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August 14, 2015

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Attention: Maiya Andrews, PE
Public Works Director

Subject: Letter Report
Eagle Landing May 2015 Site Visit
Burien, Washington
File No. 3416-053-05

INTRODUCTION AND SCOPE

This Letter Report provides a summary of our May 19, 2015 site reconnaissance to evaluate the west-facing slope located along the shoreline of Puget Sound in Eagle Landing Park in Burien, Washington, and to assess the safety of a public staircase leading down the slope to the shoreline.

GeoEngineers, Inc. (GeoEngineers) conducted a previous reconnaissance of the slope, staircase and shoreline on December 19, 2014, the results of which are presented in our "Eagle Landing Landslide Evaluation" memorandum dated January 15, 2015. The December 2014 reconnaissance was conducted in response to a request from Maiya Andrews of the City of Burien (City) to Galan McInelly of GeoEngineers to visit a landslide that was reported in Eagle Landing Park located near the lower platform of a public staircase to the beach. The landslide apparently occurred following uncharacteristically severe storms with high winds and precipitation during the week of December 1, 2014. The landslide exposed some steel pin piles supporting the lower platform. Consequently, the City closed access to the staircase. On December 17, 2014, our services were requested by Maiya Andrews during a conversation with Galan McInelly after she observed a potential crack propagating across the slope upslope of the failure that occurred during the week of December 1, 2014.

In a conversation with Galan McInelly on May 20, 2015, Maiya Andrews requested a follow-up site visit to determine if and how conditions at the site have changed since our December 2014 visit. This Letter Report summarizes changes observed during this visit.

Our scope of work was as follows:

1. Review our December 2014 report and information in our files;
2. Perform a brief reconnaissance to document changes in site conditions since our previous site visits in 2014; and

3. Prepare this Letter Report summarizing observations and our recommendations regarding short-term safety response for pedestrian access to Eagle Park, and discussion of long-term solutions.

SITE GEOLOGY

We reviewed published geologic maps of the area (Waldron, 1962; Booth & Waldron, 2004) which indicate that the site is mapped as Vashon-age advance outwash (Qva) overlying pre-Fraser-age fine-grained deposits (Qpff). The advance outwash consists of well-bedded sand and gravel deposited by meltwater streams and rivers in front of advancing the advancing glacier in the Puget lowland, and is almost devoid of silt or clay, except near the base of the unit. The underlying pre-Fraser fine-grained deposits consist predominantly of laminated silt and clay. As described by Shannon & Wilson (2003), the outwash and fine-grained deposits are covered by colluvium. Colluvium is loose material that has moved downslope due to gravity; it is commonly attributed to root loosening, freeze-thaw action, animal burrowing or from landslide or other erosion processes that originate from higher elevations (in this case, the upper portions of Eagle landing Park). Both Shannon & Wilson and GeoEngineers document interbedded hard clay, silt and sand exposures at the beach.

DECEMBER 2014 SITE RECONNAISSANCE

We completed a site reconnaissance at Eagle Landing Park on December 18, 2014 to evaluate the December 2014 slope failure located near the shoreline and near the lower sections of the stairs. This evaluation was conducted to develop a preliminary opinion regarding the cause of the slope failure, risk to public safety along the stairs and slope, and the potential risk for future slope failure. We were not able to complete a reconnaissance of the base of the slope or access the beach and shoreline at that time due to the high tide and the unstable and unsafe condition of the slope. A detailed summary of the December 2014 site reconnaissance is presented in our "Eagle Landing Landslide Evaluation" memorandum dated January 15, 2015. A site plan from that memorandum documenting site conditions is presented in Figure 1.

MAY 2015 SITE RECONNAISSANCE

We completed a follow-up site reconnaissance on May 19, 2015 to identify and document changes in site conditions since our December 2014 visit. We accessed the site by the main trail from the parking lot down to the stairs. We observed the condition of the staircase and concrete piers supporting it, and traversed portions of the west-facing slope on the north and south sides of the staircase. The entrance to the staircase was cordoned off with a chainlink cage enclosure to prevent public access. We observed that a bypass trail had been established through the vegetation near the fenced area to an unsecured segment of the staircase downslope of the upper stair landing. It appears that pedestrians have established the trail to circumvent the blocked portion of the staircase and gain access to the stairs.

