GEOTECHNICAL REPORT

PROPOSED SINGLE FAMILY RESIDENCE
710 3RD AVENUE
OREGON CITY, OREGON

Prepared for:

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1.0 Introduction

Strata Design LLC (STRATA) has prepared this Report of Geotechnical Investigation for the proposed single family residence located at 710 3rd Avenue in Oregon City, Oregon (see Vicinity Map, Figure 1).

2.0 Scope of Work

Our study included a site reconnaissance, reviews of historical records and geologic maps, and this report of findings. From our evaluation of surface conditions, we provide geotechnical engineering recommendations for design and construction of the development. In general, our scope of work consisted of the following:

- Review prior exploratory test pit, soil classifications and laboratory analysis completed in nearby public data inventoried borings (where available).
- Provide geotechnical recommendations for slope stability, site preparation, stripping depths, utility trench excavation and backfill, wet/dry weather earthwork, fill type for imported materials, use of on-site soils, compaction criteria, and grading.
- Provide geotechnical engineering recommendations for design and construction of shallow spread foundations and floor slabs.
- Estimate settlement of foundations and floor slabs based on preliminarily assumed building design loadings.
- Provide recommendations for the Seismic Site Class, mapped maximum considered earthquake spectral response accelerations, site seismic coefficients, and Seismic Design Category.
- Provide a qualitative discussion of seismic hazards at the site, including liquefaction potential, slope instability, and surface rupture.
- Provide a written report summarizing the results of our Geotechnical Investigation.

3.0 Site and Subsurface Conditions

3.1 Existing Conditions and Proposed Development

The 0.11 acre site is moderately to steeply sloping. A review of historical aerial imagery available on Google Earth indicates the site has been vacant land since 1994, the year of the earliest image. The site is heavily vegetated with blackberries and native plants.

The proposed development consists of a two-story, single-family residence. Site improvements will also include a driveway, landscape retaining walls, and underground utilities.

3.2 Subsurface Conditions

Many attempts were made throughout the property to assess subsurface conditions using a hand auger. Due to rocky soil conditions, the hand auger borings encountered practical refusal within the highly organic, silty gravel, surficial top soil. Based on topographic expression, undocumented fill is likely present in the areas indicated on the Site Plan, Figure 2. Therefore, the exact depth of undocumented fill is unknown, but fill appeared likely to extend to depths of 3 to 4 feet.

Native soils are anticipated to be similar to those documented in nearby test pits from the geotechnical report on file for the lot subdivision located approximately 150 feet east of the subject site. Those test pits generally encountered medium dense, silty sand within the upper most 5 feet. Below 5 feet, nearby test pits either encountered cobbles and boulders up to 2 feet in diameter or medium dense silty sand with basalt fragments up to 12 inches in diameter.

3.3 Site Geology

Available geological mapping (Trimble[1]) indicates that the site is underlain by Columbia River Basalt. Ground water is mapped at a depth of about 20 feet below the ground surface (Snyder[2]).

The Oregon Department of Geology and Mineral Industries (DOGAMI) Statewide Landslide Information Layer of Oregon (SLIDO[3]) indicates the site is located within the toe of a large, complex, ancient landslide. It is our understanding that this designation is inferred by the presence of landslide morphology as shown on DOGAMI's bare earth lidar imagery.

4.0 Geotechnical Recommendations

4.1 General

The conclusions and recommendations presented in this report are based on the information provided to us, our assumptions of subsurface conditions bases on nearby subsurface data provided by others, and our professional judgment. STRATA should be consulted for further recommendations if the design and/or location of the proposed development changes, or variations and/or undesirable geotechnical conditions are encountered during site development. It should be anticipated that some unknown relict features (utilities, old fill, etc.) may exist beyond what we can reasonably ascertain by this field investigation.

4.2 Slope Stability

Following our review of lidar imagery, we believe the site is likely located at the toe of a large ancient landslide. There does not appear to be any evidence of recent slope instability in the immediate vicinity of the site. Observed site slopes are generally smooth and uniform, consistent with stable slope conditions.

Provided the recommendations of this report are incorporated into the design and construction of the project, planned site development are unlikely to adversely affect global slope stability. We assume that grading will be limited to excavations needed to construct the building's footings and other minor site grading. Permanent cut slopes should be planned no steeper than 2H:1V (Horizontal:Vertical). If significant amounts of fill are proposed, Strata should review the proposed grading plan.

