

Attachment F
Geologic Hazards Report

April 5, 2023

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Attention: Nathan Watson, PE

Subject: Port of Grays Harbor Terminal 4 Development
Geologic Hazards Report
Aberdeen, Washington
File No. 0102-065-00

INTRODUCTION AND PROJECT DESCRIPTION

The Port of Grays Harbor (Port) is proposing the Terminal 4 Expansion and Redevelopment Project (Port project) to expand rail and shipping capacity at Terminal 4 at the Port of Grays Harbor located in the cities of Hoquiam and Aberdeen, Washington, to accommodate growth of dry bulk, breakbulk, and roll-on/roll-off cargos. Ag Processing, Inc. (AGP), is proposing to expand its operations at Terminal 4 (AGP project). Together, the Port and AGP projects are referred to as the Proposed Project.

The Port is located on the Pacific coast of Washington state in Grays Harbor County. The Port is located near the mouth of the Chehalis River. The Pacific Ocean is accessed from the Port via the Grays Harbor deep-draft federal navigation channel within Grays Harbor. The Hoquiam River is approximately 1.5 miles slightly northwest of the Port. Rennie Island is just south of the Port and is within Grays Harbor. Other surrounding cities include Aberdeen, Cosmopolis and Hoquiam, Washington.

The purpose of this technical report is to describe geologic hazards identified at the project area and potential impacts of these hazards on the Proposed Project. This technical report will be used to support environmental review of the Proposed Project by the state and federal agencies with a funding, jurisdictional, or permitting authority over the Proposed Project. This includes compliance with the Washington State Environmental Policy Act (SEPA) and the National Environmental Policy Act (NEPA). This technical report will be used as supporting documentation for permitting efforts.

STUDY AREA

The study area for assessment of geologic hazards consists of the On-Site Project Area as defined in the *Port of Grays Harbor Terminal 4 Expansion and Redevelopment Project Description Technical Report* (Anchor QEA 2023). The On-Site Project Area is the area that will be physically modified for the Proposed Project and will experience direct impacts from construction and operation of Proposed Project. Most physical project changes would occur in this area therefore impacts, to or effects from, geologic hazards are limited to this area.



GEOLOGIC CONDITIONS

The Geologic Map of the Humptulips Quadrangle and Adjacent Areas, Grays Harbor County, Washington (Rau 1986) includes the project area. This map identifies the soils underlying the project area as Quaternary deposits. These deposits are described as alluvium, which typically consists of interbedded deposits of sand and fine-grained soils such as silt and clay. Lenses of dense sand and gravel area also present within the alluvium at the project area. Underlying alluvium at the project area is sandstone bedrock. Artificial fill is also present in the project area and all upland portions of the Port, where fill was placed to develop the entire marine terminal complex.

The mapped geologic conditions are consistent with our observations in both subsurface explorations performed by GeoEngineers, Inc. (GeoEngineers) and explorations performed by others that were reviewed.

Artificial fill at the project area can consist of medium dense sand and gravel with variable silt content, debris, or wood waste. Fill thicknesses have been observed to be on the order of 5 to 15 feet.

Natural alluvium soils at the project area are highly interbedded and the layering is complex and non-uniform. The upper most alluvium soil unit consists primarily of loose to medium dense sand and silty sand and very soft to medium stiff silt. The base of the loose sand/soft silt alluvium unit has been observed to extend as deep as about 125 feet below ground surface (bgs). Below this depth alluvium can consist of dense to very dense gravel with variable sand and silt content. The gravel alluvium unit is expected to be underlain by sandstone bedrock, however the depth to bedrock has not been confirmed in many locations at the project area.

The project area is located in a high seismic zone. The largest contribution to the seismic hazard is from the Cascadia Subduction Zone located off the coast of Washington and about 30 to 40 kilometers from the project area. This fault is predicted to be capable of generating a 9.0 magnitude earthquake and is also predicted to trigger a significant tsunami that could inundate the areas surrounding Grays Harbor. The estimated average recurrence interval for this event is currently under debate and the estimated ranges vary significantly. But the average recurrence interval is generally accepted to be about 250 years.

