Earth Solutions NW LLC

• Geotechnical Engineering
• Construction Monitoring
• Environmental Sciences

August 4, 2015
Revised October 2, 2015
ES-2953.03

Polygon Northwest Company
PO Box 1349
Bellevue, Washington 98009

Attention: Mr. Richard Rawlings

Subject: Critical Areas Study
Westridge South
Northeast Discovery Drive and
7th Avenue Northeast
Issaquah, Washington

Reference: City of Issaquah
Review Comments
Dated September 8, 2015

Permit No. PP14-00002

Earth Solutions NW, LLC
Geotechnical Engineering Study
Microsoft Property
Issaquah, Washington
ES-2953.01, dated March 11, 2014

Core Design
Westridge South
Preliminary Site Plan, Sheet 4

Shannon & Wilson
Peer Review of
Issaquah Highlands Stormwater Infiltration Analysis
Project No. 21-1-20067-001, dated August 5, 2004

Dear Mr. Rawlings:

Subsequent to receiving the referenced City of Issaquah and third party review (AMEC), Earth Solutions NW, LLC (ESNW) has prepared this critical areas study (CAS) for the subject project.

ESNW reviewed geologic maps for the region and a client provided topographical survey and conducted explorations on the subject site as part of preparing this document. Site exploration included drilling, logging and sampling one boring at the site to correlate conditions to published resources, a reconnaissance of the site and the adjacent slopes, slope stability analyses and preparation of this report.

Project Description

The subject site is located on the southwest corner of the intersection between Northeast Discovery Drive and 7th Avenue Northeast in the Highlands area of Issaquah, Washington. A vicinity map is provided on Plate 1 illustrating the general site location.

The current surface conditions are the result of past grading on the site completed as part of the overall Issaquah Highlands development project. The result of the grading created a stormwater retention pond located through the main north-south central axis of the site and level areas that are used as walking trails, utility access and other minor uses. Grading resulted in a berm feature that extends along the entire western and southern property limits and ranges in height up to about ten feet.

A new residential development is planned for the site in the area that includes the existing stormwater pond. Grading will consist of backfilling the current stormwater pond and rough grading to create level building pad areas. Based on review of the referenced plans, the grading will largely follow the existing topography using minor cuts and fills, generally less than about six feet. Low rockeries and landscape retaining walls will be used across the site to accommodate the grade changes. Rockeries will be utilized along portions of the western and southern project limits to accommodate the grade change. The majority of the rockeries will be constructed against cuts made as part of reconfiguring the existing berm feature located to the west and south of the current pond location to create building lots. This grading activity will create level building areas for the single-family residences and associated improvements, including lots 20 through 49 that are located adjacent to the descending slopes bordering the site to the west and south. Grading adjacent to the top of the slopes will generally consist of cuts that will be faced with rockeries.

The site plan illustrated on the referenced site plan was developed to generally conform with surrounding residential projects in terms of configuration and traffic flow, and applicable development code requirements. Particular attention was paid to protecting the surrounding steep slopes from runoff generated from the project site. The majority of the existing grades around the western and southern perimeter portions of the project will be lowered and faced with rockeries. This configuration will effectively reduce or largely mitigate additional loading at the top of the steep slopes and reduce the potential for runoff to flow over these sensitive areas. This approach will maintain the stability along the steep slopes located adjacent to the project by effectively separating the development area from the natural slope. The current proposal will not disturb areas that meet the criteria for steep slope hazards as defined by City of Issaquah development code.

Grading plans reviewed indicate that for Lots 21 through about Lot 29, a rockery will be constructed along native cuts and reinforced fill up to about 10 feet in height along the western property boundary. From about Lots 30 through 40, a cut rockery about five feet in height will be constructed along the slope-side boundary. For Lots 41 through 49, lot grading will include cuts and fills of about five feet or less used to construct the building pads. General structural fill will be used to grade out the remainder of the pads for Lots 21 through 49. Final grading plans were not available; however, provided the recommendations in this report are followed, in our opinion, the proposed project will not increase the potential for instability along the adjacent slopes

Site History

The subject site is part of the Issaquah Highlands planned community development project. Around 2002, grading commenced in this parcel in support of the larger project. In January 2004, a debris-flow landslide event occurred above Camp Creek. We reviewed the referenced peer review of the Stormwater Infiltration Analysis White Paper prepared by Shannon & Wilson dated August 5, 2004. This document provided a historical description of the Camp Creek area and offered analysis and comments related to the cause, mode and stabilization of the Camp Creek slide area. The reader is referred to this document for a comprehensive discussion of the Camp Creek slide. For the purpose of this CAS, it is acknowledged that there was a significant slide event in the Camp Creek area. This area has been stabilized using quarry spalls and is currently stable.

Around 2009 a stormwater retention pond was constructed that is illustrated on the aerial photograph attached as Plate 2.

Since the 2004 landside event, we are unaware of additional landslide activity in this area or areas adjacent to the subject property. The remaining slope areas surrounding the Camp Creek slide were stable at the time of our site reconnaissance.

Subsurface Conditions

ESNW was on-site May 6, 2015 to observe and log a boring in the area described as Lot 38 on the site plan. The approximate location of the boring is shown on the attached Preliminary Site Plan prepared by Core Design. The boring was advanced along the crest of the steep slope using a drill rig and operator retained by ESNW. The boring was advanced to a depth of 41.5 feet. Based on our past experience in the area, and data acquired through subsurface exploration (borings) the soil conditions comprising the slope consist of medium dense to dense silty sand with gravel (Unified Soil Classification, SM) transitioning to firm sand and gravel deposits. The log of the boring is attached. Site access constraints largely controlled the number and location of the exploration program. From an engineering standpoint, the soil that comprises this slope complex is comprised largely of granular soils consistent with outwash/alluvial fan deposits. We reviewed a boring log prepared by Terra Associates, Inc. for the Microsoft Corporation as a supplement to our exploration. Log B-401 was advanced to a depth of 220 feet in March 2005 as part of an infiltration evaluation. This exploration reported dense to very dense sand and gravel extending to the full depth. A thin layer of dense to very dense sandy silt was reported at a depth of about 140 feet below existing grade (+/- 440 feet).

Very light groundwater seepage was observed at a depth of 25 feet below the existing surface elevation at the boring location completed by our firm. In our opinion, this seepage does not represent a chronic or established groundwater zone, rather it is considered isolated and incidental. While flow volumes may increase in this zone during the winter/spring seasons, we do not anticipate this condition will decrease stability of the slope area.

Geologic Map designation for the area describes older outwash deposits (Qvr2). This soil unit is the second oldest (Pleistocene-aged) within a five-unit classification scheme and was deposited from an alluvial fan associated with ancient Lake Snoqualmie and surrounding drainage regimes. This soil unit extends from about 0.5 mile east through the site to about 0.5 mile to the west of Southeast Issaquah-Fall City Road. This soil unit was over-ridden by glacial ice sheets and is exposed in near-vertical cuts exposed within the commercial gravel mining operation adjacent to the site. For this reason, apparent cohesion is most-likely present to some degree within this soil unit, or the apparent internal angle of friction is higher than typical for this soil type. A well-known document titled "Geotechnical Properties of Geologic Units", Koloski, et al 1989 assigns a cohesion value of up to 1,000 psf to outwash soil deposits (Table 5) for Puget Sound soils. This correlates well with the exposed near-vertical excavation slopes made within the commercial aggregate business located just to the west within the same deposit material.

Steep Slope Visual Site Reconnaissance

ESNW representatives conducted a visual site reconnaissance on May 15 and July 27, 2015 of the steep slope areas located surrounding the proposed development envelope, including but not limited to the Camp Creek slide area. The Camp Creek slide area about half way down the slope. The slide occurred on January 30, 2004 and is discussed in more depth with the Site History section of this CAS. We traversed the area above, around and within the slide area to observe current conditions. During the site reconnaissance, we looked for signs of mode of the failure, age and whether recent slide activity has occurred. Based on the visual site reconnaissance, the slide appears to be relatively shallow, similar to a debris-flow type failure. The topography around this feature is quite steep but appears stable with the majority of the mature fir trees showing little to no signs of soil creep such as arched trunks and the surface consists primarily of native groundcover. Large gravels were common along the forested slope surface which is indicative of typical outwash deposits.

The exposed portion of the slide area appears over-steepened due to small-scale soil loss as the area achieves the natural angle of repose, but no signs of further activity such as deep-seated rotational failure or large skin-slide movements were observed. Evidence of soil loss included void areas below protective mesh that was staked at the top and was likely installed soon after the initial landslide to protect the ground cover just above and along the top of the slide area. Much of the surface below the crest of the slide area appears well-vegetated with low-growing bushes and saplings. Vegetation is dense along the lower flanks of the slide area and decreases toward the upper area where a combination of steeper slope and raveling of the sandy soil occurs. No obvious evidence of groundwater seeps were observed during our reconnaissance.

Based on review of the referenced peer review document, the slide occurred primarily as a result of high-volume discharge flows within the lower Camp Creek spring that progressed up the slope.

Based on the observations made during our reconnaissance, the slide area appears stable. The crest of the slide is over-steepened and some minor soil loss should be expected as this area achieves a steady-state slope configuration. However, this area, in the current configuration does not impact the proposed project from a stability standpoint. The natural slope areas that were not affected by the Camp Creek slide are considered stable with respect to landslide activity in the current configuration. Provided conditions such as surface water discharge and the conditions at the top of the slope remain largely unchanged, in our opinion, the steep slopes will remain stable. Based on the conditions observed during our slope reconnaissance, the stabilization elements (quarry spall blanket) are working favorably and no signs of excess movement were observed.

Slope Stability Assessment

Core Design prepared existing and post-grading slope sections through areas selected by ESNW to evaluate slope stability. Sections A-A through F-F are presented on the attached Section Exhibit. We did not evaluate Sections A-A and B-B for the post-construction conditions because these areas do not contain descending slopes or slopes that are considered potential landslide hazard areas due to lower slope gradients. Our analyses were therefore focused on Lots 27 through 49. Two primary modes of slope failure are most common in settings such as those found on the slopes adjacent to the subject property; shallow debris-flow and deep-seated block-slide failures. Our analyses evaluated both scenarios in terms of calculated FOS and likelihood of occurrence. To determine appropriate soil strength parameters, we modeled the existing slope to determine the requirements to achieve a FOS of 1.0 in a static condition (actual calculated minimum FOS was 1.128). This approach provides a realistic approach to model slope stability where exhaustive exploration is either not possible or not practical. These soil parameters are provided below. We then viewed the calculated slip surfaces to gain insight into the more likely mode of failure (shallow versus deeper) and how this relates to the buffer/setback configuration that is currently being proposed. ESNW evaluated the stability of the slopes bordering the site using the SlopeW computer program. Slope inclination was based on topographic data provided by Core. The slope stability output is attached. With respect to geologic cross-sections, for this slope the sections provided in the SlopeW output sufficiently describe the soil and groundwater conditions comprising the adjacent slopes from a geotechnical engineering standpoint. The analysis through section D-D does not include the quarry spall blanket that is present along the vast majority of the Camp Creek slide area as part of the stabilization efforts. This component provides added stability of the affected area.

Soil strength parameters were developed based on the soil conditions observed in the boring, the current inclination of the slope and the lack of indications of chronic or pervasive deep-seated failure and the 2010 WSDOT Geotechnical Design Manual Chapter 6.4.3.1 recommended design parameters for seismic analysis of slope stability. Review of a boring completed near the subject site but within the same general depositional environment suggests the slope is comprised of a fairly uniform sequence of deltaic alluvial sand/gravel to a depth of about 220 feet below existing grade at the top of the slope. It is important to recognize that structural improvements such as single-family residences and associated structures are light (typically equivalent to two feet of soil) and do not impose significantly increased loading of soils at depth. The geologic cross-sections are included on each of the SlopeW output sheets that were requested by the third-party reviewer. This is reinforced when comparing the existing and post-construction calculated factor of safety values for sections D-D through F-F. The surcharge has no effect on the overall global stability of the adjacent slope. Following are the design parameters used in the analysis:

Soil	Coefficient of Friction	Cohesion
Weathered sand/gravel	34°	100 psf
GP-GM (dense)	40°	300 psf

The soil strength parameters that were developed for the static conditions were then used to evaluate the seismic conditions. The design peak ground acceleration (PGA) of 0.44g was determined using the USGS on-line seismic design mapping software. A horizontal pseudo-static coefficient of 0.22g, which equates to one-half of the design PGA was used to model the slope stability (Kramer 1996). We estimate the pseudo-static yield acceleration for this slope complex is about 0.2g. The slip surface areas were defined using available topographic information and considered the impact that the proposed development will have on the existing slope. Because the proposed project will include removing soil from the top of the steep slopes across much of the western and southern margins, the net increase in soil loading will be insignificant. Furthermore, because the project will be designed to protect the slopes from water flowing over the slope and collecting/conveying drains from buildings, roads and retaining walls/rockeries, slope stability modeling of existing conditions is appropriate. The landslide activity that has been documented along the adjacent steep slopes was primarily related to water flow and/or malfunctioning stormwater facilities; both conditions were located at the toe of the slopes. The stormwater pond located on the subject site will be filled and stormwater will be collected and conveyed to an approved system, which will remove this potential water source from the steep slopes. We are unaware of landslide activity that has initiated from the upper slope regions of this complex. Therefore, in our opinion, the extent of slope stability modeling that was completed is adequate to assess the stability of this area.

The internal angle of friction used for our analysis is based partly on existing slope angle of repose. Based on topographic information provided on the Core site plan, the slope is generally inclined at an angle of between about 30 to 33 degrees. However, the slope is stable. The Camp Creek slide area appears stable and we are unaware of landslide activity since the January 2004 slide and this area is much steeper than the surrounding slope. Therefore, our approach was to apply soil parameters that resulted in acceptable factor-of-safety calculations and apply them to the current stability analysis. In this respect, while the internal angle of friction value used for analysis is higher than average, it reflects the stability of the system assessed and in our opinion, is valid. The table below provides calculated FOS values for the sections we evaluated.

Section	FOS Existing Static	FOS Existing Seismic	Post Const. Static	Post Const. Seismic	Comments
A-A	5.461	2.311	n/a*	n/a*	
B-B	4.383	1.795	n/a*	n/a*	
C-C	2.750	1.624	3.139	1.848	
D-D	1.564	1.054	1.724	1.142	
E-E	1.857	1.201	1.857	1.201	
F-F	1.857	1.201	1.857	1.201	

(*indicates conditions where existing FOS values are sufficiently high such that post-construction analysis is not needed)

The analysis suggests that the steeper sloped areas are stable in a static condition. The analysis indicates that shallow debris-flow type failures are more common on this slope complex which is expected. Section D-D had the lowest static calculated FOS (1.564); however this critical failure surface was very shallow. When we looked at the failure plane through the proposed buffer and building setback, the calculated FOS increased. This type of failure mechanism is often related to natural weathering and excess water in the form of shallow interflow and/or surface flow. The analysis also indicates that the proposal, including the reduced buffer of 10 feet will not increase the potential for slope instability. In our opinion, this should be the primary criteria for evaluating a proposal because while there may be variations in the soil and groundwater information used for analysis in terms of a relatively homogenous slope complex, all things being equal, if a proposed configuration does not lower the calculated factor of safety, it should not pose an increased threat of instability on the areas evaluated. The information we reviewed regarding the soil and groundwater conditions within or near the subject property suggest that the slope is comprised of a fairly uniform sequence of ancient deltaic granular deposits.

The results of our stability analyses indicate the development proposal will not decrease the existing stability of the adjacent slopes and in fact in most cases will increase the stability. Given the drainage improvements that will be incorporated into the development, in our opinion, the existing stability of the slopes will be enhanced by the collection and redirection of stormwater away from the slope. Furthermore, the proposed grading plan indicates existing grades near the majority of the steep slope areas will be lowered. This will result in little to no increase in loading of the steep slope areas and in this respect, the inherent stability of the steep slopes will be maintained. The analysis also indicates that calculated factors-of-safety along the reduced buffers will be higher than existing conditions.

