January 13, 2016 **DRAFT** Project No. 14-03741-10

Eric LaFrance, PE
City of Redmond
Public Work
PO Box 97010; MS: 2NPW
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RE: GEOTECHNICAL ASSESSMENT ENGINEERING REPORT
REDMOND WOODINVILLE ROAD CULVERT AT NE 98TH STREET

Dear Eric:

This letter summarizes our geotechnical assessment of the culvert located at the intersection of Redmond Woodinville Road (State Route [SR] 202) and NE 98th Street. Golder Associates Inc. (Golder) completed this work in accordance with City of Redmond (City) Task Order #15-10.

1.0 BACKGROUND

The Redmond Woodinville Road culvert is a 24-inch-diameter corrugated metal pipe (CMP) that conveys stormwater across SR 202. The road section through this area is a cut/fill section with minor cuts on the east side and fills on the west side. The west side fill section is retained by a cantilevered solider pile retaining wall constructed between 1999 and 2000 in response to some downslope slope stability issues (AGI 1999). The culvert inlet is located on the east side of SR 202 and is a standard grated inlet. The culvert discharges into a ravine below the existing solider pile retaining wall on the west side of SR 202. The exposed portion of the culvert outlet located west of the solider pile wall has broken into several pieces, resulting in erosion along the ravine and a buildup of sediment at a birdcage inlet structure located approximately 130 feet downstream of the culvert outlet..

The solider pile retaining wall is approximately 270 feet in length, with a typical exposed height of 7 to 8 feet and piles installed between 42 and 55 feet below the roadway. We understand the City may be concerned about the current erosion below the retaining wall and culvert migrating towards the wall resulting in damage to the wall or SR 202.

2.0 SITE VISIT

On December 2, 2015, Golder performed a site visit to observe the existing culvert damage, assess the erosion within the ravine, and review the condition of the existing solider pile retaining wall. The following observations were made:

- At approximately 50 feet downstream of the existing culvert outlet, glacial till is exposed within the drainage channel. This material is very competent.
- From the existing culvert outlet to approximately 50 feet downstream, approximately 2 to 3 feet of loose colluvium overlies the till. This material is being eroded and the channel bank is being actively undermined. There are several places in the channel where the side slopes have been undermined and the ground surface and trees overhang the channel. These areas will eventually collapse into the channel.
    - Within this area, there is fill debris (downed trees/logs) within the channel. Fill debris includes 18 to 24-inch diameter logs.

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- No obvious signs of instability or damage were observed along the face of the solider pile retaining wall. The wall visually appears straight. The wall face is located approximately 40 feet horizontally east of the area of active channel erosion.
- The asphalt surfacing for SR 202 extends over the top of the solider pile wall so Golder could not observe the tops of the piles or backfill behind the wall.
- No obvious visual signs of distress (e.g. cracking or other damage) were observed to the SR 202 asphalt surfacing. Depending on when the pavement was placed, there could be damage to the subgrade that has not migrated to the surface to date. However, since there were no signs of distress on the face or at the toe of the wall, major damage is unlikely.
- Drainage pipes were observed at base of wall but no noticeable water was discharging above the existing culvert.

3.0 RETAINING WALL DESIGN REVIEW

The City provided two reports and as-built drawings (AGI 2000b) on the existing solider pile retaining wall prepared by AGI Technologies (AGI) for Golder's review. The geotechnical report (AGI 1999) summarizes AGI's geotechnical investigation of the landslide that occurred in 1999 prior to installation of the soldier pile wall and provides stabilization recommendations. The geotechnical inspection report (AGI 2000a) summarizes AGI's engineering, inspection, and testing services during construction of the soldier pile wall. We understand AGI also prepared plans and specifications for the soldier pile wall in 1999 (AGI 2000a). They may have also produced an engineering design report including their engineering analyses. Neither were available to Golder.

Three geotechnical borings were drilled and inclinometers installed in the vicinity of the landslide as part of the geotechnical investigation (AGI 1999). AGI concluded the slope stability issues resulting in the slide were due to instability within the slope at the interface between the fill and underlying native soil deposits and failure of the gabion wall originally installed to support SR 202. The depth of the failure plane was reported to be approximately 25 feet below the road surface. AGI recommended and the City approved a cantilever solider pile retaining wall.

