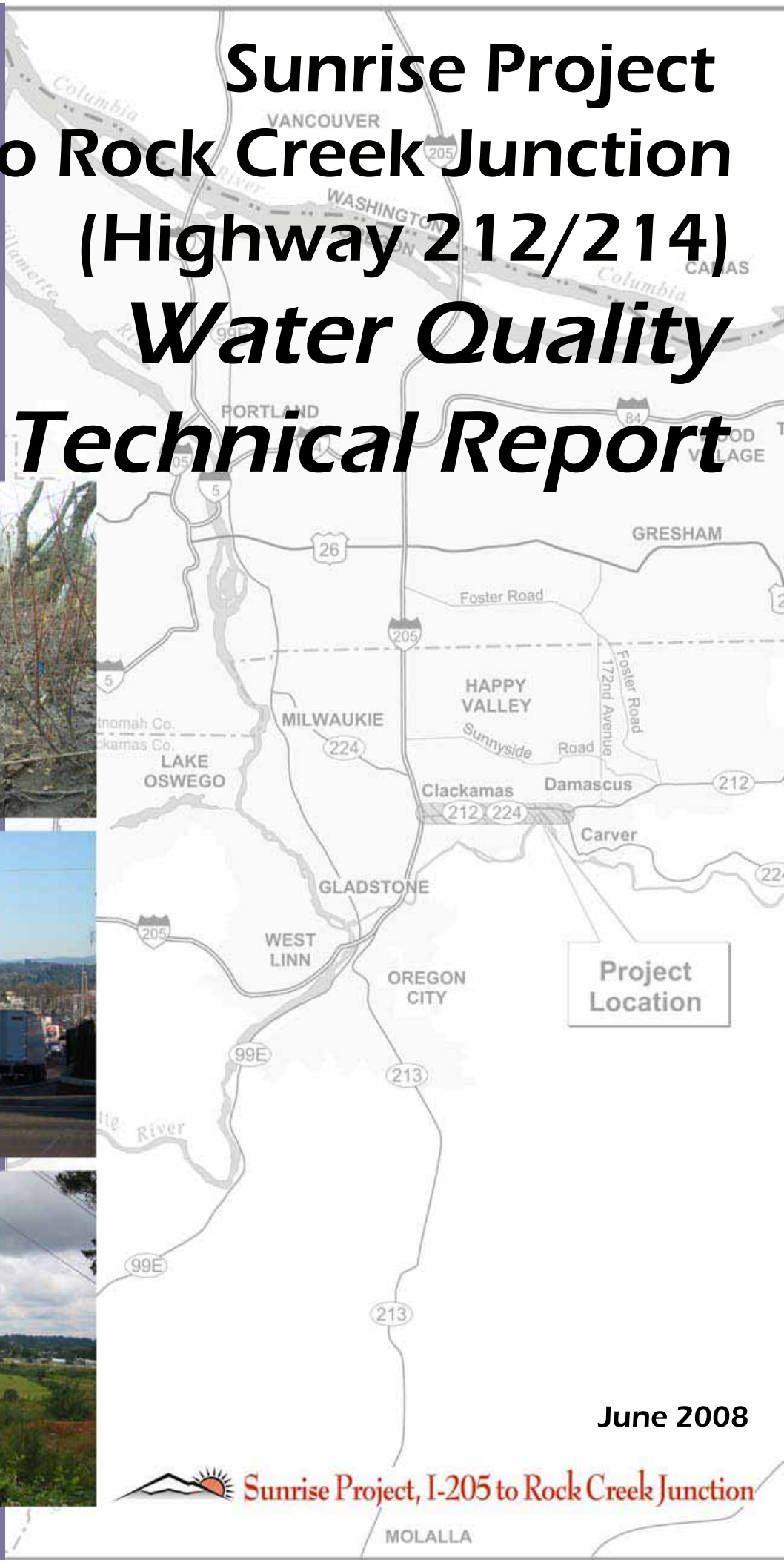
Sunrise Project
I-205 to Rock Creek Junction (Highway 212/214)
Water Quality Technical Report



June 2008

Sunrise Project, I-205 to Rock Creek Junction

October 2008

TO: Readers of the Sunrise Technical Reports

FROM: Sunrise Project Team

SUBJECT: Differences between Sunrise SDEIS and Technical Reports

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The Sunrise Project: I-205 to Rock Creek Junction Supplemental Draft Environmental Impact Statement (SDEIS) presents information summarized from numerous technical documents. Most of these documents are discipline specific technical reports (e.g., cultural resources, noise, wetlands, etc.). These reports include a detailed explanation of the data gathering and analytical methods used by each discipline team.

The technical reports are longer and more detailed than the SDEIS and should be referred to for information beyond that which is presented in the SDEIS. Findings summarized in the SDEIS are supported by analysis in the technical reports and their appendices. References used to develop the reports and underlying data are presented in the technical reports.

The draft technical reports were largely completed in late 2007. Since the technical reports were completed, new information has been discovered that has been incorporated into the SDEIS. Thus, the SDEIS reflects more recent public and agency input than is included in the technical reports. For example, since the technical reports were completed, additional work has been conducted for the cultural resource documentation for Camp Withycombe and the RTP planning process has progressed with federal approvals of local plans. Also, the cumulative effects section of the document was written after reviewing all of the technical reports. No one technical report includes this comprehensive analysis.

Please refer to the appropriate section of the SDEIS for the most current information.

SUMMARY

This technical report describes the analysis and predictions of the impacts of Sunrise Project alternatives on water quality in four drainage basins: Dean Creek, Cow Creek, Sieben Creek, and Rock Creek. Dean Creek is a tributary to Mt. Scott Creek, which in turn is tributary to Kellogg Creek. Cow Creek, Sieben Creek, and Rock Creek are tributaries to the Clackamas River.

Existing pollutant loading within the four drainage basins was determined from historical data and serves as a pre-project baseline.

Water quality impacts are based on the increase in impervious area for the two build alternatives and associated design options. This analysis only provides information on the predicted in-stream concentrations resulting from project runoff; other tributary development is not considered. The use of only upstream tributary areas gives a worst-case analysis since it provides the minimum dilution of pollutants prior to entering the receiving water.

Design options for Build Alternatives 2 and 3 were analyzed to determine the design option configurations that produce the maximum water quality impacts and the minimum water quality impacts. A comparison between the Alternative 1: No-Build baseline and the maximum and minimum impacts is also presented. The analysis details the maximum and minimum possible water quality impacts, and any other combination of design options will produce water quality impacts between these two extremes.

The maximum and the minimum water quality impacts with and without mitigation were calculated according to the same methodology that was used to develop the existing conditions baseline. Tables 26 through 33 summarize the calculated once-in-three-year exceedances for post-project alternatives as a percentage of the baseline alternative.

According to the analysis, Cow Creek has the greatest calculated increase in annual pollutant loads; however, Dean Creek registers the greatest calculated increase in three-year exceedance concentration. These two creeks are also the most heavily impacted by urbanization. Except for the lower reaches, these creeks are constructed drainage channels, not natural channels, so the increased flow is not anticipated to adversely affect their morphology. The lower reaches of both creeks are more natural, so mitigation for water quantity and quality may need to be included in final designs.

Impacts to Sieben Creek and Rock Creek are minimal, both for annual pollutant load and three-year exceedance concentrations. These creeks will undergo a small percent increase in impervious area as a result of the Sunrise Project. These creeks still have some natural character and the proposed project should have minimal effects on either water quality or creek morphology.

There is minimal difference between the maximum and the minimum water quality impacts, with the exception of Cow Creek. Cow Creek is profoundly impacted by development and has no natural component; therefore, the effects of the increased impervious area should be limited to the water quality issues, given that the anticipated water quantity detention mitigation requirements should alleviate any hydrologic impact from the increased impervious area.

No indirect water quality effects are anticipated from the proposed project. The project area is highly urbanized. If the project prompts some development or redevelopment, such development may require water quantity mitigation in addition to the proposed water quality mitigation for this project. Other development upstream and within the drainage basins intersected by this project will also be subject to regulatory requirements for mitigation of storm water quality and quantity controls.

No cumulative water quality effects are anticipated from the no-build alternative or the proposed project, however, the project will contribute to additional pollutant loading and concentrations. Since the project will include water quality and quantity mitigation, additional loadings and concentrations should be kept to a minimal level. If the project does prompt redevelopment, such redevelopment will require storm water mitigation in addition to the project related storm water mitigation.

Table 1 summarizes the increase in impervious area added to each of the four drainage basins as a result of the proposed project.

Table S1. New Impervious Area Added to Each Drainage Basin

Design Option	New Impervious Area (acres)				
	Sieben Basin	Cow Basin	Dean Basin	Rock Basin	Total
ALTERNATIVE 1*	52	27	33	283	395
ALTERNATIVE 2					
Zone A					
Baseline	–	5.5	32.9	–	38.4
Option A-2	–	5.5	27.9	–	33.4
Zone B					
Baseline	–	27	–	–	27
Option B-2	-	30.9	–	–	30.9
Zone C					
Baseline	10.2	5.6	–	4	19.8
Option C-2	9.8	5.7	–	4	19.5
Option C-3	11.2	6.3	–	4	21.5
Zone D					
Baseline	–	–	–	37.2	37.2
Option D-2	–	–	–	37.4	37.4
Option D-3	–	–	–	38	38
Maximum (Options B-2, C-3, D-3)	11.2	42.7	32.9	42	128.8
Minimum (A-2, C-2)	9.8	38.2	27.9	41.2	117.1
ALTERNATIVE 3					
Zone A					
Baseline	–	5.5	32.9	–	38.4
Option A-2	–	5.5	27.9	–	33.4
Design Option	New Impervious Area (acres)				
	Sieben Basin	Cow Basin	Dean Basin	Rock Basin	Total
Zone B					
Baseline	–	17.9	–	–	17.9
Zone C					
Baseline	10.2	5.6	–	4	19.8
Option C-2	9.8	5.7	–	4	19.5
Option C-3	11.2	6.3	–	4	21.5
Zone D					
Baseline	–	–	–	37.2	37.2
Option D-2	–	–	–	37.4	37.4
Option D-3	–	–	–	38	38
Maximum (Options C-3, D-3)	11.2	29.7	32.9	42	115.8
Minimum (A-2, C-2)	9.8	29.1	27.9	41.2	108

*Alternative 1 or the No Build option lists Existing area .

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INTRODUCTION

Project Location

The proposed project is located in the western, urbanized portion of Clackamas County in the vicinity of State Highway 212/224 (see Figure 1, Project Vicinity). The project limits extend approximately 4.9 miles from approximately 1,000 feet west of SE Johnson Road to SE 172nd Avenue, just beyond Rock Creek Junction where Highways 212 and 224 diverge.

Project Purpose and Need

The purpose of this project is to effectively address congestion and safety problems in the Highway 212/224 corridor between its interchange with Interstate 205 (I-205) and Rock Creek Junction, and to serve the growing demand for regional travel and access to the state highway system.

The need for the project is generated by the following factors:

- Highway 212/224 between I-205 and Rock Creek Junction is currently experiencing unacceptable levels of congestion and delay during the peak travel periods. By 2030, the projected traffic volume will exceed the volume that the existing four-lane arterial can be expected to handle at an acceptable level of service.
- By 2030, the numbers of households and jobs in the area served by this section of Highway 212/224 are expected to increase by 136 percent and 85 percent, respectively.
- Both the north and southbound weave sections of I-205 between SE 82nd Avenue and Highway 212/224 are approaching capacity, resulting in frequent stop-and-go movements, difficulty in changing lanes, and long queues forming because of minor incidents. By 2015, this section of I-205 is expected to exceed its design capacity and the extent of these stop-and-go movements may continue to grow if no action is taken. Some traffic traveling on the Milwaukie Expressway (Highway 224) heading east on Highway 212/224, as well as the reverse direction, may have to use either the above section of I-205 or the currently congested SE 82nd Avenue.
- Highway 212/224 near I-205 is ranked in the top 10 percent of state routes for vehicle crash rate. A vehicle crash rate of 3.10 was reported for this area during the 5-year period from 1998 through 2002. The comparable statewide facility rate is 2.47. The high crash rate is attributed to severe congestion and roadway deficiencies. Inadequate bicycle and pedestrian facilities reduce the safety and connectivity for these modes of travel in the project area.

Proposed Action

The proposed action would provide a new limited-access expressway between I-205 and the Rock Creek Junction. The facility would be comprised of six lanes, plus auxiliary lanes, and would include an improved interchange at I-205. This new expressway would become the designated State Highway 212/224, with the existing route reverting to a county arterial.

ALTERNATIVES

A no-build alternative and two build alternatives are being evaluated. Design options within each of the build alternatives are also being considered. Both build alternatives and all design options would incorporate an improved interchange at I-205 and an interchange at Rock Creek Junction. The alignment of the facility would generally follow a natural bluff-line that extends from Mt. Talbert east to Rock Creek on the north side of Highway 212/224. Associated improvements to address local circulation are also included.

Alternative 1: No-Build

The National Environmental Policy Act (NEPA), Oregon Department of Transportation (ODOT), and Federal Highway Administration (FHWA) guidelines require that a no-build option be evaluated. The No-Build Alternative (see Figure 2) would maintain the existing roadway except for committed improvements scheduled in ODOT's four-year Statewide Transportation Improvement Program (STIP) and Metro's Financially Constrained Projects listed in the Regional Transportation Plan (RTP). These listed projects include the following:

- Widen SE 82nd Avenue between Lawnfield Road and Highway 212/224.
- Improve the Highway 212 connection to Mather Road via SE 102nd Avenue and Industrial Way.
- Construct a new northerly extension of Highway 224 at Rock Creek Junction that curves east to connect to SE 162nd and SE 172nd Avenues.
- Create a climbing lane on Highway 212 between Rock Creek Junction and SE 172nd Avenue.
- Widen SE 172nd Avenue between Foster Road and Highway 212.
- Widen Highway 224 between Rock Creek Junction and the Carver Bridge.
- Widen the Carver Bridge to five lanes.

