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January 5, 2015

City of Burien
400 SW 152nd Street, Suite 300
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Attention: Maiya Andrews, PE
Public Works Director

Subject: Memorandum
Eagle Landing Landslide Evaluation
Burien, Washington
File No. 3416-053-04

INTRODUCTION AND SCOPE

This memorandum provides a summary of our site reconnaissance on December 19, 2014 to evaluate a west-facing slope located along the shoreline of the 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.

During the week of December 1, 2014, the Puget Sound area experienced uncharacteristically severe storms with high winds and precipitation. The Sound also experienced high tides during the first few weeks of December. On December 10, 2014, Maiya Andrews of the City of Burien (City) Public Works Department informed Galan McInelly of GeoEngineers, Inc. (GeoEngineers), that residents reported a landslide in Eagle Landing Park located near the lower platform of a public staircase to the beach and that the landslide exposed some steel 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.

Our scope of work was as follows:

1. Research local geologic conditions by reviewing available resources including digital data from public sources and pertinent maps, reports, and other documents that are in our files.
2. Conduct a site reconnaissance to: 1) assess site conditions; 2) determine if the stairs can be safely used in whole or in part by the public to access the beach; and 3) determine if there is another route the City can use to allow the public to access the beach.
3. Prepare this short memorandum documenting our observations and opinions regarding the cause slope movement and any conceptual recommendations for additional investigations or measures that are appropriate. Any engineering design or analyses will be done under separate contract. These and other additional services can be provided upon request.

BACKGROUND AND DOCUMENT REVIEW

GeoEngineers reviewed the following reports regarding landslide activity at Eagle Landing Park in Burien, Washington:

- Shannon & Wilson, Inc., 2002. Evaluation of Mass Wasting, Branson Property, Burien, Washington.
- Shannon & Wilson, Inc., 2003. Design Statement Regarding Branson Park Stairway.
- Shannon & Wilson, Inc., 2003. Geotechnical Report Branson Park, Burien, Washington.
- Gilles Consulting, 2013. Evaluation of Trees at Eagle Landing Park.
- GeoEngineers, Inc. 2013. Letter Report, Eagle Landing Landslide Evaluation, Burien, Washington.

In 2002, the City requested Shannon & Wilson's services to assess the Branson property (now Eagle Landing Park). At that time the City was proposing to purchase a portion of the property. In their report, Shannon & Wilson presented their evaluation of the mass wasting processes on the Branson property and addressed the City's concern regarding contribution of sediment from the upland part of the slope to the beach along Puget Sound. Shannon & Wilson found that the Branson property was not a "large supplier of sediment to the beach environment" compared to other Puget Sound bluffs, but the report did note that the Branson slope is a "regular and consistent supplier of coarse to fine sediment due to mass movement processes." In particular, one landslide located near the southern margin of the Branson property was evaluated and documented. Shannon & Wilson identify a "chute" on the south edge of the property, and notes "the coarse sediment is primarily supplied by debris flows in the chute on the south edge of the property and from periodic erosion of the toe of the very steep slope just north of the debris chute." Subsequently, Shannon & Wilson conducted shallow, hand-excavated subsurface explorations at the park and provided geotechnical recommendations for the staircase that the City constructed and maintains at the site. GeoEngineers conducted a site reconnaissance of the area in February 2013, to evaluate a landslide reported on the west-facing slope of along the shoreline of Eagle Landing Park. Based on their reconnaissance, it appeared that the reported 2013 landslide occupied the same area as the chute, but that the chute area had expanded into a landslide. According to the report produced by Gilles, the landslide occurred sometime before Christmas in December 2012.

We observed the debris chute landslide area (December 2012 landslide) during our December 19, 2014 site reconnaissance. Based on our review of previous information, it appears as though the debris chute landslide area has continued to erode headward into the slope and has produced an expanded landslide scarp since the time of Shannon & Wilson's evaluation in 2002, and since the time of our 2013 reconnaissance (GeoEngineers 2013). We discuss this landslide, as well as the recent December 2014 slope failure in more detail in the Site Reconnaissance section below.

SITE GEOLOGY

We reviewed a published map of the area (Waldron, 1962). The mapped geologic unit in the area is identified as advance outwash (Qsa) which Waldron (1962) describes as sand, and sand and pebble to cobble gravel with very fine sand and laminated silt. This unit was deposited by proglacial streams formed at the front of advancing glaciers in the Puget Sound. As described by Shannon & Wilson, these deposits are covered by colluvium. Colluvium is loose material that accumulates on slopes 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). Shannon & Wilson also documents interbedded hard clay, silt and sand exposures at the beach.