4.3 Site Preparation

Any existing topsoil and vegetation should be stripped and removed from proposed improvement areas. The actual stripping depth should be based on field observations at the time of construction. Trees and shrub removal should include the removal of significant roots. Depending on the methods used to remove the roots, considerable disturbance and loosening of subgrade soils could occur. Disturbed soil should be removed to expose undisturbed, competent native soils. The resulting excavations should be backfilled with structural fill.

Any relic structures such as existing foundations, pavement and utilities should be removed from within

1 Trimble, D.E., 1963, Geology of Portland, Oregon and adjacent areas: U.S. Geological Survey Bulletin 1119, 119p., 1 plate, scale 1:62,500.

2 Snyder, D.T., 2008, Estimated Depth to Ground Water and Configuration of the Water Table in the Portland, Oregon Area: U.S. Geological Survey Scientific Investigations Report 2008–5059, 41 p., 3 plates.

3 SLIDO, maintained by the Oregon Department of Geology and Mineral Industries: http://www.gis.dogami.oregon.gov/maps/slido

the development area. Undocumented fill should be removed. Undocumented fill may be present in areas beyond those indicated on the Site Plan, Figure 2. Where encountered below settlement sensitive site improvements, undocumented fill will require removal to expose undisturbed, competent native subgrade soils. Excavations for removal of the structures, pavements, undocumented fill and underground effects should be properly backfilled with structural fill prior to development of the site.

4.4 Shallow Spread Foundations

Based on our understanding of the proposed development, shallow spread footings may be used to support column and perimeter structural loads provided they are founded on undisturbed, competent native soils or on properly placed and compacted structural fill that extends to this material. An allowable bearing capacity of 2,000 psf may be utilized in design. These bearing pressures are a net bearing pressure, and apply to the total of dead and long-term live loads. The allowable pressure used for design may be increased by a factor of 1.5 when considering seismic or wind loads.

It is necessary that foundations bear on competent native soils which have been field-verified by the geotechnical engineer during construction. If soft, loose, or otherwise unsuitable soils are encountered, over-excavation may be recommended to mitigate those soils. The resulting over-excavation should be brought back to grade with structural fill. Structural fill for footings should be constructed a minimum of 12 inches wider on each side of the footing for every vertical foot of over-excavation below the concrete footing base.

In accordance with building code, individual spread footings should be sized for a minimum width of 18 inches, and continuous wall footings have a minimum width of 12 inches. Excavations near footings should not extend within a 1H:1V plane projected out and down from the outside, bottom edge of the footings.

4.4.1 Settlement

Where utilizing shallow spread footings for the building foundations, we estimate that the structure will experience no more than 1 inch of total settlement and 3/4-inch of differential settlement under the assumed loading. This assumes that subgrade soils are verified in the field by the geotechnical professional as undisturbed, competent native soil.

4.4.2 Lateral Capacity

We recommend using a maximum passive (equivalent-fluid) earth pressure of 350 pounds per cubic foot (pcf) for design of footings confined by the imported granular structural fill pad that is placed and compacted during construction as recommended herein. The recommended earth pressure was computed using a factor of safety of 1.5, which is appropriate due to the amount of movement required to develop full passive resistance.

To develop the above capacity, concrete must be poured neat in the excavation or the perimeter of the foundation must be backfilled with imported granular structural fill, the adjacent grade must be level, and ground water must remain below the base of the foundation throughout the year. Adjacent development (e.g. slabs, pavements, etc.) and/or the upper 12-inches of adjacent unpaved, structural fill areas should not be considered when calculating passive resistance. An ultimate coefficient of friction equal to 0.45 may be used when calculating resistance to sliding for footings founded on the granular structural fill (crushed rock).

4.5 Floor Slabs

Satisfactory subgrade support for floor slabs constructed on grade, supporting up to 200 psf area loading, can be obtained from the undisturbed, competent native soil, or on properly placed and compacted structural fill that extends to this material. Where undocumented fill soils or otherwise unsuitable soils are encountered, they should be over-excavated as recommended by the geotechnical representative at the time of construction. The resulting over-excavation should be brought back to grade with structural fill.

