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To: Planning Commission
From: Clinton Spencer, City Planner CS
Subject: Proposed Amendment to Hermiston Transportation System Plan to Reconfigure South Highway 395 Corridor Refinement Plan
Date: February 2, 2016

The City of Hermiston and George Dress et al have worked to prepare an amendment to the South Highway 395 Corridor Refinement Plan in the Transportation System Plan (TSP) to reconfigure the traffic signal and off-highway circulation plans contained within that document. The current corridor refinement plan was prepared by the city and ODOT and adopted in 2003. The primary purpose of the corridor refinement plan is to create a plan for a system of off-highway streets to channel traffic to a set of five highway intersections which will eventually be signalized as traffic volumes warrant. The city is working on processing a development application for a large retail operation and several future lease pads immediately south of Hermiston Foods on Highway 395. Initial traffic analysis for this development indicates that at full buildout a traffic signal will be needed. The existing TSP does not reflect a traffic light at this access point. The Oregon Department of Transportation (ODOT) requires any signal installed on a state facility to be included in a city's TSP before it will consider any funding mechanism or allow the signal to be installed.

The existing circulation and signal plan is included in Figure 1 below.

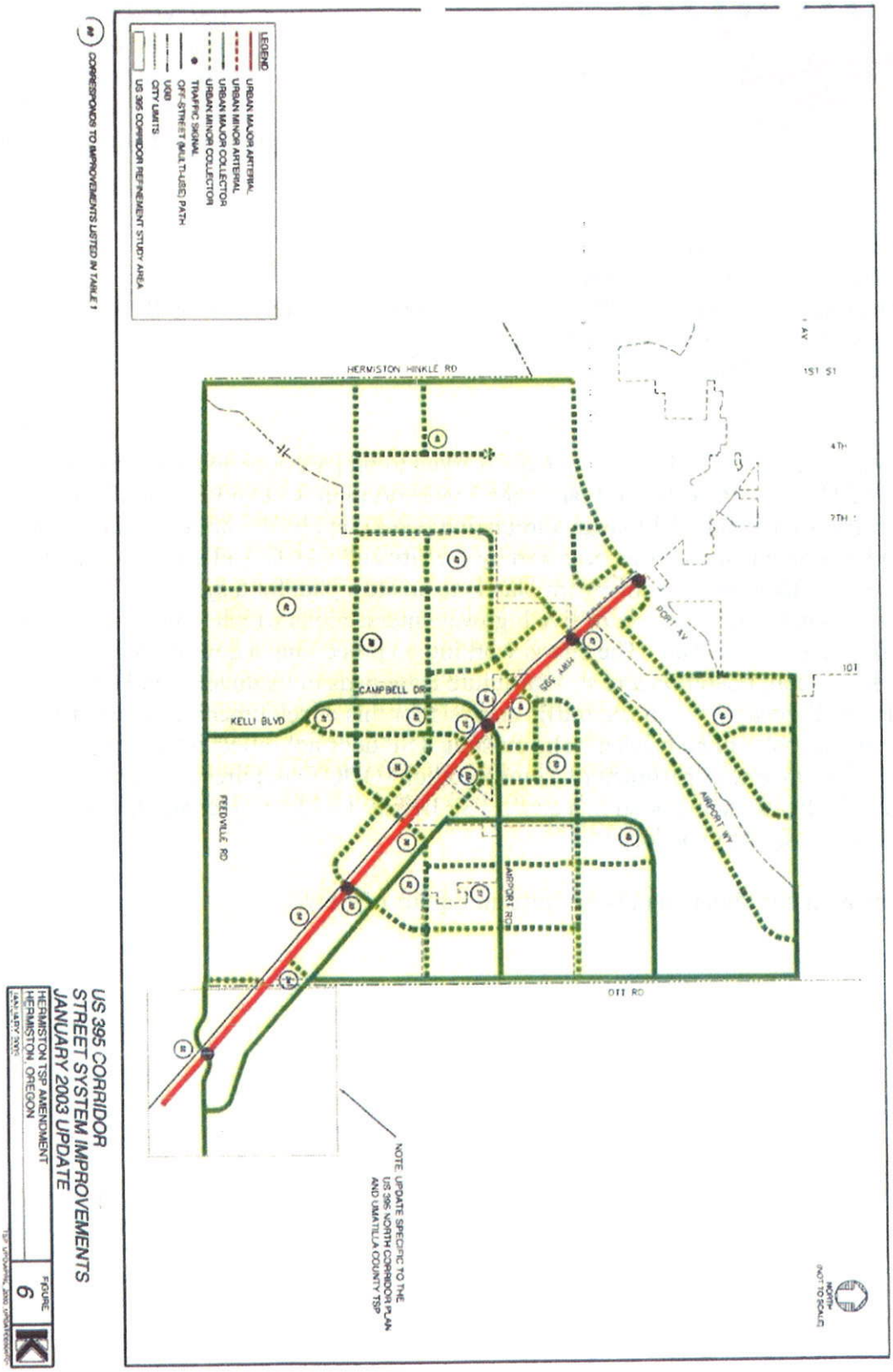


Figure 1 2003 Signal and Circulation Plan

The proposed amendment will add a new traffic signal between the proposed signals at Airport Road and at the truck entrance for the Wal-Mart distribution center. The amendment to the plan will add a new signal at the existing truck entrance for Hermiston Foods. This new signal location will require a change from the existing access as a public access easement to a public road.

A copy of the revised layout is included in Figure 2 below. The new signal is highlighted by the number 1 in a squared circle.

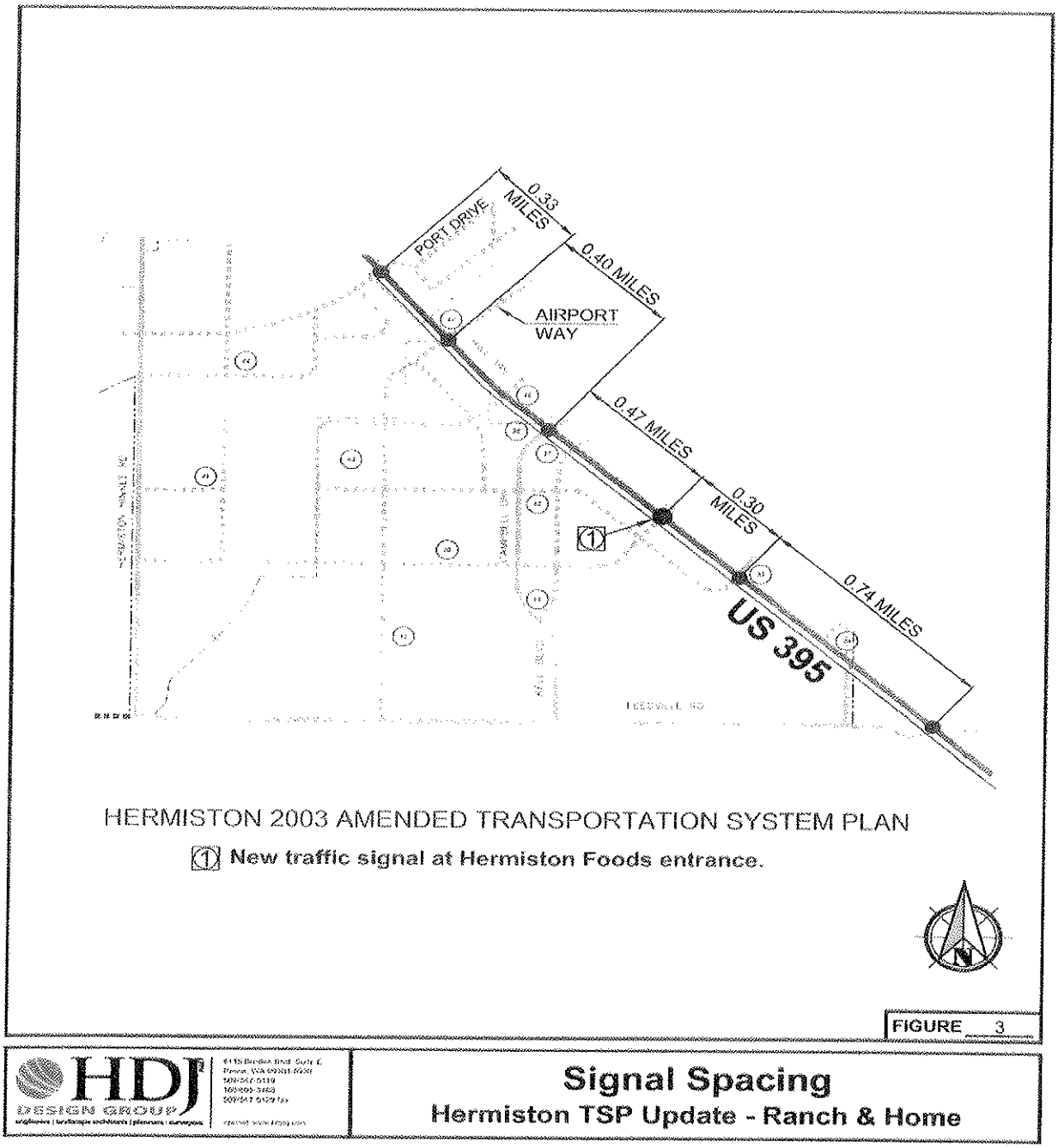


Figure 2 Proposed 2016 TSP Amendment

A copy of the full TSP amendment report is attached to this memo.

Highway 395 through this area is a 55 mph speed zone. Installing a traffic signal in a high speed corridor such as this will require additional traffic calming measures as part of any signal construction and operation. Calming measures will include advance warning signage with flashing beacons, lane reconfiguration to slow traffic, and possibly rumble strips.

The signal itself will help the overall circulation of the south Hermiston industrial area in several ways. It will improve spacing for traffic, creating better gaps in traffic for vehicles entering the highway. It will create a new full access intersection for the off-highway circulation network. Specifically, new east/west public streets are already planned to intersect at this point. A new signal will provide cross highway access. The local street network as depicted in Figures 1 and 2 will funnel trips from Kelli Blvd and Airport Road to the new proposed signal and the proposed signals at Airport Road and the Wal-Mart distribution center.

