GeoEngineers
17425 NE Union Hill Road, Suite 250
Redmond, Washington 98052
425.861.6000

June 4, 2018

City of Burien
400 SW 152nd Street, Suite 300
Burien, Washington 98166-1957

Attention: Maiya Andrews, PE
Public Works Director

Subject: 2018 Eagle Landing Park Stairway Assessment
Burien, Washington
File No. 3416-053-09

INTRODUCTION AND SCOPE

This letter report summarizes our site reconnaissance on March 15, 2018 to evaluate a west-facing slope located along the shoreline of the Puget Sound in Eagle Landing Park in Burien, Washington. We visited the site at the request of Maiya Andrews with the City of Burien Public Works Department. The purpose of our reconnaissance was to re-assess safety considerations for a closed public staircase leading down the slope to the shoreline (Figure 1).

We previously prepared a memorandum dated January 5, 2015 and letter reports dated August 14, 2015 and July 12, 2016 in which we summarized our reconnaissance of the slope and shoreline to document landslide activity and assessed the closure of the stairway for public use. In the 2015 reports we observed that the slope movement had significantly affected the landings located closest to the beach and had caused one of the lower landings to fail entirely. We recommended closure of the stairs due to public safety considerations in the January 2015 report. We recommended removal of the lower three flights of stairs and lower two landings in the August 2015 report. In our July 2016 report we recommended removing all flights of stairs downslope of Landing 6 (see Figure 2).

We understand that there has been a continued desire by some users to access the shoreline using the stairs, or to at least have partial access to the stairs for exercise. All measures to keep the public out of the area have been bypassed and an unauthorized, non-standard “trail” has been developed down the steep slope that may represent a liability to the city. The trail has been used by members of the public, despite the warning signs and fencing that was put in place following the stair closure.

SCOPE OF WORK

Our scope of work was as follows:

1. Review our previous reports on Eagle Landing Park, particularly our January 2015, August 2015 and July 2016 documents that focused on the stairway safety.
2. Complete a brief surface reconnaissance to observe ground surface condition for indications of recent slope movement and trees that are, or may become, susceptible to toppling onto the stairway or affect a landing foundation as a result of the continuing slope movement. We also identified trees that, due to proximity to the stairway, growth habit and observed or potential declining health may represent a risk to the stairway and public safety, particularly in conjunction with potential slope movement.
3. Prepare this letter documenting our observations and opinions regarding tree toppling and the stability of the stairway with respect to slope movement that has occurred from the time that we provided our July 2016 letter.

BACKGROUND AND DOCUMENT REVIEW

GeoEngineers, Inc. (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.

GeoEngineers, Inc., January 2015. Memorandum, Eagle Landing Landslide Evaluation, Burien, Washington.

GeoEngineers, Inc., August 2015. Letter Report, Eagle Landing May 2015 Site Visit, Burien, Washington.

GeoEngineers, Inc., 2016 Letter Report. Eagle Landing Stairway Evaluation, Burien, Washington.

SITE GEOLOGY

We reviewed a published geologic 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. 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 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 laminated silt interbeds near the base of and within the glacial advance outwash mapped in the area.

SITE RECONNAISSANCE



Photograph 1. View of Top of Stairway with Discarded Fencing Downslope

We completed a site reconnaissance at Eagle Landing Park on March 15, 2018 to evaluate the slope conditions near the stairway and the foundations of the stairway landings, particularly near lower sections of the stairs (see Figure 2, Site Map). Cody Gibson and Craig Erdman of GeoEngineers conducted the site visit to evaluate changes in the slope indicative of slope movement, observe the condition of the foundation support of the landings, identify any trees that pose a threat of toppling onto the stairway and evaluate the risk to public safety along the stairs and slope.