Base rock material placed directly below the slab should have a maximum particle size of ¾-inch or less. For floor slabs constructed as recommended, a static modulus of subgrade reaction of 120 kips per cubic foot (kcf), or 240 kcf for dynamic modulus, is recommended for design. Floor slabs constructed as recommended will likely settle less than ½-inch. For general floor slab construction, slabs should be jointed around columns and walls to permit slabs and foundations to settle differentially.

The crushed rock base recommended may also serve as a capillary break in providing some protection against moisture intrusion. Ultimately, use of a vapor retarding membrane or other additional vapor barrier will be determined by the architect and/or owner. If a vapor retarder or vapor barrier is placed below the slab, its location should be based on current American Concrete Institute (ACI) guidelines, ACI 302 Guide for Concrete Floor and Slab Construction.

4.6 Structural Fill

Non-organic soils may be used as structural fill provided they are properly moisture conditioned for compaction. For clay and silt soils, this will require a significant period of dry weather. Gravels up to 4 inches in diameter may be used as structural fill, but larger material is unsuitable for reuse as structural fill.

Imported granular structural fill should consist of crushed rock that is fairly well graded between coarse and fine particle sizes. The granular fill should contain no organic matter, debris, or particles larger than 4 inches, and have less than 5 percent material passing the U.S. Standard No. 200 Sieve. For the footing base pads, the percentage of fines can be increased to 12 percent of the material passing the U.S. Standard No. 200 Sieve if placed during dry weather, and provided the fill material is moisture-conditioned, as necessary, for proper compaction. For fine grading purposes, the maximum particle size should be limited to no more than 1½ inches for granular fill placed under structural elements (footings, concrete slabs, etc.).

Structural fill should be placed in lifts with a maximum compacted thickness of about 12 inches. Structural backfill should be compacted to a minimum of 95 percent of the material's maximum dry density as determined in general accordance with ASTM D1557 (Modified Proctor).

4.7 Temporary Excavation and Shoring

We anticipate that temporary excavations can proceed using conventional equipment to the depths required for construction. Temporary excavations deeper than 4 feet must be sloped or shored. For planning purposes, soils encountered during construction are anticipated to be Type C soils which may be sloped as steep as 1.5H:1V.

It is recommended that heavy construction equipment, building materials, excavated soil, and vehicular traffic not be allowed within a distance equal to 1/3 of the slope height from the top of any excavation. Temporary excavations and cut slopes should be carefully evaluated and monitored by the contractor during construction based on actual observed soil conditions. Excavation slopes may require more layback in the extreme wet seasons and/or be covered with clear plastic sheets. The contractor shall be responsible for maintaining safe excavation slopes and/or shoring.

4.8 Utility Trenches

A permanent groundwater table was not observed in our exploration, however perched groundwater seepage may be present, particularly during the wet season. If seepage is encountered during construction, the stability of the trench may be undermined and the sidewalls should be flattened or shored. It is the contractor's responsibility to select the excavation and dewatering methods, to monitor the trench excavations for safety, and to provide any shoring required to protect personnel and adjacent improvements. All trench excavations should be in accordance with applicable OSHA and State regulations.

Trench backfill for the utility pipe base and pipe zone should be placed in accordance with the pipe manufacturer's recommendations. In the absence of manufacturer guidelines, it should be placed in maximum 10-inch-thick loose lifts, and compacted to not less than 90 percent of the material's maximum dry density, as determined in general accordance with ASTM D1557. Backfill above the pipe zone should be placed in maximum 10-inch-thick loose lifts, and compacted to not less than 92 percent of the material's maximum dry density in general accordance with ASTM D1557. Trench backfill within 3 feet of finished subgrade elevation should be placed in maximum 10-inch-thick loose lifts and compacted to not less than 95 percent of the material's maximum dry density as determined in general accordance with ASTM D1557.

4.9 Pavement Section

The following are general recommendations for typical on-site pavement applications. At the time of this report, specific design criteria regarding vehicle use, type, and frequency were unknown.

For areas of new construction, we recommend that geotextile fabric be placed over the prepared soil subgrade to maintain separation between the subgrade and imported aggregate. Geotextile material should conform to AASHTO M288 Class 2 application (non-woven geotextile), such as Geotex 701, Mirafi 180N, etc. Geotextile should be placed in conformance with OSSC 00350 (Geosynthetic Installation).

