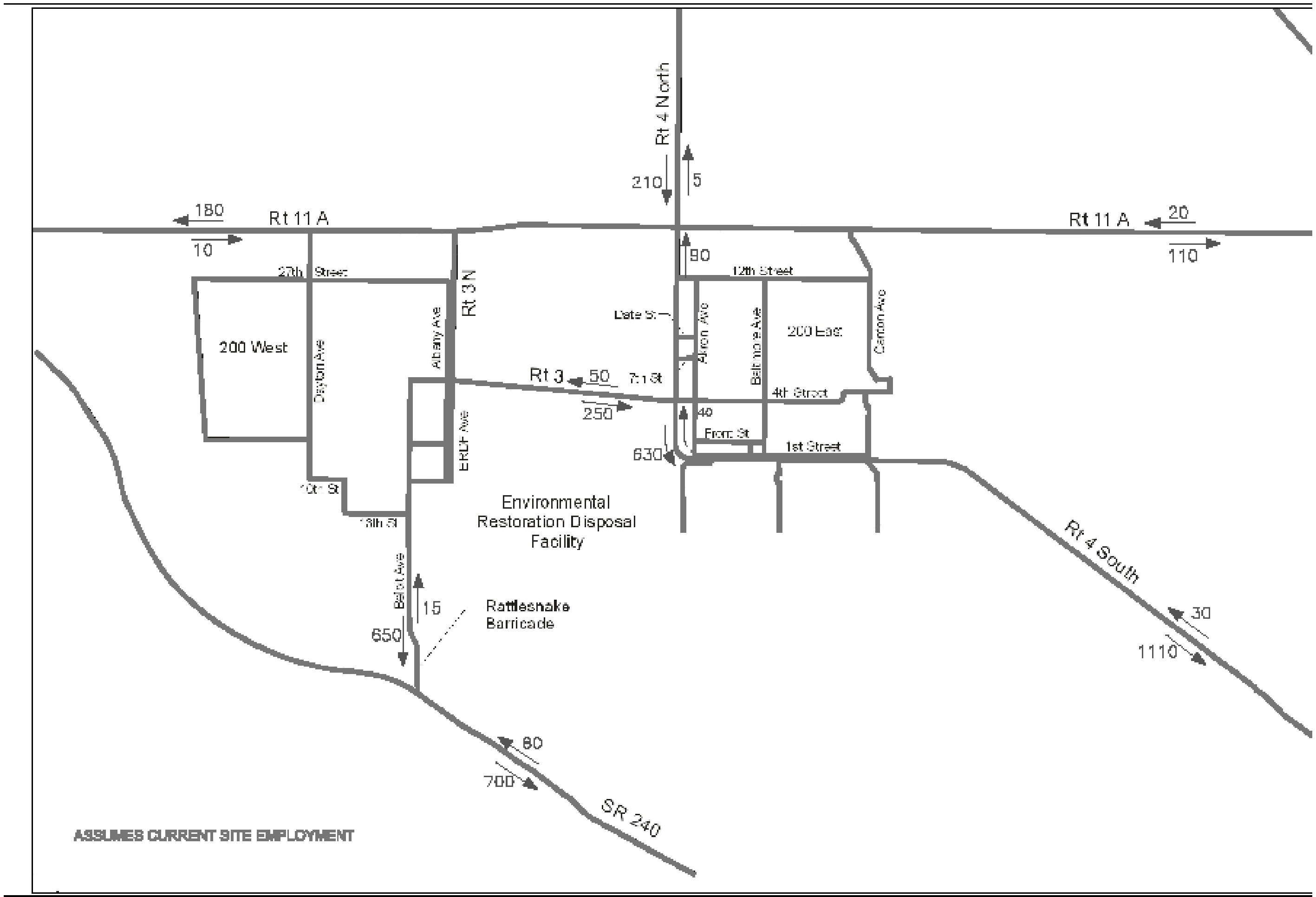
Figure 7C
WEEKDAY AM PEAK CORRIDOR VOLUMES
ALTERNATIVE 2 (ROUTE 4 SOUTH INBOUND ONLY)
ALTERNATIVE 3/4 (ROUTE 4 SOUTH REVERSIBLE)



TSI Transportation Solutions, Inc.

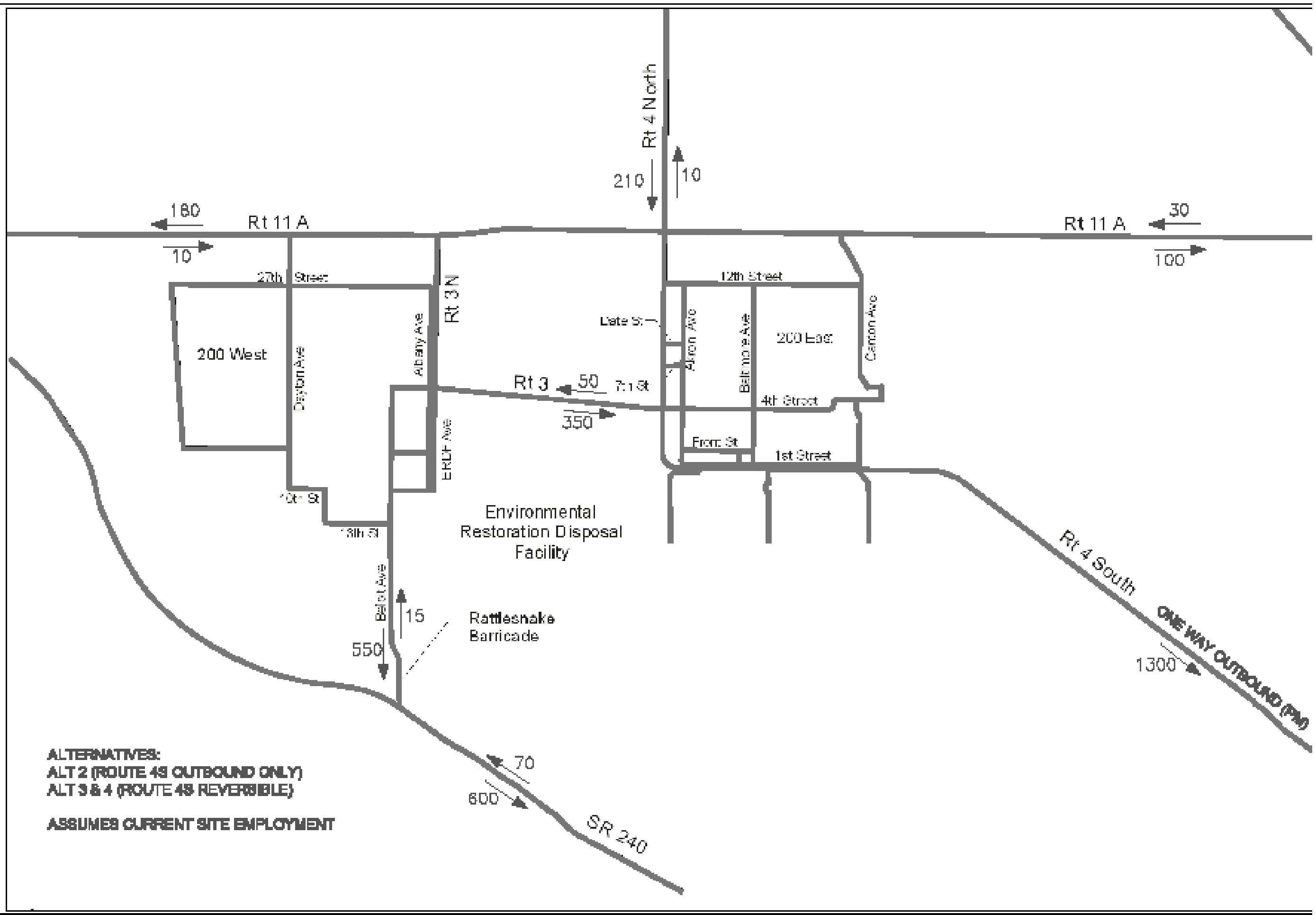
Figure 7D
WEEKDAY AM PEAK CORRIDOR VOLUMES
ALTERNATIVE 5 (WIDEN ALL OF ROUTE 4 SOUTH TO 4/5 LANES)