When interpreting slope stability analyses, in our opinion, it is important to understand the limitations of the analytical tools and how the analysis relates to actual site conditions. In our experience, analytical software can produce results that do not reflect actual site conditions and in some instances, it is better to use the analytical software as a tool or component for evaluation not the sole determination of effects on stability.

In this case, while there have been recorded landslides along the adjacent slopes, the most recent Camp Creek slide was due in large part to malfunctions within drainage structures and non-natural system inputs (stormwater infiltration). In the natural condition, this slope is stable. The surface indicators as discussed in this report suggest that the slope is largely in a steady-state condition with respect to slope configuration.

Groundwater was observed at our boring location and was noted as incidental. While we would expect higher flow volumes to occur during the wetter winter season, in our opinion it is unlikely that natural groundwater flows would cause instability similar to those that were present during the Camp Creek failure.

Landslide Hazard Areas (Section 22)

There are slopes surrounding the property that contain areas that meet the criteria for landslide hazard, i.e. those areas that are inclined at least 40 percent and where springs are known to exist. However, the proposed project includes design elements that will result in insignificant potential impacts to the landslide hazard areas. These elements include removing a potential subsurface water source by filling the existing stormwater pond, modifying surface water flow patterns such that the slopes are protected and largely reducing the loading configuration of the top of the steep slopes by lowering grades. Therefore, in our opinion, the proposed project will not increase the potential for instability along the descending slopes adjacent to the site.

Landslide Hazard Area Buffer

In our opinion, standard lot setbacks can be applied to Lots 21 through 37 without an additional buffer. Based on review of the site plan, building pads for Lots 41 through 49 will be biased toward the frontage and will provide a backyard setback in excess of 25 feet. This is acceptable from a geotechnical standpoint. The calculated factor of safety for this setback meets accepted minimum criteria (FOS of at least 1.5).

Seismic Hazard Areas (Section 23)

The risk of seismic hazards on the subject site is very low. The risk of seismic hazards on the adjacent slopes would most likely be in the form of seismically-induced landslide activity. The slope stability analyses included in this report indicate that there is no net increase in the potential for seismically-induced landslide activity on the adjacent steep slopes. In any case, no alterations are planned for the steep slopes or the buffer areas on this site. In this respect, the proposed project will not increase the potential for seismic hazard.

Steep Slope Buffer (Section 24A)

No grading activities are planned for steep slope hazard areas or the buffer areas as described in this section. In our opinion, provided the recommendations below are followed, the buffer can be reduced to 10 feet, with a building setback (BSBL) of 15 feet, for a total structure setback of 25 feet from the steep slopes located on Lots 37 through 49 as depicted on the Cross-Section detail on Slope Exhibit attached. The total setback of 25 feet should be measured horizontally from the edge of the foundation to the face of the slope. The lots located along the western site boundary (Lots 20 through 37) are sufficiently set back from steep slope and landslide hazard areas and will not require a buffer.

The following provisions must be complied with as a part of the project plans:

- Lots must be graded to direct or otherwise convey surface water away from the top of steep slopes.
- All water collected in drainage systems must discharged to an approved storm system.
- The applicable recommendations included in the referenced geotechnical engineering study must also be complied with.

Limited Exemptions (Section 24D)

There are some areas within the site that are inclined at 40 percent or greater and are less than 20 feet in height; however, these areas were created during past legal grading and as such are exempt from the general steep slope hazard development standards. These areas can be shown on a scaled site plan and where they meet the exemption standard.

Critical Area Functions and Values

The southern and western areas of the site are adjacent to steep slope areas. These areas are outside the development envelope and will remain intact, unaltered and protected from impacts associated with the proposed development. The proposed project scope includes construction of a residential development consistent with surrounding Issaquah Highland parcels. On this basis, the functions and values of these critical areas will not be impacted by the project plans.

Staged Slope Stability

Due to the proximity of steep slopes, we evaluated the stability of the existing conditions, considered construction conditions and modeled post-construction conditions.

The slope stability analyses provide an assessment of the existing conditions at various locations along the site margins (Sections A-A through E-E). It is acknowledged that these slopes are susceptible to shallow debris-flow type failures as part of natural weathering processes and this is discussed in detail in this critical areas study.

During mass grading activities, erosion control and surface water flow control will be critical. Water must not be allowed to flow over or pond above descending slope areas along the southern and western project margins. Performance of erosion and surface water flow controls must be monitored during grading to ensure the measures are functioning properly and modify measures where needed.

From a post-construction standpoint, final grades must ensure that surface water does not flow over, or pond above descending slopes. Drainage systems for the proposed structure must ensure water is conveyed away from the steep slopes adjacent to the project.

Provided the recommendations detailed in the referenced geotechnical report and this critical areas study are followed, in our opinion, the risk of potential instability along the adjacent slopes will not be increased.

The Protection Mechanisms that are detailed in IHDA Section 24 must be included in the site designs. The items listed in subsection b are addressed in the referenced geotechnical report prepared by ESNW. In any case, we should review the final grading plans to confirm the minimum protection mechanisms have been included.

We trust this report meets your current needs. If you have any questions, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

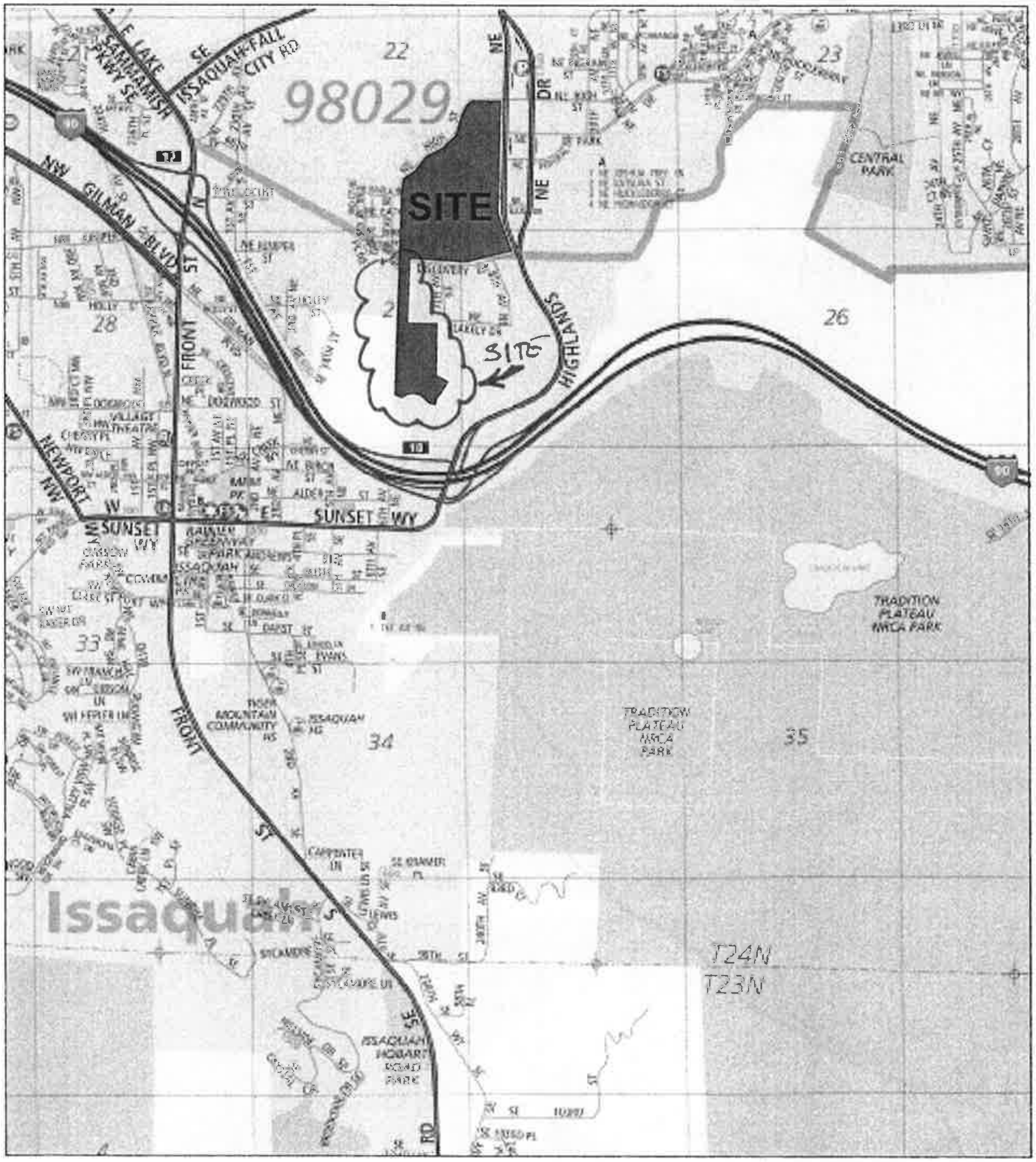
KYLE R. CAMPBELL
STATE OF WASHINGTON
27674
REGISTERED
PROFESSIONAL ENGINEER
10/2/15

Scott S. Riegel, L.G., L.E.G.
Project Manager

Kyle R. Campbell, P.E.
Principal

Attachments: Vicinity Map
Site Plan
Aerial Site Plan
Slope Exhibit/Site Plan (Core)
Section Exhibit (Core)
Boring Log, and
Slope W output

cc: Core Design
Attention: Mr. Gary Sharnbroich (Email only)



Reference:
King County, Washington
Map 628
By The Thomas Guide
Rand McNally
32nd Edition

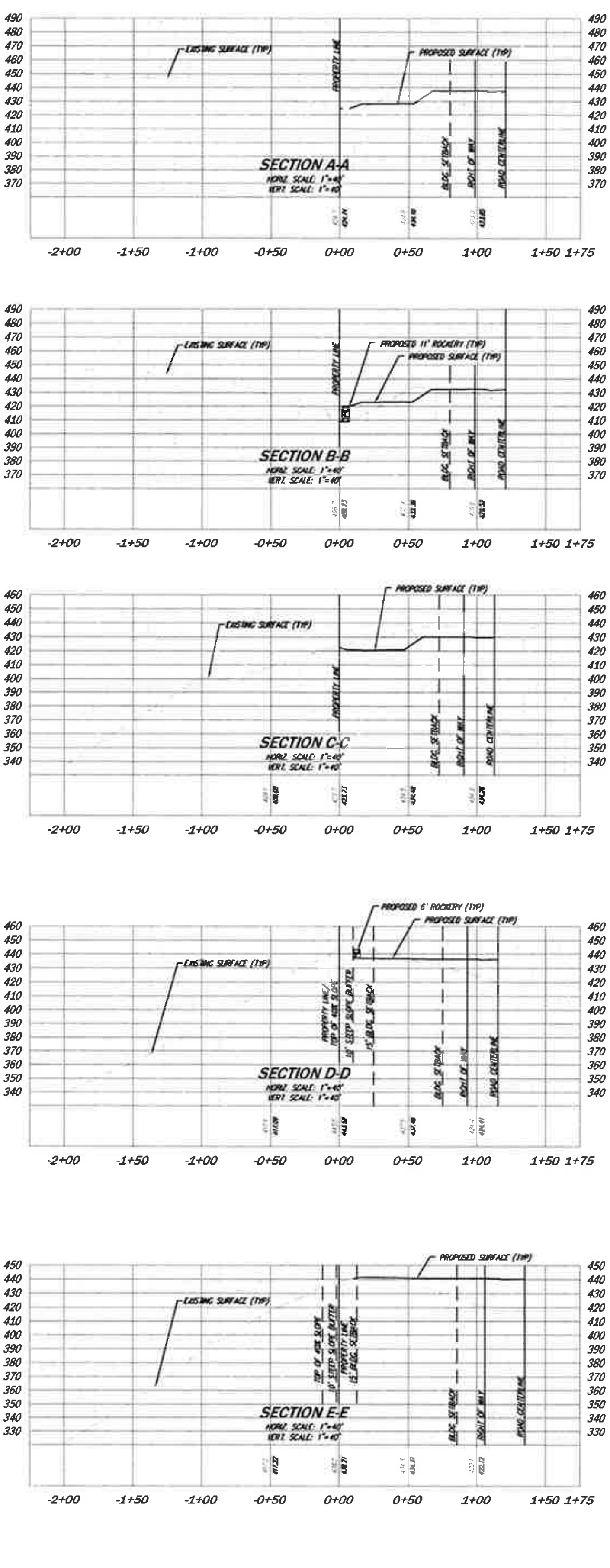
NORTH

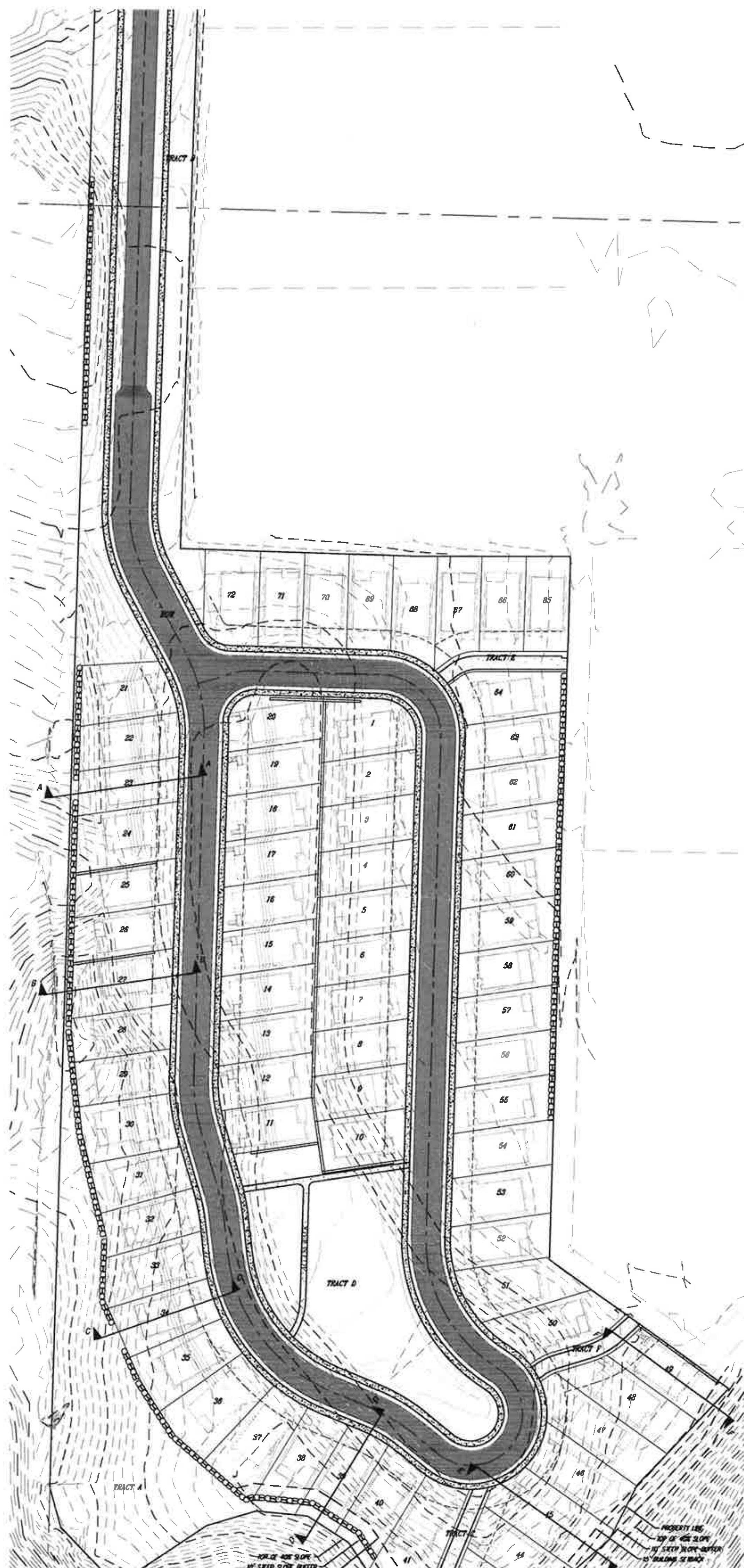
Earth Solutions NW LLC
Geotechnical Engineering, Construction Monitoring and Environmental Sciences

Vicinity Map
Microsoft Property
Issaquah, Washington

Drwn. GLS	Date 09/12/2013	Proj. No. 2953.01
Checked HTW	Date Sept. 2013	Plate 1

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.





