Appendix F

GEOTECHNICAL ASSESSMENT TM 2023

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TECHNICAL MEMORANDUM

To: Dave Price / Carollo Engineers

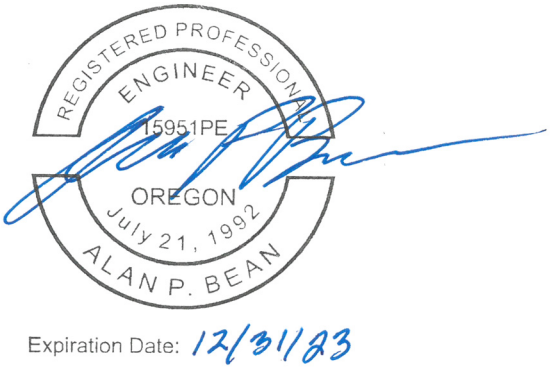
From: Alan P. Bean / Northwest Geotech, Inc.

Date: October 3, 2023

Subject: Facility Crack Survey and Supplemental Exploration Results Wilsonville WWTP Campus

Project: Wilsonville WWTP Master Plan

Project No. 00-231579-0



Expiration Date: 12/31/23

Purpose and Scope

The purpose of this memorandum is to provide Geotechnical opinions and recommendations based on past and present site investigations and engineering analysis performed for this study. Our initial scope of work was completed and reported in a technical memorandum dated June 25, 2021. A supplemental scope of work was initiated in July of 2023, and consisted of performing a detailed visual crack survey of the existing facility and an exploratory boring performed for the purpose of identifying/confirming the mined depth of the prior gravel pit that the plant was constructed over. Due to this new subsurface information, this memorandum supersedes some of our prior conclusions where noted herein.

Our prior scope included developing CSZ site specific spectra for structures and assessing geotechnical/geologic hazards and risks that may influence master planning, and was based on borings previously completed by others in 2009 (GeoDesign). In order to facilitate spectra development three geophysical survey lines were performed across the site to acquire Vs30 shear wave velocity profiles.

Site Overview and Explorations

The plant site is a former gravel pit located approximately 600 feet from the Willamette River as indicated on the Vicinity Map, Figure 1. We understand that the pit mining operation was primarily used to construct the adjacent Willamette River bridge approach embankments in 1953. Major plant construction and expansion occurred in the mid-70s, mid-90s and again in 2012, and improvements continue to be constructed as recent as 2020.

Prior to the 2009 borings, we understand that test pits were the only available exploration data. The 2009 borings were largely performed around the perimeter and are identified on the attached Exploration Location Map, Figure 2. The resulting interpretive GeoDesign cross sections indicated a pit base in the range of elevation 85 to 92, marginally sloping to the south. NGI's boring conducted in August of 2023 is provided in Figure 3, and indicated the pit was excavated to the depth where a Troutdale Formation clay soil was present near elevation 64 feet, or roughly 21 to 28 feet below the previously understood depth of the pit. This additional spoil fill material is largely below the static water surface in the pit which was measured at an approximate elevation of 83 feet.

All or some of the prior borings may have been drilled above the sloping pit excavation sides which could have contributed to the mis-interpretation of a much shallower pit back in 2009. The gravel and pavement surfacing present throughout the lower level of the campus ranges from elevation 113 feet in the north to 107 feet in the south, resulting in an interpreted pit depth of 43 to 49 feet.

Subsurface Condition

Based on our recent boring, prior borings included in our 2021 technical memorandum, and reviewed test pit summaries and photos, the site backfill can generally be described as loose to medium dense mix of gravel-silt-sand with cobbles and boulders. Swarms of boulder and cobble spoils were encountered in one or more previous test pits and within the recent sonic boring (B-1) from a depth of 10 to 20 feet. Native soils below the pit backfill consisted of Troutdale Formation stiff to very stiff clay of medium to high plasticity. Locally, the Troutdale Formation is composed of a wide variety of stratified over-consolidated, hard clay and cohesive silts with inter-beds of weathered sands and gravels; typically the more granular beds are cemented, and course gravel with a clay matrix is also characteristic of the formation.