Alternative 2: Build with Midpoint Interchange

This alternative is distinguished by the inclusion of a midpoint interchange in the vicinity of SE 122nd Avenue, which would connect the expressway to the existing Highway 212/224 (see Figure 3).

Alternative 3: Build with No Midpoint Interchange

In contrast to Alternative 2, this alternative would not have a midpoint interchange, resulting in no access to the expressway between I-205 and Rock Creek Junction (see Figure 4).

Design Options

In addition to the two build alternatives described above, a number of design options are under consideration. These options are organized by geographic zones, as described below.

- ***Zone A*** is the westernmost portion of the corridor and represents the I-205 Interchange Area and the Lawnfield Business Area, with a western terminus aligned with SE Johnson Road

and an eastern terminus bisecting Camp Withycombe. The north and south boundaries extend from Clackamas Town Center to south of SE Jennifer Street.

- ***Zone B*** is the "Midpoint Area" and extends from Camp Withycombe to SE 135th Avenue, north to Clackamas High School and south to SE Jennifer Street.

- ***Zone C*** has the same north and south boundaries as Zone B and extends from SE 135th Avenue east to the Rock Creek area.

- ***Zone D*** represents the eastern end of the corridor and stretches east to SE 172nd Avenue with the same north and south boundaries as Zones B and C.

Many design options were considered, but only a few were carried forward for study. The design options described below retain their original numbering system.

Design Option A-2: Modified 1996 Design

This design option, located in Zone A, would extend SE Lawnfield Road west and south toward SE Clackamas Road (see Figures 5, 6 and 7). A further change would be to route SE Mather Road west to the SE Lawnfield Road extension, instead of south along SE Industrial Way.

Design Option B-2: 1996 Split Interchange (Modified)

Located in Zone B, this design option for the midpoint interchange would incorporate a modified split interchange involving both SE 122nd Avenue and SE 135th Avenue. This option would be applicable only to Alternative 2, as displayed in Figures 5, 6, and 8.

Design Option C-2: Central Alignment

This design option, located in Zone C and displayed in Figures 5, 6, and 9, would adjust the corridor alignment in the vicinity of Rock Creek closer to the existing Highway 212/224 alignment.

Design Option C-3: Modified Follow Tree-Line Alignment

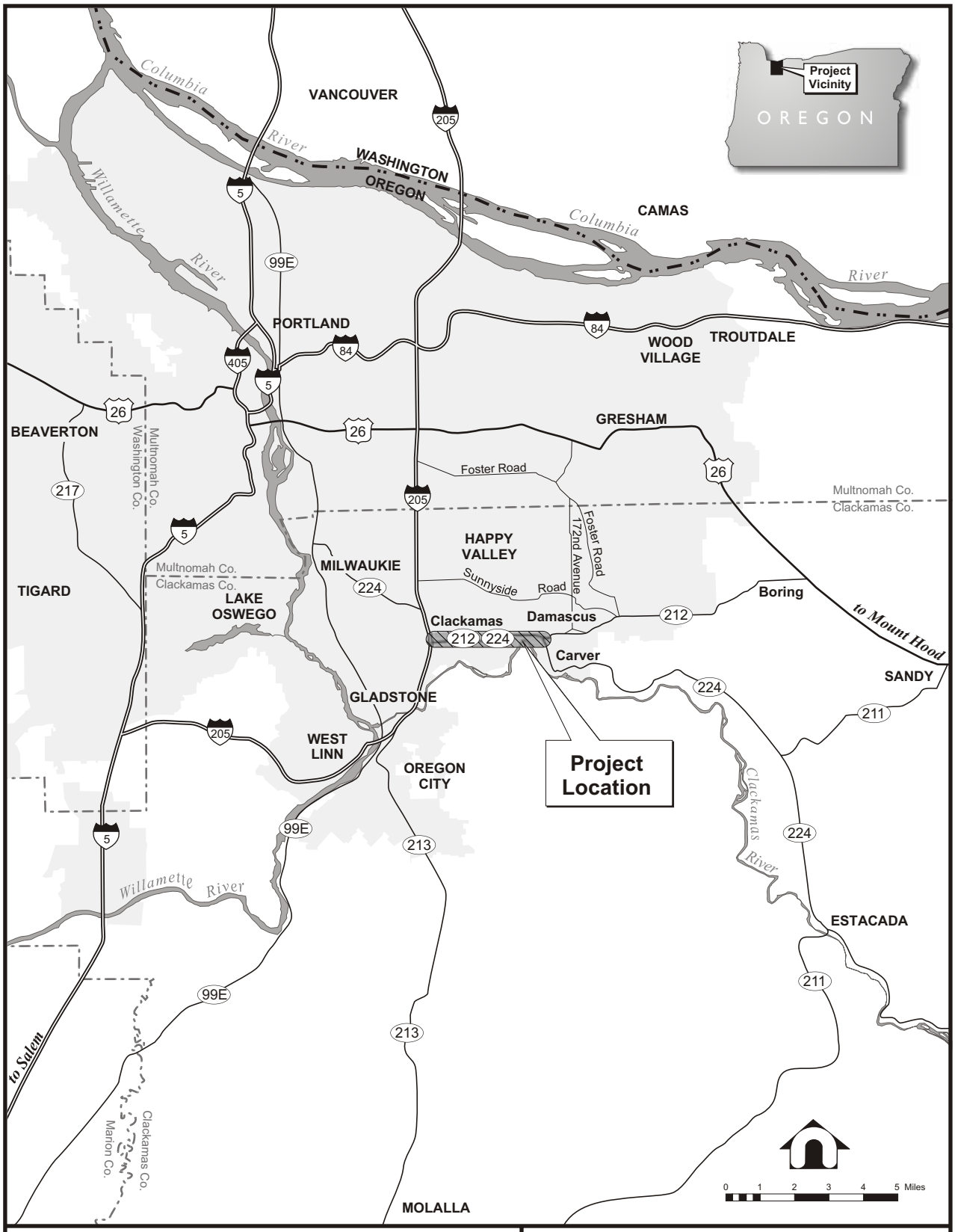
In contrast to Option C-2, this option would more closely follow the existing tree line to the north, as shown in Figures 5, 6, and 10.

Design Option D-2: Alignment through Knoll (Folded Diamond Interchange)

Instead of incorporating a folded diamond interchange north of a natural knoll in Zone D, this option would place the alignment through the knoll, as depicted in Figures 5, 6, and 11.

Design Option D-3: Single-Point Diamond Interchange

This design option replaces the folded diamond interchange with a single-point diamond- design interchange situated farther south in Zone D, as shown in Figures 5, 6, and 12.



Legend

- County Boundary
- Project Location
- Rivers
- State Boundary
- Urban Growth Boundary

INCORPORATED CITY

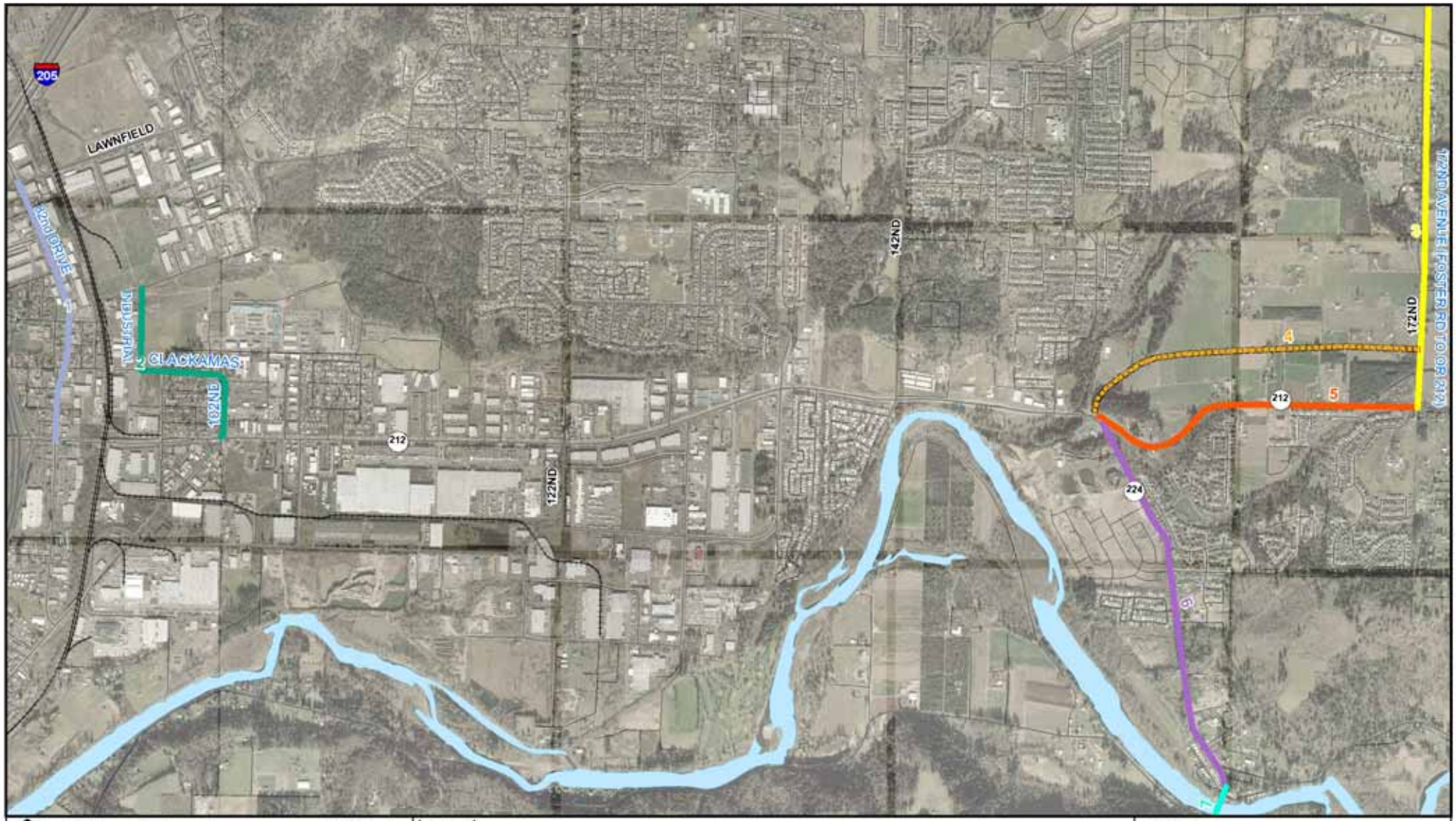
Unincorporated Community

- Interstate
- U.S. Highway
- State Highway
- Other Major Roads

Figure 1

Project Vicinity

Sunrise Project, I-205 to Rock Creek Junction



2,000 1,000 0 2,000 Feet

Sources:
ODOT and Metro, Portland OR

Legend

Railroad

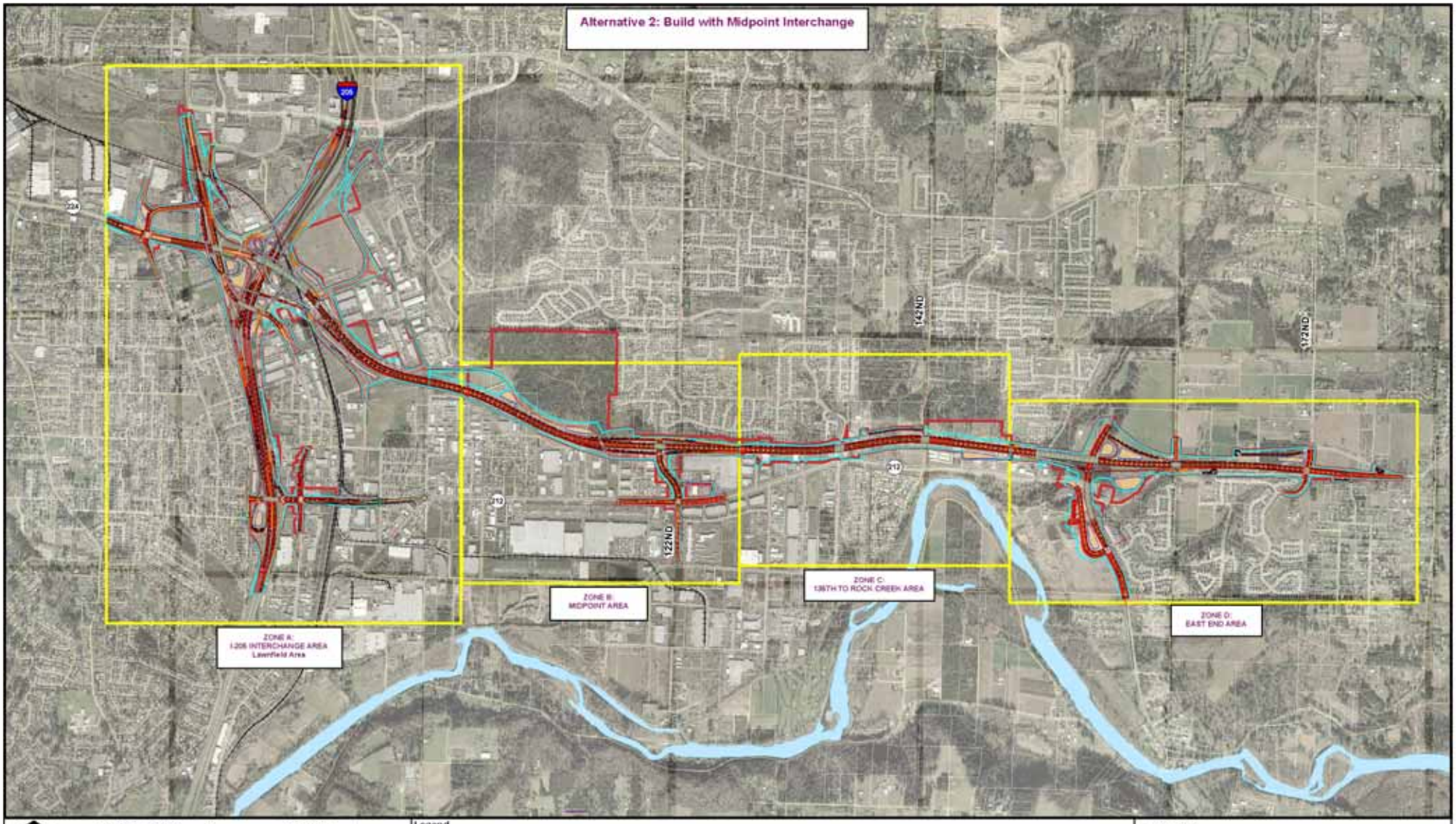
Future Funded Projects

1 Widen to 5 Lanes
2 Upgrade Roadway
3 Widen to 5 Lanes
4 New Arterial
5 Hwy 212 Widening
6 Hwy 224 Widening
7 Widen to 5 Lanes

