HOMER
Intersections Planning Study

Prepared by Kinney Engineering, USKH, and Brooks & Associates
for the State of Alaska Department of Transportation & Public Facilities

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Table of Common Abbreviations

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
AM	Morning (Time)
Ave or Ave.	Avenue
AWSC	All Way Stop Sign Control
CBD	Central Business District
CTWLTL	Center-Two-Way-Left-Turn-Lane
DOT&PF	(Alaska) Department Of Transportation And Public Facilities
EB	Eastbound
EBLT or EBL	Eastbound Left Turn
EBRT or EBR	Eastbound Right Turn
EBT	Eastbound Through
ft. or ft	Feet or Foot
FHWA	Federal Highway Administration
GDSH	Geometric Design of Streets and Highways
HCS	Highway Capacity Software
HSIPHB	Highway Safety Improvement Program Handbook
Hwy or Hwy.	Highway
ISD	Intersection Sight Distance
ITE	Institute of Transportation Engineers
LOS	Level of Service
MEV	Million Entering Vehicles
MOA	Municipality of Anchorage
MPH	Miles Per Hour
MUTCD	Manual on Uniform Traffic Control Devices
NB	Northbound
NBLT or NBL	Northbound Left Turn
NBRT or NBR	Northbound Right Turn
NBT	Northbound Through
NCHRP	National Cooperative Highway Research Program
OWSC	One Way Stop Sign Control (Tee intersections)
PM	Afternoon or Evening (Time)
SB	Southbound
SBLT or SBL	Southbound Left Turn
SBRT or SBR	Southbound Right Turn
SBT	Southbound Through
sec or sec.	Seconds
St or St.	Street
TRB	Transportation Research Board
TWSC	Two Way Stop Sign Control

UCL	Upper Control Limit
v/c	Volume To Capacity Ratio
veh or veh.	Vehicle(s)
Vph	Vehicles Per Hour
WB	Westbound
WBLT or WBL	Westbound Left Turn
WBRT or WBR	Westbound Right Turn
WBT	Westbound Through

EXECUTIVE SUMMARY

The Homer Intersections Planning Study provides a basis for further project development in Homer, Alaska. There were five elements for this study:

- Capacity and control evaluation of 12 existing intersections
    - 11 intersections: minor street stop control
    - 1 intersection: all-way stop control
    - 11 evaluated for summer traffic conditions
    - 3 evaluated for winter conditions (proximity to High School)
- Traffic forecasts for current year and for year 2021 (also 2011 where applicable)
- Intersection safety (crash) studies
- Pedestrian crossings
- Public involvement
    - Surveys sent to public agencies and businesses
    - Presentations to City of Homer staff and council, public, and DOT&PF

These intersections were evaluated for crash experience, future control requirements, and future operational performance. The intersections under this study include:

- Pioneer Avenue and the Sterling Highway (summer)
- Main Street and the Sterling Highway (summer)
- Heath Street and the Sterling Highway (summer)
- Lake Street and the Sterling Highway (summer)
- Lake Street and Pioneer Avenue (winter and summer)
- Heath Street and Pioneer Avenue (winter and summer)
- Main Street and Pioneer Avenue (summer)
- Bartlett Street and Pioneer Avenue (summer)
- Sterling Highway and West Hill Road (summer)
- East End Road and East Hill Road
- Sterling Highway and Kachemak Bay Drive (summer)
- East End Road and Fairview Avenue (winter only)

The study includes five existing pedestrian crosswalk locations along Pioneer Avenue and four on Sterling Highway. These locations include:

- Pioneer Avenue and Bartlett Street, east leg
- Pioneer Avenue and Main Street, east leg
- Pioneer Avenue and Svedlund Street, east leg
- Pioneer Avenue and Kachemak Way, east leg
- Pioneer Avenue and Heath Street, west leg
- Sterling Highway and Pioneer Avenue, east leg
- Sterling Highway and Main Street, east leg
- Sterling Highway and Poopdeck Street, east leg
- Sterling Highway and Lake Street, east leg

Traffic Forecasts

The 2001 Homer QRS II model was updated to include recently constructed generators and proposed, committed developments. Average annual daily traffic (AADT) and summer average daily traffic (ADT) were prepared, as well as summer and winter morning and evening peak hour turning movements. The overall system traffic growth in Homer is about 2% per year.

Intersection Safety Studies

Crash rates and frequencies at intersections are not higher than would be expected and intersection safety performance is acceptable. Some intersection elements do not meet nominal standards or guidelines, but these do not appear to contribute to crashes. As such, no countermeasures are required for safety, but proposed intersection congestion treatments will enhance safety.

Pedestrian Studies

Pedestrian refuges on the Sterling Highway (listed above) allow two-stage crossings within desirable delay guidelines (1 or more crossing gaps per minute). These will perform adequately with future 2021 traffic. Summer and winter traffic conditions on Pioneer Avenue do not have the desirable 1 or more crossing gaps per minute at the eastern pedestrian crossings during peak traffic (commuting or school dismissal). Well before 2021, all pedestrian crossings will have less than desirable crossing opportunities because of the increased traffic flow. Pioneer Avenue treatments for pedestrians include mid-block or intersection refuge islands or narrowings (chokers). Also, proposed intersection congestion treatments will enhance safety.

Intersection Studies

Existing, all-way stop, modern roundabouts, and signalization control alternatives were evaluated on an individual intersection basis and as systems. The following tables summarize implementation schedules.

Intersection	Estimated Year of Need		
	All-Way Stop	**Roundabout**	**Traffic Signal**
Sterling Highway and West Hill Road	No treatment is required, it can remain as a two-way-stop-control intersection		
Sterling Highway and Pioneer Ave	-	2005 to 2011	
Sterling Highway and Main Street	-	Now	
Sterling Highway and Heath Street	-	Now	
Sterling Highway and Lake Street	Short term	Now	
Sterling Highway and Kachemak Bay Dr	-	Reevaluate in 2010	

Intersection	Estimated Year of Need		
	All-Way Stop	**Roundabout**	**Traffic Signal**
Pioneer Avenue and Bartlett Street	No treatment is required, it can remain as a two-way-stop-control intersection		
Pioneer Avenue and Main Street	Before 2011	2011	
Pioneer Avenue and Heath Street	-	Now	
Pioneer Avenue & Lake St/East End Rd	Existing	Now (depending upon treatment at Heath St)	
East End Road and Fairview Avenue	2011- Turn Lane Improvements Only		
East End Road and East Hill Road	-	Reevaluate in 2010	

Signal and roundabout combinations at Pioneer/Lake and Pioneer/Heath intersections are not feasible due to overlapping functional areas. Two signals or two roundabouts will function if driveway left-turns are restricted. Extending Heath Street or extending Lake Street affects the permanent intersections control. A Heath Street extension would likely preclude roundabouts because of right-of-way and would require two signals, which would be difficult to operate due to the close spacing. A Lake Street Extension would facilitate a roundabout because the new alignment would require extensive right-of way acquisition. A one-way couplet using Lake Street northbound and Heath Street southbound would be another option for more efficient intersection operation.

Recommendations

Intersections that require control change to signals or roundabouts will function well, at good levels of service, under either control. The Alaska Department of Transportation and Public Facilities (DOT&PF) supports the development of modern roundabouts at these locations because of the good operational performance of roundabouts, superior safety performance, and reduced maintenance costs.

The Pioneer Avenue/Heath Street and Pioneer Avenue/Lake Street/East End Road intersection alternatives largely will depend upon which extension option is implemented: Heath Street to East Hill Road or Lake Street to East Hill Road. Moreover, this analysis shows that signals will work for the Heath Street and Lake Street intersections, but there are operational and safety issues with the close spacing that cannot be fully resolved through phasing. Because of these uncertainties, DOT&PF recommends a separate project evaluation including an environmental document to select an alternative. This will draw upon and expand on this intersection project conclusions.

Recommended improvements are summarized on the following page.

HOMER Intersections Planning Study

LEGEND

- SIGNALIZATION
- ROUNDABOUT
- CHANNELIZATION
- PEDESTRIAN REFUGE ISLAND / CHOKER
- PROPOSED ROAD CONNECTIONS (THIS REPORT AND OTHERS)
- 20XX YEAR OF NEED
- ALL WAY STOP CONTROL

RECOMMENDED IMPROVEMENTS

1000 0 500 1000

BAR SCALE (FEET)

1 INTRODUCTION

1.1 Traffic Study Purpose and Need

The City of Homer (City) is in transition from a small rural community to an urban center surrounded by outlying residential areas. Growth in population has resulted in increased vehicle traffic, especially in the downtown area. In addition, Homer is a center for tourism and recreational activities, and the summer traffic is almost twice the winter levels and adds a wide variety of vehicles to the streets, including recreational vehicles and vehicles towing trailers.

Traffic congestion is becoming a significant issue in the Homer downtown central business district (CBD) area. These downtown streets serve as accesses to businesses, institutions, and residential areas, and are also links in the system for trips to the north and east of Homer to the outlying residential districts. There are other routes to these areas, but the CBD system is the most direct for many of the residents.

A second impact of congestion is the affect on pedestrians. Homer is a very walkable city because of the good sidewalk and trail network and because of the proximity and intermixing of residences, businesses, institutions and recreational opportunities. However, crossing some streets, most notably the Sterling Highway and Pioneer Avenue, is increasingly more difficult because the elevated traffic levels have fewer and fewer acceptable gaps. As a result, walking mobility is less than desired, which has negative effects for local residents and for the businesses that rely on walking tourists in the summer months.

As with most urban street systems, street capacity is constrained at the intersections. Intersections are controlled with two-way or all-way stop signs, and as traffic volumes increase, these controls are no longer able to accommodate traffic demand. Levels of service (LOS) are declining below acceptable levels, and other control treatments, including all-way stops, roundabouts, and traffic signals are required to improve LOS, reduce congestion, and make intersections more efficient for current and future operations.

The Sterling Highway (also known as the Homer Bypass), Pioneer Avenue, and Lake Street form the critical links for “downtown” traffic, forming a circulating triangle through the CBD. Traffic congestion is evident at the three busier corners of this system: the Sterling Highway and Pioneer

Avenue, the Sterling Highway and Lake Street, and Lake Street and Pioneer Avenue. However, as more land parcels develop commercially, increasing vehicular and pedestrian demand on intersections will occur at other intersections as well.

The “downtown intersections” analyzed in this study are within the CBD triangle. These streets provide both vehicle and pedestrian access for businesses, residences, and some institutions; as well as being a part of the overall network mobility. These intersections include:

- Pioneer Avenue and the Sterling Highway
- Main Street and the Sterling Highway
- Heath Street and the Sterling Highway
- Lake Street and the Sterling Highway
- Lake Street and Pioneer Avenue
- Heath Street and Pioneer Avenue
- Main Street and Pioneer Avenue
- Bartlett Street and Pioneer Avenue

Three of the busiest “peripheral intersections” analyzed in this study are outside the CBD triangle and are more oriented to area mobility than to access. These intersections include:

- Sterling Highway and West Hill Road
- East End Road and East Hill Road
- Sterling Highway and Kachemak Bay Drive

The Homer High School is adjacent to Pioneer Avenue and as a traffic generator, has considerable impact to the study area during the winter. Related to Homer High School, the three most affected “High School intersections” are:

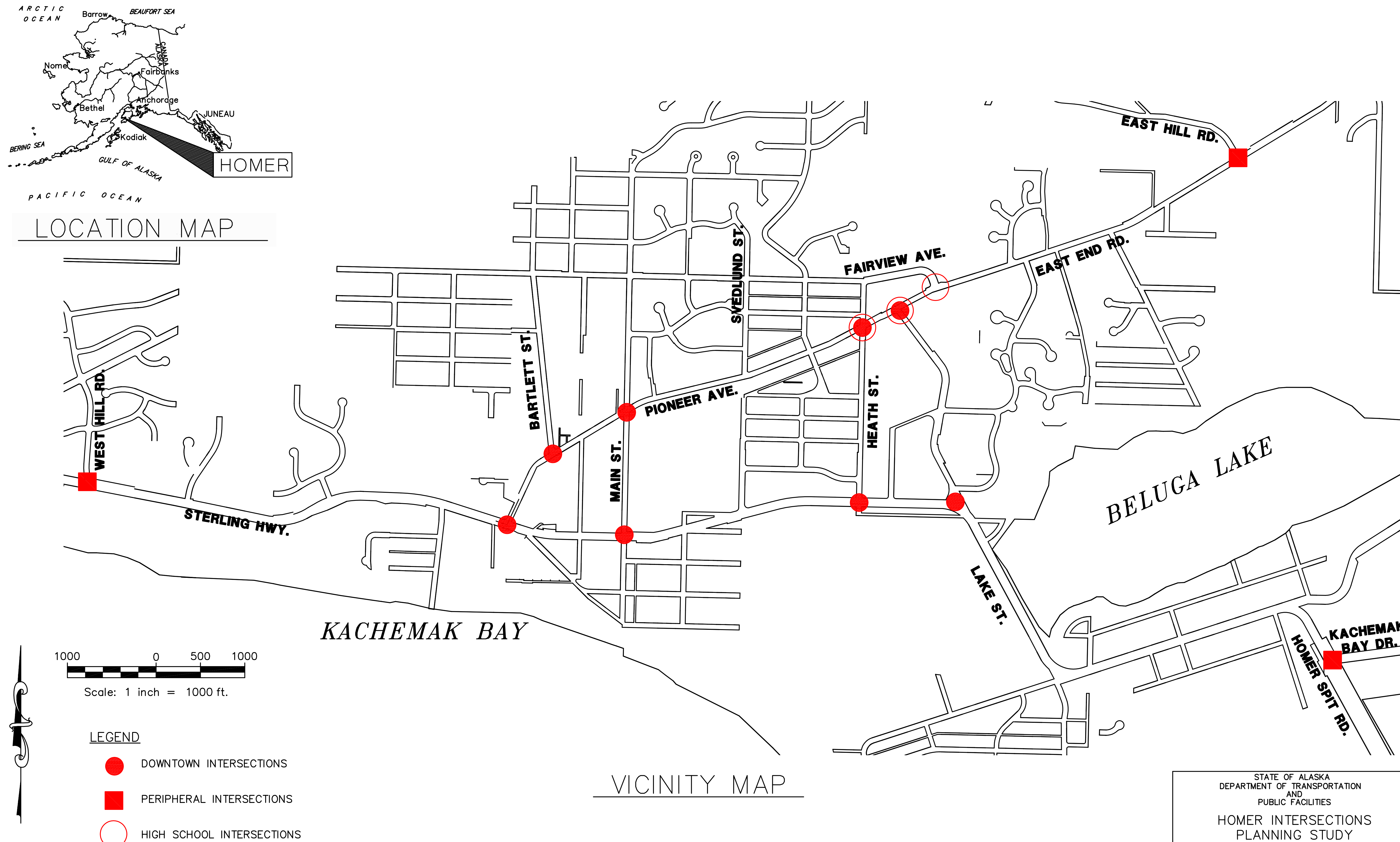
- Heath Street and Pioneer Avenue
- Lake Street and Pioneer Avenue
- East End Road and Fairview Avenue

This study assesses current and long term pedestrian access and mobility needs and evaluates recently installed pedestrian crossings on Pioneer Avenue and Sterling Highway.

This project examines solutions to serve vehicles and pedestrians and how intersections fit together as a system. The cost and effectiveness of intersection solutions will be evaluated in the near term and long term.

1.2 Study Area

Figure 1 presents the project study area.



STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES

HOMER INTERSECTIONS
PLANNING STUDY

VICINITY MAP

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:1000'	FIGURE	1

1.3 Organization of this Report

The report is organized around the framework of the study analysis elements. The following elements are included.

- *Current Conditions* are described under Section 2, including the Homer street network, general land use, traffic volumes, and speeds.
- *Traffic Volume Forecast* are presented under Section 3. This work includes Average Daily Traffic (ADT) for summer and winter seasons and intersection turning movements during peaks of summer and winter seasons.
- *Safety Analyses* are in Section 4. This work consists of a substantive study to determine actual safety performance, a nominal study to determine compliance with standards, and input from those with expertise (emergency responders) and the public.
- *Existing Conditions Operational Performance* is summarized for the system in Section 5 for both current and forecasted traffic.
- *Pedestrian Considerations* are addressed in Section 6. This section evaluates crossings on Pioneer Avenue.
- *Intersection Control Warrants and Guidelines* are in Section 7, which include a warrant or guideline evaluation of all-way or two-way stop sign controls, modern roundabouts, and traffic signals.
- *Alternative Formulation* is in Section 8. This includes operational evaluations of the control alternatives for individual intersections and system alternatives.
- *Costs and Impacts* are presented in Section 9.
- *Alternative Evaluations* are presented in Section 10 and include development and comparison of vehicular operational performance measures, safety performance measures, pedestrian performance measures, costs, and impacts.
- *Public Involvement* is summarized under Section 11.

1.4 Past Work

The *2001 Homer Area Transportation Plan (Updated 2004)* provided the basis of traffic forecasts and the 2021 proposed street network program. In addition to this plan, the travel demand QRSII model (retained by original contributing authors Kinney Engineering/Northland Systems Engineering) was updated to include the Oceans and Islands Center, the proposed Fred Meyer

Store (northwest corner of the Homer Bypass/Lake intersection), new library (northwest corner of Hazel/Heath intersection), and University of Alaska developments that were not in the original model. Figure 2 presents the 2021 proposed street network in the project area.

In addition to the updated plan, there are two traffic impact analyses that are being developed concurrently with this study. The first is for the proposed Fred Meyer retail store and the second is for the library expansion.

Past work by the City and DOT&PF has typically focused on corridors, and intersection needs are not always obvious from typical roadway paving projects. This Homer Intersections Planning Study fills this gap to plan ahead for future scopes of work.

Plotted: Thursday, Jun 23, 2005, 9:04am

Plotted by: wwebb

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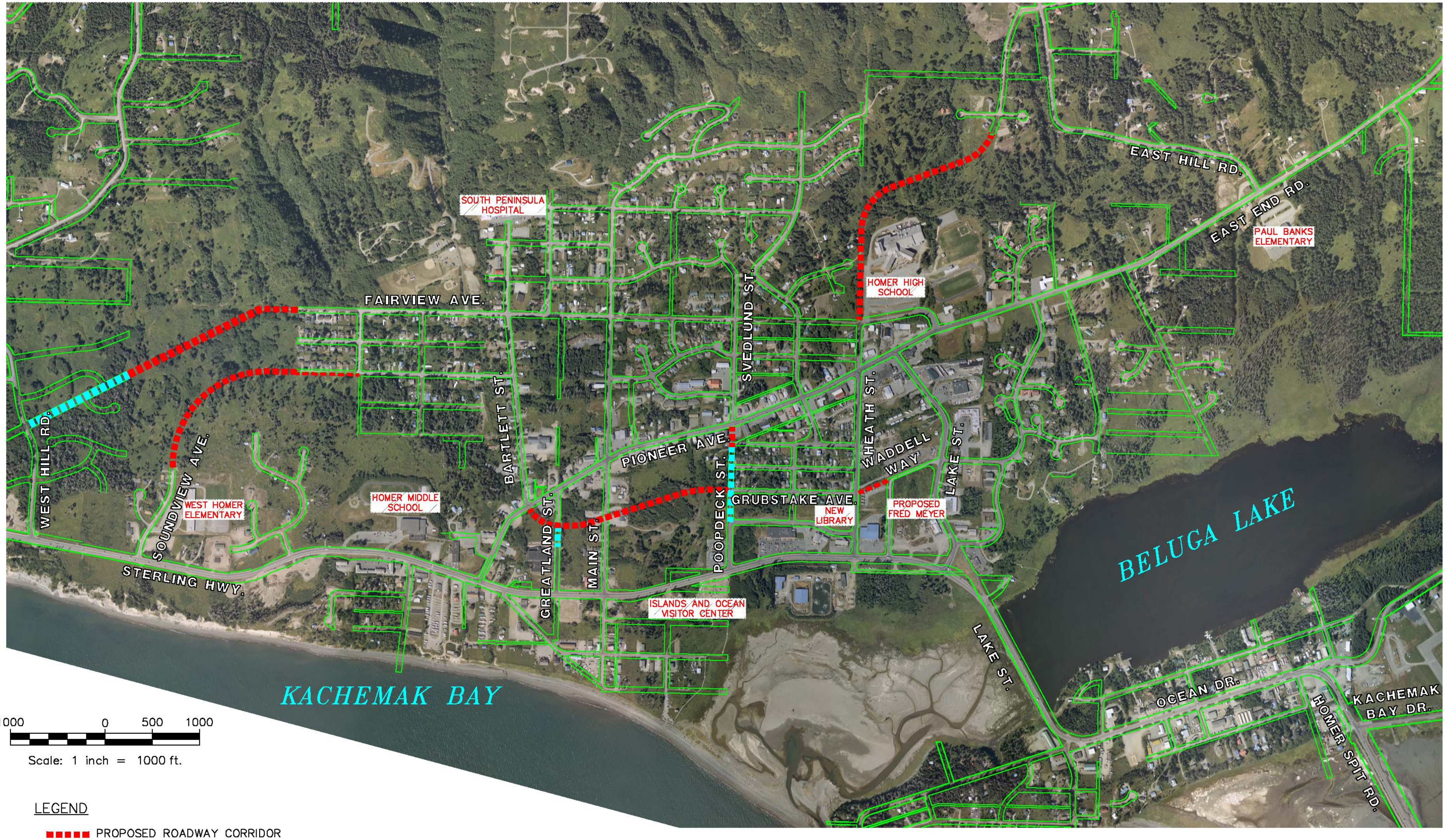

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Scale: 1 inch = 1000 ft.

LEGEND

PROPOSED ROADWAY CORRIDOR

PLATTED ROADWAY CORRIDOR (NOT BUILT)

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES

HOMER INTERSECTIONS
PLANNING STUDY
HOMER TRANSPORTATION PLAN
2021 STREET NETWORK

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:1000'	FIGURE	2

1.5 Project References and Standards

- *2001 Homer Area Transportation Plan* (Updated 2004), Mike Taurianinen, P.E., Consulting Engineers, Inc.
- *Central Region Annual Traffic Volume Report*, DOT&PF, Volumes for 1993 to 2003.
- *Geometric Design of Streets and Highways, 2001,* (GDSH or Green Book) American Association of State Highway and Transportation Officials (AASHTO).
- *Alaska Preconstruction Manual* (PCM), ADOT&PF.
- National Cooperative Highway Research Program (NCHRP) Report 162, *Methods for Evaluating Highway Safety Improvements*, Laughland, et. al.
- The *Highway Safety Improvement Program Handbook* (HSIPHB), ADOT&PF, January 25, 2002, with 2002 Supplemental Rates provided by the Central Region Traffic and Safety Section.
- *Alaska Traffic Accidents* , ADOT&PF.
- *Highway Capacity Manual*, (HCM2000) TRB, 2000.
- *Manual of Traffic Signal Design*, Second Edition, James H. Kell and Iris J. Fullerton, Institute of Transportation Engineers (ITE).
- *Traffic Engineering Handbook,* ITE 5th Ed.
- *Traffic Engineering Handbook,* ITE 4th Ed.
- NCHRP Report 457, *Engineering Study Guide for Evaluating Intersection Improvements*, Bonneson and Fountaine, 2001.
- Federal Highway Administration (FHWA) RD-00-067 *Roundabouts: An Informational Guide*, 1999.
- *Manual on Uniform Traffic Control Devices Millennium Edition* (MUTCD), FHWA.
- *Access Management Manual*, TRB 2004
- *Highway Capacity Software 2000* (HCS), McTrans.
- Synchro and SimTraffic, Trafficware.
- *RODEL 1 Interactive Roundabout Design Software and Manual*, Rodel Software Ltd and Staffordshire County Council.
- *aaSidra Software*, Akcelik and Associates.
- NCHRP Report 187 *Quick-Response Urban Travel Estimation Techniques and Transferable Parameters*.

- USDOT Technical Report *Calibration and Adjustment of System Planning Models*, by Dane Ismart, Alan Horowitz, Arthur Sosslau, George Dresser, Richard Hall, and Mike Meyers, December 1990.
- *State-Of-The-Art Report On: Roundabouts Design, Modeling And Simulation,* Mohamed A. Aty, and Yasser Hosni, University of Central Florida, March 2001.
- *Alternative Treatments for At-Grade Pedestrian Crossings,* Lalani and the ITE Pedestrian and Bicycle Task Force, ITE, 2001.
- *Guide for the Planning, Design and Operation of Pedestrian Facilities*, AASHTO 2004
- NCHRP Report 255, *Highway Traffic Data for Urbanized Area Project, Planning and Design*, N.J. Pedersen and D.R. Samdah.
- *Traffic Calming Protocol Manual*, Draft, Municipality of Anchorage (MOA) Traffic Department, November 2000

1.6 Study Duration

This study has a design year of 2021. This year coincides with the planning horizon year used in the *2001 Homer Area Transportation Plan*.

2 CURRENT CONDITIONS

2.1 Homer Street Network

2.1.1 Functional Classification

Table 1 summarizes functional the classification for the streets involved in this study.

Street	CDS Route Number	Functional Classification
Bartlett Street	110500	Rural Minor Collector
East End Road	110300	Rural Major Collector
East Hill Road	110305	Rural Minor Collector
Fairview Drive	--	Rural Local Road
Heath Street	110025	Rural Local Road
Kachemak Bay Drive	110200	Rural Major Collector
Lake Street	110150	Rural Major Collector
Main Street	110625	Rural Local Road
Pioneer Avenue	110100	Rural Major Collector
Sterling Highway/Homer Bypass	110000	Rural Principal Arterial
West Hill Road	110800	Rural Minor Collector

(Reference DOT&PF CDS Log)

Table 1- Street Functional Classifications

The streets of this study are classified as rural streets, primarily because of Homer's population. AASHTO uses a rural characterization for areas with populations of less than 5,000. Current population is about 4,500 in the area (including Kachemak City and Fritz Creek population centers). However, the streets and intersections within the downtown CBD triangle resemble urban streets, with curb, gutter, and sidewalk, and should be planned as urban streets.

2.1.2 General Characterization of Streets

Sterling Highway, Pioneer Avenue, and East End Road are the primary corridors for this study. Tables 2 and 3 summarize key cross-sectional attributes of these primary streets.

	Pioneer Ave	East End Rd, near East Hill Rd
Lanes	2, 13-ft lanes	2, 12-ft lanes
Median	14-ft center-two-way-left-turn	None
Shoulder Width	None	4-ft, both sides
Curb and Gutter	Both sides	Both sides
Sidewalk	5-ft both sides	5-ft both sides
Pathway	None	None
Illumination	Continuous	Continuous

Table 2- Pioneer Avenue and East End Road Cross-Sectional Design Elements

	Sterling Hwy near West Hill Rd	Sterling Hwy, Pioneer Ave to Lake St	Sterling Hwy (Ocean Drive), from Lake St to FAA Rd	Sterling Hwy near Kachemak Bay Rd
Lanes	4, 12-ft inside, 12.5-ft outside	2, 12-ft lanes	2, 12-ft	2, 12-ft
Median	None	14-ft. center-two-way-left-turn	None	None
Shoulder Width	4.5-ft	4-ft. both sides	2-ft, north side 8-ft, south side	None
Curb and Gutter	North side only	Both sides	None	None
Sidewalk	None	None	None	None
Pathway	8-ft, north side	8-ft both sides	8-ft, south side (includes shoulder)	8-ft, east side
Illumination	Continuous	Continuous	Continuous	Intersection

Table 3- Sterling Highway Cross-Sectional Design Elements

These streets are urban in character and use urban design criteria and standards. Intersection lane configurations are presented in Figure 3.

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HOMER INTERSECTIONS PLANNING STUDY
SCHEMATIC INTERSECTION LANE CONFIGURATIONS

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:1000'	FIGURE	3

2.2 General Land Use

Commercial development dominates Pioneer Avenue, Sterling Highway, Lake Street, and Heath Street. There are institutional developments as well, and many of the cross-streets that branch from these streets serve residential developments.

2.3 Traffic Volumes

2.3.1 Past Average Annual Daily Traffic (AADT)

Table 4 summarizes the 1993 to 2002 AADT of key streets of the study area and the most recent year, 2003. This is taken from the *Central Region Annual Traffic Volume Report* for the respective years. The averaged 1993 to 2002 time period coincides with the 10-year crash study period.

Appendix A contains yearly AADT volumes for all years and includes estimates of AADT on segments which are included in the *Central Region Annual Traffic Volume Report.*

Begin	End	1993 to 2002 Average AADT	2003 AADT
Sterling Highway CDS Route 110000			
Southwest Marine Highway	FAA Road	4,133	4,055
FAA Road	Lake Street	6,907	6,250
Lake Street	Main Street	7,752	9,393
Main Street	Pioneer Avenue	5,799	8,838
Pioneer Avenue	Crittenden Drive	7,206	9,370
Crittenden Drive	West Hill Road	6,109	6,890
West Hill Road	Rogers Loop	4,258	4,960
Pioneer Avenue CDS Route 110100			
Lake Street	Main Street	7,067	6,871
Main Street	Sterling Highway	4,877	4,580
Lake Street CDS Route 110150			
Sterling Highway	Pioneer Avenue	5,508	6,110
Kachemak Bay Drive CDS Route 110200			
Sterling Highway	Lou's Storage Facility	1,775	2,130
East End Road CDS Route 110300			
Lake Street	East Hill Road	7,400	7,776

Begin	End	1993 to 2002 Average AADT	2003 AADT
East Hill Road	Kachemak Bay Drive	4,686	4,650
East Hill Road CDS Route 110305			
East End Road	Mission Road	1,546	1,590
Bartlett Street CDS Route 110500			
Pioneer Avenue	Fairview Avenue	1,491	1,913
Main Street CDS Route 110625			
Bunnell Avenue	Sterling Highway	1,832	1,898
Sterling Highway	Pioneer Avenue	2,547	2,640
West Hill Road CDS Route 110800			
Sterling Highway	Miller Loop	1,481	2,075

Table 4- Study Area AADT 1993 to 2002 Averaged and 2003

2.3.2 Intersection Turning Movement Counts

Intersection turning movements were performed by DOT&PF at key intersections within the CBD triangle area in 2003 and 2004. Kinney Engineering collected turning movements at the peripheral intersections during the fall/winter of 2004 and 2005.

Current turning movements (2003, 2004, and 2005) are presented in Appendix A.

2.4 Speeds

Table 5 summarizes the posted speeds for the streets in this study. The posted speeds on streets and roads that are outside of the CBD triangle have been periodically verified by DOT&PF speed studies (from Traffic and Safety Section files). As such, these would represent the 85th percentile speed as well. Posted speeds on State routes within the CBD triangle are set by DOT&PF with local government input and concurrence.

Street	Speed Limit (mph)	Background Comments
Bartlett Street	25	25 mph limits are default to state law speeds for residential areas without any major studies.
East End Road (near town)	25	
East End Road (near East Hill Road)	35	Reset to 35 MPH consistent with the functional class of a dual curb extension of the urban section from Pioneer Ave.
East Hill Road	30	Set by DOT&PF using low volume analysis of curves and driving speeds.
Fairview Drive	25	25 mph limits are default to state law speeds for residential areas without any major studies.
Heath Street	25	
Kachemak Bay Drive	35	Kachemak Bay Dr retains its original gravel road speed limit and has not been reevaluated since paving.
Lake Street	25	
Main Street	25	
Pioneer Avenue	25	
Sterling Highway (through study area)	35	Set by DOT based upon 85th percentile speeds and density of development.
Sterling Highway (west of West Hill Road)	45	
West Hill Road	30	Set by DOT&PF using low volume analysis of curves and driving speeds.

Table 5- Study Area Posted Speed Limits (Background Comments Provided by DOT&PF)

Speed is a component of several traffic engineering studies that are a part of this report. The 85th percentile speed is a factor in signal warrants and is used to determine posted speed limits for some locations. As Table 5 indicates, other methods were used to determine posted speeds for many of the streets in Homer. For the purposes of this study, the posted speed is assumed to represent the 85th percentile speed.

Minimum intersection sight distance is determined by posted approach speeds.

3 TRAFFIC VOLUME FORECASTS

Traffic Volume forecasts were developed for:

- AADT - the total volume over the year on roadway divided by 365 days
- Summer ADT - summer traffic volumes which are the peak condition
- Winter ADT
- Summer intersection turning movement for peak hours
- Winter intersection turning movements for school peak hours (school intersections only)

Forecasted AADT and Summer ADT were developed with a QRS II travel demand model. These daily volumes were used in warrant calculations, and to develop growth rates for intersection turning movement forecasts. Turning movements during the peak hour represent the design condition that the intersections must accommodate.

3.1 QRS II Urban Travel Demand Model Update

The *2001 Homer Area Transportation Plan* used the QRS II urban planning demand model for forecasting traffic volumes and to test effectiveness of planned improvements. In that effort, several scenarios were developed that apply to this study, including a 1999 Base model with the recently constructed intermodal dock, 2021 Summer with Dock, 2021 Summer Street Projects, and 2021 base with dock models. The models are described in detail in the *2001 Homer Area Transportation Plan*.

The 1999 Base with Dock model was revised with new information and techniques acquired in the intervening years since the model was first developed in 2001. No new centroids were added to the 1999 model, but productions and attractions at the special generators and external stations were reviewed and updated. This base model was the basis for calibration and validation and served as the platform for the 2021 models. The model was re-calibrated in accordance with accepted practice.

Based on discussions with City of Homer personnel, new centroids representing the new library, the Islands and Oceans center, the proposed Fred Meyer store, and the new hockey rink were added to the 2021 Summer with Dock, 2021 Summer Street Projects, and 2021 Base with Dock models.

The 2021 Summer Street Projects model was revised to include only the most recent street projects envisioned by the Homer Planning Department. The 2021 network includes the following new streets within the project study area:

- Connection from Soundview Avenue at the Sterling Highway to the west end of Fairview Avenue;
- Heath Street Extension to East Hill Road
- Poopdeck Street extended to Pioneer Street
- Waddell Way extended to Heath Street
- Greatland Street extended to Pioneer Avenue at Bartlett Street
- CBD east west-street from Grubstake Street across Poopdeck Street, Main Street, and Greatland Street, connecting to Pioneer Avenue at Bartlett Street. (This street, along with Greatland extension on the west side and Waddell extension on the east side would provide a parallel corridor to Pioneer Avenue from Bartlett Street to Lake Street.)
- Fairview Extension to West Hill Road.

These planned improvements are shown in Figure 2.

3.2 Methodology

3.2.1 AADT Forecast Methods

AADT volumes were forecasted for 2011 (intermediate year for evaluation of traffic control alternatives) and 2021 (design year) by comparison of growth of the transportation model in several different ways:

- Weighted growth on “best” representing road segments confined to the intersection study area in this report. A weighted growth for all segments was determined between model summer volumes in 1999 and 2021 committed network (see Figure 2).
- Growth of the Homer area model base vehicle trips (trips not adjusted to summer trips) between years 1999 and 2021.
- Growth of the Homer area model summer vehicle trips (based trips adjusted to summer trips) between years 1999 and 2021.
- Growth at the three DOT&PF Central Region permanent traffic counters located on the Sterling Highway and East End Road. A weighted growth was determined from 2003 Central Region summer ADT and 2021-build model volumes.

In addition, the traffic growth for the study area outline was compared to socio-economic growth outlined in the *Homer Area Transportation Plan.*

All methodologies are resolved to express traffic growth forecasts in an equivalent average annual growth rate, percent per year, and equivalent overall growth factors to establish forecasted volumes. The methodology resolves the forecasts to an existing base year (2003) and design year (2021). The base year is essentially the current traffic volume. The arbitrary year forecast (2011) is determined from an extrapolated growth factor from 2003 and 2021 volumes. The traffic annual growth rate used in this study for the Homer area is two percent per year. The final overall growth factor between 2003 and 2021 is 1.43 (computed as 1.02^{18}).

3.2.2 Turning Movement Forecast Methods

Turning movement traffic volumes were developed for morning (AM) and evening (PM) peak hours for summer traffic conditions and winter school conditions for the project intersections. Summer traffic was forecasted for all intersections. The three intersections that had winter forecasts because of their proximity to Homer High School include:

- Heath Street and Pioneer Avenue
- Lake Street and Pioneer Avenue
- East Fairview Avenue and East End Road

In general, the proportional growth method was used to initially develop 2021 turning movement volumes (vehicles per hour). This method determines future turning movements by applying a growth factor to existing year turning movement counts.

$TM_{2021} = GF_{weighted} \times TM_{existing}$

Where:

TM is the existing or 2021 turning movement volume adjusted to summer or school condition using Central Region ADT factors.

$GF_{weighted}$ is the weighted growth factor (1.43) based on the average annual growth rate in the study area of two percent per year between base year 2003 and forecasted design year 2021 (refer to discussion under 3.2.1 *AADT Forecast Methods*).

Lastly, traffic volumes were redistributed between Heath Street and Lake Street to determine the final 2021 forecasted turning movement. Volumes were redistributed to more closely resemble reaction to growing intersection congestion and also the transportation model, which showed a large growth on Heath Street and no growth on Lake Street.

3.3 Future (2011 and 2021) Model Results

Forecasted AADT and turning movements are in Appendix B.

4 SAFETY ANALYSIS

4.1 Methodology

As part of this study, a four-part safety analysis identifying safety issues has been conducted. These include:

- "'measurable' from accident data" (determined through comparison of accident frequencies to rates developed by the Highway Safety Improvement Program);
- "'measurable' by law" (i.e., where "critical roadway features no longer meet Department standards or laws (13 AAC 02)");
- "'perceived' by expertise" (as determined from judgment of local emergency response professionals); and
- "'perceived' by observation" (as determined from others, including the engineers).

Safety performance is important in forming intersection control and geometric alternatives. Crash experience is one of the warrants used to select either signal or all-way stop control intersections. Crash reduction is a significant benefit of modern roundabout intersections.

Substantive safety analysis is discussed in Section 4.2. Section 4.3 addresses nominal safety considerations involving comparison of existing physical intersection attributes (based on as-builts and field measurements) with standards. Sections 4.4 and 4.5 address perceptions by expertise and observation, respectively.

The substantive evaluation follows a statistical approach that is presented in Appendix C. Ten years of crash data were evaluated (1993 to 2002). Where applicable, the historical crash rates are compared to population average rates, taken from DOT&PF Central Region Highway Safety Improvement Program data. In addition, this report presents accident composition data for intersections.

