INDUSTRIAL WAY
INTERSECTION PROJECT | LONGVIEW
OREGON WAY

Soils and Geology Technical Analysis

Prepared for:

Washington State Department of Transportation

COWLITZ COUNTY WASHINGTON

Prepared by:

WSP USA
851 SW Sixth Avenue, Suite 1600
Portland, Oregon 97204

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Acronyms and Abbreviations

CSZ	Cascadia Subduction Zone
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
GSA Alternative	Grade-Separated Option A Alternative
PGSB Alternative	Partial Grade-Separated Option B Alternative
SR	State Route
WSDOT	Washington State Department of Transportation

1.0 INTRODUCTION

The Industrial Way / Oregon Way Intersection Project is located in the industrial area of Longview, Washington at the intersection of Industrial Way (State Route [SR] 432), Oregon Way, and SR 433. This intersection provides a critical connection of two Highways of Statewide Significance that support significant passenger and freight truck movement. The purpose of the project is to develop an affordable long-term solution that:

- Maintains or improves emergency response
- Improves travel reliability for all vehicles
- Accommodates current and future freight truck and passenger vehicle movement through the intersection and across the region and states.

The purpose of this document is to describe the existing conditions of soils and geology, discuss effects and benefits the project would have on those conditions, and recommend mitigation measures to address adverse effects. The information contained in this technical analysis supports the project's Environmental Impact Statement (EIS).

The analysis contained in this document uses the information relevant to the Industrial Way / Oregon Way intersection from the Washington State Department of Transportation's *Memorandum: SR-432 Longview Industrial Area Highway and Rail Realignment Preliminary Geotechnical Engineering Recommendations* (WSDOT 2007).

2.0 DESCRIPTION OF ALTERNATIVES

Three alternatives are being evaluated to address the project's purpose and need: the No Build Alternative, the Grade-Separated Option A Alternative (GSA Alternative), and the Partial Grade-Separated Option B Alternative (PGSB Alternative). Each alternative is described in Chapter 2 of the project's EIS.

3.0 AFFECTED ENVIRONMENT

Geology and soil considerations important to the project include topography, geology, soil characteristics, groundwater conditions, and geologic hazards. These considerations affect the type of construction methods used for the project and, if not adequately considered during project design, could affect the long-term operations and pose a risk to public safety. Regional geology and seismicity would not change as a result of the project, but they would have an important influence on how the project is designed and constructed.

3.1 Site Conditions

3.1.1 Topography

The Industrial Way/Oregon Way Intersection Project (project) is located near the confluence of the Columbia, Cowlitz, and Coweeman Rivers, between the Coastal Range to the west and the Cascade Range to the east. The surface topography within the project limits consists of low lying flood plain terraces adjacent to the rivers with typical elevation ranging from 5 to 20 feet above sea level.

3.1.2 Geology

The project vicinity is primarily underlain by alluvium deposited over volcanic deposits (bedrock), which were formed during the Tertiary and Quaternary periods (Livingstone 1966). The alluvium generally consists of silt, sand, and gravel deposited in streambeds and fans, and the bedrock generally consists of thin layers of sandstone and siltstone over basalt. Top of bedrock in the vicinity of the project is estimated to be 300 to 400 feet below ground surface (Sweet-Edwards/EMCON 1991). Fill material was also placed during the original construction of roadway and railways in the area. The dominant (over 90 percent) surface soil type in the project area is Caples silty clay loam, 0 to 3 percent slopes (USDA 2017). Groundwater is generally shallow (10 feet or less below ground surface) in the project area.

3.1.3 Seismicity

The project is located in a seismically active region which has been subjected to earthquakes in the historic past and will undoubtedly undergo shaking again in the future. In general, the seismicity of western Washington is predominantly influenced by the subduction of the Juan de Fuca Plate under the North American Plate. Earthquakes in the project vicinity result from any one of three sources including:

- The Cascadia Subduction Zone (CSZ) at least 100 kilometers off the coast of Washington
- The deep intraplate or Benioff zone located approximately 20 to 40 miles within the Juan de Fuca plate
- The shallow crustal faults located within the continental crust.

On the basis of geologic evidence gathered from coastal areas in Washington and Oregon during the past 25 years, the CSZ is believed to be capable of producing an earthquake of magnitude 9 or greater on the Richter scale. These earthquakes may occur at the interface of the Juan de Fuca Plate where it subducts under the North America Plate. Earthquakes associated with this source have occurred in approximately 300 to 800-year intervals with the last known event occurred in the year 1700.

Most of the historic earthquakes that have affected western Washington have been intraplate events, which occurred at depths within the subducting Juan de Fuca plate. These events included the Olympia Earthquake in 1949 (magnitude 7.1), the Puget Sound (SeaTac) event in 1965 (magnitude 6.5), and most recently the Nisqually Earthquake in 2001 (magnitude 6.8). While the maximum magnitude of the intraplate events is not precisely known, this zone has typically been associated with a maximum earthquake magnitude of 7.5.