Figure 2

Alternative 1: No-Build

Sunrise Project, I-205 to Rock Creek Junction



N

2,000 1,000 0 2,000 Feet

Sources:
ODOT and Metro, Portland OR

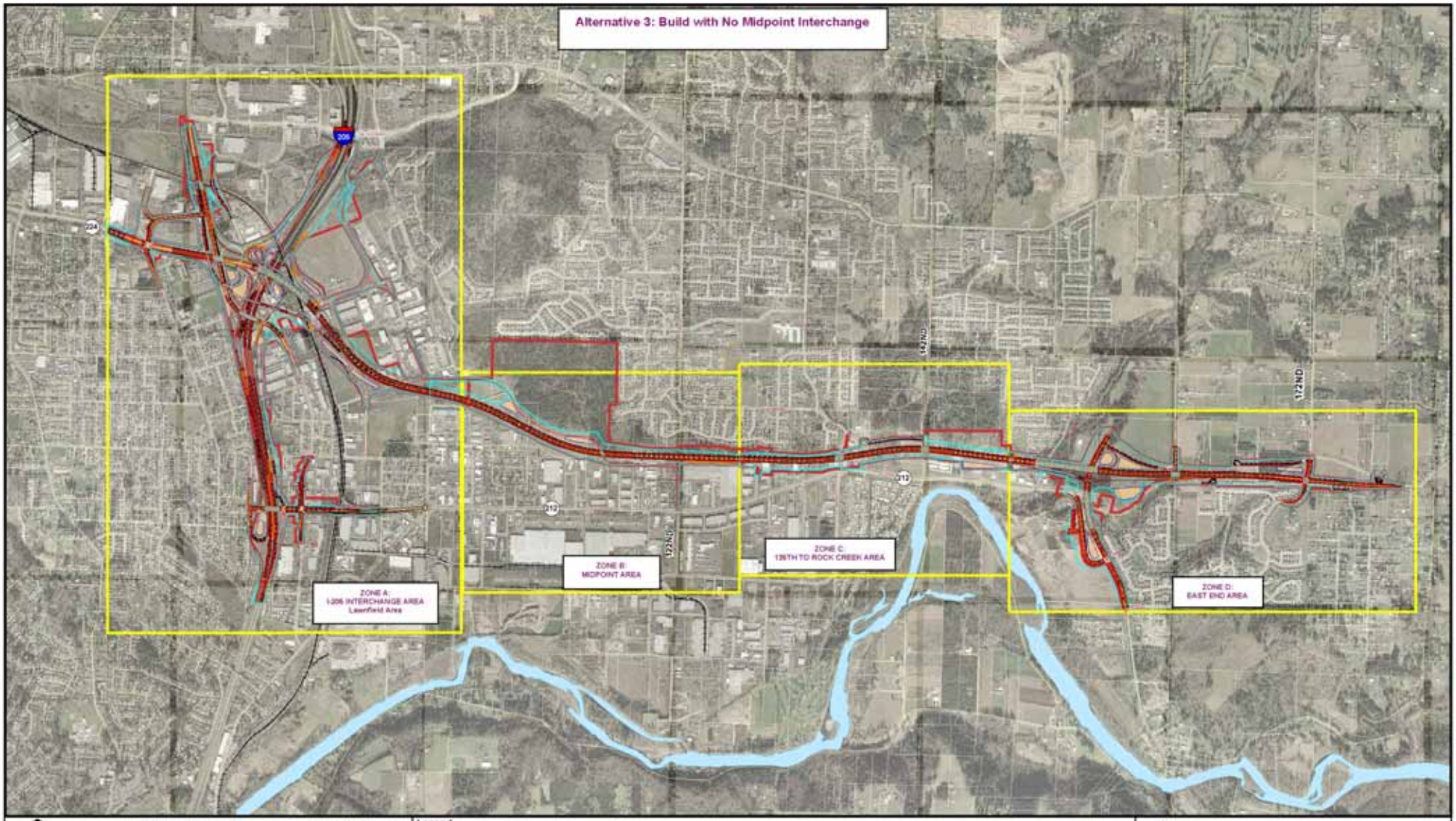
Legend

- Zone Boundary
- Construction Impact Line
- Lanelane
- Lane Striping
- Median
- Proposed Rights-Of-Way Line
- Tax Lots
- Wall
- Water Quality/Retention
- Railroad
- Structure

Figure 3

Alternative 2: Build with Midpoint Interchange

Sunrise Project, I-205 to Rock Creek Junction



2,000 1,000 0 2,000 Feet

Sources:
ODOT and Metro, Portland OR

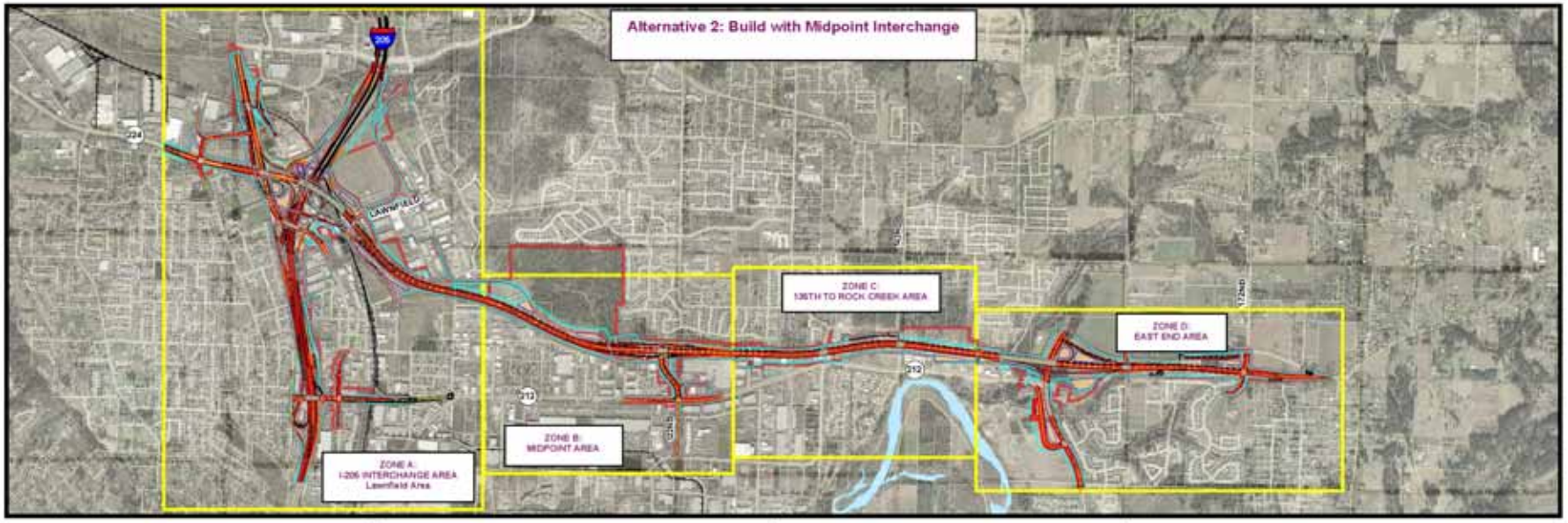
Legend

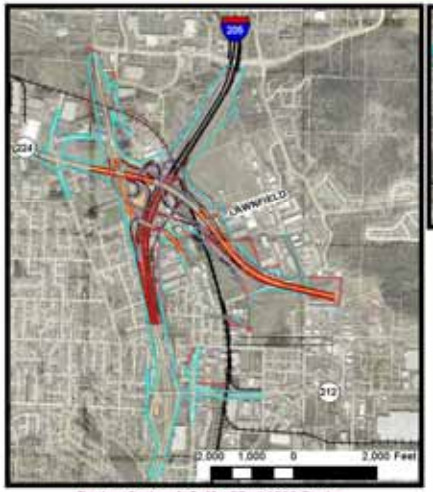
- Zone Boundary
- Construction Impact Line
- Lanelane
- Lane Striping
- Median
- Proposed Right-Of-Way Line
- Tax Lots
- Wall
- Water Quality/Retention
- Railroad
- Structure

Figure 4

Alternative 3: Build with No Midpoint Interchange

Sunrise Project, I-205 to Rock Creek Junction





Design Option A-2: Modified 1996 Design

Design Option B-2: 1996 Split Interchange

Design Option C-2: Central Alignment

Design Option D-2: Alignment Through Knoll
(Folded Diamond Interchange)

Design Option C-3: Modified Follow Tree-Line Alignment

Design Option D-3: Single Point Diamond Interchange

N

3,000 1,500 0 3,000 Feet

Note: Scale bar represents main Alternative 2 data frame

Sources:
ODOT and Metro, Portland OR

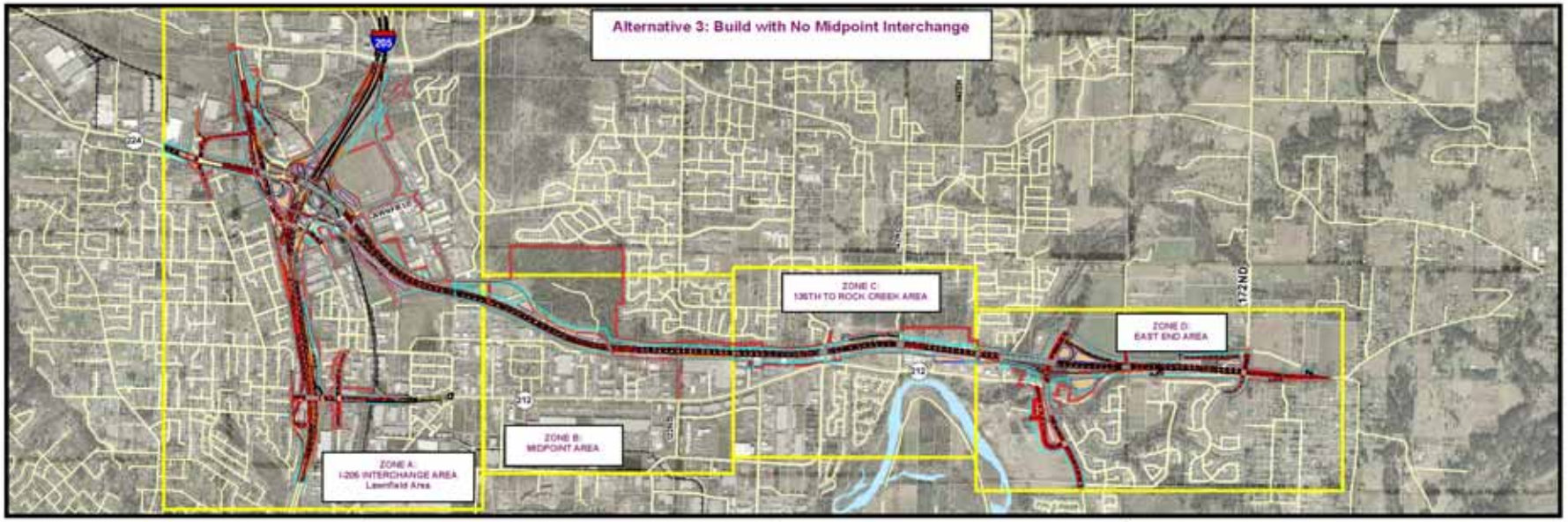
Legend

- Zone Boundary
- Construction Impact Line
- Lanelane
- Median
- Proposed Right-Of-Way Line
- Tax Lots
- Wall
- Water Quality/Retention
- Railroad
- Structure

Figure 5

Alternative 2 with Design Options

Sunrise Project, I-205 to Rock Creek Junction



Design Option A2: Modified 1996 Design

Design Option C-2: Central Alignment

Design Option D-2: Alignment Through Knoll (Folded Diamond Interchange)