Seismic Hazards and Response

The previous site-specific spectra and discussion is acceptable in our opinion as provided and used in the master plan studies. Seismic liquefaction is anticipated to be quite variable in isolated pockets below elevation 83. Due to the variability, we do not anticipate it having an appreciable effect on the response spectra overall.

While the depth of the anticipated pockets of liquefaction are not anticipated to result in bearing failure of existing structure spread footing foundations at elevations of 95 feet or higher, nor bearing failure of large mat foundations regardless of elevation, we do recommend review of structure foundations types and loads that are present below elevation 95 feet.

In order to estimate vertical settlement that may result from liquefaction, we utilized the Liquefy Pro software to model the anticipated range of settlement for a Cascadia Subduction Zone full rupture event at a moment magnitude of M_W=9.2 and base acceleration of 0.2g. We modeled the range of relative density from an equivalent SPT blow count of 10 to 25, which represents our interpretation of conditions below the water table from the recent boring as well as prior borings

assuming the re-interpretation of saturated pit fill to a depth of 44 feet (elevation 64 feet). The results indicate a range from 4 inches to 9 inches of liquefaction induced settlement can be anticipated for a natural deposit of slightly silty to silty, gravelly sand. In our opinion, and considering the variability in density and permeability, a total and differential settlement of 1 to 5 inches is a reasonable assumption over a distance of 25 feet. We do not anticipate that liquefaction induced lateral spreading will be a significant hazard within the boundaries of the pit.

Previously, we recommended assuming 1 inch of seismic settlement for every 15 feet of unsaturated spoil fill anticipated to be present beneath a facility when the pit depth was assumed to be above the water table elevation and indicated differential settlement may be assumed to be 1 inch in 30 lateral feet. This prior analysis of the unsaturated soil column settlement would be in addition to the saturated spoil fill settlement discussed in the prior paragraph.

Seismic Hazard Mitigation

We had previously identified that the primary hazard within the site is loss of support due to soil migration/piping in areas of concentrated infiltration or simply groundwater flow. At least one such sink hole had occurred in the vicinity of a catch basin in the past 10 years. Many of the same methods to mitigate soil piping hazards are utilized for seismic liquefaction hazards. We anticipate that the best method of mitigation would be high mobility grouting of the pit spoils. High mobility grouting simply injects cement slurry on a relatively close borehole spacing and can be adapted for use in interiors of structures with smaller equipment. It is also possible that alternative methods of making the grout holes utilizing rapid percussion air-track drilling for grout injection may achieve similar results. Locally, the Keller Group is equipped to perform many types of grouting and forms of wet soil mixing. The grouting equipment can work at angles of 30 degrees from vertical for soil improvement beneath existing structures.

We recommend new structure planning include ground improvement or deep foundation systems and structural slabs. Existing structures planned for seismic upgrade investments should also include ground improvement in the form of grouting to mitigate the seismic hazard.

With the exception of our new interpretation (and boring) indicating a much deeper pit and related seismic settlement hazard discussed herein, all other discussions and recommendations included in our July 2021 technical memorandum are unchanged.

Existing Facility Crack Survey

We performed a visual crack survey of the facilities that were accessible without specific fall protection equipment. The crack locations are approximate and utilized nearby features and geometry identifiable on the base drawings utilized to manually record the visual survey. The attached Figure 4, sheets 1 and 2 document this effort. The crack types were separated into typical hairline cracks, control joints with cracks/movement, and open or more pronounced cracks. Overall, many of the structures had very few cracks, a testament to the conservative design process that would be important for structures constructed over uncontrolled spoil fills.

Nonetheless, a few structures did indicate that some differential settlement stress had occurred or is occurring. The crack survey provides a baseline for evaluating or monitoring any future cracking progression and we recommend it be repeated every 5 to 10 years for signs of progression.