Finally, movements along the near-surface crustal faults can cause “shallow” earthquakes (10 to 15 miles deep) with magnitude greater than 6. The closest mapped crustal faults are approximately 50 miles from the project area.

3.2 Geologic Hazards

An important consideration for the construction and operation of the project would be the potential for geologic hazards, including steep slopes, erosion, landslides, seismicity, and soft soils. The seismic category includes secondary effects such as liquefaction and settlement. The following geologic hazards have been identified within the vicinity of the project:

- Seismic hazard: The project area is subjected to potential risk from earthquake-induced ground shaking and fault displacement. The ground shaking can result in slope failure, settlement, soil liquefaction, tsunamis, or seiches — all of which pose a risk to the public.

- Soil liquefaction: Soil liquefaction is the phase change phenomenon whereby a saturated soil substantially loses strength (or the soil is said to exhibit residual shear strength) and stiffness in response to a shear stress (usually a cyclic shear stress induced by earthquake shaking). Soil liquefaction is of particular concern because it has often been the cause of damage to structures during past earthquakes. The consequences of liquefaction include loss in the strength and settlement of the soil. The loss of soil strength can lead to lateral spreading (i.e., downslope movement of soils), downdrag on pile foundations, bearing failure of retaining walls and spread footings, or flotation of buried vaults and pipes. Examples of liquefiable soils located in the project area include the artificial fill and the tidal flat deposits.
- Soft soils: Soft soil conditions can also be a form of geologic hazard because they have low strengths and can be highly compressible. Without appropriate design consideration, the presence of soft soils can lead to embankment failures during construction or long-term settlement and would add to the maintenance requirements for the project.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 No Build Alternative

4.1.1 Direct Effects

Under the No Build Alternative, construction of the project would not take place. The existing geology and soils environment would essentially remain unchanged. However, the existing risk from seismic hazards would still exist.

4.1.2 Indirect Effects

There would be no indirect impacts for the No Build Alternative.

4.2 Grade-Separated Option A (GSA) Alternative

4.2.1 Effects during Construction

Impacts during construction of the GSA Alternative would be associated with the equipment used to perform the construction, as well as the direct and indirect impacts of the construction activities. Construction activities have the potential to cause a number of short-term impacts on the environment related to geology and soils.

Erosion Hazards

Clearing of protective vegetation, fill placement, and spoils removal or stockpiling during construction of the GSA Alternative would allow rainfall and runoff to erode soil particles. The severity of potential erosion is a function of the quantity of vegetation removed, site topography, rainfall, types of soils, and the volume and configuration of soils stockpiled.

Slope Failure

Construction of the GSA Alternative would involve grade changes, cuts and fills, and/or installation of bridge and retaining structures that have the potential to cause slope failure.

Seismic Hazards

An earthquake could occur during construction of the GSA Alternative, resulting in embankment failures, liquefaction, or ground settlement. The risk of seismic hazards to construction is considered low because there is a low probability that an earthquake would occur during the actual construction period. If a large earthquake were to occur, the major risk would be to the ongoing construction activities. Work schedules would likely be delayed as efforts are made to repair damaged components of the work. Some disruption could also occur to utilities or nearby structures from the damage to exposed cuts or fills.

Construction-Induced Vibrations

The use of heavy equipment during construction of the GSA Alternative would cause ground vibrations. The level of vibrations depends on the type of heavy equipment, distance from the source, and ability of the soil to transmit vibrations. The main concern for construction vibration is potential damage to the adjacent structures and most construction processes do not generate high enough vibration levels to approach damage criteria. The major sources of construction vibration include impact pile driving and vibratory rollers for soil compaction. The only activity with potential to cause building damage is impact pile driving at locations within 25 feet of structures.

Settlements from New Earth Loads

New embankments or fill areas would be used to meet grade requirements for the GSA Alternatives. These retained fills could be up to 20 feet high. These earth loads could cause settlement of the existing ground. Most of these settlements would occur during construction; however, for some soil types, the settlements could also occur during operation. Settlements from new earth loads would be of primary concern in areas that have soft and compressible soils. The new earth loads would cause compression of soft soils below adjacent structures and facilities. The extent of compression beyond the footprint of the new earth load can extend 20 feet or more from the load. The impacts on adjacent areas could include the settlement of buildings or residential structures, damage to roadways and sidewalks, resulting in additional maintenance work, and damage to buried utilities located next to new embankments or fill areas.

Excavations for Foundations and Removal of Unsuitable Material

Excavations for structure foundations and relocation of utilities under the GSA Alternative, if not supported correctly, could result in failure and collapse of the ground next to the excavations, causing damage to buried utilities and to structures or roadways located adjacent to the excavations. The impact to utilities and buried structures is considered low during construction. Existing soils excavated during construction that cannot be used as structural fill or for landscape material would require removal from the project footprint and disposal elsewhere. Disposal of the material at off-site locations would result in additional truck traffic, dust, and other construction-related impacts.