Figures 8 A-D Weekday P.M. Corridor Volumes – Existing and Alternatives



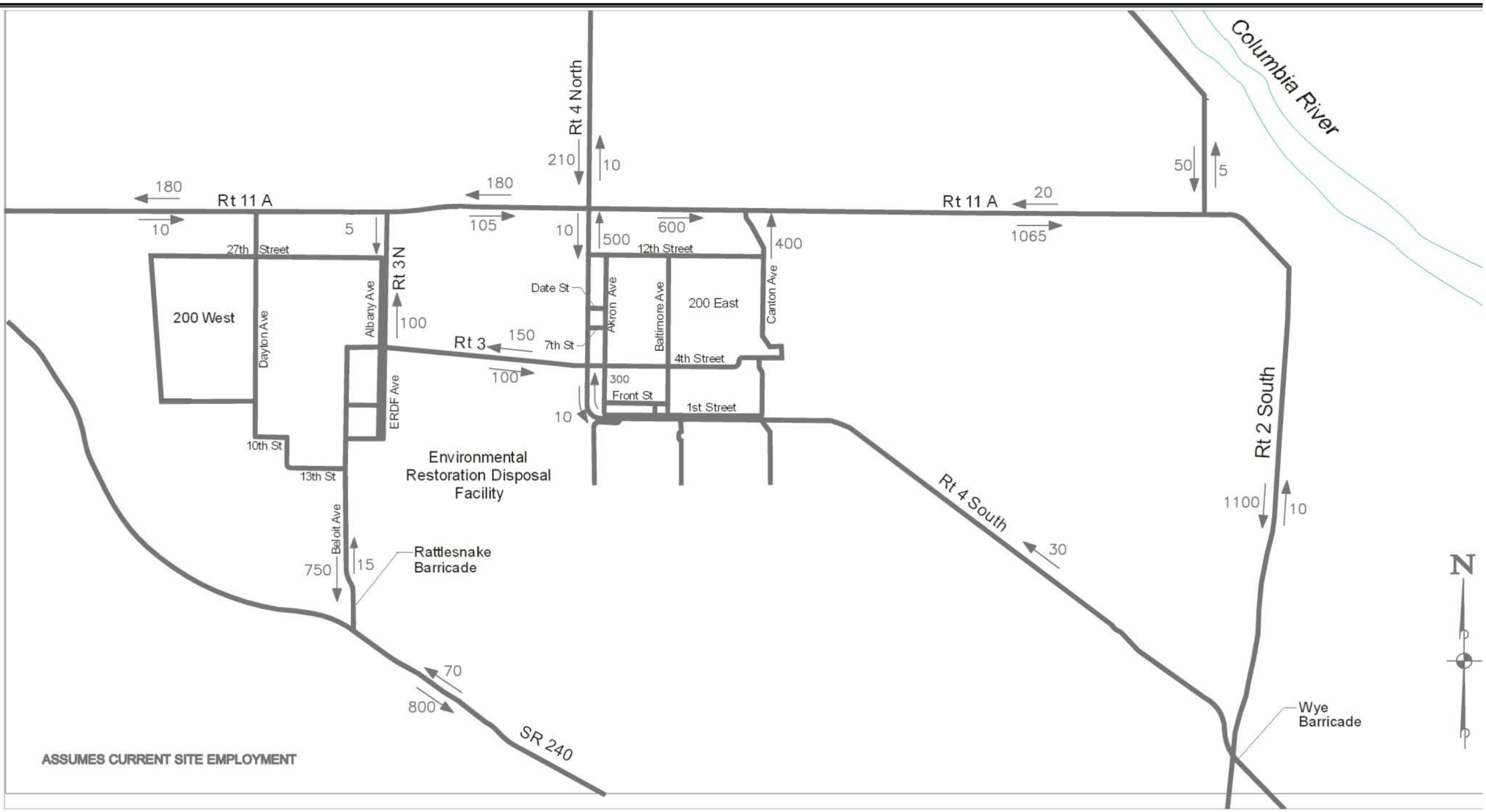
TSI
Transportation Solutions, Inc.

Figure 8A
WEEKDAY PM PEAK CORRIDOR VOLUMES
2009 EXISTING, ALTERNATIVE 1



TSI Transportation Solutions, Inc.