Requirements

The TSP is considered to be an implementing document of the city's comprehensive plan. When considering a request to amend the comprehensive plan, the approval criteria are contained in Chapter 156 of the Hermiston Code of Ordinances. The criteria are as follows:

156.08 AMENDMENTS.

After the Planning Commission and City Council determine that proposed amendments should be considered, amendment of the Comprehensive Plan shall be based on the following procedure and requirements:

(A) A public hearing date and notice thereof through a newspaper of general circulation in the city at least ten days prior to the hearing;

(B) Copies of proposed amendments shall be made available for review at least ten days prior to the Planning Commission hearing;

(C) After the close of the public hearing, the Planning Commission shall make findings of fact and recommend to the City Council adoption, revision or denial of the proposed amendments;

(D) Upon receipt of the Planning Commission recommendation, the City Council shall set a public hearing date and give notice thereof through a newspaper of general circulation in the city at least ten days prior to the hearing;

(E) Copies of proposed amendments and the Planning Commission recommendation shall be made available for review at least ten days prior to the City Council hearing;

(F) After the close of the public hearing, the City Council shall make findings of fact and adopt, adopt with changes or deny the proposed amendments. Adoption is contingent upon:

(1) City adoption is final in the case of amendment to the plan map for the area within the city limits;

(2) County adoption in the case of amendment to plan policies or the plan map for the urban growth area; or

(3) County adoption and LCDC approval in the case of amendment to plan goals or urban growth boundary location.

(G) Copies of the plan amendments adopted by the city shall be sent to Umatilla County and the LCDC.

All amendments to the city's land use rules must also demonstrate compliance with the statewide planning goals.

Recommended Findings

Subject to the comments and considerations of the public hearing, the following findings are presented:

Statewide Planning Goals and Comprehensive Plan Policies.

Goal 1 and Policy 1. Citizen Involvement. The City will insure that citizens have an adequate opportunity to be involved in all phases of the planning process.

1. Notice of the planning commission hearing was published in the Hermiston Herald at least 20 days prior to the hearing on January 20, 2016 in accordance with §156.08(A) of the Hermiston Code of Ordinances.

2. The Planning Commission held a public hearing on February 10, 2016 in accordance with §157.226(F).

3. The City Council held a public hearing on February 22, 2016 in accordance with §157.226(F)

Goal 1 and Policy 2. Planning Process. The City of Hermiston will monitor and update periodically its comprehensive plan and implementing ordinances to respond to changing conditions.

4. Policy 2 requires the City to annually review development activity and its impacts.

5. The planning commission reviewed the Highway 395 Corridor Refinement Plan in the TSP and determined that an additional signal is justified to service proposed retail development.

Goal 2 and Policy 3. Intergovernmental Coordination. The City of Hermiston will facilitate intergovernmental coordination so that decisions affecting local, state, and federal planning and development actions in the Hermiston area are rendered in an efficient and consistent manner.

6. The notice of proposed amendment was sent to the Department of Land Conservation and Development on January 4, 2016, more than 35 days prior to the first evidentiary hearing in accord with Oregon Administrative Rules, Chapter 660, Division 18.

Goal 3 Agricultural Lands.

7. There are no tracts of actively farmed land in the area proposed for service by the proposed traffic signal.

Goal 4 Forest Lands, Goal 15 Willamette River Greenway, Goal 16 Estuarine Resources, Goal 17 Coastal Shorelands, Goal 18 Beaches and Dunes, Goal 19 Ocean Resources.

8. There are no tracts of lands subject to Goals 4, 15, 16, 17, 18, or 19 anywhere within the city limits or UGB. These goals are not applicable.

Goal 5 Natural Resources, Scenic and Historic Areas, and Open Space, Goal 6 Air, Water and Land Resource Quality, Goal 7 Areas Subject to Natural Hazards, Goal 8 Recreation Needs, Goal 9 Economic Development, Goal 11 Public Facilities and Services, Goal 13 Energy Conservation, Goal 14 Urbanization.

9. The City's acknowledged comprehensive plan has policies established for compliance with Goals 5, 6, 7, 8, 9, 11, 13, and 14. No new uses are being permitted through the amendment. No additional findings must be made demonstrating compliance with these Goals.

Goal 9 Housing

10. There are no tracts of housing land in the service area for the proposed signal. Goal 9 is not applicable to this amendment and no additional findings are required.

Goal 12 Transportation and OAR 660, Division 012

11. OAR 660-012-0015 requires all cities to develop and maintain a transportation system plan.

12. Preparation of local TSPs must be coordinated with ODOT. The city provided a copy of the amendment to ODOT on January 4, 2016. ODOT has reviewed the proposed amendment.

13. When there is a conflict between an existing TSP and either the functional classification of a road or other conflict with the requirements of maintaining the operation of the transportation system, the TSP must be amended to maintain functionality. The proposed retail development will require a new signal above and beyond those already planned in the TSP. Thus, the TSP must be amended to include the necessary signal planning.

Hermiston Comprehensive Planning Ordinance §156.08

14. Notice of the public hearing on the proposed amendment was published in the Hermiston Herald on January 20 and January 27, 2016 more than 10 days in advance of the public hearing in accordance with 156.08(A).

15. Copies of the proposed TSP amendment have been available in the planning department office since January 20, 2016 in accordance with 156.08(B).

16. The planning commission adopted findings of fact regarding the proposed amendment following the closure of the public hearing on February 10, 2016. The planning commission recommended adoption of the proposed amendment to the city council based upon the findings of fact in accordance with 156.08(C).

17. The city council will hold a public hearing on February 22, 2016 regarding the proposed amendment. Notice of the city council hearing was published in the Hermiston Herald on February 3 and February 10, 2016 more than 10 days prior to the hearing in accordance with 156.08(D).

18. The planning commission recommendation and proposed amendment were made available to the public on February 11, 2016, more than 10 days prior to the city council hearing in accordance with 156.08(E).

19. The proposed amendment relates to a portion of the city's transportation system which is entirely within city limits. Adoption of the amendment is final upon adoption by the city council in accordance with 156.08(F)(1).

20. Notice of adoption will be sent to the LCDC and Umatilla County no later than five days after adoption by the city council in accordance with 156.08(G).

Staff Recommendation

Staff recommends that the planning commission make a recommendation to the city council that the amendment to the city's transportation system plan be adopted and incorporated into the TSP based on the findings of fact as adopted.

REGISTERED PROFESSIONAL ENGINEER 85811PE OREGON NOV 9, 2011 JOHN ANDREW MANIX

12/4/15

HDJ DESIGN GROUP PC
engineers landscape architects planners surveyors

Date: December 4, 2015

To: Clinton Spencer

From: John Manix, PE

Re: City of Hermiston Transportation System Plan Update – Ranch and Home Development

Introduction:

This memo is intended as an update to the *City of Hermiston Transportation System Plan* (TSP) based on the proposed modifications associated with the Ranch and Home commercial development. *See Figure 1 for a vicinity map and Appendix A for excerpt from the 2003 updated TSP project map.*

The current TSP proposes a "backage road" (Project Number 35) through and conflicting with the Ranch and Home site, and the *Ranch and Home's Traffic Impact Analysis* (TIA) Report recommends a traffic signal at the shared Ranch and Home/Hermiston Foods driveway intersection with US 395. The current TSP was updated in 2005 based on the *US 395 Corridor Refinement Plan.*[1] This memo also addresses the October 6, 2015 letter from Oregon Department of Transportation (ODOT) commenting on Ranch and Home Development and the TIA.

Recommendations:

Revise City of Hermiston's Transportation System Plan project listed as follows and illustrated in Figure 2:

1. Modify Project 35 to shorten proposed minor collector backage road, parallel to US 395, between Kelli Boulevard to the proposed minor arterial listed as Project 39 (Hermiston Foods driveway).
2. Modify project 36 to include a full access traffic signal at the proposed minor arterial intersection with US 395, near the Hermiston Foods driveway. With the proposed traffic signal for the Ranch and Home Development and the Hermiston Foods driveway, include an advance warning sign assembly "PREPARE TO STOP WHEN FLASHING" and advance vehicle detection system.

Background:

The *US 395 Corridor Refinement Plan* was jointly funded by the City of Hermiston and ODOT to address the overall management direction established by the July 2000, *US 395 North Corridor Plan. This plan was developed* by ODOT and called for an access management plan with raised medians on US 395 from Kelli Boulevard to Rosalynn Drive. The *US 395 Corridor Refinement Plan* called for a series of projects, including a network of minor arterials and collectors near US 395, between Port Avenue and Feedville Road that included a series of proposed signalized intersections with access restrictions, such as right-in and right-out. To provide access to the abutting properties, the *US 395 Corridor Refinement Plan* called for a "backage road" that would collect and distribute traffic from the adjacent property to the proposed signals. A backage road is similar to a frontage road as it parallels a highway

[1] Kittelson and Associates, *US 395 Corridor Refinement Plan (Port Drive to Feedville Road), January 2003.*

but it runs along the back of the abutting properties. This separation positions intersections approximately a city block from the signalized intersection which minimizes conflicts and provides room for queueing at the signal for the cross street to US 395. The plan intended the backage roads to follow property lines so to minimize conflicts with abutting properties. The preferred alternative project list from the *US 395 Corridor Refinement Plan* was adopted by the City in January 2003 as a TSP update.

In 2012, the City of Hermiston processed land use rezoning to relocate the Eastern Oregon Trade and Event Center (EOTEC) to a new location north of Airport Road, contiguous to the southern boundary of the Hermiston Municipal Airport, and west of Ott Road. The 2012 *Fairgrounds Overlay Zone District Transportation Impact Analysis Report* prepared by Group Mackenzie estimated that the EOTEC would generate upwards of 1,000 PM peak hour trips for events. These trips are currently anticipated to enter and exit the site from US 395 via Airport Road or a possibly an extension of Able Drive.

In 2015, the Ranch and Home Company proposed a larger commercial development between Hermiston Foods and the Walmart Distribution Center. *See Figure 1 for a vicinity map from the projects TIA.* This large scale retail development on 17.59 acres site estimates to generate 4,426 trips per day and is the type of development the City of Hermiston envisioned for the *US 395 Corridor Refinement Plan.* The TSP Project 35 directs the backage road through the Ranch and Home site and significantly limits the commercial development plans. The Ranch and Home development was conditioned by the City to prepare a TIA plan which would identify traffic impacts and mitigation of the proposed project. The TIA concluded a traffic signal was needed on US 395 at the entrance between the existing Hermiston Foods driveway and the proposed Ranch and Home, often referred to as the "Hermiston Foods driveway."

