Terrebonne Refinement Plan

Date:	July 5, 2018	Project #: 21463 ODOT Key #21162
To:	Terrebonne Refinement Plan Project Management Team (PMT)	
From:	Matt Kittelson, PE & Jacqueline Gulczynski – Kittelson & Associates, Inc.	
Subject:	Final Technical Memorandum #2 – Analysis Methodology & Assumptions (Task 3.3)	

This memorandum documents the methodology and key assumptions that are proposed for use in the existing and future conditions and alternative analyses for the Terrebonne Refinement Plan (TRP). The methodologies included in this memorandum are based on guidance provided in the Oregon Department of Transportation (ODOT) *Analysis Procedures Manual* (APM), Versions 1 and 2 as they relate to Terrebonne.

STUDY INTERSECTIONS

Two-hour traffic counts (4:00-6:00 PM) were collected in April 2018. The counts were collected Tuesday, April 24th. While video was taken at the 21 intersections, only six study intersections were reduced and recorded for vehicle turning movements, pedestrian volumes, bicycle volumes, truck volumes and passenger car volumes. These intersections will be analyzed under existing and future conditions:

- US 97/Lower Bridge Way/North 11th St
- US 97/South 11th St
- US 97/B St/Smith Rock Way
- US 97/ Underwood Ave/C Ave
- 19th St/Lower Bridge Way
- 11th St/Smith Rock Way

All other intersection will be reduced if necessary for alternative analysis purposes. These intersections include:

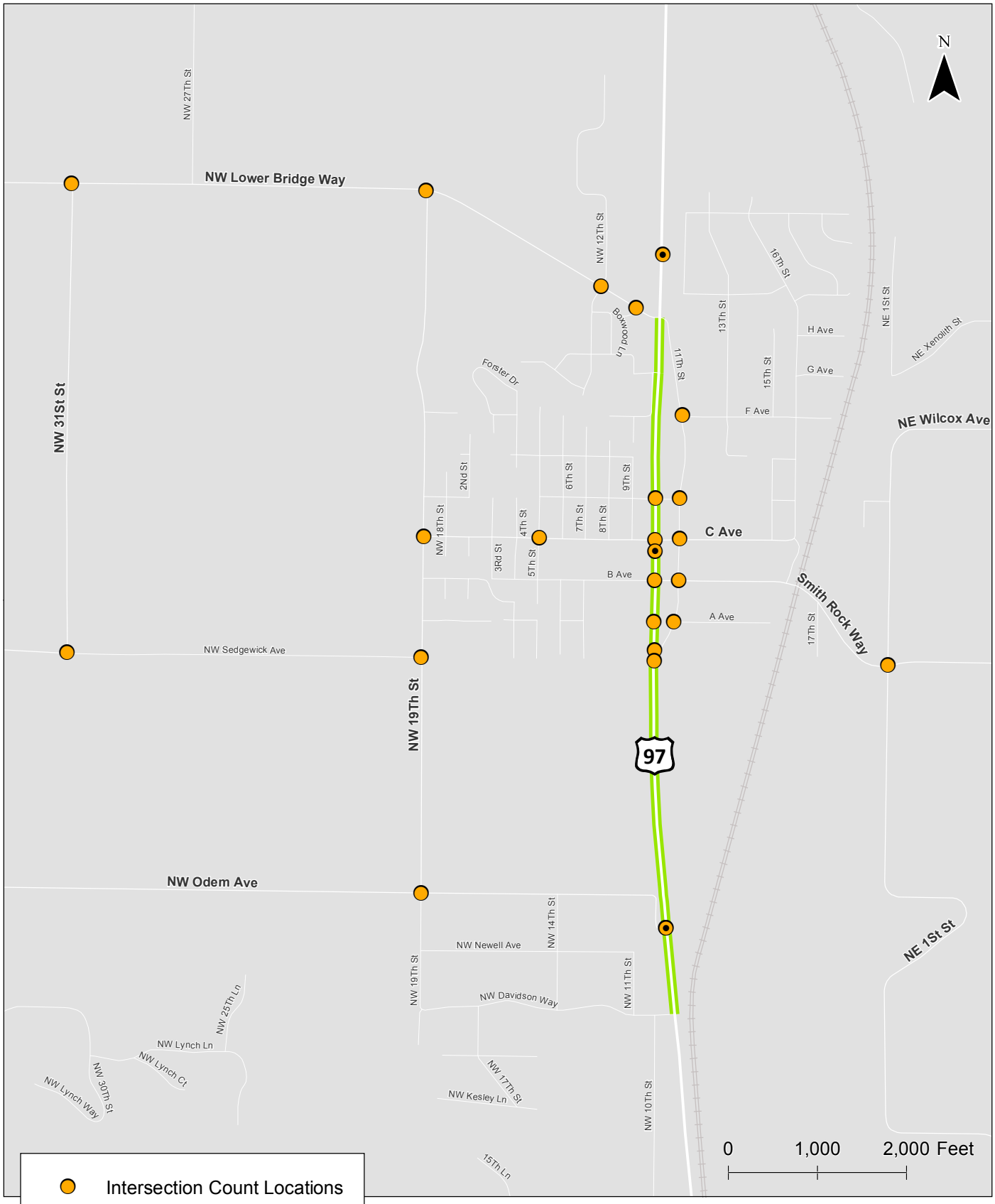
- US 97/Central Ave
- US 97/A Ave
- US 97/NW 10th St
- US 97/NW Odem Ave
- 11th St/F Ave