4.2 Substantive Safety

The Homer study area had 235 crashes at 42 intersections between 1993 and 2002. An additional 42 crashes occurred in accident segments, for a total of 277. Of these crashes, none involved fatalities. There were a total of 5 major injury collisions (involving 1 major injury each), and 86 minor injury crashes (with 111 people suffering minor injuries). The remaining 186 crashes were property damage only. Table 6 presents the 10-year crash frequencies for the study intersections and their rank in terms of highest frequencies.

Intersection	1993-2002 Crashes	Rank (Study Area)
Pioneer Avenue and Main Street	21	1 (Tie)
Sterling Highway and Lake Street	21	1 (Tie)
Sterling Highway and Main Street	15	3
Sterling Highway and Pioneer Avenue	14	4
Sterling Highway and Kachemak Bay Drive	13	5
Sterling Highway and Heath Street	12	6
East End Road and East Hill Road	11	7 (Tie)
Pioneer Avenue and East End Road/Lake Street	11	7 (Tie)
Pioneer Avenue and Heath Street	11	7 (Tie)
Sterling Highway and West Hill Road	10	10
Pioneer Avenue and Bartlett Street	6	13
East End Road and Fairview Avenue	5	15

Table 6- Study Area Intersection Crashes and Rank within Study Area

Designated study intersections hold the ten highest ranks for the CBD triangle and the peripheral intersection areas. Other intersections that are not included in the study are Pioneer Avenue and Svedlund Street (11^{th} with 9 crashes), Lake Street and Smoky Bay Way/Waddell Way (12^{th} with 7 crashes), and Sterling Highway and B Street (tied for 13^{th} with 6 crashes).

4.2.1 Crash Rate Analysis

Crash rates were compared with both the population average rates (for intersections with the same number of conflicts and control configuration) and the critical rate in conformance with the methodology discussed in Appendix C. The results, based on the 10-year study period for the 12 intersections of this study, are the summarized in Table 7.

Intersection	Number of Crashes (1993 to 2002)	10-Year Average Entering AADT	Crashes per Million Entering Vehicles (Crash/MEV)	Population Average Accident Rate (2002 Central Region data) (Crash/MEV)	Upper Control Limit (UCL) @ 95% Level, Critical Rate (Crash/MEV)	Rate> Average Rate?	Rate > Critical Rate?
Sterling Highway and West Hill Road	10	5,924	0.463	0.602	0.900	no	no
Sterling Highway and Pioneer Avenue	14	8,941	0.429	0.602	0.841	no	no
Sterling Highway and Main Street	15	8,965	0.458	0.649	0.896	no	no
Sterling Highway and Heath Street	12	9,250	0.355	0.649	0.892	no	no
Sterling Highway and Lake Street	21	10,084	0.571	0.602	0.826	no	no
Sterling Highway and Kachemak Bay Drive	13	5,020	0.710	0.602	0.927	**yes**	no
Pioneer Avenue and Bartlett Street	6	5,622	0.292	0.602	0.908	no	no
Pioneer Avenue and East End Road/Lake Street	11	9,988	0.302	0.602	0.827	no	no
Pioneer Avenue and Heath Street	11	8,455	0.356	0.649	0.904	no	no
Pioneer Avenue and Main Street	21	8,196	0.702	0.649	0.908	**yes**	no
East End Road and Fairview Avenue	5	7,650	0.179	0.602	0.861	no	no
East End Road and East Hill Road	11	6,816	0.442	0.602	0.878	no	no

Table 7- Study Area Intersection Crash Rates, 1993 to 2002

Only two of the intersections in this study had a crash rate higher than the population average. Among the 42 total intersections surveyed for this study, there were no other intersections that had a higher than average accident rate. No intersections had rates exceeding the critical rate, and as such, none of these are of concern for targeted safety funding at this time. The accident history is discussed in Section 4.2.2.

4.2.2 Individual Intersections Analysis

The following sections discuss the types of crashes and their contributing factors. Collision diagrams for the intersections are presented in Appendix D.

4.2.2.1 Pioneer Avenue and Sterling Highway

Fourteen crashes were recorded at this intersection between 1993 and 2002. The crashes at this location were distributed among three general categories. Five were rear end collisions, three were right angle collisions, and two were left turn collisions.

Figure 4 shows the time of day distribution.

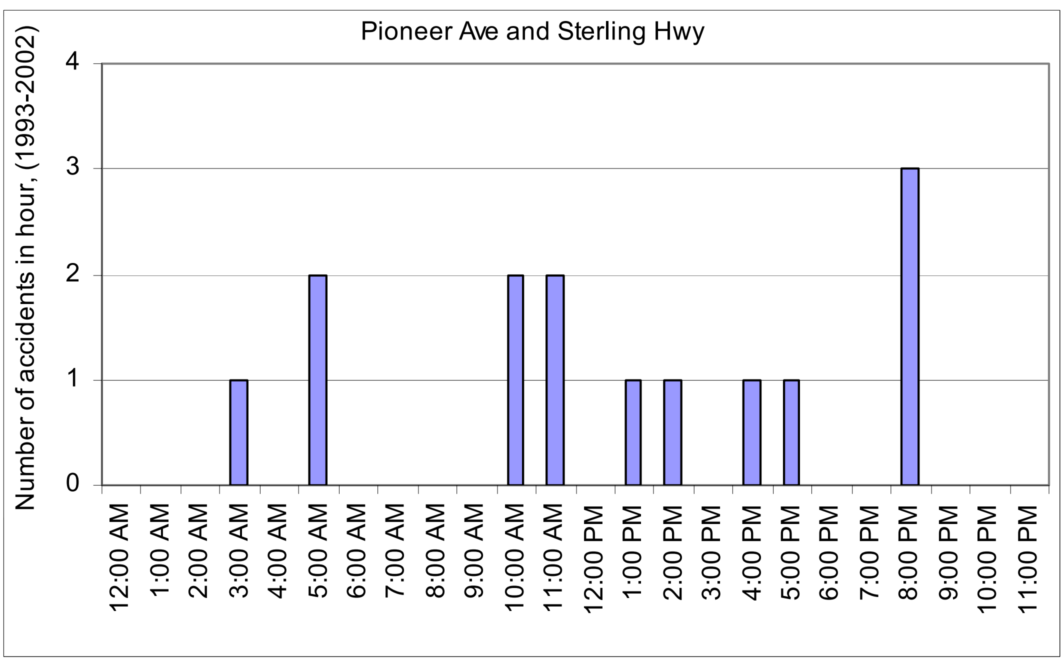


Figure 4- Time of Day Distribution: Pioneer Avenue and Sterling Highway, 1993 to 2002 Crashes

Nine of fourteen occurred on a dry surface, while five were on a snowy surface. In 10 of 14 cases, the crashes involved property damage only, and in the other 5 cases, minor injuries were involved.

There is no pattern in the accident type or direction that stands out in this case. Because of that, and the low accident rate, we considered this intersection no further.

4.2.2.2 Pioneer Avenue and Bartlett Street

Six crashes occurred at this intersection during the ten-year study period. One of the collisions resulted in minor injury and the rest were property damage only. Times of day distribution of the collisions are shown in Figure 5.

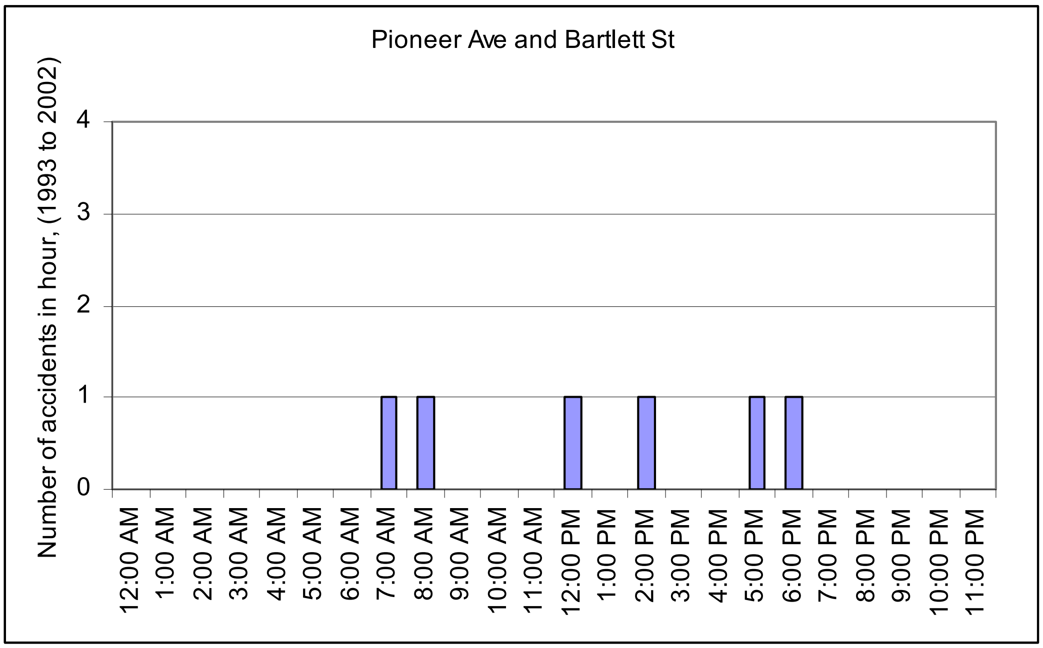


Figure 5- Time of Day Distribution: Pioneer Avenue and Sterling Highway, 1993 to 2002 Crashes

Snow and ice were reported on the surface four times. Dry surface was reported in two cases. There were two right-angle collisions, three rear-end crashes, and one backing collision. All rear end collisions occurred on the southbound approach, and all angle crashes involved westbound and southbound vehicles.

4.2.2.3 Pioneer Avenue and Main Street

A total of 21 crashes occurred in the 10-year study period. This location had a crash rate that was less than the comparative population. Fourteen of the crashes involved property damage only, while seven involved minor injuries.

Time of day crash distribution is shown in Figure 6.

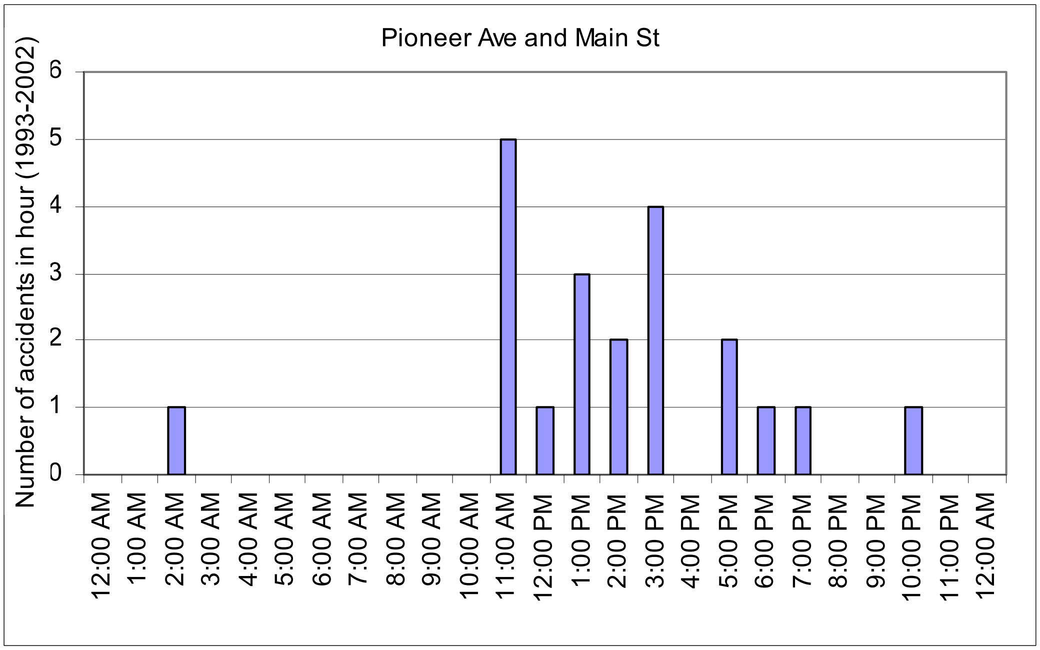


Figure 6- Time of Day Distribution: Pioneer Avenue and Main Street, 1993 to 2002 Crashes

Snow and ice were reported on the surface 10 times, and the surface was wet 4 times. Dry surface was reported in five instances, and in two cases, there was no report of the road surface condition.

There were 9 right-angle collisions and 8 rear-end crashes. Among right-angle collisions, “Vehicle 1” (normally referring to the vehicle at fault) was southbound four times, and two times each for eastbound and northbound vehicles. The highest right angle frequency involved collisions between southbound and westbound vehicles (4 of 9 right-angle collisions). Eastbound with northbound and northbound with westbound right-angle collisions accounted for two instances each.

Northbound rear-end crashes accounted for five out of the eight, with one each involving southbound, eastbound and westbound vehicle pairs.

4.2.2.4 Sterling Highway and Main Street

Right-angle crashes were the most frequent type of crash at this intersection with a total of 9 out of the 15. Rear-ends crashes accounted for three crashes, left turns for two crashes, and one was a single vehicle rollover.

Six of nine right angle collisions were between northbound and westbound vehicles. Southbound and westbound angle collisions occurred twice, and one northbound and eastbound right angle collision occurred. In total, westbound vehicles were involved in eight of the nine instances and only one collision involved an eastbound vehicle.

Figure 7 illustrates time of day distribution.

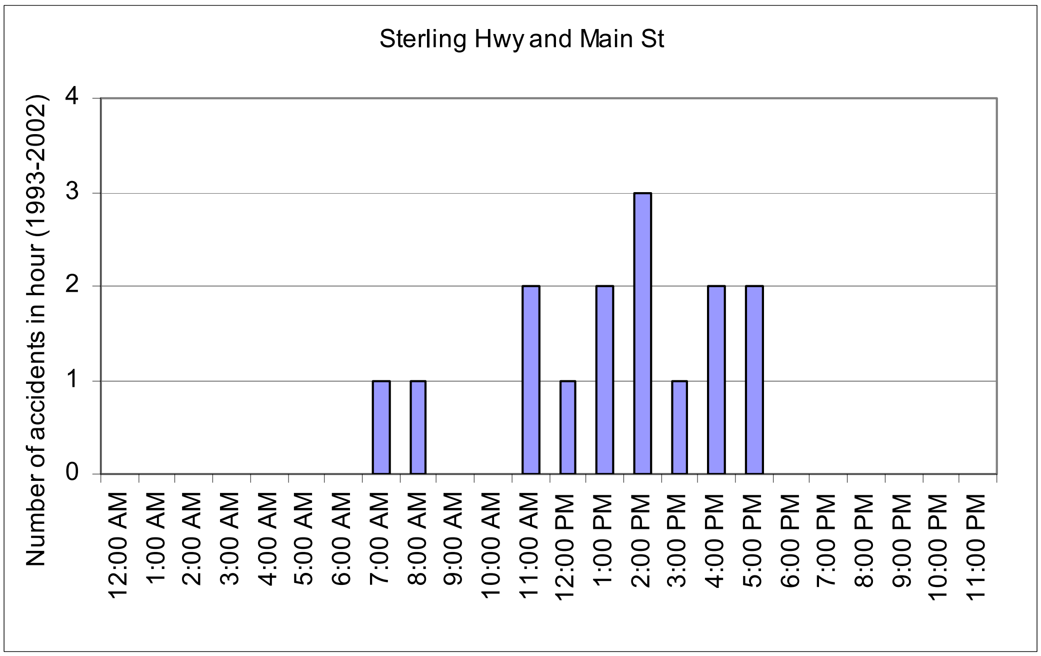


Figure 7- Time of Day Distribution: Sterling Highway and Main Street, 1993 to 2002 Crashes

Seven of the fifteen crashes occurred on a dry surface; in five cases, there was a snow and ice surface, and in two cases the surface was wet.

Eight of the fifteen crashes were property damage only, six involved minor injuries and one involved a major injury. The major injury accident included five persons with minor injuries in addition to the victim with major injuries; it was a right-angle collision involving a northbound collision with a westbound vehicle, where the driver disregarded the stop sign and entered the Sterling Highway from Main Street.

Although this intersection crash rate is not above the critical level, it has crash frequencies (1.5 per year, average) that may increase with traffic growth. Several of the dominate crash types (left turns and right angles) are correctable by signals or roundabouts. In addition, there is a high percentage of injury crashes compared to the overall State of Alaska severity population proportions. Roundabouts reduce intersection crash severities.

4.2.2.5 Pioneer Avenue and Heath Street

The 11 crashes at this location were comprised of 4 right angle collisions, 2 bicycle/pedestrian collisions, 2 rear end collisions, 1 backing accident, and 1 left turn collision. In terms of directionality, there was no pattern or cluster of crashes related to a specific movement.

Nine of the crashes involved property damage only; the other two involved minor injuries. Figure 8 shows the time of day collision distribution.

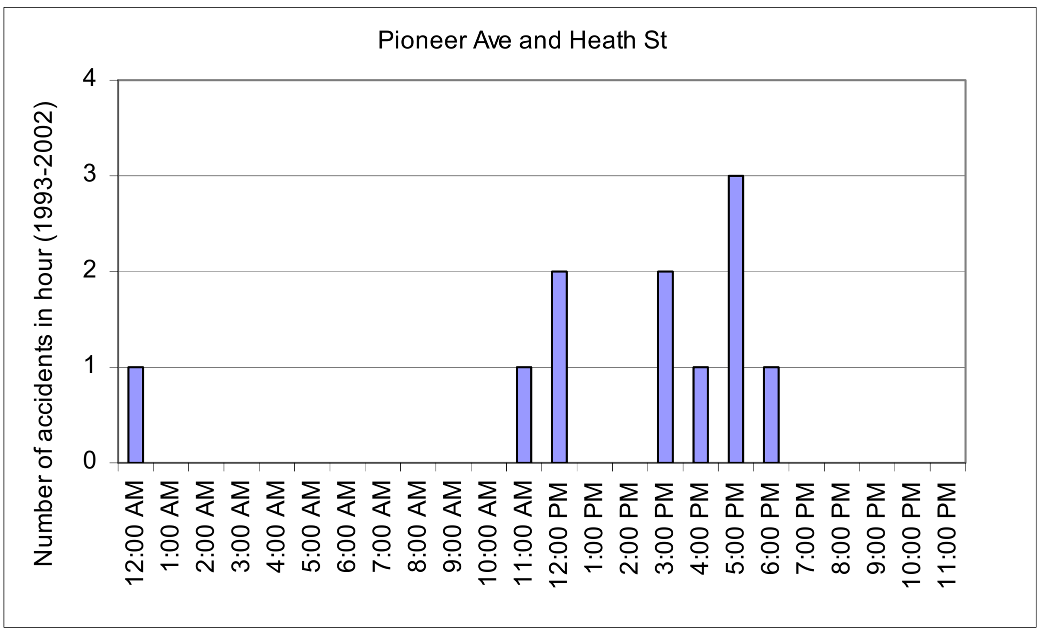


Figure 8- Time of Day Distribution: Pioneer Avenue and Heath Street, 1993 to 2002 Crashes

The road surface was dry in 6 of the 11 crashes. In three cases, there was a snow and ice road surface, and in one case, the surface was reported wet.

This intersection also is a main access point to the Homer High School. Seven of the eleven crashes, or 64 percent, occurred during the school year during the study period. This is slightly below, but roughly in conformance with, the proportion of the calendar year occupied by the school year (75 percent). The composition of accident types did not appear to have meaningful differences in patterns from those outside the school year period. From a severity perspective, it is noted that the two minor injuries at this intersection both occurred outside the school year period.

Although this intersection crash rate is not above the critical level, it has crash frequencies that may increase with traffic growth. Several of the dominant crash types are correctable by signals or roundabouts.

4.2.2.6 Sterling Highway and Heath Street

There were 12 collisions at this intersection, with no dominant accident type during the study period. The most frequent crashes were rear ends (four occurrences), left turn collisions (three each), and right angle collisions (two each). There was no clear pattern to be drawn from vehicle direction in these collisions; left turn collisions were more frequent for eastbound rather than westbound (two occurrences), while rear-ends collisions were more frequent for southbound vehicles (also two occurrences).

Nine of twelve crashes involved property damage only, and the other three involved minor injuries.

Figure 9 illustrates time of day distribution.

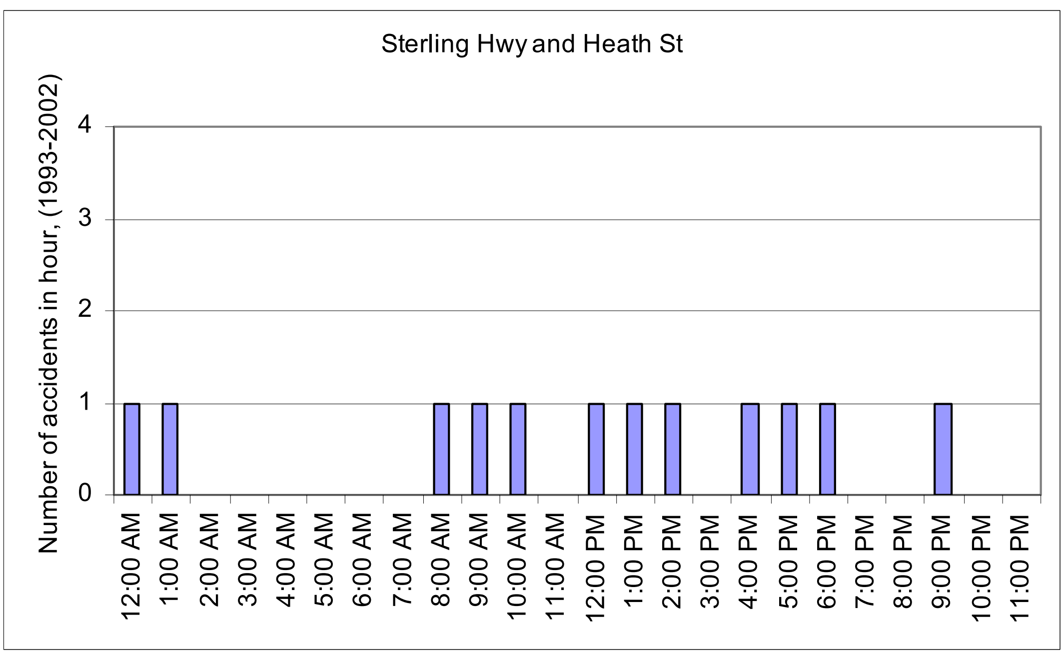


Figure 9- Time of Day Distribution: Sterling Highway and Heath Street, 1993 to 2002 Crashes

Seven of the twelve crashes happened in daylight conditions, two in dark but illuminated conditions, and one was reported to occur in darkness. The road surface was dry in 7 of 12 cases, snowy in 4 cases, and "other" in 1 case.

4.2.2.7 Sterling Highway and Lake Street

Right angle collisions comprised 10 of the 21 total collisions during the 10 year study period. Four of the twenty-one were left turn collisions; there were three rear end collisions, one head-on, and three single vehicle crashes (overturning, fixed object and moose collisions).

Four of the ten right angle collisions involved westbound and southbound vehicles. Two right angle collisions were between eastbound and southbound vehicles. Two collisions were between southbound and westbound vehicles (involving turning movements from Lake Street onto the Sterling Highway), one of which caused a major injury.

In addition to the major injury incident, four crashes involved minor injuries. The remaining 16 were property damage only incidents.

Figure 10 depicts the time of day crash distributions.

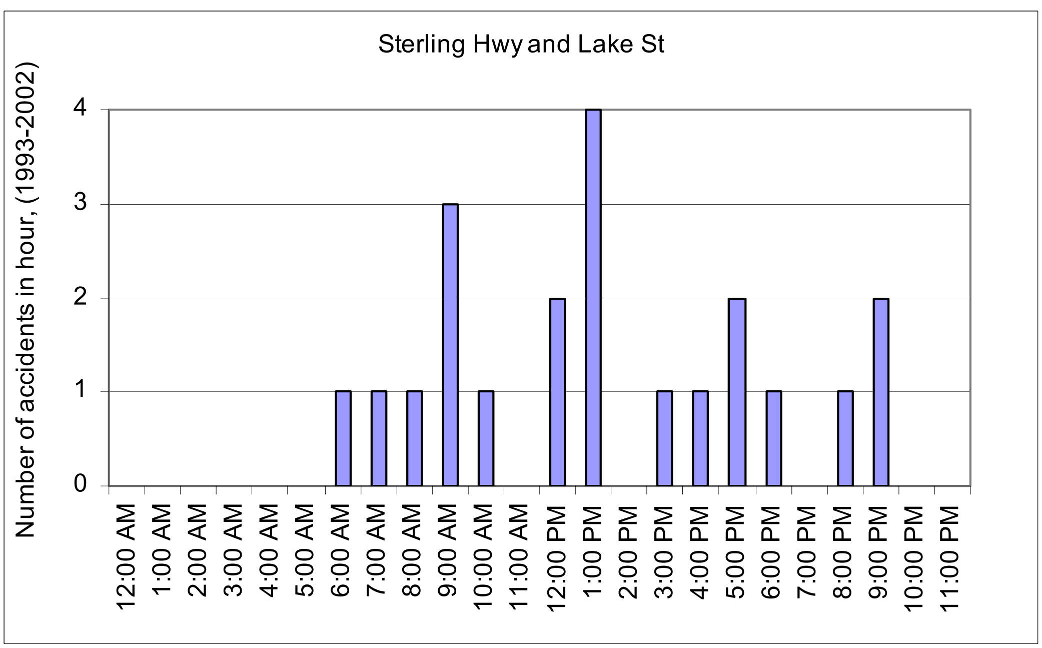


Figure 10- Time of Day Distribution, Sterling Highway and Lake Street, 1993 to 2002 Crashes

In thirteen of twenty-one cases, the crashes occurred on a dry road surface. In five cases, the road surface was snow and ice, and in one case it was wet. Two crashes showed no surface report.

There were no reported collisions at this intersection from 1999 to 2002.

Although this intersection crash rate is not above the critical level, it has crash frequencies (three to four per year for the reported years) that may increase with traffic growth. Several of the dominant crash types (left turns and right angles) are correctable by signals or roundabouts. Roundabouts would likely reduce rear-end crashes as well, and would reduce intersection crash severities.

4.2.2.8 Lake Street, Pioneer Avenue and East End Road

There were 11 crashes at this four-way stop intersection in the 1993-2002 period. Rear end collisions dominated in this intersection during the study period (7 of 11 total), with northbound rear-end collisions accounting for 4 of the 7. Two more were right angle collisions, one was a left turn accident, and one was a single vehicle run-off-road collision with a “curb/wall.” There were two minor injury crashes, one of them a rear end collision and the other involving the collision with the “curb/wall.”

In eight of eleven cases, the road surface was reported dry; in the other three, the road surface was uncoded. Time of day distribution is presented in Figure 11.

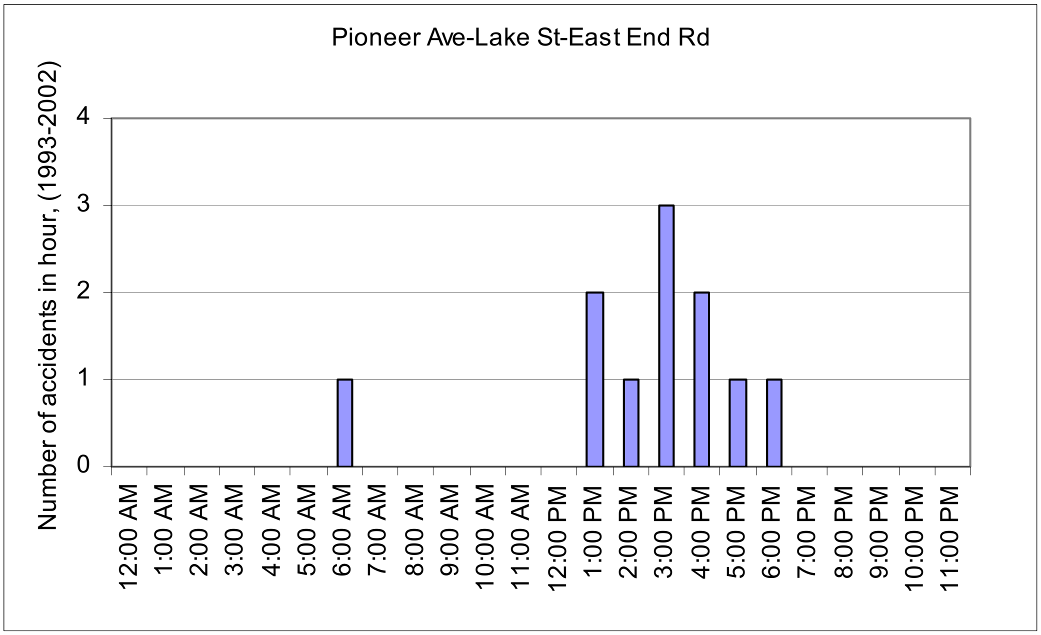


Figure 11- Time of Day Distribution, Pioneer Avenue, Lake Street, and East End Road 1993 to 2002 Crashes

Daylight was reported in six cases, with light not reported in the other five. Crashes were most common for the northbound direction when compared to other directions for both "Vehicle 1" (normally at fault) and "Vehicle 2." In 4 of 11 cases, Vehicle 1 was northbound; it was westbound in 3 cases, eastbound in 2 cases and southbound once.

This is one of the intersections highly impacted by Homer High School operations. The school-year rate is therefore less than one-third the average accident rate for unsignalized tee intersections in the Central Region. Six of the eleven crashes recorded at this intersection during the study period were during the "school year" period. Thus, school-session crashes constituted 55 percent of the total, despite the fact that school sessions cover 75 percent of the year. Therefore, the accident rate during school sessions was actually lower than it was in the summer months.

The accident composition during the school years differed only marginally from the accident composition of the years as a whole. The percentage of rear end collisions (relative to all crashes) was 50 percent, compared with the 64 percent share of rear-ends collisions for the year as a whole. The only other deviation of note is that two of three angle collisions occurred while school was in session; however, this is roughly in conformance with the proportion the school year occupies of the calendar year.

In terms of severity, both of the minor injury incidents recorded in the study period occurred during the school year.

4.2.2.9 Sterling Highway and West Hill Road

Ten crashes occurred during the study period. There were three right angle collisions, followed by two moose collisions. There was one each of the following categories: single-vehicle run-off-road/ditch; single-vehicle overturning; bicycle collision; rear-end collision; and backing collision.

Seven of the ten crashes were property damage only; the other three involved minor injuries. The road surface was recorded as dry in four of the reported crashes; in five cases, the surface was covered with snow or ice.

The data are insufficient to determine the impact of lighting on crashes; daylight was reported four times, darkness with light once, and in five cases, the lighting conditions were not recorded. Figure 12 summarizes the time of day distributions for the collisions.

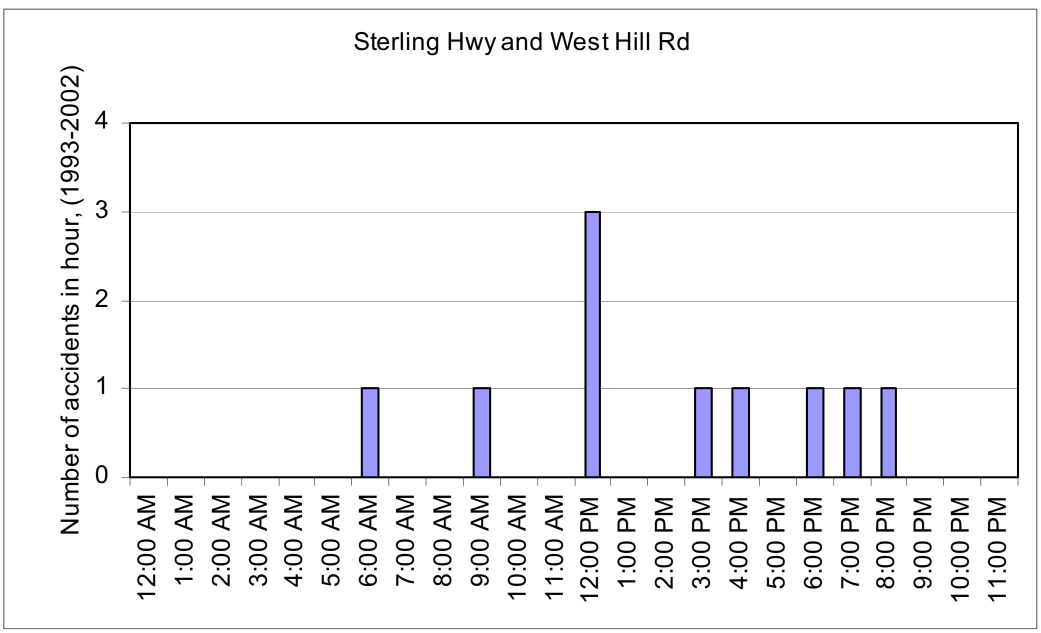


Figure 12- Time of Day Distribution: Sterling Highway and West Hill Road, 1993 to 2002 Crashes

4.2.2.10 East End Road and East Hill Road

Of the 11 crashes at this intersection, the most frequent accident types were rear ends and right angle collisions (each with 4 occurrences). Other crashes included a right-angle collision coupled with a rear-end collision, a moose collision, and a left-turn accident. An examination of the vehicle directions shows no distinct pattern or cluster of occurrences in either of the main accident types. Perhaps the only notable finding is that of the rear-end collisions, two of the four occurred on East Hill Road southbound (which has a negative grade); the other two were both eastbound with the forward vehicle turning north onto East Hill Road.

In 4 of the 11 crashes, the road surface was recorded as dry. In six cases, the road surface was compromised: three involved snow/ice road surfaces and three involved wet surfaces. In terms of roadway lighting conditions at the time of the crashes, these were reported in 7 of 11 cases. Five of the crashes occurred in daylight, one in twilight, and one after dark with roadway lighting. Figure 13 depicts the time of day distributions for the crashes.

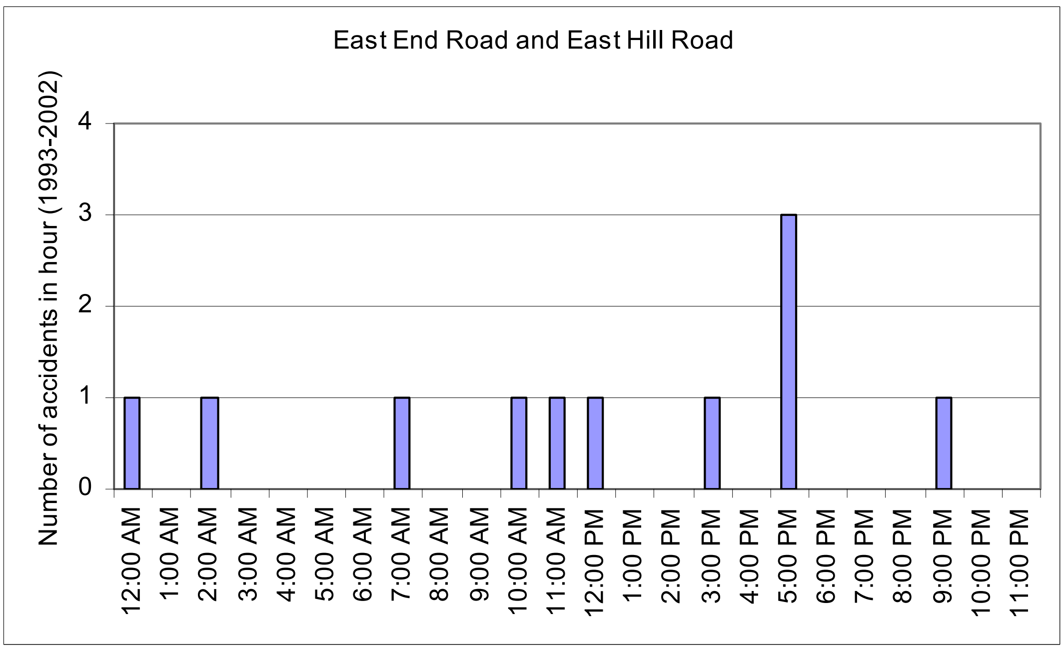


Figure 13 - Time of Day Distribution: East End Road and East Hill Road, 1993 to 2002 Crashes

4.2.2.11 Sterling Highway and Kachemak Bay Drive

Over the 10-year study period, there were 13 crashes at this 4-leg intersection. The west leg of this intersection is a driveway that provides access to Starvin Marvin, a local pizza establishment. This location had a crash rate that was higher than the comparative population average, but was substantially less than the critical rate.

There were four rear-end collisions at this location. However, there was little commonality in the direction of rear-ends collisions: there was one rear-end collision in each of the three approach directions, and one was unrecorded.

There were also two head-on collisions, one involving north/south, and one involving east/west (the eastbound having just executed a left turn from the Homer Spit Road southbound approach). There were also four single-vehicle run-off-road collisions with fixed objects or snow banks, three of which involved southbound vehicles with undetermined pre-actions.

In the accident reports, “Vehicle 1” (generally driven by the at-fault driver) was southbound in at least 5 of the 13 cases, eastbound (after a turning movement from Homer Spit Road) in 3 cases, and westbound twice. In two cases, directions were unknown or unrecorded.

In 10 of the 13 crashes, only property damage was recorded. In the other three collisions, minor injuries occurred. The road surface was dry in 9 of 13 collisions; snow and/or ice covered the surface 3 times, and the surface was covered in “oily mud” in 1 case.

There is a 5 percent downhill grade on the Sterling Highway in the southbound direction. This grade is more than the AASHTO desirable 3 percent maximum intersection approach grade, but less than the AASHTO maximum recommended intersection approach grade of 6 percent. The DOT&PF uses 4 percent or less around Anchorage, and desirable grades on landings are +2 percent to -2 percent.

Lighting conditions were reported for 10 of the 13 crashes. Among those 10, there was daylight in six cases and darkness in four. Figure 14 summarizes time of day distribution.