Design Option C-3: Modified Follow Tree-Line Alignment

Design Option D-3: Single-Point Diamond Interchange

3,000 1,500 0 3,000 Feet

Note: Scale bar represents main Alternative 3 data frame

Sources:
ODOT and Metro, Portland OR

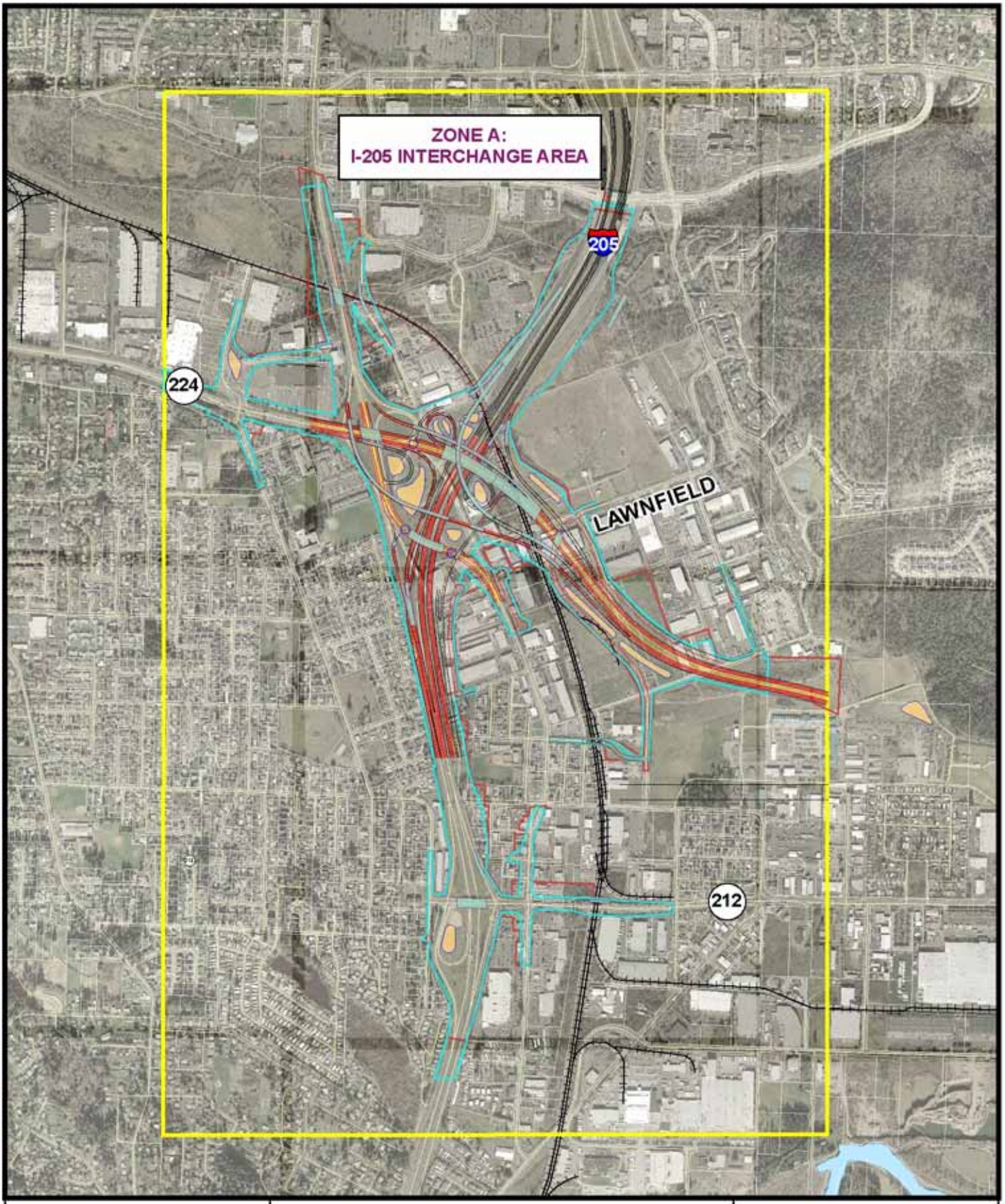
Legend

- Zone Boundary
- Construction Impact Line
- Lanelane
- Median
- Proposed Rights-Of-Way Line
- Tax Lots
- Wall
- Water Quality/Retention
- Railroad
- Structure

Figure 6

Alternative 3 with Design Options

Sunrise Project, I-205 to Rock Creek Junction



810 405 0 810 Feet

Sources
ODOT and Metro, Portland OR

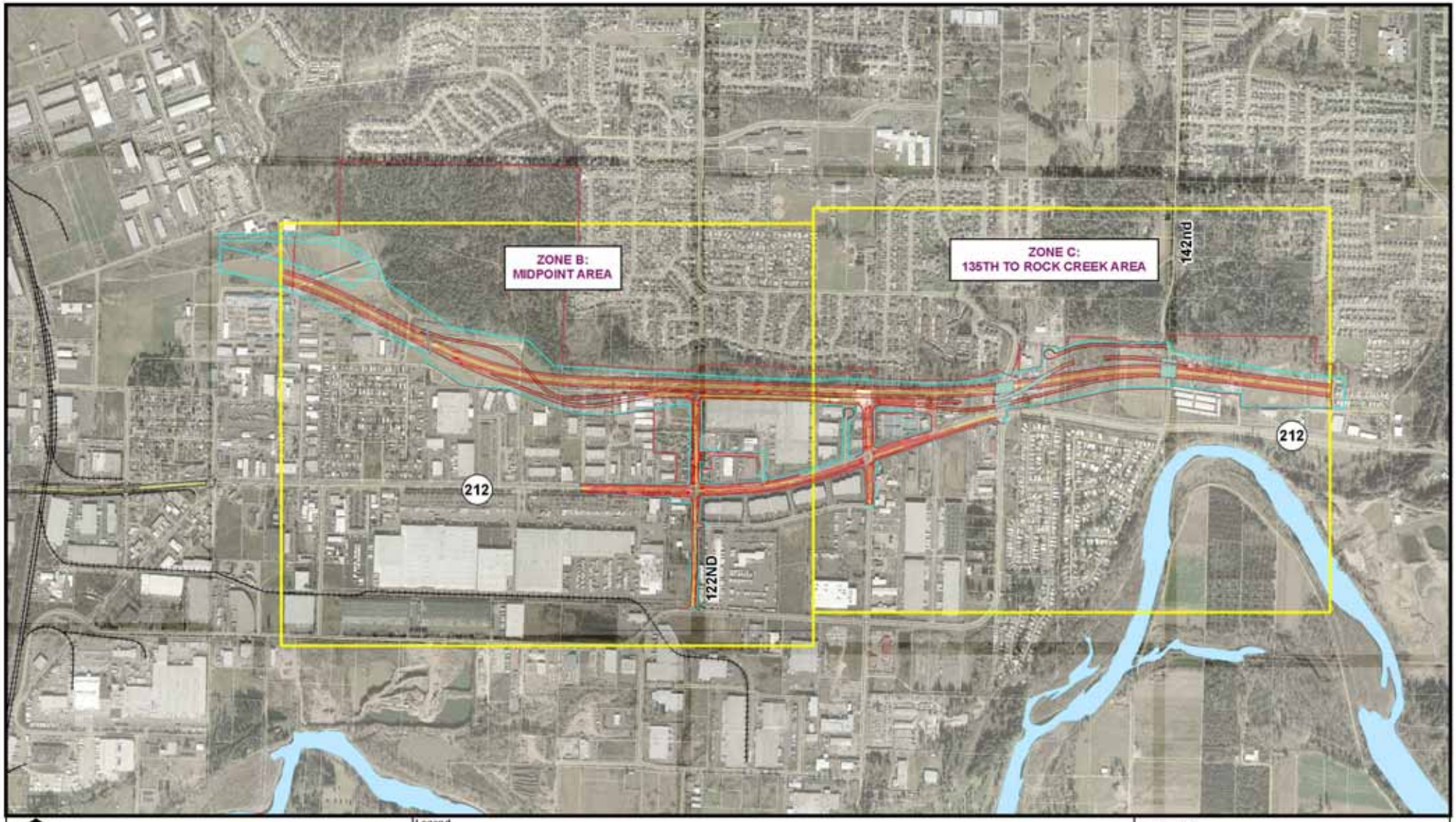
Legend

- Zone Boundary
- Construction Impact Line
- Laneline
- Median
- Proposed Right-Of-Way Line
- Tax Lots
- Wall
- Water Quality/Retention
- Railroad
- Structure

Figure 7

Option A-2:
Modified 1996 Design

Sunrise Project, I-205 to Rock Creek Junction



950 475 0 950 Feet

Sources:
ODOT and Metro, Portland OR

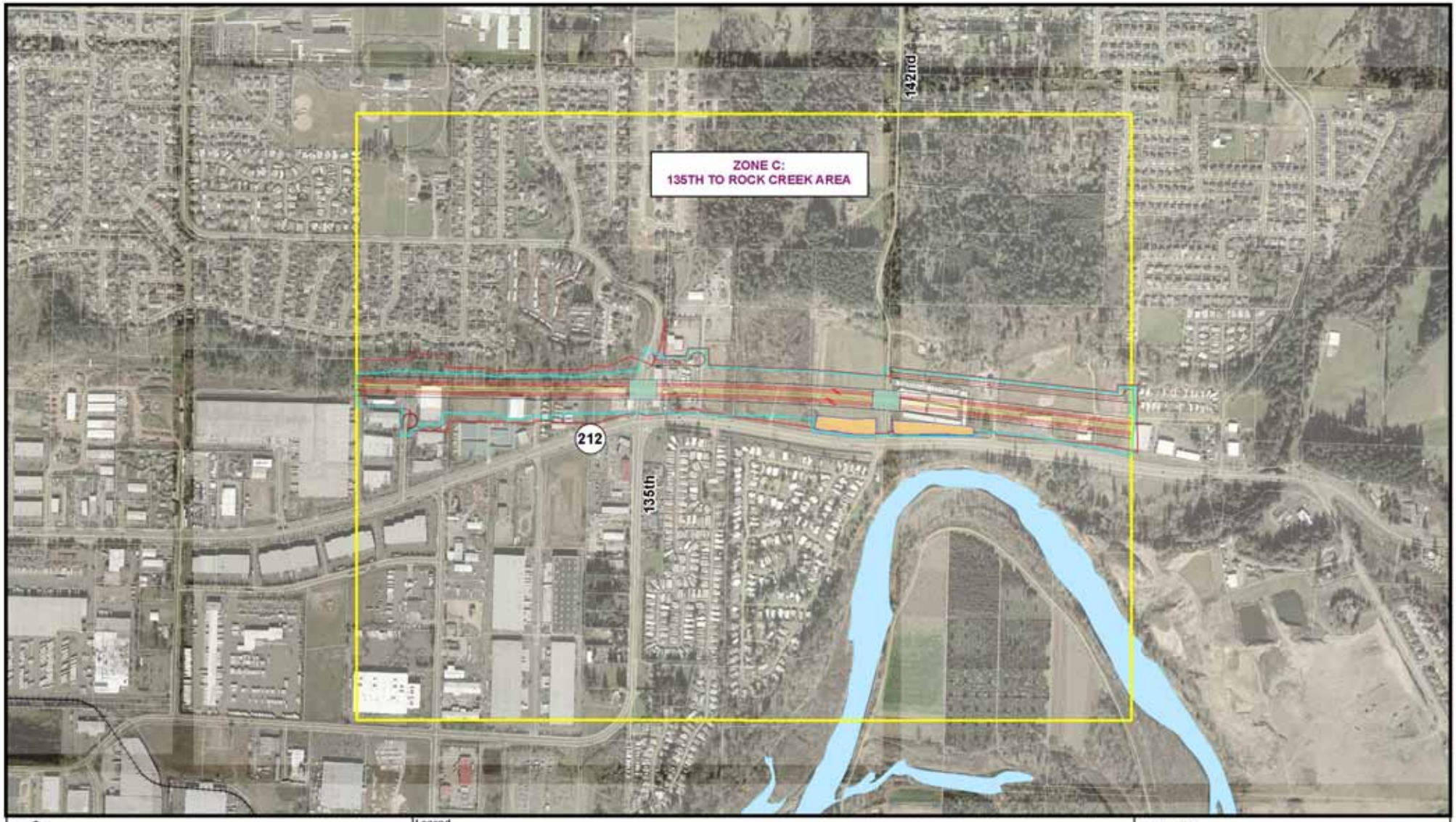
Legend

- Zone Boundary
- Construction Impact Line
- Lanelane
- Median
- Proposed Right-Of-Way Line
- Tax Lots
- Wall
- Water Quality/Retention
- Railroad
- Structure

Figure 8

Option B-2: 1996 Split Interchange

Sunrise Project, I-205 to Rock Creek Junction



800 400 0 800 Feet

Sources:
ODOT and Metro, Portland OR

Legend
Zone Boundary
Construction Impact Line
Lanelane
Median
Proposed Right-Of-Way Line
Tax Lots
Wall
Water Quality/Retention
Railroad
Structure