WESTRIDGE SOUTH

CORE

ENGINEERING • PLANNING • SURVEYING

SEPTEMBER 18, 2015

1" = 40'

King County iMap

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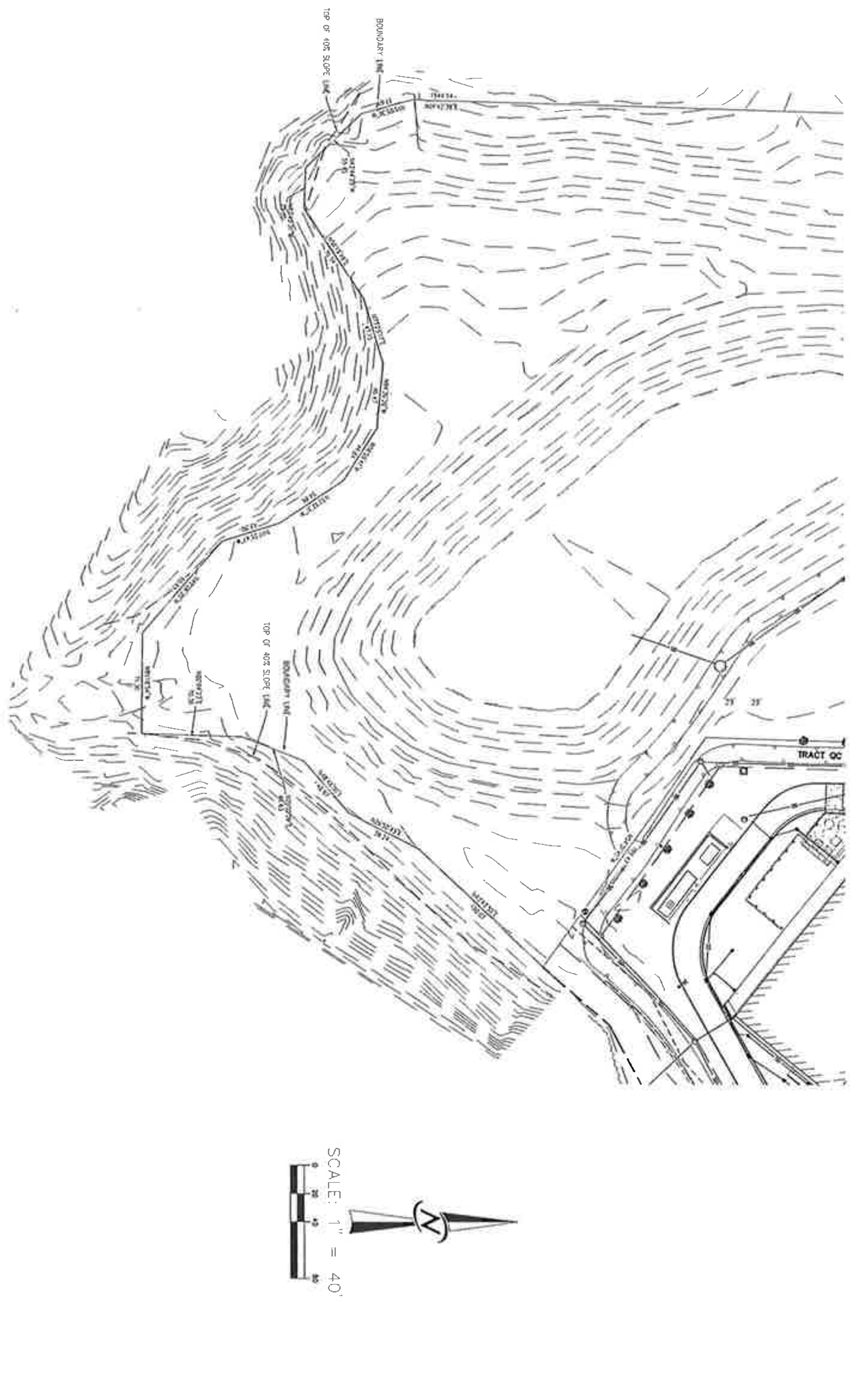
Date: 7/28/2015

Notes:

King County GIS CENTER

A PORTION OF THE NW 1/4 AND SW 1/4, SEC. 27, TWP. 24 N., RGE. 6 E., W.M.



DATE	JULY 2015
DESIGNED	
DRAWN	
APPROVED	GARY R. SHARNBROICH
GARY R. SHARNBROICH, P.E. PROJECT MANAGER	

PROJECT NUMBER 13128

SHEET OF

WESTRIDGE

POLYGON NORTHWEST
11624 SE 5TH STREET, SUITE 200
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ENGINEERING • PLANNING • SURVEYING

REVISIONS

Earth Solutions NWLLC

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

DUAL SYMBOLS are used to indicate borderline soil classifications.

The discussion in the text of this report is necessary for a proper understanding of the nature of the material presented in the attached logs.

Earth Solutions NW
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Telephone: 425-449-4704
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BORING NUMBER B-1

CLIENT Polygon NW
PROJECT NAME Westridge South
PROJECT NUMBER 2953.02
PROJECT LOCATION Issaquah, Washington
DATE STARTED 5/6/15 **COMPLETED** 5/6/15
GROUND ELEVATION 440 ft **HOLE SIZE**
DRILLING CONTRACTOR Geologic Drill
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING —
LOGGED BY SHA **CHECKED BY** SHA
AT END OF DRILLING —
NOTES
AFTER DRILLING —

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					TPSL		0.5 TOPSOIL 439.5
					SW-SM		Brown well graded SAND with silt and gravel, dense, moist
	SS	100	4-20-11 (31)	MC = 6.20%			
							4.0 436.0
5					SP		Brown poorly graded SAND with gravel, dense, moist
	SS	100	5-13-21 (34)	MC = 8.10%			
	SS	100	19-17-15 (32)	MC = 5.50%			
10	SS	100	9-7-7 (14)	MC = 4.60% Fines = 3.50%			11.0 429.0
					GP-GM		Brown poorly graded GRAVEL with silt and sand, medium dense, moist
15							-decreasing sand content and increased gravel content
20							

(Continued Next Page)

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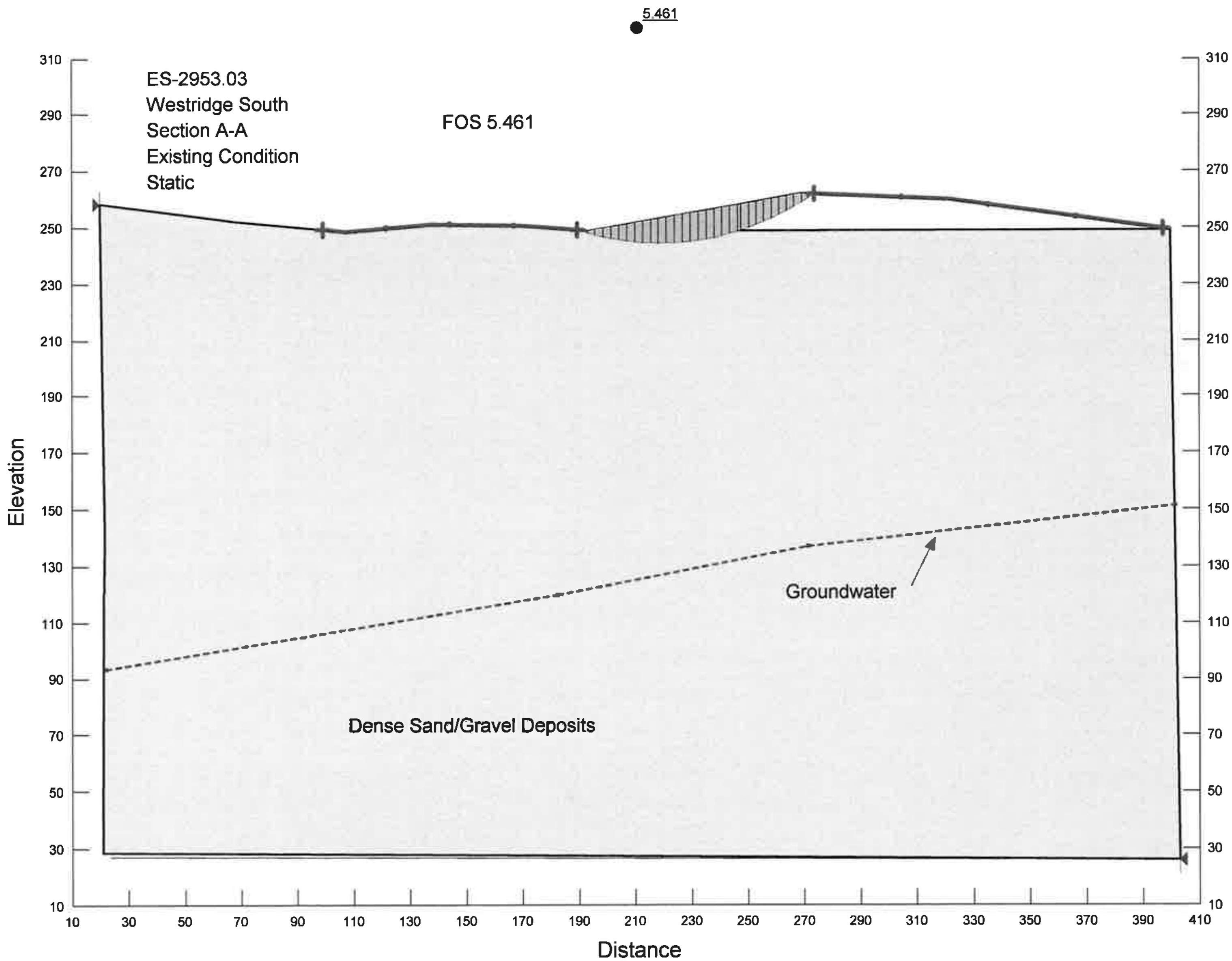
BORING NUMBER B-1

CLIENT Polygon NW | PROJECT NAME Westridge South
PROJECT NUMBER 2953.02 | PROJECT LOCATION Issaquah, Washington

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
20	SS	100	16-23-35 (58)	MC = 6.30%	GP-GM		Brown poorly graded GRAVEL with silt and sand, medium dense, moist *(continued)* -becomes dense
25	SS	100	9-11-14 (25)	MC = 6.70% Fines = 7.70%			
30	SS	100	8-13-14 (27)	MC = 7.20%			
35	SS	100	20-11-16 (27)	MC = 8.40%			
40	SS	100	9-12-16 (28)	MC = 8.00%			-becomes medium dense
41.5							398.5 Boring terminated at 41.5 feet below existing grade. Groundwater seepage encountered at 25.0 feet during drilling. Bottom of hole at 41.5 feet.


5.461
ES-2953.03
Westridge South
Section A-A
Existing Condition
Static
FOS 5.461
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance
310
290
270
250
230
210
190
170
150
130
110
90
70
50
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10
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30
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70
90
110
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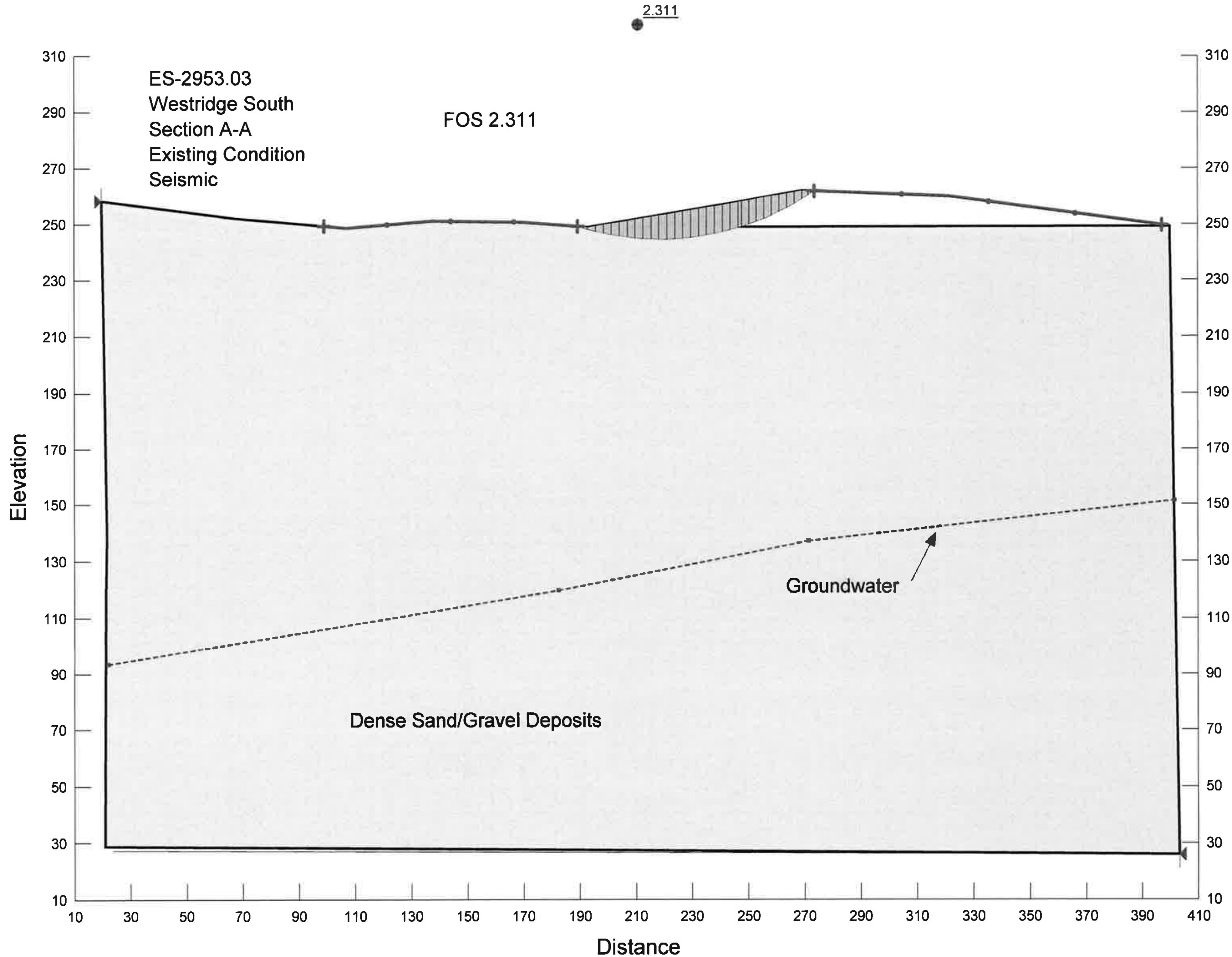
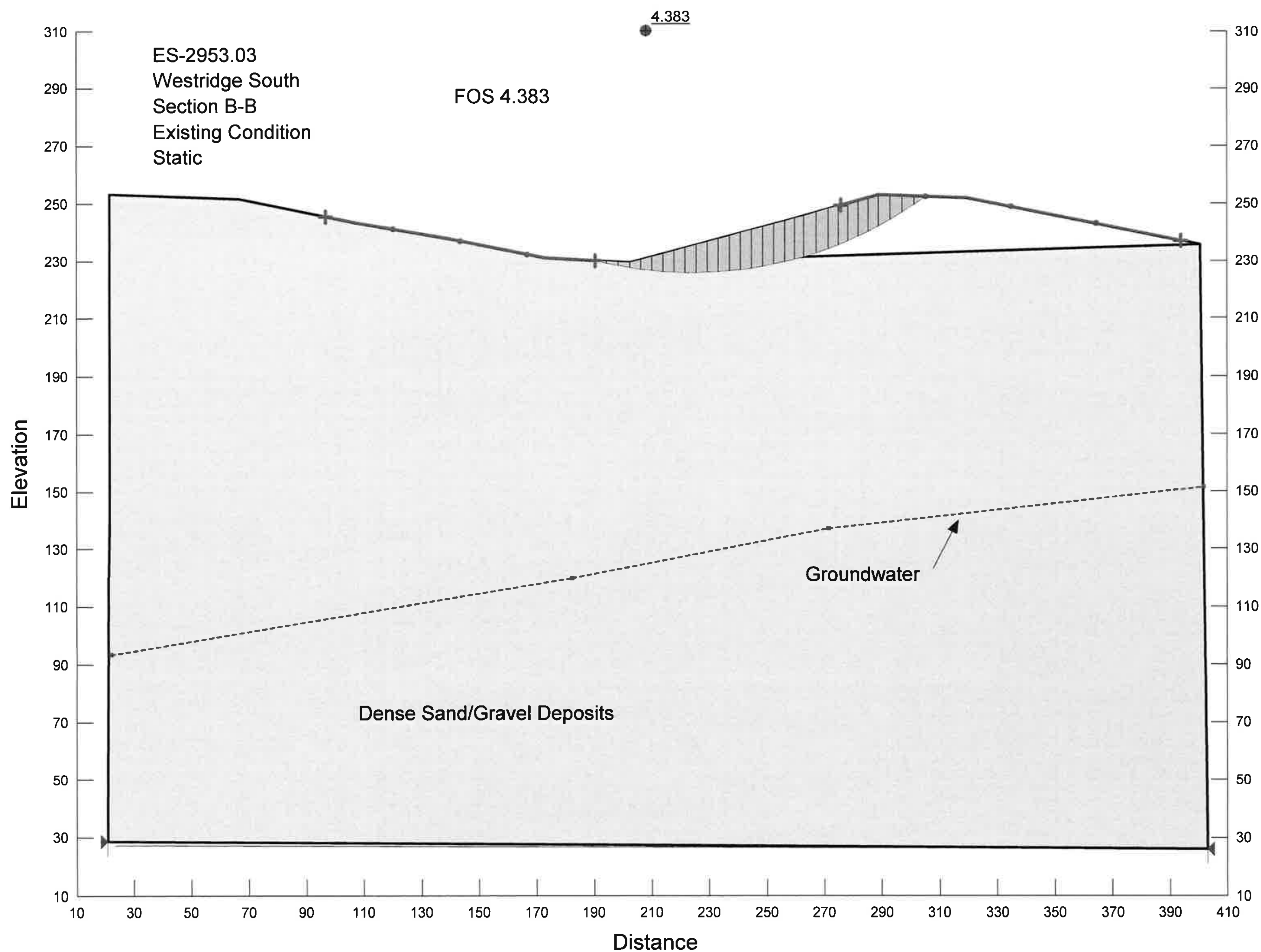
330
350
370
390
410