During our site reconnaissance, near surface soils were observed in slope exposures and in the scarp of the December 2012 and December 2014 landslides. We generally found that approximately the upper 2 to 3 feet of slope deposits are colluvium, and is 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.

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 base of the west facing slope along the shoreline and near the lower sections of the stairs, and to evaluate the December 2012 landslide (see Figure 1, Site Map). This evaluation was conducted to develop a preliminary opinion regarding the cause of the recent 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 due to the high tide and the unstable and unsafe condition of the slope.

We accessed the west-facing slope taking the main trail that begins at the parking lot through the park down to the stairs. We observed the condition of the staircase and concrete piers that support the staircase and traversed the west-facing slope on the north and south sides of the staircase. The upland topography was generally irregular with variable slope gradient (about 40 to 100 percent). The park 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 are observed to have a straight growth habit. The slope gradient abruptly steepens at the stairs to between 60 and 80 percent or more.

We visually inspected the stairs and concrete support platforms. We observed that erosion and soil creep has exposed up to 6 inches of the base of the concrete platforms for most of the stairway (Figure 2). We did not observe cracks or indication of movement for most of the platforms. Near the base of the slope, we observed that recent wave action had removed soil from the toe of the slope and from around the two concrete platforms at the base of the staircase, exposing the steel piles beneath the platforms. It appeared that the second platform from the bottom has been rotated by the slope movement and has detached from the stairs above (Figure 3). We were not able to access the beach due to high tides, but we did observe several recently downed trees along the beach, north of the stair access. We also observed that portions of the slope at the base of the stairs has been undercut several feet by wave action.

We observed a ground crack that propagated from the toe of the landslide at the face of the exposed slope between the first and second platform (looking upslope from the beach). The crack continued 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 ground crack then propagates 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 (Figure 4). The crack ranged from 1 to over 6 feet in depth, and from about

6 inches to at least 3 feet in width and was 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 (Figure 5).

We also observed the 2012 landslide during our December 18, 2014 site reconnaissance. As noted above, recent 2014 crack and failure scarp intercepted the northern sidewall of the 2012 slide area (Figure 4). Evidence of very recent slope movement was observed, including fresh mounds of loose soil and exposures of clay (Figure 6), a fresh scarp having a minimum of 15 feet of relief (Figure 6), and recently fallen trees along the sidewalls. Farther upslope of this area, occasional healed slumps were observed with old scarp lines spanning a distance of up to approximately 20 feet (Figure 7).

We observed irregular topography and groundwater seepage on the north side of the stairs. The seepage was occasionally near outcrops of interbedded sands and clay. These observations are consistent with previous observations made by GeoEngineers during our 2013 reconnaissance.

DISCUSSION AND CONCLUSIONS

General

Based on our review of available information and our site reconnaissance, it is our opinion that erosion of the toe of the west-facing shoreline has destabilized the steep, lower portion of the slope. Based on our review of tide charts and storm events and the timing of the 2014 slope failure, it is our opinion that the severe storm events and high tides during those storm events in the first few weeks of November and December significantly eroded the base of the slope and the slope around the lower two concrete stairway platforms. The 2014 wave and slide activity has resulted in the separation of the second pier from the lower portion of the staircase. We anticipate that continued slope movement will cause further damage to the lower portions of the staircase. We also observed that recent slope movement has caused many trees to fall throughout the slide area.

Based on the results of our site reconnaissance, it is our opinion that the recent slope failure and landsliding will likely continue in the short and long term (i.e., within 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 recently observed separation of the stairs 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. It is our opinion that an alternate route to the beach could be assessed during drier weather conditions in 2015. Additional slope evaluations should also be conducted when the tides allow for beach access.

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 the 2012 and 2014 landslides. 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

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.

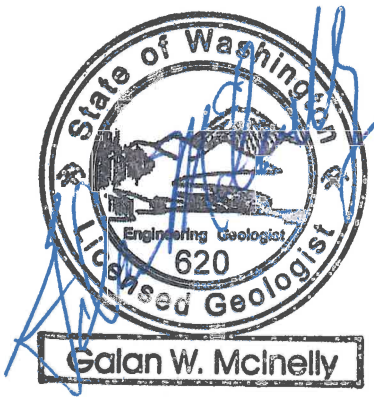
Shannon & Wilson, Inc., "Design Statement Regarding Branson Park Stairway," Burien, Washington, November 14, 2003.