The slope is generally forested by deciduous trees including Maple and Alder trees, and several large cedar trees with a dense understory of ferns, ivy, blackberry and deciduous shrubs. The majority of the trees are bowed and leaning downhill, but some cedar trees were observed to have a straight growth habit. We observed an abundance of leaning and/or partially uprooted tree stems that could present a toppling hazard to people accessing the staircase, surrounding slope, and toe-of-slope along the beach.

We visually inspected the stairs and concrete support platforms. We observed that erosion and soil creep have exposed up to 12 inches of the base of the concrete platforms for most of the stairway. Near the base of the slope, we observed that wave action has continued to remove soil from the toe of the slope and from around the two concrete platforms at the base of the staircase, further exposing the steel piles beneath the platforms since December of 2014. It appeared that the second platform from the bottom has been rotated (tilted) considerably by slope movement compared to observations made in December 2014. We also observed additional separation of the detached stair segment relative to December 2014. The detached span of stairs had fallen from the platform to the ground on the downslope end of the span. We observed another bypass trail through the vegetation adjacent to the stairs just upslope of the toe of the slope and north of the stairs. It appears that trail is being used to access the beach, and to avoid the detached stair segment. The bypass trail is inclined in excess of 100 percent and exposes loose raveling sandy soil. We accessed the beach and observed a number recently toppled trees along the beach, and partially toppled/uprooted trees north and south of the stair access. Portions of the slope at the base of the stairs have been undercut several feet by wave action.

During our site reconnaissance, near surface soils were observed in slope exposures and in the scarps of the December 2012 and December 2014 landslides (details of these landslides are discussed in our "Eagle Landing Landslide Evaluation" memorandum dated January 15, 2015). We generally found that approximately the upper 2 to 3 feet of slope deposits are colluvium composed of fine to medium sand with silt, gravel and occasional cobbles. Toward the base of the slope, we observed exposures of laminated silt and clay; likely part of interglacial deposits or interbeds near the base of and within the glacial advance outwash mapped in the area.

We observed the crack and scarp-like features that we documented during our previous visit that extend from the toe of the landslide at the face of the exposed slope between the first and second platforms (looking upslope from the beach). The features continue under the stairs between the second and third platforms and within 5 to 10 feet of the fourth platform for about 25 to 30 feet. The feature then extends to the southeast and upslope for about 25 feet, travels subparallel to the shore for about 25 feet, and then curves southeast for an estimated 15 feet, where it intercepts the 2012 landslide. The crack ranges from 1 to over 6 feet in depth, and from about 6 inches to at least 3 feet in width and is often off-set vertically approximately 1 to 4 feet downslope. Many recently-fallen trees were observed in areas that were off-set 3 to 4 feet.

We also observed the scarp area of the 2012 landslide during our May 2015 site reconnaissance. Evidence of very recent slope movement was observed, including fresh mounds of loose soil and exposures of clay at the base of the scarp, and recently fallen trees along the flanks of the feature.

DISCUSSION AND CONCLUSIONS

General

Based on our review of available information and our site reconnaissance, it is our opinion that erosion of shoreline has continued to destabilize the steep, lower portion of the slope. Severe storm events and high tides have episodically eroded the base of the slope and the slope around the lower two concrete stairway platforms. It is likely wave undercutting and continued slide activity during the wet season of Winter 2014/2015 has resulted in the full separation and partial collapse of the second pier from the lower

portion of the staircase. We expect that continued slope movement will cause additional damage to the lower portions of the staircase, with potential for major components of the lower staircase to topple onto the beach. We also observed that recent slope movement has caused many trees to topple or partially topple throughout the slide area. Partially toppled trees present a particular hazard to people attempting to access the sloped portions of the park and/or utilize the beach along the toe of the slope.