As we approached the crest of the slope where the stairway begins, we observed the warning signage placed by the City along with the discarded fencing that had been placed to limit access to the stairs. The fencing had been thrown to the side of the stairs and no longer limits access to the start of the stairway. An unauthorized trail is present along the north side of the stairway that followed along the stairway for the first two landings. In addition to the vertical fencing at the top of the head of the stairs, trail users were also previously restricted from using the upper part of the stairs by fencing that had been placed over the top of the stairs. This fencing has also been discarded over the railings and the stairway is entirely accessible.

We observed no indication of significant slope movement adjacent to the stairs along the upper approximate three-quarters of the stairway and landings. Where exposed, the length of exposed pipe piles supporting the foundations we observed at the landings was typically less than about 6 inches in height. This is consistent with the observations in our previous 2016 site visit, where erosion and creep had exposed up to about 6 inches below portions of the upper landings.



Photograph 2. View of landslide undermining Landing 9

The 2014 landslide now located adjacent and downslope of Landings 9 and 10 has continued to expand both up hill and laterally across the slope. This is shown as the landslide undermining Landings 9 and 10 in Figure 2. The slope erosion and slope movement are significantly undermining Landing 9 and has encroached on Landing 10 as the landslide enlarged both upslope and widened laterally north. The landslide movement caused a 14- to

18-inch-diameter red cedar to topple in 2016, exposing the underlying soil and accelerating the local rate of erosion. Based on review of previous photographs, a tree near the toe of the landslide has toppled, close to the previously toppled red cedar.

We identified 12 trees, both deciduous and evergreen, that pose significant risk of toppling onto the landings or stairway spans. The trees range in size from 14 inches to greater than 30 inches DBH (diameter at breast height) and are summarized in Table 1 and shown in Figure 2.

TABLE 1. SUMMARY OF POTENTIAL HAZARD TREES

Tree Number	Tree Type and Size (DBH)	Potential Point of Impact
1	Big Leaf Maple, ~30" DBH	Landing 5
2, 3	Alder, ~12 to 14" DBH	Landings 5, 6 and stairs
4	Alder, ~30" DBH	Landings 8, 9 and stairs
5, 6, 7	Alder, ~12-16" DBH	Landings 6, 7, 8 and stairs
8	Alder, ~30" DBH	Landings 7, 8 and stairs
9	Red Cedar, ~30" DBH	Landings 7, 8, 9 and stairs
10	Big Leaf Maple, ~36" DBH	Landing 8, 9 and stairs
11	Alder, ~30" DBH	Landing 9
12	Alder, 16" DBH	Stairway between Landings 7 and 8

DISCUSSION AND CONCLUSIONS

General

Based on our review of available information and our site reconnaissance, it is our opinion that portions of the stairway have presently not been affected by slope movement associated with the 2012 landslide (Eagle Landing Tree Landslide in Figure 2). However, the 2014 landslide, adjacent to Landings 9 and 10, is directly impacting the stability of Landings 9 and 10. The landslide is undermining the concrete landings and has exposed more than 18 inches of the supporting pipe piles. It is likely that movement and enlargement of the landslide will continue, with possible additional impacts to the stairway. In addition, slope movement can result in the tilting and toppling of trees that could impact the users of the stairway.



Photograph 3. View of recent tree topple below Landings 9 and 10

The trees listed in Table 1 have been identified as hazardous or potentially hazardous to the stairway as well as users. Hazard trees were identified based on 1) potential for falling onto the stairs because of slope movement, soil creep and/or erosion; or 2) trees leaning toward the stairway or landings because of growth habit (e.g. most of the alders grow towards the light), and that present a potential hazard to the stairway or

users due to size, age and/or indications of decay. Several trees had pistol-butted trunks and signs of wood rot, while other trees observed had no pistol butting but were still inclined downslope towards the stairway. Two of the trees we evaluated during our site visit were included in our 2016 Eagle Landing Evaluation memo and are numbered 9 and 10 on Figure 2.