Limitations

Within the limitations of scope, schedule, and budget, our services have been completed in accordance with the geotechnical practices in this area at the time this memorandum was prepared. No warranty is expressed or implied. This memorandum was prepared for the exclusive use of NGI's client for the specific project and NGI does not authorize the segmented use of the advice herein or the reliance upon the report by third parties without written authorization of NGI. The boring log and related information depict generalized subsurface conditions only at the specific location and at the particular time the subsurface exploration was completed. Soil and groundwater conditions at other locations can be expected to differ. Also, the passage of time may result in a change in the soil and groundwater conditions at the site. This report pertains to the subject site only and is not applicable to adjacent sites nor is it valid for types of development other than that to which it refers. This report may only be copied in its entirety.

Attachments: Figure 1 – Vicinity Map
Figure 2 – Exploration Location Map
Figure 3 – Bore Log B-1
Figure 4 – Visual crack Survey

VICINITY MAP

PROJECT NO. 00-231579-0	WILSONVILLE WASTE WATER TREATMENT PLANT MASTER PLAN WILSONVILLE, OREGON	FIGURE NO. 1

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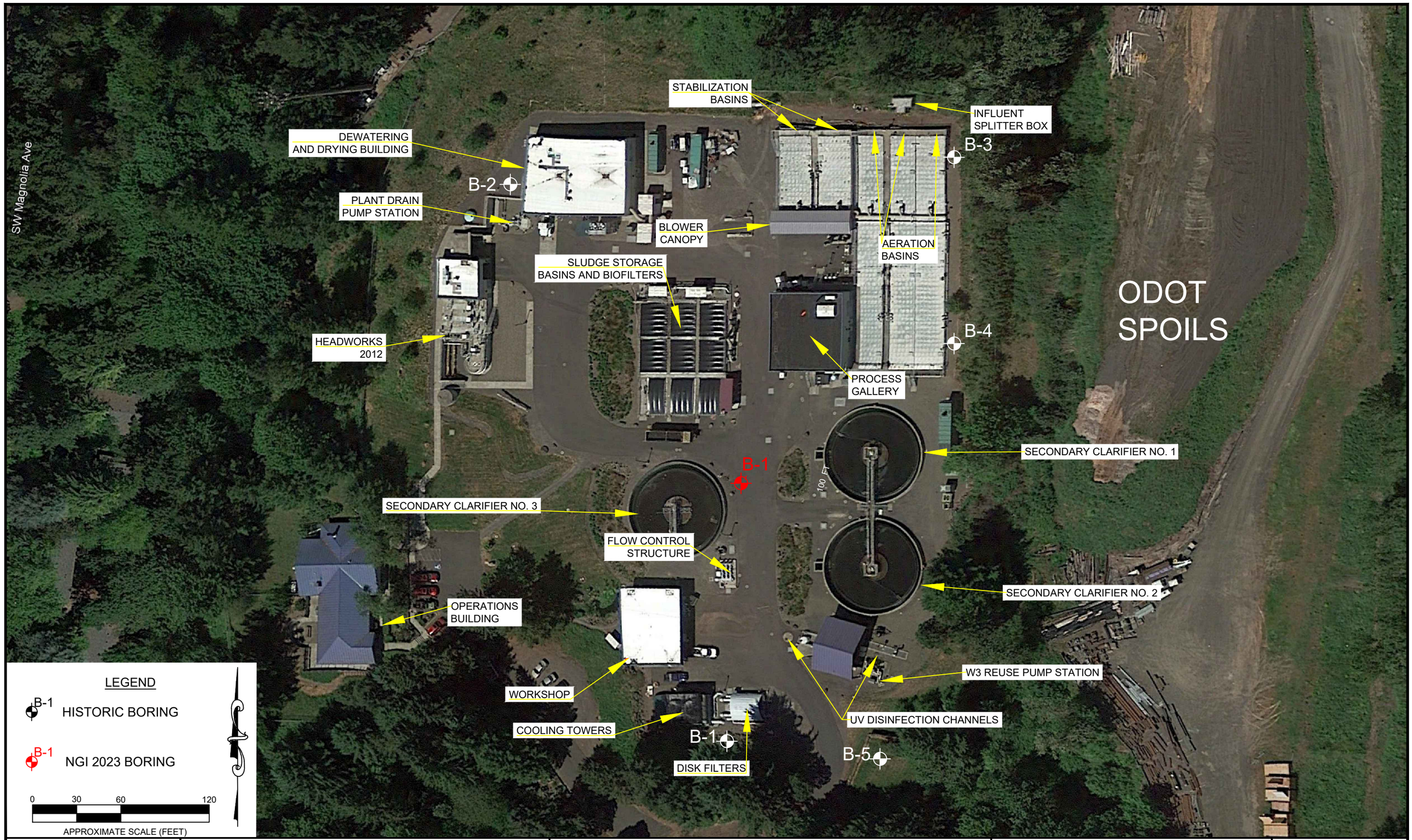
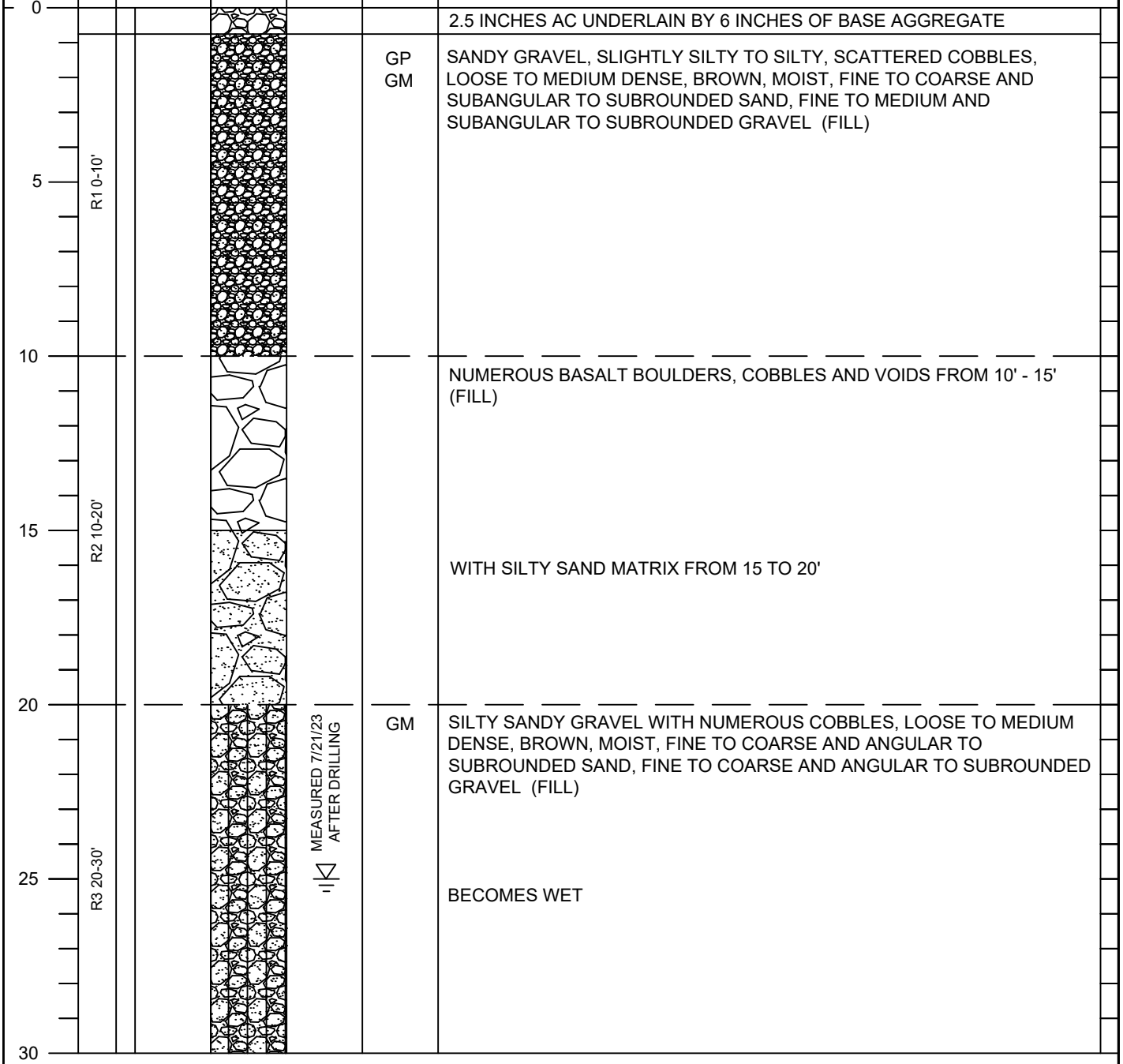