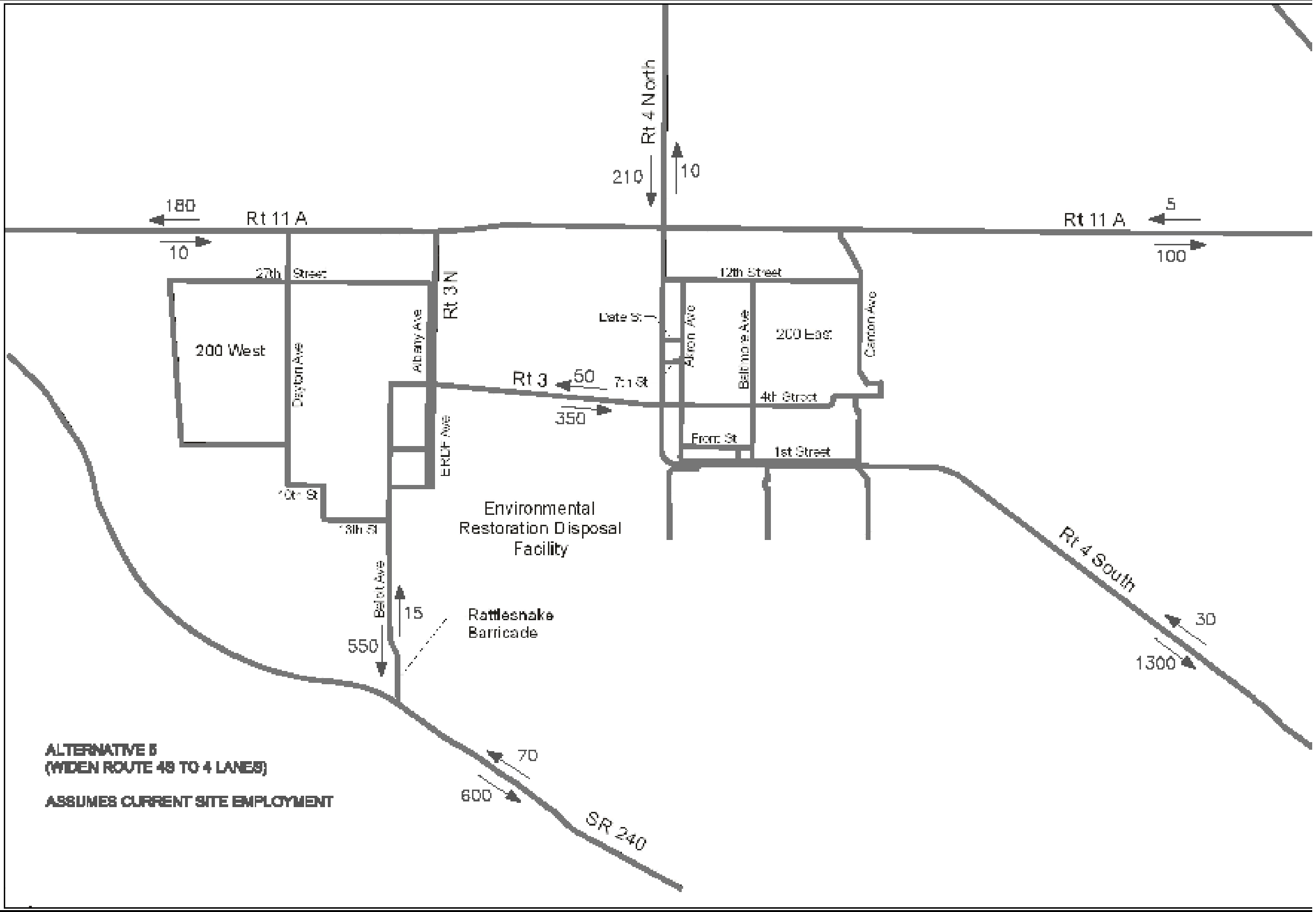
Figure 8B
WEEKDAY PM PEAK CORRIDOR VOLUMES
ALTERNATE 2 (ROUTE 4 SOUTH OUTBOUND ONLY)
ALTERNATIVE 3/4 (ROUTE 4 SOUTH REVERSIBLE)



TSI
Transportation Solutions, Inc.

Figure 8C
WEEKDAY PM PEAK CORRIDOR VOLUMES
ALTERNATIVE 2 (ROUTE 4 SOUTH INBOUND ONLY)

Hanford Safety Assessment



TSI
Transportation Solutions, Inc.

Figure 8D
WEEKDAY PM PEAK CORRIDOR VOLUMES
ALTERNATIVE 5 (WIDEN ALL OF ROUTE 4 SOUTH TO 4/5 LANES)

Figure 9 – Hanford Site Road Mileage

Future Operations

TSI has also done a preliminary evaluation of the future plans to consolidate the bulk of the activity on the Hanford Reservation to the 200 Areas on the Central Plateau by approximately 2015. The plan envisions allowing certain road infrastructure on the site to deteriorate while concentrating road maintenance and operations efforts on the core road segments serving the 200 Areas. Consideration has been given to closing the Yakima and Wye Barricades to minimize future road infrastructure costs. Preliminary analysis indicates that the peak hour vehicular traffic from the combined activities of the Central Plateau Area would overwhelm a two lane Beloit Avenue Route and would cause the Beloit Avenue intersection with SR240 to fail. Such a consolidation of traffic to one route would also likely cause segments of SR240 between the Bypass Highway and the Rattlesnake Barricade to fall below LOS C in both the AM peak period and the PM peak period which would be in violation of adopted WSDOT and Benton County LOS standards.

However, TSI believes that a portion of the traffic that currently accesses the Hanford Site via SR240 and Beloit Road likely would utilize Route 4 South if the recommended improvements are implemented. Therefore, we recommend that traffic operations options be analyzed in conjunction with anticipated workforce ramp-up and ramp-down scenarios to determine which roads serving the Hanford Site might be reasonably abandoned and which should be maintained or improved to maintain reasonable traffic safety, operations, mobility and access.

Acknowledgements

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Appendices

U.S. Department of Transportation
Federal Highway Administration

FHWA Home | Feedback

FHWA CORPORATE RESEARCH AND TECHNOLOGY
Priority, Market-Ready Technologies and Innovations List: Roundabouts

Problem: Intersection crashes account for more than 45 percent of all crashes nationwide

Intersection safety is a serious problem in the United States. Addressing this problem is one of the Federal Highway Administration's (FHWA) top priorities.

In 2004, more than 2.7 million intersection-related crashes occurred, accounting for more than 45 percent of all crashes in the United States. That same year, intersection fatalities were 9,117 or 21 percent of all traffic fatalities.

In addition, approximately 45 percent of all injury crashes, or nearly 900,000 crashes, occurred at intersections. Each year, side-impact crashes, which occur mostly at intersections, cause more than one-third of all vehicle occupant deaths.
Why are there so many intersection crashes?