For areas of proposed AC, we recommend a minimum of 9 inches compacted thickness of 1½"-0 crushed aggregate base course underlying 3 inches of asphalt concrete. The crushed rock should have no more than 5 percent of the material passing the U.S. Standard No. 200 Sieve, and be compacted to not less than 95% of the modified Proctor maximum dry density (ASTM D1557). In our opinion, the recommended driveway section is suitable for support of emergency vehicles with a gross vehicular weight of 75,000 pounds, with point loads up to 12,500 pounds. For areas of proposed gravel driveways, we recommend 12 inches of compacted thickness of 1½"-0 crushed aggregate. The rock thickness may be reduced in areas of gravel yard depending on type of traffic and frequency of use.

4.10 Wet Weather Considerations

We recommend stabilizing the areas of the site experiencing heavily loaded construction traffic with a support layer of crushed rock with 3-inch or greater particle size. Silt fences, inlet protection, soil stockpile covers, etc., are required to reduce sediment transport during construction to acceptable levels. Measures to reduce erosion should be implemented in general accordance with project civil site plan and State, City, and County regulations regarding erosion control, where applicable.

4.11 Seismic Design Considerations

4.11.1 Liquefaction Hazards

In general, liquefaction occurs when deposits of loose/soft, saturated, cohesionless soils, generally sands and sandy-silts, are subjected to strong earthquake shaking. If these deposits cannot drain quickly enough, then the pore water pressures can increase and approach the value of the overburden pressure. When the pore water pressure increases to this value, the shear strength of the soil trends toward zero, causing a liquefiable condition. For fine-grained soils, susceptibility to liquefaction is evaluated based on penetration resistance and plasticity, among other characteristics. Coarse grained (sands, gravels) soils identified as susceptible to liquefaction are typically assessed based on penetration resistance. It is our opinion that there would be a relatively low risk of liquefaction-related hazards posed by the underlying native soils.

4.11.2 Seismic Design Parameters

Earthquake ground motion parameters for the site were obtained based on the USGS Seismic Design Values for Buildings - Ground Motion Parameter Calculator[4] via California's SEAOC/OSHPD (Structural Engineers Association of California / Office of Statewide Health Planning and Development) Seismic Design Maps Tool, using a soil Site Class D. The following table shows the seismic ground values for this design case based on the 2012 IBC.

Table 1: Seismic Ground Motion Values (2012/15 IBC, Site Class D)

Parameter		Value
Mapped Acceleration Parameters	Spectral Acceleration, 0.2 second (S_s)	0.934g
	Spectral Acceleration, 1.0 second (S_1)	0.403g
Site Coefficients	Site Coefficient, 0.2 sec. (F_A)	1.126
	Site Coefficient, 1.0 sec. (F_V)	1.597
Adjusted MCE Spectral Response Parameters	MCE Spectral Acceleration, 0.2 sec. (S_{MS})	1.052g
	MCE Spectral Acceleration, 1.0 sec. (S_{M1})	0.644g
Design Spectral Response Accelerations	Design Spectral Acceleration, 0.2 seconds (S_{DS})	0.701g
	Design Spectral Acceleration, 1.0 second (S_{D1})	0.429g

5.0 LIMITATIONS

We have provided current design recommendations based on prior site explorations that indicate the soil conditions at only those specific locations and only to the depths explored. These observations do not account for potential variations in soil types, thickness, or water level that may exist between or away from the explorations. If subsurface conditions vary from those encountered in our site exploration, STRATA should be alerted to the change in conditions so that we may provide additional recommendations, if necessary. Observation by experienced geotechnical personnel should be considered an integral part of the construction process. The owner is responsible for insuring that the project designers and contractors implement our recommendations. This study consisted of visual examinations and a review of readily available geologic resources judged pertinent to the evaluation. Accordingly, the limitations of this study must be recognized.

STRATA recommends that the geotechnical design review take place prior to releasing bid packets to contractors. We recommend that the geotechnical engineer or their representative be included in attending the project pre-construction meetings.