- 11th St/Central Ave
- 11th St/C Ave
- 11th St/A Ave
- 19th St/Underwood Ave
- 19th St/Almeter Ave
- 19th St/NE Odem Ave
- Lower Bridge Way/Morning Glory Dr
- Smith Rock Way/NE 1st St
- Lower Bridge Way/12th St
- Underwood Ave/5th St

In addition to the turning movement counts, 72-hour volume, speed, and vehicle classification counts were collected at the following locations, also in April 2018:

- US 97 approximately 600 feet north of Lower Bridge Way
- US 97 approximately 100 feet south of C Ave
- US 97 approximately 500 ft south of NW 10th St

Figure 1 illustrates the location of the identified study intersections and the tube count locations. Both the turning movement counts and the tube counts were collected consistent with Task 4.2.A of the Work Order Contract (WOC) scope of work.



Traffic Count Locations
Terrebonne, Oregon

Figure
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KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane Oregon South FIPS 3602 Feet Intl

INTERSECTION OPERATIONAL STANDARDS

Per Task 4.2.B, the following performance measures and information will be provided for each on the initial six (6) study intersections, regardless of jurisdictional control:

- Volume-to-capacity (v/c) ratio;
- Level-of-service (LOS);
- Delay;
- 95th Percentile queuing (not-simulation based); and
- Turning movement counts.

This information will be provided in tables, figures, and/or technical appendices, but where possible will be provided in figures to give the general public a more clear and relatable understanding of the analysis results.

ODOT Mobility Targets

ODOT assesses intersection operations based on established mobility targets (as defined by the volume-to-capacity (v/c) ratio). Table 6 of the *Oregon Highway Plan* (OHP) provides the mobility targets for facilities outside the Portland Metro area (Note that Highway Design Manual standards will be used to evaluate potential solutions in TM #6, Identification of Preferred Alternatives). There is one state facility within the study area: US 97 (The Dalles-California Highway) which is designated by the OHP as Statewide Freight Route. It is also designated as an Expressway north of Lower Bridge Way and south of 11th Street, but not within the downtown Terrebonne core.

