Noise Technical Report

K18731: Brett Way Extension Project

Klamath County, Oregon

Oregon Department of Transportation

August 2019

Noise Technical Report

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Prepared by: Monica Franz, Air Quality and Noise Coordinator &
Daniel Burgin, Noise Program Leader

Reviewed by: Natalie Liljenwall, P.E., Environmental Engineering Program Leader

REGISTERED PROFESSIONAL
ENGINEER
73534
S.N. Liljenwall
OREGON
JANUARY 08, 2009
SHARON NATALIE LILJENWALL

RENEWS: 12-31-2020

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1. Summary

This report analyzes potential noise impact associated with the Brett Way roadway extension south of OR 140 from Summers Lane to Homedale Road, and roundabout at the intersection of OR 140 and Homedale Road in Klamath County, Oregon. The extension is intended to facilitate future development of the Klamath Falls Industrial Airport Park. The project adds a new roadway which is a trigger for a Type I project that is subject to the requirements of the Federal traffic noise standard (23 CFR 772); therefore a noise impact analysis is required for the project. A project overview is shown in Figure 1. The conceptual design of the roundabout is show in Figure 2.

Oregon Department of Transportation (ODOT) noise specialists evaluated the Project for potential noise impacts to noise-sensitive locations using the Federal Highway Administration (FHWA) Traffic Noise Model (TNM) Version 2.5 (FHWA, 2004). The noise analysis indicated that Existing condition (2016) noise levels ranged from 53 to 70 hourly equivalent decibels on the A-weighted scale (dBA Leqh). Noise levels are predicted to range from 53 to 70 dBA Leqh for No Build (2039) scenario and 55 to 71 dBA Leqh for the Build (2039) scenario.

Under the Build scenario, fourteen (14) noise sensitive receivers representing thirteen (13) residences and one recreation use are predicted to exceed the ODOT Noise Abatement Approach Criteria (NAAC). However, no noise sensitive receivers are predicted to experience noise levels that result in a substantial (10 dBA or greater) increase over existing noise levels (also called a subtaintial noise impact). Since traffic noise impacts were predicted, noise abatement was evaluated. However, noise abatement did not meet feasible or reasonable criteria and will not be recommended.

Any noise related to project construction would be temporary and would be mitigated by the noise control restrictions contained in the standard construction specifications for the project. Night work may be required for this project. Noise variances from Klamath County may be required to perform night work. A table of construction noise levels and discussion of potential construction noise mitigation measures from ODOT's Standard Specifications are included in the appendices of this noise report.

The project area contains undeveloped land which could change with future development. Noise level contours were developed for Brett Way and OR 140 to assist local planning officials with future zoning decisions. Based on noise modeling results for the design year 2039 Build scenario, any proposed residential or public-use facilities or commercial property developed closer than 50 feet from the Brett Way Extension fog line would have the potential to experience noise levels that exceed the NAAC (65 dBA). Any proposed residential or public-use facilities developed closer than 200 feet from the OR 140 would experience noise levels that exceed the NAAC. Any commercial facilities developed closer than 100 feet from OR 140 would experience noise levels that exceed the NAAC (70 dBA). A copy of this report will be sent to the Klamath County Planning Departments. This report will serve to inform the local government of the effects of the proposed project on local noise levels.

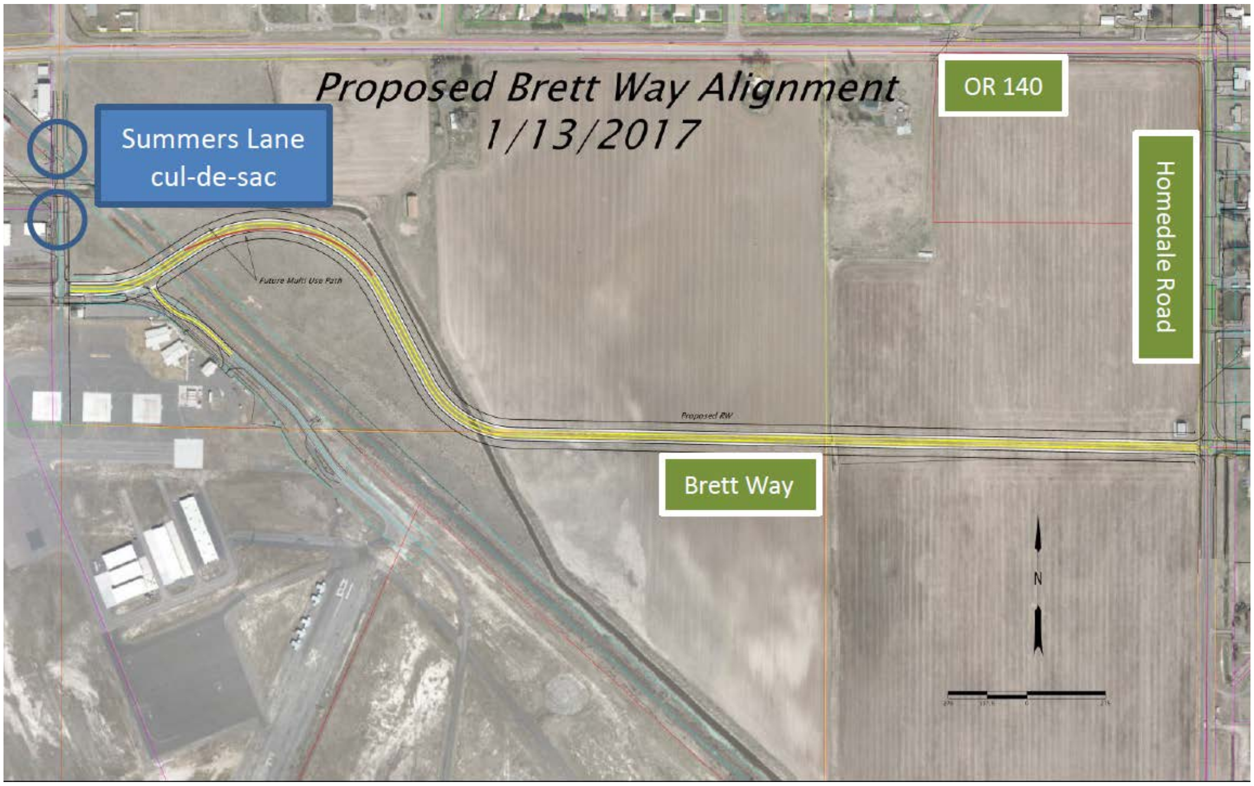

Figure 1. Project Overview

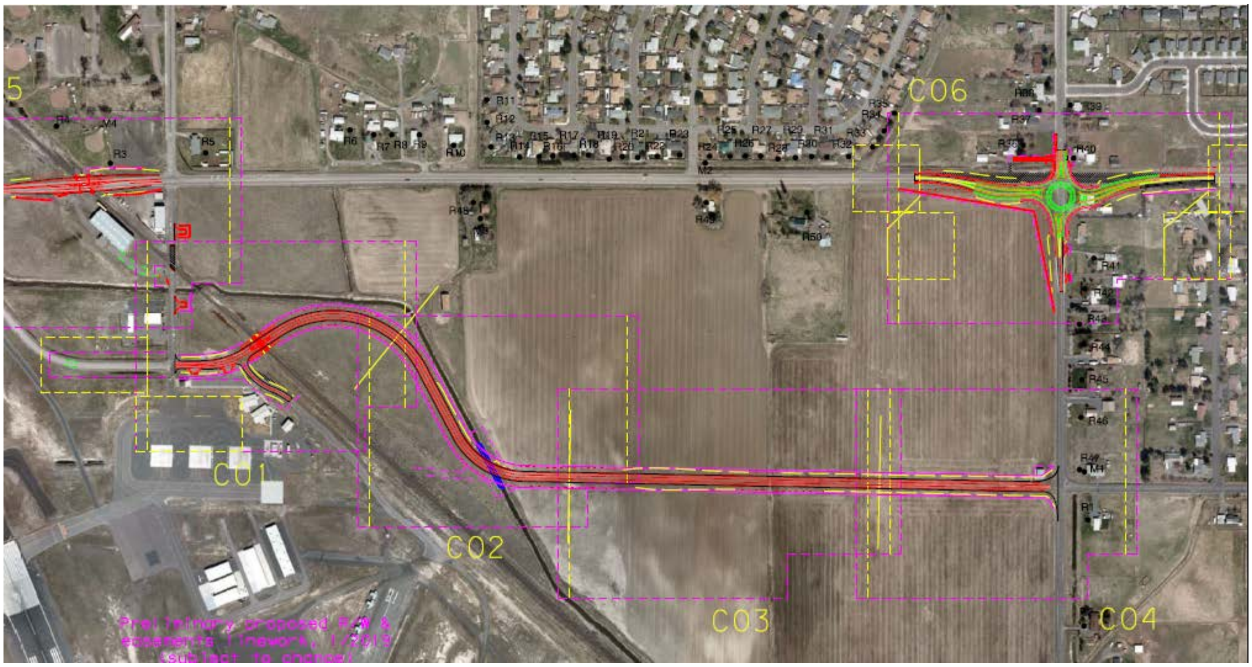

Figure 2. Conceptual Design Drawing with Roundabout

2. Existing Land Use and Zoning

The area of potential impact (API) is the area adjacent to the right-of-way (ROW) for the Build scenario where noise impacts could occur to sensitive noise receptors during project operation or construction. The noise API is determined by predictive modeling and based on guidance in the ODOT Noise Manual (ODOT, 2011). Noise sensitive land uses are generally defined as locations where people reside or where the presence of unwanted sound could adversely affect the designated use of the land.

The project is located within Klamath County, and borders the city of Klamath Falls. The land use in the area is residential, industrial, or undeveloped land. There are pockets of residential areas in on the north and east sides of the project, along OR 140 between Summers Lane and Homedale Road, and along Homedale Road. The area of the roadway extension is currently zoned light industrial and planned unit development.

The Burlington Northern Santa Fe (BNSF) railway crosses the Brett Way extension to the west. The Crater Lake-Klamath Regional Airport is also to the west of the project.

Zoning

A review of the Klamath County zoning maps indicated industrial and residential land uses throughout the project area. There are two residential displacements in the area of the roundabout and one at the intersection of Brett Way and Airway Drive planned as part of this project. A zoning map is shown in Figure 3.

3. Methodology

Guidance from ODOT Noise Manual (July 2011) was used in the preparation of this noise technical report. Predicted noise levels were compared to the NAAC and the impacts were assessed. If traffic noise impacts are predicted, noise abatement measures must be considered for feasibility and reasonableness.

3.1 Traffic Noise Regulations and Impact Criteria

23 CFR 772 and ODOT Noise Policies

The FHWA Noise Standard, 23 CFR 772, defines noise impacts as predicted traffic noise levels that approach or exceed the noise abatement criteria for the project Build scenario or when there is a substantial increase in predicted traffic noise levels from Existing condition to the Build scenario. Methods of determining traffic noise impacts are discussed below.

Noise abatement criteria have been established according to various types of land use activities as shown in Table 1. Noise levels are measured in hourly equivalent decibels on the A-weighted scale (dBA Leq(h)). An impact occurs when the predicted traffic noise levels approach or exceed the noise abatement criteria. According to ODOT's noise policy, NAAC has been defined as 2 dBA less than the FHWA levels shown in Table 1. Residences (Activity Category B), schools, parks, churches, and other land uses in activity category C are impacted by traffic noise when project noise levels reach 65 dBA Leqh for frequently-used outdoor areas.

A traffic noise impact may also occur when the predicted traffic noise levels for the project substantially exceed the existing noise levels. An increase of 10 dBA or greater is considered a substantial noise increase impact in Oregon.