ODOT submitted a letter to the City of Hermiston on October 6, 2015. This letter noted inconsistencies with the City's TSP and recommended that other safety concerns be addressed. These concerns and comments brought up by ODOT are summarized as follows:

- The proposed signal at the Hermiston Foods driveway may compromise the other proposed signals in the TSP. The applicant should verify that the proposed signal does not impact the traffic signals identified in the TSP.
- The TSP calls for the backage road to extend to the Walmart Distribution Center driveway at US 395 and a traffic signal at this location. The City should consider if this is still necessary in light of the proposed event center (EOTEC) on Airport Road.
- A roundabout should be considered as an alternative to a traffic signal due to safety concerns of traffic stopping from 55 MPH rural highway approach. If a roundabout is not used traffic calming should be considered.

Based on these comments, the City has directed the applicant to process a TSP update in the form of a technical memo. After discussing the TSP update with both ODOT and City staff, it was agreed that the scope of work would address the following questions:

1. What is the impact on signal spacing standards and the possible impact of the proposed signal at the Hermiston driveway?

2. What are the impacts of the proposed Ranch and Home signal on the proposed signal at Airport Way?
3. What are the impacts on the projects listed in the 2003 Hermiston TSP Amendment?
4. What is the interaction between passenger vehicles from the Ranch and Home Development, and the Hermiston Food and Walmart Distribution Center trucks?
5. Is a roundabout a viable alternative to a signal and if not what other traffic calming measures can be used as a safety enhancement to a traffic signal?
6. What are the impact of a signal on the off-set intersection at the US 395/Hermiston Foods entrance/E-Z Storage entrance?
7. Does the proposed or current TSP projects impact industrial development?

Evaluation:

The following section addresses the questions above:

What are the impacts on signal spacing standards and the possible impact of the proposed signal at the Hermiston driveway?

In this case, the primary issue with signal spacing is related to possible impacts to signal system coordination. No specific standard was found for signal spacing. The MUTCD cites that signals should be coordinated with spacing under a half mile.[2] The MUTCD also cites that signals may meet warrants based on signal coordination, based on engineering study, but not if the spacing is under 1,000 feet. With spacing greater than a half mile the platoon will disperse and coordination will be less effective. With spacing less than 1,000 feet, the queue at upstream signals may interfere with progression of the platoon through the signal system. Figure 3 shows the spacing of the signal and it is likely that with the proposed signal at Ranch and Homes development driveway (existing Hermiston Foods driveway) it will improve coordinated signal operation by making the spacing more uniform from Port Avenue to Walmart Distribution Center Driveway. Thus, the proposed signal at Ranch and Home/Hermiston Foods/US 395 will have a positive impact on signal system operation associated with signal spacing.

What are the impacts of the proposed Ranch and Home signal on the proposed signal at Airport Way?

Beyond the impacts on signal system coordination addressed above, the possible impacts of the proposed signal at Ranch and Home development is related to traffic diversion. This is challenging to quantify due to the uncertainty of the land development and the supporting land uses. Based on careful review of the *US 395 Corridor Refinement Plan* and the *Fairgrounds Overlay Zone District Transportation Impact Analysis Report*; a traffic signal at Ranch and Home entrance will better distribute the trips to the adjacent property to US 395 between Airport Road and the Walmart Distribution Center.

The *US 395 Corridor Refinement Plan* estimates a 4,000 PM peak hour trips entering and exiting US 395 between Airport Road and the Walmart Distribution Center. With the current TSP, most of those trips that need to make a left turn across US 395 will need to use the signals proposed at either the Airport Road or the Walmart Distribution Center signals. With most of the egress trips destined for Hermiston, the Airport Road intersection is likely to take the largest share of these trips on the west side of US 395. Thus, the proposed signal at Ranch and Home should reduce the traffic impacts on the future Airport

[2] FHWA, *Manual on Uniform Traffic Control Devices, 2009 Edition.*

Road/Campbell Drive/US 395 signal by providing an additional egress opportunity for left turning vehicles.

The backage road was proposed as supporting development by improving the access. In this case, it severely restricts development by sub-dividing a large retail site into smaller lots, restricting land-use options. Assuming the backage road through the Ranch and Home site is not built, future trips need a signal to access US 395. The proposed signal at the Walmart Distribution Center driveway will not be accessible from the west side of US 395. Thus, the proposed traffic signal will provide another access point to US 395 other than the future Airport Road/Campbell Drive/US 395 traffic signal.

What are the impacts on the projects listed in the 2003 Hermiston TSP Amendment?
The most significant impacts are on Project 35, the backage road on the west side of US 395. The Ranch and Home development proposes to eliminate a portion from the Hermiston Foods driveway to the Walmart Distribution Center driveway. With the proposed signal at Ranch and Home/Hermiston Foods/US 395 intersection, the surrounding area still will be served.

Project 33, the signal at the Walmart Distribution Center Driveway/US 395 intersection, may be impacted without the connection to west side backing road (Project 35). Without the traffic from the west side of US 395 connected to the Walmart Distribution Center driveway at US 395, it may not meet warrants in the future. For this update, it is not recommended that this project be removed from the project list because future development on the east side of US 395 may produce enough trips to meet signal warrants.

The project list from 2003 Hermiston TSP Amendment is based on the *US 395 Corridor Refinement Plan*. After careful review of the series of technical memos that make up the *US 395 Corridor Refinement Plan*, it is clear that this planning process involves extensive analysis and public involvement, including a project team of technical stakeholders. Thus the Ranch and Home modifications to the TSP project list should be kept to a minimum. The *US 395 Corridor Refinement Plan* acknowledged that the plan would need refinement as land adjacent to US 395 is developed but at this early stage the update should only recommend minor refinements.

What is the interaction between passenger vehicles from the Ranch and Home Development, and the Hermiston Food and Walmart Distribution Center trucks?
At the Hermiston Food driveway (the location of the proposed Ranch and Home traffic signal), the interaction is minor due to time of day that truck ingress and egress the site verses passenger vehicles. The traffic counts from both the *US 395 Corridor Refinement Plan* and the Ranch and Home TIA counted few if any trucks turning into or out of the site in the AM, Mid-day or PM peak hours. At the Walmart Distribution Center driveway, the truck volume is moderately high for truck volume, with 7 exiting and 18 entering in the AM, 29 exiting and 18 entering in the mid-day, and 13 exiting and 20 entering in the PM peak hours. The Walmart Distribution Center staff are reported to have expressed reservations about mixing passenger vehicles with truck traffic associated with the proposed backage road in the current TSP. The length of left turn lane on the Walmart Distribution Center driveway will be constrained due to the backage road driveway intersection with the Walmart Distribution Center driveway. If the Ranch and Home development traffic destine for northbound US 395 was directed through this intersection, per the existing TSP (Project 35), the queue with trucks added is a concern. With a double left turn, it will require upwards of 225 feet of left turn storage for Ranch and Home development traffic. This long queue would be very disruptive to the Walmart Distribution Center

operation. Thus, due to the moderately high truck traffic and the constrained roadway geometry at the Walmart Distribution Center, the backage road should not be terminated at Walmart Distribution Center driveway intersection with US 395.

Is a roundabout a viable alternative to a signal and if not what other traffic calming measures can be used as a safety enhancement to a traffic signal?

Signals on the State Highway system are a significant safety concern to the Department of Transportation staff in both Oregon and Washington. With a high speed approach to a traffic signal, red light running and rear-end collisions can result in fatal or serious injury collisions. Based on their safety record, ODOT and WSDOT encourage roundabouts as an alternative,. In this case, ODOT has traffic safety concerns with rural locations where traffic has traveled long distances prior to encountering a traffic signal.

As this relates to the Hermiston TSP, the first proposed signalized intersection on the US 395 corridor, at US 395 and Feedville Road (Project 55) is a much better location of a proposed roundabout to address the ODOT safety concerns. This will be the location where traffic will first encounter a traffic signal, as northbound rural traffic enters an urban area. While this intersection may take some time to receive upgraded traffic controls. , it is still not recommended that the City of Hermiston or ODOT use roundabouts in place of traffic signals at any other intersection of US 395, from Port Avenue to the Walmart Distribution Center driveway, for the following reasons:

- The US 395 corridor is an ideal candidate for signal coordination based on signal spacing. The signals are between 0.3 to 0.47 mile spacing from Port Avenue to the Walmart distribution center driveway. A roundabout at the Ranch and Home development would compromise the future signal coordination by dispersing the platoon as it moves through the roundabout.
- The US 395 corridor with the signals, 4 lanes, and a center median has the capacity to meet the forecast volumes. The *2012 Fairgrounds Overlay Zone District Transportation Impact Analysis Report* recommended a revised annual growth rate of less than 1%.
- Traffic signals are much more cost effective under these conditions. Roundabouts tend to cost approximately $1,000,000, depending on the enhancements and right-of-way. At about one third the cost or $300,000 a traffic signal is a much better value.
- Assuming a double lane roundabout, substantial right-of-way will be needed from adjacent property owners, can be very challenging to purchase by a developer.

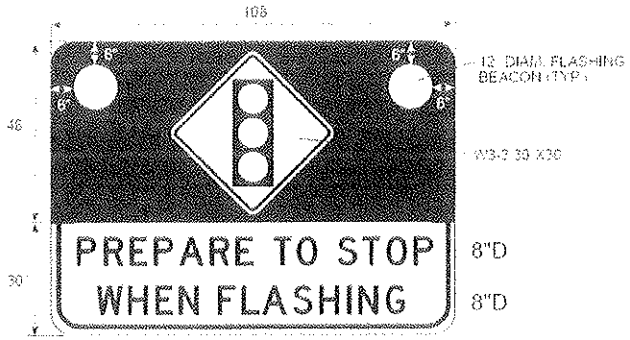
A roundabout has one significant benefit for the Ranch and Home main entrance, the queue length on the west leg is significantly shorter compared to a traffic signal. The 2015 Ranch and Home Transportation Impact Analysis report recommends a 225 long, double left turn lane for the traffic signal between Ranch and Home and Hermiston Foods. With the same 2025 design hourly volumes, a roundabout is estimated to generate a 50 foot queue length for a single lane approach on the Hermiston Foods and Ranch and Home approach.