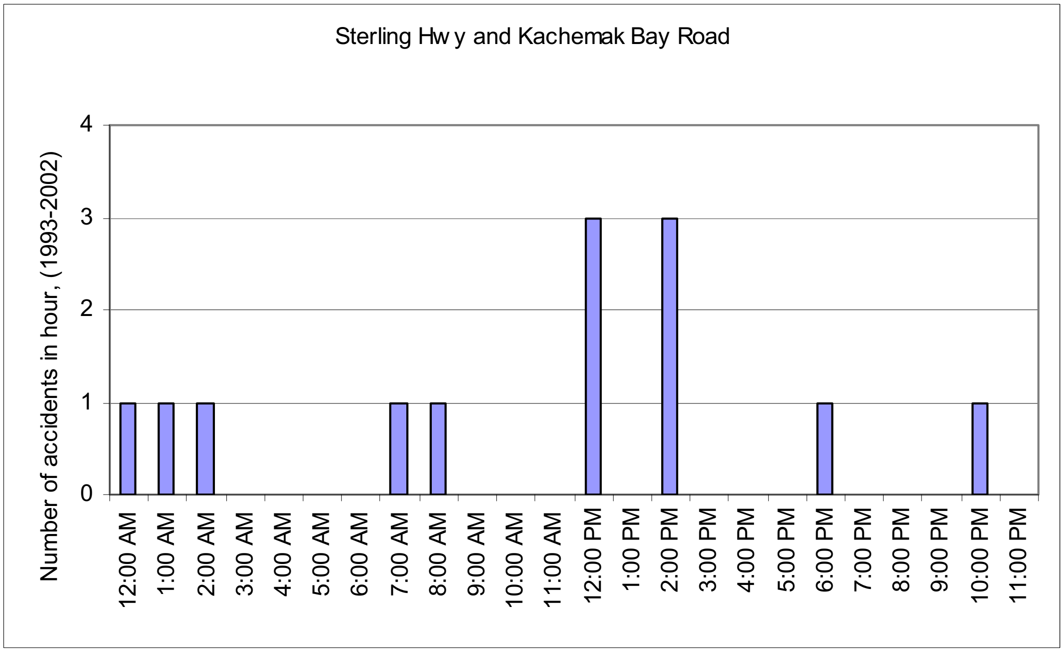


Figure 14- Time of Day Distribution: Sterling Highway and Kachemak Bay Road, 1993 to 2002 Crashes

4.2.2.12 East End Road and Fairview Avenue

All five of the crashes recorded at this three-leg intersection in the ten-year study period occurred during the school year, reflecting increased use of the Fairview approach during that time of year. One collision resulted in a minor injury and the rest were property damage only. Four crashes were rear end collisions and one was a right angle collision. Three collisions occurred during school hours, with the other two occurring during the evening commuting peak hour.

This intersection now has an eastbound left-turn storage lane now as a part of the ongoing East End Road rehabilitation project. At least one and possibly two of the rear-end collisions may have been correctable by this new auxiliary lane.

4.3 Nominal Safety

This section addresses compliance with current construction standards and guidelines. Meeting nominal safety is an objective for projects but may not correlate with actual safety experience. However, where crash experience is of concern on facilities that do not meet nominal safety, a typical countermeasure would be to reconstruct the intersection to comply with current standards and guidelines.

The project intersections had the following nominal safety standard elements evaluated.

- *Intersection Skew Angle*- Intersection skew angles can affect sight distance and maneuverability. AASHTO recommends intersection angles should be between 60 and 90 degrees. This is a guideline and not a design standard.
- *Corner Curb Radius*- This also affects maneuverability. A desirable intersection curb radius allows design vehicles to turn without encroaching outside of the origin and receiving lanes. According to Chapter 2 of AASHTO, most of the intersections in the study area should use the single unit truck as a design vehicle. The WB-67 combination truck trailer should be considered for the Sterling Highway/Lake Street, Pioneer Avenue / Lake Street / East End Road, and Sterling Highway / Kachemak Bay Road intersections since they are on a truck route. Simple corner radii of 30 feet and 50 feet are adequate for passenger cars and single unit trucks, respectively; and WB-67 vehicles would require a more complex combination of radius and taper treatments than a simple radius. However, where pedestrians are expected, as is the case in Homer, larger radii to enhance maneuverability will increase pedestrian crossing times and exposure. As such, the maximum corner radius is 40 to 50 feet, which is acceptable where larger trucks are less frequent. Smaller radii can be offset with tapers or wider egress and receiving lanes to improve turning. This is a guideline and not a design standard.
- *Approach Grades*- AASHTO recommends a maximum approach grades of 6 percent at intersections to minimize impacts on stopping distance and stop and start impacts when road surfaces are slick. This is a guideline and not a design standard. DOT&PF uses 4 percent or less around Anchorage, and desirable grades on landings are +2 percent to -2 percent.
- *Auxiliary Turning Lanes*- AASHTO Exhibit 9-75 provides guidance on the need for left-turn lanes on two-lane highways. NCHRP 457 Figure 2-5 includes this method and expands the treatment evaluation to four-lane highways. In addition NCHRP includes guidelines for right-turn treatments; either full auxiliary lanes or simple radii with a short lead-in taper for mainline approaches.
- *Sight Distance*- Minimum intersection sight distance (ISD) for stopped controlled intersections is stopping sight distance, where the driver's eye is between 14.4 to 17.8 feet from the travel way at a height of 3.5 feet above pavement, and viewing an approach vehicle that is 3.5 feet above the pavement. Minimum ISD for 25 mph mainline approach speed is 155 feet, for 35 mph mainline approach speed the ISD is

250 feet, and for 45 mph mainline approach speed it is 360 feet. Minimum ISD is a standard.

4.3.1 Intersection Maneuverability (Skew and Corner Radii)

Table 8 summarizes the intersections' conformance with skew and corner radii guidelines. In addition, the table presents the results of a turning template analysis of the intersection and indicates if the intersection has geometrics which are adequate for the design vehicle turning paths or which movements would encroach into adjoining or oncoming lanes to complete the turn.

Intersection	Skew Angle (degrees)	Corner Radius (feet)				Turning Template Analysis	
		NW	NE	SE	SW	Design Vehicle	Results
West Hill Road and Sterling Highway	75	40	50	-	-	SU	Satisfactory, no encroachment
Pioneer Avenue and Sterling Highway	83	40	40	-	-	SU	Satisfactory, no encroachment
Main Street and Sterling Highway	90	40	40	40	40	SU	Satisfactory, no encroachment
Heath Street and Sterling Highway	89	40	40	40	40	SU	Satisfactory, no encroachment
Lake Street and Sterling Highway	90	45	45	-	-	WB-67	WBRT, EBLT, SBRT encroach
Kachemak Bay Drive and Sterling Highway	70	-	50	50	-	WB-67	NBRT, WBRT, WBLT encroach
Main Street and Pioneer Avenue	58	40	40	40	40	SU	Satisfactory, no encroachment
Pioneer Avenue and Bartlett Street	63	30	30	-	-	SU	Satisfactory, no encroachment
Heath Street and Pioneer Avenue	63	35	30	35	30	SU	Satisfactory, no encroachment
Lake Street and Pioneer Avenue/East End Road	82	-	-	50	50	WB-67	NBRT, EBRT, WBLT, NBLT encroach
Fairview Road and East End Road	89	40	40	-	-	SU	Satisfactory, no encroachment
East Hill Road and East End Road	88	40	40	-	-	SU	Satisfactory, no encroachment

[1]These intersections are under construction, new radii are presented

Table 8- Intersection Skew Angles and Corner Radii

4.3.2 Intersection Approach Grades

Table 9 summarizes the intersections' conformance with approach grade guidelines. As the table shows, several of the intersection approaches exceed AASHTO guidelines. The landing length is the relatively flat area that precedes the intersection. Landings are desirable to allow vehicles to start on slick surfaces.

Intersection	Stopped Approaches							
	Northbound		Southbound		Eastbound		Westbound	
	Grade	Landing (feet)	Grade	Landing (feet)	Grade	Landing (feet)	Grade	Landing (feet)
West Hill Road and Sterling Highway	-	-	-9%	50	-	-	-	-
Pioneer Avenue and Sterling Highway	-	-	-6%	40	-	-	-	-
Main Street and Sterling Highway	8.6%	40	-6.4%	40	-	-	-	-
Heath Street and Sterling Highway	8.6%	40	-2.9%	100	-	-	-	-
Lake Street and Sterling Highway	-	-	Flat	100	-	-	-	-
Kachemak Bay Drive and Sterling Highway	-	-	-	-	-	-	7%	20
Main Street and Pioneer Avenue	3%	60	-7%	0	-	-	-	-
Pioneer Avenue and Bartlett Street	-	-	-7%	0	-	-	-	-
Heath Street and Pioneer Avenue	2%	0	-5%	0'	-	-	-	-
Lake Street and Pioneer Avenue/East End Road	2%	50	-	-	Flat	100	Flat	100
Fairview Road and East End Road	-	-	-7%	30	-	-	-	-
East Hill Road and East End Road	-	-	-11%	30	-	-	-	-

Table 9- Intersection Approach Grades

4.3.3 Auxiliary Lanes

Table 10 summarizes the existing auxiliary lanes for the intersections.

Intersection	Auxiliary Lane Movement	Length (feet)
Heath Street and Pioneer Avenue	NBRT	75

Intersection	Auxiliary Lane Movement	Length (feet)
	EBLT	CTWLTL
	WBLT	CTWLTL
Main Street and Pioneer Avenue	EBLT	CTWLTL
	WBLT	CTWLTL
Bartlett Street and Pioneer Avenue	EBLT	CTWLTL
	WBLT	CTWLTL
Heath Street and Sterling Highway	EBLT	150
	WBLT	150
Main Street and Sterling Highway	EBLT	150
	WBLT	150
Pioneer Avenue and Sterling Highway	EBLT	200
	SBLT	100
Lake Street and Sterling Highway	EBLT	150
	WBLT	200
	SBLT	125
Lake Street- Pioneer Avenue- East End Rd	EBLT	75
	EBRT	75
	WBLT	125
Fairview Avenue and East End Road	EBLT	CTWLTL
East Hill Road and East End Road	EBLT	250 (new)

Table 10- Intersection Auxiliary Lanes

The Sterling Highway and West Hill Road was evaluated in accordance with left turn lane and right turn treatment guidelines in AASHTO and NCHRP 457. Table 11 summarizes these results. A SBLT lane is warranted for Kachemak Bay Road and Sterling Highway, and a simple radius and taper right turn treatment is warranted for the Lake Street and Sterling Highway intersection.

Intersection	Need for Mainline Left Turn Lanes	Need for Mainline Right Turn Treatment
Heath Street and Pioneer Avenue	Existing	N/A
Main Street and Pioneer Avenue	Existing	N/A
Bartlett Street and Pioneer Avenue	Existing	N/A

Intersection	Need for Mainline Left Turn Lanes	Need for Mainline Right Turn Treatment
Heath Street and Sterling Highway	Existing	No right turn treatment is warranted
Main Street and Sterling Highway	Existing	No right turn treatment is warranted
Pioneer Avenue and Sterling Highway	Existing	No Right Turn Treatment is Warranted
Lake Street and Sterling Highway	Existing	Existing right turn lane
Lake Street- Pioneer Avenue- East End Road	Existing	N/A
Fairview Avenue and East End Road	Existing	N/A
East Hill Road and East End Road	Existing	No right turn treatment is warranted
West Hill Road and Sterling Highway	EBLT is not warranted	No right turn treatment is warranted
Kachemak Bay Road and Sterling Highway	SBLT is warranted	No right turn treatment is warranted

Note: N/A indicates an urban setting that is not conducive to right-turn lanes without crash experience or capacity benefits.

Table 11- Auxiliary Lane Guideline Warrants

4.3.4 Intersection Sight Distance

Table 12 summarizes the intersection sight distance. All intersections meet minimum sight distance standards.

Intersection	Approach	Speed	ISD to Right (feet)	ISD to Left (feet)
West Hill Road and Sterling Highway	Southbound	45 mph right, 35 mph to Left	>360	>250
Pioneer Avenue and Sterling Highway	Southbound	35 mph	>250	>250
Main Street and Sterling Highway	Southbound	35 mph	>250	>250
	Northbound	35 mph	>250	>250
Heath Street and Sterling Highway	Southbound	35 mph	>250	>250
	Northbound	35 mph	>250	>250
Lake Street and Sterling Highway	Southbound	35 mph	>250	>250

Intersection	Approach	Speed	ISD to Right (feet)	ISD to Left (feet)
Kachemak Bay Drive and Sterling Highway	Westbound	35 mph	>250	>250
Bartlett Street and Pioneer Avenue	Southbound	25 mph	>155	>155
Main Street and Pioneer Avenue	Southbound	25 mph	>155	>155
	Northbound	25 mph	>155	>155
Heath Street and Pioneer Avenue	Southbound	25 mph	>155	>155
	Northbound	25 mph	>155	>155
Lake Street and Pioneer Avenue/East End Road	All-Way Stop, ISD > 155			
Fairview Road and East End Road	Southbound	25 mph	>155	>155
East Hill Road and East End Road	Southbound	35 mph	>250	>250

Table 12- Intersection Sight Distance

4.4 Perceived by Expertise

In general, the public and emergency responders identified issues with all the area intersections. They identified areas with poor or non-existent lane and crosswalk pavement markings, missing or inadequate crosswalk signage, heavy traffic volumes, difficultly turning onto and off of major streets because of traffic volumes. At many of the intersections they perceive a need for traffic signals for two reasons: 1) to provide gaps for turning vehicles, and 2) provide safer crossings for pedestrians. (Note that the City and DOT&PF have improved pedestrian mobility and safety with recent crosswalk projects.) Most indicated that Homer traffic volumes are increasing and, while it worsens in the summer months, many of the suggested intersection improvements are needed year-around. Another predominate comment concerned driver behavior, especially disregard for signage, pavement markings, and pedestrian safety.

4.5 Perceived by Observation

Appendix F summarizes correspondence over 20 years on this project area relating to safety issues. All issues raised were evaluated to determine if action was necessary. It appear all issues that have been fully addressed by the City or by DOT&PF.

4.6 Consolidated Analysis

4.6.1 Trends and Issues

The intersection safety studies found that intersection rates are within acceptable levels and annual crash frequency is relatively low.

4.6.2 Countermeasures and Recommendations

No reactive countermeasures are required for crash reduction. There are proposed improvements under other sections of this study that would benefit safety, but the primary purpose of them would be congestion relief or vehicle and pedestrian mobility.

5 EXISTING CONDITIONS INTERSECTION CAPACITY ANALYSIS

Existing intersections and stop control were evaluated under the forecasted 2021 traffic. This section summarizes this work and would represent expected operations if no improvements or changes were made to the network.

5.1 Evaluation Methodology

All-way-stop control, minor-street stop control were performed in accordance with the procedures outlined in the Transportation Research Board Highway Capacity Manual 2000 (HCM) using Synchro/SimTraffic, Version 6, distributed by Trafficware. These methods are macroscopic in nature and can only evaluate a single intersection.

Microscopic simulation is also employed to evaluate operational overlapping impacts of the intersections. The simulation results are included to better illustrate performance relate to the interaction of queues, overlapping of functional areas of closely spaced intersections, and approaches with high v/c ratios.

The performance measures for minor-street stop control only and all-way-stop control includes control delay, level of service (LOS) and volume to capacity ratio (v/c) for the movements of the intersection, which include the street approaches under sign control, or major movements that must yield to oncoming traffic, such as left-turning traffic. These are performance measures are further discussed under Appendix E.

Where Simtraffic simulation performance measures are reported in tables (in parenthesis) for comparison to HCM measures, an average of at least 5 simulations is used to determine performance measures. Additional simulations were conducted and results averaged where more precise results were needed.

Note that the HCM all-way-stop-control (AWSC) method cannot be used to analyze an intersection with more than 2 lanes on a single approach. In addition, the HCM model cannot be used to analyze impacts to one intersection caused by a nearby intersection. Simulation, for both cases, is used as a means to measure intersection performance.

5.2 Level of Service

AASHTO's GDHS Exhibit 2-32 presents design year levels of service (LOS) guidelines for facilities related to this study.

- Arterial Roads (intersections included)- Rural arterials should have LOS B or better in level terrain conditions and urban arterials should have a minimum LOS of C. As the Sterling Highway becomes more urbanized, as is expected, the minimum desirable LOS would be C.
- Collector Roads (intersections included) - AASHTO states that rural collectors should have a LOS C or better in level terrain conditions. This guideline also recommends LOS D for urban collectors in urban and suburban settings, which will apply to this project as this area becomes more urbanized.
- Local Roads (intersections included) - The minimum LOS for these local roads may be D for all rural and urban roadways.

The minimum desirable level of service established for this study is LOS C for 2021. However, LOS D is acceptable in urban areas, and may be acceptable as Homer continues to become more urbanized.

In addition to reporting the LOS, total delay is reported, and the volumes to capacity ratio for movements are reported. A good practical limit for v/c ratio is 0.85, or 85% of capacity. This upper value represents good planning and design practice, in that there is some reserve capacity to absorb surges in volumes or flow turbulence.

5.3 Intersection Performance Measures

Analyses under this section summarize the performance of the intersections in their existing intersection configurations and traffic control for existing year and 2021 traffic volumes. Reported values include those for critical movements or movements that are most affected. The Winter condition is represented by peak hour traffic influenced by the high school.

5.3.1 Sterling Highway and West Hill Road

Table 13 summarizes performance measures at West Hill Road for existing and future summer traffic conditions; the results are based on existing intersection configuration of OWSC at West Hill Road. This intersection is a 3-leg intersection.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
Existing AM	0.41	16.3	C
2021 AM	0.69	30.3	D
Existing PM	0.25	16.4	C
2021 PM	0.55	32.4	D

Table 13- Performance Measures for Sterling Highway/West Hill Road Intersection, Existing Configuration and Summer Conditions

West Hill Road currently operates at an acceptable LOS C during peak periods. The performance of the intersection will be undesirable in 2021 if the area remains rural since higher delays (or a lower LOS) are generally more accepted in urban settings.

Based on the existing and 2021 conditions, vehicle queuing at the intersection will have negligible impact to the Sterling/West Hill intersection or the surrounding intersections.

5.3.2 Sterling Highway and Pioneer Avenue

Table 14 summarizes summer performance of minor street critical movements for both existing and future conditions. The table assumes current intersection configuration. Pioneer Avenue is OWSC and T's at Sterling Highway.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
Existing AM	0.06	17.1	C
2021 AM	0.13	23.5	C
Existing PM	0.32	24.5	C
2021 PM	0.67	57.6	F

Table 14- Performance Measures for Sterling Highway/Pioneer Avenue Intersection, Existing Configuration and Summer Conditions

According to AASHTO criteria, Pioneer Avenue currently operates at an acceptable LOS C during peak summer hours. The performance of the intersection will be undesirable in 2021 during the summer evening peak hour.

Based on the 2021 traffic conditions, southbound queuing could be excessive because of the failing LOS while all other turn lanes would provide ample storage.

5.3.3 Sterling Highway and Main Street

Table 15 evaluates both current and future minor street movement based on the existing intersection configuration. The Main Street intersection approaches are stop controlled (TWSC), while the Sterling Highway approaches are not stopped controlled.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
Existing AM	0.15	14.0	B
2021 AM	0.31	20.6	C
Existing PM	0.70	58.1	F
2021 PM	2.59	>300	F

Table 15- Performance Measures for Sterling Highway/Main Street Intersection, Existing Configuration and Summer Conditions

Main Street currently operates at an undesirable LOS F during the summer PM peak hour. The intersection will operate adequately during the summer AM peak hour in the year 2021.

With the existing configuration, queuing can be expected to grow and be excessive on the southbound approach by the year 2021 with potential to block a future Grubstake east-west extension and accesses between Sterling Highway and Pioneer Avenue.

5.3.4 Sterling Highway and Heath Street

Table 16 summarizes performance measures for the critical minor street movement for existing and future summer traffic conditions; the results are based on existing intersection configurations. Heath Street is under TWSC, Sterling Highway has no controls.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
Existing AM	0.18	12.6	B
2021 AM	0.50	22.3	C
Existing PM	0.51 (southbound)	29.3 (northbound)	D
2021 PM	2.44	>300	F

Table 16- Performance Measures for Sterling Highway/Heath Street Intersection, Existing Configuration and Summer Conditions

Heath Street currently operates at an acceptable LOS D. The intersection will operate adequately during the summer AM peak hour in the year 2021; however, Heath Street will operate at an undesirable LOS F in 2021 during the summer PM peak hour.

With the existing configuration, queuing can be expected to grow and be excessive on the southbound approach by the year 2021 with potential to block Hazel Avenue and other accesses to Heath Street between Sterling Highway and Pioneer Avenue.

5.3.5 Sterling Highway and Lake Street

Table 17 summarizes performance measures for Lake Street. Both existing and future summer traffic conditions; the results are based on the existing configuration of OWSC on Lake Street.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
Existing AM	0.33	15.1	C
2021 AM	0.60	26.7	D
Existing PM	1.29	>180	F
2021 PM	3.93	>300	F

Table 17- Performance Measures for Sterling Highway/Lake Street Intersection, Existing Configuration and Summer Conditions

The Lake Street critical movement currently operates at an undesirable LOS F during the summer evening peak hour; for the same hour, the movement will operate at an undesirable LOS F in 2021.

With the existing configuration, queuing can be expected to grow and be excessive on the southbound approach by the year 2021 with likelihood of blocking Ben Walters Lane, Hazel Avenue and other accesses to Lake Street between Sterling Highway and Pioneer Avenue. Blockages at the Ben Walters Lane/Lake Street intersections will potentially cause greater diversion of traffic to other intersections (i.e. Pioneer Avenue/Lake Street) and further diminish their performance.

5.3.6 Sterling Highway and Kachemak Bay Road

Table 18 summarizes performance measures for Kachemak Bay Road for both existing and future summer traffic conditions; the results are based on OWSC on Kachemak Bay Road.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
Existing AM	0.26	11.8	B
2021 AM	0.46	16.7	C
Existing PM	0.52	22.4	C
2021 PM	1.27	>150	F

Table 18- Performance Measures for Sterling Highway/Kachemak Bay Road Intersection, Existing Configuration and Summer Conditions

The Kachemak Bay Road approach currently operates at an acceptable LOS for both peak hours in the summer. The approach fails in 2021 during the summer PM peak hour. Excessive queuing can be expected on the westbound approach in 2021.

5.3.7 Pioneer Avenue and Bartlett Street

Pioneer Avenue and Bartlett Street is a currently a "tee" intersection,, but would be a 4-leg intersection in the future once the CBD east-west connection is completed. Bartlett Street is stop sign controlled. Table 19 summarizes performance measures for the critical minor street movement for existing and future summer traffic conditions; the results are based on existing intersection configurations.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
Existing AM	0.11	11.8	B
2021 AM	0.20	15.2	C
Existing PM	0.35	16.3	C
2021 PM	0.78	46.9	E

Table 19- Performance Measures for Pioneer Avenue/Bartlett Street Intersection, Existing Configuration and Summer Conditions

The Bartlett Street approach currently operates at an acceptable LOS during both AM and PM peak hours in the summer. The approach will operate at an undesirable LOS E with 2021 summer PM peak hour conditions and the added northbound approach.

5.3.8 Pioneer Avenue and Main Street

Table 20 summarizes performance measures for Main Street. Both existing and future traffic conditions are presented for operations on the existing TWSC configuration.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
Existing AM	0.27	17.9	C
2021 AM	0.46	26.7	D
Existing PM	0.37	23.0	C
2021 PM	0.82	71.3	F

Table 20- Performance Measures for Pioneer Avenue/Main Street Intersection, Existing Configuration and Summer Conditions

Currently, the Main Street approaches operate at an acceptable LOS in both AM and PM peak conditions. The minor street approach will operate at an undesirable LOS during the 2021 summer PM peak hour.

5.3.9 Pioneer Avenue and Heath Street

Table 21 summarizes performance measures for Heath Street, for both existing and future summer and winter traffic conditions; the results are based on existing intersection configurations (TWSC on Heath Street). Results of the simulation analysis are shown to illustrate the system-wide affects of the intersection's proximity to Lake/Pioneer intersection to the east.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
Summer Conditions			
Existing AM	0.06	14.5 (13.5)	B (B)
2021 AM (southbound left) (northbound left)	0.53	32.7 (75.8)** (59.5)**	D (F)** (F)**
Existing PM (southbound)	0.17	19.6 (27.7)**	C (D)**
2021 PM (southbound) (northbound)	1.26	>150 (>800)* (>800)*	F (F)* (F)*
Winter Conditions			
Existing AM (southbound) (northbound left)	0.50	23.9 (46.3)** (30.5)**	C (E)** (D)**
2021 AM (northbound) (southbound)	1.31 1.09	>200 (170)** >100 (350)**	F (F)** F (F)**
Existing PM (northbound left) (southbound)	0.42	22.9 (39.7)** (37.6)**	C (E)** (E)**
2021 PM (northbound)	2.33	>500 (150)**	F (F)**

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
(southbound)		(400)**	(F)**
** - eastbound traffic slowing for Lake Street stop control affects reported delays. * - eastbound traffic queues through intersection from Lake Street. Values are much worse than reported. Note: Simulation results are reported in parentheses.			

Table 21- Performance Measures for Pioneer Avenue/Heath Street Intersection, Existing Configuration; Summer and Winter Conditions

The Heath Street approaches currently operate at an acceptable LOS during both morning and evening summer peak hours; however, the approaches operate at an undesirable LOS during both AM and PM winter peak hours. LOS is currently reduced in the winter partly due to the affects of high school traffic and the influence in queues and required upstream functional area for the eastbound stop control at the Pioneer/Lake Street intersection. The intersection will operate at an undesirable LOS F for both AM and PM peak hour traffic conditions during summer and winter months.

In 2021, eastbound queues will be expected to extend through Heath Street from the Lake Street/Pioneer intersection. Excessive queuing can be expected on both northbound and southbound approaches.

5.3.10 Pioneer Avenue, Lake Street, and East End Road

Table 22 summarizes performance measures for the critical minor street movement for existing and future summer and winter traffic conditions with the results are based on existing intersection configurations. Results of the simulation analysis are shown for 2 reasons. First, HCM methods cannot be used for intersections with multiple lane approaches; and second, to illustrate the system-wide affects of the intersection's proximity to adjacent intersections along Pioneer Avenue.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	Control Delay - Seconds/ Vehicle	Level of Service (LOS)
Summer Conditions			
Existing AM (northbound left)	*	(6.4)*	(A)*
2021 AM (northbound left)	*	(8.3)*	(A)*
Existing PM (northbound left)	*	(12.3)*	(B)*
2021 PM (eastbound) (eastbound left) (northbound)	 * * *	 (48.0)*, ** (40.6)*, ** (35.0)*, **	 (E)*, ** (E)*, ** (E)*, **
Winter Conditions			
Existing AM (westbound)	*	(7.5)*	(A)*
2021 AM (westbound)	*	(12.0)*	(B)*
Existing PM (westbound)	*	(9.6)*	(A)*
2021 PM (northbound) (westbound) (eastbound)	 *	 (44.8)* (31.5)* (31.3)*, **	 (E)* (D)* (D)*,**
* The HCM methodology cannot analyze for ≥ 2 lanes on an approach. ** Eastbound queues extend through Heath Street. Values may be worse than reported. Note: Simulation results are reported in parentheses.			

Table 22- Performance Measures for Pioneer Avenue/Lake Street/East End Road Intersection, Existing Configuration; Summer and Winter Conditions

With the all-way-stop control, the critical movements operate at an acceptable LOS for summer and winter AM and PM peak conditions. The critical movements will operate at an undesirable LOS for 2021 summer and winter pm peak with the all-way-stop control.

Eastbound queues can be expected to block the Heath Street/Pioneer intersection in 2021 during the PM peak hour.

5.3.11 East End Road and Fairview Avenue

Table 23 summarizes performance measures for Fairview Avenue, both existing and future winter traffic conditions with the results are based on existing intersection configurations. Results of the simulation analysis are shown to illustrate the system-wide affects of the intersection's proximity to the Lake/Pioneer intersection to the west.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	**Control Delay - Seconds/ Vehicle**	**Level of Service (LOS)**
Existing AM (southbound left)	0.15	17.1 (18.2)	C (C)
2021 AM (southbound left)	0.36	32.8 (57.2)**	D (F)**
Existing PM	0.24	19.8 (20.4)	C (C)
2021 PM (southbound left)	0.65	58.6 (75.7)**	F (F)**
** - traffic slowing for Lake Street stop control affects reported delays. Note: Simulation results are reported in parentheses.			

Table 23- Performance Measures for East End Road/Fairview Avenue Intersection, Existing Configuration; Winter Conditions

The Fairview Avenue approach currently operates at an acceptable LOS for both AM and PM, winter conditions; conversely, the approach experiences undesirable delays (LOS F) in 2021 for all of the scenarios. The differences between the HCM and simulation performance measures (in parenthesis) illustrate the affects that the Pioneer/Lake intersection required functional area has on the Fairview intersection; when compared to the HCM values, the simulation delays at Fairview for tend to be longer because simulation values take into account the interaction between the two intersections.

The westbound left turn lane can be expected to provide adequate storage for left turn queues in 2021.

5.3.12 East End Road and East Hill Road

Table 24 summarizes performance measures for East Hill Road, using summer data, for present and future conditions. The table is based on the current configuration of OWSC on East Hill Road.

Year	Results for Critical Movement(s) on Minor Street Approaches		
	Volume to Capacity Ratio (v/c)	**Control Delay - Seconds/ Vehicle**	**Level of Service (LOS)**
Existing AM	1.29	>150	F
2021 AM	2.56	>300	F
Existing PM	0.25	16.1	C
2021 PM	0.66	46.7	E

Table 24- Performance Measures for East End Road/East Hill Road Intersection, Existing Configuration and Summer Conditions

The southbound approach operates in an undesirable LOS In the current year AM peak conditions. During the weekdays, east and west directions experience high peaks for a short duration (fifteen to twenty minutes) at this intersection around 8:30 AM. Field observations show that gaps become available at East End Road when, at the intersection of Mariner/East End Road just to the east of E Hill Road, few left turning vehicles on the westbound approach impede westbound through traffic while waiting for gaps.

The table shows that the southbound approach operates at an undesirable LOS in the summer of 2021 during both AM and PM peak hours with the existing configuration.

Southbound queuing can be expected to be excessive in 2021.

5.4 Existing Conditions Intersection Capacity Summary

Table 25 summarizes existing conditions LOS analysis.

Intersection, Major Road and Minor Road (Control)	Current Controlling LOS (Time Period)	Future 2021 LOS (Time Period)	Estimated Year When LOS Is Undesirable
Sterling Highway and West Hill Road (OWSC)	C (AM and PM)	D (AM and PM)	2015 [1]
Sterling Highway and Pioneer Avenue (OWSC)	C (AM and PM)	F (PM)	2011
Sterling Highway and Main Street (TWSC)	F (PM)	F (PM)	2005
Sterling Highway and Heath Street (TWSC)	D (PM)	F (PM)	2005
Sterling Highway and Lake Street (OWSC)	F (PM)	F (PM)	2005
Sterling Highway and Kachemak Bay Drive	C (PM)	F (PM)	2011
Pioneer Avenue and Bartlett Street (OWSC current, TWSC in future)	C (PM)	E (PM)	2011
Pioneer Avenue and Main Street (TWSC)	C (AM and PM)	F (PM)	2011
Pioneer Avenue and Heath Street (TWSC)	E (AM Winter)	F (All Peaks, Winter and Summer)	2005
Pioneer Avenue, Lake Street, and East End Road (AWSC)	B (PM Summer)	E (PM Summer)	2011
East End Road and Fairview Avenue (OWSC)	C/D (AM)	F (PM Peaks, Winter and Summer)	2011
East End Road and East Hill Road (OWSC)	F (AM)	F (AM)	2005

[1] Based on strict interpretation AASHTO LOS guidelines, action will be required at the Sterling/West Hill intersection because of the LOS D. However, as Homer becomes more urbanized, the tolerance and expectations of delay will increase and LOS D may be acceptable.

Table 25- Existing Conditions and Control LOS Summary

6 EXISTING CONDITIONS PEDESTRIAN FACILITIES ANALYSIS

6.1 Existing Facilities/Pedestrian Issues

The figure on the next page presents Homer's existing pedestrian facilities.

During the summer of 2004, there was project for Sterling Highway pedestrian crossings. A second project was installed on Pioneer Avenue. These are described in more detail in subsections 6.1.2 and 6.1.3.

6.1.1 Pedestrian Crossing Performance Measures

The MUTCD has signalization warrants that serve general pedestrians and school children as pedestrians. The volume thresholds for these warrants are not satisfied in the study area. Another measure of the quality of the pedestrian crossings is the availability of adequate gaps to cross the traffic stream. When there is a demand for crossing that has inadequate gap opportunities, other solutions are available besides traffic signals.

HCM2000 has a methodology for assigning a level of service to uncontrolled pedestrian crossings. Chapter 18 presents a calculation for determining average pedestrian delay using vehicle flow rate and critical gap time as inputs. The level of service depends upon the average pedestrian delay. These calculations and levels of service are described in more detail in Appendix E. It should be noted that the HCM2000 equation applies to a random gap state, typically with average gaps that exceed 6 seconds. The HCM2000 equation underestimates delay when an intermediate or congested state exists.

The primary performance measure should be the number of crossing opportunities per minute, with a minimum crossing opportunities of 1 per minute as indication of satisfactory performance. This is a straight-forward computation as part of a gap study. For future estimation of gaps, the pedestrian delay computed by the HCM2000 equation may be used to estimate future crossing opportunities per minute.

MAP DOES NOT INCLUDE WIDE SHOULDERS AVAILABLE FOR BICYCLE USE

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES

HOMER INTERSECTIONS
PLANNING STUDY

PEDESTRIAN FACILITIES

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	NTS	FIGURE	15

6.1.2 Sterling Highway (Homer Bypass) Pedestrian Crossings

ADOT&PF designed and installed crossings at the following four locations in response to Homer's request to improve pedestrian safety and mobility. The painting of the crosswalks was not completed in the 2004 season because of the weather, but will be completed in 2005.

- Pioneer Avenue: This is a 3-leg intersection. The crosswalk will be 10-foot wide, and have 24-inch wide white longitudinal markings that are spaced 2-foot apart. The crossing is installed on the east leg of the intersection and has a raised doweled curb refuge island. The crossing has pedestrian crossing signs. This site is a major intersection in Homer, with nearby schools, museum, and other facilities that generate pedestrians on both sides of the By-Pass. The 10-foot wide refuge island was installed because the existing gaps in peak hour traffic (discussed in 6.2.1 below) are better negotiated as 2-stage crossings. However, off-peak crossings at lower volumes would be less difficult. By providing the island, the pedestrian can assess crossing one traffic stream at a time, each with a much shorter crossing length and gap requirement.

- Main Street: The crosswalk is across the east leg of this 4-leg intersection. The crosswalk is 10-foot wide, and has 24-inch wide white longitudinal markings that are spaced 2-foot apart; and is further marked by pedestrian crossing signs. Main Street extends into the old Homer town site area. The four-leg intersection precludes refuge islands because left-turn lanes are needed on both Homer By-Pass approaches for the 4-leg intersection.

- Poopdeck Street: This is a 3-leg intersection. The crosswalk will be 10-foot wide, and have 24-inch wide white longitudinal markings that are spaced 2-feet apart. The crossing is installed on the east leg of the intersection and has a raised doweled curb refuge island. The crossing has pedestrian crossing signs. The Poopdeck crossing connects the Poopdeck trail and mall parking areas to the Oceans and Islands Visitor's Center and other facilities on the south side of the By-Pass, serving both visitors and residents. The 10-foot wide refuge island was installed because the existing gaps in peak hour traffic are better negotiated as 2-stage crossings. However, off-peak crossings at lower volumes would be less difficult.

- Lake Street: The 3-leg intersection has marked a crosswalk consisting of transverse 24-inch wide white markings that are spaced 10-foot apart on the north and east legs. The east leg has a refuge island and pedestrian crossing signs. The north leg is under stop sign control. These crossing provide access for Lake Street pedestrians to cross and use the trail to Beluga Slough and out to the Spit. This is a major trail route across the busiest traffic flow in the Homer area. The 10-foot wide refuge island was installed because the existing gaps in peak hour traffic are better negotiated as 2-stage crossings. However, off-peak crossings at lower volumes would be less difficult.

These dowelled refuge islands were determined to be needed by ADOT&PF after engineering studies determine that gaps in the peak hour traffic stream were suitable for two-stage crossings. The crossings with refuge islands were controversial and prompted an initial negative reaction from some of the public and from some area truckers and tour companies. These were designed by DOT&PF using semi-truck turning templates. The City of Homer M&O tested the impact of the islands on large vehicle maneuverability using their fleet, and found them to work well.

The Sterling Highway By-Pass pedestrian crossing spacing ranged from about 1,300 feet to about 2,300 feet. Generally, for fully developed urban areas having high pedestrian volumes, Lalani and AASHTO 2004 recommend mid-block crossings whenever the distance between controlled crossings exceeds 660 feet. This is because pedestrians should not be expected to make excessive or inconvenient diversions in their travel path to cross at a controlled intersection. Because motorists do not generally expect mid-block crossings, they should only be used where truly needed and should be well signed and marked. For less developed urban areas such as Homer, mid-block crossings should only be used where a large number of pedestrians are expected to cross the roadway, such as at a major pedestrian traffic generator or where a multi-use trail crosses the roadway. Thusly, the Sterling Highway By-Pass pedestrian crossings have been located on current or logical pedestrian routes.

6.1.3 Pioneer Avenue Pedestrian Crossings

Pioneer Avenue was reconstructed to its present street section in 1985. Following that project, Homer Public Works painted crosswalk markings across Pioneer Avenue.

The ADOT&PF provided the design of Pioneer Avenue crosswalks and signs that were installed by Homer Public Works forces during the summer of 2005. The crosswalks were the longitudinal type (10-foot width, 24-inch wide longitudinal white stripes that are spaced 2-feet apart).

Refuge islands were not installed with the crossings, primarily because there is a CTWLTL for left turning traffic, which also serves as temporary snow storage. In addition, the design was not preceded by gap studies in which the need for refuge islands would be established. However, Pioneer Avenue has similar traffic volumes to the Sterling Highway By-Pass, except vehicle speeds are lower. As such, we expect gap problems on Pioneer Avenue to be about the same as on the Sterling Highway By-Pass. In all cases, pedestrian crosswalks will be established in accordance with the ATM. This study includes gap studies and forecasts for the following locations.