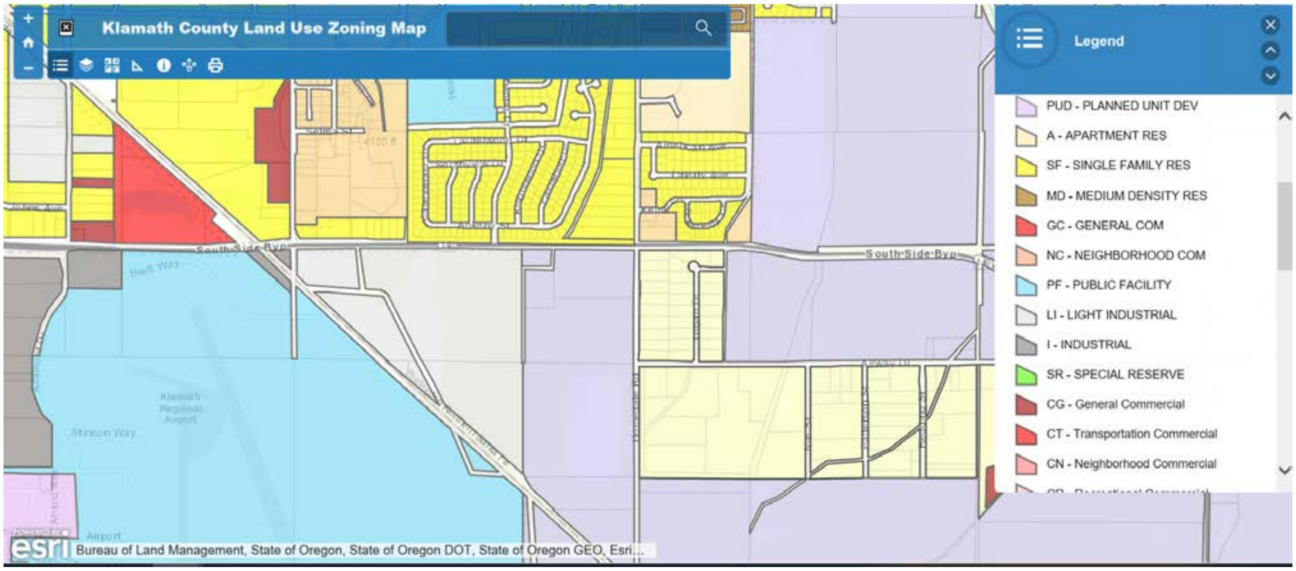

Figure 3. Zoning Map

Table 1. Noise Abatement Criteria

Activity Category	Activity Criteria[a] Leq (h)		Evaluation Location	Land Use Activity Description
	FHWA NAC[b]	ODOT NAAC[c]		
A	57	55	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where preserving those qualities is essential if the area is to continue to serve its intended purpose
B[d]	67	65	Exterior	Residential
C[d]	67	65	Exterior	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings
D	52	50	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E[d]	72	70	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in A-D or F
F	—	—	—	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	—	—	—	Undeveloped lands that are not permitted

[a.] The Leq(h) Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.
[b.] Federal Highway Administration noise abatement criteria.
[c.] Oregon Department of Transportation noise abatement approach criteria.
[d.] Includes undeveloped lands permitted for this activity category.

State

Oregon Administrative Rule (OAR) 340 Division 35. Oregon Department of Environmental Quality (DEQ). "Noise Control Regulations." Oregon Administrative Rules.
This regulation sets allowable noise levels for individual vehicles and for industrial and commercial uses. Maximum allowable noise levels for in-use vehicles in Oregon are determined by vehicle type, operating conditions, and model year.

Local

City of Klamath Falls, Klamath County
Klamath County and the City of Klamath Falls do not have noise ordinances regarding night work.

3.2 Measurement

Noise levels were measured according to procedures outlined in the ODOT Noise Manual, using a Larson Davis LXT integrating sound level meter. The sound level meter and calibrator are calibrated annually to ensure accurate sound level measurements. Concurrent traffic counts by vehicle classification were taken during the noise level monitoring. Existing noise levels were monitored at three locations within the Project study area for the purpose of validating the FHWA's Traffic Noise Model (TNM). The monitoring locations and the existing roadway configuration are shown in the figures in Appendix A.

The predominant noise source observed during monitoring was local traffic. However, wind, rail noise and some aviation noise were also noted during monitoring. During the measurement period, noises other than the ambient noise, such as train horn and passby were removed from calculation of the Leq. Wind was especially high (over 10 mph) during the monitoring and likely accounts for the difference in monitored and modeled results.

Using the measured noise level data and concurrent traffic counts, the TNM model was validated. If monitored and modeled results are within 3 dBA, the model is considered to reasonably predict noise levels for the Project area. The results of the model validation in Table 2 show that modeled and measured noise levels agree within +/- 3 dBA.

Measurement field data sheets, sketches, photos and calibration certificates for the instruments are included in the Appendix B of this report.

Table 2. Noise Measurements and TNM Validation

Measurement Site	Location	Land Use (Activity Category)	Distance to Nearest Major Roadway Centerline (feet) and Roadway Name	Measured Noise Level (dBA L_{eq})	TNM Predicted Noise Level (dBA L_{eq})	Difference Between Measured and TNM Predicted Noise Levels (dBA)
M1	5405 Airway Drive	B	82' to Homedale Road	57.5	56.8	0.7
M2	4828 Southside Expwy	B	160' to OR 140	58.0	60.7	-2.7
M3	Ball Field Bleachers	C	200' to OR 140	61.1	59.2	1.9

3.3 Modeling

Traffic noise levels for this project were calculated using TNM to predict the peak hour noise levels for the Existing condition (2016) and the No Build and Build scenarios (2039) at nearby receivers. TNM computes highway traffic noise at nearby receivers, and aids in the design of mitigation measures. Receivers are modeling locations representing noise sensitive properties as defined in Table 1. Receivers can represent more than one land use and can represent more than one noise sensitive unit or receptor, but for this project each receptor was modeled as an individual reciever. For most noise sensitive land uses, Federal traffic noise regulations require that frequently-used exterior areas of noise sensitive properties are used for modeling locations. For residential properties, exterior areas closest to ODOT right-of-way are used as receiver modeling locations. Residences that would have to be displaced in order to build the project were not included in the model. These are denoted with an "X" on the figures in Appendix A.

Inputs to the model include three-dimensional coordinates for roads and receivers, vehicle volumes by vehicle classes, vehicle speeds, and traffic control devices. Additionally, data on the characteristics and locations of specific ground types, topographical features, and other features likely to influence the propagation of vehicle noise between the roadway and the receiver can be used in TNM.

Roadway lanes were modeled separately, and roadway widths were adjusted to ensure the full asphalt roadway surface was modeled. Posted speeds were used for all vehicles in all lanes. The new roadway is a single lane in each direction with a 14' center lane for the length of the project. All lanes were included in the build scenario model. The TNM modeling files for all cases are on file electronically with ODOT.

3.4 Traffic Data

Traffic data for Existing year (2016) and future No Build and Build years (2039) was provided by ODOT's Region 4 Traffic engineering group and their consultant, Kittelson and Associates. (ODOT, 2019). The traffic data used in the noise analysis were developed by traffic engineers using assumptions about levels of future development in the region and captures the indirect or secondary effects that may result from the Project.

Roadway links were calculated from peak hour intersection counts provided. Posted speeds were used for all scenarios. Traffic data for Existing (2016), No Build and Build (2039) are included in Appendix C.

Rail and train horn noise were not included in this analysis; however, the rail operator, Burlington Northern Santa Fe (BNSF) was contacted to discuss their train schedule in the project area. Details are included here for informational purposes:

- BNSF railway operates approximately five trips per day.
- Trains typically operate a maximum of 40 miles per hour
- Average train carload varies from 80-120 cars per train
- Average of 2-3 diesel/electric locomotives per train
- The schedule varies.
- The track is welded and at all public grade crossings the horn must be blown at a decibel level ranging from 96-110.

3.5 Noise Abatement Requirements

If project traffic noise impacts are identified, ODOT is, at a minimum, required to analyze noise barriers using the feasibility and reasonableness criteria set forth in the ODOT Noise Manual (ODOT, 2011). If a nosie barrier meets the feasibility criteria, then more detailed abatement analysis must be performed. If it does not pass the feasibility criteria, the abatement analysis is finished and abatement would not be recommended for inclusion into the project design. For abatement, primary consideration is given to frequently-used exterior areas. Further discussion of mitigation measures and criteria are found in Section 7 of this report.

4. Existing Noise Levels

For existing conditions, 35 receivers were modeled which represent 33 Category B residential receptors and two (2) Category C receptors (baseball fields). Twelve (12) Category B receptors and one (1) category C receptor are predicted to exceed the ODOT NAAC. Table 3 summarizes the modeled Existing noise level data. For the Existing condition, noise levels in the project area range from 53 to 70 dBA Leqh.

5. Build and No Build Noise Levels

For the No Build scenario, the noise levels in the project area are predicted to range from 53 to 70 dBA Leqh. Fifteen (15) Category B receptors and one (1) Category C receptor are predicted to exceed the ODOT NAAC under the No Build scenario. Noise levels at each receptor increase by either 0 or 1 dBA between Existing and No Build scenarios.

Under the Build scenario, noise levels in the project area are predicted to range from 55 to 71 dBA Leqh. Thirteen (13) Category B and one (1) Category C noise sensitive receptor are predicted to be impacted. At any given receiver location, change in sound level between exisiting and Build scenario ranged from a four (4) dBA decrease to a six (6) dBA increase, so none of the receptors experience a substantial noise increase impact. The decrease in sound levels is predicted in the area of the roundabout, where the roadway centerline is moving away from the residences, and traffic must slow to move through the intersection. The area with the largest increase in sound level are located along Homedale Road near the proposed intersection with Brett Way. All of the receptors that are predicted to experience a noise impact under the build scenario are also predicted to exceed the NAAC for the No Build scenario. None of the impacted receptors experience an increase in sound level from existing to build of greater than one (1) dBA. Table 3 summarizes the noise level data for the No Build and Build scenarios.

Table 3. Predicted Sound Levels (dBA L_{eq})

Receiver	Land Use	Noise Abatement Approach Criteria (NAAC)	Existing (2016) Sound Level	No Build Design Year (2039) Sound Level	Build Design Year (2039) Sound Level	Increase in Sound Level from Existing to Build
R1	Baseball Field (C)	65	70	70	71	1
R2	Baseball Field (C)	65	60	61	61	1
R3	Residential (B)	65	68	68	69	1
R4	Residential (B)	65	68	69	68	0
R5	Residential (B)	65	67	68	68	1
R6	Residential (B)	65	64	65	65	1
R7	Residential (B)	65	65	66	62	-3
R8	Residential (B)	65	61	62	61	0
R9	Residential (B)	65	62	62	62	0

Receiver	Land Use	Noise Abatement Approach Criteria (NAAC)	Existing (2016) Sound Level	No Build Design Year (2039) Sound Level	Build Design Year (2039) Sound Level	Increase in Sound Level from Existing to Build
R10	Residential (B)	65	66	66	65	-1
R11	Residential (B)	65	70	70	68	-2
R12	Residential (B)	65	56	57	55	-1
R13	Residential (B)	65	58	58	57	-1
R14	Residential (B)	65	60	61	59	-1
R15	Residential (B)	65	62	63	60	-2
R16	Residential (B)	65	66	67	66	0
R17	Residential (B)	65	66	67	67	1
R18	Residential (B)	65	66	67	67	1
R19	Residential (B)	65	65	66	66	1
R20	Residential (B)	65	65	66	66	1
R21	Residential (B)	65	64	65	65	1
R22	Residential (B)	65	57	57	59	2
R23	Residential (B)	65	55	56	60	5
R24	Residential (B)	65	56	57	62	6
R25	Residential (B)	65	54	55	60	6
R26	Residential (B)	65	54	55	60	6
R27	Residential (B)	65	54	55	60	6
R28	Residential (B)	65	56	57	61	5
R29	Residential (B)	65	53	53	56	3
R30	Residential (B)	65	54	54	55	1
R31	Residential (B)	65	60	60	59	-1
R32	Residential (B)	65	64	65	64	0
R33	Residential (B)	65	63	64	64	1
R34	Residential (B)	65	60	61	61	1
R35	Residential (B)	65	66	66	65	-1
		MIN	53	53	55	
		MAX	70	70	71	
		NAAC Exceedances	12(B)/1(C)	15(B)/1(C)	13(B)/1(C)	

Note: Each receiver in Table 3 represents one receptor. Red indicates where sound levels are at or above the NAAC. Receptors with sound levels at or above the NAAC in the build scenario are considered impacted.

6. Abatement Consideration

Noise mitigation must be considered and evaluated for feasibility and reasonableness for properties predicted to exceed the ODOT NAAC, or that are predicted to experience substantial noise increase for the Build scenario.

Feasibility or constructability of an abatement measure includes acoustical and engineering factors. For the abatement to be feasible, ODOT requires that a simple majority of impacted receptors achieve at least a 5-dBA reduction in noise levels. ODOT also considers engineering factors such as barrier height, safety, topography, drainage, utilities, and access issues when determining feasibility.

For abatement measures to be reasonable, ODOT requires that the barriers meets three reasonableness criteria:

- cost per benefited property less than or equal to $25,000;
- at least one benefited property meets the noise reduction design goal of 7 dBA;
- the abatement is approved by a simple majority of property owners and residents.

6.1. Alternative Abatement Measures

Several alternative forms of noise abatement were considered for this project but would not be effective at mitigating noise impact.

- Truck restrictions were considered, however along the new Brett Way alignment, the truck percent is shown to be less than 5% of total vehicles.
- Speed restrictions were also considered but are impractical because the posted speed for the new Brett Way alignment is 35 mph.
- An alignment change or depressing the the new Brett Way alignment could be considered, however the noise impacts are predicted along existing roadways in the corridor, where it would be impractical to realign the existing road.
- Earth berms can be considered in place of concrete walls, but a significant amount of land is required for their placement.

6.2. Noise Barriers

Noise barriers can be quite effective in reducing highway traffic noise for receptors within approximately 200 feet of a highway; however, it is worthwhile noting that noise barriers have limitations. For a noise barrier to be effective, it must be high enough and long enough to block the view of a road. Noise barriers are typically not effective for elevated properties on a hillside overlooking a road or for buildings that rise above the barrier. A noise barrier can achieve a 5 dBA noise level reduction when it is tall enough to break the line-of-sight from the highway to the receiver and can achieve an approximate 1 dBA additional noise level reduction for each 2 feet of height after it breaks the line-of-sight. A general rule is that the length of the noise barrier should extend 4 times as far in each direction as the distance from the receptor to the barrier (FHWA, 2011).