It is worth noting that both the trucking industry and ODOT maintenance staff have expressed reservation with roundabouts. Truck drivers frequently comment that use of truck apron or using both circulating lanes to make a turn is a safety concern. Roundabouts will become more acceptable to both these users and stakeholders with added familiarity but this location should not be a test case based on the close proximity to Hermiston Foods and the Walmart Distribution Center truck traffic.

ODOT recommended that "traffic calming" be considered as a traffic safety enhancement to a traffic signal. The intent is to slow traffic approaching the proposed traffic signal to minimize the risk of collisions with high speed, rural, highway traffic. The median can be modified to reduce the design speed of approaching traffic by creating horizontal deflection but takes substantial median modification. Similar to the high speed approach to a roundabout, widening to added horizontal curves for a serpentine alignment to the roadway for 500 feet prior to the intersection would likely be necessary to bring traffic down to urban speeds prior to the signal. Unless US 395 is reduced to one lane, some drivers may resort to risky behavior of using unsafe lane changes to maintain speed on the approach. There are a lot of other traffic calming techniques, some that are not appropriate at this location, such as speed humps, and others with very limited success in changing behavior such as speed bars or rumble strips.

As a safety enhancement for the proposed traffic signal, the following alternative is recommended:

- Install traffic activated warning signs on the northbound approach to the signal 400-500 feet in advance. WSDOT used advance warning signs in very similar circumstances on southbound on SR 503 as traffic approaches the first signal in the City Battle Ground, WA at NE 244th Ave-NE 25 St. *See Appendix B for WSDOT white paper on the use of PREPARE TO STOP WHEN FLASHING sign assembly.*



The key to success is to provide a message that commands attention, provides adequate reaction time, provides a clear and simple message, and fulfills a need. The use of traffic or signal activated flashing lights are effective at command attention of approaching traffic. Another benefit of this method is that it can be further enhanced with additional advanced traffic control if necessary. For example, use of radar signs (speed limit signs with radar feedback messages) can provide additional traffic calming. The proposed signal should also use a robust vehicle detection system that addresses dilemma zone consideration of approaching high speed traffic.

What is the impact on the off-set intersection at the US 395/Hermiston Foods entrance/E-Z Storage entrance?
The traffic to and from the E-Z Storage has been counted as low as 1 or 2 vehicles in the peak hours. The Hermiston Foods Driveway is offset 85 feet from the access of E-Z Storage. With the signal, the median should be extended on US 395 south to restrict left turn movements from US 395 to the E-Z Storage driveway. Access from Hermiston can be maintained via the proposed signal by making a U-turn in the short term. In the long term, TSP project 51 will eliminate the need for a U-turn.

Does proposed or current TSP projects impact industrial development?
The zoning in the vicinity of the project is a combination of commercial, light and heavy industrial (C-2, M-1 and M-2). With the opportunity to receive grant funding for transportation projects related to

industrial land use, the scope of the study included review of the impact on truck access by the proposed updated and current TSP.

Hermiston Foods is the current industrial land use, just north of the Ranch and Home development Presently Hermiston Foods trucks either ingress or egress late at night or rely on the Kelli Blvd. intersection for access. The proposed signal by the Ranch and Home development will improve truck access during hours with higher traffic volumes and reduce out of direction travel of only using the Kellie Blvd intersection. The traffic signal will provide better gaps in traffic than the current two-way STOP sign control intersections at both the driveway and the Kelli Blvd. The current TSP would further limit access to Hermiston Food by directing all truck traffic to the Airport Rd/Campbell Dr/US 395 and Wall Mart Distribution Center/US 395 future signals. Hermiston Foods future access in the current TSP is highly dependent on the backing road that will take some time to implement and appears to be conflicting with the existing Hermiston Food facilities. Thus, the new signal between Ranch and Home and Hermiston Foods may eliminate the need for the backing road on the west side of US 395 (Project 35).

The proposed traffic signal opens access to large tracks of property zoned Commercial/Industrial (C-2/M-1) on the east and west side of US 395. Thus, the current TSP will delay and prevent industrial/commercial development with the restriction of access as proposed in Project 36. Projects 40 and 52, the backing roadways east and west of US 395, will delay development waiting for their completion. There is approximately 42 acres of property zoned Industrial (M-1) in close proximity to the proposed signal that can gain access to US 395 with the signal. *See Figure 4 for the industrial zoning in the vicinity of the proposed signal.*

Thus, the proposed signal at the Ranch and Home/Hermiston Foods access roadway will not compromise access to the adjacent commercial and industrial property but will significantly improve access compared to the existing TSP projects. This signal should be a good candidate for grant funding targeting industrial land use development.

Conclusions:

The following conclusions are based on the review of background material and evaluation of the possible impacts of the proposed changes to the TSP.

- This update is a refinement to the current TSP based on the *US 395 Corridor Refinement Plan* but kept changes to a minimum to honor past process. Thus, the proposed signal at the Ranch and Home/Hermiston Foods /US 395 intersection should be added to the plan and not replace the proposed signal at the Walmart Distribution Center as recommended in the Ranch and Home TIA report. The backage road proposed through the Ranch and Home site should be curtailed but the remainder should remain in the TSP.
- The proposed signal at the Ranch and Home/Hermiston Foods/US 395 intersection will have a positive impact on the TSP signal system from the Walmart Distribution Center to Port Ave US 395 by creating more consistent spacing.
- The proposed signal at the Ranch and Home/Hermiston Foods/US 395 intersection will have a positive impact on TSP Project 37, the signal at Airport Road/Campbell Rd/US 395, by diverting traffic to away and reducing impacts.
- The proposed Ranch and Home development and recommended transportation projects have the most impact on TSP Project 33, the traffic signal at the Walmart Distribution

Center/US 395. It may not meet warrants in the future without the connection to the backage road. The TSP backage road, Project 35, will be shorter but not significantly impacted.

- The proposed signal at the Ranch and Home/Hermiston Foods/US 395 intersection and the reduction in the backage road will have a positive impact on truck access on US 395. The trucks destine to Hermiston Foods will have a signal for their late-night and early-morning access to US 395. If the Ranch and Home development distributed its trips to Walmart Distribution Center Driveway as proposed in TSP Project 35, the queue would interfere with truck traffic at their driveway.
- Traffic signals on rural highways after a long distance of uninterrupted traffic flow are a safety concern. A roundabout was considered and has significant benefits, such as reduced queuing at the Ranch and Home approach. It also has negative impacts, such as platoon dispersion on US 395 in the middle of signal system. A better location is at the Feedville/US 395 intersection, TSP Project 55, to address safety concerns associated with the first signal encountered by rural highway traffic. As an alternative to a roundabout that will address the safety concern, a PREPARE TO STOP WHEN FLASHING sign assembly is proposed to alert drivers that they are approaching a signal. This can be further enhanced with additional advanced vehicle detection to address dilemma zones for high speed traffic, a speed limit reduction and the use of radar signs.
- The proposed signal at the Ranch and Home/Hermiston Foods/US 395 intersection will require extending the median to eliminate the left turn from US 395 to EZ Storage. But access will be maintained by a U-turn that will meet the very low traffic volume in and out of the facility during the peak traffic hours.
- The proposed signal at the Ranch and Home/Hermiston Foods/US 395 intersection will have a positive impact on industrial development in the vicinity. With approximately 42 acres of land zoned Commercial/Industrial (C-2/M-1), tributary to the proposed signal, improving access to US 395 will enhance development by lowering infrastructure improvement costs.

Recommendations

Revise City of Hermiston's Transportation System Plan listed as follows and illustrated in Figure 1:

1. Modify Project 35--Shorten the proposed minor collector backage road, parallel to US 395, between Kelli Boulevard to the proposed minor arterial listed as Project 39 (Hermiston Foods driveway).
2. Modify Project 36-- Include a full access traffic signal at the proposed minor arterial intersection with US 395, near the Hermiston Foods driveway. With the proposed traffic signal for the Ranch and Home Development and the Hermiston Foods driveway, include an advance warning sign assembly "PREPARE TO STOP WHEN FLASHING" and advance vehicle detection system.

Appendix A – 2003 City of Hermiston TSP Amendments

Appendix B – 2006 WSDOT White Paper – Prepare to Stop When Flashing (PTSWF) System Pilot Project Interim Guidelines.