Figure 9

Option C-2: Central Alignment

Sunrise Project, I-205 to Rock Creek Junction

800 400 0 800 Feet

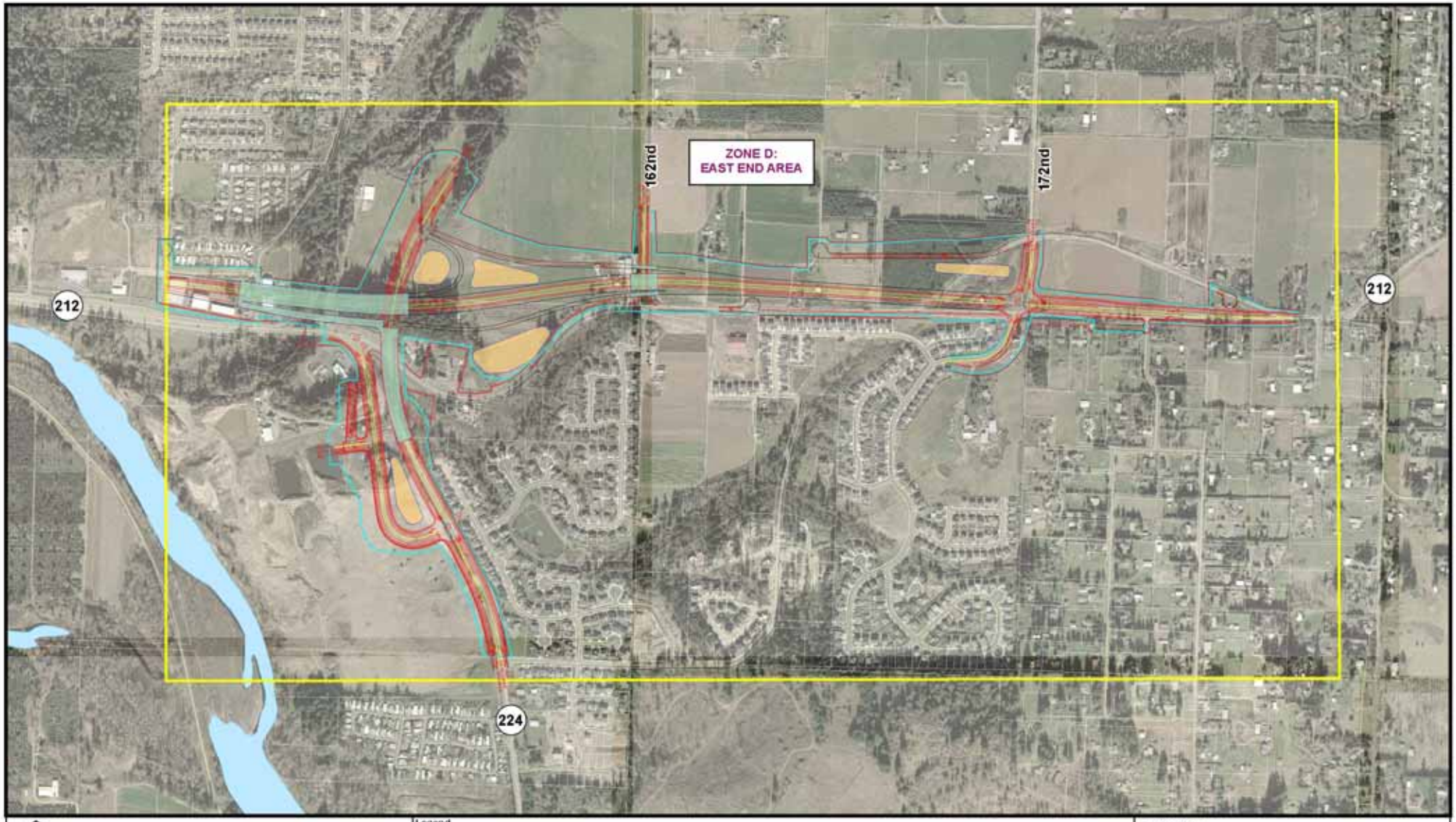
Sources:
ODOT and Metro, Portland OR

Legend
Zone Boundary
Construction Impact Line
Laneline
Median
Proposed Right-Of-Way Line
Tax Lots
Wall
Water Quality/Retention
Railroad
Structure

Figure 10

Option C-3: Modified Follow Tree-line Alignment

Sunrise Project, I-205 to Rock Creek Junction



800 400 0 800 Feet

Sources:
ODOT and Metro, Portland OR

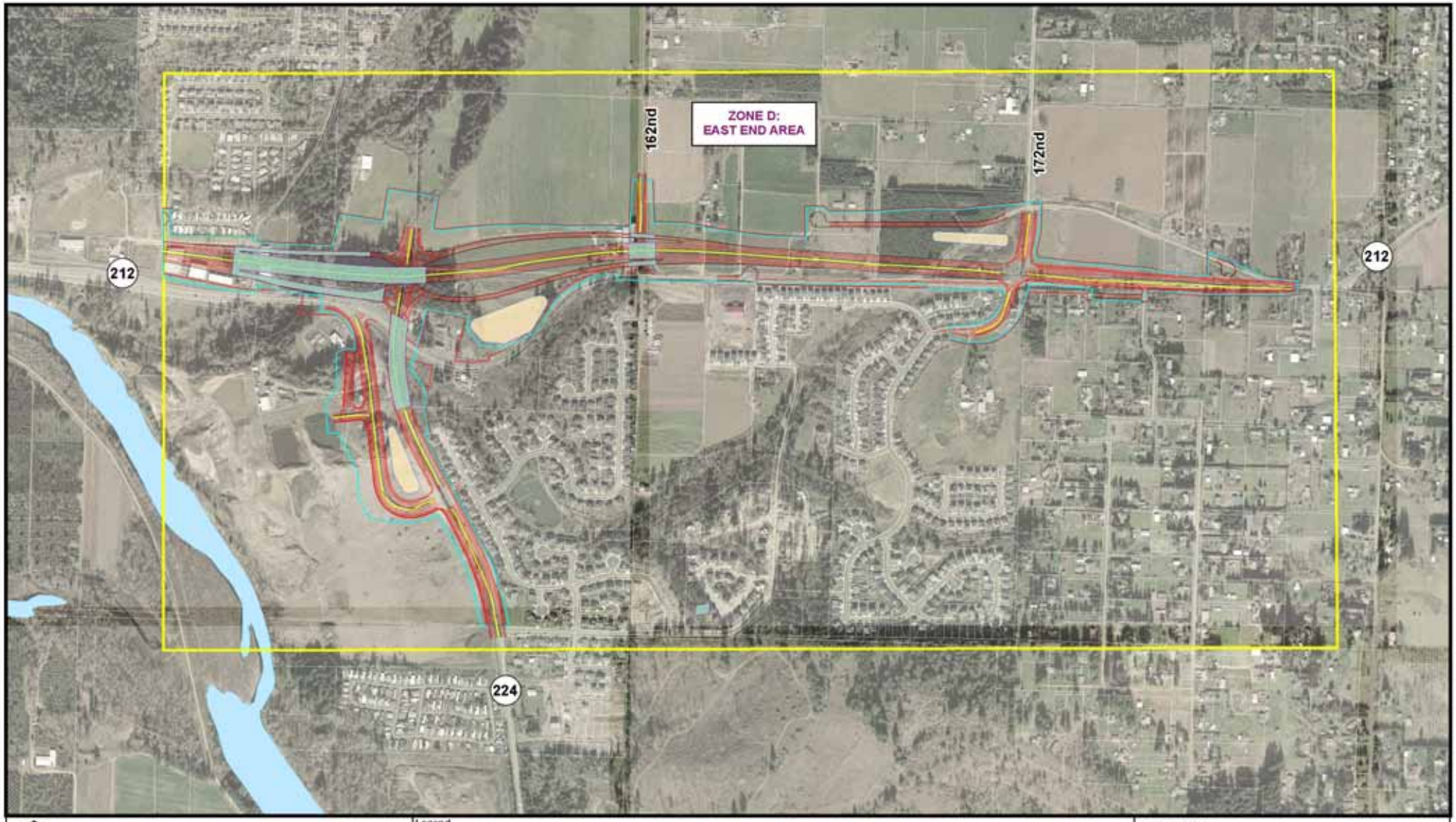
Legend

- Zone Boundary
- Construction Impact Line
- Laneline
- Median
- Proposed Right-Of-Way Line
- Tax Lots
- Wall
- Water Quality/Retention
- Railroad
- Structure

Figure 11

Option D-2: Alignment Through Knoll (Folded Diamond Interchange)

Sunrise Project, I-205 to Rock Creek Junction



800 400 0 800 Feet

Sources:
ODOT and Metro, Portland OR

Legend

- Zone Boundary
- Construction Impact Line
- Laneline
- Median
- Proposed Right-Of-Way Line
- Tax Lots
- Wall
- Water Quality/Retention
- Railroad
- Structure

Figure 12

Option D-3: Single Point Diamond Interchange

Sunrise Project, I-205 to Rock Creek Junction

METHODOLOGY AND DATA SOURCES

The data in this technical report provides information on potential effects of storm water runoff from the proposed project to aquatic resources in the project vicinity. This technical report summarizes the analysis and predictions of the impacts of project alternatives on water quality in Dean Creek, Cow Creek, Sieben Creek, and Rock Creek. Dean Creek is a tributary to Mt. Scott Creek, which is tributary to Kellogg Creek. Cow Creek, Sieben Creek, and Rock Creek are tributaries to the Clackamas River. Creek tributary areas, upstream of the proposed project, are listed in Table 2.

Table 2. Creek Tributary Areas

Creek	Tributary Area* (acres)	Tributary Area* (sq mi)
Dean Creek	75	0.117
Cow Creek	265	0.414
Sieben Creek	1,176	1.0
Rock Creek	5,754	8.99

* Area upstream of the proposed project.

The methods for this study are primarily based on FHWA procedures, as identified in Pollutant Loadings and Impacts from Highway Storm Water Runoff (FHWA-RD-88-006, April 1990). They just show the theoretical increase in annual loading and pollutant concentrations from the extra impervious area added by the Sunrise project, they do not represent actual pollutant loading within the drainage area. The results from this probabilistic procedure can be used to predict the possibility of a once-in-three-year exceedance of acute water quality criteria. These procedures have been modified by ODOT.

ODOT modified the FHWA procedures outlined in FHWA-RD-88-006 as follows. Site median concentrations were taken from ODOT storm water sampling data, as reported on its National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit application, instead of from the Nationwide Urban Runoff Program (NURP) data used by FHWA. ODOT site median concentrations, as taken from ODOT's MS4 permit application, were typically measured at sites with greater urbanization and higher traffic volumes than the NURP studies; therefore, the actual median concentrations for this project will probably be lower than those assumed. Water quality criteria are taken from the Oregon Department of Environmental Quality (DEQ) acute and chronic requirements (Table 20 of DEQ's water quality standards), instead of U.S. Environmental Protection Agency (EPA) acute and threshold requirements as reported in FHWA-RD-88-006. Solubility data were taken from NURP studies, where available. Once a preferred alternative has been selected, future studies can continue to use the FHWA method with the ODOT MS4 permit data, or more specific medium concentration data from on-site monitoring can be used.

Water quality impacts are based upon the increase in impervious area for the various alternatives. This analysis only provides information on the predicted in-stream concentrations resulting from project runoff; other tributary development is not considered. Tributary areas are calculated upstream from the point the proposed project intersects the stream or river. The use of only upstream tributary areas gives a worst-case analysis since it provides the minimum dilution of pollutants prior to their entering the receiving water.

AFFECTED ENVIRONMENT

The project crosses four major drainages—Dean Creek, Cow Creek, Sieben Creek, and Rock Creek See Table 2). Dean Creek flows to the northwest and is a tributary of Mt. Scott Creek. The other creeks flow south and are tributary to the Clackamas River. The project is outside of the regulatory 100-year floodplain, which covers the Clackamas River and the extreme lower end of Rock Creek, south of Highway 212.

The Clackamas River, Cow Creek, Rock Creek, and Sieben Creek are listed on DEQ's 303(d) List (§303(d) of the Federal Clean Water Act) of water bodies that do not meet water quality standards. Table 3 presents the 303(d) listed water bodies in the project area and immediately downstream. Including the 303d listing information in the report does not necessarily mean that highway runoff is the direct cause of the water quality problems highlighted in the following table. Highway runoff can carry heavy concentrations of bacteria, but usually is a secondary source. The primary source is usually from the area the highway bisects.

Table 3. 303(d) Listed Reaches

Water Body	Listed Reaches (RM)*	Parameter
Clackamas River	0 – 22.9	Temperature
Clackamas River	0 – 15	Bacteria (6/01 – 9/30)
Cow Creek	0 – 2.6	Temperature (10/01 – 5/31)
Cow Creek	0 – 2.6	Bacteria (10/01 – 5/31)
Sieben Creek	0 – 1.8	Bacteria (10/01 – 5/31)
Rock Creek	0 – 6.1	Bacteria (10/01 – 5/31)

* River mile

In response to water quality violations, the Clean Water Act requires a total maximum daily load (TMDL) to be established. A TMDL determines how much pollution can be added to a fresh water body without exceeding water quality standards. It identifies where pollution comes from within a particular basin and divides or "allocates" the pollution loads among different sources. Allocations are given to point sources, such as industries and sewage treatment plants that discharge into the river, and to nonpoint sources, such as runoff from farms, forests, and urban areas. A TMDL accounts for "background"—i.e., the amount of pollution naturally found in the water—and it includes a margin of safety to account for uncertainty. A TMDL can also include a reserve that allows for new or increased discharges into a particular water body in the future. Two TMDLs have been developed for the Clackamas Subbasin: one for bacteria and one for temperature. Final TMDLs for the Willamette River Basin, of which the Clackamas River is a tributary, have been established. See the Oregon DEQ web site for more detail.

DEQ maintains a database of water quality sampling information for the state. Four sampling sites were determined to be relevant to the proposed project. The sampling station data were obtained from the DEQ Web site from their Laboratory Analytical Storage and Retrieval (LASAR) database. Data collected was for all sampling dates contained in the database, no dates were excluded. Due to the face that the data collected is limited, it is more historical in nature and may or may not represent current existing conditions. The sampling stations are listed in Table 4.

Table 4. Oregon DEQ Sampling Station Locations

Water Body	Location	Station No.
Clackamas River	Highway 99E (Gladstone)	10360
Clackamas River	Riverside Park	29045
Clackamas River	Carver	10625
Rock Creek	Highway 212	11354

For this study, the parameters of interest for which data were available include total suspended solids (TSS), 5-day biochemical oxygen demand (BOD_5), nitrogen as ammonia (Ammonia N), cadmium, copper, lead, and zinc. The majority of the data was collected prior to 1975 and is historical water quality data. The median values for each parameter, at each location, are presented in Table 5. Median values were employed as opposed to average values due to the small number of samples and the non-normal distribution of the data. Normality was determined using the probability plot correlation coefficient test for normality. The median is a non-parametric statistic, and it better represents the central tendency of non-normally distributed data. Where data are normally distributed, the median is equivalent to the mean.