The following Pioneer Avenue intersections had crosswalks and signs installed in 2005.

- Bartlett Street, east leg,
- Main Street, east leg,
- Svedlund Street, east leg,
- Kachemak Way, east leg, and
- Heath Street, west leg.

The spacings of these crosswalks are as follows:

- Bartlett Street to Main Street: 980 feet
- Main Street to Svedlund Street: 1,385 feet
- Svedlund Street to Kachemak Way: 795 feet
- Kachemak Way to Heath Street: 660 feet

With the exception of the Kachemak Way to Heath Street crossing, the spacing exceeds 660 feet between crossing points. For reasons discussed in Section 6.1.2, as the CBD area gets more densely developed, the use of marked and signed mid-block crossings will need to be evaluated on a case-by-case basis for potential installation in areas where there are major pedestrian traffic generators or where multi-use trails crosses the roadway.

6.2 Crossing Gap Analysis

6.2.1 Sterling Highway Existing Conditions, Current and Future

Gap studies were performed by ADOT&PF near Main Street and Poopdeck Street in August 2003 during noon, and late afternoon hours. It should be noted that the permanent traffic recorder information on Sterling Highway between Main Street and Lake Street show little variation in traffic between noon and the evening commute peak hour. The 2003 16-hour turning movement counts indicate little variation in Sterling Highway traffic over the afternoon as well, but do indicate noon and the evening peak hours as having about the same volumes.

One-half crossings and full crossing studies were considered. Neither location had adequate gaps for full crossing in the peak hour, and which resulted in refuge islands at the Pioneer, Poopdeck, and Lake crossings. Single-stage gap data was collected, in which overall crossing performance can be assessed. This is summarized in the table below. The minimum gap time for a single pedestrian crossing is 7 seconds.

Time	Average Percent Delay One-half crossing, Single Traffic Stream	Estimated ½ Crossings Opportunities Per Minute (rounded)	Average Delay Time before Crossing Gaps are Available (seconds)
Main Street			
Noon	26%	6	3
Late Afternoon	44%	4	6
Poopdeck Street			
Noon	47%	4	7
Late Afternoon	40%	5	5

Table 26- Current Pedestrian Crossing Performance for Sterling Highway, One-Half Crossing

The crossings with refuge islands have very good crossing opportunities (much greater than the minimum of 1 per minute). Future performance for 2024 summer conditions is estimated with the HCM equations and summarized in the following table below. The 2024 one-way traffic stream is estimated from the forecasted turning movements at the nearby study intersections.

	Sterling Highway, One Way Volume, Vehicles per hour	Computed Average Delay (seconds)	Percent Pedestrian Delay	½ Crossing Opportunities Per Minute (rounded)
Main Street	800	10	41%	2
Poopdeck Street	700	8	36%	2

Table 27- 2021 Pedestrian Crossing Performance (Forecasted) for Sterling Highway, One-Half Crossing

As Table 27 shows, pedestrian crossings with refuges on Sterling Highway will continue to operate satisfactorily for the project study duration (≥1 per minute). Those crossings without refuges (Main Street and other unmarked crossings) will not have adequate gaps. Additional treatment would be required to improve peak hour gaps.

6.2.2 Pioneer Avenue Existing Conditions, Current and Future

Table 28 summarizes November 2004 pedestrian gap studies at the Pioneer Avenue locations. The street width is 40 feet, and critical gap for a full crossing is 14 seconds (rounded).

Time	Pioneer Avenue Volume Vehicles per Hour	Percent Pedestrian Delay	Crossing Opportunities per Minute	Observed Average Delay per Pedestrian (seconds)
Bartlett Street				
Noon	221	25%	3.2	4.6
Early Afternoon	266	28%	3.1	5.4
Main Street				
Mid-Morning	270	34%	2.8	7.2
Noon	395	56%	1.9	17.9
Svedlund Street				
Noon	576	73%	1.2	37.5
Kachemak Way				
Noon	527	68%	1.4	29.4
Heath Street				
Mid-Morning	391	44%	2.40	11.0
Noon	591	75%	1.06	42.7
School Dismissal	792	93%	0.30	184.5

Table 28- Current Pedestrian Crossing Performance for Pioneer Avenue, Winter Conditions, Full Crossing

The following tables summarize the current summer crossing performance, and 2021 summer performances for these crossings. Both of these tables were computed with the HCM2000 pedestrian delay equation using 2004 peak hour counts or 2021 peak hour forecast volumes as inputs. As with Sterling Highway, the counts on Pioneer Avenue traffic are at consistent levels throughout the afternoon, so that peak hour estimates would also represent conditions during most of the afternoon.

	Pioneer Avenue Volume Vehicles per Hour	Computed Delay (seconds)	Percent Pedestrian Delay	Crossing Opportunities per Minute
Bartlett Street	507	30	68%	1.4
Main Street	627	46	77%	1.0
Svedlund Street	799	82	85%	0.6
Kachemak Way	799	82	85%	0.6
Heath Street	862	101	88%	0.5

Table 29- Current Pedestrian Crossing Performance for Pioneer Avenue, Summer Conditions, Full Crossing

	Pioneer Avenue Volume Vehicles per Hour	Computed Delay (seconds)	Percent Pedestrian Delay	Crossing Opportunities per Minute
Bartlett Street	735	66	83%	0.7
Main Street	882	108	89%	0.5
Svedlund Street	1140	249	95%	0.2
Kachemak Way	1140	249	95%	0.2
Heath Street	1222	324	96%	0.2

Table 30- 2021 Pedestrian Crossing Performance for Pioneer Avenue, Summer Conditions, Full Crossing

As indicated in Tables 29, the intersections along the eastern part of the Pioneer Avenue CBD in summer do not have sufficient number of gaps to attain at least one crossing per minute. In 2021, shown in Table 30, none of the intersections during summer would meet this objective.

6.3 Summary of Existing Conditions Pedestrian Performance Measures

The pedestrian crossings with refuges on Sterling Highway will operate satisfactorily for the project study duration by providing 1 crossing gap per minute through 2021. Those crossings without refuges (Main Street and other unmarked crossings) will not have adequate gaps in the peak hour. Pioneer Avenue pedestrian crossings do not meet crossing gap objectives. Section 8.4 discusses pedestrian crossing alternatives.

7 INTERSECTION CONTROL WARRANTS

This discussion develops intersection control options to address the current or future capacity deficiencies listed in Section 5. Proposed intersection controls evaluated in this study include signalization, all-way stops, and modern roundabouts.

7.1 Intersection Control Warrants

In addition to be being recognized as crash reduction or capacity improvements; signalization, all-way stops, and modern roundabouts also have operational, safety, and cost issues, in which may make these controls undesirable in some cases. As such, warrants or guidelines have been developed that should be satisfied prior to installation of these systems.

7.1.1 Existing Conditions Signalization Warrants

Signals should only be considered for intersections if one or more warrants established by the Manual of Uniform Traffic Control Devices (MUTCD) are satisfied. The warrants include:

- Warrant 1- Eight-Hour Volume (Conditions A, B, and 80% of A and B Combined)
- Warrant 2- Four-Hour Volume
- Warrant 3- Peak Hour Volume
- Warrant 4- Minimum Pedestrian Volumes
- Warrant 5- School Crossings
- Warrant 6- Coordinated Signal System
- Warrant 7- Crash Experience (5 or more correctable crashes in a 12-month period, and volume criteria)
- Warrant 8- Roadway Network

These warrants require current vehicle and pedestrian volumes, speeds, and crash history. The warrants are evaluated in accordance with MUTCD procedures for these inputs. Seventy percent of volume warrant values from the MUTCD were used because of the rural area. The Kenai Peninsula School District have stated that all Homer area elementary school students, grades K-6 are bussed to school and that there are no designated hazardous walking routes for Homer middle and high school students, grades 7-12. Warrants 4, 5 and 6 do not apply to the intersections of this project and were not evaluated.

There are several disadvantages to signalization that should be considered. Cross-street delay is reduced, but the mainline traffic is penalized. As such, signals may increase overall system delay. While right angle and left turn collisions are reduced by signalization, rear end collisions may increase, especially on high-speed approaches that were formally free-flow conditions. Lastly, signals have an ongoing maintenance and operations burden. The MUTCD encourages engineers to seek less restrictive alternatives to signals, such as roundabouts or 4-way stop sign control, even in locations where one or more warrants are satisfied.

The MUTCD's warrant discussion encourages the engineer to exercise judgment on the amount of right-turn traffic that should be subtracted from the minor street traffic volume. NCHRP 457 provides a methodology to determine right turn volume adjustments for the warrant analysis. This methodology was used for this analysis.

7.1.2 All-Way Stop Sign Control

The MUTCD and NCHRP 457 provide guidelines for determining where all-way stop signs should be applied to an intersection. There are four conditions for an all-way stop control in which satisfying any one of the conditions may justify this type of control.

- Condition A- All-way stop sign con may be used as an interim control measure if a signal is warranted.
- Condition B- All-way stop sign control may be used to correct a crash history of 5 or more crashes during a 12-month period that would have been correctable with this control in place.
- Condition C- Minimum Volumes:
    - C.1: Major street volumes (both approaches) or 300 vph for any 8 hours of an average day.
    - C.2: Combined vehicular, bicycle, and pedestrian volume (both approaches) of 200 units per hour for the same 8 hours stated above.
    - C.3: Where 85th percentile speeds exceed 40 mph, use 70% of the major street volumes and minor street units.
- Condition D- Where no single criterion is satisfied, but B, C.1, and C.2 are all satisfied to 80% of the stated minimum values.

7.1.3 Future Signal Warrants

The MUTCD warrant system described above only evaluates recent or current conditions. Cal-Trans has a methodology for future signal warrants based that is presented in the Institute of Transportation Engineers (ITE) *Manual of Traffic Signal Design*, Second Edition, by James H. Kell and Iris J. Fullerton. The method uses future estimated average daily traffic as the input variables and estimates whether the intersection with future estimated average daily traffic would meet the Manual of Uniform Traffic Control Devices signal Warrant 1, Condition A-Minimum Vehicular Volume; Condition B- Interruption of Continuous Traffic; and the combination of warrants allowed in MUTCD procedure.

7.1.4 Modern Roundabout Screening Guidelines

The MUTCD describes roundabouts as good alternatives to signals, offering good operational performances, as well as crash reduction. NCHRP 457 Table 2-12, provides a framework to determine if a roundabout would be suitable for a location.

Question
1) Will operation as an uncontrolled or two-way-stop-controlled intersection yield unacceptable delay?
2) Is the daily entering volume less than the maximum service volume for a roundabout? (Use Figure 2-3 of NCHRP 457)
3) Is the subject junction located outside of the coordinated signal network?
4) Is the ratio of major-road to minor-road volume less than 5?
5) Is the entering drivers view free of sight obstructions?
6) Will the subject junction infrequently be used by large or oversized trucks?
7) Will the subject junction infrequently be used by pedestrians and bicyclists?

Table 31- Roundabout Suitability Questions

As NCHRP 457 points out, the more frequently that these questions are answered with “Yes”, then the more likely that this intersection would work well as a roundabout.

7.2 Intersection Control Analysis

7.2.1 Signalization Warrant Analysis

Table 27 summarizes the current warrants for the project intersections. The volumes for this warrant evaluation are based on 2003 to 2005 turning movement counts. Where only peak hours were performed, the intermediate hours were estimated from the Sterling Highway permanent traffic recording station located between Lake Street and Main Street.

Intersection	Warrant 1- 8-Hour Vehicular Volume, Condition A- Minimum Vehicular Volume	Warrant 1- 8-Hour Vehicular Volume, Condition B- Interruption of Continuous Traffic	Warrant 1- 8-Hour Vehicular Volume, Condition C- Combination of A&B	Warrant 2- 4-Hour Vehicular Volume	Warrant 3- Peak Hour Volume	Warrant 7- Crash Experience	Warrant 8- Roadway Network
Summer Conditions							
Sterling Hwy and West Hill Rd	No	No	No	No	No	No	No
Sterling Hwy and Pioneer Ave	No	Yes	No	Yes	No	No	Yes
Main St and Sterling Hwy	No	Yes	No	Yes	Yes	No	Yes
Sterling Hwy and Heath St	No	Yes	Yes	Yes	Yes	No	Yes
Sterling Hwy and Lake St	Yes	Yes	Yes	Yes	Yes	No	Yes
Sterling Hwy (Homer Spit Rd) and Kachemak Bay Dr	No	No	No	No	No	No	No
Pioneer Ave and Bartlett St	No	No	No	No	No	No	No
Pioneer Ave and Main St	No	No	No	No	No	No	No
Pioneer Ave and Heath St	No	No	No	No	No	No	No
Pioneer Ave, Lake St, East End Rd	No	Yes	Yes	Yes	Yes	No	Yes
East End Rd and Fairview Ave	No	No	No	No	No	No	No
East End Rd and East Hill Rd	No	No	No	No	No	No	No
Winter Conditions (School Intersection Only)							
Pioneer Ave and Heath St	No	No	No	No	No	No	No
Pioneer Ave, Lake St, East End Rd	No	Yes	Yes	Yes	Yes	No	Yes
East End Rd and Fairview Ave	No	No	No	No	No	No	No

Table 32- Signalization Warrants, Current Conditions

This table reveals that the following intersections currently satisfy no warrants.

- East End Rd and Fairview Ave
- East End Rd and East Hill Rd
- Pioneer Ave and Main St
- Pioneer Ave and Heath St
- Sterling Hwy (Homer Spit Rd) and Kachemak Bay Dr
- Sterling Highway and West Hill Road

Sterling Highway and Pioneer Avenue satisfy two volume warrants (Warrant 1 Condition B and Warrant 2 4-hour). As such this location may be considered as marginal, and alternatives to signals should be evaluated. Moreover, both of these locations have acceptable levels of service.

The following intersections are strong candidates for signalization because they meet several of the warrants. However, these should also be evaluated for alternative treatments.

- Main Street and Sterling Highway
- Sterling Highway and Heath Street
- Sterling Highway and Lake Street
- Pioneer Avenue, Lake Street, and East End Road

The Cal-Trans warrant was used to determine if intersections would satisfy signal warrants in the future. This analysis requires future estimated ADT inputs, found in Appendix B. Table 33 summarizes the results of this analysis.

Intersection	Analysis Year	Warrant 1- 8-Hour Vehicular Volume, Condition A- Minimum Vehicular Volume	Warrant 1- 8-Hour Vehicular Volume, Condition B- Interruption of Continuous Traffic	Warrant 1- 8-Hour Vehicular Volume, Condition C- Combination of A&B
Summer Conditions				
Sterling Hwy and West Hill Rd	2011	No	Yes	Yes
	2021	Yes	Yes	Yes
Sterling Hwy and Pioneer Ave	2011	No	Yes	No
	2021	No	Yes	No
Main St and Sterling Hwy	2011	Yes	Yes	Yes
	2021	Yes	Yes	Yes
Sterling Hwy and Heath St	2011	Yes	Yes	Yes
	2021	Yes	Yes	Yes
Sterling Hwy and Lake St	2011	Yes	Yes	Yes
	2021	Yes	Yes	Yes
Sterling Hwy (Homer Spit Rd) & Kachemak Bay Dr	2011	No	Yes	No
	2021	No	Yes	No
Pioneer Ave and Bartlett St	2011	No	No	No
	2021	No	No	No
Pioneer Ave and Main St	2011	No	No	No
	2021	No	Yes	Yes
Pioneer Ave and Heath St	2011	Yes	Yes	Yes
	2021	Yes	Yes	Yes
Pioneer Ave and Lake St	2011	Yes	Yes	Yes
	2021	Yes	Yes	Yes
East End Rd & Fairview Ave	2011	No	Yes	No
	2021	No	Yes	Yes
East End Rd and East Hill Rd	2011	No	Yes	No
	2021	No	Yes	No
Winter Conditions (School Intersection Only)				
Pioneer Ave and Heath St	2011	No	No	No
	2021	No	No	No
Pioneer Ave and Lake St	2011	Yes	Yes	Yes
	2021	Yes	Yes	Yes
East End Rd and Fairview Ave	2011	No	No	No
	2021	No	No	No

Table 33- Cal Trans Future Signal Warrants

All intersections will meet Cal Trans signal warrants by 2011 except Pioneer Avenue and Main Street, which satisfies warrants by 2021; and Pioneer Avenue and Bartlett Street which never satisfies the warrants.

7.2.2 All-Way Stop Sign Control Warrants Analysis

The intersections were evaluated with all way stop sign control warrants. Future hourly volumes were estimated by applying computed growth factors to the base year. Intersections meeting AWSC warrants require further capacity evaluation as supplied later in this report.

This analysis finds that the Sterling Highway intersections with West Hill Road, Main Street, Heath Street, and Kachemak Bay Road; and the East End Road intersections with Fairview Drive and East Hill Road should not use AWSC intersection as a permanent measure. These locations do not satisfy, or only satisfy one of the condition warrants B, C or D. Table 34 summarizes AWSC warrants.

Intersection	Year	Condition A. Traffic Signal Warrants Met?	Condition B. Crash History (> 5 in 12 months)?	Condition C.1 & C.2 Minimum Volumes?	Condition C.3 70% of Minimum Volumes (Speed > 40mph)?	Condition D 80% of Minimum Volumes (Crashes > 4 in 12 months)?	Is AWSC Recommended for Further Evaluation?
Sterling Hwy and W Hill Rd	Existing	No	No	No	No	No	No
	2011	Yes	No	No	No	No	
	2021	Yes	No	No	No	No	
Sterling Hwy and Pioneer Avenue	Existing	Yes	No	No	No	No	Yes
	2011	Yes	No	Yes	No	No	
	2021	Yes	No	Yes	No	No	
Sterling Hwy and Main Street	Existing	Yes	No	No	No	No	No
	2011	Yes	No	No	No	No	
	2021	Yes	No	No	No	No	
Sterling Hwy and Heath Street	Existing	Yes	No	No	No	No	No
	2011	Yes	No	No	No	No	
	2021	Yes	No	Yes	No	No	
Sterling Hwy and Lake Street	Existing	Yes	No	Yes	No	Yes	Yes
	2011	Yes	No	Yes	No	Yes	

Intersection	Year	Condition A. Traffic Signal Warrants Met?	Condition B. Crash History (> 5 in 12 months)?	Condition C.1 & C.2 Minimum Volumes?	Condition C.3 70% of Minimum Volumes (Speed > 40mph)?	Condition D 80% of Minimum Volumes (Crashes > 4 in 12 months)?	Is AWSC Recommended for Further Evaluation?
	2021	Yes	No	Yes	No	Yes	
Sterling Hwy and Kachemak Bay Road	Existing	Yes	No	No	No	No	No
	2011	Yes	No	No	No	No	
	2021	Yes	No	Yes	No	No	
Pioneer Avenue and Bartlett Street	Existing	No	No	No	No	No	No
	2011	No	No	No	No	No	
	2021	No	No	No	No	No	
Pioneer Avenue and Main Street	Existing	No	No	No	No	No	Yes
	2011	No	No	Yes	No	No	
	2021	Yes	No	Yes	No	No	
Pioneer Avenue and Heath Street	Existing	No	No	No	No	No	Yes
	2011	Yes	No	No	No	Yes	
	2021	Yes	No	Yes	No	Yes	
Pioneer Avenue and Lake Street	Existing	No	No	Yes	No	No	Yes-Existing AWSC
	2011	Yes	No	Yes	No	No	
	2021	Yes	No	Yes	No	No	
East End Road and Fairview	Existing	No	No	No	No	No	No
	2011	Yes	No	No	No	No	
	2021	Yes	No	No	No	No	
East End Road and East Hill Rd	Existing	No	No	No	No	No	No
	2011	Yes	No	No	No	No	
	2021	Yes	No	No	No	No	

Table 34- All Way Stop Sign Control Warrants

7.2.3 Modern Roundabout Screening Analysis

Modern roundabout guidelines from NCHRP 457 were applied to the project intersections. Tables 35 and 36 summarize the results.

Guideline Questions	Sterling Highway Intersections					
	West Hill Rd	Pioneer Ave	Main Street	Heath Street	Lake Street	Kachemak Bay Dr
1. Will operation as an uncontrolled or 2-way stop controlled intersection yield unacceptable delay?	No - LOS D	Yes	Yes	Yes	Yes	Yes
2a. Is the daily entering volume less than the maximum daily service volume for a ***1-lane*** approach roundabout? If not see next row.	Yes	No	No	No	No	No
2b. Is the daily entering volume less than the maximum daily service volume for a ***2-lane*** approach roundabout?	N/A	Yes	Yes	Yes	Yes	Yes
3. Is the subject junction located outside of a coordinated signal network?	Yes	Yes	Yes	Yes	Yes	Yes
4. Is the ratio of major-road-to-minor-road volume less than 5.0?	No	Yes	Yes	No	Yes	No
Ratio➔	5.7 : 1	4.7 : 1	4.8 : 1	6.3 : 1	4.2 : 1	5.9 : 1
5. Is the entering driver's view free of sight obstructions (i.e. due to grade, curvature, or vegetation)?	Yes	Yes	Yes	Yes	Yes	Yes
6. Will the subject junction be infrequently used by large or over-sized trucks?	Yes	Yes	Yes	Yes	Yes	Yes
7. Will the subject junction be infrequently used by pedestrians and bicyclists?	Yes	No-Moderate to High Use	No-Moderate Use	No-Moderate Use	No-Moderate to High Use	No - Bike Path Leads to the intersection

Table 35- Sterling Highway Intersections, Roundabout Suitability

Guideline Questions	Pioneer Avenue Intersections				East End Road Intersections	
	Bartlett St	Main St	Heath St	Lake St	Fairview Ave	East Hill Rd
1. Will operation as an uncontrolled or 2-way stop controlled intersection yield unacceptable delay?	Yes	Yes	Yes	Yes	Yes	Yes
2. Is the daily entering volume less than the maximum daily service volume for a 1-lane roundabout?	Yes	Yes	Yes	No	Yes	Yes
3. Is the subject junction located outside of a coordinated signal network?	Yes	Yes	Yes	Yes	Yes	Yes
4. Is the ratio of major-road-to-minor-road volume less than 5.0?	Yes	Yes	Yes	Yes	No	No
Ratio➔	2.1 :1	2.2 : 1	2.8 : 1	2.8 : 1	9.2 : 1	7.8 : 1
5. Is the entering driver's view free of sight obstructions (i.e. due to grade, curvature, or vegetation)?	Yes	Yes	Yes	Yes	Yes	Yes
6. Will the subject junction be infrequently used by large or over-sized trucks?	Yes	Yes	Yes	Yes	Yes	Yes
7. Will the subject junction be infrequently used by pedestrians and bicyclists?	No - Expect Moderate (Winter) to Heavy (Summer) Ped Usage	No - Expect Moderate (Winter) to Heavy (Summer) Pedestrian Usage	No - Expect Moderate (Winter) to Heavy (Summer) Pedestrian Usage	No - Expect Moderate (Winter) to Heavy (Summer) Pedestrian Usage	No - Expect Moderate (Winter) to Heavy (Summer) Ped Usage	Yes

Table 36- Pioneer Avenue and East End Road Intersections, Roundabout Suitability

NCHRP 457 provides the guidance that the more “Yes” answers for an intersection, then the more likely that a modern roundabout would work well at that location.

All Sterling Highway intersections are good candidates for modern roundabouts, in that they have “Yes” answers to most of the screening questions. The service volume guideline indicates that all should have 2-lane approaches except for the West Hill Road intersection. However, levels of service analyses using capacity analysis methods indicate that 1-lane approaches would be adequate for all roundabouts.

Although the Pioneer intersections also have a majority of “Yes” answers, the built-up urbanized setting of Pioneer Avenue would require extensive right-of-way purchase and business relocation.

8 ALTERNATIVES

This section evaluates control alternatives for the project intersections under future traffic. Following the discussion on methodology in subsection 8.1, the intersections are evaluated individually under different control alternatives in subsection 8.2. However, it is important to recognize that some of these intersections will influence each other, especially those within close proximity of one another. Because of the overlap of functional areas and interaction, subsection 8.3 proposes and evaluates two system-level alternatives for the CBD triangle and peripheral intersections

8.1 Methodology

8.1.1 Evaluation Tools

All-way-stop control and signalized Intersection capacity analyses were performed in accordance with the procedures outlined in the Transportation Research Board Highway Capacity Manual 2000 (HCM) using Synchro/SimTraffic, Version 6, distributed by Trafficware. Because the US roundabout capacity method is still under development, the project roundabout intersections were evaluated with both empirical (Rodel) and analytical (aaSidra) software tools.

Aty and Hosni provides a summary of the Rodel and aaSidra programs. Rodel is based upon the empirical British method. Rodel's capacity formula is based on the relationship between entry capacity and various geometric parameters including entry angle, entry width, approach width, entry radius, and inscribed circle diameter. The aaSidra program is based upon the analytical Australian method. The capacity of a roundabout is calculated using a gap acceptance approach similar to the process described in the HCM for analyzing two-way stop-controlled intersections. The capacity formula calculates the capacity of each approach as a function of the circulating flow, the critical gap, and the follow-up time.

Microsimulation using Simtraffic was used as well. The simulation results are included to better illustrate performance relate to:

- Interaction of queues
- Overlapping of functional areas of closely spaced intersections
- Approaches with high v/c ratios

Note that the HCM AWSC method cannot be used to analyze an intersection with more than 2 lanes on a single approach; therefore, simulation is another means to measure performance for this condition.

Where microsimulation performance measures are reported for comparison to HCM measure, an average of at least 5 simulations is used to determine performance measures. Additional simulations were conducted and results averaged where more precise results were needed.

8.1.2 Intersection Performance Measures

The performance measures for all-way-stop control includes control delay, level of service (LOS) and volume to capacity ratio (v/c) for the movements of the intersection, which include the street approaches under sign control, or major movements that must yield to oncoming traffic, such as left-turning traffic.

The operational performance measures used for roundabout and signalized intersection analysis are levels of service, control delay (seconds delay per vehicle), and volume to capacity ratio (v/c), all values which are reported for the entire intersection. A common limit for v/c values is 0.85, or 85% of capacity. This upper value represents good design practice, in that there is some reserve capacity to absorb surges in volumes or flow turbulence. Caution should be taken for roundabout approach designs from typical values if an approach to a roundabout approaches a v/c of 0.85; capacity at a roundabout decreases with an increase in traffic demand. Where approaches were close to a v/c of 0.85, approach geometry was adjusted to provide for higher confidence levels so to avoid excessive delays.

See Appendix E for detailed description of level of service definitions.

8.1.3 Queues and Available Storage

Reported queues are based on the maximum 95th percentile queuing requirements for all seasonal and time of day scenarios. Available storage is also reported for turn lanes as well as available storage to the adjacent upstream intersection for any through vehicles before intersection blockages can occur.

Table 1150-1 of *the Alaska Preconstruction Manual* offers guidance for auxiliary lane lengths. Since most of the project is within a 35 mph posted zone, lanes need only to provide storage for the design queues. The one area that is the exception is the west leg of the West Hill Road intersection with the Sterling Highway. An auxiliary lane in this area should be designed for deceleration and storage.

8.1.4 Design and Analysis Parameters for Modern Roundabouts

Figure 16shows the design elements of a modern roundabout.

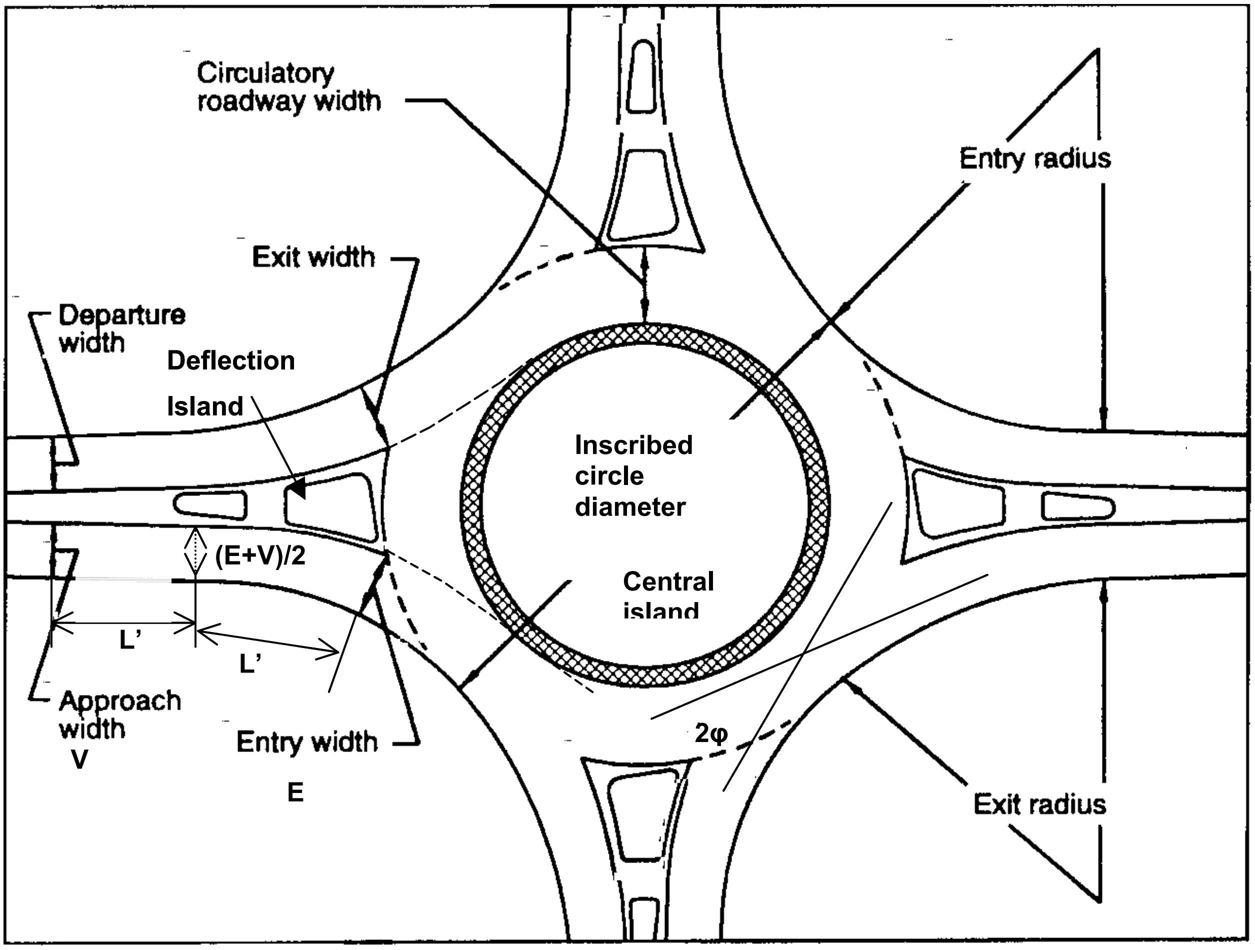


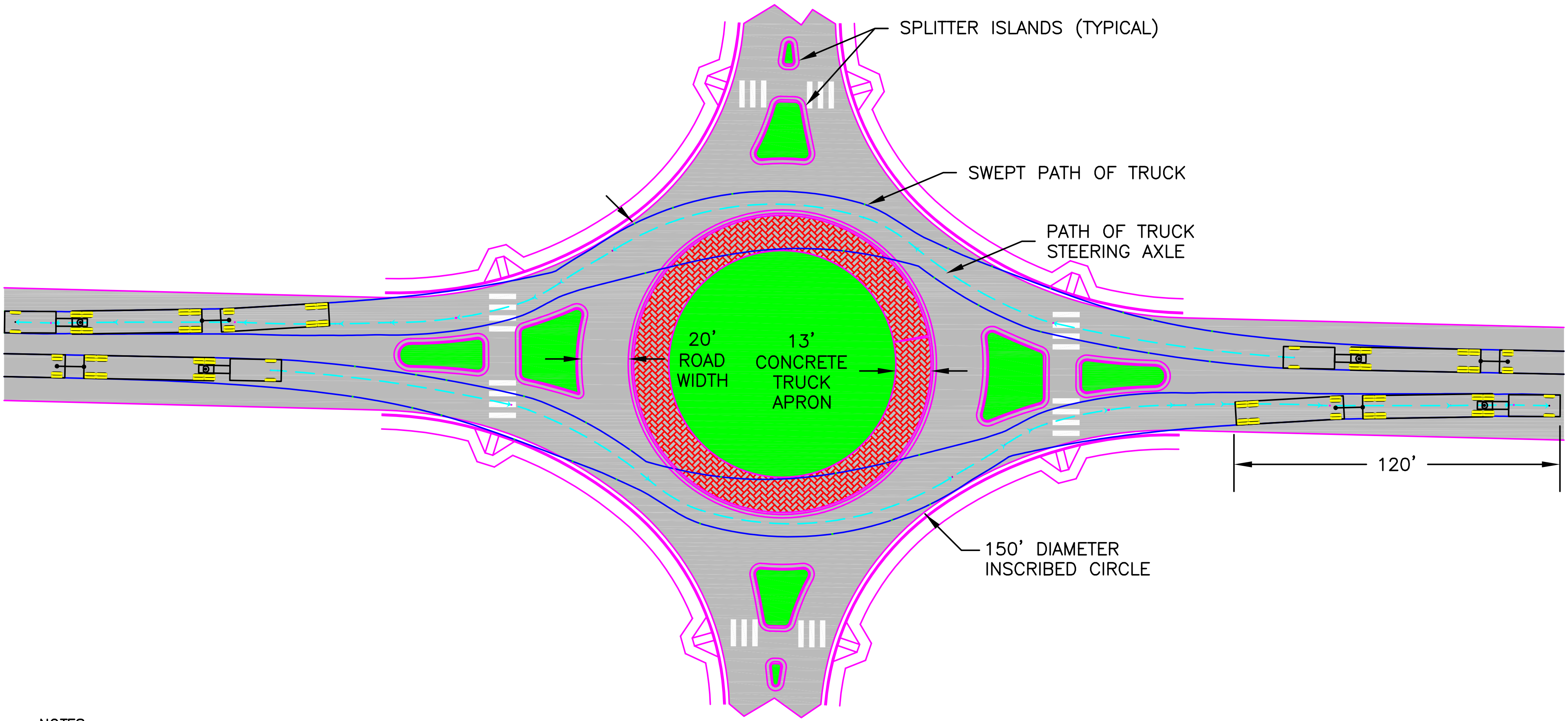
Figure 16-Roundabout Geometric Elements

Table 37 lists values for these parameters for 1-lane approach roundabouts. Sources include FHWA RD-00-067 *Roundabouts: An Informational Guide* and *Interactive Roundabout Design Software and Manual*, Rodel Software Ltd and Staffordshire County Council.

Single Lane Approach Roundabout		
Element	**Value**	**Source, Comments**
Inscribed Circle Diameter	100-foot to140-foot single lane	FHWA with local experience. Will be adequate for WB-50 design vehicles.
Central Island Diameter	Approximately 100 feet (for 140-foot diameter, single circulation lane), with an outer mountable apron that accommodates occasional truck-trailer combinations larger than WB-50.	Inscribed Circle Diameter- 2 x Circulatory Road Width.
Approach Width, V	Lane Width (assumed 12 feet)	FHWA, Rodel
Entry Width, E	14 to 16 feet for single lane (14' assumed for most cases)	FHWA
L′	Minimum 16 feet (Rodel), 40 feet recommended minimum (FHWA) assumed for most cases	Use 40 feet. (derived from FHWA's recommendation of an 80-foot flare taper in urban areas.)
Φ	25 to 35 degrees	Rodel
Entry Radius, Single Lane	>30 feet, <100 feet	Rodel, FHWA
Exit Radius, Single Lane	>50 feet (FHWA)	Rodel recommend that the exit radius be determined as transition from circulatory road width, through the deflection island, and to the departure width. Radius should be selected so that the taper is 15 or 20 to 1.
Circulatory Road Width	1 to 1.2 x E, use 20 feet minimum for single lane	Rodel, FHWA
Deflection Island (splitter island), Exit Width	Defined by tangential extensions to the Central Island	FHWA and Rodel. FWHA recommends a minimum of 5-foot pedestrian refuge be located at about 20 feet from the yield line.

Table 37- Typical Design Values for Single-Lane Approach Roundabout Geometric Elements

It is important to acknowledge that the Sterling Highway through Homer serves a large number of trucks hauling gravel from the Nikiski area and trucks hauling freight from the Port of Homer with double trailer combinations. The Alaska Administrative Code 17AAC25.014 (a) allows for a total combination length of 120 linear feet, with the two trailers accounting for a total of 95 feet of the 120-foot total length. As such, roundabouts to accommodate double combinations must have a larger diameter than the typical design values listed in Table 37. However, Figure 17 illustrates that a roundabout can still be designed to accommodate these trucks.



NOTES:

1. DESIGN VEHICLE IS A LONG-HAUL CONVENTIONAL TRACTOR WITH A SLEEPER CAB, PULLING DOUBLE TRAILERS FOR AN OVERALL TOTAL LENGTH OF 120 FEET.

2. INSCRIBED CIRCLE DIAMETER IS 150' TO ACCOMMODATE THROUGH MOVEMENT OF 95' DOUBLE TRAILER CONFIGURATION. CENTER ISLAND DIAMETER IS 110' AND TRUCK APRON WIDTH IS 13'. THESE DIMENSIONS MAY BE MODIFIED DURING DESIGN TO ACCOMMODATE ACTUAL FIELD CONDITIONS.

3. THE OFFSET DISTANCE FOR PLACEMENT OF CURB AND GUTTER (SHY DISTANCE) WILL BE 2 FEET FROM THE FACE OF CURB TO THE EDGE OF TRAVELED WAY.

4. THE LAKE STREET/STERLING HIGHWAY ROUNDABOUT WILL BE LARGER TO ACCOMMODATE LEFT TURNING TRUCKS.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

HOMER INTERSECTIONS PLANNING STUDY

ROUNDABOUT TRUCK MOVEMENTS

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	NTS	FIGURE	17

8.2 Individual Intersection Control Alternative Operational Performance Evaluations

This subsection presents the individual intersection control performance with 2021 traffic. The intersections are evaluated as isolated intersections with little consideration in this subsection as to the system operations. System consideration will be addressed in section 8.3.