Four of the six study intersections are located on US 97. Table 6 of the OHP states that a freight route on a statewide highway outside of an urban grown boundary in an unincorporated community should maintain a mobility target v/c ratio less than 0.70. The expressway designation also identifies a mobility target v/c ratio less than 0.70. However, the OHP states that non-state highway unsignalized intersection approaches should adhere to the volume to capacity ratio for District/Local Interest Roads. Therefore, the mobility standard for the side street approaches to US 97 intersections within the study area is a v/c ratio less than 0.80.

Table 10-2 of the ODOT 2012 Highway Design Manual (HDM) provides V/C ratios used to assist in identifying future system deficiencies and evaluating future alternatives on state highways. The ODOT HDM states that a statewide (NHS) freight route in an unincorporated community should be designed for a mobility target v/c ratio less than 0.60 for a new roadway. Depending on the operational efficiencies of various identified alternative improvements, an alternative mobility standard may be presented within the refinement planning process.

The remaining two intersections are owned and maintained by Deschutes County, which has an adopted performance standard of Level of Service (LOS) D or better. Table 1 shows the intersection control and mobility targets for the study intersections.

Table 1. Study Intersection Control and Mobility Target

Study Int. #	Intersection	Classification / Jurisdiction	Intersection Control	Mobility Target	
1	US 97/Lower Bridge Way/N 11th Street	ODOT	Unsignalized	Side-Street: OHP: v/c<0.80 Mainline: OHP: v/c<0.70:	HDM: v/c<0.60
2	US 97/S 11th Street	ODOT	Unsignalized	Side-Street: OHP: v/c<0.80 Mainline: OHP: v/c<0.70:	HDM: v/c<0.60
3	US 97/B Street/Smith Rock Way	ODOT	Unsignalized	Side-Street: OHP: v/c<0.80 Mainline: OHP: v/c<0.70:	HDM: v/c<0.60
4	US 97/Underwood Avenue/C Avenue	ODOT	Unsignalized	Side-Street: OHP: v/c<0.80 Mainline: OHP: v/c<0.70:	HDM: v/c<0.60
5	19th Street/Lower Bridge Way	County	Unsignalized	LOS D	
6	11th Street/Smith Rock Way	County	Unsignalized	LOS D	

SEASONAL ADJUSTMENT FACTOR

Per Task 4.2.B, all traffic counts along the state routes to reflect 30th highest hour conditions. Version 2 of the APM identifies three methods for identifying seasonal adjustment factors for highway traffic volumes, of which the on-site Automatic Traffic Recorders (ATR) have been identified by ODOT as the most accurate method of use.

As stated within Section 5.4.1 of the APM,

"The On-Site ATR Method is used when an ATR is within or near the project area. If located outside of the project area, there should be no major intersections between the ATR and the project area, and it should be within a minimal distance so that the traffic characteristics such as road class, number of lanes, rural/urban area, etc., are comparable. It is also important to check that the project area's AADT in the Transportation Volume Table is within +/- 10% of the ATRs AADT.".

There are no ATRs located within the community of Terrebonne. The two closest ATRs are in north Redmond and south Madras. ODOT Transportation Volume Tables include traffic AADT data and vehicle classification data throughout the state. Traffic data on US 97 is collected and reported based on milepost. AADT was reported in Terrebonne on US 97 approximately 100 feet north of "A" Avenue. The traffic volumes in Terrebonne were slightly higher than the +10% range of volumes compared to the ATR located in Madras (16-002).

If on site ATR data is not available, the APM suggests using the ATR Characteristic Table Method. The Characteristic Table Method uses an average of ATR data from locations throughout the state that have general characteristics similar to the roadway in the project area. The 2017 ATR Characteristic Table was

referenced to identify an appropriate seasonal adjustment factor for US 97 in Terrebonne. The following assumptions were input into the table to accommodate a wide range of potential similar ATR locations that described Central Oregon attributes:

- **2016 Seasonal Traffic Trend** – Summer, Agricultural, Recreational Summer, Recreational Summer and Winter
- **Area Type** – Rural, Small Urban Fringe
- **Number of Lanes** – 2, 3
- **Weekly Traffic Trend** – Weekend
- **2016 AADT** - >13,000