Noise abatement measures for schools, parks, places of worship, and other nonresidential developments will consider the total abatement cost. To assess reasonable cost for nonresidential uses (Categories C, D, and E), ODOT uses a method that considers hours of use of the noise impacted area relative to peak hour traffic, total hours of use per day, and number of persons benefiting from abatement. The county was not able to provide specific data regarding the baseball field usage so professional judgement was used to estimate usage. This estimate is intended to err on the side of considering more usage rather than less.

Noise mitigation is only provided for areas where frequent human use occurs and where a lowered noise level would be a benefit. Areas where noise mitigation is not normally recommended include areas such as sidewalks, parking lots, storage areas, industrial areas, or areas where people might pass through on a temporary basis but would be unlikely to spend significant amounts of time. Noise barriers were considered on alignments within existing ODOT right-of-way. Reasonableness calculations for benefited receptors were made using a barrier cost of $20 per square foot for post and panel. These costs do not include acquisition of additional right-of-way to place noise barriers, maintenance access roads, required utility moves, and costs associated with site-specific conditions.

The following subsections describe the mitigation that was analyzed for traffic noise impacts identified in the Build scenario.

Barrier 1: Barrier along OR 140 WB near Baseball Fields

A noise barrier was analyzed at this location to abate noise impact at the baseball field (**R1**). Of the two receptor sites at the baseball fields, one is impacted under the Build scenario. A noise barrier 10 feet tall by 243 feet long and 2,426 square feet in size was evaluated using TNM and was determined to provide the noise reduction goal of at least 7 dBA at one receptor. A special use calculation was completed per the ODOT Noise Manual, and the result showed that reasonableness criteria was not met. The calculation counted all visitors to the baseball field as being represented by R1, even though R1 is located in right field very close to the highway. Most visiors will be further from the highway than that. The special use analysis of Barrier 1 is attached in Table D1 of Appendix D and the location of the noise barrier is shown in Figure D1.

Abatement at this site is not reasonable, and is not reccomended.

Barrier 2: Residential Neighborhood East of Homedale Road

Receivers **R16 through R21** represent six noise impacted residences along Mickshelly Circle, located at the east end of the project, northeast of the proposed roundabout at Homedale Road. The residential properties in this area are densely spaced with the backyards in close proximity to OR 140. A noise barrier 600 feet long was evaluated using TNM for the impacted sites at multiple iterations of height. The detailed analysis of Barrier 2 is included as Table D2 in Appendix D and the location of the noise barrier is shown in Figure D2.

A barrier 10 or 12 feet tall, would provide 5 dBA reduction to four (4) or five (5) of the six (6) impacted receptors respectively. Since they provide 5 dBA reduction to the majority of the impacted receptors, a noise barrier at either height would be considerd feasible, but neither meet the design goal of providing at least 7 dBA for at least one receptor, so they are not considered reasonable.

A barrier 14 feet tall, would provide 5 dBA reduction to all six (6) impacted receptors, so it is considered feasible, and it provides 7 dBA reduction at two (2) receptors, so it meets the noise reduction design goal. This barrier is estimated to cost $168,000, and benefit 6 total receptors, so the cost per benefitted receptor is $28,000 which exceeds the maximum to considered reasonable which is $25,000.

Abatement at this site is not reasonable, and is not recommended.

Abatement Considerations at Other Impacted Receptors

Receiver **R3** represents a noise impacted single family residence in the northeast quadrant of the intersection at OR140 and Summers Lane. The structure is about 60 feet from Summers Lane, and approximately 100 feet from OR 140. In order to provide adequate noise reduction to meet the feasibility criteria, the noise barrier length extending in each direction from the residence would need to be four times the distance from the noise barrier to the receptor. There is not room to place an 800 foot long barrier along Summers Lane and OR 140 between this residence's driveway access on Summers Lane, and the neighboring driveway access on OR 140. Furthermore, even if a larger barrier, with gaps large enough to provide adequate sight distance at each driveway access, were capable of reducing sound levels at the receptor, such a barrier would not be cost effective. An 800 foot barrier ten feet tall would be estimated to cost $160,000. Such a barrier would only have one benefitted receptor and would exceed the maximum allowable cost per benefitted receptor of $25,000. Abatement at this location is not reasonable and is not recommended.

Recievers **R4, R5, and R6** represent three noise impacted single family residences on the south side of OR 217, to the north of the proposed Brett Way Extension. The difference in Build and No Build sound levels for these receptors ranged between -1 and +1, which suggests that OR 140, not Brett Way Extension, is the primary noise source for these receptors. As such, a barrier intended to reduce noise at these locations would need to be located along OR 140, not Brett Way. These receptors are located so far apart that any attempts to reduce noise for all three with one barrier along OR 140 would not be cost effective. Futhermore, any barrier intended to provide noise reduction at any one of them would have to have a gap large enough to provide adequate sight distance at each driveway access, which would prevent noise barriers from reaching the noise reduction design goal at any of these locations. Abatement at these locations are not reasonable and not recommended.

Recievers **R10, R11, and R35** represent three impacted single family residences on the east side of Homedale Road between OR 140 and Kellal Lane to the north. Each has a driveway access on Homedale Road. A barrier could not be constructed along Homedale at this location while maintaining driveway access and adequate sight distance. A barrier along OR 140 wrapping around to Homedale Road would have to end at the first residential driveway on Homedale Road and would be unable to provide adequate noise reduction at these receptors. Abatement at this location is not feasible and not recommended.

7. Construction Noise Analysis

Areas adjacent to the Project will be exposed to construction noise. A table summarizing construction noise levels is included in Appendix E. Although temporary, the additional noise can be quite annoying. The attached Construction Noise Mitigation Appendix describes measures that may be incorporated to mitigate the effects of construction noise. These measures are incorporated into the Project's noise control specifications for construction (SP00290.32).

The Cities of Klamath Falls as well as Klamath County do not have a night time construction noise variance requirement.

8. *Information for Local Government Officials*

Some parcels within the project study area are currently undeveloped (Activity Category G). To provide information to local officials on the suitability of these parcels for different types of future land uses under the 2039 Build scenario, the distance from the fogline of OR140 and Brett Way to the impact threshold for Activity Category B, C, and E land uses (as defined in Table 1) were predicted using a TNM model run. Receivers were placed at intervals of 50 feet from the fog line of the roadway (outer edge of pavement). Table 4 shows the results of this.

The nearest receivers, at 50 feet from the fog line of the Brett Way extension, were predicted to experience 58 dBA under the build scenario. Since this did not determine a distance from the roadway within which the NAAC is exceeded, additional recievers were placed adjacent to Brett Way as close as 20 feet. At 20 feet from the edge of the roadway, the sound level was 61dBA. The projected volumes on Brett Way Extension for the design year (2039) are not heavy enough to cause exceedances to the NAAC.

Any proposed residential or public-use facilities developed closer than 150 feet from OR 140 would experience noise levels that exceed the NAAC(65 dBA). Any noise-sensitive commercial facilities developed closer than 100 feet from OR 140 would experience noise levels that exceed the NAAC (70 dBA).

It should be noted that the distances to noise impact contours for different land uses are guidelines only. More detailed noise analyses should be performed for specific future developments.

A copy of this report will be sent to the Klamath County Planning Department. This report will serve to inform local jurisdictions of the effects of the proposed project on local noise levels. Some land uses in the project area may not be compatible with the project's noise environment unless noise is considered in the plans and designs for future development of the properties.

Local government officials should consider these sounds levels when approving land use development in these locations. Provision of noise abatement measures for new developments becomes the responsibility of local governments, developers, and land owners after the date of public knowledge of the project. In the event that residential development occurs on this land after the project is approved, ODOT would not be responsible for mitigating any noise impacts associated with the project.

Table 4. Distance from Roadway to Noise Abatement Criteria Threshold

Roadway	Distance to NAAC Category E: 70 dBA Contour (feet)	Distance to NAAC Category B&C: 65 dBA Contour (feet
Brett Way	N/A	N/A
OR 140	100	150

Note: N/A means the NAAC was not exceeded for any distance from this roadway including as close as 20 feet.

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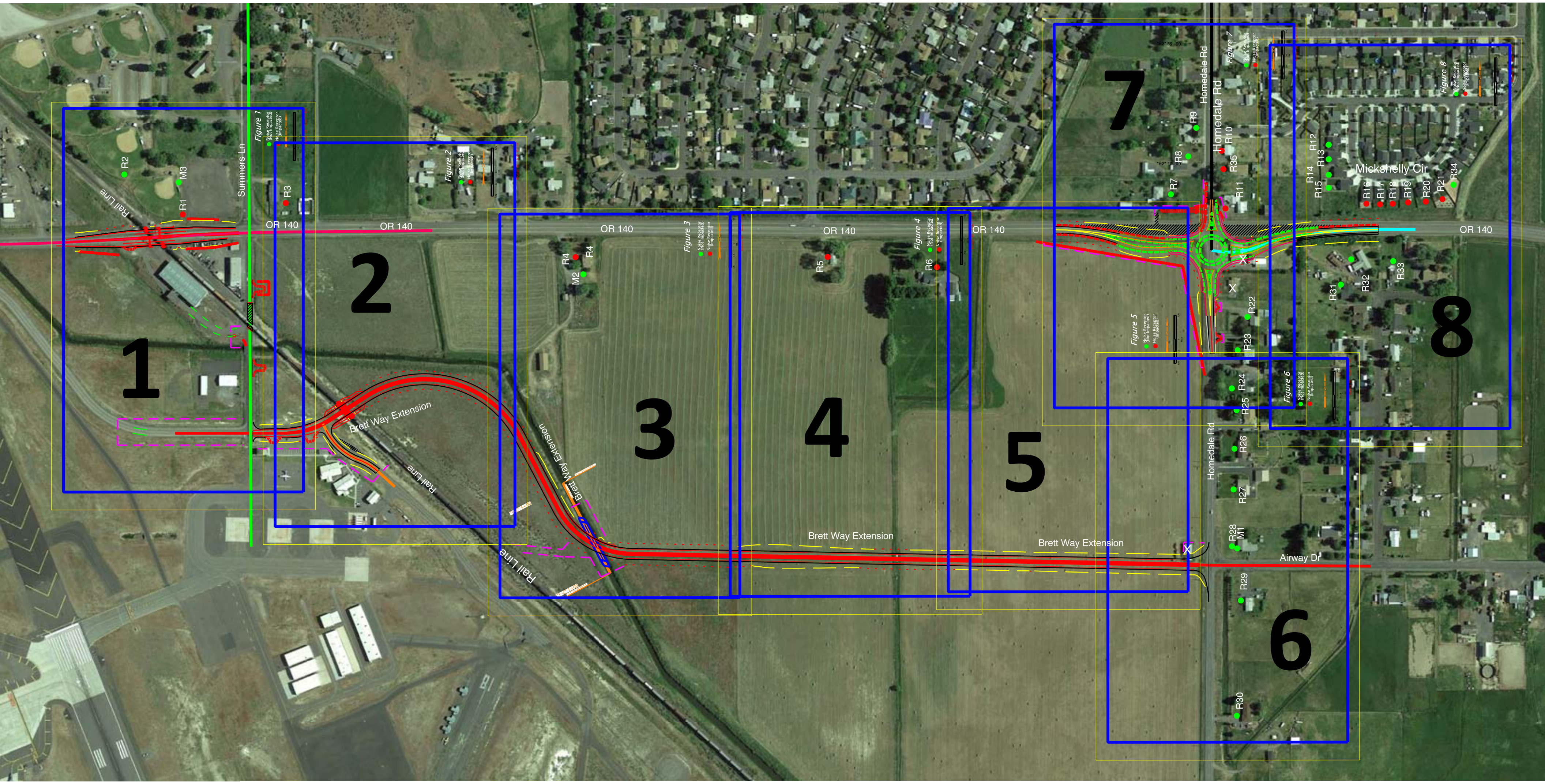
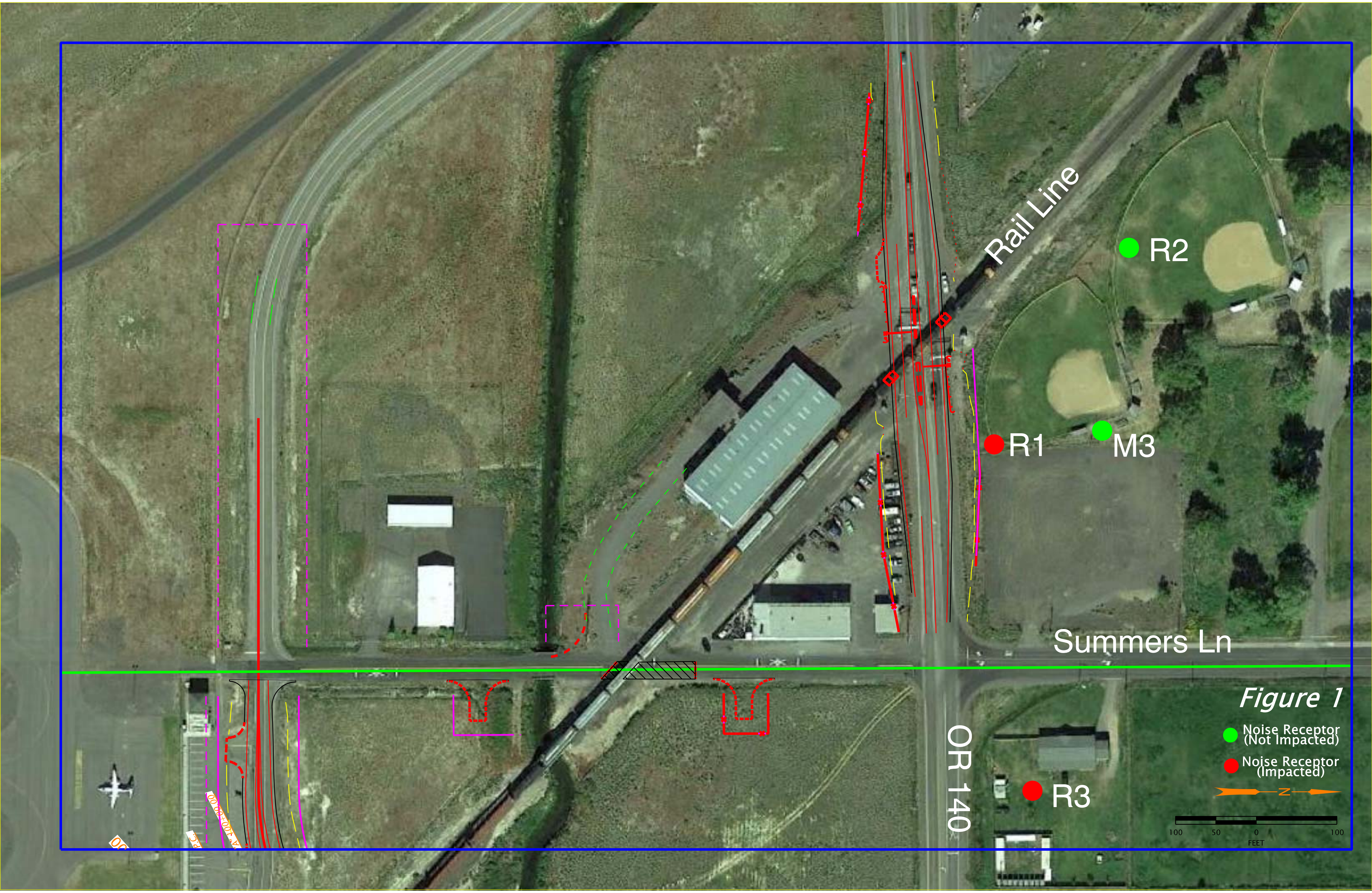
Klamath Falls City Code Chapter 5