PROJECT NO. 00-231579-0	EXPLORATION LOCATION MAP	WILSONVILLE WASTE WATER TREATMENT PLANT MASTER PLAN WILSONVILLE, OREGON	Northwest Geotech, Inc. An RMA Company	FIGURE NO. 2

DRILLING COMPANY: WESTERN STATES | RIG: GEO PROBE 8150 SONIC | DATE: 7/21/2023

BORING DIAMETER: 5 INCHES | DRIVE WEIGHT: 140 LBS | DROP: 30 INCHES | ELEVATION: ~108 FT



BORING LOG B-1

PROJECT NO. 00-231579-0	WILSONVILLE WASTE WATER TREATMENT PLANT MASTER PLAN WILSONVILLE, OREGON	FIGURE NO. 3 (1/2)

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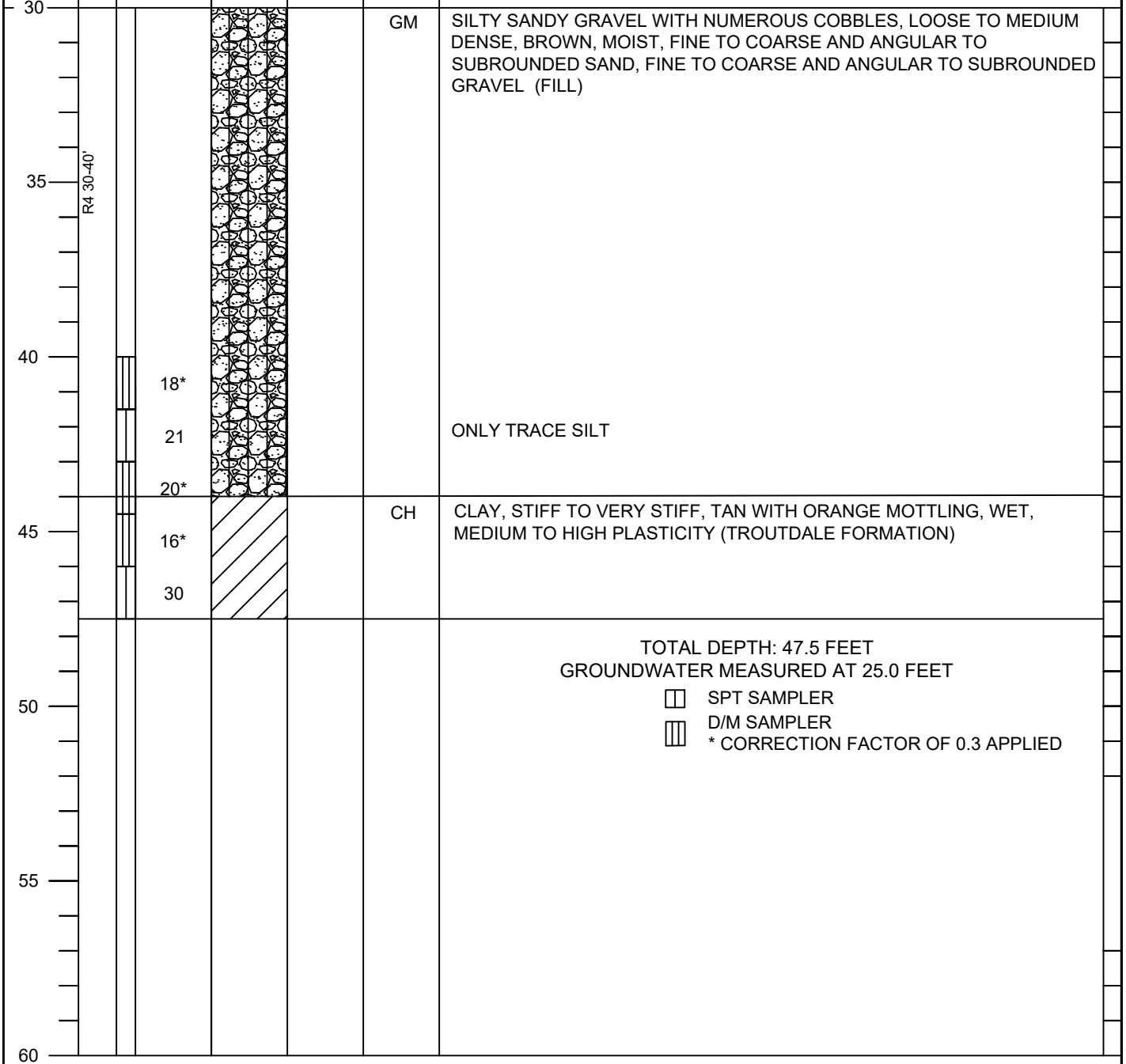
BORING DIAMETER: 5 INCHES | DRIVE WEIGHT: 140 LBS | DROP: 30 INCHES | ELEVATION: ~108 FT