Two locations remained after the filtered selection, one of which was the ATR located south of Madras. After assessing both the on-site ATR options and completing the ATR Characteristic Table, the Madras ATR (16-002) was selected as the most appropriate seasonal adjustment factor method for the following reasons:

- There are minimal major intersections between Terrebonne and Madras City Limits;
- The ATR is located 18 miles north of Terrebonne on the same state highway;
- The ATR Characteristics Table identified the 16-002 ATR as a viable selection;
- US 97 in Central Oregon shares similar seasonal trends compared to other state highways based on regional, commuter, and tourist demand trends of the area.

The seasonal adjustment factor was determined by averaging the monthly ADT over the course of the most recent 5-year period (2012-2016). Table 2 summarizes ODOT intersections to be analyzed as part of the TRP and corresponding seasonal adjustment factors. No seasonal adjustment factors are proposed for intersection of 19th St/Lower Bridge Way as this road is likely dominated by commuter, residential demand that is unlikely to exhibit substantial seasonal variation.

Table 1: On-Site ATR Method Seasonal Adjustment Method

ATR Station	ATR Location	Seasonal Adjustment Factor	Applied Area
ATR 07-002	US97/US26 MP 97.11; THE DALLES-CALIFORNIA HIGHWAY NO. 4; 0.18 mile north of Madras-Prineville Highway No. 360 (US26)	1.21	US 97 corridor, 11th St/Smith Rock Way

ANALYSIS MODEL PARAMETERS

The bullets below identify the proposed sources of data and methodologies to be used to analyze traffic conditions in Terrebonne. Analyses of all state facilities will be conducted according to the most-recent

version of the APM, unless otherwise agreed upon by both ODOT's Transportation Planning and Analysis Unit (TPAU) and the consultant team.

1. *Intersection/Roadway Geometry* (lane numbers and arrangements, cross-section elements, signal phasing, etc.) will be reviewed through aerial photography and confirmed through a field review. Available as-built data may also be used to verify existing roadway geometry. The analysis models will be built on scaled roadway line work from GIS or aerial photography in Synchro analysis software.

2. *Operational Data* (such as posted speeds, intersection control, parking, right-turn on red, etc.) will be field verified. Data will be reviewed during a field visit and supplemented by available GIS data, aerials, photos, and the ODOT Video Log.

3. *Peak Hour Factors* (PHF) will be calculated for each intersection and applied to the existing conditions analyses. Where applicable, corridor or regional PHFs may be developed. PHFs of 0.95 will be used for the future analysis for high-order facilities (arterials), with 0.90 applied to medium-order facilities (collectors) and 0.85 applied to local roads. If the existing PHF is greater than these default future values, the existing PHF will be applied.

4. Traffic Operations
    a. Highway Capacity Manual (HCM) methodology shall be used for intersection analyses of the design hour conditions. The existing and future no-build analysis will utilize Synchro software for all study intersections. Level-of-service, delay, and volume-to-capacity ratios will be reported at each of the study intersections regardless of roadway jurisdiction.

    b. Queuing analysis methodology will be based on Synchro 95th percentile queue lengths as appropriate; ODOT's two-way stop-controlled intersection calculator tool will be used to estimate queue lengths for two-way stop-controlled intersections. Microsimulation is not proposed as part of the long-range planning effort.

Synchro Input Assumptions

Synchro software will be used for the intersection analyses. This analysis will be consistent with the HCM procedures. Table 3 lists the proposed input parameters.