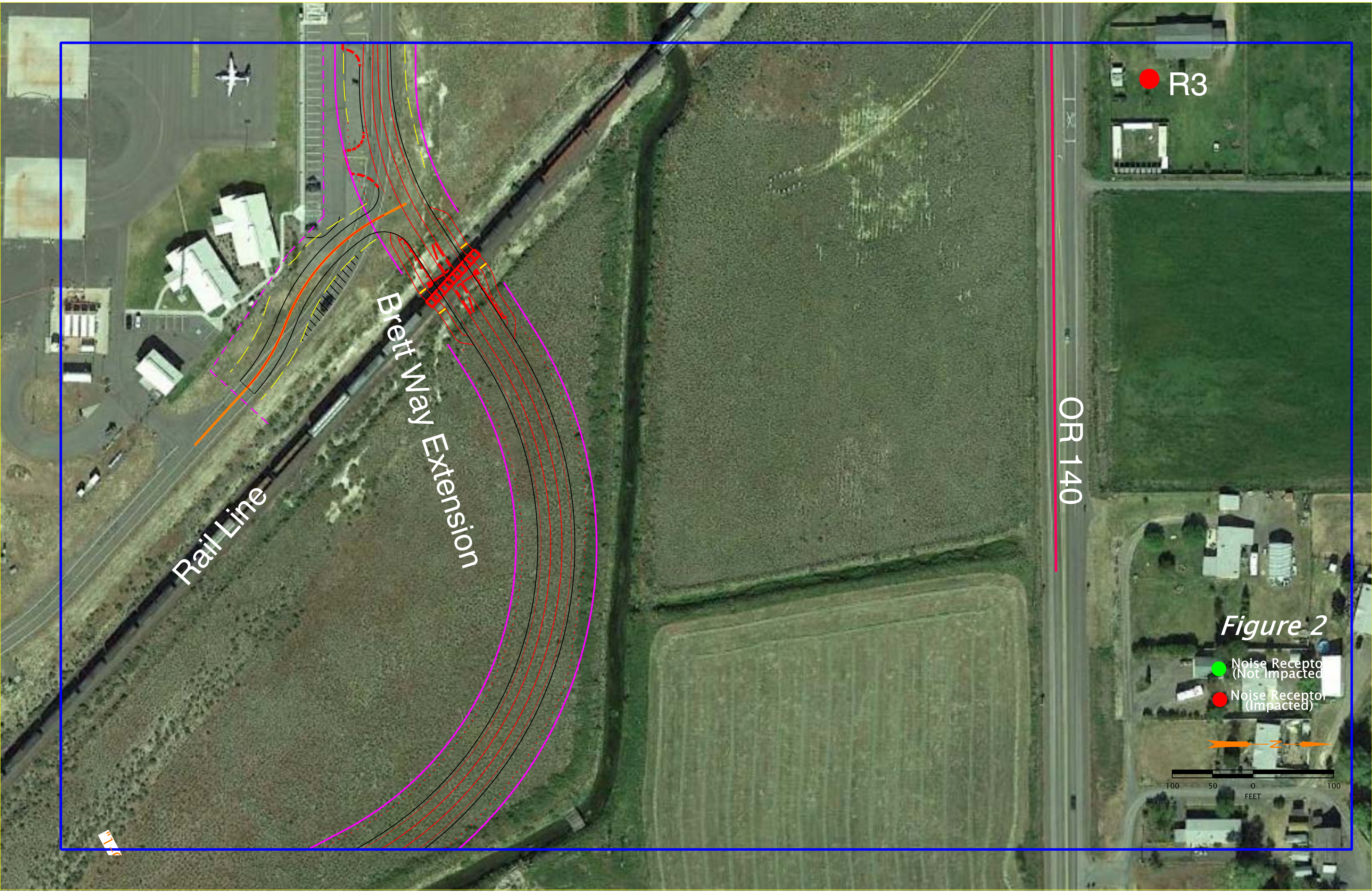
Appendix A: Figures

Project Area Figure Layout





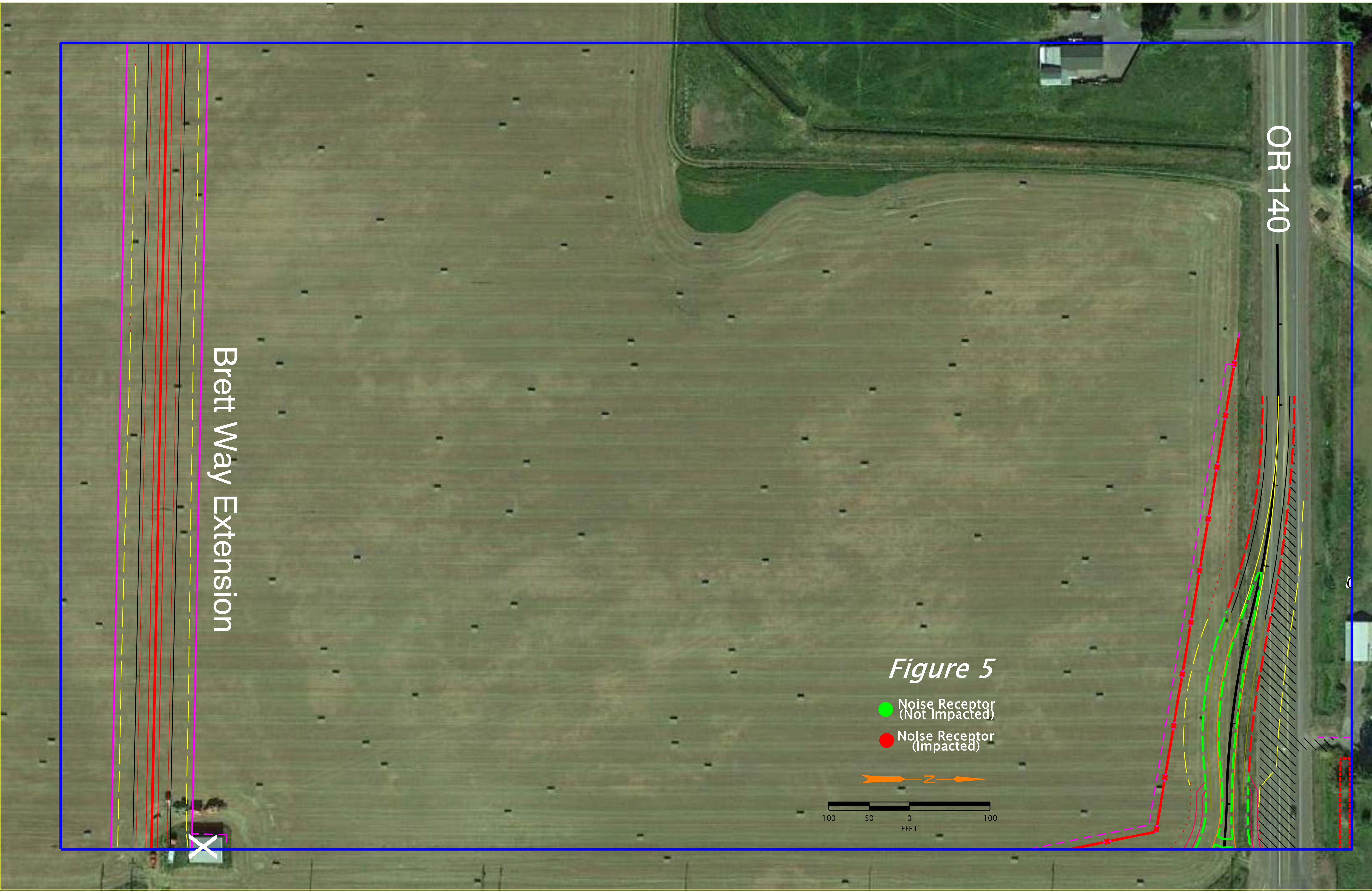
Rail Line
R2
R1
M3
Summers Ln
OR 140
R3
Figure 1
Noise Receptor (Not Impacted)
Noise Receptor (Impacted)
N
100
50
0
100
FEET

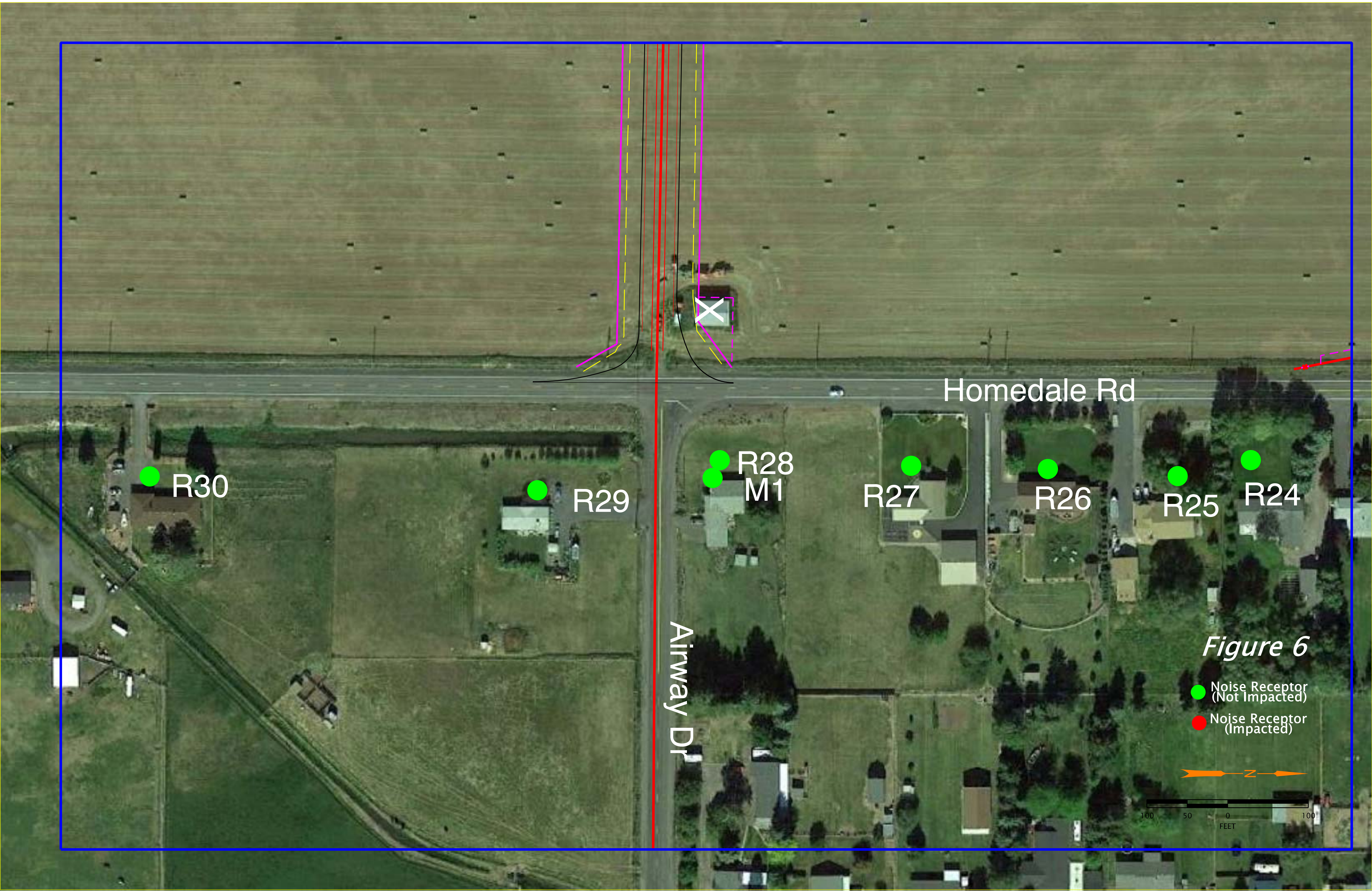

R3
OR 140
Brett Way Extension
Rail Line
Figure 2
Noise Receptor (Not Impacted)
Noise Receptor (Impacted)
N
100
50
0
100
FEET

