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Memorandum

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Subject: Geotechnical Condition Assessment
Ridgefield Wildlife Refuge
River S Unit Access Project
WA RRP RIDG 100(2)

Geotechnical Memorandum No. 08-12

SUMMARY

This memorandum summarizes the results of a geotechnical literature and field review of the existing access road to the Ridgefield River 'S' Unit. This review included about 0.4 miles of the Ridgefield Wildlife Refuge Road corridor from the intersection with Hillhurst Road to the bridge over Lake River. This road accesses the 4.2 mile long Auto Tour Route through the River 'S' Unit. The intent of this review is to document the existing geotechnical conditions along the corridor and identify existing geotechnical issues.

The first part of this memorandum summarizes the information gathered from a literature review. The second part of this memorandum summarizes observations and conclusions made based on a field review. The field review consisted of a general surface reconnaissance of the existing access road and bridge.

Literature Review

AVAILABLE SUBSURFACE INFORMATION

WFLHD was provided with a Geotechnical Report for the Ridgefield Rail Overpass Project off of Pioneer Street west of downtown Ridgefield, about ¾ mile northwest of the Ridgefield access Bridge. The report contains 5 boring logs from the site of the proposed Ridgefield Rail Overpass. It is interpreted that the soil types encountered will be similar at the Ridgefield Wildlife Refuge Road. The borings generally encountered layers of unconsolidated silt, clay and fine sand overlying very dense sand and gravel.

SITE CONDITIONS

The Ridgefield Wildlife Refuge Road begins at the intersection with Hillhurst Road at about elevation 265 feet. It follows a natural drainage down to Lake River descending to about elevation 15 feet. Before the road crosses the river, it crosses a double set of railroad tracks. A lidar map of the access road is attached as **Figure 1** (attached).

The existing Lake River Bridge is a 331.5 foot long, single lane, timber trestle structure with 19 spans originally built in 1970, and in 1980 two spans were replaced with a single span through an agreement between the Refuge and a private contractor to facilitate movement of barged equipment along Lake River. The 55.5 foot main span is composed of steel beams and the 18 other spans vary in length from 8 feet to 17 feet and are spanned by timber beams. The 16 foot wide deck consists of transverse timber planks, longitudinal timber running planks with timber bridge rail and curbs. The trestle bents and abutments contain timber piles, bracing and caps. All timber is noted to be treated.

SITE GEOLOGY

The site is within the geologic province known as the Puget-Willamette Lowland which extends from Puget Sound into west-central Oregon between the Coast Range and the Cascade Range. Ridgefield is near the deepest part of the basin which is believed to have been filled with as much as 550 m of sediments carried in from the east by the Columbia River (Evarts, 2004).

The surficial geology of the site is mapped and described on the Geologic Map of the Ridgefield Quadrangle, Clark and Cowlitz Counties, Washington (Evarts, 2004). Descending from the intersection with Hillhurst Road, the soils along the access road are mapped as cataclysmic-flood deposits (Qfs), conglomerate (QTc), and alluvium (Qa). The cataclysmic-flood deposits are described as unconsolidated clay, silt, and fine to medium sand. The conglomerate is described as semi-consolidated pebble and cobble gravel that is poorly sorted to moderately well-sorted and contains minor lenses of cemented sand generally less than 2 m thick. The conglomerate layer is often locally included as part of the Troutdale Formation. The alluvium is described as unconsolidated sediments underlying the modern floodplains of the Columbia River and Lake River.

GEOLOGIC HAZARDS

Geologic hazards relevant to this site were reviewed as part of this corridor assessment. Clark County has an online map database that identifies landslide, liquefaction, and erosion hazards. The USGS Earthquake Hazards Program website was used to perform a seismic deaggregation for the site and locate nearby active faults.

Landslides

The cut slopes and natural slopes within the drainage along the road are mapped as “potential” and “moderate” under Landslide Hazard Areas in the Clark County Maps Online database for Slopes and Geologic Hazards. See attached **Figure 2** (attached).

Seismicity and Liquefaction

The USGS interactive deaggregations website was used to determine the seismic hazard at the site. The current AASHTO Bridge Design Specifications (2012) specify a design seismic event with a 7 percent probability of exceedance in 75 years which is approximately a 1000-year return period. The peak ground acceleration for the specified return period was determined to be 0.28g using the USGS 2008 deaggregation website. The closest active fault is the Portland Hills Fault located about 11 miles south of bridge. The deaggregation indicates the sources contributing significantly to the seismic hazard at the site are the Cascadia Subduction Zone (megathrust and floating), western US gridded crustal faults, and 50-km deep intraplate earthquakes.

In the Clark County Maps Online database for Slopes and Geologic Hazards the Liquefaction hazard along most of the alignment is mapped as “very low” and “very low to low”. However, the low and flat-laying area on both sides of the bridge is mapped as a “moderate to high” liquefaction hazard. See attached **Figure 3** (attached).

This bridge site has a seismic hazard and subsurface conditions that would require special consideration during design of a replacement structure.

Erosion

In the Clark County Maps Online database for Slopes and Geologic Hazards the entire drainage that parallels most of the access road and the slopes facing Lake River are mapped as a “Severe Erosion Hazard Area”. See **Figure 4** (attached).

Site Observations

Brian Collins, WFLHD Geotechnical Engineer, and Jeff Berg, WFLHD Structural Engineer, visited the site on March 27, 2012. The field review consisted of a general surface reconnaissance of the existing access road and bridge. It should be noted that the extent of the field review is limited to interpretations of surface features.