Table 3. Synchro Operations Parameters/Assumptions

Arterial Intersection Parameters	Existing Conditions
Peak Hour Factor	From traffic counts
Conflicting Bikes and Pedestrian per Hour	From traffic counts, as available
Ideal Saturation Flow Rate (for all movements)	1,750 passenger cars per hour green per lane
Lane Width	12 feet unless field observations suggest otherwise
Percent Heavy Vehicles	From traffic counts by movement, as available
95th percentile vehicle queues	Synchro HCM summary output

CRASH ANALYSES

Per Task 4.2D, the most recent five years of crash data, as provided by ODOT, will be reviewed at the study intersections and study segments (where tube count data was collected). Any intersections or roadway segments that are identified as a Top 5% and 10% Safety Priority Index System (SPIS) site will be included in the crash data.

Intersection crash rates at each location will be compared to the 90th percentile rates, critical crash rates and the excess proportion of specific crash types, per the APM. Crash rates will also be compared to the ODOT Crash Tables II and IV severe injury and fatal crash rates. Any locations where the rates are exceeded, we will identify potential countermeasures using the ODOT All Roads Transportation Safety (ARTS) crash reduction factors.

FORECAST YEAR VOLUME DEVELOPMENT

Per task 4.3.A of the scope, the baseline year 2040 will be used as the future design year. Growth factors were developed using ODOT's historical trends method, which relies on traffic volumes from previous years to develop a growth pattern for use in projected future volumes. ODOT maintains Future Volumes Tables that summarize current and future year traffic volumes for state roadways throughout the State. To calculate the growth rate for Terrebonne, the singular Terrebonne historic count location and two locations from the north and two from the south were reviewed from the Future Volumes Table. The ODOT APM guidance states that data with an R-squared value (RSQ, a measure of fit) of less than 0.75 should not be used when calculating future growth. The Terrebonne count location exhibits an RSQ=0.16. Three of the four adjacent count locations exhibit RSQ values above 0.75. Based on these values, we propose a growth rate of 1.9% to evaluate future condition. Table 4 shows the ODOT Future Volumes Table and the respective values.

Deschutes County typically applies a 2-3% annual growth rate to forecast future volumes on county roads. A conservative 3% annual growth rate will be applied to county roads including the turning movements of roads intersecting with US 97.

Table 4. ODOT Future Growth Table

HWY	MP	DIR	Location	2014	2036	RSQ[1]	Growth Rate
004[2]	105.83	1	0.10 mile south of Culver Highway	13000	18500	0.9830	1.9%
004[2]	112.83	1	Jefferson-Deschutes County Line	13600	19000	0.9361	1.8%
004	115.86	1	0.02 mile north of "A" Avenue at Terrebonne	13700	16300	0.1632	0.9%
004	118.50	1	0.02 mile north of O'Neil Highway	15600	21000	0.3341	1.6%
004[2]	119.09	1	North Redmond Automatic Traffic Recorder, Sta. 09-023, 0.57 mile south of O'Neil Highway No. 370	19700	27800	MODEL[3]	1.9%
						Average Growth	**1.9%**

[1]RSQ=R-squared value, describing the fit of the data to the line

[2]Rows highlighted in grey = RSQ >0.75, were used for the calculated growth rate

[3]MODEL = data was obtained from the Transportation Planning Analysis Unit (TPAU) Travel Demand Model

ACTIVE TRANSPORTATION ANALYSIS

Per Task 4.2.C, the scope of work, existing gaps in the sidewalks, bicycle network, and transit network along the primary routes will be identified. Quantitative and qualitative analysis of active transportation facilities will be performed consistent with APM, Version 2 and include:

1. Qualitative (multimodal) assessment for transit modes;
2. A qualitative assessment of transit service and identification of underserved areas.
3. Gaps in intermodal connectivity (reference the Deschutes County TSP for existing deficiencies).
4. Identification of safety concerns
5. Identification of barriers (gaps, topography)
6. Level of stress analysis (already completed for US97 segments)
7. Identification of treatments to achieve LTS 1 or 2 (i.e. separation) where existing conditions currently exceed.

NEXT STEPS

We look forward to your review of the assumptions and parameters documented herein and proposed to be used as part of the Terrebonne Refinement Plan Existing and Future conditions and alternative analyses.