AWSC, signals, and roundabouts are evaluated and summarized in this section even though some of the controls may not be warranted or are not feasible for that location. As subsection 6.2.2 indicates, the Sterling Highway intersections with West Hill Road, Main Street, Heath Street, and Kachemak Bay Road; and the East End Road intersections with Fairview Drive and East Hill Road should not use AWSC intersections as a permanent measure. Even so, these control alternatives operational performances are presented for each of these intersections.

Also, roundabouts for the Pioneer Avenue intersections with Bartlett Street, Main Street, Heath Street, and Lake Street and Fairview Avenue /East End Road would require right of way and relocation impacts associated with construction. These locations have operational performance measures reported even though roundabouts are likely to be more expensive to build. On the other hand, roundabout annual maintenance costs are much less than signalized intersection costs. It is unlikely that DOT&PF would be able to fund maintenance and operations of signals at these remote locations to higher levels of quality. It is likely that maintenance responders would reside in another location, and therefore response for repairs, or operational adjustments would be slow. It may be in the best interest of the community that the local government takes over these responsibilities. Of course, this burden is eliminated entirely if roundabout or AWSC intersections are used.

Auxiliary lane lengths follow recommendations in the *Alaska Preconstruction Manual* Table 1150-1.

8.2.1 Sterling Highway and West Hill Road

The warrants and screening analysis found that roundabouts and signals are feasible for the future, but that AWSC is not. West Hill Road has an approach grade of -9%. FHWA RD-00-067 states that grades should not exceed -4%, but also states that roundabouts shouldn't be dismissed because of grades, since other intersections under same conditions may not provide better solutions.

Table 38 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 summer AM and PM peak hours.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control (Not Recommended by Warrants)				
AM	Intersection Results		10.0	B
	Eastbound Results (critical)	0.71	10.3	B
PM	Intersection Results		15.5 (12.2)	C (C)
	Westbound Results (critical)	0.97	16.8 (11.7)	C (C)
Note: Simulation results are reported in parentheses.				
Modern Roundabout				
AM	aaSidra Results	0.585	6.4	A
	Rodel Results	0.43	6.4	A
PM	aaSidra Results	0.542	4.8	A
	Rodel Results	0.55	8.8	A
Traffic Signal Control				
AM	Intersection Results*	0.51	8.3	A
PM	Intersection Results*	0.45	7.3	A

*Includes EBLT lane, length should be 250 feet for deceleration and queue storage.

Table 38- Performance Measures for Sterling Highway/West Hill Road 2021 Summer Conditions

According to the above table, the intersection will operate at an acceptable LOS for all-way-stop-control (AWSC) in 2021; however, the westbound movement for this intersection operates at capacity and is likely to experience a low LOS with slight fluctuations in summer traffic patterns during the PM peak hour. An AWSC will likely not be a viable option for intersection control in 2021. This conclusion agrees with the screening analysis.

A modern roundabout or a traffic signal control would provide for the best Level of Service with negligible differences in performance between the two types of control.

Table 39 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBT	SBR
Existing Storage Available (feet)	>1000			>1000			*130*		
All-Way-Stop-Control Queues (feet)		125			102			143	125
Roundabout Queues (feet)		174			177			49	
Traffic Signal Queues (feet)*	<25 feet	131			120			122	

*Includes EBLT lane, length should be 250 feet for deceleration and queue storage.

Table 39- Maximum of all 2021 95th Percentile Queues and Available Storages for Sterling Highway/West Hill Road

Based on the table provided, storage will most likely not be a concern with the intersection in 2021 regardless of the intersection control used. With minor traffic fluctuations during summer pm peaks, westbound queues may be worse than reported for an AWSC since the approach operates at capacity.

8.2.2 Sterling Highway and Pioneer Avenue

The warrants and screening analysis found that roundabouts, AWSC, and signals are feasible for the future operations at this location. Table 40 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 summer AM and PM peak hours. The lane existing intersection geometrics and configurations are adequate for the signal alternatives. The AWSC alternative would include a WBRT lane, but would not perform adequately and is not recommended.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control				
AM	Intersection Results		8.5	A
	Eastbound Results (critical)	0.52	8.5	A
PM	Intersection Results		25.2*	D*
	Westbound Results (critical)	1.30*	>50*	F*
* Includes addition of 100-foot right turn lane westbound (storage)				
Modern Roundabout				
AM	aaSidra Results	0.427	6.2	A

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
	Rodel Results	0.35	4.9	A
PM	aaSidra Results	0.586	6.4	A
	Rodel Results	0.54	7.6	A
Traffic Signal Control				
AM	Intersection Results	0.35	8.9	A
PM	Intersection Results	0.86	15.4	B

Table 40- Performance Measures for Sterling Highway/Pioneer Avenue 2021 Summer Conditions

According to the above table, the westbound movement will operate at an undesirable LOS F with an AWSC in 2021 during the PM peak hour. An AWSC would not be a viable option for intersection control in 2021 regardless of intersection improvements listed in the table.

A modern roundabout or a traffic signal control would provide for the best alternative in intersection control based on the performance measures. If adequate spacing between signalized intersections, minimal access, and turn lanes are provided along the Sterling Highway, the difference in performance between the two types of intersection control will be negligible since progression through signals is more attainable.

Table 41 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	EBL	**EBT**	**EBR**	**WBL**	**WBT**	**WBR**	**SBL**	**SBT**	**SBR**
Existing Storage Available (feet)	*260*	*>1000*			*820*		*200*		
All-Way-Stop-Control Queues (feet) *	106	156			521	100	88		135
Roundabout Queues (feet)		117			177			144	
Traffic Signal Queues (feet)	57	113			34		124		76

* Assumes addition of 100-foot westbound right turn lane for summer PM peak

Table 41- Maximum of all 2021 95th Percentile Queues and Available Storages for Sterling Highway/Pioneer Avenue

Based on the table provided, storage will most likely not be a concern with the intersection in 2021 regardless of signal or roundabout control. Excessive queuing can be expected for AWSC on the westbound approach during summer PM peaks since the approach operates at LOS F during this time.

8.2.3 Sterling Highway and Main Street

The warrants and screening analysis found that roundabouts and signals are feasible for the future, but that AWSC is not feasible for this location. Table 42 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 summer AM and PM peak hours. Signals would require additional intersection lanes as described in the table. The AWSC, although not recommended, would not perform adequately even with additional lanes shown in the table.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control (Not Recommended by Warrants)				
AM	Intersection Results		8.7	A
	Eastbound Results (critical)	0.53	8.6	A
PM	Intersection Results		>45* (45.1)	E* (E)
	Westbound Results (critical)	1.62*	>85* (66.6)	F* (F)
* Includes addition of 100-foot right turn lanes for eastbound/westbound and 2- lane approaches for northbound (100-foot right turn lane and through-left turn lane) and southbound (100-foot right turn lane and through-left lane) Note: Simulation results are reported in parentheses.				
Modern Roundabout				
AM	aaSidra Results	0.281	5.4	A
	Rodel Results	0.24	4.2	A
PM	aaSidra Results	0.588	6.4	A
	Rodel Results	0.57	8.5	A
Traffic Signal Control				
AM	Intersection Results	0.32	11.8	B
PM	Intersection Results	0.66*	14.0*	B*
* requires a two-lane southbound approach with an exclusive 150-foot auxiliary right turn lane (or exclusive left turn lane) for queue storage (LOS D is the maximum achievable LOS for southbound left turns)				

Table 42- Performance Measures for Sterling Highway/Main Street 2021 Summer Conditions

According to the above table, the westbound movement will operate at an undesirable LOS F for AWSC in 2021 during the PM peak hour. An AWSC would not be a viable option for intersection control in 2021 regardless of intersection improvements listed in the table.

A modern roundabout or a traffic signal control would provide for the best alternatives in intersection control based on the performance measures.

Table 43 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Storage Available (feet)	*255*	*490*		*255*	*1320*		*600*			*1400*		
All-Way-Stop-Control Queues (feet) *	107	244	49	139	353	38		49	59	75	65	107
Roundabout Queues (feet)		190			190						59	
Traffic Signal Queues(feet) **	15	286			164			69			145	29

* Requires 100-foot right turn lanes for eastbound and westbound; 2-lane approaches for northbound (right turn lane and through-left turn lane) and southbound (left turn lane and through-right turn lane).
** Requires 2-lane approach for southbound (with 150-foot exclusive right turn or left turn lane)

Table 43- Maximum of all 2021 95th Percentile Queues and Available Storages for Sterling Highway/Main Street

Based on the table provided, storage will most likely not be a concern with the intersection in 2021 regardless of signal or roundabout control. Excessive queuing can be expected for AWSC on the westbound approach during summer peak hours.

8.2.4 Sterling Highway and Heath Street

Am AWSC is not recommended for this location because warrants aren't strongly satisfied. Roundabouts or signals are preferable. Table 44 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 summer AM and PM peak hours. Although not recommended, an AWSC would require additional lanes as described in the table, and even so would not perform adequately. The existing lane geometry and configuration is adequate for signal control.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control (Not Recommended by Warrants)				
AM	Intersection Results		9.5	A
	Eastbound Results (critical)	0.59	10.2	B
PM	Intersection Results		(84.4) *	(F) *
	Westbound Results (critical)	(1.4) *	(207.3) *	(F) *
* Includes addition of 100-foot right turn lanes for eastbound/westbound and 2 lane approach for southbound (100-foot right turn lane and through-left lane) Note: Simulation results are reported in parentheses.				
Modern Roundabout				
AM	aaSidra Results	0.303	5.8	A
	Rodel Results	0.29	4.5	A
PM	aaSidra Results	0.624	7.2	A
	Rodel Results	0.58	8.4	A
Traffic Signal Control				
AM	Intersection Results	0.43	14.4	B
PM	Intersection Results	0.83	21.4	C

Table 44- Performance Measures for Sterling Highway/Heath Street 2021 Summer Conditions

According to the above table, the entire intersection will operate at an undesirable LOS F for AWSC in 2021 during the PM peak hour. As was indicated in the warrants and screening analysis, an AWSC would not be a viable option for intersection control in 2021 regardless of intersection improvements listed in the table.

A modern roundabout would provide for the best alternatives in intersection control based on the performance measures; however traffic signal control would provide good operational service as well. If adequate spacing between signalized intersections, minimal access, and turn lanes are provided along the Sterling Highway, the difference in performance between the two types of intersection control are reduced since progression through signals is more attainable (delay is reduced).

Table 45 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Storage Available (feet)	*255*	*1300*		*280*	*335*		*100*			*270*		
All-Way-Stop-Control Queues (feet) *	82	180	18	32	263	50		36			93	81
Roundabout Queues (feet)		169			150			80			162	
Traffic Signal Queues (feet)	29	201			127			36			232	
*Requires a 100-foot right turn lane for eastbound and westbound; 2-lane approach for southbound (100-foot right turn lane and through-left turn lane).												

Table 45- Maximum of all 2021 95th Percentile Queues and Available Storages for Sterling Highway/Heath Street

Based on the table provided, storage will most likely not be a concern with the intersection in 2021 regardless of signal or roundabout control. For AWSC, excessive queuing is likely to pose problems for the intersection (Waddell Way/Sterling Highway) east of Heath Street.

8.2.5 Sterling Highway and Lake Street

All types of proposed intersection control alternatives are feasible for this location. Table 46 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 summer AM and PM peak hours. AWSC and signals would use current lane layouts.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control				
AM	Intersection Results		9.4	A
	Eastbound Results (critical)	0.58	9.8	A
PM	Intersection Results		32.7	D
	Westbound Results (critical)	1.23	44.3	E
Modern Roundabout				
AM	aaSidra Results	0.407	5.9	A
	Rodel Results	0.36	5.1	A
PM	aaSidra Results	0.713	8.9	A
	Rodel Results	0.68	11.2	B
Traffic Signal Control				
AM	Intersection Results	0.31	12.4	B
PM	Intersection Results	0.64*	16.3*	B*
* maximum achievable Level of Service for left turn southbound is LOS D based on cycle length used.				

Table 46- Performance Measures for Sterling Highway/Lake Street, 2021 Summer Conditions

According to the above table, the westbound movement will operate at an undesirable LOS E for AWSC in 2021 during the PM peak hour. An AWSC would not be a viable option for intersection control in 2021 regardless of intersection improvements.

A modern roundabout would provide for the best alternative based on the performance measures; however traffic signal control is also feasible. If adequate spacing between signalized intersections, minimal access, and turn lanes are provided along the Sterling Highway, the difference in performance between the two types of intersection control are reduced since progression through signals is more attainable (delay is reduced).

Table 47 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBT	SBR
Existing Storage Available (feet)	*255*	*610*			*>1000*	*260*	*290*		
All-Way-Stop-Control Queues (feet)	133	206			450	287	89		79
Roundabout Queues (feet)		294			280			218	
Traffic Signal Queues (feet)	109	121			339	35	212		64

Table 47- Maximum of all 2021 95th Percentile Queues and Available Storages for Sterling Highway/Lake Street

Based on the table provided, storage will most likely not be a concern with the intersection in 2021 with signal or roundabout control. For AWSC, excessive queuing can be expected on the westbound approach during the summer PM peak hour.

8.2.6 Sterling Highway and Kachemak Bay Road

Table 48 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 summer AM and PM peak hours. A signal would require a new SBLT lane. Although AWSC is not recommended by the screening analysis, results are shown for comparison.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control (Not Recommended by Warrants)				
AM	Intersection Results		8.7	A
	Southbound Results (critical)	0.48	9.2	A
PM	Intersection Results		13.2* (35.0)	B* (D)
	Northbound Results (critical)	0.95*	19.1* (71.9)	C* (F)
* Includes addition of southbound 100-foot left turn lane (queue storage) Note: Simulation results are reported in parentheses.				
Modern Roundabout				
AM	aaSidra Results	0.24	8.1	A
	Rodel Results	0.24	4.3	A
PM	aaSidra Results	0.52	8.4	A
	Rodel Results	0.48	6.7	A
Traffic Signal Control				
AM	Intersection Results	0.56	8.4	A
PM	Intersection Results	0.78*	15.8*	B*
* Intersection requires addition of southbound 150-foot left turn lane (queue storage) to avoid LOS F on the southbound approach.				

Table 48- Performance Measures for Sterling Highway/Kachemak Bay Road, 2021 Summer Conditions

Based on the HCM methodology, the northbound movement will operate at an acceptable LOS C for AWSC in 2021 during the PM peak hour; however simulated results show that the northbound movement will fail with an AWSC. Because the v/c ratio of the northbound movement is greater than the practical operating limit of 0.85, it is likely the northbound movement will experience LOS F during times with small traffic fluctuations in the PM peak hour in 2021. An AWSC will most likely not be a viable option for intersection control in 2021 even with intersection improvements mentioned in the table.

A modern roundabout or a traffic signal would provide for adequate intersection control based on the performance measures with a roundabout providing for slightly better LOS during PM peak conditions.

Table 49 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Storage Available					*>1500*			*710*	
All-Way-Stop-Control Queues (feet) *		119			581		86	133	
Roundabout Queues (feet)		87			141			127	
Traffic Signal Queues (feet) *	203				399		82	136	

* Requires addition of a 150-foot southbound left turn lane for summer PM peak.

Table 49- Maximum of all 2021 95th Percentile Queues and Available Storages for Sterling Highway/Kachemak Bay Road

Based on the table provided, storage will most likely not be a concern with the intersection in 2021 regardless of signal or roundabout control. For AWSC, excessive queuing would be expected on the northbound approach during the summer PM peak hour.

8.2.7 Pioneer Avenue and Bartlett Street

This intersection does not meet screening criteria for alternative intersection controls for combinations of 2021 summer AM and PM peak hours. This will function as a two-way stop control intersection in the future.

8.2.8 Pioneer Avenue and Main Street

This intersection satisfies screening criteria for AWSC, roundabouts, and signals. Table 50 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 summer AM and PM peak hours. The existing lane geometrics and configurations would support the AWSC and signal control alternatives.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control				
AM	Intersection		9.3	A
	Critical Movement	0.56	10.0	A
PM	Intersection		16.5 (25.3)	C (D)
	Westbound (Critical)	1.02	25.8 (46.1)	D (E)
Note: development proximity to intersection limits ability to add lanes. Note: Simulation results are reported in parentheses.				

Modern Roundabout				
AM	aaSidra Results	0.262	2.2	A
	Rodel Results	0.23	4.1	A
PM	aaSidra Results	0.420	3.0	A
	Rodel Results	0.35	5.2	A
Traffic Signal Control				
AM	Intersection Results	0.35	12.8	B
PM	Intersection Results	0.53	17.4	B

Table 50- Performance Measures for Pioneer Avenue and Main Street, 2021 Summer Conditions

HCM results show that the westbound movement will operate at an acceptable LOS D for an AWSC in 2021 during the PM peak hour; however, simulation shows the movement to be undesirable at LOS E in 2021. Because the v/c ratio is greater than 1, the movement could experience LOS F with slight traffic fluctuations during the summer PM peak.

The current TWSC operation will be acceptable for the next several years. Table 20 in subsection 5.3.8 shows good levels of service now, C for AM and PM peak hours, with an end of life LOS of D/F if TWSC were retained. As such, the time of need for changing from a TWSC to an AWSC or other control would probably be around 2011. AWSC may not be a viable option for intersection control in 2021, as shown in Table 50, above, but would likely be acceptable from most of the study period.

In 2021, a modern roundabout or a traffic signal would provide for adequate intersection control based on the performance measures with a roundabout providing for slightly better LOS during peak conditions. However, a roundabout would be more costly than traffic signal control to construct because of right of way and business impacts.

Table 51 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Storage Available (feet)	*200*	*970*		*200*	*1380*		*1400*			*840*		
All-Way-Stop-Control Queues (feet)	80	185		88	201			76			74	80
Roundabout Queues (feet)		76			105			47			37	
Traffic Signal Queues (feet)	20	198		7	240			132			115	

Table 51- Maximum of all 2021 95th Percentile Queues and Available Storages for Pioneer Avenue/Main Street

Based on the table provided, storage will most likely not be a concern with the intersection in 2021 with signal control. For AWSC, queues greater than 200 feet could be expected in the summer PM peak hour on the westbound approach as traffic approaches capacity on the westbound approach prior to 2021.

8.2.9 Pioneer Avenue and Heath Street

Screening found all proposed intersection controls are feasible at this location. However, roundabouts are not recommended because of right-of-way and relocation impacts. Table 52 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 winter and summer, AM and PM peak hours. Winter analysis is included here because this intersection is influence by high school traffic; and winter conditions are the design conditions for southbound geometrics. As shown in the table, both AWSC and signals would require new lane configurations.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control				
AM Summer	Intersection		13.8 (10.4)	B (B)
	Westbound Eastbound	0.88	18.5 (9.4) (14.3)	C (A) (B)
PM Summer	Intersection		39.5* (117)	E* (F)
	Eastbound Westbound	1.32* 1.31*	51.3* (286.1) 52.6* (47.9)	F* (F) F* (E)
AM Winter	Intersection		31.2* (51.4)	D* (F)
	Westbound	1.32*	52.6* (89.1) (WB queue = 466 ft)	F* (F)
PM Winter	Intersection		31.0* (37.1)	D* (E)
	Eastbound	1.23	44.5* (43.4)	E* (E)

* Includes addition of southbound 100-foot right turn lane (westbound queues extend through Lake Street) Note: Simulation results are reported in parentheses.				
Modern Roundabout				
AM Summer	aaSidra Results	0.563	3.5	A
	Rodel Results	0.33	4.9	A
PM Summer	aaSidra Results	0.557	3.1	A
	Rodel Results	0.49	6.9	A
AM Winter	aaSidra Results	0.575	3.6	A
	Rodel Results	0.47	6.4	A
PM Winter	aaSidra Results	0.518	3.6	A
	Rodel Results	0.46	6.4	A
Traffic Signal Control				
AM Summer	Intersection Results	0.46	13.5	B
PM Summer	Intersection Results	0.74	19.5	B
AM Winter	Intersection Results	0.72 *	15.9 *	B *
PM Winter	Intersection Results	0.66 *	21.3 *	C *
* Requires two-lane approach (shared through/right and 100-foot left turn lane) for northbound and southbound approaches to accommodate queue storage.				

Table 52 – Performance Measures for Pioneer Avenue and Heath Street, 2021 Summer and Winter Conditions

The *Homer Transportation Plan* calls for the extension of Heath Street to the north of Pioneer Avenue, and if so, the eastbound and westbound movements will operate at an undesirable LOS F under AWSC at some time in 2021 regardless of the type control at Lake Street/Pioneer intersection. An AWSC would not be a viable option for intersection control in 2021 regardless of intersection improvements listed in the table.

A modern roundabout would provide for very good intersection operational performance measures. However, because of the amount of right of way and associated relocation impacts required for a roundabout, it would be more costly than a signal.

Signal control would provide for intersection LOS C or B during peak hours if properly spaced with other signalized intersections on Pioneer Avenue. If a signal were installed at Heath/Pioneer, the intersection control at Lake/Pioneer would most likely have to be converted to two-way stop control or traffic signal.

Table 53 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Storage Available (feet)	*200*	*665*		*200*	*450*		*770*		*130*	*508*		
All-Way-Stop-Control Queues (feet) *	296	775		m305	m473			103	62		74	106
Roundabout Queues (feet)		169			150			162			80	
Traffic Signal Queues (feet)**	44	341		39	291		70	140	42	25	127	

* Assumes two lane approach (right turn lane and through-left lane) for southbound for summer PM, winter AM and winter-PM.
M – queues are metered by upstream intersection all-way-stop-control and are likely to be worse than reported.
**Requires two-lane approach (shared through/right and 100-foot left turn lane) for northbound and southbound approaches.

Table 53 – Maximum of all 2021 95th Percentile Queues and Available Storages for Pioneer Avenue/Heath Street

Queues reported in the above table for the westbound approach for a traffic signal and AWSC control are largely dependent upon the type of upstream control and should be used with caution; assuming upstream control does not meter the queues on this approach, the westbound queues can be expected to be longer.

Well-timed traffic signals could control westbound queuing to some degree if provided at Pioneer intersections with Heath and Lake Streets. Based on the table provided, the westbound through queues can be expected to block the westbound left turn lane for entering left turn vehicles for both control types. For this reason also, westbound queuing can be expected to be longer than the reported value.

For a traffic signal installation in 2021, the lanes should be reconfigured on the northbound approach to a left turn lane and a shared though-right lane. The southbound approach would be similarly reconfigured.

For AWSC at Heath/Pioneer, long queues can be expected on the westbound approach during the 2021 summer PM peak hour. Blockage of the Lake/Pioneer intersection could be expected during this time period with the AWSC at Heath/Pioneer.

8.2.10 Pioneer Avenue, East End Road, and Lake Street

This location met the warrants and guidelines for all types of intersection controls, but roundabouts are not recommended because of the right of way and relocation impacts. Table 54 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 summer and winter, AM and PM peak hours. Winter operations were included because of the close proximity to the high school intersections at Heath Street and Fairview Avenue.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control				
AM Summer	Intersection	[redacted]	(7.5)	(A)
	Southbound	[redacted]	(10.5)	(B)
PM Summer	Intersection	[redacted]	(27.1)	(D)
	Northbound Left	[redacted]	(55.8)	(F)
AM Winter	Intersection	[redacted]	(53.5)	(F)
	Westbound Left	[redacted]	(55.7)	(F)
PM Winter	Intersection	[redacted]	(23.9)	(D)
	Westbound	[redacted]	(29.3)	(D)
Note: All analyses were Simulation results are reported in parentheses. Note: Simulated conditions are based on AWSC at Heath and Fairview intersections with Pioneer; conditions are likely to be worse than reported for east-west traffic. Queuing from Pioneer/Heath intersection influences values for left turns on the north approach.				
Modern Roundabout				
AM Summer	aaSidra Results	0.457	2.7	A
	Rodel Results	0.35	5.0	A
PM Summer	aaSidra Results	0.488	3.6	A
	Rodel Results	0.49	6.6	A
AM Winter	aaSidra Results	0.477	2.4	A
	Rodel Results	0.44	5.9	A
PM Winter	aaSidra Results	0.576	3.5	A
	Rodel Results	0.54	7.2	A
Traffic Signal Control				
AM Summer	Intersection Results	0.53	8.1	A
PM Summer	Intersection Results	0.65*	11.3*	B*
AM Winter	Intersection Results	0.59	7.0	A
PM Winter	Intersection Results	0.78	16.2	B
* Requires 2-lane approach for northbound approach (100-foot right turn lane for queue storage, and through-left turn lane) for summer PM peak.				

Table 54- Performance Measures for Pioneer Avenue, East End Road and Lake Street, 2021 Summer and Winter Conditions

AWSC values in the above table assume AWSC at the adjacent Pioneer Avenue intersections with Heath Street and Fairview Avenue. Values in the table for AWSC are likely to be worse than reported for the east-west direction due to the upstream metering and should be compared with delays for Pioneer Avenue thru traffic delays at the upstream intersections. The westbound left turn at Lake/Pioneer intersection will operate at an undesirable LOS F at some time in 2021 regardless of the type control at Heath/Pioneer intersection. An AWSC would not be a viable option for intersection control in 2021.

A modern roundabout or a traffic signal would provide for adequate intersection control based on the performance measures with a roundabout providing for slightly better LOS during peak conditions; however a roundabout is more costly because of the impacts.

Signal control would provide for intersection LOS A or B during peak hours if properly spaced with other signalized intersections on Pioneer Avenue. Eastbound queues forming at the signal would cause some excess delay to two-way-stop controlled vehicles on the Heath/Pioneer intersection northbound and southbound approaches. More discussion on this topic is provided later in Section 9.

The northbound approach would be widened for a right-turn only lane (100-feet long) and a shared through-left lane.

Table 55 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	EBL	**EBT**	**EBR**	**WBL**	**WBT**	**WBR**	**NBL**	**NBT**	**NBR**	**SBL**	**SBT**	**SBR**
Existing Storage Available (feet)	*130*	*450*	*152*	*205*	*437*		*1300*			*75*		
All-Way-Stop-Control Queues (feet)	25	m174	m123	m181	m311			589			56	25
Roundabout Queues (feet)		132			176			120			13	
Traffic Signal Queues (feet) **		88	1	16	44			139	52		30	

** Requires 2-lane approach for northbound (100 foot right turn lane and through-left turn lane) for summer PM queue storage
m – queues are metered by upstream intersection all-way-stop-control and are likely to be worse than reported

Table 55 – Maximum of all 2021 95th Percentile Queues and Available Storages for Pioneer Avenue/Lake Street

Queues reported in the above table for the eastbound and westbound approach for a traffic signal and AWSC control are largely dependent upon the type of upstream control. If upstream control does not meter the queues on this approach, the eastbound and westbound queues can be expected to be slightly longer for AWSC and much longer for traffic signal control.

As a signalized intersection, left turn lanes provided on Pioneer Avenue can be expected to provide for adequate storage, however, through queues can be expected to block the left turn lanes if not metered by upstream control. For this reason also, eastbound and westbound queuing can be expected to be longer than the reported value but should not have a significant effect on the overall intersection operation.

8.2.11 East End Road and Fairview Avenue

A warrants and guidelines screening analysis shows that AWSC for this intersection is not recommended. In addition, roundabouts are not recommended here because of the impacts. Table 56 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 summer and winter, AM and PM peak hours. Winter operations are included because this intersection serves as a primary access to the high school.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control (Not Recommended by Warrants)				
AM Summer	Intersection		47.9** (30.1)	E** (D)
	Westbound	1.65**	87.2** (52.1)	F** (F)
PM Summer	Intersection		40.8* (37.3)	E* (E)
	Westbound	1.37*	57.0* (55.3)	F* (F)
AM Winter	Intersection		33.5** (25.0)	D** (D)
	Critical Movement	1.40	59.7** (41.8)	F** (E)
PM Winter	Intersection		25.0** (14.4)	D** (B)
	Westbound	1.17**	37.8** (19.7)	E** (C)
* Includes improvement to two-lane approach for southbound ** Includes improvement to two-lane approach for southbound and right turn lane for westbound Note: Simulation results are reported in parentheses.				
Modern Roundabout				
AM	aaSidra Results	0.643	3.5	A
	Rodel Results	0.63	9.2	A
PM	aaSidra Results	0.601	3.4	A
	Rodel Results	0.60	8.3	A
AM	aaSidra Results	0.572	3.5	A
	Rodel Results	0.53	7.1	A
PM	aaSidra Results	0.496	3.1	A
	Rodel Results	0.47	5.9	A

Traffic Signal Control				
AM Summer	Intersection Results	0.66*	12.9*	B*
PM Summer	Intersection Results	0.65	11.2	B
AM Winter	Intersection Results	0.69 *	16.4 *	B *
PM Winter	Intersection Results	0.57 *	10.2 *	B *
* Option to include a 100-foot westbound right turn lane for queue storage (raises westbound approach from LOS D to LOS C)				

Table 56 – Performance Measures for East End Road and Fairview Avenue – 2021 Summer and Winter Conditions

According to the above table, the westbound movement will operate at an undesirable LOS E or F for AWSC in 2021 during many peak hour conditions. An AWSC would not be a viable option for intersection control in 2021 regardless of intersection improvements listed in the table.

A modern roundabout or a traffic signal would provide for adequate intersection control based on the performance measures with a roundabout providing for slightly better LOS during peak conditions. Because of the amount of space required for a roundabout, it would be a more costly solution for intersection control than signalization.

Signal control would provide for adequate intersection LOS B during peak hours. As an individual intersection, without regard to adjacent intersection control, a signal is feasible. This alternative is discussed further in Section 8.3.

Table 57 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBT	SBR
Existing Storage Available (feet)	*130*	*437*			*2100*			*800*	
All-Way-Stop-Control Queues (feet) *	m152	m313			771	639	56		46
Roundabout Queues (feet)		208			212			36	
Traffic Signal Queues (feet) **	40	229			396	25	90		

* *Requires addition of right turn lane for westbound for summer AM, winter AM and winter PM; left and right turn lanes for southbound for summer-winter and AM-PM.*
m – queues are metered by upstream intersection all-way-stop-control and are likely to be worse than reported
*** Requires 100-foot right turn lane for westbound for summer AM.*

Table 57 – Maximum of all 2021 95th Percentile Queues and Available Storages for East End Road and Fairview Avenue

Queues reported in the above table for the eastbound approach for a traffic signal and AWSC control are largely dependent upon the location and type of upstream control and should be used with caution. If upstream control does not meter the queues on this approach, the eastbound and westbound queues could be expected to be longer for AWSC and traffic signal control.

As a signalized intersection, the left turn lane provided on Pioneer Avenue can be expected to provide for adequate storage, however, eastbound queues can be expected to block the left turn lane if not metered by upstream control. For this reason also, eastbound queuing could be expected to be longer than the reported value.

8.2.12 East End Road and East Hill Road

AWSC warrants were not satisfied at this location. Table 58 provides a summary of the performance measures and intersection approach geometry requirements for alternative intersection controls for combinations of 2021 summer AM and PM peak hours.

		Volume to Capacity Ratio (v/c)	Control Delay Seconds per vehicle	Level of Service (LOS)
All-Way-Stop Control (Not Recommended by Warrants)				
AM	Intersection		88.9*	F*
	SBLT Critical Movement	2.27*	>150*	F*
PM	Intersection		34.0*	D*
	Critical Movement	1.37*	54.3*	F*
* includes improvement to two-lane approach for southbound & center two-way-left-turn-lane (TWLTL) in East End Road Median east of intersection (includes right turn lane for westbound for summer PM)				
Modern Roundabout				
AM	aaSidra Results	0.812	10.5	B
	Rodel Results	0.74	18.6	C
PM	aaSidra Results	0.680	5.2	A
	Rodel Results	0.69	16.5	C
East End Rd and East Hill Road east-west approaches require larger than typical single lane: Eastbound: *E = 15 feet and L' = 50 feet; Westbound E = 15 feet and L' = 100 feet.*				
Traffic Signal Control				
AM	Intersection Results	0.67*	22.2*	C*
PM	Intersection Results	0.67	9.6	A
* Requires the addition of 100-foot westbound right turn lane; also requires two-lane approach (100 foot SBR and 100 foot SBL)				

Table 58 – Performance Measures for East End Road/East Hill Road – 2021 Summer Conditions

According to the above table, the intersection will operate at an undesirable LOS F for AWSC in 2021 during many peak hour conditions. An AWSC would not be a viable option for intersection control in 2021 regardless of intersection improvements listed in the table.

Table 59 compares the maximum of the 2021 95th percentile queues for all peak hour scenarios for each of the alternative intersection controls. Available storage is provided as a comparison to the queues to indicate where blockages of traffic may have an additional affect on LOS of this intersection or any upstream intersections.

	EBL	EBT	EBR	WBL	WBT	WBR	SBL	SBT	SBR
Existing Storage Available (feet)	*330*	*>1000*		*1600 (280 to school)*					
All-Way-Stop-Control Queues (feet) *	280	478			1494	44	39		169
Roundabout Queues (feet) ***		293			342			369	
Traffic Signal Queues (feet) **	73	332			248	17	92		88

* Requires right turn lane for westbound, and left turn and right turn lane for southbound, for summer PM (also includes a center two-way-left turn lane east of intersection where applicable)
*** Eastbound and westbound approaches require modifications of approach throat width (E) and half-taper length (L') from typical single lane roundabout configuration to achieve desirable operating conditions.
** Requires of 100-foot right turn lane for westbound, and 100-foot left turn lane and 100-foot right turn lane for southbound approach

Table 59 – Maximum of all 2021 95th Percentile Queues and Available Storages for East End Road and East Hill Road

For AWSC, excessive queuing can be expected on the eastbound and westbound approach during the summer PM peak hour and is not likely a feasible intersection control. Results for roundabout control show lengthy queuing on the southbound approach which may require a two-lane southbound approach if there is a concern with the north approach grade and visibility on the approach.

8.3 System-Level Alternatives

This subsection presents the network on a whole system-level. As such the analysis considers proximities of the intersections to one another, and operational influences or impacts. Intersection spacing affects overlap of functional areas (where downstream operations back into an intersection), progression, and crash reduction potential

8.3.1 Functional Area Considerations

The *Access Management Manual* published by the Transportation Research Board (TRB) outlines clearance requirements to upstream intersections based on an approaching driver's distance traveled during reaction, distance traveled during deceleration and back of queues, which varies with intersection control type. The intersection desirable functional area (minimum desirable intersection spacing) is based on these criteria. This desirable spacing or functional area is needed so that upstream intersection capacity and safety is not influenced by the downstream intersection. Where desirable upstream intersection spacing is not available on the major roadway, opportunity for upstream entrance onto the major roadway is reduced and accident potential is increased. As a result, raised medians between intersections to reduce accident potential and conflicts may be installed. Table 60 summarizes, by intersection control, where desirable upstream intersections spacing cannot be achieved resulting in operational problems.

Control Type	Direction	Desirable Upstream Spacing (feet)	Available Upstream Area (Feet)	Affected Upstream Intersection
Sterling Highway and Pioneer Avenue				
AWSC	Westbound	871	820	Greatland Street (future intersection)
Sterling Highway and Main Street				
AWSC	Eastbound	594	490	Greatland Street (future intersection)
Roundabout	Eastbound	540	410	
Signal	Eastbound	636	490	
Sterling Highway and Heath Street				
AWSC	Westbound	613	335	Waddell Way
Roundabout	Westbound	500	255	
Signal	Westbound	477	335	
Sterling Highway and Lake Street				
Roundabout	Eastbound	644	530	Waddell Way
Pioneer Avenue and Heath Street				
AWSC	Eastbound	980	665	Kachemak Way
AWSC	Westbound	m678	450	Lake Street
Roundabout	Westbound	355	370	Lake Street
Signal	Westbound	m496	450	Lake Street
Pioneer Avenue and Lake Street				
AWSC	Eastbound	>400	450	Heath Street
AWSC	Westbound	>510	437	Fairview Avenue
Roundabout	Eastbound	337	370	Heath Street
Roundabout	Westbound	381	357	Fairview Avenue
Signal	Eastbound	m293	450	Heath Street
East End Road and E Fairview Avenue				
AWSC	Eastbound	>510	437	Lake Street
East End Rd and East Hill Rd				
AWSC	Westbound	2,024	1600 to Mariner Dr; 280 to School Access	Mariner Dr and School Access
Roundabout	Westbound	872	170	School Access
Signal	Westbound	778	280	School Access

m – metered queues are influenced by upstream control and may be longer than reported

Table 60 - Comparison of 2021 Desirable Intersection Spacing (Based on Upstream Functional Area) and Upstream Intersections Affected

Progression is an important consideration in signalization spacing. The ITE *Engineering Handbook* and the *Access Management* gives guidance for signalized intersection spacing to maintain progression speeds. Table 61 summarizes recommended spacing based on speed and cycle length.

Speed (mph)	Cycle (seconds)	Intersection Spacing (feet)
25 mph	70	1,280
	80	1,470
	90	1,630
35 mph	90	2,310
	105	2,695
	120	3,080

Table 61- Signalized Intersection Spacing Guidelines

Cycle lengths were chosen based on the characteristic of the roadway (speed, traffic, pedestrian use, road classification, capacity and queuing concerns). For Pioneer Avenue/East End Road, from Heath Street to Fairview Street, an 80 second cycle (common during peak traffic periods in downtown areas) at approximately ¼ mile intersection spacing provides good progression and gives ample time to provide left turn phasing on the major street if necessary In the future. For the Sterling Highway, from Pioneer Avenue to Lake Street, approximately ½ mile provides the best spacing for signal progression using a 105 second cycle.

At this point in the analysis, intersections have been screened for control type, have had operational evaluations for LOS and queuing, and have evaluated the functional area overlap potential. Deficiencies in any one of these evaluation areas may discard that type of control. Table 62 summarizes the feasible intersection control at each intersection based upon warrants, LOS, existing storage availability and desirable upstream intersection spacing (functional area).