SLOPE INCLINATIONS

The existing road template appears to have generally been constructed with a partial cut bench on the uphill side and a fill on the downhill side. Both the cut and fill slopes are relatively steep with slope angles ranging from 40 degrees (1V:1.2H) to vertical. Natural slopes within the drainage were generally between 30 degrees (1V:1.75H) to 40 degrees (1V:1.2H). A photograph of a typical roadway section is shown in **Figure 5**.

Figure 5. Photo of Typical Road Section, Looking Northwest (towards Lake River).

SOIL AND GROUNDWATER

The soil types observed in the existing cut slopes were consistent with the descriptions on the geologic map. Near the top of the hill the soils exposed were visually classified as silt with some clay, moist, brown, low plasticity. Further down the road the steeper and higher cuts exposed conglomerate that was visually classified as gravel and cobbles in a fine to medium grained silty sand matrix, subrounded to round gravel and cobbles, 6-inch minus. Near the lower end of the alignment a layer of weakly cemented fine to medium sand with silt was observed underlying the conglomerate. Seepage was observed in this area just above the contact of the two layers. See **Figure 6** below.

Figure 6. Photos of conglomerate (left) and sand (right) layers.

LANDSLIDES

A fairly significant landslide was observed on the opposite side of the drainage from the road. See location of landslide in **Figure 1** (attached) and photo of landslide in **Figure 7**. The landslide encompassed an area of about one acre. It appears from the age of the trees on top of the slide mass that it occurred within the last 20 years. The slide is not impacting the roadway; however, if continued movement dams the drainage, it could cause significant flooding and erosion or a larger failure that could have significant impacts to the existing road.

Figure 7. Landslide Observed Across Drainage from Refuge Access Road.

Several smaller slumps were observed in the native slopes throughout the drainage. These slumps are shown as shallow bowl shaped depressions in the lidar imagery of **Figure 1** (attached). The shallow slumping does not appear to be a significant problem other than having the potential to deposit debris on the road during heavy precipitation events.

The shallow slumps and also the larger landslide previously mentioned are commonly observed throughout this geologic formation mapped as conglomerate by Evarts (2004). As previously stated, this formation is often included as part of the Troutdale Formation. The formation consists of very dense and slightly cemented gravel and cobbles so it will stand at vertical slopes as observed along this road. However, when the material becomes saturated it loses significant strength often resulting in landslides ranging from shallow slumps to massive ground movements; both observed with the drainage that the Refuge access road follows. Slopes in the conglomerate are sometimes cut vertical to minimize the amount of precipitation that directly impacts the slope. Once the slope deviates from vertical it must be laid back to an angle that will be stable considering the amount of precipitation that it will be exposed to. Generally these materials would be stable at slopes of 1V:1.5H or flatter.

The vertical cuts in the conglomerate material were 30 to 40 feet high along the Refuge access road. The slope had about 10 feet (measured vertically) of accumulated sloughed material at the toe. The angle of repose of the sloughed material was between 35 degrees (1V:1.5H) to 40 degrees (1V:1.2H).

DETENTION BASIN

A detention basin was observed on private land near the intersection with Hillhurst Road. See aerial photo in **Figure 8** showing its location. The detention basin is situated on the level ground at the top of the slope above the road. It was not inspected since it is on private property.

Storage of water, even if temporary, at the top of a slope can raise the local groundwater table and increase the likelihood of landslides.

Figure 8. Aerial Photograph of Refuge Access Road (2012 Google Earth).

BRIDGE

Routine bridge inspections have been performed by other agencies. Jeff Berg, WFLHD Structural Engineer, also performed a site visit and existing condition assessment. His findings are provided in a separate memorandum.

The west abutment was reconstructed between 2008 and 2010 and the piles and cap appeared to be in good condition. The timber piles, pile cap, and wingwall at the east abutment had moderate to heavy rot (as documented in the 2010 Bridge Inspection Report). The piles, pile cap, and wingwalls also exhibit visible rotation (See **Figure 9**). The piles in the river were not accessible, but the Inspection Report also indicates moderate to heavy rot in the piles above the water line.

This bridge was originally constructed in 1970. The durability of timber piles is a function of the site conditions. The durability if most effected when timber piles are subjected to alternate wetting and drying cycles that leads to damage and decay by insects.

Figure 9. Picture of East Abutment, note Pile Rotation.

The FHWA Driven Pile Foundations Manual (Hannigan et al, 2006) lists the expected durability for round timber piles as follows:

- Timber piles permanently below the groundwater table will typically last indefinitely,
- Treated trestle piles over land will generally last about 75 years in northern states,
- Treated piles in fresh water will typically last 5 to 10 years less than land trestle piles in the same area, and
- Treated marine piles will typically last about 50 years in northern climates.

Data from a USGS gage station on the Refuge Road access bridge indicates that the water level of the river fluctuates twice daily with magnitudes up to 2 feet. This is interpreted to be related to tidal influence. Due to the highly variable water level and the observed rot the piles should be considered to be in a marine environment when interpreting the durability and the expected service life should be 50 years.

Considering the short spans and the relatively lightweight superstructure, it is interpreted that the piles have relatively small loads. However, since the piles are nearing their expected service life and there is observed moderate to heavy rot an analysis of the pile loads versus the remaining pile capacity is recommended. The remaining pile capacity could be established following an inspection and coring of the piles in the river. This should be done during low water so the cores can be taken in the zone that experiences the most fluctuation in water level.

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