An intersection is a planned point of conflict in the roadway system. With different crossing and entering movements by both drivers and pedestrians, an intersection is one of the most complex traffic situations that motorists encounter. Add the element of speeding motorists who disregard traffic controls, and the dangers are compounded.
Who is most likely to be affected?

Situations involving complex speed-distance judgments under time constraints, as found at intersections, can be problematic for many drivers and pedestrians, especially senior drivers and pedestrians. Approximately half of fatal crashes involving drivers 80 or older take place at intersections.
Solution: Roundabouts are a proven safety solution that prevent and reduce the severity of intersection crashes

and traffic engineering measures have improved, but the annual number of intersection fatalities has not changed significantly. To reduce crashes and improve intersection safety, FHWA recommends the use of roundabouts, where appropriate. Roundabouts must be designed to meet the needs of all road users--drivers, pedestrians, pedestrians with disabilities, and bicyclists. Proper site selection and pedestrian channelization are essential to making roundabouts accessible to all users.
What is a roundabout and how does its design improve intersection safety?

A roundabout is a one-way, circular intersection in which traffic flows around a center island. Roundabouts are designed to meet the needs of all road users--drivers, pedestrians, pedestrians with disabilities, and bicyclists. A roundabout eliminates some of the conflicting traffic, such as left turns, which cause crashes at traditional intersections. Because roundabout traffic enters or exits only through right turns, the occurrence of severe crashes is substantially reduced. Smallangle collisions that may occur as a result of a right-hand turn are typically less severe than other types of collisions.

Not all circular intersections are roundabouts. Many existing traffic circles or rotaries operate under different traffic rules and have experienced operational and safety problems.

The three safety design features of a roundabout are yield control of entering traffic; channelized approaches that deflect traffic into the proper one-way, counterclockwise flow; and geometric curvature of the circular road and angles of entry to slow the speed of vehicles. These three features are critical to the success of a roundabout because they effectively decrease driving speed to typically 48 kilometers (30 miles) per hour or less.

Putting It in Perspective In 2004: Approximately 1 intersection-related fatality occurred every hour. Approximately 2 intersection-related injury crashes occurred every minute. Financial loss from intersection crashes was $96 billion.

Benefits Crashes are less severe than other intersection crashes. Safer than traditional intersections. Cost-effective way to improve intersection safety. Increased traffic capacity and improved traffic flow. No signal equipment to maintain. Aesthetic benefits.

Successful Applications: There are increasing numbers of examples of roundabouts demonstrating success in reducing crashes

A 2000 study by the Insurance Institute for Highway Safety and several other organizations evaluated 24 intersections in California, Colorado, Florida, Kansas, Maine, Maryland, South Carolina, and Vermont before and after construction of roundabouts. The study revealed a 39-percent decrease in crashes, a 76-percent decrease in injury crashes, and a 90-percent reduction in crashes involving fatal or incapacitating injuries.

A December 2002 study of 15 single-lane roundabouts in Maryland showed a 60-percent decrease in total crash rates, an 82-percent reduction in injury crash rates, a 100-percent decrease in the fatal crash rate, and a 27-percent reduction in property-damage-only (PDO) crash rates. In addition, a soon-to-be-published study by the National Cooperative Highway Research Program found that the installation of roundabouts led to a 35-percent reduction in total crashes and a 76-percent reduction in crashes causing injuries or fatalities.

These are but a few examples of the safety benefits of roundabouts. There also are operational benefits from roundabouts, such as less delay and increased traffic capacity.

RC46.61.415
When local authorities may alter maximum limits.

(1) Whenever local authorities in their respective jurisdictions determine on the basis of an engineering and traffic investigation that the maximum speed permitted under RCW 46.61.400 or 46.61.440 is greater or less than is reasonable and safe under the conditions found to exist upon a highway or part of a highway, the local authority may determine and declare a reasonable and safe maximum limit thereon which

(a) Decreases the limit at intersections; or

(b) Increases the limit but not to more than sixty miles per hour; or

(c) Decreases the limit but not to less than twenty miles per hour.

(2) Local authorities in their respective jurisdictions shall determine by an engineering and traffic investigation the proper maximum speed for all arterial streets and shall declare a reasonable and safe maximum limit thereon which may be greater or less than the maximum speed permitted under RCW 46.61.400(2) but shall not exceed sixty miles per hour.

(3) The secretary of transportation is authorized to establish speed limits on county roads and city and town streets as shall be necessary to conform with any federal requirements which are a prescribed condition for the allocation of federal funds to the state.

(4) Any altered limit established as hereinbefore authorized shall be effective when appropriate signs giving notice thereof are erected. Such maximum speed limit may be declared to be effective at all times or at such times as are indicated upon such signs; and differing limits may be established for different times of day, different types of vehicles, varying weather conditions, and other factors bearing on safe speeds, which shall be effective when posted upon appropriate fixed or variable signs.

(5) Any alteration of maximum limits on state highways within incorporated cities or towns by local authorities shall not be effective until such alteration has been approved by the secretary of transportation.

RCW 46.63.170
Automated traffic safety cameras — Definition.

(1) The use of automated traffic safety cameras for issuance of notices of infraction is subject to the following requirements:

(a) The appropriate local legislative authority must first enact an ordinance allowing for their use to detect one or more of the following: Stoplight, railroad crossing, or school speed zone violations. At a minimum, the local ordinance must contain the restrictions described in this section and provisions for public notice and signage. Cities and counties using automated traffic safety cameras before July 24, 2005, are subject to the restrictions described in this section, but are not required to enact an authorizing ordinance.

(b) Use of automated traffic safety cameras is restricted to two-arterial intersections, railroad crossings, and school speed zones only.

(c) During the 2009-2011 fiscal biennium, automated traffic safety cameras may be used to detect speed violations for the purposes of section 201(2), chapter 470, Laws of 2009 if the local legislative authority first enacts an ordinance authorizing the use of cameras to detect speed violations.

(d) Automated traffic safety cameras may only take pictures of the vehicle and vehicle license plate and only while an infraction is occurring. The picture must not reveal the face of the driver or of passengers in the vehicle.

(e) A notice of infraction must be mailed to the registered owner of the vehicle within fourteen days of the violation, or to the renter of a vehicle within fourteen days of establishing the renter's name and address under subsection (3)(a) of this section. The law enforcement officer issuing the notice of infraction shall include with it a certificate or facsimile thereof, based upon inspection of photographs, microphotographs, or electronic images produced by an automated traffic safety camera, stating the facts supporting the notice of infraction. This certificate or facsimile is prima facie evidence of the facts contained in it and is admissible in a proceeding charging a violation under this chapter. The photographs, microphotographs, or electronic images evidencing the violation must be available for inspection and admission into evidence in a proceeding to adjudicate the liability for the infraction. A person receiving a notice of infraction based on evidence detected by an automated traffic safety camera may respond to the notice by mail.