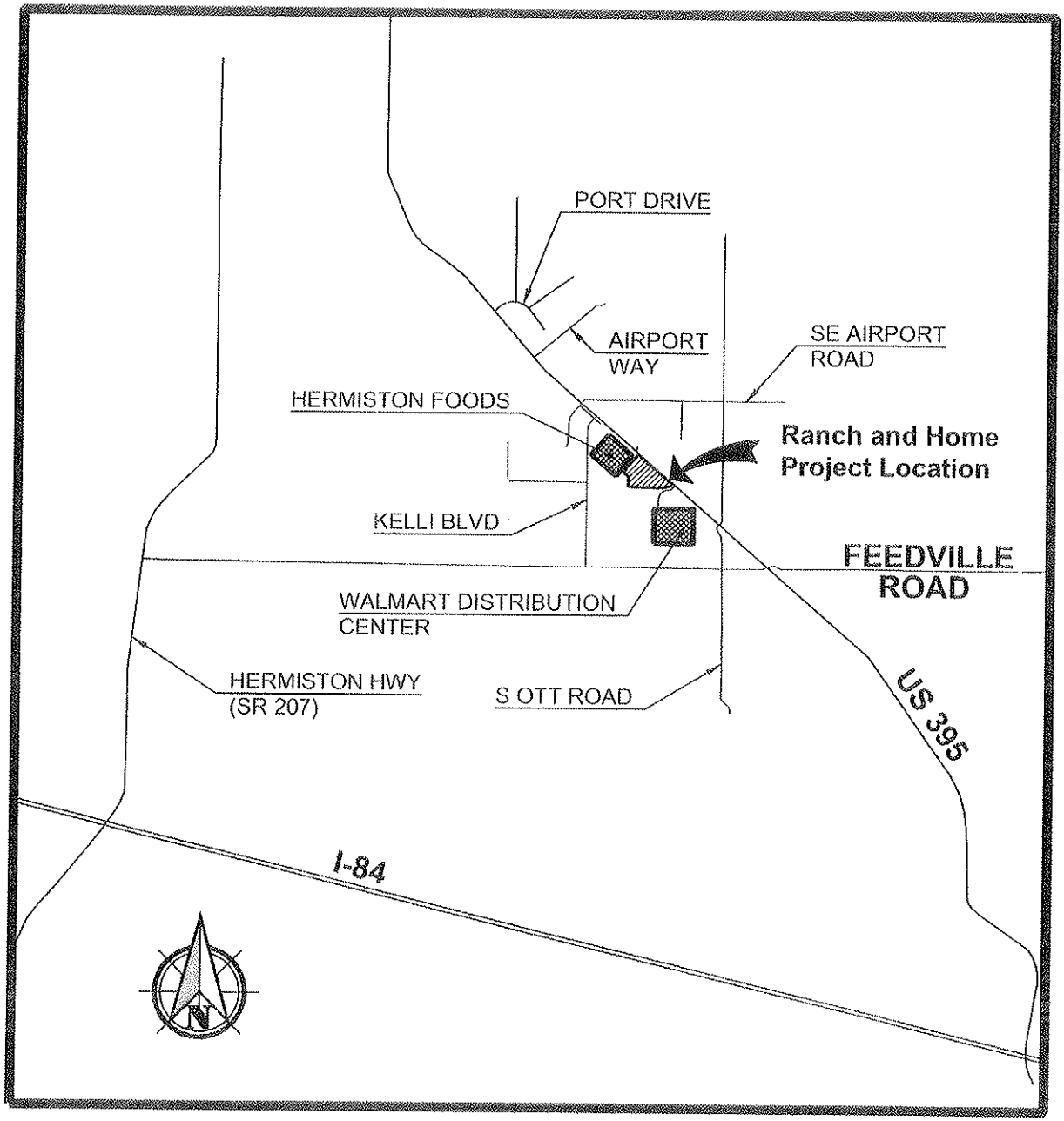


FIGURE 1

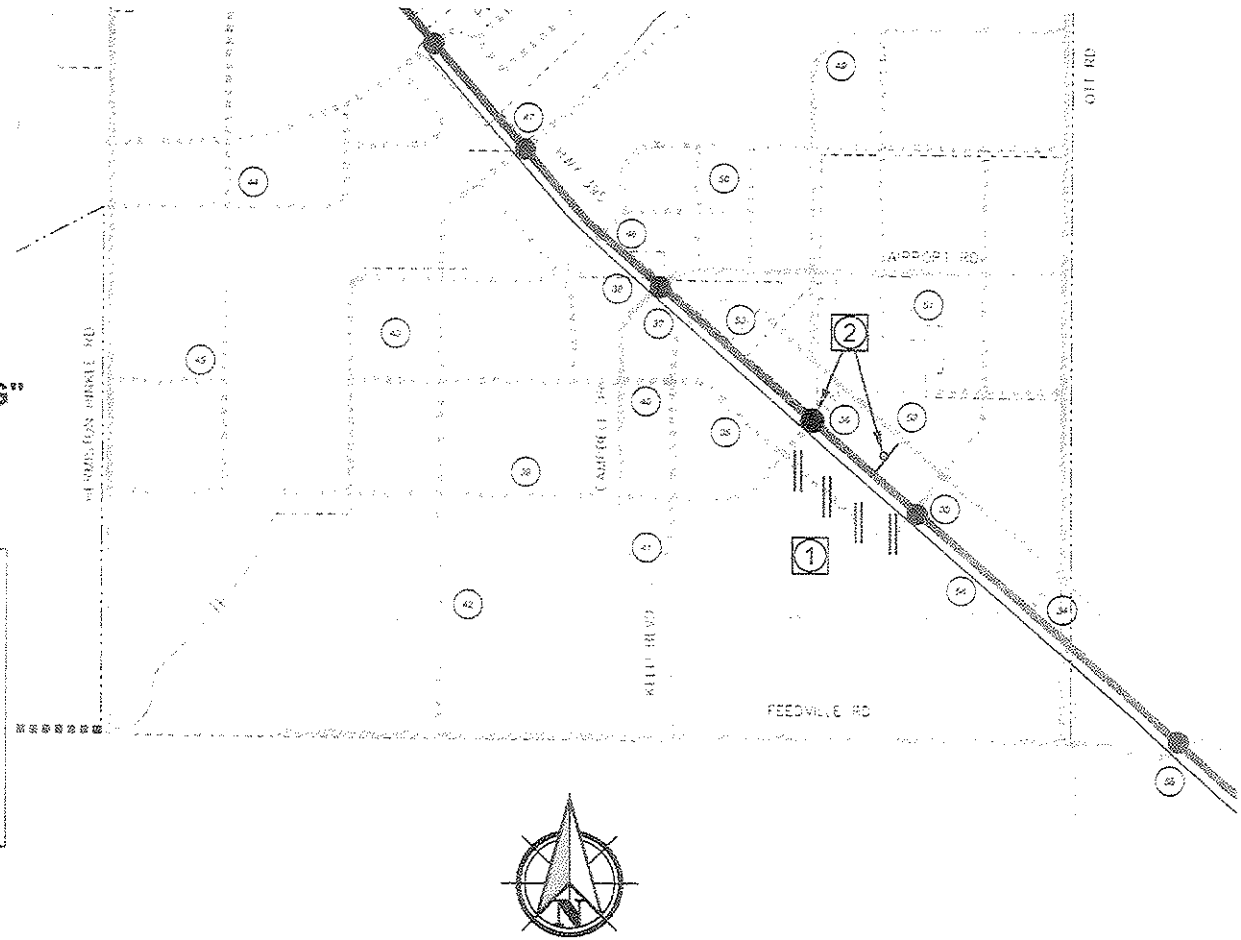
HDJ DESIGN GROUP
engineers | landscape architects | planners | surveyors
6115 Burden Blvd, Suite E
Pasco, WA 99301-6930
509/547-5119
360/695-3488
509/547-5129 fax
Internet: www.hdjdg.com

Vicinity Map

Hermiston TSP Update - Ranch & Home

1 REVISE PROJECT TO SHORTEN 35.

2 REVISE PROJECT 36 TO INCLUDE FULL ACCESS SIGNAL WITH "PREPARE TO STOP WHEN FLASHING" SIGN.



LEGEND
- URBAN MAJOR ARTERIAL
- URBAN MINOR ARTERIAL
- URBAN MAJOR COLLECTOR
- URBAN MINOR COLLECTOR
- RURAL ARTERIAL
- RURAL COLLECTOR
- TRAFFIC SIGNAL
- OFF-STREET (MULTI-USE) PATH
- UGB
- CITY LIMITS
- SOUTH HERMISTON STUDY AREA
- US 395 CORRIDOR REFINEMENT STUDY AREA

FIGURE 2

HDJ DESIGN GROUP
engineers | landscape architects | planners | surveyors
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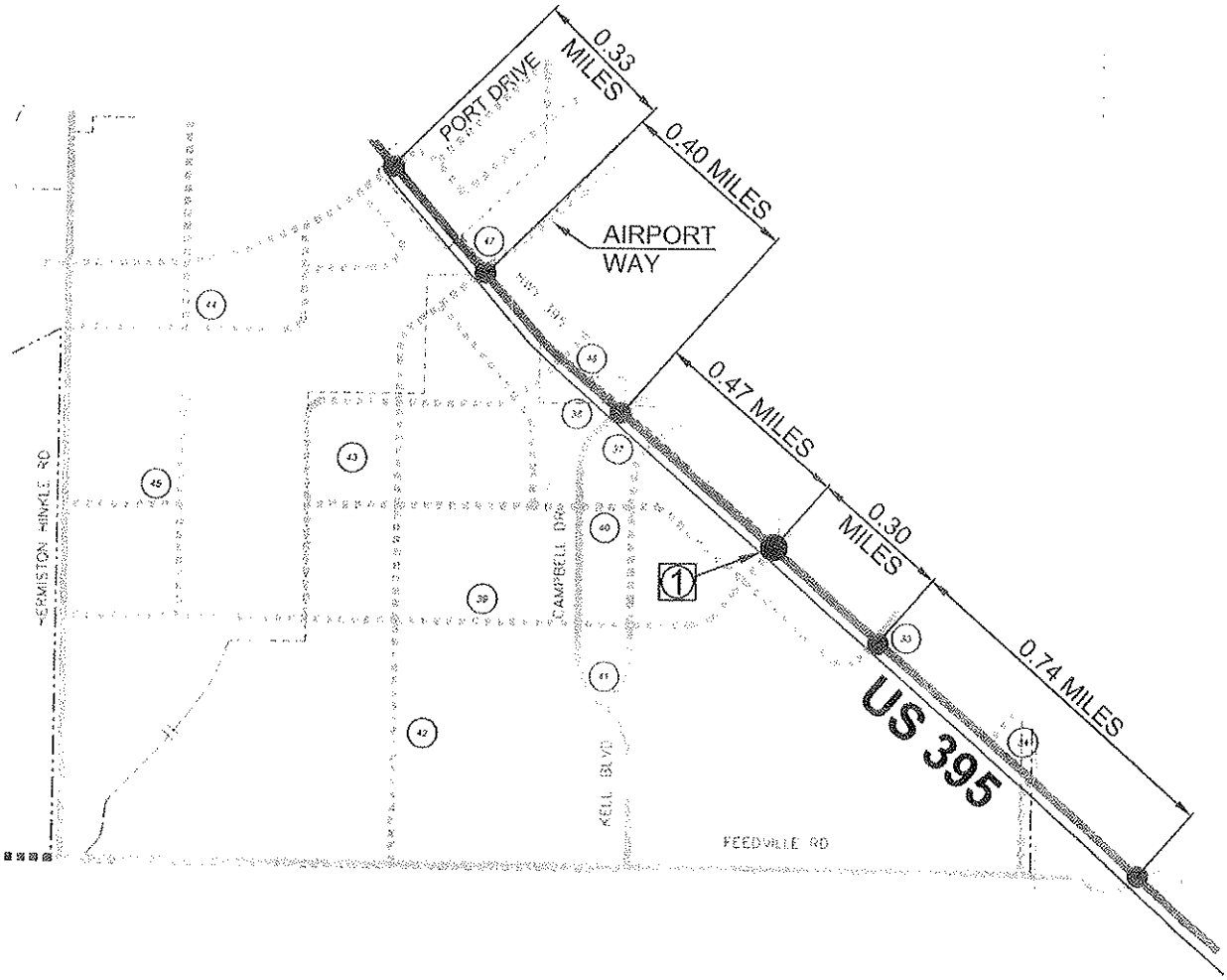
TSP Project Recommendations