GEOLOGIC HAZARDS

The City of Aberdeen identifies specific potential geologic hazards in their code; Erosion Hazard, Landslide Hazard, Seismic Hazard, and other geological events including tsunamis, mass wasting, debris flows, rock falls, and differential settlement. Of the identified hazards, it is our opinion that Erosion Hazard, Landslide Hazard, Seismic Hazards, tsunamis, and differential settlement present the greatest risk to the project area. These potential hazards are addressed in the sections below.

Large scale geologic hazards, such as seismic hazards and tsunami hazards are inherent to the region and are not affected by development. More acute hazards such erosion, landslides, or differential settlement cannot be affected if they are not present at the site or within the influence of modifications to the On-Site Project Area. In either case the study area has the same or nearly the same likelihood of experiencing an event in either the Proposed Project or the No Action Alternative.

Erosion Hazard

The project area is predominately flat and therefore there is little risk of extreme or widespread erosion. Further, stormwater infrastructure designed as part of the Proposed Project will be used to collect and manage runoff and greatly reduce the erosion potential of the project area.



The riverbank slopes will be subject to potentially erosive forces from both natural river flows and from movement of large ships. Any work on the riverbank slopes will be designed for these erosive forces and slope protection will be added as necessary.

There will be an increased erosion potential during earthwork portions of construction. In our opinion these risks can be adequately managed with standard best management practices. No additional considerations are required.

Based on our assessment of the project area and the planned activities it is our opinion that the project area and Proposed Project is a low risk for an erosion hazard.

Sites with a moderate erosion hazard risk would include sloping sites that could create higher velocity runoff or sites with significant areas of exposed highly erodible soils. Sites with a high erosion hazard risk would include sloping sites and sites with concentrated flow combined with highly erodible soils.

It is also our opinion that standard best management practices for sediment and erosion control (i.e., silt fences and temporary surfacing) are appropriate for low risk erosion hazards, including the Proposed Project. It should also be noted that that the Proposed Project will improve site drainage and surface exposed soils thereby marginally reducing the erosion hazard when compared to the No Action Alternative.

Landslide Hazard

The project area is relatively flat except for the riverbank slope. Stability of the riverbank slope is being considered for all structures adjacent the riverbank. There are no other significant slopes in the project area. Any modifications to the riverbank slope will be evaluated and designed to meet a minimum factor of safety for stability or to increase the stability from its current condition.

Based on our assessment of the project area and the planned construction, it is our opinion that the project area and Proposed Project is a low risk for a landside hazard. It is also our opinion that the Proposed Project will not decrease the stability or riverbank slope, or otherwise create a landslide hazard.

Sites with a moderate landslide hazard risk would include sites with historic landslides or sloping sites where the stability of the slopes can be managed or improved such to maintain minimum stability standards. Sites with a high landslide hazard risk include sloping sites or sites with more recent or active landslides where the stability cannot be improved within the scope of the project.

Seismic Hazard

The project area is in a high seismic region. Seismic hazards include strong ground shaking, soil liquefaction, and the potential for soil liquefaction to result in both ground subsidence and lateral spread of riverbank slopes.

The effects of seismic ground shaking are being considered and incorporated into the design of the Proposed Project. Design standards will include designing structures for either the 2018 edition of the International Building Code (IBC) or American Society of Civil Engineers (ASCE) 61-14 Seismic Design of Piers and Wharves, as appropriate.

The effect of ground subsidence from liquefaction is being considered through appropriate foundation design. Larger and more critical structures will be supported on deep pile foundations that greatly reduce the potential for seismic induced total and differential settlement. Smaller ancillary structures that are



supported on shallow foundations will be designed to be flexible and accommodate the anticipated total and differential settlement.