Table 5. Summary of Median Concentrations

Pollutant	Median Concentration (mg/L)			
	Clackamas River at Gladstone (10360)	Clackamas River at Carver (10625)	Clackamas River at Riverside Park (29045)	Rock Creek at Hwy212 (11354)
TSS	8.0	5.0	2.8	6.0
BOD_5	0.85	0.50	–	0.60
Ammonia N	0.00020	0.00050	0.07000	0.00035
Cadmium*	0.0006	<0.0002	–	–
Copper*	0.001	0.002	–	–
Lead*	0.001	<0.001	–	–
Zinc*	<0.002	<0.002	–	–

* Metals are "Total" in that the number includes Solid and Dissolved.

Fresh water quality criteria for acute concentrations and chronic concentrations of the parameters of interest are listed in Table 6. The criteria presented are from OAR 340, Division 41 (DEQ's Table 20), where they are given in micrograms per liter (µg/L). The criteria have been converted to milligrams per liter (mg/L) to simplify comparison with the sample data. Comparing the historical data medians to the existing criteria, the median values are below the established criteria.

Table 6. Applicable Fresh Water Quality Criteria

Parameter*	Acute (mg/L)	Chronic (mg/L)
Cadmium	0.0039+	0.0011+
Copper	0.018+	0.012+
Lead	0.082+	0.0032+
Zinc	0.120+	0.110+

*+ Hardness Dependent Criteria 100mg/L used

Summaries of the data collection time frames and the number of samples taken at each sampling location are provided in Tables 7 through 10.

Table 7. Clackamas River at Gladstone Data Collection Summary

Pollutant	Station 10360 Summary		
	Begin Sample Date	End Sample Date	Number of Samples
TSS	8/17/1965	12/23/1975	22
BOD_5	7/24/1957	8/11/1977	34
Ammonia N	8/17/1965	8/11/1977	51
Cadmium	8/31/1982	8/31/1982	1
Copper	8/31/1982	8/31/1982	1
Lead	8/31/1982	8/31/1982	1
Zinc	8/31/1982	8/31/1982	1

Table 8. Clackamas River at Carver Data Collection Summary

Pollutant	Station 10625 Summary		
	Begin Sample Date	End Sample Date	Number of Samples
TSS	5/17/1966	12/23/1975	9
BOD_5	5/17/1966	12/23/1975	13
Ammonia N	5/17/1966	12/23/1975	21
Cadmium	8/31/1982	8/31/1982	1
Copper	8/31/1982	8/31/1982	1
Lead	8/31/1982	8/31/1982	1
Zinc	8/31/1982	8/31/1982	1

Table 9. Clackamas River at Riverside Park Data Collection Summary

Pollutant	Station 29045 Summary		
	Begin Sample Date	End Sample Date	Number of Samples
TSS	10/2/2002	7/14/2005	6
BOD_5	–	–	–
Ammonia N	10/2/2002	10/2/2002	1
Cadmium	–	–	–
Copper	–	–	–
Lead	–	–	–
Zinc	–	–	–

Table 10. Rock Creek at Carver Data Collection Summary

Pollutant	Station 11354 Summary		
	Begin Sample Date	End Sample Date	Number of Samples
TSS	4/3/1973	9/22/1975	3
BOD_5	11/7/1973	9/22/1975	2
Ammonia N	11/7/1973	9/22/1975	5
Cadmium	–	–	–
Copper	–	–	–
Lead	–	–	–
Zinc	–	–	–

In addition to the determination of the median concentrations for each parameter, the TSS, BOD_5, and Ammonia N data sets were analyzed for significant differences between the concentrations observed at the upstream sampling point along the Clackamas River at Carver (Station 10625) and the downstream sampling point along the Clackamas River at Highway 99E in Gladstone (Station 10360). These two points were chosen because of their location and similar sampling history. The sampling location at Carver is upstream of the urbanized portion of the river, while the sampling location at Gladstone is well within the urban zone and downstream of urban areas. If the two data sets for each parameter are determined to be statistically similar, then it may imply that no disproportional pollution source for the respective parameter exists between the two locations. The converse may be true if the data for each parameter are determined to be statistically different at the two locations.

To ensure similar conditions, data were compared from samples taken on the same dates. The compared data sets were from samples collected from 1966 to 1969. A non-parametric Matched-Pair Sign test was used to evaluate the statistical difference in the observed concentrations between the samples taken at each location. The null hypothesis of the Matched-Pair Sign test is that the probability of a value from one group being higher than a value taken from the other group is one-half. The alternate hypothesis is that the probability of a value from one group being higher than a value taken from the other group is not equal to one-half. Essentially, if the null hypothesis is not rejected, it implies that the two locations tend to produce similar observations. Because of the sample size, the exact form of the Matched-Pair Sign test was used. The resulting "p-value" associated with that test was determined for all three parameters and compared to a 5 percent significance level for Type 1 error. For all three parameters, the p-value was greater than 0.05. Therefore, the null hypothesis was not rejected, implying that the concentrations of each parameter did not significantly differ statistically at either location from 1966 to 1969. The Matched-Pair Sign test results are summarized in Table 11.

Table 11. Matched-Pair Sign Test Results for Clackamas River at Gladstone (Station 10360)

Pollutant	Number of Samples	p-value
TSS	8	1.00
Ammonia N	18	0.39
BOD_5	8	0.45

In summary, the data are historical water quality data that may or may not represent current existing conditions. In previous years, the concentrations of TSS, BOD_5 demand, and Ammonia N in the Clackamas River, under similar conditions, did not significantly increase or decrease from the upstream sampling station at Carver to the downstream sampling station at Highway 99E in Gladstone. This may imply that despite urbanization between the two locations along the river, no significant disproportionate source contributed to the concentration of these parameters. However, this also may not be representative of the existing conditions.

Based on current data, the following discussion and Tables 12 through 23 were developed as an existing condition baseline "Alternative 1 – No Build" for comparison with the build alternatives. See the section titled "Methodology and Data Sources" for an explanation on how the following tables are calculated.

Dean Creek

Dean Creek flows northwest to a confluence with Mt. Scott Creek. Its major headwater is Mount Talbert on the east. The creek drains the extensive KEX radio tower wetland complex between I-205 and Mount Talbert. The lower drainage area is a mix of commercial and industrial land use. The Mount Talbert area is a combination of forested and residential land use. In this area, Dean Creek looks similar to an irrigation ditch and has been channeled to run along the railroad tracks.

Event mean concentrations and annual loadings for runoff from the baseline project area are presented in Table 12. These estimates are based on ODOT's NPDES monitoring data from Portland.

Table 12. Event Mean Concentrations and Annual Loadings from Baseline Project Runoff to Dean Creek

Parameter	Event Mean Concentration (mg/L)	Annual Loading (pounds/year)
TSS	259	58,843
BOD_5	13.6	3,096
TKN*	3.07	697.2
Ammonia N	0.908	206
Total Phosphorus	0.515	117
Cadmium	0.00258	0.586
Copper	0.0478	10.9
Lead	0.0785	17.9
Zinc	0.307	69.7
Dissolved Cadmium	-	-
Dissolved Copper	0.0098	2.23
Dissolved Lead	-	-
Dissolved Zinc	0.0736	16.7

*TKN = Total Kjeldahl Nitrogen.

The once-in-three-year exceedance concentrations were calculated using the aforementioned FHWA-RD-88-006 methodology, based on the current conditions for Dean Creek. The results are listed in Table 13.

Table 13. Calculated Existing Once-in-three-year Total Pollutant Concentration Exceedance in Dean Creek

Parameter	Concentration
TSS (mg/L)	802
BOD_5 (mg/L)	42.2
TKN (mg/L)	9.50
Ammonia-N (mg/L)	2.81
Total Phosphorus (mg/L)	1.60
Cadmium (µg/L)	7.98
Copper (µg/L)	148

Parameter	Concentration
Lead (µg/L)	243
Zinc (µg/L)	950
Dissolved Cadmium (µg/L)	-
Dissolved Copper (µg/L)	30.4
Dissolved Lead (µg/L)	-
Dissolved Zinc (µg/L)	228

Table 14 reports DEQ's acute fresh water quality criteria (DEQ's Table 20) and the ratio of the calculated once-in-three-year total pollutant concentration exceedances for existing conditions in Dean Creek to the acute water quality criteria.

Table 14. Acute Water Quality Criteria and Ratio of Calculated Once in Three-Year Total Pollutant Concentration Exceedance to the Acute Water Quality Criteria for Existing Conditions in Dean Creek

Parameter	Acute Water Quality Criteria	Ratio (Conc./WQ Criteria)
TSS (mg/L)	–	–
BOD_5 (mg/L)	–	–
TKN (mg/L)	–	–
Ammonia-N (mg/L)	–	–
Total Phosphorus (mg/L)	–	–
Cadmium (µg/L)	3.9	2.05
Copper (µg/L)	18	8.22
Lead (µg/L)	82	2.96
Zinc (µg/L)	120	7.92
Dissolved Cadmium (µg/L)	3.9	-
Dissolved Copper (µg/L)	18	1.69
Dissolved Lead (µg/L)	82	-
Dissolved Zinc (µg/L)	120	1.90

As shown in Table 14, acute water quality criteria are exceeded on a once-in-three-year basis for existing conditions. A criterion is exceeded when the ratio is greater than 1.0.

Cow Creek

Cow Creek starts south of the alignment and flows southwest to the Clackamas River. The drainage is composed of a combination of open channel and closed conduit. The drainage area consists of commercial and industrial land uses.

Event mean concentrations and annual loadings for runoff from the baseline project area are listed in Table 15. These estimates are based on ODOT's NPDES monitoring data from Portland.

Table 15. Event Mean Concentrations and Annual Loadings from Project Runoff to Cow Creek

Parameter	Event Mean Concentration (mg/L)	Annual Loading (pounds/year)
TSS	259	48,144
BOD_5	13.6	2,533
TKN	3.07	570
Ammonia-N	0.908	169
Total Phosphorus	0.515	95.8
Cadmium	0.00258	0.479
Copper	0.0478	8.90
Lead	0.0785	14.6
Zinc	0.307	57.0
Dissolved Cadmium	-	-
Dissolved Copper	0.0098	1.83
Dissolved Lead	-	-
Dissolved Zinc	0.0736	13.7

The once-in-three-year exceedance concentrations were calculated, using the FHWA-RD-88-006 methodology, based on the current conditions for Cow Creek. The results are listed in Table 16.

Table 16. Calculated Existing Once-in-Three-Year Total Pollutant Concentration Exceedance in Cow Creek

Parameter	Concentration
TSS (mg/L)	562
BOD_5 (mg/L)	29.5
TKN (mg/L)	6.66
Ammonia-N (mg/L)	1.97
Total Phosphorus (mg/L)	1.12
Cadmium (µg/L)	5.59
Copper (µg/L)	104
Lead (µg/L)	170
Zinc (µg/L)	666
Dissolved Cadmium (µg/L)	-
Dissolved Copper (µg/L)	21.3
Dissolved Lead (µg/L)	-
Dissolved Zinc (µg/L)	160

Table 17 reports DEQ's acute fresh water quality criteria (DEQ's Table 20) and the ratio of the calculated once-in-three-year total pollutant concentration exceedances for existing conditions in Cow Creek to the acute water quality criteria.

Table 17. Acute Water Quality Criteria and Ratio of Calculated Once in Three-Year Total Pollutant Concentration Exceedance to the Acute Water Quality Criteria for Existing Conditions in Cow Creek

Parameter	Acute Water Quality Criteria	Ratio (Conc./WQ Criteria)
TSS (mg/L)	–	–
BOD_5 (mg/L)	–	–
TKN (mg/L)	–	–
Ammonia-N (mg/L)	–	–
Total Phosphorus (mg/L)	–	–
Cadmium (µg/L)	3.9	1.43
Copper (µg/L)	18	5.78
Lead (µg/L)	82	2.07
Zinc (µg/L)	120	5.55
Dissolved Cadmium (µg/L)	3.9	-
Dissolved Copper (µg/L)	18	1.18
Dissolved Lead (µg/L)	82	-
Dissolved Zinc (µg/L)	120	1.33

As shown in Table 17, acute water quality criteria are exceeded on a once-in-three-year basis for existing conditions. A criterion is exceeded when the ratio is greater than 1.0.

Sieben Creek

Sieben Creek flows south and is tributary from the hills north of the proposed project area. South of the project area, the creek has been ditched to the Clackamas River. The drainage area is primarily forested and residential. The creek is deeply incised with vertical soil banks.

Event mean concentrations and annual loadings for runoff from the baseline project area are contained in Table 18. These estimates are based on ODOT's NPDES monitoring data from Portland.

Table 18. Event Mean Concentrations and Annual Loadings from Project Runoff to Sieben Creek

Parameter	Event Mean Concentration (mg/L)	Annual Loading (pounds/year)
TSS	259	92,722
BOD_5	13.6	4,878
TKN	3.07	1,099
Ammonia N	0.908	325
Total Phosphorus	0.515	185
Cadmium	0.00258	0.923
Copper	0.0478	17.1
Lead	0.0785	28.1
Zinc	0.307	110
Dissolved Cadmium	-	-
Dissolved Copper	0.0098	3.52
Dissolved Lead	-	-
Dissolved Zinc	0.0736	26.4

The once–in-three-year exceedance concentrations were calculated using the FHWA-RD-88-006 methodology, based on the current conditions for Sieben Creek. The results are presented in Table 19.