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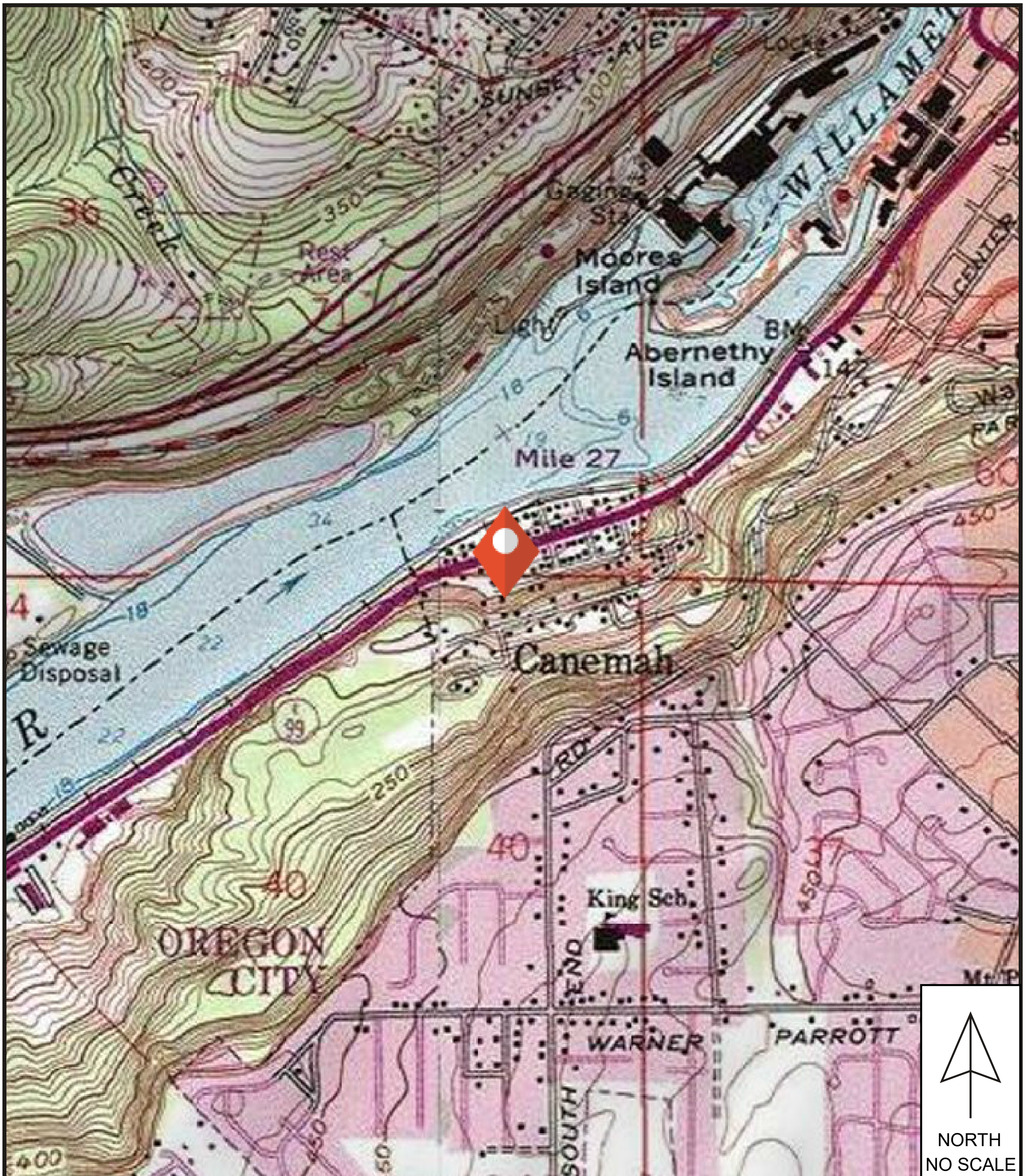
[4] United States Geological Survey, 2012. Seismic Design Parameters determined using:, "U.S. Seismic Design Maps Web Application - Version 3.0.1," from the website http://earthquake.usgs.gov/designmaps/us/application.php.