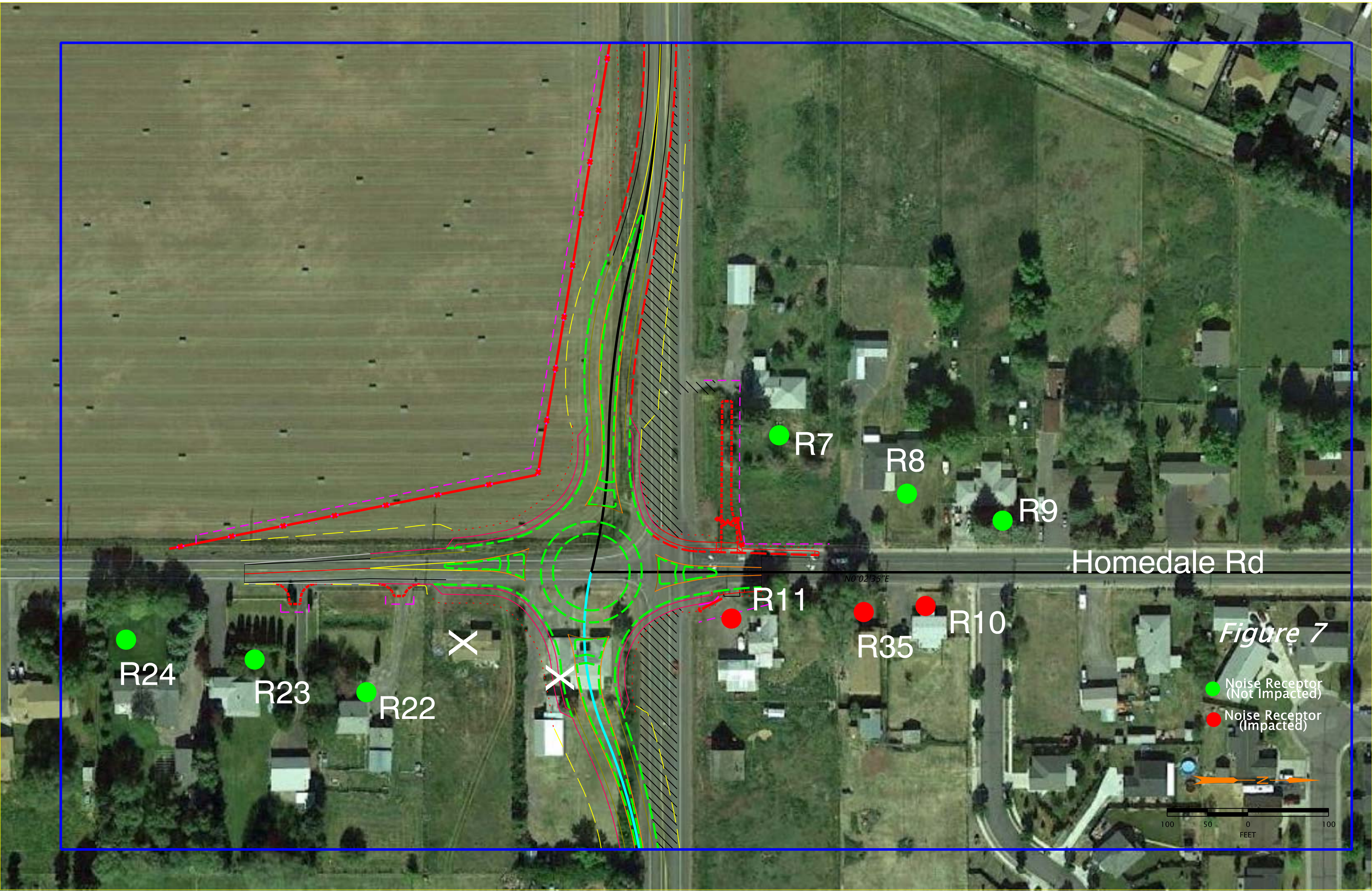

Rail Line
Brett Way Extension
R4
M2
OR 140
Figure 3
Noise Receptor (Not Impacted)
Noise Receptor (Impacted)
N
100
50
0
100
FEET


Brett Way Extension
R5
OR 140
R6
Noise Receptor (Not Impacted)
Noise Receptor (Impacted)
N
100
50
0
100
FEET

Figure 4


OR 140
Brett Way Extension
Figure 5
Noise Receptor (Not Impacted)
Noise Receptor (Impacted)
N
100
50
0
100
FEET


Homedale Rd
Airway Dr
R30
R29
R28
M1
R27
R26
R25
R24
Figure 6
Noise Receptor (Not Impacted)
Noise Receptor (Impacted)
N
100
50
0
100
FEET


Homedale Rd
R7
R8
R9
R11
R10
R35
R24
R23
R22
N0°02'35"E
Figure 7
Noise Receptor (Not Impacted)
Noise Receptor (Impacted)
100
50
0
100
FEET

R14
R12
R15
R13
R31
R32
R16
R17
R18
R19
R20
R21
R33
R34
Micksheily Cir
OR 140
Figure 8
Noise Receptor (Not Impacted)
Noise Receptor (Impacted)
N
FEET

Appendix B: Noise Measurement Data

This appendix includes Field Data forms for three noise measurement locations, photos from two angles at each noise monitoring location, and calibration certificates for the noise equipment.

Oregon Department of Transportation

Geo-Environmental Section

Noise Measurement Data Sheet

Project Name: Brett Way Extension	Key Number: 18731
Measurement Site: # M 1	Address: 5405 Airway Dr
Date: 5/17/2019	Location: front/side yard
Analyst: M Franz + K Hanson	Noise Meter: LD LXT
Start Time: 1010 AM	Duration: 20 min

Weather: rain sprinkle

Temperature: 40-50°

Wind: 10+ mph

Calibration Pre-check: 114.13 dB

Calibration Post-check: 113.91

Concurrent Traffic Count

Roadway Name:	Homedale NB	Homedale SB	Airway both
Autos:	12	13	6
Medium Trucks:			
Heavy Trucks:	1	0	1
Buses:			
Motorcycles:			
Speed:	55mph		25 mph

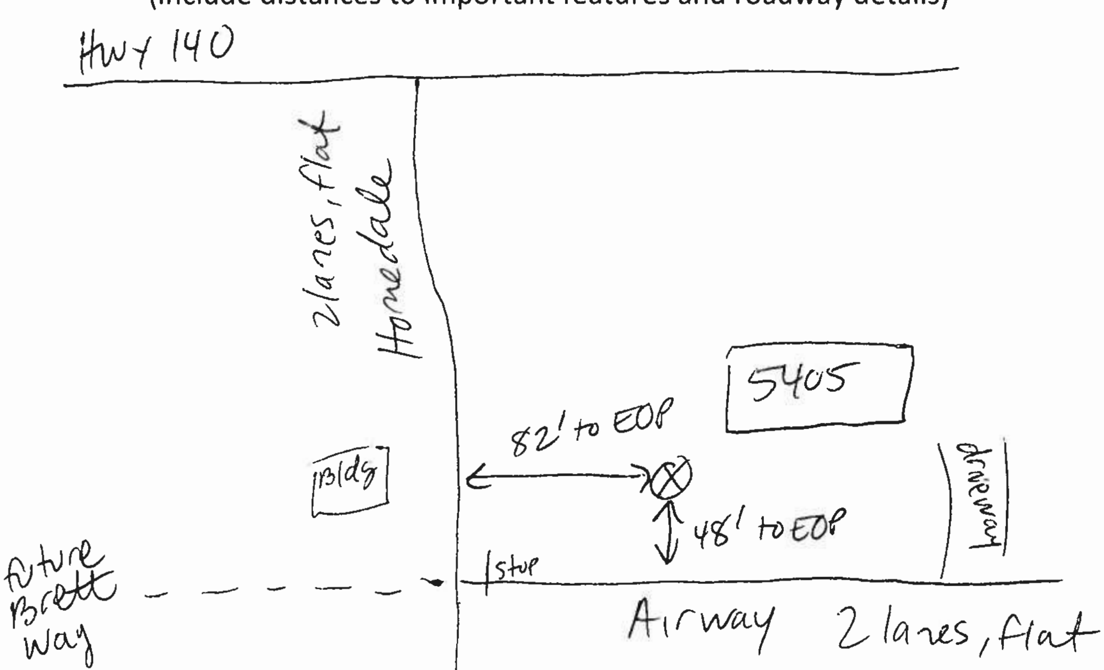
Results slow

L_{eq}	57.5

Notes/Other Noises/Excluded minutes:

Sketch of meter location:

(include distances to important features and roadway details)



Brett Way Extension KN18731

Measurement Site 1: 5405 Airway Drive Side Yard

Looking at intersection of Airway Dr and Homedale Road

Looking at Residence on Airway Drive

Oregon Department of Transportation

Geo-Environmental Section

Noise Measurement Data Sheet

Project Name: Brett Way Extension	Key Number: 18731
Measurement Site: # M2	Address: 4828 Southside Expwy
Date: 5/17/2019	Location: backyard
Analyst: M Franz, K Hanson	Noise Meter: LD LXT
Start Time: 0846 am	Duration: 20 min

Weather: cloudy

Temperature: 40-50°

Wind: 5-10 mph windy

Calibration Pre-check: 114.01

Calibration Post-check: 113.97

Concurrent Traffic Count

Roadway Name:	OR140 EB	WB
Autos:	69	123
Medium Trucks:		
Heavy Trucks:	8	14
Buses:		
Motorcycles:		
Speed:	55mph	

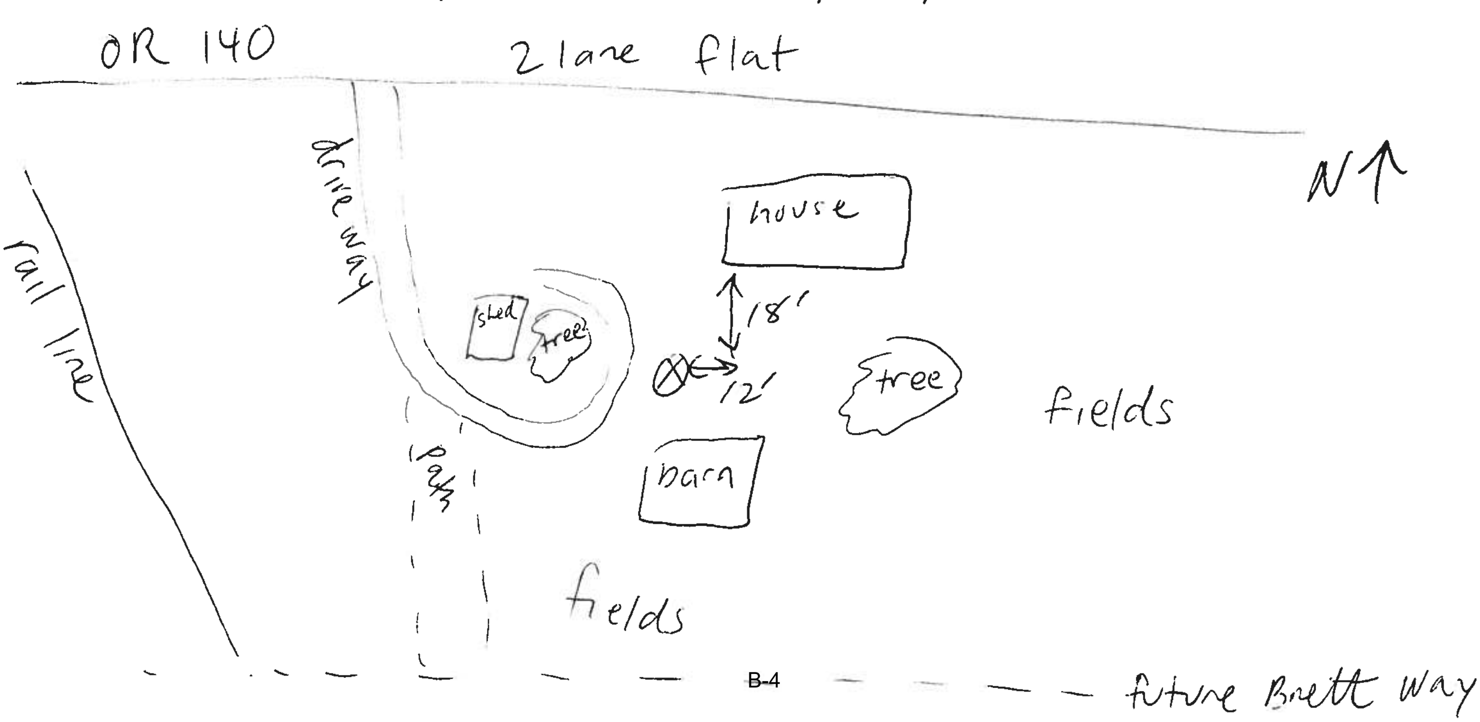
Results slow

Leq	58.0

Notes/Other Noises/Excluded minutes:

aircraft landed @ 12 min, 18 min

Sketch of meter location:
(include distances to important features and roadway details)