	All-Way Stop Control			Modern Roundabout			Traffic Signal		
	LOS Met (C or Better)?	Queue Storage Met?	Intersection Spacing Met?	LOS Met (C or Better)?	Queue Storage Met?	Intersection Spacing Met?	LOS Met (C or Better)?	Queue Storage Met?	Intersection Spacing Met?
Sterling Highway Intersections									
West Hill Rd	Not Recommended by Warrants			Y	Y	Y	Y	Y	Y
Pioneer Ave	N	-	-	Y	Y	Y	Y	Y	Y
Main St	Not Recommended by Warrants			Y	Y	Y[2]	Y	Y	Y[2]
Heath St	Not Recommended by Warrants			Y	Y	Y[2]	Y	Y[4]	Y[2]
Lake St	N	-	-	Y	Y	Y[2]	Y	Y[4]	Y
Kachemak Bay Rd	Not Recommended by Warrants			Y	Y	Y	Y	Y	Y
Pioneer Avenue Intersections									
Bartlett St	Not Recommended by Warrants			Not Recommended by Screening			Not Recommended by Warrants		
Main St	N[1]	-	-	Y	Y	Y	Y	Y[4]	Y
Heath St	N	-	-	Y	Y	Y[3]	Y	Y[4]	N[3]
Lake St	N[1]	-	-	Y	Y	Y[3]	Y	Y[4]	N[3]
East End Road Intersection									
Fairview Ave	Not Recommended by Warrants			Y	Y	Y	Y	Y[4]	Y[3]
East Hill Rd.	Not Recommended by Warrants			Y	Y	Y[2]	Y	Y[4]	Y[2]

Y – Yes; N – No

[1] AWSC could be considered as an interim control prior to 2021

[2] Upstream (minor) intersection is affected; however, affected intersection does not include a major intersection in this study.

[3] Upstream (major) intersection is affected to some degree; however operational impacts may be reduced for signals with appropriate upstream signal location and signal timing. A raised median will also be needed between Heath Street and Lake Street to restrict access to Pioneer Avenue to right-in and right-out only. Refer to discussion on intersection control.

[4] Turn lane Storage or Blockages may be of some concern. Refer to discussion on intersection control for mitigation.

Table 62- Summary of Intersection Traffic Control Feasibility in 2021

Sterling/West Hill would operate at an LOS D in 2021 under the existing configuration. Although this would be below the desired LOS C, as the area becomes more urban or suburban, LOS D becomes acceptable by most drivers according to AASHTO.

8.3.2 System Alternatives: Sterling Highway (Homer Bypass) Corridor, Pioneer Avenue to Lake Street

Either signalization or roundabouts are recommended for the intersections within this segment. The Main Street, Heath Street, and Lake Street intersections currently meet signal warrants (congestion warrants, but not crash experience), and have undesirable LOS. Pioneer Street currently satisfies signal warrants (two volume warrants), but operates at an acceptable LOS for the near term (up to 2011).

Signal progression is most favorable (delay is least) if signals are placed at Main Street and Heath Street. With signals at Heath Street and Main Street, signals could be installed either at Sterling/Pioneer or Sterling/Lake intersections, but not both locations, with only minor impact to progression for this segment near the downtown area. Signalization of all four of these segment intersections would have a negative affect on progression.

The Pioneer/Sterling intersection has a significant pedestrian crossing activity. Both roundabouts and signals would enhance pedestrian mobility. Signals would provide pedestrian actuated signal crossing. Roundabouts reduce approach speeds. Crossing pedestrians are more likely to interact and communicate with drivers traveling at low speeds, and are more comfortable with lower speed gaps. More importantly roundabouts reduce speeds so that pedestrian collisions are usually of lesser severity.

The Lake/Sterling intersection is strongly warranted for a signal (congestion warrants, but not crash experience), and has a very poor LOS (F). It has poles set and geometrics in place for an immediate signal installation. This has been identified as a significant pedestrian crossing, and pedestrians would benefit from either signalization or a roundabout. In addition, trucks use Lake Street, and either a signal or roundabout would accommodate the turning maneuvers.

Heath and Main Streets intersections would function well as roundabouts with signals or roundabouts installed at Lake and Pioneer intersections. Roundabouts at these locations perform as well or better than the signals in terms of delay and LOS, and would have less queuing and functional area impacts. These will also moderate speeds along this corridor and, if combined with signals, would allow the signals to operate in a non-coordinated (free) mode that will help minimize cycle lengths and queues.

Main Street grades (+9% uphill northbound) exceed recommended approach grades. FHWA Roundabouts: An Informational guide recommends grades through a roundabout be less than 4%; and indicates that a negative approach grades is of more concern than positive grades. This reference also states that roundabouts shouldn't be eliminated from consideration because of grades, since other intersection treatments under those conditions may not operate any better than a roundabout.

In summary the feasible intersection controls to attain good system operations for the Sterling Highway between Pioneer Avenue and Lake Street are presented in Table 63. These recommendations stand no matter what development options are implemented for the Pioneer Avenue corridor.

	Pioneer Avenue	**Main Street**	**Heath Street**	**Lake Street**
Control	Signalization or Roundabout 100 to 140-ft Diameter, Single Circulation Lane	Roundabout 100 to 140-ft Diameter, Single Circulation Lane	Roundabout 100 to140-ft Diameter, Single Circulation Lane	Signalization or Roundabout 100 to140-ft Diameter, Single Circulation Lane
Lane Configuration	Signals: Existing, no widening required Roundabout: 1-lane approaches	1-lane approaches	1-lane approaches	Signals: Existing, no widening required Roundabout: 1-lane approaches
2021 LOS	Signals: A (AM), B (PM) Roundabout: A (AM and PM)	A (AM and PM)	A (AM and PM)	Signals: A (AM), B (PM) Roundabout: A (AM) and A/B (PM)

Table 63- Sterling Highway (Homer Bypass), Pioneer Avenue to Lake Street 2021 Intersection Control

Signalization or roundabouts are feasible at the Pioneer and Lake Street intersections, however DOT&PF would prefer roundabouts because of long-term maintenance and operations considerations. It is unlikely that DOT&PF would be able to fund maintenance and operations of signals in Homer to the level that is needed for liability and good operational adjustment response that would be expected by the public. DOT&PF may be looking more at that the local or borough governments to take over these signal maintenance responsibilities. One of the biggest advantages for roundabouts is that local governments wouldn't have to hire and train staff that would be required for signals.

8.3.3 System Alternatives: Pioneer Avenue /East End Road Corridor, Sterling Highway to Fairview Avenue

The 2021 solutions for the intersection on this corridor are signalization. However, only the Pioneer Avenue, Lake Street, and East End Road intersection currently satisfies signalization warrants (congestion warrants only, not crash experience). The Pioneer Avenue intersections with Main Street and Heath Street are projected to satisfy volume signal warrants in 2011, and the Fairview Avenue and East End Road intersection is projected to meet signal warrants in 2011, as well. The Bartlett Street intersection will not meet warrants within this study project, even with the extension of Bartlett to the south and connection to the east-west CBD corridor.

From an operational performance perspective, current LOS for the intersections are acceptable except for the Heath Street intersection which has a LOS E. All other intersections except Bartlett Street would have to be improved by 2011.

The Main Street intersection is forecasted to need a different treatment than the current TWSC by 2011. It would operate well as an AWSC intersection for most of the study period. Long-term solution for 2021 design year traffic would be signalization or roundabouts.

8.3.3.1 Heath Street Extension Option

Under the 2021 Homer Transportation Plan, Heath Street will be extended to connect with East Hill Road. Another option, reviewed in 8.3.3.1 below would be to extend Lake Street, instead of Heath Street, and follow the same general corridor to the East Hill Road connection.

Treatments of the Main Street and Bartlett Street intersections are independent of whether Heath or Lake is extended. The success of any control alternative rests with the treatments of the Heath, Lake and Fairview intersections. This is complicated by the close spacing of the intersections (about 400 feet between Heath and Lake, and about 500 feet between Lake and

Fairview) in which functional areas will overlap, blocking queues can develop, and progression can be poor. Because the need for treatment on Heath Street is eminent, treatments may be imposed upon the adjacent intersections even though warrants and operational concerns wouldn't require it otherwise.

Signalization of all three intersections would not be desirable even though warrants either satisfied now or in the future. The following treatment combinations were evaluated but eventually discarded.

- A signal a Heath Street and TWSC for Lake Street and Fairview Avenue intersections was evaluated. Analysis shows that the signal would have a good LOS, and would provide gaps for the Lake and Fairview approach traffic. However, northbound left turns would fail at Lake Street when the westbound movement is heaviest and the signal is coordinated with Main Street. Heath Street would become the primary truck route, which may have mobility consequences because of Heath Street grades.

- Another option would be to signalize the Pioneer/Lake intersection and retain TWSC for Heath Street and Fairview Avenue. Lake Street queues would back into the Heath intersection and therefore this is not a feasible solution.

- Signals at Pioneer Avenue intersections with Lake Street and Fairview Avenue would provide good LOS for through traffic on Pioneer Avenue at these two intersections. However, it does not service the residential area to the north of Heath Street very well and would not resolve the issue with excessive delays on the Heath Street two-way-stop controlled approaches due to queuing from Lake Street. As such, this is not feasible.

- Signals provided on Pioneer Avenue at Heath Street and at Fairview Avenue would degrade operations of the Pioneer Avenue through traffic and cause excessive delays on the stop controlled (two-way-stop control) northbound approach at Lake Street. This option is not feasible.

Signalization of both Heath/Pioneer and Lake/Pioneer intersections would provide acceptable LOS for traffic on all Heath and Lake Street approaches to Pioneer Avenue with only minimal disruption to traffic on Pioneer Avenue. This solution minimizes delay to the minor streets by controlling queues between the intersections and preventing overlapping of functional area the best when compared to other solutions. The solution also services the high school during peak periods since the school would have an access to the future Heath Street Extension. The two intersections can be synchronized to coordinate passage through the intersections, and avoid queue spillback and disruption of movements on adjacent approaches to Pioneer Avenue. However, the two signals have overlapping upstream functional areas. A continuous median with channelized left turn lanes would be required to reduce driveway turning movement conflicts and minimize impacts to operations and crash potential. Businesses along this segment would be restricted to right-in and right-out turning movements.

Microsimulation was used for these intersections because of the close spacing. Table 64 summarizes performance measures for this alternative.

	Pioneer Avenue & Lake Street (Signal)		Pioneer Avenue & Heath Street (Signal)		East End Rd & Fairview Avenue (Two-Way-Stop)	
2021 Scenario	**Signal Delay (sec/veh)**	**LOS**	**Signal Delay (sec/veh)**	**LOS**	**Minor Street Delay (sec/veh)**	**LOS**
PM Summer	12.5	A	18.5	B	>100	F
AM Summer	7.6	A	12.6	A	22.6	C
PM Winter	11.2	A	16.3	B	>100	F
AM Winter	22.7	C	25.9	C	39.8	E
Required Additional Lane Improvements and Signalization: Lake/Pioneer: 2 approach lanes for northbound (exclusive 100-foot NB right turn lane); 5-phase signal control (protected-permitted left for westbound only) Heath/Pioneer: Exclusive 100-foot left-turn lane and shared thru/right-turn lane for both northbound and southbound. 6-phase signal control (protected-permissive left turns for eastbound and westbound) Fairview/Pioneer: Westbound 100-foot right turn lane installed; two lanes southbound approach installed (Use100-foot SBRT, and SBLT from through lane extended).						

Table 64- 2021 Simulation Performance Measures for Alternative with the Heath Street Extension to the North of Pioneer Avenue

The Fairview Avenue would operate below desirable levels, but for only peak periods. Moreover, most Fairview traffic would be able to use the Heath Street signal should delay become intolerable.

8.3.3.2 Lake Street Extension Option of Heath Street Extension Corridor

The other extension option to connect the downtown to East Hill Road would be the extension of Lake Street north of Pioneer Avenue to align with the proposed Homer Transportation Plan

Heath Street Extension corridor. Lake Street would extend to the north and then merge into the north-south alignment to the west of the high school as shown in Figure 16 below.

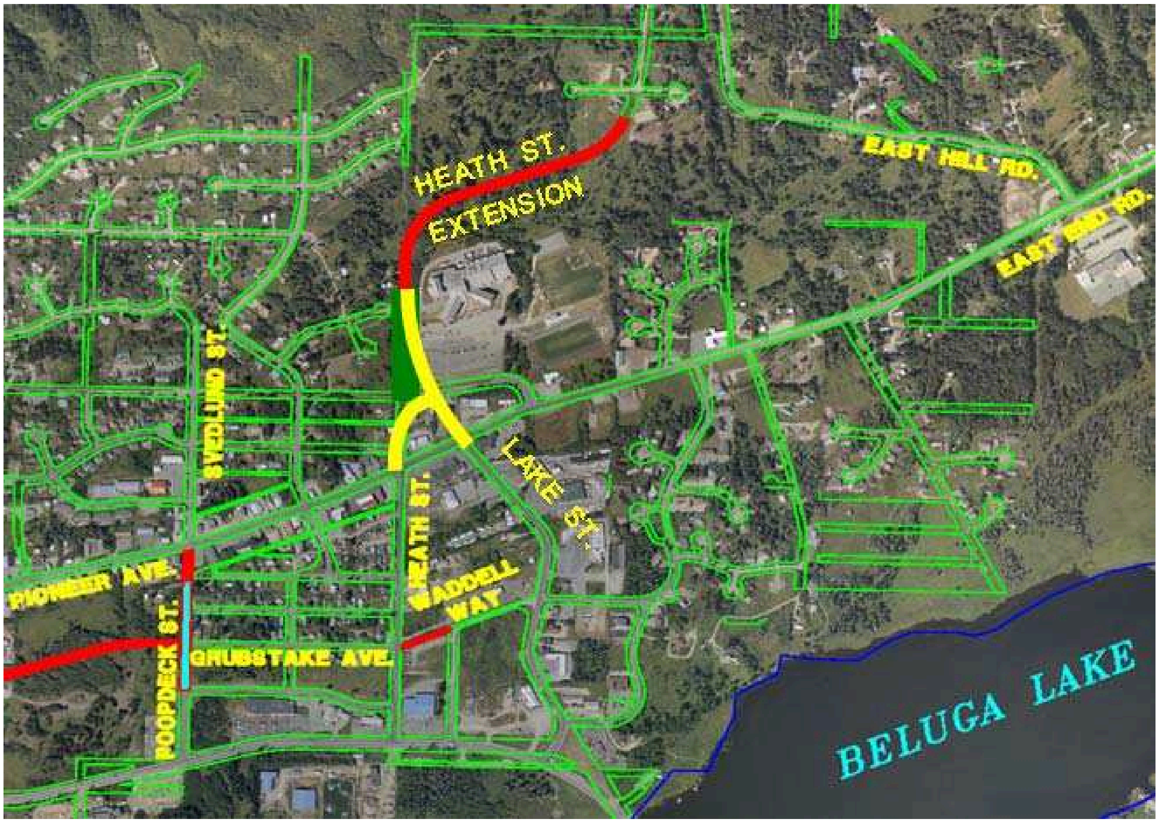


Figure 18- Lake Street Extension Option (yellow) of Heath Street Extension Corridor (red) with Heath Street Connection North of Pioneer

This option would require the demolition of the Kenai Peninsula Borough Maintenance Building. Either a signal or a roundabout would be installed at the Lake Street/Pioneer Avenue intersection. Heath Street and Fairview Avenue intersections would remain as TWSC intersections.

Heath Street would be required to extend to the north of Pioneer Avenue and connect to Lake Street to encourage southbound right turn use (for high school traffic) at Heath Street; this would alleviate potential congestion at the proposed Lake Street signal.

With this alternative, the upstream functional area from Lake Street will overlap at Heath Street approaches; however, southbound and northbound shared through-left turns would decrease and would have other route choices, specifically to divert to either Main Street or Lake Street if delays in the PM peak hour are excessive.

Traffic circulation in the immediate area would likely be modified over what is presented in Appendix B. More traffic would shift to the Lake signal, than what is projected with the Heath Street Extension. Microsimulation of this option (with a signal at Lake Street) was performed with SimTraffic, and Table 65 summarizes performance measures for intersections as well as necessary improvements.

	Pioneer Avenue & Lake Street (Signal)		Pioneer Avenue & Heath Street (Two-Way-Stop)		East End Rd & Fairview Avenue (Two-Way-Stop)	
2021 Scenario	**Signal Delay (sec/veh)**	**LOS**	**Minor Street Delay (sec/veh)**	**LOS**	**Minor Street Delay (sec/veh)**	**LOS**
PM Summer	20.7	C/B	59.4 (SB left)	F	68.7	F
AM Summer	11.4	A	27.6 (NB thru)	D	39.2	E
PM Winter	18.8	B	133.7 (SB thru)	F	66.4	F
AM Winter	12.3	A	93.7 (NB left)	F	95.1	F
Required Geometric and Signalization Improvements: 150-foot NBLT and NBT/NBR northbound approach and 100-foot SBLT and SBT/SBR southbound approach at Lake/Pioneer 6-phase signal control (protected-permitted lefts for northbound and westbound) Single lane approach southbound at Heath/Pioneer Fairview/Pioneer: 100-foot westbound right turn lane; 100-foot southbound right turn						

Table 65- 2021 Simulation Performance Measures for Alternative with the Lake Street Extension to the North of Pioneer Avenue

Heath Street approaches to Pioneer Avenue will incur its greatest delay during PM high school traffic conditions and will have an undesirable LOS during most of the peak hours throughout the year in 2021. However, Heath traffic will have other route choice options, and would adjust accordingly. Also, the planned extension of Poopdeck, although not evaluated in this study, provides additional circulation choices for Heath traffic and may be developed concurrently with the Heath Street Extension corridor. The Fairview/Pioneer intersection will have an undesirable LOS during all peak hours in 2021.

8.3.3.3 Feasible Pioneer Avenue/ East End Road Corridor Plan

The Pioneer Avenue/Heath Street and Pioneer Avenue/Lake Street/East End Road intersection alternatives largely will depend upon if Heath Street is extended to connect to East Hill Road; and upon whether the Lake Street option is used. Moreover, this analysis shows that signals will work for the Heath Street and Lake Street intersections, but there are operational and safety issues with the close spacing that cannot be fully resolved through phasing. There is also a possibility of converting Lake Street and Heath Street to northbound and southbound one-way streets, respectively to form a couplet. This option would make closely spaced signals more feasible due to the reduced complications of coordinating signals on one-way streets.

Because of the number of possible configurations for Heath Street and Lake Street, DOT&PF recommends a separate evaluation of the corridors to determine which layout would best serve Homer. This detailed analysis would draw upon and expand on the conclusions of this Homer Intersections Planning Study.

Table 66 summarizes feasible intersection control alternatives and the current recommendation. It should be noted that the Lake Street extension option would require extensive right-of-way acquisition, and if selected would make a Lake Street/Pioneer roundabout very feasible. Final combination of control alternatives would be determined by a corridor study, but DOT&PF would prefer roundabouts because of long-term maintenance and operations considerations as previously discussed, therefore the Lake Street extension option of the Heath Street corridor is favored by DOT&PF. With this option, a roundabout would be installed at Lake Street, and Heath Street would remain as a TWSC intersection. Although, LOS at Heath under an AWSC would be undesirable, drivers have good alternative route choices if delay becomes too long.

	Main Street (until 2011)	Main Street (after 2011)	Heath Street	Lake Street	Fairview Avenue
			Heath Street and Lake Street Control Combinations should be verified in a separate project study that advances the corridor towards an environmental document.		
Control	TWSC	AWSC	TWSC	100 to 140-foot single lane roundabout	TWSC
Lane Configuration	Existing, no widening required	Existing, no widening required	Existing	Single approach lanes	100-foot WBRT lane 100-foot SBRT and SBLT
2021 LOS	-	C (AM and PM)	F, but other circulation opportunities are available	A (AM & PM)	C (AM summer) E/F (all other peaks)

Table 66- Pioneer Avenue /East End Road Corridor, Sterling Highway to Fairview Avenue Intersection Control

8.3.4 System Alternatives: Peripheral Intersections

West Hill Road and Sterling Highway, Kachemak Bay Drive and Sterling Highway, and East Hill Road and East End Road do not currently meet signalization warrants, but will meet them by 2011. Operations for the West Hill Road and Kachemak Bay Drive intersections are good now, but will decline to below desirable levels by 2015 and 2011, respectively.

The East Hill Road intersection has short periods of congestion in the morning that are the result of the nearby elementary school, but exhibits good operations through the rest of the day. As with the other intersections, the LOS will decline to undesirable levels about the same time as when signal warrants are forecasted to be satisfied.

The existing TWSC is recommended to be retained at these intersections until 2011. By 2011, other treatments are expected to be required for the Kachemak Bay Drive and East Hill Road, but West Hill Road may remain as a TWSC if the community can accept a LOS D. These intersections should be reevaluated (counts and analysis) in 5 years to confirm traffic growth has increased to levels that were forecasted, and to verify control options.

	All Peripheral Intersections (until 2011)	West Hill Road and Sterling Hwy (after 2011)	Kachemak Bay Drive and Sterling Highway (after 2011)	East Hill Road and East End Road
Control	TWSC	TWSC	Signalization or Roundabout 100 to140-ft Diameter, Single Circulation Lane	Signalization or Roundabout 100 to140-ft Diameter, Single Circulation Lane
Lane Configuration	Existing, no widening required	Existing, no widening required	Signalization: Add 150-foot SBLT lane Roundabout: Single lane approaches	Signalization: 100-foot WBRT lane 100-foot SBRT and SBLT Roundabout: Single lane approaches
2021 LOS	-	D (AM and PM, SBL/R)	Signal: A (AM) B (PM) Roundabout: A (AM & PM)	Signal: C (AM) A (PM) Roundabout: C (AM & PM Rodel Results)

Table 67- Peripheral Intersections Intersection Control

8.4 Pedestrian Crossing Alternatives

8.4.1 Sterling Highway Alternatives Pedestrian Performance Evaluation

One-half crossings are acceptable crossing strategies for Sterling Highway though 2021. The current pedestrian crossings with refuges on Sterling Highway (Pioneer, Poopdeck, Lake) are forecasted to perform very well in the future by providing at least ½ crossing gap per minute. The crossing at Main Street would not provide adequate gaps, because no refuge island is provided.

Crossing is enhanced further with the proposed intersection alternatives treatments. Signalization of Pioneer Street and Main Street would provide actuated crossings, under signal control. The proposed roundabouts at Main Street and Heath Street would have splitter islands that provide refuges for pedestrian ½ crossings on all legs. If grades on Main Street prohibit a roundabout, signalization would provide protected crossings under signal control.

The Poopdeck Street pedestrian crossing with a refuge island is compatible with proposed intersection treatments and should be maintained along this corridor.

As discussed under subsection 6.1.2, these crossing locations ware sited where demand was noted or where logical walking route crossings existed.

8.4.2 Pioneer Avenue Alternatives Pedestrian Performance Evaluation

The existing crosswalks at Bartlett Street, Main Street, Svedlund Street, Kachemak Way, and Heath Street, do not have ideal crossing gap frequency (less than one per minute) for a full crossing (40 feet width) of Pioneer Avenue during summer traffic conditions.

The proposed signalization of Main Street, Heath Street, and Lake Street intersections with Pioneer Drive will provide improved crossings under signal control at these locations. However, the crossings at Bartlett Street, and at Kachemak Way and Svedlund Street will remain unsignalized.

An analysis was performed using microscopic simulation model of the corridor in 2021 with the proposed Pioneer Avenue signals at Sterling Highway and at Main, Heath and Lake Streets to ascertain if the signals would create platoons of traffic and improve gaps for pedestrian crossings. The model was calibrated to the existing conditions and traffic by adjusting headways and travel speeds in SimTraffic and comparing the simulated distributions to observed distributions.

The model indicates that Sterling and Main signals would create about 1.1 gaps per minute in 2021 that would be adequate for crossing. As such, no additional treatment for the Bartlett Street crossing would be required.

The crossings between the Main Street signal and the Heath Street Signal show significantly more pedestrian delay (estimate 3 minutes) than the Bartlett crossing, with only 0.3 full crossing opportunities per minute. Therefore additional treatments of the crossings should be considered.

One treatment strategy would be to reduce the width of the street to two through lanes in the vicinity of the crossings, perhaps relocating the crossing away from the intersections so that left-turn channelization could be developed as needed. This narrowing scheme is shown in Figure 17, below for intersections and at mid-block locations. This narrowing would reduce the crossing distance to 24 feet, and the simulation model indicates that there would be about 1.1 crossing opportunities per minute, which exceeds pedestrian crossing service objectives.

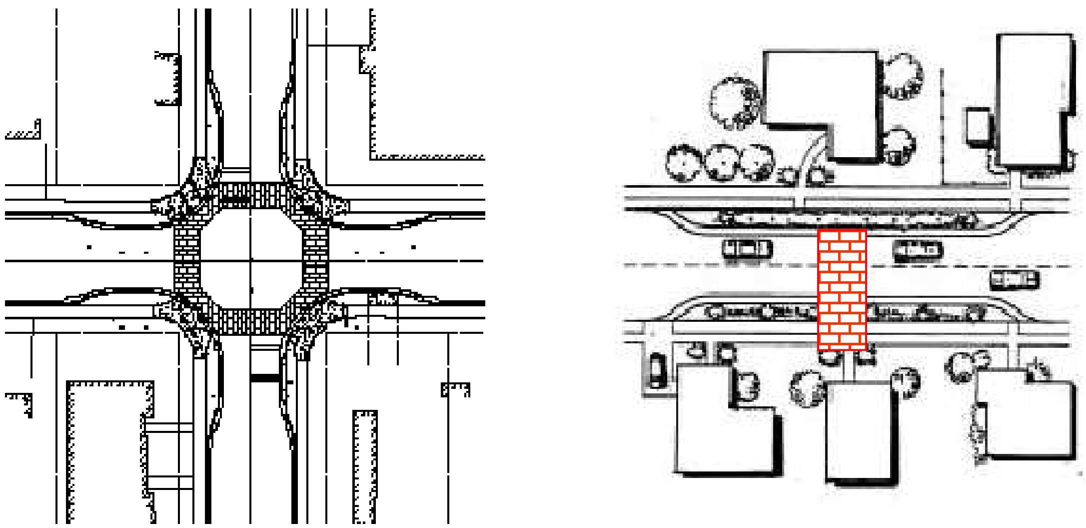


Figure 19- Intersection Choker and Mid-Block Choker (From MOA *Traffic Calming Protocol Manual*)

A second treatment would be installation of refuge islands that would allow ½ crossings at a time. This is the same treatment that is used on Sterling Highway. Pedestrian islands must be at least 6 feet wide, but at "tee" intersections they could be at wide as the CTWLTL. This reduces the crossing width to from 40 feet, to between 12 to 14 feet depending upon the island design. With this treatment the simulated data shows that there would be over 5, ½ crossing opportunities per minute in 2021. This treatment could be deployed in mid-block locations as well, as shown in Figure 18.

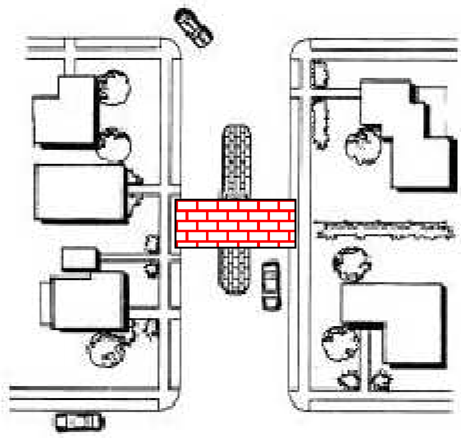


Figure 20- Mid-Block Refuge Island (From MOA *Traffic Calming Protocol Manual*)

Either treatment device should be considered at, or in the near vicinity of, the crossings at Kachemak Way and Svedlund Street to create desirable pedestrian crossing gap frequency.

All recommendations for installation of chokers will validated against freight movement needs.

Ideally for fully developed urban areas, the spacing between crossings should be around 660 feet. The existing distance between crossings is:

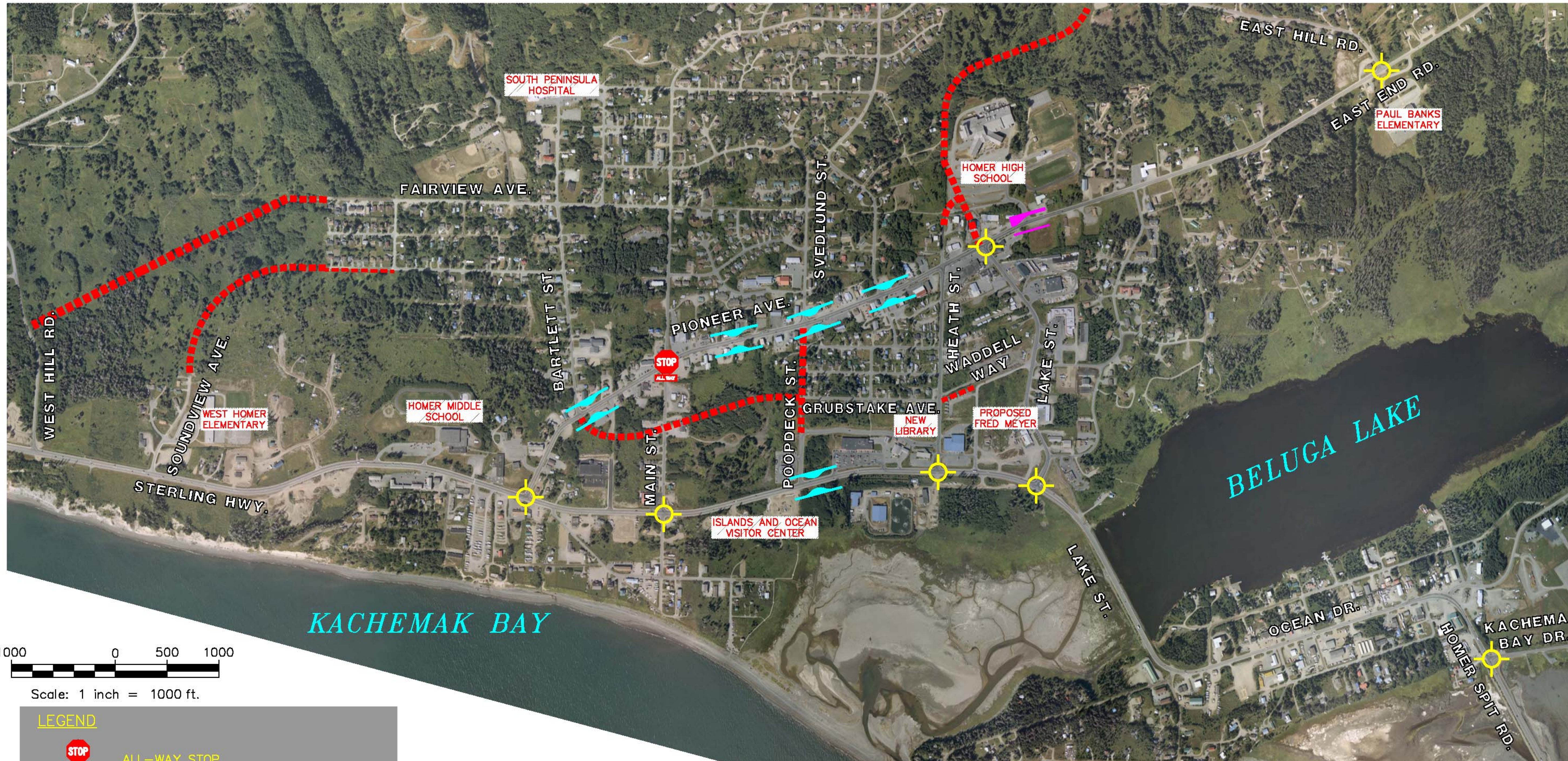
- Bartlett Street to Main Street: 980 feet
- Main Street to Svedlund Street: 1,385 feet
- Svedlund Street to Kachemak Way: 795 feet
- Kachemak Way to Heath Street: 660 feet

Two additional crossings at mid-block or intersections should be considered in the Main Street to Svedlund Street segment to reduce spacings to more desirable distances. Although the Bartlett to Main Streets segment is greater than desirable, gaps are frequent enough (>1 minute) so that unmarked full-crossings would be acceptable. Because motorists do not generally expect mid-block crossings, they should only be used where truly needed and should be well signed and marked. For less developed urban areas such as Homer, mid-block crossings should only be used where a large number of pedestrians are expected to cross the roadway, such as at a major pedestrian traffic generator or where a multi-use trail crosses the roadway.

Alternatively, or in addition to these recommended treatments, Homer may launch a program of education and enforcement to encourage drivers on Pioneer to yield to pedestrians upon entry into the roadway.

Comprehensive Overview of Alternatives

Figure 21 following this page presents intersection control and pedestrian facilities alternatives.



1000 0 500 1000

Scale: 1 inch = 1000 ft.

LEGEND

ALL-WAY STOP

ROUNDABOUT

LEFT OR RIGHT TURN CHANNELIZATION

PEDESTRIAN REFUGE ISLAND/CHOKER

PROPOSED ROAD CONNECTIONS (THIS REPORT AND OTHERS)

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

HOMER INTERSECTIONS PLANNING STUDY

RECOMMENDED IMPROVEMENTS

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:1000'	FIGURE	21

Plotted: Tuesday, Oct 25, 2005, 4:25pm

Plotted by: wwebb

I:\813603\Dwgs\021 proposed improvements.dwg

8.5 Future Development Compatibility with This Study

The volume forecasts used in this study included some near term possible developments, including Fred Meyer and other institutions. Therefore overall volumes and demand are accounted for in this study. Actual route assignments from new developments may vary with the site circulation plans. Some approaches recommend in this study may have to be modified further with additional turning lanes. However, all of the recommended intersection configurations and control have additional capacity to accommodate additional demand from changed circulation or unanticipated development. As such, intersection control alternatives recommended in this study are expected to be adequate for a wide range of development densities and uses.

9 SUMMARY OF PUBLIC INVOLVEMENT

The public involvement program for the Homer Intersection Study included two major activities. The first, a detailed survey of stakeholders to fully understand the scope of the problems to be solved and second, a public meeting to present and summarize the findings of the technical analysis and the survey.

The following paragraphs describe the approach to the survey. A summary of the responses and comment received about the study intersections follows.

In February 2005, Brooks and Associates, as a subcontractor to USKH, Inc., prepared and mailed surveys to agencies and businesses identified as key stakeholders. The survey was developed to gain local knowledge of real and perceptions problems at intersections in the study area. Additionally the survey sought input on potential solutions and provided several open-ended questions to gain general concerns. To ease stakeholder completion of the survey, it could be filled out by hand and returned via fax or mail, or it could be filled out on-line via a "Survey Monkey™" Internet survey tool. To ensure good response the team made follow up calls and sent reminder emails to the stakeholders. Twenty-one (21) surveys were mailed. Several stakeholders contacted the team after receiving their surveys and asked to pass it along to other stakeholders and the team encouraged them to do so. In total, fifteen (15) surveys were returned. The full list of individuals receiving and completing the survey is identified in below.

Department/Agency	Name*	Position
	Anonymous *	
Boys & Girls Club	Loretta Erickson*	Director
Chux Cab	Shane John	Owner
Citizen	Julie Davis*	
Fireweed Academy	Kiki Abrahamson	Principal
Homer Fire Department	Robert L. Painter*	
Homer Fire Department, EMS	Steve Boyle*	E S Specialist
Homer Flex School	Karen Wessel	Principal
Homer High School	Ron Keffer*	Principal
Homer Middle School	Glen Szymoniak	Principal
Homer Police Department	Mark Robl*	Chief
Homer Police Department	Randy Rosencrans*	Lieutenant

Department/Agency	Name*	Position
Homer Police Department	Will Hutt	Sergeant
Homer Police Department	Dave Shealy*	Sergeant
Homer Police Department	Stephen E Smith*	Police Officer
Homer Police Department	Paul Meyer*	Police Officer
Homer Senior Citizens Inc	Fred Lau*	Director
Homer Tours, Inc.	Shelly Erickson*	Owner
Kostas Taxi Service	Nick and Toy Bairamis*	Operator
Laidlaw Education Services	Dave Etzwiler	Field Safety Supervisor
Paul Banks Elementary School	Benny Abraham	Principal
PetroMarine Services	Carol Inman	Manager
Public Works	Carey Meyer	Director
South Peninsula Hospital	Sue Brooks RN*	Safe Kids Coalition
West Homer Elementary School	Charlie Walsworth	Principal
*Survey Returned		

Table 68- Survey Respondents

9.1 EMS Response to Letters of Inquiry

We received responses from the Homer Fire and Police Departments (see list below). The responses to the specific questions are summarized below.

Department/Agency	Name*	Position
Homer Fire Department	Robert L. Painter*	
Homer Fire Department, EMS	Steve Boyle*	E S Specialist
Homer Police Department	Mark Robl*	Chief
Homer Police Department	Randy Rosencrans*	Lieutenant
Homer Police Department	Dave Shealy*	Sergeant
Homer Police Department	Stephen E Smith*	Police Officer
Homer Police Department	Paul Meyer*	Police Officer
*Survey Returned		

Table 69- EMS Responses

In general the responses from emergency response folks discussed:

- The high and increasing volume of traffic, both winter and summer, in Homer.
- The difficult in making left turning movements when traffic volume is high.
- The speeds on streets
- Lack of roadway striping – for both vehicles and pedestrians

- Concerns for pedestrian safety at study intersections
- The need for some type of stop control at area intersections, to provide safe crossing for pedestrians and to provide gaps for turning vehicles.
- Concerns in the area of the high school because of young drivers, speeds, and traffic volumes.
- The importance of accommodating all vehicle types at the intersections—passenger vehicle to RV's and trucks.

There was no clear consensus on the type of stop control to use. Many wanted to upgrade stop sign controlled intersections to traffic light control. Some desire roundabouts, others are concerned about them. For some intersections, one person might express concern while another did not see a concern.

The following section provides all the comments received from the survey, broken down by study intersection. These comments have been edited to correct spelling and to combine like comments. The full detail of the survey responses is contained in Appendix G.

9.2 Public/Agency Response of Letters of Inquiry

Survey responses were received from the following individuals representing their agency or self.