To reduce risk to trail users from tree fall and other slope/landslide related hazards, and fall hazards related to the existing stairway system, we recommend that the landings and stairways be demolished and removed from the slope. We recommend that the City further discourage pioneering of trails down the slope to reduce the potential for slips, trips and falls on improperly formed trails. We recommend that the City consider taking the following additional actions to reduce hazards to public safety:

- Installing permanent chain link fencing to discourage the public from accessing the stairway, the stairway corridor and the slope.
- Place signage describing the specific hazards such as risk from potential tree fall, sharp drop-offs, steep and slippery slopes and from landslide activity.
- In the interim, 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. We also recommend that you retain an arborist to evaluate the potentially hazardous trees we have identified. The arborist should also evaluate the health of other trees within toppling distance of the stairways.

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 landslides that occurred in 2012 and 2014 that continue to show activity as well as the potential for future slope movements that could affect the public. Our recommendations are general in nature and are intended to provide guidance to further understand 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., 2016. "Letter Report. Eagle Landing Stairway Evaluation, Burien, Washington." Prepared for the City of Burien Public Works Department. File No. 3416-053-08. Dated July 12, 2016.

GeoEngineers, Inc., 2015a. Letter Report, Eagle Landing May 2015 Site Visit, Burien, Washington." Prepared for the City of Burien Public Works Department. File No. 3416-053-05. Dated August 14, 2015.

GeoEngineers, Inc., 2015b. "Memorandum, Eagle Landing Landslide Evaluation, Burien, Washington." Prepared for the City of Burien Public Works Department. File No. 3416-053-04. Dated January 5, 2015.

GeoEngineers, Inc., 2013. "Letter Report, Eagle Landing Landslide Evaluation, Burien, Washington." Prepared for the City of Burien Public Works Department. File No. 3416-053-00. Dated March 13, 2013.

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

Shannon & Wilson, Inc., 2002. "Evaluation of Mass Wasting, Branson Property, Burien, Washington." Prepared for the City of Burien. Dated March 18, 2002.

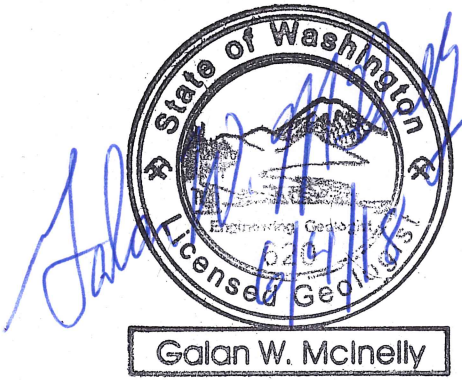
Shannon & Wilson, Inc., "Design Statement Regarding Branson Park Stairway, Burien, Washington." Prepared for the City of Burien. Dated November 14, 2003.

Shannon & Wilson, Inc., "Geotechnical Report, Branson Park, Burien, Washington." Prepared for the City of Burien. Dated 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.