Brett Way Extension KN18731

Measurement Site 2: 4828 Southside Expwy Backyard

Looking towards airport

Looking towards residence on Southside Expwy

Oregon Department of Transportation

Geo-Environmental Section

Noise Measurement Data Sheet

Project Name: Brett Way Extension	Key Number: 18731
Measurement Site: # M3	Address: Ball Fields 140/summer
Date: 5/17/2019	Location: Bleachers
Analyst: M Franz & K Hanson	Noise Meter: LD LXT
Start Time: 0815 am	Duration: 20 min

Weather: cloudy

Temperature: 40-50°

Wind: 5-10 mph

Calibration Pre-check: 114.04

Calibration Post-check: 113.98

Concurrent Traffic Count

Roadway Name:	OR 140 EB	WB	Summers 2 way
Autos:	69	131	13
Medium Trucks:			
Heavy Trucks:	11	9	
Buses:			
Motorcycles:			
Speed:	55 mph		25 mph

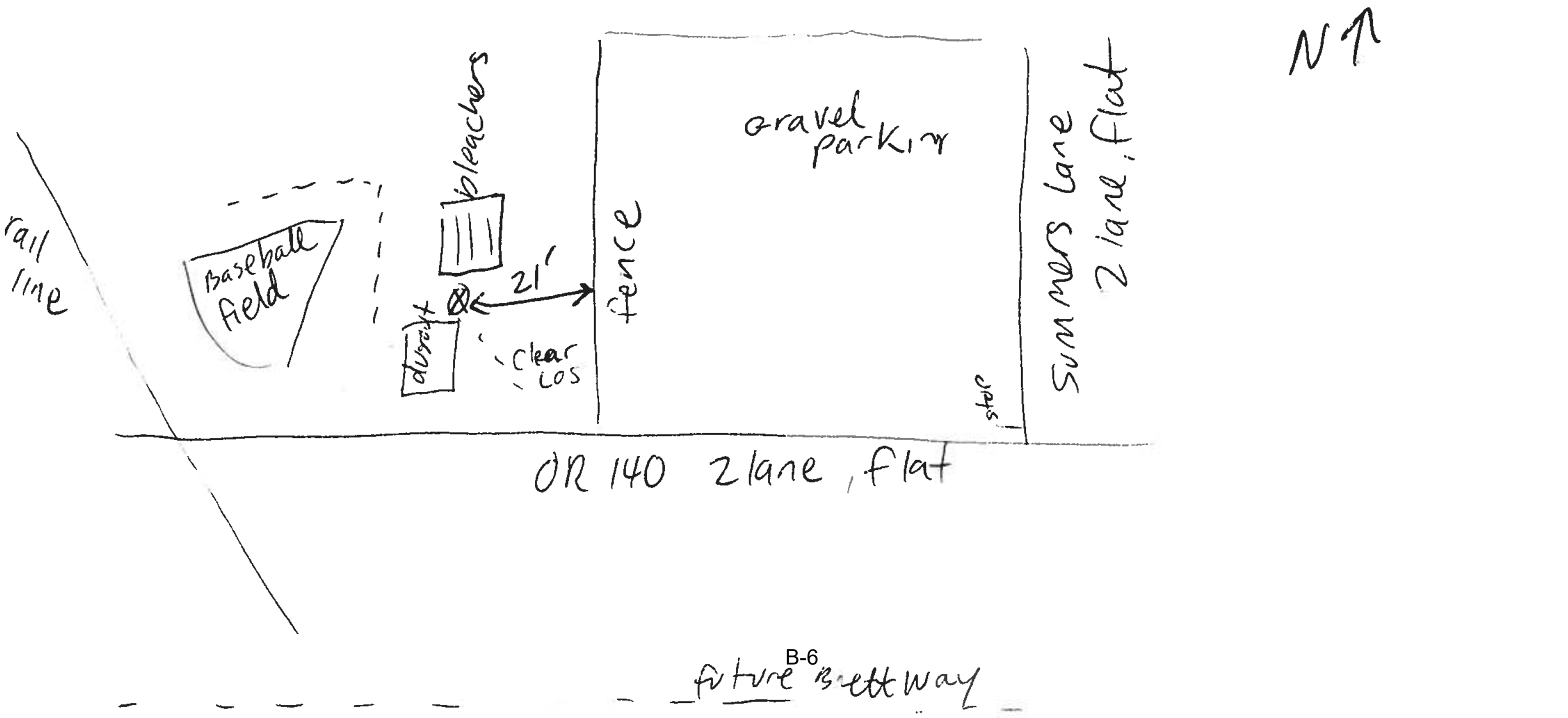
stopped counting when train came

Results

	slow	excluding train
L_{eq}	76.9	61.1

Notes/Other Noises/Excluded minutes:
train whistle @ 15-16 min then pass by

Sketch of meter location:
(include distances to important features and roadway details)



Brett Way Extension KN18731

Measurement Site 3: Little League Ball Fields

Looking across gravel parking lot towards Summer Lane

Looking towards OR140 at rail crossing

Calibration Certificate

Certificate Number 2019004926

Customer:
Oregon Department of Transportation
4040 Fairview Drive SE
Salem,OR 97302,United States

Model Number	CAL200	***Procedure Number***	D0001.8386			
Serial Number	16740	***Technician***	Scott Montgomery			
Test Results	**Pass**	***Calibration Date***	24 Apr 2019			
Initial Condition	As Manufactured	***Calibration Due***				
		Temperature	23	°C	± 0.3 °C	
Description	Larson Davis CAL200 Acoustic Calibrator	***Humidity***	32	%RH	± 3 %RH	
		Static Pressure	101.3	kPa	± 1 kPa	

Evaluation Method The data is aquired by the insert voltage calibration method using the reference microphone's open circuit sensitivity. Data reported in dB re 20 µPa.

Compliance Standards Compliant to Manufacturer Specifications per D0001.8190 and the following standards:
IEC 60942:2017 ANSI S1.40-2006

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Agilent 34401A DMM	09/06/2018	09/06/2019	001021
Larson Davis Model 2900 Real Time Analyzer	04/02/2019	04/02/2020	001051
Microphone Calibration System	03/04/2019	03/04/2020	005446
1/2" Preamplifier	09/20/2018	09/20/2019	006506
Larson Davis 1/2" Preamplifier 7-pin LEMO	08/07/2018	08/07/2019	006507
1/2 inch Microphone - RI - 200V	05/10/2018	05/10/2019	006510
Pressure Transducer	07/18/2018	07/18/2019	007368

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1681 West 820 North
Provo,UT 84601,United States
716-684-0001

ilac-MRA ACCREDITED Cert #3622.01

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A PCB PIEZOTRONICS DIV.

Calibration Certificate

Certificate Number 2019001226

Customer:

Oregon Department of Transportation
4040 Fairview Drive SE
Salem, OR 97302, United States

Model Number	LxT SE
Serial Number	0003340
Test Results	**Pass**
Initial Condition	AS RECEIVED same as shipped
Description	Sound Expert LxT Class 1 Sound Level Meter Firmware Revision: 2.302

Procedure Number	D0001.8378		
Technician	Ron Harris		
Calibration Date	30 Jan 2019		
Calibration Due	30 Jan 2020		
Temperature	22.7	°C	± 0.25 °C
Humidity	50.4	%RH	± 2.0 %RH
Static Pressure	86.42	kPa	± 0.13 kPa

Evaluation Method Tested electrically using Larson Davis PRMLxT1L S/N 027659 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 23.6 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert Lxt, I770.01 Rev J Supporting Firmware Version 2.301, 2015-04-30

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 μPa

Calibration Certificate

Certificate Number 2019001235
Customer:
Oregon Department of Transportation
4040 Fairview Drive SE
Salem, OR 97302, United States

Model Number	PRMLxT1L	***Procedure Number***	D0001.8383		
Serial Number	027659	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	30 Jan 2019		
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***	30 Jan 2020		
		Temperature	23.2	°C	± 0.01 °C
Description	Larson Davis 1/2" Preamplifier for LxT Class 1 -1 dB	***Humidity***	50.9	%RH	± 0.5 %RH
		Static Pressure	86.41	kPa	± 0.03 kPa

Evaluation Method Tested electrically using a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Standards Used

Description	**Cal Date**	**Cal Due**	**Cal Standard**
Larson Davis Model 2900 Real Time Analyzer	03/07/2018	03/07/2019	003003
Hart Scientific 2626-H Temperature Probe	02/02/2018	02/02/2019	006767
Agilent 34401A DMM	06/29/2018	06/29/2019	007165
SRS DS360 Ultra Low Distortion Generator	10/04/2018	10/04/2019	007167

Calibration Certificate

Certificate Number 2019001236
Customer:
Oregon Department of Transportation
4040 Fairview Drive SE
Salem, OR 97302, United States

Model Number	LxT SE	***Procedure Number***	D0001.8384		
Serial Number	0003340	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	30 Jan 2019		
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***	30 Jan 2020		
Description	Sound Expert LxT Class 1 Sound Level Meter Firmware Revision: 2.302	***Temperature***	22.79	°C	± 0.25 °C
		Humidity	50.9	%RH	± 2.0 %RH
		Static Pressure	86.4	kPa	± 0.13 kPa

Evaluation Method ***Tested with:*** ***Data reported in dB re 20 μPa.***

Larson Davis PRMLxT1L. S/N 027659
PCB 377B02. S/N LW136694
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0108

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert Lxt, I770.01 Rev J Supporting Firmware Version 2.301, 2015-04-30

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Cert. #3622.01

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Appendix C: Traffic Data

Traffic data for Existing year (2016) and future No Build and Build years (2039) was provided by ODOT's Region 4 Traffic engineering group and their consultant, Kittelson and Associates. (ODOT, 2019). Roadway links were calculated from peak hour intersection counts provided. Posted speeds were used for all scenarios.

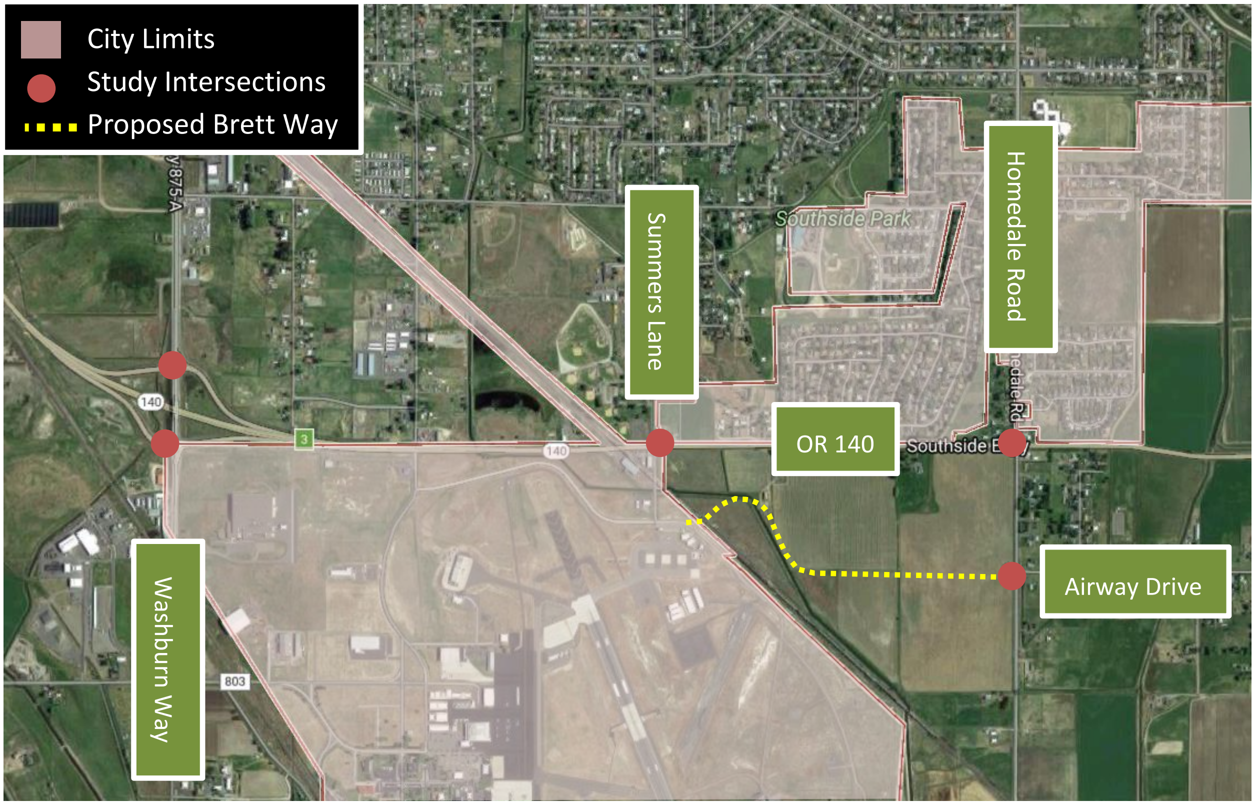


Exhibit 2. Study Area and Study Intersections

SITE CONDITIONS AND ADJACENT LAND USES

The Brett Way Extension is located in southeast Klamath Falls, east of the Crater Lake - Klamath Regional Airport. OR 140 (Southside Expressway) is the primary corridor through the study area. South of OR 140, the airport is zoned as a Public Facility (PF). The land east of the airport and south of OR 140 is currently undeveloped farmland but is planned for industrial development. The north side of OR 140 is predominately medium density residential development. The OR 140/Summers Lane intersection is within the city limits of Klamath Falls (as highlighted in Exhibit 2); however, the remaining intersections are located within the jurisdiction of Klamath County

TRANSPORTATION FACILITIES

OR 140 is a primary east-west commuter and freight route for Klamath Falls and provides regional connections. The Oregon Highway Plan (OHP) designates OR 140 as a Statewide Highway on the National Highway System (NHS), a Freight/truck route, and an Expressway through the study area (from MP 2.80 to 4.63). Characteristics of all study roadways are summarized in Table 1.