Based on our observations it is our opinion that stabilizing the slope would likely require significant effort and expense. Buttressing the slope using very large rock would likely be the most cost efficient and appropriate method. That approach would require significant permitting, barging in rock and construction equipment, and working from the beach only during low tides. Other methods of stabilizing the toe of the slope might include soldier pile wall construction, which would be considerably more expensive and disruptive to the shoreline and slope (if it is feasible at all).

Based on the results of our site reconnaissance, it is our opinion that episodic slope movement will likely continue over the short and long term (i.e., days to years). As a result, it is our opinion that the City should keep the stairs to the west-facing slope and access to the beach closed. The separation and collapse of the stair span from the second platform, the recently fallen trees along the beach and the slope, the current slope activity and the potential for continued slope movement represents a hazard to public safety along the slope and on the beach. It is also our recommendation that a new route down to the beach not be developed at this time. We further recommend that the City consider taking the following actions to reduce hazards to public safety:

- Consider addition precautions to prevent public access to the steep slopes and landslide hazard area. This might include measures such as extending chainlink fencing along the crest of the slope north and south of the upper staircase entrance, following the elevation contour of the upper staircase entrance to prevent pedestrians from bypassing the existing barricade. Additional hazard warning signs may also be warranted.
- Dismantle and/or demolish the staircase segments downslope of the damaged portions of the staircase (lower three segments), including the partially-toppled second landing.
- Consider felling partially-toppled and/or leaning trees along the toe of the slope that have the potential to topple onto the beach and represent a hazard to pedestrians.

LIMITATIONS

We have prepared this report for the City of Burien and their authorized agents and regulatory agencies for evaluation of a landslide concerns at Eagle Landing Park in Burien, Washington.

Our services were provided to assist in the evaluation of on-going landslide movement at Eagle Landing Park. Our recommendations are preliminary and are intended to provide guidance to further evaluate and manage the potential risk for continued failure of the slope and potential impacts to the property. Qualified engineering geology, engineering and construction practices can help mitigate these risks if implemented in a timely manner.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of engineering geology in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our

professional knowledge, judgment and experience. No warranty or other conditions, express or implied, should be understood.

REFERENCES

GeoEngineers, Inc. "Eagle Landing Landslide Evaluation" memorandum, January 15, 2015

Gilles, B.K., "Evaluation of Trees at Eagle Landing Park," Gilles Consulting, February 8, 2013.

Laprade, W.T., "Evaluation of Mass Wasting, Branson Property, Burien, Washington," Shannon & Wilson, Inc., March 18, 2002.

Shannon & Wilson, Inc., "Design Statement Regarding Branson Park Stairway," Burien, Washington, November 14, 2003.

Shannon & Wilson, Inc., "Geotechnical Report," Branson Park, Burien, Washington, March 20, 2003.

Waldron, H.H., "Geology of the Des Moines Quadrangle, Washington." 1:24,000. U.S. Geological Survey Geologic Quadrangle Map GQ-159. 1962.

We trust that this Letter Report meets your needs at this time. Please do not hesitate to contact us if you have questions or require additional information.

Sincerely,
GeoEngineers, Inc.

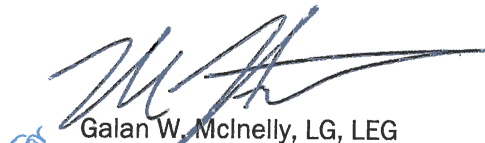


Ben Cashman
Project Geologist

BHC:CFE:GWM:cam

List of Figures

Figure 1. Site Plan



for Galan W. McInelly, LG, LEG
Principal

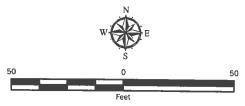
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Data Source: King County

Notes:
 1. The locations of all features shown are approximate.
 2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
 Projection: NAD83 Washington North

-  Seepage
-  Previously Mapped Landslide
-  Approximate Headscarp (December 2014)
-  Stairs in Eagle Landing Park
-  10 Foot Contours



Site Plan	
Eagle Landing Landslide Evaluation Burien, Washington	
	Figure 1