2.311
ES-2953.03
Westridge South
Section A-A
Existing Condition
Seismic
FOS 2.311
Elevation
Groundwater
Dense Sand/Gravel Deposits
Distance


ES-2953.03
Westridge South
Section B-B
Existing Condition
Static
FOS 4.383
4.383
Elevation
Distance
Dense Sand/Gravel Deposits
Groundwater
310
290
270
250
230
210
190
170
150
130
110
90
70
50
30
10
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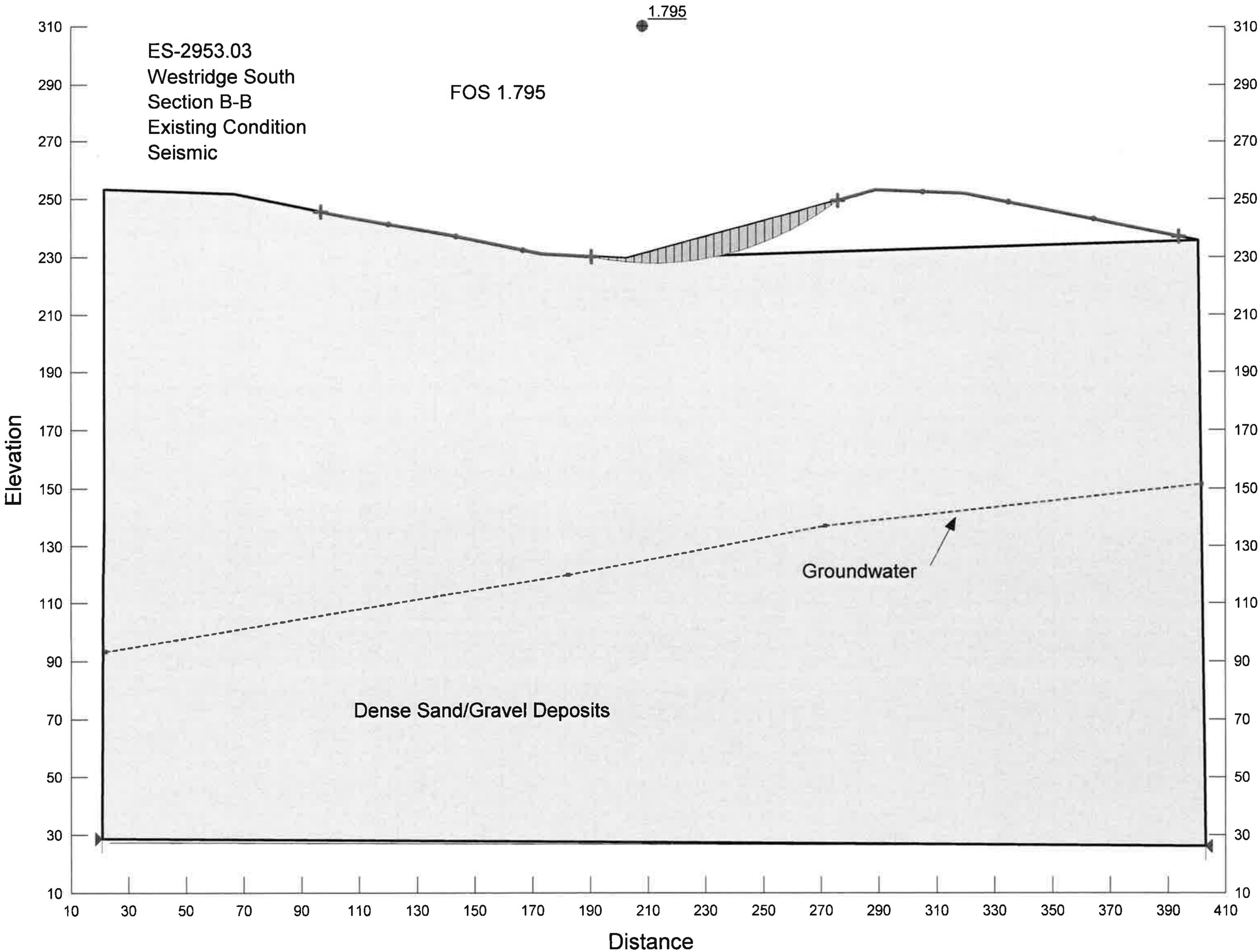
70
90
110
130
150
170
190
210
230
250
270
290
310
330
350
370
390
410


1.795
ES-2953.03
Westridge South
Section B-B
Existing Condition
Seismic
FOS 1.795
Elevation
Groundwater
Dense Sand/Gravel Deposits
Distance
310
290
270
250
230
210
190
170
150
130
110
90
70
50
30
10
10
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50
70
90
110
130
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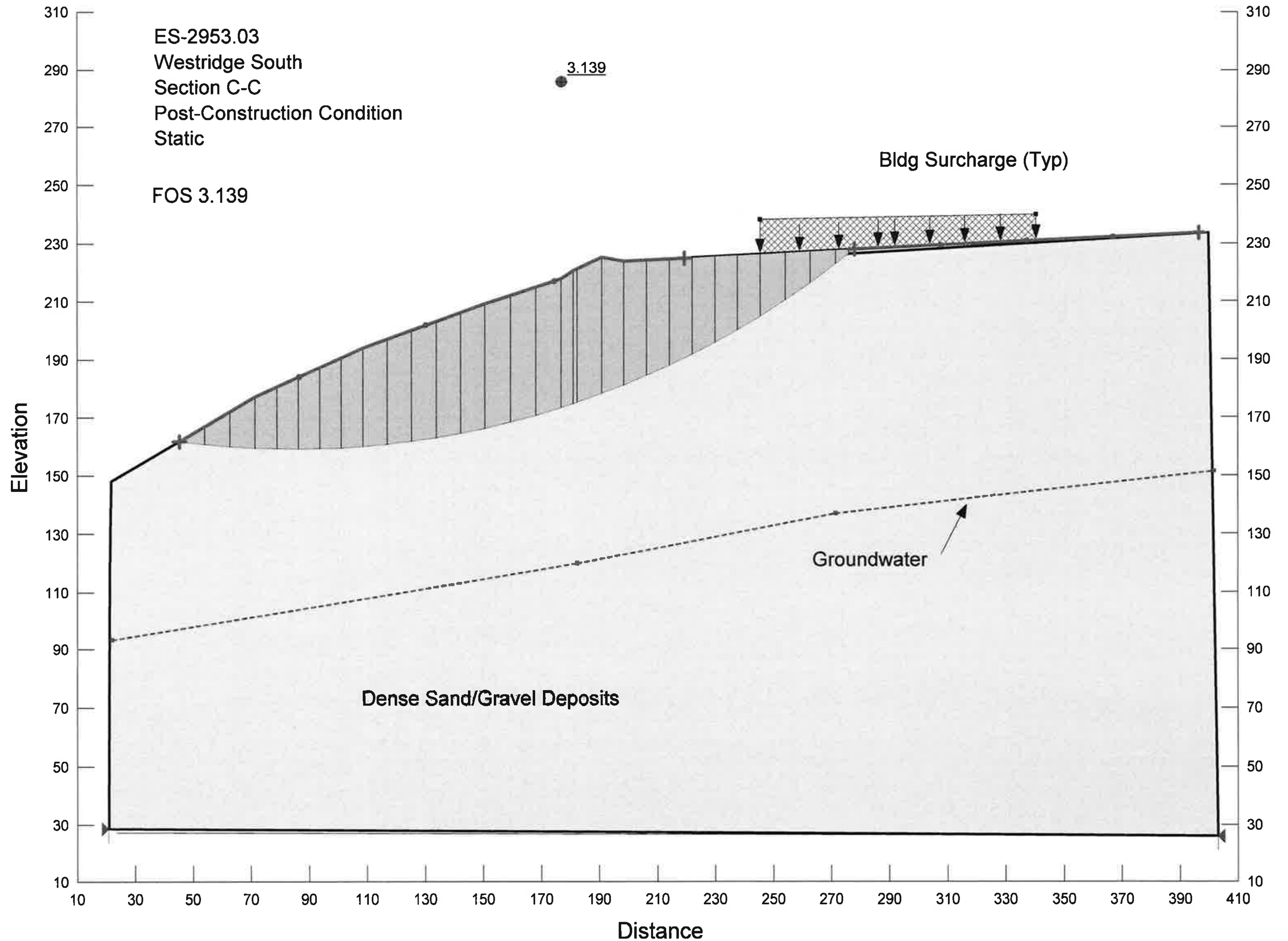
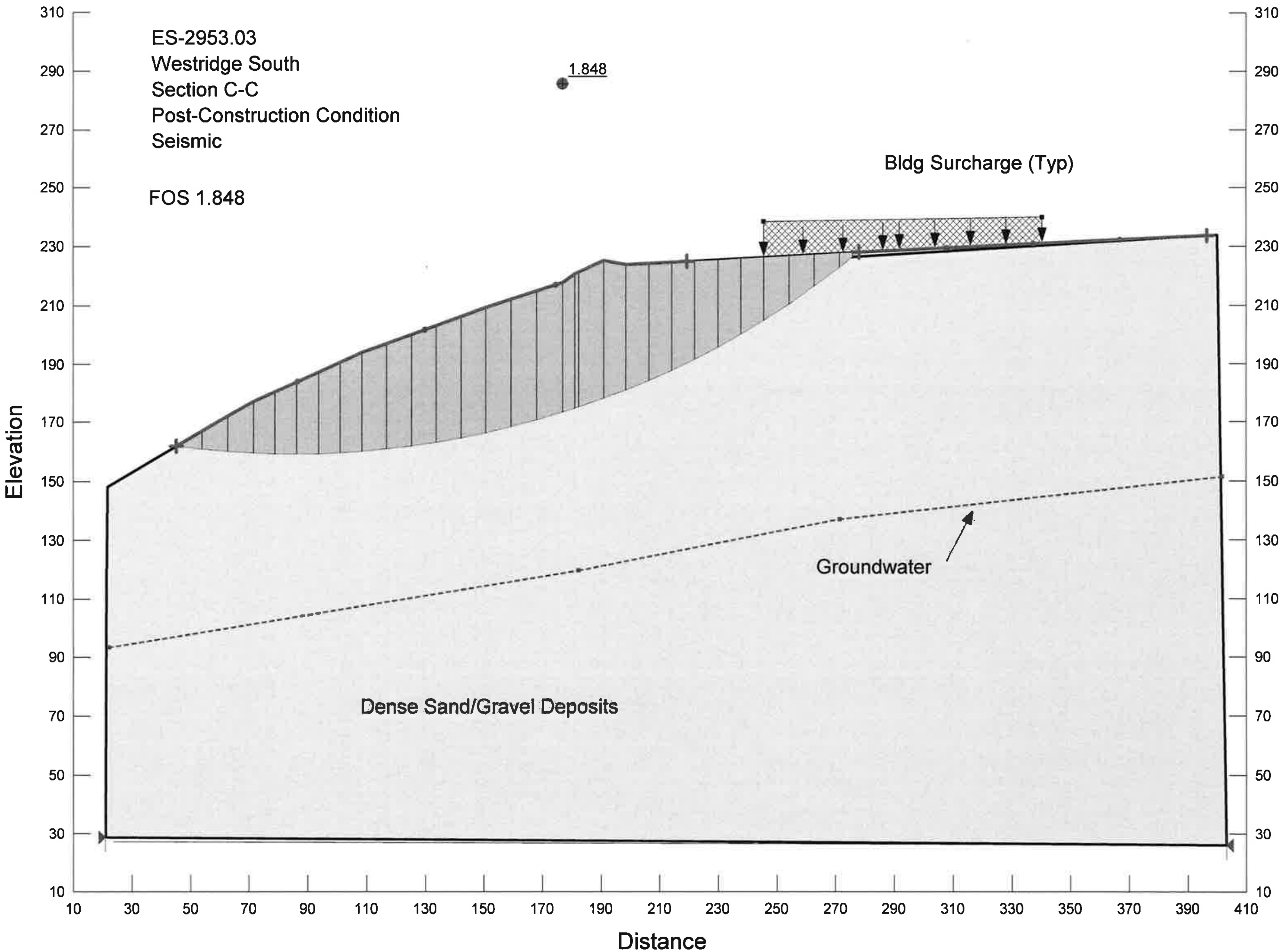
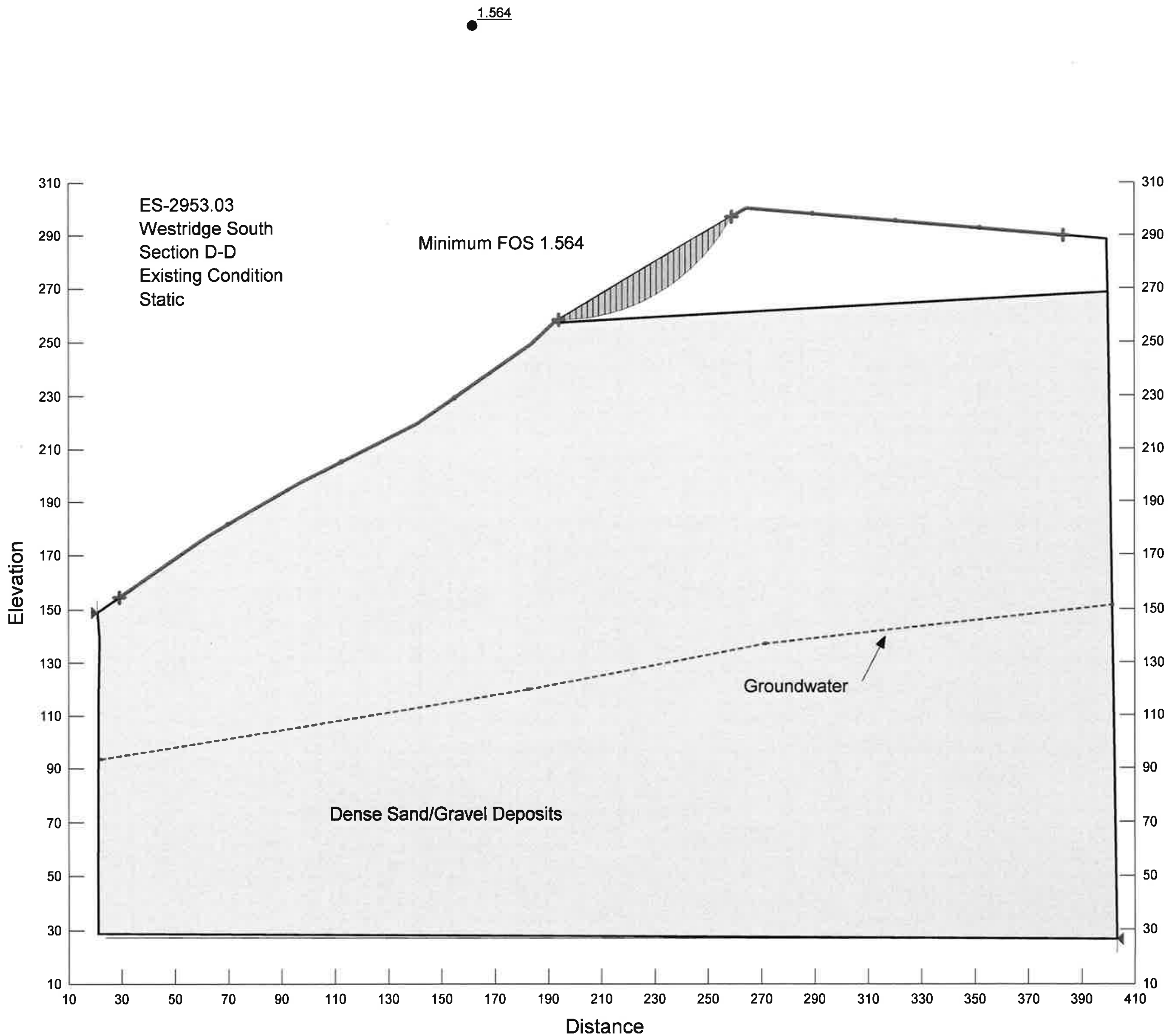
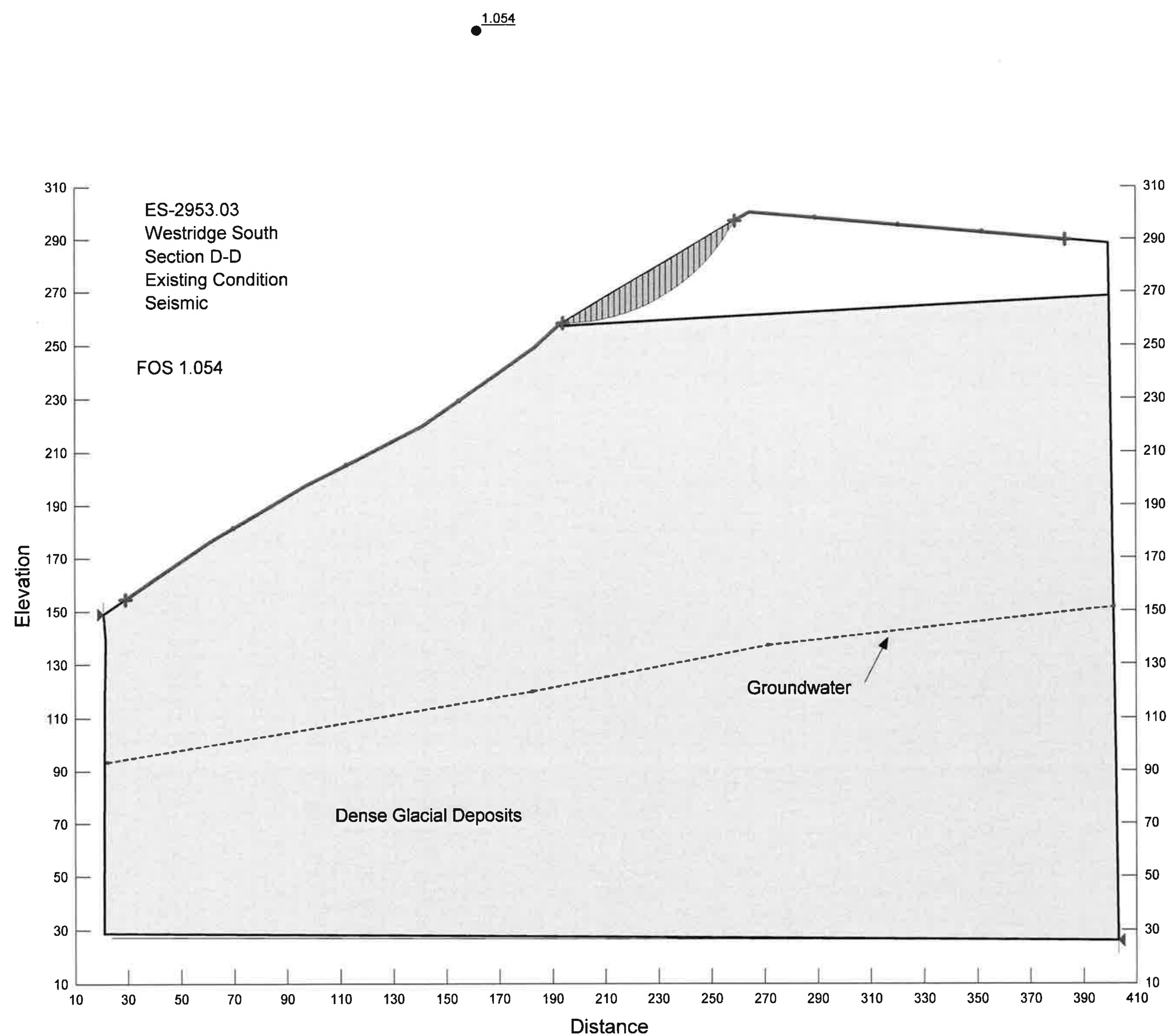
170
190
210
230
250
270
290
310
330
350
370
390
410