BORING LOG B-1

PROJECT NO. 00-231579-0	WILSONVILLE WASTE WATER TREATMENT PLANT MASTER PLAN WILSONVILLE, OREGON	FIGURE NO. 3 (2/2)

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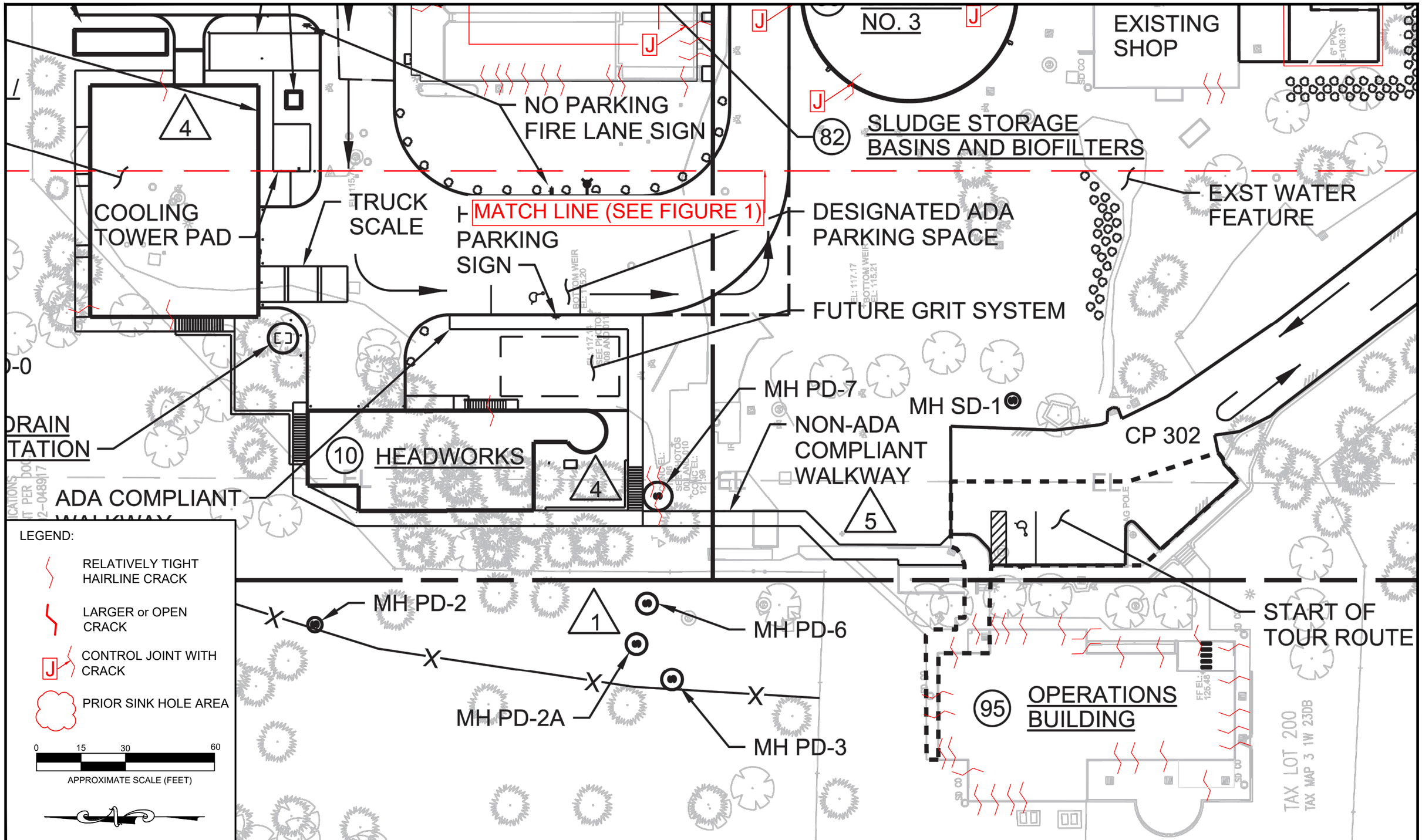
LEGEND:
- RELATIVELY TIGHT HAIRLINE CRACK
- LARGER or OPEN CRACK
- J — CONTROL JOINT WITH CRACK
- PRIOR SINK HOLE AREA

8
CH502
40
SECONDARY PROCESS FACILITY
CH501
STABILIZATION BASINS
FUTURE PAD
STAIRWAY
EXISTING PROCESS GALLERY
BLOWER CANOPY
9
TRANSFORMER
ODOR CONTROL PAD
GENERATOR
EXISTING SECONDARY CLARIFIER NO. 1
7
EXISTING SECONDARY CLARIFIER NO. 2
CH500
MH PD-8 FLOWMETER MANHOLE
PRIOR SINK HOLE AREA
MH PD-9
70
NO CRACKS OBSERVED
AREA NOT ACCESSIBLE
NO PARKING FIRE LANE SIGN
53
FLOW CONTROL STRUCTURE
6
2
50
SECONDARY CLARIFIER NO. 3
EXISTING SHOP
82
SLUDGE STORAGE BASINS AND BIOFILTERS
TAX LOT 100
TAX MAP 3 1W 23DB

0 15 30 60
APPROXIMATE SCALE (FEET)

PROJECT NO. 00-231579-0	VISUAL CRACK SURVEY	WILSONVILLE WASTE WATER TREATMENT PLANT MASTER PLAN WILSONVILLE, OREGON	Northwest Geotech, Inc. An RMA Company	FIGURE NO. 4 (1/2)



PROJECT NO. 00-231579-0	VISUAL CRACK SURVEY	WILSONVILLE WASTE WATER TREATMENT PLANT MASTER PLAN WILSONVILLE, OREGON	Northwest Geotech, Inc. An RMA Company	FIGURE NO. 4 (2/2)