Each of the study intersections is unsignalized with the exception of the traffic signal at the OR 140 Eastbound Ramp/Washburn Way intersection. As depicted in Exhibit 3, the remaining study intersections are minor-street stop-controlled.

Table 1. Existing Transportation Facilities in the Study Area

Roadway	Functional Classification	Number of Lanes	Posted Speed (mph)	Sidewalks	Bicycle Lanes	On-Street Parking
OR 140 (Southside Expressway)	Statewide Highway/ Expressway	2-3 Lanes	55	No	No	No
Homedale Road	Collector	2 Lanes	35-55	No	No	No
Airway Drive	Local	2 Lanes	45	No	No	No
Summers Lane	Collector	2-3 Lanes	35	No	No	No
Washburn Way	Major Arterial/ Collector	3-5 Lanes	45	Yes	Partial[1]	No

[1] Washburn Way has wide, striped shoulders without bicycle lane markings within the study area.

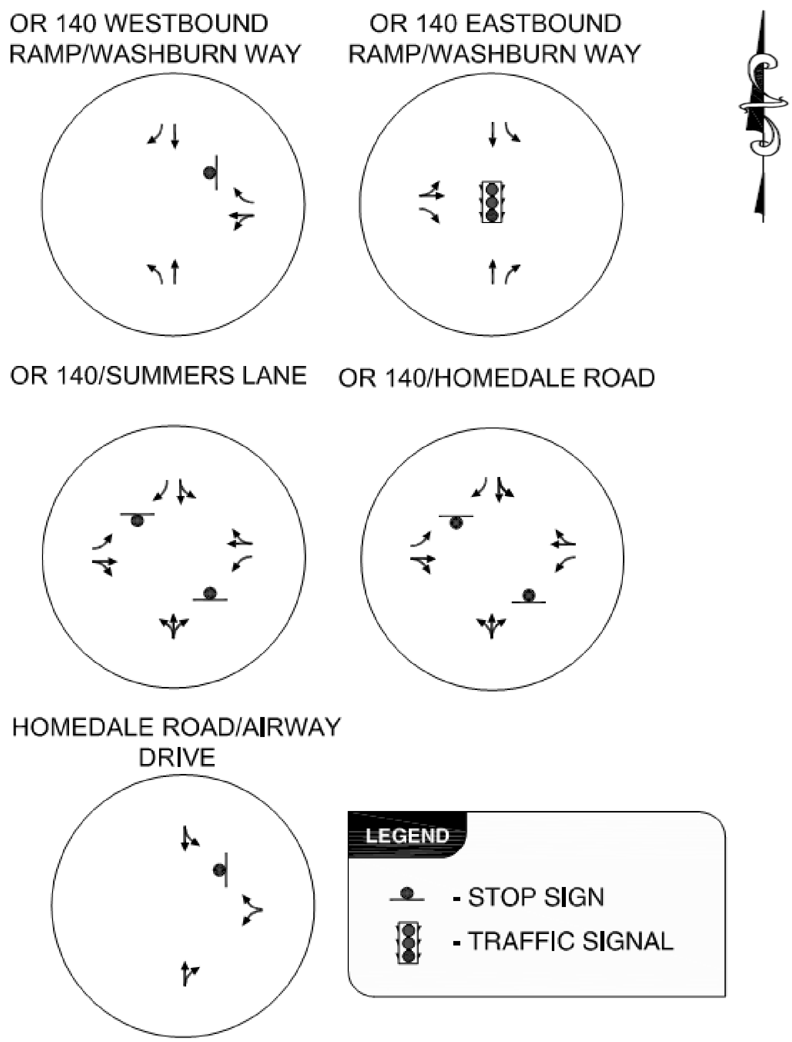


Exhibit 3. Existing Lane Configurations and Traffic Control Devices

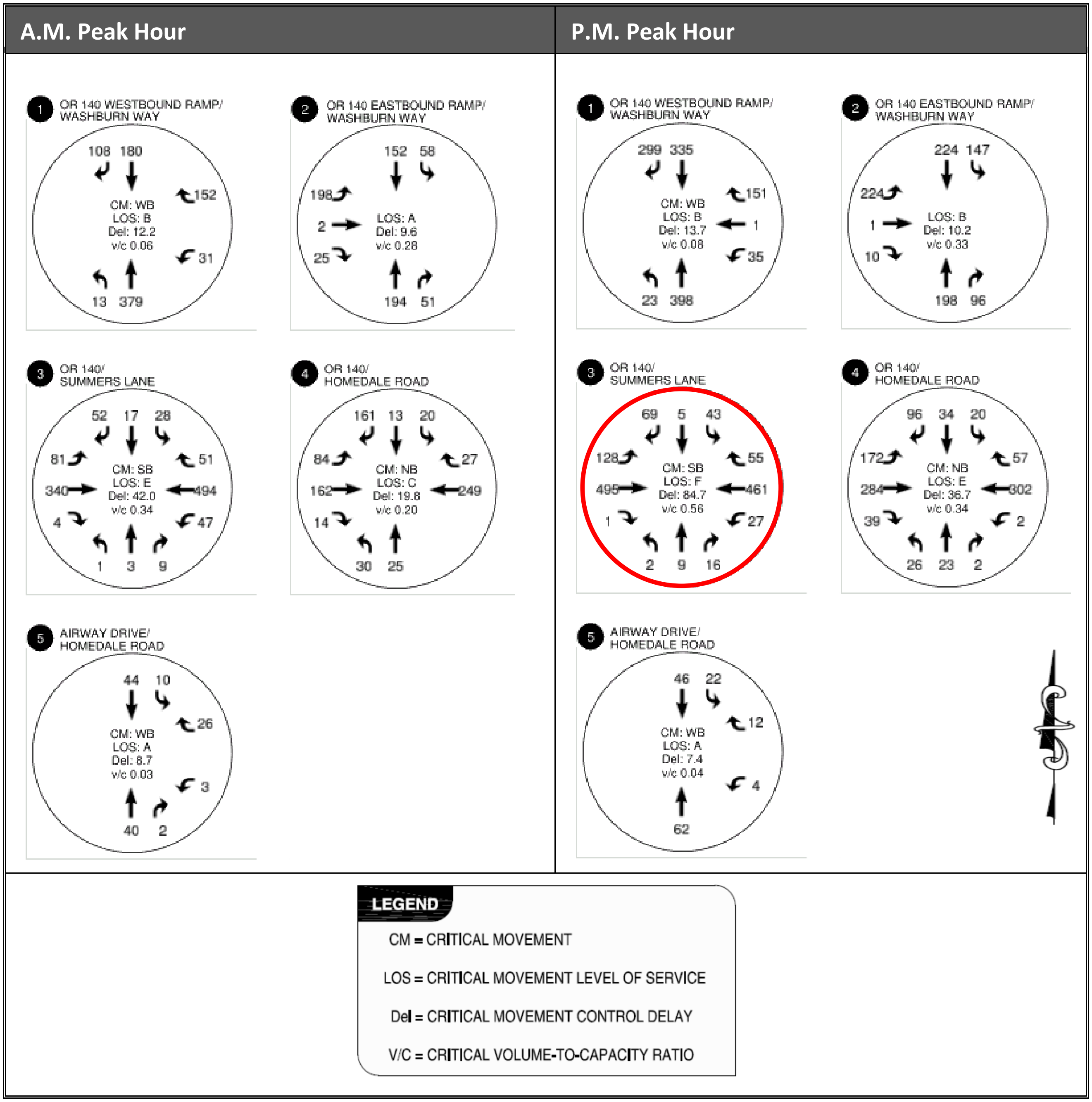


Exhibit 4. 2016 Existing Traffic Conditions Operations

CRASH HISTORY

Crash reports for the study intersections over a five-year period (January 1, 2011 - December 31, 2015) were obtained from the ODOT crash database. Table 2 summarizes the crashes at the study intersections by crash type and severity. *Appendix E contains the crash data summary.*