Based on review of the provided AGI reports, the wall design appears adequate from a conceptual standpoint. Golder did not check AGI's design since we do not have AGI's design assumptions and engineering analyses. The piles are embedded well below the slide failure plane and are of standard diameter (HP 14x117). The wall alignment also extends past the surface expression of slope instability observed by AGI. However, the following items were considered to be possible red flags:

1. The pile spacing around the culvert crossing was adjusted due to slumping/sloughing encountered while drilling in the fill at and below the existing gabion wall (note: the gabion wall was not removed during construction). A surface depression formed and some gabion baskets deformed due to the poor soil conditions and drilling activities.
2. It was reported that additional structural concrete was required to backfill the drill holes for the piles around the culvert. This may indicate the presence of voids in the vicinity.
3. While drilling for pile #28 (adjacent to the existing culvert), the pipe to manhole connection at manhole MH7854 was damaged. The field notes indicate the driller did not hit the culvert or manhole, but water filled the shaft and was observed discharging from the culvert outlet in the ravine. The hole was backfilled with control density fill (CDF) and allowed to cure over night before re-drilling the hole. Uncontrolled discharge of water behind a retaining wall and above a slope could be a source of erosion and potential damage to the wall. Drains are shown on the as-built drawings and were observed during the site visit; however, the seepage may be below the level of the drains.

4.0 RECOMMENDATIONS

We understand the City reviewed several alternatives and is proceeding with the option to open cut near a manhole (MH7854) located on the west side of SR 202 (above the soldier pile wall), replace or repair the existing culvert between manhole MH7854 and manhole MH7784 located on the east side of SR 202 using trenchless methods, and abandon an existing chamber adjacent to manhole MH7854 in place. Then, the existing culvert pipe located west of the solider pile wall will be repaired using a trenchless method and an additional approximately 65 feet of new 18-inch-diameter HDPE pipe will be installed to extend the pipe past the highly erodible and actively undermined area of the channel as discussed in Section 2.0.

4.1 Construction Staging Above Wall

The work area to access manhole MH7854 and the special chamber shown on the plan view is approximately 11 feet wide. For comparison, a Caterpillar 235 excavator is 11.8 feet wide to the outside of the tracks. Additional width may be necessary; such as, a minimum of 15 feet, which would encroach into southbound SR 202.

The wall was designed to support traffic loading. Construction equipment and stockpiles staged above the wall should not exceed typical traffic live loading limits. The contractor should be responsible for establishing staging requirements and maintaining the integrity of the wall and SR 202.

4.2 Filling Within Ravine

The eroded/undermined colluvium along the pipe alignment will need to be removed and/or backfilled with a material that stabilizes the channel, supports the culvert extension, and provides drainage.

The backfill material should consist of imported granular fill, such as the following Washington State Department of Transportation (WSDOT 2016) materials:

- Gravel Base (Section 9-03.10),
- Gravel Borrow (Section 9-03.14(1)), or
- Select Borrow (Section 9-03.14(2))

Other fill materials may be used with approval of a qualified geotechnical engineer.

4.3 Retaining Walls

If the area by Manhole MH7854 is excavated, the existing gabion wall may be exposed. Provisions should be considered for supporting the wall so that the wall is not damaged during construction and the basket fill does not collapse into the excavation.

Regardless of which trenchless method is used to replace the existing culvert, care should be taken during drilling of the new pipe between the cantilever soldier pile wall piles. We recommend that the existing culvert remain in place and the same alignment be used for the new culvert. Drilling a new hole between the piles could compromise the integrity of the wall. Also, poor soil conditions and voids were encountered while drilling the piles in the vicinity of the culvert that may also be encountered while drilling for the culvert. We recommend that a qualified geotechnical engineer be on-site during drilling and inspect the wall after drilling.

If voids are encountered during excavation to replace Manhole MH7854 and expose the existing culvert, a qualified geotechnical engineer should inspect the excavation before further work is completed.

4.4 Pipe Anchoring

Considering the steepness and unstable nature of the slope, the new above ground stormwater pipe should be anchored. Pipe laid above ground has a tendency to creep downslope. The pipe can be anchored using a screw anchor assembly consisting of augered helical screw anchors on either side of the pipe and a pipe saddle at regular intervals. The spacing of the anchors depends on the pull-out strength of the pipe anchor, steepness of slope, diameter of pipe and type of pipe material. At a minimum, the pipe should be anchored at the uphill end with supports to restrain lateral movement.

The pipe should be of a continuous length or have butt-fusion welded joints for HDPE pipe or restrained joints for other pipe material. The pipe bedding material should also be properly compacted to reduce the risk of erosion and gullying along the pipe alignment.

Sincerely,

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5.0 REFERENCES

AGI Technologies. 1999. Geotechnical Engineering Report, Redmond-Woodinville Landslide Stabilization, Redmond, Washington. December 10.

AGI Technologies. 2000a. Redmond-Woodinville Road/NE 98th Street, Landslide Stabilization, Geotechnical Testing and Observation Report. April 7.

AGI Technologies. 2000b. City of Redmond, Redmond-Woodinville Road/NE 98th Street, Landslide Stabilization. As-built drawings. May 5.

Washington State Department of Transportation (WSDOT), 2016, Standard Specifications for Road, Bridge, and Municipal Construction. Publication Number: M 41-10.