(f) The registered owner of a vehicle is responsible for an infraction under RCW 46.63.030(1)(e) unless the registered owner overcomes the presumption in RCW 46.63.075, or, in the case of a rental car business, satisfies the conditions under subsection (3) of this section. If appropriate under the circumstances, a renter identified under subsection (3)(a) of this section is responsible for an infraction.

(g) Notwithstanding any other provision of law, all photographs, microphotographs, or electronic images prepared under this section are for the exclusive use of law enforcement in the discharge of duties under this section and are not open to the public and may not be used in a court in a pending action or proceeding unless the action or proceeding relates to a violation under this section. No photograph, microphotograph, or electronic image may be used for any purpose other than enforcement of violations under this section nor retained longer than necessary to enforce this section.

(h) All locations where an automated traffic safety camera is used must be clearly marked by placing signs in locations that clearly indicate to a driver that he or she is entering a zone where traffic laws are enforced by an automated traffic safety camera.

(i) If a county or city has established an authorized automated traffic safety camera program under this section, the compensation paid to the manufacturer or vendor of the equipment used must be based only upon the value of the equipment and services provided or rendered in support of the system, and may not be based upon a portion of the fine or civil penalty imposed or the revenue generated by the equipment.

(2) Infractions detected through the use of automated traffic safety cameras are not part of the registered owner's driving record under RCW 46.52.101 and 46.52.120. Additionally, infractions generated by the use of automated traffic safety cameras under this section shall be processed in the same manner as parking infractions, including for the purposes of RCW 3.50.100, 35.20.220, 46.16.216, and 46.20.270(3). However, the amount of the fine issued for an infraction generated through the use of an automated traffic safety camera shall not exceed the amount of a fine issued for other parking infractions within the jurisdiction.

(3) If the registered owner of the vehicle is a rental car business, the law enforcement agency shall, before a notice of infraction being issued under this section, provide a written notice to the rental car business that a notice of infraction may be issued to the rental car business if the rental car business does not, within eighteen days of receiving the written notice, provide to the issuing agency by return mail:

(a) A statement under oath stating the name and known mailing address of the individual driving or renting the vehicle when the infraction occurred; or

(b) A statement under oath that the business is unable to determine who was driving or renting the vehicle at the time the infraction occurred because the vehicle was stolen at the time of the infraction. A statement provided under this subsection must be accompanied by a copy of a filed police report regarding the vehicle theft; or

(c) In lieu of identifying the vehicle operator, the rental car business may pay the applicable penalty.

Timely mailing of this statement to the issuing law enforcement agency relieves a rental car business of any liability under this chapter for the notice of infraction.

(4) Nothing in this section prohibits a law enforcement officer from issuing a notice of traffic infraction to a person in control of a vehicle at the time a violation occurs under RCW 46.63.030(1)(a), (b), or (c).

(5) For the purposes of this section, "automated traffic safety camera" means a device that uses a vehicle sensor installed to work in conjunction with an intersection traffic control system, a railroad

grade crossing control system, or a speed measuring device, and a camera synchronized to automatically record one or more sequenced photographs, microphotographs, or electronic images of the rear of a motor vehicle at the time the vehicle fails to stop when facing a steady red traffic control signal or an activated railroad grade crossing control signal, or exceeds a speed limit in a school speed zone as detected by a speed measuring device. During the 2009-2011 fiscal biennium, an automated traffic safety camera includes a camera used to detect speed violations for the purposes of section 201(2), chapter 470, Laws of 2009.

(6) During the 2009-2011 fiscal biennium, this section does not apply to automated traffic safety cameras for the purposes of section 218(2), chapter 470, Laws of 2009.
[2009 c 470 § 714; 2007 c 372 § 3; 2005 c 167 § 1.]
Notes:
Effective date -- 2009 c 470: See note following RCW 46.68.170.

SENATE BILL 5712

State of Washington **61st Legislature** **2009 Regular Session**

By Senator Jacobsen
Read first time 01/29/09. Referred to Committee on Transportation.

AN ACT Relating to using traffic safety cameras on certain arterial streets; amending RCW 46.63.170; and creating a new section.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF WASHINGTON:
<u>NEW SECTION.</u> Sec. 1 It is the intent of the legislature that this act increase the tools available to the state's largest urban area to increase pedestrian and driver safety. More than six hundred pedestrians have been killed on Washington state streets and roadways in the past eight years. The city of Seattle experiences more than four hundred collisions involving pedestrians each year, and an average of six pedestrian fatalities a year. Excessive driver speed is often cited as a factor in traffic fatalities.
The state's largest urban area is encouraged to use traffic safety cameras for the purpose of detecting speeding violations at locations with the highest pedestrian, bicycle, and vehicular traffic accident history.
Sec. 2 RCW 46.63.170 and 2007 c 372 s 3 are each amended to read as follows:
(1) The use of automated traffic safety cameras for issuance of notices of infraction is subject to the following requirements:
(a) The appropriate local legislative authority must first enact an ordinance allowing for their use to detect one or more of the following: Stoplight, railroad crossing, or school speed zone violations<u>, or speed violations on arterial streets in cities with a population over five hundred thousand only</u>. At a minimum, the local ordinance must contain the restrictions described in this section and provisions for public notice and signage. Cities and counties using automated traffic safety cameras before July 24, 2005, are subject to the restrictions described in this section, but are not required to enact an authorizing ordinance.
(b) Use of automated traffic safety cameras is restricted to two-arterial intersections, railroad crossings, ((and)) school speed zones<u>, and arterial streets in cities with a population over five hundred thousand</u> only.
(c) Automated traffic safety cameras may only take pictures of the vehicle and vehicle license plate and only while an infraction is occurring. The picture must not reveal the face of the driver or of passengers in the vehicle.
(d) A notice of infraction must be mailed to the registered owner of the vehicle within fourteen days of the violation, or to the renter of a vehicle within fourteen days of establishing the renter's name and address under subsection (3)(a) of this section. The law enforcement officer issuing the notice of infraction shall include with it a certificate or facsimile thereof, based upon inspection of photographs, microphotographs, or electronic images produced by an automated traffic safety camera, stating the facts supporting the notice of infraction. This certificate or facsimile is prima facie evidence of the facts contained in it and is admissible in a proceeding charging a violation under this chapter. The photographs, microphotographs, or electronic images evidencing the violation must be available for inspection and admission into evidence in a proceeding to adjudicate the liability for the infraction. A person receiving a notice of infraction based on evidence detected by an automated traffic safety camera may respond to the notice by mail.