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.



Eliya Hogan
Staff Geologist

Galan W. McInelly, LG, LEG
Principal

ERH:CRW:GWM:cam

List of Figures
Figure 1. Site Plan
Figures 2 through 7. Site Photographs

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

N W E S
50 0 50
Feet

Site Plan

Eagle Landing Landslide Evaluation
Burien, Washington

GEOENGINEERS

Figure 1

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Typical erosion and soil creep observed at the base of one of the stair concrete platforms.

File No. 03416-053-04

Site Photographs	
Eagle Landing Landslide Evaluation Burien, Washington	
GeoEngineers	Figure 2

Toe slope below second platform eroded by wave action with vertical cut of up to 3 feet.

Detached stair at the second platform from the bottom of the slope.

File No. 03416-053-04

Site Photographs	
Eagle Landing Landslide Evaluation Burien, Washington	
GeoEngineers	Figure 3

Approximate trace of ground crack. View facing southeast from the 2nd platform from the bottom.

Approximate location of 2014 ground crack intercepting 2012 landslide and 2002 debris chute area, near the southern end of the park property (orange dotted line outlines general north and south landslide limits, yellow dashed line is approximate trace of 2014 ground crack). View to the southeast.

Site Photographs	
Eagle Landing Landslide Evaluation Burien, Washington	
GEOENGINEERS	Figure 4

File No. 03416-053-04

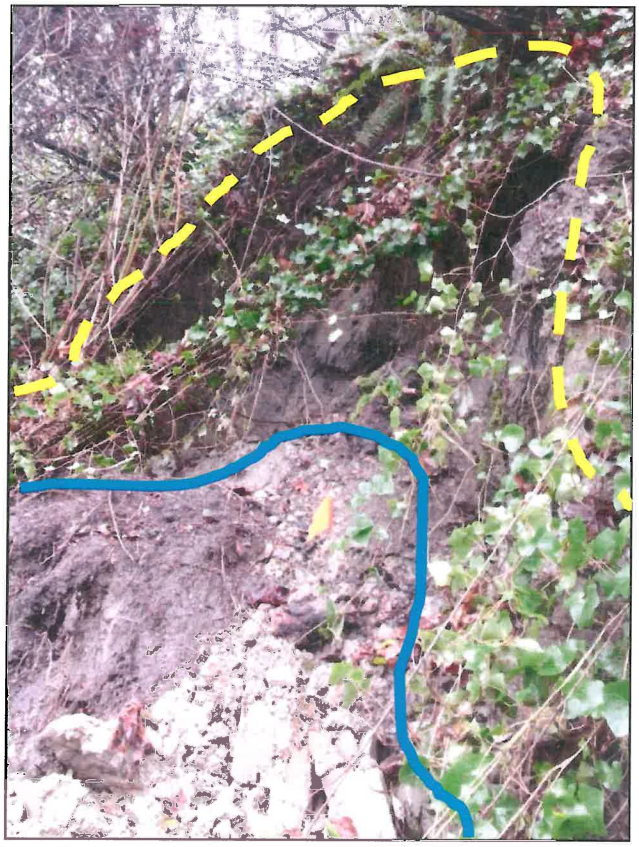
Observed ground crack approximately 1 foot wide and 4 feet deep.

Recently downed trees within slide. View facing west-northwest.

File No. 03416-053-04

Site Photographs	
Eagle Landing Landslide Evaluation Burien, Washington	
GeoEngineers	Figure 5

Seepage observed along clay layer exposed at base of slope, in 2012 landslide runout area.



Recent movement and sloughing of headscarp of 2012 landslide. Note fresh piles of soil (outlined in blue) and lack of vegetation growing on the vertical scarp. Scarp (outlined in yellow) is estimated between 10 to 15 feet in height.

Site Photographs

Eagle Landing Landslide Evaluation
Burien, Washington

GeoEngineers

Figure 6

File No. 03416-053-04

Older slumps above 2012 Landslide area (outlined in white). View facing northwest.

File No. 03416-053-04

Site Photographs	
Eagle Landing Landslide Evaluation Burien, Washington	
GeoEngineers	Figure 7