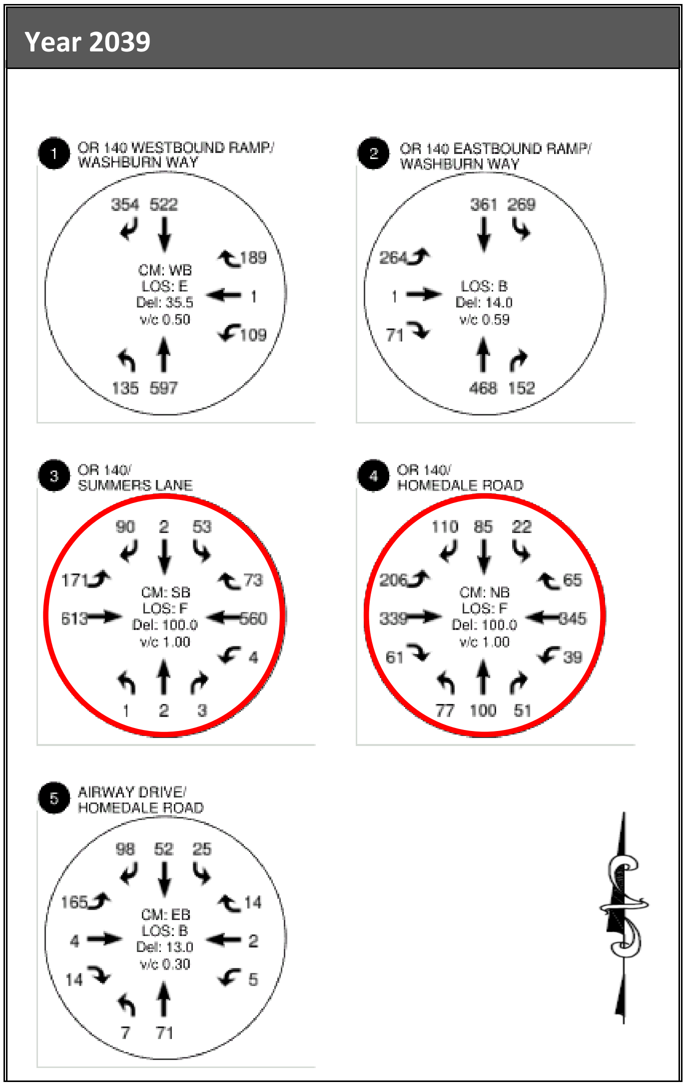


Exhibit 8. Year 2039 Intersection Operations - Existing Traffic Control

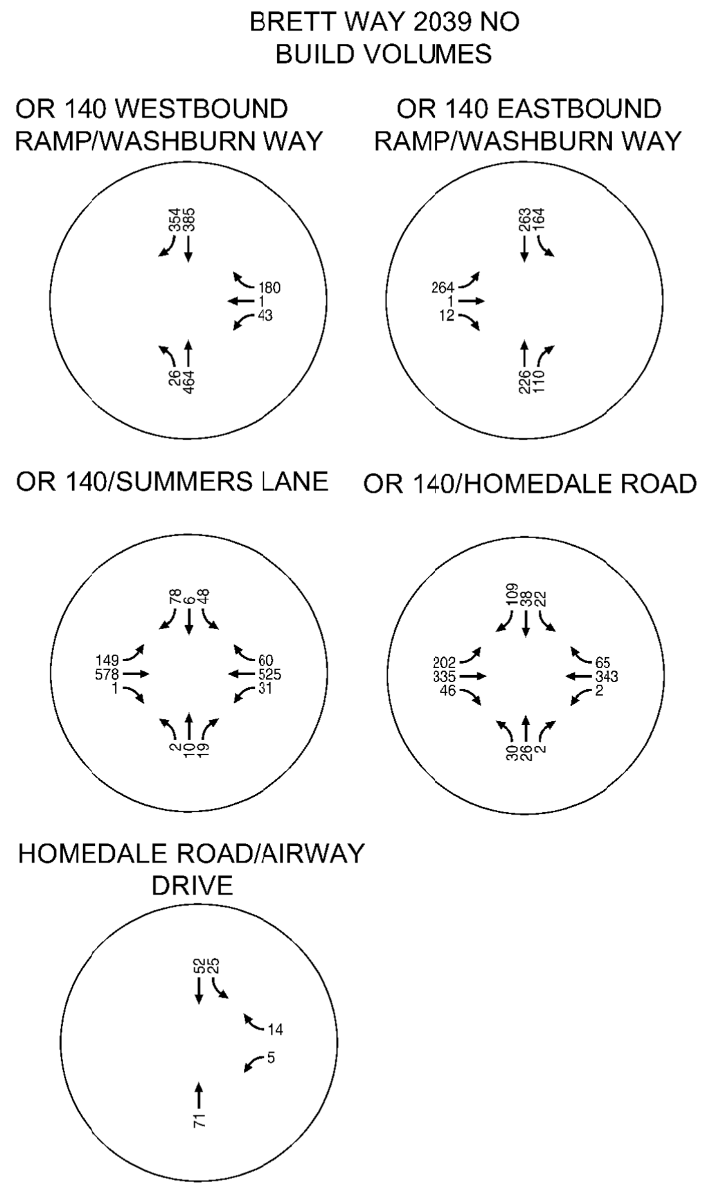
Table 6 summarizes the operational analysis for a traffic signal at the OR 140/Summers Lane intersection and a traffic signal and roundabout at the OR 140/Homedale Road intersection under the base lane configuration assumptions previously described (i.e. left, through/right for all signalized approaches and single-lane for all roundabout approaches).

Table 6. Operational Analysis for Year 2039 Weekday PM Peak Hour – Traffic Control Alternatives

Alternative	Intersection	LOS	Delay (s)	v/c[1]	95th% Queue (feet)			
					EB	WB	NB	SB
Traffic Signal	OR 140/Summers Lane	B	18.5	0.60	125	275	25	75
	OR 140/Homedale Road	C	21.6	0.59	150	225	100	150
Roundabout	OR 140/Homedale Road	A	9.8	0.56	100	75	50	25

[1] Intersection V/C for signalized intersection; Critical Movement V/C for roundabout intersection

As shown in Table 6, both a traffic signal and roundabout would meet mobility targets at the project intersection of OR 140/Homedale Road. A roundabout would result in less average delay and shorter



2039 No Build Traffic Volumes
Klamath Falls, OR

Figure
A

H:\19\19553 - Brett Way Extension\dwgs\figs\existing.dwg Jan 11, 2019 - 10:29am - jgulczynski Layout Tab: Layout2

Appendix D: Mitigation Analyses


Rail Line
R2
Barrier 1 (Not Reccomended)
R1
M3
Summers Ln
OR 140
R3
Figure D1
Noise Receptor (Not Impacted)
Noise Receptor (Impacted)
N
100
50
0
100
FEET
Rotation: 0°
Scale: 1"=100'

Table D1: Special Use Calculation for Ball Field Barrier 1

	Special Use Calculation	Values	Notes
1	Length of proposed barrier (ft)	243	
2	Height of proposed barrier (ft)	10	
3	Multiply item 1 by item 2 (ft2)	2430	
4	Enter the average amount of time that a person stays at the site per visit (hours)	3	estimated length of baseball game/practice
5	Average number of people that use this site per day that will receive at least 5 dBA benefit from abatement at the site (people)	12.86	estimated 60 people per day for one field, 3 days per week, for 6 months per year
6	Multiply item 4 by item 5 (person-hr)	38.57	
7	7Divide item 3 by item 6 (ft2/person-hr)	63.00	
8	8 Multiply $25,000 by item 7 ($/person-hr/ft2)	$1,575,000	
9	Does item 8 exceed the "abatement cost factor" of: English units = $518,758/person-hr/ft2?	yes	
10	If item 9 is no, abatement meets reasonable criteria		
11	If item 9 is yes, abatement does not meet reasonableness criteria	X	

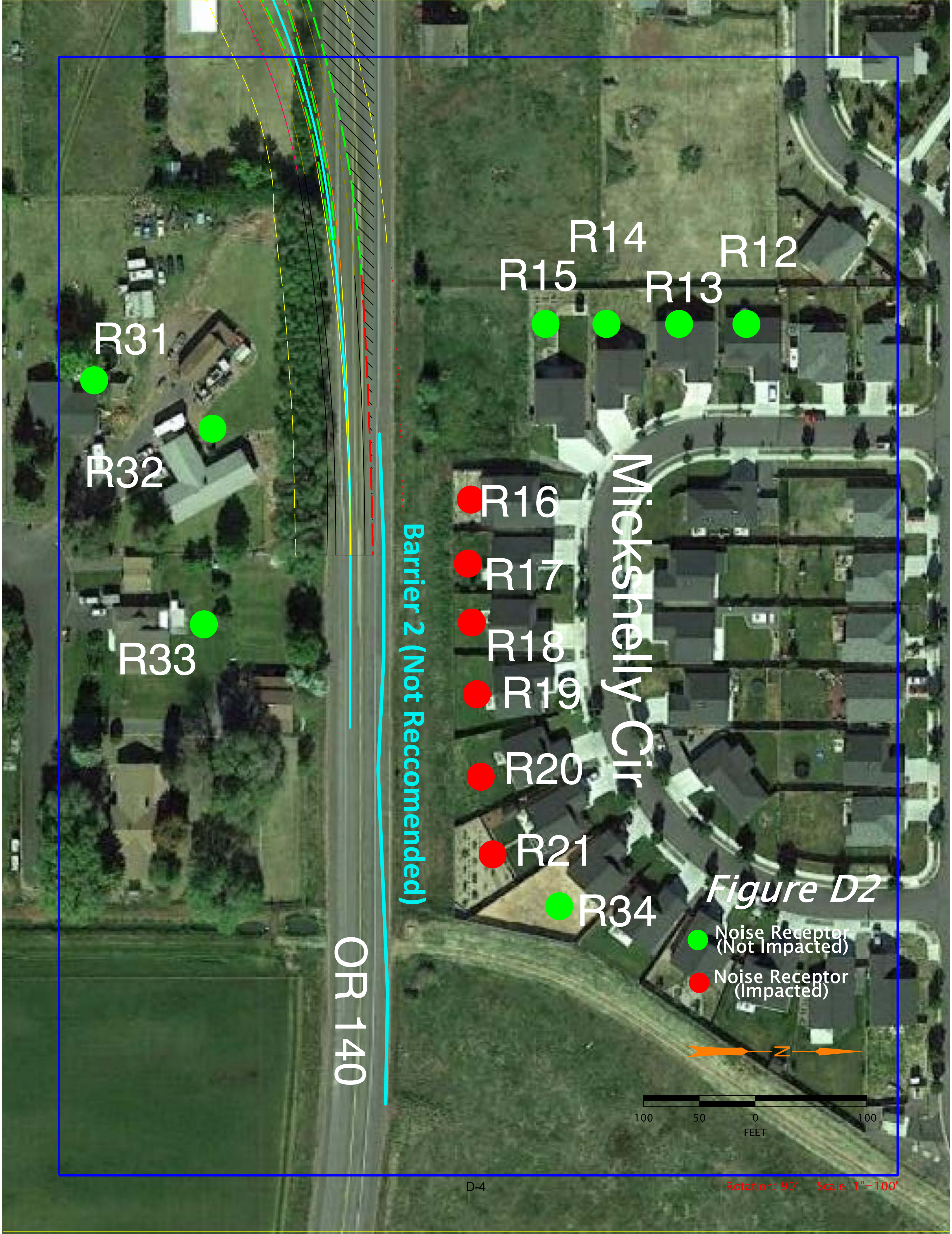

R14
R12
R15
R13
R31
R32
R16
R17
R18
R19
R20
R21
R34
R33
Micksnelly Cir
Barrier 2 (Not Reccomended)
OR 140
Noise Receptor (Not Impacted)
Noise Receptor (Impacted)
N
100
50
0
100
FEET
Rotation: 90°
Scale: 1"=100'

Figure D2

Table D2: Barrier Analysis for Residential Barrier 2

Based on 14 ft

Receiver	Existing Leq	Build Leq	Build Increase over Existing	10 ft wall Sound Level	10 ft wall IL	12 ft wall sound level	12 ft wall IL	14 ft wall Sound level	14 ft wall IL	Receivers with IL>=7 dBA	Benefited Receivers >=5 dBA	Impacted Receivers with>= 5 dBA IL	Impacted Receivers not benefited
R12	56	55	-1	55	0	55	0	55	0	0	0	0	0
R13	58	57	-1	56	1	56	1	56	1	0	0	0	0
R14	60	59	-1	58	1	58	1	58	1	0	0	0	0
R15	62	60	-2	60	0	59	1	59	1	0	0	0	0
R16	66	66	0	62	4	61	5	61	5	0	1	1	0
R17	66	67	1	62	5	61	6	60	7	1	1	1	0
R18	66	67	1	62	5	61	6	60	7	1	1	1	0
R19	65	66	1	62	4	61	5	60	6	0	1	1	0
R20	65	66	1	62	4	61	5	60	6	0	1	1	0
R21	64	65	1	61	4	61	4	60	5	0	1	1	0
R34	60	61	1	59	2	59	2	58	3	0	0	0	0

impacted receivers 6

sum 6 6 0

Total receivers benefited (>=5 dBA)	6
Wall Height (ft)	14
Wall Length (ft)	600
Wall Area (sf)	8400
Wall Cost ($/sf)	20
Total cost of wall	$168,000
Cost effectiveness ($/benefited)	$28,000
Cost reasonableness criteria	$25,000
Cost effectiveness<Cost Reasonableness	**No**

IL= insertion loss

Appendix E: Construction Noise Levels and Mitigation

		Equipment type	Noise level (dBA) at 50 feet	Noise Level (dBA) Average at 50 feet[a]	Noise Level (dBA) Average at 50 feet[b]
Equipment Powered by Internal Combustion Engines	Earth Moving	Front Loaders	72-84	78	85
		Backhoes	72-93	83	83
		Tractors	77-96	87	85
		Scrapers	80-93	87	87
		Graders	80-93	84	84
		Pavers	86-89	88	--
		Trucks	82-94	88	--
	Materials Handling	Concrete Mixers	75-88	82	--
		Concrete Pumps	81-84	83	--
		Cranes, Movable	75-88	82	79
		Cranes, Derrick	86-89	88	--
	Stationary	Pumps	68-72	70	--
		Generators	71-82	77	--
		Compressors	74-87	81	73
	Impact Equipment	Mounted Breakers (Hoe rams)	76-94[c]	85	--
		Pneumatic Wrenches	82-89	86	--
		Jackhammers & Rock Drills	81-98	90	--
		Impact Drivers (Peak)	95-106	101	--
	Other	Vibrator	69-81	101	--
		Saws	72-82	77	--

[a] From the Colorado construction Noise Symposium, Construction Noise Ranges Chart

[b] From Highway Construction Noise: Measurement, Prediction and Mitigation. U.S. Department of Transportation, Federal Highway Administration, HH1-22/R10-91(200)EW

[c] From Allied Construction Products, Cleveland, OH 1999

Mitigation for Construction Noise Impacts (2018 ODOT Specifications)

ODOT includes standard project specifications (290.32) for all projects to mitigate construction noise impacts. The following construction measures reflect current ODOT standard specifications:

Comply with ORS 467, OAR 340-035, all other applicable laws, and the following construction noise abatement measures:

- Do not perform construction within 1,000 feet of an occupied dwelling on Sundays or legal holidays, or between the hours of 10:00 p.m. and 6:00 a.m. on other days without the approval of the Engineer.
- Use equipment with sound-control devices no less effective than those provided on the original Equipment. Equipment with un-muffled exhausts is prohibited.
- Use equipment complying with pertinent equipment noise standards of the EPA.
- Do not drive piling or perform blasting operations within 3,000 feet of an occupied dwelling on Sundays or legal holidays, or between the hours of 8:00 p.m. and 8:00 a.m. on other days without the approval of the Engineer.
- Mitigate the noise from rock crushing or screening operations performed within 3,000 feet of all occupied dwellings by placing material stockpiles between the operation and the affected dwellings, or by other means approved by the Engineer.

If a specific noise impact complaint is received during construction of the project, one or more of the following noise mitigation measures may be required, at no additional cost to the Agency, as directed by the Engineer:

- Locate stationary construction equipment as far from nearby noise-sensitive properties as feasible.
- Shut off idling Equipment.
- Reschedule construction operations to avoid periods of noise annoyance identified in the complaint.
- Notify nearby residents whenever extremely noisy work will be occurring.
- Install temporary or portable acoustic barriers around stationary construction noise sources.
- Operate electrically powered Equipment using line voltage power or solar power.