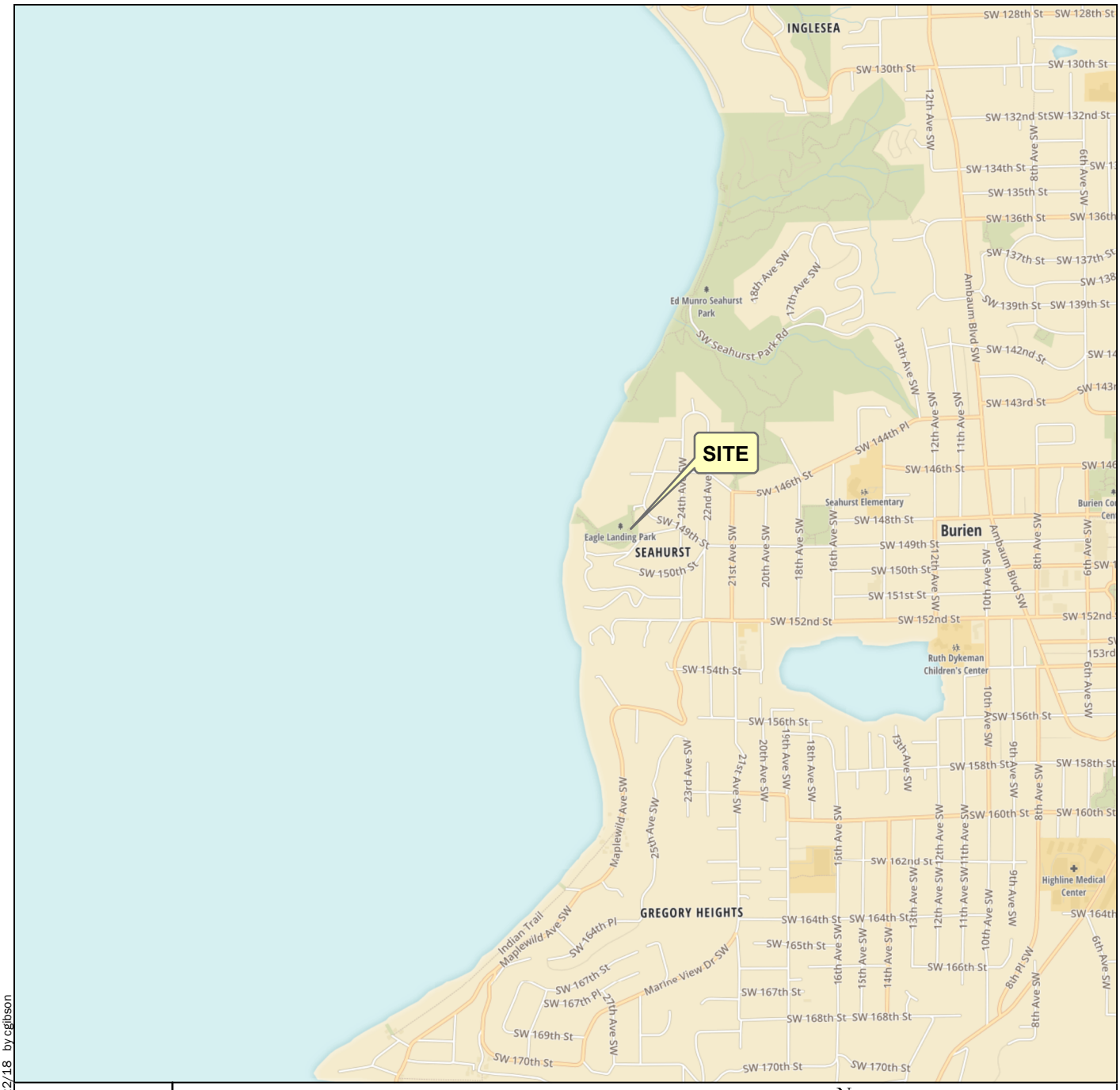
Cody R. Gibson
Staff Geologist

Galan W. McInelly, LG, LEG
Principal

CRG:CFE:GWM:cam

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Feet

Vicinity Map

2018 Eagle Landing Park Stairway Assessment
Burien, Washington

GeoEngineers

Figure 1

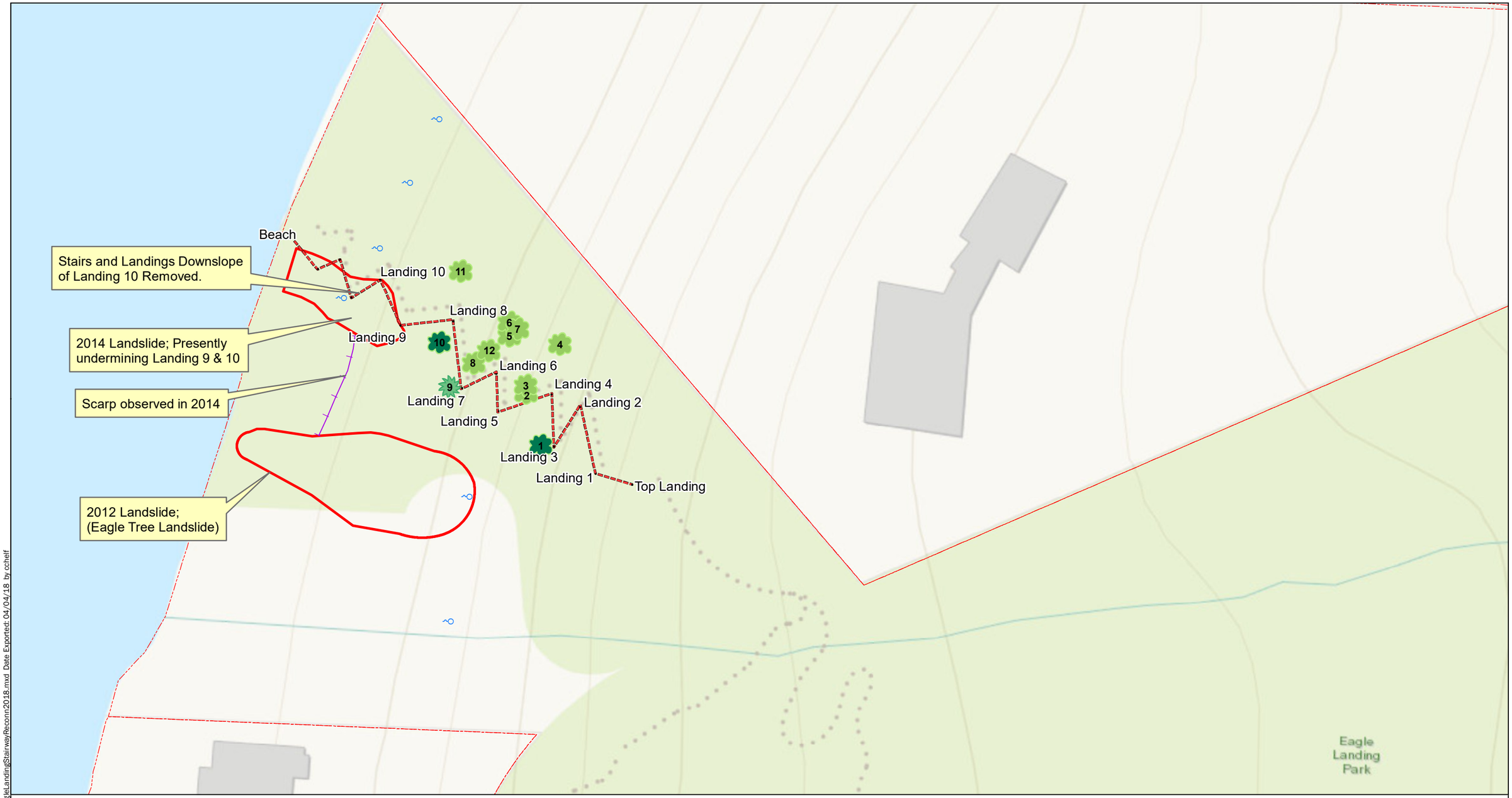
Notes:

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.

Data Source: Mapbox Open Street Map, 2016

Projection: NAD 1983 UTM Zone 10N

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Data Source: Contours from Burien Elevation Model (201X); 1:24K Geology from Washington Department of Natural Resources (201X); Field points from GeoEngineers Site Visit 2016-03-23

Projection: NAD 1983 2011 StatePlane Washington North FIPS 4601 Ft US

Legend

- Seepage
- Approximate Stair Location
- Parcel Boundary
- Landslide

Trees

- Deciduous - Alder
- Deciduous - Big Leaf Maple
- Evergreen

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Feet

Site Plan

2018 Eagle Landing Park Stairway Assessment
Burien, Washington

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Figure 2

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