Department/Agency	Name*	Position
	Anonymous *	
Boys and Girls Club	Loretta Erickson*	Director
Citizen	Julie Davis*	
Fireweed Academy	Kiki Abrahamson	Principal
Homer Flex School	Karen Wessel	Principal
Homer High School	Ron Keffer*	Principal
Homer Middle School	Glen Szymoniak	Principal
Homer Senior Citizens Inc	Fred Lau*	Director
Homer Tours, Inc.	Shelly Erickson*	Owner
Kostas Taxi Service	Nick and Toy Bairamis*	Operator
South Peninsula Hospital	Sue Brooks RN*	Safe Kids Coalition
*Survey Returned		

Table 70- Public Responses

The public responses can be summarized as follows:

- Heath Street and Pioneer needs a traffic signal to accommodate buses, student drivers and student pedestrians at school start and end.
- Interest in roundabout at Lake Street and the Sterling Highway.
- Mixed view of the safety of pedestrians crossing the street at roundabouts
- Concern for pedestrian safety near Homer High School
- Desire to increase the number of traffic signals in Homer—because of traffic volume increase
- Desire for flashing yellow light at Boys and Girls Club
- Traffic signals help senior citizens cross the road
- In Homer, most motorists do not stop at crosswalks as compared to motorists who actually stop at crosswalks at roundabouts on Dowling Road in Anchorage.
- Consider intersection at Svedlund and Pioneer, location of a major sight distance problem and seniors going to lunch at the Senior Center use it heavily.
- Clearly mark pedestrian crosswalks and provide better signage to increase drive awareness. Additionally, where there is a clear demand and connectivity, consider installing raised pedestrian refuges, chokers, and medians; supplemented with overhead wig-wag amber flashing beacons that can also be activated by pedestrians and signage.
- Left turn lane needed at East End Road and East Hill Road.
- Sterling Highway and Kachemak Bay Drive – turning lanes and bike path are needed
- In the summer a traffic signal at Pioneer Avenue and Sterling Highway
- Repaint the road striping
- Left turn lanes at most intersections

Survey responses regarding each intersection should be read in detail by design team when the project advances to ensure the details provided, such as sight-distance problems are addressed. The complete surveys are provided in Appendix G.

9.3 Public Meeting

A public meeting was held for this project at Homer City Hall on June 14th, 2005 to discuss the results of the technical analysis of the study intersections. The meeting started out as an open house and then a presentation was given with comments taken afterward. The same presentation was delivered to the City Council on June 13th. The public meeting was advertised in the Homer News and Homer Tribune. Copies of meeting materials and comments collected are included in Appendix G. In general, the comments were about the roundabout proposals, either for or against them. There were however a few comments specifically requesting something be done very soon at Lake Street and Sterling Highway.

10 COSTS AND IMPACTS

Many of the proposed control alternatives listed in this report will require widening or modifying the existing roadway beyond the current road footprint. As such, right of way will need to be acquired at many of the intersections requiring improvements. In addition, utilities frequently locate their physical plant in road right of ways, which can lead to conflicts when roads must be reconfigured. The following utilities are known to operate in the Homer area:

- Alaska Communications Systems (ACS)
- General Communications, Inc. (GCI)
- Homer Electric Association (HEA)
- Homer Water/Wastewater Utility (HWWU)

Storm drains, maintained by Homer Public Works and DOT&PF, are also in the project area and will be affected by the proposed improvements.

Physical plant maps were collected from ACS, GCI, and HEA and added to the base maps for the project. Storm drain catch basins were also added to our base maps. Impacts to these utilities are outlined in the subsequent section of the report. It was assumed that impacts to the HWWU system would be minor (such as adjusting manholes and relocating fire hydrants), so it was not included in the impact analysis.

Right of way and utility impacts are discussed on an intersection-by-intersection basis in the following sections.

10.1 Sterling Highway and West End Road

No control or channelization improvements are necessary at this intersection.

10.2 Sterling Highway and Pioneer Avenue

A roundabout or signalization has been recommended for this intersection. Refer to Figure 22 at the end of this section.

To construct a roundabout, approximately 10,500 square feet of ROW will have to be acquired in all four quadrants of the intersection, including part of the building in the southwest quadrant. Additionally, the driveway access on the south side of this intersection will need to be closed off and moved to the shared access point on the west end of the parcel. Retaining walls will most likely need to be constructed on the north side of the intersection as part of a roundabout installation. Roundabout construction will also require the relocation of two shared utility poles, a length of underground electric cables, and at least three storm drain catch basins.

Signalization would require approximately 330 square feet of new ROW in the northeast quadrant of this intersection. As with the roundabout, the driveway access on the south side of this intersection will need to be closed off and moved to the shared access point on the west end of the parcel. Both of these requirements are expected to have minor impacts on the affected properties. Signalization will also require he relocation of the existing power pole in the northeast quadrant. Minor storm drain modifications will be required with no other significant utility impacts known of at this time.

10.3 Sterling Highway and Main Street

A roundabout or signalization has been recommended for this intersection. Refer to Figure 23 at the end of the end of Section 10.

The footprint of a new roundabout will require right of way acquisitions in all quadrants of the intersection with the residential property in the southwest quadrant requiring a total take. Retaining walls will be required in the northwest quadrant to minimize impact to the parking area of Napa Auto Parts. The existing driveway on Main Street will remain at its current location with the drive onto the Sterling Highway being shifted approximately 50’ to the west.

Two existing utility poles, located in the northwest and southwest quadrants, will require relocation due to conflicts with a new roundabout. Storm drain modifications will be required with no other significant utility impacts known of at this time.

Installation of a signal at this intersection will require acquisition of right of way in the southwest and southeast quadrants of this intersection, which should have minor impacts on the existing land uses. No utility impacts are anticipated due to signalization at this intersection.

10.4 Sterling Highway and Heath Street

A roundabout or signalization has been recommended at this intersection. Figure 23 at the end of Section 10 depicts these alternatives.

The footprint of a new roundabout will require ROW acquisitions in all quadrants of the intersection. Paved parking lots exist in both the northeast and northwest quadrants, and no development is present in the southeast and southwest quadrants. Impacts to the affected properties are expected to be minor. Driveways on Heath Street north of the Sterling Highway would have minor impacts and would remain at their current locations.

Approximately 300' of underground telephone cable may need to be relocated due to roundabout construction, and some storm drain modifications will be required. No other significant utility impacts known of at this time.

Installation of a signal at this intersection will require acquisition of ROW in the southwest quadrant of this intersection, which should have no impact on the existing land use. Minor underground utility impacts are anticipated due to signalization at this intersection.

10.5 Sterling Highway and Lake Street

A roundabout or signalization has been recommended at this intersection. Figure 24 at the end of Section 10 depicts these alternatives.

Installation of a roundabout at this location will not require any right of way acquisition. Utility impacts due to roundabout construction are expected to be limited to relocation of underground electric cables and some storm drain modifications. No other impacts are anticipated due to roundabout construction at this location.

Installation of a signal at this intersection was anticipated during the Lake Street Rehabilitation project completed in 1998, at which time signal poles and conduit were installed. Additionally, loop detectors were installed as part of the most recent repaving project. However, several curb modifications will be necessary to accommodate a WB-67 design vehicle at this intersection. These modifications will not have any right of way or utility impacts, aside from minor storm drain modifications.

10.6 Sterling Highway and Kachemak Bay Drive

A roundabout or signalization has been recommended at this intersection. Figures 26 and 27 at the end of Section 10 depict these alternatives.

Roundabout construction at this location will require ROW on the west side of the intersection, from a vacant, state owned parcel. While no private property will be required for this project, a driveway access may have to be relocated. Roundabout construction would also require the relocation of two underground ACS cables, but no other impacts are expected.

Signalization will require widening the Sterling Highway to add a left turn lane, and the installation of signal equipment. There is ample right of way in this area to accommodate the extra construction. However, driveway access on the west side of this intersection will need to be closed off and access moved to the common road access to the north. This is expected to have minor impacts on the affected property. As with a roundabout, signal construction will also affect the underground ACS cables in the area. These cables will require relocation before work commences on these improvements.

10.7 Pioneer Avenue and Main Street

AWSC intersection should be adequate through most of the project life. No roadway changes are necessary to accommodate AWSC.

10.8 Pioneer Avenue and Heath Street

As mentioned previously in this report, there are several different control options that could be used at this intersection. However, the control used is dependent on whether Heath Street or Lake Street is extended to the north, and on the control used at Lake Street. At this point, the

Lake Street extension is being proposed, which requires no change at Pioneer Avenue and Heath Street.

10.9 Pioneer Avenue and Lake Street

If Lake Street is extended north of Pioneer Avenue, through the existing Kenai Peninsula Borough maintenance facility, a roundabout or signal control will be necessary at this intersection. Figures 28 and 29 at the end of Section 10 depict these alternatives.

In addition to the Borough maintenance facility, roundabout construction will require ROW acquisition from the northeast, southeast, and southwest quadrants, including reconstruction of the sign in the southeast quadrant. Impacts to the southern properties are expected to be significant, but should not require full takes. In any event, the roundabout can be shifted to the north to partially mitigate the property requirements to the south.

Signalization will require widening Lake Street to accommodate a new left turn lane. Additional right of way will not be required for the additional lane, but will be required for the signal equipment and to bring the intersection up to current design standards. Right of way acquisition is expected from the northeast, southeast, and southwest quadrants in addition to the Borough maintenance building, including reconstruction of a sign in the southeast quadrant of this intersection. Reconstructing the sign will require additional compensation to the affected business, but the other right of way requirements are expected to have minor impacts on the affected businesses.

Roundabout construction and signalization both will impact underground ACS facilities in this area. Their cables run along the north side of Pioneer Avenue and crosses Pioneer Avenue to run along the west side of Lake Street. The cable along Lake Street (approximately 150') will have to be relocated to accommodate any improvements. There are also minor storm drain modifications and additions that would be required at this intersection.

10.10 East End Road and Fairview Avenue

No control improvements are necessary at this intersection. However a 100-foot WBRT lane and 100-foot SBRT and SBLT lanes should be installed at this location.

10.11 East End Road and East Hill Road

A roundabout or signalization has been recommended at this intersection. Figures 30 and 31 at the end of Section 10 depict these alternatives.

Due to area topography, roundabout construction at this location would require significant amounts of ROW in all quadrants of the intersection, including reconstruction of the driveway to Paul Banks Elementary. However, due to the rural nature of the area, the impacts of the ROW acquisition should be relatively minor. Installation of a roundabout will require relocation of 2 utility poles, 400 feet of underground ACS and GCI cables, and at least two storm drain catch basins.

Signalization will require widening East Hill Road and the east leg of East End Road to accommodate new right turn lanes. The new turn lanes and the new signal equipment will require 1110 square feet of right of way acquisition from two parcels. Both of the acquisitions are expected to have minor impacts on the affected properties. The signal work will require relocation of 300 feet of underground ACS and GCI cables and 2 storm drain catch basins.

10.12 Costs

The anticipated capital costs for the recommended improvements at each intersection are itemized in Table 71. The total capital cost of all nine intersections is $12,810,000, using 2005 construction cost data. Table 72 includes capital costs for signalizing 7 of the project intersections instead of installing roundabouts. In general, capital costs are mostly federal construction dollars, with a 10 percent match of state or local match dollars. Detailed capital cost information is located in Appendix H.

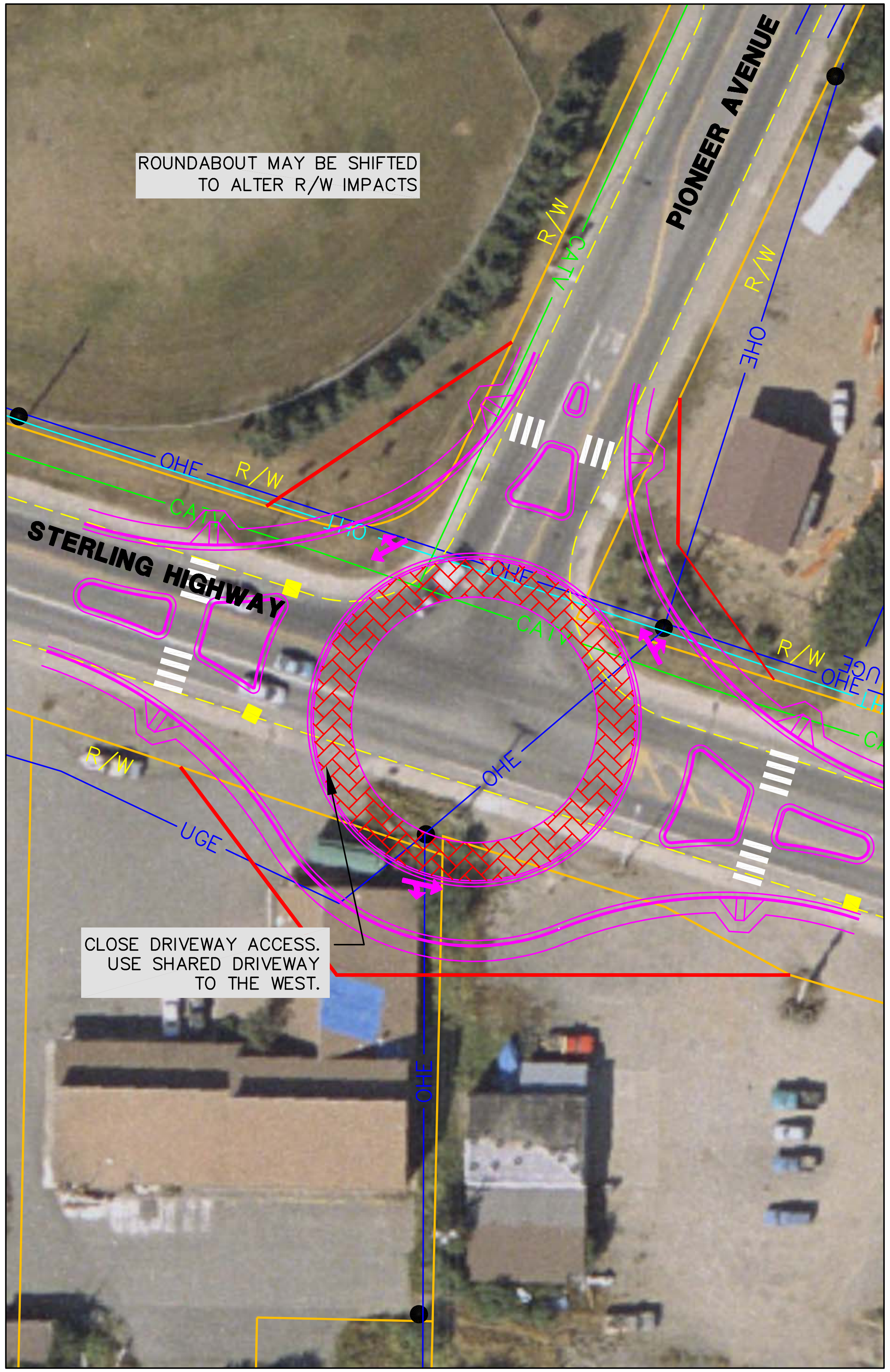
Maintenance costs, on the other hand, are paid for entirely with state and/or local funds and are an obligation that continues indefinitely. In addition to the upfront capital costs, annual maintenance and operations are expected to cost $20,000 for each signalized intersection, which includes expenses such as electricity, replacement parts, and a contribution towards a signal maintenance technician. Roundabout and stop controlled intersections on the other hand will add virtually no increased maintenance obligations.

Intersection		Proposed Control	Preliminary Design	ROW Acquisition	Utilities	Construction	Contract Administration	Total
Sterling Highway	West Hill Road	TWSC	$0	$0	$0	$0	$0	$0
	Pioneer Avenue	Roundabout	$62,000	$600,000	$135,000	$624,000	$204,000	$1,869,000
	Main Street	Roundabout	$126,000	$200,000	$127,500	$1,264,000	$239,000	$2,250,000
	Heath Street	Roundabout	$83,000	$225,000	$40,000	$833,000	$165,000	$1,548,000
	Lake Street	Roundabout	$70,000	$0	$35,500	$697,000	$110,000	$1,049,000
	Kachemak Bay Drive	Roundabout	$62,000	$50,000	$55,000	$621,000	$109,000	$1,032,000
Pioneer Avenue	Main Street	AWSC	$0	$0	$0	$0	$0	$0
	Heath Street	TWSC	$10,000	$30,000	$20,000	$98,000	$22,000	$207,000
	Lake Street	Roundabout	$101,000	$600,000	$35,000	$1,011,000	$247,000	$2,293,000
East End Rd	Fairview Avenue	TWSC	$7,000	$0	$40,000	$74,000	$17,000	$159,000
	East Hill Road	Roundabout	$97,000	$400,000	$146,000	$969,000	$227,000	$2,115,000
Chokers/Islands	Pioneer Avenue		$15,000	$0	$0	$146,000	$22,000	$210,000
	Sterling Highway		$4,000	$0	$0	$36,000	$5,000	$52,000
					Total Capital Cost of Proposed Improvements:			**$12,740,000**
					Total Maintenance and Operations Costs:			**$0**
Note: Total capital costs include a 15% contingency markup								

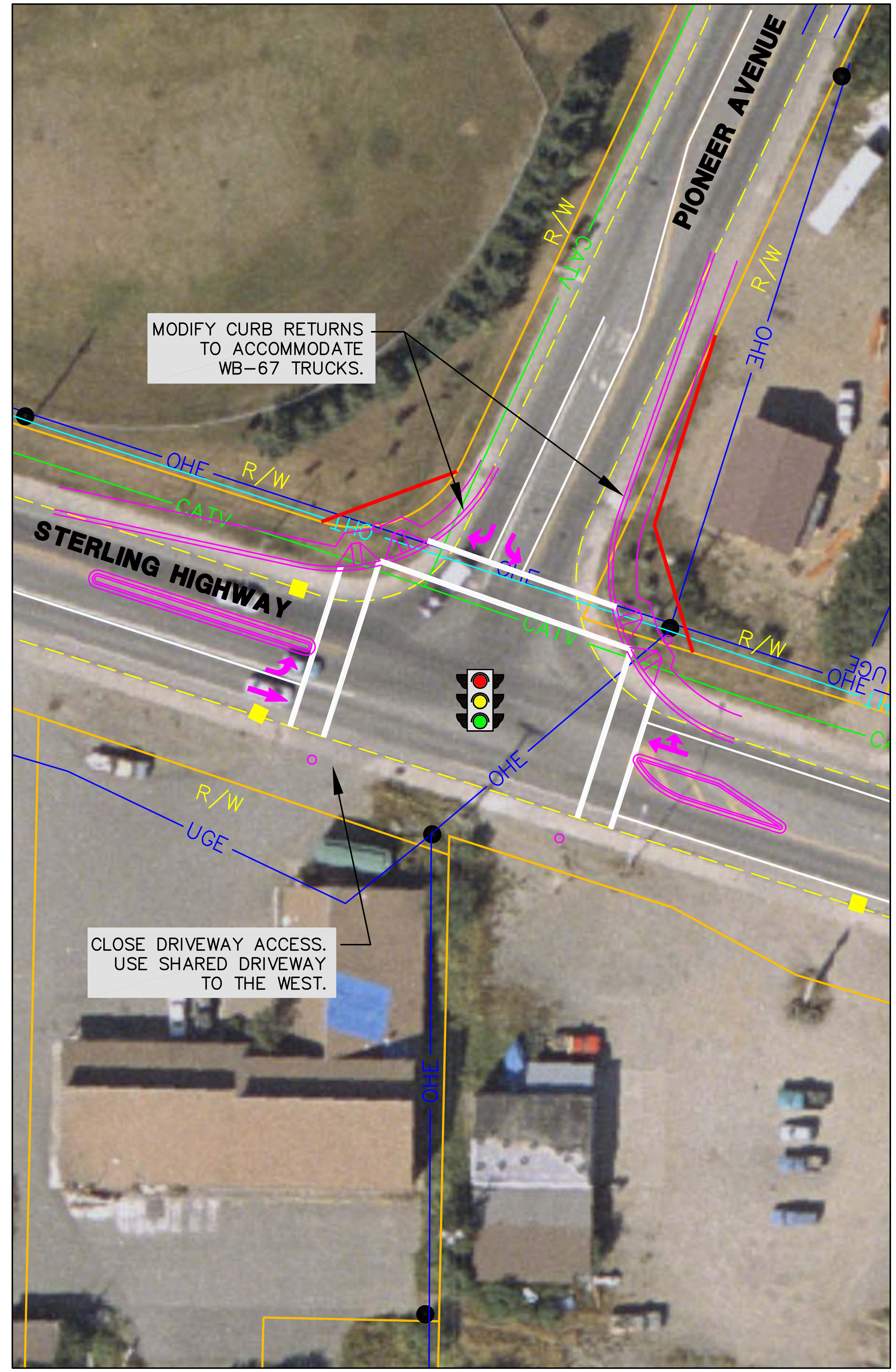
Table 71- Recommended Alternative Costs

Intersection		Alternative Control	Preliminary Design	ROW Acquisition	Utilities	Construction	Contract Administration	Total
Sterling Highway	West Hill Road	TWSC	$0	$0	$0	$0	$0	$0
	Pioneer Avenue	Signal	$49,000	$15,000	$55,000	$492,000	$84,000	$799,300
	Main Street	Signal	$46,000	$1,800	$0	$458,000	$69,000	$661,000
	Heath Street	Signal	$46,000	$10,000	$0	$458,000	$70,000	$671,600
	Lake Street	Signal	$33,000	$0	$0	$326,000	$49,000	$469,200
	Kachemak Bay Drive	Signal	$47,000	$0	$70,000	$468,000	$81,000	$765,900
Pioneer Avenue	Main Street	AWSC	$0	$0	$0	$0	$0	$0
	Heath Street	TWSC	$10,000	$30,000	$20,000	$98,000	$22,000	$207,000
	Lake Street	Signal	$86,000	$400,000	$36,000	$863,000	$195,000	$1,817,000
East End Rd	Fairview Avenue	TWSC	$7,000	$0	$40,000	$74,000	$17,000	$158,700
	East Hill Road	Signal	$42,000	$20,000	$110,000	$419,000	$82,000	$774,000
Chokers/Islands	Pioneer Avenue		$15,000	$0	$0	$146,000	$22,000	$210,500
	Sterling Highway		$4,000	$0	$0	$36,000	$5,000	$51,800
					Total Capital Cost of Proposed Improvements:			**$6,586,000**
					Total Maintenance and Operations Costs:			**$140,000**
Note: Total capital costs include a 15% contingency markup								

Table 72- Signal Alternative Costs



ROUNDABOUT ALTERNATIVE



SIGNAL ALTERNATIVE

Scale: 1 inch = 50 ft.

50 0 25 50

LEGEND

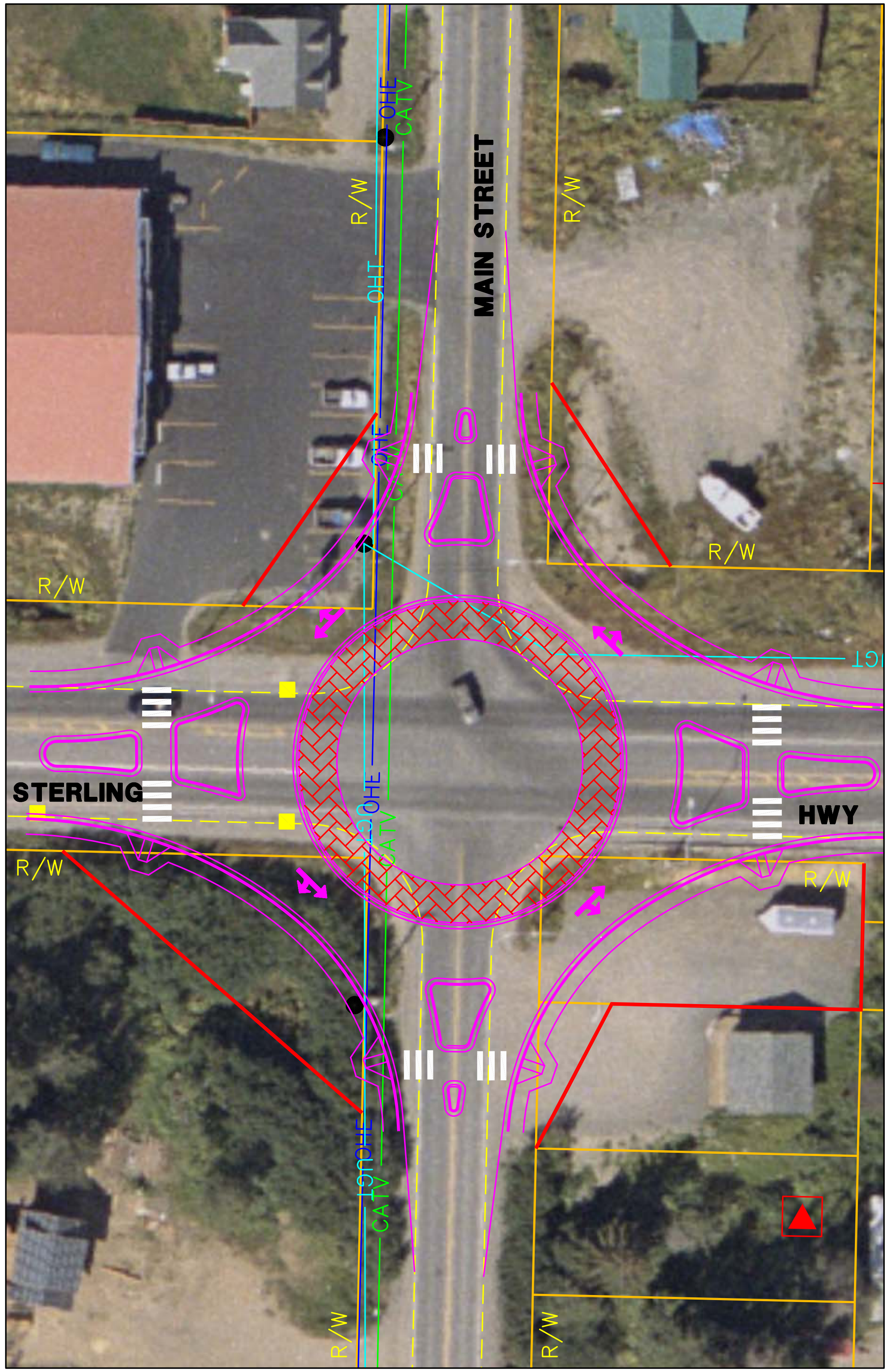
OHE	OH ELECTRIC
UGE	UG ELECTRIC
OHT	OH TELEPHONE
UGT	UG TELEPHONE
CATV	CABLE TV
	STORM DRAINS
	UTILITY POLES
	TRANSFORMER
SWT	ELECTRICAL SWITCH
	EXIST EDGE OF ROAD
	PROP IMPROVEMENTS
	TRUCK APRON
	R/W & LOT LINES
	PROPOSED R/W

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES

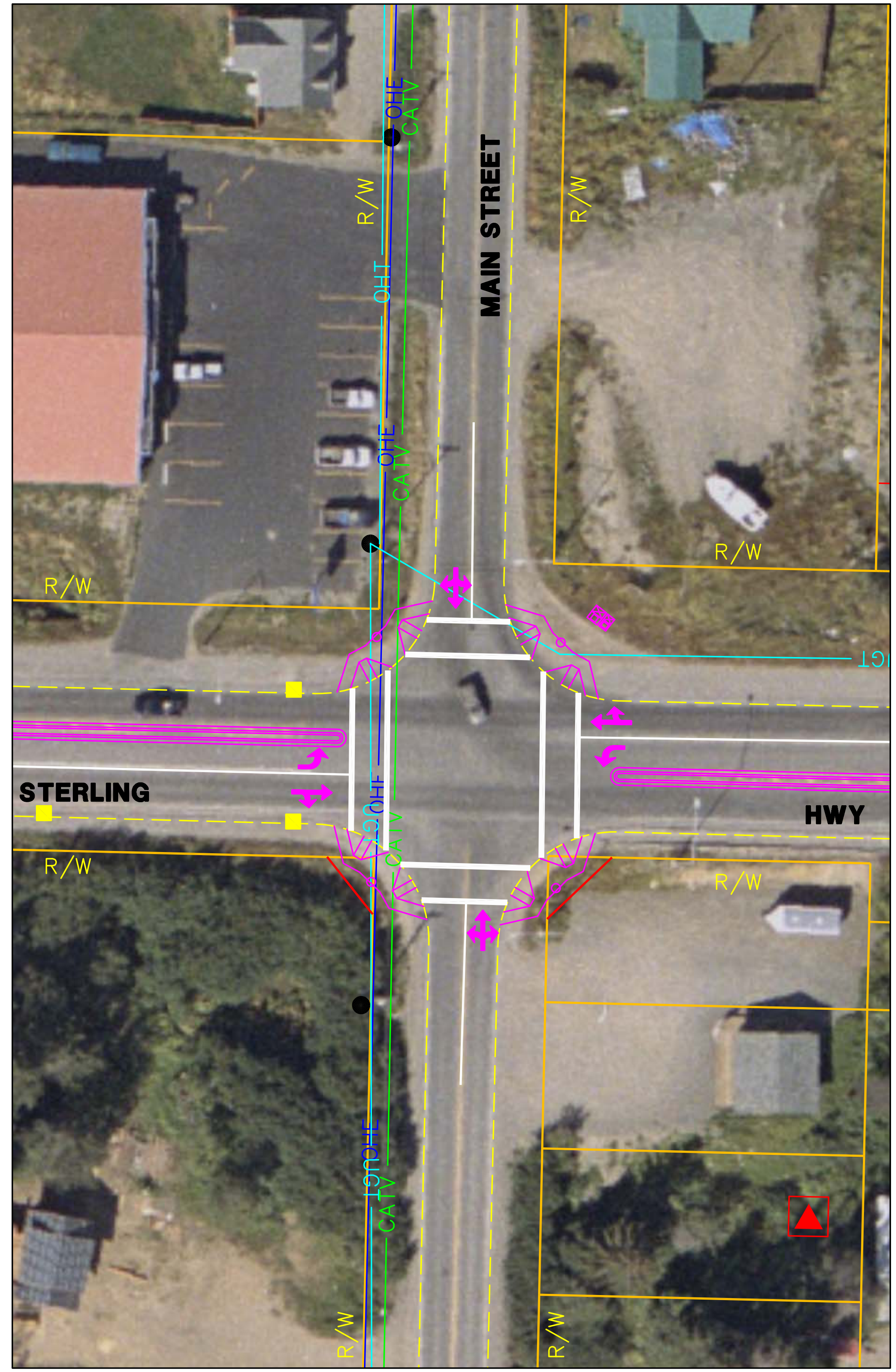
HOMER INTERSECTIONS
PLANNING STUDY
STERLING HIGHWAY/PIONEER DRIVE
IMPROVEMENT ALTERNATIVES

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:50'	FIGURE	22

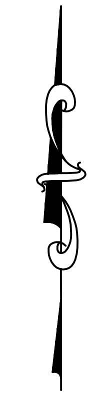
I:\813603\Dwgs\813603-STERLING FIGS.dwg   Plotted by: wwebb   Plotted: Thursday, Jun 23, 2005, 10:22am

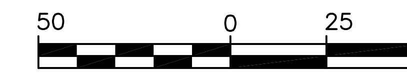


ROUNDABOUT ALTERNATIVE



SIGNAL ALTERNATIVE





Scale: 1 inch = 50 ft.

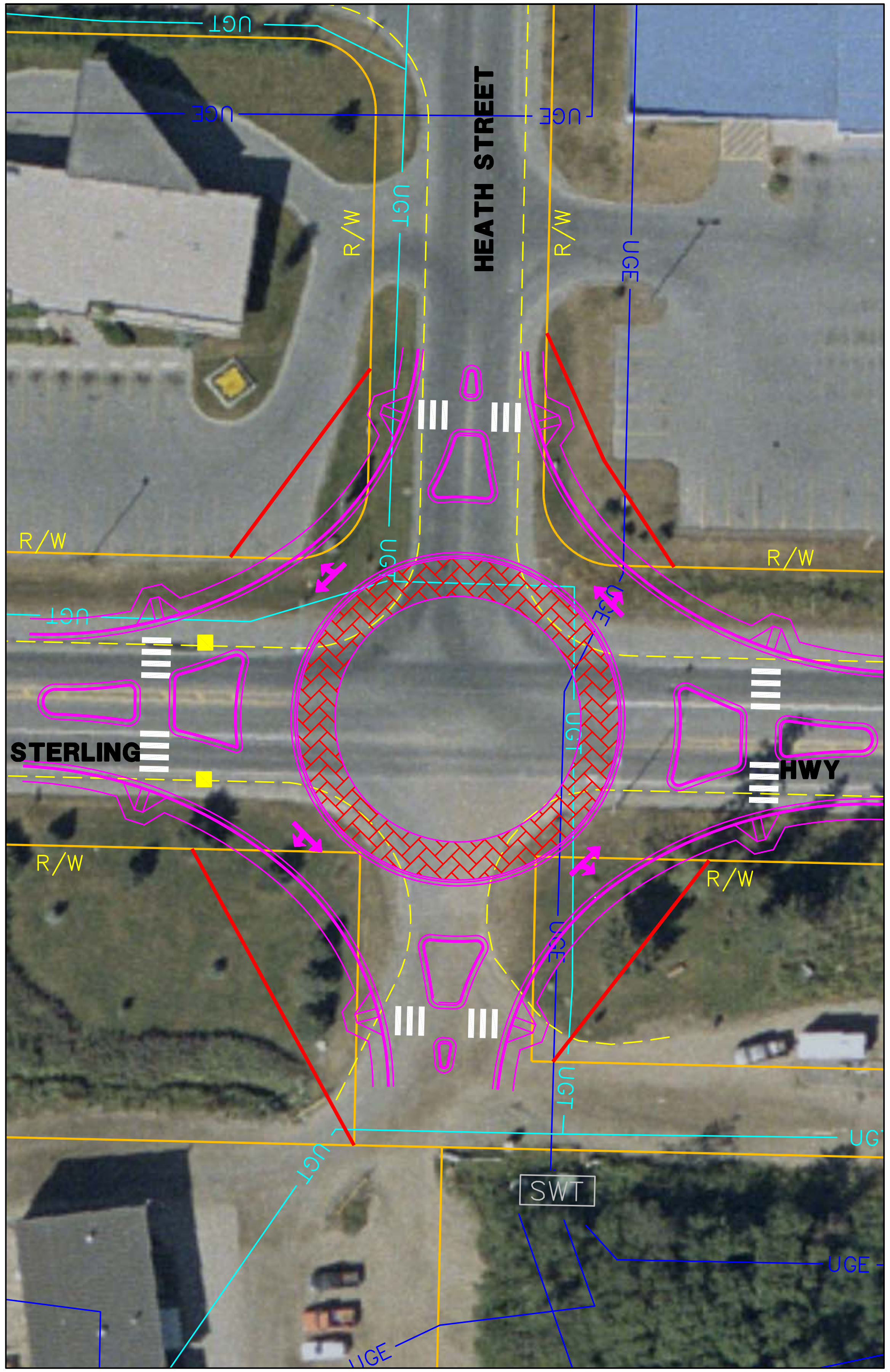
LEGEND

OHE	OH ELECTRIC
UGE	UG ELECTRIC
OHT	OH TELEPHONE
UGT	UG TELEPHONE
CATV	CABLE TV
	STORM DRAINS
	UTILITY POLES
	TRANSFORMER
SWT	ELECTRICAL SWITCH
	EXIST EDGE OF ROAD
	PROP IMPROVEMENTS
	TRUCK APRON
	R/W & LOT LINES
	PROPOSED R/W

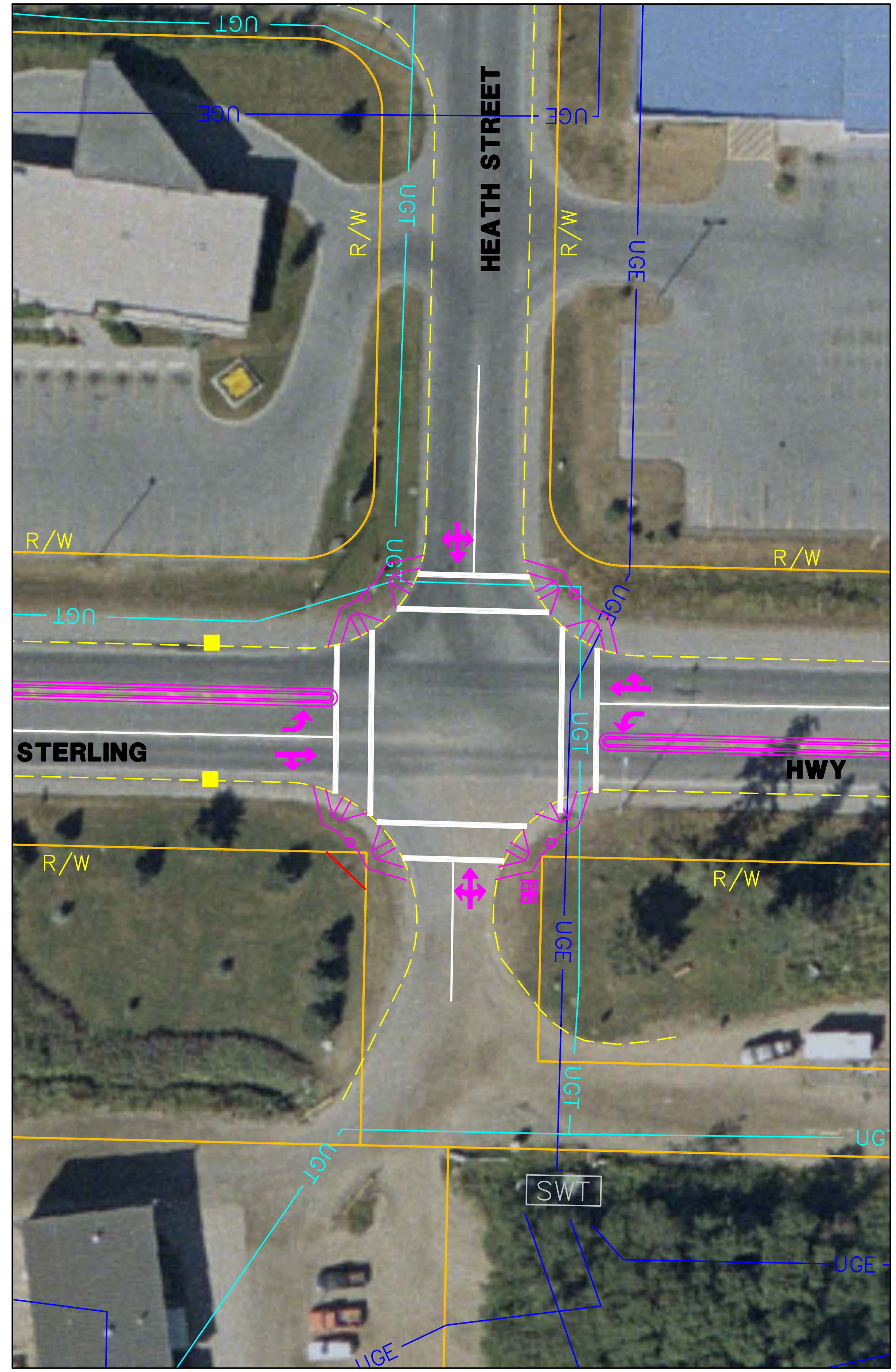
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES

HOMER INTERSECTIONS
PLANNING STUDY
STERLING HIGHWAY/MAIN STREET
IMPROVEMENT ALTERNATIVES

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:50'	FIGURE	23



ROUNDABOUT ALTERNATIVE



SIGNAL ALTERNATIVE

50 0 25 50

Scale: 1 inch = 50 ft.