(e) The registered owner of a vehicle is responsible for an infraction under RCW 46.63.030(1)(e) unless the registered owner overcomes the presumption in RCW 46.63.075, or, in the case of a rental car business, satisfies the conditions under subsection (3) of this section. If appropriate under the circumstances, a renter identified under subsection (3)(a) of this section is responsible for an infraction.
(f) Notwithstanding any other provision of law, all photographs, microphotographs, or electronic images prepared under this section are for the exclusive use of law enforcement in the discharge of duties under this section and are not open to the public and may not be used in a court in a pending action or proceeding unless the action or proceeding relates to a violation under this section. No photograph, microphotograph, or electronic image may be used for any purpose other than enforcement of violations under this section nor retained longer than necessary to enforce this section.
(g) All locations where an automated traffic safety camera is used must be clearly marked by placing signs in locations that clearly indicate to a driver that he or she is entering a zone where traffic laws are enforced by an automated traffic safety camera.
(h) If a county or city has established an authorized automated traffic safety camera program under this section, the compensation paid to the manufacturer or vendor of the equipment used must be based only upon the value of the equipment and services provided or rendered in support of the system, and may not be based upon a portion of the fine or civil penalty imposed or the revenue generated by the equipment.
(2) Infractions detected through the use of automated traffic safety cameras are not part of the registered owner's driving record under RCW 46.52.101 and 46.52.120. Additionally, infractions generated by the use of automated traffic safety cameras under this section shall be processed in the same manner as parking infractions, including for the purposes of RCW ((3.46.120,)) 3.50.100, 35.20.220, 46.16.216, and 46.20.270(3). However, the amount of the fine issued for an infraction generated through the use of an automated traffic safety camera shall not exceed the amount of a fine issued for other parking infractions within the jurisdiction.
(3) If the registered owner of the vehicle is a rental car business, the law enforcement agency shall, before a notice of infraction being issued under this section, provide a written notice to the rental car business that a notice of infraction may be issued to the rental car business if the rental car business does not, within eighteen days of receiving the written notice, provide to the issuing agency by return mail:
(a) A statement under oath stating the name and known mailing address of the individual driving or renting the vehicle when the infraction occurred; or
(b) A statement under oath that the business is unable to determine who was driving or renting the vehicle at the time the infraction occurred because the vehicle was stolen at the time of the infraction. A statement provided under this subsection must be accompanied by a copy of a filed police report regarding the vehicle theft; or
(c) In lieu of identifying the vehicle operator, the rental car business may pay the applicable penalty. Timely mailing of this statement to the issuing law enforcement agency relieves a rental car business of any liability under this chapter for the notice of infraction.
(4) Nothing in this section prohibits a law enforcement officer from issuing a notice of traffic infraction to a person in control of a vehicle at the time a violation occurs under RCW 46.63.030(1)(a), (b), or (c).
(5) For the purposes of this section, "automated traffic safety camera" means a device that uses a vehicle sensor installed to work in conjunction with an intersection traffic control system, a railroad grade crossing control system, or a speed measuring device, and a camera synchronized to automatically record one or more sequenced photographs, microphotographs, or electronic images

of the rear of a motor vehicle at the time the vehicle fails to stop when facing a steady red traffic control signal or an activated railroad grade crossing control signal, or exceeds a speed limit ((in a school speed zone)) as detected by a speed measuring device.

--- END ---

Effects of Raising and Lowering Speed Limits

(Part of the Reasonable Drivers Unanimous site)
>.from/sl-irrel"-->
Full Text
Plain Text Version
Final Report
(Abstract and Finding)

Report No. FHWA-RD-92-084 **October 1992**

U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, Virginia 22101-2296

The objectives of this research was to determine the effects of raising and lowering posted speed limits on driver behavior and accidents for non-limited access rural and urban highways. Speed and accident data were collected in 22 States at 100 sites before and after speed limits were altered. Before and after data were also collected simultaneously at comparison sites where speed limits were not changed to control for the time trends. Repeated measurements were made at 14 sites to examine short - and long-term effects of speed limit changes.
The results of the study indicated that lowering posted speed limits by as much as 20 mi/h (32 km/h), or raising speed limits by as much as 15 mi/h (24 km/h) had little effect on motorist' speed. The majority of motorist did not drive 5 mi/h (8 km/h) above the posted speed limits when speed limits were raised, nor did they reduce their speed by 5 or 10 mi/h (8 or 16 km/h) when speed limits are lowered. Data collected at the study sites indicated that the majority of speed limits are posed below the average speed of traffic. Lowering speed limits below the 50th percentile does not reduce accidents, but does significantly increase driver violations of the speed limit. Conversely, raising the posted speed limits did not increase speeds or accidents.

Introduction

This study was conducted to examine driver behavior and accident effects of raising and lowering posted speed limits on nonlimited access rural and urban highways. While much research in recent years has focused on the effects of the 55 and 65 mi/h (89 and 105 km/h) speed limits on limited access facilities, the major emphasis of this research is on streets and highways that were posted between 20 and 55 mi/h (32 and 89 km/h)
A maximum speed limit is posted or set by statute on a highway to inform motorists of the highest speed considered to be safe and reasonable under favorable road, traffic, and weather conditions. A review of early vehicles speed legislation in the United States suggests that regulations were established to improve public safety. The rational for government regulation of speed is based on the fact that unreasonable speed may cause damage and injury. Speed laws also provide a basis for punishing the unreasonable behavior of an individual driver.
Every State has a basic speed statute requiring drivers to operate their vehicles at a speed that is reasonable and prudent under existing conditions. This law recognizes that the maximum safe speed varies due to traffic, roadway, weather, light and other conditions, and places the responsibility of selecting a safe and reasonable speed on the driver.

The majority of motorists select a speed to reach their destination in the shortest time possible and to avoid endangering themselves, others, and their property. In selecting their speed, motorist consider roadway, traffic, weather, and other conditions. The collective judgment of the majority of motorists represents the level of reasonable travel and acceptable risk. Prior research has shown that the upper region of acceptable risk is in the vicinity of the 85th percentile speed.