Hermiston TSP Update - Ranch & Home



HERMISTON 2003 AMENDED TRANSPORTATION SYSTEM PLAN

1 **New traffic signal at Hermiston Foods entrance.**

FIGURE 3

HDJ DESIGN GROUP
engineers | landscape architects | planners | surveyors
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Signal Spacing

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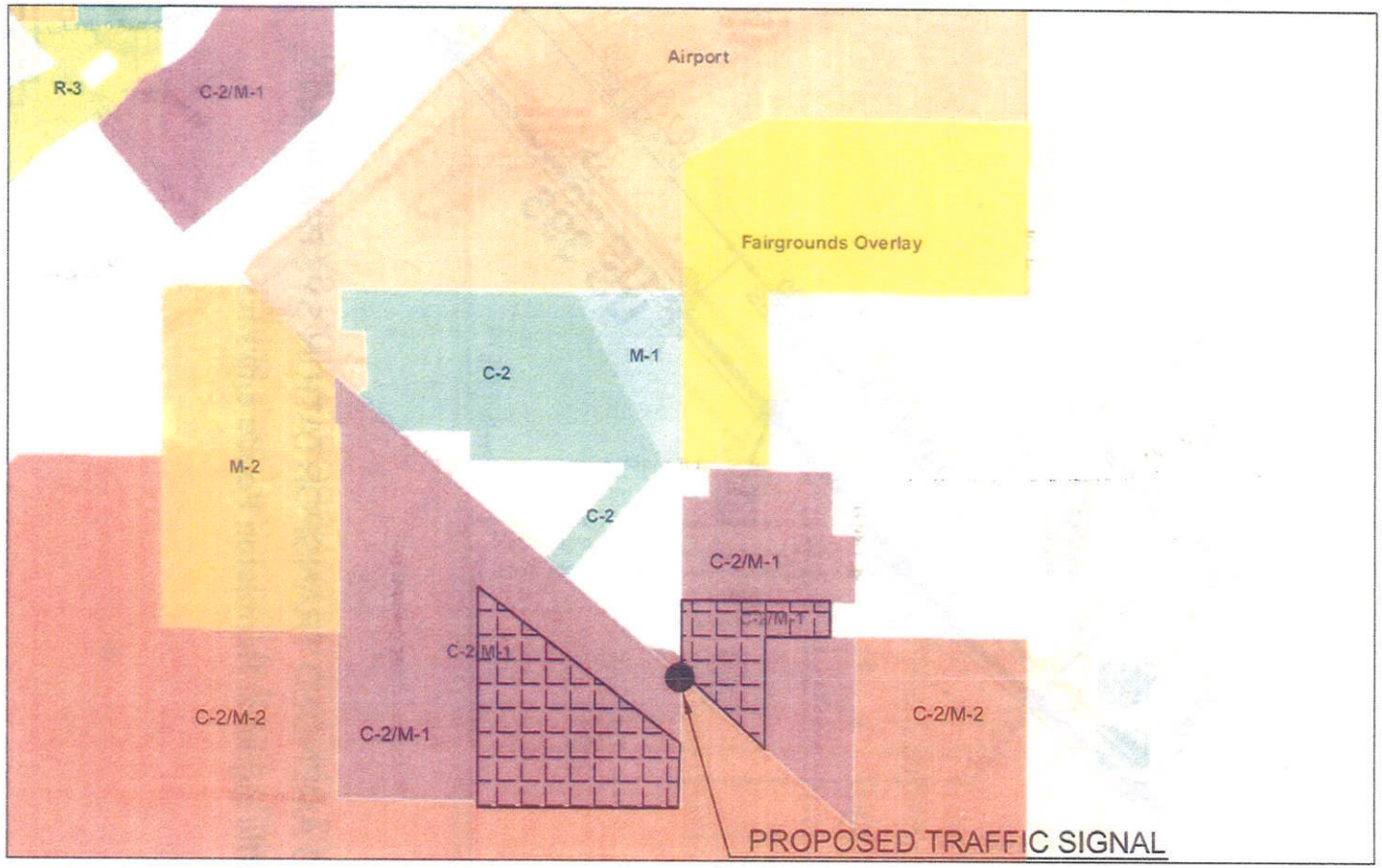
Hermiston Zoning



INDUSTRIAL LAND CLOSE TO PROPOSED SIGNAL

FIGURE 4

HDJ DESIGN GROUP PLLC
engineers | landscape architects | planners | surveyors
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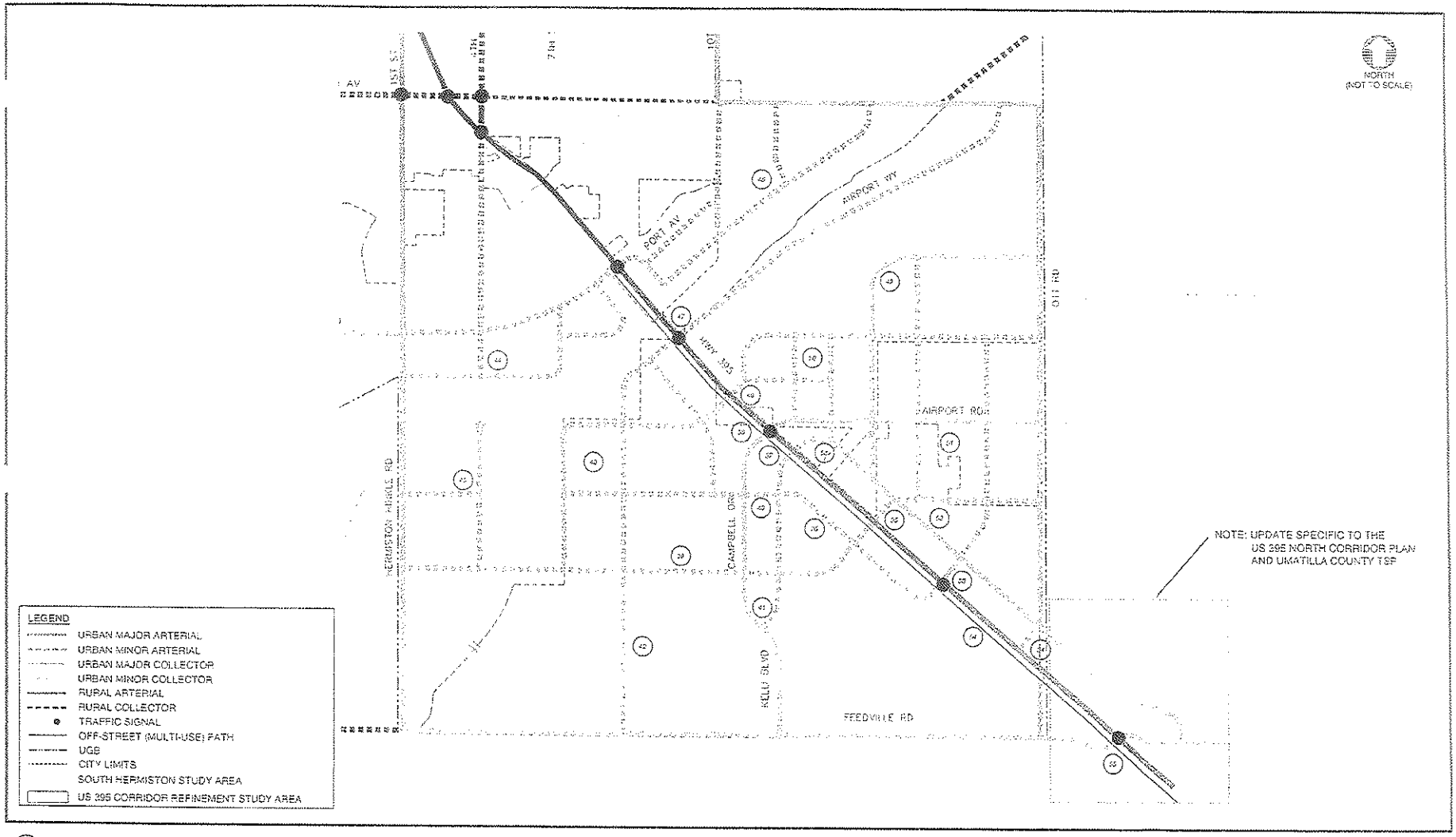
Industrial Land

Hermiston TSP Update - Ranch & Home

Appendix A



(#) CORRESPONDS TO IMPROVEMENTS LISTED IN TABLE 1

US 395 CORRIDOR
STREET SYSTEM IMPROVEMENTS
JANUARY 2003 UPDATE

HERMISTON TSP AMENDMENT HERMISTON, OREGON JANUARY 2003	FIGURE 6

Table 1
Recommended 20-Year Street Improvement Projects
US 395 Corridor Refinement Study Area

Fig 6 id #	Project Description	Priority	Estimated Cost (Yr. 2002 $)	Potential Funding Source(s)
33	Provide a signalized access portal to US 395 (when warranted by a traffic engineering study) at the current Wal-Mart Distribution Center access to be served by a major collector roadway east of US 395 and a minor collector west of US 395.	Near-term	$225,000	AMG, PDF, TEP, SDC, GF
34	Realign the north and south approaches to Ott Road such that they intersect US 395 at a complete 90-degree angle. The future intersections should be limited to right-in/right-out driveways to help preserve access management along the highway.	Mid-term, but not before improvements #33 and #52	$550,000	AMG, PDF, TEP, SDC, GF
35	Develop a minor collector backage road that runs parallel to US 395 between Kelli Boulevard and the Wal-Mart Distribution Center truck access road.	Near-term, but not before improvements #33.	$1,750,000	PDF, LID, GF
36	Re-construct a limited access right-in/right-out driveway to US 395 near the current Hermiston Foods driveway to be served by minor collector roadways on both sides of the highway.	Mid-term, following improvements #33, #35, & #52	$25,000	AMG, TEP, SDC, PDF, STIP
37	Re-construct a limited access intersection (left-in/right-in/right-out) at the US 395/Kelli Boulevard intersection.	Mid-term, following the completion of improvements #33, #35, #38 & #40	$25,000	AMG, TEP, SDC, PDF, STIP
38	Signalize the US 395/Campbell Drive/Airport Road intersection when warranted by a traffic engineering study.	Mid-term	$225,000	STIP, PDF, LID, GF
39	Develop a minor collector roadway to facilitate east/west travel between Hermiston-Hinkle Road and US 395.	Long-term	$5,375,000	PDF, LID, GF
40	Upon redevelopment of adjacent land parcels, develop a minor collector connection between Campbell Drive and Kelli Boulevard.	Mid-term	$275,000	PDF, GF, LID
41	Extend Campbell Drive at major collector standards south and east to Kelli Boulevard (1st Phase). Realign a portion of Kelli Boulevard so that it intersects the extension of Campbell Drive (2nd Phase).	Long-term	$1,075,000	GF, LID, TEP
42	Develop a minor collector roadway to facilitate north/south travel between US 395 and Feedville Road.	Long-term	$3,700,000	PDF, LID, GF
43	Develop a series of minor collector roadways to ensure circulation and connectivity upon redevelopment of the large agriculture plots within the western study area.	Long-term	$5,825,000	PDF, LID, GF