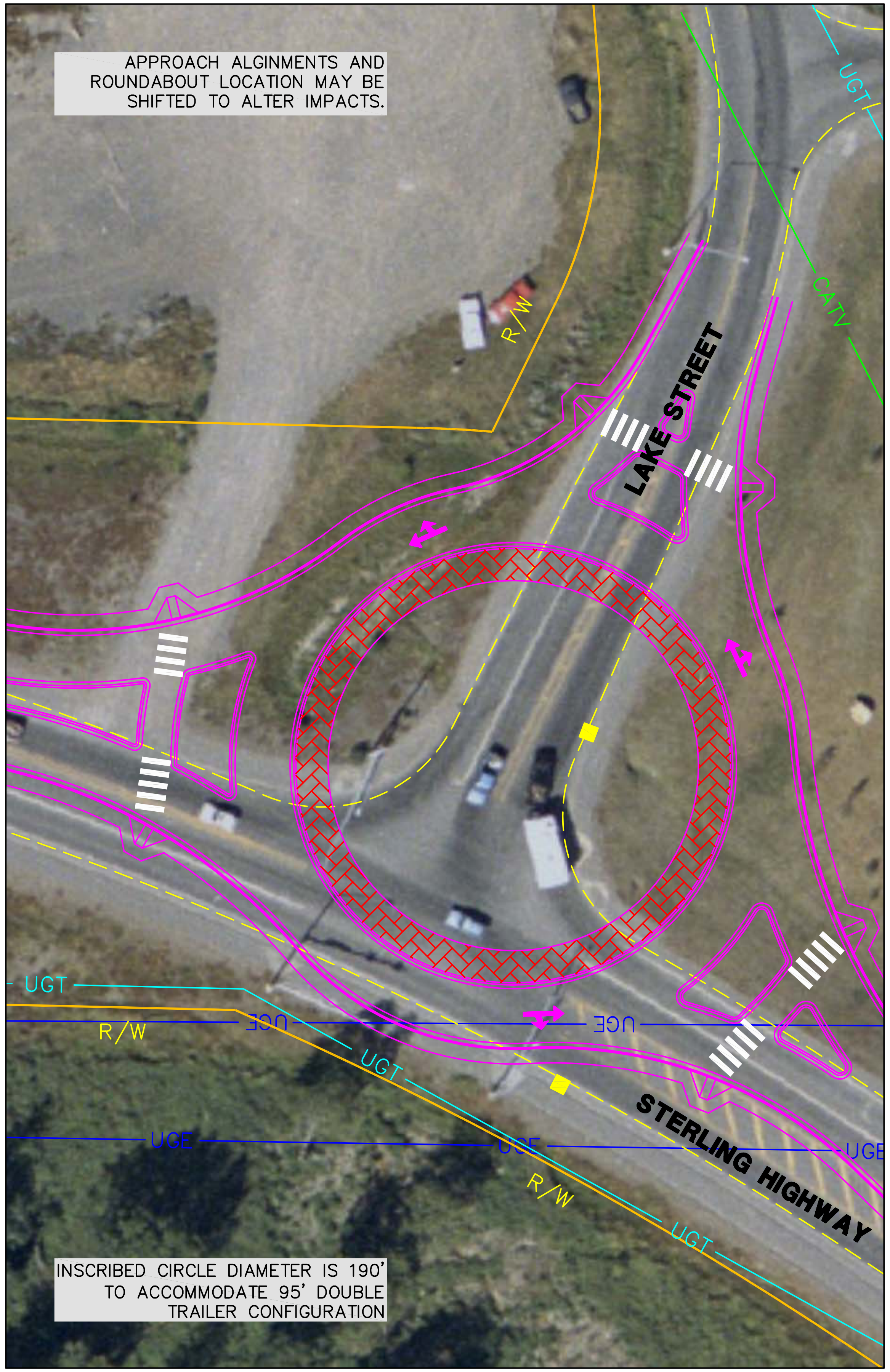
LEGEND

OHE	OH ELECTRIC
UGE	UG ELECTRIC
OHT	OH TELEPHONE
UGT	UG TELEPHONE
CATV	CABLE TV
	STORM DRAINS
	UTILITY POLES
	TRANSFORMER
SWT	ELECTRICAL SWITCH
	EXIST EDGE OF ROAD
	PROP IMPROVEMENTS
	TRUCK APRON
	R/W & LOT LINES
	PROPOSED R/W

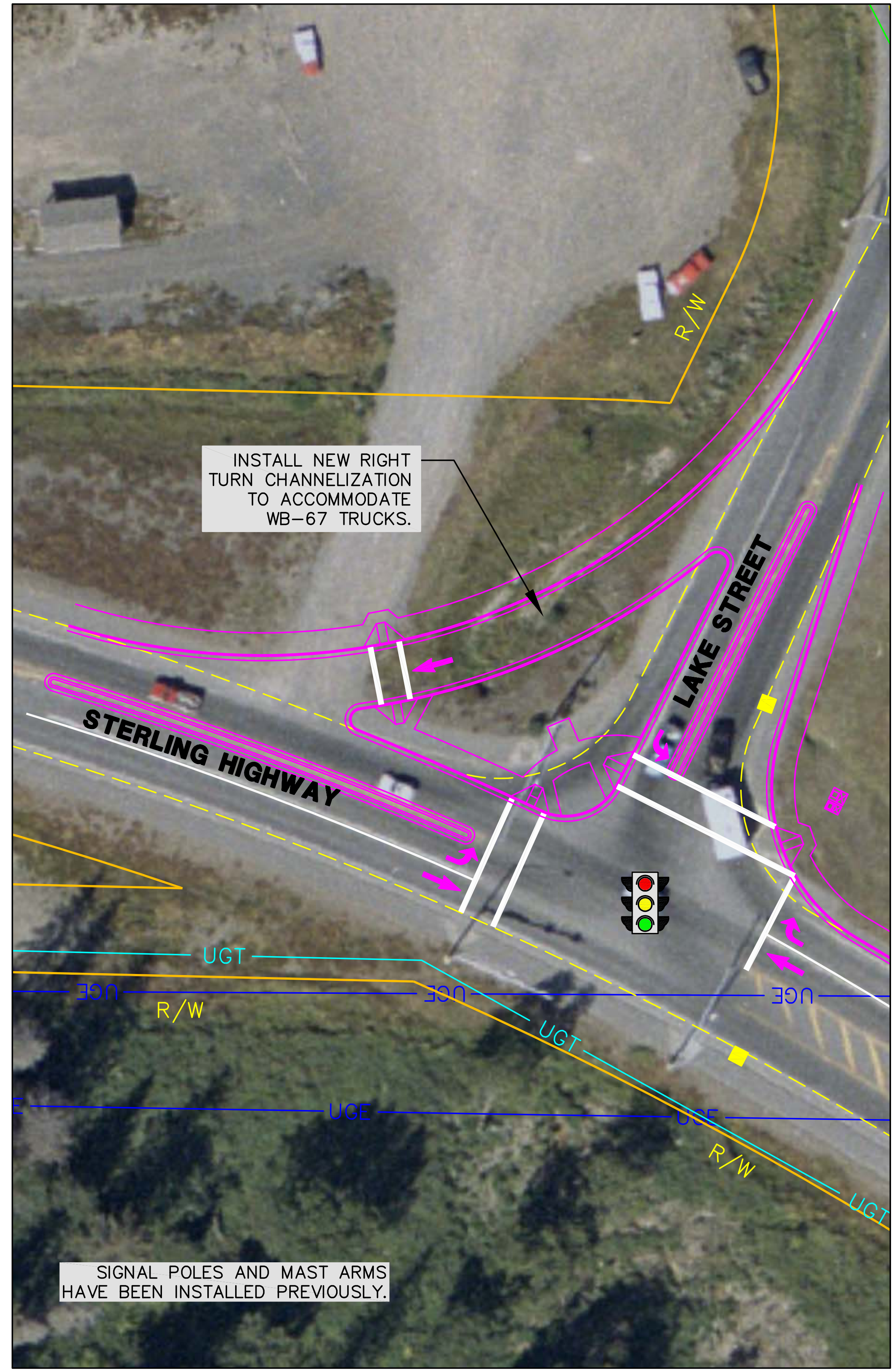
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES

HOMER INTERSECTIONS
PLANNING STUDY
STERLING HIGHWAY/HEATH STREET
IMPROVEMENT ALTERNATIVES

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:50'	FIGURE	24



ROUNDABOUT ALTERNATIVE



SIGNAL ALTERNATIVE

50 0 25 50

Scale: 1 inch = 50 ft.

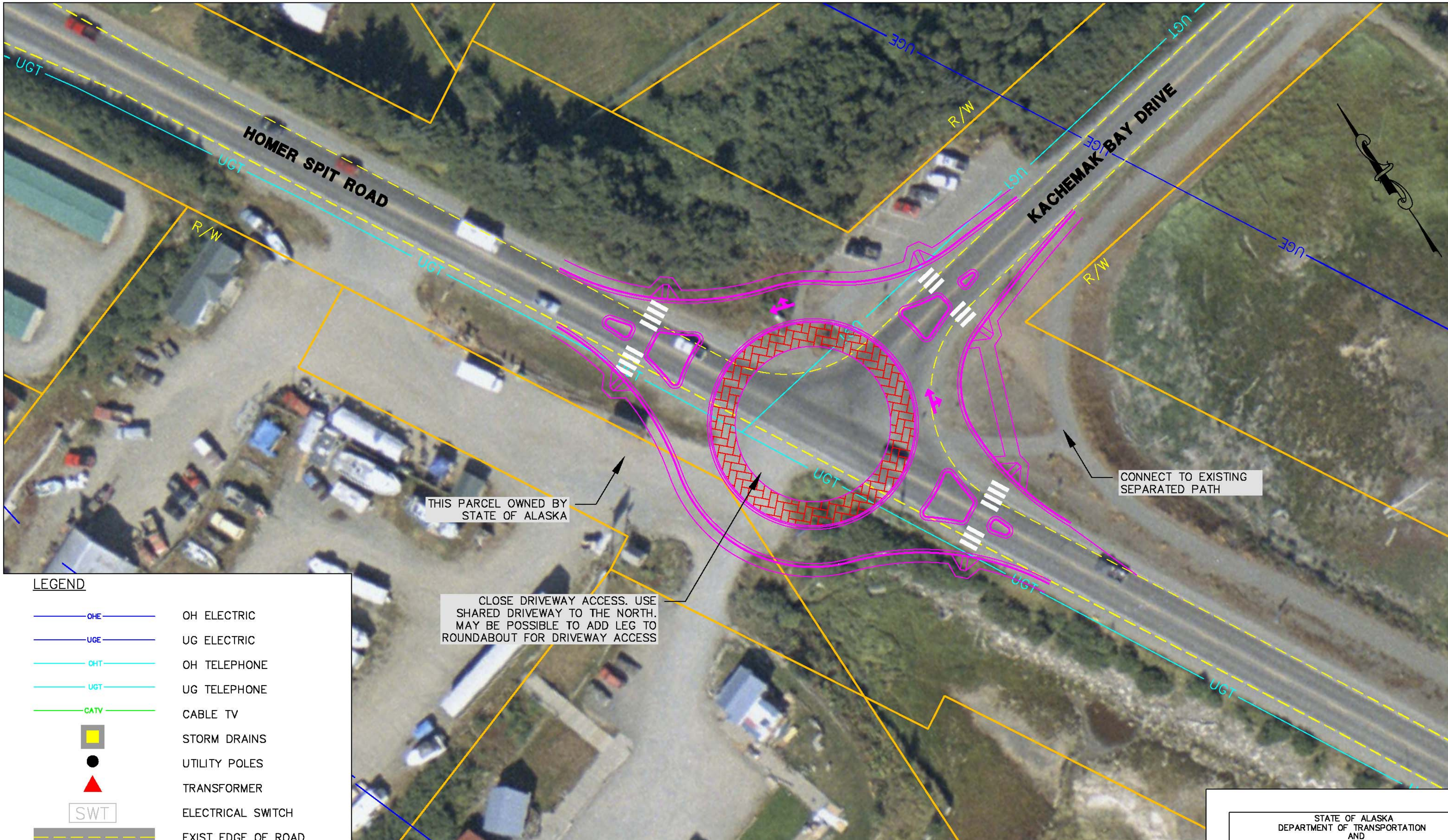
LEGEND

- OHE — OH ELECTRIC
- UGE — UG ELECTRIC
- OHT — OH TELEPHONE
- UGT — UG TELEPHONE
- CATV — CABLE TV
- STORM DRAINS
- UTILITY POLES
- TRANSFORMER
- SWT — ELECTRICAL SWITCH
- EXIST EDGE OF ROAD
- PROP IMPROVEMENTS
- TRUCK APRON
- R/W & LOT LINES
- PROPOSED R/W

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

HOMER INTERSECTIONS PLANNING STUDY
STERLING HIGHWAY/LAKE STREET IMPROVEMENT ALTERNATIVES

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:50'	FIGURE	25



LEGEND

OHE	OH ELECTRIC
UGE	UG ELECTRIC
OHT	OH TELEPHONE
UGT	UG TELEPHONE
CATV	CABLE TV
	STORM DRAINS
	UTILITY POLES
	TRANSFORMER
SWT	ELECTRICAL SWITCH
	EXIST EDGE OF ROAD
	PROP IMPROVEMENTS
	TRUCK APRON
	R/W & LOT LINES
	PROPOSED R/W

HOMER SPIT ROAD @ KACHEMAK BAY DRIVE

50 0 25 50

Scale: 1 inch = 50 ft.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

HOMER INTERSECTIONS PLANNING STUDY
HOMER SPIT RD/KACHEMAK BAY DR
ROUNDABOUT ALTERNATIVE

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:50'	FIGURE	26

Plotted: Thursday, Jun 23, 2005, 10:40am

Plotted by: wwebb

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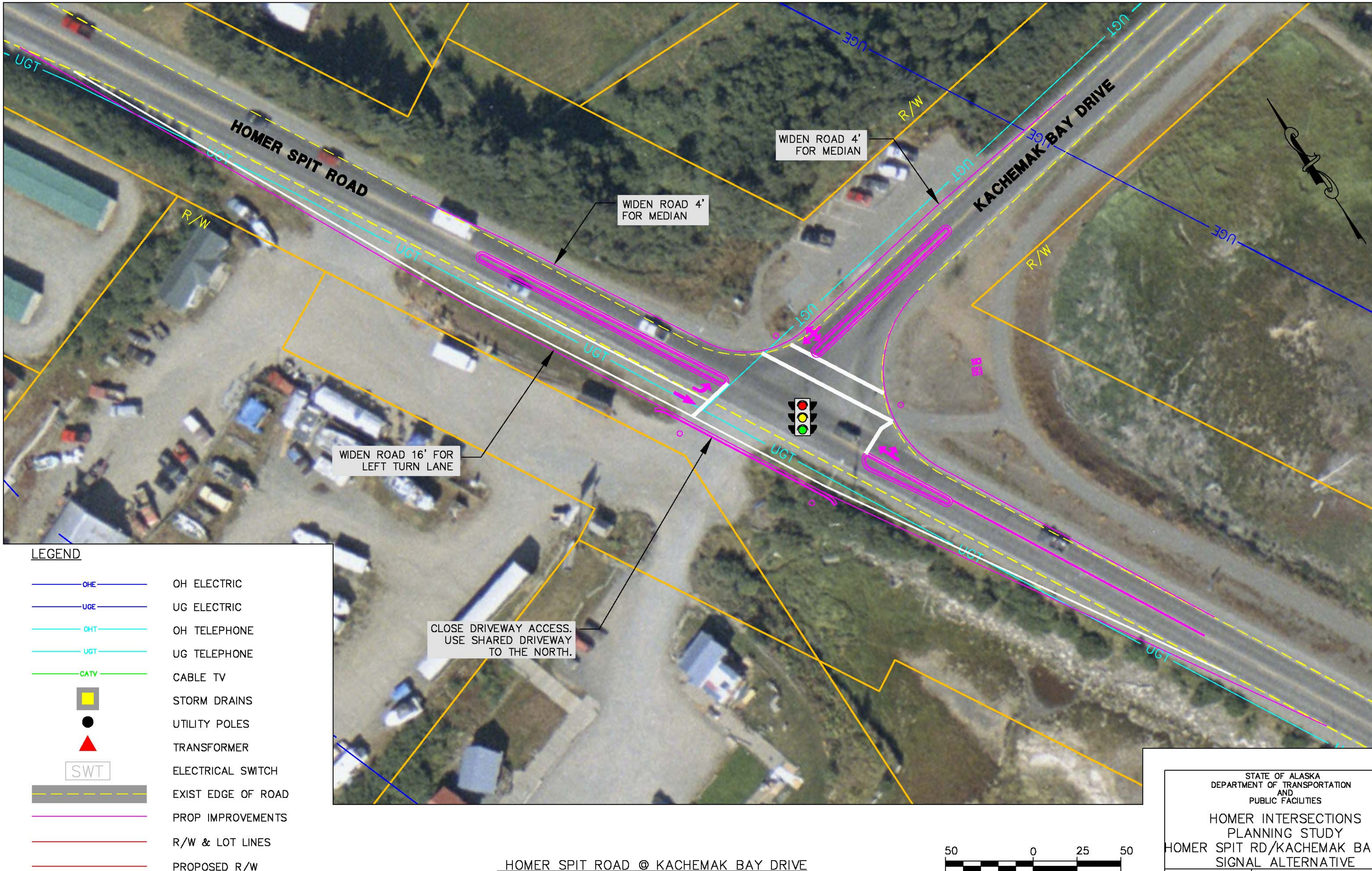


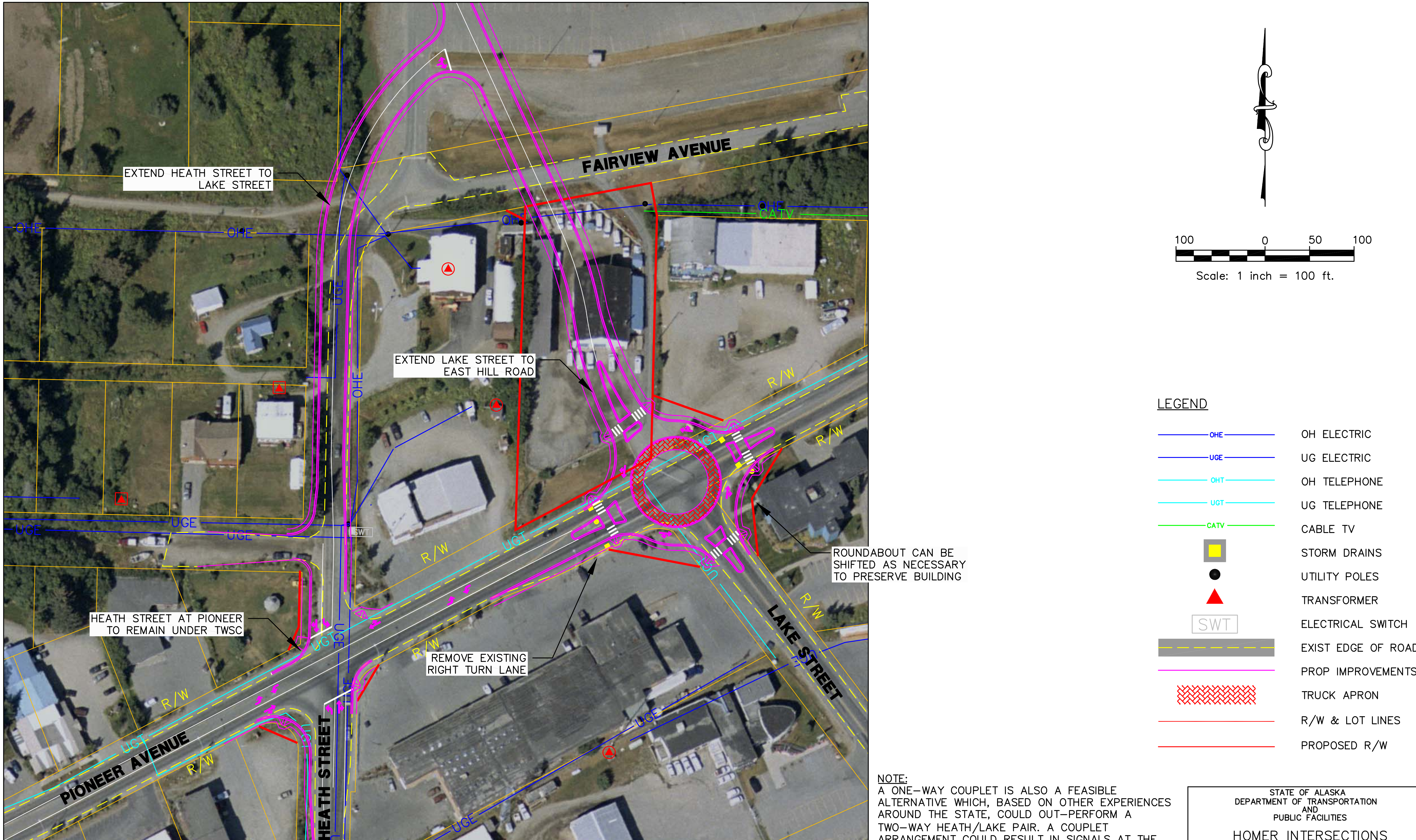
HOMER SPIT ROAD @ KACHEMAK BAY DRIVE

50 0 25 50
Scale: 1 inch = 50 ft.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES

HOMER INTERSECTIONS PLANNING STUDY
HOMER SPIT RD/KACHEMAK BAY DR
SIGNAL ALTERNATIVE

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:50'	FIGURE	27



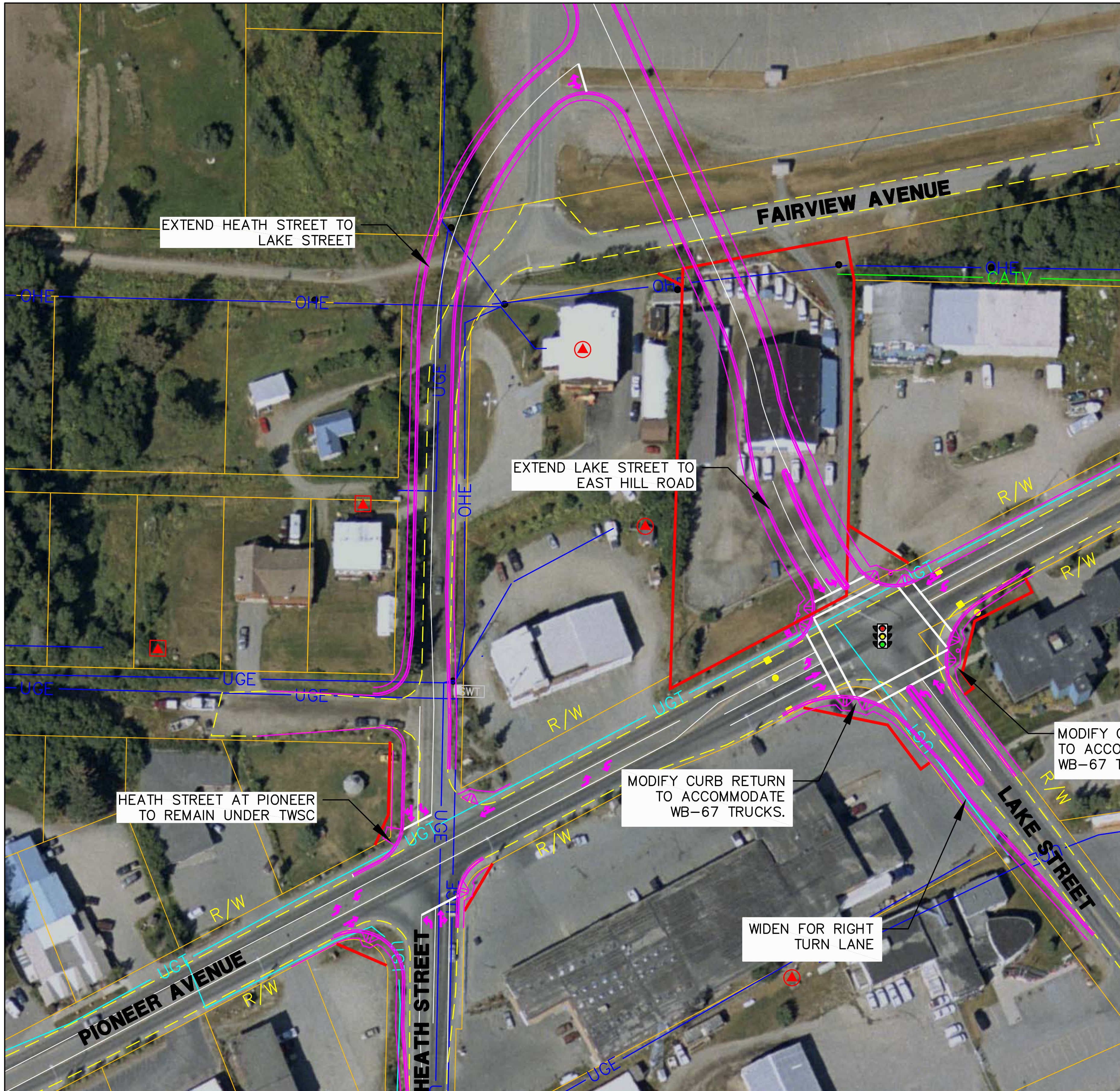
PIONEER AVE @ LAKE ST ROUNDABOUT ALTERNATIVE

NOTE:
A ONE-WAY COUPLET IS ALSO A FEASIBLE ALTERNATIVE WHICH, BASED ON OTHER EXPERIENCES AROUND THE STATE, COULD OUT-PERFORM A TWO-WAY HEATH/LAKE PAIR. A COUPLET ARRANGEMENT COULD RESULT IN SIGNALS AT THE LAKE/PIONEER AND HEATH/PIONEER INTERSECTIONS. THE CONNECTIONS TO FAIRVIEW ALSO DEPEND ON THE FINAL HEATH/LAKE CONFIGURATION.

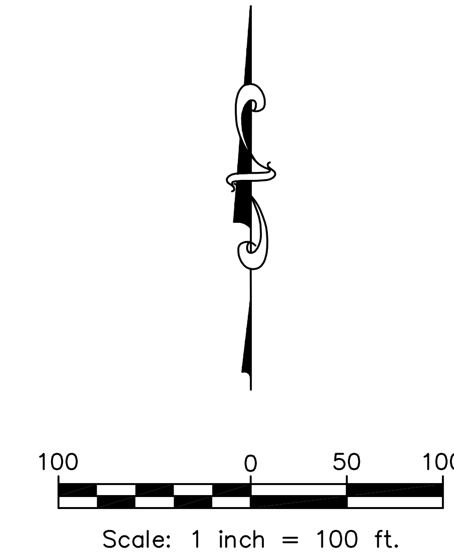
STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

HOMER INTERSECTIONS PLANNING STUDY
PIONEER AVE/LAKE ST ROUNDABOUT ALTERNATIVE

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:100'	FIGURE	28



PIONEER AVE @ LAKE ST SIGNAL ALTERNATIVE



LEGEND

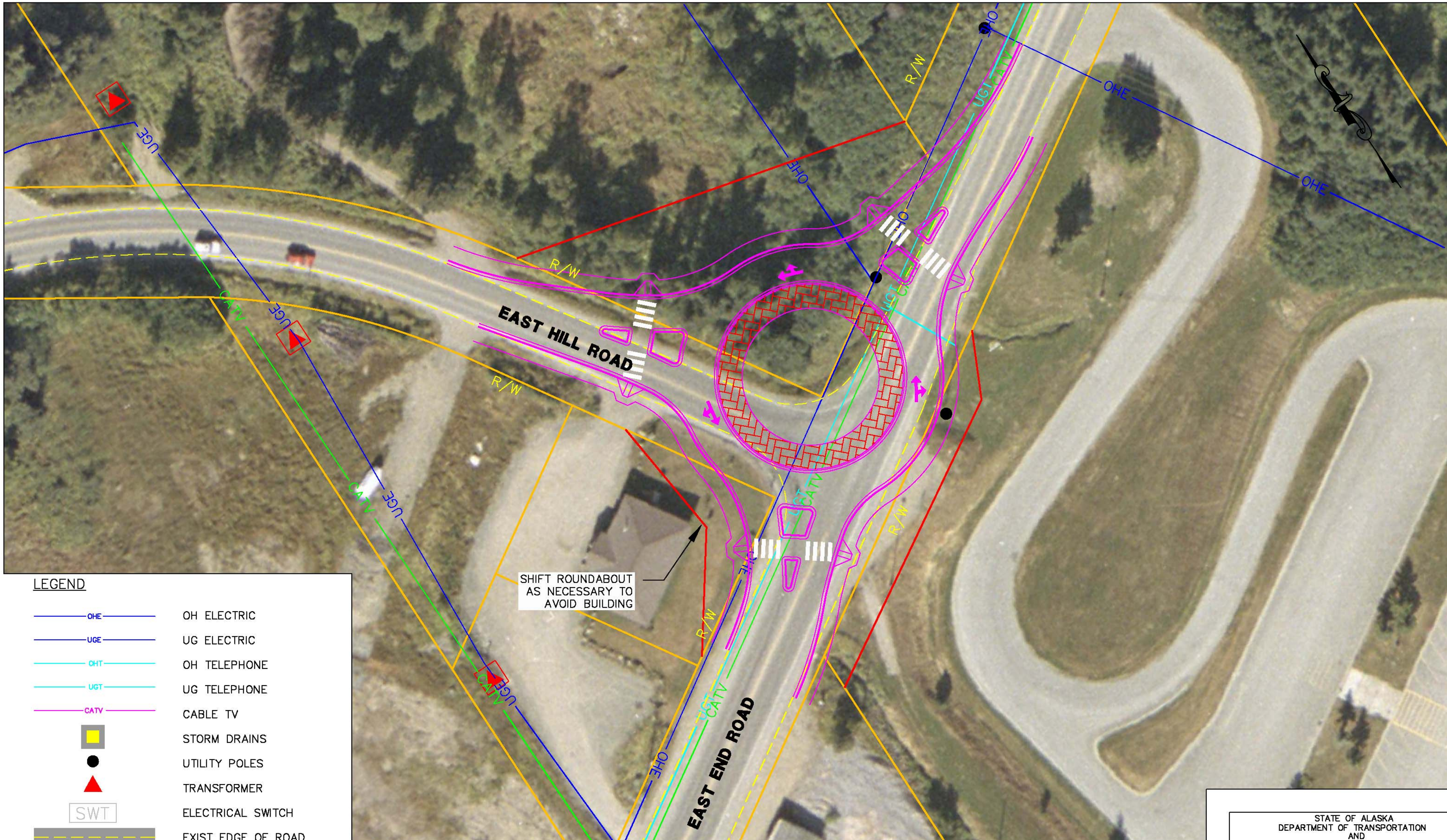
- OHE — OH ELECTRIC
- UGE — UG ELECTRIC
- OHT — OH TELEPHONE
- UGT — UG TELEPHONE
- CATV — CABLE TV
- STORM DRAINS
- UTILITY POLES
- TRANSFORMER
- SWT — ELECTRICAL SWITCH
- EXIST EDGE OF ROAD
- PROP IMPROVEMENTS
- TRUCK APRON
- R/W & LOT LINES
- PROPOSED R/W

NOTE:
A ONE-WAY COUPLET IS ALSO A FEASIBLE ALTERNATIVE WHICH, BASED ON OTHER EXPERIENCES AROUND THE STATE, COULD OUT-PERFORM A TWO-WAY HEATH/LAKE PAIR. A COUPLET ARRANGEMENT COULD RESULT IN SIGNALS AT THE LAKE/PIONEER AND HEATH/PIONEER INTERSECTIONS. THE CONNECTIONS TO FAIRVIEW ALSO DEPEND ON THE FINAL HEATH/LAKE CONFIGURATION.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

HOMER INTERSECTIONS PLANNING STUDY
PIONEER AVE/LAKE ST SIGNAL ALTERNATIVE

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:100'	FIGURE	29



LEGEND

OHE	OH ELECTRIC
UGE	UG ELECTRIC
OHT	OH TELEPHONE
UGT	UG TELEPHONE
CATV	CABLE TV
	STORM DRAINS
	UTILITY POLES
	TRANSFORMER
SWT	ELECTRICAL SWITCH
	EXIST EDGE OF ROAD
	PROP IMPROVEMENTS
	TRUCK APRON
	R/W & LOT LINES
	PROPOSED R/W

EAST END ROAD @ EAST HILL ROAD ROUNDABOUT ALTERNATIVE

50 0 25 50

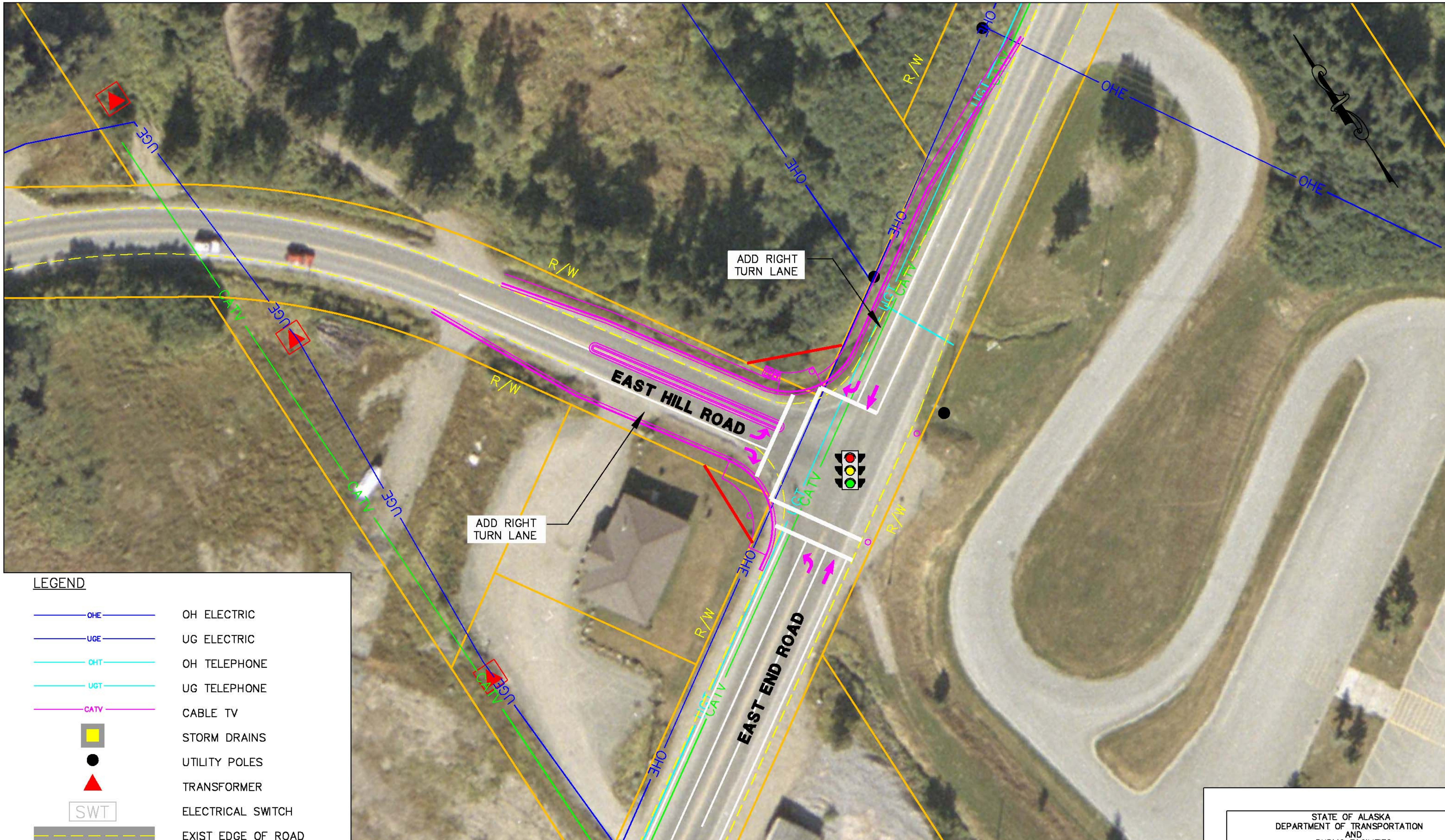
Scale: 1 inch = 50 ft.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES

HOMER INTERSECTIONS PLANNING STUDY
EAST END RD/EAST HILL RD ROUNDABOUT ALTERNATIVE

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:50'	FIGURE	30

Plotted: Thursday, Jun 23, 2005, 9:08am
Plotted by: wwebb
I:\813603\Dwgs\813603-EAST END FIG.dwg



LEGEND

OHE	OH ELECTRIC
UGE	UG ELECTRIC
OHT	OH TELEPHONE
UGT	UG TELEPHONE
CATV	CABLE TV
	STORM DRAINS
	UTILITY POLES
	TRANSFORMER
SWT	ELECTRICAL SWITCH
	EXIST EDGE OF ROAD
	PROP IMPROVEMENTS
	R/W & LOT LINES
	PROPOSED R/W

EAST END ROAD @ EAST HILL ROAD SIGNAL ALTERNATIVE

50 0 25 50

Scale: 1 inch = 50 ft.

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
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PUBLIC FACILITIES

HOMER INTERSECTIONS
PLANNING STUDY
EAST END RD/EAST HILL RD
SIGNAL ALTERNATIVE

DRAWN:	WAW	PROJ. NO.	56311
SCALE:	1:50'	FIGURE	31

Plotted: Thursday, Jun 23, 2005, 9:30am

Plotted by: wwebb

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List of Appendixes