Dewatering

Dewatering of excavations located below the groundwater table during construction of the GSA Alternative could result in settlement of nearby structures, if proper consideration is not given to the effects of water level changes.

4.2.2 Direct Effects

The GSA Alternative would include construction of new bridges with foundations, retaining walls, embankments, surface roadways, soft soil removal and replacement, general clearing and grubbing including tree removal, and utility relocations. The area of disturbance would be approximately 51 acres, as shown in Table 1. The bridge foundations would be either drilled shafts or driven piles with lengths between 100 and 150 feet. Up to 5 feet of near-surface soil would be excavated and replaced with free draining rock at all bridge approach embankments. New embankments from 10 to 20 feet in height would be required to reach the new elevated intersection. New walls would be constructed to retain embankment fill where there is insufficient space for the construction of embankment slopes.

Table 1. Area of Disturbance by Alternative

	No Build Alternative	GSA Alternative	PGSB Alternative
Area of Disturbance (acres)	0	51	50

Seismic Hazards

The GSA Alternative would be located within a seismically active area. The consequences of a seismic event during operations would be strong ground shaking, which could lead to liquefaction of loose, saturated, cohesionless soils, settlement from densification of loose soils, downdrag and lateral spreading on pile foundations, instability of embankments, or increased earth pressures on retaining walls. These effects could damage the constructed structures and facilities.

Long-Term Settlement of Embankments or Retained Fills

Embankment would be used in some areas to meet grade requirements of the GSA Alternative. In addition, retaining walls would also be used to minimize the area covered by fill. Construction would involve placing imported fill on existing ground. The fill would cause new earth loads on the existing soil, which could lead to long-term settlement if soft and compressible soils are present. Settlement of compressible soils beneath proposed embankments or fill areas could require periodic maintenance of the new infrastructure and/or poor roadway quality when maintenance is not performed. Utilities or other structures located adjacent to the new embankments or fill areas could also settle as a result of increased loads. In areas where settlement-prone soils exist, minimization measures would be used to avoid the detrimental effects of settlements.

In summary, the degree of the impacts described above would depend on the specific site conditions, development plans, and final design. In all cases, the severity or frequency of the hazard or impact could be avoided or minimized using conventional design and construction methods. Where impacts are found to be moderate to high, more effort would be required during design to evaluate the severity of the impact and identify an adequate avoidance or minimization method.

4.2.3 Indirect Effects

Indirect impacts for the GSA Alternative include geotechnical risks such as grading fill slopes too steeply during project construction or establishing high-maintenance exposed slopes, which could lead to long-term erosion problems. Additionally, a large precipitation event could lead to embankment soil saturation and initiate slope failures on slopes that would normally be stable. Liquefaction of the embankment or wall foundation subgrade during an earthquake also could lead to slope and wall failures.

4.3 Partial Grade-Separated Option B (PGSB) Alternative

4.3.1 Effects during Construction

Effects during construction of the PGSB Alternative would be the same as those described for the GSA Alternative in Section 4.2.1. The area of disturbance would be approximately 50 acres, as listed in Table 1.

4.3.2 Direct Effects

Direct effects of the PGSB Alternative would be the same as those described for the GSA Alternative in Section 4.2.2.

4.3.3 Indirect Effects

Indirect effects of the PGSB Alternative would be the same as those described for the GSA Alternative in Section 4.2.3.

5.0 MEASURES TO AVOID OR MINIMIZE PROJECT EFFECTS

5.1 Mitigation for Construction Impacts

The following measures could be used to minimize and/or mitigate impacts of construction of either the GSA or PGSB Alternative:

- Maintain vegetation to the extent possible, and provide adequate surface water runoff systems.
- Construct erosion and sediment control measures downslope.
- Use temporary erosion control blankets and mulching to minimize erosion prior to vegetation establishment.
- Use retaining structures designed for the loads from moving soils.
- Implement construction specifications and quality assurance programs that prohibit over-steepened slopes.
- Relocate or protect utilities where ground settlement cannot be avoided.
- Control changes in groundwater elevation near critical structures with localized dewatering and groundwater injection methods.
- Use sheetpile barrier systems to control the horizontal extent of groundwater withdrawal.

5.2 Mitigation for Direct Impacts

The following measures could be used to minimize and/or mitigate the direct impacts of the GSA or PGSB Alternative:

- Consider the use of stone columns or grouted columns in areas with liquefiable and/or compressible soils.
- Consider the use of pile-supported embankments to transfer earth loads to incompressible layers.
- Excavate unsuitable and/or liquefiable soils beyond the footprint of each embankment and replace with engineered fill as necessary.

6.0 REFERENCES

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