Fig 6 id #	Project Description	Priority	Estimated Cost (Yr. 2002 $)	Potential Funding Source(s)
44	Extend SE 4th Street along the western boundary of the Hermiston Cemetery to a new east/west minor collector facility that would run parallel to the Gettman Road extension.	Mid-term	$2,075,000	PDF, LID, GF
45	Upon the redevelopment of the Hermiston Agriculture Experiment Station, provide a new minor collector roadway along the SE 4th Street alignment. Upgrade and extend Experiment Station Road to this 4th Street alignment.	Long-term	$1,575,000	PDF, LID
46	Develop a full access intersection at US 395 to be served by a future extension of Able Drive. This intersection should be limited to a right-in/right-out/left-in access when warranted by a traffic engineering study.	Long-term, following the completion of improvements #43 & #47	$225,000	STIP, AMG, PDF
47	Develop a signalized access intersection at the US 395/Airport Way intersection when warranted by a traffic engineering study.	Long-term, following completion of elements of improvement #43	$225,000	GF, SDC, TEP, PDF, STIP
48	Complete a minor collector roadway system upon redevelopment of the vacant land north of the airport, irrigation canal, and rail line.	Mid-term	$3,150,000	PDF, SDC, LID, TEP
49	Develop a major collector roadway to facilitate north/south travel within the northeast quadrant of the US 395 Refinement Plan study area.	Mid-term	$3,300,000	PDF, SDC, LID, TEP
50	Develop a series of minor collector roadways to facilitate circulation south of the Hermiston Airport.	Mid-term	$3,375,000	PDF, SDC, LID, TEP
51	Develop a series of minor collector roadways to facilitate circulation within the northeast quadrant of the US 395 Refinement Plan study area.	Long-term	$7,125,000	PDF, SDC, LID, TEP
52	Develop a major collector backage road between Kelli Boulevard and Ott Road.	Near-term	$2,875,000	PDF, SDC, LID, TEP
53	Extend Kelli Boulevard east of US 395 to connect into a minor collector roadway network.	Near-term	$1,100,000	PDF, SDC, LID
54	Develop a multi-use path along the west side of US 395. This path will require a bridge crossing over the feed canal and rail line.	Mid-term	$450,000	GF, STIP, TEP
55	Signalize the US 395/Feedville Road intersection when warranted by a traffic engineering study. (Improvement specific to the US 395 North Corridor Plan)	Long-term	$225,000	STIP

Note: Potential Funding Sources include the Following:

STIP – State Transportation Improvement Program (ODOT)
GF – City of Hermiston General Fund
SDC – City of Hermiston Transportation System Development Charge
TEP – Transportation Enhancement Program
PDF – Private Development Funds
AMG – Access Management Grant
LID – Local Improvement District
County – Umatilla County
LSN – Local Street Network

Implementation Requirements

The order of implementing the US 395 (Port Drive to Feedville Road) Corridor Refinement Plan projects were developed jointly by the City of Hermiston and ODOT to ensure the integrity of the US 395 corridor as well as local access and circulation. This implementation strategy is outlined in the following bullet points.

- Access improvements to US 395 will need to occur on an incremental basis depending upon the rate and location of new development.
  - The signalization of the US 395/Campbell Drive/Airport Road intersection (*Improvement #38*) in the near to mid-term will begin to shape future circulation patterns within the US 395 study area.
  - The signalization of the US 395/Wal-Mart Distribution Center driveway (*Improvement #33*) should occur when traffic signal warrants merit installation. The need for signalization will likely be facilitated by roadway *Improvements #35 and #52*.
  - *Improvement #36* will occur upon redevelopment of adjacent land parcels and the completion of *Improvements #35 and #52*.
  - The signalization of the US 395/Airport Way intersection (*Improvement #47*) will occur when upon the completion of future roadways associated with *Improvement #43* and when traffic signal warrants merit installation.
  - The future extension of Able Drive (*Improvement #46*) and its future intersection with US 395 should be limited to a right-in/right-out/left-in access upon the completion of *Improvements #43 and #47*.
  - The limited access modifications to the US 395/Kelli Boulevard (*Improvement #37*) should occur after completion of Improvements #33, #35, #38, and #40.
  - The limited access modifications to the US 395/Ott Road (*Improvement #34*) should occur after the completion of *Improvement #33 and #52*.
  - The signalization of US 395/Feedville Road (*Improvement #55*) should occur when traffic signal warrants merit installation. This is likely to be a long-term improvement that will be required upon the redevelopment of the large agricultural plots of the western US 395 study area. This improvement project is specific to the US 395 North Corridor Plan.
- The majority of the circulation roadways and necessary right-of-way can begin to be acquired and constructed upon the redevelopment of individual land parcels. Specific projects that should occur on a phased basis include the following:
  - To facilitate future circulation and access patterns, right-of-way and roadways associated with *Improvement #53* should begin to be acquired and constructed in the near term.
  - Future circulation roadways such as Improvements #35 and #52 should occur upon the redevelopment of adjacent land parcels. These roadways will serve as

Appendix B

Washington State
Department of Transportation

White Paper

Ted Trepanier
State Traffic Engineer

Effective Date: **August 10, 2006**

Prepare to Stop When Flashing (PTSWF) Systems Pilot Project Interim Guidelines

I. Introduction

A. Purpose

To provide guidance to WSDOT personnel in the design, operation, and study of Prepare To Stop When Flashing (PTSWF) systems.

B. References

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), FHWA, June 2001 Millennium Edition, including the *Washington State Modifications to the MUTCD*, M 24-01, 2003

Design Manual, M 22-01

A Policy On Geometric Design of Highways and Streets 2004, 5th Edition AASHTO

ITE Traffic Engineering Handbook, 4th Edition

C. Background

WSDOT is continuously looking for ways to operate our highway facilities in the most efficient and safe way possible. With this goal in mind, WSDOT collected collision data and performed statistical analysis on this information at existing PTSWF operated systems on state highways. Also, research was conducted by reviewing many public records on the subject. Furthermore, State Traffic Departments throughout the country were contacted to poll their experiences with these systems. After completing this analysis, WSDOT concluded that there are potential safety benefits in operating this type of installation at select locations.

D. Discussion

It is the goal of WSDOT to allow PTSWF systems to be installed throughout the state by following the attached PTSWF Pilot Project Interim Guidelines. When a region decides to install a PTSWF system they shall contact the State Traffic Engineer as a means of documenting when the study period begins. The Region Traffic office shall submit a copy of all final drawings and calculations for the PTSWF system to the State Traffic Engineer prior to project implementation. The drawing includes flashing beacon locations, sign locations and mounting details consistent with the pilot study guidelines.

II. Instructions

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION PREPARE TO STOP WHEN FLASHING (PTSWF) SYSTEM PILOT PROJECT INTERIM GUIDELINES

PURPOSE

The purpose of this document is to provide WSDOT Traffic personnel with uniform guidelines to design, operate and study prepare to stop when flashing (PTSWF) systems. These technical guidelines shall be effective on the date of this White Paper.

IMPLEMENTATION

These guidelines are to be implemented for new PTSWF System installations. For existing systems, flasher timing adjustments should be implemented within six months of the effective date in order to provide consistency of operations with new systems.

INTRODUCTION

The PTSWF System is a sign/flasher combination that at certain high-speed locations may provide additional information to the motorist describing the operation of the traffic signal. It has been found that the installation of a PTSWF System may assist the driver in making safer and more efficient driving decisions. This additional information is to get the driver's attention, and inform the driver that he or she must prepare to stop for a red light signal indication. The PTSWF System described above is what WSDOT currently uses in select situations to convey this information.

The PTSWF sign may be placed on main line approaches to applicable high-speed signalized intersections. The PTSWF sign is connected to the traffic signal in such a way that prior to the main line green phase changing to yellow, the flasher is turned on to warn the approaching drivers of the impending change. Specific timing intervals will be determined on a case-by-case basis for each signalized intersection.

Some objectives of an optimally designed combination of traffic signal and PTSWF system are:

- to inform the driver that a signal indication will change to yellow or red in advance of a required decision to stop
- to minimize the number of drivers that are required to make that decision in the dilemma zone; and
- to reduce red-light running, particularly by heavy commercial vehicles.

GENERAL GUIDELINES

PTSWF system implementation is appropriate only at high-speed locations where the posted speed is 45 mph or greater. In addition, it should be considered that the operation of a PTSWF system has the potential to cause increased delay to side street traffic.

Guidelines for a PTSWF system are as follows:

Any one of these categories or other considerations may justify the installation of PTSWF system.

Table 1
PTSWF Guidelines

CATEGORY	CRITERIA	COMMENT
1. Isolated or unexpected signalized intersection.	Where there is a long distance from the last intersection at which the main line is controlled, or the intersection is unexpected.	This guideline may be applicable where the distance from the last intersection is greater than 10 miles, or a freeway terminus, or at other locations where the intersection is unexpected
2. Limited sight distance	Where the distance to the stop bar, D, with two signal heads visible is insufficient: $D \leq 1.47Vt + \frac{V^2}{0.93(a + 32.2(G/100))}$ Where: D = distance to stop bar in (ft) V = posted speed (mph) t = reaction time, 2.5 seconds a = deceleration rate 10 ft/s^2 (all traffic)* 8 ft/s^2 (Trucks)** G = Grade %	* *Traffic Engineering Handbook*, 5th Edition, page 481 ** A deceleration rate of 8 ft/s^2 may be used when the Criteria from the Category *Grade and Truck Volume* is met. See Category 3
3. Grade/Truck Volume	Where the roadway has a grade of 3% or greater and truck volume exceeds 15%.	
4. Accidents	If an approach has a collision history that is not correctible with other countermeasures.	If no sight distance or dilemma zone problems exist, PTSWF may not be an appropriate countermeasure to accident problems.
5. Engineering Judgment	Approval of Region Traffic Engineer	Approval shall be based on an Engineering Study.