ES-2953.03
Westridge South
Section C-C
Post-Construction Condition
Static
FOS 3.139
3.139
Bldg Surcharge (Typ)
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance


ES-2953.03
Westridge South
Section C-C
Post-Construction Condition
Seismic
FOS 1.848
1.848
Bldg Surcharge (Typ)
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance



1.564
ES-2953.03
Westridge South
Section D-D
Existing Condition
Static
Minimum FOS 1.564
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance


1.054
ES-2953.03
Westridge South
Section D-D
Existing Condition
Seismic
FOS 1.054
Groundwater
Dense Glacial Deposits
Elevation
Distance
310
290
270
250
230
210
190
170
150
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110
90
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310
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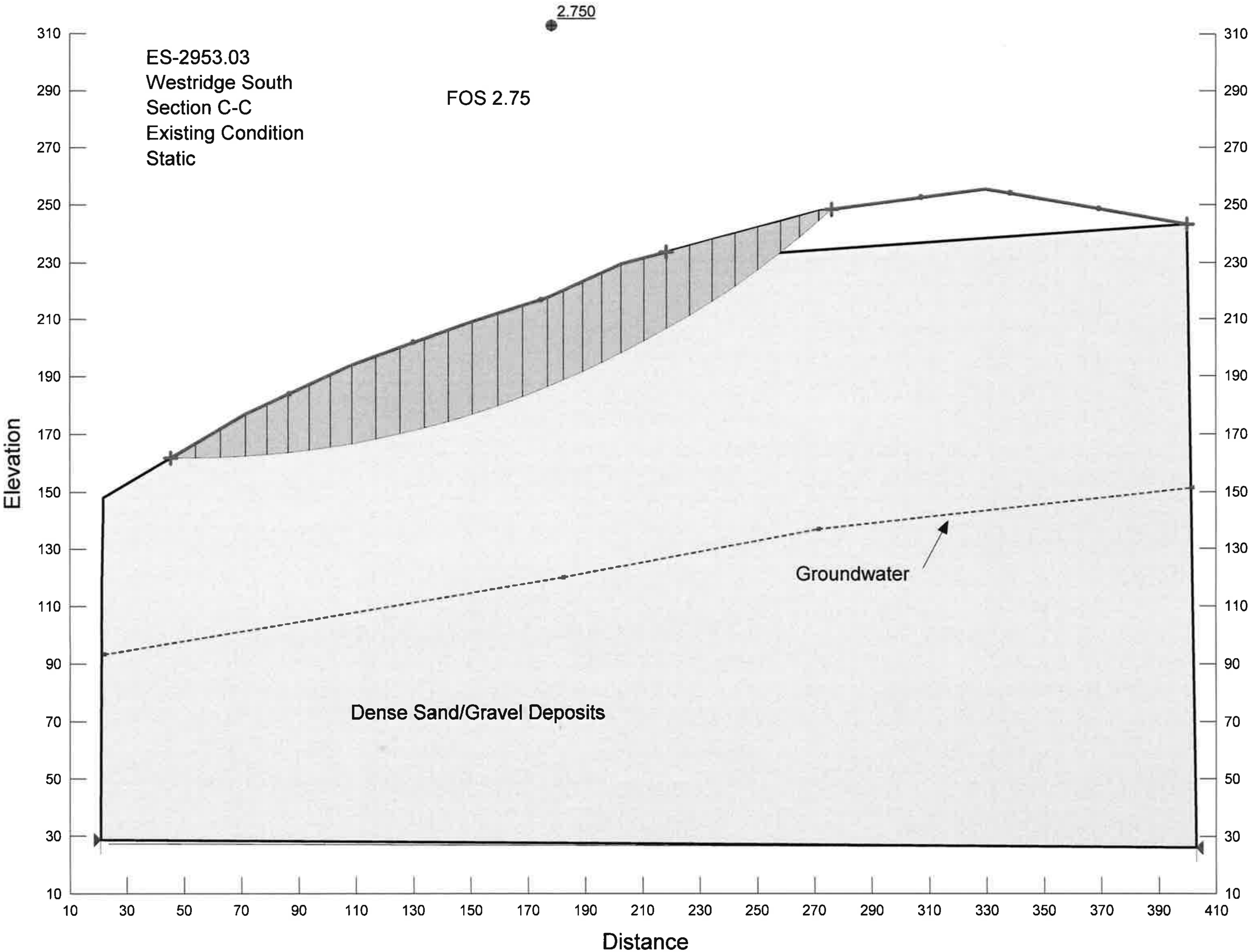
390
410


2.750
ES-2953.03
Westridge South
Section C-C
Existing Condition
Static
FOS 2.75
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance
310
290
270
250
230
210
190
170
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290
310
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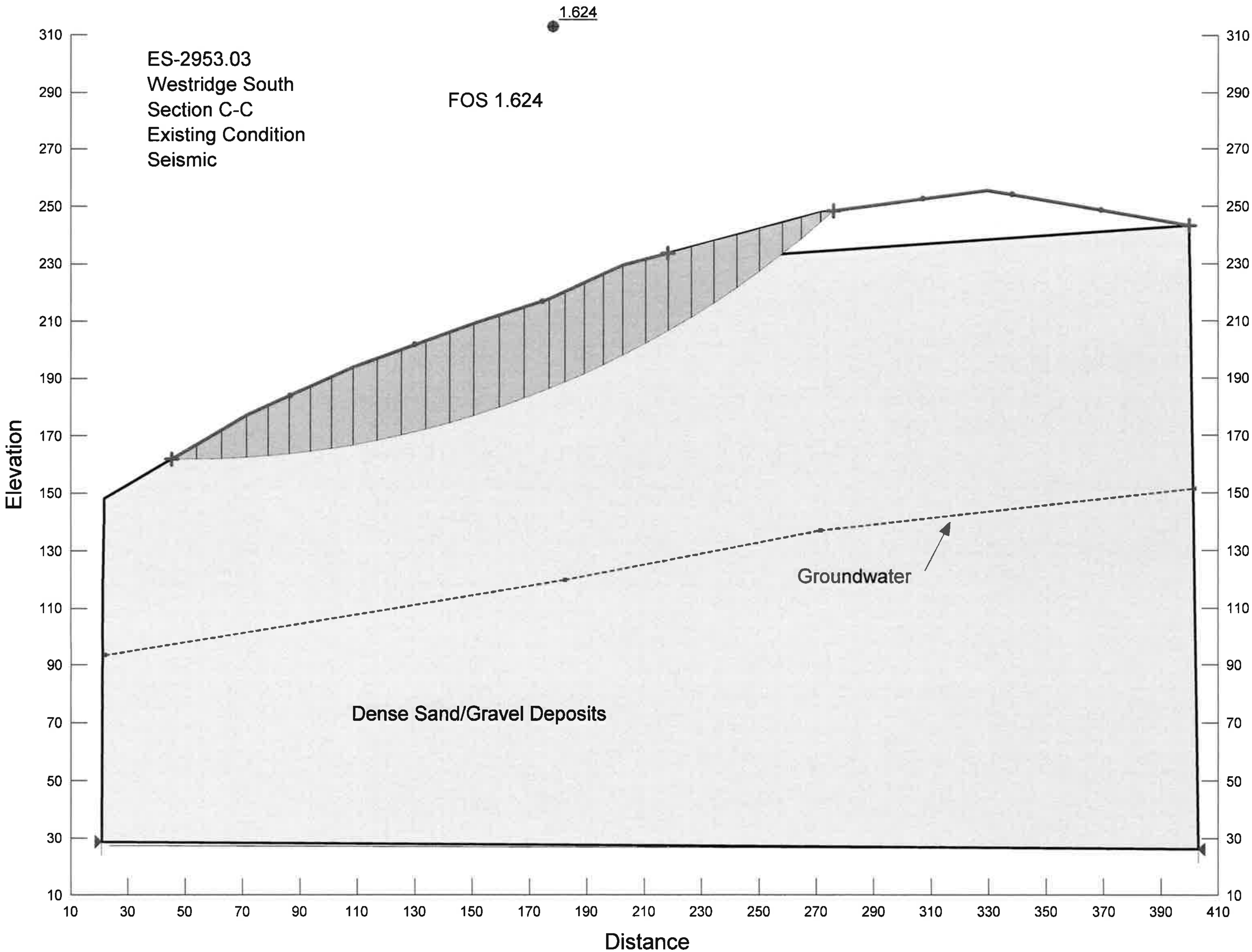
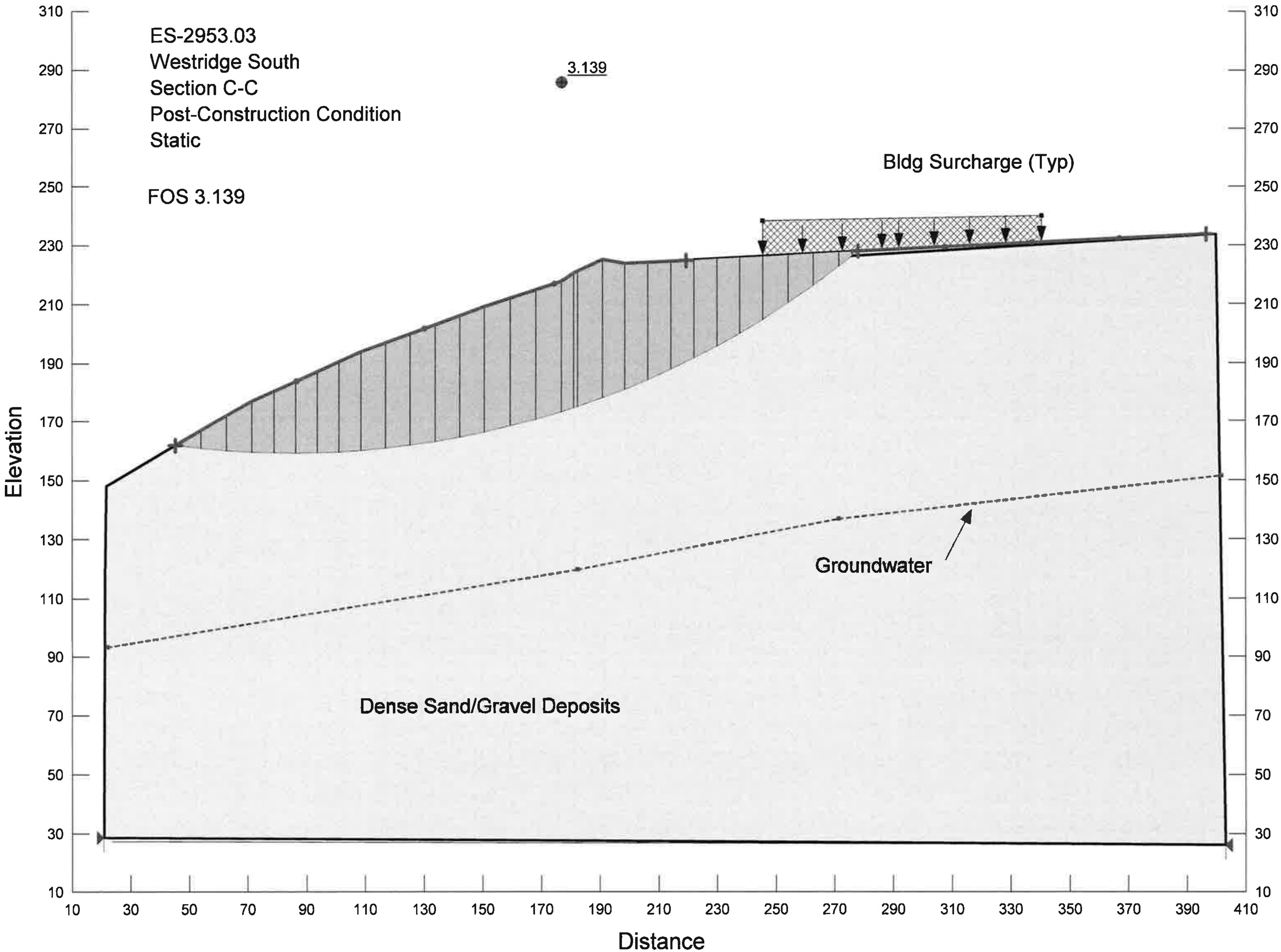
370
390
410