Table 19. Calculated Existing Once-in-three-year Total Pollutant Concentration Exceedance in Sieben Creek

Parameter	Concentration
TSS (mg/L)	455
BOD_5 (mg/L)	23.9
TKN (mg/L)	5.39
Ammonia-N (mg/L)	1.59
Total Phosphorus (mg/L)	0.905
Cadmium (µg/L)	4.53
Copper (µg/L)	84.0

Parameter	Concentration
Lead (µg/L)	138
Zinc (µg/l)	539
Dissolved Cadmium (µg/L)	-
Dissolved Copper (µg/L)	17.2
Dissolved Lead (µg/L)	-
Dissolved Zinc (µg/L)	129

DEQ's Table 20 reports DEQ's acute fresh water quality criteria and the ratio of the calculated once-in-three-year total pollutant concentration exceedances for existing conditions in Sieben Creek to the acute water quality criteria.

Table 20. Acute Water Quality Criteria and Ratio of Calculated Once in Three Year Total Pollutant Concentration Exceedance to the Acute Water Quality Criteria for Existing Conditions in Sieben Creek

Parameter	Acute Water Quality Criteria	Ratio (Conc./WQ Criteria)
TSS (mg/l)	–	–
BOD_5 (mg/L)	–	–
TKN (mg/L)	–	–
Ammonia-N (mg/L)	–	–
Total Phosphorus (mg/L)	–	–
Cadmium (µg/L)	3.9	1.16
Copper (µg/L)	18	4.67
Lead (µg/L)	82	1.68
Zinc (µg/L)	120	4.49
Dissolved Cadmium (µg/L)	3.9	-
Dissolved Copper (µg/L)	18	0.956
Dissolved Lead (µg/L)	82	-
Dissolved Zinc (µg/L)	120	1.08

As shown in Table 20, acute water quality criteria are exceeded on a once-in-three-year basis for existing conditions. A criterion is exceeded when the ratio is greater than 1.0.

Rock Creek

Rock Creek is a major drainage flowing south into the Clackamas River. The creek originates in the hills north of the proposed project. The drainage area is a mixture of forested, agricultural, and residential land use. The creek riparian area is heavily wooded, with steep rock banks.

Event mean concentrations and annual loadings for runoff from the baseline project area are listed in Table 21. These estimates are based on ODOT's NPDES monitoring data from Portland.

Table 21. Event Mean Concentrations and Annual Loadings from Project Runoff to Rock Creek

Parameter	Event Mean Concentration (mg/L)	Annual Loading (pounds/year)
TSS	259	504,620
BOD_5	13.6	26,546
TKN	3.07	5,979
Ammonia-N	0.908	1,770
Total Phosphorus	0.515	1,004
Cadmium	0.00258	5.02
Copper	0.0478	93.3
Lead	0.0785	153
Zinc	0.307	598
Dissolved Cadmium	-	-
Dissolved Copper	0.0098	19.1
Dissolved Lead	-	-
Dissolved Zinc	0.0736	143

The once-in-three-year exceedance concentrations were calculated, using the aforementioned FHWA-RD-88-006 methodology, based on the current conditions for Rock Creek. The results are listed in Table 22.

Table 22. Calculated Existing Once in Three Year Total Pollutant Concentration Exceedance in Rock Creek

Parameter	Concentration
TSS (mg/L)	470
BOD_5 (mg/L)	24.7
TKN (mg/L)	5.57
Ammonia-N (mg/L)	1.65
Total Phosphorus (mg/L)	0.935
Cadmium (µg/L)	4.68
Copper (µg/L)	86.8

Parameter	Concentration
Lead (µg/L)	142
Zinc (µg/L)	557
Dissolved Cadmium (µg/L)	-
Dissolved Copper (µg/L)	17.8
Dissolved Lead (µg/L)	-
Dissolved Zinc (µg/L)	134

Table 23 reports DEQ's acute fresh water quality criteria (DEQ's Table 20) and the ratio of the calculated once-in-three-year total pollutant concentration exceedances for existing conditions in Rock Creek to the acute water quality criteria.

Table 23. Acute Water Quality Criteria and Ratio of Calculated Once in Three Year Total Pollutant Concentration Exceedance to the Acute Water Quality Criteria for Existing Conditions in Rock Creek

Parameter	Acute Water Quality Criteria	Ratio (Conc./WQ Criteria)
TSS (mg/L)	–	–
BOD_5 (mg/L)	–	–
TKN (mg/L)	–	–
Ammonia-N (mg/L)	–	–
Total Phosphorus (mg/L)	–	–
Cadmium (µg/L)	3.9	1.20
Copper (µg/L)	18	4.82
Lead (µg/L)	82	1.73
Zinc (µg/L)	120	4.64
Dissolved Cadmium (µg/L)	3.9	-
Dissolved Copper (µg/L)	18	0.989
Dissolved Lead (µg/L)	82	-
Dissolved Zinc (µg/L)	120	1.12

As shown in Table 23, acute water quality criteria are shown to be exceeded on a once-in-three-year basis for existing conditions. A criterion is exceeded when the ratio is greater than 1.0.

ENVIRONMENTAL CONSEQUENCES

There are three fundamental alternatives under consideration: Alternative 1 (no-build), Alternative 2 (with a midpoint interchange), and Alternative 3 (without a midpoint interchange).

Alternative 1: No-Build

The No-Build Alternative is a baseline for change and would result in no change to existing water quality conditions.

Alternative 2 and 3: Build

Each alternative has four zones (Zones A through D). Each zone has one or more design options. The water quality and hydrologic impacts are based on the impervious area associated with each alternative and/or option.

Because the probabilistic procedures for predicting water quality impacts are based on the increased impervious area of a project, the design options for Alternatives 2 and 3 were combined into alternatives with options that resulted in the maximum and minimum new impervious areas. Table 24 lists these results.

Each of the four drainage basins affected by the two build alternatives and the various design options were assessed. For example, if Design Option C-2 is selected, 9.8 acres of impervious area will be added to Sieben Creek drainage basin, 5.7 acres to Cow Creek, and 4 acres to Rock Creek, totaling 19.5 acres. Table 24 lists the amount of impervious area added to each drainage area under each of the design options.

Table 24. Total New Impervious Area for Alternative 2 and Alternative 3 for the Maximum and Minimum New Impervious Area

Alternative 1	Hydrologic Impact	Design Options	Total New Impervious Area (acres)
Alternative 2	Highest	B-2, C-3, D-3	128.8
	Lowest	A-2, C-2	117.1
Alternative 3	Highest	C-3, D-3	115.8
	Lowest	A-2, C-2,	108

Alternative 2 produces the greatest hydrologic impact and Alternative 3 produces the least hydrologic impact when the design options indicated above were selected. The highest impact scenario is Alternative 2 with Design Options B-2, C-3, and D-3. This scenario is referred to as Maximum. The lowest impact scenario is Alternative 3 with Design Options A-2 and C-2. This scenario is referred to as Minimum. The maximum and minimum possible water quality impacts are calculated in the following sections for Maximum and Minimum by the same methods used for the existing conditions (see Affected Environment section). Table 25 lists the minimum and maximum percent increase in impervious area by alternative for each drainage basin. All other scenarios lie between these two extremes.

Table 25. Percent Increase in Impervious Area

Drainage Basin	Minimum	Maximum
Dean Creek	85	99
Cow Creek	108	158
Sieben Creek	19	22
Rock Creek	15	15

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The following Tables 26 through 33 show the water quality impact with no treatment or mitigation. They just show the theoretical increase in annual loading and pollutant concentrations from the extra impervious area added by the Sunrise project, they do not represent actual pollutant loading within the drainage area. They were created using the same methods used for Tables 12 through 23, or the existing condition baseline (see Effected Environment). Tables 26 through 33 can be compared to Tables 12 through 23 for a contrast between the pollutants generated by pre-project and post-project runoff.

Dean Creek

The annual pollutant loadings were calculated for Minimum and Maximum using the FHWA-RD-88-006 methodology, based on the post-project conditions for Dean Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 26.

Table 26. Change in Annual Loadings to Dean Creek

Parameter	Annual Loading Difference* (%)	
	Minimum	Maximum
TSS	85	100
BOD_5	85	100
TKN	85	100
Ammonia N	85	100
Total Phosphorus	85	100
Cadmium	84	100
Copper	84	99
Lead	84	99
Zinc	85	99
Dissolved Cadmium	--	--
Dissolved Copper	85	100
Dissolved Lead	--	--
Dissolved Zinc	85	100

*Expressed as $\frac{Minimum\ or Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The once-in-three-year exceedance concentrations were calculated for Minimum and Maximum, using the aforementioned FHWA-RD-88-006 methodology, based on the post-project conditions for Dean Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 27.

Table 27. Change in Existing Once-in-three-year Total Pollutant Concentration Exceedance in Dean Creek

Parameter	3-Year Exceedance Difference* (%)	
	Minimum	Maximum
TSS	50	57
BOD_5	50	57
TKN	49	58
Ammonia N	50	58
Total Phosphorus	49	57
Cadmium	50	58
Copper	50	57
Lead	50	58
Zinc	49	57
Dissolved Cadmium	–	–
Dissoved Copper	50	58
Dissolved Lead	–	–
Dissolved Zinc	50	57

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

Cow Creek

The annual pollutant loadings were calculated for minimum and maximum using the FHWA-RD-88-006 methodology, based on the post-project conditions for Cow Creek. The results presented as a percent change comparison with the no build alternative are listed in Table 28.

Table 28. Change in Annual Loadings to Cow Creek

Parameter	Annual Loading Difference* (%)	
	Minimum	Maximum
TSS	108	158
BOD_5	108	158
TKN	108	158
Ammonia-N	108	158
Total Phosphorus	108	158
Cadmium	108	159
Copper	108	158
Lead	108	158
Zinc	109	158
Dissolved Cadmium	–	–
Dissolved. Copper	107	157
Dissolved Lead	–	–
Dissolved Zinc	108	158

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The once-in-three-year exceedance concentrations were calculated for Minimum and Maximum using the FHWA-RD-88-006 methodology, based on the post-project conditions for Cow Creek. The results presented as a percent change comparison with the no-build alternative are listed Table 29.

Table 29. Change in Existing Once in Three Year Total Pollutant Concentration Exceedance in Cow Creek

Parameter	3-Year Exceedance Difference* (%)	
	Minimum	Maximum
TSS	17	24
BOD_5	17	24
TKN	17	24
Ammonia N	17	24
Total Phosphorus	17	23
Cadmium	17	24
Copper	17	23
Lead	17	24
Zinc	17	24
Dissolved Cadmium	–	–
Dissolved Copper	**17**	**24**
Dissolved Lead	–	–
Dissolved Zinc	17	24

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

Sieben Creek

The annual pollutant loadings were calculated for Minimum and Maximum using the FHWA-RD-88-006 methodology, based on the post-project conditions for Sieben Creek. The results presented as a percent change comparison with the no build alternative are listed in Table 30.

Table 30. Change in Annual Loadings to Sieben Creek

Parameter	Annual Loading Difference* (%)	
	Minimum	Maximum
TSS	19	22
BOD_5	19	22
TKN	19	21
Ammonia N	19	22
Total Phosphorus	18	21
Cadmium	19	21
Copper	19	22
Lead	19	22
Zinc	19	22
Dissolved Cadmium	–	–
Dissolve Copper	19	21
Dissolved Lead	–	–
Dissolved Zinc	19	22

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The once-in-three-year exceedance concentrations were calculated for Minimum and Maximum, using the FHWA-RD-88-006 methodology, based on the post-project conditions for Sieben Creek. The results presented as a percent change comparison with the no build alternative are listed in Table 31.

Table 31. Change in Existing Once-in-three-year Total Pollutant Concentration Exceedance in Sieben Creek

Parameter	3-Year Exceedance Difference* (%)	
	Minimum	Maximum
TSS	6	7
BOD_5	6	7
TKN	6	7
Ammonia N	6	8
Total Phosphorus	6	7
Cadmium	6	7
Copper	6	7
Lead	6	7
Zinc	6	7
Dissolved Cadmium	–	–
Dissolved Copper	6	7
Dissolved Lead	–	–
Dissolved Zinc	6	7

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

Rock Creek

The annual pollutant loadings were calculated for Minimum and Maximum using the FHWA-RD-88-006 methodology, based on the post-project conditions for Rock Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 32.

Table 32. Change in Annual Loadings to Rock Creek

Parameter	Annual Loading Difference* (%)	
	Minimum	Maximum
TSS	15	15
BOD_5	15	15
TKN	15	15
Ammonia-N	15	15
Total Phosphorus	15	15
Cadmium	15	15
Copper	15	15
Lead	14	15
Zinc	15	15
Dissolved Cadmium	–	–
Dissolved Copper	15	15
Dissolved Lead	–	–
Dissolved Zinc	15	15

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The once-in-three-year exceedance concentrations were calculated for Minimum and Maximum using the FHWA-RD-88-006 methodology, based on the post-project conditions for Rock Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 33.

Table 33. Change in Existing Once-in-three-year Total Pollutant Concentration Exceedance in Rock Creek

Parameter	3-Year Exceedance Difference* (%)	
	Minimum	Maximum
TSS	4	5
BOD_5	5	5
TKN	4	5
Ammonia-N	4	5
Total Phosphorus	5	5
Cadmium	4	5
Copper	5	5
Lead	5	5
Zinc	4	5
Dissolved Cadmium	–	–
Dissolved Copper	4	5
Dissolved Lead	–	–
Dissolved Zinc	4	4

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

Summary of environmental consequences

As noted in the preceding tables, Cow Creek has the greatest calculated increase in annual pollutant loads; however, Dean Creek has the greatest calculated increase in once-in-three-year exceedance concentration. These two creeks are also the most heavily impacted by urbanization. They already have a high percentage of impervious tributary area and have been enclosed and channelized into drainage ditches. They also have the highest project related percent increase in impervious area. Except for the lower reaches, these creeks are constructed drainage channels, not natural channels, so the increased flow is not anticipated to adversely affect their morphology. The lower reaches of both creeks are more natural, so mitigation for water quantity and quality may need to be included in final designs.