Lateral spreading related to seismic activity typically involves lateral displacement of large, surficial blocks of non-liquefied soil when a layer of underlying soil loses strength due to liquefaction during seismic shaking. The potential for lateral spread at the project area near the riverbank is high. This risk decreases further from the riverbank. The load from lateral spread on the structures constructed on or near the riverbank can be incorporated into the design as a method for mitigating the effects of this risk.

It is our opinion that the seismic hazard at the project area is high, but that these risks can be adequately mitigated through appropriate design.

Sites with a low seismic hazard risk include areas of low seismicity or projects that would not be affected by ground shaking. Sites with a moderate seismic hazard risk include areas with moderate seismicity and projects that have been designed to withstand some level of ground shaking.

Tsunamis

The project area is located in a tsunami inundation zone. The Tsunami inundation of southwest Washington map indicates a modeled inundation depth greater than 2.5 feet over the majority of the project area and greater than 6 feet adjacent the riverbank. This mapped risk is generally lower than the surrounding areas, which consistently indicated inundation greater than 6 feet.

It is our opinion that the tsunami hazard at the site is high. However, the Proposed Project is industrial and there will be relatively few people on site at any given time. Therefore, evacuation is an appropriate mitigation measure for mitigating the risk from the tsunami hazard. It is our opinion that the tsunami hazard can be appropriately mitigated by developing or updating evacuation procedures.

Sites with a low tsunami hazard risk include inland areas or areas of low seismicity. Sites with a moderate tsunami hazard risk include coastal areas with high seismicity but that have sufficient separation from the coast or sufficient elevation that the tsunami is unlikely to cause damage to structures or people.

Differential Settlement

Differential settlement is when one part of a structure settles more than another part of the structure. While some differential settlement is expected and accounted for in standard structural design and detailing, larger differential settlements can be damaging as it creates unexpected stresses on the structure.

The project area geology consists of significant amounts of unconsolidated alluvium and uncontrolled artificial fill. These soils have the potential for large total settlements and, due to natural soil variation, this can result in large differential settlements. This will be addressed through the design process. Larger and more critical structures will be supported on deep pile foundations that greatly reduce the potential for total and differential settlements. Smaller ancillary structures that are supported on shallow foundations will be designed to be flexible and accommodate the anticipated total and differential settlements.

It is our opinion that differential settlement risk is moderate and can be adequately managed through design of the structures.

Sites with a low differential settlement risk include areas with little to no risk of large total settlement. Sites with a high differential settlement risk include areas with the potential for large settlement and highly variable geologic or soil conditions.



CONCLUSIONS

It is our opinion based on our understanding of the regional geology, current and proposed conditions, and the proposed design criteria that the identified geologic hazards either are not present at the project area or can be adequately managed through appropriate design.

It is also our opinion that the Proposed Project: 1) will not increase the threat of the geological hazard to adjacent properties beyond pre-development conditions; 2) will not adversely impact other critical areas; and 3) will be designed so that hazards to the project are mitigated to a level equal to or less than pre-development conditions.

REFERENCES

City of Aberdeen Critical Area Ordinance, Prepared by HDR, Amended July 28, 2021.

Anchor QEA (Anchor QEA, LLC), 2023a. *Port of Grays Harbor Terminal 4 Expansion and Redevelopment Project Description Technical Report*. January 2023.

GeoEngineers, “Geotechnical Engineering Services Report, Port of Grays Harbor – Fry Creek and Rail Crossing Improvements, Grays Harbor County, Washington”, November 2022

GeoEngineers, “Port of Grays Harbor Terminal 4A Yard Development, Dry Dock Fill Analysis report, 30-Percent Design Submittal, Aberdeen, Washington”, January 2023

GeoEngineers, “Geotechnical Engineering Services report, AGP Meal Storage Expansion, Port of Grays Harbor, Washington”, December 2022

Geologic Map of the Humptulips Quadrangle and Adjacent Areas, Grays Harbor County, Washington (Rau 1986).

Tsunami inundation of southwest Washington – Grays Harbor to norther Willapa Bay, Eungard D. W. et al. 2018.

Sincerely,
GeoEngineers, Inc.



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