1.624
ES-2953.03
Westridge South
Section C-C
Existing Condition
Seismic
FOS 1.624
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance



ES-2953.03
Westridge South
Section C-C
Post-Construction Condition
Static
FOS 3.139
3.139
Bldg Surcharge (Typ)
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance
310
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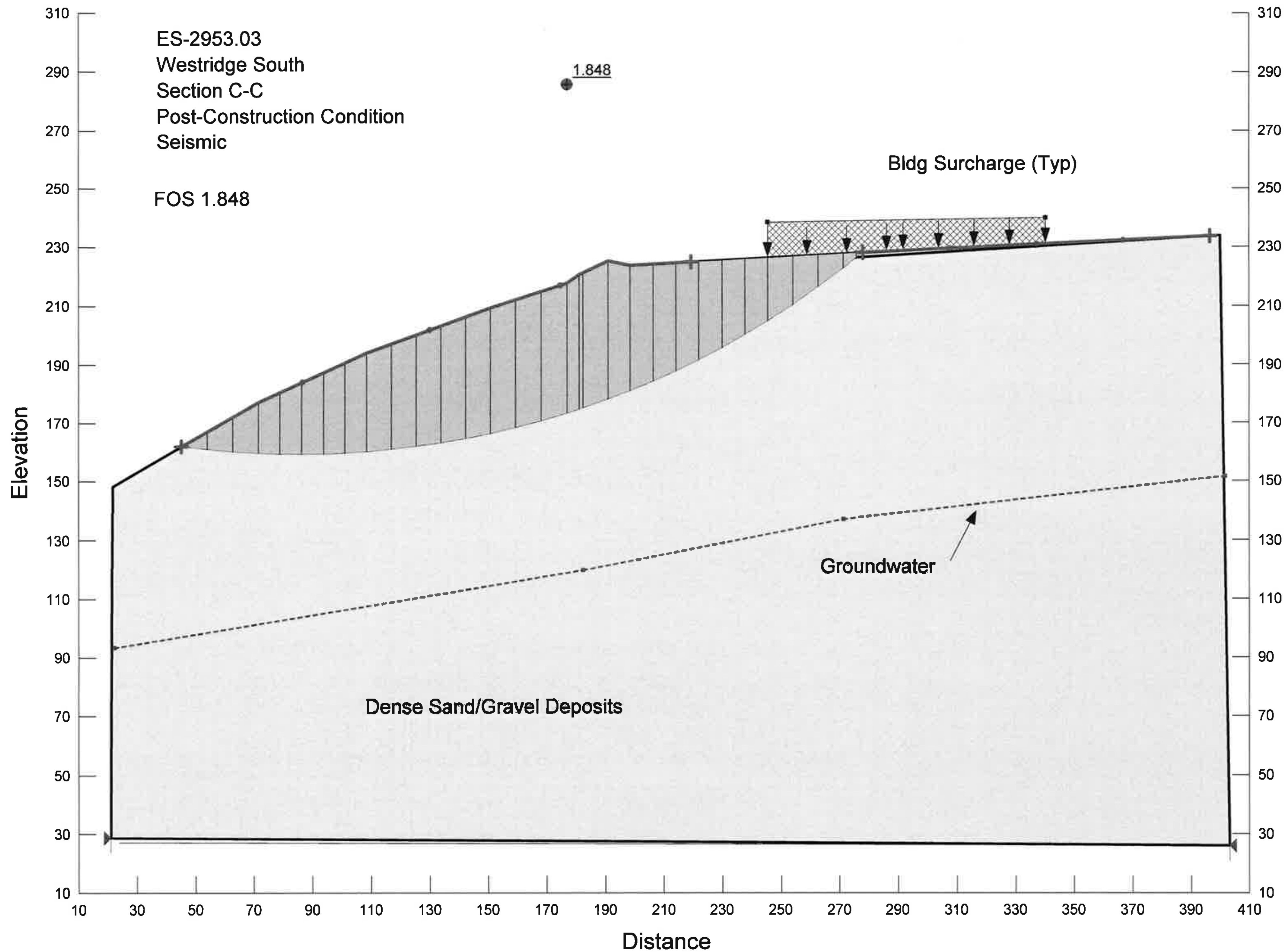
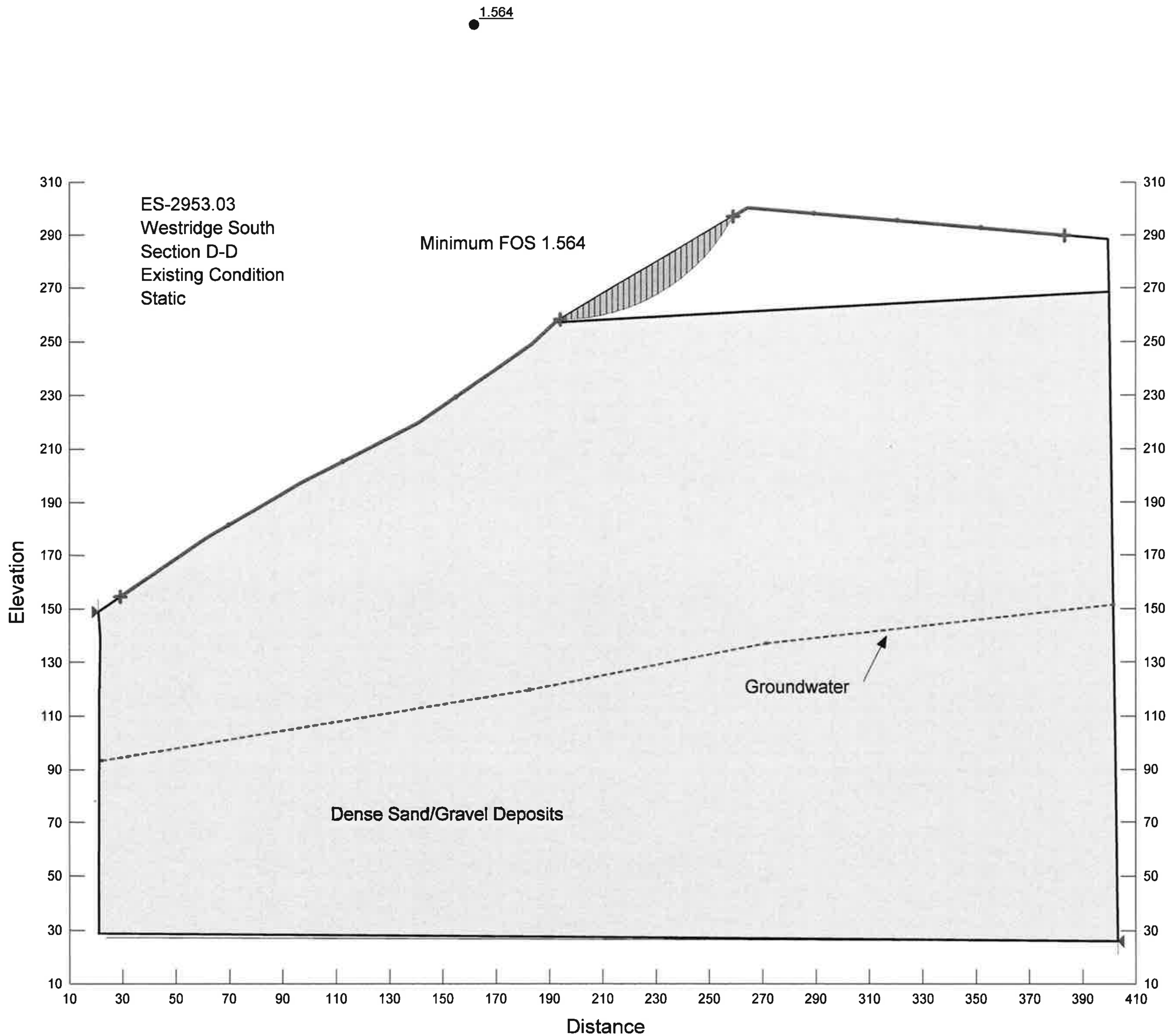
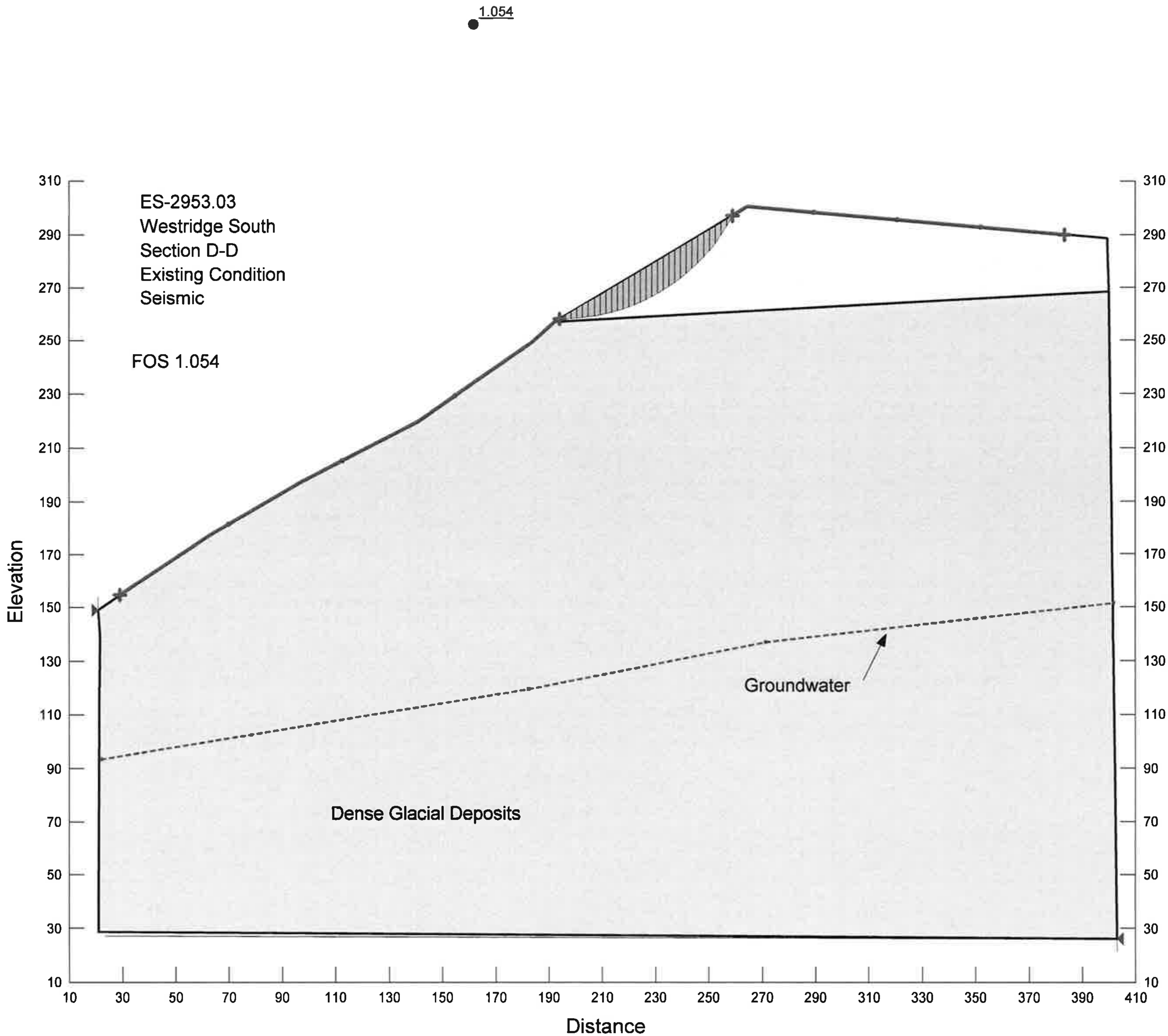

ES-2953.03
Westridge South
Section C-C
Post-Construction Condition
Seismic
FOS 1.848
1.848
Bldg Surcharge (Typ)
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance



1.564
ES-2953.03
Westridge South
Section D-D
Existing Condition
Static
Minimum FOS 1.564
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance


1.054
ES-2953.03
Westridge South
Section D-D
Existing Condition
Seismic
FOS 1.054
Dense Glacial Deposits
Groundwater
Elevation
Distance
310
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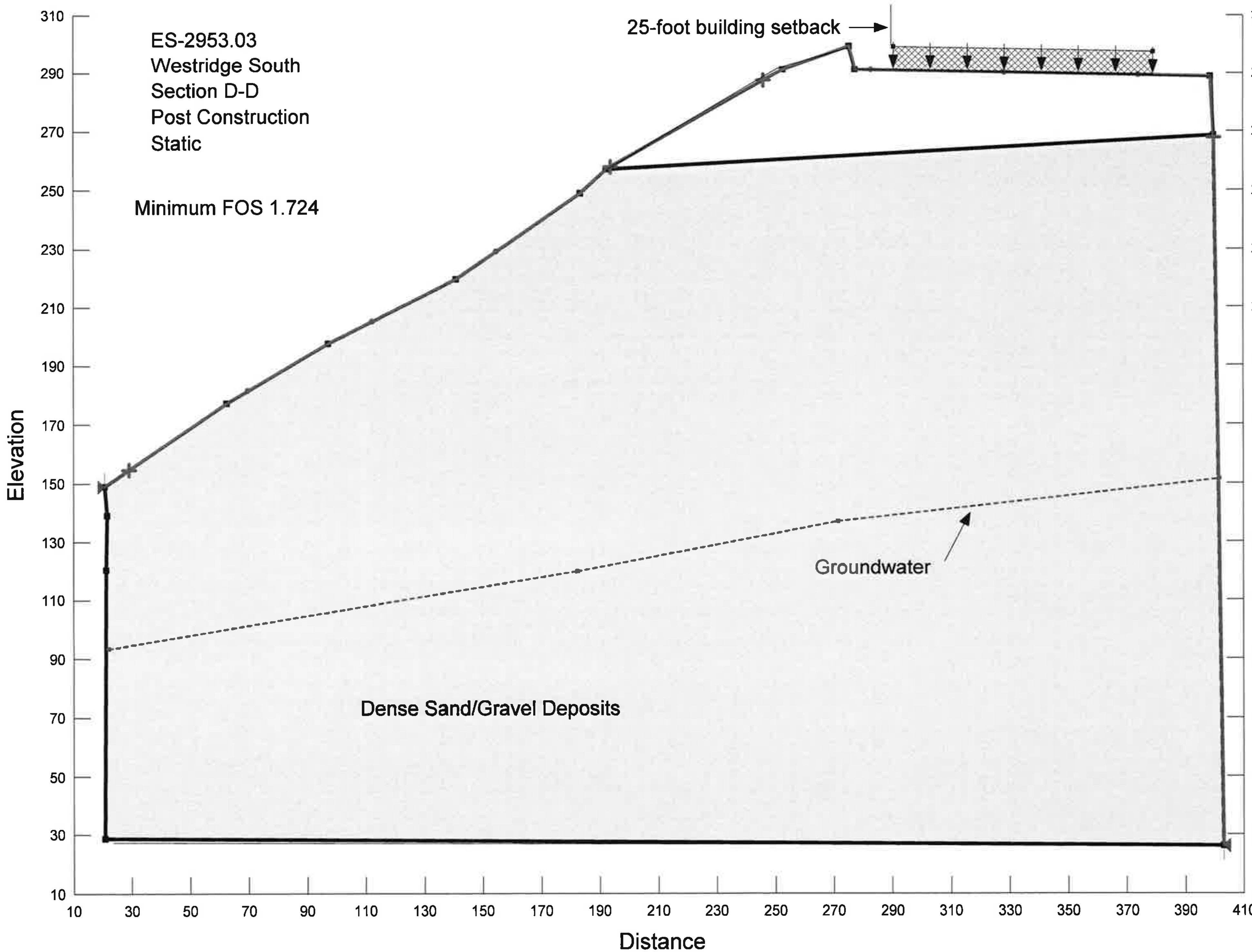
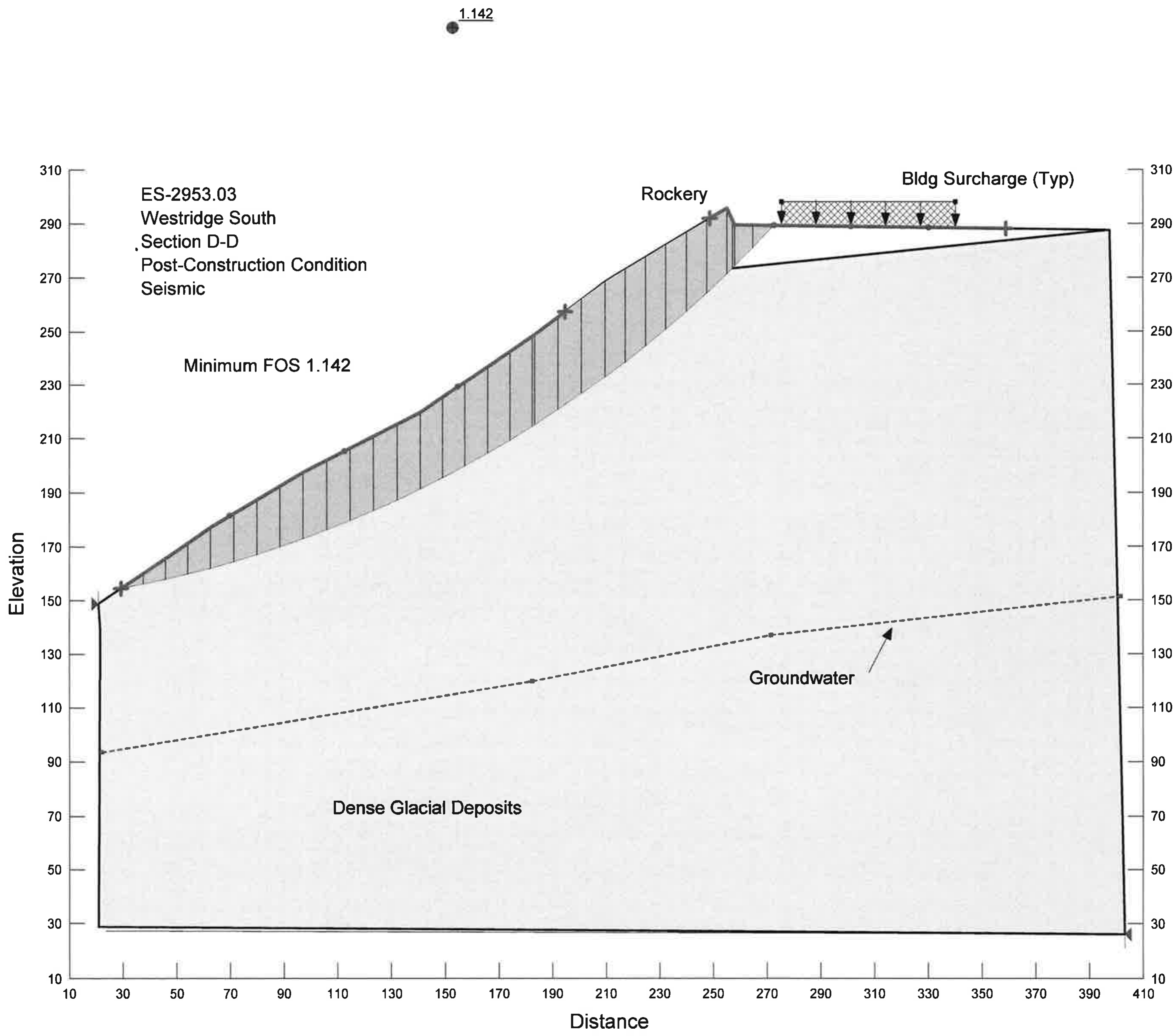


ES-2953.03
Westridge South
Section D-D
Post Construction
Static
Minimum FOS 1.724
25-foot building setback
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance


1.142
ES-2953.03
Westridge South
Section D-D
Post-Construction Condition
Seismic
Minimum FOS 1.142
Rockery
Bldg Surcharge (Typ)
Groundwater
Dense Glacial Deposits
Elevation
Distance
310
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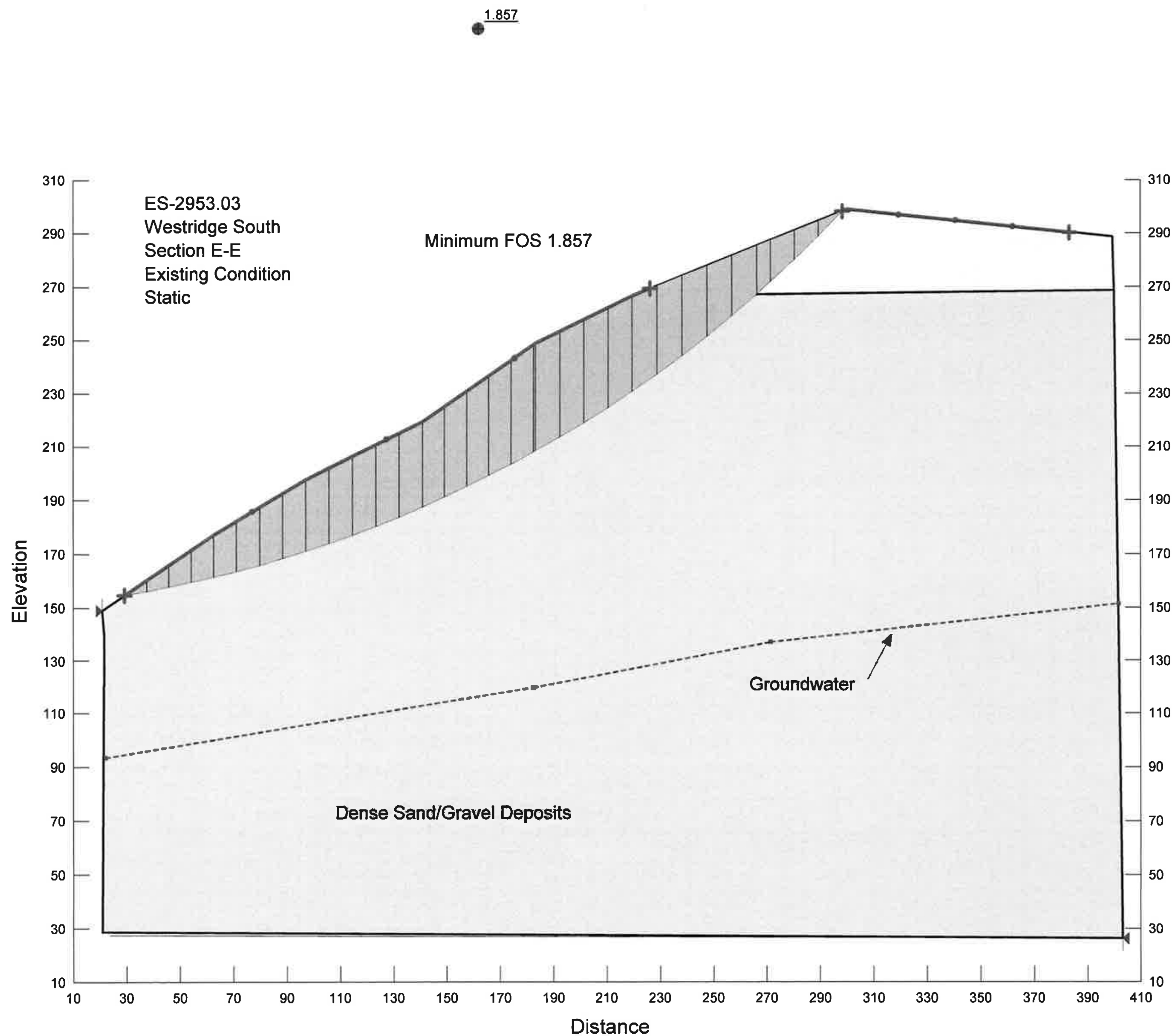
10 30 50 70 90 110 130 150 170 190 210 230 250 270 290 310 330 350 370 390 410


1.857
ES-2953.03
Westridge South
Section E-E
Existing Condition
Static
Minimum FOS 1.857
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance
10
30
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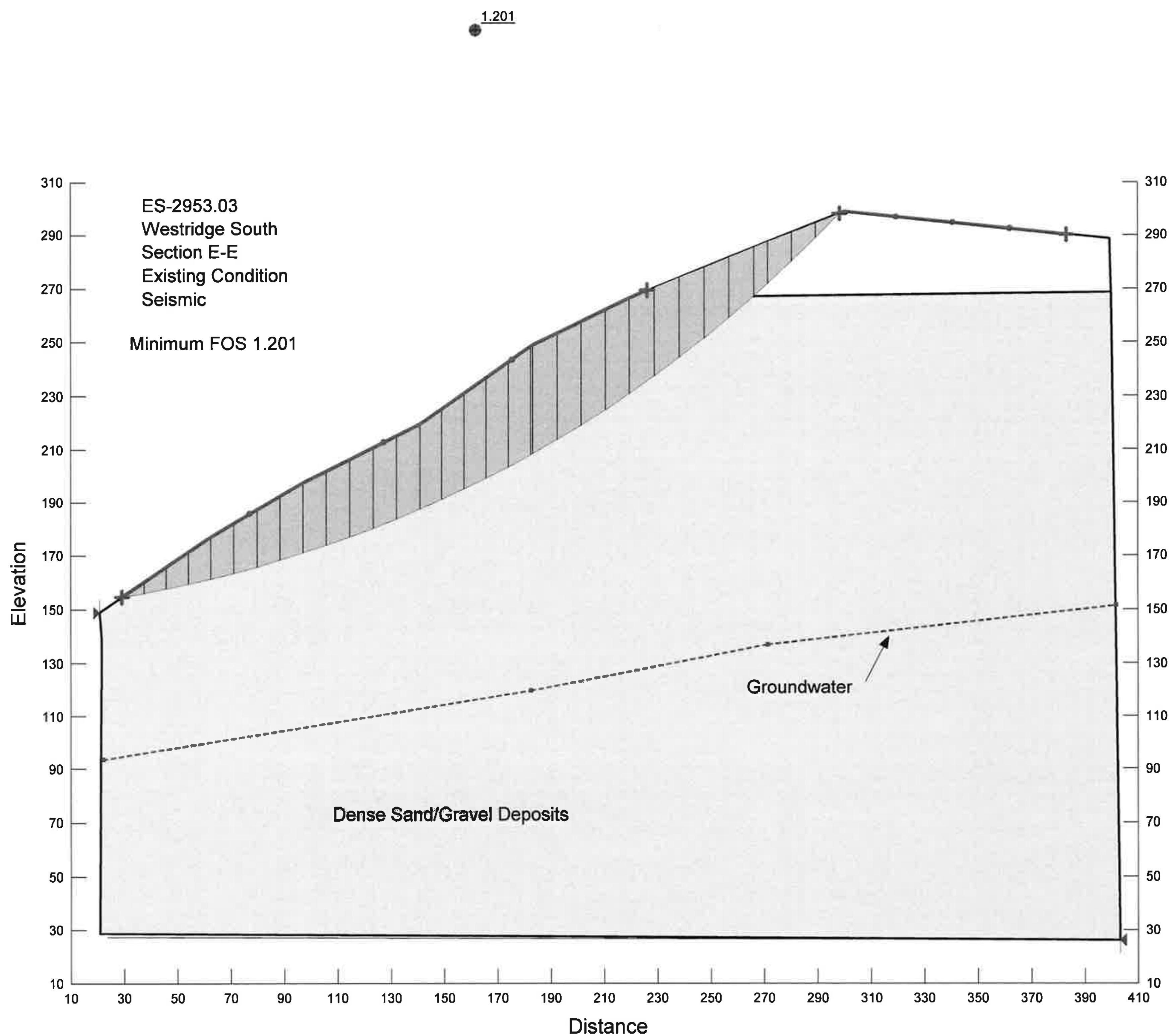