Impacts to Sieben and Rock creeks are minimal, both for annual pollutant load and three-year exceedance concentrations. These creeks will receive a relatively small percent increase in impervious area as a result of the proposed project. These creeks still maintain a relatively natural character, and the project should have minimal effects on either water quality or creek morphology.

As indicated in Table 26, there is minimal difference between the minimum and the maximum water quality impacts, with the exception of Cow Creek. The anticipated detention requirements should mitigate any hydrologic impact from increased impervious area. For the Cow Creek Basin, the difference is a 108 percent increase in impervious area for the minimum scenario compared with a 158 percent increase for the maximum scenario. Cow Creek is currently profoundly impacted by development and has no natural component except in its lower reach. Consequently, the effects of the increased impervious area may be limited to the aforementioned water quality issues, but it is recommended that water quantity mitigation be included in the engineering design cycle for all drainage basins once an alternative is selected. This will ensure

that the alternative selected will not have adverse effects downstream on either water quality or quantity issues such as channel morphology or ecology.

Indirect Effects

No indirect water quality effects are anticipated from the proposed project. The project area is highly urbanized. If the project prompts some development or redevelopment, such development may require water quantity mitigation in addition to the proposed water quality mitigation for this project. Development upstream and within the drainage basins intersected by this project will also be subject to regulatory requirements for mitigation of storm water quality and quantity controls. This will ensure that effects to stream riparian zones or wetland areas will be minimal. Please see the BA or Fish Technical Reports for more information on projected effects on either streams or wetlands.

Cumulative Effects

No cumulative water quality effects are anticipated from the no-build alternative or the proposed project, however, the project will contribute to additional pollutant loading and concentrations. Since the project will include water quality and quantity mitigation, additional loadings and concentrations should be kept to a minimal level. The project area is currently fully urbanized. If the project does prompt redevelopment, such redevelopment will require storm water mitigation in addition to the project related storm water mitigation.

Summary of Permits required

Storm water runoff from new impervious areas will require permits from Clackamas County. The proposed project will require a Clackamas County Service District No. 1 permit for the storm system. The permit will require water quality treatment and potential detention of runoff from the new roadway. For construction activities, DEQ has designated Clackamas County as its agent for the review, issuance, and enforcement of NPDES 1200-C permits. This permit identifies the activities required if construction disturbs more than 1 acre of land, in order to assure an acceptable standard of water quality.

The Federal 404 Wetland Removal Fill permit requires that storm water management be addressed. Typically, the U.S. Army Corps of Engineers requires concurrence from the National Oceanic and Atmospheric Administration (NOAA) Fisheries regarding the appropriate management of storm water. Current standards are contained in NOAA's Programmatic Biological Opinion, and NOAA's HCD Stormwater Online Guidance: ESA Guidance for Analyzing Storm water Effects (March 2003).

Treatment and Mitigation Measures

The proposed project design will need to meet permit requirements and design guidance cited in the preceding section. This effort will most likely require water quality and quantity treatment or mitigation. Detention will also be required as mitigation for hydrologic impacts and/or mitigation for downstream hydraulic deficiencies. Water quality treatment and detention will need to meet both the Clackamas County Water Environment Services requirements and the National Marine Fisheries Service (NMFS) guidelines for storm water management.

The post-project conditions with mitigation for each water basin and both build alternatives was analyzed. For the analysis it was assumed that water quality treatment would be provided for all

new impervious area. Existing impervious area was assumed not to be treated. The water quality treatment levels assumed for this analysis were 70 percent removal of particulates and 20 percent removal of soluble pollutants. The NOAA Programmatic Biological Opinion for Standard Local Operating Procedures for Endangered Species (SLOPES) (2004) requires water quality treatment for 72 percent of the 2-year, 24-hour storm event. Water quality treatment guidance specifies treatment per local jurisdictional standards of two-thirds of the 2-year, 24-hour storm event (Clackamas County, 2005).

It is anticipated that the water quantity control facilities will be sized to meet NOAA's programmatic Biological Opinion for SLOPES. The quantity control requirements are such that the duration of post-project discharge matches the pre-project discharge rates from one-half of the 2-year peak flow up to the 50-year peak flow. Water quantity treatment guidance specifies that detention shall be designed to reduce the 25-year, 24-hour, post-project runoff rate to a 2-year, 24-hour existing discharge rate, and from the 2-year, 24-hour, post-project rate to one half of the 2-year, 24-hour pre-developed discharge rate (Clackamas County, 2005).

The following Tables 34 through 41 show the water quality impact after mitigation treatment according to the preceding standards. Tables 34 through 41 can be compared to Tables 26 through 33 for a contrast between mitigated and non-mitigated runoff. Standards are met by following the requirements for mitigation treatment.

The annual pollutant loadings were calculated for Minimum and Maximum with water quality and quantity control mitigation measures using the FHWA-RD-88-006 methodology, based on the post-project conditions for Dean Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 35. Again since the FHWA methodology was used, the results are theoretical, and do not represent pollutant loading within the drainage area. Once a preferred alternative has been selected, future studies can continue to use the FHWA method with the ODOT MS4 permit data, or more specific medium concentration data from on-site monitoring can be used. If site specific data does not exist or is not statically adequate, it is suggested that monitoring runoff pollutant levels from the existing area be considered.

Please note, this document will be used in conjunction with other documents to help in the selection of a preferred alternative. Once a preferred alternative has been selected, a detailed treatment and mitigation analysis will be conducted and included in a Stormwater Report. The actual number, type, and location will be included in the Stormwater Report. However, figures 2 through 12 do show possible locations for such treatment or mitigation facilities. These locations were investigated in a Conceptual Stormwater Analysis. The report (Conceptual Stormwater Impact Analysis) contained water quality and quantity analysis and existing and new impervious area was included in the calculations.

Table 34. Change in Annual Loadings to Dean Creek with Mitigation

Parameter	Annual Loading Difference* (%)	
	Minimum	Maximum
TSS	25	30
BOD_5	42	50
TKN	42	50
Ammonia N	30	35
Total Phosphorus	47	55
Cadmium	30	35
Copper	42	50
Lead	29	35
Zinc	42	49
Dissolved Cadmium	--	--
Dissolved Copper	68	80
Dissolved Lead	--	--
Dissolved Zinc	68	80

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The once-in-three-year exceedance concentrations were calculated for Minimum and Maximum with water quality and quantity control mitigation measures using the FHWA-RD-88-006 methodology, based on the post-project conditions for Dean Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 35.

Table 35. Change in Existing Once-in-three-year Total Pollutant Concentration Exceedance in Dean Creek with Mitigation

Parameter	3-Year Exceedance Difference* (%)	
	Minimum	Maximum
TSS	2	2
BOD_5	16	18
TKN	16	18
Ammonia N	5	6
Total Phosphorus	19	21
Cadmium	5	6
Copper	16	18
Lead	5	6
Zinc	16	18
Dissolved Cadmium	–	–
Dissoved Copper	36	42
Dissolved Lead	–	–
Dissolved Zinc	36	42

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The annual pollutant loadings were calculated for Minimum and Maximum with water quality and quantity control mitigation measures using the FHWA-RD-88-006 methodology, based on the post-project conditions for Cow Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 36.

Table 36. Change in Annual Loadings to Cow Creek with Mitigation

Parameter	Annual Loading Difference* (%)	
	Minimum	Maximum
TSS	31	47
BOD_5	53	79
TKN	53	79
Ammonia N	36	55
Total Phosphorus	58	87
Cadmium	36	55
Copper	53	79
Lead	36	55
Zinc	53	7
Dissolved Cadmium	–	–
Dissolved. Copper	85	127
Dissolved Lead	–	–
Dissolved Zinc	85	127

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The once-in-three-year exceedance concentrations were calculated for Minimum and Maximum with water quality and quantity control mitigation measures using the FHWA-RD-88-006 methodology, based on the post-project conditions for Cow Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 37.

Table 37. Change in Existing Once in Three Year Total Pollutant Concentration Exceedance in Cow Creek with Mitigation

Parameter	3-Year Exceedance Difference* (%)	
	Minimum	Maximum
TSS	-26	-30
BOD_5	-14	-14
TKN	-14	-14
Ammonia N	-23	-26
Total Phosphorus	-11	-11
Cadmium	-23	-26
Copper	-14	-14
Lead	-23	-25
Zinc	-14	-14
Dissolved Cadmium	–	–
Dissolved Copper	–	–
Dissolved Lead	–	–
Dissolved Zinc	4	9

*Expressed as $\frac{Min\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The annual pollutant loadings were calculated for Minimum and Maximum with water quality and quantity control mitigation measures using the FHWA-RD-88-006 methodology, based on the post-project conditions for Sieben Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 38.

Table 38. Change in Annual Loadings to Sieben Creek with Mitigation

Parameter	Annual Loading Difference* (%)	
	Minimum	Maximum
TSS	6	7
BOD_5	10	11
TKN	10	11
Ammonia N	7	8
Total Phosphorus	1	11
Cadmium	7	8
Copper	10	11
Lead	7	8
Zinc	9	11
Dissolved Cadmium	–	–
Dissolve Copper	15	16
Dissolved Lead	–	–
Dissolved Zinc	15	17

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The once-in-three-year exceedance concentrations were calculated for Minimum and Maximum with water quality and quantity control mitigation measures using the FHWA-RD-88-006 methodology, based on the post-project conditions for Sieben Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 39.

Table 39. Change in Existing Once-in-three-year Total Pollutant Concentration Exceedance in Sieben Creek with Mitigation

Parameter	3-Year Exceedance Difference* (%)	
	Minimum	Maximum
TSS	-6	-6
BOD_5	-3	-2
TKN	-3	-2
Ammonia N	-5	-4
Total Phosphorus	-2	-2
Cadmium	-5	-5
Copper	-2	-2
Lead	-5	-5
Zinc	-3	-2
Dissolved Cadmium	–	–
Dissolved Copper	3	3
Dissolved Lead	–	–
Dissolved Zinc	3	3

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The annual pollutant loadings were calculated for Minimum and Maximum with water quality and quantity control mitigation measures using the FHWA-RD-88-006 methodology, based on the post-project conditions for Rock Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 40.

Table 40. Change in Annual Loadings to Rock Creek with Mitigation

Parameter	Annual Loading Difference* (%)	
	Minimum	Maximum
TSS	4	5
BOD_5	7	7
TKN	7	7
Ammonia N	5	2
Total Phosphorus	8	8
Cadmium	5	5
Copper	7	7
Lead	5	5
Zinc	7	
Dissolved Cadmium	–	–
Dissolved Copper	12	12
Dissolved Lead	–	–
Dissolved Zinc	11	12

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

The once-in-three-year exceedance concentrations were calculated for Minimum and Maximum with water quality and quantity control mitigation measures using the FHWA-RD-88-006 methodology, based on the post-project conditions for Rock Creek. The results presented as a percent change comparison with the no-build alternative are listed in Table 41.

Table 41. Change in Existing Once-in-three-year Total Pollutant Concentration Exceedance in Rock Creek with Mitigation

Parameter	3-Year Exceedance Difference* (%)	
	Minimum	Maximum
TSS	-5	-5
BOD_5	-2	-2
TKN	-2	-2
Ammonia N	-4	-4
Total Phosphorus	-2	-1
Cadmium	-4	-4
Copper	-2	-
Lead	-4	-4
Zinc	-2	-2
Dissolved Cadmium	–	–
Dissolved Copper	2	2
Dissolved Lead	–	–
Dissolved Zinc	1	1

*Expressed as $\frac{Minimum\ or\ Maximum\ -\ NO\ BUILD}{NO\ BUILD} \times 100$

Enhancement Opportunities

Enhancement opportunities exist for the creeks within the project area. Dean and Cow Creeks have been profoundly urbanized; however, they do offer some limited opportunity for enhancement, particularly shading for temperature mitigation of their open sections. Sieben (except for its lower reach from creek mile 0.1 to 0.5) and Rock Creeks are in a relatively natural condition. Some opportunities exist for bank stabilization and riparian vegetation enhancement.

REFERENCES AND AGENCY CONSULTATIONS

Oregon Department of Environmental Quality (DEQ). 2006. Laboratory Analytical Storage and Retrieval (LASAR) database.

Oregon Department of Environmental Quality (DEQ). Willamette Basin Draft TMDL: Clackamas Subbasin. September 2004.

Surface Water Management Rules and Regulations for Clackamas County Service District No. 1. February 1, 2005.

National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service, Northwest Region. March 2003. HCD Storm water Online Guidance: ESA Guidance for Analyzing Storm water Effects. U.S. Department of Commerce.

Federal Highway Administration (FHWA), Research Development and Technology Turner-Fairbank Highway Research Center. April 1990. Pollutant Loadings and Impacts from Highway Storm water Runoff, Volume I. FHWA-RD-88-006. U.S. Department of Transportation.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Region. 2004. Programmatic Biological Opinion for Standard Local Operating Procedures for Endangered Species (SLOPES). November 30, 2004.

David Evans & Associates, Inc. 2006. Technical Memorandum: Conceptual Stormwater Impact Analysis, Sunrise Corridor. February 20, 2006.

ACRONYMS AND ABBREVIATIONS

Ammonia N	Nitrogen as ammonia
BOD_5	five-day biochemical oxygen demand
DEQ	Department of Environmental Quality
DMA	Designated Management Agency
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
µg/L	microgram per liter
mg/L	milligrams per liter
LASAR	Laboratory Analytical Storage and Retrieval
MS4	Municipal Separate Storm Sewer System
NMFS	National Marine Fisheries Service
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NURP	Nationwide Urban Runoff Program
ODOT	Oregon Department of Transportation
RTP	Regional Transportation Plan
SLOPES	Standard Local Operating Procedures for Endangered Species
STIP	State Transportation Improvement Plan
TKU	Total Kjeldahl Nitrogen
TMDL	total maximum daily load
TSS	total suspended solids

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