Most traffic engineers believe that speed limits should be posted to reflect the maximum speed considered to be safe and reasonable by the majority of drivers using the roadway under favorable conditions. Procedures used to set speed limits have evolved through years of experience and research. Most States and localities set safe and reasonable maximum speed limits based on the results of an engineering and traffic investigation. While all States and most jurisdictions use the 85th percentile speed as a major factor n selecting the appropriate speed limit for a given street or highway, other factors such as roadside development, accident experience, and design speed are often subjectively considered.

The lack of consensus on how to establish safe and reasonable speed limits has led to nonuniform limits. While newspapers and scientific articles dating to the early 1900's discuss the problem and need for uniform limits, engineers such as Bearwald, in 1964, criticized traffic engineers for using nonuniform limits in both rural and urban areas and called for the establishment of speed zones of a factual and scientific basis as opposed to opinion and political expediency. Bearwald's suggestion apparently received little attention. For example, Harkey recently examined speed limits in rural and urban areas in four States and found that speed limits were set from 6 to 14 mi/h (10 to 23 km.h) below the 85th percentile speed.

One primary reason for setting speed limits lower than speed considered safe and reasonable by the majority of motorists is based on the belief that lower speed limits reduced seeds and accidents. Also it has been frequently suggested that most motorists drive 5 to 10 mi/h (8 to 16 km/h) over the posted speed limit, so lower limits should be established to account for this condition.

Conversely, it is believed that raising the speed limit increases speeds and accidents. For example, following a severe accident, one of the most frequent requests made to highway jurisdictions is to lower the speed limit. These requests are founded on public knowledge that accident severity increases with increasing vehicle speed because in a collision, the amount of kinetic energy dissipated is proportional to the square of the velocity. Simply stated, when a vehicle is involved in a crash the higher the vehicle speed, the greater the chance of being seriously injured or killed. However, as noted by a number of researchers, the potential for being involved in an accident is highest when traveling at speed much lower or much higher than the majority of motorists.

Arbitrary, unrealistic and nonuniform speed limits have created a socially acceptable disregard for speed limits. Unrealistic limits increase accident risks for persons who attempt to comply with limit by driving slower or faster than the majority of road users, Unreasonably low limits significantly decrease driver compliance and give road users such as person not familiar with the road and pedestrians, a false indication of actual traffic speeds.

Unrealistically high speed limits increase accident risk for drivers who are inexperienced or who disregard the basic speed law. Unrealistic limits also place enforcement officials and judges in the position of subjectively selecting and punishing violators. This practice can result in punishing average drivers, as well as high-risk violators.

For years, traffic engineering texts have supported the conclusion that motorists ignore unreasonable speed limits. Both formal research and informal operational observations conducted for many years indicate that there is very little change in the mean or 85th percentile speed as the result of raising or lowering the posted limit. Very few accident studies have been conducted to determine the safety effects or altering posted speed limits.

Highway administrators, enforcement officials, the judiciary system, and the public need factual information concerning the effects of speed limits to address pertinent issues. For example, do lower posted speed limits reduce vehicle speeds and accidents? If the speed limit is raised, will speeds and accidents increase? Do most motorists driver 5 to 10 mi/h (8 to 16 km/h) above the posted speed limit. What are the effects or lowering and raising speed limits on driver compliance? Answers to these questions and related issues are addressed in this report.

Summary of Findings

The pertinent findings of this study, conducted to examine the effects of lowing and raising posted speed limits on nonlimited access rural and urban highways, are listed below:

- Based on the free-flow speed data collected for a 24-h period at the experimental and comparison sites in 22 States, posted speed limits were set, on the average, at the 45th percentile speed or below the average speed of traffic
- Speed limits were posted, on average, between 5 and 16 mi/h (8 and 26 km/h) below the 85th percentile speed.
- Lowering speed limits by 5, 10, 15, or 20 mi/h (8, 16, 24, or 26 km/h) at the study sites had a minor effect on vehicle speeds. Posting lower speed limits does not decrease motorist's speeds.
- Raising speed limits by 5, 10, or 15 mi/h (8, 16, or 25 km/h) at the rural and urban sites had a minor effect on vehicle speeds. In other words, an increase in the posted speed limit did not create a corresponding increase in vehicle speeds.
- The average change in any of the percentile speeds at the experimental sites was less than 1.5 mi/h (2.4 m/h), regardless of whether the speed limit was raised or lowered.
- Where speed limits were lowered, an examination of speed distribution indicated the slowest drivers (1st percentile) increased their speed approximately 1 mi/h (1/6 km/h). There were no changes on the high-speed drivers (99th percentile)
- At sites where speed limits were raised, there was an increase of less than 1.5 mi/h (2.4 km/h) for drivers traveling at and below the 75th percentile speed. When the posted limits were raised by 10 and 15 mi/h (16 and 24 km/h), there was a small decrease in the 99th percentile speed.
- Raising speed limits in the region of the 85th percentile speed has an extremely beneficial effect on drivers complying with the posted speed limits.
- Lowering speed limits in the 33rd percentile speed (the average percentile that speed were posted in this study) provides a noncompliance rate of approximately 67 percent.
- After speed limits were altered at the experimental sites, less than one-half of the drivers complied with the new posed limits.
- Only minor changes in vehicles following as headways less than 2s were found at the experimental sites.
- Accidents at the 58 experimental sites where speed limits were lowered increased by 5.4 percent. The level of confidence of this estimate is 44 percent. The 95 percent confidence limits for this estimate ranges from a reduction in accidents of 11 percent to an increase of 26 percent.
- Accidents at the 41 experimental sites where speed limits were raised decreased by 6.7 percent. The level of confidence of this estimate in 59 percent. The 95 percent confidence limits for this estimate ranges from a reduction in accidents of 21 percent to an increase of 10 percent.
- Lowering speed limits more than 5 mi/h (8 km/h) below the 85th percentile speed of traffic did not reduce accidents.

- The indirect effects of speed limit changes on a sample of contiguous and adjacent roadways was found to be very small and insignificant.

Conclusion

The primary conclusion of this research is that the majority of motorist on the nonlimited access rural and urban highways examined in this study did not decrease or increase their speed as a result of either lowering or raising the posted speed limit by 4, 10, or 15 mi/h (8, 16, or 24 km/h). In other words, this nationwide study confirms the results of numerous other observational studies which found that the majority or motorist do not alter their speed to conform to speed limits they perceive as unreasonable for prevailing conditions.