1.201
ES-2953.03
Westridge South
Section E-E
Existing Condition
Seismic
Minimum FOS 1.201
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance
310
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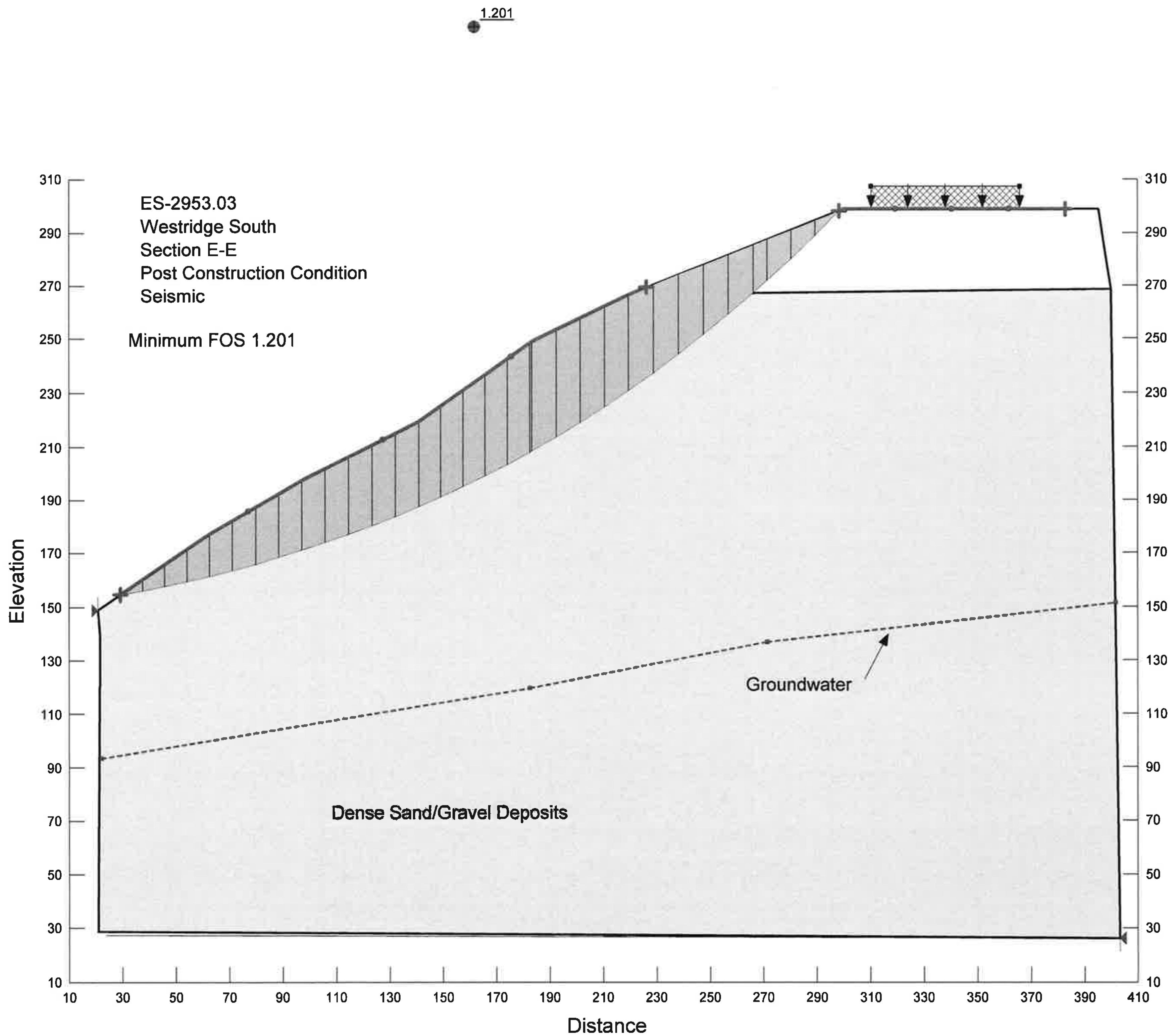
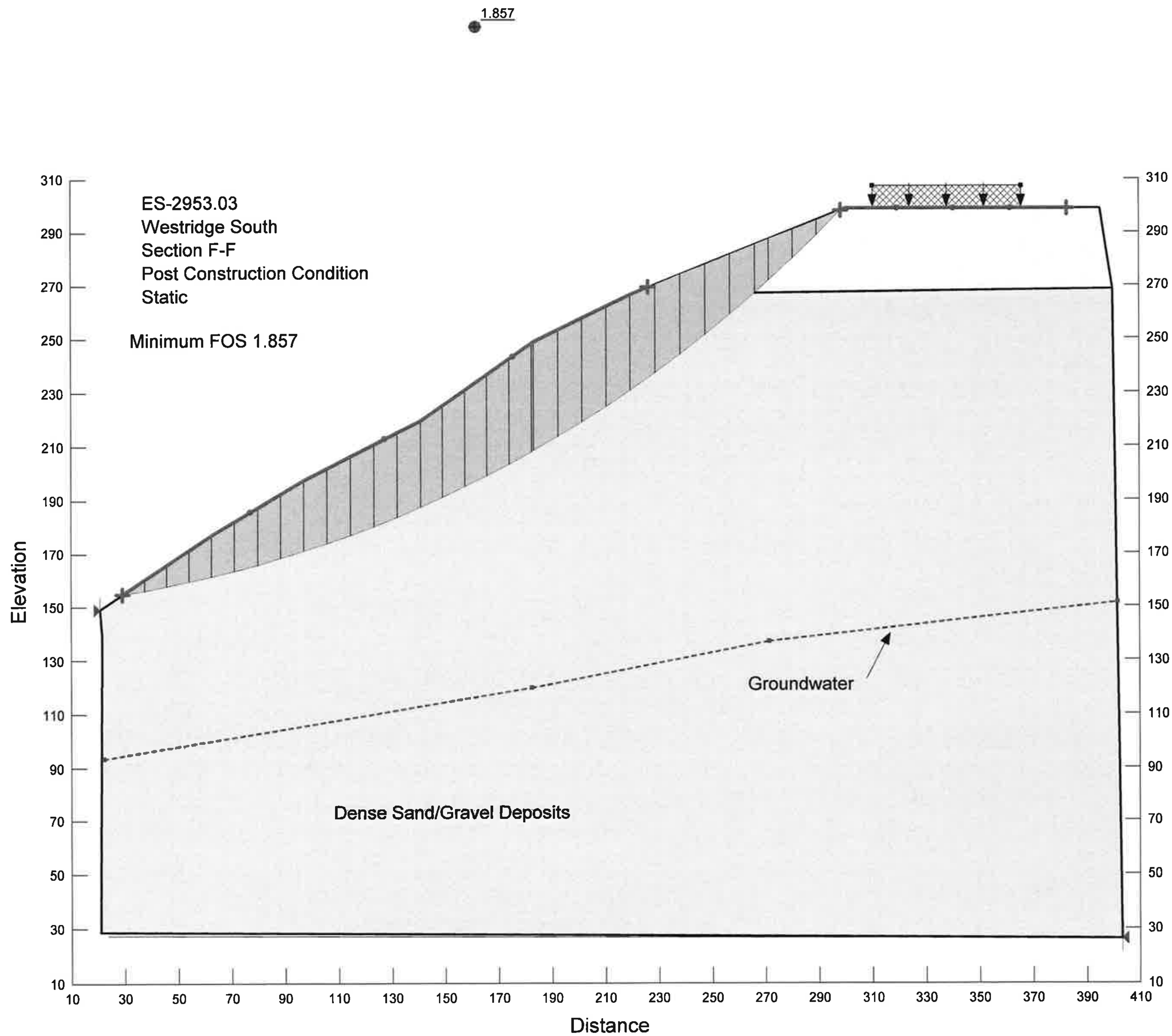


1.201
ES-2953.03
Westridge South
Section E-E
Post Construction Condition
Seismic
Minimum FOS 1.201
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance
310 290 270 250 230 210 190 170 150 130 110 90 70 50 30 10
10 30 50 70 90 110 130 150 170 190 210 230 250 270 290 310 330 350 370 390 410


1.857
ES-2953.03
Westridge South
Section F-F
Post Construction Condition
Static
Minimum FOS 1.857
Groundwater
Dense Sand/Gravel Deposits
Elevation
Distance
310
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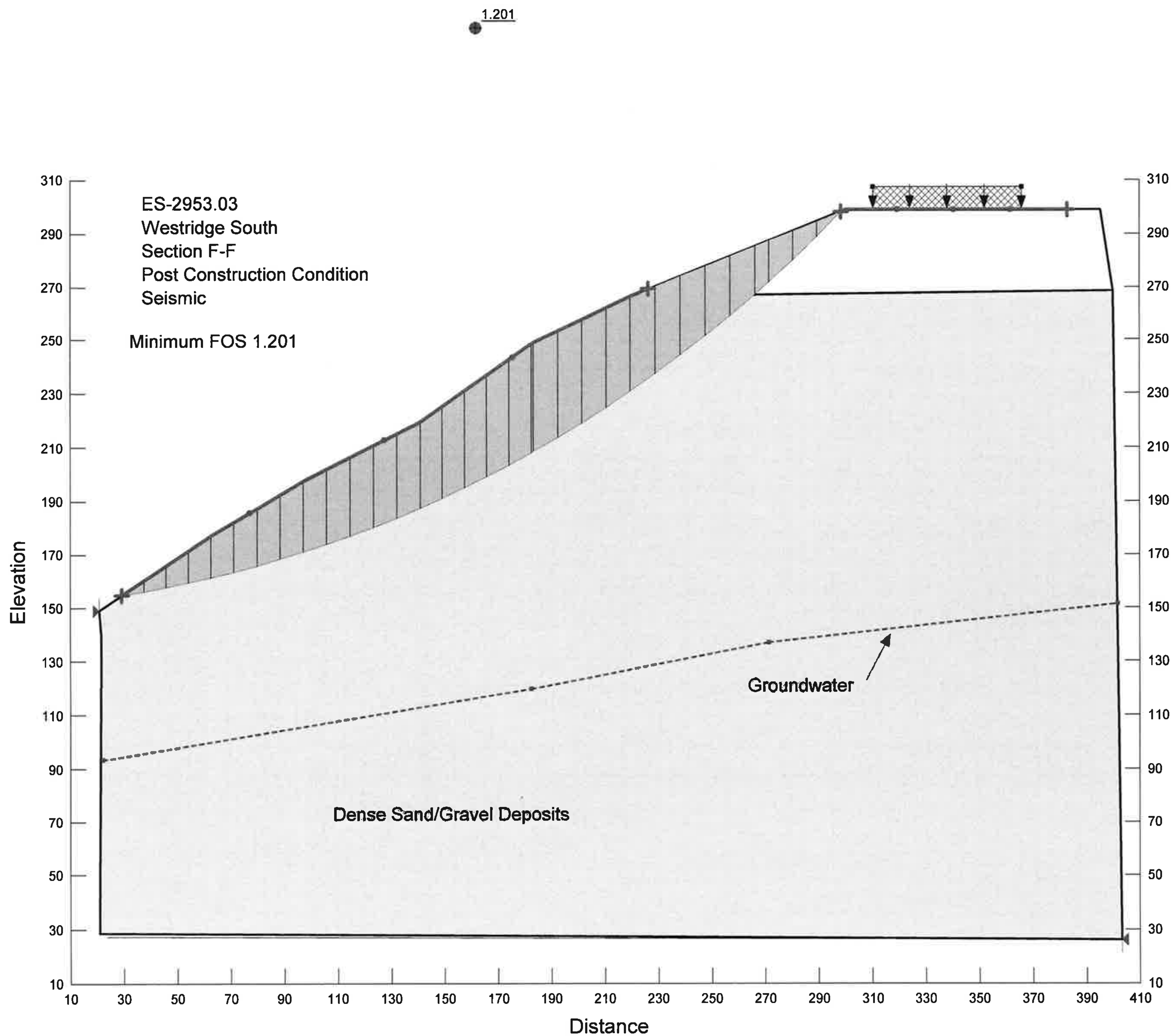
1.201
ES-2953.03
Westridge South
Section F-F
Post Construction Condition
Seismic
Minimum FOS 1.201
Dense Sand/Gravel Deposits
Groundwater
Elevation
Distance

SLOPE/W Analysis

File Information

Created By: Scott Riegel
Revision Number: 53
Last Edited By: Scott Riegel
Date: 09/29/2015
Time: 12:04:47 PM
File Name: ES-2953.03 D-D PostConst Seismic.gsz
Directory: C:\Users\scott.riegel\Documents\GeoSlope Runs\
Last Solved Date: 09/29/2015
Last Solved Time: 12:04:50 PM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

- Kind: SLOPE/W
- Method: Morgenstern-Price
- Settings
  - Apply Phreatic Correction: No
  - Side Function
    - Interslice force function option: Half-Sine
  - PWP Conditions Source: Piezometric Line
  - Use Staged Rapid Drawdown: No
- Slip Surface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: No
  - Tension Crack
    - Tension Crack Option: (none)
- FOS Distribution
  - FOS Calculation Option: Constant

Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Weathered Recessional Sand/Gravel

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 100 psf
Phi: 34 °
Phi-B: 0 °

Unweathered Sand/Gravel

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion: 300 psf
Phi: 40 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (29.18438, 154.64489) ft
Left-Zone Right Coordinate: (194.73223, 257.42375) ft
Left-Zone Increment: 4
Right Projection: Range
Right-Zone Left Coordinate: (248.79209, 291.91311) ft
Right-Zone Right Coordinate: (358.89751, 288.10902) ft
Right-Zone Increment: 4
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (20.80072, 148.95033) ft
Right Coordinate: (403.15619, 26.08743) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	22.13803	93.45308
	182.49112	119.79663
	271.4897	136.97527
	401.67607	151.41797

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 250 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	275.45405	297.87312
	340.11394	297.87312

Seismic Loads

Horz Seismic Load: 0.22
Ignore seismic load in strength: No

Regions

	Material	Points	Area (ft^2)
Region 1	Weathered Recessional Sand/Gravel	1,2,3,4	1685.2816
Region 2	Unweathered Sand/Gravel	4,3,5,6,7,8,9,10,11,12,13	81771.048

Points

	X (ft)	Y (ft)
Point 1	257.9393	289.49012
Point 2	255.10327	295.67663
Point 3	209.61258	268.54935
Point 4	397.38093	287.58257
Point 5	183.39915	248.95033
Point 6	140.87946	219.61962
Point 7	97.17868	197.57238
Point 8	62.53301	177.29679
Point 9	20.80072	148.95033
Point 10	21.58813	139.10781
Point 11	21.30288	120.41158

Point 12	20.80072	28.67474
Point 13	403.15619	26.08743

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	7	1.142	(-51.273, 587.364)	440.135	(272.565, 289.29)	(29.1844, 154.645)

Slices of Slip Surface: 7

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	7	33.35296	155.4617	0	212.40179	178.22627	300
2	7	41.690115	157.1793	0	729.81071	612.3839	300
3	7	50.02727	159.06605	0	1246.9679	1046.3303	300
4	7	58.36443	161.12425	0	1752.0961	1470.1832	300
5	7	66.86372	163.4033	0	2191.2057	1838.6399	300
6	7	75.52514	165.91305	0	2547.282	2137.4234	300
7	7	84.186555	168.6169	0	2844.453	2386.7795	300
8	7	92.84797	171.51875	0	3072.8109	2578.3945	300
9	7	101.54874	174.6378	0	3189.2457	2676.0949	300
10	7	110.2889	177.98055	0	3196.9422	2682.5531	300
11	7	119.02905	181.5391	0	3140.9874	2635.6014	300
12	7	127.7692	185.3191	0	3031.4638	2543.7002	300
13	7	136.5094	189.3269	0	2880.801	2417.279	300
14	7	145.04065	193.46245	0	2775.7808	2329.1566	300
15	7	153.36295	197.72175	0	2720.3448	2282.6403	300
16	7	161.6853	202.20795	0	2648.1221	2222.0382	300
17	7	170.00765	206.92905	0	2567.1602	2154.1032	300
18	7	178.32995	211.894	0	2483.7382	2084.1038	300
19	7	182.9451	214.72395	0	2439.7226	2047.1703	300
20	7	187.76805	217.8355	0	2410.1896	2022.3892	300
21	7	196.5059	223.6379	0	2366.2018	1985.4791	300
22	7	205.2437	229.7479	0	2326.0875	1951.8191	300
23	7	213.4035	235.7352	0	2245.931	1884.5598	300
24	7	220.98525	241.57345	0	2123.1513	1781.5354	300
25	7	228.567	247.68125	0	1998.6157	1677.0377	300
26	7	236.1488	254.0735	0	1868.3178	1567.7048	300
27	7	243.7306	260.7669	0	1727.6396	1449.6617	300
28	7	251.3124	267.78035	0	1571.3024	1318.4793	300
29	7	256.12725	272.36885	0	1271.0317	1066.5222	300
30	7	257.54525	273.75615	0	1122.66	757.2437	100
31	7	261.3269	277.5624	0	802.40283	541.22755	100
32	7	268.1021	284.55355	0	302.29036	203.89742	100
33	7	272.02715	288.70825	0	-12.308409	-8.3021267	100