APPLICATION / PROCEDURE

Due to the complex nature of traffic flow characteristics and the various intersection geometric layouts, the following guidelines shall be applied using an engineering study coupled with engineering judgment. Engineering judgment should be based in part on data such as complaints, violations, conformity of practice, and traffic conflicts. Documentation shall be prepared that discusses why decisions were made and how the following countermeasures have been considered prior to installation of a PTSWF system. Although not all inclusive, examples of countermeasures include:

- improving dilemma zone detection
- adjusting existing signal timing parameters such as; yellow clearance time, red interval, passage time, max green time(s) etc.
- installing and enhancing advanced warning signing
- sight distance improvements
- modification of the signal system such as adding additional signal heads
- adjusting speed limits.

The State Traffic Engineer shall review the proposed installation documentation, with final written approval granted by the Region Traffic Engineer. For study purposes, notice of the installation date shall be forwarded to the State Traffic Engineer.

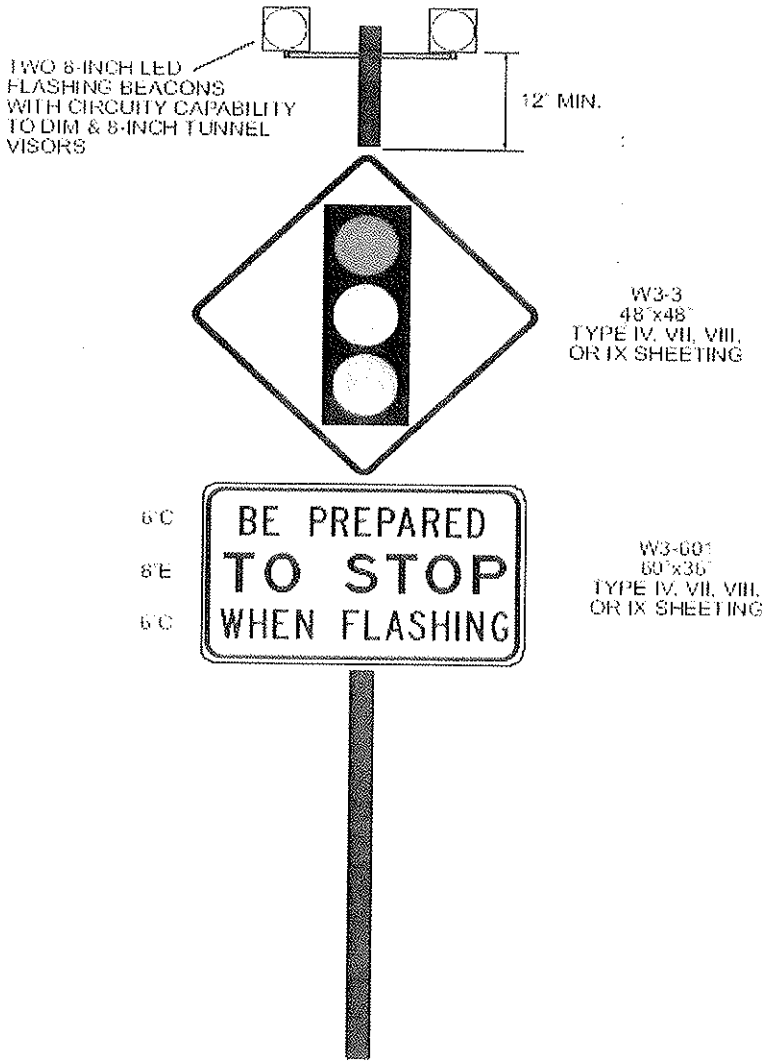
DESIGN / INSTALLATION

1. **Details** - Figures 1 and 2 show conceptual drawings of the PTSWF sign/flashing beacon combination for median, shoulder and overhead mounting installation locations. Contact the Headquarters Traffic Design office for special design details. Prior to the termination of the green phase (Advanced Green) and during the yellow and red clearance intervals, the flasher shall flash yellow either alternately or simultaneously (see MUTCD section 4K.03). In addition, consideration should be given to extending the flash while the queue of vehicles begins to move on the following initial green indication. A general rule of thumb for this movement is approximately 4 seconds. The flasher will also flash if the signal goes into flashing operation. In addition, power shall be supplied to the PTSWF System from the signal control cabinet. A backup uninterrupted power supply (UPS) should be considered at each location. For any questions concerning the design of the PTSWF System contact the Headquarters Traffic Design office.

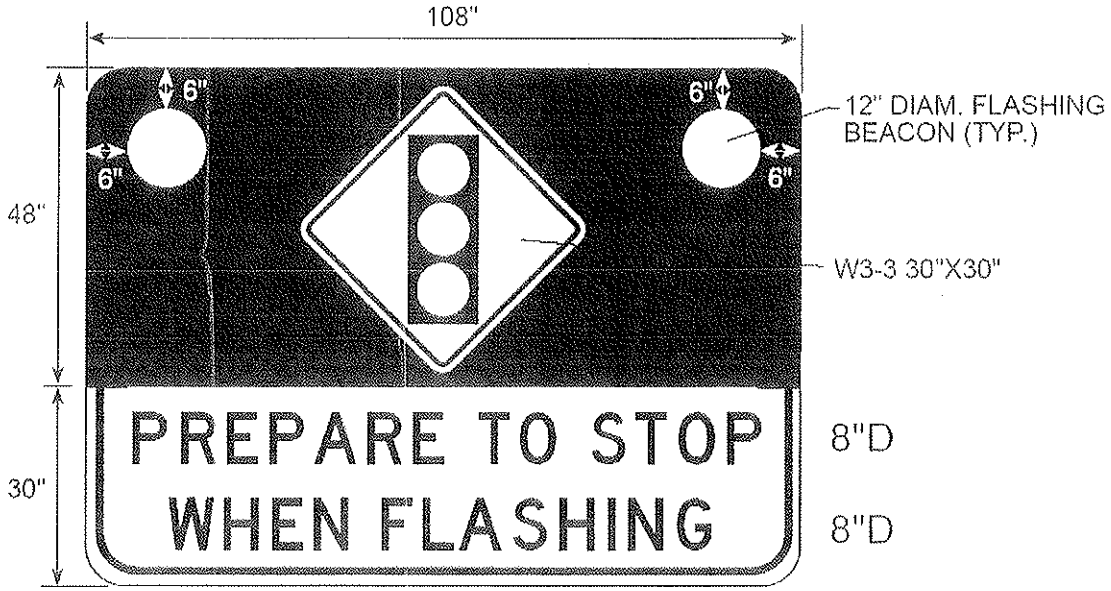
2. **Placement** - Considering the roadway environment, the PTSWF sign should generally be set back from the intersection in accordance with Table 1. At locations on multilane divided roadways, the PTSWF sign shall be placed on both sides of the approach or mounted overhead.

3. **Advanced Green** The Advanced Green is the amount of time; prior to the signal turning yellow that, the flashing beacons on the PTSWF sign flash. The Advanced Green time(s) is shown in Table 1.

4. **Detector Placement** - Consider WSDOT *Design Manual* guidelines when installing signal detection.



Installation at Median or Shoulder Barrier Locations
Figure 1



COLORS

TOP
STANDARD COLORS FOR W3-3
BACKGROUND - BLACK (NON REFL)

BOTTOM
LEGEND - BLACK (NON REFL)
BACKGROUND - YELLOW (REFL)

Overhead or Shoulder Mount Installation
Figure 2

Table 2
Advanced Warning Flasher Sign Placement

		Sign Placement Distance									
	GRADE	45 mph		50 mph		55 mph		60 mph		65 mph	
		D (ft)	Advance Green (sec)	D (ft)	Advance Green (sec)	D (ft)	Advance Green (sec)	D (ft)	Advance Green (sec)	D (ft)	Advance Green (sec)
Downhill	-8%	392	7.0	472	7.4	559	7.8	653	8.2	754	8.6
	-7%	380	6.8	457	7.2	540	7.6	631	7.9	729	8.4
	-6%	369	6.6	443	7.0	524	7.3	611	7.7	705	8.1
	-5%	358	6.5	430	6.8	508	7.2	593	7.5	684	7.9
	-4%	349	6.3	418	6.6	494	7.0	576	7.3	664	7.7
	-3%	340	6.2	407	6.5	481	6.8	560	7.1	645	7.5
	-2%	332	6.1	397	6.4	468	6.7	545	7.0	628	7.3
	-1%	324	6.0	388	6.2	457	6.5	532	6.8	612	7.1
	0%	317	5.9	379	6.1	446	6.4	519	6.7	597	7.0
Uphill	1%	310	5.8	370	6.0	436	6.3	507	6.5	583	6.8
	2%	303	5.7	362	5.9	426	6.1	495	6.4	569	6.7
	3%	297	5.6	355	5.8	417	6.0	485	6.3	557	6.6
	4%	292	5.5	348	5.7	409	5.9	475	6.2	545	6.4
	5%	286	5.4	341	5.6	401	5.8	465	6.1	534	6.3
	6%	281	5.3	335	5.5	393	5.7	456	6.0	523	6.2
	7%	277	5.2	329	5.4	386	5.6	448	5.9	513	6.1
	8%	272	5.2	324	5.4	379	5.6	440	5.8	504	6.0

For situations other than those listed in Table 2, Sign Distance and the Advanced Green Time can be computed by the following equations:

Distance From Stop-bar to PTSWF Sign

$$D = 1.47Vt + \frac{V^2}{30\left[\left(\frac{a}{32.2}\right) \pm \frac{G}{100}\right]}$$

Where :

$D = Sign\ placement\ distance$

$V = Posted\ speed\ (mph)$

$t = Perception\ /\ reaction\ time\ (1.5\ s)$

$a = Deceleration\ rate\ (10\ ft\ /\ \sec^2)$

$G = Grade\ (\%)$

Advanced Green Time

$$AG = \frac{D + Dp}{V * 1.47}$$

Where:

AG = *Advance Green Time (s)*

D = *Distance from stop bar to PTSWF sign (ft)*

Dp = *Minimum distance that flashers can be perceived (70 ft)*

V = *Posted speed (mph)*