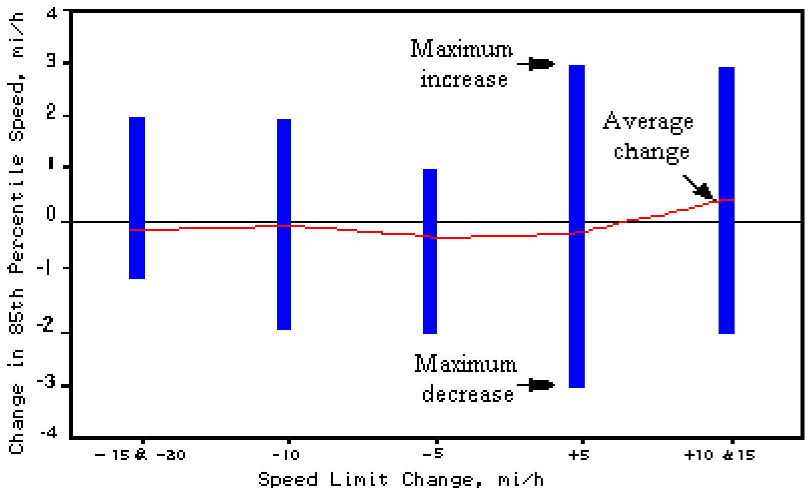

Figure 10. Maximum and average changes in the 85th percentile speeds at the experimental sites.

The data clearly show that lowering posted speed limits did not reduce vehicle speeds or accidents. Also, lowering speed limits well below the 86th percentile speed did not increase speeds and accidents. Conversely, raising the posted speed limits did not increase speeds and accidents. The majority of motorist did not drive 5 to 10 mi/h (8 to 16 km/h) above the posted speed limit when speed limits were raised, nor did they reduce their speed by 5 or 10 mi/h (8 to 16 km/h) when speed limits were lowered.

Because there were few changes in the speed distribution, it is not surprising that the overall effects of speed limit changes on accidents were minor. It is interesting to note that compliance decreased when speed limits were lowered and accidents tended to increase. Conversely, when compliance improved after speed limits are raised, accidents tended to decrease.

Based on the sites examined in 22 States, it is apparent that the majority of highway agencies set speed limits below the average speed of traffic as opposed to setting limits in the upper region of the minimum accident risk band or about 85th percentile speed. This practice means that more than one-half of the motorist are in technical violation of the speed limits laws.

Although there are variations from State to State, on average, speed limits were posed 5 and 16 mi/h (8 and 26 km/h) below the 85th percentile speed. As all States use the 85th percentile as a major criterion for establishing safe and reasonable speed limits, it is surprising that the new speed limits posted on the experimental sections examined in this study deviated so far from the 85th percentile speed. There are several plausible reasons. Once commonly cited reason for posting unreasonably low speed limits is public and political pressure. While individuals and politicians clearly influence some speed limit decision, there are other factors involved.

Although the 85th percentile speed is used as the major guideline in setting speed limits, other factors such as land use, pedestrian activity, accident history, etc., are often subjectively considered in the decision making process. Together, these factors can account for sped limits that are set 10 mi/h (16 km/h) below the 85th percentile speed. In addition, the 85th percentile speed is often estimated based on a minimum of 200 vehicles or 2 h sample. This process does not take into account the wide hourly fluctuations in the 85th percentile speed over a 24-h period. Furthermore, the vehicle selection process use of radar which is detected by motorist contribute to a bias sample, i.e., usually lower then the average 24-h 85th percentile speed.

Although the study sites could not be randomly selected, they represent a wide range of rural and urban conditions, traffic volume, and regional situations. As large changes in the posted speed limit did not create a meaningful increase or decrease in the motorists' speeds at the study sites, it is plausible that this effect would also be found on other nonlimited rural and urban access highways.

The data collected during this study indicate that there are no benefits, either from a safety or operational point of view, from establishing speed limits less than the 85th percentile speed. This does not mean that all speed limits should be raised. Traffic and engineer investigations should be conducted to obtain an accurate measure of the speed distribution. Greater emphasis should be placed on using the 85th percentile speed in setting safe and reasonable speed limits. These studies should be repeated as land use and traffic characteristics change.

The information provided in this report will be useful to highway agencies, enforcement officials, and other involved in establishing uniform safe and reasonable speed limits on the nation's highways. The graphics, such as figure 10 on p.15 [above], can be used to illustrate the effects of speed limit changes on vehicle speeds. As shown below, figure 41 (which shows the changes in accidents, as well as the 95th percentile confidence limits of the changes) can be used to illustrate the effects of lowering and raising speed limits in accidents. This figure should only be used by persons who have read the accident analysis section in this report and have a basic understanding of the analysis results.

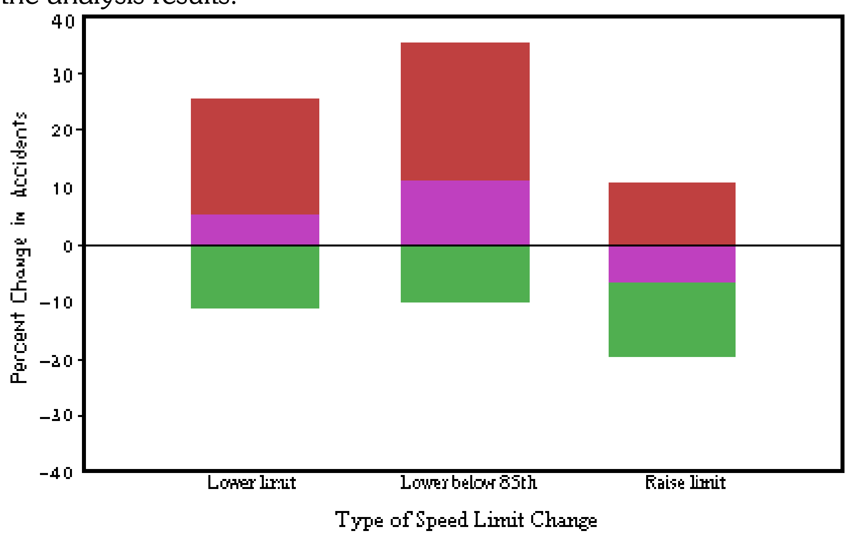

Figure 41. Summary of accident effects of altering posted speed limits.

Performing Organization Name and Address:
Martin R. Parker & Associates, Inc.
38549 Laurenwood Drive
Wayne, Michigan 48184-1073
Sponsoring Agency Name and Address:
Office of Safety and Traffic Operations R&D
Federal Highway Administration

6300 Georgetown Pike
McLean, Virginia 22101-2296