Sincerely,
STRATA DESIGN, LLC

Principal Engineer

Paul Rabay
Project Engineer

VICINITY MAP

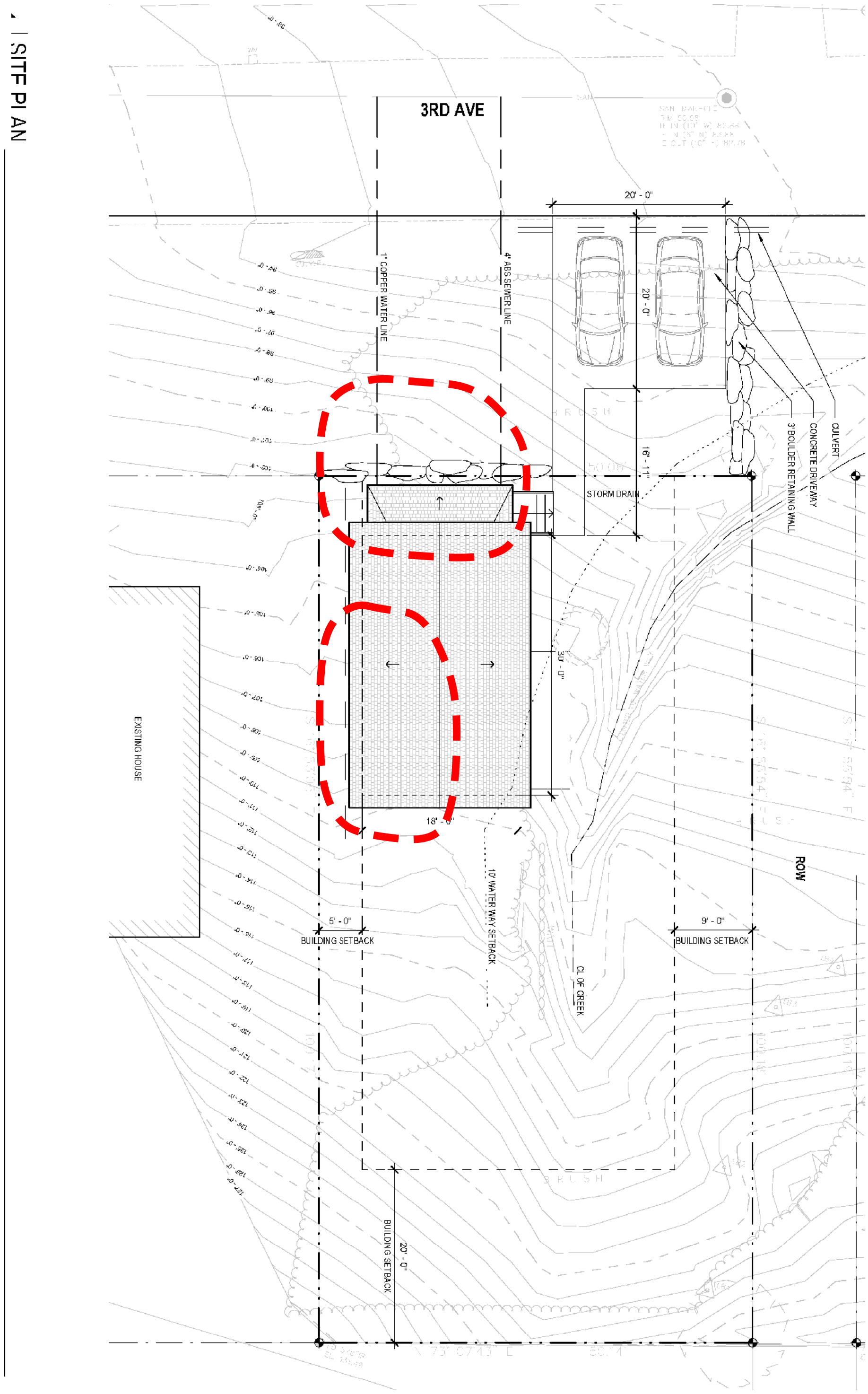


Project: 710 3rd Avenue
Oregon City, Oregon

FIGURE 1

STRATA DESIGN

SITE PLAN



Legend: Probable Extent of Undocumented Fill Based on Observed Topographic Expression

NORTH
NO SCALE

Project: 710 3rd Avenue
Oregon City, Oregon

Base map provided by Outside Architecture

FIGURE 2

STRATA DESIGN

FIG 3

Topography
2-ft and 10-ft Contour Map
710 3rd Ave - Canemah - Oregon City

Job #100.19-168 By: rsg
Version: 4/18/19

5 0 5 10 ft

Source: 2014 Lidar
from OR-DNR

NOTES:

BOUNDARY LINES SHOWN ARE APPROXIMATE, BASED ON COUNTY GIS MAPS.

CONTOURS ARE 2-FOOT INTERVALS, PROCESSED FROM 2014 METRO LIDAR SURVEY.